



# Certificate of Calibration

Calibration Certification Information			
Cal. Date: February 3, 2021	Rootsmeter S/N: 438320	Ta: 293	°K
Operator: Jim Tisch		Pa: 750.6	mm Hg
Calibration Model #: TE-5025A	Calibrator S/N: <b>3880</b>		

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.4550	3.2	2.00
2	3	4	1	1.0280	6.4	4.00
3	5	6	1	0.9180	8.0	5.00
4	7	8	1	0.8750	8.8	5.50
5	9	10	1	0.7220	12.8	8.00

Data Tabulation					
Vstd (m3)	Qstd (x-axis)	$\sqrt{\Delta H \left( \frac{Pa}{Pstd} \right) \left( \frac{Tstd}{Ta} \right)}$ (y-axis)	Va	Qa (x-axis)	$\sqrt{\Delta H \left( \frac{Ta}{Pa} \right)}$ (y-axis)
1.0002	0.6874	1.4174	0.9957	0.6844	0.8836
0.9959	0.9688	2.0044	0.9915	0.9645	1.2496
0.9937	1.0825	2.2410	0.9893	1.0777	1.3971
0.9927	1.1345	2.3504	0.9883	1.1295	1.4653
0.9873	1.3675	2.8347	0.9829	1.3614	1.7672
<b>QSTD</b>	m=	<b>2.08437</b>	<b>QA</b>	m=	<b>1.30520</b>
	b=	<b>-0.01508</b>		b=	<b>-0.00940</b>
	r=	<b>1.00000</b>		r=	<b>1.00000</b>

Calculations	
Vstd= $\Delta Vol \left( \frac{Pa - \Delta P}{Pstd} \right) \left( \frac{Tstd}{Ta} \right)$	Va= $\Delta Vol \left( \frac{Pa - \Delta P}{Pa} \right)$
Qstd= $Vstd / \Delta Time$	Qa= $Va / \Delta Time$
For subsequent flow rate calculations:	
Qstd= $1/m \left( \left( \sqrt{\Delta H \left( \frac{Pa}{Pstd} \right) \left( \frac{Tstd}{Ta} \right)} \right) - b \right)$	Qa= $1/m \left( \left( \sqrt{\Delta H \left( \frac{Ta}{Pa} \right)} \right) - b \right)$

Standard Conditions	
Tstd:	298.15 °K
Pstd:	760 mm Hg
<b>Key</b>	
ΔH: calibrator manometer reading (in H2O)	
ΔP: rootsmeter manometer reading (mm Hg)	
Ta: actual absolute temperature (°K)	
Pa: actual barometric pressure (mm Hg)	
b: intercept	
m: slope	

RECALIBRATION
US EPA recommends annual recalibration per 1998 40 Code of Federal Regulations Part 50 to 51, Appendix B to Part 50, Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere, 9.2.17, page 30



Lam Environmental Services Limited

**Calibration Data for High Volume Sampler (TSP Sampler)**

Location : CMA2a  
 Equipment no. : HVS002

Calibration Date : 01-Sep-21  
 Calibration Due Date : 01-Nov-21

**CALIBRATION OF CONTINUOUS FLOW RECORDER**

Ambient Condition			
Temperature, T <sub>a</sub>	301.7	Kelvin	Pressure, P <sub>a</sub>
			1010 mmHg

Orifice Transfer Standard Information					
Equipment No.	3880	Slope, m <sub>c</sub>	2.08437	Intercept, b <sub>c</sub>	-0.01508
Last Calibration Date	03-Feb-21	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $= m_c \times Q_{std} + b_c$			
Next Calibration Date	03-Feb-22				

Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.3	1.3	2.6	0.7748	29	28.7732
2	1.8	1.8	3.6	0.9104	35	34.7263
3	2.7	2.7	5.4	1.1134	48	47.6247
4	3.7	3.7	7.4	1.3021	52	51.5934
5	4.7	4.7	9.4	1.4667	63	62.5074

By Linear Regression of Y on X

Slope, m = 47.4554      Intercept, b = -7.7950  
 Correlation Coefficient\* = 0.9907  
 Calibration Accepted = Yes/No\*\*

\* if Correlation Coefficient &lt; 0.990, check and recalibration again.

\*\* Delete as appropriate.

Remarks : \_\_\_\_\_  
 \_\_\_\_\_

Calibrated by : Garry Yu  
 Date : 01-Sep-21

Checked by : James Chu  
 Date : 01-Sep-21



Lam Environmental Services Limited

**Calibration Data for High Volume Sampler (TSP Sampler)**

Location : CMA2a Calibration Date : 28-Oct-21  
 Equipment no. : HVS002 Calibration Due Date : 28-Dec-21

**CALIBRATION OF CONTINUOUS FLOW RECORDER**

Ambient Condition			
Temperature, T <sub>a</sub>	298.7	Kelvin	Pressure, P <sub>a</sub>
			1018 mmHg

Orifice Transfer Standard Information					
Equipment No.	3880	Slope, m <sub>c</sub>	2.08437	Intercept, b <sub>c</sub>	-0.01508
Last Calibration Date	3-Feb-21	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$ $= m_c \times Q_{std} + b_c$			
Next Calibration Date	3-Feb-22				

Calibration of TSP						
Calibration Point	Manometer Reading			Q <sub>std</sub> (m <sup>3</sup> / min.) X-axis	Continuous Flow Recorder, W (CFM)	IC (W(P <sub>a</sub> /1013.3x298/T <sub>a</sub> ) <sup>1/2</sup> /35.31) Y-axis
	(up)	(down)	(difference)			
1	1.3	1.3	2.6	0.7817	28	28.0306
2	1.9	1.9	3.8	0.9435	32	32.0349
3	3.0	3.0	6.0	1.1837	42	42.0459
4	3.9	3.9	7.8	1.3486	46	46.0502
5	5.0	5.0	10.0	1.5260	52	52.0568

By Linear Regression of Y on X

Slope, m = 32.9282 Intercept, b = 1.9558

Correlation Coefficient\* = 0.9969

Calibration Accepted = Yes/No\*\*

\* if Correlation Coefficient &lt; 0.990, check and recalibration again.

\*\* Delete as appropriate.

Remarks : \_\_\_\_\_

Calibrated by : Garry Yu Checked by : James Chu  
 Date : 28-Oct-21 Date : 28-Oct-21

# Calibration Certificate

Certificate Number 2021010517

**Customer:**

Lam Geotechnics Ltd

**Model Number** LxT SE

**Serial Number** 0005062

**Test Results** Pass

**Initial Condition** Inoperable

**Description** Sound Expert LxT  
Class 1 Sound Level Meter  
Firmware Revision: 2.404

**Procedure Number** D0001.8384

**Technician** Ron Harris

**Calibration Date** 26 Aug 2021

**Calibration Due**

**Temperature** 23.29 °C ± 0.25 °C

**Humidity** 51.9 %RH ± 2.0 %RH

**Static Pressure** 86.13 kPa ± 0.13 kPa

**Evaluation Method**

**Tested with:**

PCB 377B02, S/N 173734

Larson Davis CAL291, S/N 0108

Larson Davis CAL200, S/N 9079

Larson Davis PRMLxT1L, S/N 042836

**Data reported in dB re 20 µPa.**

**Compliance Standards**

Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1

IEC 60804:2000 Type 1

IEC 61252:2002

IEC 61260:2001 Class 1

IEC 61672:2013 Class 1

ANSI S1.4-2014 Class 1

ANSI S1.4 (R2006) Type 1

ANSI S1.11 (R2009) Class 1

ANSI S1.25 (R2007)

ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2017.

Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to 1/2" adaptor is used with the preamplifier.

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716-684-0001

2021-8-26T07:51:18



Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Description	Standards Used		
	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2020-09-18	2021-09-18	001250
Hart Scientific 2626-H Temperature Probe	2021-02-04	2022-08-04	006767
Larson Davis CAL200 Acoustic Calibrator	2021-07-21	2022-07-21	007027
Larson Davis Model 831	2021-03-02	2022-03-02	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2021-03-03	2022-03-03	007185
SRS DS360 Ultra Low Distortion Generator	2021-04-13	2022-04-13	007635
Larson Davis 1/2" Preamplifier for Model 831 Type 1	2020-10-06	2021-10-06	PCB0004783

### Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.00	113.80	114.20	0.14	Pass

As Received Level: 116.07

Adjusted Level: 114.00

-- End of measurement results--

### Loaded Circuit Sensitivity

Measurement	Test Result [dB re 1 V / Pa]	Lower Limit [dB re 1 V / Pa]	Upper Limit [dB re 1 V / Pa]	Expanded Uncertainty [dB]	Result
1000 Hz	-27.69	-29.61	-26.24	0.14	Pass

-- End of measurement results--

### Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.20	-0.20	-1.20	0.80	0.23	Pass
1000	0.13	0.00	-0.70	0.70	0.23	Pass
8000	-2.49	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

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## Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted	40.32

-- End of measurement results--

-- End of Report--

Signatory: Ron Harris

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## CERTIFICATE OF CALIBRATION

Certificate No.: 21CA0120 03

Page: 1 of 2

### Item tested

Description: Acoustical Calibrator (Class 1)  
Manufacturer: Honglim Co., Ltd.  
Type/Model No.: HLES-02  
Serial/Equipment No.: 2019612870  
Adaptors used: -

