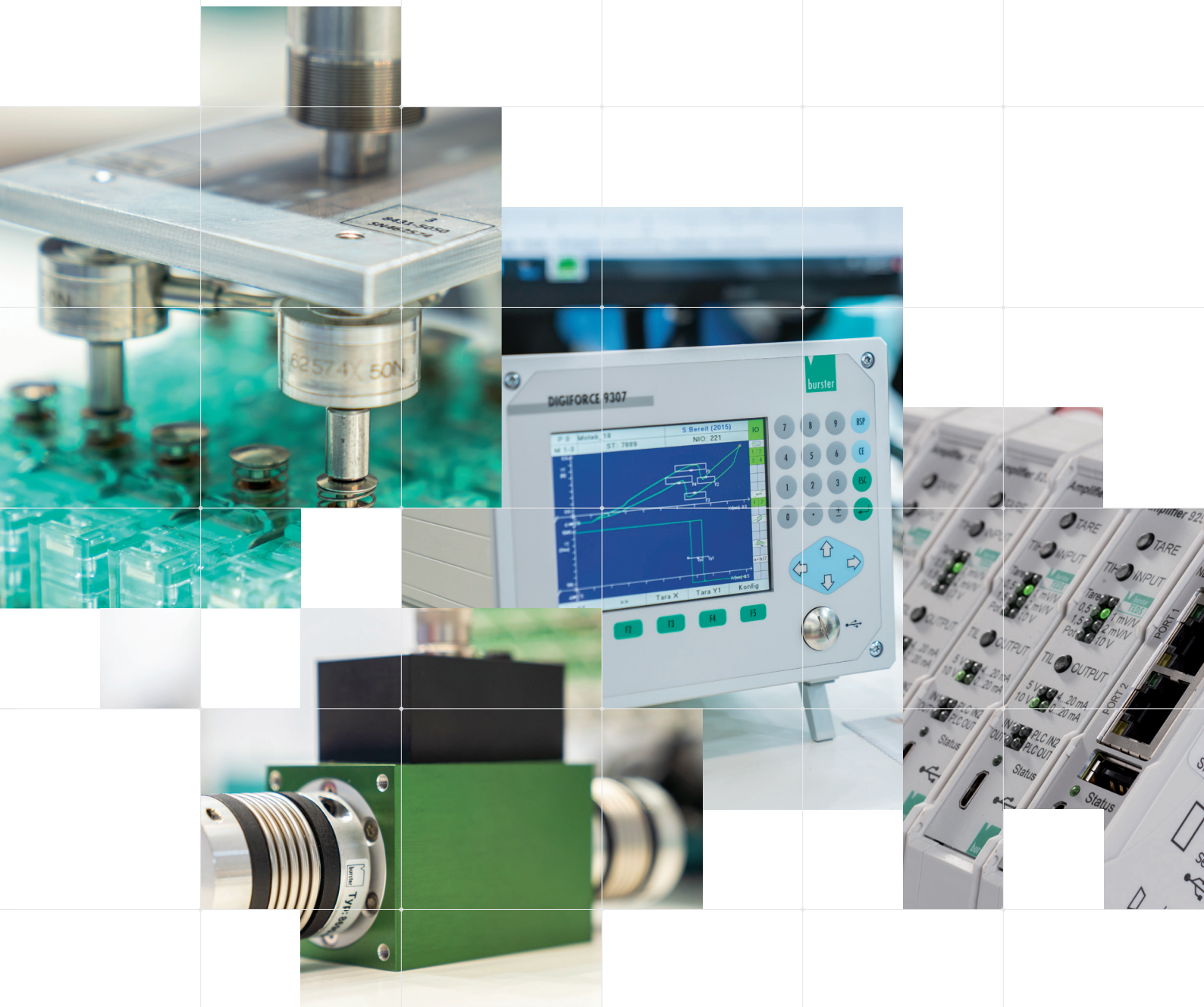


burster

# THE MEASUREMENT SOLUTION

YOUR INDIVIDUAL PRODUCT INFORMATION





# THE MEASUREMENT SOLUTION

## HIGH-TECH FROM A STRONG SOURCE

burster specializes in the development, production and sale of measuring and test devices, sensors and measurement systems as well as calibration services. Since 1961, burster has set standards for precision, quality and flexibility. This has made the German medium-sized enterprise one of the world's foremost suppliers of sensor signal processing and process monitoring systems.

Globally, burster is in contact with more than 140,000 people in industry and R&D. We are partners for mechanical and plant engineering and automation, the automotive industry and its suppliers, electrical and electronic engineering, the chemicals industry, e-mobility as well as many other sectors and future or niche markets such as medical engineering, biotechnology and robotics.



# SENSOR ELECTRONICS

## FORCE AND DISPLACEMENT MONITORING

### TYP DIGIFORCE® 9307



#### Press-fit Control

- Measurement channels: 6
- Max. amount of active measurement channels: 3
- Type of sensor: Strain gauge, ...

### TYP DIGIFORCE® 9311



#### For monitoring press-fit, joining, rivet and caulking operations

- Measurement channels: 2
- Max. amount of active measurement channels: 2

### TYP 9110



#### Low-Cost hand lever presses monitoring

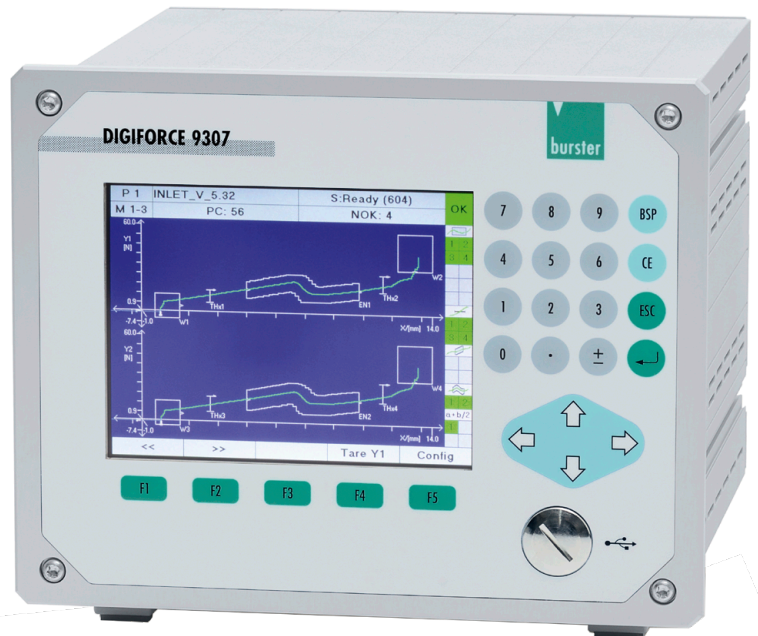
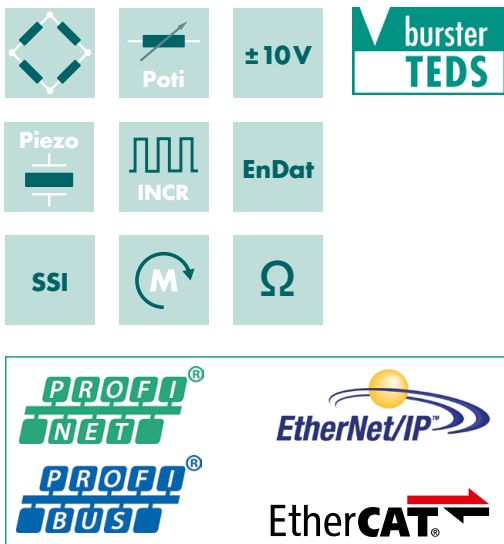
- Measurement channels: 2
- Max. amount of active measurement channels: 2

# Universal Process-Controller

For monitoring press-fit and joining operations, torque and process curves, plus spring and switch testing, including resistance measurement, signal testing and leak detection  
**DIGIFORCE®**

Series 9307

Code: 9307 EN  
Delivery: ex stock/2 weeks  
Warranty: 24 months



## Application

The DIGIFORCE® 9307 monitors processes in which precisely defined functional relationships between two or more measured quantities need to be demonstrated. These measured quantities are recorded synchronously during the manufacturing process or subsequent functional testing to produce a measurement curve, which is then assessed using graphical and mathematical evaluation techniques. After internal evaluation, the measurement curve and computed evaluation results are visualized on the color display and are also output at the external control interfaces. The processes in the controller are optimized by a powerful real-time operating system to achieve an extremely fast evaluation cycle: it typically takes just 15 ms to deliver the global OK or NOK evaluation result, which can then be analyzed by the higher-level controller.

In addition to the traditional evaluation windows with defined entry and exit sides, the DIGIFORCE® 9307 also offers thresholds, trapeziums of type X or Y and envelopes as graphical evaluation elements. Individual evaluation results from the graphical tools can then be combined by mathematical operations to provide even more analysis flexibility for a huge range of signal curves.

DIGIFORCE® has a wide range of process control applications, including monitoring processes such as joining, riveting or caulking, or checking torque curves, for instance for hinges or high-quality rotary controls. Even complex signal/time curves (e.g. pressure curves, leaks etc.) can be monitored using the large choice of evaluation techniques.

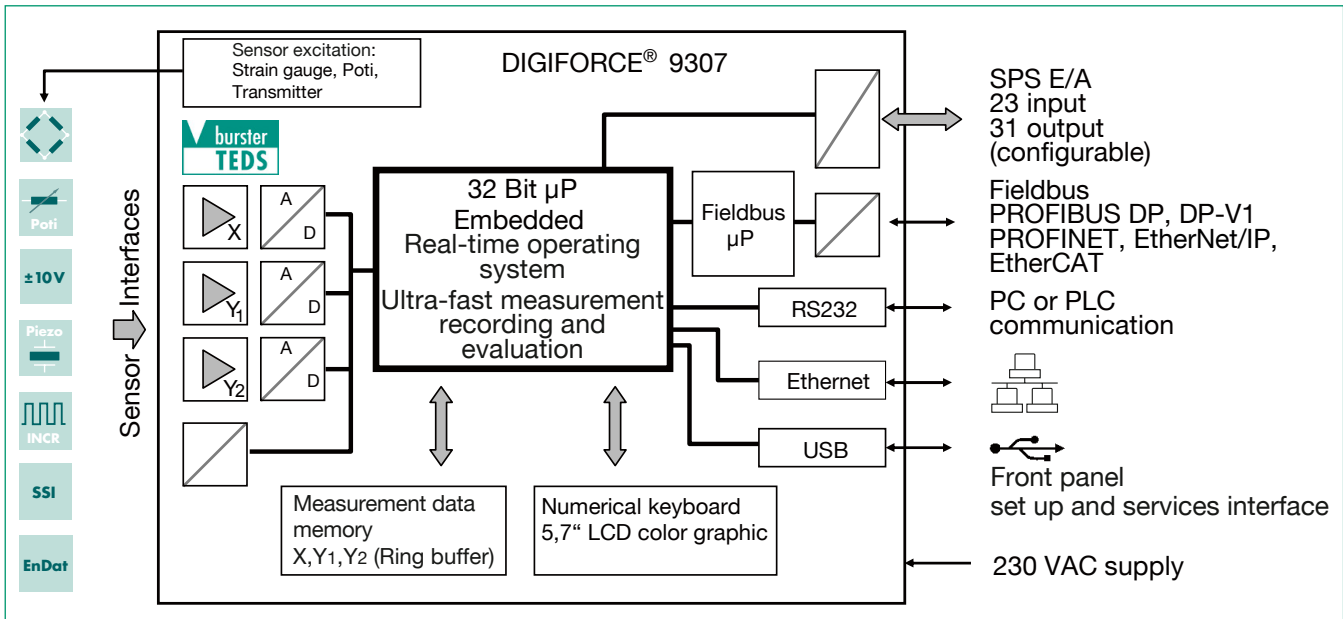
Simultaneous recording of up to two Y variables ( $Y_1$  and  $Y_2$ ) with respect to a common X variable allows many applications to

- Comprehensive process monitoring delivered by innovative evaluation elements window, thresholds, trapeziums, envelopes and mathematical operations
- High measurement accuracy 0.05 % possible at 10 KHz sampling rate
- Flexible process integration thanks to a range of Fieldbus interfaces
- Simultaneous monitoring of two synchronous processes
- Ultra-fast evaluation and data transfer for dynamic measurements
- Ethernet, USB, RS232 as standard
- Up to 128 measurement programs for a large variety of parts
- Transfer of process, component and worker data
- Intelligent signal sampling using a combination of  $\Delta t$ ,  $\Delta X$ ,  $\Delta Y$
- Automatic sensor recognition from burster TEDS
- DigiControl PC software with powerful data-logging function for process data

use one DIGIFORCE® controller to monitor two synchronous processes.

