The use of 4-20mA indicators in hazardous areas

Introduction

Loop powered indicators have been used in intrinsically safe systems for some time, but 'nA' indicators which are non-sparking devices that may be installed in Zone 2, are less common. This article considers both types, but gives more attention to the less established 'nA' indicators which 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 the majority of these indicators is illustrated by Figure 1.

The operation of the indicator can be simply explained as follows: the 4-20mA current flows through the resistor R1 and the forward biased diode D1. The voltage across D1 is multiplied by a switch-mode power supply and used to power the instrument. The voltage developed across R1 provides the input signal to the analogue to digital converter which drives the display. The major operational requirements of the indicator are to produce an accurate measurement and drop as few [1.5V] of the available line volts as possible. Indicators usually can incorporate backlighting and alarm facilities but these facilities are not discussed in this document.

The increasing use of risk analysis techniques in determining the probability of explosions in plants where explosive gases may be present has resulted in the major part of the hazardous areas of plants being designated as Zone 2. Increased attention to avoiding leaks for ecological, economic and safety reasons have also contributed to enlarging Zone 2 locations. From the viewpoint of indicators this is fortunate since indicators are usually mounted in Zone 2 so as to minimise the risk to personnel. Human beings should avoid Zone 1 locations whenever possible since humans can present an electrostatic and frictional sparking risk, make mistakes and are susceptible to toxic gases.

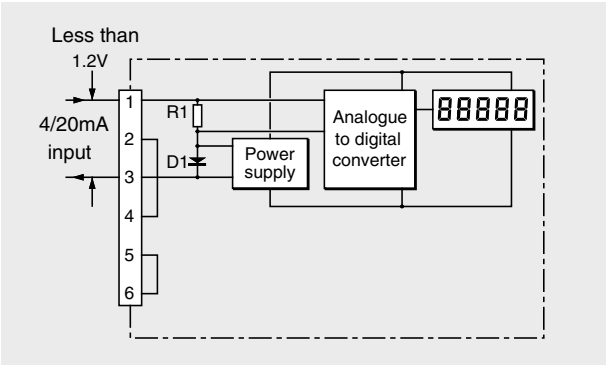


Figure 1 - IndicatorBlock Diagram

The use of intrinsically safe indicators

Intrinsically safe indicators are usually certified 'ia IIC T5' to IECEx and ATEX requirements. This enables them to be used in all surface industry locations and with all gases with the exception of carbon disulphide and ethyl nitrite, 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 normally designates the input terminals as satisfying the requirements of 'simple apparatus' and consequently they 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 safe system. The permitted location of the field equipment is determined by the system analysis and is unaffected by the inclusion of the indicator. The requirements of intrinsically safe systems are widely documented elsewhere and hence this document gives a more extensive treatment to the less well documented use of 'nA' indicators.

Reference1 gives a detailed account of the application of intrinsically safe indicators.

The use of 'nA' indicators

The application of 'nA' indicators is less common than intrinsically safe indicators but they do solve the problem of providing indication in hazardous areas for all other methods of protection. 'nA' instruments use the same basic circuit as intrinsically safe instruments but must meet the more stringent enclosure requirements of the 'nA' standard. There are requirements for impact resistance, ingress protection and in addition for plastic enclosures, tests for resistance to solar radiation and requirements for anti-static properties. The majority of intrinsically safe indicators meet these requirements for operational reasons but they are not all required for compliance with the standard. In practice the only significant difference between the two types of indicator is the incomprehensible label.

'nA' indicators are usually certified by

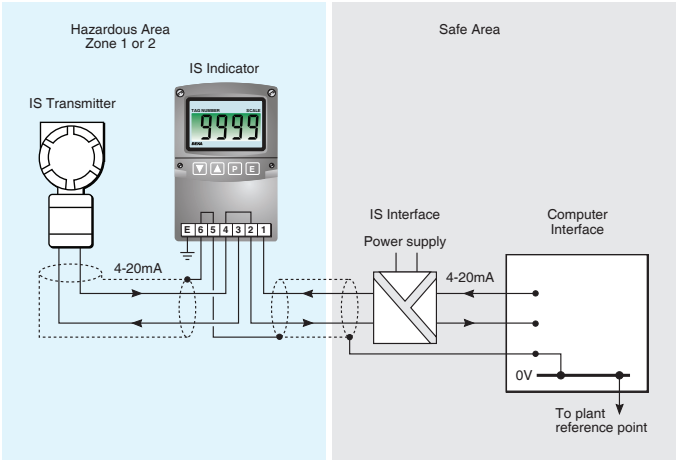
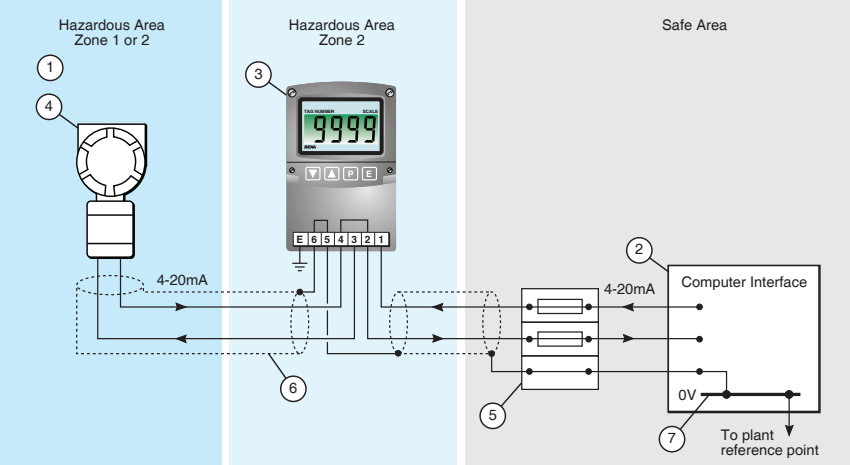


