भारतीय मानक

Indian Standard

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विमान — ग्राउंड सपोर्ट विद्युत आपूर्ति — सामान्य अपेक्षाएँ

(पहला पुनरीक्षण)

Aircraft — Ground Support Electrical Supplies — General Requirements

(First Revision)

ICS 49.060; 49.100

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NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical to ISO 6858 : 2017 'Aircraft — Ground support electrical supplies — General requirements' issued by International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of Air and Space Vehicles Sectional Committee and approval of the Transport Engineering Division Council.

This standard was first published in 1975. First revision of this standard is undertaken to align it with the latest version of ISO 6858 : 2017.

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'; and
b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their respective place, are listed below along with their degree of equivalence for the editions indicated. For undated references, the latest editions of the referenced document applies, including any corrigenda and amendment:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 461-1 Aircraft — Connectors for ground electrical supplies — Part 1: Design, performance and test requirements	IS 13835 (Part 1) : 2011/ISO 461-1 : 2003 Aircraft — Connectors for ground electrical supplies: Part 1 Design, performance and test requirements (*first revision*)	Identical
ISO 461-2 Aircraft — Connectors for ground electrical supplies — Part 2: Dimensions	IS 13835 (Part 2) : 2012/ISO 461-2 : 1985 Aircraft — Connectors for ground electrical supplies: Part 2 Dimensions (*first revision*)	Identical
ISO 12100 Safety of machinery — General principles for design — Risk assessment and risk reduction	IS 16819 : 2018/ISO 12100 : 2010 Safety of machinery — General principles for design — Risk assessment and risk reduction	Identical
ISO 13850 Safety of machinery — Emergency stop function — Principles for design	IS 16818 : 2018/ISO 13850 : 2015 Safety of machinery — Emergency stop function — Principles for design	Identical
IEC 60204-1 Safety of machinery — Electrical equipment of machines — Part 1: General requirements	IS 16504 (Part 1) : 2019/IEC 60204-1 : 2016 Safety of machinery — Electrical equipment of machines: Part 1 General requirements (*first revision*)	Identical

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Introduction

The purpose of this document is to foster compatibility between the providers, distributors and users of aircraft ground support electrical power. This update takes into account several recent trends in aircraft electrical systems, including increase in nonlinear load content on aircraft.

Indian Standard

AIRCRAFT — GROUND SUPPORT ELECTRICAL SUPPLIES — GENERAL REQUIREMENTS

(First Revision)

1 Scope

This document specifies the electrical output characteristics and interface requirements between an aircraft and ground support electrical supplies. This includes all external electric power generation facilities, provided as part of a central source or in point-of-use application. Requirements for safety features are also included. Performance and safety issues under regional control are not addressed in this document. Requirements for ground traffic control purposes, such as towing points, identification and warning lights, etc. are also excluded.

The electrical characteristics relate to nominal 28 V DC and either 115/200 V or 230/400 V three-phase, 400 Hz AC outputs measured at the aircraft attaching connector as indicated in Figure 1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 461-1, *Aircraft — Connectors for ground electrical supplies — Part 1: Design, performance and test requirements*

ISO 461-2, *Aircraft — Connectors for ground electrical supplies — Part 2: Dimensions*

ISO 1540, *Aerospace — Characteristics of aircraft electrical systems*

ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment*

ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 12384, *Aerospace — Requirements for digital equipment for measurements of aircraft electrical power characteristics*

ISO 13850, *Safety of machinery — Emergency stop function — Principles for design*

IEC 60204-1, *Safety of machinery — Electrical equipment of machines — Part1: General requirements*

IEC 61140, *Protection against electrical shock — Common aspects for installation and equipment*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 1540 and ISO 461 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
alternator speed
nominal speed at which the alternator operates to produce 400 Hz

3.2
altitude
maximum height in feet above sea level at which the *unit* (3.24) needs to operate and maintain characteristics within recommended limits

3.3
ambient temperature
temperature range in degrees Celsius in which the *unit* (3.24) needs to operate and maintain characteristics within recommended limits

3.4
break transfer
mode of transferring the aircraft load from aircraft power source to ground power facility or vice versa whereby power to the aircraft is momentarily interrupted

3.5
connector
supply cable interface with the aircraft

3.6
constant power load
AC utilization equipment which contains active elements that result in an inversely proportional draw of current to that of the applied voltage

3.7
dead front
area of equipment which operators access that has no live voltage potential

3.8
dielectric test
test where high voltages is impressed between a component and the chassis of the *unit* (3.24) to check the insulation characteristics

3.9
emergency stop
E-stop
manually activated switch that is placed in an easily accessible and highly visible position which when depressed causes an immediate stop to the provision of electrical power from the nearby *facility* (3.10) source

3.10
facility
equipment designed to supply electrical power to an aircraft on the ground, including means for power generation, conversion and distribution

Note 1 to entry: Two types of AC facilities are defined by this document. Type 1 is intended for use with more recent aircrafts that have a large electronic load content while Type 2 is intended for use with legacy aircrafts that have a large content of inductive motor loads.

3.11
ground power unit
external power unit
GPU
rotating or static source (or combination thereof) supplied by the ground *facility* (3.10) to source electrical power while the aircraft is on the ground

Note 1 to entry: It may be either a point-of-use or centrally located ground power electrical supply in land-based facilities, or a shipboard power supply in marine applications.

3.12
highest phase voltage limiting
means of limiting the highest phase voltage of the *unit* (3.24) output during any unbalanced load condition

3.13
line drop compensation
system of increasing the *unit* (3.24) output voltage in proportion to the current in the output cable(s) such that the voltage is held constant at the aircraft receptacle

3.14
nominal voltage rating
root-mean-square, line-to-neutral and line-to-line voltage at which the *unit* (3.24) output is rated

Note 1 to entry: The unit is normally set such that output voltage is maintained at this value.

3.15
output terminals
terminals on the ground power unit side of the output-power feeders

3.16
overload rating
time-limited output capacity

Note 1 to entry: It is measured in kVA for an AC unit and in ampere for a DC unit.

3.17
prime mover
source of power for driving the alternator

Note 1 to entry: This generally refers to either a diesel engine (engine generator set) or a utility power-driven motor (motor generator set) with respect to ground support equipment.

3.18
rated load
maximum continuous output in kVA for AC and maximum continuous current in ampere for DC

3.19
remote sensing
means of providing constant voltage at the aircraft receptacle(s) by sensing the voltage at the receptacle with separate leads in the output cable

3.20
temperature rise
rise in degrees above ambient for components of the *unit* (3.24)

3.21
total life
hours of use from time of delivery of the equipment to the using activity until its identity is destroyed by classifying it as salvage and/or subject to cannibalization

3.22
trip
actuation of electrical switchgear to inhibit or stop the flow of current through the device

3.23
type of mounting
means of mounting the *unit* (3.24) and controls

3.24
unit
complete power package

EXAMPLE *Prime mover* (3.17), alternator and all associated equipment and systems.

3.25
voltage transient recovery
time required for the output voltage to recover to and remain within the prescribed limits after load application or removal

4 Technical basis

Limits defined in this document are based upon historical as well as near-term projected equipment characteristics. They have been derived, following an analysis of ground power facilities, ground power distribution systems, aircraft distribution systems and aircraft user equipment characteristics in an effort to provide compatibility between ground power and the aircraft. These limits provide allowance for typical power quality degradations as power moves downstream from the aircraft's ground power connector (where this document applies) and arrives at the input terminals of user equipment (where ISO 1540 applies).

5 Electrical characteristics

5.1 General

5.1.1 Overview

As illustrated in Figure 1, the combination of the facility, the interconnecting cable and the on-board electrical network shall combine to provide electrical power at the aircraft user equipment input as defined in ISO 1540. The characteristics viewed at the aircraft interfacing connector, when the facility is supplying power to the aircraft, are those specifically defined in this document. These are generally similar to those of ISO 1540 but account for items such as voltage drop in the aircraft network. Voltage at the facility source terminals are not defined.

Because of the complex nature of the aircraft network, and often the power quality degrading effects of aircraft user equipment, the characteristics defined by this document are likely to be inferior to those which the facility source might provide when connected to a simple load simulation (e.g. a linear load bank). Test conditions found in this document are therefore aimed at providing manufacturers with reasonable ability to verify their equipment's performance prior to connection to an aircraft.

The AC voltage characteristics stated below apply to line-to-neutral quantities. Line-to-line characteristics should be as a result of the specified line-to-neutral values. All AC voltages and currents are rms values unless otherwise stated.

All DC values are mean values unless otherwise stated.

The stated capacity of the facility equipment shall be provided at the end of the aircraft interfacing connector.

The facility equipment should be designed so that normal service maintenance will ensure the retention of these specified characteristics throughout the full range of operational and environmental conditions likely to be encountered in the location in which they are installed over its service life.

5.1.2 Alternating current (AC) power sources

5.1.2.1 General

The AC power system shall be three-phase, with a four-wire, wye-connected output, a nominal voltage of either 115/200 V or 230/400 V, a nominal frequency of 400 Hz and a phase sequence of A-B-C. The neutral point shall be connected in accordance with the circuits shown in Figure 2. If tied to the chassis ground, the tie shall be capable of withstanding maximum ground fault current for a minimum of 5 s.

The output voltage shall be sufficiently adjustable to allow the checking of overvoltage and undervoltage protective devices in an unloaded condition.

NOTE AC facility performance can be measurably affected by the formation of the three-phase cable bundle between the facility source and the aircraft. In addition to basic ampacity considerations, cabling is preferred which maintains equal distances between any two phases and between each phase and neutral conductors.

5.1.2.2 AC source rating

Two distinct AC source types, Type 1 and Type 2, are defined in this document. Type 1 AC sources are defined to support all aircraft types and load suites. Type 2 AC sources are defined to support classical aircraft with load conditions that are predominantly motor loads.

Each ground facility source shall indicate its continuous power capacity in kilo-volt-amperes (kVA). Its short-term overload capacity shall be a function of its continuous capacity according to Table 1. Continuous power capacity and source type (Type 1 or Type 2) shall be clearly marked for operator inspection.

Power factor and overload capability as a function of the type classification shall be as follows.

