1 Operating instructions/system description Zener barriers

1.1 Operating instructions

Application

- These devices are used in C&I technology for the galvanic isolation of C&I signals, such as 20 mA and 10 V unit signals, and also for the adaptation and/or standardisation of signals. Devices which have intrinsically safe control circuits are used to operate field devices within hazardous areas.
- The data sheets of the individual devices contain the electrical data stated in the EC-Type Examination Certificate and are a valid part of the instruction.
- Zener barriers are not suitable for the isolation of signals in power engineering, unless this is specifically referred to in the respective data sheet.
- The respective statutory regulations and directives governing the application or intended use should be observed.
- Devices that were operated in general electric installations must not be used afterwards in electric installations that are in connection to explosive hazardous areas.
- Intrinsic safe circuits that were operated with circuits of other types of protection may not be used as intrinsic safe circuits afterwards.
- Circuits in type of protection "nL" that were operated with circuits of other types of protection (except intrinsic safe circuits) must not be used in type of protection "nL" afterwards.

Installation and commissioning in the safe area

(Commissioning and installation must by carried out by specially trained qualified personnel only.)

<u>Installation of the interface devices in the safe area</u>

- The devices are constructed to satisfy the IP20 protection classification and must be protected accordingly from adverse environmental conditions such as water spray or dirt exceeding the pollution severity level 2.
- The devices must be installed outside the hazardous area!
- For devices with intrinsically safe circuits, the protected circuit (light blue identification on the device) can be located in the hazardous area. It is especially important to ensure that all non-intrinsically safe circuits are safely isolated.
- The installation of the intrinsically safe circuits is to be conducted in accordance with the relevant installation regulations.
- The respective peak values of the field device and the associated device with regard to explosion protection should be considered when connecting intrinsically safe field devices with the intrinsically safe circuits of Zener barriers (demonstration of intrinsic safety).
  Here EN 60079-14/IEC60079-14 is to be observed.
- If more channels of one device are to be connected parallel it must be ensured that the parallel connection is made directly at the terminals. For the demonstration of intrinsic safety the maximum values of the parallel connection are to be regarded.
- When intrinsically safe circuits are used in areas made hazardous by dust (Ex zone "D") only appropriately certificated field devices must be used.
- The EU certificates of conformity or EC-Type Examination Certificates should be observed. It is especially important to observe the "special conditions" where these are contained in the certificates.

<u>Installation and commissioning of the interface devices within zone 2 of the hazardous area:</u>

- Only devices with the relevant statement of conformity from an approved test centre or covered by the manufacturer's declaration of conformity can be installed in zone 2.
- The individual data sheets indicate whether these conditions are met.
- The devices should be installed in a switch or junction box, which:
  - corresponds at least IP54 in accordance to EN 60529.
  - is confirm to the requirements of resistance to light and resistance to impact corresponding to EN 50014/ IEC 60079-0.
  - is confirm to the requirements of thermal endurance corresponding to EN 50014/IEC 60079-15.
  - must not cause ignition danger by electrostatic charge during intended use, maintenance and cleaning.
- For devices with intrinsically safe circuits, the protected circuit (light blue identification on the device) can be located in the hazardous area. It is especially important to ensure that all non-intrinsically safe circuits are safely isolated.
- The installation of the intrinsically safe circuits is to be conducted in accordance with the relevant installation regulations.
- The respective peak values of the field device and the associated device with regard to explosion protection should be considered when connecting intrinsically safe field devices with the intrinsically safe circuits of Zener barriers (demonstration of intrinsic safety).
  Here EN 60079-14/IEC60079-14 is to be observed.
- If more channels of one device are to be connected parallel it must be ensured that the parallel connection is made directly at the terminals. For the demonstration of intrinsic safety the maximum values of the parallel connection are to be regarded.
- When intrinsically safe circuits are used in areas made hazardous by dust (Ex zone "D"), only appropriately certificated field devices must be used.
- The EU certificate of conformity, the EC-Type Examination Certificate, the EU statement on conformity or the manufacturer's declaration of conformity should be observed. It is especially important to observe the "Special Conditions" where these are contained in the certificates.

Repair and maintenance

The transfer characteristics of the devices remain stable, even over long periods of time, thus eliminating the need for regular adjustment. Maintenance is therefore not required.

Fault elimination

No changes can be made to devices which are operated in hazardous areas. Repairs on the device are also not allowed.

Directive conformity

Directive 94/9/EC, associated standards see valid EC-Type Examination Certificates and/or EU statements of conformity.

Isolation coordinates for devices with Ex-certificate according to EN 50020

The devices are assessed for pollution degree 2 according to EN 50178.

Ambient conditions

Ambient temperature: -20 °C ... +60 °C (253 K ... 333 K)
Storage temperature: -25 °C ... +70 °C (248 K ... 343 K)
Humidity: max. 75 % rel. humidity without moisture condensation.

Date of issue 12/13/05

1.2 Operating principle

The Zener diodes in the barriers are connected in the reverse direction. The breakdown voltage of the diodes is not exceeded in normal operation.

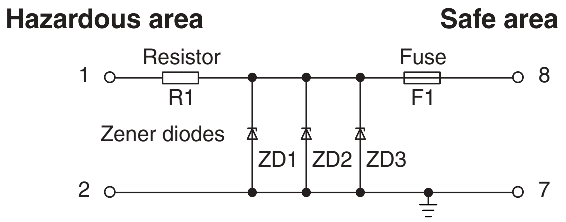


Figure 1.1 Circuit diagram

If this voltage is exceeded, due to a fault in the safe area, the diodes start to conduct, causing the fuse to blow, thus preventing the transfer of unacceptably high energy into the hazardous area.

Terminals 7 and 8 are connected to the devices in the non-hazardous area. The single condition that these devices must satisfy, is that they must not contain a source whose potential relative to earth is greater than 250 V/253 V_{eff} AC or 250/253 V DC.

Terminals 1 and 2 are connected to the intrinsically safe circuits in the hazardous area. If they are used in the hazardous area, active intrinsically safe apparatus must be certificated unless the electrical values of such apparatus do not exceed any of the following values: 1.5 V; 0.1 A; 25 mW.

Pepperl+Fuchs Zener barriers are identified in terms of voltage, resistance and polarity, e. g. 10 V, 50 Ω, positive polarity. These figures correspond to the Zener voltage U_z and the total resistance of all barrier components. They therefore represent the safety values. The values stated on the type identification label correspond to the "worst case" data for U_z (U_o) and I_k (I_o) determined during certification.

I_k is obtained by dividing U_z by the resistance R1. It should be noted once again, however, that these values do not correspond to the operating range of the Zener barrier.

Ideally, Zener diodes would not allow any current in the reverse direction until the Zener voltage has been attained. In practice, Zener diodes do allow a small leakage current, the value of which increases as the applied voltage is increased.

The operating range of a Zener barrier must therefore be such that it is below the Zener voltage, so that the leakage current is restricted to a minimum. Zener barriers are normally tested to ensure that at the prescribed voltage the leakage current is smaller than 10 µA.

These voltages are stated in the data sheet for a given barrier, together with the leakage current. If the leakage current for a given voltage differs from 10 µA, this is specifically stated.

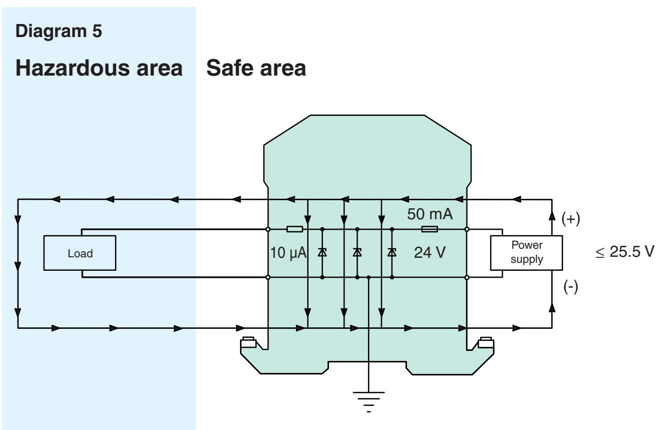


Figure 1.2 This figure shows a selection of leakage currents through the Zener barriers under normal circumstances. The Zener barriers conduct a maximum of 10 (1) µA leakage current so long as the supply voltage is less than 25.5 V. This is normal and has very little effect on the load. If the voltage exceeds 25.5 V, the Zener diodes start to conduct more current. This can have an effect on the operating current and the accuracy. It is therefore recommended that a controlled voltage source be used, which maintains the voltage under the value at which the diodes will start to conduct.
(A 24 V, 300 Ω barrier is represented here as an example)

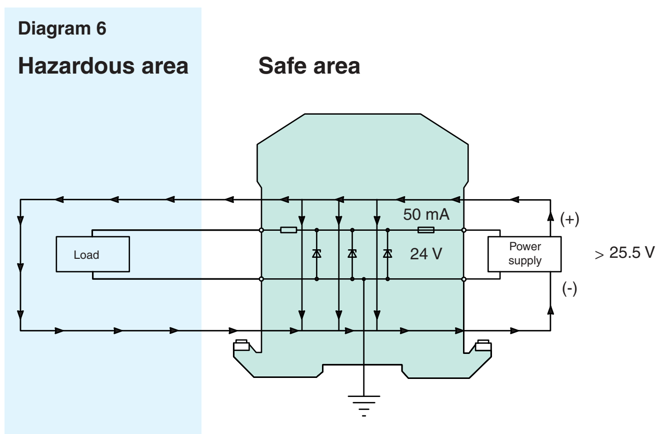


Figure 1.3 This figure shows that if the maximum permissible input (supply) voltage is exceeded, the total current drains through the Zener diodes, without reaching the explosive surroundings.

Pepperl+Fuchs Zener barriers have a low series resistance, given by the sum of the resistance R1 and the resistance value of the fuse F1. Due to the low series resistance, an inadvertent short-circuiting of terminals 1 and 2 can cause the fuse to blow. In order to avoid this, some barriers are available with electronic current limitation (CL-version).

If the Zener barriers are provided with a resistance, this limits the short-circuit current to a safe value in the event of a short-circuit of the connecting wiring in the hazardous area or a connection to earth of the wiring attached to terminal 1, as the fuse blows.

Many barriers are available with a resistance connected between the output terminals. These are used in 4 mA … 20 mA transmitter circuits. The resistance converts the current in the intrinsically safe circuit into a voltage that can be measured in the safe area.

Pepperl+Fuchs Zener barriers can be used in many applications. In the simplest case, a single channel barrier with a ground connection is used. But in many applications it is not desirable that the intrinsically safe circuit is connected directly to ground. If the circuit in the safe area is grounded, under some circumstances grounding of the intrinsically safe circuit can lead to faults within the system. In this case, quasi ground-free intrinsically safe circuits can be constructed with two or more barriers. This floating circuitry can be simply achieved with 2- or 3-channel barriers.

Double grounding of intrinsically safe circuits is not permitted. The insulation voltage of the wiring and field devices, measured with respect to ground, must be greater than 500 V AC. The permissible ambient temperature of the Zener barriers is between -20 °C … 60 °C.

1.3 Multi-channel barriers

Analogue circuits are often connected to two-channel barriers (see Figure 1.5). Since there is no grounding on this type of circuit, the system is a quasi floating one. It is termed "quasi floating", because it is "one Zener voltage" above the ground potential. Although it does not actually float, the signal-to-noise ratio is improved.

A further advantage of multi-channel Zener barriers is that a higher packing density can be achieved.

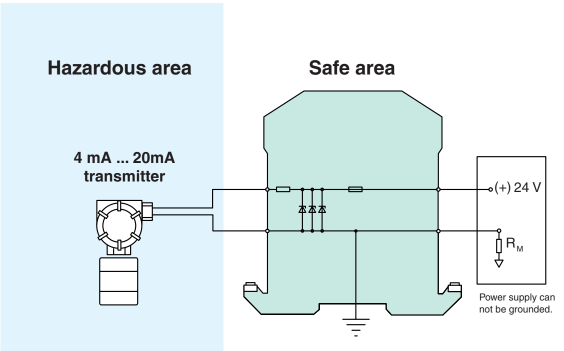


Figure 1.4 Single-channel Zener barrier

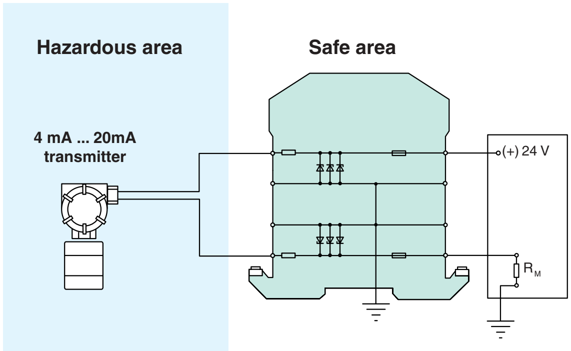


Figure 1.5 Two-channel Zener barrier

1.4 Grounding of Zener barriers

Intrinsically safe circuits with Zener barriers without galvanic isolation must be grounded. The cross-section of the ground connection, using a copper conductor, must be at least 4 mm^2 (for further details see EN 60079-14, section 12.2.4). The maintenance of these requirements prevents the occurrence of a dangerous potential with respect to ground.

A fault of the type illustrated in figure 8.6 can cause a dangerous spark if the Zener barrier is not grounded, but grounding is provided via the field device in the intrinsically safe circuit (Figure 1.5). If a potential occurs in the fault case, which is higher than permitted (see Figure 1.6) the Zener diodes become conducting and the current is conducted away via the ground. The fuse "blows".

