

DOLPHIN TEMPERATURE SENSOR CALIBRATION

HOW TO CALIBRATE THE INTERNAL TEMPERATURE SENSOR OF ENOCEAN DOLPHIN MODULES

10 September 2026



Observe precautions! Electrostatic sensitive devices!

Patent protected:

WO98/36395, DE 100 25 561, DE 101 50 128,
WO 2004/051591, DE 103 01 678 A1, DE 10309334,
WO 04/109236, WO 05/096482, WO 02/095707,
US 6,747,573, US 7,019,241

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REVISION HISTORY

The following major modifications and improvements have been made to this document:

Version	Author	Reviewer	Date	Major Changes
1.0	AS	-	2011.09	First version
1.1	AS	-	2015.10	Language and layout revised
1.2	MH	-	2021.10	New document template
2.0	AZ	SA, JB	2026.09	Document maintenance

Published by EnOcean GmbH, St.-Martin-Straße 76, 81541 Munich, Germany
www.enocean.com, info@enocean.com, phone +49 (89) 6734 689-0

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The modules must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.

Components of the modules are considered and should be disposed of as hazardous waste. Local government regulations are to be observed.

Packing: Please use the recycling operators known to you.

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1 Introduction

All EnOcean modules that are based on the Dolphin platform contain an internal temperature sensor. This sensor must be calibrated before it can be used. STM 330 modules are delivered with the calibration values already stored in the module. For every other Dolphin module, the calibration has to be carried out once per module.

This application note explains:

- How to calibrate the internal temperature sensor of Dolphin based modules

The calibration can be performed on every Dolphin module that provides a programming interface. The specification of the internal temperature sensor is given in the Dolphin Core Description [1].

Note: The sensor measures the temperature of the chip. It is therefore only useful in energy harvesting applications, for example STM 31x, STM 330 or STM 300, where the chip stays in sleep mode most of the time. In a line powered application, the chip heats up during operation and the measured values become inaccurate.

1.1 Required tools and equipment

The following tools and equipment are needed for the calibration:

- Keil C51 compiler
- DolphinStudio
- EOP350 programmer
- Calibrated reference thermometer

1.2 References

- [1] EnOcean Dolphin Core Description
https://www.enocean.com/.../dolphin_core_description_v1.1.pdf
- [2] IEEE Std 754, IEEE Standard for Floating-Point Arithmetic
<https://standards.ieee.org/ieee/754/6210/>
- [3] EnOcean Dolphin API package
<https://www.enocean.com/en/product/dolphinapi/>

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2 Calibration

The module calculates the temperature from the voltage of the internal temperature sensor. The following equation is used:

$$T = T_{\text{cal}} + K \times (V_{\text{meas}} - V_{\text{meas_cal}})$$

Where:

- T is the temperature that the module reports.
- T_{cal} is the temperature that is measured with the calibrated reference thermometer during the calibration.
- K is the temperature slope constant. For the EO3000I chip it has the fixed value 0.0242.
- V_{meas} is the voltage that the internal temperature sensor delivers during operation.
- $V_{\text{meas_cal}}$ is the voltage that the internal temperature sensor delivers during the calibration.

Two values have to be determined during the calibration: the calibrated temperature T_{cal} and the calibrated sensor voltage $V_{\text{meas_cal}}$. Both values are stored in the module together with the temperature slope K .

2.1 Measurement conditions

The calibration has to be performed at a constant ambient temperature of $23\text{ °C} \pm 5\text{ °C}$. The following conditions apply:

- Use a reference thermometer with high sensitivity and an accuracy of at least 0.3 °C .
- Measure T_{cal} on the surface of the chip or of the module.
- Make sure that the module has not been heated up by a running application before the measurement.
- Sample the sensor voltage at the same time as the reference temperature.
- Repeat the measurement several times and use the average value as the reference.

2.2 Measuring the sensor voltage

The internal temperature sensor is read through the analog input VTEMP. The example below shows a single measurement:

```
// VBG is used as the ADC reference for the analogue signal of the internal
// temperature sensor. VBG is more stable than VDD_2, but it can only be
// used if the analogue voltage stays below VBG (1.25 V).

sint16 s16TemperatureAD;
io_enableAnalog(5);
io_u1pMeasAnalog(VTEMP, s16TemperatureAD);
```

The complete measurement sequence is shown in the STM 330 example source code [3].

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2.3 Storing the calibration values

The temperature slope K and the calibrated temperature T_{cal} are floating point values. They have to be stored in the IEEE 754 format [2]. Table 1 lists the address and the size of every calibration value in the configuration area of the module.

