DEVELOPMENT & MANUFACTURING OF SMART AFC DRIVE & CONTROL SYSTEM

PROJECT OBJECTIVE AND INNOVATION

The H2020 Clean Sky 2 project FloCos is coordinated by Trisitec UG and performed with the help of Cedrat Technologies. The project will focus on an integrated Active Flow Control (AFC) actuator driving system taking into account the specific requirements of piezoelectrically driven Synthetic Jet Actuators (Figure 1).

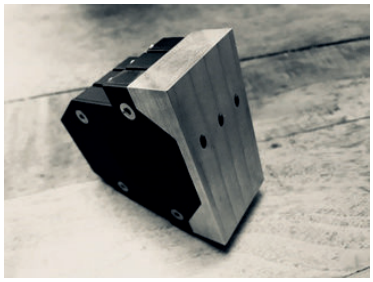

Figure 1 : Fraunhofer ENAS Synthetic Jet Actuator

The system is divided into two different main parts: the electronic amplifier unit on the one hand and the control part on the other hand. For making measurement values available which will be used for closed-loop control of the actuator, a dedicated measurement circuit will be developed and optimized for this specific application. FloCoS will not only provide smart power amplifier solutions, but also efficient solutions. State-of-the-art power recovery technologies will be used to minimize the needed power for driving the piezoelectric elements. For the addressed application scenarios, e.g. the test of actuators in large scale wind tunnel test studies, there are special requirements for remote access and control for the system. For the test of the actuators as well as the aerodynamic concepts, the actuators have to be driven in Wind Tunnel Test (WT/T) environment, where control computers and power supply connectors may be far away from the point of action. FloCoS provide a remote access to all system parameters with an advanced monitoring and logging functionality.

FloCoS contributes to the ACARE Flightpath 2050 ambitious goals. Less pollution and noise will be reached while reducing the use of fossil fuels during flight as addressed in the overall objective of Clean Sky 2.

Figure 2: Final 2x48 channels CTEC Drive & Control system

CHARACTERISTICS AND ARCHITECTURE

The main characteristics are the following:

› Actuator's specifications

Number of channels	Up to 96 channels (2x48 channels rack)
Excitation frequency	Up to 2500Hz
Actuator capacitance	Up to 200nF

› Amplifier characteristics

Max output current	250mA per channel
Max output voltage	0-200V amplitude
Max output power	20W per channel

› Power supply

Input	110 / 230 VAC
Output	210 VDC
Maximum power	600W

› Communication (TCP/IP)

Network interface layer	Ethernet
Network layer	Internet (IPv4)
Network configuration	DHCP client + APIPA
Transport layer	TCP (+ UDP network discovery)
Application layer	CTEC specific protocol

Figure 3 : FLOCOS characteristics

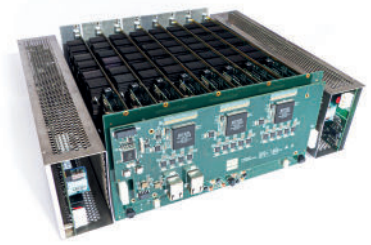

Figure 4 : Inside view of an electronic rack

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2X SC600 POWER SUPPLY BOARDS

These power supplies include a PFC (Power Factor Correction) function and use an LLC resonant converter architecture, to achieve an optimal efficiency.

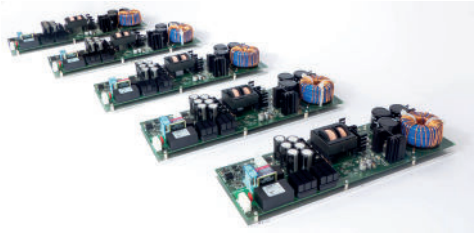

Figure 5 : SC600 power supply boards

8X AMPLIFIER BOARDS

Each amplifier board have 6 independent linear amplifier channels, and a voltage and current feedback for monitoring and driving. There are 2 MCU daughter boards emplacements for driving and monitoring purpose.

