

GAS TURBINE METER

IGTM-CT AND IGTM-WT

*Installation, Operation and
Maintenance Manual (IOM)*
English Version



CONTENTS

1	INTRODUCTION	4
1.1	Dear customer	4
1.2	Notice	4
1.3	Brief description	5
1.4	Parts and documents supplied with the IGTM	5
1.5	Instructions for storage and conservation	5
1.6	Principle of operation	6
1.7	Nameplate details	6
1.8	Documentation	7
1.8.1	Approvals	7
1.8.2	Inspection certificate EN 10204 - 3.1	7
1.8.3	Hydro test and air seal test	7
1.8.4	Initial verification and calibration	7
1.8.5	Example certificates	8
2	INSTALLATION	12
2.1	Safety instructions and warnings: See back page	12
2.2	Instructions specific to the EC Pressure Equipment Directive (PED)	12
2.3	Installation	13
2.3.1	Lubrication system and lubrication before start up	13
2.3.2	Required upstream and downstream length	15
2.3.3	Flow direction and orientation	15
2.3.4	Volume conversion	15
2.3.5	Connection pressure transmitter at pm -point	16
2.3.6	Temperature measurement	16
2.3.7	Density measurement	17
2.3.8	Energy measurement	17
2.3.9	Index head and pulse transmitters	17
2.3.10	Specification of reed switches (R1 or R10 in the index head)	19
2.3.11	Specifications of high frequency sensors (HF1 to HF4)	20
2.3.12	Electrical connection schematics for pulse transmitters	20
2.3.13	Required settings for flow computers and flow converters	20
3	OPERATION	22
3.1	Accuracy	22
3.2	Operating flow range	23
3.2.1	Flow range at elevated pressure	23
3.2.2	Overload	23
3.3	Temperature range	24
3.4	Maximum pressure	24
3.5	Pressure loss under operating conditions	24
3.6	Material of construction	24
3.7	Gas composition and flow conditions	25
4	MAINTENANCE	26
4.1	Regular lubrication	26
4.2	Spare parts	26
4.3	Spin test	27
4.4	Recalibration	27
5	WARRANTY	28
6	APPENDIX WITH TABLES AND FIGURES	29
7	SAFETY INSTRUCTIONS AND WARNINGS	45

LIST OF FIGURES

Figure 1:	Exploded view of main parts	4
Figure 2:	Name plate (MID version), CE/PED label and pulse label	6
Figure 3:	Inspection Certificate EN10304 - 3.1	8
Figure 4:	ATEX certificate for IGTM sensors HF1/2 and for HF3/4	9
Figure 5:	ATEX declaration of conformity for LF Reed switches	9
Figure 6:	Optional calibration certificates (examples), performed with air at ambient conditions: Initial verification – “Verification certificate”, Factory calibration – “Certificate of conformity”, Calibration data and error curve.....	10
Figure 7:	Optional calibration certificate (example), performed with high pressure gas	11
Figure 8:	Mechanical counter: reading the index head display.....	18
Figure 9:	Orientation change of the index head	18
Figure 10:	Drawing of index head internals with connector diagram.....	19
Figure 11:	IGTM scheme with location of pulse transmitters	21
Figure 12:	Connection diagram for low frequency reed switch	21
Figure 13:	Connection diagram for high frequency sensors	21
Figure 14:	Internal sensor connection diagram	22
Figure 15:	Turn down ratio at elevated pressure	23
Figure 16:	vemmtec ISO 9001 Certificate	30
Figure 17:	EC type-approval certificate original style (German original and English translation)	31
Figure 18:	EC MID approval for IGTM-CT	32
Figure 19:	EC-Conformity declaration (example).....	32
Figure 20:	Main parts of the IGTM	34
Figure 21:	Gear drawing	35
Figure 22:	Seal plan	38
Figure 23:	Dimensional drawing IGTM-CT	42
Figure 24:	Dimensional drawing IGTM-WT	44

LIST OF FORMULAS

Formula 1:	Volume conversion	16
Formula 2:	Flow range at elevated pressure	23
Formula 3:	Pressure loss under operating conditions	24

LIST OF TABLES

Table 1:	Essential Safety Requirements (ESR) of the Pressure Equipment Directive (PED)	12
Table 2:	Oil pumps	14
Table 3:	Lubrication quantity at start up	15
Table 4:	Available pulse transmitters	18
Table 5:	Flange rating and maximum operating pressure	24
Table 6:	Standard material specification	25
Table 7:	Periodical lubrication quantities	26
Table 8:	Nominal spin-down times (with mechanical index head and standard bearings)	27
Table 9:	Technical standards, rules and guidelines	29
Table 10:	List of approvals.....	30
Table 11:	Gas types.....	33
Table 12:	Spare parts listing	37
Table 13:	Intrinsically safe equipment	38
Table 14:	Size dependent data and k-factors.....	40
Table 15:	Diameter, flow rate and extended range combinations IGTM-CT	41
Table 16:	Gas velocity and pressure loss	42
Table 17:	Dimensions and weights IGTM-CT	43
Table 18:	Dimensions and weights IGTM-WT	44

1 INTRODUCTION

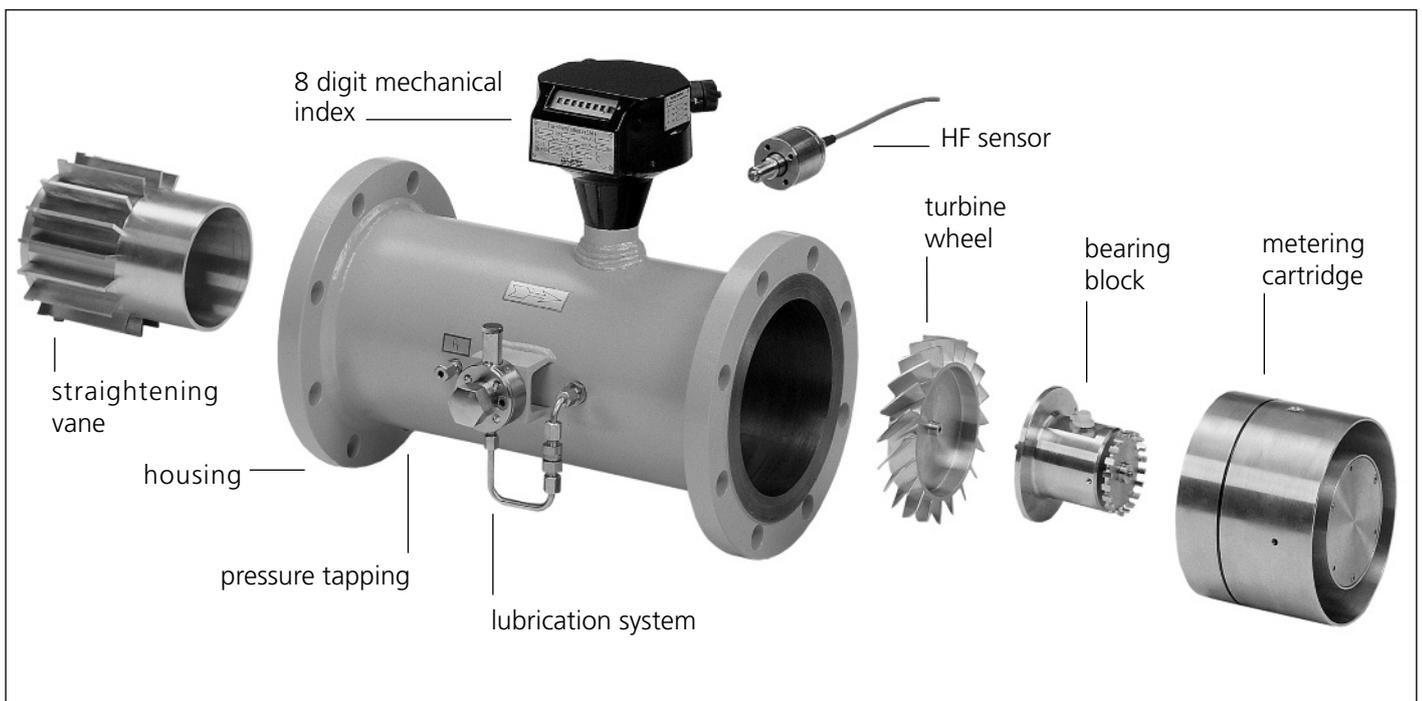
1.1 Dear customer

Congratulations on your new purchase of a high quality measurement device, the IGTM Gas Turbine Meter. To take full advantage of the potential of your metering equipment, we advise you to thoroughly read this manual and follow the recommendations and warnings.

This manual gives recommendations to enable you to obtain highly accurate metering results and describes the handling, installation, and maintenance of your turbine meter. It is very important that you follow the safety recommendations for installation, hook up, and the maintenance guidelines.

This document contains the unit dimensions and operational ranges. It also describes performance, calibration, and outputs of the instrument.

Figure 1: Exploded view of main parts



1.2 Notice

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Potsdam-Babelsberg, Germany

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1.3 Brief description

The **vemm tec** IGTM (International Gas Turbine Meter) is designed in accordance with all major international standards.

The IGTM counts the increment of gas volume flowing through an annular passage in the meter. The gas volume is totalized on a local mechanical counter. In addition, pulse signals are generated to infer the gas flow and volume. The indicated gas volume is the actual volume that passed the meter at the actual temperature and pressure.

The IGTM is available in two models; CT and WT. The CT-model is approved for custody transfer in the European Community and other countries. It provides a high-accuracy turbine meter with a mechanical counter and electronic pulse outputs. The IGTM-CT has a body length of three times the nominal diameter: 3 DN. The IGTM-WT (Wafer Type) is a short meter with an aluminium body, and needs to be clamped between flanges. The WT model is only available for low pressure classes (PN10/16 and ANSI 150#). The IGTM-WT model is not suitable for custody transfer purposes.

1.4 Parts and documents supplied with the IGTM

Your package includes:

- IGTM – Gas Turbine Meter
- Bottle with lubricant for initial lubrication and two years operation (for meters with a lubrication system only)
- Male connectors (when ordered; the female plugs are mounted in the meter, the ordered male plugs are delivered unassembled for connection on site)
- Copies of calibration documents (if applicable)
- Copies of pressure test documents (if applicable)
- “Instructions for Installation” (the leaflet should stay in close proximity of the meter)
- “Instructions for Storage” (a leaflet)
- “Installation, Operation and Maintenance Manual” (this manual; as a hard copy or as PDF file)

The complete original certificates ordered will be shipped separately. If applicable (and if ordered) the documents supplied are:

- Inspection Certificate EN 10204 - 3.1
- Pressure test certificates (hydro test and air seal test)
- Verification certificate (of legal calibration) or Certificate of Conformity
- Calibration results (data and error curve)
- High pressure calibration certificate
- Applicable CE documentation (ATEX, PED, for IGTM-CT also MID)
- Material certificates of pressure containing parts
- Welding certificates
- Non-destructive test: Radiographic Examination Record
- Others on request

Each shipment is checked for completeness and released by Quality Assurance Staff prior to shipment.

You should check the meter and accessories by means of the order acknowledgement and the delivery note for completeness. Any damages caused during transport should also be checked. Please immediately contact your sales agent, if the goods are incomplete or damaged.

1.5 Instructions for storage and conservation

- A gas turbine meter is a high precision instrument; it should be handled with care.
- Never use the index head or the oil pump to lift the meter.

vemm tec suggests storing the IGTM in the original crating/packing to avoid damage during storage. IGTM gas turbine meters must be stored in a non-condensing atmosphere in a temperature range from -25 to +55 °C. If a meter is stored for more than 3 months or under alternative conditions, the meter needs to be conserved properly.

vemm tec suggests to keep the original crating/packing of your IGTM gas turbine meter for future use. Please use the original crating/packing and fixing materials to secure your IGTM during all further transports, and to avoid damage during transport.

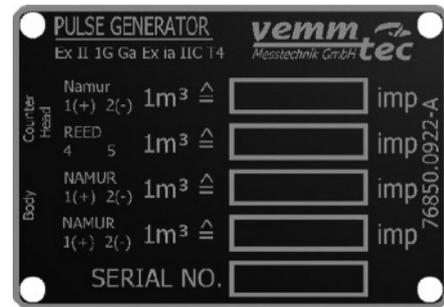
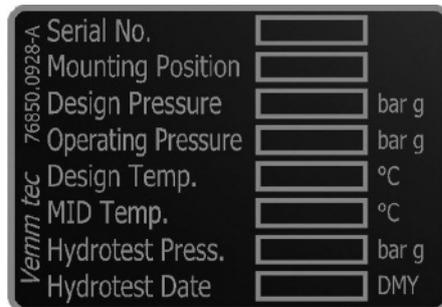
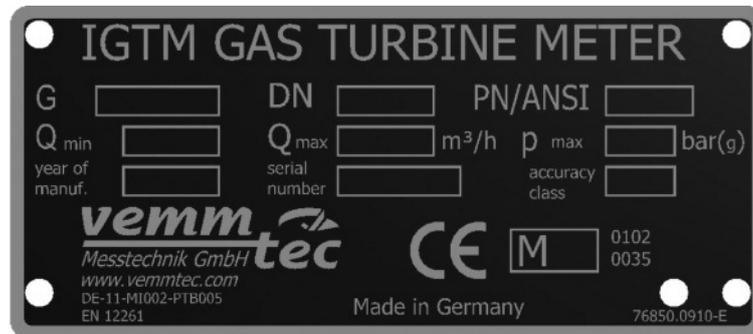
1.6 Principle of operation

The operation of the IGTM is based on the measurement of the velocity of gas. The flowing gas is accelerated and conditioned by the meter's straightening section. The integrated straightening vanes prepare the gas flow profile by removing undesirable swirl, turbulence and asymmetry before the gas reaches the rotating turbine wheel. The dynamic forces of the flowing fluid cause the rotor to rotate. The turbine wheel is mounted on the main shaft with special high-precision and low-friction ball bearings. The turbine wheel has helical blades with a known angle relative to the gas flow. The conditioned and accelerated gas drives the turbine wheel with an angular velocity that is proportional with the gas velocity. The rotation of the turbine wheel and the main shaft eventually drive the eight digit mechanical counter in the index head. The rotating turbine wheel can also generate pulses directly by proximity sensors that create a pulse for each passing turbine blade. By accumulating the pulses, the total passed volume and gas flow rate can be calculated.

1.7 Nameplate details

Your meter is equipped with a main label. Figure 2 shows the English version. Alternatively, labels are available in German or other languages. The label contains information such as size, pressure rating, and flow rate which are valid for this meter. Please refer to Table 14 to check size and G rating. Only use the meter in the indicated ranges for flow, pressure and temperature.

Figure 2: Name plate (MID version), CE/PED label and pulse label



1.8 Documentation

1.8.1 Approvals

The IGTM was specifically designed to be in accordance with all relevant international standards, including EC (European Community) directives MID and PED and the rigid German regulations for custody transfer. Please refer to Table 9 for a list of technical standards, rules, and guidelines.

The IGTM-CT meter is approved for custody transfer in all EC countries. Please refer to Figure 17 for the original style EC type approval certificate; and to Figure 18 for the MID approval. Metrological type approvals are also available for Algeria, Brazil, China, Czech Republic, Hungary, Italy, Malaysia, Romania, and South Korea. Other approvals are pending. Please contact **vemm tec** for a complete list.

If your meter was ordered to be in accordance with a specific (country) approval the main label should be in accordance with that approval. If no specific approval was specified at the time of order, the standard label in English language will be applied.

1.8.2 Inspection certificate EN 10204 - 3.1

Every meter can be delivered with an "Inspection Certificate EN 10204 - 3.1" (see Figure 3).

As an option, you may order the complete Material Certification Package 3.1 containing:

- "Hydro Test Protocol" and "Air Seal Test Protocol"
- Material certificates of pressure containing parts
- ATEX / EEx (intrinsically safe) certification of the high frequency (NAMUR) sensors
- Welding certificates (if applicable)
- Non-destructive test reports (X-ray) (if applicable)

Additional certification must be ordered separately, for example: other non-destructive test reports or third party inspection certificates.

1.8.3 Hydro test and air seal test

All IGTMs are statically pressure tested in accordance with the flange rating and with the appropriate standards and customer requirements. Flange ratings and maximum operating pressures of the IGTM are mentioned in Section 3.4 and on the CE label.

- Hydro test of the meter housing at 1.5 x maximum operating pressure
- Air seal test of the completely assembled meter at 1.1 x maximum operating pressure

Certificates of these tests are included in the optional Material Certification Package 3.1. (This must be requested at the time of your order.) Each meter is marked with **Wx Lx** on the meter flange (for the IGTM-WT at the meter body), where x is a single digit number, to indicate that the test is passed.

1.8.4 Initial verification and calibration

Gas flow meters for custody transfer purposes usually have an initial verification (legal calibration) or under MID rules a calibration and final verification According to Module F or Module D. These verifications can be performed at our factory with air at ambient conditions. The calibration facility is listed as "Accredited Test Centre for Gas Meters GN 5 at **vemm tec** Messtechnik GmbH". Accreditation is performed and supervised by the "Landesamt für Mess- und Eichwesen, Land Brandenburg (Eichamt)", that is the German State Verification Authority, State Brandenburg (Weights & Measures). The reference meters used for the calibrations are traceable to the national standards of the Federal Republic of Germany at the Physikalisch-Technische Bundesanstalt (PTB). The calibration managers of GN 5 are certified verification officers. After having passed the calibration, a "Verification certificate" is issued. It is signed and stamped by "GN 5" (or equivalent according to the applicable approvals).

If a legal verification certificate is not required, a factory calibration with air at ambient conditions is performed at above mentioned calibration facility. The "Certificate of Conformity" proves that the meter has been tested and complies with the stated error limits. It is signed and stamped by "**vemm tec** Messtechnik GmbH".

In both cases (verification or factory calibration) a two page certificate with the measured data and curve can be issued at additional cost.

The k-factors [Imp/m³] for the HF sensors of each IGTM are determined during calibration. They are shown on a label on the index head and the calibration certificate with 6 significant digits. The k-factors are specific for each meter and correspond with specific gears in the index head. The factor determined by the calibration is the one that should be used in your calculations and flow correcting devices.

If at any time the meter is re-calibrated and the correction gears in the index head are changed, the k-factor for the HF sensors must also be adjusted.

Each IGTM has been flow tested, quality checked, and sealed:

- After verification, the meter is lead sealed according to the applicable (legal) requirements (depending on approval)
- If the meter is factory calibrated, it is lead sealed with factory seals.

Please verify that all seals are present before mounting the meter in the pipeline (refer to Figure 22 for seal locations). If any of the seals are broken, removed or damaged, the meter may not be used for custody transfer measurements in most countries. The seals must not be painted. Your warranty will become void, if any lead seal with the original stamp is damaged.

If requested, high pressure calibrations with natural gas will be performed at external High Pressure Test Facilities, such as PIGSAR Dorsten (Germany), EnBW PasCaLab Stuttgart (Germany), NMI Euroloop (The Netherlands), or FORCE (Denmark). These facilities are approved for legal verifications in the respective countries. Please enquire.

1.8.5 Example certificates

Figure 3: Inspection certificate EN 10304 - 3.1

Inspection Certificate EN 10204 - 3.1

Formblatt 08-15, Revision 4 - Oktober 05
Page 1 of 1, file: .xls

vemmtec - Messtechnik GmbH
Haupt- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

Order date
Reference-No.
Customer name

Inspected device	IGTM Gas Turbine Meter		
Manufactured by	vemmtec Messtechnik GmbH, Germany, ref. 135161494		
Selection code	76801 - 42321 - 131 - 542	Serial number	
Model	IGTM-CT	Year of manuf.	2013
G size rating	G 650	Range: Qmin	32 m ³ /h
Diameter	DN 150 (6")	Range: Qmax	1000 m ³ /h
Flanges	ANSI 600#	Max. oper. press.	103 bar (g)
Body material	Carbon Steel		
Temp. range	-20 .. +60 °C (gas temperature and ambient temperature)		
Medium	Non-corrosive gas (According to DVGW G 260)		
Technical standards			
EN 12261 / ASME B 16.5; DIN 30690-1; DVGW G 469; DVGW G 492; vemmtec PA 10-03; vemmtec PA PU 002 01			
Strength and leak tests			
Hydrostatic test performed with water at		156 bar (g).	Duration: 5 minutes minimum.
Air seal test performed with air at		114,4 bar (g).	Duration: 5 minutes minimum.
Calibration			
The calibration was performed according to 71/318/EEC at the vemmtec calibration facility with air at ambient conditions. This facility is listed as Accredited Test Centre GN 5 in the Federal Republic of Germany. The standards used for the measurements are traceable to the national standards at the Physikalisch-Technische Bundesanstalt (PTB).			
Declaration of conformity			
This certifies that the measuring device has been designed, manufactured, tested, and inspected in accordance with the standards and technical specifications of above mentioned contract. The requirements in the standards referred to are fulfilled. All tests have been passed. The unit was found in perfect condition before dispatching.			