Table 1 — Minimum capacity requirements for AC facility sources

AC facility capacities		Continuous	Overload (% of rated kVA)			
Type	**Power factor range**	**(% of rated kVA)**	**10 min**	**5 min**	**10 s**	**2 s**
1	0,8 lagging to unity	100 %	110 %	125 %	140 %	—
	0,7 to 0,8 lagging	—	—	—	140 %	200 %
2	0,8 lagging to unity	80 %	—	100 %	—	—
	0,7 to 0,8 lagging	100 %	—	—	120 %	150 %
NOTE 1 Power factor range is the average three-phase power factor. Individual phase power factors can be different.						
NOTE 2 Type 1 or Type 2 facility requirement is per aircraft manufacturer direction.						
NOTE 3 Aircraft with multiple facility connections can assume that all are independent 90 kVA sources.						

5.1.3 Direct current (DC) power sources

5.1.3.1 General

The DC power system shall be a two wire system having a nominal voltage (at the aircraft plug) of 28 V, the output of which shall be connected in accordance with the circuits shown in Figure 3.

5.1.3.2 DC source rating

The continuous and engine start rating of the DC ground power facility, in amperes shall be clearly marked for operator inspection.

Engine start rating, which is also used for wash and purge cycles, is required for a minimum of 30 s to accommodate both a short-term, peak current inrush and an overload value during engine motoring.

The facilities' peak current capability shall be adjustable, as required to coordinate with different aircrafts. Recommended values for engine start rating, related to the continuous rating, are as follows.

Continuous rating	Recommended engine start rating
a) 300 A	between 600 A and 1 200 A
b) 350 A	between 700 A and 1 400 A
c) 400 A	between 800 A and 1 600 A
d) 600 A	between 1 200 A and 2 000 A
e) 800 A	between 1 200 A and 2 500 A

Declaration of any additional overload current capability, and the associated time period the facility may provide, shall also be clearly marked for operator inspection.

NOTE Current levels listed above exceed those defined by ISO 461-1.

5.2 Interface connector

The interconnecting cable shall be terminated with a ground supply connector complying with the requirements of ISO 461-1 and ISO 461-2 for all continuous ratings supported.

NOTE 230 V AC equipment is not defined by ISO 461–1 and ISO 461–2. Suitable styles for 230/400 V ground connection plugs and sockets would need to be defined in the International Standards to support the usage of higher voltage systems.

5.3 Electromagnetic interference

5.3.1 Utility interface

If the facility requires a utility power input, it shall be tested in accordance with the requirements of the relevant national standard.

5.3.2 Aircraft interface

The facility shall be tested for conducted emissions in accordance with the requirements of ISO 7137, Category B limits.

5.4 AC steady-state output characteristics

5.4.1 General

AC voltage characteristics are to be guaranteed at the mating interface between the ground facility plug and the aircraft connector, as indicated in Figure 1, throughout the extremes of electrical loading and environmental conditions stated in this document.

5.4.2 Steady-state AC load characteristics

Table 2 lists the range of AC steady-state aircraft load characteristics expected to be provided through the aircraft connector(s) during normal (no failure) conditions.

Table 2 — Aircraft steady-state loading characteristics

Parameter	Minimum	Maximum	Units	Comment
Current draw	0	100 %	Rated amperes	Continuous, as per Table 1
Power factor	0,7 lagging	Unity	—	Each phase PF is independent of the other two phases.
Current imbalance	0	1/3	—	Facilities of up to 40 kVA
	0	1/6	—	Facilities of more than 40 kVA
Single-phase rectifier load content	0	1/9	Phase kVA rating	Rectifier load may be on any or all phases.
Three-phase (6-pulse) rectifier load content	0	1/6	Output kVA rating	—
Three-phase transformer rectifier (12-pulse)	0	1/3	Output kVA rating	—
Three-phase transformer rectifier (12-pulse) with constant power load characteristic	0	1/3	Output kVA rating	Type 1 facilities of more than 60 kVA

NOTE 1 In all cases, additional load may be resistive.

NOTE 2 Conditions shown may appear simultaneously within the facilities capacity limitations.

5.4.3 Steady-state AC voltage performance

5.4.3.1 General

AC ground power facility steady-state electrical characteristics at the aircraft connector shall be within the limits of Table 3 for all load conditions identified in Table 2. In cases where there is more than one aircraft connection with the ground power facility, all outputs shall be maintained within these limits.

Phase relationship between the three phases is as shown in Figure 4.

5.4.3.2 Highest phase voltage limiting feature

Means shall be provided in any Type 1 ground power facility to limit the highest phase voltage to 124 V (248 V for 230/400 V systems) at all aircraft connectors during unbalanced load conditions.

5.4.3.3 Line drop compensation feature

Means shall be provided in the ground power facility to compensate for the reduction in AC voltage between the ground power facility and the aircraft connector (due to voltage drop in the interfacing cable) such that the characteristics of Table 3 are maintained during all steady-state loading conditions.

Sources with multiple outputs shall coordinate these regulation features to accomplish the performance required in Table 3 during conditions of unequal loading of the individual outputs.

5.4.3.4 Voltage regulation in presence of highly distorting loads

Means of voltage sensing for the regulation function shall maintain regulation during conditions of up to 10 % voltage total distortion.

Table 3 — Steady-state limits for 115/200 V AC three-phase ground power systems

Steady state conditions (see 5.4.3)	**Limits at aircraft connector(s)**	
	0–rated load	**Rated load to overload**
Phase voltages		
3-phase average (Vrms)	112,0 to 120,5	110,0 to 120,5
Individual phase (Vrms)	109,5 to 122,0	106,0 to 122,0
Unbalance (Vrms)	4,0	—
Displacement (degrees)	117,5 to 122,5	—
Voltage modulation	—	—
Max peak-valley amplitude (Vpk)	3,5	—
Frequency components	Figure 5	—
Voltage waveform		
Crest factor	1,31 to 1,51	—
Distortion factor	5 % total	—
Individual comp. of distortion	4 % max per Figure 6	—
DC Component (V DC)	−0,1 to +0,1	—
Frequency		
Frequency (Hz)	395 to 405	390 to 410
Frequency modulation	Figure 7	—

NOTE 1 Limits for 230 V AC systems shall be 230/115 times as those shown above, except for values in percentage.

NOTE 2 See Table 2 for loading conditions which apply to these performance limits.

5.5 AC transient characteristics

5.5.1 General

AC ground power facility transient performance shall be within the limits stated herein for the identified AC load characteristics.

5.5.2 Transient AC load characteristics

The following are the transient AC load characteristics expected through the aircraft connector(s) during normal (no failure) conditions:

a) balanced three-phase load application or removals within the capacity limits of Table 1;

b) motor start load transient — base load plus low power factor (0,4 PF to 0,6 PF lagging typical) motor current inrush, as specified for individual applications, not to exceed the rated output capability;

c) momentary parallel with on-board aircraft power sources during a no-break power transfer (NBPT);

d) very short duration (one to three cycles) of high (approximately 300 %) peak inrush currents, decaying to steady-state levels within 150 mS when first energizing aircraft buses.

5.5.3 Transient AC voltage

Transient AC voltage surges produced by the ground power facility at the aircraft connector shall remain within the limits of Figure 8 as a result of the transient AC load conditions identified in 5.5.2 within the capacity limits of Table 1.

5.5.3.1 No-break power transfer limits

Type 1 facilities shall be able to operate in an uninterrupted fashion during NBPT and maintain voltage and frequency within specified limits when out of synchronization with the on-board power source. The ground and on-board power sources may be displaced by as much as ±30° in phase, ±2 Hz in frequency and ±10 Vrms for a maximum time duration of 100 ms. If the NBPT conditions are more severe, the unit's protection device(s) may be activated.

5.5.4 Transient frequency

Transient AC frequency surges produced by the ground power facility at the aircraft connector shall remain within the limits of Figure 9 as a result of the identified transient AC load conditions.

5.6 DC steady-state output characteristics

5.6.1 Steady-state DC load characteristics

DC ground power facility steady-state electrical characteristics at the aircraft connector shall be within the limits of Table 4 for all load conditions between 0 and rated continuous current draw.

5.6.2 Steady-state voltage

The voltage at the aircraft connector shall be between 24 V and 29,5 V for any steady-state load condition up to rated load.

5.6.3 Voltage ripple

The ripple on the DC supply shall be such that the maximum departure from the average DC level is less than 2 V. The rms value of individual spectral components of the ripple shall not exceed the values shown in Figure 10. These spectral components shall not result in a distortion factor that exceeds 3,5 %.

Table 4 — Steady-state limits for 28 V DC ground power systems

Steady state conditions (see 5.6)	**Limits at aircraft connector(s) (0–rated load)**
DC Voltage	
DC voltage (V DC)	24 to 29,5
Voltage waveform	
Voltage ripple (pk-Ave Volts)	2
Distortion factor	3,5 %
Individual comp. of distortion	per Figure 10

5.7 DC transient characteristics

5.7.1 Transient DC load characteristics (other than engine start-related)

Transient requirements at the aircraft connector(s) during normal (no failure) conditions shall include load application and removals up to rated continuous output current.

5.7.2 Transient DC voltage

Transient DC voltage surges produced by the ground power facility at the aircraft connector shall remain within the limits of Figure 11 as a result of the identified transient DC load characteristics.

5.7.3 Engine starting output characteristics

Transient voltages during the engine start will be a function of starter impedance and the applied current, resulting in transient voltages that may exceed Figure 11. Minimum voltage during a maximum current engine start condition shall be identified in the unit's standard documentation.

6 Electrical protection

6.1 General

The minimum protection to be provided shall meet the requirements in ISO 12100, IEC 60204-1, IEC 61140 and of 6.2 and 6.3. These functions are intended to both protect the personnel and the ground power facility (including distribution elements) as well as to ensure coordination with the aircraft's protective functions. Means shall be provided for periodic checking of these minimum protective circuits. When a protective circuit has operated, the facility shall remain disconnected from the aircraft until manually reset.

NOTE Electrical protection requirements herein are intended to provide an overall selective protection scheme between the facility and the aircraft, with each protecting their equipment area, preferably with the aircraft protection acting first.

6.2 AC system protection

6.2.1 Overvoltage

A protective system shall be provided which disconnects the facility from the aircraft electrical system before any line-to-neutral voltage exceeds the maximum voltage time limit of Figure 12.

6.2.2 Undervoltage

A protective system shall be provided which disconnects the facility from the aircraft electrical system when the average line-to-neutral voltage drops below the minimum voltage time limit of Figure 12.

6.2.3 Frequency

A protective system shall be provided which disconnects the facility from the aircraft electrical system when the frequency departs from the 380 Hz to 420 Hz range. A time delay of between 2 s and 3 s should be employed to reduce nuisance tripping. For frequencies below 350 Hz, the time delay shall be reduced to less than 0,2 s.

