



ITSO-C71

Effective Date: 19-07-2019

Government of India
Directorate General of Civil Aviation
Aircraft Engineering Directorate
New Delhi – 110003

Indian Technical Standard Order

Subject: Airborne Static (DC to DC) Electrical Power Converter.

1. **PURPOSE:** This Indian Technical Standard Order (ITSO) is for manufacturers of “Airborne static (DC to DC) electrical power converter” applying for an ITSO Authorization (ITSOA).

2. **APPLICABILITY:** This ITSO affect applications submitted after its effective date.

3. **REQUIREMENTS:**

a. **Functionality:** This ITSO standard covers the minimum performance standards for Airborne static (“DC to DC”) electrical power converter equipment when used as a part of communication systems, navigation systems, cabin and cockpit power applications or any other similar applications.

b. **Failure Condition Classifications:** There is no standard minimum failure condition classification for this ITSO. The failure condition classification appropriate for the equipment will depend on the intended use of the equipment in a specific aircraft. Applicant shall document the loss of function and malfunction failure condition classification for which the equipment is designed.

c. **Functional Qualification:** The converter identified and manufactured under this ITSO must meet the Minimum Performance Standard (MPS) qualification as given below:

1. **General Standards:**

a. **Ratings of components:** The equipment shall not incorporate in its design any component of such rating that, when the equipment is operated throughout the range of the specified environmental test, the ratings established by the manufacturer of the component is exceeded.

b. Effects of Test: The design of the equipment shall be such that the application of the specified test produces no discernible condition which would be detrimental to the reliability of equipment manufactured in accordance with such design.

2. Minimum Performance Standards under Standard Test Conditions: The test procedures applicable to determine the performances of the Airborne static ("DC to DC") electrical power converter equipment are set forth in Appendix "A" of this ITSO.

a. Nominal Output Voltage and Current: The nominal output voltage and current shall not be less than that specified by the manufacturer's ratings. Further the equipment shall be capable of delivering at least 10% more output power than the manufacturer's specified rating for a period of two hours.

b. Regulation: Regulation under standard conditions shall not exceed 12%. For the purpose of this standard, regulation is defined as:

$$\% \text{ Reg} = \frac{(\text{Voltage at 20\% of load}) - (\text{Voltage at maximum rated load})}{(\text{Voltage at maximum rated load})} \times 100\%$$

c. Ripple: Ripple in the output DC voltage at maximum rated output load shall not exceed $\frac{1}{10}\%$ of the output voltage when shunted by a 2 mfd capacitor and the ripple on the DC input leads is equal to 2 volts peak to peak at a frequency of 400 Hz. For equipment designed for operation on 13.75 volts DC, the ripple on the input leads need not exceed 1 volt peak to peak.

d. Over Voltage: There shall be no permanent damage to any of the solid state devices (transistors) or the components when the power converter is delivering full rated output power and is subjected to 50% increased input DC voltage above the standard operating voltage for duration of not less than five minutes.

e. Short Circuit conditions: There shall be no degradation of the power converter or its components as a result of sustained short circuit applied separately to each output of a multiple output power converter, or simultaneously to all DC outputs for a period of not less than one minute. Within five minutes after removal of the short circuit condition, the equipment shall be capable of continuous operation at the manufacturer's rated output load for a period of eight hours without degradation of performance.

f. Emission of Radio Frequency Energy: The emission of radio frequency energy at discreet frequencies within the range of 90 kHz to 1500 MHz shall not exceed 200 microvolts between any cable terminal to ground.

Note: It is recognized that the radio frequency emissions having a level considerably less than the maximum permitted by the above standard are capable of interfering with the operation of other electronic equipment in an aircraft installation. It is also recognized that the method of reducing the level of

emission of radio frequency energy to much lower values are known.

