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Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 1, *Aerospace electrical requirements*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 20949 series can be found on the ISO website.

Introduction

This document provides general requirements of the smart contactor for aircraft.

Smart Contactor based power distribution systems are emerging among advanced aircraft applications, especially among More Electric Aircraft and All Electric Aircraft. Standardization is increasingly needed for Smart Contactors in aircraft power systems based on intelligent high current switching and protecting technology. Those systems have the potential for higher reliability and longer operating life, with higher capability for status sensing, over-current protection, lower maintenance costs, higher flexibility of designing power switching as well as protecting performance compared with conventional contactor switched systems.

The purpose of this document, the definitions of smart contactor and the contents of the document are as follows:

a) The purpose of this document:

   1) To standardize the requirements for smart contactors that are physically and environmentally diversified.

   2) To provide the applicable document for various smart contactors.

b) The definitions of smart contactor:

   1) Consists of an intelligent circuit and a power switch.

   2) Turns on/off the power output by receiving the control signal.

   3) Detects the over current in the load which results in shutting down for this current.

   4) Indicates the on/off status of the power output.

   5) Reports the status of smart contactor.

c) The contents of this document:

   1) Definitions of the technical terms.

   2) Electrical requirements.

   3) Test methods.

In order to satisfy the purpose of this document, requirements such as physical, environmental and individual items are specified in accordance with the detail requirements that are issued individually.

Aircraft — Smart contactor — General requirements

1 Scope

This document specifies the definitions, titles of design and general requirements and test methods to determine the performance of smart contactors for use in aircraft electrical power systems. The smart contactor consists of a switching driving circuit and a power switch for protection, action on control signals, and providing status information.

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 1540, *Aerospace — Characteristics of aircraft electrical systems*

ISO 2678:1985,*Environmental tests for aircraft equipment — Insulation resistance and high voltage tests for electrical equipment*

ISO 7137:1995,*Aircraft — Environmental conditions and test procedures for airborne equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 https://www.iso.org/obp

3.1
bounce time
for a contact which is closing (opening) its circuit, the time interval between the instant when the contact circuit first closes (opens) and the instant when the circuit is finally closed (opened)

3.2
contact bounce
intermittent opening of contacts after initial closure due to contact impact

3.3
control signals
signals including control or status which is specified for operation of the smart contactor, i.e. voltage supply, control signals including turn on/off, switch status, and/or communication signals, or other

3.4
load voltage
voltage between the power output terminal of the smart contactor and the power ground

3.5
off state
condition which, with the turn-off signal applied, the device prevents power from being passed to the load

3.6
on state
condition which, with the turn-on signal applied, the device allows power to be passed to the load

3.7
peak let-through current
peak value of the current at maximum system voltage that the smart contactor will conduct for a specified time interval without damage

3.8
power dissipation
power dissipation which includes all power dissipated in the power switching circuit, power losses due to internal leakage currents, and power supplies

Note 1 to entry: When the smart contactor is OFF, the power dissipation includes only dissipation due to leakage currents and internal power supplies.

3.9
reset
restoration of the tripped smart contactor to a state from which it can be turned ON

3.10
rupture current
maximum current the power circuit is capable of interrupting at maximum system voltage without damage

3.11
short circuit
circuit with the impedance of less than 1 mΩ applied between the output terminal and ground

3.12
short-circuit current
maximum current that the power circuit will pass without damage for a specified maximum time under the most adverse combination of electrical and environmental conditions

3.13
smart contactor
device consisting of an intelligent circuit and a power switch

Note 1 to entry: The contactor provides a power switch for high current from its power supply to its load terminal when in the ON state and a high impedance in the OFF state. The intelligent circuit consists of a driving circuit to drive the contactor, a detecting circuit sensing the current in the load and intelligent core circuit with but not limited to programmable signal processing, programmable protection characteristics, commutating capability that can trip, report device status, provide command to driving circuit in accordance with the control signal and the on/off status.

Note 2 to entry: The state of the power switch normally conforms to that represented by the last command signal applied to the smart contactor.

— The smart contactor reverts to the OFF state on detection of an electrical overload or other specified condition. A resetting operation is required to terminate the trip state. Trip-free action prevents the ON state being held in the presence of an overload trip condition.