6.2.4 Overcurrent and short circuits

The overcurrent protective system shall automatically remove power from a facility output when its time/load characteristic exceeds its rating. Overcurrent protection should have an inverse time characteristic and should operate to protect the facility if a short circuit occurs within the ground power source or its distribution system. A suitable minimum time delay shall be employed to reduce the likelihood of nuisance tripping (e.g. at least five cycles in duration). Ground facility power is not required to provide current to clear circuit breakers on the aircraft.

Overload protection on a multiple output facility shall function independently for all outputs. The ground power facility shall only trip the output associated with the overcurrent condition. No current limit associated voltage foldback mode shall be used; however, peak output currents shall be limited to no more than 1 600 A.

6.2.5 Phase sequence

A phase sequence protective system shall be provided which prevents the facility from being connected to the aircraft electrical system when the phase rotation of the generated voltage is not consistent with that of Figure 4.

6.2.6 DC content

Ground facilities that generate AC power through solid state means shall include protection for DC content voltage. An inverse time-trip characteristic shall be provided to limit the voltage-time characteristics below and shown in Figure 13.

6.2.7 Open neutral/phase conductors

Ground facilities that generate AC power shall include protection for open neutral conductors. The facility shall remove its supply upon loss of the neutral conductor path.

It is encouraged that facility 400 Hz cable systems which employ multiple neutral conductors in an individual harness have the ability to detect and identify individual open neutral conductors to avoid power quality degradation during a latent failure condition.

NOTE Open phase conductor protection is assumed to be provided by the aircraft system and therefore, not required of the facility, unless necessary for its own self-protection.

6.2.8 Earth/Ground fault

Utility supplied AC ground power facilities which are not grounding the AC neutral shall continuously monitor the voltage potential between utility ground/chassis and 400 Hz AC neutral and provide earth/ground fault protection. The facility shall remove its supply upon detection of a voltage potential not to exceed 50 Vpk for a time period not to exceed one second. Means shall be provided to prevent unintentional and intentional override of this protection.

6.3 DC system protection

6.3.1 Overvoltage

A protective system shall be provided which disconnects the facility from the aircraft electrical system before the voltage exceeds the maximum voltage time limit of Figure 14.

6.3.2 Undervoltage

A protective system shall be provided which disconnects the facility from the aircraft electrical system before the voltage exceeds the minimum voltage time limit of Figure 14. A time delay of between two seconds and four seconds shall be provided to prevent nuisance tripping. If the facility has engine start capability, the minimum voltage time limit shall be coordinated with the expected worst case characteristics during engine start.

6.3.3 Reverse polarity

A protective system shall be provided which prevents the facility from being connected to the aircraft electrical system when the polarity of the generated voltage is incorrect.

6.3.4 Reverse current

A protection system shall be provided which disconnects the facility from the aircraft electrical system if the reverse current exceeds 5 % of the continuous rating of the facility. In no circumstances shall the aircraft electrical system be permitted to motor the facility's prime mover.

6.3.5 Overcurrent and short circuits

The overcurrent protective system shall automatically remove power from a facility output when its time/load characteristic exceeds its rating. In order to ensure compatibility and reduce the likelihood of aircraft equipment damage, DC ground power facilities used for engine starting shall have an output current limit feature with an accuracy of at least ±10 %.

7 Control circuit and supply

7.1 Control circuits

Unless otherwise required by the relevant specification, the facility shall be capable of connection through aircraft connectors having control circuits which are functionally equivalent to those shown in Figure 2 for an AC facility or Figure 3 for a DC facility.

7.2 Aircraft interlock supply for AC facilities

7.2.1 General

When commanded on by an operator, facility power shall be provided to the aircraft for a minimum of 2,5 s without the aircraft providing the interlock signal at Pin F. This time period allows on-board aircraft controls to energize and may be met by automatic timer or continuous operator action. It shall not be possible for the facility to supply power to the aircraft through this connection. Anytime after the aircraft interlock (Pin F) has been provided, the facility shall remove its supply within 0,25 s upon removal of the interlock signal. The facility should be tolerant of momentary interruptions in the interlock signal of up to 50 mS duration.

7.2.2 Interlock signal characteristics

The voltage supply at Pin E, typically provided by the aircraft, will be consistent with the steady-state and transient characteristics of 28 V DC power defined in ISO 1540. The current required from the aircraft electrical system for this purpose shall not exceed 0,5 A.

7.2.3 Maintenance mode

An easily accessible tool or key-operated or cover-locked switch or control shall allow qualified personnel the selection of either of the following two modes:

a) normal, for aircraft loads;

b) maintenance, for dummy loads or no load.

In maintenance position, the interlock circuit shall be inhibited with maintenance mode clearly identified. If an interlock signal is present, the unit shall automatically return to normal mode.

8 Test requirements

Any supplier of a ground power facility that references this document shall provide, when requested by someone intending to purchase such equipment, proof of conformity by means of electrical test results. These tests shall include the stated electrical load conditions identified in Clause 5 and identification of acceptably meeting the performance and protection requirements found in Clauses 5 and 6. Performance measurements shall be made at the aircraft connector end. The external power cable (in maximum length) is expected to be used in service. Maximum cable lengths successfully tested shall be reflected in the nameplate data. Annex A shall be consulted for test requirements of AC facilities and Annex B for DC facilities. Application of digital equipment to make measurements required in these tests shall follow the methods outlined in ISO 12384.

9 Safety requirements

9.1 General

Each ground support facility shall incorporate, when applicable, the following safety procedures.

9.2 Mechanical safety features

9.2.1 Hot temperatures

The ground supply facility shall include protections necessary (e.g. overtemperature) as necessary to maintain the safety and reliabity of the operation and limit the exposure of the equipment to potential damage.

9.2.2 Fuel tank

The fuel tank filler shall be accessible from the ground level and shall be located to minimize the possibility of fuel impinging on electrical or engine components during filling operations.

9.2.3 Exhaust

The prime mover exhaust shall be routed clear of fuel and electrical system components. If routed through areas where leakage of oil and grease or fuel could occur, the exhaust system shall be shielded from direct contact with leakage.

The exhaust system shall be designed to minimize the emission of sparks.

9.2.4 Foreign object ingestion

Adequate guards shall be provided to prevent entry of foreign debris as a result of cooling air suction or accidental acts of operating or maintenance personnel.

9.2.5 Control panel

There shall be unrestricted access to the controls and instruments on the control panel which shall contain all controls necessary for the operation and control of the ground power facility. The panel controls and instruments shall be adequately illuminated for night operation. Indicating instruments shall be readable from the operator's normal position and controls shall be clearly identified. The layout of the control panel shall be such that controls and instruments are grouped according to function, i.e. prime mover, alternator, etc.

Adequate operating instructions shall be placed in close proximity to the control panel.

9.2.6 Ergonomics

The facility shall be easily operated by personnel possessing no special skills who have been given training on the equipment. All operator controls and instruments shall be conveniently grouped at one location. Operation shall be easily accomplished while wearing foul-weather clothing.

9.2.7 Fire fighting

All facilities shall be fitted with fire suppression equipment adequate to deal with an electrical fire and contain any fire propagated by hazardous conditions such as a breakage in a prime mover's fuel supply line. Equipment shall be acceptable to local and national standards upon installation.

9.3 Electrical safety features

9.3.1 Overload

The facility shall observe the electrical performance and protection requirements of this document and any other requirements warranted to prevent electrical overload.

9.3.2 Fault conditions

The main switch and any device which breaks the main supply under fault conditions shall be designed that an operator cannot readily override the safety features.

9.3.3 Trip switch

All facilities shall incorporate a prominently situated emergency stop device at all control places, in accordance with ISO 13850 category 0 or 1, to isolate the supplies to the aircraft and shut down the facility immediately if a dangerous situation is observed.

9.3.4 Earthing

Earthing of the AC or DC facility outputs is selective in this document. Primary guidance should be available from airframer instructions, national regulation or contractual specification for the equipment. The facility shall provide means to earth the aircraft while connected to facility power. Means shall be provided to earth the facility frame or chassis with a capability that supports maximum earth fault currents. The AC neutral and DC negative outputs shall be electrically connected via removable means to the facility frame or chassis. Provision shall be made, however, for isolating them separately from the facility frame or chassis in consideration of alternative means to earth the aircraft.

9.3.5 Facility with electrical supply

The electrical supply for the drive motor or conversion circuitry and all associated operating and monitoring equipment shall be electrically separated from that reserved for the circuits' connection to the aircraft. All possible precautions shall be taken to prevent interaction between the input and output circuits. This shall include both physical separation, and in the case of alternating current sources with static conversion means, a safety isolating transformer (e.g. IEC 61558-2-6).

The neutral of the utility provided electrical power shall not be earthed at the facility. Utility-supplied ground conductor shall be bonded to the facility chassis or case.

9.4 Features to safeguard personnel

9.4.1 General

Ground support equipment shall offer safety to personnel operating the equipment or in its vicinity. The safety of electrical equipment of ground support electrical supplies shall comply with ISO 12100, IEC 60204-1, IEC 61140 and the requirements of this document.

Electrically live terminals, rotating parts and hot surfaces shall be protected against inadvertent contact.

All rotating or moving parts shall be shielded to prevent accidental contact while unit is in normal operating mode. Safety signs shall be provided.

9.4.2 Electrical contact

Control panel doors should be provided with locks to prevent entrance other than by authorized personnel when practical. All controls, instruments, and wiring shall be mounted in a dead front enclosure. Only authorized personnel shall be capable of operating the unit with control panel doors open. Inside the control panel, any voltage over 50 V shall be specially shielded or suitably interlocked to prevent accidental contact. Load contactor(s) shall be provided so that the feeder cable(s) are not energized except when engaged with the aircraft plug. Suitable warning labels or covers shall be provided if internal voltages decay slowly after shutdown.

9.4.3 Anti-arcing protection

Load contactor(s) interlocked with the aircraft electrical system shall be provided so that the feeder cable(s) do not remain energized except when engaged with the aircraft plug. Standard wiring diagrams are given in Figures 2 and 3.

9.4.4 Noise

The overall noise level of a mobile facility shall not exceed 85 dB(A) at a distance of 7 m. Noise-attenuated (insonorized) units shall not exceed 80 dB(A) at 3 m (10 ft).

9.4.5 Vibration

The unit shall be designed and constructed so that no parts will work loose in service. It shall be built to withstand the stresses, shocks, vibrations, and other conditions/incidents in shipping, storage, installation, and service.

