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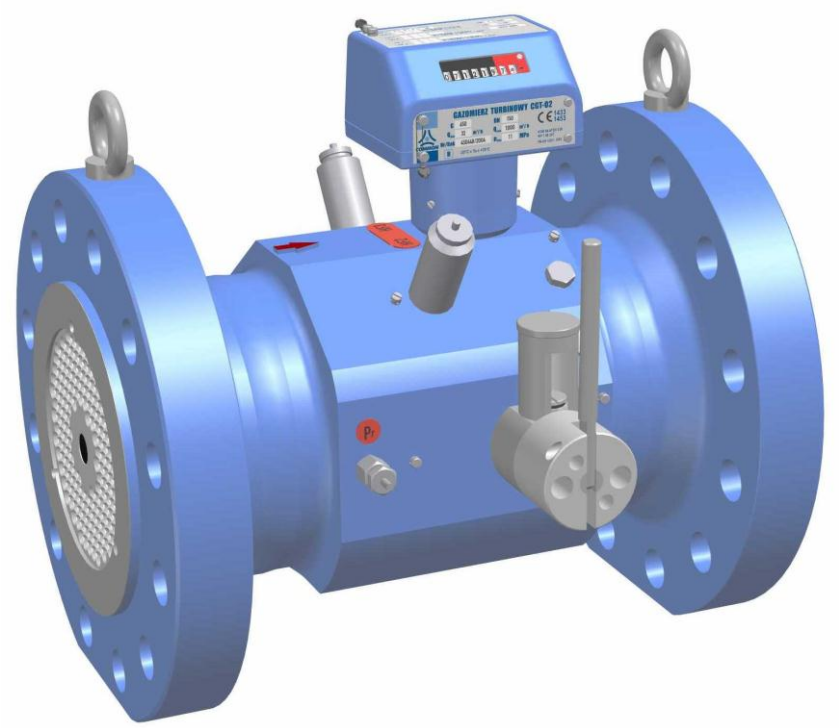
TURBINE GAS METERS

CGT-02

OPERATION MANUAL

(Technical manual)



CGT / IO12 / MID
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PLEASE READ THE OPERATION MANUAL BEFORE INSTALLING AND OPERATING THE GAS METER

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I. INTENDED USE AND CONDITIONS OF USE

Intended use

Turbine gas meters CGT-02 are electromechanical pressure devices designed to measure the volume of gas flowing through a system. In standard embodiment, the gas meters may be used at sites with probable occurrence of explosive atmospheres formed as mixtures of gases classified as explosion groups IIA and IIB (and group IIC for the special purpose embodiment) with air.

Table 1 lists the physical properties of the most common gases and gas mixtures that may be measured with CGT-02 gas meters. The gas meters are produced with the following connection types: PN10, PN16, PN20 (ANSI150), PN25, PN40, PN50 (ANSI300), PN63/PN64, PN100, PN110 (ANSI600).

The turbine gas meters can be used both indoors in stabilized temperature conditions and outdoors (open location); however, in the latter case, it is recommended that the gas meter is shielded from direct exposure to atmospheric factors (metal containers, casings, roofs, shields etc.)

Conditions for use

1. Directive 2004/22/WE (MID) compliance:

- Certificate: PL-MI002-1450CM0003
- CE marking: CE Mxx 1450, Oil and Gas Institute
- working pressure range: $p \leq 0.4$ MPa
- ambient temperature range: $-25°C \leq t \leq +70°C$
- gas temperature range: $-25°C \leq tg \leq +55°C$
- storage temperature range: $-30°C \leq ts \leq +70°C$
- mechanical environment class: M2
- electromagnetic environment class: E2
- metrological parameters: Table 1.
- metrological accuracy class: 1.0
- operational position: H, VU, VD
- harmonized standards: PN-EN 12261:2005 (EN 12261:2002+AC:2003), PN-EN 12261:2005/A1:2008 (EN 12261:2002/A1:2006)

2. Directive 94/9/WE (ATEX) compliance:

- certificate: KDB 04ATEX036, Central Mining Institute, Experimental Mine ”Barbara”
- CE marking: CE 1453,
- operation conditions: standard embodiment Ex II 2G Ex ia IIB T5 Gb; special-purpose embodiment Ex II 2G Ex ia IIC T5 Gb
- meter case index of protection: IP66/IP67,
- harmonized standards: PN-EN 13463-1:2010 (EN 13463-1:2009), PN-EN 60079-0:2009 (EN 60079-0:2009), PN-EN 60079-11:2010 (EN 60079-11:2007).

3. Directive 97/23/WE (PED) compliance:

- certificate: 67/JN/2004-003/3,
- CE marking: CE 1433, Office of Technical Inspection

- Maximum calculated pressure for gas meter bodies:

connection PN10	PS = 1.0 MPa,
connection PN16	PS = 1.6 MPa,
connection PN20	PS = 2 MPa,
connection PN25	PS = 2.5 MPa,
connection PN40	PS = 4 MPa,
connection PN50	PS = 5 MPa,
connection PN63/64	PS = 6.4 MPa,
connection PN100	PS = 10 MPa,
connection PN110	PS = 11 MPa,

- ambient temperature range $-25°C \leq t \leq +70°C$
- compliance with technical specification WUDT/UC/2003.

4. Directive 2004/108/WE (EMC) compliance:

Requirements met by the use of LF and HF pulse emitters (NAMUR) compliant with the following harmonized standards: PN-EN 60947-5-2:2011 (EN 60947-5-2:2007), PN-EN 60947-5-6:2002 (EN 60947-5-6:2000).

Table 1. Physical properties of the most common gases and gas mixtures that may be measured with CGT-02 gas meters. Densities are specified under pressure of 101.325 kPa at 20^o C

Gas or gas mixture	Chemical symbol (formula)	Density ρ [kg/m^3]	Density relative to air	Gas meter embodiment
argon	Ar	1.66	1.38	standard IIB
nitrogen	N_2	1.16	0.97	standard IIB
butane	C_4H_{10}	2.53	2.1	standard IIB
carbon dioxide	CO_2	1.84	1.53	standard IIB
ethane	C_2H_6	1.27	1.06	standard IIB
ethylene	C_2H_4	1.17	0.98	standard IIB
natural gas	$\approx CH_4$	ca. 0.75	ca. 0.63	standard IIB
helium	He	0.17	0.14	standard IIB
methane	CH_4	0.67	0.55	standard IIB
propane	C_3H_8	1.87	1.56	standard IIB
carbon monoxide	CO	1.16	0.97	standard IIB
acetylene	C_2H_2	1.09	0.91	special IIC
hydrogen	H_2	0.084	0.07	special IIC
air	–	1.20	1	standard IIB

The basic metrological parameters of CGT-02 turbine gas meters are listed in Table 2. The table should not be taken as current sales offer; relevant information may be obtained at the Marketing Department.

The gas meter causes a gas pressure drop in the system. The numerical value of the pressure drop typical for the CGT-02 gas meter at gas density of ρ_0 1.2 kg/m^3 may be found in the graph in Figure 1.

In actual conditions, pressure loss Δp_r [Pa] is calculated from the formula:

$$\Delta p_{rz} = \frac{\rho}{\rho_o} \frac{p_a + p}{p_a} \Delta p$$

where: ρ – gas density from Table 1 [kg/m^3],
p_a – atmospheric pressure ($p_a \cong 101$ [kPa]),
p – gauge gas pressure upstream of the gas meter [kPa],
Δp – pressure drop in reference conditions (as per Fig. 1) [Pa]..

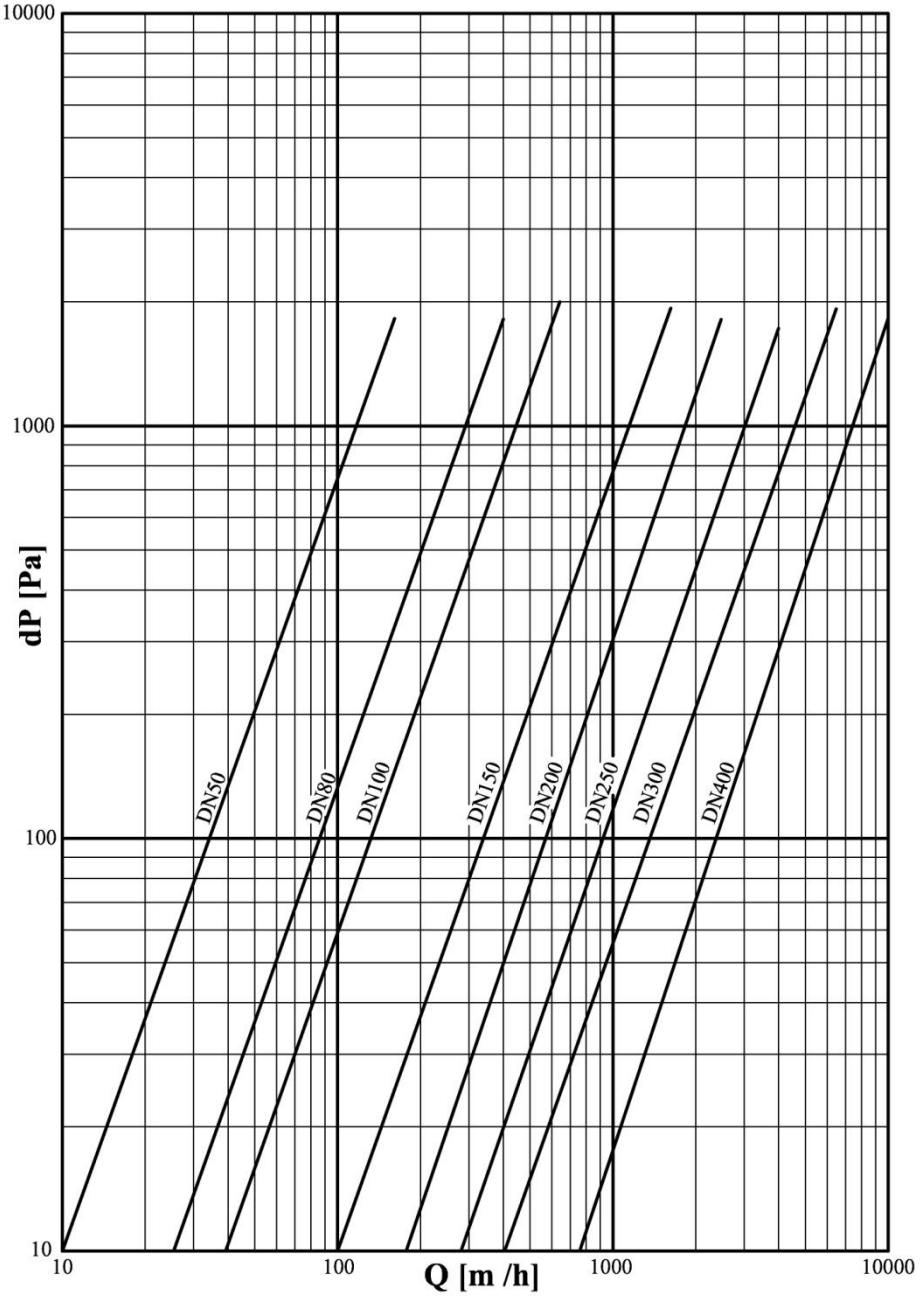


Fig. 1. Pressure loss of CGT-02 gas meters
at the reference density of ρ_o = 1.2 kg/m^3

Table 2. Basic metrological parameters of CGT-02 meter in the DN50÷DN400 range at maximum operating pressure p ≤0.4 MPa

DN nominal diameter	**G** Gas meter size	**Q_{max}** Maximum flow	**Q_{min}** minimum flow at scale:		**LF** emitter constant	**HF1, HF2** emitter constant (approximate)	**HF3 ÷ HF6** emitter constant (approximate)
			1:20	1:30			
_	_	m^3/h	[m^3/h]	[m^3/h]	[pulses / m^3]	[pulses / m^3]	[pulses / m^3]
DN 50	G 65	100	5	–	10	2610	94829
DN 80	G 100	160	8	–	1	742	26974
	G 160	250	13	8	1	742	26974
	G 250	400	20	13	1	470	17059
DN 100	G 160	250	13	–	1	692	16782
	G 250	400	20	13	1	692	16782
	G 400	650	32	20	1	401	9719
DN 150	G 400	650	32	20	1	227	6873
	G 650	1000	50	32	1	227	6873
	G 1000	1600	80	50	0.1	129	3910
DN 200	G 650	1000	50	32	1	114	3113
	G 1000	1600	80	50	0.1	116	3167
	G 1600	2500	130	80	0.1	67	2025
DN 250	G 1000	1600	80	50	0.1	58	2111
	G 1600	2500	130	80	0.1	58	2111
	G 2500	4000	200	130	0.1	34	1223
DN 300	G 1600	2500	130	80	0.1	32	1181
	G 2500	4000	200	130	0.1	32	1181
	G 4000	6500	320	200	0.1	19	680
DN 400	G 2500	4000	200	130	0.1	13	444
	G 4000	6500	320	200	0.1	13	444
	G 6500	10000	500	320	0.1	7.0	285

II. DESIGN AND FUNCTION

Operation of the turbine gas meter is based on the principle of proportionality of the speed of rotation of a turbine rotor to the linear velocity or the volumetric flow of gas. The gas flowing into the gas meter (fig 2) is directed via an inlet straightener into the measurement assembly and triggers the rotation of the rotor. The rotational motion of rotor is transmitted to the counter by means of cog gears and magnetic clutch. The counter mechanism totals up the volume flowing through the device, and an 8-digit counter indicates the total volume. Each gas meter of the CGT-02 series is verified in the range of Q_{min} to Q_{max} (Table 2), and in that range the accuracy of the meter is verified.

