Operating Instructions

for

Insertion Paddle Wheel Flowmeter/Monitor

Model: DOR

We don’t accept warranty and liability claims neither upon this publication nor in case of improper treatment of the described products.

The document may contain technical inaccuracies and typographical errors. The content will be revised on a regular basis. These changes will be implemented in later versions. The described products can be improved and changed at any time without prior notice.

1. Contents

Manufactured and sold by:

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2. Note

Please read these operating instructions before unpacking and putting the unit into operation. Follow the instructions precisely as described herein.
The instruction manuals on our website www.kobold.com are always for currently manufactured version of our products. Due to technical changes, the instruction manuals available online may not always correspond to the product version you have purchased. If you need an instruction manual that corresponds to the purchased product version, you can request it from us free of charge by email (info.de@kobold.com) in PDF format, specifying the relevant invoice number and serial number. If you wish, the operating instructions can also be sent to you by post in paper form against an applicable postage fee.

The devices are only to be used, maintained and serviced by persons familiar with these operating instructions and in accordance with local regulations applying to Health & Safety and prevention of accidents.

When used in machines, the measuring unit should be used only when the machines fulfil the EC-machine guidelines.

as per PED 2014/68/EU
In acc. with Article 4 Paragraph (3), "Sound Engineering Practice", of the PED 2014/68/EU no CE mark.

Operating pressure restrictions applied as follows:

Nominal connection size	PS
1.5“ (40 mm)	25 bar
2” (50 mm)	20 bar

3. Instrument Inspection

Instruments are inspected before shipping and sent out in perfect condition.
Should damage to a device be visible, we recommend a thorough inspection of the delivery packaging. In case of damage, please inform your parcel service / forwarding agent immediately, since they are responsible for damages during transit.

Scope of delivery:
The standard delivery includes:
- Insertion Paddle Wheel Flowmeter/Monitor Model: DOR

4. Regulation Use

Any use of the device, which exceeds the manufacturer's specification, may invalidate its warranty. Therefore, any resulting damage is not the responsibility of the manufacturer. The user assumes all risk for such usage.

5. Operating Principle

The DOR series insertion paddle wheel flow sensor is a very cost effective instrument for accurately measuring the flow of water or water-like liquids in large pipes.
The sensor is inserted into the process piping via a thread-o-let or half nipple fitting. Liquid flow through the pipe results in rotation of the affixed paddle wheel. The rotational speed of the paddle is proportional to the flow velocity, and therefore, proportional to the flowrate in the pipe.
The insertion type design provides a measuring technique that is much less expensive than full bore flowmeters, especially in larger pipe sizes. Insertion paddle wheel sensors are a robust measuring technology that boasts exceptional tolerance to dirt and solids.
The DOR series features an all 316 L stainless steel body. The rotor is made of PVDF or PEEK, with a long-life, graphite/PTFE self-lubricating bearing. The DOR has an integral, precision insertion mechanism that allows the installer to insert the rotor to the precise depth in the pipe for optimal readings.
Outputs include NPN open collector frequency, and/or reed contact frequency. Optional indicators include battery powered totalisers, loop powered ratemeter/totalizers and batch controllers.
The DOR-5 is suitable for "hot tap" installation. With its symmetrical design the DOR may be used for bi-directional flow measurement.

6. Important Information

Thank you for purchasing a Kobold Insertion Flowmeter. It is important that you read this manual to gain a full understanding of the capability and operational aspects of the equipment you are about to install.

This information is provided only to assist in the installation of the product and does not diminish your obligation to read the manual.

1. Select a location that meets the requirements as illustrated on the guideline sheet (please see the data sheet/order codes). An ideal installation would provide for 25 diameters of straight pipe upstream from the meter and 10 diameters downstream.

You will also need to know the pipe internal diameter (NB) and pipe wall thickness for calculation of the insertion depth. *(refer page 8.)* Non ideal installations may require in-situ calibration *(refer to the factory for details).*

2. After screwing the flowmeter in place ensure the flow alignment mark located on the top positioning collar of the meter aligns with the flow in the pipe *(refer page 8).* This ensures the paddle is correctly aligned to the flow.
Note. the meter is bi-directional so a flow direction arrow is not provided.

3. Calculate and adjust the height of the flowmeter *(refer page 8).*

4. Electrical Installation depends on the model you have purchased.
If the dualpulse is fitted or supplied with a receiving instrument such as a totaliser or rate totaliser please refer to the appropriate manual and page 13 of this manual. For pulse output meters, select the appropriate output and wire to your receiving device. *(refer pages 10 to12).*

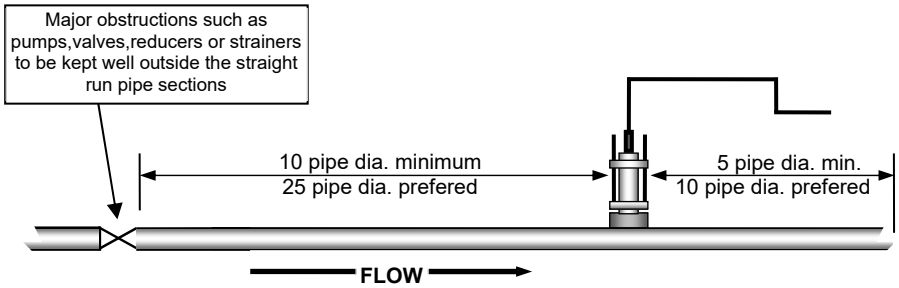
5. Calculate the flowmeter K *(scale)* factor to suit the installation. For ideal installations refer to page 14 or 15 or 16 of the flowmeter Manual. For non ideal installations the K-factor may be calculated by performing an in-situ calibration. Enter the appropriate K-factor into your receiving instrument.

