FEDERAL AGENCY FOR TECHNICAL
REGULATION AND METROLOGY

CERTIFICATE

on measurement instruments type approval

CH.C.29.004.A No. 47165

Valid to July 9th, 2017

MEASUREMENT INSTRUMENTS TYPE NAME
Mass flowmeter Promass X

MANUFACTURER
Endress+Hauser Flowtec AG, Switzerland

REGISTRATION No. **50365-12**

VERIFICATION DOCUMENT
MP 50365-12

VERIFICATION INTERVAL **4 years**

The type of measurement instruments is approved by the order of the Federal agency for technical regulation and metrology of **July 9th, 2012** No. **483**

The measurement instruments type is described in the appendix to this certificate being its integral part.

Federal agency deputy
administrator

Y.R. Petrosyan

July 19th, 2012

Series SI

No. 005478

MEASURING INSTRUMENT TYPE DESCRIPTION

Mass flowmeters Promass X

Measurement instrument function

Mass flowmeters Promass X (further - flowmeters) are used to measure mass and volume flow, mass, volume, density and temperature of liquids, gases, solutions, oils, and etc.

Measurement instrument description

The flowmeter consists of the primary flow transmitter Promass X with two pairs of curved measuring tubes and the electronic transmitter. Depending on the version, terminal flanges can have the diameter of 300...400 mm.

The principle of the mass flow measurement is based on the measurement of the Coriolis force originating in tubes of the primary mass transmitter when the measured medium is passing through them. The principle of the density measurement is based on the measurement of the resonance frequency of the primary transmitter tube oscillations. The temperature is measured using the - resistance thermometer, built in the primary transmitter housing. The volume flow and volume are determined based on measured values of the mass flow, mass and density of the operating environment.

The primary transmitter signals are processed by the electronic transmitter (Promass 83 or Promass 84) mounted in the compact or remote version in the hermetical housing. The electronic transmitter also performs the following functions:

- calculation of the mass flow and liquid or gas mass (in one or two flow directions);
- calculation of the volume flow and liquid volume (in one or two flow directions);
- conversion of the volume flow, volume and density by the specified temperature;
- display of measurement results for the flow, quantity, density, and temperature; and also display of the conversed parameters in different units;
- compensation of the additional error caused by the difference of the process temperature and pressure from the calibration temperature and pressure;
- self-monitoring of faults and their display;
- batching;
- sending the measuring data in analog and/or digital form to the personal computer, controller or remote indication device.

Flowmeters can have explosion proof design (1Exd[ia]IIC/IIBT6...T1 or 2Exde[ia]IIC/IIBT6...T1). The certificate of conformity to the explosion protection requirements ROSS SN.GB05.V03722 No. 0466121 of 14.11.2011; Rostechnadzor permission No. PPC 00 - 047181 of 02.03.2012).

Service software FieldTool, FieldCare, and also the FieidCheck device are used to perform maintenance, setup, and diagnostics of flowmeters from PC.

Software

The flowmeter software consists of two components: Firmware и Software. The measurement results are processed and calculated (metrological meaningful software part) by special design ratios stored in the firmware as Hex-files. The firmware digital ID (checksum) cannot be accessed.

The software name has a structure of X.Y.Z, where:
X - Firmware ID: for transmitters 83, 84 - is specified by a digit 3; Y - the current software version ID (00...99) – depends on the transmitter functionality (different digital communication protocols, and also compatibility with the service software).
Z – service ID (e.g. for improvement or bugs tracing) – it is not connected with the flowmeter functionality and metrological characteristics.

The software name is displayed on the transmitter screen during switching on (it is inactive and cannot be changed).

Flowmeter software identification data

Software name	Software - identification - name	Software version number (ID)	Digital software ID (the executable code checksum)	Algorithm for the software digital ID calculation
Promass Amplifier	SW-REV.AMP	V3.0y.zz	not displayed	CITT reflected
Promass Communication	SW-REV.I/0	Vl.0y.zz	not displayed	CRC32

The flowmeter software is protected from intended and unintended modifications with the protection level C according to MI 3286-2010.

