PalmSens 4 ™

POTENTIOSTAT / GALVANOSTAT /
IMPEDANCE ANALYZER

Contents

PalmSens4: Compact, Versatile and Powerful

Wireless Bluetooth or USB connection

Optional BiPot and iR-drop compensation

Battery and USB powered

Shipped in rugged carrying case (see page 12)

EIS up to 1 MHz

Aluminium body in a rugged rubber sleeve

18-bit resolution

Total weight: 500 g

software for Windows and Android

Always a backup

The PalmSens4 is equipped with internal storage memory of 8 GB. This means all your measurements can automatically be saved on-board as backup. All internally stored measurements can be browsed and transferred back to the PC easily using PSTrace. Your data is always with your instrument wherever you take it.

Not compatible with techniques: EIS, MultiStep and MixedMode

Available configurations

The PalmSens4 is available with ±5V or ±10V DC-potential ranges and with different maximum frequencies for FRA / EIS. The following table shows the applicable product codes:

	Potential range ±5V [05]	Potential range ±10V [10]
NO EIS [F0]	PS4.F0.05	PS4.F0.10
EIS up to 100 kHz [F1]	PS4.F1.05	PS4.F1.10
EIS up to 1 MHz [F2]	PS4.F2.05	PS4.F2.10

PalmSens
Compact Electrochemical Interfaces

Supported Techniques

The PalmSens4 supports the following electrochemical techniques:

Voltammetric techniques

▪ Linear Sweep Voltammetry	**LSV**
▪ Cyclic Voltammetry	**CV**
▪ Fast Cyclic Voltammetry	**FCV**
▪ AC Voltammetry	**ACV**

Pulsed techniques

▪ Differential Pulse Voltammetry	**DPV**
▪ Square Wave Voltammetry	**SWV**
▪ Normal Pulse Voltammetry	**NPV**

> These methods can all be used in their stripping modes which are applied for (ultra-) trace analysis.

Amperometric techniques

|	
▪ Chronoamperometry	**CA**
▪ Zero Resistance Amperometry	**ZRA**
▪ Chronocoulometry	**CC**
▪ MultiStep Amperometry	**MA**
▪ Fast Amperometry	**FAM**
▪ Pulsed Amperometric Detection	**PAD**
▪ Multiple-Pulse Amperometric Detection	**MPAD**

Galvanostatic techniques

▪ Linear Sweep Potentiometry	**LSP**
▪ Chronopotentiometry	**CP**
▪ MultiStep Potentiometry	**MP**
▪ Open Circuit Potentiometry	**OCP**
▪ Stripping Chronopotentiometry	**SCP or PSA**

Other

|	
▪ Mixed Mode	**MM**
▪ Potentiostatic/Galvanostatic Impedance spectroscopy	**EIS/GEIS**
o Potential scan or current scan	
o Fixed potential or fixed current	
o Time scan	

PSTrace: Software for Windows
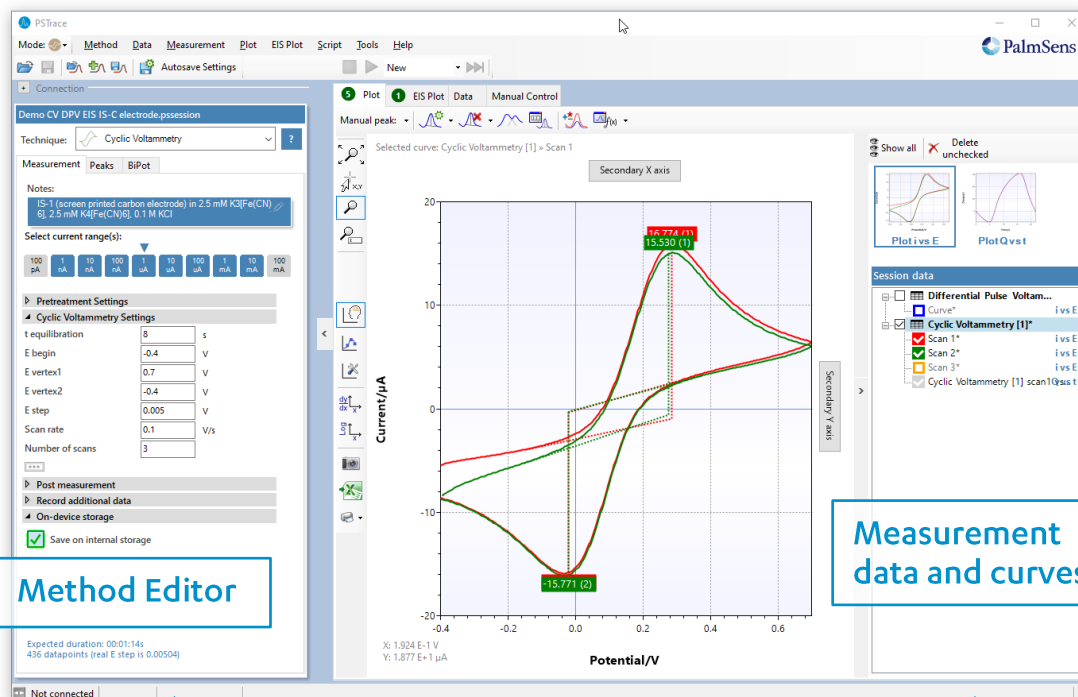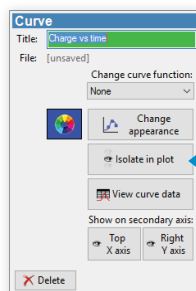