Place: Potsdam, Germany

vt 1 / Mr. Otfried JANZ: Quality Inspector

Date: 26 Mrz 2014

Signature:

Inspector's stamp:

Company's stamp: vemmtec Messtechnik GmbH
Gartenstraße 20
D-14482 Potsdam-Sabersberg
☎ 0331 / 70 96-0
Fax: 70 96-201/270

fb081504

Telefon: +49(0)331 / 70 96-0 HlFax: +49(0)331 / 70 96-201 und 70 96-270 -Mail: info@vemmtec.com Internet: www.vemmtec.com	Bankverbindung: Landesbank Berlin (LBB AG) Kto.-Nr.: 6 607 223 036 BLZ: 100 500 00 IBAN: DE94 1006 0000 0007 0230 36 BIC: BELA3303	Bankverbindung: Bayerische Hypo- und Vereinsbank AG Kto.-Nr.: 355 170 233 BLZ: 160 200 88 IBAN: DE33 1602 0060 0351 7023 33 BIC: HYVE3333
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Geschäftsführer: Karst von Dellen
 Registergericht: Kreisgericht Potsdam
 Handelsregister: HRB 3559
 Umsatzsteuer-Identifikationsnummer: DE 138402535

Figure 4: ATEX certificate for IGTM sensors HF1/2 and for HF 3/4

Physikalisch-Technische Bundesanstalt **PTB**
Braunschweig und Berlin



(1) **EC-TYPE-EXAMINATION CERTIFICATE**
(Translation)

(2) Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres - **Directive 94/9/EC**

(3) EC-type-examination Certificate Number:
PTB 01 ATEX 2192

(4) Equipment: Inductive proximity switch, type N95000

(5) Manufacturer: ifm electronic gmbh

(6) Address: 45127 Essen, Germany

(7) This equipment and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The Physikalisch-Technische Bundesanstalt, notified body No. 0102 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.
The examination and test results are recorded in the confidential report PTB Ex 01-21258.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:
EN 50014:1997 + A1 + A2 EN 50020:1994 EN 50284:1999 EN 1127-1:1997

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-type-examination Certificate relates only to the design, examination and tests of the specified equipment in accordance to the Directive 94/9/EC. Further requirements of the Directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.

(12) The marking of the equipment shall include the following:



Zertifizierungsstelle Explosionsschutz Braunschweig, February 1, 2002
By order: 
Dr.-Ing. U. Johannsmeyer
Regierungsdirektor



sheet 1/2

EC-type-examination Certificates without signature and official stamp shall not be valid. The certificates may be circulated only without alteration. Extracts or alterations are subject to approval by the Physikalisch-Technische Bundesanstalt. In case of dispute, the German text shall prevail.
Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

 **DEKRA**

(1) **EG-Baumusterprüfbescheinigung**

(2) - Richtlinie 94/9/EG -
Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen

(3) **BVS 08 ATEX E 026**

(4) Gerät: Näherungssensor Typ I7*2***-N***

(5) Hersteller: ifm electronic gmbh

(6) Anschrift: 45127 Essen

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

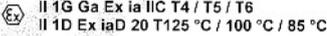
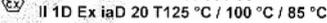
(8) Die Zertifizierungsstelle der DEKRA EXAM GmbH, benannte Stelle Nr. 0158 gemäß Artikel 9 der Richtlinie 94/9/EG des Europäischen Parlaments und des Rates vom 23. März 1994, bescheinigt, dass das Gerät die grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie erfüllt. Die Ergebnisse der Prüfung sind in dem Prüfprotokoll BVS PP 08 2029 EG niedergelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen wurden erfüllt durch Übereinstimmung mit:
EN 50014:2006 Allgemeine Anforderungen
EN 50075:11:2007 Eigensicherheit I
IEC 60079-26:2006 Gruppe I Zone 0-Geräte
EN 57241-0:2006 Allgemeine Anforderungen
EN 57241-11:2004 Eigensicherheit ID

(10) Falls das Zeichen „X“ hinter der Bescheinigungsnummer steht, wird in der Anlage zu dieser Baumusterprüfbescheinigung auf besondere Bedingungen für die sichere Anwendung des Gerätes hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf die Konzeption und die Bauüberprüfung des beschriebenen Gerätes in Übereinstimmung mit der Richtlinie 94/9/EG. Für Herstellung und in Verkehr bringen des Gerätes sind weitere Anforderungen der Richtlinie zu erfüllen, die nicht durch diese Bescheinigung abgedeckt sind.

(12) Die Kennzeichnung des Gerätes muss die folgenden Angaben enthalten:

DEKRA EXAM GmbH
Bochum, den 31. März 2008

 
Zertifizierungsstelle Fachbereich

Seite 1 von 2 zu BVS 08 ATEX E 026
Diese Prüfbescheinigung ist ein Dokument der DEKRA EXAM GmbH
DEKRA EXAM GmbH | Jernestraße 9 | 44708 Bochum | Telefon 0234/2956-105 | Telefax 0234/2956-110 | E-Mail: ze-exam@dekra.com

Figure 5: ATEX declaration of conformity for LF Reed switches

CE **Declaration of Conformity** **vemmtec**
Konformitätserklärung Messtechnik GmbH

No.: 03/2010
Nr.

Issuer's name: **vemmtec Messtechnik GmbH**
Name des Ausstellers: Burkhard Quade

Issuer's address: Gartenstraße 20
Adresse des Ausstellers: 14482 Potsdam
Germany

Object of declaration:
Gegenstand der Erklärung:

The Turbinmeter IGTM DN 50 ... DN 400 are equipped to the volume impulse expenditure LF with a Reed contact. The development and manufacture was carried out considering after listed standards.

Der Turbinenradgaszähler IGTM DN 50 ... DN 400 sind zur LF-Volumenimpulsausgabe mit einem Reedkontakt ausgerüstet. Die Konstruktion und Fertigung wurde unter Beachtung folgend aufgeführter Normen ausgeführt.

The object of the declaration described above is in conformity with the requirements of the following documents:
Das oben beschriebene Produkt ist konform mit den Anforderungen der folgenden Dokumente:

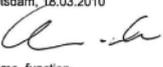
Document No. Dokument-Nr.	Title Titel	Edition/Date of issue Ausgabedatum
94/9/EG	Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen	Norm: EN 50014+A1+A2 EN 50020 2000-02 2003-08
94/9/EC	Equipment and protective systems intended for use in potentially explosive atmospheres	
89/336/EWG	Elektromagnetische Verträglichkeit	Norm: EN 60947-5-6 2000-12
89/336/EEC	Electromagnetic compatibility	

Additional information:
Zusätzliche Informationen:

vemmtec Messtechnik GmbH – Gartenstraße 20 – 14482 Potsdam – www.vemmtec.com

CE **Declaration of Conformity** **vemmtec**
Konformitätserklärung Messtechnik GmbH

Potsdam, 18.03.2010
Place, Date


Name, function
Quade, Project Engineer

Name, function

vemmtec Messtechnik GmbH – Gartenstraße 20 – 14482 Potsdam – www.vemmtec.com

Figure 6: Optional calibration certificates (examples), performed with air at ambient conditions: Initial verification – “Verification certificate”, Factory calibration – “Certificate of conformity”, Calibration data and error curve

**Staatlich anerkannte Prüfstelle für Messgeräte für Gas GN 5
bei der vemmtec Messtechnik GmbH**
Accredited Test Centre for Gas Meters GN 5 at vemmtec Messtechnik GmbH

**DIE BEI DEN MESSUNGEN VERWENDETEN NORMALE SIND AUF DIE NATIONALEN NORMALE
BEI DER PHYSIKALISCH-TECHNISCHEN BUNDESANSTALT (PTB) RÜCKGEFÜHRT.
THE STANDARDS USED FOR THE MEASUREMENTS ARE TRACEABLE TO THE NATIONAL STANDARDS OF THE
FEDERAL REPUBLIC OF GERMANY AT THE PHYSIKALISCH-TECHNISCHE BUNDESANSTALT (PTB).**

Eichschein

Verification certificate

Gegenstand der Prüfung Turbinenradgaszähler IGTM-CT Größe G650
Object of inspection DN 150(6") ANSI 300 Flow rating

Hersteller vemmtec
Manufacturer

Identifikation Baujahr 2014
Identification Year

Antragsteller vemmtec
Applicant Referenz-Nr. -

Zulassungsnummer D97/7.211.16
Approval number k-Faktor [imp/m³] HF 1
k-Faktor [imp/m³] HF 2
k-Faktor 378,947 [imp/m³] HF 3
k-Faktor [imp/m³] HF 4
k-Faktor 1 [imp/m³] 1R1
k-Faktor 1 [imp/m³] 2R1

Datum der Eichung 20. Mai 2014
Date of verification

Prüfer BÜ.
Calibrator Justierräder 38 / 48

Ergebnis Die Eichfehlergrenzen werden eingehalten.
Result The meter is in compliance with the legal EC error limits.

**Die Gültigkeit der Eichung erlischt vorzeitig, wenn eine der in §13 Absatz 1 der Eichordnung beschriebenen
Veränderung eingetreten ist.**
The validity of the verification has ceased to exist if one of the changes listed in §13 section 1 of the Eichordnung has occurred.

**Eichscheine ohne Unterschrift und Stempel haben keine Gültigkeit. Dieser Eichschein darf nur unverändert
weiterverbreitet werden.**
Verification certificates without signature and stamp are not valid. This verification certificate may only be reproduced if unchanged form.

Ort und Datum Potsdam, 21. Mai 2014
Place and date

Stempel
STÄATLICH ANERKANNTE PRÜFSTELLE
GN 5
POTSDAM

Unterschrift
Signature

Prüfstelle GN 5 bei der vemmtec Messtechnik GmbH, Gartenstr. 20, 14482 Potsdam, Germany
Tel.: +49(0)331/7096-289; Fax: +49(0)331/7096-270; E-Mail: info_haupt@vemmtec.com

vemmtec
Messtechnik GmbH

vemmtec Messtechnik GmbH
Haupt- und Nebenstrasse, Gartenstraße 20 • D-14482 Potsdam/Germany

Calibration facility for Gas measurement equipment with ambient air

THE STANDARDS USED FOR THE MEASUREMENTS ARE TRACEABLE TO THE NATIONAL STANDARDS OF THE
FEDERAL REPUBLIC OF GERMANY AT THE PHYSIKALISCH-TECHNISCHE BUNDESANSTALT (PTB).

CERTIFICATE OF CONFORMITY

Type: IGTM - CT
Sales order: -
Serial number: -
Approval number: D97/7.211.16
Year: 2013
Normalisation wheels: 25 / 31
Customer: vemmtec

Manufacturer: vemmtec
Test date: 12 Jun 2013
Calibrator: Kl.

Remarks:
Error limits in compliance with DIN 33 800.

Size: DN 100 (4")
Pressure rating: ANSI 300
Flow rating: G 400
Q_{max}: 32 [m³/h]
Q_{min}: 650 [imp/m³] HF1
k-factor: 9222,92 [imp/m³] HF1
9222,92 [imp/m³] HF2
432,325 [imp/m³] HF3
- [imp/m³] HF4
k-factor: 1 [imp/m³] R1
- [imp/m³] R2

Normalisation wheels: 25 / 31

Remarks:
Error limits in compliance with DIN 33 800.

Potsdam, 01.07.2013

vemmtec Messtechnik GmbH
Gartenstr. 20
D-14482 Potsdam

Signature **Stamp**

Not valid without signature and stamp. No changes and modifications allowed without permission of certified personnel.

Telefon: +49(0)331 / 70 96-0 Bankverbindung: Landesbank Berlin (LBB AG) Geschäftsführer: Kerst von Dellen
Telefax: +49(0)331 / 70 96-201 und 70 96-270 Kto.-Nr.: 8 607 023 035 Registergericht: Michael Lohr
E-Mail: info@vemmtec.com BIC: 100 500 00 IBAN: DE54 1005 0000 6607 0230 35 Handelsregister: HRB 3056
Internet: www.vemmtec.com BIC: BELADE33XXX IBAN: DE33 1500 0088 0 355 70233 Umsatzsteuer- Identnummer: DE 13462035

vemmtec
Messtechnik GmbH

vemmtec Messtechnik GmbH
Haupt- und Nebenstrasse, Gartenstraße 20 • D-14482 Potsdam/Germany

Atmospherical test stand facility for gas meters

Sales order: -
Customer: vemmtec
Type: IGTM - CT
Size: DN 100 (4")
Manufacturer: vemmtec
Serial number: -
Approval number: D97/7.211.16
Pressure rating: ANSI 300
Size: G 400
Sensor type: -
k-factor: [pulse/m³]: 9222,92
Correction gear 1: 25
Correction gear 2: 31
Min flow [m³/h]: 32
Max flow [m³/h]: 650
Year: 2013
Calibrator: Kl.
Test date: 12.06.2013

Q [m ³ /h]	V ₀ [m ³]	V _p [m ³]	p ₀ [mbar]	p _p [mbar]	Δp ₀ [°C]	Δp _p [°C]	No.	f ₀ [%]	f _p [%]
648.6	15.2263	15.0001	997.0	990.6	23.94	23.52	3	-0.09	-0.23
648.2	15.2263	15.0001	987.1	990.6	23.91	23.46	3	-0.09	-0.23
455.2	10.1354	10.0000	1001.0	1002.7	23.87	23.54	3	-0.01	-0.27
455.1	10.1358	10.0000	1002.0	1002.8	23.90	23.58	3	-0.01	-0.22
259.9	6.0627	6.0000	1008.9	1010.4	23.82	23.63	2	-0.18	-0.18
260.0	6.0630	6.0000	1008.9	1010.4	23.77	23.49	2	-0.18	-0.18
162.4	4.0422	4.0000	1012.2	1012.8	23.86	23.78	2	-0.10	-0.26
162.4	4.0427	4.0000	1012.2	1012.8	23.90	23.86	2	-0.10	-0.29
65.0	1.5023	1.5000	1012.1	1014.1	23.73	24.03	1	-0.09	+0.64
65.0	1.5023	1.5000	1012.0	1014.0	23.76	24.05	1	-0.09	+0.64
32.0	1.0031	1.0000	1013.7	1014.2	23.78	24.10	1	-0.13	+0.30
32.0	1.0031	1.0000	1013.6	1014.2	23.81	24.13	1	-0.13	+0.29

Signature

vemmtec Messtechnik GmbH
Gartenstr. 20
D-14482 Potsdam

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Telefax: +49(0)331 / 70 96-201 und 70 96-270 Kto.-Nr.: 8 607 023 035 Registergericht: Kreisgericht Potsdam
E-Mail: info@vemmtec.com BIC: 100 500 00 IBAN: DE54 1005 0000 6607 0230 35 Handelsregister: HRB 3056
Internet: www.vemmtec.com BIC: BELADE33XXX IBAN: DE33 1500 0088 0 355 70233 Umsatzsteuer- Identnummer: DE 13462035

vemmtec
Messtechnik GmbH

vemmtec Messtechnik GmbH
Haupt- und Nebenstrasse, Gartenstraße 20 • D-14482 Potsdam/Germany

Calibration data and error curve

Serial No.:

Signature

vemmtec Messtechnik GmbH
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D-14482 Potsdam

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E-Mail: info@vemmtec.com BIC: 100 500 00 IBAN: DE54 1005 0000 6607 0230 35 Handelsregister: HRB 3056
Internet: www.vemmtec.com BIC: BELADE33XXX IBAN: DE33 1500 0088 0 355 70233 Umsatzsteuer- Identnummer: DE 13462035

Figure 7: Optional calibration certificate (example), performed with high pressure gas

pigsar™
Operator of German National Standards
for volume of high-pressure natural gas

page 1 of 4

Calibration Certificate

Number 12010/2013
Date 2013-06-18

Applicant Name: Vemmtec Messtechnik GmbH
Order no.

Meter under test Description: Turbine meter
Manufacturer: Vemmtec
Type: IGTM
Serial number:
Nominal size: G400
Range of flowrate: 32...650 m³/h
Year of manufacture: 2013
Nominal diameter of meter: 100 mm
Nominal diameter of flange: 100 mm
Nominal flange pressure: ANSI 300 RF

Date of test 2013-06-18

Results The results of the calibration are presented on page 3.

Test procedure PTB-Prüfregeln Band 30, Messgeräte für Gas, Hochdruckprüfung von Gaszählern
Physikalisch-Technische Bundesanstalt, Braunschweig und Berlin, 2003

Test facility pigsar represents the National Standard of the Federal Republic of Germany for the unit of volume for high pressure natural gas under supervision of PTB. pigsar disseminates the harmonized values for the unit of volume for high pressure gas flow measurements of the Federal Republic of Germany, France and The Netherlands. pigsar is accredited according to EN ISO 17025.

Traceability The presented results of the calibration are based on the unified Dutch-French-German reference values for the unit of volume for high-pressure gas flow measurements. On June-02-1999, PTB (Physikalisch-Technische Bundesanstalt) and VSL (formerly NMI-VSL, Netherlands Measurement Institute - Van Swinden Laboratorium) and later on May-04-2004 LNE (The Laboratoire national de métrologie et d'essais) have joined the harmonization (unification) procedure and the use of these reference values, see page 2.

Dorsten, 2013-06-18



pigsar™, Van Swinden Centrum 4.00, Kijkduin 1205, 2201 SZ, Rotterdam, Nederland
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page 2 of 4

The presented results of the calibration are based on the harmonized Dutch-French-German reference values for the unit of Volume for High Pressure Natural Gas flow measurements. In Paris, on 2004-May-4, PTB (Physikalisch-Technische Bundesanstalt), VSL (Van Swinden Laboratorium) and LNE (The Laboratoire national de métrologie et d'essais) have agreed on the harmonization and the use of these reference values.

PTB
The Physikalisch-Technische Bundesanstalt (PTB) in Braunschweig and Berlin is the national institute for science and technology and the highest technical authority of the Federal Republic of Germany for the field of metrology and certain sectors of safety engineering. The PTB comes under the auspices of the Federal Ministry of Economics. It meets the requirements for calibration and testing laboratories as defined in the EN ISO/IEC 17025.

It is the fundamental task of the PTB to realize and maintain the legal units in compliance with the International System of Units (SI) and to disseminate them, above all within the framework of legal and industrial metrology. The PTB thus is on top of the metrological hierarchy in Germany.

This certificate is consistent with the Calibration and Measurement Capabilities (CMCs) that are included in Appendix C of the Mutual Recognition Arrangement (MRA) drawn up by the International Committee for Weights and Measures (CIPM). Under the MRA, all participating institutes recognize the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see <http://www.bipm.org>).

VSL
Dutch Metrology Institute
VSL is the National Metrology Institute of The Netherlands and is part of the Holland Metrology Group (formerly known as NMI Group). VSL is appointed by the Dutch Government as the national institute for developing and maintaining the national measurement standards.

VSL makes an important contribution towards the reliability, quality and innovation of products and processes, both in business and society at large and provides a direct link to international accepted measurement standards in order to achieve traceability for measurement results of companies, laboratories and organisations.

VSL is accredited by RvA (Raad voor Accreditatie, Board of Accreditation) to perform calibrations conform ISO17025 and is accredited to perform initial verification services for and on behalf of NMI Certin B.V.

