Data Sheet

Measuring System “autarkon®“ Steam Flow Meter VMT 100 in Microprocessor Technology

METRA Energie-Messtechnik
Member of Bopp & Reuther Messtechnik Group

Application

Metering and recording of the mass flow of saturated / superheated steam with pressure and temperature compensation.
The compact measuring orifice plate can be adapted to the designed characteristic value via the diameter ratio, thus maximizing the turn down of the system.
No pipe reduction of the nominal diameter required.

VMT 100

Special Features

- No moving parts in the flow section
- Compact, highly integrated measuring system
- All wetted parts in stainless steel
- Measuring system can be optimized according to the operation data
- Automatic correction of flow coefficient and expansion factor
- Modular design
- With pressure and temperature compensation (option)
- With integrated zero-balancing module, thus zero and long-term stable (option)
- Mainly maintenance-free
- Minimum installation effort due to integration of differential and absolute pressure transducer into one device
- With display (option) for mass flow, volume, pressure and temperature
- Standard turn down 1 : 20 for mass flow

General

The VMT 100 D is a measuring system in modular design. It consists of three transducers and an integrated flow meter. In the compact version described below, the temperature sensor is integrated into the system. A compact orifice plate is used as a pressure differential transducer.

Temperature sensor

Absolute pressure transducer

Pressure differential transducer

The VMT 100 D acquires the medium properties pressure, temperature and pressure differential continuously. The electronic circuitry corrects all variable parameters dependent on these properties and calculates the mass flow or the standardized volume flow.

$$q = f(\alpha, \varepsilon, d_t, \Delta p, \varphi)$$

q : flow rate

α: volume factor
function of:
Reynolds´ number,
pressure differential device,
diameter ratio,
velocity of approach factor

φ: density
function of pressure and temperature

Δp: differential pressure
function of velocity, density, diameter ratio

ε: expansion factor
function of pressure ratio,
isentropic exponent,
pressure differential device

d_t: throat diameter
function of temperature,
expansion coefficient of the pressure differential device

Functional Principle

VMT 100 D without hydraulic zero-balancing module

The VMT 100 D is a compact, universal measuring system suited for the most common media like liquids, technical gases and steam.
Due to the modular design the measuring system can be adapted to the customer's requirements. The pressure differential transducer is optimized according to the customer specific operating data. Thus, the best possible solution with regard to turn down, accuracy and pressure loss can be achieved. The velocity-proportional pressure differential is determined by a pressure differential transducer adapted to the respective application. This can be an orifice plate, a measuring nozzle, a Venturi tube or a dynamic pressure probe. The values for pressure differential, fluid pressure and temperature are read by a transducer integrated into the system and then converted into a volume flow, mass flow or standard volume flow signal.
Three pressure differential transducers are available (0-100 mbar, 0-600 mbar and 0-2000 mbar).
Thus, a turn down 1:5 **(without zero-balancing module)** with a measuring uncertainty of ± 1% related to the current volume or mass flow can be achieved.

VMT 100 D with hydraulic zero-balancing module

By implementing a hydraulic zero-balancing module, the turn down can be extended, optimizing the measuring accuracy at the same time. The functional principle is as follows:
The zero point of the differential pressure transmitter is automatically balanced depending on the resulting differential pressure. Due to this repetitive balancing method, the VMT 100 D offers zero and long-term stability. Disturbances influencing the zero point are automatically eliminated (temperature and pressure changes, ageing). In connection with the hydraulic zero-balancing module, the VMT 100 allows a turn down of 1:20 with an accuracy of ≤ 1% related to the actual value of the volume or mass flow.

Design

The design of the VMT 100 D is modular, ensuring a high flexibility.

Compact orifice plate

Diameter ratio adapted to specific operating conditions ensuring optimum turn down.

Integrated temperature sensor to acquire the medium temperature.

Temperature decoupling module

Filling orifice facilitates commissioning

3-way shut-off valve module

for facilitates service and test.

