ADC-4
ANALOG TO DIGITAL CONVERTER

TECHNICAL REFERENCE

Click for more info: www.eeci.com/adc-4p.htm

PHONE.................. (937) 349-6000
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SPECIFICATIONS

Power Supply......................	9 to 14 volts DC (300MA)
Protocol for Serial Data I/O..	50 to 19,200 baud (defaults to 8 data bits, no parity & 1 or 2 stop bits) (sampling at a maximum of 850 samples per second single channel)
Resolution..........................	4 channels at 12 bit (providing 4,096 increments per channel) 8 channels at 8 or 10 bit with optional port #2 (256 or 1,024 increments)
Input Channels...................	4 analog channels (12 analog channels with optional port #2)
Expansion Capability..........	up to (112) relays (using EX-16 Relay Expansion cards) up to (128) status inputs (using ST-32 Status Expansion cards) or... up to (24) additional 8 or 10 bit analog inputs (using AD-16 Analog Expansion) up to (24) temperature inputs (using the /E and /F Temperature Input options)
Software Compatibility.........	All Windows operating systems, DOS and most other operating systems.
Hardware Compatibility.......	Typically this will be all computers that support serial communications, from the slowest 8086 to the fastest Quad core and newer.
Weight...............................	6 ounces
Size...................................	7 inches by 5 inches

TECHNICAL SUPPORT

Technical support for our products is available by calling (937) 349-6000. If a technical adviser is not available, please leave your name, phone number and a time that you can be reached. Your call will be returned as soon as possible and within 8 hours.

WARRANTY AND CARE OF THE ADC-4

The ADC-4 Analog to Digital Converter is warranted against factory defects for a period of 90 days from the date of purchase. The ADC-4 has proven to be extremely reliable in actual operation during field tests. We recommend that

the ADC-4 and associated hardware be installed in a suitable enclosure (4 mounting holes are provided on the circuit board) and that reasonable precautions be taken to protect the circuit from static discharge. The most likely damage to occur is that caused by lightning discharge through the power supply or serial I/O lines. The best way to prevent this type of damage is to install a Power Protector (Part # SP-120 or Surgebuster #120K15A) in the electrical outlet which supplies power to the hardware. Shielding the analog input lines will provide additional protection. If further protection is desired, install a TransZorb across the power input to the interface card (part #SP-12K) or you may add the /T option when ordering.

CONNECTION DIAGRAM

A D C - 4   A N A L O G   T O   D I G I T A L   C O N V E R T E R

10K

ANALOG INPUT PORT #1
to connect inputs 1 thru 4
(12 bit)

ANALOG INPUT PORT #2
to connect inputs 5 thru 12
(8 or 10 bit if installed)

RED

J4

J3

RED

RELAY EXPANSION PORT
connect up to (7) EX-16
expansion cards to control
up to 112 relays

RED

INPUT EXPANSION PORT
connect up to (4) ST-32
status expansion cards for
an additional (128) status
inputs or (1) AD-16 analog
expansion card for (16)
additional analog inputs

RED

ALL RIBBON CABLES MUST
BE INSTALLED WITH THE
KEY NOTCH POINTING
UP (red conductor should be
positioned as shown, see
illustration on page 16)

T R S - - +

ADC-4 TERMINAL BLOCK CONNECTIONS

(T) RS-232 Transmitter (connect to green wire)
(R) RS-232 Receiver (connect to white wire)
(S) (+) 12 volt control signal for use with RS-232 (connect to black wire)
(-) RS-232 signal ground (connect to red wire)
(-) Power supply (black wire)   (use caution, reversed polarity may
(+) Power supply (red wire)   cause damage, 9 to 14 volts DC only)

POWER SUPPLY REQUIREMENTS

The ADC-4 may be powered from any DC voltage source which will supply 300 ma within a voltage range of 9 to 14 volts. The recommend power supply for use with a single ADC-4 card is the PS-GP-1 (wall transformer supply). Use caution when connecting the power source, reversed polarity may cause damage.

The heat dissipation of the 7805 regulator on the ADC-4 will be greatly reduced with a 9 volt power source. The PS-9VDC-500 and PS-9VDC-1000 wall transformer power supplies may be used to power both the ADC-4 and expansion card(s). If 12 volt adapters are used, the 7812 regulator which is suppled with the power supply should be used to regulate voltage to the hardware (as shown on page 8). The PS-12VDC-500 and PS-12VDC-1000 are unregulated supplies and may produce voltages as high as 18 volts.

The 12 bit converter is sensitive to power supply noise and slow power-up (as a result of the on- chip microprocessor). See the section on the following page on ADC-4 power-up.

POWER SUPPLY FUSING: A 500 milliamp (.5 amp) in-line fuse should be installed in series with the (+) power supply lead to protect the power supply and the ADC-4 from damage (or order with the /T option).

SET UP AND TESTING

PLEASE TEST ALL YOUR HARDWARE FOR PROPER OPERATION UPON RECEIVING YOUR ORDER

(1) Connect the serial cable to COM1 of your computer and connect the other end to the ADC-4 as shown page 2. If you did not order a serial cable with your ADC-4, you may construct your own as shown on page 4. Connect the PS-GP-1 power supply to the (+) and (-) terminals on the ADC-4 terminal block and plug the power supply into a 120 VAC power source. Use caution not to set the ADC-4 card on a metal surface or the ADC-4 may be damaged. Connect a DB-9 socket with 6 wires attached to analog input port #1 (if port # 2 is installed, connect an RCT-8 terminal block). The ADC-4 is factory set for 19,200 baud which is the proper setting for use with the test software which is provided on CD.

(2) If your operating systems is Windows 95, 98, ME, or Windows 2000 you must use the Universal App on the installation CD for testing your ADC-4. Windows XP, Vista, Windows 7, Windows 8 and up users may install the .Net App* which uses the Microsoft .Net Framework. Click the install App button on the installation CD startup window or run setup.exe in the folder Windows Data Acquisition Program. If prompted about an older file, keep your newer file. Once installed, run the ADC-16 program. The program defaults to Com 1. Other Com ports may be selected if required.

*Please note that the Microsoft .Net Framework must be installed on your system. If the .Net Framework is not installed on your computer, the ADC-4 installation program will attempt to download and install the .Net Framework from the Microsoft web site through your internet connection. This may take 5 minutes or longer. In order for the .Net Framework to install correctly, your computer must be up to date with Windows update (Windows XP must have service pack 3 installed). This is especially important with Windows XP and Vista. You may update your computer by clicking on the start button, All Programs, Windows Update and clicking on "Check for Updates".

Your screen will show a row of 4 numbers. The top 4 numbers represent the analog inputs for port #1 (12 bit in 4,096 increments) and the bottom 8 numbers represent the analog inputs for port #2 (8 or 10 bit, 256 or 1,024 increments if installed). The numbers may be fluctuating as a result of noise on the analog inputs (this is normal). If the 12 bit analog inputs do not appear to be functional, reset the ADC-4 by removing power briefly (see below).

