

Print Back



**Government of India**  
**Ministry of Commerce & Industry**  
**Petroleum & Explosives Safety Organisation (PESO)**  
**5th Floor, A-Block, CGO Complex, Seminary Hills,**  
**Nagpur - 440006**

E-mail : [explosives@explosives.gov.in](mailto:explosives@explosives.gov.in)

Phone/Fax No : 0712 -2510248, Fax-2510577

Approval No : A/P/HQ/MH/104/7146 (P532033)

Dated : 24/05/2022

To,

**M/s. Emerson – Rosemount, Micro Motion Inc.,**  
**12001 Technology Drive,Eden Prairie**  
**MN 55344**  
**U.S.A**

**Sub :** Approval of Flame Proof, Intrinsically Safe Type Electrical Equipment under Petroleum Rules 2002-Regarding.

Sir(s),

Please refer to your letter No. **OIN1066826** dated **08/05/2022** on the subject.

The following Ex electrical equipment(s) manufactured by you according to **IEC 60079-0 : 2017, IEC 60079-1 : 2014-06, IEC 60079-11 : 2011, IEC 60079-26 : 2014,** standards and covered under **DEKRA Certification B.V.** Test reports mentioned below is/are approved for use in **Zone 1** of Gas **IIC** hazardous areas coming under the the Petroleum Rules, 2002 administered by this Organization.

Sr. No	Description	Safety Protection	Equipment reference Number	Test Agency			Drawing no
				Name	Certificate No.	Certificate Date	
1	Magnetic Flow Tube Models 8711-M/L	Ex db [ia Ga] IIC T6....T3 Gb	<b>P532033/1</b>	DEKRA Certification B.V.	IECEX DEK 14.0031X Issue No. 8	12/05/2021	08732-2020 Sheet 1-9 Rev AG
2	Magnetic Flow Tube Models 8705-M	Ex db [ia Ga] IIC T6....T3 Gb	<b>P532033/2</b>	DEKRA Certification B.V.	IECEX DEK 14.0031X Issue No. 8	12/05/2021	08732-2020 Sheet 1-9 Rev AG
3	Magnetic Flow Transmitter Models 8712EM	Ex db [ia Ga] IIC T6....T3 Gb	<b>P532033/3</b>	DEKRA Certification B.V.	IECEX DEK 14.0031X Issue No. 8	12/05/2021	08732-2020 Sheet 1-9 Rev AG

This Approval is granted subject to observance of the following conditions:-

- 1)The design and construction of the equipment shall be strictly in accordance with description, condition and drawings as mentioned in the DEKRA Certification B.V. Test Reports referred to above.
- 2)The equipment shall be used only with approved type of accessories and associated apparatus.
- 3)Each equipment shall be marked either by raised lettering cast integrally or by plate attached permanently to the main structure to indicate conspicuously:-
  - (a) Name of the manufacturer
  - (b) Name and number by which the equipment is identified.
  - (c) Number & date of the test report of the DEKRA Certification B.V. applicable to the equipment.
  - (d) Equipment reference number of this letter by which use of apparatus is approved.
  - (e) Protection level.

- 4) A certificate to the effect that the equipment has been manufactured strictly in accordance with the drawing referred to in the DEKRA Certification B.V. Test report and is identical with the one tested and certified at DEKRA Certification B.V. shall be furnished with each equipment.
- 5) The customer shall be supplied with a copy of this letter, an extract of the conditions and maintenance schedule, if any, recommended by DEKRA Certification B.V. in their test reports and copy of instructions booklet detailing operation & maintenance of the equipment so as to maintain its Flame Proof characteristics.
- 6) The After sales service and maintenance of subject equipment shall be looked after by your representative M/s. Emerson Process Management (India) Private Limited, Plot No. A-145/4, T.T.C. Industrial Area, M.I.D.C. Pawane, Near Koparkhairne, Navi Mumbai - 400 710 (Maharashtra)

**Conditions of the Approval:-**

The approval for above equipment is subject to validity of IECEx Quality Assessment Report No. NO/PRE/QAR15.0018.

This approval also covers the permissible variations as approved under the DEKRA Certification B.V. test reports referred above. This approval is liable to be cancelled if any of the conditions of the approval is violated or not complied with. The approval may also be amended or withdrawn at any time, if considered necessary in the interest of safety.

The field performance report from actual users/your customers of the subject equipment may please be collected and furnished to this office for verification and record on annual basis.

The Approval is Valid upto **31/12/2026**

Yours faithfully,

**(A.B. Tamgadge)**  
**Controller of Explosives**  
**For Chief Controller of Explosives**  
**Nagpur**

Copy to :

1. Jt. Chief Controller of Explosives, West Circle, MUMBAI
2. M/s. Emerson Process Management (India) Private Limited, Plot No. A-145/4, T.T.C. Industrial Area, M.I.D.C. Pawane, Near Koparkhairne, Navi Mumbai - 400 710 (Maharashtra)

**for Chief Controller of Explosives**  
**Nagpur**

(For more information regarding status, fees and other details please visit our website <http://peso.gov.in>)

**This is System Generated document. Signature is not required.**

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# IECEX Certificate of Conformity

## INTERNATIONAL ELECTROTECHNICAL COMMISSION IEC Certification System for Explosive Atmospheres

for rules and details of the IECEx Scheme visit [www.iecex.com](http://www.iecex.com)

Certificate No.: **IECEX DEK 14.0031X** Page 1 of 6 Certificate history:  
Status: **Current** Issue No: 8 [Issue 7 \(2020-10-07\)](#)  
Date of Issue: 2021-05-12 [Issue 6 \(2019-03-22\)](#)  
Applicant: **Emerson – Rosemount, Micro Motion Inc.** [Issue 5 \(2018-04-05\)](#)  
12001 Technology Drive [Issue 4 \(2017-09-12\)](#)  
Eden Prairie [Issue 3 \(2017-03-14\)](#)  
MN 55344 [Issue 2 \(2016-06-03\)](#)  
**United States of America** [Issue 1 \(2015-02-18\)](#)  
[Issue 0 \(2014-12-23\)](#)

Equipment: **Magnetic Flow Transmitter Models 8732EM and 8712EM and Magnetic Flow Tube Models 8705-M and 8711-M/L**

Optional accessory:

Type of Protection: **Ex db, Ex eb, Ex ia, Ex ib, Ex ic, Ex nA, Ex ec and Ex tb**

Marking: For details see Annex 1 to NL/DEK/ExTR14.0033/08.

