



AEROSPACE RECOMMENDED PRACTICE

ARP5879™

REV. A

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Superseding ARP5879

(R) Recommended Test Requirements for Electrohydrostatic Actuators

RATIONALE

This revision aligns the document with the terminology of ISO 22072 and includes test requirements relevant to EHAs.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) provides recommended test requirements for electrohydrostatic actuators (EHAs).

NOTE: This document does not address tests and issues of a higher system level, such as the primary flight control surface level where multiple EHAs and or electrohydraulic servoactuators (EHSAs) may be integrated.

1.1 Purpose

The purpose of this document is to facilitate the generation of test specifications, plans and procedures for EHAs covering Integration, Acceptance, and Qualification testing.

1.2 Field of Application

This document focuses on EHA issues for both military and commercial aircraft applications.

NOTE: It should be the user's responsibility to ensure that particular qualification or certification requirements, or applicable specifications, standards, or regulations for the intended application are satisfied by the EHA design, and the tests and test methods that are developed.

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 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP1281	Actuators: Aircraft Flight Controls, Power Operated, Hydraulic, General Specification For
ARP1383	Aerospace - Impulse Testing of Hydraulic Components
ARP4386	Terminology and Definitions for Aerospace Fluid Power, Actuation and Control Technologies
ARP5007	Development Process - Aerospace Fly-By-Wire Actuation System
ARP6154	Aerospace Fluid Power Electrohydrostatic Module, Design, Performance and Test Recommendations
ARP7490	Recommended Guidelines for the Specifications of Motor Control Electronics for Electrically Powered Actuators
AS4941	Aerospace - General Requirements for Commercial Aircraft Hydraulic Components
AS8775	Hydraulic System Components, Aircraft and Missiles, General Specification For

2.1.2 ISO Publications

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

ISO 22072 Aerospace - Electrohydrostatic actuator (EHA) - Characteristics to be defined in procurement specifications

2.1.3 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

2.1.4 U.S. Government Publications

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

MIL-STD-704 Aircraft Electric Power Characteristics

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

2.2 Related Publications

The following publications are provided for information purposes and are not a required part of this SAE Technical Report.

2.2.1 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.

ARP6025 Duty Cycle Considerations for Electrohydrostatic Actuators

2.3 Terminology

Refer to ARP4386 and ISO 22072 for EHA specific terminology.

2.4 Abbreviations

ACE	actuator control electronics
ATP	acceptance test procedure
BIT	built-in test
CE	control electronics
EBHA	electrical backup hydraulic actuator
EHA	electrohydrostatic actuator
EHAS	electrohydrostatic actuation system
EHM	electrohydrostatic module
EHSA	electrohydraulic servoactuator
EMI	electromagnetic interference

ESD	electrostatic discharge
HIRF	high-intensity radiated field
ICD	interface control document
IAP	integrated actuator package
MCE	motor control electronics
MDE	motor drive electronics
PDE	power drive electronics
REU	remote electronics unit
SOV	solenoid operated valve
UUT	unit under test

3. GENERAL

An EHA incorporates a linear or rotary hydraulic actuator and a variable speed, bidirectional electric servomotor driving a fixed displacement hydraulic pump for actuator control, and associated power drive electronics (PDE). The tests and the issues documented in this ARP are not necessarily all-inclusive.

An EHA is typically comprised of the motor control electronics (MCE) or motor drive electronics (MDE), a variable-speed bidirectional electric motor, a bidirectional hydraulic pump, a manifold (with the functionality required by the system), and a hydraulic actuator. Refer to ARP7490 for alternate terms used for MCE. In some applications, the function of the Test Console and MCE may be physically combined or separated.

An electrohydrostatic module (EHM) is typically comprised of the MCE, variable speed bidirectional electric motor, and bidirectional hydraulic pump. Refer to ARP6154 for details of the design performance and test recommendations for an EHM.

To test an EHA, a test setup is required and is comprised of a Test Controller, a Test Console, including a Data Acquisition System, and a Loading Actuator. The unit under test (UUT) in Figure 1 represents a typical EHA. Additional connections may be required depending on the specific UUT and Test Stand. Mechanical and hydraulic interfaces are not included in Figure 1. The Test Controller may be fabricated from actuator control electronics (ACE) or a remote electronics unit (REU) depending on the system and hardware availability.

