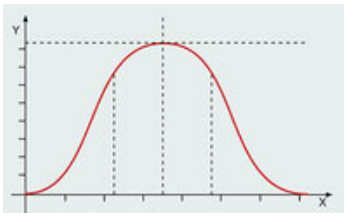
Stating measurement uncertainty with WinSAM*

While recording physical values according to standard DIN EN 62058-31 it is required to state the measurement uncertainty in addition to the measurement results. This regulation aims to standardize the procedure of detection and statement of measurement uncertainty internationally in order to make measurement results comparable all over the world and to evaluate the quality of the measurement result.

Definition and influences



Measurement uncertainty (MU) describes a parameter associated to the measurement result characterizing the dispersion of values. The measurement uncertainty limits the range, in between the „true value“ of the measuring value with a specified confidence level of 95,45 % is.

Measurement uncertainty characterizes the quality of a measurement result.

In metrology it is necessary to determine and report these deviations or measurement uncertainties, because a physical measurement always provides values, which will deviate from the „true values“. Measurement results can be influenced e. g. by inherent measurement deviation or long-term stability of the reference standard (systematic measurement deviation). Influences of external magnetic field, contact resistances at the connection points e. g. at the meter contact or the arrangement of the construction can also affect the measurement results (non-systematic measurement deviation).

Statistical or non-statistical analysis

In general, two types of measurement uncertainties will be distinguished:

Type A refers to the statistical analysis of the measurement. These values can be calculated and are reproducible.

Type B refers to non-statistical determined values e. g. information from data sheets and/or manufacturers data of the test equipment or the device under test.

Traceability

Meaning in metrology

- Objectifying measurement results
- Consistent and reproducible calculations
- Traceability of measurement uncertainties
- Worldwide comparability of measurement results

* applies only from WinSAM version >7.2.3

Information about the calculation in WinSAM

Only a few steps are required to get WinSAM configuration to calculate the measurement uncertainty (shown down below) automatically. The final report is included.

1. Standard measurement uncertainty of the system (u_{MTS})

$$u_{MTS} = \frac{U_{MTS}}{K_{MTS}}$$

Inside the configuration the inserted values for measurement uncertainty is divided by the coverage factor (K_{MTS}).
In this case the coverage factor is always 2, independent if the calculation in WinSAM is activated for “according to specifications” or“ with measuring values”.

2. Measurement uncertainty of the device under test (u_{DUT})

$$u_{DUT} = \frac{\sigma}{\sqrt{n}}$$

The measurement uncertainty of the device under test (DUT) is being calculated with the standard deviation σ and the number of measurements n.

3. Total measurement uncertainty (u_{ges})

$$u_{ges} = \sqrt{{u_{DUT}}^2 + {u_{MTS}}^2}$$

The total standard measurement uncertainty (u_{ges}) comprises the standard measurement uncertainty of the device under test (u_{DUT}) and the standard measurement uncertainty of the meter test system (u_{MTS}).

4. Effective degree of freedom (V_{eff})

$$V_{eff} = \frac{(u_{ges})^4 * (n-1)}{(u_{DUT})^4}$$

The effective degree of freedom is being calculated with the total standard measurement uncertainty (u_{ges}), the standard measurement uncertainty of the device under test (u_{DUT}) and the number of measurements (n-1).

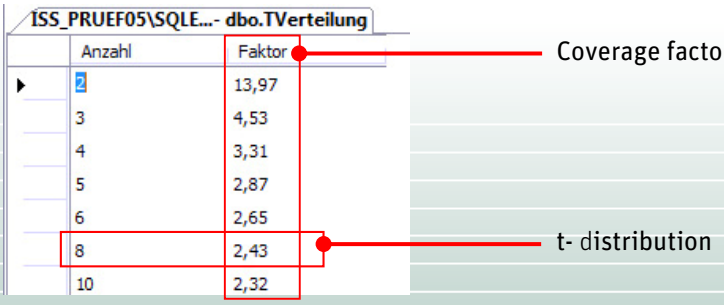
If the result of this measurement is ≥ 100 the coverage factor K will be specified as 2.

If the result is < 100 the coverage factor K will be selected from the table inside the database (see picture t-distribution) according to the number of measurements.

5. Expanded measurement uncertainty

$$U_{ges} = u_{ges} \times K$$

The expanded measurement uncertainty U_{ges} is the product of the total standard measurement uncertainty u_{ges} and the coverage factor K as defined above (point 4).



Extract of the table of the WinSAM database

Calculation of corrected error limits

$$e_{corr} = \frac{6}{5} \times e_{min} - U$$

According to DIN EN 62058-31 it is required to calculate and adapt the corrected error limit (e_{corr}), if the measurement uncertainty is 20 ... 50 % of the error limit (e_{min}). The corrected error limit comprises of the error limit according to the manufacturer specification (e_{min}), the correction factor (6/5) and the expanded measurement uncertainty (U).