### Item submitted by

Customer: Lam Environmental Services Limited.  
Address of Customer: -  
Request No.: -  
Date of receipt: 20-Jan-2021

Date of test: 24-Jan-2021

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Lab standard microphone	B&K 4180	2341427	11-May-2021	SCL
Preamplifier	B&K 2673	2743150	03-Jun-2021	CEPREI
Measuring amplifier	B&K 2610	2346941	03-Jun-2021	CEPREI
Signal generator	DS 360	33873	19-May-2021	CEPREI
Digital multi-meter	34401A	US36087050	19-May-2021	CEPREI
Audio analyzer	8903B	GB41300350	18-May-2021	CEPREI
Universal counter	53132A	MY40003662	18-May-2021	CEPREI

### Ambient conditions

Temperature:  $21 \pm 1$  °C  
Relative humidity:  $55 \pm 10$  %  
Air pressure:  $1000 \pm 5$  hPa

### Test specifications

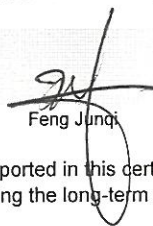
- The Sound Calibrator has been calibrated in accordance with the requirements as specified in IEC 60942 1997 Annex B and the lab calibration procedure SMTP004-CA-156.
- The calibrator was tested with its axis vertical facing downwards at the specific frequency using insert voltage technique.
- The results are rounded to the nearest 0.01 dB and 0.1 Hz and have not been corrected for variations from a reference pressure of 1013.25 hectoPascals as the maker's information indicates that the instrument is insensitive to pressure changes.

### Test results

This is to certify that the sound calibrator conforms to the requirements of annex B of IEC 60942: 1997 for the conditions under which the test was performed. This does not imply that the sound calibrator meets IEC 60942 under any other conditions.

Details of the performed measurements are presented on page 2 of this certificate.

Approved Signatory:

  
Feng Junqi

Date: 25-Jan-2021

Company Chop:



Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument. The results apply to the item as received.





# Calibration Certificate

Certificate Number 2020014198

Customer:

Lam Geotechnics Ltd

<b>Model Number</b>	LxT SE	<b>Procedure Number</b>	D0001.8384
<b>Serial Number</b>	0006307	<b>Technician</b>	Ron Harris
<b>Test Results</b>	<b>Pass</b>	<b>Calibration Date</b>	28 Dec 2020
<b>Initial Condition</b>	As Manufactured	<b>Calibration Due</b>	
<b>Description</b>	Sound Expert LxT Class 1 Sound Level Meter Firmware Revision: 2.404	<b>Temperature</b>	23.25 °C ± 0.25 °C
		<b>Humidity</b>	51.6 %RH ± 2.0 %RH
		<b>Static Pressure</b>	85.71 kPa ± 0.13 kPa

**Evaluation Method**      **Tested with:**      **Data reported in dB re 20 µPa.**

Larson Davis PRMLxT1L. S/N 070008  
PCB 377B02. S/N 325638  
Larson Davis CAL200. S/N 9079  
Larson Davis CAL291. S/N 0108

**Compliance Standards**      Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2017.

**Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis LxT Manual for SoundTrack LxT & SoundExpert Lxt, I770.01 Rev J Supporting Firmware Version 2.301, 2015-04-30

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**Certificate Number 2020014198**

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to 1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa

Periodic tests were performed in accordance with procedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used				
Description	Cal Date	Cal Due	Cal Standard	
Larson Davis CAL291 Residual Intensity Calibrator	2020-09-18	2021-09-18	001250	
Hart Scientific 2626-S Humidity/Temperature Sensor	2020-05-12	2021-05-12	006943	
Larson Davis CAL200 Acoustic Calibrator	2020-07-21	2021-07-21	007027	
Larson Davis Model 831	2020-03-02	2021-03-02	007182	
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2020-03-05	2021-03-05	007185	
SRS DS360 Ultra Low Distortion Generator	2020-04-14	2021-04-14	007635	
Larson Davis 1/2" Preamplifier for Model 831 Type 1	2020-10-06	2021-10-06	PCB0004783	

**Acoustic Calibration**

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.01	113.80	114.20	0.14	Pass

**Loaded Circuit Sensitivity**

Measurement	Test Result [dB re 1 V / Pa]	Lower Limit [dB re 1 V / Pa]	Upper Limit [dB re 1 V / Pa]	Expanded Uncertainty [dB]	Result
1000 Hz	-27.74	-29.61	-26.24	0.14	Pass

-- End of measurement results--



### Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.18	-0.20	-1.20	0.80	0.23	Pass
1000	0.16	0.00	-0.70	0.70	0.23	Pass
8000	-3.19	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

### Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted	40.20

-- End of measurement results--

-- End of Report--

Signatory: Ron Harris





## CERTIFICATE OF CALIBRATION

Certificate No.: 21CA0222 03 Page 1 of 2

### Item tested

Description:	Sound Level Meter (Class 1)	Microphone	Preamp
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250	4189	ZC0032
Serial/Equipment No.:	2701778	2755097	19223
Adaptors used:	-	-	-

### Item submitted by

Customer Name: Lam Geotechnics Limited.  
Address of Customer: -  
Request No.: -  
Date of receipt: 22-Feb-2021

Date of test: 23-Feb-2021

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	23-Aug-2021	CIGISMEC
Signal generator	DS 360	33873	19-May-2021	CEPREI

### Ambient conditions

Temperature:  $22 \pm 1$  °C  
Relative humidity:  $55 \pm 10$  %  
Air pressure:  $1000 \pm 5$  hPa

### Test specifications

- 1, The Sound Level Meter has been calibrated in accordance with the requirements as specified in BS 7580: Part 1: 1997 and the lab calibration procedure SMTP004-CA-152.
- 2, The electrical tests were performed using an electrical signal substituted for the microphone which was removed and replaced by an equivalent capacitance within a tolerance of  $\pm 20\%$ .
- 3, The acoustic calibration was performed using an B&K 4226 sound calibrator and corrections was applied for the difference between the free-field and pressure responsiveness of the Sound Level Meter.

### Test results

This is to certify that the Sound Level Meter conforms to BS 7580: Part 1: 1997 for the conditions under which the test was performed.

Details of the performed measurements are presented on page 2 of this certificate.

Actual Measurement data are documented on worksheets.

Approved Signatory:

Feng Junqi

Date: 24-Feb-2021

Company Chop:



Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument. The results apply to the item as received.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 21CA0222 03 Page 2 of 2

### 1, Electrical Tests

The electrical tests were performed using an equivalent capacitance substituted for the microphone. The results are given in below with test status and the estimated uncertainties. The "Pass" means the result of the test is inside the tolerances stated in the test specifications. The "-" means the result of test is outside these tolerances.

Test:	Subtest:	Status:	Expanded Uncertainty (dB)	Coverage Factor
Self-generated noise	A	Pass	0.3	
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	Reference SPL on all other ranges	Pass	0.3	
	2 dB below upper limit of each range	Pass	0.3	
	2 dB above lower limit of each range	Pass	0.3	
Linearity range for SPL	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	A	Pass	0.3	
	C	Pass	0.3	
Frequency weightings	Lin	Pass	0.3	
	Time weightings	Single Burst Fast	Pass	0.3
	Single Burst Slow	Pass	0.3	
Peak response	Single 100µs rectangular pulse	Pass	0.3	
	R.M.S. accuracy	Crest factor of 3	Pass	0.3
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor 1/10 <sup>3</sup> at 4kHz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>4</sup> at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
	Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4
Overload indication	SPL	Pass	0.3	
	Leq	Pass	0.4	

### 2, Acoustic tests

The complete sound level meter was calibrated on the reference range using a B&K 4226 acoustic calibrator with 1000Hz and SPL 94 dB. The sensitivity of the sound level meter was adjusted. The test result at 125 Hz and 8000 Hz are given in below with test status and the estimated uncertainties.

Test:	Subtest	Status	Expanded Uncertainty (dB)	Coverage Factor
Acoustic response	Weighting A at 125 Hz	Pass	0.3	
	Weighting A at 8000 Hz	Pass	0.5	

### 3, Response to associated sound calibrator

N/A

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by:

Date:

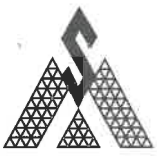
Fung Chi Yip  
23-Feb-2021

Checked by:

Date:

Feng Junqi  
24-Feb-2021

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.



Test Data for Sound Level Meter

Page 1 of 5

Sound level meter type:	2250	Serial No.	2701778	Date	23-Feb-2021
Microphone type:	4189	Serial No.	2755097		
Preamp type:	ZC0032	Serial No.	19223	Report:	21CA0222 03

**SELF GENERATED NOISE TEST**

The noise test is performed in the most sensitive range of the SLM with the microphone replaced by an equivalent impedance.

