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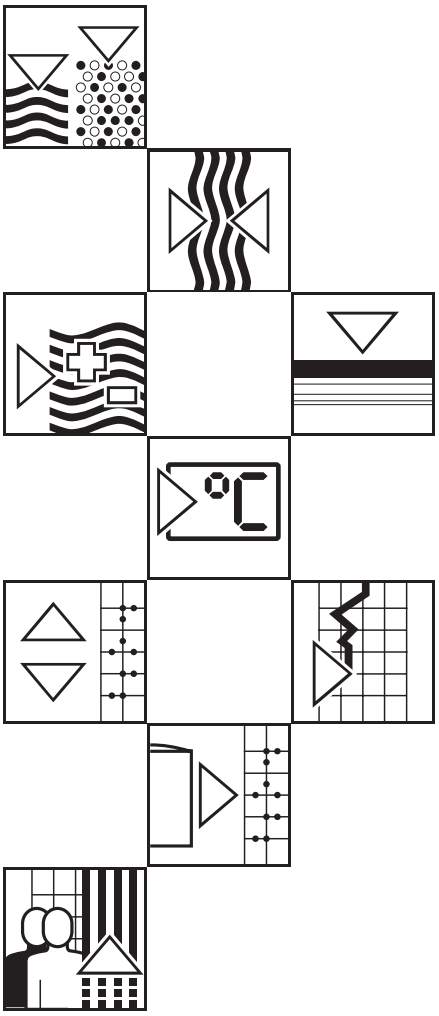
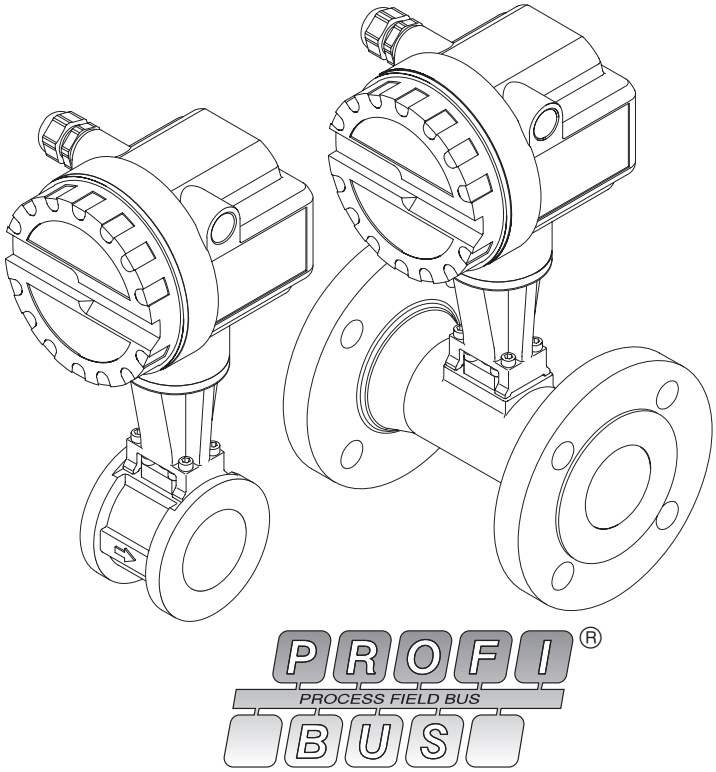
PW77 PA V1.00.XX

prowirl 77
Vortex Flow Measuring System (PROFIBUS-PA)

Operating Manual





PROFI® PROCESS FIELD BUS

Endress+Hauser

The Power of Know How

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1 Safety Instructions

1.1 Correct usage

- Prowirl 77 is only to be used for measuring the volumentric flowrate of saturated steam, superheated steam, gases and liquids. If the process pressure and temperature are constant, then Prowirl 77 can also indicate the flowrate in units of mass, energy or corrected volume.
- The manufacturer assumes no liability for damage caused by incorrect use of the instrument.
- Instruments which are ordered with hazardous area approvals are supplied with a separate “Ex documentation”, which is an integral part of this Operating Manual. The instructions and connected loads provided in this supplement must be closely observed! An appropriate pictogram is shown on the front page of the Ex documentation according to the approval given and the test centre.

1.2 Dangers and Notes

All instruments are designed to meet state-of-the-art safety requirements, have been tested, and have left the works in an operationally perfectly safe condition.
The devices were developed according to EN 61010 “Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures”. A hazardous situation may occur if the flowmeter is not used for the purpose it was designed for or is used incorrectly. Please carefully note the information provided in this Operating Manual indicated by the pictograms:

Warning!
A “warning” indicates actions or procedures which, if not performed correctly, may lead to personal injury or a safety hazard.
Please strictly observe the instructions supplied and proceed carefully.


Warning!

Caution!
A “caution” indicates actions or procedures which, if not performed correctly, may lead to faulty operation or destruction of the instrument. Please strictly observe the respective instructions.


Caution!

Note!
A “note” indicates actions or procedures which, if not performed correctly, may indirectly affect operation or lead to an unexpected instrument response.


Note!

1.3 Operational safety

- The Prowirl 77 measuring system fulfills the general safety regulations according to EN 61010 and the interference immunity regulations (EMC) according to European standard EN 50081 Part 1 and 2 / EN 50082 Part 1 and 2 as well as NAMUR recommendations.
- Housing ingress protection IP 67 according to EN 60529.
- A comprehensive self-monitoring feature of the measuring system ensures high operational safety.
- After loss of power supply (which is provided by the field bus), the configuration data of the measuring system remain in the EEPROM (without batteries). The totalizer remains on the value last shown.

1.4 Personnel for Installation, Start-up and Operation

- Mounting, electrical installation, start-up and maintenance of the instrument may only be carried out by trained personnel authorised by the operator of the facility. Personnel must absolutely and without fail read and understand this Operating Manual before carrying out its instructions.
- The instrument may only be operated by personnel who are authorised and trained by the operator of the facility. All instructions in this manual are to be observed without fail.
- In case of corrosive fluids, the compatibility of the material of all wetted parts such as measuring pipe, bluff body, sensor and gaskets is to be verified. This also applies to fluids used to clean the Prowirl 77 flowmeter. Endress+Hauser will be pleased to provide you with any help required.
- The installer has to make sure that the measuring system is correctly wired up according to the wiring diagrams. The complete bus system is to be grounded.


Warning!

There is no longer any contact protection once the housing cover is removed

Please observe all provisions valid for your country pertaining to opening and repair of electrical devices.

1.5 Repairs, Dangerous Chemicals

The following procedures must be carried out before a Prowirl 77 is sent to Endress+Hauser for repair:

- A note must be enclosed with the instrument, containing a description of the fault, the application and the chemical and physical properties of the fluid being measured.
- Remove all residue which may be present. Pay special attention to the gasket grooves and crevices where fluid may be present. This is especially important if the fluid is dangerous to health, e.g. corrosive, poisonous, carcinogenic, radioactive, etc.
- No instrument should be returned to us without all dangerous material being removed first.

Incomplete cleaning of the instrument may result in waste disposal requirements or cause harm to personnel (burns, etc.). Any costs arising from this will be charged to the operator of the instrument.

1.6 Technical Improvements

The manufacturer reserves the right to modify technical data without prior notice. Your local E+H Sales Office will supply you with all current information and any updates to this Operating Manual.

2 System Description

The Prowirl 77 vortex flowmeter measures the volumetric flow of steam, gases and liquids for fluid temperatures in the range of –200...+400 °C and at nominal pressures of up to PN 160 / ANSI class 600.

Prowirl 77 measures the volumetric flow at operating conditions. If the process pressure and temperature are constant, Prowirl 77 can be programmed to supply the flowrate in mass, energy or corrected volume units.

2.1 Prowirl 77 Measuring System

A measuring system consists of:
- Prowirl 77 transmitter
- Prowirl 77 W, Prowirl 77 F or Prowirl 77 H body

The Prowirl 77 transmitter is available in different versions. The transmitter versions differ in the type of electrical output signals and digital communication capabilities.

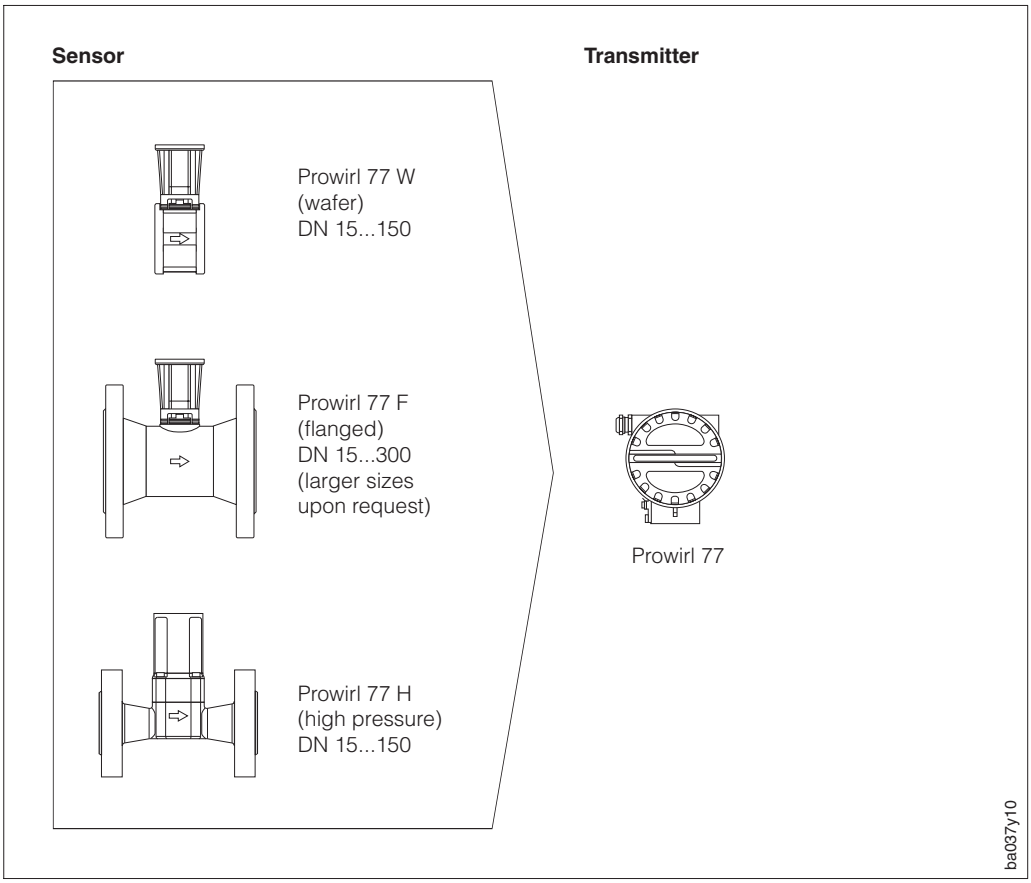


Fig. 1
Prowirl 77 measuring system

This Operating Manual describes the “PROFIBUS-PA” version.
The Prowirl 77 transmitter is available in two other versions:
- Version: “PFM”
- Version: “4...20 mA” (optional with HART)

Operation of those versions is not included in this Operating Manual. Separate Operating Manuals for those instruments are available on request.

The various Prowirl 77 transmitters can be freely combined with all meter body versions. This guarantees flexibility when matching a complete meter to specific industrial process conditions.

3 Mounting and Installation

3.1 General Information

Protection IP 67 (EN 60529)
The instruments fulfil all the requirements for IP 67. The following points must always be observed in order to ensure protection to IP 67 after istallation in the field or after servicing:

- Housing gaskets must be clean and undamaged when inserted in the gasket groove. The gaskets may need to be dried, cleaned or replaced.
- All housing screws and the housing cover must be firmly tightened.
- The cables used for connecting must have an outer diameter in the specified range.
- The cable gland must be firmly tightened (see Fig. 2).
- The cable must loop down before entering the cable gland to ensure that no moisture can enter it (see Fig. 2).
- Any unused cable glands are to be replaced with a plug.
- The protective bushing should not be removed from the cable gland.

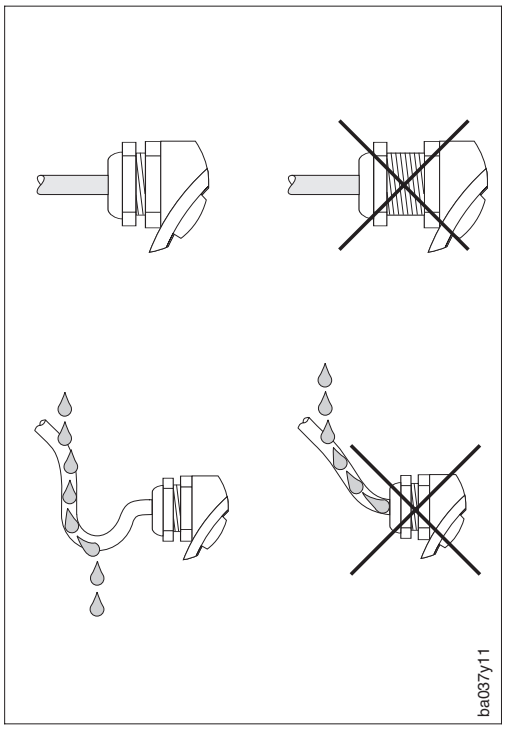


Fig. 2
Protection IP 67

Temperature ranges
- The maximum approved ambient and process temperatures must be observed (see page 56).
- Observe also the instructions on piping insulation and mounting position (see page 11).

3.2 Installation

A vortex flowmeter requires a fully developed flow profile as a prerequisite for measuring volume accurately. The following points must therefore be noted when mounting the Prowirl 77 in the pipeline.

Pipe inner diameter
When ordering, ensure that the nominal diameter and pipe schedule (DIN/ANSI/JIS) are correct, since calibration of the flowmeter and therefore the achieveable accuracy of the measuring point are dependent on these specifications.

