⊕ # User's Guide

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Content

1. APPLICATION

Flow meters FMG600 SERIES are primarily used for measuring instantaneous flow rate and volume of water or similar liquids passed through the meter. Flow meters shall only be used in standard non-explosive environments.

Any installation of flow meter must be in conformity with technical conditions mentioned in this manual.

Measurements can be done in both flow directions, with high measurement accuracy over a wide range of flow rates 0.33 to 32.8 ft/s (0.1 to 10 m/s). The minimum required conductivity of the measured medium is 20 µS/cm.

The measurement evaluation electronic unit includes a two-line alphanumeric display to show the measured values where various operational parameters of the meter can be selected by means of an associated keyboard. Available are two passive binary outputs (frequency, pulse and limit values), one active current output and an output to connect a digital communication line. All meter functions and output parameters can be reset during the meter operation.

Should the need arise; the user may combine any sensor of the FMG600 series with any electronic units without re-calibration of the meter on a test stand. The only thing that needs be done is to enter into the electronic unit memory the calibration constants and excitation frequency of the selected sensor; these data are given on the rating plate of the sensor. The value of threshold flow rate shall be set between 0.5 and 1% of the specified maximum flow rate.

2. MEASUREMENT PRINCIPLE

The function of an induction flow meter is based on Faraday's induction law. The meter sensor consists of a non-magnetic and non-conductive tube with two embedded measuring electrodes to pick up the induced voltage. To create an alternating magnetic field, two coils are fitted onto the tube in parallel with the plane defined by the active parts of the measuring electrodes. Now if a conductive liquid flows across magnetic field **B**, voltage **U** will appear on the measuring electrodes proportional to the flow velocity v and the conductor length **l**.

U = B x l x v

  U   induced voltage
  B   magnetic flux density
  l   distance between the measuring electrodes
  v   liquid flow velocity
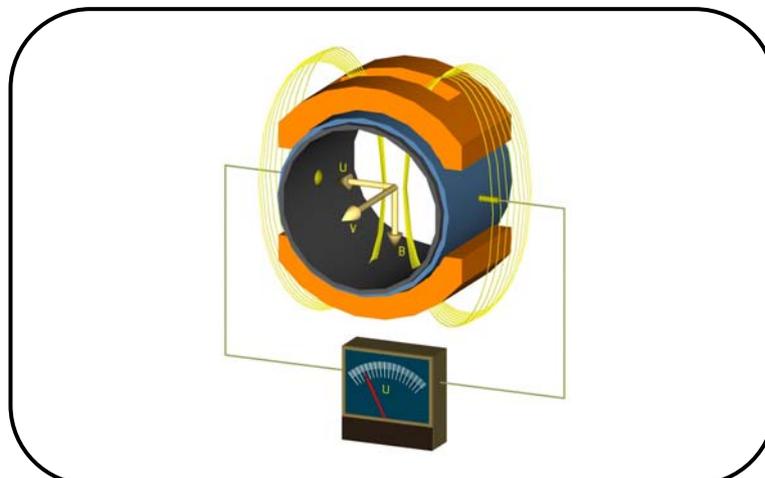
As the magnetic flux density and distance between the electrodes are constant, the induced voltage is proportional to the liquid flow velocity in the tube. The value of the volume flow rate can then be readily determined as a product of the flow velocity and square section of the tube, **Q = v x S.**

3. TECHNICAL DESCRIPTION

3.1. General

The induction flow meter consists of a sensor through which the measured liquid flows and an electronic unit where the low-level signal from the sensor is modified to a standardized form suitable for further processing in various industrial electronic devices. The output signal is proportional to the volume flow rate of the measured liquid. The only factor limiting the application of induction flow meters is the requirement that the measured liquid shall be conductive and non-magnetic. The induction flow meter can be designed either as a compact device or with the sensor separated from the associated electronic unit. In the former case, the electronic unit is fitted directly onto the meter sensor, in the latter case it is connected to the sensor by special cable.

The sensor design shall take into consideration the type of the measured liquid and its operational parameters. To facilitate fitting into the liquid piping, the sensor can be provided with end flanges, threaded, or it maybe of a flangeless design. The supply voltage, types of output signal and communication interface can be selected according to the customer requirements.

The basic configuration of induction flow meter includes two insulated passive binary outputs (each with an opt coupler including a transistor output), insulated RS485 communications, dry relay, 4-20 mA output and the USB communication interface. This USB interface is not insulated as it is used for factory calibration purposes only. Optional accessories to this basic configuration are INPUT1 and OUTPUT3 for batching (all with galvanic separation) –B, empty pipe detection -EPT.

Upon fastening the connecting wires into the respective terminals, make sure to tighten the bolts holding the lid of the electronic unit and seal the cable glands. Fit blinds into the unused gland openings.

3.2. Meter design

3.2.1. Remote version

Flanged sensor connected by a cable with the associated separate electronic unit.
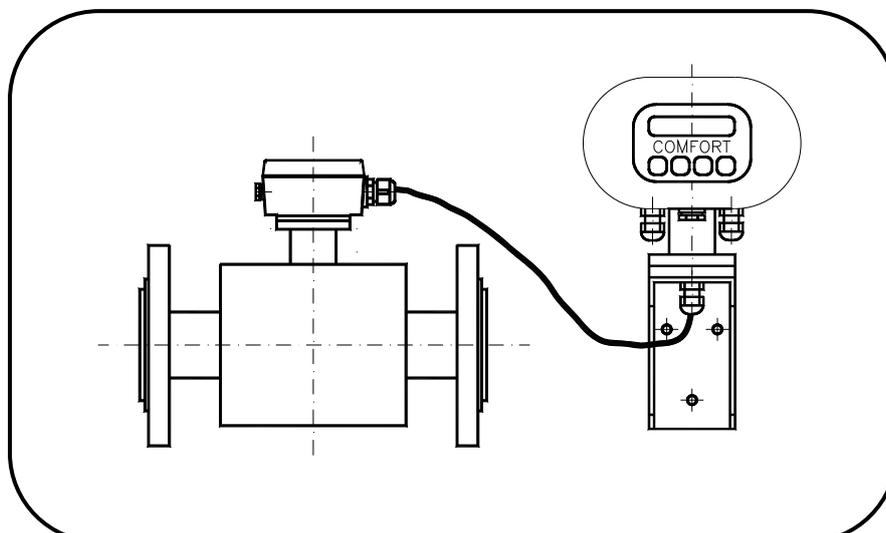
Dimensions of the box to accommodate separate electronic unit and the mounting bracket
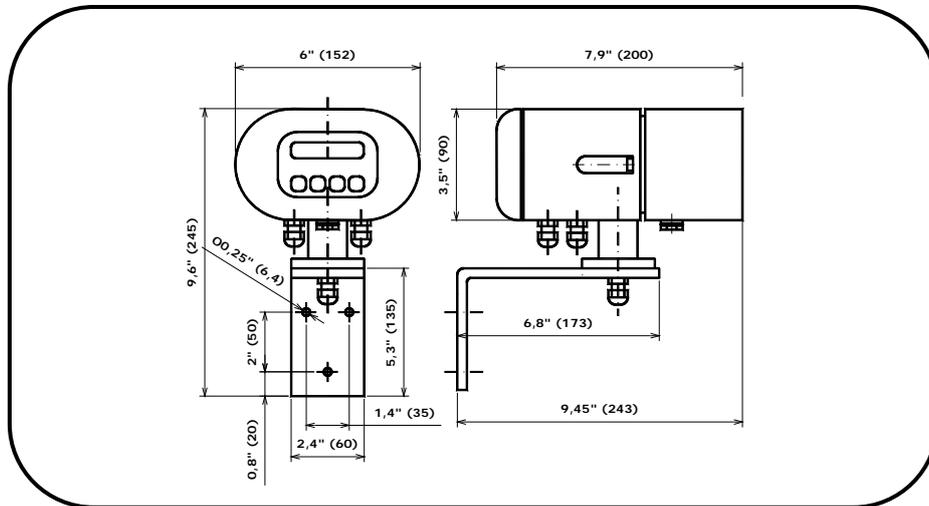
3.2.2. Compact version

Compact design solution for a flanged sensor with associated electronic unit
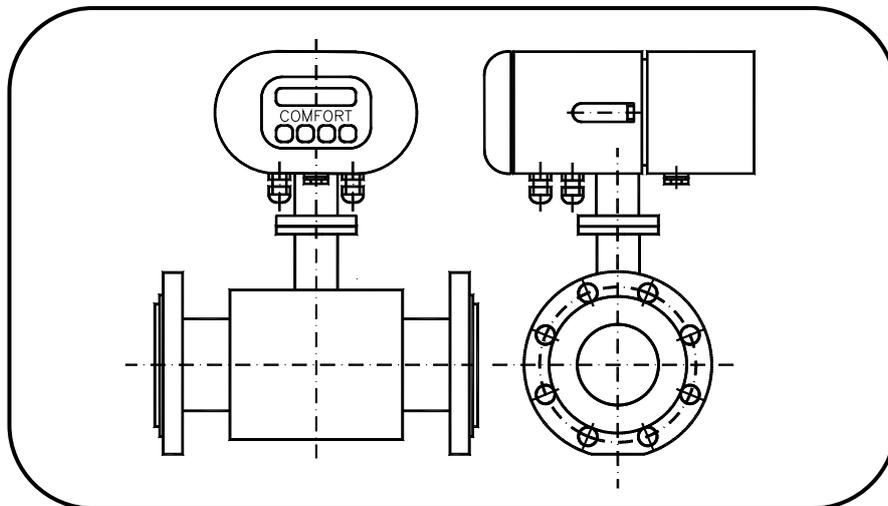
Dimensions of the box to accommodate a compact version of the flow meter
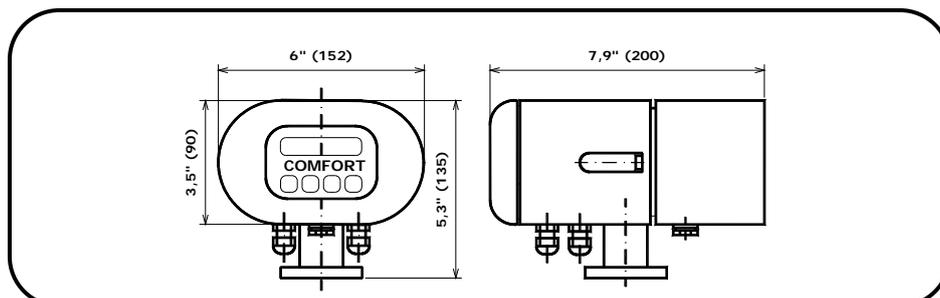
4. TECHNICAL PARAMETERS

4.1. Flow sensor

4.1.1. Selection of correct sensor size

The following table shows minimum and maximum flow rates for various sensor sizes and flow velocities ranging from 0.33 to 32.81 ft/s (0.1 to 10 m/s). The operational flow-velocity range is best to choose 1.64 to 16.40 ft/s (0.5 to 5 m/s), see the diagram below. For lower flow velocities, the measurement accuracy is worse while at higher flow velocities the turbulences at contact edges may cause undesirable interference. Minimum and maximum flow rates for various sensor sizes

DIN	ANSI	GPM		l / s		GPH		m³ / hour	
DN	inches	Qmin	Qmax	Qmin	Qmax	Qmin	Qmax	Qmin	Qmax
15	½	0.29	29	0.018	1.8	17.2	1712	0.065	6.5
20	¾	0.528	52.8	0.0333	3.33	31.7	3167	0.12	12
25	1	0.79	79	0.05	5	47.6	4755	0.18	18
32	1 ¼-	1.32	132	0.0833	8.33	79.3	7925	0.30	30
40	1½	1.98	198	0.125	12.5	118.9	11888	0.45	45
50	2	3.17	317	0.2	20	190	19020	0.72	72
65	2 ½	5.28	528	0.3333	33.33	317	31700	1.2	120
80	3	7.93	793	0.5	50	475.5	47552	1.8	180
100	4	12.33	1233	0.7777	77.77	739.6	73962	2.8	280
125	5	18.93	1893	1.1944	119.44	1136	113594	4.3	430
150	6	28.62	2862	1.8055	180.55	1717	171711	6.5	650
200	8	50.63	5063	3.194	319.4	3038	303764	11.5	1150
250	10	79.25	7925	5	500	4755	475523	18	1800
300	12	111	11100	7	700	6657	665732	25.2	2520

Operational flow rates and flow velocities for various sensor sizes
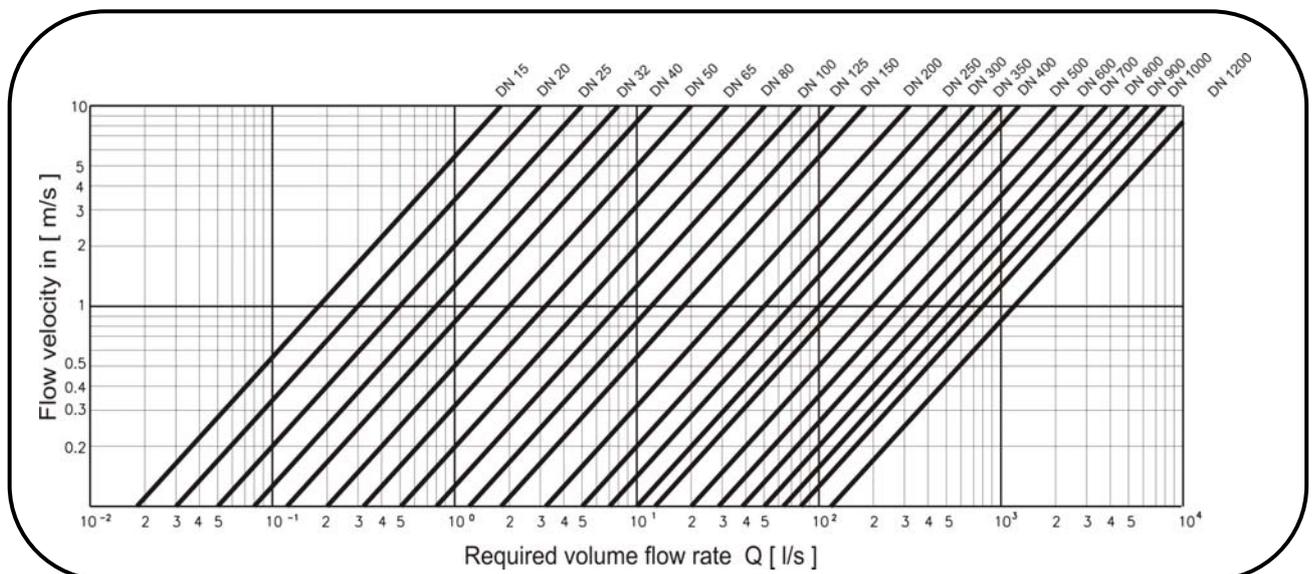
4.1.2. Operational pressure of measured liquid

The standard versions of flow sensors have the following pressure rating:

Sensor size	Pressure rating
DN 15 – DN 300 1/2" and 12"	PN 10 (1.0 MPa) 145 PSI

4.1.3. Selection of electrode material

Standard electrodes made of Hastelloy C4. However, in special applications it may be necessary to select a different material. On request, Omega can supply electrodes made of tantalum -TGE.