Approved for issue on behalf of the IECEx  
Certification Body:

**R. Schuller**

Position:

**Certification Manager**

Signature:  
(for printed version)

Date:

2021-05-12

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting [www.iecex.com](http://www.iecex.com) or use of this QR Code.



Certificate issued by:

**DEKRA Certification B.V.**  
**Meander 1051**  
**6825 MJ Arnhem**  
**Netherlands**





# IECEX Certificate of Conformity

Certificate No.: **IECEX DEK 14.0031X**

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Date of issue: 2021-05-12

Issue No: 8

Manufacturer: **Emerson – Rosemount, Micro Motion Inc.**  
12001 Technology Drive  
Eden Prairie  
MN 55344  
**United States of America**

Additional  
manufacturing  
locations:

**F-R Tecnologías De Flujo, S.A. De C.V.**  
Rosemount Flow Division Operations  
Ave. Miguel de Cervantes 111  
31136 Chihuahua  
**Mexico**

**Emerson Process Management Flow B.V.**  
Neonstraat 1  
6718 WX Ede  
**Netherlands**

**Emerson Process Management Flow  
Technologies Co., Ltd.**  
111, Xing Min South Road  
Jiangning District, Nanjing  
Jiangsu Province, 211100  
**China**

**Emerson SRL**  
Emerson Street No 4  
400641 Cluj-Napoca, Romania  
**Romania**

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements. This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended

## STANDARDS :

The equipment and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards

**IEC 60079-0:2017** Explosive atmospheres - Part 0: Equipment - General requirements  
Edition:7.0

**IEC 60079-1:2014-06** Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"  
Edition:7.0

**IEC 60079-11:2011** Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"  
Edition:6.0

**IEC 60079-15:2010** Explosive atmospheres - Part 15: Equipment protection by type of protection "n"  
Edition:4

**IEC 60079-26:2014-10** Explosive atmospheres – Part 26: Equipment with Equipment Protection Level (EPL) Ga  
Edition:3.0

**IEC 60079-31:2013** Explosive atmospheres - Part 31: Equipment dust ignition protection by enclosure "t"  
Edition:2

**IEC 60079-7:2017** Explosive atmospheres - Part 7: Equipment protection by increased safety "e"  
Edition:5.1

This Certificate **does not** indicate compliance with safety and performance requirements other than those expressly included in the Standards listed above.

## TEST & ASSESSMENT REPORTS:

A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in:

Test Reports:

[NL/DEK/ExTR14.0030/09](#)

[NL/DEK/ExTR14.0031/08](#)

[NL/DEK/ExTR14.0033/08](#)



# IECEX Certificate of Conformity

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Quality Assessment Report:

[NO/PRE/QAR15.0018/02](#)



# IECEX Certificate of Conformity

Certificate No.: **IECEX DEK 14.0031X**

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Date of issue: 2021-05-12

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## EQUIPMENT:

Equipment and systems covered by this Certificate are as follows:

### Magnetic Flow Transmitter Model 8732EM

The Magnetic Flow Transmitter Model 8732EM may be remote mounted from or integrally mounted on the Magnetic Flow Tubes Models 8705-M or 8711-M/L.

The 8732EM Transmitter comprises a termination compartment in types of protection Ex eb, Ex db, Ex nA, Ex ec or Ex tb for connecting power and output signal (optionally intrinsically safe Ex ia). The main compartment of the enclosure in types of protection Ex db, Ex nA, Ex ec or Ex tb includes the electronics, optional Local Operator Interface (LOI) or display, intrinsically safe Ex ia supplies for the flow sensor and optionally intrinsically safe Ex ia output signal.

For connection to the Magnetic Flow Tubes, the transmitter comprises a current limiting circuit.

The connection to the Remote Mount Magnetic Flow Tube terminals for the field coils and electrode wiring (optionally intrinsically safe Ex ia) are provided in the Remote Junction Box compartment in types of protection Ex eb, Ex nA, Ex ec or Ex tb.

The Integral Mount Transmitter is mounted directly on the tube adaptor of the Magnetic Flow Tube.

Degree of protection, per IEC 60079-0 and IEC 60529: IP66  
Ambient temperature range:  $-50\text{ °C} \leq T_{\text{amb}} \leq +60\text{ °C}$

For more information see Annex 1 to NL/DEK/ExTR14.0033/07.

## SPECIFIC CONDITIONS OF USE: YES as shown below:

### Magnetic Flow Transmitter Models 8732EM

- Models marked with ESD warning label, do not rub surface with a dry cloth or clean with solvents to avoid electrostatic charge build-up.
- Conduit entries must be installed to maintain the enclosure ingress rating of IP66.
- Terminals for the output signals of the Magnetic Flow Transmitters, cannot withstand the 500 V isolation test between signal and ground, due to integral transient protection up to a voltage of 250 Vac. This must be taken into account upon installation.
- The property class of the special fasteners which attach the Magnetic Flow Tube or Transmitter Remote Junction Box to the Magnetic Transmitter is A2-70 or A4-70 SST.
- For information on the dimensions of the flameproof joints the manufacturer shall be contacted.

### Magnetic Flow Transmitter Models 8712EM

- Models marked with ESD warning label, do not rub surface with a dry cloth or clean with solvents to avoid electrostatic charge build-up.
- Conduit entries must be installed to maintain the enclosure ingress rating of IP 66 or IP69K.
- When utilizing the keypad of Magnetic Flow Transmitter Model 8712EM, instructions for safe use regarding potential electrostatic charging hazard have to be followed.
- Terminals for the output signals of the Magnetic Flow Transmitters, cannot withstand the 500 V isolation test between signal and ground, due to integral transient protection. This must be taken into account upon installation.