— The state of the power switch is represented by an indication signal supplied by the smart contactor.

3.14
supply voltage
voltage applied between the power input terminal of the smart contactor and the power ground

3.15
switch status
indication showing the actual state of the smart contactor (ON state or OFF state)

3.16
trip
automatic reversion to the OFF state of the smart contactor output caused by an overload condition

3.17
trip curve
curve which sets the minimum and maximum trip points of the smart contactor and is plotted as current versus time

3.18
trip free
feature which will prevent subsequent re-closing unless preceded by a reset signal, when the smart contactor has tripped due to an over current condition

3.19
trip time
time interval between the application of an over current condition and the 10 % value of rated output current

Note 1 to entry: In general, the higher is the over current condition the shorter is the trip time.

3.20
turn-off signal
control signal level at which the smart contactor is turned OFF.

3.21
turn-off time
time interval between initiation of turn-off signal and the time when the output reach 10 % of its steady-state ON value

3.22
turn-on signal
control signal level at which the smart contactor is turned ON

3.23
turn-on time
time interval between initiation of turn-on signal and the time when the output reach 90 % of its steady-state ON value

3.24
unwanted trip
tripping function in response to a condition that is not an over-current protection but a condition that occurs as part of the normal or anticipated operation of circuit components

Note 1 to entry: Nuisance trip is synonymous with unwanted trip.

3.25
voltage drop
voltage across input and output terminals of the smart contactor in the ON state at the specified load

4 General requirements

4.1 Detail specification sheets

The device manufacturer shall prepare an individual specification sheet for each type of device produced. The individual specification sheet shall define the value for parameters.

4.2 Materials

Materials shall be used which will enable the smart contactors to meet the performance requirements of this document.

Materials used shall not support combustion, give off noxious gases in harmful quantities, give off gases in quantities sufficient to cause explosion of sealed enclosures, cause functional contamination of any part of the smart contactor, or form unintended current-carrying tracks when subjected to any of the tests specified herein.

4.3 Construction

Smart contactors shall be of design, construction, minimum mass and physical dimensions compatible with requirements. Smart contactors shall be designed so as to ensure proper operation when mounted in any attitude.

The construction of the smart contactors shall preclude mechanical damage, flaking of finish, loosing of terminals, or deterioration of marking when subjected to the test methods of this document.

4.4 Terminals

4.4.1 Main terminals

4.4.1.1 General

There are two acceptable types of terminal as follows.

4.4.1.2 Stud terminals (threaded)

These terminals shall accept connections using aircraft-approved crimped-type lugs. A flat washer having a diameter at least equal to that of the base of the terminal, and a standard nut with suitable locking washer shall be used on each terminal. Suitable insulation barriers shall be placed between the terminals in order to prevent an accidental short circuit. The height and extent of these barriers shall be sufficient to prevent the short-circuiting of any adjacent terminals through the presence over these partitions of a flat conducting part.

No rotation or other loosening of a terminal, or any fixed portion of a terminal, shall be caused by material flow or shrinkage, or any mechanical force (specified in Tables 1 and 2) involved in connection or disconnection, throughout the life of the smart contactor.

The equivalent metric threads given in Table 2 may be used.

Each terminal shall have a terminal seat that shall provide the normal current-conduction path. The diameter of the seat shall not be less than the area necessary to assure that the current density does not exceed l,55 A/mm^2. The seat does not include the cross-sectional area of the stud.

Stud terminals shall be capable of accommodating two crimped-type lugs, with hardware as specified. A minimum of one and a half threads shall remain above the nut, with all parts tightened in place.

4.4.1.3 Plug-in terminals

Plug-in terminals, where applicable, shall conform to the dimensions and requirements necessary for proper mating with the associated sockets.

Units shall have the electrical and environmental tests performed with the associated socket or connector assembled to the unit.