In View of the above, the emission standards were set at a level which can be met by the exercise of reasonable care in design and yet effect the reduction in the present overall interference problem. Lower emission levels are desirable and it is, therefore, recommended that the equipment manufacturers make a determined effort to reduce the level of emission from electronic equipment to the lowest practicable value below that specified above.

g. Dielectric Strength: The equipment shall withstand without evidence of damage the application of a sinusoidal voltage between each transformer output winding and frame for a period of five seconds. The RMS value of the sinusoidal voltage applied shall be either five times the maximum operating voltage existing across that winding during operation when delivering full rated output or 500 volts, whichever is greater. During the application of this test, all diodes, transistors and capacitors may be disconnected.

3. Minimum Performance Standards under Environmental Test Conditions:

Demonstrate the required performance for applicable tests specified below under environmental test conditions as prescribed in RTCA/DO-160G, "Environmental Conditions and Test Procedures for Airborne Equipment," dated 08th December 2010.

a. Low Temperature Test: The converter shall be subjected to the low temperature environmental conditions as specified in the applicable category of RTCA DO-160G and with primary power voltage 10% less than standard test voltage applied, the following requirements shall be met:

- i. The output voltage shall not vary more than 12½ % from that obtained at standard test conditions.
- ii. The standard test condition requirements for Ripple shall be met.

b. High Temperature Test: The converter shall be subjected to the high temperature environmental conditions as specified in the applicable category of RTCA DO-160G and with primary power voltage 10% higher than standard test voltage applied, the following requirements shall be met:

- i. The output voltage shall not vary more than 12½ % from that obtained at standard test conditions.
- ii. The standard test condition requirements for Nominal output voltage & current, Regulation and Ripple shall be met.

c. Altitude Test: The converter shall be subjected to the maximum operating altitude conditions of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

d. Decompression Test: The converter shall be subjected to the decompression conditions of RTCA DO-160G and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

e. Overpressure Test: The converter shall be subjected to the overpressure conditions of RTCA DO-160G and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

f. Temperature Variation Test: The converter shall be subjected to the Temperature Variation conditions as specified in the applicable category of RTCA DO-160G, the standard test condition requirements for Regulation and Ripple shall be met

g. Humidity Test: The converter shall be subjected to the humidity conditions as specified in the applicable category of RTCA DO-160G. Following the exposure and within fifteen (15) minutes from the time primary power is applied, the converter shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

h. Operational Shock and Crash Safety Test: The converter shall be subjected to the operational shock and crash safety test conditions as specified in the applicable category of RTCA DO-160G. Following the operational shock test, the converter shall meet the standard test condition requirements for Regulation and Ripple. Following the crash safety test, the converter shall have remained in its mounting by its intended means and no parts of the equipment or its mounting shall have become detached and free from the equipment.

i. Vibration Test: The converter shall be subjected to the Vibration conditions as specified in the applicable category of RTCA DO-160G, and shall meet the standard test condition requirements for Regulation and Ripple.

j. Explosive Atmosphere Test: Convertors which are to be marked with an Explosion Category A/E/H shall be tested in accordance with the explosion conditions as specified in the applicable category of RTCA DO-160G.

k. Waterproofness Test: Convertors which are to be marked with a waterproofness Category shall be subjected to the waterproofness conditions as specified in the applicable category of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

l. Fluids Susceptibility Test: Convertors which are to be marked with a Fluids Susceptibility Category shall be subjected to the fluids susceptibility conditions of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

m. Sand and Dust Test: Convertors which are to be marked with sand and dust Category shall be subjected to the sand and dust conditions of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

n. Fungus Resistance Test: Convertors which are to be marked with a Fungus Resistance Category shall be subjected to fungus conditions of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

o. Salt Fog Test: Convertors which are to be marked with a Salt Fog Category shall be subjected to Salt Fog conditions as specified in the applicable category of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

p. Magnetic Effect Test: The Converter shall be tested for the magnetic effect as per RTCA DO-160G to determine the equipment category.

