

Instrument calibration sheet

Certificate N°	000017/2021	Date of issue	28.09.21
Client	ENEL Produzione	Work order	8000000591

Instrument specification

Type	Conductivity meter	Manufacturer	Endress-Hauser	Serial number	E3087205G00
Min capacity	0	Max capacity	14000	Model	Liquiline CM442
Readability At 0	1	Readability	1	Unit of measure	µS/cm
Description	C1 Itar Conductivity meter			Next Calibration	28.12.21

Test ambient conditions

Location	ENEL - C1 Itar			Date of test	28.09.21 00:00
Temperature	24,5	Humidity	84	Pressure	1020hPa

Standard certificates used

Name	Number	Issuer	Date of issue
Conductivity	18L93	Hanna Instruments	27.07.20

Calibration summary

Test	Certificate name	Uncertainty	Temperature	Humidity	Pressure
Repeatability	Conductivity	0,532291µS/cm	24,5	84	1020
Linearity	Conductivity	0,974761µS/cm	18° C	69%	1020hPa

Expanded uncertainty 1,949521µS/cm

Notes

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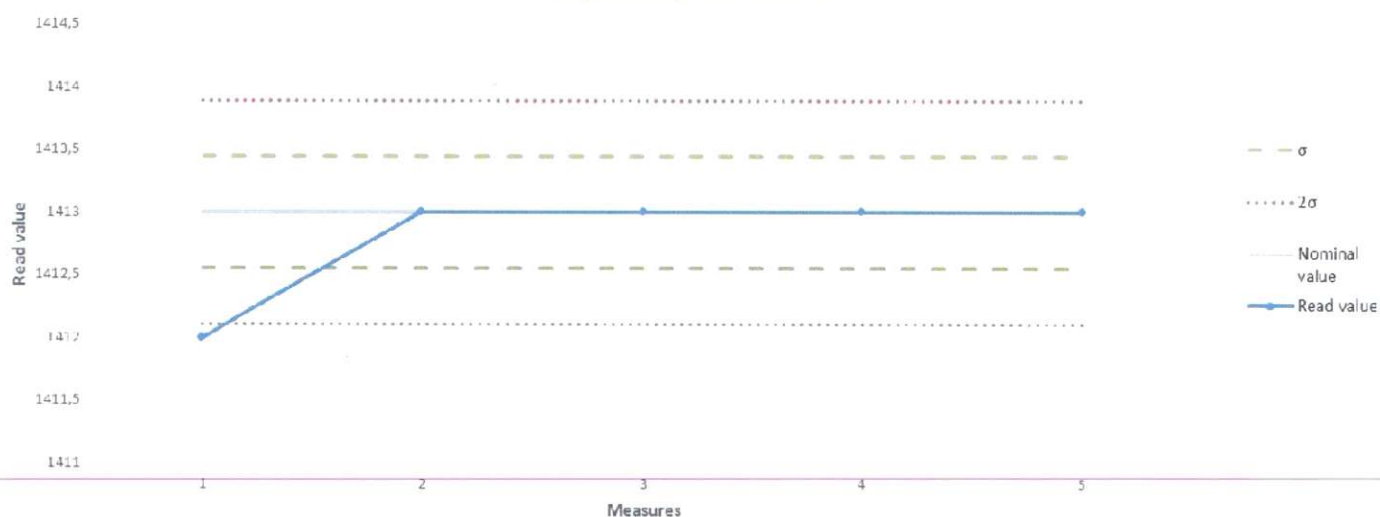

Repeatability

Measure	Nominal value	Conventional value	Read value	Deviation	Standard reference		
					Serial	Uncertainty	OIML
1	1413	1412	1412	0	51100533	0,01	
2	1413	1412	1413	1	51100533	0,01	
3	1413	1412	1413	1	51100533	0,01	
4	1413	1412	1413	1	51100533	0,01	
5	1413	1412	1413	1	51100533	0,01	

