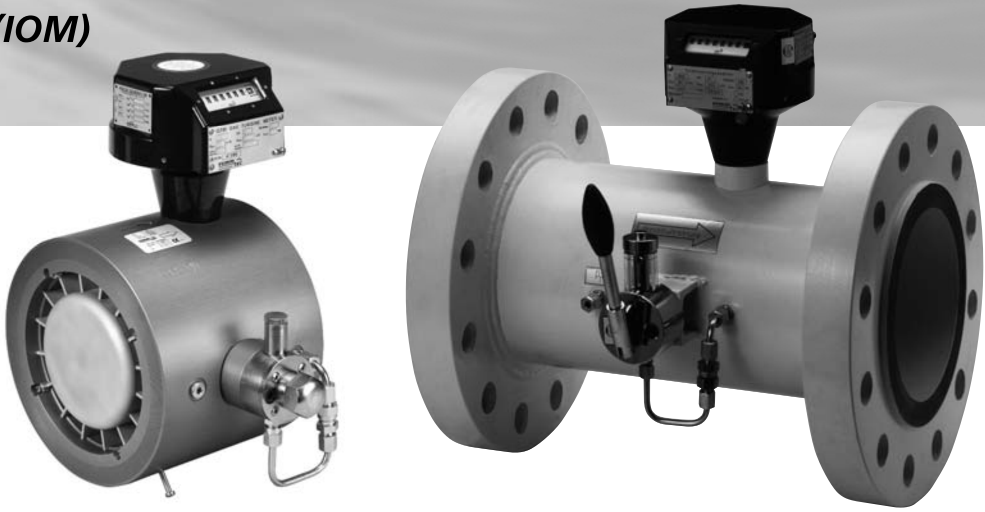
GAS TURBINE METER
IGTM-CT AND IGTM-WT

Installation, Operation and Maintenance Manual (IOM)
English Version



Gas - Measurement

vemm tec
Messtechnik GmbH

vemm tec Messtechnik GmbH

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1 INTRODUCTION

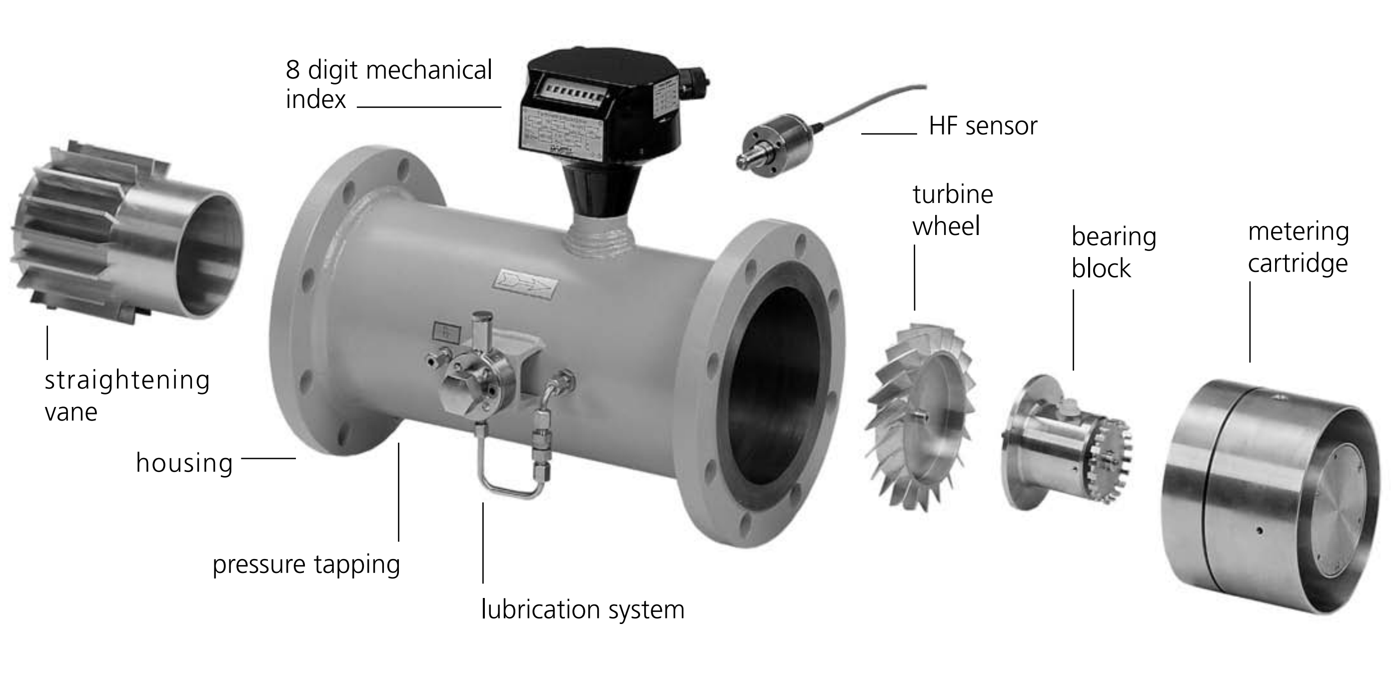
1.1 Dear customer

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

vemm tec Messtechnik GmbH ("***vemm tec***") shall not be liable for technical or editorial errors in this manual or omissions from this manual. ***vemm tec*** makes no warranties, express or implied, including the implied warranties of merchantability, and fitness for a particular purpose with respect to this manual. In no event, shall ***vemm tec*** be liable for any special or consequential damages including, but not limited to, loss of production, loss of profits, etc.

Product names used herein are for manufacturer or supplier identification only and may be trademarks / registered trademarks of these companies.

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)
- "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.

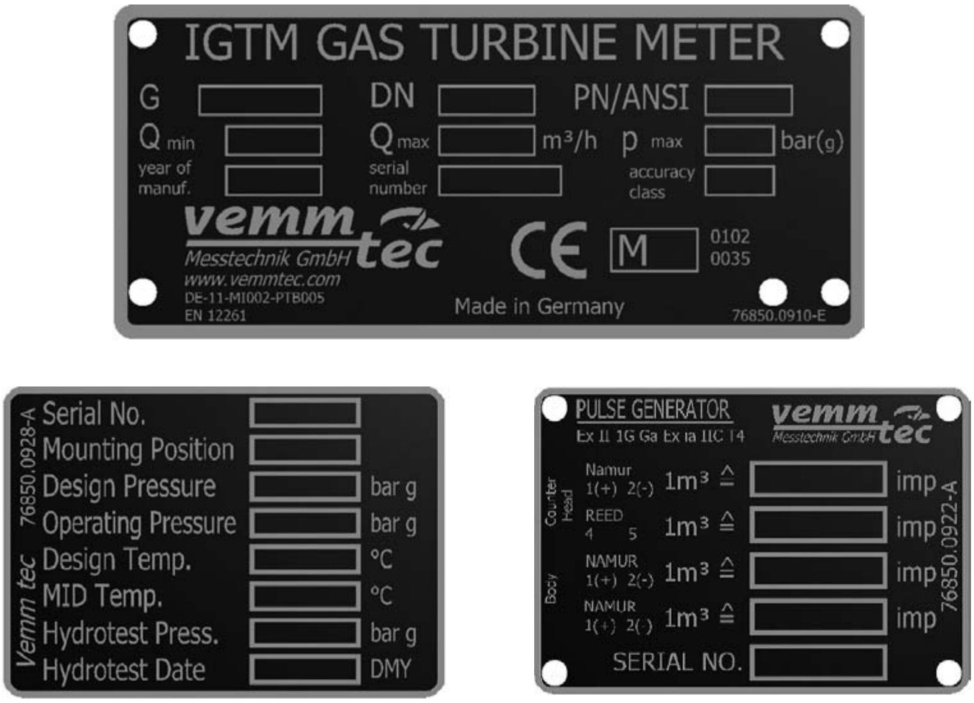
1.6 Principle of operation

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, Hungary, Malaysia 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 please order 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.

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

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.

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

vemm tec Messtechnik GmbH

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

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

EN ISO 9001 EN ISO 14001 DNV Certified Company

Order date
Reference-No.
Customer name

Inspected device	**IGTM Gas Turbine Meter**		
Manufactured by	**vemm tec 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 m3/h
Diameter	DN 150 (6")	Range: Qmax	1000 m3/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;
vemm tec PA 10-03; vemm tec 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 vemm tec 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 refered to are fulfilled. All tests have been passed.
The unit was found in perfect condition before dispatching.

Place	Date	Signature	Inspector´s stamp	Company´s stamp
Potsdam, Germany	26 Mrz 2014			vemm tec Messtechnik GmbH Gartenstraße 20 D-14482 Potsdam-Babelsberg ☎ 0331 / 70 96-0 Fax: 70 96-201/270

vt 1 / Mr. Otfried JANZ: Quality Inspector

fb081504

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-Mail: info@vemmtec.com
nternet: www.vemmtec.com

Bankverbindung:
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Kto.-Nr.: 6 607 023 035
BLZ: 100 500 00
IBAN: DE54 1005 0000 6607 0230 35
BIC: BELADEBEXXX

Bankverbindung:
Bayerische Hypo- und Vereinsbank AG
Kto.-Nr.: 355 170 233
BLZ: 160 200 86
IBAN: DE33 1602 0086 0 3551 70233
BIC: HYVEDEMM470

Geschäftsführer: Karst van Dellen
Registergericht: Kreisgericht Potsdam
Handelsregister: HRB 3559
Umsatzsteuer-Identnummer: DE 138402535

Figure 4: ATEX certificates

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

PTB

(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:

II 1 G EEx ia IIC T6

Zertifizierungsstelle Explosionsschutz
By order:

Braunschweig, February 1, 2002

Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT 24

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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

IGTM sensor HF1/2 (VEM 2084/10): DN 80 - DN 400

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 werden erfüllt durch Übereinstimmung mit:

EN 60079-0:2006	Allgemeine Anforderungen
EN 60079-11:2007	Eigensicherheit 'i'
IEC 60079-26:2006	Gruppe II Zone 0-Geräte
EN 61241-0 2006	Allgemeine Anforderungen
EN 61241-11: 2004	Eigensicherheit 'iD'

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

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf die Konzeption und die Baumusterprüfung 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:

II 1G Ga Ex ia IIC T4 / T5 / T6
II 1D Ex iaD 20 T125 °C / 100 °C / 85 °C

DEKRA EXAM GmbH
Bochum, den 31. März 2008

Zertifizierungsstelle Fachbereich

Seite 1 von 2 zu BVS 08 ATEX E 026
Dieses Zertifikat darf nur vollständig und unverändert weiterverbreitet werden.
DEKRA EXAM GmbH Dinnendahlstraße 9 44809 Bochum Telefon 0234/3696-105 Telefax 0234/3696-110 E-mail zs-exam@dekra.com

IGTM sensor HF3/4 (VEM 1971/09)

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

PTB

(1) **EG-Baumusterprüfbescheinigung**

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

(3) EG-Baumusterprüfbescheinigungsnummer

PTB 00 ATEX 2048 X

(4) Gerät: Zylinderförmige induktive Sensoren Typen NC... und NJ...

