AV CONSULTING B.V.
Calibration Laboratory

BIJLAGE 7 : ONZEKERHEIDSBEREKENINGEN

AV CONSULTING B.V.
Calibration Laboratory

Uncertainty Estimate Accelerometer

Uncertainty Estimate Calibrators

Uncertainty Estimate Microphone (with and without SLM)

Uncertainty Estimate Sound Level Meters

FO-003 Uncertainty Estimate Accelerometer 8305-amp.10-80Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-ampl.03-08Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-ampl.100-800Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-ampl.1000-2000Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-ampl.2500-4000Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-ampl.5000-8000Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-ampl.10000Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-phase 03-1000Hz.pdf
FO-003 Uncertainty Estimate Accelerometer 8305-phase 2500-10000Hz.pdf

FO-028F Uncertainty Estimate Acoustical Calibration Electical Calibrator.pdf
FO-028F Uncertainty Estimate Acoustical Calibration-Phistonphone L0-class.pdf
FO-028F Uncertainty Estimate Acoustical Generated SPL-4228-L0.pdf
FO-028F Uncertainty Estimate Acoustical Generated SPL-4228L0+SLM.pdf
FO-028F Uncertainty Estimate Acoustical Generated SPL-4231LS.pdf
FO-028F Uncertainty Estimate Acoustical Generated SPL-4231LS+SLM.pdf

FO-028A Uncertainty Estimate BK-4226 multicalibrator+Microphone-4-8kHz.pdf
FO-028A Uncertainty Estimate BK-4226 Multicalibrator+Microphone8-16kHz.pdf
FO-028A Uncertainty Estimate BK-4226 multicalibrator-Microphone-2-4kHz.pdf
FO-028A Uncertainty Estimate BK-4226 multicalibrator-Microphone31-2000hz.pdf
FO-028A Uncertainty Estimate BK-4226 multicalibrator-Microphone-Total.pdf
FO-028A Uncertainty Estimate Calibrator (Laboratory Standard) 94 [dB] @ 1000 [Hz].pdf
FO-028A Uncertainty Estimate Pistonphone Laboratory Standard 124 [dB] @251,18 [Hz].pdf

Measurement Result Units:	%	Measurement Range and Parameter:	3-8Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	*d.f.*	Estimated Unc in Measurement Units (%)	Type (A, B)	Probability Distribution	Divisor	Std Unc (%)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	V	0,552%	m/s²	20	0,5522	B	Normal, 2s	2	0,2761	19,37%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 (AV-003)	q,cal	0,50%	m/s²	1000	0,5	B	Rectangular	1,732051	0,288675135	21,17%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305	s,cal	0,659%		1000	0,659	B	Normal, 2s	2	0,3295	27,58%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio	δtce	0,01%	m/s²	1000	0,01	B	Rectangular	1,732051	0,005773503	0,01%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer	CΔt	0,30%	m/s²	1000	0,3	B	Rectangular	1,732051	0,173205081	7,62%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,80%		20	0,008	A	Normal, 2s	2	0,004	0,00%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity	δtvs	1,04%	m/s²	1000	0,58	B	Special	4,242641	0,136707311	4,75%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer	δsf	0,05%	m/s²	1000	0,05	B	Rectangular	1,732051	0,028867513	0,21%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT	δrm	0,15%	m/s²	1000	0,15	B	Rectangular	1,732051	0,08660254	1,91%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01%	m/s²	1000	0,01	B	Rectangular	1,732051	0,005773503	0,01%	
Drift of reference transducer,between calibrations	δdr	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	3,39%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,35%	m/s²	1000	0,35	B	Rectangular	1,732051	0,202072594	10,37%	Maximum (literature Euromet)
Influance from non-linearity of amplifiers	δnl	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,08%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from non-linearity of transducers	δtr	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,08%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from gravity	δg	0,00094%	m/s²	1000	0,000940	B	Rectangular	1,732051	0,000542709	0,00007482%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter	δe	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,08%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Euromet)
Influence of Waveform Generator BK4052distortion	δTd	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	3,39%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
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						B	Rectangular				
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						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*495*						100,00%	
								Combined Uncertainty, u_c	0,627407345		
								Coverage factor, *k, uses effective degrees of freedom*	2,01	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	1,261088764		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,3	%	

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Measurement Result Units:	%	Measurement Range and Parameter:	10Hz-80Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	*d.f.*	Estimated Unc in Measurement Units (%)	Type (A, B)	Probability Distribution	Divisor	Std Unc (%)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	V	0,112%	m/s²	20	0,112	B	Normal, 2s	2	0,056	1,12%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,06 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 (AV-003)	q,cal	0,50%	m/s²	1000	0,5	B	Rectangular	1,732051	0,288675135	29,70%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305	s,cal	0,58%		1000	0,58	B	Normal, 2s	2	0,29	29,98%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio	δtce	0,01%	m/s²	1000	0,01	B	Rectangular	1,732051	0,005773503	0,01%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer	CΔt	0,30%	m/s²	1000	0,3	B	Rectangular	1,732051	0,173205081	10,69%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,80%		20	0,008	A	Normal, 2s	2	0,004	0,01%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity	δtvs	1,04%	m/s²	1000	0,58	B	Special	4,242641	0,136707311	6,66%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer	δsf	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,11%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT	δrm	0,10%	m/s²	1000	0,1	B	Rectangular	1,732051	0,057735027	1,19%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01%	m/s²	1000	0,01	B	Rectangular	1,732051	0,005773503	0,01%	
Drift of reference transducer,between calibrations	δdr	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	4,75%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,30%	m/s²	1000	0,3	B	Rectangular	1,732051	0,173205081	10,69%	Maximum (literature Euromet)
Influance from non-linearity of amplifiers	δnl	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,11%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from non-linearity of transducers	δtr	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,11%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from gravity	δg	0,00094%	m/s²	1000	0,000940	B	Rectangular	1,732051	0,000542709	0,00026783%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter	δe	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,11%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Euromet)
Influence of Waveform Generator BK4052distortion	δTd	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	4,75%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
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Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*4622*						100,00%	
									Combined Uncertainty, u_c	0,529661386	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	1,059322771	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,1	%

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FO-003 Uncertainty Estimate Accelerometer 8305.xlsx Acceleration [ms-2] frequency range 100 - 800 [Hz] Amplitude

Measurement Result Units:	%	Measurement Range and Parameter:	100-800Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (%)	Type (A, B)	Probability Distribution	Divisor	Std Unc (%)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	V	0,062%	m/s²	20	0,062	B	Normal, 2s	2	0,031	0,33%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 (AV-003)	q,cal	0,50%	m/s²	1000	0,5	B	Rectangular	1,732051	0,288675135	28,27%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305	s,cal	0,58%		1000	0,58	B	Normal, 2s	2	0,29	28,53%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio	δtce	0,02%	m/s²	1000	0,02	B	Rectangular	1,732051	0,011547005	0,05%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer	CΔt	0,30%	m/s²	1000	0,3	B	Rectangular	1,732051	0,173205081	10,18%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,80%		20	0,008	A	Normal, 2s	2	0,004	0,01%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity	δtvs	1,04%	m/s²	1000	0,58	B	Special	4,242641	0,136707311	6,34%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer	δsf	0,07%	m/s²	1000	0,07	B	Rectangular	1,732051	0,040414519	0,55%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT	δrm	0,15%	m/s²	1000	0,15	B	Rectangular	1,732051	0,08660254	2,54%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01%	m/s²	1000	0,01	B	Rectangular	1,732051	0,005773503	0,01%	
Drift of reference transducer,between calibrations	δdr	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	4,52%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,35%	m/s²	1000	0,35	B	Rectangular	1,732051	0,202072594	13,85%	Maximum (literature Eurometer)
Influance from non-linearity of amplifiers	δnl	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,10%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Eurometer)
Influance from non-linearity of transducers	δtr	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,10%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Eurometer)
Influance from gravity	δg	0,00094%	m/s²	1000	0,000940	B	Rectangular	1,732051	0,000542709	0,00009991%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter	δe	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,10%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Eurometer)
Influence of Waveform Generator BK4052distortion	δTd	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	4,52%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
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						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	*v*			*20*							
Effective Degrees of Freedom	v_{eff}			*4996*						100,00%	
								Combined Uncertainty, u_c	0,542954433		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	1,085908867		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,1	%	

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FO-003 Uncertainty Estimate Accelerometer 8305.xlsxAcceleration [ms-2] frequency range 1000 - 2000 [Hz] Amplitude

Measurement Result Units:	%	Measurement Range and Parameter:	1000-2000Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (%)	Type (A, B)	Probability Distribution	Divisor	§	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	V	0,062%	m/s²	20	0,062	B	Normal, 2s	2	0,031	0,30%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 (AV-003)	q,cal	0,50%	m/s²	1000	0,5	B	Rectangular	1,732051	0,288675135	26,13%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305	s,cal	0,66%		1000	0,658	B	Normal, 2s	2	0,329	33,94%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio	δtce	0,02%	m/s²	1000	0,02	B	Rectangular	1,732051	0,011547005	0,04%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer	CΔt	0,30%	m/s²	1000	0,3	B	Rectangular	1,732051	0,173205081	9,41%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,80%		20	0,008	A	Normal, 2s	2	0,004	0,01%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity	δtvs	1,04%	m/s²	1000	0,58	B	Special	4,242641	0,136707311	5,86%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer	δsf	0,07%	m/s²	1000	0,07	B	Rectangular	1,732051	0,040414519	0,51%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT	δrm	0,15%	m/s²	1000	0,15	B	Rectangular	1,732051	0,08660254	2,35%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01%	m/s²	1000	0,01	B	Rectangular	1,732051	0,005773503	0,01%	
Drift of reference transducer,between calibrations	δdr	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	4,18%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,35%	m/s²	1000	0,35	B	Rectangular	1,732051	0,202072594	12,80%	Maximum (literature Eurometer)
Influance from non-linearity of amplifiers	δnl	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,09%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Eurometer)
Influance from non-linearity of transducers	δtr	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,09%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Eurometer)
Influance from gravity	δg	0,00094%	m/s²	1000	0,000940	B	Rectangular	1,732051	0,000542709	0,00009235%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter	δe	0,03%	m/s²	1000	0,03	B	Rectangular	1,732051	0,017320508	0,09%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Eurometer)
Influence of Waveform Generator BK4052distortion	δTd	0,20%	m/s²	1000	0,2	B	Rectangular	1,732051	0,115470054	4,18%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
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						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*4615*						100,00%	
								Combined Uncertainty, u_c	0,564748189		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	1,129496378		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,1	%	

