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Aerospace — Solid-state remote power controllers — General performance requirements

Aéronautique et espace — Contacteurs-disjoncteurs statiques commandés à distance — Exigences générales de performance

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 27027 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 1, *Aerospace electrical requirements*.

Introduction

This International Standard is intended to standardize the requirements for solid-state (remote) power controllers (SSPC) that are physically and environmentally diversified, and to provide the applicable standard document for various solid-state (remote) power controllers.

The solid-state (remote) power controller

- consists of a solid-state switching device and its driver circuit;
- turns on/off the power output by receiving the control signal;
- detects the over current into the load and limits or trips the current;
- indicates the on/off status of the power output.

This International Standard contains definitions of the technical term, electrical requirements and test methods.

For the purposes of this International Standard, requirements such as physical, environmental and individual items are specified in accordance with the detailed requirements that are issued individually.

Aerospace — Solid-state remote power controllers — General performance requirements

1 Scope

This International Standard specifies the definitions, general performance requirements and test methods to determine the performance of solid-state (remote) power controllers (SSPC) for use in aerospace electrical power systems.

The solid-state (remote) power controller consists of solid-state switching device(s) and associated solid-state circuitry for protection, action of control signals and providing status information.

2 Normative references

The following referenced documents are indispensable for the application 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*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply

3.1
turn-on time
⟨d.c. devices and non-zero crossing turn-on a.c. devices⟩ time interval between initiation of turn-on signal and the time when the output reaches 90 % of its steady-state ON value, as shown in Figure 1 a)

3.2
turn-on time
⟨a.c. devices with zero-crossing turn-on⟩ time interval between initiation of turn-on signal and the time when the output switch is ON at zero crossing, as shown in Figure 1 b)

3.3
turn-off time
⟨d.c. devices and non-zero crossing turn-off a.c. devices⟩ time interval between initiation of turn-off signal and the time when the output reaches 10 % of its steady-state ON value, as shown in Figure 1 a)

3.4
turn-off time
⟨a.c. devices with zero-crossing turn-off⟩ time interval between initiation of turn-off signal and the time when the output switch is OFF at zero crossing, as shown in Figure 1 b)

3.5
turn-on signal
control signal level at which the power controller is turned ON

3.6
turn-off signal
control signal level at which the power controller is turned OFF

3.7
load voltage rise and fall time
⟨d.c. devices and non-zero crossing turn-off a.c. devices⟩ time interval between 10 % and 90 % of the steady state load voltage value, as shown in Figure 1 a)

3.8
soft on/off
function for the power output current to increase linearly with turn-on signal and to decrease linearly with turn-off signal

3.9
supply voltage
voltage applied between the power input terminal of the SSPC and the power ground

3.10
load voltage
voltage between the power output terminal of the SSPC and the power ground

3.11
voltage drop
voltage across load and line terminals of the SSPC in the ON state at the specified load

3.12
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 When SSPC is OFF, the power dissipation includes only dissipation due to leakage currents and internal power supplies.

3.13
trip
automatic reversion to the OFF state of the SSPC output caused by an over load condition

3.14
trip free
feature which will prevent subsequent re-closing unless preceded by a reset signal, when the SSPC has tripped due to an over current condition

3.15
trip time
time interval between the application of an over current condition and the 10 % value of rated output current

NOTE In general, the higher the over current condition, the shorter the trip time.

3.16
trip curve
curve which sets the minimum and maximum trip points of the SSPC and which is plotted as current versus time

3.17
reset
restoration of the tripped SSPC to a state from which it can be turned ON

3.18
on state
condition which, with the turn-on signal applied, the device allows power to be passed to the load

3.19
off state
condition which, with the turn-off signal applied, the device prevents power from being passed to the load

3.20
short circuit
circuit with impedance of less than 1 mΩ applied between the output terminal and ground

3.21
current limiting
function to limit the power output current to the required level within required time from overload or short circuit conditions, as shown in Figure 2

3.22
peak let-through current
peak value of the current at maximum system voltage that the SSPC will conduct for a specified time interval without damage

3.23
zero voltage turn-on/zero current turn-off
⟨a.c. devices⟩ characteristic that requires the SSPC to turn ON and turn OFF only at the half-cycle zero-crossing point, regardless of when the control signal is applied or removed

3.24
reverse current
current into the load terminal of the SSPC from the load energy source

4 Requirements

4.1 Detailed requirements

The individual item requirements shall be specified in accordance with the detailed requirements that are issued individually.

4.2 Electrical characteristics

When tested as specified in 5.1, the SSPC shall operate with supply voltage variations in accordance with ISO 1540 or the detailed requirements. The SSPC shall be capable of controlling all types of loads as required by the detailed requirements.

4.3 Performance

4.3.1 Control signals

When tested as specified in 5.2, the control signals shall be as specified in the detailed requirements.

