



The new EP1816-3008 EtherCAT Box has two integrated 3-axis acceleration sensors and 16 digital inputs.

Scientific Automation enables local acquisition of measured data with robust IP 67 modules

EtherCAT Box – System-integrated measurement technology for harsh environments

Local acquisition of measured data in machines and systems offers many benefits, such as reduced effort in terms of engineering, installation and commissioning along with shorter response times for process events. The key is a wide range of measurement modules, which also cover complex signal types and seamless integration in the control system. EtherCAT Box modules from Beckhoff are ideal for implementing such a system. They open up all the options offered by high-performance EtherCAT technology for the IP-67 world outside of electrical cabinets.



Scientific Automation integrates measuring functions into standard control technology not only in the IP 20 world – such as temperature measurement in this example – but also in harsh IP 67 environments.

PC-based control and EtherCAT communication provide a high-performance platform, and not only for traditional control tasks such as PLC, Motion Control and control technology. The holistic Scientific Automation approach that Beckhoff pursues seamlessly integrates additional technology areas such as robotics, sophisticated measurement and data processing, as well as Condition Monitoring and energy monitoring. Rather than utilizing a “black box” solution that is complicated to integrate, measurement technology can be implemented and also retrofitted easily using standard I/O components and standard engineering processes. The main advantage lies in the basic system structure: The measured data are logged in a simple, cost-effective and highly scalable manner by EtherCAT terminals or IP 67 modules and are then transferred via very fast EtherCAT communication to a high-performance Industrial PC for processing.

Robust housings ensure reliable use in the field

To complement the wide range of IP 20-rated measurement terminals, Beckhoff started at an early stage to map corresponding functions for solutions in protection class IP 67. The result is a comprehensive EtherCAT Box family, which is still being expanded continuously with new variants. These modules from the IP 67 series integrate direct EtherCAT interfaces, so that high performance is retained right down to each module. This enables new technologies in the IP 67 world: fast process data communication with eXtreme Fast Control (XFC), integrated drive functions and high-precision measurement technology directly in the field.

From digital I/Os to complex signal types

The EtherCAT Box modules cover the typical range of requirements for IP 67 I/O signals: digital inputs with different filters (3.0 ms or 10 μ s), digital outputs with 0.5 and 2 A output current, combination modules with freely selectable inputs or outputs, analog inputs and outputs with 16-bit resolution, thermocouple and RTD inputs, as well as stepper motor modules. With integrated XFC functionality, the EP1258 EtherCAT Box opens up a wide range of new applications, which in the past were not possible with an IP 67 module. With eight digital inputs it logs fast binary signals from the process level and transfers them in an electrically isolated manner to the control system. The signals are furnished with a time stamp that identifies the time of the last edge change with a resolution of 1 ns. In this way signal variations can be traced exactly over time and related to the EtherCAT distributed clocks across the system.

Integrated acceleration and angle measurement

This diversity enables connection of almost any sensor and actuator type and the logging of complex signal types. A good example is the new EP1816-3008 EtherCAT Box. With 16 digital inputs it logs binary control signals from the process level and features two integrated 3-axis acceleration sensors. It is easy to install and can be used to implement cost-effective vibration and shock/oscillation monitoring directly in the field. It also supports inclination measurement in X and Y directions. The acceleration sensors with 16-bit resolution in the optional ranges $\pm 2g$, $\pm 4g$, $\pm 8g$ and $\pm 16g$ are realized as so-called MEMS (Micro-Electronic-Mechanical Systems). Compared with the conventional combination of sensors and separate data sampling, this solution is more cost-



The EP3744-0041 EtherCAT Box integrates quadruple compressed air measurement into the EtherCAT system – economically and directly in the process.

effective and easier to install and integrate in the control system. Furthermore, it offers another advantage: Two sensors, which are arranged at 90° angles, make the EP1816-3008 a redundant measuring system, and moreover, the results can be reliably verified in the controller. A typical application for the 3-axis acceleration box is vibration and shock/oscillation monitoring of machines and buildings. For example, vibrations of robot arms can be monitored exactly and with no great effort via the measured accelerations. For wood sawing machines, an EP1816-3008 mounted on the work table offers reliable monitoring of the saw blade angle adjustment thanks to its fast signal acquisition, as another example.

The most efficient way to measure compressed air

The new EP3744 differential pressure measurement box is a compact and integrated solution for measuring, monitoring and analysis of compressed air supplies, which are encountered in almost all areas of industrial automation. This EtherCAT Box has six digital inputs, two digital outputs and four pressure inputs with integrated 6 mm fittings. The pressure is measured as the difference to the fifth pressure connection, which is fed via a hose into a protected environment for IP 67 conformity. This all adds up to a compact stand-alone device for the direct measurement and monitoring of pressure in the field. On the one hand, it eliminates long routes and hose connections from the process to the control cabinet, and on the other hand, it facilitates separation of electric and pneumatic systems, as stipulated for many applications. The EP3744 can be used for operating pressure monitoring, for example. In addition, the decentralized and system-integrated pressure measurement is the ideal solution for the prompt detection and localization of leaks. The EP3744 can also contribute to a trouble-free processing sequence: for example, the vacuum necessary for the gripping process in automatic pick-and-place machines can be monitored without great expense. To do this the EtherCAT Box needs only to be integrated into the compressed air supply to the suction gripper via a simple T junction.