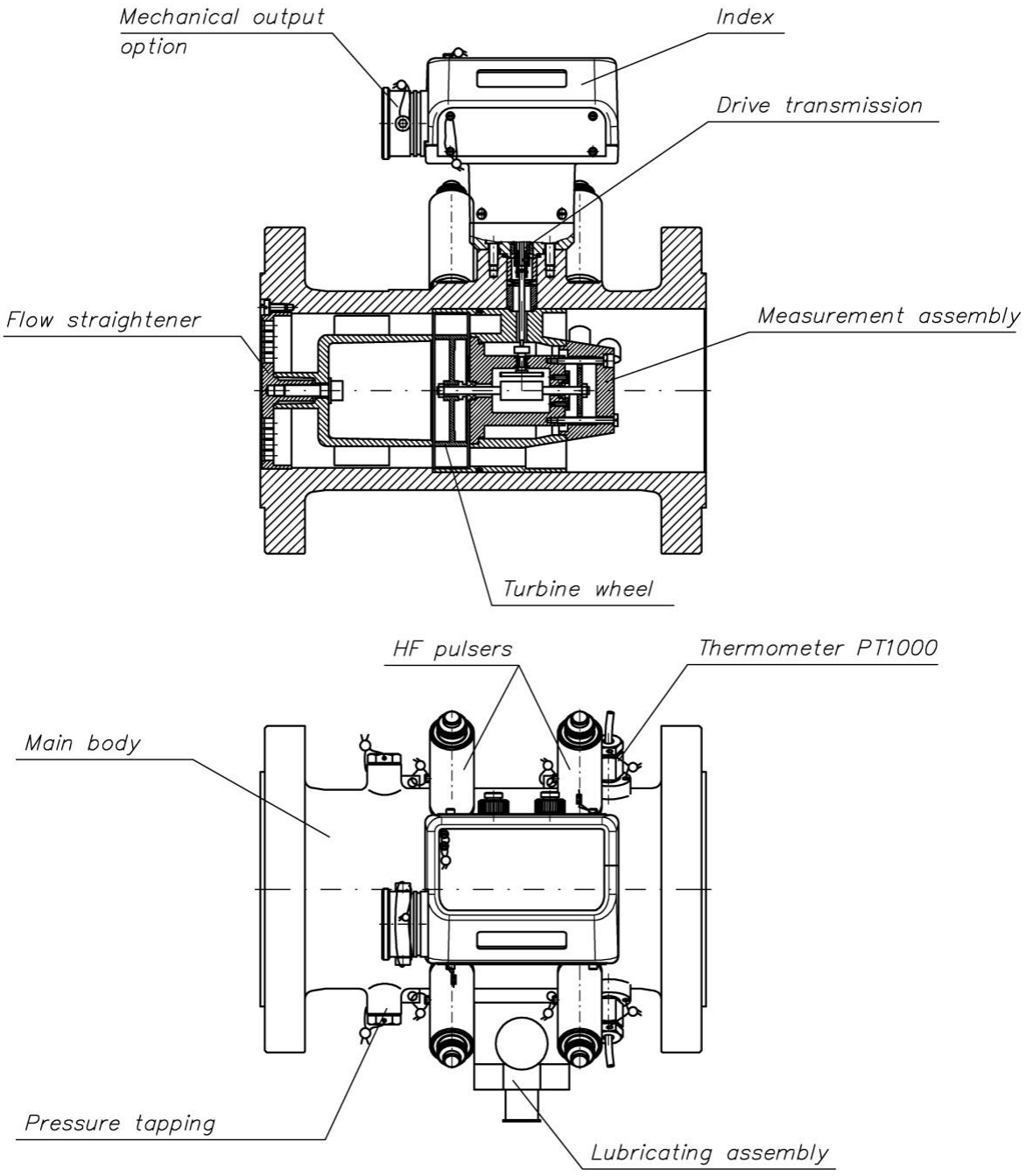


Fig. 2 Cross-section of the turbine gas meter CGT-02

The turbine gas meter CGT-02 (Fig. 2) is built of the following basic elements:

Main body. The main body carries all loads originating from both the gas pressure and the system connections. Bodies of the gas meters with nominal diameters of DN50 to DN200 and PN16 or PN 20 connections may be manufactured in two versions - either as machined steel forgings or spheroidal cast iron castings. Bodies with PN25, PN40, PN50, PN63/64, PN100 and PN110 are available only in the steel version. Larger bodies, with nominal diameters of DN250 and above are always made of welded steel. Each body is complete with two connection flanges with type "B" faces and connection dimensions compliant with the PN-EN1092-1:2006 and the PN-ISO 7005-1:1996 standards. The flange dimensions, as well as overall dimensions and estimated weights of the gas meters in their standard embodiments are listed in Tables 3a and 3b and indicated in Figure 18. By special orders, the body may be delivered with different types of flanges compliant with: Polish Standards (e.g. with protruded lips or grooves) or with ISO, ANSI or GOST standards. The gas meter body is complete with connectors for high frequency signal emitters and sockets for pressure gauges and sockets for temperature pockets for thermometers (see section III).

Measurement turbine assembly. The measurement turbine assembly consists of the turbine, the gear system and the inlet straightener. The turbine rotor is placed along the gas meter body axis and seated on two high precision ball bearings. The flow straightener placed in front of the turbine makes the gas flow symmetrical and directs it onto the turbine blades. The gear system (consisting of a worm gear and a cylindrical gear) reduces and transfers the rotational speed and transmits the drive onto the magnetic clutch.

Drive transmission assembly. The drive transmission assembly consists of a magnetic clutch with gas-tight partition. The driving part of the clutch is located inside the partitioned chamber, while the driven part is located outside the partitioned chamber. The clutch transmits the drive from the pressure zone to the counter assembly, located outside the gas flow area. The driven part of the clutch may be complete with a reference wheel acting as an inducer for the high frequency emitter.

The counter assembly. The counter assembly further reduces the rotational speed (by means of a worm gear and cylindrical gears) to drive the mechanical counter and the elements that induce the low frequency electric signal emitters. The assembly is also complete with sockets for transmitting the low and high frequency electric signals outside the gas meter. The gas meter counter may be optionally equipped with a mechanical outlet.

Lubrication system. The lubrication system is used to lubricate the turbine rotor bearings. The remaining mechanisms of CGT-02 gas meters are not subject to external lubrication and make use of bearings equipped with grease reserves. The greasing may be accomplished by means of a manual plunger pump with integrated oil reservoir (capacity of 20 cm^3) or via a special lubrication gear.

The gas meters are available in the following versions:

- maintenance-free version (not designed for external lubrication),
- version featuring a special valve for external lubrication,
- version with plunger pump.

By default, DN50 gas meters are not designed for external lubrication. Optionally, they may be equipped with plunger pumps or lubrication valves.

III. READOUT DEVICE AND MEASUREMENT OUTPUTS

The gas meter CGT-02 is equipped with a readout device in the form of a mechanical counter with electric signal outputs. The body of the gas meter is complete with sockets for implementation of external HF emitters and outlets for the (optional) measurement of pressure and temperature. The outlets allow to monitor the gas meter operation and to connect the external equipment. Fig. 3 shows the location of the measurement outlets on the gas meter.

The mechanical counter is located inside the counter assembly and visible through a polycarbonate inspection window. The counter allows direct readout of the actual volume of gas that has flown through the gas meter under particular pressure and temperature conditions. The counter assembly may be rotated around its axis in a range of ca. 350^{o}, allowing for convenient readout of the counter from virtually all directions.

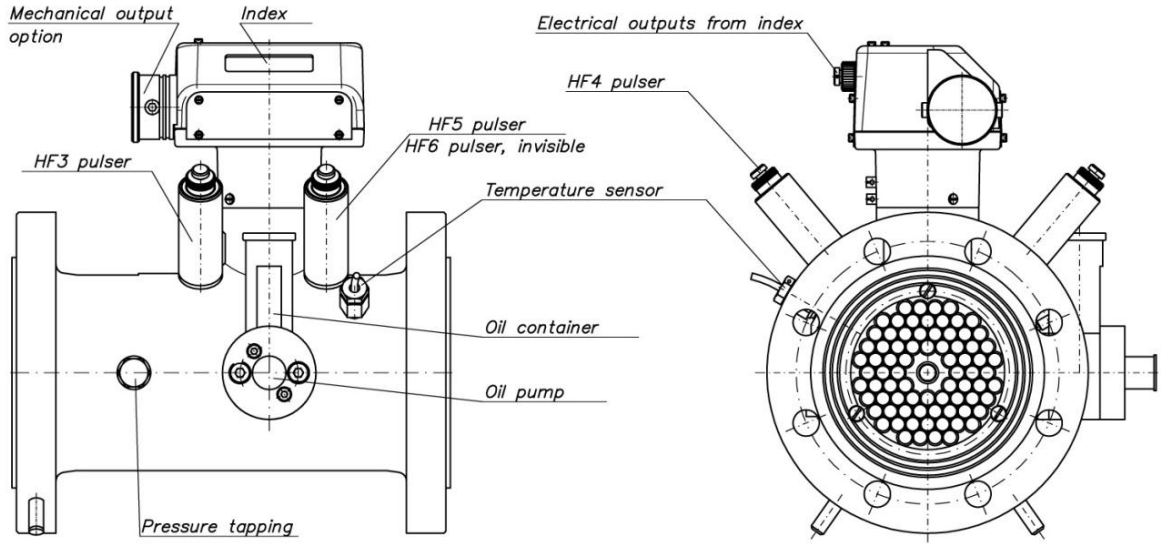


Fig. 3. Location of measurement outlets in CGT-02 gas meters.

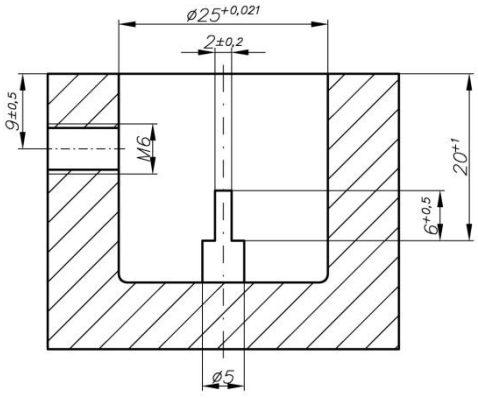


Fig. 4. Mechanical outlet clutch dimensions

Mechanical counter outlet The gas meter may be optionally equipped with a mechanical outlet. A paddled tip of the counter shaft is located on the left side of the counter and covered by a protective cap. The mechanical outlet may be used to drive external devices. The rotational speed of the shaft is identical to the speed of the fastest counter barrel. The shaft rotates in clockwise direction. Maximum allowable momentum of the shaft tip is 0.25 Nmm.

Electrical counter outlets There are two possible types of electric signal outlets: low frequency (LF) outlets and high frequency (HF) outlets. The counter may be equipped with the maximum of two sockets and six electric pulse emitters.

- two inductive high frequency emitters (HF),
- two inductive low frequency emitters (LFI),
- Two low frequency reed contact emitters (LFK),

and with a control circuit featuring a normally closed reed relay switch AFK or, alternatively, any other emitter.

