PCT Workshop 2016

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Identifying Calculation Problems

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Examiner Calculation sheet

Historically, each examiner checked data using their own method.

Now, there is a single calculation sheet used to check and automatically find issues in the test data provided for audit.

The sheet flags insufficient S/N, less than 6 RT measurements, >6dB differences in adjacent 1/3 octave source data, etc .

To check a calculation, the sheet needs to be able to handle all calculations for all variations of single/multiple loudspeakers, static/sweep, any number of RT and background measurement, etc

Examiner Calculation sheet

		50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz	250 Hz	315 Hz
	D1	30.70739	31.33092652	35.63492	37.89223	37.57875	35.62996	42.58035	42.38005	43.331391
	D2	30.70739	31.33092652	35.63492	37.89223	37.57875	35.62996	42.58035	42.38005	43.331391
	D1 D2 diffe	0	0	0	0	0	0	0	0	0
	D	30.70739	31.33092652	35.63492	37.89223	37.57875	35.62996	42.58035	42.38005	43.331391
	DnT	29.61718	30.54258703	34.7942	35.31162	34.8704	33.24924	43.22493	42.80187	44.62829
	DnT round	29.6	30.5	34.8	35.3	34.9	33.2	43.2	42.8	44.6
	from tester	0	0	0	35.3	34.9	33.2	43.2	42.8	44.6
	difference	29.6	30.5	34.8	0.0	0.0	0.0	0.0	0.0	0.0
	curve				31	34	37	40	43	46
		calculated	from tester							
DnT,w		50	50				adverse dev	28.5		
Ctr		-5	-5							
DnT,w + Ctr		45	45							
6dB?		3.211317	13.7990986	9.565513	0.322691	2.383751	1.166608	2.285696	2.067904	2.3423319
worst 6dB in range		6.243738								
min bg clearance		8.870585	18.17464533	32.91126	38.15096	34.57902	30.88207	25.98969	23.35512	19.031616
worst bg clearance in r		12.95151								
at least 6 R		16								
0.5 seconds		0								

ISO140-4 log average speaker measurements

measured. In this case L is determined by

$$L = 10 \lg \left(\frac{1}{n} \sum_{j=1}^{n} 10^{L_j/10} \right) \text{ dB} \qquad \ldots(1)$$

where L_j are the sound pressure levels L_1 to L_n at n different positions in the room

=IF(SUM(D8:D19)=D8,D8,10*LOG(AVERAGE(AC8:AC19)))

Where the AC values are 10^(Lj/10)

If there is only 1 measurement, there is no average. If there are more, log average.

You know your setup and do not have to cope with these variables.

This applies to source measurements and to receiver measurements.

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ISO140-4 BG correction

The background noise level shall be at least 6 dB (and preferably more than 10 dB) below the level of signal and background noise combined. If the difference in levels is smaller than 10 dB but greater than 6 dB, calculate corrections to the signal level according to the following equation:

$$L = 10 \lg \left(10^{L_{sb}/10} - 10^{L_b/10}\right) \text{ dB}$$

where

- L is the adjusted signal level, in decibels;
- L_{sb} is the level of signal and background noise combined, in decibels;
- L_b is the background noise level, in decibels.

If the difference in levels is less than or equal to 6 dB in any of the frequency bands, use the correction 1,3 dB corresponding to a difference of 6 dB. In that case, indicate D_n, D_{nT} or R' in the measurement report so that it is clear that the reported values are the limit of measurement [see j) of clause 9].

=IF((BD36)>=10,BD34,IF((BD36)<=6,BD34-1.3,(10*LOG(10^(BD34/10)-10^(BD60/10)))))

If signal value is 10dB or greater clear of background (i.e. >=10), there is no correction.

If the difference in level between the signal value and background value is less than or equal to 6dB (i.e. <=6), then the 1.3dB correction is applied.

All other cases are a log subtraction. (i.e. >6 and <10, which are the remaining possibilities)

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ISO140-4/ADE multiple speaker positions

level difference, *D*

difference, in decibels, in the space and time average sound pressure levels produced in two rooms by one or more sound sources in one of them:

$$D = L_1 - L_2 \quad \text{...(2)}$$

where

L_1 is the average sound pressure level in the source room;

L_2 is the average sound pressure level in the receiving room.

B2.6 The sound source should now be moved to the next position in the source room and the above procedure repeated to determine another level difference. At least two positions should be used for the source. The level differences obtained from each source position should be arithmetically averaged to determine the level difference, *D* as defined in BS EN ISO 140-4:1998.

