# OSM/IN DECISION

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| **Standard:** | General | **Sub clause:** | all | **Sheet N°:** | OSM/IN 267 |
| **Subject:** | How to record and report Test Measurements | **Key words:** | Significant Digits | **Meeting N°:**<br>**Item:** | 24 (2014)<br>4.4.5 |

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|---|---|
| **Question:** | How many significant digits have to be taken into account for the Test Measurements when a measure is closed to the limit? |
| **Proposal:** | Otherwise specified in the standard, the following guidance can be used for the determination and the recording of the relevant Significant Digits for a test measurement.<br><br>All the Test Measurements have to be recorded with a least the same Precision (1) as the Instrument Accuracy of Measuring Range, stated in the document CTL251E.<br><br>When the number of the Significant Digits of Test Limit is ≥ 3, no rounding of Test Measurement or result is allowed.<br><br>If the Precision of the Instrument Accuracy of Measuring Range is ≥ to Unit and the number of the Significant Digits of Test limit is < 3, the Min Precision of the Test Measurement shall be at least 10 x better.<br><br>Rounding of Test Measurement or result is allowed, only when the Precision of the Instrument is > to Min Precision required by CTL251E and when the Test Measurement is closed to the Test Limit with the following condition :<br><br>For a Maximum Test Limit :<br>**(Test Limit - Test Measurement –) ≤ 0,5 or**<br>**(5 x Measurement Instrument Accuracy), if lower.**<br><br>For a Minimum Test Limit :<br>**(Test Limit Test - Measurement -) ≥ 0,5 or**<br>**(5 x Measurement Instrument Accuracy), if lower**<br><br>Therefore, it would be recommended to record Test Measurement value with at least 3 Significant Digits, when is possible. |

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| | The following rounding method for numbers resulting from measurements or calculations performed on measured numbers can be used.<br><br>When the digit next beyond the last digit to be retained is less than 5, the last digit retained is unchanged.<br>When the digit next beyond the last digit to be retained is greater than 5, increase the last digit retained by 1.<br>When the digit next beyond the last digit to be retained is 5, and there are no digits beyond this 5, or only zeroes, increase the last digit retained by 1 if it is odd, leave the digit unchanged if it is even.<br>Increase the last digit retained by 1, if there are non-zero digits beyond this 5.<br><br>In that case the relevant Significant Digits, after the rounding method, shall be recorded and only this value has to be reported in the TRF. |

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|---|---|
| **Remark**: | When the Test Measurement is out of the Instrument Accuracy Measuring Range, the Test Measurement shall be recorded and reported in the TRF as follow:<br><br>Test Measurement < Instrument Accuracy of Min Range Value or<br>Test Measurement > Instrument Accuracy of Max Range Value |

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| **Explanatory notes:** | **Data Recording - General**:<br>• Correct recording of test results, requires knowledge of the capability of measuring instruments. Correct recording of results of calculations requires that rules for calculations involving significant digits be followed.<br>• The results of measurements and calculations should be recorded with the number of significant digits that reflect the precision and accuracy of the result so that correct conclusions can be drawn from the value presented. Recording too many digits implies false precision. Recording too few digits results in round-off errors.<br>• The number of significant digits used to report results of measurements and calculations may be reduced to reflect the precision and accuracy contained in a specification governing the testing and interpretation of the results.<br><br>(1) **Precision :**<br>The actual position of the rightmost significant digit. If that digit is to the right of the decimal point, we state the position as so many decimal places. If that position is to the left of the decimal point, it is more common to state the precision using words like “tens,” “hundreds,” “thousands,” etc. |

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**Linear dimensions measurements**

Example 1:

| | | |
|---|---|---|
| Test Limit Max: | 3 mm | Significant Digit =1; |
| Measurement Accuracy Min: | 0,1 mm | Precision Min = 1 digit after the decimal (acc. CTL251E) |

Therefore the min number of the Significant Digits of the result of measurement shall be 2,
and no rounding result is allowed.

If possible, the number of the Significant Digits of the results of measurements should be 3,
and rounding result will be allowed.