### Magnetic Flow Tube Models 8705-M and 8711-M/L

- The Magnetic Flow Tubes wetted parts may contain Titanium and Zirconium. It is the responsibility of the end user to eliminate ignition hazards due to impact or friction for processes that require EPL Ga or Gb.
- The Magnetic Flow Tube contains non-conductive liners covering the grounded flow tube. For process requiring EPL Ga, precautions shall be taken to avoid the liner being charged by the flow of non-conductive media.
- In order to maintain the ingress protection level on the M3 and M4 electrode housing, the copper crush washer that seals the electrode access plug shall be replaced when the plug is reinstalled. The copper crush washer is one time use only.
- The property class of the special fasteners which attach the Magnetic Flow Tube or Transmitter Remote Junction Box to the Magnetic Transmitter is A2-70 or A4-70 SST.
- Models marked with ESD warning label, do not rub surface with a dry cloth or clean with solvents to avoid electrostatic charge build-up.
- For information on the dimensions of the flameproof joints the manufacturer shall be contacted.
- Conduit entries must be installed to maintain the enclosure ingress rating of IP66.



# IECEX Certificate of Conformity

Certificate No.: **IECEX DEK 14.0031X**

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## Equipment (continued):

### Magnetic Flow Transmitter Model 8712EM

The Magnetic Flow Transmitter Model 8712EM is remote mounted from the Magnetic Flow Tubes Models 8705-M or 8711-M/L.

The main compartment of the enclosure in types of protection Ex ec, Ex nA or Ex tb includes the electronics, optional Local Operator Interface (LOI), optional intrinsically safe Ex ia supplies for the flow sensor and optionally intrinsically safe Ex ia output signal. The optional keypad for the LOI is in type of protection Ex ic.

The 8712EM Transmitter comprises a termination compartment in types of protection Ex ec, Ex nA or Ex tb for connecting power and output signal (with optional intrinsically safe Ex ia outputs), field coils and electrode wiring (optionally intrinsically safe Ex ia).

For connection to the Magnetic Flow Tubes, the transmitter comprises a current limiting circuit.

Degree of protection, per IEC 60079-0 and IEC 60529: IP66  
Degree of protection, per ISO 20653: IP69K  
Ambient temperature range:  $-40\text{ °C} \leq T_{\text{amb}} \leq +60\text{ °C}$

### Magnetic Flow Tube Models 8705-M and 8711-M/L

The Magnetic Flow Tube Models 8705-M and 8711-M/L are designed for use with Magnetic Flow Transmitter Model 8732EM or 8712EM.

The Magnetic Flow Tube Models 8705-M and 8711-M/L may be remote mounted from the Magnetic Flow Transmitter Model 8732EM or 8712EM or may be integrally mounted to the Magnetic Flow Transmitter Model 8732EM. The Magnetic Flow Tube Model 8705-M is utilized with flanges for process connection. Model 8711-M/L is utilized with wafer process connection.

The Remote Mount Flow Tube comprises a Remote Junction Box in types of protection Ex eb, Ex nA, Ex ec or Ex tb for the connection of the field coils and electrode wiring (optionally intrinsically safe Ex ia, Ex ib or Ex ic) to the Remote Mount Magnetic Flow Transmitter.

The field coils are mounted in a welded compartment in types of protection Ex eb, Ex nA, Ex ec or Ex tb. The electrodes (optionally intrinsically safe Ex ia, Ex ib or Ex ic) are mounted in the same welded compartment as the field coils but protrude into the process medium.

The electrodes utilized in Model 8705-M may optionally be mounted in electrode housings that allow EPL Ga rating.

When utilized as EPL Db equipment, EPL Db does not apply to the process.

Degree of protection, per IEC 60079-0 and IEC 60529: IP66 Integral Mount  
Ambient temperature range:  
Carbon Steel wrapper (housing):  $-29\text{ °C} \leq T_{\text{amb}} \leq +60\text{ °C}$   
Stainless Steel wrapper (housing):  $-50\text{ °C} \leq T_{\text{amb}} \leq +60\text{ °C}$

For more information see Annex 1 to NL/DEK/ExTR14.0033/08.



# IECEX Certificate of Conformity

Certificate No.: **IECEX DEK 14.0031X**

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**DETAILS OF CERTIFICATE CHANGES (for issues 1 and above)**

Minor Drawing and construction changes

**Annex:**

[382894400-ExTR14.0033.08-Annex1.pdf](#)



Note: In this document [.] is used as decimal separator.

**Nomenclature Magnetic Flow Transmitter Model 8732EM and electrical data**

8732EM   R   1   B   2   K1   ...   M4   RT50   ...   SH   ...   V1   ...   F090...  
 I        II    III   IV   V   VI        VII    VIII        IX        X

