SKF Multilog On-line System DMx and temperature measurements

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Introduction

The SKF Multilog On-line System DMx was introduced as an intrinsically safe, vibration based Machine Protection System. However, there have been requests for the device to include temperature measurements.

This is a common requirement to upgrade obsolete analog API 670 monitoring systems. These would often measure (for example) 16 channels of vibration and axial position, and 6 channels of temperature. Each temperature sensor chain would involve direct connection of a Resistive Temperature Detector (RTD) or Thermocouple to the monitor.

This application note describes how to address this situation with an SKF Multilog DMx.

The SKF Multilog On-line System DMx module.

RTDs and thermocouples

These are industry standard devices for sensing temperature. These devices operate on low currents and voltages. Thermocouple sensors (such as J or K type) use a very low voltage, and typically require special cold junction compensation. Both RTDs and thermocouples require linearization curves to convert the measured voltage (or current) to an accurate temperature reading.

With the exception of directly connected Eddy Current Probes (for radial vibration and axial position) the SKF Multilog DMx requires a linearized input. Hence, to handle RTDs and thermocouples, the SKF Multilog DMx requires an external temperature-current converter or "temperature transmitter."

Figure 1. Examples of industry standard devices such as RTDs and thermocouples.

Temperature Transmitters

By using an external temperature transmitter, temperature sensor signals can be linearized and converted to a current signal. This current signal is then sent to the SKF Multilog DMx and handled as a DC input.

Temperature transmitters are commonplace on the general instrumentation market. They are small, low power devices that use a two wire connection. Over these two wires, the devices are powered and the output signal is returned as a 4 to 20 mA signal to the SKF Multilog DMx.

These transmitters are available for use with both RTDs and thermocouples. Some models are programmable for the sensor type and measuring range used with the transmitter. This programmability makes these devices an ideal addition to the SKF Multilog DMx as a front-end temperature transmitter.

For Intrinsically Safe (IS) use, care must be taken to maintain the safety of the loop. By powering the transmitter from the SKF Multilog DMx, you are making sure that the power to any transmitter does not exceed the allowed parameters on the certification.

Figure 2. PR533x, example of a temperature to current transmitter.

However, the selected model must still have the correct "entity parameters" for IS use with the SKF Multilog DMx. This is discussed in more detail later.

Multiple vendors for these types of transmitters exist. SKF Condition Monitoring Center – San Diego has tested the SKF Multilog DMx with the PR533x range of modules from PR electronics – see **Figure 2**.

This model has entity parameters compatible for use with the SKF Multilog DMx in a hazardous area. The model can, of course, also be used in nonhazardous area applications.

Connection to the SKF Multilog DMx

The transmitter is connected directly to the SKF Multilog DMx. Power for the transmitter and current loop is supplied by the SKF Multilog DMx. In this case, a model CMMA 9920 must be used.

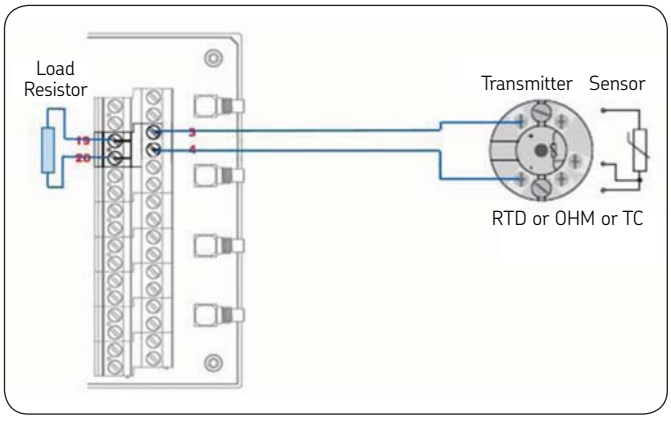

Figure 3. Temperature transmitter to SKF Multilog DMx connection.

An extract from the SKF Multilog DMx manual illustrating a typical connection to the SKF Multilog DMx is shown in **Figure 3**. The transmitter receives an RTD or thermocouple as its input, and provides a 4 to 20 mA current signal as its output. A load resistor on the SKF Multilog DMx is required to convert the current output from the transmitter to a voltage.

For each channel, the SKF Multilog DMx can supply up to 14 mA current at 20 volts. This power is enough for the selected temperature transmitter to work. However, you cannot create current, so this 14 mA supply is insufficient to give a 20 mA full scale range. This limitation can simply be overcome in practice by only using 50% of the full scale (such as, a 4 to 12 mA range). Since the temperature transmitter is programmable, the full scale can be adjusted to fit the requirements.