10 General design features

10.1 Environmental conditions

Electrical ground support equipment shall be capable of withstanding or operating satisfactorily when exposed to the following conditions with suitable derating:

a) ambient temperature range of −30 °C to +52 °C (−22 °F to +125 °F) when operating;

b) ambient temperature range of −40 °C to +60 °C (−40 °F to +140 °F) when not operating;

c) relative humidity of between 10 % and 100 % (noncondensing);

d) full operating performance up to an altitude of 3 050 m (10 000 ft) above sea level without any derating unless noted in the nameplate data.

10.2 Life expectancy

Electrical ground support equipment shall be designed for a minimum life expectancy of 15 years with routine service and periodic adjustment.

10.3 Manufacturing, service and support features

10.3.1 General

The ground support facility should be designed and manufactured so that normal service maintenance will ensure the retention of characteristics specified in this document throughout life expectancy.

10.3.2 Material, parts and processes

All materials shall be new and suitable for the purpose intended.

No component shall be used in the assembly of the equipment that will be subjected to conditions in excess of the original manufacturer's recommended operating limits. Components shall be suitably selected to ensure a rated service life.

No hidden or inaccessible fasteners shall be used unless adequately secured to prevent turning, i.e. rivets, tapped threads, tack welded nuts, or studs.

Fire resistant and non-moisture absorbing materials shall be used wherever possible.

10.3.3 Moisture and fungus resistance

Equipment and controls that are exposed to the weather shall be weather-resistant type.

10.3.4 Corrosion of metal parts

Suitable and adequate corrosion protection shall be applied throughout the equipment.

10.3.5 Workmanship

Electrical ground support equipment, including all parts and accessories, shall be fabricated and finished in a workmanlike manner. Particular attention shall be given to freedom from blemishes, defects, burrs, and sharp edges; accuracy of dimensions, radii of fillets, and marking of parts and assemblies; thoroughness of soldering, welding, brazing, painting, wiring, and riveting; and alignment of parts and tightness of assembly screws, bolts, etc.

10.3.6 Product enclosures

Cabinet enclosures shall be designed to be suitable for the intended environmental conditions. The components and subassemblies shall be mounted in such a manner that no damage will occur as a result of transportation. Means shall be provided for easy access to the component parts contained therein.

The equipment shall be suitably primed and finished.

10.3.7 Service access for adjustments and repairs

Electrical ground support equipment shall be constructed such that maintenance personnel can easily make adjustments and repairs.

Only standard tools shall be required for maintenance of any parts of the equipment.

Major assemblies and components shall be easily disconnected and removed from the equipment without the necessity for extensive disassembly of the other components. Lifting eyes, forklift channels, or other devices shall be provided where required. Adequate identification shall be provided for wiring, terminals, and controls.

10.3.8 Interchangeability and replaceability

All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance.

11 Installation, operation and maintenance

A complete manual shall be provided with each unit containing the following information in accordance with the requirements of ISO 12100:

a) unit description and specification;

b) installation and pre-start procedures;

c) starting and operating instructions;

d) maintenance and troubleshooting instructions;

e) replacement parts list;

f) schematics and point-to-point wiring diagrams;

g) engine manual (if applicable);

h) "Type" definition and cable maximum length of AC supply.

Manuals shall be provided concurrent with the delivery of first production unit.

12 Labelling

All ground power facilities shall be fitted with a metal or pressure-sensitive data plate displaying the following minimum information:

a) manufacturer's name, part or model number, serial number, and revision status;

b) electrical supply requirements;

c) nominal output voltage or voltages;

d) output rating of the facility, including "Type" definition of an AC supply and maximum cable length for which performance tests were successfully completed;

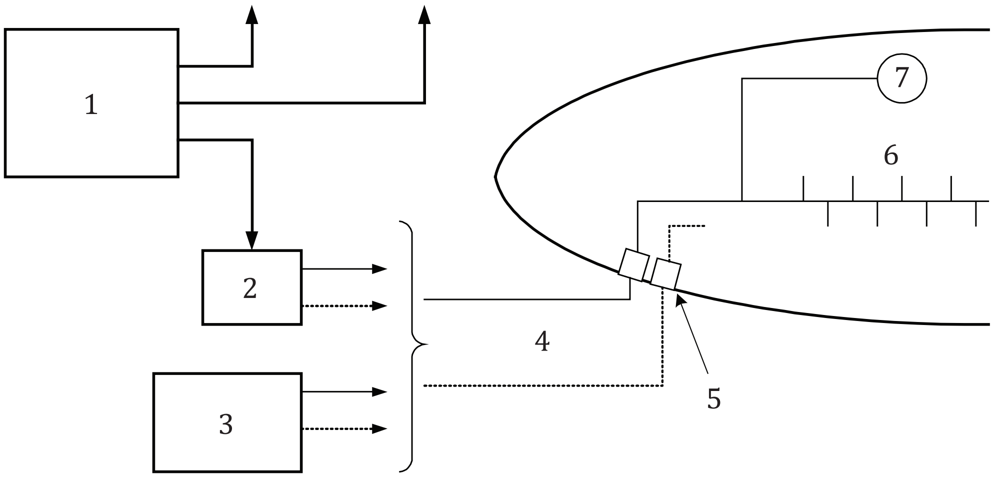
e) environmental restrictions (including non-overlap of requirements);

f) number of this document or unique specification.

All instruments and controls shall be suitably identified. Adequate operating instruction placards shall be permanently affixed in proximity to all control panels.

A warning label shall be permanently affixed to each relevant service panel where high voltages are present.

Fuses and circuit breakers shall be suitably marked as to circuit designation.



Key

1 central facility source type

2 gate box

3 point-of-use source type

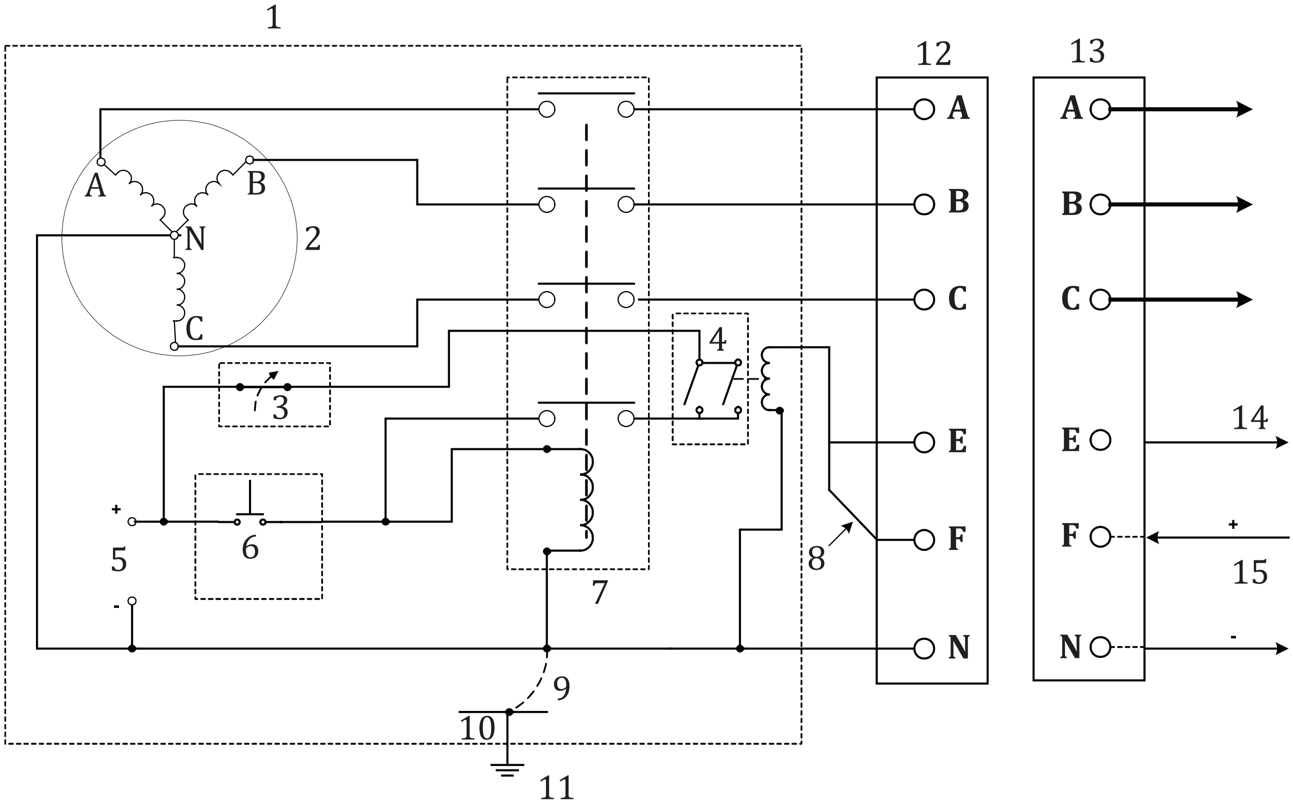
4 GPU stinger(s)

5 point-of-measurement for ISO 6858 power quality

6 user equipment connections (ISO 1540 measurement point)

7 on board aircraft generator

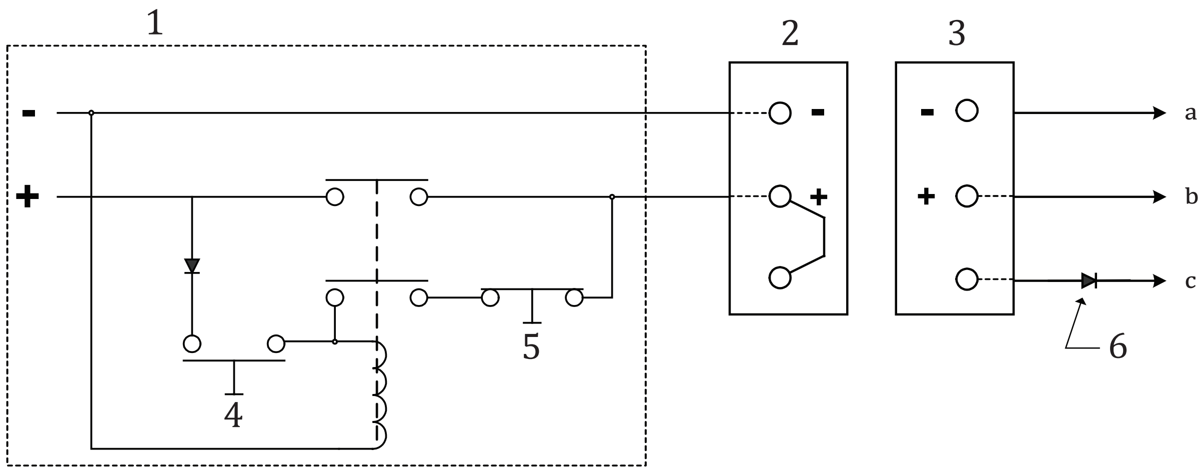
Figure 1 — Power quality measurement points for external and aircraft power