To use the flowmeter in accounting and calculation operations, the switching unit housing can be sealed by a regulatory agency. The system appearance is shown in Figure 1.

The primary transmitter (sensor) in the compact version

Electronic transmitter

Figure 1

The sealing scheme is shown in Figure 2.

a b

Switching unit housing of the compact (a) and remote (b) version

Figure 2

Metrological and technical characteristics

Characteristic Name	Promass X
Diameters of terminal flanges, mm	300, 350, 400
Liquid mass flow measuring range, t/h	8.2...4100
Liquid volume flow measuring range (by water under normal conditions), m3/h	8.2...4100
Gas mass flow measuring range, t/h, where ρgas (kg/m3) is the gas density under operating conditions	$\frac{(8.2...4100)\times \rho gas}{200}$
Media temperature range, °C	-50...+180
Density measuring range, kg/m3	500...1800
Permissible relative error for the flowmeter with transmitter 83/84, %*: - mass flow and liquid mass; - mass flow and gas mass; - volume flow and liquid volume.	 ±0.05/±0.10 ±0.35 ±0.10
Permissible absolute error for liquid density measurement, kg/m3**	±0.5/±1/±10
Permissible absolute error for temperature measurement, °C	±(0.5+0.005 × T)***
Media pressure range, MPa	0...10
Environmental air temperature, °C	-40...+60
Output signal, digital communication (using the transmitter 83/84)**	0/4...20 mA, pulse/freq., relay, HART status Modbus RS485, PROFIBUS PA
Power supply	85...260/20...55 V AC, 45...65 Hz, 16...62 V DC
Transporting and storage temperature, °C	-40...+80
Installation length (with flanges), mm	1714...1950
Weight, kg	553...564
Average lifespan, years	15

* at Q<175 t/h, the accuracy is calculated by formula:
±0.05%± (Z_c/Q)*100%, or ±0.10% ± (Z_c/Q)*100%,
where Z_c - the zero point stability, Q - the current flow value.
** depends on the order code;
*** T - process temperature, °C

Measurement instrument package contents

	Name	Marking	Quantity	Note
1.	Flowmeter consisting of: - primary transmitter - electronic transmitter	 Promass X 83/84	1	according to ordering info
2.	Accessories		1	according to ordering info
3.	Operation manual		1	for the appropriate flowmeter version
4.	Passport		1	
5.	Verification procedure		1	

Verification
is performed according to the MP 50365-12 method "State System for Ensuring Uniform Measurement. Mass flowmeters Promass X. Verification procedure", approved by FGUP "VNIIMC" in May of 2012. Main verification means:

- verification unit for liquids with flow range relevant for the verified flowmeter;
- electronic calculating frequency meter 43-49A, amplitude up to 50 V, frequency 0...10 kHz
- amperevoltmeter P386, measuring range 0.1-10 V, accuracy ±0.05%;
- lab thermometer with the scale division 0.1 °C according to TU25-2021.003-88;
- areometers with the density measuring interval 500-1800 kg/m^3 according to GOST 18481-81 and the accuracy 0.1; 0.5; 1 kg/m^3.

Information on measurement procedures (methods)
are described in the operating instructions.

Regulatory and technical documents with the requirements to mass flowmeters Promass X

1. GOST R 52931 -2008 Devices for control and regulation of technology processes.
2. Company's technical documentation.

Recommendations on applications in the sphere of the state regulation for the measurements uniformity maintenance
performance of trade and goods exchange operations.

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Deputy Administrator of the
Federal agency for technical
regulation and metrology — Y.R. Petrosyan

July 19th, 2012

L.S.

