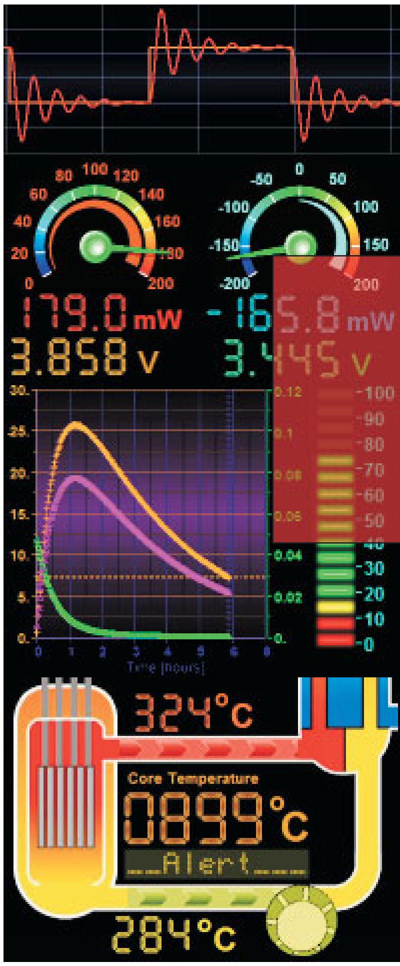
Measurement Configuration

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.

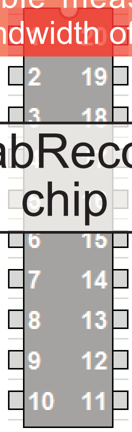


LabRecon

Software and Hardware for Measurement, Control and Simulation

Measurement Configuration - Data Path

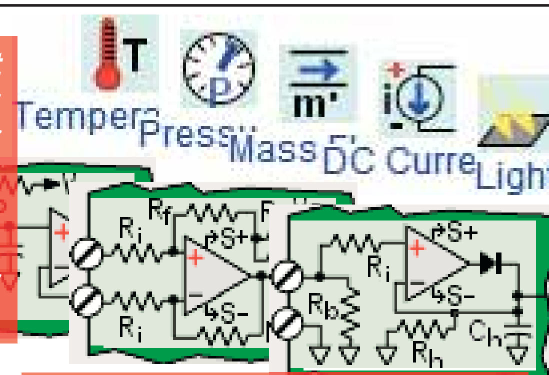
Each Analog Input is sampled at 100 Hz and a digital filter reduces noise resulting in stable measurements at a bandwidth of 2 Hz.



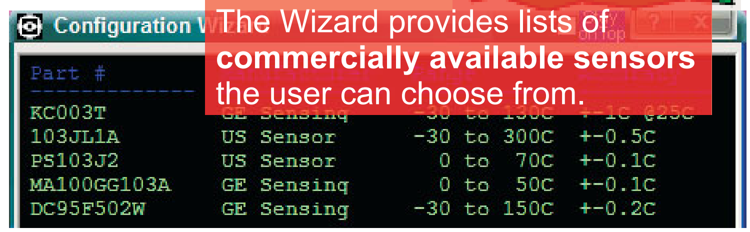
LabRecon chip

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.

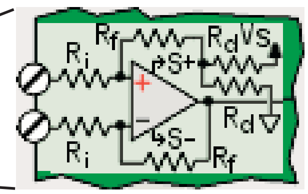


The Wizard provides lists of **commercially available sensors** the user can choose from.

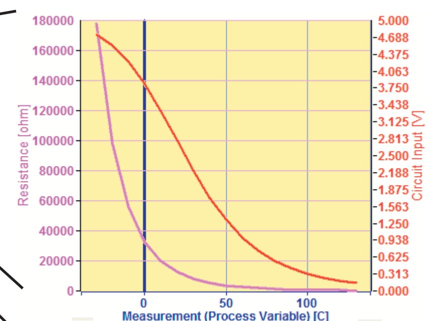


LabRecon Software

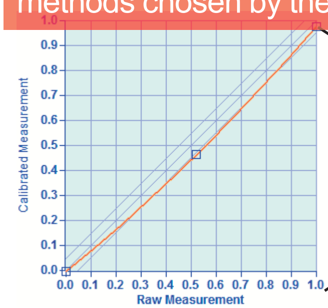
Circuit Scaling



Sensor Scaling



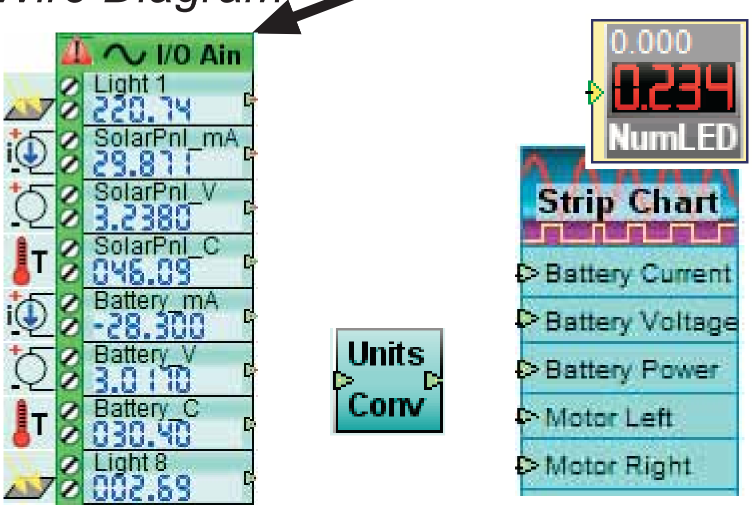
A **Calibration Polynomial** is calculated via **1, 2, or 3 Point Calibration** or other methods chosen by the user.



