AN14539

3-wire RTD with NAFE13388

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Document information

Information	Content
Keywords	3-wire RTD measurement, industrial temperature measurement, Pt100 measurement system, NAFE13388-EVB
Abstract	This document describes the implementation of a fully protected, high-precision 3-wire RTD measurement system using the NAFE13388.

1 Introduction

The NXP NAFE13388/NAFE73388 (NAFExx388) family of devices features highly configurable, industrial-grade, multichannel analog input analog front-end (AI-AFE) that meet high-precision measurement requirements.

In this document, the implementation of a fully protected, high-precision, 3-wire RTD measurement system using the NAFE13388 is described.

The system can measure RTD resistance when exposed to temperatures from -200 °C to 850 °C and minimizes the error caused by lead wire resistances using an optimized, single-injection current circuitry.

The test results are presented in the case of the sensor directly connected to the measurement system and when it is connected with long wires.

2 Pt100 introduction

The most-used RTD sensor in the industrial environment is the Pt100 with a 385 °C temperature coefficient. The Pt100 has a resistance value of 100 Ω at 0 °C.Table 1 shows the Pt100 resistance values when the temperature goes from -200 °C to 850 °C.

Table 1. Pt100 resistance vs temperature

Temperature [°C]	Pt100 [Ω]
-200	18.5
-100	60.2
0	100
100	138.5
200	175.8
300	212.1
400	247.1
500	281
600	313.7
700	345.3
800	375.7
850	390.5

The above values are also shown in a graphic format in Figure 1. It is possible to notice that the temperature vs resistance relationship is not linear. A linear trendline is also added in the graph to show the difference.

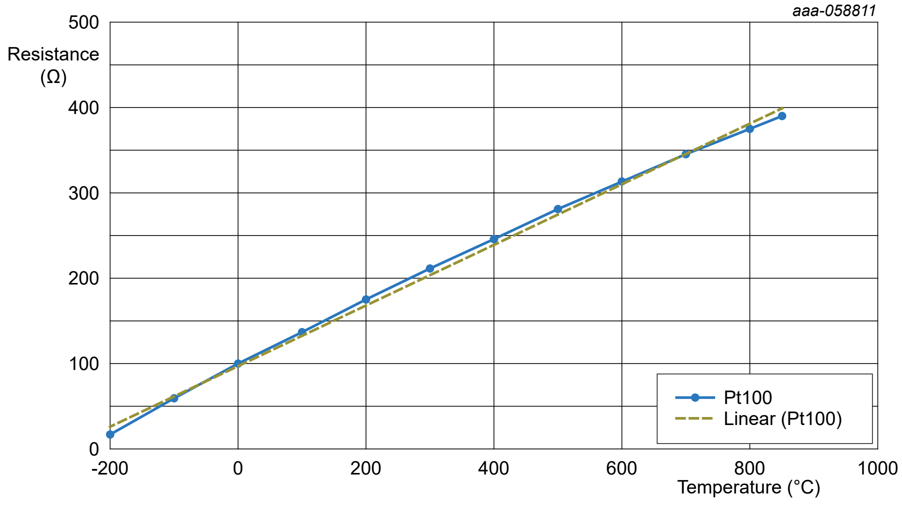

Figure 1. Pt100 resistance vs temperature

2.1 Pt100 accuracy class targets

RTD sensor characteristics have been standardized over time. There are different standards defined worldwide. However, most of the standards have similar specifications. One of the most common standards is IEC 60751.

Table 2 shows the different classes according to the IEC 60751 specification.

Table 2. Pt100 resistance vs temperature

Class	Accuracy	Temperature range	Application
AA	±(0.1 + 0.0017*| t |)	-50 °C to 250 °C	-
A	±(0.15 + 0.002*| t |)	-100 °C to 450 °C	Medical
B	±(0.3 + 0.005*| t |)	-196 °C to 600 °C	Industrial
C	±(0.6 + 0.01*| t |)	-196 °C to 600 °C	-

Where |t| is the absolute value of the temperature in °C.

Even if the RTD can reach temperature ranges from -200 °C to 850 °C, the most common used temperature range is from -200 °C to 600 °C.

Class B is the most common, particularly in industrial applications. It is the target class for the system under test.

Figure 2 shows the accuracy tolerance in degrees Celsius vs the RTD temperature of the above classes.

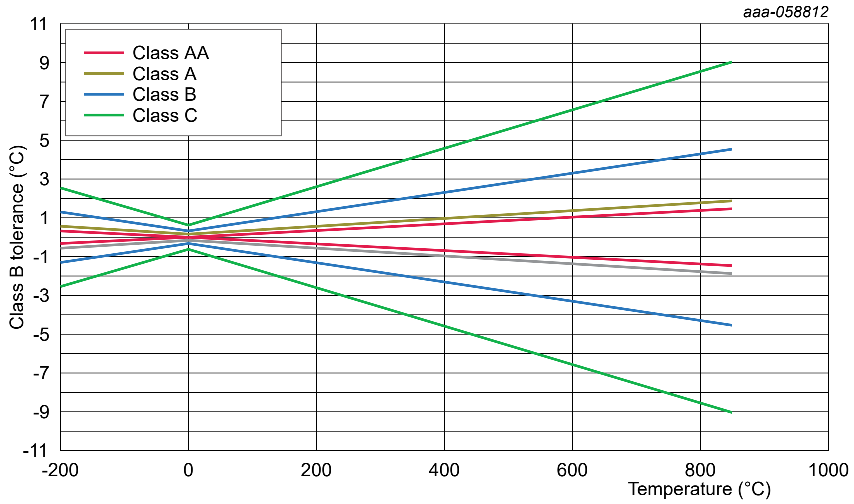

Figure 2. IEC 60751 classes

2.2 RTD wiring

Usually, RTDs are connected to the measurement system with long wires that are plugged to the screw connectors. These wires have their own resistance and, when the injected current flows through them, this creates a voltage drop that can cause an error in the measurement. In most of the installations, the wire length can range from a few meters to hundreds of meters. The corresponding resistance depends on the wire section that is typically between 12 AWG and 26 AWG, thus determining a wire resistance between a few ohms to tens of ohms.

To overcome the wire resistance error, a few RTD wiring configurations are possible: 4-wire (most precise), 3-wire, and 2-wire.

In the 4-wire configuration, the wiring resistance has no impact because the current injection and the measurement occur in two different wire pairs.

