



Technical Standard Order

Subject: VDL MODE 2 COMMUNICATIONS EQUIPMENT

1. PURPOSE. This technical standard order (TSO) is for manufacturers applying for a TSO authorization or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your very high frequency (VHF) digital link (VDL) mode 2 communications equipment must first meet for approval and identification with the applicable TSO marking.

2. APPLICABILITY.

a. This TSO affects new applications submitted after its effective date.

b. Major design changes to VDL mode 2 communications equipment approved under this TSO will require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) § 21.611(b).

3. REQUIREMENTS.

a. New models of VDL mode 2 equipment identified and manufactured on or after the effective date of this TSO must meet the MPS in RTCA, Inc. document RTCA/DO-281A, *Minimum Operational Performance Standards for Aircraft VDL Mode 2 Physical, Link, and Network Layer*, dated November 8, 2005, Sections 2.2 and 2.3.

b. The MPS allow for different equipment classes as defined by RTCA/DO-281A, Section 2.1.8. There are three equipment classes, summarized below:

Table 1. Equipment Class for VDL Mode 2

Equipment Class	Description
F	VDL mode 2 receiver used in a 25 kilohertz (kHz) channel separation environment
7	VDL mode 2 transmitter used in a 25 kHz channel separation environment, intended to operate with a range of 200 nautical miles
8	VDL mode 2 transmitter used in a 25 kHz channel separation environment, intended to operate with a range of 100 nautical miles

(1) In addition to *equipment* classes, the MPS allow for five different *equipment architecture* classes, defined in RTCA/DO-281A, Section 2.1.9. RTCA/DO-281A, Appendix B correlates the applicable requirements to equipment architecture classes. VDL mode 2 protocol layers and sub-layers are comprised of the physical, media access control (MAC), data link

services (DLS), link management entity (LME), subnetwork access protocol (SNAcP) and subnetwork dependent convergence function (SNDCF). Table 2 below presents the five equipment architecture classes and VDL mode 2 functionalities they provide:

Table 2. Equipment Architecture Classes for VDL Mode 2

Equipment Architecture Class	Equipment Name	VDL Mode 2 Functionality (Layers/Sub Layers)
V (non-International Standards Organization (ISO) 8208)	VHF digital radio (VDR)	Physical, MAC and LME, DLS
W (non-ISO 8208)	Communication management unit (CMU)	LME and DLS
X (ISO 8208)	VHF digital radio (VDR)	Physical, MAC, LME, DLS, SNAcP and SNDCF
Y	VHF digital radio (VDR)	Physical and MAC
Z (ISO 8208)	Communication management unit (CMU)	LME, MAC, DLS, SNAcP and SNDCF

(2) We expect this equipment will also have functionality not covered by this TSO. You must identify and describe added functionality according to paragraph **5.b(4)** of this TSO. Examples of added functionality are other VHF digital link implementations such as: Mode A, Aircraft Communications Addressing and Reporting System (ACARS), ACARS over aviation VHF link control (AVLC) (AOA), and functionality above the VDL mode 2 protocol layers (see RTCA/DO-281 Section 1.2).

c. Functionality. This TSO's standards apply to equipment intended for aircraft VDL mode 2 communications operating in the radio frequency range of 117.975 megahertz (MHz) to 137.000 MHz. VDL mode 2 equipment covered by this TSO is principally intended for aeronautical operational control (AOC) and air traffic services (ATS) safety communications. Equipment developed under this TSO will work with aircraft equipment used to communicate tactical and strategic information.

d. Failure Condition Classification. Failure of the function defined in paragraphs **3.a** and **3.c** of this TSO is a *major* failure condition. Develop the system to at least the design assurance level and quantitative safety objectives commensurate with this failure condition classification. See appendix 1 for additional guidance on design assurance levels and quantitative safety objectives.

e. Functional Qualification. Demonstrate the required performance under the test conditions in RTCA/DO-281A, Section 2.4. Appendix B of RTCA/DO-281A correlates verification tests to equipment architecture classes. Table 2, above, depicts equipment architecture classes that vary, depending on the VDL mode 2 functions they provide.

f. Environmental Qualification. Demonstrate the required environmental performance under the test conditions specified in RTCA/DO-281A, Section 2.3. Environmental conditions used in these environmental performance tests are in RTCA/DO-160E or EUROCAE/ED-14E, both titled *Environmental Conditions and Test Procedures for Airborne Equipment* and dated December 9, 2004.

g. Software Qualification. If the article includes software, develop the software according to RTCA/DO-178B or EUROCAE/ED-12B, both titled *Software Considerations in Airborne Systems and Equipment Certification* and dated December 1, 1992.

h. Electronic Hardware Qualification. If the article includes a complex custom micro-coded component, develop the component to the guidance in FAA Advisory Circular (AC) 20-152, *RTCA, Inc. Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware*, or EUROCAE/ED-80, *Design Assurance Guidance for Airborne Electronic Hardware*, dated April 19, 2000. The hardware design assurance level should be consistent with the failure condition classification in paragraph **3.d** of this TSO.

i. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under 14 CFR § 21.609 before submitting your data package.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in 14 CFR § 21.607(d), except:

(1) 14 CFR § 21.607(d)(2). Use the name, type, and part number. Do not use the optional model number.

