BRITISH STANDARD

BS 2G 112: 1956

Specification for

Air-driven directional gyroscopes for aircraft

Foreword

BS G 112:1949, "*Direction indicator for aircraft*" specified requirements for the general and detailed construction, and for the accuracy of both air-driven and electrically-operated instruments. This standard has been prepared, under the authority of the Aircraft Industry Standards Committee, to provide an up-to-date specification for air-driven directional gyroscopes in the light of experience gained in the application of the relevant requirements of G 112, which it supersedes. The requirements of G 112 for electrically-operated instruments are covered by BS G 122, "*Aircraft magnetic compass, remote reading (gyro stabilized).*"

Information has been added relating to the incidence of testing, and recommendations included in respect of tests to verify the serviceability of the instruments.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 5 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.

This British Standard, having been approved by the Aircraft Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council of the Institution on 19 April 1956

The following BSI references relate to the work on this standard:—
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Amendments issued since publication

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Contents

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1 Scope

This British Standard specifies the design requirements, performance and test procedure for air-driven directional gyroscopes for aircraft.

2 Definition

For the purpose of this British Standard the following definition shall apply:—

directional gyroscope

an instrument used on aircraft to indicate changes in heading of the aircraft by reference to a gyroscope coupled mechanically to an indicating system comprising a reference mark or pointer and a compass card. It is also referred to as a "direction indicator"

Section 1. General requirements

3 Case size

The instrument case shall be not more than 4½ in. wide, 5¼ in. high and 5½ in. deep.

4 Fixing holes

The attachment of the instrument shall be effected by four fixing holes spaced $4^{1}/_{6}$ in. laterally and $3^{29}/_{32}$ in. vertically with integral 2BA stiffnuts: otherwise the fixing holes should be in accordance with those specified for aircraft instrument cases in BS G 100, "*General requirements for electrical equipment and indicating instruments for aircraft*."

5 General construction

The instrument shall be sound and suitable for its purpose and shall comply with the relevant requirements of BS G 100.

Section 2. Particular requirements

6 Construction

a) The instrument shall consist of a gyroscope rotating about a substantially horizontal axis and mounted in a gimbal system the outer axis of which is parallel to the vertical axis (OZ) of the aircraft.

b) The instrument shall be designed to operate with an air pressure difference from inlet to outlet of from 3 in. to 5 in. of mercury and with a maximum consumption of 1.3 cu. ft. of free air per minute.

c) The rotor of the instrument shall start under normal temperature conditions when a pressure difference from inlet to outlet of 1 in. of mercury is applied, and shall settle to its datum position rapidly.

d) The preferred presentation shall be a vertical compass card driven through unit ratio gearing by the outer gimbal, which shall be read against a fiducial mark fixed to the instrument case.

e) The gyroscope shall possess complete freedom about the outer gimbal axis and not less than ± 55° (but preferably ± 85°) about the inner gimbal axis.

f) Means shall be provided to maintain the axis of spin of the gyroscope substantially horizontal.

g) Means shall be provided for bringing the compass card to any desired position to synchronize with the aircraft compass. The operating knob shall be labelled "SYN" (Synchronize), and shall be spring-loaded outwards (push to engage).

h) A pointer shall be provided which can be set to any desired heading and the operating knob shall be labelled "Set Heading" or "Set HDG".

7 Air filter

The instrument shall have a replaceable and efficient air filter at the air inlet to prevent ingress of dust. The filter shall satisfy the requirements of the pressure drop test specified in Clause **28**.

8 Robustness

The instrument shall be so designed that shock loads giving an acceleration of 50 *g* in any direction do not impair the performance.

9 Air outlet connections

A suitable arrangement of air outlet connections is shown in Figure 1.

10 Moment of momentum

The angular moment of momentum shall be as high as possible consistent with size.

11 Lubrication

The rotor and gimbal bearings shall be designed to give satisfactory performance throughout the operating life of the instrument without re-lubrication.

12 Balance

The rotor shall be dynamically balanced about its axis of spin.

