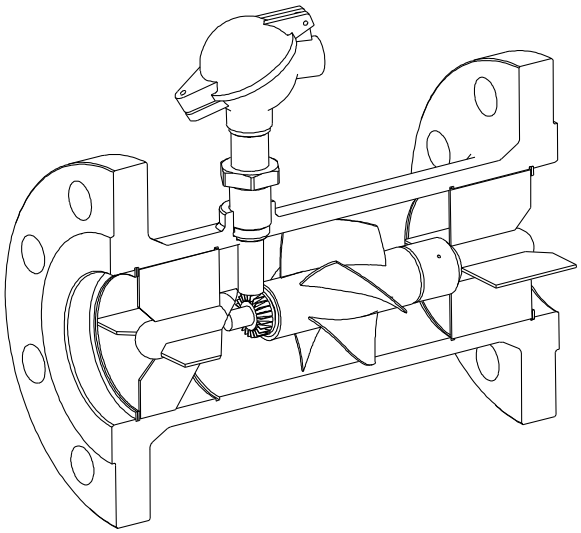
TURBOQUANT-R

TURBINE METERS



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APPLICATION FIELD

The TURBOQUANT type turbine meters – with their electronic signal processing and displaying units – are well proved and widely applicated instruments in industrial flow measurement. These instruments provide reliable, continuous and accurate measurement of the quantity of fluids flowing in closed conduits under pressure. The systems built of the signal processing units attached to them can be used for automatic control and recording of flow, control of batching and proportional mixing etc. The TURBOQUANT turbine meters are built with slide bearings therefore they are applicable for almost any kind of liquids, even for the strongly aggressive ones. Their field of application is widened by the fact that in intrinsically safe construction they can be used in explosive area, too (Figures 9, 10), according to the Category 2 of the Application Group II of the related UC Directives of ATEX 94/9.

Main industrial application field of turbine meters:

- in oil and gas industry measurement of crude oil, semi-final and final products of refineries;
- in chemical industry measurement of paints, lac, solvents and diluents;
- in machinery, power plants and communal plants measurement of water and fuel;
- measurement of most different fluids used in pharmaceutical and food industry.

4 PRINCIPLE OF OPERATION (Figures 1., 2.)

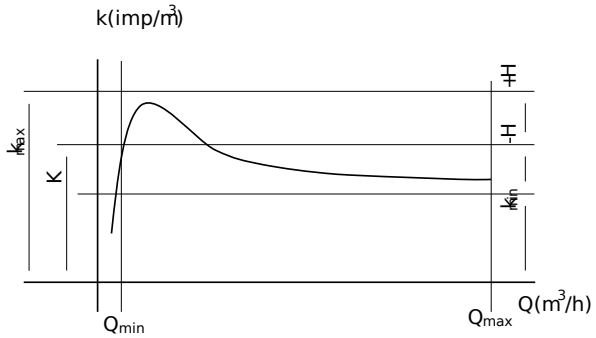
The turbine meter is a measuring device sensing the speed of fluid flowing in conduit under pressure. A rotor with axial flow-through is placed in the way of the fluid flowing through the turbine meter, which is rotating with a speed proportional to the flowrate. An inductive transducer senses the speed of the rotor. The flux of the coil assembled with permanent magnet is changed at turbine sizes ϕ6 mm - ϕ75 mm by the rotors made of ferromagnetic material, and ϕ100 mm and larger sizes the by the blades of the cogged ferromagnetic wheel turning together with the rotor. The frequency of the induced electric pulses is proportional to the speed of the rotor and through it to the flowrate of the measured fluid.

TECHNICAL DATA

Metrological data

Specific pulse number

The number of pulses induced during the flowthrough of volume unit is the specific pulse number (k). This is slightly depending on the flowrate (Q). This function is described by the calibration diagram:



Calibration factor

This is the arithmetic mean value of the maximal and minimal specific pulse numbers measured within the measuring range under reference conditions (K). This value is determined for each turbine individually and it is reported in the test certificate of the turbine meter. The calibration factors characteristic for the type can be found in Table 8. The individual values can differ from this with ±10%.

Linearity

The maximal relative deviation of the specific pulse numbers within the measuring range from the calibration factor (H). The linearity values characteristic for the type under reference conditions can be found in Table 8.