LNE
The Laboratoire national de métrologie et d'essais (LNE) is the company designated by the French government as responsible of policy in terms of metrology in replacement of BNM (Bureau National de Métrologie) since January 2005.

The LNE is also designated by the French government as the Legal Metrology Service to perform type approvals and verifications. Thus, it is the fundamental task of the LNE to realize, develop and maintain the national primary standards and to insure the traceability of industries and users to the S.I units by the realization of specific instrumentation and calibration benches.

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page 3 of 4

Certificate Number: 12010/2013
Date: 2013-06-18

Applicant Vemmtec Messtechnik GmbH

Meter under Test Type: Turbine meter IGTM
Manufacturer: Vemmtec
Serial number:
Nominal Size: G400
Year of manufacture: 2013

Test Conditions

Test medium	Natural gas	CO ₂	1,36	mole %
Pressure, absolute	30,9	bar	H ₂	0,0
Gas Temperature	19	°C	Calorific value, s	10,19
Gas density (p, T)	75,0	kg/m³	Density, normal	0,8302
Dyn. Viscosity (p, T)	1,20E-5	Pa s	Normal condition	273,15 K, 101,325 kPa

Results (as left)

Q1 / Qmax	Q1 (m³/h)	Reynoldnumber	Deviation (%)	Unc. (%)
0,03	16,65	0,12 *10 ⁶	-0,54	0,15
0,05	32,31	0,24 *10 ⁶	-0,12	0,14
0,10	64,57	0,47 *10 ⁶	0,10	0,13
0,25	161,20	1,20 *10 ⁶	0,07	0,13
0,50	324,07	2,38 *10 ⁶	0,13	0,13
0,75	489,79	3,62 *10 ⁶	0,10	0,13
1,00	650,78	4,81 *10 ⁶	0,00	0,13

Weighted mean error, with continuous and linear decrease of weighting factor between 0,7 Qmax and Qmax: 0,07 %

The deviation is defined as: $Deviation = \frac{(Indicated\ Value - Reference\ Value)}{(Reference\ Value)} \cdot 100\%$
where the reference volume refers to the conditions at the meter under test. The reported values of this deviation are the arithmetical means of n single repeat measurements at each flow-rate.

The reported total uncertainty is defined as: $U_{total} = \sqrt{U_{harmonized}^2 + U_{meter}^2}$
where $U_{harmonized}$ is the expanded uncertainty of the harmonized reference value, stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, and U_{meter} is the expanded standard uncertainty of the meter under test, determined on the base of n repeats at each flow-rate, multiplied by Student-t-factor (n) / n^{0,5}, with a probability of 95%.

Remarks Security marks are applied

The calibration of the meter had been performed in following configuration:
Flowconditioner (138386) – upstream pipe (450 mm) – meter
Flowconditioner were provided by the manufacturer/customer.

Tested in Dorsten at pigsar, on 2013-06-18 Schiffmann

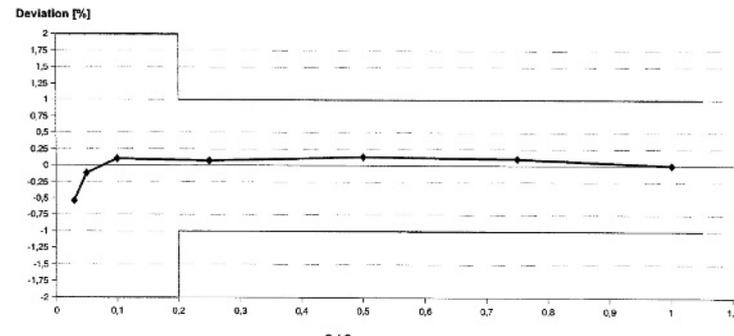
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page 4/4
12010/2013

Error Curve

Type of meter: Turbine meter	Customer: Vemmtec Messtechnik GmbH	DN: 100 mm	p (abs): 31 bar	HF 1	9336,05	pulses / m³
Meter no:	Manufacturer: Vemmtec	Size: G400	Q max: 650 m³/h	HF 2	9336,06	pulses / m³
Date: 2013-06-18	Gear 1: 47		Q min: 32 m³/h	HF 3	437,965	pulses / m³
Inspector: Schiffmann	Gear 2: 59		R 1	1.0000	pulses / m³	

Deviation [%]



Q / Q max

2 INSTALLATION

2.1 Safety instructions and warnings: See back page

2.2 Instructions specific to the EC Pressure Equipment Directive (PED)

This chapter identifies specific installation and operation instructions necessary to ensure compliance with the Essential Safety Requirements (ESR) of the European Economic Area Pressure Equipment Directive (PED) 97/23/EC.

This document applies to IGTM Gas Turbine Meters manufactured by **vemm tec** Messtechnik GmbH (Potsdam-Babelsberg, Germany).

vemm tec Messtechnik GmbH's IGTM Gas Turbine Meters are supplied as components to be installed in the end users piping system. It is therefore the responsibility of the end user to ensure compliance with the requirements of the directive and regulations quoted in this section. Guidance for compliance of the relevant Essential Safety Requirements of the Pressure Equipment Directive 97/23/EC is given below.

You will find an example PED Declaration in Figure 19.

Table 1: Essential Safety Requirements (ESR) of the Pressure Equipment Directive (PED) (Part 1, continued on next page)

PED ESR Ref.	Essential Safety Requirements (ESR)	Compliance Requirement
2.3	<p>Provisions to ensure safe handling and operation.</p> <p>The method of operation specified for pressure equipment must be such as to preclude any reasonably foreseen risk in operation of the equipment. Particular attention must be paid, where appropriate to the following.</p> <p>Closures & openings</p> <p>Devices to prevent physical access whilst pressure or a vacuum exists</p> <p>Surface temperature</p> <p>Decomposition of unstable fluids</p>	<p>During removal and replacement of any parts such as the index head, the lubrication system, high frequency sensors or thermo-wells, the end user shall ensure that the meter has been properly isolated and the internal pressure has been safely vented.</p> <p>The end user shall ensure that the IGTM's are installed in a properly designed system with access limitation in place if required.</p> <p>It is the responsibility of the end user to assess the expected surface temperature in service, and if necessary, take precautions to avoid personnel coming into contact with the equipment.</p> <p>It is not envisaged that, for the designed service, the equipment shall come into contact with unstable fluids. However, the end user should assess the risk and take any steps considered necessary.</p>

Table 1: Essential Safety Requirements (ESR) of the Pressure Equipment Directive (PED) (Part 2)

<p>2.4</p>	<p>Means of examination</p> <p>Pressure equipment must be designed and constructed so that all necessary examinations to ensure safety can be carried out.</p>	<p>For the examination of all pressure containing parts of the IGTM, the meter needs to be removed from the line. It is the responsibility of the end user to ensure that the internal pressure has been safely vented before the meter is removed from the line. It is also the responsibility of the end user to use suitable material and that the employees performing the removal are well trained in assembling and disassembling high pressure gas lines.</p> <p>The end user should refer to the "Installation, Operation and Maintenance Manual" supplied with each meter. It is not considered that the process medium for which the equipment is designed will give rise to severe corrosion/erosion problems. It is the end user's responsibility to monitor any change in the process medium that may cause concern.</p>
<p>2.5</p>	<p>Means of draining and venting</p> <p>Harmful effects such as vacuum collapse, corrosion, and uncontrolled chemical reactions must be avoided.</p>	<p>It is the responsibility of the end user to ensure that the equipment is installed in a well-designed piping system to avoid such hazards.</p>
<p>2.6</p>	<p>Corrosion or other chemical attack</p>	<p>It is not probable that the process medium for which the equipment is designed will give rise to severe corrosion problems. It is the end user's responsibility to monitor any change in the process medium that may cause concern.</p>
<p>2.7</p>	<p>Wear</p>	<p>It is not considered that the use of the IGTM for fluid metering will give rise to any abnormal wear problems. It is the responsibility of the end user to install any necessary filtration upstream of the IGTM to maintain the condition of the process medium. In addition, ensure that no moisture or particles larger than 5 µm can enter the meter.</p>
<p>2.10</p>	<p>Protection against exceeding the allowable limits of the pressure equipment</p>	<p>The IGTM must be installed in a well-designed piping system with adequate protection against excessive pressure.</p>
<p>2.12</p>	<p>External fire</p>	<p>The IGTM has no special accessories for fire damage limitation. It is the responsibility of the end user to provide adequate fire fighting facilities on site.</p>
<p>7.3</p>	<p>Pressure limiting devices, particularly for pressure vessels</p>	<p>The IGTM is not a pressure vessel and has no integral pressure limiting devices. It is the responsibility of the end user to ensure that the IGTM is installed in a well-designed system so that momentary pressure surges are limited to fewer than 10 % of the IGTM's maximum operating pressure.</p>

2.3 Installation

Your IGTM is a high precision metering instrument that can only perform efficiently when the following installation guidelines are followed.

NOTE: Install the meter preferably indoors. If installed outdoors, it is recommended to protect the meter from direct sunlight and rain.

2.3.1 Lubrication system and lubrication before start up

Each standard IGTM-CT is equipped with an oil system and lubrication pump. The oil pump is dimensioned according to the size of the meter, as mentioned in Table 2.

- The small oil pump is operated by a push button: Remove the hex-cap before operating.
- The larger pumps have an operating lever: One stroke is to move the lever forward and back to its original position.

As an option, your IGTM-CT up to and including DN 100 (4"); of pressure classed PN10/16 and ANSI 150 can be provided with permanently lubricated bearings. No oil pump is supplied with these kinds of meters.

The IGTM-WT is provided with permanent lubricated bearings for the sizes DN50 (2") to DN100 (4"). Bigger diameters are provided with a lubrication system.

CAUTION: Before the initial start-up meters with an oil pump must be lubricated as described in this section.

To achieve a longer meter life, regular lubrication is required. Typically, for a clean, dry-gas application, lubrication is recommended every 3 months. For dirty gas, more frequent lubrication is required. Specification of the lubrication oil and quantities follow hereafter.

Table 2: Oil pumps

Meter size IGTM-CT	Meter size IGTM-WT	Oil pump size	Volume / Stroke	Container
Optional for CT DN 50 (2") / DN 80 (3") DN 100 (4")	DN 50 (2") / DN65 (2½") DN 80 (3") / DN 100 (4")	No lubrication pump; Life time lubricated bearings		
Standard for CT DN 50 (2") / DN 80 (3") DN 100 (4")	DN 150 (6") DN 200 (8")	Small	0.14 cm ³ /Stroke	1 cm ³
DN 150 (6") / DN 200 (8") / DN 250 (10")		Medium	0.5 cm ³ /Stroke	10 cm ³
DN 300 (12") / DN 400 (16") ¹⁾		Large	0.5 cm ³ /Stroke	50 cm ³

¹⁾ Until April 2014 the large pump had a volume /stroke of 1.0 cm³ and a 120 cm³ container
This pump can be identified by the square shape of the pump housing

The lubrication system is specially designed for high-pressure applications. The force to operate the pump is minimal. The lubrication system is exposed to the full gas pressure. To prevent gas leakage, the pump is equipped with an internal non-return valve. A second non-return valve is installed in the lubrication line that goes into the meter body.

The lubrication system is designed to allow lubrication even under hostile environment conditions. An internal anti-freeze feature counteracts the small amounts of moisture that may be present either in the oil or the reservoir. The turbine is shipped with a small amount of oil in each bearing. This amount is only sufficient for initial operation at the factory and calibration.

Lubrication before start-up (for meters with a lubrication system)

The prescribed lubricant for the IGTM is Shell MORLINA 10 or equivalent. For IGTM-CT models that are operated under MID approval and for meters operating at low temperatures ISOFLEX PDP 38 is the prescribed lubricant. vemm tec supplies an amount of bearing lubrication oil with each IGTM. This initial quantity is sufficient to cover two years of operation for normal applications. For transporting and handling purposes, each turbine is supplied without any oil in the pump and lubrication system. Before start-up operation you must proceed as followed:

- Step 1: Fill the reservoir with oil. Close the cover of the reservoir after filling to avoid polluting the oil.
- Step 2: Apply the initial amount of oil to the lubrication system with the number of strokes of the oil pump shown in the table below. One stroke is a push forward and back to the original position.
The push button of the small oil pump can be accessed by removing the hex-cap of the pump.
- Step 3: Check the oil level (during initial lubrication it will be necessary to refill the reservoir).
Close the cover of the reservoir after filling to avoid polluting the oil.

Table 3: Lubrication quantity at start up

Meter Size	Initial lubrication IGTM-CT (before first use)	Initial lubrication IGTM-WT (before first use)
DN 50 (2")	24 Strokes = 3.4 cm ³	N/A
DN 80 (3")	26 Strokes = 3.7 cm ³	N/A
DN 100 (4")	26 Strokes = 3.7 cm ³	N/A
DN 150 (6")	8 Strokes = 4 cm ³	29 Strokes = 4.1 cm ³
DN 200 (8")	12 Strokes = 6 cm ³	29 Strokes = 4.1 cm ³
DN 250 (10")	12 Strokes = 6 cm ³	--
DN 300 (12")	20 Strokes = 10 cm ³ ¹⁾	--
DN 400 (16")	20 Strokes = 10 cm ³ ¹⁾	--

¹⁾ Applicable for the round shaped pump fitted from April 2014. For the older square shaped pump 10 strokes provide the required 10 cm³

After the initial lubrication the bearings must be lubricated at regular intervals as described in Section 4.1. Lubrication not only reduces the friction of the bearings, it also flushes small particles that may have collected around the bearings over time.

2.3.2 Required upstream and downstream length

The IGTM should be installed in a straight pipe section of equal nominal diameter to the meter. The meter axis should be concentric and identical to the piping axis. Gaskets immediately upstream and downstream of the meter should not protrude into the stream.

The IGTM-CT **requires** a minimum upstream length of 2 meter diameters to comply with the MID guideline.

For the best results, we **recommend** a 5 diameter long straight upstream (inlet) section without valves, filters, control valves, reducers, T-pieces, and safety shut-off valves.

The straight downstream (outlet) section is **recommended** to be 1 diameter long, for best results 3 diameters. Some standards require the temperature transmitter to be installed in this section. (See Section 2.3.6 in this manual.)

For customer specific meter applications, other upstream and downstream lengths may be required.

2.3.3 Flow direction and orientation

The flow direction of the meter is indicated on the meter with an arrow. The index head is standard mounted for flow direction from left to right, unless specified differently at the time of your order.

CAUTION: Reverse flow will damage the meter.

The meter is standardly equipped for horizontal installation. However, meters up to DN 100 (4") can also be operated vertically. In this case the oil pump must be equipped with an adapter for vertical operation. The flow direction needs to be indicated when ordering an IGTM. Meters with permanent lubrication can either be installed horizontally or vertically. For options, please consult your sales agent.

Meters that are operating under EC-MID approval can only be operated horizontally!

2.3.4 Volume conversion

vemmtec can provide you with flow conversion devices, ranging from a converter with only basic features to a sophisticated flow computer. The latter has features like curve corrections, valve controls, gas chromatograph readouts, and other customer specified functions.

We offer such devices on your request. Please enquire for more details.

A flow conversion device connected to the IGTM will convert the volume measured at actual conditions to volume at base conditions with the following formula (nomenclature according to EN 12405).

Take care that the flow conversion device can measure the highest frequency that the gas turbine meters can generate: That is the frequency that occurs at Q_{max} multiplied by 1.2 for cases of over speeding.

Formula 1: Volume conversion

$$V_b = \frac{p}{p_b} \cdot \frac{T_b}{T} \cdot \frac{Z_b}{Z} \cdot V$$

V_b = Volume at base conditions	(converted volume)	[m ³]
V = Volume at measurement conditions	(unconverted volume)	[m ³]
	(number of pulses from the gas meter divided by the gas meter's k-factor)	
p = Absolute gas pressure at measurement conditions	(actual pressure)	[bar abs]
p_b = Absolute pressure at base conditions	(or other specified pressure)	[1.01325 bar]
T_b = Absolute temperature at base conditions	(or other specified temperature)	[273.15 K]
T = Absolute gas temperature at measurement conditions		[K]
Z_b = Compressibility factor of the gas at base conditions		
Z = Compressibility factor of the gas at measurement conditions		

2.3.5 Connection pressure transmitter at p_m -point

A pressure tap is located on the meter housing to enable the measurement of the static pressure upstream of the turbine wheel. It must be shut before start up and during operation either with a screw plug or with connection to a pressure transmitter.

The pressure measurement point is marked as p_m (or before p_r): pressure at measurement conditions. The bore is 3 mm and perpendicular to the wall. It has a G 1/8 cylindrical female thread and for the IGTM-CT a fitting for tubing with 6 mm diameter. Connection to 6 mm stainless steel tubing (standard) is recommended. If the pressure tap is not needed, it must be sealed with a G 1/8 dummy plug. When ordered the IGTM-CT can have a pressure tap with 1/2" NPT or M12X1.5 female thread (not possible for all models).

NOTE: The tubing connection of 6 mm diameter is NOT identical with 1/4" diameter tubing (6.35 mm). Replace the inner ring or the connector if the tubing is non-metric.

The pressure reference point should be used for connecting the pressure transmitter of the flow converter or flow computer in order to convert the measured volume to base conditions, called standard or normal conditions in some countries. The p_m -point is used during the determination of the meter calibration curve and this p_m -point should be used for custody transfer applications. Using a different pressure point may cause small errors in the flow measurement and the conversion to base conditions.

2.3.6 Temperature measurement

The temperature transmitter is required when a flow converter or flow computer is used to convert the measured volume to base conditions, called standard or normal conditions in some countries. The temperature sensor should be installed in a thermo-well.

As an option, the IGTM-CT can be equipped with an integrated thermo-well. As an alternative, the temperature measurement shall be located downstream of the meter. **vemmtec** recommends 1 to 3 meter diameters distance downstream from the meter, but not more than 600 mm. No pressure drop should occur between the temperature device and the meter. The temperature sensor is recommended to be within the centre third of the pipe and be protected from heat transfer from the external environment.

A second thermo-well close to the other one may be added to allow in-line checking of the main temperature sensor.

Some specific models of the IGTM are equipped with thermo-wells integrated in the meter body. Do not replace these thermo-wells by other models and **do not remove** these thermo-wells when the meter is pressurized.

2.3.7 Density measurement

When a line density meter is used, the above mentioned requirements for pressure and temperature should be followed for the location of the density meter. Most density meters will be installed in a separate pocket, which was welded into the pipeline. The density meter will typically be installed in the downstream section of the IGTM (3 – 5 meter diameters) to measure the density at operating temperature conditions. The sample gas flowing through the density meter should be taken from the p_m -point of the IGTM to ensure the density is measured at the correct line pressure.

Please refer to the recommendations of the density meter manufacturer for optimal results.

Base density can be measured at any point in the installation, as long as the gas sample flowing through the density meter is representative of the actual flowing gas.

2.3.8 Energy measurement

In order to calculate the energy content of the passed gas, the converted volume is to be multiplied by the heating value. The volume conversion is described in Section 2.3.4. The heating value of the gas can be determined in several ways. The most commonly used methods are:

- On-line analysis with a process gas chromatograph
- On-line analysis with a calorimeter
- Laboratory analysis of a collected sample
- Calculation by pipeline simulation

The PTZ-BOX electronic volume converters can calculate the heating value from the gas composition and as such can calculate the energy content of the passed gas.

2.3.9 Index head and pulse transmitters

The IGTM index head is rated IP 67 after IEC 60529, which is dust-tight and protected against water jets. The index head is provided with a special breathing filter that equalizes pressure differences between index head and environment. Due to these provisions the IGTM can be installed outside but we recommend installing a simple sun and rain shield above the index head. All IGTM sockets with properly fitted caps or connectors for pulse transmitters are rated IP 67.

Every index head is equipped with high-quality bearings and polished gears for low-friction. To ensure that each revolution of the mechanical counter corresponds with a known volume, a final factory flow test is performed. As a part of this test, the ratio of the gears is checked and if necessary adjusted. These gears are inside the index head and the head is lead-sealed to prevent unauthorized access.