Alternatively, this feature can be used to evaluate an application with three process variables, for instance the force/displacement curve and associated current consumption of a lifting electromagnet. While DIGIFORCE® is used in many automated production areas, it is equally at home in the manual workstation, for instance to monitor force/displacement when using hand presses for assembly or for random spot-checking in goods inwards.

**Block diagram**



**Measurement data acquisition**

With an active measurement, which can be triggered by different events, the synchronously measured quantities X, Y<sub>1</sub> and optionally Y<sub>2</sub> are saved in the measurement data memory. Real-time signals can indicate whether measurements are exceeding set signal levels while the measurement is still in progress. The evaluation phase follows immediately after the measurement. In this phase, DIGIFORCE® checks whether the recorded measurement curve(s) satisfy the stored graphical and mathematical evaluation criteria. If any of these criteria has been infringed, the measurement is classified as BAD (NOK), otherwise it is rated as GOOD (OK). Once this evaluation is complete, the measurement curve, the global OK or NOK result and numerous process-related values are displayed in a suite of measurement windows and updated at the Fieldbus interface. The processing steps of the evaluation phase, which finishes when the equipment is ready for the next measurement, have been optimized so that even dynamic manufacturing processes can be monitored.

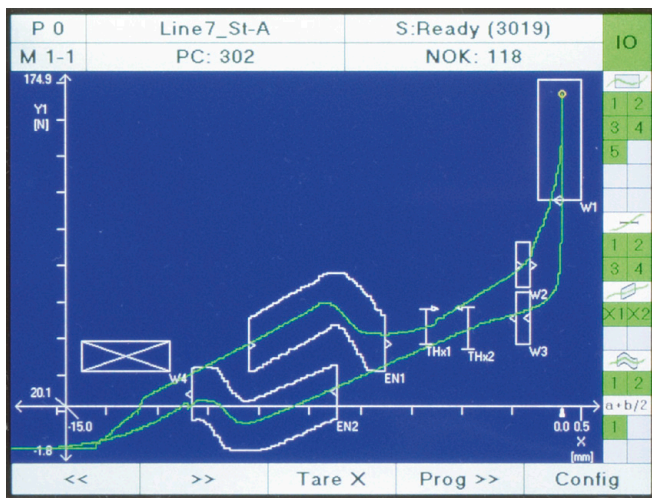


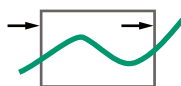
Figure: Measurement window M1-1 contains a graph of the measurement curve. Shows a curve containing a forward and return section and detailed evaluation using windows, envelopes, thresholds and mathematical operations.

**Evaluation of a measurement curve**

As a universal evaluation tool for a vast range of curve shapes, the DIGIFORCE® 9307 provides configurable evaluation elements, which can be used to classify a measurement curve as OK or NOK. In addition to the traditional evaluation windows with defined entry and exit sides, the DIGIFORCE® 9307 also uses thresholds, trapeziums of type X or Y and envelopes as graphical evaluation elements. Individual evaluation results from the graphical tools can then be combined by mathematical operations to provide even more analysis flexibility for a range of signal curves. The graphical evaluation elements can be configured both numerically and graphically in setup mode using one or more recorded measurement curves. They can be used in any combination, even overlapping in an X/Y graph.

**Window evaluation**

Symbol



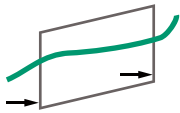
Max. number: 10

The Window evaluation element tests whether the curve has passed through the defined entry side and exit side in the window area. The user can configure these entry/exit sides as required, and can even set multiple input/output sides. A live signal can be assigned to up to two windows, which is enabled immediately during recording if any infringement occurs. It is also possible to define windows of type NOT (no entry/exit) or BLOCK (curve ends inside the window) by suitable configuration of the entry/exit sides. This evaluation element also calculates the values listed below, which can optionally be displayed and also input to user-definable mathematical functions for further processing and evaluation:

- ▶ Entry and exit coordinates (measurement pairs)
- ▶ Local minimum/maximum
- ▶ Absolute minimum/maximum
- ▶ Mean value  $Y_{Mean}$
- ▶ Integral (area below curve to  $Y_{MIN}$  limit inside window)
- ▶ Curve gradient
- ▶ Inflection point

## Trapezium evaluation element

Symbol

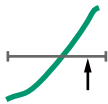


Max. number: 4

The DIGIFORCE® 9307 offers two different types of trapezium: the type-X trapezium window with fixed  $X_{MIN}$ ,  $X_{MAX}$  limits and type-Y trapezium with fixed  $Y_{MIN}$ ,  $Y_{MAX}$  limits. The trapezium evaluation element tests whether the curve has passed through the defined entry and exit sides; only one entry side can be configured for this element. The entry/exit values are calculated.

## Threshold evaluation element

Symbol



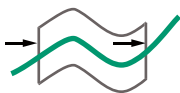
Max. number: 4

The threshold evaluation element can be used to calculate and monitor where the measurement curve passes through a defined X-value or Y-value. The user can choose between threshold type X or Y. Threshold type Y provides the following extra results:

- ▶ Local minimum/maximum
- ▶ Absolute minimum/maximum
- ▶ Mean value  $Y_{Mean}$
- ▶ Integral (area between curve and X-axis in the threshold region  $X_{MIN}$  to  $X_{MAX}$ )
- ▶ Curve gradient
- ▶ Inflexion point

## Envelope evaluation element

Symbol



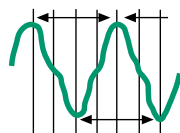
Max. number: 2

The DIGIFORCE® 9307 can use one or more measurement curves to generate up to two envelopes. The user can then customize a generated envelope in the X-domain, and also set tolerances for the Y-domain. For a measurement curve comprising a forward and return curve section, the envelope cannot lie over the turning point.

When subsequently monitoring a measurement in measurement mode, DIGIFORCE® tests whether the measurement curve lies within the defined envelope band i.e. is classified OK, or whether the curve passes outside the valid envelope and hence must be classified NOK.

## Rotary switch evaluation element

Symbol

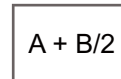


Max. number: 2

The Rotary switch evaluation element enables haptic testing of rotary switches and rotary or rotating controls comprising up to 32 control positions. This evaluation tests whether the number and level of force maxima and minima satisfy the saved criteria. In addition, the angular distance and Y-mean value of the extreme values will be monitored.

## Mathematical operation

Symbol



Max. number: 10 of which 6 can be evaluation

Specific measurement curve variables and results from the graphical evaluation elements can be combined using basic mathematical operators (+, -, x, ÷) and evaluated. A result can be processed further in a subsequent operation. The evaluation is fed into the global evaluation result. The results of a mathematical operation can be displayed in a measurement window and retrieved via the Fieldbus and/or communication interfaces.

## Flexible process integration

The DIGIFORCE® 9307 has the versatility to integrate into practically all process environments. A huge number of detailed requirements can be implemented using the numerous I/Os (23 inputs / 31 outputs), some of which can be assigned user-defined functions. A measurement can be started and terminated at variable times by different internal and external events.

## Sampling and recording measurement signals

Signals can be sampled as a combination of time interval ( $\Delta t$ ), X-interval and Y-interval ( $\Delta X$ ,  $\Delta Y$ ) to provide a flexible yet also compressed measurement recording. Curve areas containing a constant or steadily changing signal can be reproduced with just a few stored measurement points, while steep signal slopes or alternating waveforms require many points.

## Start/Stop conditions for measurement recording

The DIGIFORCE® 9307 lets the user define independent start/stop logic.

Start conditions: Ext. control signal, measurement above or below a definable X-value or Y-value.

Stop conditions: Ext. control signal, measurement above or below a definable X-value or Y-value, timeout, definable number of recorded measurements reached.

## Recording and evaluating two synchronous processes

Two signal curves  $Y_1$  and  $Y_2$  can be recorded with respect to a common X-channel and evaluated in one measurement phase. For the evaluation, the user assigns the required graphical evaluation elements to each graph, and the evaluation is performed independently using separate process signals (OK- $Y_{1/2}$ ). Alternatively, it is possible to monitor an application that has three process variables.

## Limit monitoring in real time

**S1 ... S4**

The user is able to assign the switching signals S1 ... S4 to the three measurement channels X,  $Y_{1/2}$  as required, and can set their polarity. The associated PLC I/Os and Fieldbus signals are updated both in standby mode and also in real time during the measurement cycle (response time < 10 ms).

**NOK ... ONLINE<sub>1/2</sub>** Up to two live signals (NOK-ONLINE<sub>1/2</sub>)

can be used if the curve does not pass through the permitted region of the window evaluation element. This allows pre-emptive termination of a joining process in ultra-quick time if the two components get intertwined, protecting parts, tools or even the entire system from damage.

**Process data**

The DIGIFORCE® 9307 visualizes a comprehensive set of process data during measurement mode and automatic production mode. All relevant process data can be transferred to the controller or PC environment immediately after a measurement. The user can switch between the following process windows:

- ▶ M1-1/2 Graph of  $Y_1(X)$  or  $Y_2(X)$  measurement curve
- ▶ M1-3 Shared display of  $Y_{1/2}(X)$  curves
- ▶ M2-1/2 General display of  $Y_1(X)$  or  $Y_2(X)$  curves
- ▶ M3 Full-screen PASS/FAIL or smiley
- ▶ M4 Entry/exit data for evaluation elements
- ▶ M5 List of user-specific process values (up to 24 values)
- ▶ M6 Statistics on all graphical evaluation elements (trend/histogram)
- ▶ M7 Job sheet containing process, worker and parts data for transfer to process-data acquisition

Each process window displays the global header containing information on the selected measurement program, the associated part quantities and NOK figures, and the global OK/NOK evaluation. The status field on the right shows the evaluation elements that are active in the measurement program and their individual results.

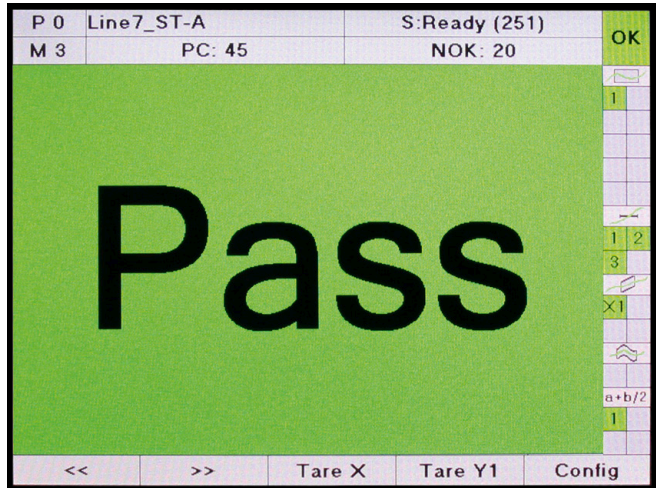


Figure: A full-screen PASS/FAIL indicator gives operating personnel a clear picture of the global OK/NOK evaluation (OK/NOK smiley also possible).