Designation	Explanation	Value	Explanation																																																																				
I	Model	8732EM	Magnetic Flow Transmitter – Field Mount																																																																				
II	Transmitter Mount	R T	Remote Mount Integral Mount																																																																				
III	Transmitter Power Supply	1 2 3	AC (90 - 250 Vac, 50 / 60 Hz), not for Ex nA DC (12 - 42 Vdc) DC (12 - 30 Vdc)																																																																				
IV	Outputs	A B M F P	Non-IS: 4 - 20 mA with digital HART Protocol & Scalable Pulse Output I.S.: 4 - 20 mA Intrinsically Safe Output with digital HART Protocol & Intrinsically Safe Scalable Pulse Output Non-I.S.: Modbus RS-485 I.S.: Intrinsically Safe Fieldbus / FISCO and Intrinsically Safe Scalable Pulse Output I.S.: Intrinsically Safe Profibus and Intrinsically Safe Scalable Pulse Output																																																																				
V	Conduit entries	1 or 4 2 or 5	½-14 NPT female CM20, M20 female																																																																				
VI	Safety Approval Option	K1 ATEX K7 IECEx K9 IECEx N1 ATEX N7 IECEx ND ATEX	<table border="0"> <tr> <td>⊕ II 2 (1) G</td> <td>Ex db eb [ja Ga] IIC T6...T3 Gb</td> </tr> <tr> <td>⊕ II 2 D</td> <td>Ex tb IIIC T80 °C...T200 °C Db</td> </tr> <tr> <td>⊕ II 2 (1) G</td> <td>Ex db eb [ja Ga] IIC T6...T3 Gb</td> </tr> <tr> <td>⊕ II 2 (1) D</td> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db **</td> </tr> <tr> <td>⊕ II 2 (1) G</td> <td>Ex db [ja Ga] IIC T6...T3 Gb *</td> </tr> <tr> <td>⊕ II 2 D</td> <td>Ex tb IIIC T80 °C...T200 °C Db</td> </tr> <tr> <td>⊕ II 2 (1) G</td> <td>Ex db [ja Ga] IIC T6...T3 Gb *</td> </tr> <tr> <td>⊕ II 2 (1) D</td> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db **</td> </tr> </table> <table border="0"> <tr> <td>Ex db eb [ja Ga] IIC T6...T3 Gb</td> <td></td> </tr> <tr> <td>Ex tb IIIC T80 °C...T200 °C Db</td> <td></td> </tr> <tr> <td>Ex db eb [ja Ga] IIC T6...T3 Gb</td> <td></td> </tr> <tr> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db **</td> <td></td> </tr> <tr> <td>Ex db [ja Ga] IIC T6...T3 Gb *</td> <td></td> </tr> <tr> <td>Ex tb IIIC T80 °C...T200 °C Db</td> <td></td> </tr> <tr> <td>Ex db [ja Ga] IIC T6...T3 Gb *</td> <td></td> </tr> <tr> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db **</td> <td></td> </tr> </table> <table border="0"> <tr> <td>Ex db eb [ja Ga] IIC T6...T3 Gb</td> <td></td> </tr> <tr> <td>Ex tb IIIC T80 °C...T200 °C Db</td> <td></td> </tr> <tr> <td>Ex db eb [ja Ga] IIC T6...T3 Gb</td> <td></td> </tr> <tr> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db **</td> <td></td> </tr> </table> <table border="0"> <tr> <td>⊕ II 3 (1) G</td> <td>Ex nA [ja Ga] IIC T4...T3 Gc ***</td> </tr> <tr> <td>⊕ II 3 (1) G</td> <td>Ex ec [ja Ga] IIC T4...T3 Gc ***</td> </tr> <tr> <td>⊕ II 2 D</td> <td>Ex tb IIIC T80 °C...T200 °C Db</td> </tr> <tr> <td>⊕ II 3 (1) G</td> <td>Ex nA [ja Ga] IIC T4...T3 Gc ***</td> </tr> <tr> <td>⊕ II 3 (1) G</td> <td>Ex ec [ja Ga] IIC T4...T3 Gc ***</td> </tr> <tr> <td>⊕ II 2 (1) D</td> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db **</td> </tr> </table> <table border="0"> <tr> <td>Ex nA [ja Ga] IIC T4...T3 Gc ***</td> <td></td> </tr> <tr> <td>Ex ec [ja Ga] IIC T4...T3 Gc ***</td> <td></td> </tr> <tr> <td>Ex tb IIIC T80 °C...T200 °C Db</td> <td></td> </tr> <tr> <td>Ex nA [ja Ga] IIC T4...T3 Gc ***</td> <td></td> </tr> <tr> <td>Ex ec [ja Ga] IIC T4...T3 Gc ***</td> <td></td> </tr> <tr> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db **</td> <td></td> </tr> </table> <table border="0"> <tr> <td>⊕ II 2 D</td> <td>Ex tb IIIC T80 °C...T200 °C Db</td> </tr> <tr> <td>⊕ II 2 (1) D</td> <td>Ex tb [ja Da] IIIC T80 °C...T200 °C Db</td> </tr> </table>	⊕ II 2 (1) G	Ex db eb [ja Ga] IIC T6...T3 Gb	⊕ II 2 D	Ex tb IIIC T80 °C...T200 °C Db	⊕ II 2 (1) G	Ex db eb [ja Ga] IIC T6...T3 Gb	⊕ II 2 (1) D	Ex tb [ja Da] IIIC T80 °C...T200 °C Db **	⊕ II 2 (1) G	Ex db [ja Ga] IIC T6...T3 Gb *	⊕ II 2 D	Ex tb IIIC T80 °C...T200 °C Db	⊕ II 2 (1) G	Ex db [ja Ga] IIC T6...T3 Gb *	⊕ II 2 (1) D	Ex tb [ja Da] IIIC T80 °C...T200 °C Db **	Ex db eb [ja Ga] IIC T6...T3 Gb		Ex tb IIIC T80 °C...T200 °C Db		Ex db eb [ja Ga] IIC T6...T3 Gb		Ex tb [ja Da] IIIC T80 °C...T200 °C Db **		Ex db [ja Ga] IIC T6...T3 Gb *		Ex tb IIIC T80 °C...T200 °C Db		Ex db [ja Ga] IIC T6...T3 Gb *		Ex tb [ja Da] IIIC T80 °C...T200 °C Db **		Ex db eb [ja Ga] IIC T6...T3 Gb		Ex tb IIIC T80 °C...T200 °C Db		Ex db eb [ja Ga] IIC T6...T3 Gb		Ex tb [ja Da] IIIC T80 °C...T200 °C Db **		⊕ II 3 (1) G	Ex nA [ja Ga] IIC T4...T3 Gc ***	⊕ II 3 (1) G	Ex ec [ja Ga] IIC T4...T3 Gc ***	⊕ II 2 D	Ex tb IIIC T80 °C...T200 °C Db	⊕ II 3 (1) G	Ex nA [ja Ga] IIC T4...T3 Gc ***	⊕ II 3 (1) G	Ex ec [ja Ga] IIC T4...T3 Gc ***	⊕ II 2 (1) D	Ex tb [ja Da] IIIC T80 °C...T200 °C Db **	Ex nA [ja Ga] IIC T4...T3 Gc ***		Ex ec [ja Ga] IIC T4...T3 Gc ***		Ex tb IIIC T80 °C...T200 °C Db		Ex nA [ja Ga] IIC T4...T3 Gc ***		Ex ec [ja Ga] IIC T4...T3 Gc ***		Ex tb [ja Da] IIIC T80 °C...T200 °C Db **		⊕ II 2 D	Ex tb IIIC T80 °C...T200 °C Db	⊕ II 2 (1) D	Ex tb [ja Da] IIIC T80 °C...T200 °C Db
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⊕ II 2 (1) D	Ex tb [ja Da] IIIC T80 °C...T200 °C Db **																																																																						
Ex nA [ja Ga] IIC T4...T3 Gc ***																																																																							
Ex ec [ja Ga] IIC T4...T3 Gc ***																																																																							
Ex tb IIIC T80 °C...T200 °C Db																																																																							
Ex nA [ja Ga] IIC T4...T3 Gc ***																																																																							
Ex ec [ja Ga] IIC T4...T3 Gc ***																																																																							
Ex tb [ja Da] IIIC T80 °C...T200 °C Db **																																																																							
⊕ II 2 D	Ex tb IIIC T80 °C...T200 °C Db																																																																						
⊕ II 2 (1) D	Ex tb [ja Da] IIIC T80 °C...T200 °C Db																																																																						

