Extremely accurate, fast and robust: High-end measurement technology from Beckhoff.
Maximise your production efficiency with high-precision measurement technology.

Measurement technology at high speed
Faster measurements with sampling rates exceeding 10 ksps can scan even highly dynamic processes and provide valuable data for subsequent analyses.

Measurement technology provides insight
Precise measurement technologies with an accuracy of better than 100 ppm and a 24-bit resolution creates true added value because it can detect even the smallest deviations and enable corrective action. Low temperature drift ensures predictable error limits even across long machine runs for improved product quality and less production variations.

Measurement technology provides a complete overview
Synchronous measurement technology scans multiple channels simultaneously – even for multiple machines. This comprehensive synchronised process image overview can help you implement a high-quality measurement infrastructure across a wide range of systems.

Reduced production costs:
High-precision measurement technology reduces the consumption of raw materials and energy in production.

Increased availability:
Reliable measurement technology forms the foundation for advanced predictive maintenance solutions.

Optimised product quality:
Highly precise measurement technology increases the processing quality of your production.
Measurement technology adds value
Proactive measurement technology checks its own functionality and the status of the cabling to produce reliable data in operations that run unattended over long periods. This improves the overall quality and availability of your processes and enables more informed decisions, because you receive valid and traceable quality data for each part produced.

Measurement technology saves money
Measurement technology for automated applications creates an impressive return on investment very quickly. It makes tight fault tolerances possible, and since faulty parts are identified right away, they won’t negatively impact downstream production.

Measurement technology supplies data to the cloud
Analog and digital inputs gather all data and status information, which can then be processed and stored locally or in the cloud via TwinCAT Connectivity functions. This promotes data insight – generated by Beckhoff measurement technology.

Enhanced process quality:
High-speed measurement technology reduces cycle times and accelerates production processes – while dramatically reducing the rate of rejects.

System-integrated measurement technology increases competitiveness
- Increased productivity
- Increased availability through predictive maintenance
- Reduced material consumption
- Improved process quality
- Improved product quality
- Direct connectivity enables Industrie 4.0 solutions

Ideal for Industrie 4.0 applications:
System-integrated measurement technology manages high data volumes for power and condition monitoring.
Complete your control system: with simple measurement technology integration.

Milestone in automation
The new ELM-series measurement device family represents a milestone in the world of automation. It features powerful, robust and user-friendly measurement technology that was designed especially for use in industry-standard control cabinets with short installation deadlines. Other features include extensive self-diagnostics to ensure reliable long-term operation even in unattended environments without frequent maintenance routines. For example, the EtherCAT platform-wide measurement solution for existing PC- and EtherCAT-based control applications without performance losses through platform or system breaks.

High-precision measurement technology for automation applications
With its new ELM-series EtherCAT device family, Beckhoff is adding high-precision and high-speed technologies to its portfolio of measurement technology devices. These powerful EtherCAT modules open new doors in terms of time and measurement precision, synchronisation and especially long-term reliability that previously were only possible with cost-intensive specialised equipment introduced into integrated automation systems. As a result, Beckhoff offers a platform-wide measurement solution for existing PC- and EtherCAT-based control applications.

Integrate measurement technology into your overall control system: TwinCAT integrates PLC, motion control, measurement technology as well as I/O and cloud connectivity on a single, universal software platform.
Bringing precision measurement technologies into the industrial environment enables makers of traditional manufacturing, testing and inspection equipment to further advance their applications. Measurement technology modules instantly recognise potentially faulty measurements that could otherwise have been considered valid in the past. This feature is implemented via extensive connection diagnostics, self-tests and continuous internal checks as well as the constant monitoring of temperature and inputs to recognise overloads. Features like high resolution, high measurement accuracy and a high sampling rate – all of which have long been common in lab environments – are now made available by Beckhoff for conventional industrial automation applications. This is done by leveraging long years of experience in series production of automation components.

Beckhoff measurement technology combines established I/O technology standards with the latest advances in high-precision measurement technology:
1. Standard 12/16-bit analog measurement
2. Energy monitoring in power grids
3. Condition monitoring (vibration measurement technology)
4. NEW: High-precision measurement technology

Beckhoff – automation and measurement technology from a single source:
- Complete automation toolbox with IPC, I/O, motion control and automation
- Comprehensive toolbox for centralised and distributed measurement technology concepts
- Systems based on standard components
- Easy integration into existing control environments
- Innovative, well-established vendor with global reach

We reserve the right to make technical changes.
Seamless integration from data acquisition to analysis: the Beckhoff measurement chain.

