PICOSTRAIN

Application Note

Rspan-by-Temp-Compensation
Compensation of gain error for
uncompensated load cells

1 Preface

Basically, there are compensated load cells (load cells with compensation resistor Rspan) and uncompensated load cells (without compensation resistor Rspan). The gain drift of uncompensated load cells is quite high, approximately in the range of 200-400 ppm/K.

Picostrain offers a possibility to reduce the gain drift of uncompensated load cells. This method is called „rspan-by-temp compensation". The name is derived from the fact that the compensation is done by the help of a temperature measurement with 2 resistors.

Please note, that this compensation method is able to reduce the gain drift of an <u>uncompensated</u> load cell. If the load cell is compensated, that means there is an Rspan resistor, you can apply the Tk-Gain and Tk-Offset correction as described in our dedicated White Paper WP002 "How to lower the Gain and Offset Drift of a Load Cell", available on www.acam.de/download-section.de

The compensation method described in this application note is generally suited for all load cells <u>without</u> compensation resistors. Due to the fact, that the temperature measurement nowadays is often realized with low-cost resistors, this compensation method will be applied mainly in commercial scales like body scales for example.

2 How it is done

By means of two resistors with different temperature coefficients the temperature is determined within PSO8 / PSO81. The measurement principle is to compare the resistor's values and their change over temperature. As one resistor has a much higher temperature coefficient (TK) than the other, there is a significant change in the ratio of those 2 resistors.

Figure 1
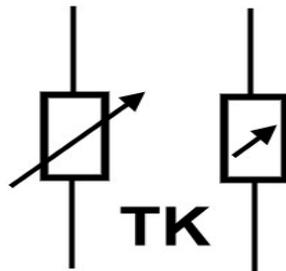
The change of the ratio is used by an implemented hardware algorithm to correct the gain drift of an uncompensated load cell. Of course the TK of the resistor pair needs to match the load cell's TK behavior, therefore a factor (TK-Gain) needs to be determined.

As long as the accuracy and stability of the load cell's drift behavior as well as the TK of the resistor pair remains the same, this Tk-Gain factor does not need to be changed (even not if the different charges of PSO8 / PSO81 are used). This is the same situation as you find it also with classical AD converter solutions using the 2 resistors temperature correction.

Generally, the accuracy of this compensation method is mainly dependent on the accuracy and TK factor of the used resistors (1 temperature sensitive, the other one ,fixed'). E.g. with a simple carbon resistor as the temperature dependent resistor, factors 6-8 can be reached.

Preparations

1. First make sure that the 2 resistors are mounted on your PCB at ports PSEP1 and PSEP2 (Pin 11, 12 of PSO8 / O81) in this way:

> PSEP1: RG1 / Rtemp, e.g. carbon resistor
> PSEP2: RG2 / Rref, e.g. standard SMD metal film resistor

Note:

The resistors' values should be in the range of the strain gage resistor's value, e.g. with an 1kOhm load cell they should be also 1kOhm. If Wheatstone is used, RG1 & RG2 are 0.75x Rsg.

2 How it is done

Now the register configuration of PS08/PS081 must be adapted. If you work with the PS08/081 evaluation system all settings can easily be done in the ALU-page of the software. If you work with your own hardware the configuration is changed by writing the appropriate value to the refering configuration register.

2. Set all multiplication factors (Mult_HBx) to a positive number, at best to +1 (set configuration register configreg_04 to configreg_07 to 0x100000). Then make sure that the bits mod_rspan & rspan_by_temp are set (configreg_01, bit 6 and 8).

Figure 2
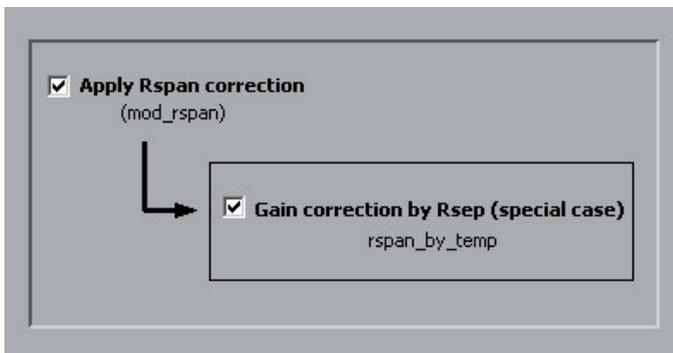
3. Set TK-Gain to 1.0 and TK-Offset to 0.0 (configreg_08 to 0x100000, configreg_09 to 0x000000).

Measurements

Set the sensitivity of your load cell in the evaluation software. Make sure that the scaling is correct, in other words the correct weight is displayed at ambient temperature (e.g. 100kg are displayed when putting on 100kg on the scale).