Note: In this document [.] is used as decimal separator.

**Nomenclature Magnetic Flow Transmitter Model 8732EM and electrical data (continued)**

Designation	Explanation	Value	Explanation
VI	Safety Approval Option	NF IECEx	Ex tb IIIC T80 °C...T200 °C Db
			Ex tb [ia Da] IIIC T80 °C...T200 °C Db
		NOTE:*	Integral Mount (see II) option only
		**	Intrinsically Safe Output (see IV) options B, F or P
		***	DC Transmitter Power Supply only (12 - 42 Vdc)
VII	Display Option	M4	LOI
		M5	Display
VIII	Remote Cable Option	RTxx ****	Standard Temperature Component
		RHxx ****	Extended Temperature Component
		NOTE:	**** Length = xx x 10 ft, max. 500 ft
IX	Options	--	Aluminum, standard paint
		SH	Stainless Steel Electronics Housing
		Vx	Special Paint Systems *****
X	Specials	F090x	Special Paint Systems *****
		NOTE:	***** Subject to special conditions for safe use.

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Note: In this document [.] is used as decimal separator.

**Nomenclature Magnetic Flow Transmitter Model 8712EM and electrical data**

8712EM   R   2   B   2   N7   ...   M4   RT50   ...   Vx   ...   F090...  
 I      II   III   IV   V   VI                      VII   VIII                      IX                      X

Designation	Explanation	Value	Explanation
I	Model	8712EM	Magnetic Flow Transmitter – Field Mount
II	Transmitter Mount	R	Remote Mount
III	Transmitter Power Supply	1 2 3	AC (90 - 250 Vac, 50 / 60 Hz) DC (12 - 42 Vdc) DC (12 – 30 Vdc)
IV	Outputs	A B M F P	Non-I.S.: 4 - 20 mA with digital HART Protocol & Scalable Pulse Output I.S.: 4 - 20 mA Intrinsically Safe Output with digital HART Protocol & Intrinsically Safe Scalable Pulse Output Non-I.S.: Modbus RS-485 I.S.: Intrinsically Safe Fieldbus / FISCO and Intrinsically Safe Scalable Pulse Output I.S.: Intrinsically Safe Profibus and Intrinsically Safe Scalable Pulse Output
V	Conduit entries	1 2	½-14 NPT female CM20, M20 female
VI	Safety Approval Option	N1 ATEX	⊕ II 3 (1) G Ex nA ic [ia Ga] IIC T4 Gc ** ⊕ II 3 (1) G Ex ec ic [ia Ga] IIC T4 Gc ** ⊕ II 2 D Ex tb IIIC T80 °C Db
			⊕ II 3 (1) G Ex nA ic [ia Ga] IIC T4 Gc ** ⊕ II 3 (1) G Ex ec ic [ia Ga] IIC T4 Gc ** ⊕ II 2 (1) D Ex tb [ia Da] IIIC T80 °C Db *
			Ex nA ic [ia Ga] IIC T4 Gc ** Ex ec ic [ia Ga] IIC T4 Gc ** Ex tb IIIC T80 °C Db
			Ex nA ic [ia Ga] IIC T4 Gc ** Ex ec ic [ia Ga] IIC T4 Gc ** Ex tb [ia Da] IIIC T80 °C Db *
			Ex nA ic [ia Ga] IIC T4 Gc ** Ex ec ic [ia Ga] IIC T4 Gc ** Ex tb IIIC T80 °C Db
			Ex nA ic [ia Ga] IIC T4 Gc ** Ex ec ic [ia Ga] IIC T4 Gc ** Ex tb [ia Da] IIIC T80 °C Db *
			⊕ II 2 D Ex tb IIIC T80 °C Db ⊕ II 2 (1) D Ex tb [ia Da] IIIC T80 °C Db *
			Ex tb IIIC T80 °C Db Ex tb [ia Da] IIIC T80 °C Db *
		NOTE: * Intrinsically Safe Output (see IV) options B, F, or P ** DC Transmitter Power Supply only (12 - 42 Vdc)	
VII	Display Option	-- M4 M5	Without LOI and keypad LOI + keypad Display
VIII	Remote Cable Option	Rxx	Standard Temperature Component
		NOTE: ***	Length = xx x 10 ft, max. 500 ft
IX	Options	-- Vx	Aluminum, standard paint Special Paint Systems ****
X	Specials	F090x	Special Paint Systems ****
		NOTE: ****	Subject to special conditions for safe use.