**Case 1** : (Test Limit -Test Measurement) > 5 x Measurement Accuracy (0,01)

| | | |
|---|---|---|
| **Test Measurement**: | 2,94 mm | 3 Significant Digits |
| Value to be Recorded: | 2,94 mm | 3 Significant Digits |
| Value to Reported in TRF: | 2,94 mm | 3 Significant Digits |
| Test Result: | | **PASS** |

**Case 2** : (Test Limit -Test Measurement) ≤ 5 x Measurement Accuracy (0,01)

| | | |
|---|---|---|
| **Test Measurement1**: | 3,05 mm | 3 Significant Digits |
| Value to be Recorded: | 3,05 mm | 3 Significant Digits |
| Rounding Value: | 3,0 mm | 2 Significant Digits |
| Value to Reported in TRF: | 3,0 mm | 2 Significant Digits |
| Test Result: | | **PASS** |
| **Test Measurement2**: | 3,06 mm | 3 Significant Digits |
| Value to be Recorded: | 3,06 mm | 3 Significant Digits |
| Rounding Value: | 3,1 mm | 2 Significant Digits |
| Value to Reported in TRF: | 3,1 mm | 2 Significant Digits |
| Test Result: | | **FAIL** |

If, the number of the Significant Digits of the results of measurements will be 2

| | | |
|---|---|---|
| **Test Measurement3**: | 3,1 mm | 2 Significant Digits |
| Value to be Recorded: | 3,1 mm | 2 Significant Digits |
| Value to Reported in TRF: | 3,1 mm | 2 Significant Digits |
| Test Result: | | **FAIL** |

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Example 2:

| | | |
|---|---|---|
| Test Limit Max: | 100 mm | Significant Digit =3; |
| Measurement Accuracy Min: | 0,5 % (0,5 mm) | Precision Min = 1 digit after the decimal (acc. CTL251E) |

As the number of the Significant Digits of the Test Limit is ≥ 3, no rounding result is allowed.

All the relevant Significant Digits of the result of measurement shall be recorded.

| | | |
|---|---|---|
| **Test Measurement1**: | 94,7 mm | 3 Significant Digits |
| Value to be Recorded: | 94,7 mm | 3 Significant Digits |
| Value to Reported in TRF: | 94,7 mm | 3 Significant Digits |
| Test Result: | | **PASS** |
| **Test Measurement2**: | 100,0 mm | 4 Significant Digits |
| Value to be Recorded: | 100,0 mm | 4 Significant Digits |
| Value to Reported in TRF: | 100,0 mm | 4 Significant Digits |
| Test Result: | | **PASS** |
| **Test Measurement3**: | 100,1 mm | 4 Significant Digits |
| Value to be Recorded: | 100,1 mm | 4 Significant Digits |
| Value to Reported in TRF: | 100,1 mm | 4 Significant Digits |
| Test Result: | | **FAIL** |

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**Temperature rise measurement:**

Example 3:

| | | |
|---|---|---|
| Test Limit Max: | 65 K | Significant Digit =2; |
| Measurement Accuracy Min: | 2 K | Precision is to Unit but<br>Min Precision shall be at least 1 digit after the decimal |

Therefore the min number of the Significant Digits of the result of measurement shall be 2,
no rounding result is allowed.

If possible, the number of the Significant Digits of the result of measurement should be 3,
rounding result is allowed

**Case 1** : (Test Limit -Test Measurement) > 5 x Measurement Accuracy (0,1)

| | | |
|---|---|---|
| **Test Measurement**: | 64,4 K | 3 Significant Digits |
| Value to be Recorded: | 64,4 K | 3 Significant Digits |
| Value to Reported in TRF: | 64,4 K | 3 Significant Digits |
| Test Result: | | **PASS** |

**Case 2** : (Test Limit -Test Measurement) ≤ 5 x Measurement Accuracy (0,1)

| | | |
|---|---|---|
| **Test Measurement1**: | 65,4 K | 3 Significant Digits |
| Value to be Recorded: | 65,4 K | 3 Significant Digits |
| Rounding Value: | 65 K | 2 Significant Digits |
| Value to Reported in TRF: | 65 K | 2 Significant Digits |
| Test Result: | | **PASS** |
| **Test Measurement2**: | 65,5 K | 3 Significant Digits |
| Value to be Recorded: | 65,5 K | 3 Significant Digits |
| Rounding Value: | 66 K | 2 Significant Digits |
| Value to Reported in TRF: | 66 K | 2 Significant Digits |
| Test Result: | | **FAIL** |

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**Tripping Time measurement:**

Example 4:

| | | |
|---|---|---|
| Test Limit Max: | 40 ms | Significant Digit =2; |
| Measurement Accuracy Min: | 5% (2 ms) | Precision is to Units but<br>Precision Min shall be at least 1 digit after the decimal |

Therefore the min number of the Significant Digits of the result of measurement shall be 2,
no rounding result allowed.