q. Power Input Test: The Converter shall be subjected to the power input conditions of RTCA DO-160G and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

r. Voltage Spike Test: The Converter shall be subjected to the Voltage Spike conditions of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

s. Audio Frequency Conducted Susceptibility – Power Inputs Test: The Converter shall be subjected to the audio frequency conducted susceptibility conditions of RTCA DO-160G and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

t. Induced Signal Susceptibility Test: The Converter shall be subjected to the Induced Signal Susceptibility conditions of RTCA DO-160G and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

u. Radio Frequency Susceptibility (Radiated and Conducted) Test: The Converter shall be subjected to the Radio Frequency Susceptibility conditions of RTCA DO-160G and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

v. Emission of Radio Frequency Energy: The Converter shall be tested for the emission of radio frequency energy as per RTCA DO-160G, for the Category to which the instrument is designed. The radio frequency emissions shall be within limits of the test requirement.

w. Lightning Induced Transient Susceptibility Test: The Converter shall be subjected to the Lightning Induced Transient Susceptibility conditions of RTCA DO-160G, for the Category to which the instrument is designed and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

x. Electrostatic Discharge Test (ESD): The Converter shall be tested in accordance with the Electrostatic Discharge requirements of RTCA DO-160G, and shall meet the standard test condition requirements for Nominal output voltage & current, Regulation and Ripple.

y. Fire, Flammability Test: Convertors which are to be marked with Fire, Flammability Category shall be tested as per the conditions specified in RTCA DO-160G.

z. Low Voltage Test:

- i. When the primary power voltage(s) is 80% of the standard test voltage(s), the equipment shall operate electrically.
- ii. Gradual reduction of the primary voltage(s) from 80% to 50% of standard test voltage (s) shall produce no condition detrimental to the reliability of the equipment.
- iii. Gradual reduction of the primary power voltage(s) from 50% to 0% of standard test voltage(s) shall produce no evidence external to the equipment of the presence of fire or smoke.

4. DEVIATIONS: The DGCA has provisions for alternative or equivalent means of compliance to the criteria in this ITSO. Manufacturers invoking these provisions must demonstrate that they maintain an equivalent level of safety and must apply for a deviation as per CAR21.610.

4. MARKING: The marking information specified in CAR 21.807 shall be legibly and permanently marked on each hardware element manufactured under this ITSO.

Each separate component of equipment that is manufactured under this ITSO must be permanently and legibly marked with at least the name of the manufacturer and the ITSO number.

5. APPLICATION DATA REQUIREMENTS: The applicant must submit the DGCA (AED), a Statement of Compliance (Form CA-35 of CAR 21) along with documents required under CAR 21.605 and one copy of each of the following technical data in support of design & production capability:

- a. A Manual(s) containing the following:
 1. Operating instructions and article limitations sufficient to describe the equipment's operational capability.
 2. Installation procedures and limitations sufficient to ensure that the equipment when installed according to the installation or operational procedures, still meets this ITSO's requirements. Limitations must identify any unique aspects of the installation. The limitations must include a note with the following statement:

“This article meets the minimum performance and quality control standards required by an Indian technical standard order (ITSO). Installation of this article requires separate approval.”