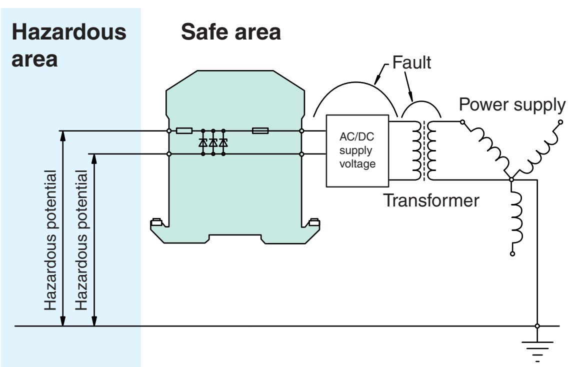


Figure 1.6 Non-grounded Zener barrier

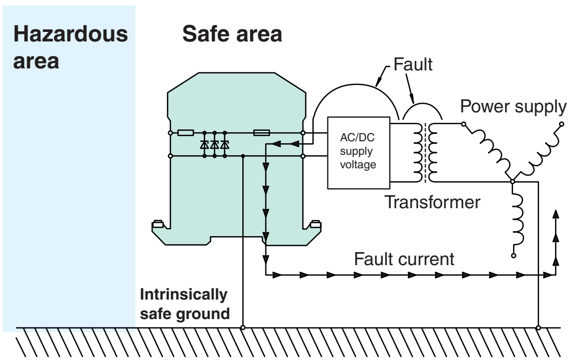


Figure 1.7 Grounded Zener barriers
The system must have its own independent ground conductor, through which no supply system current flows.

1.5 Installation notes

Pepperl+Fuchs Zener barriers in the Z 7, Z 8 and Z 9 series can be mounted on a standard rail to EN 50022 in 3 different arrangements.

- Equipotential bonding via the standard rail (grounding of all snapped-on Zener barriers)

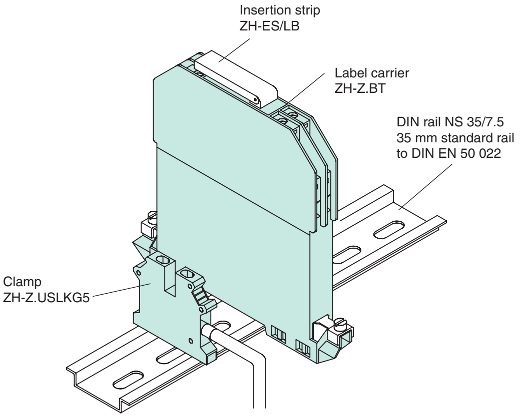


Figure 1.8 Equipotential bonding via the standard rail

- Group grounding through insulated mounting

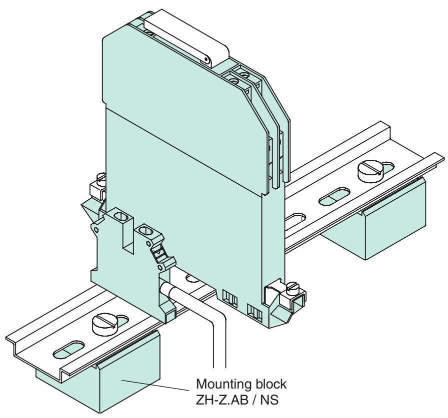


Figure 1.9 Insulated mounting (Individual grounding)

- Individual grounding through insulated mounting

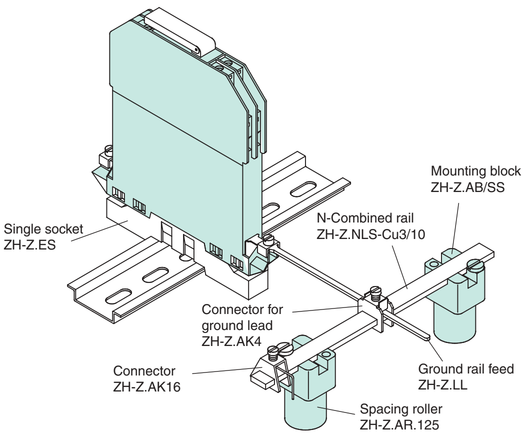


Figure 1.10 Insulated mounting (Individual grounding)

Pepperl+Fuchs Zener barriers also feature a space-saving 12.5 mm housing which incorporates up to 3 channels.

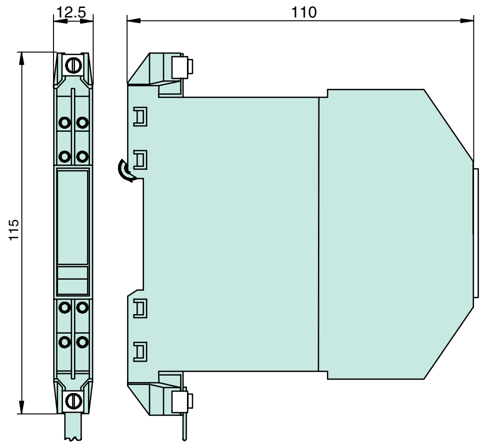


Figure 1.11 Mechanical features

Construction: Modular terminal housing in Makrolon, flammability classification UL 94: V -0
Fixing: Snaps onto 35 mm standard rail to EN 50022
Connection options: Self-opening terminals, max. core cross-section 2 x 2.5 mm²

The barriers are usually installed in racks or control cabinets. They can be built into housings under production conditions, with the proviso that the housing must afford adequate protection. They can also be employed in hazardous areas, when it has been ascertained that the housing has been certificated for this purpose.

The installation must be carried out in such a way that the intrinsic safety is not compromised by the following factors:

- Danger of mechanical damage
- Non-authorised changes or influence exerted by external personnel
- Humidity, dust or foreign bodies
- Ambient temperature exceeding the permissible level
- The connection of non-intrinsically safe circuits to intrinsically safe circuits

Grounding of the mounting rail is of the normal type, i. e. both ends are connected to the intrinsically safe ground. This also simplifies checking the grounding.

Many installations provide the option of subsequent expansion. Replacement cable for this purpose can be connected to the Z 799 dummy barrier and unused cable can be connected to the intrinsically safe ground.

1.6 Zener barrier specifications

Nominal data

The following are typical data used in the description of a barrier:
28 V, 300 Ω, 93 mA. These values relate to the maximum voltage, the minimum value of the built-in resistance and the resulting maximum current.

The maximum voltage stated is not representative of the operating range, it is the maximum value that can be attained in a failure case, before the fuse responds. The resistance value is not identical to the maximum series resistance. These values merely provide an indication of the maximum values that can apply in the case of a failure.

Series resistance

This is the resistance that can be measured between the two ends of a barrier channel. It is obtained from the sum of the resistance R and resistance value of the fuse at an ambient temperature of 20 °C.

Polarity

Zener barriers are available in various versions. On Zener barriers for positive polarities the anodes of the Zener diodes are grounded. On barriers for negative polarities it is the cathodes which are grounded. On barriers for alternating polarities, interconnected Zener diodes are employed and one side is grounded. These can be used for both alternating voltage signals and direct voltage signals.

Maximum voltage in the intrinsically safe circuit. (U_z)

This is the maximum value of voltage that can occur in the intrinsically safe circuit in the failure case.

Maximum current in the intrinsically safe circuit (I_k)

This is the maximum current that can flow in the intrinsically safe circuit in the failure case.

Maximum input voltage (max. U_{in})

The maximum voltage (correct polarity) that can be applied between the contacts in the safe area and the ground without the fuse responding. This value is determined for an open intrinsically safe circuit and an ambient temperature of 20 °C.

Input voltage (U_{in} at 10 (1) µA)

The maximum voltage (correct polarity) that can be applied between the contacts in the safe area and the ground at a defined leakage current (as a rule 10 µA). This is the upper value of the recommended operating range.

Maximum connectable external capacitance C_{max}

This is the maximum capacitance that can be connected to the terminals of the barrier intrinsically safe circuit. This value is determined from the sum of the wiring capacitance and the input capacitance of the field device.

Maximum connectable external inductance L_{max}

This is the maximum inductance that can be connected to the terminals of the barrier intrinsically safe circuit. The value is determined from the sum of the inductance of the wiring and the input inductance of the field device.

Note:

The designations of the values given in the specifications above are not those of the relevant standards, but those specified on certificates of conformity (e. g. in EN 60079-14, Section 3, I_K is now I_O).

1.7 How to select the correct barrier

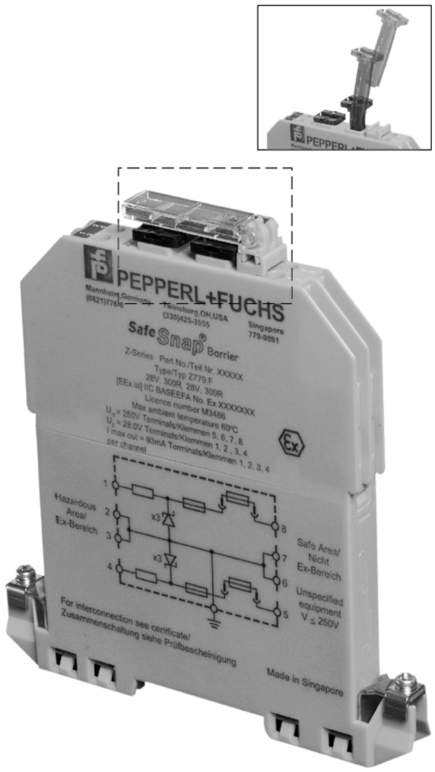
For very many applications the standard solutions are given in this catalogue, in the section on Example Applications. However, in the event that a particular application has not been covered, the following information may be helpful.

1. First decide whether it will be necessary to have a floating circuit, or whether the intrinsically safe circuit can be connected directly to ground. Check whether any existing instrumentation is grounded. If the answer is yes, then check whether additional grounding could lead to faults. Bear in mind that the floating circuit offers a better common-mode rejection characteristic than the grounded circuit. On the other hand, it is more expensive. If a floating circuit is employed, the barriers will normally resist a ground fault.
2. Select the required polarity. This is either determined by the circuit itself, or by any other existing grounds in the circuit. In most applications barriers for positive polarities are used. In order to achieve greater system standardisation, barriers suitable for alternating polarities can be used in place of unipolar ones.
3. Decide the nominal voltage of the Zener barrier. Then determine the maximum output voltage of the device in the safe area during normal operation. Normally the required value is the next highest nominal voltage of a Zener barrier. If these values are close together, it could be that the recommended operating range of the Zener barrier is exceeded. The consequence of this is that the leakage current will be greater than 10 µA. In this case a barrier with a higher nominal voltage should be used. The leakage current is determined for an open intrinsically safe circuit and this then represents the maximum value at the given voltage.
4. Take account of the maximum series resistance of the Zener barrier and its effect on the intrinsically safe circuit. Make sure that this resistance does not cause an inadmissibly high loss of voltage. In circuits having high resistance - usually when voltage signals are being transferred - this resistance is not relevant. If for example a barrier has a max. series resistance of 1 kΩ, then the resulting error is 0.1 %, if the input resistance of the connected device is 1 MΩ.
5. Check whether or not the field device must be certificated for use in the hazardous area. If certification is necessary, check what the prerequisites are for permitting the field device to be used in connection with a Zener barrier.
6. What is the overall length of the cabling between the voltage supply and the field device? Note the number of conductors in the system!

Date of issue 12/13/05

7. The following points have to be clarified if special field devices are used.

- If the field device is a 4 mA ... 20 mA transmitter: What load in ohms can be connected to the transmitter so that it can attain 20 mA as before?
- If the field device is a current/pressure converter: What load can be connected to the controller card so that it can attain 20 mA as before?
- If the field device is a transmitter: How high is the load in the safe area? (typically, resistances of up to 250 Ω are used in the controller)



Barrier with replaceable back-up fuse

The introduction of a replaceable back-up fuse ahead of the integrated fuse provides protection against faults which could occur during the commissioning of the system. It is always arranged that the outer fuse will respond before the inner, innaccessible fuse. The fuses used are specially intended for use on barriers.

Type Channels		Max. series resistance	U_{in} at 10 µA	U_{in} max	Fuse rating	External fuse	Fuse supplied by LITTLEFUSE
		Ω	V	V	mA	mA	
Z 715.F	1	106	13	13.6	100	63	217,063
Z 728.F	1	327	27	28	80	50	217,05
Z 728.H.F	1	250	27	28	80	50	217,05
Z 765.F	2	106	13	13.6	100	63	217,063
		106	13	13.6	100	63	
Z 779.F	2	327	27	28	80	50	217,05
		327	27	28	80	50	
Z 779.H.F	2	250	27	28	80	50	217,05
		250	27	28	80	50	
Z 787.F	2	327	27	28	80	50	217,05
		36 + 0.9 V	27	28	80	50	
Z 787.H.F	2	250	27	28	80	50	217,05
		25 + 0.9 V	27	28	80	50	
Z 960.F	2	64	6.5	9.5	80	50	217.05
		64	6.5	9.5	80	50	
Z 961.F	2	106	6.5	8.1	160	100	217.1
		106	6.5	8.1	160	100	
Z 966.F	2	166	10	11.7	100	63	217.063
		166	10	11.7	100	63	