Temperature transmitter setup

This section describes a typical setup of a PR533x series "transmitter," using programming software that must be supplied with the device.

Temperature channel example

Sensor type: RTD 100 Ω input
Measuring range: 0 to 150 °C
OK Detection: Yes. Downscale.
Load resistor: 1 000 Ω, 1%, 0.5 W

Transmitter programming

To match the required range, and the 14 mA limitation above, the transmitter is programmed for a full scale of 300 °C, which is illustrated in **Figure 4**.

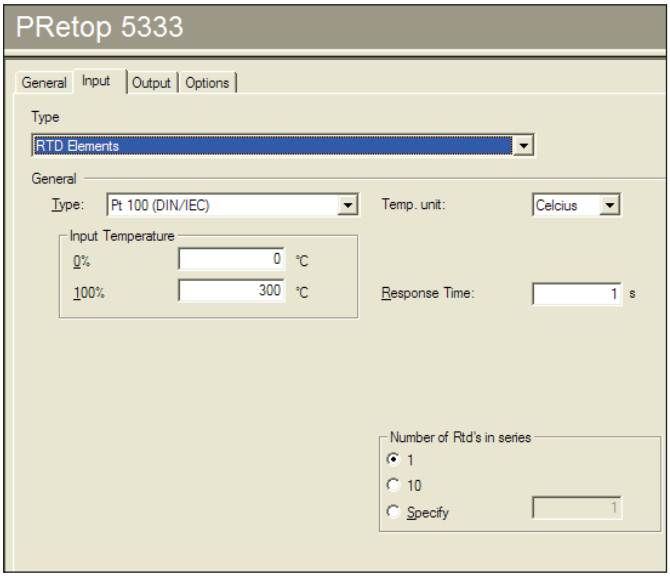

Figure 4. Input screen, PR533x series.

Figure 5 shows the associated output of the transmitter.

The programmed output is 4 to 20 mA and the action upon a defective sensor or cable is set to "downscale." This means that:

- at 0 °C, the current output is 4 mA
- at 150 °C, the current output is 12 mA
- In the case of a bad sensor or cable, current is 3.5 mA (or lower)

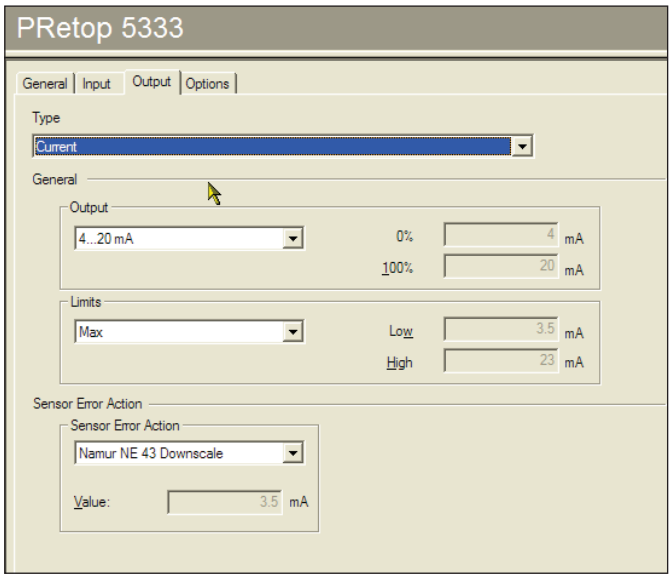

Figure 5. Output screen, PR533x series.

Load resistor on SKF Multilog DMx input.

As show in **Figure 3**, a load resistor is required across the SKF Multilog DMx input terminals. The current (I) from the transmitter generates voltage (U) over the load resistor (R).

The voltage is calculated as U = I ¥ R.

For a 1 000 Ω resistor, at 4 mA current, the voltage over the load resistor is 4 volts. At 12 mA, the voltage is 12 volts.

SKF Multilog DMx sensitivity

SKF Multilog DMx sensitivity is set using the following formula:

mV/EU = R · 16/Programmed Transmitter Range

In this case:

mV/EU = 1 000 · 16/300 = 53.33 mV/°C

Since the transmitter output is 4 mA when the temperature sensor measures 0 °C, an offset must be calculated to allow the SKF Multilog DMx to provide the correct result. The offset is calculated as:

Offset = Offset Current · R/Sensitivity:

In this case:

Offset = 4 mA · 1 000/53.33 = 75 °C

SKF Multilog DMx setup

This section describes how a CMMA 9920 module channel is configured using SKF Multilog DMx Manager software for the above example.