Table 1 — Strength of threaded terminals (Static value of pull and torque)

Thread designation	Force		Installation torque		Design torque	
	N	lbf	N·m	lbf-in	N·m	lbf-in
No. 4-40 UNC	22,2	5	0,3	2,4	0,5	4,4
No. 6-32 UNC	133,4	30	0,5	4,5	1,1	10
No. 8-32 UNC	155,7	35	1	9	2,3	20
No. 10-32 UNF	177,9	40	1,7	14,5	3,7	32
No. 10-24 UNC	177,9	40	1,8	16	4	35
1/4-28 UNF	222,4	50	3,9	34	8,6	75
5/16-24 UNF	311,4	70	5,2	45	11,5	100
3/8-24 UNF	444,8	100	7,8	68	17,3	150
7/16-20 UNF	444,8	100	7,8	68	17,3	150
1/2-20 UNF	444,8	100	7,8	68	17,3	150

1) See Reference [4].

Table 2 — Strength of threaded terminals — Metric units (Static value of pull and torque)

Thread designation	Force		Installation torque		Design torque	
	N	lbf	N-m	lbf-in	N·m	lbf-in
M2,5	22,2	5	0,3	2,4	0,5	4,4
M3	133,4	30	0,5	4,5	1,1	10
M4	155,7	35	1	9	2,3	20
M5	177,9	40	1,8	16	4	35
M8	311,4	70	5,2	45	11,5	100
M10	444,8	100	7,8	68	17,3	150
M12×1,25	444,8	100	7,8	68	17,3	150
M14×1,25	444,8	100	7,8	68	17,3	150

NOTE There is no direct metric equivalent to the thread size l/4-28 UNF. M7 would correspond but is not used.

4.4.2 Auxiliary terminals

The auxiliary circuits and control/status connections may be connected by stud, plug-in or connector terminals to the appropriate specification.

4.5 Enclosures

4.5.1 General

The enclosure design is identified by a single digit, in accordance with Table 3.

Table 3 — Enclosure design

Type	Enclosure
1	Open
2	Enclosed (ventilated, explosion-proof)
3	Sealed (other than hermetically)
4	Hermetically sealed

4.5.2 Open enclosures

Type 1 smart contactors shall be uniformly coated on all surfaces with the exception of the mounting and terminals.

4.5.3 Enclosed enclosures (ventilated explosion-proof)

Unsealed units shall be totally enclosed for mechanical and dust protection and shall be explosion-proof.

4.5.4 Sealed (other than hermetically) enclosures

Environmentally sealed enclosures shall be constructed by any means other than that defined under hermetically sealed enclosures to achieve the degree of seal specified. Environmentally sealed units shall be purged and filled with a suitable gas of such characteristics that the leakage rate may be determined by conventional means. The units shall be designed to ensure that the essential electrical performance is not jeopardized in the event of a failure of the environmental seal in service.

4.5.5 Hermetically sealed enclosures

Hermetically sealed enclosures shall be constructed as gas-tight enclosures which have been completely sealed by fusion of glass or ceramic to metal, or by welding, brazing or soldering of metal to metal. Hermetically sealed units shall be purged and filled with a suitable inert gas of such characteristics that the leakage rate may be determined by conventional means.

4.5.6 Grounding of enclosures

The enclosures for type 2, 3 and 4 smart contactors shall be electrically isolated and provide means for grounding where appropriate.

The mountings shall provide an effective electrical contact to ground when the unit is mounted as specified. Alternatively, the enclosures shall be provided with a grounding connection such as a terminal or lug.

The covers shall be rugged in design, constructed of high-impact materials and securely mounted to the unit. Metal covers shall be provided with a means of grounding.

4.6 Installation clearances

Adequate clearance shall be provided for the installation of terminals mounting hardware. Clearance for socket wrenches shall be provided, where appropriate. Special installation tools shall not be required.

4.7 Terminal marking

Stud terminal identification shall be durable and legibly marked.

4.8 Terminal covers and barriers

The unit shall be provided with adequate covering or separation of terminal parts to provide protection against inadvertent shorting, grounding, or contact by personnel. Barriers may be removable or may be integral with removable covers.

Terminal covers and barriers shall be designed to meet performance requirements applicable to the unit. The enclosure(s) shall be so designed that when the cover is removed, the smart contactor shall be capable or operating without adjustment.

The cover design shall be such that pressure differentials cannot exist between the inside and outside.

