

**Monitor
Processes Reliably –
and Cut Costs**



Process Inspection

Quality Monitoring for Fastening Technology – with INSPECT Systems



Schatz – Your Kistler Group Partner for Quality Monitoring and Cost Efficiency

Schatz GmbH, now a member of the Kistler Group, was established in 1955: ever since then, it has been the only system house of its sort in the world that focuses on quality monitoring of bolting processes in laboratories and manufacturing facilities. We offer a range of services that will make your company safer, more reliable and more cost-effective: starting with tool testing and process analysis, employee training and qualification, all the way through to quality monitoring of bolted joints – based on know-how, sensors and systems that are "Made in Germany".

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Process Inspection: the Guarantee of Quality

To monitor the quality of production processes in fastening technology: that is the purpose of our vast range of high-performance INSPECT systems for fasteners such as bolted joints. As well as monitoring the fastening processes, our systems ensure that errors are detected at an early stage so they can be rectified as quickly as possible. These products ensure that fastening processes are reliable. But that's not all: by playing a fundamental role in process optimization, they contribute to the continuous improvement process in production.

Convincing Advantages for Your Business

All our efforts to achieve optimum fastening processes through quality assurance focus on one goal: business success for our customers. There is only one way to boost productivity and enhance quality: by consistently increasing process reliability and optimizing the use of monitoring, so as to cut down outlay on inspections and corrective measures.

The Benefits of Using INSPECT Systems

- Reduced quality costs
- In-process error detection
- Immediate in-process quality correction
- Optimized fasteners
- Enhanced efficiency in the fastening process
- Documentation
- Protection against product liability cases
- Reproducible inspection processes
- Traceable results
- Compliance with standards



Compliance with Standards: a Key Quality Characteristic

Requirements for process inspections on fasteners are governed by a wide variety of international and customer-specific standards. These requirements change constantly to keep pace with the latest technological developments.

That's why our inspection systems are highly flexible, with the ability to adapt repeatedly to the latest requirements. The software structure is designed for regular updates, and the modular structure of our INSPECT systems means that changes to hardware requirements can be implemented immediately.

Measuring systems from Schatz are used by renowned customers in many sectors of industry across the globe.

Here are just a few examples:

- Automotive industry
- Aerospace industry
- Commercial vehicle manufacturers
- Supply sector
- Research and educational facilities
- Inspection service providers

