



G 218 : Part 1 : 1975

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British Standard: Aerospace Series
Specification for

Proximity switches for aircraft

Part 1. General requirements

Interrupteurs de proximité pour les aéronefs 1ère Partie. Caractéristiques générales
Nahschalter für Flugzeuge Teil 1. Allgemeine Anforderungen

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Foreword

This British Standard has been prepared at the request of the Aerospace Industry Standards Committee and Society of British Aerospace Companies to cover class 1 proximity switches, for use in unprotected positions on aircraft, and class 2 proximity switches, intended for less arduous environment.

This Part 1 deals with the general requirements for all proximity switches and will be followed by Part 2 'Magnetic proximity switch requirements' and Part 3 'Inductive proximity switch requirements'. Further

parts may be added, in due course, covering other basic methods of operation. This document takes account of Ministry of Defence (Procurement Executive) specifications, EL 2120 Magnetic Proximity Switches, and specification EL 2116 Inductive Proximity Switches.

Other Parts of the standard are:

- Part 2 Magnetic proximity switch requirements.
- Part 3 Inductive proximity switch requirements.

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British Standards Institution • 2 Park Street • London W1A 2BS

Telephone 01-629 9000

Telex 266933

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Specification

1. Scope

Part 1 of this British Standard specifies the general requirements for proximity switches suitable for use in nominal 28 V d.c. or 115/200 V, 400 Hz a.c. systems in aircraft.

Two classes of switch are specified: class 1, switches for use in unprotected positions on aircraft; class 2, switches intended for less arduous environmental conditions than class 1. The minimum requirements for class 2 switches are given in appendix C.

Requirements specific to a particular method of operation are given in the relevant further parts of this standard which must be read in conjunction with this Part 1.

2. References

This standard makes reference to the following British Standards.

- BS 2011 Methods for the environmental testing of electronic components and electronic equipment
- BS 6001 Sampling procedures and tables for inspection by attributes
- BS 9150 Electrical relays of assessed quality: generic data and methods of test
- 2G 100 General requirements for electrical equipment and indicating instruments for aircraft.
 - Part 2 Environmental and operating conditions
- 3G 100 General requirements for equipment for use in aircraft
 - Part 0 Introduction
 - Part 1 Identification and declarations
 - Part 2 All equipment
 - Section 1. Construction
 - Section 2. Magnetic influence
 - Section 3. Environmental conditions
 - Subsection 3.1: Vibration
 - 3.2 Temperature-pressure requirements
 - 3.3 Mould growth
 - 3.5 Explosion-proofness
 - 3.6 Acceleration requirements
 - 3.7 Tropical exposure
 - 3.8 Salt mist
 - 3.9 Ice formation
 - 3.10 Fluid contamination
 - Part 3 Characteristics of aircraft electrical systems
 - Part 4 Electric equipment
 - Section 1. Construction and general
 - Section 1.1 Electrical insulation tests
 - Section 2. Electromagnetic interference at radio and audio frequencies.

- G 216 Hand operated thermally compensated, miniature single and triple pole circuit-breakers.

The following specification is also referred to in this standard.

EL 2011 Electric cables for aircraft — uniflexef-glasmet and uniflexefglas. [Obtainable from Ministry of Defence (Procurement Executive), St Giles Court, London].

3. Definitions

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

- 3.1 proximity switch.** A switch system which provides one or more circuit switching functions when the target is brought within the declared operating region of the sensor. The system may include a separate relay or electronic module in addition to the target and sensor.
- 3.2 target.** A specific material which is moved into proximity with the sensor in order to operate the switch.
- 3.3 sensor.** A device designed to detect with the proximity of a target.
- 3.4 electronic module.** An arrangement of solid-state electronic components which operates as a switch when actuated by an electrical signal from the sensor.
- 3.5 overtravel.** The distance between the operating position and the total travel position.
- 3.6 operating position.** The position, relative to the sensor, to which the target must be advanced in the intended direction of operation to cause subsequent operation of the switch. This may be reached by a head-on or a side-on approach of the target.
- 3.7 release position.** The position of the target relative to the sensor to which the target must be withdrawn to de-operate the switch.
- 3.8 differential travel.** The distance between the operating position and the release position.
- 3.9 simultaneity.** The time interval between the first and last similar output circuit operation of the switch when operated by a target moving at 250 mm/s.
- 3.10 ice shear force.** The force required to disrupt ice formation on either/or target and sensor that would prevent correct operation.
- 3.11 response.** The interval between a target entering or leaving the operating region and the completion of the electrical switching functions.
- 3.12 normal temperature, pressure and humidity**