Repeatability

The deviation of specific pulse number values at a given flowrate measured under identical conditions. Their characteristic values are given in Table 8. This feature is significant when a measurement more accurate than the linearity of the turbine meter is necessary. Most of the signal processing units is capable to store more different values of the calibration diagram and take it in account during the measurement. With this method the accuracy of the turbine meter can be increased practically until the repeatability.

Reference conditions

Ambient air temperature:	25± 5 ºC
Relative humidity of air:	45...75 %
Reference fluid:	water
- temperature:	23± 8 ºC
- pressure downstream of the turbine meter	min. 1 bar overpressure

Electric data

Direct pickup

The inductive pickup of the turbine meter provides a nearly sinusoidal isolated frequency signal the electric features of it by maximal flowrate are given in Table 8. Electric strength between the pickup coil and the body of the turbine meter is 500V. The turbine meter and its pickup is constructed to conform the prescriptions of standards EN 50014 and EN 50020. In case of intrinsically safe application the circuit on Figure 9. must be applied. In this case the protection mode of the measuring system is:
Ex II.2.G EEx ib IIC T3...T6 within the temperature limits given in Table 6.

Pickup assembled with preamplifier

The pulses in the range of mV of the inductive pickups of turbine meters can be transmitted to longer distances and free of disturbances to the signal processing units by applying the LA6/1 two wires preamplifier. Because of the low signal level at sizes DN6, 12 and 15, application of preamplifier is recommended in all cases. It can be reasonable at larger sizes, too, in case the field is strongly loaded with electric noises. The turbine meter, the pickup and the preamplifier has been constructed to conform the prescriptions of standards EN 50014 and EN 50020. In case of intrinsically safe application the circuit on Figure 5. must be applied. In this case the protection mode of the measuring system is:
Ex II.2.G EEx ib IIC T3...T6 within the temperature limits given in Table 6.
Technical parameters of the preamplifier:
Power supply: 4,5...28 V DC
Input: TURBOQUANT pickup (0...1500 Hz, 3...3000mVeff)
Ranges of output current:

Signal level	"G" position of type (Table 1)		
	1	2	3
"0"	max. 3 mA	max. 7 mA	max. 1,2 mA
"1"	max.11 mA min.9 mA	max.15 mA min.13 mA	max.4 mA min. 3,6 mA

Housing: B10 GDME (HIRSCHMANN connector)
Temperature range: -40...+110°C
Protection: IP 65 EN 60529
Dimensions: Figure 8.

Application data

Size and type selection (Table 1.)

Measured fluid

Chemical composition: The turbine meter is suitable for measurement of all those fluids the corrosive effect of which the materials in contact with the fluid are resistant (Table 3.).
Viscosity: parameter affecting the linearity. Under 15cSt the effect of it is not more than 0,5%. The turbine meter can also measure fluids

of higher viscosity, but in such cases it is recommended to determine the calibration factor by local calibration (so called provering).

Gas content: gas present in the liquid in form of bubble affects the accuracy of the measurement. Gas bubbles uniformly distributed cause error nearly equal to their volume rate. Care must be taken for separating larger volumes of gases in the upstream pipe section.

Solid particle contamination: contamination not larger than 50 g/m^3 is not influencing the durability significantly. In case of greater contamination concentration the application of filter is recommended. 80 % of the contamination can be under the size of 50 µm, 20 % can be under the size of 0,5 mm. The hardness of contamination under the size of 50 µm must be under 100HB, the hardness of those above 50 µm can be on discretion.

Fibrous content: this kind of contamination is not allowed, it must be filtered.

Materials (Tables 4. and 5.)

Temperature ranges
Temperature ranges in Tables 5. and 6. are valid only for the turbine meters assembled with Cannon connector and ball-head connector without limitations. (Figure 8.). In case of Hirschmann connector the temperature range is only -40...+110 °C.

Other operational conditions
- The specified measuring accuracy can be obtained in case the turbine meter is operated in a measuring section according to Figure 3.
- Installation position horizontal ±5°, direction of flow as indicated by the arrow on the body.
- Generally the meter must not be overloaded, but an overload is permitted in 5% of the operating time.
- Ambient magnetic field: max. 200 A/m
- Acceleration due to vibration: max. 0,5g (0-500 Hz)

Accessories
1 pc. Electric connector
1 pc. Instrument manual
1 pc. Certificate of quality
1 pc. Test certificate
1 pc. Piece test certificate (only in case of intrinsically safe applications)

PRELIMINARY RECOMMENDATIONS

Preparation of operation

Unpacking, transporting to site
It is practical to transport the turbine meter to site in factory packing. The general prescriptions are valid for unpacking. Over the size of DN37 **it is forbidden to lift and move the turbine meter by grabbing the pickup!** After removing the protective caps and dust protection cover make sure that the transport did not cause visible changes at the inner parts of the turbine meter. Protect the turbine meter freed of protective cap and dust protection cover but not yet installed from ambient contamination.