**The sensors**
Beckhoff I/O modules accommodate most common sensors:
- Force
- Pressure
- Temperature
- Speed (rpm)
- Frequency
- Torque
- Measurement bridges
- Vibration
- Current
- Voltage
- ...

**Measurement technology hardware**
Beckhoff offers I/O modules in various protection ratings for common sensors:
- DIN rail-mountable IP 20 modules
  - Bus Terminals
  - EtherCAT Terminals
- **NEW:** EtherCAT measurement modules in connector-compatible metal housings
- Flexibly installed IP 67 modules
  - Fieldbus Box
  - EtherCAT Box, also available in stainless steel and die-cast zinc housings

**Measurement technology bus**
Performance counts, which is why EtherCAT has become established as a major measurement technology bus:
- With a usable data rate of 100 Mbit, EtherCAT can accommodate hundreds of channels with 24-bit resolution and over-sampling, synchronous scanning, cable redundancy, and time stamps with ns resolution.
- PROFINET, PROFINET, EtherNet/IP, etc.: All measurement data can alternatively be collected via many other Beckhoff-supported fieldbus systems.
Measurement software “on premise”
“On premise” describes the use of TwinCAT 3 on a local control IPC with engineering, PLC, motion control, safety, visualisation, communication and measurement technology on a single software platform:
- TwinCAT Analytics for in-process and post-process analytics
- TwinCAT Power Monitoring for power grid analytics
- TwinCAT Condition Monitoring for signal analytics
- TwinCAT MATLAB®/Simulink®: Integrates MATLAB®/Simulink® models and algorithms into standard automation applications

Measurement software in the cloud
Many TwinCAT features can be used not only locally in the machine controller, but also in the cloud:
- TwinCAT IoT: Communication with various cloud systems via protocols like OPC UA Pub/Sub, AMQP or MQTT
- TwinCAT Analytics: Analysis of the complete process image of multiple machines in a central system for perfect data aggregation
- TwinCAT Connectivity to implement cloud computing, data storage and third-party measurement software, such as LabView, based on open interfaces in TwinCATs
- TwinCAT Analytics Cloud Storage Provider: Easy connection to storage services on various public cloud platforms

The measurement technology bus
- EtherCAT®
- PROFINET®
- PROFIBUS®
- EtherNet/IP

The measurement software in the cloud
- TwinCAT 3

The measurement software on premise
- TwinCAT 3
The new EtherCAT measurement modules:

How valuable is your data?
Do you know whether your machines and systems (still) produce correct measurements? Or do you trust on a successful commissioning process? Are the final test results all that’s needed to confirm that everything is working as it should? Whether in a new production line, power distribution system, packaging line or lab – reliable measurement values are the reward for your investment. Only customers who trust your systems will award you new orders. Integrated high-end measurement technology shines with its lean architecture and accurate and reliable data. Thorough preliminary tests and calibrations.
We reserve the right to make technical changes.

<table>
<thead>
<tr>
<th>Fast:</th>
<th>Basic models feature up to 50,000 samples per second with 24-bit resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precise timing:</td>
<td>Exact &lt; 1 μs synchronisation with EtherCAT distributed clocks, both internally and externally with a superordinate clock</td>
</tr>
<tr>
<td>Precise values:</td>
<td>Measurement accuracy of 100 ppm and better with high temperature stability, depending on the measurement range</td>
</tr>
<tr>
<td>Proactive:</td>
<td>Integrated connectivity and functional diagnostics ensure long-term operating reliability</td>
</tr>
</tbody>
</table>

in the production facilities at Beckhoff ensure reliable and precise measurement functionality.