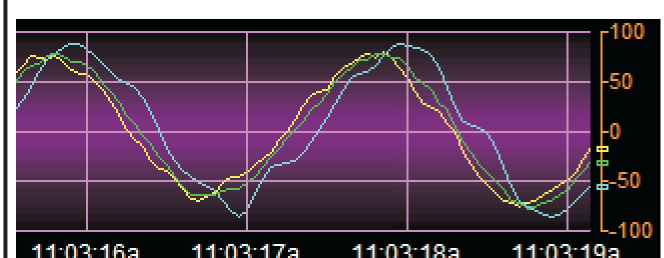
Calibration Correction

Filtering and Hysteresis

Wire Diagram



Panel



Strip Chart

LabRecon
Measurement Configuration

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

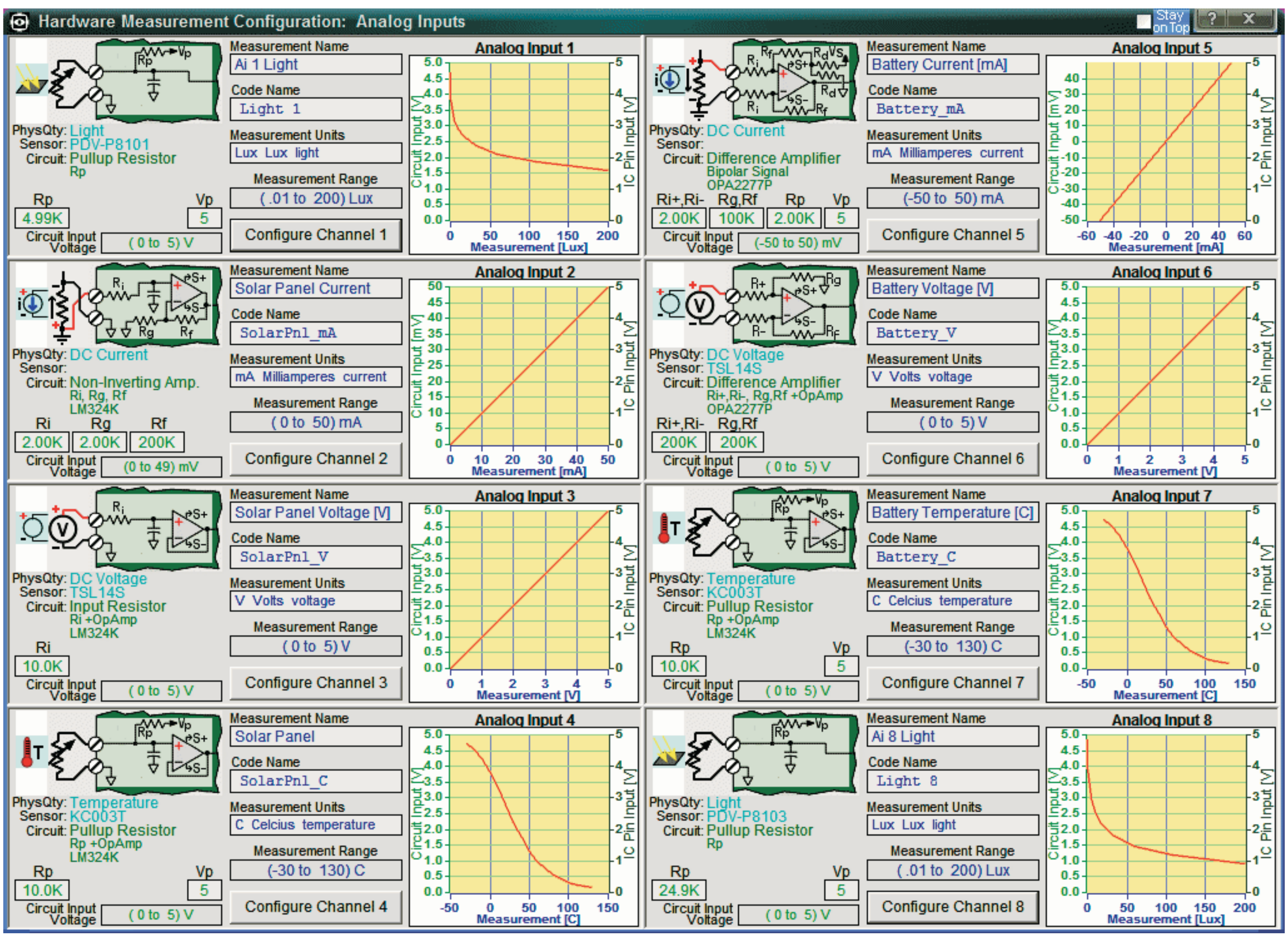
The Wizard presents the user with lists of commercially available sensor part numbers and their parameters. Upon the selection of a sensor, *LabRecon* uses its embedded scaling database to automatically implement software scaling (linear or non-linear). *LabRecon* will further provide a suggested circuit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