Key

1	typical AC ground supply	9	removable jumper
2	alternator (phase sequence A-B-C)	10	facility frame
3	“off” switch	11	earth reference
4	test switch	12	ground supply free socket
5	28 V DC control supply	13	aircraft fixed plug
6	GPU “on” switch (momentary)	14	to control
7	AC supply contactor	15	aircraft 28 V DC supply
8	fixed jumper		

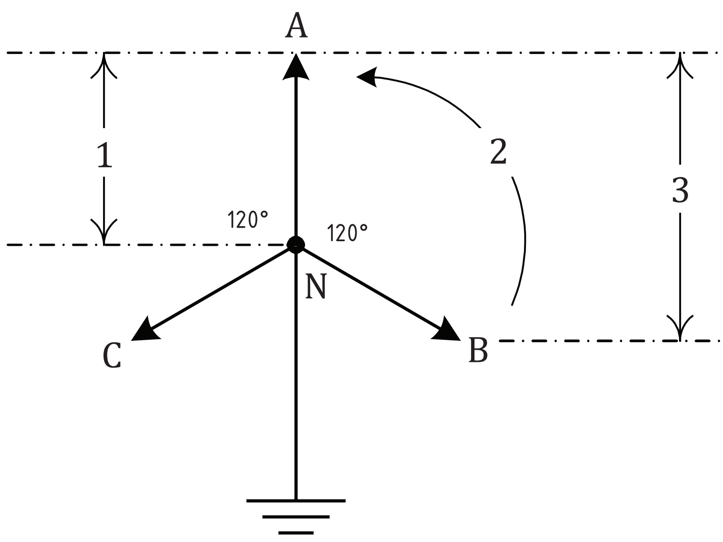
Figure 2 — Standard wiring diagram for three-phase AC plug and socket with Pin E/F interlock



Key

1 typical DC ground supply
2 ground supply free socket
3 aircraft fixed plug
4 on switch
5 off switch
6 reverse polarity protection
a To airframe.
b To aircraft busbar.
c To control.

Figure 3 — Standard wiring diagram for DC plug and socket



Key

1 phase voltage (L-N)
2 direction of positive phase duration
3 line voltage (L-L)

Note Displacement factor calculations only examine the phase displacement between the fundamental components of the voltage waveform.

Figure 4 — Diagram of line designations and normal phase sequence

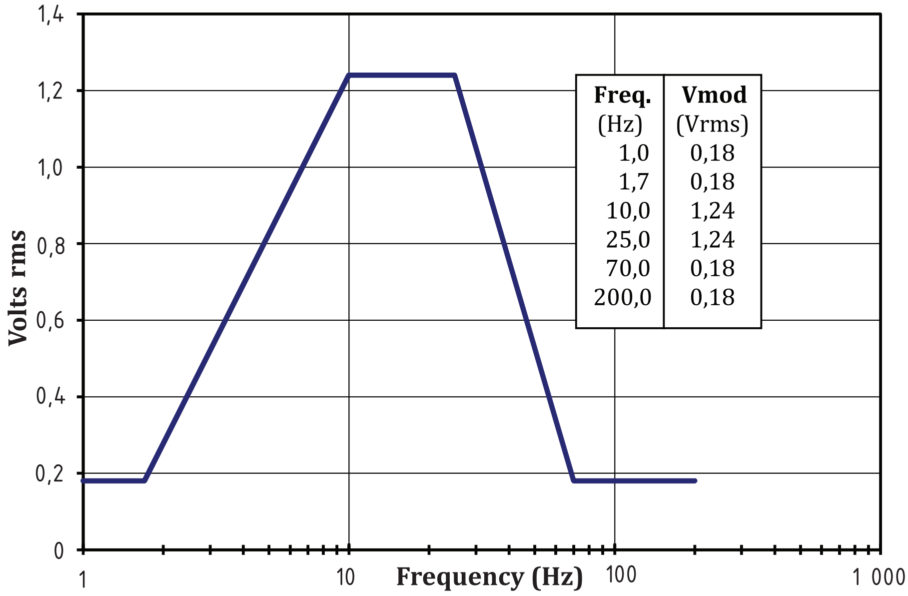


Figure 5 — Limits for spectral components of voltage modulation

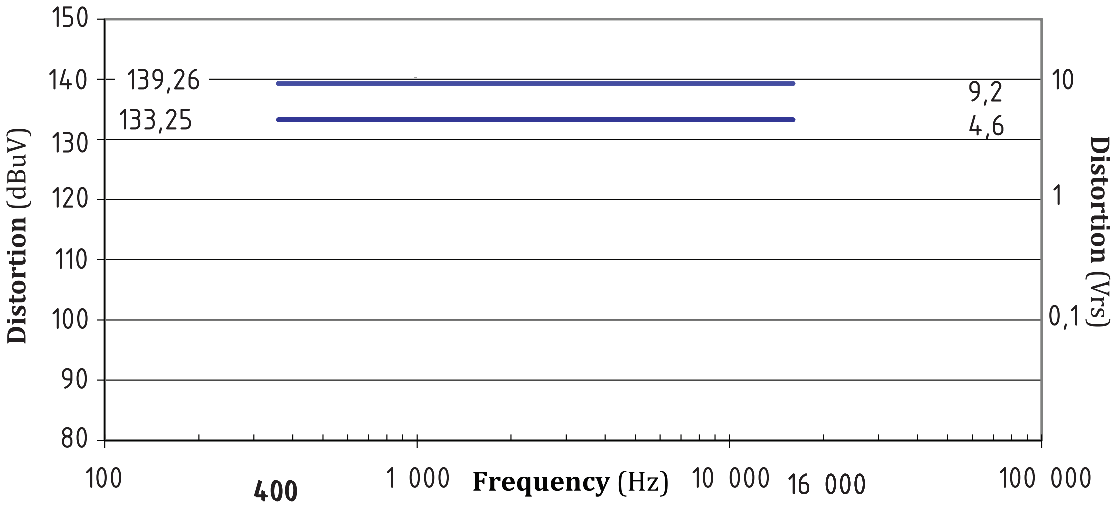


Figure 6 — Limits for spectral components of voltage distortion

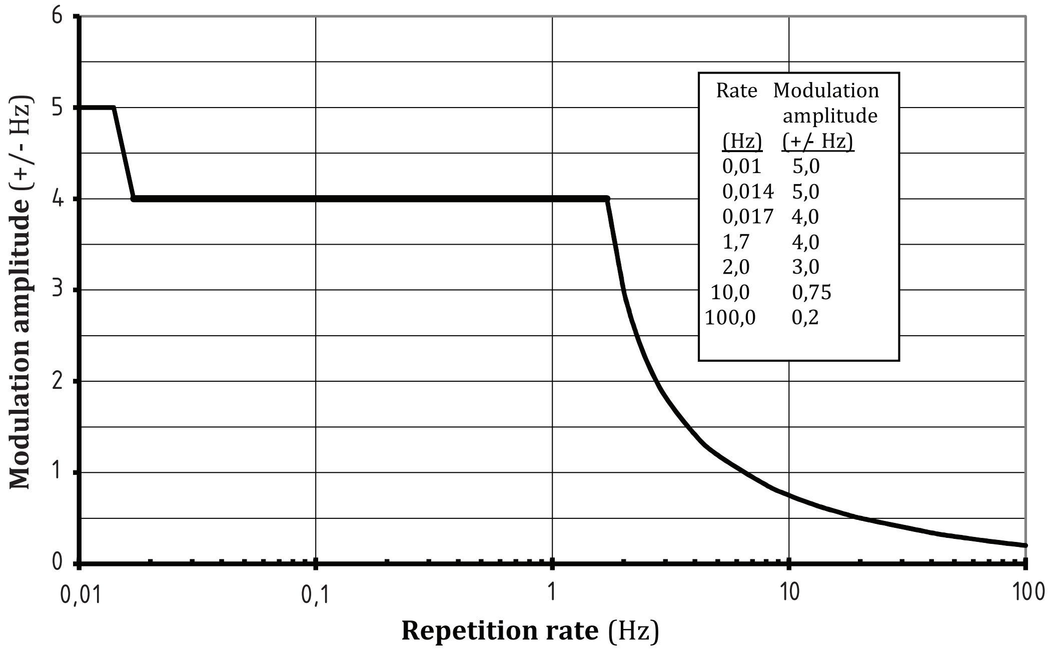
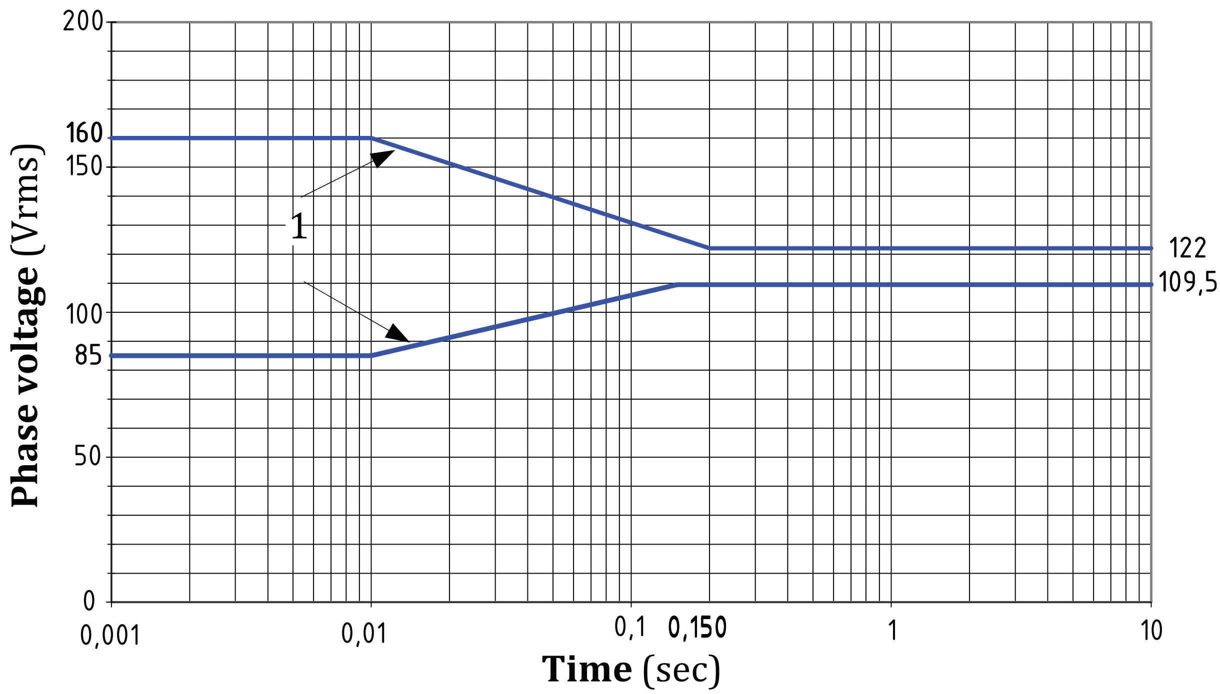


