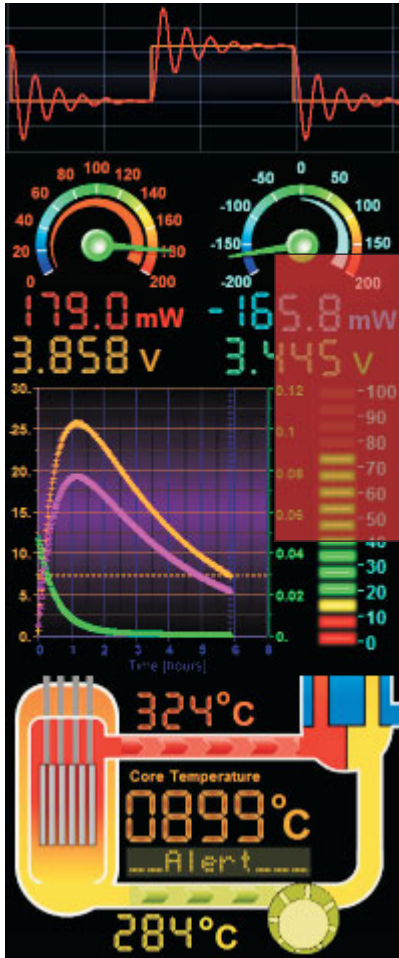


## Measurement Configuration

The LabRecon chip has 8 Analog Inputs to measure physical quantities from analog sensors. The LabRecon software offers many options to convert the sensor outputs to engineering units.

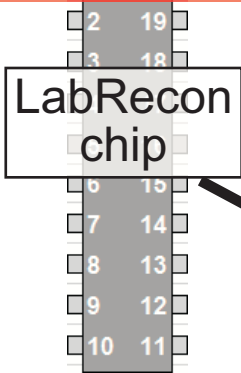


## LabRecon

*Software and Hardware for  
Measurement, Control and Simulation*

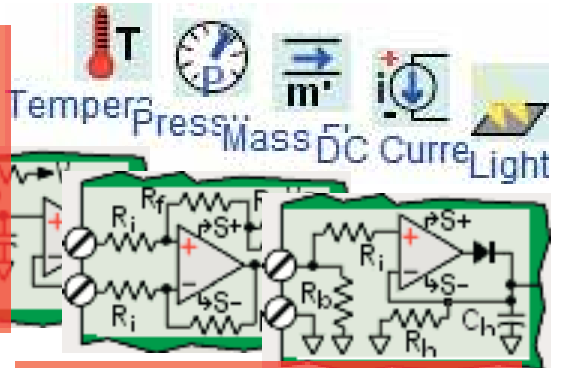
Measurement Configuration - Data Path

Each Analog Input is sampled at 100 Hz and a digital filter reduces noise resulting in stable measurements at a bandwidth of 2 Hz.



USB, Bluetooth (wireless), or Serial

The *Measurement Wizard* can employ built-in profiles for sensors and circuits to automatically provide a circuit design and implement linear or non-linear scaling.



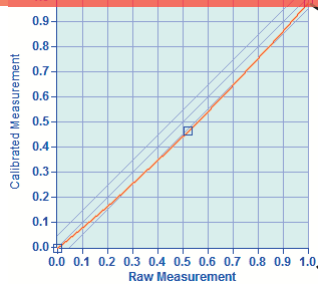
Configuration Wizard

Part #	Sensor	Range	Offset
KC003T	GE Sensing	-30 to 150C	+1C @25C
103JL1A	US Sensor	-30 to 300C	+0.5C
PS103J2	US Sensor	0 to 70C	+0.1C
MA100GG103A	GE Sensing	0 to 50C	+0.1C
DC95F502W	GE Sensing	-30 to 150C	+0.2C

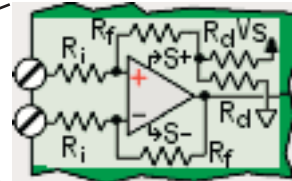
The Wizard provides lists of commercially available sensors the user can choose from.

LabRecon Software

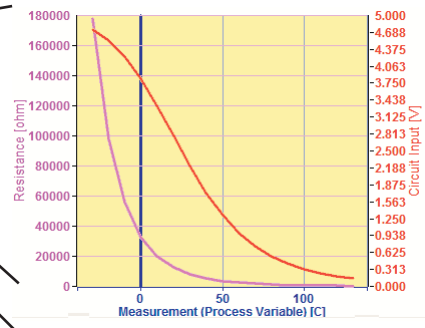
A Calibration Polynomial is calculated via 1, 2, or 3 Point Calibration or other methods chosen by the user.



Circuit Scaling



Sensor Scaling



Calibration Correction

Filtering and Hysteresis

Wire Diagram

I/O Ain

- Light 1: 220.74
- SolarPnl\_mA: 29.871
- SolarPnl\_V: 3.2380
- SolarPnl\_C: 046.09
- Battery mA: -28.300
- Battery V: 3.0170
- Battery C: 030.40
- Light 8: 002.69

0.000  
0.234  
NumLED

Strip Chart

- Battery Current
- Battery Voltage
- Battery Power
- Motor Left
- Motor Right

Units Conv

Panel

029.93

Strip Chart

11:03:16a 11:03:17a 11:03:18a 11:03:19a

LabRecon employs a **built-in database** of sensor scaling and circuits profiles to allow the user to quickly implement many types of measurements. The user can use either the **Measurement Configuration Wizard** or **configuration screens** to select a sensor, design a conditioning circuit, scale the measurement, & perform calibration correction.

