BS 3101 : 1986

UDC 681.5 : 621.316.541-213.34 : 622.822.3

British Standard Specification for

Control and interlock circuits primarily associated with flameproof restrained plugs and sockets for use in coal mines

Spécifications relatives aux circuits de commande et de verrouillage associés principalement à des prises de courant antidéflagrantes à dispositif de retenue pour utilisation dans les mines de charbon

Steuerstromkreise und Verriegelungsstromkreise, die vorwiegend in Zusammenhang schlagewettersicheren Steckverbindungen im Bergbau verwendet werden

Confirmed
January 2011

British Standards

Foreword

This revision of BS 3101 has been prepared under the direction of the Mining and Quarrying Requisites Standards Committee and supersedes BS 3101 : 1959, which is withdrawn. It continues to aid manufacturers in establishing standard characteristics and operating conditions for control circuits for use primarily in coal mines; it does this by specifying requirements for circuits and associated apparatus which are necessary to ensure that the components of the control units away from the supply and control unit (gate-end box) can be used with any such unit that has a circuit complying with this standard. This revision provides for local or remote control and now includes requirements for optional interlock circuits and resistor proving systems which will enhance the operational safety of the control circuit.

This standard refers only to BS 1259, since at the date of publication no comparable British Standard or European standard exists relative to control and interlock circuits.

Attention is drawn to appendix A, which recommends operational requirements for equipment using a control circuit complying with this standard.

Compliance with a British Standard does not of itself confer immunity from legal obligations. Attention is drawn to the Health & Safety at Work etc. Act 1974, the Mines and Quarries Act 1954, the Regulations made under these Acts, and also any other appropriate statutory requirements or bye-laws. These place responsibility for complying with certain specific safety requirements on the manufacturer and the user. The address of the recognized certification authority in the United Kingdom for Group I (coal mining) apparatus is as follows:

Health and Safety Executive
HSE (M) Certification Support Unit
Harpur Hill
Buxton
Derbyshire SK17 9JN

Contents

Specification

1 Scope

This British Standard specifies requirements for control and interlock circuits which are required to be intrinsically safe and which are primarily associated with the pilot contacts of flameproof restrained plugs and sockets for use in coal mines. Provision is made for the control circuit to operate in local or remote control. When a resistor proving system is provided the operational requirements are given in clause **6**.

NOTE 1. Appendix A gives recommended operational requirements for equipment using a control circuit complying with this standard.

NOTE 2. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1 restrained plug and socket. A plug and socket in which the two portions are engaged, retained and disengaged by means of a manually operated device.

2.2 control circuit. All the conducting parts included in a circuit which is intended to control the closing and opening operations of the primary switching device, e.g. main circuit contactor.

2.3 resistor proving system. Means for proving the operation of the control apparatus by detecting the correct insertion of the 30 Ω resistor in the RUN position.

2.4 interlock circuit. Means for proving that remote apparatus is connected by cable.

3 Control circuit requirements

3.1 Intrinsic safety

The control circuit shall be intrinsically safe in accordance with BS 1259.

NOTE. Appendix B defines the conditions under which the circuit can be considered as intrinsically safe.

3.2 Cable resistance

All the requirements of clause **3** shall be satisfied with any external cable having a lead and return resistance in the range 0 Ω to 5 Ω.

3.3 Voltage limits for operation

With the switching device in the OFF position, the control circuit shall operate in the correct sequence of operations for starting, at voltages down to 75 % of the rated input voltage* of the apparatus with which this circuit is used.

With the switching device in the RUN position, the control circuit shall continue to operate at voltages down to 60 % of the rated input voltage of the apparatus with which this circuit is used, and under no condition shall it continue to operate at 20 % or less of that rated input voltage.

3.4 Maximum current

The maximum current, when an impedance of 1.0 Ω is connected between the terminal of the control circuit and earth, shall not exceed 0.25 A (r.m.s.) for voltages in the range 0 % to 120 % of the rated input voltage of the apparatus with which this circuit is used.

3.5 Circuit resistance

The following shall apply.

(a) *Switching device at START:* the control circuit shall not operate at the rated input voltage if the lead and return resistance of the external circuit is 23 Ω or greater.

