

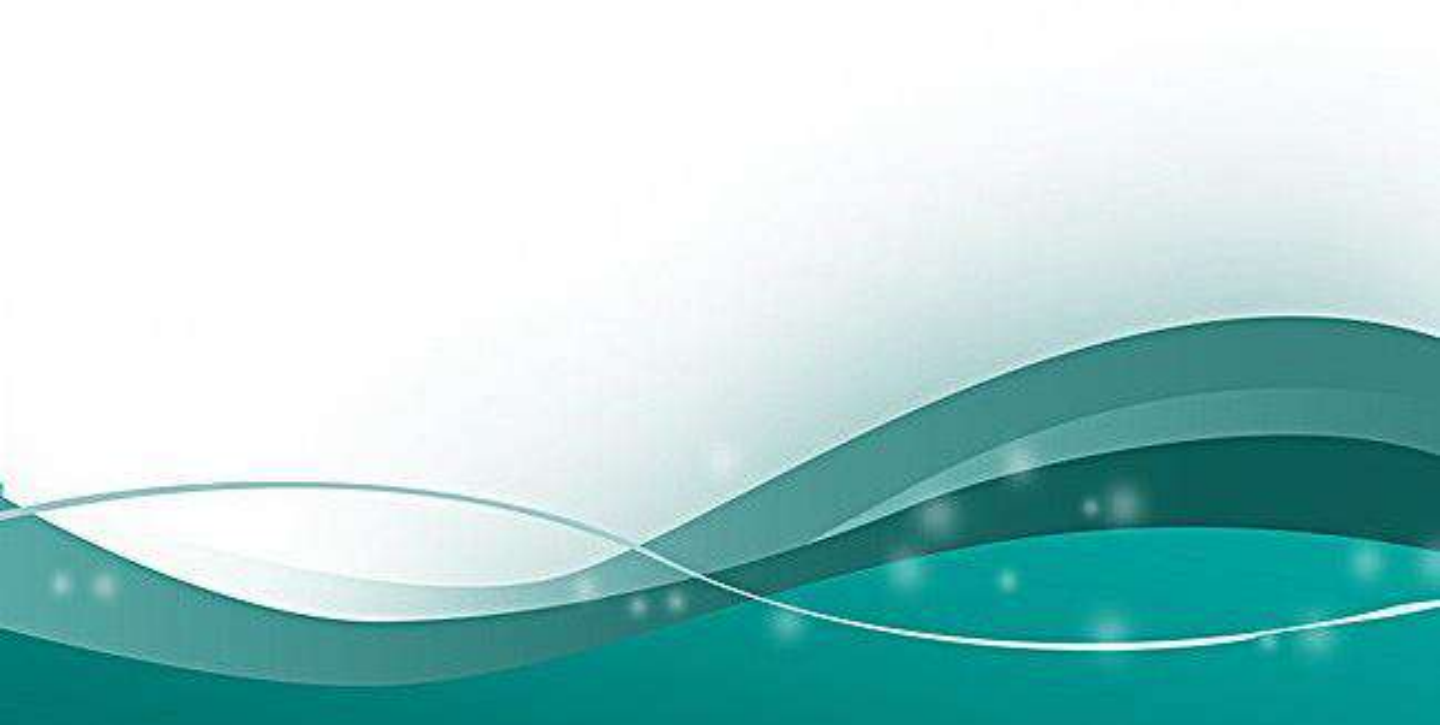
ภาคผนวก จ

เอกสารสอบเทียบความถูกต้องของเครื่องมือ

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บริษัท ยูไนเต็ด แอนนาลิสต์ แอนด์ เอ็นจิเนียริง คอนซัลแตนท์ จำกัด

---



Enviro-Service Co., Ltd.

1110/254 Moo 3, Tambon Bang Rak Phatthana, Amphur Bang Bua Thong, Nonthaburi 11110  
Tel. 098 362 9152, 089 478 7885

E-mail: sales@envi-ees.com

Certificate No. : E22-08038

Page : 1 of 6

## CERTIFICATE OF CALIBRATION

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

Description of Equipment : Console meter

Manufacturer : Apex Instrument

Model Number : XC-572-V

Serial Number : 0803018

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 realize the units 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, Envi 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. Sanya Sangnil

Approved by :

(Mr. Mana Fuekhud)  
Technical Manager



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Certificate No. : E22-08038  
Page : 2 of 6

## 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 Conditions			Factors/Conversions	
Console Model Number	XC-572-V	Date	Time	22/08/2022	Std Temp	293 K
Console Serial Number	0803018	Calibration Reference No.		E22-08038	Std Press	760 mm Hg
DGM Model Number	SK25EX	Barometric Pressure		755.24 mmHg	K <sub>i</sub>	0.386
DGM Serial Number	00002780	Calibration Meter Gamma		0.999	Console Leak Check	
				PASS		

