

# Instrument calibration sheet

Certificate N°	000160	Date of issue	09/12/2019
Client	ENEL Produzione	Work order	8000000591

## Instrument specification

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

## Test ambient conditions

Location	ENEL - C1 Itar			Date of test	09/12/2019 00:00
Temperature	16 °C	Humidity	81%	Pressure	1018hPa

## Standard certificates used

Name	Number	Issuer	Date of issue
Conductivity	13105820	XS Solutions	02/07/2018

## Calibration summary

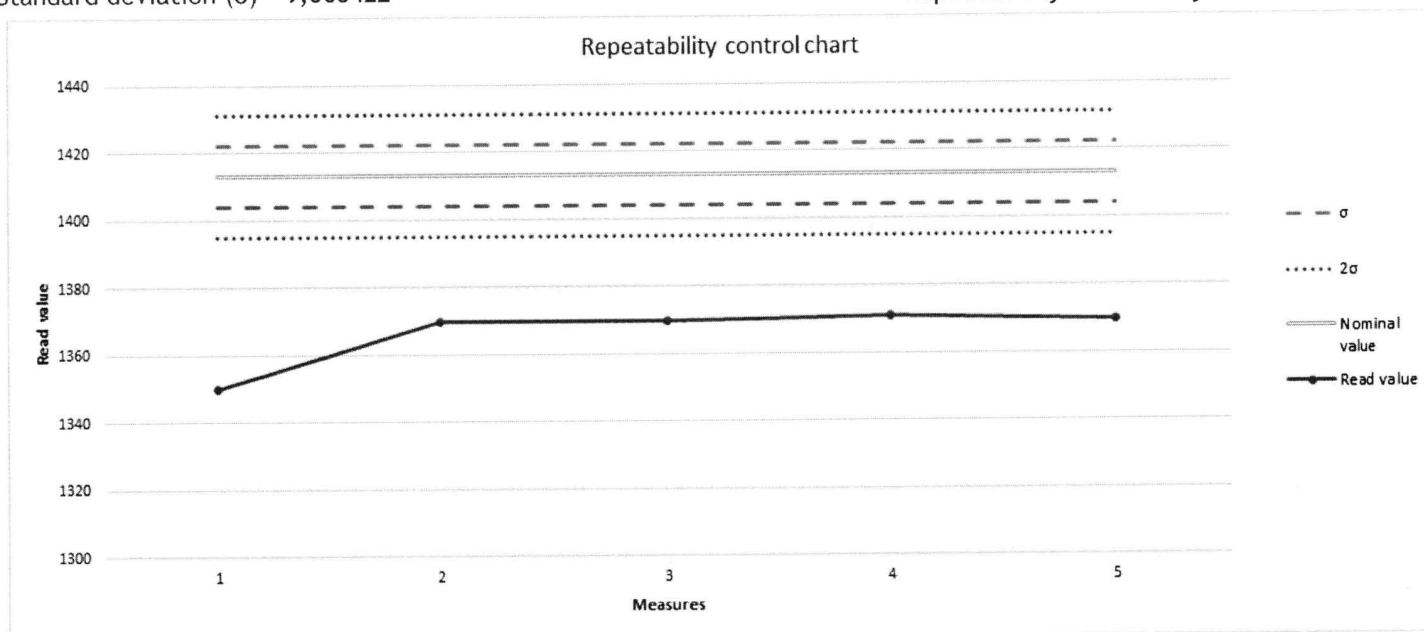
Test	Certificate name	Uncertainty	Temperature	Humidity	Pressure
Repeatability	Conductivity	9,071016µS/cm	16 °C	81%	1018hPa
Linearity	Conductivity	9,080207µS/cm	16 °C	81%	1018hPa
Expanded uncertainty				18,160414µS/cm	

