

# ADC-4U15 ANALOG TO DIGITAL CONVERTER

TECHNICAL REFERENCE



Click for more info: [www.eeci.com/adc-4u15p.htm](http://www.eeci.com/adc-4u15p.htm)

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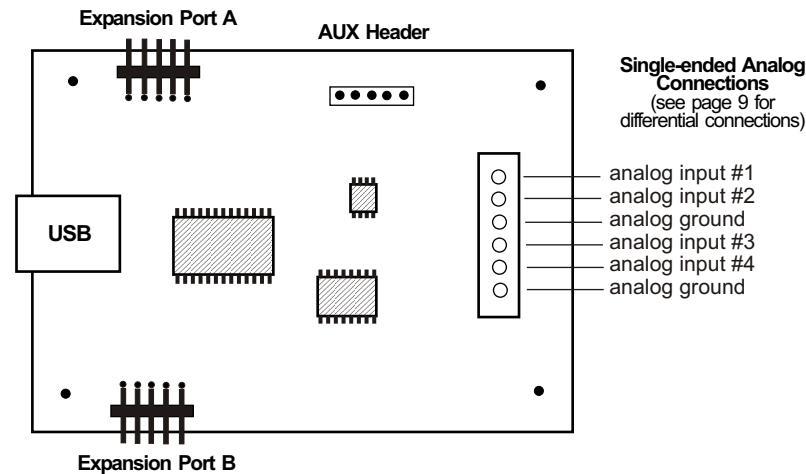
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## SPECIFICATIONS

Power Supply.....	5 volts DC - powered from USB port (USB version only)
Operating Temp. Range.....	-40° C to +85° C
Serial Data Protocol.....	75 to 6,000,000 baud - auto detect (defaults to 115,200 baud) Full duplex operation (data bits, parity, stop bits will auto detect)
Maximum Sampling Rate.....	100 samples per second or better
Analog Inputs.....	4 single-ended inputs (15 bit resolution) - no missing codes or 2 fully differential inputs (16 bit resolution) - no missing codes (15 bit resolution will divide your measurement range into 32,768 different increments) (16 bit resolution will divide your measurement range into 65,536 different increments)
Input Impedance.....	Common mode better than 6 mega ohm
Voltage Input Range.....	Selectable at: 0 to 256 millivolt, 0 to 512 millivolt, 0 to 1.02 volt, 0 to 2.05 volts, 0 to 4.1 volts and 0 to 6.1 volts (with 5 V max)* *the voltage resolution per increment can be determined by dividing one of the above reference voltages by 32,768 for 15 bit or by 65,536 for 16 bit.
Expansion Capability.....	expandable to control up to 144 relays/inputs (or combinations) using EX-8M, EXM-8, EXM-16 or EXM-32 Relay I/O Expansion Modules
Interface.....	USB (also available in WiFi version (ADC4-15WIFI), Ethernet version (ADC4-15FENET) RS-232 version (ADC4-15RS232) or RS-485 version (ADC4-15RS485))
Software Compatibility.....	Windows XP, Vista, Windows Server, Windows 7, Windows 8 and Windows 10 Windows 2000 and Windows ME using alternate software
Weight.....	.5 ounce
Size.....	1.875 inches by 2.5 inches      Please see page 12 for additional specifications.

## SET-UP AND TESTING

### CONNECTION DIAGRAM ADC-4U15 ANALOG TO DIGITAL CONVERTER



### DESCRIPTION

The ADC-4U15 Analog to Digital converters connect to any available USB port on your desktop or laptop PC (including some tablets and phones). Four analog inputs channels are provided for conversion to 15 bit digital format. The converters may be set to two channel fully differential mode with 16 bit resolution if required. Two optional expansion ports are available for connection of up to 16 relays, 16 status inputs or combinations of relays and inputs.

### 24 HOUR 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. Calls received during normal business hours are usually returned within minutes.

### WARRANTY AND CARE OF THE ADC-4U15

The ADC-4U15 Analog to Digital Converters are warranted against factory defects for a period of 90 days from the date of purchase. The ADC-4U15 has proven to be extremely reliable in actual operation during field tests. We recommend that the ADC-4U15 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.

