Aerospace

Implementing a Flight-Worthy Motor Controller: How to Ensure Efficient DO-254 Certification

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In a typical aircraft, power is extracted from the aircraft's engines to provide pneumatic or hydraulic pressure that is distributed throughout the craft. The pressure is used to operate numerous subsystems, such as the primary and secondary flight controls, landing gear deployment and retraction mechanisms, aircraft braking systems and thrust reversers, cargo doors and so forth. Traditional pneumatic and hydraulic systems use highly reliable, mature technologies. However, these systems consist of numerous pumps and pressure lines that spread throughout the aircraft and are often triple-redundant. Such pneumatic and hydraulic systems are heavy and require extensive inspection to ensure that they do not leak or otherwise fail.

A recent industry trend involves replacing pneumatic and hydraulic systems with electrical motors and controllers that weigh less, are easier to install and maintain, and also improve fuel consumption. For example, replacing the hydraulic actuation systems on an aircraft with electric motors or electro-hydraulic systems can allow removal of hydraulic tubing and pumps, resulting in significant weight reductions. Maintenance time and costs are also reduced, since electrical systems are generally more reliable than hydraulic systems and are easier to inspect (usually done electronically). Hydraulic pumps also place a continuous load on the engines, whereas motors apply load on the engines only when electrical power is needed.

There are numerous opportunities for replacing hydraulic or pneumatic systems on an aircraft with electrical motors, including fans, chillers, compactors, vacuum generation, seat actuation, cross-aisle stowage, main deck loading systems and other hydraulic systems. Replacing hydraulic and pneumatic systems with electrical motors and controllers translates directly to the bottom line in terms of lower operating and maintenance costs, easier maintenance checks and increased aircraft availability.

A typical motor controller commutates a motor to control torque, speed and position. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, regulating the speed, and increasing and limiting the motor current while simultaneously protecting against temperature, current and voltage abnormalities. Additionally, motor controllers are designed to be software programmable and flexible in order to support various motor types, accept different system power and motion feedback devices, perform EMI/EMC conditioning and allow for the network exchange of the control and status information. A block diagram of a typical motor controller system is provided in Figure 1.

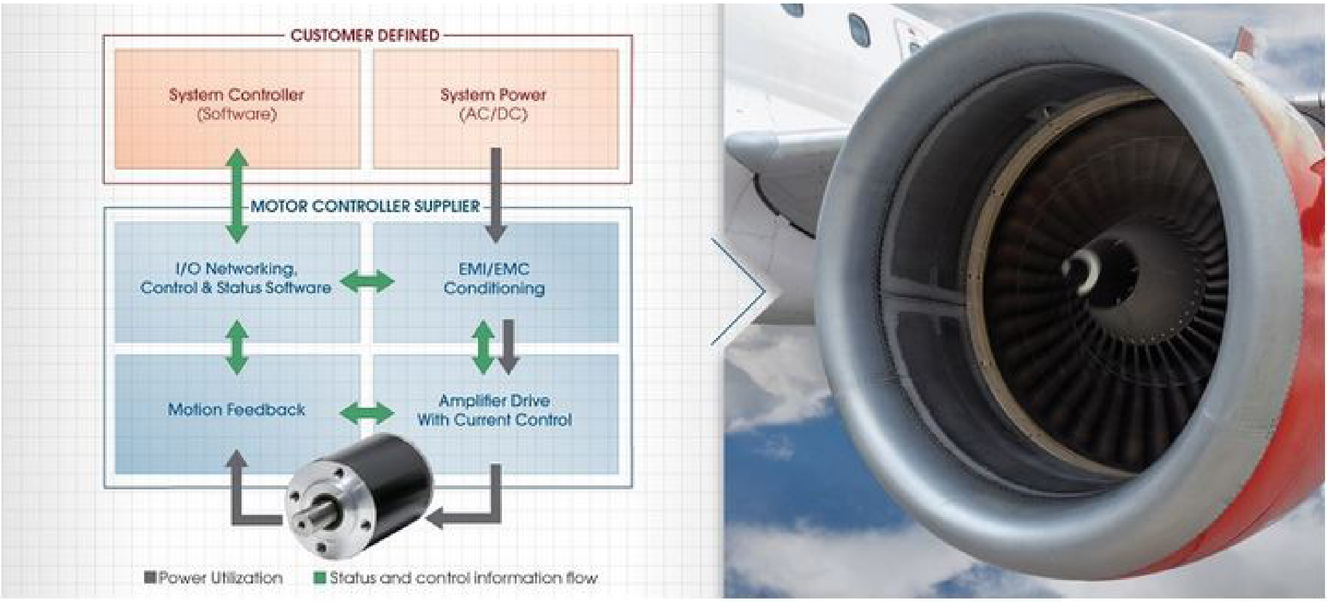

Figure 1. Motor controller block diagram.

