OPERATING MANUAL

DIGIFORCE®
model 9307

Valid from: 21.09.2023

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DIGIFORCE® 9307

THE MEASUREMENT SOLUTION. **burster**

EU-Konformitätserklärung (nach EN ISO/IEC 17050-1:2010)
EU-Declaration of conformity (in accordance with EN ISO/IEC 17050-1:2010)

Name des Ausstellers: burster präzisionsmesstechnik gmbh & co kg
Issuer's name:

Anschrift des Ausstellers: Talstr. 1-5
Issuer's address: 76593 Gernsbach, Germany

Gegenstand der Erklärung: Universeller Prozess-Controller DIGIFORCE®
Object of the declaration: *Universal Process-Controller DIGIFORCE®*

Modellnummer(n) (Typ): DIGIFORCE® 9307
Model number / type:

Diese Erklärung beinhaltet obengenannte Produkte mit allen Optionen
This declaration covers all options of the above product(s)

Das oben beschriebene Produkt ist konform mit den Anforderungen der folgenden Dokumente:
The object of the declaration described above is in conformity with the requirements of the following documents:

Dokument-Nr. *Documents No.*	Titel *Title*	Ausgabe *Edition*
2011/65/EU + delegD (EU) 2015/863	Richtlinie zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten *Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment*	2011 + 2015
2014/35/EU	Richtlinie zur Harmonisierung der Rechtsvorschriften der Mitgliedsstaaten über die Bereitstellung elektrischer Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen auf dem Markt *Directive on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits*	2014
2014/30/EU	Richtlinie zur Harmonisierung der Rechtsvorschriften der Mitgliedsstaaten über die Elektromagnetische Verträglichkeit *Directive on the harmonization of the laws of the Member States relating to electromagnetic compatibility*	2014
EN 61010-1	Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte – Teil 1: Allgemeine Anforderungen *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements*	2020 + A1:2022 + A2:2023
EN 61326-1	Elektrische Mess-, Steuer-, Regel- und Laborgeräte – EMV-Anforderungen – Teil 1: Allgemeine Anforderungen *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*	2022
EN 55011	Industrielle, wissenschaftliche und medizinische Geräte – Funkstörungen – Grenzwerte und Messverfahren, Gruppe 1, Grenzwertklasse A *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement, group 1, class A*	2022

Gernsbach	22.06.2023	ppa. Christian Karius
Ort / *place*	Datum / *date*	*Quality Manager*

Dieses Dokument ist entsprechend EN ISO/IEC 17050-1:2010 Abs. 6.1g **ohne Unterschrift** gültig /
*According EN ISO/IEC 17050 this document **is valid without a signature.***
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www.burster.com

Table of contents

1   For your safety

The following symbols on the DIGIFORCE® 9307 and in this operating manual warn of hazards.

1.1   Symbols used in this manual

1.1.1   Signal words

The following signal words are used in the operating manual according to the specified hazard classification.

⚠ **DANGER**
High degree of risk: indicates a hazardous situation which, if not avoided, will result in death or serious injury.
⚠ **WARNING**
Moderate degree of risk: indicates a hazardous situation which, if not avoided, may result in death or serious injury.
⚠ **CAUTION**
Low degree of risk: indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE
Property damage to the equipment or the surroundings will result if the hazard is not avoided.

Note: It is important to heed these safety notices in order to ensure you handle the DIGIFORCE® 9307 correctly.

IMPORTANT: Follow the information given in the operating manual.

1.1.2   Pictograms

Symbol	Description
⚠	**Electric shock hazard**
⚠	**Electrostatic discharge. Do not touch!** Take precautionary measures against static discharge.
❗	Observe the advice for protecting the DIGIFORCE® 9307.

1.2 Symbols and precautionary statements on the DIGIFORCE® 9307

Symbol	Description
⚠	**Hazard warning** Disconnect the power plug before opening – Follow safety instructions – Professional servicing only.
(ESD symbol)	**Electrostatic discharge. Do not touch!** Electrostatic discharge can damage the piezoelectric connector (F). Take precautionary measures to prevent a static discharge at connector F.
Warning ! To prevent electrical shock do not open device.	**Warning of electrical shock hazard.** Do not open the DIGIFORCE® 9307.
To prevent fire replace only with same type and rating of fuse !	**Warning of fire hazard.** Always replace the fuse with a fuse of the same type and rating.