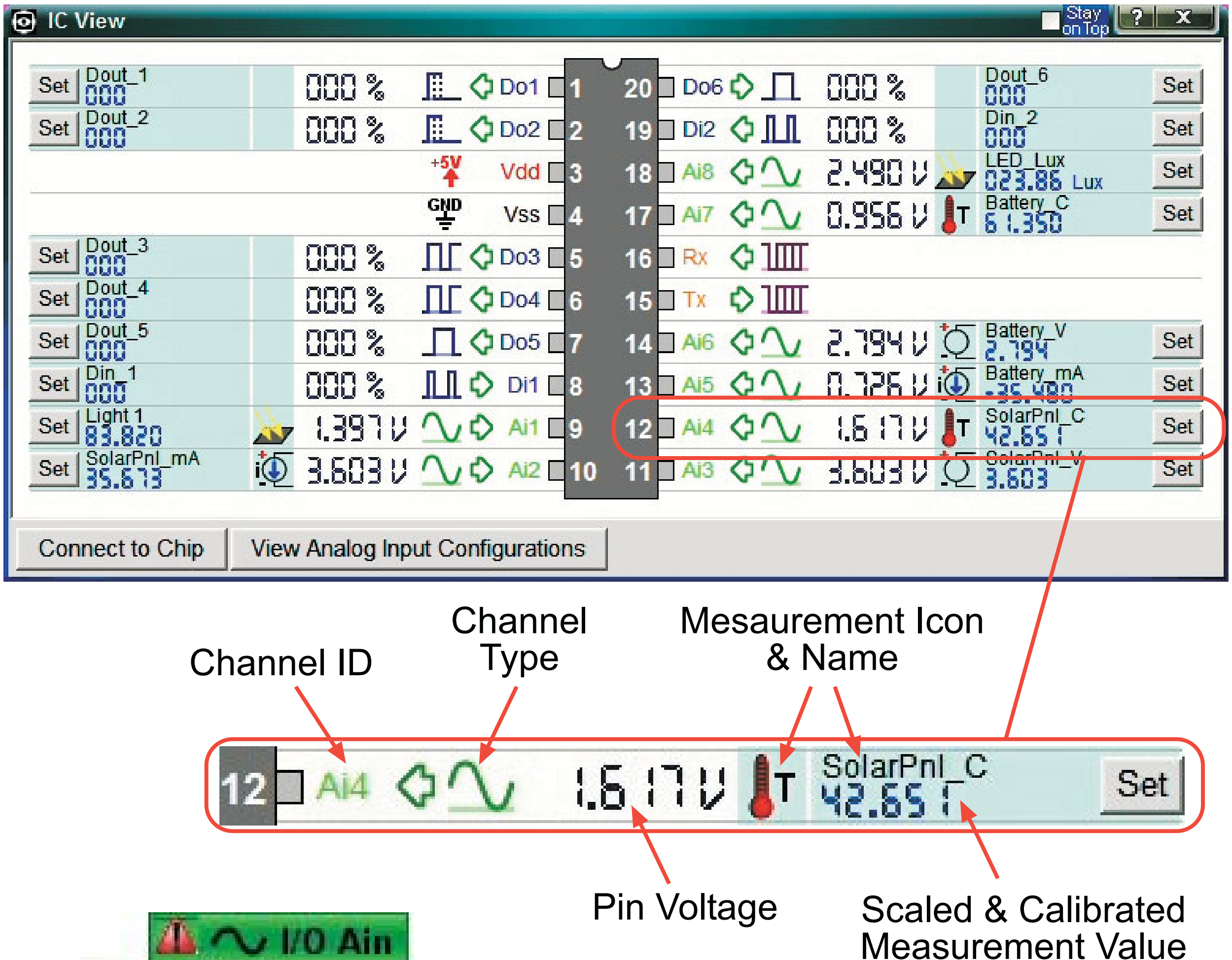
Each block provides a summary of the channel configuration including the measurement (sensor) icon, interface, circuit with component values, and a scaling chart, which represents the relationship used to scale (convert) the circuit input voltage to a measurement value.

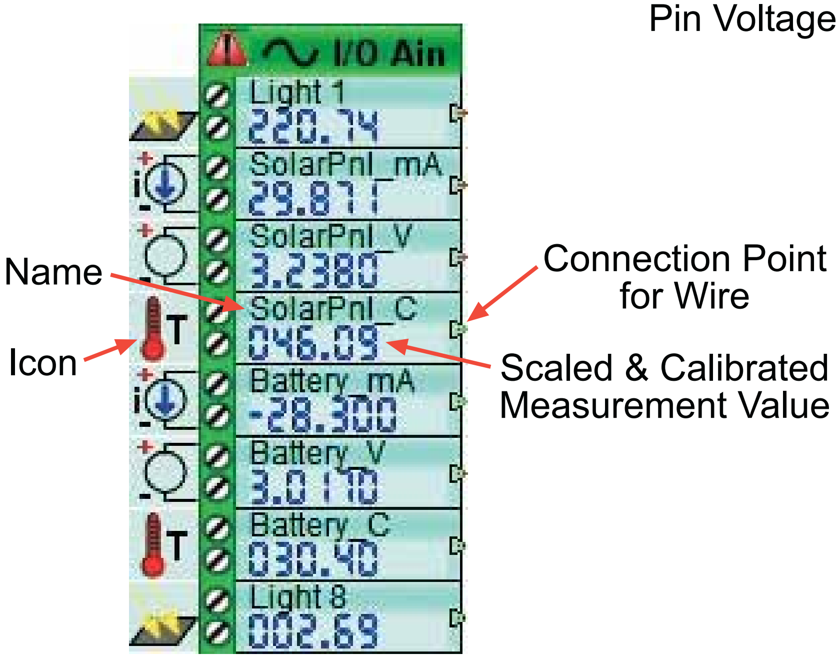


LabRecon Chip (Integrated Circuit) View

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.