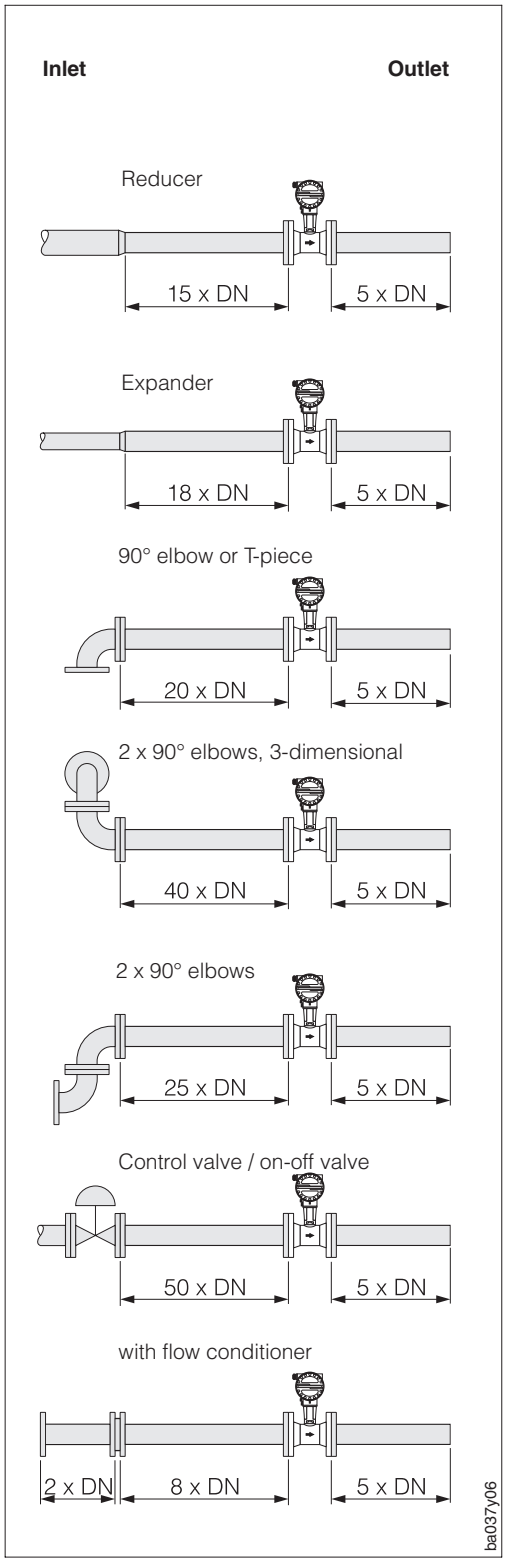


Fig. 3
Inlet and outlet piping requirements

Inlet and outlet sections
To ensure an undisturbed flow profile, the vortex flowmeter should be mounted upstream of any flow disturbances such as pipe elbows, reducers or valves, otherwise the longest possible section of piping should be between the disturbance and the flowmeter. The figures on the left show the *minimum section of straight piping* downstream of the disturbance as multiples of the nominal diameter of the pipe in DN. If two or more flow disturbances are located upstream, then the longest inlet section recommended should be used.

There must also be a straight outlet section of sufficient length downstream from the flowmeter to ensure that the vortices are properly developed.

Flow conditioner
With limited space and large pipes, it is not always possible to use the inlet sections given above. In such cases the specially developed perforated plate flow conditioner (see page 53 ff.) can be fitted as shown on the left. The flow conditioner is held between two piping flanges and centred with the flange bolts. It reduces the length of the inlet section downstream from flow disturbances to 10 x DN while maintaining high accuracy measurement.

Installation site
The Prowirl 77 can be mounted in any position in the piping. An arrow on the meter body shows the direction of flow.

For measuring liquids in vertical pipes, the meter should be installed in upward flow direction (Position A) to ensure a full pipe.

For horizontal pipelines positions B, C and D are possible. With hot piping (e.g. steam), position C or D must be selected in order to respect the maximum permissible ambient temperature at the electronics. For ambient temperatures see Technical Data, page 56.

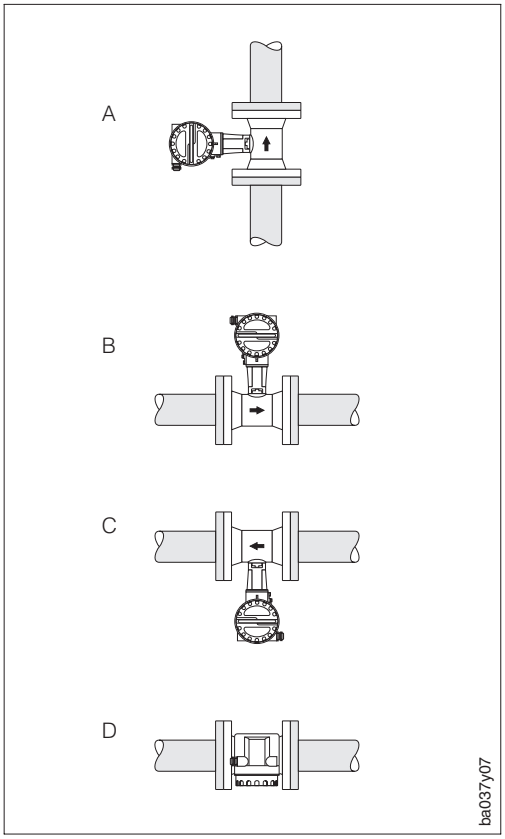


Fig. 4
Orientation

Pressure and temperature measurement points
Pressure and temperature measurement points are to be mounted *downstream* of the Prowirl 77 so that they affect vortex formation as little as possible.

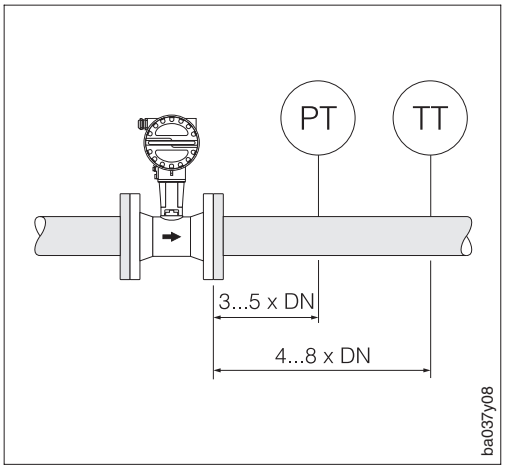
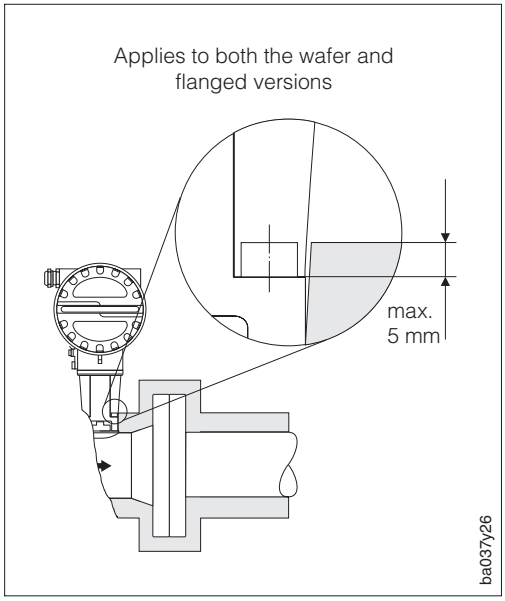


Fig. 5
Mounting pressure and temperature sensors

Pipeline insulation wafer/flanged version
Pipeline insulation is often used to prevent energy loss in hot processes.

Caution!
When insulating, ensure that sufficient pipe stand surface area is exposed. The exposed area serves as a radiator and protects the electronics from overheating.



Caution!

Fig. 6
Pipeline insulation wafer/flanged version

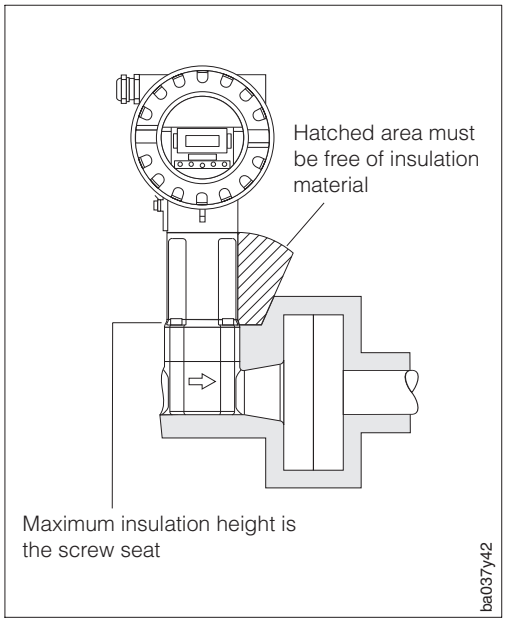


Fig. 7
Piping insulation
high pressure version

Piping insulation
high pressure version

The pipe stand must be free from insulation in order to guarantee temperature radiation and therefore to keep the electronics from overheating.

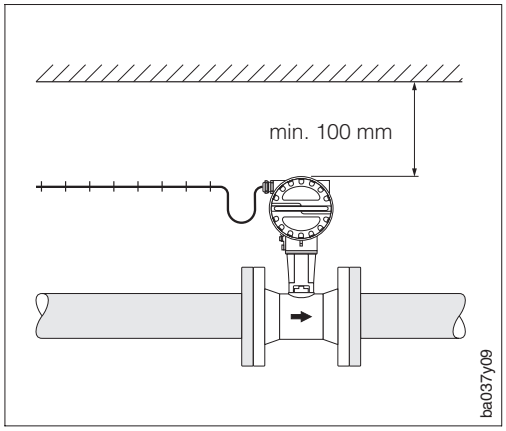


Fig. 8
Minimum spacing for mounting and removing the transmitter housing

Minimum spacing

When servicing or connecting the "Flowjack" simulator, it is necessary to remove the transmitter housing from the housing support.
When installing in the piping, observe the following cable lengths and minimum space:

- Minimum space in all directions 100 mm
- Cable length required L + 150 mm

Caution!
Removing the transmitter from the pipe stand is to be carried out by E+H service personnel only!

3.3 Mounting the Flowmeter

Caution!
Note the following points before installing the flowmeter:


Caution!

- Remove all packaging used for transport and protective coverings from the flowmeter before installing the flowmeter in the pipeline.
- Ensure that the inner diameters of the gaskets are identical or larger than those of the meter body and process piping. Gaskets which protrude into the flow affect vortex formation behind the bluff body and lead to inaccurate measurement. Therefore, the gaskets delivered by E+H come with a slightly bigger inner diameter than the measuring pipe.
- Ensure that the direction of the arrow on the meter body agrees with the direction of flow in the pipeline.
- Face-to-face lengths:
  – Prowirl W (wafer version): 65 mm
  – Prowirl F (flanged version) → see page 50
  – Prowirl H (high pressure version) → see page 52

Mounting Prowirl W
Mounting the wafer is carried out using a mounting set consisting of:
- bolts
- centering rings
- nuts
- washers
- gaskets

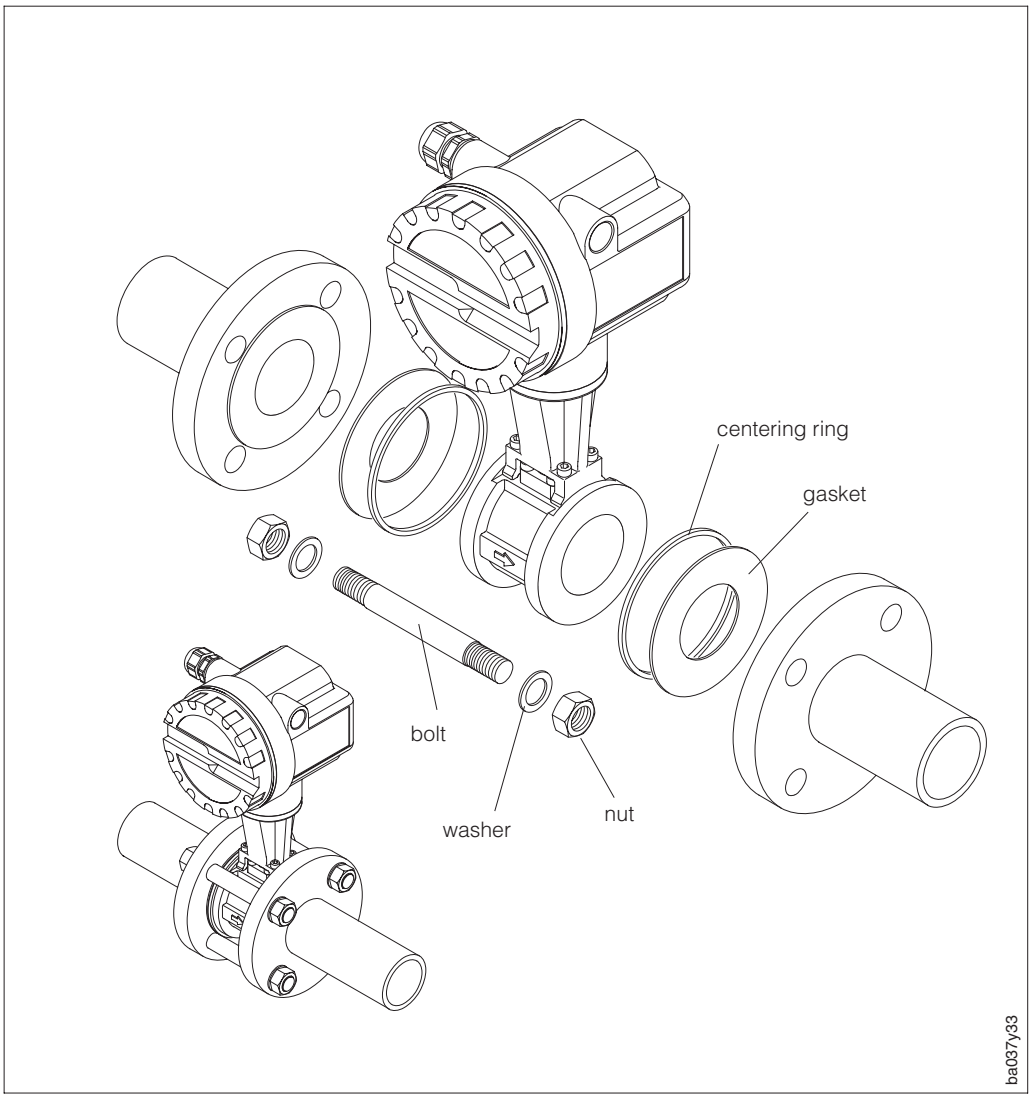


Fig. 9
Mounting the Prowirl W wafer version

3.4 Rotating the electronics housing

The electronics housing of Prowirl 77 can be rotated in 90° steps on the pipe stand. This is carried out as follows:

① Remove the securing screw at the pipe stand (minimum one turn).
② Pull out the electronics housing to the mechanical stop and then rotate it to the position required (in 90° steps). Push the housing back into the housing support.
③ Fasten the securing screw.