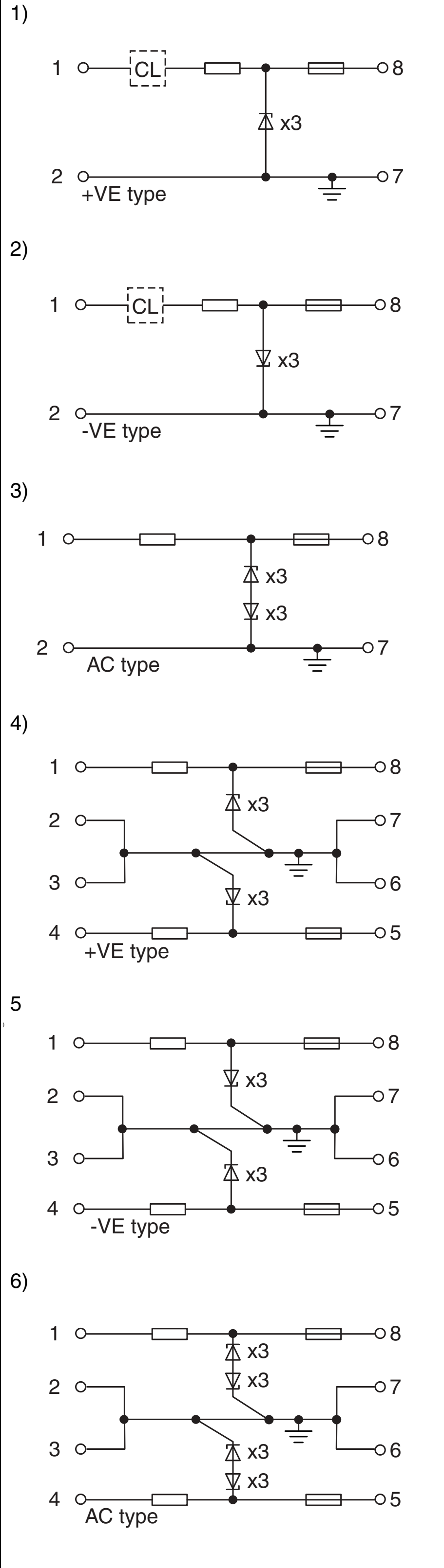
Type			Nominal data		Intrinsically safe characteristics for [EEx ia] IIC							Certification no.
+ ve	- ve	a.c.	V	Ω	U_z (V)	R_{min} (Ω)	I_K(mA)	P_{max}(W)	C_{max} (µF)	L_{max} (mH)	L/R Ratio	
Z 705	Z 805	–	5	10	4.94	9.8	504	0.62	100	0.14	57	BAS 01 ATEX 7005
–	–	Z 905	5	10	4.98	9.8	499	0.61	100	0.14	57	BAS 01 ATEX 7005
Z 710	Z 810	–	10	50	9.56	49	195	0.47	3	0.86	73	BAS 01 ATEX 7005
–	–	Z 910	10	50	9.94	49	203	0.50	3	0.86	73	BAS 01 ATEX 7005
Z 713	Z 813	–	15.75	22	15.75	21.8	723	2.84	0.48	0.076	12.5	BAS 01 ATEX 7005
Z 715	Z 815	–	15	100	14.7	98	150	0.55	0.58	1.3	64	BAS 01 ATEX 7005
Z 715.F	Z 815.F	–	15	100	14.7	98	150	0.55	0.62	1.45	67	BAS 01 ATEX 7096
–	–	Z 915	15	100	15.0	98	153	0.57	0.58	1.3	64	BAS 01 ATEX 7005
Z 715.1K	–	–	15	1k	14.7	980	15	0.06	0.58	144	570	BAS 01 ATEX 7005
–	–	Z 915.1K	15	1k	15	980	15	0.06	0.58	144	570	BAS 01 ATEX 7005
Z 722	Z 822	–	22	150	22	147	150	0.82	0.17	1.45	45	BAS 01 ATEX 7005
Z 728	Z 828	–	28	300	28	301	93	0.65	0.083	3.05	56	BAS 01 ATEX 7005
Z 728.H	–	–	28	240	28	235	119	0.83	0.083	1.82	44	BAS 01 ATEX 7005
Z 728.F	Z 828.F	–	28	300	28	301	93	0.65	0.083	4.21	55	BAS 01 ATEX 7096
Z 728.H.F	Z 828.H.F	–	28	240	28	235	119	0.83	0.083	2.59	44	BAS 00 ATEX 7096
Z 728.CL	Z 828.CL	–	28	300	28	301	93	0.65	0.083	3.05	56	BAS 01 ATEX 7005
–	–	Z 928	28	300	28	301	93	0.65	0.083	3.05	56	BAS 01 ATEX 7005
Z 755	–	–	5	10	4.94	9.8	504	0.62	100	0.14	57	BAS 01 ATEX 7005
			5	10	4.94	9.8	504	0.62	100	0.14	57	
					4.94	4.9	1008	1.25	100	0.03	22	
–	–	Z 955	5	10	4.89	9.8	499	0..61	100	0.14	57	BAS 01 ATEX 7005
			5	10	4.89	9.8	499	0.61	100	0.14	57	
					9.78	4.9	998	1.22	3.3	0.03	22	
Z 757	Z 857	–	7	10	7.14	9.8	729	1.3	13.5	0.07	28	BAS 01 ATEX 7005
			7	10	7.14	9.8	729	1.3	13.5	0.07	28	
					7.14	4.9	1457	2.6	13.5	0.02	11	
–	–	Z 961	9	100	8.7	98	89	0.19	4.9	4.69	182	BAS 01 ATEX 7005
			9	100	8.7	98	89	0.19	4.9	4.69	182	
					17.4	98	178	0.39	0.346	1.14	72	
–	–	Z 961.F	9	100	8.7	98	89	0.192	4.9	4.39	176	BAS 01 ATEX 7096
			9	100	8.7	98	89	0.192	4.9	4.39	176	
					17.4	98	178	0.384	0.31	1.07	67	
–	–	Z 961.H	9	360	8.7	352.8	25	0.05	4.9	57	613	BAS 01 ATEX 7005
			9	360	8.7	352.8	25	0.05	4.9	57	613	
					17.4	355	49	0.11	0.346	15.2	249	
Z 764	Z 864	–	12	1k	11.6	980	12	0.03	1.41	240	1.0	BAS 01 ATEX 7005
			12	1k	11.6	980	12	0.03	1.41	240	1.0	
					11.6	490	24	0.06	1.41	61	360	
–	–	Z 964	12	1k	12	980	12	0.04	1.41	240	1.0	BAS 01 ATEX 7005
			12	1k	12	980	12	0.04	1.41	240	1.0	
					24	490	24	0.08	0.125	61	360	
Z 765	Z 865	–	15	100	14.7	98	150	0.55	0.58	1.3	64	BAS 01 ATEX 7005
			15	100	14.7	98	150	0.55	0.58	1.3	64	
					14.7	49	300	1.1	0.58	0.32	22	
Z 765.F	Z 865.F	–	15	100	14.7	98	150	0.55	0.62	1.45	67	BAS 01 ATEX 7096
			15	100	14.7	98	150	0.55	0.62	1.45	67	
					14.7	49	300	1.1	0.62	0.32	22	

Date of issue 12/13/05

Max. end-to-end resistance	U_{in} at 10 µA	U_{in} max	Fuse rating	see circuit diagram No.	see note 2
Ω	V	V	mA		
18.18	0.9 (1 µA)	4.8	250	1), 2)	
18.18	0.9 (1 µA)	4.7	250	3)	
56	6.5	8.9	100	1), 2)	
56	6.5	9.3	100	3)	
29	13.7	14.6	160		
107	13.0	13.6	100	1), 2)	
121	13.0	13.8	63		
107	13.0	14.0	100	3)	
1025	13.0	13.6	100	3)	
1025	13.0	14.0	100	1), 2)	
166	19.0	20.1	50	1), 2)	
327	26.5	28.0	50	1), 2)	
250	26.5	28.0	80		
341	26.5	28.0	50		
273	26.5	28.0	50		
342 + 2 V	26.5	28.0	50	1), 2)	
327	26.0	27.6	50	3)	
18.18	0.9 (1 µA)	4.8	250	4), 5)	A1
18.18	0.9 (1 µA)	4.8	250		A2
–	–	–	–		B
18.18	0.9 (1 µA)	4.7	250	6)	A1
18.18	0.9 (1 µA)	4.7	250		A2
–	–	–	–		B
15.5	6.0	6.9	200	4), 5)	A1
15.5	6.0	6.9	200		A2
–	–	–	–		B
106	6.5	8.1	100	6)	A1
106	6.5	8.1	100		A2
–	–	–	–		B
113	6.5	8.0	100		A1
380	6.5	8.1	50		A2
–	–	–	–		B
380	6.5	8.1	50	6)	A1
380	6.5	8.1	50		A2
–	–	–	–		B
1033	10.0	11.0	50	4), 5)	A1
1033	10.0	11.0	50		A2
–	–	–	–		B
1033	10.0	11.7	50	6)	A1
1033	10.0	11.7	50		A2
–	–	–	–		B
107	13.0	13.6	100	4), 5)	A1
107	13.0	13.6	100		A2
–	–	–	–		B
121	13.0	13.9	63		A1
121	13.0	13.9	63		A2
–	–	–	–		B

Circuit diagram

Hazardous area connections | Safe area connections



Date of issue 12/13/05

How to select the correct barrier

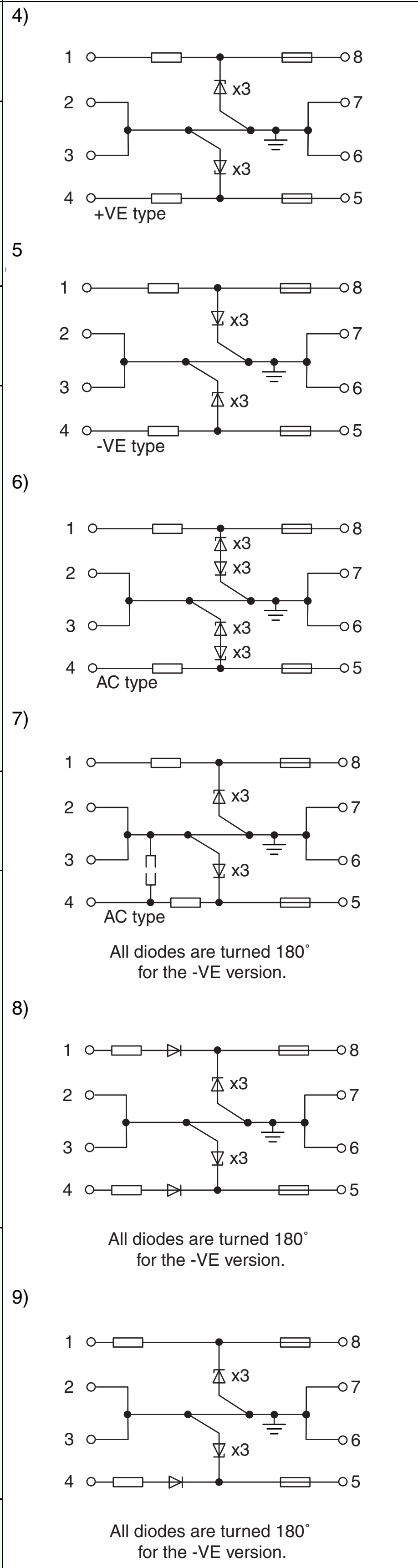
Type			Nominal data		Intrinsically safe characteristics for [EEx ia] IIC							Certification no.
+ ve	- ve	a.c.	V	Ω	U_z (V)	R_{min} (Ω)	I_K(mA)	P_{max}(W)	C_{max} (µF)	L_{max} (mH)	L/R Ratio	
–	–	Z 966	12	150	12	147	82	0.24	1.41	5.52	147	BAS 01 ATEX 7005
			12	150	12	147	82	0.24	1.41	5.52	147	
					24	73.5	164	0.48	0.125	1.38	57	
–	–	Z 966.F	12	150	12	147	82	0.24	–	–	–	BAS 01 ATEX 7096
			12	150	12	147	82	0.24	–	–	–	
					24	73.5	164	0.49	–	–	–	
–	–	Z 966.H	12	75	12	73.5	164	0.49	1.41	1.38	75	BAS 01 ATEX 7005
			12	75	12	73.5	164	0.49	1.41	1.38	75	
					24	36.5	328	0.98	0.125	0.33	36	
Z 772	Z 872	–	22	150	22	147	150	0.82	0.17	1.45	45	BAS 01 ATEX 7005
			22	150	22	147	150	0.82	0.17	1.45	45	
					22	73.5	300	1.64	no approval for IIC			
Z 778	Z 878	–	28	600	28	607	46	0.32	0.083	17.2	109	BAS 01 ATEX 7005
			28	600	28	607	46	0.32	0.083	17.2	109	
					28	303.5	93	0.65	0.083	3.05	42	
Z 779	Z 879	–	28	300	28	301	93	0.65	0.083	3.05	56	BAS 01 ATEX 7005
			28	300	28	301	93	0.65	0.083	3.05	56	
					28	150.5	186	1.3	no approval for IIC			
Z 779.H	Z 879.H	–	28	240	28	235	119	0.83	0.083	1.82	44	BAS 01 ATEX 7005
			28	240	28	235	119	0.83	0.083	1.82	44	
					28	117.5	238	1.67	no approval for IIC			
Z 779.F	Z 879.F	–	28	300	28	301	93	0.65	0.083	4.21	55	BAS 00 ATEX 7096
			28	300	28	301	93	0.65	0.083	4.21	55	
Z 779.H.F	Z 879.H.F	–	28	240	28	235	120	0.83	0.083	2.59	44	BAS 01 ATEX 7096
			28	240	28	235	120	0.83	0.083	2.59	44	
Z 786	Z 886		28	Diode	28	Diode	0	0.0	0.083	–	–	BAS 01 ATEX 7005
			28	Diode	28	Diode	0	0.0	0.083	–	–	
			28	Diode	28	Diode	0	0.0	0.083	–	–	
Z 787	Z 887	–	28	300	28	301	93	0.65	0.083	3.05	56	BAS 01 ATEX 7005
			28	Diode	28	Diode	0	0	0.083	–	–	
					28	301	93	0.65	0.083	3.05	56	
Z 787.H	Z 887.H	–	28	240	28	235	119	0.83	0.083	2.82	44	BAS 01 ATEX 7005
			28	Diode	28	Diode	0	0	0.083	see note 1		
					28	235	119	0.83	0.083	2.82	44	
Z 787.F	Z 887.F	–	28	300	28	301	93	0.65	0.083	4.21	55	BAS 01 ATEX 7096
			28	Diode	28	21.8	Diode	0	0.083	–	–	
					28	301	93	0.65	0.083	4.21	55	
Z 787.H.F	Z 887.H.F	–	28	240	28	235.2	120	0.83	0.083	2.59	44	BAS 01 ATEX 7096
			28	Diode	28	14.7	Diode	0	0.083	–	–	
					28	235.2	120	0.83	0.083	2.59	44	
Z 788	Z 888	–	28	300	28	301	93	0.65	0.083	3.05	56	BAS 01 ATEX 7005
			10	50	9.56	49	195	0.47	3.0	0.86	73	
					28	42	288	0.87	0.083	0.32	26	
Z 788.H	Z 888.H	–	28	240	28	235	119	0.83	0.083	1.82	44	BAS 01 ATEX 7005
			10	50	9.56	49	195	0.47	3.0	0.86	73	
					28	40	314	1.0	0.083	0.26	25	
Z 788.R	–	–	28	300	28	301	93	0.65	0.083	3.05	56	BAS 01 ATEX 7005
			10	50	9.56	49	195	0.47	3.0	0.86	73	
					28	42	288	0.87	0.083	0.32	26	
Z 789	–	–	28	300	28	307	91.2	0.638	–	–	–	BAS 01 ATEX 7005
			28	Diode	28	–	–	–	–	–	–	
			28	Diode	28	–	–	–	–	–	–	
Z 796	Z 896	–	26.6	320	26.6	314	85	0.56	0.094	5.14	64	BAS 01 ATEX 7005
			20.5	415	20.5	407	50	0.26	0.204	14.6	138	
					26.6	177	135	0.82	0.094	2.05	34	