In the 3-wire configuration, the wire resistance takes part in the measurement, but its impact can be reduced with special correction techniques.

In the 2-wire configuration, it is not possible to cancel or compensate for the error. This configuration is used when the wires are not so long, or an RTD with a high resistance value is used, such as Pt1000.

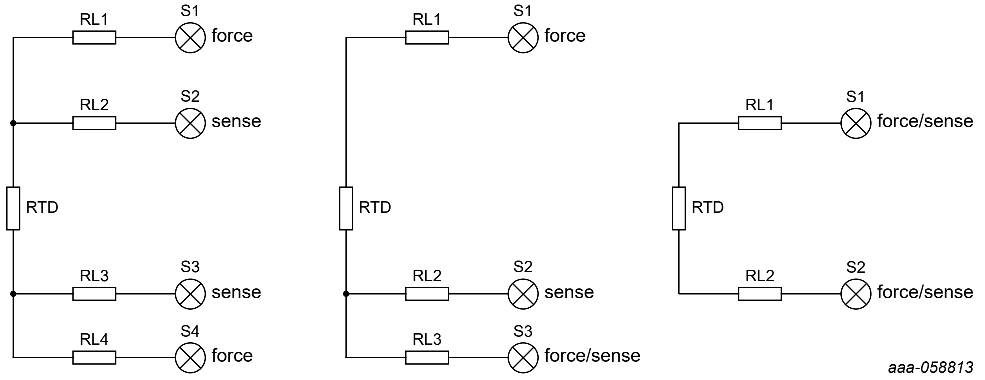

Figure 3. 4-, 3- and 2-wire configuration

2.3 Protection

As the distance between the measurement system and the measurement point could be hundreds of meters, these wires are exposed to voltage surges of a few kilovolts, in general, caused by lightning. The measurement system must be protected on such occasions. A typical protection consists of a transient voltage suppression diode (TVS) that can absorb energy.

3 RTD measurement solution with NAFE13388

3.1 Introduction to NAFE13388

In this section, the characteristics of the NAFE13388 that are relevant for the RTD measurement system under test are presented.

3.2 Overview

The NAFE13388 and all the related variants, for example the high-speed NAFE73388, and the non-factory calibrated NAFE13188, are highly configurable industrial-grade multichannel universal input analog front-ends (NAFE) that meet high-precision measurement requirements. The NAFE13388 family of products is designed to measure any input voltage and currents typically used in the industrial market, such as ±10V, ±0 to 20mA, RTDs and thermocouples.

The device integrates low-leakage, high-voltage fast multiplexers (mux), low-offset and low-drift programmable gain amplifier (PGA) and buffers, high data rate 24-bit sigma-delta analog-to-digital converter (ADC), precise voltage and current excitation source, and low-drift voltage reference. The digital data are read by the host MCU/MPU through the SPI.

The current excitation source is specifically designed for RTD measurement, featuring a low temperature drift of 4 ppm/°C typical. This characteristic, together with the other precise blocks of the signal chain, including the voltage reference, allows capture of low total unadjusted error (TUE) both at room temperature and in the extended temperature range. These characteristics the NAFE to meet the stringent requirements of RTD measurement systems.

In addition to user calibration, the NAFE13388 offers the possibility to use factory-calibrated gain and offset coefficients stored in its nonvolatile memory (NVM). This option allows the user to avoid costly and time-consuming onboard calibration.

3.3 Current excitation

The NAFE13388 includes a programmable voltage or current excitation source (VEXC/IEXC) with positive and negative polarity options.

In case of RTD application, the IEXC source is configured as positive current output. The magnitude of the current ranges from 1 µA to 2 mA. The selection of the current is done by setting the corresponding bit in the CH_CONFIG3 register.

The most common current excitation for a Pt100 application ranges from 250 µA to 1 mA. These options are covered by IEXC settings.

The excitation current can be routed to any of the eight analog input pins of the NAFE13388. This feature allows complete configurability in multiple RTD systems.

The IEXC source has a typical temperature drift of ±4 ppm/°C, thus allowing single-point system calibration at room temperature while keeping optimal performances, even when the measurement system is subjected to temperature variations.

3.4 Surge protection

As shown in the circuit of Figure 4, the NAFE13388 does not require additional components at the inputs for surge protections.

The NAFE13388 protection architecture improves RTD measurement accuracy when combined with the reduction or elimination of external components.

For example, the SMBJ33CA is a common protection device available from different semiconductor companies and commonly used to protect the inputs of an RTD system. The SMBJ33CA has a maximum specified leakage current of 1 uA. As seen in Figure 4, where a typical connection of the TVS is shown, their leakage current is sunk from the excitation current on S2 and S3 connectors. If the excitation current is set at 500 μA, a current of just 499 μA goes through the RTD because 1 μA goes to the TVS connected to S2. The leakage current on S3 has no effect because it is out of the measurement path. This effect can be compensated for by performing the onboard calibration. However, when the system is subjected to temperature variations, this leakage current will change, thus determining the error in the measurement.

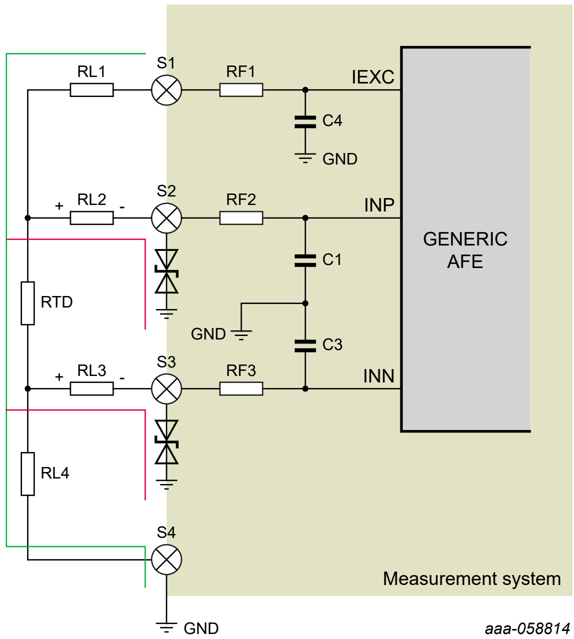

Figure 4. Effect of TVS leakage on RTD measurement

3.5 Logical channels and sequencer

The NAFE13388 can store 16 different measurement configurations. Each measurement configuration applies different settings to the input multiplexer, PGA gain, calibration coefficients, data rate, SINC filter and IEXC. In this way, 16 logical channels (CH0 to CH15) are available to the user. With the channel-based configurations, the user may switch among the configured channels seamlessly, and without the need to perform multiple SPI transactions to set up various configurations before each ADC conversion. The 16 configurable logical channels are all independent. The user can activate the conversion on one, two, or any other number of channels. The selected active channels do not need to be consecutive.

