

ภาคผนวกที่ 4

เอกสารสอบเทียบเครื่องมือ



BECTHAI BANGKOK EQUIPMENT & CHEMICAL CO., LTD.
CALIBRATION LABORATORY

300 Phaholyothin Road, Phayathai, Bangkok 10400, Thailand Tel: +66 2615-2929 Fax: +66 2615-2350-1
E-mail: bkk@becthai.com Website: www.becthai.com



Certificate No. : CAL-22-284

Page : 1 of 3

CERTIFICATE OF CALIBRATION

| | | |
|-----------------------|---|--|
| Equipment | : | Spectrophotometer |
| Manufacturer | : | Thermo Scientific |
| Model | : | Genesys 20 |
| Serial No. | : | 3SGT041007 |
| ID No. | : | LB-Eq-029 |
| Customer | : | Special Lab Envi And Consultant Co., Ltd. |
| | : | 47/91-93 Moo 3, Tambol Tait , Amphur Pakrad, |
| | : | Nonthaburi, 11120. |
| Location | : | Becthai Laboratory |
| Date of Receipt | : | 5 May 2022 |
| Date of Calibration | : | 5 May 2022 |
| Date of Issue | : | 5 May 2022 |
| Ambient Temperature | : | (25±10) °C |
| Relative Humidity | : | (60±20) % |
| Condition As-Received | : | Used Item |

Calibrated by

(Mr.Somphop Duangnguan)

Calibration Engineer

Approved by

(Ms. Jintana Sangthaijaroenlap)

Calibration Manager

The reported expended uncertainty of measurement was based on a combined standard uncertainty multiplied by a coverage factor $k=2.00$, providing a level of confidence of approximately 95%.

This certificate may not be reproduced other than in full, except with the prior written approval of the head of Calibration Laboratory.

Indicated values are valid for the state of the Spectrophotometer at the time of calibration only.



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Certificate No. : CAL-22-284

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CALIBRATION REPORT

Conditions of this result of calibration

1. Reference Standard Material :

| <u>Material</u> | <u>Model</u> | <u>Serial No.</u> | <u>Cert.No.</u> | <u>Due date</u> |
|------------------------|--------------|-------------------|-----------------|-----------------|
| Holmium Glass Filter | RM-HG | 24563 | 90313 | 2 Mar 23 |
| Didymium Glass Filter | RM-DG | 24562 | 90311 | 2 Mar 23 |
| Neutral Density Filter | RM-1N2N3N | 24568 | 90324 | 3 Mar 23 |

2. **Traceability** : This certification is traceable to the International System of Unit maintained at;
The Starna Scientific Ltd. Accredited Calibration Laboratory No. 0659.

3. Method of calibration :

The calibration procedure was carried out according to the Guide to CPM-CAL-02 based on ASTM E275-08 (2013) and-
ASTM E925-09 (2014).

4. Result of calibration :

(☒) without adjustment

(☐) after adjustment

5. Equipment Specifications:

| | | |
|----------------------|-----|--------|
| Spectral Bandwidth : | 8 | nm |
| Data Interval : | 1 | nm |
| Scan Speed : | N/A | nm/min |



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Certificate No. : CAL-22-284

Page : 3 of 3

CALIBRATION REPORT

Wavelength Calibration

| Certified Values of Reference Material (nm) | Nominal Value (nm) | UUC*Reading (nm) | Error (nm) | Uncertainty of Measurement (\pm nm) |
|--|-----------------------|---------------------|---------------|---|
| 418.40 | 418 | 419 | 0.60 | 0.59 |
| 537.00 | 537 | 537 | 0.00 | 0.59 |
| 638.00 | 638 | 638 | 0.00 | 0.59 |

