

Electrical apparatus for explosive gas atmospheres —

Part 25: Intrinsically safe systems

The European Standard EN 60079-25:2004 has the status of a British Standard

ICS 29.260.20

National foreword

This British Standard is the official English language version of EN 60079-25:2004, incorporating Corrigendum April 2006. It is identical with IEC60079-25:2003.It supersedes BS 5501-9:1982 which remains current as obsolescent but will be withdrawn no later than 1 July 2006.

The UK participation in its preparation was entrusted by Technical Committee GEL/31, Electrical apparatus for explosive gas atmospheres, to Subcommittee GEL/31/13, Intrinsically safe apparatus which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Electrical apparatus for explosive gas atmospheres
Part 25: Intrinsically safe systems
(IEC 60079-25:2003)

Matériel électrique pour atmosphères
explosives gazeuses
Partie 25: Systèmes de sécurité
intrinsèque
(CEI 60079-25:2003)

Elektrische Betriebsmittel für
gasexplosionsgefährdete Bereiche
Teil 25: Eigensichere Systeme
(IEC 60079-25:2003)

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CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 31G/115/FDIS, future edition 1 of IEC 60079-25, prepared by SC 31G, Intrinsically-safe apparatus, of IEC TC 31, Electrical apparatus for explosive atmospheres, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60079-25 on 2003-12-02.

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The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2006-12-01

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Annexes ZA and ZZ have been added by CENELEC.

The contents of the corrigendum of April 2006 have been included in this copy.

Endorsement notice

The text of the International Standard IEC 60079-25:2003 was approved by CENELEC as a European Standard without any modification.

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ELECTRICAL APPARATUS FOR EXPLOSIVE GAS ATMOSPHERES –

Part 25: Intrinsically safe systems

1 Scope

1.1 This part of IEC 60079 contains the specific requirements for construction and assessment of intrinsically safe electrical systems, type of protection “i”, intended for use, as a whole or in part, in explosive atmospheres in Group II locations. This standard is intended for use by the designer of the system who may be a manufacturer, a specialist consultant or a member of the end-user’s staff.

1.2 This standard supplements IEC 60079-11, the requirements of which apply to electrical apparatus used in intrinsically safe electrical systems.

1.3 The installation requirements of a Group II system designed in accordance with this standard are specified in IEC 60079-14.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60079-0, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-11:1999, *Electrical apparatus for explosive gas atmospheres – Part 11: Intrinsic safety “i”*

IEC 60079-14:2002, *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installations in hazardous areas (other than mines)*

3 Definitions

For the purposes of this document, the following definitions, specific to intrinsically safe electrical systems, apply. They supplement the definitions which are given in IEC 60079-0 and IEC 60079-11.

3.1

intrinsically safe electrical system

assembly of interconnected items of electrical apparatus, described in a descriptive system document, in which the circuits or parts of circuits, intended to be used in an explosive atmosphere, are intrinsically safe circuits

3.1.1**certified intrinsically safe electrical system**

electrical system conforming to 3.1 for which a certificate has been issued confirming that the electrical system complies with this standard

3.1.2**uncertified intrinsically safe electrical system**

electrical system conforming to 3.1 for which the knowledge of the electrical parameters of the items of certified intrinsically safe electrical apparatus, certified associated apparatus, simple apparatus and the knowledge of the electrical and physical parameters of the interconnecting wiring permit the unambiguous deduction that intrinsic safety is preserved

3.2**descriptive system document**

document in which the items of electrical apparatus, their electrical parameters and those of the interconnecting wiring are specified

3.3**system designer**

person who is responsible for the descriptive system document, has the necessary competence to fulfil the task and who is empowered to enter into the commitments on behalf of his employer

3.4**maximum cable capacitance (C_c)**

maximum capacitance of the interconnecting cable that can be connected into an intrinsically safe circuit without invalidating intrinsic safety

3.5**maximum cable inductance (L_c)**

maximum inductance of the interconnecting cable that can be connected into an intrinsically safe circuit without invalidating intrinsic safety

3.6**maximum cable inductance to resistance ratio (L_c/R_c)**

maximum value of the ratio inductance (L_c) to resistance (R_c) of the interconnecting cable that can be connected into an intrinsically safe circuit without invalidating intrinsic safety

3.7**linear power supply**

power source from which the available output current is determined by a resistor. The output voltage decreases linearly as the output current increases

3.8**non-linear power supply**

power supply where the output voltage and output current have a non-linear relationship

EXAMPLE A supply with a constant voltage output up to a constant current limit controlled by semiconductors.