**High-end measurement technology in metal housings**
Long-term reliability, adjustability in the field, self-diagnostics and high temperature stability are core requirements for any industrial measurement device. That’s why the ELM-series of high-end measurement devices from Beckhoff is available in metal housings. Effective heat dissipation and shielding deliver technological improvements over the tried-and-tested EL Series. Robust and well protected, the Beckhoff metal modules implement sophisticated measurement technology on the DIN rail. Beckhoff measurement technology is often employed in unattended environments where no one inspects the wiring or checks the plausibility of measurement results on a daily basis. That’s why industrial users expect measurement technologies that can self-check and validate as effectively as technically feasible. Integrated connection diagnostics in the EtherCAT measurement modules check for cable breaks and short circuits, and an internal self-test function provides improved operating and measurement reliability. Both are new ways of combating the unknown quantity of measurement uncertainty.

**Reliable measurement technology meets industrial requirements:**
- Up to 50,000 samples per second
- Measurement accuracy of 100 ppm at 23 °C
- Metal housings for optimum heat dissipation
- Extremely robust – ideal for harsh environments
- Flexible connector front-end: LEMO, BNC, push-in
- Pretreated in the factory for high-quality measurement results
- Integrated connection and functional diagnostics
- Optional factory calibration certificate
New measurement technology approach
The ELM-series EtherCAT measurement modules reflect the successful packaging of established precision measurement technology for machine design and engineering with robust, long-term usability in mind. This approach also benefits test bench and lab applications by making attractively priced industrial measurement technology in different versions available to fulfill challenging requirements. It provides multifunction channels with many integrated and online switchable measurement ranges as well as price-optimised variants for varying channel quantities.

DIN rail-mountable modules in metal housings
- Use on the DIN rail with well-known EtherCAT Terminals
- Can accept cable shield and ground (PE) as the conductor and fastens mechanically
- Provides effective heat dissipation for analog electronics and discharge of heat to rear wall of control cabinets.
- Suitable for use in demanding, low-maintenance environments
- Provides a protective barrier around the high-quality electronic components
- Reduces the impact of electromagnetic interference (EMI)

Flexible connector front-end
- Push-in connector with maintenance quick-release — the standard solution for typical requirements. Easy to assemble with or without wire end ferrule, and long-term reliable.
- BNC technology for vibration analysis, quick-and-easy bayonet connection, well-shielded through coax cable for quick wiring modifications.
- High-quality LEMO connectors for high-end applications. Slightly more difficult to assemble, but offers consistent shielding and is usable as a power plug; easily removable for maintenance or other purposes.

For industrial and testing applications:
New Beckhoff measurement technology hardware.
We reserve the right to make technical changes.

Beckhoff offers extensive measurement technology expertise:
- Deep measurement technology knowledge in-house
- Development, design and production processes are closely integrated
- Superior manufacturing competencies
- Comprehensive expertise in measurement module calibration, alignment and adjustment
- Sophisticated module tuning enhances measurement precision

High-quality look and feel that matches the high-end measurement precision.

High process stability
Process stability is especially important in mostly unattended installations with infrequent maintenance. The devices must autonomously determine whether they can still measure correctly, because no test engineer can check them for irregularities on a daily basis:
- Extensive diagnostics immediately detect short-circuits, cable breaks and shunts to the extent technically possible.
- Comprehensive self-test and repeat internal checks

Continuous monitoring of temperature and inputs to detect overloads and prevent critical failures
- Diagnostic reports continuously available via EtherCAT

Traceability and recalibration
Each Beckhoff measurement technology terminal has its own unique ID for which a factory certificate can be issued. Also, via the Beckhoff recalibration service, ELM devices can be checked, aligned and recalibrated at the factory in Verl, Germany.

Optionally integrated shield connectors for each analog cable enable clean crimping. Ultimately, high-quality analog measurement technology always starts with the cable connection.
High-end measurement technology requires high signal processing in the EtherCAT measurement modules. The “intrinsic values” of the EtherCAT measurement modules open up entirely new opportunities for the use of measurement technology in automation as well as testing and inspection applications. The entire data acquisition process has been redeveloped and rebuilt by Beckhoff – from the analog electrical signal to the handover of the digitised values, all enhanced with data that improve reliability and time resolution. Over 20 years of experience integrating electronics in modular I/O terminal housings have been incorporated in the development, testing and production of the ELM-series.