1.2.1 Conventions used in the operating manual

Designation	Description
[Fx]	Function keys F1 to F5 on the front panel
[Text]	Buttons on the front panel
Arrow buttons **[Direction]**	⇨, ⇦, ⇧ and ⇩ buttons on the front panel
"Term"	Terms used in te instrument menues

2   Introduction

IMPORTANT: Read the operating manual carefully before using the equipment, and keep for future reference.

2.1   Intended use

The DIGIFORCE® 9307 is an instrument for monitoring repetitive production processes. Its core function is to record and analyze signals from processes in which physical variables, such as force, pressure or torque, vary as a function of displacement, angle or time according to a defined curve. The resultant measurement curve is analyzed using graphical evaluation elements such as windows, envelopes and thresholds. The result of the analysis is classified as "OK" or "NOT OK" (NOK) and can be retrieved from various interfaces.

The instrument is not a substitute for a safety device; for instance it cannot be used as an emergency stop device in a press for when the pressure exceeds a set limit.

2.2   Customer service

2.2.1   Customer service department

For repair inquiries, please telephone our Service department on +49 7224 645-53, or email: service@burster.com (Germany only). If you are outside Germany, you should contact your burster agent (see also www.burster.com).

Please have the serial number to hand. The serial number is essential to establishing the definite technical status of the instrument and providing help quickly. You will find the serial number on the type plate of the DIGIFORCE® 9307.

2.2.2   Contact person

If you have any questions relating to the DIGIFORCE® 9307, please go directly to burster praezisionsmesstechnik gmbh & co. kg, or if outside Germany, please contact your burster agent (see also www.burster.com).

Head office

burster praezisionsmesstechnik gmbh & co kg
Talstr. 1 - 5
76593 Gernsbach
Germany

Telephone: +49-7224-645-0
Fax: +49-7224-645-88
Email: info@burster.com

2.3   Download the test certificates

You have the option to download the test certificate for your DIGIFORCE® 9307 online. To do this, you need to register at http://www.burster.com/en/registration/. You can then download the test certificate directly by entering the serial number.

2.4   Ambient conditions

2.4.1   Storage conditions

The following requirements must be met when storing the DIGIFORCE® 9307:

- The DIGIFORCE® 9307 must be packed in clean packaging
- Store in dry environment
- No condensation
- Store at temperatures between 0° C and +60° C

2.4.2   Operating conditions

The following requirements must be met when operating the DIGIFORCE® 9307:

- Always operate indoors
- Maximum height: above sea level 2000 m
- Operate at temperatures between: +5 °C ... +40 °C, ideally +23 °C
- Humidity: 80% up to +31 °C, decreasing flinearly above that temperature to 50% at T_{max}, no condensation
- Class of protecion:1
- Transient overvoltage category: CAT II
- Potential with respect to ground: ≤ 12 VDC between analog ground and ground
- Supply voltage: 90 to 264 VAC_{eff}, 47 to 63 Hz

2.4.3   Restrictions on use

The DIGIFORCE® 9307 does not pose a hazard if used within its specification and in accordance with the safety regulations.

The manufacturer does not accept liability for any personal injury or property damage arising from misinterpretation of measurement results.

IMPORTANT: The DIGIFORCE® 9307 is not intended as a substitute for safety devices and protective equipment. Use safety devices and protective equipment.

2.4.4 Cleaning

⚠	⚠ **DANGER**
	Electrical shock hazard
	Disconnect the DIGIFORCE® 9307 from the power plug before cleaning.

Disconnect the DIGIFORCE® 9307 from the power plug and use a slightly damp cloth for cleaning the unit.

!	**NOTICE**
	Do **not** immerse the DIGIFORCE® 9307 in water or hold it under running water. Do not use strong cleaning agents as these may damage the DIGIFORCE® 9307. Use a slightly damp cloth to clean the DIGIFORCE® 9307.

2.5 Personal

Personnel must be familiar with the relevant regulations. They must follow these regulations. Only trained personnel who are familiar with the applicable safety regulations are permitted to operate the DIGIFORCE® 9307.

burster is happy to provide your operating personnel with training on the DIGIFORCE® 9307. To find out more, please look at our range of services at www.burster.com.