Method Editor

Measurement data and curves

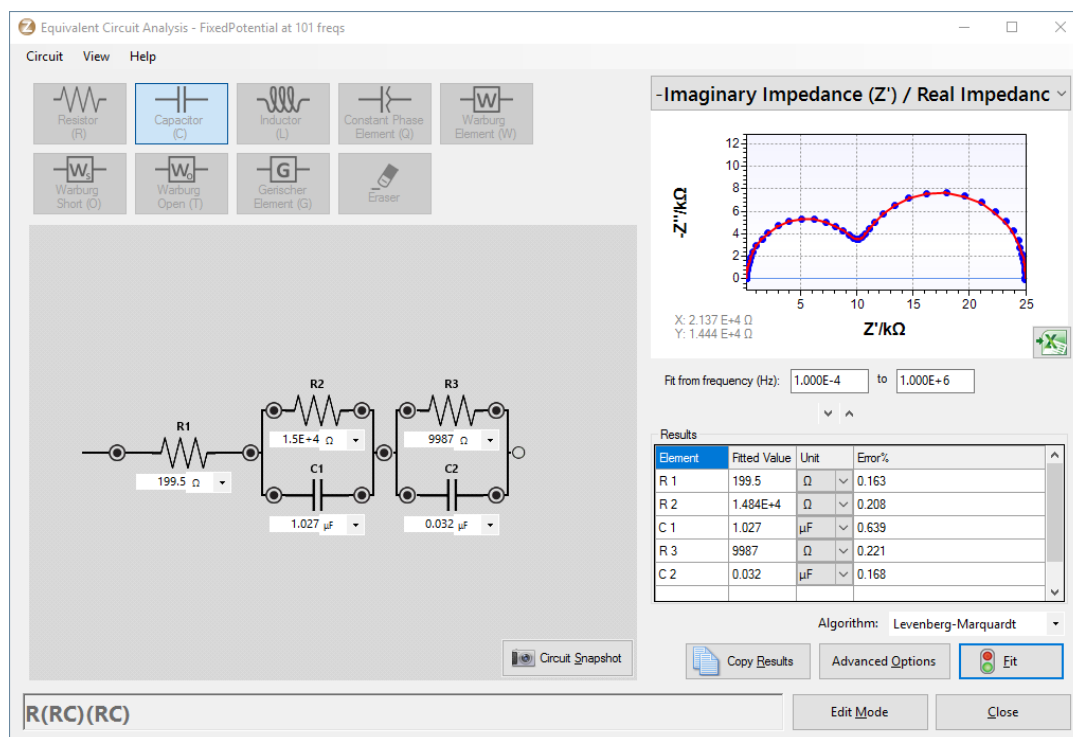Select current ranges for auto ranging and the starting current range.

Switch between plots if curves with different units are available.
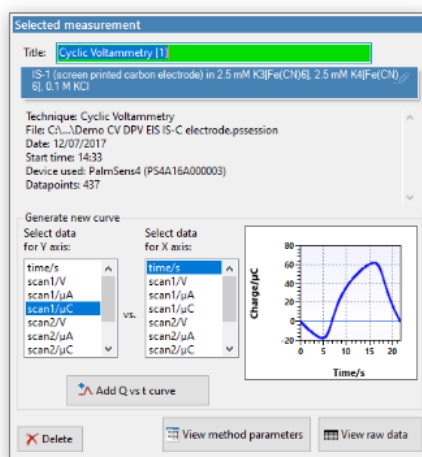
Click on a measurement in the legend to see the available data and to generate more curves.