4 Descriptive system document

A descriptive system document shall be created for all systems. The descriptive system document shall provide an adequate analysis of the level of safety achieved by the system.

Annex E comprises examples of typical diagrams, which illustrate the requirements of the descriptive system document.

The minimum requirements are as follows:

- a) block diagram of the system listing all the items of apparatus within the system;
- b) a statement of the group subdivision, temperature classification, category and ambient temperature rating in accordance with Clauses 5, 6 and 7;
- c) the requirements and permitted parameters of the interconnecting wiring in accordance with Clause 8;
- d) details of the earthing and bonding points of the systems in accordance with Clause 9. When surge protection devices are used, an analysis in accordance with Clause 10 shall also be included;
- e) where applicable the justification of the assessment of apparatus as 'simple apparatus' in accordance with IEC 60079-11 shall be included. In particular, where several pieces of simple apparatus are included, the analysis of the summation of their parameters shall be available;
- f) a unique identification of the descriptive system document shall be created;
- g) the system designer shall sign and date the document.

5 Grouping and classification

Intrinsically safe electrical systems shall be placed in Group II as defined in IEC 60079-0. The system as a whole or parts thereof shall be given a further subdivision of the classification as appropriate.

Apparatus within a Group II intrinsically safe system, intended for use in explosive atmospheres, shall be given a surface temperature class in accordance with IEC 60079-0 and IEC 60079-11.

NOTE 1 In Group II intrinsically safe electrical systems, or parts thereof, the subdivisions A, B, C may be different from those of the particular intrinsically safe electrical apparatus and associated electrical apparatus included in the system.

NOTE 2 Different parts of the same intrinsically safe electrical system may have different subdivisions (A, B, C). The apparatus used may have different surface temperature classes and different ambient temperature ratings.

6 System categories

6.1 General

Each part of an intrinsically safe electrical system intended for use in a explosive atmosphere shall be placed in a category either "ia" or "ib" in accordance with IEC 60079-11. The complete system need not necessarily be placed in a single category.

The descriptive system document shall specify the category of the system or, where necessary, the category of different parts of the system.

NOTE For example, where an instrument is primarily an "ib" instrument but which is designed for the connection of an "ia" sensor, such as a pH measuring instrument with its connected probe, the part of the system up to the instrument is "ib" and the sensor and its connections "ia".

Clause 11 contains details of the required assessment.

6.2 Category “ia”

Where the requirements applicable to electrical apparatus of category “ia” (see 5.2 of IEC 60079-11) are satisfied by an intrinsically safe system or part of a system considered as an entity, then that system or part of a system shall be placed in category “ia”.

6.3 Category “ib”

Where the requirements applicable to electrical apparatus of category “ib” (see 5.3 of IEC 60079-11) are satisfied by an intrinsically safe system or part of a system considered as an entity, then that system or part of a system shall be placed in category “ib”.

7 Ambient temperature rating

Where part or all the intrinsically safe system is specified as being suitable for operation outside the normal operating temperature range of $-20\text{ }^{\circ}\text{C}$ and $+40\text{ }^{\circ}\text{C}$, this shall be specified in the descriptive system document.

8 Field wiring

The electrical parameters of the interconnecting wiring upon which intrinsic safety depends and their derivation shall be specified in the descriptive system document. Alternatively, a specific type of cable shall be specified and the justification for its use included in the documentation. Where a specific type of cable is specified, then it shall comply with the relevant requirements of IEC 60079-14.

Where relevant, the descriptive system document shall also specify the permissible types of multicore cables as specified in IEC 60079-14, which each particular circuit may utilize. In the particular case where faults between separate circuits have not been taken into account, then a note shall be included on the block diagram of the descriptive system document stating the following: “where the interconnecting cable utilizes part of a multicore containing other intrinsically safe circuits, then the multicore must be in accordance with the requirements of a multicore type A or B as specified in IEC 60079-14”.

9 Earthing and bonding of intrinsically safe systems

In general, an intrinsically safe circuit shall either be fully floating or bonded to the reference potential associated with the hazardous area at one point only. The level of isolation required (except at one point) is to be designed to withstand a 500 V insulation test in accordance with 6.4.12 of IEC 60079-11. Where this requirement is not met, then the circuit shall be considered to be earthed at that point. More than one earth connection is permitted on a circuit, provided that the circuit is galvanically separated into sub-circuits, each of which has only one earth point.