RUSSIAN METROLOGICAL SERVICE RESEARCH INSTITUTE
(FGUP "VNIIMS")

APPROVED

Head of the Federal State Unitary Enterprise
GZI SI "VNIIMS"
V.N. Yanshin

May 22nd, 2012

State System for Ensuring Uniform Measurement

MASS FLOWMETERS PROMASS X

Verification procedure

MP 50365-12

MOSCOW
2012

1. INTRODUCTION

1.1 The present document is applied to all mass flowmeters Promass (further - flowmeters) produced by the Endress+Hauser Flowtec AG (Switzerland) company used in applications of the state metrological control and supervision; and sets procedures and means of their initial and periodic verifications at the issue from the factory and after repair.

1.2 Initial verification is performed by the manufacturer: Endress+Hauser Flowtec AG (Switzerland).

1.3 Verification interval shall not exceed 4 years.

2. VERIFICATION OPERATIONS

2.1 Verification includes the following operations:

2.1.1 visual inspection, item 7.1;
2.1.2 flowmeter software ID check, item 7.2;
2.1.3 leaktightness check, item 7.3;
2.1.4 testing, item 7.4;
2.1.5 metrological characteristics definition, item 7.5.

3. VERIFICATION MEANS

3.1 Verification is performed using the following reference values and testing equipment:

3.1.1 For operations in item 2.1.2, the hydraulic press with the testing gauge of the accuracy rating no more than 0.4.

Metrological characteristics are defined using the following verification and testing equipment:

- calibration unit for fluids of the flow range matching the calibrated flowmeter
- piston verification unit completed with a flow density transmitter for quantity and quality measurement systems for oil, oil products, and liquid hydrocarbons;
- electronic pulse register with the amplitude up to 50 V and frequency 0...10 kHz;
- DC milliampermeter with the measuring range 0/4...20 mA and the accuracy ±0.05%;
- lab thermometer with the scale division 0.1 °C according to TU25-2021.003-88, and the temperature measuring range by reference points of the operation in item 7.4.4;
- areometers with the density measuring interval 500...2000 kg/m^3 according to GOST 18481-81 and the accuracy 0.1; 0.5; 1 kg/m^3;

electronic second meter "Integral S-01", absolute accuracy (9.6*10-6 T+0.01), where T - the measured time interval, s;

- DC power supply of 24 V, AC power supply of 220 V with the frequency 50 Hz;
- aspiration psychrometer for humidity measurements in the range of 30...90%.

3.3 The used samples shall be checked and have valid verification certificates.

3.4 It is allowed to use other references with characteristics that comply with standards specified in item 3.2.

4. SAFETY REQUIREMENTS

4.1. During verification, the following safety requirements must be observed:

- labour and fire safety rules valid for the verification unit;
- safety rules for working with the used references, testing equipment and tested flowmeter set in the operating instructions.

4.2. Wiring works must be performed according to GOST 12.3.032 and "Rules for electrical equipment installation" (section VII).

4.3. The verification can be performed by persons with the safety rules qualification group not lower than II according to the "Safety rules at the consumer electric installations operation", who studied the flowmeter operating instructions and this document.

5. VERIFICATION CONDITIONS

5.1 The verification shall be performed with the observance of the following conditions:

- verification media – piped water, kerosene, oil, gasoline, diesel oil, mineral oil and etc.;
- ambient air temperature 20 ± 5 °C;
- process temperature 15...25 °C, the temperature fluctuations during measurement shall not exceed 0.5 °C;
- relative air humidity 30...80%; atmosphere pressure 86...107 kPa.

6. VERIFICATION PREPARATION

6.1 The verified flowmeter is installed at the verification unit and prepared for work according to the corresponding operating instructions or verified on-site without removal using the reference testing equipment that conforms to the accuracy standards set in item 3.2.

6.2 The current output is checked. To do it, the verifier randomly specifies not less than three of the existing current values in the "simulation current" cell.

The absolute accuracy Δ_i by the current signal is calculated by formula

$$\Delta i = |Is| - |Ip| \qquad (1)$$

where

I_p - the flowmeter output current in mA;

I_s - test current in mA,

The flowmeter shall be considered to pass the current output verification if the error does not exceed the permissible absolute error for the current signal

$$|\Delta i| \leq |\Delta' i|$$

where the permissible absolute error for the current signal Δ'_i of the flowmeter is specified in the operating instructions according to its version.