The sequencer will step through the activated channels to execute a conversion.

Once the start conversion command is issued, the sequencer will begin the ADC conversions on the enabled channels and apply the related channel settings. The sequencer can be configured to stop upon completing the conversion of the last enabled channel or to automatically start again from the first channel.

Figure 5 shows an example of two enabled (CH0 and CH1) channels. After the host sends the start command (CMD_MM), the sequencer continuously performs the two measurements. The host does not need to change the configuration between CH0 and CH1 measurements.

As described later in this document, this feature simplifies the implementation of the wire resistance cancellation technique.

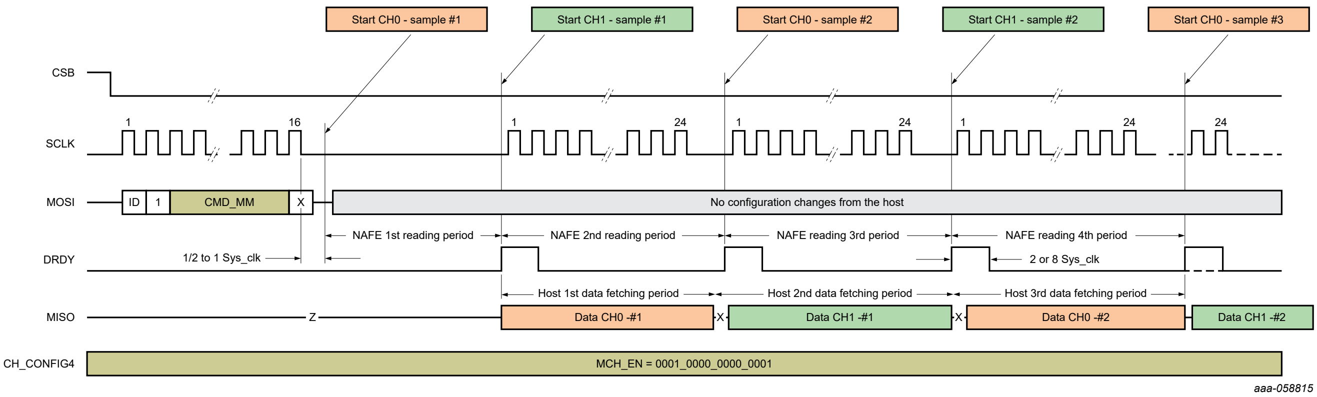

Figure 5. Example of SPI transaction with the sequencer

3.6 Factory-calibrated RTD coefficients

The NAFE13388 family is available with or without factory-calibrated coefficients for voltage gain and offset. These coefficients are stored in the device nonvolatile memory at the NXP factory. In addition to the gain and offset coefficients for voltage measurements, the NAFE13388 also features RTD-specific calibration coefficients.

These 24-bit coefficients are stored in an optional calibration register (OPT_COEFx). The host should copy them to the system gain and offset calibration registers (GAIN_COEFx and OFFSET_COEFx) to use them in the conversions.

As indicated in Table 3, there are four pairs of stored gain/offset values: RTD1, RTD2, RTD3, RTD4.

Table 3. Optional and RTD-calibrated coefficients register

CAL register	NVM stored parameter	Nominal value	Stored format	Setting description
OPT_COEF3[23:0]	RTD_OFFSET1	0	—	Factory CAL coefficient for gain = 16 V/V, VIEX_VI = 1, VIEX_MAG = 9/d (250 uA)
OPT_COEF4[23:0]	RTD_GAIN1	1	G = 2^24/4	Factory CAL coefficient for gain = 16 V/V, VIEX_VI = 1, VIEX_MAG = 9/d (250 uA)
OPT_COEF5[23:0]	RTD_OFFSET2	0	—	Factory CAL coefficient for gain = 8 V/V, VIEX_VI = 1, VIEX_MAG = 11/d (500 uA)
OPT_COEF6[23:0]	RTD_GAIN2	1	G = 2^24/4	Factory CAL coefficient for gain = 8 V/V, VIEX_VI = 1, VIEX_MAG = 11/d (500 uA)
OPT_COEF7[23:0]	RTD_OFFSET3	0	—	Factory CAL coefficient for gain = 4 V/V, VIEX_VI = 1, VIEX_MAG = 13/d (1 mA)
OPT_COEF8[23:0]	RTD_GAIN3	1	G = 2^24/4	Factory CAL coefficient for gain = 4 V/V, VIEX_VI = 1, VIEX_MAG = 13/d (1 mA)
OPT_COEF9[23:0]	RTD_OFFSET4	0	—	Factory CAL coefficient for gain = 0.8 V/V, VIEX_VI = 1, VIEX_MAG = 13/d (1 mA)
OPT_COEF10[23:0]	RTD_GAIN4	1	G = 2^24/4	Factory CAL coefficient for gain = 0.8 V/V, VIEX_VI = 1, VIEX_MAG = 13/d (1 mA)
OPT_COEF11[23:0]	—	—	—	—
OPT_COEF12[23:0]	—	—	—	—
OPT_COEF13[23:0]	—	—	—	—
OPT_COEF14[23:0]	—	—	—	—
OPT_COEF15[23:0]	—	—	—	—

By combining the gain and excitation current values we can calculate the maximum resistance that can be measured.

As shown in Table 4, the RTD1, RTD2, RTD3 pairs are applicable to Pt100 measurements, while RTD4 to Pt1000 sensors.

Table 4. Maximum resistance for RTD factory-calibrated coefficients

	Gain	Full scale	IEXC	Max R
RTD1	16	125mV	250 µA	500 Ω
RTD2	8	250 mV	500 µA	500 Ω
RTD3	4	500 mV	1 mA	500 Ω
RTD4	0.8	2.5V	1 mA	2.5 kΩ

The RTD2 coefficients will be used to test the performance of the system to offer a cost-optimized solution that avoids the expensive onboard calibration process.