**Newly developed for highest demands**
- The ELM-series features high-end technology: Signal processing in the EtherCAT measurement modules.
- Analog-to-digital conversion in 24-bit resolution
- 2 freely parameterisable filters up to the 39th order
- High-quality, stable and robust input electronics
- Carefully selected components with high stability, robust EMC protection circuitry and proven design from previously-designed terminals have been combined to provide reliable inputs for high quality demands.
- In the multifunction models, which also sport a switching feature, the variants are equipped with individual feature upgrades. For example, the ELM360x IEPE modules feature different supply currents, and the ELM350x measurement bridge modules can supply a wider voltage range.
- Since the units are pre-aged by Beckhoff before they are calibrated, they deliver application stability from the start.

**State-of-the-art analog/digital converters**
- 24-bit resolution for high signal detail
- Synchronised scanning with delta-sigma conversion across multiple channels and terminals via EtherCAT distributed clocks
- 10 ksp/s sampling rates with the standard
-end technology: modules.

terminal version; over 20 ksps in 2-channel models; up to ultra-fast 50 ksps 24-bit IEPE scanning with the ELM360x

The filtering machine
- Powerful and efficient local calculation in the terminal
- CoE-selectable Butterworth filters or self-defined filters using coefficients
- Resolves aliasing problems and creates room for selective filters or band-stop filters that can be changed at runtime

Decimation unit
- Channel sampling rate changeable at runtime
- Uses oversampling to transmit measured data over EtherCAT

Special functions
- Special functions can be activated optionally
- A TrueRMS algorithm converts the data stream accordingly
- Optional 2-stage decimation/integration unit

Free scaling
- After being changed to fit the electrical measurement range (e.g. 0…+10 V), the measurement value can be converted.

EtherCAT – the measurement technology fieldbus
- 100 µs minimum EtherCAT cycle time
- Oversampling for transmitting larger data packets per cycle
- Synchronised via distributed clocks

■ Classic gain/offset with \( y = mx + b \), with internal correction table or with totally free supporting point table up to linearisation

BECKHOFF New Automation Technology
Firmly established: EtherCAT from Beckhoff

As the inventor of EtherCAT, Beckhoff continues to play a leading role in the advancement of the protocol and in the development of innovative products for EtherCAT, especially the modular EtherCAT Terminal I/O system. Additionally, EtherCAT has become firmly established in the measurement technology world. With its high data rate of 100 Mbit/s, EtherCAT meets many measurement technology requirements in lab and production environments. Other benefits include the ease with which equipment manufacturers can integrate EtherCAT into their products. After 14 years, the EtherCAT Technology Group (ETG) provides an almost unlimited variety of devices via almost 4,000 member companies and 100 master device manufacturers. Almost every sensor type is now available with an EtherCAT interface. With its EtherCAT-based modular I/O terminal system and TwinCAT PC-based control software, Beckhoff provides the automation infrastructure for many machines, which is why the company’s ultra-precise, DIN rail-mounted measurement technology is such a valuable addition. It simplifies control cabinet design, saves space and streamlines procurement processes, because all the automation, control and measurement technologies are available from a single
equipment manufacturer. The direct integration of precise measurement technology into the control platform via EtherCAT promotes simpler system architectures and reduces complexity. It also delivers fieldbus technology capabilities such as easy configuration based on EtherCAT standards, synchronised scanning via distributed clocks (including external synchronisation with PTP/IEEE 1588-based and other time sources) and consistent diagnostics from the controller to the I/O level.

Ultra-precise time synchronisation
A measurement value is defined by two essential characteristics: the value itself (and its uncertainty) as well as the exact time at which the measurement was taken. With its distributed clocks, EtherCAT enables highly accurate synchronisation of all inputs and outputs with an uncertainty factor that is typically well below 1 µs between the devices on the network and also relative to a global reference time. On the other hand, the precision of the EtherCAT measurement modules significantly improves the reading of the values. As a result, times and values are now determined much more accurately than with standard automation technologies.