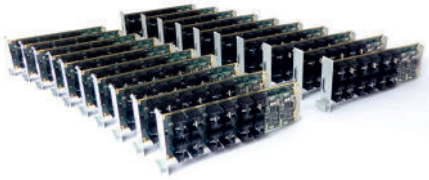

Figure 6 : Amplifier boards

16 MCU DAUGHTER BOARDS

MCU daughter boards are mounted on the amplifier boards and include all the digital functions needed for each channel: ADC, DAC, microcontroller, current/voltage phase detection. They can drive 3 amplifier channels. Each one can generate an independent sinus command signal, or an amplitude modulated signal. Thanks to the voltage / current phase detection, MCU boards can work as MPPT (Maximum Power Point Tracker) and generate an optimal driving command to each actuator. One can see on figure 8.a and 8.b the relation between the actuator flow speed vs the U/I phase. The MPPT algorithm is tracking the minimum U/I phase, thus corresponds to the maximum output flow velocity, while requiring a minimum electric power.

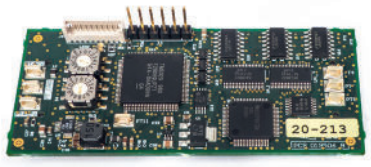

Figure 7 : MCU daughter board

Figure 8.a : Actuator output flow speed vs frequency (below)

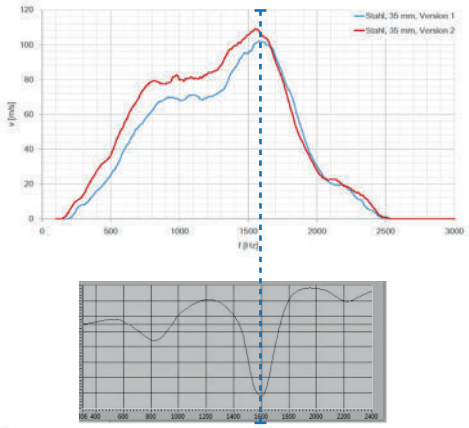

Figure 8.b : Amplifier U/I phase vs frequency (above)

This board can register the voltage and current measurement during time lap and let them be downloaded later.All these functionalities are independently configured through the TCP/IP network, to be internally generated, or asserted to a common one, generated by the master rack.

1X SWITCH DAUGHTER BOARD

Installed behind a backplane board, this daughter board integrates multiple active functions. This board includes all the switches for the TCP/IP network, and the Ethernet controllers for each MCU boards. There are additional ports, to communicate between master and slave(s) rack(s), and outside the system (for the client supervisor). This communication solution is proposed in regard of the testing phase in the wind tunnel, where the distance between the rack and the supervisor could be long.

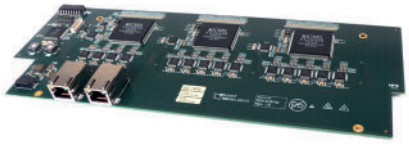

Figure 9 : Switch daughter board

The main microcontroller is located on this board, to generate any common signals to all the channels: A sinus command, a modulation signal, and a trigger to allow a synchronous acquisition of voltage and current measurements.

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CTEC CONTRIBUTION IN THE PROJECT

CTEC is mainly focusing on the following tasks in the project:

- Contribution to the development of the specification documentation for the whole system
- Development of the overall system architecture
- Development of the HV DC/DC and Amplifier System
- Development of the driving and monitoring software

KEY FEATURES

- Channel independent or synchronous signal generation capabilities
- Internal TCP/IP network for configuration and download of monitoring data
- Integrated Maximum Power Point Tracking algorithm for closed-loop optimal command
- Efficient LLC resonant converter power supply

PARTNERS

- Trisitec UG
- Cedrat Technologies
- Fraunhofer ENAS (Topic Manager)

The know-how and the competencies acquired in FloCoS will enable CTEC and TriSiTec to strengthen their position as being reliable and capable partners for future support and collaboration with industrial partners in the areas of Active Flow Control systems and technologies.

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