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FO-003 Uncertainty Estimate Accelerometer 8305.xlsx Acceleration [ms-2] frequency range 2500 - 4000 [Hz] Amplitude

Measurement Result Units:	%	Measurement Range and Parameter:	2500-4000Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (%)	Type (A, B)	Probability Distribution	Divisor	Std Unc (%)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	V	0,062%	m/s²	20	0,062	B	Normal, 2s	2	0,031	0,10%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 (AV-003)	q,cal	0,50%	m/s²	1000	0,5	B	Rectangular	1,7320508	0,288675135	9,01%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305	s,cal	1,69%		1000	1,69	B	Normal, 2s	2	0,845	77,21%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio	δtce	0,02%	m/s²	1000	0,02	B	Rectangular	1,7320508	0,011547005	0,01%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer	CΔt	0,30%	m/s²	1000	0,3	B	Rectangular	1,7320508	0,173205081	3,24%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,80%		20	0,008	A	Normal, 2s	2	0,004	0,00%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity	δtvs	1,04%	m/s²	1000	0,58	B	Special	4,2426407	0,136707311	2,02%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer	δsf	0,07%	m/s²	1000	0,07	B	Rectangular	1,7320508	0,040414519	0,18%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT	δrm	0,15%	m/s²	1000	0,15	B	Rectangular	1,7320508	0,08660254	0,81%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01%	m/s²	1000	0,01	B	Rectangular	1,7320508	0,005773503	0,00%	
Drift of reference transducer,between calibrations	δdr	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	1,44%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,35%	m/s²	1000	0,35	B	Rectangular	1,7320508	0,202072594	4,42%	Maximum (literature Euromet)
Influance from non-linearity of amplifiers	δnl	0,03%	m/s²	1000	0,03	B	Rectangular	1,7320508	0,017320508	0,03%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from non-linearity of transducers	δtr	0,03%	m/s²	1000	0,03	B	Rectangular	1,7320508	0,017320508	0,03%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from gravity	δg	0,00094%	m/s²	1000	0,000940	B	Rectangular	1,7320508	0,000542709	0,00003185%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter	δe	0,03%	m/s²	1000	0,03	B	Rectangular	1,7320508	0,017320508	0,03%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Euromet)
Influence of Waveform Generator BK4052distortion	δTd	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	1,44%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
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						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	*v*			*20*							
Effective Degrees of Freedom	v_{eff}			*1643*						100,00%	
								Combined Uncertainty, u_c	0,961625975		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	1,923251951		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,9	*%*	

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FO-003 Uncertainty Estimate Accelerometer 8305.xlsx Acceleration [ms-2] frequency range 5000 - 8000 [Hz] Amplitude

Measurement Result Units:	%	Measurement Range and Parameter:	5000-8000Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (%)	Type (A, B)	Probability Distribution	Divisor	Std Unc (%)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	V	0,062%	m/s²	20	0,062	B	Normal, 2s	2	0,031	0,05%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 (AV-003)	q,cal	0,50%	m/s²	1000	0,5	B	Rectangular	1,7320508	0,288675135	4,75%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305	s,cal	2,47%		1000	2,47	B	Normal, 2s	2	1,235	86,93%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio	δtce	0,02%	m/s²	1000	0,02	B	Rectangular	1,7320508	0,011547005	0,01%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer	CΔt	0,30%	m/s²	1000	0,3	B	Rectangular	1,7320508	0,173205081	1,71%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,80%		20	0,008	A	Normal, 2s	2	0,004	0,00%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity	δtvs	1,04%	m/s²	1000	0,58	B	Special	4,2426407	0,136707311	1,07%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer	δsf	0,07%	m/s²	1000	0,07	B	Rectangular	1,7320508	0,040414519	0,09%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT	δrm	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	0,76%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01%	m/s²	1000	0,01	B	Rectangular	1,7320508	0,005773503	0,00%	
Drift of reference transducer,between calibrations	δdr	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	0,76%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,40%	m/s²	1000	0,4	B	Rectangular	1,7320508	0,230940108	3,04%	Maximum (literature Euromet)
Influance from non-linearity of amplifiers	δnl	0,03%	m/s²	1000	0,03	B	Rectangular	1,7320508	0,017320508	0,02%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from non-linearity of transducers	δtr	0,03%	m/s²	1000	0,03	B	Rectangular	1,7320508	0,017320508	0,02%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from gravity	δg	0,00094%	m/s²	1000	0,000940	B	Rectangular	1,7320508	0,000542709	0,00001679%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter	δe	0,04%	m/s²	1000	0,04	B	Rectangular	1,7320508	0,023094011	0,03%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Euromet)
Influence of Waveform Generator BK4052distortion	δTd	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	0,76%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
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						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*1316*						100,00%	
								Combined Uncertainty, u_c	1,324572076		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	2,649144151		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	2,6	%	

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FO-003 Uncertainty Estimate Accelerometer 8305.xlsx

Acceleration [ms-2] frequency range 10000 [Hz] Amplitude

Measurement Result Units:	%	Measurement Range and Parameter:	10000Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	*d.f.*	Estimated Unc in Measurement Units (%)	Type (A, B)	Probability Distribution	Divisor	Std Unc (%)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	V	0,062%	m/s²	20	0,062	B	Normal, 2s	2	0,031	0,03%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 (AV-003)	q,cal	0,50%	m/s²	1000	0,5	B	Rectangular	1,7320508	0,288675135	2,89%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305	s,cal	3,26%		1000	3,26	B	Normal, 2s	2	1,63	92,06%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio	δtce	0,02%	m/s²	1000	0,02	B	Rectangular	1,7320508	0,011547005	0,00%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer	CΔt	0,30%	m/s²	1000	0,3	B	Rectangular	1,7320508	0,173205081	1,04%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,80%		20	0,008	A	Normal, 2s	2	0,004	0,00%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity	δtvs	1,04%	m/s²	1000	0,58	B	Special	4,2426407	0,136707311	0,65%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer	δsf	0,07%	m/s²	1000	0,07	B	Rectangular	1,7320508	0,040414519	0,06%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT	δrm	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	0,46%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01%	m/s²	1000	0,01	B	Rectangular	1,7320508	0,005773503	0,00%	
Drift of reference transducer,between calibrations	δdr	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	0,46%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,40%	m/s²	1000	0,4	B	Rectangular	1,7320508	0,230940108	1,85%	Maximum (literature Euromet)
Influance from non-linearity of amplifiers	δnl	0,03%	m/s²	1000	0,03	B	Rectangular	1,7320508	0,017320508	0,01%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from non-linearity of transducers	δtr	0,03%	m/s²	1000	0,03	B	Rectangular	1,7320508	0,017320508	0,01%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from gravity	δg	0,00094%	m/s²	1000	0,000940	B	Rectangular	1,7320508	0,000542709	0,00001021%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter	δe	0,04%	m/s²	1000	0,04	B	Rectangular	1,7320508	0,023094011	0,02%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Euromet)
Influence of Waveform Generator BK4052distortion	δTd	0,20%	m/s²	1000	0,2	B	Rectangular	1,7320508	0,115470054	0,46%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
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						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*1178*						100,00%	
								Combined Uncertainty, u_c	1,698872033		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	3,397744065		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	3,4	%	

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FO-003 Uncertainty Estimate Accelerometer 8305.xlsx

Acceleration [ms-2] frequency range 03 - 1000 [Hz] Phase φ°

Measurement Result Units:	ϕ°	Measurement Range and Parameter:	3-1000Hz phase Shift Worst Case

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (ϕ°)	Type (A, B)	Probability Distribution	Divisor	Std Unc (ϕ°)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, phase shift φ°	V	0,07000	ϕ°	20	0,070	B	Normal, 2s	2	0,035	0,28%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 phase shift ϕ°	q,cal	0,45800	ϕ°	1000	0,458	B	Rectangular	1,7320508	0,264426423	15,90%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305 phase shift ϕ°	s,cal	1,00000		1000	1,000	B	Normal, 2s	2	0,5	56,86%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio phase shift ϕ°	δtce	0,00020	ϕ°	1000	0,020	B	Rectangular	1,7320508	0,011547005	0,03%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer phase shift ϕ°	CΔt	0,25600	ϕ°	1000	0,256	B	Rectangular	1,7320508	0,147801669	4,97%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,00000	ϕ°	20	0,000	A	Normal, 2s	2	0	0,00%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity phase shift ϕ°	δtvs	0,66600	ϕ°	1000	0,666	B	Special	4,2426407	0,156977705	5,60%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer phase shift ϕ°	δsf	0,07000	ϕ°	1000	0,070	B	Rectangular	1,7320508	0,040414519	0,37%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT phase shift ϕ°	δrm	0,15000	ϕ°	1000	0,150	B	Rectangular	1,7320508	0,08660254	1,71%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01000	ϕ°	1000	0,010	B	Rectangular	1,7320508	0,005773503	0,01%	Estimated less than (literature Euromet)
Drift of reference transducer,between calibrations phase shift ϕ°	δdr	0,22800		1000	0,228	B	Rectangular	1,7320508	0,131635861	3,94%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,35000	ϕ°	1000	0,350	B	Rectangular	1,7320508	0,202072594	9,29%	Maximum (literature Euromet)
Influance from non-linearity of amplifiers phase shift ϕ°	δnl	0,03500	ϕ°	1000	0,035	B	Rectangular	1,7320508	0,020207259	0,09%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from non-linearity of transducers phase shift ϕ°	δtr	0,03500	ϕ°	1000	0,035	B	Rectangular	1,7320508	0,020207259	0,09%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from gravity	δg	0,00000	ϕ°	1000	0,000000	B	Rectangular	1,7320508	0	0,00000000%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter phase shift ϕ°	δe	0,03500	ϕ°	1000	0,035	B	Rectangular	1,7320508	0,020207259	0,09%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Euromet)
Influence of Waveform Generator BK4052distortion phase shift ϕ°	δTd	0,10000	ϕ°	1000	0,1	B	Rectangular	1,7320508	0,057735027	0,76%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
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						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*2738*						100,00%	
								Combined Uncertainty, u_c	0,663063597		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	1,326127193		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,3	*ϕ°*	

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FO-003 Uncertainty Estimate Accelerometer 8305.xlsx Acceleration [ms-2] frequency range 1250 - 10000 [Hz] Phase φ°

Measurement Result Units:	ϕ°	Measurement Range and Parameter:	1250-10000Hz phase Shift Worst Case