 EtherCAT optimises measurement technology architectures:
- Single communication technology for machine control and measurements
- Optimally coordinated products and technologies
- The world’s fastest Ethernet fieldbus
- 500 compatible EtherCAT I/O Terminals
- Open protocol for easy integration of third-party products
- Timestamping for maximised measurement quality
- Investment protection: no versioning

We reserve the right to make technical changes.
The One Cable Automation fieldbus
With EtherCAT P, Beckhoff combines communication and power supply in a single standard 4-wire Ethernet cable. The 24 V DC supply of the EtherCAT P slaves and of the connected sensors and actuators is integrated: $U_s$ (system and sensor supply) and $U_p$ (peripheral voltage for actuators) are electrically isolated from each other and can each supply a current of up to 3 A to the connected components. At the same time, all the benefits of EtherCAT, such as freedom in topology design, high speed, optimum bandwidth utilisation, telegram processing on-the-fly, high-precision synchronisation, extensive diagnostics functionality and more are fully retained.
The currents of U_1 and U_2 are directly injected into the wires of the 100 Mbit/s line, enabling the realisation of highly cost-effective, space-saving connections. EtherCAT P offers benefits both for the connection of smaller remote I/O stations in terminal boxes and for decentralised I/O components throughout the process. A connector family was developed especially for EtherCAT P in order to prevent potential damage caused by confusion with standard EtherCAT slave connectors. It covers all applications from the 24 V I/O level up to drives with 400 V AC or 600 V DC and a current of up to 64 A.

Combining EtherCAT P with decentralised measurement technology creates an entirely new set of synergies in every machine. High-quality measurements can now be collected from each section of a line with relative little wiring effort. The concept also applies to temporary or even portable measurement stations which can be positioned wherever they are needed. For control cabinet installations, the EK1300 EtherCAT P Coupler must be used to connect EtherCAT measurement technology modules. Since the EtherCAT P specification has been disclosed by the ETG, any equipment manufacturer can implement it. EtherCAT P brings industrial measurement technology and non-cabinet IP-67 environments together.

The high-speed fieldbus with “One Cable Advantage”:
- Optimised for direct connection of EtherCAT P devices in the field
- Reduced wiring effort saves time
- Fewer sources of error
- Smaller sensors and actuators through elimination of separate supply cables
- Easy connection of components
The Beckhoff system at a glance.

Software

User Mode/Engineering

- TC Measurement – Filter Designer
- TC Measurement – Scope View/Server (base free)
- TC Measurement – Bode Plot
- TC Measurement – Analytics

Runtime

- Filter Library
- Power Monitoring Library
- Condition Monitoring Library

Hardware

Metrological Automation | Scientific Automation

Performance class
- Precision: ELM3xxx
- Standard: EL30xx, EL31xx

Application examples
- Energy Measurement: EL34xx, EL37xx
- Condition Monitoring: EL3xxx

SAP HANA®, Microsoft Azure®, Amazon AWS™

MES | ERP | TC Analytics
The Beckhoff system transports and processes data between all levels of modern machine control – from the lowest I/O level, either directly or via sensor buses, and via the most common fieldbus systems to the PC-based control system. Once the data has been processed using the wide range of available software modules, it is stored in databases and transmitted to analytics systems, which can be located on-premise in the machine, in a central location in the production environment, or in the cloud. Flexibility, expandability and scalability are the key benefits of the Beckhoff system that can also be used to achieve great advantages in measurement technology applications.
High-end measurement technology in series: the EtherCAT measurement modules.

<table>
<thead>
<tr>
<th></th>
<th>ELM3704-0001</th>
<th>ELM3704</th>
<th>ELM3702</th>
<th>ELM3004</th>
<th>ELM3002</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Channels</strong></td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>24 bit</td>
<td>24 bit</td>
<td>24 bit</td>
<td>24 bit</td>
<td>24 bit</td>
</tr>
<tr>
<td><strong>Max. sampling rate</strong></td>
<td>10 ksp</td>
<td>10 ksp</td>
<td>10 ksp</td>
<td>10 ksp</td>
<td>10 ksp</td>
</tr>
<tr>
<td><strong>Connection technology</strong></td>
<td>LEMO, 8-pin</td>
<td>Push-in, 6-pin</td>
<td>Push-in, 6-pin</td>
<td>Push-in, 2-pin</td>
<td>Push-in, 2-pin</td>
</tr>
<tr>
<td><strong>U</strong> (0…10/30 V, ±10 V)</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>I</strong> -10/0/+4…+10/+20 mA</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>Measurement bridge (5G)</strong></td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>IEPE</strong></td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>Resistance measurement</strong></td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>Potentiometer</strong></td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>Temperature (RTD)</strong></td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td><strong>Temperature (Thermocouple)</strong></td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>

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We reserve the right to make technical changes.
### High-end measurement technology in series: the EtherCAT measurement modules