Safety regulations
At unpacking, moving and installing the turbine meters the safety regulations for lifting burden must be followed. For connecting turbine meters operated at fire and explosion hazardous site zener barriers with parameters according to figures 9. and 10. can be applied. In this case the protection mode of the measuring system is:

EEx ib IIC T3...T6 (EN 50014, EN 50020).
Fluid temperatures corresponding to the temperature classes are in Table 6.

Assembling conditions
Regarding flow technical considerations, in order to obtain specified accuracy a so-called measuring section must be built in the direct neighborhood of the turbine meter (Figure 3.). At installation of upstream and downstream pipe sections the prescription for uniaxiality corresponding to IT14 accuracy class must be followed. Care must be taken for sizing the gaskets without deflection and the concentric positioning.

Filtering
In case of measuring liquids containing fibrous materials or sediments care must be taken for proper filtering of the liquid. The filter must be positioned before the 10xDN long upstream pipe section. For filter selection generally the considerations described in chapter "Measured fluid" should be followed, but in all cases it is recommended to ask the advice of our application expert, too.

Electric connection
The turbine meter must be connected to the display and signal processing unit of the flow measuring system with flexible shielded cable according to the instructions in their manuals. The connection of the connector on the turbine meter and the diameter of the applied cable can be seen on Figure 8. The turbine meter must be protected against the effect of external magnetic fields. In most cases it is enough to keep 1-2 m distance from disturbing sources (transformers, electric motors, magnetic switches etc.). After the final arrangement of the connecting cable make sure that in flowless case (by standing rotor) the electronic unit displays zero flow. If electric noises cause flow indication, the source of the noise must be located and by shielding or rearrangement of the cable their effect must be eliminated.

Setup for operation
When starting a new technology the turbine meter (and, if possible, the whole measuring section) must be protected against the stronger contamination occurring at first fill up of the conduit, by using a bypass section or substituting section temporarily. After flushing follow the steps below:
1. After pressurizing the tightness must be checked.
2. Check the correct setting of calibration factor at the signal processing unit.
3. Switch the electronic display unit on.
4. Gradually start the flow of the fluid.

MAINTENANCE
The maintenance of the measuring section should be performed according to the operational conditions. When filter is applied it practically means the cleaning or replacing of filter insert before clogging. It is recommended to re-calibrate or re-approve the turbine meters once a year, this time the condition of the rotor and the shafts must be checked in an expertised workshop.

REPAIR
When measuring uncertainties get over the specified limits the parts containing bearings (stators and the rotor) can be replaced if necessary. Only parts certified by the manufacturer can be used for replacing. Disassembling and repairing of the turbine meters must be performed or directed only by properly skilled experts. Repair should be performed in well-equipped workshop by using the proper special tools according to directions. After disassembling and repair the turbine meters must be calibrated. After the new calibration the determined new calibration factor must be set at the electronic display unit. Parts necessary for maintenance and repair of turbine meters can be ordered from our issue titled "Parts list of TURBOQUANT turbine meters".

STORAGE, TRANSPORT
Temperature of storing room:
At flange 1.4541 and. 1.1106: -50...+60 °C
At flange 1.0566: -20...+60 °C

It is forbidden to lift the turbine by the pickup!
It is forbidden to drop the turbine hard!
it is forbidden to roll the turbine on the flanges!
The manufacturer takes the warranty for the operation of the turbine meters by specification only in case of following the prescriptions above.

RIGHT FOR CHANGES
MMG Ltd. keeps the right to perform changes on the turbine meters without preliminary notice in order of technical improvement.
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Table 1. Type selection

69 **AB-0-CDE-FG**

AB	SIZE DN	SIZE max. m^3/h
01	6	0,275
02	6	0,55
03	12	1,1
04	15	2,2
05	15	4
06	18	8
07	25	16
08	37	34
09	50	68
14	15	2,2
15	15	4
16	18	8
17	25	16
18	37	34
19	50	68
21	6	0,275
22	6	0,55
23	12	1,1
24	15	2,2
25	15	4
26	18	8
27	25	16
28	37	34
29	50	68
30	75	135
31	100	270
32	150	550
33	200	1100
34	250	1900
35	300	2700
36	400	4000
41	6	0,275
42	6	0,55
43	12	1,1
44	15	2,2
45	15	4
46	18	8
47	25	16
56	18	8
57	25	16
58	37	34
59	50	68