Upon receiving your ADC-4U15, you should connect and test the operation of the hardware to verify proper operation. Please set-up and test the ADC-4U15 as follows (Windows XP\*, Vista, Windows Server 2008, 2012, Windows 7, 8 or later) \*service pack 3

(1) Connect your ADC-4U15 Analog to Digital converter to your computer USB port using a CC-USBB cable (1 to 10 foot). A high percentage of systems will already have a USB Com driver installed and this is indicated by a pop up balloon in the lower right side of your screen. The balloon message may automatically assign a com port to your ADC-4U15 and the com port assigned will be shown. If this occurs then make note of the com port for step 4 and go to step 2. The balloon message may also indicate that a driver has been located on your system and is being installed and after which a com port is assigned to the ADC-4U15. If this occurs then make note of the com port for step 4 and go to step 2.

The balloon message may request to search Windows Update for the correct driver. If you are connected to the Internet, you may click yes and allow the USB com driver to be installed and after which a com port is assigned to the ADC-4U15. If this occurs, then make note of the com port for step 4 and go to step 2.

With Windows XP, the "Found New Hardware Wizard" may pop up. If you have an Internet connection, allow the wizard to connect to Windows Update and install the USB com driver, then go to step 2.

If none of the above actions occur or if an error message is shown, you may install the USB Com driver\* from the supplied CD by clicking the "Install USB Com Driver" button in the CD start window. After the USB com driver is installed, disconnect your ADC-4U15 from the USB port, wait 5 seconds and plug back in. You may see a balloon message with the com port assigned to the ADC-4U15 (if not, you will find the com port assigned in step 2).

\*before installing a new USB com driver, go to Control Panel/Device Manager/Ports to check if a Prolific driver is shown (expand the category by clicking on the + or arrow). If you see a "Prolific USB to Serial Comm Port (COM-)" entry, the number to the right of COM is your com port. Right click on the entry, then properties, then the driver tab to check the version. If you have an out of date version and an Internet connection, click the "Update Driver" button to install the updated driver. Please note that it may be necessary to remove the outdated Prolific Com driver before the updated driver will correctly install (the supplied CD driver installation feature has a remove option - click Install Com Driver).

(2) Check your USB Com driver by going to Control Panel/Device Manager/Ports (see detail on the next page for your Windows version) or click the "Open Control Panel" button on the supplied CD start window. Click the small triangle (or +) to the left of Ports to expand the Ports category, right click the Prolific USB to Serial Comm Port, 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 up to date then please note the Com port number assigned and jump to step 3.

If your USB Com driver is not up to date, click the "Update Driver" button (under driver tab). If the driver does not update, disconnect the ADC-4U15 USB cable from your computer and install the updated USB Com driver (located on your ADC-4U15 CD from the start window, in the USB Com driver folder or from Windows Update). Please see detail\*

(3) After you have verified or installed an up to date USB Com driver, reconnect your ADC-4U15 Analog to Digital to any available USB port on your computer and insert the ADC-4U15 CD. Install the ADC-4U15 Software Interface\* by clicking the "Install Software Interface" button in the CD start window (if you have auto-start disabled, you may browse to the Windows Test Program folder and double click on setup.exe). A desktop icon for the ADC-4U15 will be created.

\*Please note that the Microsoft .Net Framework must be installed on your system. If the .Net Framework is not installed on your computer, the installation program (ADC-4U15 Software Interface) 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. 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".

After the installation is complete, a pop-up window will ask for the com port to be used with your ADC-4U15 Analog to Digital converter. Enter the com port found during steps 1 or 2 and click OK. Your screen should show a row of four numbers. The numbers may be random or fluctuating as a result of noise on the analog inputs (this is normal for floating or unconnected inputs). The default reference voltage is set to 4 volts (0 to 4 volt analog input range)