Analog Input Channel Measurement Configuration Screen

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

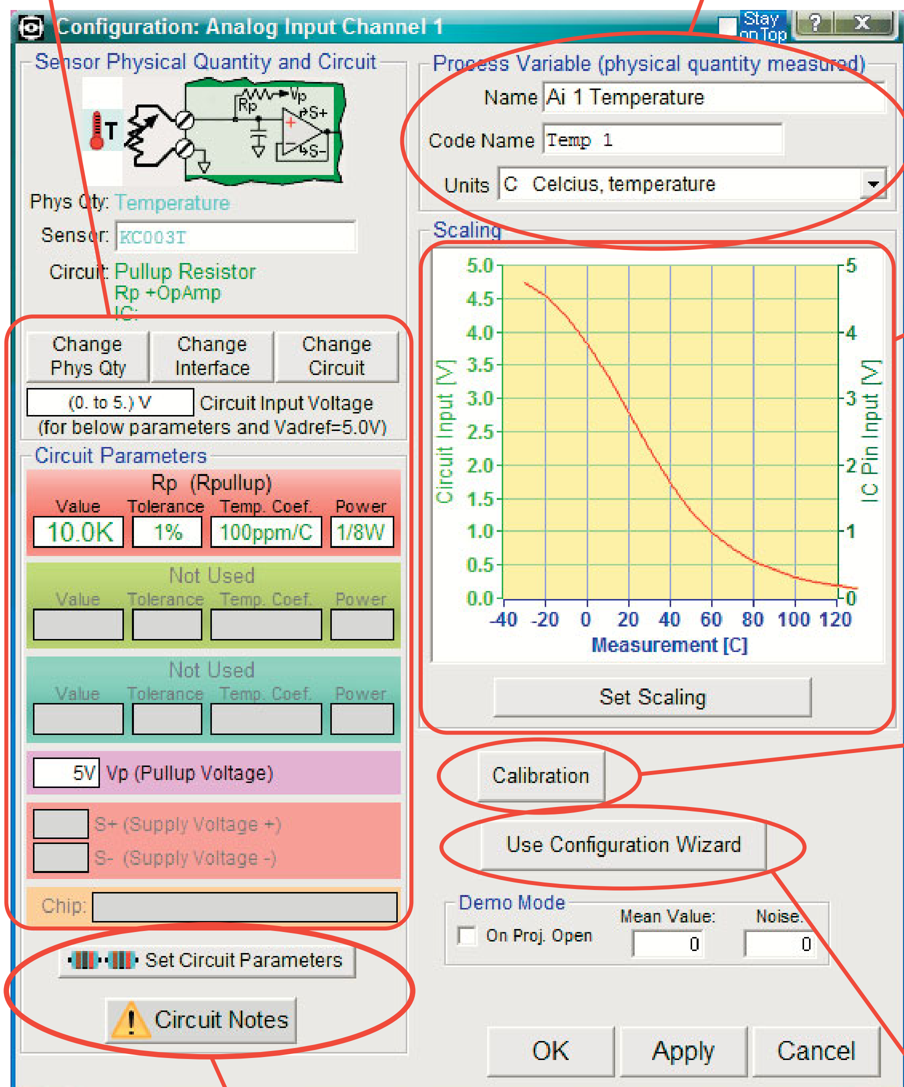
This section also shows the Component values used in the Circuit to achieve the Input Voltage range shown.

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 pysical 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.

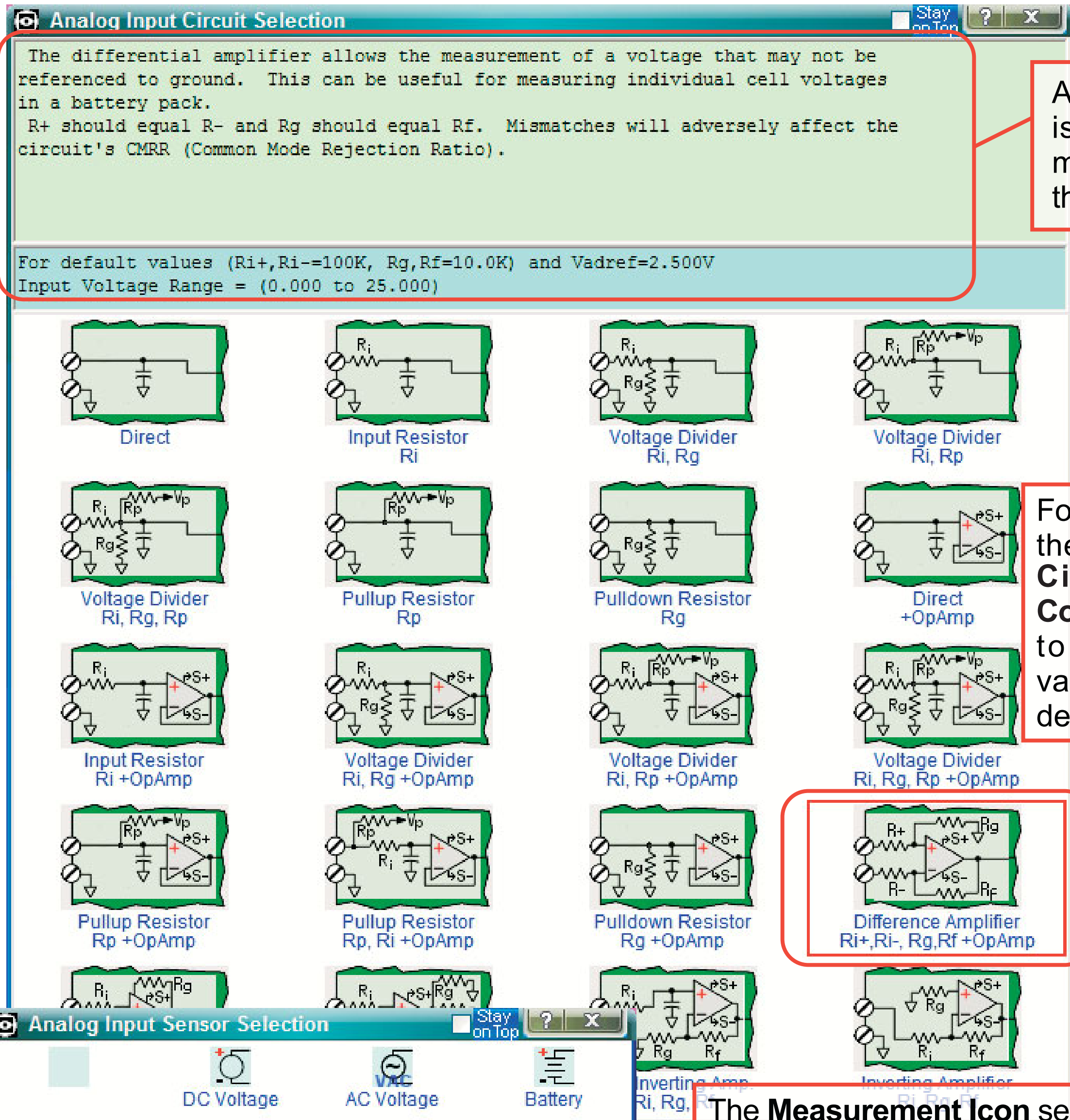
The “Set Circuit Parameters” opens the Circuit Parameter Configuration Screen to allow the user to choose from a list of examples for various Input Voltage Ranges or to change individual component values.

