

# ***PROline prosonic flow 93***

## ***Division 1***



**Fieldbus  
Foundation**



Ex documentation for the BA 078D and BA 079D operating instructions according to FACTORY MUTUAL standards



Ex documentation for the BA 078D and BA 079D operating instructions according to CANADIAN STANDARDS ASSOCIATION



**Endress + Hauser**

The Power of Know How





# PROline prosonic flow 93

## Division 1

en

**Ex documentation**  
**for the BA 078D and BA 079D operating instructions**  
**according to FACTORY MUTUAL standards**



Example: **XP / I / 1 / ABCD**

### Type of Protection

XP	Explosionproof
IS	Intrinsically Safe Apparatus
AIS	Associated Apparatus with Intrinsically Safe Connections
ANI	Nonincendive Field Wiring Circuit
PX, PY, PZ	Pressurized
APX, APY, APZ	Associated Pressurization Systems/Components
NI	Nonincendive
DIP	Dust-Ignitionproof
S	Special Protection

### Class

I	Class I (Gas)
II	Class II (Dust)
III	Class III (Fibre)

### Division

1	Division 1
2	Division 2

### Group

FM / NEC	Gases, vapours and dusts (Examples)	Min. ignition temperature [μJ]
A	Acetylene, carbon disulfide (Class I)	0.02
B	Hydrogen, ethyl nitrate (Class I)	0.02
C	Ethylene, isoprene (Class I)	0.06
D	Acetone, ethane, benzene, ethanoic acid, gasolines, diesel oil, aircraft fuel, methane, heating oil, crude oil, hexane, ether (Class I)	0.18
E	Metallic powder (Class II)	
F	Coal dust (Class II)	
G	Mill dust (Class II)	
	Textile fibres (Class III)	

### Temperature Class

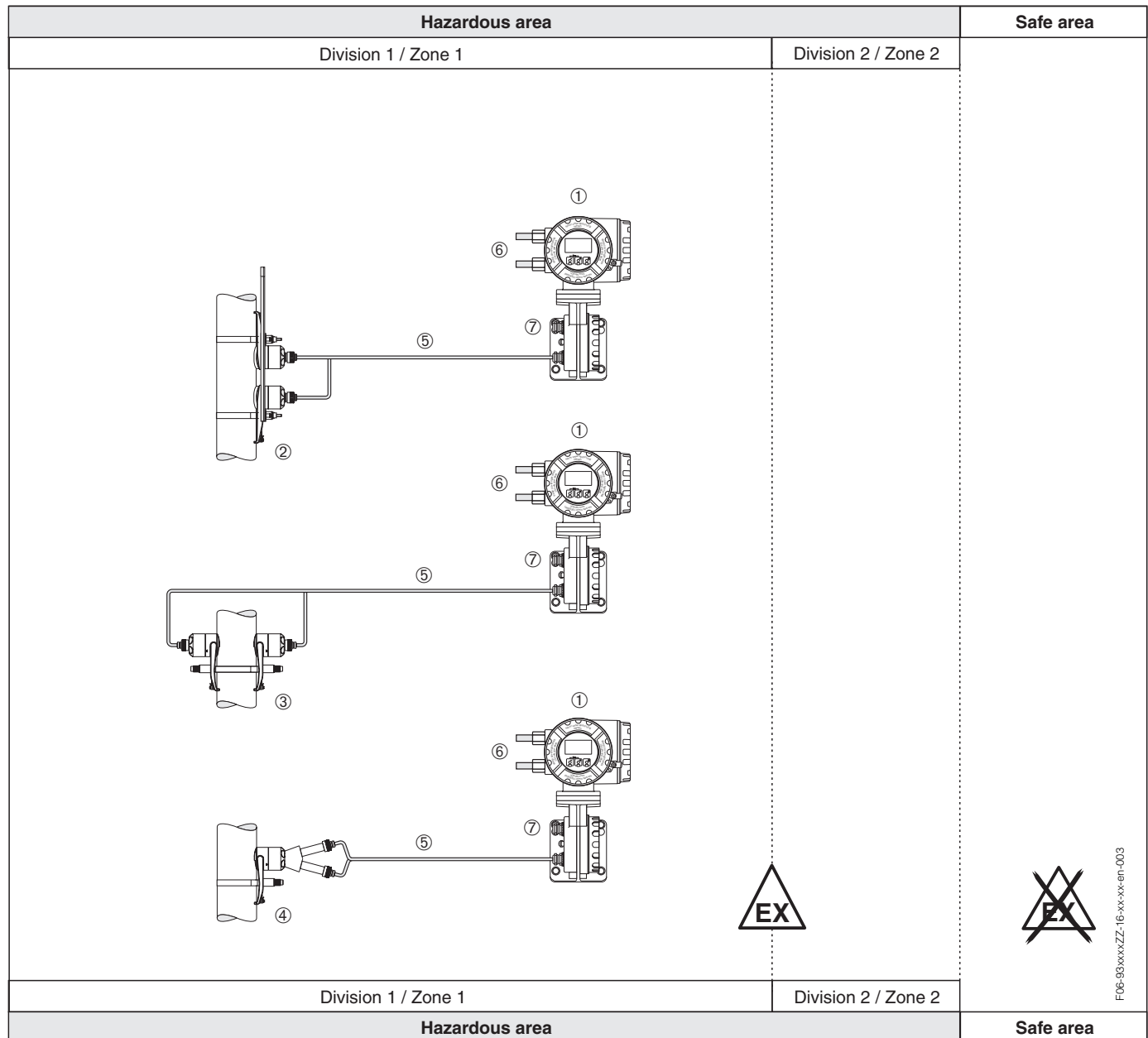
FM 3611	Maximum surface temperature	
T1	842 °F	450 °C
T2	572 °F	300 °C
T2A	536 °F	280 °C
T2B	500 °F	260 °C
T2C	446 °F	230 °C
T2D	419 °F	215 °C
T3	392 °F	200 °C
T3A	356 °F	180 °C
T3B	329 °F	165 °C
T3C	320 °F	160 °C
T4	275 °F	135 °C
T4A	248 °F	120 °C
T5	212 °F	100 °C
T6	185 °F	85 °C

Factory Mutual



**Endress + Hauser**  
The Power of Know How





F06-93xxxZZ-16-xx-xx-en-003

① Ultrasonic transmitter Prosonic Flow 93 FOUNDATION Fieldbus in:  
XP-AIS-DIP / I,II,III / 1 / ABCDEFG / T6

Explosionproof Enclosure

② Flow measuring sensors Prosonic Flow P (Clamp On) in:  
IS-DIP / I,II,III / 1 / ABCDEFG / T6-T1  
NEMA 6P

For ambient and medium temperature ranges,  
and temperature class, see Page 3.

Interconnection of components ① and ⑤ with sensors ②, ③ or ④ as loop concept.

For number references ⑥ and ⑦ see on Page 8.

③ Sensor velocity measuring sensors Prosonic Flow DDU 18  
(Clamp On) in:  
IS-DIP / I,II,III / 1 / ABCDEFG / T6-T1  
NEMA 6P

④ Wall thickness measuring sensor Prosonic Flow DDU 19  
(Clamp On) in:  
IS-DIP / I,II,III / 1 / ABCDEFG / T6-T1  
NEMA 4X

⑤ For safety reasons the max. cable length is 30 m.  
For interconnection between transmitter and sensors only  
prefabricated Endress+Hauser cables shall be used.  
Replace defective cables with new cables.

## Temperature tables

### Prosonic Flow\*\*PA\*-A/B\*\*\*\*\*N\*\*\*\*\* and Sound velocity measuring sensors DDU 18-A\*\*\*

at $T_a = 140\text{ }^{\circ}\text{F}$		Max. medium temperature [ $^{\circ}\text{F}$ ] in					
		T6	T5	T4	T3	T2	T1
<b>Sensors**PA*-A/B*****N*****</b>	PVC cables	176	176	176	176	176	176
<b>Sensors DDU 18-A***</b>	PVC cables	176	176	176	176	176	176

The minimum medium temperature is  $-40\text{ }^{\circ}\text{F}$

### Prosonic Flow\*\*PA\*-E/F\*\*\*\*\*N\*\*\*\*\* and Sound velocity measuring sensors DDU 18-B\*\*\*

at $T_a = 140\text{ }^{\circ}\text{F}$		Max. medium temperature [ $^{\circ}\text{F}$ ] in					
		T6	T5	T4	T3	T2	T1
<b>Sensors**PA*-E/F*****N*****</b>	PTFE cables	176	203	266	338	338	338
<b>Sensors DDU 18-B***</b>	PTFE cables	176	203	266	338	338	338

The minimum medium temperature is  $32\text{ }^{\circ}\text{F}$

### Wall thickness measuring sensor DDU 19-A\*\*\*

at $T_a = 140\text{ }^{\circ}\text{F}$		Max. medium temperature [ $^{\circ}\text{F}$ ] in					
		T6	T5	T4	T3	T2	T1
<b>Sensor DDU 19-A***</b>	PVC or PTFE cables	176	176	176	176	176	176

The minimum medium temperature is  $-4\text{ }^{\circ}\text{F}$

### Transmitter Prosonic Flow 93 P\*\*-\*\*\*\*\*

The Prosonic Flow 93 transmitter has a T6 temperature class rating when installed in the Explosionproof Enclosure for operation at ambient temperatures up to  $T_a = 140\text{ }^{\circ}\text{F}$ .

The maximum ambient temperature range is  $-4\dots+140\text{ }^{\circ}\text{F}$ .



Note:

At the specified medium temperatures, the equipment is not subjected to temperatures impermissible for the temperature class in question.

## Approvals

No. / approval type	Description
J.I. 3010849  (See Page 5 for notes on special conditions)	for the electric flow measuring system Prosonic Flow 93 P FOUNDATION Fieldbus  <b>Identification:</b> see below

<b>Transmitter Prosonic Flow 93 FOUNDATION Fieldbus</b>	
Prosonic Flow 93 P**-*****N****.	G = FOUNDATION Fieldbus, EEx i FISCO K = FOUNDATION Fieldbus
Prosonic Flow 93 P**-*****N****	<b>XP-AIS-DIP / I,II,III / 1 / ABCDEFG / T6</b>
<b>Flow measuring sensors</b>	
Prosonic Flow P	<b>IS-DIP / I,II,III / 1 / ABCDEFG / T6-T1</b>
<b>Sound velocity measuring sensors</b>	
Prosonic Flow DDU 18	<b>IS-DIP / I,II,III / 1 / ABCDEFG / T6-T1</b>
<b>Wall thickness measuring sensor</b>	
Prosonic Flow DDU 19	<b>IS-DIP / I,II,III / 1 / ABCDEFG / T6-T1</b>

## Notified body

The Prosonic Flow measuring system was tested for approval by the following named entity:

FM: Factory Mutual Research

## Special conditions



1. Control room equipment shall not use or generate more than 250 V rms.

Caution:

2. Use supply wires suitable for 41 °F above ambient temperature, but at least for 176 °F.
3. The specified temperature class in conjunction with the ambient temperature and the medium temperature must be in compliance with the tables on Page 3.
4. It is not permissible to connect the service adapter in explosive atmospheres.
5. Install per National Electrical Code. Install intrinsically safe circuits per NEC ANSI/NFPA 70 and ISA RP 12.6 respecting the explosionproof integrity of the enclosure.



Warning:

6. Substitution of components may impair intrinsic safety.
7. The flowmeter must be integrated into the potential equalisation system (see Fig. 1).

## General warnings



- Installation, connection to the electricity supply, commissioning and maintenance of the devices must be carried out by qualified specialists trained to work on Ex-rated devices.
- Compliance with national regulations relating to the installation of devices in potentially explosive atmospheres is mandatory, if such regulations exist.
- Open the device only when it is de-energized (and after a delay of at least 10 minutes following shutdown of the power supply).
- The housing of the Ex-rated transmitter can be turned in 90° steps. Whereas the non-Ex version has a bayonet adapter, however, the Ex version has a thread. Recesses for centering the worm screw are provided to prevent inadvertent movement of the transmitter housing.  
It is permissible to turn the transmitter housing through a maximum of 180° during operation (in either direction), without compromising explosion protection.  
After turning the housing the worm screw must be tightened again.
- The screw cap has to be removed before the local display can be turned, and this must be done with the device de-energized (and after a delay of at least 10 minutes following shutdown of the power supply). Be sure that the device is closed properly, before connecting it to power again.

Electrical connections

Power supply connection

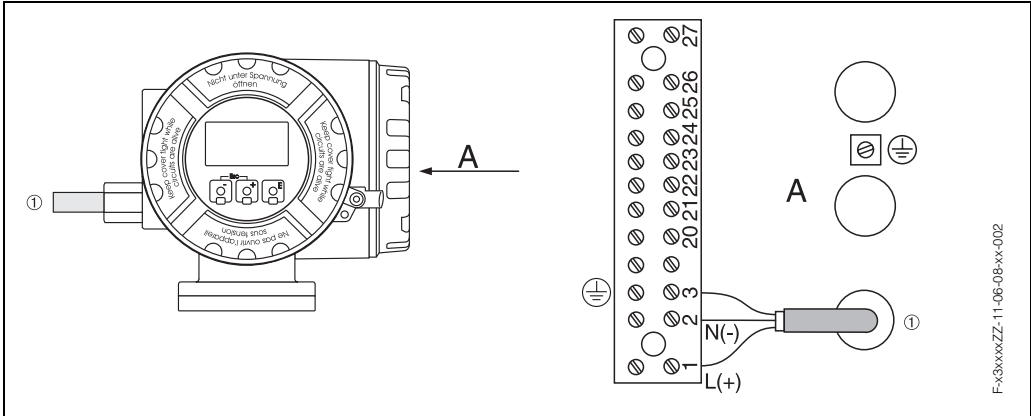


Fig. 1: ① = Power supply cable  
A = View A

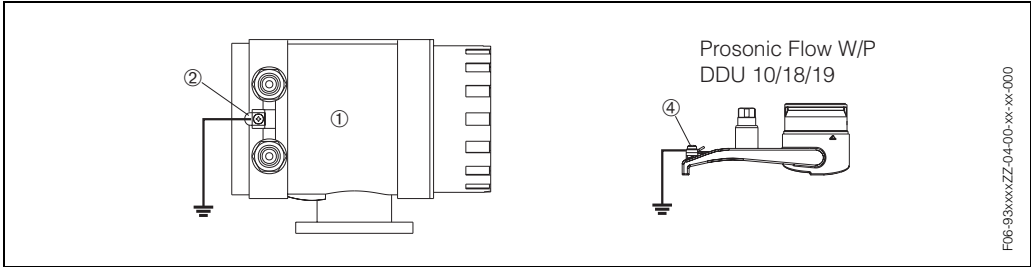


Fig. 2: Ground terminal for potential equalisation



Caution:

- The transmitter ① is to be securely connected to the potential equalization system using the screw terminal ② on the outside of the transmitter housing.
- The sensor holders are to be grounded using the external screw terminal ④. Alternatively, the sensor can be connected to the potential equalization system via the pipeline when a ground connection according to regulations can be assured.

The table below contains the values that are identical for all versions, irrespective of the type code.

Transmitter Prosonic Flow 93

Teminals	1	2	3
	L (+)	N (–)	
Designation	Power supply ①		Protective earth
Functional values	AC: U = 85...260 V or AC: U = 20...55 V or DC: U = 16...62 V  Power consumption: 15 VA / 15 W		Caution: Follow ground network requirements for the facility
Intrinsically safe circuit	no		
U <sub>m</sub> =	260 V AC		



Input/output circuit

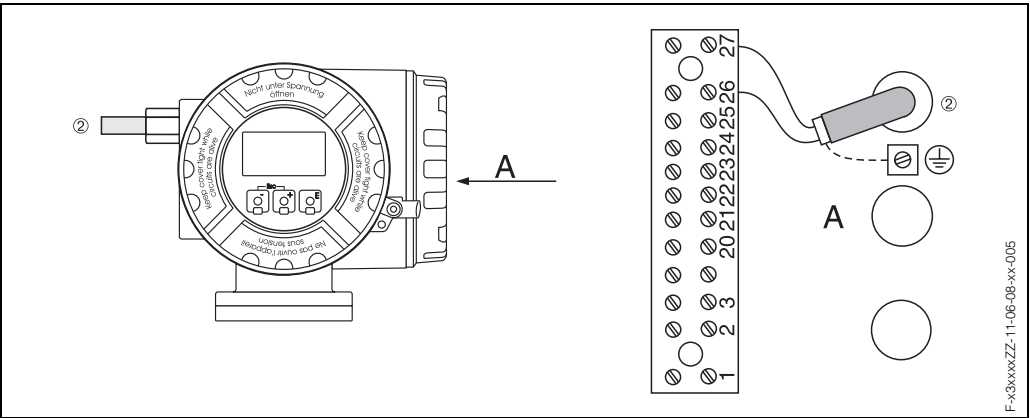


Fig. 3: ② = bus cable (FOUNDATION Fieldbus)  
A = view A



Note:  
The table below contains the values which depend on the type code (type of device).  
Always remember to compare the type code in the table with the code on the nameplate  
of your device.

Transmitter Prosonic Flow 93\*\*\*-\*\*\*\*\*G

Terminals	20	21	22	23	24	25	26	27
	+	-	+	-	+	-	+	-
Designation							FOUNDATION Fieldbus ②	
Functional values							$U_B = 9...32\text{ V DC}$ $I_B = 12\text{ mA}$	
Intrinsically safe circuit							EEx ia	
$U_i =$							30 V AC	
$I_i =$							500 mA	
$P_i =$							5.5 W	
$L_i =$							10 $\mu\text{H}$	
$C_i =$							5 nF	

Transmitter Prosonic Flow 93\*\*\*-\*\*\*\*\*K

Terminals	20	21	22	23	24	25	26	27
	+	-	+	-	+	-	+	-
Designation							FOUNDATION Fieldbus ②	
Functional values							$U_B = 9...32\text{ V DC}$ $I_B = 12\text{ mA}$	
Intrinsically safe circuit							no	
$U_{\text{max}} =$							260 V AC	
$I_{\text{max}} =$							500 mA	

## Device fuse



Warning:

Use only fuses of the following types; the fuses are installed on the power supply board:

- Voltage 20...55 V AC / 16...62 V DC:  
fuse 2.0 A slow-blow, breaking capacity 1500 A  
(Schurter, 0001.2503 or Wickmann, Standard Type 181 2.0 A)
- Voltage 85...260 V AC:  
fuse 0.8 A slow-blow, breaking capacity 1500 A  
(Schurter, 0001.2507 or Wickmann, Standard Type 181 0.8 A)

## Cable entries

For number reference see the figure on Page 2.

- ⑥ *Cable entries for the transmitter terminal compartment (XP version)*  
*power supply / bus cable: (Prosonic Flow 93)*  
Choice of thread for cable entries, ½" NPT.
- ⑦ *Cable entries for the transmitter terminal compartment*  
*sensor cable connection:*  
A special cable gland allows you to insert both sensor cables (per channel) into the connection compartment simultaneously.  
Cable gland M20x1.5 for 2 x Ø 4 mm or threaded adapter ½" NPT, G ½".

Make sure that the XP cable entries are secured to prevent working loose.

## Cable specifications

The sensor cable connection between sensor and transmitter has an EEx i type of protection rating.

- The cables are available in lengths of 5 m (16 ft), 10 m (33 ft), 15 m (49 ft) and 30 m (98 ft).
- You can choose between PTFE and PVC cable materials.



Caution:

Use the ready-to-use cables supplied by E+H with each sensor pair.

## Connecting the sensor connecting cable



Warning:

Switch off the power supply before opening the connection compartment. Do not install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.

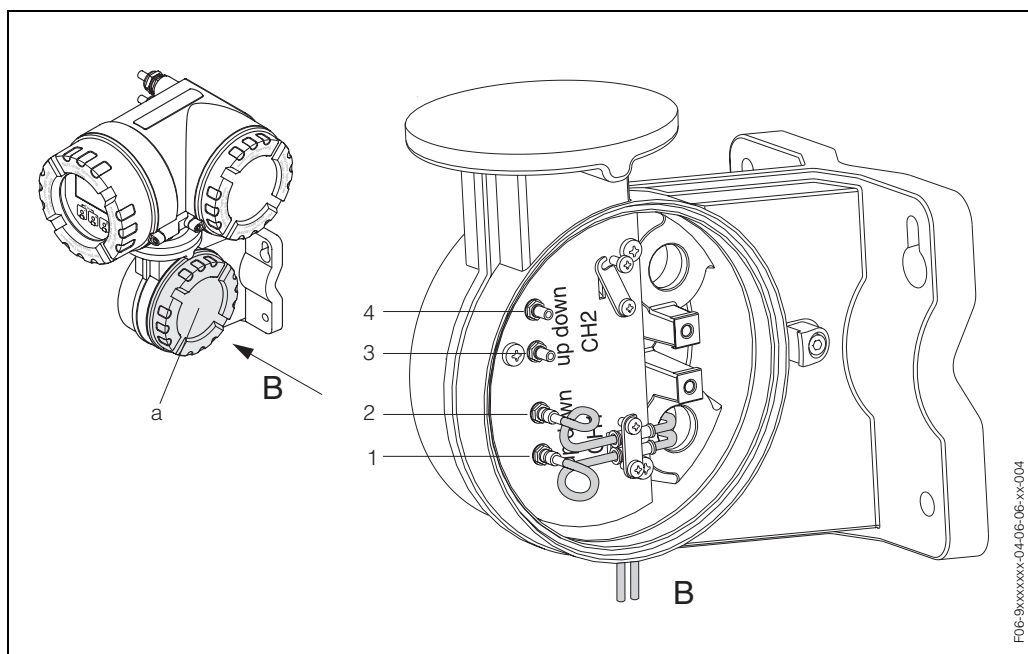


Fig. 4: Connecting the two possible measuring systems (one or two-channel)

*a* = view B

1 = channel 1 upstream

2 = channel 1 downstream

3 = channel 2 upstream

4 = channel 2 downstream

Procedure:

1. Transmitter: remove cover (a, Fig. 4) from the connection compartment.
2. Remove blank cover for the cable entries for channel 1 and channel 2.
3. Remove special cable entry (supplied with sensors). Run both sensor connecting cables through the cover (b) of the cable gland and into the connection compartment.
4. Position the cable fixing sleeves (c) of the sensor cables exactly next each other (Detail C). Position the ground contact terminals (d) and screw them tight.

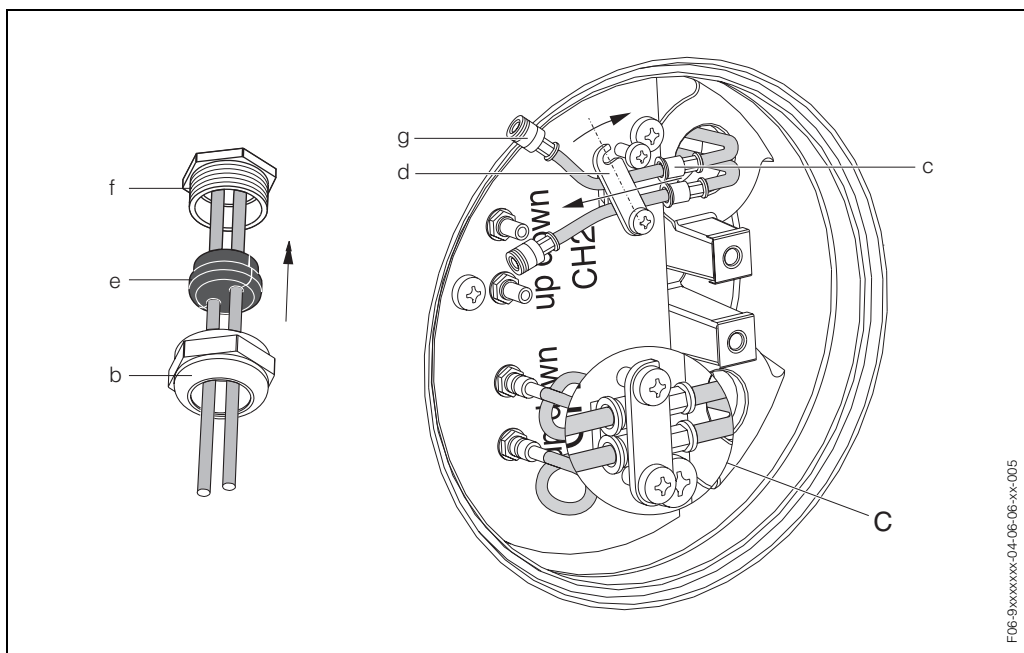


Fig. 5: Connecting the sensor connecting cable

5. Spread the rubber seal (e) along the side slit using a suitable tool (e.g. a large screwdriver) so that both sensor cables are clamped within. Push the rubber seal up into the cable gland bracket (f). Close the cover of the cable gland (b) so that it is tight.
6. Plug in the sensor cable connectors analogue to the arrangement in Fig. 4.
7. Transmitter: secure cover (a) on the connection compartment.

## Removing and installing printed circuit boards

### Field housing: removing and installing printed circuit boards (Fig. 6)



Caution:

- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purposely built for electrostatically sensitive devices!



Warning:

- Danger of explosion! Open the device only when it is de-energized (and after a delay of at least 10 minutes following shutdown of the power supply).
- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purposely built for electrostatically sensitive devices!