Temperature	15 °C to 35 °C
Pressure	86 kPa to 106 kPa (860 mbar) to (1060 mbar)
Humidity	45 % to 75 %
- 3.13 vane operation.** A form of engagement of target and sensor in which one enters as a vane in a channel of the other.



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3.14 magnetic shunt. An alternative magnetic circuit provided to reduce the effective field on the sensing element.

3.15 circuit malfunction. The opening or closing of an output circuit which is not demanded by the sensing mechanism.

3.16 head-on approach. The approach of target to sensor such that the movement is perpendicular to the plane of the sensing face.

3.17 side-on approach. The approach of the target to sensor such that the movement is parallel to the plane of the sensing face.

3.18 full engagement. The position where the target is located at the minimum designed clearance from the sensor.

3.19 quality assurance. The maintenance of type test standard by periodic special testing during production.

4. Complete switch

4.1 Description and design parameters

4.1.1 Class 1 switches, intended for unprotected positions, shall comply with Part 1, and the relevant further Part of this standard.

Class 2 switches, suitable for less arduous environments shall comply with appendix C.

4.1.2 All switches shall operate by a target moving into the influence-field of a sensor to initiate a switching function. Detailed methods of sensing and switching shall comply with further Parts of this standard.

4.1.3 The complete switch should be hermetically sealed but certain other designs may meet the requirements of this standard.

4.1.4 Overtravel of the target after the switching action has occurred shall be provided; the actual value shall be as stated in the relevant further parts of this standard.

4.1.5 All exposed metals parts shall be insulated from all current carrying parts and should be connected to earth via the mounting.

4.1.6 Connections shall be as defined in 6.3.1 for the sensor and 7.3 for a separate module or relay.

4.1.7 Each lead or terminal shall be identified by a number in accordance with the diagram on the switch and/or appropriate drawings.

4.1.8 The switches shall be suitable for mounting in any attitude. The recommended tolerances on installational position shall take into account any long term drift of operating characteristics.

4.1.9 The switches shall be designed to meet the environmental conditions specified in 4.4 and operate satisfactorily with the power supplies defined in 3G 100: Part 3.

4.1.10 Target and sensor shall be provided with means for ensuring accurate reproducible alignment as defined in the relevant installation drawing.

4.1.11 The switches shall be designed to operate with target speeds up to 250 mm/s. The response time shall be kept to a minimum and shall be declared by the manufacturer.

For target speeds in excess of 250 mm/s see 9.12.

4.1.12 In addition to the declarations required by 3G 100: Part 1, the manufacturer shall declare the following.

(a) The limits of target position along each intended direction of operation in respect of:

- (1) overtravel,
- (2) movement differential travel,
- (3) operating position.

(b) Cyclic overload current (see 9.11).

(c) Any limitation with respect to adjacent materials or switch interference.

4.2 Marking. In addition to the output connection diagram and flying lead identification, the following shall be clearly and indelibly marked on each part.

- (a) The number of this British Standard, G 218, and classification.
- (b) The manufacturer's name or identification.
- (c) The manufacturer's type number.
- (d) The manufacturer's date code.

4.3 Electrical and mechanical rating and life. The electrical and mechanical ratings of the switch shall be in accordance with the further Parts of this standard.

4.4 Environmental conditions

NOTE. Electronic modules for installation in protected zones remote from the sensor may comply with a less stringent environmental class/grade of 3G 100: Part 2: Section 3.

4.4.1. Temperature and pressure. The switches shall be designed to meet 3G 100: Part 2: Section 3: Subsection 3.2, grade V-1 as specified in 9.16.

4.4.2. Tropical exposure. The switches shall comply with the requirements of 3G 100: Part 2: Section 3: Subsection 3.7 as specified in 9.17.