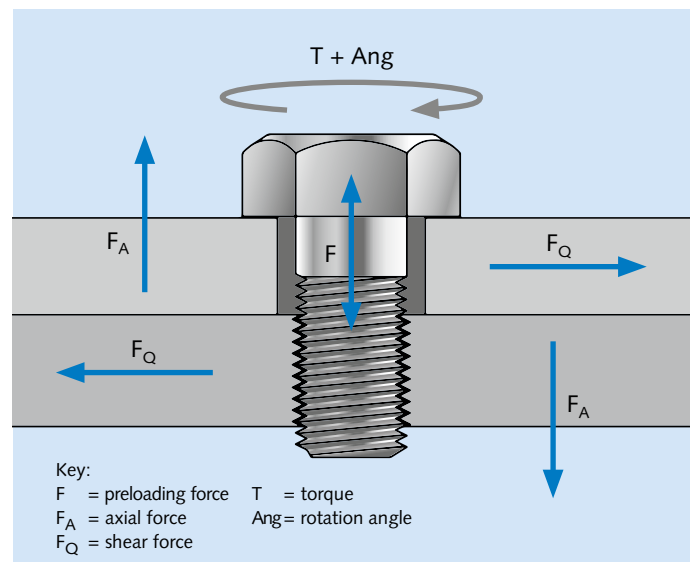


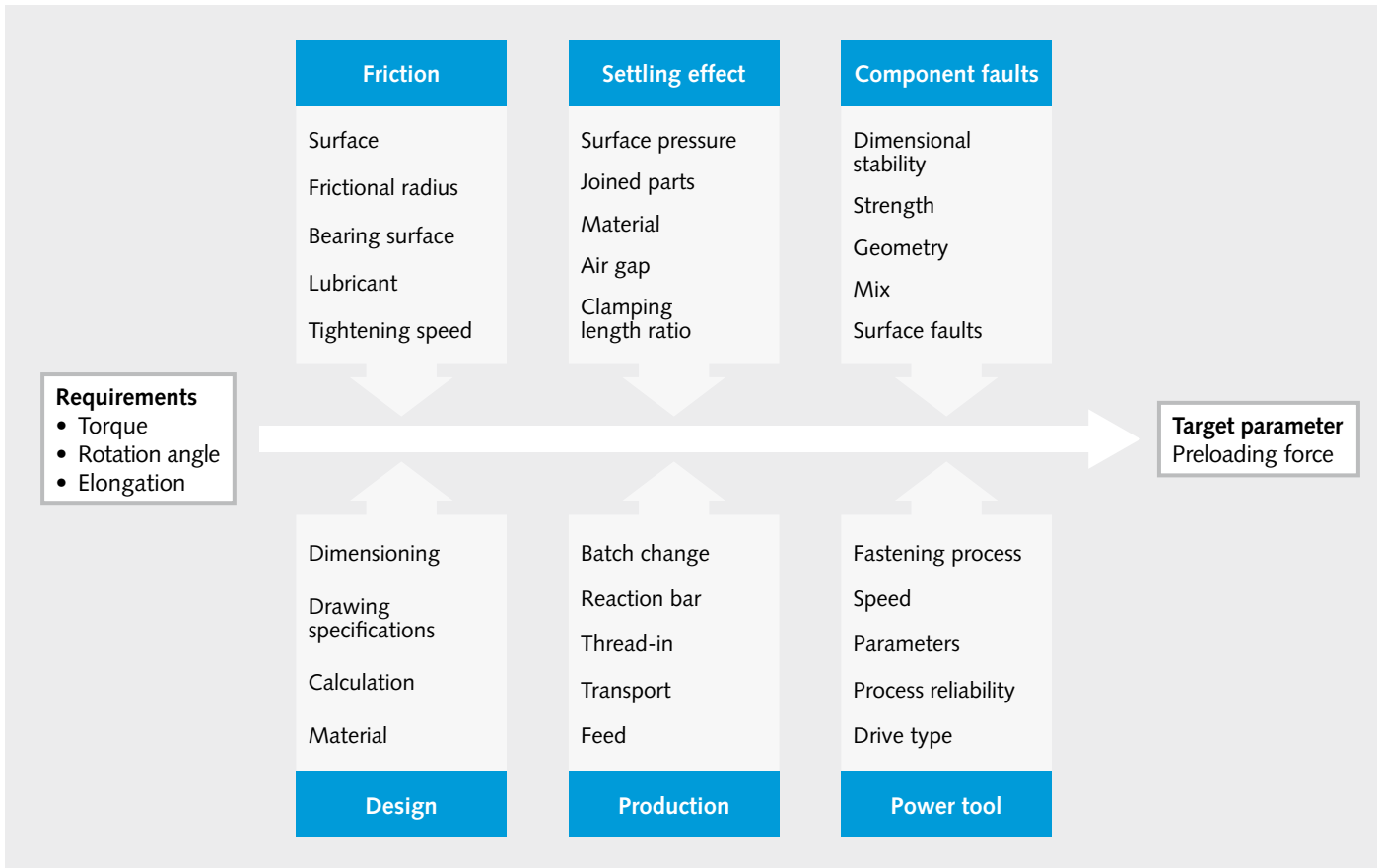
Manufacturing Processes Demand Reliable Fastening

The purpose of a bolted joint is to provide a permanently reliable connection between several components or parts until the joint is deliberately released. This unique functionality is the key characteristic of this fastening method.

The Bolted Joint as a Fastener That Can Be Released

Multiple components in a permanently connected state must behave like one complete component as the result of the clamping or preloading force applied between the components – even when external loads are applied. The coupled joint must not come apart due to loss of the frictional bond, otherwise the connection will be released. Furthermore, the maximum preloading force must not be exceeded, otherwise overloading will occur and the connection may fail. Of all connecting methods, the bolted joint is the only one that can be released without destruction and can generally be used again.





Key parameters influencing the target parameter of preloading force (based on source: VDI/VDE 2645 sheet 3)

Assembling a Bolted Joint

The objective when assembling a bolted joint is to achieve a preloading force in the joint that is as exact and reproducible as possible. Measuring the preloading force directly during assembly is a complex and time-consuming process. In the current state of the art, therefore, torque and rotation angle are used as auxiliary variables; these measurands are recorded and statistically evaluated to validate the process. The spreads of attained torque and rotation angle inevitably produce spreads in the resultant preloading force.

Influences on the Production Process for a Bolted Joint

Due to numerous influencing factors, the preloading force attained has a complex relationship with the introduced torque and the rotation angle; this is clearly set out in many standards such as VDI/VDE 2645 sheet 3. So that these influencing factors can be kept as constant and low as possible at a very early stage in the process for manufacturing a bolted joint, analysis of the influencing parameters must begin back in the planning and prototype phase. This also allows early detection of influencing factors that have not been taken into account.