4 Measurement system under test

The measurement system under test is the standard NAFE13388 evaluation board (NAFE13388-EVB). To configure the NAFE13388 and take the measurement data, the GUI associated with the NAFE13388-EVB has been used.

Figure 6 shows the simplified schematic of the system under test. Just the relevant components for the purpose of the test are shown. The complete schematic is available in the NAFE13388-EVB documentation.

The RFx/CFx components are used as antialiasing filters and implements the surge protection network. RFx values are 2.4 kΩ and CFx are 1 nF. In Figure 6, the wire resistances are also shown: RL1, RL2, RL3.

The NAFE13388 gives the possibility to use any of the eight analog input pins for current excitation. In this test, the AI2P pin is used as current excitation and AI1P, AI1N are used for the differential voltage measurement across the RTD.

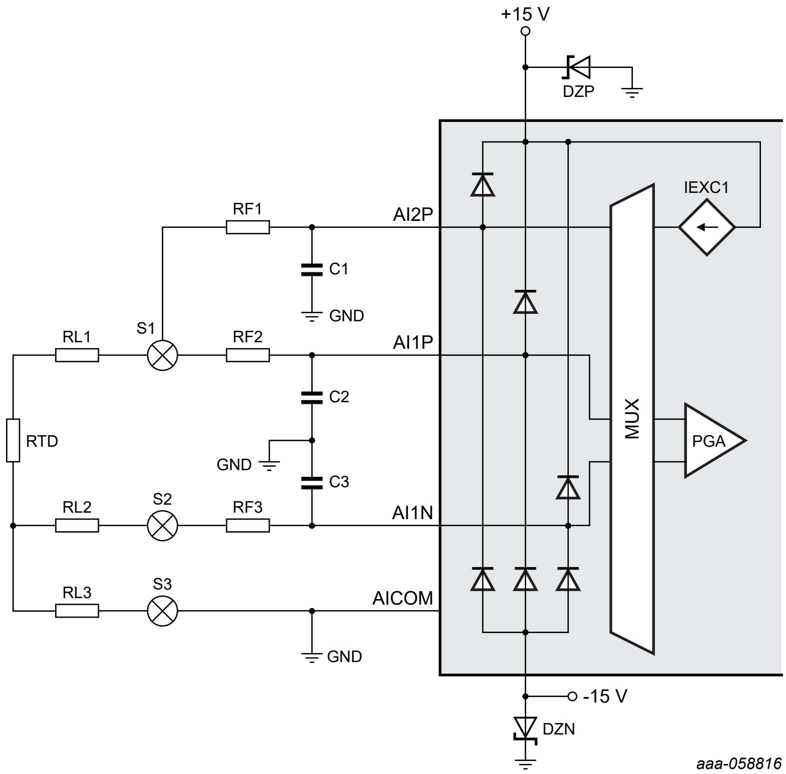

Figure 6. 3-wire RTD implementation with NAFE13388

Since testing a Pt100 in the full temperature range requires a very special equipment, its behavior has been emulated by connecting different resistors from 18 Ω to 330 Ω. This is possible because, electrically, the Pt100 is equivalent to a resistance.

Table 5 shows the configuration of the system under test.

Table 5. Summary of the system under test

Component	Value
Pt100 – (emulated with resistors)	18 to 330 Ω
IEXC	500 µA
PGA gain	16x
Data rate	50 SPS

Table 5. Summary of the system under test*...continued*

Component	Value
Digital filter	SINC4 + SINC3
System operating temperature	-30 to 110 °C

4.1 Description of the technique to cancel the error of the wire resistance

In Figure 7, the IEXC current path is shown. The current is injected through the AI2P pin and flows through RF1, RL1, RTD, and RL3 to ground. The RTD voltage measurement is taken between AI1P and AIN pins.

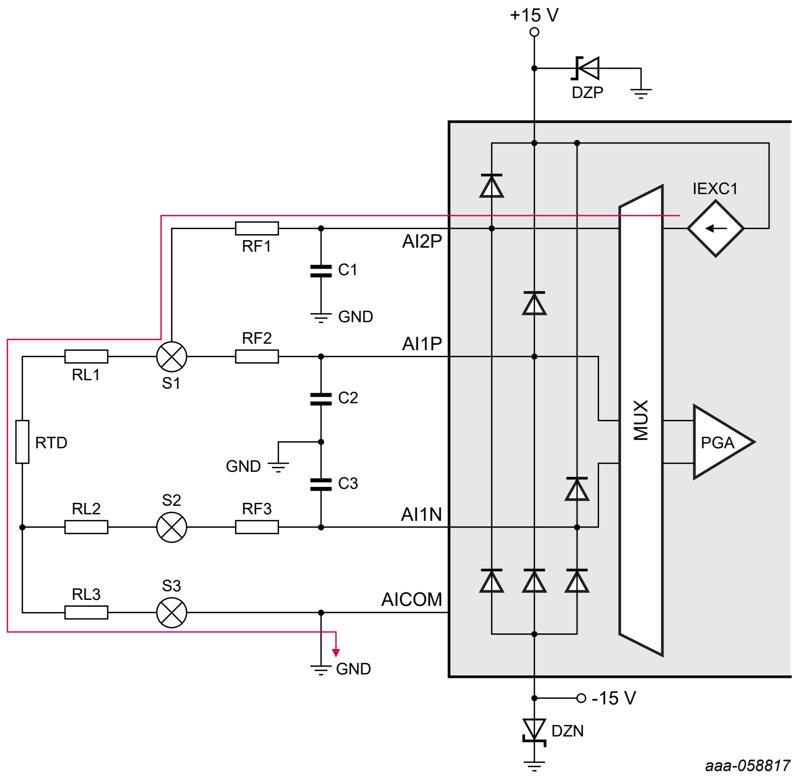

Figure 7. IEXC current path

The following is a detailed analysis of the contribution to the measured voltage between AI1P and AI1N (Meas#1).

Equation 1: $V_{(AI1P\text{-}AI1N)} = I_{EXC} \times (RL1 + R_{RTD})$

Equation 1 shows that the measurement is strongly affected by the RTD wire resistance.

For example, the resistance of a 10-meter 25 AWG wire is about 1 Ω. A 1 Ω error on a Pt100 with a 385 °C temperature coefficient corresponds to 2.6 °C. This type of error is too large and does not meet any of the accuracy classes.

The NAFE13388 implements a technique that reduces this error.