4.3.2 Turn-on and turn-off time

When tested as specified in 5.3, the turn-on and turn-off time shall be as specified in the detailed requirements.

4.3.3 Load voltage rise and fall time (soft on/off function)

When tested as specified in 5.4, the rise and fall time as the soft on/off function shall be as specified in the detailed requirements.

4.3.4 Isolation

The control/power isolation test voltage shall be as specified in the detailed requirements, when tested as specified in 5.5.

4.3.5 Control signal levels

When tested as specified in 5.6, the control signal levels shall be as specified (see 4.1). Where maximum control signals are specified (see 4.1), the signal shall be applied for 10 min without any damage to the SSPC.

4.3.6 Voltage drop

When tested as specified in 5.7, the voltage drop shall not exceed the values specified in the detailed requirements for load current values from no load to 100 % rated.

4.3.7 Off state leakage current

When tested as specified in 5.8, the leakage current shall not exceed the values specified in the detailed requirements.

4.3.8 Off state output voltage

When tested as specified in 5.9, the output voltage shall not exceed the values specified in the detailed requirements.

4.3.9 Power dissipation

When tested as specified in 5.10, the power dissipation shall not exceed the values specified in the detailed requirements.

4.3.10 Overload characteristics

4.3.10.1 Current limiting

When specified in the detailed requirements and tested as specified in 5.11.1, the output current shall be within the trip curve specified. At the initiation of the overload condition, the peak let through current (see 4.1) shall not exceed the value specified.

4.3.10.2 Trip characteristics

When tested as specified in 5.11.2, the SSPC shall not reset until commanded, and the trip time shall be within the trip curve specified in the detailed requirements without any damage.

4.3.11 State indication

The SSPC shall provide the means of state indication specified in the detailed requirements when tested as specified in 5.12. The state indication shall include the detection of load current above or below a minimum current threshold, and the presence or absence of drive to the output power switches, as specified in the detailed requirements. These state indication means, in conjunction with the control signal, shall be capable of providing feedback on normal controller operation or controller faults, as specified in the detailed requirements.

4.3.12 Trip-free characteristics

When tested as specified in 5.13, the SSPC shall reset, trip-out and stay tripped out for the duration of the test.

4.3.13 Zero voltage turn-on and zero current turn-off (a.c. SSPC)

When tested as specified in 5.14, the SSPC turn-on shall occur at zero voltage crossover within the voltage or time specified, and the SSPC turn-off shall occur at zero current crossover within the current or time specified. The SSPC shall turn-on and turn-off at the same voltage slope when specified.

4.3.14 Reverse current

When specified in the detailed requirements and tested as specified in 5.15, the SSPC shall not be damaged, and shall be performed as specified.

4.3.15 Exponential rate of voltage rise

When tested as specified in 5.16, the SSPC shall achieve the specified output voltage within the specified time.

5 Quality assurance provisions

5.1 General provisions regarding electrical characteristics

When performing electrical tests, the SSPC shall be mounted on a suitable heat sink (see 4.1).

5.2 Control signals (see 4.3.1)

5.2.1 General

The control signals shall be verified as specified in 5.2.2 and 5.2.3.

5.2.2 Turn-on signal

With the SSPC connected as shown in Figure 3, apply rated supply voltage and adjust the load resistance for rated load ± 5 %. Apply the minimum turn-on signal with the control function generator and note that the SSPC turns ON.

5.2.3 Turn-off signal

With the SSPC ON at rated control signal, apply the maximum turn-off signal with the function generator and note that the SSPC turns OFF.

5.3 Turn-on and turn-off time

Measure turn-on and turn-off time with the SSPC operated as in 5.2.2 and 5.2.3.

5.4 Load voltage rise and fall time

Measure the rise and fall time with the SSPC operated as in 5.2.2 and 5.2.3.

5.5 Isolation (see 4.3.4)

The power-in terminal, power-out terminal and power-ground terminal shall be shorted together. All remaining terminals shall be shorted together. The points of application shall be the signal-ground and power-ground terminals and the electrification time shall be ⩽ 2 min, as specified in the detailed requirements.

5.6 Control signal levels (see 4.3.5)

With rated supply voltage applied, apply control signals with the level as specified (see 4.1) and measure control current or voltage. Repeat test for each control signal level specified (see 4.1).

5.7 Voltage drop (see 4.3.6)

With the SSPC connected as shown in Figure 3, measure the voltage between the power-in and the power-out terminals while operating at 10 %, 50 % and 100 % rated load. For the a.c. SSPC, a true RMS voltmeter shall be used.

5.8 Leakage current (see 4.3.7)

Connect the SSPC as shown in Figure 3, with the load resistance adjusted for maximum of 10 Ω, rated supply voltage applied to the power-in terminal with the control circuit commanded OFF, and read the leakage current.