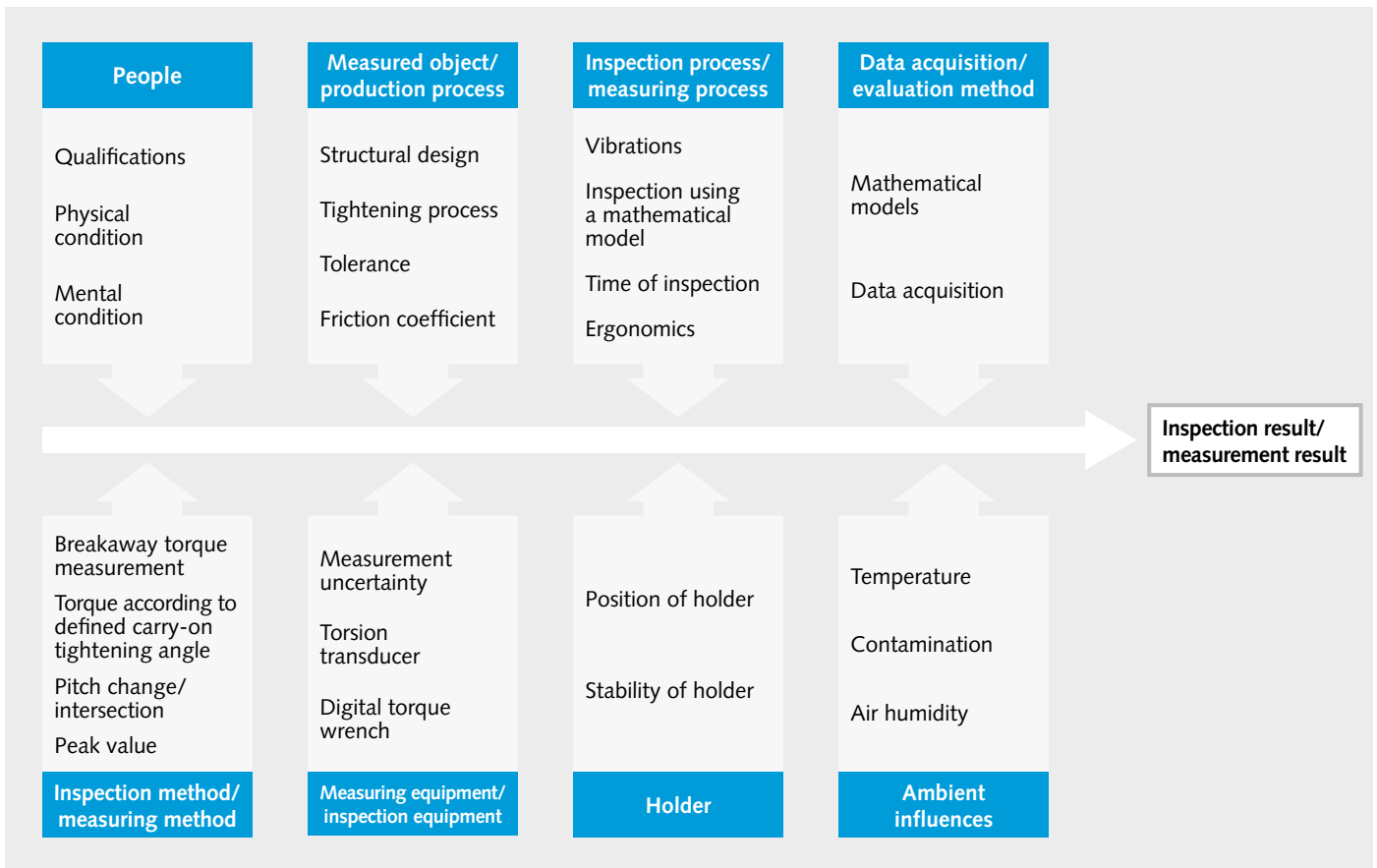
Process Inspection: the Systematic Approach

End-To-End Quality Assurance – All Along the Line

Each INSPECT system from Schatz is a complete inspection system to determine process characteristics in fastening technology. From monitoring of the fastening process through to comprehensive documentation of the process parameters and results: these systems cover the entire range of requirements for a vast variety of process inspections. End-to-end inspection and documentation provides proof of the quality of the bolted joint. But that's not all: it also facilitates targeted monitoring of tolerance limits, making it possible to detect process deviations at an early stage.