Click on a curve in the legend to change its title or appearance.

Other functions in PSTrace 5

- Equivalent Circuit Fitting for EIS
- Scripting
- Open your data in Origin and Excel with one click of a button
- Save all available curves, measurement data and methods to a single file
- Load measurements on the internal storage
- Direct validation of method parameters

System requirements

Minimum PC requirements are:
- Windows 7, 8, or 10 (32-bit or 64-bit)
- 1 GHz or faster 32-bit (x86) or 64-bit (x64) processor
- 1 GB RAM (32-bit) or 2 GB RAM (64-bit)

For more information about software visit www.palmsens.com/software

Integration with third party software:

- Excel
- Origin
- Matlab
- ZView

PStouch: App for Android

PStouch is an app for Android devices compatible with all PalmSens, EmStat and Sensit potentiostats.
Works with PalmSens4 via USB (depending on the Android device) or wireless via Bluetooth.

PStouch features:

- Setting up and running measurements
- Loading and saving measured curves
- Analysing and manipulating peaks
- Sharing measurement data directly via any service like email or Dropbox
- Concentration determination by means of Standard Addition or Calibration Curve
- Support for PalmSens accessories such as a Multiplexer or Stirrer
- All method and curve files are fully compatible with PSTrace software for Windows.

For more information about our software visit:
www.palmsens.com/software

Download PStouch for free in the Google Play Store

PalmSens4 System Specifications

General

dc-potential range	config	PS4.F#.05	PS4.F#.10
		±5 V	±10 V
compliance voltage		±10 V	
maximum current		±30 mA (typical)	
max. acquisition rate		150,000 points/s	

Potentiostat (controlled potential mode)

applied dc-potential resolution	76.3 µV (18-bit)
applied potential accuracy	≤ 0.1% ±1 mV offset
current ranges	100 pA to 10 mA (9 ranges)
measured current accuracy	≤ 0.1% at Full Scale Range
measured current resolution	0.005% of current range (18-bit, 5 fA on 100 pA range) 0.0025% of 10 mA range

Galvanostat (controlled current mode)

current ranges	1 nA to 10 mA (8 ranges)
applied dc-current	±6 x applied current range
applied dc-current resolution	0.0076% of applied current range (<10 mA) 0.0038% of 10 mA range
measured dc-potential resolution	78 µV at ±10 V (gain 1, 18-bit) 7.8 µV at ±1 V (gain 10) 0.78 µV at ±0.1 V (gain 100)
measured dc-potential accuracy	≤ 0.05% or ±1 mV (for $\|E\| < \pm9$ V) ≤ 0.2% (for $\|E\| \geq \pm9$ V)

FRA / EIS (impedance measurements)

frequency range	config	PS4.F1.##	PS4.F2.##
		10 µHz to 100 kHz	10 µHz to 1 MHz
ac-amplitude range		1 mV to 0.25 V rms, or 0.7 V p-p	

GEIS (galvanostatic impedance measurements)

frequency range	10 µHz to 100 kHz (all configurations)
ac-amplitude range	0.001 x CR to 0.4 x CR (<10 mA) 0.001 x CR to 0.2 x CR (10 mA) (CR=current range)

Electrometer

electrometer amplifier input	> 1 TΩ // 10 pF
bandwidth	1 MHz

Other

electrode connections	2 mm banana pins for RE, WE, CE and GND
housing	aluminium body with rubber sleeve: 15.7 x 9.7 x 3.5 cm
weight	+/- 500 g
temperature range	0 ℃ to +50 ℃[1]
power supply	USB or internal LiPo battery
communication	USB and Bluetooth
battery time	> 16 hours idle time > 5 hours idle time with BiPot module installed > 4 hours with cell on at max. current Extendible by means of power bank
internal storage space	8 GB (or >100 milion datapoints)

Auxiliary port (D-Sub 15)

analog input	±10 V, 18-bit
analog output	0-10 V, 12-bit (1 kOhm output impedance)
4 digital outputs	5 V
1 digital input	5 V
i-out and E-out	raw output of current and potential E-out ±10 V (1 kOhm output impedance) i-out ±6 V (1 kOhm output impedance)
power	5 V-output (max. 150 mA)

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[1] All the components of the PalmSens4 are rated to the industrial standard of -40 °C to +85 °C The battery of the PalmSens4 is rated -20 °C to +60 °C when discharging and rated 0 °C to +45 °C when charging. The PalmSens4 is calibrated at 21 °C . The most sensitive components of the PalmSens4 have a temperature drift of 50 ppm. At 1°C or 41 °C, measurement drift of up to 0.1% may be experienced.

