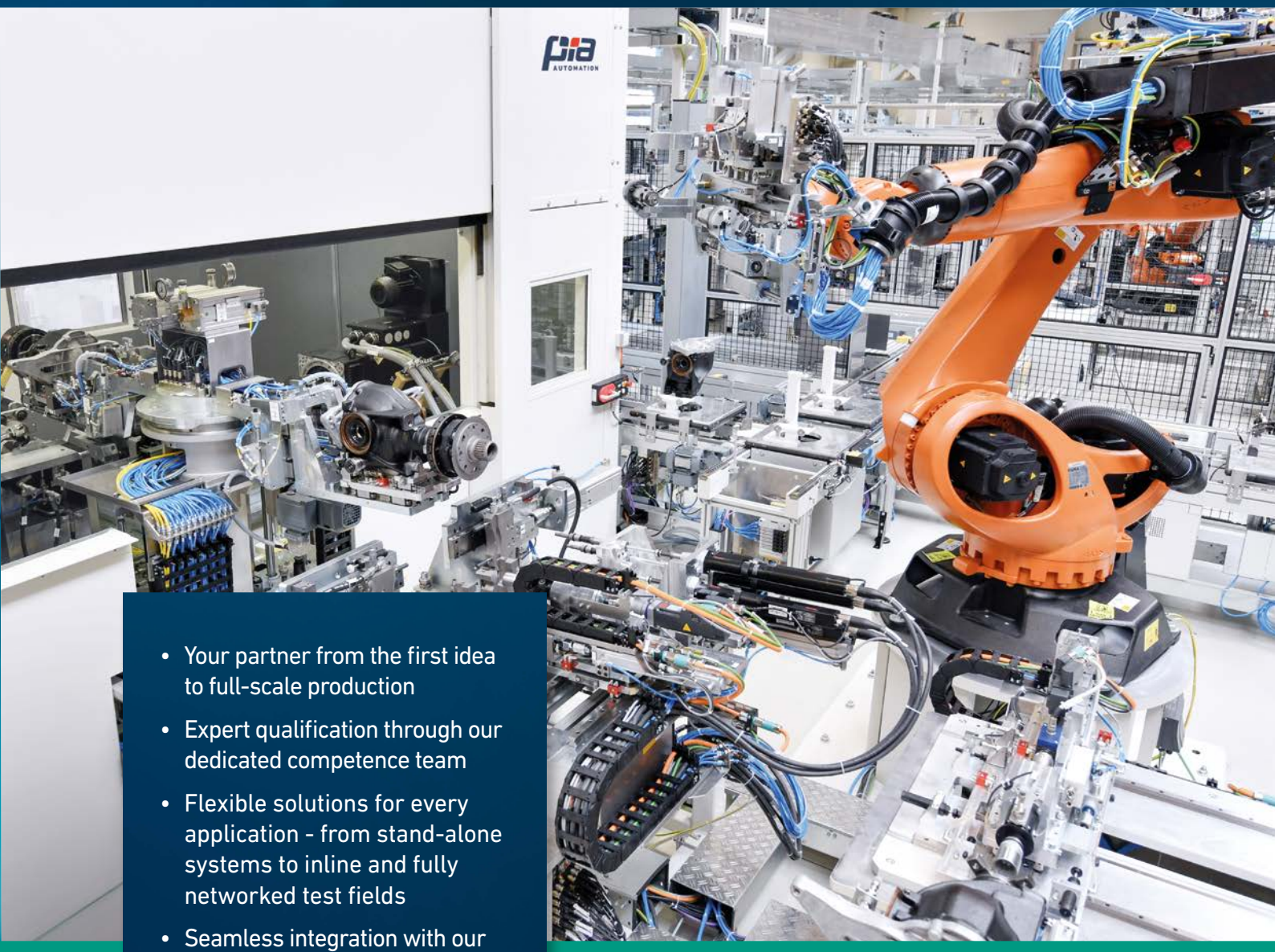
END-OF-LINE TESTER TECHNOLOGY FROM PIA



- Your partner from the first idea to full-scale production
- Expert qualification through our dedicated competence team
- Flexible solutions for every application - from stand-alone systems to inline and fully networked test fields
- Seamless integration with our Industry 4.0 solutions for maximum efficiency and connectivity

Electronics are an essential part of modern products – making end-of-line testing all the more crucial for ensuring quality, safety, and customer satisfaction.To achieve maximum test coverage and high throughput, PIA Automation offers flexible, fully customized testing solutions.

