BRITISH STANDARD

BS 6182-1: 1994

Intrinsically safe power supplies for use in coal mines —

Part 1: Specification for d.c. power supplies

Confirmed January 2011

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Mining Requisites Standards Policy Committee (MRE/-) to Technical Committee MRE/25, upon which the following bodies were represented:

Association of British Mining Equipment Companies

British Coal Corporation

Council for Electrical Equipment for Flammable Atmospheres (BEAMA)

Health and Safety Executive

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Contents

Foreword

This revision of this Part of BS 6182 has been prepared under the direction of the Mining Requisites Standards Policy Committee and takes account of experience gained since this standard was first published in 1982. It supersedes BS 6182-1:1982, which is withdrawn. In this revision the specification to provide intrinsically safe outputs suitable for use in coal mines has been developed to allow for alternatives to constant voltage transformers and for alternative power sources to mains.

BS 6182 is published in three Parts and specifies a range of d.c. and a.c. power supplies and rechargeable battery units to give a power output ensuring both a minimum acceptable performance with connected apparatus and a maximum power output dictated by the requirements of intrinsic safety.

BS 6182-2:1982 specifies requirements for power supplies providing a.c. outputs. Two output voltages are specified for the following purposes:

a) a 12 V r.m.s. output to supply intrinsically safe apparatus where maximum power availability is the predominant requirement;

b) a 15 V r.m.s. output to supply intrinsically safe apparatus where a higher operating voltage is more important than available power.

BS 6182-3:1982 specifies requirements for a range of rechargeable battery units that are to be charged from the power supplies specified in Parts 1 and 2.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Attention is drawn to the Health and Safety at Work etc. Act 1974 [1], the Mines and Quarries Act 1954 [2], the Regulations made under these Acts, and also any other appropriate statutory requirements or Bye-laws. These place responsibility for complying with specific safety requirements on the manufacturer and the user. The address of the recognized certification authorities in the United Kingdom for intrinsic safety aspects are:

Health and Safety Executive,
Mining Equipment Certification Service,
Harpur Hill,
Buxton,
Derbyshire,
SK17 9JN.

SIRA Certification Service
Saighton Lane,
Saighton,
Chester.
CH3 6EG.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 6182 specifies requirements for the construction and testing of a range of power supply units intended to be certified intrinsically safe for use in coal mines and which provide an intrinsically safe d.c. output as follows:

a) an 18 DC type power supply provides a nominal 18 V output that may be used, for example, to float charge an intrinsically safe battery with a nominal discharge end-point voltage of 12 V;

b) a 12 DC type power supply provides a nominal 12 V output for use where battery standby is not required, or to float charge an intrinsically safe battery with a nominal discharge end-point voltage of 7.5 V;

c) a 7.5 DC type power supply provides a nominal 7.5 V output that may be used, for example, with equipment using logic circuits requiring 5 V for operation.

It is intended that the components forming the power supply circuit be assembled on to a chassis that may be incorporated within either a flameproof enclosure or, where the power supply is located outside a potentially explosive atmosphere, within some other suitable enclosure. Requirements for these enclosures are not given in this standard. Guidance on interconnection with other apparatus is given in Annex A.

In addition to the definitive requirements, this standard also requires the information detailed in clause **4** to be documented. For compliance with this standard, both the definitive requirements and the documented item has to be satisfied.

2 References

2.1 Normative references

This Part of BS 6182 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Part of BS 6182 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 6182 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definition

For the purposes of this Part of BS 6182, the following definition applies.

power supply unit

An assembly of components forming a power supply circuit mounted on a metal chassis.

4 Information and requirements to be agreed and to be documented

Information on the a.c. or d.c. electrical supply to the power units to be supplied by the purchaser shall be fully documented (see **5.4**). Both the definitive requirements specified throughout the standard and this documented item shall be satisfied before a claim of compliance with the standard can be made and verified.

5 Design and construction

5.1 General

The power supply unit shall conform to BS 5501-7:1977 for Group I category "ia" apparatus.

The power supply unit shall be designed for incorporation within one of the following:

a) a purpose-designed flameproof enclosure housing only a power supply unit(s); or

b) a flameproof enclosure containing other apparatus, in which case the power supply unit shall be fitted with covers to give a degree of protection not less than IP20 as defined in BS EN 60529:1992; or

c) a non-flameproof enclosure where the power supply unit is located outside a potentially explosive atmosphere.

NOTE It is intended in each case that power supply units will be separately certified.

5.2 Power supply unit output

Each type of power supply unit, i.e. 18 DC, 12 DC and 7.5 DC, shall conform to the appropriate output values given in columns 3, 4, 5 and 6 of Table 1.