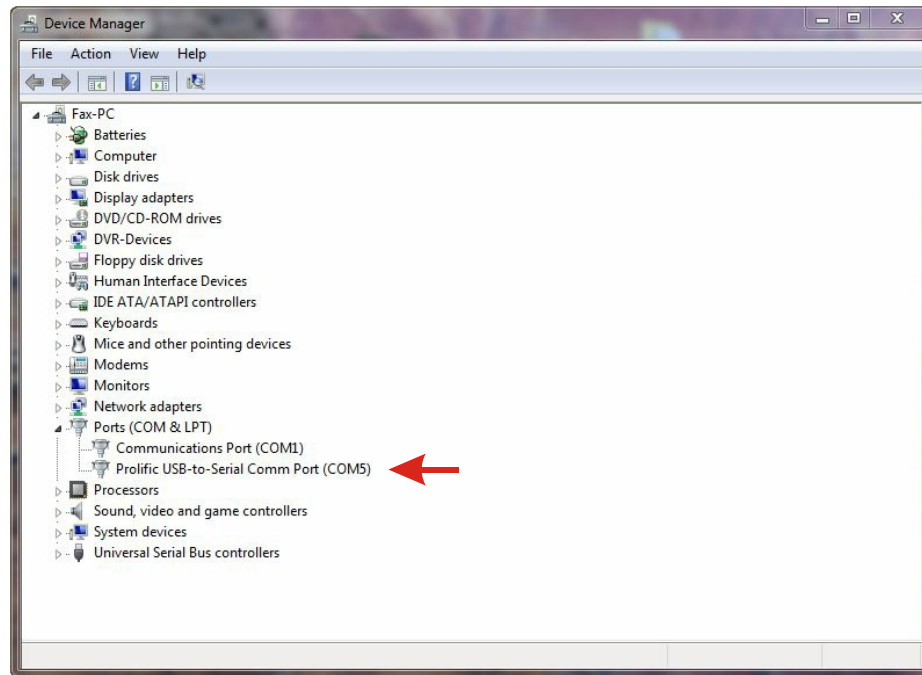
(4) Test each analog input by connecting each input (one at a time) to one of the GND (reference -) terminals. Your screen should show a "0" for that input. After this is completed, connect each input (one at a time) with 4 volts DC supplied between one of the GND (-) terminals and the analog input terminal (+). Your screen should show a "32,767" for 15 bit single ended inputs. If additional testing is desired, connect a 10k ohm 10 or 20 turn potentiometer to each input (one at a time) as shown on page 10, figure B. The input shown on the screen should increment from 0 to 32,767 (15 bit). The number shown for each input should increment by one (in 32,768 increments for 15 bit inputs) as the potentiometer is slowly adjusted from 0 to 20 turns. Differential inputs (16 bit) will increment from -32,768 to +32,767 in 65,536 increments.

(5) If operation of the analog inputs are normal, then testing is now complete and your ADC-4U15 may be placed in service. If problems are encountered during testing, proceed to the trouble-shooting procedures shown on page 5.

### HOW TO OPEN DEVICE MANAGER

#### Windows XP, VISTA or Windows 7

Click the Start Button (lower left of screen), then Control Panel (right side). With the view set to classic view, small or large icons, click (or double click) the Device Manager icon. With Windows XP you will need to click the System icon (in Control Panel) then the Hardware Tab then the Device Manager button. You may also use the supplied CD to open Device Manager by clicking the "Open Device Manager" button when the CD auto starts.



#### Windows 8, 8.1, 10 and Windows Server 2012

Move your mouse cursor to the lower right side of your screen and click on Settings. Click on Control Panel near the top and click on the Device Manager icon.

### TROUBLE-SHOOTING THE ADC-4U15

(1) Verify that your USB com driver is installed by going to Device Manager and checking for the Prolific USB to Serial Comm Port entry. Right click on the entry, then Properties, select the Driver tab and verify that the driver is dated 8/15/2014 or later. If the driver is out of date, connect to the Internet and click the Update Driver button. Please note that an out of date driver may allow the ADC-4U15 to partially function and/or with erratic operation.

(2) Verify that the Prolific USB to Serial Comm Port entry is the com port used by your ADC-4U15. You may do this by watching the entry in Device Manager and unplugging your ADC-4U15 from your computer USB port. The entry should disappear and then re-appear when you plug the ADC-4U15 back in to your computer USB port.

(3) Try replacing the USB cable and/or using a different USB port.

(4) Verify that the ADC-4U15 Software Interface is correctly installed and running. Click the blue 4 icon in your system tray (bottom right) and check for the correct com port setting (should show the correct com port open). If the window below the COM indicator shows "COM Not Found!" then a com port issue is the problem (check for another program that may be using the com port). You may right click the taskbar at the bottom of your screen, then Task Manager to view running applications (select the processes tab).