Figure 7 — Limits for spectral components of frequency modulation



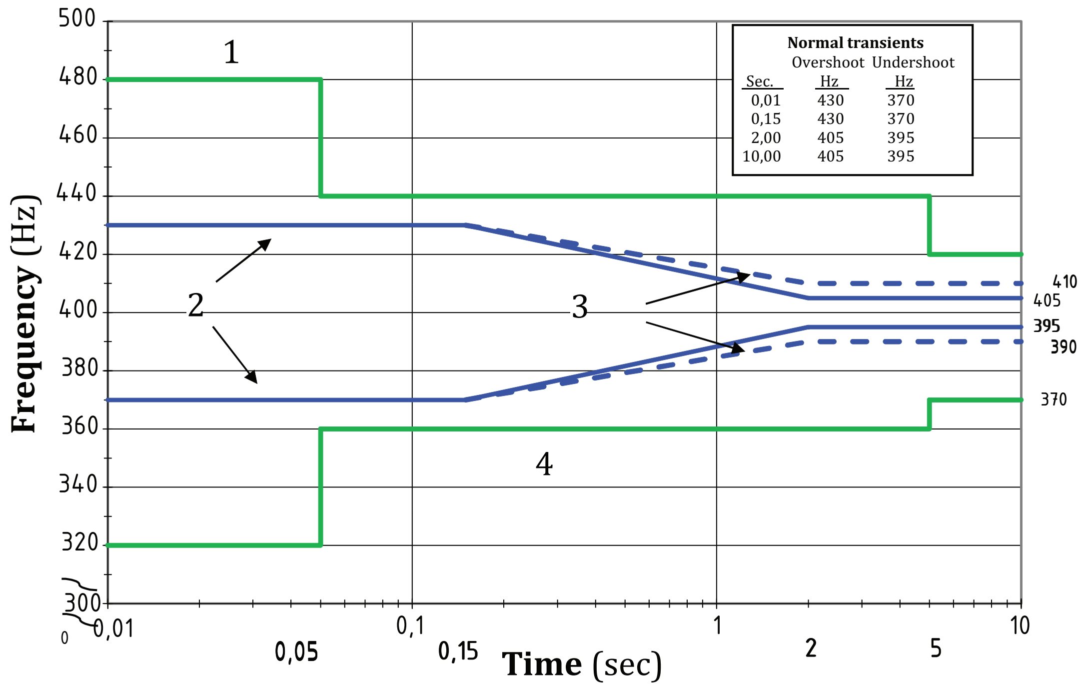
Key

1 normal transients

NOTE 1 Limits are for rms values. Peak values are a function of the values shown and the crest factor limits of Table 3 (Vpk = crest factor × Vrms).

NOTE 2 Limits for 230 V are 230/115 times those shown.

Figure 8 — Envelope for normal AC voltage transients



Key

1 over frequency trip limit

2 normal transients

3 overload transients

4 under frequency trip limit

NOTE Frequency transients of less than the time periods shown are not identified.

Figure 9 — Envelope for AC frequency transients

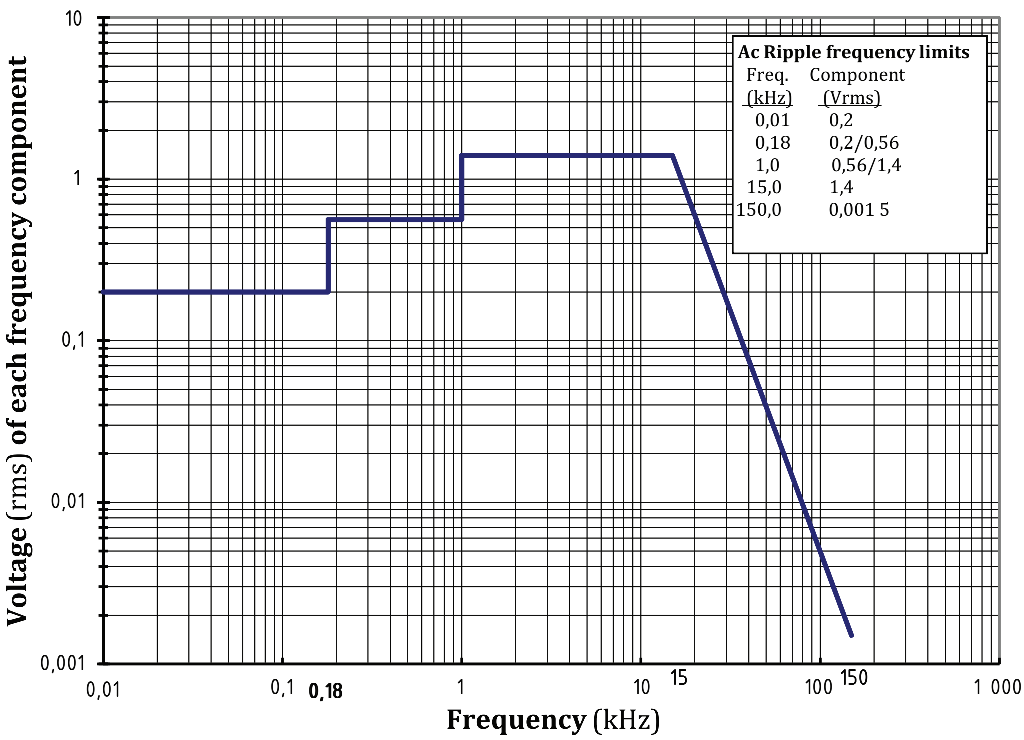


Figure 10 — Limits for spectral components of 28 V DC system ripple

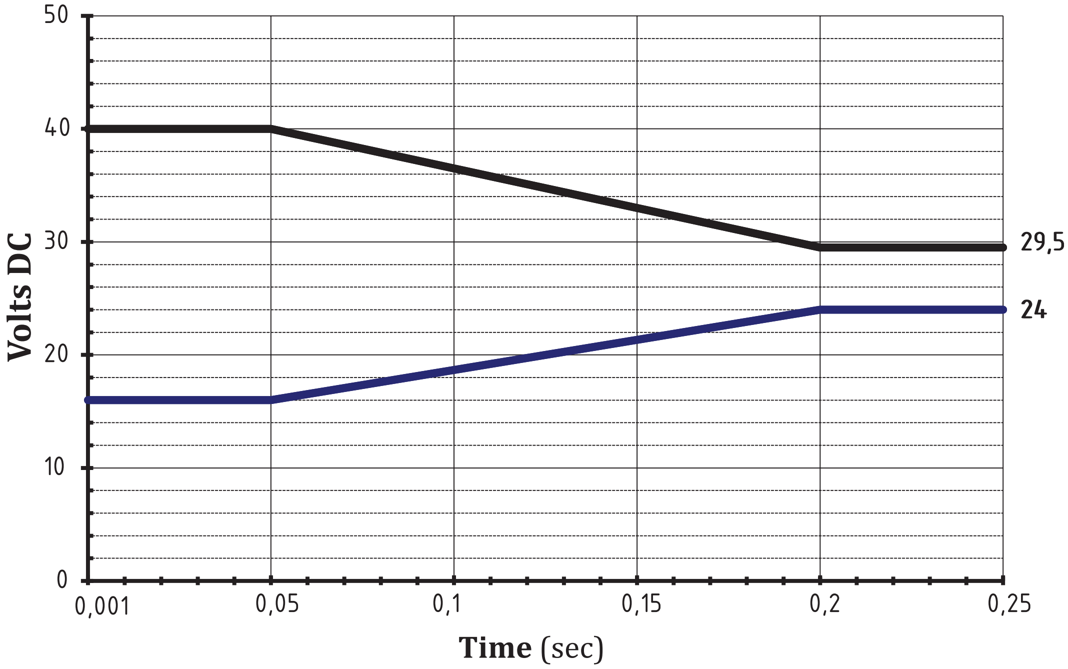
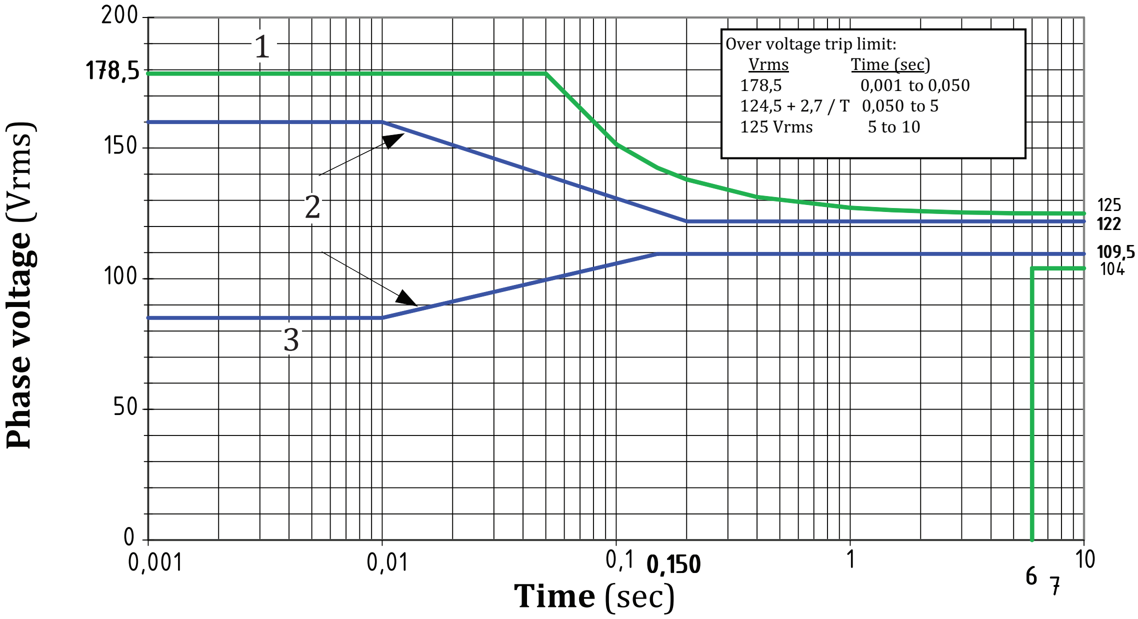


Figure 11 — Envelope for normal DC voltage transients



Key

1 overvoltage trip limit

2 normal transients

3 undervoltage trip limit

NOTE 1 Limits are for rms values. Peak values are a function of the values shown and the crest factor limits (Vpk = crest factor × Vrms).

