Performance verification of dimensional measuring instruments in automotive industry

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Outline

1. Conformity assessment of measurement devices
2. Selection of laboratories for industrial measurement purposes
3. Proposal for conformity assessment for measurement devices

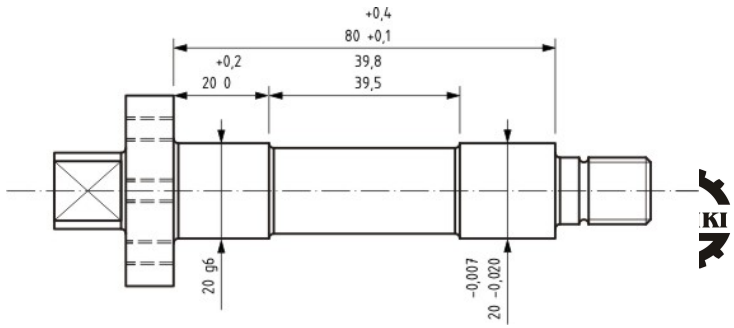
Outline

The Process of Decision Making in Conformity Assessment

Is the measurement device is good enough to use it during quality control?

1. The calibration of the measurement device and the determination of the measurement uncertainty values throughout the scale for defined scale values.
2. The determination of the customer requirements, the definition of the base reference line of the conformance process.
3. Statements about the compliance

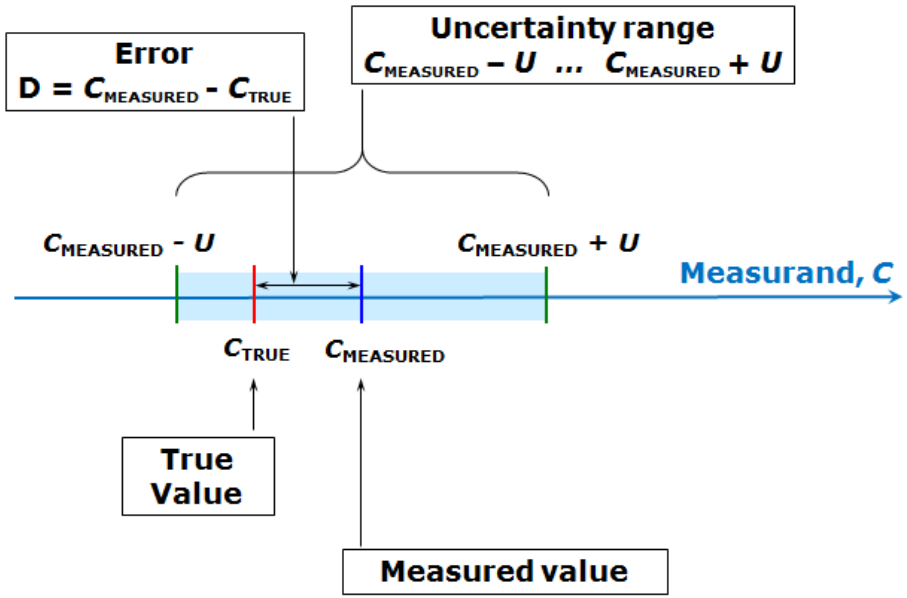
MPE (Maximum permissible error) according to DIN 863



Calibration and Measurement Uncertainty

Calibration (VIM3)

