

ภาคผนวก จ

เอกสารสอบเทียบความถูกต้องของเครื่องมือ

บริษัท ยูไนเต็ด แอนนาลิสต์ แอนด์ เอ็นจิเนียริง คอนซัลแตนท์ จำกัด



Enviro Equipment Service Co., Ltd.

110/234 Moo 3, Tambon Bang Rak Plantation, Amphur Bang Bua Thong, Nonthaburi 11110

Tel. 091 362 9152, 089 478 7885

E-mail: sales@enviro-es.com

Certificate No. : E22-08018

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CERTIFICATE OF CALIBRATION

Customer : United Analyst and Engineering Consultant Co., Ltd.
Address : 81 Soi Udonsook 41, Sukhumvit Road, Bangchak, Phraekhumsong, Bangkok 10260

Description of Equipment : Console meter

Manufacturer : Apex Instrument

Model Number : XC-S2-A

Serial Number : 0003018

ID-Control No. : *

Environment Conditions : Temperature : (25 ± 2) °C

: Humidity : (50 ± 15) % RH

Cal. Date : 22/08/2022

Issue Date : 22/08/2022

Calibration Method or Calibration Procedure Used

US EPA Method (United State Environmental Protection Agency)

This certificate is traceable to national standard, which makes the validity of measurement according to the International System of Units (SI).

Result of Calibration

This certificate may not be reproduced other than in full except with prior written approval of the Technical Manager, Enviro Equipment Service Company Limited.

These reported uncertainties of measurement are expanded by a coverage factor of k=2, providing a 95% confidence level.

Calibrated by : Mr. Saanya Sangnil

Approved by :

(Mr. Maria Parkkud)

Technical Manager



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Certificate No. : E22-08018

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METHOD 5 CONSOLE CALIBRATION USING REFERENCE WET GAS METER W-NK-2.5-B-Z No.547425 5-POINT METRIC UNIT

Meter Console Information		Calibration Condition		Envelope Compensation	
Console Model Number	XC-S2-A	Date	22/08/2022	Sold Temp	293 K
Console Serial Number	6003018	Calibration Reference No.	E22-08038	Sold Press	760 mm Hg
DGM Model Number	5K250-X	Barometric Pressure	755.24 mmHg	K ₁	0.306
DGM Serial Number	00002780	Calibration Meter Gamma	0.990	Console Leak Check	PASS

Calibration Data									
Run Time	Elapsed (Q)	DGM Orifice (mm I.D.)	Metering Console			Calibration Meter			Outlet Temp
			Volume	Volume	Outlet Temp	Volume	Volume	Outlet Temp	
			Initial (V _{in})	Final (V _{out})	Initial (t _{in})	Initial (V _{in})	Final (V _{out})	Initial (t _{in})	Final (t _{out})
min			m ³	m ³	°C	m ³	m ³	°C	°C
11.25	13.0	898.1510	898.2910	898.2910	29	90.45264	90.45792	24	24
11.33	13.0	898.2910	898.4310	898.4310	29	90.50792	90.72554	24	24
7.77	26.0	898.4320	898.4520	898.4520	29	90.73418	90.86926	24	24
7.75	26.0	898.5820	898.7220	898.7220	29	90.86926	91.00398	24	24
13.13	40.0	898.7220	899.0120	899.0120	29	91.01454	91.20300	25	25
13.12	40.0	899.0120	899.2936	899.2936	29	91.25300	91.45110	25	25
9.83	70.0	899.3120	899.5920	899.5920	29	91.56906	91.83620	25	25
9.82	70.0	899.5920	899.8720	899.8720	29	91.83620	92.10288	25	25
8.08	90.0	899.8650	900.1650	900.1650	30	92.11486	92.37984	24	24
8.67	90.0	900.1650	900.4450	900.4450	30	92.37984	92.64466	24	24



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Meter Console Information		Calibration Conditions		Factory Specifications	
Console Model Number	XC-872-V	Date	22/08/2022	Sid Temp	293 K
Console Serial Number	0803018	Calibration Reference No.	E22-08038	Sid Press	760 mm Hg
DCM Model Number	SK25EX	Barometric Pressure	755.24 mmHg	K ₁	0.386
DCM Serial Number	00002780	Calibration Meter Gamma	0.999	Console Leak Check	PASS

Calibration Data

Gamma

Standardized Data				Dry Gas Meter		
Dry Gas Meter (V _{read})	Calibration Meter (V _{read})	Calibration Factor		Fluoride Std & Corr (Q _{standard})	JR12 m ³ /min (ΔH ₀)	Variation (ΔH ₀)
		Value (V)	Variation (ΔV)			
m ³	m ³ /min	m ³	m ³ /min	m ³ /min	mm H ₂ O	
0.037	0.012	0.064	0.012	0.012	41.539	-1.642
0.037	0.012	0.133	0.012	0.014	41.946	-1.236
0.038	0.018	0.132	0.017	0.009	39.814	-5.307
0.038	0.018	0.132	0.017	0.009	39.855	-3.326
0.035	0.021	0.262	0.020	0.002	46.487	1.409
0.035	0.021	0.262	0.020	0.008	44.620	1.438
0.039	0.028	0.437	0.047	-0.005	44.426	1.244
0.038	0.028	0.261	0.027	0.016	44.409	1.313
0.037	0.032	0.260	0.030	0.015	45.326	2.144
0.037	0.032	0.260	0.030	0.016	45.206	2.025
		0.952	V Average			ΔH ₀ Average

Note: For Calibration Factor V, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ±0.02.

For ΔH₀, verified pressure differential that equates to 0.75 cm (0.0212 m) or 0.30 in (0.0076 m) at standard temperature and pressure, acceptable tolerance of individual values from the average is ±0.2 inches (5.08 mm) H₂O.

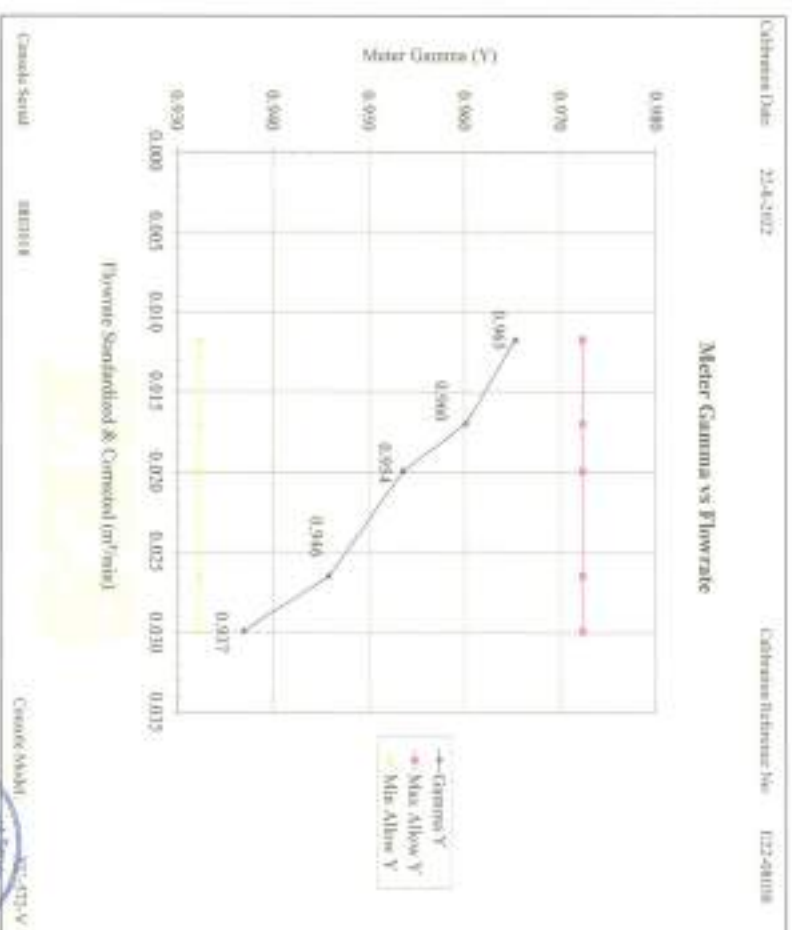


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Meter Console Information		Calibration Conditions		Factory Specifications	
Console Model Number	XC-872-V	Date	22/08/2022	Sid Temp	293 K
Console Serial Number	0803018	Calibration Reference No.	E22-08038	Sid Press	760 mm Hg
DCM Model Number	SK25EX	Barometric Pressure	755.24 mmHg	K ₁	0.386
DCM Serial Number	00002780	Calibration Meter Gamma	0.999	Console Leak Check	PASS