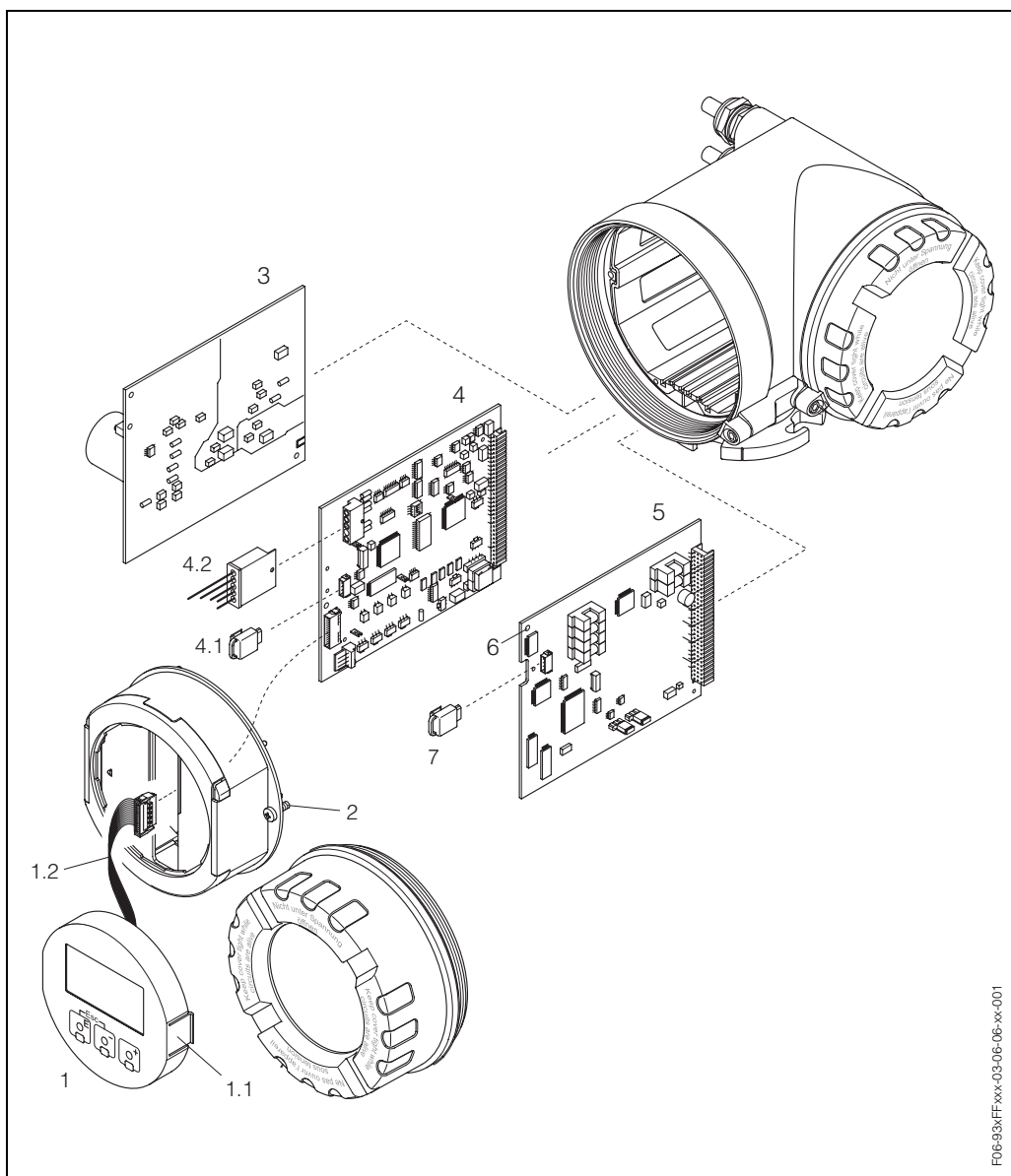
1. Remove the cover of the electronics compartment.
2. Remove the local display (1) as follows:
  - Press in the latches (1.1) at the side and remove the display module.
  - Disconnect the ribbon cable (1.2) of the display module from the amplifier board.
3. Remove the screws and remove the cover (2) from the electronics compartment.
4. Remove power unit board and I/O board (3, 5):  
Insert a thin pin into the hole (6) provided for the purpose and pull the board clear of its holder.
5. Remove amplifier board (4):
  - Disconnect the plug of the sensor signal cable (4.2) from the board.
  - Insert a thin pin into the hole (6) provided for the purpose and pull the board clear of its holder.
6. Installation is the reverse of the removal procedure.



Caution:

Use only original Endress+Hauser parts. Only replace printed circuit boards with identical ones.

7. If you cannot maintain the dielectric strength of the device during the work stages, carry out a test according to the manufacturer's specifications.

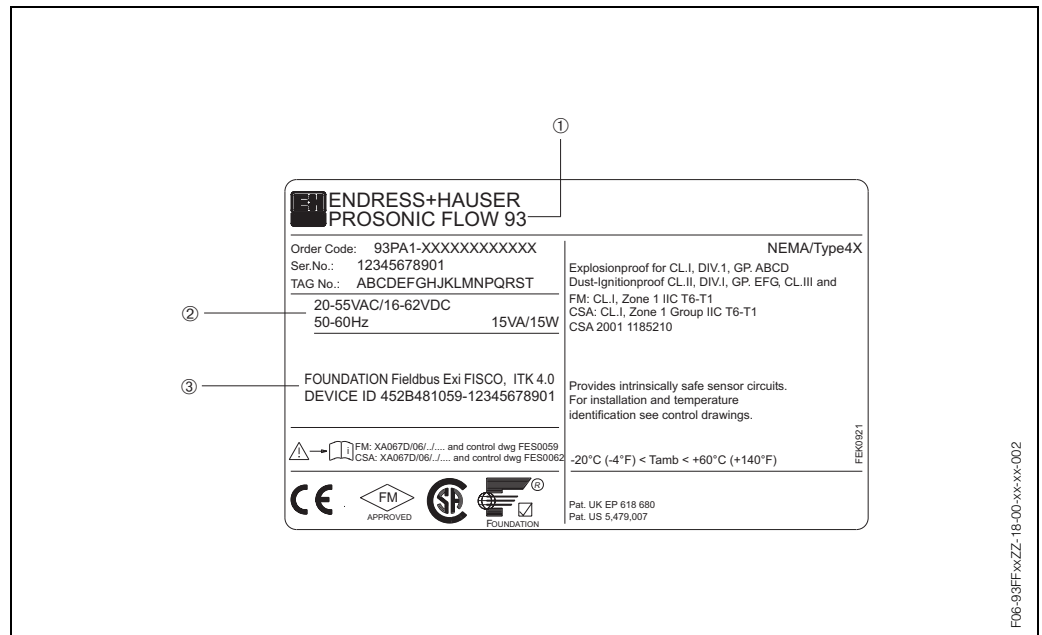


F06-93x4FFxx-03-06-06-xx-001

Fig. 6: Field housing: removing and installing printed circuit boards

- 1 Local display
- 1.1 Latch
- 1.2 Ribbon cable (display module)
- 2 Screws of electronics compartment cover
- 3 Power unit board
- 4 Amplifier board
- 4.1 T-DAT™ (transmitter data memory)
- 4.2 Unplug sensor signal cable
- 5 I/O board (type FOUNDATION Fieldbus)
- 6 Aperture for installing/removing boards
- 7 F-Chip™ (function chip for optional software)

## Exchanging electronics components



The following information on the nameplate must be compared for the information on the repairs set. Modules must not be exchanged unless this information is identical:

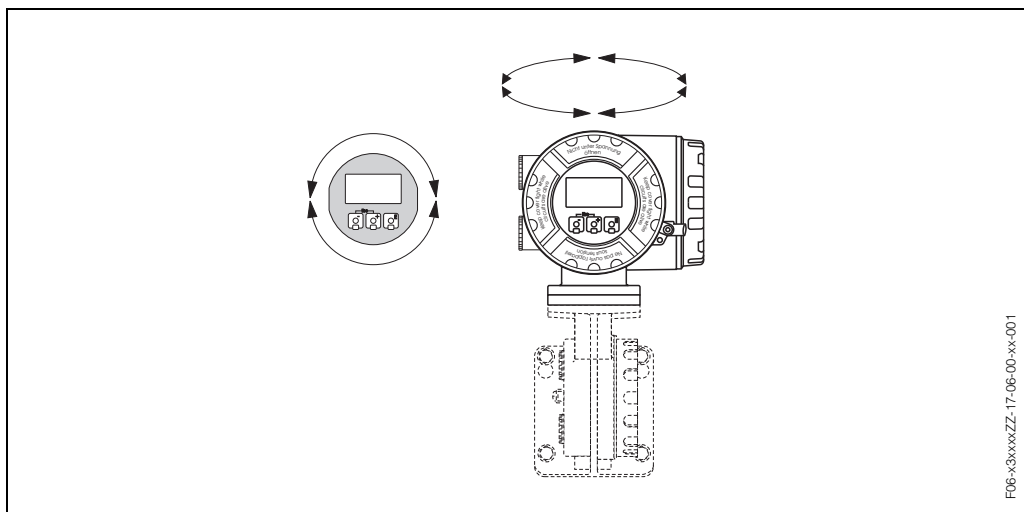
Power unit board: ① and ②

Amplifier board: ①

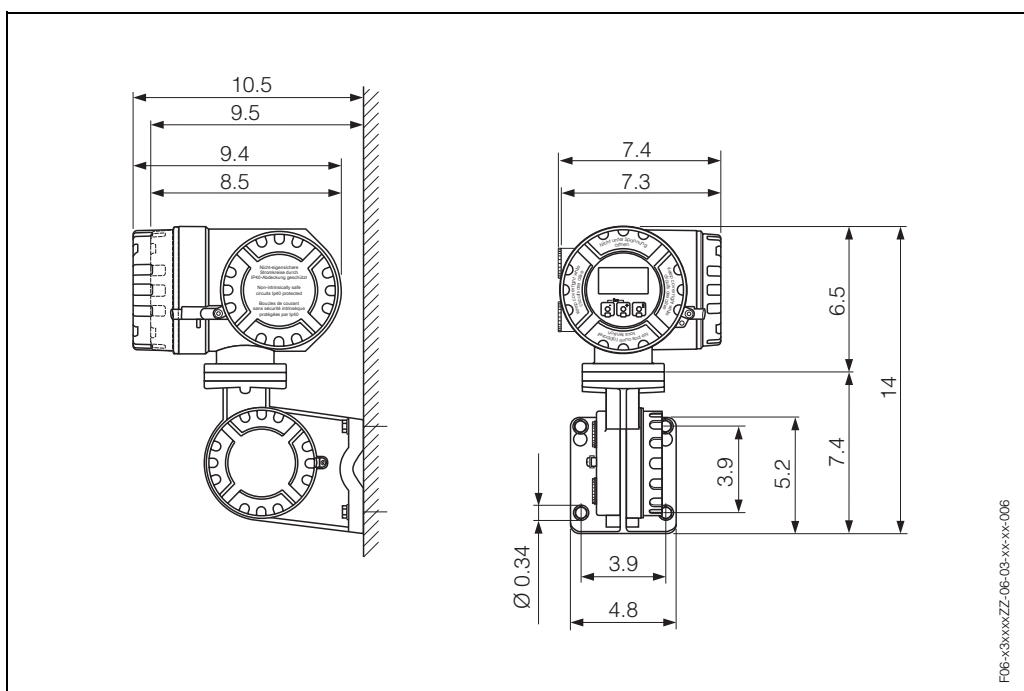
I/O board: ③

## Turning the transmitter housing and the local display

To obtain the optimum orientation of the display of the field housing, it is possible to turn the display or the head of the measuring transmitter housing up to 360°.



## Dimensions Prosonic Flow 93 transmitter



## Weight

Housing for transmitter:

- Wall-mounted housing: 13.3 lbs
- Field housing: 14.8 lbs

Measuring sensors:

- Flow measuring sensors P incl. mounting rail and tensioning bands: 6.2 lbs
- Sound velocity measuring sensors DDU 18 incl. tensioning bands: 5.3 lbs
- Wall thickness measuring sensor DDU 19 incl. tensioning band: 3.3 lbs



## Bus cable for FOUNDATION Fieldbus

The Fieldbus FOUNDATION defines four different types of cable in the specification creating the physical transmission layer (FF-816) which is analogous to IEC 61158-2. A two-core cable is always specified.

The electrical data has not been specified but determines important characteristics of the design of the fieldbus, such as distances bridged, number of participants, electro-magnetic compatibility, etc.

Two of the four cable types in the standard are specified in the following table.

	Cable type A (reference)	Cable type B
<i>Cable construction</i>	twisted pair, shielded	one or more twisted pairs, fully shielded
<i>Core cross-section (nominal)</i>	0.8 mm <sup>2</sup> (AWG 18)	0.32 mm <sup>2</sup> (AWG 22)
<i>Loop resistance (direct current)</i>	44 Ω/km	112 Ω/km
<i>Impedance at 31.25 kHz</i>	100 Ω ± 20%	100 Ω ± 30%
<i>Attenuation constant at 39 kHz</i>	3 dB/km	5 dB/km
<i>Capacitive unsymmetry</i>	2 nF/km	2 nF/km
<i>Envelope delay distortion (7.9...39 kHz)</i>	1.7 μs/km	**
<i>Degree of voltage of shielding</i>	90%	**
<i>Max. bus segment length (inc. spur lines)</i>	1900 m (6234 ft)	1200 m (3937 ft)

Tab. 1: Cable types

We recommend the use of cables meeting the minimum requirements of type A as transmission medium, particularly for the installation of new systems. The recommended network expansion is made up of the length of the main cable and the length of all spurs. The line between distribution box and field device is described as a spur. The maximum length of a spur depends on the number of spurs (>1 m [3 ft]). A maximum of four field devices can be connected to a spur.

Number of spurs	1...12	13...14	15...18	19...24	25...32
Max. length per spur	120 m (394 ft)	90 m (295 ft)	60 m (197 ft)	30 m (98 ft)	1 m (3 ft)

Tab. 2: Table of possible spur line lengths

The following table shows examples of FOUNDATION Fieldbus bus cables (type A) from various manufacturers.

Supplier	Model	Order number
Belden	3076	—
Kerpen	FB-02YS (St+C) Y-FL	74220001 (light blue) 74220004 (black)
Siemens	SIMATIC NET bus cable	6XV1830-5AH10 (light blue) 6XV1830-5BH10 (black)

Tab. 3: Possible cable suppliers

### Bus termination

The start and end of each fieldbus segment are always to be terminated with a bus terminator.

- In the case of a branched bus segment the measuring device furthest from the segment connector represents the end of the bus.
- If the fieldbus is extended with a repeater then the extension must also be terminated at both ends.

### Selecting and connecting components

The FOUNDATION Fieldbus allows several devices from different manufacturers to be generally connected to a bus segment. When selecting components for use in areas with an explosion risk only components marked as intrinsically safe, explosion-protected electrical equipment or as intrinsically safe associated electrical equipment may be used. When combining different fieldbus devices and fieldbus components, in addition to functional considerations, technical safety factors must be considered if explosion protection is to be ensured.

## Implementation of intrinsic safety in the FOUNDATION Fieldbus H1

The FOUNDATION Fieldbus H1 can be made intrinsically safe for use in areas with an explosion risk (Ex i). To do this, according to the FOUNDATION Fieldbus specification a suitable safety component must be installed (FF-816) between the safe area and the area with an explosion risk. The intrinsically safe bus segment can be supplied either by a non-intrinsically safe power supply with a safety barrier downstream or by a fieldbus power supply with an intrinsically safe output.

It is recommended that the cable shielding be grounded at both ends (refer to Fig. 8, Page 19).

Installation example of a galvanic isolator with bus feed:

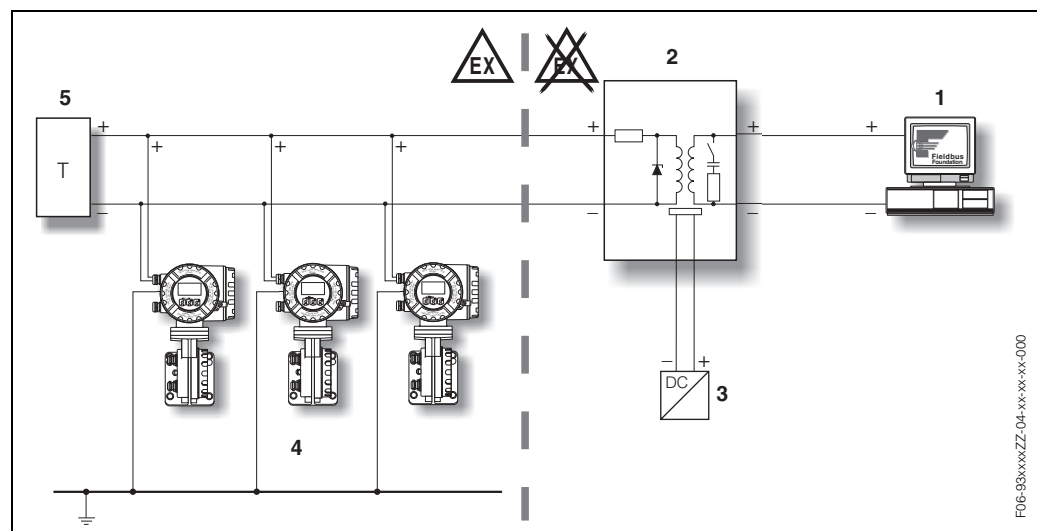


Fig. 7: Typical embodiment of a galvanic isolator including fieldbus power supply

- 1 = DCS with integrated FOUNDATION Fieldbus H1 interface card  
 2 = fieldbus power supply: galvanic isolator  
 3 = fieldbus power supply  
 4 = Prosonic Flow 93 bus devices for hazardous area  
 5 = terminator (T) = bus termination

## Proof of intrinsic safety

Proof of intrinsic safety for the intrinsically safe bus segment can be made by using one of the following models:

- Entity model
- FISCO model

Both models differ from one another by their consideration of the cable. While the FISCO model considers the transmission line as distributed inductance and capacitance, the basis of this consideration for the Entity model is concentrated inductance and capacitance. The result of this is that lower quantities of power can be transmitted with the Entity model into the Ex area, and that the number of field devices that can be operated on a power repeater is therefore lower than with the FISCO model.

In the case of failure, instruments from different manufacturers can be exchanged when their safety-relevant data is taken into consideration. This data is: electrical parameters, device group and category, and the temperature class.

Both these models are briefly described in the following.

## The Entity model

The Entity model is based on the observation that the cable represents concentrated inductance and capacitance. The result is that less electrical power can be transmitted into the area subject to the risk of explosion when compared with the FISCO model.

The following conditions must be met in the safety according to the entity model considerations:

Field device Hazardous area	Mandatory	Power supply Safe area
Maximum voltage [U <sub>i</sub> ]	≥	Idle voltage of the safety element [U <sub>o</sub> ]
Maximum current [I <sub>i</sub> ]	≥	Short-circuit current [I <sub>o</sub> ]
Maximum power [P <sub>i</sub> ]	≥	[P <sub>o</sub> ]
Effective internal capacitance [C <sub>i</sub> ] + cable capacitance	≤	Maximum permitted external capacitance [C <sub>o</sub> ]
Effective internal inductance [L <sub>i</sub> ] + cable inductance	≤	Maximum permitted external inductance [L <sub>o</sub> ]

Tab. 4: General dependencies

In addition, the following measures must be taken:

- determine permissible explosion group for the bus segment
- determine all effective energy stores (L<sub>i</sub>, C<sub>i</sub>, capacitance and inductance per unit length)
- check locally supplied operating units for galvanic isolation
- harmonize temperature class and ambient temperature



Note:

Configuration example see Page 21

## The FISCO model

The German Federal Physical-Technical Institute (PTB) has developed the FISCO model which was published in Report PTB-W-53 "Examination on Intrinsic Safety for Field Bus Systems".

The FISCO model makes possible the interconnection of intrinsically safe apparatus and one intrinsically safe associated apparatus, without having to have separate certification for respective connections.

The criteria for the intrinsic safety of an interconnection (bus segment) is given under the following interrelationships:

1. To transmit power and data, the bus system uses the physical configuration defined by IEC 61158-2. This is the case for FOUNDATION Fieldbus and the H1 bus.
2. Only one active source is permitted on a bus segment (here the power repeater). All other components work as passive current sinks.
3. The basic current consumption of a field device is at least 10 mA.
4.  $U_i$ ,  $I_i$  and  $P_i$  of the bus device  $\geq U_o$ ,  $I_o$  and  $P_o$  of the associated equipment (bus power supply).
5. Each instrument must fulfill the following requirement:  $C_i \leq 5 \text{ nF}$ ,  $L_i \leq 10 \text{ }\mu\text{H}$
6. The permissible line length for EEx ia IIC applications is 1000 m (3280 ft).
7. The permissible spur length for Ex applications is 30 m (98 ft) per spur.
8. The transmission line that is used must conform to the following cable parameters:  
Resistor coating:  $15 \text{ }\Omega/\text{km} < R' < 150 \text{ }\Omega/\text{km}$   
Inductance coating:  $0.4 \text{ mH/km} < L' < 1 \text{ mH/km}$   
Capacitance coating:  $80 \text{ nF/km} < C' < 200 \text{ nF/km}$  (including the shield)
9. The bus segment must be terminated on both ends of the line with a terminal bus resistor. A terminal resistor is integrated into the power repeater so that an external bus terminator is only required on the other end. According to the FISCO model the fieldbus terminator must conform to the following limits:  
–  $90 \text{ }\Omega < R < 100 \text{ }\Omega$   
–  $0 \text{ }\mu\text{F} < C < 2.2 \text{ }\mu\text{F}$



Note:  
Configuration example see Page 28

## Potential equalisation with shielding grounded at both ends

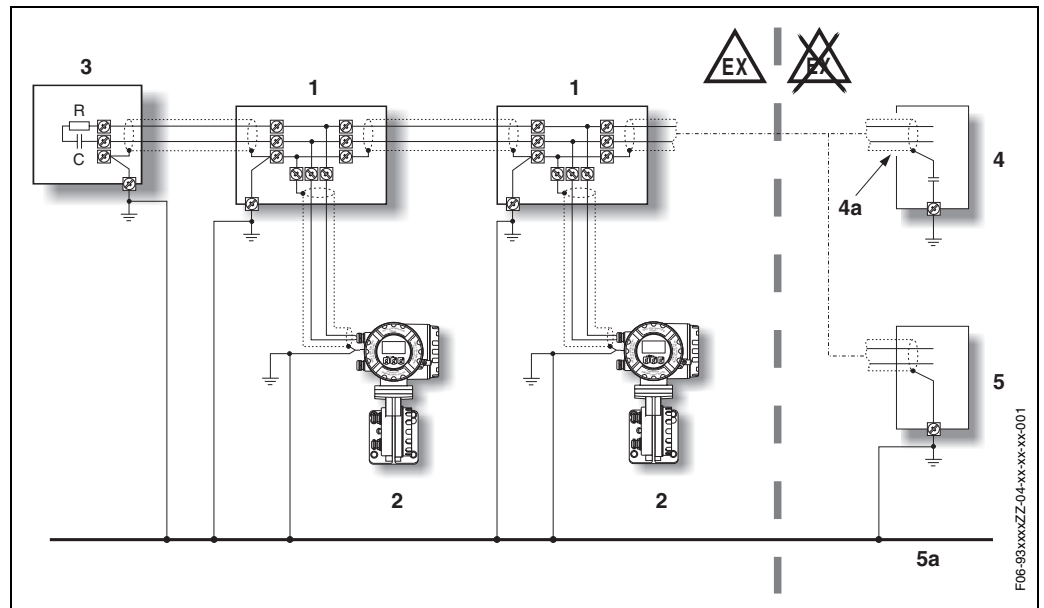


Fig. 8: Examples of the connection of potential equalisation lines

- 1 = distributor/T-box
- 2 = Prosonic Flow 93 bus devices for hazardous area
- 3 = bus termination:  $R = 90 \dots 100 \Omega$ ,  $C = 0 \dots 2.2 \mu F$
- 4 = fieldbus power supply variant 4a
- 4a = shielding connected via capacitor
- 5 = fieldbus power supply variant 5a
- 5a = potential equalisation line led out

### Variant 4/4a:

With capacitive grounding of the shielding in the safe area the potential equalisation line does not need to be led out of the safe area.

Use small capacitors (e.g. 1 nF, 1500 V, dielectric strength, ceramic). The total capacitance connected at the shielding must not exceed 10 nF.

### Variant 5/5a:

Potential equalisation line is led out of the safe area.

## Network configuration for FOUNDATION Fieldbus H1

### General remarks

Various aspects are to be considered when configuring a FOUNDATION Fieldbus H1 segment and these must essentially be checked by two general types of considerations:

### Functional considerations

In the functional considerations, the characteristic of the technical function data laid down in IEC 61158-2 for the transmission technology of the FOUNDATION Fieldbus H1 and the physical network structure is checked. Here it must always be ensured that the total base currents of all bus participants does not exceed the maximum permissible feed current of the bus power supply and that the field devices are always supplied with a minimum bus voltage of 9 V.

### Technical safety considerations

For use of the FOUNDATION Fieldbus H1 in an area with an explosion risk, proof of intrinsic safety is to be provided for the entire bus segment by means of the technical safety considerations. Proof of intrinsic safety for the intrinsically safe bus segment can be made by using one of the following models:

#### *Entity model*

The safety considerations correspond to those in a conventional 4...20 mA measuring circuit. The only exception is that here more than one field device is supplied by the power supply. The safety considerations must result in the knowledge that the fieldbus power supply does not exceed the safety parameters (P-, U-, I-values) of the field devices and that the inductance and capacitance are within the permissible limits (example see Page 21).