The internal multiplexer of the NAFE13388 can do measurements on any input pins, including the dedicated pin for pseudodifferential measurement named AICOM.

To reduce the error of Equation 1, the NAFE13388 is programmed to measure the voltage between AI1N and AICOM (Meas #2), which is given by:

Equation 2: $V_{(AI1N\text{-}AICOM)} = I_{EXC} \times RL3$

Subtracting Equation 1 and Equation 2 produces the following:

Equation 3: $V_{(AI1P\text{-}AI1N)} - V_{(AI1N\text{-}AICOM)} = I_{EXC} \times RL1 + I_{EXC} \times R_{RTD} - I_{EXC} \times RL3$

It is important to notice that in both Meas#1 and Meas#2, the current excitation does not change, so the IEXC value is exactly the same in both equations.

By assuming RL1 = RL3 = RL2, which is a reasonable assumption in 3-wire RTD measurements because the wires are all the same type and length, the IEXC · RL1 and IEXC · RL3, terms of the equation, cancel each other. Equation 3 results as follows:

Equation 4: $V_{(RTD)} = V_{(AI1P\text{-}AI1N)} - V_{(AI1N\text{-}AICOM)} = I_{EXC} \times R_{RTD}$

The measured voltage is now only given by the RTD value. The wire resistance theoretically is completely canceled, thus making this technique independent on the wire length. In practical measurements, the contribution of the wire resistance cannot be completely canceled because any measurement has its intrinsic error. However, the test results show that this residual error is well inside the targeted tolerance class.

4.2 Implementing the wire cancelation technique with NAFE logical channels and sequencer

The NAFE13388 simplifies the above procedure by using the logical channels and sequencer described in Section 3.5.

To implement the described technique, logical channel 0 (LCH0) is configured to measure the voltage between AI1P and AI1N, while logical channel 1 (LCH1) is configured to measure the voltage between AI1N and AICOM.

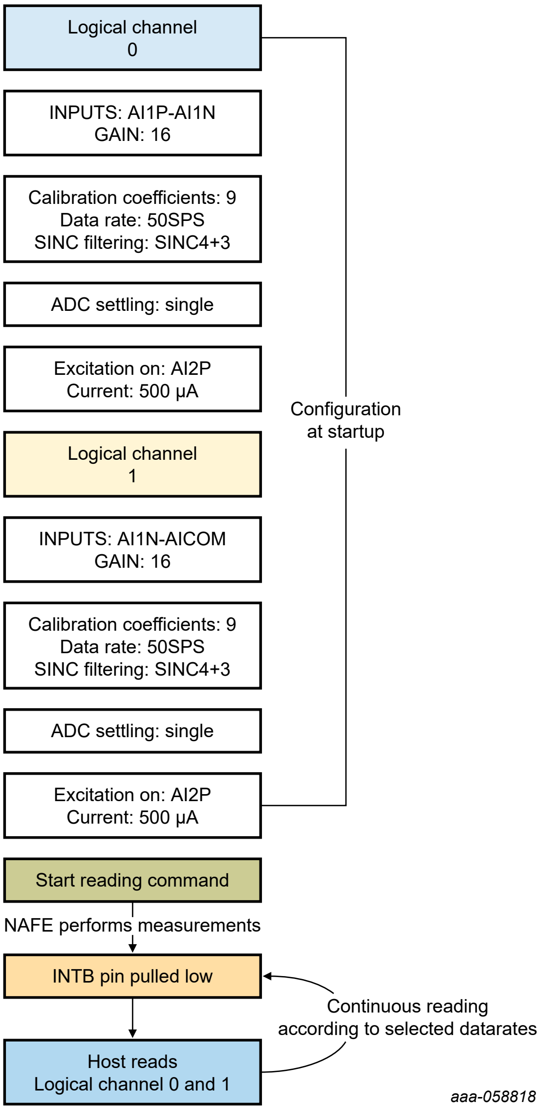

Figure 8. Logical channels configuration for 3-wire RTD

Once the two acquisitions are done, the NAFE13388 advises the host that the data are ready through its DRDY pin. The host reads them all at once and applies the subtraction of Equation 4 to get the corrected RTD voltage value.

5 Measurement results

The performance of the system has been verified with lab measurements.

Two main sets of measurements have been performed:

- Using factory calibration coefficients
- Using user calibration coefficients

For each of the two sets, the measurement is done with the resistor directly connected to the screw terminals (Figure 9) and with the resistor connected with 7 meters of 25 AWG wires, which introduce an additional series resistance of 0.72 Ω (Figure 10).

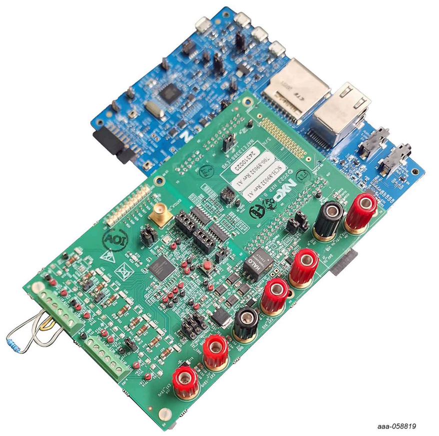

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Figure 9. Resistor connected to the screw terminals (yellow wire represents the third wire of the RTD)

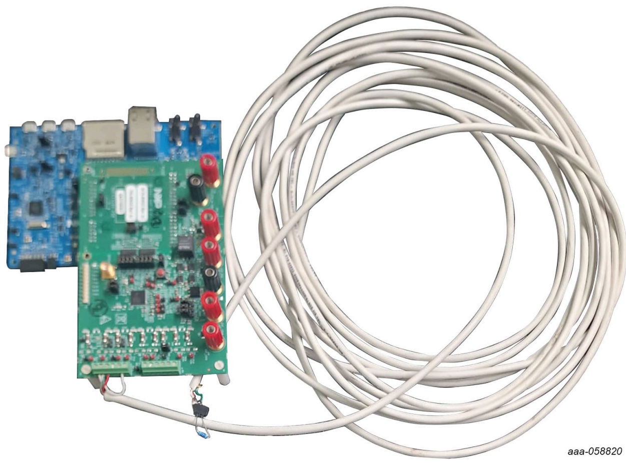

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Figure 10. Resistor connected with long wires

The exact value of the resistors that simulate the Pt100 have been measured using a precise digital multimeter. Their values are reported in the measurement result tables as RDMM.

