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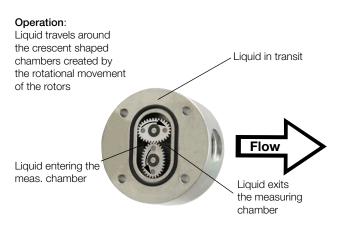
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Principle of Operation

Oval gear flowmeters are categorised as positive displacement flow technology. When liquid flows through this type of positive displacement flowmeter, two oval geared rotors measure a constant volume per rotation within a precisely machined measuring chamber. With each rotation, a constant volume of liquid is measured. The rotation of the oval gears is sensed via magnets embedded within the rotors. These magnets transmit a high resolution pulse output. The output signal can be processed externally via a remote display controller or PLC or via a variety of output/display options available as accessories attached to the flowmeters.



The positive displacement flow technology allows for precise flow measurement of most clean liquids regardless of the media conductivity. Other liquid properties also have a minimal effect on the performance of this type of meter. Flow profile conditioning is not required as with alternative flow technology options making oval gear installations simple to install in tight spaces and at an economical price.

Areas of Application

For all viscous, non abrasive clean liquids like:

- Petroleum
 Grease
 Greuse
 Fuels
 Ink etc.
- Pastes

Stainless steel flowmeters are suited to most products and chemicals and aluminium meters are suitable for fuels, fuel oils & lubricating liquids.

Technical Details

lechnical Details	
Material	
DON-1	
Body:	aluminium
Oval wheels:	PPS GF30/PTFE, PEEK
Axes:	stainless steel 1.4404
DON-2	
Body:	stainless steel 1.4404
	DON-x04DON-x15
	stainless steel 1.4404/1.3955
	DON-x20DON-x60
Oval wheels:	stainless steel 1.4404
	DON-x04DON-x40 stainless steel 1.3955
	DON-x45DON-x60
Bearing:	carbon graphite
Axes:	stainless steel 1.4404
	Stall liess Steel 1.4404
DON-8 Body:	stainless steel 1.4404
Douy.	DON-x04 DON-x15
	stainl. steel 1.4404/1.3955
	DON-x20DON-x60
Oval wheels:	PPS GF30/PTFE, PEEK
Axes:	stainless steel 1.4404
O-rings:	medium temperature
0	FKM: -20+150°C
	NBR: -20+100°C
	FEP-O-seal: -15+130°C
	(FEP-O-seal, FEP encased, with solid core
	EPDM/FKM, only for DON-x04x40)
	Fluoroprene [®] acc. to regulation (EC) No. 1935/2004
Cover for	Tegulation (EC) No. 1933/2004
cable connection:	polyamide PA6 GF35 UL94 HB/VO
Cable Connection.	stainless steel 1.4404 (optional)
Magnet	
encapsulation:	DON-x04DON-x10
	PEEK
	DON-x15DON-x60
	st. st. 1.4404

No responsibility taken for errors; subject to change without prior notice.