3. A summary of the test conditions used for environmental qualifications for each component of the article.
For example, a form as described in RTCA DO-160G “Environmental Conditions and Test Procedures for Airborne Equipment” Appendix A
 4. Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the converter.
 5. List of the major components replaceable components, by part number, that makes up the converter. Include vendor part number cross-references, when applicable.
- b. Instructions covering periodic maintenance, calibration, and repair, to ensure that the converter continues to meet the ITSO approved design. Include recommended inspection intervals and service life, as appropriate.
 - c. A drawing depicting how the article will be marked with the information required by paragraph 5 of this ITSO.
 - d. Identify functionality or performance contained in the article not evaluated under paragraph 3(c) of this ITSO (that is, non-ITSO functions). Non-ITSO functions are accepted in parallel with the ITSO authorization. For those non-ITSO functions to be accepted, the applicant must declare these functions and include the following information with your ITSO application:
 1. Description of the non- ITSO function(s), such as performance specifications, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming that the non-ITSO function(s) do not interfere with the article’s compliance with the requirements of paragraph 3.
 2. Installation procedures and limitations sufficient to ensure that the non-ITSO function(s) meets the declared functions and performance specification(s) described in paragraph 6(d)1.
 3. Instructions for continued performance applicable to the non-ITSO function(s) described in paragraph 6(d)1.
 4. Interface requirements and applicable installation test procedures to ensure compliance with the performance data defined in paragraph 6(d)1.
 5. Test plans, analysis and results, as appropriate, to verify that performance of the hosting ITSO article is not affected by the non-ITSO function(s).
 6. Test plans, analysis and results, as appropriate, to verify the function and performance of the non-ITSO function(s) as described in paragraph 6(d)1.
 7. Material and process specifications list.
 8. List of all drawings and processes (including revision level) that define the article’s design.
 9. Manufacturer’s ITSO qualification report showing results of testing accomplished according to paragraph 3(c) of this ITSO.

6. MANUFACTURER DATA REQUIREMENTS: In addition to those data requirements that are to be furnished directly to the DGCA (AED), the manufacturer must have following technical data available for review by the DGCA having preview of the manufacturer's facilities:

- a. Functional qualification specifications for qualifying each production article to ensure compliance with this ITSO.
- b. Equipment calibration procedures.
- c. Schematic drawings.
- d. Wiring diagrams.
- e. Material and process specifications.
- f. The results of the environmental qualification tests conducted according to paragraph 3(c) 3 of this ITSO.
- g. If the article contains non-ITSO function(s), the applicant must also make available items 7(a) through 7(f) as they pertain to the non-ITSO function(s).

7. DATA TO BE FURNISHED WITH MANUFACTURED UNITS: One copy of the data and information specified in paragraphs 6(a) and 6(b) of this ITSO for installation, certification, use, and/or continued airworthiness, must be provided to each person receiving for use of one or more articles manufactured under this ITSO. In addition, a note with the following statement should be included:

"The conditions and tests required for ITSO approval of this article are minimum performance standards. It is the responsibility of those desiring to install this article either on or within a specific type or class of aircraft to determine that the aircraft installation conditions are within the ITSO standards, If not within the ITSO standards, the article may be installed only if further evaluation by the applicant documents an acceptable installation and is approved by the Administrator."

8. AVAILABILITY OF REFERENCE DOCUMENTS:

- a. Copies of CAR 21 are available on DGCA website at www.dgca.nic.in
- b. Copies of RTCA documents may be purchased online through website: www.rtca.org
- c. current list of Indian Technical Standard Orders available on DGCA website at www.dgca.nic.in



(G. Rajasekar)

Joint Director General
For Director General of Civil Aviation

Test Procedures

AIRBORNE STATIC ("DC TO DC") ELECTRICAL POWER CONVERTER

1. **Power Input Voltage:** Unless otherwise specified, all tests shall be conducted with the power input voltage adjusted to the design voltage within $\pm 2\%$. The input voltage shall be measured at the power converter input terminals.

Note: Design voltages in use as of the date of this report are 13.75 VDC and 27.5 VDC and defined as standard condition.

2. **Adjustment of Equipment:** The equipment under test shall be properly adjusted in accordance with the manufacturer's recommended practices prior to the application of the specified tests.
 3. **Test Equipment Precautions:** Due precautions shall be taken during the conduct of these tests to prevent the introduction of error resulting from the improper connection of voltmeters, oscilloscopes and other test instruments across the input and output impedances of the equipment under test.
 4. **Ambient Conditions:** Unless otherwise specified, all tests shall be conducted under conditions of ambient room temperature, pressure and humidity.
 5. **Warm-up Period:** Unless otherwise specified, all tests shall be conducted after a warm-up period of not less than fifteen (15) minutes.
 6. **Connected Loads:** Unless otherwise specified, all tests shall be performed with the equipment connected to loads having the impedance value for which it is designed.
- **TEST PROCEDURES:** The test procedures set forth below are satisfactory for use in determining the performance of airborne static ("DC to DC") electrical power converter equipment. Test procedure's which provide equivalent information may also be used.