7. Mechanical Connection

7.1 Meter location

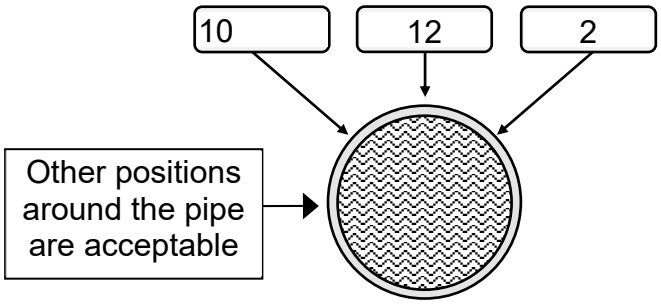
Choose an appropriate section of horizontal or vertical pipe as per the guidelines below. With vertical pipe installations the media should be pumped up through the pipe past the flow sensor so that any entrained air will pass freely.

The DOR flow sensor requires a fully developed turbulent flow profile to ensure maximum measurement accuracy and repeatability. This can be achieved by installing the DOR in a straight run of pipe. We recommend at least 10 but ideally 25 straight pipe diameters upstream & at least 5 but ideally 10 pipe diameters downstream of the flowmeter. Major obstructions such as pumps, valves or strainers will require longer straight runs before and after the flowmeter.



7.2 Meter installation & orientation

Cut a 40mm diameter hole (1.6") on either the 2, 10 or 12 o'clock positions of the pipe. If there is any likelihood of air entrainment in a horizontal pipe do not locate the flow transducer in the 12 o'clock position.



Install a female threaded weld on fitting (threadolet) or service saddle.
Wrap the threads of the flowmeter with Teflon tape or sealing compound & screw the unit into the installed fitting.

7.3 Height adjustment calculation

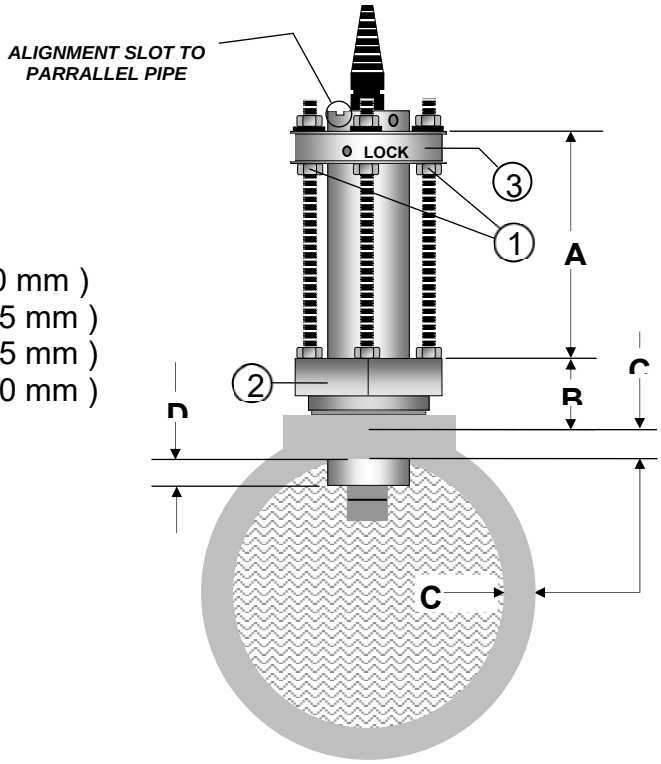
Calculate the adjustment height **A** for DOR-42 (or **AA** for the DOR-52) as follows:

A (for DOR-42) = 175 mm (6.9") - (B + C + D)
AA (for DOR-52) = 420 mm (16.5") - (B + C + D)

Where:
B = Distance between the top of the pipe & the top of the hex adaptor.
C = Pipe wall thickness
D = Insertion depth (pipe ID ÷ 8)

Examples of insertion depth **D**:

For 40 mm pipe ID (**D=** 5.0 mm)
For 50 mm pipe ID (**D=** 6.25 mm)
For 100 mm pipe ID (**D=** 12.5 mm)
For 400 mm pipe ID (**D=** 50.0 mm)



