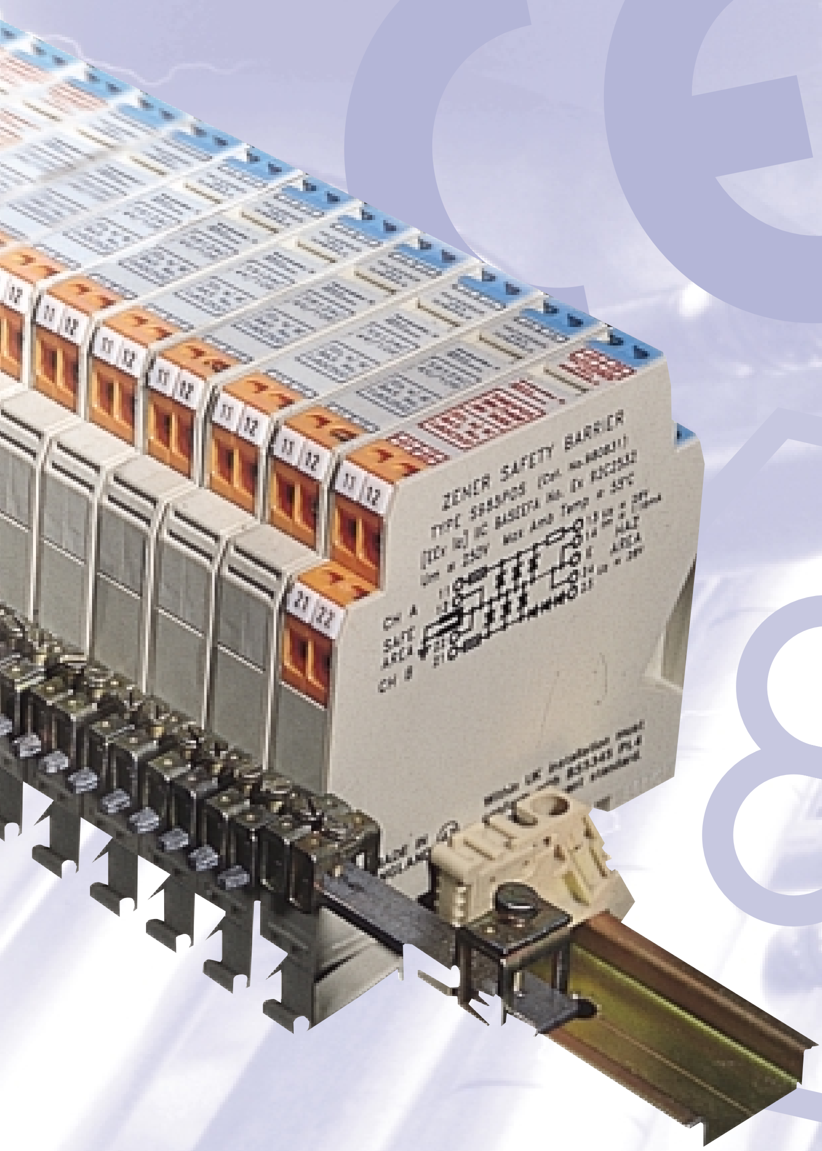
RTK

Intrinsic Safety Technical Paper



The earthing of Zener Barrier installations

Permission to illustrate this Note with extracts from the following publications is gratefully acknowledged:

EN 60079-14

It is recommended that the quoted Standard is studied in more detail so that extracts are understood in context.

RTKtec 102

Introduction

The earthing or grounding of zener barrier installations in intrinsically safe instrumentation and control systems is a common source of concern to installation engineers.

The underlying concern breeds the suspicion that satisfactory earthing is difficult or troublesome to provide, a suspicion which in fact is often unfounded. It is therefore helpful firstly to have a clear understanding of what the earthing seeks to achieve, and secondly to know how to carry it out with confidence.

Barrier earth requirement

The zener barrier, standing alone, controls with certainty the maximum values of voltage and current available between its output terminals which will be connected to the hazardous area circuit. However, without a further connection, it cannot control the potential which may occur between either of its output terminals and local earth in the hazardous area.

As accidental earth faults in the hazardous area are considered liable to occur, then this further earth connection is an essential ingredient in ensuring that the system is in fact intrinsically safe.

Code of Practice

EN 60079-14:1992 tells us that the barrier earth terminals should be connected to a high-integrity earth point which will ensure a path of not more than 1ohm to the main power system earth point.

It is perhaps unfortunate that for many years the expression “main power system earth point” has been taken to mean the point at which the electricity supply company makes the earth connection to its substation transformer neutral. Many diagrams which show the barrier earth connected back to this point may have been misleading – especially as not all power systems have an earthed neutral point.

The “main power system earth point” should be understood to mean the earth point to which all the electrical (and often structural) earth connections are made (directly or indirectly) from the hazardous area to be protected.