(b) *Switching device at RUN:* the control circuit shall cease to operate with as low a value of external resistance (excluding circuit components) as can be tolerated for stability, but this resistance shall not exceed 70 Ω.

3.6 Interruption and restoration of supply

With the switching device in the RUN position, when, for any reason, there is an interruption and restoration of supply, the control circuit shall not operate with the input voltage at any value up to and including 120 % of the rated input voltage of the apparatus with which this circuit is used.

3.7 Inclination to normal direction

The control circuit shall comply with all the requirements of this standard, with the components inclined in any direction at an angle of 15° to their normal position.

3.8 Operation under control circuit to earth fault conditions

Under an earth fault condition, the control circuit shall not operate or shall cease to operate as follows.

(a) *Switching device at START:* the control circuit shall not operate if the fault resistance is 40 Ω or less.

(b) *Switching device at RUN:* the control circuit shall cease to operate if the fault resistance is 50 Ω or less.

(c) *Switching device returned to OFF (from either START or RUN):* irrespective of the magnitude of the fault, when the switching device is returned to OFF, the control circuit shall cease to operate with the input voltage at any value up to and including 120 % of the rated input voltage of the apparatus with which this circuit is to be used.

NOTE. In practice, detection of the fault resistance will be at higher values than the stated limits.

* It is permissible for input tappings to the primary of the control circuit transformer to be used, so that when the corresponding rated input voltage is applied, the circuit control voltage has nominally the same value.

4 Control circuit connections

4.1 General

The apparatus for control shall consist of a switching device, a resistor and a half-wave rectifier.

The switching sequence shall ensure that with the switching device in the OFF position the circuit is opened, in the START position the rectifier only is in circuit and in the RUN position the resistor and rectifier are connected in series.

4.2 Remote control

The apparatus shall be connected as shown in figure 1.

NOTE. It will be necessary for the purchaser to make request of the supplier if opposite polarity of the rectifier is required.

4.3 Local control

The apparatus shall be connected as shown in figure 2.

NOTE. It will be necessary for the purchaser to make request of the supplier if opposite polarity of the rectifier is required.

