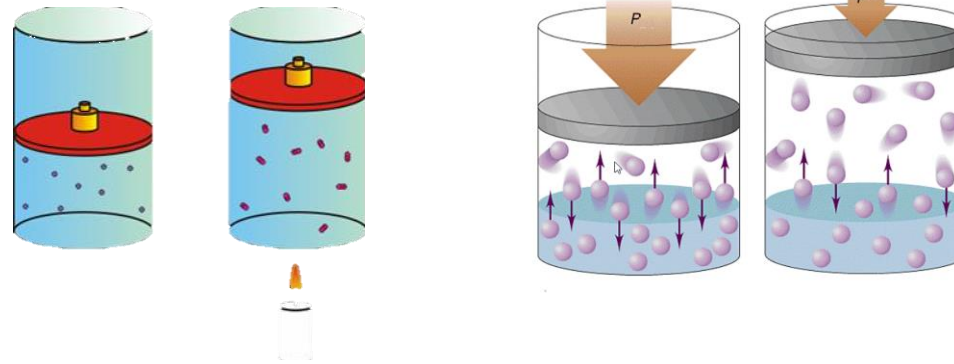
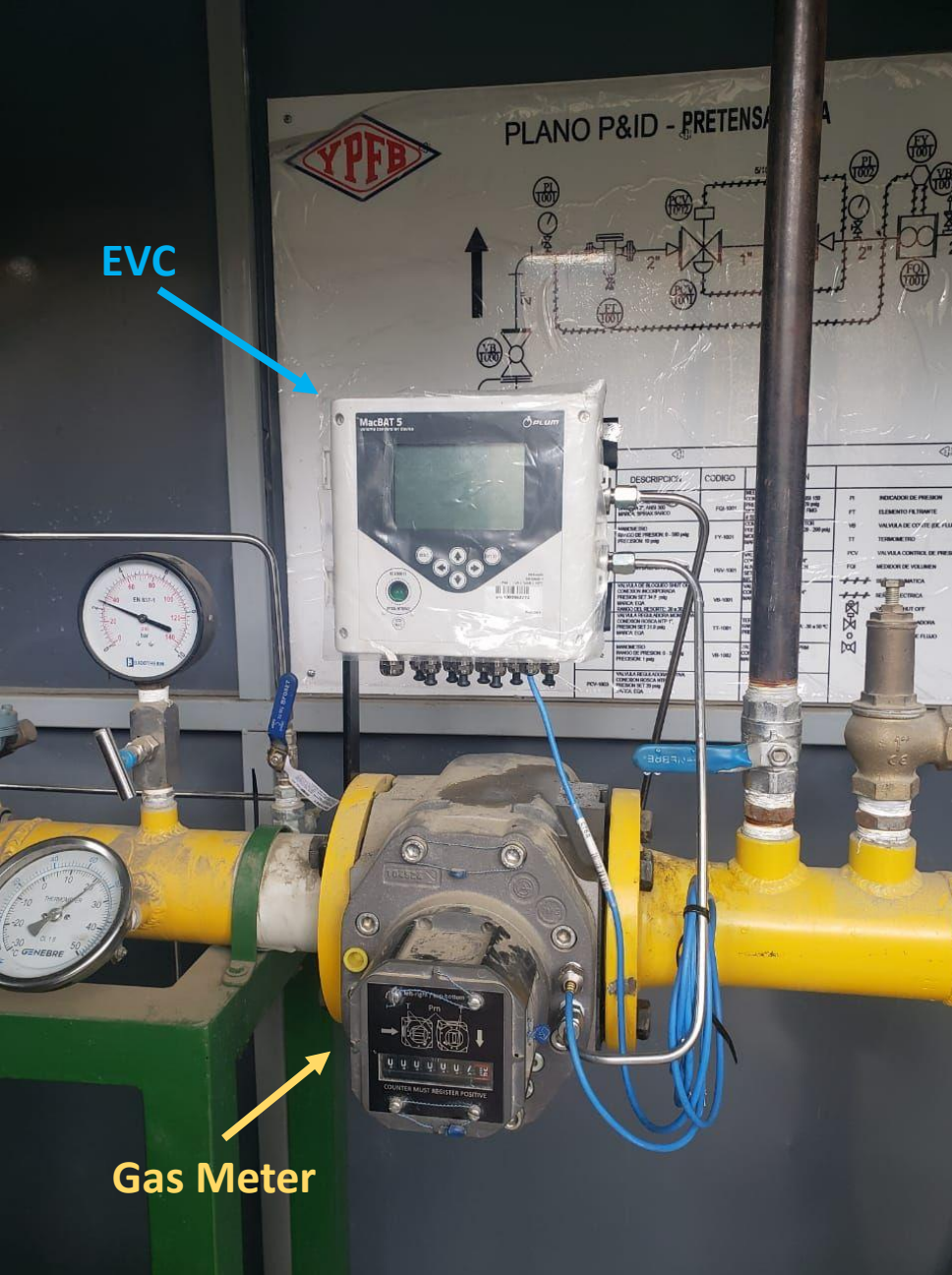


