Evaluation Certificate

Number **TC8272** revision 6
Project number 2172717

Issued by	NMi Certin B.V.
In accordance with	- WELMEC 8.8 "General and Administrative Aspects of the Voluntary System of Modular Evaluation of Measuring instruments under the MID". - WELMEC 7.2 "Software Guide" - OIML R117-1 Edition 2007 (E) "Dynamic measuring systems for liquids other than water".
Producer	Emerson Process Management Micro Motion Inc. 7070 Winchester Cricle Boulder, CO 80301 Unites States of America
Part	A **density sensor**, intended to be used as a part of a measuring instrument

Producer's mark or name	:	Micro Motion Inc.
Type designation	:	CDM100
Accuracy class	:	0,3; 0,5; 1,0
Destined for the measurement of	:	Products in a liquid state, excluding under pressure liquefied gases.

Further properties and test results are described in the annexes:
– Description TC8272 revision 6;
– Documentation folder TC8272-2.

Remarks
– This revision replaces the previous revisions;
– The documentation folder is not changed.

Issuing Authority

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INSPECTION
RvA I 122

1 General information about the density sensor

Properties of this density sensor, whether mentioned or not, shall not conflict with the legislation.

This Evaluation Certificate is the positive result of the applied voluntary, modular approach, for a component of a measuring instrument, as described in WELMEC 8.8.

The complete measuring system must be covered by an EC-type examination certificate or an EU-type examination certificate.

1.1 Essential parts

The density sensor is composed of the following parts:

Description	Documentation	Remarks
Measurement sensor	8272/0-01	
	8272/4-01	With updates to the sensors internal circuit board.
Transmitter	8272/0-02	Assembly of the transmitter to the measurement sensor
	8272/0-05	Core Board
	8272/0-06	Exi Power Supply
	8272/0-07	Exd power Supply
	8272/0-08	Display with infra-red keys Note: the display is optional.
External Power supply	8272/0-09	QUINT-PS/1AC/24DC/3.5 100 – 240 VAC input
	8272/0-10	QUINT-PS/24DC/24DC/5 24 VDC input

1.2 Essential characteristics

1.2.1 Construction / working principle

In the housing of the measurement sensor, two parallel tubes are mounted which are set into a vibrating motion which is controlled by the transmitter. The two pick-off coils generate signals representative for the frequency of motion of the measurement tubes. The resonance frequency depends, among other things, on the density of the liquid in the measurement tubes.
The transmitter can output this resonant frequency either directly or via serial communication.
The transmitter is capable of density calculations as specified in chapters 1.2.10 and 1.2.11 of this description. These density values can be outputted via RS-485 Modbus serial communication, BELL 202 HART protocol or 4 … 20 mA analog signal.

1.2.2 Product range (density and/or viscosity)

- Densities between 630 and 1300 kg/m^3
- Viscosities between 0,6 and 8,5 mPa·s

1.2.3 Maximum operating pressure: 100 bar(g)

1.2.4 Maximum flow rate: 10 kg/min

1.2.5 Temperature range liquid: -10 °C / +60 °C

1.2.6 Temperature range ambient: -10 °C / +55 °C

1.2.7 Environment classes: M2 / E2

1.2.8 Software specification (refer to WELMEC 7.2)
- Software type P;
- Risk Class C;
- Extension T and I-5 apply.

Software versions	CRC Checksum
1.62	ED596201
1.64	628A6935
2.00	8C64F133
2.02	2936EF98
2.10	AEA67C3D
2.11	A0162290

The software version can be checked:
- At power up of the instrument (if equipped with a display)
- Electronically via serial communication (ProLink or Hart communicator);
- Manually via the menu system of the density sensor (if equipped with a display):
  - Cover (Press) both the [SCROLL] + [SELECT] buttons for five seconds until “SEE ALARM” or “OFF-LINE MAINT” is displayed;
  - Press [SCROLL] until “OFF-LINE MAINT” appears and press [SELECT];
  - Press [SCROLL], than [SELECT], than [SCROLL] to confirm to enter the OFF-LINE MAINT screens.
  - Press [SCROLL] until “OFF-LINE SWVER” appears and press [SELECT] to view the software revision;
  - Press [SCROLL] to move to the next screen to view the checksum.
    The menu system is automatically aborted after two minutes of inactivity.

1.2.9 The transmitters Core Board and Exi/Exd power supply are installed in a potting shell, which is filled with potting. See documentation 8272/0-03 and 8272/0-04.

1.2.10 Density calculation

The density sensor when connected to an external pressure and temperature element via HART is capable of calculating the line density and also converting it to density at reference conditions using the methods specified in chapter 1.2.11.
This density is calculated using the Mobrey/Solatron density formulas.

For clarity, the formulas are given below:

$Rho = K0 + K1 \cdot \tau + K2 \cdot \tau^2$;
$Rho_t = Rho\ (1 + K18\ (t - 20)) + K19\ (t - 20)$; *Temperature correction*
$Rho_{tp} = Rho_t\ (1 + (K20A + K20B\ (P - 1)) \cdot (P-1)) + (K21A + K21B\ (P-1)) \cdot (P - 1)$. *Pressure correction*

With:

- τ Time period in µs;
- t Line temperature in °C;
- P Absolute line pressure in bar(a);

K0, K1, K2, K18, K19, K20A, K20B, K21A and K21B are coefficients determined during the calibration of the instrument and are stored in the instrument.

For the CDM100; K1, K20A, K20B and K21B are set to 0, resulting in the following simplified equations:

$Rho = K0 + K2 \cdot \tau^2$
$Rho_t = Rho\ (1 + K18\ (t - 20)) + K19\ (t - 20)$;
$Rho_{tp} = Rho_t + K21A \cdot (P - 1)$.