FAST FLEXIBLE AUTOMATED

Quality inspection at every assembly step

End-of-Line Testing is a key element of automated assembly and production processes. It provides comprehensive verification of product functionality, safety, and quality directly at the end of the production line. Inspections can also be integrated after individual assembly steps. These inline inspections enable early error detection, minimize rework and scrap, and improve both process reliability and overall manufacturing efficiency. Deviations can be identified and corrected at an early stage, before they impact downstream operations.

Applications range from production lines in e-mobility and New Energy Vehicles (NEV) to consumer goods and medical devices. PIA offers versatile comprehensive and modular test systems. Tailored to specific customer requirements, End-of-Line Testing can be flexibly adapted to different production environments and technical specifications.

TEST PROCESSES

- Flashing of specific test or final control unit software
- Static and dynamic electrical tests (e.g. insulation and resistance tests, voltage, current, ...)
- Counter measurement and calibration (e.g. torque transmission of couplings, resolver offset, currents, ...)
- Functional tests (parking lock, disconnect unit, differential lock, etc.) and their characteristics
- Measurement of structure-borne noise (NVH) and airborne noise
- Rotational acceleration test
- Performance check
- Emulation of electrical components (e.g. battery, motor, resolver and inverter)
- Simulation of vehicle communication bus
- Structure-borne sound test
- Camera inspection
- Leak and flow test
- Ultrasonic testing
- Measurement of circumferential backlash

BENEFITS

- Wide range of applications (stand-alone, inline, interlinked test fields)
- Flexible loading systems (manual, handling, robot, transfer) for scalable expansion stages
- Optimal interaction with our industry 4.0 solutions
- Development, production, support and know-how from one source (one-stop shopping)
- Experience in numerous test procedures for more than 50 years
- Single test nest and double test nest possible
- Test in mounting position (horizontal and vertical)
- High flexibility and availability
- Low space requirement
- Short loading times
- Simple operation
- Freely programmable test sequence
- Solutions for data storage of quality data and for production data acquisition
- Reuse by changing the testing tools
- Possibility of upgrading to future mechatronicsash

EOL COMPETENCES

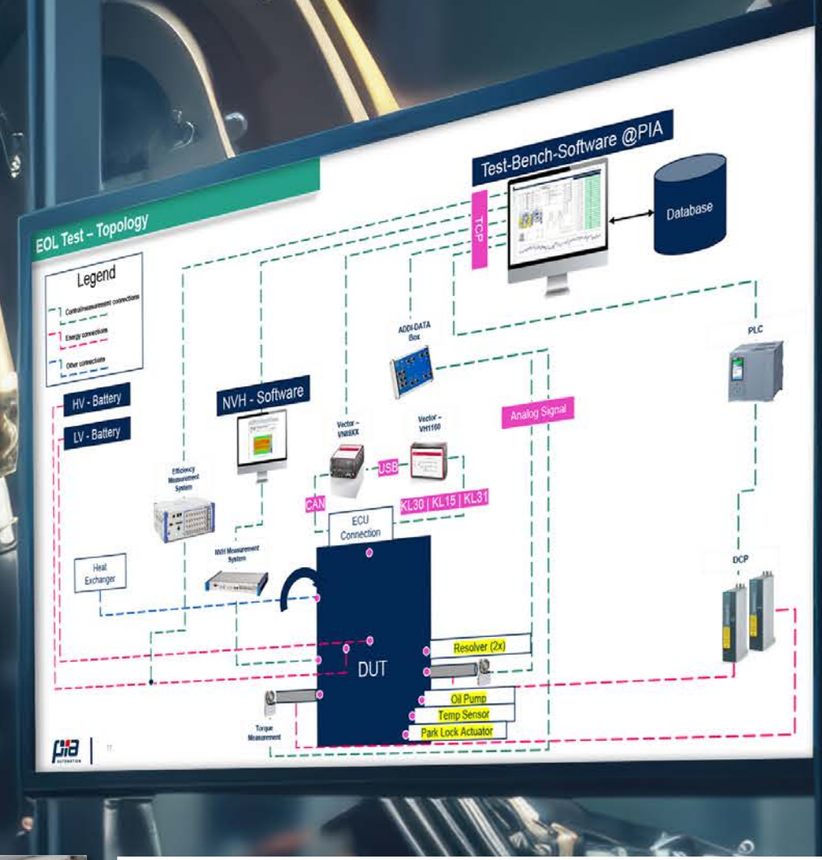
End-of-Line Testing by PIA: Smart, Scalable, and Precise