Calibration Date: 22/8/2022

Calibration Reference No.: E22-08038



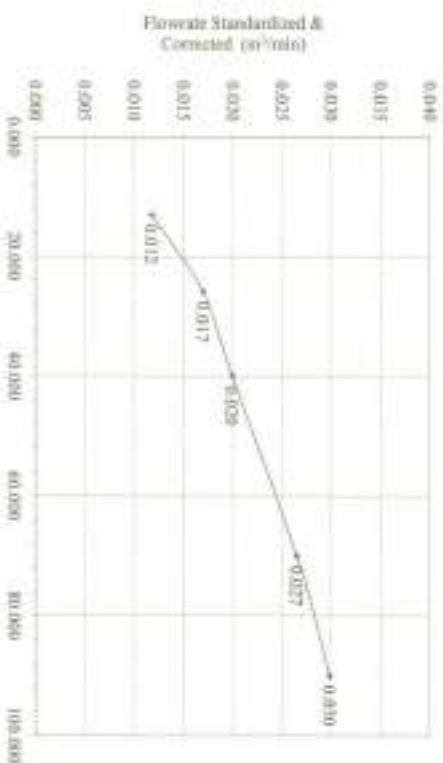
เอกสารไม่ควบคุม

Meter Console Information		Calibration Conditions		Factory Dimensions	
Console Model Number	XC-572-V	Date	Time	Std Temp	293 K
Console Serial Number	0803018	Calibration Reference No.	E22-08038	Std Press	760 mm Hg
DCM Model Number	SR25FX	Barometric Pressure	758.24 mmHg	K1	0.386
DCM Serial Number	00002780	Calibration Meter Error	0.999	Console Leak Check	PASS

Calibration Date: 22-8-2022

Calibration Reference No: E22-08038

Meter Pressure vs Flowrate



Console Serial: 0803018

Console Model: XC-572-V



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THERMOCOUPLES SYSTEM CALIBRATION

Sampling System Equipment Information		Calibration Conditions	
Console Model Number	XC-572-V	Date	Time
Console Serial Number	0803018	Calibration Reference No.	E22-08038
DCM Model Number	SR25FX	Reference Thermometer	DMGCON
DCM Serial Number	00002780	Serial Number	K0169105
Meter Box Model Number	JT/NC0 765 KF		
Meter Box Serial Number	JC 16095		

Channel and test point	Tolerance									
	Console Thermocouple Simulator									
	Meter Box Channel Temperature Reading (°C)									
Stack	-18.0	25.0	38.0	93.0	149.0	268.0	371.0	487.0	593.0	816.0
Stack	-16.0	25.0	38.0	93.0	150.0	259.0	371.0	487.0	593.0	815.0
Aux	-16.0	25.0	38.0	93.0	150.0					
Probe	-16.0	25.0	38.0	93.0	150.0					
Filter	-16.0	25.0	38.0	93.0	150.0					
Exit	-16.0	25.0	38.0							

	Tolerance Range
Stack	± 1.50%
Probe	± 2.0 °C
Filter	± 3.0 °C
	Absolute
	Meter
	Exit
	± 3.0 °C
	± 2.0 °C



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Standard References (Table 1)

Standard	Certificate No.	Vendor	Due date
Oxygen (O ₂) 2.098 % Vol	4210/21	UNIS	30-Sep-25
Oxygen (O ₂) 10.09 % Vol	3453/19	UNIS	10-Jul-23
Oxygen (O ₂) 21.08 % Vol	3452/19	UNIS	16-Jul-23
Carbon monoxide (CO) 90.97 ppm	2890/21	UNIS	24-Jul-23
Carbon monoxide (CO) 389.9 ppm	3183/21	UNIS	22-Jul-23
Carbon monoxide (CO) 1003 ppm	3182/21	UNIS	23-Aug-23
Nitrogen Dioxide (NO ₂) 10.15 ppm	3372/21	UNIS	10-Aug-23
Nitrogen Dioxide (NO ₂) 40.95 ppm	3280/21	UNIS	26-Jul-24
Nitrogen Dioxide (NO ₂) 262.2 ppm	3279/21	UNIS	20-Jul-23
Nitric Oxide (NO) 38.08 ppm	3251/21	UNIS	27-Jul-24
Nitric Oxide (NO) 151.9 ppm	3257/21	UNIS	27-Jul-24
Nitric Oxide (NO) 330.6 ppm	3064/21	UNIS	07-Jul-23
Sulfur Dioxide (SO ₂) 10.04 ppm	3255/21	UNIS	25-Jul-23
Sulfur Dioxide (SO ₂) 100.3 ppm	4062/20	UNIS	20-Nov-23
Sulfur Dioxide (SO ₂) 600.1 ppm	3204/21	UNIS	20-Jul-23

Measured room conditions

Temperature : 23.6 °C Humidity : 54.6 %RH Pressure : 1015.3 mmHg

Calibration conditions

Gas Temperature : 23 °C Flow rate : 1.200 mL/min Gas pressure : 1017.0 mmHg

Calibration Results before Adjustment (Table 2)

Parameter of Standard	Standard Values	Mean of UMC	Error	Uncertainty (±)
O ₂ (%Vol)	2.496	2.57	0.073	0.30
O ₂ (%Vol)	10.10	9.88	0.14	0.40
O ₂ (%Vol)	21.00	21.08	0.08	0.80
CO (ppm)	90.97	80	0.97	3.0
CO (ppm)	389.9	305	-4.9	6.0
CO (ppm)	1003	911	-10	12
NO ₂ (ppm)	10.15	7.8	-2.35	1.5
NO ₂ (ppm)	40.95	30.96	-9.99	0.0
NO ₂ (ppm)	262.2	202.8	-11.4	12
NO (ppm)	38.08	28	-5.08	8.0
NO (ppm)	151.9	140	-10.9	6.0
NO (ppm)	330.6	320.6	-22.6	12
SO ₂ (ppm)	10.04	50.04	-4.04	0.0
SO ₂ (ppm)	100.3	95	-5.3	6.0
SO ₂ (ppm)	600.1	640	39.9	13

Instrument description : Flow gas Analyzer

Instrument model : Telsis 550XL

Instrument serial no. : 97270344

ID no. or control no. : UME BPA1113/2505

Manufacturer : Telsis BE. B. Co. MOA

Probe description : -

Probe serial : -

Customer name : UNITED ANALYST AND ENGINEERING CONSULTANT CO.,LTD.

Customer address : 111 KSI UTHONGSUKEE, SATHUMMIT ROAD, BANACHUEE, PHANOMOLUK, 10000

Total pages of certificate : 3 Pages

Receiving no. : L-222833

Receiving date : 10-Aug-22

Parameter of calibration : Gas Calibration Oxygen 2.498, 10.00, 21.00 %Vol, Carbon Monoxide 90.97, 389.9, 1003 ppm, Nitrogen Dioxide 10.15, 40.95, 262.2 ppm, Nitric Oxide 38.08, 151.9, 330.6 ppm, Sulfur Dioxide 10.04, 100.3, 600.1 ppm

Condition of UUC : Used

Ambient condition : All of the Measurement were carried out in the standard laboratory

Temperature : 23.65 °C

Humidity : 55.4 ± 1% %RH

Calibration place : 17/121 Sri Nagsamrangan 47 Yoke, 48, Thongkongsong, Laks, Bangkok 10210

Calibration procedure no. : 86-CL-2B-C

The calibration certificate expressed uncertainty of measurement is stated as the standard uncertainty of instrument multiplied by coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

This certificate is applied only to item under test. Environmental condition

This Calibration Certificate may not be reproduced after 5 days of the receipt with the permission of the issuing laboratory.

Calibration certificates without signature and seal are invalid.

The calibration certificates documents are provided to national standards, which make measurement according to the International System of Units (SI).

Date of calibration : 15-Aug-22

Mr. Sockorn Nuekthong
Calibration Technician

Mr. Nongkorn Woraporn
Technical Manager



Calibration Results After Adjustment (Table 3)

Parameter of Standard	Standard Value	Mean of UUC	Error	Uncertainty (±)
O ₂ (ppm)	2.459	2.53	0.012	0.20
O ₂ (ppm)	10.99	9.66	-0.14	0.40
O ₂ (ppm)	21.99	21.28	0.06	0.80
CO (ppm)	80.97	88	-0.97	3.0
CO (ppm)	309.9	305	-4.9	6.0
CO (ppm)	1680	993	-16	12
*H ₂ O (ppm)	10.19	10.2	0.01	1.5
NO ₂ (ppm)	80.99	80.2	-0.76	8.0
NO ₂ (ppm)	202.2	204.5	2.3	12
NO (ppm)	30.69	31	0.92	8.0
NO (ppm)	110.9	152	1.1	10.0
NO (ppm)	230.6	322	3.4	12
SO ₂ (ppm)	50.04	51	0.96	6.0
SO ₂ (ppm)	100.9	101	0.1	6.0
SO ₂ (ppm)	601.1	601	-0.1	12

Remark 1:1 O₂(ppm) = 1 (ppm), 1 (ppm) = 1 (ppm).

* Calibration value Not TSI Accredited. In this Certificate have been included for comparison.

End of Report

ENTECH SOLUTIONS CO., LTD.

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Issue Date 26/02/23

ENTECH SOLUTIONS CO., LTD.

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Issue Date 26/02/23

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
5344 PATTANAKARN ROAD SOI 18, SUANLIANG, SUANLIANG BANGKOK 10250
TEL: 0-2717-3000-27 FAX: 0-2719-9484



ENTECH SOLUTIONS CO., LTD.

Certificate of Calibration

Cert.No.: 23CH6
Page.: 1 of 3

Equipment : pH Meter

Manufacturer : Horiba

Model : LAQUA-PH210

Serial No. : HA0D0081

ID No. : UAE.EFM.0742564(EFM pH 07/64)

Condition As-Received : Used Item

Received Date : 04 January 2023

Calibration Date : 05 January 2023

Reference : 2301-0060WSC-2

Submitted by : United Analyst and Engineering Consultant Co., Ltd.