13 Marking

In addition to the marking required by BS G 100, instruments shall be marked with the latitude at which the instrument is compensated for the earth's rotation.

Section 3. Tests

14 General

a) The requirements of this section are based upon the assumption that testing is carried out at the same latitude as that for which the instrument is compensated.

b) Tests shall be made to prove compliance with all the requirements of this British Standard. It is not intended or recommended that complete tests shall be made on every instrument supplied.

Two kinds of test therefore are specified as follows:—

Type tests. — (Clauses **15** to **28**) which shall be made on representative samples of each particular design and range of instrument, as follows:

i) *Proof tests* — a sample instrument shall be subjected to all the tests specified in Clauses **15** to **23** inclusive.

ii) *Endurance tests* — a second sample instrument shall be subjected to the tests specified in Clauses **24**, **25** and **26**.

iii) *Climatic tests* — a further sample instrument shall be subjected to the tests specified in Clause **27**.

Routine production tests. — (Clause **29**) which shall be made on every instrument manufactured in accordance with the British Standard.

c) The minimum tests recommended to verify the serviceability of instruments manufactured in compliance with this British Standard are indicated in the Appendix.

d) The following conditions shall apply to all tests, unless otherwise specified:—

i) The instrument shall be mounted in the normal position and tested at room temperature (15° to 20 °C). The normal position shall be that in which the plane of the front face of the mounting flange is vertical and the centre line through the top fixing screw holes is horizontal within ¼°.

ii) All tests shall be effected with a pressure difference from inlet to outlet of 3½ ± ⅛ in. of mercury.

iii) From the time of starting ten minutes shall be allowed for the instrument to attain maximum speed. During the first seven minutes of this period, exercising with an amplitude about each gimbal axis of approximately 7½°, i.e., 15° total movement, may be permitted.

Type tests

15 Air consumption

With a pressure difference from inlet to outlet of 3½ in. of mercury the instrument shall not consume more than 1.2 cu ft of free air per minute reduced to a temperature of 15 °C and a pressure of 760 mm of mercury.

16 Starting test

The instrument shall be connected to an air source incorporating a relief valve, a manometer and an ON/OFF tap. The relief valve shall be set to control the pressure difference applied from inlet to outlet to a maximum of 1 in. of mercury. After setting the relief valve the tap shall be turned off and the rotor allowed to come to rest. When the rotor is stationary, the tap shall be turned on quickly and the air flow allowed to continue for 30 seconds; the tap shall then be turned off. The instrument shall be immediately rotated about a vertical axis and the card shall be stabilized.

17 Gyroscope drift test

The instrument shall be mounted and operated as specified in Clause **14** d). The compass card shall be set to 0°(N), and the table shall be set for roll, pitch and yaw motion to give an amplitude of 1½° and a period of between 5–7 cycles per minute. The direction of motion of the table shall be reversed at regular intervals of approximately one minute duration. After 15 minutes the table shall be stopped and arranged horizontally, when the drift of the card shall be not more than 3°.

18 Roll, pitch and yaw test

The instrument shall be mounted on a gyroscope test table and subjected to a roll, pitch and yaw test at an amplitude of 7½° and from 5 to 7 oscillations per minute. Whilst running, the table shall be reversed at one minute intervals. Starting with the case and gyroscope vertical and the card reading 0°(N), the drift of the card after the table has been in motion for ten minutes shall not exceed 3°.

19 Rotation test

The instrument shall be mounted on a turntable, the speed of rotation of which shall be between 180° and 210° per minute. After one complete revolution of the table the difference between card readings before and after the test shall not exceed 1°. To eliminate backlash in the instrument gearing, the table shall be first rotated to the datum in the direction in which the test is to be made, and after completing the revolution the table shall not over-run the datum.

20 Turning test

With the instrument mounted on a turntable the speed of rotation shall be adjusted to complete one revolution in from 28 to 32 seconds. The instrument shall then be rotated through six revolutions in both clockwise and counter-clockwise directions. After each six revolutions the drift of the gyroscope in azimuth shall not exceed 3°. To eliminate backlash in the gear, the table shall be first rotated to datum in the direction in which the test is to be made. The card reading shall then be noted, and on completion of the six revolutions the table shall not over-run the datum.