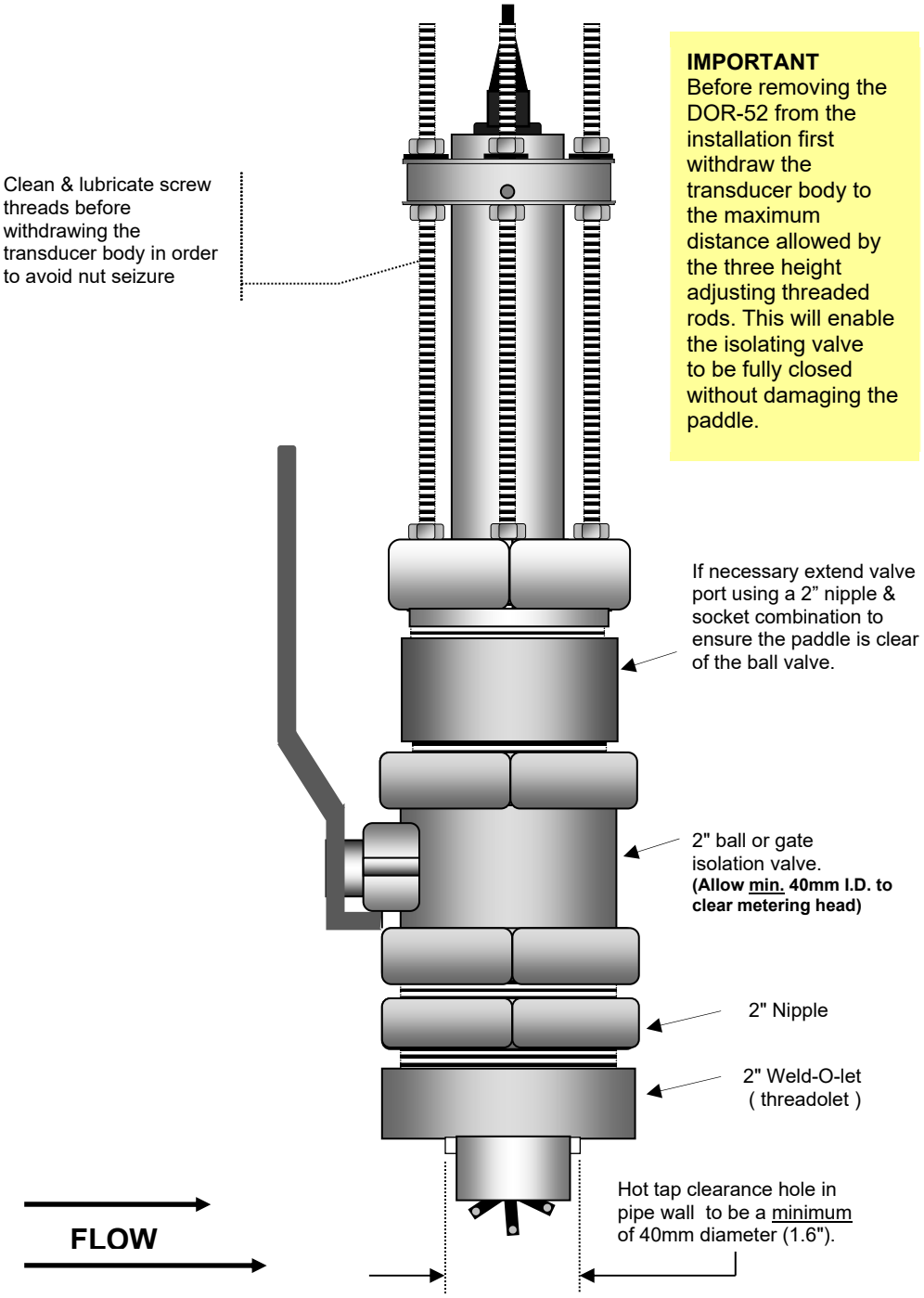
Turn the height adjustment nuts (1) as required so that the distance between the top of the hex adaptor (2) and the top of the positioning collar (3) equals your calculated distance **A** (for DOR-42) or **AA** for model DOR-52. Retighten the height adjustment nuts (1).

7.4 Flow direction orientation

The unit is bi-directional however the paddle must be aligned with the direction of flow.

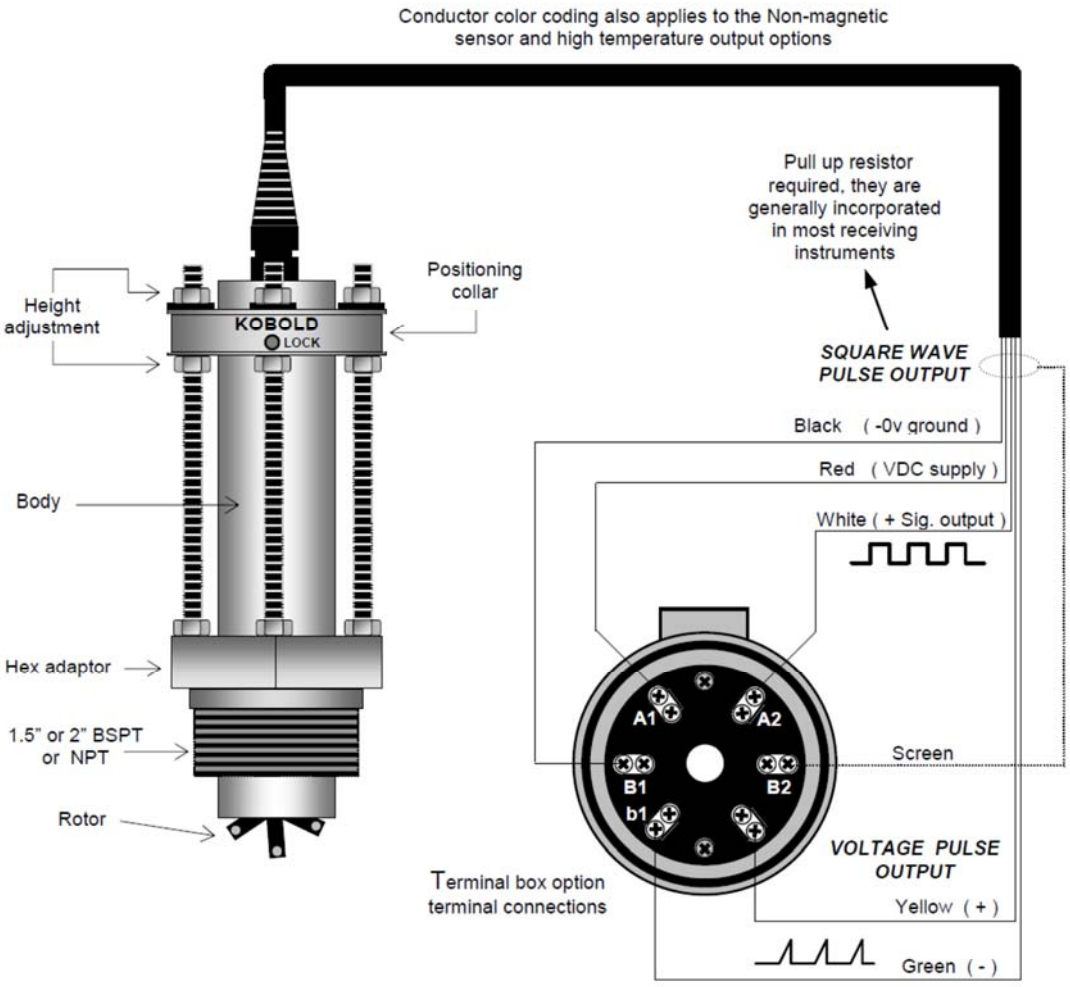
Using a 2mm hex key (Allen key), unlock the locking screw located on the positioning collar (3) then insert the hex key (as a lever) in the body rotating hole located above the collar, turn the body until the alignment slot is parallel with the direction of pipe. Retighten the locking screw.