### Measurement Configuration Wizard

The Wizard presents the user with lists of commercially available sensor part numbers and their parameters. Upon the selection of a sensor, LabRecon uses its embedded scaling database to automatically implement software scaling (linear or non-linear). LabRecon will further provide a suggested circuit schematic with calculated resistor values to condition the sensor output or measurement.

The Wizard can also present the user with lists of ranges of voltage or current measurements that can be made directly. Upon the selection of a range, LabRecon will apply the proper software scaling and provides a suggested circuit schematic.

### Analog Input Configuration Display Screen

This screen, shown below, displays the configuration for 8 Analog Input Measurement Channels. Clicking on a "Configure Channel" button allows using the Wizard or manual configuration.

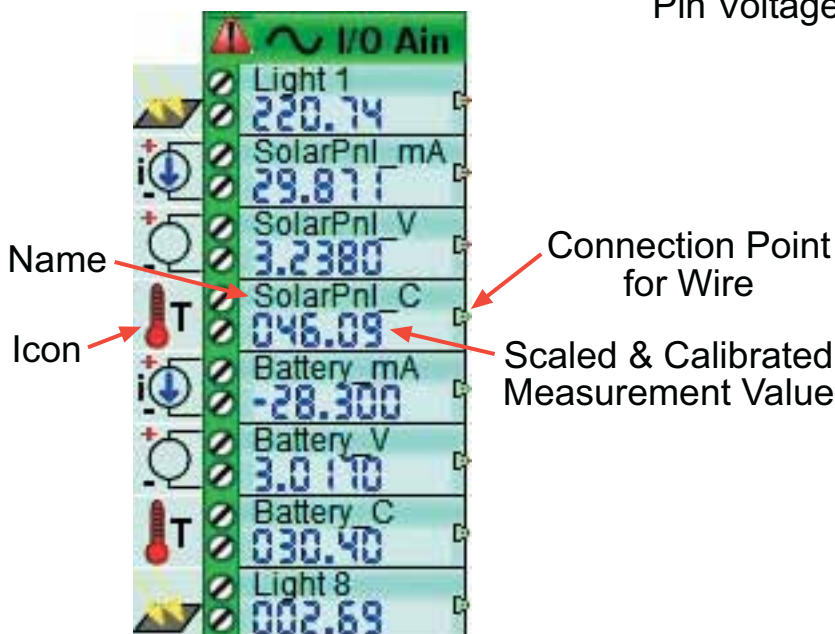
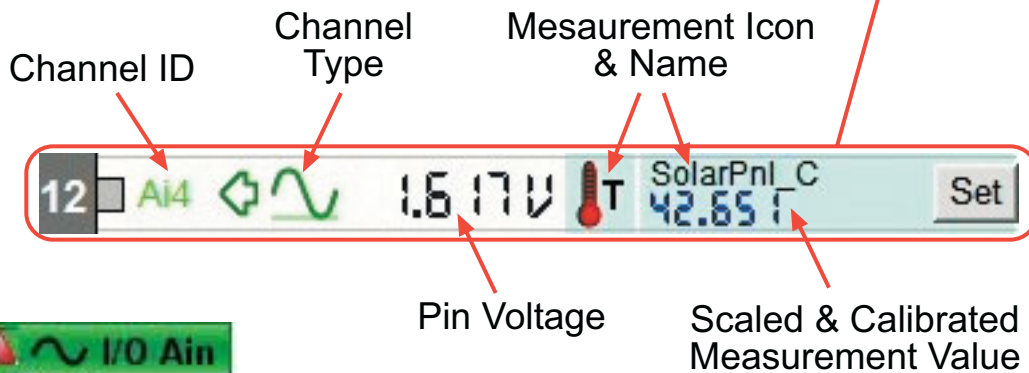
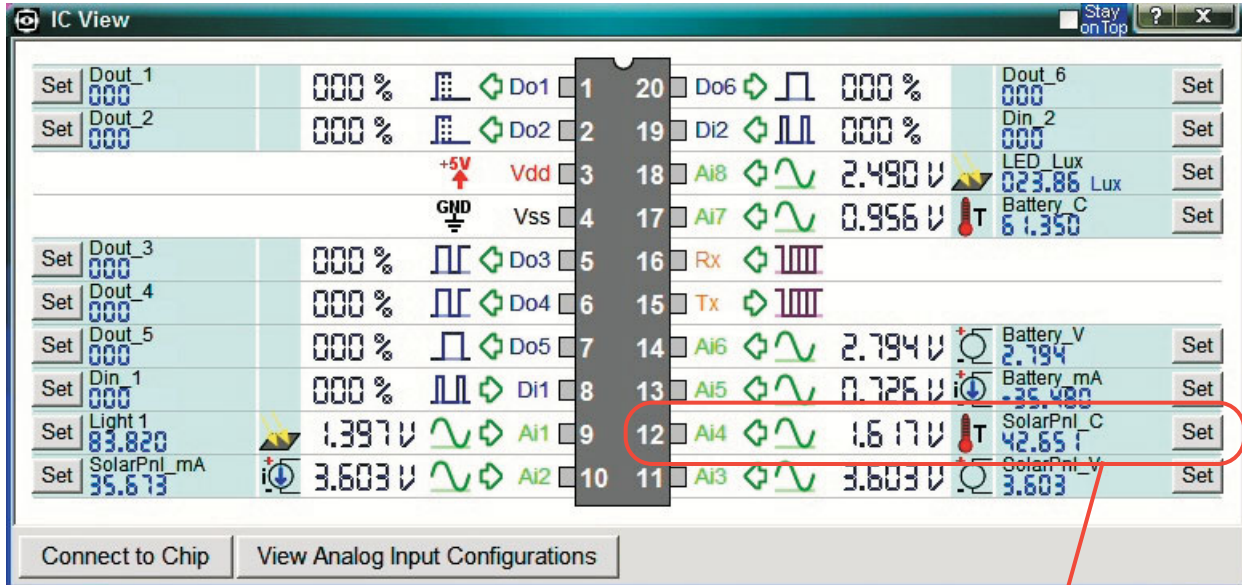
Each block provides a summary of the channel configuration including the measurement (sensor) icon, interface, circuit with component values, and a scaling chart, which represents the relationship used to scale (convert) the circuit input voltage to a measurement value.