5.3 Minimum output voltage

The output voltage shall not fall below the nominal value shown in column 1 of Table 1 at the current stated in column 3 under all combinations of input supply and component tolerances.

Table 1 — Output characteristics

Type of power supply unit	1	2	3	4	5	6
	Nominal output voltage	Nominal output current	Minimum output current to maintain nominal output voltage (see 5.3)	Output voltage range at nominal output current level	Output voltage range at no load	Maximum output voltage under any conditions of service (see note)
	V	mA	mA	V	V	V
18 DC	18	140	125	17.48 to 19.04	18.8 to 22.4	22.4
12 DC	12	500	466	11.77 to 13.13	12.4 to 14.4	14.4
7.5 DC	7.5	1 400	1 430	7.64 to 8.6	7.7 to 9	9

NOTE These values are used when assessing the intrinsic safety of connected apparatus.

5.4 Input supply voltage

Power supply units shall be designed to operate from an a.c. or d.c. source stated by the purchaser on the enquiry and/or order, provided the input circuits are galvanically separated from the output circuits.

Mains-fed power supply units shall be designed to operate from single phase a.c. voltages at a specified mains frequency within the range 48 Hz to 62 Hz. The tolerance on mains input voltages shall be + 10 % to – 25 %.

For other types of supply the input voltage tolerances shall be as nominated by the manufacturer.

NOTE The value of the mains voltage is not specified as a requirement of this standard. The preferred values are 120 V and/or 240 V, or 550 V and/or 1 100 V.

5.5 Working temperature

When enclosed in the manner of **5.1** a) or **5.1** c), the power supply unit shall be capable of operating continuously where the enclosure is subject to an ambient temperature in the range of – 5 °C to + 40 °C.

NOTE When the power supply unit is intended for enclosure in the manner of **5.1** b), the operating temperature range should be agreed between the purchaser and the manufacturer. The preferred range is – 5 °C to + 70 °C.

5.6 Power supply circuit

5.6.1 *General*

The power supply circuit shall be as shown in Figure 1. Circuit components shall be mounted on a metal chassis having facilities for making a connection to earth. Any covers required by **5.1** b) shall be fixed in a manner to prevent unauthorized interference and, if made of metal, shall be electrically connected to the metal chassis.

5.6.2 *Creepage distances and clearances to earth*

The device providing galvanic separation, and all components connected to its output side, shall be so mounted that any conducting parts of the circuit, other than the negative line, shall be infallibly separated from earthed metal parts by the appropriate creepage and clearance distances specified in BS 5501-7:1977.

5.6.3 *Insulation from earth*

In addition to the requirements of BS 5501-7:1977, the insulation resistance between all parts of the circuit on the output side of the galvanic separation and earth shall be not less than 1 MΩ when tested at 500 V d.c.

5.7 Circuit requirements

5.7.1 *General*

All components shall conform to the relevant requirements specified in BS 5501-7:1977, and shall also conform to Table 2 of this Part.

5.7.2 *Input connections*

Effective means shall be provided to prevent the input connections to any adjustable voltage tappings being easily changed.

NOTE For example, soldered connections are acceptable.

The input connections shall be clearly and unambiguously identified so as to avoid incorrect connection.

5.7.3 *Reservoir capacitor voltage* (C1)

5.7.3.1 With the circuit as in Figure 1, the voltage including ripple across the reservoir capacitor shall not exceed the value given in Table 2 over the range of input voltages specified (see **5.4**) and an ambient temperature range of – 5 °C to + 40 °C.