(3) Test each analog input by connecting each input (one at a time) to the reference (-) terminal on the DB-9 or RCT-8 (see page 5). Your screen should show a "0" for that input. After this is completed, connect each input (one at a time) to the reference (+). Your screen should show a "4095" for the 12 bit inputs, "1023" for 10 bit inputs or "255" for 8 bit inputs. If additional testing is desired, use a 20 turn 10K trimpot with the top terminal connected to reference (+), the bottom terminal connected to reference (-) and the middle (slider) terminal connected to the analog input. The input shown on the screen should increment from "0 to 4095" for 12 bit inputs, from "0 to 1023" for 10 bit inputs and from "0 to 255" for 8 bit inputs. The number on each input should increment by one as the trimpot is adjusted from 0 to 20 turns.

(4) If operation of the analog inputs are normal then testing is now complete and your ADC-4 may be placed in service. If problems are encountered during testing, proceed to page 5 for trouble-shooting procedures.

ADC-4 POWER-UP

Caution must be taken when suppling power to the ADC-4. The 12 bit converter has an on-chip microprocessor which is sensitive to power supply noise and low voltage power-up. The on-chip microprocessor may not "boot" properly if the power supply is noisy or if power is supplied too slowly. If the microprocessor does not "boot" properly, the 12 bit inputs may not function or may behave erratically. If you experience difficulty with the 12 bit inputs of the ADC-4 as a result of the microprocessor not booting properly, connect your power source as shown on the following page. The 2200 mf capacitor must be placed before the switch and fully charged before power is supplied to the ADC-4. Close the switch to power the ADC-4 and boot the 12 bit microprocessor.

CONNECTOR PIN-OUTS
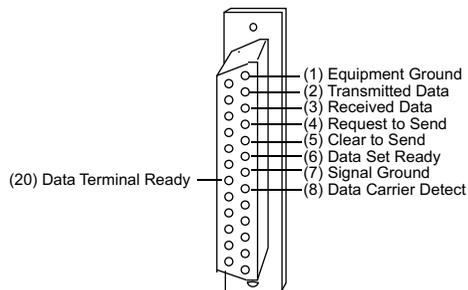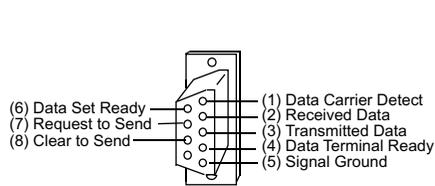
DB-9 CONNECTOR...SOCKET (female)
(rear view/solder side)

DB-9 Pins   Connection

(1)   Data Carrier Detect* (connect to black wire or terminal (S) on the ADC-4)
NOTE: This connection is not needed on most computers.

(2)   Received Data (connect to green wire or terminal (T) on the ADC-4)

(3)   Transmitted Data (connect to white wire or terminal (R) on the ADC-4)

(5)   Signal Ground (connect to red wire or terminal (-) on the ADC-4)
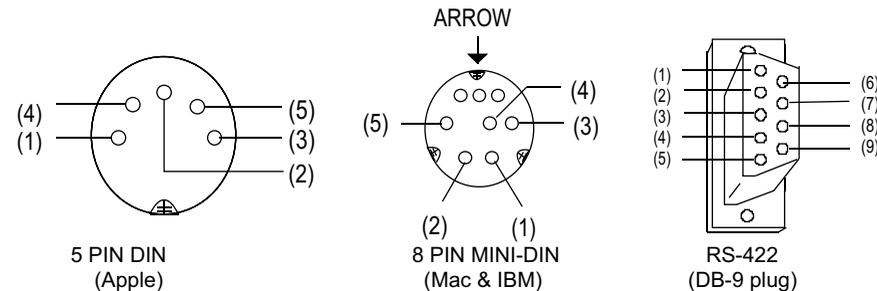
The following pins are optional and may be used as needed for specific applications.

(4)   Data Terminal Ready (DTR) output from your PC.

(6)   Data Set Ready (DSR) input to your PC.

(7)   Request To Send (RTS) output from your PC.

(8)   Clear To Send (CTS) input to your PC.

DB-25 CONNECTOR...SOCKET (female)
(rear view/solder side)

DB-25 Pins   Connection

(2)   Transmitted Data (connect to white wire or terminal (R) on the ADC-4)

(3)   Received Data (connect to green wire or terminal (T) on the ADC-4)

(7)   Signal Ground (connect to red wire or terminal (-) on the ADC-4)

(8)   Data Carrier Detect* (connect to black wire or terminal (S) on the ADC-4)
NOTE: This connection is not needed on most computers.

The following pins are optional and may be used as needed for specific applications.

(4)   Request to Send (RTS) output from your PC.

(5)   Clear to Send (CTS) input to your PC.

(6)   Data Set Ready (DSR) input to your PC.

(20) Data Terminal Ready (DTR) output from your PC.

ADDITIONAL CONNECTOR PIN-OUTS

5 PIN DIN
(Apple)

Pin #   Connection

(1) DTR
(2) Signal Ground
(3) DSR
(4) Transmitted Data
(5) Received Data

8 PIN MINI-DIN
(Mac & IBM)

Pin #   Connection

(1) DTR
(2) DSR, DCD & CTS
(3) Transmitted Data
(4) Signal Ground
(5) Received Data

RS-422
(DB-9 plug)

Pin #   Connection

(2) Transmitter (+)
(3) Equipment Ground
(4) Receiver (+)
(7) Transmitter (-)
(8) Receiver (-)

NOTE: The above connector illustrations are viewed from the rear (solder side).

RCT-8 TERMINAL BLOCK CONNECTIONS (8 & 10 BIT)   12 BIT DB-9 CONNECTIONS
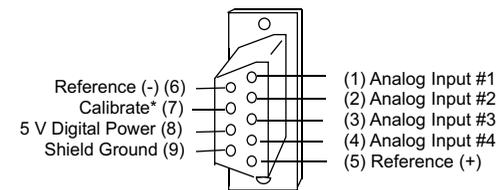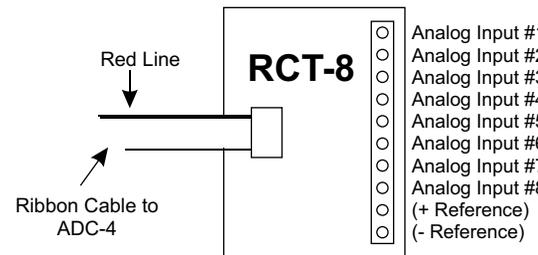
NOTE: The RCT-16 will have the same connections as two RCT-8

DB-9 SOCKET (female)
viewed from solder side (rear)
*see page 9

TROUBLE SHOOTING THE ADC-4

(1) Verify power to the ADC-4 by checking for a minimum of 9 volts DC at the terminal block and for 5 volts DC on the 2200 mf capacitor located above the terminal block (low voltage may indicate an overload). Also check for the correct polarity of the power. Verify that the ADC-4 is set to the same baud rate as what appears on the test software screen.

