HOW TO ACHIEVE OPTIMUM SENSOR READ OUT

Executive summary
Exergen IRt/c sensors are small, passive devices with very high performance levels. The passive nature of the IRt/c's results in very small repeatability and interchangeability errors, and an unprecedented long term stability. These properties are essential for their use in OEM manufacturers, who aim to build machines that function consistently and predictably.

There are no any active processes in the sensor such as signal amplification or AD conversion. As a result, the sensor generates a non-linear, high impedance thermocouple signal that differs slightly from conventional thermocouples. Without an accurate and reliable readout process, the accuracy and consistency of the sensors could be impaired by readout errors.

This white paper explains how to select readout devices, and how to design readout electronics, for optimal sensor readout.

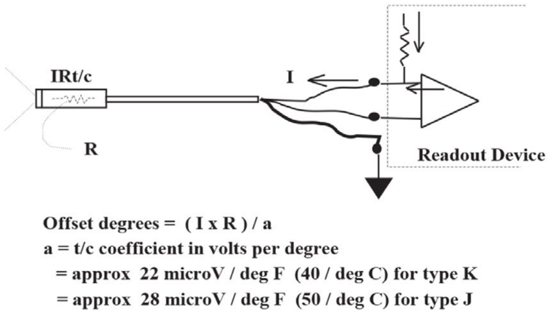
Sensor readout
The Exergen IR temperature sensors stand out from other sensors in the market by the fact that they are unpowered, passive devices. This has many huge advantages over powered sensors or contact sensors. Our sensors stand out in terms of accuracy, speed and reliability. They are passive devices that can not drift and do not need any maintenance or recalibration in the field – the repeatability error and interchangeability error are the smallest you'll find in any IR sensor. Especially for OEM applications this is a big pro. They are IP67 rated and will remain stable and reliable for decades when not misused.

They generate a non-linear, thermocouple output signal that can be read out with readout devices that have a thermocouple input channel. Please check this video for instructions: https://www.youtube.com/watch?v=6wsjGUibwV4&feature=emb_logo

High impedance - Leakage current
Our sensors generate a non-linear mV output signal. They are calibrated to follow the linear signal of a standard thermocouple, so you can read out the sensor with a device that has a thermocouple input channel.
There is an important difference however between a standard thermocouple and our sensors: our sensors have a high impedance. All readout devices generate leakage current to detect sensor breaks. The combination of high impedance and high leakage current creates a measurement error.

For accurate and consistent sensor readout, it's essential to use readout electronics that have low leakage current – there will be no (or minimal) errors in the readout.
Please check Tech Note 16

The Input Bias current of the readout device should be < 10nA.



Cold Junction Compensation
There is no cold junction compensation inside the sensor, you still need cold junction compensation (CJC) in your readout device. Most PLCs with thermocouple input channel have CJC integrated, make sure it is switched on for the correct thermocouple type.

If you use a PCB for readout, you should have an accurate temperature sensor in your PCB that measures ambient temperature as close as possible to the place where the sensor thermocouple wires are connected with the PCB, and CJC has to be set up with this temperature sensor.

Electronics design

If you design your own readout electronics (as opposed to using a PLC or datalogger), please check the following information:

An example of a schematic to readout high impedance sensors can be found on our website

Important factors to consider are:

- Opamp selection: If you want to use an OpAmp, the Input Bias current is an important parameter to consider. The input bias current should be < 10nA to prevent leakage current issues with our high impedance sensors.
- A/D converter: With direct A / D converters you talk about input impedances determined by the input sampler capacitor. And it must fall in the Mega ohms, the higher the better to prevent leakage current issues.
- Recommended AD converters, some of which have built-in CJC:
  - https://www.ti.com/product/ADS1118
  - https://www.analog.com/en/products/ltc2487.html#product-overview
  - https://www.analog.com/en/products/ltc2496.html#product-overview
  - https://www.analog.com/en/products/ad8495.html#product-overview (Nice chip for single channel solutions but pricy for multichannel because needs additional A/D converter)

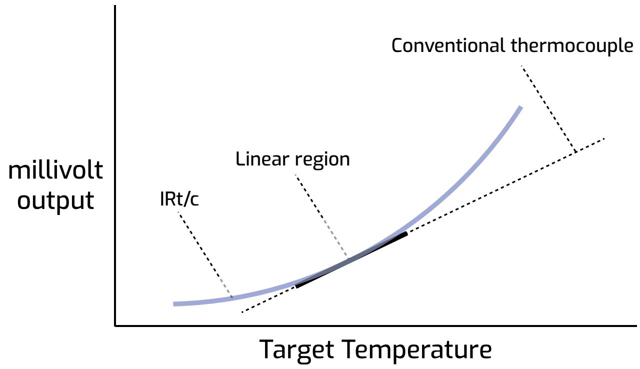
- Evaluation board: this development board is recommended for testing your IC.
- https://nl.farnell.com/texas-instruments/430boost-ads1118/eval-board-ads1118-adc/dp/3125715
- The input impedance runs high in the Mega ohms And with internal precision temp sensor for CJ compensation.

Signal linearization

All IRt/c's are self-powered devices, which rely on the incoming infrared radiation to produce the signal through thermoelectric effects. Accordingly, the signal will follow the rules of radiation thermal physics, and be subject to the non-linearities inherent in the process.

However, over a range of temperatures, the IRt/c output is sufficiently linear to produce a signal which can be interchanged directly for a conventional t/c signal. For example, specifying a 2% match to t/c linearity results in a temperature range in which the IRt/c will produce a signal within 2% of the conventional t/c operating over that range. Specifying 5% will produce a somewhat wider range, etc.

Each IRt/c model is specifically designed for optimum performance in the region of best linear fit with conventional t/c's, but can be used outside of this range by simply calibrating the readout device appropriately. The output signal is smooth and continuous over its entire rated temperature range, and maintains 0,01°C (0.02°F) repeatability over its entire range.



The actual signal generated by the IRt/c can be approximated with a fourth order polynomial function of target temperature. Alternatively, the mV tables or 'look-up' tables are available that correlate mV signal to target temperature over the full sensing range of each sensor model. Both the polynomial functions, as the mV tables, can be used to linearize the signal and increase measurement accuracy over a wider temperature range.

Pastoor Clercxstraat 26
5465 RH Veghel
The Netherlands
+31 (0)413 376 599
www.cleverir.com
info@cleverir.com