Screens shall be connected to earth or the structure in accordance with IEC 60079-14. Where a system is intended for use in an installation where significant potential differences (greater than 10 V) between the structure and the circuit can occur, the preferred technique is to use a circuit galvanically isolated from external influences such as changes in ground potential at some distance from the structure. Particular care is required where part of the system is intended to be used in a zone 0 location.

The descriptive system document should clearly indicate which point or points of the system are intended to be connected to the plant reference potential and any special requirements of such a bond. This may be achieved by cross-references to IEC 60079-14. The point or points at which the intrinsically safe system is connected to the plant shall be determined in accordance with IEC 60079-14.

10 Protection against lightning and other electrical surges

Where a risk analysis shows that an installation is particularly susceptible to lightning or other surges, precautions shall be taken to avoid the possible hazards.

If part of an intrinsically safe circuit is installed in a zone 0 in such a way that there is a risk of developing hazardous or damaging potential differences within the zone 0, a surge protection device shall be installed. Surge protection is required between each conductor of the cable including the screen and the structure where the conductor is not already bonded to the structure. The surge protection device shall be installed outside but as near to the boundary of zone 0 as is practicable, preferably within 1 m.

Surge protection for apparatus in zones 1 and 2 shall be included in the system design for highly susceptible locations.

The surge protection device shall be capable of diverting a minimum peak discharge current of 10 kA (8/20 μ s impulse according to IEC 60060-1 for 10 operations). The connection between the protection device and the local structure shall have a minimum cross-sectional area equivalent to 4 mm² copper. The cable between the intrinsically safe apparatus in zone 0 and the surge protection device shall be installed in such a way that it is protected from lightning. Any surge protection device introduced into an intrinsically safe circuit shall be suitably explosion protected for its intended location.

The use of surge protection devices which interconnect the circuit and the structure via non-linear devices such as gas discharge tubes and semiconductors is not considered to adversely affect the intrinsic safety of a circuit, provided that in normal operation the current through the device is less than 10 μ A.

NOTE If insulation testing at 500 V is carried out under well-controlled conditions, then it may be necessary to disconnect the surge suppression devices to prevent them invalidating the measurement.

Intrinsically safe systems utilizing surge suppression techniques must be supported by an adequately documented analysis of the effect of indirect multiple earthing, taking into account the criteria set out above. The capacitance and inductance of the surge suppression devices shall be considered in the assessment of the intrinsically safe system.

Annex F illustrates some aspects of the design of surge protection of an intrinsically safe system.

11 Assessment of an intrinsically safe system

11.1 General

Where a system contains apparatus which does not separately conform to IEC 60079-11, then that system shall be analysed as a whole. The system shall be analysed as if it were an apparatus. A category “ia” system shall be analysed in accordance with the criteria of 5.2 of IEC 60079-11. A category “ib” system shall be analysed in accordance with the criteria of 5.3 of IEC 60079-11. In addition to the faults within the apparatus, the failures within the field wiring listed in 11.3 shall also be taken into account.

NOTE 1 It is recognized that applying faults to the system as a whole is less stringent than applying faults to each piece of apparatus; nevertheless, this is considered to achieve an acceptable level of safety.

Where all the necessary information is available, it is permissible to apply the fault count to the system as a whole even when apparatus conforming to IEC 60079-11 is being used. This is an alternative solution to the more usual straightforward comparison of input and output characteristics of the separately analysed or tested apparatus. Where a system contains only separately analysed or tested apparatus conforming to IEC 60079-11, the compatibility of all the apparatus included in the system shall be demonstrated. Faults within the apparatus have already been considered and no further consideration of these faults is necessary. Where a system contains a single source of power, then the output parameters of the power source take into account the possible cable failures, and consequently these failures do not need to be further considered. Annex A contains further details of the analysis of these simple circuits.