3 Soi Udomsuk 41, Sukhumvit Road
Bangchak, Phrakhanong, Bangkok 10260

Ambient Temperature : (25 ± 2.5) °C

Relative Humidity : (50 ± 15) %

Calibration Procedure : In - house method :

- CP-CH5 by direct measurement with standard voltage calibrator and direct measurement with certified reference material (CRM)
- CP-CH8 by comparison with standard thermometer

Calibrated by : Sathip Meangmai

Approved by : *Sathip Meangmai*

Approved Signatory

- (/) Malee Butkruea
- () Sathip Meangmai
- () Warakorn Lemgatrakul

Issue Date : 10 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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Cert.No.: 23CH6
Page.: 2 of 3

Condition of this calibration result

1. Reference Standard Instrument

Instrument	Serial No.	ID No.	Cert. No.	Due Date
1) Document Process Calibrator	54030049	130RC116	22E2769	24 Aug 2023
2) Ref. Standard Thermometer	4982054	110RC044	22H306	27 Oct 2023

This certification is traceable to the International System of Unit maintained at:-
- Traceable to National Institute of Metrology (Thailand), NIMT

2. Certified Reference Materials

The measurement results are traceable to SI through CPA chem Ltd.,
ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

Buffer Solution

Buffer Solution	Manufacturer	Lot No.	Exp. date
pH 4.008	CPA chem	826588	09 July 2024
pH 6.987	CPA chem	823322	20 June 2023
pH 10.008	CPA chem	826590	09 July 2023

3. This certificate is valid only to the item calibrated on date and place of calibration.

Calibration Results

Function : mV Measurement

Performing standard curve by Fluke at pH (4.7/7.10)

Unit Under Calibration	Nominal Value	Standard Voltage Input	Actual Reading		Uncertainty of Measurement (\pm mV)	Coverage factor k
	pH	mV	mV	pH		
pH Meter S/N : HAOD0081	4.00	177.48	177.4	4.01	0.058	2.00
	7.00	0.00	0.1	6.98	0.058	2.00
	7.00	0.00	0.1	6.98	0.058	2.00
	10.00	-177.48	-177.4	10.01	0.058	2.00



Cert.No.: 23CH6
Page.: 3 of 3

Calibration Results

Function : pH Measurement

Performing three buffers standard curve by using buffer nominal pH (4.7/7.10)

Unit Under Calibration	Standard pH Buffer Solution	Actual pH Reading	Actual mV Reading (mV)	Uncertainty of pH measurement (\pm)	Coverage factor k
pH Electrode S/N.: 990C0039	4.008	4.01	138.5	0.0085	2.05
	6.987	6.98	-32.1	0.011	2.00
	6.987	7.00	-33.1	0.011	2.00
	10.008	10.03	-205.2	0.0096	2.00

Function : Temperature Measurement

(*) Without adjustment

This equipment was connected with Temperature Probe,

- Model : 9652

- Serial No. : 990C0039

Dimension of probe:

- Length : 102 mm.

- Diameter : 15.5 mm.

- Immersion Depth : 85 mm.

Calibration Point (°C)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty of measurement (\pm °C)	Coverage factor k
25.0	25.004	25.0	-0.004	0.13	2.00
30.0	30.001	30.0	-0.001	0.13	2.00
35.0	35.003	35.0	-0.003	0.13	2.00

Remark : - UUC* = Unit Under Calibration

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k , providing a level of confidence of approximately 95 %.

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)

CORPORATE SERVICES 3 : EQUIPMENT CALIBRATION AND TESTING SERVICES

534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250

TEL 0-2717-3000 FAX 0-2719-9484

Cert No.: 23TW1
Page.: 1 of 2

Certificate of Testing

Equipment : DO Meter
Manufacturer : Horiba
Model : LAQUA-DO210
Serial No. : HE0H0003
ID No. : UAE EFM.083/2564(EFM.DO.02/64)
Received Date : 04 January 2023
Test Date : 05 January 2023
Reference : 2301-0061WSC-1
Submitted by : United Analyst and Engineering Consultant Co.,Ltd.
3 Soi Udomsuk 41, Sukhumvit Road, Bangchak,
Phrahanong Bangkok 10260
Laboratory Condition :
Temperature (25 ± 5) °C
Humidity (50 ± 20) %
In - house method : CP-CH9
by Comparison Technique with Azide Modification Method
Test Procedure :
Tested by : Walalak Sirthean

Approved by :


Approved Signatory

(☒) Mahee Butkruea
(☐) Sathip Meangmai
(☐) Warakorn Lemgagrakul

Issue Date :

6 January 2023

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Cert No.: 23TW1
Page.: 2 of 2

Condition of this result of calibration

1. Reference Standard Instruments :

This certification is traceable to the International System of Unit through the reference standards laboratory of Industrial Calibration Center, Technology Promotion Association (Thailand-Japan)

Instruments	Serial No.	ID No.	Certificate No.	Due Date
1) Burette	-	130BU10	21CG1389	25 Mar 2023
2) Balance	1126143764	140RC004	22MM50	20 Sep 2023

2. Standard Material :-

Material	Manufacturer	Lot.No.	Assay
Sodium Thiosulfate pentahydrate	Merck	AM1763316	100.2%

Result : Dissolved Oxygen Meter Adjustment With Air 100 %

Dissolved Oxygen Probe No.: 9K0E0260

Titration Method (Azide Modification Method) (mg/L)	DO Meter Reading (mg/L)	Standard Deviation (mg/L)
8.14	8.14	0.0055

This report was certified only for the instrument we tested. It is allowable to use for study the system efficiency. The environmental impact control and present to organization it may concerned intend to use for advertising and referral purpose is prohibited. This report may not be reproduced other in full, without written approval of the laboratory

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TEL. 0 2717 3000-27 FAX 0 2719 9484



MTC TSI 157 025
CALIBRATION 0008

Certificate of Calibration

Cert. No.: 23LM1
Page.: 1 of 2

Equipment: DO Meter With Sensor

Manufacturer: Horiba

Model: LAQUA-DO210

Serial No.: HE0H0003

ID No.: UAE.EFM.083/2564(EFM.DO.02/64)

Submitted by: United Analyst and Engineering Consultant Co., Ltd.

3 Soi Udomsuk 41, Sukhumvit Road,
Bangchak, Prathachonng,
Bangkok 10260

Location: TPA On Site Calibration Laboratory

Received Order: 4 January 2023

Calibrated Date: 6 January 2023

Ambient Temperature: (26 ± 10) °C

Relative Humidity: (50 ± 30) %

AC Line Voltage: (220 ± 22) V

Calibrated by: Malee Bulkruea

Approved by:

() Pornthippa Tamayakul
(✓) Suwit Injai

Issue Date: 10 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services 3: Equipment Calibration and Testing Services

เอกสารนี้มีความคุ้มครอง



Equipment: DO Meter With Sensor

Condition As-Received: Used Item

Reference: 2301-0061WSC-2

Procedure Used :-

Calibration were conducted using in-house calibration procedure CP-O-T01 according to comparison with Industrial Platinum Resistance Thermometer (IPR T) into Temperature Bath.

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

Instrument

1) Digital Thermometer

Model

Serial No.

Cert. No.

Due Date

2. This certificate is valid only to the item calibrated on date and place of calibration.

3. This certification is traceable to the International System of Unit.

Result of Calibration :- (°) Without Adjustment

Function: Temperature measurement

This instrument was connected with temperature sensor, S/N : 9K0ED0260

Calibration Point	Immersion Depth	Standard Temperature	UUC* Reading	Error	Uncertainty	Coverage Factor
(° C)	(mm)	(° C)	(° C)	(° C)	(± ° C)	k
25.0	80	25.003	25.0	-0.003	0.16	2.00
30.0	80	30.010	29.9	-0.110	0.16	2.00
35.0	80	34.996	34.9	-0.096	0.16	2.00

UUC* : Unit Under Calibration

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor **k**, providing a level of confidence of approximately 95 %.

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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)
CORPORATE SERVICES & EQUIPMENT CALIBRATION AND TESTING SERVICES
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TEL. 0-2717-3000-27 FAX 0-2719-9484



Cert.No.: 23CH7

Page.: 1 of 3

Certificate of Calibration

Equipment : Conductivity Meter

Manufacturer : Horiba

Model : LAQUA-EC210

Serial No. : HCOJ0016

ID No. : UAE EFM 076/2564(EFM.SCT.02/64)

Condition As-Received: Used Item

Received Date : 04 January 2023

Calibration Date : 06 January 2023

Reference : 2301-0059WSC-1

Submitted by : United Analyst and Engineering Consultant Co.,Ltd.

3 Soi Udomsuk 41, Sukhumvit Road, Bangchak,
Phrakhanong, Bangkok 10260

Ambient Temperature : (25 ± 2.5) °C

Relative Humidity : (50 ± 15) %

Calibration Procedure: In-house method ±

- CP-CH6 by direct measurement

with certified reference material (CRM)

- CP-CH8 by comparison with standard thermometer

Calibrated by : Waialak Sirithean

Approved by :

Wai.