#### *FISCO model*

If proof of intrinsic safety is made according to the FISCO model, it is to be verified that all components connected to the bus segment (field instruments, bus power supplies, bus terminator) are laid out according to the FISCO model. If this is the case, it must be proven that for each bus component the values of  $U_i$ ,  $I_i$  and  $P_i$  are greater or the same as the values of  $U_o$ ,  $I_o$  and  $P_o$  for the associated equipment (bus power supply). Example see Page 28.

### Configuration example for a FOUNDATION Fieldbus H1 segment

Based on the following example, the functional and safety-relevant considerations and calculations for the specification of a FOUNDATION Fieldbus H1 segment are carried out.

## Configuration example Entity model

Fig. 9 shows the typical structure and the associated components. The field devices are operated on a segment with the type of protection EEx ia. A galvanic isolator is used for the transition to the area with explosion risk. Field devices with a lower power consumption, such as the Cerabar S pressure gauge, are supplied via the two-wire line. In contrast, the Prosonic Flow 93 as a four-wire device must be supplied via an local power supply.

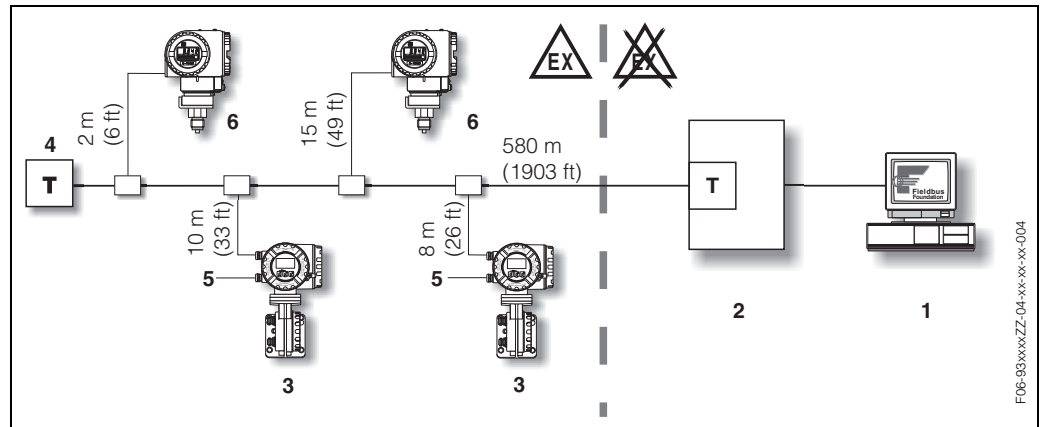


Fig. 9: Typical example of a bus connection with a fieldbus power supply of type MTL 5053

- 1 = DCS with integrated FOUNDATION Fieldbus H1 interface card
- 2 = fieldbus power supply, model MTL 5053
- 3 = Prosonic Flow 93 bus devices for hazardous area
- 4 = terminator (T) = bus termination
- 5 = transducer supply
- 6 = Cerabar S bus devices for hazardous area

## Functional considerations

Using the following procedure the functional considerations checks whether the desired segment structure meets the basic requirements for transmission to the physical layer in IEC 61158-2.

*Step 1 – compilation of the functional characteristic values of the fieldbus components*

- Fieldbus power supply MTL 5053:

$$\begin{aligned} U_S &= 18.4 \text{ V} \\ I_S &= 80 \text{ mA} \\ R_Q &= 105 \Omega (\text{source impedance}) \end{aligned}$$

- Fieldbus line:

Cable type A

$$\begin{aligned} R_{WK} &= 44 \Omega/\text{km} (\text{effective resistance per unit length}) \\ \text{max. permissible cable length } L_{\text{perm.}} &= 1900 \text{ m (6234 ft)} \end{aligned}$$

- Fieldbus device Prosonic Flow 93:

$$\begin{aligned} I_B &= 12 \text{ mA (basic current)} \\ U_B &= 9...32 \text{ V (perm. operating voltage)} \\ I_{FDE} &= 0 \text{ mA (fault current)} \\ I_{\text{startup}} &= 0 (< I_B) \end{aligned}$$

- Fieldbus device Cerabar S:

$$\begin{aligned} I_B &= 10.5 \text{ mA (basic current)} \\ U_B &= 9...32 \text{ V (perm. operating voltage)} \\ I_{FDE} &= 0 \text{ mA (fault current)} \\ I_{\text{startup}} &= 0 (< I_B) \end{aligned}$$

### Step 2 – calculation of cable length and checking of network structure

The maximum cable length is always determined by the type of cable used. The actual cable length, which is made up of the length of the main cable and the length of the spur lines, must not exceed this value. The spur lines are also to be checked (refer to Table 2, Page 15). The following restrictions apply to the specification of the cable length and network structure:

- Where cable type A is used the cable length  $L_{perm.}$  may be max. 1900 m (6234 ft).
- Checking the spur line lengths (refer to Table 2, Page 15).

Calculation of actual cable length:

$$\begin{aligned} L_{SEG} &= L_{main.} + \Sigma L_{spurs} \\ &= 580 \text{ m (1903 ft)} + 35 \text{ m (115 ft)} \\ &= \underline{\underline{615 \text{ m (2018 ft)}}} \end{aligned}$$

Checking the conditions

Consideration	Condition met?
$L_{SEG} < L_{perm.}$	✓ Yes
$L_{spurs} < 120 \text{ m (394 ft)}$	✓ Yes

If one of the conditions is not met then the network structure must be revised.

### Step 3 – current calculation

The number of field devices that can be connected to the H1 segment depends on the fieldbus power supply selected (supply voltage and supply current) and the current consumption of the field devices. Thus, the number of devices that can be connected is reduced if a field device consumes a basic current of more than 10 mA, e.g. 20 mA. By adding up the basic currents  $I_B$  of the field devices plus the response current in the event of a fault  $I_{FDE}$  for the FDE (**F**ault **D**isconnect **E**lectronics) and the current for the data modulation  $I_{MOD}$  (+9 mA) you can determine the minimum supply current that the fieldbus power supply must supply.

If, on switching on the device, the startup  $I_{startup}$  current is greater than the basic current, then the startup current must be taken into consideration in the calculation. The response current for the FDE ( $I_{FDE}$ ) is calculated for each field device from the difference between the maximum current in the event of a fault and the basic current. The field device with the greatest response current is taken into consideration in the current balance sheet.

Provided that no more than one FDE responds, the following condition must be taken into consideration in the calculation of the segment current  $I_{SEG}$ :

$$\begin{aligned} I_{Seff.} &\geq I_{SEG} \\ &\text{where} \\ I_{SEG} &= \Sigma I_B + \max I_{FDE} + I_{MOD} + I_{startup} \end{aligned}$$



In the example the calculation formula results in the following segment current consumption  $I_{SEG}$ , where  $I_{FDE} = 0$ ,  $I_{startup} = 0$ , since the field devices used do not consume additional current in the event of a fault and the startup current is less than the bus current:

$$\begin{aligned} I_{SEG} &= \Sigma I_B + \max. I_{FDE} + I_{MOD} + I_{startup} \\ &= 45 \text{ mA} + 0 \text{ mA} + 9 \text{ mA} + 0 \text{ mA} \\ &= \underline{\underline{54 \text{ mA}}} \end{aligned}$$

The next step checks whether the current consumption  $I_{SEG}$  calculated is within the current limits of the fieldbus power supply. The maximum available supply current  $I_{Seff.}$  is calculated taking into consideration the current drops caused by the source impedance  $R_Q$  of the fieldbus power supply and then by the effective resistance per unit of length of the fieldbus line. Also, the condition must be met that the supply voltage at the furthest field device must be at least 9 V. To make the overall considerations easier it is assumed that all the field devices FD (refer to Fig. 10) are connected at the end of the fieldbus line.

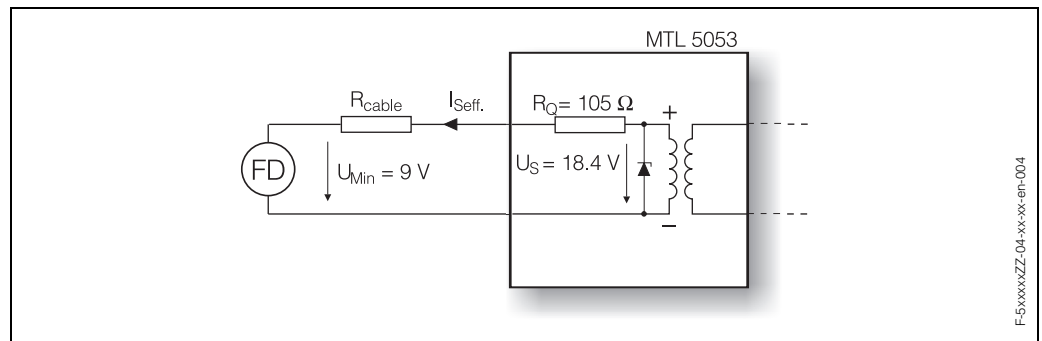


Fig. 10: Replacement circuit diagram

In order that the available supply current  $I_{Seff.}$  can be calculated the resistance value for the fieldbus line  $R_{cable}$  must first be calculated:

$$\begin{aligned} R_{cable} &= R_{WK} \times L_{SEG} \\ &= 44 \Omega/\text{km} \times 0.615 \text{ km} \\ &= \underline{\underline{27 \Omega}} \end{aligned}$$

Calculation of the maximum available supply current  $I_{Seff.}$  of the fieldbus power supply:

When calculating the maximum available supply current it must be ensured that a minimum supply voltage of 9 V is applied at the field devices:

$$\begin{aligned} I_{Seff.} &= (U_S - 9 \text{ V}) / (R_Q + R_{cable}) \\ &= (18.4 \text{ V} - 9 \text{ V}) / (105 \Omega + 27 \Omega) \\ &= \underline{\underline{71.2 \text{ mA}}} \end{aligned}$$

Observing the conditions stated, a supply current of  $I_{Seff.} = 71.2 \text{ mA}$  is available for the field devices on the bus segment. Since the actual current consumption of the segment is only 54 mA, from the point of view of the functional considerations proper functioning of the segment is ensured.

For reasons of safety the actual voltage  $U_{FG \text{ eff.}}$  of the furthest field device can be calculated as follows:

$$\begin{aligned} U_{FG \text{ eff.}} &= U_S - I_{SEG} \times (R_Q + R_{cable}) \\ &= 18.4 \text{ V} - 54 \text{ mA} \times (105 \Omega + 27 \Omega) \\ &= 18.4 \text{ V} - 7.1 \text{ V} \\ &= \underline{\underline{11.2 \text{ V}}} \end{aligned}$$

Checking the conditions:

Consideration	Condition met?
$I_{seff} \geq I_{SEG}$ 71.2 mA $\geq$ 54 mA	✓ Yes
$U_{FG\ eff.} \geq 9\ V$ 11.2 V $\geq$ 9 V	✓ Yes

#### Final consideration:

From a purely functional point of view the bus segment shown in the example can be operated based on the positive results. Further optimization of the network with a view to connecting a greater number of field devices or realizing a longer line length can be achieved by selecting the right fieldbus power supply and cable type.

#### Technical safety considerations

using variant Prosonic Flow 93\*\*\*-\*\*\*\*\*G

#### Step 1 – compilation of technical values relevant to safety:

*Bus power supply MTL 5053 (associated electrical apparatus)*

##### • Nominal values:

$U_o$	=	22 V
$I_o$	=	216 mA
$P_o$	=	1.2 W

	Explosion group		
	IIC	IIB	IIA
Capacitance $C_o$	0.165 $\mu$ F	1.14 $\mu$ F	4.20 $\mu$ F
Inductance $L_o$	0.32 mH	3.00 mH	7.00 mH
$L/R_{ratio}$	31 $\mu$ H/ $\Omega$	126 $\mu$ H/ $\Omega$	242 $\mu$ H/ $\Omega$

Tab. 5: External connection values of bus power supply MTL 5053 depending on temperature class

*Prosonic Flow 93 (explosion protected electrical apparatus with intrinsically safe FF output):*

##### • Nominal values:

$U_i$	=	30 V
$I_i$	=	500 mA
$P_i$	=	5.5 W
$L_i$	=	10 $\mu$ H
$C_i$	=	5 nF

*Cerabar S (explosion protected electrical apparatus with intrinsically safe FF output):*

##### • Nominal values Entity:

$U_i$	=	24 V
$I_i$	=	250 mA
$P_i$	=	1.2 W
$L_i$	=	10 $\mu$ H
$C_i$	=	5 nF

*Bus cable type 3076 from Belden (shielded bus cable):*

- Nominal values:

$R'$	=	24 $\Omega/\text{km}$ (loop resistance)
$C'$	=	82 nF/km (capacitance per unit length between the two wires)
$L'$	=	623 $\mu\text{H}/\text{km}$ (inductance per unit length of the two wires)
$C'_{\text{LS}}$	=	147 nF/km (capacitance per unit length wire against shielding)

*Bus termination:*

- Nominal values:

$U_i$	=	30 V
$P_i$	=	1.2 W
$C_i$	=	negligible

The effective capacitance of the bus line is derived first from the capacitance per unit length  $C'$ , which is effectively the capacitance between the two wires. In the case of the shielded wires the order of capacitance “wire against shielding” and “shielding against wire” must be observed. The total capacitance of the bus line is thus calculated as follows:

$$C'_{\text{eff/cable}} = (C' + 0.5 \times C'_{\text{LS}}) \times L_{\text{SEG}}$$

The total length of the bus line  $L_{\text{SEG}}$  is made up of the length of the main cable and the length of all spurs. Using the system structure illustrated in Fig. 10 the following data relevant to safety emerges for the bus line:

$$\begin{aligned}
 L_{\text{SEG}} &= L_{\text{main}} + \sum L_{\text{spurs}} \\
 &= 580 \text{ m (1903 ft)} + 35 \text{ m (115 ft)} \\
 &= \underline{\underline{615 \text{ m (2018 ft)}}} \\
 C'_{\text{eff./cable}} &= (C' + 0.5 \times C'_{\text{LS}}) \times L_{\text{SEG}} \\
 &= (82 \text{ nF/km} + 0.5 \times 147 \text{ nF/km}) \times 0.615 \text{ km} \\
 &= \underline{\underline{95.6 \text{ nF}}} \\
 L'_{\text{eff./cable}} &= L' \times L_{\text{SEG}} \\
 &= 623 \mu\text{H/km} \times 0.615 \text{ km} \\
 &= \underline{\underline{383.1 \mu\text{H}}}
 \end{aligned}$$

## Step 2 – technical safety considerations

This step uses the existing data to check whether connecting the equipment is permissible from the point of view of technical safety. The conditions shown in Table 5 (Page 24) apply to these safety considerations. First the functional data of the equipment used is compared. In this consideration it is crucial that the maximum output voltage and output current of the bus power supply does not exceed the permitted maximum input voltage and input current of the individual field devices. Here we consider possible error behaviour by the bus power supply that could result in the stated maximum values on the intrinsically safe sides.

Intrinsically safe equipment	Condition	Associated equipment MTL 5053	Condition met?
<b>Prosonic Flow 93</b>			
$U_i = 30 \text{ V}$	$\geq$	$U_o = 22 \text{ V}$	✓ Yes
$I_i = 500 \text{ mA}$	$\geq$	$I_o = 216 \text{ mA}$	✓ Yes
$P_i = 5.5 \text{ W}$	$\geq$	$P_o = 1.2 \text{ W}$	✓ Yes
As a further condition galvanic isolation must be provided due to the local supply			✓ Yes
<b>Cerabar S</b>			
$U_i = 24 \text{ V}$	$\geq$	$U_o = 22 \text{ V}$	✓ Yes
$I_i = 250 \text{ mA}$	$\geq$	$I_o = 216 \text{ mA}$	✓ Yes
$P_i = 1.2 \text{ W}$	$\geq$	$P_o = 1.2 \text{ W}$	✓ Yes
<b>FBT1</b>			
$U_i = 30 \text{ V}$	$\geq$	$U_o = 22 \text{ V}$	✓ Yes
$P_i = 1.2 \text{ W}$	$\geq$	$P_o = 1.2 \text{ W}$	✓ Yes

In addition to these values the limit values and the maximum permissible external capacitance  $C_o$  and inductance  $L_o$  must be observed for the supply circuit. To do this the sum of all effective inductance and capacitance in the hazardous area is formed (the internal capacitance of the bus termination is assumed to be 0). The resulting value must be less than the maximum permissible value specified by the fieldbus power supply.

The equivalent concentrated capacitance and inductance in the hazardous area is calculated as follows:

$$\begin{aligned}
 C_{\text{eff.}} &= (C_{i/\text{Prosonic Flow 93}} \times 2) + (C_{i/\text{Cerabar S}} \times 2) + C'_{\text{eff./cable}} + C_{i/\text{bus termination}} \\
 &= (5 \text{ nF} \times 4) + 95.6 \text{ nF} \\
 &= 115.6 \text{ nF}
 \end{aligned}$$

$$\begin{aligned}
 L_{\text{eff.}} &= (L_{i/\text{Prosonic Flow 93}} \times 2) + (L_{i/\text{Cerabar S}} \times 2) + L'_{\text{eff./cable}} \\
 &= (10 \text{ } \mu\text{H} \times 4) + 383.1 \text{ } \mu\text{H} \\
 &= 423.1 \text{ } \mu\text{H}
 \end{aligned}$$

Intrinsically safe equipment Prosonic Flow 93	Condition	Associated equipment MTL 5053	Condition met?
Total capacitance $C_{\text{eff.}} = 115.6 \text{ nF}$	<	perm. capacitance for IIC $C_o = 165 \text{ nF}$	✓ Yes
Total inductance $L_{\text{eff.}} = 423.1 \text{ }\mu\text{H}$	<	perm. inductance for IIC $L_o = 320 \text{ }\mu\text{H}$	No

Tab. 6: Safety considerations (example)

If, in the example examined, the condition  $L_{\text{eff.}} < L_o$  is met, then the demonstration of intrinsic safety with respect to the electrical parameters has a positive result. In this example, however, the condition was not met since the bus line selected is too long.

Possible solutions:

1. Reduce the main line by 175 m (574 ft) to 405 m (1329 ft) (this can be achieved by installing the barrier in the immediate vicinity of Explosion Zone 1, for example).
2. Check under what conditions the manufacturer of the safety barrier or segment connector allows the use of the L/R ratio for technical safety considerations.

Since all the users are permissible for explosion group IIC and the corresponding parameters have been taken into consideration, the bus segment can be used for gases in explosion group IIC.

The permissible ambient temperature may be considered either individually for each device at the respective place of installation, or specified uniformly for the bus segment as a whole. In the latter case the lowest value of the ambient temperature applies.

Required temperature class	Intrinsically safe equipment	Maximum ambient temperature
T6	Cerabar S	104 °F
	Prosonic Flow 93	122 °F (at 176 °F medium temperature)

## Configuration example FISCO model

Fig. 11 shows the typical structure and the associated components. The field devices are operated on a segment with the type of protection EEx ia. A galvanic isolator is used for the transition to the area with explosion risk. Field devices with a lower power consumption, such as the Cerabar S pressure gauge, are supplied via the two-wire line. In contrast, the Prosonic Flow 93 as a four-wire device must be supplied via an local power supply.

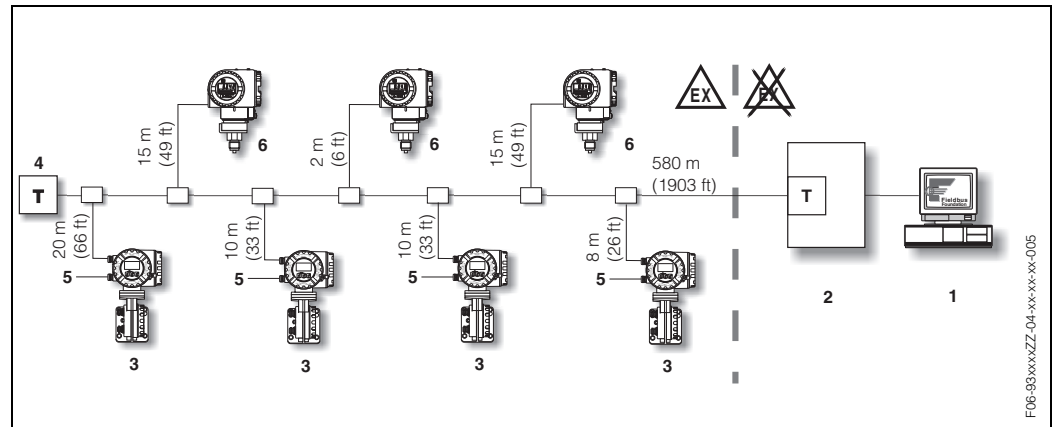


Fig. 11: Typical example of a bus connection with a fieldbus power supply  
Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs)

- 1 = DCS with integrated FOUNDATION Fieldbus H1 interface card
- 2 = fieldbus power supply acc. FISCO model, Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs)
- 3 = Prosonic Flow 93 bus devices for hazardous area
- 4 = terminator (T) = bus termination
- 5 = transducer supply
- 6 = Cerabar S bus devices for hazardous area

## Functional considerations

Using the following procedure the functional considerations checks whether the desired segment structure meets the basic requirements for transmission to the physical layer in IEC 61158-2.

### Step 1 – compilation of the functional characteristic values of the fieldbus components

- Fieldbus power supply according FISCO model, Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs):

$$U_S = 12.8 \text{ V (power supply voltage)}$$

$$I_S = 100 \text{ mA (power supply current)}$$

- Fieldbus line:

Cable type A

$$R_{WK} = 44 \text{ } \Omega/\text{km (effective resistance per unit length)}$$

- Fieldbus device Prosonic Flow 93:

$$I_B = 12 \text{ mA (basic current)}$$

$$U_B = 9...32 \text{ V (perm. operating voltage)}$$

$$I_{FDE} = 0 \text{ mA (fault current)}$$

$$I_{\text{startup}} = 0 (< I_B)$$

- Fieldbus device Cerabar S:

$$\begin{aligned}
 I_B &= 10.5 \text{ mA (basic current)} \\
 U_B &= 9...32 \text{ V (perm. operating voltage)} \\
 I_{FDE} &= 0 \text{ mA (fault current)} \\
 I_{\text{startup}} &= 0 (< I_B)
 \end{aligned}$$

### Step 2 – calculation of cable length and checking of network structure

An approved maximum length of 1000 meters (3280 ft) has been set with the FISCO model for EEx ia IIC applications in order that the inductance and capacitance of the fieldbus cable can be ignored when used in hazardous area applications. This length comprises the length of the main cable and the total length of the drop cables together. In addition, it must be taken into account that the approved maximum length of a drop cable is 30 m (98 ft).

#### Calculation of actual cable length $L_{SEG}$ :

$$\begin{aligned}
 L_{SEG} &= L_{\text{main.}} + \Sigma L_{\text{spurs}} \\
 &= 580 \text{ m (1903 ft)} + 80 \text{ m (262 ft)} \\
 &= \underline{\underline{660 \text{ m (2165 ft)}}}
 \end{aligned}$$

Checking the conditions:

Consideration	Condition met?
$L_{SEG} < 1000 \text{ m (3280 ft)}$ $660 \text{ m (2165 ft)} < 1000 \text{ m (3280 ft)}$	✓ Yes
$L_{\text{spurs}} < 30 \text{ m (98 ft)}$	✓ Yes

If one of the conditions is not met then the network structure must be revised.

### Step 3 – current calculation

The number of field devices that can be connected to the H1 segment depends on the fieldbus power supply selected (supply voltage and supply current) and the current consumption of the field devices. Thus, the number of devices that can be connected is reduced if a field device consumes a basic current of more than 10 mA, e.g. 20 mA. By adding up the basic currents  $I_B$  of the field devices plus the response current in the event of a fault  $I_{FDE}$  for the FDE (**F**ault **D**isconnect **E**lectronics) and the current for the data modulation  $I_{MOD}$  (+9 mA) you can determine the minimum supply current that the fieldbus power supply must supply.

If, on switching on the device, the startup  $I_{\text{startup}}$  current is greater than the basic current, then the startup current must be taken into consideration in the calculation. The response current for the FDE ( $I_{FDE}$ ) is calculated for each field device from the difference between the maximum current in the event of a fault and the basic current. The field device with the greatest response current is taken into consideration in the current balance sheet.

Provided that no more than one FDE responds, the following condition must be taken into consideration in the calculation of the segment current  $I_{SEG}$ :

$$\begin{aligned}
 I_{SEG} &\leq I_S \\
 &\text{where} \\
 I_{SEG} &= \Sigma I_B + \max I_{FDE} + I_{MOD} + I_{\text{startup}}
 \end{aligned}$$

In the example the calculation formula results in the following segment current consumption  $I_{SEG}$ , where  $I_{FDE} = 0$ ,  $I_{startup} = 0$ , since the field devices used do not consume additional current in the event of a fault and the startup current is less than the bus current. In addition, the modulation current  $I_{MOD}$  for the installed bus power supply KLD2-PR-Ex1.IEC1 by Pepperl+Fuchs need not be considered since the value of the supply current  $I_S$  already includes this.

$$\begin{aligned} I_{SEG} &= \Sigma I_B \\ &= \underline{\underline{79.5 \text{ mA}}} \end{aligned}$$

Checking the conditions:

Consideration	Condition met?
$I_{SEG} \leq I_S$ $79.5 \text{ mA} \leq 100 \text{ mA}$	✓ Yes

#### Step 4 – Voltage at the last instrument

The cable resistance causes a segment voltage drop, which is largest at the instrument farthest away from the bus power supply. For this reason it must be ensured that the minimum operating voltage of 9 V is available at this instrument.