Find Da (L1a-L2a) average source level for speaker position a minus corresponding bg corrected receiver level

Find Db (L1b-L2b) average source level for speaker position b minus corresponding bg corrected receiver level

D = (Da +Db)/2.

then correct for RT

then round to 1dp

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32.0dB

To evaluate the results of a measurement made in accordance with ISO 140-3, ISO 140-4, ISO 140-5, ISO 140-9 and ISO 140-10 in one-third-octave bands (or octave bands), given to 0,1 dB, shift the relevant reference curve in steps of 1 dB towards the measured curve until the sum of unfavourable deviations is as large as possible but not more than 32,0 dB (measurement in 16 one-third-octave bands) or 10,0 dB (measurement in 5 octave bands).

An unfavourable deviation at a particular frequency occurs when the result of measurements is less than the reference value. Only the unfavourable deviations shall be taken into account.

32.0dB isn't 32dB or 32.00dB . The sum of the unfavourable deviations needs to be rounded to 1dp before the above test is undertaken. This can also have a floating point error issue if there is no rounding.

Rounding

B2.1 Sound insulation testing for the purposes of Regulation 41 of the Building Regulations and Regulation 20(1) and (5) of the Approved Inspectors Regulations 2010, must be done in accordance with: BS EN ISO 140-4:1998; BS EN ISO 140- 7:1998; BS EN ISO 717-1:1997; BS EN ISO 717-2:1997; BS EN 20354:1993. When calculating sound insulation test results, no rounding should occur in any calculation until required by the relevant Standards, the BS EN ISO 140 series and the BS EN ISO 717 series.

For the statement of the airborne sound insulation between rooms, the values of the normalized level difference D_n, the standardized level difference D_{nT} or the apparent sound reduction index R' shall be given at all frequencies of measurement, to one decimal place, in tabular form and in the form of a curve. Graphs in the test report shall show the value

B3.2 When calculating sound insulation test results, no rounding should occur in any calculation until required by the relevant Standards, i.e. the BS EN ISO 140 series and the BS EN ISO 717 series.

To the letter of the standards, the only rounding should come at the end in order to present the D_{nT} to 1dp.