(2) Check the Com Port used with the ADC-4. Open device manager by clicking on the "Open Device Manager" button on your installation CD (or by going to control panel). Click the small triangle (or +) to the left of Ports to expand the Ports category, right click on the Com port that you have the ADC-4 connected to and click properties. Check the Com port status and verify that you have the test program set to this Com port and verify that you have the ADC-4 connected to this Com port.

If you are connecting the ADC-4 to a USB port, the Com port entry must be "Prolific USB to Serial Comm Port". Right click on this entry, click properties and open the Driver tab. Your USB Com driver must be Prolific version

3.4.62.293 or higher (dated 10/17/2013 or later). If your USB Com driver is not up to date, then right click the "Prolific USB to Serial Comm Port" entry and click update driver. If you do not see a "Prolific USB to Serial Comm Port" entry then the USB cable driver is not correctly installed. You may re-install the driver from the supplied CD or Windows Update. You may verify that you have the ADC-4 connected to this "Prolific USB to Serial Comm Port" entry by watching the entry and unplugging the ADC-4 USB cable from your computer. The entry should disappear and then re-appear when you re-connect the USB cable to the ADC-4.

(3) If erratic operation is experienced, check for loose connections at the ribbon cable connections and terminal block (tug on each wire going into the terminal block), check for power supply interruptions or short circuits caused by metal contact to the ADC-4 circuit areas or other connected hardware. When more than three EX-16 cards are connected to the ADC-16, an external power feed is required (see EX-16 manual).

NOTE: With some programming languages the semicolon (;) at the end of the command is used to suppress the carriage return and line feed. A line feed will transmit a "10" and a carriage return will transmit a "13".

(4) The input voltage to any of the analog inputs must not exceed the reference voltage (nor should the input go negative with respect to the reference) or erratic data may be generated on one or more of the analog channels. When an external reference is used, the reference voltage must be within 100 millivolts of the supply voltage to the A to D IC (approximately 5 volts DC) when operating in a MODE (2) jumper configuration (see page 11). When operating in a MODE (3) jumper configuration (8 bit only), the reference voltage must be a minimum of 1.2 volts and the reference voltage must be centered about the supply voltage to the ADC0809 IC. When operating in a MODE (3) jumper configuration, the input voltage to any of the analog inputs must not exceed the reference voltage (nor should the input go negative with respect to the reference) or erratic data may be generated on one or more of the analog channels.

If after checking thoroughly you are still unable to correct the problem, contact us at (349) 349-6000 for technical support.

CONNECTION OF THE ADC-4 DIRECTLY TO A MODEM

The ADC-4 may be connected directly to a modem at a remote location without the need for a PC at the remote site. The modem at the remote site is then considered DCE equipment (Data Communications Equipment) and requires that the serial transmitter and receiver lines be reversed (pins 2 & 3 on a DB-25 and DB-9) when connecting to the ADC-4. When the ADC-4 is connected directly to a computer, the computer is considered to be DTE equipment (Data Terminal Equipment) and the pin-outs shown on the preceding page are correct.

EXPANSION PORTS

The ADC-4 provides two expansion ports for additional I/O operations using a single COM port. The Relay Expansion Port allows up to (112) relays (or other output devices) to be controlled by software or keyboard input (using EX-16 relay expansion cards). Each EX-16 expansion card will provide control for 16 additional relays. A total of seven EX-16 expansion cards may be connected to the AR-16, ADC-4(8)(16) or STA-8(16). The first EX-16 expansion card is connected to the relay expansion port on the AR-16, ADC-4(8)(16) or STA-(8)(16) using the RC-20 ribbon cable. Additional EX-16 expansion cards connect to the preceding EX-16 with the RC-20 ribbon cable. The relay output ports on the EX-16 are identical to those on the AR-16 and accept the same relay cards and other accessories as the AR-16. Shunts on the EX-16 are used to select the relay output port desired. A variety of relay cards with various contact configurations are available for connection to the EX-16 expansion cards. Relays are controlled by transmitting a relay code (32 thru 255). Each relay is assigned 2 codes, one to energize the relay and the other to de-energize the relay. The relay code is determined by using the following formula: RELAY CODE = (RELAY # times 2) - 1...to energize the relay or RELAY CODE = (RELAY # times 2) - 2...to de-energize the relay. Additional information is provided with the EX-16 relay expansion card.

ADDING ADDITIONAL INPUTS

The Input Expansion Port allows up to (128) additional status inputs or (16) additional analog inputs to be connected (using up to (4) ST-32 status expansion cards or (1) AD-16 analog expansion card). Each ST-32 expansion card will provide an additional 32 status inputs. The first ST-32 card connects to the input expansion port on the ADC-4. Additional ST-32 cards connect to the preceding ST-32 card. One AD-16 analog expansion card can be connected to the ADC-4 in place of the ST-32 expansion cards to provide an additional 16 analog inputs. If more than 32 analog inputs are required, contact technical support for customized hardware. The software channel codes for the AD-16 analog inputs are 16 to 31. The additional analog inputs are identical to those described on pages 10, 11 & 12 for the ADC-4 and the software is handled in the same manner with the exception of the channel codes. The status inputs are read by transmitting a single byte status port code to the ADC-4. Transmitting a 16 would request information for the first 8 status inputs on the ST-32 status expansion card. The ADC-4 would then transmit a single byte number (each bit representing one status input). Additional information is provided with the ST-32 status expansion card.

For applications requiring more than 32 analog inputs/128 status inputs or applications requiring more than 112 relays, the PS-4 or PS-8 port selector may be used as a bank selector to select one bank of 32 analog inputs/128 status inputs and 112 relays. In this manner, up to 4,096 analog inputs or up to 16,384 status inputs may be connected and 14,336 relays may be controlled (128 banks times 112 relays and 128 status inputs or 32 analog inputs). An example of this method is shown on page 9 using four banks to provide 128 analog inputs and control of 448 relays.

BAUD RATE SELECTION FOR THE ADC-4

Select the desired baud rate by placing the removable shunts in the positions which correspond to the desired baud rate. All four of the shunts must be in place for the ADC-4 to operate properly. The default baud rate is 19,200.