Calibration Data									
Metering Console					Calibration Meter				
Run Time	DGM Orifice	Volume	Volume	Outlet Temp	Volume	Volume	Outlet Temp	Outlet Temp	
Elapsed (Q)	(P <sub>m</sub> )	(V <sub>m</sub> )	(V <sub>m</sub> )	(t <sub>m</sub> )	(V <sub>wi</sub> )	(V <sub>wf</sub> )	(t <sub>wi</sub> )	(t <sub>wf</sub> )	
min	mm H <sub>2</sub> O	m <sup>3</sup>	m <sup>3</sup>	°C	m <sup>3</sup>	m <sup>3</sup>	°C	°C	
11.25	13.0	898.1510	898.2910	29	90.45264	90.58792	24	24	
11.33	13.0	898.2910	898.4310	29	90.58792	90.73254	24	24	
7.77	26.0	898.4420	898.5820	29	90.73418	90.86926	24	24	
7.75	26.0	898.5820	898.7220	29	90.86926	91.00398	24	24	
13.13	40.0	898.7330	899.0130	29	91.01454	91.28308	25	25	
13.12	40.0	899.0130	899.2930	29	91.28308	91.55118	25	25	
9.83	70.0	899.3120	899.5920	29	91.56906	91.83630	25	25	
9.82	70.0	899.5920	899.8720	29	91.83630	92.10288	25	25	
8.68	90.0	899.8850	900.1650	30	92.11486	92.37984	24	24	
8.67	90.0	900.1650	900.4450	30	92.37984	92.64466	24	24	



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Meter Console Information			Calibration Conditions			Factors/Conversions		
Console Model Number	XC-572-V		Date	Time	22/08/2022	01:25 PM	Sid Temp	293 K
Console Serial Number	0803018		Calibration Reference No.	E22-08038			Sid Press	760 mm Hg
DGM Model Number	SK25EX		Barometric Pressure	755.24			K <sub>i</sub>	0.386
DGM Serial Number	00002780		Calibration Meter Gamma	0.999			Console Leak Check	PASS

### Calibration Data Results

Standardized Data		Calibration Factor		Dry Gas Meter		Variation (ΔH <sub>@</sub> )
Dry Gas Meter (V <sub>std</sub> )	(Q <sub>std</sub> )	Calibration Meter (V <sub>w</sub> )	(Q <sub>w</sub> )	Value (Y)	Variation (ΔY)	
m <sup>3</sup>	m <sup>3</sup> /min	m <sup>3</sup>	m <sup>3</sup> /min			(Q <sub>std</sub> )
0.137	0.012	0.132	0.012	0.964	0.012	0.012
0.137	0.012	0.133	0.012	0.967	0.014	0.012
0.138	0.018	0.132	0.017	0.961	0.009	0.017
0.138	0.018	0.132	0.017	0.959	0.007	0.017
0.275	0.021	0.262	0.020	0.954	0.002	0.020
0.275	0.021	0.262	0.020	0.953	0.000	0.020
0.275	0.028	0.261	0.027	0.947	-0.005	0.027
0.275	0.028	0.260	0.027	0.945	-0.008	0.027
0.277	0.032	0.260	0.030	0.937	-0.015	0.030
0.277	0.032	0.259	0.030	0.937	-0.016	0.030
				0.952	Y Average	ΔH <sub>@</sub> Average
						43.181

Note: For Calibration Factor Y, 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 ΔH<sub>@</sub>, orifice pressure differential that equates to 0.75 cfm (0.0212 m<sup>3</sup>/min) at standard temperature and pressure, acceptable tolerance of individual values from the average is ±0.2 inches (5.1mm) H<sub>2</sub>O.

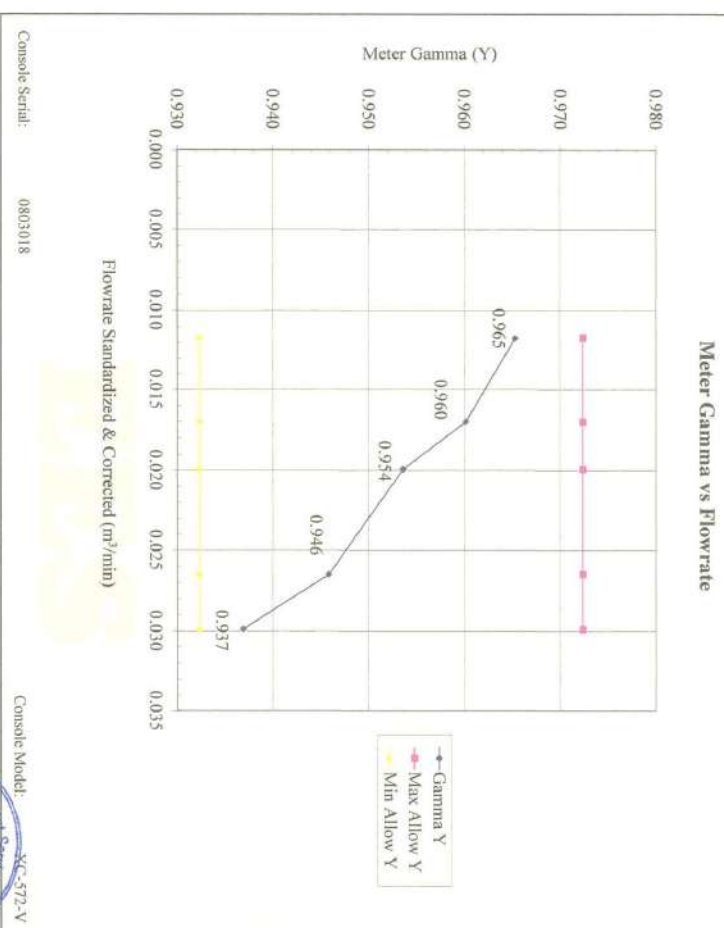


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Meter Console Information			Calibration Conditions			Factors/Conversions		
Console Model Number	XC-572-V		Date	Time	22/08/2022	01:25 PM	Sid Temp	293 K
Console Serial Number	0803018		Calibration Reference No.	E22-08038			Sid Press	760 mm Hg
DGM Model Number	SK25EX		Barometric Pressure	755.24			K <sub>i</sub>	0.386
DGM Serial Number	00002780		Calibration Meter Gamma	0.999			Console Leak Check	PASS