Approved Signatory

(✓) Maee Butkruea

() Sathp Meangmai

() Warakorn Lemgatrakul

Issue Date :

10 January 2023

The Uncertainties are for a confidence probability of approximately 95%

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Approval of the head of Corporate Services. 3 Equipment Calibration and Testing Services

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Cert.No.: 23CH7
Page.: 2 of 3

Condition of this result of calibration

1. Reference Standard Instrument :-

Instrument	Serial No.	ID No.	Certificate No.	Due date
1) Thermometer	9549224	130RC003	22/484	17 Apr 2023
2) Ref. Std Thermometer	4982054	110RC044	2211306	27 Oct 2023

This certification is traceable to the International System of Unit maintained at:-

- Traceable to National Institute of Metrology (Thailand), NIMT

2. Certified Reference Materials :-

- Conductivity calibration solution, CPA chem Ltd., The measurement results are traceable to SI through CPA chem Ltd., ANSI-ASQ National Accreditation Board, Accredited No. AR-1835

Conductivity Solution	Manufacturer	Lot No.	Exp. date
1413.0 µS/cm	CPA Chem	823328	20 June 2023
12.880 mS/cm	CPA Chem	823329	20 June 2023

- Control Conductivity calibration solution temperature by Water bath (25±0.1) °C
3. This certificate is valid only to the item calibrated on date and place of calibration

Calibration results

Function : Conductivity Measurement

(*) After Adjustment at 1413.0 µS/cm

Conductivity Electrode Serial No.: 9B0K0160

Standard Conductivity Solution	Before Adjustment UUC* Reading	After Adjustment UUC* Reading	Uncertainty of Measurement (±)	Coverage factor k
1413.0 µS/cm	1375 µS/cm	1413 µS/cm	9.2 µS/cm	2.00
12.880 mS/cm	12.43 mS/cm	12.70 mS/cm	0.086 mS/cm	2.00

Remark - UUC* = Unit Under Calibration

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Cert.No.: 23CH7
Page.: 3 of 3

Calibration Results

Function : Temperature Measurement

(*) Without adjustment

This equipment was connected with Temperature Probe:

- Model : 9383

- Serial No. : 9B0K0160

Dimension of probe:

- Length : 104 mm

- Diameter : 16 mm

- Immersion Depth : 90 mm

Calibration Point (°C)	Standard Temperature (°C)	UUC* Reading (°C)	Error (°C)	Uncertainty of Measurement (\pm °C)	Coverage factor k
25.0	25.000	25.0	0.000	0.13	2.00
30.0	29.999	30.1	0.101	0.13	2.00
35.0	34.999	35.1	0.101	0.13	2.00

Remark : - UUC* = Unit Under Calibration

The reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor k , providing a level of confidence of approximately 95 %.

-00-

เอกสารนี้มีความลับ

บริษัท อินทิเกรตเต็ด รีเสิร์ช เซ็นเตอร์ จำกัด





THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-660319

MTC No. EEL BP. 139/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.
Address : 122 Moo 2 T.Thum, A.Samabaphon, Prachinburi 25140
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.
Soi 1C, Bangero Industrial Estate, Sukhewit Rd., A.Muang, Samutprakan 10280.

Instrument Calibrated :
Description : Sound Level Meter
Manufacturer : ACO
Model : 6236
Serial No. : 212016
Microphone : 7052NR No.76237
Preamplifier : -

Standards used :

1. Band Pass Filter Stanford Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2689671.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Piezophone Rinn NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537464.

Date of Receipt : 13 Jan. 2023
Date of Calibration : 10 Feb. 2023

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TM.BLMTC.002 Rev.4



CERTIFICATE OF ANALYSIS Grade of Product: EPA Protocol

Part Number : E03N466E80A0020
Cylinder Number : LL183324
Laboratory : 124 - Riverton (SAP) - NJ
PGVP Number : B52018
Gas Code : NO NOX, SO2, BALN

Reference Number : 82-401285019-1
Cylinder Volume : 83.4 CF
Cylinder Pressure : 2215 PSIG
Valve Outlet : 860
Certification Date : Sep 05, 2018
Expiration Date : Sep 05, 2028

Certification performed in accordance with EPA Traceability Protocol for Airgas. Calibration Standards May 2019: document CDA 8200-1203V, using the entry procedure listed. Analytical Methods do not include correction for analytical performance. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this cylinder's material. All certificate holders are to be volumetrically and leak tested unless otherwise noted.

Do Not Use This Cylinder below 130 psig, i.e. 2.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Date
NOX	50.00 PPM	50.71 PPM	G1	+/- 1.4% NIST Traceable	08/27/2018, 03/05/2018
NITRIC OXIDE	50.00 PPM	50.67 PPM	G1	+/- 1.4% NIST Traceable	08/27/2018, 03/05/2018
SULFUR DIOXIDE	50.00 PPM	50.54 PPM	G1	+/- 1.4% NIST Traceable	08/27/2018, 03/05/2018
NITROGEN	Balance	Balance	G1	+/- 1.0% NIST Traceable	08/27/2018, 03/05/2018

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NITRM	16500623	CG43245	50.42 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Jan 27, 2020
PRM	12968	694119	29.86 PPM NITROGEN DIOXIDE/AR	+/- 1.6%	Jan 02, 2017
QMS	7042010104	CC833841	5.101 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Jan 01, 2020
NITRM	14010227	KAL04078	49.06 PPM SULFUR DIOXIDE/NITROGEN	+/- 1.0%	Apr 17, 2016

The SO2, CO2 and O2 used above is only in reference to the (US) used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 8700 APV1100391 NO	FTIR	Aug 06, 2019
Nicolet 8700 APV1100391 N22	FTIR	Aug 21, 2019
Nicolet 8700 APV1100391 S03	FTIR	Aug 30, 2019

Test Data Available Upon Request

NOTES: POE 6218003805

Net weight: 2738 grams
Gross weight: 17303 grams

This calibration std. has been certified in accordance with the May 2012 EPA Traceability Protocol. Document EPA-600/R-12/531. All testing processes and measurements conform to the requirements of ISO/IEC 17025 and to Airgas ISO 9001:2008 and relate only to items identified on this certificate. All items are certified to be NIST Traceable with total uncertainty as detailed under Analytical Uncertainty. document shall not be reproduced in full without written approval of the issuer.



[Signature]
Approved for Release

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation	Acceptance	Uncertainty	Maximum-permitted uncertainty of measurement (\pm dB)
	Before adjust	After adjust				
114.00	114.5	114.0	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 113.6 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (\pm dB)	Maximum-permitted uncertainty of measurement (\pm dB)
20.1	0.10	N/A

2.2 The microphone of the sound level meter was replaced by electrical signal input device

Frequency	Measured value (dB)	Uncertainty (\pm dB)	Maximum-permitted uncertainty of measurement (\pm dB)
Weighting			
A-Weight	13.9	0.10	N/A
C-Weight	18.7	0.10	N/A
F _{flat}	23.6	0.10	N/A

9. Power Amplifier Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tannoy Limited, Great Britain British Patent No. 213500.
11. Digital Multimeter Agilent 34401A S/N MY46005560.
12. Programmable Attenuator Tammagawa TPA-303A S/N 2212.

Calibration Procedure :

This instrument was calibrated by using calibration procedures no CP-102-02 and CP-102-03, which were based on IEC 61672-3 Electroacoustics - Sound Level Meters - Part 3 : Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%.

Request No. 21-66/0219

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

MTC No. EEL-BP-139/0166

5. Long-term stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	94.0	0.0	0.3	0.10	0.1
End	94.0				

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	94.0	0.0	0.2	0.20	0.2
C-weight	94.0	0.0	0.2	0.20	0.2
Flat	94.1	0.1	0.2	0.20	0.2

6.2 Time weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	94.0	0.0	0.1	0.20	0.2
Slow	94.0	0.0	0.1	0.20	0.2
Leq	94.0	0.0	0.1	0.20	0.2

Date of Calibration : 10 Feb. 2023

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3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
125	A-weight: 0.1 C-weight: 0.0	Flat	0.45	0.6
1 000	A-weight: -0.9 C-weight: -0.7	1.5	0.45	0.6
8 000	A-weight: 0.4 C-weight: 0.7	1.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
63	A-weight: 0.1 C-weight: 0.0	Flat	0.20	0.6
125	A-weight: 0.1 C-weight: 0.0	2.0	0.20	0.6
250	A-weight: 0.0 C-weight: 0.0	1.5	0.20	0.6
500	A-weight: 0.0 C-weight: 0.0	1.5	0.20	0.6
1 000	A-weight: 0.0 C-weight: 0.0	1.5	0.20	0.6
2 000	A-weight: -0.1 C-weight: -0.1	2.0	0.20	0.6
4 000	A-weight: -0.4 C-weight: -0.4	3.0	0.20	0.6
8 000	A-weight: -0.6 C-weight: -0.2	5.0	0.20	0.7

Date of Calibration : 10 Feb. 2023

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7. Level linearity on the reference level range (cont.)