EN 60079-14 clarifies that the use of the power supply earth point above applies to TN-S systems only (separate neutral and earth conductors in the hazardous area), i.e. not TN-C systems in which both earthing and neutral power return share the same conductor, nor IT systems in which the supply neutral is not directly earthed.

EN 60079-14 gives the useful alternative instruction that the barrier earth terminals shall be connected to the equipotential bonding system by the shortest practicable route. This alternative earthing method is not affected by the style of power supply system, nor is the limiting maximum path resistance of 1 ohm stated. This means that in almost all cases a suitable earthing point can be found without any difficulty.

Practical earth connection

For the earth connection which is related to the main power system earth point both the standards give the same advice, in suggesting a connection to the earth bar which may be found in a local switch room or by the use of separate earth rods. While the use of the switch room earth busbar is usually a good choice, in a practical situation it is often very difficult to ensure that a path resistance of less than 1 ohm can be relied upon by the use of separate earth rods and we strongly recommend that providing a barrier earth in this way is avoided wherever possible.

If we are to follow the alternative method of making a connection to the equipotential bonding system independently of the power supply earth, this too will be equally satisfactory and can be relied upon to achieve the desired result of making sure that the barriers are earthed to the same earth potential which is found in the hazardous area to be protected.

In some countries, especially Germany, it is the normal practice to provide an equipotential plane in the form of an electrically conducting mesh underneath the whole site before the plant is erected. This mesh forms the equipotential bonding system, a connection down to which will provide ideal conditions for furnishing the necessary earth connection to zener barriers. Even if such special provision is not made, then the common grounding of the metal enclosures of plant equipment, motors, luminaires, switchgear and structural components of the building will together usually constitute an equipotential bonding system suitable for the connection of zener safety barriers.

In the final analysis, both systems, whether or not directly related to the electrical main power system earth point, may in fact be indistinguishable and illustrate that a suitable earth connection point for zener barriers is usually easy to find.

Making the earth connection

The connection between the zener barrier earth busbar and the chosen earthing point needs to be made by at least one conductor having a cross section of not less than $4mm^2$ copper. However, it is usual both for purposes of reliability and to facilitate testing, that at least two separate conductors between the barrier earth busbar and the chosen earthing point are provided. In this case each shall have minimum cross section of $1.5mm^2$ copper, and it is usual to run these conductors along different routes where possible. Each conductor should have individual terminations at each end so that any one path is completely independent of any defects which may occur in the continuity of other path(s) in the earthing system.

To prevent the possibility of unrelated fault currents being passed down the barrier earth conductor(s), these conductors shall be installed for zener barrier earthing purposes alone, and shall not be used for earth connections of any other unrelated plant or equipment.

Cable installations

Instrumentation cables commonly incorporate earthed screens or shields to reduce noise on long cable runs. Where these screens are covered by an insulating sheath, as is the usual cable construction, then the screen is connected to the barrier earth terminal or busbar in the safe area barrier enclosure.

These cable screens must be kept isolated from earth in the hazardous area to avoid spurious earth currents being fed back into the barrier earthing system. Of course, if intermediate junction boxes are installed, they will include insulated terminals for the ongoing continuity of cable screens.

Where the field cables are armoured, or are of the mineral-insulated metal-sheathed type, then their armour or sheath is assumed to have contact with earth in the hazardous area, either by their fixings or brass glands, or by deliberate connection. In these cases the armour or sheath must not be connected to barrier earth.

Special cases

There are occasions where the installing engineer might reasonably conceive of an alternative earthing arrangement which will provide for a safe situation, particularly where the hazardous area is confined to only a very small part of the plant.

Such a situation might involve a paint spray booth within a site which is otherwise non-hazardous. Intrinsically safe instrumentation or control circuits within the booth would be protected by barriers mounted in the control panel immediately outside. In such a situation, if the metal structure of the booth and the items of plant and equipment within the booth are all adequately earth bonded together then this earth bonding could be extended to include the barrier earth connection and so provide a safe situation in which the intrinsically safe circuits are closely related to the local earth potential within the paint spraying confines.

Figure 1

Traditional representation of barrier earthing. The connection of the barrier earth conductor to the same earth point as is used for the electricity supply transformer neutral is usually impractical. In any case, efforts to physically reach this point often do not make an ideal barrier earth connection.

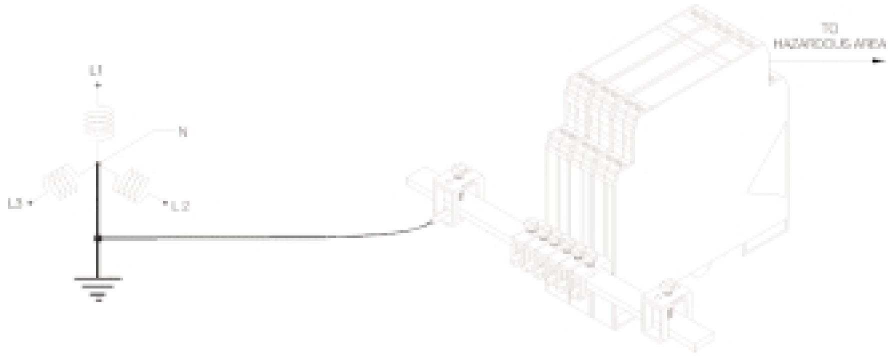


Figure 2

Separate earth rods are permitted, but there remains the need to maintain less than one ohm (R1 + R2) to the main power system earth which can be difficult to ensure. Also, as this diagram shows, it can be possible for earth fault currents in the power system to cause unwanted voltages to appear at the barrier earth.