Definition of 'Process Inspection'

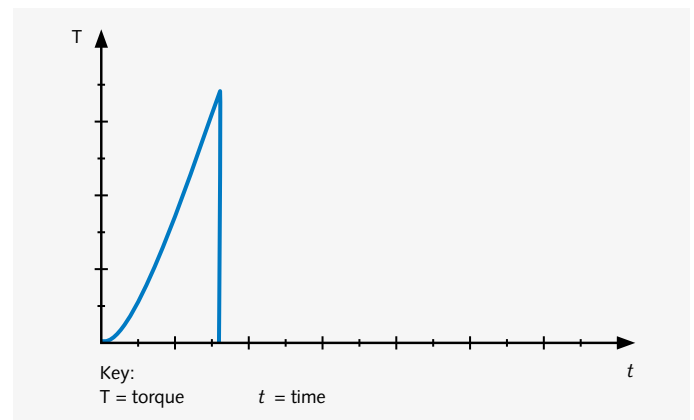
To ensure comparability, process inspections are always based on reference data from an identical or comparable fastening scenario and on fixed definitions of overall conditions. All the important influencing parameters for the inspection process are taken into account and recorded as appropriate. VDI/VDE 2645 sheet 3 defines the relevant methods, influencing parameters, overall conditions and evaluation algorithms. By specifying this data, process inspections are clearly defined so they ensure that a fastening process is capable of delivering quality under series conditions. Users must also have appropriate specialist knowledge about bolted joints, and staff must be suitably trained.



Key influencing parameters in the inspection process (based on source: VDI/VDE 2645 sheet 3)

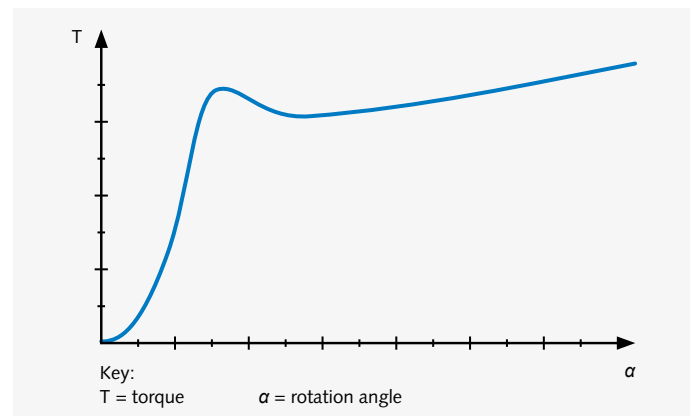
Process Inspection in the Fastening Process with In-Process Measurement

In-process measurement is the name given to the method for verifying the fastening process directly during assembly, with a process inspection. Based on the real fastening scenario, this process inspection method takes account of all the influencing parameters directly, during the actual assembly: examples include the tightening tool spread, type of fastening process, frictional influences of the fastener components and influences caused by the worker or ambient factors. For this purpose, a torque/rotation angle sensor is adapted in the bolting assemblage between the fastener and the tightening tool; the fastening curve is recorded and evaluated statistically for the process inspection.



Process Inspection after Completion of Fastening, with Carry-On Tightening

Carry-on tightening is the name of the method used to verify the fastening process and carry out a process inspection after the fasteners have been assembled correctly. This method is used in the real fastening scenario following assembly, usually after a defined waiting period. The purpose is to determine the torque required to carry on tightening the bolted joint by 'a defined amount'. This method can take account of parameters that influence the bolted joint but which (as a general rule) only appear after assembly. Parameters that can undergo this type of process inspection include (for example) settling of the bolted joint due to surface smoothing as the result of surface pressure. For this purpose, a torque-angle wrench is used to carry on tightening a fastener that has already been bolted, without damaging the bolted joint itself. The fastening curve is recorded and is then evaluated statistically, using suitable evaluation algorithms to provide clear definitions for the process inspection.



Sensors, Measurement and Evaluation Unit, Parameterization and Evaluation Software

Torque and Torque/Rotation Angle Sensors

Sensors based on the strain gage principle with a rotating transducer shaft deliver reliable and accurate measurements. They are especially suitable for dynamic determinations of exact, reproducible torque measurement values during fastener assembly.

As an option, an incremental encoder disk is fitted on the transducer shaft to transmit the angle signal (corresponding to the direction of rotation) via an optical barrier sensor, with signal conditioning as appropriate.

Rugged steel or aluminum housings protect the inner workings of the sensors, making them suitable for measurements under harsh production conditions.

According to choice, the sensors can be equipped with a permanently connected cable or can be supplied as a plug-in version, designed for Schatz measurement instruments in each case.

The integrated Schatz AUTOCODE® guarantees automatic sensor detection on Schatz measuring systems to reduce errors during use.

Our inhouse development department, our own sensor manufacturing facility and our calibration laboratory accredited by DAkkS (the German accreditation body) guarantee sensors with optimum sensitivity and assured quality traceability.

Analysis Wrench or Torque/Rotation Angle Hand Sensors

Sensors based on the strain gage principle with a bending beam deliver reliable and accurate measurements. They are especially suitable for quasistatic determinations of exact, reproducible torque measurement values in the carry-on tightening process.