Calibration Date: 22-8-2022

Calibration Reference No: E22-08038



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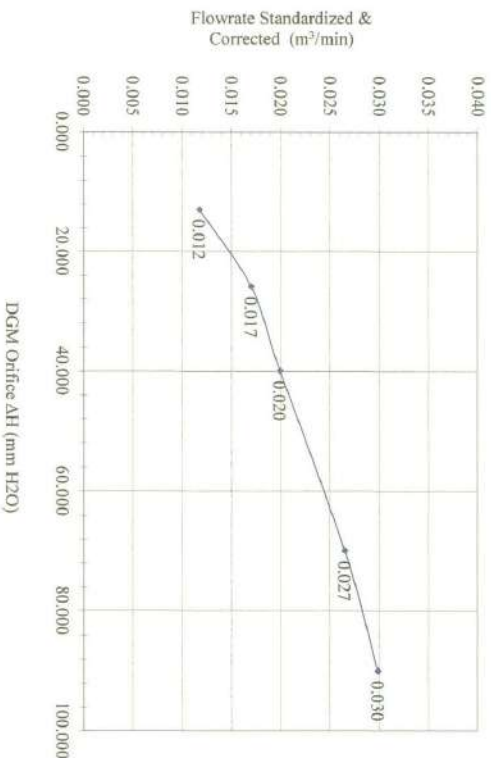


Meter Console Information			Calibration Conditions			Factors/Conversions		
Console Model Number	XC-572-V	Date	22/08/2022	Time	01:25 PM	Sid Temp	293	K
Console Serial Number	0803018	Calibration Reference No.	E22-08038			Sid Press	760	mm Hg
DGM Model Number	SK25EX	Barometric Pressure	755.24		mHg	K <sub>1</sub>	0.386	
DGM Serial Number	00002780	Calibration Meter Gamma	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	22/08/2022	Time	03:15 PM
Console Serial Number	0803018	Calibration Reference No.	E22-08038		
DGM Model Number	SK25EX	Reference Thermometer	DIGICON		
DGM Serial Number	00002780	Serial Number	183169105		
Meter Box Model Number	JENCO 765 KF				
Meter Box Serial Number	JC 16095				

### Results

Channel and test point		Console Thermocouple Simulator							
		Meter Box Channel Temperature Reading (°C)							
Stack	-18.0	25.0	38.0	93.0	149.0	260.0	371.0	482.0	593.0
	-16.0	25.0	38.0	93.0	150.0	259.0	371.0	482.0	593.0
Aux	-16.0	25.0	38.0	93.0	150.0				
	-16.0	25.0	38.0	93.0	150.0				
Probe	-16.0	25.0	38.0	93.0	150.0				
	-16.0	25.0	38.0	93.0	150.0				
Filter	-16.0	25.0	38.0	93.0	150.0				
	-16.0	25.0	38.0	93.0	150.0				
Exit	-16.0	25.0	38.0						
	-16.0	25.0	38.0						

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



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Instrument description : Flue gas Analyzer

Instrument model : Testo 350XL

Instrument serial no. : 02376344

ID no. or control no. : UAE.EMA2.113/2555

Manufacturer : Testo SE & Co. KGaA

Probe description : -

Probe model : -

Probe serial : -

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

Customer address : 81 SOT UDOMSUK41,SUKHUMVIT ROAD,BANGCHAK PRAKANONG BANGKOK 10260

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 80.97,309.9,1003 ppm,

Nitrogen Dioxide 10.19,80.92,202.2 ppm, Nitric Oxide 30.08,150.9,320.6 ppm,

Sulphur Dioxide 50.04,100.9,601.1 ppm)

Condition of UUC. : Used

Ambient condition : All of the Measurement were carried out the stabilized laboratory

Temperature : 23 ±5 °C

Humidity : 55 ± 15 %RH

Calibration place : 17/121 Soi Ngamwongwan 47 Yaek 48, Toongsongkhong, Laksi, Bangkok 10210

Calibration procedure no. : WI-CL-28-C

The calibration certificate expanded uncertainty of measurement is stated as the standard uncertainty of measurement

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 other than in full except with the permission of the issuing laboratory.

Calibration certificates without signature and seal not valid.

This calibration certificate documents are traceability to national standards, which realize measurement according to the

International System of Units (SI).