(2) 14 CFR § 21.607(d)(3). Use the date of manufacture when that information is critical for maintenance or inspections, or both. Do not use the optional serial number.

b. Also, mark the following permanently and legibly with at least the manufacturer's name, subassembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools),

(2) Each interchangeable element, and

(3) Each sub-assembly of the article that you determined may be interchangeable.

c. If the component includes software, then the part number must include hardware and software identification. Or you can use a separate part number for hardware and software. Either way, you must include a means to show the modification status.

NOTE: Similar software versions, approved to different software levels, must be differentiated by part number.

d. If applicable, identify deviations granted to the article by marking "Deviation. See installation/instruction manual (IM)" after the TSO number. You can abbreviate the marking to "(Dev. See IM)."

e. When applicable, identify the equipment as an incomplete system or state that the article performs functions beyond those described in paragraphs **3.a** and **3.c** of this TSO.

f. Mark equipment class(es) as defined in RTCA/DO-281A, Section 2.1.8. A satisfactory marking sample is "Equipment Class: F and 7." Equipment classes don't apply for equipment architecture class W and Z. Mark "Equipment Class: N/A" for equipment architecture classes W and Z. Equipment class markings in the installation procedures and limitations of paragraph **5.b(6)** of this TSO qualify as a viable method. However, you then must include a reference to the specific installation manual with the required information on the nameplate of the component.

g. Mark equipment architecture class(es) as defined in of RTCA/DO-281A, Section 2.1.9. A satisfactory marking sample is "Equipment Architecture Class: X." Equipment architecture class markings in the installation procedures and limitations of paragraph **5.b(6)** of this TSO qualify as a viable method. However, you then must include a reference to the specific installation manual with the required information on the nameplate of the component.

5. APPLICATION DATA REQUIREMENTS. As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities a statement of conformance, as specified in 14 CFR § 21.605(a)(1) and one copy each of the following technical data to support our design and production approval. (Under 14 CFR § 21.617(a)(2), LODA applicants submit the same data through their civil aviation authority:)

a. Operating instructions and equipment limitations in an IM, sufficient to describe the equipment's operational capability. Describe any deviations in detail. If needed, identify equipment by part number, version, revision, and criticality level of software, classification for use, and environmental categories.

b. Installation procedures and limitations in an IM, sufficient to ensure that the article, when installed in accordance with the installation procedures, continues to meet the requirements of this TSO and will meet the airworthiness and operating requirements appropriate for the intended type of aircraft and operation. The limitations must include:

(1) A note with the following statement:

The conditions and tests required for TSO approval of this article are minimum performance standards. Those installing this article, on or in a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must have separate approval for installation in an aircraft. The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

(2) Development assurance level(s) for the functions defined in paragraphs **3.a** and **3.c** of this TSO.

(3) Quantitative safety objectives for the functions defined in paragraphs **3.a** and **3.c** of this TSO

(4) When applicable, identify the equipment as an incomplete system or that the equipment accomplishes additional functions beyond that described in paragraphs **3.a** and **3.c** of this TSO. Also, describe the functions provided by the equipment.

(5) Any unique aspects of the installation, including those relevant to any deviations that may have been granted.

(6) The equipment class(es) and architecture class(es) that the equipment has been qualified to perform and the functions provided by these class(es). Write the description so an installer of the equipment will know the equipment being installed meets the intentions of the installation.

c. Schematic drawings of the installation procedures.

d. Wiring diagrams of the installation procedures.

e. Equipment specifications.

f. List of components, by part number, that make up the system complying with the standards prescribed in this TSO. Include vendor part number cross-references when applicable.

g. A component maintenance manual (CMM) covering periodic maintenance, calibration and repair, for the continued airworthiness of installed equipment. Include recommended inspection intervals and service life. Details of deviations granted, as noted in paragraphs **5.a** and **5.b** of this TSO and relevant to continued airworthiness, must also be described.

h. Material and process specifications list.