(5) Remove the ADC-4U15 USB cable from your computer, wait 5 seconds and plug back in. Open the ADC-4U15 Software Interface by clicking on the blue icon in your system tray and double click on the blue EECl logo to reset the com port. You should see a reset message followed by a COM open indication. Click Setup and uncheck "Allow External Commands". If this corrects the issue that you are experiencing then an external application is the problem.

(6) If erratic operation is experienced, check for loose connections at the terminal block (tug on each wire going into the terminal block), check for short circuits caused by metal contact to the ADC circuit areas or other connected hardware.

(7) 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 when not in differential mode) or erratic data may be generated on one or more of the analog channels.

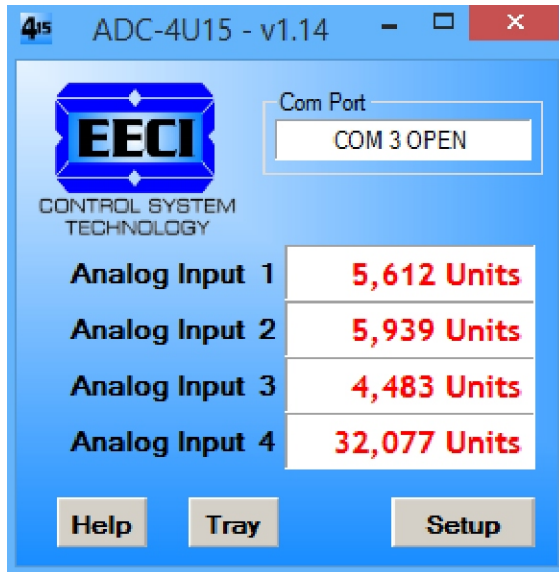
Please contact EECl Support at (800) 842-7714 or (937) 349-6000 if you require additional assistance or have questions.

### EXPANSION PORTS

The ADC-4U15 provides two expansion ports for additional I/O operations using the same COM port. The expansion ports may used to connect up to 16 relays (8 per expansion port) or to connect up to 16 inputs (or combinations of relays and inputs) using EX-8M expansion cards. The relay output ports on the EX-8M are identical to those on the AR-16, EX-16 and EX-32 and accept the same relay cards and other accessories as the AR-16. A variety of relay cards with various contact configurations are available for connection to the EX-8M expansion cards. A partial list of relay cards includes the RD-8, RD-8M, RG-8, RH-8, RI-8, RJ-8, RL-8, RN-8, RN-8M, RP-8 and RJ-8. The RYD-8 relay driver card may be used to control larger power relays, contactors, solenoids, valves or other devices. The DA-1 Digital to Analog converter may be used to output a 0 to 5 volt or a 0 to 10 volt analog level. For additional information on the EX-8M Expansion card, please refer the the EX-8M Technical Reference available on the EECl web site.

### USE OF THE ADC-4U15 WITHOUT THE MICROSOFT .NET FRAMEWORK

The ADC-4U15 may be used with older operating systems such as Windows 2000 and Windows ME. The Microsoft .Net Framework is not compatible with operating systems older than Windows XP so a different software interface is required for use with the ADC-4U15. Please contact EECl technical support for a download of the appropriate software interface.



## THE ADC-4U15 SOFTWARE INTERFACE

The ADC-4U15 Software Interface allows you to set all of the basic operating characteristics of the hardware and permits the ADC-4U15 to send and receive data from other Windows applications or programs that you create.

When the software interface is started for the first time you are prompted for the com port that is to be used with the ADC-4U15. This com port number is saved in the settings file "adc4U15-set.ini" which is created in the folder c:\eecI\adc-4U15. The interface will then start using the com port assigned. The com port indicator should have a "COM Open" message as shown to the left with the correct com port shown. The com port may be changed by clicking the Setup button and changing the com number in the Com Port window and clicking Apply.

Clicking the Setup button allows you to label the analog inputs for each of the 4 channels. The com port, baud rate and sampling rate settings are changed below. Checking the box for differential input will allow differential inputs to be connected to the terminal block

on the ADC-4U15 (display will change to two channel mode). The boxes for reference input allow you to set the desired voltage input range. Un-checking the Allow External Commands box will prevent other Windows applications from sending or receiving data from the ADC-4U15. The data logger may be enabled by checking the box in the data logger section and entering the desired time interval and file type information.

