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2.6 - AIN [U6 Datasheet]

AIN Overview

The LabJack U6 has 14 user accessible analog inputs built-in. All the analog inputs are available on the DB37 connector, and the first 4 are also available on the built-in screw terminals.

The analog inputs have variable resolution, where the time required per sample increases with increasing resolution. The value passed for ResolutionIndex is from 0-8, where 0 corresponds to default resolution, 1 is roughly 16-bit resolution (RMS or effective), and 8 is roughly 19-bit resolution. The U6-Pro has additional ResolutionIndex settings 9-12 that use the alternate high-resolution converter (24-bit sigma-delta) and correspond to roughly 19-bit to 22-bit resolution. The default value of 0 corresponds to 8 (U6 command-response), 9 (U6-Pro command-response), or 1 (stream mode). See Appendix B for more details about ResolutionIndex.

The analog inputs are connected to a high-impedance instrumentation amplifier. This in-amp buffers the signal for the internal ADCs, allows for single-ended or differential conversions, and provides gains of x1, x10, x100, and x1000 (corresponding to ranges of ±10V, ±1V, ±0.1V, and ±0.01V).

Differential channels are adjacent even/odd pairs only, such as AIN2-AIN3. Thus the positive channel must be even and the negative channel must be +1. The Windows UD driver has different IOTypes for single-ended or differential reads, but the differential IOType can always be used as a negative channel (x1 parameter) of 0/15/199 equates to a single-ended reading.

The inputs are not artificially pulled to 0.0 volts, as that would reduce the input impedance, so readings obtained from floating channels will generally not be 0.0 volts. The readings from floating channels depend on adjacent channels and sample rate and have little meaning. See Section 2.6.3.8.

Settling time is the time from a step change in the input signal to when the signal is sampled by the ADC. A step change in this case is caused when the internal multiplexers change from one channel to another. In general, more settling time is required as gain and resolution are increased. The default “auto” settling time ensures that the device meets specifications at any gain and resolution for source impedances up to at least 1000 ohms. In command/response mode, the effect of the SettlingFactor parameter is 0=Auto, 1=20us, 2=50us, 3=100us, 4=200us, 5=500us, 6=1ms, 7=2ms, 8=5ms, 9=10ms. Stream mode has its own settling parameter which is multiplied by 10 microseconds to determine settling time. The timings in Section 3 are measured with “auto” settling.

Duplicated Terminals (AIN0-AIN3)

AIN0-AIN3 appear on the built-in screw-terminals and also on the DB37 connector. You should only connect to one or the other, not both at the same time.

To prevent damage due to accidental short circuit, both connection paths have their own series resistor. All AIN lines have a 2.2k series resistor, and in the case of AIN0-AIN3 the duplicated connections each have their own series resistor, so if you measure the resistance between the duplicate terminals you will see about 4.4k.

2.6.1 - Channel Numbers [U6 Datasheet]

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The LabJack U6 has 16 total built-in analog inputs. Two of these are connected internally (AIN14/AIN15), leaving 14 user accessible analog inputs (AIN0-AIN13). The first 4 analog inputs, AIN0-AIN3, appear both on the screw terminals and on the DB37 connector. There is about 4.4 kΩ of resistance between the duplicated connections, so connecting signals to both will not short-circuit the signals but they will contend with each other.

Table 2.6.1-1. Positive Channel Numbers

Positive Channel #	
0-13	Single-Ended
0,2,4,6,8,10,12	Differential
14	Temp Sensor (deg K)
15	GND

Table 2.6.1-2. Negative Channel Numbers

Negative Channel #	
1,3,5,7,9,11,13	Differential
0,15,199	Single-Ended

(GND)

The Mux80 accessory uses multiplexer ICs to easily expand the total number of analog inputs available from 14 to 84, or you can connect multiplexer chips yourself.

The DB37 connector has 3 MIO lines (shared with CIO0-CIO2) designed to address expansion multiplexer ICs (integrated circuits), allowing for up to 112 total external analog inputs. The DG408 from Intersil is a recommended multiplexer, and a convenient ±12 volt power supply is available so the multiplexers can pass bipolar signals (see Vm+/Vm- discussion in Section 2.11). Figure 2-2 shows the typical connections for a pair of multiplexers.