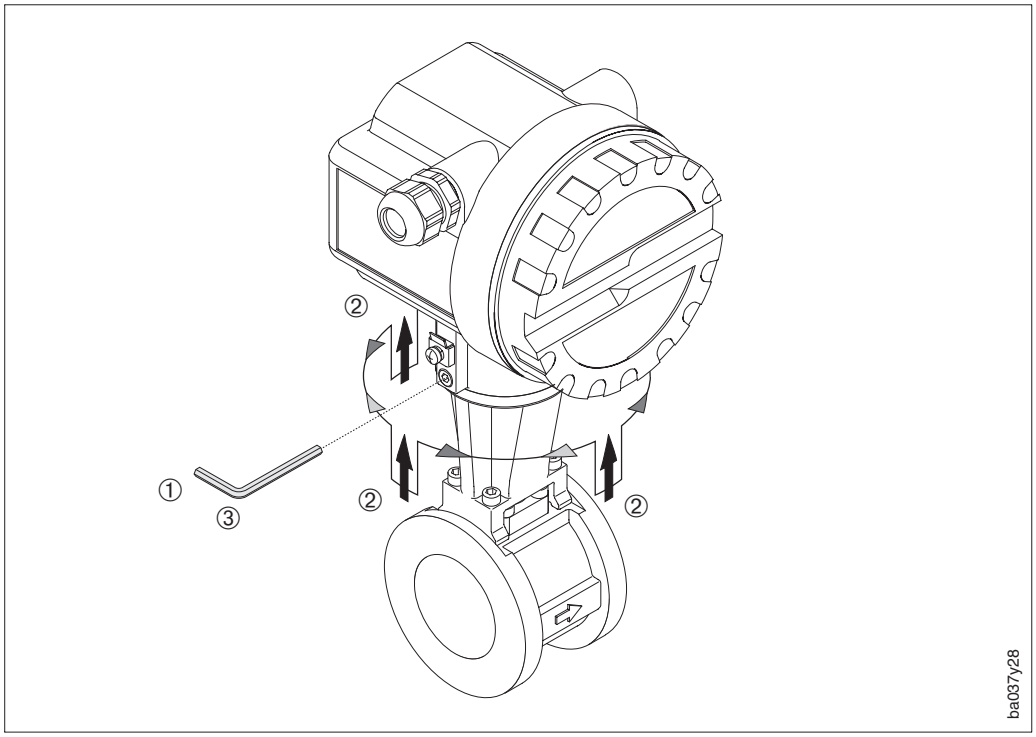


Fig. 10
Rotating the electronics housing

4 Electrical Connection

4.1 Connecting the Transmitter

Caution!
- All relevant national installation regulations must be observed.
- When installing an Ex version transmitter, please read the separate Ex documentation supplied.

Procedure
1. Unscrew the front cover.
2. Loosen the two Phillips screws on the upper cover plate and let it swing down.
3. Feed the power and signal cables through the cable gland.
4. Wire up according to the wiring diagram shown on this page.
5. Replace the cover plate and secure.
6. Screw the front cover securely again to the transmitter housing.

4.2 Wiring Diagram

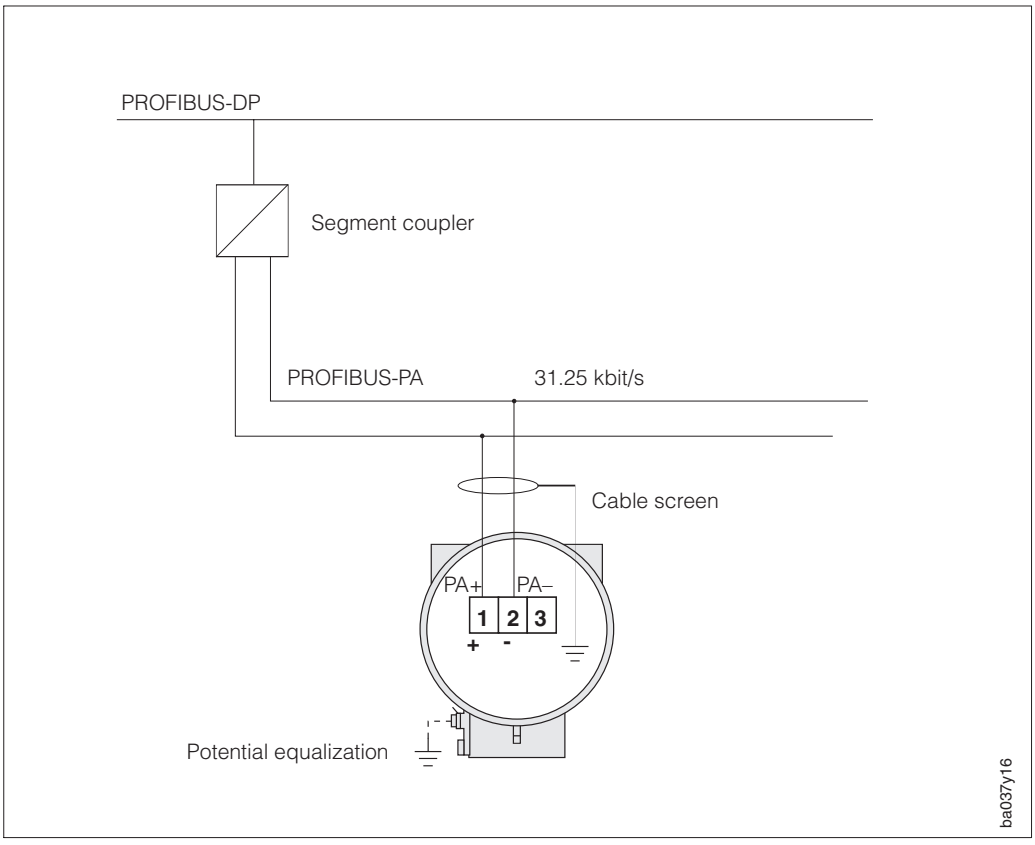


Fig.11
Connection of PROFIBUS-PA devices to a PROFIBUS-DP network

Connect cable according to wiring diagram.
- Connect cable cores to clamp 1 and 2. An exchange of the polarity has no influence on operation.
- Connect cable shielding to the internal grounding.
- The external ground terminal must be connected to the potential equalization grid. The grounding design of the plant is to be observed. The bus cable should always be screened at both ends.

5 Communication

5.1 PROFIBUS-PA interface

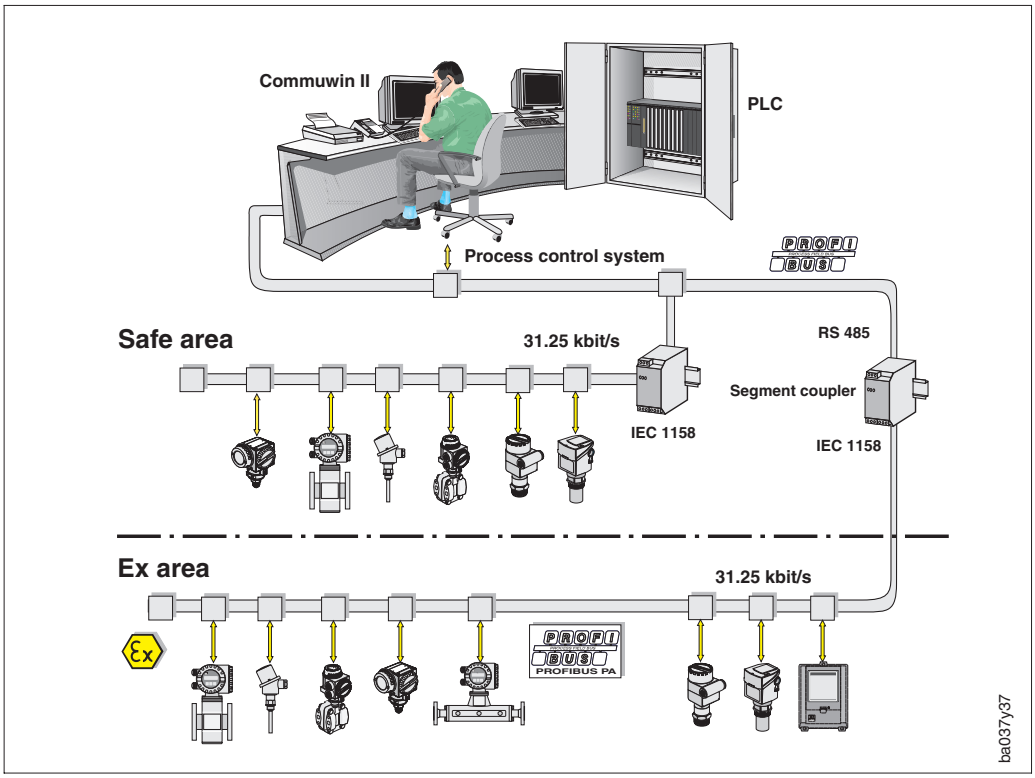


Fig. 12
Principle of PROFIBUS-PA

Note!
Additional specification details about PROFIBUS-PA Profile 2.0 fieldbus can be found in Operating Manual BA 198F/00/en “Field Communication PROFIBUS-DP/-PA: Guidelines for planning and commissioning”.

Note!

General
Prowirl 77 (PROFIBUS-PA version) has a PROFIBUS-PA interface according to the fieldbus standard PROFIBUS-DP, EN 50170 Volume 2.
This enables it to exchange data with process control systems which comply to this standard. Integrating into a control system must be in accordance with the specifications for PROFIBUS-PA profiles.

Transmission partner
Prowirl 77 always acts as a slave in a control system and, depending on the type of application, can therefore exchange data with one or several masters.
The master can be a process control system, a PLC or a PC with a PROFIBUS-DP plug-in communication board.

Note!
In project management, note that the Prowirl 77 current consumption is 12 mA.

Note!

Caution!
In order to protect the PROFIBUS-PA segment from the effects of any serious faults occurring in the instrument (e.g. short circuiting), the IEC 61158-2 interface is fitted with a safety fuse. When the fuse is activated, the instrument is permanently separated from the bus. The electronics must then be replaced.

Caution!

5.2 Configuration of Device Address

The address of a PROFIBUS-PA device must always be set. Without a correctly set address, the device will not be recognized by the control system. Valid device address numbers range from 0...126. In a PROFIBUS-PA network, the address must only be assigned once. All devices are delivered from the factory with the default address 126. This address can be used for testing the device and for connecting the device to a running PROFIBUS-PA network. After that the address must be changed in order to connect with further devices. The configuration of the device address for a Prowirl 77 can be done either with the help of an operating program (DP master Class II, e.g. Commuwin II) or locally by using DIP switches which can be reached by unscrewing the front cover.

Configuration of address mode

DIP switch No. 8: OFF = Addressing via the bus system
ON = Addressing via DIP switches No. 1...7 at the device (see Fig. 13)

Procedure

1. Remove the housing cover.
2. Set the DIP switches with a pointed object.
3. Replace and secure the housing cover.

Note!

Note!
The Prowirl 77 factory setting is as indicated below.

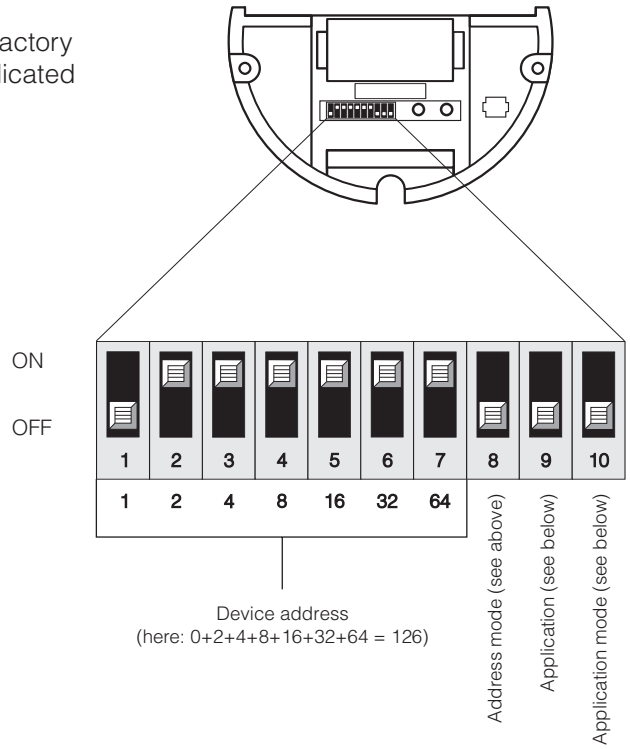


Fig. 13
Configuration of device address using the DIP switches

Configuration of application (fluid)

DIP switch No. 10: OFF = Application is configured via bus system
ON = Application is configured via DIP switch No. 9 (No. 9: OFF = liquid or No. 9: ON = gas/steam)

5.3 System integration

The GSD files are necessary for the configuration of a PROFIBUS-DP network. The GSD file (simple text file) describes e.g. the data transmission rate supported by the device or the kind and format of digital information which the PLC receives from the device.

Each device receives an identification number from the PROFIBUS user organization (PROFIBUS Nutzerorganisation PNO) which defines the GSD file name.
For Endress+Hauser, this ID number always starts with “15XX”.

Name of device	ID-No.	GSD-file	Type-file	Bitmaps
Prowirl 77	1510 (hex)	EH__1510.gsd	EH_1510x.200	EH1510_d.bmp EH1510_n.bmp EH1510_s.bmp

The GSD files of all Endress+Hauser devices can be obtained as follows:
- INTERNET: – Endress+Hauser → *http://www.endress.com* (Product Avenue → Downloadstreet → Field Communication St.)
  – PNO → *http://www.profibus.com* (GSD library)
- As floppy disc from Endress+Hauser: **Order number 943157-0000**

Contents of Download file in INTERNET and floppy disc:
- All Endress+Hauser-GSD files
- Endress+Hauser type files
- Endress+Hauser bitmap files
- Useful information about the devices

Using the GSD and type files:
The GSD files have to be copied in a specific subdirectory of the PROFIBUS-DP configuration software of your PLC.

Example 1:
Configuration software Siemens STEP7 for PLC Siemens S7-300/400.
There is a subdirectory \siemens\step7\s7data\gsd.

Additional to the GSD files there are bitmap files. With these the measuring devices are graphically presented. The bitmap files must be copied in subdirectory \siemens\step7\s7data\nsbmp.

Example 2:
If you are using a Siemens S5 PLC and your PROFIBUS-PA network is configured with configuration software COM ET200, you need type files (x.200 files).

Example 3:
On the floppy disc in directory GSD there is a subdirectory which contains GSD files with a standard identifier (0x94). These GSD files must be used e.g. for a PLC5 from Allen-Bradley.

For another configuration software, please ask your PLC supplier for the correct subdirectory.

5.4 Cyclic Data Transfer (Data_Exchange)

With PROFIBUS-PA, the cyclic transmission of analog values to the process control system uses data blocks with a length of 5 bytes. The measured value is portrayed in the first 4 bytes in the form of floating comma numbers according to the IEEE standard (see page 22). The 5th byte contains standardized status information which belongs to the instrument (see page 22).

PLC → Prowirl 77 (Output data)

Index output data	Data item	Access	Data format/remarks	Factory setting (unit)
0	control	write	With every transition of this byte from 0 to another number, a binary control can be performed with the cyclic service. A transition from any bit pattern to 0 has no effect. 0 → 1: reset totalizer 0 → 2... 255: reserved	–

Prowirl 77 → PLC (Input data)

Index output data	Data item	Access	Data format/remarks	Factory setting (unit)
0, 1, 2, 3	flow (volume/time)	read	32-Bit floating point number (IEEE-754) see page 22	dm^3/s
4	status flow	read	see status codes page 22	–
5, 6, 7, 8	totalizer (volume)	read	32-Bit floating point number (IEEE-754)	dm^3
9	status totalizer	read	see status codes page 22	–

If not all outputs of Prowirl 77 are required, single data blocks can be eliminated from the cyclic telegram using the device configuration from the PLC software. Only data blocks which are needed in the system should be activated, thereby improving the throughput of a PROFIBUS-PA system.

In Prowirl 77, three data blocks can be activated for cyclic data exchange. The following table shows the necessary configuration data in extended format (h means that the number is a hexadecimal number).