The ADC-4U15 Software Interface may be started in driver only mode by checking the Start Minimized box. Any changes made to Setup will not take effect until you click the Apply button. Clicking the Apply button saves the new settings to the adc4U15-set.ini file so that if the software interface is shut down, it will restart with all the new settings. Click the Tray button (driver only mode) to close the window after the ADC-4U15 Software Interface is set-up for your application. A blue 4 icon will appear in your system tray (click to re-open the software interface). The ADC-4U15 Software Interface may be left open when used as a stand alone data logger or if an external application is not used. The ADC-4U15 Software Interface may be completely shut down (and driver unloaded) by clicking the red X on the top right of the software interface. Once shut down, you will need to double click the ADC-4U15 desktop icon to re-start the ADC-4U15 Software Interface (or clicking the ADC-4U15 icon under All Programs in the EECI folder). The Help button will provide additional assistance if you installed the Tech Reference from the ADC-4U15 installation CD.

### AUTO START-UP FOR THE ADC-4U15 SOFTWARE INTERFACE

To automatically start the ADC-4U15 software interface, copy your ADC-4U15 desktop icon (right click) and paste in your computer Startup folder. In Windows XP up through Windows 7, the start-up folder is located by clicking your Start button and clicking on All Programs then scrolling down to the Startup folder. In Windows 8 and 8.1, move your cursor to the lower right of your screen and then click on Search. In Search, scroll all the way right and click "run" (under Windows System). Enter "shell:startup" (no quotes) and click OK. Your computer will start up normally with the ADC-4U15 Software Interface running and shown in your system tray. You may also place your own application in the start-up folder to boot directly to your application (set the ADC-4U15 Software Interface to start minimized).

## THE ADC-4U15 DATA LOGGER

The ADC-4U15 Software Interface provides a data logger function that will save analog input readings to a file at preset time intervals. Scale and offset values may be factored into the recorded data event along with an input label by entering the desired values at the setup screen by clicking the Analog Setup button. The ADC-4U15 data logger may be used stand alone if an external application is not used. The file output format may be set to plain text, CSV or text delimited formats and may be imported into database or spreadsheet applications if required. The data log interval may be set to seconds or minutes by clicking the button to the right of the setting. A suffix may be added to the logged value (such as PSI, Volts, °, etc.). Extended ASCII characters may be added by holding down the alt key and entering the ASCII code on your keyboard keypad. Example: to display a degree symbol, hold down the alt key and enter 248 on your keypad. The precision setting allows you to log your data in integer only, tenth, hundredth, thousandth or auto select.

### PROGRAMMING EXAMPLES

#### VISUAL BASIC EXAMPLE (Microsoft Visual Studio)

To use these example, copy the code module (supplied on your CD) to a sub called readInputs(). From the toolbox, drag (4) labels and a timer control to your form. Insert the following code into the timer sub. The (4) ADC-4U15 analog inputs are displayed in labels 1 through 4.

```
Private Sub Timer1_Tick(sender As Object, e As EventArgs) Handles Timer1.Tick
```

```
readInputs() 'collect analog inputs
```

```
For W = 1 To 4
```

```
MyLabelArray(W).Text = inputByte(W)
Next W
```

```
End Sub
```

#### VISUAL C# EXAMPLE (Microsoft Visual Studio)

```
private void timer1_Tick(object sender, EventArgs e)
{
    ReadInputs();

    for (int i = 1; i < 5; i++)
    {
        MyLabelArray[i].Text = inputByte[i].ToString();
    }
}
```

The entire source code program examples and the complete project code are provided on your installation CD along with additional 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 examples in all the programming languages 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. Please contact EECI technical support for more information.

## VOLTAGE REFERENCE INPUT

The ADC-4U15 allows for several different reference voltage configurations. The reference voltage determines the voltage input range for all (4) analog input channels or (2) channels in differential mode. The following configurations are selectable from the setup page of the ADC-4U15. Option 1 is the default setting.