5.9 Off state output voltage (see 4.3.8)

Connect the SSPC as shown in Figure 3, without the load resistance, rated supply voltage applied to the power-in terminal with the control circuit commanded OFF, and read the output voltage on a voltmeter of internal resistance ⩾ 10 MΩ.

5.10 Power dissipation (see 4.3.9)

Connect the SSPC as shown in Figure 3, with the load resistance adjusted for short circuit, rated supply voltage applied to the power-in terminal, and the controller commanded OFF. Calculate the power dissipation for the OFF state, including bias and control. With the controller commanded ON, calculate the power dissipation for the ON state for loads of 10 %, 50 % and 100 % rated load, unless otherwise specified in the specification sheet, including bias and control power.

5.11 Overload characteristic tests

5.11.1 Current limiting (see 4.3.10.1)

Connect the SSPC as shown in Figure 3. With the load adjusted to the rated level, apply rated supply voltage and turn on the control. While monitoring the current out of the SSPC, apply a short circuit across the load and measure the peak let-through current and the current limit level.

5.11.2 Trip characteristics (see 4.3.10.2)

Connect the SSPC as shown in Figure 3. With rated supply voltage, verify that the SSPC meets the trip characteristics at various current levels, as specified in the detailed requirements.

5.12 State indication signal(s) (see 4.3.11)

Connect the SSPC as shown in Figure 3. Apply rated voltage and adjust the load resistance for 100 % rated load. Apply an OFF command to the control input. Monitor the specified (see 4.1) state indication feedback to verify normal OFF operation and delay time. Apply an ON command to the control input and verify normal ON operation and delay time. Reduce the load current below the indication. Increase the load current above the trip threshold and observe that the SSPC trips. Verify specified (see 4.1) trip indication and delay times.

5.13 Trip-free characteristics (see 4.3.12)

With the SSPC connected as shown in Figure 3, apply rated voltage adjust load resistor for short circuit and command controller ON. Observe that the SSPC trips out. Reset the controller and command controller ON. Maintain the ON command for at least 1 min and verify that the SSPC resets and trips only once.

5.14 Zero voltage turn-on (ZVTO) and zero current turn-off (ZCTO) (see 4.3.13)

Connect the SSPC as shown in Figure 3. Apply rated supply voltage and adjust load impedance for rated load with a 45 % lagging power factor. Apply the nominal turn-on signal and subsequently apply the nominal turn-off signal. Monitor the load voltage and current. Repeat test 10 times. Adjust the load impedance to reduce the load current below the specified (see 4.1) minimum and repeat.

5.15 Reverse current (see 4.3.14)

Connect the SSPC as shown in Figure 4 with load capacitance in accordance with the detailed requirements. Charge the rated supply voltage to the load capacitor. While monitoring the current the power-in line of the SSPC, close S1 and record the current waveforms. The SSPC shall be performed as specified after dissipating a reverse energy.

5.16 Exponential rate of voltage rise (see 4.3.15)

The SSPC shall be tested for exponential rate of voltage rise (when applicable) using the procedure below.

a) See Figure 5 for the test set up.

b) Apply the specified control turn-off voltage.

c) Adjust voltmeter V_1 to the maximum rated voltage. For the a.c. SSPC, V_1 is the maximum rated voltage, calculated as follows:

$$V_1 = \sqrt{2} \times V_{\text{rated,RMS}} \quad (1)$$

d) With the power terminals (in and out) of the device disconnected, adjust resistor R_1 to a value determined by the following calculation:

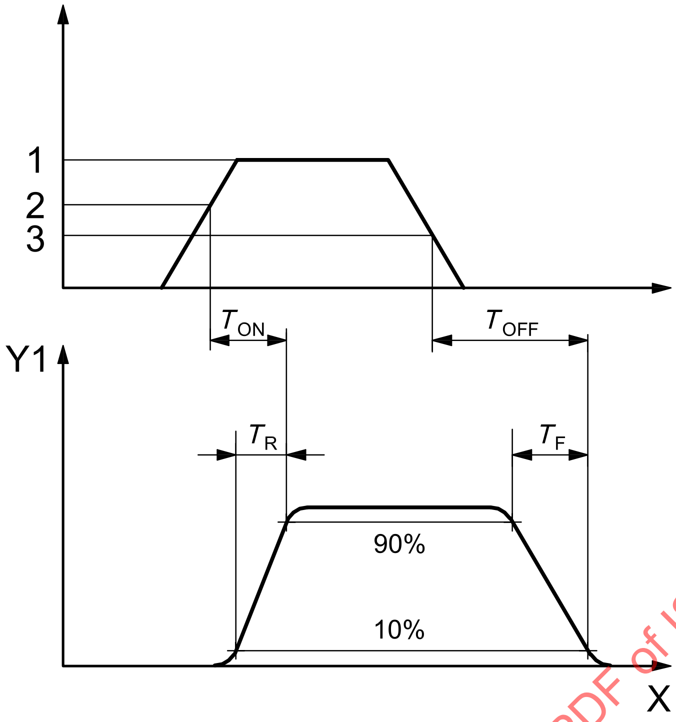
$$R_1 = 0{,}632 \times \frac{V_1}{C_1 \left(d_V / d_t \right)} \quad (2)$$

where d_V / d_t is as specified in Figure 5.

e) Reconnect the power terminals (in and out) of the device under test to the circuit shown in Figure 5.