EXAMPLE SHOWS 9,600
BAUD SELECTED

Bottom View
(solder side)
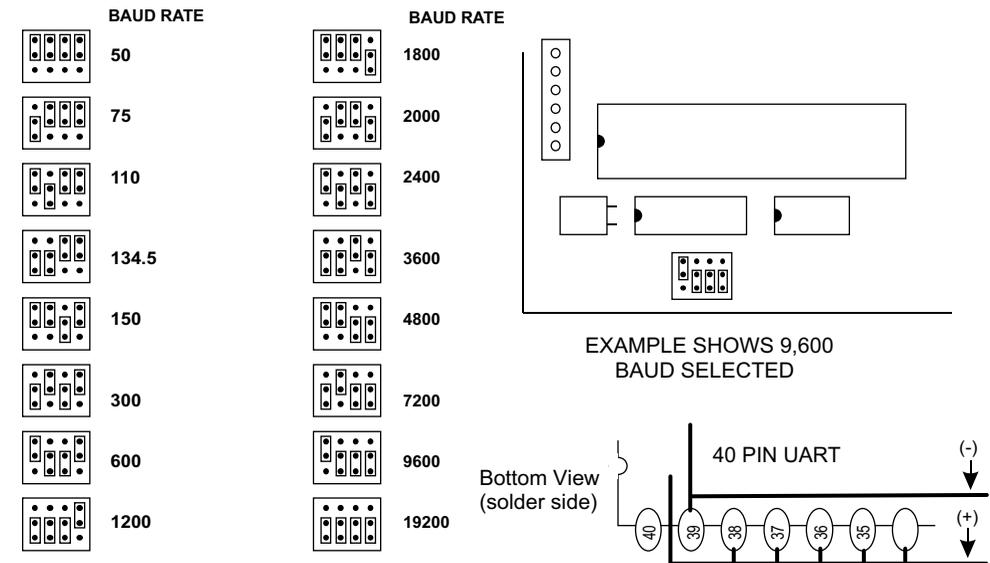
40 PIN UART

CHANGING PROTOCOL SETTINGS

PARITY, WORD LENGTH and STOP BITS: These functions are selected using pins 35, 36, 37, 38 and 39 on the 40 pin UART IC on the ADC-4 (shown above). Connect the pins to the (+) 5 volt or (-) ground power feed (located above and below pins 35 thru 39) to select the desired protocol (as shown in the chart on the following page). Be sure to cut the existing circuit trace using a knife (if different).

PIN 39 (EPE)	WLS1	WLS2	SBS (PINS 38, 37, 36)	PIN 35 (PI)
0 = Odd Parity	0	0	0 (5 data bits, 1 stop bit)	0 = Parity On
1 = Even parity	0	0	1 (5 data bits, 1.5 stop bits)	1 = Parity Off
	1	0	0 (6 data bits, 1 stop bit)	
	1	0	1 (6 data bits, 2 stop bits)	NOTE: 1=(+5 VDC), 0=(ground (-))
	0	1	0 (7 data bits, 1 stop bit)	All pins must be connected to 5 volts or
	0	1	1 (7 data bits, 2 stop bits)	ground. Do not allow any pins to float
	1	1	0 (8 data bits, 1 stop bit)	(pins left unconnected).
	1	1	1 (8 data bits, 2 stop bits)	

USE OF UNREGULATED WALL TRANSFORMERS

The PS-12VDC-1000 and PS-12VDC-500 power supplies are unregulated and may produce voltages substantially higher then the 12 volts DC that is labeled on the device. The 7805 regulator on the ADC-4 and any relays powered by the higher voltage may produce an excessive (and undesirable) amount of heat which may require additional air flow or ventilation to prevent overheating. Voltages over 14 volts DC may damage the Maxim IC on the ADC-4. The 7812 regulator (supplied with the power supply) may be used to regulate voltage to the ADC-4 and relay card(s). Connect the 7812 regulator as shown below:
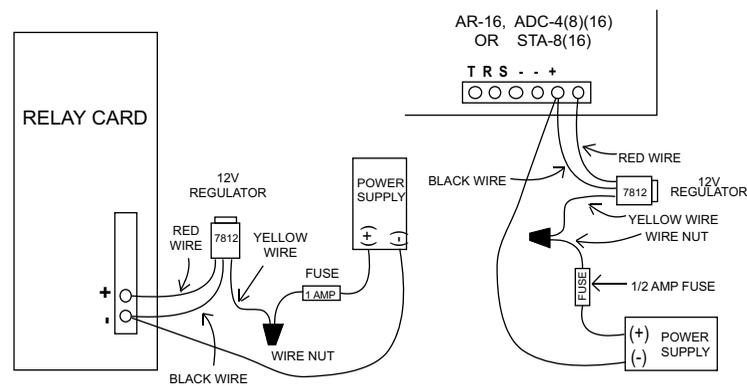
BLACK WIRE: connect to the (-) terminal on the ADC-4 and to the (-) wire coming from the power supply.

RED WIRE: connect to the (+) terminal on the ADC-4.

YELLOW WIRE: connect to the (+) wire coming from the power supply.

USE CAUTION: The metal tab on the regulator is electrically connected to the (-) wire (black). Before connecting the red & black wires to the ADC-4, check for 12 volts DC across the wires (red should equal (+)).

## VOLTAGE INPUT AMPLIFICATION AND SIGNAL CONDITIONING

Lower signal levels (such as the output signal from a watt transducer, pressure transducer, load cell, etc.) with typical full scale voltages of only 20 to 100 millivolts will require the addition of the VA-1 instrumentation amplifier. The VA-1 connects to any of the analog inputs and will convert a millivolt signal input to a 0 to 5 volt output for connection to the ADC-4. Signal levels this low will require shielded wire in place of a twisted pair. A gain adjustment on the VA-1 will set the input scale. The shield should be left disconnected at the source and grounded to an earth ground at the VA-1. Applications requiring an isolated analog input should use the VI-1I linear optocoupler instrumentation amplifier.

CONNECTION OF DIFFERENTIAL SIGNALS: The ADC-4 inputs are single-ended. If differential inputs are required, the VA-1 may be used to convert a differential signal into a 0 to 5 volt signal for connection to the ADC-4. The VA-1 has a reference input (for connection to the ADC-4 reference) which is used to generate a 2.5 volt offset. The gain adjustment on the VA-1 may be adjusted to allow for differential signals as low as (+) and (-) 5 millivolts or as high as (+) and (-) 5 volts.

ANALOG LINEAR OPTOCOUPLERS: The VI-1I or VI-8I linear optocoupler instrumentation amplifiers may be used when the analog input signal must be electrically isolated (such as with pressure transducers, ground referenced signals or for safety).