(5) Hersteller: Pepperl + Fuchs GmbH

(6) Anschrift: D-68307 Mannheim

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

(8) Die Physikalisch-Technische Bundesanstalt bescheinigt als benannte Stelle Nr. 0102 nach Artikel 9 der Richtlinie des Rates der Europäischen Gemeinschaften vom 23. März 1994 (94/9/EG) die Erfüllung der 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.

Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfbericht PTB Ex 00-29206 festgelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

EN 50014:1997 EN 50020:1994

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

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf Konzeption und Bau des festgelegten Gerätes gemäß Richtlinie 94/9/EG. Weitere Anforderungen dieser Richtlinie gelten für die Herstellung und das Inverkehrbringen dieses Gerätes.

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

II 2 G EEx ia IIC T6

Zertifizierungsstelle Explosionsschutz
Im Auftrag

Braunschweig, 26. September 2000

Dr.-Ing. U. Johannsmeyer
Regierungsdirektor

PHYSIKALISCH-TECHNISCHE BUNDESANSTALT 21

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EG-Baumusterprüfbescheinigungen ohne Unterschrift und ohne Siegel haben keine Gültigkeit.
Diese EG-Baumusterprüfbescheinigung darf nur unverändert weiterverbreitet werden.
Auszüge oder Änderungen bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.

Physikalisch-Technische Bundesanstalt • Bundesallee 100 • D-38116 Braunschweig

IGTM sensor HF1 (VEM 949/03): DN 50

Figure 5: Declaration of conformity for LF Reed switches

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

No.: 2015 / 0001
Nr.

Issuer´s name: **vemm tec Messtechnik GmbH**
Name des Ausstellers: *Karst van Dellen*

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

Object of declaraiton:
Gegenstand der Erklärung:

The Turbine meters IGTM DN 50…DN 600 are equipped for the volume impulse generation with a LF Reed contact. The development and manufacture was carried out considering the below listed standards.
Die Turbinenradgaszähler IGTM DN 50 … 600 sind zur Volumenimpulsausgabe mit einem Reedkontakt ausgerüstet. Die Konstruktion und Fertigung wurde unter Beachtung nachfolgend 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/EC	Equipment and protective Systems, intended for use in potentially explosive atmospheres	Norm: DIN EN 60079-0 DIN EN 60079-11 DIN EN 60947-5-6	2004-12 2007-08 2000-12
94/9/EG	*Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen*		
89/336/EWG	Electromagnetic compatibility	Norm: EN 61000-6-2	2010-01
89/336/EWG	*Elektromagnetische Verträglichkeit*		

Additional information:
Zusätzliche Information:

Potsdam, 01.10.2015 Place, Date

Karst van Dellen
Managing Director

Name, function

vemm tec 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 vemm tec Messtechnik GmbH
Accredited Test Centre for Gas Meters GN 5 at vemm tec 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 *Object of inspection*	Turbinenradgaszähler DN 200(8")	IGTM-CT PN 16	Größe *Flow rating*	G 1000	
Hersteller *Manufacturer*	vemm tec Messtechnik GmbH		Q_{min} / Q_{max}	80 / 1600	[m³/h] / [m³/h]
Identifikation *Identification*	149123		Baujahr *Year*	2015	
Antragsteller *Applicant*	Active Flow Controls Ltd		Referenz-Nr. *Reference-no.*	A-1500901	
Zulassungsnummer *Approval number*	D97/7.211.16		k-Faktor		[imp/m³] HF 1
			k-Faktor		[imp/m³] HF 2
			k-Faktor	144,954	[imp/m³] HF 3
Datum der Eichung *Date of verification*	04. Sep 2015		k-Faktor		[imp/m³] HF 4
			k-Faktor	0,1	[imp/m³] 1R1
			k-Faktor	0,1	[imp/m³] 2R1
Prüfer *Calibrator*	Büchner		Justierräder *Normalisation wheels*	26 / 32	

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

Q_{min} <= Q < 0,20 Q_{max}	2%
0,20 Q_{max} <= Q <= Q_{max}	1%

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 occured.

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 in unchanged form.

Ort und Datum *Place and date*	Stempel *Stamp*	Unterschrift *Signature*
Potsdam, 07. September 2015	STAATLICH ANERKANNTE PRÜFSTELLE GN 5 POTSDAM	[signature]

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

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FB 752 02 Rev.: 00

vemm tec Messtechnik GmbH

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

Calibration facility for gas measurement equipment with air at ambient conditions

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

Calibration Certificate

Type:	IGTM - CT	**Size:**	DN 200 (8")	
Kind of meter:	Turbine gas meter	**Pressure Rating:**	PN 16	
Sales Order:	A-1500901	**Flow Rating:**	G 1000	
Serial Number:	149123	**Qmin:**	80,00	[m³/h]
Approval Number:	D97/7.211.16	**Qmax:**	1600,00	[m³/h]
Year of Manufacture:	2015			
Normalisation Wheels:	26/32	**k-factor (HF1):**	--	[imp/m³]
Manufacturer:	vemm tec Messtechnik GmbH	**k-factor (HF2):**	--	[imp/m³]
Test Date:	04.09.2015	**k-factor (HF3):**	144,954	[imp/m³]
Customer:	Active Flow Controls Ltd	**k-factor (HF4):**	--	[imp/m³]
Calibrator:	Büchner	**k-factor (NF 1):**	0,100000	[imp/m³]
		k-factor (NF 2):	0,100000	[imp/m³]

Error Limits:

Qmax >= Q >= Qt:	+/- 1,00	[%]
Qt > Q >= Qmin:	+/- 2,00	[%]
Qt:	320,00	[m³/h]

Place and date:	Official Stamp:	Signature:
Potsdam, 07.09.2015	vemm tec Messtechnik GmbH Gartenstr. 20 D-14482 Potsdam	[signature]

Certificate number: 3660 — Page 1 — Test bench: P3

FB 752 02 Rev.: 00

vemm tec Messtechnik GmbH

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

Calibration facility for gas measurement equipment with air at ambient conditions

Customer:	Active Flow Controls Ltd	**Leading sensor:**	HF 3
Sales Order:	A-1500901	**k-factor [imp/m³]:**	2754,14
Type:	IGTM - CT	**Normalisation Wheels:**	26/32
Kind of meter:	Turbine gas meter	**Qmin [m³/h]:**	80,00
Size:	DN 200 (8")	**Qmax [m³/h]:**	1600,00
Manufacturer:	vemm tec Messtechnik GmbH	**Year of Manufacture:**	2015
Serial Number:	149123	**Calibrator:**	Büchner
Approval Number:	D97/7.211.16	**Test Date:**	04.09.2015
Pressure Rating:	PN 16	**Mounting position during test:**	horizontal
Flow Rating:	G 1000		
Ambient tempreture:	22,63 °C		
Ambient pressure:	1011,48 mbar		

	Q[m³/h]	V [m3]	p [mbar]	T[°C]	dp[mbar]	f[%]
meter under test	1573,03	26,22	992,07	22,96	6,57	-0,16
Ref. 3	1603,62	26,75	989,02	22,70		0,07
meter under test	1101,91	18,36	997,17	22,94	3,31	-0,11
Ref. 3	1121,22	18,70	995,62	22,72		0,11
meter under test	630,32	10,50	1000,53	22,87	1,10	0,00
Ref. 2	644,48	10,75	993,08	22,65		0,18
meter under test	394,51	6,58	1001,56	22,89	0,46	0,12
Ref. 2	401,12	6,69	998,54	22,69		0,07
meter under test	157,83	2,63	1002,14	22,71	0,10	0,18
Ref. 1	161,68	2,70	991,14	22,53		-0,08
meter under test	78,71	1,31	1002,23	22,75	0,03	-0,09
Ref. 1	80,19	1,34	999,37	22,58		-0,14

WME (weighted mean error) : -0,05 %

Place and date:	Official Stamp:	Signature:
Potsdam, 07.09.2015	vemm tec Messtechnik GmbH Gartenstr. 20 D-14482 Potsdam	[signature]

Certificate number: 3660 — Page 2 — Test bench: P3

Telefon: +49(0)331 / 70 96-0 Telefax: +49(0)331 / 70 96-201 und 70 96-270 Internet: www.vemmtec.com
Bankverbindung: Landesbank Berlin (LBB AG) IBAN: DE54 1005 0000 6607 0230 35 BIC: BELADEBEXXX
Bankverbindung: Bayerische Hypo- und Vereinsbank AG IBAN: DE33 1602 0086 0 3551 70233 BIC: HYVEDEMM470
Geschäftsführer: Karst van Dellen Registergericht: Kreisgericht Potsdam Handelsregister: HRB 3559 Umsatzsteuer-Identnummer: DE 138402535

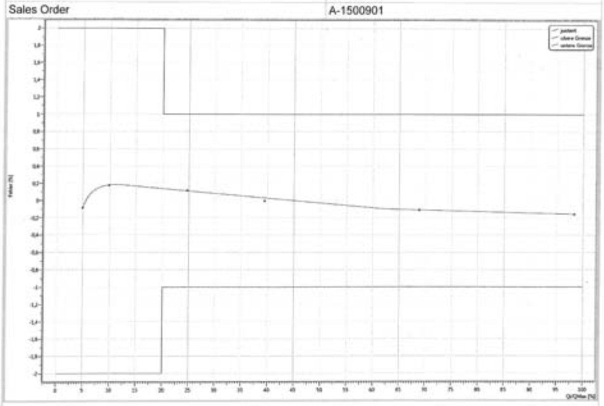
FB 752 02 Rev.: 00

vemm tec Messtechnik GmbH

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

Performance Curve

Type	IGTM - CT
Serial Number	149123
Size	DN 200 (8")
Qmin [m³/h]	80,00
Qmax [m³/h]	1600,00
Sales Order	A-1500901



Place and date:	Official Stamp:	Signature:
Potsdam, 07.09.2015	vemm tec Messtechnik GmbH Gartenstr. 20 D-14482 Potsdam	[signature]

Certificate number: 3660 — Page 3 — Test bench: P3

Telefon: +49(0)331 / 70 96-0 Telefax: +49(0)331 / 70 96-201 und 70 96-270 Internet: www.vemmtec.com
Bankverbindung: Landesbank Berlin (LBB AG) IBAN: DE54 1005 0000 6607 0230 35 BIC: BELADEBEXXX
Bankverbindung: Bayerische Hypo- und Vereinsbank AG IBAN: DE33 1602 0086 0 3551 70233 BIC: HYVEDEMM470
Geschäftsführer: Karst van Dellen Registergericht: Kreisgericht Potsdam Handelsregister: HRB 3559 Umsatzsteuer-Identnummer: DE 138402535

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

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

Calibration Certificate

Number 12010/2013
Date 2013-06-18

Applicant	Name:	Vemm tec 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 harmonised 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

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.

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.