Covering industries from e-mobility to consumer and medical products, PIA offers modular and scalable test systems that ensure full functionality, safety, and quality control throughout the entire production process. Our comprehensive portfolio includes electrical and functional testing, NVH (Noise, Vibration, Harshness) analysis, leak detection, high-resolution vision inspection, and advanced digital simulations - all designed to meet the most demanding industry standards.

Leveraging decades of engineering expertise and a deep understanding of automation, we develop intelligent, fully integrated End-of-Line (EOL) solutions that are both flexible and future-proof. From initial software validation and hardware diagnostics to final quality assurance and documentation, our systems are engineered to adapt seamlessly to evolving production environments.

Thanks to in-house development capabilities and a strong focus on Industry 4.0 technologies — including IoT connectivity, real-time data analysis, and machine learning integration — our solutions enable predictive maintenance, reduced down-time, and enhanced traceability. Whether in high-volume automotive manufacturing or precision-critical medical device assembly, PIA ensures that every product leaving your line meets the highest standards of performance, compliance, and customer satisfaction.

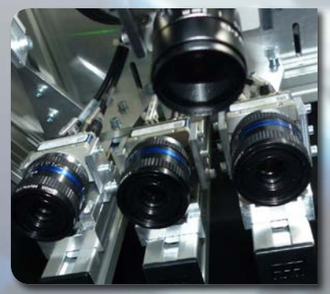
Tailored to your specific production requirements, our testing systems are designed not just to verify, but to optimize - making quality a built-in feature of your manufacturing process.



DISPLAY INSPECTION

Display measurement technology from the PIA Machine Vision modular system

- Scalable vision systems: 2 - 43 MP Area photometer
- Quality inspection defects: Pixel defects, particle and line defects, bubble and scratch inspections
- Quality Illumination: Illumination homogeneity black and white value, mura, luminance calibration
- Display colorimetry: exact color location and luminance determination



LUMINANCE – SYMBOL INSPECTION

When things get complicated – PIA SmartVision:

- The scalable vision solution: Adjustable resolution, distance and quantity of cameras and lenses
- Cost-effective: through use of industrial cameras and PCs
- Proven system: hundreds of cameras already in continuous use
- Individual solutions: You have very special requirements? Your vision test implemented by our programming and image processing experts

HIGH COST PRODUCTS INSPECTION

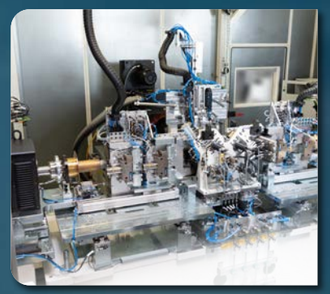
- Camera + robot: Maximum flexibility
- Teach-in: CAD product data can be used
- Product non-specific: changed test requirements, product variations and even new products through software parameterization
- DeepLearning and classic BV: Both approaches possible -> Networking

TEST OF SWITCHES WITH DISPLAYS

- Traceability via line computer
- Volume dosing from cartridge, needle measurement
- Plasma cleaning / surface activation
- Camera-based position measurement and correction
- Positioning & bonding with defined adhesive gap (e.g., TFT displays)
- Visualization of adhesive flow
- UV-LED pre-curing & final curing

HIGH VOLTAGE TESTING

- Insulation Test: Electrical Safety between HV conductors and housing
- High-Voltage Withstand Test: Applies defined test voltage to confirm dielectric strength and insulation reliability
- Resistance Test: Measure winding and contact resistance to identify short circuits



POWERTRAIN TESTING

End-of-Line systems ensure complete functional verification of gearboxes, RDUs, and PDUs before they leave production.