C	BUSHING MATERIAL
4	Teflon
6	Tungsten carbide

D	BODY MATERIAL
	Body Flange
2	1.4541 1.4541
3	1.4541 1.0566
4	1.4541 1.1106
1	Threaded body (1.4541)

E	PRESSURE CLASS bar
1	10
2	16
3	25
4	40
5	64
6	100
7	160
8	250
9	320

F	SEALING SURFACE
0	Threaded
1	Recess
2	Notch
3	Flat
4	Lens

G	OUTPUT SIGNAL
0	Pick-up coil
1	Preamplifier (3...10 mA)
2	Preamplifier (6...14mA)
3	Preamplifier (1,2...4mA)
S	Special

Notes:

Connections

A=0 Pipe thread (Table 3.)
A=1 Spec. thread(320 bar)
A=2,3 Flange (Table 2.)
A=4 Ermeto (320 bar)
A=5 Special rotor

Shaft bushing

In case of DN6 and 12 only teflon bushing can be selected (C=4)

Table 2 Pressure classes of flanged turbine meters

PN (bar)	DN (mm) 6	12	15	18	25	37	50	75	100	150	200-400
10	↑	↑	↑	↑	↑	↑	↑	**	↑	↑	**
16	↑	↑	↑	↑	↑	↑	↑	↑	**	**	**
25	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	**
40	**	**	**	**	**	**	**	**	**	**	**
64	↑	↑	↑ -	↑		↑	**	**	**	**	**
100	↑	↑	↑ -	↑		↑	**	**	**	**	-
160	**	**	**	-	**	**	**	**	**	**	-
250	**	**	**	-	**	**	**	**	**	- -	

Table 3 Pressure classes of pipe threaded turbine meters

DN 6,12	250 bar
DN 15	160 bar
DN 18, 25, 37, 50	100 bar

Table 4 Materials in contact with the measured fluid

Body, stators	1.4541
Rotor	1.4034 (DN6-75), 1.4541, (DN100-400)
Bearng	Tungstene Carbide or Teflon

Table 5 Operating temperature limits

Flange material	1.0566	1.1106, 1.4541
Ambient*	-20...+60°C	-50...+60 °C
Fluid*	-20...+150°C	-50...+150 °C

* See the temperature limits for connectors at Figure 8.

Table 6 Fluid temperature and the Ex temperature classes*

	°C		°C
T3	-50... +75°C	T4	-50... +60°C
T5		T6	

* See the temperature limits for connectors at Figure 8.

Table 7 Metrological data

DN (mm)	Q_{max}	Linearity	Repeatability	Shaft bushing
6	20...100%	±1%	0,15%	TEFLON
12	20...100%	±1%	0,15%	
15	10...100%	±0,5%	0,05%	
18...75	10...100%	±0,5%	0,03%	
100...400	16...100%	±0,4%	0,03%	
6	- - -			TUNGSTEN CARBIDE
12	20...100%	±1%	0,15%	
15	20...100%	±0,5%	0,05%	
18...75	20...100%	±0,5%	0,03%	
100...400	20...100%	±0,4%	0,03%	

Table 8 Main application technical features

DN (mm)	Max. flowrate (m3/h)	(1) (imp/m3)	(1) (2) (Hz)	(2) (mA eff)	(3) (bar)	Mass (kg) (4)	(5)
6	0,275	17 000 000	1300	40	0,4	0,2	1,6/2
6	0,55	8 500 000	1300	40	0,4	0,2	1,6/2
12	1,1	4 090 000	1250	60	0,35	0,25	2/2,4
15	2,2	1 960 000	1200	80	0,35	0,25/1,5	2/2,4
15	4	1 080 000	1200	80	0,35	0,25/1,5	2/2,4
18	8	562 000/173 200	1250/385	200	0,35	0,25/1,4	2,6/3,2
25	16	259 000/99 000	1150/440	200	0,3	0,4/1,6	3,7/4,5
37	34 95	300/39 200	900/370	250	0,3 0,5/4	6,2/10	
50	68 60	880/19 600	1150/ 300	0,3	1,2/6,2	8,3/12	
75	135 16	000 600	400	0,3	16/20		
100	270 12	000 900	200	0,25	25/35		
150	550 5	236 800	200	0,25	40/50		
200	1100 3	109 950	200	0,25	65/78		
250	1900 1	800 950	200	0,25	76/91		
300	2700 1	267 950	200	0,25	83/100		
400	4000 900	1000	200	0,25	132/158		

Notes: (1) The value after "/" is valid for special rotor (A=5). **(2)** pick-off coil by maximal flowrate. **(3)** With water, by maximal flowrate. **(4)** The value after "/" is valid for special threaded version (A=1). **(5)** The value before "/" refers to minimal, after "/" refers to maximal pressure class.

