Integrated Quality Management System

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Contents

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2 Measured Value Quality Identification

2.1 General

As a general rule, a *quality tag* is appended to every measured value. This concerns the sampling values as well as the stored values. With the help of the *quality tag*, it can be specified for each measured value whether the measured value is fundamentally correct, or whether, during its recording, there was a situation that could have falsified the measured value.

Possible quality tags:

Denotation	Quality Tag	Trigger	Description
Measured value OK	A		No error present
Plausibility error	P	One or more quality tests have delivered errors. (Leaving the scope of application, variability test error)	The measured value is present, but questionable.

Auxiliary attachment not OK	B	The evaluation of the formula for the auxiliary attachment has registered an error.	Measured value disturbed, but can be applied further, with exceptions, at least for further error analysis due to the disturbed measured values.
Measured value invalid	C	No measured values present, see Chapter 2.2, Page 3	The measured value is invalid and must not be applied further.
Measured value not utilisable	D	Sensor and/or calculation has recognized an error.	The measured value is not utilisable. Reason: e.g. sensor has detected a wire break, not enough measured values for the compression, sensor was switched to the dismantled mode by the maintenance service.
Maintenance	W	Activation of the maintenance operating mode	Measured value possibly disturbed by maintenance works and/or selective maintenance works at this measuring channel.
Time error	Z	The measured value is influenced by an adjustment of the clock-time (e.g. mean value formation etc.) and/or the RTC has detected an error.	Time assignment of the measured value is disturbed, but can be applied further with exceptions, at least for further error analysis due to the disturbed measured values.
Survey Value	K	The value was assigned as survey value by the user.	

The different quality tags, that deviate from the *measured value OK*, are represented as individual bits.

During the linking of several channels, the bit patterns are linked by means of OR. The quality tag of the result follows from the highest value bit; the other bits can deliver supplementary information.

Bit 7	**6**	**5**	**4**	**3**	**2**	**1**	**Bit 0**
C	D	W	-	P	B	Z	K
High priority ⟶ low priority							

The measured value quality tags have further effects besides the classification of the measured value:

- In the case of *C*, *D* as well as *W*, no further measured value checks take place.

2.2 Determination of Quality Tag

For the *quality tag* of a calculation (e.g. *compression*, *formula*) the *quality tag* of the individual measured values is linked by means of OR; for the evaluation, only the highest value bit (with highest priority) is considered. The result of the measurement is thus, the worst quality tag of the individual measured values.

2.2.1 Determination in the Case of Compressed Parameters

At the end of the calculation period, it is determined if the necessary number of measured values for the determination are present. If individual measured values are missing due to an error in the measurement system, this error is determined here. The percentage rate of minimum necessary measured values is set in *system parameter* menu item and is normally set at 100%. If the minimum number is not achieved, the quality tag of the stored value is set at *D*.

Here, also, the same rule applies: The *quality tag* of the result always has the *worst quality tag* of the individual measured values.

2.2.2 Quality Tag for Formula Evaluation

The *worst quality tag* of the channels applied during the calculation is derived as the *quality* of the formula result.
Only exception: In the function $betterof()$, the *quality of the better channel* is applied, the *quality of the worse channel* remains unconsidered.

If an error occurs during the evaluation of the formula, which has the effect that the result of the formula cannot be calculated (e.g. division by 0), the measured value is set at *invalid* and the quality tag is set at *C*.

2.3 Mathematical Evaluations in the Measuring Interfaces

Some Gealog Measuring Interfaces already conduct mathematical preliminary evaluations, the result of which is recognizable in the sampling value of the measuring channel. These errors, which are recognised in the sensor, result in the *D* quality tag.

3 Calculations with Measured Values

Calculations are conducted for all measuring channels with *mathematics* attribute. Channels with the *mathematics* attribute receive the mathematical formula as additional configuration parameter. The calculation is conducted on the basis of this formula. The sampling values are always drawn on for the calculation. This means that for each sampling, the physical measured values are inserted in the formula and the result of this evaluation represents the sampling value of the mathematics channel. An integral value (raw value) is calculated from the calculated value through the application of min. and max. that is then stored in the measured value memory.

3.1 Mathematical formula

Within the framework of channel configuration, a mathematical formula in clear text can be entered for channels with *mathematics* attribute. The resulting value of the formula is used as the sampling value. All methods of measured value compression are additionally applicable for these mathematics channels.

For all other channels, a formula for additional calculation of the quality, e.g. monitoring of an auxiliary attachment, can be applied. .

During the calculation, the sampling values are available to all the channels required at this point of time. For instance, channel 1 is a mathematics channel; measured values from channel 3 are required in the formula → the measured value of channel 3 is determined before the calculation.

The entry of the formula is not case-sensitive and no intervals and/or space characters are required in order to enter the formula correctly. The only exception here is the entry of a negative number; here, a space character must precede the negative number in order to correctly interpret the minus character.