Serial calibration of PTZ Electronic Volume Correctors

C  **NFERENCE**
2 **22** Metrology for Digital
Transformation
SIM-MWG-14



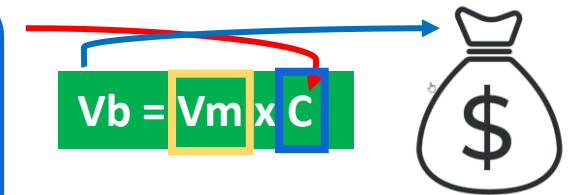
 Metrology for Digital
Transformation
SIM-MWG-14



PRESSURE & TEMPERATURE

Charles' and Boyle's laws are often combined to give an "ideal gas law"

- **P** – Base Pressure
- **T** – Base Temperature
- **Z** – Gas Compressibility (AGA)



GAS COMPRESSIBILITY (AGA)

NG does not behave like an ideal gas at pressures above 60 psia. To compensate for the non-ideal nature of natural gas, the compressibility factor (Z) is calculated.



Metrological Compliance.

Certification :

Product/Model (EVC) - MID module B
 Manufacturing Process - MID module D

Standard: EN 12405-1:2018



PTB
 Physikalisch-Technische Bundesanstalt
 Nationaler Metrologieinstitut

KBS
 Konformitätsbewertungsstelle



EU-Baumusterprüfbescheinigung
 EU Type-examination Certificate

Ausgestellt für:
 PLUM
 ul. Wapnia 11, Ignielki
 18-010 Nowe Polecno

gemäß:
 Anhang II Modul B der Richtlinie 2014/32/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die Bereitstellung von Messgeräten auf dem Markt.
 Annex II Module B of the Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments.

Gerätart:
 Zustands-Mengenwert für Gas
 Volume-concentration device for gas
 oder Temperatur-Mengenwert für Gas
 or temperature-concentration device for gas

Typbezeichnung:
 MacBAT 5

Nr. der Bescheinigung:
 DE-19-MI002-PTB004, Revision 5

Gültig bis:
 03.07.2029

Anzahl der Seiten:
 26

Geschäftszeichen:
 PTB-1.424.100102

Notifizierte Stelle:
 0102

Zertifizierung:
 Braunschweig, 16.03.2022

Stempel:
 Braunschweig, 16.03.2022

Unterschrift:
 R. Römisch



P - Pressure

Maximum permissible error for pressure measurements:

20 °C (± 3 °C)	(-25 ÷ 70) °C
± 0,2 % of measured value	± 0,5 % of measured value

T - Temperature

Maximum permissible error for measurements

20 °C (± 3 °C)	(-25 ÷ 70) °C
± 0,1%	± 0,2 %

C – Correction Factor

The maximum permissible error (MPE) according to standard „EN 12405-1”	0,5 % at reference conditions
	1 % at nominal operating conditions

EU Type-examination Certificate



Metrology for Digital Transformation

SIM-MWG-14



Report of Conformity Test.

EN 12405-1 (Section A.1.4.2)

$$e_c = \frac{C - C_{cr}}{C_{cr}} \cdot 100\%$$

Table A.1

	p_{min}	p_2	p_3	p_4	p_{max}
T_{min}	1 ⇒	2 =	3 ⇒	4 =	5 ↓
T	↓ 10	⇐ 9	⇐ 8	⇐ 7	⇐ 6
T_{max}	11 ⇒	12 =	13 ⇒	14 =	15

Type: **MacBAT 5**
 Serial number: **1005610625**
 Program version / Bootloader version: **S007.73_V072028 / B14**
 CRC: **CrcMain=50670700; CrcBoot=15FBCC2D**
 Gas pressure measurement range: **(0.8 ÷ 10) bar abs**
 Gas temperature measurement range: **(-30 ÷ 70) °C**
 PRT sensor: type **CT6A**, serial number: **1005545579**