4.1.4. Sensor tube lining

Teflon
Teflon (**PTFE**) lining is a universal solution for highly corrosive liquids and temperatures ranging from -4 °F to 302 °F (–20 to +150°C). Typical applications are in the chemical and food processing industries.

4.1.5. Compact or remote meter version?

   Temperature of the liquid is lower than 122 °F (50°C): It is possible to use both, compact or remote version. Using of the version is only question of the layout or customer wish.
   Temperature of the liquid is higher than 122 °F (50°C): Must be used remote version!

To prevent electromagnetic interference via the connecting cable, the sensor and separate electronic unit of the meter in the remote version should be located as close as possible to each other. The maximum cable length depends on the conductivity of the measured liquid (see the following diagram). Standard cable length is 19,7" (6 m). .
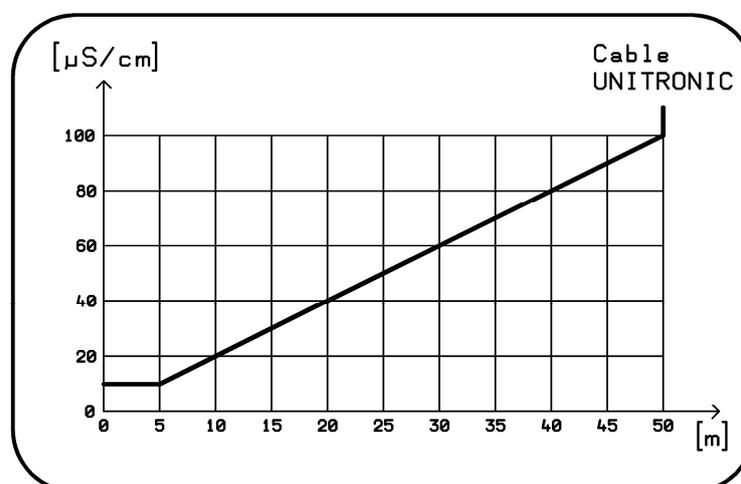
4.1.6. Dimensions of flanged sensor
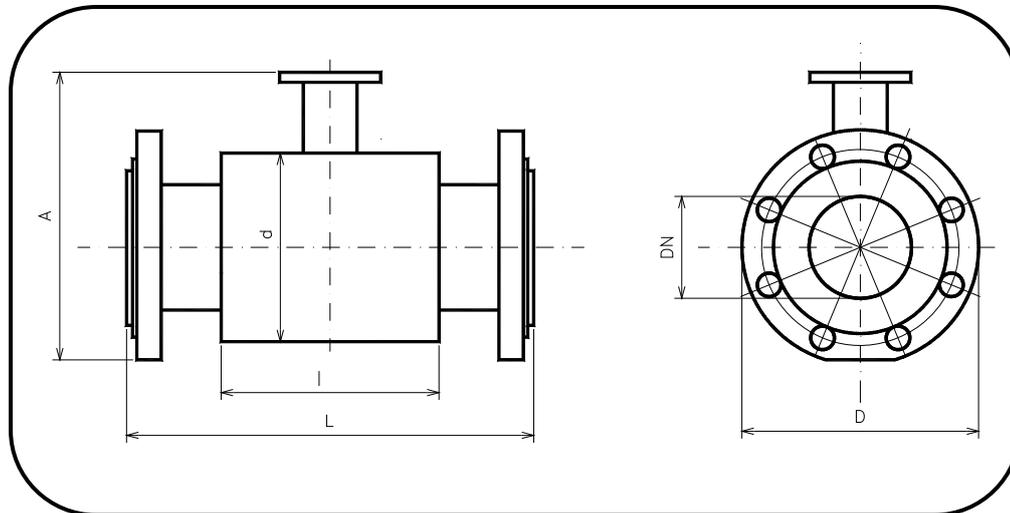
Sensor dimensions for various rated diameters Line size (DN)

Flanges according standard ANSI B 16.5 150 lb/sq.in.

	Nom. size DN	D Inches (mm)	d Inches (mm)	A* Inches (mm)	L Inches (mm)	l Inches (mm)	Weight lb (kg)
PN10	½" (15)	3.5 (89)	2.4 (62)	6.5 (164)	7.9 (200)	2.6 (66)	7 (3)
	¾" (20)	3.9 (99)	2.4 (62)	6.7 (170)	7.9 (200)	2.6 (66)	7 (3)
	1" (25)	4.3 (108)	2.8 (72)	7.1 (180)	7.9 (200)	3.8 (96)	7 (3)
	1 ¼" (32)	4.6 (117)	3.2 (82)	7.8 (199)	7.9 (200)	3.8 (96)	9 (4)
	1 ½" (40)	5.0 (127)	3.6 (92)	8.2 (209)	7.9 (200)	3.8 (96)	9 (4)
	2" (50)	6.0 (152)	4.2 (107)	8.8 (223)	7.9 (200)	3.8 (96)	13 (6)
	2 ½" (65)	7.0 (178)	5.0 (127)	9.6 (244)	7.9 (200)	3.8 (96)	20 (9)
	3" (80)	7.5 (191)	5.6 (142)	10.2 (260)	7.9 (200)	3.8 (96)	31 (14)
	4" (100)	9.0 (229)	6.4 (162)	11.0 (280)	9.8 (250)	3.8 (96)	35 (16)
	5" (125)	10.0 (254)	7.6 (192)	12.2 (310)	9.8 (250)	5.0 (126)	42 (17)
	6" (150)	11.0 (279)	8.6 (218)	13.4 (340)	11.8 (300)	5.0 (126)	55 (26)
	8" (200)	13.5 (343)	10.8 (274)	15.7 (398)	13.8 (350)	8.3 (211)	91 (41)
	10" (250)	16.0 (406)	14.6 (370)	18.9 (480)	17.7 (450)	8.3 (211)	120 (54)
	12" (300)	19.0 (483)	16.5 (420)	21.1 (535)	19.7 (500)	12.6 (320)	170 (77)

* Dimension A (sensor height) is net of the electronic unit box (or terminal box in the remote meter version).
  Weights of the sensors are only approximate.

4.1.7. Dimensions Tri Clover sensor

Tri-Clover

Size DN/OD	ID	GPM		l / s		GPH		m³ / hour	
Inch (mm)	mm	Qmin	Qmax	Qmin	Qmax	Qmin	Qmax	Qmin	Qmax
½ (12.70)	9.40	0.1094	11.0001	0.0069	0.6940	6.564	660.006	0.0248	2.4984
¾ (19.05)	15.75	0.3091	30.8812	0.0195	1.9483	18.546	1852.872	0.0702	7.0139
1 (25.40)	22.1	0.6087	60.8018	0.0384	3.8360	36.522	3648.108	0.1382	13.8096
1 ½ (38.10)	34.8	1.5074	150.7603	0.0951	9.5115	90.444	9045.618	0.3424	34.2414
2 (50.80)	47.5	2.8087	280.8756	0.1772	17.7205	168.522	16852.536	0.6379	63.7938
2 ½ (63.50)	60.2	4.5110	451.1493	0.2846	28.4631	270.660	27068.958	1.0246	102.4672

OD Outer Diameter
ID Inner Diameter
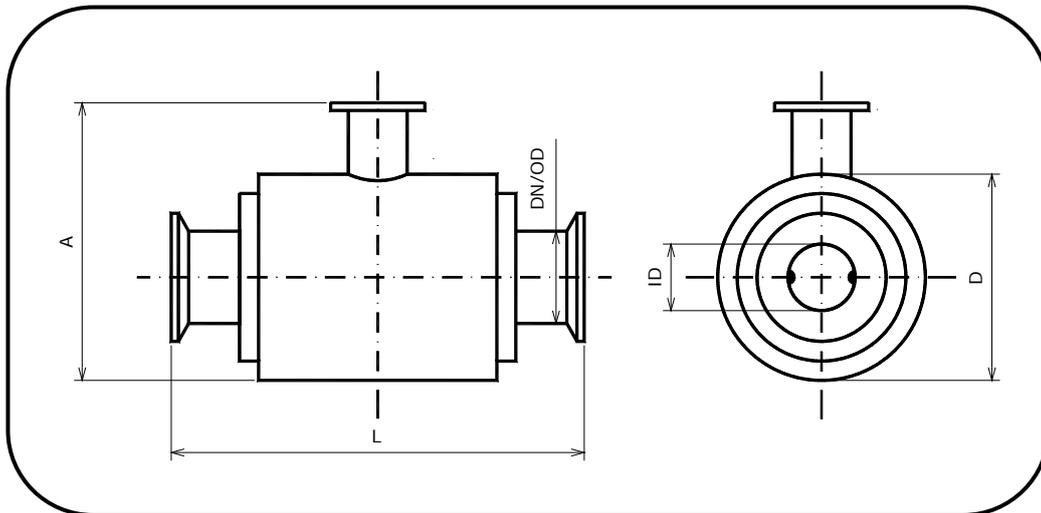
Sensor dimensions for various rated diameters Line size (DN)

Flanges according Tri Clover
OD Outer Diameter
ID Inner Diameter

	Size DN/OD	ID	D	A*	L	Weight
	Inches (mm)	inches (mm)	Inches (mm)	Inches (mm)	Inches (mm)	lb (kg)
PN10	½" (12.70)	0,37 (9.40)	2.9 (74)	5.6 (143)	5.4 (137)	3.5 (1.6)
	¾" (19.05)	0,62 (15.75)	2.9 (74)	5.6 (143)	5.4 (137)	3.5 (1.6)
	1" (25.40)	0,87 (22.1)	2.9 (74)	5.6 (143)	5.4 (137)	3.7 (1.7)
	1 ½" (38.10)	1,37 (34.8)	3.7 (94)	6.4 (163)	5.4 (137)	4.8 (4.8)
	2" (50.80)	1,87 (47.5)	4.1 (104)	6.8 (173)	5.4 (137)	()
	2 ½" (63.50)	2,37 (60.2)	5.1 (129)	7.8 (199)	7.6 (192)	()

* Dimension A (sensor height) is net of the electronic unit box (or terminal box in the distributed meter version).
  Weights of the sensors are only approximate.

4.1.8. Flow sensor specifications

Sensor size	Flanged sensors, ½ " to 12 " (DN 15 to DN 300) Tri Clover, ½ " to 2 ½ "
Operational pressure	PN 10 (1.0 MPa) for DN 15 to 300, Tri Clover
Mechanical connection	Flanges acc. to 150# ANSI B Tri Clover
grounding	On flanges Grounding rings grounding electrode
Limit flow velocities of measured liquid	From 0.33 to 32.81 ft/s (0.1 m/s to 10 m/s)
Maximum temperature of measured liquid	up to 302 ºF (150 ºC)
Minimum conductivity of measured liquid	20 µS/cm
Empty pipe alarm	Optional from 2 " (DN 50) -EPT
Lining	Teflon (PTFE)
Measuring electrodes	Hastelloy C4 standard Platinum/gold -GGE Tantalum –TGE
Protection class	IP 67
Storage temperature	14 to 158 ºF (-10 ºC to +70 ºC) at max. relative air humidity 70%

4.2. Electronic unit box

The signal-processing electronic unit is accommodated in a cast aluminum box coated on the surface with paint of hue RAL 1017. The box is held by four M5 bolts with hexagonal socket heads. Upon loosening the bolts slightly the box can be rotated around horizontal axis through ±180°. At the rear of the box is a terminal board under a lid held in position by six bolts with hexagonal socket heads. At the rear bottom part of the box there are cable glands and a special valve preventing condensation of the air humidity inside the box. The unused gland openings shall be blinded. The front panel of the box is fitted with a two-line background-illuminated display unit and a four-button membrane keyboard.

Prior to putting the meter in service, check the correct sealing of all active glands, blinding of the unused ones and tightening of the bolts holding the terminal board lid.

4.2.1. Electronic unit specifications

Power source	230 V~ (+10 % / -15 %) / 50 ÷ 60 Hz optional 115 V~ (+10 % / -15 %) / 50 ÷ 60 Hz optional 24 V~ (+10 % / -15 %) / 50 ÷ 60 Hz optional 24 V = (±10 %) Standard
Power consumption	15 VA
Line fuse	T250 mA, T2,0 A (with power supply 24 V)
Electric shock protection according to standard CSN 332000-4-41	Automated disconnection from power source in TN-S network
Box material	Aluminum casting
Weight	6.6 lb (3.0 kg)
Ambient temperature	23 to 131 ºF (-5 °C to 55 °C) (protected from direct sun light)
Storage temperature	14 to 158 ºF (-10 °C to 70 °C) at relative air humidity not exceeding 70 %
Flow velocity range	0.33 to 32.8 ft/s (0.1 to 10 m/s)
Maximum flow error	0.2 % for 10 to 100 % Qmax 0.5 % for 5 to 100 % Qmax
Zero adjustment	Standard
Output 1 - passive output, insulated Output 2 - passive output, insulated Relay output Active current output, insulated	Binary multi-function optocoupler 30 V/50 mA Binary multi-function optocoupler 30 V/50 mA Binary multi-function relay 30V DC /0,3 A, Analog 0 (4) to 20 mA, max. Load 1000 Ohm
Serial communication ports	USB (not insulated) for factory calibration only RS 485 (insulated)
Protection class	IP 67

5. METER APPLICATION RULES

5.1. Sensor placement in piping

No chemical injection or batching unit (such as chlorine compound injector) should be located at the input side of the sensor. The insufficient homogeneity of the flowing liquid may affect the flow-rate values indicated by the meter.

