Climate Sensor (Temperature / Humidity) based on EnOcean Modules

Wireless climate sensors are essential to set up intelligent automation in green buildings. EnOcean wireless devices are energetic optimized for indoor self-powered sensor applications. You can find an overview of available STM sensor modules on the EnOcean website.

The following note provides some examples of ambient sensors and their applications in a combined room sensor based on STM devices. Please note that EnOcean also offers complete, P&P modules like STM 3xy devices for indoor applications with already calibrated sensors, energy storage, learn button, antenna and solar panel on-board.

For more details, please always consult the current user manuals and EEP documentation. Please note that the following examples are rough concepts only.

1. TEMPERATURE SENSOR

Sensors for temperature measurement are suitable for a large variety of applications in heating, air conditioning or industry: for indoor temperature monitoring, as outdoor temperature sensors, etc. Selection criteria for temperature sensors: type, temperature range, resistance range, measuring accuracy, environment, response time, power requirements, dimensional requirements and cost. One common application circuit for temperature measurement is the Wheatstone bridge with a thermistor used as one bridge leg. The most used sensors therefore are NTC or PTC thermistors (temperature dependent, passive resistors).

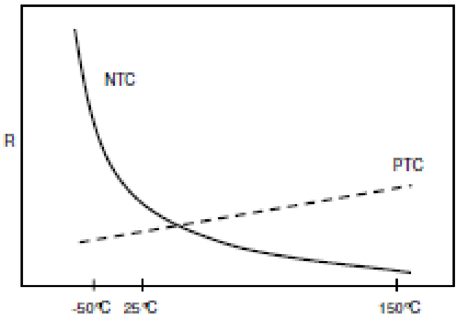

Fig. 1: NTC vs. PTC behaviour

Their high sensitivity and low cost makes NTC sensors ideal candidates for low cost temperature sensing applications. NTC are resistors based on certain metal oxides, whose resistance decreases with increasing temperature. Because their resistance falls off with increasing temperature, they call Negative Temperature Coefficient (NTC) sensors. The pronounced non-linearity limits unfortunately their application field.

In opposite, PTC's employ the property that the electrical resistance of metals typical increases with temperature, means they are Positive Temperature Coefficient (PTC) sensors. The main metals in use are platinum (Pt) and nickel (Ni). The most widely used sensor is the 100 ohm or 1000 ohm Pt thermometer (Pt100 / Pt1000). These more expensive but much more accurate sensors offer the best linearity and long-term stability over large temperature ranges. Their temperature dependence is international standardized and accordingly they need no calibration.

The following wireless sensor concept allows measurement of temperature using a Pt1000 element with 3.85 Ω/°C temperature coefficient in a Wheatstone bridge. The bridge works in a ratio-metric configuration; the system reference voltage drives both the sensor and the ADC. By using the same reference for both the sensor excitation and ADC, voltage variations of the reference will be cancelled. The temperature range of the circuit example is approx. −20 to +45 °C (Pt1000 = 921 Ω @-20 °C to 1175 Ω @+45 °C). The temperature offset is controlled by R2. For highest resolution, V_{OUT} range must be GND to V_{REF}. The used OPs are supplied by the STM device and therefore must be low power single supply, rail-to-rail I/O, operate at voltages as low as 1.8 V, and have a quiescent current lower than 1 mA. The application concept below uses an AD8607 (dual, rail-to-rail, precision, micro power OP). The slope (temperature dependent Vout) is determined by the relation R5/R4. Note: V_{OUT} must be limited to maximum allowed AD Input (V_{REF})