Complete range of infrastructure components

For the consistent decentralized configuration of machine or system data acquisition, corresponding infrastructure components are required. The new EP9224 Smart Power Box even combines the infrastructure component with measurement functionality: The 4/4-channel power distribution enables the connection of four EtherCAT Box power supply branches. In each 24 V branch the current consumption for the control voltage and peripheral voltage is monitored, limited and switched off if necessary. All input voltage and output current values can be analyzed in the controller via the process data. In the event of a fault, the continuous logging of relevant data such as current values or temperature facilitates troubleshooting. The data can be retrieved from a ring buffer in order to pinpoint the causes of faults.

EtherCAT supports virtually any topology, which can also be directly branched in the field using the EtherCAT Box modules. If several junctions are required at one point in the star topology, an EtherCAT junction can be used to branch the topology further. Analogous to the infrastructure components with IP 20 protection, the EP9128 eight-way EtherCAT star hub offers the possibility to construct the branches of the topology with the smallest possible number of components in the IP 67 world as well. The EtherCAT network is connected to the input port of the star hub and can be extended via the other seven ports.

The EP9521 and EP9522 EtherCAT/Industrial Ethernet modules for fast industrial Ethernet/100 Mbaud serve as media converters from optical fiber to copper and vice versa. Both media converters are suitable for multimode fiber-optic cables. In addition to the copper branch, the 2-channel EP9522 enables further optical fiber topologies to be configured via a second optical fiber port, while the single-channel EtherCAT Box EP9521 is used for direct transfers between the two media. The CU2608 IP 67 Ethernet switch is another important infrastructure component with robust design. In a compact plastic housing it



The EP9224 combines a 4/4-channel power distribution for EtherCAT Box modules with comprehensive current measurement and data logging functionality.

offers eight d-coded M12 Ethernet ports, 10/100 Mbaud, half or full duplex, automatic baud rate detection, cross-over detection along with clear and fast diagnostics.

Software optimizes measurement technology integration

The new TwinCAT 3 software generation, which is integrated in Microsoft Visual Studio®, was designed to meet the needs of Scientific Automation, i.e. the convergence of automation and advanced measurement technology. The real-time environment is designed to enable almost any number of PLCs, safety PLCs and C++ tasks to be executed on the same or on different CPU cores. The new TwinCAT 3 Condition Monitoring library enables the utilization of these options: Raw data can be logged with a fast task and processed further with a somewhat slower task. This is ideal for continuous measured data logging and independent analysis in a second task, based on a wide range of algorithms. The individual function blocks of the Condition Monitoring library store their results in a global transfer tray, a kind of memory table. From there the results can be copied to variables or processed further via other algorithms so that a customized measuring and analysis chain can be configured.

No Beckhoff-specific blocks or other modifications of the original model are required for creating Matlab®/Simulink® modules. The Matlab® and Simulink® coders generate C++ code, which is then compiled into a TwinCAT 3 module. Modules can easily be re-used through instantiation. The block diagram from Simulink® can be visualized directly in TwinCAT for setting break points, for example.

TwinCAT Scope offers display options for all relevant Scientific Automation software signals. The View component is used for visualization of signals in the form of charts, the Server component records the data on the respective target device. Scope is able to take precise measurement readings right down to the

Measurement technology integration for Industry 4.0

The ScAut innovation project is part of the Leading-Edge Cluster, "it's OWL" (Intelligent Technical Systems OstWestfalenLippe), and is managed by Beckhoff as the consortium leader. ScAut illustrates the trend-setting nature of the holistic approach embodied by Scientific Automation. The idea is – in the spirit of Industry 4.0 – to utilize the ever-growing capacity reserves of PC technology for implementing scientific findings on standard machine controllers. A concrete example is process-optimized drilling, in which spindle current and power, feed current and power, vibration of the spindle and workpiece, drill hole temperature, chip formation and drilling pattern are all used as control parameters for optimizing production efforts.

microsecond range and can visualize oversampling values from the EtherCAT measuring terminals, for example.

Accessories for efficient system configuration

The wiring for protection class IP 67 is simplified significantly thanks to pre-assembled cables for EtherCAT, power and sensors. Wiring errors are effectively prevented, reducing commissioning times as a result. In addition, field-configurable connectors and cables are available for maximum flexibility. Combination I/O modules and the high signal granularity also reduce system costs.

Further Information:

www.beckhoff.com/EtherCAT-Box