5.1 Test results with factory calibration coefficients

As introduced in Section 3.6, by using the stored calibration coefficients, the NAFE13388 allows measurement of resistance with good accuracy without user calibration procedure.

To perform the tests, the RTD2 coefficients have been used. The offset coefficient has been copied from OPT_COEF5[23:0] to OFFSET_COEF9[23:0] and the gain coefficient has been copied from OPT_COEF6[23:0] to GAIN_COEF9[23:0]. So the offset/gain pair of coefficients is now on the pointer 9 of the system gain and offset calibration register.

This is automatically done by clicking **Load RTD Coefficients** in the Calibration tab of the NAFE13388 GUI.

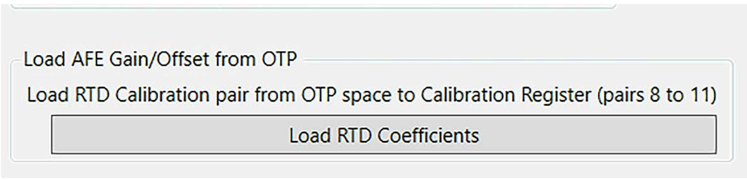

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Figure 11. Load RTD coefficients using the NAFE13388 GUI

Once the calibration coefficients have been loaded in the pointer 9, all the settings (gain, data rate, input mux, IEXC) for LCH0 and LCH1 have been configured in the GUI.

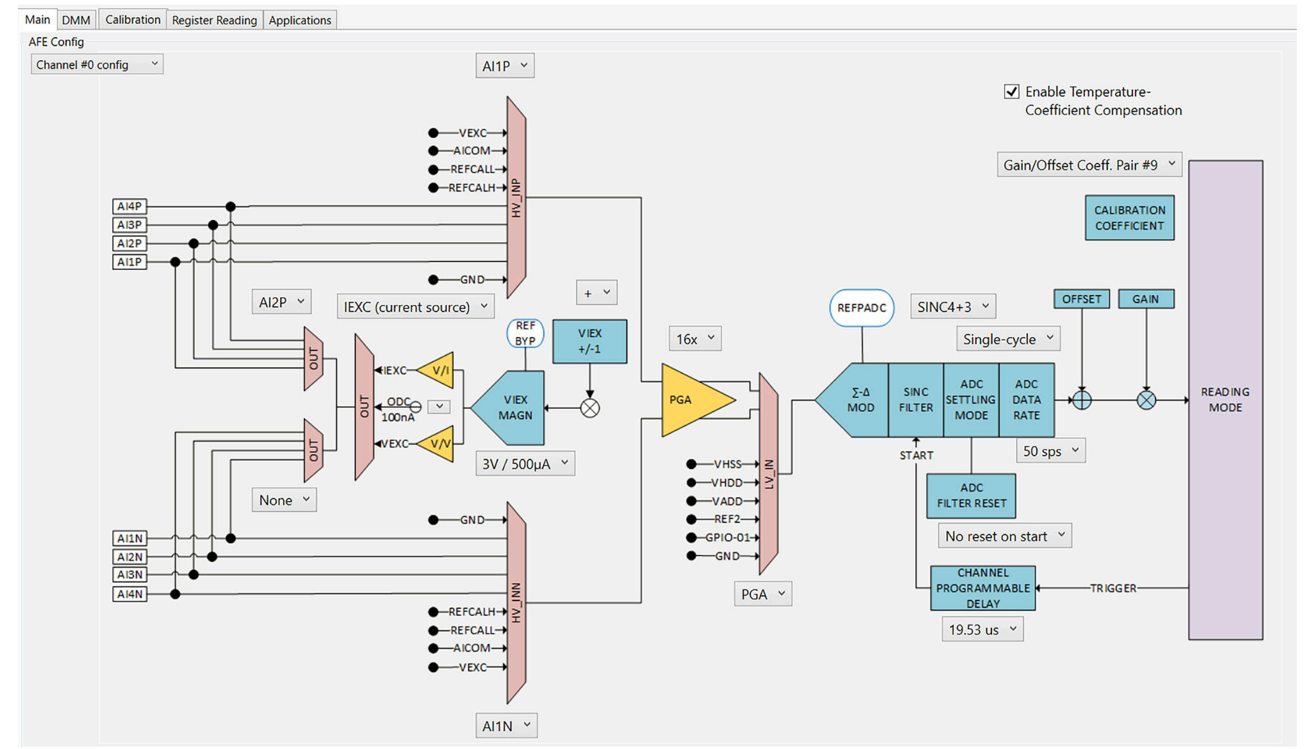

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Figure 12. Logical channel 0 GUI configuration