Noise level in A weighting	12.6	dB
Noise level in C weighting	13.8	dB
Noise level in Lin	20.0	dB

**LINEARITY TEST**

The linearity is tested relative to the reference sound pressure level using a continuous sinusoidal signal of frequency 4 kHz. The measurement is made on the reference range for indications at 5 dB intervals starting from the 94 dB reference sound pressure level. And until within 5 dB of the upper and lower limits of the reference range, the measurements shall be made at 1 dB intervals. (SLM set to LEQ/SPL)

Reference/Expected level	Actual level		Tolerance	Deviation	
	non-integrated	integrated		non-integrated	integrated
dB	dB	dB	+/- dB	dB	dB
94.0	94.0	94.0	0.7	0.0	0.0
99.0	99.0	99.0	0.7	0.0	0.0
104.0	104.0	104.0	0.7	0.0	0.0
109.0	109.0	109.0	0.7	0.0	0.0
114.0	114.0	114.0	0.7	0.0	0.0
119.0	119.0	119.0	0.7	0.0	0.0
124.0	124.0	124.0	0.7	0.0	0.0
129.0	129.0	129.0	0.7	0.0	0.0
134.0	134.0	134.0	0.7	0.0	0.0
135.0	135.0	135.0	0.7	0.0	0.0
136.0	136.0	136.0	0.7	0.0	0.0
137.0	137.0	137.0	0.7	0.0	0.0
138.0	138.0	138.0	0.7	0.0	0.0
139.0	139.0	139.0	0.7	0.0	0.0
140.0	140.0	140.0	0.7	0.0	0.0
89.0	89.0	89.0	0.7	0.0	0.0
84.0	84.0	84.0	0.7	0.0	0.0
79.0	79.0	79.0	0.7	0.0	0.0
74.0	74.0	74.0	0.7	0.0	0.0
69.0	69.0	69.0	0.7	0.0	0.0
64.0	64.0	64.0	0.7	0.0	0.0
59.0	59.0	59.0	0.7	0.0	0.0
54.0	54.0	54.0	0.7	0.0	0.0
49.0	49.0	49.0	0.7	0.0	0.0
44.0	44.0	44.0	0.7	0.0	0.0
39.0	39.0	39.0	0.7	0.0	0.0



Test Data for Sound Level Meter

Page 2 of 5

Sound level meter type: 2250 Serial No. 2701778 Date 23-Feb-2021  
Microphone type: 4189 Serial No. 2755097  
Preamp type: ZC0032 Serial No. 19223 Report: 21CA0222 03

34.0	34.0	34.0	0.7	0.0	0.0
33.0	33.0	33.0	0.7	0.0	0.0
32.0	32.0	32.0	0.7	0.0	0.0
31.0	31.0	31.0	0.7	0.0	0.0
30.0	30.0	30.0	0.7	0.0	0.0

Measurements for an indication of the reference SPL on all other ranges which include it

Other ranges	Expected level	Actual level	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
20-140	94.0	94.0	0.7	0.0

Measurements on all level ranges for indications 2 dB below the upper limit and 2 dB above the lower limit

Ranges	Reference/Expected level	Actual level	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
20-140	30.0	30.0	0.7	0.0
	138.0	138.0	0.7	0.0

## FREQUENCY WEIGHTING TEST

The frequency response of the weighting networks are tested at octave intervals over the frequency ranges 31.5 Hz to 12500 Hz. The signal level at 1000 Hz is set to give an indication of the reference SPL.

Frequency weighting A:

Frequency	Ref. level	Expected level	Correction of electrical response	Actual level	Tolerance(dB)		Deviation *
					+	-	
Hz	dB	dB	dB	dB	+	-	dB
1000.0	94.0	94.0	0.0	94.0	0.0	0.0	0.0
31.6	94.0	54.6	N/A	54.6	1.5	1.5	0.0
63.1	94.0	67.8	0.0	67.8	1.5	1.5	0.0
125.9	94.0	77.9	0.0	77.9	1.0	1.0	0.0
251.2	94.0	85.4	0.0	85.4	1.0	1.0	0.0
501.2	94.0	90.8	0.0	90.7	1.0	1.0	-0.1
1995.0	94.0	95.2	0.0	95.2	1.0	1.0	0.0
3981.0	94.0	95.0	-0.1	94.9	1.0	1.0	0.0
7943.0	94.0	92.9	-0.3	92.6	1.5	3.0	0.0
12590.0	94.0	89.7	-0.3	89.4	3.0	6.0	0.0

Frequency weighting C:

Frequency	Ref. level	Expected level	Correction of electrical response	Actual level	Tolerance(dB)		Deviation *
					+	-	
Hz	dB	dB	dB	dB	+	-	dB
1000.0	94.0	94.0	0.0	94.0	0.0	0.0	0.0
31.6	94.0	91.0	N/A	91.1	1.5	1.5	0.1
63.1	94.0	93.2	0.0	93.2	1.5	1.5	0.0
125.9	94.0	93.8	0.0	93.8	1.0	1.0	0.0



Test Data for Sound Level Meter

Page 3 of 5

Sound level meter type: 2250 Serial No. 2701778 Date 23-Feb-2021  
Microphone type: 4189 Serial No. 2755097  
Preamp type: ZC0032 Serial No. 19223 Report: 21CA0222 03

251.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
501.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
1995.0	94.0	93.8	0.0	93.8	1.0	1.0	0.0
3981.0	94.0	93.2	-0.1	93.1	1.0	1.0	0.0
7943.0	94.0	91.0	-0.3	90.7	1.5	3.0	0.0
12590.0	94.0	87.8	-0.3	87.5	3.0	6.0	0.0

Frequency weighting Lin:

Frequency Hz	Ref. level dB	Expected level dB	Correction of electrical response dB	Actual level dB	Tolerance(dB)		Deviation * dB
					+	-	
1000.0	94.0	94.0	0.0	94.0	0.0	0.0	0.0
31.6	94.0	94.0	N/A	94.1	1.5	1.5	0.1
63.1	94.0	94.0	0.0	94.0	1.5	1.5	0.0
125.9	94.0	94.0	0.0	94.0	1.0	1.0	0.0
251.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
501.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
1995.0	94.0	94.0	0.0	94.0	1.0	1.0	0.0
3981.0	94.0	94.0	-0.1	94.0	1.0	1.0	0.1
7943.0	94.0	94.0	-0.3	93.7	1.5	3.0	0.0
12590.0	94.0	94.0	-0.3	93.7	3.0	6.0	0.0

\*Deviation = Actual level - ( Expected level + Correction of electrical response)

The correction of electrical response is specified in the Table A.2 of technical documentation of BE 1712-21. The maximum expanded uncertainty of correction of electrical response is 0.29 dB.

TIME WEIGHTING FAST TEST

Time weighting F is tested on the reference range with a single sinusoidal burst of duration 200 ms at a frequency 2000 Hz and an amplitude which produces an indication 4 dB below the upper limit of the primary indicator range when the signal is continuous. (Weight A, Maximum hold)

Ref. level dB	Expected level dB	Actual level dB	Tolerance(dB)		Deviation dB
			+	-	
116.0	115.0	115.0	1.0	1.0	0.0

TIME WEIGHTING SLOW TEST

Time weighting S is tested on the reference range with a single sinusoidal burst of duration 500 ms at a frequency 2000 Hz and an amplitude which produces an indication 4 dB below the upper limit of the primary indicator range when the signal is continuous. (Weight A, Maximum hold)

Ref. level dB	Expected level dB	Actual level dB	Tolerance(dB)		Deviation dB
			+	-	
116.0	111.9	111.9	1.0	1.0	0.0

PEAK RESPONSE TEST

The onset time of the peak detector is tested on the reference range by comparing the response to a 100 us





Test Data for Sound Level Meter

Page 4 of 5

Sound level meter type: 2250 Serial No. 2701778 Date 23-Feb-2021  
Microphone type: 4189 Serial No. 2755097  
Preamp type: ZC0032 Serial No. 19223 Report: 21CA0222 03

rectangular test pulse with the response to a 10 ms reference pulse of the same amplitude. The amplitude of the 10 ms reference pulse is such as to produce an indication 1 dB below the upper limit of the primary indicator range.

Positive polarities: (Weighting C, set the generator signal to single, Lcpeak)

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
119.0	119.0	119.6	2.0	0.6

Negative polarities:

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
119.0	119.0	119.6	2.0	0.6

RMS ACCURACY TEST

The RMS detector accuracy is tested on the reference range for a crest factor of 3.

Test frequency: 2000 Hz  
Amplitude: 2 dB below the upper limit of the primary indicator range.  
Burst repetition frequency: 40 Hz  
Tone burst signal: 11 cycles of a sine wave of frequency 2000 Hz. (Set to INT)

Time weighting	Ref. Level	Expected level	Tone burst signal	Tolerance	Deviation
	dB	dB	indication(dB)	+/- dB	dB
Slow	118.0+6.6	118.0	117.9	0.5	-0.1

TIME WEIGHTING IMPULSE TEST

Time weighting I is tested on the reference range (Set the SLM to LAImax)

Test frequency: 2000 Hz  
Amplitude: The upper limit of the primary indicator range.

Single sinusoidal burst of duration 5 ms:

Ref. Level	Single burst indication		Tolerance	Deviation
dB	Expected (dB)	Actual (dB)	+/- dB	dB
120.0	111.2	111.2	2.0	0.0

Repeated at 100 Hz

Ref. Level	Repeated burst indication		Tolerance	Deviation
dB	Expected (dB)	Actual (dB)	+/- dB	dB
120.0	117.3	117.2	1.0	-0.1

TIME AVERAGING TEST

This test compares the SLM reading for continuous sine signals with readings obtained from a sine tone burst sequence having the same RMS level. The test level is 30 dB below the upper limit of the linearity range and repeated for Type 1 SLM with 40 dB below the upper limit of the linearity.