2.6 Contents of pack

The following components are supplied:

- DIGIFORCE® 9307
- Operating manual including burster software DVD
- 1 x power lead
- 2 x D-sub male connector, 9-pin for sensor connector (A, B)
- 1 x D-sub male connector, 37-pin for PLC connector *
- 1 x D-sub female connector, 37-pin for PLC connector *
- *) not included for devices with Fieldbus option

2.7   Unpacking

⚠	**DANGER**
	Electrical shock hazard
	Never switch on the DIGIFORCE® 9307 if it shows signs of damage incurred in transit. Only ever use the DIGIFORCE® 9307 under the conditions specified in this operating manual.

Inspect the DIGIFORCE® 9307 for damage. If you suspect that the unit has been damaged during shipping, notify the delivery company within 72 hours.

The DIGIFORCE® 9307 should be shipped only in its original packaging or in packaging capable of providing an equivalent degree of protection.

2.8   Warranty

burster praezisionsmesstechnik gmbh & co kg provides a manufacturer's warranty for a period of 24 months after delivery.

Any repairs required during this time will be made without charge. This does not include damage arising from improper use.

Please note the following when sending the DIGIFORCE® 9307 in for repair:

- If there is a problem with the DIGIFORCE® 9307, please attach a note to the DIGIFORCE® 9307 case summarizing the fault.

- Technical specifications subject to change at any time without notice.
  We also state explicitly that we do not accept liability for consequential damage.

- The DIGIFORCE® 9307 must always be dispatched in suitable packaging.

2.9   Conversions and modifications

Note: The warranty shall be deemed void **immediately** if you open or dismantle the DIGIFORCE® 9307 during the warranty period.

The DIGIFORCE® 9307 does not contain any parts that are intended to be serviced by the user. Only the manufacturer's own qualified personnel are permitted to open the DIGIFORCE® 9307.

It is not permitted to make any changes to the DIGIFORCE® 9307 without the written agreement of burster praezisionsmesstechnik gmbh & co kg. burster praezisionsmesstechnik gmbh & co kg does not accept liability for damages or injury if this condition is disregarded.

2.10 Error messages when the unit is powered up

During boot-up, the DIGIFORCE® 9307 may display certain error messages.

The following errors mean that the DIGIFORCE® 9307 must be sent in for checking and possibly repair:

German error message	English error message
"Nichtflüchtige Daten korrupt"	"Non-volatile data error"
"Abgleich Fehler"	"Calibration error"
"EEPROM von Analogplatine ist leer"	"EEPROM of analog board is empty"
"Fehler beim Lesen der MAC Adresse"	"MAC Address Reading Error"

In any of these cases, please call our Service department on +49-7224-645-53 or email: service@burster.com (Germany only). If you are outside Germany, you should contact your burster agent (see also www.burster.com).

Please refer to the additional guidance on packaging in section 2.7 "Unpacking" on page 16.

If any of the following error messages arise, you must contact our Service department (Germany only). If you are outside Germany, you should contact your burster agent (see also www.burster.com).

German error message	English error message
"Analogplatine wurde getauscht"	"Analog board has been exchanged"
"Fehler beim Lesen der Seriennummer"	"Serial Number Reading Error"

For further information, please refer to section 2.2 "Customer service**Fehler! Verweisquelle konnte nicht gefunden werden.**" on page 13.

3 Principles of design and operation

Please refer to the DIGIFORCE® 9307 data sheet for technical data, full details of dimensions, weight, degree of protection etc.

3.1 Range of functions

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. A powerful real-time operating system optimizes processes to run at a very fast cycle speed in the controller. It typically takes just 20ms to provide the global OK or NOK evaluation result, which can then be analyzed by the higher-level control system.

The DIGIFORCE® 9307 offers a variety of graphical evaluation elements: in addition to traditional evaluation windows with defined entry and exit sides, you can also use thresholds, trapezoids of type X or Y and envelopes. You can then input the individual evaluation results from the graphical tools into mathematical functions, providing even more analysis flexibility for a huge range of signal curves.