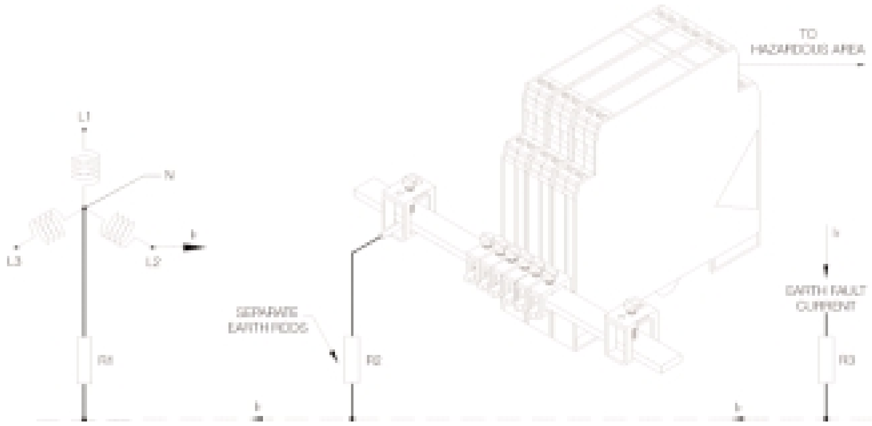


Figure 3

An equipotential bonding system comprising an underground network of earth conductors, where available, forms an ideal method of finding a local point to which the barrier earth connection may be made.

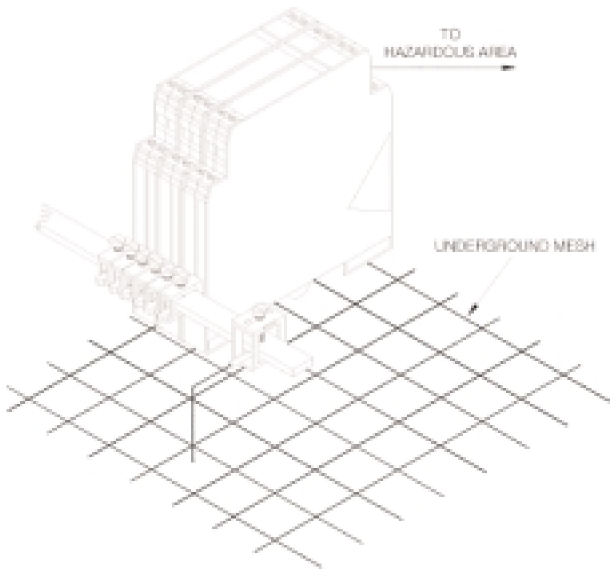
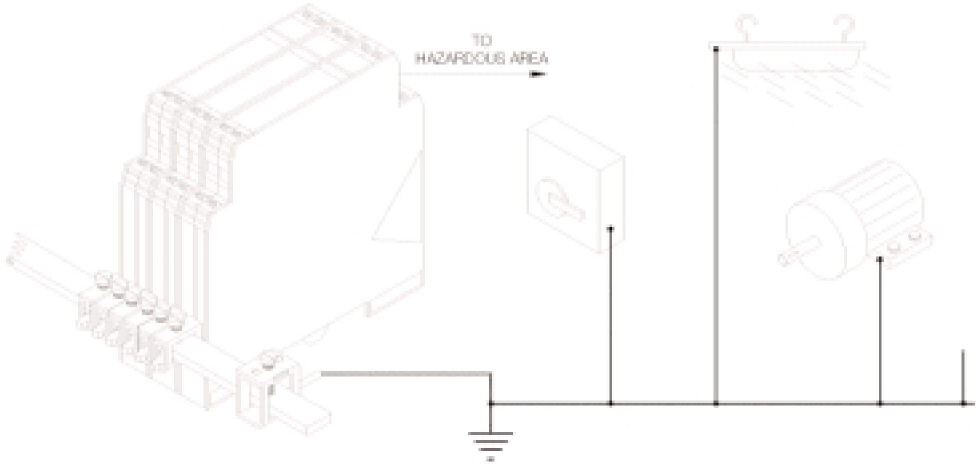


Figure 4

In other cases, it is usually easy to find a “main power system” earth point, the earth bar in a local switch room is often used. Otherwise, especially where the hazardous area is a small part of a larger non-hazardous installation, a local bonding together of electrical metal casings, housings and enclosures, with pipework, machinery and structural steel as appropriate will make a good equipotential bonding system for the purpose.



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