Frequency of tone burst: 4000 Hz

Duration of tone burst: 1 ms

Repetition Time	Level of tone burst	Expected Leq	Actual Leq	Tolerance	Deviation	Remarks
msec	dB	dB	dB	+/- dB	dB	
1000	110.0	110.0	109.9	1.0	-0.1	60s integ.
10000	100.0	100.0	99.9	1.0	-0.1	6min. integ.



Test Data for Sound Level Meter

Sound level meter type:	2250	Serial No.	2701778	Date	23-Feb-2021
Microphone type:	4189	Serial No.	2755097		
Preamp type:	ZC0032	Serial No.	19223	Report:	21CA0222 03

**PULSE RANGE AND SOUND EXPOSURE LEVEL TEST**

The test tone burst signal is superimposed on a baseline signal corresponding to the lower limit of reference range

Test frequency: 4000 Hz

Integration time: 10 sec

The integrating sound level meter set to Leq:

Duration	Rms level of	Expected	Actual	Tolerance	Deviation
msec	tone burst (dB)	dB	dB	+/- dB	dB
10	110.0	80.0	80.0	1.7	0.0

The integrating sound level meter set to SEL:

Duration	Rms level of	Expected	Actual	Tolerance	Deviation
msec	tone burst (dB)	dB	dB	+/- dB	dB
10.0	110.0	90.0	90.0	1.7	0.0

**OVERLOAD INDICATION TEST**

For SLM capable of operating in a non-integrating mode.

Test frequency: 2000 Hz

Amplitude: 2 dB below the upper limit of the primary indicator range.

Burst repetition frequency: 40 Hz

Tone burst signal: 11 cycles of a sine wave of frequency 2000 Hz.

Level	Level reduced by	Further reduced	Difference	Tolerance	Deviation
at overload (dB)	1 dB	3 dB	dB	dB	dB
134.9	133.9	130.9	3.0	1.0	0.0

For integrating SLM, with the instrument indicating Leq.

For integrating SLM, with the instrument indicating Leq and set to the reference range. The test signal as following:

The test tone burst signal is superimposed on a baseline signal corresponding to the lower limit of reference range

Test frequency: 4000 Hz

Integration time: 10 sec

Single burst duration: 1 msec

Rms level	Level reduced by	Expected level	Actual level	Tolerance	Deviation
at overload (dB)	1 dB	dB	dB	dB	dB
141.6	140.6	100.6	100.6	2.2	0.0

**ACOUSTIC TEST**

The acoustic test of the complete SLM is tested at the frequency 125 Hz and 8000 Hz using a B&K type 4226 Multifunction Acoustic Calibrator. The test is performed in A weighting.

Frequency	Expected level	Actual level		Tolerance (dB)	Deviation
		Measured (dB)			
Hz	dB			+	-
1000	94.0	94.0		0.0	0.0
125	77.9	78.0		1.0	1.0
8000	92.9	91.9		1.5	3.0

-----END-----



## CERTIFICATE OF CALIBRATION

Certificate No.: 21CA0429 02 Page 1 of 2

### Item tested

Description:	Sound Level Meter (Type 1)	Microphone	Preamp
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250-L	4950	ZC0032
Serial/Equipment No.:	2722311	2698703	13321
Adaptors used:	-	-	-

### Item submitted by

Customer Name: Lam Geotechnics Ltd.  
Address of Customer: -  
Request No.: -  
Date of receipt: 29-Apr-2021

Date of test: 30-Apr-2021

### Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	23-Aug-2021	CIGISMEC
Signal generator	DS 360	61227	19-May-2021	CEPREI

### Ambient conditions

Temperature: 22 ± 1 °C  
Relative humidity: 55 ± 10 %  
Air pressure: 1005 ± 5 hPa

### Test specifications

- 1, The Sound Level Meter has been calibrated in accordance with the requirements as specified in BS 7580: Part 1: 1997 and the lab calibration procedure SMTP004-CA-152.
- 2, The electrical tests were performed using an electrical signal substituted for the microphone which was removed and replaced by an equivalent capacitance within a tolerance of ±20%.
- 3, The acoustic calibration was performed using an B&K 4226 sound calibrator and corrections was applied for the difference between the free-field and pressure responsiveness of the Sound Level Meter.

### Test results

This is to certify that the Sound Level Meter conforms to BS 7580: Part 1: 1997 for the conditions under which the test was performed.

Details of the performed measurements are presented on page 2 of this certificate.

Actual Measurement data are documented on worksheets.

Approved Signatory:

  
Feng Junqi

Date: 03-May-2021

Company Chop:



Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument. The results apply to the item as received.



## CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 21CA0429 02 Page 2 of 2

### 1, Electrical Tests

The electrical tests were performed using an equivalent capacitance substituted for the microphone. The results are given in below with test status and the estimated uncertainties. The "Pass" means the result of the test is inside the tolerances stated in the test specifications. The "-" means the result of test is outside these tolerances.

Test:	Subtest:	Status:	Expanded Uncertainty (dB)	Coverage Factor
Self-generated noise	A	Pass	0.3	
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
	Reference SPL on all other ranges	Pass	0.3	
	2 dB below upper limit of each range	Pass	0.3	
	2 dB above lower limit of each range	Pass	0.3	
Linearity range for SPL	At reference range, Step 5 dB at 4 kHz	Pass	0.3	
	Frequency weightings			
Time weightings	A	Pass	0.3	
	C	Pass	0.3	
	Lin	Pass	0.3	
Peak response	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
R.M.S. accuracy	Single 100µs rectangular pulse	Pass	0.3	
	Crest factor of 3	Pass	0.3	
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor 1/10 <sup>3</sup> at 4kHz	Pass	0.3	
	1 ms burst duty factor 1/10 <sup>4</sup> at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
	Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4
Overload indication	SPL	Pass	0.3	
	Leq	Pass	0.4	

### 2, Acoustic tests

The complete sound level meter was calibrated on the reference range using a B&K 4226 acoustic calibrator with 1000Hz and SPL 94 dB. The sensitivity of the sound level meter was adjusted. The test result at 125 Hz and 8000 Hz are given in below with test status and the estimated uncertainties.

Test:	Subtest	Status	Expanded Uncertainty (dB)	Coverage Factor
Acoustic response	Weighting A at 125 Hz	Pass	0.3	
	Weighting A at 8000 Hz	Pass	0.5	

### 3, Response to associated sound calibrator

N/A

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by:

Date: 30-Apr-2021

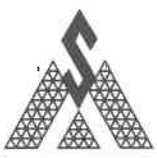
Fung Chi Yip

Checked by:

Date: 03-May-2021

Chan Yuk Yiu

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.



Test Data for Sound Level Meter

Page 1 of 5

Sound level meter type:	2250-L	Serial No.	2722311	Date	30-Apr-2021
Microphone type:	4950	Serial No.	2698703		
Preamp type:	ZC0032	Serial No.	13321	Report:	21CA0429 02

**SELF GENERATED NOISE TEST**

The noise test is performed in the most sensitive range of the SLM with the microphone replaced by an equivalent impedance.

Noise level in A weighting	13.4	dB
Noise level in C weighting	16.5	dB
Noise level in Lin	23.2	dB

**LINEARITY TEST**

The linearity is tested relative to the reference sound pressure level using a continuous sinusoidal signal of frequency 4 kHz. The measurement is made on the reference range for indications at 5 dB intervals starting from the 94 dB reference sound pressure level. And until within 5 dB of the upper and lower limits of the reference range, the measurements shall be made at 1 dB intervals. (SLM set to LEQ/SPL)

Reference/Expected level	Actual level		Tolerance	Deviation	
	non-integrated	integrated		non-integrated	integrated
dB	dB	dB	+/- dB	dB	dB
94.0	94.0	94.0	0.7	0.0	0.0
99.0	99.0	99.0	0.7	0.0	0.0
104.0	104.0	104.0	0.7	0.0	0.0
109.0	109.0	109.0	0.7	0.0	0.0
114.0	114.0	114.0	0.7	0.0	0.0
119.0	119.0	119.0	0.7	0.0	0.0
124.0	124.0	124.0	0.7	0.0	0.0
129.0	129.0	129.0	0.7	0.0	0.0
134.0	134.0	134.0	0.7	0.0	0.0
135.0	135.0	135.0	0.7	0.0	0.0
136.0	136.0	136.0	0.7	0.0	0.0
137.0	137.0	137.0	0.7	0.0	0.0
138.0	138.0	138.0	0.7	0.0	0.0
139.0	139.0	139.0	0.7	0.0	0.0
140.0	140.0	140.0	0.7	0.0	0.0
89.0	89.0	89.0	0.7	0.0	0.0
84.0	84.0	84.0	0.7	0.0	0.0
79.0	79.0	79.0	0.7	0.0	0.0
74.0	74.0	74.0	0.7	0.0	0.0
69.0	69.0	69.0	0.7	0.0	0.0
64.0	64.0	64.0	0.7	0.0	0.0
59.0	59.0	59.0	0.7	0.0	0.0
54.0	54.0	54.0	0.7	0.0	0.0
49.0	49.0	49.0	0.7	0.0	0.0
44.0	43.9	43.9	0.7	-0.1	-0.1
39.0	39.0	39.0	0.7	0.0	0.0



Test Data for Sound Level Meter

Page 2 of 5

Sound level meter type: 2250-L Serial No. 2722311 Date 30-Apr-2021  
Microphone type: 4950 Serial No. 2698703  
Preamp type: ZC0032 Serial No. 13321 Report: 21CA0429 02

34.0	34.0	34.0	0.7	0.0	0.0
33.0	33.0	33.0	0.7	0.0	0.0
32.0	32.0	32.0	0.7	0.0	0.0
31.0	31.0	31.0	0.7	0.0	0.0
30.0	30.0	30.0	0.7	0.0	0.0

Measurements for an indication of the reference SPL on all other ranges which include it

Other ranges	Expected level	Actual level	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
20-140	94.0	94.0	0.7	0.0

Measurements on all level ranges for indications 2 dB below the upper limit and 2 dB above the lower limit

Ranges	Reference/Expected level	Actual level	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
20-140	30.0	30.0	0.7	0.0
	138.0	138.0	0.7	0.0

### FREQUENCY WEIGHTING TEST

The frequency response of the weighting networks are tested at octave intervals over the frequency ranges 31.5 Hz to 12500 Hz. The signal level at 1000 Hz is set to give an indication of the reference SPL.