6.3. The frequency output is checked. To do it, the verifier randomly specifies not less than three of the existing frequency values in the "simulation frequency" cell.

The flowmeter shall be considered to pass the frequency output verification if the flowmeter output frequency equals the specified value.

7. VERIFICATION PERFORMANCE

7.1. Visual inspection.

7.1.1 The visual inspection determines the following:

- the flowmeter is not mechanically damaged that would make impossible to use it;
- text and signs on the flowmeter are clear and meet the requirements in the operating instructions;
- the flowmeter delivery is complete and complies with the documentation;
- compliance of the flowmeter version with its label.

7.1.2 The flowmeter is allowed for verification only after successful visual inspection.

7.2. Flowmeter software ID check.

When starting the flowmeter, software version numbers must be displayed on the transmitter screen using the following device menu commands:
SUPERVISION→VERSION-INFO →AMPLIFIER (show software version number V14 Promass Amplifier) and SUPERVISION → VERSION-INFO → I/O MODULE (show software version number Promass Communication). The flowmeter software version numbers must also be displayed by the switched on transmitter as inactive and unchangeable.

You cannot get access to the digital ID of the software (the executable code checksum).

Test results are considered successful if the following identification data are displayed:

Software ID name	Software version number (ID)
SW-REV.AMP	V3.0y.zz
SW-REV.I/0	Vl.0y.zz

7.3. Air-tightness check.

7.3.1 The Air-tightness is checked by creating the pressure of 1.5+1 MPa in the primary transmitter body. The holding time under pressure is not less than 15 min.

7.3.2 The flowmeter is considered to pass verification if within 15 minutes there were no leakage of the liquid/air, weld joints condensation and pressure loss.

7.4. Testing.

7.4.1 The flowmeter is tested on the verification unit by increasing/decreasing of the liquid flow within the working measuring range.

7.4.2 The testing results are considered satisfying if the increasing/decreasing of the liquid flow caused the corresponding changes in the readings on the flowmeter display, computer and controller monitor, output measuring signal/signals.

7.5. Metrological characteristics definition.

7.5.1 The relative flowmeter accuracy for mass measurements is defined by comparing mass values measured by the flowmeter with readings of the flow verification unit in two points corresponding to 0.05 Q_{max} and 0.1... 0.9 Q_{max}, where Q_{max} – maximal limit of the flowmeter measurements. At every point not less than two measurements must be performed; the permissible deviation of the set mass flow Q_m from reference points is ±3%. The liquid mass M_y is measured with the set mass flow Q_m.

The relative percentage flowmeter error for every verification flow is defined by the formula.

$$\delta_m = \frac{M_p - M_y}{M_y} \cdot 100\% \quad (2)$$

where

M_y - liquid mass measured by the unit at the set flow Q_m;

M_p - liquid mass measured by the flowmeter, i.e. flowmeter readings on the display, computer/controller monitor in mass units.

The flowmeter is considered to pass verification if the value of its relative accuracy at the mass measurement in every point at every measurement does not exceed ±(0.05;0.1)%.

Note:

- with the positive result of the mass measurement verification, the flowmeter is qualified for measurement of the mass flow;
- when using the pulse output, the mass measured by the flowmeter is recalculated by formula

$$M_p = N_i \cdot q, \quad (3)$$

where

N_i - is the number of pulses processed by the flowmeter during the mass measurement;

q is the flowmeter pulse rate at the mass measurement.

7.5.2 The flowmeter accuracy for measurements of mass by volume piston units is defined by comparing mass values recalculated based on volume and density measurements by formula

$$M_y = V_y \cdot \rho, \quad (4)$$

where

V_y - liquid volume measured by the unit;

ρ - liquid density, measured by the areometer with the density measuring range of 500...2000 kg/m^3 according to GOST 18481-81 and the accuracy 0.1 kg/m^3.