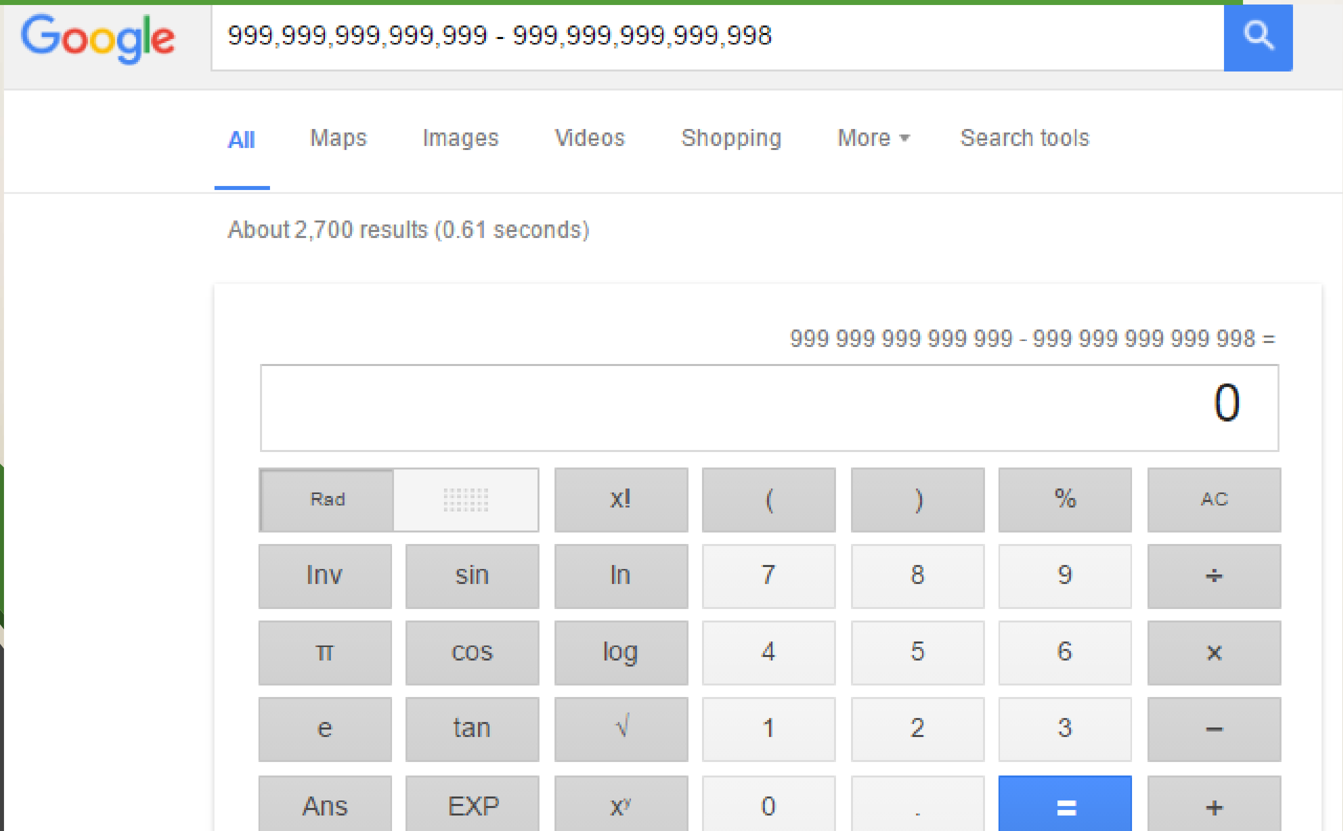
The $D_{nT,w}$ figure is an integer

However……

Floating Point Error

In decimal systems 10/3 can’t be represented accurately 3.333333333…

Similarly, binary systems (computers) can’t represent all numbers – so there is approximation. Sometimes this causes a large error.



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Floating Point Error

How to correct rounding errors in floating-point arithmetic

Email

Print

Symptoms

Many combinations of arithmetic operations on floating-point numbers in Microsoft Excel and Microsoft Works may produce results that appear to be incorrect by very small amounts. For example, the equation

=1*(.5-.4-.1)

may be evaluated to the quantity (-2.78E-17), or -0.0000000000000000278 instead of 0.

Cause

This behavior is not a problem in or a limitation of Excel or Works; this behavior occurs because the Institute of Electrical and Electronics Engineers (IEEE) 754 floating-point standard requires that numbers be stored in binary format.

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Floating Point Error

Naurally occurring in excel							fixed method	
54.0	64.0	10.000000000000200000000000000000	more				10.000000000000000000000000000000	correct
54.1	64.1	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.2	64.2	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.3	64.3	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.4	64.4	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.5	64.5	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.6	64.6	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.7	64.7	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.8	64.8	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
54.9	64.9	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
55.0	65.0	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
55.1	65.1	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
55.2	65.2	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
55.3	65.3	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
55.4	65.4	10.000000000000100000000000000000	more				10.000000000000000000000000000000	correct
55.5	65.5	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
55.6	65.6	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
55.7	65.7	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
55.8	65.8	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
55.9	65.9	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
56.0	66.0	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
56.1	66.1	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
56.2	66.2	10.000000000000000000000000000000	correct				10.000000000000000000000000000000	correct
56.3	66.3	9.999999999999990000000000000000	less				10.000000000000000000000000000000	correct
56.4	66.4	9.999999999999990000000000000000	less				10.000000000000000000000000000000	correct
56.5	66.5	9.999999999999980000000000000000	less				10.000000000000000000000000000000	correct
56.6	66.6	9.999999999999970000000000000000	less				10.000000000000000000000000000000	correct
56.7	66.7	9.999999999999960000000000000000	less				10.000000000000000000000000000000	correct
56.8	66.8	9.999999999999960000000000000000	less				10.000000000000000000000000000000	correct
56.9	66.9	9.999999999999950000000000000000	less				10.000000000000000000000000000000	correct