PalmSens4 Measurement Specifications

The following table shows limits for some technique-specific parameters.

	Parameter	Min	Max
All techniques (unless otherwise specified)	Conditioning time	0	1600 s
	Deposition time	0	1600 s
	Equilibration time	0	1600 s
	Step potential	0.076 mV	250 mV
	Pulse potential	0.076 mV	250 mV
	N data points	3	1,000,000
Normal Pulse Voltammetry (NPV) Differential Pulse Voltammetry (DPV)	Scan rate	0.1 mV/s (76.3 µV step)	100 mV/s (5 mV step)
	Pulse time	10 ms	300 ms
Square Wave Voltammetry (SWV)	Frequency	1 Hz	1250 Hz 1
AC Voltammetry (ACV)	Frequency	1 Hz	2000 Hz
Linear Sweep Voltammetry (LSV)	Scan rate	0.01 mV/s (76.3 µV step)	500 V/s (10 mV step)
Cyclic Voltammetry (CV)	Scan rate	0.01 mV/s (76.3 µV step)	500 V/s (200 mV step)
Fast Cyclic Voltammetry (CV)	Scan rate	0.4 V/s (76.3 µV step)	500 V/s (10 mV step)
	N averaged scans	2	255
	N equilibration scans	1	255
Pulsed Amperometric Detection (PAD)	Interval time	50 ms	300 s
	Pulse time	1 ms	1 s
	N data points		1,000,000 (> 100 days at 10 s interval)
Multiple-Pulse Amperometric Detection (MPAD)	Pulse time	100 ms	2 s
	Run time	1.2 s	100,000 s
	N potential levels	3	3
Chronoamperometry (CA) Chronopotentiometry (CP) Open Circuit Potentiometry (OCP)	Interval time	0.4 ms	300 s
	Run time	1 ms	> year
	When applying multiple potential or current levels:		
	N cycles	1	20,000
	N levels	1	255
	Level switching overhead time	+/-80 ms	
Fast Amperometry (FAM)	Interval time	0.02 ms	1 s
	Run time	1 ms	30 s
	N data points	3	4000 for interval time < 0.2 ms

[1] PSTrace provides the option to measure forward and reverse currents separately.

PalmSens
Compact Electrochemical Interfaces

PalmSens4 EIS Contour Accuracy Plot
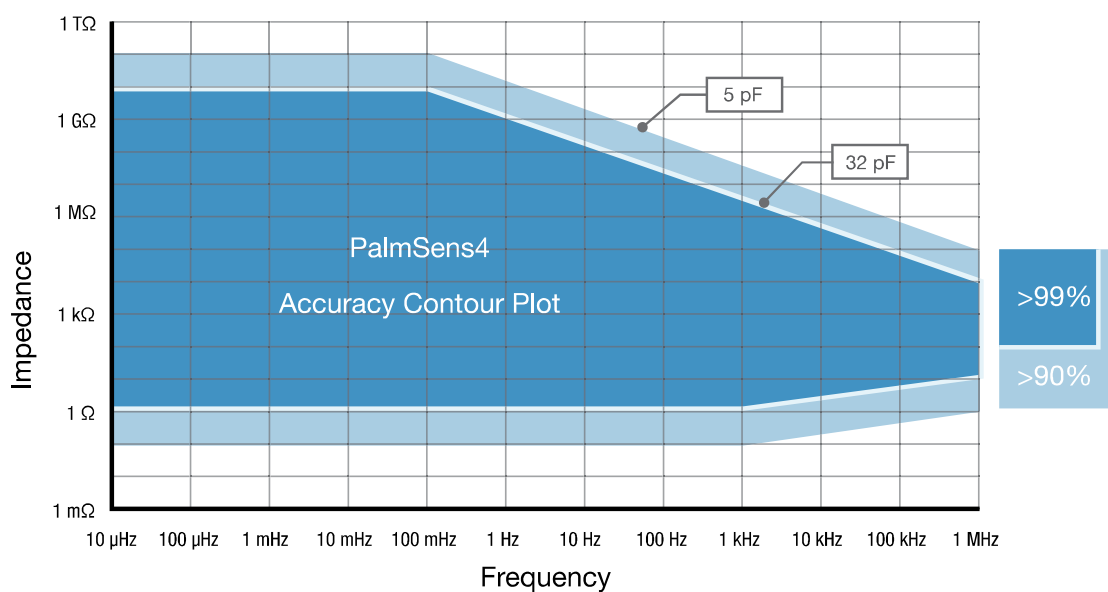
Note
The accuracy contour plot was determined under lab conditions and should be used for reference purposes. Please note that the true limits of an impedance measurement are influenced by all components in the system, e.g. cables, the environment, and the cell.