Material screws

Material screws	
For aluminium	
housing:	stainless steel (standard)
	steel, coated with GEOMET® 321
	(DON-A25)
For stainless steel	
housing:	stainless steel (standard)
	steel, coated with GEOMET [®] 321
	(optional) for higher pressure rating
	(see order details)
Accuracy	
(under reference	
conditions*):	±3% of reading 0.5-3.6 l/h (DON-x04)
	±1% of reading 3.6-36 l/h (DON-x04)
	±1% of reading (DON-x05DON-x15)
SS-rotors:	$\pm 0.5\%$ of reading
	(DON-x20DON-x60)
	±0.2% of reading
	(DON-x20DON-x60;
	with optional Z3/E3-electronics based
	on linearisation function)
PPS-rotors:	±1% of reading (DON-x20DON-x60)
	$\pm 0.5\%$ of reading
	(DON-x20DON-x60;
	with optional Z3/E3-electronics based
	on linearisation function)
	± 1 % of reading (option M)
	(better accuracy for higher viscosities
	on request)
Additional max.	
inaccuracy for	
analogue outputs	
4-20 mA:	+/-0.15% full scale
Repeatability:	typ. ± 0.03 %
Protection class:	IP 66/67 (IP 65 for M4)
Medium temp.:	-20°C+80°C for options
	Lx, Zx, M4, DON-1/DON-8 and -20°C+120°C for DON-2 with
	pulse output and options Zx with cool-
	ing fins (+150 °C with option T0)
	for models with PPS /PEEK-rotors,
	max. temp. is limited to $+80$ °C
Ambient tomp :	-20°C+80°C,
Ambient temp.:	option M4 0 °C +60 °C
Cable entry:	M20x1.5, 1/2" NPT adapter
ATEX-approval	
(option E1/E2/E3/E	5): (Ex) II 2G Ex ia IIC T4 Gb
	(-20 °C ≤Ta ≤ +60 °C)
(option HE, DE, BE,	
KE, GE, LE, RE):	⟨Ex⟩ II 2G Ex db IIC T4/T6 Gb
	€x I M2 Ex db I Mb
IECEx-approval (op	
E1/E2/E3/E5):	Ex ia IIC T4 Gb
(option HE, DE, BE,	
KE, GE, LE, RE):	Ex db IIC,
	Ex db I Mb
	10x60 (calibration oil 4.6 cSt, 25 °C, 1 bar)
	04/x05 and x15 for high viscosities (calibration oil
	0 cSt, 20°C, 5 bar) ccuracy data is valid for given viscosities and higher.
F	active state to valid for given viscositios and higher.

Maximum Pressure (threaded version)

Model	Maximum pressure (bar)					
	DON-1	DON- 2/8	DON-1 (Option-M4)	DON-2/8 (Option–M4)		
DON-x04			-	-		
DON-x05		100	-	-		
DON-x10	64		-	-		
DON-x15	04	100	-	-		
DON-x20		70*				
DON-x25		60*	40	40		
DON-x30	40	50				
DON-x35	40	50	30	30		
DON-x40						
DON-x45						
DON-x50	16	16	16	16		
DON-x55						
DON-x60						

With flanges, maximum pressure rating as above or as per flange rating, whichever is lower

* Max. pressure rating of 100 bar possible with steel screws (see order details)

Noise Level (in dB) at Full Scale

Size	PPS-Oval Wheels	Stainless Steel-Oval Wheels		
x25	83	91		
x30	84	93,1		
x35	83,5	95		
x40	85,4	96		
x45	87,5	98		
x50	86,1	99,4		
x55	86,1	98,1		
x60	85	99		

Recommended Filter (for example model MFR-DO...) DON-x04...DON-x15<75 μm micron (200 mesh) DON-x20...DON-x35<150 μm micron (100 mesh) DON-x40...DON-x60<350 μm micron (45 mesh)



Pulse Output

Reed switch pulse output (... R0/RE)

The reed switch output is a two wire normally open SPST voltage free contact ideal for installations without power or for use in hazardous area locations when Intrinsically Safe (I.S.) philosophy is adopted.

Note: when using the reed switch output the liquid temperature must not change at a rate greater than 10°C per minute.

Average switching life of reed contact (MTTF):

max. load (100 V/10 mA) 5x10⁵ switching cycles

max. load (<5 V/10 mA) 5x10⁸ switching cycles

Power supply: max. 30 V_{pc}, max. 200 mA

Hall sensor pulse output (... H0/HE)

In the electronics options H0/HE, a Hall Effect sensor is combined with an active push-pull output. The electrical connection is provided in 3-wire version. The output is actively switched either to +Vs or to ground. The external supply voltage is 8...30 $V_{\rm DC}$. No additional external circuit is required (e.g pull up resistor). The high signal is approximately equal to the supply voltage +Vs and the low signal is approximately 0 V. The electrical load may optionally be connected to the supply voltage or to GND.