RS-422 INTERFACING AND RS-232 DISTANCE LIMITATIONS

The RS-232 interface will allow the AR-16, ADC-4(8)(16) or STA-8(16) interface cards to be located up to 50 feet from the computer using a single 2 or 3 conductor wire. When distances need to be greater, the RS-422/RS-423 and the RS-422A/RS-485 interfaces will allow the Interface card to be located up to 4,000 feet from the computer using a 1 or 2 paired communications cable (2 or 4 conductor/1 or 2 twisted pairs of wire). The PS-4 or PS-8 port selector may be used to select one port (1 of 4 or 1 of 8) to control up to 8 interface cards (ADC-16, STA-16 or AR-16) at various locations up to 4,000 feet from the port selector, providing up to 256 analog inputs, up to 1,152 status inputs and providing control of up to 1,024 relays. A total of up to (16) PS-8 port selectors may be connected to a single RS-232 port, allowing for a total of 4,096 analog inputs, 18,432 status inputs and 16,384 relays.
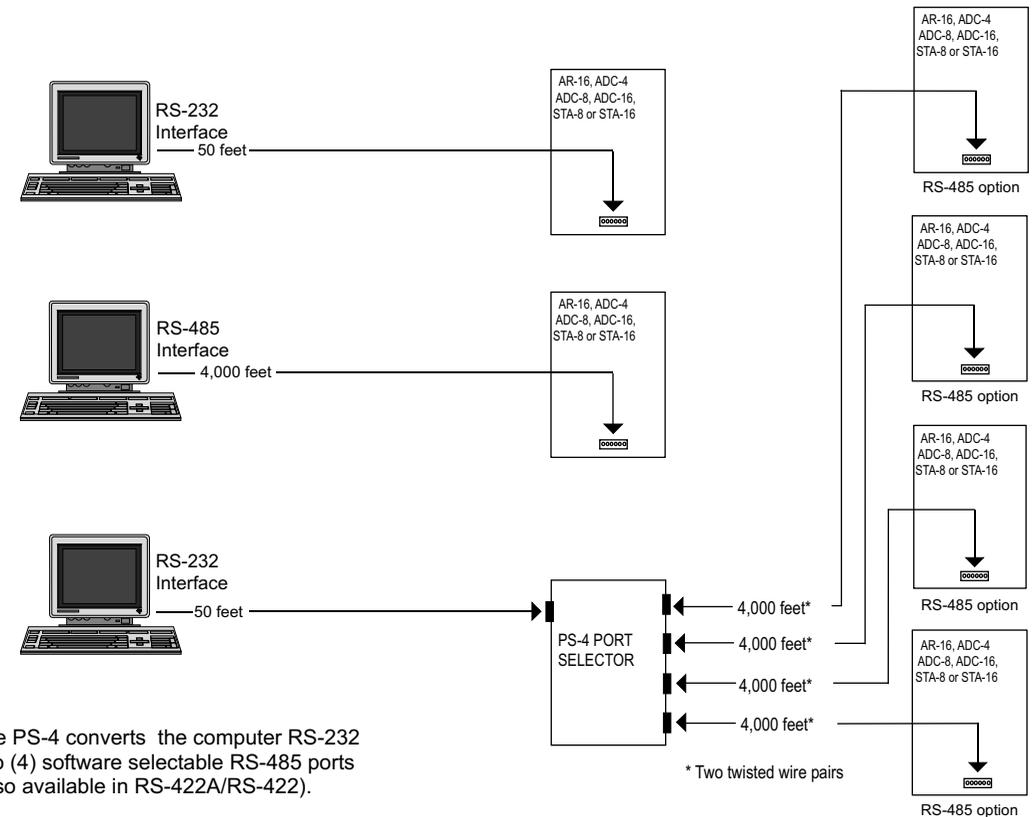
The PS-4 converts the computer RS-232 into (4) software selectable RS-485 ports (also available in RS-422A/RS-422).

* Two twisted wire pairs

CALIBRATION AND TRIMPOT ADJUSTMENT

The calibrate terminal (pin #7 on the DB-9) is not normally used. The 12 bit inputs are automatically calibrated upon power-up. The calibrate pin may be used to force an autocalibration cycle by installing a jumper on the ADC-4 to complete the circuit to pin 26 on the 28 pin A/D IC. An autocalibration cycle will be initiated with a low trigger pulse to the pin (momentary contact of DB-9 pin #7 to ground pin #9). An autocalibration cycle may be desired to improve the accuracy of the conversions if the ADC-4 has been operated for long periods of time without a power-up (over a period of months or years, performance may degrade without an autocalbration cycle).

Installed on the ADC-4 is a trimpot (two if port #2 is configured for temperature input). All trimpots are adjusted at

the factory and normally will not need adjustment. If the voltage at the reference terminals (DB-9 pins 5 & 6) are not at exactly 5.00 volts, you may adjust the voltage as follows: The top trimpot (10K) is used to adjust the reference voltage. Adjust this voltage for exactly 5.00 volts on DB-9 pins 5 & 6. The third trimpot is only installed if port #2 is configured for temperature input and is located above the relay expansion port. Adjust as described in the TE-8 reference manual.

COMMERCIAL USE OF THE ADC-4

When the ADC-4 is to be used in a commercial/industrial environment, additional action must be taken to insure long term reliability and trouble free operation of the hardware. In general, the most serious threat to the hardware will be electrical transients (most often caused by electrical storm activity). The following steps are strongly encouraged to protect the hardware and are listed in the order of highest priority:

(1) Install a voltage surge/spike protector in the 120 volt AC outlet which supplies power to the ADC-4 and to your hardware. Be sure that the electrical outlet has a third prong electrical ground and that it is correctly wired. Install TransZorbs on the power input to the ADC-4 or order the ADC-4 with the /T option.

(2) Install the ADC-4 (and any expansion cards) in a metal enclosure and ground the enclosure to a reliable earth ground (an electrical system ground using the third prong on an electrical outlet will usually be sufficient). Install a Transzorb across the power input to the ADC-4 (at the terminal block) and connect a Transzorb from the (-) terminal to the metal enclosure. An inline ½ amp fast-acting fuse should be installed prior to the transzorbs (the fuse will blow and prevent damage to the ADC-4 in the event of a major electrical surge). When the installation site is at higher elevations, in areas that are subject to increased electrical storm activity, the installation of gas-tube discharge devices and other action may be necessary (contact technical support for more information).

(3) Order the ADC-4/EX-16 with the /C Opto Isolator option. The opto isolators significantly reduce the possibility of voltage transients back-feeding to the EX-16 through the relay output lines. Care should be taken to prevent dust build-up on the printed circuit areas to prevent corrosion caused by condensation or airborne impurities.

(4) Power the ADC-4 from a 9 volt regulated DC power supply. The regulation will provide additional protection from voltage transients. A 9 volt power source will significantly reduce the heat produced by the ADC-4 and will also reduce the energy consumption of the ADC-4. If the ADC-4 is to be operated in elevated room temperatures (above 85° F), additional steps should be taken to reduce heating of the ADC-4. Install a larger heat sink on the ADC-4 regulator and install the ADC-4 in a larger metal enclosure.

12 BIT ANALOG INPUTS

The voltage input range on the 12 bit analog inputs is fixed at 0 to 5 volts DC and should not be adjusted to different voltages. For optimum accuracy, it is recommended that the reference voltage be maintained at exactly 5.00 volts DC (adjustable at the 10K trimpot).

When the analog inputs are used with ratiometric inputs (such as with potentiometer or position sensors, ratiometric transducers such as strain gauges, thermistor bridges, pressure transducers, etc.), both reference pins on the DB-9 are used (see pages 5 & 12). A 10K potentiometer is recommend for best noise immunity. Use two twisted pairs with shield when connecting the potentiometer or transducer to the DB-9 (connect ref. (+) & ref. (-) to one pair and the input & ref. (-) to the other pair). Connect unused inputs to ref. (-) and the shields to pin #9.

When the analog inputs are used for standard volt input, the reference (+) pin is not used and may be disconnected (if desired) by breaking the circuit on the ADC-4 where it merges near the 10K trimpot. The (-) side of the standard volt input should be connected to the DB-9 pin 6 (reference (-)) for all 4 channels. The (+) side of the standard volt input should connect to the desired input channel. The DB-9 cable should be no longer than necessary (to prevent noise and the resulting inaccuracy caused by the fluctuating input values). Shielded cable (a twisted pair plus shield) should be used when connecting the input to the transducer or sensing device. The twisted pair should be connected to the input and reference (-) pins on the DB-9 and the shield should be connected to the shield pin #9 on the DB-9.

