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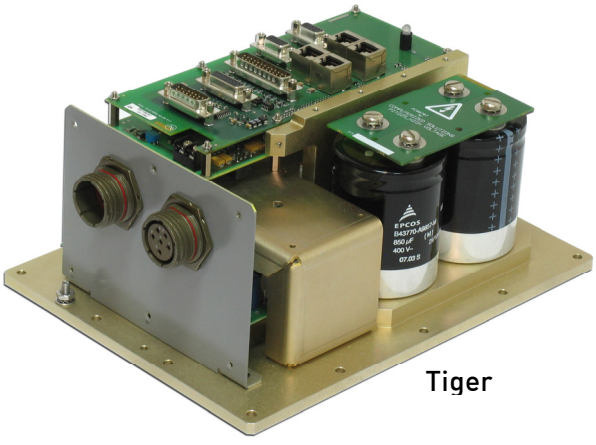
Application Solutions Case Study:

Wind Turbine Stations

Featured Products –Tiger & Eagle

Powerful Digital Servo Drives



Tiger

Eagle

Elmo
Motion Control
www.elmomc.com

Machine Description:

Wind turbines are rotating machines that convert the wind's kinetic energy into mechanical energy which in turn is converted into electricty.

Turbines used in wind farms for the commercial production of electric power have three blades, and motors controlled by servo drives point them in the direction of the wind. The blades have high tip speeds – up to six times the wind speed – and are highly efficient, with low torque ripple that contributes to good overall reliability. The blades range in length from 20 m to 40 m or more, and they can be controlled by Elmo's high performance digital servo controller – the Tiger 50/600. Elmo's Eagle 35/200 – a compact, high power and intelligent servo drive – is used as a backup drive to handle system operations in the event of an emergency or malfunction.

The blades rotate at 10 – 22 rpm, though the more advanced models operate at a constant speed. In this application solution, the servo drives control the motor blades which continuously change their angle with respect to the flow of the wind in order to maintain a constant rotational speed. All turbines are equipped with safety shut-down features to avoid damage at high wind speeds.

The Challenge:

When designing an application solution based on Elmo's products for a wind turbine, we are faced with the following challenges:

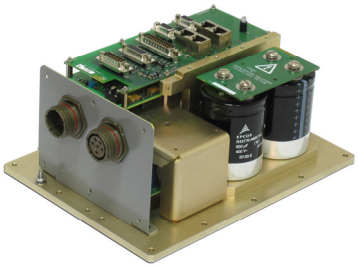
- The need for accurate, high speed control of the wind turbine's tree blades.
- The ability to control the blades that are driven by DC brushless motors.
- The requirement to supply a high reliability solution in extreme and variable conditions.
- The need to provide a solution based on products that meet safety requirements and have redundancy/backup capabilities.
- The requirement to design a solution that is compact and uses minimum space.
- The ability to provide advanced programming capabilities within the drive to enable it to respond to unexpected situations.
- The need to supply a high power, cost effective and intelligent motion control solution.
- The requirement to provide Absolute Encoder support.
- The ability to connect directly to a three-phase mains supply without the need for a DC power supply.

Elmo's Solution

The space limitations within the wind turbine for installing the servo drives requires compact electronics with very high power motor drives to supply the necessary high torque and accurately control the speed of the blades. The Tiger and Eagle drives are designed with high power density and high performance, where safety is an essential requirement.

The **Tiger** digital drive was chosen as the main driver due to its compact size, high power and ability to support up to a 600 VDC bus. It is a fully digital servo drive that can drive up to 50 A of continuous current that is required for the high torque that is necessary to drive the wind power blades at high speed.

Model number and description: TIG-50/600
Fully digital servo drive, 50 A continuous current, 40-600 VDC.
Can connect directly to a 3x380 VAC mains network.



TIG 50/600 Intelligent Digital Servo Drive

The **Eagle** digital drive was selected as an additional drive system to provide backup in case of emergency situations. It provides 35 A of continuous current at a 46-195 VDC bus. Weighing just 700 g, the Eagle is a truly unique Elmo innovation offering high power in a relatively compact package.

Model number and description: EAG-35/200
Eagle digital drive, 35 A continuous current/ 60 A peak current, 46-195 VDC.

Eagle 35/200 Intelligent Digital Servo Drive

Technical Description:

The application implementation is based on proven, ready-for-use products, using the TIG 50/600 and EAG 35/200 as the main and auxiliary system controllers respectively. They were designed for very high performance servo systems that are usually used in high power military applications. The drives are MIL-STD compliant and can operate in extended environmental conditions (EEC). The Tiger is powered directly by three-phase mains power with no need for an additional DC power supply, as it has an internal integrated DC power supply. The Eagle serves as auxiliary backup that further increases system reliability. The TIG 50/600 and EAG 35/200 are highly reliable products that have been integrated in many military applications. The drivers' reliability is not less than that of the wind turbine's DC brushless motor.