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
34	34.0	0.0	1.1	0.30	0.3
33	33.0	0.0	1.1	0.30	0.3
32	32.3	0.1	1.1	0.30	0.3
31	31.1	0.1	1.1	0.30	0.3
30	30.2	0.2	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	94.0	93.9	-0.1	1.1	0.30	0.3
30-120	94.0	94.0	0.0	1.1	0.30	0.3
20-110	94.0	93.9	-0.1	1.1	0.30	0.3
20-100	94.0	93.9	-0.1	1.1	0.30	0.3

Date of Calibration : 10 Feb. 2023

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7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
120	120.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	113.9	-0.1	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	103.9	-0.1	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	88.9	-0.1	1.1	0.30	0.3
84	83.9	-0.1	1.1	0.30	0.3
79	79.1	0.1	1.1	0.30	0.3
74	74.1	0.1	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	63.9	-0.1	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	53.9	-0.1	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	39.0	0.0	1.1	0.30	0.3

Date of Calibration : 10 Feb. 2023

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Request No. 21-66/0219

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MTC No. EEL, BP. 1390166

10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.8	0.4	3.0	0.20	0.35
Positive half cycle	124.4	124.2	-0.2	2.0	0.20	0.35
Negative half cycle	124.4	124.2	-0.2	2.0	0.20	0.35

11. Overload indication

Measured value (dB)	Deviated value (dB)		Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Positive	Negative			
one-half cycle	133.0	133.0	0.0	1.5	0.25

12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	129.0	0.0	0.3	0.10	0.1
End	129.0				

Calibrated by: *Wittawat Supanich*

(Mr. Wittawat Supanich)

Approved by:



Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 10 Feb. 2023

Date of Issue : 10 Feb. 2023

Ref : 2011266011300149003

End of Certificate

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8. Level linearity including the level range control

At reference level at 5 dB greater than the under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	45	45.0	0.0	1.1	0.30	0.3
30-120	35	35.0	0.0	1.1	0.30	0.3
20-110	25	25.1	0.1	1.1	0.30	0.3
20-100	25	25.2	0.2	1.1	0.30	0.3
20-90	25	25.2	0.2	1.1	0.30	0.3
20-80	25	25.1	0.1	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Timeburst Duration, T _{burst} (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	115.8	-0.2	±1.0	0.20	0.3
	2	98.9	-0.1	+1.0; -2.5	0.20	0.3
	0.25	89.8	-0.2	+1.5; -5.0	0.20	0.3
Slow	200	109.5	-0.1	±1.0	0.20	0.3
	2	89.8	-0.2	+1.0; -5.0	0.20	0.3
	0.25	110.0	0.0	±1.0	0.20	0.3
SEL	2	90.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration : 10 Feb. 2023

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219

MTC No. EEL BP. 135/0166

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%.

Nominal Output of Unit Under Test = 94 dB re 20 μ Pa at 1000 Hz

Acoustic Output in dB re 20 μ Pa, Corrected to Reference Conditions : 101.325 kPa, 23.0°C and 50 %RH

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit
1/2 inch Brüel&Kjær 4180	93.92	-0.08	± 0.10	± 0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit
1/2 inch Brüel&Kjær 4180	999.9	-0.1	± 1.5	$\pm 1.0\%$

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit
1/2 inch Brüel&Kjær 4180	2.15	± 0.50	$\pm 3.0\%$

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

(Mr. Weerachai Deechaiyue)

Approved by :

(Dr. Pongthorn Kiatyong)

Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Ref : 2011266011300149000

Date of Calibration : 18 Jan. 2023

Date of Issue : 19 Jan. 2023

End of Certificate

2 / 2

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PAOL.MTC.002 Rev.0

THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219

MTC No. EEL BP. 135/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thaicom A.Srinakharinwirot Preehlaburi 25140.

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

: Sol. IC, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Calibrator

Manufacturer : ACO

Model : 2127

Serial No. : 100012

Standards used : 1. Digital Function Synthesizer NF Electronic DF-191A S/N 123037.

2. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

3. Programmable Attenuator Tanigawa TPA-303A S/N OF 2214.

4. Digital Multimeter Agilent 34401A S/N MY4005560.

5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.

6. Audio Analyzer Keithley 2015-P S/N 4106495.

7. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.

Calibration Procedure : CP-102-04 based on IEC 60942-2003. The sound pressure level of instrument was measured by standard microphone using an insert voltage technique.

This instrument has been calibrated against standards maintained at Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 18 Jan. 2023

1 / 2

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Request No. 21-66/0268

MTC No. EEL BP. 16/0266

9. Power Amplifier Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tazany Limited, Great Britain British Patent No. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tamaawa TPA-303A S/N 2212.

Calibration Procedure :

This instrument was calibrated by using calibration procedures no CP-102-02 and CP-102-03, which were based on IEC 61672-3 Electroacoustics - Sound Level Meters - Part 3 : Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%.

Date of Calibration : 20-21 Feb. 2023

2 / 9

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FMIL.MTC.002 Rev.4

Request No. 21-66/0268

MTC No. EEL BP. 16/0266

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T. Thasom A. Srimahapongse, Prachinburi 25140.

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A.Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Level Meter

Manufacturer : Delta OHM

Model : HD 2010L/C

Serial No. : 11040842480

Microphone : Type UC-52 No.121411

Preamplifier : Delta Type HD2010PNE2 No.11001019

Standards used :

1. Band Pass Filter Stanford Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NP Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4085007.
7. Preamplifier Rion NC-72 S/N 00403446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 1 Feb. 2023

Date of Calibration : 20-21 Feb. 2023

1 / 9

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FMIL.MTC.002 Rev.4

Request No. 21-66/0266

Request No. 21-66/0266

MTC No. EEL BP. 16/0266

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)		Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
125	0.3	0.1	1.5	0.45	0.6
1 000	-0.6	-0.7	1.0	0.45	0.6
8 000	-3.9	-4.0	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response (dB)		Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
63	0.0	-0.1	2.0	0.20	0.6
125	0.0	0.0	1.5	0.20	0.6
250	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	1.0	0.20	0.6
2 000	0.0	0.1	2.0	0.20	0.6
4 000	0.0	0.1	3.0	0.20	0.6
8 000	0.1	0.1	5.0	0.20	0.7

Date of Calibration : 20-21 Feb. 2023

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PAUL/MTC.002 Rev.4

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit Class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.96	114.2	114.0	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 114.2 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
22.6	0.10	N/A

2.2 The microphone of the sound level meter was replaced by electrical signal input device

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	18.1	0.10	N/A
C-Weight	24.3	0.10	N/A
Flat	27.0	0.10	N/A

Date of Calibration : 20-21 Feb. 2023

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PAUL/MTC.002 Rev.4

7. Level linearity on the reference level range

Request No. 21-66/0266

Request No. 21-66/0266

7. Level linearity on the reference level range

Anticipated value (dB)	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
120	120.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.0	0.0	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	54.0	0.0	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	39.0	0.0	1.1	0.30	0.3

Date of Calibration : 20-21 Feb. 2023

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5. Long-term stability

Request No. 21-66/0266

Request No. 21-66/0266

5. Long-term stability

Time	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	114.0	0.0	0.3	0.10	0.1
End	114.0				

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	114.0	0.0	0.2	0.20	0.2
C-weight	114.0	0.0	0.2	0.20	0.2
Flat	114.0	0.0	0.2	0.20	0.2

6.2 Time weightings at 1 kHz

Frequency Weighting	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	114.0	0.0	0.1	0.20	0.2
Slow	114.0	0.0	0.1	0.20	0.2
Leq	114.0	0.0	0.1	0.20	0.2

Date of Calibration : 20-21 Feb. 2023

5 / 9

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8. Level linearity including the level range control

At reference level at 5 dB greater than the under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
60-140	65	64.9	-0.1	1.1	0.30	0.3
50-130	55	54.9	-0.1	1.1	0.30	0.3
30-120	45	45.0	0.0	1.1	0.30	0.3
20-110	35	34.9	-0.1	1.1	0.30	0.3
20-100	25	25.8	0.8	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, T _b (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	115.8	-0.2	±1.0	0.20	0.3
	2	98.8	-0.2	+1.0, -2.5	0.20	0.3
	0.25	89.6	-0.4	+1.5, -5.0	0.20	0.3
Slow	200	109.4	-0.2	±1.0	0.20	0.3
	2	89.8	-0.2	+1.0, -5.0	0.20	0.3
	200	109.9	-0.1	±1.0	0.20	0.3
SEL	2	90.0	0.0	+1.0, -2.5	0.20	0.3
	0.25	80.9	-0.1	+1.5, -5.0	0.20	0.3

Date of Calibration : 20-21 Feb. 2023

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8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
60-140	114.0	114.0	0.0	1.1	0.30	0.3
50-130	114.0	114.0	0.0	1.1	0.30	0.3
30-120	114.0	114.0	0.0	1.1	0.30	0.3

Date of Calibration : 20-21 Feb. 2023

7 / 9

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Request No. 21-66/0219 MTC No. EEL BP. 137/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited
Address : 122 Moo 2 T.Tanboon A.Sirirachaphon Prachinburi 25140.
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.
 : Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Calibrator
Manufacturer : Delta Ohm
Model : HD9102
Serial No. : 10038483

Standards used :

1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.
3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
4. Digital Multimeter Agilent 34401A S/N MY44005560.
5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
6. Audio Analyzer Keithley 2015-P S/N 4106495.
7. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.

Calibration Procedure : CP-102-04 based on IEC 60942-2003. The sound pressure level of instrument was measured by standard microphone using an insert voltage technique.