To make the overall considerations easier it is assumed that all the field devices FD (refer to Fig. 12) are connected at the end of the fieldbus line.

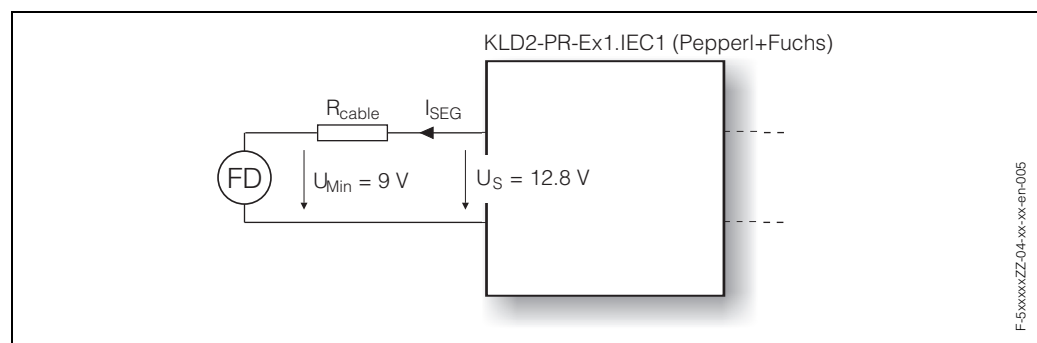


Fig. 12: Replacement circuit diagram

The resistance value  $R_{cable}$  must first be calculated in order to calculate the voltage drop caused by the fieldbus cable:

$$\begin{aligned} R_{cable} &= R_{WK} \times L_{SEG} \\ &= 44 \Omega/\text{km} \times 0.66 \text{ km} \\ &= \underline{\underline{29 \Omega}} \end{aligned}$$

Ohm's law is used to calculate the actual voltage  $U_{FG \text{ eff.}}$  at the last instrument:

$$\begin{aligned} U_{FG \text{ eff.}} &= U_S - (I_{SEG} \times R_{cable}) \\ &= 12.8 \text{ V} - (79.5 \text{ mA} \times 29 \Omega) \\ &= 12.8 \text{ V} - 2.3 \text{ V} \\ &= \underline{\underline{10.5 \text{ V}}} \end{aligned}$$



Checking the conditions:

Consideration	Condition met?
$U_{FG \text{ eff.}} \geq 9 \text{ V}$	✓ Yes
$10.5 \text{ V} \geq 9 \text{ V}$	

#### Final consideration:

From a purely functional point of view the bus segment shown in the example can be operated based on the positive results.

#### Technical safety considerations

using variant Prosonic Flow 93\*\*\*\_\*\*\*\*\*G

#### Step 1 – compilation of technical values relevant to safety:

*Fieldbus power supply (associated electrical apparatus)*  
*FISCO Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs):*

- Nominal values:

$$\begin{aligned} U_o &= 15 \text{ V} \\ I_o &= 207.2 \text{ mA} \\ P_o &= 1.93 \text{ W} \end{aligned}$$

Described in the test certificate as “associated equipment”. Suitable for connection to a fieldbus system based on the FISCO model.

*Prosonic Flow 93 (explosion protected electrical apparatus with intrinsically safe FF output):*

- Nominal values:

$$\begin{aligned} U_i &= 30 \text{ V} \\ I_i &= 500 \text{ mA} \\ P_i &= 5.5 \text{ W} \\ L_i &= 10 \mu\text{H} \\ C_i &= 5 \text{ nF} \end{aligned}$$

Suitable for connection to a fieldbus system based on the FISCO model.

*Cerabar S (explosion protected electrical apparatus with intrinsically safe FF output):*

- Nominal values FISCO:

$$\begin{aligned} U_i &= 17.5 \text{ V} \\ I_i &= 500 \text{ mA} \\ P_i &= 5.5 \text{ W} \\ L_i &= 10 \mu\text{H} \\ C_i &= 5 \text{ nF} \end{aligned}$$

Suitable for connection to a fieldbus system based on the FISCO model.

*Bus cable type A (shielded bus cable):*

- Nominal values:

$$\begin{aligned} R' &= 24 \Omega/\text{km} \text{ (loop resistance)} \\ C' &= 82 \text{ nF}/\text{km} \text{ (capacitance per unit length)} \\ L' &= 623 \mu\text{H}/\text{km} \text{ (inductance per unit length)} \end{aligned}$$

Fieldbus connection KMD0-FT-Ex (Pepperl+Fuchs):

• Nominal values:

$U_i$	=	24 V
$I_i$	=	280 mA
$P_i$	=	1.93 W
$R$	=	100 $\Omega$
$C$	=	1 $\mu$ F

Suitable for connection to a fieldbus system based on the FISCO model.

## Step 2 – technical safety considerations acc. FISCO model

This step uses the existing data to check whether connecting the equipment is permissible from the point of view of technical safety. The conditions shown in the FISCO model apply to these safety considerations (see Page 18). First the functional data of the equipment used is compared. In this consideration it is crucial that the maximum output voltage and output current of the bus power supply does not exceed the permitted maximum input voltage and input current of the individual field devices. Here we consider possible error behaviour by the bus power supply that could result in the stated maximum values on the intrinsically safe sides.

Intrinsically safe equipment	Condition	Associated equipment FISCO Power Repeater KLD2-PR-Ex1.IEC1	Condition met?
<b>Prosonic Flow 93</b>			
$U_i = 30$ V	$\geq$	$U_o = 15$ V	✓ Yes
$I_i = 500$ mA	$\geq$	$I_o = 207.2$ mA	✓ Yes
$P_i = 5.5$ W	$\geq$	$P_o = 1.93$ W	✓ Yes
As a further condition galvanic isolation must be provided due to the local supply			✓ Yes
<b>Cerabar S</b>			
$U_i = 17.5$ V	$\geq$	$U_o = 15$ V	✓ Yes
$I_i = 500$ mA	$\geq$	$I_o = 207.2$ mA	✓ Yes
$P_i = 5.5$ W	$\geq$	$P_o = 1.93$ W	✓ Yes
<b>Fieldbus connection KMD0-FT-Ex</b>			
$U_i = 24$ V	$\geq$	$U_o = 15$ V	✓ Yes
$I_i = 280$ mA	$\geq$	$I_o = 207.2$ mA	✓ Yes
$P_i = 1.93$ W	$\geq$	$P_o = 1.93$ W	✓ Yes

Since all the users are permissible for explosion group IIC and the corresponding parameters have been taken into consideration, the bus segment can be used for gases in explosion group IIC.

The permissible ambient temperature may be considered either individually for each device at the respective place of installation, or specified uniformly for the bus segment as a whole. In the latter case the lowest value of the ambient temperature applies.

Required temperature class	Intrinsically safe equipment	Maximum ambient temperature
T6	Cerabar S	104 °F
	Prosonic Flow 93	122 °F (at 176 °F medium temperature)

In the next step is the verification of whether the installed bus components fulfil the conditions and limit values set in the FISCO model. This is simplified by ensuring the bus components correspond to the FISCO model. A detailed consideration of the safety-relevant nominal values is then not necessary.

Do bus components correspond to the FISCO model?	Condition met?
Power Repeater KLD2-PR-Ex1.IEC1	✓ Yes
Prosonic Flow 93	✓ Yes
Cerabar S	✓ Yes
Fieldbus connection KMD0-FT-Ex	✓ Yes

The following conditions have been applied to the bus cable and network structure:

Bus cable:

Values	Condition	Limits acc. FISCO model	Condition met?
R'	> <	15 Ω/km 150 Ω/km	
C'	> <	80 nF/km 200 nF/km	
L'	> <	400 μH/km 1000 μH/km	
<b>Bus cable type A</b> R' = 24 Ω/km C' = 82 nF/km L' = 623 μH/km			✓ Yes

Network structure:

Consideration	Condition	Limits acc. FISCO model	Condition met?
Cable length including drop cables	≤	1000 m (3280 ft)	
L <sub>SEG</sub> = 660 m (2165 ft)	≤	1000 m (3280 ft)	✓ Yes
Drop cable length	≤	30 m (98 ft)	✓ Yes

#### Final consideration:

For the example shown, intrinsic safety according to the FISCO model can be proven.

## Device identification

Prosonic Flow 93 FOUNDATION Fieldbus transmitter and P sensor

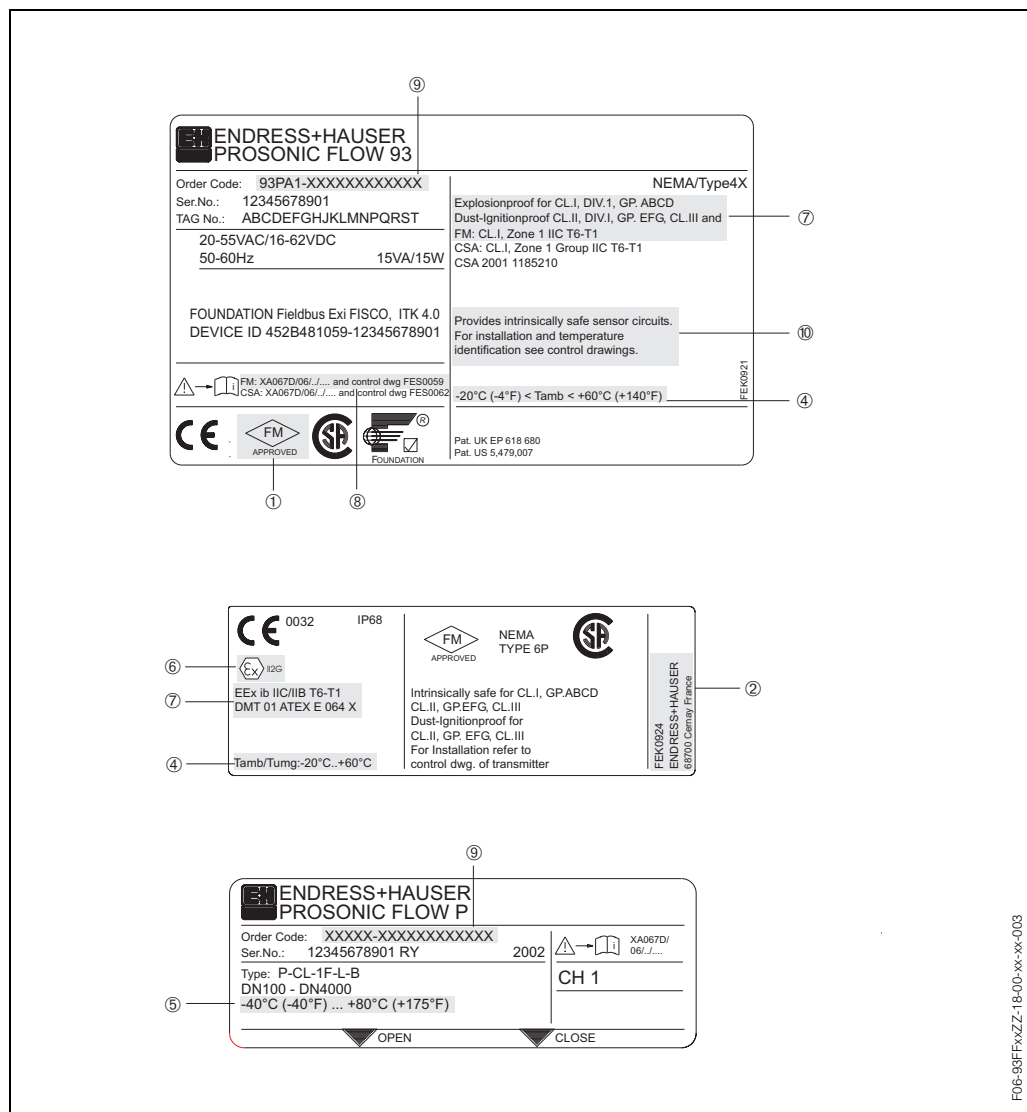


Fig. 13: Nameplate of transmitter and nameplate of sensor (example)

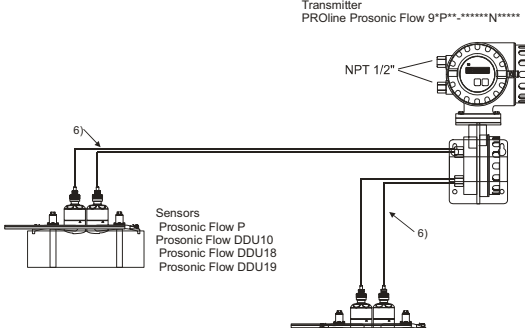
Key to nameplates (Figure 13)

No.	Meaning	No.	Meaning
①	Label of the notified body: Factory Mutual Research	⑥	Device group and device category to directive 94/9/EC
②	Place of manufacture	⑦	Type of protection and explosion group for the Prosonic Flow 93 FOUNDATION Fieldbus transmitter
③	–	⑧	Applicable Ex documentation
④	Ambient temperature range	⑨	Type code
⑤	Maximum medium temperature	⑩	Warning

## Control drawings

Endress+Hauser Reinach hereby declares that the product is in conformity with the requirements of the FACTORY MUTUAL standards.

**Hazardous Locations**  
Class I Division 1 Groups ABCD or Class I Zone 1 Groups IIC and Class II Division 1 Groups EFG and Class III



Notes:

- Control room equipment shall not use or generate more than 250 V rms.
- Install per NEC ANSI/NFPA 70. Install all intrinsically safe I/O circuits per NEC and ISA RP 12.6 respecting the Explosion-proof Integrity of the enclosure.
- Sensor circuits may be installed as intrinsically safe wiring per ISA RP 12.6 or in conduit in accordance with the NEC.
- Caution: Use supply wires suitable for 5 °C above ambient temperature, but at least for 80 °C / 176 °F.
- Class II Group G: The surface temperature of the apparatus cannot exceed 165 °C / 329 °F. The user must limit the process temperature for Group G to 160 °C.
- Cable Type for all Sensors: Use only prefabricated Endress+Hauser Cable. For reasons of safety the maximum allowed cable length is 30 m per sensor.

**Temperature table**

Sensors	T6	T5	T4A	T4	T3C	T3B	T3A	T3	T2	T1
<b>at Ta = 60°C</b>										
Pros. Flow 9*PA* - A*****	80	80	80	80	80	80	80	80	80	80
Pros. Flow 9*PA* - B*****	80	80	80	80	80	80	80	80	80	80
Prosonic Flow DDU 10 - A*****	80	80	80	80	80	80	80	80	80	80
Prosonic Flow DDU 10 - C*****	80	80	80	80	80	80	80	80	80	80
Prosonic Flow DDU18-A**	80	80	80	80	80	80	80	80	80	80
Prosonic Flow DDU19-A**	80	80	80	80	80	80	80	80	80	80
<b>at Ta = 60°C</b>										
Pros. Flow 9*PA* - E*****	80	95	115	130	155	160	170	170	170	170
Pros. Flow 9*PA* - F*****	80	95	115	130	155	160	170	170	170	170
Prosonic Flow DDU 10 - B*****	80	95	115	130	155	160	170	170	170	170
Prosonic Flow DDU 10 - D*****	80	95	115	130	155	160	170	170	170	170
Prosonic Flow DDU18-B**	80	95	115	130	155	160	170	170	170	170


**Communication modules , I/O options**

Communication options	Control Drawings
I/O option = F, H, J	see FES0059-0001 A
I/O option = G, K	see FES0059-0002 A
I/O option = S, T	see FES0059-0004 A

**WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.**

**FM Control Drawing Class I Div. 1**  
**Class I Zone 1**

**PROSONIC FLOW 9 . P**



Flowtec AG, Kaeggenstrasse 7, CH-4153 Reinach BL1, Postfach

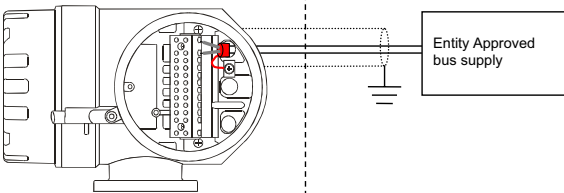
Massstab

Gezeichnet	09.03.01	UD
Geprüft		
Ex-geprüft	04.03.02	MDI
Gesehen		

**FES0059 A**

**HAZARDOUS LOCATIONS**  
Cl. I Div. 1 Groups A,B,C,D  
Cl. I Zone 1 Group IIC  
Cl. I Div. 2 Group A,B,C,D  
Cl. I Zone 2 Group IIC  
Cl. II, III Div. 1 Group E,F,G

**NON HAZARDOUS LOCATIONS**



**Notes:**

**Intrinsically safe signal output:**

- Wire all intrinsically circuits per ISA RP 12.6. or in conduit per NEC ANSI/NFPA 70
- WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.**
- Control room equipment may not use or generate more than 250 Vrms.

**Type: PROSONIC FLOW 9\*\*\*-\*\*\*\*\*G**  
**Terminals: 26, 27 (Foundation Fieldbus):**  
Intrinsically safe circuit:

$V_{max} / U_i$	$I_{max} / I_i$	$P_{max} / P_i$	$C_i$	$L_i$
30 V	500 mA	5.5 W	$\leq 5 \text{ nF}$	$\leq 10 \mu\text{H}$

Connect to entity approved associated apparatus with  
 $I_{SC}, I_i$  or  $I_0 \leq I_{max}$  or  $I_i$  and  
 $V_{OC}, V_i$  or  $U_0 \leq V_{max}$  or  $U_i$   
 $(P_0 \leq P_{max}$  or  $P_i)$

Cable parameters for Intrinsic Safety:  
 $C_{\text{cable}} \leq C_a / C_0 - \Sigma C_i$   
 $L_{\text{cable}} \leq L_a / L_0 - \Sigma L_i$  or  
 $L/R_{\text{cable}} \leq L/R_{\text{associated Apparatus}}$  and  $L_i$  of each I.S. apparatus  $\leq 10 \mu\text{H}$


Alternatively the intrinsically safe circuit ( Fieldbus Foundation ) can be connected according to the FISCO-Concept ( see FES 0059-0003).

**Nonintrinsically safe signal output:**

- Install all intrinsically safe circuits per NEC ANSI/NFPA 70 and ISA RP 12.6 respecting the Explosionproof Integrity of the enclosure
- WARNING: EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 1.**
- Control room equipment may not use or generate over 250 Vrms.

**Type: PROSONIC 9\*\*\*-\*\*\*\*\*K**  
**Terminals 26,27 (FIELD BUS FOUNDATION NON I.S.)**  
 $V \leq 32 \text{ V}, I = 10 \text{ mA}$

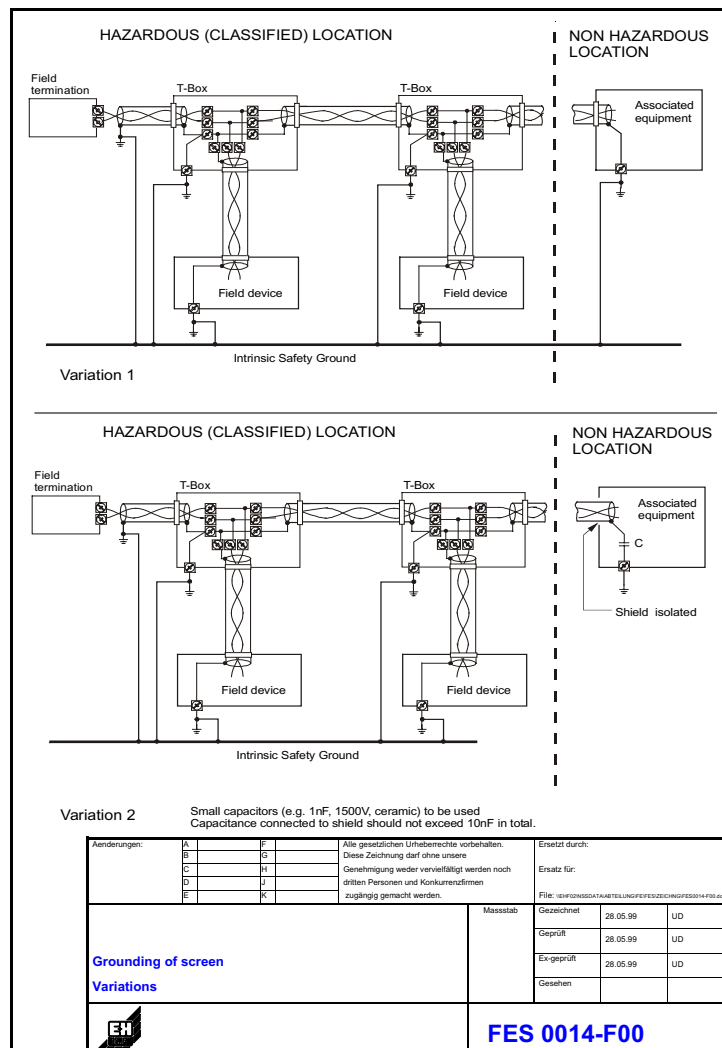
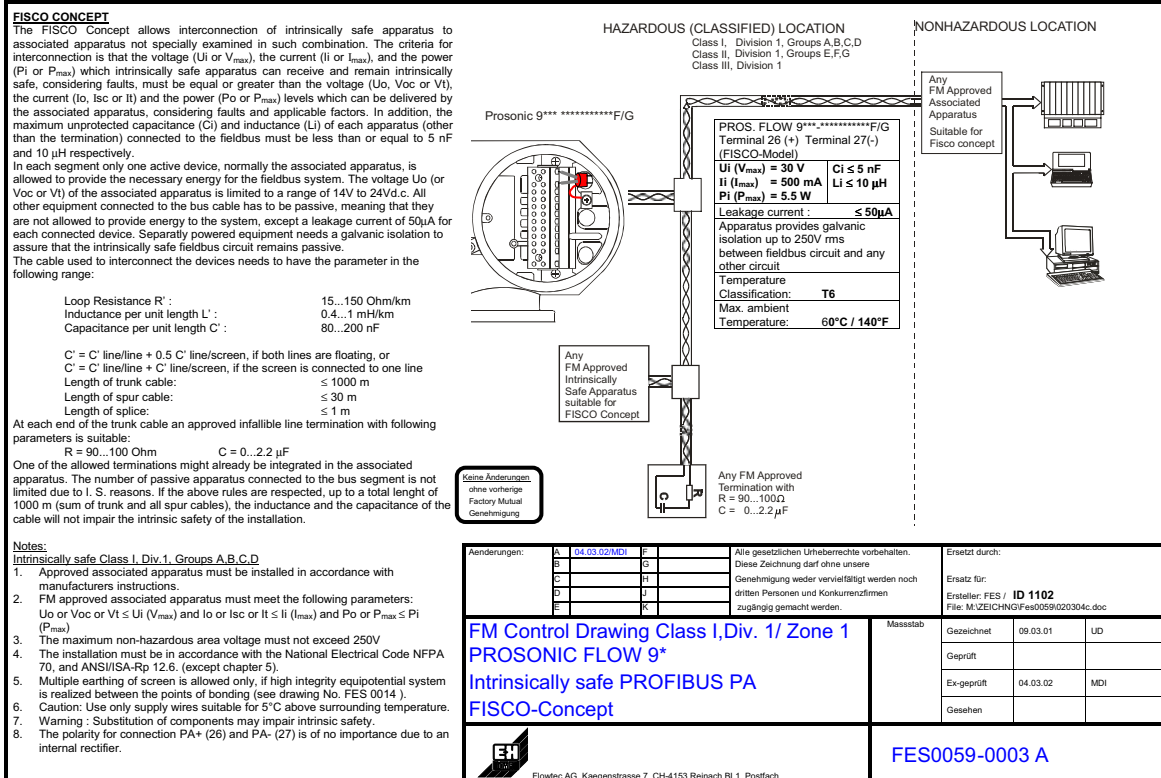
**FM Control Drawing Class I, Div. 1 / Zone**  
**PROSONIC FLOW 9\***  
**Fieldbus Foundation IS installation**  
**Fieldbus Foundation non-IS installation**



Flowtec AG, Kaeggenstrasse 7, CH-4153 Reinach BL1, Postfach

Endress + Hauser

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**Supplementary  
documentation**

TI 056D/06  
TI 057D/06

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**USA**

Endress+Hauser Inc.  
Greenwood, Indiana  
Tel. (317) 535-7138  
Fax. (317) 535-8498

**Canada**

Endress+Hauser Ltd.  
Burlington, Ontario  
Tel. (905) 681 92 92  
Fax. (905) 681 94 44

**Instruments International**

Endress+Hauser GmbH+Co.  
Weil am Rhein  
Germany  
Tel. (07621) 975-02  
Fax. (07621) 975 345





# PROline prosonic flow 93

## Division 1

**Ex documentation**  
**for the BA 078D and BA 079D operating instructions**  
**according to CANADIAN STANDARDS ASSOCIATION**



Example: **Class I, Division 1, Groups ABCD**

**Class**

I	Class I (Gas)
II	Class II (Dust)
III	Class III (Fibre)