Hydraulic zero-balancing module

Zero-point balanced and long-term stable. Large turn down and high accuracy

Pressure differential transducer:
DT 310 (0 – 100 mbar)
DT 311 (0 – 500 mbar)
DT 312 (0 – 2000 mbar)

Integrated absolute pressure transducer

Tandem transducer differential and absolute pressure integrated in one device with intelligent calculation unit.

Mass **Volume** **Standardized volume**
Mass
Volume
Standard volume

Technical Data VMT 100 D

Nominal Diameter DN	15	20	25	32	40	50	65	80	100	125	200	250
VMT 100 max. mass flow kg/h (steam) *	$m_{max} = 24440 \cdot d^2 \cdot \sqrt{\cdot \Delta p \cdot \rho}$											
Pressure differential transducer	Compact orifice plate											
Face-to-face length	65 mm											
Nominal pressure	PN 40											
Max. operating temperature	250°C compact version, up to for 350°C separate transducer, higher values on demand											
Temperature input	Pt 100 / Pt 1000, four-wire, fixed adjusted temperature Integrated Pt 500, for compact version only (see additional equipment)											
Pressure differential Δp	DT 310		DT 311			DT 312						
	0 – 100 mbar		0 – 600 mbar			0 – 2000 mbar						
Floating output, analog	1 x 4 –20 mA proportional to mass flow											
Optoelectronic coupler output	1 x mass					5 – 24 V						
	1 x fault indication					10 mA						
Digital output	M-Bus interface, Modbus interface											
Protection class	IP54											
Material	All wetted parts in stainless steel											
Power supply	24 V DC/AC – 10% + 15%, power consumption 15VA											
Test certificate	3 measuring points, basis: water											

*ρ = medium density in kg/m³, d = inner throat diameter in m
Δp = differential pressure in mbar
(0.3 DN ≤ d ≤ 0.7 DN preferably d = 0.5 DN)

Additional Equipment

Pt 500 temperature sensor integrated in measuring device (no connection to medium)
3-way shut-off valve module integrated into measuring device
Zero-balancing module for extension of measuring range and accuracy
LC Display 4 lines (for mass, mass flow, temperature and pressure, status indication)
Sensor connection cable 4-wire, screened
Integrated absolute pressure transducer 0-16 / 25 / 40 bara
8 digit remote counter, controlled by voltage-free contacts
Special calibration to glycol brines, heat carrier
Test certificate for 10 flow data points (basis : water)
Inlet and outlet pipe section with centering device for measuring ring
Intermediary for pre-installation
System test, commissioning and instruction by METRA service personnel

Determination of the steam density as a function of pressure and temperature

Saturated steam

Steam pressure p (bar abs)	**Steam temperature** t (°C)	**Steam density** ρ (kg/m³)	**Steam pressure** p (bar abs)	**Steam temperature t (°C)**	**Steam density** ρ (kg/m³)	**Steam pressure** p (bar abs)	**Steam temperature t (°C)**	**Steam density** ρ (kg/m³)
1.0	**99.63**	**0.59**	**9.0**	**175.63**	**4.65**	**21.0**	**214.85**	**10.54**
1.5	111.37	0.86	10.0	179.88	5.15	22.0	217.24	11.03
2.0	120.23	1.13	11.0	184.07	5.64	23.0	219.55	11.52
2.5	**127.43**	**1.39**	**12.0**	**187.96**	**6.13**	**24.0**	**221.78**	**12.02**
3.0	133.54	1.65	13.0	191.61	6.62	25.0	223.94	12.51
3.5	138.87	1.91	14.0	195.04	7.11	26.0	226.04	13.01
4.0	**143.62**	**2.16**	**15.0**	**198.29**	**7.60**	**27.0**	**228.07**	**13.51**
4.5	147.92	2.42	16.0	201.37	8.09	28.0	230.05	14.76
5.0	151.84	2.67	17.0	204.31	8.57	29.0	231.97	14.51
6.0	**158.84**	**3.17**	**18.0**	**207.11**	**9.07**	**30.0**	**233.84**	**15.01**
7.0	164.96	3.67	19.0	209.80	9.55			
8.0	170.41	4.16	20.0	212.37	10.05			

Superheated Steam:

In superheated steam, the steam density is reduced. An exact determination of the density can only be achieved if the h, s - Moliere diagram is applied.