Photometric Calibration for Visible

| Wavelength (nm) | Certified Values of Reference Material (A) | UUC* Reading (A) | Error (A) | Uncertainty of Measurement (\pm A) |
|--------------------|---|---------------------|--------------|--|
| 420.0 | Zero | 0.000 | 0.0000 | 0.0028 |
| | 0.5824 | 0.583 | 0.0006 | 0.0044 |
| | 0.7266 | 0.726 | -0.0006 | 0.0040 |
| | 1.0377 | 1.036 | -0.0017 | 0.0040 |
| 440.0 | Zero | 0.000 | 0.0000 | 0.0028 |
| | 0.5659 | 0.566 | 0.0001 | 0.0042 |
| | 0.7126 | 0.710 | -0.0026 | 0.0037 |
| | 1.0172 | 1.014 | -0.0032 | 0.0037 |
| 465.0 | Zero | 0.000 | 0.0000 | 0.0028 |
| | 0.5256 | 0.527 | 0.0014 | 0.0044 |
| | 0.6705 | 0.670 | -0.0005 | 0.0035 |
| | 0.9562 | 0.956 | -0.0002 | 0.0034 |
| 546.1 (546.0) | Zero | 0.000 | 0.0000 | 0.0028 |
| | 0.5236 | 0.524 | 0.0004 | 0.0036 |
| | 0.6962 | 0.696 | -0.0002 | 0.0031 |
| | 0.9933 | 0.994 | 0.0007 | 0.0032 |
| 590.0 | Zero | 0.000 | 0.0000 | 0.0028 |
| | 0.5578 | 0.559 | 0.0012 | 0.0036 |
| | 0.7523 | 0.752 | -0.0003 | 0.0031 |
| | 1.0747 | 1.075 | 0.0003 | 0.0032 |
| 635.0 | Zero | 0.000 | 0.0000 | 0.0028 |
| | 0.5655 | 0.568 | 0.0025 | 0.0035 |
| | 0.7321 | 0.734 | 0.0019 | 0.0031 |
| | 1.0454 | 1.047 | 0.0016 | 0.0031 |

Remark : Each individual filter is measured against the empty filter holder (blank) used to zero the Spectrophotometer.

Note:

UUC* : Unit Under Calibration

- End of Report -

Certificate of Calibration

Certificate No. : 65-400213-2

Page : 1 of 2

Submitted by : Special Lab Envi and Consultant Co., Ltd.
47/91 Moo 3 Thambol Tha-it, Pakkret, Nonthaburi 11120

Equipment : Air Chamber (Incubator)
Manufacturer : Lovibond Model : FKU 1800
Range : N/A °C Resolution : 0.1 °C
Serial No. : 0914643-01 ID No. : LB-Eq-004

Environment : On site calibration was carried out at the Laboratory,
Special Lab Envi and Consultant Co., Ltd.

Ambient Temperature : (28.0 to 29.0) °C

Relative Humidity : (45 to 50) %

Line Voltage : (226.0 to 226.5) V

Date of Received : 27 April 2022

Date of Calibration : 27 April 2022

Date of Issue : 30 April 2022

Calibrated by : Permpoon Chanpu

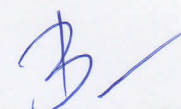
Calibration Method : CAL-M4004, TLAS G-20

The temperature scale used was based on ITS-90

Reference Standard Instruments : This certification is traceable to the International System of Units
Standard Digital Thermometer with Thermocouple probe

| ID No. | Cert. No. | Due Date | Traceability |
|-----------------|-------------|-------------|---|
| 400029 & 400032 | 64-400589-1 | 25 May 2022 | National Institute of Metrology Thailand (NIMT) |

Approved by :



(Bunjerd Masri)