**Division**

1	Division 1
2	Division 2

**Group**

CSC / NEC	Gases, vapours and dusts (Examples)	Min. ignition temperature [μJ]
A	Acetylene, carbon disulfide (Class I)	0.02
B	Hydrogen, ethyl nitrate (Class I)	0.02
C	Ethylene, isoprene (Class I)	0.06
D	Acetone, ethane, benzene (Class I)	0.18
E	Metallic powder (Class II)	
F	Coal dust (Class II)	
G	Grain dust (Class II)	
	Textile fibres (Class III)	

**Type of Protection**

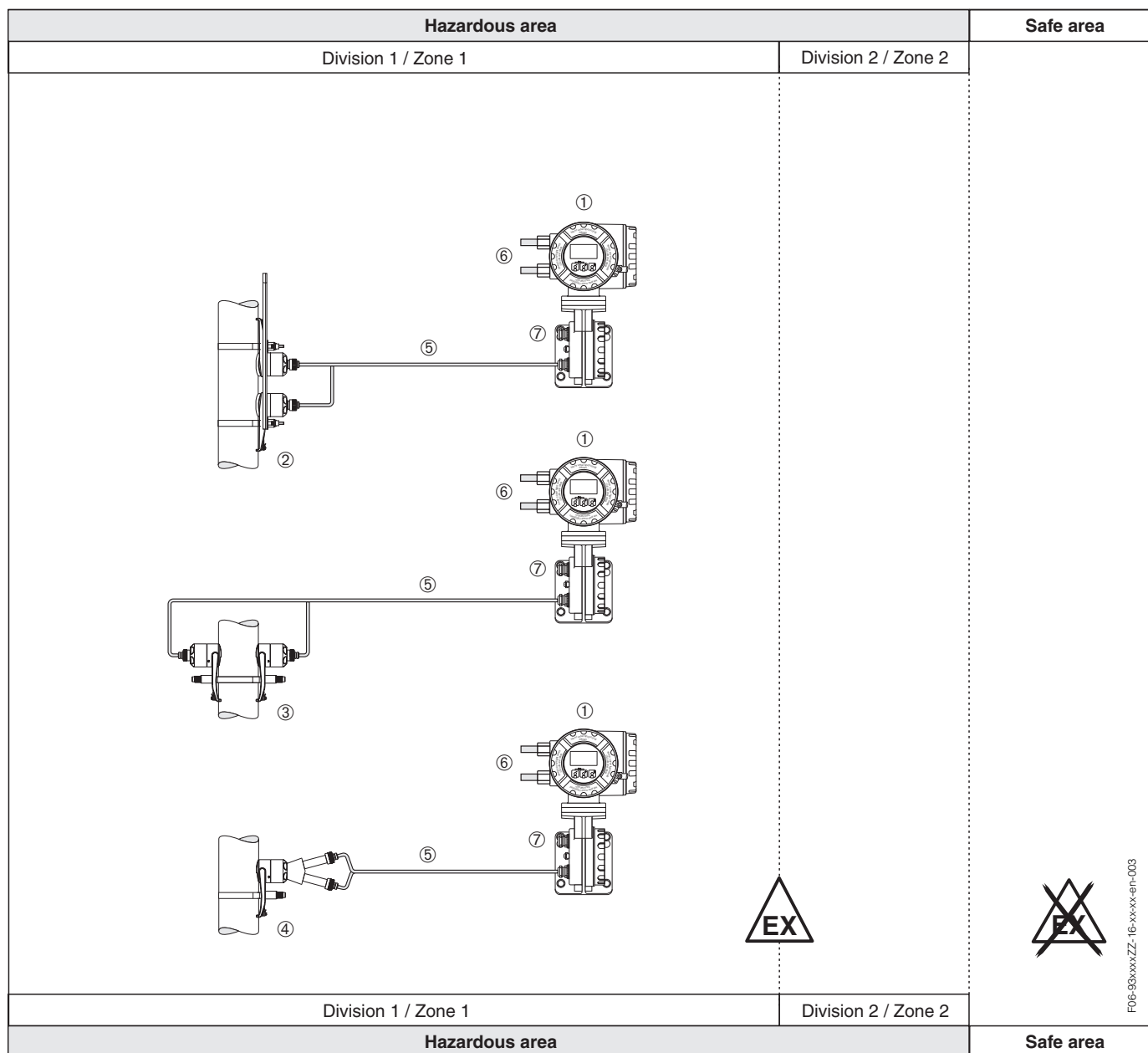
Explosionproof
Intrinsically Safe Apparatus
Associated Apparatus with Intrinsically Safe Connections
Nonincendive Field Wiring Circuit
Pressurized
Associated Pressurization Systems/Components
Nonincendive
Dust-Ignitionproof
Special Protection

**Temperature Class**

CSA	Maximum surface temperature	
T1	450 °C	842 °F
T2	300 °C	572 °F
T2A	280 °C	536 °F
T2B	260 °C	500 °F
T2C	230 °C	446 °F
T2D	215 °C	419 °F
T3	200 °C	392 °F
T3A	180 °C	356 °F
T3B	165 °C	329 °F
T3C	160 °C	320 °F
T4	135 °C	275 °F
T4A	120 °C	248 °F
T5	100 °C	212 °F
T6	85 °C	185 °F

Canadian Standards Association





F06-53-xxxxZZ-16-xx-xx-en-003

- ① Ultrasonic transmitter Prosonic Flow 93 FOUNDATION Fieldbus in:  
Explosionproof for Class I, Div. 1, GP. ABCD  
Dust-Ignitionproof Class II, Div. 1, GP. EFG, Class III

Explosionproof Enclosure

- ② Flow measuring sensors Prosonic Flow P (Clamp On) in:  
Intrinsically safe for Class I, Div. 1, GP. ABCD  
Dust-Ignitionproof for Class II, Div. 1, GP. EFG, Class III  
NEMA 6P

For ambient and medium temperature ranges,  
and temperature class, see Page 3.

Interconnection of components ① and ⑤ with sensors ②, ③ or ④ as loop concept.

For number references ⑥ and ⑦ see on Page 8.

- ③ Sensor velocity measuring sensors Prosonic Flow DDU 18 (Clamp On) in:  
Intrinsically safe for Class I, Div. 1, GP. ABCD  
Dust-Ignitionproof for Class II, Div. 1, GP. EFG, Class III  
NEMA 6P

- ④ Wall thickness measuring sensor Prosonic Flow DDU 19 (Clamp On) in:  
Intrinsically safe for Class I, Div. 1, GP. ABCD  
Dust-Ignitionproof for Class II, Div. 1, GP. EFG, Class III  
NEMA 4X

- ⑤ For safety reasons the max. cable length is 30 m.  
For interconnection between transmitter and sensors only  
prefabricated Endress+Hauser cables shall be used.  
Replace defective cables with new cables.

## Temperature tables

### Prosonic Flow\*\*PA\*-A/B\*\*\*\*\*N\*\*\*\*\* and Sound velocity measuring sensors DDU 18-A\*\*\*

at $T_a = 60\text{ °C}$		Max. medium temperature [°C] in					
		T6	T5	T4	T3	T2	T1
<b>Sensors**PA*-A/B*****N*****</b>	PVC cables	80	80	80	80	80	80
<b>Sensors DDU 18-A***</b>	PVC cables	80	80	80	80	80	80

The minimum medium temperature is  $-40\text{ °C}$

### Prosonic Flow\*\*PA\*-E/F\*\*\*\*\*N\*\*\*\*\* and Sound velocity measuring sensors DDU 18-B\*\*\*

at $T_a = 60\text{ °C}$		Max. medium temperature [°C] in					
		T6	T5	T4	T3	T2	T1
<b>Sensors**PA*-E/F*****N*****</b>	PTFE cables	80	95	130	170	170	170
<b>Sensors DDU 18-B***</b>	PTFE cables	80	95	130	170	170	170

The minimum medium temperature is  $0\text{ °C}$

### Wall thickness measuring sensor DDU 19-A\*\*\*

at $T_a = 60\text{ °C}$		Max. medium temperature [°C] in					
		T6	T5	T4	T3	T2	T1
<b>Sensor DDU 19-A***</b>	PVC or PTFE cables	80	80	80	80	80	80

The minimum medium temperature is  $-20\text{ °C}$

### Transmitter Prosonic Flow 93 P\*\*-\*\*\*\*\*

The Prosonic Flow 93 transmitter has a T6 temperature class rating when installed in the Explosionproof Enclosure for operation at ambient temperatures up to  $T_a = 60\text{ °C}$ .

The maximum ambient temperature range is  $-20\text{...}+60\text{ °C}$ .



Note:

At the specified medium temperatures, the equipment is not subjected to temperatures impermissible for the temperature class in question.

## Approvals

No. / approval type	Description
1185210  (See Page 5 for notes on special conditions)	for the electric flow measuring system Prosonic Flow 93 P FOUNDATION Fieldbus  <b>Identification:</b> see below

<b>Transmitter Prosonic Flow 93 FOUNDATION Fieldbus</b>	
Prosonic Flow 93 P** - *****N****.	G = FOUNDATION Fieldbus, EEx i FISCO K = FOUNDATION Fieldbus
Prosonic Flow 93 P** - *****N****	<b>Explosionproof for Class I, Div. 1, GP. ABCD</b> <b>Dust-Ignitionproof Class II, Div. 1, GP. EFG, Class III</b>
<b>Flow measuring sensors</b>	
Prosonic Flow P	<b>Intrinsically safe for Class I, Div. 1, GP. ABCD</b> <b>Dust-Ignitionproof for Class II, Div. 1, GP. EFG, Class III</b>
<b>Sound velocity measuring sensors</b>	
Prosonic Flow DDU 18	<b>Intrinsically safe for Class I, Div. 1, GP. ABCD</b> <b>Dust-Ignitionproof for Class II, Div. 1, GP. EFG, Class III</b>
<b>Wall thickness measuring sensor</b>	
Prosonic Flow DDU 19	<b>Intrinsically safe for Class I, Div. 1, GP. ABCD</b> <b>Dust-Ignitionproof for Class II, Div. 1, GP. EFG, Class III</b>

## Notified body

The Prosonic Flow measuring system was tested for approval by the following named entity:

CSA: Canadian Standards Association

## Special conditions



1. Control room equipment shall not use or generate more than 250 V rms

Caution:

2. Use supply wires suitable for 5 °C above ambient temperature, but at least for 80 °C.
3. The specified temperature class in conjunction with the ambient temperature and the medium temperature must be in compliance with the tables on Page 3.
4. It is not permissible to connect the service adapter in explosive atmospheres.
5. Install per Canadian Electrical Code. Install intrinsically safe circuits per CEC and ISA RP 12.6 respecting the explosionproof integrity of the enclosure.



Warning:

6. Substitution of components may impair intrinsic safety.
7. The flowmeter must be integrated into the potential equalisation system (see Fig. 1).

## General warnings



- Installation, connection to the electricity supply, commissioning and maintenance of the devices must be carried out by qualified specialists trained to work on Ex-rated devices.
- Compliance with national regulations relating to the installation of devices in potentially explosive atmospheres is mandatory, if such regulations exist.
- Open the device only when it is de-energized (and after a delay of at least 10 minutes following shutdown of the power supply).
- The housing of the Ex-rated transmitter can be turned in 90° steps. Whereas the non-Ex version has a bayonet adapter, however, the Ex version has a thread. Recesses for centering the worm screw are provided to prevent inadvertent movement of the transmitter housing.  
It is permissible to turn the transmitter housing through a maximum of 180° during operation (in either direction), without compromising explosion protection.  
After turning the housing the worm screw must be tightened again.
- The screw cap has to be removed before the local display can be turned, and this must be done with the device de-energized (and after a delay of at least 10 minutes following shutdown of the power supply). Be sure that the device is closed properly, before connecting it to power again.

## Electrical connections

### Power supply connection

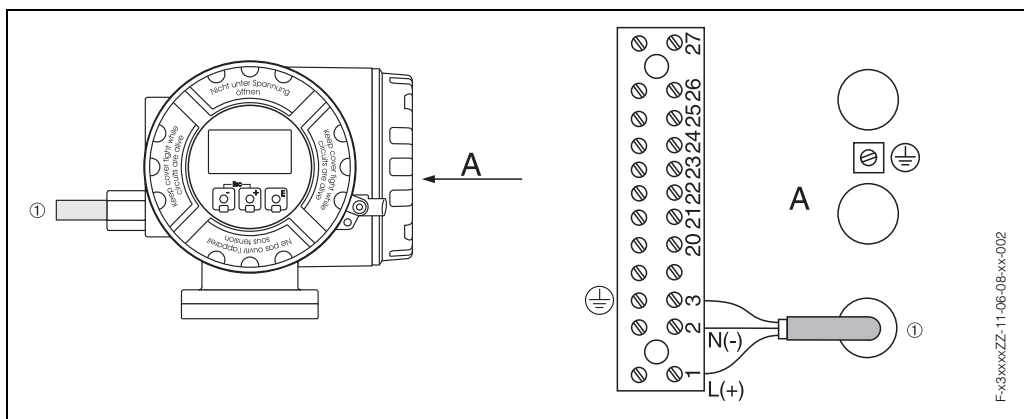


Fig. 1: ① = Power supply cable  
A = View A

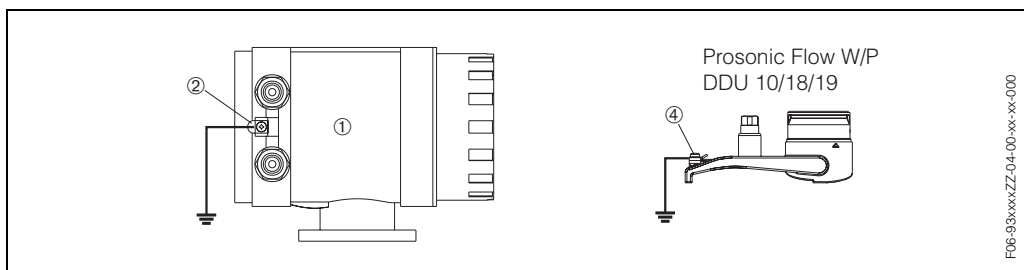


Fig. 2: Ground terminal for potential equalisation



#### Caution:

- The transmitter ① is to be securely connected to the potential equalization system using the screw terminal ② on the outside of the transmitter housing.
- The sensor holders are to be grounded using the external screw terminal ④. Alternatively, the sensor can be connected to the potential equalization system via the pipeline when a ground connection according to regulations can be assured.

The table below contains the values that are identical for all versions, irrespective of the type code.

### Transmitter Prosonic Flow 93

Terminals	1	2	3
	L (+)	N (-)	
Designation	Power supply ①		Protective earth
Functional values	AC: U = 85...260 V or AC: U = 20...55 V or DC: U = 16...62 V  Power consumption: 15 VA / 15 W		Caution: Follow ground network requirements for the facility
Intrinsically safe circuit	no		
U <sub>m</sub> =	260 V AC		

### Input/output circuit

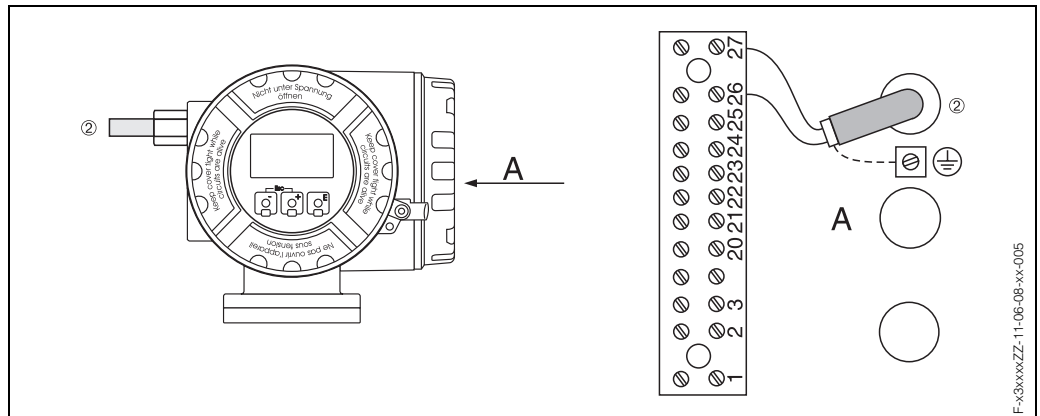


Fig. 3: ② = bus cable (FOUNDATION Fieldbus)  
A = view A



Note:

The table below contains the values which depend on the type code (type of device). Always remember to compare the type code in the table with the code on the nameplate of your device.

**Transmitter Prosonic Flow 93\*\*\*-\*\*\*\*\*G**

Terminals	20	21	22	23	24	25	26	27
	+	-	+	-	+	-	+	-
Designation							FOUNDATION Fieldbus ②	
Functional values							U <sub>B</sub> = 9...32 V DC I <sub>B</sub> = 12 mA	
Intrinsically safe circuit							EEx ia	
U <sub>i</sub> =							30 V AC	
I <sub>i</sub> =							500 mA	
P <sub>i</sub> =							5.5 W	
L <sub>i</sub> =							10 µH	
C <sub>i</sub> =							5 nF	

**Transmitter Prosonic Flow 93\*\*\*-\*\*\*\*\*K**

Terminals	20	21	22	23	24	25	26	27
	+	-	+	-	+	-	+	-
Designation							FOUNDATION Fieldbus ②	
Functional values							U <sub>B</sub> = 9...32 V DC I <sub>B</sub> = 12 mA	
Intrinsically safe circuit							no	
U <sub>max</sub> =							260 V AC	
I <sub>max</sub> =							500 mA	

## Device fuse



Warning:

Use only fuses of the following types; the fuses are installed on the power supply board:

- Voltage 20...55 V AC / 16...62 V DC:  
fuse 2.0 A slow-blow, breaking capacity 1500 A  
(Schurter, 0001.2503 or Wickmann, Standard Type 181 2.0 A)
- Voltage 85...260 V AC:  
fuse 0.8 A slow-blow, breaking capacity 1500 A  
(Schurter, 0001.2507 or Wickmann, Standard Type 181 0.8 A)

## Cable entries

For number reference see the figure on Page 2.

- ⑥ *Cable entries for the transmitter terminal compartment (XP version)*  
*power supply / bus cable: (Prosonic Flow 93)*  
Choice of thread for cable entries, ½" NPT.
- ⑦ *Cable entries for the transmitter terminal compartment*  
*sensor cable connection:*  
A special cable gland allows you to insert both sensor cables (per channel) into the connection compartment simultaneously.  
Cable gland M20x1.5 for 2 x Ø 4 mm or threaded adapter ½" NPT, G ½".

Make sure that the XP cable entries are secured to prevent working loose.



## Cable specifications

The sensor cable connection between sensor and transmitter has an EEx i type of protection rating.

- The cables are available in lengths of 5 m, 10 m, 15 m and 30 m.
- You can choose between PTFE and PVC cable materials.



Caution:

Use the ready-to-use cables supplied by E+H with each sensor pair.

## Connecting the sensor connecting cable



Warning:

Switch off the power supply before opening the connection compartment. Do not install or wire the device while it is connected to the power supply. Failure to comply with this precaution can result in irreparable damage to the electronics.

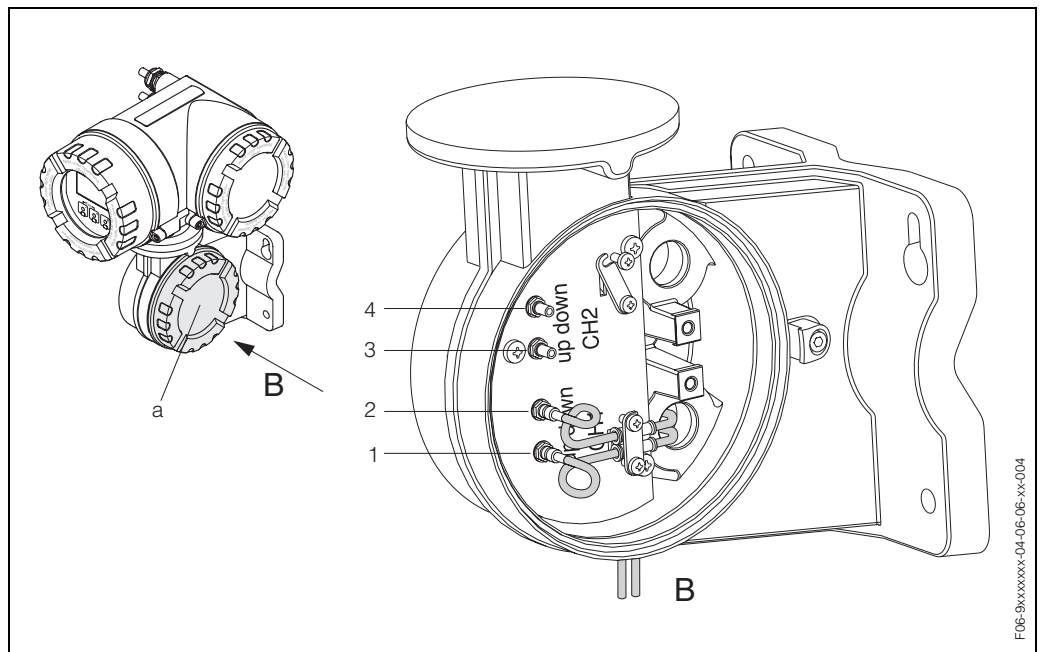


Fig. 4: Connecting the two possible measuring systems (one or two-channel)

*a* = view B

1 = channel 1 upstream

2 = channel 1 downstream

3 = channel 2 upstream

4 = channel 2 downstream

Procedure:

1. Transmitter: remove cover (a, Fig. 4) from the connection compartment.
2. Remove blank cover for the cable entries for channel 1 and channel 2.
3. Remove special cable entry (supplied with sensors). Run both sensor connecting cables through the cover (b) of the cable gland and into the connection compartment.
4. Position the cable fixing sleeves (c) of the sensor cables exactly next each other (Detail C). Position the ground contact terminals (d) and screw them tight.

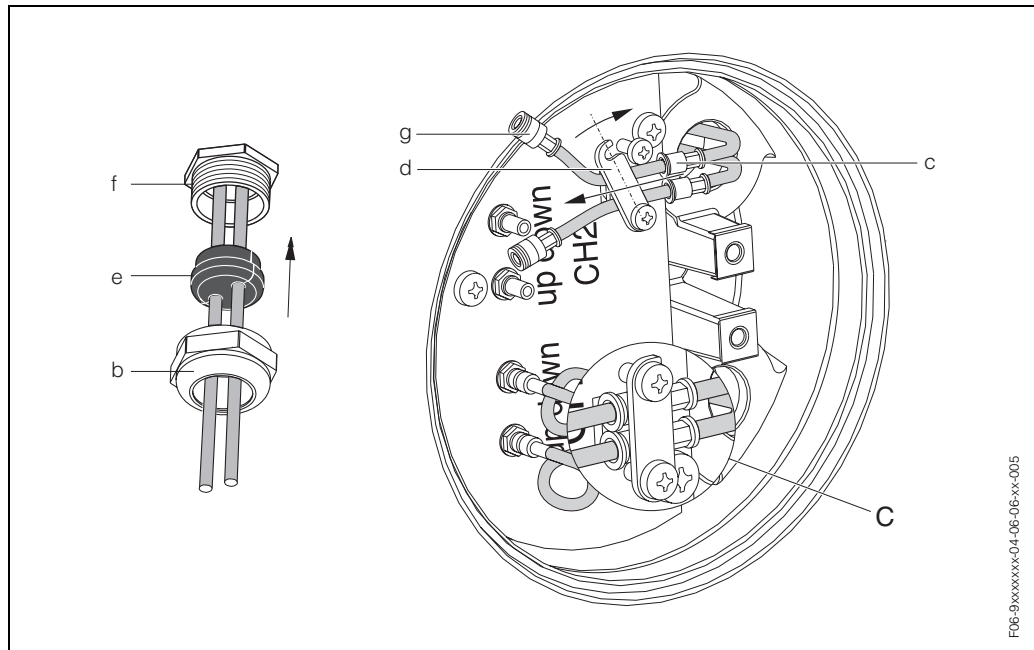


Fig. 5: Connecting the sensor connecting cable

5. Spread the rubber seal (e) along the side slit using a suitable tool (e.g. a large screwdriver) so that both sensor cables are clamped within. Push the rubber seal up into the cable gland bracket (f). Close the cover of the cable gland (b) so that it is tight.
6. Plug in the sensor cable connectors analogue to the arrangement in Fig. 4.
7. Transmitter: secure cover (a) on the connection compartment.

## Removing and installing printed circuit boards

### Field housing: removing and installing printed circuit boards (Fig. 6)



Caution:

- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purposely built for electrostatically sensitive devices!



Warning:

- Danger of explosion! Open the device only when it is de-energized (and after a delay of at least 10 minutes following shutdown of the power supply).
- Risk of damaging electronic components (ESD protection). Static electricity can damage electronic components or impair their operability. Use a workplace with a grounded working surface purposely built for electrostatically sensitive devices!

