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# LJTick-InAmp

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The LJTick-InAmp (LJTIA) is a signal-conditioning module that provides two instrumentation amplifiers ideal for low-level signals such as bridge circuits (strain gauges) and thermocouples. The LJTIA has 5 gain settings per channel and two selectable output voltage offsets (Voffset). The 4-pin design plugs into the standard AIN/AIN/GND/VS screw terminal block found on newer LabJacks such as the U3 and UE9.

The pictures below show the LJTIA plugged into the U3 on the left and plugged into the UE9 on the right.

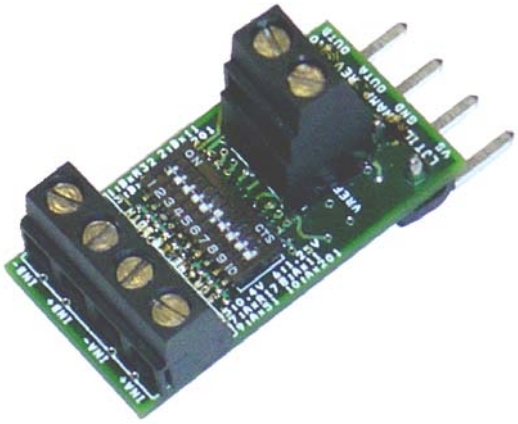


**Figure 1: LJTick-InAmp (LJTIA)**


**Figure 2: LJTIA With U3**


**Figure 3: LJTIA With UE9**

The block of 4 screw-terminals at the left edge of the LJTIA (Figure 1 above) provides a positive and negative input for each differential channel. Towards the LabJack side of the LJTIA is a pair of screw-terminals that provide a ground connection (GND) and a +2.50 volt reference (VREF). The reference is capable of sourcing enough current (see Specifications) to function as the excitation voltage for most common bridge circuits.

In between the blocks of screw-terminals is a 10-position DIP switch used to specify gain and offset.

| Switch # | Name | Description | |
|---|---|---|---|
| 1 | BxR32 | Custom gain determined by R32 | Applies to channel B only. All off equals a gain of 1. |
| 2 | Bx11 | Gain of 11 | |
| 3 | Bx52 | Gain of 51 | |
| 4 | Bx201 | Gain of 201 | |
| 5 | 0.4V | Output offset of +0.4 volts. | Voffset applies to both channels. Switch # 5 or 6 should always be on, but not both. |
| 6 | 1.25V | Output offset of +1.25 volts. | |
| 7 | AxR17 | Custom gain determined by R17 | Applies to channel A only. All off equals a gain of 1. |
| 8 | Ax11 | Gain of 11 | |
| 9 | Ax51 | Gain of 51 | |
| 10 | Ax201 | Gain of 201 | |

**Table 1: DIP Switch Descriptions**

Each channel has a switch (numbers 1 & 7) that has been left without factory-installed gain resistors. Resistors can be installed by the end-user to provide custom gains according to G=(1+(100k/R). For example, a resistance of 100 ohms would provide the maximum allowable gain of 1001.

Extending from the back of the LJTick-InAmp are four pins. The first two pins provide +5 volt power and ground from the LabJack. The other two pins are the instrumentation amplifier outputs and connect to analog inputs on the LabJack. The four pins plug directly into the 5.0 mm spaced screw terminals on the LabJack U3, UE9, or other future devices as shown in Figure 4.

