ABB MEASUREMENT & ANALYTICS | APPLICATION DESCRIPTION

ScreenMaster RVG200

Paperless recorder

Triple validation in the water industry

Measurement made easy

—
2 billion people do not have access to safe drinking water

Introduction

This publication describes how to configure a ScreenMaster RVG200 paperless recorder to perform triple validation.

Recorder requirements

ABB's ScreenMaster RVG200 paperless recorder can be configured to perform triple validation using its Math & Logic capabilities. As this recorder can also record the individual input values simultaneously, only a single recorder is required to perform both tasks.

Triple validation

Many water companies employ a process called triple validation when monitoring chlorine and pH levels in drinking water. This is a system that uses 3 sensors to measure each parameter and calculates the average of the 3 readings to determine if the chlorine and pH levels are within the critical acceptable bands for the process.

However, the system is more intelligent than just an averaging system! It also monitors the 3 sensor readings individually to ensure that each remains within its own acceptable range. An individual value that falls outside of its range is disregarded for averaging calculation purposes.

The primary aim of this system is to ensure that the water company has a redundancy system for remote sites. Instead of using a single sensor to take a measurement, 3 are used for 2 important reasons:

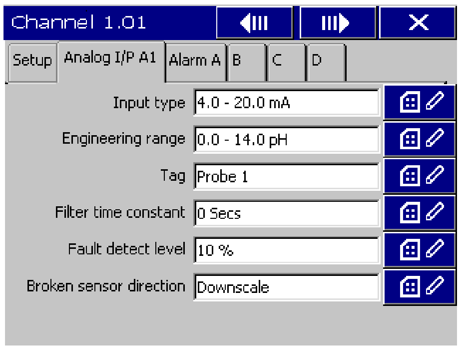
- If only 2 sensors are used and the reading from one of them drifts, it is difficult to determine which sensor is providing the correct reading. The reading from a third sensor eliminates this uncertainty.
- In the event of a sensor failure, there is no need for urgent maintenance as the system can continue to accurately monitor the process using the remaining 2 functioning sensors.

Using this system, the water company can be secure in the knowledge that it has a reliable and accurate measurement, even in remote locations, ensuring quality levels are maintained yet keeping maintenance costs low (pH can be particularly costly as the chemicals used erode the sensors and a single sensor requires regular replacement).

Note. The following example is based on pH measurement. The input setup and math/logic block configuration must be customized for individual application requirements.

Input setup

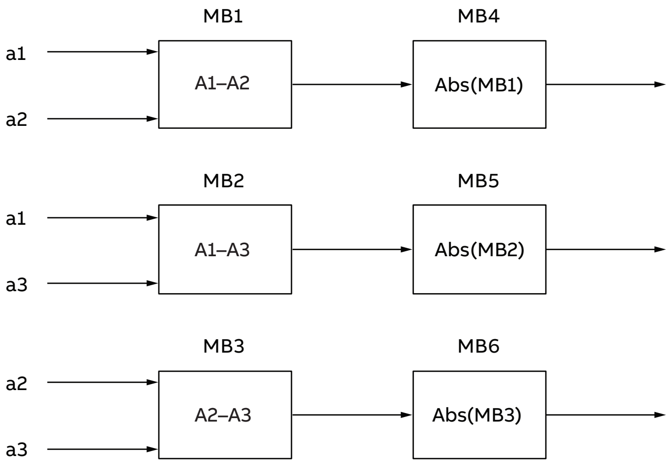
Three mA-type analog input signals are required for each measured parameter. Each input is assigned to a separate channel and configured as follows to provide the 3 individual sensor readings:



Math block configuration

The next step is to calculate the average value of all 3 inputs but this is complicated by the need to ensure that, before they can be averaged, they are all within acceptable limits.