Byte	Data item	Access	GSD block description	Configuration data (depending on PROFIBUS master)
0...4	flow + status	read	Flow Rate Block	42h, 84h, 08h, 05h
5...9	totalizer + status	read	Total Volume Block	42h, 84h, 08h, 05h
0	control	write	Total Volume Reset	20h

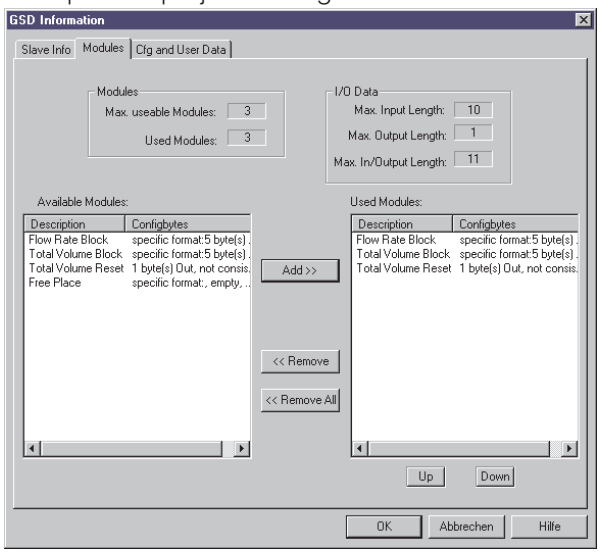
The identification code 94h can be used for PROFIBUS masters which do not support the extended format. However, the extended format is preferable since it contains additional information for interpreting the data.

The following configurations are possible with Prowirl 77:

Configuration	GSD block description	Data length
Flow with status + totalizer with status + control (= maximum configuration)	Flow Rate Block Total Volume Block Total Volume Reset	11 Bytes
Flow with status	Flow Rate Block	5 Bytes
Flow with status + totalizer with status	Flow Rate Block Total Volume Block	10 Bytes
Totalizer with status	Free Place Total Volume Block	6 Bytes
Totalizer with status + control	Free Place Total Volume Block Total Volume Reset	7 Bytes

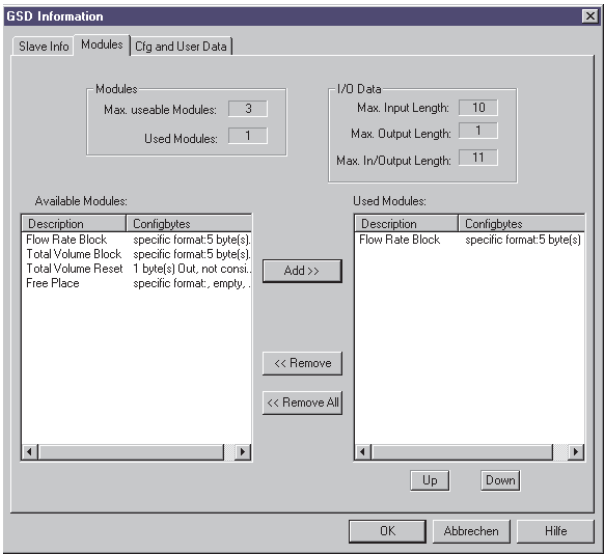
When followed by other configuration data, inactive data blocks have to be indicated with zero (0) “Free Place” as place holder in the configuration data string. Zeros at the end of the configuration data can be left out.

Example in a project management software:



Example 1:
With this configuration, the following blocks will be transmitted to the DP master, with a data length of 10 input bytes and 1 output byte:
– Flow + Status
– Totalizer + Status
– Totalizer reset

If no other configuration blocks are required, then FREE_PLACE is not needed for those data blocks not required:



Example 2:
In this configuration, Flow + Status are transmitted to the DP master.

Status codes for flow and totalizer

Prowirl 77 uses part of the status codes defined by the PROFIBUS user organization (PNO) (see PNO specification “PROFIBUS-PA Profile for Process Control Devices; General Requirements V2.0”):

Status code hex.	(dez.)	Meaning	Device status
0Fh	(15)	device failure (low and high limit bit set)	BAD
1Ch	(28)	out of service (no limit bit set)	BAD
1Fh	(31)	out of service (low and high limit bit set)	BAD
08h	(8)	not connected	BAD
40h	(64)	non-specific (no limit bit set)	UNCERTAIN
42h	(66)	non-specific (high limit bit set)	UNCERTAIN
43h	(67)	non-specific (low and high limit bit set)	UNCERTAIN
80h	(128)	O.K. (no limit bit set)	GOOD
81h	(129)	O.K. (low limit bit set)	GOOD
82h	(130)	O.K. (high limit bit set)	GOOD
83h	(131)	O.K. (low and high limit bit set)	GOOD

IEEE floating point numbers

Measured values are transmitted to the master Class I (e.g. PLC) in the IEEE-754 number format as shown below:

Byte n			Byte n + 1			Byte n + 2		Byte n + 3	
Bit 7	Bit 6	Bit 0	Bit 7	Bit 6	Bit 0	Bit 7	Bit 0	Bit 7	Bit 0
VZ	2^7 2^6 2^5 2^4 2^3 2^2 2^1		2^0	2^{-1} 2^{-2} 2^{-3} 2^{-4} 2^{-5} 2^{-6} 2^{-7}		2^{-8} 2^{-9} 2^{-10} 2^{-11} 2^{-12} 2^{-13} 2^{-14} 2^{-15}		2^{-16} 2^{-17} 2^{-18} 2^{-19} 2^{-20} 2^{-21} 2^{-22} 2^{-23}	
	Index			Mantissa		Mantissa		Mantissa	

Formula = $(-1)^{VZ} * 2^{(Index\ -127)} * (1 + Mantissa)$

Example: 40 F0 00 00 hex. = 0100 0000 1111 0000 0000 0000 0000 0000 binary

$$\text{Value} = (-1)^0 * 2^{(129-127)} * (1 + 2^{-1} + 2^{-2} + 2^{-3})$$

$$= 1 * 2^2 * (1 + 0.5 + 0.25 + 0.125)$$

$$= 1 * 4 * 1.875 = 7.5$$

5.5 Acyclic Data Transfer

The block model of Prowirl 77

With **acyclic** access, the control system or an operating program is able to control the parameters of the blocks listed below.

The Prowirl 77 software contains four different funciton blocks which correspond to the PROFIBUS-PA profile definitions:

- **Physical block**
  In the Physical block there is device specific information such as tag number, software version etc.
- **Transducer block for flow** (Flow block)
  The Transducer block contains the meter data such as calibration factor or nominal diameter.
- **AI block for flow** (AI = analog input)
  The AI block contains the basic automation functions.
  This universal function block provides the control system with all parameters for the processing of the flow measurement variable (filtering, scaling, mode and status handling).
- **Totalizer function block**
  The totalizer block allows direct access to totalizer parameters by the control system.

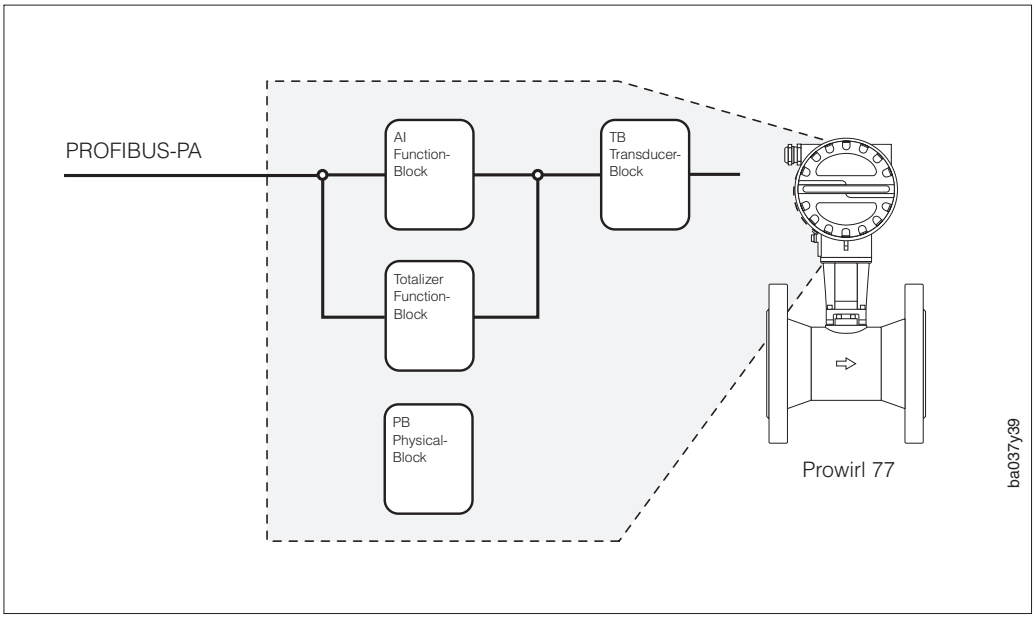


Fig. 14
Block model of Prowirl 77 PROFIBUS-PA

5.6 Prowirl 77 Slot / Index list

Basis is the definition of Profiles by the PROFIBUS user organisation (PNO).
All parameters (except for the totalizer block) are positioned in **Slot 1**.

The index can be found in the following table:


Note!

Note!
Additional information regarding the following tables can be found in "PROFIBUS-PA Profile for Process Control Devices; General Requirements V2.0".

Name	E+H Matrix	Index	Read	Write	* Parameter	Data type	Size bytes	Storage Class
Device Management								
Directory Object Header		0	X		M	Unsigned16	12	C
Composite List Directory Entries		1	X		M	Unsigned16	28	C
not used		2...13						
Physical Block (PB)								
PB Block Object		14	X		M	DS-32	20	C
PB Static Revision		15	X		M	Unsigned16	2	N
PB Tag Description	VAH0	16	X	X	M	Octet String	32	S
PB Strategy		17	X	X	M	Unsigned16	2	S
PB Alert Key		18	X	X	M	Unsigned8	1	S
PB Target Mode		19	X	X	M	Unsigned8	1	S
PB Mode Block		20	X		M	DS-37	3	N/Cst
PB Alarm Summary		21	X		M	DS-42	8	D
PB Software Revision	V5H4	22	X		M	Octet String	16	Cst
PB Hardware Revision	V5H5	23	X		M	Octet String	16	Cst
PB Device Manufacturer ID		24	X		M	Unsigned16	2	Cst
PB Device ID		25	X		M	Octet String	16	Cst
PB Device Serial Number	VAH1	26	X		M	Octet String	16	Cst
PB Diagnosis		27	X		M	Octet String	4	D
PB Diagnosis Extension		28	X		O	Octet String	6	D
PB Diagnosis Mask		29	X		M	Octet String	4	Cst
PB Diagnosis Mask Extension		30	X		O	Octet String	6	Cst
PB Device Certification		31	X	X	O	Octet String	16	N
PB Security Locking		32	X	X	O	Unsigned16	2	N
PB Factory Reset		33	X	X	O	Unsigned16	2	S
not used		34...43						
PB Descriptor		44	X	X	M	Octet String	32	S
PB Device Message		45	X	X	M	Octet String	32	S
PB Device Installation Date		46	X	X	M	Octet String	8	S
not used		47...51						
PB Actual Error Code	V5H2	52	X		O	Unsigned16	2	D
PB Last Error Code	V5H3	53	X	X	O	Unsigned16	2	D
PB UpDown Features Supported		54	X		M	Octet String	1	Cst
PB UpDown Control Parameter		55	X	X	O	Unsigned8	1	D
PB UpDown Parameter		56	X	X	O	UpDownData	20	D
PB Device Bus Address	V5H0	57	X		O	Signed8	1	D
PB Device & Software Number		58	X		O	Unsigned16	2	Cst
not used		59...64						
Transducer Block (TB) Flow								
TB Block Object		65	X		M	DS-32	20	C
TB Static Revision		66	X		M	Unsigned16	2	N
TB Tag Description		67	X	X	M	Octet String	32	S
TB Strategy		68	X	X	M	Unsigned16	2	S

Name	E+H Matrix	Index	Read	Write	* Parameter	Data type	Size bytes	Storage Class
TB Alert Key		69	X	X	M	Unsigned8	1	S
TB Target Mode		70	X	X	M	Unsigned8	1	S
TB Mode Block		71	X		M	DS-37	3	N/Cst
TB Alarm Summary		72	X		M	DS-42	8	D
TB Flowrate	V0H0	73	X		M	float	4	D
TB Nominal Size	V6H1	74	X	X	M	float	4	S
not used		75...76						
TB Flowrate Units	V1H0	77	X	X	M	Unsigned16	2	S
not used		78						
TB Calibration Factor	V6H2	79	X	X	M	float	4	S
not used		80...81						
TB Upper Sensor Limit		82	X		O	float	4	S
TB Lower Sensor Limit		83	X		O	float	4	S
not used		84...90						
TB Vortex Frequency	V0H1	91	X		O	float	4	D
not used		92...102						
TB Application Medium	V6H0	103	X	X	O	Unsigned8	1	S
TB Sensor Temperature Coefficient	V6H3	104	X	X	O	float	4	S
TB Process Temperature	V6H4	105	X	X	O	float	4	S
TB Amplification	V6H5	106	X	X	O	Unsigned8	1	S
TB User Flowrate Unit	V1H2	107	X	X	O	float	4	S
not used		108...159						
AI-Flow Block (AI) Flow								
AI Block Object		160	X		M	DS-32	20	C
AI Static Revision		161	X		M	Unsigned16	2	N
AI Tag Description		162	X	X	M	Octet String	32	S
AI Strategy		163	X	X	M	Unsigned16	2	S
AI Alert Key		164	X	X	M	Unsigned8	1	S
AI Target Mode		165	X	X	M	Unsigned8	1	S
AI Mode Block		166	X		M	DS-37	3	N/Cst
AI Alarm Summary		167	X		M	DS-42	8	D
not used		168...169						
AI Out		170	X		M	DS-33	5	D
AI PV Scale		171	X	X	M	DS-36	11	S
AI Out Scale		172	X	X	M	DS-36	11	S
not used		173						
AI Channel		174	X	X	M	Unsigned16	2	S
not used		175						
AI PV Filter Time		176	X	X	M	float	4	N
not used		177...178						
AI Alarm Hysteresis		179	X	X	M	float	4	S
not used		180						
AI HI HI Limit		181	X	X	M	float	4	S
not used		182						
AI HI Limit		183	X	X	M	float	4	S
not used		184						
AI LO Limit		185	X	X	M	float	4	S
not used		186						
AI LO LO Limit		187	X	X	M	float	4	S
not used		188...189						
AI HI HI Alarm		190	X		M	DS-39	16	D
AI HI Alarm		191	X		M	DS-39	16	D
AI LO Alarm		192	X		M	DS-39	16	D
AI LO LO Alarm		193	X		M	DS-39	16	D
AI Simulate		194	X	X	M	DS-50	6	N
not used		195...200						

Name	E+H Matrix	Index	Read	Write	* Parameter	Data type	Size bytes	Storage Class
View_1 Objects of Blocks in Slot 1								
PB View_1 Object		201	X		M	Unsigned16, DS-37,DS-42, Octet String[4]	17	D
TB View_1 Object		202	X		M	Unsigned16, DS-37,DS-42 float	17	D
AI View_1 Object		203	X		M	Unsigned16, DS-37,DS-42, DS-33	18	D