Figure 1. **Mechanical construction (DN6-75).**

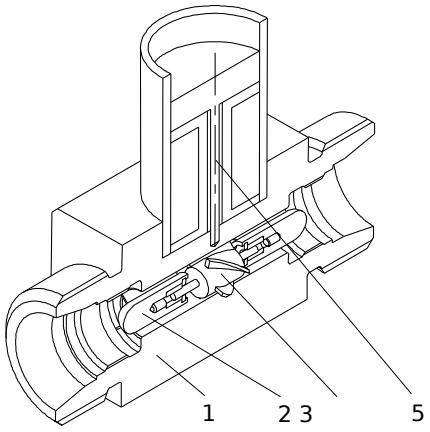
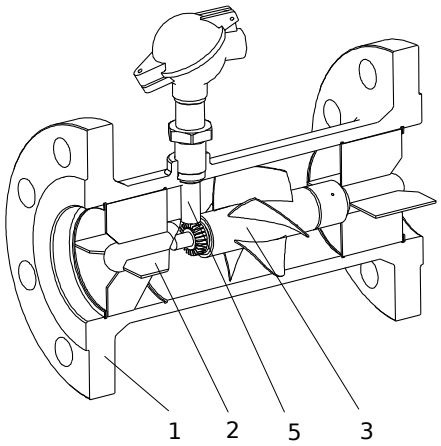


Figure 2. **Mechanical construction (DN100-400).**



1-body, 2-stators, 3-rotor, 5-pickup.

Figure 3. **Measuring section layout.**

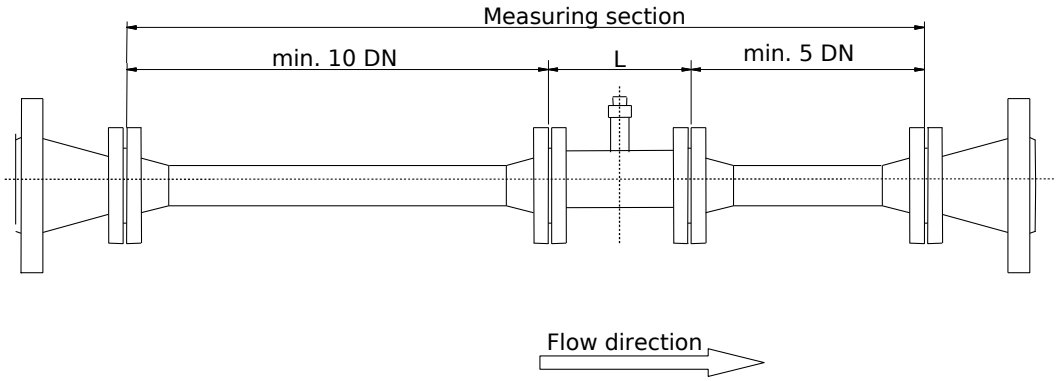
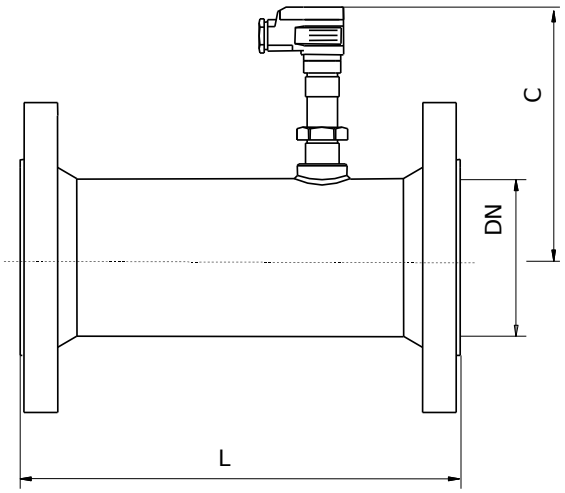


