**SP4**

Three Work Packages (WP) focused on EMA supporting technologies

WP41: Prognostic Health and Usage Monitoring (PHM). SENER

Development of PHM techniques and algorithms for measuring EMA usage and for monitoring an EMA health (e.g. motors, gearboxes, ball/roller screws, performance, etc.). Development of methods for combining the results of the PHM to generate an estimate of an EMA remaining useful life (RUL).

WP42: Advanced Control and Monitoring. BAES

Study of novel and/or advanced control and monitoring methods associated with the control and monitoring of EMAs.

Force summed (active/active) EMA configurations, sensor-less control, fault tolerant control strategies (control following failures). Velocity monitoring for fast failure detection and isolation.

WP43: Regenerated Power Management. BAES

Study of the power levels that can be regenerated (and placed on the power supply busses) by a range of different EMAs (i.e. different aircraft applications) and how this “additional power” can be managed.

**SP4 Partners**

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- **SENER**
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- **GAS-F**
  GOODRICH ACTUATION SYSTEMS (France)
- **EADS-UK**
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- **PARAGON**
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Prognostic Health and Usage Monitoring

EMAs are relatively complex items of equipment that contain electro-mechanical components. Some of these components will have a limited life expectancy and will be subject to faults that could cause a premature failure of the EMA and/or result in unacceptable performance.

The primary purpose of this WP was to develop a PHM architecture, along with methods and algorithms that could be used to measure an EMA usage and to detect changes in an EMA key characteristics – using only those sensors needed for control and monitoring. The main objective being to identify when an EMA useful life had been consumed and/or when a measurable degradation in an EMA characteristic had occurred that was indicative of an impending failure. The final challenge was to combine the results of the monitoring (usage and health) to generate an estimate of the EMA remaining useful life (RUL). The RUL would be used for maintenance/support activities.

The WP looked at methods of detecting failures in motors as well as in the EMA mechanical components. Figure left shows results of method used to detect shorted turns in a motor.

All EMAs have the potential to act as generators depending on their quadrant of operation. For ACTUATION2015 the decision was made to allow each EMA to put its regenerated power back onto the aircrafts power supply buses. A more electric aircraft (MEA) will contain many EMAs that could all be regenerating onto the power supply buses at various times during a flight cycle. Without any mitigation, this regenerated energy has the potential to increase the bus voltage to an unsafe level i.e. above a design limit.

Hence, ways of estimating how much power would be placed onto the supply buses by a representative set of EMAs, along with possible schemes keeping the buses within an acceptable set of limits were studied.

Representative aircraft configurations were used in the study. Figure left shows the EMAs that were allocated to one of the aircraft power buses.