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.

pigsar ™

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

Applicant Vemm tec 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	1,38	mole %
	Pressure, absolute	30,9	bar	H_2	0,0	mole %
	Gas Temperature	19	°C	Calorific value,s	10,19	kWh/m³
	Gas density (p, T)	25,0	kg/m³	Density,normal	0,8302	kg/m³
	Dyn. viscosity (p, T)	1,20E-5	Pa s	Normal conditions (273,15 K; 101,325 kPa)		

Results (as left)	Qi / Qmax	Qi (m³/h)	Reynoldsnumber	Deviation (%)	Utot (%)
	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	162,60	1,20 * 10^6	0,07	0,13
	0,50	324,97	2,39 * 10^6	0,13	0,13
	0,75	489,79	3,62 * 10^6	0,10	0,13
	1,00	650,76	4,81 * 10^6	0,00	0,13

Weighted mean error, with continuous and linear decrease of weighing 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:

$$U_{tot} = \sqrt{U^2_{harmonized} + U^2_{meter}}$$

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

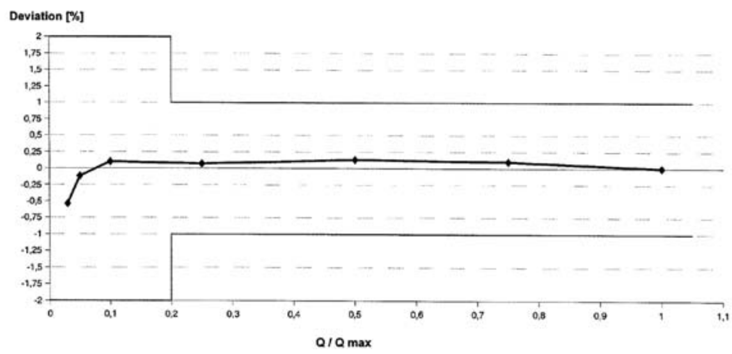
<u>The calibration of the meter had been performed in following configuration:</u>
Flowconditioner(138386) – upstream pipe (450 mm) – meter
Flowconditioner were provided by the manufacturer/customer.

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

This calibration certificate may not be reproduced other than in full except with the permission of the issuing laboratory.
Calibration certificates without signature and seal on the first page are not valid.

Error Curve

Type of meter:	Turbine meter	Customer:	Vemm tec Messtechnik GmbH	DN:	100 mm	p(abs):	31	bar	HF 1	9336.86	pulses / m³
Meter no:		Manufacturer:	Vemmtec	Size:	G400	Q max:	650	m³/h	HF 2	9336.86	pulses / m³
Date:	2013-06-18	Gear 1:	47			Q min:	32	m³/h	HF 3	437.665	pulses / m³
Inspector:	Schiffmann	Gear 2:	59			R 1	1,0000	pulses / m³	-	-	pulses / m³



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) 2014/68/EU.

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 2014/68/EU 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	**Provisions to ensure safe handling and operation.**	
	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.	
	Closures & openings	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.
	Devices to prevent physical access whilst pressure or a vacuum exists	The end user shall ensure that the IGTMs are installed in a properly designed system with access limitation in place if required.
	Surface temperature	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.
	Decomposition of unstable fluids	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.

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

2.4	**Means of examination** Pressure equipment must be designed and constructed so that all necessary examinations to ensure safety can be carried out.	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. 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.
2.5	**Means of draining and venting** Harmful effects such as vacuum collapse, corrosion, and uncontrolled chemical reactions must be avoided.	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.
2.6	**Corrosion or other chemical attack**	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.
2.7	**Wear**	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.
2.10	**Protection against exceeding the allowable limits of the pressure equipment**	The IGTM must be installed in a well-designed piping system with adequate protection against excessive pressure.
2.12	**External fire**	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.
7.3	**Pressure limiting devices, particularly for pressure vessels**	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.

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.
- Consider at least additional 5 cm distance between the pump of the IGTM Turbine Gas meter and a barrier (e. g. a wall) according to "E" in table 17, enabling you to operate the pump.

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 provides with a lubrication system.

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

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 cm³/Stroke	1 cm³
DN 150 (6") / DN 200 (8") / DN 250 (10")		Medium	0.5 cm³/Stroke	10 cm³
DN 300 (12") / DN 400 (16") [1)]		Large	0.5 cm³/Stroke	50 cm³
DN 500 (20") and DN 600 (24")		Large	0.5 cm³/Stroke	50 cm³

[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-CT is ISOFLEX PDP 38 or equivalent. ***Vemm tec*** supplies an amount of bearing lubrication oil with each IGTM-CT.
For IGTM-WT as well as for gas temperatures ≥ -10 °C lubricant Shell MORLINA S2 or equivalent can be used.
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 cm³	N/A
DN 80 (3")	26 Strokes = 3.7 cm³	N/A
DN 100 (4")	26 Strokes = 3.7 cm³	N/A
DN 150 (6")	8 Strokes = 4 cm³	29 Strokes = 4.1 cm³
DN 200 (8")	12 Strokes = 6 cm³	29 Strokes = 4.1 cm³
DN 250 (10")	12 Strokes = 6 cm³	--
DN 300 (12")	20 Strokes = 10 cm³ 1)	--
DN 400 (16")	20 Strokes = 10 cm³ 1)	--
DN 500 (20")	20 Strokes = 10 cm³ 1)	--
DN 600 (24")	20 Strokes = 10 cm³ 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

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. 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 is (MID) approved for operation with an upstream pipe length of only 2 times of the nominal diameter of the gas meter. 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 equipped as standard 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

vemm tec 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

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

V_b	=	Volume at base conditions	(converted volume)	[m^3]
V	=	Volume at measurement conditions (number of pulses from the gas meter divided by the gas meter's k-factor)	(unconverted volume)	[m^3]
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 ½" 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. ***vemm tec*** 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 it 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 Allen screws, 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 with low force.

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

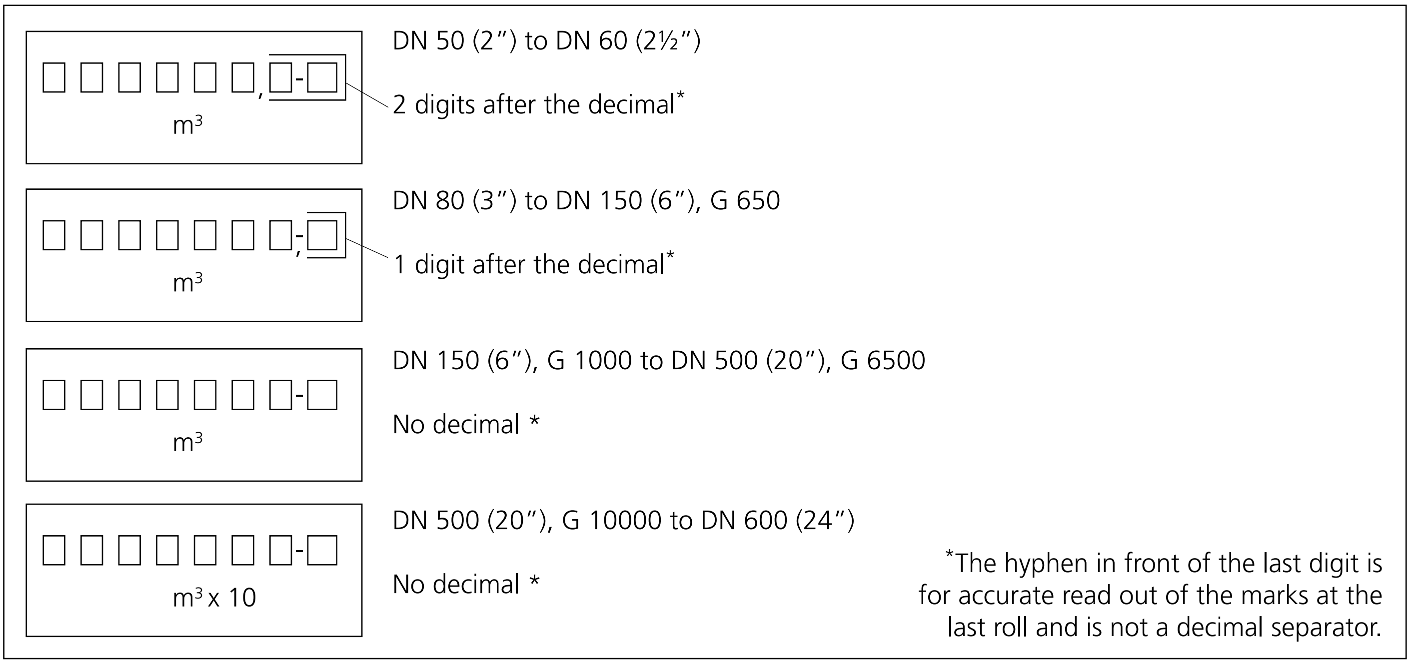
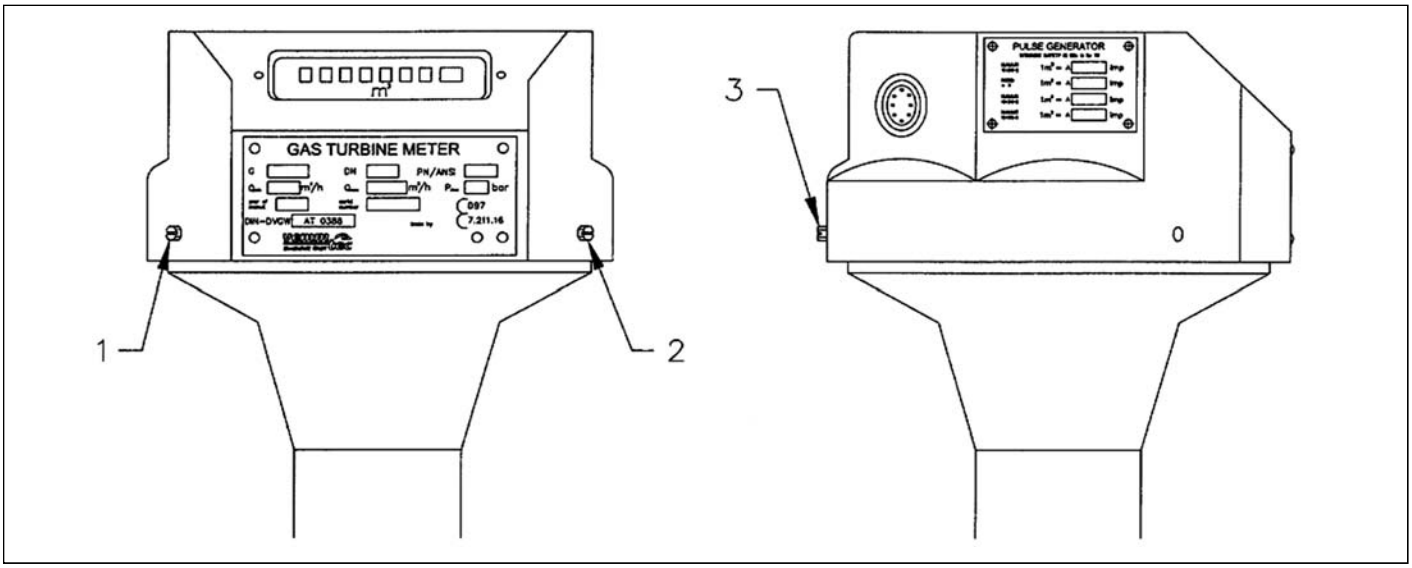