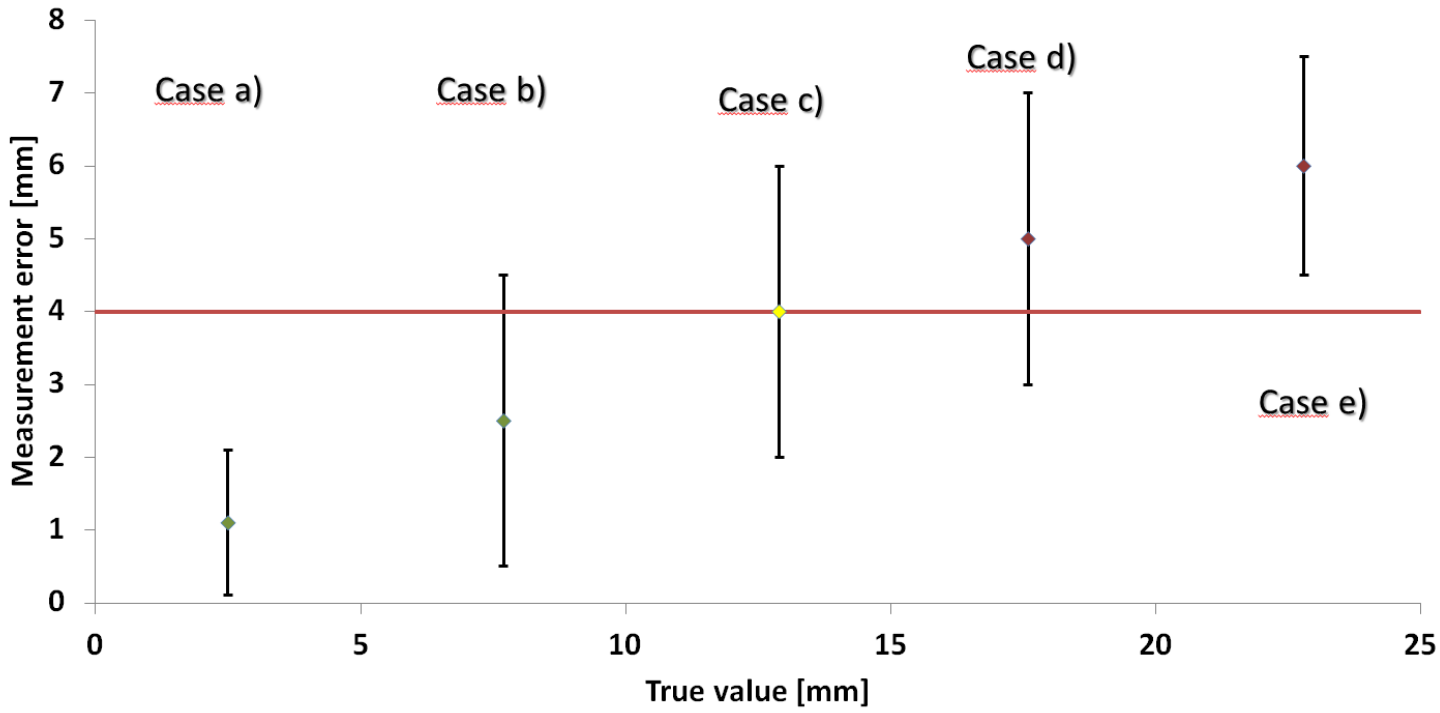
"an operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication."



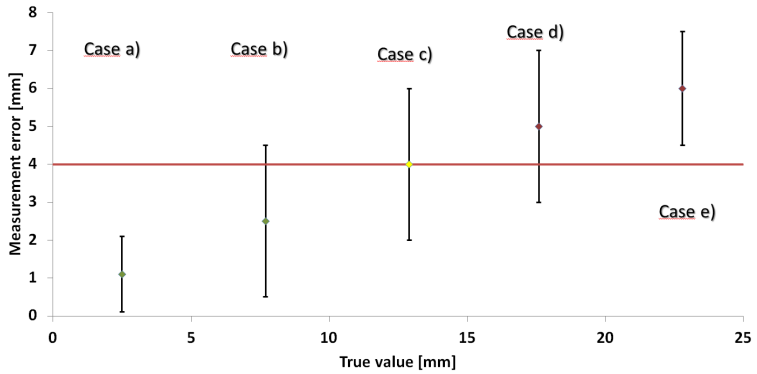
Statements of Compliance

ISO 17025 (5.10.4.2)

"When statements of compliance are made, the uncertainty of measurement shall be taken into account."



Calibration results for digital micrometer (0-25 mm)



True value [mm]	*Measurement error [μm]*	*U [μm]*	*Base of reference (MPE) [μm]*	*Decision as per GUM-philosophy*	*Decision as usual (non-accredited labs)*
2,5	1,1	1	4	compliance	compliance
7,7	2,5	2	4	#	compliance
12,9	4	2	4	#	#
17,6	5	2	4	#	non-compliance
22,8	6	1,5	4	non-compliance	non-compliance

#: it is not possible to state compliance or non-compliance

What would be the decision in industry?

