



AEROSPACE STANDARD

AS8002™**REV. B**Issued 1981-10
Revised 2020-04

Superseding AS8002A

(R) Air Data Computer – Minimum Performance Standard

RATIONALE

This standard was revised to: update certain design requirements so they apply to all air data computers; add a new equipment designation (type) for installations that require more stringent altitude tolerance requirements; update the environmental test requirements to include those of DO-160G as they apply to air data computers and add some information regarding RVSM installations to increase the awareness of related requirements not covered by this standard. A generally accepted methodology for economically showing compliance to this standard was also included in an appendix.

1. SCOPE

This SAE Aerospace Standard (AS) covers air data computer equipment (hereinafter designated the computer) which when connected to sources of aircraft electrical power, static pressure, total pressure, outside air temperature, and others specified by the manufacturer (singly or in combination) provides some or all of the following computed air data output signals (in analog and/or digital form) which may supply primary and/or standby flight instruments:

Pressure Altitude

Pressure Altitude, Baro-Corrected

Vertical Speed

Calibrated Airspeed

Mach Number

Maximum Allowable Airspeed

Over-speed Warning

Total Air Temperature

1.1 Purpose

This Standard defines minimum performance requirements under standard and environmental conditions for Air Data Computer equipment used in Subsonic Aircraft. It does not address RVSM requirements for air data computers because RVSM is a system certification whose component requirements cannot be independently detailed. Instead, this standard lists requirements for two types of air data computers. Type 1 must meet altitude tolerance requirements that are largely based on the previous revision of this standard. Type 2 must meet more stringent altitude tolerance requirements than Type 1. The altimetry error budget distribution of some RVSM installations may require Type 2 equipment. However, both Type 1 and Type 2 equipment can support RVSM certifications.

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Documents

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2. REFERENCES

2.1 Applicable documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

AC 20-115D Airborne Software Assurance

AC 91-85B Authorization of Aircraft and Operators for Flight in Reduced Vertical Separation Minimum (RVSM) Airspace

2.1.2 Other Publications

Available from Superintendent of Documents, Government Printing Office, Washington, DC 20402, www.gpo.gov or from various independent document service companies.

"U.S. Standard Atmosphere, 1976", NASA/USAF/USWB, Washington, 1976.

(NOTE: This standard is identical to the ICAO Standard Atmosphere for values within the scope of AS8002.)

"Tables of Airspeed, Altitude and Mach Number; Based on Latest International Values for Atmospheric Properties and Physical Constants" Livingston and Gracey, Technical Note D-822, NASA, Washington, 1961.

"The International System of Units; Physical Constants and Conversion Factors", Mechty, NASA SP-7012, NASA, Washington,

2.1.3 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

DO-160G Environmental Conditions and Test Procedures for Airborne Equipment

DO-178B Software Considerations in Airborne Systems and Equipment Certification

DO-178C Software Considerations in Airborne Systems and Equipment Certification

DO-254 Design Assurance Guidance for Airborne Electronic Hardware

2.1.4 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP4754 Guidelines for Development of Civil Aircraft and Systems

ARP4761 Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment

2.1.5 EUROCAE Publications

Available from EUROCAE Secretariat, 102 rue Etienne Dolet, 92240 Malakoff, France, Tel: +33 1 40 92 79 30, www.eurocae.net.

ED-241 MINIMUM OPERATIONAL PERFORMANCE SPECIFICATION FOR ALTIMETRY FUNCTION

2.2 Definitions

CALIBRATED AIRSPEED: Calibrated airspeed is indicated airspeed corrected for instrument calibration and position errors.

INDICATED AIRSPEED: Indicated airspeed is the speed of an aircraft relative to the surrounding air mass. It is uncorrected for any installation or instrument errors. Indicated airspeed represents true air speed at standard sea level conditions only, and is a function of only impact pressure.

MAY: The word “may” is used to denote a permissible or possible action. It does not express a requirement of this specification.