The screenshot displays the 'Hardware Measurement Configuration: Analog Inputs' window, which is organized into a grid of 8 channels. Each channel configuration block includes:

- Measurement Name:** Ai 1 Light, Battery Current [mA], Solar Panel Current, Battery Voltage [V], Solar Panel Voltage [V], Battery Temperature [C], Solar Panel, Ai 8 Light.
- Code Name:** Light 1, Battery\_mA, SolarPnl\_mA, Battery\_V, SolarPnl\_V, Battery\_C, SolarPnl\_C, Light 8.
- Measurement Units:** Lux Lux light, mA Milliamperes current, V Volts voltage, C Celcius temperature, Lux Lux light.
- Measurement Range:** (.01 to 200) Lux, (-50 to 50) mA, (0 to 50) mA, (0 to 5) V, (0 to 5) V, (-30 to 130) C, (-30 to 130) C, (.01 to 200) Lux.
- PhysQty:** Light, DC Current, DC Voltage, Temperature, Light.
- Sensor:** PDV-P8101, TSL145, TSL14S, KC003T, PDV-P8103.
- Circuit:** Pullup Resistor, Difference Amplifier Bipolar Signal OPA2277P, Non-Inverting Amp. LM324K, Input Resistor Ri +OpAmp LM324K, Pullup Resistor Rp +OpAmp LM324K, Pullup Resistor Rp.
- Component Values:** Rp (4.99K, 2.00K, 100K, 2.00K, 2.00K, 10.0K, 24.9K), Vp (5, 5).
- Circuit Input Voltage:** (0 to 5) V, (-50 to 50) mV, (0 to 49) mV, (0 to 5) V, (0 to 5) V, (0 to 5) V, (0 to 5) V.
- Scaling Chart:** A graph showing the relationship between the measurement value (x-axis) and the circuit input voltage (y-axis). The y-axis for all charts is 'Circuit Input [V]' ranging from 0.0 to 5.0. The x-axis varies by channel: Lux (0-200), mA (0-50), V (0-5), C (-50-150), and Lux (0-200).
- Buttons:** 'Configure Channel 1' through 'Configure Channel 8'.

This screen displays the pin layout of the *LabRecon* I.C. and can be opened via the Start Menu or Controller chip object on the Wire Diagram.

Configuration information and real-time values are displayed for pins that can be used as an I/O Channel (Analog Input, Digital Input, or Digital Output).



Analog Input Controller I/O object on Wire Diagram

Real-time measurement values appear on both the **LabRecon IC View** screen and the **Controller I/O objects** on the **Wire Diagram** in addition to objects on the **Panel**.

One can right-click on the Wire Diagram object for a pop-up menu to open the LabRecon IC View, the Channel Configurations, or the Hardware Connection screen.

The “Change Sensor”, “Change Interface”, and “Change Circuit” buttons allow the user to select from a list of options for each item.

