



Beyond intrinsic safety: implementing I

Loop-powered indicators have been used in intrinsically safe systems for some time, but non-sparking Ex ec devices that may be installed in Zone 2, and Ex eb indicators that may be installed in Zone 1 or 2, are less common. This article considers the three types but gives more attention to the less established Ex ec and Ex eb indicators which have economic and functional advantages and may be used to display the 4/20mA current flowing in hazardous area loops protected by any technique apart from intrinsic safety.

The basic operation of most 4/20mA loop-powered indicators is illustrated by Figure 1.

The operational requirements of the indicator are to produce an accurate measurement in engineering units and drop as few available line volts as possible, typically less than 1.2V. Some loop-powered indicators can incorporate display backlighting and alarm facilities, but these accessories are not discussed in this article.

The use of intrinsically safe indicators

In Europe, loop-powered 4/20mA intrinsically safe indicators are usually certified Ex ia IIC T5 to IECEx and ATEX requirements. This enables them to be used in all surface industry locations and with all gases except carbon disulphide and ethyl nitrate, which have low ignition temperatures. Indicators are not likely to be mounted in a Zone 0, but the 'ia' certification allows them to be connected in a system, part of which enters a Zone 0. The certification of these indicators



Image: Shutterstock

Ex ec and Ex eb loop-powered indicators

normally designates the 4/20mA input as complying with the requirements of 'simple apparatus'. This means that there is no significant equivalent residual capacitance or inductance between the 4/20mA indicator terminals, and that, even under fault conditions, no significant amount of energy can pass out of the indicator's terminals. Consequently, the indicator can be designed into or added to an intrinsically safe circuit without affecting the safety analysis of the circuit.

Figure 2 illustrates a typical intrinsically

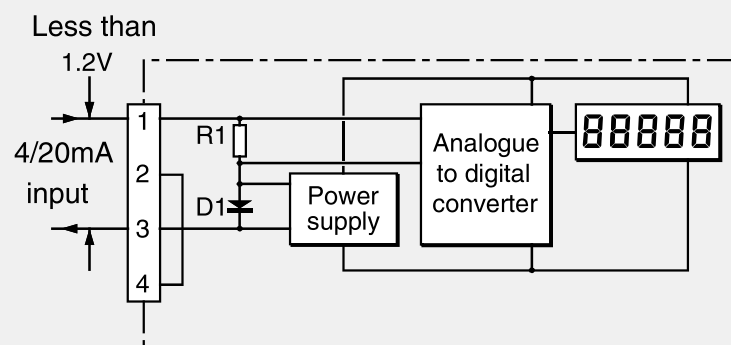


Figure 1: Indicator block diagram – Image: BEKA associates

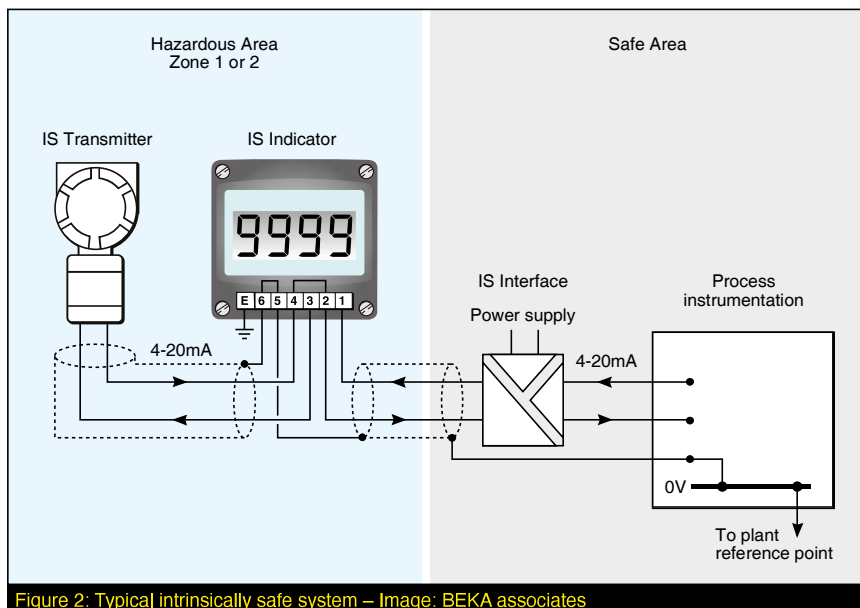


Figure 2: Typical intrinsically safe system – Image: BEKA associates

safe system. The permitted location of the field equipment is determined by the system analysis and is unaffected by the inclusion of the certified Ex ia indicator. The requirements of intrinsically safe systems are widely documented elsewhere¹.