The DIGIFORCE® 9307 has a wide range of process control applications, including monitoring processes such as joining, riveting or calking, or checking torque curves, for instance for hinges or high-quality rotary controls. You can even monitor complex signal/time curves (e.g. pressure curves, leaks etc.) 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 means that you can use one DIGIFORCE® 9307 controller to monitor two synchronous processes. Alternatively, you can also evaluate an application with three process variables, for instance the force/displacement curve and an associated electrical value of a lifting electromagnet. While the DIGIFORCE® 9307 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.
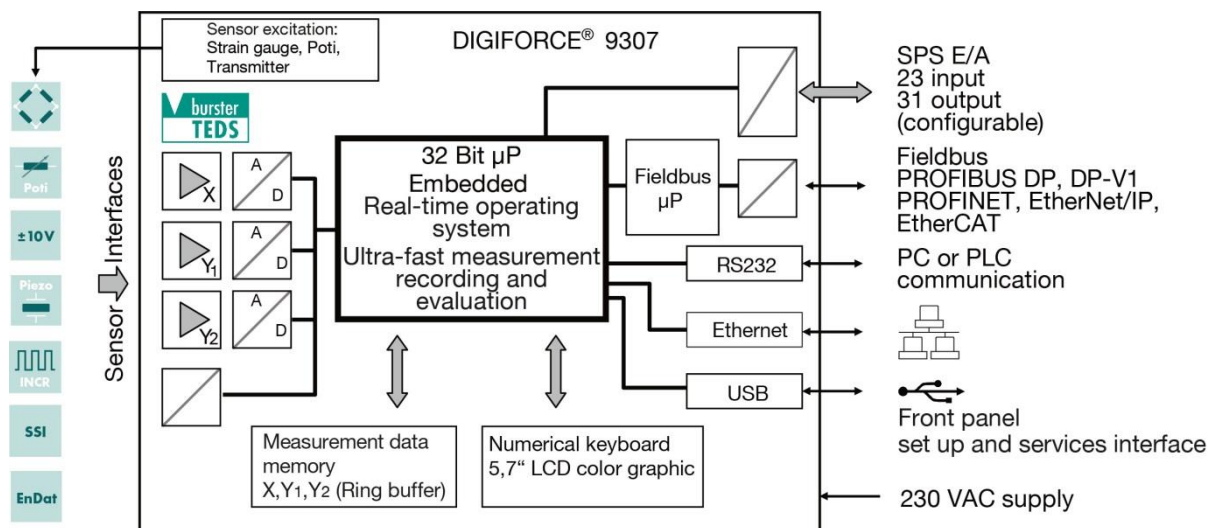
Diagram 1: Block diagram DIGIFORCE® 9307

3.2 Versions

The DIGIFORCE® 9307 lets you store 32 or optionally 128 measurement programs, and to switch rapidly between them during the process. This means that you can simply change the measurement program when you change parts or when performing sequential sub-processes on one work piece. A measurement program contains the full set of parameters for the sensors, the measurement procedure and the evaluation of the measurement curve(s). Select the program you require via the PLC interface (digital I/O or Fieldbus), a communications port or manually via the keypad.

Please refer to the data sheet for further details of the different model versions. You can obtain the latest data sheet and additional information on the DIGIFORCE® 9307 from https://goo.gl/7ZqwZN or simply use the QR code below:

3.2.1 32 measurement programs

The standard DIGIFORCE® 9307 model lets you manage up to 32 measurement programs. In addition, the DIGIFORCE® 9307 provides a very large memory for recording measurement curves with a depth of up to 5000 value pairs or value triplets.

3.2.2 128 measurement programs

Your DIGIFORCE® 9307 can handle up to 128 measurement programs if you use the DigiControl PC software to download a different instrument firmware package. The memory depth, however, is then reduced to 400 value pairs or value triplets.

3.3 Power supply

The DIGIFORCE® 9307 can be operated with a voltage of 90 … 264 VAC / 47 … 63 Hz / typical 30 VA.

⚠	**DANGER**
	Electrical shock hazard
	Inspect the power lead for damage before use. Do not connect the power lead if there are signs of damage.
	To help identify damage to the power lead in good time, test it regularly in accordance with national accident prevention regulations.

3.4 Suitable sensors

The DIGIFORCE® 9307 is able to process signals from a vast range of sensor technologies.