The mechanical counter totalizes the actual volume passing through the meter. A large eight-digit (non-resettable) display shows the totalized volume (refer to Figure 8)

For easy reading of the volume indicated at the display, the index head can be turned through 350° without violating the lead seal (refer to Figure 9). To turn the index head loosen the two inner hex nuts, located left and right from the front (1 and 2) and the screw at the back (3) (all on the upper cover), and turn the upper cover carefully with two hands without lifting it. Tighten the nuts after positioning.

CAUTION: Do not break the seals when turning the index head.

Your IGTM gas turbine meter is supplied with one or more pulse transmitters. The pulse signals can be connected to a flow computer or a volume converter. Two types of pulse transmitters are available: LF (low frequency) reed switches and HF (high frequency) NAMUR proximity sensors. Both LF and HF sensors can be fitted in the index head if specified as part of the order. If your meter is supplied with pulse transmitters at the meter body, these transmitters are HF sensors.

Figure 8: Mechanical counter: reading the index head display

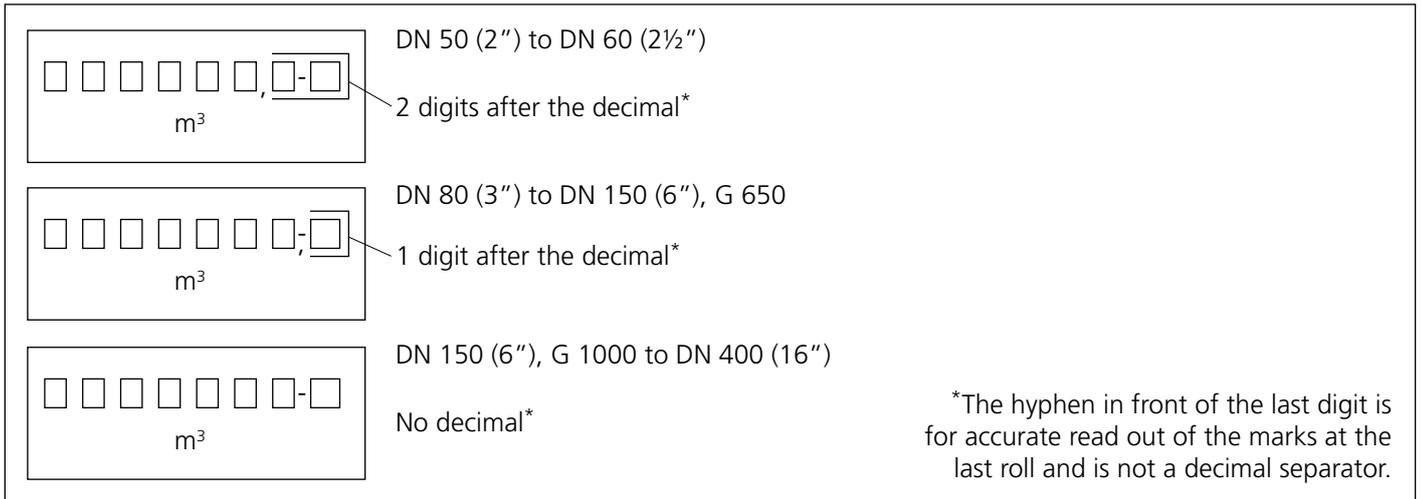


Figure 9: Orientation change of the index head

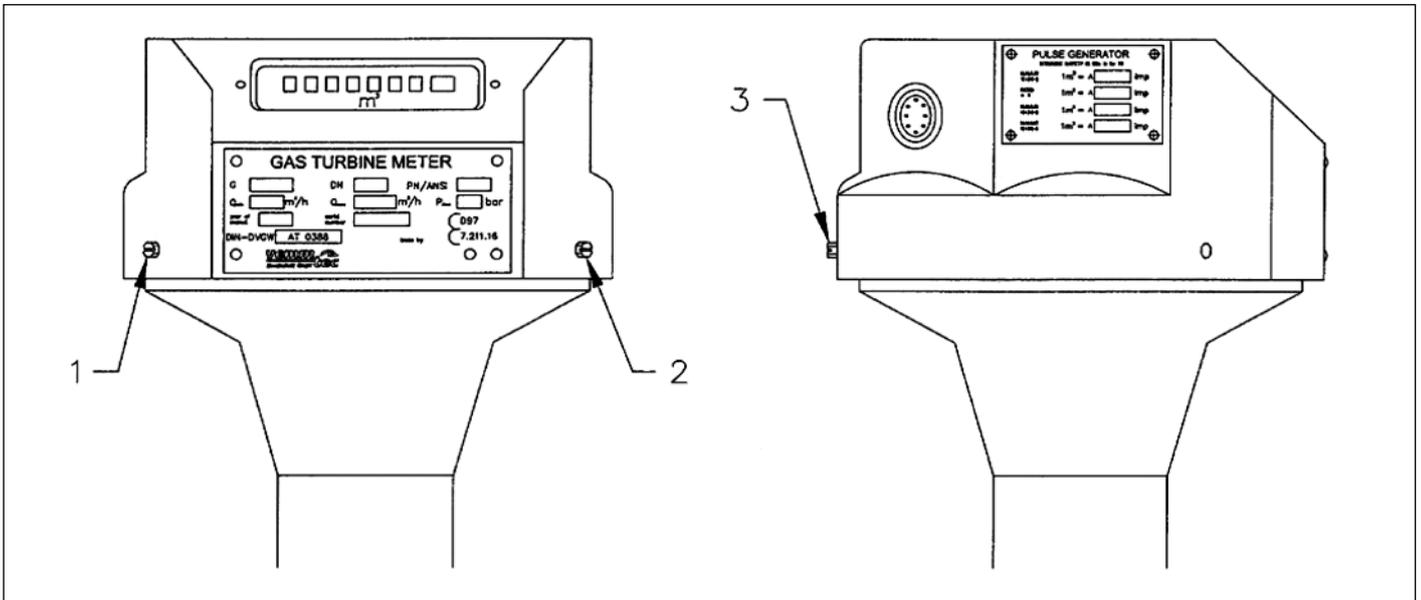


Table 4: Available pulse transmitters

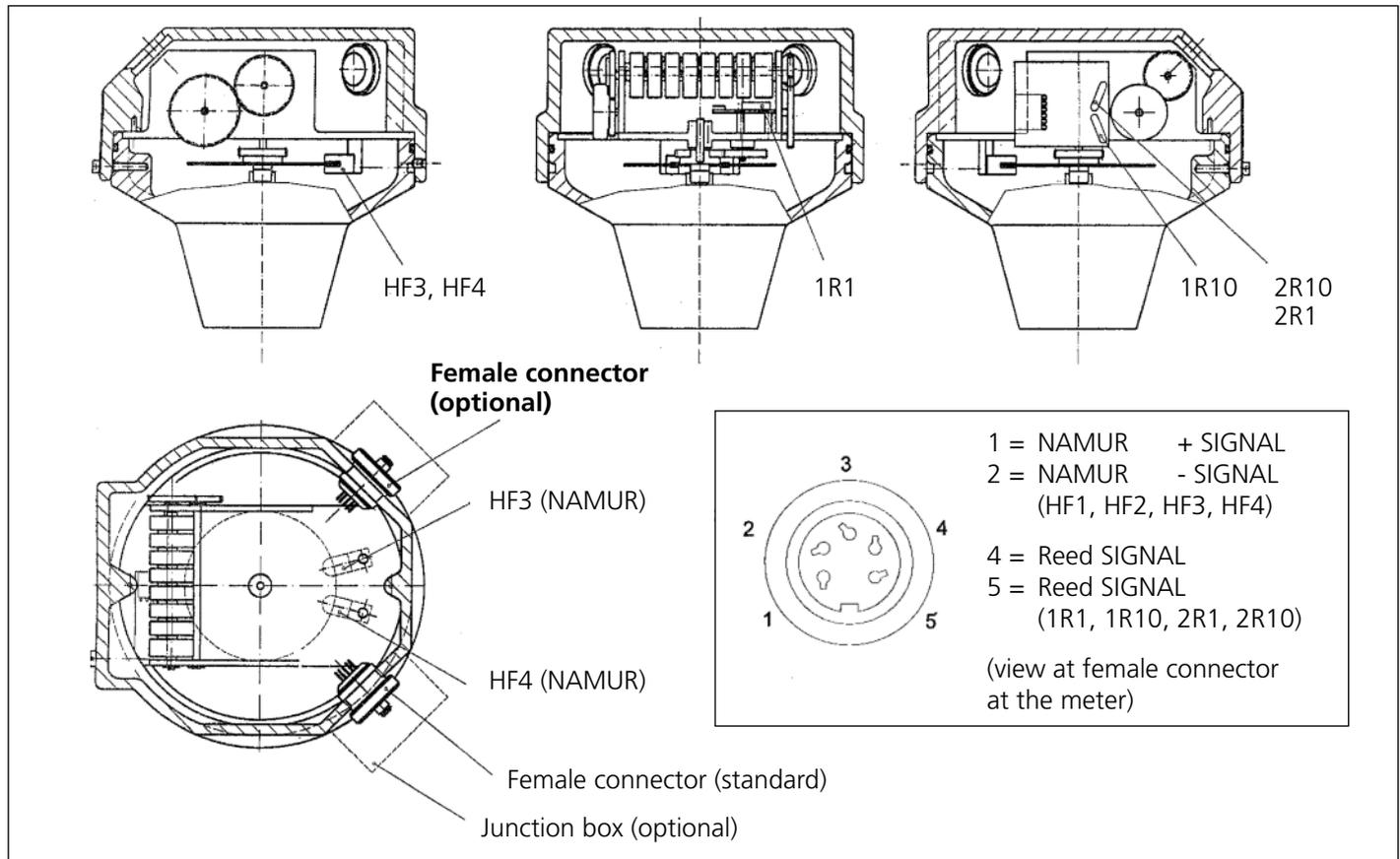
Code	Description	Maximum frequency *	Remarks
1R1, 2R1	Reed switch	< 1 Hz	1R1 standard, 2R1 optional **
1R10, 2R10	Reed switch, frequency x 10	< 10 Hz	1R10 and/or 2R10 optional **
HF3, HF4	HF NAMUR sensor (at the index head)	< 200 Hz	HF3 (for CT model standard***, WT model optional), HF4 optional
HF1	HF NAMUR sensor (at the turbine wheel)	< 4.5 kHz	optional for CT model
HF2	HF NAMUR sensor (at the reference wheel)	< 4.5 kHz (equal to HF1)	optional (only for CT model sizes DN 100 (4'') and up)

* The maximum pulse frequency depends on meter size: Please refer to Table 14 for typical values.

** A maximum of two reed switches can be supplied per meter.

*** Optionally IGTM-CT can be supplied without HF3 sensor

Figure 10: Drawing of index head internals with connector diagram



Sockets for the pulse transmitters in the index head are located at the back of the index head. A label is located alongside each of the socket(s), which indicates the type of pulse transmitter, the k-factor (number of pulses per cubic meter) and the connecting pins and their polarity. The details of the pulse transmitters in the meter body are also shown on the nameplate at the index head.

All sockets at the meter are female connectors. The corresponding male connectors can be ordered additionally with your meter. The male connector is shipped unassembled, to make the field connections. If required we can supply the male connectors assembled and connected to a cable of the requested length.

You will find more information about the sensor types and electrical connection schematics in the following sections of this manual.

2.3.10 Specification of reed switches (R1 or R10 in the index head)

As a standard, the index head is equipped with one low frequency reed contact closure switch (1R1), which gives one pulse per revolution of the last digit roll of the counter. Depending on the meter size, the volume per pulse can be 0.1, 1, or 10 m³ (see Table 14). As an option, a second reed switch (2R1) can be provided.

Alternatively, the meter can be equipped with one or two reed switches that give 10 pulses per revolution of the last digit roll of the counter (1R10, 2R10).

A maximum of two low frequency switches can be mounted in the index head.

A reed switch generates a low frequency contact closure signal. This signal can be used to connect to a flow converter (often battery powered) which may be located beside the meter in the hazardous area. Reed switches require no power for the circuit to generate pulses.

A 100 Ohm resistor is connected in series with the reed switch. If the reed switches are connected to non-intrinsically safe devices, a barrier should be used.

Please refer to the connector diagram in Figure 10, Figure 14 and electrical connection schematics in Section 2.3.12.

2.3.11 Specifications of high frequency sensors (HF1 to HF4)

A proximity sensor generates a high frequency signal according to NAMUR EN 60947-5/6 standard (8.2 V, direct current switching between 1.2 and 2.1 mA). These sensors require external power and therefore cannot be used with battery powered devices.

The sensors HF1, HF2, HF3, and HF4 are electrically identical. You will find the connector diagram in Figure 10 and electrical connection schematics in Section 2.3.12.

One high frequency proximity sensor (HF3) is provided standard in the index head at the CT models (but can be removed upon request). This sensor provides a middle range frequency signal (< 200 Hz) based on a rotating impulse disk. The detection is based on standard proximity switches. The signal is intrinsically safe and complies with the NAMUR standard (EN 60947-5/6) for intrinsically safe signals. A second high frequency sensor (HF4) can be installed optionally in the index head. The HF4 sensor generates pulses with equal frequency as the HF3 sensor.

In addition, your IGTM-CT may be equipped with one or two high frequency sensors located in the body of the turbine meter (HF1, HF2). The HF1 sensor directly generates a pulse for each passing blade of the turbine wheel, the HF2 sensor (Available for CT models DN100 or larger) works with a reference wheel. These high frequency sensors are mainly used for high accuracy applications.

The following checks can be done with the HF pulses.

- For a check on signal integrity both HF1/HF2 combined, or HF3/HF4 combined, can be connected to your flow computer. The number of HF3 and HF4 pulses must be identical. In the standard application the HF2 generates the same number of pulses as the HF1.
- For checking if no turbine wheel blade is missing, the combination of HF1 and HF2 must be used. The number of pulses generated by HF1 and HF2 is the same (in the standard gas meter).
- As an option, your meter can be specially equipped for HF1 and HF2 pulses with a specific phase shift. This allows recognition of the gas flow direction, and thus detection of reverse flow.

The pulse frequency at maximum flow of HF sensors depends on the meter size. Typical values are shown in Table 14. The k-factor [Imp/m^3] for your gas turbine meter is determined during calibration and is shown on a label on the index head and the calibration certificate. This k-factor is specific for each meter and corresponds with specific gears in the index head. The factor determined by the calibration is the one that should be used in your calculations and flow correcting devices.

2.3.12 Electrical connection schematics for pulse transmitters

The pulse transmitters used are indicated on the labels beside the connectors. Please refer to Table 4 with the available pulse transmitters and to the connector diagram in Figure 10. For specific applications it is possible that the connector has a non-standard wiring and pin allocation. In these situations a clearly indication as well at the gas meter and in this manual is provided. Examples of connections are given in Figure 11, Figure 12, and Figure 13.

CAUTION: For use with hazardous gas in potentially hazardous area (EX-ZONE), always hook up the meter to intrinsically-safe circuits. If the meter is installed in the hazardous area (EX-ZONE) only 1 pulse output per plug may be connected at the same time, either the Reed switch or the HF sensor. Exceptions to this rule should be indicated at the meter and at this manual.

The interface/barrier between hazardous and safe area operations must be suitable and can be purchased from **vemm tec**. Please refer to the recommended safety barriers in Table 13 for connecting the HF sensors to non-intrinsically safe equipment.

An analogue signal (4 – 20 mA) can be generated by using an IS frequency-current-(F/I)-converter connected to the sensor. Please refer to Table 13.

2.3.13 Required settings for flow computers and flow converters

The k-factor setting for your flow computer/flow converter is shown on the label beside the appropriate connector. These impulse values are the same as the values shown on the calibration certificate/initial verification sheet. The values given on the label are the results of calibration and these values should be used in any volume converting device connected to the turbine meter.

WARNING: Some devices use the k-factor [Imp/m^3], and other devices use the reciprocal value [m^3/Imp]. Please check carefully which value should be used in your device.