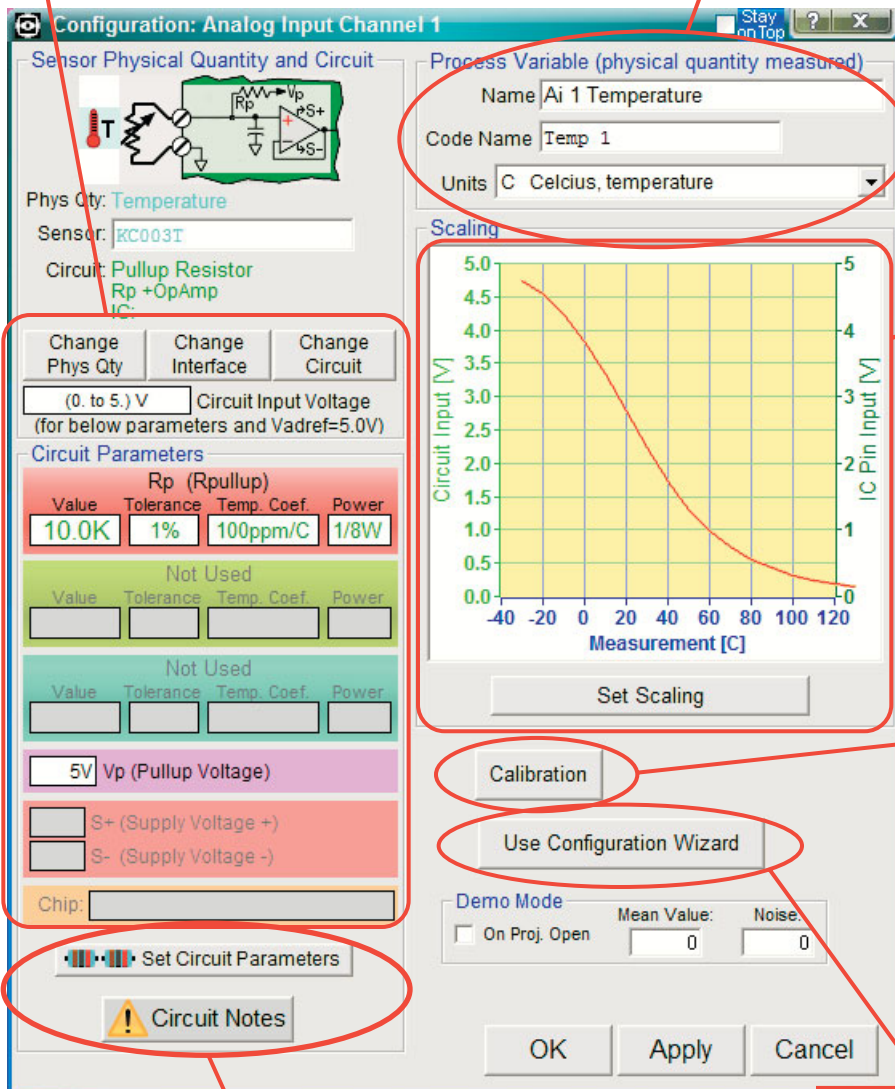
This section also shows the Component values used in the Circuit to achieve the Input Voltage range shown.

The user can use the lower “Set Circuit Parameters” button to change component values.

The Process Variable refers to the physical quantity being measured, ie temperature, light, pressure, via a sensor connected to a channel. It may also refer to a voltage measured directly.

A name for the channel can be typed into the “Name” edit box and a shortened name can be typed into the “Code Name” edit box. The “Code Name” will be displayed on the Controller I/O Object on the Wire Diagram, where space is limited for text.

The “Units” list box can be used to select units for the physical quantity being measured, ie “V”, “C”, “PSI”.



The user can open the **Scaling Configuration** screen to create a Linear or Non-Linear relationship to convert the **Sensor Output** (voltage or resistance) to a **Measurement value** in true engineering units.

This scaling can be defined either by 2 points on a coordinate plane with linear, logarithmic, or reciprocal axes or with imported X,Y Table values.

The resultant Scaling Relationship curve is shown here.

The user can open the **Calibration** screen to correct for parameter variances of specific sensors and circuit components when comparing the measurement to a reference.

The user can employ 1, 2, or 3 Point scaling or set Offset, Slope, and Curvature, parameters directly.

The “Set Circuit Parameters” opens the Circuit Parameter Configuration Screen to allow the user to choose from a list of examples for various Input Voltage Ranges or to change individual component values.

The “Circuit Notes” button displays notes of interest for the circuit.

The “Use Configuration Wizard” button will start the Wizard to allow the user to choose from lists of **commercially available sensors** or **measurement types**. The Wizard will use **built-in sensor and circuit data** to automatically set the circuit and component values and scaling parameters.

### Analog Input Circuit Selection

The differential amplifier allows the measurement of a voltage that may not be referenced to ground. This can be useful for measuring individual cell voltages in a battery pack.  
 $R_+$  should equal  $R_-$  and  $R_g$  should equal  $R_f$ . Mismatches will adversely affect the circuit's CMRR (Common Mode Rejection Ratio).

For default values ( $R_i, R_i=100K$ ,  $R_g, R_f=10.0K$ ) and  $V_{adref}=2.500V$   
 Input Voltage Range = (0.000 to 25.000)

Direct

Input Resistor  $R_i$

Voltage Divider  $R_i, R_g$

Voltage Divider  $R_i, R_p$

Voltage Divider  $R_i, R_g, R_p$

Pullup Resistor  $R_p$

Pulldown Resistor  $R_g$

Direct +OpAmp

Input Resistor  $R_i$  +OpAmp

Voltage Divider  $R_i, R_g$  +OpAmp

Voltage Divider  $R_i, R_p$  +OpAmp

Voltage Divider  $R_i, R_g, R_p$  +OpAmp

Pullup Resistor  $R_p$  +OpAmp

Pullup Resistor  $R_p, R_i$  +OpAmp

Pulldown Resistor  $R_g$  +OpAmp

Difference Amplifier  $R_i, R_i-, R_g, R_f$  +OpAmp

Inverting Amp  $R_i, R_g$

Inverting Amplifier

A circuit description is displayed as the mouse passes over the circuit selections.