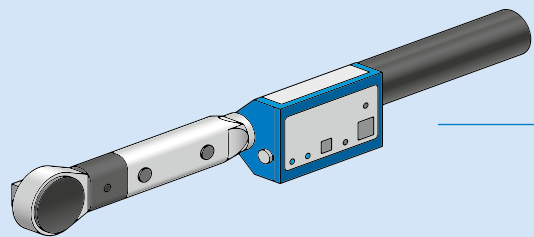
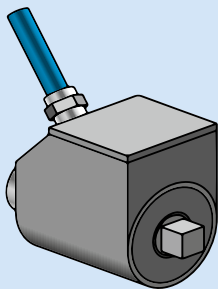
The analysis wrench is fitted with a gyroscope which transmits the relevant angle signal for the direction of rotation independently of its position, with appropriate signal conditioning.

Integrated LEDs visualize status messages and attainment of the desired target value directly on the analysis wrench.

Algorithms to calculate compensation for tool deflection, dependent on the applied torque and the exchangeable output adapter, ensure highly accurate measurements of torque and rotation angle.

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Mobile Measurement and Evaluation Unit

The InspectPro 5413-2071 standalone measurement and evaluation unit from Schatz is a highly integrated, high-precision modular measurement and evaluation instrument suitable for a diverse range of measurands. It captures all the measurement values and handles downstream processing as well as evaluation tasks. Measurement and evaluation tasks are carried out in real time, and the measurement profiles are outputted graphically in quasi-real time via the integrated 7.7-inch TFT touch display. Once inspection has begun, the measurement and evaluation unit handles all the measurement and evaluation tasks autonomously.

The measurement and evaluation unit can be parameterized directly on the device itself, with no need for an additional PC connection.

The InspectPro 5413-2071 can be extended with optional software modules to meet individual preferences and customer-/ application-specific requirements. This means, for example, that frequent or recurring inspection tasks can be stored in a fastening points administration facility so that they can easily be called up for inspections.

The measurement data is stored on an internal SD memory card in the measurement and evaluation unit. Measurement data can be transmitted to a higher-level PC system via a mini USB connection.

The unit can be operated independently of mains power thanks to a lithium ion replaceable battery pack; alternatively, for laboratory use, it can be run directly from mains power.

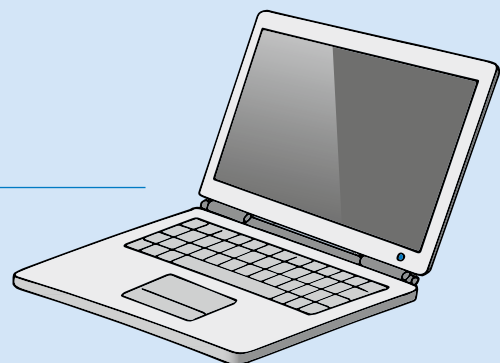
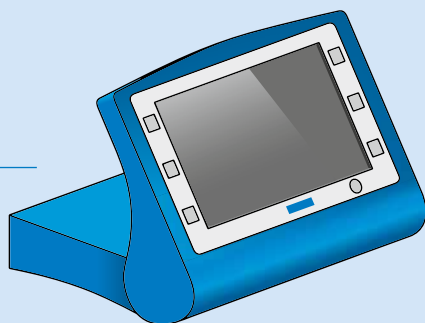
Software

CEUS® – the database-supported parameterization and evaluation software used as an option – combines all the functions required for process inspection in one convenient software platform.

It maps the complete procedures for setting customer-specific or standard-compliant process parameters, with definitions of target values for process inspection.

Our software combines evaluation with corresponding results, statistical parameters and complex graphic views. It offers a convenient way to perform long-term statistical evaluations of processes, because evaluation is based on fastening points.

Data export and generation of inspection records are also integrated in the software, so the entire parameterization and evaluation process can be carried out with no need to waste time and effort on switching between software platforms.





Inspection Task: In-Process Measurement

Application Scope

For random sample inspections of the fastening process during assembly of the fasteners in the real scenario during production, all the influencing parameters are recorded directly in the fastening scenario for direct evaluation in the measurement and evaluation unit.

System Structure

A torque or torque/rotation angle sensor is adapted directly between the output of the torque tool used (square or hex version) and that of the tool used to introduce the torque. During the fastening process, the recorded torque and/or torque/rotation angle values are transmitted directly to the measurement and evaluation unit.