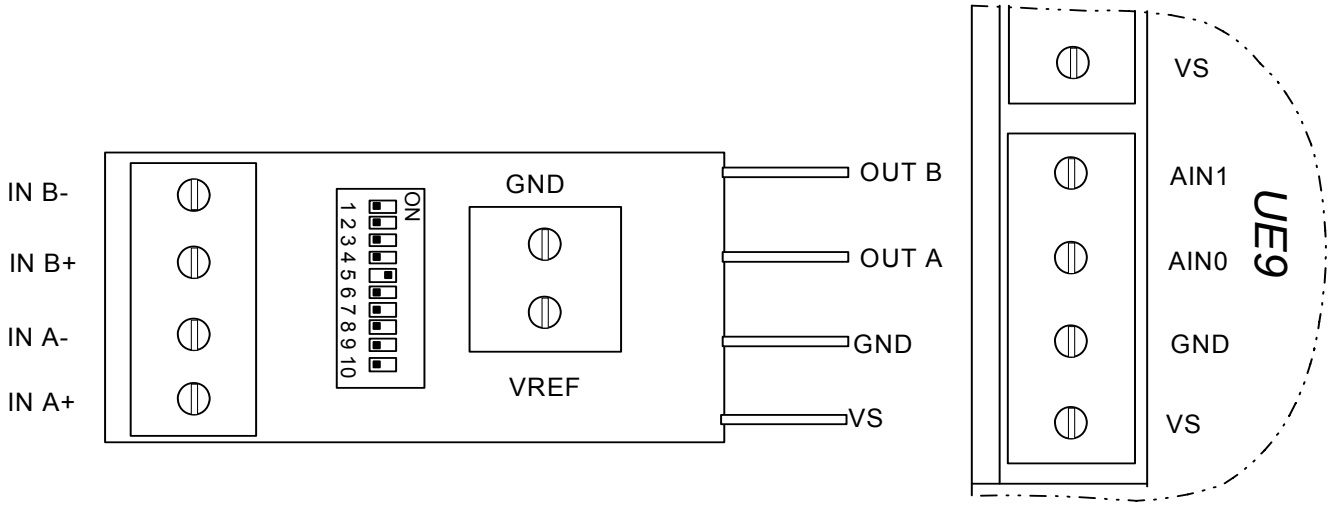



**Figure 4: LJTick-InAmp schematic lined up to UE9**

Each channel on the LJTIA has an AD623 instrumentation amplifier (in-amp) from Analog Devices. The allowable signal range (Vin) is determined by a combination of Gain, Voffset, Vcm, and Vout.

Voffset: This is an offset voltage added to the in-amp output. If DIP switch #5 is on, the offset is +0.4 volts, and if DIP switch #6 is on, the offset is +1.25 volts. One offset must always be selected (0 volts is not an option), but both offsets should never be enabled at the same time. The +0.4 volt offset is generally used with signals that are mostly unipolar, while the +1.25 volt offset is generally used with bipolar signals.

Vcm: This is the common mode voltage of the differential inputs. For an in-amp, that is defined as the average of the common mode voltage of each input. For instance, if the negative input is grounded, and a single-ended signal is connected to the positive input, Vcm is equal to Vin/2. Another common situation is when using a wheatstone bridge where VREF=2.5 is providing the excitation. In this case, each input is at about 1.25 volts compared to ground, and thus Vcm is about 1.25 volts.

Vin: This is the voltage difference between IN+ and IN-. The “Low” column is the minimum Vin where Vout is 10 mV or higher, the “High 2.5V” column is the maximum Vin where Vout is 2.5 volts or less, and the “High 4.5V” column is the maximum Vin where Vout is 4.5 volts or less.

Vout: This is the single-ended (referred to ground) voltage output from the in-amp. Because of the power supply to the in-amp, the full output swing is 0.01 volts to 4.5 volts. The “Low” and “High” columns give the output at the respective Vin.

The following Signal Range Tables cover most common situations with the LJTIA, but for other cases there is an online tool ("AD623 +5V" common mode calculator) available at analog.com:

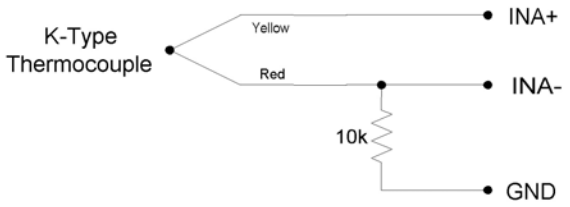
http://www.analog.com/Analog_Root/static/techSupport/designTools/interactiveTools/inamp2/inamp.html?part=AD623%205V