*Figure 9: Orientation change of the index head *)*



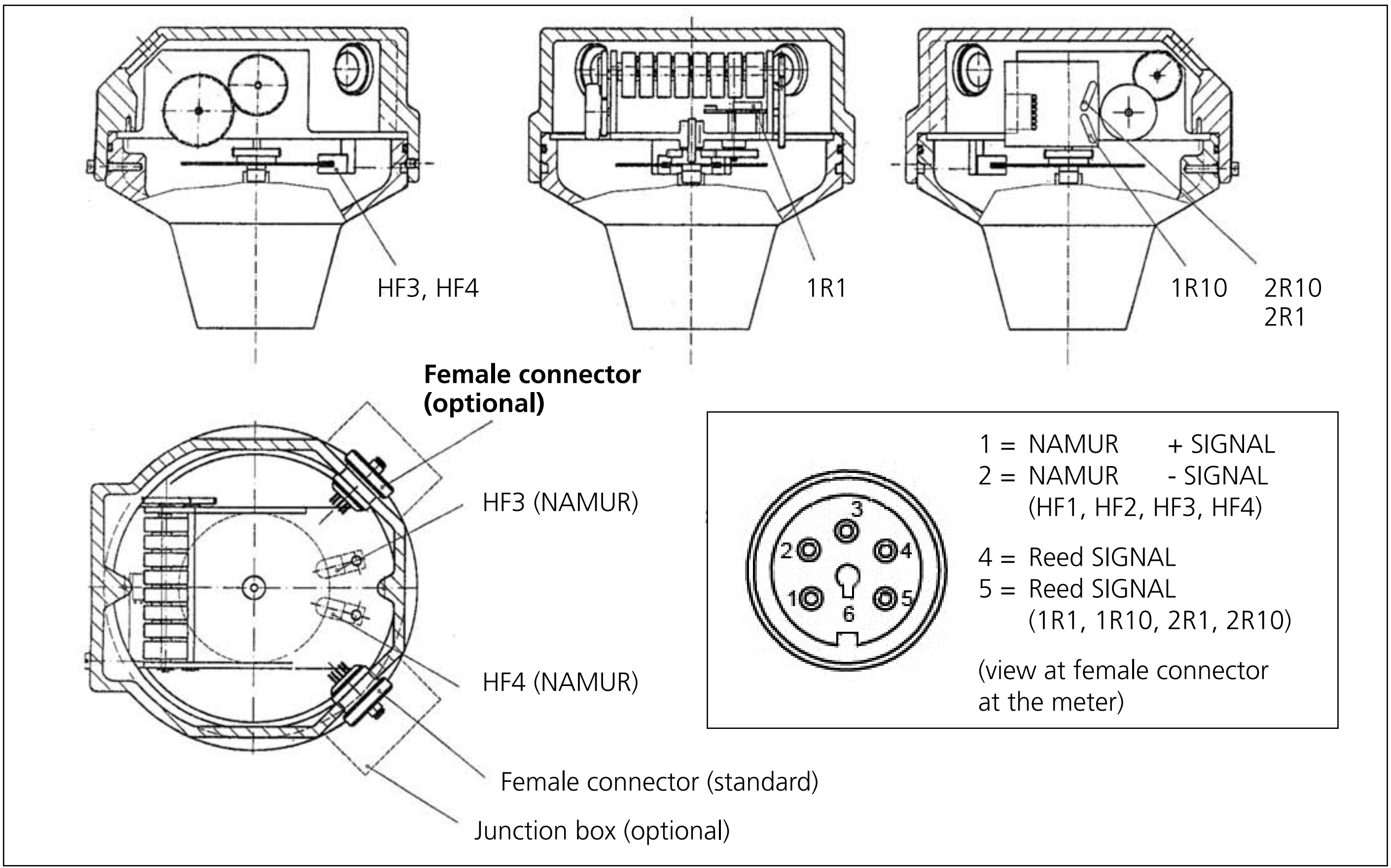
*) required tools: Allen Wrench 2 mm. Flat Screwdriver No 4

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 **



** Alternative pin allocation is possible: refer to the pulse label at the index head for final information.*

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, 10 or 100 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 lager) 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/m³] 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 and Figure 14. For specific applications it is possible that the connector has a non-standard wiring and pin allocation. In these situations a clear indication at the gas meter pulse label 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.

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/m³], and other devices use the reciprocal value [m³/Imp]. Please check carefully which value should be used in your device.

Figure 11: IGTM scheme with location of pulse transmitters

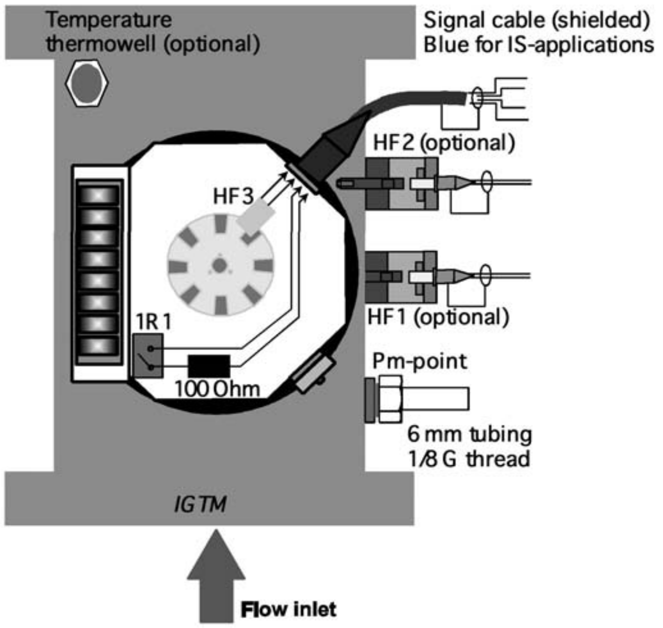


Figure 12: Connection diagram for low frequency reed switch

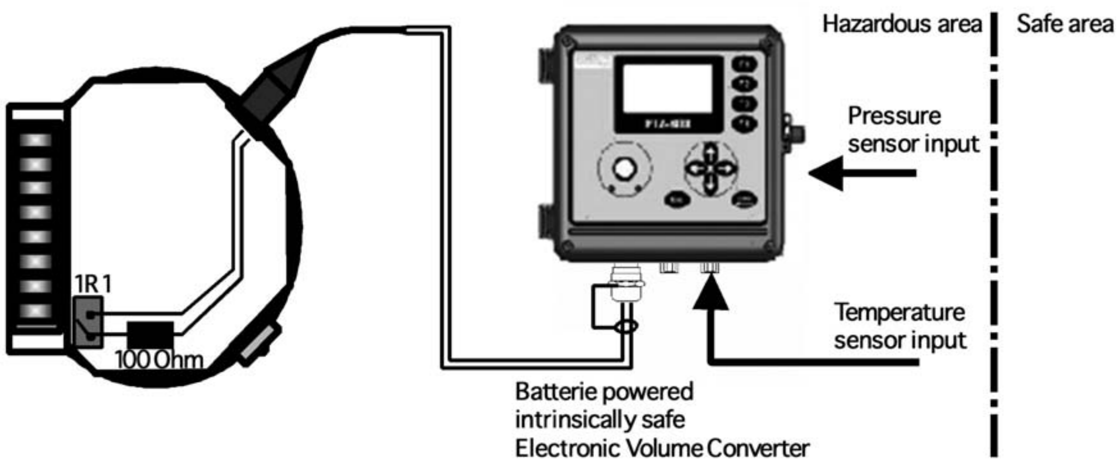
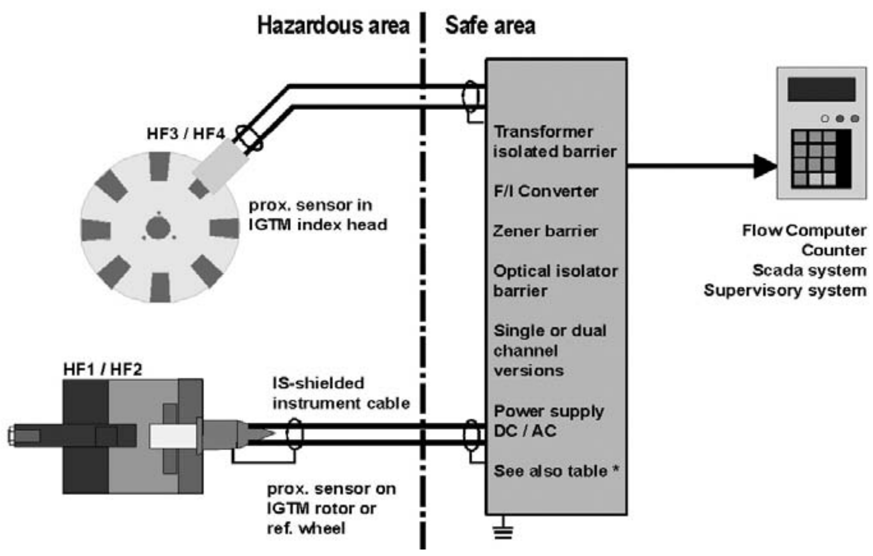


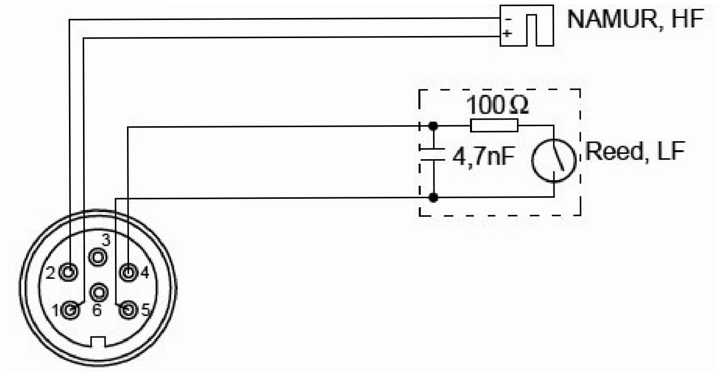
Figure 13: Connection diagram for high frequency sensors



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.
Alternative pin allocation is possible: refer to the pulse label at the index head for final information.

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):

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

Were:
Q is the actual flow [m³/h]
Q_{max} is the maximum flow of the meter [m³/h]
Q_{min} is the minimum flow of the meter [m³/h]
Q_t is the transition flow were the accuracy changes [m³/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:
± 0.5 % for $Q_t \leq Q \leq Q_{max}$
± 1.0 % 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 ≤ 0.5 %. It can be better if requested. The linearity at test pressures > 5 bar abs is typically ≤ 0.5 % for meters ≤ DN 100 (4"), between Q_t and Q_{max}. It is typically ≤ 0.3 % for meters > DN 100 (4"). That is according to EN 12261.