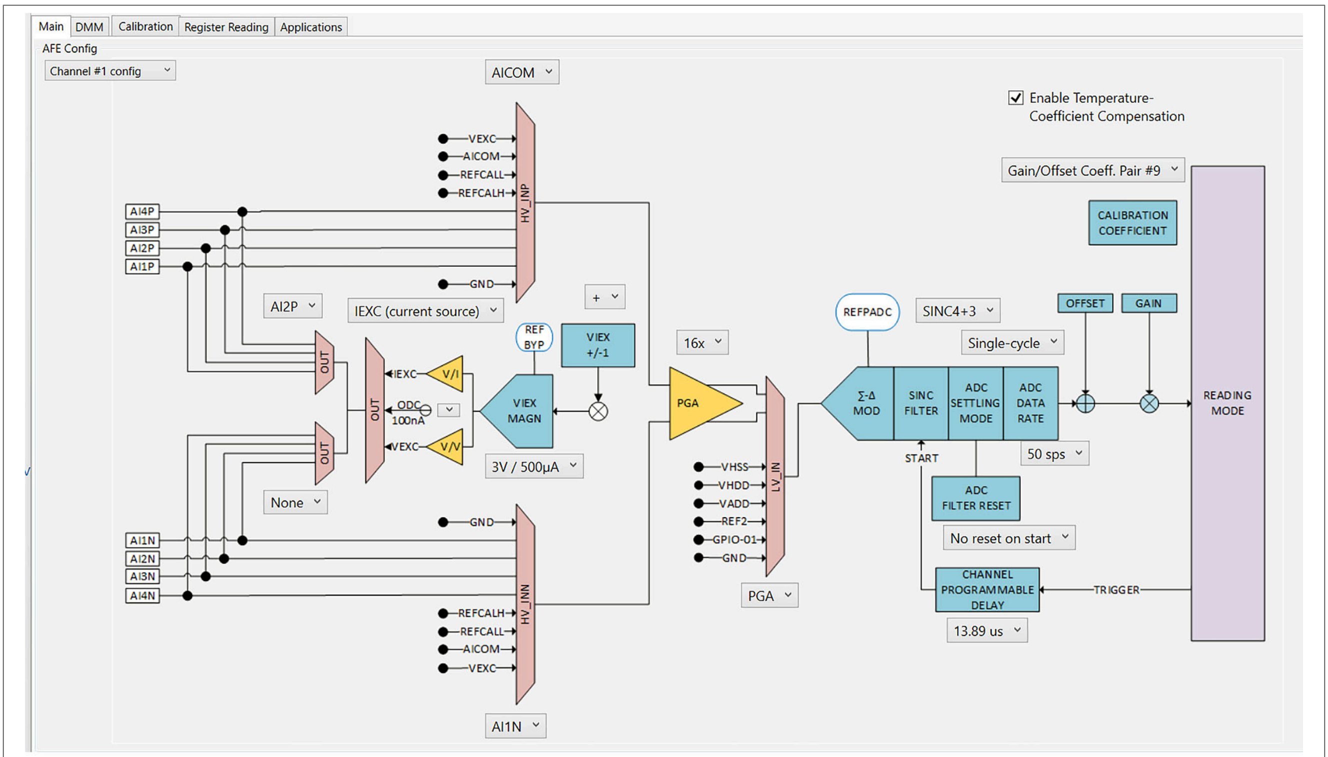

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Figure 13. Logical channel 1 GUI configuration

By using the multichannel multireading command (CMD_MM), the NAFE performs the two measurements on LCH0 and LCH1 and provides the results. Figure 14 shows an example of the result.

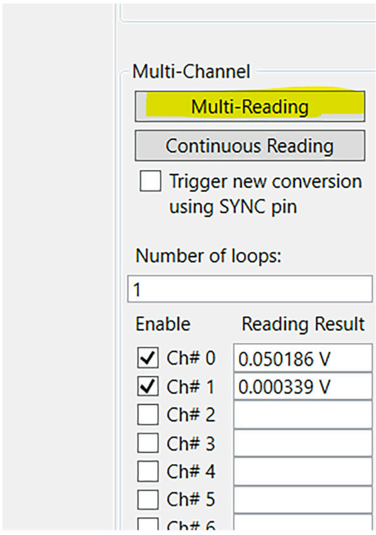

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Figure 14. Multi-Channel Multi-Reading command

Table 6 summarizes the measurement results with factory-calibrated coefficients and the resistor closely connected to the NAFE13388 evaluation board.

Table 6. Factory calibration coefficients with direct connection

Nominal resistors [Ω]	Equivalent temperature [C]	RDMM [Ω]	LCH0 [V]	LCH1 [V]	RMEAS [Ω]	Error [%]	Error [Ω]	Error [°C]
18	-200	17.940	0.008962	-	17.924	-0.09%	-0.016	**-0.04**
60	-100	61.686	0.030870	-	61.740	0.09%	0.054	**0.14**
100	0	99.651	0.049829	-	99.658	0.01%	0.007	**0.02**
180	200	179.490	0.089742	-	179.484	0.00%	-0.006	**-0.02**
250	400	239.893	0.119937	-	239.874	-0.01%	-0.019	**-0.05**
270	500	269.719	0.134846	-	269.692	-0.01%	-0.027	**-0.07**
330	650	329.579	0.164755	-	329.510	-0.02%	-0.069	**-0.18**

Where:

R-meas is calculated as (LCH0-LCH1)/IEXC;

The error in ohms is calculated as

$$R_{MEAS} - R_{DMM}$$

The error in percentage is calculated as

$$(R_{MEAS} - R_{DMM}) / R_{DMM}$$

The error in degree Celsius is calculated as Error[Ω]/0.385.

As the resistor is directly connected to the screw terminals, there is no need to compensate for the wire resistance so the LCH1 measurements have not been performed in this test.

Table 7 shows the same results, but with the resistors connected through 7 meters of 25 AWG wires.

Table 7. Factory calibration coefficients with long wire connection

Nominal resistors [Ω]	Equivalent temperature [C]	RDMM [Ω]	LCH0 [V]	LCH1 [V]	RMEAS [Ω]	Error [%]	Error [Ω]	Error [°C]
18	-200	17.940	0.009317	0.000339	17.956	0.09%	0.016	**0.04**
60	-100	61.686	0.031199	0.000339	61.72	0.06%	0.034	**0.09**
100	0	99.651	0.050183	0.000339	99.688	0.04%	0.037	**0.10**
180	200	179.490	0.090099	0.000340	179.518	0.02%	0.028	**0.07**
250	400	239.893	0.120295	0.000339	239.912	0.01%	0.019	**0.05**
270	500	269.719	0.135205	0.000339	269.732	0.00%	0.013	**0.03**
330	650	329.579	0.165118	0.000339	329.558	-0.01%	-0.021	**-0.05**

As shown from the results, the cancellation technique allows getting similar performances as if the resistor was closely connected to the evaluation board.

The above results have been plotted in Figure 15 together with Class B and Class A tolerance limits. The results are well inside Class B.

The system also meets Class A. However, there is not a big margin at 0 °C when using wires: 0.1 °C vs 0.15 °C of Class A specifications.

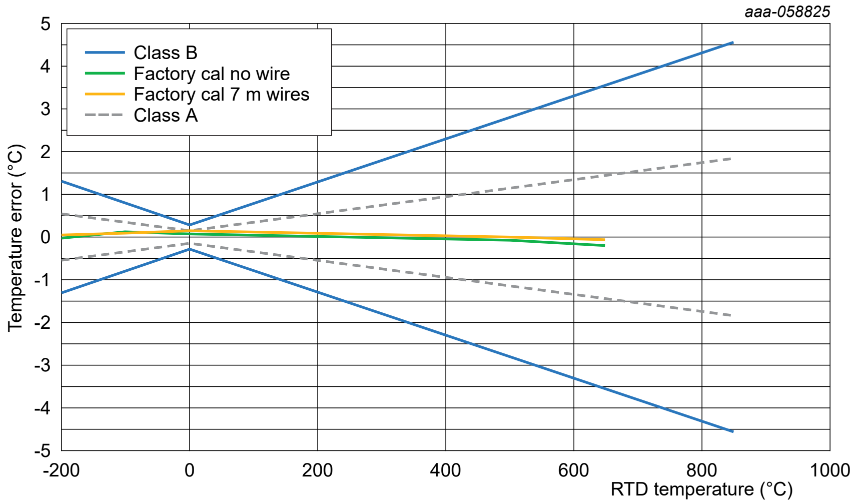

Figure 15. Factory calibration coefficients accuracy plot

5.2 Test results with user calibration coefficients

By using the onboard calibration procedure (user calibration), the errors caused by everything that is outside the NAFE13388 IC is strongly reduced.