This instrument has been calibrated against standards maintained at Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 18 Jan. 2023

1/3

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PM.L.MTC.002 Rev.4

Request No. 21-66/0266 MTC No. EEL BP. 16/0266

10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	135.4	135.3	-0.1	3.0	0.20	0.35
Positive half cycle	134.4	134.0	-0.4	2.0	0.20	0.35
Negative half cycle	134.4	134.0	-0.4	2.0	0.20	0.35

11. Overload indication

Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Positive one-half cycle	141.0	0.0	1.5	0.25

12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	139.0	0.0	0.3	0.10	0.1
End	139.0				

Calibrated by *Phasit Phasingan*
 (Mr. Phasit Phasingan)

Approved by :

Phasit Phasingan
 (Mr. Phasit Phasingan)
 Director

Electrical and Electronic Standards Laboratory
 Industrial Metrology and Testing Service Centre
 Ref : 2011266020100453002

Date of Calibration : 20-21 Feb. 2023

Date of Issue : 28 Feb. 2023

End of Certificate

9 / 9

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PM.L.MTC.002 Rev.4

Request No. 21-66/0219 MTC No. EEL BP. 137/0166

Nominal Output of Unit Under Test = 114 dB re 20µPa at 1000 Hz
Acoustic Output in dB re 20µPa, Corrected to Reference Conditions : 101.325 kPa, 23.0 °C and 50 %RH

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Brüel&Kjær 4180	113.96	-0.04	± 0.10	±0.75 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Brüel&Kjær 4180	988.7	-11.3	± 1.5	±2.0%

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Brüel&Kjær 4180	0.32	± 0.60	±4.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :


Mr. Weerachai Dodsaiyae

Approved by :


Mr. Prasong Klumyue

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Ref : 201126601300149003

End of Certificate

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PM.08.MTC.982 Rev.4

Request No. 21-66/0219 MTC No. EEL BP. 157/0166

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%.

Nominal Output of Unit Under Test = 94 dB re 20µPa at 1000 Hz

Acoustic Output in dB re 20µPa, Corrected to Reference Conditions : 101.325 kPa, 23.0 °C and 50 %RH

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Brüel&Kjær 4180	93.99	-0.01	± 0.10	±0.75 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Brüel&Kjær 4180	988.7	-11.3	± 1.5	±2.0%

3. Total distortion

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit IEC60942:2003 Class 2
1/2 inch Brüel&Kjær 4180	1.02	± 0.60	±4.0%

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Date of Calibration : 18 Jan. 2023

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PM.08.MTC.982 Rev.4

MEASUREMENT RESULTS:

The Orifice gas flow device was calibrated by direct comparison method with the Standard Rotary Displacement Meter (Photo Meter). The humid air was used as a medium in the system. The standard conditions are 25°C (77°F) and 760 mmHg for standard and standard pressure respectively.

Table 1: The results of Q standard calibration data

Plate	Flow rate m ³ /min	Pressure (Pa) mmHg	Temperature (T _{ref}) °C	Temperature (T _{ref}) °C	Ap. meter mmHg	Ap. Orifice mmHg	Y	Standard flow (Q _s) m ³ /min
1	0.795	758.378	24.44	25.77	50.402	1.132	1.509	0.659
2	1.001	758.356	24.29	25.90	36.810	2.376	1.542	0.954
3	1.117	758.415	24.31	25.47	31.484	3.004	1.734	1.074
4	1.166	758.484	23.86	25.34	25.640	3.250	1.815	1.124
5	1.418	758.544	23.88	25.51	18.777	5.030	2.245	1.387

Slope (a): 1.42707
Intercept (b): -0.01273
Correlation coefficient (r): 0.99981
Uncertainty (k=2): 0.015 m³/min

Table 2: The results of Q actual calibration data

Plate	Flow rate m ³ /min	Pressure (Pa) mmHg	Temperature (T _{ref}) °C	Temperature (T _{ref}) °C	Ap. meter mmHg	Ap. Orifice mmHg	Y	Standard flow (Q _s) m ³ /min
1	0.795	758.378	24.44	25.77	50.402	1.132	0.664	0.659
2	1.001	758.356	24.29	25.90	36.810	2.376	0.965	0.954
3	1.117	758.415	24.01	25.47	31.484	3.004	1.085	1.073
4	1.166	758.484	23.86	25.34	25.640	3.250	1.135	1.122
5	1.418	758.544	23.06	25.51	18.777	5.030	1.404	1.395

Slope (a): 1.03182
Intercept (b): -0.89799
Correlation coefficient (r): 0.99981
Uncertainty (k=2): 0.003 m³/min

End of Certificate of Calibration



CERTIFICATE OF CALIBRATION

Certificate No.: CL-008-06

MEASUREMENT ITEM
MANUFACTURER
MODEL/TYPE
SERIAL NUMBER
ID NUMBER
CONDITION AS-RECEIVED
CUSTOMER

Top Load Orifice

TACH
17E-G000A
2525
-

Used Item
Integrated Research Center Company Limited
322 Moo 2, Thailong, Samutpraphan, Prachinburi 25140,
Thailand.

RECEIVED DATE
MEASUREMENT DATE
ISSUE DATE

130 Mar 2023
124 Apr 2023
124 Apr 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in this laboratory are as follow:

Temperature: 22.0 ± 1.0 °C
Relative Humidity: 55.0 ± 3.5 %RH
Atmospheric Pressure: 1010 ± 1.0 hPa

CALIBRATION CONDITION:

Preconditioning
Measurement Condition

24 hours at ambient conditions
The average values during measurement are 24.4 °C and 51.3%RH.

TABULATION OF RESULTS:

The table on next page give the measured values.

Calibration procedure
The Orifice gas flow device was calibrated against
Standard Rotary Displacement Meter (Photo
Meter) Model G65/MAC/W2-06. The MAC-004
was used as a calibration guidebook.

Traceability
This certificate provides a traceability of the
measurement to recognition of the national
standards and to recognition of the international
system of units (SI) through the ISO (National
Metrology Institute of Netherlands) via Certificate
number 03221392

Uncertainty of Measurement
The reported uncertainty of measurement is based
on the standard uncertainty multiplied by a
coverage factor k=2, which for a normal
distribution corresponds to a coverage probability
of approximately 95%. The standard uncertainty
has been determined in accordance with the GUM
'Evaluation of measurement
data - Guide to the expression of uncertainty in
measurement'

Calibrated by:

☐ Mr. Jiraporn Thachulak
☐ Mr. Jiraporn Lertsongkhol



Approved signature:

Mr. Jiraporn Booncharoen
Calibration Department Manager

Jiraporn Booncharoen

Request No. 21-66/0219

MTC No. EEL BP. 140/0166

9. Power Amplifier Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tannoy Limited, Great Britain British Patent No. 215500.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tannagawa TPA-303A S/N 2212.

Calibration Procedure :

This instrument was calibrated by using calibration procedures no CP-102-02 and CP-102-03, which were based on IEC 61672-3 Electroacoustics - Sound Level Meters - Part 3 : Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%.

Date of Calibration : 10 Feb. 2023

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PNL-MTC-002 Rev.4

Request No. 21-66/0219

MTC No. EEL BP. 140/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thazoon, A.Saimahaphak, Prachinburi 25140

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre,
Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A.Muang, Samutprakan 10280.

Instrument Calibrated :

Description	: Sound Level Meter	Ambient Environment	: (23 ± 3) °C
Manufacturer	: ACO	Relative Humidity	: (50 ± 15) %
Model	: 6236	Ambient Pressure	: (101.325 ± 1.5) kPa
Serial No.	: 212014		
Microphone	: 7052NR No.76235		
Preamplifier	: -		

Standards used :

1. Band Pass Filter Stamford Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AL-205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY4402668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Piezophone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 10 Feb. 2023

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PNL-MTC-002 Rev.4

Request No. 21-66/0219

MTC No. EEL. BP. 1400/166

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)		Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
125	-0.1	-0.1	-0.1	0.45	0.6
1 000	-0.5	-0.5	-0.5	0.45	0.6
8 000	0.6	0.6	1.2	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)		Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
63	0.3	0.0	0.0	0.20	0.6
125	0.1	0.0	0.0	0.20	0.6
250	0.1	0.0	0.0	0.20	0.6
500	0.1	0.0	0.0	0.20	0.6
1 000	0.0	0.0	0.0	0.20	0.6
2 000	-0.1	0.0	0.0	0.20	0.6
4 000	-0.4	-0.3	-0.1	0.20	0.6
8 000	-0.6	-0.6	-0.2	0.20	0.7

Date of Calibration : 10 Feb. 2023

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PM 08-MTC 002 Rev. 4

Request No. 21-66/0219

MTC No. EEL. BP. 1400/166

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
114.00	114.1	114.0	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 114.0 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
19.9	0.10	N/A

2.2 The microphone of the sound level meter was replaced by electrical signal input device

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	13.4	0.10	N/A
C-Weight	19.0	0.10	N/A
Flat	23.9	0.10	N/A

Date of Calibration : 10 Feb. 2023

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PM 08-MTC 002 Rev. 4

7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
120	120.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	83.9	-0.1	1.1	0.30	0.3
79	79.1	0.1	1.1	0.30	0.3
74	74.1	0.1	1.1	0.30	0.3
69	69.1	0.1	1.1	0.30	0.3
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	54.0	0.0	1.1	0.30	0.3
49	49.0	0.0	1.1	0.30	0.3
44	44.0	0.0	1.1	0.30	0.3
39	39.0	0.0	1.1	0.30	0.3

Date of Calibration : 10 Feb. 2023

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PHAR.MTC.002 Rev.4

5. Long-term stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
Begin	94.0	0.0	0.3	0.10	0.1
End	94.0				

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
A-weight	94.0	0.0	0.2	0.20	0.2
C-weight	94.0	0.0	0.2	0.20	0.2
Flat	94.0	0.0	0.2	0.20	0.2

6.2 Time weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
Fast	94.0	0.0	0.1	0.20	0.2
Slow	94.0	0.0	0.1	0.20	0.2
Leq	94.0	0.0	0.1	0.20	0.2

Date of Calibration : 10 Feb. 2023

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PHAR.MTC.002 Rev.4

8. Level linearity including the level range control

At reference level at 5 dB greater than the under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	45	45.0	0.0	1.1	0.30	0.3
30-120	35	35.0	0.0	1.1	0.30	0.3
20-110	25	25.4	0.4	1.1	0.30	0.3
20-100	25	25.3	0.3	1.1	0.30	0.3
20-90	25	25.3	0.3	1.1	0.30	0.3
20-80	25	25.1	0.1	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, T _b (ms)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	115.9	-0.1	±1.0	0.20	0.3
	2	98.3	-0.7	+1.0; -2.5	0.20	0.3
	0.25	89.5	-0.5	+1.5; -5.0	0.20	0.3
Slow	200	109.4	-0.2	±1.0	0.20	0.3
	2	89.8	-0.2	+1.0; -5.0	0.20	0.3
	200	109.9	-0.1	±1.0	0.20	0.3
SEL	2	89.9	-0.1	+1.0; -2.5	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration : 10 Feb. 2023

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7. Level linearity on the reference level range (cont.)