T.1 Power Output:

EQUIPMENT REQUIRED:

Voltmeter
Ammeter

MEASUREMENT PROCEDURE:

Connect the power converter to the appropriate input power source with the ammeter in series with the output and the voltmeter connected across the output. The manufacturer's specified load shall be connected across the output(s). The output load impedance should be adjusted to the manufacturer's specified rating.

Determine that the nominal output voltage and current is at least as specified by the manufacturer and that the equipment is capable of delivering at least 10% more output power than the manufacturer's specified rating for a period of two (2) hours.

T.2 Regulation

EQUIPMENT REQUIRED:

Voltmeter
Ammeter

MEASUREMENT PROCEDURE:

Connect the power converter to the appropriate input power source with the ammeter in series with the output and the voltmeter connected across the output. The manufacturer's rated load should be connected across the output(s).

Vary the load impedance from maximum rated load to 20% of maximum rated load and note the output voltage(s) at these two load settings. Calculate the percent regulation using the formula specified in paragraph 3(c)(2)b.

T.3 Ripple

EQUIPMENT REQUIRED:

Oscilloscope

MEASUREMENT PROCEDURE:

Connect the power converter to the appropriate input power source with the power converter delivering maximum rated load. Also connect a two (2) microfarad capacitor of the proper DC working voltage across the output under test.

Using the oscilloscope as a peak to peak voltage indicating device, measure the ripple on the output power source and all output voltage(s) when ripple on the DC input leads is equal to 2 volts peak to peak at a frequency of 400 Hz or 1 volt peak to peak, whichever is applicable.

T.4 Overvoltage

EQUIPMENT REQUIRED:

Power Supply

MEASUREMENT PROCEDURE:

- a.** Connect the power converter to the power supply with the converter delivering full rated output power. Increase the output voltage from power supply to 50% greater than the input voltage for which the equipment is designed for a duration of five (5) minutes.
- b.** Following this, determine that the output voltage and current is the same as that prior to the application of the overvoltage.

T.5 Short Circuit Conditions

EQUIPMENT REQUIRED:

Voltmeter
Ammeter

MEASUREMENT PROCEDURE:

With the power converter connected to the appropriate input power source and the equipment delivering full rated output power, apply a sustained short circuit separately to each output of multiple output power converters or simultaneously to all DC outputs for a period of not less than one (1) minute.

Following this, determine that the equipment is capable of delivering the manufacturer's rated output power for a period of at least eight (8) hours. This test shall be conducted after completion of the overvoltage test specified in T.4.

T.6 Emission of Radio Frequency Energy

EQUIPMENT REQUIRED:

Noise and Field Strength Meters

MEASUREMENT PROCEDURE:

Connect the power converter to the appropriate input power source with the equipment delivering full rated output power. The input power leads shall be of 10 to 12 feet in length, normally terminated and cabled, and shall not be enclosed in conduit.

With the noise meter, measure the RF voltage developed between ground and each of the primary input and power output leads, tuning the noise meter throughout the range of frequencies from 90 kHz to 1500 MHz

T.7 Dielectric Strength

EQUIPMENT REQUIRED:

Variable AC power source

MEASUREMENT PROCEDURE:

- a. Apply an AC voltage, at the frequency used in normal operation, between each transformer output winding and frame for a period of five (5) seconds. The RMS value of the sinusoidal voltage applied shall be either five (5) times the maximum operating voltage existing across that winding during operation when delivering full rated output, or 500 volts, whichever is greater.

- b. Following this, determine that the output voltage and current under full load conditions is the same as that prior to the application of the tests.