Date of issue 12/13/05

Max. end-to-end resistance Ω	U_{in} at 10 µA V	U_{in} max V	Fuse rating mA	see circuit diagram No.	see note 2
166	10.0	11.7	50	6)	A1
166	10.0	11.7	50		A2
–	–	–	–		B
169	10.0	11.9	63		A1
169	10.0	11.9	63		A2
–	–	–	–		B
82	10.0	11.7	100	6)	A1
82	10.0	11.7	100		A2
–	–	–	–		B
166	19.0	20.1	50	4), 5)	A1
166	19.0	20.1	50		A2
–	–	–	–		B
646	26.5	28.0	50	4), 5)	A1
646	26.5	28.0	50		A2
–	–	–	–		B
327	26.5	28.0	50	4), 5)	A1
327	26.5	28.0	50		A2
–	–	–	–		B
250	26.5	28.0	80	4), 5)	A1
250	26.5	28.0	80		A2
–	–	–	–		B
341	26.5	28.0	50		
341	26.6	28.0	50		
273	26.5	28.0	50		
273	26.5	28.0	50		
36 + 0.9 V	26.5	28.0	50	8)	A1
36 + 0.9 V	26.5	28.0	50		A2
–	–	–	–		B
327	26.5	28.0	50	9)	A1
36 + 0.9 V	26.5	28.0	50		A2
–	–	–	–		B
250	26.5	28.0	80	9)	A1
25 + 0.9 V	26.5	28.0	80		A2
–	–	–	–		B
341	26.5	28.0	50		A1
50 + 0.9 V	26.5	28.0	50		A2
–	–	–	–		B
273	26.5	28.0	50		A1
43 + 0.9 V	26.5	28.0	50		A2
–	–	–	–		B
327	26.5	28.0	50	4), 5)	A1
64	6.5	9.1	50		A2
–	–	–	–		B
250	26.5	28.0	80	4), 5)	A1
64	6.5	9.1	80		A2
–	–	–	–		B
327	26.5	28.0	50	7)	A1
64	–	9.1	50		A2
–	–	–	–		B
640	26.5	27.5	50	???	A1
36 + 0.9 V	26.5	27.5	50		A2
36 + 0.9 V	26.5	27.5	50		B
340	24.0	25.1	50	4), 5)	A1
437	18.0	19.5	50		A2
–	–	–	–		B

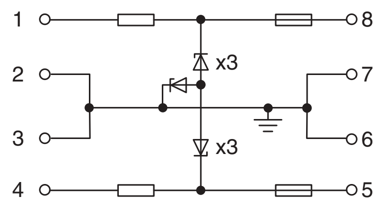
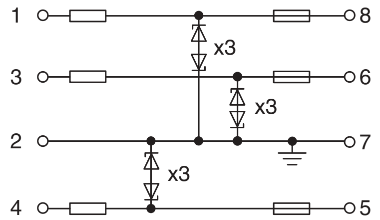
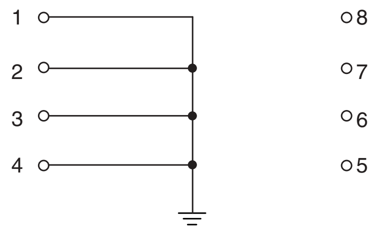
Circuit diagram

Hazardous area connections / Safe area connections



Type			Nominal data		Intrinsically safe characteristics for [EEx ia] IIC							Certification no.
+ ve	- ve	a.c.	V	Ω	U_z (V)	R_{min} (Ω)	I_K(mA)	P_{max}(W)	C_{max} (µF)	L_{max} (mH)	L/R Ratio	
–	–	Z 960	10	50	9.94	49	203	0.50	3;0	0.86	73	BAS 01 ATEX 7005
			10	50	9.94	49	203	0.50	3;0	0.86	73	
					9.94	24.5	406	1.0	3;0	0.19	26	
–	–	Z 960.F	10	50	9.94	98	203	0.51	2.63	0.82	69	BAS 01 ATEX 7096
			10	50	9.94	49	203	0.51	2.63	0.82	69	
					9.94	49	406	1.02	2.63	0.82	25	
–	–	Z 965	15	100	15	98	153	0.57	0.58	1.3	64	BAS 01 ATEX 7005
			15	100	15	98	153	0.57	0.58	1.3	64	
					15	49	306	1.14	0.58	0.29	20	
–	–	Z 967	17	120	16.8	117	143	0.60	0.38	1.63	60	BAS 01 ATEX 7005
			17	120	16.8	117	143	0.60	0.38	1.63	60	
					16.8	58	286	1.20	0.38	0.24	21	
–	–	Z 972	22	300	22	301	73	0.40	0.17	6.95	90	BAS 01 ATEX 7005
			22	300	22	301	73	0.40	0.17	6.95	90	
					22	150	146	0.80	0.17	1.45	35	
–	–	Z 978	28	600	28	607	46	0.32	0.083	17.2	109	BAS 01 ATEX 7005
			28	600	28	607	46	0.32	0.083	17.2	109	
					28	304	93	0.65	0.083	3.05	42	
–	–	Z 954	4.5	12	4.5	11.76	383	0.43	100	0.24	81	BAS 01 ATEX 7005
			4.5	12	4.5	11.76	383	0.43	100	0.24	81	
			4.5	12	4.5	11.76	383	0.43	100	0.24	81	
					9.0	5.88	765	0.86	4.9	0.068	41	
					9.0	3.92	1150	1.29	4.9	0.03	27	
					9.0	17.64	510	1.15	4.9	0.12	30	
Dummy Z 799												

Date of issue 12/13/05

Max. end-to-end resistance	U_{in} at 10 µA	U_{in} max	Fuse rating	see circuit diagram No.	Circuit diagram Hazardous area connections / Safe area connections	see note 2
Ω	V	V	mA			
64 64 – – 79 79	6.5 6.5 – – 6.5 6.5	9.5 9.5 – – 9.7 9.7	50 50 – – 50 50	10)	10) 	A1 A2 B A1 A2 B
115 115 –	13.0 13.0 –	14.2 14.2 –	50 50 –	10)		A1 A2 B
136 136 –	15.0 15.0 –	16.2 16.2 –	50 50 –	10)	11) 	A1 A2 B
327 327 –	19.0 19.0 –	20.9 20.9 –	50 50 –	10)		A1 A2 B
646 646 –	26.0 26.0 –	27.6 27.6 –	50 50 –	10)		A1 A2 B
27.27 27.27 27.27 – – –	0.9 (1 µA) 0.9 (1 µA) 0.9 (1 µA) – – –	4.9 4.9 4.9 – – –	50 50 50 – – –	11)		A1 A2 A3 B B C
						

Note 1:

Zener barriers type Z 787H and Z 887H have channels with diode returns.

The intrinsically safe terminals for the channels with diode returns should be regarded as 28 V voltage sources.

The 28 V must be considered as the theoretical maximum up to which a capacitive load can be applied to the intrinsically safe terminals due to the leakage current of the diode return. This voltage is only used in calculating the load capacitance.

Note 2:

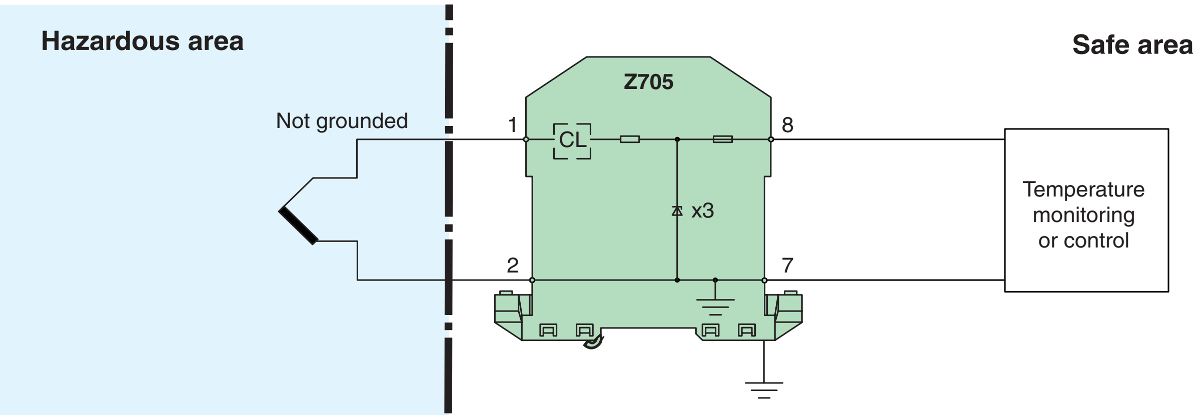
A1, A2 and A3 are separate channels.

B: Two channels in parallel circuit with a ground connection.

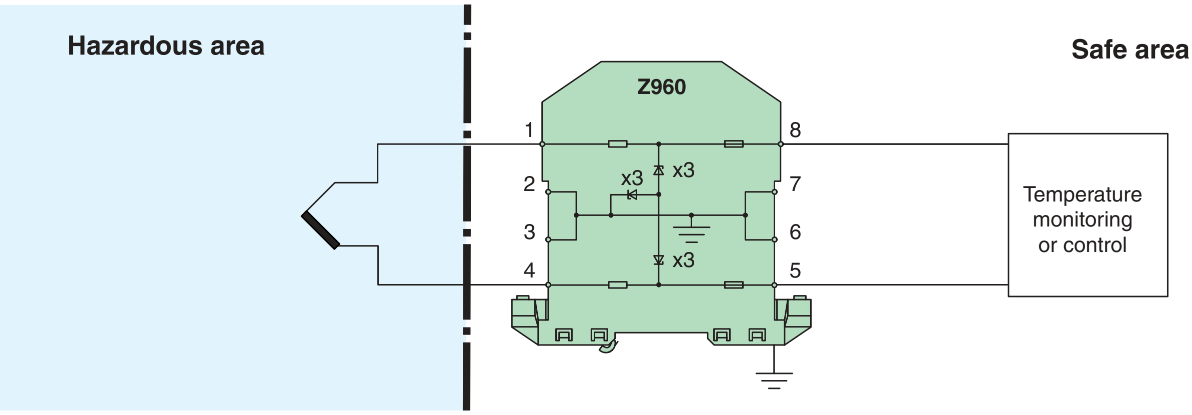
C: Two channels in series circuit without a ground return.

1.8 Application examples

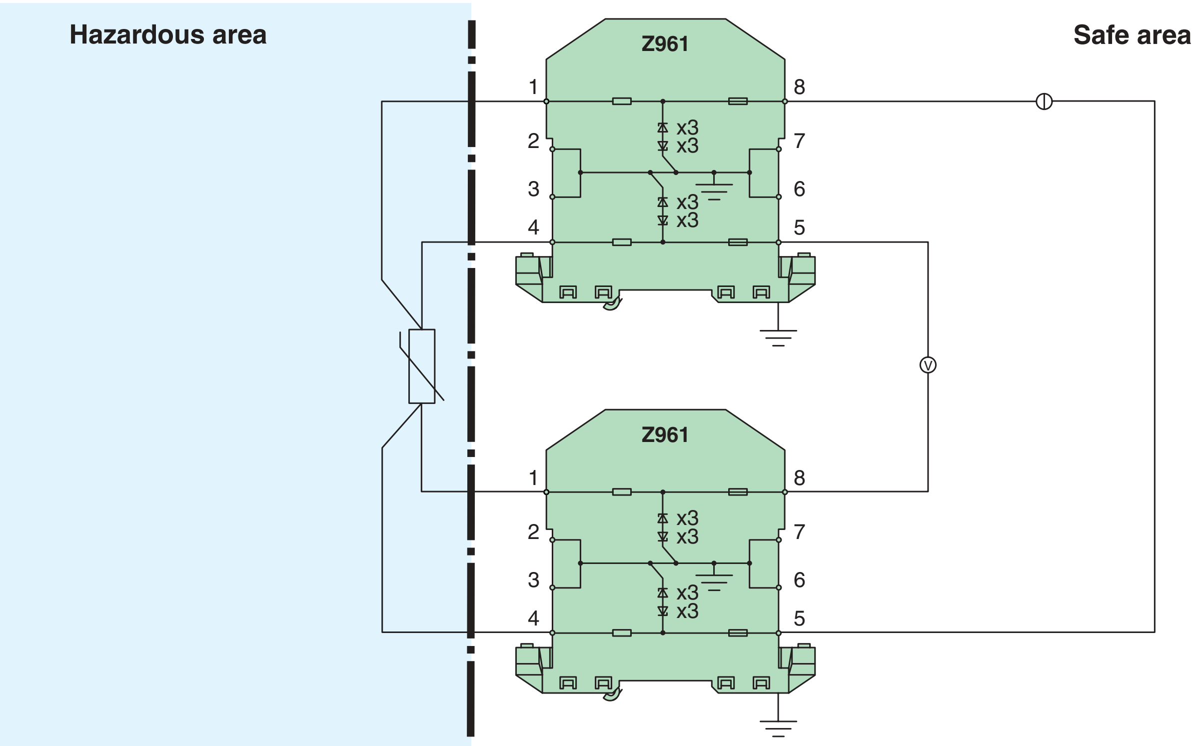
Temperature measurement



The simplest and most favourably priced solution is a single-channel Zener barrier. It should be noted, however, that the device is not grounded in the safe area. The system is approved for [EEx ia] IIC.



