



AEROSPACE INFORMATION REPORT

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Pyrotechnic Actuator for Fast Action Electrical Protection in HVDC Aerospace Application

RATIONALE

Future aircraft programs will employ high voltage direct current (HVDC) as the primary source of electric power.

In these conditions, electrical fault management requires fast acting switching devices to protect the aircraft electrical installation and limit potential damages.

The intent of this SAE Aerospace Information Report (AIR) is to gather information and define characteristics for the usage of the pyrotechnic actuator or initiator for fast action electrical protection in HVDC aerospace application.

INTRODUCTION

HVDC is becoming a primary electrical source in aircraft. AIR7502 defines four different HV voltage levels above usual legacy voltage ranges. In this field of application, electrical fault isolation will require fast acting active protection to limit effects and damages on the HV electrical system to ensure safe operation on aircraft.

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1. SCOPE

The scope of this report is to establish applicable definitions and terms prior to considering the application domain and use cases in HVDC applications. The report describes the specificities of the pyrotechnic actuator for use within a power-switching device with performances and main characteristics to consider for aerospace application.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (U.S. and Canada only) or +1 724-776-4970 (Outside U.S. and Canada), www.sae.org.

AIR6127	Managing Higher Voltages in Aerospace Electrical Systems
AIR7058	High-Voltage DC Electromechanical, Solid State, and Hybrid Switching Devices in Aerospace Applications
AIR7502	Aircraft Electrical Voltage Level Definitions
AIR8678	Architecture Examples for Electrified Propulsion Aircraft
ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Aircraft, Systems, and equipment
ARP8676	Nomenclature and Definitions for Electrified Propulsion Aircraft

Altouq, S., Fong, K., Norman, P., and Burt, G., "Pyrofuse Modeling for eVTOL Aircraft DC Protection," SAE Technical Paper 2021-01-0041, 2021, <https://doi.org/10.4271/2021-01-0041>.

2.1.2 Code of Federal Regulations (CFR) Publications

Copies of these documents are available online at www.ecfr.gov.

49 CFR Chapter I, Pipeline and Hazardous Materials Safety Administration, Department of Transportation (Parts 100 through 199)

2.1.3 GTPS Publications

Copies of these documents are available online at www.gtps.fr.

GTPS № 11F Severe Tests Statistical Method, Recommendation for designing and mastering reliable pyrotechnic devices

2.1.4 NASA Technical Standards Program Publications

Copies of these documents are available online at <https://standards.nasa.gov>.

MSFC-SPEC-3635 Pyrotechnic System Specification

2.1.5 RTCA Publications

Available from RTCA, Inc., 1150 18th Street NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO-160 Environmental Conditions and Test Procedures for Airborne Equipment (Rev G or later version)

2.2 Definitions

Major definitions for electrified propulsion aircraft can be found in ARP8676.

For ones specific to pyrotechnic actuation, terms and definitions mostly extracted from MSFC-SPEC-3635 are listed hereafter.

BRIDGEWIRE: A resistance wire incorporated into an EED to convert electrical energy into heat to cause ignition of the pyrotechnic material.

CORE CHARGE: An explosive material contained in a suitably configured sheath, usually of metal.

ELECTROEXPLOSIVE DEVICE: The first element of a pyrotechnic train. It is activated by electrical energy (joule heating) applied to an internal bridgewire that transfers energy to an explosive charge.

INITIATOR: The primary stimulus component in all pyrotechnic devices and systems.

IGNITER CARTRIDGE: A pyrotechnic device designed to initiate burning of a fuel mixture or a propellant.

PYROTECHNIC MATERIAL: A chemical or mixture of chemicals designed to produce heat, gas, pressure, or shock.

SENSITIVITY: The characteristics of an explosive or component that express its susceptibility to initiation by externally applied energy. May apply to electrical, shock, or other stimuli.

2.3 Abbreviations

AC	alternating current
DC	direct current
EED	electroexplosive devices
EM	electromechanical
EMC	electromagnetic compatibility
ES	equipment sealed
EU	equipment unsealed
eVTOL	electric vertical take-off and landing
FMEA	failure mode and effect analysis
HVDC	high voltage direct current
L/R	time constant due to inductance and resistance
OEM	original equipment manufacturer
VAC	volts AC
VDC	volts DC