Outline

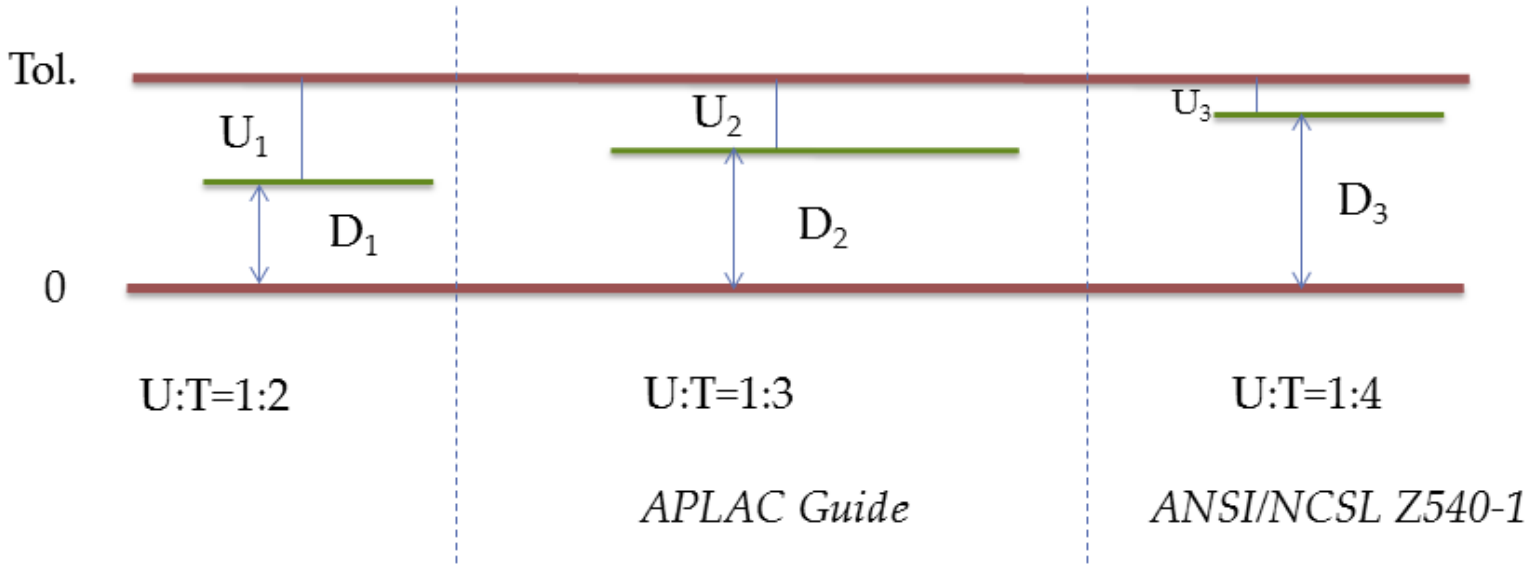
Comparison of the accredited calibration laboratories

in Hungary, NAT, in UK, UKAS

Hungary			*UK*		
Labs	*Measurement devices*	*CMC [µm]*	*Labs*	*Measurement devices*	*CMC [µm]*
X	Vernier caliper	25+L/45	A	Vernier caliper	10 + (30 x length in m)
Y	Vernier caliper	20+1.8L/100	B	Vernier caliper	10 + (15 x length in m)
Z	Vernier caliper	10-15	C	Vernier caliper	10 + (30 x length in m)
X	Micrometers	2+L/25	A	Micrometers	1.0 + (8.0 x length in m)
Y	Micrometers	5+2L/100	B	Micrometers	1.5 + (5.0 x length in m)
Z	Micrometers	7+0.005L – 3+0.005L	C	Micrometers	1.0 + (8.0 x length in m)
X	Plain plug gauges	1.4+D/30	A	Plain plug gauges	1…50 – 0.80 50…100 – 1.0 100…150 – 1.5
Y	Plain plug gauges	2-4	B	Plain plug gauges	1 … 50 – 0.80 50 … 100 – 1.0 100 … 150 – 1.5
Z	Plain plug gauges	0.75+0.004L	C	Plain plug gauges	1…50 – 1.0 50…100 – 1.5

CMC: Calibration and Measurement Capabilities,
the vernier calipers are digital, 0-150 mm; the micrometers are digital, 0-25 mm

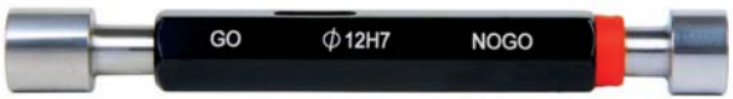
Ratio of the uncertainty of measurement to the specified interval



What should be the maximum value of CMC for a lab, if I would like to order a conformity assessment for micrometer (with $MPE = 4\mu m$)?

$2\mu m$ $1.33\mu m$ $1\mu m$

The problem with conformance assessment of plug gages



Gagemakers tolerance table

Range	*Class*					
	XXX	*XX*	*X*	*Y*	*Z*	*ZZ*
0.254mm to 20.96mm	0.00025mm	0.0005mm	0.0010mm	0.0018mm	0.0025mm	0.0050mm
20.96mm to 38.35mm	0.00038mm	0.0008mm	0.0015mm	0.0023mm	0.0030mm	0.0060mm
38.35mm to 63.75mm	0.00051mm	0.0010mm	0.0020mm	0.0030mm	0.0040mm	0.0080mm

Accredited laboratories with their CMC values in μm

X	Plain plug gauges	1.4+D/30	A	Plain plug gauges	1…50 – 0.80 50…100 – 1.0 100…150 – 1.5
Y	Plain plug gauges	2-4	B	Plain plug gauges	1 … 50 – 0.80 50 … 100 – 1.0 100 … 150 – 1.5
Z	Plain plug gauges	0.75+0.004L	C	Plain plug gauges	1…50 – 1.0 50…100 – 1.5

