imc

An Axiometrix Solutions Brand

Ultra-Light Helicopter Flight Tests

Solution for data acquisition & analysis - applied by CURTI Costruzioni Meccaniche Spa

imc Test & Measurement
Application Note

APPLICATION NOTE

Introduction

CURTI's two-seater helicopter is manufactured in Castel Bolognese, Italy, headquarters of the CURTI industrial group, a family run business with more than 40 years of experience in the defense and aerospace subcontracting and co-engineering.
The safety rescue system development, validation and product launch phases of this project were co-financed by the EU, under the SME Instrument, Horizon 2020. Being the only Italian-guided consortium that had made it into the winners list of 16 funded projects, the project features one of the few ultra-light helicopters in the world driven by a turbine engine – lighter, reliable, and with less vibration than traditional piston engines.
The project is developed in close cooperation, as far as engineering and development are concerned, with CURTI partner company Hypertec Solutions, an engineering company of the CURTI Group, which operates in the aerospace industry and is also active in motor sports, oil and gas, energy and automation sectors.
The manufacture of flight parts completely checked and verified with control systems forms part of the know-how of the company - including the use of light-weight alloys, titanium and composites, thus reducing the take-off weight to 450 kg.
This document briefly describes the application of the imc data acquisition system used during the flight test sessions of the ultra-light helicopter manufactured by CURTI Costruzioni Meccaniche Spa. Hypertec Solution Srl provided technical support in test design and experimentation. The COTS test instrumentation has been supplied by imc-Italy (represented by Instrumentation Devices Srl).

Testing the helicopter

The objective of the CURTI technicians for conducting the helicopter flight tests was to perform various kinds of measurements using analog sensors: e.g., stress, temperature, vibrations, pressures, etc. Some sensors were integrated into moving assemblies. In addition to collecting data from analog sensors, digital signals needed to be integrated, such as specific parameters originating from electronic control units (ECUs) and other systems integrated into the aircraft (combustion engines, avionics, etc.).

FIGURE 1, 2.
CURTI Zefhir under test
© Photos: CURTI

Requirements on the measurement system

Apart from the appropriate sensors, a test and measurement system was needed that could provide extensive functionality to:

- support telemetric sensor technology;
- condition and acquire analog sensor signals;
- interface to standard serial protocols, to acquire digital signals such as parameters from electronic control units;
- perform real-time mathematical calculations on measurement data and data logging for both acquired and calculated channels;
- monitor the test phases in real time.

The following is a brief description of the measurement devices supplied by imc Italy, which have enabled CURTI to meet the above mentioned requirements.

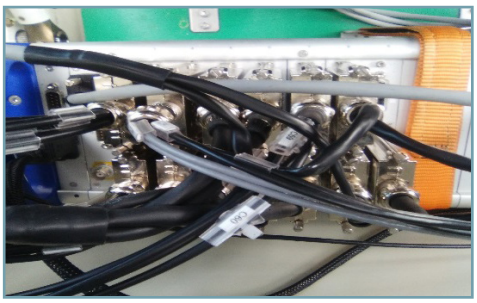

FIGURE 3,4.
Instrumented DAQ system
© Photos: CURTI

Data acquisition system

The platform selected as the tool for signal conditioning, high speed data acquisition and data logging of signals originating from the sensors installed on the helicopter and from the on-board systems, is the imc CRONOScompact 400-11 by imc Test & Measurement.

The software that accompanies this device also permits real-time mathematical operations and on-line display of acquired data, in addition to normal post-processing.

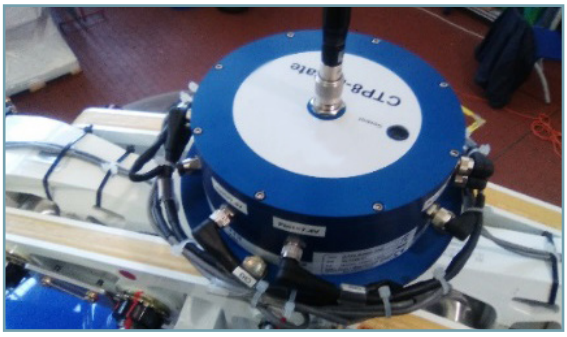

FIGURE 5.
Instrumentend imc CTP8-Rotate telemetry sensor
© Photos: CURTI

Telemetry system

The blades of the helicopter have been instrumented with strain gauges in Wheatstone bridge configurations in order to perform stress measurements. Since the rotor is in rotation relative to the rest of the helicopter, these signals are acquired by using the CTP8-Rotate telemetry system, also by imc Test & Measurement.

