

Welch-Satterthwaite Effective DOF — Instruction Guide

The Welch-Satterthwaite Effective DOF calculator combines two or more uncertainty contributions, computes the effective degrees of freedom by GUM G.4.1, reads the coverage factor from Table G.2 and reports the expanded uncertainty.

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1. Purpose and application

Use this calculator when a combined standard uncertainty rests on one or more contributors with few degrees of freedom. It tells you whether $k = 2$ is still adequate, and which contributor limits the coverage factor.

Typical applications:

- Finishing an uncertainty budget where a Type A repeatability was taken from a small number of readings.
- Checking a budget that includes a Type B estimate with uncertain bounds, whose degrees of freedom come from GUM G.4.2.
- Reporting an expanded uncertainty at a stated coverage probability (95 %, 95.45 %, 99 % or 99.73 %) rather than assuming $k = 2$.
- Finding the contributor to improve. More readings on that contributor raise v_{eff} and lower k .

You enter each contributor's standard uncertainty contribution $c_i \cdot u(x_i)$, its evaluation type and its degrees of freedom. The calculator does not multiply by sensitivity coefficients. Enter each contribution already in the measurand's unit.

2. Standards basis

The method is JCGM 100:2008 (the GUM), Annex G. Clauses are named below only where the calculator applies that clause directly.

Standard	What the calculator takes from it
JCGM 100:2008, 5.1.2	The combined standard uncertainty as the root sum of squares of uncorrelated contributions
JCGM 100:2008, G.4.1	The Welch-Satterthwaite formula for v_{eff} , and the choice between interpolation and truncation in Table G.2. This calculator truncates
JCGM 100:2008, G.4.2	Degrees of freedom of a Type B estimate from the relative uncertainty of its bounds; infinite v for exactly known bounds
JCGM 100:2008, Table G.2	The coverage factor k at 95 %, 95.45 %, 99 % and 99.73 %, every tabulated row from $v = 1$ to ∞
JCGM 100:2008, 7.2.6	Expanded uncertainty reported to at most two significant digits; rounding up is permitted
JCGM 100:2008, H.1	The gauge-block known answer used as Example 1
ISO/IEC 17025:2017, 7.6 and 7.11	The laboratory's duty to evaluate measurement uncertainty (7.6), and the requirements of 7.11 (control of data and information management), which MT-VAL-WS-001 applies to this calculator

3. How the calculator ensures accurate results

Code computes every number on the card; the language model only explains the finished results. Each contribution is read as an exact decimal and held as a fraction of integers. u_c , v_{eff} and U are formed exactly, and v_{eff} is truncated by integer division, so 35.999999999997 can never become 36. Displayed values follow conservative rules: U and u_c are rounded up, v_{eff} is truncated. The model receives the results in a block it may only quote, never recompute.

MT-VAL-WS-001 Rev E validated this calculator at production commit 5cbb347. 6,000 random budgets (32,851 contributors) were compared with three independent references, with 0 mismatches on v_{eff} , the table row, k , U , u_c , each u_i and the dominant contributors. All 28 rows of Table G.2 were exercised. Five published known answers were reproduced, including GUM H.1. All 17 edge and rejection cases and all 8 live tests passed. The method is described in [Deterministic Computation in AI-Assisted Metrology](#) (Racen, 2026).

4. Input fields

The form has three budget-level fields and one repeating group, Uncertainty contributor. Each contributor carries four fields. Add contributors with the form's + button; at least two are required.

Field	Required	Format or options	What it means
Measurand Description	Optional	Free text, e.g. DC voltage measurement at 10 V using a 6.5-digit DMM	Describe the quantity being measured and the measurement setup. This provides context for the uncertainty budget but does not affect the computation.
Uncertainty Unit	Required	Free text, e.g. V	Unit of measurement for all uncertainty contributions. All contributors must be expressed in the same unit.
Confidence Level	Required	95.45% ($k \sim 2$ at inf DOF) (default) · 95% · 99% · 99.73% ($k \sim 3$ at inf DOF)	Coverage probability for the expanded uncertainty. 95.45% corresponds to $k=2$ at infinite degrees of freedom (the standard GUM convention).
Source Description	Required, per contributor	Free text, e.g. Repeatability of DUT readings	Name or description of this uncertainty source as it appears in the GUM budget.
Uncertainty Contribution	Required, per contributor	Decimal number with a period, e.g. 0.0012	The standard uncertainty contribution of this source to the combined uncertainty: $c_i \cdot u(x_i)$. This is the product of the sensitivity coefficient and the standard uncertainty, in the same unit as the measurand.