The approved outputs for these density values are RS-485 Modbus serial communication, BELL 202 HART protocol or 4 … 20 mA analog signal.
Note: If in case the time period signal of the device is used as the output, the density meter, along with the pressure and temperature sensor needs to be then connected to a flow computer. The actual density calculations using the Mobrey/Solatron formula as stated above will then take place in the flow computer.

1.2.11 Conversion of measured density to density at reference conditions

Conversion of measured density to density at reference conditions (0 kPa, 15 °C) is carried out using:

- Table 53A for generalized crude oils;
- Table 53B for generalized products;
- Table 53D for generalized lubricating oils;

as specified in API Manual of Petroleum Measurements Standards, Chapter 11, Physical Properties Data, Section 1 (also known as ASTM D1250-07).

Conversion of measured density to density at reference conditions (0kPa, 20°C) is carried out using:

- Table 59A for generalized crude oils;
- Table 59B for generalized products;
- Table 59D for generalized lubricating oils;

as specified in API Manual of Petroleum Measurements Standards, Chapter 11, Physical Properties Data, Section 1 (also known as ASTM D1250-07).

1.2.12 Concentration Measurement uses manually configured tables, which are stored behind seal, e.g. they cannot be modified when the device is in Custody Transfer Secure Mode.
Concentration Measurement requires an approved external temperature probe; it is not allowed to use the temperature probe of the connected sensor.
Concentration Measurement feature can be used for density and volume at a defined reference temperature for any liquid for which a traceable database or norm/standard is available.

The Concentration Measurement feature is used for measuring alcohol, alcohol percentage and alcohol at 20°C (100% alcohol), based on OIML R22. This Evaluation Certificate covers alcohol percentages from 50% up to and including 100%.

1.2.13 Conversion of Fatty Acid Methyl Ester (FAME) density to density at reference conditions (15 °C) is calculated using the formula as specified in EN14214:2008 + A1:2009, "Automotive fuels - Fatty acid methyl esters (FAME) for diesel engines - Requirements and test methods"

For clarity, the formulas are given below:

Density at 15 °C = density at actual temperature + 0,723 * (product temperature -15 °C).

1.2.14 Conversion of Methyl-Ester density to density at reference conditions (15°C) is calculated using the formula:
Density at 15 °C = density at actual temperature + 0,71962 * (product temperature -15 °C).

1.3 Essential shapes

1.3.1 Inscriptions

- Type plate
  At least the following information is mentioned on the type plate of the instrument:
  - The Evaluation Certificate number "TC8272";
  - Name and/or trademark of the producer;
  - Type designation;
  - Serial number;
  - Serial number of measurement sensor and transmitter if not physically sealed against separation.
- The inscription "Diagnostic Density is not for Custody transfer" on the type plate of the density sensor or in the vicinity of the display of the density sensor.
  A similar text with the same meaning and/or in the local language is also allowed.

  Note: For software version 2.11 onwards this inscription "Diagnostic Density is not for Custody transfer" is only necessary if the time period signal is used as the output.

1.4 Conditional characteristics

- From software version 2.00 onwards the density sensor has the possibility to:
  - Show the density as calculated by the flow computer to which the density sensor is connected. This density is transmitted via Modbus from the flow computer to the density sensor.

  Or
  - Calculate the density from the tube period and programmed constants as mentioned in paragraph 1.2.10.
    Please note that the calculated density by the density sensor may only be used as a diagnostic value and it is not allowed to use this density for custody transfer purposes.
    For both possibilities, the inscription as mentioned in the second bullet of the Inscriptions shall be applied to the instrument.

- From software version 2.11 onwards the density sensor has the possibility to calculate and display the line density and density converted to reference conditions.
  The approved outputs for these calculated density values are RS-485 Modbus serial communication, BELL 202 HART protocol or 4 … 20 mA analog signal.
  If in case, the time period signal is used as the output of the density sensor then the first bullet point of this chapter 1.4 is applicable.
  The time period signal along with external temperature and pressure transmitter should be connected to a flow computer.

1.5 Conditional shapes

- The housing of the sensor and the transmitter is made of metal.
  See documentation number 8272/4-02 for the differences between the legacy case design and the new case design.

2 Seals

The following seals are applied:

- The inscriptions are fixed to the density sensor and secured against removal by seal or it will be destroyed when removed.
- After setting the dipswitches into the secured position, both lids of the transmitter are sealed against opening. Both lids are equipped with sealing eyes for this purpose.
  Note: The unit shall be switched off when setting the dipswitches.
- The transmitter is sealed against removal from the measurement sensor.
  This is done either by physically sealing the transmitter to the measurement sensor or by mentioning the measurement sensor's serial number on the type plate of the transmitter.

3 Conditions for conformity assessment

- Other parties may use this Evaluation Certificate only with the written permission of the producer.
- The calibration documents on the densitometer shall include the parameters necessary for the in field verification of the instrument.
- Verify the correct parameter settings inside the flow computer to which the density sensor is connected.
- Or in case of software version 2.11 onwards the correct parameters settings stored in the density sensor and should be verified. These parameter settings can be verified only using Emerson's Prolink III software.

4 Reports

An overview of performed tests is given in the reports:

- No. NMi-11200566-01;
- No. NMi-11200566-02;
- No. NMi- 2172717-01;
- No. NMi- 2172717-02.

A report can be a test report, an evaluation report, a type evaluation report and/or a pattern evaluation report.