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (ϕ°)	Type (A, B)	Probability Distribution	Divisor	Std Unc (ϕ°)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, phase shift φ°	V	0,07000	ϕ°	20	0,070	B	Normal, 2s	2	0,035	0,24%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Charge Amplifier Bruel Kjaer Nexus 2692 phase shift ϕ°	q,cal	0,45800	ϕ°	1000	0,458	B	Rectangular	1,732051	0,264426423	13,92%	Specifications of Bruel Kjaer ± 1% for 0°C ≤ Tcal ≤ 40 °C. Laboratory conditions 23°C ± 3°C ± 0,5%
Reference Accelerometer sensitivity BK8305 phase shift ϕ°	s,cal	1,00000		1000	1,000	B	Normal, 2s	2	0,5	49,77%	Calibration Certificate DANAK 20 Hz+ 2kHz + Uncertainty 0,5%
Triboelectric Cable effects and voltage ratio phase shift ϕ°	δtce	0,00020	ϕ°	1000	0,020	B	Rectangular	1,732051	0,011547005	0,03%	Correction compensating cables
Temperature influence on measurement transducer under test en reference transducer phase shift ϕ°	CΔt	0,25600	ϕ°	1000	0,256	B	Rectangular	1,732051	0,147801669	4,35%	Temp. (23°C ± 1°C), typical < 0,2% per 1°C for DUT. Reference transducer < 0,1% per 1°C
Readout variation on Keysight DMM	δtD	0,00000	ϕ°	20	0,000	A	Normal, 2s	2	0	0,00%	Typical measured after 20 readings on DMM
Transverse Vibration Sensitivity phase shift ϕ°	δtvs	0,66600	ϕ°	1000	0,666	B	Special	4,242641	0,156977705	4,91%	Influance from transverse acceleration. For exciter max. 10%, Reference transducer <2% and DUT <4% (literature)
Surface flatness and base strain DUT and Reference Transducer phase shift ϕ°	δsf	0,08500	ϕ°	1000	0,085	B	Rectangular	1,732051	0,049074773	0,48%	Influance of surface flatness and base strain. Estimated (literature).
Influance from relative motion in Reference Transducer and DUT phase shift ϕ°	δrm	0,20000	ϕ°	1000	0,200	B	Rectangular	1,732051	0,115470054	2,65%	Influance on measurement from relative motion. Estimated (literature)
Inexact values of constants	δiv	0,01000	ϕ°	1000	0,010	B	Rectangular	1,732051	0,005773503	0,01%	Estimated less than (literature Euromet)
Drift of reference transducer,between calibrations phase shift ϕ°	δdr	0,30000		1000	0,300	B	Rectangular	1,732051	0,173205081	5,97%	Manufacturer specifications < 0,2% per year
Friction and Tumbling due to mounting, DUT, cable, torque and plug	δft	0,50000	ϕ°	1000	0,500	B	Rectangular	1,732051	0,288675135	16,59%	Maximum (literature Euromet)
Influance from non-linearity of amplifiers phase shift ϕ°	δnl	0,03500	ϕ°	1000	0,035	B	Rectangular	1,732051	0,020207259	0,08%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from non-linearity of transducers phase shift ϕ°	δtr	0,05000	ϕ°	1000	0,050	B	Rectangular	1,732051	0,028867513	0,17%	Influence on measurent for non-linearity of amplifiers. Estimated less than (literature Euromet)
Influance from gravity	δg	0,00000	ϕ°	1000	0,000000	B	Rectangular	1,732051	0	0,00000000%	Influance from gravity Calibration Lab / Test Lab
Influance from magnetic field from exciter phase shift ϕ°	δe	0,05000	ϕ°	1000	0,05	B	Rectangular	1,732051	0,028867513	0,17%	Incluence on measurement from magnatic field from exciter. Estimated less than (literature Euromet)
Influence of Waveform Generator BK4052distortion phase shift ϕ°	δTd	0,10000	ϕ°	1000	0,1	B	Rectangular	1,732051	0,057735027	0,66%	Total harmonic Distortion less then 0,2% DC - 20kHz
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
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						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*3294*						100,00%	
								Combined Uncertainty, u_c	0,708719738		
								Coverage factor, *k, uses effective degrees of freedom*	2		*Instructions: Assess data entry and values before reporting rounded result.*
								Expanded Uncertainty, *U*	1,417439475		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,4	*ϕ°*	

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17-8-2017

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FO-028F Uncertainty Estimate Acoustical Generated SPL.xlsx — Acoustical Calibration Sound Presure Level

Measuring Sound Presure in Electrical Calibrator — Calibration of Electrical Calibrator 94 or 114 [dB] @1000[Hz]

dB ref. 20 µPa 10^3 [Hz]

Measurement Result Units:	dB

Measurement Range and Parameter:	1000Hz @ 94 or 114 dB Acoustical Actual 10^3Hz

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Microfoon reference, sensitivity calibration BK4192 WS1	Ms1	0,0500	dB	1000	0,050000	B	Rectangular	1,7320508	0,028867513	31,255%	Manufacturer uncertainty on calibration @ 1000 Hz
Microfoon sensitivity, reproducibility Bk4192	Ms2	0,0010	dB	1000	0,001000	B	Rectangular	1,7320508	0,00057735	0,013%	Sensitivity instability 0,001/year data B&K >1000years/dB
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	0,800%	Reproducibility 0,008 data Bruel & Kjaer
Preamplifier terminals	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	3,613%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0800	%	20	0,008000	A	Normal, 2s	2	0,004	0,600%	Typical measured after 20 readings on DMM, with statistics reading
Static Pressure. Reference Microphone BK4192 *)	Ps	0,0350	dB	1000	0,035000	B	Rectangular	1,7320508	0,020207259	15,315%	Ref.pressure 101,3kPa, 0,005dB/kPa for BK4192 80-105 kPa. (IEC-60943 § B.3.2.1. Specs. Bruel Kjaer. *) After calibration with 4228 pisthonphone
Tempeture, measurement conditions BK4192 Δ 3°	T1	0,0135	dB	1000	0,013500	B	Rectangular	1,7320508	0,007794229	2,278%	Ref. temp 23 graden C. 0,0045 dB/C (BK4192data sheet) 23 +/- 3°
Relative humidity, measurement conditions BK4192 Δ25%	RH1	0,0026	dB	1000	0,002550	B	Rectangular	1,7320508	0,001472243	0,081%	Ref. 50% 0,005 dB/100%RH (BK data sheet 4192) RH 25-70%
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	20	0,006200	B	Rectangular	1,7320508	0,003579572	0,481%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Voltage ratio Cross-Talk Nexus 2690	Vr-Cr	0,0250	%	1000	0,002500	B	Rectangular	1,7320508	0,001443376	0,078%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio noise Nexus 2690	Vr-n	0,0100	%	1000	0,001000	B	Rectangular	1,7320508	0,00057735	0,013%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio distortion, Nexus 2690	Vr-d	0,0030	%	1000	0,003000	B	Rectangular	1,7320508	0,001732051	0,113%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Frequency Nexus 2690	f1	0,0012	%	1000	0,000120	B	Rectangular	1,7320508	6,9282E-05	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Polarisation Voltage Nexus 2690	Uo	0,2500	%	1000	0,025000	B	Rectangular	1,7320508	0,014433757	7,814%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Amplifier Bruel Kjaer Nexus 2690	V,cal	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	11,252%	Calibration outcome. Calibration certificate @ 1000 Hz | 1V/Pa
Reference source pisthonphone 4228, temp. effect Δ 3°	δTcal	0,0015	dB	1000	0,001500	B	Rectangular	1,7320508	0,000866025	0,028%	Bruel & Kjaer 4228, 0,0005 dB/°C. Specifications B&K
Humididy effect on ref. source pisthonphone 4228 Δ20%	RH2	0,0020	dB	1000	0,002000	B	Rectangular	1,7320508	0,001154701	0,050%	Humidity Coefficient: 0,0001 dB/%RH
Uncontroled variantions on gain/capacity variations	Uv	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	1,250%	Technical Reviews Bruel & Kjaer
Effect readout and accuracy barometer UZ0004	δPs-cal	0,0340	dB	1000	0,034000	B	Norm@99%	2,58	0,013178295	6,514%	Measurement corrected with barometer UZ0004 with +/-2% accuracy.
Coupler lenght effect, unknow mismatch	Lcoup	0,0500	%	1000	0,005000	B	Rectangular	1,7320508	0,002886751	0,313%	Literature, worst case
Coupler diameter effect, unknow mismatch	Dcoup	0,0500	%	1000	0,005000	B	Rectangular	1,7320508	0,002886751	0,313%	Literature, worst case
Coupler Volume effect, unknow mismatch	Vcoup	0,0500	%	1000	0,005000	B	Rectangular	1,7320508	0,002886751	0,313%	Literature, worst case
Coupler leakage	Cpl.l	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	1,250%	Literature, standards and manufacturer data. B&K Microphone book
Long-Term Stability BK4192, one year	Cal.ǫ	0,0010	dB	1000	0,001000	B	Rectangular	1,7320508	0,00057735	0,013%	Bruel Kjaer data sheet 4192 > 1000 years/dB
Effects of air density	ρ0	0,3000	%	1000	0,030000	B	Rectangular	1,7320508	0,017320508	11,252%	Technical Reviews Bruel & Kjaer
Mismatch acoustical impedance microphone - calibrator	Ma	0,0200	dB	1000	0,020000	B	Rectangular	1,7320508	0,011547005	5,001%	Technical Reviews Bruel & Kjaer
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*6078*						100,00%	
									Combined Uncertainty, u_c	0,051635612	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, U	0,103271224	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,10	*dB*

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FO-028F Uncertainty Estimate Acoustical Generated SPL.xlsx — Acoustical Calibration Sound Presure Level

Measuring Sound Presure in Pisthonphone — Pistonphone Laboratory Standard 124 [dB] @251,18 [Hz]

dB ref. 20 µPa 10^2.4 [Hz]