Maximum output current (current source or sink): 100 mA (short circuit protected).

In addition to Hall sensor, this option is equipped with a Reed switch which works the same as Option R0/RE.

Hall sensor pulse output (...HU)

Like option H0, however with following deviations:

(i) no push-pull output - only NPN output (ii) supply voltage 5-30 $\rm V_{\rm DC}$

Hall sensor pulse output (...B0/BE)

Like options H0/HE, however with bipolar sensors and alternating polarised magnets. This option is used for pulsating flows, but it is not equipped with Reed switch and has halved K-factor as compared to H0/HE.

High-resolution Hall sensor pulse output, (...G0/GE, ...K0/KE)

Like options H0/HE; model DON-x05 and DON-x10 can be supplied with four times the count of pulses per liter (...G0/GE) and models DON-x05, DON-x10 and DON-x15 with double amount of pulses (K0/KE) (see table «Output Pulse Resolution» on the following pages).

Quadrature hall effect pulse output (...D0/DE)

DON instrument with option D0/DE is provided with two independent Hall sensors. The two Hall effect sensors are arranged to give separate outputs out of phase with one another.

The QUAD output is mostly suitable for custody transfer with redundant signal or for detecting bidirectional flows (detection of flow direction).

Maximum output current per channel (current source or sink): 100 mA (short circuit protected).

Option L0/LE

The options L0 and LE (Ex) are available with loop powered 4-20 mA output. The loop is supplied with an external power supply 16...32 $V_{\rm DC}$ The maximum resistance of the series loads (PLC analogue input/display electronics) depends on the magnitude of the supply voltage and can be calculated as:

Max. load [Ohm] = $(+Vs - 9 V_{DC}) / 0.02 A [\Omega]$

Example: +Vs = 32 V_{DC} = > max. load = 1150 Ω

+Vs = 16 V_{DC} => max. load = 350 Ω

The load can be inserted at any point in the current loop observing correct polarity.

Mechanical totaliser (...M4)

The flowmeters type DON-x20... up to DON-x60... are available with a 4-digit resettable mechanical totaliser and indication of accumulated total value. The motion of the rotors is transmitted to the mechanical register totaliser via an interfacing reduction gear train and dynamic seal assembly.

Option M4 is available for DON-x20...x40 for volume units litre and gallon, and for DON-x45...x60 for volume units 10 litres and 10 gallons.

Body material:	enamelled die-cast aluminium, powder-coated
Protection:	IP65
Ambient temp.:	0+60°C
Medium temp.:	-20+80°C