The totalizer block parameters are positioned in Slot 2, the index can be found in the following table:

Totalizer Block (TOT)								
TOT Block Object		0	X		M	DS-32	20	C
TOT Static Revision		1	X		M	Unsigned16	2	N
TOT Tag Description		2	X	X	M	Octet String	32	S
TOT Strategy		3	X	X	M	Unsigned16	2	S
TOT Alert Key		4	X	X	M	Unsigned8	1	S
TOT Target Mode		5	X	X	M	Unsigned8	1	S
TOT Mode Block		6	X		M	DS-37	3	N/Cst
TOT Alarm Summary		7	X		M	DS-42	8	D
not used		8...9						
TOT Out Total.	V0H2	10	X		M	DS-33	5	D
not used		11						
TOT Units	V1H1	12	X	X	M	Unsigned16	2	S
not used		13						
TOT Channel		14	X	X	M	Unsigned16	2	S
TOT Reset Total.	V4H1	15	X	X	M	Unsigned8	1	N
TOT Operating Mode		16	X	X	M	Unsigned8	1	S
not used		17						
TOT Failsafe Mode		18	X	X	M	Unsigned8	1	S
not used		19						
TOT Polarity		20	X	X	M	Unsigned8	1	S
not used		21						
TOT Alarm Hysteresis		22	X	X	M	float	4	S
TOT HI HI Limit		23	X	X	M	float	4	S
TOT HI Limit		24	X	X	M	float	4	S
TOT HI HI Alarm		25	X		M	DS-39	16	D
TOT HI Alarm		26	X		M	DS-39	16	D
not used		27...31						
TOT User Unit	V1H4	32	X	X	O	float	4	S
View_1 Object of Block in Slot 2								
TOT View_1 Object		33	X		M	Unsigned16, DS-37,DS-42, DS-33	18	D

* Parameter: O = Optional
M = Mandatory

5.7 Operation

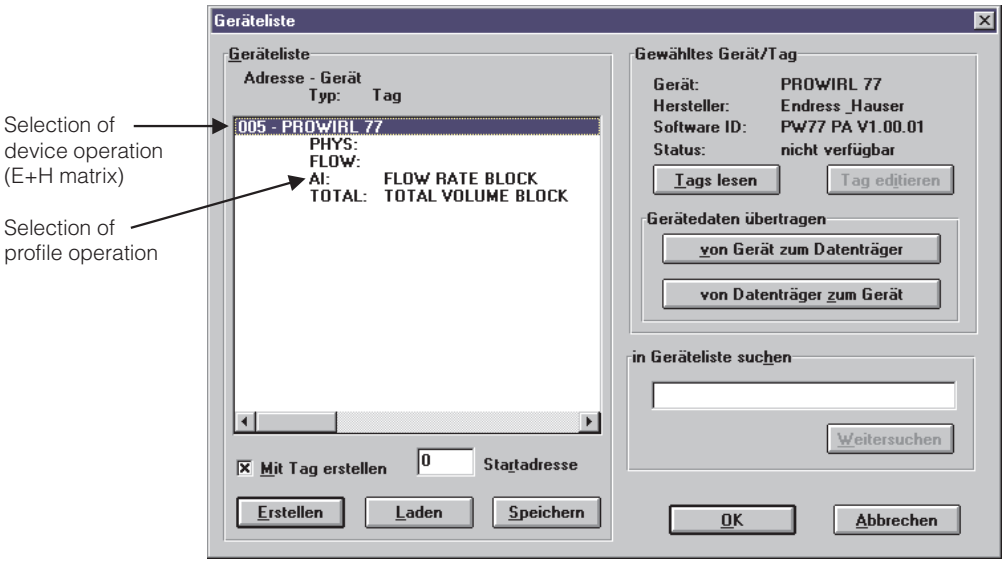
For the Prowirl 77 measuring system, various instrument functions are available which, as required, can be individually set and adapted to process conditions by a Class II master, e.g. E+H Commuwin II operating program.

Note!
An overview of all factory settings and available functions can be found on page 29 ff.

Note!

Prowirl 77 can be operated using a DP master Class II. When using the E+H "Commuwin II" operating program, the most important device parameters are represented in an E+H matrix. This matrix will be explained in chapter 6.

Selection between profile configuration and device specific configuration using Commuwin II:



- The E+H device operation is selected by clicking the device description, e.g. Prowirl 77.
- The profile operation is selected by clicking the corresponding tag, e.g. **AI: Flow Rate Block** = Prowirl 77 Analog Input Block.

The device address and the application ("LIQUID" or "GAS/STEAM") can be programmed either by using an operating program or locally with DIP switches (see page 18). The position of DIP switches No. 8 and 10 determines if these parameters are defined via bus or locally.

6 Device Functions

6.1 Commuwin II operating matrix

Transmitter “Device Block”
The configurable parameters of this matrix are described in chapter 6.2.

		H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0	**MEASURED VALUE**	FLOWRATE	VORTEX FREQUENCY	TOTALIZED VOL.							
V1	**SYSTEM-UNITS**	FLOW UNIT	VOLUME UNIT								
V2											
V3											
V4	**DISPLAY**		RESET TOTALIZER								
V5	**SYSTEM PARAMETER**	BUS ADDRESS	ACCESS CODE	DIAGNOSTIC CODE	LAST DIAGNOSTIC CODE	SOFTWARE VERSION	HARDWARE VERSION				
V6	**SENSOR DATA**	APPLICATION	NOMINAL DIAMETER	CALIBR. FACTOR	EXPANSION COEFF.	TEMPERATURE ENTRY	SELECT GAIN RANGE				
V7											
V8											
V9											
VA	**SETUP**	TAG NUMBER	SERIAL NUMBER				DEVICE PROFILE				

Programming is enabled by entering the access code (see page 39).

Commuwin II operating matrix
Transmitter “Physical Block”

		H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0											
V1											
V2											
V3											
V4											
V5											
V6											
V7	**ALARM STATUS**	CURRENT	DISABLE								
V8	**BLOCK PARAMETER**	TAG NUMBER	ST REVISION								
V9	**DIAGNOSIS**	DIAGNOSIS	DIAGNOSIS 2	DIAGNOSIS 3	MASK	MASK 2	MASK 3	SOFTWARE VERSION	HARDWARE VERSION	DIAGNOSIS EXT	DIAGNOSIS MASK EXT
VA	**DEVICE DATA**	DESCRIPTER	MANUFACTERER ID	DEVICE ID	SERIAL NUMBER	INSTALLATION DATE	MESSAGE	DEVICE CERTIFICAT	SECURITY LOCKING	SOFTWARE RESET	

Commuwin II operating matrix
Transmitter “Analog Input Block”

		H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0	**OUT**	OUT VALUE	OUT STATUS	OUT MIN	OUT MAX	OUT UNIT	PV MIN	PV MAX	PV SCALE UNIT	INTEGRATION TIME	
V1	**ALARM LIMITS**	ALARM HYSTERESIS									
V2	**HI HI ALARM**	HI HI LIM	VALUE	ALARM STATUS	SWITCH ON POINT	SWITCH OFF POINT					
V3	**HI ALARM**	HI LIM	VALUE	ALARM STATUS	SWITCH ON POINT	SWITCH OFF POINT					
V4	**LO ALARM**	LO LIM	VALUE	ALARM STATUS	SWITCH ON POINT	SWITCH OFF POINT					
V5	**LO LO ALARM**	LO LO LIM	VALUE	ALARM STATUS	SWITCH ON POINT	SWITCH OFF POINT					
V6	**BLOCK MODE**	TARGET MODE	ACTUAL	PERMITTED	NORMAL						
V7	**ALARM SUMMARY**	CURRENT	DISABLE								
V8	**BLOCK PARAMETER**	TAG DESCRIPTION	ST REVISION								
V9	**SIMULATION**	VALUE	STATUS	OF OFF							
VA											

Commuwin II operating matrix
Transmitter "Flow Transducer Matrix"

		H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
V0	**FLOWRATE**	FLOWRATE	FLOW UNIT								
V1											
V2	**VORTEX**	VORTEX FREQUENCY									
V3											
V4	**SENSOR DATA**	CALIBR. FACTOR	NOMINAL DIAMETER	LOW SENSOR LIMIT	HIGH SENSOR LIMIT						
V5	**PROCESSING PARAMETER**										
V6											
V7	**ALARM STATUS**	CURRENT	DISABLE								
V8	**BLOCK PARAMETER**	TAG NUMBER	ST REVISION								
V9	**SYSTEM PARAMETER**										
VA											

6.2 Functions descriptions

• Factory settings are shown in ***bold italics***.

Function group: MEASURED VALUE	
Flowrate	Display of actual measured volumetric flowrate (volume/time). The engineering units used are defined in the function “Flow Unit” (see page 34).
Vortex frequency	Display of actual measured vortex frequency. Page 60 shows a summary of frequency ranges which depend on nominal diameter and application.
Totalized volume	Display of total flow quantity from when measurement began. The totalizer can be reset to 0 using the function “Reset totalizer”. Note! After loss of power supply (which is provided by the field bus) the totalizer remains at the value last shown.


Note!

Function group: SYSTEM UNITS	
Flow unit	Unit for the displayed volumetric flow (volume/time). The flow unit chosen here does apply only for the acyclic requested flow value in the transducer block. The flow unit for cyclic data exchange must be set in the AI block. **Selection:** dm^3/s, dm^3/min, dm^3/h, m^3/s, m^3/min, m^3/h, ACF/s, ACF/min, ACF/h, ImpG/s, ImpG/min, ImpG/h, USG/s, USG/min, USG/h, user = user defined unit (1 dm^3 = 1 liter) Factory setting: as ordered; if not specified by customer **"dm^3/s"** is set.
Volume unit	Unit for the totalizer. The unit chosen here applies also for the cyclic data exchange. **Selection:** dm^3, m^3, ACF, ImpGal, Usgal, user = user defined unit (1 dm^3 = 1 liter) Factory setting: as ordered; if not specified by customer **"dm^3"** is set.
Custom flow unit	As well as the engineering units offered the flow rate can also be displayed in other, user-defined units (selection "user" in function "flow unit", see above). For this purpose, a conversion factor can be entered in this function giving the exact ratio of how many of the desired units correspond to the internally used reference "dm^3/s". 1 dm^3/s = Factor · [1 user-defined unit] *Example:* 1 dm^3/s is equivalent to • 60 dm^3/min → factor = 60 • 1/100 hectolitre/s → factor = 0.01 • 0.7 kg/s with a fluid density of 700 kg/m^3 → factor = 0.7 Caution! Prowirl 77 always measures the volumetric flowrate at actual operating conditions. The conversion method described here only applies to constant and exactly known process conditions. Any deviation from the assumed process conditions can lead to significant errors. Note! • The factor can be calculated with the E+H sizing program "Applicator" (version 7.01.00 and higher). Choose Prowirl 77 as instrument and enter the operating values of your application. The flow rate should be entered in the desired units. In the window "Conversions" with flow as unit to convert, the factor is shown above the table at the right (format: X.XXX E (±)YY). On the following pages please find detailed instructions with examples for the calculation of the factor for mass or corrected volume. **Input:** Value range: $1.0 \cdot 10^{-9}$...$9.999 \cdot 10^{9}$


Caution!


Note!

Function group: SYSTEM UNITS

The following instructions explain in more detail pages 34 and 37.

Instructions for user-defined mass units:

Density at operating conditions in kg/m^3

for desired time base (not for totalizer)
.../s → 1
.../min. → 60
.../h → 3600
.../d → 86400

for desired mass unit
kg/... → 1
t/... → 1000
lbs/... → 0.4536

$$[\ldots] = \frac{[\ldots]}{1000} \times [\ldots] \times \frac{1}{[\ldots]}$$

ba032y01

"Custom flow unit"

or

"Custom total unit"

Examples:
To display the *mass flow* of superheated steam at 200 °C and 12 bar in "kg/h".
According to the steam table the density is 5.91 kg/m^3:

"Custom flow unit" = $\frac{5.91}{1000} \cdot 3600 \cdot \frac{1}{1} = 21.276$

To display the *totalized mass* in "kg" for the same superheated steam application (density 5.91 kg/m^3):

"Custom total unit" = $\frac{5.91}{1000} \cdot \frac{1}{1} = 0.00591$

Function group: SYSTEM UNITS

The following instructions explain in more detail pages 34 and 37.

Instructions for user-defined corrected volume units:

Fluid density at operating conditions / for desired time base (not applicable for totalizer) / for desired corrected volume unit

$$[\ldots] = \frac{[\ldots]}{[\ldots]} \times [\ldots] \times \frac{1}{[\ldots]}$$

ba032y02

Fluid density at reference conditions (e.g. = 0 °C and 1.013 bar)

.../s	→ 1
.../min.	→ 60
.../h	→ 3600
.../d	→ 86400

Ndm^3/...	→ 1
Nm^3/...	→ 1000
SCF/...	→ 28.317
Imp.gallon/...	→ 4.546

"Custom flow unit"

or

"Custom total unit"

Examples:
To display the *corrected volume flow* of compressed air at 3 bar and 60 °C in "Nm^3/h".
The density is 3.14 kg/m^3 for those operating conditions. The density of air at reference conditions (1.013 bar, 0 °C) is 1.2936 kg/m^3:

$$\text{"Custom flow unit"} = \frac{3.14}{1.2936} \cdot 3600 \cdot \frac{1}{1000} = 8.738$$

To display the *corrected volume total* in "Nm^3" for the same application (compressed air at 3 bar, 60 °C):

$$\text{"Custom total unit"} = \frac{3.14}{1.2936} \cdot \frac{1}{1000} = 0.002427$$

For **ideal gases** the following simplified formula can be used to calculate corrected volumes only when reference conditions are at 0 °C and 1.013 bar (abs):

for desired time base (not applicable for totalizer) / process pressure in bar (abs)

$$[\ldots] = \frac{[\ldots] \times [\ldots] \times 273.15}{[\ldots] \times 1.013 \times ([\ldots] + 273.15)}$$

ba032y03

for desired corrected volume

Ndm^3/...	→ 1
Nm^3/...	→ 1000

process temperature °C

"Custom flow unit"

or

"Custom total unit"

Function group: SYSTEM UNITS	
Custom totalizer unit	As well as the engineering units offered for the totalizer, other user-defined units (selection “user” in function “Volume unit”, see page 34) can also be used. For this purpose, a conversion factor can be entered in this function giving the exact ratio of how many of the desired units correspond to the internally used reference unit “dm^3”. 1 dm^3 = factor · [1 user-defined unit] *Example:* 1 dm^3 is equivalent to • 1000 cm^3 → factor = 1000 • 1/100 hectolitre → factor = 0.01 • 0.7 kg with a fluid density of 700 kg/m^3 → factor = 0.7 Caution! Prowirl 77 always measures volumetric flowrate at actual operating conditions. The conversion method described here only applies to constant and exactly known process conditions. Any deviation from the assumed process conditions can lead to significant errors. Note! • The factor can be calculated with the E+H sizing program “Applicator” (version 7.01.00 and higher). Proceed as described on page 34. The factor for the user-defined totalizer units is equal to the factor of the corresponding flow unit .../s. Example: If the user-defined unit for the totalizer is kg, the factor corresponds to the factor for kg/s. • On the previous pages please find detailed instructions with examples for the calculation of the factor for mass or corrected volume. **Input:** Value range: $1.0 \cdot 10^{-9}$...$9.999 \cdot 10^{9}$


Caution!