The meter performance will be the best if the liquid flow in the piping is well stabilized; therefore it is necessary to observe specific rules for the sensor placement in piping. In the contact planes between the sensor and the adjoining piping sections should be no edges as these would cause flow turbulence. Make sure that straight piping sections are provided before and after the sensor; their required length is proportional to the inner diameter of the piping concerned.

If more than one flow-disturbing element such as pipe bend or fitting is located near the sensor, the required length of straight piping section on the sensor side concerned should be multiplied by the quantity of such elements.

In the cases of bi-directional flow-rate measurement, the same conditions concerning flow stability shall be met at the input and output sides of the sensor.
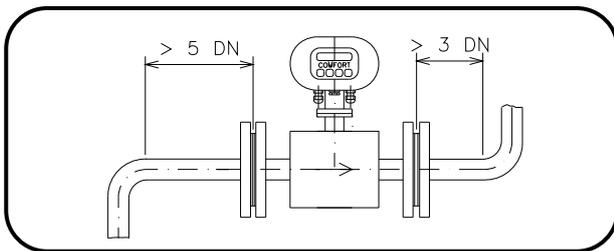
Required straight piping sections
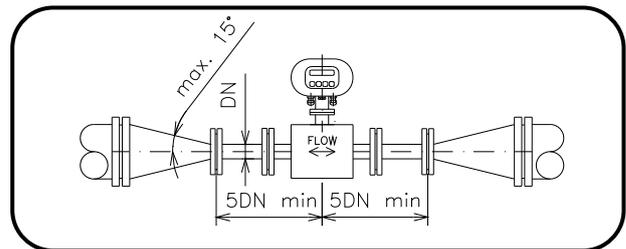
Pipe narrowing

.
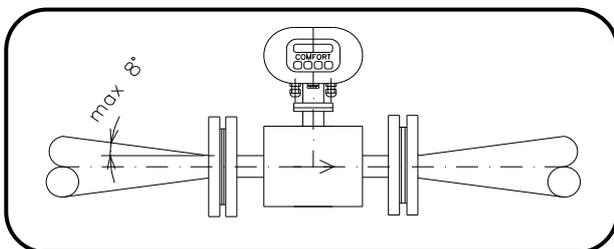
In the case where the pipeline nominal size is bigger than nominal size of flow meter, it is necessary to use conical reduction with the maximum slope 15°. In the case of bi-directional flow, conical reduction must be installed on both sides, both with minimum straight piping 5 DN. In the case of horizontal installation, eccentric reduction must be use to prevent bubbling.

Pipe narrowing sections with angles not exceeding 8° can be taken for straight sections (see picture above)

In the cases where the liquid is pumped, the flow sensor shall always be placed at the output side of the pump to prevent underpressure in the piping which might damage the sensor. The required length of the straight piping section between the pump and sensor is then at least 25 DN.
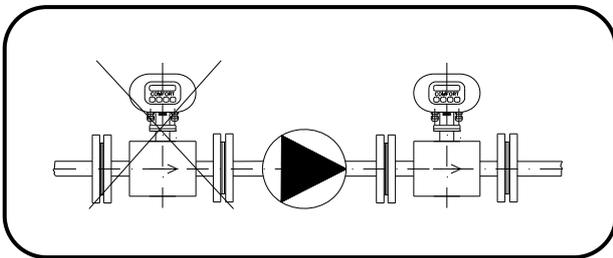
Pump in the piping
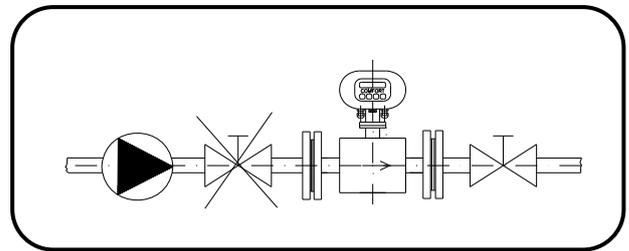
Closing valve in the piping

For the same reason, the sensor shall be always placed before the closing valve in the piping.

The sensor can be fitted in the piping in either horizontal or vertical position. However, make sure that the electrode axis is always horizontal and, if the sensor is mounted in a horizontal position, the flange section for attachment of the electronic unit box faces upwards.
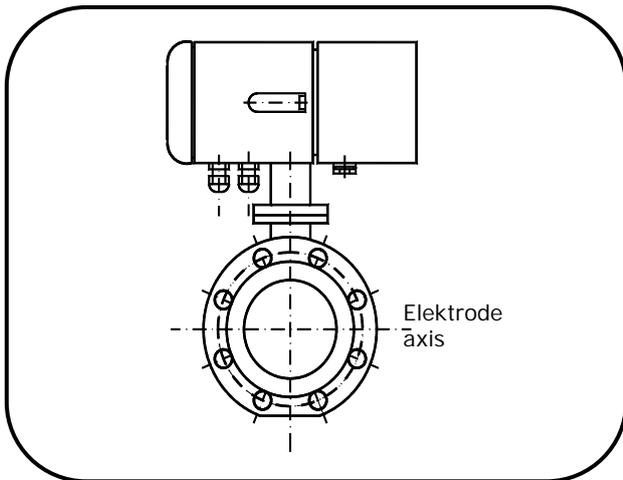
Electrode axis
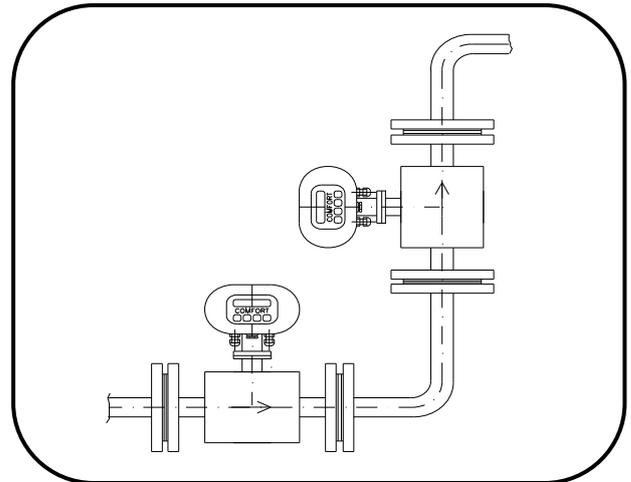
Sensor mounted in a vertical position

In the cases where the sensor is mounted in a vertical position, the flow direction shall always be upwards.
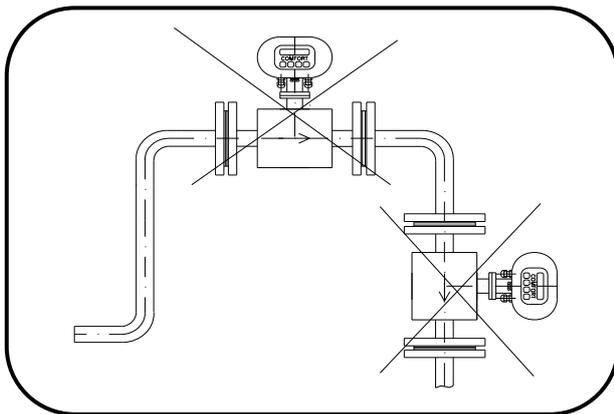
Risk of liquid aeration
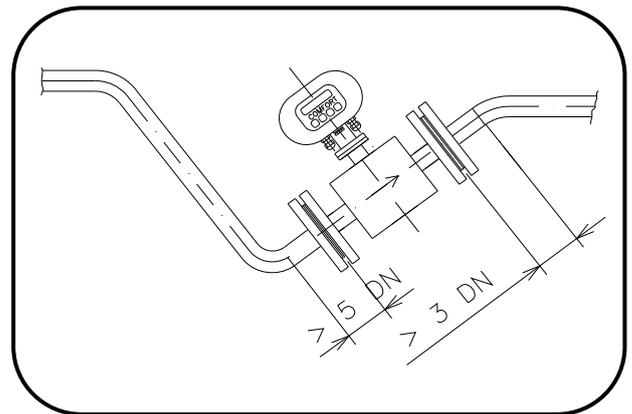
Permanent flooding of sensor

To ensure correct meter function at all times, the measured liquid shall completely fill up the sensor and no air bubbles shall be permitted to accumulate or develop in the sensor tube. Therefore the sensor shall never be placed in the upper pocket of the piping or in a vertical piping section where the flow direction is downwards.

In piping systems where complete flooding of the piping cannot always be guaranteed, consider placing the sensor in a bottom pocket where full flooding is sure.

If the sensor is located near a free discharge point, such point shall be by at least 2 DN higher than the top part of the sensor.
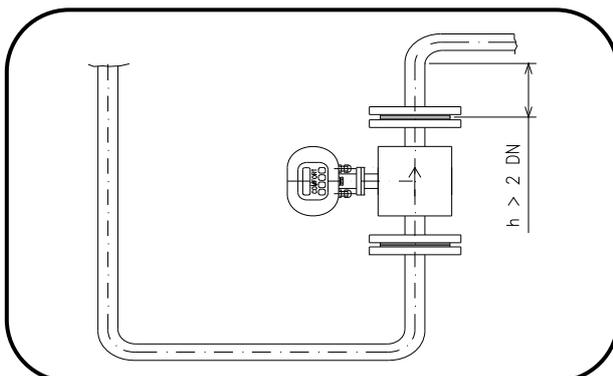
Sensor placement near free discharge point

Make sure that the adjoining piping is clamped/supported as close to the sensor as possible, to prevent vibrations and damage to the sensor.
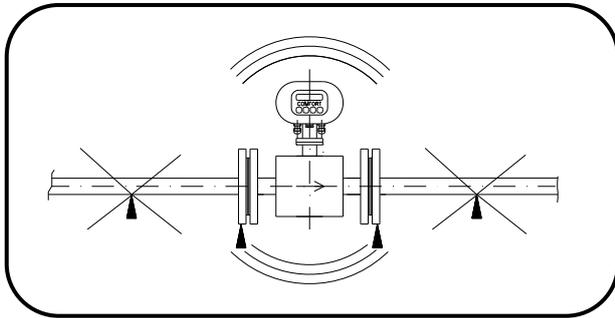
Undesirable sensor vibrations
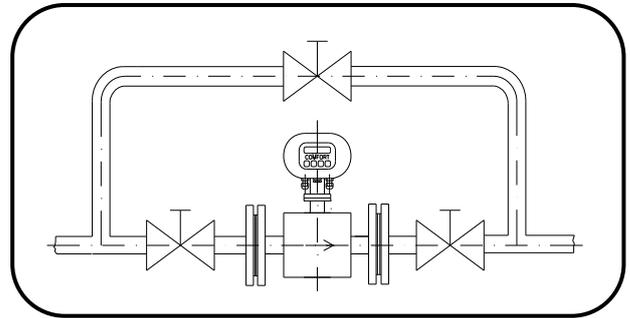
Sensor bypass

In applications where continuous liquid flow is essential, a bypass shall be provided to allow for sensor servicing. A sensor bypass may be also reasonable solution in the cases where, to dismantle the flow sensor from the piping, liquid from a very long piping section would have to be discharged.

5.2. Sensor earthing

The correct meter function requires that the sensor and adjoining piping sections be connected by low-impedance earthing conductors to the earth potential and the protection conductor of the power source. The overall arrangement shall be such that the potentials of the measured liquid at the sensor input and output sides are close to the ground.

5.2.1. Flanged version

With a flanged sensor installed in conductive piping, the flanges shall be electrically connected and the piping put to the earth.
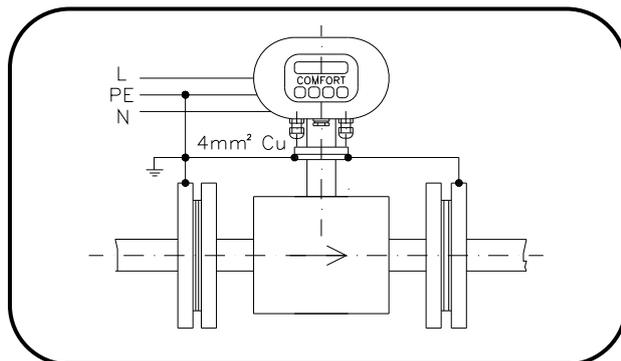
Flange earthing connection
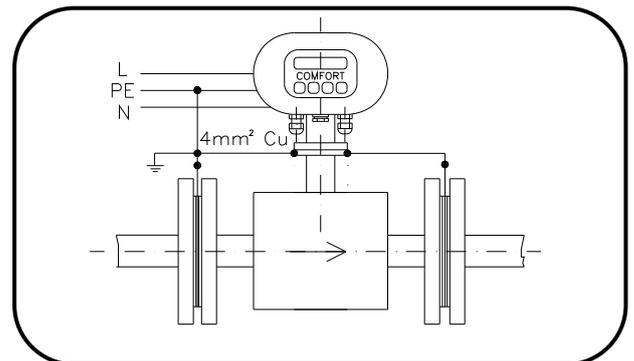
Earthing rings

Should the adjoining piping sections be non-conductive, grounding rings or similar arrangement shall be used to ensure that the electric potential of the measured liquid is put to the earth.

With a remote version, it is recommended to electrically connect flow sensor with electronics housing box with conductors AWG10 or AWG12 to assure stabilization of the electric potentials.

