

MEASUREMENT UNCERTAINTY REPORT

1. Main data

Name	CALBRATION OF A WEIGHT OF NOMINAL VALUE 10 KG
File	EA4-S2-Calibration of a weight of nominal value 10 kg.gmf
Created	03.06.2017 14:55 :
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MCM	Adaptive procedure	Tolerance	Number of trials
Yes	No	0.2δ	220x10 ³

1.1. Description

The calibration of a weight of nominal value 10 kg of OIML class M1 is carried out by comparison to a reference standard (OIML class F2) of the same nominal value using a mass comparator whose performance characteristics have previously been determined.

Correlation: None of the input quantities are considered to be correlated to any significant extent.

1.2. Model

$$m_X = m_S + \delta m_D + \delta m + \delta m_C + \delta B$$

1.3. List of Quantities

Quantity	Name
m_X	conventional mass of the unknown
m_S	conventional mass of the standard
δm_D	drift of value of the standard since its last calibration
δm	observed difference in mass between the unknown mass and the standard
δm_C	correction for eccentricity and magnetic effects
δB	correction for air buoyancy

1.4. Quantities description

Quantity	Description	Comment
m_X	Type: Result Unit: g Uncert. unit: mg Factor: 10E-3 Format: Absolute Distribution: Normal distribution Coverage probability (%): 95.45 Proof of capability: Yes Tolerance or distribution interval: 1 g Capability index-Limit value: $C_m = 4$ Compliance assessment: Two-sided Lower specification limit: 9999.5 g Upper specification limit: 10000.5 g Decision rule: Stringent Acceptance - Stringent Rejection	Maximum Permissible Error (MPE) for Class M1 in accordance with OIML R111 is 500 mg.
m_S	Type: Type B Unit: g Uncert. unit: mg Factor: 10E-3 Uncertainty estimate: Expanded uncertainty Distribution: Normal Degrees of freedom: ∞ Value: 10000.005g Rel. uncertainty: 45mg Coverage probability (%): 95.00 Coverage factor: 2.00	Reference standard (m_S): The calibration certificate for the reference standard gives a value of 10 000,005 g with an associated expanded uncertainty of 45 mg (coverage factor $k = 2$).

	Stand. uncertainty: 22.50g	
δm_D	Type: Type B Unit: g Uncert. unit: mg Factor: 10E-3 Uncertainty estimate: Relative limit of error Distribution: Rectangular Value: g Half-width of limits: 0.015g Rel. error of uncertainty: 0	Drift of the value of the standard (δm_D): The drift of the value of the reference standard is estimated from previous calibrations to be zero within ± 15 mg.
δm	Type: Type A Unit: g Uncert. unit: mg Factor: 10E-3 Method of observation: Indirect Number of observations: 3 Uncertainty evaluation: Pooled estimate Uncertainty estimate: Stand. deviation Distribution: Normal Degrees of freedom: ∞ Stand. deviation: 25mg Stand. uncertainty: 14.43mg	Comparator (δm): A previous evaluation of the repeatability of the mass difference between two weights of the same nominal value gives a pooled estimate of standard deviation of 25 mg. Measurements: Three observations of the difference in mass between the unknown mass and the standard are obtained using the substitution method and the substitution scheme ABBA ABBA ABBA:
δm_C	Type: Type B Unit: g Uncert. unit: mg Factor: 10E-3 Uncertainty estimate: Relative limit of error Distribution: Rectangular Value: g Half-width of limits: 0.01g Rel. error of uncertainty: 0	Comparator (δm_C): No correction is applied for the comparator, whereas variations due to eccentricity and magnetic effects are estimated to have rectangular limits of ± 10 mg.
δB	Type: Type B Unit: g Uncert. unit: mg Factor: 10E-3 Uncertainty estimate: Relative limit of error Distribution: Rectangular Value: g Half-width of limits: 0.01g Rel. error of uncertainty: 0	Air buoyancy (δB): No correction is made for the effects of air buoyancy, the limits of deviation are estimated to be $\pm 1 \times 10^{-6}$ of the nominal value.

1.5. Correlation matrix (Input quantities)

Quantity 1	Quantity 2	Correlation coefficient
		0




2. Observations

Quantity	Unit	Number of observations	Observations	Mean value	Stand. uncertainty	Bayesian stand. uncertainty
δm	g	3	0.0 0.0 0.0	0.0	0,0	---

3. GUF - Uncertainty budget

3.1. Budget

Quantity	Value	Stand. uncertainty	Distribution	DoF	Sensitivity coefficient	Quantities with zero contribution
m_S	10000,0050 g	22,5 mg	Normal	∞	1,00	
δm_D	0,0 g	8,66 mg	Rectangular	∞	1,00	

δm	0,0 g	14,4 mg	Normal	2	1,00	
δm_C	0,0 g	5,77 mg	Rectangular	∞	1,00	
δB	0,0 g	5,77 mg	Rectangular	∞	1,00	

3.2. Combined Standard Uncertainty

Quantity	Comb. stand. uncertainty	Comb. relat. uncertainty	Effective degrees of freedom
m_X	29,3 mg	$2,93 \times 10^{-6}$	34

3.3. Result

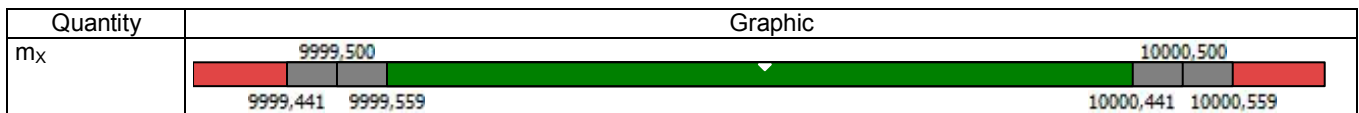
Quantity	Value	Expanded uncertainty	Expanded rel. uncertainty	Coverage factor	Coverage probability	Distribution
m_X	10000,005 g	± 59 mg	$\pm 0,59 \times 10^{-3}$ %	2.00	95.45 %	Normal