Real-time data display

The installation of a graphics display from imc directly in the cockpit allows for real-time visualization of measurement data. This permits the direct monitoring of test results and parameters during test flights from on board the helicopter.

FIGURE 6.
Real-time data display
© Photos: CURTI

Vibration measurements

The vibrations in certain parts of the helicopter structure have been recorded with the use of accelerometers. The sensors chosen for this application were the MEMS-type triaxial accelerometers, model SDI 2476-50, produced by Silicon Designs Inc.

FIGURE 7.
MEMS accelerometer
© Photos: CURTI

Details of the instrumentation used

imc CRONOScompact is a modular data acquisition system, configurable with 4 to 128 analog channels for various types of physical sensors. It allows system sampling rates of up to 400 kS/s, with 100 kHz per channel and A/D conversion to 24/16-bit. In stand-alone mode, it may be combined with a graphics display, which permits real-time visualization of acquired and calculated data.

imc CRONOScompact may also be operated with direct connection to single or multiple PCs via Ethernet (or WLAN), for on-line graphical and numerical display of test data and for the storage of data on a PC or Server. It also supports the synchronous acquisition of digital signals (event and pulse counting, on/off signals, tachometric signals, and incremental encoder), parameters from digital bus protocols (CAN, ARINC, IENA, AFDX, etc.) and GPS position.

imc CRONOScompact operates in stand-alone mode, with autonomous real-time processing of acquired data through imc Online FAMOS, for calculations of immediately available result parameters. The storage of both raw and result data is assured on internal removable flash memory (CF card).

imc Online FAMOS, thanks to DSPs, integrated into the data acquisition equipment, permits the real-time processing of analysis and result data from acquired channels without using a PC. More than 150 elementary functions are available to be combined arbitrarily, in order to implement sophisticated and customized evaluation algorithms. It is possible to perform synchronized mathematical calculations on hundreds of “live” data channels originating from the acquisition.

FIGURE 8.
imc CRONOScompact DAQ system

Software environment for testing and data aquisition
imc STUDIO is an integrated and flexible modular software environment which can be used in conjunction with any data acquisition and measurement platform from imc. Following the set-up of the hardware device, it permits the acquisition, processing and real-time display of any combination of analog and digital signals in tests lasting from seconds to an entire year. Test and measurement procedures can be carried out as either a guided process, interacting with an operator or entirely automatic.

Data visualization and customized GUI design is supported by creating display panels using simple drag & drop action. In combination with the imc FAMOS signal analysis software, it is possible to automate data analysis, post-processing and generate test reports.

A powerful signal analysis software
imc FAMOS is a powerful package for analysis of measurement data and for the visualization and documentation of results. It includes hundreds of analytical functions and mathematics and features the most versatile and complete selection of graphical and numerical presentation tools. To perform an operation upon a complete data set (e.g., time series), simply edit the corresponding mathematical expression in an explicit manner, i.e.:
New Parameter = Channel A + Channel B

The result is the new virtual parameter, which may be directly visualized or further processed. Complex analytical algorithms may be organized in automatic sequences, right down to formatted ready-to-print report pages with charts, graphics and texts.

CTP8-Rotate Telemetry Sensor
CTP8-Rotate is a telemetry system designed for installation on rotating assemblies, wheel rims and helicopter rotors.
It offers up to 8 measurement channels for strain gauge sensors in quarter, half and full bridge configuration, potentiometric, ICP/IEPE transducers, thermocouples and voltage signals. And, furthermore, CTP8-Rotate provides a bandwidth of 12 kHz per channel with A/D converter resolution of 16-bit. Versions are available with up to 32 channels.

FIGURE 9.
imc CTP-NT Rotate Telemetry Sensor

Accelerometer (MEMS)

SDI 2476 is a sturdy triaxial capacitive-type micro-machined accelerometer (MEMS), encapsulated in a small aluminum housing, complete with built-in electronics. It requires a simple, unregulated power supply between 8 and 32 VDC, and provides a low-noise analog voltage output proportional to the measured acceleration. It is available in the following measurement ranges: ± 2, 5, 10, 25, 50, 100 and 200 g full scale, with a frequency response from DC to 2 kHz. It can be operated in temperatures from -55°C to +125°C.

FIGURE 10.
SDI 2476 accelerometer (MEMS)