4.4.3. Resistance to mould growth. The switches shall comply with the 28 day test specified in 3G 100: Part 2: Section 3: Subsection 3.3 as specified in 9.18.

4.4.4 Vibration. Unless specified in the further parts of this standard, switches shall be suitable for use within the vibration conditions specified in 3G 100: Part 2:

Section 3: Subsection 3.1 'category 4 region A conditions' as specified in 9.14. Separate modules shall meet category 3 region B conditions as a minimum requirement.

4.4.5 Acceleration. The switches shall be in accordance with the requirements specified in 9.15 for the following acceleration grades.

- (a) Normal acceleration: grade C, class 1A (i)
- (b) Crash acceleration: grade F, class 11 of 3G 100: Part 2: Section 3: Subsection 3.6.

4.4.6 Ice-formation. Unless otherwise stated the switches shall be capable of undergoing and passing the ice-formation tests specified in 9.8.

4.4.7 Fluid contamination. The switches shall comply with the requirements specified in 9.19.

4.4.8. Salt mist. The switches shall comply with the 3G 100: Part 2: Section 3: Subsection 3.8, severity 1, as specified in 9.20.

4.5 Sealing. The switches shall comply with the requirements specified in 9.23.

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4.6 Explosion proofness. The switches shall comply with the requirements of 3G 100: Part 2: Section 3: Subsection 3.5, to a category appropriate to the switch enclosure as specified in 9.21.

4.7 Magnetic influence. Switches shall not cause magnetic interference beyond the limit specified in 3G 100: Part 2: Section 2, nor shall their operation be adversely affected by such interference. Because of mutual interference, it may not be possible to place targets or sensors close together. The supplier shall state any limitations in this respect and declare the same in any limitations of use. The requirements specified in 9.22 shall be met.

4.8 Electromagnetic interference. Switches shall not radiate, nor conduct, nor be susceptible to radio interference beyond the limit as specified in 3G 100: Part 4: Section 2. The performance of the switches shall not be adversely affected by inadvertent pickups from leads which are running in close proximity with the switch leads. The requirements specified in 9.25 shall be met.

4.9 Supply voltage variation. Switches shall not be damaged, nor their performance adversely affected, by transient voltages or ripple on the d.c. supply as specified in 3G 100: Part 3. The requirements specified in 9.24 shall be met.

4.10 Dimensions and mounting methods. The dimensions and mounting methods shall be as specified in the further Parts of this standard.

4.11 Overall response time. The response time for operation and de-operation shall not exceed 20 ms, unless otherwise specified in the further Parts of this standard.

4.12 Switching arrangements

4.12.1 A minimum of two complementary outputs should be provided. Methods of series and parallel operation shall be stated by the manufacturer. Isolation of the outputs with respect to the input supplies shall also be stated.

4.12.2 Outputs shall be suitable for the control of the loads specified in the further Parts of this standard.

4.12.3 Voltage drops shall be in accordance with the requirements specified in 9.6.

4.13 Positive line switching. The switch should be commutable between a position in the positive line (load to earth) or in the negative line (switch to earth). If this is impracticable then positive line switching is preferred.

4.14 Circuit protection

4.14.1 Accidental reversal of the polarity of the supply shall not damage the switch.

4.14.2 The switch should include short circuit protection to operate whether the circuit is made at the time of occurrence or whether the switch is closed on to the overload. The method of overload function shall be as stated in the relevant further Parts of this standard. Alternatively the switch shall meet the requirements for the short circuit test specified in 9.9.

4.15 Magnetic debris. The switch performance shall not be adversely affected by small particles of magnetic swarf or filings adhering to the target or sensor due to operating, or residual magnetism or due to a thin film of grease on these parts. The requirements specified in 9.26 shall be met.

4.16 Non-magnetic materials. The performance of the switch when installed in its operational mode shall not be adversely affected by adjacent non-magnetic materials such as aircraft, aluminium alloys and titanium, or any debris from such materials. The requirements specified in 9.26 shall be met.

4.17 Cable length. The switch performance shall not be adversely affected by up to 80 m of up to size 20 cable between the sensor and any associated electronic module.

