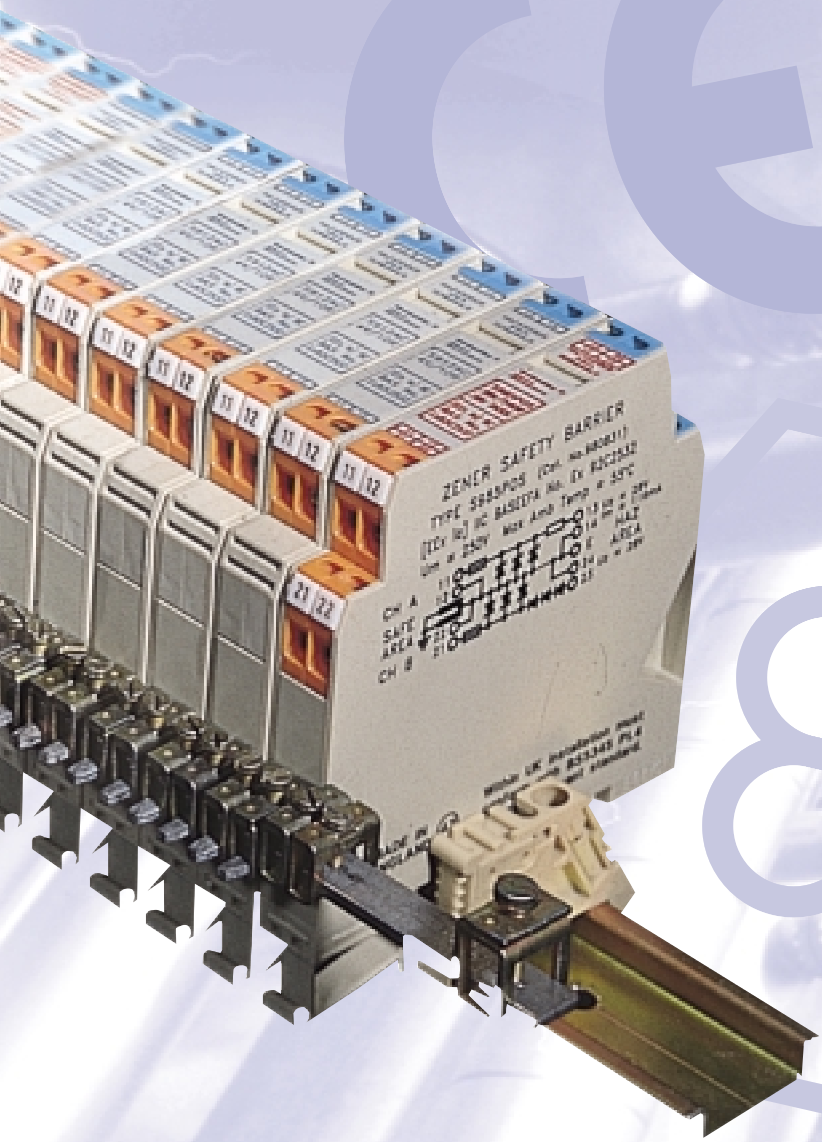
RTK

Intrinsic Safety Technical Paper



Zener Barriers or Isolation Interfaces?

RTKtec 103

Introduction

Engineers planning an instrumentation and control system for an hazardous area installation will often need to make a choice at the outset, whether to incorporate zener barriers or isolation interfaces, or both.

Types of Interface

While we speak of the two types of interface as though they are quite different entities, in fact the isolator (or galvanic or active barrier) contains all the elements of the zener barrier plus additional circuits to isolate the hazardous area circuit from the safe area circuit.

The introduction of this isolation between the safe and hazardous area circuits brings with it a number of advantages and disadvantages which need to be understood before a responsible choice may be made.

Earthing requirements

Perhaps the most important advantage of the isolator lies in the fact that, unlike the zener barrier, an earth connection is not required. Engineers familiar with conventional barriers will all appreciate that the provision of a secure earth path is essential, and probably some promoters of the isolation techniques have over-emphasised difficulties in making this earth connection. In fact, although instances do exist, it is seldom the case that a satisfactory earthing system cannot be found when the nature of the earthing requirement is clearly understood.

Of course, in the instances such as localised installations of only a few interfaces, where the provision of an earthing system can be very expensive, the isolation interface will realise benefits in simplicity and economy of installation.

Advice concerning earthing arrangements for zener barriers is contained in RTKtec 102 “The Earthing of Zener Barrier Installations”.

Insulation requirements

To avoid the presence of uncontrolled earth loop or earth invasion currents in zener barrier circuits, the hazardous area circuit may be grounded at one point only, namely; at the barrier location. To ensure that a second earth connection is not present, it is a requirement that barrier-protected circuits are able to withstand an insulation test at 500 volts to earth without breakdown.

It follows that, because the isolation interface has no earth connection at the hazardous area terminals, an earth connection in the hazardous area cannot give rise to spurious currents, and there is therefore no need to ensure insulation. This feature is especially useful in installations where an insulation test is impractical, for example with earthed thermocouples or with conductivity level probes.

Furthermore, if a preventive maintenance programme involving the testing of all intrinsically safe loops is a routine during plant shutdowns, then the time spent in insulation testing may be saved where isolators are installed.

Discharge path

Where isolators are used, it should be realised that because the field conductors are earth-free some precaution must be taken to avoid the risk of cable cores charging to uncontrolled potentials, so acquiring stored capacitive energy which may be incendive.