21 Backlash test

With the instrument operating and mounted on a turntable, the table shall be rotated by hand in a clockwise direction until the table graduation mark is in line with the table datum, when the compass card reading shall be noted. The table shall then be rotated in a clockwise direction, through approximately 90° and then shall be rotated in a counter-clockwise direction until the table graduation mark is again in line with the table datum. The compass card reading shall not differ from the previous reading by more than 2°. When setting the table graduation mark to the table datum, the table shall not over-run the datum.

22 Temperature test

a) With the gyroscope stationary, the instrument shall be maintained at a temperature of – 20 °C for a period of three-quarters of an hour. Ten minutes shall be allowed for the gyroscope to attain maximum speed, during which time the turntable and the instrument may be exercised by rotation either clockwise or counter-clockwise. The turning test specified in Clause **20** shall then be repeated at – 20 °C and the drift shall not exceed 5°.

b) After the test in a) the air supply shall be turned off and the temperature lowered to – 55 °C. After three-quarters of an hour at that temperature the gyroscope shall start and continue to run on application of a pressure difference of 3½ in. of mercury, as observed by appropriate deflection of the card when the test table is turned in either direction.

c) After the test in b) the air supply shall be turned off and the temperature gradually raised to + 50 °C. After three-quarters of an hour at that temperature the turning test specified in Clause **20** shall be repeated at + 50 °C, when the drift shall not exceed 5°.

d) After the test in c) the air supply shall be turned off and the temperature raised to + 70 °C. After three-quarters of an hour at that temperature the gyroscope shall start and continue to run on application of a pressure difference of 3½ in. of mercury, as observed by appropriate deflection of the card when the test table is turned in either direction.

e) On completion of the tests in a) to d) the instrument shall be subjected to and shall comply with the tests specified in Clauses **16** to **20** inclusive.

23 Compass interference

The compass safe distance shall be not more than 5 in. when measured in accordance with BS G 100.

24 Vibration tests

The instrument shall be subjected to the resonance and fatigue tests specified in BS G 100 appropriate to its installation position and its declared vibration grade and shall comply with the tests specified in Clauses **16** to **21** inclusive.

25 Endurance tests

The instrument shall be mounted and run on a rocking table so that both gimbal axes are rocked equally with a total movement of 5° at 5 to 7 complete oscillations per minute for 1 000 hours at normal temperature (15 °C to 20 °C.). After this test the instrument shall comply with the requirements of the serviceability tests (see Appendix) without further lubrication or adjustment.

NOTE It may be necessary to connect the two gimbals flexibly to maintain the gyroscope spin axis at right angles to the outer gimbal axis during this test.

26 Impact acceleration test

The instrument shall be subjected to the acceleration test specified in BS G 100, Clause **32**, after which it shall comply with the requirements of the tests specified in Clauses **15** to **21** of this British Standard.

27 Climatic tests

The instrument shall be subjected to the climatic tests specified in BS G 100, Clause **25**, and the following tests shall be applied at the appropriate points, defined in Table 1:—

Test point	Clause	Tests
A1	**16**	— Starting test.
	22 c)	— Temperature test.
A2	**16**	— Starting test.
	22 d)	— Temperature test.
B	**16**	— Starting test.
	22 b)	— Temperature test (at – 40 °C).
C	**16**	— Starting test.
	22 c)	— Temperature test (at + 50 °C).
D	**16**	— Starting test.
	17	— Gyroscope drift test.
	18	— Roll, pitch and yaw test
	19	— Rotation test.
	20	— Turning test.
	21	— Backlash test.