$V_b = V_m \times C$

$$e_v = \frac{V_b - V_{cr}}{V_{cr}} \cdot 100\%$$

Conversion factor C

Reference value			Indication of tested device			Error	Uncertainty of measurement
Temperature	Pressure	Conversion factor	Temperature	Pressure	Conversion factor		
t_{cv}	p_{cv}	C_{cv}	t	p	C	e_c ¹⁾	U_c
°C	bar	-	°C	bar	-	%	%
-30.01	0.8001	0.936694	-30.00	0.8002	0.936857	0.02	0.14
-30.01	3.1000	3.668876	-30.00	3.1004	3.669179	0.01	0.12
-30.01	5.4000	6.461697	-30.00	5.4006	6.462162	0.01	0.09
-30.01	7.7000	9.318366	-30.00	7.7007	9.318890	0.01	0.09
-30.01	10.0000	12.241760	-30.01	10.0002	12.242020	0.00	0.09
19.98	10.0000	9.923814	19.97	10.0006	9.924736	0.01	0.08
19.99	7.7000	7.596400	19.98	7.7005	7.597117	0.01	0.08
19.98	3.1000	3.022834	19.97	3.1005	3.023372	0.02	0.12
19.99	0.8000	0.775598	19.98	0.8000	0.775633	0.00	0.14
69.97	0.8000	0.662028	69.95	0.8001	0.662110	0.01	0.14
69.97	3.1000	2.573585	69.95	3.1004	2.574081	0.02	0.12
69.97	5.4000	4.497634	69.96	5.4004	4.498142	0.01	0.08
69.97	7.7000	6.433994	69.96	7.7007	6.434769	0.01	0.08
69.97	10.0000	8.382779	69.95	10.0005	8.383512	0.01	0.08

EN ISO/IEC 17025:2017

MIDer

RESULTS



Error máximo e_c	0.02%	< 0.5%
Error e_v	0.01%	< 0.5%
Error máximo e_p	0.03%	< 0.2%
Error máximo e_t	0.01%	< 0.1%



AP 074



Calibration Bench.



- a) Multi-level rack (50 pieces)
- b) Thermostat (50 T sensors)
- c) Compressor and vacuum pump
- d) Gas flow simulation (pulses)
- e) RS-485 serial connection with control PC
- f) Proprietary software (MIDer)
- g) Automatic generation of digital calibration certificates
- h) Air-conditioned room

**CONDICIONES
AMBIENTALES**

Temperatura ambiente: $(22.2 \div 23.7) \text{ }^\circ\text{C}$
Humedad relativa: $(37 \div 50) \%$

Capacity: 50 pieces per shift
Conformity: Welmec 11.1 Recomendation
(Module D of Directive 2014/32/EU - BMC < 1/3 MPE)



Thermostat.





Modular pressure controller.





Flow simulation (pulses).





Proprietary software (MIDer).

- a) Reading of reference devices
- b) Checking the stability of P and T
- c) Adjustment of correctors (base conditions, algorithm, gas composition)
- d) Execution of the Volume Correction (MIDer)
- e) Reading of corrector values (P, T, C, Vm, Vb)
- f) Calculation of errors and uncertainties
- g) Conforming or non-conforming classification
- h) Generation of calibration certificates

VEREDICTO
REVISADO POR

Aprobado
Marcin Bołtruczyk

M. Bołtruczyk

All testing is done unattended.
We have 3 workstations, giving a total capacity of 150 devices per shift.



Final Report.



PLUM Sp. z o.o.
CALIBRATION LABORATORY
 ul. Wspólna 19, Ignatki
 16-001 Kleosin, Poland
 tel. +48 85 749 70 00, fax. +48 85 749 70 14
 e-mail: laboratorium@plum.pl

PLUM Sp. z o.o. is certified for production, final product inspection and testing according to module D of Directive 2014/32/EU of the European Parliament and of the Council: certificate of quality system no. 0119-SJ-A002-09.

REPORT OF CONFORMITY TEST

Date of issue 14.04.2022 Report No: 643/50/LA/C/2022 Page 1/2

OBJECT OF CONFORMITY TEST	Volume conversion device Type: MacBAT 5 Serial number: 1005610625 Program version / Bootloader version: S007.73_V072028 / B14 CRC: CrcMain=50670700; CrcBoot=15FBCC2D Gas pressure measurement range: (0.8 ± 10) bar abs Gas temperature measurement range: (-30 ± 70) °C PRT sensor: type CT6A , serial number: 1005545579
MANUFACTURER	PLUM Sp. z o.o. ul. Wspólna 19, Ignatki, 16-001 Kleosin, Poland
EU-TYPE EXAMINATION CERTIFICATE	DE-19-MI002-PIB004
METHOD AND TEST CONDITIONS	Test procedure: ILAJ 5.4/10, according to point A.1.4.2 of EN 12405-1. Base conditions: $p_0 = 1.01325 \text{ bar}$, $T_0 = 15 \text{ °C}$ Combustion reference temperature: $T_1 = 15 \text{ °C}$ Test algorithm range: (-30 ± 70) °C Algorithm: AGA8-92DC Test gas (%mol): C1=85.9, C2=8.5, C3=2.3, nC4=0.35, iC4=0.35, nC5=0.05, iC5=0.05, neo-C5=0, C6=+0, N2=1, CO2=1.5, C6H14=0, C7H16=0, C8H18=0, C9H20=0, C10H22=0, H2=0, H2O=0, H2S=0, CO=0, He=0, Ar=0, O2=0
CONFORMITY WITH REQUIREMENTS	The object of conformity test meets the requirements specified in Annex IV of Directive 2014/32/EU of the European Parliament and of the Council. The results of conformity test have been presented on page 2 of this report including uncertainty of measurement.