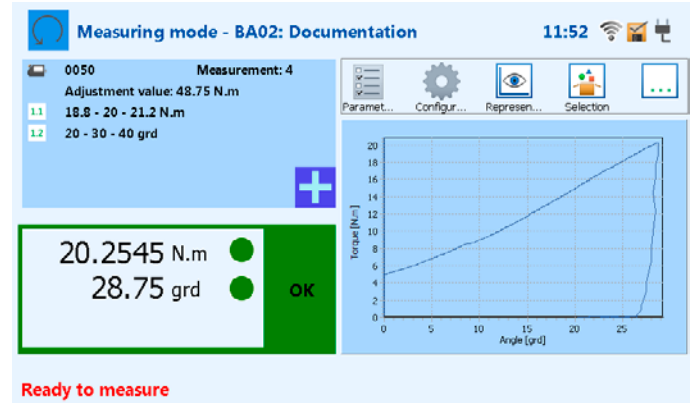
Benefits

The combination of an autonomous, mobile InspectPro measuring instrument with a diverse range of torque or torque/rotation angle sensors can accomplish a variety of in-process measurement and inspection tasks on an application-specific basis during production, with many different fastening technologies. Examples include:

- fastening with handheld power tools
- fastening with built-in power tools integrated in the production line
- fastening with hand wrenches



In-process measurement in practice



Measurement curve and evaluation of an in-process measurement

The measurement values can be displayed in numerical and graphic form on the screen of the measurement and evaluation unit. They can be evaluated directly on the basis of specified tolerances and statistical values. The measurement profile can also be viewed in graphic form to identify effects during tightening, joining or assembly. All measurement data can be stored directly on the measurement and evaluation unit for documentation and later evaluations.

Additional software modules allow extended graphic process evaluation via the Windows® CEUS® software and a fastening points administration facility, which can store process and statistical parameters required to evaluate individual recurring fastening processes.

Key data

- Standalone measurement and evaluation unit
- Lithium ion replaceable battery pack
- Swiveling 7.7-inch TFT color touch display
- Standard torque range up to 5,000 N·m
- Measurement data export via mini USB

Options:

- Mains operation
- Fastening points administration software module
- Extended graphic process evaluation with Windows® CEUS® software
- Adapter cables for external sensors (active and passive)



Inspection Task: Carry-On Tightening

Application Scope

The method known as 'carry-on tightening' is commonly used to qualify the assembly torques or the bolted joint in certain cases. These include assembly processes where in-process measurement cannot be used (e.g. due to lack of space) or where the process capability has to be proven after a defined waiting period (e.g. in order to take account of settling processes in the bolted joint).

System Structure

The analysis wrench is adapted to the inspection object with the torque introduction tool, and carry-on tightening of the fastener (which has already been bolted) is performed by applying a defined torque, based on process limits. During the carry-on tightening process, the torque/rotation angle values are transmitted directly to the measurement and evaluation unit. To ensure precise compliance with the specified process limits for carry-on tightening, the analysis wrench is equipped with status LEDs. This tells the operator that the bolted joint is still within the specified process limits, even after carry-on tightening.

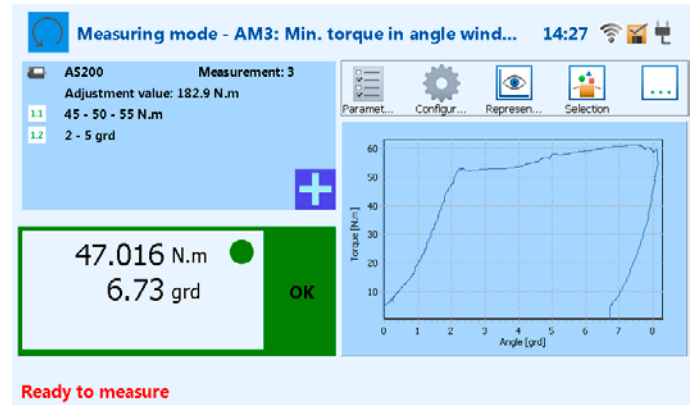
Benefits

InspectPro's "Carry-on tightening" software module stores the measurement methods (based on VDI/VDE 2645 sheet 3) proposed for carry-on tightening measurements, with the corresponding evaluation algorithms; parameterization for specific fastening points is possible. Examples include:

- Peak value measurement
- Torque on rotation angle
- Minimum after breakaway
- Determination of intersection
- Pitch change



Determination of carry-on tightening in practice



Measurement curve and evaluation of determined carry-on tightening

The measurement values can be displayed in numerical and graphic form on the screen of the measurement and evaluation unit. Based on the predefined carry-on tightening mode and the specified tolerances and statistical parameters, these values can be evaluated directly. Another benefit: the measurement profile can be shown in graphic form to identify effects during carry-on tightening, such as any breakaway torque that may be present. All measurement data can be stored directly on the measurement and evaluation unit for documentation and later evaluations.