Frequency weighting A:

Frequency	Ref. level	Expected level	Correction of electrical response	Actual level	Tolerance(dB)		Deviation *
					+	-	
Hz	dB	dB	dB	dB			dB
1000.0	94.0	94.0	0.0	94.0	0.0	0.0	0.0
31.6	94.0	54.6	N/A	54.5	1.5	1.5	-0.1
63.1	94.0	67.8	0.0	67.8	1.5	1.5	0.0
125.9	94.0	77.9	0.0	77.9	1.0	1.0	0.0
251.2	94.0	85.4	0.0	85.4	1.0	1.0	0.0
501.2	94.0	90.8	0.0	90.8	1.0	1.0	0.0
1995.0	94.0	95.2	0.0	95.2	1.0	1.0	0.0
3981.0	94.0	95.0	-0.1	94.9	1.0	1.0	0.0
7943.0	94.0	92.9	-0.3	92.6	1.5	3.0	0.0
12590.0	94.0	89.7	-0.3	89.4	3.0	6.0	0.0

Frequency weighting C:

Frequency	Ref. level	Expected level	Correction of electrical response	Actual level	Tolerance(dB)		Deviation *
					+	-	
Hz	dB	dB	dB	dB			dB
1000.0	94.0	94.0	0.0	94.0	0.0	0.0	0.0
31.6	94.0	91.0	N/A	91.1	1.5	1.5	0.1
63.1	94.0	93.2	0.0	93.2	1.5	1.5	0.0
125.9	94.0	93.8	0.0	93.8	1.0	1.0	0.0



Test Data for Sound Level Meter

Page 3 of 5

Sound level meter type: 2250-L Serial No. 2722311 Date 30-Apr-2021  
Microphone type: 4950 Serial No. 2698703  
Preamp type: ZC0032 Serial No. 13321 Report: 21CA0429 02

251.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
501.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
1995.0	94.0	93.8	0.0	93.8	1.0	1.0	0.0
3981.0	94.0	93.2	-0.1	93.1	1.0	1.0	0.0
7943.0	94.0	91.0	-0.3	90.7	1.5	3.0	0.0
12590.0	94.0	87.8	-0.3	87.5	3.0	6.0	0.0

Frequency weighting Lin:

Frequency Hz	Ref. level dB	Expected level dB	Correction of electrical response dB	Actual level dB	Tolerance(dB)		Deviation * dB
					+	-	
1000.0	94.0	94.0	0.0	94.0	0.0	0.0	0.0
31.6	94.0	94.0	N/A	94.1	1.5	1.5	0.1
63.1	94.0	94.0	0.0	94.0	1.5	1.5	0.0
125.9	94.0	94.0	0.0	94.0	1.0	1.0	0.0
251.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
501.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
1995.0	94.0	94.0	0.0	94.0	1.0	1.0	0.0
3981.0	94.0	94.0	-0.1	93.9	1.0	1.0	0.0
7943.0	94.0	94.0	-0.3	93.7	1.5	3.0	0.0
12590.0	94.0	94.0	-0.3	93.7	3.0	6.0	0.0

\*Deviation = Actual level - ( Expected level + Correction of electrical response)

The correction of electrical response is specified in the Table A.2 of technical documentation of BE 1853-11. The maximum expanded uncertainty of correction of electrical response is 0.3 dB.

TIME WEIGHTING FAST TEST

Time weighting F is tested on the reference range with a single sinusoidal burst of duration 200 ms at a frequency 2000 Hz and an amplitude which produces an indication 4 dB below the upper limit of the primary indicator range when the signal is continuous. (Weight A, Maximum hold)

Ref. level dB	Expected level dB	Actual level dB	Tolerance(dB)		Deviation dB
			+	-	
136.0	135.0	135.0	1.0	1.0	0.0

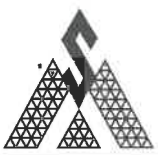
TIME WEIGHTING SLOW TEST

Time weighting S is tested on the reference range with a single sinusoidal burst of duration 500 ms at a frequency 2000 Hz and an amplitude which produces an indication 4 dB below the upper limit of the primary indicator range when the signal is continuous. (Weight A, Maximum hold)

Ref. level dB	Expected level dB	Actual level dB	Tolerance(dB)		Deviation dB
			+	-	
136.0	131.9	131.9	1.0	1.0	0.0

PEAK RESPONSE TEST

The onset time of the peak detector is tested on the reference range by comparing the response to a 100 us rectangular test pulse with the response to a 10 ms reference pulse of the same amplitude. The amplitude of the



Test Data for Sound Level Meter

Page 4 of 5

Sound level meter type: 2250-L Serial No. 2722311 Date 30-Apr-2021  
Microphone type: 4950 Serial No. 2698703  
Preamp type: ZC0032 Serial No. 13321 Report: 21CA0429 02

10 ms reference pulse is such as to produce an indication 1 dB below the upper limit of the primary indicator range.

Positive polarities: (Weighting C, set the generator signal to single, Lcpeak)

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
139.0	139.0	137.5	2.0	-1.5

Negative polarities:

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
139.0	139.0	137.5	2.0	-1.5

RMS ACCURACY TEST

The RMS detector accuracy is tested on the reference range for a crest factor of 3.

Test frequency: 2000 Hz  
Amplitude: 2 dB below the upper limit of the primary indicator range.  
Burst repetition frequency: 40 Hz  
Tone burst signal: 11 cycles of a sine wave of frequency 2000 Hz. (Set to INT)

Time weighting	Ref. Level	Expected level	Tone burst signal	Tolerance	Deviation
	dB	dB	indication(dB)	+/- dB	dB
Slow	118.0+6.6	118.0	117.9	0.5	-0.1

TIME WEIGHTING IMPULSE TEST

Time weighting I is tested on the reference range (Set the SLM to LAImax)

Test frequency: 2000 Hz  
Amplitude: The upper limit of the primary indicator range.

Single sinusoidal burst of duration 5 ms:

Ref. Level	Single burst indication		Tolerance	Deviation
dB	Expected (dB)	Actual (dB)	+/- dB	dB
140.0	131.2	131.1	2.0	-0.1

Repeated at 100 Hz

Ref. Level	Repeated burst indication		Tolerance	Deviation
dB	Expected (dB)	Actual (dB)	+/- dB	dB
140.0	137.3	137.2	1.0	-0.1

TIME AVERAGING TEST

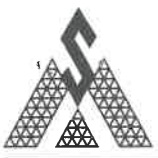
This test compares the SLM reading for continuous sine signals with readings obtained from a sine tone burst sequence having the same RMS level. The test level is 30 dB below the upper limit of the linearity range and repeated for Type 1 SLM with 40 dB below the upper limit of the linearity.

Frequency of tone burst: 4000 Hz

Duration of tone burst: 1 ms

Repetition Time	Level of tone burst	Expected Leq	Actual Leq	Tolerance	Deviation	Remarks
msec	dB	dB	dB	+/- dB	dB	
1000	110.0	110.0	109.9	1.0	-0.1	60s integ.
10000	100.0	100.0	99.9	1.0	-0.1	6min. integ.





Test Data for Sound Level Meter

Sound level meter type: 2250-L Serial No. 2722311 Date 30-Apr-2021  
Microphone type: 4950 Serial No. 2698703  
Preamp type: ZC0032 Serial No. 13321 Report: 21CA0429 02

**PULSE RANGE AND SOUND EXPOSURE LEVEL TEST**

The test tone burst signal is superimposed on a baseline signal corresponding to the lower limit of reference range

Test frequency: 4000 Hz

Integration time: 10 sec

The integrating sound level meter set to Leq:

Duration	Rms level of	Expected	Actual	Tolerance	Deviation
msec	tone burst (dB)	dB	dB	+/- dB	dB
10	110.0	80.0	80.0	1.7	0.0

The integrating sound level meter set to SEL:

Duration	Rms level of	Expected	Actual	Tolerance	Deviation
msec	tone burst (dB)	dB	dB	+/- dB	dB
10.0	110.0	90.0	90.0	1.7	0.0

**OVERLOAD INDICATION TEST**

For SLM capable of operating in a non-integrating mode.