- Option 1: 4.096 volt - allows a (0 to 4.1) volt input range ((4) channel single ended)  
allows a (-4.1 to +4.1) volt input range ((2) channel fully differential)
- Option 2: 5 volt - allows a (0 to 5 volt) input range or (-5 to +5) in differential mode  
(4) channel single ended or (2) channel fully differential
- Option 3: 2 volt - allows a (0 to 2) volt input range or (-2 to +2) in differential mode  
(4) channel single ended or (2) channel fully differential
- Option 4: 1 volt - allows a (0 to 1) volt input range or (-1 to +1) volts in differential mode  
(4) channel single ended or (2) channel fully differential
- Option 5: .5 volt - allows a (0 to .5) volt input range or (-.5 to +.5) volts in differential mode  
(4) channel single ended or (2) channel fully differential
- Option 6: .25 volt - allows a (0 to .25) volt input range or (-.25 to +.25) volts in differential mode  
(4) channel single ended or (2) channel fully differential

## SINGLE ENDED ANALOG VOLTAGE INPUTS

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 for a specific voltage applied to the divider circuit use the following formula:  $(VI \text{ divided by } DF) \times 51 = TV$  (where TV = transmitted value sent by the ADC, 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 (8 bit).

The voltage input source may be located up to several hundred feet from the ADC. The wire which connects the ADC to the signal source should be a twisted pair to reduce possible input noise (22 or 24 gauge communication cable or CAT5 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).

Lower millivolt signal levels (such as the output signals 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, VA-2, VA-4 or VA-8 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 input into the ADC. Signal levels this low will may require shielded cable to reduce noise. An 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 isolated analog inputs require the VI-8I linear opto isolated amplifier.

**NOTE:** When the analog inputs are left floating, (no connection) the ADC will transmit fluctuating numbers as a result of noise present at the inputs. We recommend that any unused inputs be connected to GND (reference (-)) to prevent possible errors on other channels (differential inputs should have both inputs shorted together).

**FILTERING INPUT NOISE:** A .1 uf filter capacitor is installed on the ADC card (one for each channel) which significantly reduces errors and fluctuation as a result of input noise. A 2.7 mf or 10 mf tantalum capacitor may added for additional filtering (input response time will be slower).

Shown on the following pages in figures A, B & C are methods for reading contact closure, potentiometer movement & light levels.

## VOLTAGE INPUT AMPLIFICATION AND SIGNAL CONDITIONING

The ADC-4U15 defaults to a 0 to 4 volt input range (setup allows input ranges as low as 0 to .25 volts). When the input voltage range is required to be lower, (such as with a watt transducer or load cell) an external instrumentation amplifier must be used to amplify the input signal to the 0 to 4 volt input range of the ADC.

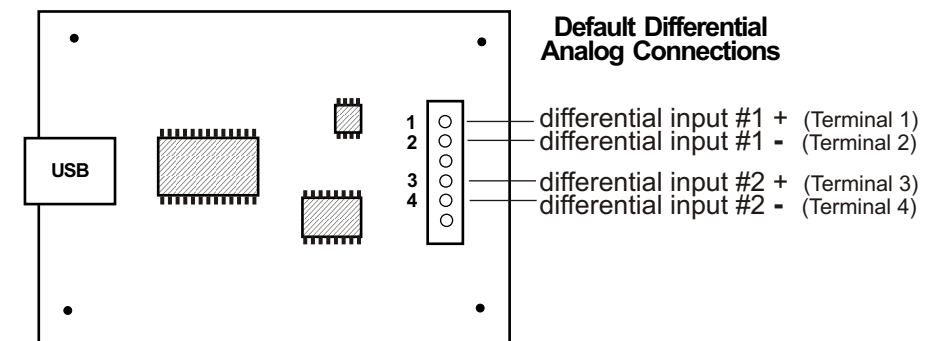
Several general purpose instrumentation amplifiers are available to amplify lower signal levels to the 0 to 4 volt range required by the ADC (for use with 8, 10 and 12 bit inputs). The VA-1 is a single channel amplifier for connection to the ADC-4U15, ADC-8U or ADC-12U. The VA-2, VA-4 and VA-8 amplifiers are two, four and eight channel versions of the VA-1. The VA-1, VA-2, VA-4 and VA-8 all provide 15 turn potentiometer(s) for gain adjustment (amplification level). The amplification level is adjusted for a 0 to 100 millivolt input at the factory. The amplification level may adjusted for signal inputs as low as 0 to 5 millivolts or as high as 0 to 5 volts. 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 when connecting to the ADC. Signal levels this low may require shielded twisted pair wire. The shield should be left disconnected at the source and grounded to an earth electrical ground at the VA-1.