The reed relay emitters LFK are designed to work with a battery-powered or grid/battery-powered data logger and volume converter located in the vicinity of the gas meter (up to ca. 2 m). The induction emitters, both of the LFI and the HF type, may emit electric current signals over significantly longer distances (up to ca. 200 m, depending on conditions). Due to high power consumption, they are designed to work only with grid-powered volume converters. Gas volumes corresponding to individual pulses of the LF emitter are presented in Table 2.

The number of HF pulses per one cubic meter of gas is determined individually for each gas meter and listed on the type plate.

All emitters located in the gas meter counter assembly are connected to Tuchel C091 31N006 100 2 sockets located in the back wall of the counter case. Cords connected to sockets should be equipped with Tuchel C091 31H006 100 2 plugs. Tuchel connections in CGT-02 gas meters are in the IP67 protection class. Table 3 presents potential connections of emitters to individual electric signal output sockets.

Table 3. Potential connections of gas meter emitters to counter output sockets

	contact	polarity	LFK 1		LFK 2		AFK		LFI 1		LFI 2		HF 1		HF 2	
Socket 1	1	–	S						O							
	4	+		S						O						
	2	–			O		P		P		O				O	
	5	+				O		P		P		O				O
	3	–					O						P			
	6	+						O						P		
Socket 2	1	–			P				O							
	4	+				P				O						
	2	–			O		O				P				O	
	5	+				O		O				P				O
	3	–											O		P	
	6	+												O		P

S – standard connections
P – preferred connections
O – optional connections

Standard embodiment of the CGT-02 gas meter features only one low frequency reed contact emitter LFK 1.

One of the inductive emitters HF3 to HF6 installed in the gas meter body may act as a control element in the CGT-02 meter. The constants for emitters HF3-HF6 are listed on the type plate.

In line with the conditions for use, the CGT-02 gas meters should be equipped with emitters allowing for at least ⟨Ex⟩II 2G Ex ib IIC T5 Gb protection. This condition is satisfied for instance by the following emitters used in the counter:

- HF type Bi1-EG05-Y1(1) by Hans Turck GmbH; ⟨Ex⟩ II 1G Ex ia IIC T6.
- LFI type Si5-K09-Y1-LF(1) by Hans Turck GmbH; ⟨Ex⟩ II 1G Ex ia IIC T6.
- LFK type CLFK-02 by Common S.A. ⟨Ex⟩ II 2G Ex ia IIC T6.

(1) – required linear characteristics of the emitter power circuit.

Intrinsic safety parameters of the emitters installed in the gas meter are listed on the type plate.

Acceptable intrinsic safety parameters

HF	LFI	LFK
U_i = 20 V DC	**U_i = 20 V DC**	**U_i = 15.5 V DC**
I_i = 60 mA	**I_i = 60 mA**	**I_i = 52 mA**
P_i = 200 mW	**P_i = 130 mW**	**P_i = 169 mW**
L_i = 150 µH	**L_i = 350 µH**	**L_i ≈ 0**
C_i = 150 nF	**C_i = 250 nF**	**C_i ≈ 0**

Nominal operating parameters of the emitters:

reed contact emitter **CLFK-02**:

closed switch resistance $R_z = 100\Omega \div 2\ k\Omega$,
open switch resistance $R_o > 100\ M\Omega$,
max. switching frequency $f_p = 2$ Hz .

inductive emitters	**Si5-K09-Y1-LF**	**Bi1-EG05-Y1**
max. switching frequency	$f_p = 2$ Hz,	$f_p = 0.5$ kHz.

The remaining nominal operating parameters of the emitters used in the gas meters are in line with the requirements of the PN-EN 60947-5-6:2002 standard.

Electrical outlets for HF emitter signals in the gas meter body

The high frequency pulse emitter may be placed in the main body of the gas meter above the turbine rotor or above the reference wheel with the number of cogs equal to the number of turbine blades. In such case, the magnetic field of the HF emitter is modulated by the turbine rotor or the reference wheel, respectively. The emitter is mounted in a slot in location shown in Fig. 3. The slot is complete with a M16 x 1.5 threaded socket (Fig. 5).

Installation of the HF emitter in the gas meter body requires high precision and the use of electronic control equipment and as such must be performed only by a representative of the manufacturer or a company authorized by the manufacturer.

Maximum of four near field inductive high frequency emitters (HF) may be installed in the gas meter:

- two HF emitters at the turbine rotor, and
- two HF emitters at the optional reference wheel.

The emitters should allow for at least ⟨Ex⟩ 2G Ex ib IIC T5 Gb protection. These conditions are satisfied, for example, by the following emitters:

- **CHFI-01** by Common S.A., equipped with Bi1-EG05-Y1(1) sensors (Hans Turck GmbH), – Ex II 1G Ex ia IIC T6,
- **CHFI-0**3 by Common S.A., equipped with Bi3-EG12-RY1/S1000(1) sensors (Hans Turck GmbH), – Ex II 1G Ex ia IIC T6,

(1) – required linear characteristics of the emitter power circuit.

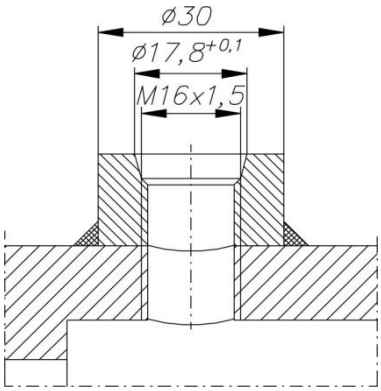


Fig. 5. The dimensions of the tap for installation of the HF pulse emitter.

Acceptable intrinsic safety parameters:

CHFI-01	CHFI-03
U_i = 20 V DC	U_i = 20 V DC
I_i = 60 mA	I_i = 60 mA
P_i = 200 mW	P_i = 200 mW
L_i = 150 µH	L_i = 350 µH
C_i = 150 nF	C_i = 180 nF

Intrinsic safety parameters are listed in the type plate located at the emitter casing (Fig. 10).

The emitters are equipped with 4-pin Tuchel C091 31W004 100 2 connectors. They should be connected to cords with Tuchel C091 31D004 100 2 slots. The emitter is connected to pins 3 and 4. Figure 6 presents a diagram of the connection of the emitter with the measurement circuit.

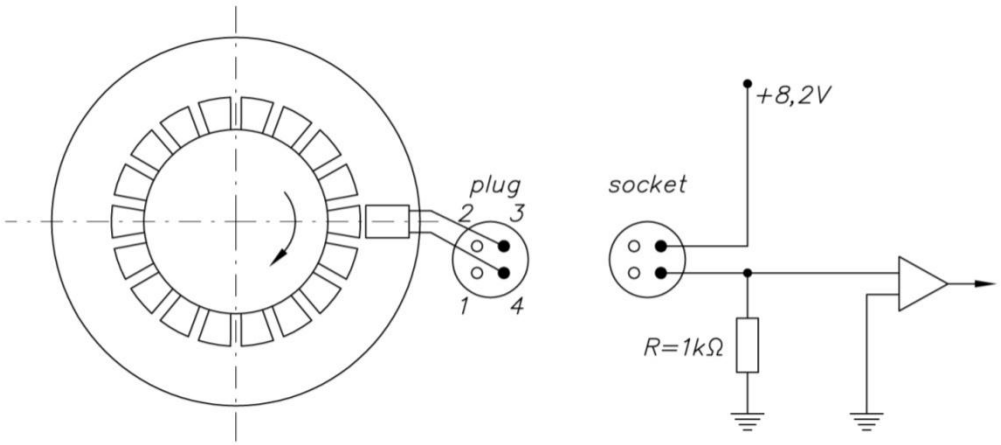


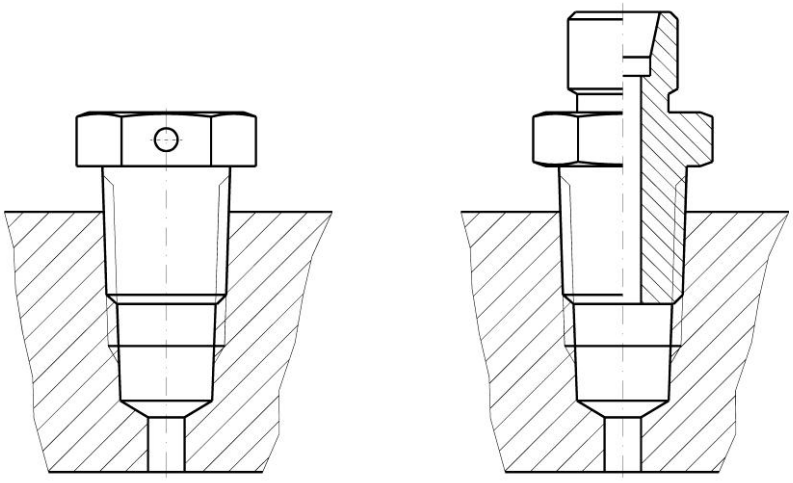
Fig. 6. Diagram of the HF emitter connection.

The number of HF pulses per one square meter of gas is determined individually for each gas meter and listed on the electrical outlets type plate. (Figs. 9 and 10), placed at the top of the counter.

The HF outlet is particularly useful for tracking changes in the flux of the agent flowing through the gas meter.

Pressure measurement outlet.

Pressure measurement outlets (pulse openings) are located at both sides of the main body (Fig. 3). Openings are complete with ¼ NPT threaded slots (Fig. 7).



a.) b.)

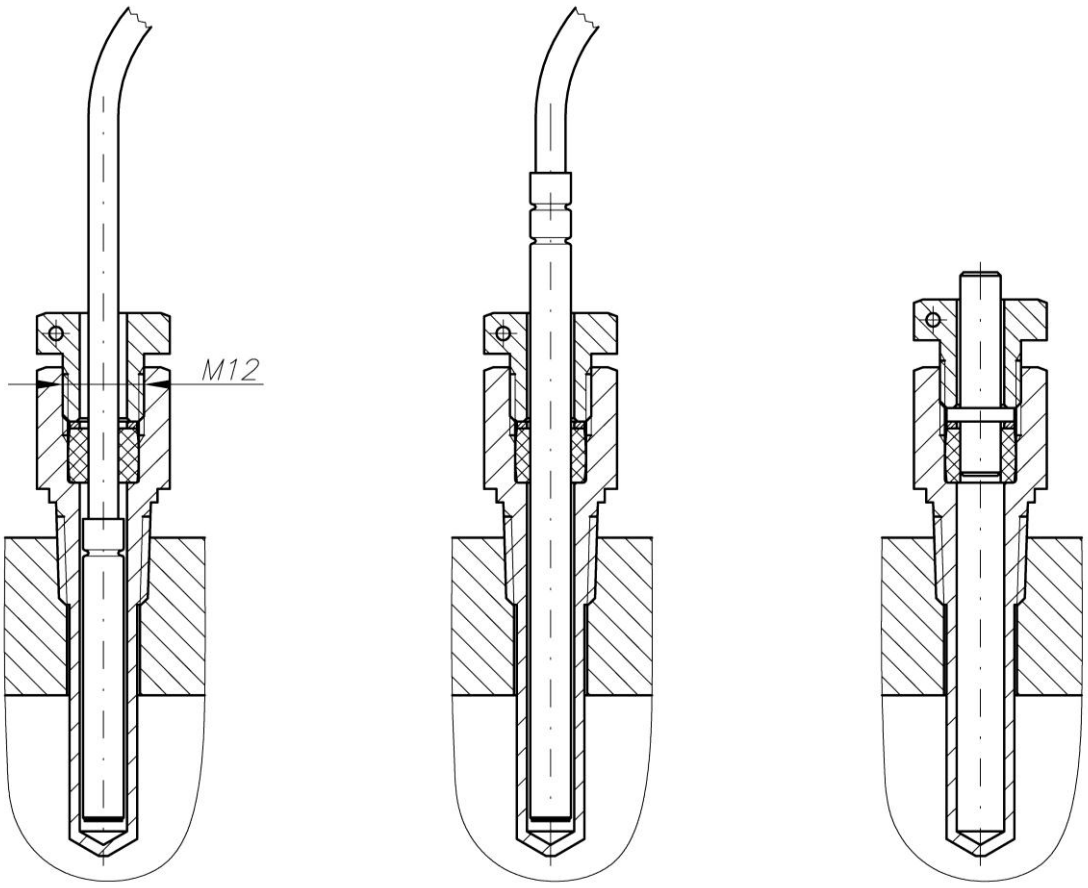
Fig. 7. ¼ NPT pressure measurement slot.