MUST: The word “must” is used in this document to express an essential (mandatory) requirement that is required by a specific regulation. Any deviation from the specified requirement shall require justification.

PRESSURE ALTITUDE: Pressure altitude is the height above sea level (standard datum plane) on a standard day when the barometric pressure is 29.92126 in Hg (1013.25 mb).

RVSM: Reduced Vertical Separation Minima or Minimum (RVSM) is defined as the reduction of the minimum vertical separation between aircraft provided by air traffic control from 2000 to 1000 feet at flight levels from 29000 feet up to 41000 feet (RVSM airspace).

SHALL: The word “shall” is used in this document to express an essential requirement where compliance is mandatory. Any deviation from the specified requirement shall require justification.

SHOULD: The word “should” is used in this document to express a recommendation.

2.3 Abbreviations and Acronyms

Baro	Barometric
°C	Degree Celcius
ft	Feet
EUROCAE	European Organization for Civil Aviation Equipment
FAA	Federal Aviation Administration
h	Hour
km	Kilometer
M _{mo}	Maximum operating Mach number
m	Meter
mb	Millibar
P _t	Total pressure
P _s	Static pressure

q_c	Impact (dynamic) pressure
RTCA	RTCA Inc.
RMS	Root mean square
RVSM	Reduced vertical separation minima
SI	International System of Units
SSEC	Static source error correction
TAT	Total air temperature
V_{mo}	Maximum operating limit speed

3. GENERAL REQUIREMENTS

3.1 Operation of Controls

The operation of controls intended for use during flight, if any, in all possible position combinations and sequences including OFF, shall not result in a condition whose presence or continuation would be detrimental to the continued performance of the computer.

3.2 Accessibility of Controls

Controls which are not normally adjusted in flight shall not be readily accessible to flight personnel, when the computer is installed in accordance with the manufacturer's instructions.

3.3 Compatibility of Components

If the computer consists of more than one component and these components are individually acceptable but require matching for proper operation, these individual components shall be identified on the equipment nameplate in a manner that will ensure proper matching.

3.4 Interchangeability

Instruments and components which are identified with the same manufacturer's part number shall be interchangeable.

3.5 Flammability

The instrument shall comply with the fire, flammability test requirements of DO-160G, Section 26, category C.

3.6 Altitude Reference

Calibration of the static air sensing mechanism for pressure altitude outputs (including baro-corrected if supplied) shall be to the geopotential altitude tables of U.S. Standard Atmosphere, 1976.

3.7 Calibrated Airspeed and Mach Reference

Calibrated airspeed and Mach outputs shall be calibrated per Tables in NASA Technical Note D-822 dated August 1961.

3.8 Alarm Signal

A means shall be provided for the computer to indicate its output integrity is degraded, or that its outputs are not derived from live pressure measurements.

The air data computer shall provide information for a status indication that allows for positive detection of any operational and non-operational state.

These requirements ensure that a reliable indication is available to prevent consuming equipment from being adversely affected by any detectable condition impacting the computer's integrity. Possible conditions include, but are not limited to, erroneous pressure measurements or calculations, stale outputs, artificial outputs provided for test purposes, or outputs that can be read when the computer is unpowered. Computers that provide digital outputs can accomplish this by providing a status indication with the output data, or by terminating transmission of the digital output.

3.9 Self-Test Capability

If the computer contains a self-test feature which might adversely affect using systems, then the installer must ensure a means is provided to permit deactivating those systems during the self-test cycle. In-flight, self-test activating controls shall provide a means to warn the pilot of this mode of operation, and the installer must provide a means to warn the pilot which subsystems, if any, are deactivated. Self-test features shall be spring loaded or otherwise arranged to return automatically to the normal operating mode.