If possible, the number of the Significant Digits of the results of measurements should be 3,
rounding result allowed

**Case 1** : (Test Limit -Test Measurement) > 5 x Measurement Accuracy (0,1)

| | | |
|---|---|---|
| Test Limit Max: | 40 ms | 2 Significant Digits; |
| Measurement Accuracy: | 0,1 ms; | 2 Significant Digits |
| **Test Measurement**: | 39,4 ms | 3 Significant Digits |
| Value to be Recorded: | 39,4 ms | 3 Significant Digits |
| Value to Reported in TRF: | 39,4 ms | 3 Significant Digits |
| Test Result: | | **PASS** |

**Case 2** : (Test Limit -Test Measurement) ≤ 5 x Measurement Accuracy (0,1)

| | | |
|---|---|---|
| **Test Measurement1**: | 40,5 ms | 3 Significant Digits |
| Value to be Recorded: | 40,5 ms | 3 Significant Digits |
| Rounding Value: | 40 ms | 2 Significant Digits |
| Value to Reported in TRF: | 40 ms | 2 Significant Digits |
| Test Result: | | **PASS** |
| **Test Measurement2**: | 40,6 ms | 3 Significant Digits |
| Value to be Recorded: | 40,6 ms | 3 Significant Digits |
| Rounding Value: | 41 ms | 2 Significant Digits |
| Value to Reported in TRF: | 41 ms | 2 Significant Digits |
| Test Result: | | **FAIL** |

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**Tripping Time measurement:**

Example 5:

| | | |
|---|---|---|
| Test Limit Max: | 300 ms | Significant Digit =3; |
| Measurement Accuracy Min: | 10 ms | Precision is to Tens but<br>Min Precision could be to Units |

As the number of the Significant Digits of the Test Limit is ≥ 3, no rounding result is allowed.

All the relevant Significant Digits of the results of measurements shall be recorded.

**Case 1** : (Test Limit -Test Measurement) > 0,5

| | | |
|---|---|---|
| **Test Measurement**: | 95 ms | 2 Significant Digits |
| Value to be Recorded: | 95 ms | 2 Significant Digits |
| Value to Reported in TRF: | 95 ms | 2 Significant Digits |
| Test Result: | | **PASS** |
| **Test Measurement2**: | 301 ms | 3 Significant Digits |
| Value to be Recorded: | 301 ms | 3 Significant Digits |
| Value to Reported in TRF: | 301 ms | 3 Significant Digits |
| Test Result: | | **FAIL** |

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**Leakage current measurement:**

Example 6:

| | | |
|---|---|---|
| Test Limit Max: | 2 mA | Significant Digit =1; |
| Measurement Accuracy Min: | 3,5% (0,07 mA) | Precision Min = 2 digits after the decimal (acc. CTL251E) |

Therefore the min number of the Significant Digits of the result of measurement shall be 3, and no rounding result is allowed.

**Case 1** : (Test Limit -Test Measurement) > 5 x Measurement Accuracy (0,01)

| | | |
|---|---|---|
| **Test Measurement1**: | 1,74 mA | 3 Significant Digits |
| Value to be Recorded: | 1,74 mA | 3 Significant Digits |
| Value to Reported in TRF: | 1,74 mA | 3 Significant Digits |
| Test Result: | | **PASS** |

**Case 2** : (Test Limit -Test Measurement) ≤ 5 x Measurement Accuracy (0,01)

| | | |
|---|---|---|
| **Test Measurement1**: | 2,00 mA | 3 Significant Digits |
| Value to be Recorded: | 2,00 mA | 3 Significant Digits |
| Value to Reported in TRF: | 2,00 mA | 3 Significant Digits |
| Test Result: | | **PASS** |
| **Test Measurement2**: | 2,01 mA | 3 Significant Digits |
| Value to be Recorded: | 2,01 mA | 3 Significant Digits |
| Value to Reported: | 2,01 mA | 3 Significant Digits |
| Test Result: | | **FAIL** |