Measurement Result Units:	dB	Measurement Range and Parameter:	250Hz @ 124 dB Acoustical Actual 10^2.4Hz (251.18Hz)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Microfoon reference, sensitivity calibration BK4160	Ms1	0,0200	dB	1000	0,020000	B	Rectangular	1,7320508	0,011547005	6,907%	Manufacturer uncertainty on calibration @ 1000 Hz
Microfoon sensitivity, reproducibility Bk4160	Ms2	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	1,105%	Sensitivity instability 0,008/year data B&K @ 1000Hz
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	1,105%	Reproducibility 0,008 data Bruel & Kjaer
Preamplifier terminals	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	4,990%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0800	%	20	0,008000	A	Normal, 2s	2	0,004	0,829%	Typical measured after 20 readings on DMM, with statistics reading
Static Pressure. Reference Microphone BK4160 Δ 21 hPa	Ps	0,0340	dB	1000	0,034000	B	Rectangular	1,7320508	0,019629909	19,960%	Ref.pressure 101,3kPa, 0,0016dB/hPa for BK4160 99-1034 kPa. Measurement corrected with barometer UZ0004 with +/-2% accuracy.
Tempeture, measurement conditions BK4160 Δ 3°	T1	0,0090	dB	1000	0,009000	B	Rectangular	1,7320508	0,005196152	1,399%	Ref. temp 23 graden C. 0,003 dB/C (BK4160 data sheet) 23 +/- 3°
Relative humidity, measurement conditions BK4160 Δ20%	RH1	0,0026	dB	1000	0,002550	B	Rectangular	1,7320508	0,001472243	0,112%	Ref. 50% 0,00255dB/100%RH (BK data sheet 4160) RH 40-70%
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	20	0,006200	B	Rectangular	1,7320508	0,003579572	0,664%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Voltage ratio Cross-Talk Nexus 2690	Vr-Cr	0,0250	%	1000	0,002500	B	Rectangular	1,7320508	0,001443376	0,108%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio noise Nexus 2690	Vr-n	0,0100	%	1000	0,001000	B	Rectangular	1,7320508	0,00057735	0,017%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio distortion, Nexus 2690	Vr-d	0,0030	%	1000	0,003000	B	Rectangular	1,7320508	0,001732051	0,155%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Frequency Nexus 2690	f1	0,0012	%	1000	0,000120	B	Rectangular	1,7320508	6,9282E-05	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Polarisation Voltage Nexus 2690	Uo	0,2500	%	1000	0,025000	B	Rectangular	1,7320508	0,014433757	10,792%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Amplifier Bruel Kjaer Nexus 2690	V,cal	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	15,540%	Calibration outcome. Calibration certificate @ 1000 Hz | 1V/Pa
Reference source pisthonphone 4228, temp. effect Δ 3°	δTcal	0,0015	dB	1000	0,001500	B	Rectangular	1,7320508	0,000866025	0,039%	Bruel & Kjaer 4228, 0,0005 dB/°C. Specifications B&K
Humididy effect on ref. source pisthonphone 4228 Δ20%	RH2	0,0020	dB	1000	0,002000	B	Rectangular	1,7320508	0,001154701	0,069%	Humidity Coefficient: 0,0001 dB/%RH
Uncontroled variantions on gain/capacity variations	Uv	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	1,727%	Technical Reviews Bruel & Kjaer
Effect readout and accuracy barometer UZ0004	δPs-cal	0,0340	dB	1000	0,034000	B	Norm@99%	2,58	0,013178295	8,996%	Measurement corrected with barometer UZ0004 with +/-2% accuracy.
Coupler lenght effect, mismatch	Lcoup	0,0500	%	1000	0,005000	B	Rectangular	1,7320508	0,002886751	0,432%	Literature, standards and manufacturer data. B&K Microphone book
Coupler diameter effect, mismatch	Dcoup	0,0500	%	1000	0,005000	B	Rectangular	1,7320508	0,002886751	0,432%	Literature, standards and manufacturer data. B&K Microphone book
Coupler Volume effect, mismatch	Vcoup	0,0500	%	1000	0,005000	B	Rectangular	1,7320508	0,002886751	0,432%	Literature, standards and manufacturer data. B&K Microphone book
Coupler leakage	Cpl.l	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	1,727%	Literature, standards and manufacturer data. B&K Microphone book
Long-Term Stability BK4160, one year	Cal.ρ	0,0010	dB	1000	0,001000	B	Rectangular	1,7320508	0,00057735	0,017%	Bruel Kjaer data sheet 4160 > 1000 years/dB
Effects of air density	ρ0	0,3000	%	1000	0,030000	B	Rectangular	1,7320508	0,017320508	15,540%	Technical Reviews Bruel & Kjaer
Mismatch acoustical impedance microphone - calibrator	Ma	0,0200	dB	1000	0,020000	B	Rectangular	1,7320508	0,011547005	6,907%	Technical Reviews Bruel & Kjaer
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				

Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*7896*						100,00%	
								Combined Uncertainty, u_c	0,043937301		
								Coverage factor, *k, uses effective degrees of freedom*	2		*Instructions: Assess data entry and values before reporting rounded result.*
								Expanded Uncertainty, *U*	0,087874602		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,088	*dB*	

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FO-028F Uncertainty Estimate Acoustical Generated SPL.xlsx Acoustical Calibration Sound Presure Level

Generated Sound Presure Calibrator (Class Laboratory Standard) 124 [dB] @ 251,18 [Hz]

dB ref. 20 µPa

Measurement Result Units:	dB

Measurement Range and Parameter:	250Hz @ 124 dB Acoustical Actual 10^2.4Hz (251.18Hz)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Reference source pisthonphone 4228, accuracy pressure	δSpl-cal	0,0900	dB	1000	0,090000	B	Norm@99%	2,58	0,034883721	62,384%	Bruel & Kjaer 4228. Specifications B&K Class-0L +/- 0,3% with barometer UZ0004. 0,09 dB @ 99% calibration chart Bruel Kjaer
Environmental conditions effects on DUT	δdut	0,0000	dB	1000	0,000000	B	Rectangular	1,732051	0	0,000%	Maximum effect for one single sine @ one amplitud ref.conditions
Display resolution DUT	δdutd	0,0000	dB	1000	0,000000	B	Rectangular	1,732051	0	0,000%	
Frequency	f	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	10,680%	Calibration report Bruel & Kjaer
Reproducibility of calibration results	Cal.r	0,0080	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	1,094%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Reference source pisthonphone 4228, temp. effect Δ 3°	δTcal	0,0015		1000	0,001500	B	Rectangular	1,732051	0,000866025	0,038%	Ref. temp 23 graden C. 0,0015 dB/C 23 +/- 3° (specs.4231)
Humididy effect on ref. source pisthonphone 4228 Δ20%	RH2	0,0020	dB	1000	0,002000	B	Rectangular	1,732051	0,001154701	0,068%	Ref. 50% 0,001dB/%RH RH 40-70% (specs.4231)
Frequency accuracy ref.source pisthonphone 4228	f2-cal	0,1000	%	1000	0,010000	B	Rectangular	1,732051	0,005773503	1,709%	Ref.pressure 101,3kPa, 0,00008dB/kPa 85-108 kPa. (specs.4231)
Effect readout and accuracy barometer UZ0004	δPs-cal	0,0340	dB	1000	0,034000	B	Rectangular	1,732051	0,019629909	19,754%	Measurement corrected with barometer UZ0004 with +/-2% accuracy.
Calibration shift one year	Cal.ρ	0,0150	dB	1000	0,015000	B	Rectangular	1,732051	0,008660254	3,845%	Specifications and literature Sound Calibrator 4228
Sort-term stability	Sτ	0,0050	dB	1000	0,005000	B	Rectangular	1,732051	0,002886751	0,427%	Specifications and literature Sound Calibrator 4228
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*2264*						100,00%	
									Combined Uncertainty, u_c	0,044165869	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	0,088331738	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,088	*dB*

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FO-028F Uncertainty Estimate Acoustical Generated SPL.xlsx Acoustical Calibration Sound Presure Level
Generated Sound Presure in combination with Calibrator (Class Laboratory Standard) 124 [dB] @ 251,18 [Hz]
Calibrations with Sound Level Meter dB ref. 20 µPa

Measurement Result Units:	dB	Measurement Range and Parameter:	250Hz @ 124 dB Acoustical Actual 10^2.4Hz (251.18Hz)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Reference source pisthonphone 4228, accuracy pressure	δSpl-cal	0,0900	dB	1000	0,090000	B	Norm@99%	2,58	0,034883721	35,180%	Bruel & Kjaer 4228. Specifications B&K Class-0L +/- 0,3% with barometer UZ0004
Environmental conditions effects on DUT	δdut	0,0450	dB	1000	0,045000	B	Rectangular	1,732051	0,025980762	19,515%	Maximum effect for one single sine @ one amplitud ref.conditions
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	24,092%	IEC-61672-3 under §4.2
Frequency	f	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	6,023%	Calibration report Bruel & Kjaer
Reproducibility of calibration results	Cal.r	0,0080	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,617%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Reference source pisthonphone 4228, temp. effect Δ 3°	δTcal	0,0015	dB	1000	0,001500	B	Rectangular	1,732051	0,000866025	0,022%	Ref. temp 23 graden C. 0,0015 dB/C 23 +/- 3° (specs.4231)
Humididy effect on ref. source pisthonphone 4228 Δ20%	RH2	0,0020	dB	1000	0,002000	B	Rectangular	1,732051	0,001154701	0,039%	Ref. 50% 0,001dB/%RH RH 40-70% (specs.4231)
Frequency accuracy ref.source pisthonphone 4228	f2-cal	0,1000	%	1000	0,010000	B	Rectangular	1,732051	0,005773503	0,964%	Ref.pressure 101,3kPa, 0,00008dB/kPa 85-108 kPa. (specs.4231)
Effect readout and accuracy barometer UZ0004	δPs-cal	0,0340	dB	1000	0,034000	B	Rectangular	1,732051	0,019629909	11,140%	Measurement corrected with barometer UZ0004 with +/-2% accuracy.
Calibration shift one year	Cal.ρ	0,0150	dB	1000	0,015000	B	Rectangular	1,732051	0,008660254	2,168%	Specifications and literature Sound Calibrator 4228
Sort-term stability	Sτ	0,0050	dB	1000	0,005000	B	Rectangular	1,732051	0,002886751	0,241%	Specifications and literature Sound Calibrator 4228
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*4227*						100,00%	
									Combined Uncertainty, u_c	0,058812901	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	0,117625802	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,12	*dB*

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FO-028F Uncertainty Estimate Acoustical Generated SPL.xlsx Acoustical Calibration Sound Presure Level