3.1.1 Syntax of the Formula

Representation	**Parameters**	**Significance**
$+ - */$		Basic calculation types
%		remainder during division
^		to the power (Exponent)
-123, -123.45, $12.4E-56$		constants
pi, e		π and/or Euler constant
()		brackets
$sin(\alpha)$	angle in radiant	sine of the angle
$cos(\alpha)$	angle in radiant	cosine of the angle
$tan(\alpha)$	angle in radiant	tangent of the angle
$asin(x)$	value in radiant	Arc sine of the value
$acos(x)$	value in radiant	Arc cosine of the value
$atan(x)$	value in radiant	Arc tangent of the value
$atan2(y,x)$	two lengths	$atan(\frac{y}{x})$ Arc tangent of the two lengths, correct for all four quadrants
$rad(\alpha)$	angle	conversion of an angle from degree to radiant
$grad(\alpha)$	angle	conversion of an angle from radiant to degree
$ln(x)$	value	natural logarithm of value
$log(x)$	value	logarithm basis 10 of value
$exp(x)$	value	exponent
$pow(x,y)$	basis, exponent	basis to the power of exponent x^y
$sqrt(x)$	value	root
$sqr(x)$	value	square
$abs(x)$	value	absolute amount
$round(x)$	value	rounding
$floor(x)$	value	rounding down of the value
$ceil(x)$	value	rounding up of the value
$min(x,y)$	two values	finding the lower value
$max(x,y)$	two values	finding the higher value
$time()$	no parameters	current clock time in seconds
$gps()$	no parameters	time of the last valid GPS telegram in seconds
$count()$	no parameters	counter
$real(x,y)$ $re(x,y)$	amount, angle	Calculation of the real part

Representation	Parameters	Significance
$imag(r,\varphi)$ $im(r,\varphi)$	amount, angle	Calculation of the imaginary part
$r(x,y)$	Real part, imaginary part	calculation of the amount
$phi(x,y)$	Real part, imaginary part	calculation of the angle
$interpol(x,\ x_1,\ y_1,\ x_2,\ y_2)$	value to be calculated, two support points	linear interpolation
$polynom(x,\ a_0,\ a_1,\ \ldots,\ a_6)$	8 values	polynomial calculation $(a_0 + a_1 * x + a_2 * x^2 + \ldots)$
$u1(x)$ $tab1(x)$ $convert1(x)$	value	conversion table 1 applied to the value
$u2(x)$ $tab2(x)$ $convert2(x)$	value	conversion table 2 applied to the value
$value(x)$	channel number	value of the measuring channel (sampling value)
$bettervalue(x,y)$	two channel numbers	value of the measuring channel with quality tag. The value of measuring channel x is inserted in the case of identical identification.
$<\ >$ bzw. $lt\ \ gt$		comparison of smaller than and greater than
$<=\ >=$ bzw. $le\ \ ge$		comparison of smaller than/equal to and greater than/equal to
$=, ==, eq$		comparison of equal to
$!=, <>, ne$		comparison of not equal to
$epsilon(x,y,i)$	two values, interval	delivers TRUE, when the absolute difference of both the values is smaller than the assigned interval Application: Quality test comparison of doubled sensors
and, &&, &		bitwise *and*
or, $\vert$, $\vert\vert$		bitwise *or*
xor		bitwise *exclusive or*
$not(x)$, $!(x)$	bool expression	log. negation
$service()$	no parameters	delivers TRUE, if the maintenance is activated

An <expression> is a mathematically correct linking of the above elements.

True value:

- TRUE is represented as digit 1, all values not equal to 0 are valid as TRUE.
- FALSE is represented as figure 0, all values quantitatively less than 0.01 are valid as FALSE.

Number values:

- leading sign (optional)

- minimum one digit (0..9) or decimal point (.)
- Exponent (optional): 'E' or 'e', leading sign (optional), decimal digits

3.2 Doubled sensors

Due to reasons of reliability the sensors can be executed twice for individual parameters. In this case, there is the possibility of using the following mathematical function:

- In addition to the storage of measured values of the individual sensors, a *pseudo channel* can also be registered. The values of the pseudo channel are calculated with the help of the corresponding mathematics function (*bettervalue*).
- The data of the *pseudo channel* corresponds to the main channel, as long as no errors occur. If the quality tag of the main channel is worse than the *quality tag of the subsidiary channel*, the measured values of the subsidiary channel are inserted in the *pseudo channel*.
- The *pseudo channel*, like every other channel, can also be checked for threshold value overflow, etc.

3.3 Survey Value Channels

Survey value channels serves the purpose of saving manually recorded comparative values of particular measuring channels, in order to enable a later check of the sensor.

Survey values are saved in measuring channels with *survey values* attribute.

The storage of survey values is completely identical to that of measuring channels with variable storage. This means that the survey values can be displayed with *stored values* menu item, and/or they are transferred from the PC during data transfer and can be displayed there accordingly.

After the assignment of the *associated channel*, all parameters of the associated channel are copied to the parameters of the survey value channel.

Certain *channel parameters of survey value channels* are not applied:

- Sampling rate, storing rate
- Storage: is always variable, i.e. there is no background measurement for this channel
- Short name, physical unit same as the associated measuring channel

Fundamentally, *survey values*, like other values, are also saved in measured value memory.