Field	Required	Format or options	What it means
Evaluation Type	Required, per contributor	Type A · Type B	How this uncertainty source was evaluated. Type A: from statistical analysis of repeated observations. Type B: from non-statistical methods (specifications, certificates, published data, engineering judgment).
Degrees of Freedom	Required, per contributor	A number greater than 0, or infinity, e.g. 9	Degrees of freedom for this source. Type A: enter n-1 where n is the number of independent observations (e.g., 10 measurements gives 9 DOF). Type B with well-known bounds: enter 50 or "infinity". Type B with uncertain bounds: compute per GUM Section G.4.2.

No field is conditional. Every field shows for every request, and none depends on another field's value.

4.1 Confidence Level

The option sets the Table G.2 column used for k.

Option	Table G.2 column	k at $v = \infty$
95.45% ($k \approx 2$ at inf DOF)	p = 95.45 %	2.000
95%	p = 95 %	1.960
99%	p = 99 %	2.576
99.73% ($k \approx 3$ at inf DOF)	p = 99.73 %	3.000

The card repeats the level without its note, for example 95.45%. Choose 95.45% to match the common $k = 2$ convention. Choose 95% when a customer or procedure states 95 % coverage.

4.2 Evaluation Type

Type A and Type B are recorded for each contributor and passed to the explanation. They do not change any number. v_{eff} depends only on the contribution and its degrees of freedom.

4.3 Degrees of Freedom

- **Type A.** Enter $n - 1$ for n independent readings. Ten readings give 9.
- **Type B, uncertain bounds.** Enter the value from GUM G.4.2, $v \approx \frac{1}{2} (\Delta u/u)^{-2}$. Fractional values such as 12.5 are accepted.
- **Type B, exactly known bounds.** Enter infinity. Only four words are read as infinite: infinity, inf, infinite and ∞ , in any letter case. The help text also suggests 50 for well-known bounds. 50 is a finite v : it adds a small term to the denominator and can give a slightly larger k than infinity. In Example 2, $v = 50$ instead of infinity for the reference gives $k = 2.14$ instead of 2.13. Use infinity only when the bounds are treated as exactly known (GUM G.4.2).

- **Large finite values.** Any number is used as entered, however large. 1000 is a finite v of 1000, not infinity. The former rule that treated $v \geq 1000$ as infinite was removed on 18 October 2026, so $v = 999$ and $v = 1000$ now give the same k .
- Zero, negative values and words other than the four infinity tokens are refused.

4.4 Uncertainty Contribution

Enter the standard uncertainty (one standard deviation) already multiplied by its sensitivity coefficient. Do not enter an expanded uncertainty or a half-width; convert it first, for example with the Type B Uncertainty Estimator. A negative value is accepted, since only its square and fourth power are used. A unit typed after the number must match Uncertainty Unit exactly.

5. Units and unit conversion

This calculator offers no unit domains and performs no unit conversion. Uncertainty Unit is free text, so any unit can be used: V, nm, °C, Ω , N·m, ppm and so on. Unlike the TUR, TAR, Type B and GUM budget calculators, it does not use the shared table of exact conversion factors.

The rules are:

- Every contribution must already be in the declared unit. Convert before you enter, for example with the SI Unit Converter.
- A bare number is read in the declared unit. This is the recommended entry.
- A number followed by a unit is accepted only when that unit is exactly the declared unit. The comparison is case-sensitive, because mV (milli) and MV (mega) differ by 10^9 .
- A spelled-out or different unit is refused, for example 0.8 mV when the declared unit is V. The calculator never converts or guesses.
- The declared unit is copied unchanged to the u_c and U rows of the card.

v_{eff} is dimensionless. Scaling every contribution by the same factor, for example entering a budget in mV instead of V, leaves v_{eff} , the row and k unchanged. MT-VAL-WS-001 confirmed this on 1,500 of 1,500 budgets scaled by 1,000.