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Description</th>
<th>Channels</th>
<th>Resolution</th>
<th>Sampling Rate</th>
<th>Connector Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELM3104</td>
<td>4-channel current measurement</td>
<td>4</td>
<td>24 bit</td>
<td>10 ksps</td>
<td>Push-in, 2-pin</td>
</tr>
<tr>
<td>ELM3102</td>
<td>2-channel current measurement</td>
<td>2</td>
<td>24 bit</td>
<td>20 ksps</td>
<td>Push-in, 2-pin</td>
</tr>
<tr>
<td>ELM3504</td>
<td>4-channel strain gauge (SG) evaluation</td>
<td>4</td>
<td>24 bit</td>
<td>10 ksps</td>
<td>Push-in, 6-pin</td>
</tr>
<tr>
<td>ELM3502</td>
<td>2-channel strain gauge (SG) evaluation</td>
<td>2</td>
<td>24 bit</td>
<td>20 ksps</td>
<td>Push-in, 6-pin</td>
</tr>
<tr>
<td>ELM3604-0002</td>
<td>4-channel analog input IEPE</td>
<td>4</td>
<td>24 bit</td>
<td>20 ksps</td>
<td>BNC</td>
</tr>
<tr>
<td>ELM3602-0002</td>
<td>2-channel analog input IEPE</td>
<td>2</td>
<td>24 bit</td>
<td>50 ksps</td>
<td>BNC</td>
</tr>
</tbody>
</table>

We reserve the right to make technical changes.
Measurement modules for any application.

<table>
<thead>
<tr>
<th>Analog Input</th>
<th>Performance Class</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi</td>
<td>Precision</td>
<td>Standard</td>
</tr>
<tr>
<td>U (0…10/30 V, ±10 V)</td>
<td>EL3602-0010</td>
<td>Digital multimeter EL3681</td>
</tr>
<tr>
<td>-10/0/+4…+10/+20 mA</td>
<td>EL3612</td>
<td>Differential input, 24 bit EL3602-0002</td>
</tr>
<tr>
<td>-100…+10 V, -20/0/+4…+20 mA 230/690V, 1/5A</td>
<td>EL3314-0010</td>
<td>Types J, K, L, ... U, 24 bit EL3314</td>
</tr>
<tr>
<td>Temperature (Thermocouple)</td>
<td>EL320x-0010</td>
<td>PT100, 16 bit EL320x</td>
</tr>
<tr>
<td>Strain gauge (SG)</td>
<td>EL3356-0010</td>
<td>24 bit, with self-calibration, ELM350x</td>
</tr>
<tr>
<td>IEPE</td>
<td>ELM360x</td>
<td>25 kbps, 24 bit EM3701</td>
</tr>
</tbody>
</table>

Please note: For some of the above series, factory calibration certificates are available. Please contact Beckhoff if you are interested. All EL/KL terminals (with a few exceptions) are available as ES/KS versions featuring a pluggable wiring level.

Beckhoff – the measurement technology expert

The high-precision modules in the ELM-series are not the first products for measurement applications offered by Beckhoff. Previously introduced devices for special measurement tasks include the EL-series EtherCAT Terminals as well as Bus Terminals in the KL-series and the IP 67 box module series from Beckhoff. They fulfill the promise made by Beckhoff to be present in specialty fields like weighing technology or vibration measurement with technologically leading automation components. Examples include the EL3692 resistance measurement terminal, which mea-
For all industries ranging from wood processing to metal processing to wind turbines
For all applications ranging from industrial and test bed measurement technology to condition monitoring and power monitoring
We reserve the right to make technical changes.

Foundation for Big Data: TwinCAT

TwinCAT automation software provides a platform for the generation of engineering and runtime modules which can be used to implement PLC, motion control, safety, and also measurement applications involving cycle-synchronous data collection, resulting in real Big Data applications. Since the complete engineering process for such applications can be carried out centrally in Microsoft Visual Studio® for the TwinCAT system, it is the only software needed to configure, parameterise, program and diagnose the automation devices. Applications are object-oriented and can be written in the PLC programming languages of IEC 61131-3 or in C++. For scientific and measurement-related applications, the integration of MATLAB®/Simulink® deserves special mention because it enables the execution of Simulink® models within the TwinCAT runtime environment. The parameters and variables of the models are graphically displayed in Visual Studio® within the project and can be modified even at runtime. A large variety of tools is available and enables e.g. the application of pattern recognition algorithms to measurement data.
25

We reserve the right to make technical changes.