Figure 11: IGTM scheme with location of pulse transmitters

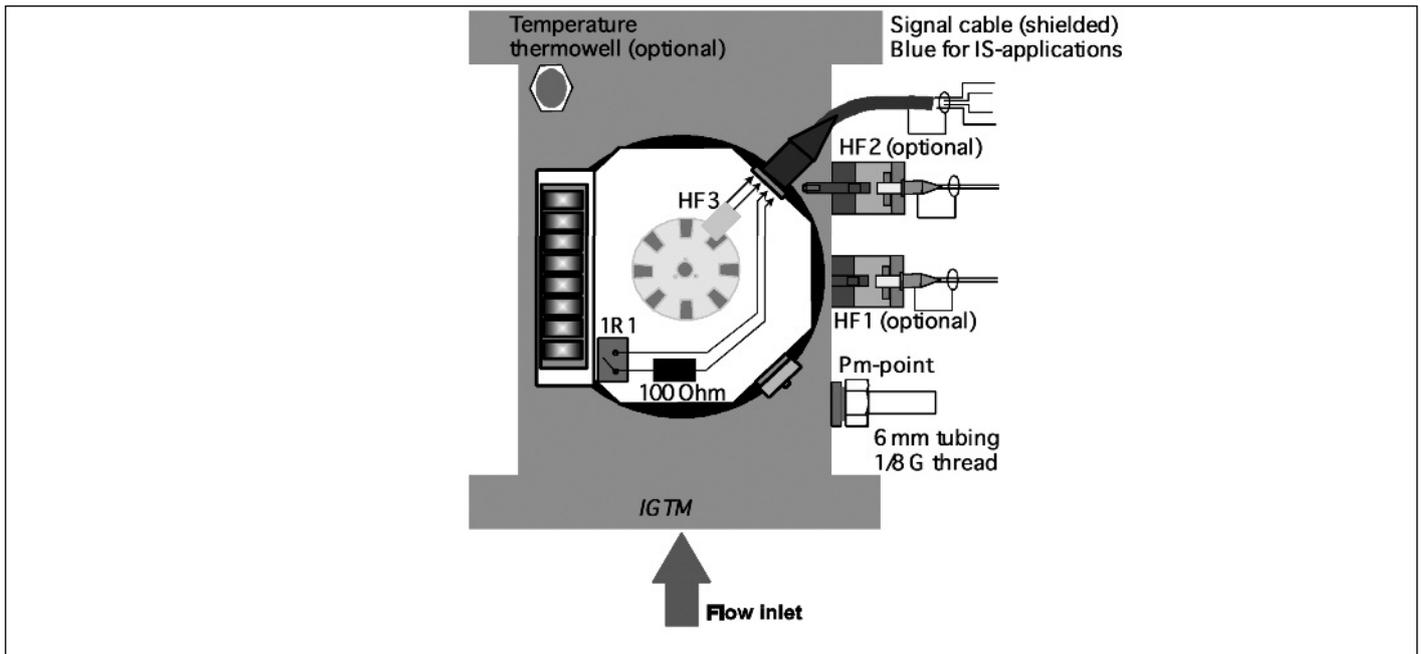


Figure 12: Connection diagram for low frequency reed switch

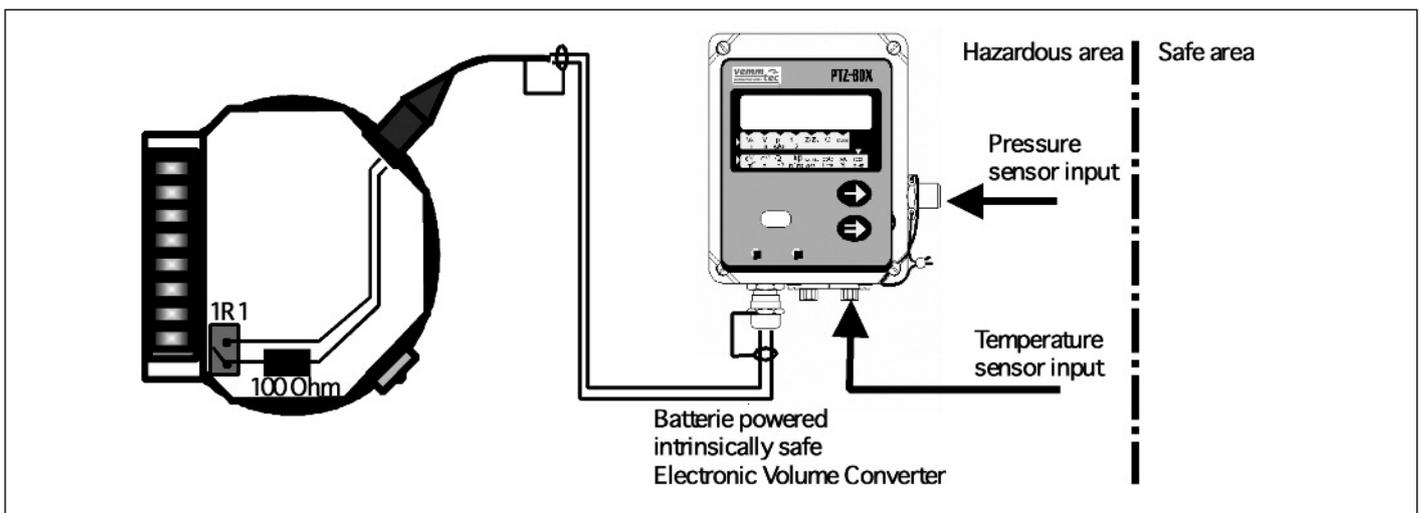
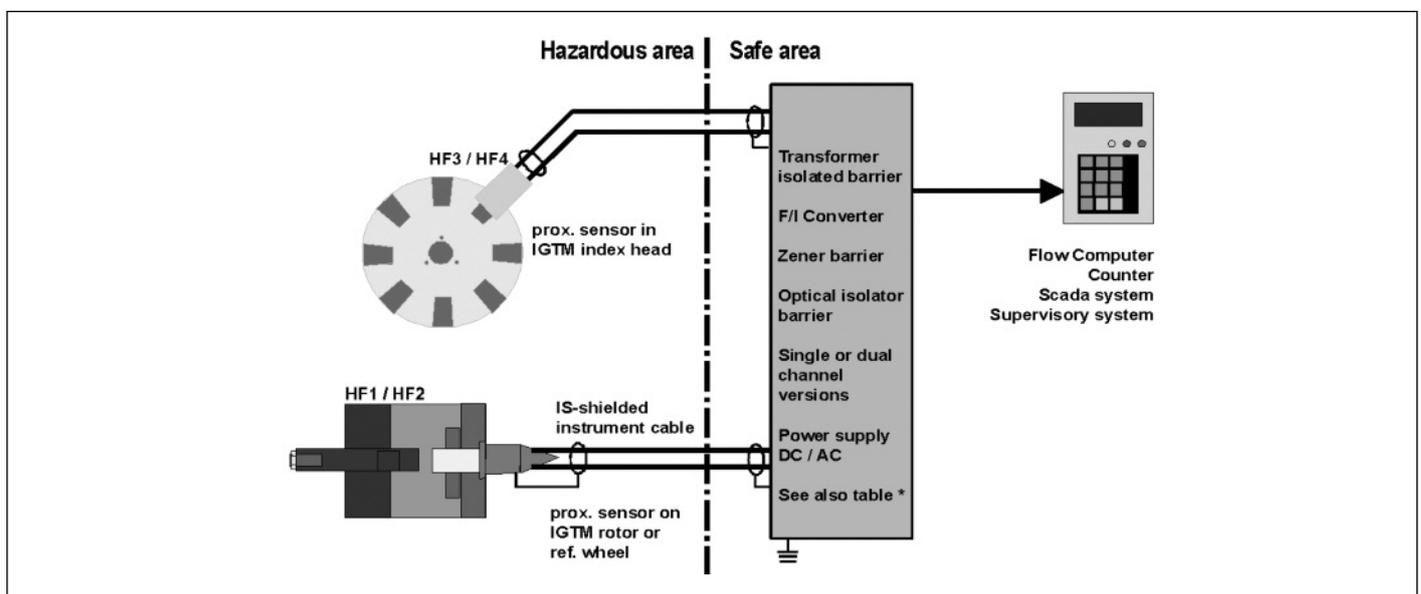


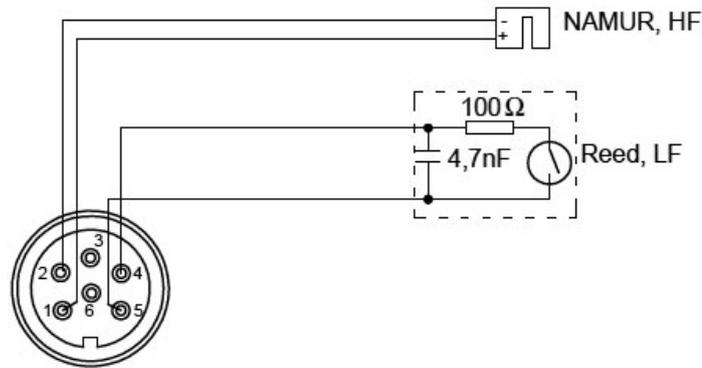
Figure 13: Connection diagram for high frequency sensors



In the event your computer provides curve correction, k-factors should be set for several flow rates. Please refer to the manual of your flow computer for applying these factors.

For reed switches, the pulse length is factory set to switch high between the digit 6 and 9 on the last digit roll of the counter. Your flow convertor should be equipped with a debouncing feature or have a low pass filter so that it is not affected by a slightly bouncing signal. The sensor connection diagram of the IGTM; shown in Figure 14 indicates that the IGTM already have a simple de-bouncing feature in the internal circuit.

Figure 14: Internal sensor connection diagram



3 OPERATION

3.1 Accuracy

IGTM-CT

Standard accuracy limits for all IGTM-CT models are (in accordance with the MID and other EC directives and with many other countries regulations):

$$\begin{aligned} &\pm 1 \% \text{ for } Q_t \leq Q \leq Q_{\max} \\ &\pm 2 \% \text{ for } Q_{\min} \leq Q < Q_t \end{aligned}$$

Were:

Q is the actual flow [m^3/h]

Q_{\max} is the maximum flow of the meter [m^3/h]

Q_{\min} is the minimum flow of the meter [m^3/h]

Q_t is the transition flow where the accuracy changes [m^3/h];

according to EN 12261:

for a flow range 1:20, $Q_t = 20 \% Q_{\max}$

for a flow range 1:30, $Q_t = 15 \% Q_{\max}$

As an option for the CT model the accuracy limits can be improved to:

$$\pm 0.5 \% \text{ for } Q_t \leq Q \leq Q_{\max}$$

$$\pm 1.0 \% \text{ for } Q_{\min} \leq Q < Q_t$$

Depending on the applicable approval, temperature limitation may apply!

Between Q_t and Q_{\max} , the linearity of metering at atmospheric pressure is typically $\leq 0.5 \%$. It can be better if requested. The linearity at test pressures $> 5 \text{ bar abs}$ is typically $\leq 0.5 \%$ for meters $\leq \text{DN } 100 (4\text{'})$, between Q_t and Q_{\max} . It is typically $\leq 0.3 \%$ for meters $> \text{DN } 100 (4\text{'})$. That is according to EN 12261.

The repeatability of the IGTM is $\pm 0.1 \%$ or better. The EN 12261 stability requirements allow a span of 0.2% . The reproducibility of metering is also $\pm 0.1 \%$ or better.

Specific accuracy or linearity specifications can be offered on request.

IGTM-WT

The standard accuracy limits for the IGTM-WT models are:

$$\pm 1.5 \% \text{ for } 0.2Q_{\max} \leq Q \leq Q_{\max}$$

$$\pm 3.0 \% \text{ for } Q_{\min} \leq Q < 0.2Q_{\max}$$

3.2 Operating flow range

The flow range of the IGTM-CT according to the MID approval, is 1:20 or 1:30 (Q_{min} to Q_{max}).

According to the 71/318/EEC (old style EEC) approval the flow range of the IGTM-CT, is 1:20 (Q_{min} to Q_{max}). With small meter size DN 50 (2"); with special designs, or with low relative density gases (relative density < 0.6), the range may be restricted to 1:10 or 1:5. Meters with improved ranges (up to 1:40) are available in certain sizes. These meters are specially prepared. Please refer to Table 15.

The turbine meter still operates properly far below Q_{min} . However, the accuracy at these low flow rates decreases.

3.2.1 Flow range at elevated pressure

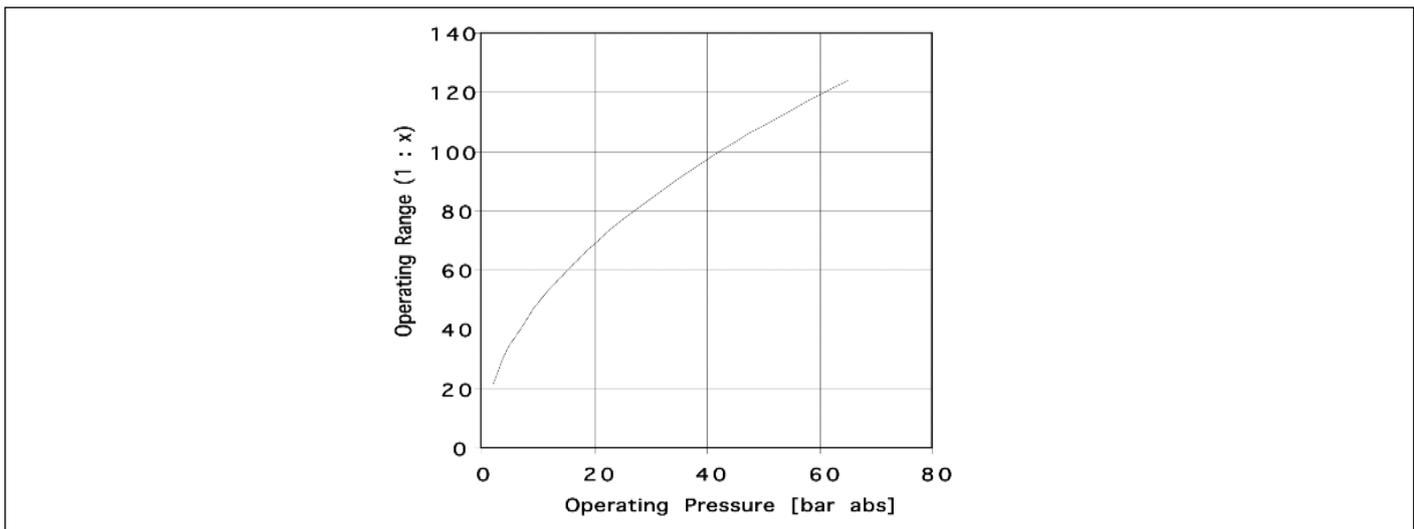
At higher operating pressure, the density of the gas increases. With increasing density, the available driving force increases. The increased momentum reduces the relative influence of the bearing friction. The additional momentum increases the rotor drive, which in turn decreases the minimum flow rate at which the meter will remain within legal error limits at low flow rates. Effectively, the range of the IGTM increases; Q_{max} remains the same, Q_{min} reduces. The new Q_{min} ($Q_{min,m}$) can be approximated with the following formula (See also Figure 15).

Formula 2: Flow range at elevated pressure

$$Q_{min,m} = Q_{min} \sqrt{\frac{\rho_{air,b} \cdot P_b}{\rho_b \cdot P_m}}$$

$Q_{min,m}$	=	Minimum flow rate at actual pressure	(approximated value)	[m ³ /h]
Q_{min}	=	Minimum flow rate as specified	(see Table 14)	[m ³ /h]
$\rho_{air,b}$	=	Density of air at base conditions		[1.293 kg/m ³]
ρ_b	=	Gas density at base conditions		[kg/m ³]
P_b	=	Absolute pressure at base conditions		[1.013 bar abs]
P_m	=	Absolute gas pressure at measurement conditions (actual pressure)		[bar abs]

Figure 15: Turn down ratio at elevated pressure



3.2.2 Overload

The IGTM is designed to compensate for a limited time of operation with a flow rate overload of maximum 20 % above Q_{max} . The overload must occur gradually and without pulsations. In the case that an electronic volume converter is connected it need to be ensured that this volume converter specifications enables the measurement of the 20% higher frequency of the pulse output of the gas meter in overload conditions.

3.3 Temperature range

Different approvals and standards allows different temperature ranges. According to all these approvals all meters are at least suitable for a temperature range of -20 to +55 °C (gas temperature and ambient temperature), which equals -4 °F to +131 °F. For customer specific applications, other temperature ranges may apply. In case you have a specific demand for the temperature range, please indicate required approvals, region of installation and requested sensors. Under MID approval the temperature may not exceed -20 to +55 °C.

3.4 Maximum pressure

Flange rating and maximum operating pressure of your meter are indicated on the main label at the meter and in the calibration certificate. IGTM gas turbine meters are available for the following maximum pressures as specified per CE-PED regulations.

Table 5: Flange rating and maximum operating pressure

Flange rating	Maximum operating pressure [bar (g)]
ANSI 150#	20
ANSI 300#	52
ANSI 600#	104 (100 for certain approvals)
PN 10	10
PN 16	16
PN 25	25
PN 40	40
PN 64	64
PN 100	100

According to CE-MID (applicable for the IGTM-CT sold under MID approve) regulations the pressure range allowed for the measurement depend on the calibration pressure and is indicated at the meter.

3.5 Pressure loss under operating conditions

The pressure loss at actual pressure and actual flow can roughly be calculated using the values from Table 16 and the following formula. This formula assumes a purely quadratic behaviour which is not exactly the case due to fluid dynamic effects.

Formula 3: Pressure loss under operating conditions

$$\Delta p \approx \Delta p_r \cdot \frac{\rho}{\rho_r} \cdot \left(\frac{Q}{Q_{max}} \right)^2$$

ΔP	= Pressure loss at measurement conditions	(with the measured gas)	[mbar]
ΔP_r	= Pressure loss at reference conditions	(see Table 16 at 100 % flow)	[mbar]
ρ	= Density at measurement conditions (actual density of the measured gas)		[kg/m ³]
ρ_r	= Density at reference conditions	(with natural gas)	[0.8 kg/m ³]
Q	= Actual flow rate of the measured gas		[m ³ /h]
Q_{max}	= Maximum flow rate of the gas meter	(see Table 16)	[m ³ /h]

3.6 Material of construction

The standard materials of construction are listed in Table 6. Some gas types require special materials, please check the material compatibility or enquire at **vemmtec**.

Table 6: Standard material specification

Part description	Material description
Housing	IGTM CT Ductile iron (EN-GJS-400-18-LT) Max: DN 200 and PN16/ANSI150 or carbon steel (cast or welded) or stainless steel (on request) IGTM-WT Aluminium, Eloxated (EN AW 5083)
Straightening vane	Aluminium
Turbine wheel	Aluminium
Metering insert	Aluminium
Bearing block	Aluminium
Bearings	Stainless steel
Shafts	Stainless steel
Gears	Stainless steel or synthetic material
Magnetic coupling	Stainless steel
Index head	Aluminium
Counter	Synthetic material
Counter plate	Aluminium

3.7 Gas composition and flow conditions

The standard IGTM can be used for all non-aggressive gases, like natural gas, methane, propane, butane, city and fabricated gas, air, nitrogen, etc. (Please refer to Table 11).

Special designs are available for aggressive gases like sour gas, biogas, and oxygen. Never use a standard meter for these applications without a **vemm tec** confirmation.

The IGTM reaches its full potential when the turbine rotor is subjected to uniform and undisturbed gas velocity within the meter housing. The integrated flow conditioner of the IGTM-CT is designed to comply with EN 12261, ISO 9951, and OIML perturbation test conditions. It also creates stable flow conditions for the turbine rotor. In practice, the performance of the IGTM will also slightly depend on the installation. The IGTM is substantially less sensitive for effect from flow disturbances than other devices. In poorly designed gas-metering installations, some conditions can lead to increased error of the meter.

Pulsating gas flow and intermittent flows should be avoided. Pulsating or intermittent flow leads to under or over registration due to rotor inertia. Large and fast pressure fluctuations should also be avoided. When filling a piping section, always let the pressure and flow increase slowly to avoid overloading. Open valves very carefully and slowly. Preferably install bypass lines over ball valves to fill the line before opening the valve.

Heavy vibrations must be avoided: Mechanical factors: Class M1.

Heavy electromagnetic fields need to be avoided: Electromagnetic factors: Class E2

The gas flow must be free from contaminants, water, condensate, dust and particles. These can damage the delicate bearings and the rotor. When dust collects over time, it has an adverse effect on the metering accuracy. Dirty gases should be filtered with a 5 micron particle filter.

Lubricate your IGTM before start up and at regular intervals during operation (see Sections 2.3.1 and 4.1).

Turbine meters are occasionally over-dimensioned or oversized. This may be due to higher future flow rates or seasonal fluctuations. When a gas turbine meter operates below its stated minimum flow rate, this typically results in a negative error. Under high pressure conditions this effect is partially compensated (Section 3.2.1).

4 MAINTENANCE

4.1 Regular lubrication

On request, IGTM-CT up to DN 100 (4") can be provided with permanently lubricated bearings. IGTM-WT up to DN100 (4") are always equipped with permanent lubricated bearings.

Each **standard** IGTM-CT is equipped with an oil pump. For details about the lubrication system, please refer to Section 2.3.1. The meters that are provided with a lubrication pump must be regularly lubricated with the oil quantities detailed in Table 7. For lubrication, the cap on the oil reservoir should be unscrewed and the reservoir can be carefully filled with oil. The reservoir may need refilling during the lubrication session. Always close the cap of the reservoir to avoid contaminating the oil with dirt and moisture.

In standard applications (clean and dry gas, nominal meter usage), the lubrication interval is every 3 months. When the gas is dirty or when the meter is operated at design extremes more frequent lubrication is recommended.

Gas turbine meters should not be lubricated shortly before calibration.

Table 7: Periodical lubrication quantities

Meter size	Initial lubrication IGTM-CT (before first use)	Initial lubrication IGTM-WT (before first use)
DN 50 (2")	7 Strokes = 1 cm ³	N/A
DN 80 (3")	7 Strokes = 1 cm ³	N/A
DN 100 (4")	10 Strokes = 1.4 cm ³	N/A
DN 150 (6")	6 Strokes = 3 cm ³	22 Strokes = 3.1 cm ³
DN 200 (8")	6 Strokes = 3 cm ³	22 Strokes = 3.1 cm ³
DN 250 (10")	6 Strokes = 3 cm ³	-
DN 300 (12")	6 Strokes = 3 cm ³ ¹⁾	-
DN 400 (16")	6 Strokes = 3 cm ³ ¹⁾	-

¹⁾ Applicable for the round shaped pump fitted from April 2014. For the older square shaped pump 3 strokes provide the required 3 cm³

WARNING: Over-lubrication (interval frequency and quantity) may cause dirt accumulation in the downstream path of the oil. Excessive lubrication may cause metering inaccuracy at very low flow rates.

4.2 Spare parts

No commissioning spare parts are required. Under normal operating conditions, no operational spare parts are required. Under extreme operating/environmental conditions or where meters are situated in less accessible areas, spare part storage as mentioned in Table 12 can be considered. For special circumstances, dedicated spare parts lists may be applicable.

The following 2 years operation spare parts might come into consideration (part.-nos. depending on diameter and G-rate):

- Lubrication oil 50 ml
- Set of O-rings
- Connector for pulse sensors (male)
- Electronic revision set for index head

A repair of defective meters is preferably performed by the manufacturer; a new calibration is needed afterwards. Spare parts and labour hours will be quoted after inspection.

For custody transfer purposes and for best performance after repair, gas turbine meters should be calibrated at an approved calibration facility. See Section 4.4 in this manual.

4.3 Spin test

For a fast, limited test of the meter condition, a spin test can be performed.

Please allow the meter to reach ambient temperature, and ensure a relatively draft-free environment to conduct the test. Do not lubricate the meter before performing a spin test.

With the meter out of the line, the meter rotor can be blown to rotate at close to maximum speed by applying compressed air (with an air gun) from the inlet side of the meter. The air will rotate the rotor. Exposure time minimum is 10 – 15 seconds.