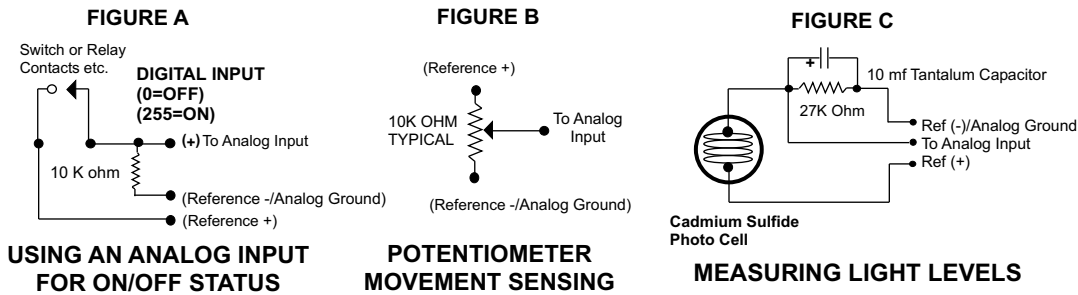
**CONNECTION OF DIFFERENTIAL SIGNALS TO THE VA-1:** If low level differential inputs are required, the VA-1 may be used to convert a differential signal into a 0 to 5 volt signal for connection to the ADC. The VA series amplifiers have a reference input (for connection to the ADC reference) which is used to generate a 2.5 volt offset (adjustable). The gain adjustment on the VA series amplifiers may be adjusted to allow for differential signals as low as (+) and (-) 5 millivolts or as high as (+) and (-) 5 volts. Using the VA-1 will allow the use of all 4 single ended inputs on the ADC-4U15 since the low level differential input to the VA-1 is converted to a single ended signal for connection to the ADC-4U15.

## DIFFERENTIAL ANALOG INPUTS

The ADC-4U15 may be set to accept (2) fully differential inputs in place of the (4) single ended inputs. The differential voltage input range is determined by the reference setting as shown on the previous page. The differential input signal connects to terminals 1 and 2 for differential channel 1 and terminals 3 and 4 for differential channel 2. The GND terminal connections are not used.

## DIFFERENTIAL ANALOG INPUT TERMINAL BLOCK CONNECTIONS

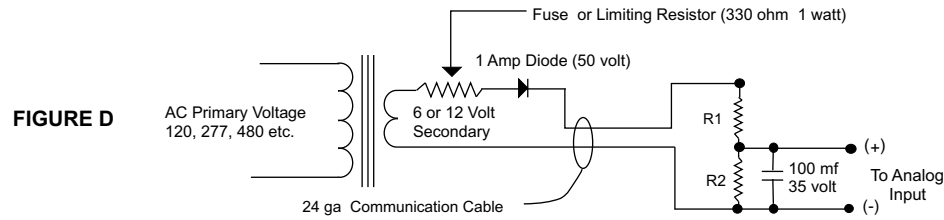




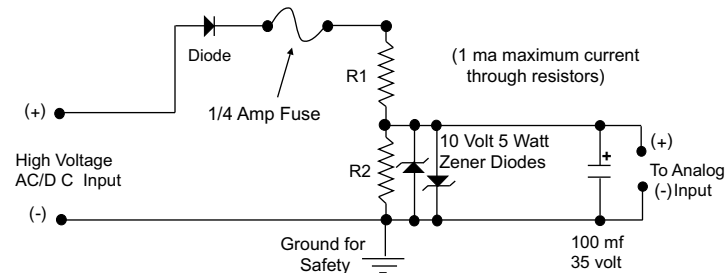
**USING AN ANALOG INPUT FOR ON/OFF STATUS**

**POTENTIOMETER MOVEMENT SENSING**

**MEASURING LIGHT LEVELS**



**FIGURE D**



**FIGURE E**

**HIGH VOLTAGE INTERFACING**

**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 and the fire/injury/electrocution hazard caused by an open or short circuit, 10 volt 2 watt zener diodes and a 1/4 amp fuse should be connected as shown in figure E. Wire used to interconnect a high voltage input must be rated for use with the higher voltage. When connecting the ADC to high voltage AC equipment the method shown in figure D above is recommended.