Note!

Function group: MEASURED VALUE DISPLAY	
Reset totalizer	This function sets the totalizer to “zero” (reset). **Selection:** ***NO*** = Totalizer will not be reset YES = Totalizer is reset to zero

Function group: SYSTEM PARAMETERS	
Bus address	Display of the assigned device address. Changing the device address is explained in chapter 5.2.
Access code	The data of the Prowirl 77 measuring system are protected against unintentional changes. However, this input protection is valid only for the Commuwin II device matrix. By entering the code number 77, programming is enabled and the settings of the instrument can then be changed. Programming is locked by entering any number (not 77) in this function.

Function group: SYSTEM PARAMETERS	
Diagnostic code	The appropriate error message is shown in this function if the Prowirl 77 measuring system recognizes an error. The Prowirl 77 measuring system distinguishes between two kinds of errors: ***System errors:*** In the cyclic data telegram the status is set to “BAD”. In this function an error code appears. The red LED lights up permanently. These errors directly affect flow measurement → remedy the error immediately (see below). ***Warnings:*** In the cyclic data telegram the status is “GOOD” (flow) or “UNCERTAIN” (totalizer). The red LED flashes. These errors do not affect flow measurement directly; however these “uncritical” errors must be remedied as soon as possible. Note! When more than one error is present, the one with the highest priority is diplayed. **Display and remedial action** See section 7 “Trouble-shooting” on page 45.
Last diagnostic code	Display of the last shown, in the meantime remedied error message.


Note!

Function group: SYSTEM PARAMETERS	
Software version	Display of current software version. The numbers have the following meaning: **Display (Example):** PW77 PA V1.00.00 Number changes if minor alterations have been made to the new software. This also applies to special versions of the software. Number changes if the new software contains additional functions. Number changes if basic alterations have been made to the software.
Hardware version	Display of current hardware version. The numbers have the following meaning: **Display (Example):** PW77 PA V1.01.00 Number changes if minor alterations have been made to the new hardware. This also applies to special versions of the hardware. Number changes if the new hardware contains additional functions. Number changes if basic alterations have been made to the hardware.

Function group: SENSOR DATA	
Application	Selects whether a liquid or a gas (or steam) is to be measured. The nominal diameter and the setting selected here define the filter setting of the preamplifier. A change of the fluid via this function is possible only if DIP switch no. 10 at the device is set to "OFF" (see page 18). **Selection:** Liquid = flow measurement for liquids Gas/steam = flow measurement for gas/steam Factory setting: as ordered; if not specified by customer **"Liquid"** is set.
Nominal diameter Caution!	Selecting the nominal diameter of the flowmeter. Caution! Any alteration to the nominal diameter affects the entire measuring system and is only required when replacing the flowmeter electronics. It is then necessary to enter a new K-factor in function "Calibration factor" (see below). **Selection:** 15 – 25 – 40 – 50 – 80 – 100 – 150 – 200 – 250 – 300 Factory setting: ***dependent*** on the flowmeter
Calibration factor Caution!	The K-factor describes how many vortices per unit volume (1 dm^3) occur in the sensor. This value is determined in the factory by calibration and then printed on the meter body. Caution! The K-factor should not be altered under normal circumstances. **Input:** Value range: 0.01...999.9 (Imp/dm^3) Factory setting: ***dependent*** on the flowmeter
Expansion coefficient	The temperature coefficient describes the effects of process temperature on the calibration of the instrument. This coefficient is a function of the meter body and is correctly adjusted in the factory. It must only be altered if a meter body made of another material is mounted at a later date. A setting in this function affects the displayed flow and the internal totalizer. Any setting in this function affects measurement only if the value of the process temperature is set to a different value than the factory setting. **Input:** Value range: $1.0 \cdot 10^{-5}$...$9.999 \cdot 10^{-5}$ / Kelvin Factory setting: ***4.88 ·10^{-5} / K*** for stainless steel A 351 CF3M (1.4404)

Function group: MEASURING SYSTEM DATA	
Temperature entry	The flowmeter (measuring pipe and bluff body) expands according to the process temperature and affects the calibration of the instrument. This effect is proportional to the difference from the calibration temperature 293.15 K (20 °C). If the process temperature is constant and accurately known the calibration factor can be compensated numerically by entering the process temperature in this function. **Input:** Value range: 0...999 K (Kelvin); this corresponds to –273.15...726 °C Factory setting: ***293.15 K***; this corresponds to 20 °C Caution: The approved operating temperature of the measuring system is not affected by this setting. Note therefore the application limits given in Section 9 “Technical Data” (see page 55).
Select gain range	All Prowirl 77 flowmeters are set for optimum operation at process conditions stated by the customer when ordering. Under certain process conditions the effects of interference signals (e.g. by strong vibration) can be suppressed by adjusting the amplifier. Adjusting the amplifier can also extend the measuring range: • For slow flowing liquid with low density and weak interference effects. → choose a higher amplification level. • For fast flowing fluid with high density and strong interference effects (plant vibration) or pressure pulses → choose. a lower amplification level. An incorrectly set amplifier can have the following consequences: • The measuring range is limited so that small flow rates are no longer detected or indicated → increase amplification. • Unwanted interference effects are detected so that flow is still indicated even under no-flow conditions → reduce amplification. **Selection:** VERY LOW, LOW, ***NORMAL***, HIGH


Caution!

Function group: SETUP	
Tag number	Measuring point designation (name) as chosen by the customer.
Serial number	Display of the Prowirl 77 serial number defined by the manufacturer.
Device profile	With this switching field a display of the single PROFIBUS function block can be obtained in matrix format. In this way, all Prowirl 77 PROFIBUS-PA parameters can be programmed comfortably by Commuwin II. **Input:** ***Device data*** – Physical Block – Transducer Block – AI Transmitter – Totalizer Block

7 Trouble-shooting

The Prowirl 77 measuring system operates without the need for maintenance. However, if a fault should occur or incorrect measurements are suspected, then the following instructions will be of help in identifying the cause of and remedying any possible errors.


Warning!

Warning!
- All local regulations and all safety instructions in this operating manual are to be strictly observed when making electrical connections.
- All data and regulations on Ex instruments in the separate Ex documentation are to be strictly observed.

Errors and faults identified by the continuous self-monitoring system can be called up by the control system using the PROFBUS-PA interface.
The Prowirl 77 measuring system distinguishes between two kinds of errors:

System error:
This error directly affects flow measurement → remedy the error immediately.
- In the cyclic data telegram the status is set to “BAD”.
- The red LED lights up permanently.
- The totalizer remains at the last registered value.
- In function “Diagnostic code” an error code is displayed.

System errors		
Code	**Cause**	**Remedy**
101	Defective sensor	Check and, if necessary, replace the sensor through E+H Service
102	EEPROM error (checksum error)	Contact E+H Service
103	Communication error with sensor	Self-monitoring system starts a remedying try, otherwise contact E+H Service
104	Error in ASIC	Contact E+H Service
106	Download active i.e. configuration data are being digitally transmitted to the Prowirl 77 system	The sensor will operate normally again once download is finished
116	An error has occurred during the download of configuration data	Reload the configuration data

Warnings:
These errors do not affect flow measurement directly → The measurement system continues to measure.
- In the cyclic data telegram the totalizer status can be “UNCERTAIN”.
- The red LED flashes.

Warnings		
Code	**Cause**	**Remedy**
211	Correct value of totalizer is not guaranteed (check sum error)	Reset totalizer (see “function discription” on page 33)
250	Initializing active	Wait until initializing is finished

Note:
When more than one error is present, the one with the highest priority is displayed.


Note!

The Prowirl 77 measuring system is fitted with two LEDs to indicate its operating status. They can be seen after removing the housing cover.

The green LED does light up permanently when the device is powered by the field bus. Flashing of the green LED means communication between device and control system by cyclic data exchange. The red LED should not light up at faultless operation.

Green LED does not light up
- Has the wiring been done according to wiring diagram on page 15?

Red LED lights up permanently
- A system error has occurred. Description see page 45.

Red LED flashes
- A warning is displayed. Description see page 45.

No flow signal
- For liquids: Is the pipeline completely filled? The pipeline must always be completely filled to ensure accurate and reliable flow measurement.
- Has all packing material and protective disks been removed from the meter body?
- Have the right configuration files been copied?

Flow signal under no-flow conditions
Is the flowmeter subject to vibrations greater than 1g?
In such cases flow may be indicated under no-flow conditions due to the frequency and direction of oscillations.

Remedial procedure on flowmeter:
– Turn the sensor through 90°. The measuring system is most responsive to vibration in the direction of sensor displacement. The vibration has less effect on the measuring system in other axes.
– The amplification can be reduced using the function “Select gain range” (see page 43).

Remedial procedure with mechanical layout of the installation:
– If the source of the vibration (e.g. pump or valve) can be identified, then decoupling or supporting the source can reduce vibration.
– Supporting the pipeline near the flowmeter.

Poor or strongly varying flow signal

- Is the fluid to be measured single-phase and homogeneous?
  The fluid must be single-phase and homogeneous, and the pipeline always completely filled to ensure accurate and reliable flow measurement. In many cases the measuring result may be improved under poor conditions by taking the following measures:
  – For liquids with low gas content in horizontal pipelines, the flowmeter should be mounted with the head pointing downward or to one side. This improves the measuring signal as the sensor is positioned away from any gas bubbles.
  – For liquids with low solids content, the electronic housing should not be mounted pointing downward.
  – For steam or gas with low liquid content, the electronic housing should not be mounted pointing downward.

- Do the inlet and outlet sections correspond to the mounting instructions on page 10?

- Are gaskets of the correct internal diameter (not smaller than the pipeline) and correctly centred?

- Is the static pressure sufficiently large to prevent cavitation at the flowmeter?

- Is the flow within the measuring range of the flowmeter (see “Technical Data” page 55)?
  The start of the measuring range depends on the density and viscosity of the fluid which in turn are functions of temperature. With gases and steam, density is also a function of pressure.

- Are pressure pulsations superimposed on the operating pressure (e.g. due to piston pumps)? These pulsations may affect vortex shedding if they have a similar frequency to that of the vortex shedding itself.

- Have the fluid (“Application”) and nominal diameter been set correctly? “Application” must be set to “Liquid” for liquids, and set to “Gas/steam” for gases and steam. The nominal diameter of the flowmeter must agree with the setting “Nominal diameter”. The settings in these two functions determine the filter settings and can thus affect the measuring range.

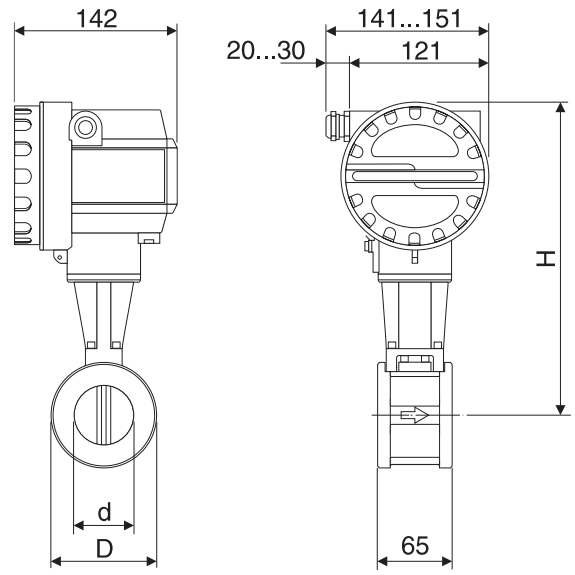
- Does the K-factor of the instrument agree with the setting in the function “Calibration factor”?

Maintenance / Calibration

If correctly installed, the meter will operate without maintenance. If installed as a production quality-relevant (ISO 9000) measurement point, the Prowirl 77 can be recalibrated by Endress+Hauser on accredited calibration rigs, traceable according to EN 45001, and supplied with an internationally recognized certificate according to EA (European cooperation for Accreditation of Laboratories).

8 Dimensions and Weights

8.1 Dimensions Prowirl 77 W



Wafer version for flanges according to:

- DIN 2501, PN 10...40
- ANSI B16.5, Cl. 150/300, Sch40
- JIS B2238, 10K/20K, Sch40

Mounting kits for self centering mounting between flanges can be ordered with the instrument (see page 13).

Fig. 15
Dimensions of Prowirl 77 W

For the high/low temperature option, H increases by 40 mm and the weight by approx. 0.5 kg.

DN		d	D	H	Weight
DIN	ANSI	[mm]	[mm]	[mm]	[kg]
15	½"	16.50	45.0	247	3.0
25	1"	27.60	64.0	257	3.2
40	1½"	42.00	82.0	265	3.8
50	2"	53.50	92.0	272	4.1
80	3"	80.25	127.0	286	5.5
100	4"	104.75	157.2	299	6.5
150	6"	156.75	215.9	325	9.0

8.2 Dimensions Prowirl 77 F

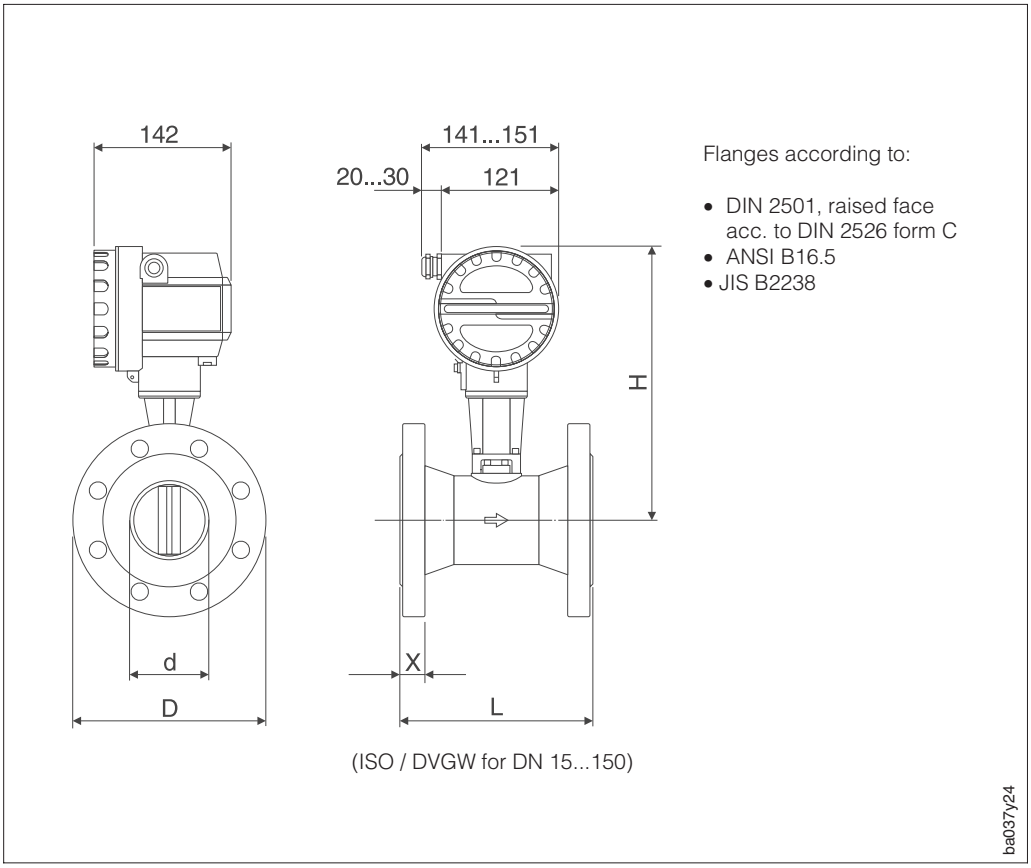


Fig. 16
Dimensions of Prowirl 77 F

For the high/low temperature option, H increases by 40 mm and the weight by approx. 0.5 kg.