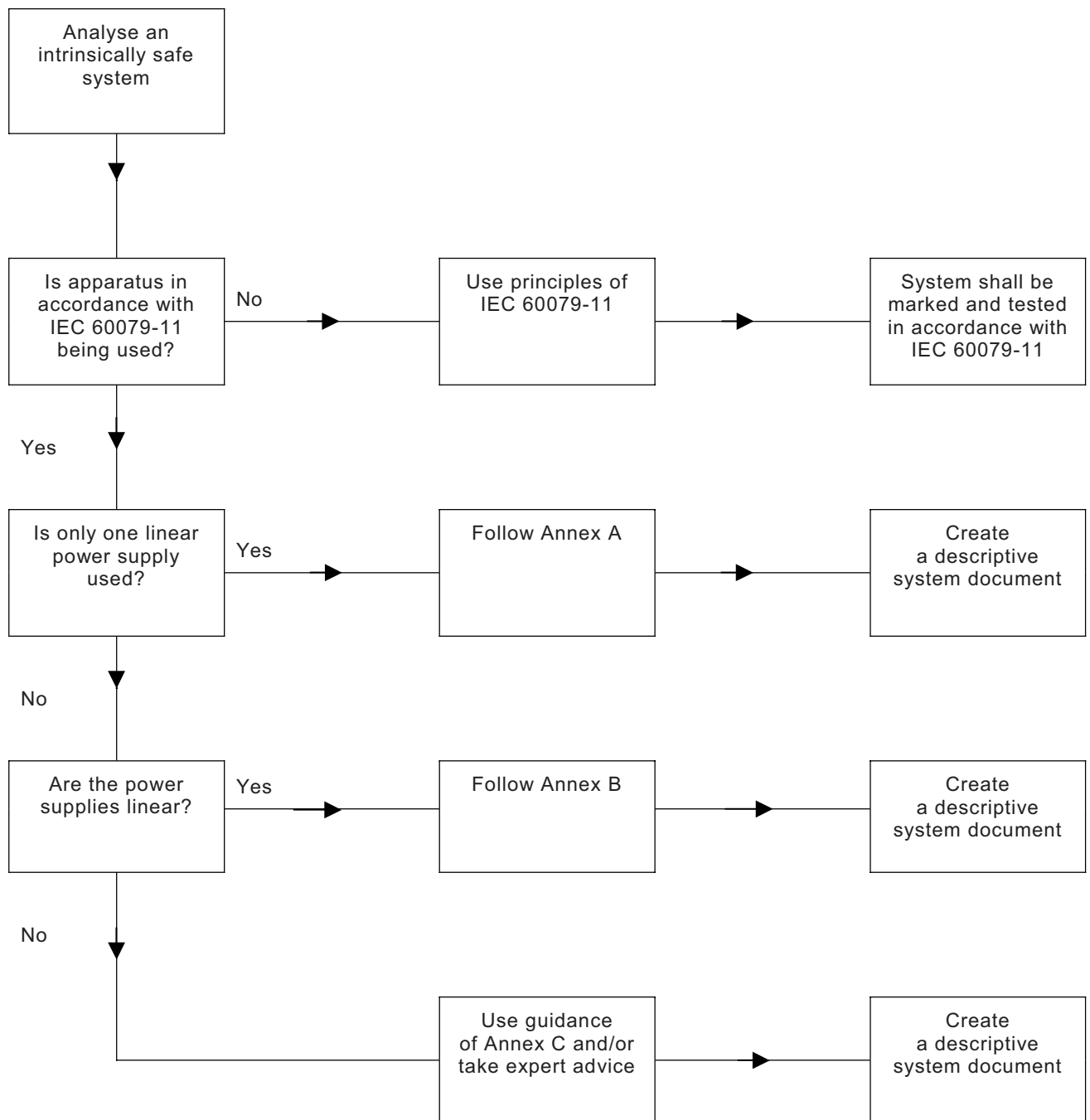
Where apparatus can possibly interconnect separate intrinsically safe circuits, for example, a resistance thermometer with two separate resistance windings, then the interconnected circuits shall be assessed as a single circuit.

When a system contains more than one linear source of power, then the effect of the combined sources of power shall be analysed. Annex B illustrates the analysis to be used in the most frequently occurring combinations.

If an intrinsically safe system contains more than one source of power, and one or more of these sources are non-linear, the assessment method described in Annex B cannot be used. For this kind of intrinsically safe system, Annex C explains how the system analysis can be done if the combination contains a single non-linear power supply.

NOTE 2 If further expert advice is required, it should be sought from a body such as an accepted certification body (ACB) under the IECEx scheme.

Figure 1 illustrates the principles of system analysis.



IEC 1950/03

Figure 1 – Systems analysis

11.2 Analysis of inductive circuits

Where an apparatus has a well-defined inductance and resistance either by virtue of its documentation or construction, then the safety of the inductive aspects of the system shall be confirmed by the process defined in Annex D.