The repeatability of the IGTM is ± 0.1 % or better. The EN 12261 stability requirements allow a span of 0.2 %. The reproducibility of metering is also ± 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:
± 1.5 % for $0.2Q_{max} \leq Q \leq Q_{max}$
± 3.0 % 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

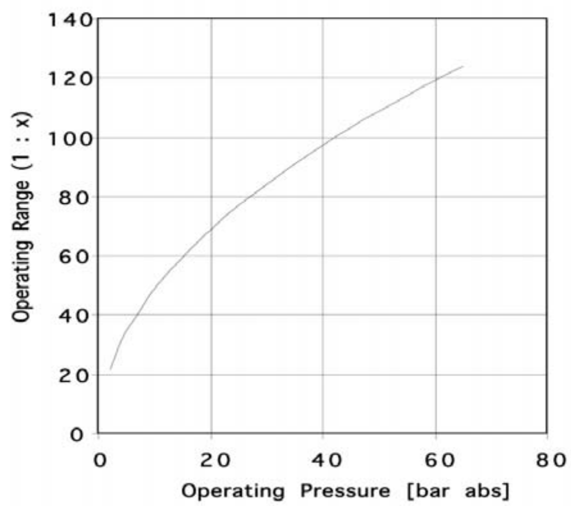
At higher operating pressure, the density of the gas increases. With increasing density, the available driving force increases. The increased momentum reduces the relative influence of the bearing friction. The additional momentum increases the rotor drive, which in turn decreases the minimum flow rate 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)	[m³/h]
Q_{min}	=	Minimum flow rate as specified	(see Table 14)	[m³/h]
$\rho_{air,b}$	=	Density of air at base conditions		[1.293 kg/m³]
ρ_b	=	Gas density at base conditions		[kg/m³]
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 allow 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#	103 (100 for certain approvals)
PN 10	10
PN 16	16
PN 25	25
PN 40	40
PN 63	63
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/m³]
ρ_r	=	Density at reference conditions	(with natural gas)	[0.8 kg/m³]
Q	=	Actual flow rate of the measured gas		[m³/h]
Q_{max}	=	Maximum flow rate of the gas meter	(see Table 16)	[m³/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 ***vemm tec***.

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, anodized (EN AW 5083)
Flow conditioner	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 (see Table 7).

Gas turbine meters should not be lubricated shortly before calibration.

Table 7: Periodical lubrication quantities

Meter size	Periodical Lubrication IGTM-CT	Periodical Lubrication IGTM-WT	Increased Lubrication Frequency 2)
DN 50 (2")	7 Strokes = 1 cm^3	N/A	bi-weekly
DN 80 (3")	7 Strokes = 1 cm^3	N/A	bi-weekly
DN 100 (4")	10 Strokes = 1.4 cm^3	N/A	bi-weekly
DN 150 (6")	6 Strokes = 3 cm^3	22 Strokes = 3.1 cm^3	bi-weekly
DN 200 (8")	6 Strokes = 3 cm^3	22 Strokes = 3.1 cm^3	bi-weekly
DN 250 (10")	6 Strokes = 3 cm^3	–	weekly
DN 300 (12")	6 Strokes = 3 cm^3 1)	–	weekly
DN 400 (16")	6 Strokes = 3 cm^3 1)	–	daily
DN 500 (20")	6 Strokes = 3 cm^3	–	daily
DN 600 (24")	6 Strokes = 3 cm^3	–	daily

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

2) for special gases, see Table 11

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
DN 500 (20")	> 360 seconds
DN 600 (24")	> 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 delivery date of the Goods, according to the "General Terms and Conditions of Business (GTC) of the ***vemm tec*** Messtechnik GmbH (vemm tec) for Export", 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 non-compliance to the "Installation, Operation and Maintenance Manual"
(ii) to damages caused by unsuitable or incorrect 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;
(iii) to equipment, materials, parts and accessories manufactured by others;
(iv) to correctness of any externally performed calibrations, either at ambient conditions or at elevated pressure.
The warranty also becomes invalid when devices supplied with our seal no longer possess the original, undisturbed seal.

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 component or complete IGTM Gas Turbine Meter 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 were ordered.

6 APPENDIX WITH TABLES AND FIGURES

Table 9: Technical standards, rules and guidelines

International and German standards	
EN 12261	Gas meters – Turbine gas meters
ISO 9951	Measurement of gas flow in closed conduits – Turbine meters
AGA 7	Measurement of gas by turbine meters
EN 50014 to 50020	Electrical apparatus for potentially explosive atmospheres
DIN 30690-1	Construction elements in the gas supply system – part 1: Requirements for construction elements in gas supply systems
EC (European Community) guidelines	
2014/32/EU 31.03.2004	Measuring Instruments Directive (MID)
2014/34/EU	Equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)
2014/68/EU	Pressure Equipment Directive (PED)
PTB (Germany) guidelines	
PTB-A 7.1	Volume gas meters
PTB-Prüfregeln Band 29	Gas meters: Testing of volume gas meters with air at atmospheric pressure
PTB-Prüfregeln Band 30	Measurement devices for gas: High pressure test of gas meters
TR G 13	Installation and operation of gas turbine meters
DVGW (Germany) regulations	
G 260/I	Gas quality
G 260/II	Supplementary rules for gases of the second gas family
G 261	Measuring gas quality
G 285	Hydrate inhibition in natural gas with methanol
G 469	Pressure testing for piping and systems in gas supply
G 486	Gas law deviation factors and natural gas compressibility factors – calculation and application
G 486-B2:2005-12	Extended requirements for the calculation and application of real gas factors and compressibility factors of natural gasses.
G 491	Gas pressure regulating stations with inlet pressures exceeding 4 bar up to 100 bar – design, construction, montage, testing and start up
G 492/II	Systems for large quantities gas measurement with an operating pressure above 4 bar up to 100 bar
G 493	Procedure for granting DVGW certification for manufacturers of pressure control and gas measurement equipment
G 495:2006-07	Gas plants and systems - Maintenance
OIML	
R 6	General provisions for gas volume meters (replaced by R137)
R 32	Rotary piston gas meters and turbine gas meters (replaced by R137)
R 137-1	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

ISO 9001 and 14001

vemm tec Messtechnik GmbH is certified according to ISO 9001:2008, (see Figure 16) and ISO 14001:2004.

Metrological approvals

IGTM Gas Turbine Meters are legally approved for custody transfer within the European Economic Community according to Directive 2014/32/EU of the European Parliament and of the Council with examination certificate DE-11-MI002-PTB005, issued by Physikalisch-Technische Bundesanstalt (PTB) [Germany]. Refer to Table 15 for approved sizes and ranges.

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.

Figure 16: vemm tec ISO 9001 Certificate


DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No: 123188-2012-AE-GER-DAkkS
Initial certification date: 27. June 2009
Valid: 18. February 2016 - 15. September 2018

This is to certify that the management system of

vemm tec Messtechnik GmbH
Gartenstr. 20, 14482 Potsdam, Germany

has been found to conform to the Management System standards:

ISO 9001:2008
ISO 14001:2004

This certificate is valid for the following scope:

Design, engineering, manufacturing, installation, calibration, sales and services of equipment, components and systems for Gas- and Fluid Measurement Technology

Place and date:
Essen, 14. February 2016

DAkkS Deutsche Akkreditierungsstelle D-ZM-18453-01-00

For the issuing office:
DNV GL - Business Assurance
Schnieringshof 14, 45329 Essen, Germany

Thomas Beck
Technical Manager

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance Zertifizierung und Umweltgutachter GmbH, Schnieringshof 14, 45329 Essen, Germany. TEL:+49 201 7296-222. www.dnvgl.de/assurance

Design and compliance certification

CE	EC-Conformity declaration, Notified Body TÜV 0035 (see Figure 19)
PED 97/23/EC (new 2014/68/EU)	Certificate of Notified Body TÜV 0035: CE-0085CN0327

ATEX (explosive Atmosphere)

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 (seeFigure 4)
HF3/HF4: BVS 08 ATEX E026 (see Figure 4)
HF1 for DN50: PTB 00 ATEX 2048 X (see Figure 4)

Figure 17: EC MID approval for IGTM-CT

Physikalisch-Technische Bundesanstalt PTB
Braunschweig und Berlin

EG-Baumusterprüfbescheinigung
EC type-examination certificate

Ausgestellt für: *Issued to:*	vemm tec Messtechnik GmbH Gartenstr. 20 14482 Potsdam
Rechtsbezug: *In accordance with:*	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). *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).*
Geräteart: *Type of instrument:*	Gaszähler *Gas Meter*
Typbezeichnung: *Type designation:*	IGTM
Nr. der Bescheinigung: *Certificate number:*	DE-11-MI002-PTB005
Gültig bis: *Valid until:*	09.10.2021
Anzahl der Seiten: *Number of pages:*	17
Geschäftszeichen: *Reference No.:*	PTB-1.42-4047513
Benannte Stelle: *Notified Body:*	0102
Ort, Ausstellungsdatum: *Date of issue:*	Braunschweig, 10.10.2011

Zertifizierer: *Certifier:*
Im Auftrag *By order*
Dr. Rainer Kramer

Siegel *Seal*

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

Hinweise
EG-Baumusterprüfbescheinigungen ohne Unterschrift und Siegel haben keine Gültigkeit. Diese EG-Baumusterprüfbescheinigung darf nur unverändert weiterverbreitet werden. Auszüge bedürfen der Genehmigung der Physikalisch-Technischen Bundesanstalt.
Note
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 - Abbestraße 2-12 - D-10587 Berlin

R3-00020516

Figure 18: EC-Conformity declaration (example)

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

vemm tec - Messtechnik GmbH
Haus- und Lieferadresse: Gartenstraße 20 • D-14482 Potsdam/Germany

ISO 9001 ISO 14001 DNV Certified Company

Object of declaration Gegenstand der Erklärung:	**IGTM - CT** **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	
Titel Titel	Measurement Equipment Directive Messgeräterichtlinie		Pressure Equipment Directive Druckgeräterichtlinie	
Edititon Ausgabedatum	03/2004 03/2004		05/1997 05/1997	
Module Modul	Module B Modul B	Module F Modul F	Module B Modul B	Module D Modul D
Certificate No. Zertifikat-Nr.	DE-11-MI002-PTB005 DE-11-MI002-PTB005	VT_Ref. MI-002/02/13 VT_Ref. MI-002/02/13	CE-0085CN0327 CE-0085CN0327	01 202 610/Q-07 0001 01 202 610/Q-07 0001
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	DVGW Cert GmbH Josef-Wimmer-Str. 53123 Bonn Germany	TÜV Cert Am Grauen Stein 51105 Köln Germany
No. Nr.	0102 0102	0102 0102	0085 0085	0035 0035
Marking Kennzechnung	CE M13 0106 0035			