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Floating Point Error

Example 1

Example 1	L2	Difference	
0	10	=B3-A3	=IF(C3=10,"correct",IF(C3<10,"less","more"))
0.1	10.1	=B4-A4	=IF(C4=10,"correct",IF(C4<10,"less","more"))
0.2	10.2	=B5-A5	=IF(C5=10,"correct",IF(C5<10,"less","more"))
0.3	10.3	=B6-A6	=IF(C6=10,"correct",IF(C6<10,"less","more"))
0.4	10.4	=B7-A7	=IF(C7=10,"correct",IF(C7<10,"less","more"))
0.5	10.5	=B8-A8	=IF(C8=10,"correct",IF(C8<10,"less","more"))
0.6	10.6	=B9-A9	=IF(C9=10,"correct",IF(C9<10,"less","more"))
0.7	10.7	=B10-A10	=IF(C10=10,"correct",IF(C10<10,"less","more"))
0.8	10.8	=B11-A11	=IF(C11=10,"correct",IF(C11<10,"less","more"))
0.9	10.9	=B12-A12	=IF(C12=10,"correct",IF(C12<10,"less","more"))
1	11	=B13-A13	=IF(C13=10,"correct",IF(C13<10,"less","more"))
1.1	11.1	=B14-A14	=IF(C14=10,"correct",IF(C14<10,"less","more"))
1.2	11.2	=B15-A15	=IF(C15=10,"correct",IF(C15<10,"less","more"))
1.3	11.3	=B16-A16	=IF(C16=10,"correct",IF(C16<10,"less","more"))
1.4	11.4	=B17-A17	=IF(C17=10,"correct",IF(C17<10,"less","more"))
1.5	11.5	=B18-A18	=IF(C18=10,"correct",IF(C18<10,"less","more"))
1.6	11.6	=B19-A19	=IF(C19=10,"correct",IF(C19<10,"less","more"))
1.7	11.7	=B20-A20	=IF(C20=10,"correct",IF(C20<10,"less","more"))
1.8	11.8	=B21-A21	=IF(C21=10,"correct",IF(C21<10,"less","more"))
1.9	11.9	=B22-A22	=IF(C22=10,"correct",IF(C22<10,"less","more"))
2	12	=B22-A22	=IF(C23=10,"correct",IF(C23<10,"less","more"))
2.1	12.1	=B22-A22	=IF(C24=10,"correct",IF(C24<10,"less","more"))

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Floating Point Error

		Example 1				Example 2		
B2	L2	Difference			1000 total	Rounded Difference		1000 total
0.0	10.0	10.000000000000000000000000000000	correct		52 correct	10.000000000000000000000000000000	correct	1000 correct
0.1	10.1	10.000000000000000000000000000000	correct		491 less	10.000000000000000000000000000000	correct	0 less
0.2	10.2	10.000000000000000000000000000000	correct		457 more	10.000000000000000000000000000000	correct	0 more
0.3	10.3	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
0.4	10.4	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
0.5	10.5	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
0.6	10.6	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
0.7	10.7	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
0.8	10.8	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
0.9	10.9	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
1.0	11.0	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
1.1	11.1	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
1.2	11.2	10.000000000000000000000000000000	correct			10.000000000000000000000000000000	correct	
1.3	11.3	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
1.4	11.4	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
1.5	11.5	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
1.6	11.6	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
1.7	11.7	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
1.8	11.8	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
1.9	11.9	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.0	12.0	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.1	12.1	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.2	12.2	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.3	12.3	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.4	12.4	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.5	12.5	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.6	12.6	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	
2.7	12.7	9.999999999999990000000000000000	less			10.000000000000000000000000000000	correct	

Floating Point Error

The solution is to round the "difference between receiver and background" to 10dp

=ROUND(B3-A3,10)

This doesn't affect the result, but prevents the mishandling of the bg correction.

The difference between receiver level and background should be rounded as above. This figure should be used to select the correct the background correction.

This is either truly compliant with the standards, or suitably compliant (causing no change other than removing an error), depending on your view.

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Tricky Data

The ANC-issued tricky data was created for testers to check that their calculations were working correctly.

Testing all scenarios of receiver levels relative to background

Testing averaging

Testing 32.0dB calculations

Testing floating point calculations

"This file contains a number of sets of mock airborne test data

Each set of data is intended to test your calculation for a number of key issues.

There are four sets of data for static position testers to use, and four sets of data for sweep testers to use.

In each case, the correctly calculated third octave and overall results are presented, and your calculated values should match these calculated values.

Please note that the data is not intended to simulate real test data, and in many cases would be unacceptable for a real site, however the purpose of the data is to test your calculation method, it is not intended to represent good site data."

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Impact

Same approach as airborne. Similar errors are possible with 32.0dB background correction, averaging, floating point errors, etc.

Log average values before processing.

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Acceptable

A +/-0.1dB error in any 1/3 D_{nT} or L'_{nT} has been deemed acceptable by the committee.

Clearly, sometimes a 0.1dB error in a 1/3 octave will lead to 32.0dB becoming 32.1dB

or a 32.1dB result becoming 32.0dB and the overall result will shift.

Calculations and results are the responsibility of the tester.

Any third-party methods must be checked and used with caution.

It is possible that the 0.1dB allowance reduces in the future, therefore the aim should be precision from all testers.