4

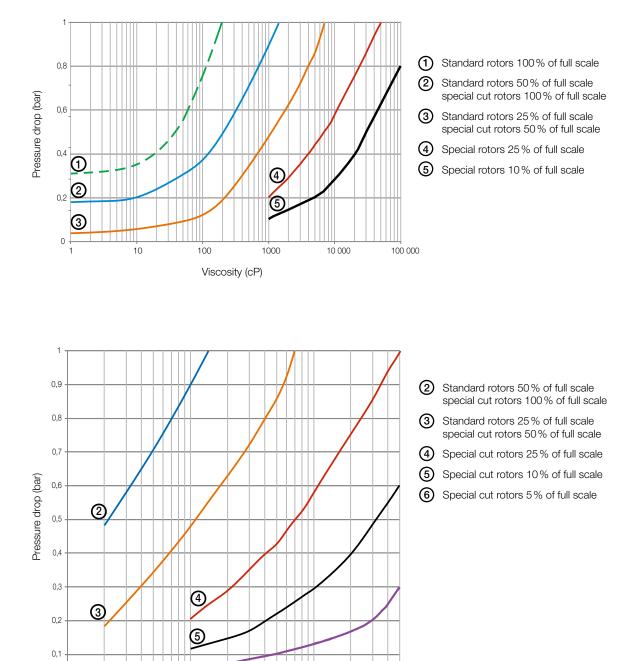


Electronic with LCD Display

Model	Z1	Z2	Z3	Z5	ZE	ZB	E1	E2	E3	E5
Function	dual totaliser	dosing unit	rate/counter			dual totaliser	dosing unit	rate/ counter	rate/ counter	
Power supply										
External	5-28 V _{DC}	12-28 V _{DC}	5-28	B V _{DC}	9-28 V _{DC}	-	$U_i = 28 V$ $I_i = 100 mA$ $P_i = 0.7 W$			
Battery operation (output deactivated) ²⁾	yes	no	yes	no	yes	yes	yes	no	yes	no
Battery included in shipment ³⁾	yes	-	yes	-	yes	yes	yes	-	yes	-
LCD display										
Selectable units	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Decimal point	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Accumulative total	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Resettable total	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Linearisation	yes	no	yes	yes	yes	yes	yes	no	yes	yes
Rate display	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Backlighting	yes	yes	yes	yes	yes	no	no	no	no	no
Input							I			1
Sensors			Hall sensor/	reed switch	1			reed s	witch	
Outputs										
4-20 mA	no	no	yes	yes	no	no	no	no	yes	yes
Flow rate alarm min./max.	no	no	NPN/PNP/ PP	NPN/PNP/ PP	no	no	no	no	no	with solid-state relay boarc
Batch end & control	no	yes	no	no	no	no	no	yes	no	no
Pulse outputs	no	no	PP	PP	PP	no	no	no	no	with
2 x SPDT relays ¹⁾	no	yes	no	yes	no	no	no	with solid-state relay board	no	solid-state relay board
Installation					·			· · · · · ·		<u>^</u>
IP65	yes	yes	yes	yes	IP66/67	IP66/67	yes	yes	yes	yes
Cable entries						k1.5/ NPT				
Medium temperature (Option: max. +120 °C)	-20+80°C									
Ambient temperature	-20+80°C -20+60°C									
Housing material	PA6 GF35 UL94 HB/VO/PC UL94 V-2									
ATEX approval	no yes									

 11 Replaces solid state outputs, for details see data sheet ZOK 21 Battery operation only applicable with reed switch sensor »Rx« 31 Options Z5, Z6, Z7, Z8 and Z9 are shipped without batteries





DON Pressure Drop Curves versus Viscosity

Viscosity (cP)

6

1000

Pressure drop limit versus flowrate

The curves above represent the pressure drop for standard cut oval rotors. Special cut rotors option «Y» have alternate tooth relieve which effectively reduces the pressure drop by

50%. When sizing a meter, be sure your selection falls **below** the 1 bar maximum allowable pressure drop line on the graph.

10 000

50 000

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0

100



Viscosities (cP)	Standard rotor	Special cut rotor	
≤ 1 000	1	1	
≤ 2000	0.5	1	
≤ 4000	0.42	0.84	
≤ 6000	0.33	0.66	
≤ 8000	0.25	0.5	
≤ 30 000	0.15	0.3	
≤ 60 000	0.12	0.25	
≤ 150 000	0.1	0.2	
≤ 250 000	0.05	0.1	
≤ 1 000 000	0.025	0.05	

Maximum Flowrate Multiplier (for higher viscosities)

Special cut rotors for higher viscosities

For viscosity > 1000 cP, special cut rotors option «Y» should be used to reduce pressure drop. This applies to DONx15 and larger sizes. For higher viscosities, the flowmeter max. flowrate is de-rated according to the attached chart. At viscosities <1000 cP these special rotors are less accurate.