Supervisor

The Uncertainties are for a confidence probability of approximately 95%

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Certificate of Calibration

Certificate No. : 65-400213-2

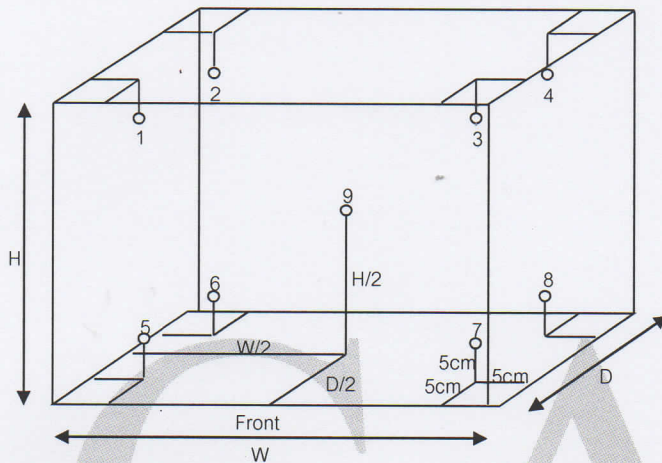
Page : 2 of 2

Result of Calibration : Without Adjustment

UUC Condition As-Received : Good

Function : Temperature measurement

This instrument was setting air ventilation at position 0 (close)



Inside of Chamber

W = 0.55 m

D = 0.73 m

H = 0.50 m

Capacity = 0.20 m³

| Test Point (°C) | Setting Temperature (°C) | Indicating Temperature (°C) | Measured Temperature (°C) @ Sensor No. | | | | | | | | | Uncertainty (± °C) |
|-----------------|--------------------------|-----------------------------|--|------|------|------|------|------|------|------|------|--------------------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| 20.0 | 19.3 | 19.3 | 20.2 | 20.1 | 20.1 | 20.0 | 20.0 | 20.0 | 20.1 | 20.0 | 20.0 | 0.65 |

| Test Point (°C) | Setting Temperature (°C) | Indicating Temperature (°C) | Measured Uniformity (°C) | Measured Stability (°C) | Overall Variation (°C) |
|-----------------|--------------------------|-----------------------------|--------------------------|-------------------------|------------------------|
| 20.0 | 19.3 | 19.3 | 0.3 | 0.3 | 0.7 |

Remark The uncertainty is not combine uniformity of the air chamber

This result of calibration was found accurate as shown on date and place of calibration only.

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%

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Certificate of Calibration

Certificate No. : 65-200126-1

Page : 1 of 2

Submitted by : Special Lab Envi and Consultant Co., Ltd.
47/91 Moo 3, Tambol Tha-It, Pakkret, Nonthaburi 11120

Equipment : Electronic Balance
Manufacturer : AND Model : GR-200
Serial No. : 14245322 ID No. : LB-Eg-016
Capacity : 210 g Resolution : 0.0001 g

Environment : On site calibration was carried out at the Laboratory, Special Lab Envi and Consultant Co., Ltd.
Ambient Temperature : (26.8 to 27.0) °C
Relative Humidity : (53.6 to 55.7) %
Air Pressure : 1006.0 mbar

Date of Received : 27 April 2022

Date of Calibration : 27 April 2022

Date of Issue : 03 May 2022

Calibrated by : Akaradath Thippichai

Calibration Method : In-house method CAL-M2001 based on UKAS Publication ref : LAB 14
Edition 5, July 2015

Reference Standard Instruments : This certification is traceable to the International System of Units

Standard Weights

| ID No. | Cert. No. | Due Date | Traceability |
|------------|-----------|-------------|--|
| E261-E2624 | C02213103 | 18 Nov 2022 | National Institute of Metrology (Thailand), (NIMT) |

Approved by :



(Surachai Promthong)