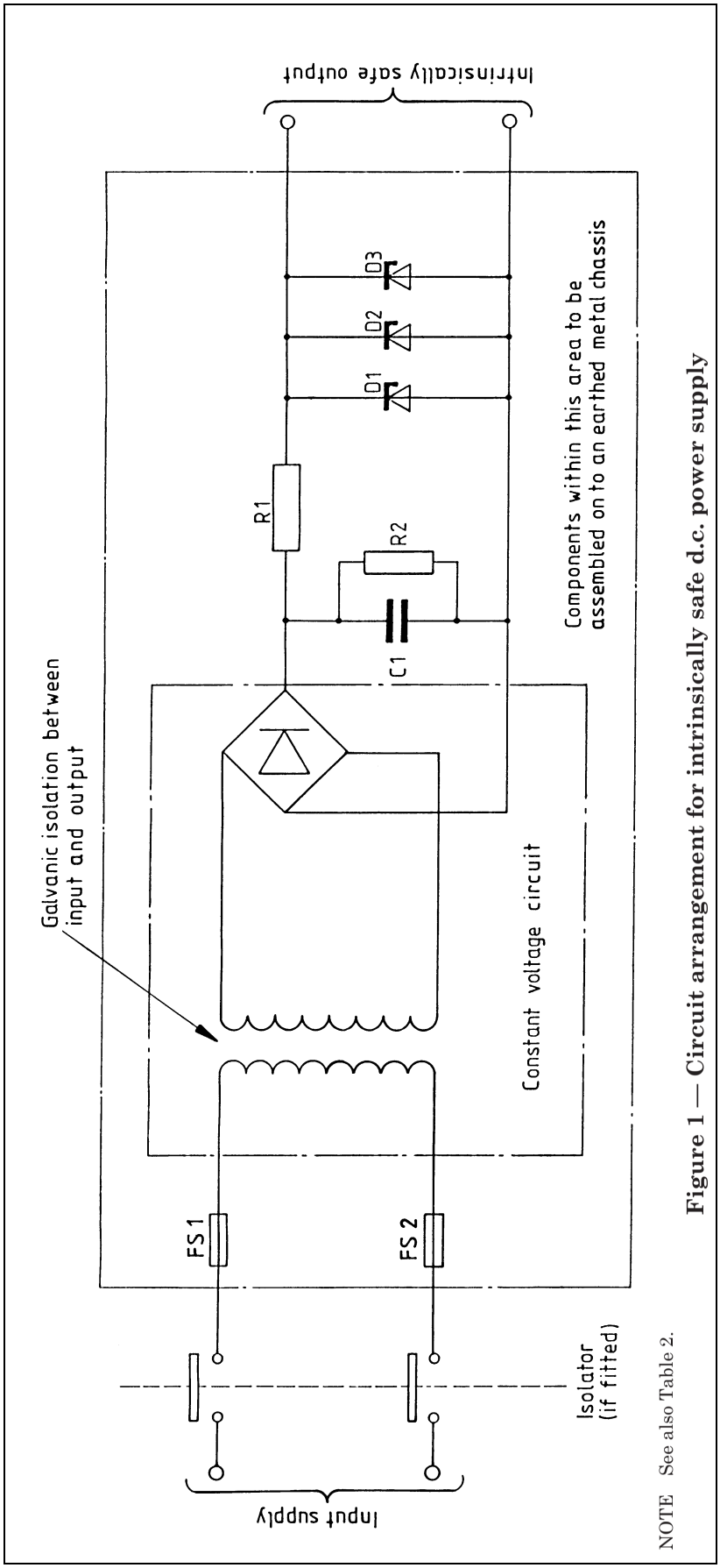

Figure 1 — Circuit arrangement for intrinsically safe d.c. power supply

NOTE See also Table 2.

Table 2 — Component specifications

				Type of power supply unit		
				18 DC	15 DC	7.5 DC
Maximum fuse rating FS1 and FS2			A	2	2	2
Constant voltage circuit (for input supply see **5.4**)	Voltage across reservoir capacitor (C1)	a)	V	24.72 max. (see **5.7.3.1**)	16.64 max. (see **5.7.3.1**)	14.42 max. (see **5.7.3.1**)
		b)	V	29.00 max. (see **5.7.3.2**)	18.75 max. (see **5.7.3.2**)	17.5 max. (see **5.7.3.2**)
	Peak-to peak ripple voltage across reservoir capacitor (C1) (see **5.7.3.3**)		V	0.16 max.	0.32 max.	0.72 max.
Bridge rectifier rating	Minimum peak reverse voltage		V	75	75	75
	Minimum r.m.s. forward current		A	1	3	5
Reservoir capacitor (C1)	Minimum working voltage		V	40	25	25
Current limiting resistor (R1)	Current limiting resistance (see note 1)		Ω	(41 ± 1) %	(7.1 ± 1) %	(4.2 ± 1) %
	Power rating (see note 2)		W	23	60	76
Capacitor discharge resistor (R2)	Maximum resistance		Ω	10 500	10 500	10 500
Zener diode (D1, D2, D3)	Voltage (see **5.7.6**)		V	(20 ± 5) %	(13 ± 5) %	(8.2 ± 5) %
	Minimum power rating (see note 3)		W	5	12	19

NOTE 1 These values are calculated under the terms of paragraph 2 of clause **9** of BS 5501-7:1977.
NOTE 2 The values shown include a two-thirds derating factor as required by BS 5501-7:1977 (see also **5.7.5**)
NOTE 3 The values shown include a two-thirds derating factor as required by BS 5501-7:1977 (see also **5.7.6**). If higher ratings are used in the design then leakage current is an important factor in meeting the requirements of Table 1 and selection of the zener diode may be necessary.

5.7.3.2 With the circuit as in Figure 1, but with the zener diodes disconnected and no load on the output, the voltage including ripple across the reservoir capacitor shall not exceed the value given in Table 2, over the range of input voltages specified (see **5.4**) and an ambient temperature range of – 5 °C to + 40 °C.