i. The quality control system (QCS) description required by 14 CFR §§ 21.143 and 21.605(a)(3), including functional test specifications used to qualify each production article to ensure compliance with this TSO. The QCS should ensure that you will detect any change to the equipment that could adversely affect compliance with the TSO MPS, and reject the item accordingly. (Not required for LODA applicants).

j. Manufacturer's TSO qualification test report.

k. Nameplate drawing providing the information required by paragraph **4** of this TSO.

l. List of all drawings and processes (including revision level) that define the article's design. For a minor change, follow the directions in 14 CFR § 21.611(a). Show any revisions to the drawing list only on our request.

m. An environmental qualifications form as described in RTCA/DO-160E for each component of the system.

n. If the article includes a digital computer: a plan for software aspects of certification (PSAC), software configuration index (SCI), and software accomplishment summary (SAS). We recommend that you submit the PSAC early in the software development process. Early submittal allows us to quickly resolve issues, such as partitioning and determination of software levels.

o. If the article includes a complex custom micro-coded component: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary. We recommend that you submit the PHAC early in the hardware development process. Early submittal allows us to quickly resolve issues.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to us, have available for review by the responsible ACO or civil aviation authorities:

- a. Functional qualification specifications to be used to qualify each production article to ensure compliance with this TSO.
- b. Equipment calibration procedures.
- c. Corrective maintenance procedures within 12 months after TSO authorization.
- d. Schematic drawings.
- e. Wiring diagrams.
- f. Material and process specifications.
- g. Results of the environmental qualification tests conducted per RTCA/DO-160E or EUROCAE/ED-14E.
- h. If the article includes a digital computer, the appropriate documentation as defined in RTCA/DO-178B or EUROCAE ED-12B or including all data supporting the applicable objectives found in either RTCA/DO-178B or EUROCAE/ED-12B, Annex A, Process Objectives and Outputs by Software Level.
- i. If the article includes a complex custom micro-coded component, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254 or EUROCAE/ED-80, Appendix A, Table A-1.

7. FURNISHED DATA REQUIREMENTS. If furnishing one or more articles manufactured under this TSO to one entity (such as an operator or repair station), provide one copy of the technical data and information specified in paragraphs **5.a** through **5.g** of this TSO. Add any data or information necessary for the proper installation, certification, use, or for continued airworthiness of the equipment.

8. HOW TO GET REFERENCED DOCUMENTS.

- a. Order RTCA documents from RTCA Inc., 1828 L Street NW, Suite 805, Washington, D.C. 20036-4001. You can also order online from the RTCA Internet website at: www.rtca.org.
- b. Order EUROCAE documents from EUROCAE, 17 rue Hamelin, 75116 Paris, France. You can also order online from the EUROCAE Internet website at: www.eurocae.com.
- c. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096. You can also order online from the SAE Internet website at: www.sae.org.
- d. Order copies of 14 CFR part 21, Subpart O from the Superintendent of Documents, Government Printing Office, P.O. Box 37154, Pittsburgh PA 15250-7954. Telephone (202) 512-1800, fax (202) 512-2250. Copies may also be obtained online at www.access.gpo.gov. Select "Access," then "Online Bookstore." Select "Aviation," then "Code of Federal Regulations."

e. You can find a current list of technical standard orders on the FAA Internet website Regulatory and Guidance Library at <http://rgl.faa.gov>. You will also find the TSO Index of Articles, and a link to the advisory circular section, at the same site.

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APPENDIX 1. ADDITIONAL GUIDANCE ON DESIGN ASSURANCE LEVELS AND QUANTITATIVE SAFETY OBJECTIVES

1.1 PURPOSE. Although the major hazard classification remains the same regardless of an aircraft installation, the design assurance levels and quantitative safety objectives commensurate to the hazard classification may vary for different aircraft installations.

1.2 DESIGN ASSURANCE LEVELS. You'll find guidance on establishing design assurance levels for different installations in the latest versions of:

- For a *system*, SAE International's Aerospace Recommended Practice (ARP) 4754, *Certification Considerations for Highly Integrated or Complex Aircraft Systems*, dated June 27, 1996.
- For *hardware*, RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*, dated April 19, 2000.
- For *software*, RTCA/DO-178B and EUROCAE document ED-12B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992.

1.3 QUANTITATIVE SAFETY OBJECTIVES. You'll find guidance on establishing quantitative safety objectives for different installations on aircraft certificated under the provisions of 14 CFR parts 23, 25, 27 or 29 in the latest revisions of:

- AC 23.1309-1, *Equipment, Systems And Installations In Part 23 Airplanes*,
- AC 25.1309-1, *System Design And Analysis*,
- AC 27-1, *Certification of Normal Category Rotorcraft*, and
- AC 29-2, *Certification of Transport Category Rotorcraft*.