The outlets are used to connect pressure transducers, either directly to the socket (Fig. 7b) or via three-way valves. Outlets that not in use are blinded with plugs (Fig. 7a). Both plugs and sockets may be protected by installation seals.

Temperature measurement outlet.

The turbine gas meter CGT-02 allows temperature measurements only when delivered as a special order version; temperature pockets are not available in the standard version.

Temperature measurement outlets are located at both sides of the main body (Fig. 3). Temperature pockets are placed in the main body openings (Fig. 8). Temperature pockets are complete with M12 x 1.5 threaded sockets. Electric thermometer tips or temperature transducers are immersed in silicone oil in the temperature pockets (Figs. 8a and 8b). Temperature pockets which are not in use (Fig. 8c) are blinded with plugs. Outlets that are not in use are blinded with ¼ NPT plugs (Fig. 7a).



a) type 1 b) type 2 c) plugged temp. pocket

Fig. 8 Temperature pockets

IV. LABELING AND PROTECTION

Information on the basic technical parameters of the gas meter along with the serial number and manufacture year is listed on type plates (Figs. 9a and 9b) screwed to the counter casing. The top of the gas meter body features signs informing about the direction of gas flow and the locations of pressure and temperature measurement outlets (Fig. 11).

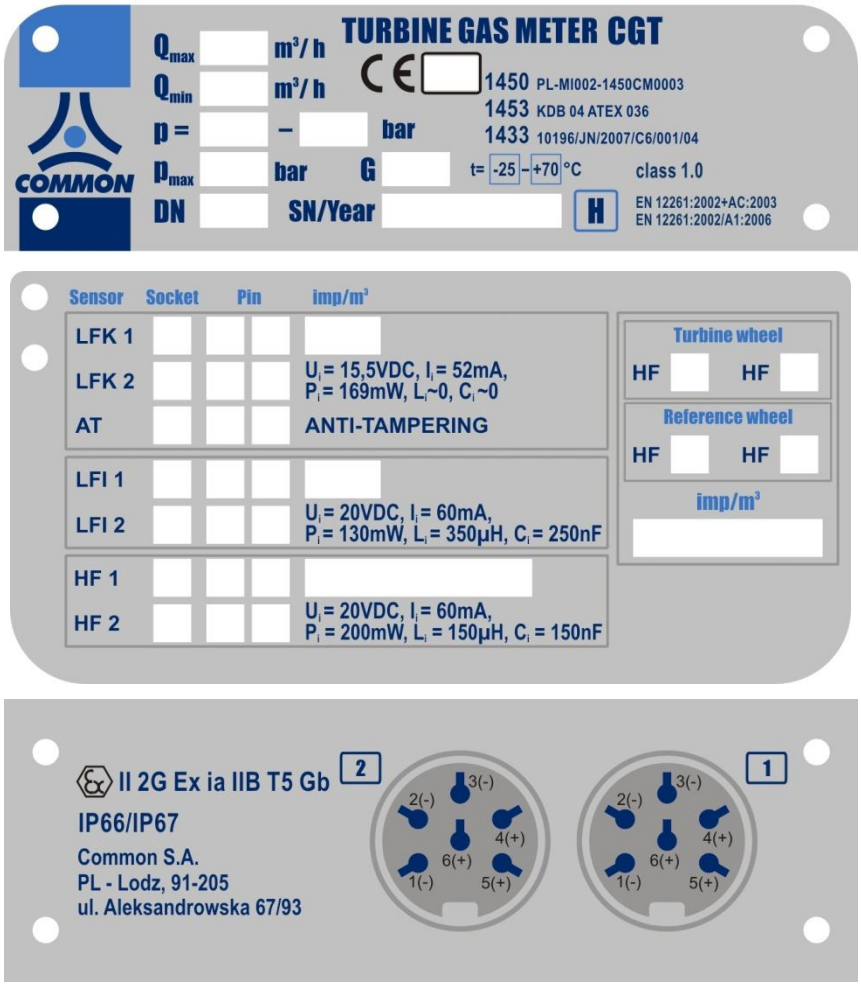


Fig. 9a. Type plates – standard version

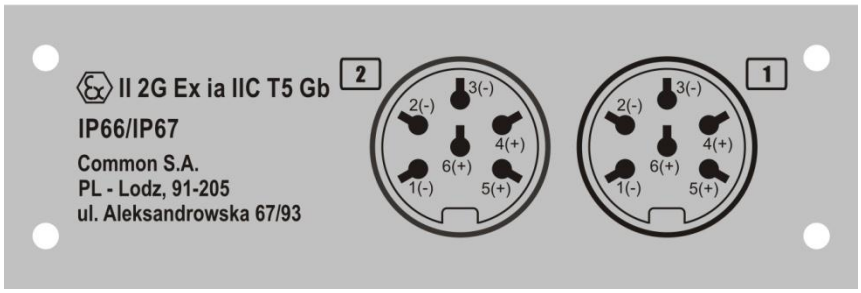


Fig. 9b. Type plates – special version example

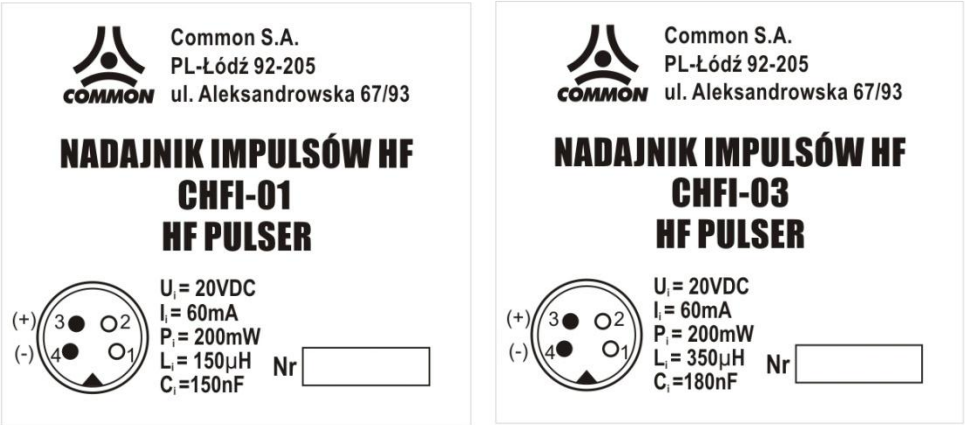


Fig. 10. HF emitter type plate

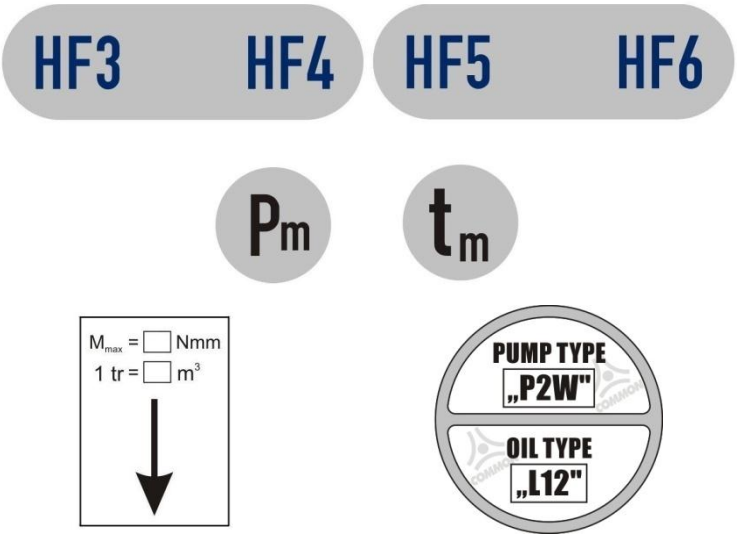


Fig. 11. Markings of pressure and temperature measurement outlets, HF outlets, mechanical outlet, and example of oil & oil pump type.

Following verification by the authorized manufacturer laboratory, each gas meter is protected with seals placed in locations shown in Fig. 12. Seal P1 features the original validation or revalidation stamp (Fig. 13) while seals P2, P3, P4, P5, P6, P7, P8, P9, P10 feature protection stamps.

By request of the customer, the gas meter may be delivered along with the verification certificate that documents its verification.

Retaining the original verification stamp seal is required for the gas meter to be considered a legal measurement device.

Installation seals placed at the connectors of the pressure transducers P7, HF emitters P8, temperature transducers P9 and possibly at the mechanical outlet P10 may feature stamps placed by the manufacturer, gas supplier or authorized installer. In addition, installation seals

should be placed on the blinders (plugs) of unused electrical outlets and possibly on the three-way valve connected to the volume converter (see section VIII.)

The original verification period depends on metrological regulations in the country of installation. Before the end of the verification period, the gas meter should be submitted for secondary verification at an authorized laboratory (one should also provide for the waiting time before the actual legal approval date)

Common S.A. offers renewed legal approval at manufacturer's laboratory, allowing for adjustments or repairs of the gas meters, if required.

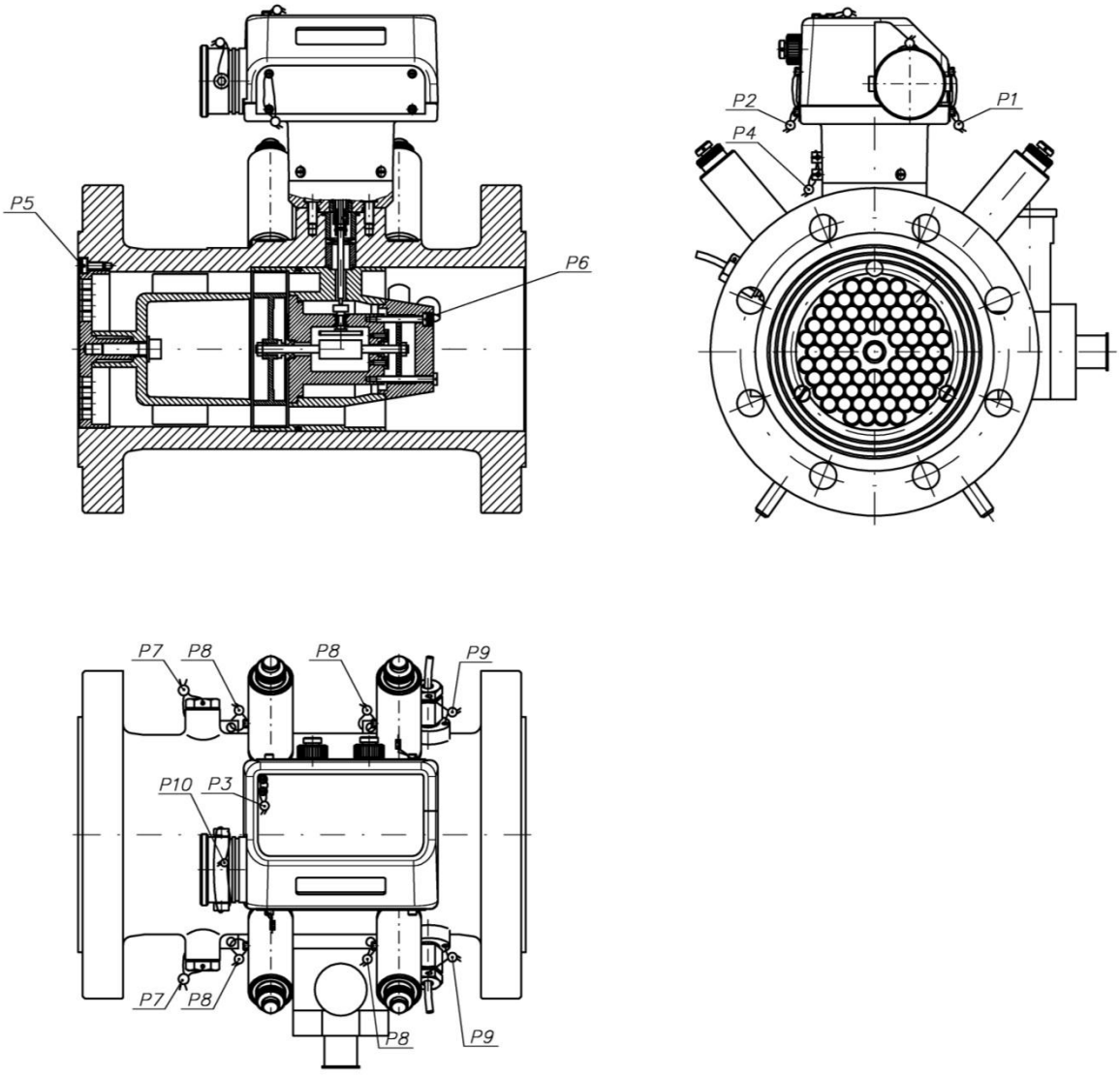


Fig. 12. Locations of seals on CGT-02 gas makers

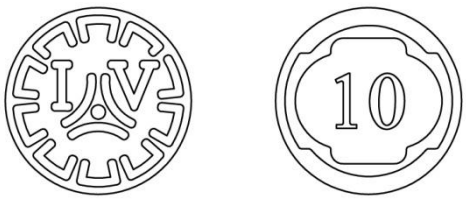


Fig. 13. Original verification stamp

V. PACKAGING, TRANSPORT AND STORAGE

The gas meter is supplied in factory-made packaging which provides appropriate protection during transport and storage. For gas meter sizes from DN50 to DN100, the packaging consists of reinforced cardboard box and profiled cardboard inserts. Side walls of the box feature handle holes for transporting the gas meter. Gas meters sized DN150 and larger are placed on appropriate wooden pallets and protected by profiled inserts and cardboard covers. Appropriate information regarding the contents and restrictions regarding gas meter loading/unloading and transport is printed on the packaging.