4.18 Interchangeability. There shall be no externally accessible adjustment on any part of the switch in respect of its electrical performance. Like units or assemblies shall be fully interchangeable, dimensionally, electrically, and functionally, without recourse to further adjustment.

4.19 Reliability. The following requirements shall be satisfied in connection with life operation and mean time between failures.

4.19.1 Life operation. The switch shall achieve not less than 10^5 operations at maximum rated resistive load.

4.19.2 Mean time between failures. The mean time between failures (MTBF) shall not be less than 10^4 at maximum resistive load for a declared duty cycle.

5. Target

5.1 General

5.1.1 Form. The form of target shall be a rigid robust piece of material stiffened, if necessary, so that it can be mounted to project clear of any supporting structure.

5.1.2 Marking. The target shall be marked with the intended direction of motion, and mounting face, if applicable. The following additional information shall also be marked.

(a) The manufacturer's type or part number.

(b) The number of this British Standard, G 218.

5.2 Mechanical

5.2.1 Lateral strength. The strength of the target in any axis at right angles to the intended direction of motion shall be adequate to withstand a force of at least 900 N applied at the edge furthest from the mounting, without damage or permanent distortion.

5.2.2 Longitudinal strength. The strength of the target along the intended axis of motion, and the strength of the mounting arrangement, shall be adequate to withstand a distributed force of 900 N without damage or permanent distortion.

5.3 Electrical

Earth bonding. Provision shall be made for bonding the target to the airframe such that all exposed metal parts have a resistance to that point of less than 0.025 Ω .

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6. Sensor**6.1 General**

6.1.1 Form. The sensor shall be designed preferably for bolt mounting and shall incorporate 'potted-in' flying leads.

6.1.2 Marking. The sensor shall be marked to indicate the operative face. Additional information as specified in 2.3 of 3G 100: Part 1 shall also be marked.

6.1.3 Stacking. It should be possible to mount sensors side by side. However because of the possibility of mutual interference, the supplier shall declare any limitations.

6.2 Mechanical

6.2.1 Strength. The strength of the sensor in any axis and the mounting arrangements shall be adequate to withstand a distributed compressive force of 900 N applied in any direction without damage or loss of performance.

6.2.2 Flying lead anchorage. The flying leads shall be mechanically anchored to withstand a pull of 45 N on any one or combination of leads, without damage to the wire, insulation or potting.

6.3 Electrical

6.3.1 Connections. Connections shall be by flying leads to 2 m length and should be of Uniflexefglas 20*, yellow, etched in the approved manner prior to potting. They shall be protected from damage due to flexing at the point of emergence of the leads. Any proposed alternative form of connection or cable, with similar or superior properties, shall not be used without the prior approval of the approving authority†.

6.3.2 Earthing. Provision shall be made for bonding the sensor to the airframe such that all exposed metal parts have a resistance to that point of less than 0.025 Ω .

7. Associated relays or electronic modules

7.1 Relay. Where a relay is supplied as a part of the complete switching system in order to ensure complete compatibility with sensors, it shall be the responsibility of the supplier to ensure that it will meet all the requirements, including compatibility, interchangeability and reliability.

7.1.1 Form. Relays shall comply with the requirements of BS 9150 and satisfy the environmental conditions specified in 4.1.3 and 4.4 of this standard.

7.1.2 Marking. Relays shall be marked to show compliance with BS 9150 and also with the marking requirements specified in 4.2 of this standard.

7.2 Electronic module. Where an electronic module is required as a separate item it shall be fully interchangeable without adjustment to the switch system.

7.3 Electrical connections. Connections to the relay or module shall be by any approved method.

8. Tests

8.1 Nature and order of tests. Tests shall be made to prove compliance with the relevant requirements of this standard. It is not intended or recommended that all tests be made on every proximity switch.

Four kinds of tests, therefore, are specified as follows.

(a) *Type tests (9.1 to 9.27).* Type tests shall be made on switches which have previously passed the production tests. Each basic type of switch shall be subjected to type tests in accordance with the schedule in table 1 in the order stated. It is not intended that variants of a basic type of switch shall be subjected to all of the tests. The extent of type tests on such switches shall be agreed between the manufacturers and the approving authority†.