Measurements are performed in two points corresponding to 0.05 Q_{max} and 0.1...0.9 Q_{max}, where Q_{max} is the maximal limit for flowmeter measurements. At every point not less than two measurements must be performed; the permissible deviation of the set mass flow Q_m from

reference points is ±3%.

The relative percentage flowmeter error for every verification flow is defined by formula (2).

The flowmeter is considered to pass verification if the value of its accuracy at the mass measurement in every point at every measurement does not exceed ±0.1%.

Notes:

- with the positive result of the mass measurement verification, the flowmeter is qualified for measurement of the mass flow;
- when using the pulse output, the mass measured by the flowmeter is recalculated by formula (3).

7.5.3 The flowmeter accuracy for measurements of volume flow is defined by comparing the flowmeter measured liquid volume with readings of the primary flow verification unit in two points corresponding to 0.05 Q_{max} and 0.1...0.9 Q_{max}, where Q_{max} is the maximal limit for flowmeter measurements. At every point not less than two measurements must be performed; the permissible deviation of the set volume flow Qv from reference points is ±3%.

The relative percentage flowmeter accuracy for every verification flow is defined by formula

$$\delta_V = \frac{Q_p - Q_y}{Q_y} \cdot 100\%,$$

where

Q_y - liquid volume flow measured by the verification unit;

Q_p - liquid volume flow measured by the flowmeter, i.e. flowmeter readings on the display, computer/controller monitor, derived as the average value for the measurement time by formula

$$Q_P = \frac{V_p}{\tau} \quad (5)$$

where V_p - the volume measured by the flowmeter for the measurement time;

τ - measurement time.

The flowmeter is considered to pass verification if the value of its accuracy at the volume flow measurement in every point at every measurement does not exceed ±0.1%.

Note: With the positive result of the volume flow measurement verification, the flowmeter is qualified for measurement of the volume flow.

7.5.4 The flowmeter absolute error for the density measurements is defined by comparing the readings of the display, computer and controller monitor with the areometer readings within the density measuring working range. To do it, take a verification medium sample at the pipeline outlet run and pour it into the vessel. The liquid density is measured by the areometer. The number of measurements must be not less than two.

The absolute density measurement error $\Delta_п$ at every point at every measurement is calculated by formula

$$\Delta_п = \rho_p - \rho ,$$

Where

ρ_p - the density value measured by the flowmeter;

$\rho_д = \frac{\rho_0}{1 + \alpha(t - t_0)}$. – the density measured by the areometer at the process temperature t, ρ_0 - the liquid density at t_0 = 20 °C, α - liquid formation volume factor, 1/°C.

The flowmeter is considered to pass verification if the density measurement absolute accuracy value $\Delta_п$ at every point at every measurement does not exceed the permissible density measurement absolute error specified in the operating instructions that corresponds its version (±0.5...±20) kg/m^3.

Note: The flowmeter can be verified for the density measurement both at the verification unit and without the flowmeter removal on-site.

7.5.5 The absolute temperature measurement error is defined by comparing the readings of the display, computer and controller monitor with the readings of the reference thermometer within the temperature measuring working range. To do it, the thermometer is immersed in the verification medium near the flowmeter location and take not less than two temperature measurements.

The absolute temperature measurement error Δt at every point at every measurement is calculated by formula

$$\Delta_t = t_p - t_T$$

where

t_p - the temperature value measured by the flowmeter;

t_T- the temperature value measured by the thermometer.

The flowmeter is considered to pass verification if the absolute temperature measurement error Δt at every point at every measurement does not exceed the permissible absolute error for the flowmeter at the temperature measurement calculated by the formula

$$\Delta'_t \leq \pm 0.5 \pm 0.005 t_T$$

where

t_T - the temperature value measured by the thermometer, °C.

I.e., $|\Delta_t| \leq |\Delta'_t|$ is true.