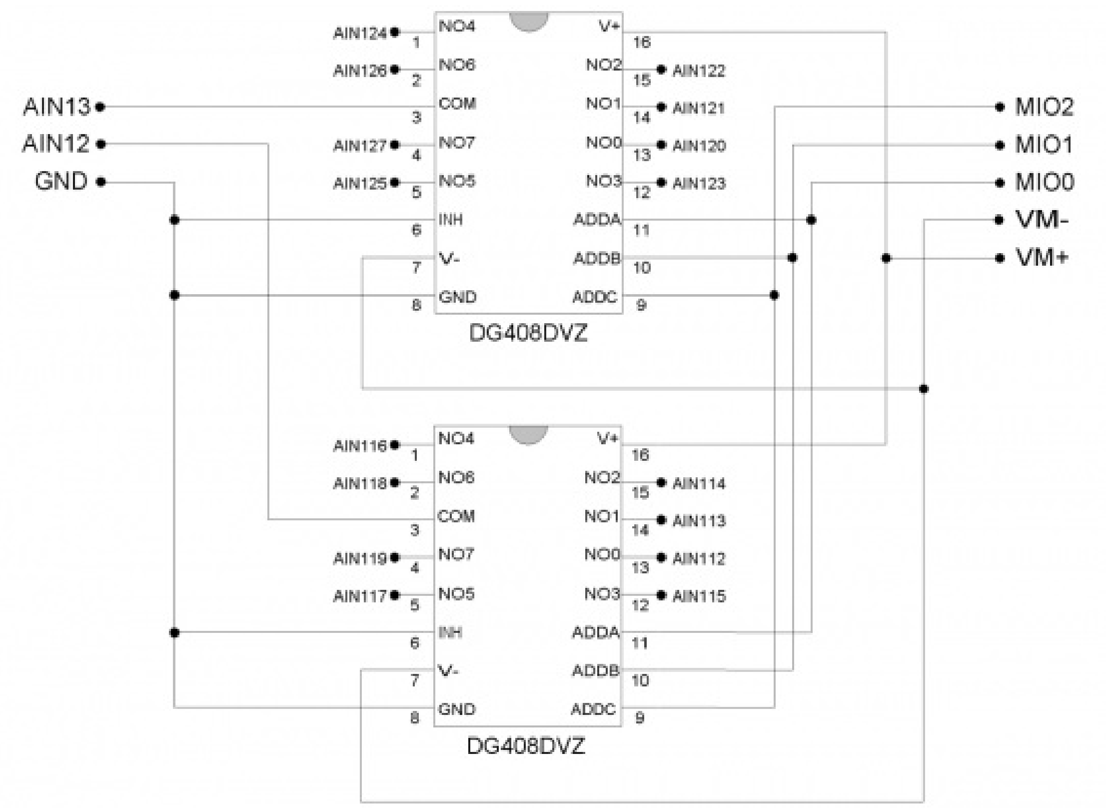

Figure 2-2. Typical External Multiplexer Connections

To make use of external multiplexers, the user must be comfortable reading a simple schematic (such as Figure 2-2) and making basic connections on a solderless breadboard (such as the EB37). Initially, it is recommended to test the basic operation of the multiplexers without the MIO lines connected. Simply connect different voltages to NO0 and NO1, connect ADDA/ADDB/ADDC to GND, and the NO0 voltage should appear on COM. Then connect ADDA to VS and the NO1 voltage should appear on COM.

If any of the AIN channel numbers passed to a U6 function are in the range 16-127 (extended channels), the MIO lines will automatically be set to output and the correct state while sampling that channel. For instance, a channel number of 28 will cause the MIO to be set to b100 and the ADC will sample AIN1. Channel number besides 16-127 will have no affect on the MIO. The extended channel number mapping is shown in Table 2-2.

For differential extended channels, the positive channel must map to an even channel from 0-12, and the negative channel must map to the odd channel 1 higher (i.e. 1-13). That means that for extended channel numbers the negative channel must be 8 higher than the positive channel. For example, a valid differential extended channel pair would be Ch+ = AIN70 and Ch- = AIN78, since AIN70 maps to AIN6 and AIN78 maps to AIN7. For more information on differential extended channels, see the Mux80 Datasheet.

In command/response mode, after sampling an extended channel the MIO lines remain in that same condition until commanded differently by another extended channel or another function. When streaming with any extended channels, the MIO lines are all set to output-low for any non extended analog channels. For special channels (digital/timers/counters), the MIO are driven to unspecified states. Note that the StopStream can occur during any sample within a scan, so the MIO lines will wind up configured for any of the extended channels in the scan. If a stream does not have any extended channels, the MIO lines are not affected.

Table 2.6.1-3. Expanded Channel Mapping

U6	MIO Multiplexed
Channel	Channels
0	16-23
1	24-31
2	32-39
3	40-47
4	48-55
5	56-63
6	64-71
7	72-79
8	80-87
9	88-95
10	96-103
11	104-111
12	112-119
13	120-127

2.6.2 - Converting Binary Readings to Voltages [U6 Datasheet]

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This information is only needed when using low-level functions and other ways of getting binary readings. Readings in volts already have the calibration constants applied. The UD driver, for example, normally returns voltage readings unless binary readings are specifically requested.

Following are the nominal input voltage ranges for the analog inputs.

Table 2.6.2-1. Nominal Analog Input Voltage Ranges

	Gain	Max V	Min V
Bipolar	1	10.1	-10.6
Bipolar	10	1.01	-1.06
Bipolar	100	0.101	-0.106
Bipolar	1000	0.0101	-0.0106

The readings returned by the analog inputs are raw binary values (low-level functions). An approximate voltage conversion can be performed as:

Volts(uncalibrated) = (Bits/65536)*Span

Where span is the maximum voltage minus the minimum voltage from the table above. For a proper voltage conversion, though, use the calibration values (Slope and Offset) stored in the internal flash on the Control processor.

Volts = (Slope * Bits) + Offset

In both cases, “Bits” is always aligned to 16-bits, so if the raw binary value is 24-bit data it must be divided by 256 before converting to voltage. Binary readings are always unsigned integers.

Since the U6 uses multiplexers, all channels have the same calibration for a given input range.