6. Calculation method

The calculator takes $y_i = c_i \cdot u(x_i)$ as entered and assumes the contributions are uncorrelated.

6.1 Combined standard uncertainty

$$u_c = \sqrt{\sum_{i=1}^N y_i^2}$$

6.2 Effective degrees of freedom (GUM G.4.1)

$$\nu_{\mathrm{eff}} = \frac{u_c^4}{\sum_{i=1}^N \frac{y_i^4}{\nu_i}}, \quad \frac{y_i^4}{\nu_i} = 0 \text{ when } \nu_i = \infty$$

The sum below the line is the W-S denominator. The calculator forms ν_{eff} as an exact fraction and truncates it to the next lower integer. GUM G.4.1 permits either interpolation in Table G.2 or truncation; this calculator always truncates. Truncation gives a lower ν , a larger k and a larger U .

$$\nu = \lfloor \nu_{\mathrm{eff}} \rfloor$$

Two cases have their own behaviour:

- **Every ν_i infinite.** The denominator is exactly 0. ν_{eff} is infinity and k comes from the ∞ row. No contributor has a share of the denominator, so the card shows the dominant contributor as "none (every ν_i infinite)".
- **ν_{eff} below 1.** This happens only with fractional ν_i below 1. The calculator uses the $\nu = 1$ row and shows ν_{eff} to one decimal with "(row 1 used)", for example 0.5 (row 1 used). Below 0.1 it shows "< 0.1 (row 1 used)". The coverage probability is then only a rough indication. On the card, Nu Eff Truncated then shows 0 while Coverage Factor Source Nu shows 1. Below 0.1, Nu Eff Raw also shows 0, and only the headline says "< 0.1".

6.3 Coverage factor and expanded uncertainty

k is read from Table G.2 at the truncated ν , using the highest tabulated row at or below it. The table has rows 1 to 20, 25, 30, 35, 40, 45, 50, 100 and ∞ . The calculator never interpolates. Any finite ν above 100 uses the 100 row, not the ∞ row; for example $\nu = 150$ at 95.45 % gives $k = 2.025$, not 2.000.

$$U = k \cdot u_c$$

The card also compares k with 2:

$$\Delta k = k - 2, \quad \text{understatement if } k = 2 \text{ were used} = \frac{k - 2}{k} \times 100\%$$

The second figure is the fraction by which U would be too small if $k = 2$ were used. It is negative when k is below 2, for example $k = 1.96$ at 95 % with every ν_i infinite.

6.4 Dominant contributors

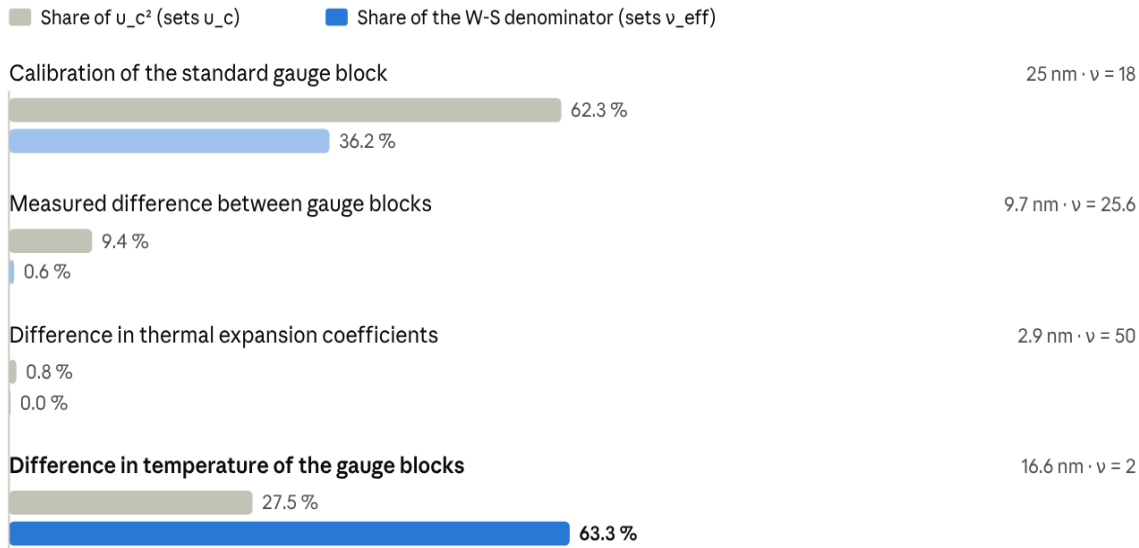
The calculator names two dominant contributors, and they can differ:

$$\text{variance share}_i = \frac{y_i^2}{u_c^2} \times 100\%, \quad \text{denominator share}_i = \frac{y_i^4 / \nu_i}{\sum_j y_j^4 / \nu_j} \times 100\%$$

The largest variance share dominates u_c . The largest denominator share limits ν_{eff} ; improving that contributor's degrees of freedom raises ν_{eff} most. Contributors tied at the maximum are all named, separated by semicolons.

Temperature difference: 27 % of the variance, 63 % of the W-S denominator

GUM H.1 gauge block (Example 1). Shares computed from each contribution and its degrees of freedom



Bar length = percent of the total (full width = 100 %). More degrees of freedom on the blue leader raise v_{eff} most.

Example 1 inputs (GUM H.1) · 4 contributors

Figure 1. Shares of u_c^2 and of the W-S denominator for the GUM H.1 gauge block. The standard's calibration dominates the variance; the temperature difference, with $v = 2$, dominates the denominator and so limits v_{eff} .

6.5 Display rules

Quantity	Rule on the card and in exports
Expanded uncertainty U	Rounded up to 2 significant figures, decided exactly; trailing zeros kept (0.0020)
Combined standard uncertainty u_c	Rounded up to 3 significant figures, decided exactly
v_{eff} (truncated)	Integer, truncated by exact integer division
v_{eff} (raw)	Truncated to 1 decimal, so 23.97 shows 23.9, never 24.0
Coverage factor k	As printed in Table G.2, never re-rounded; a trailing zero is not printed (2.10 shows as 2.1)
W-S denominator	3 significant figures ($\times 10^n$ notation for very small or large values)

Quantity	Rule on the card and in exports
Shares of variance and denominator	Percent, 1 decimal
Δk	3 decimals
Understatement if $k = 2$ used	Percent, 1 decimal

These U and u_c rules are the same as in the GUM Uncertainty Budget Calculator, so both report the same U for the same budget.

7. Reading the results

The card opens with a headline that carries the answer in one line:

$nu_{eff} = 16, k = 2.92 \text{ at } 99\% - U = 93 \text{ nm}$

The headline gives the truncated v_{eff} , k , the confidence level and U in the declared unit. With every v_i infinite it reads " $nu_{eff} = \text{infinity}$ ". Below 1 it reads, for example, " $nu_{eff} = 0.5$ (row 1 used)".

The result rows follow, in this order:

Row on the card	What it shows
Combined Standard Uncertainty — Value	u_c , rounded up to 3 significant figures
Combined Standard Uncertainty — Unit	The declared Uncertainty Unit
Ws Denominator	The W-S denominator $\sum y_i^4/v_i$ in the declared unit to the fourth power; "0 (every nu_i infinite)" when no v_i is finite
Nu Eff Raw	v_{eff} truncated to 1 decimal, or infinity; 0 when v_{eff} is below 0.1 (only the headline then says "< 0.1")
Nu Eff Truncated	The integer part of v_{eff} , or infinity. Below 1 it shows 0, while the table row used is 1 (see Coverage Factor Source Nu)
Nu Eff Infinite	Yes when every v_i is infinite, otherwise No
Coverage Factor	k from Table G.2
Coverage Factor Source Nu	The Table G.2 row actually used (16, 100, infinity and so on)
Confidence Level	The selected coverage probability
Expanded Uncertainty — Value	U, rounded up to 2 significant figures
Expanded Uncertainty — Unit	The declared Uncertainty Unit

Row on the card	What it shows
Dominant Contributor	The source with the largest share of the W-S denominator, or "none (every v_i infinite)"
Dominant Contributor Share Percent	That source's share of the denominator; absent when none is dominant
Dominant Contributor By Variance	The source with the largest share of u_c^2
Dominant Contributor Variance Share Percent	That source's share of u_c^2
Comparison To K2 — Delta K	$k - 2$
Comparison To K2 — Percent Understatement If K2 Used	$(k - 2)/k \times 100$

Compare Coverage Factor Source Nu with Nu Eff Truncated. When they differ, v fell between tabulated rows and the next lower row was used.