Generated Sound Presure Calibrator (Class Laboratory Standard) 124 [dB] @ 251,18 [Hz]

dB ref. 20 µPa

Measurement Result Units:	dB

Measurement Range and Parameter:	250Hz @ 124 dB Acoustical Actual 10^2.4Hz (251.18Hz)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Reference source pisthonphone 4228, accuracy pressure	δSpl-cal	0,0900	dB	1000	0,090000	B	Norm@99%	2,58	0,034883721	62,384%	Bruel & Kjaer 4228. Specifications B&K Class-0L +/- 0,3% with barometer UZ0004. 0,09 dB @ 99% calibration chart Bruel Kjaer
Environmental conditions effects on DUT	δdut	0,0000	dB	1000	0,000000	B	Rectangular	1,732051	0	0,000%	Maximum effect for one single sine @ one amplitud ref.conditions
Display resolution DUT	δdutd	0,0000	dB	1000	0,000000	B	Rectangular	1,732051	0	0,000%	
Frequency	f	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	10,680%	Calibration report Bruel & Kjaer
Reproducibility of calibration results	Cal.r	0,0080	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	1,094%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Reference source pisthonphone 4228, temp. effect Δ 3°	δTcal	0,0015		1000	0,001500	B	Rectangular	1,732051	0,000866025	0,038%	Ref. temp 23 graden C. 0,0015 dB/C 23 +/- 3° (specs.4231)
Humididy effect on ref. source pisthonphone 4228 Δ20%	RH2	0,0020	dB	1000	0,002000	B	Rectangular	1,732051	0,001154701	0,068%	Ref. 50% 0,001dB/%RH RH 40-70% (specs.4231)
Frequency accuracy ref.source pisthonphone 4228	f2-cal	0,1000	%	1000	0,010000	B	Rectangular	1,732051	0,005773503	1,709%	Ref.pressure 101,3kPa, 0,00008dB/kPa 85-108 kPa. (specs.4231)
Effect readout and accuracy barometer UZ0004	δPs-cal	0,0340	dB	1000	0,034000	B	Rectangular	1,732051	0,019629909	19,754%	Measurement corrected with barometer UZ0004 with +/-2% accuracy.
Calibration shift one year	Cal.ρ	0,0150	dB	1000	0,015000	B	Rectangular	1,732051	0,008660254	3,845%	Specifications and literature Sound Calibrator 4228
Sort-term stability	Sτ	0,0050	dB	1000	0,005000	B	Rectangular	1,732051	0,002886751	0,427%	Specifications and literature Sound Calibrator 4228
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*2264*						100,00%	
									Combined Uncertainty, u_c	0,044165869	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	0,088331738	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,088	*dB*

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Benedenberg 100A 2861 LH BERGAMBACHT
THE NETHERLANDS Tel.: 0182-352311

6-9-2017

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FO-028F Uncertainty Estimate Acoustical Generated SPL.xlsx Acoustical Calibration Sound Presure Level
Generated Sound Presure in combination with SLM Calibrator (Class Laboratory Standard) 94 [dB] @ 1000 [Hz]
ation with Sound Level Meter dB ref. 20 µPa

Measurement Result Units:	dB	Measurement Range and Parameter:	1000 Hz @ 94 dB Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Bruel & Kjaer Calibrator 42312 LS	Vr-lab	0,0400	dB	1000	0,040000	B	Normal, 2s	2	0,02	7,319%	Calibration report Bruel & Kjaer
Environmental conditions effects on DUT	δdut	0,0450	dB	1000	0,045000	B	Rectangular	1,732051	0,025980762	12,350%	Maximum effect for one single sine @ one amplitud ref.conditions
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	15,247%	IEC-61672-3 under §4.2
Frequency, distortion	f	0,8500	%	1000	0,085000	B	Rectangular	1,732051	0,049074773	44,064%	Calibration report Bruel & Kjaer @ 94 dB
Reproducibility of calibration results	Cal.r	0,0080	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,390%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Tempeture, measurement conditions Δ 6°	T1	0,0090	dB	1000	0,009000	B	Rectangular	1,732051	0,005196152	0,494%	Ref. temp 23 graden C. 0,0015 dB/C 23 +/- 3° (specs.4231)
Relative humidity, measurement conditions Δ20%	RH1	0,0200	dB	1000	0,020000	B	Rectangular	1,732051	0,011547005	2,440%	Ref. 50% 0,001dB/%RH RH 40-70% (specs.4231)
Static Pressure. Δ 16,3kPa	Ps	0,0013	dB	1000	0,001300	B	Rectangular	1,732051	0,000750555	0,010%	Ref.pressure 101,3kPa, 0,00008dB/kPa 85-108 kPa. (specs.4231)
Sort-term stability	Sτ	0,0200	dB	1000	0,020000	B	Rectangular	1,732051	0,011547005	2,440%	Specifications Sound Calibrator 4231
Calibration shift one year	Cal.ρ	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	15,247%	Specifications Sound Calibrator 4231
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*3809*						100,00%	
								Combined Uncertainty, u_c	0,073929448		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	0,147858897		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,15	*dB*	

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FO-028A Uncertainty Estimate Sound BK-4226 multicalibrator-Microphone.xlsx Acoustical Calibration of Sound Pressure Level

Microphone with preamp

31,5 Hz - 2000Hz

Measurement Result Units:	dB	Measurement Range and Parameter:	31,5-2000Hz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Pressure field BK4226, deviation	δdv	0,1200	dB	1000	0,120000	B	Rectangular	1,7320508	0,069282032	85,337%	Calibration certificate of B&K 4226
Microphone diaphragm damping factor in coupler	δdd	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Literature frequency range 20Hz-2000Hz Worst Case @ 1kHz
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	0,379%	Reproducibility 0,008 data Bruel & Kjaer
Terminals and cable uncertainties	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	1,713%	Literature, from IEC standards.
Mismach acoustical impedance microphone-calibrator	Ma	0,0200	dB	1000	0,020000	B	Rectangular	1,7320508	0,011547005	2,370%	Bruel & Kjaer technical reviews data
Coupler lenght (BK4226)	Lcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature wost case @ 32 Hz
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature @ 32 Hz
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,7320508	0,002136196	0,081%	Manufacturer data and literature @ 32 Hz
Coupler leakage (BK4226)	Cpl.l	0,0173	dB	1000	0,017300	B	Rectangular	1,7320508	0,00998816	1,774%	Manufacturer data and literature worst case @ 32 Hz
	δdut	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
	δdutd	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
Influence of ambient temperature Δ 3 celsius	δTcal	0,0060	dB	1000	0,006000	B	Rectangular	1,7320508	0,003464102	0,213%	Specifications B&K 0,002 dB/C
Influence of ambient pressure Δ 30 hPa	δps	0,0165	dB	1000	0,016500	B	Rectangular	1,7320508	0,009526279	1,613%	Specifications B&K 0,00055 dB/hPa @ max. 30hPa
Magnatic Field Sensitivity, max. influence	Mf	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,593%	Specificatinos B&K <0,01 dB
Effects of air density	ρ0	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	5,334%	Bruel & Kjaer technical reviews data
Uncontroled variations on gain/capacity etc.	Uv	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,593%	Bruel & Kjaer technical reviews data
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*1364*						100,00%	
								Combined Uncertainty, u_c	0,074998356		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	0,149996711		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,15	*dB*	

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FO-028A Uncertainty Estimate Sound BK-4226 multicalibrator-Microphone with preamp

Acoustical Calibration of Sound Pressure Level 4000Hz - 8000Hz

Measurement Result Units:	dB	Measurement Range and Parameter:	4000Hz-8000Hz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Pressure field BK4226, deviation	δdv	0,2500	dB	1000	0,110000	B	Rectangular	1,7320508	0,06350853	83,023%	Calibration certificate of B&K 4226
Microphone diaphragm damping factor in coupler	δdd	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Literature frequency range 20Hz-2000Hz Worst Case @ 1kHz
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	0,439%	Reproducibility 0,008 data Bruel & Kjaer
Terminals and cable uncertainties	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	1,983%	Literature, from IEC standards.
Mismach acoustical impedance microphone-calibrator	Ma	0,0200	dB	1000	0,020000	B	Rectangular	1,7320508	0,011547005	2,745%	Bruel & Kjaer technical reviews data
Coupler lenght (BK4226)	Lcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature wost case @ 32 Hz
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature @ 32 Hz
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,7320508	0,002136196	0,094%	Manufacturer data and literature @ 32 Hz
Coupler leakage (BK4226)	Cpl.l	0,0173	dB	1000	0,017300	B	Rectangular	1,7320508	0,00998816	2,054%	Manufacturer data and literature worst case @ 32 Hz
	δdut	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
	δdutd	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
Influence of ambient temperature Δ 3 celsius	δTcal	0,0060	dB	1000	0,006000	B	Rectangular	1,7320508	0,003464102	0,247%	Specifications B&K 0,002 dB/C
Influence of ambient pressure Δ 30 hPa	δps	0,0165	dB	1000	0,016500	B	Rectangular	1,7320508	0,009526279	1,868%	Specifications B&K 0,00055 dB/hPa @ max. 30hPa
Magnatic Field Sensitivity, max. influence	Mf	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,686%	Specificatinos B&K <0,01 dB
Effects of air density	ρ0	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	6,175%	Bruel & Kjaer technical reviews data
Uncontroled variations on gain/capacity etc.	Uv	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,686%	Bruel & Kjaer technical reviews data
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*1438*						100,00%	
								Combined Uncertainty, u_c	0,069699976		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, U	0,139399952		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,14	*dB*	

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FO-028A Uncertainty Estimate Sound BK-4226 multicalibrator-Microphone with preamp

Acoustical Calibration of Sound Pressure Level 8000Hz - 16000Hz

Measurement Result Units:	dB	Measurement Range and Parameter:	8000Hz-16000Hz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Pressure field BK4226, deviation	δdv	0,1200	dB	1000	0,120000	B	Rectangular	1,7320508	0,069282032	85,337%	Calibration certificate of B&K 4226
Microphone diaphragm damping factor in coupler	δdd	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Literature frequency range 20Hz-2000Hz Worst Case @ 1kHz
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	0,379%	Reproducibility 0,008 data Bruel & Kjaer
Terminals and cable uncertainties	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	1,713%	Literature, from IEC standards.
Mismach acoustical impedance microphone-calibrator	Ma	0,0200	dB	1000	0,020000	B	Rectangular	1,7320508	0,011547005	2,370%	Bruel & Kjaer technical reviews data
Coupler lenght (BK4226)	Lcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature wost case @ 32 Hz
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature @ 32 Hz
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,7320508	0,002136196	0,081%	Manufacturer data and literature @ 32 Hz
Coupler leakage (BK4226)	Cpl.l	0,0173	dB	1000	0,017300	B	Rectangular	1,7320508	0,00998816	1,774%	Manufacturer data and literature worst case @ 32 Hz
	δdut	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
	δdutd	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
Influence of ambient temperature Δ 3 celsius	δTcal	0,0060	dB	1000	0,006000	B	Rectangular	1,7320508	0,003464102	0,213%	Specifications B&K 0,002 dB/C
Influence of ambient pressure Δ 30 hPa	δps	0,0165	dB	1000	0,016500	B	Rectangular	1,7320508	0,009526279	1,613%	Specifications B&K 0,00055 dB/hPa @ max. 30hPa
Magnatic Field Sensitivity, max. influence	Mf	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,593%	Specificatinos B&K <0,01 dB
Effects of air density	ρ0	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	5,334%	Bruel & Kjaer technical reviews data
Uncontroled variations on gain/capacity etc.	Uv	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,593%	Bruel & Kjaer technical reviews data
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*1364*						100,00%	
								Combined Uncertainty, u_c	0,074998356		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, U	0,149996711		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,15	*dB*	