See Section 5.4 for details about the location of the U6 calibration constants.

2.6.3 - Typical Analog Input Connections [U6 Datasheet]

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Typical Analog Input Connections Overview

A common question is “can this sensor/signal be measured with the U6”. Unless the signal has a voltage (referred to U6 ground) beyond the limits in Appendix A, it can be connected without damaging the U6, but more thought is required to determine what is necessary to make useful measurements with the U6 or any measurement device.

Voltage (versus ground): The single-ended analog inputs on the U6 measure a voltage with respect to U6 ground. The differential inputs measure the voltage difference between two channels, but the voltage on each channel with respect to ground must still be within the common mode limits specified in Appendix A. When measuring parameters other than voltage, or voltages too big or too small for the U6, some sort of sensor or transducer is required to produce the proper voltage signal. Examples are a temperature sensor, amplifier, resistive voltage divider, or perhaps a combination of such things.

Impedance: When connecting the U6, or any measuring device, to a signal source, it must be considered what impact the measuring device will have on the signal. The main consideration is whether the currents going into or out of the U6 analog input will cause noticeable voltage errors due to the impedance of the source. See Appendix A for the recommended maximum source impedance.

Resolution (and Accuracy): Based on the selected input range and resolution of the U6, the resolution can be determined in terms of voltage or engineering units. For example, assume some temperature sensor provides a 0-10 mV signal, corresponding to 0-100 degrees C. Samples are then acquired with the U6 using the ±10 volt input range and 16-bit resolution, resulting in a voltage resolution of about 20/65536 = 305 µV. That means there will be about 33 discrete steps across the 10 mV span of the signal, and the overall resolution is about 3 degrees C. Accuracy (which is different than resolution) will also need to be considered. Appendix A places some boundaries on expected accuracy, but an in-system calibration can generally be done to provide absolute accuracy down to the INL limits of the U6.

Speed: How fast does the signal need to be sampled? For instance, if the signal is a waveform, what information is needed: peak, average, RMS, shape, frequency, … ? Answers to these questions will help decide how many points are needed per waveform cycle, and thus what sampling rate is required. In the case of multiple channels, the scan rate is also considered. See Sections 3.1 and 3.2.

2.6.3.1 - Signal from the LabJack [U6 Datasheet]

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One example of measuring a signal from the U6 itself, is with an analog output. All I/O on the U6 share a common ground, so the voltage on an analog output (DAC) can be measured by simply connecting a single wire from that terminal to an AIN terminal. The analog output must be set to a voltage within the range of the analog input.

2.6.3.2 - Unpowered Isolated Signal [U6 Datasheet]

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An example of an unpowered isolated signal would be a thermocouple or photocell where the sensor leads are not shorted to any external voltages. Such a sensor typically has two leads. The positive lead connects to an AINx terminal and the negative lead connects to aGND terminal.

An exception might be a thermocouple housed in a metal probe where the negative lead of the thermocouple is shorted to the metal probe housing. If this probe is put in contact with something (engine block, pipe, …) that is connected to ground or some other external voltage, care needs to be taken to insure valid measurements and prevent damage.

2.6.3.3 - Signal Powered By the LabJack [U6 Datasheet]

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A typical example of this type of signal is a 3-wire temperature sensor. The sensor has a power and ground wire that connect to Vs and GND on the LabJack, and then has a signal wire that simply connects to an AINx terminal.

Another variation is a 4-wire sensor where there are two signal wires (positive and negative) rather than one. If the negative signal is the same as power ground, or can be shorted ground, then the positive signal can be connected to AINx and a single-ended measurement can be made. A typical example where this does not work is a bridge type sensor providing the raw bridge output (strain gage bridge / pressure sensor / load cell … with no built-in amplifier) with non-isolated excitation voltage. In this case the signal voltage is the difference between the positive and negative signal, and the negative signal cannot be shorted to ground. An instrumentation amplifier is required to convert the differential signal to signal-ended, and probably also to amplify the signal. The U6 has an internal instrumentation amplifier, and thus can take the differential signal (AIN0-AIN1 for example) and also provide amplification.

2.6.3.4 - Signal Powered Externally [U6 Datasheet]

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An example is a box with a wire coming out that is defined as a 0-5 volt analog signal and a second wire labeled as ground. The signal is known to have 0-5 volts compared to the ground wire, but the complication is what is the voltage of the box ground compared to the LabJack ground.

If the box is known to be electrically isolated from the LabJack, the box ground can simply be connected to LabJack GND. An example would be if the box was plastic, powered by an internal battery, and does not have any wires besides the signal and ground which are connected to AINx and GND on the LabJack. Such a case is obviously isolated and easy to keep isolated. In practical applications, though, signals thought to be isolated are often not at all, or perhaps are isolated at some time but the isolation is easily lost at another time.

If the box ground is known to be the same as the LabJackGND, then perhaps only the one signal wire needs to be connected to the LabJack, but it generally does not hurt to go ahead and connect the ground wire to LabJack GND with a 100 Ω resistor. You definitely do not want to connect the grounds without a resistor.