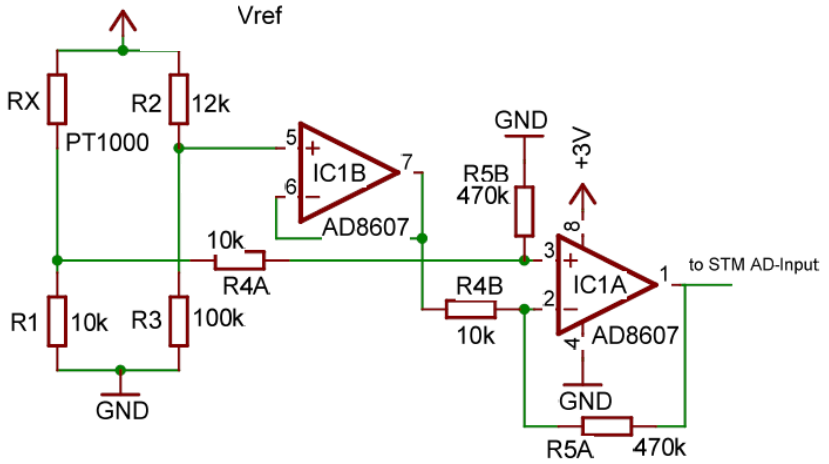

Fig. 2: Example of temperature sensor and signal conditioning circuit

The relation between Rx (Pt1000 temperature dependent current value) and V_{OUT} is:

$$Rx = \frac{R1||(R4+R5)}{\dfrac{V_{OUT}\,R4}{V_{REF}\,R5} + \dfrac{R3}{R2+R3}} - R1||(R4+R5)$$

With these values, V_{OUT} varies between about 0 V@+45 °C to about V_{REF}@-20 °C, meaning that the resolution here is about V_{REF}/65 °C.

°C	Ω	°C	Ω
-20	921.6	+20	1077.9
-10	960.9	+30	1116.7
0	1000.0	+40	1155.4
+10	1039.0	+50	1194.0

Tab. 1: Pt1000 resistance vs. temperature table (dependence about +3.9 Ω/°C)

2. RELATIVE HUMIDITY SENSOR

Suitable passive relative humidity (RH) sensors change their capacitance with the humidity. Such a humidity sensor is nothing other than a two-terminal capacitor that increases its value as water molecules are absorbed into its active polymer dielectric. This capacity variation correlates to the relative humidity. Usually, low-cost solutions deliver a frequency dependent output signal. Typical Requirements:

- Measurement range ideally 0% - 100% r.H.
- Accuracy better than ±5% r.H. between 30% - 70% r.H. and 0-40°C
- Result ready after device wake-up within 2 ms
- Supply voltage max. 1,8 V

The circuit diagram below (Fig. 2) shows a rough concept based on capacitive humidity sensors. Basic components to be adapted for specific sensor and application.

The circuit generates an oscillating signal with a humidity dependent frequency and converts this into a PWM signal proportional to the relative humidity. This output can be directly applied to the STM AD input and its width measured by appropiate FW.

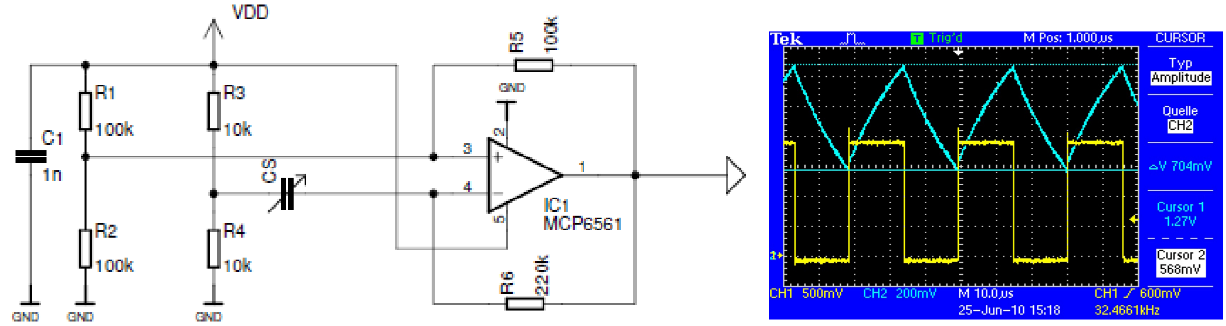

Fig. 3: Example of humidity sensor and signal conditioning circuit

The example circuit shown above based on the comparator MCP6561, where the relative humidity sensor CS used as a variable capacity generates a rectangular signal with variable period T of around 30 µs. A STM 3xy module with appropriate FW measures the humidity dependent period and correlates it to the current relative humidity value.

Background: calibration of humidity sensors

Digital humidity sensors are most already calibrated but they need higher supply voltage (typically >2.7 V) and deliver the humidity value digital via UART, which needs more time. Therefore, they are not very suitable for this application. Unfortunately, calibration of analogue humidity sensors takes some effort.