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Note: In this document [.] is used as decimal separator.

**Nomenclature Magnetic Flow Tube Model 8705-M and electrical data**

8705 ... S A 005 ... M4 K1 ... G1 L1 B3 ... J1 SC ... V1 ... SH ... F090x  
 I II III IV V VI VII VIII IX X XI XII XIII XIV

Designation	Explanation	Value	Explanation
I	Model	8705	Magnetic Flow Tube
II	Electrode Material	Custom	See special conditions for safe use
III	Electrode Types	Custom	Seal of electrodes comply with IEC 61010-1.
IV	Line Size	005 to 360	1/2" NPS (15 mm) to 36" NPS (900 mm)
V	Electrode Housing *	M0 M1 M2 M3 M4	Category 2 G or 3 G, EPL Gb or Gc Category 2 G or 3 G, EPL Gb or Gc Category 1/2 G or 1/3 G, EPL Ga/Gb or Ga/Gc Category 1/2 G or 1/3 G, EPL Ga/Gb or Ga/Gc Category 1/2 G or 1/3 G, EPL Ga/Gb or Ga/Gc
VI	Safety Approvals	K1 ATEX	Ex II 1/2 G Ex eb ia IIC T5...T3 Ga/Gb *
			Ex II 2 D Ex tb IIIC T80 °C...T200 °C Db
			Ex II 2 G Ex eb ib IIC T5...T3 Gb **
			Ex II 2 D Ex tb IIIC T80 °C...T200 °C Db
		K7 IECEX	Ex eb ia IIC T5...T3 Ga/Gb *
			Ex tb IIIC T80 °C...T200 °C Db
		K9 IECEX	Ex eb ib IIC T5...T3 Gb **
			Ex tb IIIC T80 °C...T200 °C Db
		N1 ATEX	Ex II 1/3 G Ex nA ia IIC T5...T3 Ga/Gc * line sizes 8"- 36"
			Ex II 1/3 G Ex ec ia IIC T5...T3 Ga/Gc * line sizes 8"- 36"
Ex II 2 D Ex tb IIIC T80 °C...T200 °C Db			
Ex II 3 G Ex nA ic IIC T5...T3 Gc * line sizes 0.5" - 6" / **			
Ex II 3 G Ex ec ic IIC T5...T3 Gc * line sizes 0.5" - 6" / **			
Ex II 2 D Ex tb IIIC T80 °C...T200 °C Db			
N7 IECEX	Ex nA ia IIC T5...T3 Ga/Gc * line sizes 8"- 36"		
	Ex ec ia IIC T5...T3 Ga/Gc * line sizes 8"- 36"		
	Ex tb IIIC T 80 °C...T200 °C Db		
	Ex nA ic IIC T5...T3 Gc * line sizes 0.5" - 6" / **		
ND ATEX	Ex ec ic IIC T5...T3 Gc * line sizes 0.5" - 6" / **		
	Ex tb IIIC T 80 °C...T200 °C Db		
NF IECEX	Ex tb IIIC T80 °C...T200 °C Db		
NOTE:*		Electrode Housing M2, M3 and M4 only	
**		Electrode Housing M0 and M1 only	
VII	Grounding rings material	Custom	See special conditions for safe use
VIII	Lining protector material	Custom	See special conditions for safe use
IX	Mounting Configuration	B3	Integral Mount with Model 8732EM
X	Optional conduit entries	J1	CM20, M20 female
XI	Remote Junction Box (RJB) material	--	Aluminum, standard paint
		SJ	316 Stainless steel
XII	Special paint options	Vx	Special Paint Systems ***
XIII	Wrapper (housing) material	--	Carbon Steel (w. Aluminum RJB), standard paint
		SH	316 Stainless Steel (w. Stainless Steel RJB)
XIV	Specials	F090x	Special Paint Systems ***
		NOTE: *** Subject to special conditions for safe use.	

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Note: In this document [.] is used as decimal separator.

**Nomenclature Magnetic Flow Tube Model 8711-M/L and electrical data**

8711 ... S A 15F L ... K1 ... G1 ... J1 SC ... V1 ... F090x  
 I II III IV V VI VII VIII IX X XI

Designation	Explanation	Value	Explanation
I	Model	8711	Magnetic Flow Tube
II	Electrode Material	Custom	See special conditions for safe use
III	Electrode Types	Custom	Seal of electrodes comply with IEC 61010-1.
IV	Line Size	015 to 080	1½" NPS (40 mm) to 8" NPS (900 mm)
V	Mounting Configuration	L M	Remote Mount from Transmitter Integral Mount with Transmitter
VI	Safety Approvals	K1 ATEX	Ex eb ib IIC T5...T3 Gb Ex tb IIIC T80 °C...T200 °C Db
		K7 IECEX	Ex eb ib IIC T5...T3 Gb Ex tb IIIC T80 °C...T200 °C Db
		K9 IECEX	Ex eb ib IIC T5...T3 Gb Ex tb IIIC T80 °C...T200 °C Db
		N1 ATEX	Ex nA ic IIC T5...T3 Gc Ex ec ic IIC T5...T3 Gc Ex tb IIIC T80 °C...T200 °C Db
		N7 IECEX	Ex nA ic IIC T5...T3 Gc Ex ec ic IIC T5...T3 Gc Ex tb IIIC T80 °C...T200 °C Db
		ND ATEX	Ex tb IIIC T80 °C...T200 °C Db
		NF IECEX	Ex tb IIIC T80 °C...T200 °C Db
VII	Grounding rings material	Custom	See special conditions for safe use
VIII	Optional conduit entries	J1	CM20, M20 female
IX	Remote Junction Box material	-- SJ	Aluminum, standard paint * 316 Stainless steel *
		NOTE: *	Flow Tube with Carbon Steel wrapper (housing)
X	Special paint options	Vx	Special Paint Systems **
XI	Specials	F090x	Special Paint Systems **
		NOTE: **	Subject to special conditions for safe use.