Note: The flowmeter can be verified for the temperature measurement both at the verification unit ad without the flowmeter removal on-site.

7.6. With the positive result of the verification in a liquid medium, the flowmeter is qualified for measurements in gas working media with the metrological characteristics specified in the operating instructions according to the flowmeter version.

7.7. When using the flowmeter with quantity and quality measurement systems for oil, oil products and liquid hydrocarbons on-site, the periodic verification can be performed according to MI 3151-2008 or MI 3272-2010.

8. DOCUMENTATION OF VERIFICATION RESULTS

8.1 The verification results shall be documented in a protocol according to forms specified in Appendix A.

8.2 Positive results are documented as a certificate with performance of procedures set by PR 50.2.006.

8.3 For negative results, procedures set by PR50.2.006 are performed.

PROTOCOL for verification of the mass flowmeter Promass ___ . **Appendix 1**

Serial number _____
DN, mm _____
The flow measuring range applied, t/h _____

Verification results
6.1 Conclusion on the verification preparation _____
7.1 Conclusion on the visual inspection _____
7.2 Flowmeter software ID check. _____
7.3 Conclusion on the leaktightnesscheck _____
7.4 Conclusion on the testing _____

7.5.1 Definition of the accuracy for mass flow measurements δ_m.

Mass flow [t/h]	Measurement	Flowmeter reading for the measured mass, M_p [t]	Verification unit reading, M_y [t]	Relative accuracy, δ_m [%]	Permissible error value [%]
	1				
	2				
	1				
	2				
	1				
	2				
	1				
	2				
	1				
	2				
	1				
	2				

Conclusion on the flowmeter operational integrity:

Verified by: _____( )

PROTOCOL for verification of the mass flowmeter Promass _____

Serial number _____
DN, mm _____
The flow measuring range applied, t/h _____

Verification results
6.1 Conclusion on the verification preparation _____
7.2 Flowmeter software ID check. _____
7.3 Conclusion on the leaktightnesscheck _____
7.4 Conclusion on the testing _____

7.5.3 Definition of the accuracy for volume flow measurements δ_V, [%]

Measurement	Flowmeter readings, m^3/h [Q_p]	Verification unit readings, m^3/h [Q_y]	Relative accuracy, δ_V [%]	Permissible error value, [%]
1				
2				
1				
2				
1				
2				
1				
2				
1				
2				

Conclusion on the flowmeter operational integrity: _____

Verified by: _____ ( )

PROTOCOL for verification of the mass flowmeter Promass _____

Serial number _____
DN, mm _____
Tested parameter _____

Verification results
6.1 Conclusion on the verification preparation _____
7.2 Flowmeter software ID check _____
7.3 Conclusion on the leaktightnesscheck _____
7.4 Conclusion on the testing _____

7.5.4 Definition of the absolute accuracy for the density measurements $\Delta_{П}$, (kg/dm^3)

Measurement	The density value measured by the flowmeter $\rho_{Р;}$ (kg/dm^3)	The density value measured by the areometer $\rho_{д}$, (kg/dm^3)	Absolute accuracy, $\Delta_{п}$, (kg/dm^3)
1			
2			

Conclusion on the flowmeter operational integrity:

Verified by: _____ ( )

PROTOCOL for verification of the mass flowmeter Promass _____

Serial number _____
DN, mm _____
Serial number _____

Verification results
6.1 Conclusion on the verification preparation _____
7.2 Flowmeter software ID check _____
7.3 Conclusion on the leaktightnesscheck _____
7.4 Conclusion on the testing _____

7.5.5 Definition of the absolute accuracy for the temperature measurements Δ_t [°C]

Measu-rement	The temperature value measured by the flowmeter, t_p [°C]	The temperature value measured by the thermometer, t_T [°C]	Absolute accuracy, Δ_t [°C]	Permissible error, [^{0}C]
1				
2				

Conclusion on the flowmeter operational integrity:

Verified by: _____ ( )