There are numerous technical challenges in replacing an aircraft's hydraulic and pneumatic systems with electrical motors, hybrid electro-hydraulic devices, controllers and drives. Until recently, the lack of electrical power generation capability, together with the volume of the power conditioning equipment and the advanced control required, rendered this approach unfeasible. Today, novel methods of generating, distributing and using power on board aircraft have driven the development of newer, more efficient or power dense technologies in smaller footprints, such as variable frequency generators, alternative energy sources (e.g., hydrogen and solar cells, battery storage), highly integrated embedded digital systems and distributed system architectures. Advanced power distribution and management systems provide fully automatic monitoring, control, protection and switching of aircraft electrical loads under normal and emergency conditions with load management, including automatic load shedding and restoration, to make the most efficient use of available power.

Regulatory challenges must also be addressed with the introduction of new electronics into aircraft, such as motors, controllers and drives. Standard DO-254, Design Assurance Guidance for Airborne Electronic Hardware, provides guidance for the development of airborne electronic hardware that is critical to the safe operation of aircraft. The five levels of compliance, A through E, depend on the effect a hardware failure will have on the operation of the aircraft (Table 1). Level A is the most stringent, defined as "catastrophic" (e.g., loss of the aircraft), while a failure of Level E hardware will not affect the safety of the aircraft. Meeting Level A compliance for complex electronic hardware requires a much higher level of verification and validation than Level E compliance. The DO-254 certification process involves numerous steps throughout the life cycle of the electronic hardware, from requirements definition, through the design, development, production, verification, validation and qualification of the hardware.

LEVEL	DESCRIPTION: Failure will cause or contribute to...	EXAMPLE
A	A catastrophic failure of the aircraft	Mechanical Guidance, Aircraft Control, Life Support, Power, Primary Flight Systems, Sensors, Actuators
B	A hazardous / severe failure condition	Flight Displays, Indicators, Auxilliary Controls
C	A major failure condition	Navigation Displays, Aircraft Communications
D	A minor failure condition	Internal Mechancial, Crew Equipment
E	No effect on the aircraft or on pilot workload	Passenger Equipment

Table 1. Five levels of DO-254 compliance.

Data Device Corporation (DDC) is a premier manufacturer of high-reliability data networking, power control, motion feedback and motor controller devices for brush, three-phase brushless and induction motors, operating from 28 V to 600 V and demanding up to 20 kilowatts of power for a wide range of military and civilian aircraft.

Our extensive knowledge and history of designing and fabricating MIL-STD electronic components and systems enables us to adhere to the strict manufacturing and quality control procedures needed for DO-254 certification for both military and civilian aircraft. This allows us to reduce time to market and manage technical and program risks by leveraging certifiable and proven design blocks with high technology-readiness levels. DDC is also experienced in design documentation and requirements traceability as a part of internal standard design and verification standard operating procedures.

As an example, a DO-254 Line Replaceable Unit product (shown in Figure 2) is designed for demanding high reliability commercial and military aerospace applications. Furthermore, it is fully programmable and reconfigurable to meet current and future system requirements without the need for costly updates to hardware and packaging. This product is intended to satisfy numerous electro-mechanical actuation applications such as pumps, fans, valve controls, winch and cargo loading systems, vacuum generation, compressors, seat control, waste compactors and air handling systems.

Figure 2. DDC's compact and configurable Line Replaceable Unit (LRU) products allow for system reuse and design flexibility. Source: Data Device Corporation

For more information about DDC's Line Replaceable Units, visit http://www.ddc-web.com/Products/Motor-Control/Line-Replaceable-Units/.