However, an approximate determination of the steam density can be achieved via the general state equation of ideal gases.

$$\rho = p / (Ri \times T)$$

ρ = steam density in kg/m³

p = steam pressure in N/m² (Pa)

Ri = specific gas constant

(for steam 462 (Nm/(kgK))

T = steam temperature in K

Calculation example:

Asserted: steam pressure p = 10 bara = 10 x 10^5 N/m² (Pa)

steam temperature T = 200 °C

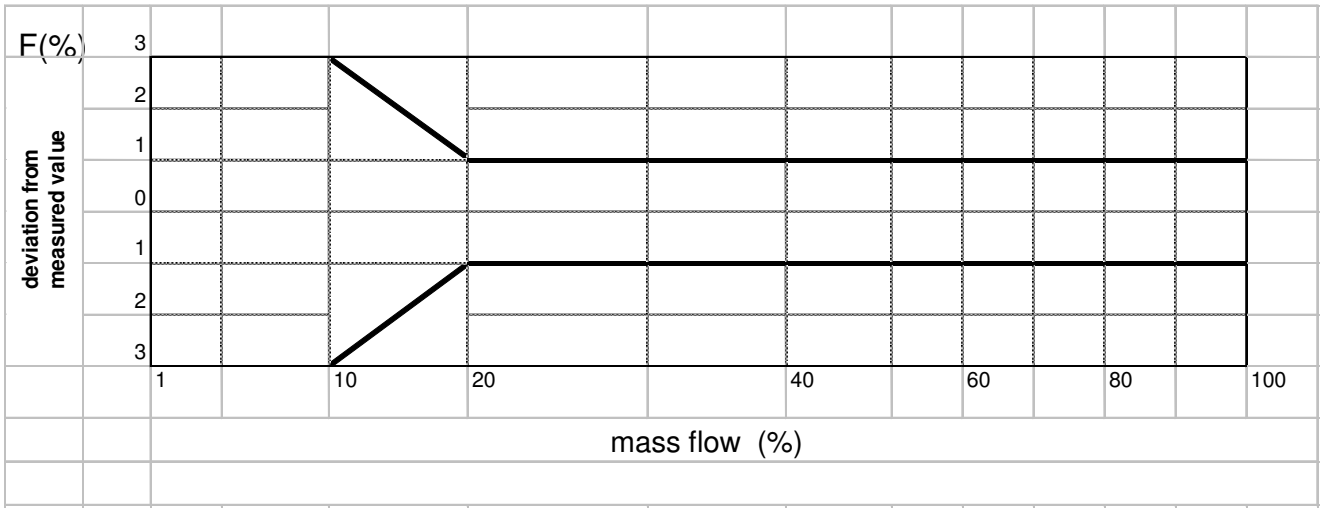
absolute steam temperature T = 200 °C + 273 K = 473 K

Ri = 462 (Nm/(kgK))