11.3 Failures in field wiring

When designing a system which requires consideration of the failure of the field wiring, then the following failures shall be applied:

- a) open circuit of any number of field wiring conductors;
- b) short circuit between any numbers of field wiring conductors and screens;
- c) failure to the bonded structure or armour at any point. For the purposes of this analysis, the return path in the structure or armour shall be considered to have zero impedance and not to introduce any voltage or current into the circuit.

The acceptable parameters of the interconnecting cables shall be calculated using a factor of safety of 1,5 in accordance with 10.4.2 of IEC 60079-11.

11.4 Type verifications and type tests

Where it is necessary to carry out type verifications and/or type tests to establish that a system is adequately safe, then the methods specified in Clause 10 of IEC 60079-11 shall be used.

12 Marking

All apparatus within the system shall be readily identifiable. In the case of 'simple apparatus', a traceable plant identification label is acceptable.

The minimum requirement is that the relevant descriptive system document shall be readily traceable. One acceptable technique is a clear instrument loop number, which identifies the loop documentation, which in turn lists the descriptive system document.

If a system contains apparatus separately assessed or tested in accordance with IEC 60079-11, such apparatus retains its original marking.

Where a system is assessed as a whole and is found to conform to IEC 60079-11, then each piece of apparatus shall be marked in accordance with that standard.

Annex A (normative)

Assessment of a simple intrinsically safe system

This simple analysis is only applicable when the system considered uses only one source of power.

The process of determining the acceptability of the simple system, which is illustrated by the example of Figure A.1, shall be as follows:

- a) determine the category or group subdivision of the system by consideration of the information for the two individual pieces of certified apparatus. The system adopts the lowest common denominator of the two pieces of apparatus. Hence, if either piece of apparatus is "ib", then the system is "ib". The group subdivision is determined by the least sensitive group IIC, IIB, IIA in order of decreasing sensitivity. In the example illustrated by Figure A.1 the system becomes Ex ia IIC. It is permitted for different parts in the system to have different categorization and classification. In these circumstances, the descriptive system document should clearly define the separate parts of the circuit;
- b) check the voltage, current and power parameters as follows:

$$U_o \leq U_i$$

$$I_o \leq I_i$$

$$P_o \leq P_i$$

Where the effective input resistance of the intrinsically safe apparatus is specified, then the calculation of the permitted input current may include this parameter. In the example illustrated there is no problem;

- c) determine the temperature classification of the intrinsically safe apparatus, which may depend on the current or power parameters of the connected source;
- d) the maximum permitted cable capacitance $[C_c]$ is the permitted capacitance for the source of power $[C_o]$ less the effective input capacitance of the intrinsically safe apparatus $[C_i]$ that is $C_c = C_o - C_i$;
- e) the maximum permitted cable inductance $[L_c]$ is the permitted inductance for the source of power $[L_o]$ less the effective input inductance of the intrinsically safe apparatus $[L_i]$ that is $L_c = L_o - L_i$;
- f) where the power supply is a resistance limited linear source, then the permissible L_c/R_c ratio is determined in accordance with Annex D.

Some sources of power can be bi-directional, for example, shunt diode safety barriers intended for alternating current signals. In these circumstances, the effect of both polarity outputs shall be considered.

HAZARDOUS AREA		NON HAZARDOUS AREA	
Intrinsically safe apparatus	System	Associated apparatus	
Ex ia IIC T4	Ex ia IIC	[Ex ia} IIC	
		U_o	28 V
		I_o	93 mA
	Cable parameters	P_o	0,65 W
		L_o	3 mH
		L_c/R_c	54 μ H/ Ω
U_i		C_o	83 nF
I_i			
P_i			
L_i			
C_i			

IEC 1951/03

Figure A.1 – Interconnection of intrinsically safe apparatus with associated apparatus

Annex B (normative)

Assessment of circuits with more than one source of power

This analysis is only applicable when the power sources considered use a linear resistive limited output. It is not applicable to power sources using other forms of current limitation.

IEC 60079-14, Annex B, contains a simplified procedure, which gives conservative results, which ensure a safe installation and may be used as an alternative to this annex.

Where there is more than one source of power and the interconnections are made under controlled conditions so as to provide adequate segregation and mechanical stability in accordance with IEC 60079-11, then the interconnections are considered to fail to open and short circuit but not so as to reverse the connections or to change a series into a parallel connection or a parallel connection into a series one. Interconnections made within a rack or panel constructed in a location with adequate quality control and test facilities are an example of the degree of integrity required.