5.2.2 Tri Clover
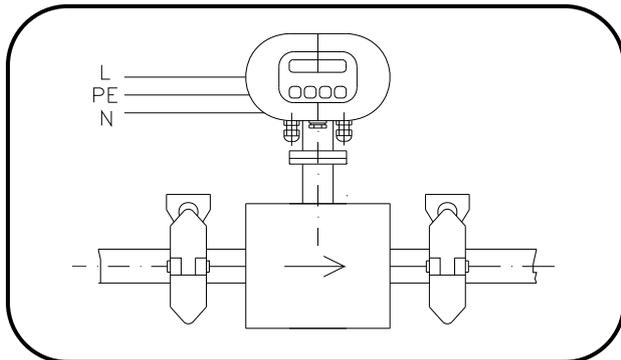
Tri Clover Flange earthing connection   Additional earthing
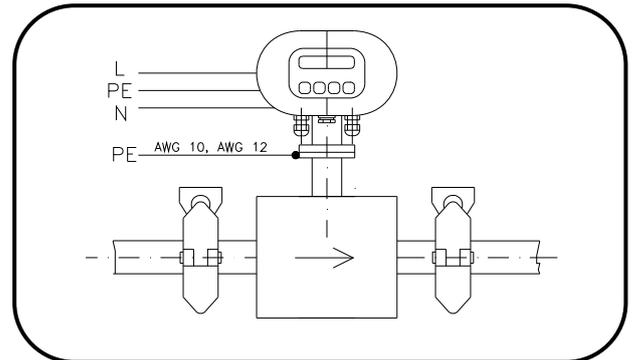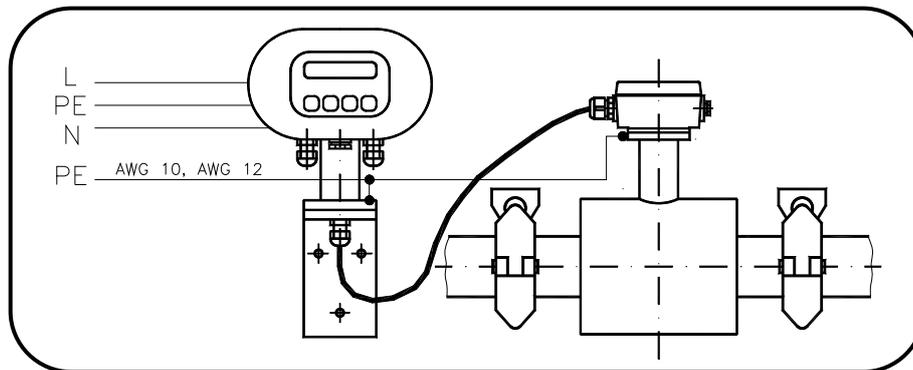
With a remote version, it is recommended to electrically connect flow sensor with electronics housing box with conductors AWG10 or AWG12 to assure stabilization of the electric potentials.

6. FLOW METER INSTALLATION AND OPERATIONAL START

The meter installation work shall be performed in strict observance of the procedures and rules described in this manual.

To prevent undesirable interference, the power cables shall be laid at least 10" (25 cm) away from all signal cables. The signal cables include the cable connecting the sensor and the associated electronic unit (in the case of a remote meter version), signal output cables and the cable of the RS 485 communication line. All cables shall be laid outside the thermal insulation layer on the piping. Only shielded conductors shall be used to connect the output signals and the RS 485 line where the shielding shall be connected to the ground potential only on the side of the control system.
In applications where high levels of electromagnetic field interference at the measuring location can be expected (e.g. in the vicinity of power frequency converters), the remote meter version should be avoided. In these cases it is also recommended to include a filter in the power supply line to the electronic unit.

Filter specification: The filter suppresses spread of the undesirable high frequency disturbances from power supply cable into the flow meter. It is possible to find standard product of any filter producer. Use filter with desired protection, or install filter inside of the box with protection. Filter should be as near to the converter, as possible. Keep all security standards.

Operating voltage:	115 V/60 Hz (250V/50Hz)
Nominal current:	0,5A and more
Losses:	10 kHz 10 to 20 dB
	10MHz 40dB

6.1. Sensor installation

The measurement point chosen for the sensor installation should ensure that the internal part of the sensor is fully flooded with the measured liquid at all times. Any, if partial, emptying or aeration of sensor in operation shall be avoided. If the sensor is mounted in vertical position, the only permitted liquid flow direction is upwards. No thermal insulation shall be used on the sensor body.

Sensor must never be under thermal insulation. If flow meter is installed in the pipeline with thermal insulation, this insulation must be interrupted and sensor must be out of the insulation.

The internal diameters of the piping, connecting flanges and the sensor tube shall be identical. The flange faces shall be perpendicular to the piping. The input and output piping sections including seals shall be perfectly aligned, with no protruding edges. In the case of a non-conductive piping, use grounding rings on both sides of the sensor.

The arrow on the sensor body shall indicate the liquid flow direction (positive flow direction).

Upon loosening the four bolts holding the electronic unit box in position on the sensor, the box can be rotated through ±180°. The same system for the box rotation can be used if the box is mounted on a bracket attached to a vertical support plate or wall.

Do not expose the electronics box to straight sunshine, for outdoor installation use cove or shield - it is not in the normal scope of supply.

6.2. Electric connections of induction flow meter

The terminals for connecting cables can be accessed upon removal of a cover at the rear part of the box housing the electronic unit. The cover is held by six socket-head bolts. A schematic diagram of the connections is shown on the rear side of the cover. Note: USB is for factory calibration only.
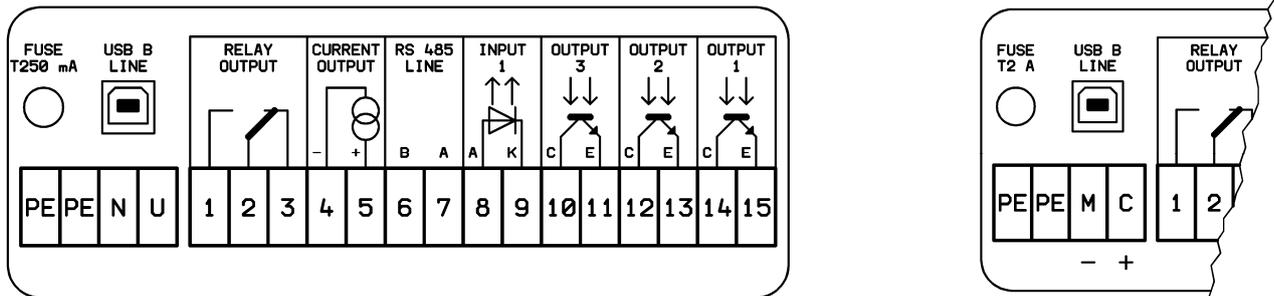
Examples of labels showing power supply (line voltage or 24VDC source) and meter signal interconnection

6.2.1. Connection to power source

Terminal	24V 115V 230V/AC/50 ÷ 60 Hz
PE	PE grounding conductor
N	N neutral conductor
U	L phase conductor

Terminal	24V/DC
PE	PE grounding conductor
M	M middle conductor
C	L+ +24 V

To connect the power source, use a standard cable of three conductors of square section, not exceeding 3 x AWG 16 (1,5 mm^2). For ambient temperatures over 122 ºF (50 ºC), use a cable with rated operating temperature of at least 194 ºF (90 ºC). Only cables with outer diameters from 0.16" to 0.31"(4 to 8 mm) can be used with grommet. Using of other diameters of cables cause breaking of protection IP67.

The earthing conductor shall be longer than the phase and neutral conductors. This is a safety requirement as in the case of loosening the cable clamping in the gland, the earthing conductor shall be the last to be disconnected from the terminal.

The power supply line shall be protected by an overcurrent circuit breaker. A seal should be applied on the breaker to prevent unauthorised handling. The electronic unit has no independent power switch.. The recommended rating of the overcurrent circuit breaker is 4 to 6 A.

6.2.2. Output signal connections

Terminal	Polarity	Function	Comments
1	Switching contact	Change-over contact	Optocoupler contacts.
2	Central contact	Output relay	0,3 A, 30 VDC
3	Break contact		
4	- pole	Current output	Active output, loading Rz max. 1000 Ω.
5	+ pole		No external power source needed.
6	Conductor B (-)	RS 485	To be directly connected
7	Conductor A (+)		to the communication line.
8	Anode (+)	Dosing (optional)	
9	Cathode (-)	Binary input 1	Passive input. 5 VDC, 10 mA.
10	Optocoupler. collector (+)	Dosing (optional)	Passive output, requires external power
11	Optocoupler emitter (-)	Binary output 3	source and loading resistor..
12	Optocoupler collector (+)	Binary output 2	Passive output, requires external power
13	Optocoupler emitter (-)		source and loading resistor.
14	Optocoupler collector (+)	Binary output 1	Passive output, requires external power
15	Optocoupler collector (-)		source and loading resistor.

The output terminals can be connected to other electronic equipment using standard shielded signal cables.

For connecting between output terminal and other device can be used shielded data cable with diameter 0.12 to 0.26 " (3 to 6,5 mm) and intersection AWG 20 to AWG 16 (0,5 to 1,5 mm^2). For connection of output signals and communication is necessary to use shielded cables. Shielding must be connected only on one side of the control system.

After finishing connection, screw up all screws of covers and ensure that it is fixed well. Plug up all unused grommets and check, that used grommets are tight.

6.3. Connection between sensor and electronic unit (remote version)

In a compact version of the meter, this connection is internal. With a remote meter version, the electronic unit shall be connected to the associated sensor be means of a special cable supplied attached on the electronic unit side. On the sensor side, connect the cable wires paying attention to the wire insulation colors and the terminal identification labels.

Special cable UNITRONIC Cy PiDy 3x2x0.25 length up to 50m, temperature up to 70°C:

Brown BN	A
Blue BU	B
White WH	C
Green GN	D
Yellow YE	E
Yellow and green GNYE	Shielding
Pink PK	W2
Gray GY	W1

6.4. Connection between sensor and electronic unit (remote meter version, protection class IP 68)

In the IP 68 version of the flow sensor, the terminal box is sealed by cast plastic and the connecting cable is fixed on the sensor side. On the electronic unit side, the cable is provided with a screw-on connector with its mating part mounted on the electronic unit bracket. To prevent unauthorised handling, this connector can be sealed. The hole for the seal wire is provided in the bracket.

6.5. Operational start

6.5.1 Operational start

The induction flow meter of either compact or remote design shall first be fitted mechanically and then the power supply and output terminals interconnected. Then switch on the power voltage. For a short while, the meter display will read WELCOME TO OMEGA FMG600 SERIES. Then one of the items of the DISPLAYED DATA menu will appear.

6.5.2. Operational data

The meter includes a two-line alpha-numeric display of 2 x 16 characters with a background illumination. The display illumination function works in a power-saving mode where the illumination is automatically switched off 120 seconds following the last push-button action. On depressing any push-button, the display background illumination is reactivated.

The keyboard includes four push-button provided with the following symbols:
1. Push-button ⊙ , the "roller" push-button, direction downwards
2. Push-button ⊟ , movement upwards, in the direction of the arrow
3. Push-button ⊡ , password entry push-button
4. Push-button ⊡ , also referred to as the "enter" push-button

The meter display makes possible reading of up to nine different types of data. To switch to the desired type of data, use pushbuttons ⊙ (direction downwards) and ⊟ (direction upwards).

To display temporary data, depress push-button ⊡. Depress push-button ⊡ again to return to the total data display mode.

1. Flow rate
Average flow rate determined from the specified number of samples.

```
┌─────────────────────┐
│ Flowrate            │
│  120.678   m3/h     │
└─────────────────────┘
```

Display reading: Flow rate

2. Total volume +
The total volume of the measured fluid passed through the meter sensor in the direction of the arrow on the sensor body since the measurement start, or the temporary volume, i.e. the volume of fluid passed since the last resetting of the temporary volume + data.
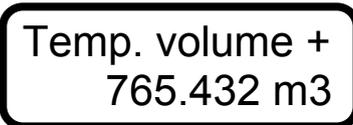
```
┌─────────────────────┐        ┌─────────────────────┐
│ Total volume +      │        │ Temp. volume +      │
│    1234.567 m3      │        │    765.432 m3       │
└─────────────────────┘        └─────────────────────┘
```

Display reading: Total volume +

3. Total volume -
The total volume of the measured fluid passed in the direction against the arrow on the sensor body since the measurement started, or the temporary volume since the last resetting of the temporary volume – data.

```
┌─────────────────────┐        ┌─────────────────────┐
│ Total volume -      │        │ Temp. volume -      │
│     123.456 m3      │        │    65.321 m3        │
└─────────────────────┘        └─────────────────────┘
```

Display reading: Total volume –

4. Total difference

The difference between fluid volumes passed in the positive (+) and negative (-) directions since the measurement start, or temporary difference from the last resetting of the temporary difference data.

```
Total difference
  1111.111 m3
```

```
Temp.difference
  700.111 m3
```

Display reading: Total difference

5. Operational time

The length of the time period, in hours and minutes, counted from the first meter start, or the length of the temporary time period measured since the last resetting of the temporary time data.

```
Operational time
 12345:55  h:m
```

```
Temporary time
  543:21  h:m
```

Display reading: Operational time

Upon switching off the induction flow meter, the data readings under items 3, 4, 5 and 6 are stored at the EEPROM unit and restored upon each new meter start.

6. Percentage flow rate

Flow rate information in the form of a horizontal bar whose length corresponds to the flow rate value in per cent of a selected 100% value (need not necessarily be the same as the maximum flow rate for the given sensor). The figure on the right side offers the digital form of the same information. The minus sign before the figure indicates negative flow data.

```
Percent.flowrate
❚❚_____ - 20%
```

Display reading: Per cent flow rate

7. Last error

Abbreviated text of the last error message.

```
Last error
7:sensor discon.
```

```
Last error
E-007 015/015
```

Display reading: Last error

In the case of a meter error, the display will immediately show a message including a short description of the error concerned. Upon depressing push-button 🕙 , the meter will return to the data display mode, while the abbreviated error message and error code are stored in the "previous errors" register. While an error is indicated, the measurement functions continue undisturbed. In the cases of errors E6 and E7, zero flow rate is indicated throughout the error condition duration.

The user may review earlier error codes and messages up to 255 previous error messages stored in the error register. To access this function, depress push-button 🕙 (previous error display). In the data format E-XXX YYY/ZZZ are: XXX the error code, YYY error ordinal number, and ZZZ the total number of error codes stored in the register. To page in the list use push-button 🕙 . To return to the data display mode, depress push-button 🕙 . Error register is reset with switching power on.

The error messages are:
E0: No error.
E1: Error in CRC EEPROM. Incorrect data check sum in the EEPROM unit. This error may occur when the processor, following a power failure, does not manage to store all data in the EEPROM unit.
E2: OUT1 (multi-functional output) is in the impulse mode of operation and the memory block storing the unsent impulses overflows.
E3: OUT2 (multi-functional output) is in the impulse mode of operation and the memory block storing the unsent impulses overflows.
E4: Multifunctional output RELAY is set for pulse output and there is memory of pulses overflow.
E5: WDOG: the processor reset due to the overflow condition in the timer controlling the length of the programming loop.
E6: Not fully flooded piping.
E7: Open current loop in the impulse generation circuitry of the meter sensor.
E8: Error in +5 V power line.
E9: Error in +24 V power line.
E10: Error in -5 V power line.
E11: Actual flow rate exceeded the selected Imax value.
E12: Failure in frame receipt confirmation while communicating via the RS 232 serial line.
E13: Not processed

Error indication mode enabled: error information is displayed and entered into the error register. Some errors result in setting the indicated flow rate at zero.
Error indication mode disabled: the error information is entered into the error register.