First, the sensor type is configured as a “Temperature C” sensor, see **Figure 6**.

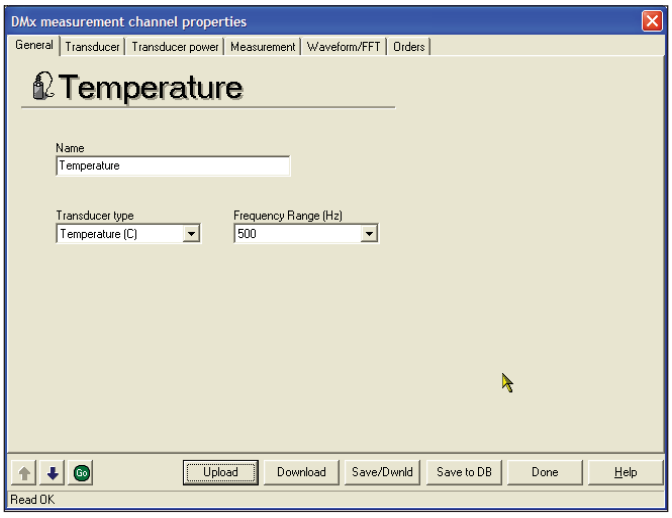

Figure 6. SKF Multilog DMx measurement channel – general tab.

Then the Transducer OK settings are used to generate a sensor failure indication. A current below 3.8 mA, or a current above 12.5 mA, generates a sensor NOT OK, see **Figure 7**.

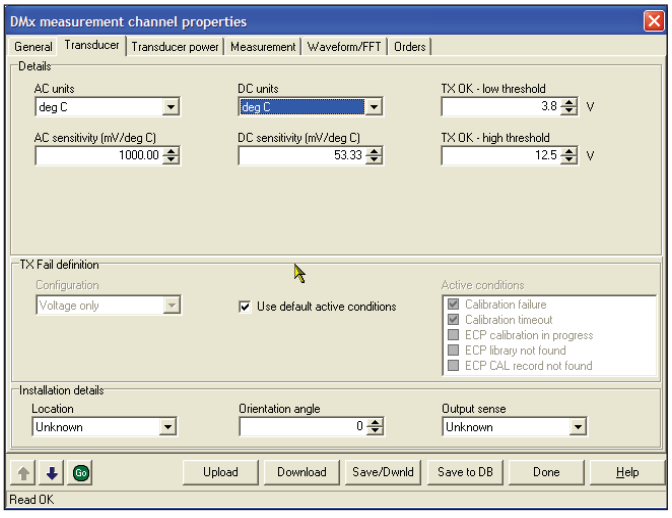

Figure 7. SKF Multilog DMx measurement channel – transducer tab.

Next, the sensor power is configured for constant voltage, see **Figure 8**.

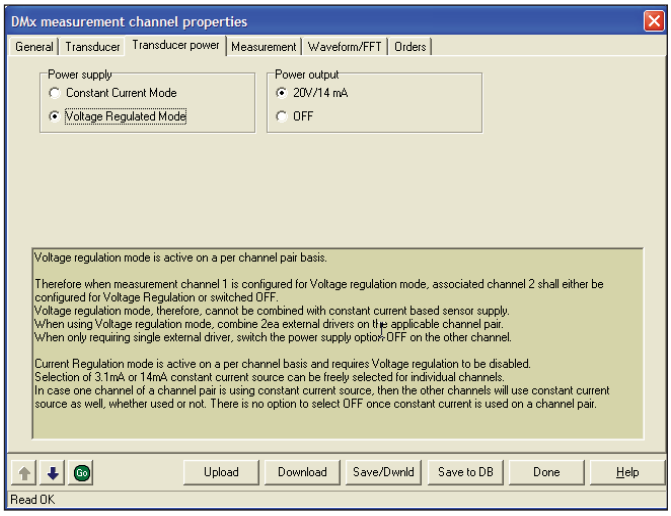

Figure 8. SKF Multilog DMx measurement channel – transducer power Tab.

Finally, in **Figure 9**, the measurement defaults to a “deg C” unit and, as temperature is a DC measurement, the AC filtering is set to “Off,” both AC and DC smoothing are set to 1 second.

The 75 °C offset calculated, is entered in the “Offset” field as shown in **Figure 9**.

Any alarms required from the SKF Multilog DMx are set using the normal alarm settings pages.