Gas meters submitted for repair or renewal of legal verification should be sent in factory-made packaging or other packaging providing at least equal protection during transport.

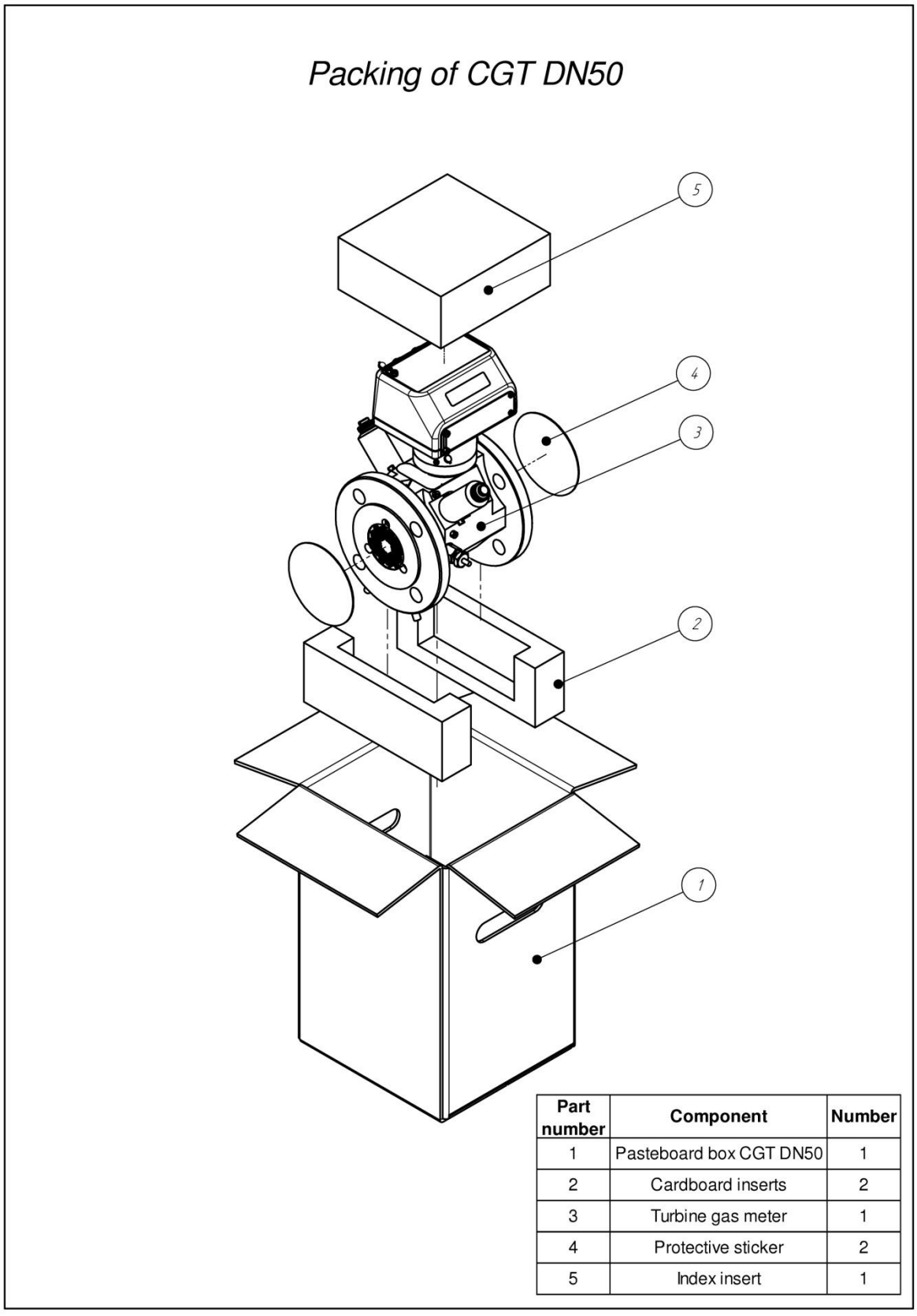
Each turbine gas meter by Common S.A. is supplied with the following:

- a 6-pin Tuchel C091 31H006 100 2 plug to be used for connecting a volume converter or recorder to the low frequency electric signal outlet (in case the converter has not been connected to the gas meter in the factory);
- a 4-pin Tuchel C091 31D004 100 2 socket if the gas meter is equipped with a HF emitter in the main body;
- a bottle of oil for the gas meter lubrication system (0.25 L);
- the technical manual.

The turbine gas meter is a high precision measurement device and should be handled with appropriate caution.

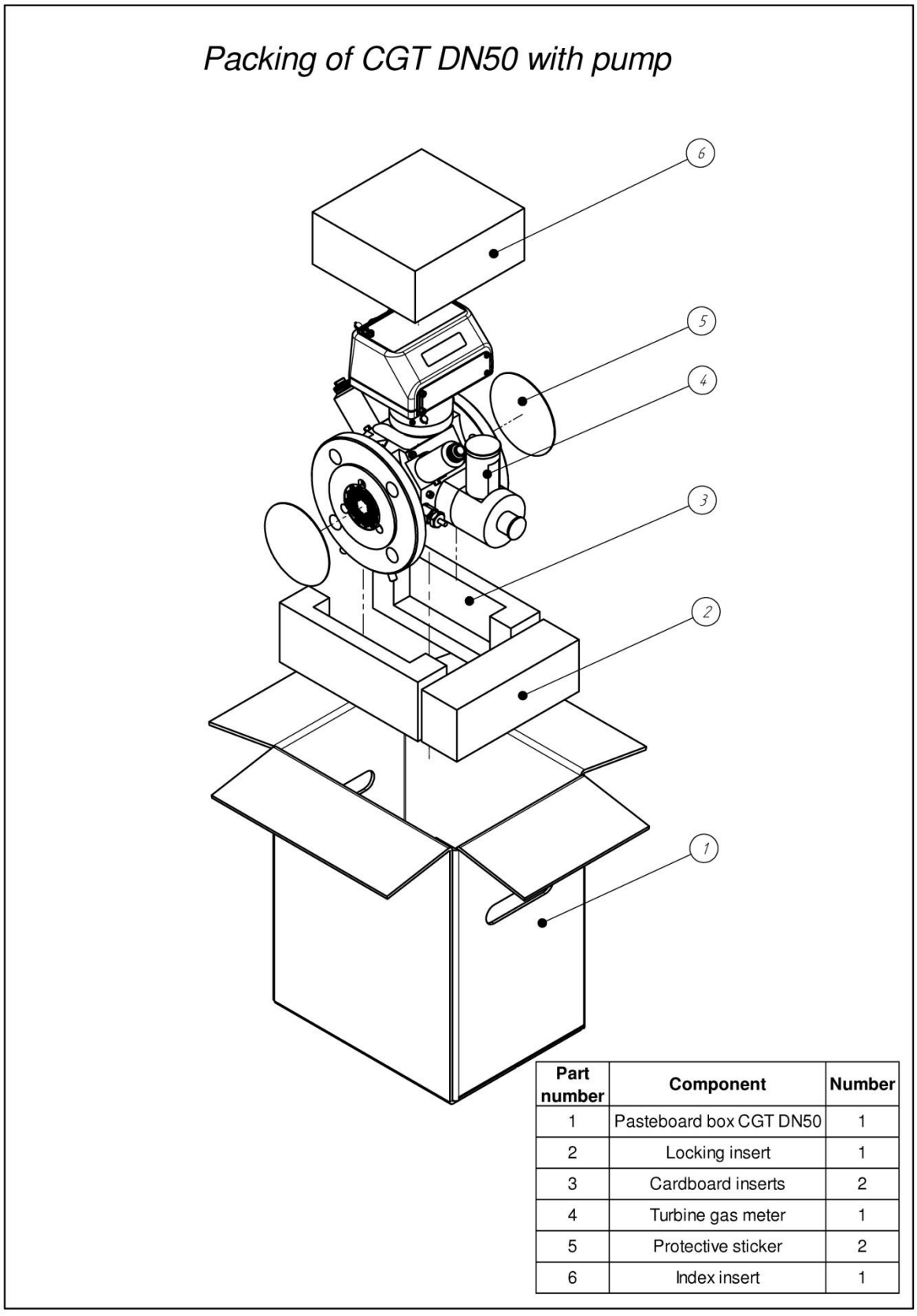
Following principles should be observed during transport and storage of the gas meters:

1. Gas meters should not be thrown, turned over or subjected to strong impacts (e.g. during fast transport using carts without springs).
2. Due to the possibility of oil leaks, the gas meters should be transported only in the target operation position, i.e. with the oil reservoir cap pointing upward. Position changes required by the installation process should last as shortly as possible (maximum a dozen or so seconds) The above does not apply to gas meters of size DN50.
3. One must not lift the gas meter by holding the counter assembly case. Transport of heavy gas meters should be performed using ear-handle screws placed in the gas meter flanges.
4. Special care should be taken when loading, unloading and handling high pressure gas meters, as they are characterized by large weights.
5. Factory-placed covers or other shields of gas meter orifices should not be removed until directly before installation.
6. The storage site should protect the gas meter from atmospheric precipitation and moisture.
7. Care should be taken of the seals placed on the gas meter. **Damage of seals may lead to warranty voidance and legal consequences as regards the clearance of accounts between the gas supplier and the customer.**
8. It is not necessary to lubricate the bearings of gas meters when stored at the warehouse.