At a time $t = 0$ the flow of air should be stopped. At the same time, a stopwatch is activated. The rotor should be left to spin freely until it comes to a complete stop: no more forward rotation. The time in seconds required for the rotor to come to a complete standstill is called the spin-down time.

A significant decrease of spin-down time indicates either a bearing problem or a significant build-up of dirt or sludge in the bearings. The spin-down time gives a rough indication of the meter bearing condition. If the time has dropped more than 50 % from the indicated values in Table 8, a bearing replacement is required. The spin test gives an indication of the meter performance and accuracy at the low flow rates. A reduced spin down does not necessarily indicate a loss of accuracy at middle or high flow rates; it indicates a loss of range and accuracy at low flow rates.

Table 8: Nominal spin-down times (with mechanical index head and standard bearings)

Meter Size	Nominal spin-down time
DN 50 (2")	50 seconds
DN 80 (3")	120 seconds
DN 100 (4")	240 seconds
DN 150 (6")	> 360 seconds
DN 200 (8")	> 360 seconds
DN 250 (10")	> 360 seconds
DN 300 (12")	> 360 seconds
DN 400 (16")	> 360 seconds

4.4 Recalibration

Legal requirements for recalibration are different in each country. If no recalibration requirements apply, **vemm tec** suggests a recalibration period of 6 – 12 years. This period should be more frequent when operating in harsh conditions, such as dirty gas or pulsating flow. **vemm tec** can perform legal verifications or factory calibrations with ambient air. When the meter is checked or reconditioned, a new calibration should also be performed. Do not lubricate a meter just before calibration!

In addition, you can recalibrate the meter with high pressure gas.

Please refer to Section 1.8.4.

NOTE: If at any time the meter is recalibrated and the correction gears in the index head are changed, the k-factor for the HF sensors must also be adjusted.

Example

For custody transfer, a standard IGTM with an oil pump may be used in Germany for a 12-year period without recalibration. A permanently lubricated IGTM without oil pump may be used in Germany for 8 years without recalibration. Other countries have different regulations.

5 WARRANTY

IGTM Gas Turbine Meters supplied by **vemm tec** are guaranteed against defects due to faulty material or workmanship for 12 months from the date of placement into operation, but not more than 18 months from the date of dispatch for Goods, according to the "General Terms and Conditions" of **vemm tec** Messtechnik GmbH, unless otherwise agreed in writing.

Replacement parts provided under the terms of this declaration are warranted for the remainder of the warranty period applicable to the Goods, as if these parts were original components of the Goods.

This warranty does not extend

- (i) to damages caused by unsuitable or improper use, faulty installation, or operation by the Customer or third parties, natural wear and tear, faulty or negligent treatment or maintenance, the use of unsuitable operating or substitute materials, deficient assembly and damages caused by chemical, electronic or electric influence;
- (ii) to equipment, materials, parts and accessories manufactured by others;
- (iii) to correctness of any externally performed calibrations, either at ambient conditions or at elevated pressure.

Improper use also includes breaking the seals of the meter and non-compliance to the "Installation, Operation and Maintenance Manual".

vemm tec accepts no liability for Goods being fit for the purpose required by the Customer unless it shall have been given full and accurate particulars of the Customer's requirements and of the conditions under which the Goods are required to be used.

Upon written notification received by **vemm tec** within the above-stated warranty period of any failure to conform to the above warranty, upon return prepaid to the address specified by **vemm tec** of any non-conforming original part or component, and upon inspection by **vemm tec** to verify said non-conformity, **vemm tec** at its sole option either shall repair or replace said original part or component without charge to the Customer, or shall refund the Customer the price thereof. Externally performed calibrations are not covered by warranty. However, if **vemm tec**'s inspection fails to verify the claimed non-conformity the Customer will be liable for any costs incurred by **vemm tec** in investigating the claimed non-conformity. The remedies set forth herein are exclusive without regard to whether any defect was discoverable or latent at the time of delivery of the Goods to the Customer.

Goods, once delivered, may be returned to **vemm tec** only with prior written authority from **vemm tec** unless those Goods are accepted by **vemm tec** as being defective as to the material or workmanship. In the event of a return authorized by **vemm tec**, **vemm tec** shall have the right to charge carriage to and from the delivery location and the costs involved in the removal of the Goods from the Customer's premises.

All further claims of the Customer against **vemm tec** as well as our subcontractors are – in accordance with the law – excluded, including compensation for consequential damages and damages based on repairs and replacements, except in the case of conscious negligence or compulsory liability for the lack of guaranteed qualities.

Claims for warranty and service need to be addressed to the **vemm tec** office or to the **vemm tec** agent where the meters originally are ordered.

6 APPENDIX WITH TABLES AND FIGURES

Table 9: Technical standards, rules and guidelines

International and German standards	
EN 12261 ISO 9951 AGA 7 EN 50014 to 50020 DIN 30690-1	Gas meters – Turbine gas meters Measurement of gas flow in closed conduits – Turbine meters Measurement of gas by turbine meters Electrical apparatus for potentially explosive atmospheres Construction elements in the gas supply system – part 1: Requirements for construction elements in gas supply systems
EC (European Community) guidelines	
2004/22/EC 31.03.2004 94/9/EC 23.03.1994 97/23/EC 29.05.1997	Measuring Instruments Directive (MID) Equipment and protective systems intended for use in potentially explosive atmospheres (ATEX) Pressure Equipment Directive (PED)
PTB (Germany) guidelines	
PTB-A 7.1 PTB-Prüfregeln Band 29 PTB-Prüfregeln Band 30 TR G 13	Volume gas meters Gas meters: Testing of volume gas meters with air at atmospheric pressure Measurement devices for gas: High pressure test of gas meters Installation and operation of gas turbine meters
DVGW (Germany) regulations	
G 260/I G 260/II G 261 G 285 G 469 G 486 G 486-B2 (2005-12) G 491 G 492/II G 493 G 495 (2006-07)	Gas quality Supplementary rules for gases of the second gas family Measuring gas quality Hydrate inhibition in natural gas with methanol Pressure testing for piping and systems in gas supply Gas law deviation factors and natural gas compressibility factors – calculation and application Extended requirements for the calculation and application of real gas factors and compressibility factors of natural gasses. Gas pressure regulating stations with inlet pressures exceeding 4 bar up to 100 bar – design, construction, montage, testing and start up Systems for large quantities gas measurement with an operating pressure above 4 bar up to 100 bar Procedure for granting DVGW certification for manufacturers of pressure control and gas measurement equipment Gas plants and systems - Maintenance
OIML	
R 6 R 32 R 137-1	General provisions for gas volume meters (replaced by R137) Rotary piston gas meters and turbine gas meters (replaced by R137) Gas meters – part 1: Requirements (replaces the R6, R31 and R32)

Many national standards and laws are based on the above.

Table 10: List of approvals

Figure 16: vemm tec ISO 9001 Certificate

<p>ISO 9001 and 14001</p> <p>vemm tec Messtechnik GmbH is certified according to ISO 9001:2008, (see Figure 16) and ISO 14001:2004.</p>	
<p>Metrological approvals</p> <p>IGTM Gas Turbine Meters are legally approved for custody transfer within the European Economic Community according to Directive 2004/22/EC of the European Parliament and of the Council, dated 31 March 2004 with examination certificate DE-11-MI002-PTB005, issued by Physikalisch-Technische Bundesanstalt (PTB) [Germany]. Refer to Table 15 for approved sizes and ranges.</p> <p>The original European approval issued by PTB is still valid: PTB 1.33-3271.51-DMB-E16 with sign E-D97 7.211.16 (see Figure 17)</p> <p>In addition, approvals in several countries have been granted and are in process as a continuing effort. Approvals are currently available for the following countries: Algeria (ONML), Brazil (INMETRO) China (NIM), Czech Republic (CMI) Germany (PTB), Hungary (NOM) Italy (MSE), Malaysia (SIRIM) Romania (BRML), South Korea (MPI) Others are in progress.</p>	
<p>Design and compliance certification</p> <p>CE EC-Conformity declaration, Notified Body TÜV 0035 (see Figure 19) PED 97/23/EC Certificate of Notified Body TÜV 0035: CE-0085CN0327</p>	<p>Design and compliance certification</p> <p>ATEX (explosive Atmosphere)</p> <p>The Reed switch sensors are considered to be simple apparatus and as such do not require ATEX approval. The pulse generators applied in HF1 to HF4 are approved according to ATEX for the use in hazardous areas subject to explosive gases. In all cases the sensors should be connected to an intrinsically safe circuit after NAMUR (EN 60947-5/6). The following certificates for our sensors have been obtained (choice of sensors depending on model and manufacturing possibilities) HF1/HF2: PTB 01 ATEX 2192 (see Figure 4) HF3/HF4: BVS 08 ATEX E026 (see Figure 4)</p>

Figure 17: EC type-approval certificate original style (German original and English translation)

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

EWG-Bauartzulassung vom 25.04.1997
EEC type-approval certificate, dated 25.04.1997

3. Nachtrag
Supplement 3

Seite 1 von 2 Seiten
Page 1 of 2 pages

Zulassungsinhaber: vemm tec Messtechnik GmbH
Issued to: Gartenstr. 20
14482 Potsdam

Bauart: Turbinenradgaszähler
in respect of: Typ IGTM

Die oben genannte Bauartzulassung wird gemäß §26 der Eichordnung wie folgt geändert:

Hinweise
Nachträge ohne Unterschrift und Siegel haben keine Gültigkeit. Nachträge sind Bestandteil der Bauartzulassung und dürfen nur unverändert weiterverbreitet werden. Auszüge bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.
Note
Supplements without signature and seal are not valid. Supplements are part of the type approval certificate and may not be reproduced other than in full. Extracts may be taken only with the permission of the Physikalisch-Technische Bundesanstalt.

Rechtsbehelfsbehaltung
Gegen diesen Bescheid kann innerhalb eines Monats nach Bekanntgabe schriftlich oder zur Niederschrift Widerspruch bei der Physikalisch-Technischen Bundesanstalt unter einer der nachstehenden Adressen eingeleitet werden.
Information on legal remedies available
Objection may be made to this notification within one month of its receipt either in writing or orally recorded, to the Physikalisch-Technische Bundesanstalt at one of the following addresses:

Physikalisch-Technische Bundesanstalt
Bundesallee 100
38116 Braunschweig
GERMANY

Alteestraße 2-12
10587 Berlin
GERMANY

RL0003

English Translation

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin

EEC type-approval certificate, dated 25.04.1997

Supplement 3

Page 1 of 2 pages

Issued to: vemm tec Messtechnik GmbH
Gartenstr. 20
14482 Potsdam

In respect of: Gas Turbine Meters
Model IGTM

According to § 26 of the "Eichordnung" the above mentioned Type Approval is changed as follows.

Note:
Supplements without signature and seal are not valid. Supplements are part of the type approval certificate and may not be reproduced other than in full. Extracts may be taken only with the permission of the Physikalisch-Technische Bundesanstalt.

Information on legal remedies available
Objection may be made to this notification within one month of its receipt either in writing or orally recorded, to the Physikalisch-Technische Bundesanstalt at one of the following addresses:

Physikalisch-Technische Bundesanstalt
Bundesallee 100
38116 Braunschweig
GERMANY

Alteestraße 2-12
10587 Berlin
GERMANY

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

EWG-Bauartzulassung vom 25.04.1997
EEC type-approval certificate, dated 25.04.1997

3. Nachtrag
Supplement 3

Seite 2 von 2 Seiten
Page 2 of 2 pages

8 Eichtechnische Prüfung

8.1 Prüfung

Dieser Abschnitt erhält folgende neue Fassung:

Als Prüfvorschrift gelten die PTB-Prüfregeln Band 4 „Volumengaszähler“ in der 2. neubearbeiteten Auflage 1982. Alternativ können auch – in Abhängigkeit vom vorgesehenen Betriebsdruck des zur Eichung gestellten Turbinenradgaszählers – entweder Band 29 „Messgeräte für Gas – Gaszähler, Prüfung von Volumengaszählern mit Luft bei Atmosphärendruck“ oder Band 30 „Messgeräte für Gas – Hochdruckprüfung von Gaszählern“ verwendet werden.

10 Gültigkeitsdauer der Zulassung

Dieser Abschnitt erhält folgende neue Fassung:

Diese Zulassung hat Gültigkeit bis zum 18. 5. 2016

Der Zulassungsschein mit der Anlage vom 25. 4. 1997, Geschäftszeichen PTB-1.33-3271.51-DMB-E16, sowie die Nachträge Nr. 1 vom 02.10.2001, Geschäftszeichen PTB-1.33-01064992 Nr. 2 vom 14.11.2002, Geschäftszeichen PTB-1.33-02001578 bleiben bis auf die durch diesen Nachtrag geregelten Änderungen unverändert gültig.

Im Auftrag
By order
Dr. Roland Schmidt

Braunschweig, 19.05.2006
Geschäftszeichen: PTB-1.42-4024257
Reference No.:

Siegel
Seal

English Translation

Physikalisch-Technische Bundesanstalt
Braunschweig and Berlin

EEC type-approval certificate, dated 25.04.1997

Supplement 3

Page 2 of 2 pages

8. Legal calibrations

8.1 Initial verification

This section is changed as follows:

For the initial verification the following test prescription applies: PTB Testing Instruction Volume 4, "Gas Volume Meters" in the 2nd revised issue 1982. Alternatively, one of the following PTB Testing Instruction can be used – depending on the planned actual pressure of the gas turbine meter under test: either Volume 29 "Gas measurement devices – gas meters, calibration of volume gas meters with air at ambient pressure" or Volume 30 "Gas measurement devices – high pressure calibration of gas meters".

10 Validity of the Type Approval

This section is changed as follows:

This type approval is valid until 18 May 2016.

The type approval certificate with attachment dated 25 April 1997, reference no. PTB-1.33-3271.51-DMB-E16 as well as the supplements No. 1 dated 02 October 2001, reference no. PTB-1.33-01064992 No. 2 dated 14 November 2002, reference no. PTB-1.33-02001578 remain valid except for the changes which are mentioned in this supplement.

By order
[Signature] Braunschweig, 19 May 2006
[PTB Stamp] Reference No.: PTB 1.42.4024257
Dr. Roland Schmidt: Seal

Figure 18: EC MID approval for IGTM-CT

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

PTB

EG-Baumusterprüfbescheinigung
EC type-examination certificate

Ausgestellt für: vemm tec Messtechnik GmbH
Issued to: Gartenstr. 20, 14482 Potsdam

Rechtsbezug: Richtlinie 2004/22/EG des Europäischen Parlaments und des Rates vom 31. März 2004 über Messgeräte (ABl. L 135 S. 1), umgesetzt durch die Vierte Verordnung zur Änderung der Eichordnung vom 8. Februar 2007 (BGBl. I S. 70).
In accordance with: Directive 2004/22/EC of the European Parliament and of the Council of 31 March 2004 on measuring instruments (OJ L 135 p. 1), implemented by the Fourth Ordinance for amending the Verification Ordinance dated 8 February 2007 (Federal Law Gazette I, p. 70).

Gerätetyp: Gaszähler
Type of instrument: Gas Meter
Typbezeichnung: IGTM
Type designation: IGTM
Nr. der Bescheinigung: DE-11-MI002-PTB005
Certificate number: DE-11-MI002-PTB005
Gültig bis: 09.10.2021
Valid until: 09.10.2021
Anzahl der Seiten: 17
Number of pages: 17
Geschäftszeichen: PTB-1.42-4047513
Reference No.: PTB-1.42-4047513
Benannte Stelle: 0102
Notified Body: 0102
Ort, Ausstellungsdatum: Braunschweig, 10.10.2011
Date of issue: Braunschweig, 10.10.2011

Zertifizierer: Dr. Rainor Kramer
Certifier: Dr. Rainor Kramer
Im Auftrag: By order

Bewerter: Dr. Roland Schmidt
Evaluator: Dr. Roland Schmidt
Im Auftrag: By order

RS-00202515

Hinweise: EG-Baumusterprüfbescheinigungen ohne Unterschrift und Siegel haben keine Gültigkeit. Diese EG-Baumusterprüfbescheinigung darf nur unverändert weitervertrieben werden. Auszüge bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.
EC type-examination certificates without signature and seal are not valid. This EC type-examination certificate may not be reproduced other than in full. Extracts may be taken only with the permission of the Physikalisch-Technische Bundesanstalt.

Physikalisch-Technische Bundesanstalt - Bundesallee 100 - D-38116 Braunschweig - Abteistraße 2-12 - D-10587 Berlin

Figure 19: EC-Conformity declaration (example)

CE Declaration of Conformity Konformitätserklärung **vemm tec**
Messtechnik GmbH

VEMM TEC - Messtechnik GmbH
Incar: IPC-Unterpreise, Sachverwalter 20 • D-14482 Potsdam/Damrow

Object of declaration: IGTM - CT
Gegenstand der Erklärung: SNr.: DN 80, G 250, PN 16

The object of the declaration described above is in conformity with the requirements of the following documents:
Das oben beschriebene Produkt ist konform mit den Anforderungen der folgenden Dokumente:

Document No. / Dokument-Nr.	2004/22/EC / 2004/22/EG	97/23/EC / 97/23/EG
Title / Titel	Measurement Equipment Directive / Messgeräterichtlinie	Pressure Equipment Directive / Druckgeräterichtlinie
Edition / Ausgabeedition	03/2004 / 03/2004	05/1997 / 05/1997
Module / Modul	Module B / Modul B	Module F / Modul F
Certificate No. / Zertifikat-Nr.	DE-11-MI002-PTB005 / DE-11-MI002-PTB005	VT_Ref. MI-002/02/13 / VT_Ref. MI-002/02/13
Standards / Standards	DIN EN ISO 12261:2008 / AD2000	
Notified Body / Benannte Stelle	PTB Braunschweig Bundesallee 100 38116 Braunschweig Germany	PTB Berlin Brandenburg Stahnsdorfer Str. 81 14532 Kleinmachnow Germany
No. / Nr.	0102 / 0102	0085 / 0085
Marking / Kennzeichnung	CE M13 0108 / 0035	

VEMM TEC Messtechnik GmbH
Gartenstraße 20
Potsdam, 31.01.2014
Date: 31.01.2014
Stamp: 31.01.2014
Signature: [Signature]

Telefon: +49(0)31 776 85-0
Telefax: +49(0)31 776 85-201 und 76 95-270
E-Mail: info@vemmtec.com
Internet: www.vemmtec.com

Bankverbindung: Landesbank Berlin (LBB AG)
Kto.-Nr.: 8 607 023 035
BLZ: 100 500 00
IBAN: 1054 1056 0000 6607 0293 35
BIC: BELA2633XXX

Bankverbindung: Deutsche Hypo- und Vereinsbank AG
Kto.-Nr.: 355 173 233
BLZ: 100 200 86
IBAN: 1053 1002 0080 3551 7023 33
BIC: DE33 1002 0080 3551 7023 33

Geschäftsführer: Kurt van Dellen
Registrierungsamt: Kantongericht Potsdam
Handelsregister: HRB 3559
Umsatzsteuer-Identifikationsnummer: DE 134402535

Table 11: Gas types

Gas type	Symbol	Density at base conditions (1.013 bar a) [kg/m ³]	Suitable at IGTM		Meter housing	Notes
			CT	WT		
Acetylene	C ₂ H ₂	1.17	X		Special	Aluminium parts Teflon coated
Air		1.29	X	X	Standard	
Ammonia	NH ₃	0.77	X		Standard	O-rings / lubrication
Argon	Ar	1.78	X	X	Standard	
Biogas			X		Special	Special internal
Butane	C ₄ H ₁₀	2.70	X	X	Standard	
Carbon dioxide	CO ₂	1.98	X	X	Standard	Except foodstuff industry
Carbon monoxide	CO	1.25	X		Standard	
City gas		0.90	X		Standard	
Ethane	C ₂ H ₆	1.36	X	X	Standard	
Ethylene (gas phase)	C ₂ H ₄	1.26	X		Standard	Special internal
Flue gases			X		Special	O-rings / lubrication
Freon (gas phase)	CCl ₂ F ₂	5.66	X		Standard	O-rings / lubrication
Helium	He	0.18	X	X	Standard	Special internal
Hydrogen	H ₂	0.09	X		Special	Special flow range
Hydrogen sulphide (0.2 %)	H ₂ S	1.54	X		Special	Special internal
Methane	CH ₄	0.72	X	X	Standard	
Natural Gas		0.83	X	X	Standard	
Nitrogen	N ₂	1.25	X	X	Standard	
Oxygen (pure)	O ₂	1.43	X		Standard	Special internal
Pentane	C ₅ H ₁₂	3.46	X	X	Standard	
Propane	C ₃ H ₈	2.02	X	X	Standard	
Propylene (gas phase)	C ₃ H ₆	1.92	X		Standard	Special internal
Sour gas			X		Special	O-rings / lubrication
Sulphur dioxide (0.2 %)	SO ₂	2.93	X		Special	Special internal

 For all specials, please enquire at **vemm tec**.