- NVH Analysis: Detects imbalance, vibration, and mechanical irregularities
- Active power test: Evaluates performance and efficiency under load
- Functional Testing: Validates parking lock, disconnect unit and differential functions

YOUR PARTNER FOR EOL TEST SYSTEMS

End-of-Line Testing – Powertrain & E-Mobility

Our solutions cover the entire spectrum of modern drive technologies – from traditional combustion gearboxes to fully electric e-drive systems.Each system is developed with the highest precision to unite mechanical, electrical, and functional requirements within a seamless testing architecture.

Modular system concepts enable combined testing of transmissions, RDUs, PDUs, and e-motor components – flexibly scalable from manual to fully automated operation. Our test systems are characterized by short cycle times, high repeatability, and full process integration. They record, analyze, and document all relevant parameters – from torque and vibration behavior to high-voltage insulation and inverter functionality.

With the PIA Software Platform and the PIA Industrial App Suite, testing processes are intelligently controlled and data is captured in real time. This creates transparency, boosts output, and reduces testing costs – ensuring maximum efficiency and long-term process reliability in series production.

TYPICAL TESTS

Mechanical Tests
- Torque and speed testing for performance evaluation
- Efficiency measurement and load simulation under realistic conditions
- Rotational acceleration testing and comprehensive performance checks

NVH Analyses
- Structure-borne and airborne noise measurements for acoustic assessment
- Vibration analysis and imbalance control to ensure maximum smoothness and precision
- Resonance testing for optimizing component dynamics

Electrical Tests
- Insulation, resistance, and high-voltage tests to ensure electrical safety
- Current, voltage, and power measurement for detailed performance data
- Simulation of electrical components such as batteries, motors, resolvers, and inverters

Functional Tests
- Testing of park-lock, disconnect, and differential systems
- Functional verification of inverters and control units
- Validation of torque distribution and drive control

Sensor and Calibration Tests
- Resolver and encoder calibration for precise rotor position detection
- Verification of position sensors and signal processing
- Calibration of current sensors

Communication & Software
- Flashing of control units with final software versions
- Bus communication via CAN, LIN, or FlexRay
- Integration of AUTOSAR-UDS functions such as security access, fault diagnostics, and calibration

ADVANTAGES

- **One system for all drive technologies –** from combustion engines to e-drives
- **Modular architecture** – adaptable to products, cycle times, and production environments
- **High measurement precision** – synchronized measurement to < 1 µs at up to 1 M samples/s
- **Industry 4.0 ready** – real-time data integration, reporting, and analysis
- **AI-powered optimization** – identifies correlations between test bench and production line
- **One-stop solution** – development, production, software, and service from a single source

End-of-Line Testing – Power Electronics

Inverters, battery management systems (BMS), and power electronics are essential for NEVs because they make the battery's energy usable, ensure safe operation, and largely determine the vehicle's overall performance. The inverter controls the motor, the BMS monitors and protects the battery, and the power electronics manage stable energy flow between the battery, drivetrain, and onboard systems. PIA as assembly line manufacturer enables these complex components to be built with high quality, consistency, and efficiency by providing precise automation solutions, robust processes, and integrated testing systems that support reliable mass production.

Modular system concepts for semi-automatic and automatic end-of-line tester enable universal testing for boosters and converters.