The use of Ex ec indicators

The application of Ex ec indicators is less common than intrinsically safe indicators,

but they do solve the problem of providing indication in Zone 2 hazardous areas for all non-intrinsically safe methods of protection. Ex ec instruments use the same basic circuit as intrinsically safe instruments but must meet the more stringent enclosure requirements of the international Ex e increased safety standard. There are requirements for impact resistance and ingress protection, and for plastic

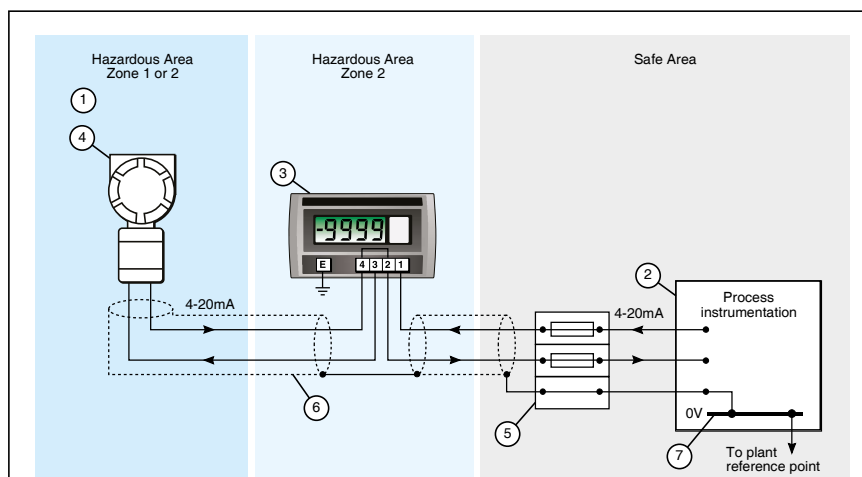
enclosures, tests for resistance to solar radiation and ageing. Some intrinsically safe indicators also satisfy these requirements for operational reasons, but they are not required for compliance with the intrinsic safety standard.

Certified Ex ec indicators usually have an IECEx Certificate of Conformity and an ATEX Type Examination Certificate. The ATEX Directive permits self-certification of Category 3 equipment such as these indicators, but increasingly, end-users prefer third party certification. Indicators are usually certified T5, resulting in a maximum input rating of typically U_{max} 30V and I_{max} 200mA.

Certified Ex ec indicators mounted in Zone 2 can provide indication of the 4/20mA signal from equipment in the safe area and equipment in the hazardous area using any method of protection such as Ex d, Ex e, Ex m and Ex p, other than intrinsic safety. The essential difference in the principles of the method of energy limiting protection used in intrinsic safety from those used in the other methods of protection prevents the use of Ex ec instruments in intrinsically safe circuits. Similarly, intrinsically safe instruments cannot be readily used with equipment using other methods of protection. Figure 3 shows how certified Ex ec indicators may be used in Zone 2 to display the output from hazardous area instrumentation protected by other techniques, such as Ex d and Ex p².

The use of Ex eb indicators

Ex eb indicators can be installed in Zone 1 or 2 to provide indication of the 4/20mA signal from equipment in the safe area and equipment in the hazardous area employing all other methods of protection such as Ex d, Ex e, Ex m and Ex p, except intrinsic safety Ex i. International increased safety standards exclude the use of electronic components, such as semiconductors and electrolytic capacitors from Level of Protection 'eb' apparatus. Therefore, Ex eb certified indicators always employ at least one additional type of hazardous area protection such as encapsulation Ex mb.



NOTE 1 The permitted location of the field equipment is determined by its apparatus certificate

NOTE 2 The process instrumentation must provide a regulated supply with an output voltage $\leq$ voltage rating of all the components in the loop, and accept the 4/20mA return signal.

NOTE 3 The Ex ec certified indicator, which may be field or panel mounting, must be mounted in Zone 2 within its permitted temperature range.

NOTE 4 The field equipment may use any method of protection other than intrinsic safety

NOTE 5 The fuses, which must be located in a safe area, provide over current protection and a means of isolation for the circuit.