Figure 20: Main parts of the IGTM

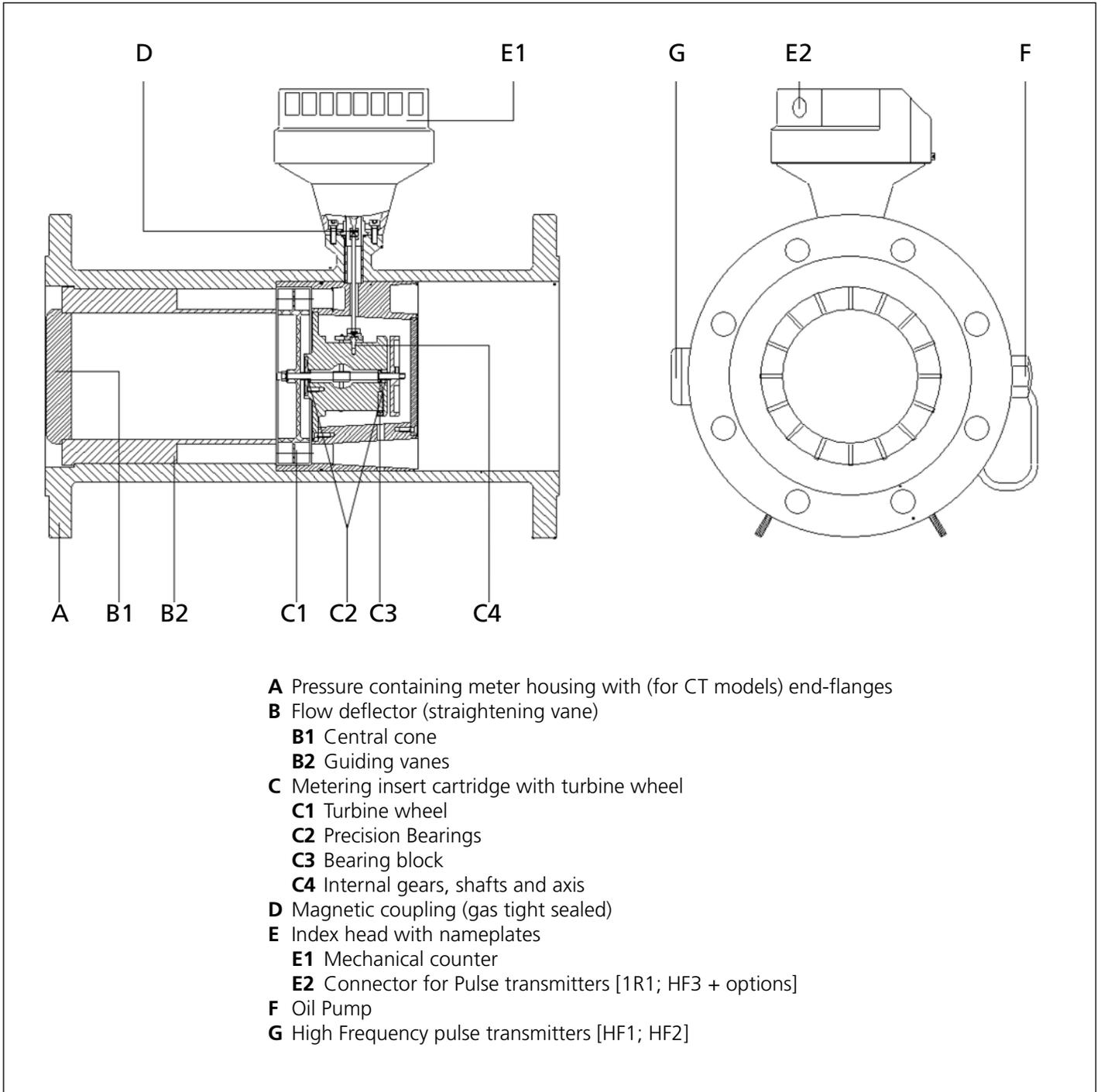


Figure 21: Gear drawing

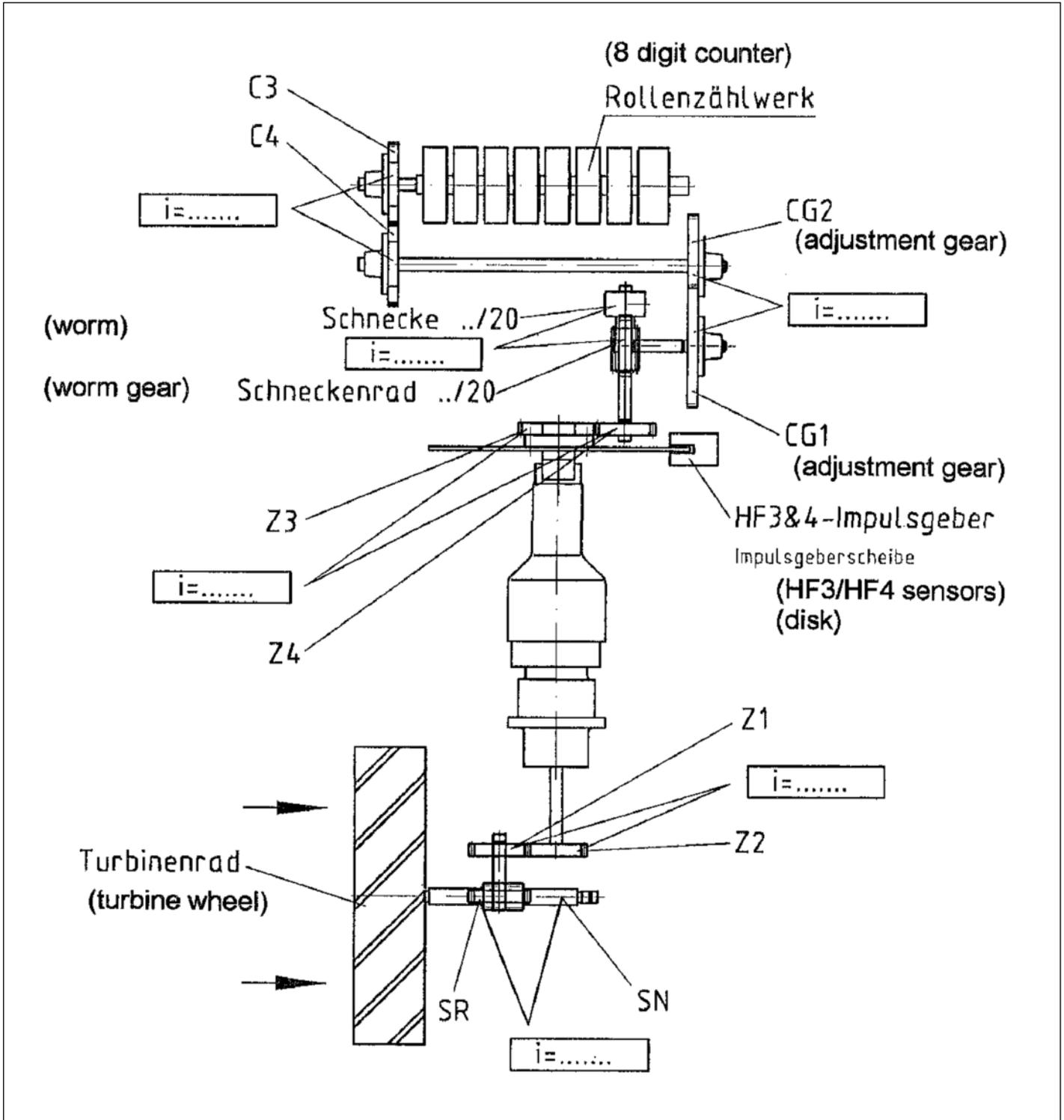


Table 12: Spare parts listing

Description	Part-number							
	DN 50 (2")	DN 80 (3")	DN 100 (4")	DN 150 (6")	DN 200 (8")	DN 250 (10")	DN 300 (12")	DN 400 (16")
Index head internals	Please enquire (Fitted for the requested meter: Please mention the serial number of your meter.)							
Index head complete (excluding magnetic coupling)	Please enquire (Completely mounted with counter for a particular size, G-rate and serial number.)							
Electronic revision set for index head (1R1, HF3)	76850.0280 (green HF sensor) or 76850.0280a (orange HF sensor) (Consisting of PCB for Reed switch 1R1 as well as proximity switch including mounting set for HF3.)							
Electronic revision set for index head (1R1, 1R10, HF3, HF4)	76850.0281 (green HF sensors) or 76850.0281a (orange HF sensors) (Consisting of PCB for 2 Reed switches (1R1/2R1/1R10/2R10) as well as proximity switch including mounting set for HF3 and HF4.)							
HF1 assembly HF2 assembly	Please enquire (Please indicate meter serial number.)							
Connector for pulse sensors (male)	76850.0276 (PG7 for 4-6 mm cable diameter) or 76850.0286 (PG9 for 6-8 mm cable diameter) (Suitable for all standard sensor connections)							
Magnetic coupling	76850.0100							
Metering cartridge	(Including aluminium turbine wheel, bearing block, bearings, shafts, completely assembled and tested. Please indicate meter size and G-rate.)							
with turbine wheel 30 deg.	n/a	76842.3000 76842.1730D	76843.3000 76843.1730D	76844.3000	76845.3000	76846.3000	76847.3000	76848.3000
with turbine wheel 45 deg.	76841.1000 76841.1700D ⁴⁾	76842.1000 76842.1700D ⁴⁾	76843.1000 76843.1700D ⁴⁾	76844.1000 76844.1600 ⁵⁾	76845.1000	76846.1000	76847.1000	76848.1000
Spare turbine wheel 30 deg.	n/a	76842.1023	76843.1023	76844.1023	76845.1023	76846.1023	76847.1023	76848.1023
Spare turbine wheel 45 deg.	76841.1003	76842.1003	76843.1003	76844.1003	76845.1003	76846.1003	76847.1003	76848.1003
Flow straightener IGTM-CT	76821.1700	76822.1800	76823.1700 76823.1800 ¹⁾	76824.1700 ²⁾ 76824.1710	76825.1000	76826.1000	76827.1400	76828.2000
Flow straightener IGTM-WT	76821.1700	76822.2500	76823.2500	76824.2500	76825.1600	76826.1500 ³⁾ 76826.1600	76827.1500	76828.1600
Set of O-rings (for internals, index head, sensors, coupling)	76850.0291	76850.0292	76850.0293	76850.0294	76850.0295	76850.0296	76850.0297	76850.0298
Oil pump (piping not included)	76540.0030C			76863.1102C			76863.1104C	
Lubrication oil for oil system Bottle with 50 ml oil Bottle with 100 ml oil Bottle with 500 ml oil Bottle with 1000 ml oil	Standard lubricant SHELL MORLINA 10 (Tellus10) or equivalent 76250.1003 76250.1004 76250.1007 76250.1005				Lubricant for MID approved meters or for low temperature applications: ISOFEX PDP 38 76850.1003 76850.1004 76850.1007 76850.1005			
Non-return valve for oiler piping	76540.0031							

Remarks:

- 1) G400 only
- 2) G1000 only
- 3) G2500 only
- 4) The "D" after the part number refers to metering cartridges with permanent lubricated bearings
- 5) For pressure classes of PN40 / ANSI 300# and higher

For other spare parts, please enquire

Table 13: Intrinsically safe equipment
(Please find more information in the internet at www.pepperl-fuchs.com, and www.turck.com.)

Fuction	Input Channels			Output			Power	Serial Number	
	Number	Reed switch	HF Namur	Number	Transistor	Analogue 0/4-20 mA		Make: Turck	Make: Pepperl + Fuchs
Transformer Isolated Barrier	1	X	X	2	active	-	24 VDC	IM1-12Ex-T	KFD2-ST2-Ex1.LB
Transformer Isolated Barrier	2	X	X	2	active	-	24 VDC	IM1-22Ex-T	KFD2-ST2-Ex2
Transformer Isolated Barrier	1	X	X	2	passive	-	24 VDC	IM1-22Ex-T	KFD2-SOT2-Ex1.LB
Transformer Isolated Barrier	2	X	X	2	passive	-	24 VDC	IM1-22Ex-T	KFD2-SOT2-Ex2
Transformer Isolated Barrier	2	X	X	2	passive	-	115 VAC	IM1-22Ex-T	KFA5-SOT-Ex2
Transformer Isolated Barrier	2	X	X	2	passive	-	230 VAC	IM1-22Ex-T	KFA6-SOT2-EX2
Frequency-Current Converter	1	X	X	1		X	24 VDC	IM21-14Ex-CDTRI	KFD2-UFC-Ex1.D
Frequency-Current Converter	1	X	X	1		X	85-253 VAC	IM21-14Ex-CDTRI	KFU8-UFC-Ex1.D
Frequency divider	1	X	X	1	passive		24 VDC	IM21-14Ex-CDTRI	KFD2-UFC-Ex1.D
Frequency divider	1	X	X	1	passive		85-253 VAC	IM21-14Ex-CDTRI	KFU8-UFC-Ex1.D
Frequency monitor switch	1	X	X	1	passive		24 VDC	IM21-14Ex-CDTRI	KFD2-UFC-Ex1.D
Frequency monitor switch	1	X	X	1	passive		85-253 VAC	IM21-14Ex-CDTRI	KFU8-UFC-Ex1.D

The indicated models are suggested by the applicable manufacturers. In case the devices are not delivered by **vemm tec**, **vemm tec** can not be hold responsible for unproper operation.
Carefully check the maximum frequency the devices can handle!

Figure 22: Seal plan

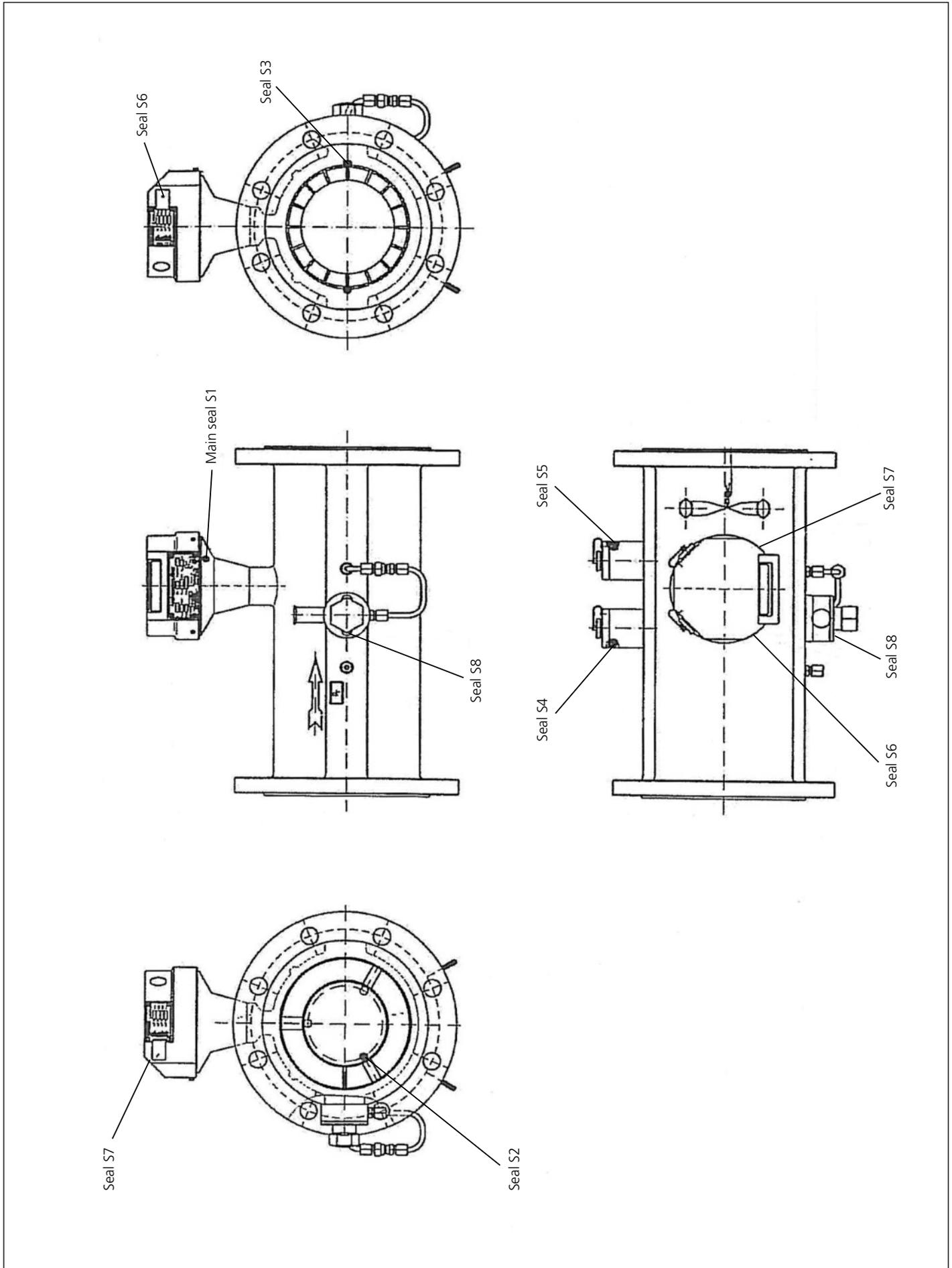


Table 14: Size dependent data and k-factors

Nominal diameter [mm] (inch)	Size rating G	IGTM-CT		IGTM-WT *)		Rotating speed turbine wheel at Q _{max} [min ⁻¹]	Turbine wheel		Maximum frequency				k-factor		
		Q _{max} [m ³ /h]	Q _{min} [m ³ /h] Standard flow range	Q _{max} [m ³ /h]	Q _{min} [m ³ /h]		blade angle	number of blades	HF1/HF2 approx. [Hz]	HF3/HF4 approx. [Hz]	HF1/HF2 approx. [lmp/m ³]	HF3/HF4 approx. [lmp/m ³]	CT only	CT, option WT	CT+WT
DN 50 (2")	G 40 *)	65	13	--	--	8900	45	16	2800	80	0.18	155000	4400	10	10
	G 65 *)	100	10	100	10	13700	45	16	4300	120	0.28	155000	4400	10	10
DN65 (2½")	G100	--	--	160	13		38	16	--	315	0.45	--	7200	10	10
DN 80 (3")	G 100	160	8	--	--	6200	45	16	1900	50	0.04	42200	1200	1	1
	G 160	250	13	250	10	9600	45	16	2900	80	0.07	42200	1200	1	1
	G 250	400	20	400	20	8900	30	16	2600	70	0.11	23500	670	1	1
	G 400	650	32	650	32	8900	30	16	2600	70	0.11	23500	670	1	1
DN 100 (4")	G 160	250	13	--	--	4300	45	16	1200	60	0.07	17000	800	1	1
	G 250	400	20	400	13	6900	45	16	1900	90	0.11	17000	800	1	1
	G 400	650	32	650	32	6500	30	16	1700	80	0.18	9400	440	1	1
	G 650	1000	50	1000	32	5200	45	20	1700	100	0.28	6280	360	1	1
DN 150 (6")	G 400	650	32	--	--	3400	45	20	1100	70	0.18	6280	360	1	1
	G 650	1000	50	1000	32	4800	45	20	1700	100	0.28	6280	360	1	1
	G 1000	1600	80	1600	80	4800	30	20	1600	60	0.04	3570	135	0.1	0.1
	G 650	1000	50	--	--	2200	45	20	790	40	0.03	2840	150	0.1	0.1
DN 200 (8")	G 1000	1600	80	1600	50	3500	45	20	1300	70	0.04	2840	150	0.1	0.1
	G 1600	2500	130	2500	130	3100	30	20	1100	60	0.07	1510	80	0.1	0.1
	G 1000	1600	80	--	--	2000	45	24	830	60	0.04	1870	135	0.1	0.1
	G 1600	2500	130	--	--	3100	45	24	1300	90	0.07	1870	135	0.1	0.1
DN 250 (10")	G 2500	4000	200	--	--	2900	30	24	1200	90	0.11	1110	80	0.1	0.1
	G 1600	2500	130	--	--	1900	45	24	780	60	0.07	1120	80	0.1	0.1
	G 2500	4000	200	--	--	3000	45	24	1300	90	0.11	1120	80	0.1	0.1
	G 4000	6500	320	--	--	2800	30	24	1200	130	0.18	660	75	0.1	0.1
DN 400 (16")	G 2500	4000	200	--	--	1600	45	24	610	60	0.11	550	55	0.1	0.1
	G 4000	6500	320	--	--	2600	45	24	990	100	0.18	550	55	0.1	0.1
	G 6500	10000	500	--	--	2300	30	24	1300	130	0.28	470	50	0.1	0.1
	G 6500	10000	500	--	--	2300	30	24	1300	130	0.28	470	50	0.1	0.1

*) Not approved under MID

The indicated frequency values and k-factors of HF1/HF2 and HF3/HF4 are for information only. The final values will be mentioned at the meter's nameplate and in the calibration certificate.