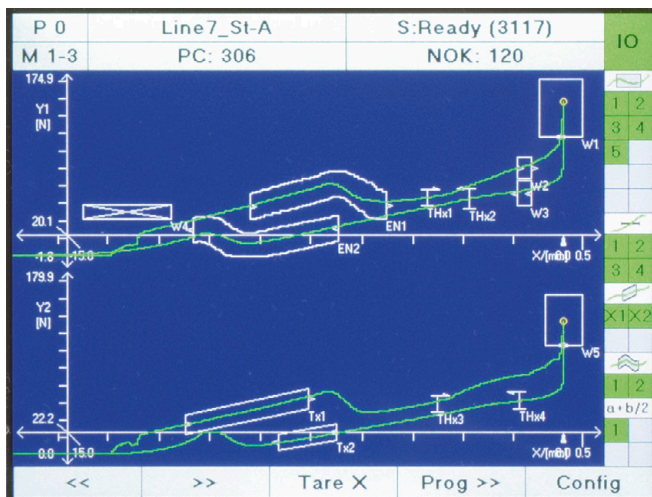


Figure: Display showing the two measurement curves  $Y_1(X)$  and  $Y_2(X)$

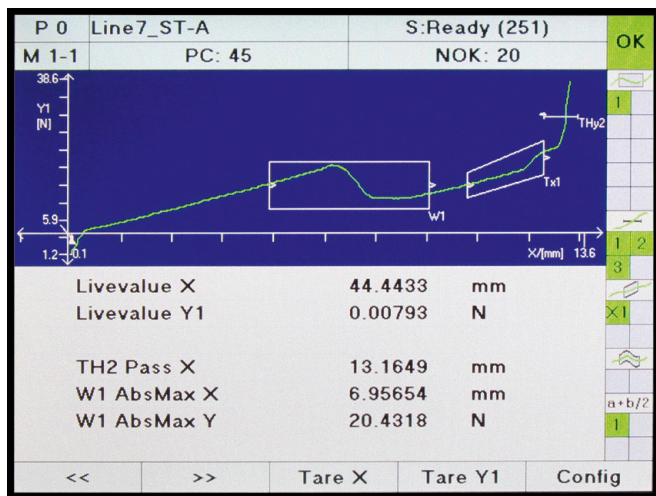


Figure: Process dialog showing sensor live values and process values from the last measurement.

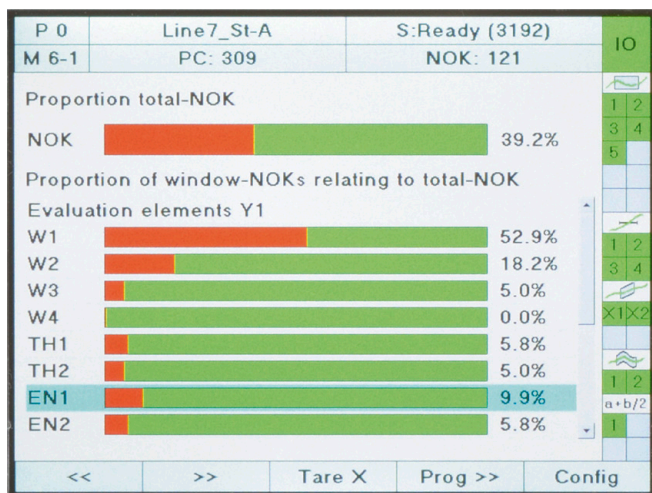


Figure: Statistics showing the frequency and distribution of NOK evaluations. It is also possible to display a trend diagram and histogram for the entry/exit data for each active graphical evaluation element.

**Sensor configuration and adjustment**

The user can choose which physical channels A...F to assign to the measurement graphs (X,  $Y_{1/2}$  coordinates) and set the graph scale. This gives the user the freedom, for instance, to use a preferred mounting for a displacement sensor, and then set the scale to display/evaluate a decreasing or increasing, positive or negative displacement. There are several options for adjustment: adopting the sensor specification from the burster TEDS electronic data sheet, manual input from the sensor certificate data, or using the teach-in process.



## Fieldbus interface

An independent communication processor provides the Fieldbus interface via PROFIBUS, PROFINET, EtherCAT or EtherNet/IP.

## Cyclical realtime process data

- ▶ Process control
- ▶ Retrieval of specific measurement results
- ▶ Live values of the active sensors

## Non cyclical parameter/ADMIN/result data

- ▶ Transfer of component/worker/job data for logging
- ▶ Complete device configuration
- ▶ Retrieval of large amounts of process and curve data

## 32/128 measurement programs

The DIGIFORCE® 9307 comes with the capability to manage up to 32 measurement programs, which can be rapidly selected via I/O, Fieldbus or keypad. Each measurement program contains the full configuration of sensors, measurement procedure and evaluations. The PC software DigiControl can be used to download alternative DIGIFORCE® 9307 firmware, which has the capability to handle up to 128 measurement programs. This firmware re-allocates the internal memory so that up to 400 measurement pairs/triplets can be recorded.

The intelligent sampling tool, with its facility to combine variables ( $\Delta t$ ,  $\Delta X$  and  $\Delta Y$ ), ensures that these 400 value pairs are normally sufficient to reproduce and evaluate a measurement curve.

## DigiControl PC software for DIGIFORCE® 9307, 9310 and 9311

The **basic version** of this software, available free of charge, offers full device configuration, data backups, and export and display of measurement curves including all evaluation results. An especially convenient feature is the facility to define graphical evaluation elements such as envelopes, windows, trapeziums and thresholds from a set of curves measured for master or reference parts. Alternatively, pre-archived measurements can also be analyzed to create new evaluations.

In addition to these basic functions, the **Plus version** (9307-P100) of the DigiControl PC software provides an automatic production mode, allowing log measurement data during production with clear parts referencing, for example. The resultant measurement reports are not only available in the internal program format, but can also be ported into the following formats: ASCII raw data, EXCEL, PDF Print and SQL.

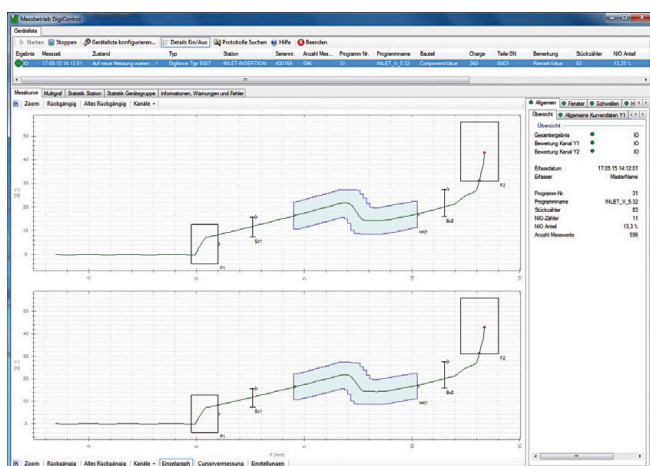


Figure: The „measurement mode“ function displays the curve and status information of the most recent measurement. A multi-channel view is also possible. The corresponding log is automatically saved in the background.

## Internal measurement curve memory

In graphical setup mode, one or more imported measurement curves can be used to configure the evaluation elements. This is still possible even if the process requires a change in measurement program back at the setup stage. Up to ten measurement curves can be saved in each measurement program as a curve array, which then provides the basis for the evaluations to be defined. In measurement mode, this memory acts as a ring buffer, where the remaining 50 measurement curves are stored. The DigiControl PC software can be used to retrieve and analyze these measurements.

## User-definable function keys

The function keys F1...F4 below the display can be assigned to various functions as required. The following functions are available for selection for example: browse measurement screens, tare, start/stop measurement, change program, confirm OK/NOK evaluations, sensor test.

## burster TEDS\*

DIGIFORCE® 9307 uses burster TEDS (Transducer Electronic Data Sheet) for automatic identification of sensors connected to channels A and B. The instrument reads the relevant sensor data from an EEPROM chip in the sensor connector and uses this data to perform the necessary channel configuration automatically. The memory chip in the sensor connector is programmed as part of a service provided when the sensor is first ordered or subsequently calibrated. The burster TEDS feature is only available for sensors that have a permanently fitted connecting lead.

\* available for SN 530000 onwards (Q2/2018)

Even for synchronous processes involving large amounts of data, logging of measurement data is optimized to achieve an ultra-short cycle time. For more complex tasks, the software also supports an additional remote interface, for instance for loading a new device configuration or transferring component names for measurement-data logging.

## Porting DIGIFORCE® 9306 to DIGIFORCE® 9307

DigiControl can be used to create a DIGIFORCE® 9307 device configuration from a DIGIFORCE® 9306 backup file. This is done by importing the sensor and evaluation settings and selecting as close a configuration as possible for the DIGIFORCE® 9307. Then just a few minor final adjustments and settings are needed to resume production under process control.

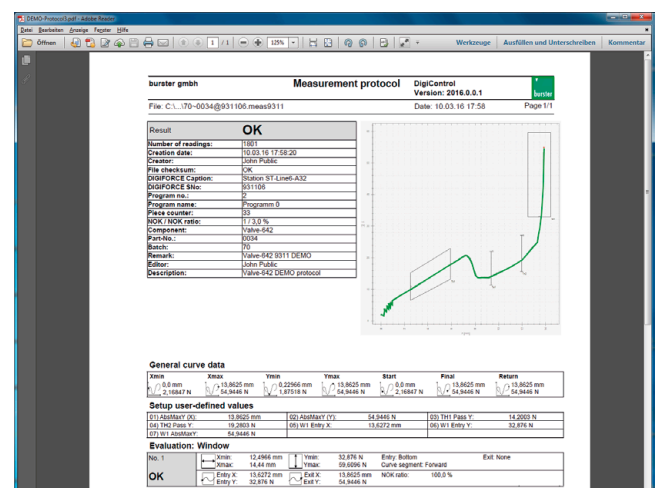


Figure: A Data-log wizard provides filters for selecting and displaying stored measurement logs. A log printout containing component data, curve information and all evaluation results can be generated for each individual measurement log.



**General Technical Data**

Sampling rate:	10 kHz
Signal sampling:	$\Delta X, \Delta Y, \Delta t$ in any combination
Measurement curves:	$Y_1(X)$ and $Y_2(X)$
Digitalization:	16 bit
Evaluation time:	15 ms
Measurement programs:	32 (5,000 value pairs)* / 128 (400 value pairs)
Power supply:	90 ... 264 VAC / 47 ... 63 Hz / typically 30 VA
Delay in real-time limit signals S1 ... S4:	< 10 ms
Operating temperature range:	+ 5 ... + 23 ... + 40°C
Protection class:	IP30 / IP65 panel-mounted
Display:	5,7" TFT LCD (640 x 480)
Keypad:	numerical, configurable function keys

\* Factory-installed device firmware. Firmware can be changed via PC software DigiControl.

**Compatible Sensors**

Flexible assignment of physical channels A ... F to measurement graphs (X/Y<sub>1/2</sub> coordinates)

**Channel A, B (strain gauge, potentiometer, process signals)**

**Strain gauge sensors**

Measurement ranges:	$\pm 1 \dots 40$ mV/V
Bridge resistance:	120 $\Omega$ ... 5 k $\Omega$
Excitation voltage:	2.5 V, 5 V, 10 V
Excitation current:	35 mA or 70 mA @ 10 V
Cut-off frequency:	5 ... 5,000 Hz in discrete bands
Total error:	< 0.05% F.S. @ $\geq 1$ mV/V < 0.1 % F.S. @ < 1 mV/V

**Potentiometer, process signals**

Excitation voltage:	5 V / 10 V
Transmitter excitation:	24 V, 150 mA
Measurement ranges:	$\pm 5$ V, $\pm 10$ V
Excitation current:	100 mA max.
Cut-off frequency:	5 ... 5,000 Hz in discrete bands
Total error:	< 0,05 % F.S.