Date of calibration : 15-Aug-22

*Signature*

Mr. Sedawut Nueathong

Calibration Technician

*Signature*

Mrs. Nongluck Wongsettee

Technical Manager

Standard References (Table 1)

Standard	Certificate No.	Vendor	Due date
Oxygen ( O2 ) 2.498 % Vol	4219/21	Unde	30-Sep-25
Oxygen ( O2 ) 10.00 % Vol	2453/19	Unde	18-Jul-23
Oxygen ( O2 ) 21.00 % Vol	2426/19	Unde	16-Jul-23
Carbon monoxide ( CO ) 80.97 ppm	2842/21	Unde	24-Jun-23
Carbon monoxide ( CO ) 309.9 ppm	2803/21	Unde	22-Jun-23
Carbon monoxide ( CO ) 1003 ppm	2829/21	Unde	23-Apr-23
Nitrogen Dioxide ( NO2 ) 10.19 ppm	3372/21	Unde	02-Aug-23
Nitrogen Dioxide ( NO2 ) 80.96 ppm	3240/21	Unde	26-Jun-24
Nitrogen Dioxide ( NO2 ) 202.2 ppm	3229/21	Unde	20-Jul-23
Nitric Oxide ( NO ) 30.08 ppm	56510068	Nimt	13-Jun-24
Nitric Oxide ( NO ) 150.9 ppm	2857/21	Unde	27-Jun-23
Nitric Oxide ( NO ) 320.6 ppm	2944/21	Unde	02-Jul-23
Sulphur Dioxide ( SO2 ) 50.04 ppm	3205/21	Unde	25-Jul-23
Sulphur Dioxide ( SO2 ) 100.9 ppm	4942/20	Unde	20-Nov-22
Sulphur Dioxide ( SO2 ) 601.1 ppm	3204/21	Unde	20-Jul-23

Measured room conditions

Temperature : 23.6 °C Humidity : 56.6 %RH Pressure : 1015.3 mbar

Calibration conditions

Gas Temperature : 23 °C Flow rate : 1,200 ml/min Gas pressure : 1021.9 mbar

Calibration Results Before Adjustment (Table 2)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O2 (%Vol)	2.498	2.53	0.032	0.20
O2 (%Vol)	10.00	9.86	-0.14	0.40
O2 (%Vol)	21.00	21.08	0.08	0.80
CO (ppm)	80.97	80	-0.97	3.0
CO (ppm)	309.9	305	-4.9	6.0
CO (ppm)	1003	993	-10	12
*NO2 (ppm)	10.19	7.8	-2.39	1.5
NO2 (ppm)	80.96	74.4	-6.56	8.0
NO2 (ppm)	202.2	190.8	-11.4	12
NO (ppm)	30.08	25	-5.08	8.0
NO (ppm)	150.9	140	-10.9	8.0
NO (ppm)	320.6	298	-22.6	12
SO2 (ppm)	50.04	46	-4.04	6.0
SO2 (ppm)	100.9	95	-5.9	6.0
SO2 (ppm)	601.1	640	38.9	13



Calibration Results After Adjustment (Table 3)

Parameter of Standard	Standard Values	Mean of UUC	Error	Uncertainty (±)
O2 (%Vol)	2.498	2.53	0.032	0.20
O2 (%Vol)	10.00	9.86	-0.14	0.40
O2 (%Vol)	21.00	21.08	0.08	0.80
CO (ppm)	80.97	80	-0.97	3.0
CO (ppm)	309.9	305	-4.9	6.0
CO (ppm)	1003	993	-10	12
*NO2 (ppm)	10.19	10.2	0.01	1.5
NO2 (ppm)	80.96	80.2	-0.76	8.0
NO2 (ppm)	202.2	204.5	2.3	12
NO (ppm)	30.08	31	0.92	8.0
NO (ppm)	150.9	152	1.1	12
NO (ppm)	320.6	322	1.4	6.0
SO2 (ppm)	50.04	51	0.96	6.0
SO2 (ppm)	100.9	101	0.1	6.0
SO2 (ppm)	601.1	601	-0.1	13

Remark : 1 cmol/mol = 1 %vol., 1 μmol/mol = 1 ppm.

\* Calibrations marked Not TISI Accredited "in this Certificate have been included for completeness."

## End of Report



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



## 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.074/2564(EFM pH 07/64)

Condition As-Received:

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 :

Approved Signatory

( / ) Maee Butkruea  
( ) Sathip Meangmai  
( ) Warakorn Lemgatrakul

Issue Date : 10 January 2023

The Uncertainties are for a confidence probability of approximately 95%

This certificate may not be reproduced other than in full, except with the prior written Approval of the head of Corporate Services 3: Equipment Calibration and Testing Services





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

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 ( $^{\circ}$ C)	Standard Temperature ( $^{\circ}$ C)	UUC* Reading ( $^{\circ}$ C)	Error ( $^{\circ}$ C)	Uncertainty of measurement ( $\pm$ $^{\circ}$ 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 %.

-o0o-

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# TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)

## CORPORATE SERVICES 3 : EQUIPMENT CALIBRATION AND TESTING SERVICES

53/44 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,  
Phra Khanong, Bangkok 10260  
**Laboratory Condition :** Temperature ( 25 ± 5 ) °C  
Humidity (50 ± 20) %  
**Test Procedure :** In - house method : CP-CH9  
by Comparison Technique with Azide Modification Method

**Tested by :** Walalak Sritrhean

**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.: 9K0ED260

Titration Method (Azide Modification Method)	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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TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
5344 PATTANAKARN ROAD SOI 18, SUKUM 18/2, SUKUM 18/2, BANGKOK 10250  
TEL. 0-2717-3000-27 FAX. 0-2719-9484



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

## Certificate of Calibration

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, Phraekhanong,  
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 Butkruea

Approved by:

( ) Pornthippa Tamayakul  
(✓) Suwit Imjai

Approved Signatory

Issue Date: 10 January 2023

The Uncertainties are for a confidence probability of approximately 95%

This certificate may not be reproduced other than in full, except with the prior written  
Approval of the head of Corporate Services 3: Equipment Calibration and Testing Services.

