

MINIMUM PERFORMANCE STANDARD FOR  
TURN AND SLIP INSTRUMENT

1. PURPOSE

This standard establishes the minimum performance standards for turn and slip instruments for aircraft use.

2. SCOPE

2.1 This standard covers Turn and Slip Instruments which measure and display the rate of turn about the vertical axis and incorporate an integral slip indicator.

2.2 Applicable Documents: The following document shall form a part of this specification to the extent specified herein:

Radio Technical Commission for Aeronautics (RTCA) Document DO-138 dated 27 June 1968, on Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments. (Copies may be obtained from RTCA Secretariat, Suite 302, 2000 K Street, N. W., Washington, D. C. 20006).

3. GENERAL STANDARDS

3.1 This standard covers three basic types of turn and slip instruments:

Type I - Driven by air pressure.  
Type II - Driven electrically by direct current.  
Type III - Driven electrically by alternating current.

3.2 Operation of Controls: The design of the instrument must be such that any controls intended for use during flight cannot be operated in any possible position combinations or sequences that would result in a condition detrimental to the continued performance of the instrument.

3.3 Accessibility of Controls: Controls which are not normally adjusted in flight must not be readily accessible to flight personnel.

3.4 Effect of Tests: Unless otherwise stated, the application of the specified tests must not produce a subsequently discernible condition which would be detrimental to the continued performance of the instrument.

3.5 Fire Resistance: Except for small parts (such as knobs, fasteners, seals, grommets, and small electrical parts) that would not contribute significantly to the propagation of a fire, all materials used must be self-extinguishing when tested in accordance with the requirements of Federal Aviation Regulation 25.1359 (d) and Appendix F thereto, with the exception that materials tested may be configured in accordance with paragraph (b) of Appendix F or may be configured as used.

3.6 Indicating Means: Rate-of-turn may be indicated by means of a pointer, deflecting in the direction of turn, or by any other means conforming to these standards. The rate-of-turn pointer may be remotely located from the rate-of-turn gyro. Slip may be indicated by means of a ball, free to move in a curved transparent tube, or by any other means conforming to these standards.

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- 3.7 Visibility: Turn and slip indications must be visible from any point within the frustum of a cone the side of which makes an angle of at least 30 degrees with the perpendicular to the dial and the small diameter of which is the aperture of the instrument case.
- 3.8 Power Malfunction Indication: For Types II and III instruments, means must be incorporated in the instrument to indicate the loss of adequate power to the rate-of-turn gyro and primary signal voltages to the pointer in remote instruments. The indicating means must indicate a failure or malfunction in a positive manner.
- 3.9 Reflectance, Cover Glass: The total reflectance of the instrument cover glass including the integral lighting wedge, if applicable, shall not exceed 10% of the incident light. This reflectance applies over the visible light spectrum from 450 milli-microns to 600 milli-microns, and over an incident solid angle of 60° perpendicular to the viewing plane.

#### 4. PERFORMANCE STANDARDS UNDER STANDARD CONDITIONS

The test conditions applicable to a determination of the performance of turn and slip instruments are set forth in Appendix A of this standard. All instruments shall be tested in accordance with the manufacturers recommendations. The manufacturer shall conduct sufficient tests to prove compliance with these Minimum Performance Standards.

- 4.1 Turn Indicator Starting: Instrument performance must be achieved within three (3) minutes after normal rated power is applied for both air and electric operated instruments. By application of 50% of rated suction of air operated indicators and 80% of rated voltage for electrically operated indicators, the gyro must start, continue to rotate, and provide an adequate indication of turning motions. However, under the reduced power conditions, the turn indicator sensitivity and damping requirements do not apply. If the instrument incorporates a gyro speed monitoring device which provides a positive indication when the gyro speed is below that necessary to meet instrument performance, the starting time may exceed three minutes.
- 4.2 Turn Indicator Characteristics:
- (a) Sensitivity When the instrument is operating under rated power and subjected to the turning rates specified about the vertical axis, the turn instrument deflection, in inches or millimetres, must be within the limits of either Column A or B. The indicator movement must be smooth.