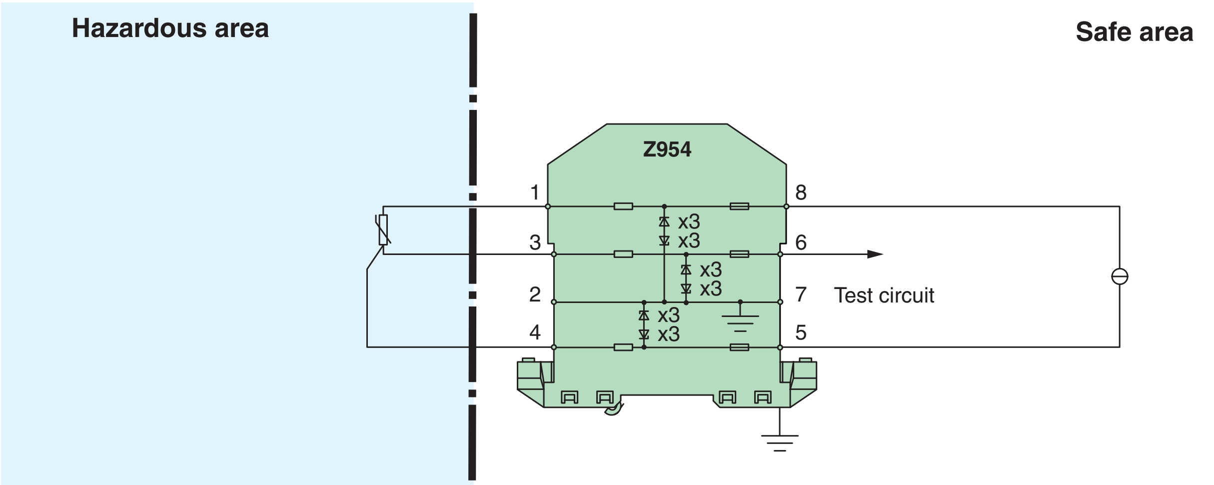
The use of a two-channel barrier prevents the direct ground connection of the intrinsically safe circuit. Grounding only takes place in the event of a fault, when the Zener diodes conduct. This circuit arrangement prevents the occurrence of mutual interference between the various circuits. The system is approved for [EEx ia] IIC.



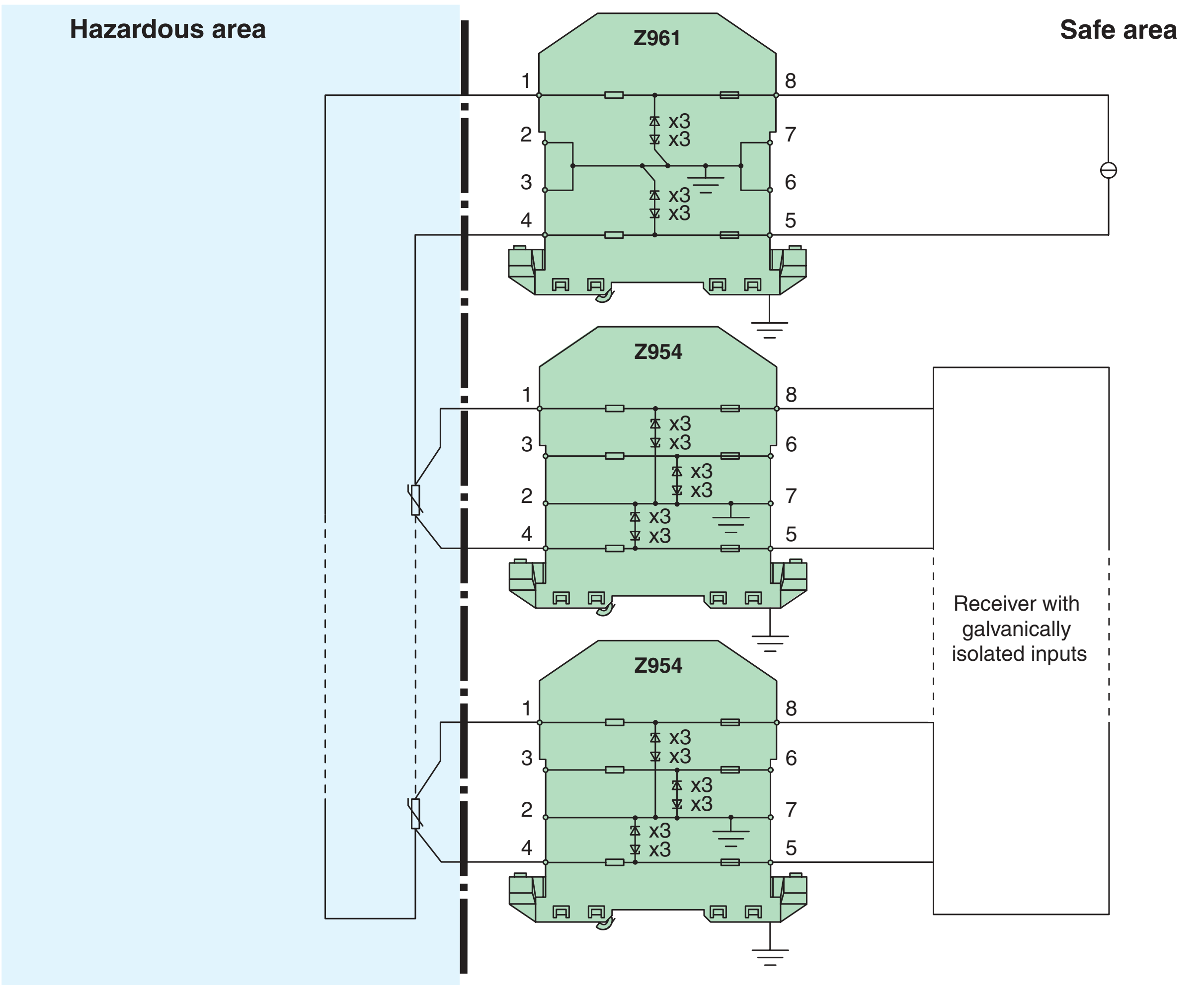
The illustration shows the set up for a temperature measurement with a 4-wire Pt100. None of the 4 wires is connected directly to ground. The complete system is therefore "quasi ground-free". This is the best option when the intention is to suppress the influence of the end-to-end resistance of the barrier on the measuring accuracy as far as possible.

Date of issue 12/13/05

Temperature measurement



The circuit arrangement shows the connection of a Pt100 in 3-wire technology, using the 3-channel Zener barrier Z 954. The whole system is quasi ground-free. All 3 barriers have identical end-to-end resistances, so that the resulting error is restricted to a minimum. The system is approved for [EEx ia] IIC.

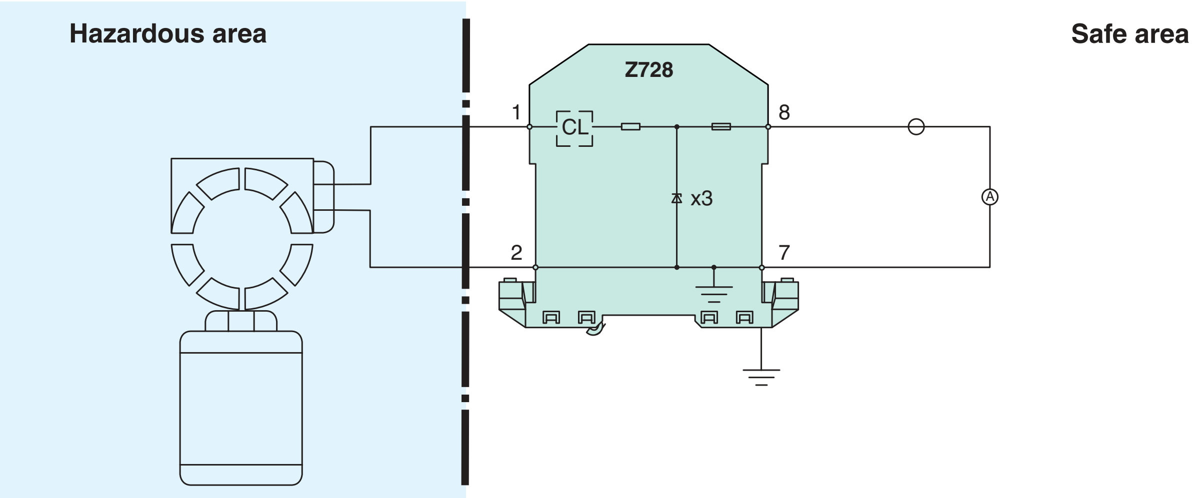


The circuit consists of a system of a maximum of seven Pt100s. The Pt100s are connected in series to a constant current source. Each voltage signal is transferred to a receiver via a Z 954.

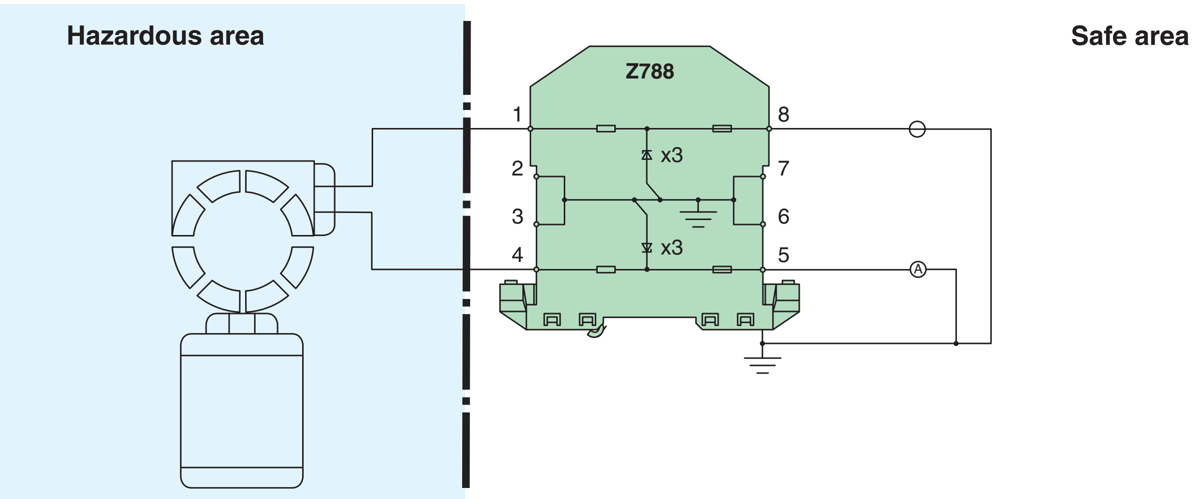
The Z 954s have been selected due to their high end-to-end resistance. Due to the high input resistance of the receiver, the high end-to-end resistance has practically no effect on the accuracy of measurement.

Date of issue 12/13/05

0 mA … 20 mA/4 mA … 20 mA transmitter



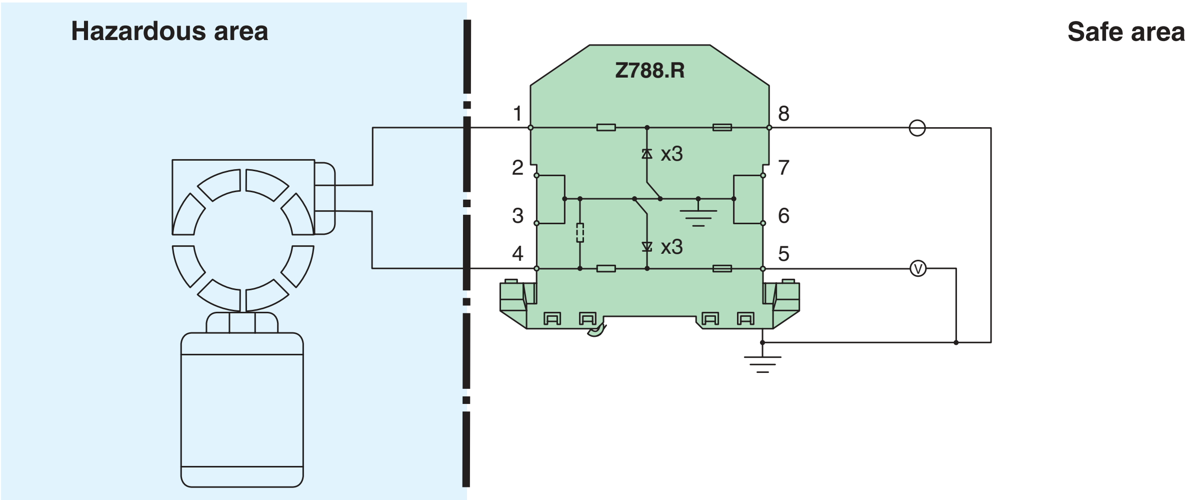
If a ground-free power supply is available, the use of a single-channel Zener barrier, grounded in the safe area, represents the simplest and most economical solution. The ammeter can be used in combination with a recording instrument, a trip amplifier, or a 250 Ω resistance, or replaced by these devices. In so doing, the overall resistance of the arrangement must be taken into account. The working range of the barrier caters for an input voltage of up to 27 V. For each built-in 250 Ω resistance the output voltage of the power supply can be increased by 1 V. By using a 250 Ω resistance and a supply voltage of 28 V, a source of 16.5 V at 20 mA is available to the transmitter in the hazardous area. The internal voltage drop across the barrier is then 6.5 V. The system is approved for [EEx ia] IIC.



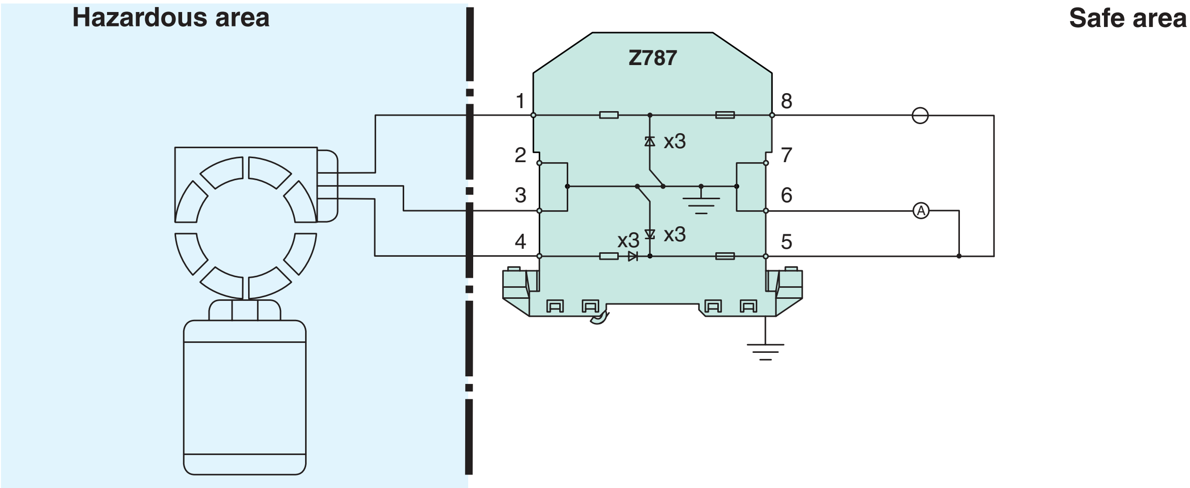
With this 2-channel Zener barrier, it is possible to supply a number of circuits with one source. All the wiring is quasi ground-free. The maximum voltage supply is 27 V. The internal voltage drop across the barrier is 7.8 V at 20 mA, so that 19.2 V are available for the field device and ammeter. If the ammeter for converting the current signal into a 1 V … 5 V voltage signal is replaced by a 250 Ω resistance, then 14.2 V are available at the field device. The system is approved for [EEx ia] IIC.