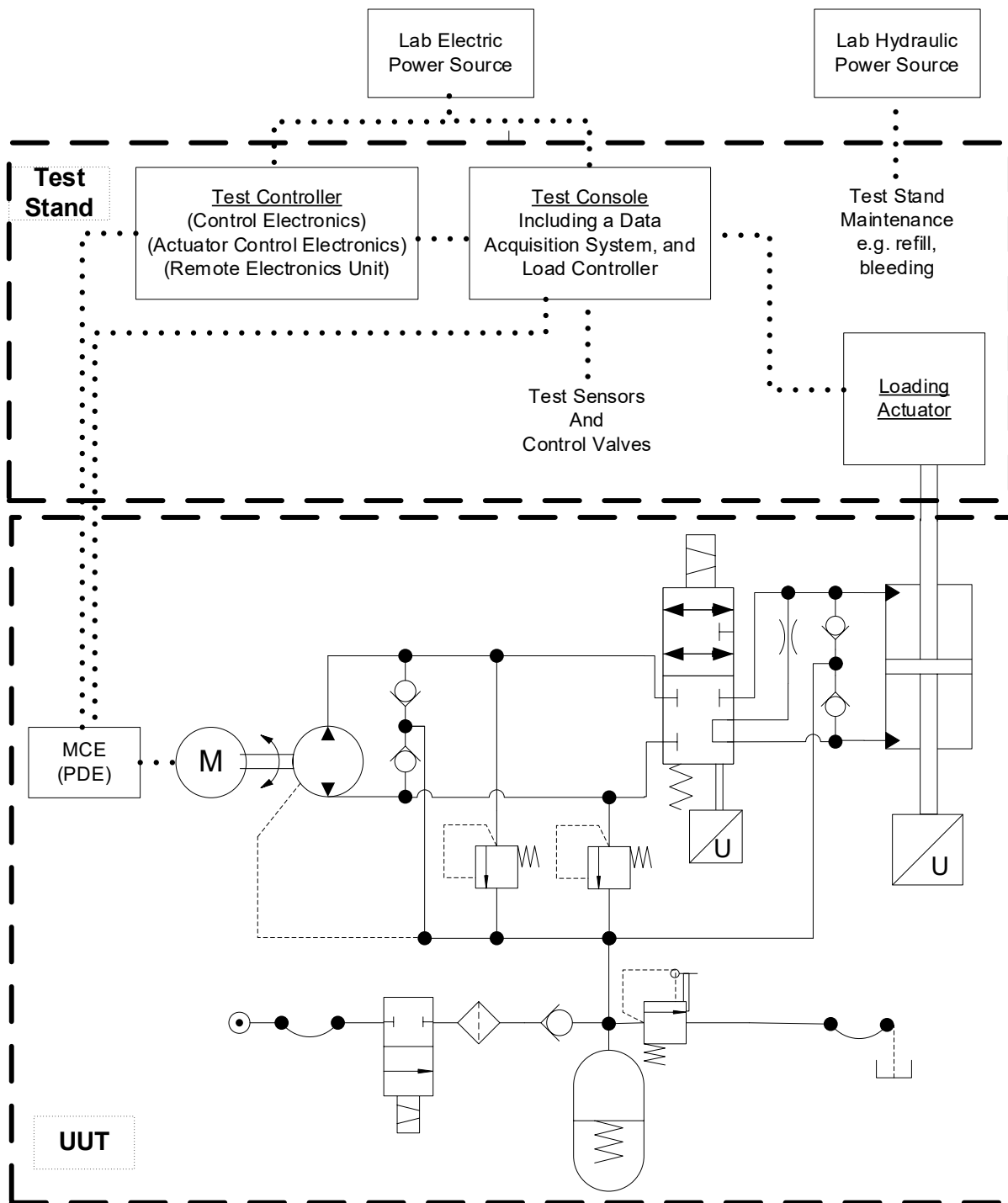


Figure 1 - EHA and test stand schematic diagram

If this document does not list a test applicable to both EHAs and EHSAs, the reader may refer to ARP1281, which addresses test issues applicable to EHSAs.

In the discussion of the tests and test methodologies contained in this document, the numerical definition or specification of the test parameters to be imposed or measured is not included. These definitions or specifications should be developed to conform to the requirements of the applicable EHA technical specification document, considering the usual influencing factors such as instrumentation accuracy, test temperature, etc.

4. TEST CONSIDERATIONS

4.1 System Considerations

The performance of an EHA is heavily dependent upon the associated electronics – both the power drive for the electric motor, as well as the associated control loop closures. The EHA includes the MCE, whether mounted locally on the actuator itself, or at a remote location (refer to ARP4386, ARP7490, or ISO 22072). ACE or an REU, by definition, are not a part of the EHA. While this definition of an EHA facilitates isolation of the discussion of the critical EHA elements, physical separation between the MCE and Test Controller may or may not be distinct.

This document is intended to discuss issues related to testing of the EHA and includes issues related to the MCE. While this document is not intended to discuss issues related to the Test Controller, it is to be recognized that the planning and execution of several, if not most, tests on an EHA needs to be undertaken with full consideration of the impact that the Test Controller used to test the EHA will have on the EHA under test.

For example, the EHA has performance capability dependent upon the motor capability, the capability of the MCE and the supply voltage, power control algorithms built into the MCE, and all loop closures around the MCE, the motor, and the EHA. Similarly, the failure transient performance of the EHA is dependent upon the performance of any mode select valves within the EHA, the electrical energization/de-energization of electrically actuated mode select valves and the motor, and the control algorithms that govern various EHA functions.

The test methods should also consider balanced and unbalanced actuator configurations. For example, unbalanced actuators may introduce unique test requirements based on the direction of travel and the capability of the compensator.

As such, in all those instances where an EHA is subjected to a test that necessitates electronics for its operation and the electronics have an impact on the performance of the EHA, the Test Controller will be either:

- a. The actual electronics to be used with the actuator (e.g., the ACE or REU),

or

- b. The test electronics that are used to test the EHA, which should be validated separately and independently as being of the required configuration and capability, to ensure accurate EHA test results. Such electronics may be termed validated electronics (or a validated Test Controller).

4.2 Component Considerations

4.2.1 Motor Control Electronics (MCE)

A critical safety consideration in handling the MCE in a test environment is to ensure that the MCE is discharged before handling it. While a typical MCE contains bleed resistors or other devices to ensure the internal charge on capacitors has been depleted, the time over which the discharge occurs can vary, and in the event of failure of the bleed device, may not discharge at all. It is imperative that before handling the MCE, the voltage from source to return be verified to be at a safe level, usually below 30 V.