Note: The physical connectors, and hence the sensors connected to these connectors, are assigned to the recorded curve variables (X/Y1/2 curve) in the "Channel settings". configuration menu.

DIGIFORCE® 9307 works with these sensor technologies

Symbol	Model	Connector
	Strain gage sensor	A, B, D*
Poti	Potentiometer	A, B, D*
±10V	Process signal	A, B, D*
INCR	Incremental encoder with/without reference signal, distance coding	C
SSI	SSI sensor	C
EnDat	Heidenhain EnDat 2.2	C
(M)	Torque / angular displacement	D*
Piezo	Piezoelectric (option)	F*
Ω	Resistance measurement	E*

*) connectors D, E and F are optional

Connection example

Potentiometric displacement sensor, model 8712 → Connector A → Channel X (X-axis)

Tension and compression load cell, model 8524 → Connector B → Channel Y (Y-axis)

Force/displacement curve (X/Y graph)
F (N)
s (mm)
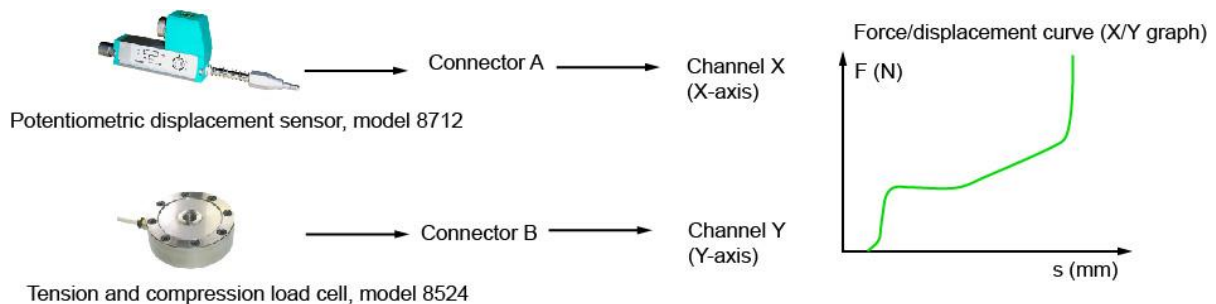
Diagram 2: Connection example

3.4.1 Automatic sensor identification (burster TEDS)

DIGIFORCE® 9307 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 plug, and can then use this data to perform the necessary channel configuration automatically. The memory chip in the sensor plug is programmed when the sensor is first ordered or subsequently calibrated. The burster TEDS feature is only available for sensors with a permanently fitted connecting lead.

Note: It is only possible to use the burster TEDS function at the standard connectors A and B (available for the following configuration onwards: serial number 530000 with software V201801 (32/128)).
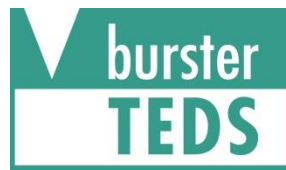
Diagram 3:   burster TEDS label

3.5 Recording measurement curves

An external control signal or an internal condition triggers the measurement. Immediately after receiving this active start condition, the DIGIFORCE® 9307 starts to write to the data memory the values measured by the sensors as X/Y value pairs. The DIGIFORCE® 9307 stops making these measurements when a stop condition is met.

Evaluation of the recorded measurement curve begins straight afterwards, with the DIGIFORCE® 9307 checking whether the curve satisfies all the defined evaluation elements. If this is the case, the measurement is assessed as "OK". If at least one evaluation condition has been infringed, however, the DIGIFORCE® 9307 assesses the measurement as "NOK".

The DIGIFORCE® 9307 refreshes the display in the measurement menu and also the control signals at the PLC interface as soon as the evaluation has finished.

3.5.1 Starting/stopping a measurement

You can use different events as a start and/or stop signal. These events do not need to relate to each other.

Starting a measurement:

- External control signal
- Sensor reading above or below a defined X-value (e.g. a linear position).
- Sensor reading above or below a defined Y-value (e.g. a force).