(b) *Production tests (10.1 to 10.10).* Production tests shall be performed on every switch in the order stated.

(c) *Quality assurance tests (11.1 to 11.4).* Quality assurance tests shall be performed on samples selected in accordance with the schedule in table 6.

(d) *Serviceability tests.* Minimum tests recommended to verify the serviceability of switches after storage or use are indicated in appendix B.

8.1.1 Repeat type tests. When granted, approval will normally last for four years. Near the end of this period, the approving authority will review the situation with the manufacturer and agree the action to be taken in time to complete such action as is necessary.

The action to be taken will depend on the history of the switch over the four year period and will be one of the following.

(a) Extension of type approval for a further four years.

(b) Repeat of the type tests in full or in part, depending upon the nature and frequency of defects reported in service.

(c) Repeat of the type tests in full, or in part, as a result of the introduction of design changes or changes in manufacturing processes, which may affect the validity of type tests under which the unit is currently approved.

The extent of a part repeat type test shall be agreed between the manufacturer and the approving authorities. Such tests may comprise individual tests, or parts thereof, selected from table 1 on the required number of switches, or on a fewer number of specimens as may be considered adequate.

*Uniflexefglas leads complying with Ministry of Defence (Procurement Executive) Specification EL 2011.

†The approving authorities for switches in British civil or military aircraft are respectively the Airworthiness Division, Civil Aviation Authority, and the Ministry of Defence (Procurement Executive), (through a design authority approved by them).

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8.2 General tests requirements

8.2.1 The switches are to be numbered for purposes of recording and allocation of tests, and the actual batch serial numbers and issue numbers of the switches used in the tests shall be recorded.

8.2.2 If apparatus is not available at the contractor's works for any of these tests, they may be carried out by an approved testing establishment.

8.2.3 All tests shall be carried out with the switch mounted on a metal plate earthed via a 100 mA fuse.

8.2.4 In order to obtain experimental flight approval (EFA) only the tests marked with an asterisk are required. The asterisks appear adjacent to the number of the clause concerned. The number of switches subjected to tests to obtain EFA shall be agreed with the approving authority†.

8.2.5 Unless otherwise specified, tests shall be carried out at normal temperature and pressure defined in 3.12.

8.2.6 All test results shall be recorded.

8.2.7 If a switch should fail any of the tests, two further switches shall be submitted to the same series of tests up to completion of the test in which the first switch failed, and then one of the three shall continue the schedule to completion. If either of the second switches also fails, then the batch shall be deemed to have failed to meet the requirements of this standard. The approving authority for type test shall be notified accordingly, and the cause of failure investigated and subsequent action decided.

8.2.8 A record of all test equipment and circuits, as applicable, shall be made and the list shall form a part of the type test record.

8.2.9 The proximity switch action during relative movement of target and sensor shall be controlled using a micrometer screw thread device for measurement of calibration and a calibrated cam for rapid operation.

8.2.10 During any check to ensure correct operation an indicating device shall be connected to each output circuit of the proximity switch.

8.2.11 100 mH air cored coils shall be used for d.c. inductive endurance load tests.

8.2.12 Targets shall also be included in the full type test.

9. Type tests

(Refer also to the relevant further Part of the standard)

9.1 **Allocation of switches for type tests.** The manufacturer shall submit at least eight switches for the type test schedule in table 1, together with the additional switches required for the appropriate endurance tests specified in table 4. The additional number of switches shall be at least seven in order to take into account the fluid contamination tests (see 'Remarks' table 1).

9.2 **Mass (weight).** The switch, including all mounting hardware shall be weighed.

*9.3 Mechanical calibration

9.3.1 **Travel characteristics.** The travels required of the target towards the sensor to actuate the switch, shall be measured in the head-on approach and in the side approach from two directions at right angles where the design permits. The requirements of 8.2.9 and 8.2.10 shall apply.

- (a) Operate position.
- (b) De-operate position.
- (c) Differential travel.
- (d) Simultaneity.

†The approving authorities for switches in British civil or military aircraft are respectively the Airworthiness Division, Civil Aviation Authority, and the Ministry of Defence (Procurement Executive), (through a design authority approved by them).