To do this, 6 math blocks are created to calculate the difference between the 3 inputs to ensure that their individual readings are not too far apart to be included within the average calculation:

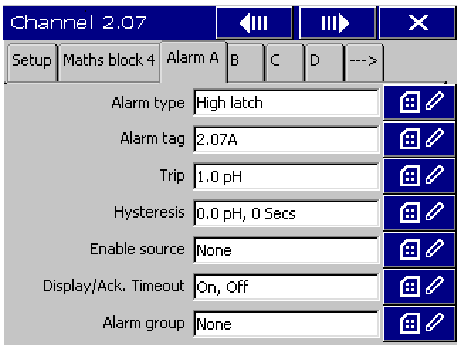


Analog inputs 1 and 2 are first assigned to math block 1 and subtracted; the result is assigned to math block 4 configured to output the absolute value of the input. Repeat the process to create math blocks 2 and 5 using inputs 1 and 3, followed by math blocks 3 and 6 using inputs 2 and 3.

Alarm configuration

Math blocks 4, 5 and 6 are now assigned to separate channels in the recorder's second process group to enable an alarm to be configured on each math block result. The alarms become the internal digital signals that trigger the recorder to include a sensor's output in the final average (or exclude it if its value is outside of the permitted range).

Math blocks 4, 5 and 6 are assigned to channels 2.7, 2.8 and 2.9, respectively. A high latch alarm is then configured on each channel with a trip level set to the value by which the sensor readings are allowed to differ before being disregarded for averaging purposes.

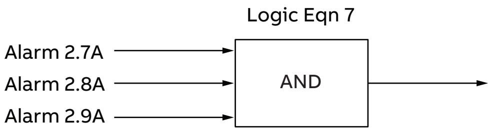


Note. If an alarm becomes active, it latches and remains active until acknowledged. When the sensor is replaced, the alarm must be acknowledged to include the reading from the new sensor in the calculation.

Logic equation configuration

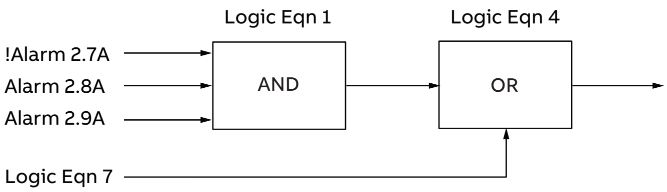
The alarms (2.7A, 2.8A and 2.9A) are now assigned to a series of logic equations configured to include the sensor's reading in (if valid), or exclude it from (if invalid), the final averaging equation, depending on its value.

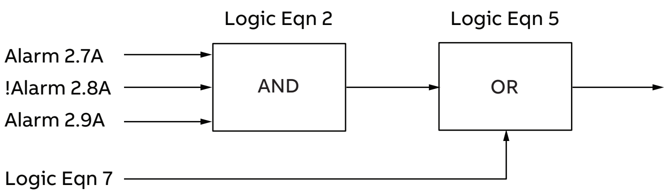
Each alarm is first assigned, un-inverted, to logic equation 7. This is an AND gate therefore its output is active only if all 3 alarms are active. This provides indication that the readings from 2 or more sensors have deviated by more than the alarm trip level.

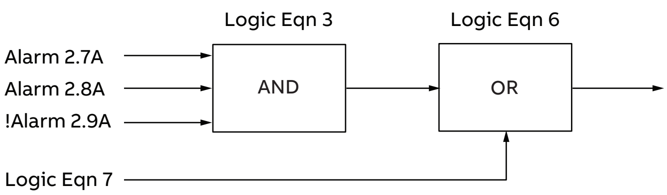


Alarms 2.7A, 2.8A and 2.9A are now assigned to logic equation 1 with alarm 2.7A inverted (indicated by '!'). Repeat the process to create logic equations 2 and 3, inverting alarms 2.7A and 2.8A in each case.

Logic equations 1, 2 and 3 are AND gates and their outputs are then OR'd with the output from logic equation 7 to create alarm logic equations 4, 5 and 6.