Date of issue 12/13/05

0 mA … 20 mA/4 mA … 20 mA transmitter

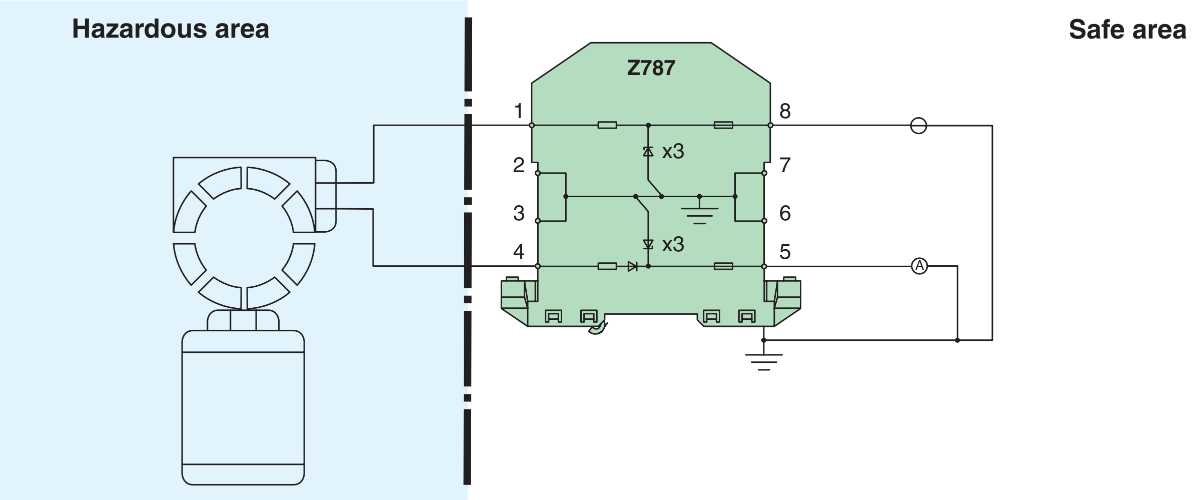


This system can be used if the field device requires a relatively high voltage. A 250 Ω resistance is connected in parallel with the intrinsically safe output of the 10 V/50 Ω output of this 2-channel barrier. Thus a voltage of 15.5 V is available at the field device if the voltage supply is 27 V. The system is approved for [EEx ia] IIC.



The combination of a 28 V, 300 Ω and a 28 V barrier with diode return is the solution for applications with 3-wire transmitters. Special attention must be paid here to the internal voltage drop. The reason for this is the diode return. The system is approved for [EEx ia] IIC.

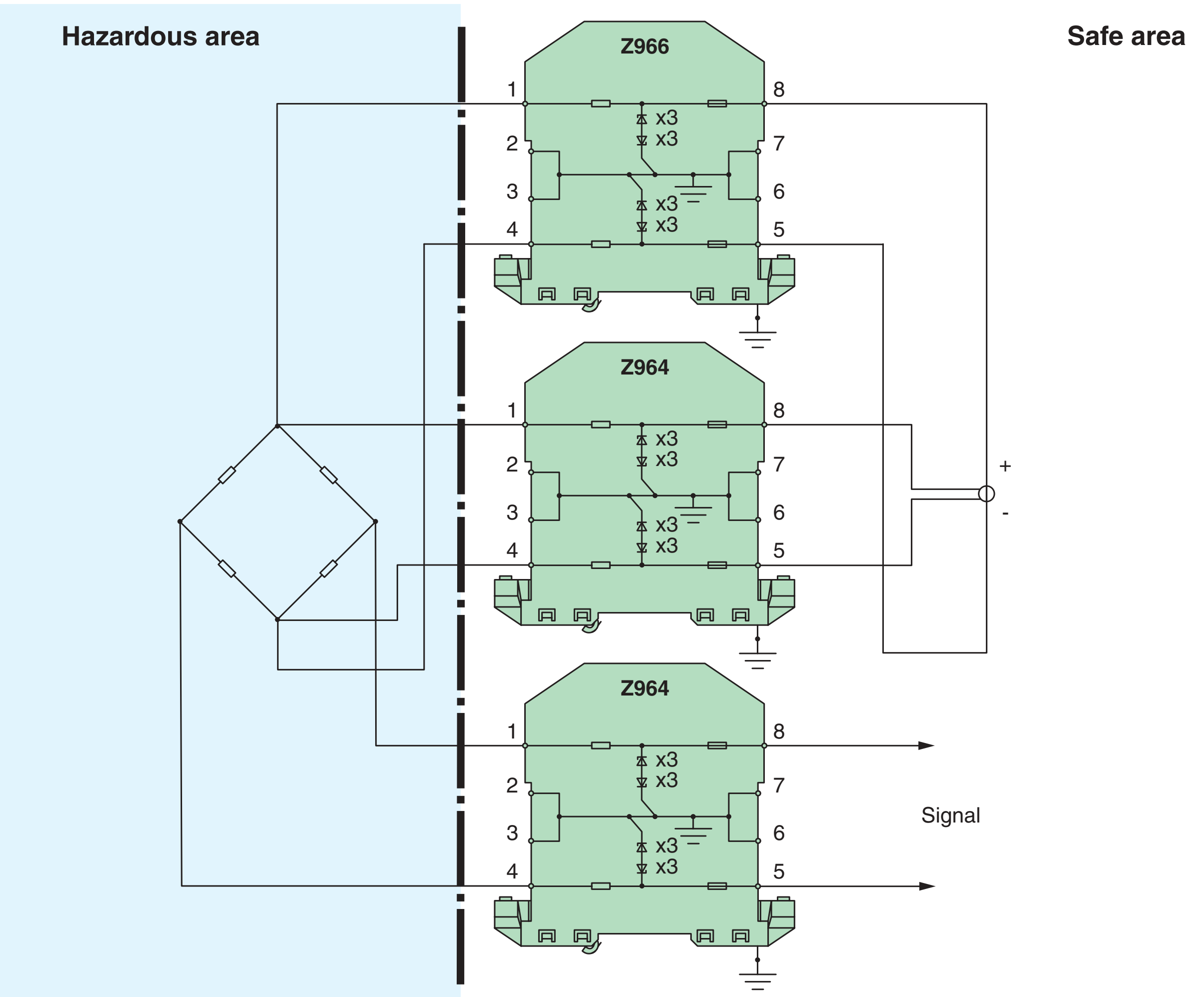
SMART transmitter



The simplest possible solution is the use of a 2-channel Zener barrier with 28 V, 300 Ω and 28 V diode return. If a regulated power supply unit provides an output voltage of 27 V, 13.9 V will be available to the transmitter and wiring in the hazardous area.

The data transfer is bidirectional, so that a non-certificated communicator can be connected and used in the the safe area. The system is approved for [EEx ia] IIC.

Strain gauge bridges

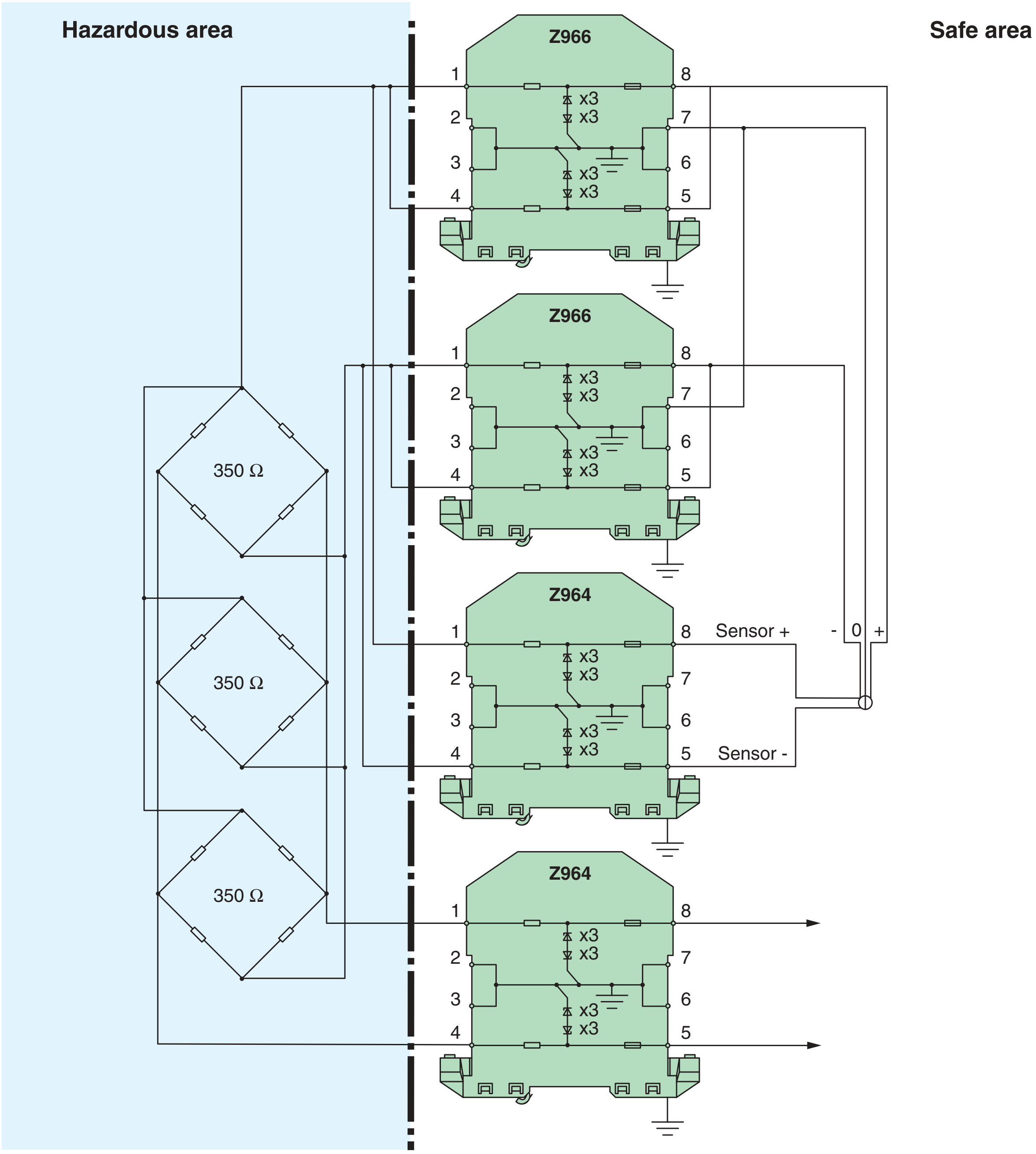


The strain gauge bridge is supplied via the Z 966. The Z 966 enables a 350 Ω strain gauge bridge to be supplied with 8 V. The voltage feedback via the Z 964 can be dispensed with, although in practice most applications require this feedback to obtain the best possible accuracy of measurement.

The millivolt signal is transferred to the safe area via the Z 964. The system is approved for [EEx ia] IIC.

Date of issue 12/13/05

Wire strain gauges

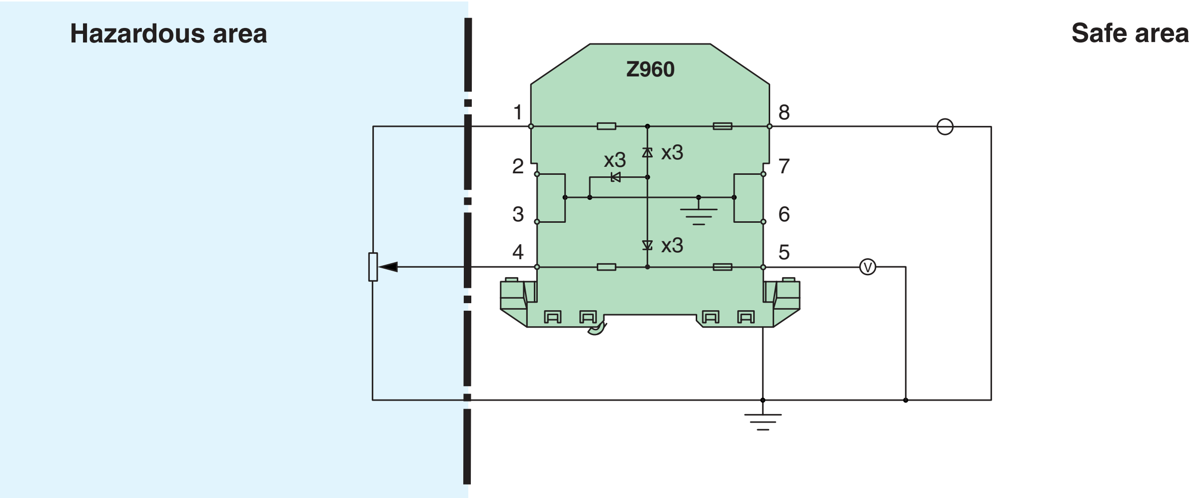


If more than one strain gauge bridge is to be supplied from a common power supply (in the example shown above there are three), a possible solution is to supply them via two Z 966s, as shown.