Stopping a measurement:

- External control signal
- Sensor reading above or below a defined X-value (e.g. a linear position).
- Sensor reading above or below a defined Y-value (e.g. a force).
- Time (timeout)
- Specified number of recorded measurements reached (user can specify number)

3.5.2 Sampling methods for the measurement signals

The DIGIFORCE® 9307 supports three different sampling methods, which you can also use in combination. In addition to time-based sampling, you can use a definable delta (Δ) X-value or delta (Δ) Y-value to record the pairs of curve values. This means that the DIGIFORCE® 9307 uses only the optimum number of sample points to record a curve accurately and to reproduce it in full. For instance it uses only a very few points to measure a force/displacement curve, which has a small gradient over the initial travel region of the joining process followed by a steep gradient into a block force.

♦ recorded measurement-value pair
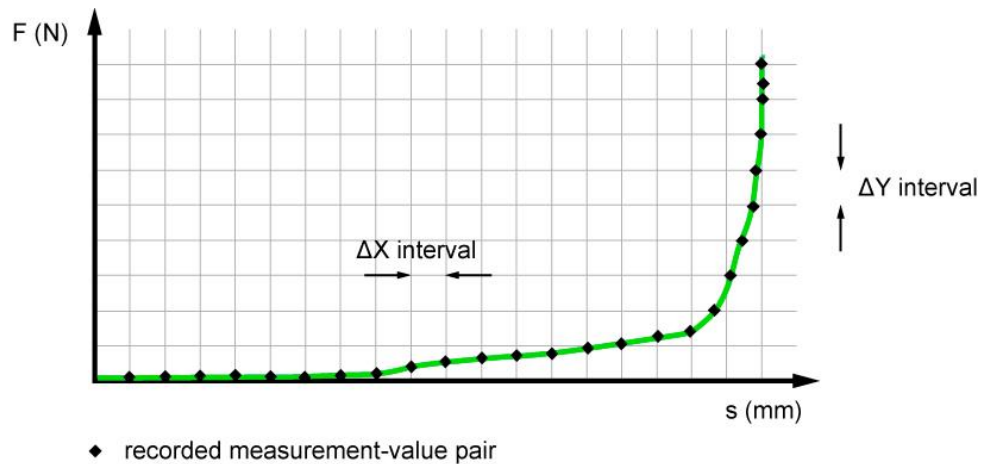
Diagram 4:   Sampling methods for the measurement signals

3.5.3 Specifying the X-axis reference

A measurement curve recorded in the DIGIFORCE® 9307 can be based on different reference points. In the case of a force/displacement curve, this reference is a defined position. In a conventional application using the ABSOLUTE reference, the reference point equals the zero point of the position measurement system. Component tolerances or tolerances in tool changeover systems, work piece supports etc. produce a spread in the X-values of the measurement curves. This spread means that the result of an evaluation element could shift into the "NOK" category. You can eliminate this spread in results, however, by using other reference points.

The DIGIFORCE® 9307 provides the following reference options:

- ABSOLUTE
- FINAL FORCE
- REFERENCE LINE overshoot/undershoot
- TRIGGER overshoot/undershoot

3.5.3.1 ABSOLUTE reference

With the ABSOLUTE setting you are defining the X-axis reference of the measurement curve to be the zero point of the sensor connected to that channel. For sensors that provide relative measurements, such as incremental linear or rotary encoders, the origin of the X-axis can also be the start signal for the measurement.