EXAMPLES OF USE

- Flashing of specific test or final control unit software
- Static and dynamic electrical tests (e.g. insulation and resis-tance tests, voltage, current, ...)
- Counter measurement and calibration (e.g. torque transmis-sion of couplings, resolver offset, currents, ...)
- Functional tests and their characteristics
- Measurement of structure-borne noise (NVH)
- Performance check
- Emulation of electrical components (e.g. battery, motor, resolver and inverter)

PROCESSES

- Loading and unloading system with mobile lifting aids
- Automatic / manual adaption
- Battery test respectively simulation system
- Test output up to 150 kW
- ISO High voltage test up to >3 KV
- Communications test (CAN)
- Potential and insulation test
- Test HV interlock (safety feature)
- Special contacting of HV connectors
- Liquid cooling
- Leak test

ADVANTAGES

- Wide range of applications (stand-alone, inline, interlinked-test facilities)
- Flexible loading systems (manual, handling, robot, transfer) for scalable expansion stages
- Optimal interaction with our industry 4.0 solutions
- Development, production, support and know-how from one-provider (One-stop shopping)

TESTING TECHNOLOGY FOR THE FUTURE

Power Electronics becomes crucial in the NEV markets. With testing technology for a wide variety of products such as high-performance inverters manufacturer provide high quality products.

End-of-Line testing, the final quality inspection before delivery of equipment and lines, is an important step in production for the perfect product. From haptic tests to electrical measurements and automotive communication: EOL – the decisive factor of manufacturing.

HIGH-TECH FOR THE HIGHEST STANDARDS

Power Electronics Inverters and semiconductor technology, are now indispensable in modern automotive manufacturing. The high-performance components with up to 300 kilowatts bring several challenges. While, for example, an emergency stop button normally shuts down the testing system immediately, this requires controlled and safe shutdown for high-performance components, else a simply switch off 300 kilowatts under load without exposing the contacts to extreme stress and creating life-threatening danger for any operator intervention.

The PIA team performs pioneering work in the field of Power Electronics. With realization of projects to global premium OEMs in high voltage electronics with 800V, PIA faced the challenges and convinced their customer with reliable long-term experience in electronic component assembly in low- and high voltage from scratch to high-end efficient solutions. Several projects have already been successfully implemented - from assembly and testing lines for automotive manufacturers to innovative semiconductor test stations for power modules.

GLOBAL COOPERATION FOR LOCAL EXPERTISE

As PIA experts are always close to customer, to understand their demands and market requirements, the continuous improvement never stops. The inhouse R&D teams approach is to develop a test rack to reduce EMC influences during inverter testing as well as optimize and reduce costs of the test setup itself.

Additionally, the use of Digital Twins and Virtual Commissioning provides benefits for customer. With EOL-Simulation PIA manage to effectively use previously the effort of sample parts, or dead delivery times that arise, for example, when shipping from Germany to foreign countries.

FUTURE SOLUTIONS

Will it be 800 or >1000 volt systems? Direct current or alternating current? PIA develop along with customer requirements. Particularly power electronics - the heart of inverters with high-performance transistors - requires the most precise tests under extreme temperature conditions. Every millimeter of cable length matters, to accept the challenges of cold and hot tests up to 175°C degrees for critical semiconductor components.

> „As partner to our customer we are not only engineering a standard testing module, else we collaborate to design from the proof of concept with all challenges the perfect solution. Therefore, close cooperation with the customer is paramount here.“

Martin Kroenung, Head of Software Engineering
PIA Automation Bad Neustadt GmbH

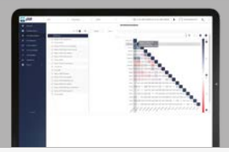
PIA INDUSTRIAL APP SUITE

The digital package of the future

The PIA Industrial App Suite (piaIAS) is a modular software package and contains smart apps to meet the challenges of assembly line operation and optimization. In developing the apps, the knowledge of custom machine builders - especially the expertise of PIA Automation - and customers from a wide range of industries were combined to create a digital solution portfolio that is perfectly aligned with customer requirements. Assembly and test systems can be analyzed worldwide, their weak points localized and their productivity optimized. It doesn't matter whether it is a single station or a complex interlinked assembly line locally on site or remotely at another location.