The card does not list each contributor. The per-contributor values (u_i rounded up to 3 significant figures, u_i^2 , u_i^4 , u_i^4/v_i and both shares) go to the written explanation, which may quote them. The PDF, Word and spreadsheet exports carry the same headline and rows as the card, because one function produces all of them.

8. Worked examples

Every result below was copied from a run of the production calculator on the text the form composes, and checked by hand in exact arithmetic.

Example 1 — GUM H.1 gauge block (published known answer)

The length of a 50 mm gauge block is found by comparison with a calibrated standard. GUM H.1 gives four contributions with their degrees of freedom.

Field	Entered
Measurand Description	Length of a nominally 50 mm gauge block by comparison with a standard (GUM H.1)
Uncertainty Unit	nm
Confidence Level	99%
Contributor 1	Calibration of the standard gauge block; 25.0; Type B; 18
Contributor 2	Measured difference between gauge blocks; 9.70; Type A; 25.6
Contributor 3	Difference in thermal expansion coefficients; 2.90; Type B; 50
Contributor 4	Difference in temperature of the gauge blocks; 16.6; Type B; 2

Hand calculation:

1. Squares: $625 + 94.09 + 8.41 + 275.56 = 1\,003.06 \text{ nm}^2$.
2. $u_c = \sqrt{1\,003.06} = 31.6711 \text{ nm}$, rounded up to 31.7 nm.
3. Denominator terms y_i^4/v_i : $390\,625/18 = 21\,701.39$; $8\,852.9281/25.6 = 345.82$; $70.7281/50 = 1.41$; $75\,933.3136/2 = 37\,966.66$. Sum = $60\,015.28 \text{ nm}^4$, shown as 6.00×10^4 .
4. $v_{\text{eff}} = 1\,003.06^2 / 60\,015.28 = 16.7646$, truncated to 16 (raw shown as 16.7).
5. Table G.2, $v = 16$, $p = 99\%$: $k = 2.92$.
6. $U = 2.92 \times 31.6711 = 92.48 \text{ nm}$, rounded up to 93 nm.
7. Denominator shares: contributor 4 has $37\,966.66/60\,015.28 = 63.3\%$. Variance shares: contributor 1 has $625/1\,003.06 = 62.3\%$.
8. $\Delta k = 0.92$; $(2.92 - 2)/2.92 = 31.5\%$.

Calculator result:

Row	Value
Headline	$nu_{\text{eff}} = 16$, $k = 2.92$ at 99% — $U = 93 \text{ nm}$
Combined Standard Uncertainty — Value	31.7 nm
Ws Denominator	6.00×10^4
Nu Eff Raw	16.7

Row	Value
Nu Eff Truncated	16
Nu Eff Infinite	No
Coverage Factor	2.92
Coverage Factor Source Nu	16
Confidence Level	99%
Expanded Uncertainty — Value	93 nm
Dominant Contributor	Difference in temperature of the gauge blocks
Dominant Contributor Share Percent	63.3
Dominant Contributor By Variance	Calibration of the standard gauge block
Dominant Contributor Variance Share Percent	62.3
Comparison To K2 — Delta K	0.92
Comparison To K2 — Percent Understatement If K2 Used	31.5

The result matches GUM H.1: ν_{eff} 16, k 2.92 and $U_{99} = 93$ nm. The GUM prints $u_c^2 = 1\,002$ nm² because it sums the unrounded components; the entries here are the rounded values it tabulates, so the sum is 1 003.06 nm². Both routes give $\nu_{\text{eff}} = 16.7$ and the same U . The two dominant contributors differ. The standard's calibration carries most of the variance, but the temperature difference, with only 2 degrees of freedom, carries 63 % of the denominator. Improving the temperature estimate would raise ν_{eff} and lower k most.