8. Dosing
Dosing is visible and functional provided this data display mode has been selected.
The selected fluid volume (dose) will wait for the active initiation signal to be brought to terminals 8-9. As soon as such signal is received, a count towards zero will commence. Upon reaching zero, OUT3 will close. The dosing action can be repeated by depressing push-button ⏎. To interrupt dosing, use push-button ⏎. To set the required dose, follow the respective procedure in the programming menu.

```
 Dosing   mode
500.00          l
```
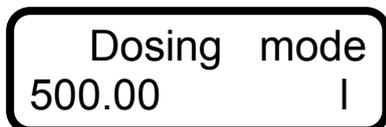
Display reading: Dosing mode

6.5.3.1. Display formats of aggregate values

If the displayed value occupies more than 11 digit places including the decimal point, the calculated value will be displayed alternately with the selected measurement unit.

6.5.3.2. Data reset

The user is not permitted to reset the aggregate data values under items 3, 4, 5 or 6. Resetting is only possible with running ("temporary") values associated with items 3, 4 5 and 6 accessible via push-button ⏎ (another depression of push-button ⏎ , will return the display to the total value display mode). When a temporary value is displayed, depress push-button ⏰ to discontinue the temporary value mode, and depress push-button ⏎ to reset the temporary value. By depressing any of push-buttons ⏰ ⊟ ⬆ and after that push-button ⏎ , return to the total value display mode. If you stop the temporary mode and wish not to reset the temporary value, depress any of push-buttons ⊟ ⬆ , whereby the count continues. To return to the total value mode, depress push-button ⏎ . This procedure will reset the edited temporary value only, the other temporary values will be unaffected.

7. PROGRAMMING

The induction flow meter can be programmed in two ways: using a computer connected to the serial meter interface, or using its own keyboard. The following description concerns the keyboard (push-button) programming procedures.

The keyboard includes four push-buttons provided with the following symbols:
1. Push-button ⊙ , the "roller" push-button, direction downwards;
2. Push-button ⊟ , movement to the right in the direction of the arrow, direction upwards;
3. Push-button ⊡ , password entry push-button, movement upwards in the direction of the arrow, movement back in the menu;
4. Push-button ⊡ , also referred to as the "enter" push-button (command confirmation).

In any menu, the selected item is on the first line with the first character blinking.

Entry the programming mode, movement within a menu and data saving

To enter the programming mode, depress push-button ⊡ and then ⊡ . The programming mode is protected against unauthorized action by a password (a four-digit number) that needs be entered before accessing the basic programming menu. Upon delivery, from the manufacturing plant, every new meter has a password of 0000.

```
  Password
0000_
```
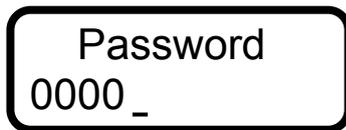
Display reading: Password

With a new meter, enter password 0000 and confirm by push-button ⊡ . Provided you have already chosen your own password, enter the same and confirm by depressing push-button ⊡ . Prior to leaving the programming mode, the password can be changed without any limitation.

Use the push-button ⊟ to move the cursor to the right. Upon reaching the extreme right position, the cursor will return to the left side of the line. The cursor is a short horizontal line to be placed under the character we wish to edit/change.

Use the push-button ⊡ to change the selected character in the direction upwards, or push-button ⊙ in the direction downwards. Upon reaching the last character in the character series available, the first eligible character will reappear.

Upon completing the editing action, confirm your choice by push-button ⊡ . Should you enter an incorrect password, the display will read "Incorrect password Try again" while the program will return to the data display mode.

```
  Password OK
Press any key
```
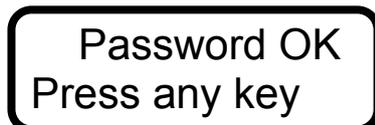
Display reading: confirmation of correct password entry: Password OK. Press any key.

With the display reading "Password OK Press any key", depress any push-button (preferably ⊡) to enter the basic programming menu.

The two-line display will always show two of the following basic menu options:

Displayed data
Samples
Analog output
Output function
Electrode clean
Serial line
Production data
Dose setting
Zero setting
100 percent
Exit

Display reading: the basic menu

Use push-buttons ⊟ and ⊠ to move upwards and downwards in the menu. As in any meter menu, the selected item is on the first display line with the initial character blinking.

Depress push-button ⊡ to enter a subordinated menu, or to edit an item. When in a subordinated menu, depress push-button ⊡ to return to the higher-level menu (the "Escape" function). When in the basic menu, the Escape command will bring forth the possibility to terminate the programming mode via the selection of the "Exit" item of the basic menu.

7.1. Programming of the basic menu items

7.1.1. Displayed data

The "Displayed data" menu allows the operator to choose which parameters are to be displayed. Using push-buttons ⊠ and ⊟ , select parameters from the following list. The Flow Rate display cannot be cancelled.

Menu: Displayed data, depress ⊡
The two-line display unit will always show two of the items from the following menu. Use push-buttons ⊠ and ⊟ to page upwards and downwards through the menu items.

Flow rate
Total volume +
Total volume -
Total difference
Operational time
Percent. Flow rate
Last error
Dosing mode

Menu: Displayed data, depress ⊡ / Total volume depress ⊡
Display line 1 will read "Do not display", line 2 "l/s …. l". Use push-buttons ⊠ and ⊟ to go up and down in the menu items. If you choose "Do not display", depress ⊡ to return to the "Displayed data" menu. If you wish to display If you wish to display "Total volume +", select the"Total Volume +" item on the menu; depress push-button ⊡ skip line 1,(Do not display) and select line 2, "l/s …. l" (flow-rate unit … volume unit). Using push-buttons ⊠ (downwards) and ⊟ (upwards), select the desired flow-rate and volume units and confirm the selection by depressing ⊡ . The display line 1 will then show "0" and line 2 "0.0".Using push-buttons ⊠ (downwards) and ⊟ (upwards), select the desired number of decimal positions, confirm the selection by depressing ⊡ and return to the "Displayed data" menu.

Comment:

The measurement unit selected for "Flow Rate" is automatically set for all other flow-rate quantities referred to in the Programming menu.
The measurement unit selected for "Total Volume +" is automatically set for all other flow-volume quantities in the Programming menu.
The measurement units for the "Total Volume –" and "Total Difference" quantities can be selected as need be, and their selection will not affect any other measured quantities to be set within the Programming menu.

Table of flow-rate and volume units
```
l/s      ….    l
l/min    ….    l
l/h      ….    l
m3/s     ….    m3
m3/min…. m3
m3/h     ….    m3
GPS      ….    G
GPM      ….    G
GPH      ….    G
```

Table of decimal positions
```
0
0.0
0.00
0.000
0.0000
0.00000
0.000000
```

User-specified units

When defining a user-specific unit, it is necessary to enter a conversion constant (a multiple of the standard flow-rate or volume units – "l/s" or "l", then depress ⏎ , define the unit name (six characters), depress ⏎, define number of decimal positions, depress ⏎ and return to the "Displayed data" menu.

Example: the desired flow rate unit is US barell per second; the conversion constant is **0.006283811**; unit name **bl/s**; number of decimal positions **0.000.**

The same procedures apply to parameter setting with Flow rate, Total volume +, Total volume – and Total difference.

While setting the parameters of Operational time, Per cent flow rate, Last error and Dosing, the options to select from are only "DISPLAY" and "NO DISPLAY".

To leave the "Displayed data" mode and return to the basic programming menu, depress push-button ⏏ .

7.1.2. Samples

The number of samples N, on the basis of which the average flow rate value is determined, can be set within the range of 1 to 255. While the measurement frequency is 6.25Hz (or 3.125, 1 or 0.5Hz), fast (step) changes in the flow rate will be smoothened within the interval of 0.08 to 20.40s (0.16 to 40.80s, 0.5 to 127.5s or 1 to 255s). The averaging feature is useful in the cases where the flow through the meter sensor is unstable, the fluid is turbulent or where there are air bubbles trapped in the fluid flow.

The averaging function helps suppress fast changes in the fluid flow rate. Average flow rate as measured and displayed is the parameter used to calculate other meter outputs.
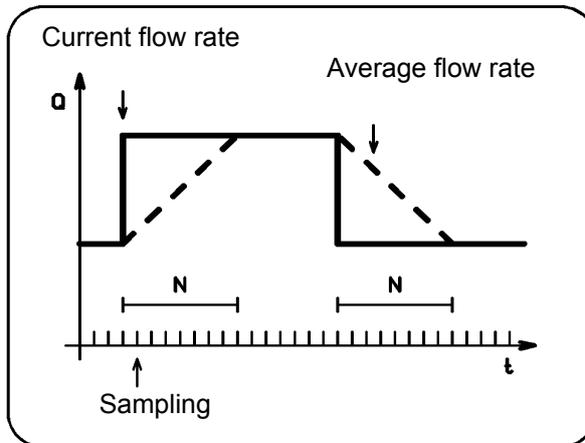
Suppression of step changes in flow rate

Menu: Number of samples, depress ⏎
The display will read "Number of samples xxx". Replace xxx by a number from the range of 1 to 255 (usually 25). Move the cursor using push-button ⊟ , and increase/decrease number using ⊡ or ⊠ , respectively. Confirm the selection by push-button ⊟ . The display will then read "Value entered Press any key". Press ⏎ or any other push-button.. This action will take you to the basic menu.

7.1.3. Analog output

Setting options

Connected to terminals 4 and 5 is a programmable current output. It is an active current output, insulated from other meter parts. The maximum output load is 1,000Ω. Depending on the fluid-flow characteristics , the output can be used in four different modes of operation (see the graphs below) and in two selectable measurement ranges.

The two-line display unit will always show two of the items from the following menu. Use push-buttons ⊠ and ⊟ to page downwards and upwards through the menu items.

Menu: Analog output, depress ⊟

0..+Q Output
0..-Q Output
|Q| Output
–Q..+Q Output
Fixed current

In all operational modes excepting the "Fixed current" mode the current output range can be user defined.

Menu: Analog output, depress ⊟ / Output 0..+Q, depress ⊟

Output 0.. 20 mA
Output 4.. 20 mA

Selection of current output

Menu: Analog output, depress ⊟ / Output 0..+Q, depress ⊟ / Output 0.. 20 mA, depress ⊟ / Flow rate for Imax
The current output setting consists of defining flow rate Qmax corresponding to Imax. Move the cursor using push-button ⊟ , and increase/decrease the Qmax value using push-buttons ⊡ and ⊠ . Select the desired

Qmax and confirm the setting by depressing ⊡ . The display will then read "Value entered Press any key". Press any key, preferable the ⊡ pusch-button. This action will take you back to the main programming menu, item "Analog output".

In the "Fixed current" mode, the output current can be set within the range of 0 to 20mA. This mode is used for meter servicing purposes.

Menu: Analog output, depress ⊡ / Fixed current, depress ⊡ / Fixed current 0.. 20 mA
Move the cursor using push-button ⊡ , and increase/decrease the current value using push-buttons ① and ⓣ . Select the desired current value and confirm the setting by depressing ⊡ . The display will then read "Value entered Press any key". Pres any key, preferably ⊡ . This action will take you back to the main menu, item "Analog output". At the same time, the defined current will start to flow through the output circuit.
The following graphs show the relationships between current I and flow rate Q for various operational modes.
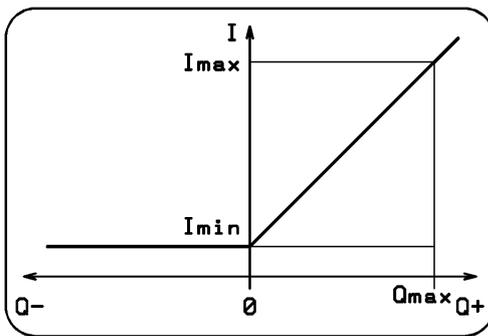
Output current for 0 ...+Q
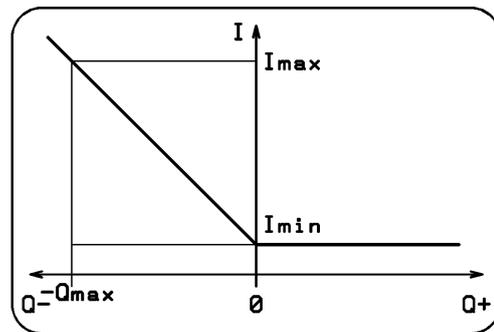
Output current for 0 ...-Q
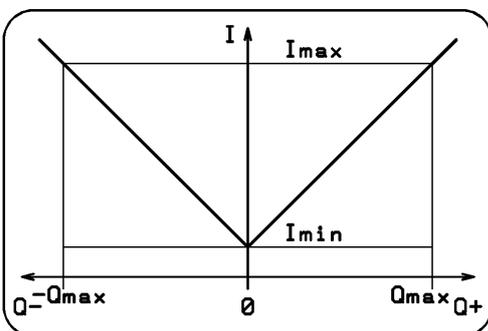
Output current for |Q|
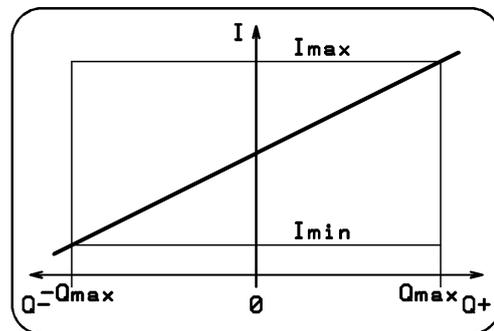
Output current for –Q ...+Q

Examples of analog output interconnections

Equipment with a current input

Equipment with current inputs
Outputs 1 and 2 serving the purpose of
identifying fluid flow direction.
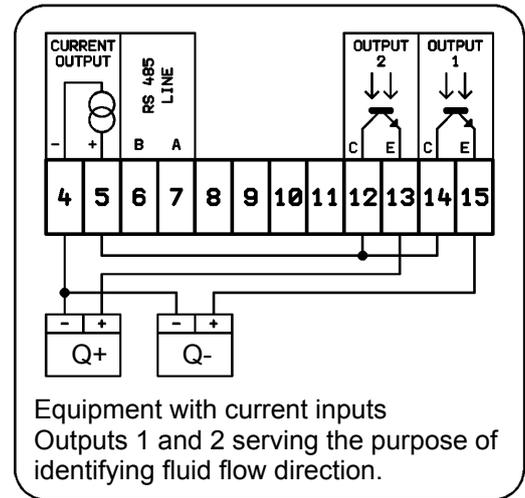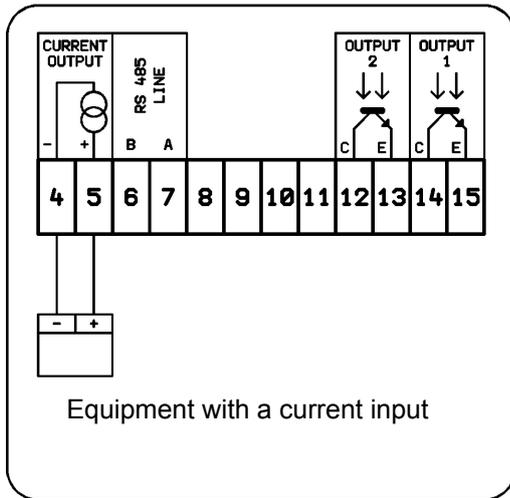
Multifunctional outputs programmed to identify the fluid flow direction and negate the flow direction, will divide the analog output operated in the "Absolute Flow Rate Value" mode into two outputs, one for each flow direction.