NOTE This value of voltage has been included to account for the possibility of an intermittent fault between the transformer and reservoir capacitor. This is a two countable fault condition as defined in BS 5501-7:1977 and as such requires a factor of safety not less than one.

5.7.3.3 With the circuit as in Figure 1, the peak-to-peak ripple voltage at the reservoir capacitor shall not exceed the value specified in Table 2 at any output current between no load and the nominal figure given in column 2 of Table 1.

5.7.4 ***Bridge rectifier***

The bridge rectifier shall be an encapsulated type.

5.7.5 ***Current limiting resistor*** **(R1)**

The current limiting resistor shall be connected in the positive line and shall be of the value given in Table 2.

NOTE The resistance may be made up from more than one resistor provided that the combination complies with the value given in Table 2.

The inductance of the current limiting resistance shall not exceed 5 μH.

The resistance shall be capable of dissipating the power given in Table 2 without exceeding the manufacturer's maximum rated hotspot temperature when the power supply is mounted in its enclosure.

5.7.6 ***Zener diodes*** **(D1, D2, D3)**

The zener diodes shall be mounted and wired such that if interconnecting wiring becomes disconnected the output will be isolated. Stud-mounted zener diodes shall have the negative line of the power supply connected to their fixing stud.

The zener diodes shall be capable of dissipating the power given in Table 2 without exceeding the manufacturer's rated junction temperature when the power supply is mounted in its enclosure.

The voltage of the zener diode specified in Table 2 shall be determined by means of a pulse test specified by the diode manufacturer and carried out at an ambient temperature of 20 °C.

5.7.7 ***Capacitor discharge resistor*** **(R2)**

The capacitor discharge resistor shall be rated at one and a half times its dissipation at the maximum capacitor voltage given in Table 2 with a minimum value of ¼ W.

6 Marking

In addition to the marking prescribed in BS 5501-7:1977, as appropriate, the power supply chassis shall be marked with:

a) the numbers and date of this British Standard, i.e. BS 6182-1:1993[1)];

b) power supply unit type (see Table 1);

c) manufacturer's serial number;

d) rated input voltage and frequency on a separate label.

In addition, when the power supply unit is intended for enclosure in the manner of **5.1** b), the marking shall include the maximum ambient temperature as agreed between the manufacturer and purchaser (see note to **5.5**). If the chassis marking is not visible with the cover fitted then the cover shall also be marked.

7 Routine tests

In addition to any tests required by BS 5501-7:1977, the following tests shall be applied to every power supply unit in an ambient temperature of 20 °C.

a) measurement of the output voltage of the reservoir capacitor (C1) with only that component connected to the constant voltage circuit over the range of input voltages specified in **5.4**.

NOTE For the purpose of this test the capacitor discharge resistor may remain connected provided that allowance is made for its effect.

b) measurement of values of voltage and current for conformity to the figures given in columns 4 and 5 of Table 1;

c) measurement of the insulation resistance for conformity to **5.6.3**.

[1)] Marking BS 6182-1:1994 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Annex A (informative) Guidance on interconnection with other equipment

The design of the power supply circuit is such that when the power supply unit is connected to a load there are limiting electrical parameters that dictate the arrangement permitted by the certifying authority. Table A.1 provides guidance on this subject for the user.

Table A.1 — Maximum inductance of cables and load for connection to the output of the power supply

Power supply type	Maximum inductance per ohm μH/Ω	Maximum inductance mH
18 DC	118	1.2
12 DC	52	0.096
7.5 DC	48	0.054

NOTE Values calculated with reference to ignition curves in IEC 79-11.

List of references (see clause 2)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS EN 60529:1992, *Specification for degrees of protection provided by enclosures (IP code).*
BS 5501, *Electrical apparatus for potentially explosive atmospheres.*
BS 5501-7:1977, *Intrinsic safety "i".*

Informative references

BSI standard publications

BRITISH STANDARDS INSTITUTION, London

BS 6182, *Intrinsically safe power supplies for use in coal mines.*
BS 6182-2:1982, *Specification for a.c. power supplies*[2)].
BS 6182-3:1982, *Specification for rechargeable battery units*[2)].

IEC standards publications

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC), Geneva. (All publications are available from BSI Customer Services)

IEC 79, *Electrical apparatus for explosive gas atmospheres.*
IEC 79-11:1984, *Construction and test of intrinsically-safe and associated apparatus.*

Other references

[1] GREAT BRITAIN. Health and Safety at Work etc. Act 1974. London: HMSO[2)].
[2] GREAT BRITAIN. Mines and Quarries Act 1954, London: HMSO[2)].

[2)] Referred to in the foreword only.

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