3.4. GUF - Validation

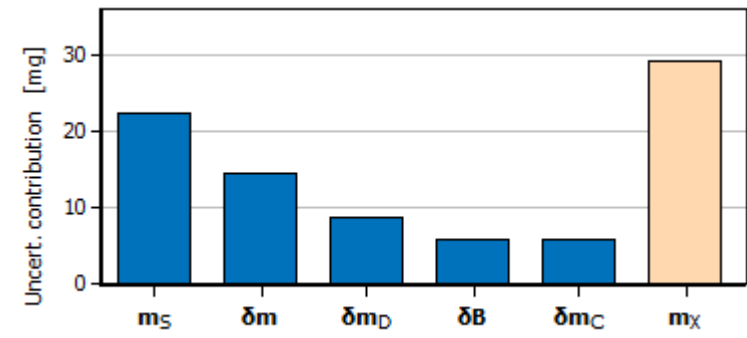
Quantity	Validation	Tolerance δ	Δ Coverage interval	Δ Result	Δ Comb. stand. uncert.
m_X	Yes	0,005000	[0,00020;-0,00020]	0,0	-0,000030

3.5. Proof of capability and compliance assessment

Quantity	Capability	Index	Limit value	Compliance	P-inside	P-outside
m_X	Yes	$C_m = 8.5$	4	Yes	100.000%	0.000%



3.6. Charts

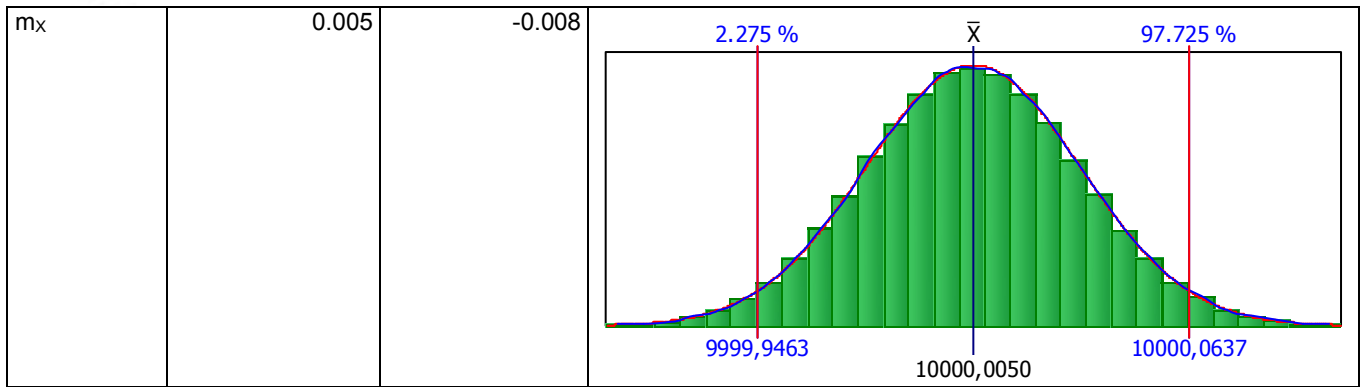
Quantity	Uncert. contribution	Rel. contribution	Graphic
m_S δm δm_D δB δm_C m_X	22,5 mg 14,4 mg 8,66 mg 5,77 mg 5,77 mg 29,3 mg	59.12 % 24.32 % 8.76 % 3.89 % 3.89 %	

4. MCM - Uncertainty budget

4.1. Statistical parameters

Quantity	Maximum	Minimum	Mean value	Stand. deviation	Quantile	Quantile
m_X	10000,1415 g	9999,8657 g	10000,0050 g	0,0293 g	9999,9463 g (2.275%)	10000,0637 g (97.725%)

Quantity	Skewness	Kurtosis	Histogram



4.2. MCM validation

Validation	Tolerance	2S(y)	2S(u)	2S(y-low)	2S(y-high)
Yes	1×10^{-3}	$0,132 \times 10^{-3}$	$0,0879 \times 10^{-3}$	$0,303 \times 10^{-3}$	$0,155 \times 10^{-3}$

4.3. Combined Standard Uncertainty

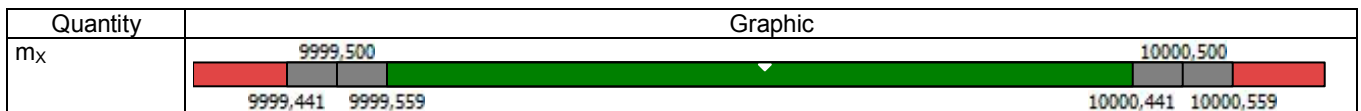
Quantity	Comb. stand. uncertainty	Comb. relat. uncertainty	Distribution
m _x	29,3 mg	$2,93 \times 10^{-6}$	Normal

4.4. Result

Quantity	Result	Expanded uncertainty	Expanded rel. uncertainty	Coverage factor	Probability
m _x	10000,0050 g	± 59 mg	$\pm 0,59 \times 10^{-3} \%$	2.00	95.45 %

4.5. Proof of capability and compliance assessment

Quantity	Capability	Index	Limit value	Compliance	P-inside	P-outside
m _x	Yes	Cm = 8.5	4	Yes	100.000%	0.000%



5. Comment

Quantity	Comment
m _x	