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FO-028A Uncertainty Estimate Sound BK-4226 multicalibrator-Microphone with preamp

Acoustical Calibration of Sound Pressure Level 8000Hz - 16000Hz

Measurement Result Units:	dB	Measurement Range and Parameter:	8000Hz-16000Hz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Pressure field BK4226, deviation	δdv	0,1200	dB	1000	0,120000	B	Rectangular	1,7320508	0,069282032	85,337%	Calibration certificate of B&K 4226
Microphone diaphragm damping factor in coupler	δdd	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Literature frequency range 20Hz-2000Hz Worst Case @ 1kHz
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	0,379%	Reproducibility 0,008 data Bruel & Kjaer
Terminals and cable uncertainties	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	1,713%	Literature, from IEC standards.
Mismach acoustical impedance microphone-calibrator	Ma	0,0200	dB	1000	0,020000	B	Rectangular	1,7320508	0,011547005	2,370%	Bruel & Kjaer technical reviews data
Coupler lenght (BK4226)	Lcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature wost case @ 32 Hz
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature @ 32 Hz
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,7320508	0,002136196	0,081%	Manufacturer data and literature @ 32 Hz
Coupler leakage (BK4226)	Cpl.l	0,0173	dB	1000	0,017300	B	Rectangular	1,7320508	0,00998816	1,774%	Manufacturer data and literature worst case @ 32 Hz
	δdut	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
	δdutd	0,0000	dB	1000	0,000000	B	Rectangular	1,7320508	0	0,000%	
Influence of ambient temperature Δ 3 celsius	δTcal	0,0060	dB	1000	0,006000	B	Rectangular	1,7320508	0,003464102	0,213%	Specifications B&K 0,002 dB/C
Influence of ambient pressure Δ 30 hPa	δps	0,0165	dB	1000	0,016500	B	Rectangular	1,7320508	0,009526279	1,613%	Specifications B&K 0,00055 dB/hPa @ max. 30hPa
Magnatic Field Sensitivity, max. influence	Mf	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,593%	Specificatinos B&K <0,01 dB
Effects of air density	ρ0	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	5,334%	Bruel & Kjaer technical reviews data
Uncontroled variations on gain/capacity etc.	Uv	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,593%	Bruel & Kjaer technical reviews data
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*1364*						100,00%	
								Combined Uncertainty, u_c	0,074998356		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, U	0,149996711		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,15	*dB*	

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FO-028A Uncertainty Estimate Sound Levelmeter Cal-Acoustical.xlsx

Acoustical Calibration Sound Presure Level
Calibrator (Class Laboratory Standard) 94 [dB] @ 1000 [Hz]
dB ref. 20 µPa

Measurement Result Units:	dB

Measurement Range and Parameter:	1000 Hz @ 94 dB Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Bruel & Kjaer Calibrator 42312 LS	Vr-lab	0,0400	dB	1000	0,040000	B	Rectangular	1,732051	0,023094011	22,112%	Calibration report Bruel & Kjaer
Environmental conditions effects on DUT	δdut	0,0450	dB	1000	0,045000	B	Rectangular	1,732051	0,025980762	27,985%	Maximum effect for one single sine @ one amplitud ref.conditions
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	34,550%	IEC-61672-3 under §4.2
Frequency	f	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	8,637%	Calibration report Bruel & Kjaer
Reproducibility of calibration results	Cal.r	0,0080	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,884%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Tempeture, measurement conditions Δ 3°	T1	0,0045	%	1000	0,004500	B	Rectangular	1,732051	0,002598076	0,280%	Ref. temp 23 graden C. 0,0015 dB/C 23 +/- 3° (specs.4231)
Relative humidity, measurement conditions Δ20%	RH1	0,0200	%	1000	0,020000	B	Rectangular	1,732051	0,011547005	5,528%	Ref. 50% 0,001dB/%RH RH 40-70% (specs.4231)
Static Pressure. Δ 16,3kPa	Ps	0,0013	%	1000	0,001300	B	Rectangular	1,732051	0,000750555	0,023%	Ref.pressure 101,3kPa, 0,00008dB/kPa 85-108 kPa. (specs.4231)
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Data Entry									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*1000*							
Effective Degrees of Freedom	v_{eff}			*3888*						100,00%	
								Combined Uncertainty, u_c	0,049111913		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	0,098223826		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,098	*dB*	

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FO-0028E Uncertainty Estimate Sound Levelmeter Cal-Electrical.xlsx

Calibration of SLM by Electrical Signal 20-20000 [Hz] @ 45-95 and 105-140 dB ref. 20 [µPa] (electrical)

Measurement Result Units:	dB

Measurement Range and Parameter:	20-20000Hz @ 45-95 /105-140 dB ref. 20µPa (electrical)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	1000	0,006200	B	Normal, 2s	2	0,0031	0,214%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,475%	Reproducibility 0,008 data Bruel & Kjaer
Connector terminals	Term	0,0370	dB	1000	0,037000	B	Rectangular	1,732051	0,02136196	10,170%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0800	%	20	0,008000	A	Rectangular	1,732051	0,004618802	0,475%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,732051	0,000144338	0,000%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,0800	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,475%	Calibration outcome DARE Certificate
Environmental conditions effects on DUT	δdut	0,0900	dB	1000	0,090000	B	Rectangular	1,732051	0,051961524	60,174%	Maximum expected uncertainty
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	18,572%	IEC-61672-3 under §4.2
Capsule replacement (pF)	C	0,0460	dB	1000	0,004600	B	Rectangular	1,732051	0,002655811	0,157%	Capacity capsule replacement. Worst case @ 20 Hz NTI-K65 15pF
Noise DS360	δN	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	4,643%	4 nV*Hz-2 - 500 nV*Hz-2 (12,6mVpp-20Vpp) <<worst case
Accuracy DS360	δAcc	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	4,643%	Manufacturer data and calibration report
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									***Instructions: Finish selections***		
Min Degrees of Freedom	*v*			*20*							
Effective Degrees of Freedom	v_{eff}			*2424*						100,00%	
								Combined Uncertainty, u_c	0,066985228		
								Coverage factor, *k, uses effective degrees of freedom*	2		***Instructions: Assess data entry and values before reporting rounded result.***
								Expanded Uncertainty, *U*	0,133970457		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,13	*dB*	

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FO-0028E Uncertainty Estimate Sound Levelmeter Cal-Electrical.xlsx

Calibration of SLM by Electrical Signal
20-20000 [Hz] @ <45 [dB] ref. 20 [µPa] (electrical)

Measurement Result Units:	dB

Measurement Range and Parameter:	20-20000Hz @<45 dB ref. 20µPa (Electrical)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	*d.f.*	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	1000	0,006200	B	Normal, 2s	2	0,0031	0,068%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Reproducibility of calibration results	Cal.r	0,0100	dB	1000	0,010000	B	Rectangular	1,732051	0,005773503	0,235%	Reproducibility 0,008 data Bruel & Kjaer
Connector terminals	Term	0,0370	dB	1000	0,037000	B	Rectangular	1,732051	0,02136196	3,221%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	1,0000	%	20	0,100000	A	Rectangular	1,732051	0,057735027	23,528%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,732051	0,000144338	0,000%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,1800	%	1000	0,018000	B	Rectangular	1,732051	0,010392305	0,762%	Calibration outcome DARE Certificate
Environmental conditions effects on DUT	δdut	0,0900	dB	1000	0,090000	B	Rectangular	1,732051	0,051961524	19,058%	Maximum expected uncertainty
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	5,882%	IEC-61672-3 under §4.2
Capsule replacement (pF)	C	0,0900	dB	1000	0,009000	B	Rectangular	1,732051	0,005196152	0,191%	Capacity capsule replacement. Worst case @ 20 Hz NTI-K65 15pF
Noise DS360 for low amplitudes	δN	1,0000	%	1000	0,100000	B	Rectangular	1,732051	0,057735027	23,528%	7,5 nV*Hz-2 (126mVpp-12,6mV) worst case
Accuracy DS360	δAcc	1,0000	%	1000	0,100000	B	Rectangular	1,732051	0,057735027	23,528%	Manufacturer data and calibration report
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									***Instructions: Finish selections***		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*342*						100,00%	
									Combined Uncertainty, u_c	0,119027871	
									Coverage factor, *k, uses effective degrees of freedom*	2,01	***Instructions: Assess data entry and values before reporting rounded result.***
									Expanded Uncertainty, *U*	0,239246021	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,24	*dB*

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Measurement Result Units:	dB

Measurement Range and Parameter:	20-20000Hz @ 75 - 105 dB ref. 20µPa (Electrical)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	1000	0,006200	B	Normal, 2s	2	0,0031	0,250%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,555%	Reproducibility 0,008 data Bruel & Kjaer
Connector terminals	Term	0,0170	dB	1000	0,017000	B	Rectangular	1,732051	0,009814955	2,506%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0400	%	20	0,004000	A	Rectangular	1,732051	0,002309401	0,139%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,732051	0,000144338	0,001%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,0800	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,555%	Calibration outcome DARE Certificate (calibration report)
Environmental conditions effects on DUT	δdut	0,0900	dB	1000	0,090000	B	Rectangular	1,732051	0,051961524	70,233%	Maximum expected uncertainty
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	21,677%	IEC-61672-3 under §4.2 (standard value)
Capsule replacement (pF)	C	0,0460	dB	1000	0,004600	B	Rectangular	1,732051	0,002655811	0,183%	Capacity capsule replacement. Worst case @ 20 Hz NTI-K65 15pF
Noise DS360	δN	0,1500	%	1000	0,015000	B	Rectangular	1,732051	0,008660254	1,951%	4 nV*Hz-2 - 500 nV*Hz-2 (12,6mVpp-20Vpp) <<<worst case
Accuracy DS360	δAcc	0,1500	%	1000	0,015000	B	Rectangular	1,732051	0,008660254	1,951%	Manufacturer data and calibration report worst case
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*1845*						100,00%	
								Combined Uncertainty, u_c	0,062002856		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	0,124005712		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,12	*dB*	