For the circuit selected the user can use the **Circuit Parameter Configuration Screen** to set component values to achieve the desired gain.

The **Measurement Icon** selected will be shown on the **Wire Diagram Object**, the **Chip View**, and **Configuration screens** to help identify the various measurements.

### Analog Input Sensor Selection

DC Voltage

AC Voltage

Battery

DC Current

AC Current

Pressure

Temperature

Light

Distance

Angle

Acceleration

Volume

Volumetric Flow

Mass Flow

Force

Torque

Strain

Magnetic Flux

Wavelength

Displacement X

Displacement Y

Displacement Z

Tilt

Sound Level

Chemical

pH

Photomultiplier

Alpha Particle

Angular Speed

### Sensor Interface Selection

Variable Resistance

Floating Battery

Powered Sensor

Low Side Shunt

High Side Shunt

4 to 20 mA

Powered Sensor Differential Output

The **sensor interface icon** selected will be shown on the **Configuration screens** to provide a further graphical representation of the sensor or measurement connections.

A screen can be opened to show information on the particular circuit including component value considerations.

A list of example circuit parameters to achieve various Input Ranges is provided that the user can click on to set the component values. Each example will display resulting circuit parameters such as input and output impedances, which are useful for considering sensor loading and analog to digital convertor driving.

**Circuit Parameters Calculation/Presets**

Input Range (0.000 to 5.000)  
Vimin to Vimax

A/D Input Volt Range 0 to Vadref  
0 to 2.5V

Circuit Gain Equation  
 $V_o = V_i * 1 / (1 + R_i / R_g)$

Vadref (A/D reference) 2.5V

Definitions/Notes:  
 Ri/Rp: Ratio of Ri to Rg  
 Alternate values of Ri and Rg can be used if they have the same ratio. Alternate values will effect Zi and Zo.  
 Ri: Input Resistor  
 Rg: Resistor to Ground  
 Zi: Input Impedance (calculated from Ri and Rg)  
 Zo: Output Impedance (calculated from Ri and Rg)  
 See Circuit Notes for further information.

Circuit Parameter Examples (for specified Vadref):

Input Range	Ri/Rg	Ri, Rg	Zi	Zo
0 to 4.0V	0.6	15.0K, 24.9K	39.9K	9.4K
0 to 5.0V	1	100K, 100K	200.0K	50.0K
0 to 7.5V	2	20.0K, 10.0K	30.0K	6.7K
0 to 10.0V	3	150K, 49.9K	199.9K	37.4K
0 to 12.5V	4	100K, 24.9K	124.9K	19.9K
0 to 15.0V	5	100K, 20.0K	120.0K	16.7K
0 to 20.0V	7	100K, 14.3K	114.3K	12.5K
0 to 25.0V	9	301K, 33.2K	334.2K	29.9K
0 to 27.5V	10	100K, 10.0K	110.0K	9.1K
0 to 30.0V	11	110K, 10.0K	120.0K	9.2K
0 to 40.0V	15	150K, 10.0K	160.0K	9.4K
0 to 50.0V	19	191K, 10.0K	201.0K	9.5K
0 to 52.5V	20	200K, 10.0K	210.0K	9.5K

Circuit Parameters

Ri (Rinput)  
Value: 10.0K, Tolerance: 1%, Temp. Coef.: 100ppm/C, Power: 1/8W

Rg (Rground)  
Value: 10.0K, Tolerance: 1%, Temp. Coef.: 100ppm/C, Power: 1/8W

Not Used

Vp (Pullup Voltage) [Dropdown]  
+5V S+ (Supply Voltage +)  
Gnd S- (Supply Voltage -)

Chip: LM324K

Combo lists allow the user to select a pull-up voltage and chip supply voltages when applicable.

Clicking on the “Change this Resistor” button will open the “Resistor Picker” screen, which will display a list of standard 1% and 5% resistor values the user can choose from. The tolerance, temperature coefficient, and power rating can also be set.

Clicking on the “Change IC” button will open the “IC Picker” screen, which will display a list of ICs the user can choose from. The list will also display pertinent IC parameters such as offset voltage, offset voltage temperature drift, supply voltage range, input and output swings, etc.

For each Circuit notes can be viewed, which cover component considerations, accuracy, and optimization.

To aid the user in choosing and identifying resistor values the Resistor Picker screen displays a list of standard 1% and 5% resistor values. As the mouse passes over values the Band Colors of the Resistor Graphic follow.

### Circuit Notes: Voltage Divider Ri, Rg +OpAmp

The voltage divider will allow a voltage larger than the voltage range of the A/D convertor to be measured.