Note: In this document [.] is used as decimal separator.

Temperature class and specified maximum surface temperature “T” (continued)

Magnetic Flow Tube Model 8705-M

6"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	90 °C		Remote	T4		Remote	T110 °C
	120 °C	Ex nA	Remote	T4		Remote	T140 °C
	155 °C		Remote	T3		Remote	T175 °C
	180 °C	Remote	T3	Remote		T200 °C	
8-36"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	90 °C		Remote	T4		Remote	T110 °C
	120 °C	Ex nA	Remote	T4		Remote	T140 °C
	155 °C		Remote	T3		Remote	T175 °C
	180 °C	Remote *	T3	Remote *		T200 °C	

NOTE: \* Line Size 8" and greater shall be mounted with Remote Junction Box Down or to the Side.

Magnetic Flow Tube Model 8711-M/L

Line Size [NPS]	Max. Process Temperature	Type of protect.	Transmitter Mounting	T-class	Type of protect.	Transmitter Mounting	Maximum surface temperature "T"
1½"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	80 °C		Integral/Remote	T4		Remote	T100 °C
	100 °C	Ex nA	Remote	T4		Remote	T120 °C
	140 °C *		Remote	T3		Remote	T160 °C
	160 °C *	Ex nA	Remote	T3		Remote	T180 °C
2"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	80 °C		Integral/Remote	T4		Remote	T100 °C
	100 °C	Ex nA	Remote	T4		Remote	T120 °C
	140 °C *		Remote	T3		Remote	T160 °C
	160 °C *	Ex nA	Remote	T3		Remote	T180 °C
3"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	80 °C		Remote	T4		Remote	T100 °C
	110 °C	Ex nA	Remote	T4		Remote	T130 °C
	150 °C *		Remote	T3		Remote	T170 °C
	170 °C *	Ex nA	Remote	T3		Remote	T190 °C
4"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	80 °C		Remote	T4		Remote	T100 °C
	115 °C	Ex nA	Remote	T4		Remote	T135 °C
	155 °C *		Remote	T3		Remote	T175 °C
	175 °C *	Ex nA	Remote	T3		Remote	T195 °C
6"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	80 °C		Remote	T4		Remote	T100 °C
	115 °C	Ex nA	Remote	T4		Remote	T135 °C
	155 °C *		Remote	T3		Remote	T175 °C
	180 °C *	Ex nA	Remote	T3		Remote	T200 °C
8"	60 °C	Ex e	Integral/Remote	T5	Ex t	Integral/Remote	T80 °C
	80 °C		Remote	T4		Remote	T100 °C
	115 °C	Ex nA	Remote	T4		Remote	T135 °C
	160 °C *		Remote	T3		Remote	T180 °C
	180 °C *	Ex nA	Remote	T3		Remote	T200 °C

NOTE: \* Flow tubes on lines with these process temperatures and higher shall be mounted with Remote Junction Box Down.

**Electrical data**

**Magnetic Transmitter Model 8732EM**

Supply circuit (terminals 9 and 10):	AC power supply	90-250 Vac; 50/60 Hz; 40 VA; $U_m = 250\text{ V}$
Supply circuit (terminals 9 and 10):	DC power supply	12-42 Vdc; 15 W; $U_m = 250\text{ V}$
Supply circuit (terminals 9 and 10):	DC power supply	12-30 Vdc; 3 W; 0.25 A; $U_m = 250\text{ V}$
Dissipated power:	AC or DC	32 VA (w. Flow Tube connected)

Data circuit (terminals 5, 6, 7 and 8): Digital I/O signals  $U_m = 250\text{ V}$

**Output Signals**

Profibus, Foundation Fieldbus:

Output circuit (terminals 1 and 2):

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 30\text{ V}$ ;  $I_i = 380\text{ mA}$ ;  $P_i = 2.85\text{ W}$ ;  $C_i = 924\text{ pF}$ ;  $L_i = 0\text{ }\mu\text{H}$ .

Output circuit (terminals 3 and 4): Pulse

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 28\text{ V}$ ;  $I_i = 100\text{ mA}$ ;  $P_i = 1.0\text{ W}$ ;  $C_i = 4.5\text{ nF}$ ;  $L_i = 0.0\text{ }\mu\text{H}$ .

FISCO:

Output circuit (terminals 1 and 2):

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit or a circuit in accordance with FISCO, with the following maximum values:

$U_i = 30\text{ V}$ ;  $I_i = 380\text{ mA}$ ;  $P_i = 5.32\text{ W}$ ;  $C_i = 924\text{ pF}$ ;  $L_i = 0\text{ }\mu\text{H}$ .

Output circuit (terminals 3 and 4): Pulse

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 28\text{ V}$ ;  $I_i = 100\text{ mA}$ ;  $P_i = 1.0\text{ W}$ ;  $C_i = 4.5\text{ nF}$ ;  $L_i = 0.0\text{ }\mu\text{H}$ .

RS-485 Modbus digital Output & Scalable Pulse Output:

Output circuit (terminals 1 and 2): Modbus  $U_m = 250\text{ V}$

Output circuit (terminals 3 and 4): Pulse  $U_m = 250\text{ V}$

4 - 20 mA with digital HART Protocol & Scalable Pulse Output:

Output circuit (terminals 1 and 2): 4-20 mA  $U_m = 250\text{ V}$

Output circuit (terminals 3 and 4): Pulse  $U_m = 250\text{ V}$

4 - 20 mA Intrinsically Safe Output with digital HART Protocol & Intrinsically Safe Scalable Pulse Output:

Output circuit (terminals 1 and 2): 4-20 mA

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 30\text{ V}$ ;  $I_i = 300\text{ mA}$ ;  $P_i = 1.0\text{ W}$ ;  $C_i = 924\text{ pF}$ ;  $L_i = 0.0\text{ }\mu\text{H}$ .