## Signal Range Tables:

| Voffset=0.4 V | | | | | | |
|---|---|---|---|---|---|---|
| **Vcm** | **Vin (differential)** | | | **Vout (single ended)** | | |
| *Gain* | **Low** | **High 2.5 V** | **High 4.5 V** | **Low** | **High 2.5 V** | **High 4.5 V** |
| **Zero** | | | | | | |
| *1* | -0.3 | 0.3 | N/A | 0.1 | 0.7 | N/A |
| *11* | -0.0354 | 0.116 | N/A | 0.0106 | 1.58 | N/A |
| *51* | -0.00764 | 0.0231 | N/A | 0.0104 | 1.58 | N/A |
| *201* | -0.00194 | 0.00587 | N/A | 0.0101 | 1.58 | N/A |
| **1.25 V** | | | | | | |
| *1* | -0.39 | 2.1 | 3.68 | 0.01 | 2.5 | 4.08 |
| *11* | -0.0354 | 0.191 | 0.334 | 0.0106 | 2.5 | 4.07 |
| *51* | -0.00764 | 0.0412 | 0.0721 | 0.0104 | 2.5 | 4.08 |
| *201* | -0.00194 | 0.0104 | 0.0183 | 0.0101 | 2.5 | 4.07 |
| **2.5 V** | | | | | | |
| *1* | -0.39 | 2.1 | 3.6 | 1.01 | 2.5 | 4 |
| *11* | -0.0354 | 0.191 | 0.327 | 0.0106 | 2.5 | 4 |
| *51* | -0.00764 | 0.0412 | 0.0803 | 0.0104 | 2.5 | 4.5 |
| *201* | -0.00194 | 0.0104 | 0.0179 | 0.0101 | 2.5 | 4 |
| **Vin/2** | | | | | | |
| *1* | -0.15 | 2.05 | 4.1 | 0.25 | 2.5 | 4.5 |
| *11* | -0.0354 | 0.118 | N/A | 0.0106 | 1.7 | N/A |
| *51* | -0.00764 | 0.024 | N/A | 0.0104 | 1.59 | N/A |
| *201* | -0.00194 | 0.0059 | N/A | 0.0101 | 1.59 | N/A |

| Voffset=1.25 V | | | | | | |
|---|---|---|---|---|---|---|
| ***Vcm*** | **Vin (differential)** | | | **Vout (single ended)** | | |
| *Gain* | **Low** | **High 2.5 V** | **High 4.5 V** | **Low** | **High 2.5 V** | **High 4.5 V** |
| **Zero** | | | | | | |
| *1* | -0.3 | 0.116 | N/A | 0.07 | 1.55 | N/A |
| *11* | -0.107 | 0.107 | N/A | 0.073 | 2.43 | N/A |
| *51* | -0.0231 | 0.0231 | N/A | 0.0719 | 2.43 | N/A |
| *201* | -0.00587 | 0.00587 | N/A | 0.0701 | 2.43 | N/A |
| **1.25 V** | | | | | | |
| *1* | -1.24 | 1.25 | 3.25 | 0.01 | 2.5 | 4.5 |
| *11* | -0.112 | 0.114 | 0.295 | 0.018 | 2.5 | 4.5 |
| *51* | -0.0243 | 0.0245 | 0.0637 | 0.0107 | 2.5 | 4.5 |
| *201* | -0.00616 | 0.00622 | 0.0162 | 0.0114 | 2.5 | 4.5 |
| **2.5 V** | | | | | | |
| *1* | -1.24 | 1.25 | 3.25 | 0.01 | 2.5 | 4.5 |
| *11* | -0.112 | 0.114 | 0.295 | 0.018 | 2.5 | 4.5 |
| *51* | -0.0243 | 0.0245 | 0.0637 | 0.0105 | 2.5 | 4.5 |
| *201* | -0.00616 | 0.00622 | 0.0161 | 0.0114 | 2.5 | 4.5 |
| **Vin/2** | | | | | | |
| *1* | -0.15 | 0.6 | 3.2 | 1.1 | 2.5 | 4.5 |
| *11* | -0.0983 | 0.113 | 0.118 | 0.169 | 2.5 | 2.55 |
| *51* | -0.0226 | 0.0236 | N/A | 0.0974 | 2.45 | N/A |
| *201* | -0.00584 | 0.0059 | N/A | 0.0762 | 2.44 | N/A |

**Example #1, Thermocouple:** A K-type thermocouple is connected to IN+ (yellow positive lead) and IN- (red negative lead), and IN- is also connected to GND through a 10k resistor (meaning that Vcm=Vin/2). In most situations, a short can simply be used for the GND connection instead of a 10k resistor.