**Channels A and B**

support burster TEDS (SN 530000 onwards)

**Channel C incremental sensors, EnDat 2.2, SSI**

Signal:	TTL / RS422, sinusoidal voltage 1 V <sub>pp</sub> , sinusoidal current 11 $\mu$ A
Counter depth:	32 bit, $\pm 2$ EXP31
Cut-off frequency:	1 MHz
Reference mark:	single, multipoint, distance-coded
Absolute value:	EnDat 2.2, SSI, reference travel for distance encoding
Transmitter excitation:	5 V, 300 mA

**Channel D combined channel analog/incremental (option)**

Strain gauge or process signal:	$\pm 1 \dots 40$ mV/V, $\pm 5$ V, $\pm 10$ V
Total error:	according to channels A, B
Incremental interface:	TTL/RS422, Sinus 1 V <sub>pp</sub> , Sinus 11 $\mu$ A
Transmitter excitation:	5 V, 300 mA / 15 V, 200 mA

**Channel E resistance measurement (option)**

Measurement ranges:	200 m $\Omega$ , 2 k $\Omega$ , 100 k $\Omega$
Total error:	< 0.5 % F.S. @ 200 m $\Omega$ , 2 k $\Omega$ < 1 % F.S. @ 100 k $\Omega$

**Channel F Piezoelectric (option)**

Measurement ranges:	1 nC ... 1 $\mu$ C in discrete bands
Cut-off frequency:	5 ... 5,000 Hz in discrete bands
Total error:	< 1 % F.S.

**Fieldbus Interfaces**

**I/O interface**

Two parallel PLC ports to EN 61131-2, 24 VDC, opto-isolated  
23 inputs D-SUB-37 (male)  
31 outputs, of which 23 configurable, maximum load I<sub>MAX</sub> 200 mA,  
D-SUB-37 (female)

**PROFIBUS (option)**

D-SUB9	
Bau drate	max. 12 Mbaud
Communication protocol	cyclic service <b>DP-V0</b> acyclic service <b>DP-V1</b>

**PROFINET, EtherNet/IP, EtherCAT (option)**

2 port western-socket (RJ45)	
Communication protocol	cyclical realtime process data non cyclical parameter data

**Communication Interfaces**

Device parameterization, data backup (up/download), high-speed measurement data logging

USB	Slave port (model B) front panel Data rate ~ 1 Mbaud
RS232	D-SUB9 (PC connecting using 1 : 1 cable 9900-K333) Format 8.1 Data rate 9600 baud ... 115.2 Kbaud
Ethernet	10/100 Mbit, Western socket (RJ45)

**Housing**

Combined desktop/panel-mounted housing (W x H x D):	205 x 160 x 240 [mm]
Desktop version:	4 rubberized feet (fitted as standard)
Front panel (W x H):	220 x 175 [mm]
Front panel cut-out (W x H):	206 x 161 [mm]
Weight:	approx. 5 kg

**Accessories**

Fixing kit for panel mounting **Model 9300-Z003**

**PC-Software**

DigiControl PC software for convenient device configuration including backup function (upload/download), laboratory mode for manual reading and analysis of measurement curves, and data-log wizard with print and export functions.

Supplied with the instrument and available free of charge from www.burster.com

DigiControl PC software including USB data cable 9900-K349 **Model 9307-P101**

PC software DigiControl: PLUS version including high-speed, in-process logging of measurement data, Data-log wizard, ASCII raw data, EXCEL, PDF and SQL export **Model 9307-P100**

**Cables and connectors**

Connecting cable for burster displacement sensors 8710 ... 8719 series, length 3 m	<b>Model 99209-591A-0090030</b>
Connecting cable for torque sensor model 8651/8661 incl. angular measurement to option channel D, length 3 m	<b>Model 99163-540A-0150030</b>

Adapter cable (Y-type) for torque sensor model 8661 incl. angular measurement to standard channels A/B and C (only to use together with model 99163-540A-015xxxx) **Model 99209-215A-0090004**

Connecting plug for A, B and E channel, D-SUB-9 (pack of 2 included with device)	<b>Model 9900-V209</b>
Connecting plug for C and D channel, D-SUB-15	<b>Model 9900-V163</b>

**burster TEDS**

Connecting plug 9-pin, Min-D including memory chip for the transducer electronic data sheet **Model 9900-V229**

Fitting the connector including programming of the electronic data sheet **99011**

**Adjustment of a complete measuring chain**

Adjustment and scaling of up to 3 sensors including test certificate **93ABG**

**Order Code**

<b>DIGIFORCE®</b>	<b>9307</b>	<b>- V</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Analog option</b>	<b>Standard</b>		<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Piezo interface			<b>X</b>	<b>1</b>	<b>X</b>	<b>X</b>
Combined channel analog / INCR (D) and resistance measurement (E)			<b>X</b>	<b>2</b>	<b>X</b>	<b>X</b>
<b>Fieldbus option</b>			<b>X</b>	<b>X</b>	<b>X</b>	<b>1</b>
EtherCAT			<b>X</b>	<b>X</b>	<b>X</b>	<b>2</b>
PROFIBUS (DP-V0/DP-V1)			<b>X</b>	<b>X</b>	<b>X</b>	<b>3</b>
PROFINET			<b>X</b>	<b>X</b>	<b>X</b>	<b>4</b>
EtherNet/IP			<b>X</b>	<b>X</b>	<b>X</b>	<b>4</b>

# DIGIFORCE® X/Y monitoring

## For monitoring press-fit, joining, rivet and caulking operations

### Series 9311

**NEW**  
Cabinet version  
available without display



Code: 9311 EN  
Delivery: ex stock/4 weeks  
Warranty: 24 months



- Flexible Fieldbus integration by PROFIBUS, PROFINET or EtherNet/IP
- Automatic sensor recognition from burster TEDS
- 3.5" colour touchscreen display
- 16 measurement programs
- Rapid data logging on USB flash drive
- New evaluation elements (trapezoid window and thresholds)
- User-configurable I/Os and 6 real-time switching signals

#### Application

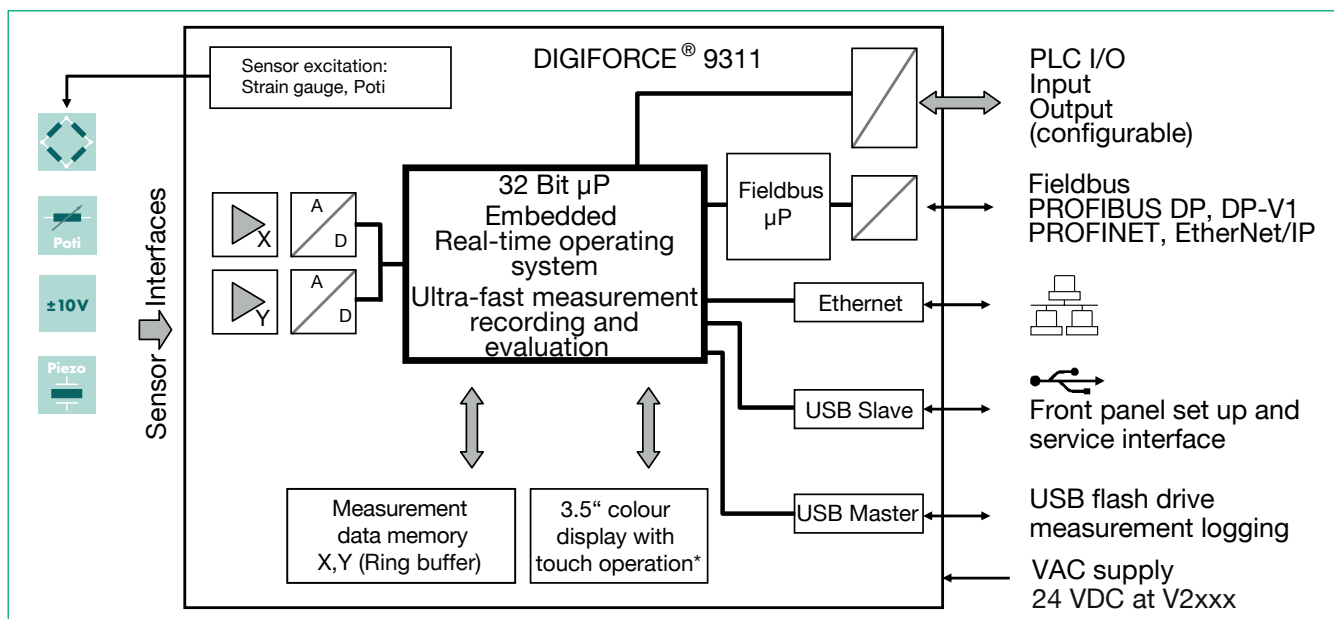
DIGIFORCE® 9311 is the new standard in efficient quality control. The pioneering force/displacement controller delivers rapid, precise evaluation results for applications that demand both high quality and high productivity. The smart performance features and intelligent hardware make test equipment quicker to set up, easier to use and capable of automatic integration in modern production systems. This unrivalled product specification gives businesses the added security and dependability they need for increasingly complex production processes. The DIGIFORCE® 9311 monitors processes in which precisely defined functional relationships need to be demonstrated between two measured quantities of the process. For instance when recording and monitoring processes such as press-insertion, joining, riveting, stamping or caulking, reliable quality control depends on synchronous and high-speed acquisition of measured values combined with analysis based on versatile evaluation elements. DIGIFORCE® 9311 provides the modern platform you need for this task, offering the widest choice of Fieldbus interfaces, including PROFINET, PROFIBUS and EtherNet/IP, to let you integrate the test setup in your particular control environment.

- Smart autoseup for evaluation elements
- Handles worker, admin and identification data
- Up to 50 most recent measurements available for display and analysis
- Records and evaluates a forward and return curve
- Live sensor values provided at the Fieldbus interface
- Synchronous logging of measurement data using DigiControl PC software for multichannel applications

Even in fully manual workstations such as manual presses with force/displacement monitoring, DIGIFORCE® 9311 can be used for convenient and efficient process monitoring thanks to custom add-on functions like acknowledge and inhibit signals.

The DIGIFORCE® 9311 uses burster TEDS to provide automatic sensor recognition. This feature automatically reads an electronic datasheet stored in the sensor so that the relevant data can be used in the measurement-channel configuration. With no chance of operator error during setup or servicing, it's best to play safe with burster TEDS. DIGIFORCE® 9311 offers versatile solutions for processes that need not just an OK/NOK evaluation but also data logging capabilities for recorded measurements and curves. Data from semi-automated and fully automated systems can be logged via the available Fieldbuses without slowing down production or via the Ethernet port (included as standard) linked to a server, host or local PC. The DigiControl PC software provides support with an automatic data logging mode that runs in parallel with production. There is also the option for high-speed data acquisition on a USB flash drive.

**Block diagram**



**Measurement data acquisition**

With an active measurement, which can be triggered by different events, the synchronously measured quantities X,Y are saved in the measurement data memory. Real-time signals can indicate whether measurements are exceeding set signal levels while the measurement is still in progress. The evaluation phase follows immediately after the measurement. In this phase, DIGIFORCE 9311 checks whether the recorded measurement curve satisfy the stored graphical evaluation criteria. If any of these criteria has been infringed, the measurement is classified as BAD (NOK), otherwise it is rated as GOOD (OK). Once this evaluation is complete, the measurement curve, the global OK or NOK result and numerous process-related values are displayed in a suite of measurement windows and updated at the Fieldbus interface. The processing steps of the evaluation phase, which finishes when the equipment is ready for the next measurement, have been optimized so that even dynamic manufacturing processes can be monitored.

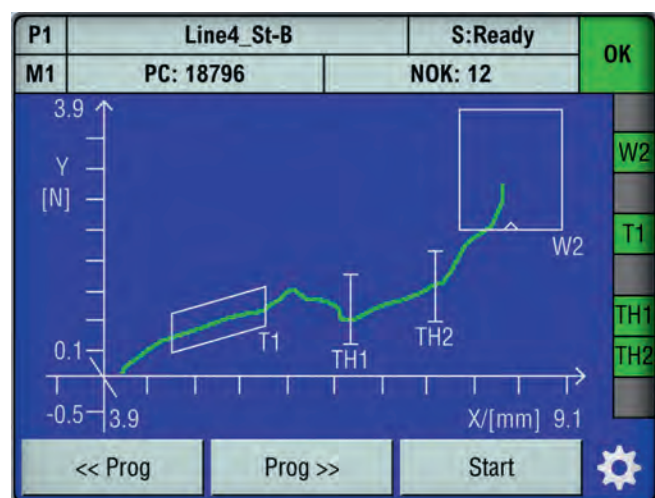


Figure: Measurement dialog M1: graphical display of measurement curve:

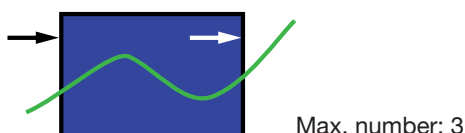
This screen shows the curve in a typical press-insertion process up to an end-point force YMAX. In this example, a trapezoid window and two threshold elements monitor the sliding-contact zone. The window (W2) ensures that the end-point force lies in the correct displacement range.