Equipment with voltage input

Current output connected as a voltage source to feed the (passive) output 2
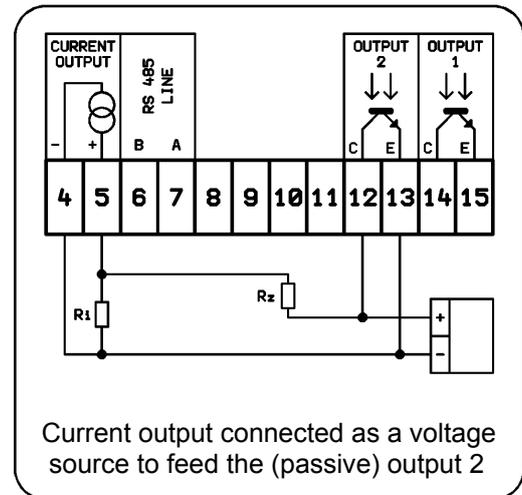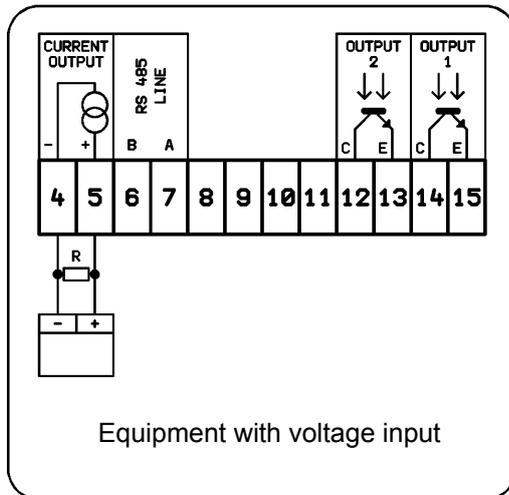
The output voltage for the associated equipment is defined as the voltage drop on resistor R. It holds: $U = I\,R$.

For the voltage range of 0.. 10V, select R = 500 Ω and the analog current output range 0.. 20mA. Resistor R shall be placed as close to the input terminals of the co-operating (controlled) equipment as possible. The maximum voltage (voltage drop on the resistor) is 10V. The input impedance of the controlled equipment shall be at least 100 times higher than that of resistor R.

The interconnection of the current output as an auxiliary power source for the binary outputs is shown in the above picture. This arrangement assumes that the current output is not used for the purposes of flow rate indicator. Here the current output needs be set in the "Fixed current" mode of operation. The voltage drop on resistor Ri is used as supply voltage for the binary output (via resistor Rz). The input impedance of the associated equipment shall be at least 10 times higher than that of resistor Rz, while Rz shall be at least 10 times higher than Ri. It holds: Ri < Rz < input impedance of the associated equipment.

Technical specifications of analog output

The analog output is controlled by a 12-bit DA converter. The operational range 0 to 20mA is divided into 4,096 steps. One step (1LSB) therefore corresponds to about 0.005mA (0.025% of 20mA). This resolution applies to all output ranges. The current range 4 ... 20mA is software-defined with the converter steps reduced accordingly. The maximum voltage at the current output is 20V; the maximum resistance of the current loop is 1,000Ω.

7.1.4. Output function

The configuration of the induction flow meter includes two binary multifunctional outputs, electrically isolated by means of optocouplers. The output transistors of the optocouplers are accessible via terminals 12-13 and 14-15. These are passive outputs that need external power source. Alternatively they can be powered by the analog output in the fixed-current mode as described above. The binary outputs can be loaded and repeatedly switch on and off currents 1 to 50mA.

Default settings: Output 1: frequency output, Output 2: pulse output.

Flow meter can be equipped with an output relay, designated in the menu as item "Relay functions". Electrically isolated relay contacts are accessible via terminals 1-2-3. For impulse output, both the impulse width and the minimum gap length are set at 0,5 s. To ensure correct functioning of the impulse function, it is necessary to set the outputimpulse constant (the fluid volume per impulse) so that the memory block of unsentimpulses would never overflow.

Menu: Output function, depress ⏎
The display will offer the following selection:

OUT1 function
OUT2 function
RELAY function

The two-line display unit will always show two of the items from the following menu. Use push-buttons 🔽 and ⊟ to page downwards and upwards through the menu items.

Menu: Output function, depress ⏎ / Output 1 function, depress ⏎
The two-line display unit will always show two of the items from the respective menu. Use push-buttons 🔽 and ⊟ to page downwards and upwards through the menu items.

The output functions available are shown in the following table:

Permanently open
Perm. closed
|Q| pulses
Q+ pulses
Q- pulses
Q+ frequency
Q- frequency
|Q| frequency
Fixed frequency
Negative flow
Non-neg. flow
Error occurred
No error occurred
Q>Q lim.
Q<Q lim.
|Q|>Q lim.
|Q|<Q lim.
Cleaning
Not cleaning

Frequency can not be used for relay output

Permanently closed (open)
These modes are only used for servicing purposes.

Menu: Output function, depress ⏎ / Output 1 (2) function, depress ⏎ /Permanently closed (open), depress ⏎
This will return the display to the menu item "Output 1 Function" or "Output 2 Function".
To return to the basic programming menu, depress push-button ①.

Pulse outputs

In any of the pulse modes, an pulse will be generated as soon as a defined (preset) fluid volume passes through the meter sensor. The impulse mode requires specification of the following three parameters: pulse width "t_U", minimum time gap between two successive impulses "t_D" and fluid volume per impulse "V".
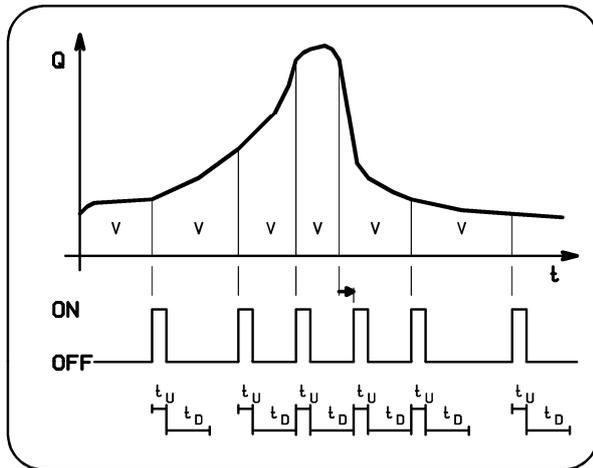
Pulse generation principle

This mode provides for integration of the flow rate values in time. As soon as a preset fluid volume V passes through the meter, an impulse of width t_U is generated. After each impulse, a gap of at least t_D follows. If, after elapsing of the t_D period, fluid volume V has not yet passed through the sensor, the output remains inactive. If the volume passed is equal to or greater than V, another impulse plus gap are immediately generated. Should the preset volume V pass before the end of the previous impulse, the non-generated impulse will be stored in a accumulator with the capacity of 255 impulses. Should the impulse accumulator overflow, an error message will be generated. To ensure correct functioning of the meter impulse function, it is necessary to set the impulse output parameters so that the expected impulse frequency shall correspond to the impulse width and gap length selected.

It holds: maximum pulse frequency = $1 / (t_U + t_D)$

The volume per impulse parameter can be set within the range of 0.001 to 1,000,000 liters. The pulse width and gap length can be set at 10 to 2,550ms in steps of 10ms. The setting procedure consists of selecting numbers from 1 to 255 on the meter display. Multiplied by 10, the figure shows the impulse width or gap length in milliseconds.

From the above it follows that the maximum impulse frequency is 50 per sec.

Regarding the flow rate conditions (see below), impulses can be generated in three different modes. During the tU periods, the output is closed.
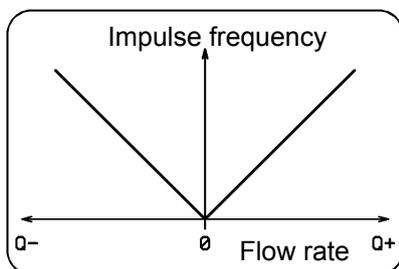
Impulses for |Q|
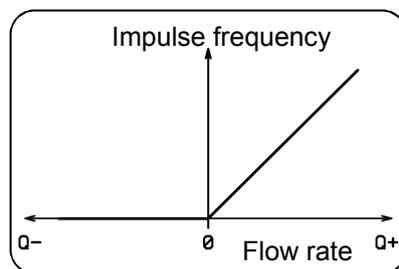
Impulses for Q+
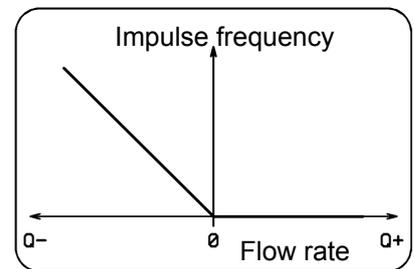
Impulses for Q-

Menu: Output function, depress ⏎ / Output 1 (2) function, depress ⏎ / Pulses for |Q|, depress ⏎ .
The display will read "Pulse width [1] xxx". Move the cursor using push-button ⊟ , and increase/decrease the values at various "x" positions using push-buttons ⊡ or ⊠ , respectively. Replace xxx by a figure which, when multiplied by 10, will give the pulse width in ms. Depress ⏎ . The display will read "Value entered Press any key". Press any key, preferably ⏎ . The display will then show the message "Gap length [1] xxx". Move the cursor using push-button ⊟ , and increase/decrease the values using push-buttons ⊡ or ⊠ , respectively. Replace xxx by a figure which, when multiplied by 10, will give the gap length in ms. Depress ⏎ . The display will read "Value entered Press any key". Press any key, preferably ⏎ . The display will then show the message "Volume per pulse [1] xxxxxxx". Move the cursor using push-button ⊟ , and increase/decrease the "x" values using push-buttons ⊡ or ⊠ , respectively. Replace xxxxxxx by a figure equal to the desired fluid volume per pulse. This figure is elsewhere referred to as the impulse constant or impulse number. Depress ⏎ . The display will read "Value entered Press any key". Press any key, preferably ⏎ . This will return the display to the menu items "Output 1 function" or Output 2 function". To return to the basic menu, depress push-button ⊡ .

Pulse number selection for FMG600 SERIES

Dimension		Qmax	Imp.number	Qmax	coefficient	Imp.number
Inches (DN)		l/s	l/imp	GPM		gallon/imp.
½ "	15	1.8	1	28.53058	3.785412	1
¾ "	20	3.33	1	52.78157	3.785412	1
1"	25	5	1	79.25161	3.785412	1
-	32	8.33	5	132.03318	3.785412	1
1½"	40	12.5	5	198.12903	3.785412	1
2"	50	20	5	317.00644	18.92706	5
-	65	33.33	10	528.29124	18.92706	5
3"	80	50	10	792.51611	18.92706	5
4"	100	77.77	50	1232.67956	18.92706	5
-	125	119.44	50	1893.16249	37.85412	10
6"	150	180.55	50	2861.77568	37.85412	10
8"	200	319.4	100	5062.59292	189.2706	50
10"	250	500	100	7925.16112	189.2706	50
12"	300	700	500	11095.22557	189.2706	50

1 gallonUS = 3.785412 l   0.264172037 gall = 1 l
pulse width = 100 ms   15.85032224 gall/min = 60 l/min
minimum gap length = 100 ms
f <= 5Hz

Impulse number selection for FMG600 SERIES for sensors Tri Clover

Dimension		Qmax	Imp.number	Qmax	coefficient	Imp.number
Inches	mm	l/s	l/imp	GPM		gallon/imp.
½ "	12.70	0.6940	1	11.0001	3.7854	1
¾ "	19.05	1.9483	1	30.8812	3.7854	1
1"	25.40	3.8360	1	60.8018	3.7854	1
1½"	38.10	9.5115	5	150.7603	3.7854	1
2"	50.80	17.7205	5	280.8756	18.9270	5
2½"	63.50	28.4631	10	451.1493	18.9270	5

Frequency outputs

In the frequency modes, the output signals will be impulses of impulse-to-gap ratio 1:1. The frequency range available is from 1Hz to 10kHz.