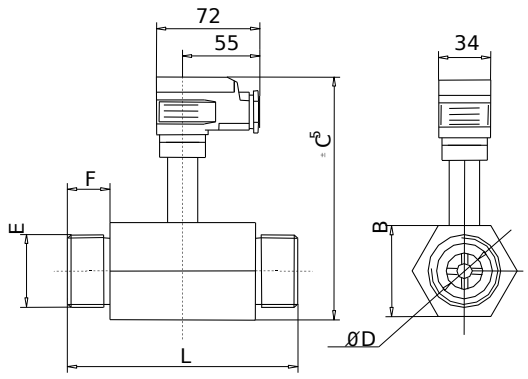
Figure 4. **Dimensions at flanged connection. (A=2, 3)**



$Ø_{DN}$	C	L
6	95	114
12	102	127
15	115	127
18	115	141
25	126	153
37	126	179
50	132	198
75	140	330
100	154	355
150	180	368
200	236	458
250	265	458
300	290	458
400	345	610

(dimensions in mm)

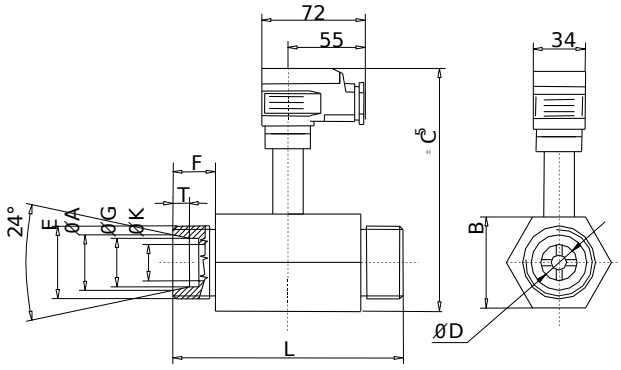
Figure 5. **Dimensions at threaded pipe connection. (A=0)**



ØD	B	C	L	E	F
6	25	82	50	8 G3/8”	12,7
12	25	86	63	5 G1/2”	19
15	25	87	63	5 G5/8”	19
18	38	89	82	6 G3/4”	22
25	38	92	89	G1”	23
37	56	99	114	G1½”	28
50	70	104		133 G2”	29,5

(dimensions in mm)

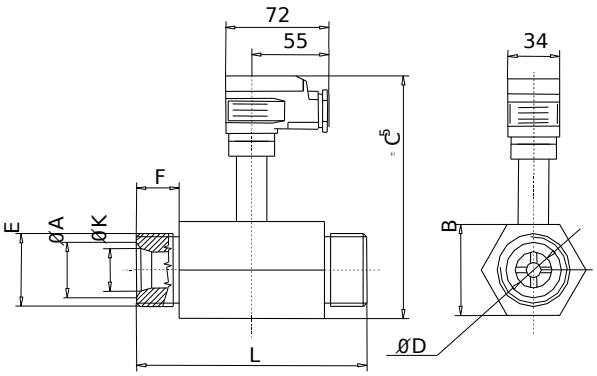
Figure 6. **Dimensions at ERMETO connection. (A=4)**



ØD	ØA	B	C	L	E	F	ØG	ØK	T
6	14,3	25	82	58	M20x1,5	12	12	8	7,5
12	18,3	36	86	76	M24x1,5	14	16	12	8,5
15	22,9	41	87	76	M30x2	16	20	15	10,5
18	27,9	48	89	130		M36x2	18	25	19 12
25	38	48	92	155		M52x2	16	35	27 10,5

(dimensions in mm)

Figure 7. **Dimensions at special threaded connection. (A=1)**



Type	ØD	ØA	B	C	L	E	F	ØK
6914	15	35	48	89	130	M42x2	32	24
6915	15	35	48	89	130	M42x2	32	24
6916	18	35	48	91	130	M42x2	33	24
6917	25	43	48	94	155	M48x2	46	30
6918	37	60	70	100,5		195	M68x3	55 45
6919	50	72	84	100,5		225	M80x3	65 58

(dimensions in mm)

Figure 8. **Connector types, dimensions, operating temperature limits and electric connection.**