7.5 Hot tap installation (model DOR-52)



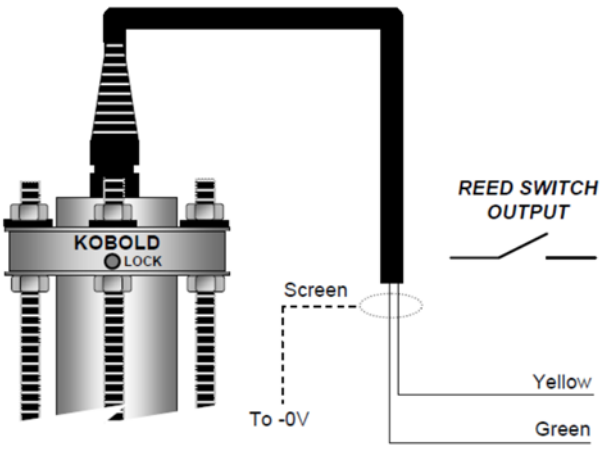
8. Electrical Connection

8.1 Standard outputs



8.2 Optional Reed switch output

The reed switch produces 1/3 of the normal pulse output value (e. g. 1/3 of the standard K-factor).



8.3 Instrument cable installation requirements

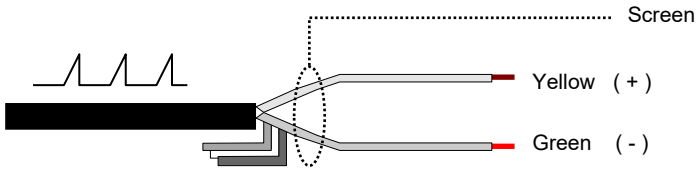
Use twisted multi-core low capacitance shielded instrument cable (22 AWG ~ 7x 0.3 stranded) for electrical connection between the flow meter and the remote instrumentation. The screen should be earthed at the readout instrument end only to protect the transmitted signal from mutual inductive interference.

The cable should **not** be run in a common conduit or parallel with power and high inductive load carrying cables as power surges may induce erroneous noise transients onto the transmitted pulse signal. Run the cable in separate conduit or with other low energy instrument cables.

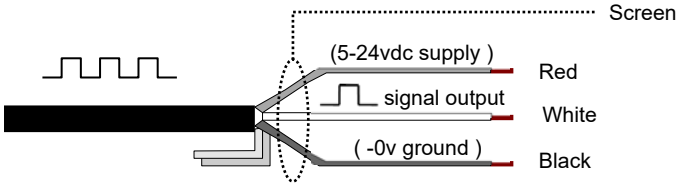
8.4 Pulse output selection (standard outputs)

The standard flowmeter has two independent pulse output signals that are linearly proportional to volumetric flow rate. Pulse transmission can be up to 1000 metres (3300 ft). An optional I.S. Reed Switch output is available *(see page 7).*

Voltage pulse *(pulse wire)* output
A self generating pulse output which produces a strong 1.5 volt voltage spike of approximately 10 micro/second duration with no dependence on rotor speed.

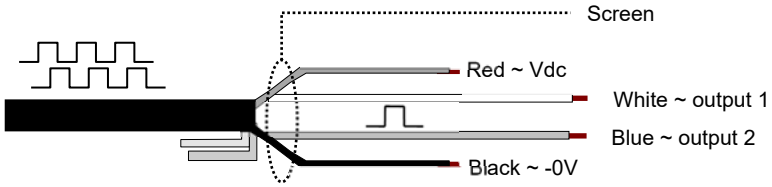


Square Wave Pulse *(Hall sensor)* *(also applies to non-magnetic & QP Hall outputs)*
An NPN open collector transistor pulse output produced by a solid state Hall Effect device. This three wire device requires 5~24vdc and produces an NPN square wave output (20mA max. sink), pulse width is 2~75 mSec. The Hall output requires a pull up resistor, these are generally incorporated in most receiving instruments. For (QP) Quadrature pulse output refer details page 12.