The addition of an Op Amp used as a buffer can result in more accurate measurements by providing a lower source impedance (Zo of Op Amp) for the A/D input. This allows interfacing to sensors that have a high output impedance (Zo of sensor).

The Op Amp can also help protect the A/D input if a part with input protection is used, ie LM324K.

Op-Amp inputs and output swing considerations:

The circuit's Input Range may be limited by the Op-Amp's input and output range limitations, especially if the S+ (Supply Positive) voltage is equal to Vdref (A/D converter Reference Voltage). The inputs or output of an Op-Amp may not be able to swing to the supply rails, S+ and S-, to maintain proper operation.

A Single Supply Op-Amp such as the LM324 will allow it inputs and output to swing to S- (Ground), but its output has a maximum voltage of S+ - 1.5V.

An Op-Amp with Rail-to-Rail inputs and outputs, such as the XXXX, will allow it inputs and output to swing very close to the Supply Rails, ie 20mV.

Either one or both Supply voltages can also be extended, ie S+ = 10V or S+ = 8V and S- = -8V, to accommodate the swing limitations.

It is advisable to consult the Op-Amp's datasheet to determine the limits of its inputs and output referenced to the S+ and S- and the maximum Supply voltages.

### Resistor Picker

Input 1

Since

to pro

the se

The c

circuit

1st Digit = 1

2nd Digit = 0

3rd Digit = 0

Multiplier = x10<sup>3</sup>

Value: 49.9K

Tolerance: 0.1%

Temp. Coef.: 1000 ppm/C

Power: 1/20W

Use the above Drop-down lists to change from default values

OK Apply Cancel

1% Tolerance Standard Values (values < 100 omitted)

100	215	464	1.00K	2.15K	4.64K	10.0K	21.5K	46.4K	100K	215K	464K
102	221	475	1.02K	2.21K	4.75K	10.2K	22.1K	47.5K	102K	221K	475K
105	226	487	1.05K	2.26K	4.87K	10.5K	22.6K	48.7K	105K	226K	487K
107	232	499	1.07K	2.32K	4.99K	10.7K	23.2K	49.9K	107K	232K	499K
110	237	511	1.10K	2.37K	5.11K	11.0K	23.7K	51.1K	110K	237K	511K
113	243	523	1.13K	2.43K	5.23K	11.3K	24.3K	52.3K	113K	243K	523K
115	249	536	1.15K	2.49K	5.36K	11.5K	24.9K	53.6K	115K	249K	536K
118	255	549	1.18K	2.55K	5.49K	11.8K	25.5K	54.9K	118K	255K	549K
121	261	562	1.21K	2.61K	5.62K	12.1K	26.1K	56.2K	121K	261K	562K
124	267	576	1.24K	2.67K	5.76K	12.4K	26.7K	57.6K	124K	267K	576K
127	274	590	1.27K	2.74K	5.90K	12.7K	27.4K	59.0K	127K	274K	590K
130	280	604	1.30K	2.80K	6.04K	13.0K	28.0K	60.4K	130K	280K	604K
133	287	619	1.33K	2.87K	6.19K	13.3K	28.7K	61.9K	133K	287K	619K
137	294	634	1.37K	2.94K	6.34K	13.7K	29.4K	63.4K	137K	294K	634K
140	301	649	1.40K	3.01K	6.49K	14.0K	30.1K	64.9K	140K	301K	649K
143	309	665	1.43K	3.09K	6.65K	14.3K	30.9K	66.5K	143K	309K	665K
147	316	681	1.47K	3.16K	6.81K	14.7K	31.6K	68.1K	147K	316K	681K
150	324	698	1.50K	3.24K	6.98K	15.0K	32.4K	69.8K	150K	324K	698K
154	332	715	1.54K	3.32K	7.15K	15.4K	33.2K	71.5K	154K	332K	715K
158	340	732	1.58K	3.40K	7.32K	15.8K	34.0K	73.2K	158K	340K	732K
162	348	750	1.62K	3.48K	7.50K	16.2K	34.8K	75.0K	162K	348K	750K
165	357	768	1.65K	3.57K	7.68K	16.5K	35.7K	76.8K	165K	357K	768K
169	365	787	1.69K	3.65K	7.87K	16.9K	36.5K	78.7K	169K	365K	787K
174	374	806	1.74K	3.74K	8.06K	17.4K	37.4K	80.6K	174K	374K	806K
178	383	825	1.78K	3.83K	8.25K	17.8K	38.3K	82.5K	178K	383K	825K
182	392	845	1.82K	3.92K	8.45K	18.2K	39.2K	84.5K	182K	392K	845K
187	402	866	1.87K	4.02K	8.66K	18.7K	40.2K	86.6K	187K	402K	866K
191	412	887	1.91K	4.12K	8.87K	19.1K	41.2K	88.7K	191K	412K	887K
196	422	909	1.96K	4.22K	9.09K	19.6K	42.2K	90.9K	196K	422K	909K
200	432	931	2.00K	4.32K	9.31K	20.0K	43.2K	93.1K	200K	432K	931K
205	442	953	2.05K	4.42K	9.53K	20.5K	44.2K	95.3K	205K	442K	953K
210	453	976	2.10K	4.53K	9.76K	21.0K	45.3K	97.6K	210K	453K	976K