Example: DON-x25 measuring oil at 8000 cP, max. flow 150 $I/min \ge 0.5 = 75 I/min new maximum flow rate.$

	se Resolution	1			D. I		
Model	Measuring range [l/min]	Reed switch Rx	Hall sensor Hx	Hall sensor Bx	Pulse/litre Quadr. hall sensor Dx	Hall sensor, high-resolution Gx	Hall sensor, high-resolution Kx
DON-x04	0.5 - 36 l/h	2670	2670	-	2670	11320	5340
DON-x05	0.5 - 36 l/h	2670	2670	-	2670	11320	5340
DON-x10	2 - 100 l/h	1062	1062	-	1062	4248	2124
DON-x15	15 - 550 l/h	351	702	351	702	-	1404
DON-x20	1 - 40	82	163	82	163	-	-
DON-x25	10 - 150	26	104	26	52	-	-
DON-x30	15 - 250	13.5	55	13.5	27	-	-
DON-x35	30 - 450	6.4	25.5	6.4	13.5	-	-
DON-x40	50 - 580	4.9	19.6	4.9	9.8	-	-
DON-x45	35 - 750	2.57	10.3	2.57	5.15	-	-
DON-x50	50 - 1000	1.5	5.9	1.5	3	-	-
DON-x55	75 - 1500	1.05	4.2	1.05	2.1	-	-
DON-x60	150 - 2500	0.56	2.3	0.56	1.15	-	-

Output Pulse Resolution

The values in above mentioned table are only approximate guidelines. The actual value for pulse rate can deviate from the values in this table and is mentioned in calibration certificate delivered with the flowmeter.



Measuring range	Но	using materi	al ⁴⁾						
[l/min]	Aluminium with PPS/ PEEK ¹²⁾ Rotor	Stainless steel	St. steel with PPS/PEEK ¹²⁾ Rotor	Connection	O-Ring Material	Electronics	Cable entry	Option	
0.5-36 l/h	DON-104H	DON-204H	DON-804H	R1 = G 1/8 N1 = 1/8" NPT		R0 = Pulse output reed			
0.5-36 l/h	DON-105H	DON-205H	DON-805H	R1 = G 1/8 N1 = 1/8"NPT		switch RE = Pulse output reed switch ATEX (Exd)			
2-100 l/h	DON-110H	DON-210H	DON-810H	R2 = G ¹ / ₄ N2 = ¹ / ₄ "NPT		H0 = Pulse output Hall sensor (Push/Pull)/ Reed switch			
15-550 l/h	DON-115H	DON-215H	DON-815H	R3 = G ³ / ₈ N3 = ³ / ₈ " NPT		HE = H0 + ATEX (Exd) HU = Pulse output Hall sensor (NPN)/Reed switch, supply 5-30			
1-40	DON-120H	DON-220H	DON-820H			B0 ³⁾ = Pulse output Hall sensor (Push / Pull) for pulsating flow BE ³⁾ = B0 + ATEX (Exd) T0 ⁸⁾ = Pulse output Hall			
10-150	DON-125H	DON-225H	DON-825H	$\begin{array}{rcl} \textbf{R6} = & G \ 1 \\ \textbf{N6} = & 1" \ NPT \\ \textbf{F6} = & DIN \ flange, \\ & PN \ 16/40 \ (DN \ 25) \\ \textbf{A6} = & ANSI \ flange, \\ & 150 \ Ibs \ (1") \\ \textbf{B6} = & ANSI \ flange, \\ & 300 \ Ibs \ (1") \\ \textbf{H6} = & G \ 1 \ (100 \ bar) \\ \textbf{P6} = & 1" \ NPT \\ & (100 \ bar) \\ \end{array}$	1 = FKM 3 ¹⁴⁾ = FEP-	sensor (Push-Pull), +150°C K0°) = Pulse output Hall sensor (Push-Pull), high resolution (x2) KE°) = K0 + ATEX (Exd) G0°2 = R0 + ATEX (Exd) G0°2 = G0 + ATEX (Exd) D0 = 2 phased outputs Hall sensor (Push- Pull) DE = D0 + ATEX (Exd)	M = M20 N = ½" NPT	0 = without N = without	
15-250	DON-130H	DON-230H	DON-830H	R8 = G 1½ N8 = 1½"NPT F8 = DIN flange, PN 16/40 (DN 40) A8 = ANSI flange, 150 lbs (1½") B8 = ANSI flange, 300 lbs (1½")	O-ring 4 = NBR 5 ¹³⁾ = Fluoro- prene® 9 = special ma- terials	 L0 = F/I transmitter, out- put: 4-20 mA "loop powered" analogue output LE = L0 + ATEX (Exd) Z1 = LCD dual totaliser, with battery supply outputs deactivated (ZOK-Z1) 	$ \begin{aligned} \mathbf{S}^{\eta} &= M20 \\ & \text{with} \\ & \text{cooling} \\ & \text{fin} \\ \mathbf{T}^{\eta} &= \frac{1}{2}^{u} \text{ NPT} \\ & \text{with} \\ & \text{cooling} \\ & \text{fin} \end{aligned} $	with cooling fin $\mathbf{T}^{\eta} = \frac{1}{2}$ " NPT with cooling	battery Y = special option (specify in clear text, not for ATEX, e. g.
30-450	DON-135H	DON-235H	DON-835H	R9 = G 2 N9 = 2" NPT F9 = DIN flange, PN 16 (DN 50) C9 ⁸⁾ = DIN flange,	(not for ATEX)	 Z2 = LCD dosing unit (ZOK-Z2) Z3 = LCD totaliser, rate, outputs: 4-20 mA, alarm, pulse (ZOK- Z3) (impulses not for 		check valve)	
50-580	DON-140H	DON-240H	DON-840H			battery supply) Z5 = as Z3, but with 2 relays/SPDT relays Z6 = Z1 + B0 Z7 = Z3 + B0 Z8 = Z1 + D0 Z9 = Z3 + D0			
35-750	DON-145H	DON-245H	DON-845H			ZE = LCD counter/flow (ZOE with external supply/with battery) ZP11 = LCD counter (flow			
50-1000	DON-150H	DON-250H	DON-850H	AB = ANSI flange, 150 lbs (3")		ZB ¹¹⁾ = LCD counter/flow (ZOE without external supply/with battery)			
75 - 1500	DON-155H	DON-255H	DON-855H	RC = G 4 NC = 4" NPT FC = DIN flange, PN 16 (DN 100) AC = ANSI flange, 150 lbs (4")					
150 - 2500 ¹⁰⁾	DON-160H	DON-260H	DON-860H			M4 ⁶⁾ = mech. totaliser	0= without		