Figure 2 - Typical Intrinsically Safe System



NOTE1 The permitted location of the field equipment is determined by the apparatus certificate.

NOTE 2 The computer interface must provide a well regulated 24V supply and accept the 4-20mA return sgnal.

NOTE 3 The indicator is certified 'nA T5' and 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 switch fuses provide over-current protection and a means of isolation for the circuit.

NOTE 6 The cables must comply wth the relevant local code of practice for installations. Usually the cable is armoured or has a toughened outer sheath and installed so as to minimise the risk of mechanical damage.

NOTE 7 Where screens are used they should be earthed at one point and carefully terminated so as to ensure continuity and avoid unintentional earth connections.

Figure 3- Typical 'nA' System

a 'Certified Approval Body' for IECEx and ATEX purposes. The ATEX Directive permits self-certification of Category 3 equipment such as these indicators but increasingly end-user's preference is for third party certification. 'nA' indicators may only be mounted in Zone 2 but since Zone 2 is the logical place for indicators this is not a severe limitation. 'nA' certification is independent of the gas classification but requires temperature classification. Indicators are usually certified T5 or T6, which requires that a maximum input current [100mA], and voltage [30V] are specified.

Figure 3 illustrates a typical application of an 'nA' certified indicator and the following notes consider the majority of factors, which have to be taken into account when considering such a system.

Certified 'nA' 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 [Ex d, Ex e, Ex m, Ex p and Ex n] other than intrinsic safety. The essential difference in the principles of the method of protection used in intrinsic safety from that used in the other methods of protection prevent the use of 'nA' instruments in intrinsically safe circuits. Similarly, Intrinsically safe instruments cannot be readily used with equipment using other methods of protection.

Reference 2, provides a detailed explanation of how certified 'nA' indicators may be used to display the output from hazardous area instrumentation protected by other techniques, such as flameproof and increased safety.

Maintenance

Indicators are usually mounted in readily accessible places in Zone 2 for operational reasons. This combined with the fact that the indicators usually have separate terminal compartments makes this a convenient point to fault find. Intrinsically safe circuits permit any action to assist fault finding and the removal of equipment without isolation. Other types of circuit 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 voltage with an intrinsically safe meter is acceptable but disconnecting wiring is not. The use of switch-fused terminals in the circuits using 'nA' indicators enables them to be isolated when maintenance requires it. This is important since 'gas clearance' certificates are difficult to obtain when the hazardous area equipment is dispersed.

Conclusion

The use of certified 'nA' indicators to provide digital indication of 4-20mA signals derived from hazardous area equipment using a method of protection other than intrinsic safety, together with the more common intrinsically safe solution, means that an acceptable solution to all such requirements exists.

Epilogue

The IEC intend to convert the 'Ex nA' requirements into 'Ex ec' requirements for no very good reason. Fortunately it will probably take another four years, which should give time to organise a smooth changeover. Since it is not anticipated that there will be any significant changes in requirements this changeover should not be too difficult. However it is possible that the light current aspects will tend to be neglected in favour of the more economically significant heavy current applications. If the changeover follows the pattern of the 'nL' to 'ic' changeover then the problem will be the ATEX requirements rather than IEC Ex requirements. Clear guidance of the acceptability of both methods of protection during the changeover period to end users and manufacturers at an early date would make all the difference.

References

1 BEKA associates Application Guide AG300 Intrinsically safe loop powered indicators.

2 BEKA associates Application Guide AG310 Installation of [extra low voltage d.c.] Ex nA instrumentation.

These references and also the Ex certification of the indicators can be downloaded from the website www beka.co.uk

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This article was written by Chris Towle who has many years experience working with hazardous area instrumentation. His involvement in standards began in 1961 on the intrinsic safety committee of BSI and was followed shortly after by joining the main and code of practice committees. From 1970 he became involved in both IEC and CENLEC intrinsic safety committees and was secretary of both for a fifteen year period. He is still actively involved in all three organisations.

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