steam density ρ = 10 x 10^5 / (462 x 473) = 4,6 kg/m³

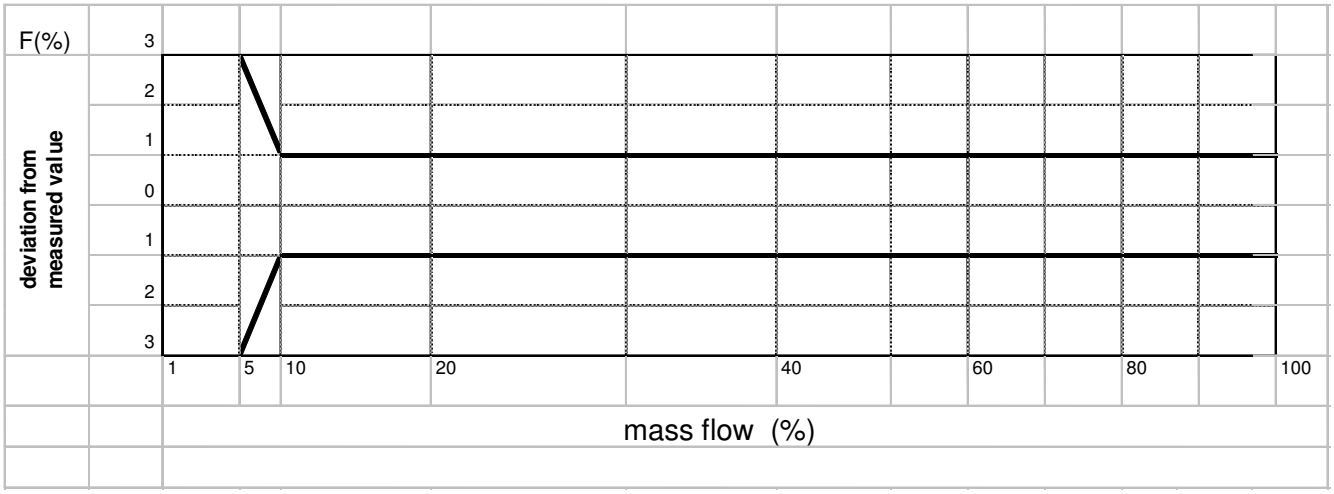
Error limits

Typical measuring incertainty for VMT 100 D without zero-balancing module for wet calibration *



* only valid if ISO 5167 is applied

Typical measuring uncertainty for VMT 100 with zero-balancing module for wet calibration*

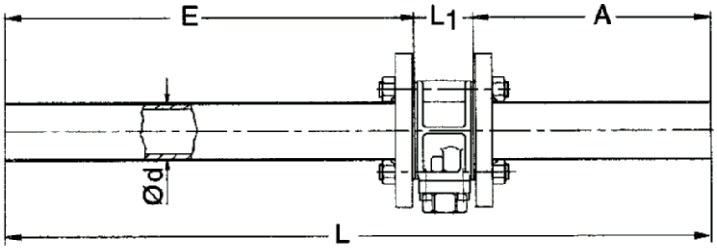


* only valid if ISO 5167 is applied

Inlet and outlet piping sections

For the exact centering of the measuring ring in the pipeline, we recommend the use of METRA centering flanges with inlet and outlet pipe sections including bolts, nuts and gaskets. For pre-installation or pressurizing and flushing of the plant, adapting rings should be used.
If the inlet and outlet pipe sections are not supplied by METRA, please ensure that the internal pipe diameter matches the measuring ring width „d“ exactly. The measuring rings comply with the nominal pressure rate PN 40. Please refer to the table below for the corresponding intermediate flanges.
In case of pipe reductions or extensions please make sure that they are concentric.

Dimensions of inlet and outlet pipe sections



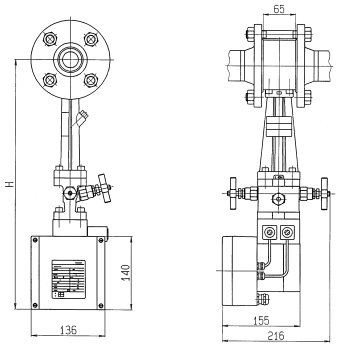
Nominal diameter	Pressure rating
DN 15 to DN 50	PN16, PN25, PN40
DN 65 to DN 125	PN25, PN40

Nominal diameter	DN	15	20	25	32	40	50	65	80	100	125	150	200	250
L	(mm)	500	550	600	700	750	1000	1200	1400	1800	2200	on demand		
E	(mm)	265	300	331	404	437	621	751	891	1151	1421	on demand		
A	(mm)	166	181	200	227	244	310	380	440	580	710	on demand		
Internal diameter d	(mm)	17.3	22.3	28.5	37.2	43.1	54.5	70.3	82.5	107.1	131.7	159.3	206.3	258.8
L_1	(mm)	65 + 2 x 2 mm gasket												
Nominal pressure	PN	40												

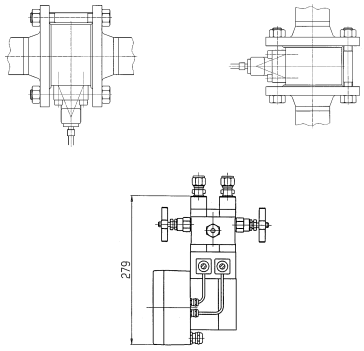
Please note:
The length of the inlet and outlet pipe sections is always dependent on the inlet disturbance and the opening ratio of the orifice plate.
It is urgently required to adhere to ISO 5161-1 up to ISO 5161-4.