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

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.

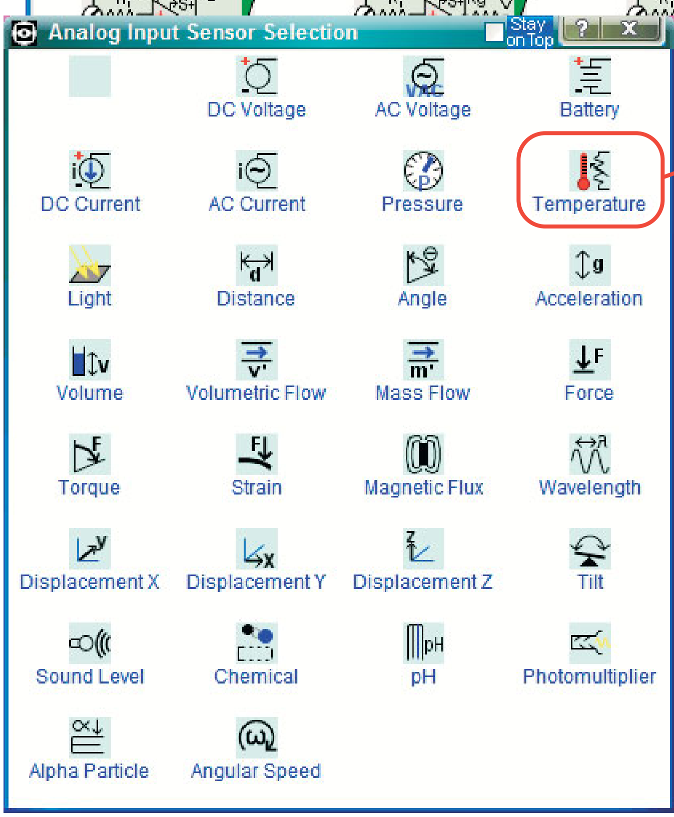
LabRecon

Selection Screens for Analog Input Circuit, Measurement/Sensor Type, and Sensor Interface

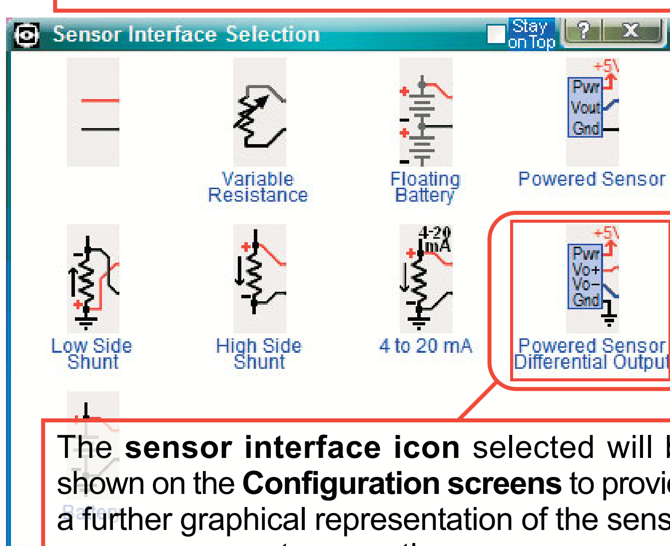


A circuit description is displayed as the mouse passes over the circuit selections.

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.