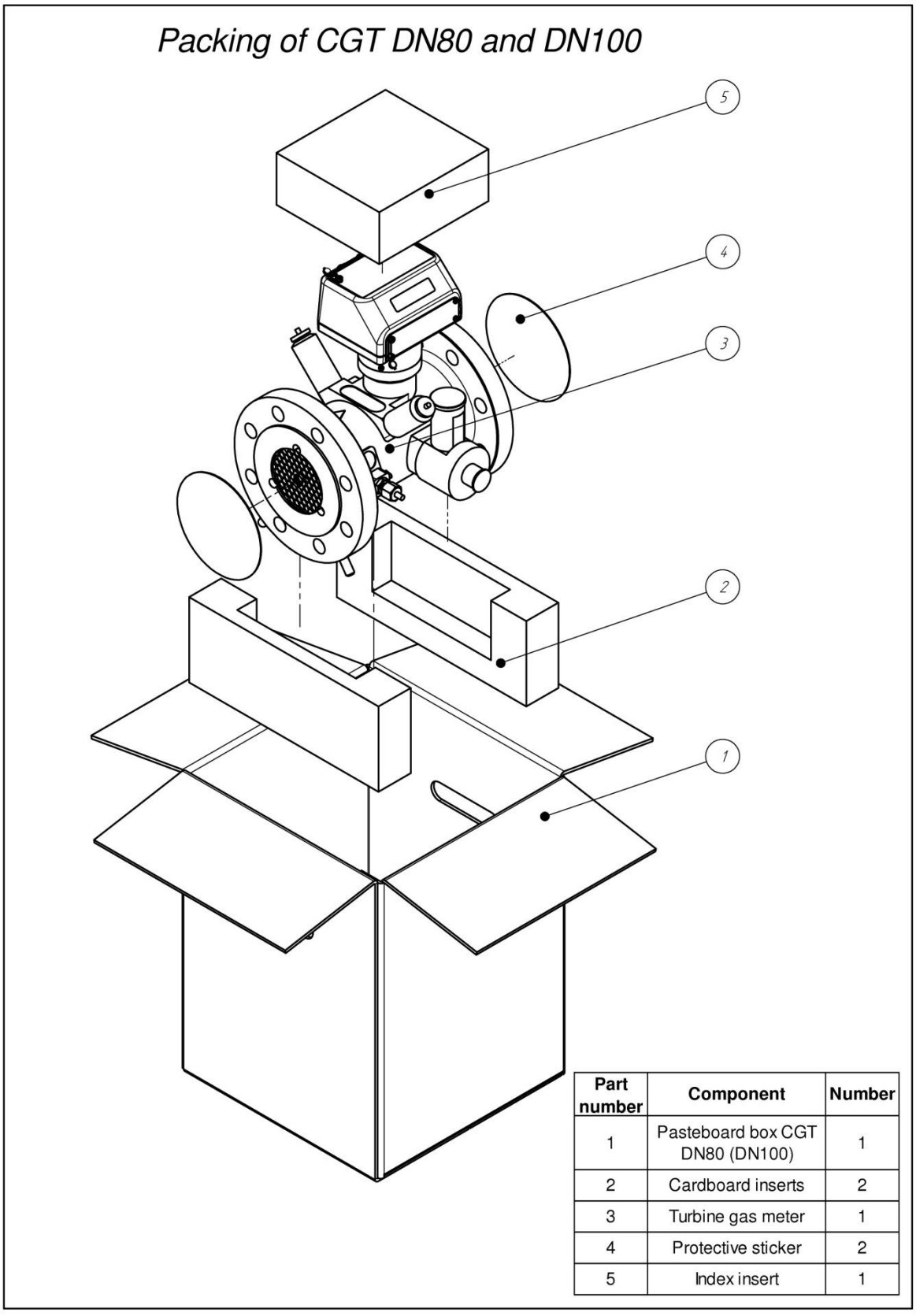
Part number	Component	Number
1	Pasteboard box CGT DN50	1
2	Cardboard inserts	2
3	Turbine gas meter	1
4	Protective sticker	2
5	Index insert	1

Fig. 14. Packaging of the DN50 turbine gas meter.



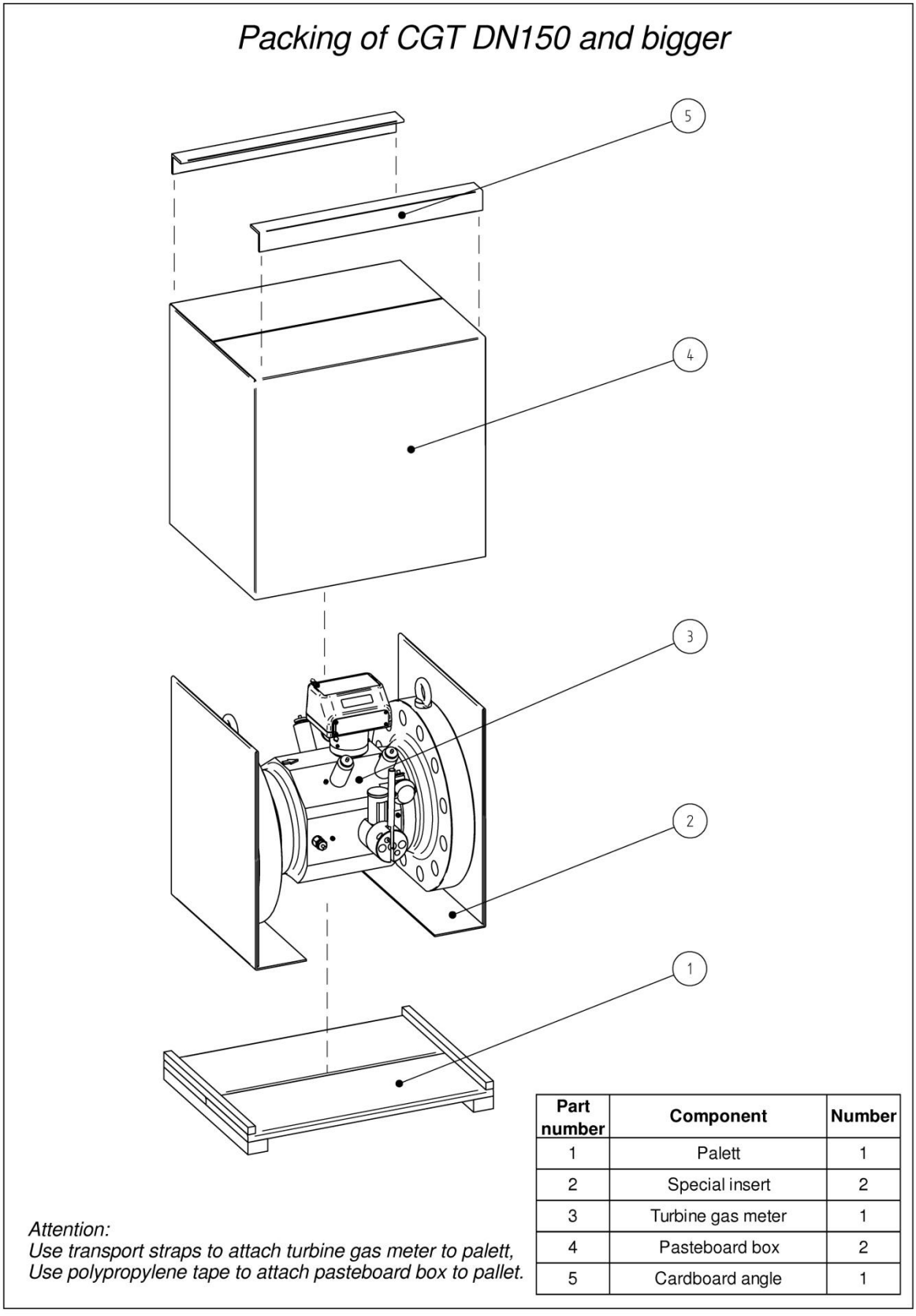
Part number	Component	Number
1	Pasteboard box CGT DN50	1
2	Locking insert	1
3	Cardboard inserts	2
4	Turbine gas meter	1
5	Protective sticker	2
6	Index insert	1

Fig. 15. Packaging of the DN50 turbine gas meter with pump.



Part number	Component	Number
1	Pasteboard box CGT DN80 (DN100)	1
2	Cardboard inserts	2
3	Turbine gas meter	1
4	Protective sticker	2
5	Index insert	1

Fig. 16. Packaging of the DN80 and DN100 turbine gas meters.



Part number	Component	Number
1	Palett	1
2	Special insert	2
3	Turbine gas meter	1
4	Pasteboard box	2
5	Cardboard angle	1

Fig. 17. Packaging of the DN150-DN400 turbine gas meters.

VI. INSTALLATION AND OPERATION

Before installing the gas meter ensure that it is suitable for the system's operational parameters. In particular, following type plate information should be taken into consideration:

- Acceptable gas meter gauge pressure [MPa), labeled p_{max}.
- Maximum actual flow [m^3/h], labeled Q_{max} .
- Acceptable working position as indicated on the type plate:
  - H horizontal (standard version),
  - VD vertical; downward vertical flow (option – by request),
  - VD vertical; upward vertical flow (option – by request),

Maximum load of the gas meter may be exceeded by not more than 25% for not longer than 30 minutes.

The CGT-02 gas meters can be used both indoors in stabilized temperature conditions and outdoors (open location). In the latter case, it is recommended that the gas meter is shielded from direct exposure to atmospheric factors (metal containers, casings, roofs, shields etc.)

The gas meter must be placed between pipes of appropriate nominal diameter, with axial alignment of the gas meter relative to the pipes according to gas industry regulations. The static load of the system of pipes should not exceed values provided for in the PN-EN 12261:2003 standard. Table 6 lists the maximum torsion and bending moment values. Gas meters with weights of more than 50 kg should rest on supports so that their weight poses no burden to the pipeline. Gas meters should not be installed at the lowest point of the system lines, as condensate and impurities may accumulate in that area.

Dimensions listed in Tables 3a and 3b and illustrated in Figure 18 may be helpful when designing the location for the installation of the gas meter.

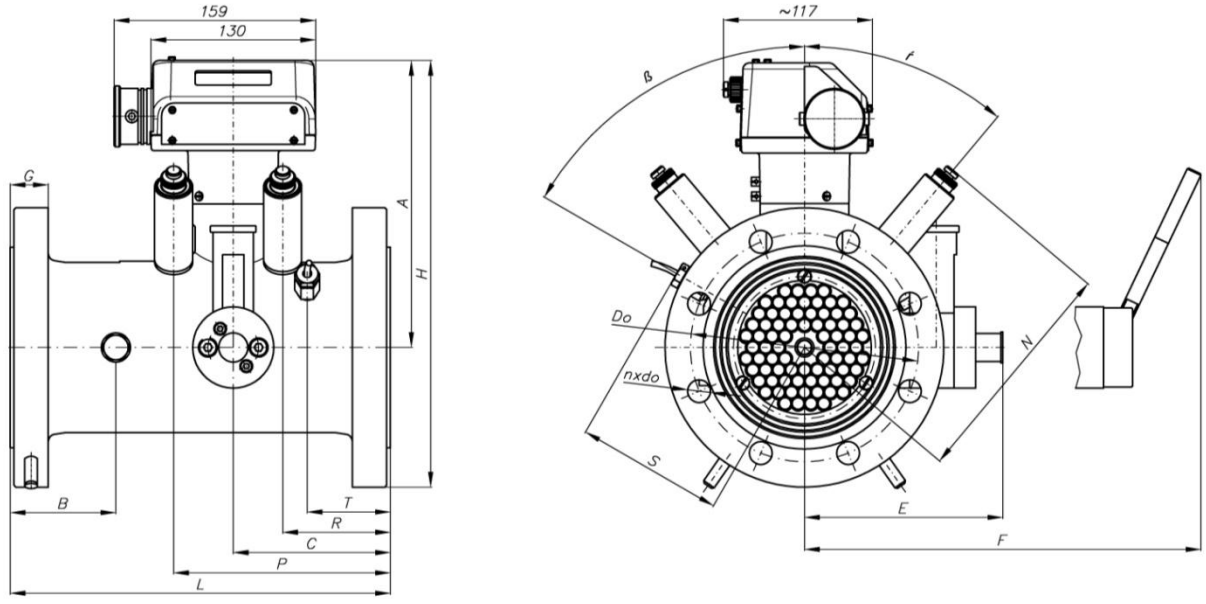


Fig. 18. Basic dimensions of CGT-02 turbine gas meters.