DN	Standard	Pressure rating	d [mm]	D [mm]	H [mm]	L [mm]	X [mm]	Weight [kg]
15 / ½"	DIN	PN 40	17.3	95.0	248	200	17	5.0
	ANSI SCHED 40	Cl. 150	15.7	88.9				
		Cl. 300	15.7	95.0				
	ANSI SCHED 80	Cl. 150	13.9	88.9				
		Cl. 300	13.9	95.0				
	JIS SCHED 40	Cl. 20K	16.1	95.0				
	JIS SCHED 80	Cl. 20K	13.9	95.0				
25 / 1"	DIN	PN 40	28.5	115.0	255	200	19	7.0
	ANSI SCHED 40	Cl. 150	26.7	107.9				
		Cl. 300	26.7	123.8				
	ANSI SCHED 80	Cl. 150	24.3	107.9				
		Cl. 300	24.3	123.8				
	JIS SCHED 40	Cl. 20K	27.2	125.0				
	JIS SCHED 80	Cl. 20K	24.3	125.0				
40 / 1½"	DIN	PN 40	43.1	150	263	200	21	10
	ANSI SCHED 40	Cl. 150	40.9	127				
		Cl. 300	40.9	155.6				
	ANSI SCHED 80	Cl. 150	38.1	127				
		Cl. 300	38.1	155.6				
	JIS SCHED 40	Cl. 20K	41.2	140				
	JIS SCHED 80	Cl. 20K	38.1	140				

Continued next page

DN	Standard	Pressure rating	d [mm]	D [mm]	H [mm]	L [mm]	X [mm]	Weight [kg]
50 / 2"	DIN	PN 40	54.5	165	270	200	24	12
	ANSI SCHED 40	Cl. 150	52.6	152.4				
		Cl. 300	52.6	165				
	ANSI SCHED 80	Cl. 150	49.2	152.4				
		Cl. 300	49.2	165				
	JIS SCHED 40	Cl. 10K	52.7	155				
		Cl. 20K	52.7	155				
	JIS SCHED 80	Cl. 10K	49.2	155				
		Cl. 20K	49.2	155				
80 / 3"	DIN	PN 40	82.5	200	283	200	30	20
	ANSI SCHED 40	Cl. 150	78	190.5				
		Cl. 300	78	210				
	ANSI SCHED 80	Cl. 150	73.7	190.5				
		Cl. 300	73.7	210				
	JIS SCHED 40	Cl. 10K	78.1	185				
		Cl. 20K	78.1	200				
	JIS SCHED 80	Cl. 10K	73.7	185				
		Cl. 20K	73.7	200				
100 / 4"	DIN	PN 16	107.1	220	295	250	33	27
		PN 40	107.1	235				
	ANSI SCHED 40	Cl. 150	102.4	228.6				
		Cl. 300	102.4	254				
	ANSI SCHED 80	Cl. 150	97	228.6				
		Cl. 300	97	254				
	JIS SCHED 40	Cl. 10K	102.3	210				
		Cl. 20K	102.3	225				
	JIS SCHED 80	Cl. 10K	97	210				
		Cl. 20K	97	225				
150 / 6"	DIN	PN 16	159.3	285	319	300	38	51
		PN 40	159.3	300				
	ANSI SCHED 40	Cl. 150	154.2	279.4				
		Cl. 300	154.2	317.5				
	ANSI SCHED 80	Cl. 150	146.3	279.4				
		Cl. 300	146.3	317.5				
	JIS SCHED 40	Cl. 10K	151	280				
		Cl. 20K	151	305				
	JIS SCHED 80	Cl. 10K	146.3	280				
		Cl. 20K	146.3	305				
200 / 8"	DIN	PN 10	207.3	340	347.5	300	43	63
		PN 16						62
		PN 25	206.5	360				68
		PN 40		375				72
	ANSI SCHED 40	Cl. 150	202.7	342.9				64
		Cl. 300		381				76
	JIS SCHED 40	Cl. 10K		330				58
		Cl. 20K		350				64
250 / 10"	DIN	PN 10	260.4	395	375.25	380	49	88
		PN 16		405				92
		PN 25	258.8	425				100
		PN 40		450				111
	ANSI SCHED 40	Cl. 150	254.5	406.4				92
		Cl. 300		444.5				109
	JIS SCHED 40	Cl. 10K		400				90
		Cl. 20K		430				104
300 / 12"	DIN	PN 10	309.7	445	397.4	450	53	121
		PN 16		460				129
		PN 25	307.9	485				140
		PN 40		515				158
	ANSI SCHED 40	Cl. 150	304.8	482.6				143
		Cl. 300		520.7				162
	JIS SCHED 40	Cl. 10K		445				119
		Cl. 20K		480				139

8.3 Dimensions Prowirl 77 H

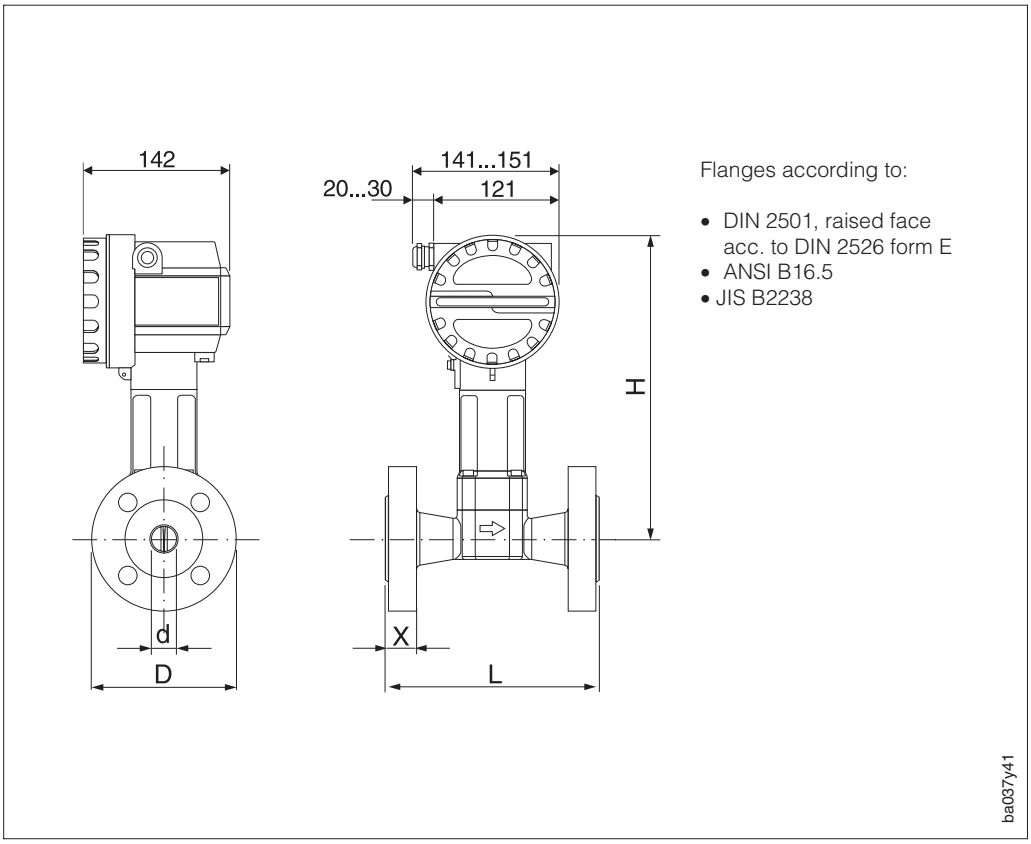


Fig. 17
Dimensions of Prowirl 77 H

DN	Standard	Pressure rating	d [mm]	D [mm]	H [mm]	L [mm]	X [mm]	Weight [kg]
15 / ½"	DIN	PN 160	17.3	105	288	200	22.4	7
	ANSI SCHED 80	Cl. 600	13.9	95.3				6
	JIS SCHED 80	Cl. 40K	13.9	115				8
25 / 1"	DIN	PN 100	28.5	140	295	200	26.4	11
		PN 160	27.9	140				11
	ANSI SCHED 80	Cl. 600	24.3	124				9
	JIS SCHED 80	Cl. 40K	24.3	130				10
40 / 1½"	DIN	PN 100	42.5	170	303	200	30.9	15
		PN 160	41.1	170				15
	ANSI SCHED 80	Cl. 600	38.1	155.4				13
	JIS SCHED 80	Cl. 40K	38.1	160				14
50 / 2"	DIN	PN 64	54.5	180	310	200	32.4	17
		PN 100	53.9	195				19
		PN 160	52.3	195				19
	ANSI SCHED 80	Cl. 600	49.2	165.1				14
	JIS SCHED 80	Cl. 40K	49.2	165				15
80 / 3"	DIN	PN 64	81.7	215	323	200	38.2	24
		PN 100	80.9	230				27
		PN 160	76.3	230				27
	ANSI SCHED 80	Cl. 600	73.7	209.6				22
	JIS SCHED 80	Cl. 40K	73.7	210				24
100 / 4"	DIN	PN 64	106.3	250	335	250	48.9	39
		PN 100	104.3	265				42
		PN 160	98.3	265				42
	ANSI SCHED 80	Cl. 600	97	273.1				43
	JIS SCHED 80	Cl. 40K	97	240				36
150 / 6"	DIN	PN 64	157.1	345	359	300	63.4	86
		PN 100	154.1	355				88
		PN 160	146.3	355				88
	ANSI SCHED 80	Cl. 600	146.3	355.6				87
	JIS SCHED 80	Cl.40K	146.6	325				77

8.4 Dimensions Flow Conditioner (DIN)

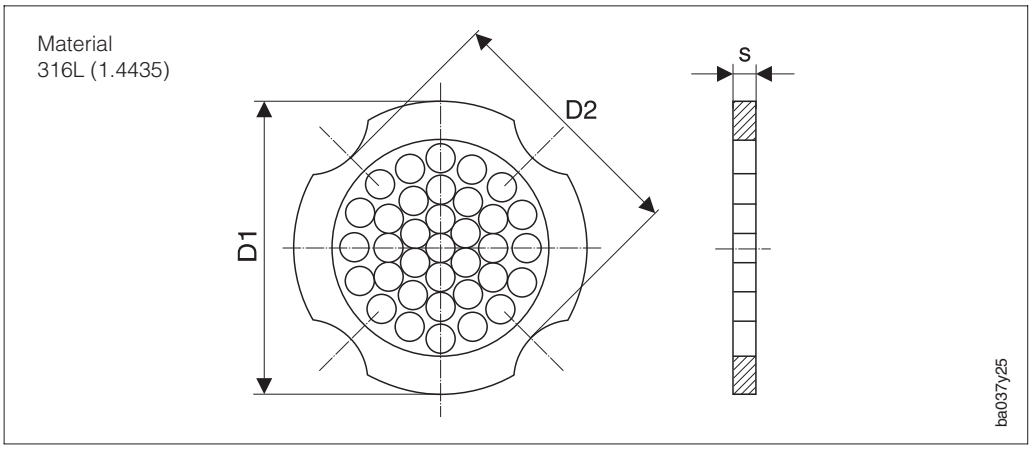


Fig. 18
Dimensions flow conditioner

Explanation of entries in column D1 / D2:

D1: The flow conditioner is clamped between bolts at its outer diameter.
D2: The flow conditioner is clamped between bolts at the indentures.

DIN					
DN	**Pressure rating**	**Centering diameter** [mm]	**D1 / D2**	**s**	**Weight** [kg]
15	PN 10...40 PN 64	54.3 64.3	D2 D1	2.0	0.04 0.05
25	PN 10...40 PN 64	74.3 85.3	D1 D1	3.5	0.12 0.15
40	PN 10...40 PN 64	95.3 106.3	D1 D1	5.3	0.3 0.4
50	PN 10...40 PN 64	110.0 116.3	D2 D1	6.8	0.5 0.6
80	PN 10...40 PN 64	145.3 151.3	D2 D1	10.1	1.4 1.4
100	PN 10/16 PN 25/40 PN 64	165.3 171.3 252.0	D2 D1 D1	13.3	2.4 2.4 2.4
150	PN 10/16 PN 25/40 PN 64	221.0 227.0 252.0	D2 D2 D1	20.0	6.3 7.8 7.8
200	PN 10 PN 16 PN 25 PN 40 PN 64	274.0 274.0 280.0 294.0 309.0	D1 D2 D1 D2 D1	26.3	11.5 12.3 12.3 15.9 15.9
250	PN 10/16 PN 25 PN 40 PN 64	330.0 340.0 355.0 363.0	D2 D1 D2 D1	33.0	25.7 25.7 27.5 27.5
300	PN 10/16 PN 25 PN 40/64	380.0 404.0 420.0	D2 D1 D1	39.6	36.4 36.4 44.7

8.5 Dimensions Flow Conditioner (ANSI)

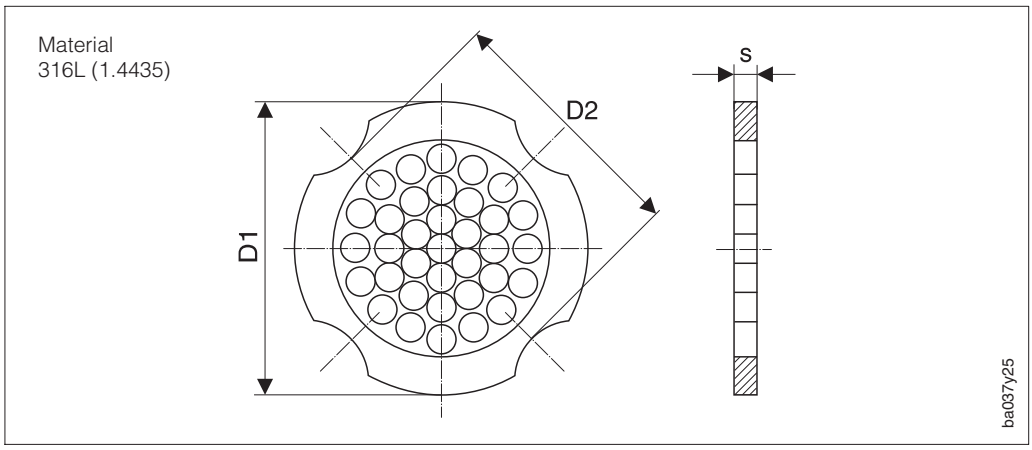


Fig. 19
Dimensions flow conditioner

Explanation of entries in column D1 / D2:

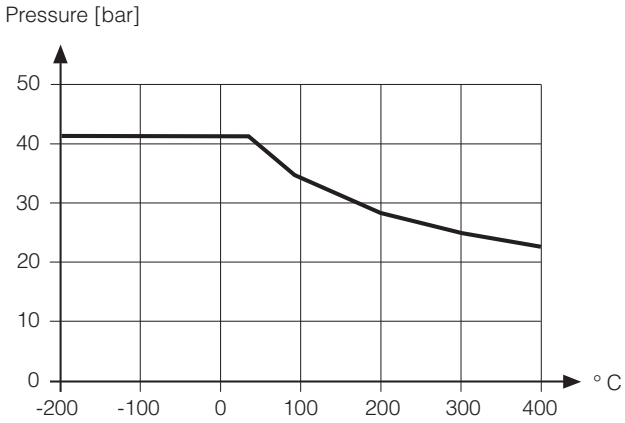
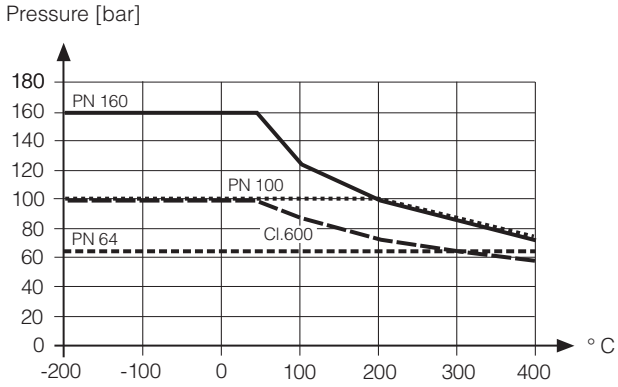
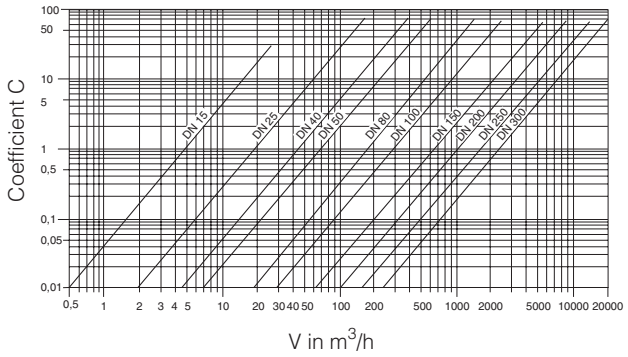
D1: The flow conditioner is clamped between bolts at its outer diameter.
D2: The flow conditioner is clamped between bolts at the indentures.

ANSI					
DN	**Pressure rating**	**Centering diameter** [mm]	**D1 / D2**	**s**	**Weight** [kg]
½"	Cl. 150 Cl. 300	51.1 56.5	D1 D1	2.0	0.03 0.04
1"	Cl. 150 Cl. 300	69.2 74.3	D2 D1	3.5	0.12 0.12
1½"	Cl. 150 Cl. 300	88.2 97.7	D2 D2	5.3	0.3 0.3
2"	Cl. 150 Cl. 300	106.6 113.0	D2 D1	6.8	0.5 0.5
3"	Cl. 150 Cl. 300	138.4 151.3	D1 D1	10.1	1.2 1.4
4"	Cl. 150 Cl. 300	176.5 182.6	D2 D1	13.3	2.7 2.7
6"	Cl. 150 Cl. 300	223.9 252.0	D1 D1	20.0	6.3 7.8
8"	Cl. 150 Cl. 300	274.0 309.0	D2 D1	26.3	12.3 15.8
10"	Cl. 150 Cl. 300	340.0 363.0	D1 D1	33.0	25.7 27.5
12"	Cl. 150 Cl. 300	404.0 420.0	D1 D1	39.6	36.4 44.6

9 Technical Data

Application ranges	
Designation	Flow measuring system “Prowirl 77”
Function	Measurement of volumetric flowrate of saturated steam, superheated steam, gases and liquids.
Operation and system design	
Measurement principle	The Prowirl 77 vortex flowmeter operates on the physical principle of Karman vortex shedding.
Measurement system	The “Prowirl 77” instrument family consists of: • Transmitter: Prowirl 77 “PFM” Prowirl 77 “4...20 mA/HART” Prowirl 77 “PROFIBUS-PA” • Meter body: Prowirl 77 W wafer version, DN 15...150 Prowirl 77 F flanged version, DN 15...300, bigger nominal diameters on request Prowirl 77 H high pressure version, DN 15...150
Input variables	
Measured variables	The average flow velocity and volumetric flow rate are proportional to the frequency of vortex shedding behind the bluff body.
Measuring range	The measuring range is dependent on the fluid and the pipe diameter (see page 60). • Full scale value: – Liquids: v_{max} = 9 m/s – Gas / steam: v_{max} = 75 m/s (DN 15 v_{max} = 46 m/s) • Lower range value: – depends on the fluid density and the Reynolds number, Re_{min} = 4000, Re_{linear} = 20000 DN 15 / 25: $v_{min} = \frac{6}{\sqrt{\rho}}$ m/s with ρ in $\frac{kg}{m^3}$ DN 40...300: $v_{min} = \frac{7}{\sqrt{\rho}}$ m/s with ρ in $\frac{kg}{m^3}$
Output variables	
Output signal	PROFIBUS-PA interface: according to EN 50170 Volume 2, PROFIBUS Transmission technique IEC 1158-2 PROFIBUS profile Class B V2.0
PA-Function	Slave
Current consumption	12 mA
Permissible power voltage	9 V...32 V (intrinsically safe version: 9 V...24 V)
FDE (Fault Disconnection Electronic)	0 mA

Output variables (continued)	
Speed of transmission	31.25 kbit/s
Signal encoding	Manchester II
Signal on alarm	The following applies for the duration of a fault: • Red LED lights up permanently • Totalizer remains at the last calculated value • Status “BAD” in the cyclic data telegram
Galvanic isolation	The electrical connections are galvanically isolated from the sensor.
Measuring accuracy	
Reference conditions	Error limits based on ISO/DIN 11631: • 20...30 °C, 2...4 bar • Calibration rig traceable to national standards
Measured error	Liquids < 0.75% o.r. for Re >20000 < 0.75% o.f.s. for Re 4000...20000 Gas / steam < 1% o.r. for Re >20000 < 1% o.f.s. for Re 4000...20000 Current output temperature coefficient < 0.03% o.f.s./Kelvin
Repeatability	≤ ±0.25% o.r.
Operating conditions	
Installation instruction	Any position (vertical, horizontal) For limitations and other recommendations see page 10
Inlet / outlet sections	Inlet section: minimum 10 x DN Outlet section: minimum 5 x DN (For detailed information on the relationship between pipe installation and pipe internals see page 10)
Ambient temperature	–40...+60 °C When mounted outside, it is recommended that it is protected from direct sunlight by a sun shade, especially in warm climates with high process temperatures.
Ingress protection	IP 67 (NEMA 4X)
Shock and vibration resistance	At least 1 g in every axis over the whole frequency range up to 500 Hz
Electromagnetic compatibility (EMC)	To EN 50081 Part 1 and 2 / EN 50082 Part 1 and 2 and NAMUR industrial standard
Process conditions	
Process temperature	• Fluid: Standard sensor –40...+260 °C High/low temperature sensor –200...+400 °C Wafer type instruments of sizes DN 100 (4") and DN 150 (6") may not be mounted in orientation according to position B (see page 10) for fluid temperatures above 200 °C. • Seal: Graphite –200...+400 °C Viton – 15...+175 °C Kalrez – 20...+220 °C Gylon (PTFE) –200...+260 °C

Process conditions (continued)	
Process pressure	DIN: PN 10...40 ANSI: Class 150 / 300 JIS: 10K / 20K Pressure-temperature curve of Prowirl 77 W and F:  ba037y32 Pressure-temperature curve of Prowirl 77 H:  ba037y32
Pressure loss	Dependent on nominal diameter and fluid: Δp [mbar] = coefficient C · density ρ [kg/m^3]  ba037y31

Mechanical construction	
Construction / dimensions	See pages 49 ff.
Weight	See pages 49 ff.
Materials: *Transmitter housing* *Sensor* *– Wafer / flange* *– Sensor* *– Pipe stand* *Gaskets*	 Powder-coated die-cast aluminium Stainless steel, A351-CF3M (1.4404) complying to NACE MR0175 Stainless steel wetted parts: – Standard and high/low temperature sensor: 316L (1.4435), complying to NACE MR0175 – High pressure sensor: A637 (2.4668) (Inconel 718), complying to NACE MR0175 non-wetted parts: – CF3 (1.4306) Stainless steel, 304L (1.4308) Graphite Viton Kalrez Gylon (PTFE)
Cable entries	Power supply and signal cable (outputs): Cable entry PG 13.5 (5...11.5 mm) or Thread for cable entries: M20 x 1.5 (8...11.5 mm) ½" NPT G½"
Process connections	Wafer: Mounting set (see page 13) for flanges: – DIN 2501, PN 10...40 – ANSI B16.5, Class 150/300, Sch40 – JIS B2238, 10K/20K, Sch40 Flange: – DIN 2501, PN 10...40, raised face acc. to DIN 2526 form C – ANSI B16.5, Class 150/300, Sch40/80 (Sch80 DN 15...150) – JIS B2238, 10K/20K, Sch40/80 (Sch80 DN 15...150) High pressure: – DIN 2501, PN 64...160, raised face acc. to DIN 2526 form E – ANSI B16.5, Class 600, Sch80 – JIS B2238, 40K, Sch80
User interface	
Operation procedure / display	• Operation using a software tool, e.g. Commuwin II • Green LED: status indication • Red LED: in case of fault error status indication
Power supply	
Power supply	Supply by PROFIBUS-PA: 9...32 V DC, for Ex devices see separate Ex documentation
Power consumption	<1 W DC (incl. sensor)
Current consumption	12 mA

Power supply (continued)	
Current at make	According to table 4, IEC 1158-2
Power failure	• LED → off • The totalizer remains at the value last shown. • All programmed data remain in the EEPROM.
Certificates and approvals	
Ex approval	*Ex i:* ATEX/CENELEC ⟨Ex⟩ II2G, EEx ib/ia IIC T1...T6 ATEX ⟨Ex⟩ II3G, EEx nA IIC T1...T6 X FM Cl I/II/III Div 1, Groups A...G CSA Class I Div 1, Groups A...D Class II Div 1, Groups E...G Class III Div 1 More information can be found in the separate Ex documentation.
CE mark	By attaching the CE mark, Endress+Hauser confirms that Prowirl 77 has been successfully tested and fulfils all legal requirements of the relevant EC directives.
Ordering	
Accessories	• Mounting set for wafer • Replacement parts according to separate price list • Flow conditioner
Supplementary documentation	• Technical Information “Field Communication, Notes PROFIBUS-PA” TI 260F/00/en • Technical Information Prowirl 77 TI 040D/06/en • Operating Manual Prowirl 77 “PFM” BA 034D/06/en • Operating Manual Prowirl 77 “4...20 mA/HART” BA 032D/06/en • System Information Prowirl SI 015D/06/en • System Information Prowirl 77 SI 021D/06/en • Ex documentation ATEX II2G/CENELEC Zone 1 XA 017D/06/a3 ATEX II3G/CENELEC Zone 2 XA 018D/06/a3 FM EX 016D/06/a2 CSA EX 017D/06/D2

External standards and guidelines	
EN 50170	Volume 2, PROFIBUS
EN 60529	IP ingress protection
EN 61010	Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures
EN 50081	Part 1 and 2 (interference emission)
EN 50082	Part 1 and 2 (interference immunity)
NAMUR	Association of Standards for Control and Regulation in the Chemical Industry (Normenabeitsgemeinschaft für Meß- und Regeltechnik in der Chemischen Industrie)
NACE	National Association of Corrosion Engineers
PNO	PROFIBUS user organization: PROFIBUS-PA Profiles for Process Control Devices V2.0

9.1 Measuring Ranges (Sensor)

The tables below show the relationship between measuring ranges and vortex frequency ranges for a typical gas (air, at 0 °C and 1.013 bar) and a typical liquid (water, at 20 °C). The column “K-factor” shows a range of typical values for the K-factor of an instrument of the corresponding size and type (wafer or flange). Your E+H Sales Office will be pleased to provide information on flowmeters for your specific application with regard to the process characteristics of the fluid and operating conditions.

Prowirl 77 W (Wafer)							
DN DIN/ANSI	**Air** (at 0 °C, 1.013 bar) [m^3/h]			**Water** (at 20 °C) [m^3/h]			**K-factor** [pulses/dm^3]
	$\dot{V}_{min}$	$\dot{V}_{max}$	F-range (Hz)	$\dot{V}_{min}$	$\dot{V}_{max}$	F-range (Hz)	min./max.
DN 15 / ½"	4	35	330...2600	0.19	7	10.0...520	245...280
DN 25 / 1"	11	160	180...2300	0.41	19	5.7...300	48...55
DN 40 / 1½"	31	375	140...1650	1.1	45	4.6...200	14...17
DN 50 / 2"	50	610	100...1200	1.8	73	3.3...150	6...8
DN 80 / 3"	112	1370	75... 850	4.0	164	2.2...110	1.9...2.4
DN 100 / 4"	191	2330	70... 800	6.9	279	2.0...100	1.1...1.4
DN 150 / 6"	428	5210	38... 450	15.4	625	1.2... 55	0.27...0.32

Prowirl 77 F (Flange) **Prowirl 77 H (High pressure to DN 150 / 6")**							
DN DIN/ANSI	**Air** (at 0 °C, 1.013 bar) [m^3/h]			**Water** (at 20 °C) [m^3/h]			**K-factor** [pulses/dm^3]
	$\dot{V}_{min}$	$\dot{V}_{max}$	F-range (Hz)	$\dot{V}_{min}$	$\dot{V}_{max}$	F-range (Hz)	min./max.
DN 15 / ½"	3	25	380...2850	0.16	5	14.0...600	390...450
DN 25 / 1"	9	125	200...2700	0.32	15	6.5...340	70...85
DN 40 / 1½"	25	310	150...1750	0.91	37	4.5...220	18...22
DN 50 / 2"	42	510	120...1350	1.5	62	3.7...170	8...11
DN 80 / 3"	95	1150	80... 900	3.4	140	2.5...115	2.5...3.2
DN 100 / 4"	164	2000	60... 700	5.9	240	1.9... 86	1.1...1.4
DN 150 / 6"	373	4540	40... 460	13.4	550	1.2... 57	0.3...0.4
DN 200 / 8"	715	8710	27... 322	25.7	1050	1.0... 39	0.1266...0.1400
DN 250 / 10"	1127	13740	23... 272	40.6	1650	0.8... 33	0.0677...0.0748
DN 300 / 12"	1617	19700	18... 209	58.2	2360	0.6... 25	0.0364...0.0402

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