8.5 Quadrature outputs

DOR series flow meters supplied with the QP option produce two NPN open collector pulse outputs from two Hall Effect sensors. The outputs are " phase offset " in their timing so that external electronics are able to differentiate. These outputs may be used to assure output signal integrity or to measure bi-directional flow.

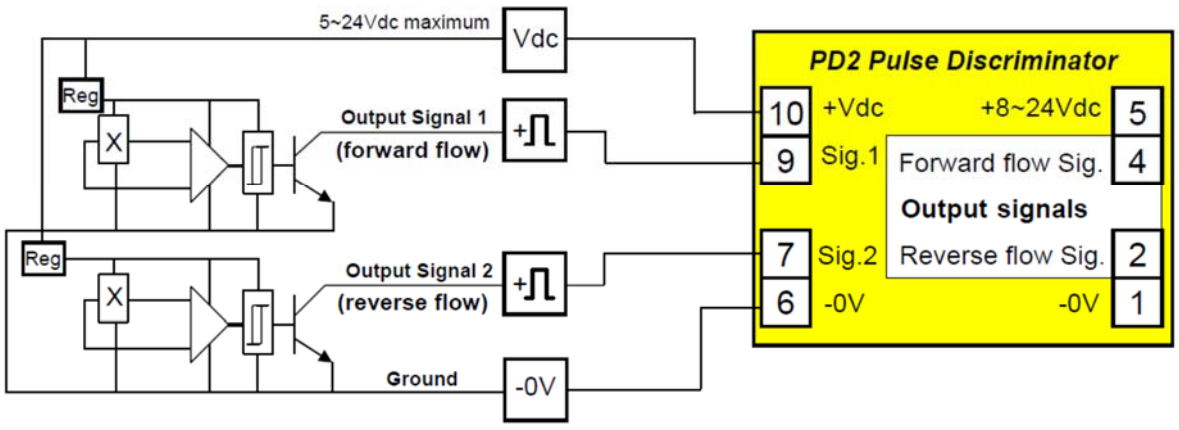


8.6 Bi-directional flow

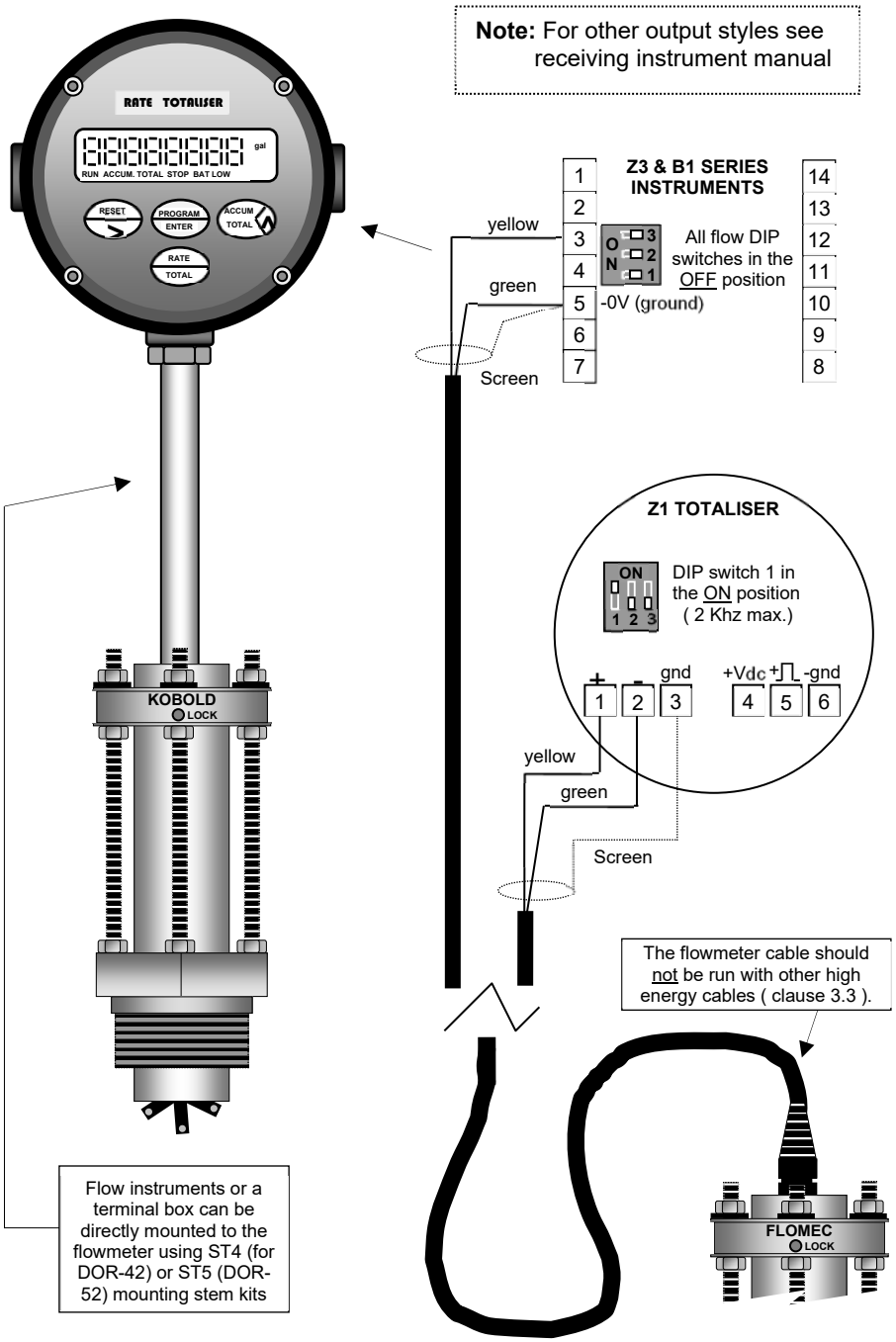
The DOR flow transducer is capable of accurately measuring flow in both directions without modification. Meters fitted with the QP output option (quadrature pulse output) may be interfaced with the Pulse Discriminator Module (PD2). The PD2 accepts the Quadrature pulse inputs & from these will discriminate between forward & reverse flow. Two individual & proportional pulse outputs can then be sent to appropriate totalising registers or an Z3 add and subtract flow rate totaliser.