If little is known about the box ground, aDMM can be used to measure the voltage of box ground compared to LabJack GND. As long as an extreme voltage is not measured, it is generally OK to connect the box ground to LabJack GND, but it is a good idea to put in a 100 Ω series resistor to prevent large currents from flowing on the ground. Use a small wattage resistor (typically 1/8 or 1/4 watt) so that it blows if too much current does flow. The only current that should flow on the ground is the return of the analog input bias current, which is on the order of nanoamps for the U6.

The SGND terminal can be used instead of GND for externally powered signals. A series resistor is not needed as SGND is fused to prevent overcurrent, but a resistor will eliminate confusion that can be caused if the fuse is tripping and resetting.

In general, if there is uncertainty, a good approach is to use aDMM to measure the voltage on each signal/ground wire without any connections to the U6. If no large voltages are noted, connect the ground to U6 SGND with a 100 Ω series resistor. Then again use the DMM to measure the voltage of each signal wire before connecting to the U6.

Another good general rule is to use the minimum number of ground connections. For instance, if connecting 8 sensors powered by the same external supply, or otherwise referred to the same external ground, only a single ground connection is needed to the U6. Perhaps the ground leads from the 8 sensors would be twisted together, and then a single wire would be connected to a 100 Ω resistor which is connected to U6 ground.

2.6.3.5 - Amplifying Small Signal Voltages [U6 Datasheet]

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This section has general information about external signal amplification. The U6 has an outstanding amplifier built-in. Combined with the high resolution capability of the U6, an external amplifier is seldom needed, and in many cases will actually degrade noise and accuracy performance.

For a do-it-yourself solution, the following figure shows an operational amplifier (op-amp) configured as non-inverting:

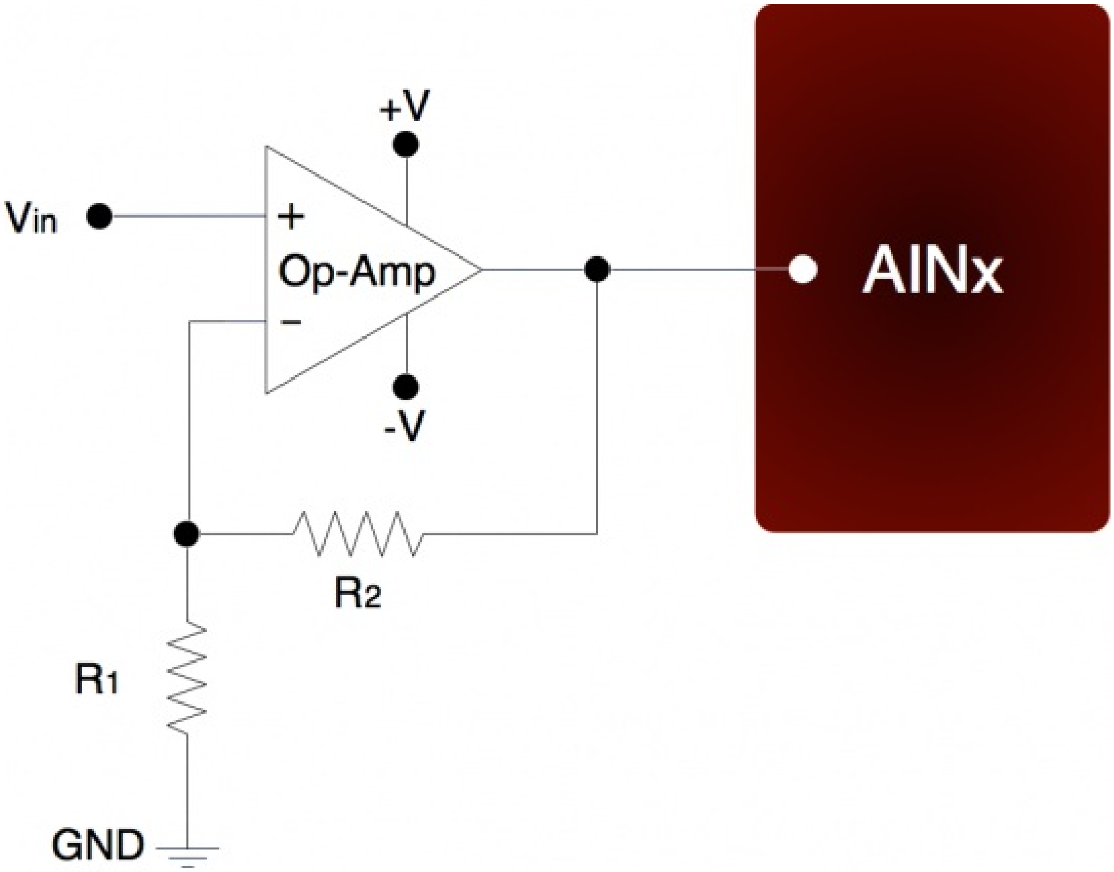

Figure 2.6.3.5-1. Non-Inverting Op-Amp Configuration

The gain of this configuration is:

Vout = Vin * (1 + (R2/R1))

100 kΩ is a typical value for R2. Note that if R2=0 (short-circuit) and R1=inf (not installed), a simple buffer with a gain equal to 1 is the result.