28 Filter pressure drop test

One per cent of the filters shall be selected at random and subjected to this test. With a flow of 2 cu ft/min. of air passing through the filter the measured pressure drop shall be between ¾ in. and 3½ in. of water. A convenient way of carrying out the test is as follows:—

The filter, mounted in a suitable housing, should be connected to a source of air under pressure (controlled by a valve). The outlet side of the filter should be connected to a calibrated jet discharging to atmosphere. The connecting pipes should be short and should nowhere be less than ⅜ in. bore. Teed-in connections on both sides of the filter should go to a water manometer for measuring the pressure difference across the filter and a similar connection on the upstream side of the jet should go to a manometer suited to the pressure difference which will give the required flow through the jet.

29 Routine production tests [As defined in Clause **14** b)]

Each instrument shall comply with the requirements of the tests specified in the following clauses of this British Standard:—

Clause		
16	—	Starting test.
17	—	Gyroscope drift test.
18	—	Roll, pitch and yaw test.
19	—	Rotation test.
20	—	Turning test.
21	—	Backlash test.

Table 1 — Climatic cycle test points

Test point	Grade 1 Instrument	Grade 2 Instrument
A1	After 8 hours at + 55 °C	(No equivalent test point)
A2	After 15 hours at + 70 °C	After 24 hours at + 55 °C (2nd day 8 o'clock)
B	After 3 hours at – 40 °C	After 16 hours at – 20 °C (3rd, 5th, 7th and 9th days at 8 o'clock)
C	After 15 hours at + 40 °C	After 16 hours at + 30 °C (4th, 6th, and 8th days at 8 o'clock)
D	After gradual cooling for 7 hours to 20 °C (at end of test cycle)	After gradual cooling for 4 hours to + 20 °C (10th day at 12 o'clock) (at end of test cycle)

Appendix Serviceability tests

The minimum tests recommended to verify the serviceability of instruments manufactured in compliance with this British Standard are as follows, with the tolerances amended where appropriate:—

a) *Conditions of test.* — As in Clause **14** d) unless otherwise stated.

b) *Exercising.* — 15 minutes normal.

— 30 minutes after being in store for more than 6 months.

c) *Functioning tests.* — Starting test (Clause **16**) – 1½ in. of mercury.

— Gyroscope drift test (Clause **17**) – 4½°.

— Roll, pitch and yaw test (Clause **18**) – 4½°.

— Rotation test (Clause **19**) – 3°.

— Turning test (Clause **20**) – 4°.

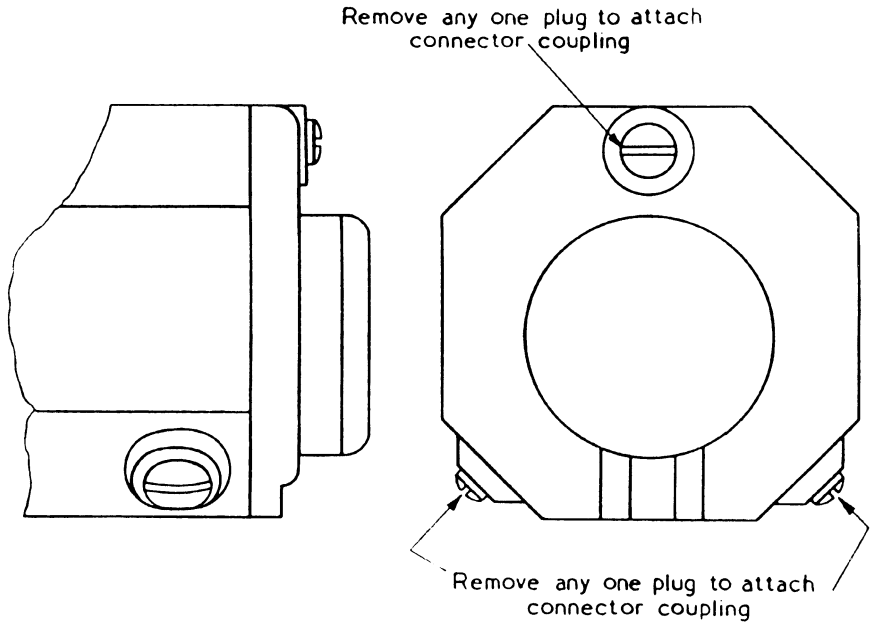

Figure 1 — Air connections for directional gyroscope

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