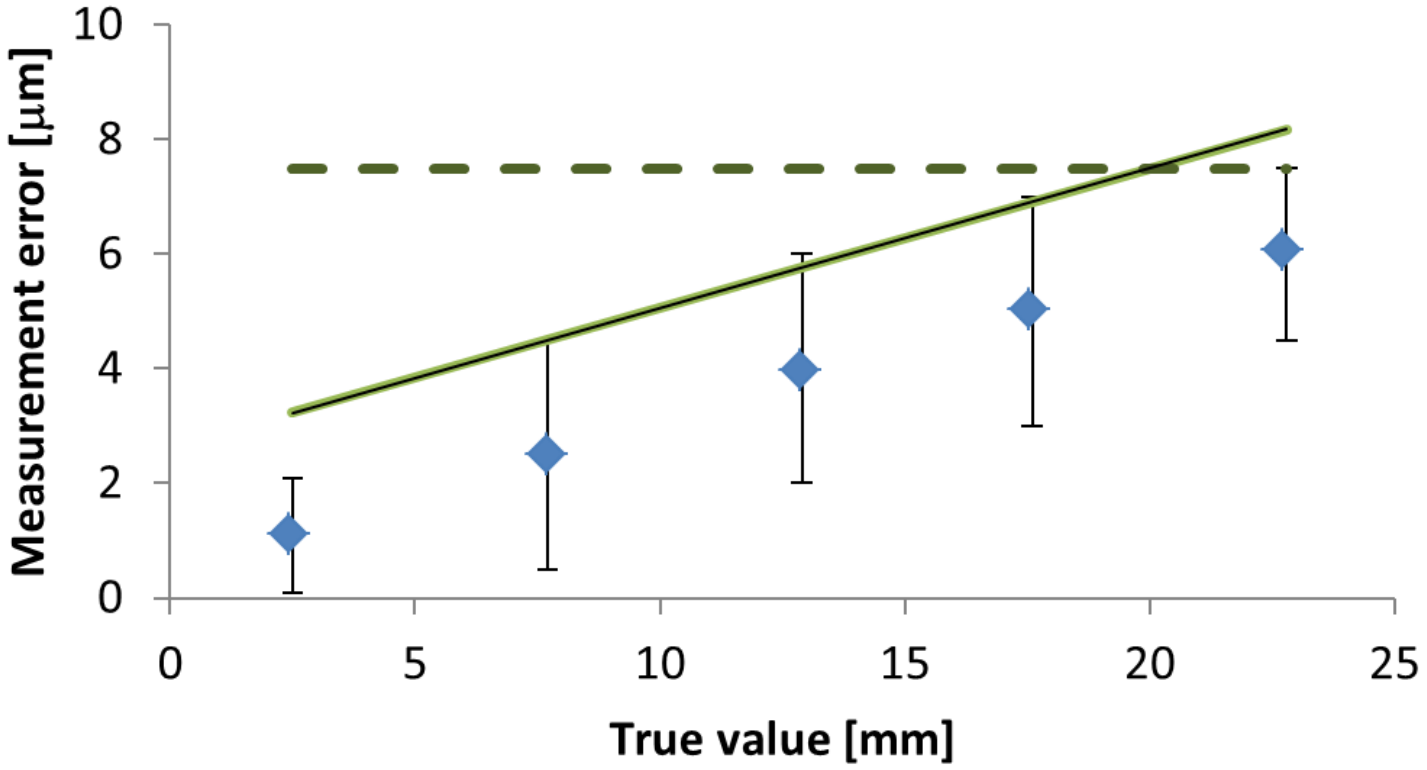
Outline

Determination of Conformance limit

$$\text{Conformance limit} = \text{Max}\{\text{Measurement error}_i + \text{Uncertainty}_i\}$$

- If the base reference value is a constant value it has to be determine the largest measurement error plus related uncertainty value.
- If the base of reference value is the function of the measurement scale the conformance limit can be calculated as follows:
  - determine the linear function between the measurement error and the examined true values of the scale with least square method
  - add the largest measurement uncertainty value to the linear function as a constant

Example for Determination of Conformance limit



Summary

- There are differences between the accredited calibration labs and labs of manufacturer of the measurement device in the process of the performance verification.
- It could be better state a conformance limit which is calculated by the labs and take into account the measurement uncertainty.This conformance limit show the behaviour of the examined measurement device, and knowing this limit it is easy to determine the compliance of the measurement device for the control of the selected manufacturing process.

- Outlook
  - Performance verification in case of Coordinate Measurement Methods.

for your kind attention!