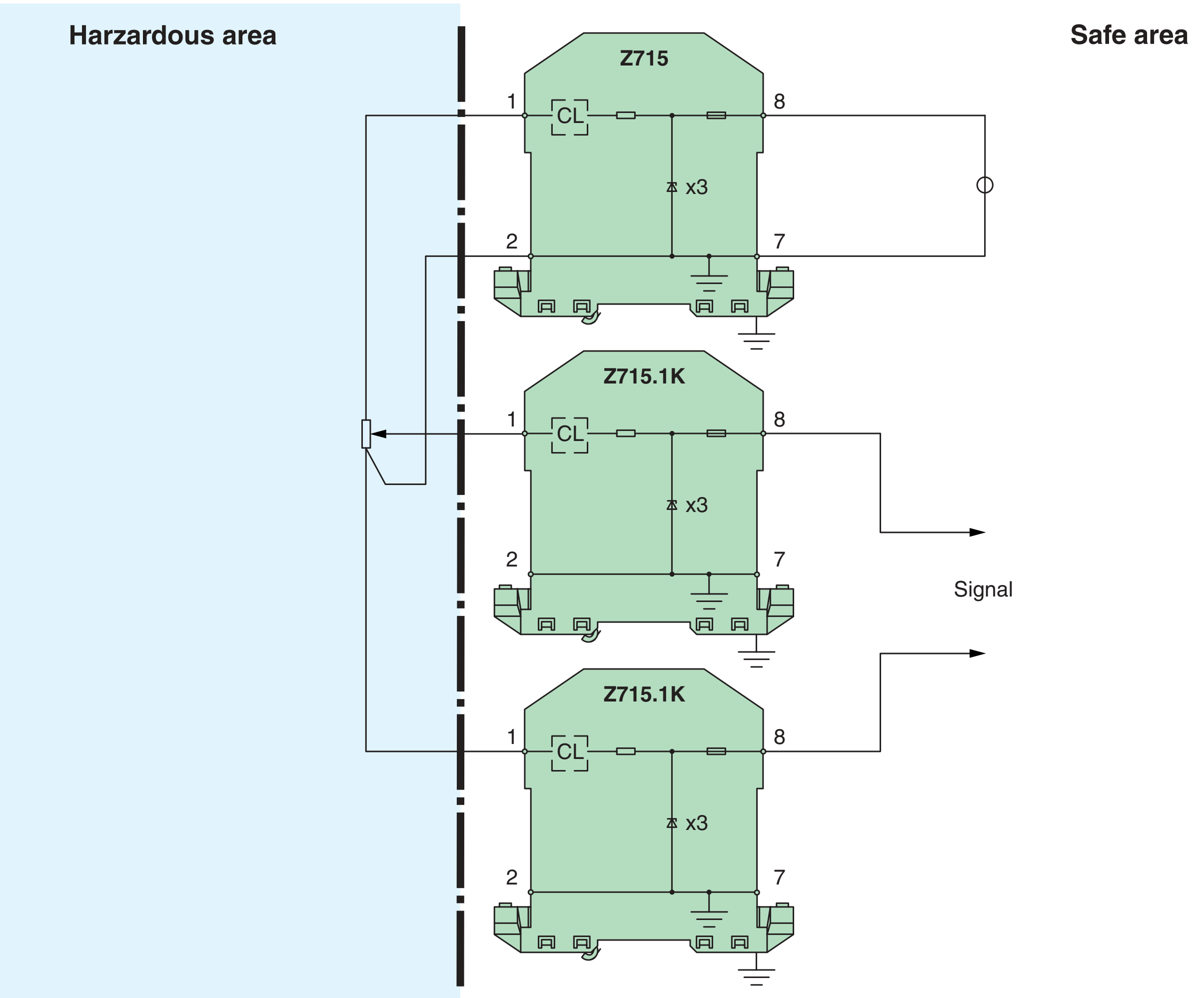
Both channels of these Zener barriers are arranged in parallel in order to reduce the end-to-end resistance. This arrangement provides 8 V to the bridges if the voltage supply is 20 V. The system is approved for [EEx ib].

Date of issue 12/13/05

Potentiometric position detection



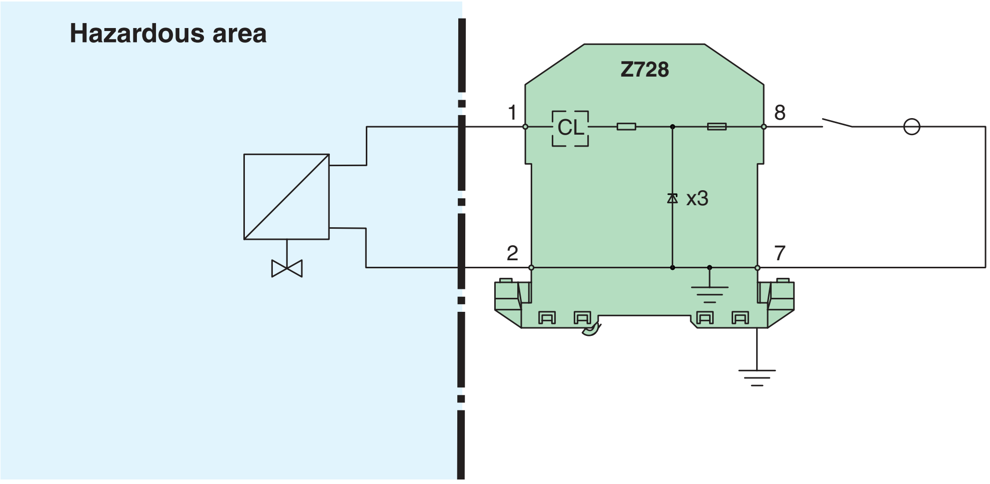
Applications in which the accuracy is not critical can be satisfied as shown above. The intrinsically safe circuit has a direct connection to ground. An additional resistance on this side would have an effect on the voltage signal and would have to be taken into account. The system is approved for [EEx ia] IIC.



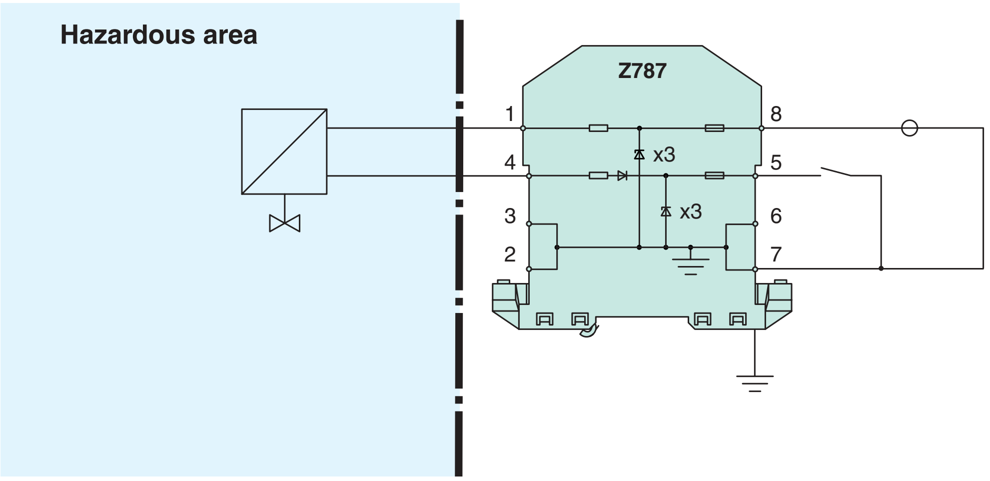
If greater accuracy is required, a 4-wire solution must be applied. The Z 715 Zener barrier transfers the power supply to the potentiometer, whilst two Z 715.1K barriers transfer the signal to the receiver. The supply voltage in the example above could be 13 V.

Date of issue 12/13/05

Solenoid valves



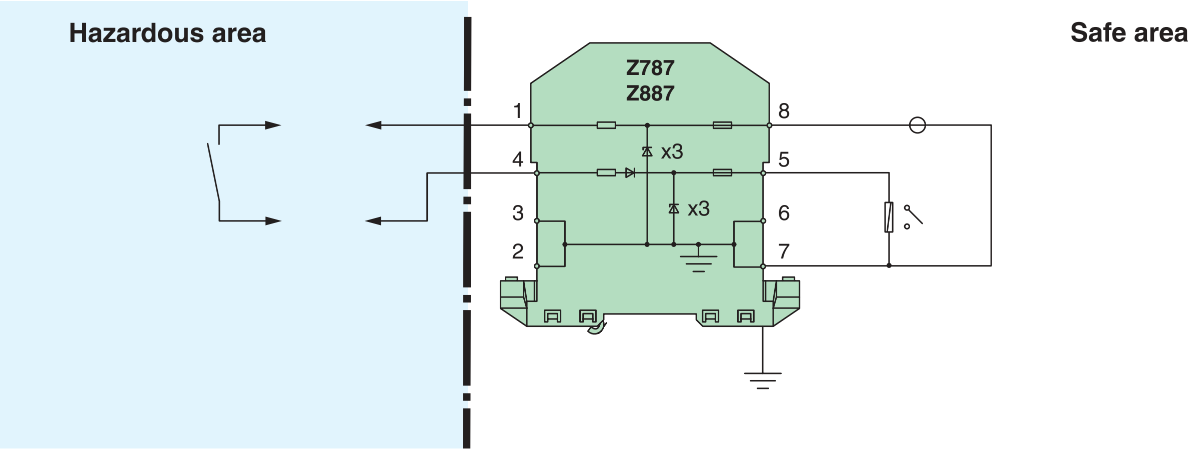
The simplest and most economical solution is a single channel Zener barrier, with the power supply grounded on its safe side. If the valve requires 30 mA at a minimum 12 V, then at a supply voltage of 27 V, 4 V would remain for the voltage drop through the field wiring. The system is approved for [EEx ia] IIC.



If the switch is in parallel circuit with the nominal mains voltage, it is usual to use a barrier combination of 28 V, 300 Ω and a 28 V diode return. In this solution, special attention has to be paid to the voltage drop in the barrier, since the diode return causes an additional loss of voltage. The system is approved for [EEx ia] IIC.

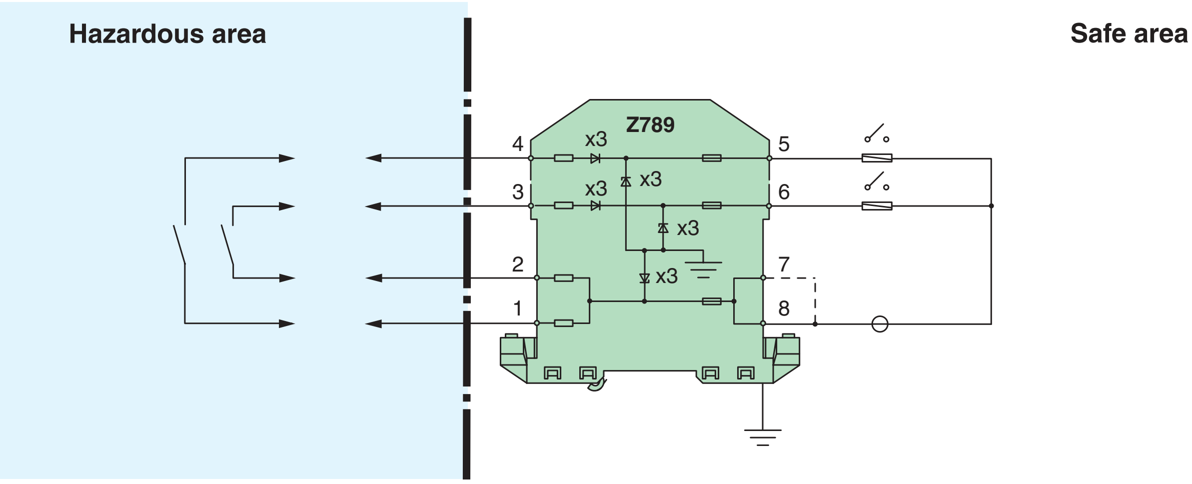
Date of issue 12/13/05

Switch status



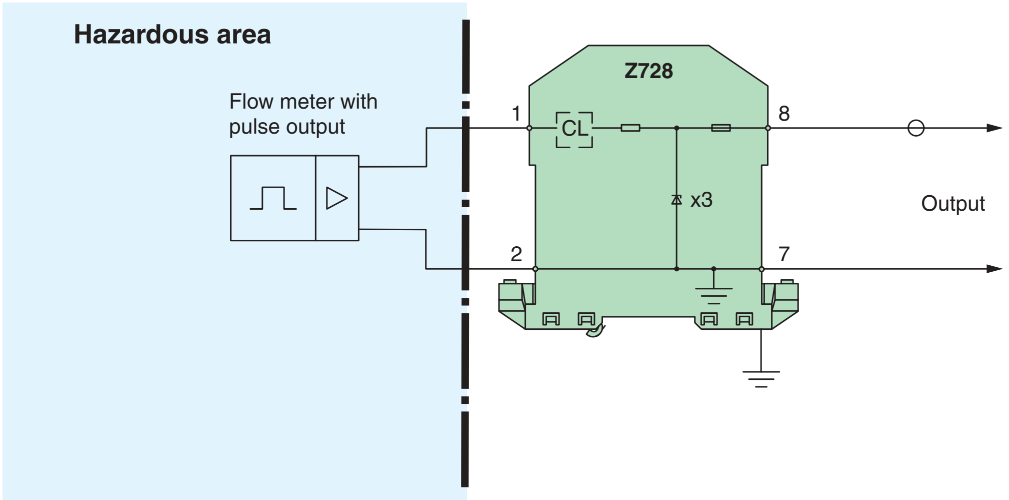
In the traditional method of switch status detection, the switch is provided with noble metal contacts suitable for low voltages and currents. A ground fault in any field wire leaves the relay in the de-energised state, despite the switch being closed. This problem is solved by the use of quasi ground-free wiring.

At a nominal voltage of up to 27 V, a typical coil with 12 V and approx. 350 Ω can be used to match the power. The Zener barrier is approved for [EEx ia] IIC. Negative polarities can be accommodated with the Z 887.