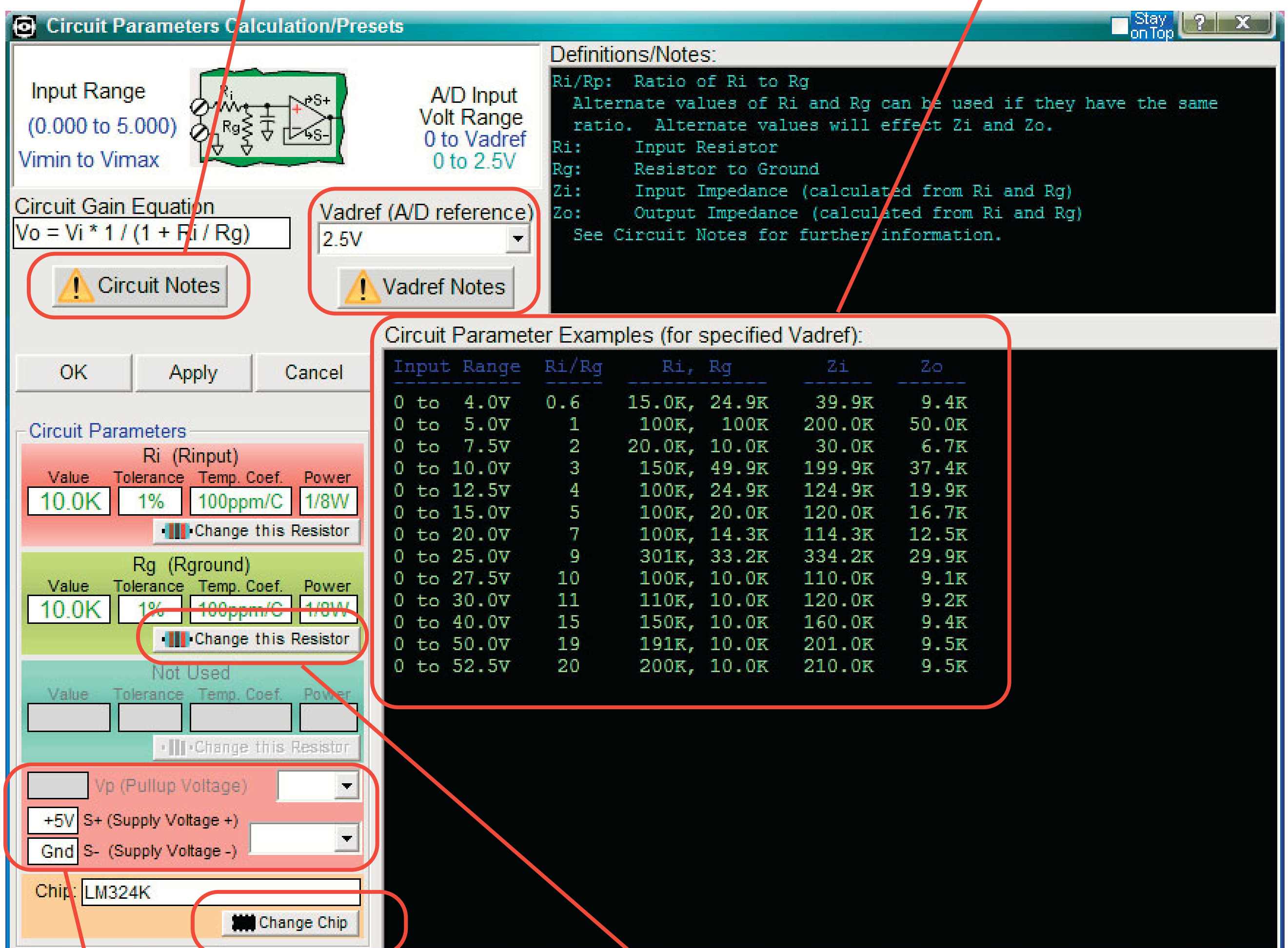


The **sensor interface icon** selected will be shown on the **Configuration screens** to provide a further graphical representation of the sensor or measurement connections.

LabRecon
Circuit Parameter Configuration Screen

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.



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

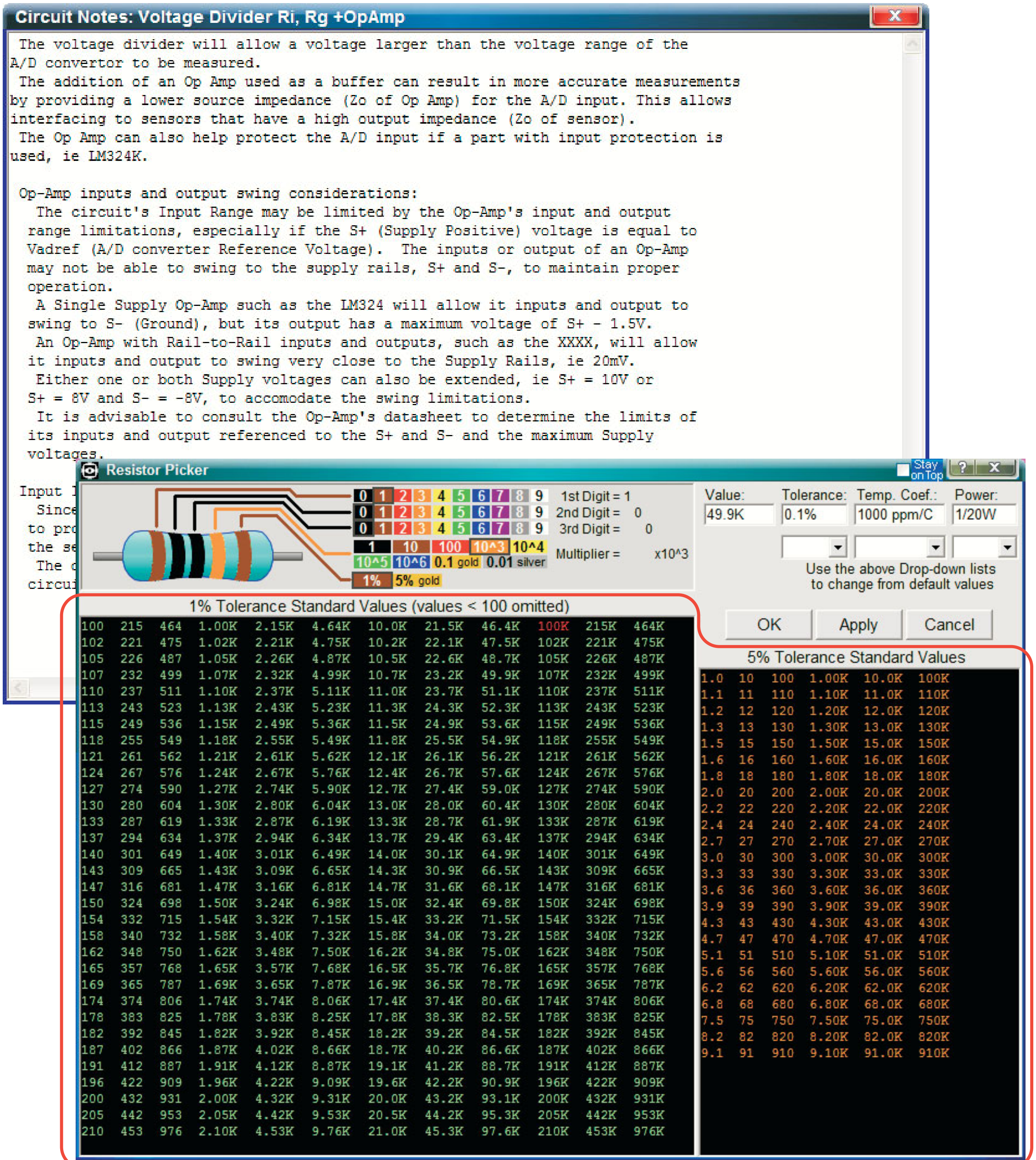
Clicking on the “Change this Resistor” button will open the “Resistor Picker” screen, which will display a list of standard 1% and 5% resistor values the user can choose from.
The tolerance, temperature coefficient, and power rating can also be set.