Laboratory Manager

The Uncertainties are for a confidence probability of approximately 95%

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Certificate of Calibration

Certificate No. : 65-200126-1

Page : 2 of 2

Result of Calibration : Without Adjustment

UUC Condition As-Received : Good

Departure of indication from nominal value

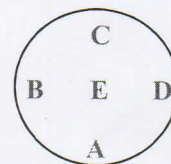
| Nominal Value (g) | Correction (g) | Uncertainty \pm (g) |
|----------------------|-------------------|--------------------------|
| 0.001 | 0.0000 | 0.00011 |
| 0.01 | 0.0000 | 0.00011 |
| 0.1 | 0.0000 | 0.00011 |
| 0.5 | -0.0001 | 0.00011 |
| 2 | 0.0000 | 0.00011 |
| 5 | -0.0001 | 0.00012 |
| 10 | 0.0000 | 0.00012 |
| 50 | -0.0001 | 0.00014 |
| 100 | 0.0001 | 0.00020 |
| 200 | 0.0001 | 0.00038 |

This result of calibration was found accurate as shown on date and place of calibration only.

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor $k = 2.11$, providing a level of confidence of approximately 95%

Eccentric error

Load test : 50 g
 A B C D E
 -0.0007 0.0000 0.0006 0.0000 0.0000 g



Repeatability

Load test : 200 g
 Stdev. : 0.00005 g

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Certificate of Calibration

Certificate No. : 65-400213-1

Page : 1 of 2

Submitted by : Special Lab Envi and Consultant Co., Ltd.
47/91 Moo 3 Thambol Tha-it, Pakkret, Nonthaburi 11120

Equipment : Air Chamber (Incubator)
Manufacturer : Lovibond Model : FKU 1800
Range : N/A °C Resolution : 0.1 °C
Serial No. : 0925481-19 ID No. : LB-Eq-005

Environment : On site calibration was carried out at the Laboratory,
Special Lab Envi and Consultant Co., Ltd.

Ambient Temperature : (29.0 to 30.0) °C

Relative Humidity : (45 to 50) %

Line Voltage : (226.0 to 226.5) V

Date of Received : 27 April 2022

Date of Calibration : 27 April 2022

Date of Issue : 30 April 2022

Calibrated by : Permpon Chanpu

Calibration Method : CAL-M4004, TLAS G-20

The temperature scale used was based on ITS-90

Reference Standard Instruments : This certification is traceable to the International System of Units
Standard Digital Thermometer with Thermocouple probe

| ID No. | Cert. No. | Due Date | Traceability |
|-----------------|-------------|-------------|---|
| 400029 & 400030 | 64-400587-1 | 23 May 2022 | National Institute of Metrology Thailand (NIMT) |

Approved by :

(Bunjerd Masri)

Supervisor

The Uncertainties are for a confidence probability of approximately 95%

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Certificate of Calibration

Certificate No. : 65-400213-1

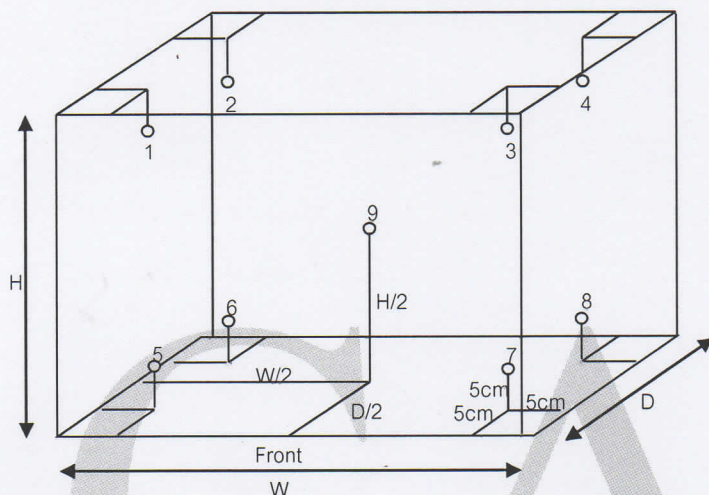
Page : 2 of 2

Result of Calibration : Without Adjustment

UUC Condition As-Received : Good

Function : Temperature measurement

This instrument was setting air ventilation at position 0 (close)



