



# AEROSPACE RECOMMENDED PRACTICE

ARP7490™

Issued

2021-11

## Recommended Guidelines for the Specifications of Motor Control Electronics for Electrically Powered Actuators

### RATIONALE

With the increasing use of Electromechanical Actuators (EMAs), Electrohydrostatic Actuators (EHAs), and Electric Back-up Hydraulic Actuators (EBHAs) in aerospace actuation applications, there is a need for guidelines for the creation of specifications for the motor control electronics that are used for operating these actuators. This document has been written to meet this need.

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## 1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides guidelines for the creation of specifications for the Motor Control Electronics (MCE) that are used for operating electrically powered actuators including:

- Electromechanical Actuators (EMAs)
- Electrohydrostatic Actuators (EHAs)
- Electric Back-Up Hydraulic Actuators (EBHAs)

### 1.1 Purpose

This document and the requirements stated herein are intended to be used as a guide by the Electric Flight Control Actuation manufacturer in preparing a detail specification for the MCE required to drive this electric actuation (EHA, EBHA, and EMA). This document may be used in conjunction with applicable industry and OEM specifications to guide the development of a comprehensive MCE specification

These guidelines may be used in whole or in part to form the desired MCE specification. This document will provide guidance on specifying Motor Control Electronics as follows:

- a. Architecture
- b. Input and Output Requirements
- c. Basic Functions
- d. Software/Firmware
- e. Manufacturing/Producibility
- f. Testing

### 1.2 Field of Application

Due to the similarity between Electrohydrostatic Actuators (EHA), Electric Back-Up Hydraulic Actuators (EBHA), and Electromechanical Actuators (EMA) flight control and utility aerospace actuators and their related MCE requirements, this document may be used as a guide for developing the control electronic specifications for any of these actuator types with a reasonable tailoring to the application.

#### NOTES:

1. The guideline information is directed towards electric actuation for use in aircraft flight control systems. However, it should be recognized that it might also apply to many other electric actuation or electric motor driven aerospace systems.
2. Unless otherwise indicated in the rest of this document, the MCE term is used to describe the Motor Control Electronics used to drive actuation servomotors.

## 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 should apply. The applicable issue of other publications should be the issue in effect on the date of the purchase order. 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 (inside USA and Canada) or +1 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

AIR6219	Development of Atmospheric Neutron Single Event Effects Analysis for Use in Safety Assessments
ARP490	Electrohydraulic Servovalves
ARP4386	Terminology and Definitions for Aerospace Fluid Power, Actuation and Control Technologies
ARP4754	Guidelines for Development of Civil Aircraft and Systems
ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
ARP6025	Duty Cycle Considerations for Electrohydrostatic Actuators
AS478	Identification Marking Methods
AS5643	Interfaces requirements for Military and Aerospace Vehicle Applications

### 2.1.2 ARINC Publications

Available from ARINC, 2551 Riva Road, Annapolis, MD 21401-7435, Tel: 410-266-4000, [www.arinc.com](http://www.arinc.com).

ARINC 422	Electrical Characteristics of Balanced Voltage Differential Interface Circuits
ARINC 429	Mark33 Digital Information Transfer System (DITS)
ARINC 485	Electrical Characteristics of Generators and Receivers for Use in Balanced Multipoint Systems
ARINC 629	Multi-Transmitter Data Bus
ARINC 664	Aircraft Data Network

### 2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, [www.astm.org](http://www.astm.org).

ASTM D149	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D1868	Standard Test Method for Detection and Measurement of Partial Discharge (Corona) Pulses in Evaluation of Insulation Systems

### 2.1.4 European Union Publications

Available from European Aviation Safety Agency, Postfach 10 12 53, D-50452 Cologne, Germany, Tel: +49-221-8999-000, [www.easa.eu.int](http://www.easa.eu.int).

RoHS	DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment
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### 2.1.5 ISO Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

ISO2669 Steady-State Acceleration

ISO2678 Insulation Resistance and High Voltage Tests for Electrical Equipment

### 2.1.6 RTCA Publications

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

RTCA/DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

RTCA/DO-178 Software Considerations in Airborne Systems and Equipment Certification

RTCA/DO-254 Design Assurance Guidance for Airborne Electronic Hardware Considerations in Airborne Systems and Equipment Certification

### 2.1.7 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-A-8870 Airplane Strength and Rigidity Vibration, Flutter, and Divergence

MIL-DTL-38999 Detail Specification: Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, And Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification For

MIL-STD-130 Identification Marking of U.S. Military Property

MIL-STD-202 Test Methods, Standard Electronic and Electrical Component Parts

MIL-STD-461 Requirements for The Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

MIL-STD-704 Aircraft Electric Power Characteristics

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

MIL-STD-1553 Digital Time Division Command/Response Multiplex Data Bus

## 2.2 Definitions

Terms used in this document are defined in ARP4386. Where new terms are used, the definitions are presented below.

Motor Control Electronics (MCE): The electronics required to power and control electric servo motors.

NOTE: Other terms used to describe Motor Control electronics include:

- Power Control Electronics (PCE)
- Power Drive Electronics (PDE)
- Power Drive Unit (PDU)
- Motor Control Unit (MCU)
- Electronic Unit (EU)

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