Min value 1412 Max value 1413 Average value 1412,8

Standard deviation (σ) 0,447214 Repeatability uncertainty 0,532291

Repeatability control chart



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Linearity

Measure	Nominal value	Conventional value	Read value	Error	Uncertainty of error	Standard reference	
						Uncertainty	OIML
1	84	83,5	84,1	0,599998	0,974761	0,01	
2	1413	1412	1412	0	0,974761	0,01	
3	12880	12892	12880	-12	0,974761	0,01	

Min value 84,1

Max value 12880

Average value

4792,033

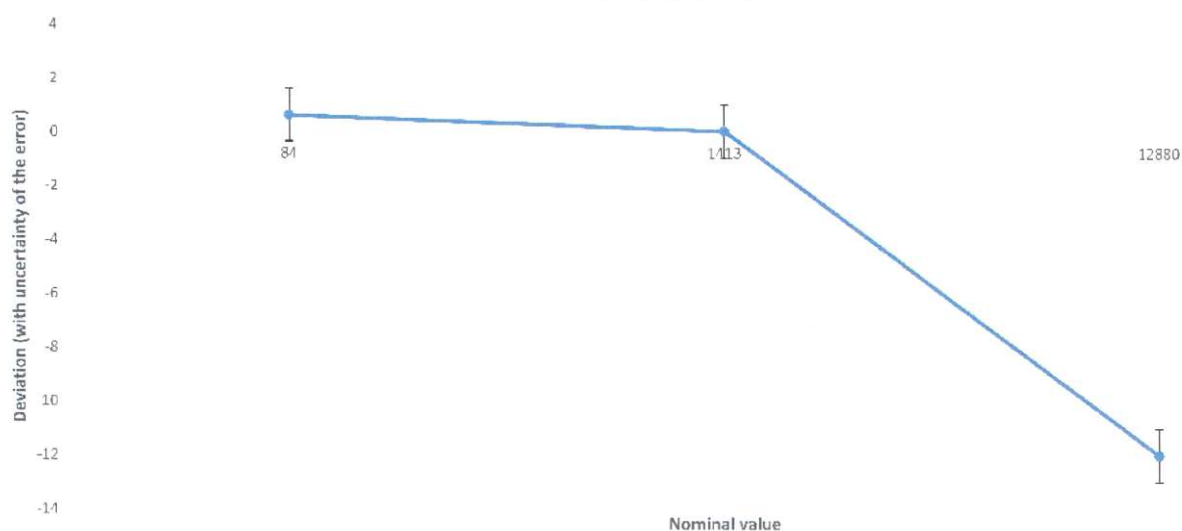
Standard deviation 12

k-Factor: 2 (95,45%)

Expanded uncertainty

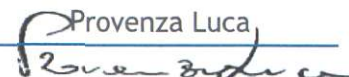
1,949521

Linearity deviation



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Formulas

Repeatability

The test consists in the repeated measure of the same reference value, under identical conditions of handling the reference and the instrument, and under constant test conditions, both as far as possible

Standard deviation is computed to allow an appraisal of the instrument's performance.

$$s(I) = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (I_i - \bar{I})^2} \quad \bar{I} = \frac{1}{n} \sum_{i=1}^n I_i$$

Repeatability standard uncertainty has been computed with the following formula, taking into account instrument's scale interval (d)

$$u_{rep} = \sqrt{s(I)^2 + \left(\frac{d_I^2}{12}\right)}$$

Linearity

This test is performed with different test values distributed fairly evenly over the normal measuring range. The purpose of this test is an appraisal of the performance of the instrument over the whole measuring range.

The uncertainty of the error is computed with the following formula and takes into account repeatability and eccentricity uncertainty when applicable:

$$u(E) = \sqrt{u^2(I_{dig0}) + u^2(I_{dig1}) + u^2(I_{rep}) + u^2(I_{ecc}) + u^2(I_{mc}) + u^2(I_{mb}) + u^2(I_{md}) + u^2(I_{mconv})}$$

The terms relative to air buoyancy (mb) and convection effects (mconv) are considered negligible due to enough acclimatisation allowed to the instrument.

Expanded uncertainty has been computed with the following formula:

$$U = u(E)_{max} k$$

For this report a coverage factor of 2 as been considered giving an overall confidence level of 95,45%