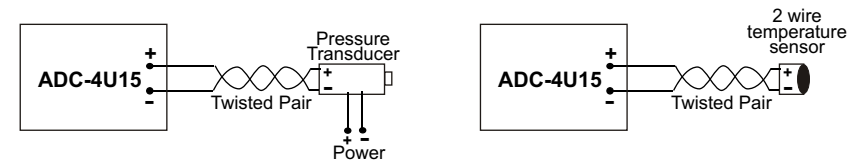
The following method is used to divide a high voltage down to the 5 volt range needed for input into the ADC. This method involves the use of two resistors (R1 and R2) which together add up to Rt (total resistance). The total resistance is determined by using the Ohms Law to compute the resistance needed 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. Multiply 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 analog input and the ADC reference (-). AC voltages over 24 volts or great enough to create an electrical shock hazard or fire should be connected to the ADC 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).

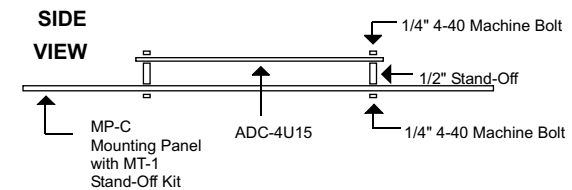
**CONNECTING SENSORS TO THE ADC-4U15**

A large variety of sensors, transducers, load cells and other devices that provide an analog output may be connected to the ADC-4U15. Most types of sensors may be located up to 1,000 feet from the ADC-4U15. Pull up resistors may be installed on the underside of the ADC-4U15 for 2 wire sensors that receive power from the USB port. The cable used to connect sensors to the ADC-4U15 should be twisted pair or shielded twisted pair to suppress environmental noise. Low cost CAT 5 cable works well when multiple sensors are in the same location.



**MOUNTING**

The ADC-4U15 Analog to Digital card may be mounted in an enclosure (part # EN-C or EN-D) or on a metal mounting panel using the MT-1 stand-off mounting hardware as shown below. The ADC-4U15 will attach to the 4 stand-off spacers using 4-40 machine screws (4 mounting holes are provided on the ADC-4U15). Contact technical support for more information on mounting panels and various mounting layouts.



PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>ANALOG INPUT</b>					
Full-scale input voltage <sup>(1)</sup>	$V_{IN} = (AIN_P) - (AIN_N)$		$\pm 4.096/PGA$		V
Analog input voltage	$AIN_P$ or $AIN_N$ to GND	GND		VDD	V
Differential input impedance			See Table 2		
Common-mode input impedance	$FS = \pm 6.144V^{(1)}$		10		MΩ
	$FS = \pm 4.096V^{(1)}, \pm 2.048V$		6		MΩ
	$FS = \pm 1.024V$		3		MΩ
	$FS = \pm 0.512V, \pm 0.256V$		100		MΩ
<b>SYSTEM PERFORMANCE</b>					
Resolution	No missing codes	16			Bits
Data rate (DR)			8, 16, 32, 64, 128, 250, 475, 880		SPS
Data rate variation	All data rates	-10		10	%
Output noise		See Typical Characteristics			
Integral nonlinearity	$DR = 8SPS, FS = \pm 2.048V$ , best fit <sup>(2)</sup>			1	LSB
Offset error	$FS = \pm 2.048V$ , differential inputs		$\pm 1$	$\pm 3$	LSB
	$FS = \pm 2.048V$ , single-ended inputs		$\pm 3$		LSB
Offset drift	$FS = \pm 2.048V$		0.005		LSB/°C
Offset power-supply rejection	$FS = \pm 2.048V$		1		LSB/V
Gain error <sup>(3)</sup>	$FS = \pm 2.048V$ at 25°C		0.01	0.15	%
Gain drift <sup>(3)</sup>	$FS = \pm 0.256V$		7		ppm/°C
	$FS = \pm 2.048V$		5	40	ppm/°C
	$FS = \pm 6.144V^{(1)}$		5		ppm/°C
Gain power-supply rejection			80		ppm/V
PGA gain match <sup>(3)</sup>	Match between any two PGA gains		0.02	0.1	%
Gain match	Match between any two inputs		0.05	0.1	%
Offset match	Match between any two inputs		3		LSB
Common-mode rejection	At dc and $FS = \pm 0.256V$		105		dB
	At dc and $FS = \pm 2.048V$		100		dB
	At dc and $FS = \pm 6.144V^{(1)}$		90		dB
	$f_{CM} = 60Hz, DR = 8SPS$		105		dB
	$f_{CM} = 50Hz, DR = 8SPS$		105		dB



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