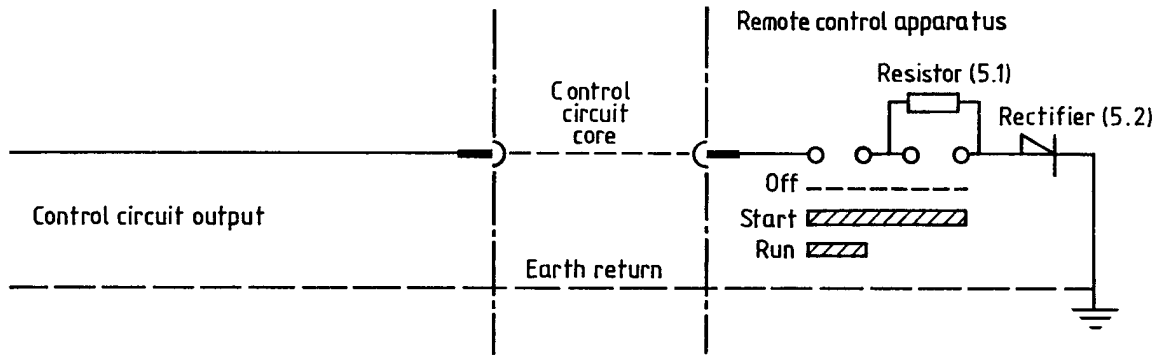

Figure 1. Connections for remote control

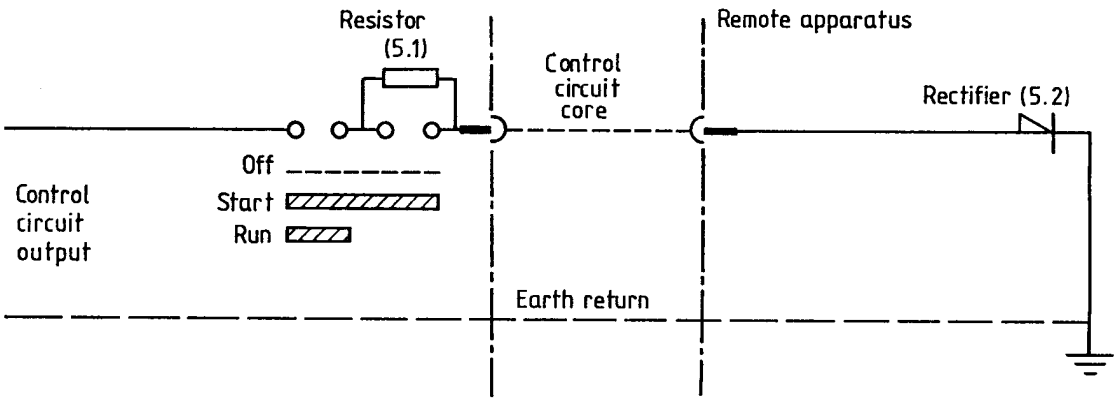

Figure 2. Connections for local control

5 Component requirements

5.1 Resistor

The resistor shall have a value of 30 Ω with a tolerance not greater than ± 2 % and a rating not less than 0.5 W at an ambient temperature of 80 °C.

5.2 Rectifier

The rectifier shall comply with the following requirements.

(a) The voltage rating shall not be less than 70 V a.c. (r.m.s.) with a corresponding repetitive peak voltage (assuming sine wave input) of 100 V. The rectifier shall withstand a transient peak voltage of at least 125 V.

(b) The continuous current rating shall not be less than 1 A a.c. (r.m.s.).

(c) The forward voltage drop, when the rectifier is carrying a current of 0.2 A d.c. and operating at the ambient temperature specified in either (1) or (2), shall be not greater than:

(1) 0.85 V at 25 °C;

(2) 0.65 V at 125 °C.

(d) The limits of forward voltage drop, specified in (c) of this subclause, shall not be exceeded during the service life.

NOTE. The service life will need to be the subject of agreement between the supplier and purchaser.

(e) At the ratings specified in (a) and (b) of this subclause, the rectifier shall be capable of continuous operation at any temperature between 0 °C and 80 °C and a relative humidity of up to 100 %, when enclosed in a robust, unventilated case.

6 Control circuit requirements when a resistor proving system is provided

6.1 General

When a resistor proving system is provided, the control circuit shall only operate when the control apparatus is connected in the correct sequence of OFF–START–RUN.

NOTE 1. It is accepted that under certain conditions, e.g. restoration of power or operation of series connected contacts, it may only be necessary to move the switching device from RUN to START and back to RUN to restore control circuit operation.

NOTE 2. For convenience the terms START and RUN will continue to be used. However, it is implicit with the resistor proving system that the START position does not complete the control circuit, but is used to prepare the circuit for operation when the switching device is moved to the RUN position.

The resistor proving system shall either be fail-safe, or means shall be provided to ensure that it has correctly detected the reduced resistance when the switching device is in the START position.

The requirements of **6.2** and **6.3** shall apply equally to remote and local control.

6.2 Circuit resistance

The resistor proving system shall prevent operation of the control circuit if, at normal voltage, the lead and return resistance of the external cable and earth circuit is less than 23 Ω.

For all values of voltage between 75 % and 120 % of the declared supply voltage, the value of resistance at which the remote control circuit ceases to operate shall not be less than 10 Ω below the minimum value of resistance at which the resistor proving system operates.

6.3 Timing

The control circuit shall only operate if the resistor proving system detects that the switching device has returned to the RUN position in not more than 5 s after moving to the START position.

7 Interlock circuit requirements

7.1 General

When provided, the interlock circuit (see figure 3) is used for proving that remote apparatus is connected by cable and shall not be used directly for starting purposes. The essential remote apparatus shall be a half-wave rectifier complying with **5.2** and connected at the remote end of the circuit.

7.2 Intrinsic safety

The interlock circuit shall be intrinsically safe in accordance with BS 1259.

NOTE. Appendix B defines the conditions under which the circuit can be considered as intrinsically safe.

7.3 Voltage limits for operation

The interlock circuit shall operate at voltages down to 75 % of the rated input voltage* and shall continue to operate at voltages down to 60 % of the rated input voltage of the apparatus with which this circuit is used, and under no condition shall it continue to operate at 20 % or less of the rated input voltage.