Potsdam, 31.01.2014

Date | Stamp | Signature

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-Mail: info@vemmtec.com
ternet: www.vemmtec.com

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Kto.-Nr.: 6 607 023 035
BLZ: 100 500 00
IBAN: DE54 1005 0000 6607 0230 35
BIC: BELADEBEXXX

Bankverbindung:
Bayerische Hypo- und Vereinsbank AG
Kto.-Nr.: 355 170 233
BLZ: 160 200 86
IBAN: DE33 1602 0086 0 3551 70233
BIC: HYVEDEMM470

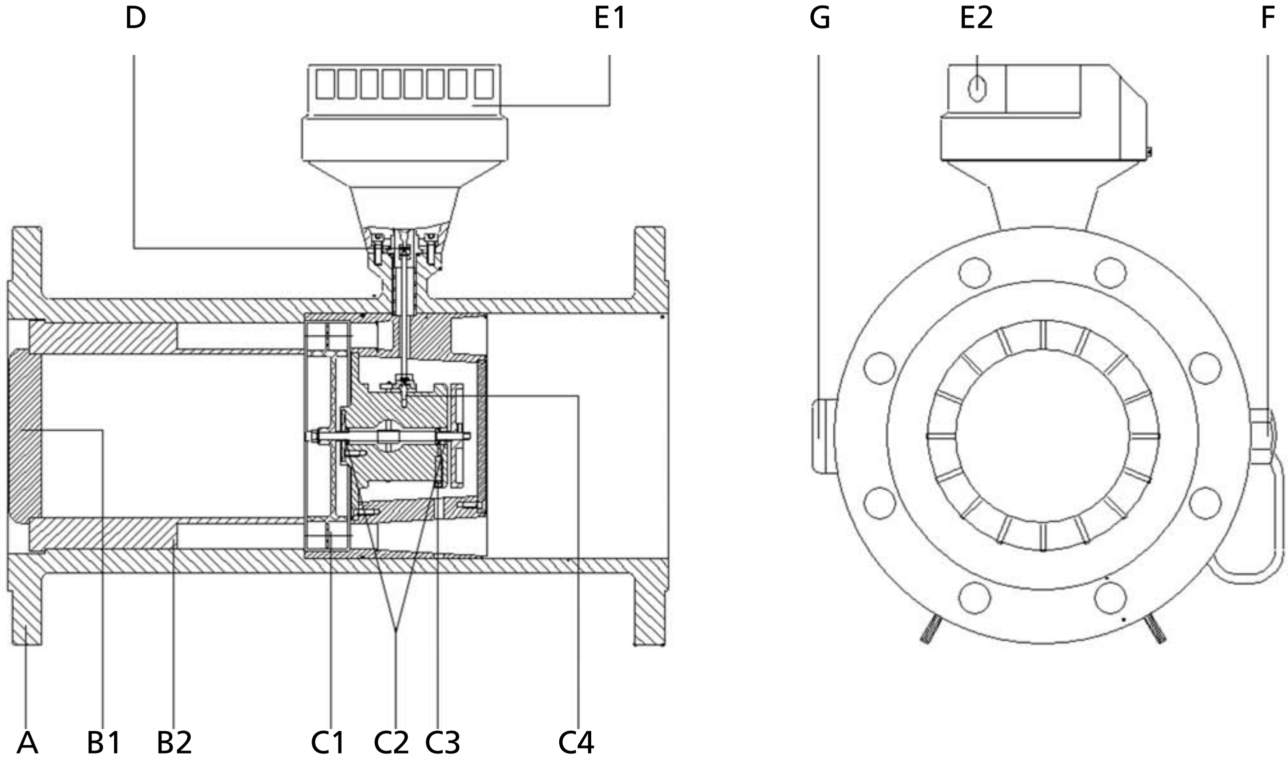
Geschäftsführer: Karst van Dellen
Registergericht: Kreisgericht Potsdam
Handelsregister: HRB 3559
Umsatzsteuer-Identnummer: DE 138402535

Table 11: Gas types

Gas type	**Symbol**	**Density at base conditions (1.013 bar a) [kg/m³]**	**Suitable at IGTM**		**Meter housing**	**Notes**
			CT	**WT**		
Acetylene	C_2H_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 + set of Viton O-rings
Butane	C_4H_{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_2H_6	1.36	X	X	Standard	
Ethylene (gas phase)	C_2H_4	1.26	X		Standard	Special internal
Flue gases*			X		Special	Viton O-rings / lubrication
Freon* (gas phase)	CCl_2F_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_2S	1.54	X		Special	Viton O-rings / 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	
Pentane	C_5H_{12}	3.46	X	X	Standard	
Propane	C_3H_8	2.02	X	X	Standard	
Propylene (gas phase)	C_3H_6	1.92	X		Standard	Special internal
Sour gas*			X		Special	Viton O-rings / lubrication
Sulphur dioxide (0.2 %)	SO_2	2.93	X		Special	Special internal

For all specials, please enquire at ***vemm tec.***
* Increased Lubrication Frequency, see Table 7

Figure 19: Main parts of the IGTM



A Pressure containing meter housing with (for CT models) end-flanges
B Flow conditioner
  B1 Central cone
  B2 Guiding vanes
C Metering insert cartridge with turbine wheel
  C1 Turbine wheel
  C2 Precision Bearings
  C3 Bearing block
  C4 Internal gears, shafts and axis
D Magnetic coupling (gas tight sealed)
E Index head with nameplates
  E1 Mechanical counter
  E2 Connector for Pulse transmitters [1R1; HF3 + options]
F Oil Pump
G High Frequency pulse transmitters [HF1; HF2]