Example 2 — DC voltage at 10 V, one Type A contributor

Field	Entered
Measurand Description	DC voltage measurement at 10 V using a 6.5-digit DMM
Uncertainty Unit	V
Confidence Level	95.45% ($k \sim 2$ at inf DOF)
Contributor 1	Repeatability of DUT readings; 0.0012; Type A; 9
Contributor 2	Reference standard calibration; 0.0008; Type B; infinity
Contributor 3	DMM resolution; 0.00029; Type B; infinity

Hand calculation:

1. Squares: $1.44 \times 10^{-6} + 6.4 \times 10^{-7} + 8.41 \times 10^{-8} = 2.1641 \times 10^{-6} \text{ V}^2$.
2. $u_c = 0.00147109 \text{ V}$, rounded up to 0.00148 V.
3. Denominator: only contributor 1 is finite. $0.0012^4/9 = 2.304 \times 10^{-13} \text{ V}^4$.
4. $v_{\text{eff}} = (2.1641 \times 10^{-6})^2 / 2.304 \times 10^{-13} = 20.33$, truncated to 20.
5. Table G.2, $v = 20$, $p = 95.45\%$: $k = 2.13$.
6. $U = 2.13 \times 0.00147109 = 0.003133 \text{ V}$, rounded up to 0.0032 V.
7. Variance share of contributor 1: $1.44/2.1641 = 66.5\%$. Its denominator share is 100 %.
8. $\Delta k = 0.13$; $0.13/2.13 = 6.1\%$.

Calculator result:

Row	Value
Headline	$nu_{\text{eff}} = 20$, $k = 2.13$ at 95.45% — $U = 0.0032 \text{ V}$
Combined Standard Uncertainty — Value	0.00148 V
Ws Denominator	2.30×10^{-13}
Nu Eff Raw	20.3
Nu Eff Truncated	20
Nu Eff Infinite	No
Coverage Factor	2.13
Coverage Factor Source Nu	20
Confidence Level	95.45%
Expanded Uncertainty — Value	0.0032 V
Dominant Contributor	Repeatability of DUT readings

Row	Value
Dominant Contributor Share Percent	100
Dominant Contributor By Variance	Repeatability of DUT readings
Dominant Contributor Variance Share Percent	66.5
Comparison To K2 — Delta K	0.13
Comparison To K2 — Percent Understatement If K2 Used	6.1

Ten readings leave the budget with 20 effective degrees of freedom. Using $k = 2$ would understate U by 6.1 %. U rounds up to 0.0032 V although $k \cdot u_c$ is 0.003133 V; the calculator never reports an uncertainty smaller than the one computed. Taking 20 readings instead of 10 is the direct way to bring k toward 2.

Example 3 — every degree of freedom infinite

The same reference and resolution contributors are entered alone, at Confidence Level 95%, with Degrees of Freedom infinity and ∞ .

- $u_c = \sqrt{(6.4 \times 10^{-7} + 8.41 \times 10^{-8})} = 0.000850941$ V, rounded up to 0.000851 V.
- The denominator is exactly 0, so v_{eff} is infinity and $k = 1.96$ from the ∞ row.
- $U = 1.96 \times 0.000850941 = 0.001668$ V, rounded up to 0.0017 V.

The calculator's headline is " $\nu_{\text{eff}} = \text{infinity}$, $k = 1.96$ at 95% — $U = 0.0017$ V". Ws Denominator shows "0 (every ν_i infinite)", Coverage Factor Source Nu shows infinity, and Dominant Contributor shows "none (every v_i infinite)". Dominant Contributor By Variance names Reference standard calibration at 88.4 %. Delta K is -0.04 and the understatement is -2 : here $k = 2$ would overstate U by 2 %.

9. Refusals and troubleshooting

When an input cannot be read without guessing, the calculator computes nothing. The card names the field, quotes what was entered and gives the fix. Each message below was produced by the production calculator.