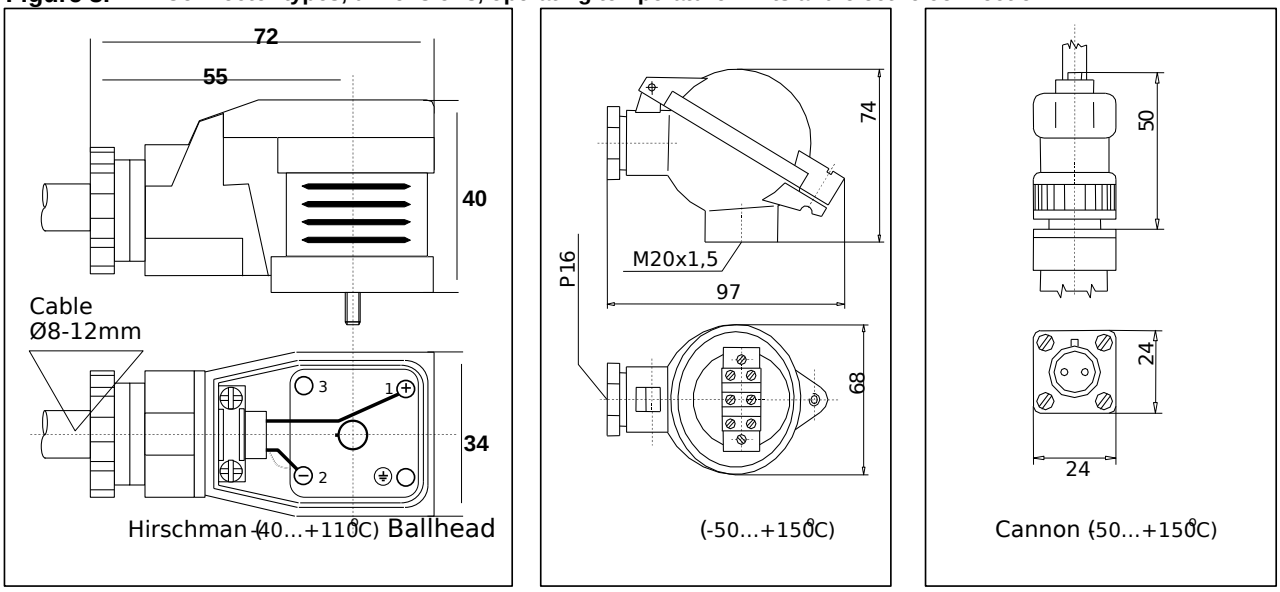


Figure 9. **Explosion hazardous application without preamplifier (G=0).**

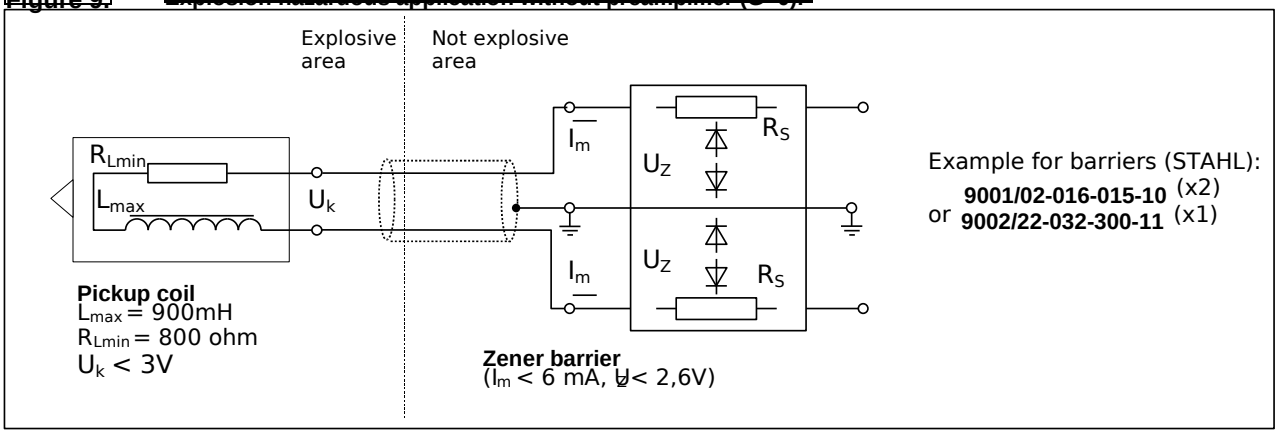
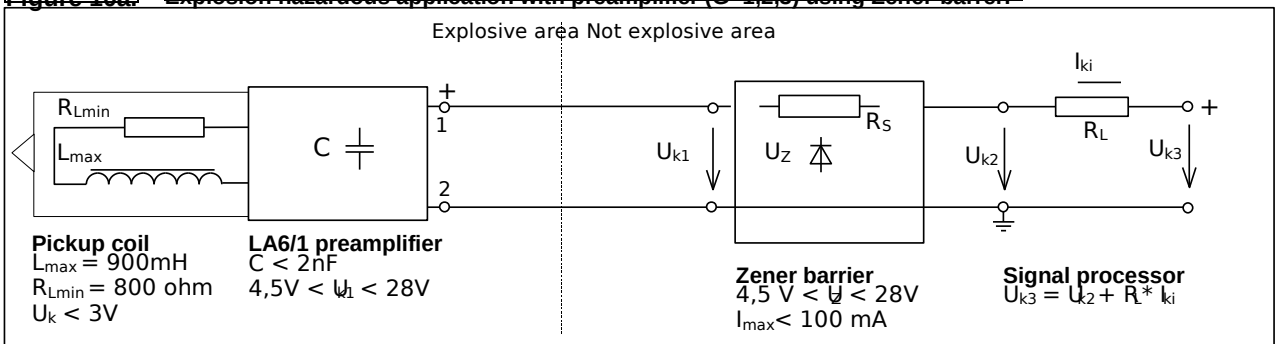