5% Tolerance Standard Values

1.0	10	100	1.00K	10.0K	100K
1.1	11	110	1.10K	11.0K	110K
1.2	12	120	1.20K	12.0K	120K
1.3	13	130	1.30K	13.0K	130K
1.5	15	150	1.50K	15.0K	150K
1.6	16	160	1.60K	16.0K	160K
1.8	18	180	1.80K	18.0K	180K
2.0	20	200	2.00K	20.0K	200K
2.2	22	220	2.20K	22.0K	220K
2.4	24	240	2.40K	24.0K	240K
2.7	27	270	2.70K	27.0K	270K
3.0	30	300	3.00K	30.0K	300K
3.3	33	330	3.30K	33.0K	330K
3.6	36	360	3.60K	36.0K	360K
3.9	39	390	3.90K	39.0K	390K
4.3	43	430	4.30K	43.0K	430K
4.7	47	470	4.70K	47.0K	470K
5.1	51	510	5.10K	51.0K	510K
5.6	56	560	5.60K	56.0K	560K
6.2	62	620	6.20K	62.0K	620K
6.8	68	680	6.80K	68.0K	680K
7.5	75	750	7.50K	75.0K	750K
8.2	82	820	8.20K	82.0K	820K
9.1	91	910	9.10K	91.0K	910K

A 1% or 5% standard value can be clicked on or a custom value can be entered.



For scaling a custom linear or non-linear relationship of measurement to sensor output can be created by 3 methods.

- 1) The user can set two X,Y Points to define a linear relationship. Applications would include Pressure, DC Current, etc.
- 2) The user can set two X,Y Points on a coordinate plane with one or both axes being Nonlinear, ie Log10(X) & Log10(Y), 1/X & Y, Log10(X) & Y. Applications would include Light(CdS) and Triangulation Distance sensors.
- 3) The user can import X,Y Table data. Applications would include Thermistors.

If the **Wizard** was used to configure the channel, this screen will show the **built-in scaling parameters** applied, which the user can modify or use as a basis for a different sensor. Other features accessible via this screen include boundary limits/extrapolation and value scaling for X,Y table data.

**Scaling Configuration: Analog Input 4**

Data Import Text Status:  
Data Row Count: 17

**Ratiometric Y Axis Values**  
 use Multiplier 10000  
 Load Example

**XY Table Values**  
 Show Codes  Show Conversions

-30	17.800
-20	9.7760
-10	5.5700
0	3.2790
10	1.9980
20	1.2520
30	0.8038
40	0.5282
50	0.3546
60	0.2466
70	0.1748
80	0.1262
90	0.0924
100	0.0688
110	0.0521
120	0.0401
130	0.0312

**Sensor Output**  
 Voltage  
 Resistance (with Pull-up Resistor)  
 Rp: 10.0K Vp: 5.0

**Scaling Method**  
 Input Value (Voltage)  
 2 Point Scaling  
 XY Table Values  
 None (Raw A/D Value)

**2 Point Scaling**  
 Measurement (X Axis) Point 1: 0 C Point 2: 100 C Axis Type: Linear  
 Circuit Input (Y Axis) 0 ohm 5 ohm Linear

**Measurement Value Boundaries**  
 None (full Input Range)  
 Use Point 1, 2 Values  
 Use Custom values  
 Custom: Minimum 0 Maximum 2.5

**Scaling Curve:**

Graph showing Thermistor Resistance defined by X,Y Table Values (purple curve) and Resultant Voltage Curve (red curve) plotted against Measurement (Process Variable) [C].

The Scaling Configuration will also account for the **resultant voltage curve** resulting from the influence of a **Bias Resistor** value for sensors defined by a measurement to resistance relationship. The user can adjust the value of this resistor to view how the measurement can be optimized.

Apply OK Cancel

# LabRecon Calibration Screen

A Calibration Curve can be defined to correct for variances of a particular Sensor and and that of components in the Circuit. The Raw Measurement value can be compared to that of a Reference Measurement to create a correction polynomial to calculate the Displayed (Calibrated) value.

3 methods can be used to define the Calibration Curve.

- 1) The user can enter 1, 2, or 3 X,Y (Actual, Raw Reading) Pairs. Using 3 points spread over the operating range calculates a 2nd degree polynomial to best correct for Offset, Slope, and Curvature (Non-Linear) errors.
- 2) The user can set Offset, Slope, and Curvature parameters directly.
- 3) The user can set the 2nd degree polynomial coefficients directly.

If the user wishes to implement further “Active Calibration”, an additional measurement can be “linked” on the Wire Diagram with functions. For example, a temperature dependant error of a humidity sensor can be corrected with an associated thermistor.

Note: This screen is best used only for calibration and not to define the measurement to output response of a sensor, which should be handled by scaling set via the **Scaling Configuration** screen.