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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-OT01 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 Model Serial No. Cert. No. Due Date

1) Digital Thermometer 1523 2188080 2211285 21 Oct 2023

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: 9K0ED260

Calibration Point ( ° C )	Immersion Depth ( mm )	Standard Temperature ( ° C )	UUC* Reading ( ° C )	Error ( ° C )	Uncertainty ( ± ° C )	Coverage Factor 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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เอกสารไม่ควบคุม



TECHNOLOGY PROMOTION ASSOCIATION (THAILAND-JAPAN)  
CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES  
5344 PATTANAKARNY ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250  
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 :** 05 January 2023  
**Reference :** 2301-0059WSC-1  
**Submitted by :** United Analyst and Engineering Consultant Co.,Ltd.  
3 Soi Udomsuk 41, Sukhumvit Road, Bangchak,  
Prakhanong, 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 :** Walalak Sirithean  
**Approved by :**   
Approved Signatory  
( / ) Mahee Butkruea  
( ) Saitip 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	221484	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., ANSL-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

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THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH (TISTR)

Request No. 21-66/0219

MTC No. EEL. BP. 139/0166

## CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thatoon, A.Srinahaphote, 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. : 212016  
Microphone : 7052NR No.76237  
Preamplifier : -

### 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 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 MY44042668.
5. Digital Function Synthesizer NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistonphone 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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WHL

### Head Office

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E-mail : sumalee@tistr.or.th

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Airgas Specialty Gases  
Airgas USA, LLC  
600 Union Landing Road  
Cinnaminson, NJ 08077-0000  
Airgas.com

## CERTIFICATE OF ANALYSIS Grade of Product: EPA Protocol

Part Number: E03N199E80A0020  
Cylinder Number: LL193324  
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: 560  
Certification Date: Sep 05, 2018  
Expiration Date: Sep 05, 2026

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. 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 calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

### ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	50.00 PPM	50.71 PPM	G1	+/- 1.4% NIST Traceable	08/27/2018, 09/05/2018
NITRIC OXIDE	50.00 PPM	50.87 PPM	G1	+/- 1.4% NIST Traceable	08/27/2018, 09/05/2018
SULFUR DIOXIDE	50.00 PPM	50.54 PPM	G1	+/- 1.0% NIST Traceable	08/27/2018, 09/05/2018
NITROGEN	Balance				

### CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	16060825	CC425865	50.42 PPM NITRIC OXIDE/NITROGEN	+/- 0.8%	Jun 27, 2020
PRM	12368	5604119	29.86 PPM NITROGEN DIOXIDE/AIR	+/- 1.5%	Jun 02, 2017
GMIS	7042010104	CC503941	5.101 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Jun 01, 2020
NTRM	14010327	KAL004376	49.08 PPM SULFUR DIOXIDE/NITROGEN	+/- 1.0%	Apr 17, 2024

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

### ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 APW1100391 NO	FTIR	Aug 09, 2018
Nicolet 6700 APW1100391 NO2	FTIR	Aug 31, 2018
Nicolet 6700 APW1100391 SO2	FTIR	Aug 30, 2018

### Triad Data Available Upon Request

NETES:PO# 5218003935

Net weight: 2736 grams

Gross weight: 17393 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 values are certified to be NIST Traceable with total uncertainty as detailed under Analytical Uncertainty. This document shall not be reproduced in full without written approval of the issuer.



TESTING CERT No. 3082.05

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
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. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tamagawa 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%.

### 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

### 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	Flat			
125	0.1	0.0	-0.1	1.5	0.45	0.6
1 000	-0.9	-0.9	-0.7	1.0	0.45	0.6
8 000	0.4	0.4	0.7	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	Flat			
63	0.1	0.0	0.0	2.0	0.20	0.6
125	0.1	0.0	0.0	1.5	0.20	0.6
250	0.0	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	-0.1	-0.1	0.0	2.0	0.20	0.6
4 000	-0.4	-0.4	-0.1	3.0	0.20	0.6
8 000	-0.6	-0.6	-0.2	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	34.0	0.0	1.1	0.30	0.3
33	33.0	0.0	1.1	0.30	0.3
32	32.1	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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## 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 one-half cycle	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 :

*Prasit Klungke*  
(Mr. Prasit Klungke)  
Director  
Electrical and Electronic Standards Laboratory  
Industrial Metrology and Testing Service Centre

Date of Calibration : 10 Feb. 2023

Date of Issue : 10 Feb. 2023

Ref : 2011266011300149005

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	Toneburst Duration, Tb(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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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 $\mu$ Pa at 1000 Hz**

**Acoustic Output in dB re 20 $\mu$ 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 Bruel&Kjaer 4180	93.92	-0.08	$\pm 0.10$	IEC60942:2003 Class 1 $\pm 0.40$ dB