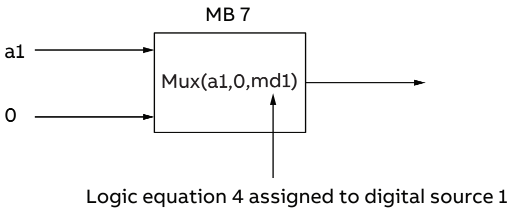
…Triple validation

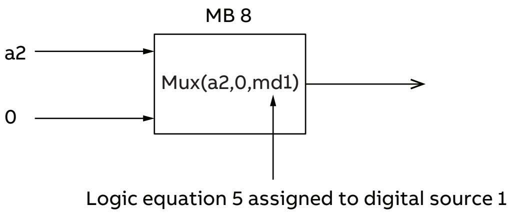
Multiplexing math block configuration

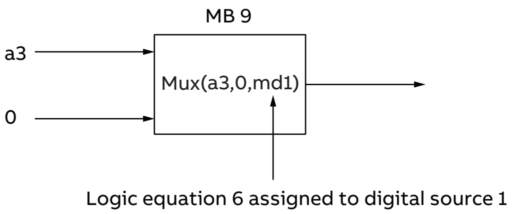
Each analog input is now assigned to its own multiplexing math block, together with a constant value of 0 and with the corresponding logic equation for that input channel (4, 5 or 6) assigned to digital source 1 of the math block.

The multiplexing math block selects either the analog input value or the 0 value depending on the state of the logic equation. If the logic equation is false, the analog input value is selected for inclusion in the averaging calculation. If the logic equation is true the 0 value is selected and the analog input is therefore excluded from the averaging equation.

The multiplexing math block outputs the analog value only if the corresponding alarm (that indicates whether the value is within limits) is inactive.



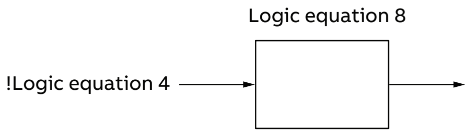


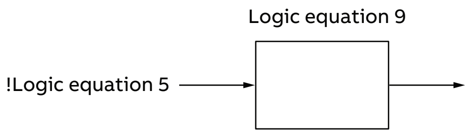


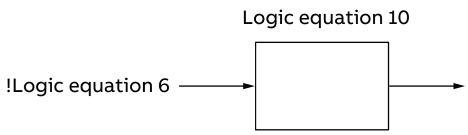
Average calculation

The final part of the process is to configure a series of math blocks to obtain the average value of the readings from the 3 sensors. However, it is important for this value to be averaged consistently, even when one of the inputs is out of range.

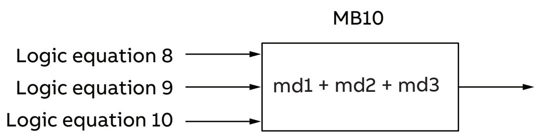
The output from each of alarm logic equations 4, 5 and 6 is input to a second logic equation (8, 9 and 10 respectively) and inverted (indicated by '!'). This results in a value of '1' from each equation when its associated alarm is inactive.



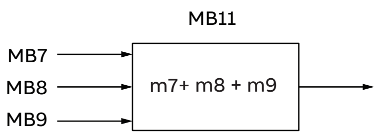




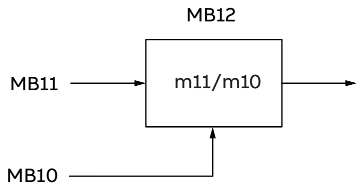
Logic equations 8, 9 and 10 are now assigned to digital sources 1, 2 and 3 of a new math block (math block 10) and added together. This results in an output of 3 from the math block if all 3 alarms are inactive. If one alarm is active, the output is 2 and if 2 alarms are active the output is 1.



Math block 11 is now created to sum the valid analog input values from multiplexing math blocks 7, 8 and 9:



Finally, math block 12 creates the average of the values from the 3 sensors by taking the sum of the valid input values from math block 11 and dividing it by the output from math block 10.



An accurate and consistent average is obtained because average = sum of the valid input values divided by the number of valid inputs. Therefore, if the sum from math block 11 comprises 3 valid input values, no alarms are active and the divisor from math block 10 is 3. If the sum from math block 11 comprises 2 valid output values, one alarm is active, therefore the divisor from math block 10 is 2 etc.

An overview of the triple validation calculation configuration can be found in Figure 1 on page 6.