While entering survey values, plausibility is not checked.

4 Quality tests

4.1 General

Based on the recorded measured values, the following described checks can be conducted. In principle, the checks are conducted with the sampling values.

No quality tests are conducted during survey value entries and compression (mean values etc.).

Mathematical functions see Chapter 3.1, Page 4 and alarms.

4.2 Monitoring of Auxiliary Attachments

Individual measuring channels can be used for monitoring of auxiliary attachments for sensors, e.g.

- Ventilator
- Sensor heating
- etc.

In the framework of channel configuration, a formula (see Chapter 3.1, Page 4) for monitoring one or more auxiliary attachments can be defined for each channel. In the case of an error of the auxiliary attachment, *B* quality tag is assigned to the measured value.

The mathematical expression must be so constructed that it delivers *1* or TRUE, if the auxiliary attachment has broken down, i.e. the formula describes the error case.

The auxiliary attachment is assumed to be disturbed, if

- the result is not equal to 0,
- the quality tag of the result is not *measured value OK (A)*.

Example:

Monitoring the operating voltage of a sensor heating; the voltage is measured as channel 1 and must be minimum 18 V.

$value(1) < 18.0$

The above expression delivers 1 and/or TRUE if the supply voltage is less than 18 V.

Monitoring the heating of a precipitation gauge. Channel 7 announces errors in the heating, i.e. 0 means *heating on* and/or *in order*. The heating is necessary only at temperatures (measuring channel 8) below 0 °C.

$(value(7)! = 0)\ \&\ (value(8) < 0)$

Monitoring of a sensor. Channel 9 delivers several status bits, however, only bit 5 out of these is decisive:

$(value(9)\ \&\ 16)$

Benchmark test: Comparison of the measured values of a measuring channel with the values of another channel. The measured value of the channel is plausible, in case the difference of the sampling values of channel 1 and 2 lies within 0.1.

$!epsilon(value(1), value(2), 0.1)$

4.3 Testing at the Level of Measuring Interfaces

In the case of some Measuring Interfaces, the Measuring Interfaces will already be able to conduct certain checks in terms of hardware. These are recorded in a measuring channel of its own in the interface.

i.e.

- wire break and short circuit on the sensor lines
- breakdown of the sensor supply voltage
- Test signal
- Check of the timing and/or syntax of data protocols for sensors with serial port
- Check of the sensor signal for plausibility in the time dimension (e.g.: for Graycode transmitters)

The result of these checks is made available to the data logger with the measured value and serves as the basic information for determining the quality tag.

4.4 Check of the Data of an Individual Measuring Channel

The setting of all the parameters of the following tests takes place as described under menu item thresholds.

Scope:

Check, whether the measured value lies between two limits. For both limits, two values are each determined for realising a hysteresis:

- Scope top
- Hysteresis
- Scope bottom
- Hysteresis

Variability test, check for measured value fluctuations:

The differences between the sampling values must not be greater than the *limits of variation*.

Parameters to be defined:

- limits of variation

Inverse variability test, check for missing measured value fluctuations:

Within a definable period, the difference between the minimum and the maximum of the sampling values must not be smaller than the *minimal limits of variation*. Thereby, sensor errors are recognized, which result in a fixed measured value (sensor very dirty, . . .).

Parameters that are to be defined:

- minimal limits of variation
- Period

5 System tests of the Data Logger

5.1 General System Functions

The data logger comes with system tests, which are checked during certain occurrences. Should this check result in an error, a system alarm is set off.

The following system tests are distinguished:

- User-ID
- Door open contact
- Monitoring of the station battery
- Monitoring of the backup battery

5.2 User-ID

For stations with an active system alarm there is an automatic alarm signal at all configured targets after the third false entry of an invalid user ID.

5.3 Door Open Contact

The door open contact is recognised becomes a special port of the data collector that becomes permanently supervised (also in the standby mode), and where a state change is noticed immediately. Usually this entrance can be used to the connection of a door open contact in order to report break-in immediately.

The door open channel is configured like other channels also.

5.4 Monitoring of the Station Battery

The data logger measures the tension of the station battery to each sampling instances. The messages are diverted directly through tension measurement out of the supply voltage of the Gealog SG. Coming and going battery alarms are registered in the protocol storage. The battery condition is indicated in the head menu of the data collector. Contingent coming and going alerts are registered in the alertmemory. The possibility exists in addition to register the tension of the station battery as a characteristic fair channel.

There are two stages of alerting:

- advance warning
- deep discharge

5.5 Monitoring of the Backup Battery

The data logger has a backup battery around in power loss the data logger correctly to power-down. In this condition, that is provided the Real Time Clock in the data logger of the backup battery.

The data logger measures regularly the tension of the backup battery. The messages are diverted directly through tension measurement of the backup battery. Coming and going battery alarms are registered in the protocol storage. As soon as the tension fells under 2,7 volts, the data collector will report this so that an exchange of the backup battery can result.