Figure 20: *Gear drawing, IGTM Gear Train Schematic*

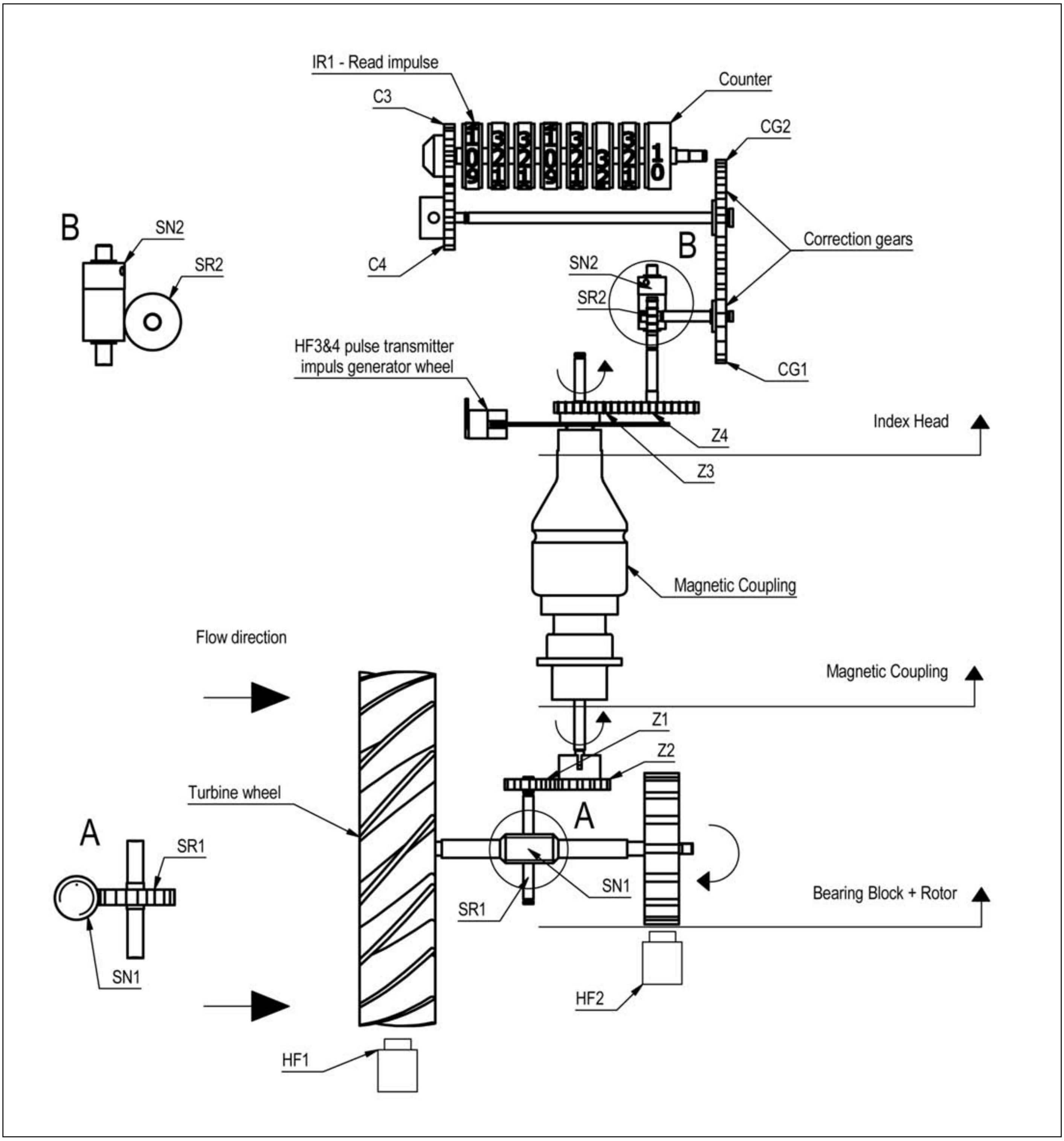


Figure 21: Seal plan

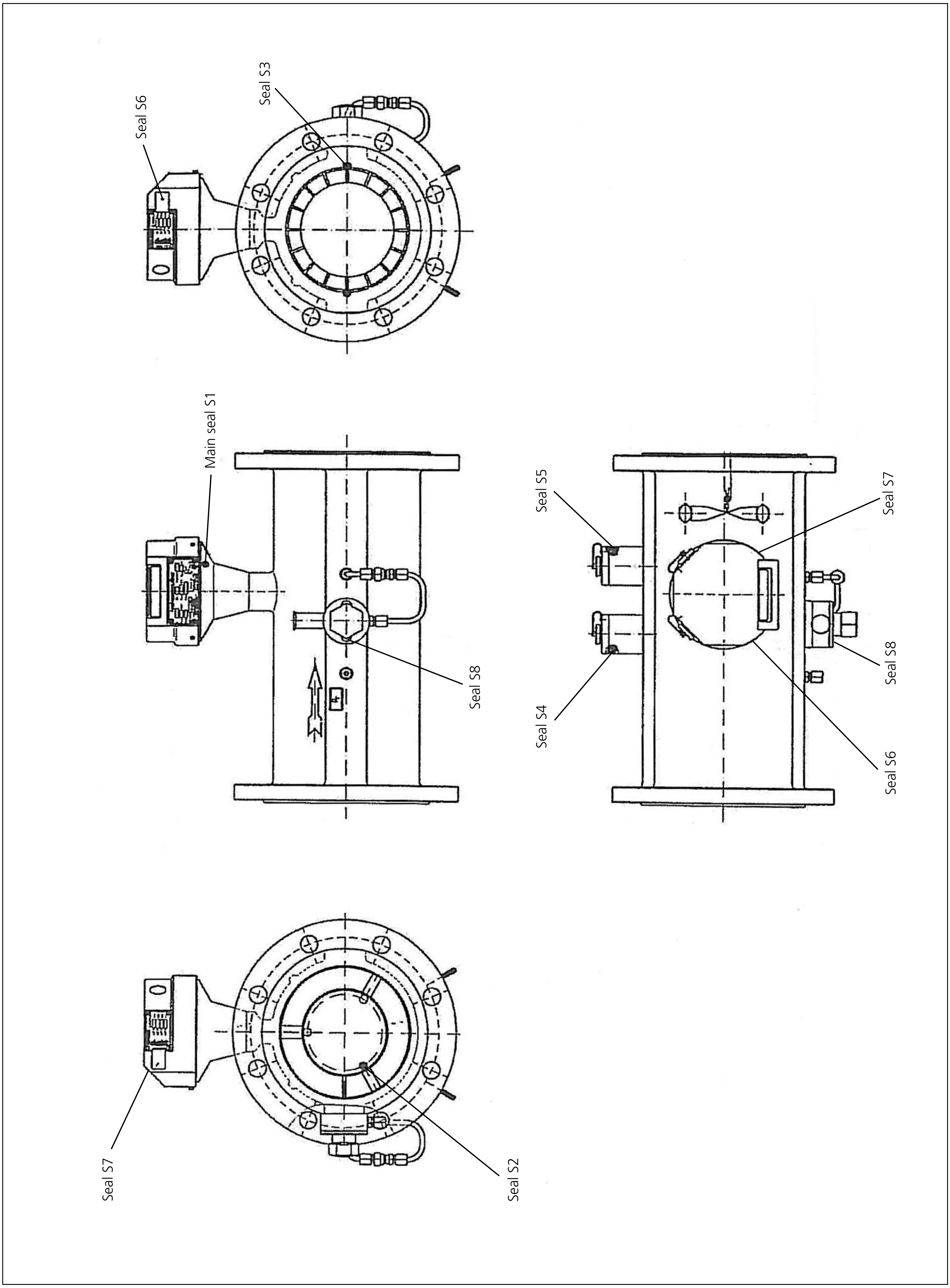


Table 12: Spare parts listing

Description	Part-number							
Spare parts per meter diameter	**DN 50 (2")**	**DN 65 (2.5")**	**DN 80 (3")**	**DN 100 (4")**	**DN 150 (6")**	**DN 200 (8")**	**DN 250 (10")**	**DN 300 (12")**
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 numbe							
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 se							
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 d (Suitable for all standard sensor connections)							
Magnetic coupling	76850.0100							
Metering cartridge	(Including aluminium turbine wheel, bearing block, bearings, shafts, completely asser and tested. Please indicate meter size and G-rate.)							
with turbine wheel 30 deg.	n/a	76841.1738	76842.3000 (38 deg)	76843.3000 76842.1730D	76844.3000 76843.1730D	76845.3000	76846.3000	76847.3000
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
Spare turbine wheel 30 deg.	n/a	76841.1073 (38 deg)	76842.1023	76843.1023	76844.1023	76845.1023	76846.1023	76847.1023
Spare turbine wheel 45 deg.	76841.1003		76842.1003	76843.1003	76844.1003	76845.1003	76846.1003	76847.1003
Flow straightener IGTM-CT	76821.1700	n/a	76822.1800 76823.1800[1]	76823.1700 76824.1710	76824.1700[2]	76825.1000	76826.1000	76827.1400
Flow straightener IGTM-WT	76821.1700	76821.1750	76822.2500	76823.2500	76824.2500	76825.1600 76826.1600	76826.1500[3]	76827.1500
Set of O-rings (for internals, index head, sensors, coupling)	76850.0291	76850.0291	76850.0292	76850.0293	76850.0294	76850.0295	76850.0296	76850.0297
Oil pump (piping not included)	76540.0030C				76863.1102C			
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	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

	DN 400 (16”)	DN 500 (20”)	DN 600 (24”)
)			
.)			
t for HF3.)			
iameter)			
mbled			
	76848.3000	76849.3000	76849.7000
	76848.1000	76849.1003	76849.4003
	76848.1023	76849.1023	76849.4023
	76848.1003	76849.1003	76849.4003
	76828.2000	76829.2000	76829.4000
	76828.1600		
	76850.0298	76850.0299	76850.02991
		76863.1104C	

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	VAC/VDC	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		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 Convertor	1	X	X	1		X	24 VDC	IM21-14Ex-CDTRI	KFD2-UFC-Ex1.D
Frequency-Current Convertor	1	X	X	1		X	85-253 VAC	IM21-14Ex-CDTRI	KFU8-UFC-Ex1.D
Frequency devider	1	X	X	1	passive		24 VDC	IM21-14Ex-CDTRI	KFD2-UFC-Ex1.D
Frequency devider	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* responsibel for unproper operation.

Carefully check the maximum frequency the devices can handle!

Table 14: Size dependent data and k-factors

Nominal	Size	IGTM-CT		IGTM-WT *)		Rotating	Turbine wheel		Maximum frequency				k-factor	
diameter	rating	Q_{max}	Q_{min}	Q_{max}	Q_{min}	speed			HF1/HF2	HF3/HF4	1R1	HF1/HF2	HF3/HF4	1R1
			Standard			turbine wheel			CT only	CT, option WT	CT+WT	CT only	CT, option WT	CT+WT
[mm]			flow range			at Q_{max}	blade	number	approx.	approx.	Reed	approx.	approx.	Reed
(inch)	G	[m³/h]	[m³/h]	[m³/h]	[m³/h]	[min⁻¹]	angle	of blades	[Hz]	[Hz]	[Hz]	[Imp/m³]	[Imp/m³]	[Imp/m³]
DN 50	G 40 *)	65	13	–	–	8900	45	16	2800	80	0,18	155000	4400	10
(2")	G 65 *)	100	10	100	10	13700	45	16	4300	120	0,28	155000	4400	10
DN 65 (2.5")	G 100 *)	–	–	160	13		38	16	–	315	0,45	–	7200	10
DN 80	G 100	160	8	–	–	6200	45	16	1900	50	0,04	42200	1200	1
(3")	G 160	250	13	250	10	9600	45	16	2900	80	0,07	42200	1200	1
	G 250	400	20	400	20	8900	30	16	2600	70	0,11	23500	670	1
DN 100	G 160	250	13	–	–	4300	45	16	1200	60	0,07	17000	800	1
(4")	G 250	400	20	400	13	6900	45	16	1900	90	0,11	17000	800	1
	G 400	650	32	650	32	6500	30	16	1700	80	0,18	9400	440	1
DN 150	G 400	650	32	–	–	3400	45	20	1100	70	0,18	6280	360	1
(6")	G 650	1000	50	1000	32	5200	45	20	1700	100	0,28	6280	360	1
	G 1000	1600	80	1600	80	4800	30	20	1600	60	0,04	3570	135	0,1
DN 200	G 650	1000	50	–	–	2200	45	20	790	40	0,03	2840	150	0,1
(8")	G 1000	1600	80	1600	50	3500	45	20	1300	70	0,04	2840	150	0,1
	G 1600	2500	130	2500	130	3100	30	20	1100	60	0,07	1510	80	0,1
DN 250	G 1000	1600	80	–	–	2000	45	24	830	60	0,04	1870	135	0,1
(10")	G 1600	2500	130	–	–	3100	45	24	1300	90	0,07	1870	135	0,1
	G 2500	4000	200	–	–	2900	30	24	1200	90	0,11	1110	80	0,1
DN 300	G 1600	2500	130	–	–	1900	45	24	780	60	0,07	1120	80	0,1
(12")	G 2500	4000	200	–	–	3000	45	24	1300	90	0,11	1120	80	0,1
	G 4000	6500	320	–	–	2800	30	24	1200	130	0,18	660	75	0,1
DN 400	G 2500	4000	200	–	–	1600	45	24	610	60	0,11	550	55	0,1
(16")	G 4000	6500	320	–	–	2600	45	24	990	100	0,18	550	55	0,1
	G 6500	10000	500	–	–	2300	30	24	1300	130	0,28	470	50	0,1
DN 500	G 4000	6500	320	–	–	1400	45	24	540	60	0,17	310	40	0,1
(20")	G 6500	10000	500	–	–	2300	45	24	860	100	0,28	310	40	0,1
	G 10000	16000	800	–	–	2000	30	24	750	30	0,04	170	8	0,01
DN 600	G 6500	10000	500	–	–	1100	45	24	420	40	0,02	150	15	0,01
(24")	G 10000	16000	800	–	–	1800	45	24	670	70	0,04	150	15	0,01
	G16000	25000	1300	–	–	1400	30	24	500	50	0,02	75	7	0,01

*) 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 **[mm] (Inch)**	**Size rating**	**Q_{max}** **[m³/h]**	**Standard flow range 1 : 20** **Q_{min} [m³/h]**	**Improved flow range 1 : 30** **Q_{min} [m³/h]**	**Best possible flow range 1: 40** **Q_{min} [m³/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
DN 500 (20")	G 4000	6500	**320**	**-**	-
	G 6500	10000	**500**	**320**	250
	G 10000	16000	**800**	**520**	400
DN 600 (24")	G 6500	10000	**500**	**-**	-
	G 10000	16000	**800**	**520**	400
	G 16000	25000	**1300**	**820**	620

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 calibration 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} [m³/h]	Q_{min} (standard flow range) [m³/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
DN 500 (20")	G 4000	6500	320	9,6	0,6	1,6	2,5
	G 6500	10000	500	14,8	1,2	3,2	5,0
	G 10000	16000	800	23,7	2,2	5,6	8,8
DN 600 (24")	G 6500	10000	500	10,01	0,6	1,5	2,4
	G 10000	16000	800	16,2	1,2	3,1	4,9
	G 16000	25000	1300	25,3	2,2	5,5	8,6