Optional BiPot Specifications

The PalmSens4 can be expanded with a BiPot module for use with a second Working Electrode.

BiPot specifications

dc-potential range	±5 V
dc-potential resolution	153 µV (16-bit)
dc-offset error	≤ 0.1% ±1 mV offset
accuracy	≤ 0.1%
current ranges	100 pA to 10 mA (9 ranges)
maximum measured current	i(WE1) + i(WE2) < 30 mA
current resolution	0.005% of current range (5 fA on 100 pA range) 0.0025% of 10mA range
current accuracy	≤ 0.1% at Full Scale Range all with additional 0.2% offset error
connection	Comes with a sensor cable with an additional (yellow) connector for WE2
power	Comes with additional USB Y-cable for extra power

Supported techniques for use with BiPot:
- Linear Sweep Voltammetry
- Cyclic Voltammetry
- Chronoamperometry
- Multistep Amperometry

Note
The BiPot module decreases the battery life of the PalmSens4 in idle mode (cell off) down to
> 5 hours.

Optional iR Compensation module specifications

iR Compensation for PalmSens4 is available as an in-factory add-on module.

iR Compensation module specifications

Method used for iR-drop compensation	Positive Feedback
Resolution of MDAC used for correcting potential	16-bit
Max. compensated resistance	1 MOhm
Max. bandwidth with iR-drop compensation enabled	10 kHz

Standard PalmSens4 Configuration

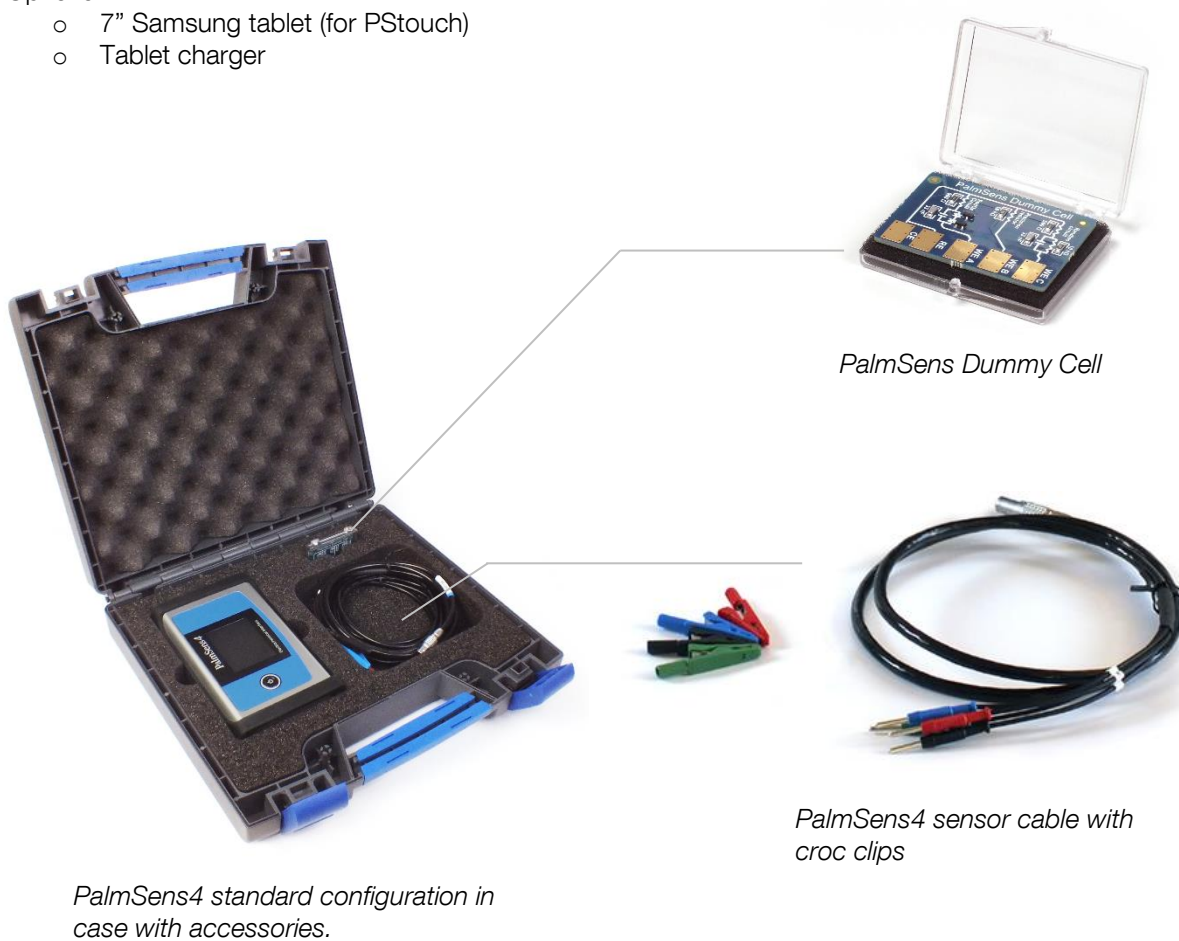A standard PalmSens4 includes a rugged carrying case with:
- PalmSens4
- USB cable
- Sensor cable
- 4 croc clips
- PalmSens Dummy Cell