There are numerous criteria used to choose an op-amp from the thousands that are available. One of the main criteria is that the op-amp can handle the input and output signal range. Often, a single-supply rail-to-rail input and output (RIRO) is used as it can be powered from Vs andGND and pass signals within the range 0-Vs. The OPA344 from Texas Instruments (ti.com) is good for many 5 volt applications. The max supply rating for the OPA344 is 5.5 volts, so for applications using Vm+/Vm- (±12 volts), the LT1490A from Linear Technologies (linear.com) might be a good option.

The op-amp is used to amplify (and buffer) a signal that is referred to the same ground as the LabJack (single-ended). If instead the signal is differential (i.e. there is a positive and negative signal both of which are different than ground), an instrumentation amplifier (in-amp) should be used. An in-amp converts a differential signal to single-ended, and generally has a simple method to set gain.

2.6.3.6 - Signal Voltages Beyond ±10 Volts

(and Resistance Measurement) [U6 Datasheet]

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The nominal maximum analog input voltage range for the U6 is ±10 volts. The basic way to handle higher voltages is with a resistive voltage divider. The following figure shows the resistive voltage divider assuming that the source voltage (Vin) is referred to the same ground as the U6 (GND).

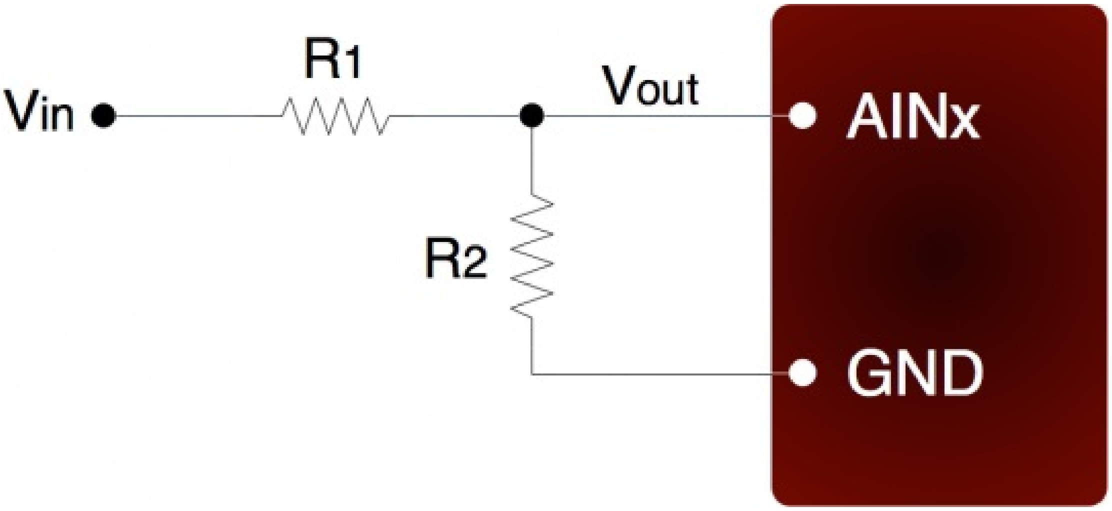

Figure 2.6.3.6-1. Voltage Divider Circuit

The attenuation of this circuit is determined by the equation:

Vout = Vin * (R2 / (R1+R2))

This divider is easily implemented by putting a resistor (R1) in series with the signal wire, and placing a second resistor (R2) from the AIN terminal to a GND terminal. To maintain specified analog input performance across all gains and resolutions, R1 should not exceed 1 kΩ (some gain/resolution combinations work fine with much higher resistance). Typically, R1 is fixed at 1 kΩ and R2 can be adjusted for the desired attenuation. For example, R1 = R2 = 1 kΩ provides a divide by 2, so a ±20 volt input will be scaled to ±10 volts and a 0-20 volt input will be scaled to 0-10 volts.

The divide by 2 configuration where R1 = R2 = 1 kΩ, presents a 2 kΩ load to the source, meaning that a ±10 volt signal will have to be able to source/sink up to ±5 mA. Some signal sources might require a load with higher resistance, in which case a buffer should be used. The following figure shows a resistive voltage divider followed by an op-amp configured as non-inverting unity-gain (i.e. a buffer).