**Evaluation of a measurement curve**

As a universal evaluation tool for a vast range of measurement curves, the DIGIFORCE 9311 provides configurable evaluation elements, which can be used to classify a measurement curve as OK or NOK. In addition to the traditional evaluation windows with defined entry and exit sides, the DIGIFORCE 9311 also uses thresholds, trapeziums of type X or Y and envelopes as graphical evaluation elements. The graphical evaluation elements can be configured both numerically and graphically in setup mode using one or more recorded measurement curves. They can be used in any combination, even overlapping in an X/Y graph.

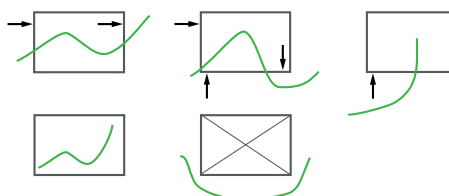
**Window evaluation element**

Symbol



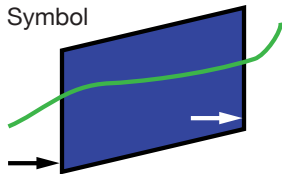
The Window evaluation element tests whether the curve has passed through the defined entry side and exit side in the window area. The user can configure these entry/exit sides as required, and can even set multiple input/output sides. A live signal can be assigned to one window, which is enabled immediately during recording if any infringement occurs. It is also possible to define windows of type NOT (no entry/exit) or BLOCK (curve ends inside the window) by suitable configuration of the entry/exit sides. The path of the X/Y curve through the window area is always analysed both for entry and exit coordinates and the absolute minimum and maximum points.

Examples of window types:



## Trapezium evaluation element

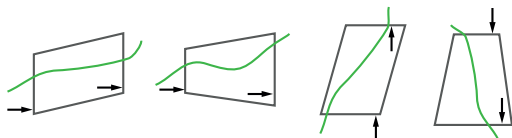
Symbol



Max. number: 2

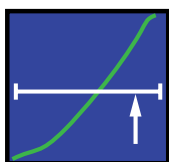
The DIGIFORCE® 9311 offers two different types of trapezium: the type-X trapezium window with fixed XMIN, XMAX limits and type-Y trapezium with fixed YMIN, YMAX limits. The trapezium evaluation element tests whether the curve has passed through the defined entry and exit sides; only one entry side can be configured for this element. The entry/exit values are calculated.

Examples of trapezium types:



## Threshold evaluation element

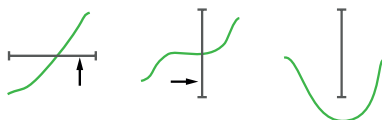
Symbol



Max. number: 2

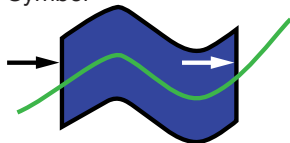
The threshold evaluation element can be used to calculate and monitor where the measurement curve passes through a defined X-value or Y-value. The user can choose between threshold type X or Y.

Examples of threshold types:



## Envelope evaluation element

Symbol



Max. number: 1

The DIGIFORCE® 9311 can use one or more measurement curves to generate one envelope. The user can then customize a generated envelope in the X-domain, and also set tolerances for the Y-domain. For a measurement curve comprising a forward and return curve section, the envelope cannot lie over the turning point.

When subsequently monitoring a measurement in measurement mode, DIGIFORCE® tests whether the measurement curve lies within the defined envelope band i.e. is classified OK, or whether the curve passes outside the valid envelope and hence must be classified NOK.

## Measuring programs

With the capability to handle 16 measuring programs, the DIGIFORCE® 9311 can switch quickly and flexibly between different component versions and/or joining parameters. The measuring programs can be selected via I/O, Fieldbus or even the Ethernet port. Sensors can be configured individually in each measuring program or using global settings.

## Flexible process integration

The DIGIFORCE® 9311 has the versatility to integrate into practically all process environments. A huge number of detailed requirements can be implemented using the numerous I/Os (10 inputs / 13 outputs), some of which can be assigned user-defined functions. A measurement can be started and terminated at variable times by different internal or external events.

## Fieldbus interface

An independent communications processor provides an optional Fieldbus interface via PROFIBUS, PROFINET or EtherNet/IP.

Cyclical real-time data

- ▶ Process control
- ▶ Retrieval of specific measurement results
- ▶ Live values from active sensors

Acyclical data for parameters, ADMIN and results

- ▶ Transfer of component/worker/job data for logging
- ▶ Complete device configuration
- ▶ Retrieval of large amounts of process and curve data

## Sampling and recording measurement signals

Signals can be sampled as a combination of time interval ( $\Delta t$ ), X-interval and Y-interval ( $\Delta X$ ,  $\Delta Y$ ) to provide a flexible yet also compressed measurement recording. Curve areas containing a constant or steadily changing signal can be reproduced with just a few stored measurement points, while steep signal slopes or alternating waveforms require many points.

## Start/Stop conditions for measurement recording

The DIGIFORCE® 9311 lets the user define independent start/stop logic.

- ▶ Start conditions: Ext. control signal, measurement above or below a definable X-value or Y-value.
- ▶ Stop conditions: Ext. control signal, measurement above or below a definable X-value or Y-value, timeout, definable number of recorded measurements reached.

## Limit monitoring in real time

S1 ... S6

The user is able to assign the switching signals S1 ... S6 to the two measurement channels as required, and can set their polarity. The associated PLC I/Os and Fieldbus signals are updated both in standby mode and also in real time during the measurement cycle (typ. response time < 3 ms).

NOK-ONLINE

The live signals OUT\_NOK\_ONL can be used if the curve does not pass through the permitted region of the window evaluation element. This allows pre-emptive termination of a joining process in ultra-quick time if the two components processed incorrect, protecting parts, tools or even the entire system from damage.

**Process data**

The DIGIFORCE® 9311 visualizes a comprehensive set of process data during measurement mode and automatic production mode\*. All relevant process data can be transferred to the controller or PC environment immediately after a measurement. The user can switch between the following process windows:

- ▶ M1 Graph of measurement curve
- ▶ M2 General display of Y(X) curves
- ▶ M3 Full-screen PASS/FAIL or smiley
- ▶ M4 Entry/exit data for evaluation elements
- ▶ M5 List of user-specific process values (up to 20 values)
- ▶ M6 Statistics on all graphical evaluation elements
- ▶ M7 Job sheet containing process, worker and parts data

Each process window displays the global header containing information on the selected measurement program, the associated part quantities and NOK figures, and the global OK/NOK evaluation. The status field on the right shows the evaluation elements that are active in the measurement program and their individual results. The user can customize the buttons at the bottom of the Process dialog touchscreens with particular device functions. Alternatively, the live values from the X/Y measurement channels can also be displayed here.

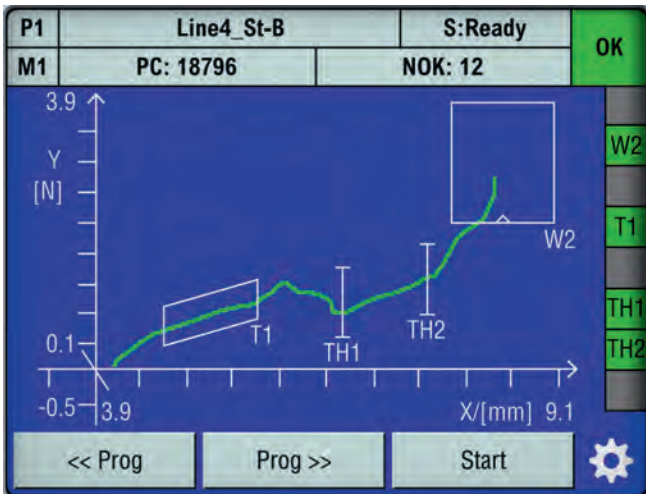


Figure: M1 – graphical display of measurement curve  
The function keys can optionally be displayed at the bottom of the screen.

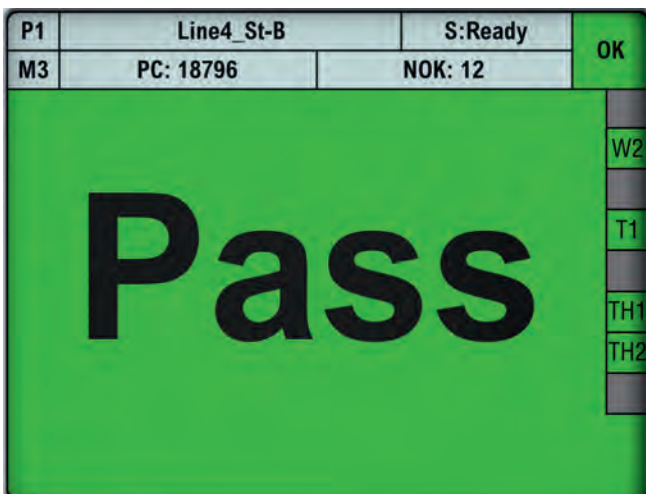


Figure: PASS/FAIL full-screen display  
A large OK/NOK smiley can be used as an alternative indicator.

**M5 – List of user-specific process values**

Users can customize their own process values in each measurement program. They can personally enter numerous different result values, for instance a force maximum inside the window and/or tolerance limits for the window. The values in this list are transmitted to the Fieldbuses directly with the OK/NOK evaluation. In addition, the measured values are also issued for logging on USB flash drive and for the Excel statistics export in the DigiControl PC software.

**Device configuration**

Device parameters can be fully configured either via the touch-screen display\* or using the DigiControl PC software (available free of charge). From any of the process screens M1 to M7, you can press the cog icon to access the main configuration level containing the following functions:

- ▶ Basic setup
- ▶ Measurement program selection
- ▶ Measurement program configuration
- ▶ Curve analysis
- ▶ Measurement program copy function

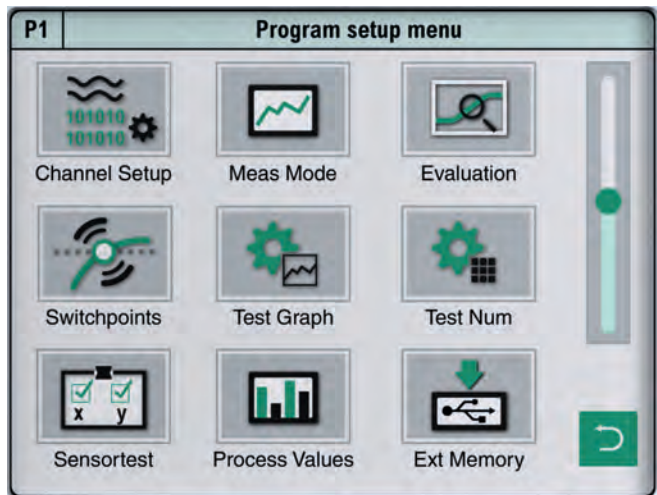


Figure: Parameterization level  
Measurement program configuration

**Logging data on USB flash drive**

A USB flash drive can be plugged into the rear USB port (type A) for local logging of measurement data. This form of data logging can be custom-configured for each measurement program. At the end of the measurement cycle and the internal evaluation in the DIGIFORCE® 9311, a data-log entry is then written into the available \*.csv-file in a time period of less than 250 msec. The log file contains a header that includes general data such as component name and batch ID, and a new line entry for each measurement, which includes the following data:

- ▶ Date / Time
- ▶ Overall result OK/NOK
- ▶ Serial number (SN from order sheet)
- ▶ Part counter
- ▶ “General curve data” dataset (2x7 floating point values)
- ▶ “User-defined values” dataset (up to 20 floating point values)

**burster TEDS**

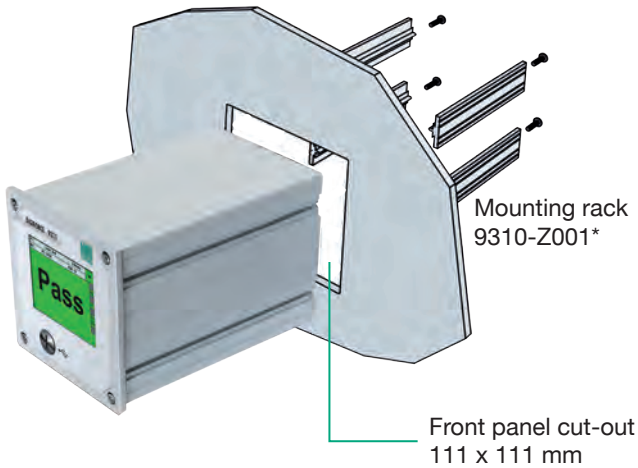
DIGIFORCE® 9311 uses the burster TEDS (Transducer Electronic Data Sheet) to provide automatic sensor recognition, i.e. the instrument reads the relevant sensor specification from an EEPROM, fitted in the sensor connector, and then uses this data to perform the necessary channel configuration automatically. The memory chip in the sensor connector is programmed as part of a service provided when the sensor is first ordered or subsequently calibrated. The burster TEDS feature is only available for sensors that have a permanently fitted connecting lead.