| Rate of Turn<br>(Degrees per<br>Minute) | Deflection of Indicator |           |             |            |
|---|-------------------------|-----------|-------------|------------|
|   | Column A                |           | Column B    |            |
|   | Inches                  | mm        | Inches      | mm         |
| 0                                       | 0 ± 0.015               | 0 ± 0.4   | 0 ± 0.015   | 0 ± 0.4    |
| 36                                      | 1/32 ± 1/64             | 0.8 ± 0.4 | 1/16 ± 1/64 | 1.6 ± 0.4  |
| 90                                      | 5/64 ± 1/32             | 2.0 ± 0.8 | 5/32 ± 1/32 | 4.0 ± 0.8  |
| 180                                     | 5/32 ± 1/32             | 4.0 ± 0.8 | 5/16 ± 1/16 | 7.9 ± 1.6  |
| 360                                     | 5/16 ± 1/16             | 7.9 ± 1.6 | 9/16 ± 1/8  | 14.3 ± 3.2 |

Column A values pertain to instruments set to indicate a standard rate of turn (180° per minute) with one indicator unit deflection. Column B provides double this displacement for indicators providing increased sensitivity.

For instruments possessing display features such that the dimensional characteristics prescribed by Columns A and B do not apply, the applicant may demonstrate that the indicator can reliably indicate the prescribed rates of turn with clarity and accuracy equivalent to that specified in Column A or B.

- (b) Damping. The time for the turn indicator or index to return to the zero mark without crossing the zero mark must be at least two but not more than four seconds, when the instrument is suddenly stopped after being rotated about its vertical axis at a rate that causes full-scale pointer or index deflection.

4.3 Slip Indicator Characteristics: The slip indicator must operate freely when the instrument is rotated about its longitudinal axis with the dial vertical. The range of slip indicators must be at least 7 degrees either side of vertical. With the instrument in its normal position for mounting, the position of the indicator must be zero (0)  $\pm$  1/32 inch (0  $\pm$  0.8 mm).

- (a) Damping. The time for the slip indicator to move from the zero position of the slip indication to the test position must not be less than 0.2 seconds following a sudden rotation of the instrument from a position of 12 degrees bank through the vertical to 12 degrees of opposite bank.
- (b) Slip Indicator Filling. Instruments using a liquid as a damping medium for the slip indicator must be so designed and filled that no part of an air bubble will be visible from a point 12 inches (30.5 cm) directly in front of the instrument when the instrument is rotated to an angle of roll of 45 degrees.

## 5. PERFORMANCE STANDARDS UNDER ENVIRONMENTAL CONDITIONS

Unless otherwise specified herein, the measurement procedures applicable to a determination of the performance of turn and slip instruments under environmental conditions are set forth in Radio Technical Commission for Aeronautics (RTCA) Document No. DO-138, entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments" dated 27 June 1968. Performance tests which must be made after subjection to test environments may be made after exposure to several environmental conditions. The order of tests must be in accordance with DO-138. The test procedures specified or referenced are satisfactory for use in determining the performance of turn and slip instruments under normal and extreme environmental conditions. Alternate approved test procedures that provide equivalent results may be used.

### 5.1 Temperature:

- (a) Low temperature. When subjected to the tests of DO-138, the instrument must operate electrically and mechanically and the requirements of paragraphs 4.1 through 4.3 of this standard must be met. The time required for the slip indicator to come to the rest position must not exceed four seconds as required by paragraph 4.3(a).
- (b) High temperature. When subjected to the tests of DO-138, the instrument must operate electrically and mechanically and the requirements of paragraph 4.1 through 4.3 of this standard must be met.

5.2 Altitude: When subjected to the tests of DO-138, the instrument must operate electrically and mechanically and the requirements of 4.1 through 4.3 of this standard must be met.

5.3 Humidity: When subjected to the tests of DO-138, standard humidity environment, the requirements of 4.1 through 4.3 of this standard must be met.

5.4 Vibration: When the instrument is tested in accordance with DO-138, standard vibration requirements, it must operate electrically and mechanically and the requirements of 4.1 through 4.3 must be met. After subjection to this test, the requirements of 4.1 through 4.3 of this standard must be met.

**5.5 Power Input:****(a) Electrical input variation test**

- (1) When the instrument is subjected to the tests in DO-138, it must meet the requirements of 4.1 through 4.3 of this standard.