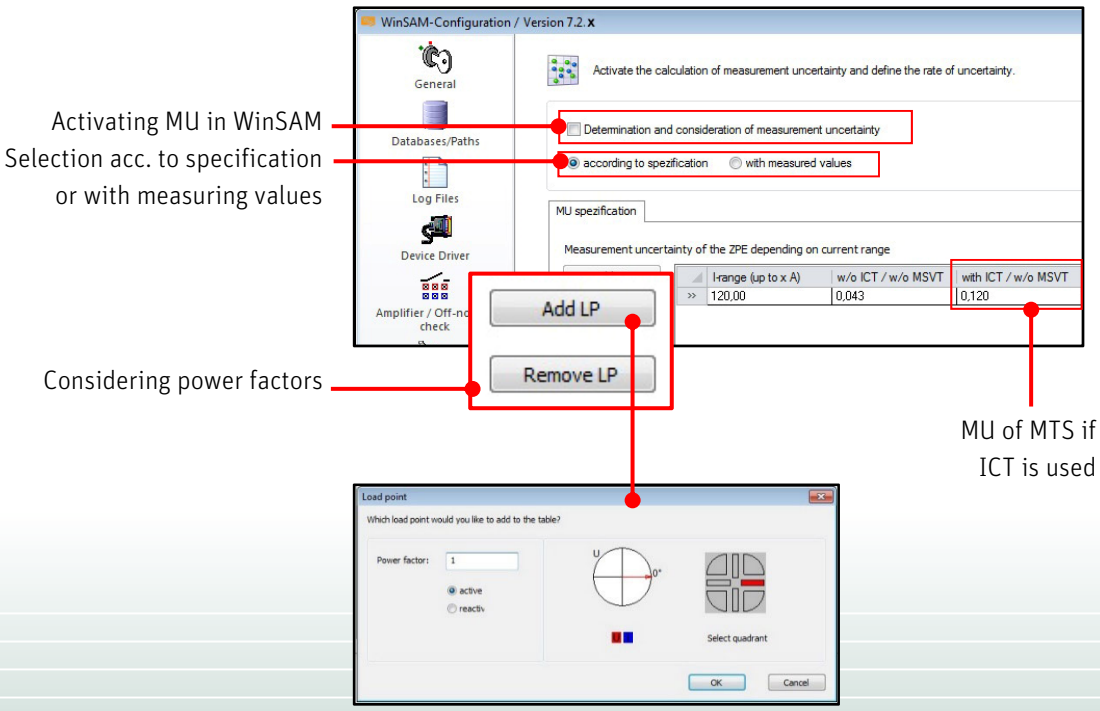
If the measurement uncertainty is lower than 20 % of the error limit there is no adaption necessary. In case that the percentage error is higher than 50 % the test equipment and its components are unsuitable for verifying the specimen.

Expanded measurement uncertainty
Error limit acc. to manufacturer's data
Correction factor (MU 20 ... 50 %)
Corrected error limit (I_{ref} cos φ)

Performance in WinSAM*

WinSAM* calculates the measurement uncertainty and the corrected error limit (e_{corr}) by using specifications from the data base and entries inside the configuration. The values can be reported if required.

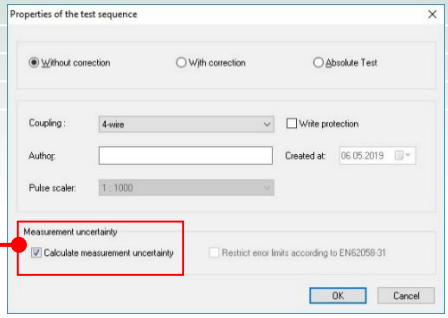
Configuration → Measurement uncertainty **



* applies only from WinSAM version >7.2.3
** display may vary according to the WinSAM version

SKEditor → Test sequence properties

Considering MU for measurements



Extract of the test report and the data base**

Standard deviation of DUT

Error limit in %

Stated MU, here: ±0,702 %

Iref cosPhi=1	MP 1
Zählerkonstante	1000,00
Prozentualer Fehler	-0,080%
Impulse	600482
Prozentualer Fehler2	-0,036%
Impulse2	600219
Prozentualer Fehler3	-0,061%
Impulse3	600368
Prozentualer Fehler4	-0,044%
Impulse4	600265
Prozentualer Fehler5	-0,078%
Impulse5	600474
Prozentualer Fehler6	-0,066%
Impulse6	600399
Prozentualer Fehler7	-0,049%
Impulse7	600299
Prozentualer Fehler8	-0,022%
Impulse8	600136
Mittelwert	-0,054%
Std. Abweichung	0,019
MPE	0,054%
U-Bereich	240V
I-Bereich	5A
Fehlerband W Oben	2,898 %
Fehlerband W Unten	-2,898 %
Erweiterte Messunsicherheit	± 0,702%
MPE ± W	0,054% ± 0,702%
Bewertung	gut

Further information on this issue

Software WinSAM

Further information about the test and control software WinSAM can be found on our website.
https://www.zera.de/products/software/

An editorial on measurement uncertainty

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