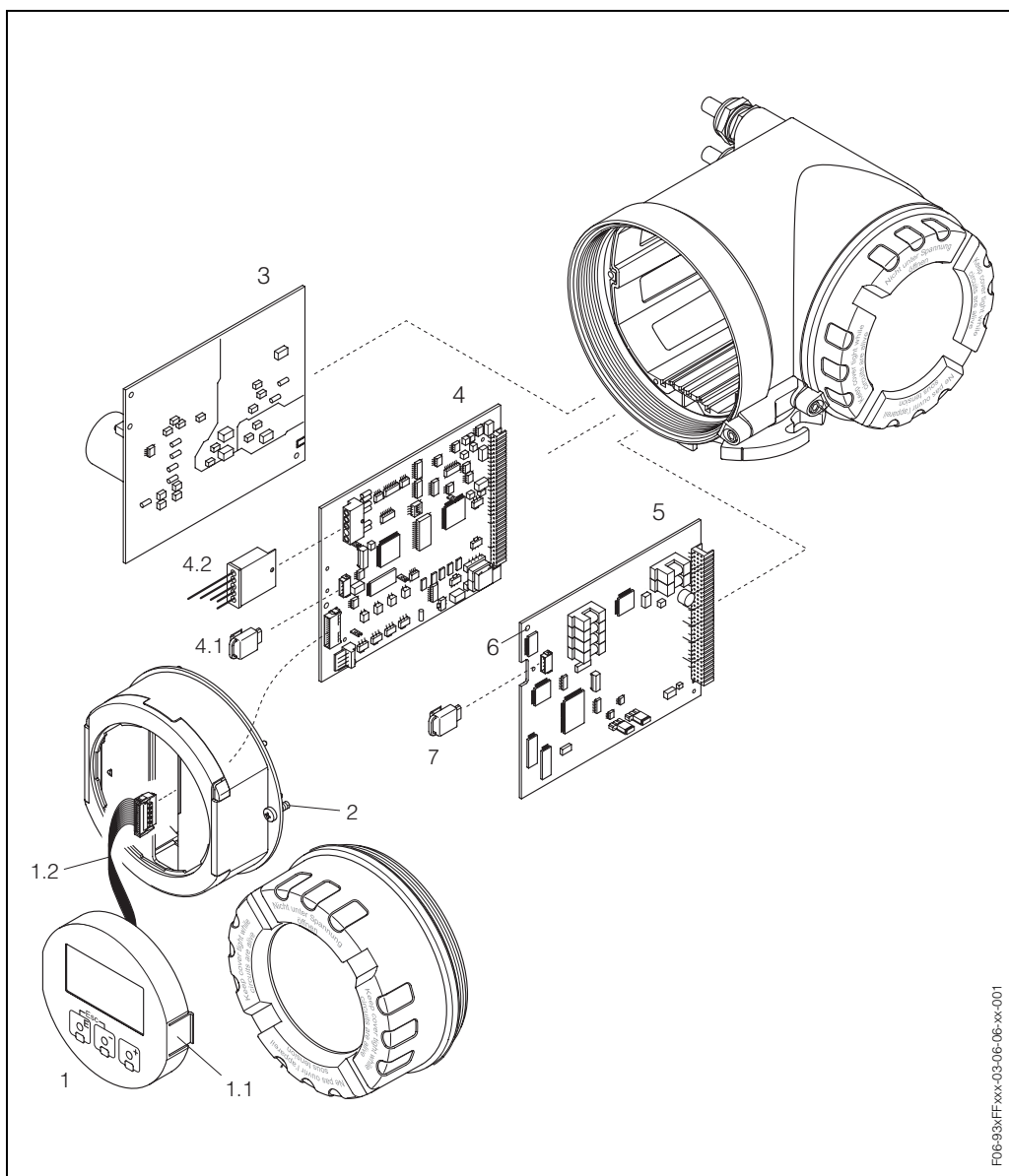
1. Remove the cover of the electronics compartment.
2. Remove the local display (1) as follows:
  - Press in the latches (1.1) at the side and remove the display module.
  - Disconnect the ribbon cable (1.2) of the display module from the amplifier board.
3. Remove the screws and remove the cover (2) from the electronics compartment.
4. Remove power unit board and I/O board (3, 5):  
Insert a thin pin into the hole (6) provided for the purpose and pull the board clear of its holder.
5. Remove amplifier board (4):
  - Disconnect the plug of the sensor signal cable (4.2) from the board.
  - Insert a thin pin into the hole (6) provided for the purpose and pull the board clear of its holder.
6. Installation is the reverse of the removal procedure.



Caution:

Use only original Endress+Hauser parts. Only replace printed circuit boards with identical ones.

7. If you cannot maintain the dielectric strength of the device during the work stages, carry out a test according to the manufacturer's specifications.

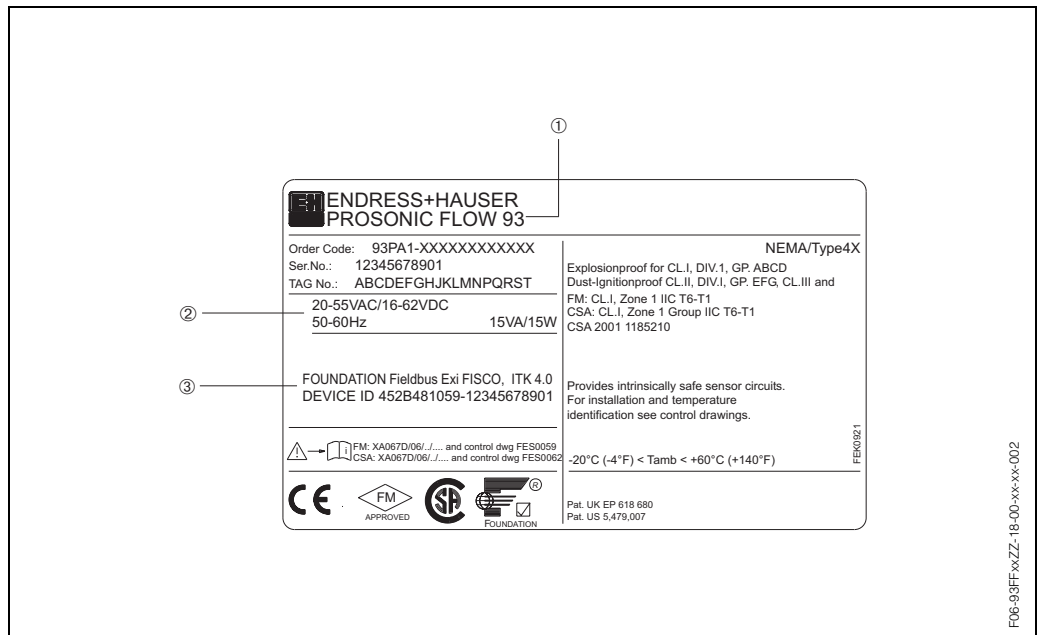


F06-93xTFxxx-03-06-06-xx-001

Fig. 6: Field housing: removing and installing printed circuit boards

- 1 Local display
- 1.1 Latch
- 1.2 Ribbon cable (display module)
- 2 Screws of electronics compartment cover
- 3 Power unit board
- 4 Amplifier board
- 4.1 T-DAT™ (transmitter data memory)
- 4.2 Unplug sensor signal cable
- 5 I/O board (type FOUNDATION Fieldbus)
- 6 Aperture for installing/removing boards
- 7 F-Chip™ (function chip for optional software)

## Exchanging electronics components



The following information on the nameplate must be compared for the information on the repairs set. Modules must not be exchanged unless this information is identical:

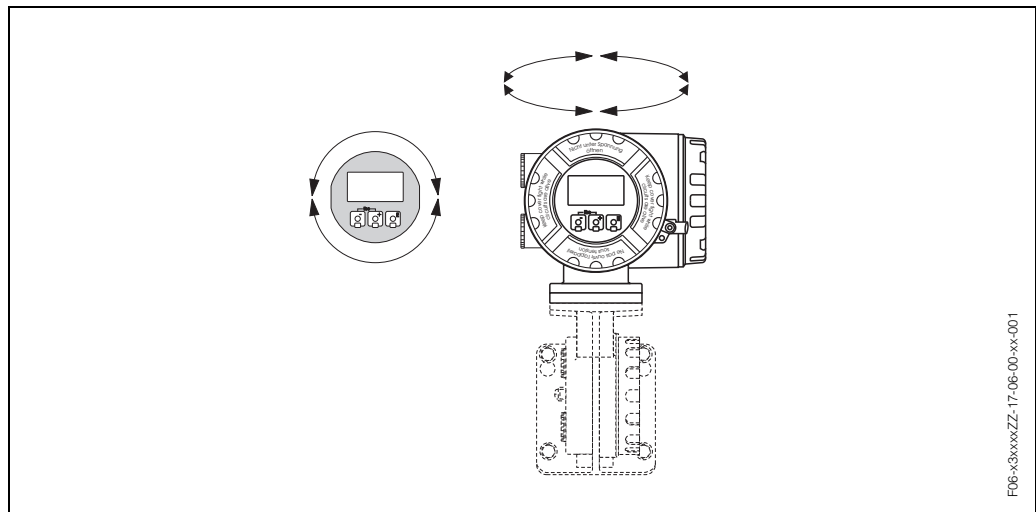
Power unit board: ① and ②

Amplifier board: ①

I/O board: ③

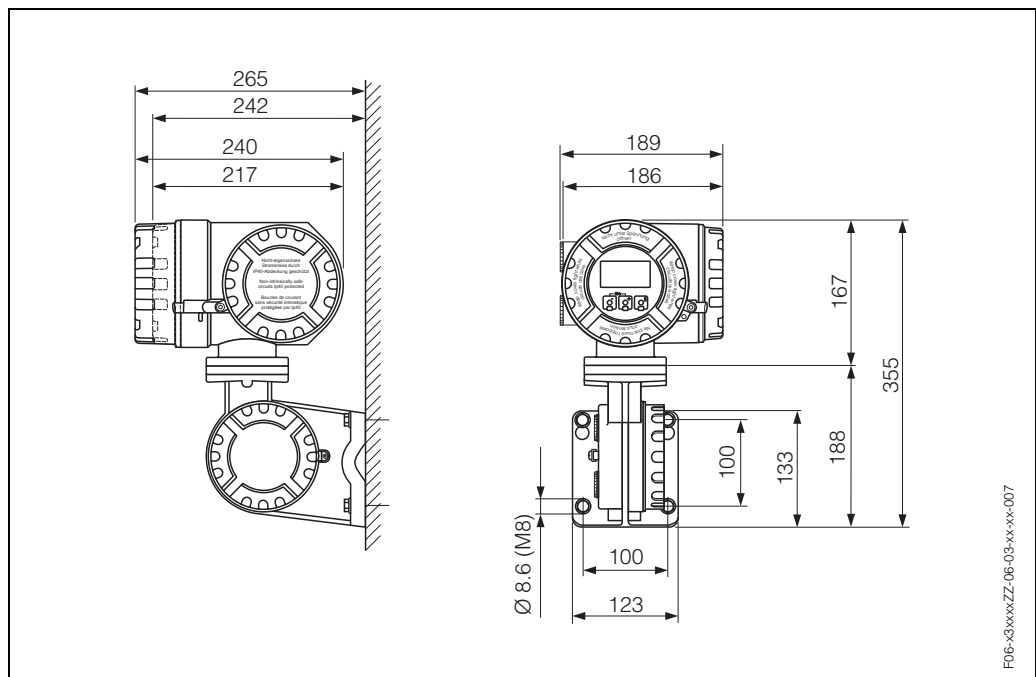
## Turning the transmitter housing and the local display

To obtain the optimum orientation of the display of the field housing, it is possible to turn the display or the head of the measuring transmitter housing up to 360°.



F06-x3xxxZZ-17-06-00-xx-001

## Dimensions Prosonic Flow 93 transmitter



F06-x3xxxZZ-06-03-xx-xx-007

## Weight

Housing for transmitter:

- Wall-mounted housing: 6.0 kg
- Field housing: 6.7 kg

Measuring sensors:

- Flow measuring sensors P incl. mounting rail and tensioning bands: 2.8 kg
- Sound velocity measuring sensors DDU 18 incl. tensioning bands: 2.4 kg
- Wall thickness measuring sensor DDU 19 incl. tensioning band: 1.5 kg

## Bus cable for FOUNDATION Fieldbus

The Fieldbus FOUNDATION defines four different types of cable in the specification creating the physical transmission layer (FF-816) which is analogous to IEC 61158-2. A two-core cable is always specified.

The electrical data has not been specified but determines important characteristics of the design of the fieldbus, such as distances bridged, number of participants, electro-magnetic compatibility, etc.

Two of the four cable types in the standard are specified in the following table.

	Cable type A (reference)	Cable type B
<i>Cable construction</i>	twisted pair, shielded	one or more twisted pairs, fully shielded
<i>Core cross-section (nominal)</i>	0.8 mm <sup>2</sup> (AWG 18)	0.32 mm <sup>2</sup> (AWG 22)
<i>Loop resistance (direct current)</i>	44 Ω/km	112 Ω/km
<i>Impedance at 31.25 kHz</i>	100 Ω ± 20%	100 Ω ± 30%
<i>Attenuation constant at 39 kHz</i>	3 dB/km	5 dB/km
<i>Capacitive unsymmetry</i>	2 nF/km	2 nF/km
<i>Envelope delay distortion (7.9...39 kHz)</i>	1.7 μs/km	**
<i>Degree of voltage of shielding</i>	90%	**
<i>Max. bus segment length (inc. spur lines)</i>	1900 m	1200 m

Tab. 1: Cable types

We recommend the use of cables meeting the minimum requirements of type A as transmission medium, particularly for the installation of new systems. The recommended network expansion is made up of the length of the main cable and the length of all spurs. The line between distribution box and field device is described as a spur. The maximum length of a spur depends on the number of spurs (> 1 m). A maximum of four field devices can be connected to a spur.

Number of spurs	1...12	13...14	15...18	19...24	25...32
Max. length per spur	120 m	90 m	60 m	30 m	1 m

Tab. 2: Table of possible spur line lengths

The following table shows examples of FOUNDATION Fieldbus bus cables (type A) from various manufacturers.

Supplier	Model	Order number
Belden	3076	—
Kerpen	FB-02YS (St+C) Y-FL	74220001 (light blue) 74220004 (black)
Siemens	SIMATIC NET bus cable	6XV1830-5AH10 (light blue) 6XV1830-5BH10 (black)

Tab. 3: Possible cable suppliers

### Bus termination

The start and end of each fieldbus segment are always to be terminated with a bus terminator.

- In the case of a branched bus segment the measuring device furthest from the segment connector represents the end of the bus.
- If the fieldbus is extended with a repeater then the extension must also be terminated at both ends.

### Selecting and connecting components

The FOUNDATION Fieldbus allows several devices from different manufacturers to be generally connected to a bus segment. When selecting components for use in areas with an explosion risk only components marked as intrinsically safe, explosion-protected electrical equipment or as intrinsically safe associated electrical equipment may be used. When combining different fieldbus devices and fieldbus components, in addition to functional considerations, technical safety factors must be considered if explosion protection is to be ensured.

## Implementation of intrinsic safety in the FOUNDATION Fieldbus H1

The FOUNDATION Fieldbus H1 can be made intrinsically safe for use in areas with an explosion risk (Ex i). To do this, according to the FOUNDATION Fieldbus specification a suitable safety component must be installed (FF-816) between the safe area and the area with an explosion risk. The intrinsically safe bus segment can be supplied either by a non-intrinsically safe power supply with a safety barrier downstream or by a fieldbus power supply with an intrinsically safe output.

It is recommended that the cable shielding be grounded at both ends (refer to Fig. 8, Page 19).

Installation example of a galvanic isolator with bus feed:

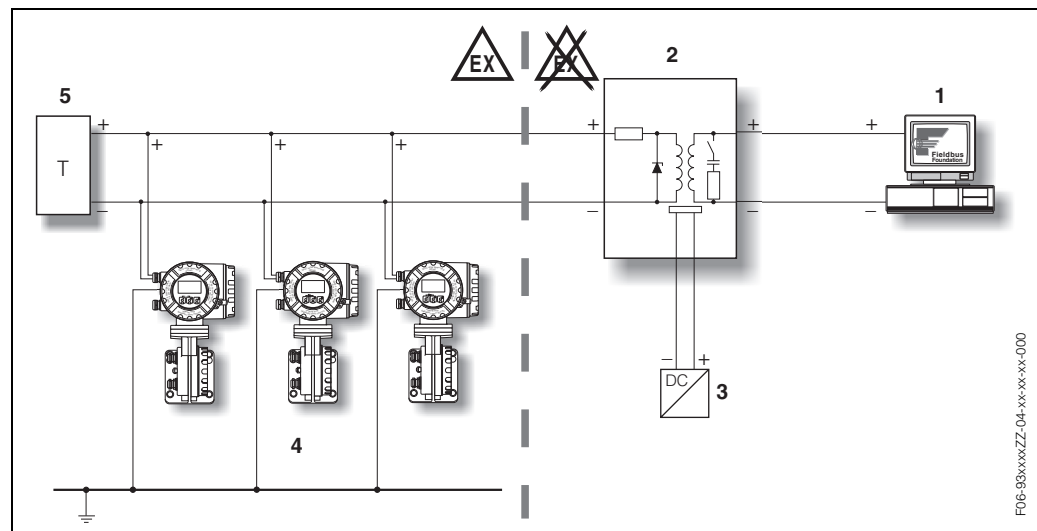


Fig. 7: Typical embodiment of a galvanic isolator including fieldbus power supply

1 = DCS with integrated FOUNDATION Fieldbus H1 interface card

2 = fieldbus power supply: galvanic isolator

3 = fieldbus power supply

4 = Prosonic Flow 93 bus devices for hazardous area

5 = terminator (T) = bus termination



## Proof of intrinsic safety

Proof of intrinsic safety for the intrinsically safe bus segment can be made by using one of the following models:

- Entity model
- FISCO model

Both models differ from one another by their consideration of the cable. While the FISCO model considers the transmission line as distributed inductance and capacitance, the basis of this consideration for the Entity model is concentrated inductance and capacitance. The result of this is that lower quantities of power can be transmitted with the Entity model into the Ex area, and that the number of field devices that can be operated on a power repeater is therefore lower than with the FISCO model.

In the case of failure, instruments from different manufacturers can be exchanged when their safety-relevant data is taken into consideration. This data is: electrical parameters, device group and category, and the temperature class.

Both these models are briefly described in the following.

### The Entity model

The Entity model is based on the observation that the cable represents concentrated inductance and capacitance. The result is that less electrical power can be transmitted into the area subject to the risk of explosion when compared with the FISCO model.

The following conditions must be met in the safety according to the entity model considerations:

Field device Hazardous area	Mandatory	Power supply Safe area
Maximum voltage [U <sub>i</sub> ]	≥	Idle voltage of the safety element [U <sub>o</sub> ]
Maximum current [I <sub>i</sub> ]	≥	Short-circuit current [I <sub>o</sub> ]
Maximum power [P <sub>i</sub> ]	≥	[P <sub>o</sub> ]
Effective internal capacitance [C <sub>i</sub> ] + cable capacitance	≤	Maximum permitted external capacitance [C <sub>o</sub> ]
Effective internal inductance [L <sub>i</sub> ] + cable inductance	≤	Maximum permitted external inductance [L <sub>o</sub> ]

Tab. 4: General dependencies

In addition, the following measures must be taken:

- determine permissible explosion group for the bus segment
- determine all effective energy stores (L<sub>i</sub>, C<sub>i</sub>, capacitance and inductance per unit length)
- check locally supplied operating units for galvanic isolation
- harmonize temperature class and ambient temperature



Note:

Configuration example see Page 21

## The FISCO model

The German Federal Physical-Technical Institute (PTB) has developed the FISCO model which was published in Report PTB-W-53 "Examination on Intrinsic Safety for Field Bus Systems".

The FISCO model makes possible the interconnection of intrinsically safe apparatus and one intrinsically safe associated apparatus, without having to have separate certification for respective connections.

The criteria for the intrinsic safety of an interconnection (bus segment) is given under the following interrelationships:

1. To transmit power and data, the bus system uses the physical configuration defined by IEC 61158-2. This is the case for FOUNDATION Fieldbus and the H1 bus.
2. Only one active source is permitted on a bus segment (here the power repeater). All other components work as passive current sinks.
3. The basic current consumption of a field device is at least 10 mA.
4.  $U_i$ ,  $I_i$  and  $P_i$  of the bus device  $\geq U_o$ ,  $I_o$  and  $P_o$  of the associated equipment (bus power supply).
5. Each instrument must fulfill the following requirement:  $C_i \leq 5 \text{ nF}$ ,  $L_i \leq 10 \text{ }\mu\text{H}$
6. The permissible line length for EEx ia IIC applications is 1000 m.
7. The permissible spur length for Ex applications is 30 m per spur.
8. The transmission line that is used must conform to the following cable parameters:  
 Resistor coating:  $15 \text{ }\Omega/\text{km} < R' < 150 \text{ }\Omega/\text{km}$   
 Inductance coating:  $0.4 \text{ mH/km} < L' < 1 \text{ mH/km}$   
 Capacitance coating:  $80 \text{ nF/km} < C' < 200 \text{ nF/km}$  (including the shield)
9. The bus segment must be terminated on both ends of the line with a terminal bus resistor. A terminal resistor is integrated into the power repeater so that an external bus terminator is only required on the other end. According to the FISCO model the fieldbus terminator must conform to the following limits:  
 –  $90 \text{ }\Omega < R < 100 \text{ }\Omega$   
 –  $0 \text{ }\mu\text{F} < C < 2.2 \text{ }\mu\text{F}$



Note:  
Configuration example see Page 28

## Potential equalisation with shielding grounded at both ends

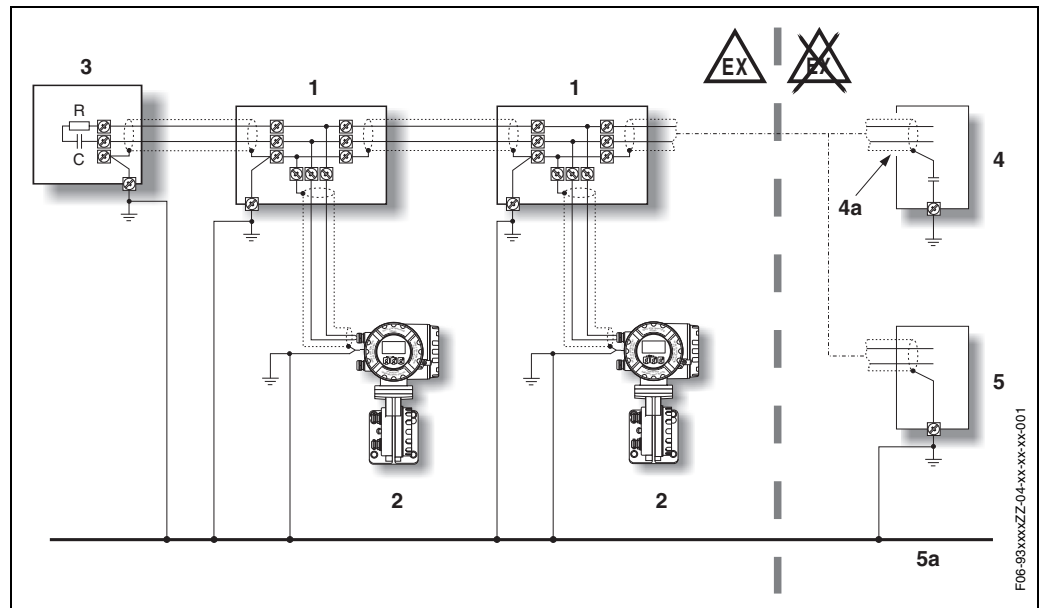


Fig. 8: Examples of the connection of potential equalisation lines

- 1 = distributor/T-box
- 2 = Prosonic Flow 93 bus devices for hazardous area
- 3 = bus termination:  $R = 90...100\ \Omega$ ,  $C = 0...2.2\ \mu F$
- 4 = fieldbus power supply variant 4a
- 4a = shielding connected via capacitor
- 5 = fieldbus power supply variant 5a
- 5a = potential equalisation line led out

### Variant 4/4a:

With capacitive grounding of the shielding in the safe area the potential equalisation line does not need to be led out of the safe area.

Use small capacitors (e.g. 1 nF, 1500 V, dielectric strength, ceramic). The total capacitance connected at the shielding must not exceed 10 nF.

### Variant 5/5a:

Potential equalisation line is led out of the safe area.

## Network configuration for FOUNDATION Fieldbus H1

### General remarks

Various aspects are to be considered when configuring a FOUNDATION Fieldbus H1 segment and these must essentially be checked by two general types of considerations:

### Functional considerations

In the functional considerations, the characteristic of the technical function data laid down in IEC 61158-2 for the transmission technology of the FOUNDATION Fieldbus H1 and the physical network structure is checked. Here it must always be ensured that the total base currents of all bus participants does not exceed the maximum permissible feed current of the bus power supply and that the field devices are always supplied with a minimum bus voltage of 9 V.

### Technical safety considerations

For use of the FOUNDATION Fieldbus H1 in an area with an explosion risk, proof of intrinsic safety is to be provided for the entire bus segment by means of the technical safety considerations. Proof of intrinsic safety for the intrinsically safe bus segment can be made by using one of the following models:

#### *Entity model*

The safety considerations correspond to those in a conventional 4...20 mA measuring circuit. The only exception is that here more than one field device is supplied by the power supply. The safety considerations must result in the knowledge that the fieldbus power supply does not exceed the safety parameters (P-, U-, I-values) of the field devices and that the inductance and capacitance are within the permissible limits (example see Page 21).

#### *FISCO model*

If proof of intrinsic safety is made according to the FISCO model, it is to be verified that all components connected to the bus segment (field instruments, bus power supplies, bus terminator) are laid out according to the FISCO model. If this is the case, it must be proven that for each bus component the values of  $U_i$ ,  $I_i$  and  $P_i$  are greater or the same as the values of  $U_o$ ,  $I_o$  and  $P_o$  for the associated equipment (bus power supply). Example see Page 28.