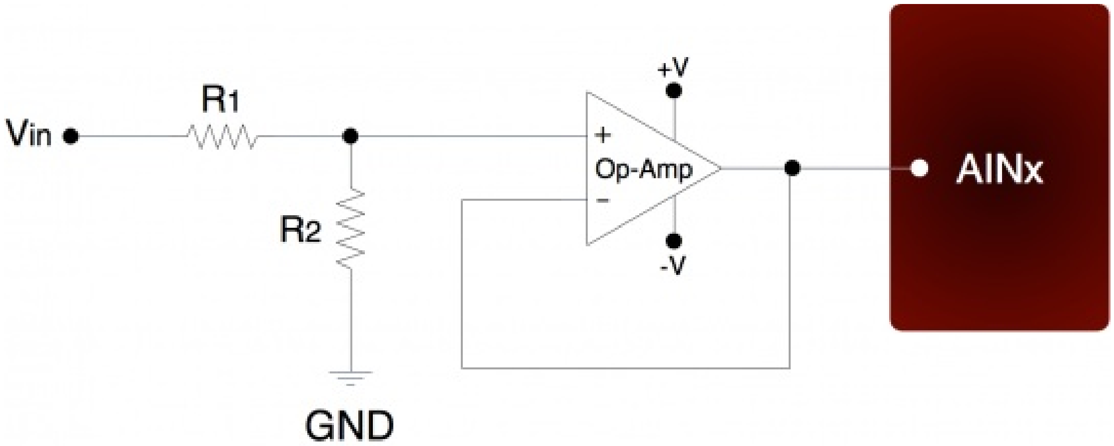

Figure 2.6.3.6-2. Buffered Voltage Divider Circuit

The op-amp is chosen to have low input bias currents so that large resistors can be used in the voltage divider. The LT1490A from Linear Technologies (linear.com) is a good choice for dual-supply applications. The LT1490A only draws 40 µA of supply current, thus many of these amps can be powered from the Vm+/Vm- supply on the U6, and can pass signals in the ±10 volt range. Since the input bias current is only -1 nA, large divider resistors such as R1 = R2 = 470 kΩ will only cause an offset of about -470 µV, and yet present a load to the source of about 1 megaohm.

For 0-5 volt applications, where the amp will be powered from Vs andGND, the LT1490A is not the best choice. When the amplifier input voltage is within 800 mV of the positive supply, the bias current jumps from -1 nA to +25 nA, which with R1 = 470 kΩ will cause the offset to change from -470 µV to +12 mV. A better choice in this case would be the OPA344 from Texas Instruments (ti.com). The OPA344 has a very small bias current that changes little across the entire voltage range. Note that when powering the amp from Vs and GND, the input and output to the op-amp is limited to that range, so if Vs is 4.8 volts your signal range will be 0-4.8 volts.

Another option is the LJTick-Divider which plugs into the U6 screw-terminals. It is similar to the buffered divider shown in Figure 2.6.3.6-2.

The information above also applies to resistance measurement. A common way to measure resistance is to build a voltage divider as shown in Figure 2.6.3.6-1, where one of the resistors is known and the other is the unknown. If Vin is known and Vout is measured, the voltage divider equation can be rearranged to solve for the unknown resistance.

A great way to measure resistance is using the current sources on the U6. By sending this known current through the resistance and measuring the voltage that results across, the value of the resistance can be calculated. Common resistive sensors are thermistors and RTDs.

2.6.3.7 - Measuring Current (Including 4-20 mA) with a Resistive Shunt [U6 Datasheet]

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The best way to handle 4-20 mA signals is with theLJTick-CurrentShunt, which is a two channel active current to voltage converter module that plugs into the U6’s screw-terminals.

The following figure shows a typical method to measure the current through a load, or to measure the 4-20 mA signal produced by a 2-wire (loop-powered) current loop sensor. The current shunt shown in the figure is simply a resistor.

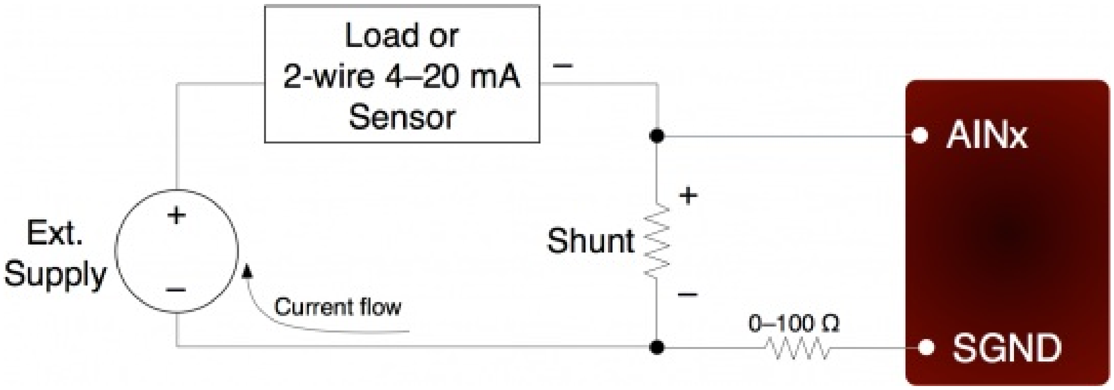

Figure 2.6.3.7-1. Current Measurement With Arbitrary Load or 2-Wire 4-20 mA Sensor

When measuring a 4-20 mA signal, a typical value for the shunt would be 240 Ω. This results in a 0.96 to 4.80 volt signal corresponding to 4-20 mA. The external supply must provide enough voltage for the sensor and the shunt, so if the sensor requires 5 volts the supply must provide at least 9.8 volts.

For applications besides 4-20 mA, the shunt is chosen based on the maximum current and how much voltage drop can be tolerated across the shunt. For instance, if the maximum current is 1.0 amp, and 2.5 volts of drop is the most that can be tolerated without affecting the load, a 2.4 Ω resistor could be used. That equates to 2.4 watts, though, which would require a special high wattage resistor. A better solution would be to use a lower resistance shunt, and rely on the outstanding performance of the U6 to resolve the smaller signal. If the maximum current to measure is too high (e.g. 100 amps), it will be difficult to find a small enough resistor and a hall-effect sensor should be considered instead of a shunt.

The following figure shows typical connections for a 3-wire 4-20 mA sensor. A typical value for the shunt would be 240 Ω which results in 0.96 to 4.80 volts.