8 BIT ANALOG VOLTAGE INPUTS

The analog voltage input must not be higher than power supply voltage for modes 1 and 2 or the rated voltage of the voltage reference device for mode 3. Voltages up to hundreds of volts may be divided down to the 5 volt range by using a simple resistance divider as shown on the following page (the signal source must be capable of driving a 1 ma load). To determine the value transmitted by the ADC-4 for a specific voltage applied to the divider circuit use the following formula: (VI divided by DF) times 51 = TV (where TV = transmitted value sent by the ADC-4, VI = voltage input to divider, DF = divider factor) DF = full scale voltage divided by 5 volts. EXAMPLE: 100 volts full scale divided by 5 = 20 = DF. A 60 volt input to the divider divided by 20 multiplied by 51 = 153 = TV, the value transmitted by the ADC-4.

8 BIT VOLTAGE REFERENCE INPUT

Each 8 channel analog input port has a separate voltage reference input and each port may be selected to function in any of the following three modes. Additional 8 or 10 bit analog ports may be added by connecting the AD-16 analog expansion card to the ADC-4.

MODE (1)..... Voltage reference equals power supply. With the factory jumpers installed, the reference (+) and reference (-) will be equal to the power supply voltage (5 volts and ground). With the jumpers installed, the voltage input scale will be 0 to 5 volts (plus or minus .2 volts, 20 millivolt resolution, 8 bit). The ADC-4 will then transmit (255)* with a 5 volt input, (0) for a 0 volt input, (128) for a 2.5 volt input and other values corresponding to the following formula:

voltage times (51) = X, where X = the integer value transmitted.

EXAMPLE: 1.9 volts times 51 = 96.9. The ADC-16 would then transmit (97) decimal (in binary) to represent a 1.9 volt analog input. The use of the power supply for the voltage reference will be adequate for most applications. MODE (1) is selected when both jumpers are installed (J1 and J2 for port #1, or J3 and J4 for port #2), all 8 channels of the analog port will then function in the MODE (1) configuration.

MODE (2)..... Voltage reference equals calibrated external voltage reference equal to power supply voltage. This method will provide a greater degree of accuracy for analog inputs which need to be referenced to the actual volt (use of the power supply for actual volt reference may introduce small errors due to variations in the power supply caused by activity of the ADC-4 functions). To select the MODE (2) configuration cut the (+) reference voltage jumper (J1 for port #1 or J3 for port #2). The jumpers to the (-) reference voltage should be left in place (J2 for port #1 or J4 for port #2). A calibrated voltage equal to the ADC-4 power supply (plus or minus .1 volt) should be applied to the voltage reference input (terminal #9 (+) and #10 (-) on the RCT-8). The voltage input may be any well regulated power supply which can be adjusted to the desired voltage without drift (for greater stability a temperature compensated power supply may be used). To determine the proper voltage, measure the ADC-4 power supply voltage on the 28 pin 0809 chip (pins #11 and #13). The resolution will be equal to the reference voltage input divided by 256. All 8 channels of the analog input port will then function in the MODE (2) configuration with J1 (port #1) or J3 (port #2) cut and the external voltage reference connected.

MODE (3)..... Adjusted voltage reference input. In this mode of operation the voltage input level may be adjusted to allow input of lower analog voltages (down to about 1.2 volts full scale). The MODE (3) configuration is selected by removing the voltage reference jumpers (J1 and J2 for port #1 or J3 and J4 for port #2) and installing a limiting resistor (3K

typical) in place of both jumpers. It is important that both resistors be installed because the reference voltage must be centered about the supply voltage of the 0809 chip. Conversion errors may occur (due to the design of the 0809 chip) if the center of the reference voltage is not equal to the center of the supply voltage (plus or minus .1 volt). The voltage reference device is then connected to the voltage reference input (terminal #9 (+) and #10 (-) on the RCT-8). The voltage reference may be soldered directly to pins #12 (+) and #16 (-) on the 0809 chip for greater stability. The voltage reference device may be a simple zener diode or LED for less critical applications (use (2) 180 ohm resisters in place of jumpers for LED). The use of a temperature compensated voltage reference will result in greater accuracy and less drift. You may contact our technical support staff for more information on the voltage references which we stock.

10 BIT ANALOG TO DIGITAL

The 10 bit option of the ADC-4 functions very similar to its 8 bit counterpart with the exception of the following:

(1) Input voltage range should be maintained at 0 to 5 volts DC (5.0 volts across the voltage reference inputs).

(2) The ADC-4 will transmit in two byte format as opposed to the single byte format of the 8 bit. The first byte received will be the most significant digits (all eight bits are used). The second byte received will be the least significant two digits (the first 6 bits will always be zero and are not used).

(3) The sampling rate of the 10 bit version will be half that of the 8 bit as a result of the two byte format of the 10 bit converter.
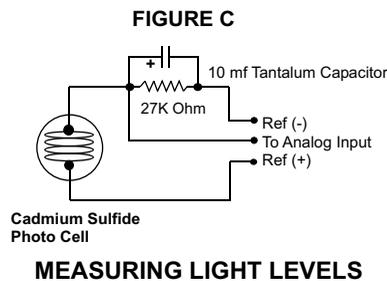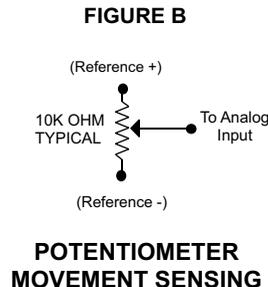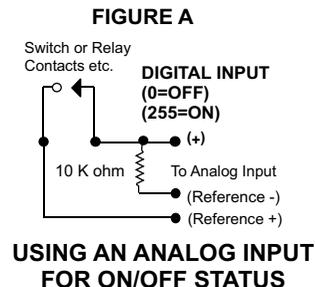
CONNECTING TO THE ADC-4 ANALOG INPUTS

The voltage input source may be located up to several hundred feet from the ADC-4. A DB-9 and the RCT-8, RCT-16 or RCP-8 are used to make the wire connections. The wire which connects the DB-9 to the signal source should be a twisted pair to reduce possible input noise (22 or 24 gauge communication cable typical). Shielded cable may be used to further protect against EMI or lightning noise (the shield should be left disconnected at the source and connected to an earth ground/equipment ground at the ADC-4). Always use shielded cable with the 12 bit analog inputs.
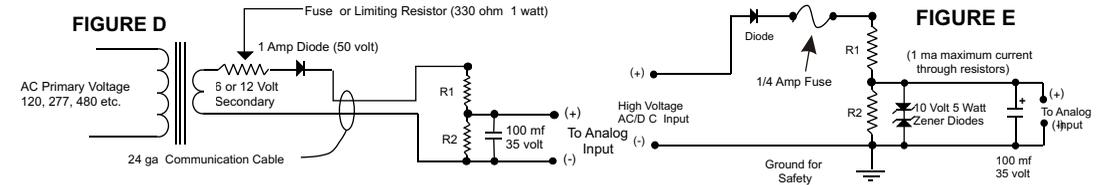
NOTE: When the analog inputs are left floating, (no connection) the ADC-4 will transmit fluctuating numbers as a result of noise present at the inputs. We recommend that any unused inputs be connected to reference (-) to prevent possible errors on other channels.