**2. Frequency**

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit
1/2 inch Bruel&Kjaer 4180	999.9	-0.1	$\pm 1.5$	IEC60942:2003 Class 1 $\pm 1.0\%$

**3. Total distortion**

Standard Microphone Type	Measured Total distortion (%)	Uncertainty (%)	Tolerance limit
1/2 inch Bruel&Kjaer 4180	2.15	$\pm 0.50$	IEC60942:2003 Class 1 $\pm 3.0\%$

**Note :** 1. No adjustment.

2. The calibrator pressure correction was not included.

3. The microphone volume correction was not included.

Calibrated by :

  
(Mr. Weerachai Deechaiyae)

Approved by :

  
(Mr. Piwat Kluaypa)

**Electrical and Electronic Standards Laboratory**  
**Industrial Metrology and Testing Service Centre**

Date of Calibration : 18 Jan. 2023

Date of Issue : 19 Jan. 2023

Ref : 2011266011300149001

End of Certificate

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FM.BLMTC.002 Rev.4

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.Thatoom A.Simahaphote 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 : ACO

Model : 2127

Serial No. : 100012

**Ambient Environment**

Temperature : (23  $\pm$  3) °C

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

Ambient Pressure : (101.325  $\pm$  1.500) kPa

**Standards used :** 1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.

2. Measuring Amplifier Bruel&Kjaer 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 Bruel&Kjaer 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

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**Head Office**  
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FM.BLMTC.002 Rev.4



Request No. 21-66/0268

MTC No. EEL. BP. 16/0266

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 Tamagawa 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

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FM.BLMTC.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. Thathom A. Srimahaphote, Prachinburi 25140.

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

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

#### Instrument Calibrated :

<b>Description</b>	: Sound Level Meter	<b>Ambient Environment</b>	
<b>Manufacturer</b>	: Delta OHM	<b>Temperature</b>	: $(23 \pm 3) ^\circ\text{C}$
<b>Model</b>	: HD 2010UC	<b>Relative Humidity</b>	: $(50 \pm 15) \%$
<b>Serial No.</b>	: 11040842480	<b>Ambient Pressure</b>	: $(101.325 \pm 1.5) \text{ kPa}$

**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 NF Electronic Instruments DF-193A S/N 122037.
6. Digital Multimeter Fluke 8520A S/N 4985007.
7. Pistonphone Rion NC-72 S/N 00402446.
8. Measuring Amplifier Brüel&Kjær 2636 S/N 1537484.

Date of Receipt : 1 Feb. 2023

Date of Calibration : 20-21 Feb. 2023

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### 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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FMBL.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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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

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	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Weighting					
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	Measured Value (dB)	Deviated value (dB)	Acceptance limit class 2 (±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
Weighting					
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

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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 <sub>b</sub> (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

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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

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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.Thatoom A.Srimahaphote Prachinburi 25140.  
**Calibrated at** : Electrical and Electronic Standards Laboratory, Industrial Metrology and Testing Service Centre.  
: Soi 1C, Bangpoo Industrial Estate, Sukhumvit Rd., Muang, Samuiprakan 10280.

### Instrument Calibrated :

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

**Ambient Environment**  
**Temperature** :  $(23 \pm 3) ^\circ\text{C}$   
**Relative Humidity** :  $(50 \pm 15) \%$   
**Ambient Pressure** :  $(101.325 \pm 1.500) \text{ kPa}$

**Standards used :**

1. Digital Function Synthesizer NF Electronic DF-193A S/N 122037.
2. Measuring Amplifier Bruel&Kjaer 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 Bruel&Kjaer 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

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FM.BLMTC.002 Rev.4

Request No. 21-66/0268

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 ( $\pm$ dB)	Uncertainty ( $\pm$ dB)	Maximum-permitted uncertainty of measurement ( $\pm$ 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

Positive one-half cycle	Measured value (dB)		Deviated value (dB)	Acceptance limit class 2 ( $\pm$ dB)	Uncertainty ( $\pm$ dB)	Maximum-permitted uncertainty of measurement ( $\pm$ dB)
	Negative one-half cycle					
141.0		141.0	0.0	1.5	0.20	0.25

### 12. High-level stability

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

Calibrated by   
(Mr. Pannasit Phasing Sri)

Approved by :

  
(Mr. Prawat Kluaypa)  
Director

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

Ref : 2011266020100453002

End of Certificate

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FM.BLMTC.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 Briel&Kjaer 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 Briel&Kjaer 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 Briel&Kjaer 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 Deechaiyae)

Approved by :

  
(Mr. Pinyawat Klunypa)

Electrical and Electronic Standards Laboratory  
Industrial Metrology and Testing Service Centre

Date of Calibration : 18 Jan. 2023

Date of Issue : 19 Jan. 2023

Ref : 2011266011300149003

End of Certificate

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FM.BL.MTC.002 Rev.4

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

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 Briel&Kjaer 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 Briel&Kjaer 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 Briel&Kjaer 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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MEASUREMENT RESULTS:

The Orifice gas flow device was calibrated by direct comparison method with the Standard Rotary Displacement Meter (Roots Meter). The humid air was used as a medium in the system. The standard conditions are 25 °C (298.15 K) and 760 mmHg for standard temperature and standard pressure respectively.

