

# CERTIFICATE OF CALIBRATION

ISSUED BY HORIBA UK LIMITED

DATE OF ISSUE 12 October 2023 CERTIFICATE NUMBER C20590



0767

## HORIBA UK LTD

Kyoto Close  
Moulton Park  
Northampton  
NN3 6FL  
Telephone: 01604 - 542500  
Telefax: 01604 - 542699

Page 1 of 2 pages

Approved Signatory

Name T.Lowe

Signature

This is an electronically controlled document.

**Customer :** Mahle Powertrain Ltd  
**Address :** St James Mill Road, Northampton, NN5 5TZ

<b>Customer Ref:</b>	4700058340	<b>Item Calibrated:</b>	Cell Pressure
<b>Site:</b>	Northampton	<b>Item Model:</b>	PTX 5072
<b>System:</b>	RDEC 1	<b>Item Serial Number:</b>	5332415
<b>System Model:</b>	Cell Pressure	<b>Item Range:</b>	50.0 kPa (A) to 110.0 kPa (A)
<b>Serial Number:</b>	HUK17100019	<b>Calibrated Range:</b>	50.0 kPa (A) to 109.5 kPa (A)
<b>Engineer:</b>	B. Bhol	<b>Calibration Date:</b>	02 October 2023
		<b>Software Version:</b>	Vets Ver 2.13.2.20008

### Method:

The instrument provides a digital indication and an electrical output corresponding to the applied pressure. The instrument was calibrated using the comparison method against a Pressure Calibrator whose calibration is traceable to national standards. The reference device was connected to the system and the pressure was reduced to its lower limit. The pressure was increased to the upper limit and stepped down at regular settings across the instruments range. The displayed instrument readings and reference readings were recorded.

The results in this certificate only apply to the unit which was calibrated at Mahle Powertrain Ltd, St James Mill Road, Northampton, NN5 5TZ.

All non-SI unit conversions are made with factors given in BS 350:2004

### Ambient Conditions

	Barometer kPa	Temperature °C	Humidity %
Start	101.2 ± 0.100	22.84 ± 0.2	47.12 ± 5.0 % rh
Finish	101.21 ± 0.100	24.84 ± 0.2	45.11 ± 5.0 % rh

### Equipment Used

Equipment	Serial Number	Calibration Date	Certificate Number
Vaisala Temp / Humidity	T1140215 & T1150199	21 June 2023	C189333
Additel	810210C0059	16 March 2023	104891

### Uncertainties

The expanded measurement uncertainty is :  $\text{SQRT}((0.05 \% p)^2 + (0.161 \text{ kPa (A)})^2)$

Where p is the pressure in kPa (A)

The uncertainty applies to the measured value of the Unit Under Calibration, after applying the calibration coefficients that were determined during its calibration.

**Condition Of Equipment** GOOD

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k = 2$ , providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

# CERTIFICATE OF CALIBRATION

UKAS Accredited Calibration Laboratory No. 0767

Certificate Number C20590

Page 2 of 2 pages

## Device Orientation

In situ - Vertical.

## Readings as Found

Coefficients

A0 = N/A

A1 = N/A

Point	Setting kPa (A)	Reading kPa (A)
Low	50.00	49.91
Ambient	101.20	101.12
High	109.50	109.41

## Comment

No Adjustment made. Displayed variation of UUT  $\pm$  0.02 kPa (A)

## Readings as Left

Coefficients

A0 = N/A

A1 = N/A

Point	Reference	Device	% Error (Rdg)	% Error (F.S)
	kPa (A)	kPa (A)		
1	50.00	49.91	-0.18	-0.08
2	109.50	109.41	-0.08	-0.08
3	107.00	106.92	-0.07	-0.07
4	105.00	104.92	-0.08	-0.07
5	103.00	102.91	-0.09	-0.08
6	101.20	101.12	-0.08	-0.07
7	95.00	94.91	-0.09	-0.08
8	90.00	89.91	-0.10	-0.08
9	85.00	84.91	-0.11	-0.08
10	80.00	79.91	-0.11	-0.08
11	50.00	49.91	-0.18	-0.08

---

End of Certificate

# Supplementary Information

## 1. Slope ( $a_1$ )

$a_1$	Criteria	Judgment
1.0001042	0.98~1.02	Pass

Formula :

$$a_1 = \frac{\sum_{i=1}^N (y_i - \bar{y}) \cdot (y_{refi} - \bar{y}_{ref})}{\sum_{i=1}^N (y_{refi} - \bar{y}_{ref})^2}$$

## 2. Intercept ( $a_0$ )

$a_0$	$a_0$ /FS	Criteria	Judgment
-0.096515	-0.0877%FS	Within $\pm 0.5\%$ FS	Pass

Formula :

$$a_0 = \bar{y} - (a_1 \cdot \bar{y}_{ref})$$

## 3. Standard Estimation of Error (SEE)

SEE	SEE/FS	Criteria	Judgment
0.0043347	0.0039%FS	Under 1.0%FS	Pass

Formula :

$$SEE_y = \sqrt{\frac{\sum_{i=1}^N [y_i - a_0 - (a_1 \cdot y_{refi})]^2}{N-2}}$$

Eq. 1065.602-11

## 4. Coefficient of Determination ( $R^2$ )

$R^2$	Criteria	Judgment
1.0000000	$\geq 0.990$	Pass

Formula :

$$R^2 = 1 - \frac{\sum_{i=1}^N [y_i - a_0 - (a_1 \cdot y_{refi})]^2}{\sum_{i=1}^N (y_i - \bar{y})^2}$$

$y_i$  : Generated Concentration at data No. i  
 $\bar{y}$  : Averaged value of generated concentration for all data  
 $y_{refi}$  : Standard concentration at data No. i  
 $\bar{y}_{ref}$  : Averaged value of standard concentration for all data  
 $N$  : Number of data

**Introduction**

The definitive statement of the accreditation status of a calibration laboratory is the Accreditation Certificate and the associated Schedule of Accreditation. This Schedule of Accreditation is a critical document, as it defines the measurement capabilities, ranges and boundaries of the calibration activities for which the organisation holds accreditation.

**Calibration and Measurement Capabilities (CMCs)**

The capabilities provided by accredited calibration laboratories are described by the Calibration and Measurement Capability (CMC), which expresses the lowest measurement uncertainty that can be achieved during a calibration. If a particular device under calibration itself contributes significantly to the uncertainty (for example, if it has limited resolution or exhibits significant non-repeatability) then the uncertainty quoted on a calibration certificate will be increased to account for such factors.

The CMC is normally used to describe the uncertainty that appears in an accredited calibration laboratory's schedule of accreditation and is the uncertainty for which the laboratory has been accredited using the procedure that was the subject of assessment. The measurement uncertainty is calculated according to the procedures given in the GUM and is normally stated as an expanded uncertainty at a coverage probability of 95 %, which usually requires the use of a coverage factor of  $k = 2$ . An accredited laboratory is not permitted to quote an uncertainty that is smaller than the published measurement uncertainty in certificates issued under its accreditation.

**Expression of CMCs - symbols and units**

It should be noted that the percentage symbol (%) represents the number 0.01. In cases where the measurement uncertainty is stated as a percentage, this is to be interpreted as meaning percentage of the measurand.

Thus, for example, a measurement uncertainty of 1.5 % means  $1.5 \times 0.01 \times q$ , where  $q$  is the quantity value. The notation  $Q[a, b]$  stands for the root-sum-square of the terms between brackets:  $Q[a, b] = [a^2 + b^2]^{1/2}$