### Configuration example for a FOUNDATION Fieldbus H1 segment

Based on the following example, the functional and safety-relevant considerations and calculations for the specification of a FOUNDATION Fieldbus H1 segment are carried out.

## Configuration example Entity model

Fig. 9 shows the typical structure and the associated components. The field devices are operated on a segment with the type of protection EEx ia. A galvanic isolator is used for the transition to the area with explosion risk. Field devices with a lower power consumption, such as the Cerabar S pressure gauge, are supplied via the two-wire line. In contrast, the Prosonic Flow 93 as a four-wire device must be supplied via an local power supply.

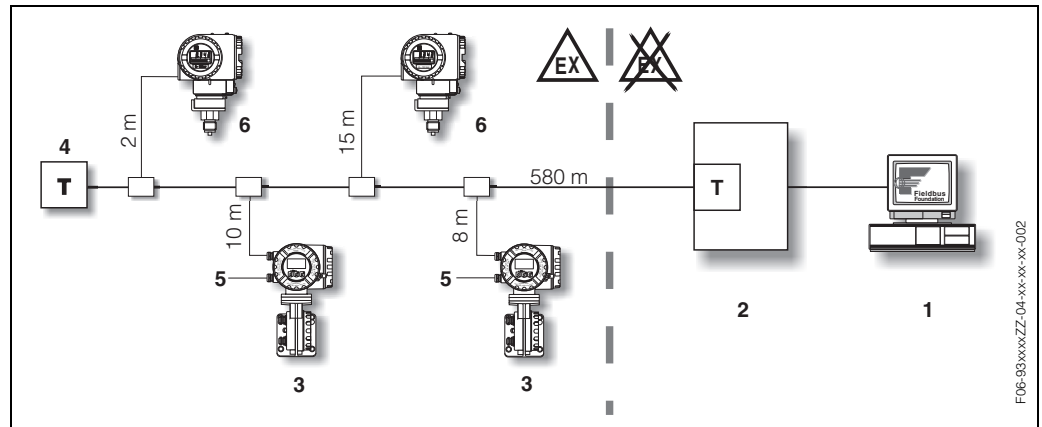


Fig. 9: Typical example of a bus connection with a fieldbus power supply of type MTL 5053

- 1 = DCS with integrated FOUNDATION Fieldbus H1 interface card  
2 = fieldbus power supply, model MTL 5053  
3 = Prosonic Flow 93 bus devices for hazardous area  
4 = terminator (T) = bus termination  
5 = transducer supply  
6 = Cerabar S bus devices for hazardous area

## Functional considerations

Using the following procedure the functional considerations checks whether the desired segment structure meets the basic requirements for transmission to the physical layer in IEC 61158-2.

*Step 1 – compilation of the functional characteristic values of the fieldbus components*

- Fieldbus power supply MTL 5053:

$$U_S = 18.4 \text{ V}$$

$$I_S = 80 \text{ mA}$$

$$R_0 = 105 \, \Omega \text{ (source impedance)}$$

- Fieldbus line:

Cable type A

$$R_{WK} = 44 \, \Omega/\text{km} \text{ (effective resistance per unit length)}$$

max. permissible cable length  $L_{perm.} = 1900 \text{ m}$

- Fieldbus device Prosonic Flow 93:

$$I_B = 12 \text{ mA (basic current)}$$

$$U_B = 9...32 \text{ V (perm. operating voltage)}$$

$$I_{\text{FDF}} = 0 \text{ mA (fault current)}$$

$$I_{\text{startup}} = 0 (< I_B)$$

- Fieldbus device Cerabar S:

$$I_B = 10.5 \text{ mA (basic current)}$$

$U_B$  = 9...32 V (perm. operating voltage)

$$I_{\text{FDF}} = 0 \text{ mA (fault current)}$$

$$I_{\text{startup}} = 0 (< I_B)$$

### Step 2 – calculation of cable length and checking of network structure

The maximum cable length is always determined by the type of cable used. The actual cable length, which is made up of the length of the main cable and the length of the spur lines, must not exceed this value. The spur lines are also to be checked (refer to Table 2, Page 15). The following restrictions apply to the specification of the cable length and network structure:

- Where cable type A is used the cable length  $L_{perm.}$  may be max. 1900 m.
- Checking the spur line lengths (refer to Table 2, Page 15).

Calculation of actual cable length:

$$\begin{aligned} L_{SEG} &= L_{main.} + \Sigma L_{spurs} \\ &= 580 \text{ m} + 35 \text{ m} \\ &= \underline{\underline{615 \text{ m}}} \end{aligned}$$

Checking the conditions

Consideration	Condition met?
$L_{SEG} < L_{perm.}$	✓ Yes
$L_{spurs} < 120 \text{ m}$	✓ Yes

If one of the conditions is not met then the network structure must be revised.

### Step 3 – current calculation

The number of field devices that can be connected to the H1 segment depends on the fieldbus power supply selected (supply voltage and supply current) and the current consumption of the field devices. Thus, the number of devices that can be connected is reduced if a field device consumes a basic current of more than 10 mA, e.g. 20 mA. By adding up the basic currents  $I_B$  of the field devices plus the response current in the event of a fault  $I_{FDE}$  for the FDE (**F**ault **D**isconnect **E**lectronics) and the current for the data modulation  $I_{MOD}$  (+9 mA) you can determine the minimum supply current that the fieldbus power supply must supply.

If, on switching on the device, the startup  $I_{startup}$  current is greater than the basic current, then the startup current must be taken into consideration in the calculation. The response current for the FDE ( $I_{FDE}$ ) is calculated for each field device from the difference between the maximum current in the event of a fault and the basic current. The field device with the greatest response current is taken into consideration in the current balance sheet.

Provided that no more than one FDE responds, the following condition must be taken into consideration in the calculation of the segment current  $I_{SEG}$ :

$$\begin{aligned} I_{Seff.} &\geq I_{SEG} \\ &\text{where} \\ I_{SEG} &= \Sigma I_B + \max I_{FDE} + I_{MOD} + I_{startup} \end{aligned}$$

In the example the calculation formula results in the following segment current consumption  $I_{SEG}$ , where  $I_{FDE} = 0$ ,  $I_{startup} = 0$ , since the field devices used do not consume additional current in the event of a fault and the startup current is less than the bus current:

$$\begin{aligned}
 I_{SEG} &= \Sigma I_B + \max. I_{FDE} + I_{MOD} + I_{startup} \\
 &= 45 \text{ mA} + 0 \text{ mA} + 9 \text{ mA} + 0 \text{ mA} \\
 &= \underline{\underline{54 \text{ mA}}}
 \end{aligned}$$

The next step checks whether the current consumption  $I_{SEG}$  calculated is within the current limits of the fieldbus power supply. The maximum available supply current  $I_{Seff.}$  is calculated taking into consideration the current drops caused by the source impedance  $R_Q$  of the fieldbus power supply and then by the effective resistance per unit of length of the fieldbus line. Also, the condition must be met that the supply voltage at the furthest field device must be at least 9 V. To make the overall considerations easier it is assumed that all the field devices FD (refer to Fig. 10) are connected at the end of the fieldbus line.

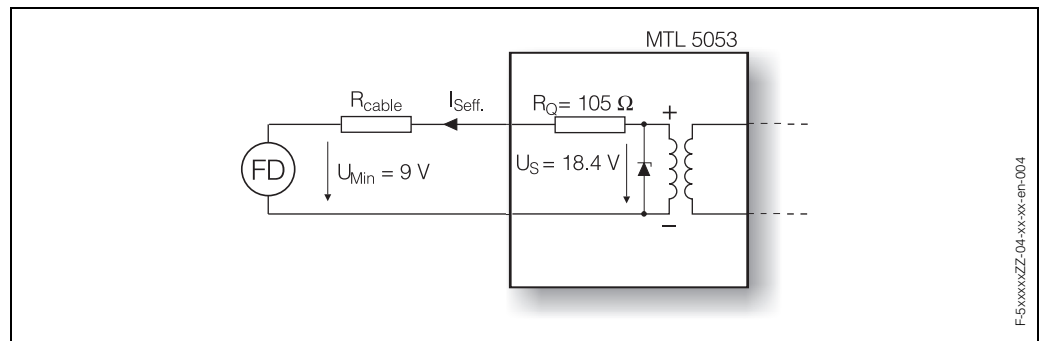


Fig. 10: Replacement circuit diagram

In order that the available supply current  $I_{Seff.}$  can be calculated the resistance value for the fieldbus line  $R_{cable}$  must first be calculated:

$$\begin{aligned}
 R_{cable} &= R_{WK} \times L_{SEG} \\
 &= 44 \text{ } \Omega/\text{km} \times 0.615 \text{ km} \\
 &= \underline{\underline{27 \text{ } \Omega}}
 \end{aligned}$$

Calculation of the maximum available supply current  $I_{Seff.}$  of the fieldbus power supply:

When calculating the maximum available supply current it must be ensured that a minimum supply voltage of 9 V is applied at the field devices:

$$\begin{aligned}
 I_{Seff.} &= (U_S - 9 \text{ V}) / (R_Q + R_{cable}) \\
 &= (18.4 \text{ V} - 9 \text{ V}) / (105 \text{ } \Omega + 27 \text{ } \Omega) \\
 &= \underline{\underline{71.2 \text{ mA}}}
 \end{aligned}$$

Observing the conditions stated, a supply current of  $I_{Seff.} = 71.2 \text{ mA}$  is available for the field devices on the bus segment. Since the actual current consumption of the segment is only 54 mA, from the point of view of the functional considerations proper functioning of the segment is ensured.

For reasons of safety the actual voltage  $U_{FG \text{ eff.}}$  of the furthest field device can be calculated as follows:

$$\begin{aligned}
 U_{FG \text{ eff.}} &= U_S - I_{SEG} \times (R_Q + R_{cable}) \\
 &= 18.4 \text{ V} - 54 \text{ mA} \times (105 \text{ } \Omega + 27 \text{ } \Omega) \\
 &= 18.4 \text{ V} - 7.1 \text{ V} \\
 &= \underline{\underline{11.2 \text{ V}}}
 \end{aligned}$$

Checking the conditions:

Consideration	Condition met?
$I_{\text{seff}} \geq I_{\text{SEG}}$ 71.2 mA $\geq$ 54 mA	✓ Yes
$U_{\text{FG eff.}} \geq 9 \text{ V}$ 11.2 V $\geq$ 9 V	✓ Yes

#### Final consideration:

From a purely functional point of view the bus segment shown in the example can be operated based on the positive results. Further optimization of the network with a view to connecting a greater number of field devices or realizing a longer line length can be achieved by selecting the right fieldbus power supply and cable type.

#### Technical safety considerations

using variant Prosonic Flow 93\*\*\*-\*\*\*\*\*G

#### Step 1 – compilation of technical values relevant to safety:

*Bus power supply MTL 5053 (associated electrical apparatus)*

##### • Nominal values:

$U_o$	=	22 V
$I_o$	=	216 mA
$P_o$	=	1.2 W

	Explosion group		
	IIC	IIB	IIA
Capacitance $C_o$	0.165 $\mu\text{F}$	1.14 $\mu\text{F}$	4.20 $\mu\text{F}$
Inductance $L_o$	0.32 mH	3.00 mH	7.00 mH
$L/R_{\text{ratio}}$	31 $\mu\text{H}/\Omega$	126 $\mu\text{H}/\Omega$	242 $\mu\text{H}/\Omega$

Tab. 5: External connection values of bus power supply MTL 5053 depending on temperature class

*Prosonic Flow 93 (explosion protected electrical apparatus with intrinsically safe FF output):*

##### • Nominal values:

$U_i$	=	30 V
$I_i$	=	500 mA
$P_i$	=	5.5 W
$L_i$	=	10 $\mu\text{H}$
$C_i$	=	5 nF

*Cerabar S (explosion protected electrical apparatus with intrinsically safe FF output):*

##### • Nominal values Entity:

$U_i$	=	24 V
$I_i$	=	250 mA
$P_i$	=	1.2 W
$L_i$	=	10 $\mu\text{H}$
$C_i$	=	5 nF



*Bus cable type 3076 from Belden (shielded bus cable):*

- Nominal values:

$R'$	=	24 $\Omega$ /km (loop resistance)
$C'$	=	82 nF/km (capacitance per unit length between the two wires)
$L'$	=	623 $\mu$ H/km (inductance per unit length of the two wires)
$C'_{LS}$	=	147 nF/km (capacitance per unit length wire against shielding)

*Bus termination:*

- Nominal values:

$U_i$	=	30 V
$P_i$	=	1.2 W
$C_i$	=	negligible

The effective capacitance of the bus line is derived first from the capacitance per unit length  $C'$ , which is effectively the capacitance between the two wires. In the case of the shielded wires the order of capacitance “wire against shielding” and “shielding against wire” must be observed. The total capacitance of the bus line is thus calculated as follows:

$$C'_{\text{eff./cable}} = (C' + 0.5 \times C'_{LS}) \times L_{\text{SEG}}$$

The total length of the bus line  $L_{\text{SEG}}$  is made up of the length of the main cable and the length of all spurs. Using the system structure illustrated in Fig. 10 the following data relevant to safety emerges for the bus line:

$$\begin{aligned}
 L_{\text{SEG}} &= L_{\text{main}} + \sum L_{\text{spurs}} \\
 &= 580 \text{ m} + 35 \text{ m} \\
 &= \underline{\underline{615 \text{ m}}} \\
 C'_{\text{eff./cable}} &= (C' + 0.5 \times C'_{LS}) \times L_{\text{SEG}} \\
 &= (82 \text{ nF/km} + 0.5 \times 147 \text{ nF/km}) \times 0.615 \text{ km} \\
 &= \underline{\underline{95.6 \text{ nF}}} \\
 L'_{\text{eff./cable}} &= L' \times L_{\text{SEG}} \\
 &= 623 \text{ } \mu\text{H/km} \times 0.615 \text{ km} \\
 &= \underline{\underline{383.1 \text{ } \mu\text{H}}}
 \end{aligned}$$

## Step 2 – technical safety considerations

This step uses the existing data to check whether connecting the equipment is permissible from the point of view of technical safety. The conditions shown in Table 5 (Page 24) apply to these safety considerations. First the functional data of the equipment used is compared. In this consideration it is crucial that the maximum output voltage and output current of the bus power supply does not exceed the permitted maximum input voltage and input current of the individual field devices. Here we consider possible error behaviour by the bus power supply that could result in the stated maximum values on the intrinsically safe sides.

Intrinsically safe equipment	Condition	Associated equipment MTL 5053	Condition met?
<b>Prosonic Flow 93</b>			
$U_i = 30 \text{ V}$	$\geq$	$U_o = 22 \text{ V}$	✓ Yes
$I_i = 500 \text{ mA}$	$\geq$	$I_o = 216 \text{ mA}$	✓ Yes
$P_i = 5.5 \text{ W}$	$\geq$	$P_o = 1.2 \text{ W}$	✓ Yes
As a further condition galvanic isolation must be provided due to the local supply			✓ Yes
<b>Cerabar S</b>			
$U_i = 24 \text{ V}$	$\geq$	$U_o = 22 \text{ V}$	✓ Yes
$I_i = 250 \text{ mA}$	$\geq$	$I_o = 216 \text{ mA}$	✓ Yes
$P_i = 1.2 \text{ W}$	$\geq$	$P_o = 1.2 \text{ W}$	✓ Yes
<b>FBT1</b>			
$U_i = 30 \text{ V}$	$\geq$	$U_o = 22 \text{ V}$	✓ Yes
$P_i = 1.2 \text{ W}$	$\geq$	$P_o = 1.2 \text{ W}$	✓ Yes

In addition to these values the limit values and the maximum permissible external capacitance  $C_o$  and inductance  $L_o$  must be observed for the supply circuit. To do this the sum of all effective inductance and capacitance in the hazardous area is formed (the internal capacitance of the bus termination is assumed to be 0). The resulting value must be less than the maximum permissible value specified by the fieldbus power supply.

The equivalent concentrated capacitance and inductance in the hazardous area is calculated as follows:

$$\begin{aligned}
 C_{\text{eff.}} &= (C_{i/\text{Prosonic Flow 93}} \times 2) + (C_{i/\text{Cerabar S}} \times 2) + C'_{\text{eff./cable}} + C_{i/\text{bus termination}} \\
 &= (5 \text{ nF} \times 4) + 95.6 \text{ nF} \\
 &= 115.6 \text{ nF}
 \end{aligned}$$

$$\begin{aligned}
 L_{\text{eff.}} &= (L_{i/\text{Prosonic Flow 93}} \times 2) + (L_{i/\text{Cerabar S}} \times 2) + L'_{\text{eff./cable}} \\
 &= (10 \text{ } \mu\text{H} \times 4) + 383.1 \text{ } \mu\text{H} \\
 &= 423.1 \text{ } \mu\text{H}
 \end{aligned}$$

Intrinsically safe equipment Prosonic Flow 93	Condition	Associated equipment MTL 5053	Condition met?
Total capacitance $C_{\text{eff.}} = 115.6 \text{ nF}$	<	perm. capacitance for IIC $C_o = 165 \text{ nF}$	✓ Yes
Total inductance $L_{\text{eff.}} = 423.1 \text{ }\mu\text{H}$	<	perm. inductance for IIC $L_o = 320 \text{ }\mu\text{H}$	No

Tab. 6: Safety considerations (example)

If, in the example examined, the condition  $L_{\text{eff.}} < L_o$  is met, then the demonstration of intrinsic safety with respect to the electrical parameters has a positive result. In this example, however, the condition was not met since the bus line selected is too long.

Possible solutions:

1. Reduce the main line by 175 m to 405 m (this can be achieved by installing the barrier in the immediate vicinity of Explosion Zone 1, for example).
2. Check under what conditions the manufacturer of the safety barrier or segment connector allows the use of the L/R ratio for technical safety considerations.

Since all the users are permissible for explosion group IIC and the corresponding parameters have been taken into consideration, the bus segment can be used for gases in explosion group IIC.

The permissible ambient temperature may be considered either individually for each device at the respective place of installation, or specified uniformly for the bus segment as a whole. In the latter case the lowest value of the ambient temperature applies.

Required temperature class	Intrinsically safe equipment	Maximum ambient temperature
T6	Cerabar S	40 °C
	Prosonic Flow 93	50 °C (at 80 °C medium temperature)

## Configuration example FISCO model

Fig. 11 shows the typical structure and the associated components. The field devices are operated on a segment with the type of protection EEx ia. A galvanic isolator is used for the transition to the area with explosion risk. Field devices with a lower power consumption, such as the Cerabar S pressure gauge, are supplied via the two-wire line. In contrast, the Prosonic Flow 93 as a four-wire device must be supplied via an local power supply.

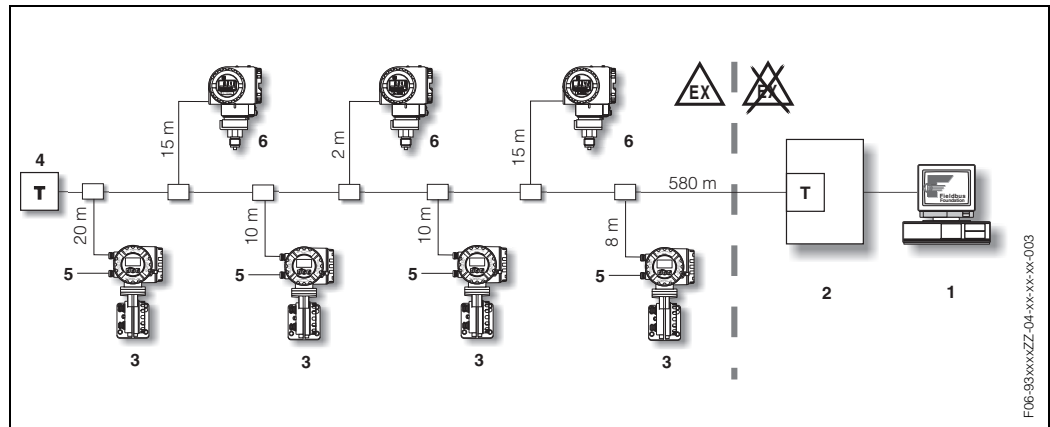


Fig. 11: Typical example of a bus connection with a fieldbus power supply  
Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs)

- 1 = DCS with integrated FOUNDATION Fieldbus H1 interface card
- 2 = fieldbus power supply acc. FISCO model, Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs)
- 3 = Prosonic Flow 93 bus devices for hazardous area
- 4 = terminator (T) = bus termination
- 5 = transducer supply
- 6 = Cerabar S bus devices for hazardous area

## Functional considerations

Using the following procedure the functional considerations checks whether the desired segment structure meets the basic requirements for transmission to the physical layer in IEC 61158-2.

*Step 1 – compilation of the functional characteristic values of the fieldbus components*

- Fieldbus power supply according FISCO model, Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs):

$$U_S = 12.8 \text{ V (power supply voltage)}$$

$$I_S = 100 \text{ mA (power supply current)}$$

- Fieldbus line:

Cable type A

$$R_{WK} = 44 \text{ } \Omega/\text{km (effective resistance per unit length)}$$

- Fieldbus device Prosonic Flow 93:

$$I_B = 12 \text{ mA (basic current)}$$

$$U_B = 9...32 \text{ V (perm. operating voltage)}$$

$$I_{FDE} = 0 \text{ mA (fault current)}$$

$$I_{\text{startup}} = 0 (< I_B)$$

- Fieldbus device Cerabar S:

$$\begin{aligned}
 I_B &= 10.5 \text{ mA (basic current)} \\
 U_B &= 9...32 \text{ V (perm. operating voltage)} \\
 I_{FDE} &= 0 \text{ mA (fault current)} \\
 I_{\text{startup}} &= 0 (< I_B)
 \end{aligned}$$

### Step 2 – calculation of cable length and checking of network structure

An approved maximum length of 1000 meters has been set with the FISCO model for EEx ia IIC applications in order that the inductance and capacitance of the fieldbus cable can be ignored when used in hazardous area applications. This length comprises the length of the main cable and the total length of the drop cables together. In addition, it must be taken into account that the approved maximum length of a drop cable is 30 m.

#### Calculation of actual cable length $L_{SEG}$ :

$$\begin{aligned}
 L_{SEG} &= L_{\text{main.}} + \Sigma L_{\text{spurs}} \\
 &= 580 \text{ m} + 80 \text{ m} \\
 &= \underline{\underline{660 \text{ m}}}
 \end{aligned}$$

Checking the conditions:

Consideration	Condition met?
$L_{SEG} < 1000 \text{ m}$ $660 \text{ m} < 1000 \text{ m}$	✓ Yes
$L_{\text{spurs}} < 30 \text{ m}$	✓ Yes

If one of the conditions is not met then the network structure must be revised.

### Step 3 – current calculation

The number of field devices that can be connected to the H1 segment depends on the fieldbus power supply selected (supply voltage and supply current) and the current consumption of the field devices. Thus, the number of devices that can be connected is reduced if a field device consumes a basic current of more than 10 mA, e.g. 20 mA. By adding up the basic currents  $I_B$  of the field devices plus the response current in the event of a fault  $I_{FDE}$  for the FDE (**F**ault **D**isconnect **E**lectronics) and the current for the data modulation  $I_{MOD}$  (+9 mA) you can determine the minimum supply current that the fieldbus power supply must supply.

If, on switching on the device, the startup  $I_{\text{startup}}$  current is greater than the basic current, then the startup current must be taken into consideration in the calculation. The response current for the FDE ( $I_{FDE}$ ) is calculated for each field device from the difference between the maximum current in the event of a fault and the basic current. The field device with the greatest response current is taken into consideration in the current balance sheet.

Provided that no more than one FDE responds, the following condition must be taken into consideration in the calculation of the segment current  $I_{SEG}$ :

$$\begin{aligned}
 I_{SEG} &\leq I_S \\
 &\text{where} \\
 I_{SEG} &= \Sigma I_B + \max I_{FDE} + I_{MOD} + I_{\text{startup}}
 \end{aligned}$$

In the example the calculation formula results in the following segment current consumption  $I_{SEG}$ , where  $I_{FDE} = 0$ ,  $I_{startup} = 0$ , since the field devices used do not consume additional current in the event of a fault and the startup current is less than the bus current. In addition, the modulation current  $I_{MOD}$  for the installed bus power supply KLD2-PR-Ex1.IEC1 by Pepperl+Fuchs need not be considered since the value of the supply current  $I_S$  already includes this.

$$\begin{aligned} I_{SEG} &= \Sigma I_B \\ &= \underline{\underline{79.5 \text{ mA}}} \end{aligned}$$

Checking the conditions:

Consideration	Condition met?
$I_{SEG} \leq I_S$ $79.5 \text{ mA} \leq 100 \text{ mA}$	✓ Yes

#### Step 4 – Voltage at the last instrument

The cable resistance causes a segment voltage drop, which is largest at the instrument farthest away from the bus power supply. For this reason it must be ensured that the minimum operating voltage of 9 V is available at this instrument.

To make the overall considerations easier it is assumed that all the field devices FD (refer to Fig. 12) are connected at the end of the fieldbus line.