3.10 Applied Pressures

The computer shall meet the accuracy requirements of this standard and shall not be damaged after having the following pressures applied to its pressure fittings while it is energized and non-energized:

Case	Applied Pressures
a	1.4 in Hg absolute (35.6 mm Hg absolute) to 32.15 in Hg absolute (816.61 mm Hg absolute) applied to the static pressure fitting.
b	125% of the impact pressure (dynamic pressure) corresponding to the maximum airspeed range of the computer plus 32.15 in Hg absolute (816.61 mm Hg absolute) applied to the total pressure fitting while 32.15 in Hg absolute (816.61 mm Hg absolute) is simultaneously applied to the static pressure fitting.
c	30.0 in Hg absolute (762.0 mm Hg absolute) applied to the total pressure fitting while 32.15 in Hg (816.61 mm Hg absolute) is simultaneously applied to the static pressure fitting.

3.11 Software and Electronic Hardware

3.11.1 Failure Condition Classification

The Design Assurance Level should be based on the process outlined in ARP4761 and ARP4754 and should be compatible with the required system integrity as determined by the installer's System Safety Assessment process.

3.11.2 Software Qualification

If the air data computer includes software, the software should be developed according to RTCA, Inc. document RTCA/DO-178C, Software Considerations in Airborne Systems and Equipment Certification, dated December 13, 2011, including referenced supplements as applicable, to at least the software level consistent with the failure condition classification defined above. Software may also be developed according to RTCA, Inc. document RTCA/DO-178B, dated December 1, 1992 if the guidance of AC 20-115D, Airborne Software Assurance, dated July 19, 2013 is followed.

3.11.3 Electronic Hardware Qualification

If the air data computer includes complex custom airborne electronic hardware, the component(s) should be developed according to RTCA, Inc. document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware, to at least the design assurance level consistent with the failure condition classification defined above. For custom airborne electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.

3.12 Identification

Items a through e shall be legibly and permanently marked on the equipment or nameplate attached thereto. Items f and g shall either be similarly marked or shall be supplied to the installer via an installation manual.

- a. Name of equipment,
- b. AS8002B Type 1 or Type 2 as appropriate,
- c. Manufacturer's model number or part number,
- d. Manufacturer's name and address,
- e. Manufacturer's serial number,
- f. Range of altitude, airspeed, and Mach,
- g. Nominal weight.

3.13 Long Term Stability (Drift) Performance

This standard does not contain a requirement for long term stability. However, users of this standard should be aware that some installations may want long term stability information to support an installation approval.

Additional sources of information on this topic are available in FAA AC 91-85B and EUROCAE ED-241.

3.14 Procedure for Interpolating and Rounding Values

If it is necessary to interpolate and use values between two values of the tables within this standard, then straight line interpolation shall be used to determine the intermediate value. Interpolated values shall be rounded to the same accuracy level as in the table using one of the following methods:

1. If the digits to be discarded begin with a digit less than 5, then the digit preceding the discarded digits is not changed.

Example: 6.9749515 rounded to two place accuracy would be 6.97

2. If the digits to be discarded begin with a 5 and at least one of the following digits is greater than 0, then the digit preceding the 5 is increased by 1.

Example: 6.9749515 rounded to four place accuracy would be 6.9750

3. If the digits to be discarded begin with a 5 and all of the following digits are 0, then the digit preceding the 5 is unchanged if it is even and increased by 1 if it is odd.

Example: 6.9749515 rounded to six place accuracy would be 6.974952

Example: 6.9749505 rounded to six place accuracy would be 6.974950

4. TEST CONDITIONS

- 4.1 All performance shall be evaluated under ambient room conditions as defined in DO-160G except where otherwise specified.
- 4.2 The pressure standards shall be accurate, with corrections, to within .004 in Hg (0.10 mm Hg).
- 4.3 A warmup period of not to exceed 30 minutes shall be allowed if specified by the manufacturer.
- 4.4 Except during the appropriate portions of friction tests, vibration as defined in DO-160G to minimize friction shall be allowed if specified by the manufacturer.
- 4.5 The output of a typical air data computer occasionally has momentary excursions that exceed the tolerance limits of the tables within this standard. Compliance to this standard shall be based on 99.7% of the observations (3 sigma) meeting the requirements of the relevant tables herein.
- 4.6 Compliance to the requirements of this standard listed in aeronautical units may also be shown by using the appropriate pressure values determined or derived from the publications listed in 2.1.2.