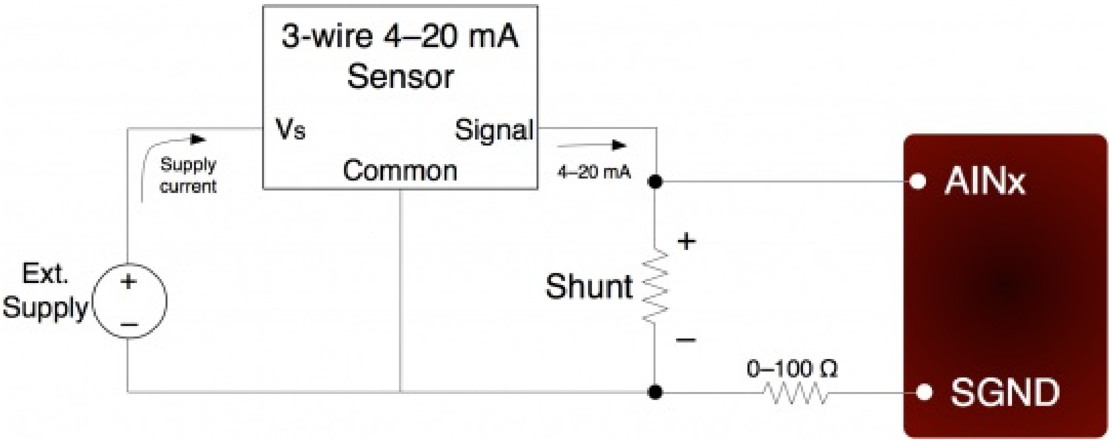

Figure 2.6.3.7-2. Current Measurement With 3-Wire 4-20 mA (Sourcing) Sensor

The sensor shown in Figure 2.6.3.7-2 is a sourcing type, where the signal sources the 4-20 mA current which is then sent through the shunt resistor and sunk into ground. Another type of 3-wire sensor is the sinking type, where the 4-20 mA current is sourced from the positive supply, sent through the shunt resistor, and then sunk into the signal wire. If sensor ground is connected to U6 ground, the sinking type of sensor presents a couple of problems, as the voltage across the shunt resistor is differential (neither side is at ground) and at least one side of the resistor has a high common mode voltage (equal to the positive sensor supply). If the sensor and/or U6 are isolated, a possible solution is to connect the sensor signal or positive sensor supply to U6 ground (instead of sensor ground). This requires a good understanding of grounding and isolation in the system. The LJTick-CurrentShunt is often a simple solution.

Both figures show a 0-100 Ω resistor in series withSGND, which is discussed in general in Section 2.6.3.4. In this case, if SGND is used (rather than GND), a direct connection (0 Ω) should be good.

The best way to handle 4-20 mA signals is with theLJTick-CurrentShunt, which is a two channel active current to voltage converter module that plugs into the U6 screw-terminals.

2.6.3.8 - Floating/Unconnected Inputs [U6 Datasheet]

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The reading from a floating (no external connection) analog input channel can be tough to predict and is likely to vary with sample timing and adjacent sampled channels. Keep in mind that a floating channel is not at 0 volts, but rather is at an undefined voltage. In order to see 0 volts, a 0 volt signal (such as GND) should be connected to the input.

Some data acquisition devices use a resistor, from the input to ground, to bias an unconnected input to read 0. This is often just for “cosmetic” reasons so that the input reads close to 0 with floating inputs, and a reason not to do that is that this resistor can degrade the input impedance of the analog input.

In a situation where it is desired that a floating channel read a particular voltage, say to detect a broken wire, a resistor can be placed from the AINx screw terminal to the desired voltage (GND, VS, DACx, …), but obviously that degrades the input impedance. The resistor value used depends on how close to the desired voltage you need to be, minimum allowable input impedance, sample rate, settling time, resolution, and adjacent channels.

2.6.4 - Internal Temperature Sensor [U6 Datasheet]

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The U6 has an internal temperature sensor. The sensor is physically located near the AIN3 screw-terminal. It is labeled U17 on the PCB, and can be seen through the gap between the AIN3 terminal and adjacent VS terminal.

The U6 enclosure typically makes a 1 °C difference in the temperature at the internal sensor. With the enclosure on the temperature at the sensor is typically 3 °C higher than ambient, while with the enclosure off the temperature at the sensor is typically 2 °C higher than ambient. The calibration constants have an offset of -3 °C, so returned calibrated readings are nominally the same as ambient with the enclosure installed, and 1 °C below ambient with the PCB in free air.

The sensor has a specified accuracy of ±2.1 °C across the entire device operating range of -40 to +85 °C. Allowing for a slight difference between the sensor temperature and the temperature of the screw-terminals, expect the returned value minus 3 °C to reflect the temperature of the built-in screw-terminals with an accuracy of ±2.5 °C.

With the UD driver, the internal temperature sensor is read by acquiring analog input channel 14 and returns °K.

The internal temperature sensor does not work in stream mode. It takes too long to settle, thus if you stream it you will typically get totally wrong readings.