Product Highlights:

	TIGER 50/600	**EAGLE 35/200**
▪ Continuous rated output current up to	50 A	35 A
▪ Maximum power	< 400 W at 50 A output	< 200 W at 35A output

	dissipation	current and 600 VDC bus	current and 200 VDC bus.
▪	Dimensions (mm)	205 x 126 x 276	134 x 95 x 60
▪	Programmable optically isolated digital inputs	10	6
▪	Programmable optically isolated digital outputs	6	2
▪	Analog input	–	1

	TIGER 50/600		**EAGLE 35/200**
▪	Continuous nominal output power: **24 kW at 380 VAC**	▪	Peak current of **70 A** for 3 seconds
▪	Guaranteed continuous rated output current of 50 A (35 ARMS) and peak output voltage greater than 93% of the DC bus	▪	Up to **7 kW** of **continuous power** or **14 kW of peak power** in a compact package
▪	Fully digital servo controller		
▪	Support for a wide range of feedback options		
▪	One RS-232 and two CANopen communication ports		
▪	Internal programming		
▪	Protection against: ▪ Shorts between motor power outputs ▪ Shorts between motor power output and power input ▪ Failure of internal power supplies ▪ Over/under voltage ▪ The motor becoming stuck ▪ Overspeed ▪ Overheating ▪ Loss of feedback ▪ Motor oscillation ▪ Following errors		

The main system controller communicates with the Main and Auxiliary drive controllers via CANopen communication. An optional RS-232 channel can be supplied to the system controller to enable communications redundancy for continuous monitoring and a secondary channel in the event of a fault. The system's upper controller – the Maestro, Elmo's Multi-Axis Controller – is able to communicate with the host through Modebus or Ethernet protocols and controls the normal operating modes of the system. This is carried out using CANopen, analog commands, RS-232 commands, and P&D or PWM commands. It communicates with both drives and it also monitors and detects the system status, such as communication faults, drive faults, motion faults, AC power lost, sensor faults, etc. and responds as required.

The main system controller controls the operation of both drives over the CANopen or RS-232 communication channel, and in parallel acts as a redundant backup, using I/O lines to control and monitor each drive and other elements of the system. The main driver operates under normal conditions where AC mains power is available. If the mains AC power drops below a certain threshold level, the auxiliary drive starts to operate from this source and takes control over the motor.

The main drive is operational under normal conditions and uses the motor's absolute encoder (or any other encoder). The auxiliary drive, which is active only if the main drive malfunctions or if the mains voltage power is off, provides redundant position control of the motor. Redundancy for the absolute encoder feedback is also available in the system. The upper controller is responsible through its control I/Os to switch between the main drive and the motor phases. The switching logic is controlled by the system controller. Each drive unit is fully programmable, and provides multi-level intelligence that significantly increases the ability of the system to respond correctly and in a timely fashion to any fault condition.

Heart beat is supported over CANopen to detect a faulty drive. The implementation includes watchdog implementations at various levels, such as lost CANopen communication, a lost I/O signal to the relays, etc., to increase the system's safety level. Both drives support brake commands to brake the motor when necessary. Additional I/O lines are connected between the various components of the system (system controller, drives, and safety and relays board) that can be used as an additional safety control and bypass. The distributed intelligence of Elmo's drives can be used to implement additional safety logic. The motor's temperature sensor is connected to the main drive.

Why Elmo:

- Powerful servo and motion control technology.
- Networking and distributed intelligence.
- Using Elmo's TIG 50/600 enables a direct connection to the mains VAC electricity network. There is no need to step down the voltage by adding an additional bulky, high power isolation transformer.
- Elmo's ET servo drives can operate from –0 °C to +60 °C meaning that there is no need for air conditioning to warm or cool the drives. This simplifies the system's complexity and significantly increases the reliability.
- Elmo's proprietary technology allows DC brushless motors to be operated in "sensorless-stepper" mode. There is no need for additional backup feedback in emergency conditions.
- Operating the DC brushless solution requires low maintenance with high reliability and performance.
- With Elmo's advanced drivers a standard DC brushless motor with a single absolute encoder can be used.
- Versatility and advanced programming enhances the performance of Elmo's solution.
- High power density products in a very compact overall solution.
- High efficiency.

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