Figure 10a. **Explosion hazardous application with preamplifier (G=1,2,3) using Zener barrer.**



At the selection of Zener barrier the inductivity and capacity increased with 2nFof the applied cable must be considered and the following conditions necessary for the operation of the measuring system:

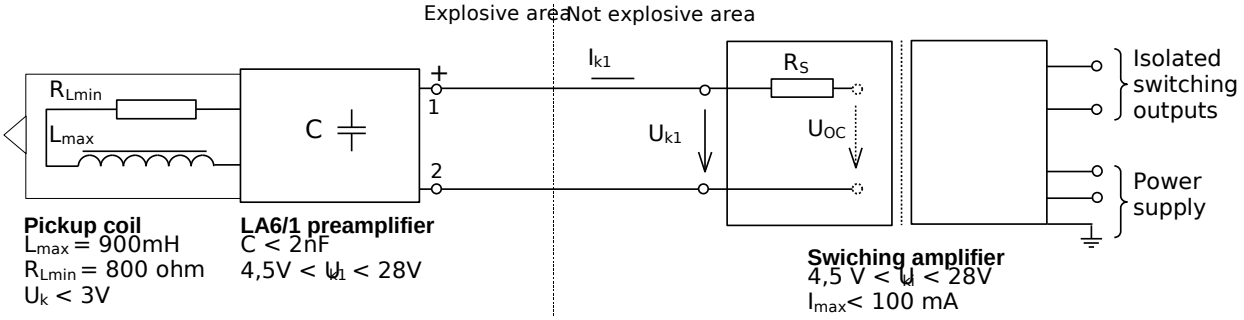
$$U_{k1min} = (U_{k3} - (R_L + R_S) * I_{ki}) > 4{,}5V; \qquad U_{k3} < U_z$$

Where the values of I_{ki} can be found in table bellow:

Signal level	"G" position of type (Table 1)		
	1	2	3
"0"	max. 3 mA	max. 7 mA	max. 1,2 mA
"1"	max.11 mA min.9 mA	max.15 mA min.13 mA	max.4 mA min. 3,6 mA

Example for barriers (STAHL):
9001/01-280-085-10 ,
or 9001/01-280-100-10

Figure 10b. **Explosion hazardous application with preamplifier (G= 1,2,3) using Switching amplifier.**



At the selection of Switching Amplifier the inductivity and capacity increased with 2nFof the applied cable must be considered and the following conditions necessary for the operation of the measuring system:

$$U_{k1min} = U_{OC} * (1 - I_{k1} / I_{SC}) > 4,5V;$$

Where:

U_{OC} - open circuit input voltage of switching amplifier
I_{SC} - short circuit input current of switching amplifier
I_{k1} - max.loading current depending on the type of preamplifier (see table bellow)

Signal level	"G" position of type (Table 1)		
	1	2	3
"0"	max. 3 mA	max. 7 mA	max. 1,2 mA
"1"	max.11 mA min.9 mA	max.15 mA min.13 mA	max.4 mA min. 3,6 mA
Recommended Switching amplifiers		K-130/3-E-10 (RECHNER)	BES-526-607-A (BALLUFF)