Then you have to make measurements at 2 different temperatures. We recommend a minimum difference of 30 Kelvin, e.g. measurement 1 at 10°C and measurement 2 at 40°C. Wait a settling time of at least 1.5h at the first temperature (e.g. 10°C) and do then the following measurements:

Table 1

10°C	TK-Gain = 0	101.0kg
	TK-Gain = 1	99.2kg

Charge the load cell with a weight > 0.5 maximum load, e.g. for a body scale with a range of 0 to 150kg, 100kg would be a good choice. Make 2 measurements with TK-Gain = 0 and TK-Gain = 1. Fill the results to the Excel spreadsheet: „TKGain_TKOffs_Calculation.xls".

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2 How it is done

Table 2

Normally, when it comes to the correction of uncompensated load cells, only the correction of the gain error is of interest. Therefore, you fill the measurement results in the fields labeled ‚high', but set the fields labled with ‚low' to zero.

Table 3

Now heat up to the higher temperature, e.g. 40°C and wait again the settling time of > 1.5h. Do the measurements again at the higher temperature and fill them to the spreadsheet accordingly. After doing so, the correct TK-Gain factor will be displayed in the spreadsheet:

In this example the correct setting for TK-Gain is 1.13948. This is the result for your scale and should be verified in a validation run. The proceding is described in the following section.

3   Validation run

Set the determined TK-G factor to register configreg_08. In our example it would be:
TK-Gain = 1.13948 (hexadecimal 0x123B4F)

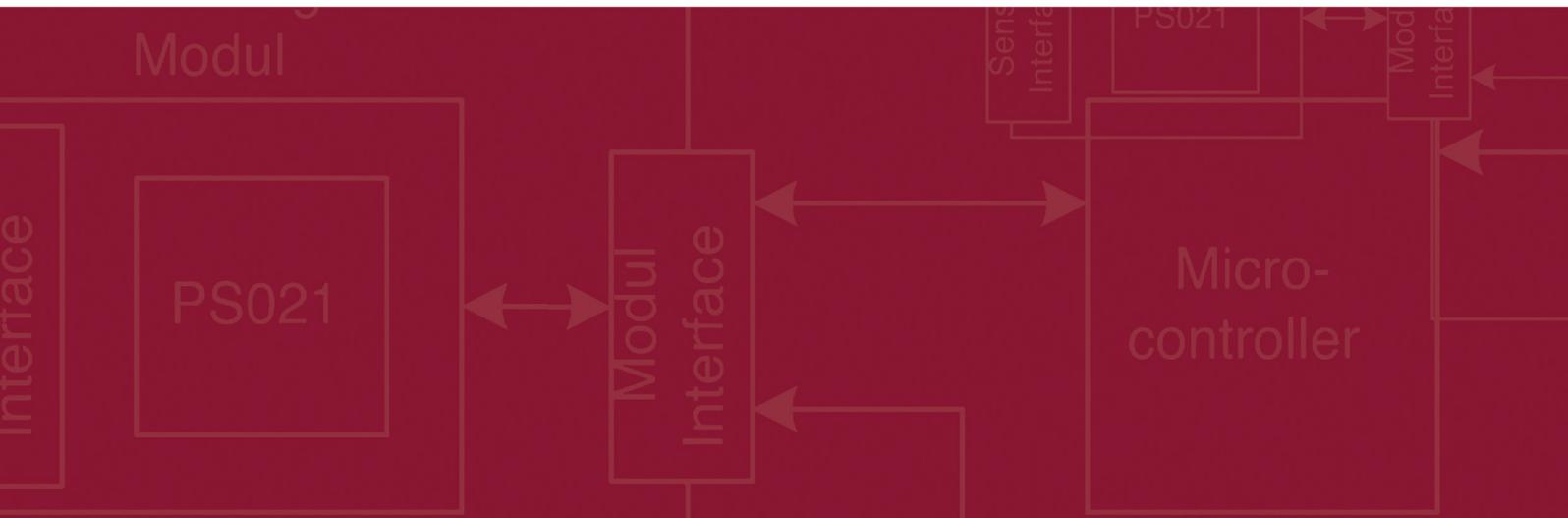Make sure the bits mod_rspan & rspan_by_temp are still set.

Now make another temperature run with 2 temperatures (e.g. 10°C and 40°C) and measure the gain. This time, you simply put on the weight and get the result, without touching the TK-Gain value. Again you should wait some time for settling before doing the measurements. Generally, the method of load cell temperature drift compensation only works with a slowly changing temperature environment.

The gain drift over temperature should now be in a reasonable range.

4 Conclusion

This application note describes the compensation method „rspan_by_temp" for reducing the gain error and shows how to apply it.

Higher accuracy than with carbon resistor as temperature sensor can be achieved by using KTY resistors. They are more accurate an have a higher TK factor which helps a lot to improve the sensing and therefore the compensation. On the other hand they have a slightly higher price. If you are interested to use KTY resistors please contact the acam team.