The desired temperature range is –100 to +500 degrees C for this example, so the thermocouple voltage will be about –0.0035 to 0.0206 mV (from NIST tables). We choose Voffset=0.4 volts and Gain=51, and set the LJTIA DIP switches accordingly, such that the allowable input range for the LJTIA is -0.0076 to +0.024 volts (Signal Range tables from this datasheet).

For other thermocouple types and temperature ranges, use the NIST tables (link below) to determine the maximum and minimum expected voltage. Then use the Signal Range Tables from this datasheet to determine the best gain and offset settings for the LJTIA.

http://srdata.nist.gov/its90/main/

In addition to amplifying the small thermocouple voltage, the temperature of the cold junction (LJTIA screw-terminals in this case) needs to be measured. This can be done by reading the internal temperature sensor on the U3 or UE9, or for improved accuracy an external sensor such as the EI-1034 (labjack.com) or LM34CAZ (national.com) can be used.

The nominal voltage offset of the LJTIA is 0.4 volts. For improved accuracy, though, actual system offset can be measured. If the end of the thermocouple is at the same temperature as the cold junction, the thermocouple voltage should be zero, so place the end of the thermocouple near the LJTIA and note the voltage measured by analog input (should be near 0.4 volts). This is the actual system offset, and should be subtracted from further analog input readings before dividing by the gain to get the thermocouple voltage.

The UD driver for Windows has a convenient function that takes in thermocouple type, thermocouple voltage, and cold junction temperature, and returns the thermocouple temperature. The following pseudocode demonstrates measurement:

```
//Read the amplified and offset thermocouple voltage from an analog input.
eGet (lngHandle, LJ_ioGET_AIN, tcChannel, &valueAIN, 0);

//Get the internal temperature reading (channel 133 on the UE9 or channel 30 on the U3).
eGet (lngHandle, LJ_ioGET_AIN, internalTempChannel, &cjTempK, 0);

//To get the thermocouple voltage we subtract the offset from the AIN voltage
//and divide by the LJTIA gain.
tcVolts = (valueAIN - offsetVoltage)/51;

//Convert TC voltage to temperature.
TCVoltsToTemp (LJ_ttK, tcVolts, cjTempK, &TCTempK);
```

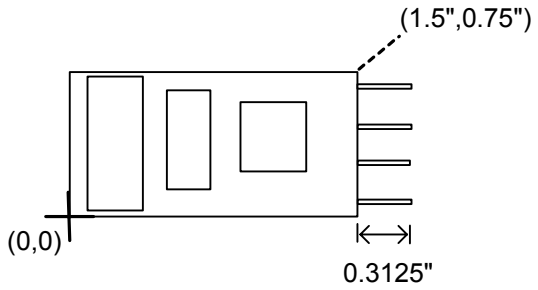
**Example #2, Bridge Circuit (strain gauge, pressure transducer, etc.):** A Wheatstone bridge is made of 350 ohm strain gauges and excited by VREF and GND (meaning that Vcm=1.25 volts). The outputs are connected to IN+ and IN- and the difference is expected to swing from +0.005 to –0.005 volts. We choose Voffset=1.25 volts and Gain=201, such that the allowable input range for the LJTIA (with 0-2.5 volt output) is –0.00616 to +0.00622 volts.

## Specifications:

| Parameter | Conditions | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| **General** | | | | | |
| Supply Voltage | | 3.6 | 5 | 5.5 | volts |
| Supply Current (1) | No Loads | | 1.5 | | mA |
| Operating Temperature | | -40 | | 85 | °C |
| **Signal Bandwidth** | | | | | |
| -3 dB Bandwidth | x1 | | 18 | | kHz |
| | x11 | | 18 | | kHz |
| | x51 | | 18 | | kHz |
| | x201 | | 10 | | kHz |
| **Vref** | | | | | |
| Output Voltage | | 2.495 | 2.50 | 2.505 | volts |
| Initial Accuracy | | | 0.2 | | % |
| Current Output (1) | For rated V accuracy | 0 | | 25 | mA |

(1) Higher currents will not cause damage, but the reference voltage will start to sag. The reference output can handle a continuous short-circuit to ground and has a short-circuit current of about 45 mA typically.