Raw (Uncalibrated) Reading  Calibrated Reading

Values OK

Calibration Points

Point 1  
Actual Raw Reading Load Raw Reading  
   Use Point

Point 2  
Actual Raw Reading Load Raw Reading  
   Use Point

Point 3  
Actual Raw Reading Load Raw Reading  
   Use Point

Resultant Polynomial (x=Raw, y=Calibrated)

Offset, Slope, Curvature

Offset

Slope

Curvature

Resultant Polynomial (x=Raw, y=Calibrated)

Calibration Coefficients/Equation

3: ,11.31,y, ,48.34,y, ,89.12,y

Calibration Method

1, 2, or 3 Calibration Points  
 Offset, Slope, Curvature  
 Coefficients/Equation

Calibrated Measurement

Raw Measurement

Apply OK Cancel

A chart displays the resultant 2nd degree polynomial used as a calibration curve. If there is no calibration correction a straight line will be shown representing a polynomial of  $y = 0 * x^2 + 1 * x + 0$ .

When using the **Measurement Wizard** the user is presented with lists of commercially available sensor part numbers including their various specifications.

Upon the selection of a sensor, *LabRecon* uses its **built-in part data** to automatically configure the proper scaling (linear or non-linear) and to provide a circuit schematic. Circuit resistor values are calculated using standard 1% values.

**Configuration Wizard**

Part #	Manufacturer	Range	Accuracy	Comments
KC003T	GE Sensing	-30 to 130C	+/-1C @25C	10Kohm @25C
103JL1A	US Sensor	-30 to 300C	+/-0.5C	10Kohm @25C +/-0.5C over 0 to 100C
PS103J2	US Sensor	0 to 70C	+/-0.1C	10Kohm @25C +/-0.1C over 0 to 70C
MA100GG103A	GE Sensing	0 to 50C	+/-0.1C	10Kohm @25C +/-0.1C over 20 to 45C
DC95F502W	GE Sensing	-30 to 150C	+/-0.2C	5Kohm @25C +/-0.2C over 0 to 70C

Example thermistors for temperature measurement

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**Configuration Wizard**

Part #	Manufacturer	Range (cm)	Range (in)	Comments
GP2D120	Sharp	4 to 40cm	1.5 to 15.7in	
GP2D12	Sharp	10 to 100cm	4 to 32in	33ma, \$13
GP2Y0A21	Sharp	10 to 80cm	4 to 32in	4.5 to 5.5V, 30ma, \$10
GP2Y0A02YK	Sharp	20 to 150cm	8 to 60in	33ma, \$14
GP2Y0A710K	Sharp	100 to 500cm	35 to 197in	33ma
GP2Y0A700K	Sharp	100 to 550cm	35 to 216in	33ma

Example LED triangulation sensors for distance measurement

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**Configuration Wizard**

Part #	Manufacturer	Range	Comments
HA-500-50	Empyro	500A	500A/50mV, 0.1 mOhm Manganin, +/-15ppm/C
HA-200-50	Empyro	200A	200A/50mV, 0.25 mOhm Manganin, +/-15ppm/C
HA-100-50	Empyro	100A	100A/50mV, 0.5 mOhm Manganin, +/-15ppm/C
HA-50-50	Empyro	50A	50A/50mV, 1 mOhm Manganin, +/-15ppm/C
HA-20-50	Empyro	20A	20A/50mV, 2.5 mOhm Manganin, +/-15ppm/C
5mOhm	any	10A	0.005 Ohm
1 Ohm	any	50mA	1 Ohm

Example current shunts for DC current measurement

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**Configuration Wizard**

Part #	Manufacturer	Range (uW/cm^2)	Response @640nm	Comments
TSL252R	Taos	0.90 to 300	1.68 V/(uW/cm^2)	2V +/-0.5 @38.5uW/cm^2
TSL251R	Taos	0.20 to 65	0.016 V/(uW/cm^2)	2V +/-0.5 @14.6uW/cm^2
TSL250R	Taos	0.06 to 25	0.064 V/(uW/cm^2)	2V +/-0.5 @31uW/cm^2
TSL257	Taos	0.01 to 6.7	0.248 V/(uW/cm^2)	2V +/-0.5 @8uW/cm^2
TSL14S	Taos	0.01 to 276	1.68 V/(uW/cm^2)	2V +/-0.5 @1.68uW/cm^2
TSL13S	Taos	0.01 to 71	0.064 V/(uW/cm^2)	2V +/-0.5 @31uW/cm^2
TSL12S	Taos	0.01 to 18	0.248 V/(uW/cm^2)	2V +/-0.5 @8uW/cm^2

Example amplified photodiode sensors for light measurement

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**Configuration Wizard**

Input Range	Ri/Rg	Ri, Rg	Zi	Zo
0 to 7.5V	0.5	100K, 200K	300.0K	66.7K
0 to 10.0V	1	100K, 100K	200.0K	50.0K
0 to 12.5V	1.5	150K, 100K	250.0K	60.0K
0 to 15.0V	2	200K, 100K	300.0K	66.7K
0 to 20.0V	3	301K, 100K	401.0K	75.1K
0 to 25.0V	4	200K, 49.9K	249.9K	39.9K
0 to 30.0V	5	100K, 20.0K	120.0K	16.7K
0 to 40.0V	7	200K, 28.7K	228.7K	25.1K

Example input ranges for DC Voltage measurement using standard resistor values