Open and powerful architecture
For easy storage of raw measurement data as well as analytical data, TwinCAT features a wide range of communication and database interfaces. In this way, for example, users can transfer data to relational or NoSQL database systems. The data can also be converted into a wide range of data formats. Standardised communication interfaces such as EtherCAT or OPC UA ensure connectivity of I/Os and special measurement devices with MES and cloud systems. Data visualisation is handled by the HTML5-based TwinCAT HMI, which enables the design of customised dashboards. To integrate demanding vision and condition monitoring applications in addition to classic measurement technology applications into the world of PC-based automation and control, the control software must be able to fully utilise the high performance of today’s multi-core CPUs. TwinCAT achieves this by optionally assigning individual control tasks to the various CPU cores. As a result, even complex algorithms can be executed with a high level of performance.

TwinCAT: All-in-one software for engineering and runtime:
- Traditional PLC, motion control and I/O functionality
- Integration of scientific tools such as MATLAB®/Simulink®
- Database connectivity even for very large data volumes
- Open, standards-compliant communication interfaces
- Advanced web-based visualisation
Maximised hardware potential: TwinCAT Measurement.

TwinCAT Scope

TwinCAT Scope is a state-of-the-art charting tool for graphical signal representation from the TwinCAT system. It enables seamless data acquisition in high-resolution and an exceptionally performant visualisation in the form of line or bar charts. Significant events can be marked and easily retrieved again using the overview chart.

The multi-core oscilloscope: TwinCAT Scope

This extremely powerful software scope is the highlight of the TwinCAT Measurement portfolio. Integrated into Visual Studio® as an independent project, it is able to visualise measurement signals in the single-digit microsecond range. In addition to established functions like trigger, chart synchronisation and cursor, TwinCAT Scope View also features multi-core support to fully utilise the computing power of each individual hardware system to display high-frequency signals, even from oversampling values. In combination with the TwinCAT Condition Monitoring Library, frequency responses can be calculated by means of the power or magnitude spectrum and visualised in Scope View.

Specific features for measurement technology

TwinCAT Measurement includes features that were designed specifically for use with the new EtherCAT ELM measurement technology modules. In the Filter Designer, for example, the user can edit filter curves graphically and download the resulting filter coefficients to the new measurement technology modules via drag-and-drop. That way, digital filters like Butterworth or Chebyshev can be easily designed as low-pass,
As key elements in automation systems, drive technology components generate large volumes of process and measurement data. However, before the data supplied by drive systems can be submitted to condition monitoring and analytics, their settings must be properly adjusted. The Bode Plot, which is based on TwinCAT Scope, is ideal for this purpose. With it, the user can transmit nominal values to the drive and graphically display the resulting frequency response and phase in order to optimise the drive parameters.

To analyse condition-based machine readings for maintenance purposes, Beckhoff provides the TwinCAT Condition Monitoring PLC library, which makes it easy to run complex mathematical algorithms on a local control IPC. It perfectly coordinates with TwinCAT Scope, for example to display frequency spectrums as bar charts.

TwinCAT Analytics offers lots of machine-specific analysis and reporting capabilities and is less mathematically complex than Condition Monitoring. From cycle-synchronous data acquisition and communication with local or public cloud systems to data analysis in a graphical user interface, TwinCAT Analytics offers everything you need for ad-hoc or continuous 24/7 application monitoring.

TwinCAT Bode Plot

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Cloud services for measurement technology

In line with Industrie 4.0 and the Internet of Things (IoT), the measurement data can also be correlated in networks or cloud systems, because TwinCAT supports cloud-based communication by default. TwinCAT Analytics is a special package within the TwinCAT Measurement toolbox for analytics in cloud systems. With a library of basic analytical algorithms, it makes it easy to identify and document significant characteristics within signals. These algorithms can also be expanded with algorithms from MATLAB®/Simulink®. Analyses can be conducted based on live as well as historical data. The historical data will be supplied by the so-called Cloud Storage Provider, which has access to cloud-based storage systems.
Integrate high-end measurement technology now:
► www.beckhoff.com/measurement-technology