\* is omitted in the version V2xxx

### Curve analysis (Viewer - version V0xxx with display only)

You can use the "Viewer" tool to look at the most recent 50 measurement curves either as individual curves or as a curve array. In addition, you have detailed numeric data available for each measurement, such as individual results from the graphical evaluation elements and the associated window entry and exit coordinates. If you are getting occasional NOK measurements, you can then use this tool to look at the measurement curve even after the test, and take suitable corrective action to prevent NOK parts. The DigiControl PC software can be used to retrieve and analyse these sets of curves.

### Panel mounting



\* not suitable for the version V2xxx

### PC software DigiControl

The **basic version**, which is available free of charge, supports full device configuration, creation of backups, and retrieval and display of measurement curves, including all evaluation results and statistics. An especially convenient feature is the definition of graphical evaluation elements such as envelopes, windows, trapeziums and thresholds based on a set of curves of measured master or reference parts. Alternatively, ready-archived measurements can also be used to create new evaluations. The **Plus version** (9311-P100) of the PC software DigiControl provides, in addition to the standard functions, an automatic production mode, which, for example, logs production measurement data with clear parts references. The resultant measurement logs are not only available in the internal program format, but can also be imported into EXCEL data. Even for

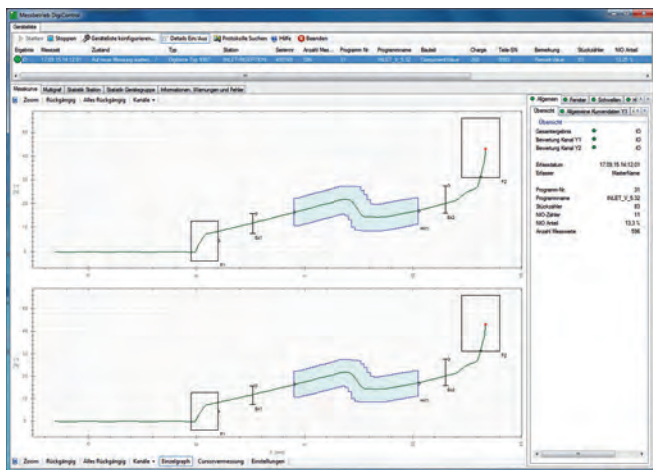


Figure: The „measurement mode“ function displays the curve and status information of the most recent measurement. A multi-channel view is also possible. The corresponding log is automatically saved in the background.

### NEW - cabinet version (V2xxx)

The cabinet module (V2xxx) is designed for snap-rail mounting according to DIN EN 50222. This version is running with 24 VDC supply voltage. Status information including evaluation results is provided by a set of monitoring LEDs. The V2xxx module can be fully configured and parameterized using the DigiControl PC-Software. The optional fieldbus interfaces like PROFINET also offers access to the configuration parameters. DIGIFORCE® 9311 cabinet module (V2xxx) includes all the standard performance features like the display version does. Networking can take place in parallel via fieldbus interface to the PLC (switch function with PROFINET and EtherNet/IP available) and via standard Ethernet to a host system. It is mainly designed for multi-channel solutions with several units and additional DigiControl human interface.

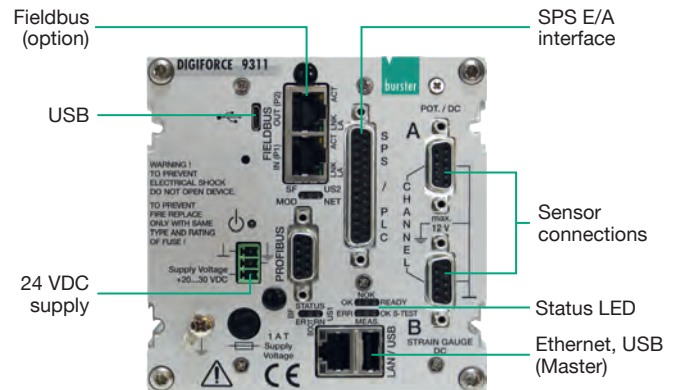


Figure: DIGIFORCE® 9311 cabinet version

synchronous processes involving large amounts of data, logging of measurement data is optimized to achieve an ultra-short cycle time. In addition, the software supports an extra remote interface for more complex tasks. This can be used, for instance, for reloading device configurations or transferring component references for measurement data logging.

### Porting from DIGIFORCE® 9310 to DIGIFORCE® 9311

A DIGIFORCE® 9311 device configuration can be generated from a DIGIFORCE® 9310 backup file using DigiControl. The software imports the sensor and evaluation settings and selects as close a configuration as possible for the DIGIFORCE® 9311.

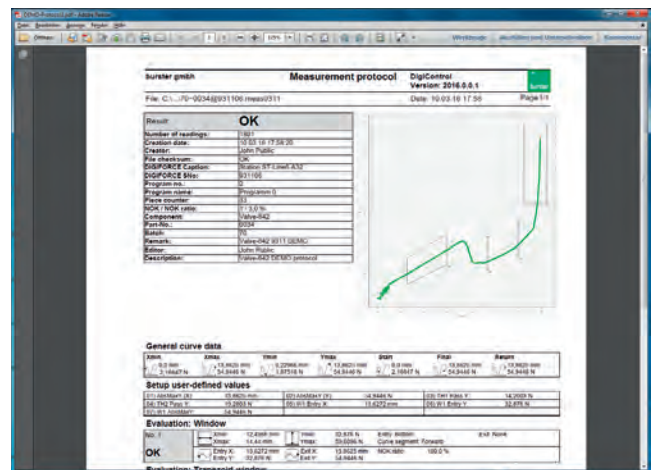


Figure: A Data-log wizard provides filters for selecting and displaying stored measurement logs. A log printout containing component data, curve information and all evaluation results can be generated for each individual measurement log.

## General Technical Data

Sampling rate:	10 kHz
Signal sampling:	$\Delta X, \Delta Y, \Delta t$ in any combination
Digitalization:	16 bit
Evaluation time:	typ. 25 ms
Measurement programs:	16
Power supply:	
Desktop/panel version V0xxx:	100 ... 240 VAC $\pm 10\%$ , 50 ... 60 Hz $\pm 10\%$
Cabinet mounted version V2xxx:	20 ... 30 VDC
Power consumption:	< 15 VA
Delay in real-time limit signals S1 ... S6:	typ. $\leq 3$ ms
Operating temperature range:	+ 5 ... + 23 ... + 40°C
Protection class:	
Desktop/panel version V0xxx:	IP40 / IP65 panel mounted
Cabinet mounted version V2xxx:	IP20
Display*:	3.5" TFT colour LCD (320 x 240)
Operation*:	touch operation
Operating language*:	German, English, French, Italian, Spanish, Chinese (only process window)

\* is omitted in the version V2xxx

## Compatible Sensors

Flexible assignment of physical channels A ... B to measurement graphs (X/Y coordinates). The function burster TEDS is not available at the optional piezo channel.

### Channel A (potentiometer, process signals)

Excitation voltage:	5 V
Excitation current:	10 mA max.
Signal range:	$\pm 5$ V, $\pm 10$ V
Cut-off frequency:	5 ... 5000 Hz in discrete bands
Total error:	< 0.2 % F.S.

### Channel B (strain gauge, process signals)

#### Strain gauge sensors

Measurement ranges:	2/4/10/20/40 mV/V
Bridge resistance:	120 $\Omega$ ... 5 k $\Omega$
Excitation voltage:	5 V
Excitation current:	30 mA max.
Cut-off frequency:	5 ... 5000 Hz in discrete bands
Total error:	< 0.2 % F.S.

#### Process signals

Measurement ranges:	$\pm 5$ V, $\pm 10$ V
Cut-off frequency:	5 ... 5000 Hz in discrete bands
Total error:	< 0.2 % F.S.

### Channel B Piezoelectric (option)

Measurement ranges:	1 nC ... 1 $\mu$ C in discrete bands
Cut-off frequency:	5 ... 5000 Hz in discrete bands
Total error:	< 1 % F.S.

This option replaces the channel for strain gauge and process signals.

### Transmitter excitation für X and Y channel

only for cabinet version V2xxx: 20 ... 30 VDC / 150 mA

## I/O and Fieldbus Interfaces

### I/O interface

Parallel PLC port according to EN 61131-2, 24 VDC, opto-isolated, positive logic  
 10 inputs, of which 3 are configurable  
 13 outputs, of which 6 are configurable, maximum load  $I_{MAX}$  500 mA,  $I_{MAX\ TOTAL}$  800 mA (all outputs)  
 D-SUB-25 (model female)

### PROFIBUS (option)

D-SUB9  
 Baud rate max. 12 MBaud  
 Communication protocol cyclic service **DP-V0**  
 acyclic service **DP-V1**

### PROFINET, EtherNet/IP (option)

2 port western-socket (RJ45)  
 Communication protocol cyclical realtime process data  
 acyclic parameter data

## Communication Interfaces

Device parameterization, data backup (up/download), high-speed measurement data logging, USB data logging

USB	Slave port (Micro-B)
	Front panel
	Data rate ~ 1 MBaud

Technical changes reserved. All data sheets at [www.burster.com](http://www.burster.com)

USB	Master port (type A) Rear side USB data logging Data format FAT16/32, max. 32 GB
Ethernet	10/100 MBit, western-socket (RJ45)

At the cabinet mounted version V2xxx all connectors are placed at the front side.