NOTE 2 Limits for 230 V are 230/115 times those shown.

Figure 12 — Envelope for AC voltage protection limits

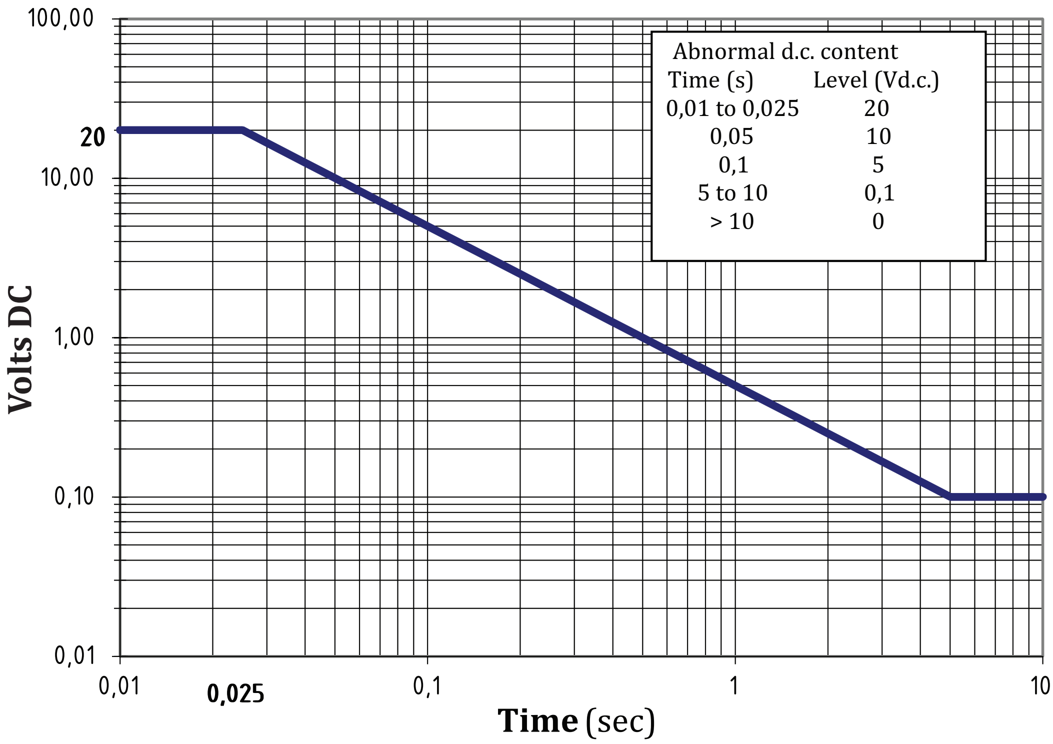
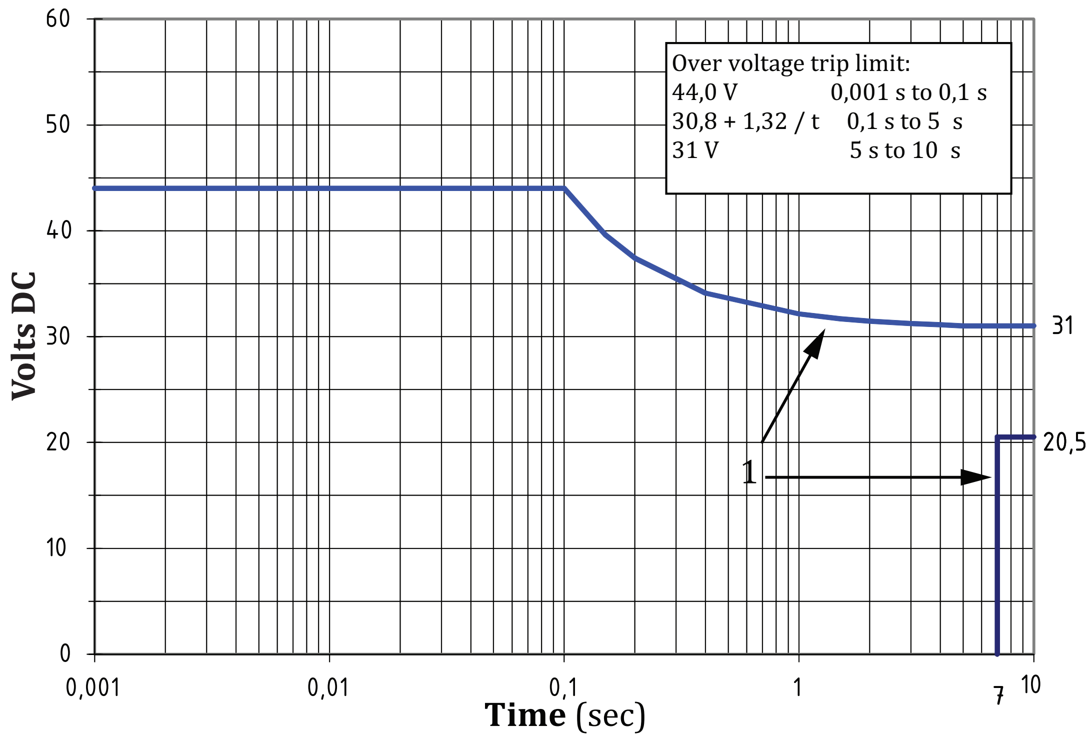


Figure 13 — Envelope for DC voltage content on AC system



Key

1 overvoltage/undervoltage trip limits

Figure 14 — Envelope for DC voltage protection limits

Annex A
(normative)

Acceptable test listing for AC facilities

A.1 Capacity tests

Load the facility per the total load values and the time values shown in Table A.1. If the facility has multiple outputs, one output shall be loaded at its rated capacity and the remaining system capacity distributed amongst the remaining outputs.

Table A.1 — Capacity load versus time

	Type 1		Type 2	
Time	**% rated capacity**	**PF**	**% rated capacity**	**PF**
2 h	100 %	1,0	80 %	Unity
10 min	110 %	0,8 lag, 1,0	N/A	—
5 min	125 %	1,0	100 %	1,0
10 s	140 %	0,7 lag	120 %	0,7 lag
2 s	200 %	0,7 lag	150 %	0,7 lag

Monitor voltage at the aircraft connector to verify continued operation within acceptable limits during the capacity tests.

A.2 Voltage adjustment test

Manipulate the voltage adjustment device and verify that overvoltage and undervoltage trips occur at the aircraft connector in accordance with the limits defined in Figure 12.

A.3 Balanced linear load tests

Load the facility at the following power levels and power factors (applicable to both Type 1 and Type 2 facilities unless otherwise noted):

a) 0 %;

b) 25 % at 0,8 PF lagging and unity;

c) 50 % at 0,8 PF lagging and unity;

d) 80 % at 0,8 PF lagging and unity;

e) 100 % at 0,8 PF lagging;

f) 100 % at unity PF (Type 1 only).

Record and verify that the steady-state limits of Table 3 for voltage, frequency and total distortion are maintained at the aircraft connector. If the facility accepts electrical power, verify that it meets the EMC requirements of Clause 5.

A.4 Unbalanced linear load tests

Load the facility at the phase current levels and power factors shown in Table A.2.

Table A.2 — Unbalanced load test points

Test	Application	Phase A load		Phase B load		Phase C load	
		Per unit current	PF	Per unit current	PF	Per unit current	PF
a)	Type 1, 2	0	—	0	—	U	0,8
b)	Type 1, 2	0	—	0	—	U	1
c)	Type 1, 2	0	—	U	0,8	U	0,8
d)	Type 1, 2	0	—	U	1	U	1
e)	Type 1, 2	(1 – U)	0,8	(1 – U)	0,8	1	0,8
f)	Type 1 only	(1 – U)	1	(1 – U)	1	1	1
g)	Type 1, 2	(1 – U)	0,8	1	0,8	1	0,8
h)	Type 1 only	(1 – U)	1	1	1	1	1

NOTE 1 In this table, U = allowed imbalance; 1/3 for facilities up to 40 kVA, 1/6 for facilities above 40 kVA.

NOTE 2 According to the definitions in ISO 1540, per unit (PU) phase current for a 90 kVA source = 90 000/115/3 or 261 arms.

Record voltage at the aircraft connector and verify that the steady-state limits of Table 3 for voltage, frequency and distortion are maintained.

A.5 Nonlinear load tests

Load the facility with the variety of linear and nonlinear loads, at the power levels and power factors shown in Table A.3 (applicable to both Type 1 and Type 2 facilities unless otherwise noted).

Table A.3 — Nonlinear load test points

Test	Linear 3Φ load		6-pulse 3Φ rectifier load	12-pulse 3Φ rectifier load	12-pulse 3Φ rectifier constant power load	Phase A 1Φ 2-pulse rectifier load	Phase B 1Φ 2-pulse rectifier load	Phase C 1Φ 2-pulse rectifier load
	Per unit power	PF	Per unit power	Per unit power	Per unit power	Per unit power	Per unit power	Per unit power
a)	1/2	0,8	1/6	0	0	0	0	0
b)	1/3	0,8	0	1/3	0	0	1/9	1/9
c)	1/3	1	1/6	1/3	0	0	0	0
d)	1/2	1	0	1/3	0	0	0	0
e)	1/3	1	1/6	0	0	1/9	0	0
f)	1/3	0,8	0	0	0	0	1/9	1/9

NOTE 1 The last two test points are only applicable to Type 1 facilities of more than 60 kVA continuous rating.

NOTE 2 6-pulse, 3Φ and 2-pulse, 1Φ loads can be constructed as defined in ISO 7137:1995, Clause 16.

NOTE 3 Constant power load implementation requires active control to cause this effect in addition to the rectifier elements.