Table 3a part I Basic dimensions and weights of CGT-02 turbine gas meters

DN	connection (flange)	body	L	H	A	B	C	E	F	G	N	P	R	S	T	α	β	mass
mm			mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	°	°	kg
50	PN10/PN16/PN25	cast iron	150	281	198	42	58	150	–	20	157	91	–	85	39	45	90	11
	PN20/ANSI150			273					–	20								11
	PN10/PN16	steel		281					–	20								12
	PN20/ANSI150			273					–	20								11
	PN25/PN40			281					–	22								12
	PN50/ANSI300			281					–	23								12
	PN63/64			288				–	194	26								15
	PN100			296				–		28								17
	PN110/ANSI600			281				–		33								13
80	PN10/PN16/PN25	cast iron	240	301	201	60	95	146	–	27	169	137	–	103	59	45	45	19
	PN20/ANSI150			296					–	27								18
	PN10/PN16	steel		301		80			–	21					–			24
	PN20/ANSI150			296					–	25					–			24
	PN25/PN40			301					–	25					–			25
	PN50/ANSI300			306					–	29					–			27
	PN63/64			309				–	212	28					–			28
	PN100			316				–		31					–			32
	PN110/ANSI600			306				–		38					–			30
100	PN10/PN16	cast iron	300	325	215	101	124	157	–	30	181	171	85	116	66	40	60	24
	PN20/ANSI150			330					–	30								25
	PN25			3330					–	30								25
	PN10/PN16	steel		325					–	23					85		65	32
	PN20/ANSI150			330					–	25								34
	PN25/PN40			333					–	25								36
	PN50/ANSI300			343					–	32								42
	PN63/64			340				–	223	30								39
	PN100			348				–		35								46
	PN110/ANSI600			353				–		45								52
150	PN10/PN16	cast iron	450	375	242	125	180	185	–	32	208	231	141	142	110	35	55	47
	PN20/ANSI150			415					–	32								46
	PN25			392					–	32								47
	PN10/PN16	steel		375		155			–	25					141		60	64
	PN20/ANSI150			415					–	26								64
	PN25/PN40			392					–	29								70
	PN50/ANSI300			432					–	36								80
	PN63/64			415				–	251	35								86
	PN100			420				–		43								96
	PN110/ANSI600			420				–	260	54								105

Table 3a part II. Basic dimensions and weights of CGT-02 turbine gas meters

DN	connection (flange)	body	L	H	A	B	C	E	F	G	N	P	R	S	T	α	β	mass
mm			mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	°	°	kg
200	PN10/PN16	cast iron	600	435	265	212	240	206	–	30	223	333	168	157	168	30	55	70
	PN20/ANSI150			438						30								70
	PN25			445					–	30								71
	PN10/PN16	steel		435					–	30								70
	PN20/ANSI150			438					–	30								71
	PN25			445					–	30								80
	PN40			453					–	34								90
	PN50/ANSI300			455					–	49								100
	PN63/64			473				–	272	49								115
	PN100			480				–		54								130
	PN110/ANSI600			475				–		62								140
250	PN10	steel	750	491	293	270	330	232	–	27	244	425	258	178	225	30	55	130
	PN16			496					–	31								130
	PN20/ANSI150			496					–	31								130
	PN25			506					–	32								140
	PN40			518					–	38								150
	PN50/ANSI300			516					–	54								175
	PN63/64			528				–	298	54								190
	PN100			546				–		61								230
	PN110/ANSI600			548				–		70								250
300	PN10	steel	900	541	318	300	350	258	–	36	268	448	278	202	245	30	55	190
	PN16			548					–	37								190
	PN20/ANSI150			561					–	37								200
	PN25			561					–	38								220
	PN40			576					–	42								240
	PN50/ANSI300			578					–	59								260
	PN63/64			583				–	324	59								270
	PN100			611				–		67								330
	PN110/ANSI600			598				–		74								340
400	PN10	steel	1200	637	354	500	400	–	387	29	306	570	348	240	348	90	30	350
	PN16			644						32								350
	PN20/ANSI150			654						37								390
	PN25			664						40								420
	PN40			684						50								450
	PN50/ANSI300			679						58								480
	PN63/64			689						60								490
	PN100			712						80								610
	PN110/ANSI600			697						84								580

Table 3b. Dimensions of the connections of CGT-02 turbine meters (DN50-DN250).

DN	connection (flange)	DZ	D0	d0	n
mm		mm	mm	mm	pcs.
50	PN10/16	165	125	18	4
	PN20/ANSI150	150	120.5	18	4
	PN25/40	165	125	18	4
	PN50/ANSI300	165	127	18	8
	PN63/64	180	135	22	4
	PN100	195	145	26	4
	PN110/ANSI600	165	127	18	8
80	PN10/16	200	160	18	8
	PN20/ANSI150	190	152.5	18	4
	PN25/40	200	160	18	8
	PN50/ANSI300	210	168.5	22	8
	PN63/64	215	170	22	8
	PN100	230	180	26	8
	PN110/ANSI600	210	168.5	22	8
100	PN10/16	220	180	18	8
	PN20/ANSI150	230	190.5	18	4
	PN25/40	235	190	22	8
	PN50/ANSI300	255	200	22	8
	PN63/64	250	200	26	8
	PN100	265	210	30	8
	PN110/ANSI600	275	216	26	8
150	PN10/16	285	240	22	8
	PN20/ANSI150	280	241.5	22	8
	PN25/40	300	250	26	8
	PN50/ANSI300	320	270	22	12
	PN63/64	345	280	33	8
	PN100	355	290	33	12
	PN110/ANSI600	355	292	29.5	12
200	PN10	340	295	22	8
	PN16	340	295	22	12
	PN20/ANSI150	345	298.5	22	8
	PN25	360	310	26	12
	PN40	375	320	30	12
	PN50/ANSI300	380	330	26	12
	PN63/64	415	345	36	12
	PN100	430	360	36	12
	PN110/ANSI600	420	349	32.5	12

DN	connection (flange)	DZ	D0	d0	n
mm		mm	mm	mm	pcs.
250	PN10	395	350	22	12
	PN16	405	355	26	12
	PN20/ANSI150	405	362	26	12
	PN25	425	370	30	12
	PN40	450	385	33	12
	PN50/ANSI300	445	387.5	29.5	16
	PN63/64	470	400	36	12
	PN100	505	430	39	12
	PN110/ANSI600	510	432	35.5	16
300	PN10	445	400	22	12
	PN16	460	410	26	12
	PN20/ANSI150	485	432	26	12
	PN25	485	430	30	16
	PN40	515	450	33	16
	PN50/ANSI300	520	451	32.5	16
	PN63/64	530	460	36	16
	PN100	585	500	42	16
	PN110/ANSI600	560	489	35.5	20
400	PN10	565	515	26	16
	PN16	580	525	29.5	16
	PN20/ANSI150	600	540	29.5	16
	PN25	620	550	36	16
	PN40	660	582	39	16
	PN50/ANSI300	650	571.5	35.5	20
	PN63/64	670	585	42	16
	PN100	715	620	48	16
	PN110/ANSI600	685	603	42	20

Impurities contained within the gas and the system may cause mechanical damage to the gas meter and reduce the measurement accuracy. Therefore, a filter with efficacy not worse than 10 μm should be placed in front of the gas meter (particularly when the flowing gas contains high amounts of impurities). In addition, the inflow side of the system should be thoroughly cleaned before installing the gas meter. Conical sack filter may be placed at the inlet of the inflow section; the filter should be removed after 1 ÷ 2 months of operation. If the filter is not removed, monitoring of the filter impurity level should be provided by means of pressure drop measurements or regular check-ups. If clogged, the sack filter may be destroyed by the gas pressure, and filter residue may seriously damage the gas meter.

The manufacturer is not responsible for any damages or stoppage of the gas meter resulting from insufficient filtration of the gas flowing through the meter.

The user should be aware of certain risks associated with changes in the gas flow intensity. If the gas flow was relatively low for a long time after system initiation, the assembly-related contaminants (e.g. welding residues) are retained in front of the gas meter. Only after the flow is significantly increased, the contaminants may be swept away by the gas, causing gas meter damage. For this reason, the sack filter may prove useful in the period in which maximum system capacity is being reached. In all cases, protection of the gas meter from mechanical damage is in the user's best interest.

Before final installation of the gas meter ensure it is properly oriented, i.e. that the arrow on the meter body points in the direction of the gas flow.

The gas meter should be connected to pipeline flanges using screws meeting the requirements of the PN-EN 1515-1, PN-EN 1515-2, PN-EN ISO 898-1, and ZN-G-4008:1995 standards. For the sake of easier screw selection, table 4 lists the minimum required limits for the plasticity of material in screws used for flange connections of CGT-02 gas meters.

Table 4. Minimum limits for the plasticity of screw material R_e [MPa].

	PN10	PN16	PN20	PN25	PN40	PN50	PN63/64	PN100	PN110
DN50	200	200	170	220	350	190	375	410	420
DN80	150	150	270	170	275	205	285	310	445
DN100	180	180	185	140	225	285	255	305	435
DN150	165	165	185	155	245	310	250	260	360
DN200	220	150	265	160	210	305	220	345	420
DN250	190	130	165	165	235	235	305	405	340
DN300	225	160	215	165	235	255	305	340	360
DN400	175	155	170	170	255	225	240	400	350

Appropriate seals should also be selected for specific flange types and nominal pressures. Flange connections should be sealed using seals made of asbestos-free plates with properties conforming to ZN-G-4008 and WUDT-UC-WO-O/19 standards. Flat seals can be used for standard flanges with type “B” faces and p_{max}= 2 MPa (according to PN-EN 1514-1:2001 or PN-EN 12560-1:2002), while values of p_{max} > 2 MPa require corrugated seals (according to PN-EN 1514-4:2001 or PN-EN 12560-4:2002), 12560-4:2002).

Appropriate screw lengths should be selected with consideration to dimensions listed in Tables 3a and 3b and the thickness of seals being used.

Tables 5a and 5b list the required screw torque values for flange connections.

Table 5a. Required screw torque values for flange connections – smooth, lubricated threads; M_{nom} [Nm].

	PN10	PN16	PN20	PN25	PN40	PN50	PN63/64	PN100	PN110
DN50	44	44	38	44	68	37	144	270	82
DN80	33	33	60	33	53	78	108	203	171
DN100	40	40	41	53	86	115	169	291	288

DN150	70	70	75	101	161	118	323	336	344
DN200	95	63	101	104	199	201	390	609	548
DN250	81	97	109	157	309	225	536	920	603
DN300	97	117	143	155	309	331	540	993	634
DN400	129	151	163	294	583	397	1000	1797	1028

Table 5b. Required screw torque values for flange connections – smooth, non-lubricated threads; M_{nom} [Nm].

	PN10	**PN16**	**PN20**	**PN25**	**PN40**	**PN50**	**PN63/64**	**PN100**	**PN110**
DN50	82	82	71	82	127	69	267	501	153
DN80	61	61	112	62	99	144	201	377	317
DN100	74	74	76	99	159	208	312	544	534
DN150	131	131	139	187	299	219	601	626	643
DN200	177	118	187	193	372	373	730	1141	1021
DN250	150	180	201	293	575	421	1005	1718	1129
DN300	180	217	265	290	576	617	1011	1863	1187
DN400	239	282	305	551	1089	743	1877	3379	1929

Table 6. Maximum torsion and bending moments exerted by the pipe system on the gas meter; M_{max} [Nm].

DN50	**DN80**	**DN100**	**DN150**	**DN200**	**DN250**	**DN300**	**DN400**
440	760	1220	2710	4470	7050	7050	7050

Before starting up the gas meter and after installation of the gas meter in the target system, the reservoir should be filled with oil and the turbine mechanism should be lubricated according to directions listed in section VII. Only the oil supplied with the gas meter should be used for this purpose. Following oils may be used with gases listed in Table 1:

- Lubrina L12 gas meter oil – distributed by Common S.A.;
- Lubrina L23 gas meter oil – distributed by Common S.A.;
- VR09 (VELOL 9Q) machinery oil – distributed by Common S.A.;
- Shell Tellus T15 hydraulic oil.

In a typical installation setting, i.e. in a bypass system (Fig. 9), the gas meter start-up procedure should proceed as follows:

1. The gas meter is installed with valves 1, 2, 5 being closed and the bypass valve 4 remaining open. The blow-off valve 3 remains open after system the system is degassed.
2. After tightening the screws connecting the gas meter and the system, air should be removed from the system using valve 5, according to appropriate regulations. Valve 3 should remain open.
3. After deaeration, valve 3 is closed and system gas pressure is equilibrated with pressure increase rate not larger than 30 ± 10 kPa/s.

4. Valve 5 is closed when the gas meter counter stops indicating the flow (associated with pressure equilibration).
5. Valve 1 is opened, followed by valve 2.
6. Bypass valve 4 may be closed after the valve 2 has been opened in full.

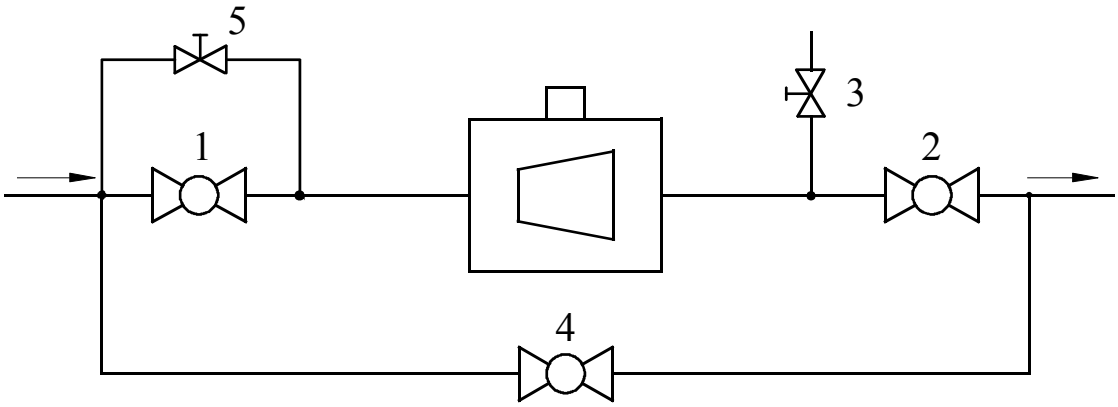


Fig. 19. A diagram of a bypass measurement system

When removing the gas meter, the above steps should be followed in reverse order, i.e.