Table 1: The results of Q Standard calibration data

Plate	Flow rate m <sup>3</sup> /min	Pressure [Pa] mmHg	Temperature [Ta] °C	Temperature [Tm] °C	Δp_meter mmHg	Δp_orifice inH <sub>2</sub> O	Y	Standard Flow [Qs] m <sup>3</sup> /min
1	0.705	758.329	24.44	23.77	50.462	1.122	1.059	0.659
2	1.001	758.356	24.29	23.90	36.610	2.376	1.542	0.954
3	1.117	758.415	24.01	23.47	31.484	3.004	1.734	1.074
4	1.166	758.484	23.86	23.34	29.640	3.290	1.815	1.124
5	1.418	758.544	23.98	23.51	18.777	5.030	2.245	1.387

Slope (m): 1.62707

Intercept (b): -0.01273

Correlation coefficient (r): 0.99981

Uncertainty (k=2): 0.015 m<sup>3</sup>/min

Table 2: The results of Q actual calibration data

Plate	Flow rate m <sup>3</sup> /min	Pressure [Pa] mmHg	Temperature [Ta] °C	Temperature [Tm] °C	Δp_meter mmHg	Δp_orifice inH <sub>2</sub> O	Y	Standard Flow [Qa] m <sup>3</sup> /min
1	0.705	758.329	24.44	23.77	50.462	1.122	0.664	0.659
2	1.001	758.356	24.29	23.90	36.610	2.376	0.965	0.954
3	1.117	758.415	24.01	23.47	31.484	3.004	1.085	1.073
4	1.166	758.484	23.86	23.34	29.640	3.290	1.135	1.122
5	1.418	758.544	23.98	23.51	18.777	5.030	1.404	1.385

Slope (m): 1.01912

Intercept (b): -0.00799

Correlation coefficient (r): 0.99981

Uncertainty (k=2): 0.015 m<sup>3</sup>/min

\*\*\*End of Certificate of Calibration\*\*\*



Calibrated by:

☐ Mr. Sorawit Thachalad  
☒ Miss Jitraporn Lertsomphol



Approved signatory:

Mr. Piriya Booncharoen  
Calibration Department Manager

*Piriya*

CERTIFICATE OF CALIBRATION

Certificate No. : CL-008-66

MEASUREMENT ITEM  
MANUFACTURER : TISCH  
MODEL/TYPE : TE-S028A  
SERIAL NUMBER : 2926  
ID NUMBER : -  
CONDITION AS-RECEIVED : Used item  
CUSTOMER : Integrated Research Center Company Limited,  
122 Moo 2, Thatoon, Srirachaphote, Prachinburi 25140,  
Thailand.

RECEIVED DATE : 20 Mar 2023  
MEASUREMENT DATE : 24 Apr 2023  
ISSUE DATE : 24 Apr 2023

ENVIRONMENTAL CONDITIONS:

Ambient condition in the laboratory are as follow:

Temperature : 23.0 ± 3.0 °C  
Relative Humidity : 55.0 ± 15.0 %RH  
Atmospheric Pressure : 1010 ± 10 hPa

CALIBRATION CONDITION:

Preconditioning : 24 hours at ambient conditions.  
Measurement Condition : 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 (Roots Meter) Model G65/IMC/N2-4p. The WI-CL-004 was used as a calibration guideline.

**Traceability:**  
This certificate provides a traceability of The measurement to recognized the national standards, and to realization of the international system of units (SI) through the VSL (National Metrology Institute of Netherlands) via Certificate number: G2211901

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'



Request No. 21-66/0219

MTC No. EEL. BP. 140/0166

9. Power Amplifier Brüel&amp;Kjær 2706 S/N 1517650.

10. Speaker Tamoy Limited, Great Britain British Patent No. 215300.

11. Digital Multimeter Agilent 34401A S/N MY44005560.

12. Programmable Attenuator Tamagawa 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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FM.BLMTC.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.Thatoom, A.Srimahaphote, 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.** : 212014**Microphone** : 7052NR No.76235**Preamplifier** : -**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 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. Pistonphone 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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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	1.5	0.45	0.6
1 000	-0.5	-0.5	1.0	0.45	0.6
8 000	0.6	0.6	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	0.3	0.0	2.0	0.20	0.6
125	0.1	0.0	1.5	0.20	0.6
250	0.1	0.0	1.5	0.20	0.6
500	0.1	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	-0.3	3.0	0.20	0.6
8 000	-0.6	-0.6	5.0	0.20	0.7

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



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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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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### 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, Tb(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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FM.BL.MTC.002 Rev.4

Request No. 21-66/0219

MTC No. EEL. BP. 138/0166

## CALIBRATION CERTIFICATE

**Submitted by** : Integrated Research Center Company Limited.  
**Address** : 122 Moo 2 T.Thatoom, A.Srimahaphote, 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** : -

**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 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. Pistophone 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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## 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	0.25

## 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 :

  
(Mr. Praware Khayapa)  
DirectorElectrical and Electronic Standards Laboratory  
Industrial Metrology and Testing Service Centre

Date of Calibration : 10 Feb. 2023

Date of Issue : 10 Feb. 2023

Ref : 201126601300149006

End of Certificate

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FM.BL.MTC.002 Rev.4



## 1. Absolute Sensitivity

Reference Acoustic Signal (dB)	Measured value (dB)		Deviation After adjust	Acceptance limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
	Before adjust	After adjust				
114.02	114.4	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 113.8 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 Weighting	Measured value (dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
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 Brüel&Kjær 2706 S/N 1517650.
10. Speaker Tammy Limited, Great Britain British Patent No. 215300.
11. Digital Multimeter Agilent 34401A S/N MY44005560.
12. Programmable Attenuator Tamagawa 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%.