**(b) Low voltage test**

- (1) When the instrument is subjected to the tests in DO-138, it must operate electrically and mechanically and degradation of performance is permissible. The degree of performance degradation shall be specified by the manufacturer.

**(c) Hydraulic/pneumatic input variation test**

- (1) When the instrument is subjected to the tests in DO-138, it must operate and degradation of performance is permissible. The degree of performance degradation shall be specified by the manufacturer.

**5.6 Conducted Voltage Transients:**

- (a) Intermittent transients - The instrument shall be subjected to the tests of DO-138, and shall meet the requirements of 4.1 through 4.3 of this standard.

- (b) Repetitive transients - The instrument shall be subjected to the tests of DO-138, and shall meet the requirements of 4.1 through 4.3 of this standard.

- (c) Interconnecting wiring induced transients - The instrument shall be subjected to the tests of DO-138, and shall meet the requirements of 4.1 through 4.3 of this standard.

- (d) Instruments operated from AC power - The instrument shall be subjected to the tests of DO-138, and shall meet the requirements of 4.1 through 4.3 of this standard.

**5.7 Conducted Audio Frequency Susceptibility Test:** The instrument shall be subjected to the tests of DO-138, and shall meet the requirement of 4.1 through 4.3 of this standard.

**5.8 Audio Frequency Magnetic Field Susceptibility:** The instrument shall be subjected to the tests of DO-138, and shall meet the requirements of 4.1 through 4.3 of this standard.

**5.9 Radio Frequency Susceptibility:** The instrument shall be subjected to the tests of DO-138, and shall meet the requirements of 4.1 through 4.3 of this standard.

**5.10 Emission of Radio Frequency Energy and Magnetic Effect:** The instrument shall be tested in accordance with radio frequency interference and magnetic effect requirements of DO-138, for the category to which the instrument is designed. As applicable, the instrument shall be tested in accordance with the magnetic effect paragraph.

**5.11 Explosion:** Instruments which are to be marked Explosion Category E must be tested in accordance with DO-138.

**5.12 Waterproofness:** Instruments which are to be marked Waterproofness Category W must be tested in accordance with DO-138. Following this test, the instrument must meet the requirements of 4.1 through 4.3 of this standard.

- 5.13 Hydraulic Fluid: Instruments which are to be marked Hydraulic Fluid Category H must be tested in accordance with DO-138. Following this test, the instrument must meet the requirements of 4.1 through 4.3 of this standard.
- 5.14 Sand and Dust: Instruments which are to be marked Sand and Dust Category D must be tested in accordance with DO-138. Following this test, the instrument must meet the requirements of 4.1 through 4.3 of this standard.
- 5.15 Fungus Resistance: Instruments which are to be marked Fungus Resistance Category F must be tested in accordance with DO-138. Following this test, the instrument must meet the requirement of 4.1 through 4.3 of this standard.
- 5.16 Salt Spray: Instruments which are to be marked Salt Spray Category S must be tested in accordance with DO-138. Following this test, the instrument must meet the requirements of 4.1 through 4.3 of this standard.

PREPARED BY  
SAE COMMITTEE A-4, AIRCRAFT INSTRUMENTS

**APPENDIX A****Standard Test Conditions**

The following conditions of tests are applicable to the instrument tests specified herein:

**Atmospheric Conditions** Unless otherwise specified, all tests required by this standard must be conducted at an atmospheric pressure of approximately 29.92 inches (760 mm) of mercury, an ambient temperature of approximately +77°F (+25°C), and a relative humidity of not greater than 85 percent. When tests are conducted with the atmospheric pressure of temperature substantially different from these values, allowance must be made for the variation from the specified conditions.

**Vibration to Minimize Friction** Unless otherwise specified, all tests for performance may be conducted with the instrument subjected to a vibration of 0.002 to 0.005 inches (0.05 to 0.13 mm) double amplitude at a frequency of 25 to 33 Hertz. The term double amplitude as used herein indicates the total displacement from positive maximum to negative maximum.

**Power Conditions** Unless otherwise specified, all tests must be conducted at the power rating recommended by the manufacturer.

**Mounting Position** Unless otherwise specified, all tests must be made with the instrument (indicator, gyroscope, etc.) mounted in their normal operating position.