1. Bypass valve 4 is closed first
2. Valve 2 is closed, followed by valve 1.
3. The measurement segment is slowly degassed using the blow-off valve 3, with pressure drop not larger than 30 ± 10 kPa/s.

The same principle should be followed in other installation settings, i.e. the flow of the gas through the gas meter should be opened or closed very slowly. Rapid change in the flow caused by sudden opening of the valve may damage the measurement turbine due to a large difference of pressure upstream and downstream of the rotor.

If there is a risk of gas meter overload (i.e. exceeding Q_{max} by more than 25 %), during exploitation, the use of a restrictor orifice is recommended. The orifice should be installed at a distance of 5÷10 nominal diameters (DN) behind the gas meter. The orifice dimensions are selected individually on the basis of the nominal diameter and gas flow, pressure and temperature. Common S.A. may design and deliver appropriate orifice at customer's request.

Counter readout correctness should be checked after installing the gas meter. Every barrel of the counter should turn smoothly and a full turn of a barrel should turn the neighbouring left barrel by 1/10 of a full turn.

Unused electrical outlet sockets must remain plugged with factory-made plugs and installation seals.

VII. OPERATION MONITORING, MAINTENANCE, FAILURES, REPAIRS

In any doubt regarding the correctness of gas meter readings, the gas meter should be removed from the system and submitted to an appropriate laboratory for verification of its metrological characteristics. The test may be performed using the control element, without breaking the legal verification seal. One of the HF emitters installed in the gas meter body may act as a control element. If no HF emitter has been installed in the gas meter, either a **CHFI-02** or a **CHFI-03** HF emitter should be connected to act as a control element. The external control element may be installed in either of the HF3 and HF4 main body sockets (Fig. 3), after the protection seal is broken and the plug is removed. The control element (HF emitter) should be screwed in to a depth allowing for a proper (i.e. consistent with the Namur standard) emitter signal to be obtained. After completion of the test and removal of the control element, the hole should be tightly closed using a plug. A protection seal should be placed on the plug.

The CGT-02 gas meters are equipped with a turbine bearing lubrication system (does not apply to the standard version of DN50 gas meters). The only activity required as part of the maintenance is periodic lubrication of bearings. Lubrication consists of pumping an amount of oil from the oil reservoir into the turbine assembly. This is achieved by pressing a plunger located under a protective cap at the front wall of the oil pump. One full plunger stroke (ca. 12 mm) pumps out ca. 1/3 cm^3 of oil. Strength required for the plunger stroke is lower than 100N. At each lubrication, the level of oil in the reservoir should be inspected. The oil should be visible through the transparent part of the reservoir wall.

Gas meters designed for p_{max} = 0.5 MPa may be equipped with a special lubrication valve instead of the oil pump. Lubrication is achieved by injecting an appropriate dose of oil through the lubrication valve from a syringe included in the set. Table 7 lists the recommended oil doses.

For gases listed in Table 1, lubrication should be performed after each gas portion V [m^3] as stated in Table 7, but not less frequently than once every month.. For refinery gases, sewage gases and sludge digestion gases, lubrication should be performed once every week.

Table 7. Recommended numbers of strokes (n) and oil volumes (V_{oil})

G	V	n	V_{oil}	G	V	n	V_{oil}
	[m^3]	strokes	[cm^3]		[m^3]	strokes	[cm^3]
G100	100,000	6	2	G 1000	1,000,000	12	4
G160	160,000	6	2	G1600	1,600,000	20	7
G250	250,000	9	3	G2500	2,500,000	20	7
G400	400,000	9	3	G4000	4,000,000	25	8
G650	650,000	12	4	G6500	6,500,000	25	8

Information on the type of oil to be used is presented on the lid of the oil reservoir or on the stopper of the lubrication valve.

Dust and other impurities may be removed from the gas meter surface using a cloth soaked in soap and water. Do not clean with solvents or other chemicals.

In case of any incorrectness in gas meter operation (e.g. irregular counter work or counter stoppage, elevated noise, crackling, oil leaks), the gas meter should be immediately submitted for repair.

Gas meter repairs may be performed only by the manufacturer or a company authorized by the manufacturer. Users must not attempt to repair the gas makers themselves!

Repairs associated with breaking the primary validation seals require renewed legal approval of the gas meter.

The CGT gas meters are subject to manufacturer's warranty. The warranty proceedings are in line with the general trade law regulations.

VIII. ADDITIONAL EQUIPMENT

Due to tariff requirements, it is often required (or recommended) for the gas meters to be operated together with electronic devices such as data loggers or volume converters and data transmission devices. Common S.A. manufactures such devices, e.g. battery/grid-powered volume converters CMK-02 and data loggers CRS-03, CRI-02. Common S.A. may deliver these devices by special orders, together with installation services. Example installations are presented in Figs. 20 and 21.

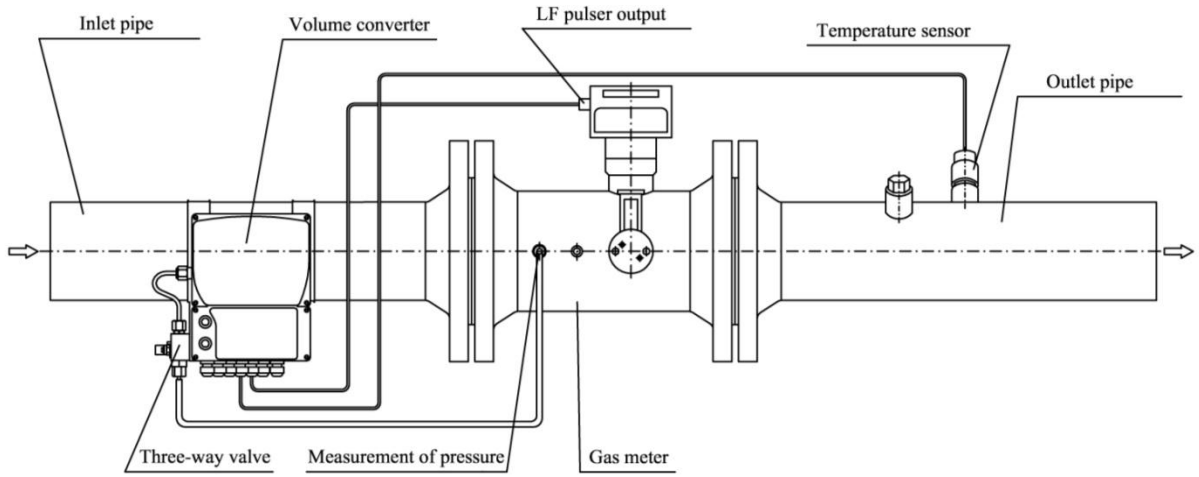


Fig. 20. An assembly consisting of a CGT-02 gas meter and a CMK-02 volume converter (the converter is installed in the inflow section)

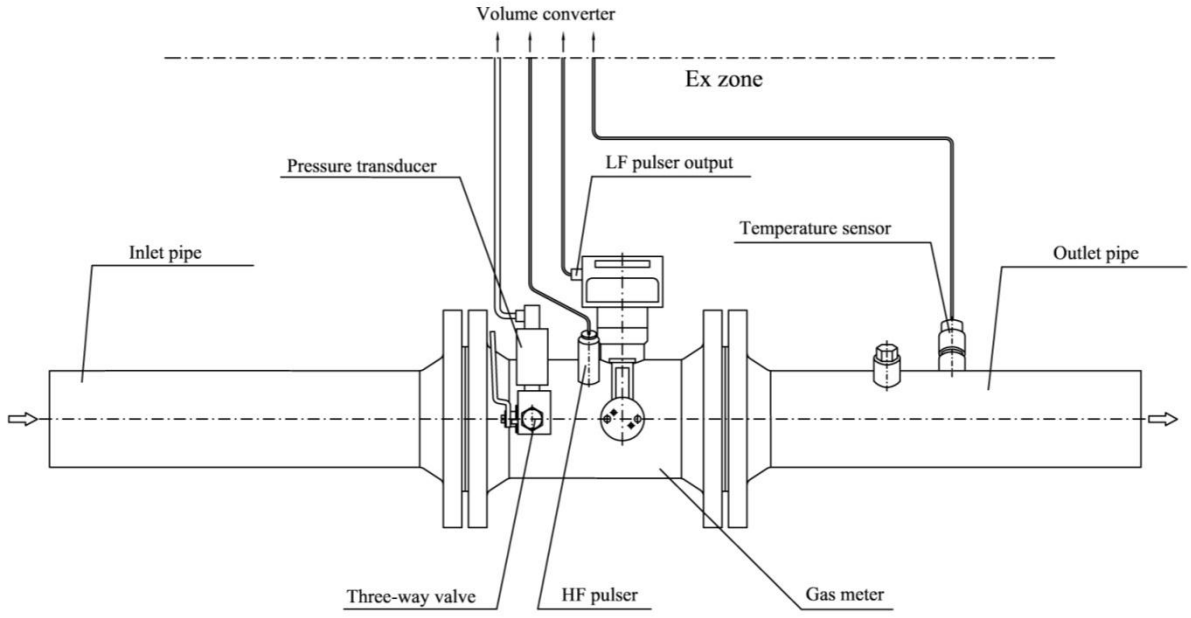


Fig. 21. Connections of a located outside the Ex zone and powered from the 220 V power grid.

The converter receives three input signals: the flow signal (from the low- or high-frequency pulse emitter), the pressure signal and the temperature signal. The pressure signal is collected at the pulse pressure measurement outlet. It is recommended that the pressure pulse is measured using a three-way CKMT valve (Fig. 22) allowing the pressure being disconnected from the sensor for the removal and inspection thereof.

Fig. 22. A three-way CKMT valve

The valve handle position is secured by a seal. The valve may be operated only under supervision of the gas company representative; after operation, the handle is again secured with an installation seal.

The temperature signal is collected from the emitter installed in appropriate temperature pocket in the outflow section (downstream the gas meter) (Fig. 20) or in a temperature pocket in the gas meter itself.

One should keep in mind that all activities associated with connection of additional equipment to the gas meter are also associated with breaking the protection seals and thus may be performed only by representatives of the gas company or the manufacturer. Unused electrical outlet sockets must remain plugged with factory-made plugs and installation seals.

IX. LIST OF STANDARDS AND TECHNICAL SPECIFICATIONS

- PN-EN 12261:2005 (EN 12261:2002+AC:2003)
  Gas meters – Turbine gas meters
- PN-EN 12261:2005/A1:2008 (EN 12261:2002/A1:2006)
  Gas meters – Turbine gas meters
- PN-EN 13463-1:2010 (EN 13463-1:2009)
  Non-electrical Equipment For use in Potentially Explosive Atmospheres - Part 1: Basic Method And Requirements
- PN-EN 60079-0:2009 (EN 60079-0:2009)
  Explosive atmospheres – Part 0: Equipment – General Requirements
- PN-EN 60079-11:2010 (EN 60079-11:2007)
  Explosive atmospheres – Part 11: Equipment Protection By Intrinsic Safety 'I'
- PN-EN 60947-5-2:2011 (EN 60947-5-2:2007)
  Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – proximity switches.
- PN-EN 60947-5-6:2002 (EN 60947-5-6:2000)
  Low-voltage switchgear and controlgear – Part 5-6: Control circuit devices and switching elements – DC interface for proximity sensors and switching amplifiers (NAMUR)
- WUDT/UC/2003
  Requirements of office of Technical Inspection – Pressure Equipment

	**After ending the usage period, the gas meter should under no circumstances be discarded into municipal waste containers. The Waste Act of 27 April 2001 imposes an obligation for selective collection of metallic waste. Gas meters should be best returned to the manufacturer who would recycle them in an appropriate fashion. If unable to do so, the user is obliged to deliver the gas meter to an appropriate recycling point.**
	Gas meter packaging should never be discarded into municipal waste containers. The packaging has been appropriately labeled; pursuant to the Act of 11 May 2001 on packagings and packaging waste, the user is obliged to submit the packaging for an appropriate recycling process.

Note: Common S.A. reserves the right to modify the design of the gas meters while retaining the compliance with relevant standards and requirements regarding accuracy and safety of operation.