Figure 22: Dimensional drawing IGTM-CT

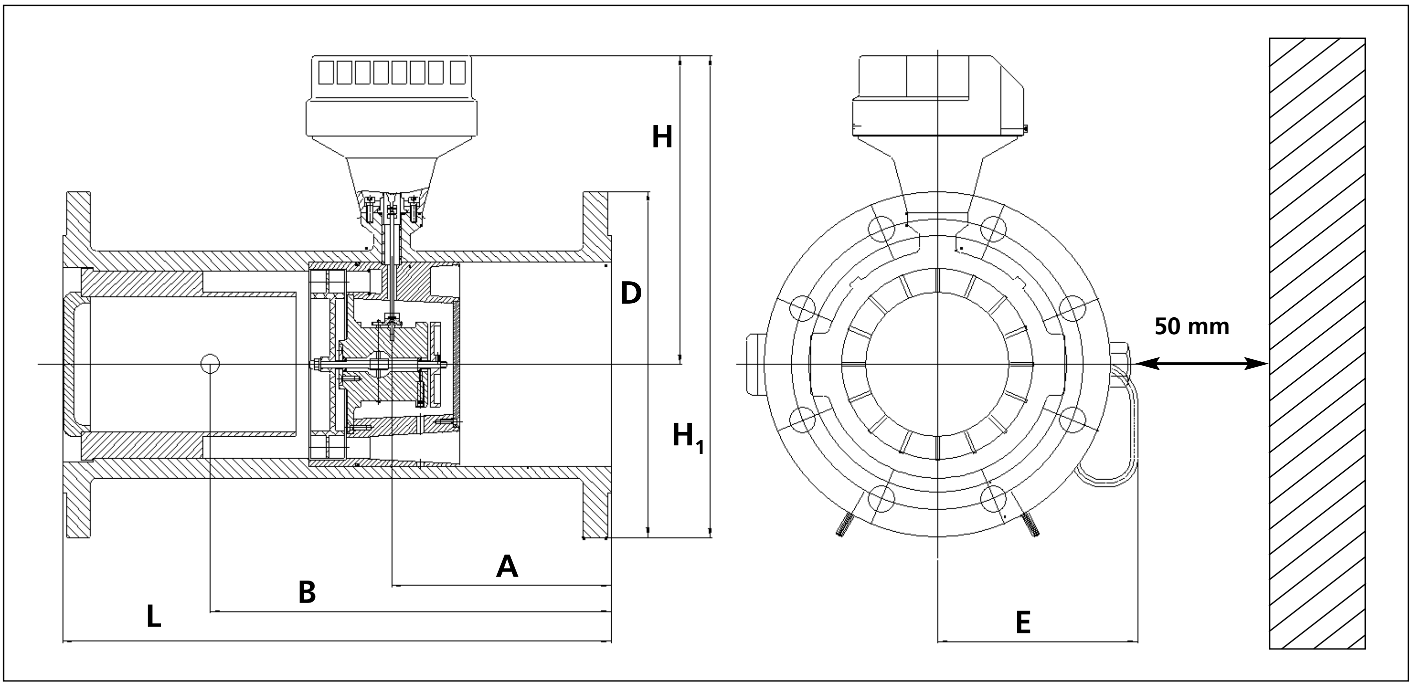


Table 17: Dimensions and weights IGTM-CT *(Part 1, continued on next page)*

DN [mm] [Inch]	Size G	A [mm]	B [mm]	E [mm]	D [mm]	H Height	Overall size Height H1 [mm]	Overall size Length L [mm]	Pressure class PN or ANSI	Body material	Weight [kg]
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	12
				127	165	200	283		PN 25/40	Steel	24
				127	180	205	295		PN 63	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	192	292		PN 10/16	Steel	24
					200	192	292		PN 25/40	Steel	26
					215	192	300		PN 63	Steel	32
					230	192	307		PN 100	Steel	35
					191	205	301		ANSI 150	Ductile Iron	17
					191	192	288		ANSI 150	Steel	24
					210	192	297		ANSI 300	Steel	28
					210	192	297		ANSI 400	Steel	29
					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	32
				140	235	215	333		PN 25/40	Steel	39
				140	250	215	340		PN 63	Steel	42
				140	265	215	348		PN 100	Steel	48
				135	229	230	345		ANSI 150	Ductile Iron	27
				140	229	215	330		ANSI 150	Steel	36
				140	254	215	342		ANSI 300	Steel	45
				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, continued on next page)*

DN [mm] [Inch]	Size G	A [mm]	B [mm]	E [mm]	D [mm]	H Height	Overall size Height H1 [mm]	Overall size Length L [mm]	Pressure class PN or ANSI	Body material	Weight [kg]
DN 150 (6")	400 or 650 or 1000	182	280	190	285	255	398	450	PN 10/16	Ductile Iron	45
				215	285	250	393		PN 10/16	Steel	45
				215	300	250	400		PN 25/40	Steel	40
				215	345	250	423		PN 63	Steel	74
				215	355	250	428		PN 100	Steel	90
				190	279	255	395		ANSI 150	Ductile Iron	50
				215	279	250	390		ANSI 150	Steel	63
				215	318	250	409		ANSI 300	Steel	80
				215	318	250	409		ANSI 400	Steel	80
				215	356	250	428		ANSI 600	Steel	103
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 63	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	116
					381		461		ANSI 400	Steel	135
					419		480		ANSI 600	Steel	158
DN 250 (10")	1000 or 1600 or 2500	300	415	240	395	285	483	750	PN 10	Steel	110
					405		488		PN 16	Steel	143
					425		498		PN 25	Steel	154
					450		510		PN 40	Steel	179
					470		520		PN 63	Steel	155
					505		538		PN 100	Steel	220
					406		488		ANSI 150	Steel	145
					445		508		ANSI 300	Steel	182
					445		508		ANSI 400	Steel	170
					508		539		ANSI 600	Steel	263
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 63	Steel	240
					585		613		PN100	Steel	345
					483		562		ANSI 150	Steel	232
					521		581		ANSI 300	Steel	279
					521		581		ANSI 400	Steel	310
					559		600		ANSI 600	Steel	355
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 63	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

Table 17: Dimensions and weights IGTM-CT

DN [mm] [Inch]	Size G	A [mm]	B [mm]	E [mm]	D [mm]	H Height	Overall size Height H1 [mm]	Length L [mm]	Pressure class PN or ANSI	Body material	Weight [kg]
DN 500 (20")	4000 or 6500 or 10000	600	730	390	670	375	710	1500	PN 10	Steel	540
					715		735		PN16	Steel	580
					730		742		PN25	Steel	640
					755		755		PN40	Steel	700
					699		725		ANSI 150	Steel	620
					775		765		ANSI 300	Steel	740
					775		765		ANSI 400	Steel	770
					813		785		ANSI 600	Steel	925
DN 600 (24")	6500 or 10000 or 16000	720	900	440	715	430	790	1800	PN 10	Steel	620
					840		850		PN 16	Steel	670
					845		855		PN 25	Steel	730
					813		840		ANSI 150	Steel	750
					915		890		ANSI 300	Steel	980
					915		890		ANSI 400	Steel	1020
					940		900		ANSI 600	Steel	1240

Figure 23: Dimensional drawing IGTM-WT

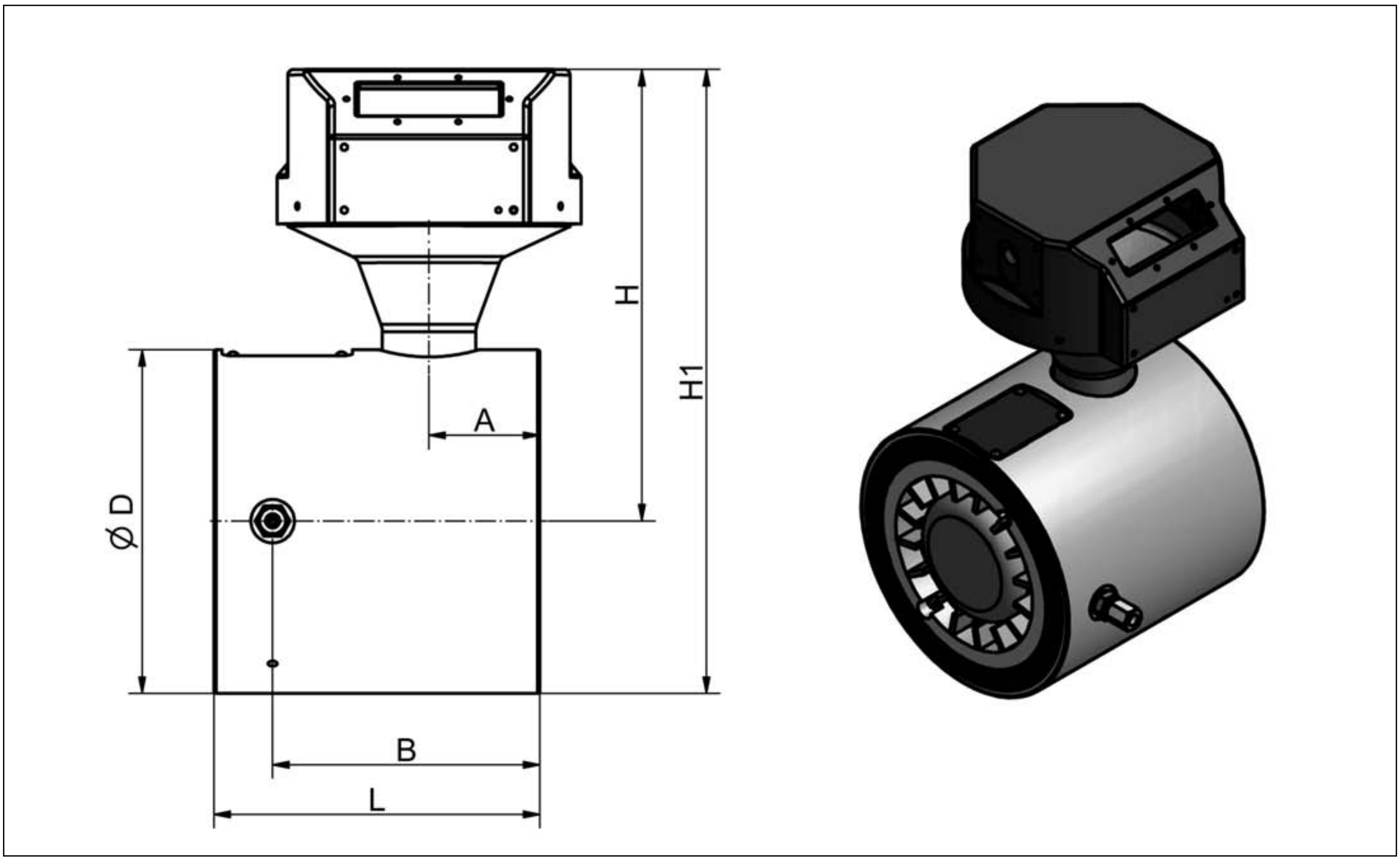


Table 18: Dimensions and weights IGTM-WT

DN [mm] [Inch]	Size G	A [mm]	B [mm]	E* [mm]	D [mm]	H Height	Overall size Height H1 [mm]	Length L [mm]	Pressure class PN or ANSI	Body material	Weight [kg]
DN 50 (2″)	40 & 65	31.5	87	-	102	176	227	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 & 160 250	26.5	82	-	138	197	266	120			5.1
DN 100 (4″)	160 & 250 400	51	123	-	158	207	286	150			6.8
DN 150 (6″)	400 & 650 1000	57	146	190	216	235	343	180			12.8
DN 200 (8″)	650 & 1000 1600	69	150	218	270	262	397	200			19.2

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

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 coutries 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.

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