Comment: The electronic unit of the meter includes only one frequency generator. It is therefore impossible to select different frequencies for each output, or combine the fixed-frequency mode at one output with frequency related to flow rate mode at the other output. On the other hand, the operator may select the frequency related to flow rate mode in the positive direction at one output with that in the negative direction at the other output, with the same frequency-to-flow-rate ratios.
Regarding the flow rate conditions, the frequency outputs can be operated in three different modes (see below).
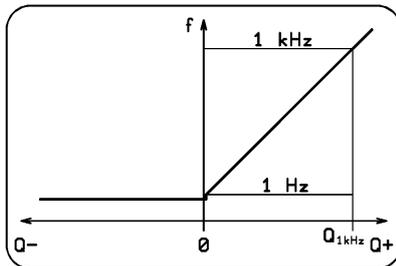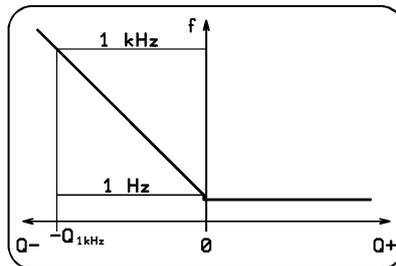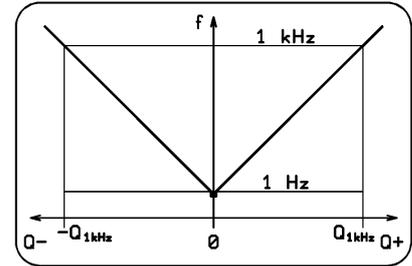
Frequency for Q+   Frequency for Q-   Frequency for |Q|

Menu: Output function, depress ⏎ / Output 1 (2) function, depress ⏎ / Frequency for Q+, depress ⏎ .
The display will read "Flow rate per 1kHz xxxx". Move the cursor using push-button ⊟ , and increase/decrease the values at various "x" positions using push-buttons ⊞ or ⊠ , respectively. Replace xxxx by a figure representing the maximum flow rate. Depress ⏎ . The display will read "Value entered Press any key". Press any key, preferably ⏎ . This will return the display to the menu items "Output 1 function" or "Output 2 function".

The fixed-frequency mode is used for servicing purposes only. The required frequency is set in Hz within the range of 1 to 10,000 in steps of 1Hz.

Menu: Output function, depress ⏎ / Output 1 (2) function, depress ⏎ / Fixed frequency, depress ⏎ .
The display will read "Fixed frequency xxxxx". Move the cursor using push-button ⊟ , increase/decrease the "x" values using push-buttons ⊞ or ⊠ , respectively. Replace xxxxx by a figure equal to the desired frequency in Hz. Depress ⏎ . The display will read "Value entered Press any key". Pres any key, preferably ⏎ . This action will return the display to the menu items "Output 1 Function" or "Output 2 Function".
To return to the basic menu, depress push-button ⊞ .

Negative (non-negative) flow direction

This mode is used to identify the flow direction. In the case of negative flow direction, the output is closed (open).

Menu: Output function, depress ⏎ / Output 1 (2) function, depress ⏎ / Negative (Non-negative) flow direction, depress ⏎ .
The display will return to the menu items "Output 1 Function" or "Output 2 Function".
To return to the basic programming menu, depress push-button ⊞ .

Error (no error) condition

In the case of a meter error, the output will close (open) and stay so as long as the error condition exists.

Menu: Output function, depress ⏎ / Output 1 (2) function, depress ⏎ / Error (No error) condition, press ⏎

The display will return to the menu items "Output 1 Function" or "Output 2 Function".
To return to the basic menu, depress push-button ⊡ .

Exceeding (dropping below) the limit values of flow rate

In the cases of exceeding (dropping below) the preset flow-rate limit values, the output will close (open). Upon return within the normal operating range, the output will open (close) again with a preset hysteresis. Regarding the flow rate conditions, there are four different modes of operation:

Q > Q lim.

Q < Q lim.

IQI > Q lim.
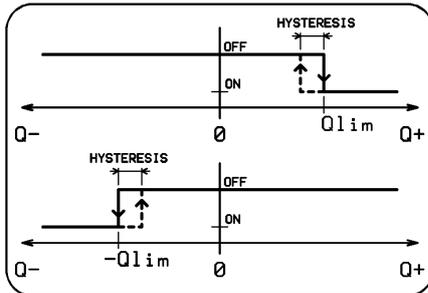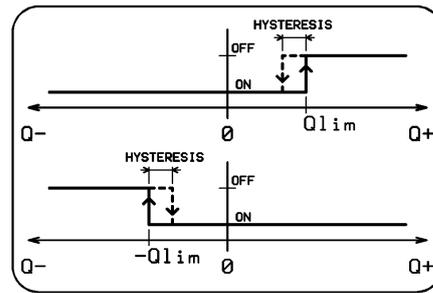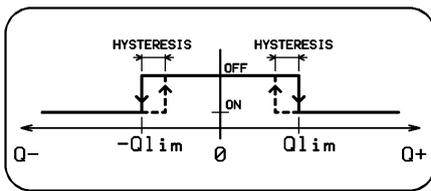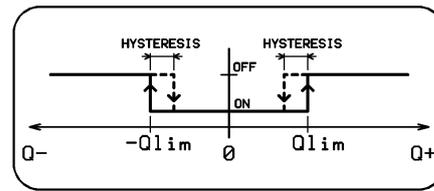
IQI < Q lim.

Menu: Output function, depress ⊡ / Output 1 (2) function, depress ⊡ / Q > Q lim., depress ⊡
The display will read "Flow rate limit [1] xxxxxx". Move the cursor using push-button ⊟ , and increase/decrease the values at various "x" positions using push-buttons ⊡ or ⊗ , respectively. Replace xxxxxx by a figure equal to the flow rate which, when exceeded, should cause the output to close. Depress ⊡ . The display will read "Value entered Press any key". Press any key, preferably ⊡ . The display will then show the message "Hysteresis [1] xxxx". Move the cursor using push-button ⊟ , and increase/decrease the "x" values using push-buttons ⊡ or ⊗ , respectively. Replace xxxx by a figure representing hysteresis, between the closing and opening output functions. Depress ⊡ . The display will read "Value entered Press any key". Press any key, preferably ⊡ . The display will return to the menu items "Output 1 function" or "Output 2 function".
To return to the basic menu, depress push-button ⊡ .

Electrode cleaning in progress (No cleaning)

While the electrode cleaning process is in progress, the output is closed (open).

Menu: Output function, depress ⊡ / Output 1 (2) function. depress ⊡ / Cleaning in progress (No cleaning), depress ⊡
The display will return to the menu items "Output 1 Function" or "Output 2 Function".
To return to the basic menu, depress push-button ⊡ .

7.1.5. Electrode cleaning

During the meter operation, non-conducting substances may accumulate in the form of a layer on the sensor electrodes. This increases the contact resistance between the electrode and the measured fluid and results in decreased measurement accuracy. The FMG600 SERIES flow meter offers a sensor electrode cleaning function without sensor dismantling. The cleaning method is based on the electro-chemical phenomenon

where the electrodes are connected to an AC voltage source causing the accumulated layer to dissolve in the measured fluid. It is recommended that the cleaning process be repeated in regular intervals.

One cleaning cycle lasts 1 minute. Measurements are discontinued during the cleaning action while the immediately preceding flow conditions are being simulated. The cleaning action can be indicated using the multifunctional outputs. While the cleaning process is in progress, message "Cleaning Electrodes" can be seen on the top display line. The bottom line shows last value of the selected measured quantity. As soon as the cleaning action is over, the meter resumes normal measurements.

There are several ways of initiating the electrode cleaning cycle:

Menu: Electrode cleaning, depress ⏎

```
    Cleaning OFF
    Single cycle
    During Power ON
    Periodic [day]
```

The two-line display unit will always show only two of the four menu items. Use push-buttons ⊗ and ⊟ to page downwards and upwards through the menu items. Select the desired item and depress ⏎ . The display will return to the basic menu, item "Electrode Cleaning"...
Upon selecting the "Single cycle" option, the cleaning process will immediately start. On completion of the cleaning cycle, the meter will return to the "Cleaning OFF" status.
The selection "During Power ON" implies that a cleaning process will be initiated wherever line voltage is switched on. In the "Periodic [Day]" mode of operation, cleaning processes will be initiated automatically in regular intervals to be chosen by the user from the range 1 to 255 days. The time counting process will always start upon setting a new cleaning period.

Comment: When using a supply voltage source 24V AC/DC, the electrode cleaning function is inoperative.

Menu: Electrode cleaning, depress ⏎ / Periodic [day], depress ⏎
The display will read "Cleaning [Day] xxx". Move the cursor using push-button ⊟ , increase/decrease the "x" values using push-buttons ⊞ or ⊗, respectively. Replace xxx by a number from 1 to 255 (days). Depress ⏎.
The display will read "Value entered Press any key". Press any key, preferably ⏎ . This action will return the display to the basic programming menu, item "Electrode Cleaning".

7.1.6. Serial line

The meter is provided with a serial communication interface, intended for servicing purposes. In the standard configuration, the USB port is implemented. Electrically insulated port RS 485 is included on special request.

Serial port USB

This port is accessible through USB type B connector. Interconnection to the computer is facilitated by means of a cable provided with USB type A connector at one end and USB type B connector at the other end.
The USB port is not insulated from the other meter circuits; it is primarily intended for servicing purposes. Permanent operational use is not recommended.

Serial port RS 485
The RS 485 port is optional accessory of the induction meter. It is electrically insulated from the other meter circuitry and allows for interconnection of up to 31 flow meters to a common communication network. The maximum length of the connecting two-wire twisted cable is 3,937 ft (1,200m). If repeaters are used, the

number of meter stations and cable length can further be increased. The cable wires are to be connected to terminals 6 and 7.

The flow meter found at the end of the communication network shall be provided with jumper W1 with a terminal resistor 120 R. Jumper W1 is located on the terminal board FNS5 between the terminal strip and lightning arrestor

Connection of flow meters to an RS 485 communication line
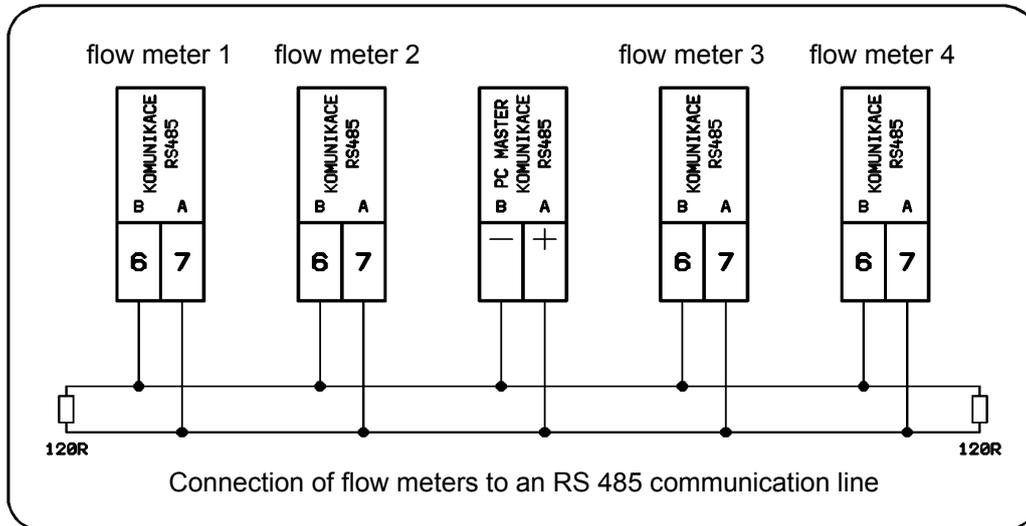
Communication
Communication consists of individual data packets. To ensure correct function of a communication network, each station must have a different address. On delivery, all induction flow meters will have the following setting of communication parameters: **Address 1, Group 1, Speed 9600Bd, Parity SL.**
Communication uses the Floset 2.0 program package.

The communication protocol is not included in this brochure; it can be obtained from the meter manufacturer on request.

Menu: Serial line, depress ⏎

> Address
> Group
> Baud rate
> Parity

The two-line display will always show two of the menu items. To page through the menu, use push buttons 🔄 (direction upwards) and ⊟ (downwards). Select the desired item and depress ⏎.

Menu: Serial line, depress ⏎ / Address, depress ⏎
The display will read "Address xxx". Replace "xxx" by a number from 1 to 255, being the meter address. Depress ⏎ . The display will show the message "Value entered Press any key". Press any key, preferably ⏎ . This command will take you back to the Serial Line menu.

Menu: Serial line, depress ⏎ / Group, depress ⏎
The display will read "Group xxx". Replace "xxx" by a number from 1 to 255, being the designation of a group of induction meters. Depress ⏎ . The display will show the message "Value entered Press any key". Press any key, preferably ⏎ . This command will take you back to the Serial Line menu.

Menu: Serial line, depress ⏎ / Baud rate, depress ⏎

All equipment connected to a particular communication line branch shall use the same communication speed. There are five optional selections of speed:

```
   1200Bd
   2400Bd
   4800Bd
   9600Bd
   19200Bd
   38400Bd
```

The two-line display will always show two of the menu items. To page through the menu, use push buttons ⏺ (direction upwards) and ⊟ (downwards). Select the desired item and depress ⏎ . This action will bring the display to the Serial Line menu.

Menu: Serial line, depress ⏎ / Parity, depress ⏎

```
   Parity --
   Parity SL
   Parity SS
   Parity LS
   Parity LL
```

The two-line display will always show two of the menu items. To page through the menu, use push buttons ⏺ (direction upwards) and ⊟ (downwards). Select the desired item and depress ⏎ . This action will bring the display to the Serial Line menu.

To return to the basic programming menu, item Serial Line, depress push-button ⏹ .

7.1.7. Production data

The first three menu items, i.e. Production Data, Series Number and Software, give basic information on the induction flow meter concerned and as such cannot be edited. The remaining items, i.e. Sensor Constants, Excitation Frequency, Suppressed Flow Rate, Language, Sensor Number, Sensor DN, Errors, Dose Correction, Flow Direction and Base Frequency can be changed by the user.

Menu: Production data, depress ⏎

```
Production date
Serial number
Software
Sensor constants
Excitation freq.
Suppressed flow
Language
Sensor number
Sensor DN
Errors
Dose correction
Flow direction
Base frequency
```

The two-line display will always show two selected menu items. To page through the menu items, depress repeatedly push-buttons ⏺ (direction downwards) and ⊟ (upwards). To select a particular menu item, depress ⏎ .

Menu: Production data, depress ⏎ / Production date, depress ⏎

The display will read "Production date dd mm rrrr". This information cannot be edited. To return to the Production data menu, depress any push-button, for example ⏎ . The menu will reappear on the display.

Menu: Production data, depress ⏎ / Serial number, depress ⏎
The display will read "Serial number xxxxxrr". This information cannot be edited. To return to the Production data menu, depress any push-button, for example ⏎ . The menu will reappear on the display.

Menu: Production data, depress ⏎ / Software, depress ⏎
The display will read "Software v.xxxxx/xx". This information cannot be edited. To return to the Production data menu, depress any push-button, for example ⏎ . The menu will reappear on the display.

