TISCH Environmental

RECALIBRATION DUE DATE:
July 17, 2021

Certificate of Calibration

Calibration Certification Information					
Cal. Date:	July 17, 2020	**Rootsmeter S/N:** 438320	**Ta:** 296	°K	
Operator:	Jim Tisch		**Pa:** 753.4	mm Hg	
Calibration Model #:	TE-5025A	**Calibrator S/N:** **3166**			

Run	Vol. Init (m3)	Vol. Final (m3)	ΔVol. (m3)	ΔTime (min)	ΔP (mm Hg)	ΔH (in H2O)
1	1	2	1	1.4450	3.2	2.00
2	3	4	1	1.0230	6.4	4.00
3	5	6	1	0.9140	7.9	5.00
4	7	8	1	0.8720	8.7	5.50
5	9	10	1	0.7190	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)	$\sqrt{\Delta H\left(Ta/Pa\right)}$ (y-axis)
0.9937	0.6877	1.4128	0.9958	0.6891	0.8865
0.9895	0.9672	1.9980	0.9915	0.9692	1.2536
0.9875	1.0804	2.2338	0.9895	1.0826	1.4016
0.9864	1.1312	2.3428	0.9885	1.1335	1.4700
0.9810	1.3644	2.8255	0.9830	1.3672	1.7729
QSTD	**m=**	**2.08877**	**QA**	**m=**	**1.30796**
	b=	**-0.02270**		**b=**	**-0.01424**
	r=	**0.99999**		**r=**	**0.99999**

Calculations

Vstd=	ΔVol((Pa-ΔP)/Pstd)(Tstd/Ta)	**Va=**	ΔVol((Pa-ΔP)/Pa)
Qstd=	Vstd/ΔTime	**Qa=**	Va/ΔTime

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= $1/m\left(\left(\sqrt{\Delta H\left(Ta/Pa\right)}\right)-b\right)$

Standard Conditions	
Tstd:	298.15 °K
Pstd:	760 mm Hg

Key
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

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Lam Environmental Services Limited

Calibration Data for High Volume Sampler (TSP Sampler)

Location	:	CMA2a	**Calbration Date**	:	06-May-21
Equipment no.	:	HVS002	**Calbration Due Date**	:	06-Jul-21

CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition					
Temperature, T_a	298.2	Kelvin	**Pressure, P_a**	1015	mmHg

Orifice Transfer Standard Information					
Equipment No.	**3166**	**Slope, m_c**	2.08877	**Intercept, bc**	-0.02270
Last Calibration Date	17-Jul-20	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$			
Next Calibration Date	17-Jul-21	$= m_c \times Q_{std} + b_c$			

Calibration of TSP						
Calibration Point	**Manometer Reading H (inches of water)**			**Q_{std}** (m^3 / min.)	**Continuous Flow Recorder, W**	**IC** ($W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31$)
	(up)	(down)	(difference)	**X-axis**	(CFM)	**Y-axis**
1	1.4	1.4	2.8	0.8125	29	29.0203
2	2.5	2.5	5.0	1.0821	38	38.0266
3	3.7	3.7	7.4	1.3141	45	45.0315
4	4.9	4.9	9.8	1.5106	51	51.0357
5	5.7	5.7	11.4	1.6284	55	55.0385

By Linear Regression of Y on X

Slope, m = 31.5758 Intercept, b = 3.5427

Correlation Coefficient* = 0.9998

Calibration Accepted = Yes/~~No~~**

* if Correlation Coefficient < 0.990, check and recalibration again.

** Delete as appropriate.

Remarks :

Calibrated by	:	Sam Lam	**Checked by**	:	James Chu
Date	:	06-May-21	**Date**	:	06-May-21

Lam Environmental Services Limited

Calibration Data for High Volume Sampler (TSP Sampler)

Location	:	CMA2a	**Calbration Date**	:	06-Jul-21
Equipment no.	:	HVS002	**Calbration Due Date**	:	06-Sep-21

CALIBRATION OF CONTINUOUS FLOW RECORDER

Ambient Condition					
Temperature, T_a	302	Kelvin	**Pressure, P_a**	1006	mmHg

Orifice Transfer Standard Information					
Equipment No.	**3166**	**Slope, m_c**	2.08877	**Intercept, bc**	-0.02270
Last Calibration Date	17-Jul-20	$(H \times P_a / 1013.3 \times 298 / T_a)^{1/2}$			
Next Calibration Date	17-Jul-21	$= m_c \times Q_{std} + b_c$			