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FO-0028E Uncertainty Estimate Sound Levelmeter Cal-Electrical.xlsx

Calibration of SLM by Electrical Signal
Single Sine @ One amplitude (Electrical)

Measurement Result Units:	dB	Measurement Range and Parameter:	Single Sine @ One amplitude (Electrical)

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	1000	0,006200	B	Normal, 2s	2	0,0031	0,528%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,732051	0,004618802	1,173%	Reproducibility 0,008 data Bruel & Kjaer
Connector terminals	Term	0,0170	dB	1000	0,017000	B	Rectangular	1,732051	0,009814955	5,295%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0400	%	20	0,004000	A	Rectangular	1,732051	0,002309401	0,293%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,732051	0,000144338	0,001%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,0800	%	1000	0,008000	B	Rectangular	1,732051	0,004618802	1,173%	Calibration outcome DARE Certificate
Environmental conditions effects on DUT	δdut	0,0450	dB	1000	0,045000	B	Rectangular	1,732051	0,025980762	37,101%	Maximum expected uncertainty for single sine @ one amplitude
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	45,804%	IEC-61672-3 under §4.2
Capsule replacement (pF)	C	0,0460	dB	1000	0,004600	B	Rectangular	1,732051	0,002655811	0,388%	Capacity capsule replacement. Worst case @ 20 Hz NTI-K65 15pF
Noise DS360	δN	0,1500	%	1000	0,015000	B	Rectangular	1,732051	0,008660254	4,122%	4 nV*Hz-2 - 500 nV*Hz-2 (12,6mVpp-20Vpp) <<<worst case
Accuracy DS360	δAcc	0,1500	%	1000	0,015000	B	Rectangular	1,732051	0,008660254	4,122%	Manufacturer data and calibration report
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						A	Normal, 2s				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	*v*			*20*							
Effective Degrees of Freedom	v_{eff}			*2821*						100,00%	
								Combined Uncertainty, u_c	0,042653888		
								Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*	
								Expanded Uncertainty, *U*	0,085307776		
								Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,085	*dB*	

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FO-028A Uncertainty Estimate Sound Levelmeter Cal-Acoustical.xlsx

Acoustical Calibration of Sound Pressure Level 31,5 Hz - 2000Hz

Measurement Result Units:	dB

Measurement Range and Parameter:	31,5-2000Hz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	20	0,006200	B	Normal, 2s	2	0,0031	0,066%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Voltage ratio Cross-Talk Nexus 2690	Vr-Cr	0,0250	%	1000	0,002500	B	Rectangular	1,7320508	0,001443376	0,014%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio noise Nexus 2690	Vr-n	0,0100	%	1000	0,001000	B	Rectangular	1,7320508	0,00057735	0,002%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio distortion, Nexus 2690	Vr-d	0,0030	%	1000	0,000300	B	Rectangular	1,7320508	0,000173205	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Frequency	f	0,0012	%	1000	0,000120	B	Rectangular	1,7320508	6,9282E-05	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Polarisation Voltage Nexus 2690	Uo	0,2500	%	1000	0,025000	B	Rectangular	1,7320508	0,014433757	1,441%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Amplifier Bruel Kjaer Nexus 2690	V,cal	0,0550	dB	1000	0,055000	B	Rectangular	1,7320508	0,031754265	6,975%	Calibration outcome. Calibration certificate
Static Pressure. Reference Microphone BK4134 Δ 16,3kPa	Ps	0,0114	dB	1000	0,011410	B	Rectangular	1,7320508	0,006587567	0,300%	Ref.pressure 101,3kPa, 0,0007dB/kPa for BK4134 85-108 kPa.
Tempeture, measurement conditions BK4134 Δ 3°	T1	0,0060	dB	1000	0,006000	B	Rectangular	1,7320508	0,003464102	0,083%	Ref. temp 23 graden C. 0,002 dB/C (BK4226 data sheet) 23 +/- 3°
Relative humidity, measurement conditions BK4134 Δ20%	RH1	0,0800	dB	1000	0,080000	B	Rectangular	1,7320508	0,046188022	14,758%	Ref. 50% 0,004dB/%RH (BK data sheet 4134) RH 40-70%
Coupler lenght (BK4226)	Lcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature wost case @ 32 Hz
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature @ 32 Hz
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,7320508	0,002136196	0,032%	Manufacturer data and literature @ 32 Hz
Coupler leakage (BK4226)	Cpl.l	0,0173	dB	1000	0,017300	B	Rectangular	1,7320508	0,00998816	0,690%	Manufacturer data and literature worst case @ 32 Hz
Microfoon reference, sensitivity calibration BK4143	Ms1	0,0800	dB	1000	0,080000	B	Rectangular	1,7320508	0,046188022	14,758%	Manufacturer uncertainty on calibration
Microfoon sensitivity, reproducibility Bk4143	Ms2	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	2,075%	Sensitivity instability 0,03/year data B&K
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	0,148%	Reproducibility 0,008 data Bruel & Kjaer
Preamplifier terminals	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	0,666%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0800	%	20	0,008000	A	Normal, 2s	2	0,004	0,111%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,7320508	0,000144338	0,000%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,0002	%	1000	0,000200	B	Rectangular	1,7320508	0,00011547	0,000%	Calibration outcome DARE Certificate
Pressure field BK4226, deviation	δdv	0,1200	dB	1000	0,120000	B	Rectangular	1,7320508	0,069282032	33,205%	Calibration outcome B&K
Microphone diaphragm damping factor in coupler	δdd	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Literature frequency range 20Hz-2000Hz Worst Case @ 1kHz
Correction frequency response pressure BK4134	δfr	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,231%	Calibration chart BK4134
Environmental conditions effects on DUT	δdut	0,0900	dB	1000	0,090000	B	Rectangular	1,7320508	0,051961524	18,678%	IEC-61672-3 under §7.3 for f<3kHz maximum effect
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,7320508	0,028867513	5,765%	IEC-61672-3 under §4.2
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*5057*						100,00%	
									Combined Uncertainty, u_c	0,120231021	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	0,240462041	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,24	*dB*

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FO-028A Uncertainty Estimate Sound Levelmeter Cal-Acoustical.xlsx Acoustical Calibration of Sound Pressure Level 2500 [Hz] - 4000 [Hz]

Measurement Result Units:	dB	Measurement Range and Parameter:	2500Hz-4000Hz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	20	0,006200	B	Normal, 2s	2	0,0031	0,030%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Voltage ratio Cross-Talk Nexus 2690	Vr-Cr	0,0250	%	1000	0,002500	B	Rectangular	1,732051	0,001443376	0,006%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio noise Nexus 2690	Vr-n	0,0100	%	1000	0,001000	B	Rectangular	1,732051	0,00057735	0,001%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio distortion, Nexus 2690	Vr-d	0,0030	%	1000	0,003000	B	Rectangular	1,732051	0,001732051	0,009%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Frequency	f	0,0012	%	1000	0,000120	B	Rectangular	1,732051	6,9282E-05	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Polarisation Voltage Nexus 2690	Uo	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	0,643%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Amplifier Bruel Kjaer Nexus 2690	V,cal	0,0550	dB	1000	0,055000	B	Rectangular	1,732051	0,031754265	3,111%	Calibration outcome. Calibration certificate
Static Pressure. Reference Microphone BK4134 Δ 16,3kPa	Ps	0,0114	dB	1000	0,011410	B	Rectangular	1,732051	0,006587567	0,134%	Ref.pressure 101,3kPa, 0,0007dB/kPa for BK4134 85-108 kPa.
Tempeture, measurement conditions BK4134 Δ 3°	T1	0,0060	dB	1000	0,006000	B	Rectangular	1,732051	0,003464102	0,037%	Ref. temp 23 graden C. 0,002 dB/C (BK4226 data sheet) 23 +/- 3°
Relative humidity, measurement conditions BK4134 Δ20%	RH1	0,0800	dB	1000	0,080000	B	Rectangular	1,732051	0,046188022	6,582%	Ref. 50% 0,004dB/%RH (BK data sheet) RH 40-70%
Coupler lenght (BK4226)	Lcoup	0,0002	dB	1000	0,000200	B	Rectangular	1,732051	0,00011547	0,000%	Manufacturer data and literature
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Manufacturer data and literature
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,732051	0,002136196	0,014%	Manufacturer data and literature
Coupler leakage (BK4226)	Cpl.l	0,0173	dB	1000	0,017300	B	Rectangular	1,732051	0,00998816	0,308%	Manufacturer data and literature worst case @ 32 Hz
Microfoon reference, sensitivity calibration BK4143	Ms1	0,0800	dB	1000	0,080000	B	Rectangular	1,732051	0,046188022	6,582%	Manufacturer uncertainty on calibration
Microfoon sensitivity, reproducibility	Ms2	0,0300	dB	1000	0,030000	B	Rectangular	1,732051	0,017320508	0,926%	Sensitivity instability 0,03/year data B&K
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,066%	Reproducibility 0,008 data Bruel & Kjaer
Preamplifier terminals	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,732051	0,009814955	0,297%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0800	%	20	0,080000	A	Normal, 2s	2	0,04	4,937%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,732051	0,000144338	0,000%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,0002	%	1000	0,000200	B	Rectangular	1,732051	0,00011547	0,000%	Calibration outcome DARE Certificate
Pressure field BK4226, deviation	δdv	0,1100	dB	1000	0,110000	B	Rectangular	1,732051	0,06350853	12,445%	Calibration outcome B&K
Microphone diaphragm damping factor in coupler	δdd	0,0010	dB	1000	0,001000	B	Rectangular	1,732051	0,00057735	0,001%	Literature frequency range 2500Hz-4000Hz Worst Case 4kHz
Correction frequency response pressure BK4134	δfr	0,2000	dB	1000	0,200000	B	Rectangular	1,732051	0,115470054	41,140%	Calibration chart BK4134
Environmental conditions effects on DUT	δdut	0,1400	dB	1000	0,140000	B	Rectangular	1,732051	0,080829038	20,159%	IEC-61672-3 under §7.3 for f>3kHz Maximum effect
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	2,571%	IEC-61672-3 under §4.2
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*2795*						100,00%	
									Combined Uncertainty, u_c	0,180026318	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	0,360052635	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,36	*dB*

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FO-028A Uncertainty Estimate Sound Levelmeter Cal-Acoustical.xlsx Acoustical Calibration of Sound Pressure Level 5000 [Hz] - 10000 [Hz]