## Housing

Combined desktop/panel-mounted housing (W x H x D):	110 x 110 x 183 [mm]
Desktop version:	4 rubberized feet (fitted as standard)
Front panel (W x H):	119 x 119 [mm]
Front panel cut-out (W x H):	111 x 111 [mm]
Weight:	ca. 1.5 kg
Panel mounting:	rubber feet are replaced by the mounting rack (order code 9310-Z001), device is inserted through the front-panel cut-off and is fixed by screws (see page 5).
Cabinet mounted version V2xxx:	for rail mounting (mounting rail to DIN EN 50022)

## Accessories

Fixing kit for panel mounting	<b>Model 9310-Z001*</b>
Connection outlines for mounting several DIGIFORCE® 9311 (2 outlines, 4 screws)	<b>Model 9310-Z002*</b>

\* not suitable for the version V2xxx

## PC software

PC software DigiControl for convenient instrument configuration including backup function (upload/download) and laboratory mode for manual reading and analysis of measurement curves, data-log wizard with print and export functions.  
 Supplied with the instrument and available free of charge from [www.burster.com](http://www.burster.com)

PC software DigiControl including USB data cable 9900-K358  
**Model 9311-P101**

PC software DigiControl: PLUS version plus highspeed, in-process logging of measurement data, data-log wizard and Excel data export  
**Model 9311-P100**

## Cable and connectors

Connecting cable for burster displacement sensors 8710 ... 8719 series, length 3 m **Model 99209-591A-0090030**

Extension cable for sensors with 9900-V209 plug, length 3 m **Model 99209-609A-0150030**

Bridging cable for routing the displacement sensor signal from DIGIFORCE® 9311 to a following device, length 0.5 m **Model 9900-K340**

USB data cable for front-side service interface, length 2 m **Model 9900-K358**

Connecting plug for A, B channel (strain gauge, process signals, potentiometer) **Model 9900-V209**

Connecting plug for PLC-I/O port, 25 pin, Min-D **Model 9900-V160**

## burster TEDS

Connector 9 pin, Min-D incl. memory chip for the electronic sensor data sheet **Model 9900-V229**

Fitting connector of the connecting plug incl. programming the electronic sensor data sheet **99011**

## Adjustment of a complete measuring chain

Adjustment and scaling of channel X and Y including test certificate **93ABG**

## Order Code

<b>DIGIFORCE®</b>	<b>9311 - V</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Standard</b> display version (AC supply)		0	0	0	0
<b>Standard</b> cabinet mounted version (DC supply)		2	0	0	0
<b>Option card analog</b> Piezo (instead of strain gauge, process signals)			1		
<b>Fieldbus</b>					
PROFIBUS (DP-V0/DP-V1)					2
PROFINET					3
EtherNet/IP					4

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 Talsir. 1-5 · Gernsbach 76593 · Phone +49-7224-6450 [www.burster.com](http://www.burster.com)  
[info@burster.com](mailto:info@burster.com)

# ForceMaster

## Low-Cost Monitoring for Manual Presses

Model 9110

Code:	9110 EN
Delivery:	ex stock
Warranty:	24 months

**NEW**  
Single-channel  
force monitoring



- Excellent value "Plug & Work" complete system
- Easy auto-configuration with automatic setting of the evaluation tools
- Smart Card system for manipulation free configuration and storage of settings
- Acoustic and optic error indication
- Data logging on USB stick (optional)
- PLC sequence control function (optional)
- Analysis and configuration software included
- Automatic sensor identification
- Hub and other component counters

### Applications

Pressure on price and quality continue to rise. The need to monitor even the simplest manufacturing and assembly process is increasingly common. With 100% monitoring of force/time curves or force displacement/time curves, the ForceMaster satisfies all requirements for ensuring the reliability of even simple press-fit processes. Thanks to its ultra-simple, single-button operation and intelligent auto-configuration, even semi-skilled staff can set up the equipment safely and quickly. "Card & Go" is the smart system that uses master, tool and PLC smart cards to make equipment settings, inhibit unauthorized changes and to trigger actions in sequence with the production process.

The ForceMaster 9110 has been developed specifically for monitoring manual lever presses. Simple manual workstations can be monitored extremely efficiently using the ForceMaster. Easy control functions that used to require an additional PLC can now be performed reliably with the ForceMaster. Tools can be changed quickly and easily using tool cards.

The ForceMaster is used for example for

- ▶ Pressing ball bearings
- ▶ Compressing powders
- ▶ Press-fitting pinion gears

### Description

The ForceMaster has a multi-voltage power supply. Excitation of the load cell and displacement sensor is provided by internal voltage-conditioning circuits. Sensor identification is built into the sensor plug, allowing sensors to be connected easily with no further configuration needed.

The integral auto-configuration tool uses a GOOD component to train the ForceMaster with the measurement curve and automatically set the evaluation elements. The user can make any further fine-tuning and adjustments to these settings manually if required.

Visual indicators such as a red and green indicator lamp signal "Good" or "Bad" parts. An audible sound is also output for "Bad" parts.

The built-in PLC function allows sequence control of up to 60 steps. This can be used, for instance, to control pneumatic cylinders, compressors for blowing out workpieces, and reject gates for OK/NOK parts.

The PC software, which is included free of charge can be used for measurement-curve analysis and fine-tuning the evaluation elements. It also lets the user view and archive the measurement curves recorded on the USB stick.



### Automatic sensor identification

The connected sensors are automatically detected by a special plug, so there is no need to configure each of the measurement channels. Faulty sensors or different measurement ranges can be changed in an instant, with no risk of mixing up sensors!

### Auto-configuration

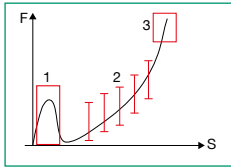
The auto-configuration function is an outstanding feature of the ForceMaster 9110.

This tool automatically predefines the start condition and position of the evaluation elements.

The basis for these settings is a GOOD production process in auto-configuration mode. The first stage in this process is to tare the force channel. This is necessary because the ForceMaster 9110 can only measure unipolar forces. Taring corrects any offset voltages and drift in the load cells. Then the ForceMaster 9110 waits for an upward movement of the press. Once the force exceeds a configurable force threshold, measurement recording begins.

If nothing else changes, the ForceMaster waits for a downward movement of the press. The teach-in training process is stopped once measurements pass below the start point. Then the measurements are analyzed and the configuration settings are made. Afterwards, in a second step, the user can choose whether to use force displacement limits (horizontal limits) or 2 gates (vertical limits) for the evaluation. There is also the option to monitor the 1 feed-in area for a maximum force. Another option is to enable monitoring of the 3 block force. As part of the block-force monitoring function, the user can also enable monitoring of the end deformation.

In addition, changes can be made to the internally calculated values and limits manually.



### Main evaluation types

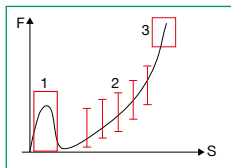
- ▶ Force displacement limits
- ▶ Gates (vertical force displacement)

The user can also enable:

- ▶ Feed-in force monitoring
- ▶ Block-force monitoring
- ▶ End-deformation monitoring
- ▶ Force alarm 1
- ▶ Force alarm 2

### Description of evaluation types

#### Feed-in area 1

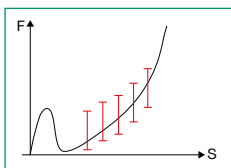


Within this area, the measurement process can be monitored for exceeding a maximum force (upper feed-in limit). Good parts are not allowed to exceed this limit.

The feed-in area is always disabled after the teach-in measurement process.

It must be enabled manually.

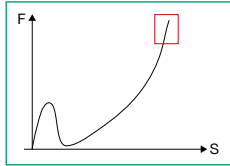
#### Gates (vertical limits) 2



With force-displacement limits, the force in this area must always exceed a minimum force (lower force limit). The force must then not drop below this limit again over the entire area. For good parts, the force must also not exceed a second force limit, the "upper force limit".

In the measuring range, the horizontal force-displacement limits are replaced by vertical force-displacement limits. 5 gates are active. Each are defined by a displacement position and an upper and lower force. The measurement curve must pass through the gate between these two forces. The gates do not have to be placed in a specific order. Evaluation is not performed until the last gate has been passed in the displacement direction.

#### Block area 3

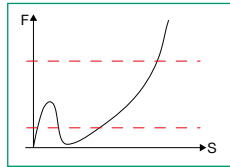


This area is usually where the end of the measurement lies, which a good part must always reach. The force limits "lower block limit" (which must be exceeded) and "upper block limit" (which the force must not drop below) are used to monitor the block force.

The measurement curve must end in this area. The curve must not go beyond the displacement point defining the block end (NOK). The measurement curve is allowed to have already exceeded the "lower block limit" when it enters this area. It is not allowed, however, to drop below the "lower block limit" again in this area.

The block area is always disabled after the teach-in measurement process. It must be enabled manually.

#### Force alarms



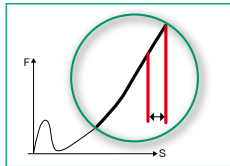
In addition to the evaluation areas 1 - 3 force alarms 1 and 2 are always available.

Force alarm 1 is used to monitor the load cell outside a started measurement. Since this is monitored over the displacement, this force monitoring is not enabled for the  $Y=f(t)$  function (no displacement measurement).

Force alarm 2 is used for continuous monitoring of the load cell - both outside and during a measurement.

CAUTION: The force alarms do not generate an NOK evaluation. They are simply used to set the "Alarm occurred" PLC output for information purposes. But only if sequence control is not enabled!

#### End deformation



This option is used for monitoring deformation of the workpiece around the maximum force. This is done by measuring the displacement when the force exceeds the "lower block limit".

The end deformation is obtained from the difference between the maximum displacement during the measurement process and the deformation value saved when the force exceeded the "lower block limit". The calculation starts once the force has dropped below the "lower block limit" again during the return stroke.

End-deformation monitoring is always disabled after the teach-in measurement process. It must be enabled manually.

### Components

Following counter options are accessible via the menu

- ▶ Parts OK
- ▶ Parts NOK
- ▶ Total parts
- ▶ Down-counter
- ▶ D-set (set value for down-counter)
- ▶ T.stroke (total-stroke counter)

### PLC sequence control function (optional)

Control is based on the principle of a sequencer. A built-in electronic cam switch is provided for this purpose. The combination of these two forms of control provides a very powerful range of functions.

In principle, one can visualize a cam as a displacement range, which is also linked to the direction of movement. This makes it possible to program certain actions that are active for as long as the press stays in this range.

A sequence is composed of a series of commands that are processed step by step. Each step contains a condition and an action. The controller waits at each step until the condition is met and then carries out the action. Only then it does move on to the next step. There are 8 inputs and 8 outputs available. Depending on the safety requirements and risk levels of the application, additional measures must be taken to achieve the necessary "safety level".

### Data logging on the USB stick

Curve data can be saved on an USB stick for subsequent analysis and assessment. This is possible for a press-insertion operation that has a cycle time of  $\geq 1$  second.

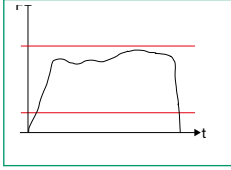
### Display options

The display can show the following options: live sensor values, actual value for force/displacement or time, live evaluation, parts counter or maximum sensor values.

## Special option force monitoring

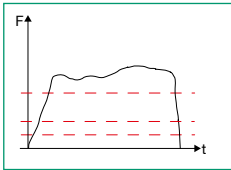
The force-time option is designed for straightforward force measurements requiring evaluation. For this application, just one load cell is connected to the ForceMaster 9110.

### Force thresholds



Force thresholds can be used to monitor whether the force lies in a defined range. A green light indicates that the force lies in the specified range. A force that exceeds the upper force threshold triggers a visual and acoustic alarm. Evaluation takes place online during measurement.

### Limits



In addition, 3 limits are available for defining various switching results. With hysteresis settings, a limit buffer and customizable switching behaviour, these switching results can be tailored to customers' requirements. There is also a facility to delete the limit via a digital input.

## Smart cards

### Master card

Only the master card allows access to the configuration menu. Without this card, the user is only permitted to view the general equipment data. It is also possible to specify in the configuration settings that faulty parts can only be confirmed with a master card.

### Tool card

The tool card can be used to save and then reload a parts-specific program configuration (ForceMaster 9110 settings for measuring and evaluating a particular device under test).

This is useful, because different parts (depending on calibration quality) can then be measured on the same equipment or in future also on different ForceMaster 9110 units, without needing to perform an auto-configuration.

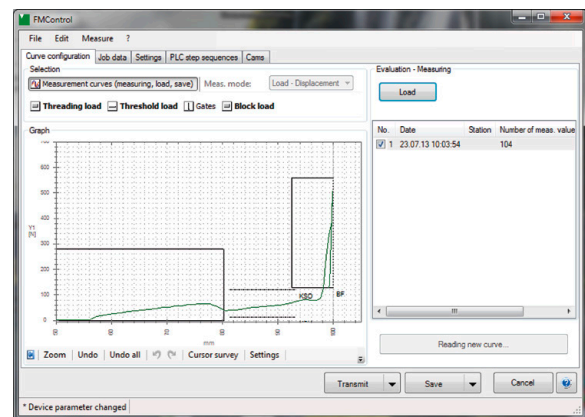
### PLC card

A sequence-control program and the associated cam configuration can be stored on the PLC card and reloaded later.