Test frequency: 2000 Hz  
Amplitude: 2 dB below the upper limit of the primary indicator range.  
Burst repetition frequency: 40 Hz  
Tone burst signal: 11 cycles of a sine wave of frequency 2000 Hz.

Level	Level reduced by	Further reduced	Difference	Tolerance	Deviation
at overload (dB)	1 dB	3 dB	dB	dB	dB
135.5	134.5	131.5	3.0	1.0	0.0

For integrating SLM, with the instrument indicating Leq.

For integrating SLM, with the instrument indicating Leq and set to the reference range. The test signal as following:  
The test tone burst signal is superimposed on a baseline signal corresponding to the lower limit of reference range

Test frequency: 4000 Hz  
Integration time: 10 sec  
Single burst duration: 1 msec

Rms level	Level reduced by	Expected level	Actual level	Tolerance	Deviation
at overload (dB)	1 dB	dB	dB	dB	dB
142.3	141.3	101.3	101.3	2.2	0.0

**ACOUSTIC TEST**

The acoustic test of the complete SLM is tested at the frequency 125 Hz and 8000 Hz using a B&K type 4226 Multifunction Acoustic Calibrator. The test is performed in A weighting.

Frequency	Expected level	Actual level		Tolerance (dB)		Deviation
		Measured (dB)		+	-	
Hz	dB	Measured (dB)				dB
1000	94.0	94.0		0.0	0.0	0.0
125	77.9	78.0		1.0	1.0	0.1
8000	92.9	93.6		1.5	3.0	0.7

-----END-----

校 正 證 書  
CALIBRATION CERTIFICATE

證書編號(Certificate No.): HBKT-20210022

第 1 頁 , 共 17 頁 (Page 1 of 17)

委託單位: LAM Geotechnics Limited

Customer:

地 址: 11/F Centre Point, 181-185 Gloucester Road, Wanchai, Hong Kong S. A. R of China

Address:

儀器名稱: Nexus調適放大器

Equipment:

型號規格: 2693-0S4

Model/Type:

製 造 商: Bruel & Kjaer

Manufacture:

機 身 號: 2099340

Serial No.

接收日期: 2021-06-11

校正日期: 2021-06-22

Date of Receipt

Date of Cal.

批准日期: 2021-06-24


Date of Approve



實驗室印章  
Chop

主 管

Approved by



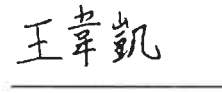
審 核

Inspected by



校 正

Calibrated by



台灣思百吉股份有限公司

Bruel & Kjaer

地址/Addr: 台北市民生東路三段128號13樓之一

電話/Tel: +886 2 25462988

網址/Website: www.bksv.cn / www.bksv.com

Bruel & Kjaer Division of Spectris Taiwan Limited

Bruel & Kjaer

13F-1, No.128, Sec.3, Min Sheng E. Road, Taipei City 105, Taiwan, R. O.C.

傳真/Fax: +886 2 25462989

# 校正說明

## Directions of Calibration

證書編號(Certificate No.): HBKT-20210022

第 2 頁, 共 17 頁 (Page2 of 17)

1 本實驗室所出具的數據均可溯源到國家計量基準和國際單位制(SI)。

All data issued by this calibration laboratory are traceable to national primary standards and the International System of Unit(SI).

2 本次測量結果僅與被測件有關。

The measurement results are only related to the Unit Under Test.

3 本次校正的技術依據(Reference documents for the calibration)

本次校準依據 P\_2690\_A12 Bruel & Kjaer NEXUS 2690 麥克風輸入型調適放大器校正程序 进行。

The calibration has been performed in accordance with P\_2690\_A12 Calibration Procedure for Nexus Range of conditioning Amplifiers Microphone Input.

4 本次校正所使用的主要測量標準 (Main measurement standards used during the calibration)

設備名稱/型號	機身編號	不確定度或準確度等級 或最大允許誤差	溯源至/證書編號	有效期至
Equipment/Model	Serial No.	Uncertainty or Accuracy Class or MPE	Traceable to/ Certificate No.	Due Date
Multimeter/ HP/3458A	2823A13040	AC Voltage $U_{rel}$ (0.001% ~0.016%), $k=2$ DC Voltage $U_{rel}$ (0.002% ~0.225%), $k=2$	財團法人台灣電子 檢驗中心/21-01- BAC-129-02L	2022-01-10

5 本次校正中主要校正參數的不確定度分別是(The uncertainty of main measurement parameter):

詳見校正結果頁。Shown in the calibration result page.

6 校正地點(Place of the calibration)

HBK校準實驗室 (臺灣)

7 校正環境條件(Environmental condition during the calibration)

溫度(Temperature) 23.2 °C 相對溫度(Relative Humidity) 60.9 %

Channel Type: DELTATRON ZX 2693  
 Channel No: 1

All measurements made non floating on input and output.  
 Transducer sensitivity : 1 V/V.

Calibrated output:  
 The gain from input to calibrated output, is calculated as measured output level, relative to measured input level. Levels are measured by means of a DMM.

Generator frequency: 1 kHz  
 When applying amplitudes below 31.62 mV (90 dBuV) a 40 dB attenuator is used.  
 Nexus: HP 10Hz, LP 100kHz  
 Output bandwidth limited with external 22.4 kHz LP filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty	
<b>Nexus setting</b>	<b>Input Level</b>					
100mV/ms-2	5.01187 Volt	V/ms-2	0.0989	0.1012	0.0997	0.0002
316mV/ms-2	5.01187 Volt	V/ms-2	0.3126	0.3199	0.3154	0.0004
1 V/ms-2	1.77828 Volt	V/ms-2	0.9886	1.0116	0.9976	0.0012
3.16 V/ms-2	0.56234 Volt	V/ms-2	3.1261	3.1989	3.1546	0.0037
10 V/ms-2	0.17783 Volt	V/ms-2	9.8855	10.1158	9.9860	0.0116
31.6 V/ms-2	0.05623 Volt	V/ms-2	31.2608	31.9890	31.5712	0.0693
100 V/ms-2	0.01778 Volt	V/ms-2	98.8553	101.1579	99.6039	0.1152
316 V/ms-2	0.00562 Volt	V/ms-2	312.6079	319.8895	314.9737	0.3641
1kV/ms-2	0.00178 Volt	V/ms-2	988.5531	1011.5795	998.0384	1.1514

注: 未经本实验室批准, 不得部份复制此校正证书。

Note: This certificate can't be partly copied if not approved by the laboratory.

**Lowpass filters:**

The frequency response of Lowpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

Input Level: 1 Volt (120 dBuV)

Nexus: Sens. 1 V/ms<sup>2</sup> (0 dB Gain)

(LP 100 k results not valid with WH 3219 option)

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
<b>Nexus setting</b>	<b>Frequency</b>				
LP 0.1k HP 1	20 Hz	% -1.14	1.16	-0.30	0.12
LP 0.1k HP 1	100 Hz	% -14.89	-6.67	-11.02	0.42
LP 1 k HP 10	200 Hz	% -1.14	1.16	-0.31	0.12
LP 1 k HP 10	1000 Hz	% -14.89	-6.67	-10.99	0.42
LP 3 k HP 10	600 Hz	% -1.14	1.16	-0.29	0.12
LP 3 k HP 10	3000 Hz	% -14.89	-6.67	-10.72	0.42
LP 10 k HP 10	2000 Hz	% -1.14	1.16	-0.39	0.12
LP 10 k HP 10	10000 Hz	% -14.89	-6.67	-11.10	0.42
LP 22.4k HP 10	4480 Hz	% -1.14	1.16	-0.44	0.12
LP 22.4k HP 10	22400 Hz	% -14.89	-6.67	-11.32	0.42
LP 30 k HP 10	6000 Hz	% -1.14	1.16	-0.34	0.12
LP 30 k HP 10	30000 Hz	% 14.89	-6.67	-10.35	0.42
LP 100 k HP 10	20000 Hz	% -1.14	1.16	-0.17	0.12
LP 100 k HP 10	60000 Hz	% -4.50	4.71	1.33	0.47
LP 100 k HP 10	100000 Hz	% -18.72	-2.28	-12.74	0.62

**Highpass filters:**

The frequency response of Highpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

Input Level: 1 Volt (120 dBuV)

Nexus: Sens. 1 V/ms<sup>2</sup> (0 dB Gain), LP 100 kHz.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
<b>Nexus setting</b>	<b>Frequency</b>				
HP 0.1	0.1 Hz	% -14.89	-6.67	-2.26	*
HP 0.1	0.5 Hz	% -1.14	1.16	-1.11	*
HP 1	1.0 Hz	% -14.89	-6.67	-10.09	*
HP 1	5.0 Hz	% -1.14	1.16	-0.60	*
HP 10	10.0 Hz	% -14.89	-6.67	-10.62	0.42
HP 10	50.0 Hz	% -1.14	1.16	-0.52	0.12

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**Inherent noise:**

The Inherent Noise is measured by connecting a short-circuit plug to the input, and measuring the output level by means of a DMM.