PIA's smart tools address different user groups with features providing information for line workers, evaluations for shift managers and the maintenance team, or reports for management. All apps share the following advantages: **(1) Increasing the degree of digitalization of production, (2) future-proofing thanks to modular and expandable design, and (3) reduction of travel costs through location - and device-independent access.**

Analysis



piaAnalyze

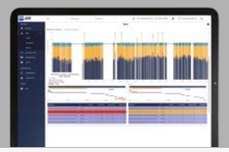
to improve the

Quality

Target group: Quality manager

Key-Features: Analysis of measurement and process data

Benefits:
- Increase in the quality of production
- Reduction of costs through rejects prevention or increase of the OK rate
- Prevention of rework and thus increase the plant profitability



piaOptimum

to optimize the

Efficiency | Availability

Target groups: Production manager | Optimization team

Key-Features: Analysis of cycle times, production numbers, alarms, and downtimes

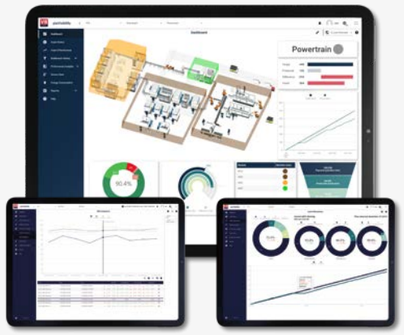
Benefits:
- Increase in efficiency, output and thus plant profitability
- Cost reduction due to earlier start of production (short ramp-up phase)
- Support for optimization measures during operation

Transparency

piaVisibility

to increase the

Digitization | Transparency



Target group: Production Manager | Maintenance | Operator

Key-Features:
- Dashboard for production data
- Calculation and visualization of the OEE key figure
- Visualization and localization of assembly line bottlenecks

Benefits:
- Reduction of costs due to the ability to react quickly to changes in key figures
- Reduction of costs due to less time and personnel needed to locate bottlenecks
- Increasing the information base (transparency) through a global and flexible assembly line insight in real time

CUSTOMER SERVICE

Our Service ensures maximum availability

With its modularly configurable Customer Service products, PIA Automation offers professional solutions for optimum system availability. The services include the full range of predictive/preventive services, rapid response and support services, which have evolved significantly over the last few years. PIA is pursuing a strategy for the future that is characterized by growth, portfolio expansion and increased e ficiency, as our customers strive for highly efficient performance of their assembly systems. This is particularly reflected in the digital services that are part of each category.

DIGITAL SERVICES

PREDICTIVE / PREVENTIVE
- MAINTENANCE AND SERVICE
- SPARE PARTS MANAGEMENT
- TRAINING
- CONSULTING

- DIGITAL SYSTEM ANALYSIS (REGULAR OR INDIVIDUAL)
- INCREASING DIGITAL TRANSPARENCY WITH PIAVISIBILITY
- IMPROVE QUALITY WITH PIAANALYZE
- OPTIMIZE EFFICIENCY WITH PIAOPTIMUM
- DIGITAL MAINTENANCE PLANNING WITH PIAMAINTENANCE

QUICK REMEDY
- ON-SITE SUPPORT

GERMANY
AUSTRIA
CROATIA
USA
CANADA
MEXICO
CHINA

- SUPPORT HOTLINE
- EXPERT HOTLINE
- REMOTE SUPPORT

SUPPORTIVE
- PRODUCTION SUPPORT
- CONVERSION AND MODERNIZATION WORK
- OPTIMIZATION
- RESIDENT ENGINEER
- DE-INSTALLATION AND RELOCATION

- REAL-TIME MONITORING AND DASHBOARDS FOR PRODUCTION MONITORING
- ROOT CAUSE / ERROR ANALYSIS
- REMOTE SOFTWARE ADJUSTMENTS

We make high-quality products available to everyone – sustainable and worldwide.

creating efficiency in global EOL technology.

Austria. Canada. China. Croatia. Germany. Mexiko. USA.

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YOUTUBE

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