Output circuit (terminals 3 and 4): Pulse

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 28\text{ V}$ ;  $I_i = 100\text{ mA}$ ;  $P_i = 1.0\text{ W}$ ;  $C_i = 4.5\text{ nF}$ ;  $L_i = 0.0\text{ }\mu\text{H}$ .



**Electrical data (continued)**

**Magnetic Transmitter Model 8712EM**

Supply circuit (terminals L1 and N/L2):	AC power supply	90-250 Vac; 50/60 Hz; 40 VA; $U_m = 250 V$
Supply circuit (terminals DC+ and DC-):	DC power supply	12-42 Vdc; 15 W; $U_m = 250 V$
Supply circuit (terminals DC+ and DC-):	DC power supply	12-30 Vdc; 3W; 0.25 A, $U_m = 250 V$
Dissipated power:	AC or DC	32 VA (w. Flow Tube connected)

Data circuit (terminals 9, 10, 11 and 12): Digital I/O signals  $U_m = 250 V$

**Output signals**

Profibus, Foundation Fieldbus:

Output circuit (terminals 7 and 8):

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 30 V$ ;  $I_i = 380 mA$ ;  $P_i = 2.85 W$ ;  $C_i = 924 pF$ ;  $L_i = 0 \mu H$ .

Output circuit (terminals 5 and 6): Pulse

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 28 V$ ;  $I_i = 100 mA$ ;  $P_i = 1.0 W$ ;  $C_i = 4.5 nF$ ;  $L_i = 0.0 \mu H$ .

FISCO:

Output circuit (terminals 7 and 8):

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit or a circuit in accordance with FISCO, with the following maximum values:

$U_i = 30 V$ ;  $I_i = 380 mA$ ;  $P_i = 5.32 W$ ;  $C_i = 924 pF$ ;  $L_i = 0 \mu H$ .

Output circuit (terminals 5 and 6): Pulse

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 28 V$ ;  $I_i = 100 mA$ ;  $P_i = 1.0 W$ ;  $C_i = 4.5 nF$ ;  $L_i = 0.0 \mu H$ .

RS-485 Modbus digital Output & Scalable Pulse Output:

Output circuit (terminals 7 and 8): Modbus  $U_m = 250 V$

Output circuit (terminals 5 and 6): Pulse  $U_m = 250 V$

4 - 20 mA with digital HART Protocol & Scalable Pulse Output:

Output circuit (terminals 7 and 8): 4-20 mA  $U_m = 250 V$

Output circuit (terminals 5 and 6): Pulse  $U_m = 250 V$

4 - 20 mA Intrinsically Safe Output with digital HART Protocol & Intrinsically Safe Scalable Pulse Output:

Output circuit (terminals 7 and 8): 4-20 mA

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 30 V$ ;  $I_i = 300 mA$ ;  $P_i = 1.0 W$ ;  $C_i = 924 pF$ ;  $L_i = 0.0 \mu H$ .

Output circuit (terminals 5 and 6): Pulse

In type of protection intrinsic safety Ex ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:

$U_i = 28 V$ ;  $I_i = 100 mA$ ;  $P_i = 1.0 W$ ;  $C_i = 4.5 nF$ ;  $L_i = 0.0 \mu H$ .

**Electrical data (continued)**

**Flow Tube connection**

Output circuit (terminals 1, 2 and 3): Coil drive 500 mA; 40 Vmax.; 9 Wmax.

For explosive gas or vapor atmospheres (Categories 1 G, 2 G and 3 G or EPL Ga, Gb, and Gc):

Output circuit (terminals 17, 18, 19): Electrode circuit

In types of protection intrinsic safety Ex ia IIC, Ex ib IIC or Ex ic IIC, with the following maximum values:

$U_o = 28.56 \text{ V}$ ;  $I_o = 5.77 \text{ mA}$ ;  $P_o = 165 \text{ mW}$ ;  $C_o = 61.7 \text{ nF}$ ;  $L_o = 1.0 \text{ H}$ .

For combustible dust atmospheres (Category 2 D or EPL Db):

Output circuit (terminals 17, 18, 19): Electrode circuit 5 V; 200  $\mu\text{A}$ ; 1 mW

**Flow Tube Models 8705-M**

**Flow Tube Remote Mount Junction Box, Transmitter connection**

Input circuit (terminals 1, 2 and 3): Coil drive 500 mA; 40 Vmax; 20 Wmax.

For explosive gas or vapor atmospheres (Categories 1 G, 2 G, 3 G or EPL Ga, Gb, Gc):

Input circuit (terminals 17, 18 and 19): Electrode circuit

In type of protection intrinsic safety Ex ia IIC, Ex ib IIC or Ex ic IIC, with the following maximum values:

$U_i = 30 \text{ V}$ ;  $I_i = 50 \text{ mA}$ ;  $P_i = 1.0 \text{ W}$ ;  $C_i = 1.9 \text{ nF}$ ;  $L_i = 630 \mu\text{H}$ .

For combustible dust atmospheres (Category 2 D or EPL Db):

Input circuit (terminals 17, 18 and 19): Electrode circuit 5 V; 200  $\mu\text{A}$ ; 1 mW

**Flow Tube Models 8711-M/L**

**Flow Tube Remote Mount Junction Box, Transmitter connection**

Input circuit (terminals 1, 2 and 3): Coil drive 500 mA; 40 Vmax.; 20 Wmax.

For explosive gas or vapor atmospheres (Categories 2 G, 3 G or EPL Gb, Gc):

Input circuit (terminals 17, 18 and 19): Electrode circuit

In type of protection intrinsic safety Ex ib IIC or Ex ic IIC, with the following maximum values:

$U_i = 30 \text{ V}$ ;  $I_i = 50 \text{ mA}$ ;  $P_i = 1.0 \text{ W}$ ;  $C_i = 1.9 \text{ nF}$ ;  $L_i = 630 \mu\text{H}$ .

For combustible dust atmospheres (Category 2 D or EPL Db):

Input circuit (terminals 17, 18 and 19): Electrode circuit 5 V; 200  $\mu\text{A}$ ; 1 mW