Note on thermocouples

If thermocouples are connected to the CB37, you want to know the temperature of the screw-terminals on the CB37. The CB37 is typically at the same temperature as ambient air, so use the direct value from a read of AIN14. Better yet, add a sensor such as the LM34CAZ to an unused analog input on the CB37 to measure the actual temperature of the CB37.

The built-in screw-terminals AIN0-AIN3 on the U6 are typically 3 °C above ambient with the enclosure installed, so when the internal temperature sensor is used for CJC for thermocouples connected to the built-in screw-terminals, it is recommended to add 3 °C to its value as you want the actual temperature of the screw-terminals, not necessarily ambient temperature.

2.6.5 - Signal Range [U6 Datasheet]

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Following are figures showing the approximate signal range of the U6 analog inputs. "Input Common-Mode Voltage" or Vcm is (Vpos + Vneg)/2.

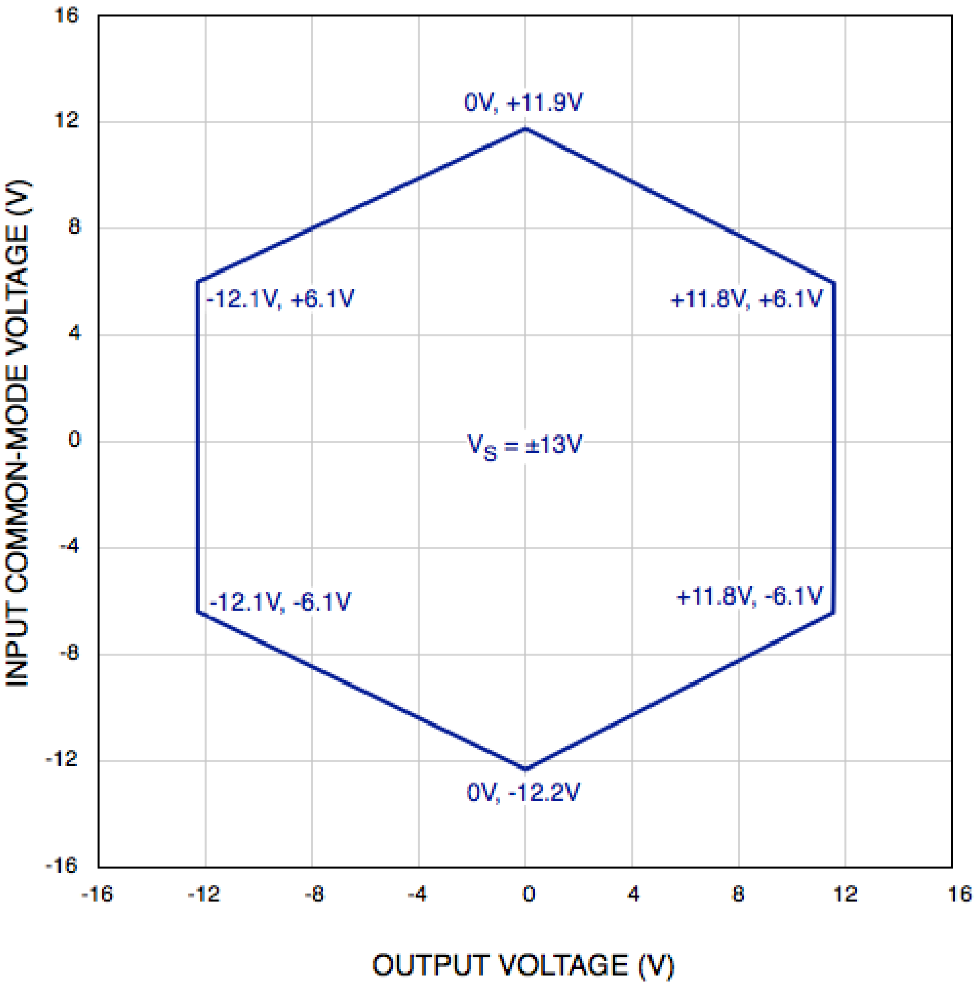
Keep in mind that the voltage of any input compared to GND should be within the Vm+ and Vmrails by at least 1.5 volts, so if Vm is the typical ±13 volts, the signals should be within ±11.5 volts compared to GND.

Example #1: Say a differential signal is measured where Vpos is 10.05 volts compared to GND and Vneg is 9.95 volts compared to ground, and G=100. That means Vcm=10.0 volts, Vdiff=0.1 volts, and the expected Vout=10.0 volts. Figures for G=10 and G=100 are not available, but Vcm=10.0 volts and Vout=10.0 volts is not valid at G=1 or G=1000, so is certainly not valid for gains in between.

Example #2: Say a differential signal is measured where Vpos is 15.0 volts compared to GND and Vneg is 14.0 volts compared to ground, and G=1. That means Vcm=14.5 volts, Vdiff=1.0 volts, and the expected Vout=1.0 volts. The voltage of each input compared to GND is too high, so this would not work at all.

Example #3: Say a single-ended signal is measured where Vpos is 10.0 volts compared to GND and G=1. That means Vcm=5.0 volts, Vdiff=10.0 volts, and the expected Vout=10.0 volts. This is fine according to the figure below.

Input Common-Mode Voltage Range vs. Output Voltage, G = 1



Input Common-Mode Voltage Range vs. Output Voltage, G = 1000