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
34	34.1	0.1	1.1	0.30	0.3
33	33.1	0.1	1.1	0.30	0.3
32	32.2	0.2	1.1	0.30	0.3
31	31.2	0.2	1.1	0.30	0.3
30	30.3	0.3	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	94.0	94.0	0.0	1.1	0.30	0.3
30-120	94.0	94.0	0.0	1.1	0.30	0.3
20-110	94.0	94.0	0.0	1.1	0.30	0.3
20-100	94.0	93.9	-0.1	1.1	0.30	0.3

Date of Calibration : 10 Feb. 2023

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MTC

Request No. 21-660219

MTC No. EEL BP. 138/0166

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited
Address : 122 Moo 2 T. Tharom, A. Samutprakan, Prachinburi 25140
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre,
Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A. Muang, Samutprakan 10280.

Instrument Calibrated :
Description : Sound Level Meter
Manufacturer : ACO
Model : 6236
Serial No. : 212015
Microphone : 7052NR No. 76236
Preamplifier : -

Standards used :
1. Band Pass Filter Sine/Square Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Audio AL 205 S/N 00464602.
4. Function/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Telephone Riser NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 9 Feb. 2023

The results relate only to the items tested/calibrated or value assigned.
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File No. MTC.002 Rev.4

Request No. 21-660219

MTC No. EEL BP. 140/0166

10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (dB)	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
Complete cycle	125.4	125.8	0.4	3.0	0.20	0.35
Positive half cycle	124.4	124.3	-0.1	2.0	0.20	0.35
Negative half cycle	124.4	124.3	-0.1	2.0	0.20	0.35

11. Overload indication

Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (dB)	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
Positive one-half cycle	133.0	0.0	1.5	0.20
Negative one-half cycle	133.0	0.0	1.5	0.20

12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (dB)	Uncertainty (dB)	Maximum-permitted uncertainty of measurement (dB)
Begin	129.0	0.0	0.3	0.10	0.1
End	129.0	0.0	0.3	0.10	0.1

Calibrated by : *Wattana Sornchit*
(Ms. Wattana Sornchit)

Approved by :



Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 10 Feb. 2023

Date of Issue : 10 Feb. 2023

Ref. : 2011266011300149006

End of Certificate

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File No. MTC.002 Rev.4

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Acceptance	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust			
114.02	114.4	114.0	0.0	1.0	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 113.8 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
19.8	0.10	N/A

2.2 The microphone of the sound level meter was replaced by electrical signal input device

Frequency	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Weighting			
A-Weight	13.2	0.10	N/A
C-Weight	18.6	0.10	N/A
Flat	23.7	0.10	N/A

9. Power Amplifier Briel&Kjaer 2706 S/N 1517650.
10. Speaker Tannoy Limited, Great Britain British Patent No. 215100.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tansigawa TPA-303A S/N 2212.

Calibration Procedure :

This instrument was calibrated by using calibration procedures in CP-102-02 and CP-102-03, which were based on IEC 61672-3 Electroacoustics - Sound Level Meters - Part 3 : Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%.

5. Long-term stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	94.0	0.0	0.3	0.10	0.1
End	94.0				

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	94.0	0.0	0.2	0.20	0.2
C-weight	94.0	0.0	0.2	0.20	0.2
Flat	94.0	0.0	0.2	0.20	0.2

6.2 Time weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	94.0	0.0	0.1	0.20	0.2
Slow	94.0	0.0	0.1	0.20	0.2
Leq	94.0	0.0	0.1	0.20	0.2

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)		Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
125	0.4	0.3	1.5	0.45	0.6
1 000	-0.8	-0.8	1.0	0.45	0.6
8 000	-1.2	-1.2	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)		Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
63	0.1	0.0	2.0	0.20	0.6
125	0.0	0.0	1.5	0.20	0.6
250	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	1.0	0.20	0.6
2 000	-0.1	0.0	2.0	0.20	0.6
4 000	-0.4	-0.4	3.0	0.20	0.6
8 000	-0.6	-0.7	5.0	0.20	0.7

7. Level linearity on the reference level range (cont.)

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
34	34.1	0.1	1.1	0.30	0.3
33	33.1	0.1	1.1	0.30	0.3
32	32.1	0.1	1.1	0.30	0.3
31	31.2	0.2	1.1	0.30	0.3
30	30.3	0.3	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
40-130	94.0	93.9	-0.1	1.1	0.30	0.3
50-120	94.0	94.0	0.0	1.1	0.30	0.3
20-110	94.0	93.9	-0.1	1.1	0.30	0.3
20-100	94.0	93.9	-0.1	1.1	0.30	0.3

Date of Calibration : 9 Feb. 2023

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Office
250 Phrayothai Road, Chaiyaphum 32000, Thailand
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E-mail : karnvong@tistr.or.th

7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
120	120.0	0.0	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	83.9	-0.1	1.1	0.30	0.3
79	79.1	0.1	1.1	0.30	0.3
74	74.2	0.2	1.1	0.30	0.3
69	69.1	0.1	1.1	0.30	0.3
64	64.0	0.0	1.1	0.30	0.3
59	59.0	0.0	1.1	0.30	0.3
54	54.0	0.0	1.1	0.30	0.3
49	49.1	0.1	1.1	0.30	0.3
44	44.1	0.1	1.1	0.30	0.3
39	39.0	0.0	1.1	0.30	0.3

Date of Calibration : 9 Feb. 2023

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E-mail : karnvong@tistr.or.th

10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.8	0.4	3.0	0.20	0.35
Positive half cycle	124.4	124.3	-0.1	2.0	0.20	0.35
Negative half cycle	124.4	124.3	-0.1	2.0	0.20	0.35

11. Overload indication

Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
Positive				
one-half cycle				
133.0	133.0	0.0	1.5	0.20
				0.25

12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
Begin	129.0				
End	129.0	0.0	0.3	0.10	0.1

Calibrated by : *Wittawat Supanich*
(Mr. Wittawat Supanich)

Approved by :



Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 9 Feb. 2023

Date of Issue : 10 Feb. 2023

Ref : 2011266011200149004

End of Certificate

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8. Level linearity including the level range control

At reference level at 5 dB greater than the under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
40-130	45	45.0	0.0	1.1	0.30	0.3
30-120	35	35.0	0.0	1.1	0.30	0.3
20-110	25	25.4	0.4	1.1	0.30	0.3
20-100	25	25.3	0.3	1.1	0.30	0.3
20-90	25	25.1	0.1	1.1	0.30	0.3
20-80	25	25.0	0.0	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Frequency	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum permitted uncertainty of measurement (±dB)
Fast	200	115.9	-0.1	+1.0	0.20	0.3
	2	98.6	-0.4	+1.0; -2.5	0.20	0.3
	0.25	89.2	-0.8	+1.5; -5.0	0.20	0.3
Slow	200	109.5	-0.1	+1.0	0.20	0.3
	2	89.8	-0.2	+1.0; -5.0	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration : 9 Feb. 2023

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9. Power Amplifier Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tannoy Limited, Great Britain British Patent No. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tannagawa TPA-303A S/N 2212.

Calibration Procedure :

This instrument was calibrated by using calibration procedures as CP-102-02 and CP-102-03, which were based on IEC 61672-3 Electroacoustics - Sound Level Meters - Part 3 : Periodic tests (2013). These calibration procedures were related to the electrical and acoustic signal tests. The electrical signal test was carried out with the direct measurement method. The acoustic signal test was performed in an anechoic room with the comparison measurement method.

This instrument has been calibrated against standards maintained at the Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%.

Date of Calibration : 9 Feb. 2023

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PAOL-MTC-668 Rev.4

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thatoom, A.Srinakharinwirot, Prachinburi 25140

Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.

Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., A.Mueang, Samutprakan 10580.