## Notes

  
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Repeatability					Standard reference		
Measure	Nominal value	Conventional value	Read value	Deviation	Serial	Uncertainty	OIML
1	1413	1412	1350	-62	51100533	0,01	
2	1413	1412	1370	-42	51100533	0,01	
3	1413	1412	1370	-42	51100533	0,01	
4	1413	1412	1371	-41	51100533	0,01	
5	1413	1412	1370	-42	51100533	0,01	

Min value 1350 Max value 1371 Average value 1366,2  
 Standard deviation ( $\sigma$ ) 9,066422 Repeatability uncertainty 9,071016



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### Linearity

Measure	Nominal value	Conventional value	Read value	Error	Uncertainty of error	Standard reference	
						Uncertainty	OIML
1	84	83,5	82	-1,5	9,080207	0,01	
2	1413	1412	1370	-42	9,080207	0,01	
3	12880	12892	12700	-192	9,080207	0,01	

Min value 82

Max value 12700

Average value

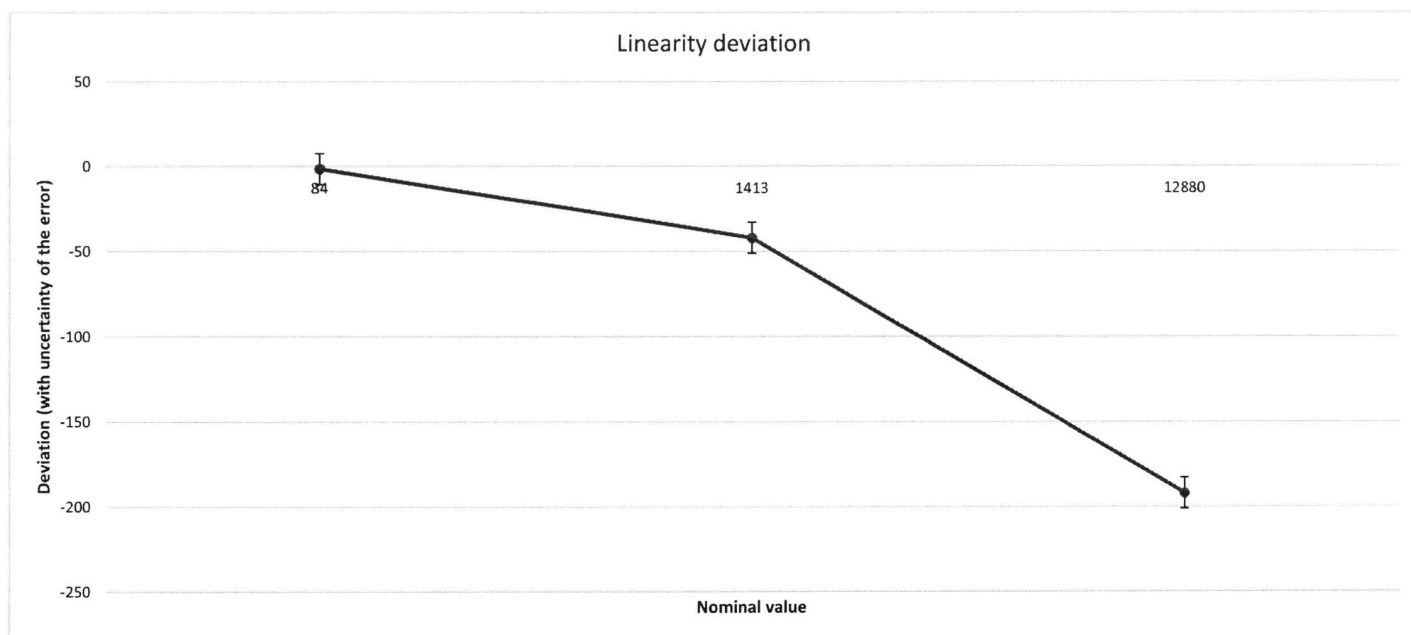
4717,333

Standard deviation 192

k-Factor: 2 (95,45%)

Expanded uncertainty

18,160414



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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%