## Dimensions:




**Declaration of Conformity**

**Manufacturers Name:** LabJack Corporation
**Manufacturers Address:** 13701 W Jewell Ave, STE 284, Lakewood, CO 80228, USA

Declares that the product

Product Name: LJTick-InAmp
Model Number: LJTIA

conforms to the following Product Specifications:

**EMC Directive: 89/336/EEC**

EN 55011 Class A
EN 61326-1: General Requirements

## Appendix A: Resolution Tables

The following tables use typical noise measurements with the LabJack U3 and UE9 to determine the noise-free and effective resolutions that can be expected with the LJTick-InAmp (LJTIA). The LJTIA was connected to an analog input on the LabJack and had IN+ shorted to IN- shorted to GND.

The counts of peak-to-peak noise were determined by collecting 128 points from the analog input and subtracting the minimum binary value from the maximum binary value. For the U3 these are based on 12-bit values, while for the UE9 these are based on 24-bit values.

The noise-free resolution is based the peak-to-peak noise counts, and corresponds to the resolution where no jitter would be seen.

The RMS noise counts is the standard deviation of the 128 collected binary values, and the effective resolution values are based on this RMS value. The effective resolution can be thought of as a specification met by *most* points, while the noise-free specifications are met by all points.

The "@LJ Inputs" values are in terms of the LabJack U3/UE9 analog input, which is the LJTIA output. Those values are divided by the LJTIA gain to determine the "@LJTIA Inputs" values, which are the resolutions that apply to the signal input to the LJTIA. For instance, a single-ended channel on the LabJack U3 with an LJTIA gain of 201 has a noise-free resolution of about 9 µV and an effective resolution of about 1.8 µV.

### LabJack U3:

LJTIA Gain = 1

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| SE | 2 | 11.0 | 0.001191 | 0.00119141 | 0.5 | 13.0 | 0.000298 | 0.00029785 |
| Diff | 2 | 11.0 | 0.002383 | 0.00238281 | 0.5 | 13.0 | 0.000596 | 0.00059570 |
| 0-3.6 | 2 | 11.0 | 0.002383 | 0.00238281 | 0.5 | 13.0 | 0.000596 | 0.00059570 |

LJTIA Gain = 11

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| SE | 2 | 11.0 | 0.001191 | 0.00010831 | 0.5 | 13.0 | 0.000298 | 0.00002708 |
| Diff | 2 | 11.0 | 0.002383 | 0.00021662 | 0.5 | 13.0 | 0.000596 | 0.00005415 |
| 0-3.6 | 2 | 11.0 | 0.002383 | 0.00021662 | 0.5 | 13.0 | 0.000596 | 0.00005415 |

LJTIA Gain = 51

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| SE | 2 | 11.0 | 0.001191 | 0.00002336 | 0.5 | 13.0 | 0.000298 | 0.00000584 |
| Diff | 2 | 11.0 | 0.002383 | 0.00004672 | 0.5 | 13.0 | 0.000596 | 0.00001168 |
| 0-3.6 | 2 | 11.0 | 0.002383 | 0.00004672 | 0.5 | 13.0 | 0.000596 | 0.00001168 |

LJTIA Gain = 201

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| SE | 3 | 10.4 | 0.001806 | 0.00000898 | 0.6 | 12.7 | 0.000367 | 0.00000182 |
| Diff | 3 | 10.4 | 0.003612 | 0.00001797 | 0.6 | 12.7 | 0.000733 | 0.00000365 |
| 0-3.6 | 3 | 10.4 | 0.003612 | 0.00001797 | 0.6 | 12.7 | 0.000733 | 0.00000365 |

**LabJack UE9 (LJTIA Gain = 1 & 11):**

All "counts" data in the following UE9 tables are from 24-bit values. To equate to counts at a particular resolution (Res) use the formula counts/(2^(24-Res)). For instance, with the UE9 set to 12-bit resolution and the 0-5 volt range, there are 8192 counts of noise when looking at 24-bit values. To equate this to 12-bit data, we take 8192/(2^12), which equals 2 counts of noise when looking at 12-bit values.