Calibration of TSP						
Calibration Point	**Manometer Reading H (inches of water)**			**Q_{std}** (m^3 / min.) **X-axis**	**Continuous Flow Recorder, W** (CFM)	**IC** $(W(P_a/1013.3 \times 298/T_a)^{1/2}/35.31)$ **Y-axis**
	(up)	(down)	(difference)			
1	4.1	4.1	8.2	1.3678	55	54.4374
2	3.3	3.3	6.6	1.2282	50	49.4885
3	2.6	2.6	5.2	1.0914	45	44.5397
4	2.2	2.2	4.4	1.0048	38	37.6113
5	1.5	1.5	3.0	0.8316	30	29.6931

By Linear Regression of Y on X

Slope, m = 47.0579 Intercept, b = -8.8342

Correlation Coefficient* = 0.9913

Calibration Accepted = Yes/~~No~~**

* if Correlation Coefficient < 0.990, check and recalibration again.

** Delete as appropriate.

Remarks :

Calibrated by	:	Sam Lam	**Checked by**	:	James Chu
Date	:	06-Jul-21	**Date**	:	06-Jul-21

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

Certificate No.: 20CA0922 01 **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.:	2722310	2698702	13318
Adaptors used:	-	-	-

Item submitted by

Customer Name:	Lam Geotechnics Ltd.
Address of Customer:	-
Request No.:	-
Date of receipt:	22-Sep-2020

Date of test: 23-Sep-2020

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	24-Dec-2020	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 responsess 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-Sep-2020 **Company Chop:** SOILS & MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

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.

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 20CA0922 01 **Page** 2 **of** 2

1, Electrical Tests

The electrical tests were perfomed 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 Uncertanity (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	A	Pass	0.3	
	C	Pass	0.3	
	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 $1/10^3$ at 4kHz	Pass	0.3	
	1 ms burst duty factor $1/10^4$ 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 Uncertanity (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: Fung Chi Yip **Date:** 23-Sep-2020

Checked by: Feng Junqi **Date:** 24-Sep-2020

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.

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SMECLab

Sound level meter	type:	2250-L	Serial No.	2722310	Date 23-Sep-2020
Microphone	type:	4950	Serial No.	2698702	
Preamp	type:	ZC0032	Serial No.	13318	Report: 20CA0922 01

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	12.8	dB
Noise level in C weighting	14.4	dB
Noise level in Lin	21.0	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	135.1	135.1	0.7	0.1	0.1
136.0	136.1	136.1	0.7	0.1	0.1
137.0	137.1	137.1	0.7	0.1	0.1
138.0	138.1	138.1	0.7	0.1	0.1
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

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SMECLab

Sound level meter type:	2250-L	Serial No.	2722310	Date	23-Sep-2020
Microphone type:	4950	Serial No.	2698702		
Preamp type:	ZC0032	Serial No.	13318	Report:	20CA0922 01

34.0	34.0	34.0	0.7	0.0	0.0
33.0	33.1	33.1	0.7	0.1	0.1
32.0	32.1	32.1	0.7	0.1	0.1
31.0	31.1	31.1	0.7	0.1	0.1
30.0	30.1	30.1	0.7	0.1	0.1

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	30.1	0.7	0.1
	138.0	138.1	0.7	0.1

FREQUENCY WEIGHTING TEST

The frequency response of the weighting netwoks 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	54.4	1.5	1.5	-0.2
63.1	94.0	67.8	0.0	67.7	1.5	1.5	-0.1
125.9	94.0	77.9	0.0	77.9	1.0	1.0	0.0
251.2	94.0	85.4	0.0	85.3	1.0	1.0	-0.1
501.2	94.0	90.8	0.0	90.7	1.0	1.0	-0.1
1995.0	94.0	95.2	0.0	95.1	1.0	1.0	-0.1
3981.0	94.0	95.0	-0.1	94.8	1.0	1.0	-0.1
7943.0	94.0	92.9	-0.3	92.5	1.5	3.0	-0.1
12590.0	94.0	89.7	-0.3	89.3	3.0	6.0	-0.1

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	91.0	1.5	1.5	0.0
63.1	94.0	93.2	0.0	93.1	1.5	1.5	-0.1
125.9	94.0	93.8	0.0	93.8	1.0	1.0	0.0

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Microphone type:	4950	Serial No.	2698702		
Preamp type:	ZC0032	Serial No.	13318	Report:	20CA0922 01