Inside of Chamber

W = 0.55 m

D = 0.73 m

H = 0.50 m

Capacity = 0.20 m³

| Test Point (°C) | Setting Temperature (°C) | Indicating Temperature (°C) | Measured Temperature (°C) @ Sensor No. | | | | | | | | | Uncertainty (± °C) |
|-----------------|--------------------------|-----------------------------|--|------|------|------|------|------|------|------|------|--------------------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
| 30.0 | 30.0 | 30.0 | 30.0 | 29.8 | 30.1 | 30.0 | 29.9 | 29.9 | 30.1 | 30.1 | 30.0 | 0.55 |
| 35.0 | 35.0 | 35.0 | 34.8 | 34.8 | 35.0 | 35.1 | 35.0 | 35.0 | 35.1 | 35.1 | 35.0 | 0.54 |
| 37.0 | 37.0 | 37.0 | 36.7 | 36.7 | 36.9 | 36.9 | 36.9 | 36.9 | 37.0 | 37.0 | 37.0 | 0.55 |

| Test Point (°C) | Setting Temperature (°C) | Indicating Temperature (°C) | Measured Uniformity (°C) | Measured Stability (°C) | Overall Variation (°C) |
|-----------------|--------------------------|-----------------------------|--------------------------|-------------------------|------------------------|
| 30.0 | 30.0 | 30.0 | 0.3 | 0.1 | 0.5 |
| 35.0 | 35.0 | 35.0 | 0.3 | 0.1 | 0.5 |
| 37.0 | 37.0 | 37.0 | 0.4 | 0.1 | 0.5 |

Remark The uncertainty is not combine uniformity of the air chamber

This result of calibration was found accurate as shown on date and place of calibration only.

This reported uncertainty of measurement was based on a standard uncertainty multiplied by a coverage factor $k = 2$, 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. 0-2717-3000-27 FAX. 0-2719-9484



Cert.No.: 22CH1158

Page.: 1 of 2

Certificate of Calibration

| | |
|-------------------------|---|
| Equipment : | pH Meter |
| Manufacturer : | Eutech |
| Model : | pH 700 |
| Serial No. : | 2858459 |
| ID No. : | LB-Eq-027 |
| Condition As-Received: | Used Item |
| Received Date : | 31 August 2022 |
| Calibration Date : | 01 September 2022 |
| Reference : | 2208-1091WN-1 |
| Submitted by : | Special Lab Envi And Consultant Co.,Ltd 47/91-93 Moo 3 Thambon Tha-it, Pakkret Nonthaburi 11120 |
| 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) |

Calibrated by : Warakorn Lerngagtrakul

Approved by :

Approved Signatory

- ☒ Malee Butkruea
☐ Saithip Meangmai
☐ Warakorn Lerngagtrakul

Issue Date : 6 September 2022

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.

A 0044873



Cert. No.: 22CH1158

Page.: 2 of 2

Condition of this calibration result

1. Reference Standard Instrument : -

| <u>Instrument</u> | <u>Serial No.</u> | <u>ID No.</u> | <u>Cert. No.</u> | <u>Due Date</u> |
|--------------------------------|-------------------|---------------|------------------|-----------------|
| 1) Document Process Calibrator | 43160066 | 130RC092 | 22E1223 | 13 Apr 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

| <u>Buffer Solution</u> | <u>Manufacturer</u> | <u>Lot No.</u> | <u>Exp. date</u> |
|------------------------|---------------------|----------------|------------------|
| pH 4.008 | CPA chem | 794120 | 14 Feb 2024 |
| pH 6.985 | CPA chem | 794122 | 14 Feb 2023 |
| pH 10.008 | CPA chem | 823323 | 20 June 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 (4,7,10)