Table A.3 *(continued)*

Test	Linear 3Φ load		6-pulse 3Φ rectifier load	12-pulse 3Φ rectifier load	12-pulse 3Φ rectifier constant power load	Phase A 1Φ 2-pulse rectifier load	Phase B 1Φ 2-pulse rectifier load	Phase C 1Φ 2-pulse rectifier load
	Per unit power	PF	Per unit power	Per unit power	Per unit power	Per unit power	Per unit power	Per unit power
g)	1/3	1	0	1/3	0	1/9	1/9	1/9
h)	1/3	0,8	0	0	1/3	0	1/9	0
i)	1/6	1	0	0	1/3	0	0	0
NOTE 1 The last two test points are only applicable to Type 1 facilities of more than 60 kVA continuous rating.								
NOTE 2 6-pulse, 3Φ and 2-pulse, 1Φ loads can be constructed as defined in ISO 7137:1995, Clause 16.								
NOTE 3 Constant power load implementation requires active control to cause this effect in addition to the rectifier elements.								

Record voltage at the aircraft connector and verify that the steady-state limits of Table 3 for voltage, frequency, modulation and distortion are maintained.

A.6 AC facility transient load tests

A.6.1 Step loads test

Apply the following step load and removals and observe that the transient frequency and voltage at the aircraft connector remain within the transient limits specified in Clause 5:

a) 0 % to 25 % at 0,8 PF;

b) 0 % to 25 % at unity;

c) 0 % to 50 % at 0,8 PF;

d) 0 % to 50 % at unity;

e) 0 % to 100 % at 0,8 PF;

f) 0 % to 100 % at unity (Type 1 only);

g) 50 % to 0 % at 0.8 PF;

h) 50 % to 0 % at unity;

i) 100 % to 2 % at 0,8 PF;

j) 100 % to 2 % at unity (Type 1 only).

A.6.2 Motor start load test

Apply the pre-loads and motor start loads, as defined in Table A.4, and observe that the transient frequency and voltage at the aircraft connector remains within the limits specified in Clause 5.

Table A.4 — Motor start load tests

Type	Test	Pre-load		Motor start load		
		Per unit power	PF	Per unit power	PF	Time (S)
1	a)	0,65	0,9	0,8	0,5	10
1	b)	0,8	0,95	1,33	0,5	2
2	c)	0,33	1	1	0,5	10
2	d)	0,85	0,8	0,66	0,55	2

A.7 AC facility protection tests

Provide sufficient stimulus to cause conditions requiring exercise of the following protective functions and verify appropriate responses:

a) overvoltage;

b) undervoltage;

c) frequency;

d) overcurrent and short circuits;

e) phase sequence;

f) DC content (if applicable);

g) open neutral/phase conductor(s);

h) earth/ground fault (if applicable).

A.8 AC facility example test data sheets

Suppliers wishing to show verification of meeting the AC facility test requirements of this document shall prepare documentation of their test results. An acceptable example is shown in Table A.5.

Table A.5 — Acceptable test data sheets for AC facilities

Cover sheet

Manufacturer	
Model	
Facility type (1 or 2)	
Rating (kVA)	
Output voltage (115/200 or 230/400 Vrms)	
GPU-to-aircraft stinger style/length used for test	
Load equipment utilized	
Test date(s)	
Test location	
Test notes (if desired)	

	A.C. Steady State Test Data Measured at Aircraft Connector										
Test	**Time**	**V_{Ave}**	**$V_{Phase\ Max}$**	**$V_{Phase\ Min}$**	**$V_{Unb.\ Max}$**	**$V_{Disp.\ Min}$**	**$V_{Disp.\ Max}$**	**$V_{Phase\ Mod\ Max}$**	**$V_{CF\ Max}$**	**$V_{Phase\ Dist.\ Max}$**	**Freq.**
	(Sec)	**(Vrms)**	**(Vrms)**	**(Vrms)**	**(Vrms)**	**(Vrms)**	**(Vrms)**	**(Vpk)**		**(%)**	**(Hz)**
	Capacity test data										
A.1 - 2 h											
A.1 - 10 min (@ 0.8 Lag)											
A.1 - 10 min (@ 1 PF)											
A.1 - 5 min											
A.1 - 10 s											
A.1 - 2 s											
	Voltage adjustment test data										
A.2 OV											
A.2 UV											
	Balanced linear load test data										
A.3 i)											
A.3 ii)											
A.3 iii)											
A.3 iv)											
A.3 v)											
A.3 vi)											
	Unbalanced linear load test data										
A.4 i)											
A.4 ii)											
A.4 iii)											
A.4 iv)											
A.4 v)											
A.4 vi)											
A.4 vii)											
A.4 viii)											
	Nonlinear load test data										
A.5 i)											
A.5 ii)											
A.5 iii)											
A.5 iv)											
A.5 v)											
A.5 vi)											
A.5 vii)											
A.5 viii)											
A.5 ix)											

NOTE Data are not required in grey cell areas.

Figure A.1 — AC steady-state data sheet

Test	A.C. transient test data measured at aircraft connector	
	Voltage (plot vs. Figure 8 limits)	Frequency (plot vs. Figure 9 limits)
	(Vrms)	(Hz)
	Step Load Tests - attach voltage and frequency plots	
A.6.1 a)		
A.6.1 b)		
A.6.1 c) @ 0.8 PF		
A.6.1 c) @ 1.0 PF		
A.6.1 d)		
A.6.1 e) @ 0.8 PF		
A.6.1 e) @ 1.0 PF		
A.6.1 f) @ 0.8 PF		
A.6.1 f) @ 1.0 PF		
	Motor Start Load Tests - attach voltage and frequency plots	
a)		
b)		
	A.C. facility protection tests - attach appropriate data to satisfy the respective protective function clause	
a)		
b)		
c)		
d)		
e)		
f)		
g)		
i)		

Figure A.2 — AC transient data sheet

Annex B
(normative)

Acceptable test listing for DC facilities

B.1 DC facility capacity tests

Load the facility per the total load values and the time values shown in Table B.1.

Table B.1 — DC facility capacity test conditions

Load (% rated current)	Time
25 %	10 min
50 %	10 min
75 %	10 min
100 %	2 h

Monitor steady-state and ripple voltage at the aircraft connector to verify continued operation within acceptable limits during the capacity tests.

B.2 DC facility transient load tests

Apply the following step load and removals and observe that the voltage limits during the transients are within the limits specified in Clause 5.

a) 0 % to 50 %;

b) 50 % to 100 %;

c) 100 % to 50 %;

d) 50 % to 0 %.

B.3 DC facility engine start tests

Apply a resistive load sufficient to draw the stated engine start current rating and verify that the minimum voltage during the engine start does not fall below the voltage guaranteed by the manufacturer.

B.4 DC facility protection tests

Provide sufficient stimulus to cause conditions requiring exercise of the following protective functions and verify appropriate responses.

a) overvoltage;

b) undervoltage;

c) reverse current;

d) overcurrent and short circuits;

e) reverse polarity.

B.5 DC facility example test data sheets

Suppliers wishing to show verification of meeting the DC facility test requirements of this document shall prepare documentation of their test results. An acceptable example is shown in Table B.2.

Table B.2 — Acceptable test data sheet for DC facilities

Manufacturer	
Model	
Rating (A DC)	
GPU-to-aircraft stinger gauge/length used for test	
Load equipment utilized	
Test date(s)	
Test location	
Test notes (if desired)	

<table>
<tr><th colspan="5">B.1 DC facility capacity tests</th></tr>
<tr><th>Load</th><th>Time</th><th>Parameter</th><th>Limit</th><th>Actual</th></tr>
<tr><td rowspan="2">25 %</td><td rowspan="2">10 min</td><td>Steady-state voltage</td><td>per Table 4</td><td></td></tr>
<tr><td>Ripple voltage</td><td>per Table 4</td><td></td></tr>
<tr><td rowspan="2">50 %</td><td rowspan="2">10 min</td><td>Steady-state voltage</td><td>per Table 4</td><td></td></tr>
<tr><td>Ripple voltage</td><td>per Table 4</td><td></td></tr>
<tr><td rowspan="2">75 %</td><td rowspan="2">10 min</td><td>Steady-state voltage</td><td>per Table 4</td><td></td></tr>
<tr><td>Ripple voltage</td><td>per Table 4</td><td></td></tr>
<tr><td rowspan="2">100 %</td><td rowspan="2">2 h</td><td>Steady-state voltage</td><td>per Table 4</td><td></td></tr>
<tr><td>Ripple voltage</td><td>per Table 4</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">B.2 DC facility transient load tests</th></tr>
<tr><th>Load change</th><th>Limit</th><th>Pass/Fail</th></tr>
<tr><td>0 % to 50 %</td><td rowspan="4">Voltage shall be plotted to demonstrate that
it does not exceed the limits specified in Figure 11.</td><td></td></tr>
<tr><td>50 % to 100 %</td><td></td></tr>
<tr><td>100 % to 50 %</td><td></td></tr>
<tr><td>50 % to 0 %</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">B.3 DC facility engine start test</th></tr>
<tr><th>Load</th><th>Minimum voltage limit</th><th>Actual value</th></tr>
<tr><td>______ A</td><td>____ V DC</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">B.4 Protection tests</th></tr>
<tr><th>Parameter</th><th>Limit</th><th>Pass/Fail</th></tr>
<tr><td>Overvoltage</td><td>per 6.3.1
(attach appropriate data to demonstrate)</td><td></td></tr>
<tr><td>Undervoltage</td><td>per 6.3.2
(attach appropriate data to demonstrate)</td><td></td></tr>
</table>

Table B.2 *(continued)*

Reverse current	per 6.3.3 (attach appropriate data to demonstrate)	
Overcurrent and Short circuits	per 6.3.4 (attach appropriate data to demonstrate)	
Reverse polarity	per 6.3.5 (attach appropriate data to demonstrate)	

Bibliography

[1] IEC 61558-2-6, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V — Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers*

(*Continued from second cover*)

The Committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard. For undated references, the latest edition of the referenced document applies, including any corrigenda and amendment:

International Standard	*Title*
ISO 1540 : 2006	Aerospace — Characteristics of aircraft electrical systems
ISO 7137 : 1995	Aircraft — Environmental conditions and test procedures for airborne equipment
ISO 12384 : 2010	Aerospace — Requirements for digital equipment for measurements of aircraft electrical power characteristics
IEC 61140 : 2016	Protection against electrical shock — Common aspects for installation and equipment

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. The Bureau of Indian Standards shall not be held responsible for identifying any or all such patent rights.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test shall be rounded off in accordance with IS 2: 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard

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