On-Board Critical Frequency Detection Firmware for Aircraft Standalone Real-Time Processing

CURTISS–WRIGHT

Challenge

- Minimise the effort required for flight engineers when analyzing hundreds of signals

- Provide real-time information to the pilot about exceedances

Solution

- KAD/MAT/101 Microcontroller module

- Firmware to detect narrow band harmonic content
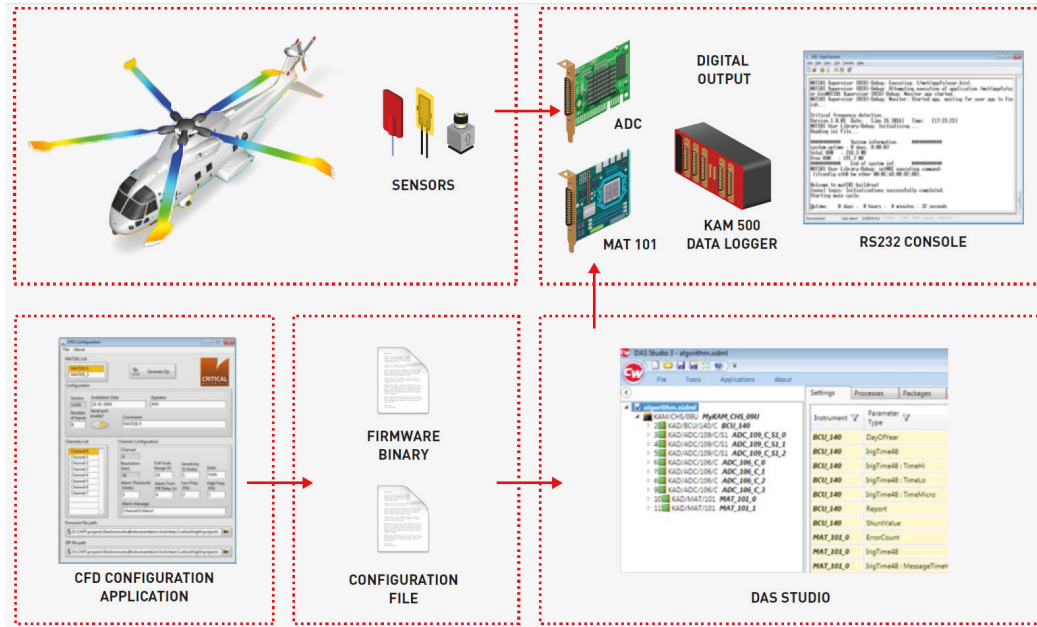
- GS Works

Results

- Real-time frequency detection firmware

- Module is certified to fly – light and compact with a dual-core C6000 DSP and ARM9 microcontroller

Challenge

Getting the right information from the aircraft in real-time during flight is something that flight engineers and pilot's want. A system that helps to minimize the effort of the flight engineer when analyzing hundreds of signals, or provides real-time information to the pilot about exceedances would provide significant benefits in flight test. To make this possible it is necessary to have a rugged data processing hardware running advanced signal processing algorithms with feature extraction in real time. This was the challenge from our customer, a major Flight Test organisation.

Solution

Curtiss-Wright's KAD/MAT/101 microcontroller module is certified hardware that can be programmed using the C language. It has a multiprocessor architecture with a DSP. Critical Materials, a Curtiss-Wright Technology Horizon partner, developed firmware to run on the MAT/101 that is able to detect narrow band harmonic content using advanced signal processing. Using techniques, such as narrow band FFT, we are able to check the existence of a harmonic with a configurable maximum amplitude. Every time the amplitude of a harmonic exceeded the programmable threshold inside the frequency band of interest, the alarm state is updated.

It is possible to view the harmonic amplitude, its frequency and the alarm state in GS Works and with third party tools such as a RS232 serial console. A TTL digital output states an alarm situation. The signal processing is done in real-time with minimum latency using the FFT capabilities of the hardware to implement complex filtering and feature extraction. The solution is completely integrated and compatible with all the tools of Curtiss-Wright for the KAM-500 airborne data acquisition unit (DAU). The output variables can be logged on GS Works, and stored on local memory cards using a recorder. The firmware is able to process up to 8 analog inputs simultaneously with 8,192 samples per second. The user simply links the analog input channel to one available input of the MAT/101 module.

Results

Critical Materials have developed firmware for the Curtiss-Wright MAT/101 microcontroller to detect narrow band frequency harmonics using FFT techniques and generate appropriate alarms to the test pilot and pre-processed data to the flight engineer. Configurable parameters enable specification of frequency range and alarm thresholds. The system works in real-time with all the signal processing done on-board using the MAT/101 digital signal processor (DSP).

Benefits

- Easy - no need to develop C code for different configurations

- Simple - user friendly Windows configuration tool

- Integrated - alarm variables to local data bus (iNET-X packets) and RS232 serial console

- Self-contained – standalone on-board, real-time signal processing in small size rugged hardware

Project Highlights

- Real-time frequency detection firmware - developed by Critical Materials for the Curtiss-Wright MAT/101 module

- This module is certified to fly – light and compact with a dual-core C6000 DSP and ARM9 microcontroller

- Configurable parameters for each input channel - no need to reprogram the firmware code

- Output variables are available as iNET-X packets - share and store on the other KAM-500 DAU modules such as data recorders, parsers, etc.

- Interface on each MAT/101 card - connect to third party hardware by RS232 or a digital output to signalise the alarm state