It is important to note that the Quadrature Pulse option has the same pulse resolution (pulses/unit volume) as a standard flowmeter for both forward & reverse outputs.

Flowmeter with QP outputs



8.7 Voltage Pulse Connection to family instruments



9. K – FACTORS (calibration factors for meter)

The K-factor (pulses / litre, gallon etc.) will vary in relation to the bore size of the pipe in which the flowmeter is installed.

The K-factors and formula shown are a result of factory testing using smooth bore piping under ideal conditions. Variations to the given K-factors may occur when using rough bore piping or inadequate flow conditioning on either side of the flow transducer (refer clause 7.1). In these instances on site calibration may be used to determine the K-factor.

9.1 Flow transducer K- factors for common pipe sizes

Pipe detail		K-factors (standard K-factors for voltage & square wave outputs)					
NB	ID (#40)	Schedule 40 pipe - (#40)			Schedule 80 pipe - (#80)		
inches	mm	p / litre	p / m3	p / USgal	p / litre	p / m3	p / USgal
1.5"	40.9	18.678	18678	70.695	21.524	21524	81.468
2"	52.6	11.238	11238	42.534	12.818	12818	48.517
2.5"	62.7	7.880	7880	29.824	8.899	8899	33.682
3"	78.0	5.062	5062	19.161	5.676	5676	21.485
3.5"	90.2	3.768	3768	14.263	4.200	4200	15.896
4"	102	2.912	2912	11.021	3.233	3233	12.237
5"	128	1.839	1839	6.959	2.025	2025	7.665
6"	154	1.268	1268	4.798	1.402	1402	5.307
8"	203	0.719	719.0	2.721	0.787	787.2	2.980
10"	255	0.450	450.3	1.705	0.496	495.9	1.877
12"	303	0.316	316.0	1.196	0.347	347.4	1.315
14"	333	0.261	260.5	0.986	0.286	285.7	1.081
16"	381	0.198	198.0	0.750	0.217	217.0	0.821
18"	429	0.156	155.8	0.590	0.171	170.6	0.646
20"	478	0.125	125.4	0.475	0.138	137.8	0.521
24"	575	0.087	86.64	0.328	0.095	95.39	0.361

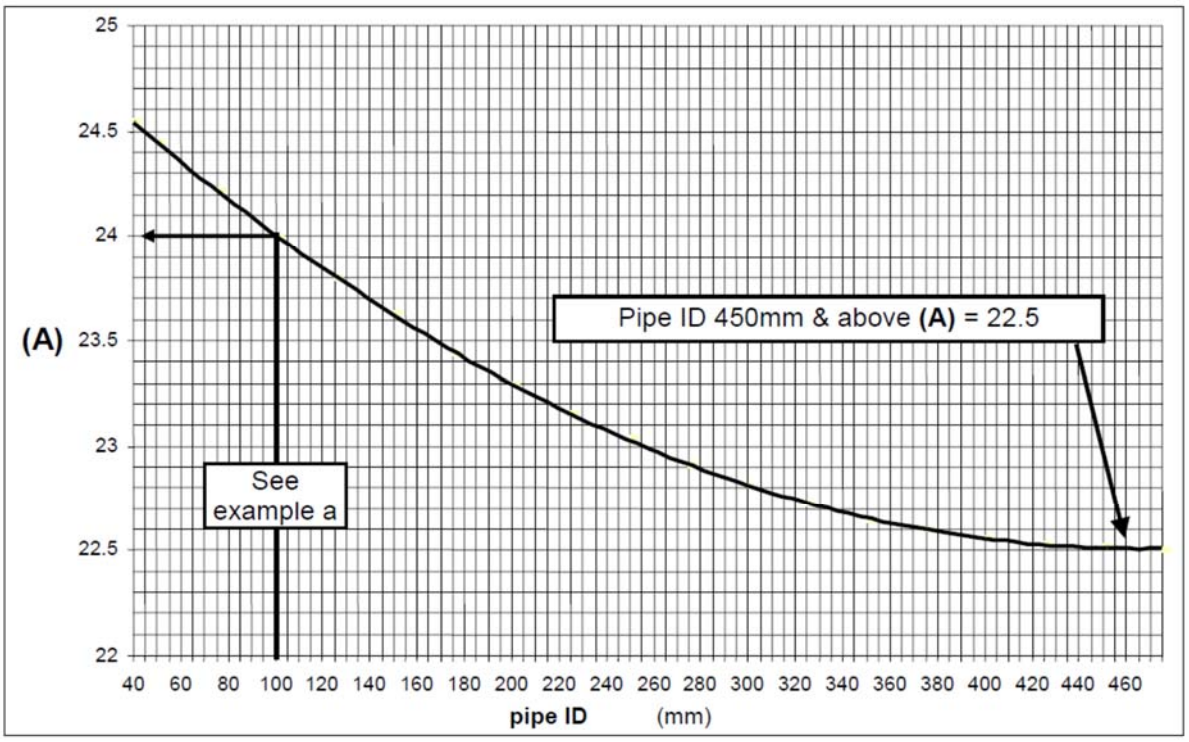
For other pipe sizes below 610 mm (24") not listed above, use the graphs and apply the formula on the following pages (15 & 16).