FILTERING INPUT NOISE: A .01 mf filter capacitor installed on the ADC-4 card (one for each channel) will significantly reduce errors and fluctuation as a result of input noise (if noise is a problem). Holes are provided on the ADC-4 for the installation of the .01 mf capacitors (specify part # CAP-16 to order a package of (16) .01 mf filter capacitors). A 2.7 mf or 10 mf tantalum capacitor may added for additional filtering (input response time will be slower).

Shown below in figures A, B & C are methods for reading contact closure, potentiometer movement & light levels.

FIGURE A

Switch or Relay Contacts etc.

DIGITAL INPUT (0=OFF) (255=ON)

10 K ohm — To Analog Input

(+)
(Reference -)
(Reference +)

USING AN ANALOG INPUT FOR ON/OFF STATUS

FIGURE B

(Reference +)

10K OHM TYPICAL — To Analog Input

(Reference -)

POTENTIOMETER MOVEMENT SENSING

FIGURE C

10 mf Tantalum Capacitor

27K Ohm

Ref (-)
To Analog Input
Ref (+)

Cadmium Sulfide Photo Cell

MEASURING LIGHT LEVELS

HIGH VOLTAGE INTERFACING

FIGURE D

Fuse or Limiting Resistor (330 ohm 1 watt)

1 Amp Diode (50 volt)

AC Primary Voltage 120, 277, 480 etc.

6 or 12 Volt Secondary

R1
R2
100 mf 35 volt

(+) To Analog Input (-)

24 ga Communication Cable

FIGURE E

Diode
R1
1/4 Amp Fuse
(1 ma maximum current through resistors)

(+)
High Voltage AC/D C Input
(-)

R2
10 Volt 5 Watt Zener Diodes

(+) To Analog Input (-)

100 mf 35 volt

Ground for Safety

CAUTION: When working with high voltages, the potential for fire, explosion, electrocution, eye injury or blindness and life threatening injuries or death exists. If you are not familiar with the precautions needed when working with high voltages, do not attempt to connect high voltage up to these circuits. To prevent the danger of a high voltage feeding back to the ADC-4 and the fire/injury/electrocution hazard caused by an open or short circuit, a 10 volt 5 watt zener diode and 1/4 amp fuse should be connected as shown in figure E. When connecting the ADC-4 to high voltage AC equipment the method shown in figure D above is recommended.

The following method is used to divide a high voltage down to the 5 volt range needed for input into the ADC-4. This method involves the use of two resistors (R1 and R2) which together add up to Rt (total resistance). The total resistance is determined by using the Ohms Law to compute the resistance needed for a 1 milliamp current flow through the resistors. EXAMPLE: If your full scale voltage is 100 volts (R = E divided by I) 100 volts divided by .001 amp = 100,000 ohms (100K ohm). To determine the proper ratio, divide 5 volts by the full scale voltage. 5 divided by 100 volts = .05. Multiple this ratio by the total resistance to determine the value of R2. R1 is then equal to the difference between the total resistance and R2. EXAMPLE: ratio .05 times total resistance 100,000 ohms = 5,000 ohms (the value of R2). Total resistance 100,000 ohms less R2 5,000 ohms = 95,000 ohms (the value of R1). To determine the power rating needed for the resistor, use the following formula: P = I squared times R. EXAMPLE: .001 squared = .000001 times R1 95,000 ohms = .095 watts. A 1/8 or 1/4 watt resistor would be sufficient. IMPORTANT: The full scale voltage used should be the highest possible voltage that could be present at the high voltage input.

AC voltages may be applied to the high voltage input if a diode is connected in series and a filter capacitor (100 mf, 35 volt typical) is connected between the ADC-4 analog input and the ADC-4 reference (-). AC voltages over 24 volts or great enough to create an electrical shock hazard or fire should be connected to the ADC-4 analog input using a step-down transformer to reduce the high voltage down to the 5 volt range as shown in figure D. A diode and filter capacitor must be connected on the secondary side of the transformer (a common low current power transformer may be used).

8 BIT CONTROL SOFTWARE

Analog information is transmitted from the ADC-4 upon receipt of a channel code which must be transmitted by the computer. The channel code is equal to the channel number - 1. To acquire the analog information on channel 1 the computer must first transmit a (0). Because of the delay which is required for the 0809 chip on the ADC-4 to make the conversion, the analog data transmitted will be for the previous channel requested. If information from just one analog input is desired, it will be necessary for the channel code to be transmitted twice. The data transmitted by the ADC-4 after the first transmission will be invalid. The following transmission by the ADC-4 will be the analog data on that channel at the time that the first channel code was received by the ADC-4. The data byte transmitted by the ADC-4 will be a binary number equal to 0 to 255 decimal (0 = 0 voltage at the analog input, 255 = full scale voltage, 128 = half scale voltage, etc.). The ADC-4 will only recognize channel codes 0 to 15 (or 0 to 31 with the AD-16 or ST-32 connected). The ADC-4 passes all higher codes to the EX-16 (if connected) for relay control functions.

12 BIT CONTROL SOFTWARE

The 12 bit control software is very similar to the 8 bit control software described above except that the data is transmitted in a two byte format. The MS byte is received first, of which only the first four LS bits are used. The LS byte is received second, of which all 8 bits are used. The typical sequence of events that occur during communication

with the 12 bit port of the ADC-4 is shown below. List the source code example for a better understanding of the sequence.

Analog information on the four 12 bit analog channels is acquired by transmitting and receiving (8) single byte codes in the correct sequence as shown:

TRANSMIT	RECEIVE	REMARKS	(all codes are decimal)
4	byte	This starts the conversion for channel 1 and selects the MS byte. The byte received will be the MS byte from the previous conversion for channel 4.	
0	byte	This selects the LS byte. The byte received will be the LS byte from the previous conversion for channel 4.	
5	byte	This starts the conversion for channel 2 and selects the MS byte. The byte received will be the MS byte from the previous conversion for channel 1.	
1	byte	This selects the LS byte. The byte received will be LS byte from the previous conversion for channel 1.	
6	byte	This starts the conversion for channel 3 and selects the MS byte. The byte received will be the MS byte from the previous conversion for channel 2.	
2	byte	This selects the LS byte. The byte received will be the LS byte from the previous conversion for channel 2.	
7	byte	This starts the conversion for channel 4 and selects the MS byte. The byte received will be the MS byte from the previous conversion for channel 3.	
3	byte	This selects the LS byte. The byte received will be LS byte from the previous conversion for channel 3.	

To continuously read the four 12 bit channels, repeat the above steps. If you are branching to a subroutine and wish to capture the data for just one read of the four channels, it will be necessary to transmit the last two bytes an additional time to receive the data on channel 4. To accomplish this, add the following to the data stream as shown below:

7	byte	This selects the MS byte. The byte received will be the MS byte from the previous conversion for channel 4.	
3	byte	This selects the LS byte. The byte received will be LS byte from the previous conversion for channel 4.	