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 pertinant IC parameters such as offset voltage, offset voltage temperature drift, supply voltage range, input and output swings, etc.

Circuit Notes & Resistor Picker screens

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.




```
 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
  Vadref (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 accomodate 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.

 Input I
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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

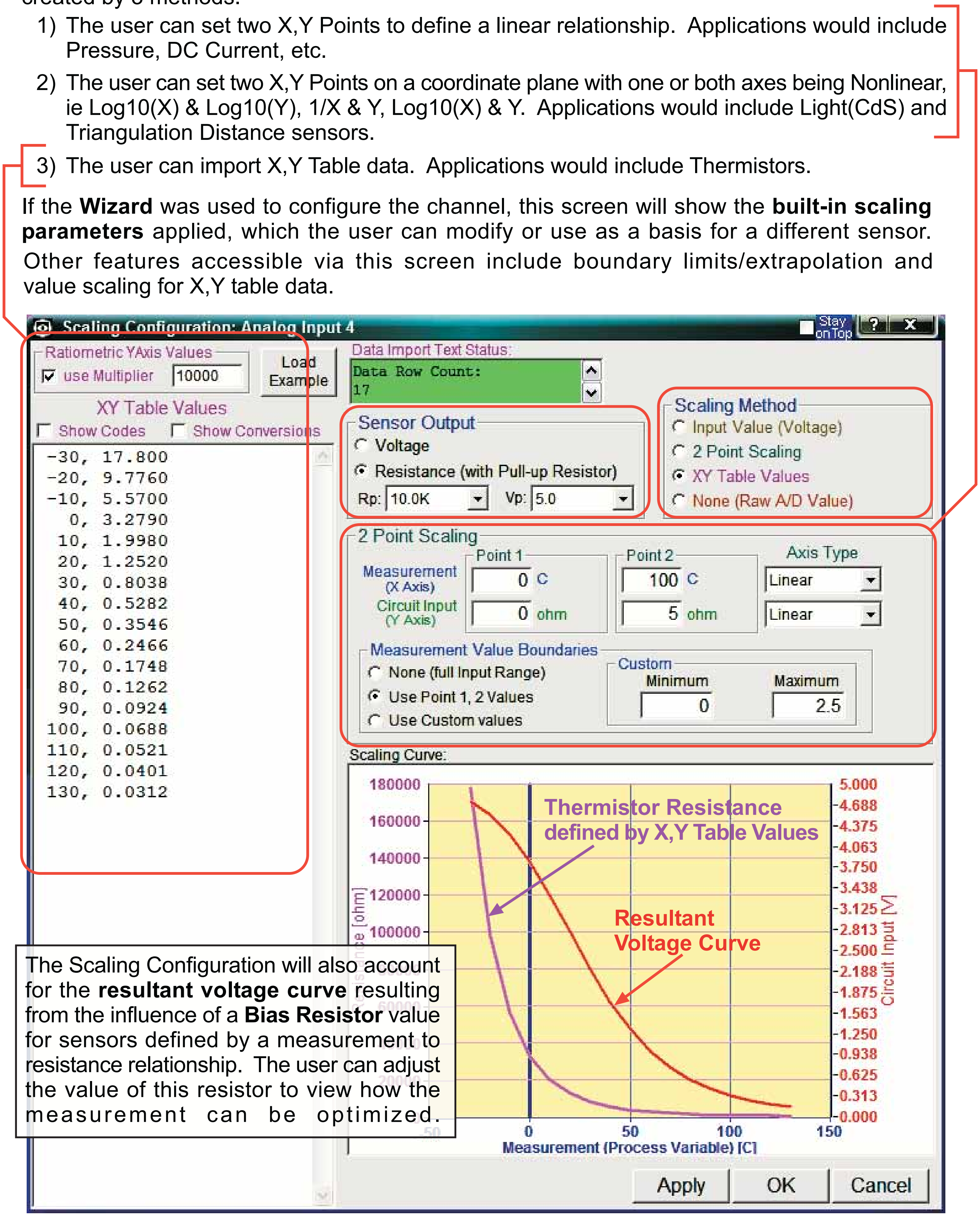
A 1% or 5% standard value can be clicked on or a custom value can be entered.

Scaling Configuration Screen

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.



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.

LabRecon
Calibration Screen

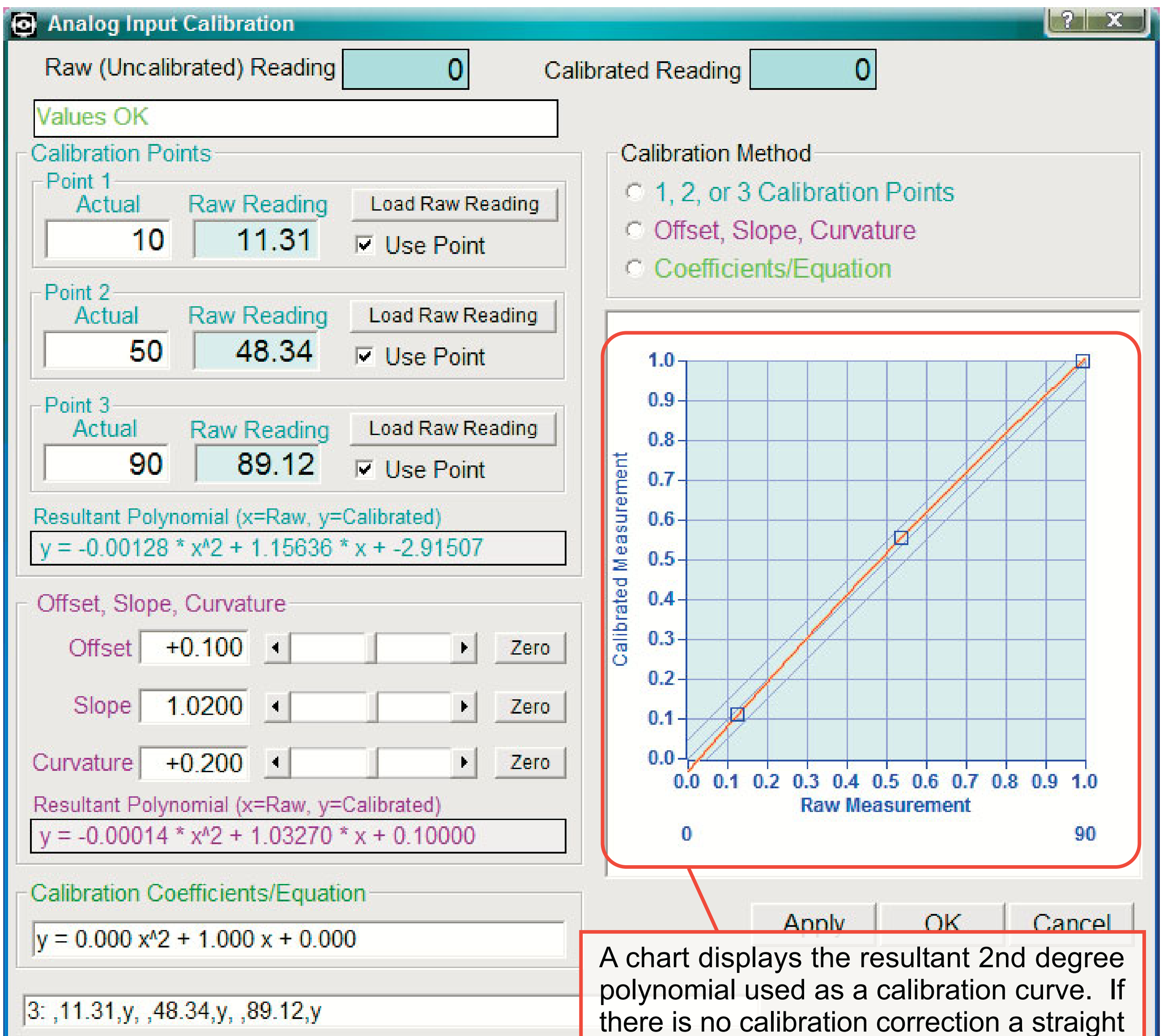
A Calibration Curve can be defined to correct for variances of a particular Sensor and and that of components in the Circuit. The Raw Measurement value can be compared to that of a Reference Measurement to create a correction polynomial to calculate the Displayed (Calibrated) value.

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.



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.

Measurement Wizard - Selecting Commercially Available Sensors

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

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

Example **thermistors** for temperature measurement

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

Configuration Wizard

Example **LED triangulation** sensors for distance measurement

Part #	Manufacturer	Range (cm)	Range (in	
GP2D120	Sharp	4 to 40cm	1.5 to 1	
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

Configuration Wizard

Example **current shunts** for DC current measurement

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

Configuration Wizard

Example **amplified photodiode** sensors for light measurement

Part #	Manufacturer	Range(uW/cm^2)	Response @640	
TSL252R	Taos	0.90 to 300		
TSL251R	Taos	0.20 to 65		2V +-0.5 @38.5uW/cm^2
TSL250R	Taos	0.06 to 25		2V +-0.5 @14.6uW/cm^2
TSL257	Taos	0.01 to 6.7	1.68 V/(uW/cm^2)	2V +-0.4 @1.68uW/cm^2
TSL14S	Taos	0.01 to 276	0.016 V/(uW/cm^2)	2V +-0.5 @120uW/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

Configuration Wizard

Example input ranges for DC Voltage measurement using standard resistor values

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