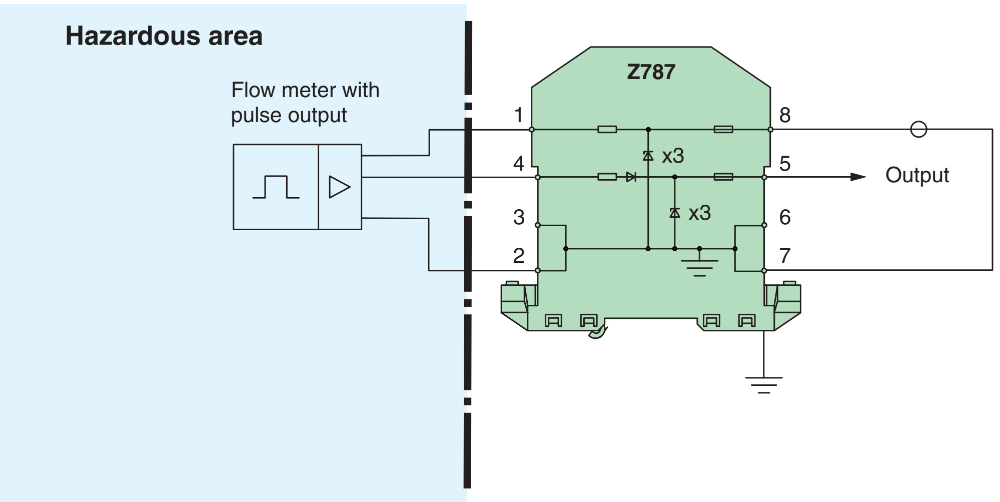


Date of issue 12/13/05

Pulse transmission and flow measurement

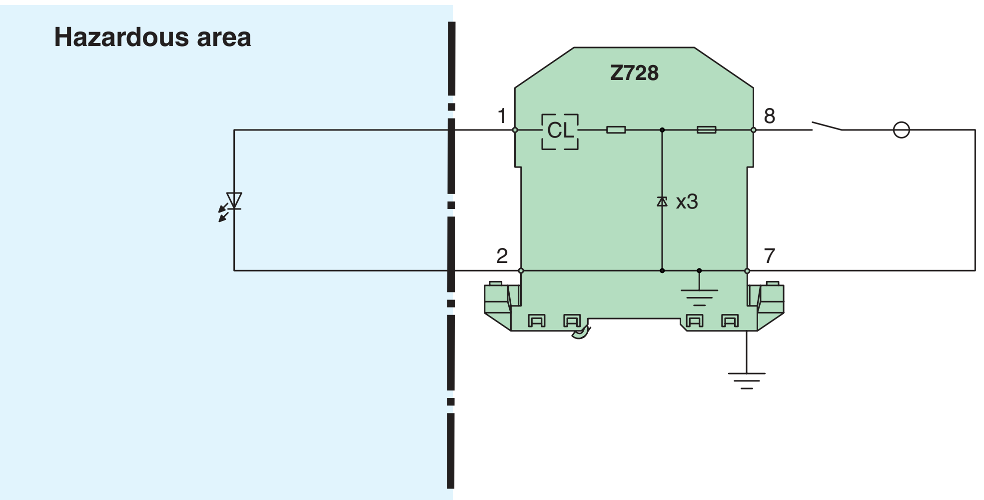


The simplest method of flow measurement, with or without a pre-amplifier, is illustrated in the circuit above. The flow meter sensor generates voltage or current pulses, which are transmitted to the safe area via the Z 728. If the sensor generates sinusoidal signals, e. g. an inductive sensor, a Zener barrier for alternating polarities can be used, for example the Z 928. The Zener barrier is approved for [EEx ia] IIC.



If the power supply to the flow meter is provided via a 28 V, 300 Ω barrier and ground, the signal can be transferred via the diode return of the Z 787. When selecting the receiver (counter), consideration must be given to the fact that the high signal is damped by the diode. The system is approved for [EEx ia] IIC.

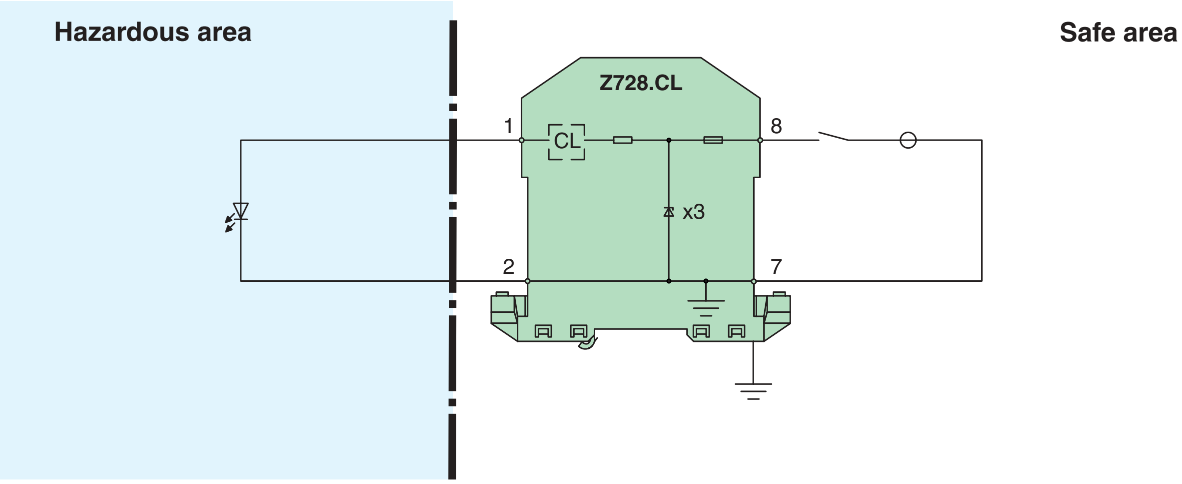
LED display



The simplest and most economical solution is the single-channel Zener barrier shown above. The nominal supply voltage is sufficiently low that the end-to-end resistance of the barrier limits the flow of current through the LED to an acceptable value. Otherwise a current-limiting resistor is required. The system is approved for [EEx ia] IIC.

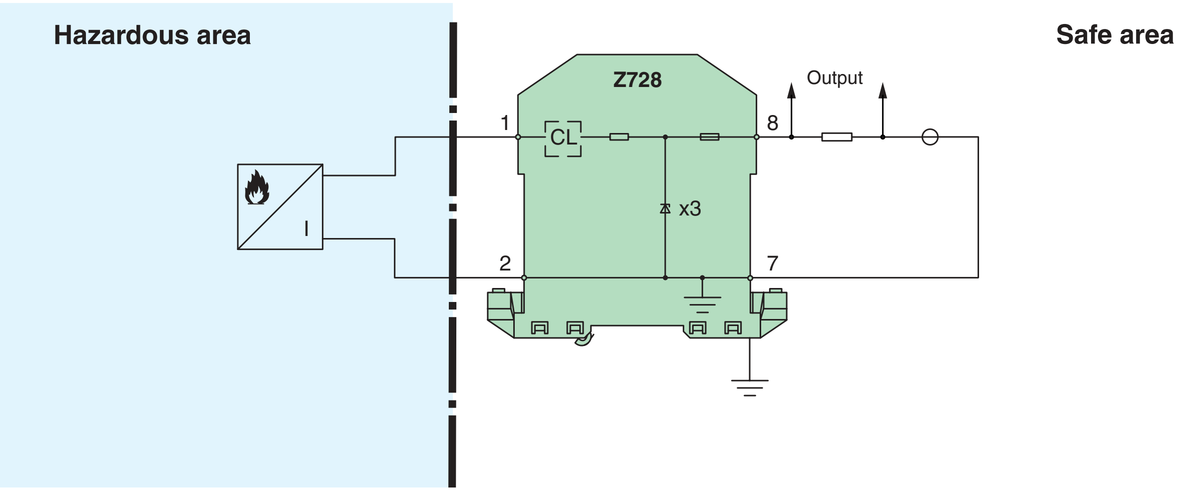
Date of issue 12/13/05

LED display

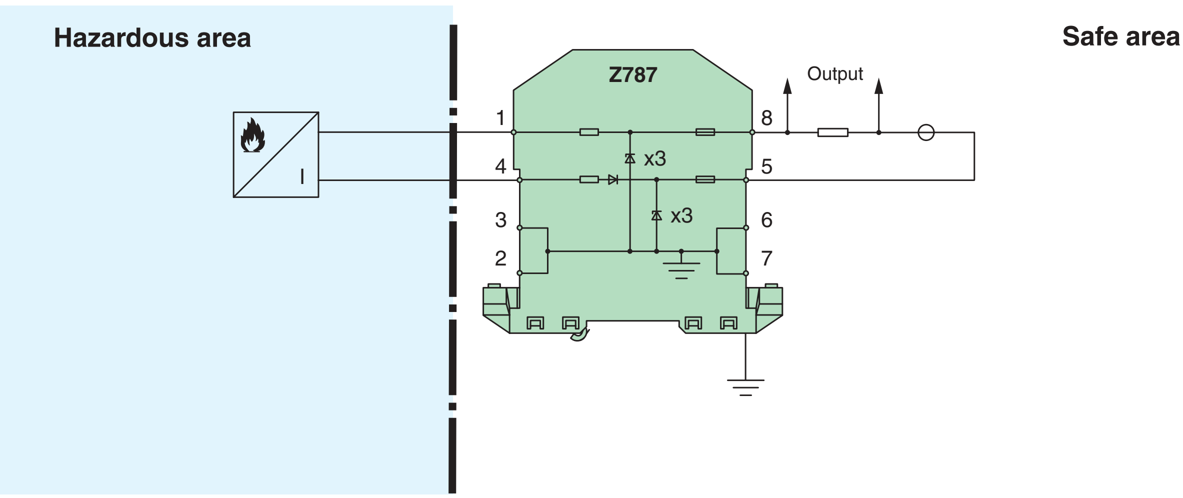


The circuit shown above does not require a current limiting resistor, since the Z 728.CL limits the current electronically to a maximum of 40 mA. At a supply voltage of 18 V … 27 V a current of 40 mA flows in the intrinsically safe circuit. This current reduces at lower nominal supply voltages. To special order, the Z 728.CL can be supplied with lower current-limiting values. The system is approved for [EEx ia] IIC. The Z 828.CL is also suitable for negative polarities.

Smoke and fire alarms



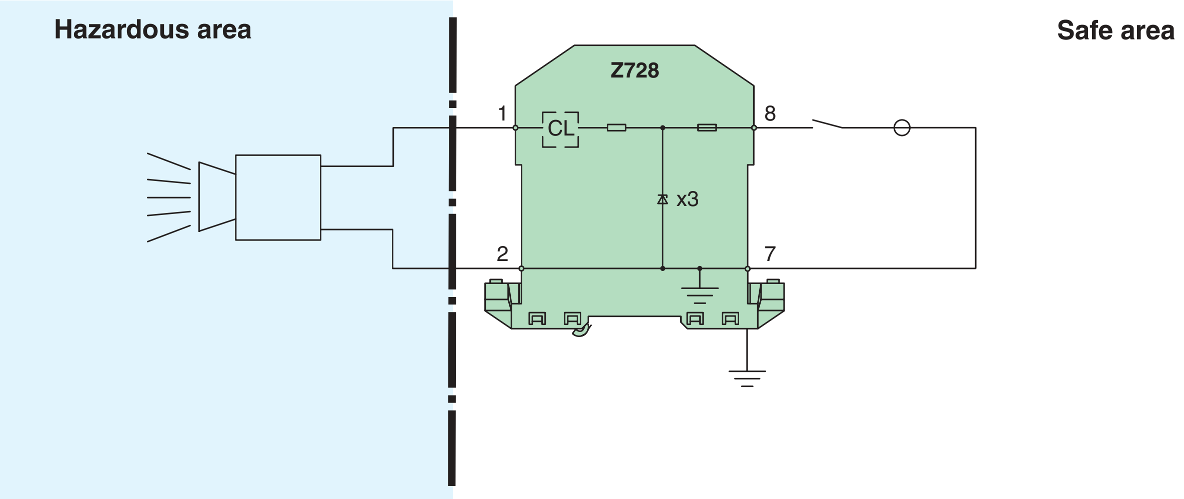
The simplest and most cost-effective solution is shown in the illustration above. With a 24 V nominal supply voltage, there is an off-state current of approx. 4 mA. When the detector responds, the current increases to approx. 25 mA or greater. The current applied to the detector is sufficient to operate the LED display with sufficient brightness. The system is approved for [EEx ia] IIC.



The system shown above is comparable to the Z 728 and is also relatively inexpensive. The Z 787 is a 2-channel device. In this application the intrinsically safe circuit is quasi ground-free. The system is approved for [EEx ia] IIC.

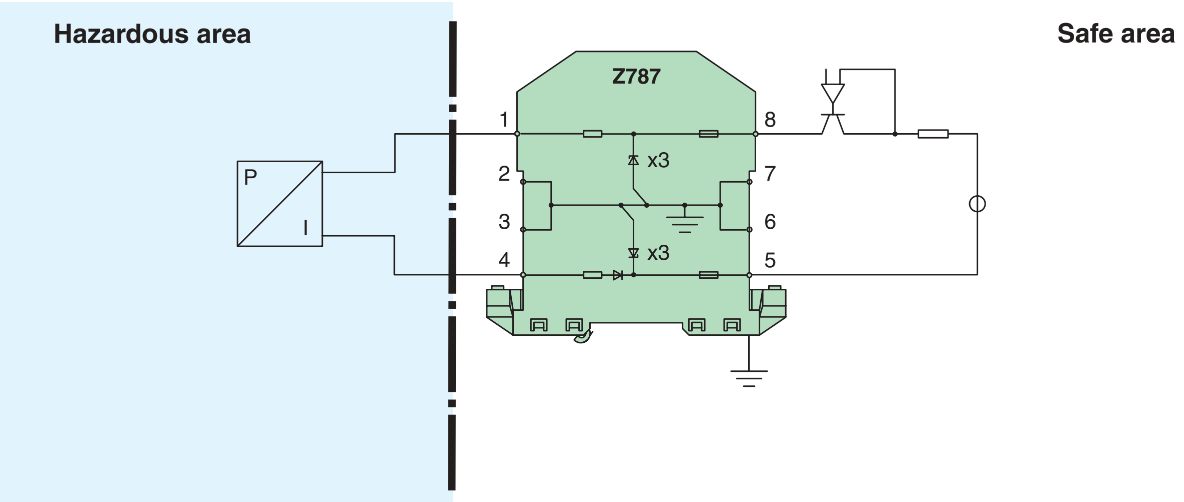
Date of issue 12/13/05

Audible alarms



Audible alarms operate at relatively high voltages and low currents. They are approved for use with various Zener barriers. The simplest solution is the circuit shown above.

I/P converters



The simplest and most cost-effective solution is a single-channel Zener barrier. The nominal supply control voltage must either be ground-free or connected to the negative output to earth. In theory, the field circuit can have a resistance of 900 Ω if the voltage supply is 27 V. In practice, however, the voltage values are lower, so that the field circuit normally has a resistance of 300 Ω.

Date of issue 12/13/05