DEPUTY MANAGER
 of the Measurement Laboratory
Piotr Chojciej
 Piotr Chojciej MSc., Eng.

REPORT OF CONFORMITY TEST issued by PLUM Sp. z o.o., CALIBRATION LABORATORY
 Date of issue: 14.04.2022 Report No: 643/50/LA/C/2022 Page 2/2

RESULTS OF CONFORMITY TEST Test results are the following.

Conversion factor C

Reference value			Indication of tested device			Error	Uncertainty of measurement
Temperature	Pressure	Conversion factor	Temperature	Pressure	Conversion factor		
t_{CV}	p_{CV}	C_{CV}	t	p	C	$e_c^{1)}$	U_c
°C	bar	-	°C	bar	-	%	%
-30.01	0.8001	0.936694	-30.00	0.8002	0.936857	0.02	0.14
-30.01	3.1000	3.668876	-30.00	3.1004	3.669179	0.01	0.12
-30.01	5.4000	6.461697	-30.00	5.4006	6.462162	0.01	0.09
-30.01	7.7000	9.318366	-30.00	7.7007	9.318890	0.01	0.09
-30.01	10.0000	12.241760	-30.01	10.0002	12.242020	0.00	0.09
19.98	10.0000	9.923814	19.97	10.0006	9.924736	0.01	0.08
19.99	7.7000	7.596400	19.98	7.7005	7.597117	0.01	0.08
19.98	3.1000	3.022834	19.97	3.1005	3.023372	0.02	0.12
19.99	0.8000	0.775598	19.98	0.8000	0.775633	0.00	0.14
69.97	0.8000	0.662028	69.95	0.8001	0.662110	0.01	0.14
69.97	3.1000	2.573585	69.95	3.1004	2.574081	0.02	0.12
69.97	5.4000	4.497634	69.96	5.4004	4.498142	0.01	0.08
69.97	7.7000	6.433994	69.96	7.7007	6.434769	0.01	0.08
69.97	10.0000	8.382779	69.95	10.0005	8.383512	0.01	0.08

¹⁾ relative error

$$e_c = \frac{C - C_{cr}}{C_{cr}} \cdot 100\%$$

Volume at base conditions V_b

Reference value			Indication of tested device	Error	Uncertainty of measurement
Temperature	Pressure	Volume at base conditions			
t_{CV}	p_{CV}	V_{CV}	V_b	$e_v^{2)}$	U_v
°C	bar	m³	m³	%	%
19.98	5.4000	529.63	529.68	0.01	0.08

²⁾ relative error

$$e_v = \frac{V_b - V_{cr}}{V_{cr}} \cdot 100\%$$

Maximum Permissible Error: MPE = 0.5%

ENVIRONMENTAL CONDITIONS Ambient temperature: (21.8 ± 24.0) °C
 Relative humidity: (38 ± 51) %

DATE OF TEST 14.04.2022

TRACEABILITY This report provides traceability of measurement to national measurement standards, which realize the units of measurement according to the International System of Units (SI). Measurement standards applied for calibration have been listed below.

Name of measurement standards	Type	Serial number
Electronic Thermometer	MacREJ 5	1004466418
Standard Pulse Counter	MacIMP F	92702
Pressure Controller	CPC 6050	41000TLX

UNCERTAINTY OF MEASUREMENT Uncertainty of measurement has been evaluated in compliance with EA-4/02 M:2013. The expanded uncertainty assigned corresponds to a coverage probability of 95% and the coverage factor $k = 2$.

In addition, more than 10% of the total production is tested in temperature chambers - statistical control. They allow to check the correct functioning over the entire temperature range of the corrector.

Rango de la Temperatura Ambiente




De -25°C a 70°C



Metrology for Digital Transformation
SIM-MWG-14



Maximum time limit in years to carry out the 1st sub-verification.

	Country	Years
	Poland	10
	Canada	7
	Spain	4
	LATAM	NA

For further information:

- 1) **Measurement Canada: G-18**—Reverification periods for gas meters, ancillary devices and metering installations.
- 2) **Spain:** ORDEN ICT/155/2020, de 7 de febrero, por la que se regula el control metrológico legal del Estado de determinados instrumentos de medida.

PLUM Sp. z o.o.

ul. Wspólna 19, Ignatki

16-001 Kleosin, Poland

KRS: 0000153696

NIP: 966-14-27-390

National Waste Database No. 000009381

E-mail:

laboratorium@plum.pl



Giovanny Zepeda
BDR PLUM