Nexus: Sens. 10kV/Pa (80dB Gain), HP 10Hz, LP 100kHz

Input shorted.

Output bandwidth limited with external A filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
A weighted	uV		2.00	1.71	*

**Reference Generator:**

Measure output level from internal generator.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
Ref Tone	dBuV	119.90	120.10	120.02	*
Test Tone	dBuV	0.00	0.00	0.00	*

**Distortion:**

Generator signal: 127 dBuV (2.24 Volt), 1 kHz

Nexus: Sens. 1 V/ms<sup>-2</sup> (0 dB Gain), HP 10Hz, LP 100kHz

Basetone is rejected with a notchfilter.

Output of the notch filter is digitized with the HP3458A DMM, and 2. harmonic and 3. harmonic is determined with a DFT.

Parameter	Unit	Upper Limit	Measured Value	Calibration Uncertainty
2. Harmonic	%	0.0030	0.0018	*
3. Harmonic	%	0.0030	0.0010	*

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Channel Type: DELTATRON ZX 2693  
 Channel No: 2

All measurements made non floating on input and output.  
 Transducer sensitivity : 1 V/V.

Calibrated output:  
 The gain from input to calibrated output, is calculated as measured output level, relative to measured input level. Levels are measured by means of a DMM.

Generator frequency: 1 kHz  
 When applying amplitudes below 31.62 mV (90 dBuV) a 40 dB attenuator is used.  
 Nexus: HP 10Hz, LP 100kHz  
 Output bandwidth limited with external 22.4 kHz LP filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty	
<b>Nexus setting</b>	<b>Input Level</b>					
100mV/ms-2	5.01187 Volt	V/ms-2	0.0989	0.1012	0.0998	0.0002
316mV/ms-2	5.01187 Volt	V/ms-2	0.3126	0.3199	0.3156	0.0004
1 V/ms-2	1.77828 Volt	V/ms-2	0.9886	1.0116	0.9980	0.0012
3.16 V/ms-2	0.56234 Volt	V/ms-2	3.1261	3.1989	3.1559	0.0037
10 V/ms-2	0.17783 Volt	V/ms-2	9.8855	10.1158	9.9868	0.0116
31.6 V/ms-2	0.05623 Volt	V/ms-2	31.2608	31.9890	31.5751	0.0693
100 V/ms-2	0.01778 Volt	V/ms-2	98.8553	101.1579	99.6129	0.1152
316 V/ms-2	0.00562 Volt	V/ms-2	312.6079	319.8895	314.9994	0.3641
1kV/ms-2	0.00178 Volt	V/ms-2	988.5531	1011.5795	997.9563	1.1514

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Note: This certificate can't be partly copied if not approved by the laboratory.

**Lowpass filters:**

The frequency response of Lowpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

Input Level: 1 Volt (120 dBuV)  
 Nexus: Sens. 1 V/ms-2 (0 dB Gain)  
 (LP 100 k results not valid with WH 3219 option)

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
<b>Nexus setting</b>	<b>Frequency</b>				
LP 0.1k HP 1	20 Hz	% -1.14	1.16	-0.27	0.12
LP 0.1k HP 1	100 Hz	% -14.89	-6.67	-11.00	0.42
LP 1 k HP 10	200 Hz	% -1.14	1.16	-0.27	0.12
LP 1 k HP 10	1000 Hz	% -14.89	-6.67	-11.08	0.42
LP 3 k HP 10	600 Hz	% -1.14	1.16	-0.26	0.12
LP 3 k HP 10	3000 Hz	% -14.89	-6.67	-10.74	0.42
LP 10 k HP 10	2000 Hz	% -1.14	1.16	-0.35	0.12
LP 10 k HP 10	10000 Hz	% -14.89	-6.67	-11.39	0.42
LP 22.4k HP 10	4480 Hz	% -1.14	1.16	-0.38	0.12
LP 22.4k HP 10	22400 Hz	% -14.89	-6.67	-11.41	0.42
LP 30 k HP 10	6000 Hz	% -1.14	1.16	-0.31	0.12
LP 30 k HP 10	30000 Hz	% -14.89	-6.67	-10.58	0.42
LP 100 k HP 10	20000 Hz	% -1.14	1.16	-0.11	0.12
LP 100 k HP 10	60000 Hz	% -4.50	4.71	1.37	0.47
LP 100 k HP 10	100000 Hz	% -18.72	-2.28	-12.97	0.62

**Highpass filters:**

The frequency response of Highpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

Input Level: 1 Volt (120 dBuV)  
 Nexus: Sens. 1 V/ms-2 (0 dB Gain), LP 100 kHz.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
<b>Nexus setting</b>	<b>Frequency</b>				
HP 0.1	0.1 Hz	% -14.89	-6.67	-2.90	*
HP 0.1	0.5 Hz	% -1.14	1.16	-1.16	*
HP 1	1.0 Hz	% -14.89	-6.67	-10.22	*
HP 1	5.0 Hz	% -1.14	1.16	-0.58	*
HP 10	10.0 Hz	% -14.89	-6.67	-10.58	0.42
HP 10	50.0 Hz	% -1.14	1.16	-0.49	0.12

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**Inherent noise:**

The Inherent Noise is measured by connecting a short-circuit plug to the input, and measuring the output level by means of a DMM.

Nexus: Sens. 10kV/Pa (80dB Gain), HP 10Hz, LP 100kHz

Input shorted.

Output bandwidth limited with external A filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
A weighted	uV		2.00	1.84	*

**Reference Generator:**

Measure output level from internal generator.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
Ref Tone	dBuV	119.90	120.10	120.02	*
Test Tone	dBuV	0.00	0.00	0.00	*

**Distortion:**

Generator signal: 127 dBuV (2.24 Volt), 1 kHz

Nexus: Sens. 1 V/ms<sup>2</sup> (0 dB Gain), HP 10Hz, LP 100kHz

Basetone is rejected with a notchfilter.

Output of the notch filter is digitized with the HP3458A DMM, and 2. harmonic and 3. harmonic is determined with a DFT.

Parameter	Unit	Upper Limit	Measured Value	Calibration Uncertainty
2. Harmonic	%	0.0030	0.0031	*
3. Harmonic	%	0.0030	0.0008	*

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Channel Type: DELTATRON ZX 2693

Channel No: 3

All measurements made non floating on input and output.

Transducer sensitivity : 1 V/V.

Calibrated output:

The gain from input to calibrated output, is calculated as measured output level, relative to measured input level. Levels are measured by means of a DMM.

Generator frequency: 1 kHz

When applying amplitudes below 31.62 mV (90 dBuV) a 40 dB attenuator is used.

Nexus: HP 10Hz, LP 100kHz

Output bandwidth limited with external 22.4 kHz LP filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty	
<b>Nexus setting</b>	<b>Input Level</b>					
100mV/ms-2	5.01187 Volt	V/ms-2	0.0989	0.1012	0.0997	0.0002
316mV/ms-2	5.01187 Volt	V/ms-2	0.3126	0.3199	0.3153	0.0004
1 V/ms-2	1.77828 Volt	V/ms-2	0.9886	1.0116	0.9972	0.0012
3.16 V/ms-2	0.56234 Volt	V/ms-2	3.1261	3.1989	3.1535	0.0037
10 V/ms-2	0.17783 Volt	V/ms-2	9.8855	10.1158	9.9791	0.0116
31.6 V/ms-2	0.05623 Volt	V/ms-2	31.2608	31.9890	31.5525	0.0693
100 V/ms-2	0.01778 Volt	V/ms-2	98.8553	101.1579	99.5377	0.1152
316 V/ms-2	0.00562 Volt	V/ms-2	312.6079	319.8895	314.7015	0.3641
1kV/ms-2	0.00178 Volt	V/ms-2	988.5531	1011.5795	997.1946	1.1514

注: 未经本实验室批准, 不得部份复制此校正证书。

Note: This certificate can't be partly copied if not approved by the laboratory.

**Lowpass filters:**

The frequency response of Lowpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

**Input Level: 1 Volt (120 dBuV)**

**Nexus: Sens. 1 V/ms-2 (0 dB Gain)**

**(LP 100 k results not valid with WH 3219 option)**

Parameter	Lower Unit	Upper Limit	Measured Limit	Calibration Value	Uncertainty
Nexus setting	Frequency				
LP 0.1k HP 1	20 Hz	%	-1.14	1.16	-0.34 0.12
LP 0.1k HP 1	100 Hz	%	-14.89	-6.67	-10.97 0.42
LP 1 k HP 10	200 Hz	%	-1.14	1.16	-0.37 0.12
LP 1 k HP 10	1000 Hz	%	-14.89	-6.67	-11.67 0.42
LP 3 k HP 10	600 Hz	%	-1.14	1.16	-0.33 0.12
LP 3 k HP 10	3000 Hz	%	-14.89	-6.67	-10.84 0.42
LP 10 k HP 10	2000 Hz	%	-1.14	1.16	-0.45 0.12
LP 10 k HP 10	10000 Hz	%	-14.89	-6.67	-11.62 0.42
LP 22.4k HP 10	4480 Hz	%	-1.14	1.16	-0.47 0.12
LP 22.4k HP 10	22400 Hz	%	-14.89	-6.67	-11.08 0.42
LP 30 k HP 10	6000 Hz	%	-1.14	1.16	-0.40 0.12
LP 30 k HP 10	30000 Hz	%	-14.89	-6.67	-10.67 0.42
LP 100 k HP 10	20000 Hz	%	-1.14	1.16	-0.22 0.12
LP 100 k HP 10	60000 Hz	%	-4.50	4.71	1.28 0.47
LP 100 k HP 10	100000 Hz	%	-18.72	-2.28	-12.99 0.62

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**Highpass filters:**

The frequency response of Highpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

**Input Level: 1 Volt (120 dBuV)**

Nexus: Sens. 1 V/ms<sup>-2</sup> (0 dB Gain), LP 100 kHz.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
<b>Nexus setting</b>	<b>Frequency</b>				
HP 0.1	0.1 Hz	% -14.89	-6.67	-1.48	*
HP 0.1	0.5 Hz	% -1.14	1.16	-1.16	*
HP 1	1.0 Hz	% -14.89	-6.67	-10.11	*
HP 1	5.0 Hz	% -1.14	1.16	-0.64	*
HP 10	10.0 Hz	% -14.89	-6.67	-10.56	0.42
HP 10	50.0 Hz	% -1.14	1.16	-0.55	0.12

**Inherent noise:**

The Inherent Noise is measured by connecting a short-circuit plug to the input, and measuring the output level by means of a DMM.