9.2 K-factors for large pipes 460 mm ID (18”) and above use:

Pulses per litre = 28647 ÷ pipe ID² (mm)
Pulses per M³ = 28647000 ÷ pipe ID² (mm)
Pulses per US gallon = 168.14 ÷ pipe ID² (inches)
Pulses per Imp. gallon = 201.94 ÷ pipe ID² (inches)

NOTE: K-factors for Reed Switch output option are 1/3 the standard factors of voltage pulse output.

9.3 Calculating K-factors (litres or m³)



Calculate K-factor (pulses / litre) using the above graph and the metric constant of 1273.2 as follows :

$$\textbf{Pulses / litre} = \frac{1273.2 \times \textbf{(A)} \text{ from graph}}{\text{pipe ID}^2 \text{ (mm)}}$$

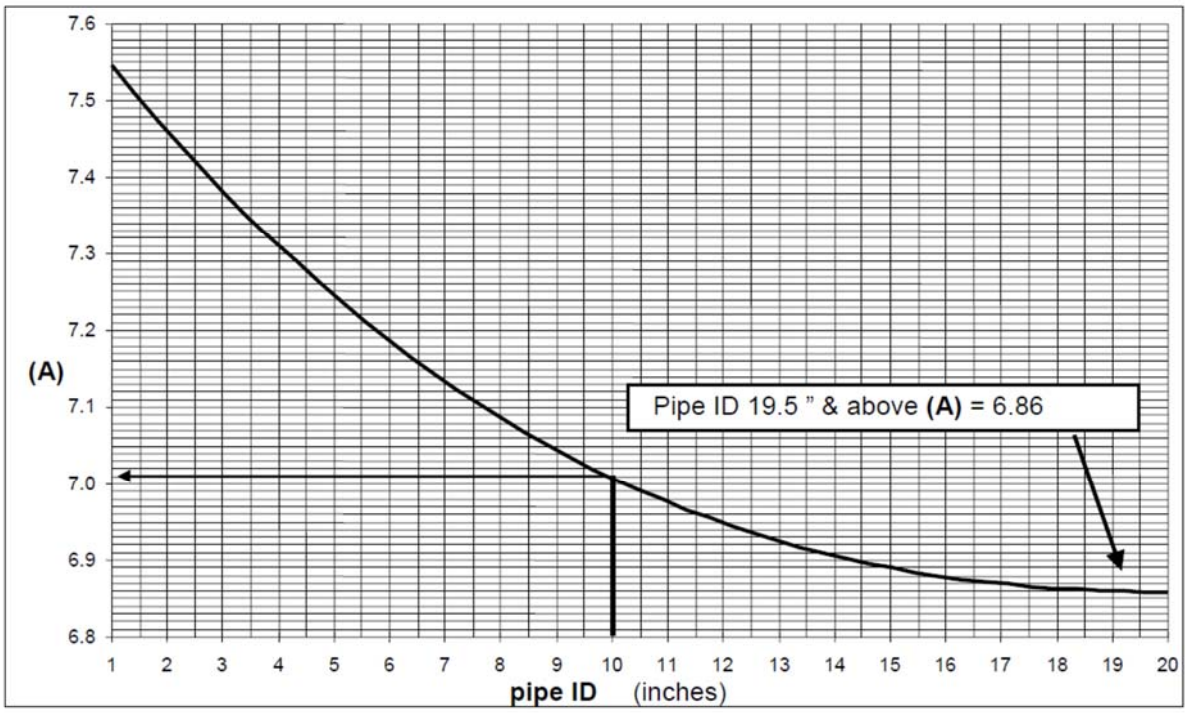
Example 'a' :
K-factor for 100mm pipe: **1)** from graph 100mm ID **(A)** = 24.0

2) pulses/litre. $= \frac{1273.2 \times 24.0}{10000} = \mathbf{3.056}$ p/litre

K-factor for m³: multiply by 1000 eg. K = 3056 p/m³
K-factor for megalitres: multiply by 1000000 eg. K = 3056000 p/megalitre

NOTE : K-factors for Reed Switch output option are 1/3 the standard factors of voltage pulse output.

9.4 Calculating K-factors (US gallons)



Calculate K-factor (pulses/gallon) using the above graph and the volumetric constant of 24.51 as follows:

$$\textbf{Pulses / US gal.} = \frac{24.51 \times \textbf{(A)} \text{ from graph}}{\text{pipe ID}^2 \text{ (inches)}}$$

Example 'b' :

K-factor for 10" pipe: **1)** from graph 10" ID **(A)** = 7.01

2) pulses/gal. $= \frac{24.51 \times 7.01}{100} = \mathbf{1.718}$ p/gal

NOTE: K-factors for Reed Switch output option are 1/3 the standard factors of voltage pulse output.