7.4 Operation under interlock circuit to earth fault conditions

The interlock circuit shall not operate if the fault resistance is 40 Ω or less, and shall cease to operate if the fault resistance is 15 Ω or less.

Irrespective of the magnitude of the fault, when the remote apparatus is in an open circuit condition, the interlock circuit shall not operate with the input voltage at any value up to and including 120 % of the rated input voltage of the apparatus with which this circuit is used.

NOTE. In practice detection of the fault resistance will be at higher values than the stated limits.

* It is permissible for input tappings to the primary of the control circuit transformer to be used, so that, when the corresponding rated input voltage is applied, the circuit control voltage has nominally the same value.

7.5 Maximum current

The maximum current, when an impedance of 1.0 Ω is connected between the terminal of the interlock circuit and earth, shall not exceed 0.25 A (r.m.s.) for voltages in the range 0 % to 120 % of the rated input voltage of the apparatus with which this circuit is used.

7.6 Inclination to normal direction

The interlock circuit shall comply with all the requirements of this standard, with the components inclined in any direction at an angle of 15° to their normal position.

7.7 Cable resistance

All the requirements of clause 7 shall be satisfied with any external cable having a lead and return resistance in the range 0 Ω to 5 Ω.

7.8 Circuit resistance

The interlock circuit shall not operate at the rated input voltage if the lead and return resistance of the external circuit is 23 Ω or greater. It shall cease to operate with as low a value of external resistance (excluding circuit components) as can be tolerated for stability, but this resistance shall not exceed 70 Ω.

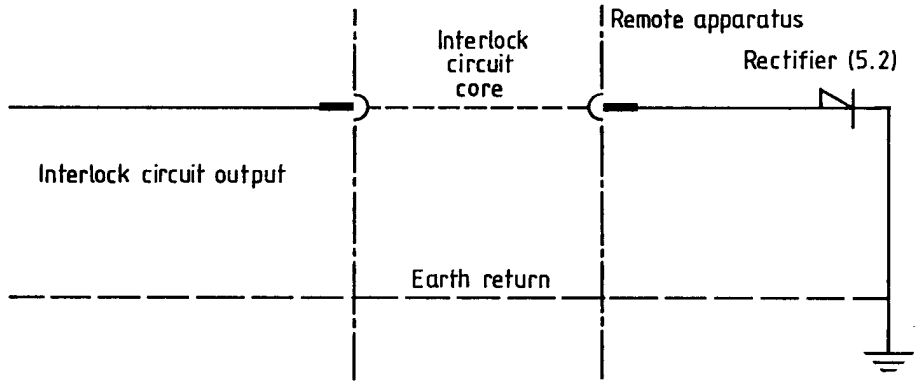

Figure 3. Connections for interlock circuits

Appendices

Appendix A. Associated controlled devices and systems

It is imperative that uncontrolled starting of machinery is prevented within defined operational limits. Therefore, associated controlled devices and systems should remain under the command of the control circuit, within the limits of this specification.

In addition to the above, if remote apparatus, as shown in figures 2 and 3, is incorrectly connected into a remote control circuit, inadvertent starting of machinery can occur, unless a resistor proving system is provided.

Standards writers calling up this specification in association with apparatus with which they are dealing need to make the matter in the first paragraph a requirement and take the matter in the second paragraph into careful consideration.

Appendix B. Conditions under which the control and interlock circuit can be considered as intrinsically safe

Control and interlock circuits can only be considered as intrinsically safe when:

(a) the main conductors in the associated trailing cable are not energized; and

(b) all the components of the circuit are housed within certified flameproof enclosures with the exception of the pilot contacts, which are exposed when the restrained plug and socket is separated.

Publication referred to

BS 1259 Intrinsically safe electrical apparatus and circuits for use in explosive atmospheres

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The following BSI references relate to the work on this standard: Committee reference MQE/16 Draft for comment 85/74238 DC

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Mining and Quarrying Requisites Standards Committee (MQE/-) to Technical Committee MQE/16, upon which the following bodies were represented:

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British Coal
Health and Safety Executive
Institution of Mining Electrical and Mining Mechanical Engineers
National Union of Mineworkers

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