Figure B.1 illustrates the usual series combination. This series situation results in the open circuit voltage U_o being $U_1 + U_2$ but the possibility of the voltage being $U_1 - U_2$ is not considered. In considering the safety of the system, three voltages U_1 , U_2 and $U_o = U_1 + U_2$ are considered together with their corresponding currents I_1 and I_2 and the combined.

$$I_o = \frac{U_1 + U_2}{R_1 + R_2}$$

Each of the three equivalent circuits has to be assessed for safety using Table A.1 of IEC 60079-11. The value of L_o , L_o/R_o and C_o must then be established for each circuit and the most onerous value used together with its relevant equivalent circuit.

A factor of safety 1,5 shall be used in determining these values in all circumstances.

NOTE Where the two voltages add, the combined circuit will decide the capacitive figure. However, the inductance and the L_o/R_o ratio may be determined by one of the separate circuits being considered on its own. The minimum inductance does not always coincide with the maximum circuit current and the minimum L_o/R_o ratio may not be coincident with the minimum inductance.

The matched power available from each of the equivalent circuits should be determined. The matched power of the combined circuit is the sum of the power available from each circuit only when the sources have the same output current.

When the sources of power are connected in parallel as in Figure B.2, then the three currents I_1 , I_2 and $I_o = I_1 + I_2$ have to be considered with their corresponding voltages U_1 , U_2 and

$$U_o = \frac{U_1 R_2 + U_2 R_1}{R_1 + R_2}$$

Each of the three equivalent circuits has to be assessed for safety using Table A.1 of IEC 60079-11. The values L_o , L_o/R_o and C_o have to be established for each circuit and the most onerous value used together with its relevant equivalent circuit. The matched power available from each of the three equivalent circuits must also be established. The matched power of the combined circuit is the sum of the power available from each circuit only when the sources have the same output voltage.

Where two sources of power are connected to the same intrinsically safe circuit and their interconnections are not well defined by reliable interconnections as illustrated in Figure B.3, then there is a possibility that the sources of power can be connected in both series and parallel. In these circumstances, all the possible equivalent circuits have to be evaluated, following both the procedures set out. The most onerous output parameters and equivalent circuits have to be utilized in establishing the integrity of the intrinsically safe system.

The hazardous area apparatus may contain a source of power, which results in the apparatus having significant output parameters, for example from internal batteries. When this occurs, the analysis of the system shall include the combination of this source of power with any source of power in the associated apparatus. Such an analysis shall normally include the reversal of the interconnection because of the possible failure of the field wiring.

Having established the representative equivalent circuits, then these circuits can be used as if there was a single source of power, and the procedure already discussed in Annex A can be used to establish whether the system as a whole is acceptably safe.

When two or more sources of power with different output voltages are interconnected then the resultant circulating current can cause additional dissipation in the regulating circuits. Where the circuits have conventional resistive current limiting, then the additional dissipation is not considered to adversely affect intrinsic safety.