Required space VMT 100

Compact version



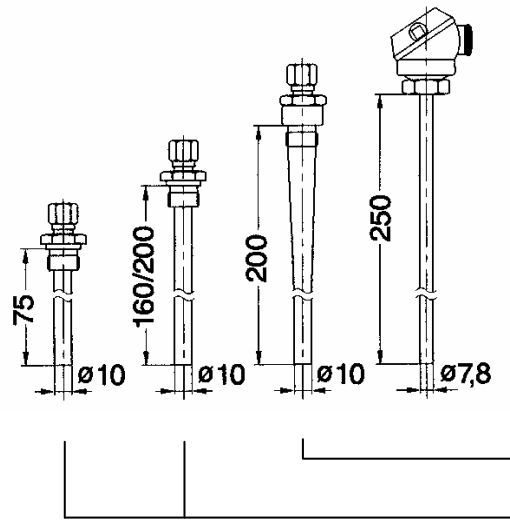
Separate version



Dimensions of compact version

DN	15	20	25	32	40	50	65	80	100	125
H (mm)	465.3	463.6	469.5	475.3	483.8	480	491	499	511.6	525

Temperature sensor with immersion pocket



type 75 fitting G ½“
type 160 fitting G ½“
type 200 fitting G ½“
type 200 welding-type immersion pocket fitting G ½“

Threads according to DIN 2999

Welding-type immersion pocket

Screw-type immersion pocket

Steam Flow Meter “autarkon®“ VMT 100 in Microprocessor Technology

Text for quotations and orders:

Steam mass flow / heat meter “autarkon“
VMT 100 D in microprocessor technology consisting of:
Transducer compact orifice plate DN …, PN …,
nominal flow … kg/h, fluid …,
operating temperature … °C, operating pressure … bara, fitting position vertical / horizontal …
all wetted parts in stainless steel
compact version/separate transducer
Transducer with ceramic measuring cell and temperature decoupling module
DT 310 pressure differential Δp 0 - 100 mbar, (PN 25)
DT 311 pressure differential Δp 0 - 600 mbar, (PN 63)
DT 312 pressure differential Δp 0 - 2000 mbar, (PN 63)
Flow meter for steam VMT 100
Power supply 24 V DC / AC ± 10%
Automatic correction of flow coefficient and expansion factor
Automatic correction of the temperature drifts of the orifice plate as well as the pipeline
Analog output 4 - 20 mA m .... kg/h
Optoelectronic coupler output for mass 5 - 24 V, 10 mA
Optoelectronic coupler output for fault indication 5 - 24 V, 10 mA
Digital output M-Bus interface
test certificate for 3 data points on accredited test stand, basis: water

Additional Equipment

Pt 500 temperature sensor integrated in measuring device (not in contact with medium)
Zero-balancing module for extension of measuring range and accuracy
LC Display 4 lines (for all relevant values)
3-way shut-off valve module with oval adapter and Swagelok fitting ø 12 x 1,5 mm
5-way shut-off valve module with oval adapter and Swagelok fitting ø 12 x 1,5 mm
(only applicable for separate transducer)
Pt 1000 temperature sensor including immersion pocket type 160 (type 75)
Immersion pocket type 200
welding-type immersion pocket type 200 solid material, stainless or creep-resistant steel
sensor connection cable, 4-wire, screened
integrated absolute pressure transducer 0-16 / 25 / 40 bara
Pt 100 temperature sensor including immersion pocket type 160 (type 75)
External absolute pressure transducer 0 - 16 / 25 / 40 bar a
8 digit remote counter, controlled by voltage-free contacts
test certificate for 10 flow data points (basis: water)
inlet and outlet pipe sections with centering flange for measuring ring
centering flange for pre-installation
System test, commissioning and instruction by METRA service personnel

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