The deliberate earthing of one of the field lines (at any point) will eliminate this risk. Alternatively a resistive discharge path may be provided (see RTKtec 109, “Protecting the IS system from outside influences”.)

EN 60019-14:1997, para 12.2.4, includes the following:-

> *“In intrinsically safe circuits which are isolated from earth, attention shall be paid to the danger of electrostatic charging. A connection to earth across a resistance of between 0.2M ohm and 1M ohm, for example for dissipation of electrostatic charges, is not deemed to be earthing.”*

Zone 0 installations

Much has been said in recent times about a proposal, stemming from Germany, to permit only isolation interfaces for circuits entering Zone 0.

While that nation may have its own reasons for following that course, it seems unlikely that any such stipulation would be universally adopted. Certainly, by definition, a circuit protected by an [EExia] zener barrier is safe to enter Zone 0.

EN 60079-14:1997, para 12.3, includes the following:-

> *"In installations with intrinsically safe circuits for zone 0 the intrinsically safe apparatus and the associated apparatus shall comply with IEC79-11, category "ia". Associated apparatus with galvanic isolation between the intrinsically safe and non-intrinsically safe circuits is preferred."*

Supply voltage tolerance

In general, instrumentation and control systems are energised by a bulk regulated power supply at 24 volts dc to a reasonably close tolerance. However, in some instances, it is necessary to include for a battery back-up, either as a permanent float or on a standby changeover arrangement, in which case a wide variation of supply voltage has to be tolerated.

The design of isolation interfaces invariably allows for a varying supply voltage, while if zener barriers are used some loops might need additional voltage limiting components to avoid damage to barriers caused by application of overvoltage.

Another example where 24 Volt supplies of poor stability are encountered is in shipboard installations. Not only do these systems involve voltage variations, but also they are usually earth free, which means that there is a risk that zener barriers could be damaged by safe area earth faults. Isolation interfaces will tolerate both of these conditions.

A small number of isolators are also available for operation direct from an AC mains supply which is convenient for some small installations, eliminating the need for a separate 24V dc power supply unit.

Power requirements

The power requirements of zener barrier protected loops are very low, there being no additional power fed to the barrier which is entirely a passive device.

In marked contrast, the isolators require a supply of power to operate their internal electronic circuits. It is not unusual for the power requirement of an isolator-protected installation to be as much as five times that of the equivalent complement of barrier-protected loops, requiring very much larger power supply capacities.

Dissipation

As a consequence, while the zener barrier only dissipates a power equivalent to the product of the field loop current and the barrier voltdrop, typically not exceeding a quarter watt under normal working conditions, it will not be unusual for an isolation interface to dissipate 2 watts or more.

This factor needs to be taken into account when designing cubicles to house a large number of interfaces, in some instances spaces may need to be left in arrays of high-dissipation units and special ventilation arrangements may need to be provided to avoid excessive local temperature rise.

Application flexibility

A striking difference between the two styles of intrinsically safe interfaces is that while the zener barrier is an universal device, one model perhaps being suitable for a number of completely different types of field loop, the isolation interface needs to be specially designed for application to only one, or a small number, of duties.

Furthermore, despite the very high level of innovation and design expertise which is evident within the extensive range of available isolation interfaces, there may remain a small number of applications for which a convenient isolation interface solution is not available.

Accuracy

In analogue instrumentation loops, any errors introduced between the currents flowing in the safe area and hazardous area circuits can be detrimental to the overall performance of the system. While the errors introduced by analogue isolation repeaters are usually very small, such errors can be non-existent when zener barriers are used.

Response

The frequency response of the zener barrier is limited only by the self-capacitance of the zener diodes and therefore, in practical cases, barriers do not restrict the passage of high frequency signals. High frequency performance of isolators is more difficult to achieve although, of course, an isolator designed for a specific application can be expected to have a sufficient response. When using electronic-output isolators with NAMUR proximity switches to follow high-speed pulse signals, the response of both the proximity switch and the interface will need to be checked.

Reliability and security

The zener barrier and isolation interface each can have totally differing influences on the operational reliability of an instrumentation and control system. The extreme simplicity of the zener barrier leads to unsurpassed long term reliability compared with the necessarily much more complex isolation interface counterpart but the continued correct operation of an isolated loop in the presence of an earth fault can be an advantage or disadvantage according to the nature of the installation.

A vital function of any installation is its ability to respond correctly to alarm or emergency signals from the field. In this connection, the relative merits of the zener barrier and the isolation interface may need careful consideration. It is outside the scope of this discussion to detail the possible faults which can lead to serious insecurity except to say that the presence and location of earth faults on a zener barrier alarm system are usually self-evident, whereas an isolated system often needs additional earth fault monitoring provisions which are not always easy to apply.

Cost and space

These two factors are an important consideration in the planning of any installation. It is often, but by no means always, the case that the zener barrier installation for a given plant requirement will be less demanding on cost and space than the isolation interface solution, and this factor will play a part when a choice is made.

Of course, a realistic spares holding for an isolation installation will be generally more extensive and costly.

Summary

FEATURE	*ZENER BARRIER*	*ISOLATION INTERFACE*
Earth connection	Essential	Not required
Insulation test	Must be able to withstand 500V	Not required
Zone 0 application	No problem	Some user preference
Tolerance of varying supply	Poor	Very good
Power requirements	Low	High
Heat dissipation	Low	High
Application flexibility	Very flexible	Not flexible
Analogue errors	Usually none	Some error introduced
Frequency response	Excellent	To suit application
Reliability	Exceptionally good	More liable to failure
Cost	Usually less	Usually more

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