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Vaisala CARBOCAP® Carbon Dioxide Transmitter GMT221 in Refrigeration Applications

The leakage of odorless and colorless CO_2 refrigerant cannot be detected without proper sensors. In the event of refrigerant leakage, CO_2 concentration can reach dangerously high levels in poorly ventilated spaces.

This document describes the performance of the Vaisala CARBOCAP® Carbon Dioxide Transmitter GMT221 performance in refrigerated environments below -20°C (-4°F). The GMT221 is designed for harsh and humid environments. The housing of the transmitter is watertight (IP65/NEMA4) and the materials have been chosen accordingly, keeping in mind especially the corrosion resistance of the transmitter probe and body.

Summary of the Cold Duration Tests for the GMT221

The normal operating temperature range for the GMT221 is specified from -20°C to +60°C. In the described tests the transmitter was tested at temperatures down to -40°C. The long-term stability of the transmitter was tested both at a constant temperature in -40°C and with a rapidly changing temperature ranging from -40°C to +70°C. In addition, the temperature dependency of the transmitter was modelled down to -30°C. The performed tests indicate that the transmitter can be used at temperatures below -20°C, even as low as down to -40°C. However, it's good to remember that the ABS plastic material used in the transmitter housing becomes fragile in cold conditions. Therefore special attention should be paid to gentle handling of the unit.

Temperature Dependency of the CO_2 Reading

The GMT221 is calibrated at the factory in the environmental conditions of 25°C and 1013 hPa. Since all gases are compressible, the CO_2 reading needs to be compensated in case the measurement environment largely deviates from these conditions.

Table 1 presents the temperature dependency of the GMT221 at 0.5% CO_2. Approximate error without internal compensation (ambient temperature MF_TEMP in factory setting at 25°C) and with internal compensation applied (ambient temperature set to desired temperature X) is shown.

Ambient temperature	Error with factory default MF_TEMP 25	Error with user set value MF_TEMP X
25°C	negligible	negligible
-20°C	+10% of reading	very small
-30°C	+17% of reading	+9% of reading

Table 1: The temperature dependency expressed as typical error in the CO_2 reading with and without internal compensations (at 0.5% CO_2).

Correcting the CO_2 Reading for Temperature Dependency

To achieve the most accurate CO_2 measurement, the internal compensation function of the transmitter should be used. The internal temperature compensation function of the GMT221 is valid down to -20°C. Please refer to the GMT220 Series User's Guide to learn how to perform the internal temperature and pressure compensations (available at www.vaisala.com).

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CO_2 transmitters are often located in temperatures below -20°C in refrigeration applications. The CO_2 reading of the GMT221 can be corrected for temperatures below -20°C using supplementary compensation formulas as presented below.

Figure 1 illustrates the temperature correction formulas of the GMT221 at temperatures below -20°C with internal compensation (MF_TEMP set to the prevailing ambient temperature) and without internal compensation (MF_TEMP set to 25°C).

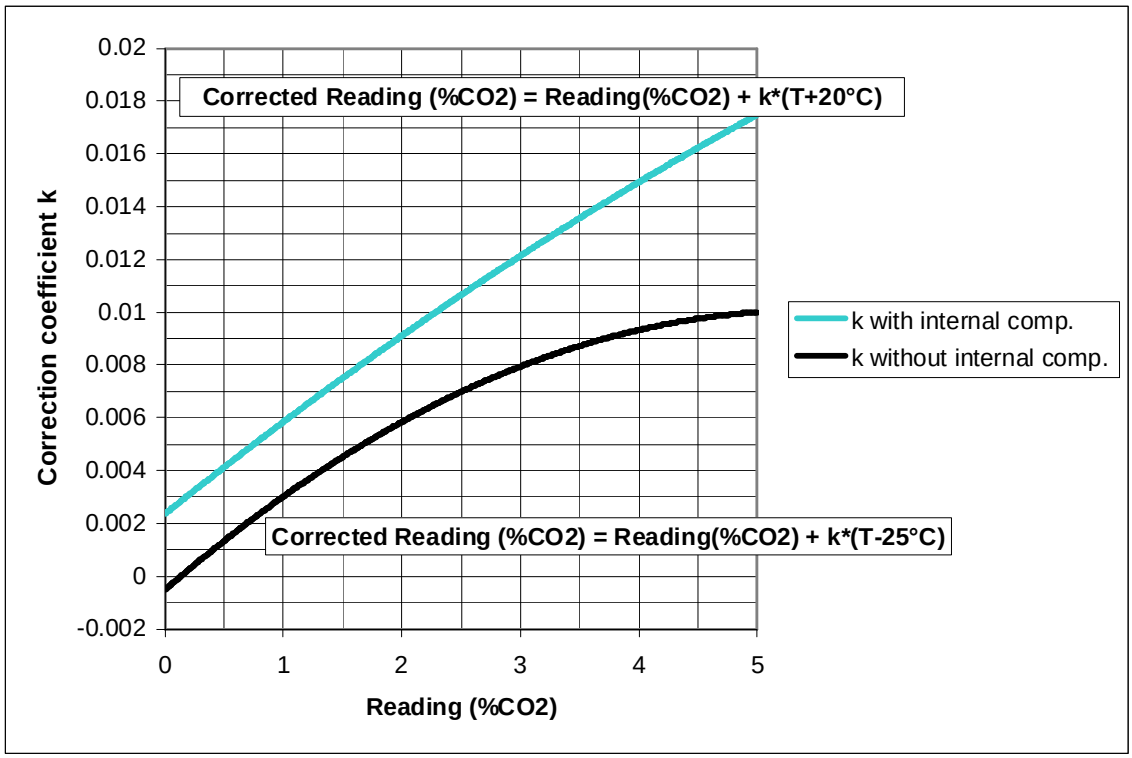

Figure 1: The temperature correction formulas for the GMT221 at temperature T (°C) below -20°C.

The correction coefficient can be approximated from Figure 1 according to the measured reading of the GMT221 transmitter. The upper curve represents the correction coefficient for CO_2 readings with applied internal compensation and the lower curve can be used to estimate the correction coefficient for CO_2 readings without internal compensation. Compensated CO_2 reading can be calculated from the following formulas:

1) With applied internal compensation:
Corrected CO_2 reading (% CO_2) = Reading (% CO_2) +k*(T+20°C)

2) Without internal compensation:
Corrected CO_2 reading (% CO_2) = Reading (% CO_2) +k*(T-25°C)

Explanations of the symbols used in the formulas:
Reading (% CO_2) = the CO_2 reading given by the transmitter (note: 10 000 ppm CO_2 = 1% CO_2),
k = the correction coefficient approximated from Figure 1
T = the prevailing ambient temperature in the measurement environment

Learn more at www.vaisala.com/GMT220