Table 1 Calibration values in the configuration area

Variable	Configuration area address	Size	Interpretation
K	0x2C	32-bit	float32 f32TemperatureSlope
T_{cal}	0x77	32-bit	float32 f32CalibTemperature
V_{meas_cal}	0x7B	16-bit	sint16 s16CalibADTemperature

This application note is delivered with the file tempcalib.xml on request. Copy this file into the folder EnOcean\DolphinStudio\Configuration. If the file is already present, no change is needed.

The Module Configuration view of DolphinStudio then offers the three calibration values and writes them directly into the module, as shown in Figure 1. The values are entered as decimal numbers. DolphinStudio converts them into the required format.

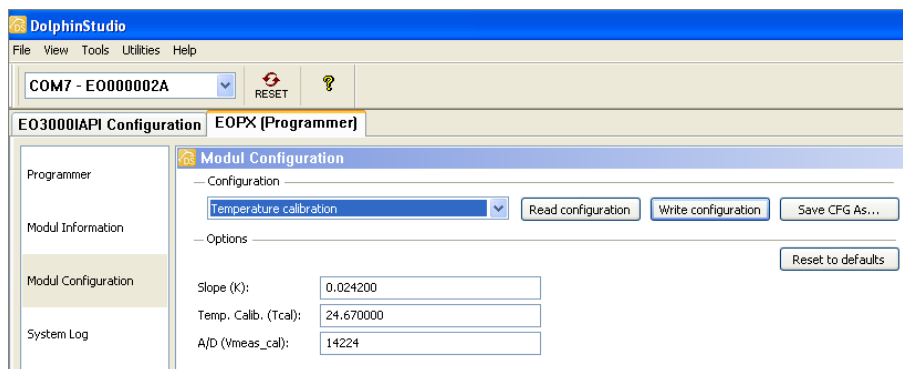


Figure 1 Calibration values in the Module Configuration view of DolphinStudio

The stored values can be checked in hexadecimal form with the configuration area viewer of DolphinStudio, as shown in Figure 2.

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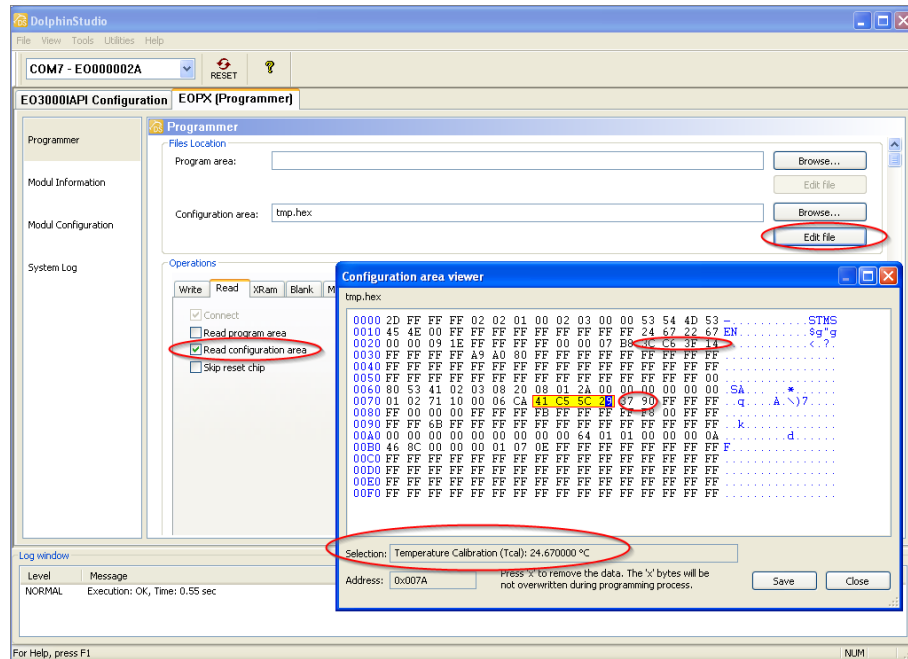


Figure 2 Calibration values in the configuration area viewer of DolphinStudio

2.4 Step-by-step calibration

The complete calibration procedure consists of the following steps:

1. Write a calibration firmware that measures $V_{\text{meas_cal}}$.
2. Download the firmware to the module.
3. Measure the A/D value of the internal temperature sensor ($V_{\text{meas_cal}}$).
4. Transmit the A/D value through the serial interface or store it in the configuration area.
5. Measure the temperature of the module with the calibrated reference thermometer (T_{cal}).
6. Store the measured temperature in the configuration area in the IEEE 754 format.
7. Store the temperature slope K in the configuration area.

Steps 4, 6 and 7 write to the configuration area. They can be carried out with DolphinStudio and the tempcalib.xml file.

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