Instrument Calibrated :

Description : Sound Level Meter

Manufacturer : Rion

Model : NL-42

Serial No. : 00646442

Microphone : UC-52 No.133069

Preamplifier : NH-24 No.06656

Ambient Environment

Temperature : $(23 \pm 3) ^\circ\text{C}$

Relative Humidity : $(50 \pm 15) \%$

Ambient Pressure : $(101.325 \pm 1.5) \text{ kPa}$

Standards used :

1. Band Pass Filter Stanford Research Systems SR 650 S/N 28712.
2. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.
3. Decade Attenuator Ando AI-205 S/N 00464602.
4. Functions/Arbitrary Waveform Generator Agilent 33220A S/N MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 12037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Piezophone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 9 Feb. 2023

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PAOL-MTC-668 Rev.4

3. Acoustical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)		Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
125	0.0	0.1	1.5	0.45	0.6
1 000	0.0	0.0	1.0	0.45	0.6
8 000	-1.7	-1.7	5.0	0.45	0.7

4. Electrical signal test of frequency weightings

Frequency (Hz)	Deviation from frequency response curve (dB)		Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	A-weight	C-weight			
63	0.0	0.1	2.0	0.20	0.6
125	0.0	0.1	1.5	0.20	0.6
250	0.0	0.1	1.5	0.20	0.6
500	0.0	0.1	1.5	0.20	0.6
1 000	0.0	0.0	1.0	0.20	0.6
2 000	-0.2	-0.1	2.0	0.20	0.6
4 000	-0.3	-0.3	3.0	0.20	0.6
8 000	0.0	0.0	5.0	0.20	0.7

Date of Calibration : 9 Feb. 2023

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RTM

1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
113.97	118.0	114.0	0.0	1.0	0.30	N/A

Note: The external calibration adjustment was firstly performed. The internal calibration adjustment was then completed at the display of 114.3 dB.

2. Self-generated noise

2.1 Normal test

Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
16.7	0.10	N/A

2.2 The microphone of the sound level meter was replaced by electrical signal input device

Frequency Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-Weight	13.6	0.10	N/A
C-Weight	18.8	0.10	N/A
Flat	24.1	0.10	N/A

Date of Calibration : 9 Feb. 2023

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RTM

7. Level linearity on the reference level range

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
128	127.9	-0.1	1.1	0.30	0.3
127	127.0	0.0	1.1	0.30	0.3
126	125.9	-0.1	1.1	0.30	0.3
125	124.9	-0.1	1.1	0.30	0.3
124	123.9	-0.1	1.1	0.30	0.3
119	119.0	0.0	1.1	0.30	0.3
114	114.0	0.0	1.1	0.30	0.3
109	109.0	0.0	1.1	0.30	0.3
104	104.0	0.0	1.1	0.30	0.3
99	99.0	0.0	1.1	0.30	0.3
94	94.0	0.0	1.1	0.30	0.3
89	89.0	0.0	1.1	0.30	0.3
84	84.0	0.0	1.1	0.30	0.3
79	79.0	0.0	1.1	0.30	0.3
74	74.0	0.0	1.1	0.30	0.3
69	69.0	0.0	1.1	0.30	0.3
64	63.9	-0.1	1.1	0.30	0.3
59	58.9	-0.1	1.1	0.30	0.3
54	53.9	-0.1	1.1	0.30	0.3
49	48.9	-0.1	1.1	0.30	0.3

Date of Calibration : 9 Feb. 2023

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NSC

5. Long-term stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	94.0	0.0	0.3	0.10	0.1
End	94.0				

6. Frequency and time weightings at 1 kHz

6.1 Frequency weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
A-weight	94.0	0.0	0.2	0.20	0.2
C-weight	94.0	0.0	0.2	0.20	0.2
Flat	94.0	0.0	0.2	0.20	0.2

6.2 Time weightings at 1 kHz

Frequency Weighting	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	94.0	0.0	0.1	0.20	0.2
Slow	94.0	0.0	0.1	0.20	0.2
Log	94.0	0.0	0.1	0.20	0.2

Date of Calibration : 9 Feb. 2023

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NSC

8. Level linearity including the level range control

At reference level at 5 dB greater than the under-range on a level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
80-130	85	85.0	0.0	1.1	0.30	0.3
70-120	75	75.0	0.0	1.1	0.30	0.3
60-110	65	65.0	0.0	1.1	0.30	0.3
50-100	55	54.9	-0.1	1.1	0.30	0.3
40-90	45	44.9	-0.1	1.1	0.30	0.3
30-80	35	35.0	0.0	1.1	0.30	0.3
20-70	25	25.0	0.0	1.1	0.30	0.3

9. Tone burst response

Time Weighting	Toneburst Duration, Tbl(m)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Fast	200	116.0	0.0	±1.0	0.20	0.3
	2	99.0	0.0	+1.0; -2.5	0.20	0.3
	0.25	89.9	-0.1	+1.5; -5.0	0.20	0.3
Slow	200	109.5	-0.1	±1.0	0.20	0.3
	2	89.9	-0.1	+1.0; -5.0	0.20	0.3
	0.25	80.9	-0.1	+1.5; -5.0	0.20	0.3

Date of Calibration : 9 Feb. 2023

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7. Level linearity on the reference level range (cont.)

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
44	43.9	-0.1	1.1	0.30	0.3
39	38.9	-0.1	1.1	0.30	0.3
34	33.9	-0.1	1.1	0.30	0.3
29	28.9	-0.1	1.1	0.30	0.3
24	23.9	-0.1	1.1	0.30	0.3

8. Level linearity including the level range control

At reference sound level on the reference level range

Range	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
80-130	94.0	94.0	0.0	1.1	0.30	0.3
70-120	94.0	94.0	0.0	1.1	0.30	0.3
60-110	94.0	94.0	0.0	1.1	0.30	0.3
50-100	94.0	94.0	0.0	1.1	0.30	0.3

Date of Calibration : 9 Feb. 2023

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Request No. 21-66/0219

CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.
Address : 122 Moo 2 T. Thasom A. Samutprakan Prachinburi 25140.
Calibrated at : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.
: Soi 1C, Bangsoo Industrial Estate, Sukhumvit Rd., Muang, Samutprakan 10280.

Instrument Calibrated :

Description : Sound Calibrator
Manufacturer : Rion
Model : NC-74
Serial No. : 35046798
Ambient Environment
Temperature : (23 ± 3) °C
Relative Humidity : (50 ± 15) %
Ambient Pressure : (101.325 ± 1.500) kPa

- Standards used :**
1. Digital Function Synthesizer NF Electronic DE-193A S/N 122037.
 2. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.
 3. Programmable Attenuator Tamagawa TPA-303A S/N OF 2214.
 4. Digital Multimeter Agilent 34401A S/N MY44005560.
 5. Pressure Transmitter Vaisala PTB202AD S/N T0650001.
 6. Audio Analyzer Keithley 2015-P S/N 4106495.
 7. Condenser Microphone Brüel&Kjær 4180 S/N 2889871.

Calibration Procedure : CP-102-04 based on IEC 60642-2003; The sound pressure level generated by sound calibrator under test shall be measured by standard microphone using an insert voltage technique.

This instrument has been calibrated against standards maintained at Electrical and Electronic Standards Laboratory (EEL), which are traceable to the International System of Units through the National Institute of Metrology (Thailand).

The information on actual reading is attached herewith and the uncertainty limits quoted refer to the measured values only.

Date of Receipt : 13 Jan. 2023

Date of Calibration : 18 Jan. 2023

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10. Peak C sound level

Number of cycles in test signal	Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Complete cycle	125.4	125.3	-0.1	3.0	0.20	0.35
Positive half cycle	124.4	124.1	-0.3	2.0	0.20	0.35
Negative half cycle	124.4	124.1	-0.3	2.0	0.20	0.35

11. Overload indication

Measured value (dB)	Deviated value (dB)		Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Positive	Negative			
one-half cycle	136.3	136.3	0.0	1.5	0.25

12. High-level stability

Time	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Begin	129.0	0.0	0.3	0.10	0.1
End	129.0				

Calibrated by : *Wichai Saeed*

(Mr. Witsawat Sornpetch)

Approved by :



Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Ref : 201266011300149009

End of Certificate

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PAE-MTC-002 Rev.4



THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219

MTC No. EEL- BP. 136/0166

The reported expanded uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%.

Nominal Output of Unit Under Test = 94 dB re 20 μ Pa at 1000 Hz

Acoustic Output in dB re 20 μ Pa, Corrected to Reference Conditions: 101.325 kPa, 23.0 °C and 50 %RH.

1. Sound Pressure Level

Standard Microphone Type	Measured Sound Pressure Level (dB)	Deviated value (dB)	Uncertainty (dB)	Tolerance limit IEC 60942:2003 Class 1
1/2 inch Brüel&Kjær 4180	93.98	-0.02	± 0.10	± 0.40 dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit IEC 60942:2003 Class 1
1/2 inch Brüel&Kjær 4180	1001.5	1.5	± 1.5	$\pm 1.0\%$

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit IEC 60942:2003 Class 1
1/2 inch Brüel&Kjær 4180	1.00	± 0.50	$\pm 3.0\%$

Note : 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was included at level of 0.16 dB from manual.

Calibrated by :

Approved by :

(Mr. Weerasak Daechniyon)

(Mr. Weerasak Daechniyon)



Electrical and Electronic Standards Laboratory
Industrial Metrology and Testing Service Centre

Date of Calibration : 18 Jan. 2023

Date of Issue : 19 Jan. 2023

Ref : 201126601100149002

End of Certificate

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TM.B.L.MTC.002 Rev.4