You can also choose the ABSOLUTE reference option when you are able to position both parts involved in a joining process with repeat precision, i.e. the work piece support always positions the work piece at the same height and the two parts to be joined (A+B) themselves have negligible tolerances in the insertion direction. In addition, part A must always start in the same position with respect to part B.
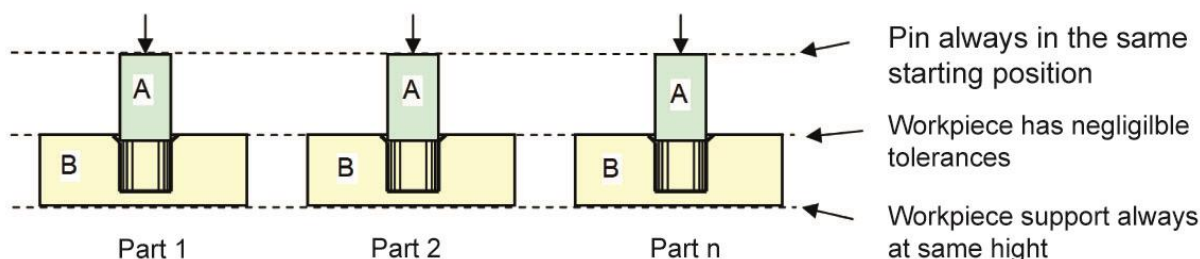
Diagram 5:   ABSOLUTE reference
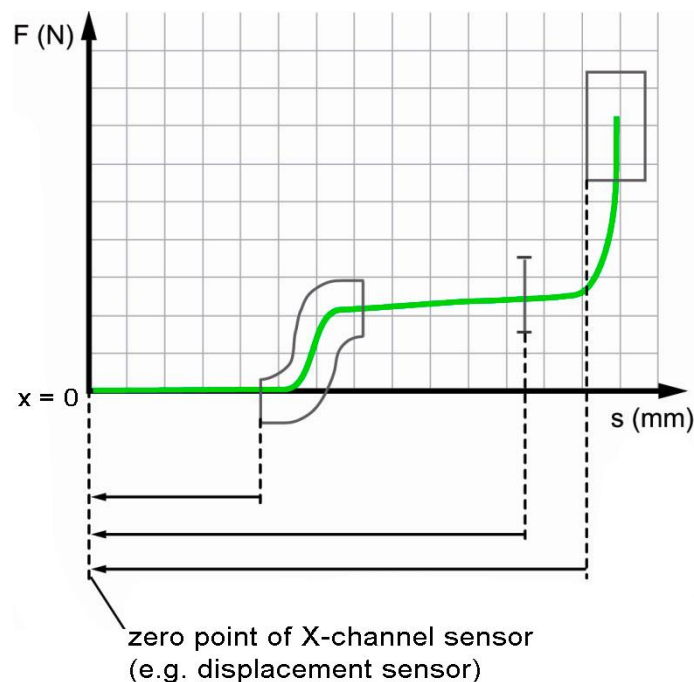
Diagram 6:   Measurement curve with ABSOLUTE reference (example)

3.5.3.2 FINAL FORCE reference

With the FINAL FORCE reference, the DIGIFORCE® 9307 delays the curve to after the measurement phase and references it to the last measurement point (final force). For a measurement curve with a forward and return section, the DIGIFORCE® 9307 sets the turning point as the zero point when "final force" is selected as the reference.

In joining processes, the block position is often known precisely and validated in advance, for instance the depth of the hole in a bearing seat. The press reaches its maximum force at this point. The DIGIFORCE® 9307 will then use this position as the reference value (zero) in the evaluation.
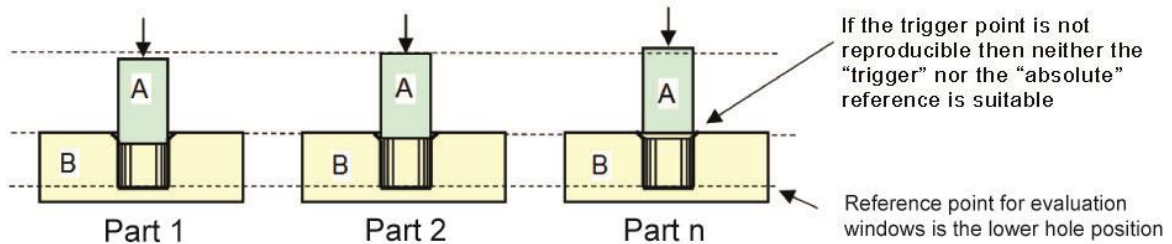
Diagram 7:   FINAL FORCE reference
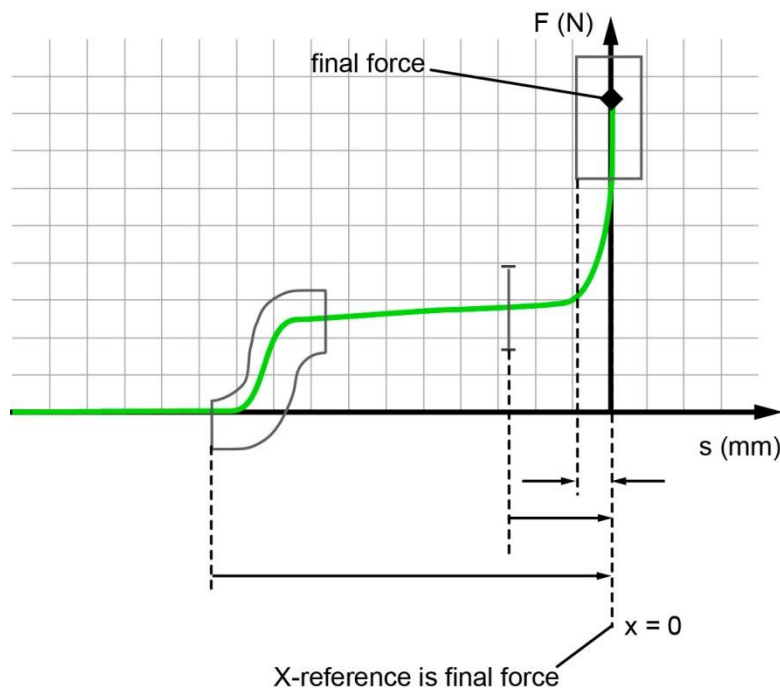
Diagram 8:   Measurement curve with FINAL FORCE reference (example)