## 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 : 9 Feb. 2023

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N/A

## 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	Flat			
125	0.4	0.3	0.3	1.5	0.45	0.6
1 000	-0.8	-0.8	-0.8	1.0	0.45	0.6
8 000	-1.2	-1.2	-0.8	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	Flat			
63	0.1	0.0	0.0	2.0	0.20	0.6
125	0.0	0.0	0.0	1.5	0.20	0.6
250	0.0	0.0	0.0	1.5	0.20	0.6
500	0.0	0.0	0.0	1.5	0.20	0.6
1 000	0.0	0.0	0.0	1.0	0.20	0.6
2 000	-0.1	0.0	0.0	2.0	0.20	0.6
4 000	-0.4	-0.4	0.0	3.0	0.20	0.6
8 000	-0.6	-0.7	-0.2	5.0	0.20	0.7

Date of Calibration : 9 Feb. 2023

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N/A

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

Anticipated value (dB)	Measured value (dB)	Deviated value (dB)	Acceptance limit class 2 ( $\pm$ dB)	Uncertainty ( $\pm$ dB)	Maximum-permitted uncertainty of measurement ( $\pm$ 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 ( $\pm$ dB)	Uncertainty ( $\pm$ dB)	Maximum-permitted uncertainty of measurement ( $\pm$ 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 : 9 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 ( $\pm$ dB)	Uncertainty ( $\pm$ dB)	Maximum-permitted uncertainty of measurement ( $\pm$ 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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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	Negative	value (dB)	limit class 2(±dB)	Uncertainty (±dB)	Maximum-permitted uncertainty of measurement (±dB)
one-half cycle	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	0.0	0.3	0.10	0.1
End	129.0				

Calibrated by :   
(Mr. Wittawat Supanich)

Approved by :

  
(Mr. Pawate Klunypa)  
Director

Electrical and Electronic Standards Laboratory  
Industrial Metrology and Testing Service Centre

Date of Calibration : 9 Feb. 2023

Date of Issue : 10 Feb. 2023

Ref : 201126601300149004

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	Toneburst Duration, Tb(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	98.6	-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
	200	109.8	-0.2	±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 : 9 Feb. 2023

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Request No. 21-66/0219

MTC No. EEL. BP. 143/0166

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 Tamagawa 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 : 9 Feb. 2023

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Request No. 21-66/0219

MTC No. EEL. BP. 143/0166

## CALIBRATION CERTIFICATE

Submitted by : Integrated Research Center Company Limited.

Address : 122 Moo 2 T.Thatoom, A.Srinahaphote, 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 : Rion

Model : NL-42

Serial No. : 00646442

Microphone : UC-52 No.153069

Preamplifier : NH-24 No.46656

#### 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 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. Pistonphone 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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## 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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N/A

## 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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N/A



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
Leq	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, Tb(ms)	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
	200	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 : 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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Wd

Request No. 21-66/0219 MTC No. EEL. BP. 136/0166

## CALIBRATION CERTIFICATE

**Submitted by** : Integrated Research Center Company Limited.  
**Address** : 122 Moo 2 T.Thatoom A.Srimahaphote 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** : 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 DF-193A S/N 122037.  
2. Measuring Amplifier Bruel&Kjaer 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 Bruel&Kjaer 4180 S/N 2889871.

**Calibration Procedure**: CP-102-04 based on IEC 60942-2003; 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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Request No. 21-66/0219

MTC No. EEL. BP. 143/0166

### 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	125.3	-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	136.5	136.5	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 : 9 Feb. 2023

Date of Issue : 9 Feb. 2023

Ref : 2011266011300149009

End of Certificate

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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 $\mu$ Pa at 1000 Hz

Acoustic Output in dB re 20 $\mu$ 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&Kjaer 4180	93.98	-0.02	$\pm 0.10$	IEC60942:2003 Class 1 $\pm 0.40$ dB

2. Frequency

Standard Microphone Type	Measured Frequency (Hz)	Deviated value (Hz)	Uncertainty (Hz)	Tolerance limit
1/2 inch Brüel&Kjaer 4180	1001.5	1.5	$\pm 1.5$	IEC60942:2003 Class 1 $\pm 1.0\%$

3. Total Distortion

Standard Microphone Type	Measured Total Distortion (%)	Uncertainty (%)	Tolerance limit
1/2 inch Brüel&Kjaer 4180	1.00	$\pm 0.50$	IEC60942:2003 Class 1 $\pm 3.0\%$

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. Weerachai Deechaiyae)

(Mr. Prawat Klunypa)

Date of Calibration : 18 Jan. 2023

Date of Issue : 19 Jan. 2023

Electrical and Electronic Standards Laboratory

Industrial Metrology and Testing Service Centre

End of Certificate

Ref : 2011266011300149002

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