Resolution = 0-12, LJTIA Gain = 1

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 12288 | 10.4 | 0.003700 | 0.00370048 | 2350 | 12.8 | 0.000701 | 0.00070111 |
| 0-2.5 | 20480 | 9.7 | 0.003006 | 0.00300572 | 4100 | 12.0 | 0.000610 | 0.00061035 |

Resolution = 17, LJTIA Gain = 1

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 408 | 15.3 | 0.000124 | 0.00012394 | 78 | 17.7 | 0.000023 | 0.00002348 |
| 0-2.5 | 620 | 14.7 | 0.000094 | 0.00009393 | 120 | 17.1 | 0.000018 | 0.00001780 |

Resolution = 18+ (UE9-Pro), LJTIA Gain = 1

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 96 | 17.4 | 0.000029 | 0.00002891 | 20 | 19.7 | 0.000006 | 0.00000587 |

Resolution = 0-12, LJTIA Gain = 11

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 12288 | 10.4 | 0.003700 | 0.00033641 | 2350 | 12.8 | 0.000701 | 0.00006374 |
| 0-2.5 | 20480 | 9.7 | 0.003006 | 0.00027325 | 4100 | 12.0 | 0.000610 | 0.00005549 |

Resolution = 17, LJTIA Gain = 11

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 408 | 15.3 | 0.000124 | 0.00001127 | 78 | 17.7 | 0.000023 | 0.00000213 |
| 0-2.5 | 620 | 14.7 | 0.000094 | 0.00000854 | 120 | 17.1 | 0.000018 | 0.00000162 |

Resolution = 18+ (UE9-Pro), LJTIA Gain = 11

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 110 | 17.2 | 0.000033 | 0.00000302 | 20 | 19.7 | 0.000006 | 0.00000053 |

**LabJack UE9 (LJTIA Gain = 51 & 201):**

All "counts" data in the following UE9 tables are from 24-bit values. To equate to counts at a particular resolution (Res) use the formula counts/(2^(24-Res)). For instance, with the UE9 set to 12-bit resolution and the 0-5 volt range, there are 8192 counts of noise when looking at 24-bit values. To equate this to 12-bit data, we take 8192/(2^12), which equals 2 counts of noise when looking at 12-bit values.

Resolution = 0-12, LJTIA Gain = 51

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 12288 | 10.4 | 0.003700 | 0.00007256 | 2350 | 12.8 | 0.000701 | 0.00001375 |
| 0-2.5 | 20480 | 9.7 | 0.003006 | 0.00005894 | 4100 | 12.0 | 0.000610 | 0.00001197 |

Resolution = 17, LJTIA Gain = 51

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 472 | 15.1 | 0.000142 | 0.00000279 | 87 | 17.6 | 0.000025 | 0.00000049 |
| 0-2.5 | 776 | 14.4 | 0.000116 | 0.00000227 | 147 | 16.8 | 0.000022 | 0.00000043 |

Resolution = 18+ (UE9-Pro), LJTIA Gain = 51

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 172 | 16.6 | 0.000050 | 0.00000099 | 29 | 19.2 | 0.000008 | 0.00000016 |

Resolution = 0-12, LJTIA Gain = 201

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 16384 | 10.0 | 0.004883 | 0.00002429 | 3500 | 12.2 | 0.001063 | 0.00000529 |
| 0-2.5 | 32768 | 9.0 | 0.004883 | 0.00002429 | 6480 | 11.3 | 0.000992 | 0.00000493 |

Resolution = 17, LJTIA Gain = 201

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 1232 | 13.7 | 0.000376 | 0.00000187 | 185 | 16.5 | 0.000054 | 0.00000027 |
| 0-2.5 | 2104 | 13.0 | 0.000305 | 0.00000152 | 376 | 15.4 | 0.000058 | 0.00000029 |

Resolution = 18+ (UE9-Pro), LJTIA Gain = 201

| Range | Peak-To-Peak Noise | Noise-Free Resolution | Noise-Free Res. @LJ Inputs | Noise-Free Res. @LJTIA Inputs | RMS Noise | Effective Resolution | Effective Res. @LJ Inputs | Effective Res. @LJTIA Inputs |
|---|---|---|---|---|---|---|---|---|
| volts | counts | bits | volts | volts | counts | bits | volts | volts |
| 0-5 | 484 | 15.1 | 0.000142 | 0.00000071 | 106 | 17.3 | 0.000031 | 0.00000015 |