## PC software

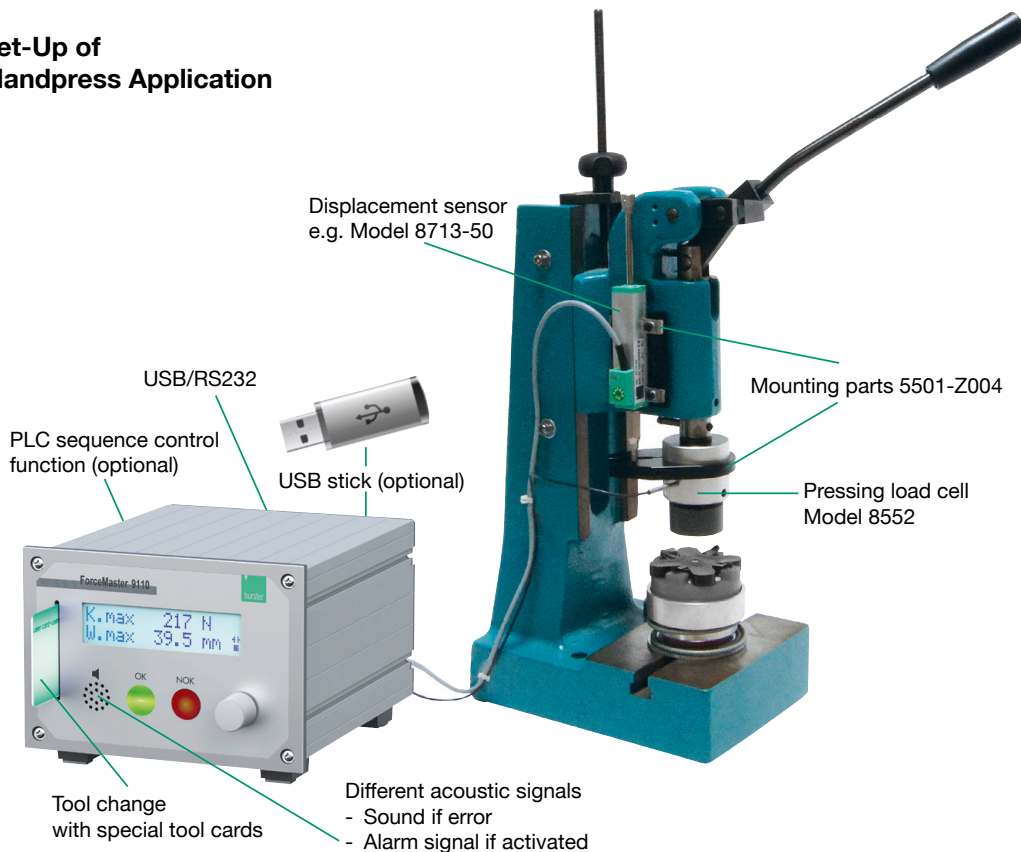
The free of charge configuration and analysis software FMControl offers following possibilities:

- ▶ Device parametrization
- ▶ Backup function
- ▶ Setting of evaluation elements according to auto configuration
- ▶ Programming the sequence
- ▶ Analysis of measurement curve
- ▶ Data storage and archiving
- ▶ Management and creation of tool smart cards



## Application

### Typical Set-Up of Manual Handpress Application



## Load cell model 8552

The force is measured by a load cell, which is fitted on the press ram between sensor and tool. The load cell is equipped with mechanical overload protection.

### Technical Data

Accuracy:	< ± 2 % F.S.
Measuring ranges:	from 0 ... 100 N to 0 ... 20 kN (50 kN ... 100 kN with model 8451)
Maximum force during use:	approx. 120% of rated force
Degree of protection:	IP54 to EN 60529
Diameter:	50 mm
Height without peg:	50 mm
Peg diameter:	10 mm
Sensor hole diameter x depth: (other pegs/holes optionally available)	standard 10 <sup>H7</sup> x 25 mm

When the sensor is used in the press, it is important to ensure that it is operated without transverse forces during the working stroke. Therefore the tool must be guided with the minimum possible play and the workpiece must be positioned securely.

Detailed technical data on the load cell is given in the 8552 data sheet.



## Displacement sensor Model 8713 (optional)

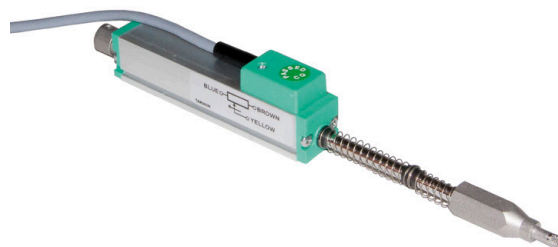
The full working stroke of the press ram can be monitored by a model 8713 displacement sensor firmly mounted on the press head.

### Technical Data

Linearity deviation:	< 0.1 % full scale
Resolution:	0.01 mm
Degree of protection:	IP40 to EN 60529

When the displacement sensor is retrofitted to an existing press, a sketch is available which identifies the positions of the mounting holes that need to be made on the press head. We recommend using our 5501-Z004 mounting kit for this purpose.

Detailed technical data on the displacement sensor is given in the 8712/8713 data sheet.



## Technical Data

### Sensors for the force channel

Bridge resistor:	350 Ω ... 5 kΩ
Connection type:	4-wire
Sensor excitation:	5 V
Excitation current:	20 mA
Power consumption:	approx. 0.3 VA
Input voltage:	1 mV ... 10 mV
Total error:	< 1 % F.S.

### Sensors for the displacement channel

Sensor type:	potentiometric displacement sensor
Track resistance:	1 kΩ ... 5 kΩ
Total error:	< 1 % F.S.

### General equipment data

Display:	2 line illuminated LCD display
Warning and confirmation sounds:	configurable signal type
Alarm signal volume:	up to 75 dB
Measurement channels:	force/displacement or force/time
Communication interfaces:	USB - Slaveport type B, on the back RS232 - D-SUB 9, 19.2 kbaud data rate
Mains power supply:	90 ... 240 V AC / 50 ... 60 Hz
Cut-off frequency:	1 kHz
Operating temperature range:	5°C ... 40°C
Storage:	- 10°C ... 60°C
Air humidity:	10 ... 80 %, non-condensing
Enclosure type:	aluminum section
Degree of protection:	IP20
Connections:	coded special plugs
Sampling interval:	10 kHz
Protection class:	1
Number of I/O:	8 inputs / 8 outputs
Response time relay:	1 ms
Total current of all outputs:	0.3 A internal excitation 1.5 A external excitation
Dimensions ( W x H x D):	174 x 119 x 213 [mm]
Weight:	approx. 3 kg

## Order Code

<b>ForceMaster Standard</b>	<b>9110 - V</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		0	0	0	0
Options	PLC sequence control function		1		
	USB stick data logging				1
	Single-channel force only	1			

## Order Information

ForceMaster with PLC function and USB data logging  
Analysis and configuration software **Model 9110-V0101**

### Accessories

In order to fit the displacement sensor securely and firmly on the press head or on the load cell itself while still allowing fine adjustment, assembly kits are available that include all necessary parts such as carriers, plates, screws and mounting diagram for correct positioning

for 8451 load cell, measurement range up to 0 ... 20 kN **5501-Z002**  
for 8451 load cell, measurement range starting from 0 ... 50 kN **5501-Z003**

for 8552 load cell **5501-Z004**

For further information see accessories' data sheet.

### Cables

Connecting cable for potentiometric displacement sensors including plug (e.g. 8712) **Model 99221-591A-0090030**

RS232 cable to PC **Model 9900-K333**

USB cable to PC **Model 9900-K349**

### Smart cards

**Master card** for full configuration access **Model 9110-Z001**

**PLC card** for storing PLC sequences on the card **Model 9110-Z002**

**Tool card** for saving tool data and measurement programs **Model 9110-Z003**

### Connectors

Connector plug for load cells, containing stored sensor calibration data **Model 9900-V245**

Connector plug for potentiometric displacement sensors, containing stored sensor calibration data **Model 9900-V221**

Connector assembly **Model 99005**



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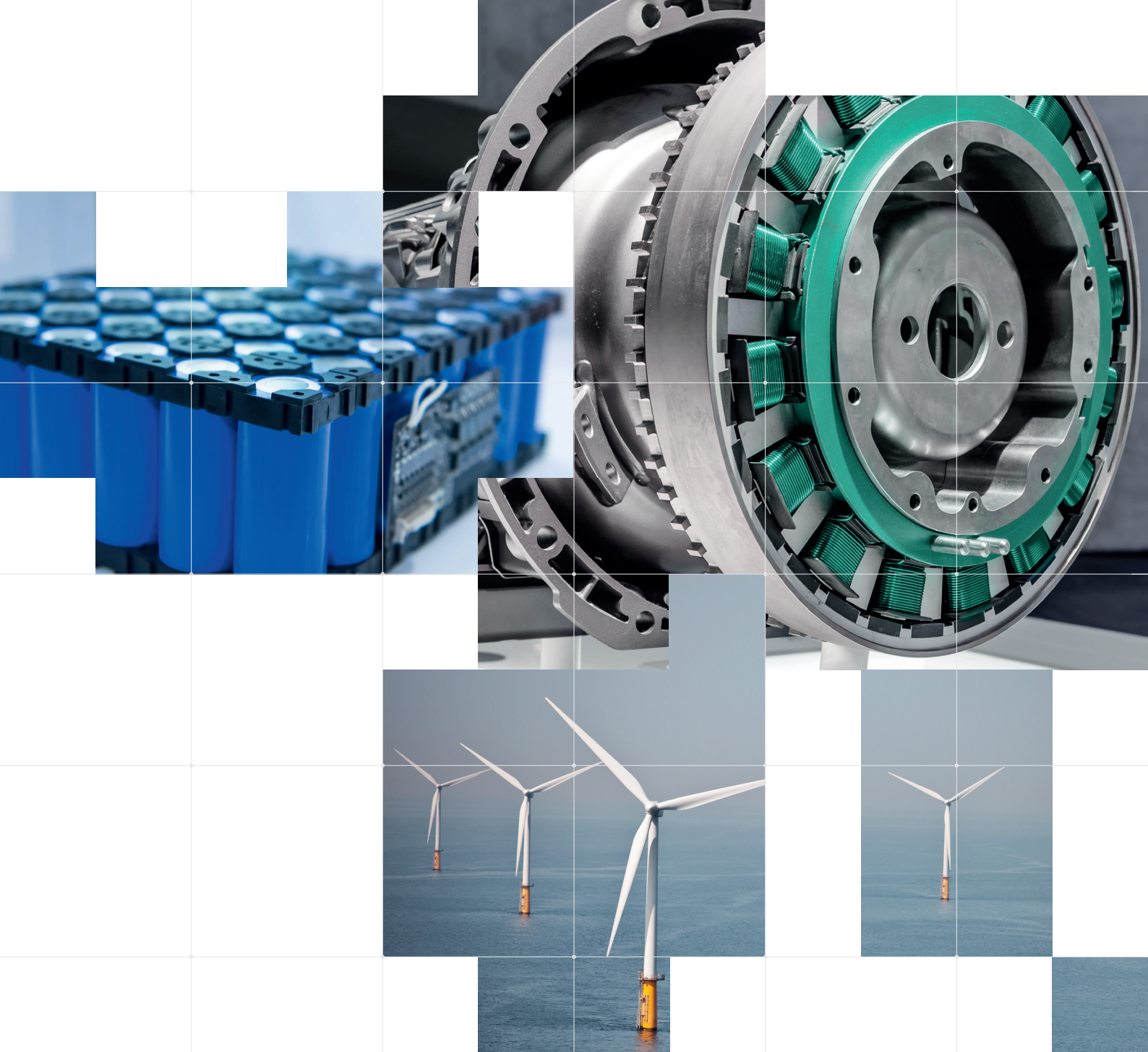
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