5. INDIVIDUAL PERFORMANCE TESTS

Each computer shall be subjected to whatever tests the manufacturer deems necessary to demonstrate specific compliance with the requirements of this standard, and shall include the following requirements as a minimum.

If static source error correction (SSEC) is performed by the computer, SSEC shall be activated during the tests of this section unless it can be shown that the environment and manufacturing processes do not affect the accuracy of the error correction. For example, an SSEC might only be a software function and therefore not affected by the environment.

The tests in this section can be performed in any order with one exception. The test per 5.11 shall be performed before any of the other tests.

5.1 Accuracy

Within the ranges specified by the manufacturer, the computer outputs shall meet the performance requirements of Tables 1 through 7 and other portions of this section, as applicable during room ambient operation. The tolerances include threshold, friction, hysteresis, and repeatability. Tolerances for intermediate values are a straight line interpolation.

NOTE: Meeting the requirements of Tables 1 and 3 does not guarantee the requirements of Table 4 will be met. For some air data computers, it may be necessary to restrict the tolerances allowed by Tables 1 and/or 3 to smaller values so the computer will meet the requirements of Table 4.

If barometric correction of altitude is supplied, a minimum of four values including the maximum negative, zero, and maximum positive corrections of Table 2 shall be used during accuracy tests at altitudes below 18000 feet. At altitudes of 18000 feet and above, a baro setting of 29.92 in Hg (1013 mb) shall be used. Between 0 and 8300 feet of altitude corrections which would provide an altitude output below 0 feet need not be applied.

5.2 Static Source Error Correction Tolerance (If Applicable)

Outputs may be corrected for static source errors of the specific aircraft model in which the instrument is intended to be used. The tolerances for the outputs as corrected are determined by the product of the allowed tolerances at nominal input of the correcting parameter and the slope of the defined correction curve.

When testing corrected parameters (altitude, airspeed, or Mach) the nominal value of the parameter at each test point indicated in Tables 1, 3, or 4 shall be adjusted to include the correction value with tolerance limits set per the above.

Figure 1 clarifies the intent of the corrected output tolerances.

5.3 Barometric Corrected Altitude (if applicable)

The computer may contain an altitude output(s) which is corrected for barometric pressure. This particular output(s) shall differ from Table 1 values by the amount shown in Table 2 for the barometric settings shown in Table 2. The tolerances shown in Table 2 are to be added to the Table 1 tolerances. The barometric altitude feature shall not change other output parameters including the normal uncorrected altitude output(s).

5.4 Additional Outputs

This test requirement was deleted.

5.5 Threshold

The flight instrument outputs shall provide a signal change of discernible magnitude upon an interface readout device of the proper phase when the input is varied incrementally or in alternate directions by the following values:

Altitude: ± 0.003 in Hg (± 0.08 mm Hg)

Airspeed: ± 0.003 in Hg (± 0.08 mm Hg) or $\pm 25\%$ of tolerance shown in Table 3, whichever is greater

The threshold requirements shall be met for each pressure parameter at three test points when at standard conditions. The threshold shall be determined by slowly increasing and decreasing the applied pressure around each test point.

Note 1: Performing the threshold test is not required as a part of the individual performance tests if the threshold response of the computer is not affected by variation in the process of its manufacture.

Note 2: Performing the threshold test is not required as a part of the environmental test requirements of Section 6 if the threshold response of the computer is not affected by variation in the process of its manufacture and the effects of those environments.