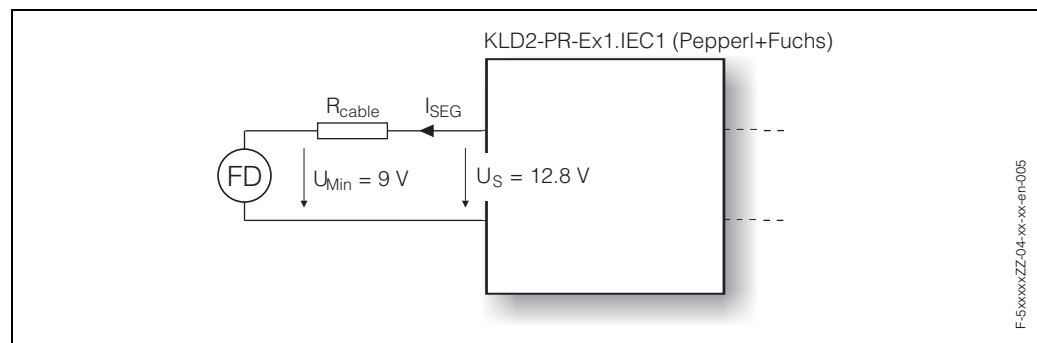


Fig. 12: Replacement circuit diagram

The resistance value  $R_{cable}$  must first be calculated in order to calculate the voltage drop caused by the fieldbus cable:

$$\begin{aligned} R_{cable} &= R_{WK} \times L_{SEG} \\ &= 44 \text{ } \Omega/\text{km} \times 0.66 \text{ km} \\ &= \underline{\underline{29 \text{ } \Omega}} \end{aligned}$$

Ohm's law is used to calculate the actual voltage  $U_{FG \text{ eff.}}$  at the last instrument:

$$\begin{aligned} U_{FG \text{ eff.}} &= U_S - (I_{SEG} \times R_{cable}) \\ &= 12.8 \text{ V} - (79.5 \text{ mA} \times 29 \text{ } \Omega) \\ &= 12.8 \text{ V} - 2.3 \text{ V} \\ &= \underline{\underline{10.5 \text{ V}}} \end{aligned}$$

Checking the conditions:

Consideration	Condition met?
$U_{FG \text{ eff.}} \geq 9 \text{ V}$	✓ Yes
$10.5 \text{ V} \geq 9 \text{ V}$	

#### Final consideration:

From a purely functional point of view the bus segment shown in the example can be operated based on the positive results.

#### Technical safety considerations

using variant Prosonic Flow 93\*\*\*\_\*\*\*\*\*G

#### Step 1 – compilation of technical values relevant to safety:

*Fieldbus power supply (associated electrical apparatus)*  
*FISCO Power Repeater KLD2-PR-Ex1.IEC1 (Pepperl+Fuchs):*

- Nominal values:

$$\begin{aligned} U_o &= 15 \text{ V} \\ I_o &= 207.2 \text{ mA} \\ P_o &= 1.93 \text{ W} \end{aligned}$$

Described in the test certificate as “associated equipment”. Suitable for connection to a fieldbus system based on the FISCO model.

*Prosonic Flow 93 (explosion protected electrical apparatus with intrinsically safe FF output):*

- Nominal values:

$$\begin{aligned} U_i &= 30 \text{ V} \\ I_i &= 500 \text{ mA} \\ P_i &= 5.5 \text{ W} \\ L_i &= 10 \mu\text{H} \\ C_i &= 5 \text{ nF} \end{aligned}$$

Suitable for connection to a fieldbus system based on the FISCO model.

*Cerabar S (explosion protected electrical apparatus with intrinsically safe FF output):*

- Nominal values FISCO:

$$\begin{aligned} U_i &= 17.5 \text{ V} \\ I_i &= 500 \text{ mA} \\ P_i &= 5.5 \text{ W} \\ L_i &= 10 \mu\text{H} \\ C_i &= 5 \text{ nF} \end{aligned}$$

Suitable for connection to a fieldbus system based on the FISCO model.

*Bus cable type A (shielded bus cable):*

- Nominal values:

$$\begin{aligned} R' &= 24 \Omega/\text{km} \text{ (loop resistance)} \\ C' &= 82 \text{ nF}/\text{km} \text{ (capacitance per unit length)} \\ L' &= 623 \mu\text{H}/\text{km} \text{ (inductance per unit length)} \end{aligned}$$

Fieldbus connection KMD0-FT-Ex (Pepperl+Fuchs):

• Nominal values:

$U_i$	=	24 V
$I_i$	=	280 mA
$P_i$	=	1.93 W
$R$	=	100 $\Omega$
$C$	=	1 $\mu$ F

Suitable for connection to a fieldbus system based on the FISCO model.

## Step 2 – technical safety considerations acc. FISCO model

This step uses the existing data to check whether connecting the equipment is permissible from the point of view of technical safety. The conditions shown in the FISCO model apply to these safety considerations (see Page 18). First the functional data of the equipment used is compared. In this consideration it is crucial that the maximum output voltage and output current of the bus power supply does not exceed the permitted maximum input voltage and input current of the individual field devices. Here we consider possible error behaviour by the bus power supply that could result in the stated maximum values on the intrinsically safe sides.

Intrinsically safe equipment	Condition	Associated equipment FISCO Power Repeater KLD2-PR-Ex1.IEC1	Condition met?
<b>Prosonic Flow 93</b>			
$U_i = 30$ V	$\geq$	$U_o = 15$ V	✓ Yes
$I_i = 500$ mA	$\geq$	$I_o = 207.2$ mA	✓ Yes
$P_i = 5.5$ W	$\geq$	$P_o = 1.93$ W	✓ Yes
As a further condition galvanic isolation must be provided due to the local supply			✓ Yes
<b>Cerabar S</b>			
$U_i = 17.5$ V	$\geq$	$U_o = 15$ V	✓ Yes
$I_i = 500$ mA	$\geq$	$I_o = 207.2$ mA	✓ Yes
$P_i = 5.5$ W	$\geq$	$P_o = 1.93$ W	✓ Yes
<b>Fieldbus connection KMD0-FT-Ex</b>			
$U_i = 24$ V	$\geq$	$U_o = 15$ V	✓ Yes
$I_i = 280$ mA	$\geq$	$I_o = 207.2$ mA	✓ Yes
$P_i = 1.93$ W	$\geq$	$P_o = 1.93$ W	✓ Yes

Since all the users are permissible for explosion group IIC and the corresponding parameters have been taken into consideration, the bus segment can be used for gases in explosion group IIC.



The permissible ambient temperature may be considered either individually for each device at the respective place of installation, or specified uniformly for the bus segment as a whole. In the latter case the lowest value of the ambient temperature applies.

Required temperature class	Intrinsically safe equipment	Maximum ambient temperature
T6	Cerabar S	40 °C
	Prosonic Flow 93	50 °C (at 80 °C medium temperature)

In the next step is the verification of whether the installed bus components fulfil the conditions and limit values set in the FISCO model. This is simplified by ensuring the bus components correspond to the FISCO model. A detailed consideration of the safety-relevant nominal values is then not necessary.

Do bus components correspond to the FISCO model?	Condition met?
Power Repeater KLD2-PR-Ex1.IEC1	✓ Yes
Prosonic Flow 93	✓ Yes
Cerabar S	✓ Yes
Fieldbus connection KMD0-FT-Ex	✓ Yes

The following conditions have been applied to the bus cable and network structure:

Bus cable:

Values	Condition	Limits acc. FISCO model	Condition met?
R'	> <	15 Ω/km 150 Ω/km	
C'	> <	80 nF/km 200 nF/km	
L'	> <	400 μH/km 1000 μH/km	
<b>Bus cable type A</b> R' = 24 Ω/km C' = 82 nF/km L' = 623 μH/km			✓ Yes

Network structure:

Consideration	Condition	Limits acc. FISCO model	Condition met?
Cable length including drop cables	≤	1000 m	
L <sub>SEG</sub> = 660 m	≤	1000 m	✓ Yes
Drop cable length	≤	30 m	✓ Yes

#### Final consideration:

For the example shown, intrinsic safety according to the FISCO model can be proven.

## Device identification

Prosonic Flow 93 FOUNDATION Fieldbus transmitter and P sensor

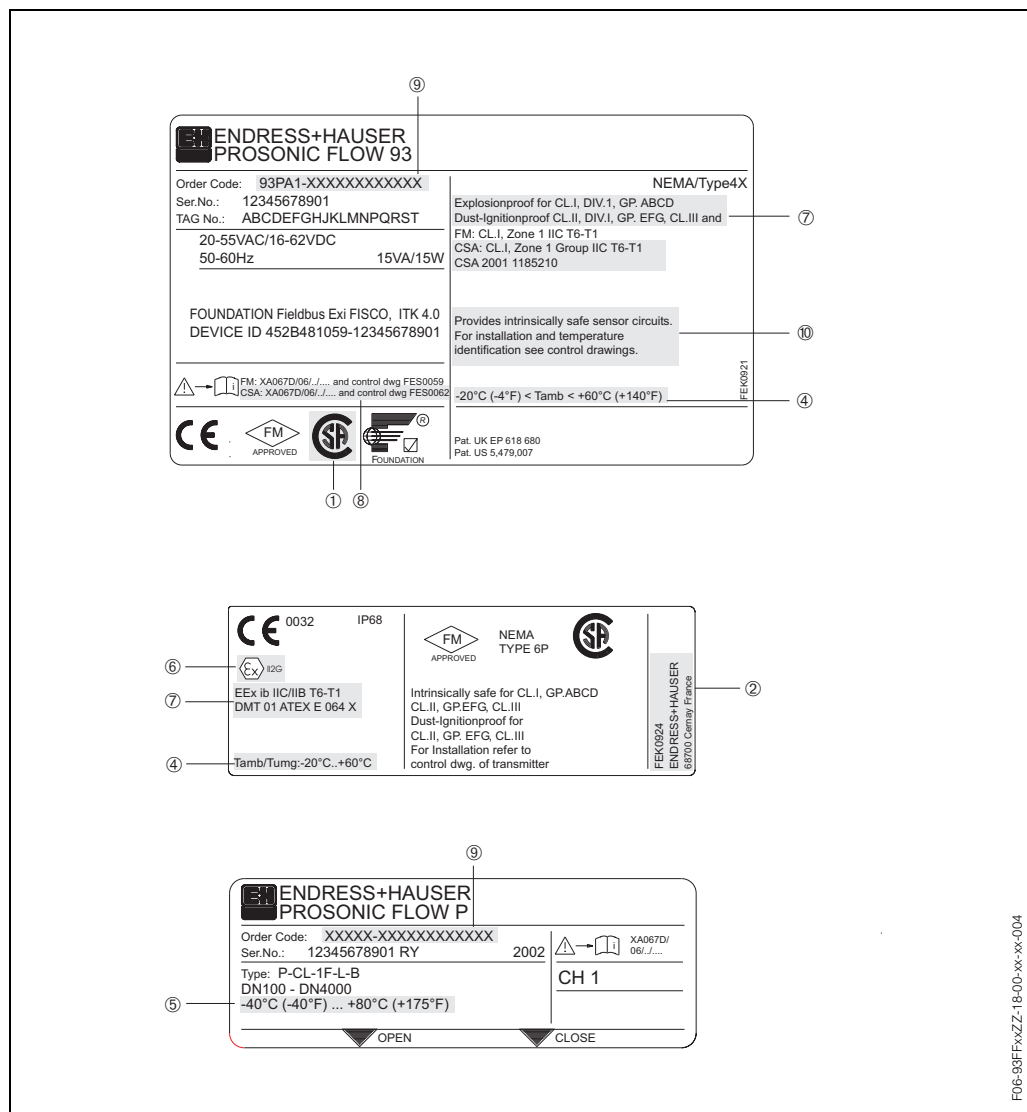


Fig. 13: Nameplate of transmitter and nameplate of sensor (example)

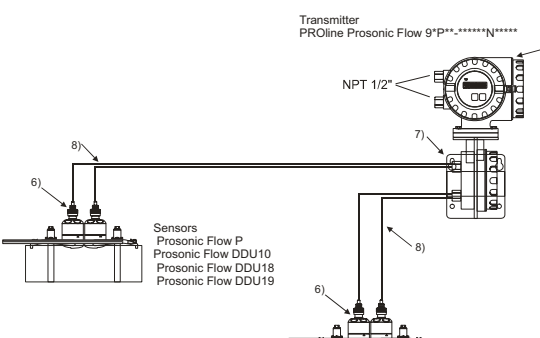
Key to nameplates (Figure 13)

No.	Meaning	No.	Meaning
①	Label of the notified body: Canadian Standards Association	⑥	Device group and device category to directive 94/9/EC
②	Place of manufacture	⑦	Type of protection and explosion group for the Prosonic Flow 93 FOUNDATION Fieldbus transmitter
③	–	⑧	Applicable Ex documentation
④	Ambient temperature range	⑨	Type code
⑤	Maximum medium temperature	⑩	Warning

## Control drawings

Endress+Hauser Reinach hereby declares that the product is in conformity with the requirements of the CADADIAN STANDARDS ASSOCIATION.

**Hazardous Locations**  
Class I Division 1 Groups ABCD or Class I Zone 1 Groups IIC and Class II Division 1 Groups EFG and Class III



**Notes:**

- Control room equipment shall not use or generate more than 250 V rms.
- Wire per Canadian Electrical Code. Wire all intrinsically safe I/O circuits per CEC respecting the Explosionsproof Integrity of the enclosure.
- Sensor circuits may be installed as intrinsically safe wiring or in conduit per CEC.
- Caution: Use supply wires suitable for 5 °C above ambient temperature, but at least for 80 °C / 176 °F.
- Class II Group G: The surface temperature of the apparatus cannot exceed 165 °C / 329 °F. The user must limit the process temperature for Group G to 160 °C.
- Cable Type for all Sensors: Use only prefabricated Endress+Hauser Cable. For reasons of safety, the maximum allowed cable length is 30 m per sensor.

**Temperature table**

Sensors	T6	T5	maximum medium temperature in °C						
	T4A	T4	T3C	T3B	T3A	T3	T2	T1	
<b>at Ta = 60 °C</b>									
Pros. Flow 9*PA* - A*****	80	80	80	80	80	80	80	80	
Pros. Flow 9*PA* - B*****	80	80	80	80	80	80	80	80	
Prosonic Flow DDU 10 - A*****	80	80	80	80	80	80	80	80	
Prosonic Flow DDU 10 - C*****	80	80	80	80	80	80	80	80	
Prosonic Flow DDU18-A***	80	80	80	80	80	80	80	80	
Prosonic Flow DDU19-A***	80	80	80	80	80	80	80	80	
<b>at Ta = 60 °C</b>									
Pros. Flow 9*PA* - E*****	80	95	115	130	155	160	170	170	
Pros. Flow 9*PA* - F*****	80	95	115	130	155	160	170	170	
Prosonic Flow DDU 10 - B*****	80	95	115	130	155	160	170	170	
Prosonic Flow DDU 10 - D*****	80	95	115	130	155	160	170	170	
Prosonic Flow DDU18-B***	80	95	115	130	155	160	170	170	
Prosonic Flow DDU19-B***	80	95	115	130	155	160	170	170	

**Communication modules , I/O options**

Communication options	Control Drawings
I/O option = F, H, J	see FES0062-0001 A
I/O option = G, K	see FES0062-0002 A
I/O option = S, T	see FES0062-0004 A

**WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.**


**Notes:**

- Control room equipment shall not use or generate more than 250 V rms.
- Wire per Canadian Electrical Code. Wire all intrinsically safe I/O circuits per CEC respecting the Explosionsproof Integrity of the enclosure.
- Sensor circuits may be installed as intrinsically safe wiring or in conduit per CEC.
- Caution: Use supply wires suitable for 5 °C above ambient temperature, but at least for 80 °C / 176 °F.
- Class II Group G: The surface temperature of the apparatus cannot exceed 165 °C / 329 °F. The user must limit the process temperature for Group G to 160 °C.
- Cable Type for all Sensors: Use only prefabricated Endress+Hauser Cable. For reasons of safety, the maximum allowed cable length is 30 m per sensor.

Änderungen:		A 05.04.02 MCH		F		Alle gesetzlichen Urheberrechte vorbehalten.		Erstellt: FES / ID 1100	
B		0		3		Diese Zeichnung darf ohne unsere		FILE: M:ZEICHN/FES0062/010310c.doc	
C		H		1		Genehmigung weder vervielfältigt werden noch			
D		J		2		dritten Personen und Konkurrenzfirmen			
E		K		3		zugänglich gemacht werden.			

**CSA Control Drawing Class I, Div. 1**  
**Class I Zone 1**

**PROSONIC FLOW 9.**

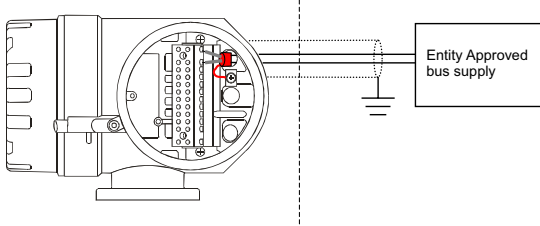


Flowtec AG, Kaegenstrasse 7, CH-4153 Reinach BL1, Postfach

**FES0062 A**

**HAZARDOUS LOCATIONS**  
Cl. I Div. 1 Groups A,B,C,D  
Cl. I Zone 1 Group IIC  
Cl. I Div. 2 Group A,B,C,D  
Cl. I Zone 2 Group IIC  
Cl. II, III Div. 1 Group E,F,G

**NON HAZARDOUS LOCATIONS**



**Notes:**

**Intrinsically safe signal output:**

- Wire all intrinsically safe circuits per ISA RP 12.6. or in conduit per Canadian Electrical Code.
- WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.**
- Control room equipment may not use or generate more than 250 Vrms.

**Type: PROSONIC 9\*\*\*.....G**  
**Terminals: 26,27 (Foundation Fieldbus):**  
Intrinsically safe circuit:

$V_{max} / U_i$	$I_{max} / I_i$	$P_{max} / P_i$	$C_i$	$L_i$
30 V	500 mA	5.5 W	$\leq 5$ nF	$\leq 10$ $\mu$ H

Connect to entity approved associated apparatus with  
 $I_{sc}$  or  $I_o \leq I_{max}$  or  $I_i$  and  
 $V_{oc}$  or  $U_o \leq V_{max}$  or  $U_i$   
 $(P_o \leq P_{max}$  or  $P_i)$

Cable parameters for Intrinsic Safety:  
 $C_{cable} \leq C_a / C_o - \Sigma C_i$   
 $L_{cable} \leq L_a / L_o - \Sigma L_i$  or  
 $L/R_{cable} \leq L/R_{associated Apparatus}$  and  $L_i$  of each I.S. apparatus  $\leq 10$   $\mu$ H

Alternatively the intrinsically safe circuit ( Fieldbus Foundation ) can be connected according to the FISCO-Concept ( see FES 0062-0003).

**Nonintrinsically safe signal output:**


- Wire all intrinsically safe circuits per Canadian Electrical Code respecting the Explosionsproof Integrity of the enclosure
- WARNING: EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 1.**
- Control room equipment may not use or generate over 250 Vrms.

**Type: PROSONIC FLOW 9\*\*\*.....K**  
**Terminals 26,27 (FIELD BUS FOUNDATION NON I.S.):**  
 $V \leq 32$  V,  $I = 10$  mA

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B		0		3		Diese Zeichnung darf ohne unsere		Ersatz für:	
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D		J		2		dritten Personen und Konkurrenzfirmen		FILE: M:ZEICHN/FES0062/010310c.doc	
E		K		3		zugänglich gemacht werden.			

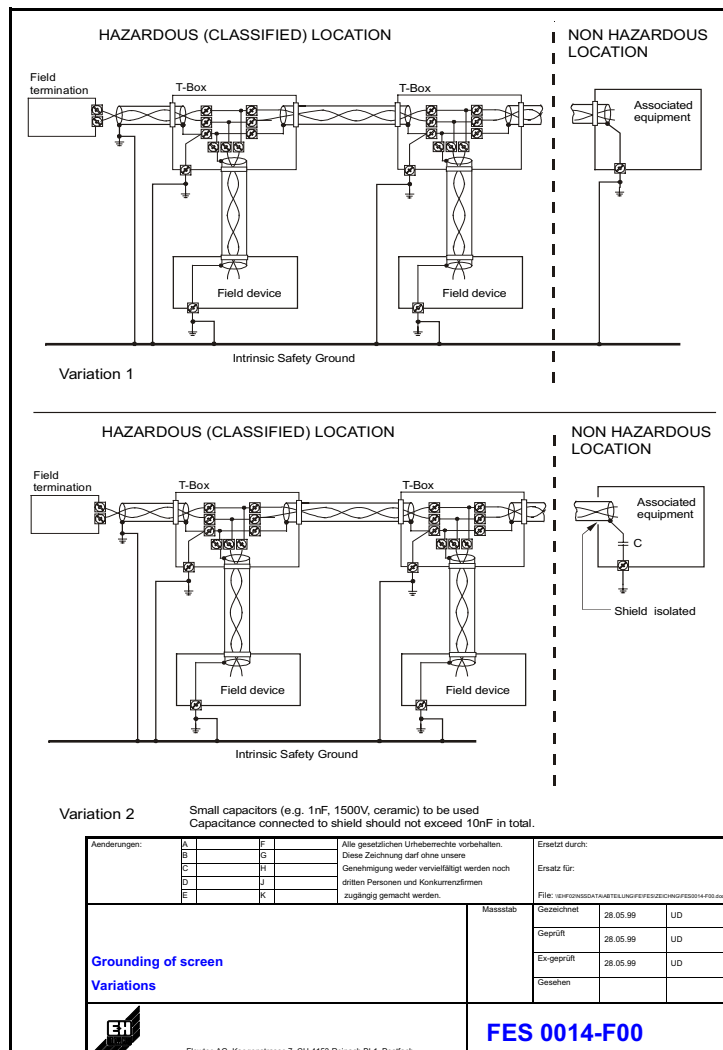
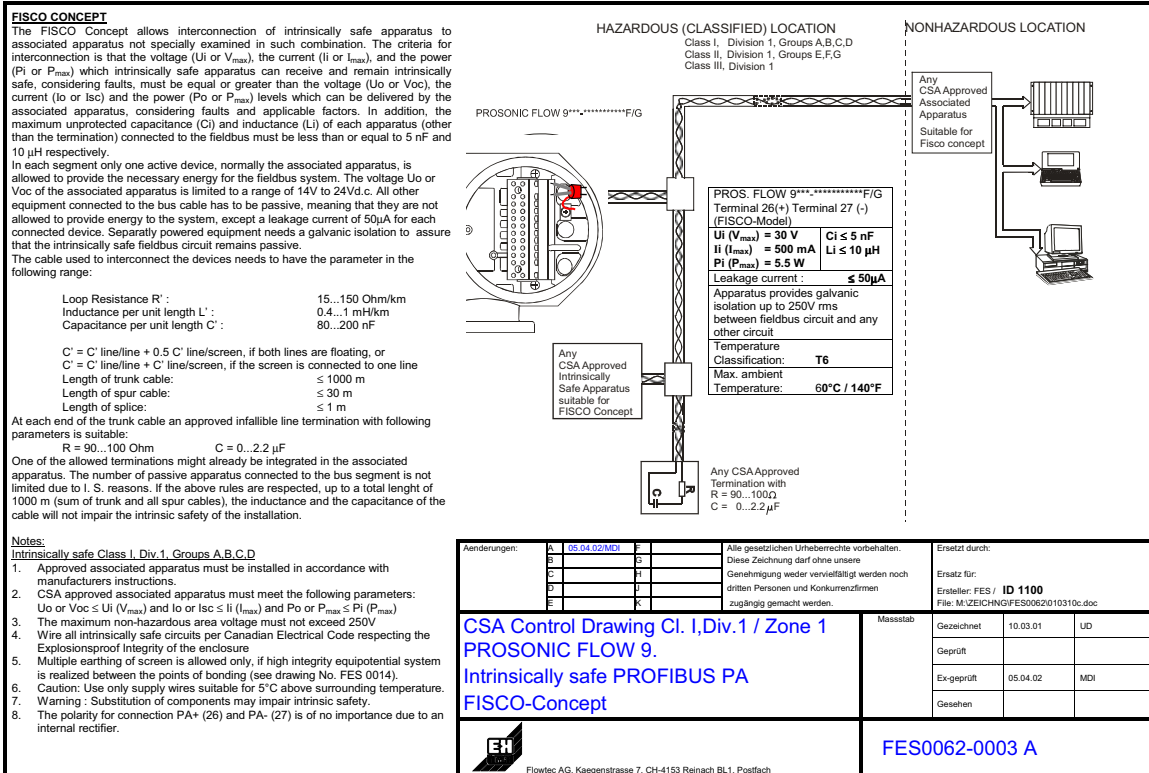
**CSA Control Drawing Class I, Div. 1/ Zone**  
**PROSONIC FLOW 9.**

**Fieldbus Foundation IS installation**  
**Fieldbus Foundation non-IS installation**



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**FES0062-0002 A**





**Supplementary  
documentation**

TI 056D/06  
TI 057D/06

**USA**

Endress+Hauser Inc.  
Greenwood, Indiana  
Tel. (317) 535-7138  
Fax. (317) 535-8498

**Canada**

Endress+Hauser Ltd.  
Burlington, Ontario  
Tel. (905) 681 92 92  
Fax. (905) 681 94 44

**Instruments International**

Endress+Hauser GmbH+Co.  
Weil am Rhein  
Germany  
Tel. (07621) 975-02  
Fax. (07621) 975 345