| Unit Under Calibration | Nominal Value | Standard Voltage Input | Actual Reading | | Uncertainty of Measurement (±mV) | Coverage factor <i>k</i> |
|---------------------------|---------------|------------------------|----------------|-------|---------------------------------------|-----------------------------|
| | pH | mV | mV | pH | | |
| pH Meter S/N.: 2858459 | 4.00 | 177.48 | 177.4 | 4.01 | 0.058 | 2.00 |
| | 6.86 | 8.28 | 8.3 | 6.86 | 0.058 | 2.00 |
| | 7.00 | 0.00 | 0.1 | 7.00 | 0.058 | 2.00 |
| | 9.18 | -128.97 | -128.9 | 9.19 | 0.058 | 2.00 |
| | 10.00 | -177.48 | -177.4 | 10.01 | 0.058 | 2.00 |

Function : pH Measurement

Performing three buffers standard curve by using buffer nominal pH (4,7,10)

| Unit Under Calibration | Standard pH Buffer Solution | Actual pH Reading | Actual mV Reading (mV) | Uncertainty of pH measurement (±) | Coverage factor <i>k</i> |
|-------------------------------|-----------------------------|-------------------|-----------------------------|--|-----------------------------|
| pH Electrode S/N.: 3101624 | 4.008 | 4.01 | 177.4 | 0.0085 | 2.05 |
| | 6.985 | 6.99 | 3.0 | 0.0099 | 2.00 |
| | 10.008 | 10.01 | -169.4 | 0.0092 | 2.00 |

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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CORPORATE SERVICES 3: EQUIPMENT CALIBRATION AND TESTING SERVICES
534/4 PATTANAKARN ROAD SOI 18, SUANLUANG, SUANLUANG BANGKOK 10250
TEL. 0-2717-3000-27 FAX. 0-2719-9484



Cert. No.: 22LM126

Page.: 1 of 2

Certificate of Calibration

Equipment : pH Meter with Sensor

Manufacturer : Eutech

Model : pH 700

Serial No. : 2858459

ID No. : LB-Eq-027

Submitted by : Special Lab Envi And Consultant Co.,Ltd
47/91-93 Moo 3 Thambon Tha-it,
Pakkret Nonthaburi 11120

Location : Chemistry Calibration Lab.2

Received Order : 31 August 2022

Calibrated Date : 1 September 2022

Ambient Temperature : (26 ± 10) °C

Relative Humidity : (50 ± 30) %

AC Line Voltage : (220 ± 22) V

Calibrated by : Warakorn Lerngagtrakul

Approved by :

Malee

Approved Signatory

- () Pornthippa Tameyakul
(☒) Malee Butkruea
() Suwit Imjai

Issue Date :

6 September 2022

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.

A 0044921



Equipment : pH Meter with Sensor

Condition As-Received : Used Item

Reference : 2208-1091WN-2

Cert. No.: 22LM126

Page.: 2 of 2

Procedure Used :-

Calibration were conducted using in-house calibration procedure CP-OT01 according to comparison with Industrial Platinum Resistance Thermometer (IPRT) into Temperature Bath.

The temperature scale used was based on ITS-90.

Condition of this result of calibration

1. Reference standard instrument:-

| <u>Instrument</u> | <u>Model</u> | <u>Serial No.</u> | <u>Cert. No.</u> | <u>Due Date</u> |
|------------------------|--------------|-------------------|------------------|-----------------|
| 1) Digital Thermometer | 53 II B | 20410013 | 22I555 | 06 May 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.: PH5TEMB01P

| <u>Calibration Point</u> (°C) | <u>Immersion Depth</u> (mm) | <u>Standard Temperature</u> (°C) | <u>UUC* Reading</u> (°C) | <u>Error</u> (°C) | <u>Uncertainty</u> (± °C) | <u>Coverage Factor</u> <i>k</i> |
|------------------------------------|----------------------------------|---------------------------------------|-------------------------------|------------------------|--------------------------------|------------------------------------|
| 25.0 | 80 | 25.004 | 25.0 | -0.004 | 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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Malu