5.6 Leakage

The leakage of the computer with static and pitot ports connected together shall not exceed 0.010 in Hg (0.25 mm Hg) per minute with a pressure equivalent to 40000 feet (5.54 in Hg or 140 mm Hg abs) applied. With a pressure equivalent to 15000 feet¹ (16.88 in Hg or 429 mm Hg abs) applied to the static port and pitot port open to the atmosphere, the leakage shall not exceed 0.010 inches (0.25 mm) of mercury per minute. These leak rates shall be measured with total volume of both Ps and Pt pressure (trapped gas) in the computer and test equipment equal to or less than 110 in³ (1803 cm³). Thermal equilibrium shall be maintained while performing this test.

NOTE 1: If the applied pressure will exceed the total pressure fitting requirement of 3.10, the pressure for this portion of the test shall be increased to provide the differential pressure defined in 3.10

5.7 Attitude Tolerance

The change in each computer's output from its output in the normally installed orientation shall be determined for at least the sensitive attitudes determined during the qualification tests per 6.31 and any additional non-sensitive attitudes the manufacturer deems necessary to demonstrate compliance with this standard. The inputs to the computer shall be per 6.31 and the change in output shall not exceed the limits in 6.31.

5.8 Power Loss

The alarm signal required by 3.8 shall be tested for power loss.

5.9 Self-Test Capabilities

The computer shall be tested per 3.9 requirements as applicable.

5.10 Insulation Resistance

The insulation resistance measured at 200 VDC for 5 seconds between all electrical circuits and the metallic case shall not be less than 5 megohms. Insulation resistance measurements shall not be made to circuits where the potential will appear across elements such as windings, resistors, capacitors, etc., since the measurement is intended only to determine adequacy of insulation.

5.11 Over-Potential Test

The computer shall not be damaged by the application of a test potential between electrical circuits, and between electrical circuits and the metallic case. The test potential shall be a sinusoidal voltage of a commercial frequency with an RMS value of five times the maximum circuit voltage. The potential shall start from zero and be increased at a uniform rate to its test value. It shall be maintained at this value for 5 seconds, and then reduced at a uniform rate to zero.

Since these tests are intended to insure proper electrical isolation for the circuit components in question, these tests shall not be applied to circuits where the potential will appear across elements such as windings, resistors, capacitors, semiconductors, etc.

Circuits that operate at potential at or below 28 V are not to be subjected to over-potential tests.

6. QUALIFICATION TESTS

As many computers as deemed necessary by the manufacturer shall be tested to demonstrate that all computers will comply with the following requirements of this standard and the appropriate sections of DO-160G. Unless otherwise specified, tests shall be performed per the category declared by the manufacturer. The performance tests that are required after each environmental test may be conducted after exposure to several environmental conditions. The order of tests must be in accordance with paragraph 3.2 of DO-160G.

6.1 Test Procedures

The test procedures specified or referenced are satisfactory for use in determining the performance of air data computers under standard and extreme environmental conditions. Alternate test procedures providing equivalent results can be proposed and approved by the appropriate regulating agency.

6.2 Operating Low Temperature Test

6.2.1 Requirements for Type 1 Computers

The computer shall be subjected to the low temperature environmental conditions as specified for the applicable category in Section 4 of DO-160G. The performance tests as specified in 5.1 through 5.5 of this standard shall be conducted at the low temperature environment. For ambient temperatures less than +10 °C the tolerance requirement shall be the sum of the standard condition tolerances plus 1.15% per additional degree C as the temperature is reduced, from +10 °C to the test temperature. After exposure to this condition, the requirements of 5.1 through 5.5 of this standard shall be met at standard conditions.

6.2.2 Requirements for Type 2 Computers

The computer shall be subjected to the low temperature environmental conditions as specified for the applicable category in Section 4 of DO-160G. The performance tests as specified in 5.1 through 5.5 of this standard shall be conducted at the low temperature environment. There is no additional tolerance allowed for non-standard temperature as there is for Type 1 computers. After exposure to this condition, the requirements of 5.1 through 5.5 of this standard shall be met at standard conditions.