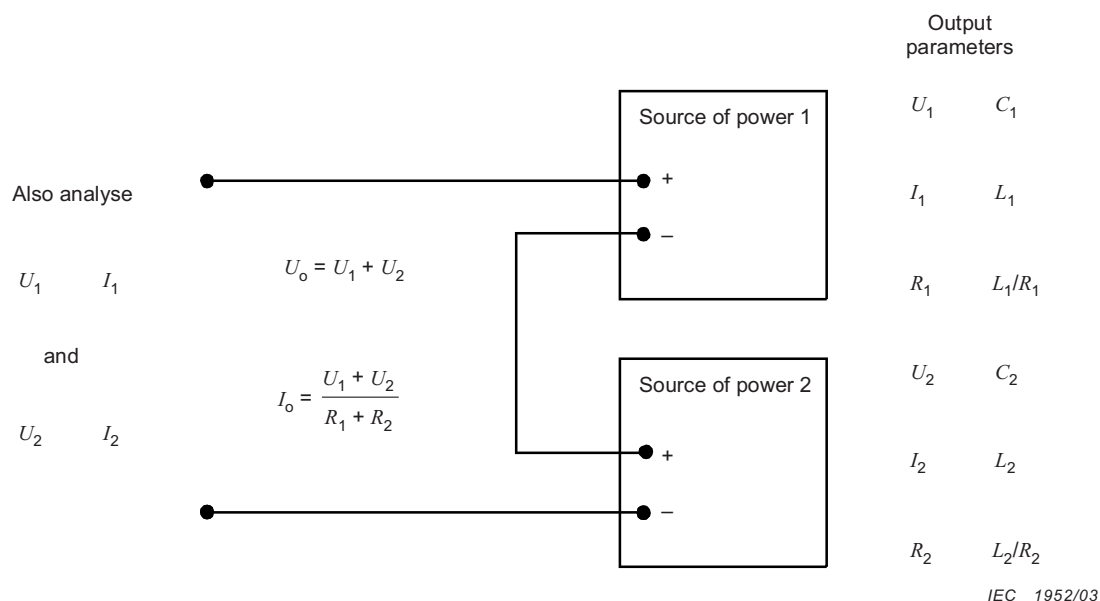


Figure B.1 – Sources of power connected in series

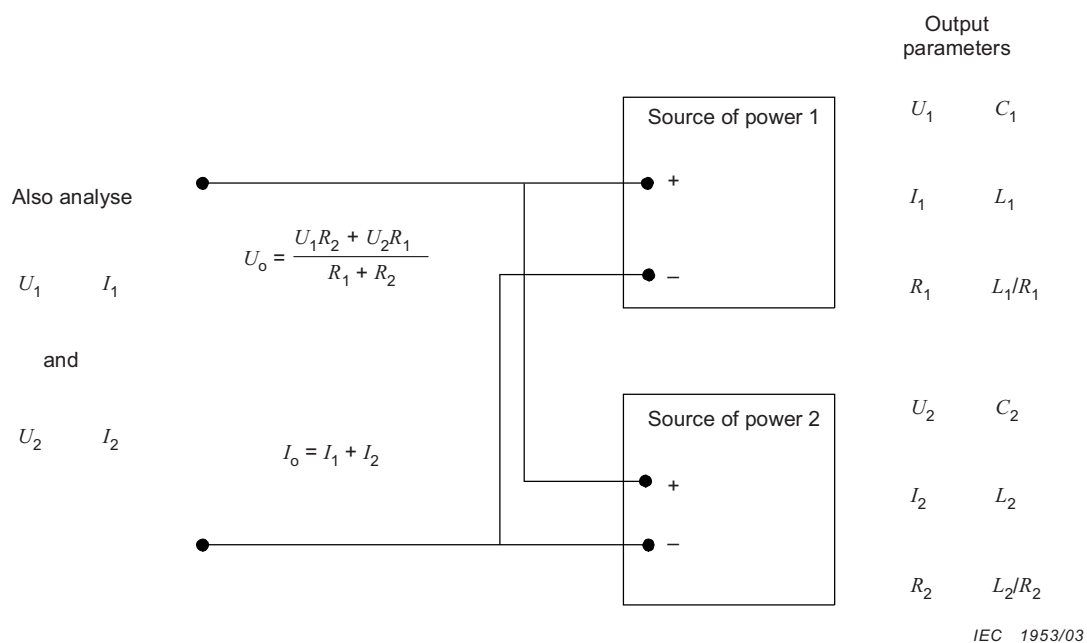


Figure B.2 – Sources of power connected in parallel

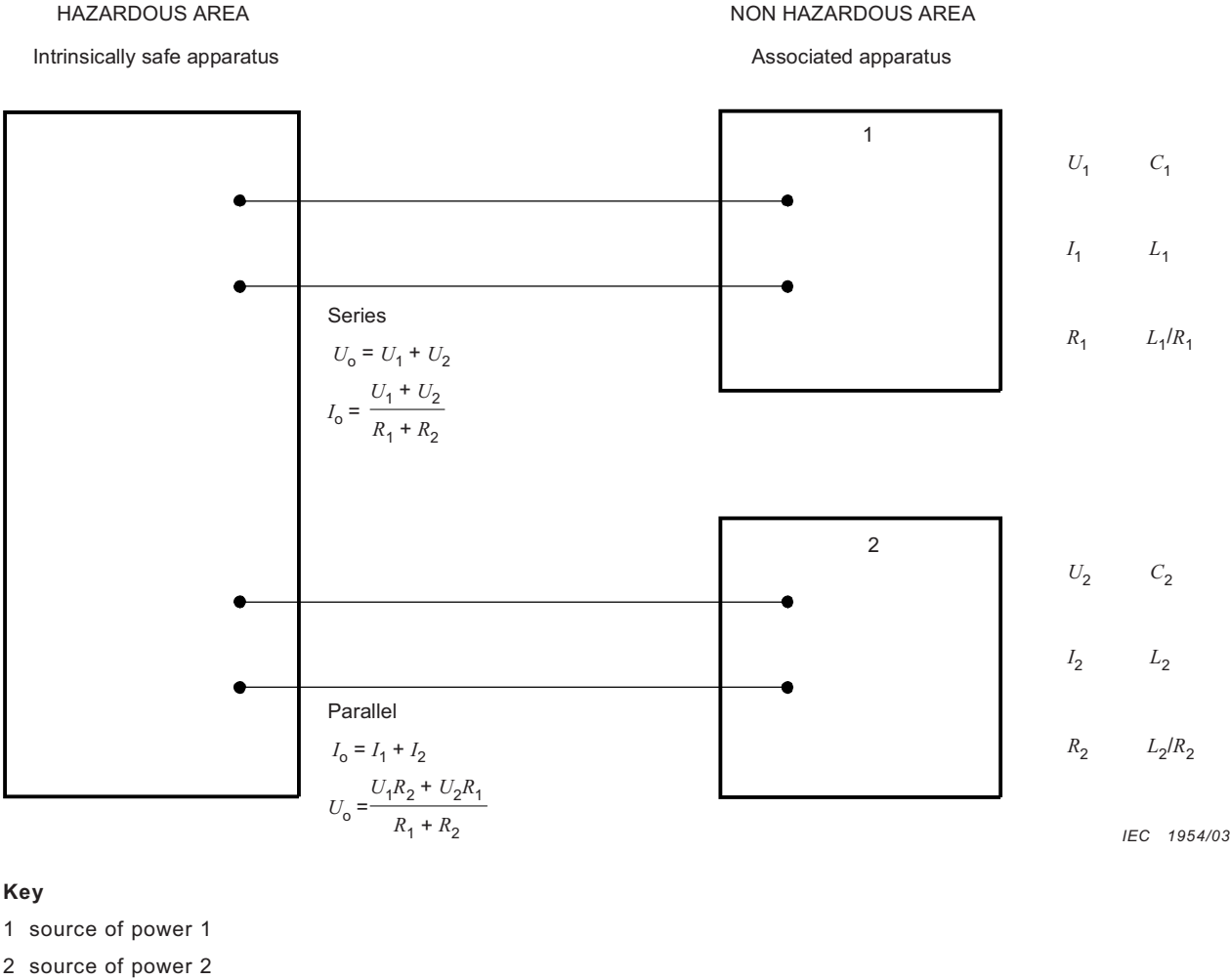


Figure B.3 – Sources of power not deliberately connected

Annex C (informative)

Interconnection of non-linear and linear intrinsically safe circuits

This subject has been under active consideration for some considerable time and is still developing. This document is the considered opinion of a major test house and has been extensively reviewed. It is the best knowledge currently available and is included so that wider experience of its use can be obtained.

The design and application of non-linear power supplies does require specialist knowledge and access to appropriate test facilities. Where an authorized test house has satisfied itself that a particular source of power is adequately safe then it is permissible to design a system in accordance with this standard. Any particular conditions relating to such a system shall be clearly stated in the accompanying documentation.

Where a safety analysis of a combination of power supplies using non-linear outputs is carried out then the interaction of the two circuits may cause a considerable increase in the dissipation in the regulating circuit components. This factor must be taken into account. It is recommended to have only one power supply containing regulating semiconductors combined with linear and/or trapezoidal sources.

C.1 Introduction

The installation rules in IEC 60079-14 permit the operator in control of a hazardous area to combine several intrinsically safe circuits by interconnection. This also includes the case where several 'associated apparatus' (that is, active in normal operation or only under fault conditions) are involved (see 12.2.5.2 of IEC 60079-14). Where this is done, it is not required to involve a testing station or an authorized engineer if a calculated or test-based proof of the intrinsic safety of the interconnection is carried out.

The test-based proof shall be performed using the standard spark test apparatus according to IEC 60079-11 considering the safety factor of the combined electrical apparatus. In this case, certain fault conditions leading to the most unfavourable ignition conditions – the 'worst case' approach – shall be taken into account. Thus this method of proof often meets with difficulties in practice and is usually reserved for testing stations.

An assessment by calculation of the interconnection can be carried out easily at least for resistive circuits, if the electrical sources involved have a linear internal resistance as shown in Figure C.1a). In this case, the ignition limit curves in IEC 60079-11 apply and the method described in IEC 60079-14, Annex A, or in Figure C.7 and Figure C.8 of this document can be used.