251.2	94.0	94.0	0.0	93.9	1.0	1.0	-0.1
501.2	94.0	94.0	0.0	94.0	1.0	1.0	0.0
1995.0	94.0	93.8	0.0	93.7	1.0	1.0	-0.1
3981.0	94.0	93.2	-0.1	93.0	1.0	1.0	-0.1
7943.0	94.0	91.0	-0.3	90.6	1.5	3.0	-0.1
12590.0	94.0	87.8	-0.3	87.4	3.0	6.0	-0.1

Frequency weighting Lin:

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	94.0	N/A	94.0	1.5	1.5	0.0
63.1	94.0	94.0	0.0	94.0	1.5	1.5	0.0
125.9	94.0	94.0	0.0	93.9	1.0	1.0	-0.1
251.2	94.0	94.0	0.0	93.9	1.0	1.0	-0.1
501.2	94.0	94.0	0.0	93.9	1.0	1.0	-0.1
1995.0	94.0	94.0	0.0	93.9	1.0	1.0	-0.1
3981.0	94.0	94.0	-0.1	93.9	1.0	1.0	0.0
7943.0	94.0	94.0	-0.3	93.6	1.5	3.0	-0.1
12590.0	94.0	94.0	-0.3	93.6	3.0	6.0	-0.1

*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	Expected level	Actual level	Tolerance(dB)		Deviation
dB	dB	dB	+	-	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	Expected level	Actual level	Tolerance(dB)		Deviation
dB	dB	dB	+	-	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 rectangular test pulse with the response to a 10 ms reference pulse of the same amplitude. The amplitude of the

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SMECLab

Sound level meter	type:	2250-L	Serial No.	2722310	Date 23-Sep-2020
Microphone	type:	4950	Serial No.	2698702	
Preamp	type:	ZC0032	Serial No.	13318	Report: 20CA0922 01

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 L, set the generator signal to single, Lzpeak)

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
119.0	119.0	119.4	2.0	0.4

Negative polarities:

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
119.0	119.0	119.4	2.0	0.4

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)

	Ref. Level	Expected level	Tone burst signal	Tolerance	Deviation
Time wighting	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	111.1	2.0	-0.1

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.

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SMECLab

Sound level meter type:	2250-L	Serial No.	2722310	Date	23-Sep-2020
Microphone type:	4950	Serial No.	2698702		
Preamp type:	ZC0032	Serial No.	13318	Report:	20CA0922 01

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	88.0	58.0	58.0	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	88.0	68.0	68.0	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
135.2	134.2	131.2	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
142.2	141.2	101.2	101.2	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
Hz	dB	Measured (dB)	+	-	dB
1000	94.0	94.0	0.0	0.0	0.0
125	77.9	77.9	1.0	1.0	0.0
8000	92.9	93.5	1.5	3.0	0.6

----------END---------

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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 ± 1 °C
Relative humidity:	55 ± 10 %
Air pressure:	1000 ± 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 responsess 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:** SOILS AND MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

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.

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CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 21CA0222 03 **Page** 2 **of** 2

1, Electrical Tests

The electrical tests were perfomed 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	A	Pass	0.3	
	C	Pass	0.3	
	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 $1/10^3$ at 4kHz	Pass	0.3	
	1 ms burst duty factor $1/10^4$ 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: Fung Chi Yip **Date:** 23-Feb-2021

Checked by: Feng Junqi **Date:** 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.

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SMECLab

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

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SMECLab

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 netwoks 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

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SMECLab

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	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	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	Expected level	Actual level	Tolerance(dB)		Deviation
dB	dB	dB	+	-	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	Expected level	Actual level	Tolerance(dB)		Deviation
dB	dB	dB	+	-	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

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SMECLab

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)

	Ref. Level	Expected level	Tone burst signal	Tolerance	Deviation
Time wighting	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.

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Tel: (852) 2873 6860 Fax: (852) 2555 7533 E-mail: smec@cigismec.com Website: www.cigismec.com

SMECLab

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
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	91.9	1.5	3.0	-1.0

----------END---------

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CERTIFICATE OF CALIBRATION

Certificate No.: 20CA0907 03 **Page** 1 **of** 2

Item tested

		Microphone	Preamp
Description:	Sound Level Meter (Type 1)		
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250-L	4950	ZC0032
Serial/Equipment No.:	3006790	2827240	21213
Adaptors used:	-	-	-

Item submitted by

Customer Name:	Lam Geotechnics Limited
Address of Customer:	-
Request No.:	-
Date of receipt:	07-Sep-2020

Date of test: 10-Sep-2020

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	24-Dec-2020	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 responsess 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:** 11-Sep-2020 **Company Chop:** SOILS & MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

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.