10. Technical Information

Velocity measuring range (linear):	0.3...10 m/s equates to approx.0.25...49,000 l/s in DN40 to DN2500 pipes; 0.15...10 m/s when using the linearisation function of electronic type ZOK-Z3 or ZOE
Linearity:	±1.5% with well est. flow profile
Repeatability:	±1% of f. s. at factory conditions and optimal straight runs
Max pressure:	80 bar
Temperature range:	-40…+100°C standard, see max. allowable medium temperature table for other options and restrictions
Material	
Body:	stainless steel 1.4404 (316L)
Rotor:	PVDF or PEEK (depending on model)
Rotor shaft:	stainless steel 1.4404 (316L)
Bearing:	graphite/PTFE
Seals:	FPM (standard): -15…+200°C
	NBR (Nitril): -65…+125°C

Electronics

Output frequency at max. velocity:	220...240 Hz (hall effect and voltage output),
	73...80 Hz (reed switch output)
Supply voltage:	see electrical output specifications and electronics comparison table in the data sheet
Electronic features:	see data sheet ZOK (only available as remote version)
Wiring (standard):	5 core, screened cable,
	length: 1 m (DOR-52), 1.5 m (DOR-42)
Transmission distance:	1,000 meters maximum, without integrated electronics
Cable entry (terminal box):	M20x1.5 (standard), 1/2“ NPT adapter (optional)
Protection Class:	IP68 (cable connection),
Straight piping requirement:	Minimum: 10xd (upstream), 5xd (downstream) Optimal: 25xd (upstream), 10xd (downstream)
Weight:	(approx., without electronics):
	1.6 kg (DOR-4), 2.5 kg (DOR-5)

11. Order Codes

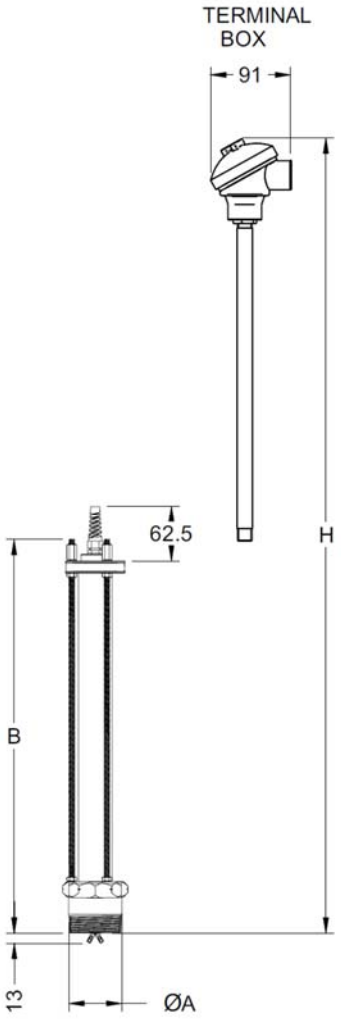
Example: **DOR-52 4 F R9 H5 00**

Model/ housing material	Rotor/shaft	Sealing material	Mechanical connection	Output/electrical connection	Electronics	Special Options
DOR-42 (for pipe size 40….900 mm) stainless steel	**2** = PVDF/ stainless steel (max. 100 °C) **4** = PEEK/ stainless steel (max. 150 °C) **X** = special on request)	**F** = FPM (standard) **N** = NBR	**R8** = R ½ male **R9** = R2 male **N8** = 1 ½“ NPT male **N9** = 2 “ NPT male	**F0** = NPN OC + 1.5 V-pulse + standard cable length[2)] **F2** = NPN OC + 1.5 V-pulse + 10 m cable **F5** = NPN OC + 1.5 V-pulse+ Terminal box on stem kit **N5**[1)] = NPN OC+ terminal box On stem kit + high temp. sensor (+150 °C) **R0** = reed switch + standard cable length[2)] **R2** = reed switch + 10 m cable **R5** = reed switch + terminal box on stem kit **Q0** = 2x NPN OC + standard cable length[2)] **Q2** = 2x NPN OC + 10 m cable **Q5** = 2x NPN OC + Terminal box on stem kit **XX** = special option (specified in clear text, consult factory)	**00**= frequency output only **XX** = special option (specified in clear text)	**none**= without **Y**= (specified in clear text)
DOR-52 (ffor pipe size 50…2500 mm) stainless steel			**R9** = R2 male **N9** = 2“ NPT male			

1) Only possible with PEEK rotor and FPM seal
2) Standard cable length DOR-42 = 1,5 m, DOR-52 = 1 m

12. Dimensions

[mm]



All dimensions in mm, ± 2 mm

	DOR – 42	**DOR - 52**
ØA	1 1/2“ or 2“ NPT/R2	2“ NPT/R2
B	198	444
Configuration	**H**	**H**
Terminal box	385	869

13. EU Declaration of Conformance

We, KOBOLD Messring GmbH, Hofheim-Ts, Germany, declare under our sole responsibility that the product:

Bi-Directional Insertion Flow Transducer Model: DOR

to which this declaration relates is in conformity with the standards noted below:

EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

EN 50581:2012 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Also, the following EC guidelines are fulfilled:

2014/30/EU EMC Directive
2011/65/EU RoHS (category 9)
2015/863/EU Delegated Directive (RoHS III)

2014/68 / EU PED Pressure Equipment Directive
Compliance is declared according to article 4, paragraph 3 – Sound Engineering Practice Annex II, table 3, with operating pressure restrictions applied as follows:

Nominal connection size	**PS**
1.5“ (40 mm)	25 bar
2” (50 mm)	20 bar

Hofheim, 05 Nov. 2019

H. Peters
General Manager

M. Wenzel
Proxy Holder