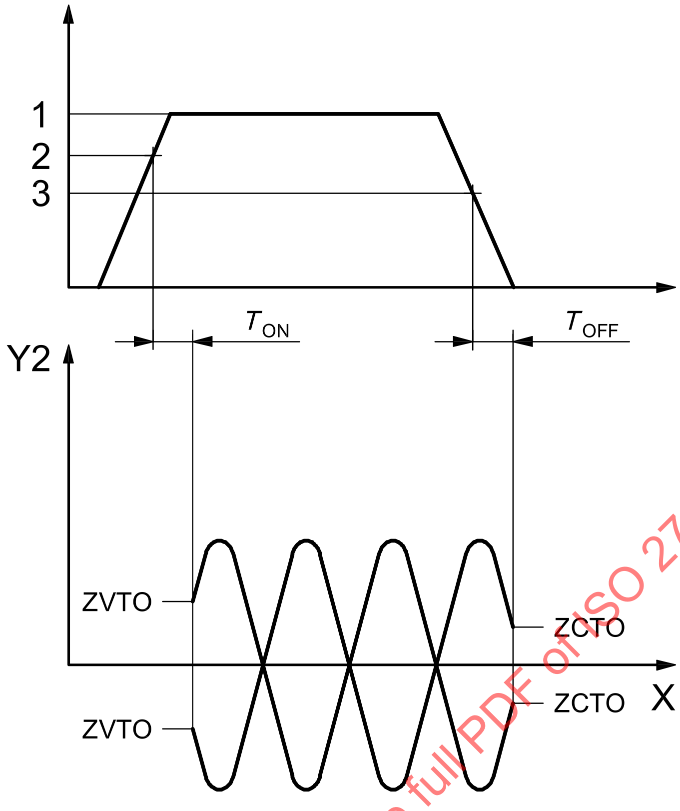
f) Close and open switch S_1 at least 10 times. After five cycles, reverse the leads to the device under test (for a.c. devices only).

g) Verify with oscilloscope CH1 (or equivalent instrument) that the device achieves the specified output voltage within the specified time.



a) d.c. SSPC

Figure 1 (*continued*)



b) a.c. SSPC

Key

X time

Y1 load voltage

Y2 load voltage; load current

1 rated control signal

2 turn on (min.)

3 turn off (max.)

T_{ON} turn-on time

T_{OFF} turn-off time

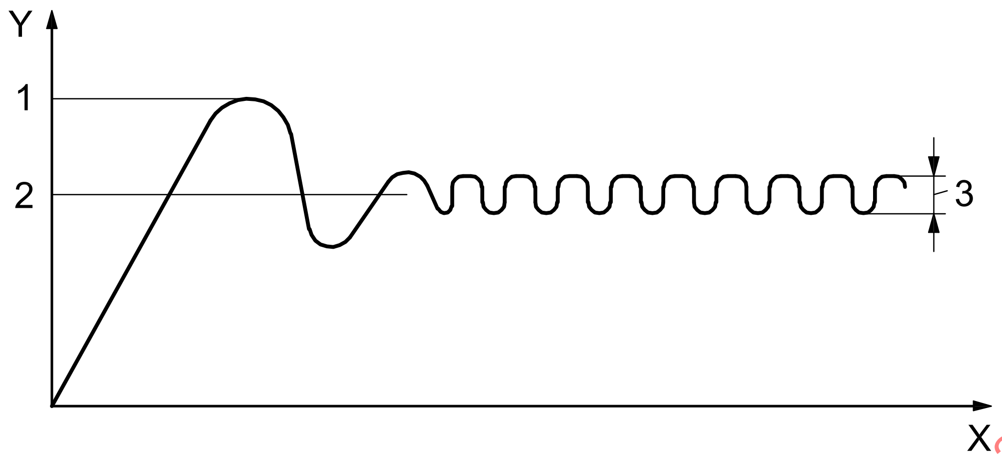
T_R rise time

T_F fall time

ZVTO zero voltage turn-on

ZCTO zero current turn-off

Figure 1 — Illustration of timing characteristics



Key

X time

Y load current

1 peak let-through current

2 specified current limit

3 ripple

Figure 2 — Overload let through current