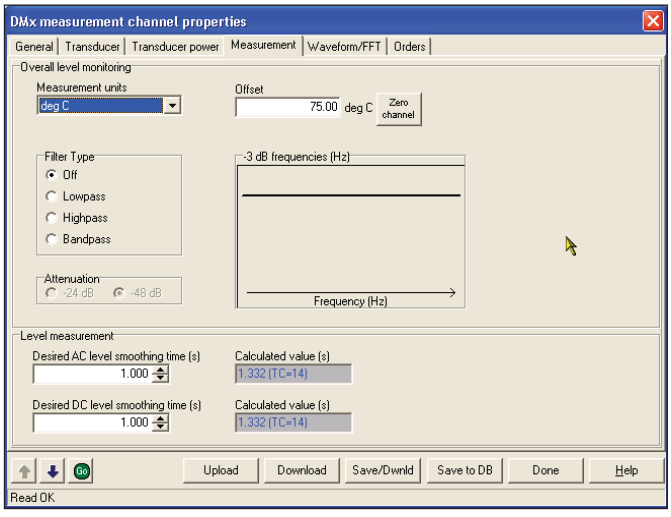

Figure 9. SKF Multilog DMx measurement channel – measurement tab.

Use in an Intrinsically Safe environment

Since the SKF Multilog DMx is certified for use in ATEX Zone 1, it is required to check if the combination of any temperature transmitter and the SKF Multilog DMx are a safe solution.

To do this, we must look at the IS parameters for the SKF Multilog DMx and the transmitter. If these match, then the combination of the two devices is a safe system. The necessary calculations are explained in the SKF Multilog DMx manual. For this example, the most relevant calculations are shown below.

PR533x entity parameters

These are found on the device's ATEX certificate. For the model PR5333D, the maximum supply and input parameters are:

U_i = 30 V; I_i = 120 mA; P_i = 0.84 W; C_i = 1nF; L_i = 10 µH.

(From ATEX certificate KEMA 03ATEX1535X issue 2, dated 12 January 2009)

SKF Multilog DMx entity parameters

The maximum output parameters for the SKF Multilog DMx are:

U_o = 26.5V; I_o = 90.9 mA; P_o = 0.432 W; C_i = Negligible; L_i = Negligible; C_{max} = 95 nf; L_{max} = 3 mH

(From ATEX certificate BVS07ATEXE075X dated 4 July 2007)

Entity parameters check

The above lead to the following Parameter Evaluation:

U_o (26.5 V) ≤ U_i (30 V) † Comply
I_o (90.9 mA) ≤ I_i (120 mA) † Comply
P_o (0.432 W) ≤ P_i (0.84 W) † Comply

Cable check

To comply with ATEX rules, a cable evaluation for the use of the temperature transmitter must also be made. This is necessary even if the transmitters are in same enclosure as the SKF Multilog DMx.

The calculation is based upon the safety descriptions of both devices, indicating the maximum allowed capacitive and inductive load. The following cabling requirements apply for meeting the Group II C requirement:

Capacitance: $C_{max} = C_{ext} – C_i$

where

C_{max} = Maximum permissible cable capacitance
C_{ext} = Maximum permissible capacitance that may be connected to the SKF Multilog DMx channel
C_i = Internal capacitance of the temperature transmitter

Hence, in this case: C_{max} = 0.095 – 0.001 = 0.094 µF

This means that, using a typical 120 pF/m cable, the distance between the transmitter and the SKF Multilog DMx module is limited to:

0.094 µF/120 pF = 0.094/0.000120 = 94/0.120 = 780 meters

Therefore, if the transmitter is located remotely, the SKF Multilog DMx – perhaps located in the RTD sensor head on the bearing cap – then the SKF Multilog DMx needs to be within 780 meters. In practice it would be only a few meters away in a junction box on the machine skid.

Intrinsically Safe conclusion

The above calculations show that the SKF Multilog DMx CMMA9920 Module can be used in combination with the PR electronics model 5333D Transmitter for classification Ex ia IIC.

The same combination can also be used, of course, in a non-IS application, as shown in **Figure 10**.

Note
For any IS installation, the system must be checked with the newest certificates for all connected equipment. The calculation above is an example using the certificates valid at the time of writing.

Summary

Use of external, programmable, temperature transmitters can provide an easy and flexible means of supporting temperature measurements with the SKF Multilog On-line System DMx, enhancing the value proposition of the system.

A transmitter model has been identified and tested and shown to be safe for use with the SKF Multilog DMx in both IS and non-IS applications.

Figure 10. SKF Multilog DMx and PR5333D transmitters (in non-IS application).

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