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Tel: (852) 2873 6860 Fax: (852) 2555 7533 E-mail: smec@cigismec.com Website: www.cigismec.com

HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 20CA0907 03 **Page** 2 **of** 2

1, Electrical Tests

The electrical tests were perfomed 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	A	Pass	0.3	
	C	Pass	0.3	
	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 $1/10^3$ at 4kHz	Pass	0.3	
	1 ms burst duty factor $1/10^4$ 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: Fung Chi Yip **Date:** 10-Sep-2020

Checked by: Feng Junqi **Date:** 11-Sep-2020

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.

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SMECLab

Sound level meter	type:	2250-L	Serial No.	3006790	Date 10-Sep-2020
Microphone	type:	4950	Serial No.	2827240	
Preamp	type:	ZC0032	Serial No.	21213	Report: 20CA0907 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	17.2	dB
Noise level in C weighting	16.6	dB
Noise level in Lin	24.6	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

Sound level meter type:	2250-L	Serial No.	3006790	Date	10-Sep-2020
Microphone type:	4950	Serial No.	2827240		
Preamp type:	ZC0032	Serial No.	21213	Report:	20CA0907 03

34.0	34.1	34.1	0.7	0.1	0.1
33.0	33.1	33.1	0.7	0.1	0.1
32.0	32.1	32.1	0.7	0.1	0.1
31.0	31.1	31.1	0.7	0.1	0.1
30.0	30.2	30.2	0.7	0.2	0.2

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	30.2	0.7	0.2
	138.0	138.0	0.7	0.0

FREQUENCY WEIGHTING TEST

The frequency response of the weighting netwoks 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	0.0	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	85.3	1.0	1.0	-0.1
501.2	94.0	90.8	0.0	90.8	1.0	1.0	0.0
1995.0	94.0	95.2	0.0	95.1	1.0	1.0	-0.1
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	89.3	3.0	6.0	-0.1

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	0.0	91.0	1.5	1.5	0.0
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

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SMECLab

Sound level meter type: 2250-L Serial No. 3006790 Date 10-Sep-2020
Microphone type: 4950 Serial No. 2827240
Preamp type: ZC0032 Serial No. 21213 Report: 20CA0907 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	87.4	3.0	6.0	-0.1

Frequency weighting Lin:

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	94.0	0.0	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	93.9	1.0	1.0	-0.1
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	Expected level	Actual level	Tolerance(dB)		Deviation
dB	dB	dB	+	-	dB
116.0	115.0	114.9	1.0	1.0	-0.1

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	Expected level	Actual level	Tolerance(dB)		Deviation
dB	dB	dB	+	-	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 rectangular test pulse with the response to a 10 ms reference pulse of the same amplitude. The amplitude of the

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SMECLab

Sound level meter type:	2250-L	Serial No.	3006790	Date	10-Sep-2020
Microphone type:	4950	Serial No.	2827240		
Preamp type:	ZC0032	Serial No.	21213	Report:	20CA0907 03

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 L, set the generator signal to single, LLPeak)

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
119.0	119.0	119.5	2.0	0.5

Negative polarities:

Ref. level	Response to 10 ms	Response to 100 us	Tolerance	Deviation
dB	dB	dB	+/- dB	dB
119.0	119.0	119.5	2.0	0.5

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)

	Ref. Level	Expected level	Tone burst signal	Tolerance	Deviation
Time wighting	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	111.1	2.0	-0.1

Repeated at 100 Hz

Ref. Level	Repeated burst indication		Tolerance	Deviation
dB	Expected (dB)	Actual (dB)	+/- dB	dB
120.0	117.3	117.1	1.0	-0.2

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	99.8	1.0	-0.2	6min. integ.

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SMECLab

Sound level meter	type:	2250-L	Serial No.	3006790	Date	10-Sep-2020
Microphone	type:	4950	Serial No.	2827240		
Preamp	type:	ZC0032	Serial No.	21213	Report:	20CA0907 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	88.0	58.0	58.0	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	88.0	68.0	68.0	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
135.9	134.9	131.9	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
142.7	141.7	101.7	101.7	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
Hz	dB	Measured (dB)	+	-	dB
1000	94.0	94.0	0.0	0.0	0.0
125	77.9	78.2	1.0	1.0	0.3
8000	92.9	92.8	1.5	3.0	-0.1