The NAFE13388 allows two points of calibration. This procedure has been done using the Calibration tab of the NAFE13388-EVB GUI.

The first calibration point has been chosen to be 60 Ohms. This choice guarantees an acceptable error at negative temperatures, but still provides good accuracy at 0 °C when the tolerance specifications are more stringent. Other options would be to choose 18 Ohms or 100 Ohms. The first will provide the smallest error in average in the full resistors' range, while the second will give the best results at 0 °C. The second is the one that corresponds to the maximum temperature, which is 330 Ω (650 °C).

Table 8. Two-point calibration

Nominal resistors [Ω]	RDMM [Ω]	Target voltage [V]	Measured voltage [V]
60	61.686	0.030843	0.031761
330	329.579	0.1647895	0.168981

Where the target voltage is: RDMM · IEXC.

The calibration procedure resulted in a gain correction of 4091493 [DEC] and offset correction of 1087 [DEC]. These values have been stored in the pointer 13 of the system calibration coefficients.

Refer to NAFE13388 data sheet for detailed description of the gain and offset calibration procedure.

With the user calibration coefficients, a new set of measurements has been generated. Also, in this case the tests have been done with the resistors connected closely and through the 7-meter wires. The results are reported in Table 9 and Table 10.

Table 9. User calibration with direct connection

Nominal resistors [Ω]	Equivalent temperature [C]	RDMM [Ω]	LCH0 [V]	LCH1 [V]	RMEAS [Ω]	Error [%]	Error [Ω]	Error [°C]
18	-200	17.94	0.008958		17.916	-0.134 %	-0.024	**-0.06**
60	-100	61.686	0.030844		61.688	0.003 %	0.002	**0.01**
100	0	99.651	0.049836		99.672	0.021 %	0.021	**0.05**
180	200	179.49	0.089762		179.524	0.019 %	0.034	**0.09**
250	400	239.893	0.119962		239.924	0.013 %	0.031	**0.08**
270	500	269.719	0.134869		269.738	0.007 %	0.019	**0.05**
330	650	329.579	0.16479		329.58	0.000 %	0.001	**0.00**

Table 10. User calibration coefficients with long wire connection

Nominal resistors [Ω]	Equivalent temperature [C]	RDMM [Ω]	LCH0 [V]	LCH1 [V]	RMEAS [Ω]	Error [%]	Error [Ω]	Error [°C]
18	-200	17.94	0.009316	0.000337	17.958	0.10%	0.018	**0.05**
60	-100	61.686	0.031203	0.000337	61.732	0.07%	0.046	**0.12**
100	0	99.651	0.050188	0.000337	99.702	0.05%	0.051	**0.13**
180	200	179.49	0.090107	0.000337	179.54	0.03%	0.05	**0.13**
250	400	239.893	0.120311	0.000337	239.948	0.02%	0.055	**0.14**
270	500	269.719	0.135227	0.000338	269.778	0.02%	0.059	**0.15**
330	650	329.579	0.165129	0.000336	329.586	0.00%	0.007	**0.02**

The above results have been plotted in Figure 16 with Class B and Class A tolerance limits. As a result of the calibration procedure, the accuracy of the system is now inside Class A, with improved margin, also at 0 °C.

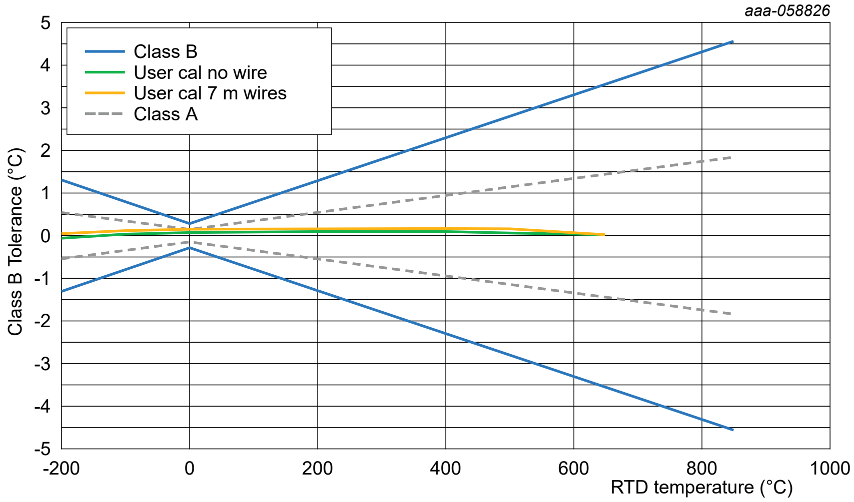

Figure 16. User calibration coefficients accuracy plot

6 Summary

The NAFE13388-EVB evaluation board configured for a 3-wire Pt100 RTD has been tested.

The flexibility of the internal multiplexer, the low-temperature drift current generator, the integrated protections, and the logical channels allow easy implementation of the measurement system.

Using the factory calibration coefficients, it is possible to reach IEC-60751 Class B tolerance avoiding the time-consuming and expensive calibration procedure in the production line.

With the guided onboard calibration procedure, the IEC-60751 Class A has been met.

The efficacy of the wire-resistance cancellation technique has been proven by measuring the accuracy when the Pt100 is connected through long wires.

7 References

[1] IEC-60751 - Industrial platinum resistance thermometers and platinum temperature sensors

[2] NAFE13388 NAFE13388/NAFE73388 data sheets

[3] AN14127 - RTD measurement system with NAFE13388/73388 family of devices

[4] American Wire Gauge (AWG) standardized wire gauge system

8 Revision history

Table 11. Revision history

Document ID	Release date	Description
AN14539 v.1.0	21 February 2025	Initial version

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