Table 15: Diameter, flow rate and extended range combinations IGTM-CT

MID approved range → (Only CT models can be MID approved)			Yes	Yes	No
Nominal diameter	Size rating	Q_{\max}	Standard flow range 1 : 20	Improved flow range 1 : 30	Best possible flow range 1: 40
[mm] (Inch)		[m ³ /h]	Q_{\min} [m ³ /h]	Q_{\min} [m ³ /h]	Q_{\min} [m ³ /h]
DN 50 (2")	G 40 ⁵⁾	65	13 ^{1) 5)}	7 ^{2) 5)}	-
	G 65 ⁵⁾	100	10 ^{3) 5)}	7 ^{4) 5)}	-
DN 80 (3")	G 100	160	8	-	-
	G 160	250	13	8	-
	G 250	400	20	13	-
DN 100 (4")	G 160	250	13	-	-
	G 250	400	20	13	10
	G 400	650	32	20	16
DN 150 (6")	G 400	650	32	-	-
	G 650	1000	50	32	25
	G 1000	1600	80	50	40
DN 200 (8")	G 650	1000	50	-	-
	G 1000	1600	80	50	40
	G 1600	2500	130	80	60
DN 250 (10")	G 1000	1600	80	-	-
	G 1600	2500	130	80	60
	G 2500	4000	200	130	100
DN 300 (12")	G 1600	2500	130	-	-
	G 2500	4000	200	130	100
	G 4000	6500	320	200	160
DN 400 (16")	G 2500	4000	200	-	-
	G 4000	6500	320	200	160
	G 6500	10000	500	320	250

Not MID approved ranges:

- 1) Flow range 1 : 5
- 2) Flow range 1 : 9
- 3) Flow range 1 : 10
- 4) Flow range 1 : 14
- 5) Not MID approved

All combinations are available in the standard accuracy:

- ± 1 % for $Q_t \leq Q \leq Q_{\max}$
- ± 2 % for $Q_{\min} \leq Q < Q_t$

The **bold** printed combinations are also available with improved accuracy:

- ± 0.5 % for $Q_t \leq Q \leq Q_{\max}$
- ± 1 % for $Q_{\min} \leq Q < Q_t$

Remark: Not all type approvals allow the technically possible ranges as mentioned above. In these cases the initial verification certificate will state the ranges according to the type approval but the calibration will be performed at the range as mentioned above.

Table 16: Gas velocity and pressure loss

Nominal diameter [mm] [inch]	Size rating	Q _{max} [m ³ /h]	Q _{min} (standard flow range) [m ³ /h]	Gas velocity at Q _{max} (in standard piping Schedule 40) [m/s]	Pressure loss with natural gas of 1.0 bar abs at specified flow rate [mbar]		
					50 % Q _{max}	80 % Q _{max}	100 % Q _{max}
DN 50 (2")	G 40	65	13	8,3	1,4	3,5	5,5
	G 65	100	10	12,8	2,9	7,5	11,7
DN 80 (3")	G 100	160	8	8,3	0,9	2,4	3,7
	G 160	250	13	13,0	2,2	5,5	8,6
	G 250	400	20	20,7	3,4	8,8	13,8
DN 100 (4")	G 160	250	13	8,4	0,8	2,0	3,1
	G 250	400	20	13,5	1,7	4,3	6,8
	G 400	650	32	22,0	2,7	6,9	10,8
DN 150 (6")	G 400	650	32	9,7	0,8	2,0	3,1
	G 650	1000	50	14,9	1,8	4,5	7,1
	G 1000	1600	80	23,8	2,8	7,2	11,3
DN 200 (8")	G 650	1000	50	8,6	0,6	1,6	2,5
	G 1000	1600	80	13,8	1,1	2,8	4,3
	G 1600	2500	130	21,5	2,5	6,5	10,2
DN 250 (10")	G 1000	1600	80	8,7	0,6	1,6	2,5
	G 1600	2500	130	13,7	1,2	3,2	4,9
	G 2500	4000	200	21,8	2,0	5,0	7,9
DN 300 (12")	G 1600	2500	130	9,5	0,6	1,6	2,5
	G 2500	4000	200	15,2	1,2	3,2	4,9
	G 4000	6500	320	24,7	2,0	5,0	7,9
DN 400 (16")	G 2500	4000	200	9,4	0,6	1,6	2,5
	G 4000	6500	320	15,4	1,2	3,2	4,9
	G 6500	10000	500	23,6	2,2	5,5	8,6

Figure 23: Dimensional drawing IGTM-CT

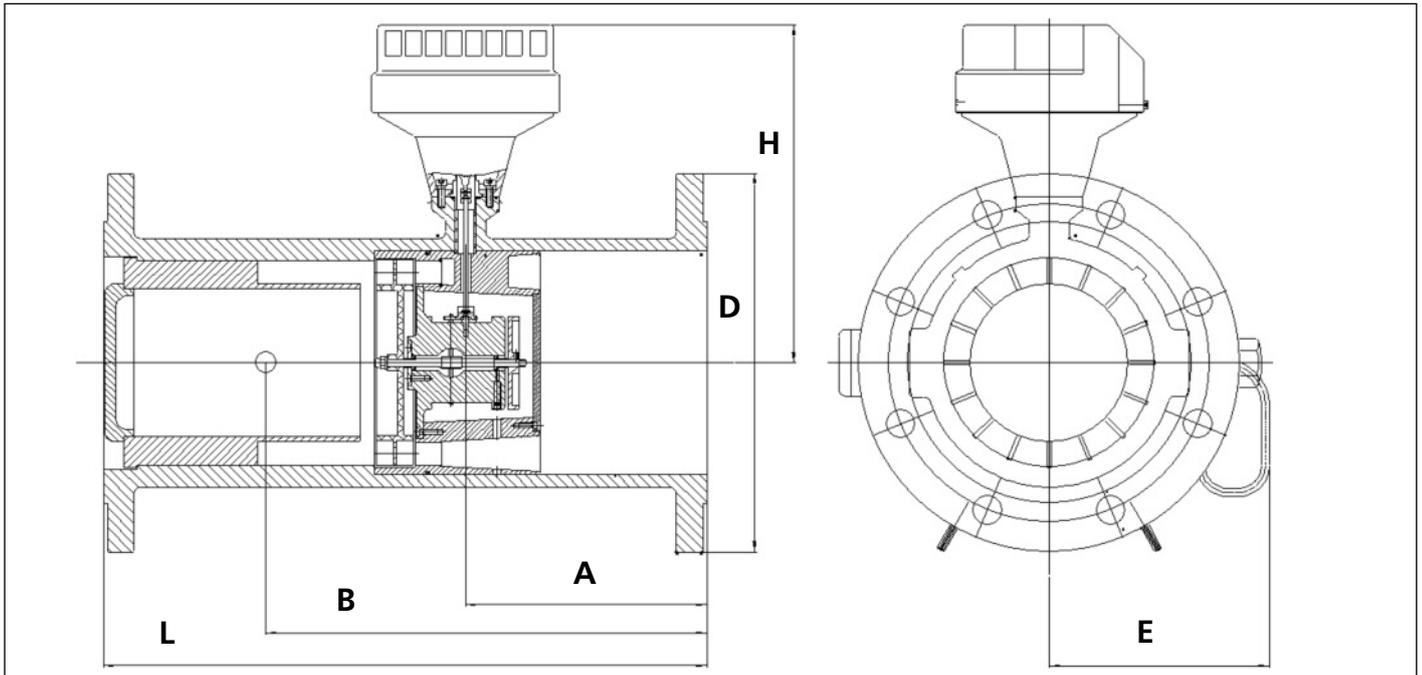


Table 17: Dimensions and weights IGTM-CT

(Part 1, continued on next page)

DN [mm] [Inch]	Size G	A [mm]	B [mm]	E [mm]	D [mm]	H Height	Overall size		Pressure class PN or ANSI	Body material	Weight [kg]
							Height H1 [mm] = H + ½D	Length L [mm]			
DN 50 (2")	40 or 65	62	109	102	165	215	298	150	PN 10/16	Ductile Iron	11
				127	165	200	283		PN 10/16	Steel	24
				127	165	200	283		PN 25/40	Steel	24
				127	180	205	295		PN 64	Steel	24
				140	195	215	313		PN 100	Steel	33
				102	152	215	291		ANSI 150	Ductile Iron	11
				127	152	200	276		ANSI 150	Steel	24
				127	165	200	283		ANSI 300	Steel	20
				127	165	200	283		ANSI 400	Steel	24
				127	165	200	283		ANSI 600	Steel	24
DN 80 (3")	100 or 160 or 250	92	160	120	200	205	305	240	PN 10/16	Ductile Iron	17
				200	200	192	292		PN 10/16	Steel	26
				200	200	192	292		PN 25/40	Steel	26
				215	215	192	300		PN 64	Steel	32
				230	230	192	307		PN 100	Steel	35
				191	191	205	301		ANSI 150	Ductile Iron	25
				191	192	192	288		ANSI 150	Steel	24
				210	210	192	297		ANSI 300	Steel	28
				210	210	192	297		ANSI 400	Steel	29
				210	210	192	297		ANSI 600	Steel	29
DN 100 (4")	160 or 250 or 400	120	205	135	220	230	340	300	PN 10/16	Ductile Iron	27
				140	220	215	325		PN 10/16	Steel	24
				140	235	215	333		PN 25/40	Steel	39
				140	250	215	340		PN 64	Steel	42
				140	265	215	348		PN 100	Steel	48
				135	229	230	345		ANSI 150	Ductile Iron	25
				140	229	215	330		ANSI 150	Steel	36
				140	254	215	342		ANSI 300	Steel	43
				140	254	215	342		ANSI 400	Steel	43
				140	273	215	352		ANSI 600	Steel	50

Table 17: Dimensions and weights IGTM-CT

(Part 2)

DN [mm] [Inch]	Size G	A [mm]	B [mm]	E [mm]	D [mm]	H Height	Overall size		Pressure class PN or ANSI	Body material	Weight [kg]
							Height H1 [mm] = H + 1/2D	Length L [mm]			
DN 150 (6")	400 or 650 or 1000	182	280	190	285	255	398	450	PN 10/16	Ductile Iron	45
					285	250	393		PN 10/16	Steel	45
					300	250	400		PN 25/40	Steel	40
					345	250	423		PN 64	Steel	74
					355	250	428		PN 100	Steel	90
					279	255	395		ANSI 150	Ductile Iron	50
					279	250	390		ANSI 150	Steel	63
					318	250	409		ANSI 300	Steel	70
					318	250	409		ANSI 400	Steel	80
					356	250	428		ANSI 600	Steel	100
DN 200 (8")	650 or 1000 or 1600	240	340	230	340	270	440	600	PN 10	Ductile Iron	76
					340		440		PN 10	Steel	78
					340		440		PN 16	Ductile Iron	76
					340		440		PN 16	Steel	78
					360		450		PN 25	Steel	90
					375		458		PN 40	Steel	100
					415		478		PN 64	Steel	125
					430		485		PN 100	Steel	160
					343		442		ANSI 150	Ductile Iron	80
					343		442		ANSI 150	Steel	83
					381		461		ANSI 300	Steel	106
					381		461		ANSI 400	Steel	135
					419		480		ANSI 600	Steel	155
DN 250 (10")	1000 or 1600 or 2500	300	415	240	395	285	483	750	PN 10	Steel	110
					405		488		PN 16	Steel	110
					425		498		PN 25	Steel	110
					450		510		PN 40	Steel	130
					470		520		PN 64	Steel	155
					505		538		PN 100	Steel	220
					406		488		ANSI 150	Steel	110
					445		508		ANSI 300	Steel	150
					445		508		ANSI 400	Steel	170
					508		539		ANSI 600	Steel	240
DN 300 (12")	1600 or 2500 or 4000	360	385	260	445	320	543	900	PN 10	Steel	120
					460		550		PN 16	Steel	130
					485		563		PN 25	Steel	150
					515		578		PN 40	Steel	180
					530		585		PN 64	Steel	240
					585		613		PN100	Steel	345
					483		562		ANSI 150	Steel	160
					521		581		ANSI 300	Steel	210
					521		581		ANSI 400	Steel	240
					559		600		ANSI 600	Steel	290
DN 400 (16")	2500 or 4000 or 6500	480	625	300	565	355	638	1200	PN 10	Steel	355
					580		645		PN 16	Steel	380
					620		665		PN 25	Steel	415
					660		685		PN 40	Steel	455
					670		690		PN 64	Steel	500
					715		713		PN100	Steel	600
					597		654		ANSI 150	Steel	432
					648		679		ANSI 300	Steel	450
					648		679		ANSI 400	Steel	500
					686		698		ANSI 600	Steel	590

Figure 24: Dimensional drawing IGTM-WT

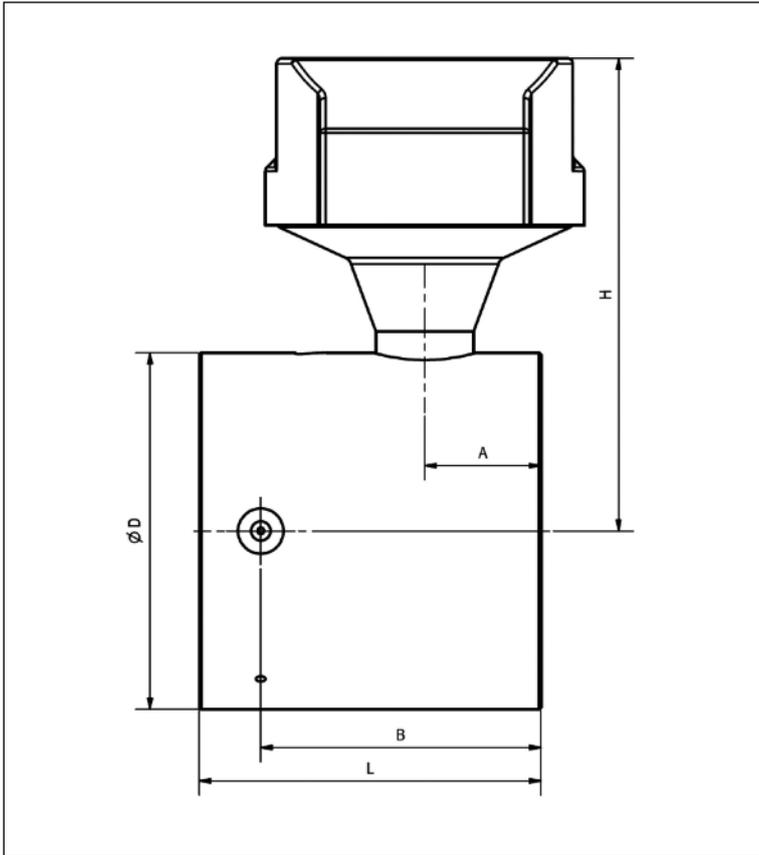


Table 18: Dimensions and weights IGTM-WT

DN [mm] [Inch]	Size G	A [mm]	B [mm]	E [mm]	D [mm]	H Height	Overall size		Pressure class PN or ANSI	Body material	Weight [kg]
							Height H1 [mm] = H + ½D	Length L [mm]			
DN 50 (2")	40 & 65	31.5	87	-	102	176	229	120	All models are suitable to fit between flanges PN10; PN16 or ANSI 150# RF	Aluminium	3.6
DN 65 (2½")	100	31.5	87	-	122	189	250	120			4.7
DN 80 (3")	100 & 160	26.5	82	-	138	197	266	120			5.1
	250										
DN 100 (4")	160 & 250	51	123	-	158	207	286	150			6.8
	400										
DN 150 (6")	400 & 650	57	146	190	216	235	343	180	12.8		
	1000										
DN 200 (8")	650 & 1000	69	150	218	270	262	397	200	19.2		
	1600										

The size E is the distance between the centre line of the gas meter and the outside of the lubrication pump.

Notes

Specific Remarks

Specific Remarks

7 SAFETY INSTRUCTIONS AND WARNINGS

Please refer to section 2.2 for specific warnings in the EC Pressure Equipment Directive.

The IGTM gas turbine meter supplied to you is a sensitive, high-quality metering instrument and should be handled with care. The smaller meters (DN 50 (2") to DN 100 (4")) should be lifted or transported with a strap. Larger meters (DN 150 (6") and up) are equipped with lifting lug holes in the flanges.

The meter should only be lifted with straps or with lifting lugs.

Never use the index (counter) head or the HF sensors as a handle bar or lifting handle.

The index head contains delicate shafts and gears that may be damaged with inappropriate handling. Improper use may cause inaccurate measurements.

Your meter may be equipped with electronic sensors. The electrical circuits are designed to be intrinsically safe (after EN 60947-5/6 NAMUR). **For use with hazardous gas in potentially hazardous area never hook up the meter to non-intrinsically-safe circuits.** Refer to hook-up diagrams for all sensor types later in this section.

Use only studs and nuts appropriate for the application and pressure class of the meter. Use new and correct size gaskets only. Ensure that flange faces are free from dirt and sharp metal filings. Gaskets should not protrude into the piping.

Do not hydro test the meter.

This was done in the factory. Water or any other liquid media will damage the meter.

Before disassembly of the meter, please observe the following rules:

- **For safety reasons NEVER disassemble a gas turbine meter under pressure.**
- **Do not remove, break, or paint any of the markings and lead seals** on a custody transfer meter, because in most countries the legal status of the meter for custody transfer measurement will become invalid. The meter must be re-calibrated at an approved test facility to regain legal status. The warranty as mentioned in this manual is only applicable if all of the markings and lead seals are undamaged and in place with the original seal stamp.
- If you replace critical internal parts (rotor, bearings, gears or complete internal components) **the meter should be recalibrated at a flow test facility** for the best accuracy. If the meter is to be used in a custody transfer application, the flow laboratory must be approved for custody transfer calibration.

Slowly and carefully fill your gas pipeline and meter-run. **Always fill** the meter pipeline section **from the upstream side** of your meter. Reverse flow and/or over load may damage the meter. Rapid gas expansion causes temperature extremes. Initial flow may cause collected dust and particles to travel and damage your meter.

To **empty** a gas filled metering section, a vent **downstream** of the meter should be used, to avoid reverse flow through your IGTM.

When provided with a lubrication system: lubricate your IGTM before the first use and at regular intervals during operation.

Please report any problems to the manufacturer.