Also included:
- PSTrace software (on USB drive)
- Manual (hardcopy)
- Quick Start document
- Calibration report

Optional
- o 7" Samsung tablet (for PStouch)
- o Tablet charger

PalmSens Dummy Cell

PalmSens4 standard configuration in case with accessories.

PalmSens4 sensor cable with croc clips

PalmSens4 Accessories

In-factory add-on modules

BiPot module

The BiPot Module is an optional extension for the PalmSens4 and is for applications requiring control of two independent working electrodes. The module fits inside the PalmSens instrument. The PSTrace software supports this module for linear sweep, cyclic voltammetry and amperometric detection with two working electrodes.

See page 11 for BiPot specifications

iR Compensation module

The iR Compensation module is an optional extension for the PalmSens4. The resistance between the reference electrode and the double layer of the specimen can cause a significant potential drop, decreasing the applied potential where it is required. The module provides positive feedback to compensate for the iR-drop between Reference electrode and the outside of the double layer of the electrochemical cell.

See page 11 for iR Compensation module specifications

Other accessories

MUX8-R2 or MUX16 multiplexer

The MUX8-R2 is an 8-channel multiplexer. It allows the PalmSens4 to measure up to 8 three-electrode cells or 8 sensors (2 or 3 electrode). In 8-WE mode it can measure up to eight working electrodes on sensor arrays with shared reference and counter electrodes. The MUX8-R2 is stackable.

The MUX16 is a 16-channel multiplexer. It allows the PalmSens4 to measure up to 16 working electrodes with shared counter and reference electrodes.

Magnetic stirrer with Switchbox

The magnetic stirrer controlled by PalmSens is ideal for stripping analysis applications. The stirrer is switched on during the conditioning and deposition stages by means of the Switchbox.

LM35/TMP36 temperature sensor

This temperature sensor allows for monitoring of temperature during an experiment.

Two point calibration allows the user to precisely calibrate the sensor for the required temperature range. The calibration curve shows a linear slope of +10 mV/°C with 0.5°C Ensured Accuracy (at 25°C). It is rated for full 2°C to 150°C range (LM35) or -40°C to 125°C range (TMP36). The sensor has low self-heating (0.08°C in still air).

Differential Electrometer Amplifier (DEA)

The PalmSens Differential Electrometer Amplifier (DEA) is a high impedance input amplifier. It can be used as a floating voltage amplifier with differential input and single output to the auxiliary port of PalmSens devices.

Default range is -10V to 10V (1x gain). Possible gains are: 2x, 5x, 10x, 20x, 50x and 100x.

Please don't hesitate to contact PalmSens for more details:
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