NOTE 6 The cables must comply with the relevant local code of practice

NOTE 7 Where screens are used they should be earthed at one point in the safe area

Figure 3: Typical Ex ec system – Image: BEKA associates

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the method of protection used in intrinsic safety from those used in the other methods of protection prevents the use of Ex eb instruments in intrinsically safe circuits.

Certified Ex eb indicators are a lower-cost alternative to flameproof Ex d indicators. Eliminating the need for expensive flameproof glands, they are easier to install and tend to be significantly lighter than flameproof models. Ex eb indicators can incorporate controls such as push buttons, enabling calibration whilst the instrument is operating in Zone 1. Figure 4 illustrates how certified Ex eb indicators may be used in Zone 1 or 2 to display the output from hazardous area instrumentation protected by other techniques, such as flameproof Ex d³.

Maintenance

For operational reasons indicators are usually mounted in readily accessible places in Zone 1 or 2, which makes this a convenient point from which to test a 4/20mA loop. Intrinsically safe circuits permit any action to assist fault-finding and the removal of equipment without isolation. Other types of protection permit

fault-finding on live circuits in Zone 2, providing that a risk assessment has demonstrated that the process cannot cause ignition. For example, measuring a voltage with an intrinsically safe meter is acceptable, but disconnecting wiring is not. Live maintenance is not permitted on Zone 1 circuits.

Both Ex ec and Ex eb certified indicators can incorporate controls such as push buttons which may be operated while the indicator is powered and functioning in the hazardous area, thus simplifying calibration.

Conclusion

The use of Ex ec and Ex eb certified loop-powered indicators to provide digital indication of 4/20mA signals derived from hazardous area equipment using a method of protection other than intrinsic safety is now well established. Together with the more common intrinsically safe solution, it is now possible to install loop-powered indication in hazardous area 4/20mA loops employing all types of protection.

Ex eb certified loop-powered indicators are an attractive substitute for traditional Ex d indicators in Zones 1 or 2. Not only are they less expensive and easier to install, but they can also have simple controls which may be used while the indicator is operating in the hazardous area. ■

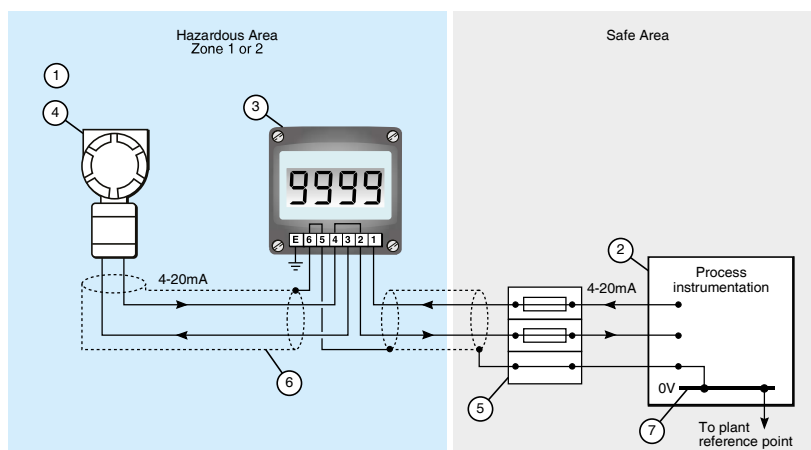
References

¹ Application Guide AG300 Intrinsically safe loop-powered indicators (https://www.beka.co.uk/application_guides/application_guide_ag300.pdf)

² Application Guide AG321 installation of [extra low voltage dc] Ex ec instrumentation (https://www.beka.co.uk/application_guides/application_guide_ag321.pdf)

³ Application Guide AG320 Installation of [extra low voltage dc] Ex eb and Ex tb instrumentation (https://www.beka.co.uk/application_guides/application_guide_ag320.pdf)

⁴ The use of 4-20mA indicators in hazardous areas: Chris Towle BSc, CEng, MIMech E, MIET, Hon FinstMC: Hazardex journal; March 2013.



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Figure 4: Typical Ex eb system – Image: BEKA associates

About the author



Olivier Lebreton CEng, MIET, is Managing and Technical Director at hazardous area display specialist, BEKA associates Ltd. Olivier has 25 years' experience managing product design projects across many different applications: oceanographic equipment, safety critical products and hazardous area instrumentation. Olivier is leading a team of engineers developing and certifying BEKA's new range of instruments.