Additional software modules allow extended graphic process evaluation via the Windows® CEUS® software and a fastening points administration facility: this can store the process and statistical parameters required to evaluate individual recurring fastening processes.

Key data

- Standalone measurement and evaluation unit
- Lithium ion replaceable battery pack
- Swiveling 7.7-inch TFT color touch display
- Predefined carry-on tightening modes
- Standard torque range up to 600 N·m
- Measurement data export via mini USB

Options:

- Mains operation
- Fastening points administration software module
- Extended graphic process evaluation with Windows® CEUS® software



Display of results

Parameterization and Evaluation with CEUS® Software

The All-In-One Software Solution

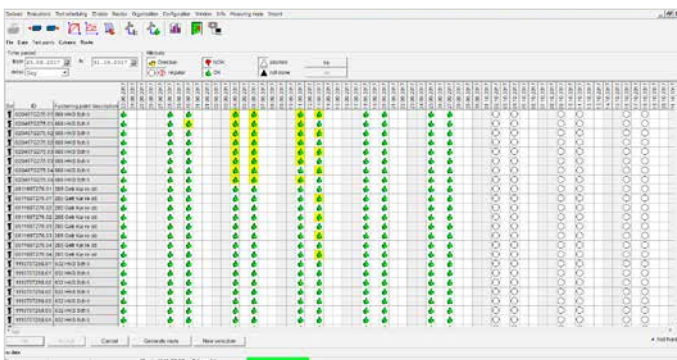
The Windows® CEUS® software developed by Schatz carries out all the tasks required before and after process inspection for standard-compliant and documented testing.

Parameterization

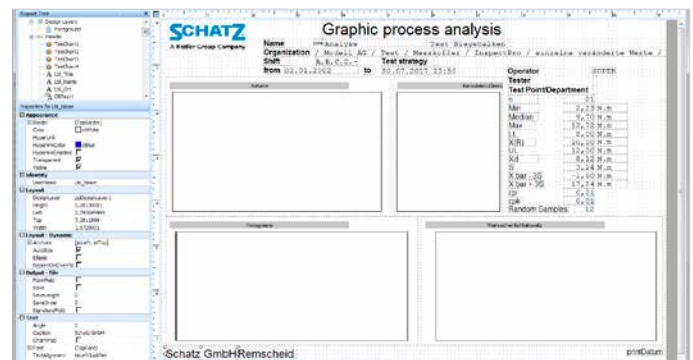
Thanks to parameterization with CEUS®, users can freely define the process inspections they require according to their own specifications and requirements, either to meet specific customer requirements and/or to comply with standards; the inspection procedures can then be saved in the fastening points. Every single one of these fastening points can be freely configured by the user as regards threshold value, joining value, target value, evaluation algorithms for results, sensors to be used, descriptive parameters, results, specified tolerances and inspection methods. It is even possible to integrate multiple tolerance selections for target values, e.g. torque and rotation angle. This allows pre-definition of a variety of fastening scenarios for process inspection; the scenarios can be implemented and then evaluated on a comparative basis.

Benefits of CEUS®

- Process inspections as per customer-specific or standard-compliant requirements
- Pre-definition of process parameters and inspection methods based on fastening points
- Data is conveniently organized and documented
- Extensive graphic analysis of measurement profiles
- Varied options for inspection reports and layouts
- Comparative evaluations



Inspection planning



Inspection report editor

Evaluation

Based on the requested process inspection, the operator can view a tabular display of multiple results from the measurement data memory for each inspection process, and the results can then be evaluated statistically.

Inspection Planning

Based on the inspection plan, the desired process inspection intervals for the fastening points to be inspected are saved in the CEUS[®] software and transmitted to the measurement and evaluation unit via the mini USB interface. Inspection staff can use this 'route' to process their workload with software support; after pending jobs have been completed (or at intervals in between), they can send the process inspection data back to the software for evaluation via the mini USB interface. This ensures adherence to the defined process inspection intervals, and it supplies proof of regular process inspection. At a glance, users can visualize adherence to predefined process inspection cycles as well as the results in each case. By mouse-clicking on a particular inspection point, the individual values and graphic measurement profiles can be visualized for error diagnosis.

Inspection Reports and Data Export

With the help of an inspection report editor, all results, tables, graphics and user-defined parameters can be integrated in any desired report form, as specified by the customer. As well as output in the form of inspection reports, all data obtained can be transferred automatically to higher-level software platforms, for example via the integrated export interface.