Menu: Production data, depress ⏎ / Sensor constants, depress ⏎

```
Constant 1
Constant 2
```

To page through the menu items, use push-buttons ⊙ (direction downwards) and ⊟ (upwards). Select the desired item and depress ⏎ . The constant value will appear on the display. Should you wish to change this value, use push-button ⊟ to place the cursor under the selected figure and increase/decrease the same using push-buttons ⊡ and ⊙ , respectively. The sensor constants shall be set at the values given on the sensor rating plate. Unless this not the case, the flow meter calibration is incorrect.

Menu: Production data, depress ⏎ / Sensor constants, depress ⏎ / Constant 1, depress ⏎
The display will read "Sensor constant 1 xxxxxxxxx". The value was set during the meter calibration at the manufacturing plant and it should not be changed. Depress ⏎ . The display will read "Value entered Press any key". Press any key, preferably ⏎ . This command will cause the menu Constant 1 / Constant 2 to reappear on the display. The same procedure applies to setting the value of Constant 2. To return to the Production data menu, depress push-button ⊡ .

Menu: Production data, depress ⏎ / Excitation frequency, depress ⏎

```
1 – 6.25  Hz
2 – 3.125 Hz
3 – 1.0 Hz
4 – 0.5 Hz
```

To page through the menu items, use push-buttons ⊙ (direction downwards) and ⊟ (upwards). Select the desired frequency and depress ⏎ .

Menu: Production data, depress ⏎ / Excitation freq., depress ⏎ / 2 – 3.125 Hz, depress ⏎
The Manufacturing data menu will reappear on the display with the item "Excitation frequency" on the first line.

Menu: Production data, depress ⏎ / Suppressed flow, depress ⏎
The display will read "Suppressed flow xxxxx". This parameter is usually set at 0.5% Qmax and may be increased in cases where it can be demonstrated that while no fluid flows through the meter sensor, the meter indicates a non-zero flow rate. Using push-button ⊟ move the cursor to the desired position and increase/decrease the selected figure by push-buttons ⊡ and ⊙ , respectively. Replace xxxx by a number equal to the desired value of suppressed flow rate. Depress ⏎ . The display will read "Value entered Press any key". Press any key, preferably ⏎ . The Production data menu will reappear on the display with the item "Suppressed flow rate" selected.

Menu: Production data, depress ⏎ / Language, depress ⏎

The display will read "[CZ] Czech / [EN] English". To page through the menu items, use push-buttons ⊗ (direction downwards) and ⊟ (upwards). Select the desired language and depress ⊡ . The Production data menu will appear on the display with the Language option on the first line.

Menu: Production data, depress ⊡ / Sensor number, depress ⊡
The display will read "Sensor number". Using push-button ⊟ move the cursor to the desired position and increase/decrease the selected figure by push-buttons ⊡ and ⊗ , respectively. Enter the sensor production series number (maximum 10 digits). Depress ⊡ . The display will read "Value entered Press any key". Press any key, preferably ⊡ . The Production data menu will reappear on the display with the Sensor Number item selected.

Menu: Production data, depress ⊡ / Sensor DN, depress ⊡
The display will read "Sensor DN". Using push-button ⊟ move the cursor to the desired position and increase/decrease the selected figure by push-buttons ⊡ and ⊗ , respectively. Enter the sensor dimension (maximum 10 digits). Depress ⊡ . The display will read "Value entered Press any key". Press any key, preferably ⊡ . The Production data menu will reappear on the display with the Sensor DN item selected.

Menu: Production data, depress ⊡ / Errors, depress ⊡
The display will read „1: Error EEPROM, 2: Overflow OUT1". Scrolling in menu is possible using push-buttons ⊗ (down) and ⊟ (up). Scroll to desired error and depress ⊡ . Display will read „Active, Non-active". With buttons ⊗ and ⊟ set desired error feature and depress ⊡ . Then you can continue with setting of another error. When finished, depress ⊡ and return to item "Errors".

Menu: Production data, depress ⊡, Dose correction, depress ⊡
The display will read "Dose Correction xxxxx". The value specified here will be added or subtracted from the earlier specified dose size. Move the cursor by repeated actuation of push-button ⊟, and set the desired value by push-buttons ⊡ and ⊗ (increase/decrease). The five "x" should be replaced by a figure representing the dose correction in the given volume units. Confirm your selection by depressing ⊡. The display will read "Value Entered Press Any Key". Depress ⊡. This takes you back to the Production Data menu, item "Dose Correction".

Menu: Production data, depress ⊡ / Flow direction, depress ⊡
The first display line will show "A → B", the second line "A ↔ B". The first line applies. Select the correct information by push-button ⊗, then depress ⊡. The display will read "Value Entered Press Any Key". Depress ⊡. The Production Data menu will appear on the display with the "Flow Direction" item selected.

Menu: Production data, depress ⊡ / Base frequency, depress ⊡
The display will read "Base Frequency LXXX". Move the cursor by repeated depressing of push-button ⊟, and set the desired value by push-buttons ⊡ and ⊗ (increase/decrease). The X-es should be replaced by a figure equal to the base frequency in Hz specified in the table shown in section 7.1.4. Then depress ⊡. The display will read "Value Entered Press Any Key". Depress ⊡. This takes you back to the Production Data menu, item "Base frequency".

To return to the basic programming menu, item "Production data", depress push-button ⊡.

7.1.8. Dose setting

The dosing mode is operational provided the Display item is selected from the "Displayed Data" menu. The dosing mode allows for measurement of the preset fluid volume (dose). The external initiation command shall be brought to the input of optocoupler IN1. As soon as the preset dose has passed through the meter probe, the output optocoupler (OUT3) will close. The dosing process will be repeated with every new external initiation signal brought to the input of optocoupler IN1. Depress push-button ⊡ to discontinue the dosing process currently in progress. Following that, the next dosing process can be initiated at any time.

Menu: Dose setting, depress ⊡
The display will read "Dose Size xxxxx". Using push-button ⊟ move the cursor to the desired decimal position and increase/decrease the selected figure by push-buttons ⊡ and ⊗, respectively. Replace xxxx by a number equal to the dose size. Depress ⊡ . The display will read "Value Entered Press Any Key". Press

any key, preferably ⏎. The basic programming menu will reappear on the display with the "Dose Setting" item selected.

7.1.9. Zero setting

The zero-setting function is useful in the cases where the actual flow rate is very small (e.g. due to leakage in closed valves) and for all practical purposes equal to zero. This function can only be used with meters in a single flow-direction application. Should you open the zero-setting programming mode by mistake (not wishing to change the zero setting), proceed using the Cancel-Zero setting sequence of commands.

Menu: Zero setting, depress ⏎
The display will read "Setting Completed" and show the flow rate as indicated by the meter prior to entry to the programming mode. Make a note of this value as it cannot be otherwise reconstructed once the new zero setting has been completed. Depress ⏎. The basic programming menu will reappear on the display with the "Zero Setting" item selected.
The new zero setting will become effective upon leaving the meter programming mode. At the same time, three flashing exclamation marks will appear on the display showing the actual flow rate values.

```
Flowrate        !!!
110.7      m3/h
```
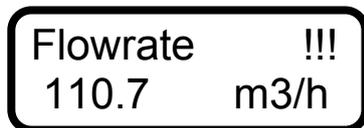
The flow-rate display image with the zero setting effective
The actual zero setting can be changed at any time by repeating the above "Zero Setting" procedure.

Cancellation of the actual zero flow-rate setting:

Menu: Zero setting, depress ⏎
The display will read "Setting Completed" and show the flow rate as indicated by the meter prior to entry to the programming mode. Depress ⊘ . The display will read "Setting Cancelled" while the flow-rate value will remain unchanged. Depress ⏎. The basic programming menu will reappear on the display with the "Zero Setting" item selected. The cancellation of zero setting will take effect upon leaving the meter programming mode. The three flashing exclamation marks on the flow-rate display will disappear.

7.1.10. 100 percent

Default value of the "100 Percent" quantity is Qmax as specified for the sensor DN(see the table of minimum and maximum flow rates in-section 4.1.1.). This default value can be reset, in particular in cases where the actual maximum flow rate is lower than Qmax.

Menu: 100 percent, depress ⏎
The display will read "100 percent xxxx". Using push-button ⊟ move the cursor to the desired decimal position and increase/decrease the selected figure by push-buttons ⊕ and ⊘ , respectively. Replace xxxx by a number equal to the flow rate identified with 100%. Depress ⏎ . The display will read "Value entered Press any key". Press any key, preferably ⏎ . The basic programming menu will reappear on the display.

7.1.11. Exit

Select "Exit" to leave the programming mode and protect the meter from any unauthorized programming action.

Menu: Exit, depress ⏎

EXIT
New password

Page through the menu using push-buttons ⊙ (direction downwards) and ⊟ (upwards). The selected menu item appears on the first line with the first character blinking. Select "EXIT" and depress ⊡ . The display will read "Write to EEPROM Press any key", usually ⊡ . The meter programming mode will be terminated and the data display menu will appear on the display. Use push-buttons ⊙ and ⊙ to page downwards and upwards through the menu items.

Select "New password" to cancel the existing password and define a new password enabling entry into the Parameter setting mode.

Menu: Exit, depress ⊡ / New password, depress ⊡
The display will read "Password 0000". Using push-button ⊟ move the cursor to the desired decimal position and increase/decrease the selected figure by push-buttons ⊞ and ⊙, respectively. Enter the new password and depress ⊡. The display will read "Value entered Press any key". Press any key, preferably ⊡ . The Exit menu will reappear on the display. Select the EXIT item and depress ⊡ . The display will read "Write to EEPROM Depress any key". Press any key, preferably ⊡. This command will terminate the programming mode and bring the data display menu on the meter display. Unless the programming procedure is terminated in this way, the flow meter parameters will not be protected by a password. Page through the menu items using push-buttons ⊙ (direction downwards) and ⊟ (upwards).

7.2. The Parameter setting menu

Flowrate	Do not display	0
Total volume +	l/s	0.0
Total volume -	l/min	0.00
Total difference	l/hour	0.000
	m3/s	0.0000
Operational time	m3/min	0.00000
Percent flowrate	m3/hour	0.000000
Last error	GPS	
Dosing mode	GPM	"Units"
	GPH	Multiplier
	User-s	

| Samples 1-255 | Display |
| | Do not display |

0..+Q Output	Output 0..20 mA	Flowrate at Imax
0..-Q Output	Output 4..20 mA	
|Q| Output		
-Q..+Q Output		
Fixed current	Fixed current 0.20 mA

OUT 1 function	Permanently open	
OUT 2 function	Perm. Closed	
RELAY function	|Q| pulses	Pulse length
	Q+ pulses	Pause length
	Q- pulses	Vol./pulse
	Q+ frequency	Flowrate at 1 kHz
	Q- frequency	
	|Q| frequency	
	Fixed frequency	Fixed frequency Hz
	Negative flow	
	Non-neg. Flow	
	Error occurred	
	No error occurred	
	Q > Q lim	Flow limit
	Q < Q lim	Hysteresis
	|Q| > Q lim	
	|Q| < Q lim	
	Cleaning	
	Not cleaning	

AFTER PASSWORD ENTRY

BASIC PROGRAMMING MENU

| Displaed data |
| Samples |
| Analog output |
| Output function |
| Elecrode clean |
| Serial line |
| Production data |
| Dose setting |
| Zero setting |
| 100 percent |
| Exit |

| OFF |
| Only once |
| During Power ON |
| Periodic [day] | Periodic [day] |

Adress	Address 1..255
Group	Group 1..255
Baud rate	1200 Bd, 2400 Bd
Parity	4800 Bd
	9600 Bd
	19200 Bd
	38400 Bd
	Parity --, sl, ss, ls, ll

Production Data menu

| Dose size |

| Executed |

| 100 percent |

EXIT	Staving to EEPROM	Programming end
New password		Return to the selected
	Password	data display mode

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ΩΕ OMEGA®	**Induction flow meter FMG600 series**	

7.3. The Production Data menu

AFTER PASSWORD
ENTRY

BASIC PROGRAMMING
MENU

| Displayed data |
| Samples |
| Analog output |
| Output function |
| Electrode clean |
| Serial line |
| Production data |
| Dose setting |
| Zero setting |
| 100 percent |
| Exit |

| Production date |
| Serial number |
| Software |
| Sensor constants |
| Excitation freq. |
| Suppressed flow |
| Language |
| Sensor number |
| Sensor DN |

| Constant 1 |
| Constant 2 |

| Constant 1 |
| Constant 2 |

1 6.25 Hz   2 3.125 Hz
3 1.0 Hz   4 0.5 Hz

Suppressed flow

CZ Czech EN Englich
…

……….

| Errors |

1: …
13: …

| Enabled |
| Disabled |

| Dose Correction |

……..

| Flow Direction |

A — — → B
A ← — → B

| Base Frequency |

Base Frequency Hz

| EXIT |
| New password |

Saving to EEPROM

Password

Programming end
Retrn to the selected
data display mode

8. STANDARD TESTS

Each finished product is thoroughly checked to establish the product completeness and compliance with the manufacturer's quality assurance standards. Subsequently the product functions are tested according to specifications of the approved test directions and subject to at least 15-hour burn-in operation cycle.

9. CALIBRATION AND VERIFICATION TESTS

The FMG600 SERIES induction flow meters are supplied from the manufacturing plant calibrated at three points on the meter characteristic.

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. **OMEGA's WARRANTY** adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that **OMEGA's** customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. **OMEGA's** Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by **OMEGA**, if the unit is found to be defective, it will be repaired or replaced at no charge. **OMEGA's WARRANTY** does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This **WARRANTY** is **VOID** if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of **OMEGA's** control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, **OMEGA** neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by **OMEGA**, either verbal or written. **OMEGA** warrants only that the parts manufactured by the company will be as specified and free of defects. **OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The** remedies of purchaser set forth herein are exclusive, and the total liability of **OMEGA** with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall **OMEGA** be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by **OMEGA** is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, **OMEGA** assumes no responsibility as set forth in our basic **WARRANTY/DISCLAIMER** language, and, additionally, purchaser will indemnify **OMEGA** and hold **OMEGA** harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the **OMEGA** Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage

FOR <u>WARRANTY</u> RETURNS, please have the following information available BEFORE contacting OMEGA:	FOR <u>NON-WARRANTY</u> REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:
1. Purchase Order number under which the product was PURCHASED,	1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product under warranty, and	2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.	3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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