---------END---------

HBK
HOTTINGER BRÜEL & KJÆR

HBK 校正實驗室
HBK Calibration Laboratory

校 正 證 書
CALIBRATION CERTIFICATE

證書編號(Certificate No.):HBKT-20210022

委託單位: Customer:	LAM Geotechnics Limited
地 址: Address:	11/F Centre Point, 181-185 Gloucester Road, Wanchai, Hong Kong S.A.R of China
儀器名稱: Equipment:	Nexus調適放大器
型號規格: Model/Type:	2693-0S4
製 造 商: Manufacture:	Bruel & Kjaer
機 身 號: Serial No.	2099340
接收日期: Date of Recept	2021-06-11
校正日期: Date of Cal.	2021-06-22
批准日期: Date of Approve	2021-06-24

Calibration Laboratory 校正實驗室 HBK 校正專用章 for calibration

實驗室印章
Chop

主 管
Approved by 戴斌

審 核
Inspected by 戴斌

校 正
Calibrated by 王韋凱

台灣思百吉股份有限公司
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HBK 校正實驗室

HBK Calibration Laboratory

校 正 說 明

Directions of Calibration

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 麥克風输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 Equipment/Model	機身編號 Serial No.	不確定度或準確度等級或最大允許誤差 Uncertainty or Accuracy Class or MPE	溯源至/證書編號 Traceable to/ Certificate No.	有效期至 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	℃	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
Nexus setting	Input Level					
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

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	-0.30	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-2 (0 dB Gain), LP 100 kHz.

Parameter		Unit	Lower Limit	Upper Limit	Measured Value	Calibration Uncertainty
Nexus setting	Frequency					
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

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-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	0.0018	*
3. Harmonic	%	0.0030	0.0010	*

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
Nexus setting	Input Level					
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

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	-0.27	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
Nexus setting	Frequency					
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

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-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	0.0031	*
3. Harmonic	%	0.0030	0.0008	*

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
Nexus setting	Input Level					
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

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

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
Nexus setting	Frequency					
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	*

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	0.0024	*
3. Harmonic	%	0.0030	0.0007	*

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
Nexus setting	Input Level					
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

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

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
Nexus setting	Frequency					
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	*

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	*

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

綜合試驗有限公司
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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

Certificate No.: 20CA1119 02-01 **Page:** 1 **of** 2

Item tested

Description:	Acoustical Calibrator (Class 1)
Manufacturer:	Larson Davis
Type/Model No.:	CAL200
Serial/Equipment No.:	13437
Adaptors used:	-

Item submitted by

Curstomer:	Lam Environmental Services Limited.
Address of Customer:	-
Request No.:	-
Date of receipt:	19-Nov-2020

Date of test: 20-Nov-2020

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

Test specifications

1, 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.

2, The calibrator was tested with its axis vertical facing downwards at the specific frequency using insert voltage technique.

3, 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

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

SOILS & MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

Approved Signatory: Feng Junqi **Date:** 21-Nov-2020 **Company Chop:**

Comments: The results reported in this certificate refer to the conditon 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.

綜合試驗有限公司
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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 20CA1119 02-01 **Page:** 2 **of** 2

1, Measured Sound Pressure Level

The output Sound Pressure Level in the calibrator head was measured at the setting and frequency shown using a calibrated laboratory standard microphone and insert voltage technique. The results are given in below with the estimated uncertainties.

(Output level in dB re 20 μPa)

Frequency Shown Hz	Output Sound Pressure Level Setting dB	Measured Output Sound Pressure Level dB	Estimated Expanded Uncertainty dB
1000	94.00	93.66	0.10

2, Sound Pressure Level Stability - Short Term Fluctuations

The Short Term Fluctuations was determined by measuring the maximum and minimum of the fast weighted DC output of the B&K 2610 measuring amplifier over a 20 second time interval as required in the standard. The Short Term Fluctuation was found to be:

At 1000 Hz **STF = 0.013 dB**

Estimated expanded uncertainty 0.005 dB

3, Actual Output Frequency

The determination of actual output frequency was made using a B&K 4180 microphone together with a B&K 2673 preamplifier connected to a B&K 2610 measuring amplifier. The AC output of the B&K 2610 was taken to an universal counter which was used to determine the frequency averaged over 20 second of operation as required by the standard. The actual output frequency at 1 KHz was:

At 1000 Hz **Actual Frequency = 1000.1 Hz**

Estimated expanded uncertainty 0.1 Hz Coverage factor k = 2.2

4, Total Noise and Distortion

For the Total Noise and Distortion measurement, the unfiltered AC output of the B&K 2610 measuring amplifier was connected to an Agilent Type 8903 B distortion analyser. The TND result at 1 KHz was:

At 1000 Hz **TND = 0.5%**

Estimated expanded uncertainty 0.7 %

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: Fung Chi Yip **Date:** 20-Nov-2020

Checked by: Feng Junqi **Date:** 21-Nov-2020

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.