A ScreenMaster RVG200 with math & logic functionality can be supplied pre-programmed from ABB with triple validation configuration, by ordering a recorder with configuration option 'B' for custom configuration and requesting 'Triple Validation Configuration' on the order.

...Triple validation

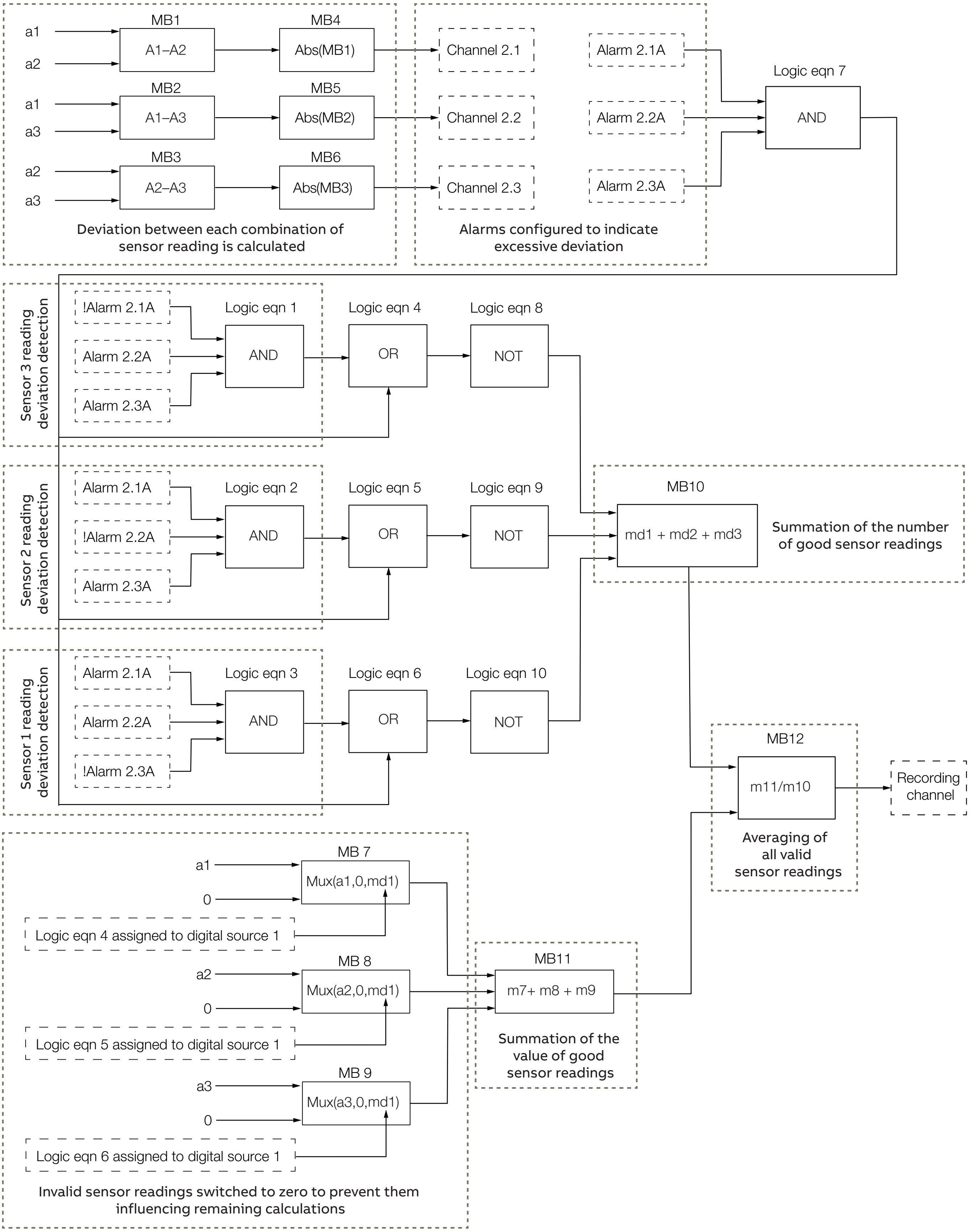


Figure 1 Triple validation calculation overview

Notes

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