Order Details (Example: DON-105H R1 1 L0 M 0)

¹ Only for DON-x32 ² Only for DON-x04, -x05 and -x10 [®] Not for DON-X04, -x05 and -x10 ⁴ Replace 'H' with 'G' to order GPH (GPM) [®] With steel screws, only for DON-2... and DON-8... [®] Only for DON-x20... DON-x60. Please specify the flow direction in clear text while ordering (possible flow directions «bottom to top» or «left to right» or «right to left» only). Standard flow direction is from bottom to top ⁷ Only for electronic options -Zx/-Ex, not for DON-1... and DON-8... [®] Only for DON-2... [®] Only for DON-x04, -x05, -x10, -x15, without Reed switch ¹⁰ Calibrated up to 2200 l/min. Higher flow rate calibration on request ¹¹¹ Without backlighting ¹² From DON-x20 PPS ¹³⁰ Only for DON-x04...x20, this version is not calibrated with oil. Use K-factor values from the data sheet. ¹⁴⁰ Only for DON-x04...x40

Oval Wheel Flowmeter Model DON



Technical Details MFR-DO (version stainless steel)

Technical Details Ivi	п-DO ()
Design:	two-par
Connections:	female t DIN ISO
Nominal pressure:	PN 40
Temperature range:	-20°C
Mesh size:	200 mes 100 mes 40 mest
Mounting position:	cover to