Nexus: Sens. 10kV/Pa (80dB Gain), HP 10Hz, LP 100kHz

Input shorted.

Output bandwidth limited with external A filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
A weighted	uV		2.00	1.79	*

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## Results of Calibration (continued page)

證書編號(Certificate No.): HBKT-20210022

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**Reference Generator:**

Measure output level from internal generator.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
Ref Tone	dBuV	119.90	120.10	120.02	*
Test Tone	dBuV	0.00	0.00	0.00	*

**Distortion:**

Generator signal: 127 dBuV (2.24 Volt), 1 kHz

Nexus: Sens. 1 V/ms<sup>2</sup> (0 dB Gain), HP 10Hz, LP 100kHz

Basetone is rejected with a notchfilter.

Output of the notch filter is digitized with the HP3458A DMM,  
and 2. harmonic and 3. harmonic is determined with a DFT.

Parameter	Unit	Upper Limit	Measured Value	Calibration Uncertainty
2. Harmonic	%	0.0030	0.0024	*
3. Harmonic	%	0.0030	0.0007	*

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Channel Type: DELTATRON ZX 2693

Channel No: 4

All measurements made non floating on input and output.

Transducer sensitivity : 1 V/V.

Calibrated output:

The gain from input to calibrated output, is calculated as measured output level, relative to measured input level. Levels are measured by means of a DMM.

Generator frequency: 1 kHz

When applying amplitudes below 31.62 mV (90 dBuV) a 40 dB attenuator is used.

Nexus: HP 10Hz, LP 100kHz

Output bandwidth limited with external 22.4 kHz LP filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty	
<b>Nexus setting</b>	<b>Input Level</b>					
100mV/ms-2	5.01187 Volt	V/ms-2	0.0989	0.1012	0.0998	0.0002
316mV/ms-2	5.01187 Volt	V/ms-2	0.3126	0.3199	0.3156	0.0004
1 V/ms-2	1.77828 Volt	V/ms-2	0.9886	1.0116	0.9981	0.0012
3.16 V/ms-2	0.56234 Volt	V/ms-2	3.1261	3.1989	3.1561	0.0037
10 V/ms-2	0.17783 Volt	V/ms-2	9.8855	10.1158	9.9870	0.0116
31.6 V/ms-2	0.05623 Volt	V/ms-2	31.2608	31.9890	31.5770	0.0693
100 V/ms-2	0.01778 Volt	V/ms-2	98.8553	101.1579	99.6130	0.1152
316 V/ms-2	0.00562 Volt	V/ms-2	312.6079	319.8895	314.9729	0.3641
1kV/ms-2	0.00178 Volt	V/ms-2	988.5531	1011.5795	997.9912	1.1514

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**Lowpass filters:**

The frequency response of Lowpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

**Input Level: 1 Volt (120 dBuV)**

**Nexus: Sens. 1 V/ms-2 (0 dB Gain)**

**(LP 100 k results not valid with WH 3219 option)**

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
Nexus setting	Frequency				
LP 0.1k HP 1	20 Hz	% -1.14	1.16	-0.28	0.12
LP 0.1k HP 1	100 Hz	% -14.89	-6.67	-11.00	0.42
LP 1 k HP 10	200 Hz	% -1.14	1.16	-0.28	0.12
LP 1 k HP 10	1000 Hz	% -14.89	-6.67	-11.15	0.42
LP 3 k HP 10	600 Hz	% -1.14	1.16	-0.25	0.12
LP 3 k HP 10	3000 Hz	% -14.89	-6.67	-10.59	0.42
LP 10 k HP 10	2000 Hz	% -1.14	1.16	-0.34	0.12
LP 10 k HP 10	10000 Hz	% -14.89	-6.67	-10.89	0.42
LP 22.4k HP 10	4480 Hz	% -1.14	1.16	-0.36	0.12
LP 22.4k HP 10	22400 Hz	% -14.89	-6.67	-10.97	0.42
LP 30 k HP 10	6000 Hz	% -1.14	1.16	-0.30	0.12
LP 30 k HP 10	30000 Hz	% -14.89	-6.67	-10.64	0.42
LP 100 k HP 10	20000 Hz	% -1.14	1.16	-0.14	0.12
LP 100 k HP 10	60000 Hz	% -4.50	4.71	0.98	0.47
LP 100 k HP 10	100000 Hz	% -18.72	-2.28	-13.11	0.62

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**Highpass filters:**

The frequency response of Highpass filters is calculated as measured output level relative to measured input level as percentage. Levels are measured by means of a DMM.

Input Level: 1 Volt (120 dBuV)

Nexus: Sens. 1 V/ms-2 (0 dB Gain), LP 100 kHz.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
<b>Nexus setting</b>	<b>Frequency</b>				
HP 0.1	0.1 Hz	% -14.89	-6.67	-2.21	*
HP 0.1	0.5 Hz	% -1.14	1.16	-1.27	*
HP 1	1.0 Hz	% -14.89	-6.67	-2.43	*
HP 1	5.0 Hz	% -1.14	1.16	-0.59	*
HP 10	10.0 Hz	% -14.89	-6.67	-10.63	0.42
HP 10	50.0 Hz	% -1.14	1.16	-0.49	0.12

**Inherent noise:**

The Inherent Noise is measured by connecting a short-circuit plug to the input, and measuring the output level by means of a DMM.

Nexus: Sens. 10kV/Pa (80dB Gain), HP 10Hz, LP 100kHz

Input shorted.

Output bandwidth limited with external A filter.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
A weighted	uV		2.00	1.86	*

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Results of Calibration (continued page)

證書編號(Certificate No.): HBKT-20210022

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**Reference Generator:**

Measure output level from internal generator.

Parameter	Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
Ref Tone	dBuV	119.90	120.10	120.02	*
Test Tone	dBuV	0.00	0.00	0.00	*

**Distortion:**

Generator signal: 127 dBuV (2.24 Volt), 1 kHz

Nexus: Sens. 1 V/ms-2 (0 dB Gain), HP 10Hz, LP 100kHz

Basetone is rejected with a notchfilter.

Output of the notch filter is digitized with the HP3458A DMM,  
and 2. harmonic and 3. harmonic is determined with a DFT.

Parameter	Unit	Upper Limit	Measured Value	Calibration Uncertainty
2. Harmonic	%	0.0030	0.0021	*
3. Harmonic	%	0.0030	0.0010	*

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### 說明 Explanation

1. 根據校正規範的相關技術要求，所有參數的校正結論見校正結果首頁概要。 According to the technical requests of the calibration procedure, please check the summary on the first page of the calibration result to get the conclusion of this calibration.

2. 以星號(\*)標稱的校正數據再我們申請的認可校正能力範圍之外，為保證校正結果的完整性，這部分校正數據也包含在校正證書內。

Results marked by asterisk (\*) are outside our scope of accreditation. The measurements are included for completeness.

3. 以上校正結果中的不確定度分析的包含概率均為 95% (k=2).

The confidence probability of uncertainty analysis of the calibration result is 95% (k=2).

4. 校正參數的不確定度見具體校正結果，參考參數的擴展不確定度見下：

The individual calibration parameter's measurement uncertainty please check the detail calibration result, the main parameters' uncertainties as below:

直流電壓：	測量範圍	( 0.1V~1KV )	$U = 0.03\%$ ,	$k=2$
DC Voltage	Range of Measurement			
直流電流：	測量範圍	( 100uA~1A )	$U = 0.02\%$ ,	$k=2$
DC current	Range of Measurement			
交流電壓：	測量範圍	( 0.1V~700V )	$U = 0.03\%$ ,	$k=2$
AC Voltage	Range of Measurement			
(1kHz)				
交流電流：	測量範圍	( 100uA~1A )	$U = 0.01\%$ ,	$k=2$
AC Current	Range of Measurement			
(1kHz)				
阻抗：	測量範圍	( 1Ω~10M Ω )	$U = 0.01\%$ ,	$k=2$
Resistance	Range of Measurement			

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