Measurement Result Units:	dB	Measurement Range and Parameter:	5000Hz-10000Hz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0600	%	20	0,006200	B	Normal, 2s	2	0,0031	0,014%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 10Hz-20kHz) 0,5 + 0,02 of Range
Voltage ratio Cross-Talk Nexus 2690	Vr-Cr	0,0250	%	1000	0,002500	B	Rectangular	1,732051	0,001443376	0,003%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio noise Nexus 2690	Vr-n	0,0100	%	1000	0,001000	B	Rectangular	1,732051	0,00057735	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Voltage ratio distortion, Nexus 2690	Vr-d	0,0030	%	1000	0,003000	B	Rectangular	1,732051	0,001732051	0,004%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Frequency	f	0,0012	%	1000	0,000120	B	Rectangular	1,732051	6,9282E-05	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Polarisation Voltage Nexus 2690	Uo	0,2500	%	1000	0,025000	B	Rectangular	1,732051	0,014433757	0,306%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz
Amplifier Bruel Kjaer Nexus 2690	V,cal	0,0550	dB	1000	0,055000	B	Rectangular	1,732051	0,031754265	1,481%	Calibration outcome. Calibration certificate
Static Pressure. Reference Microphone BK4134 Δ 16,3kPa	Ps	0,0114	dB	1000	0,011410	B	Rectangular	1,732051	0,006587567	0,064%	Ref.pressure 101,3kPa, 0,0007dB/kPa for BK4134 85-108 kPa.
Tempeture, measurement conditions BK4134 Δ 3°	T1	0,0060	dB	1000	0,006000	B	Rectangular	1,732051	0,003464102	0,018%	Ref. temp 23 graden C. 0,002 dB/C (BK4226 data sheet) 23 +/- 3°
Relative humidity, measurement conditions BK4134 Δ20%	RH1	0,0800	dB	1000	0,080000	B	Rectangular	1,732051	0,046188022	3,133%	Ref. 50% 0,004dB/%RH (BK data sheet) RH 40-70%
Coupler lenght (BK4226)	Lcoup	0,0006	dB	1000	0,000600	B	Rectangular	1,732051	0,00034641	0,000%	Manufacturer data and literature
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Manufacturer data and literature
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,732051	0,002136196	0,007%	Manufacturer data and literature
Coupler leakage (BK4226)	Cpl.l	0,0001	dB	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Manufacturer data and literature worst case @ 32 Hz
Microfoon reference, sensitivity calibration BK4143	Ms1	0,0800	dB	1000	0,080000	B	Rectangular	1,732051	0,046188022	3,133%	Manufacturer uncertainty on calibration
Microfoon sensitivity, reproducibility	Ms2	0,0300	dB	1000	0,030000	B	Rectangular	1,732051	0,017320508	0,441%	Sensitivity instability 0,03/year data B&K
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,732051	0,004618802	0,031%	Reproducibility 0,008 data Bruel & Kjaer
Preamplifier terminals	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,732051	0,009814955	0,141%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0800	%	20	0,008000	A	Normal, 2s	2	0,004	0,023%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,732051	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,732051	0,000144338	0,000%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,0002	%	1000	0,000200	B	Rectangular	1,732051	0,00011547	0,000%	Calibration outcome DARE Certificate
Pressure field BK4226, deviation	δdv	0,1100	dB	1000	0,110000	B	Rectangular	1,732051	0,06350853	5,923%	Calibration outcome B&K
Microphone diaphragm damping factor in coupler	δdd	0,0052	dB	1000	0,005100	B	Rectangular	1,732051	0,002944486	0,013%	Literature frequency range 5000Hz-10kHz Worst Case 10kHz
Correction frequency response pressure BK4134	δfr	0,3900	dB	1000	0,390000	B	Rectangular	1,732051	0,225166605	74,448%	Calibration chart BK4134
Environmental conditions effects on DUT	δdut	0,1400	dB	1000	0,140000	B	Rectangular	1,732051	0,080829038	9,594%	IEC-61672-3 under §7.3 for f>3kHz Maximum
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,732051	0,028867513	1,224%	IEC-61672-3 under §4.2
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*1756*						100,00%	
									Combined Uncertainty, u_c	0,260961348	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	0,521922695	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	0,52	*dB*

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FO-028A Uncertainty Estimate Sound Levelmeter Cal-Acoustical.xlsx

Acoustical Calibration of Sound Pressure Level 12500 [Hz] - 25000 [Hz]

Measurement Result Units:	dB

Measurement Range and Parameter:	12.5kHz-25kHz Acoustical

Sensitivity Coefficient Ci = 1 for all parameters

Uncertainty Component Description	Symbol	Estimated Uncertainty	Units	d.f.	Estimated Unc in Measurement Units (dB)	Type (A, B)	Probability Distribution	Divisor	Std Unc (dB)	Relative Contribution (%)	Explanation/Source/Notes
Keysighy 34465A, voltage ratio	Vr-lab	0,0800	%	20	0,008200	B	Normal, 2s	2	0,0041	0,005%	Specifications of Keysight and Calibrations Certificate Tcal (2 year) +/- 5°C (range 10V 20kHz-50kHz) 0,5 + 0,02 of Range
Voltage ratio Cross-Talk Nexus 2690	Vr-Cr	0,0275	%	1000	0,002750	B	Rectangular	1,7320508	0,001587713	0,001%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz +10%
Voltage ratio noise Nexus 2690	Vr-n	0,0100	%	1000	0,001100	B	Rectangular	1,7320508	0,000635085	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz +10%
Voltage ratio distortion, Nexus 2690	Vr-d	0,0033	%	1000	0,000330	B	Rectangular	1,7320508	0,000190526	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz +10%
Frequency	f	0,0013	%	1000	0,000132	B	Rectangular	1,7320508	7,62102E-05	0,000%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz +10%
Polarisation Voltage Nexus 2690	Uo	0,2500	%	1000	0,025000	A	Rectangular	1,7320508	0,014433757	0,057%	Bruel & Kjaer specs. Uncertainty claims 2 Hz- 22,4kHz +10%
Amplifier Bruel Kjaer Nexus 2690	V,cal	0,0550	dB	1000	0,055000	B	Rectangular	1,7320508	0,031754265	0,275%	Calibration outcome. Calibration certificate
Static Pressure. Reference Microphone BK4134 Δ 16,3kPa	Ps	0,0114	dB	1000	0,011410	B	Rectangular	1,7320508	0,006587567	0,012%	Ref.pressure 101,3kPa, 0,0007dB/kPa for BK4134 85-108 kPa.
Tempeture, measurement conditions BK4134 Δ 3°	T1	0,0060	dB	1000	0,006000	B	Rectangular	1,7320508	0,003464102	0,003%	Ref. temp 23 graden C. 0,002 dB/C (BK4226 data sheet) 23 +/- 3°
Relative humidity, measurement conditions BK4134 Δ20%	RH1	0,0800	dB	1000	0,080000	B	Rectangular	1,7320508	0,046188022	0,581%	Ref. 50% 0,004dB/%RH (BK data sheet) RH 40-70%
Coupler lenght (BK4226)	Lcoup	0,0100	dB	1000	0,010000	B	Rectangular	1,7320508	0,005773503	0,009%	Manufacturer data and literature
Coupler diameter (BK4226)	Dcoup	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature
Coupler Volume (BK4226)	Vcoup	0,0037	dB	1000	0,003700	B	Rectangular	1,7320508	0,002136196	0,001%	Manufacturer data and literature
Coupler leakage (BK4226)	Cpl.l	0,0001	dB	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Manufacturer data and literature worst case @ 32 Hz
Microfoon reference, sensitivity calibration BK4143	Ms1	0,0800	dB	1000	0,080000	A	Normal, 2s	2	0,04	0,436%	Manufacturer uncertainty on calibration
Microfoon sensitivity, reproducibility	Ms2	0,0300	dB	1000	0,030000	B	Rectangular	1,7320508	0,017320508	0,082%	Sensitivity instability 0,03/year data B&K
Reproducibility of calibration results	Cal.r	0,0080	dB	1000	0,008000	B	Rectangular	1,7320508	0,004618802	0,006%	Reproducibility 0,008 data Bruel & Kjaer
Preamplifier terminals	Pre1	0,0170	dB	1000	0,017000	B	Rectangular	1,7320508	0,009814955	0,026%	Literature, from IEC standard.
Readout variation on Keysight DMM	δtD	0,0800	%	20	0,008000	A	Normal, 2s	2	0,004	0,004%	Typical measured after 20 readings on DMM, with statistics reading
DS360 Ultra Low Distortion Function Generator, distortion	δTd	0,0010	%	1000	0,000100	B	Rectangular	1,7320508	5,7735E-05	0,000%	Total harmonic Distortion less then 0,001% DC - 20kHz
DS360 Ultra Low Distortion Function Generator, frequency	fg	0,0025	%	1000	0,000250	B	Rectangular	1,7320508	0,000144338	0,000%	Manufacturer data and literature and calibration report
The DS360 amlitude flatness, sine	δAel	0,0002	%	1000	0,000200	B	Rectangular	1,7320508	0,00011547	0,000%	Calibration outcome DARE Certificate
Pressure field BK4226, deviation	δdv	0,2500	dB	1000	0,250000	B	Rectangular	1,7320508	0,144337567	5,676%	Calibration outcome B&K
Microphone diaphragm damping factor in coupler	δdd	0,0070	dB	1000	0,007000	B	Rectangular	1,7320508	0,004041452	0,004%	Literature frequency range 12,5kHz-25kHz Worst Case 20kHz
Environmental conditions effects on DUT	δdut	0,1400	dB	1000	0,140000	B	Rectangular	1,7320508	0,080829038	1,780%	IEC-61672-3 under §7.3 for f>3kHz (maximum effect)
Display resolution DUT	δdutd	0,0500	dB	1000	0,050000	B	Rectangular	1,7320508	0,028867513	0,227%	IEC-61672-3 under §4.2
Correction frequency response pressure BK4134	δfr	1,0000	dB	1000	1,000000	B	Rectangular	1,7320508	0,577350269	90,815%	Calibration chart BK4134
						B	Rectangular				
						B	Rectangular				
Instructions: Finish selections or assess resulting values.									*Instructions: Finish selections*		
Min Degrees of Freedom	v			*20*							
Effective Degrees of Freedom	v_{eff}			*1207*						100,00%	
									Combined Uncertainty, u_c	0,605843583	
									Coverage factor, *k, uses effective degrees of freedom*	2	*Instructions: Assess data entry and values before reporting rounded result.*
									Expanded Uncertainty, *U*	1,211687165	
									Expanded Uncertainty, U, Rounded to 2 Significant Digits	1,2	*dB*

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