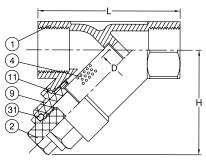
two-part screwed body female thread G ¼ ... G 3 DIN ISO 228-1 PN 40 -20 °C ... +180 °C 200 mesh/75 µm for G ¼, G % 100 mesh/150 µm for G ½, G 1, G 1½ 40 mesh/400 µm for G 2, G 3 cover toward bottom, note specified direction of flow

Materials

Body (1):	stainless steel 1.4408, EN1503-1
Plug (2):	stainless steel 1.4408, EN1503-1
Screen (4):	stainless steel 316
Bonnet (9):	stainless steel 1.4408, EN1503-1
Body seal (11):	PTFE
O-ring (31):	FPM

MFR-DO





Dimensions, weight and Order Details

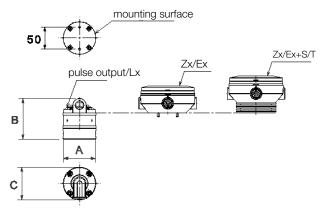
 $\begin{array}{l} \mbox{MFR-DO stainless steel version} \\ (\mbox{example: MFR-DOR15}) \end{array}$

Order no.	Size		L	н	D	Weight
			[mm]	[mm]	[mm]	[kg]
MFR-DOR08	DN08	1⁄4"	65.0	51.0	10.0	0.25
MFR-DOR10	DN10	3⁄8 "	65.0	51.0	12.0	0.25
MFR-DOR15	DN15	1⁄2"	65.0	51.0	15.0	0.25
MFR-DOR25	DN25	1"	90.0	72.0	25.0	0.70
MFR-DOR40	DN40	1½"	120.0	87.0	40.0	1.20
MFR-DOR50	DN50	2"	140.0	103.0	50.0	1.90
MFR-DOR80	DN80	3"	200.0	143.0	80.0	6.16

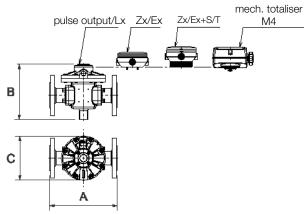


Dimensions DON-1(2/8)...

DON-x04 DON-x15

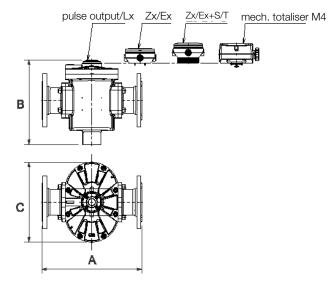


DON-x20 DON-x40



Dimensions DON-1(2/8)... (± 2 mm)

DON-x45 DON-x60

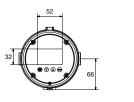


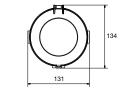
21.6

Electronic with LCD display/Zx/Ex



with optional cooling fins





Model	A [mm]		B [mm]			C [mm]		
	Thread connection	Flange connection	Pulse output/Lx	Zx/Ex	Mechanical totaliser M4	Pulse output/Lx	Zx/Ex	Mechanical totaliser M4
DON-x04	68	-	92	131	-	72	134	-
DON-x05	68	-	92	131	-	72	134	-
DON-x10	68	-	92	131	-	72	134	-
DON-x15	68	-	99	138	-	72	134	-
DON-x20	110	-	105 (101)	134 (130)	182 (178)	112	134	165
DON-x25	176	237	136	165	194	120	134	170
DON-x30	188	252	166	195	223	163	163	200
DON-x35	212	277	172	201	244	180	180	200
DON-x40	212	277	246	275	299	180	180	200
DON-x45	266	354	232	261	284	238	238	239
DON-x50	294	382	229	258	302	290	290	290
DON-x55	294	388	274	303	347	290	290	290
DON-x60	320	414	351	380	424	331	331	331

Note: Dimensions for DON-2/8... are specified in () only when they are different from DON-1...