

Example 4

Test name: calliper gauge (analog).

Result: budget of uncertainty of distance for a calliper gauge (analog).

Description: distance measurement with a calliper gauge by an expert.

Quantity X_i	Source of uncertainty	X_i	Type	Error quantity, $S_p(X_i)$	Probability shape	Distribution division factor, k	Standard uncertainty, $u(X_i)$	Sensitivity coefficient, C_i	Uncertainty contribution, $u_i(y)$
δ_{INST}	Specification for instrument	X_{INST}	B	50 μm	Rectangular	$\sqrt{3}$	29 μm	1	29 μm
δ_{read}	Reading of instrument (e.g. because of parallax)	X_{read}	B	5 μm	Rectangular	$\sqrt{3}$	2,89 μm	1	2,89 μm
δ_{temp}	Ambient temperature fluctuation	X_{temp}	B	0,1 μm	Rectangular	$\sqrt{3}$	0,0577 μm	1	0,0577 μm
δ_{calibr}	Calibration of gauge	X_{calibr}	B	0,5 μm	Rectangular	$\sqrt{3}$	2,89 μm	1	1,89 μm
δ_{abbe}	Canting of position of the measuring surface	X_{abbe}	B	60 μm	Rectangular	$\sqrt{3}$	35 μm	1	35 μm
δ_{user}	Difference in contact pressure by user	X_{user}	B	100 μm	Rectangular	$\sqrt{3}$	60 μm	1	60 μm
					Combined standard uncertainty, u_c				75 μm
					Coverage factor $k_p = 2$; confidence level: 95 %				–
					Expanded uncertainty, $U = u_c \times k_p$				150 μm

Reported result – The measured distance is $m_x \mu\text{m} \pm 150 \mu\text{m}$, $k = 2$, 95 % confidence level.

δ_{INST} MPE is the maximum permissible error given by the manufacturer. According to the technical information of the manufacturer, MPE = 0,05 mm.

Distribution is rectangular, $k = \sqrt{3}$, $u_1 = 0,05 \text{ mm} / \sqrt{3} = 29 \mu\text{m}$.

δ_{read} **reading error** – depends on human influences and practical experience. Estimated as $\pm 0,005 \text{ mm}$.

Distribution is rectangular, $k = \sqrt{3}$, $u_2 = 0,005 \text{ mm} / \sqrt{3} = 2,89 \mu\text{m}$.

δ_{temp} **temperature error** – because of the specific range of the caliper, influence of temperature can be neglected.

Distribution is rectangular, $k = \sqrt{3}$, $u_3 = 0,0001 \text{ mm} / \sqrt{3} = 0,0577 \mu\text{m}$.

δ_{calibr} **calibration of gauge** – according to calibration certificate.

Distribution is rectangular, $k = \sqrt{3}$, $u_4 = 0,005 \text{ mm} / \sqrt{3} = 2,89 \mu\text{m}$.

δ_{abbe} **canting** – because of the position of the measuring surface.

Distribution is rectangular, $k = \sqrt{3}$, $u_5 = 0,06 \text{ mm} / \sqrt{3} = 35 \mu\text{m}$.

δ_{user} **contact pressure** – influence of user, depends on the practical experience of the expert.

Distribution is rectangular, $k = \sqrt{3}$, $u_6 = 0,1 \text{ mm} / \sqrt{3} = 60 \mu\text{m}$.