PROGRAMMING EXAMPLES

The entire source code for the following examples along with the complete project code are provided on your installation CD along with source code examples in other programming languages. The programs are intended to demonstrate the fundamentals needed for development of your own software. The program examples may be copied to your program and used as a subroutine if desired.These examples will run in all versions of Visual Studio including Visual Studio Express. The installation CD will have source code examples used with Microsoft Visual Studio including Visual Basic, Visual C#,Visual C++ and ASP .Net. Additional source code examples are available in several other variations which may be more suitable for alternate programming languages (including interfacing to older DOS programs using GW Basic or QuickBasic if needed). Please contact EECI technical support for more information. Listed below is a software example that will run in GW Basic or QuickBasic. Program examples in GW Basic, QuickBasic, Visual Basic and Turbo C are provided on the disk supplied with your order.

PROGRAMMING EXAMPLES

VISUAL BASIC EXAMPLE (Microsoft Visual Studio)

```
'To open Com:

SerialPort1.PortName = "COM1"
SerialPort1.BaudRate = "9600"
SerialPort1.Open()

'To Transmit:

SerialPort1.Write(chr(XOut)) 'XOut is channel code

'To Receive:

XIn = SerialPort1.ReadByte 'XIn is analog data

'To Close Comm:

SerialPort1.Close()
```

C# EXAMPLE (Microsoft Visual Studio)

```
serialPort1.PortName = "Com1";
serialPort1.BaudRate = 9600;
serialPort1.Open();

//To Transmit:

serialPort1.Write(channelByte,0,1); //channelByte is channel code

//To Receive:

InByte[i] = serialPort1.ReadByte(); //InByte[i] is analog array

//To Close Comm:

serialPort1.Close();
```

SYSTEMS LEVEL PROGRAMMING CONSIDERATIONS

In Basic and other high level programming languages, the Line Status Register is automatically checked for incoming and outgoing bytes and handles the data flow as needed. When reading or writing to the COM port registers directly (such as in Assembly, C or using the OUT command in Basic), it will be necessary to check the Line Status Register before reading or writing the incoming or outgoing byte.

BEFORE TRANSMITTING.... check BIT 5 of the Line Status Register before sending byte (bit must be high)
BEFORE RECEIVING.... check BIT 0 of the Line Status Register before accepting byte (bit must be high)

I/O PORT REGISTER LOCATIONS FOR THE LINE STATUS REGISTER

COM 1	COM 2	COM 3	COM 4	
3FD	2FD	3ED	2ED	(hex values)

SYSTEMS LEVEL BAUD RATE SELECTION

The baud rate for IBM & compatibles may be selected by turning on the baud rate latch (bit 7 of the line control register) and setting the registers as shown to the right. Basic programmers may use the OPEN COM command to set the baud rate for COM 1 & 2 in place of this method. The baud rate and protocol for COM 3 & 4 should be selected from Basic by using the above procedure and the OUT command. An example is provided on the test disk using COM 3 & 4 from Basic.
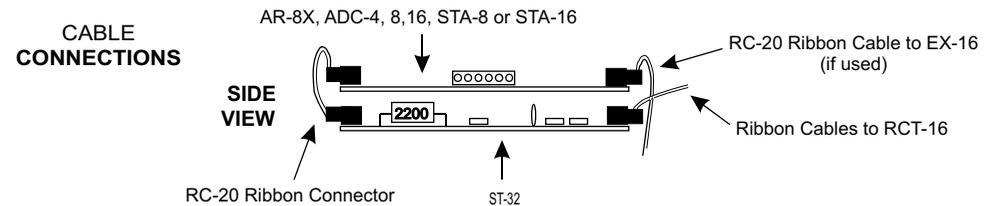
Baud Rate	MSB	LSB (decimal)
300	1	128
600	0	192
1200	0	96
9600	0	12
19200	0	6

Other standard baud rates may be selected by adjusting the given values. EXAMPLE: 4800 baud = 1/2 of 9600 = 24
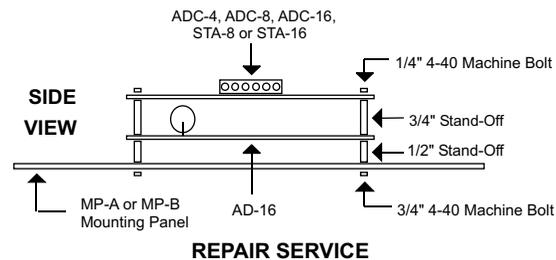
RACK MOUNTING

The ADC-4 may be rack mounted with any of the 5" by 7" cards in the CH series card holder racks. The CH-2 will hold up to (2) of the 5" by 7" cards, the CH-4 will hold up to (4) of the 5" by 7" cards and the CH-8 will hold up to (8) of the 5" by 7" cards. The interface card (AR-16, ADC-4/8/16 or STA-8/16) should be installed in the top slot of the card holder rack. The expansion cards (EX-16, ST-32 or AD-16) should be installed in the slots below the interface card. All ribbon connectors should be plugged in with the ribbon cable pointing up (see diagram). The RC-20 ribbon connector should be folded over at the top connector when connecting to the interface card or when connecting expansion cards to additional expansion cards. The use of an extended length RC-20 ribbon cable will be necessary when the AD-16 or ST-32 expansion cards are used with the EX-16 expansion cards (add one inch for each AD-16 or ST-32 card).

TYPICAL MOUNTING CONFIGURATION
(using the CH series card holder rack)

CABLE CONNECTIONS

AR-8X, ADC-4, 8,16, STA-8 or STA-16

SIDE VIEW

RC-20 Ribbon Cable to EX-16 (if used)

2200

Ribbon Cables to RCT-16

RC-20 Ribbon Connector   ST-32

MOUNTING A STAND ALONE UNIT...A single interface card may be mounted in an enclosure or on a metal mounting panel using the MT-1 stand-off mounting hardware. The ADC-4 will attach to the 4 stand-off spacers using 4-40 machine screws (4 mounting holes are provided on the ADC-4). The ADC-4 with an expansion card attached may be mounted in an enclosure or on a metal mounting panel using the MT-1 stand-off mounting hardware. The ADC-4 with an ST-32 or EX-16 will attach to the 4 stand-off spacers using 4-40 machine screws as shown below (4 mounting holes are provided on the ADC-4, ST-32 & EX-16). Contact technical support for more information on mounting panels and custom made distribution boards for use with the ADC-4, EX-16, AD-16 and ST-32.

ADC-4, ADC-8, ADC-16, STA-8 or STA-16

SIDE VIEW

1/4" 4-40 Machine Bolt

3/4" Stand-Off

1/2" Stand-Off

MP-A or MP-B Mounting Panel   AD-16   3/4" 4-40 Machine Bolt

REPAIR SERVICE

In the event that the ADC-4 is damaged from an inadvertent short circuit or other mishap, repair service is available through us by shipping your ADC-4 to the address on the rear of this manual. The charge for minor repair is $15.00 and takes about 3 business days (not including shipping).

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