Know-how Transfer by Specialists

Inspection Requirements

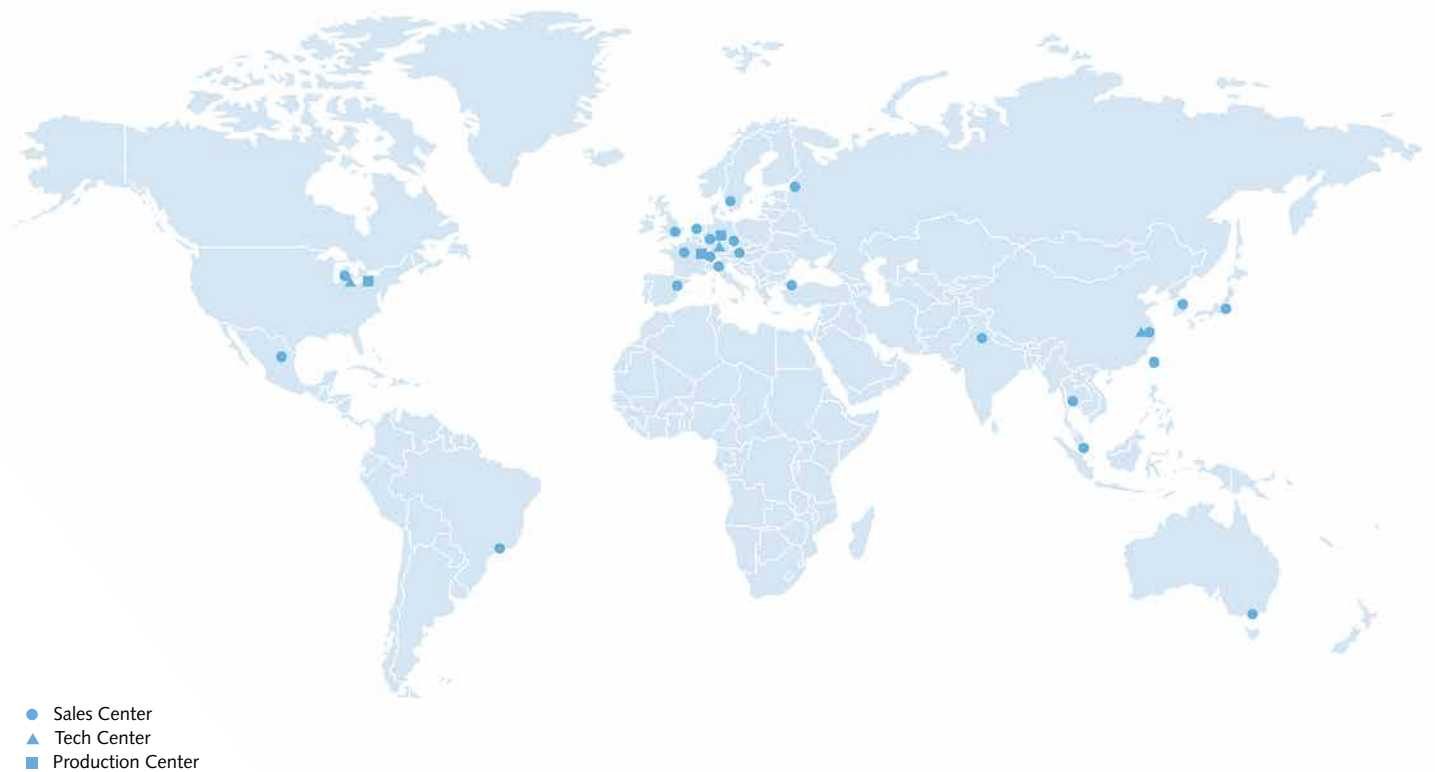
Process inspections come in a variety of different forms; they are to be found everywhere, and they call for extensive expertise when it comes to performing the inspections and evaluating the results obtained from them. As well as specialist knowledge and continuous training on the requirements set by the standards, inspection in compliance with standards calls for process-specific inspection systems.

Service by Schatz as an Independent Specialist

Customers can also request us to carry inspections out as an independent specialist. As well as our process-specific inspection systems, we will place our extensive service know-how at your disposal. We are ready to assist our customers as a professional partner for basic and advanced training, to ensure the reliability of fastening processes.

Our Range of Services for Process Inspection

- Seminars and training courses for customers
- Inspections using portable systems at the customer's premises
- Inspections in the torque range from 0.2 N·m to 5,000 N·m for in-process measurements
- Inspections in the torque range from 3 N·m to 600 N·m for carry-on tightening



At Our Customers' Service Across the Globe

Wherever fasteners are produced, coated, used and inspected, Schatz – as a member of the Kistler Group – offers sensors and systems to analyze fasteners and bolted joints, backed up by a host of services that range from professional advice and support to calibration and speedy deliveries of spare parts across the globe. To offer even better technical support, Kistler is setting up Tech Centers across the globe – delivering exactly the service that our customers expect so they can attain their quality goals.

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Kistler Group includes the Kistler Holding AG and
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