Message or situation	Cause	What to do
Cannot compute ν_{eff} — single contributor (read k directly from t -table). "1 contributor provided; at least 2 are required."	Only one contributor was entered. With one source, ν_{eff} equals its ν_i	Add a second contributor with the + button, or read k from Table G.2 at that ν
Cannot compute ν_{eff} — invalid Uncertainty Contribution. Entered: "0,0008"	A comma was used as the decimal mark	Enter decimals with a period: 0.0008
Cannot compute ν_{eff} — unit mismatch in Uncertainty Contribution. "carries the unit "mV", but the declared unit is "V""	A unit typed after the number differs from Uncertainty Unit	Restate the value in the declared unit, or enter a bare number
Cannot compute ν_{eff} — missing Uncertainty Unit	Uncertainty Unit is blank	Enter the unit shared by all contributions, e.g. V
Cannot compute ν_{eff} — invalid Degrees of Freedom. Entered: "0"	ν_i is zero or negative, which would divide by zero	Type A: enter $n - 1$. Type B: enter a value from G.4.2, or infinity
Cannot compute ν_{eff} — invalid Degrees of Freedom. Entered: "large"	A word other than infinity, inf, infinite or ∞	Enter a number, or one of the four infinity words
Cannot compute ν_{eff} — invalid Evaluation Type. Entered: "Type C"	Only Type A or Type B is accepted	Select Type A or Type B
Cannot compute ν_{eff} — invalid Confidence Level. Entered: "90%"	The text was edited to a level the form does not offer	Choose one of the four form options
Cannot compute ν_{eff} — invalid Uncertainty contributor. "Contributor numbering has a gap (1 then 3)."	The composed text was hand-edited and a contributor may have been dropped	Re-enter the contributors in the form so they run 1 to N
Result shows "(row 1 used)" and a very large k	ν_{eff} is below 1, from fractional ν_i below 1. " $\nu_{\text{eff}} = 0.5$: the $\nu = 1$ row of Table G.2 is used."	Check the ν_i entries. Raise the dominant contributor's degrees of freedom

Message or situation	Cause	What to do
Dominant Contributor shows "none (every v_i infinite)"	Every v_i was entered as infinite, so the denominator is 0	Expected behaviour. k comes from the ∞ row. Check that no contributor really has finite v
v entered as 1000 did not give the ∞ row	Since 18 October 2026, only the four infinity words mean infinite	Enter infinity if the bounds are exactly known
U looks one digit high compared with a textbook	The calculator rounds U up at 2 significant figures; some publications round to nearest	Expected. GUM-5 prints 3.9 for 3.92; this calculator shows 4.0

10. Scope and limitations

- **Uncorrelated inputs only.** The calculator has no correlation coefficients. The Welch-Satterthwaite formula is not valid for correlated contributions.
- **No sensitivity coefficients.** Enter $c_i \cdot u(x_i)$ yourself; the form has no separate c_i field.
- **Standard uncertainties only.** Expanded uncertainties, half-widths and specification limits must be converted to one standard deviation first.
- **Truncation, not interpolation.** k can be slightly larger than an interpolated value from the same table. This is the conservative choice GUM G.4.1 permits.
- **Table G.2 only.** No rows exist between 100 and ∞ , so every finite v above 100 uses the 100 row.
- **Four confidence levels.** 68.27 % and 90 % are not offered here.
- **Validated scope.** MT-VAL-WS-001 covers every number on the card and in its exports. The written explanation is outside the numerical validation; it is constrained to quote the computed values.
- **Training and reference use.** A laboratory that uses a result in its own work remains responsible for validating that use under ISO/IEC 17025:2017 7.11 (control of data and information management).
- **Two accepted notation observations.** With v_{eff} below 0.1 the headline reads " $\nu_{\text{eff}} = < 0.1$ (row 1 used)". With every v_i infinite the card writes both v_i and ν_i . Neither affects a value.

11. References

1. JCGM 100:2008, *Evaluation of measurement data — Guide to the expression of uncertainty in measurement* (GUM), clauses 5.1.2 and 7.2.6, Annex G (G.4.1, G.4.2, Table G.2) and Annex H (H.1).
2. ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*, 7.6 and 7.11 (control of data and information management).
3. UKAS M3003, *The Expression of Uncertainty and Confidence in Measurement*, Edition 6 (2024): examples B.10, K.4 and K.10, known answers in MT-VAL-WS-001.
4. JCGM GUM-5:2026, section 6.2, a known answer in MT-VAL-WS-001.
5. K. Racen, [Deterministic Computation in AI-Assisted Metrology](#), white paper, 2026.
6. MT-VAL-WS-001 Rev E, Welch-Satterthwaite calculator validation record, 18 October 2026; summarized in MT-VAL-SUM-001 Rev B.

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