Note: In pneumatic or hydraulic presses, for instance, variations in the final force and the associated bending of the mounting system (press frame) may also cause variations in the X-position. The evaluation element "Window with active online response" uses the absolute X-reference (for instance for early detection of faulty joining processes before the join is made).

3.5.3.3 REFERENCE LINE reference (overshoot/undershoot)

With the REFERENCE LINE reference, the DIGIFORCE® 9307 delays the curve until after the measurement phase. It then references the curve to the point where the Y-value went above or below a configurable Y-level.

If the final force of a pneumatic or hydraulic press varies, then using the final force as a reference would produce a spread in otherwise identical measurement curves. You can eliminate this variation, however, by selecting a reference line that lies below the final force of the press.
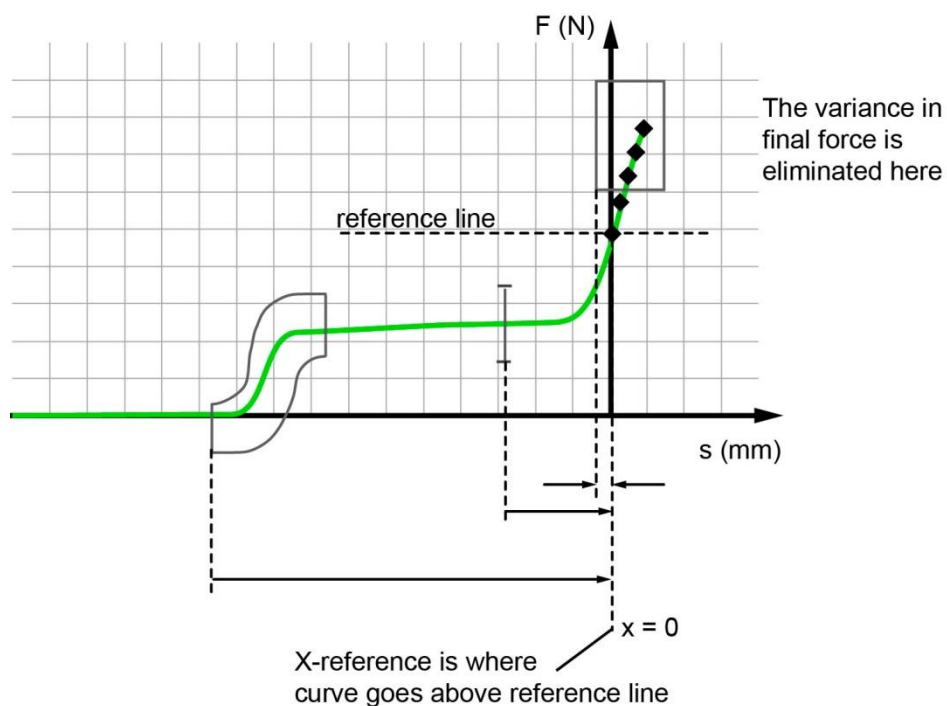
Diagram 9:   Measurement curve with REFERENCE LINE reference (example)

Note: The evaluation element "Window with active online response" uses the absolute X-reference (for instance for early detection of faulty joining processes before the join is made).

3.5.3.4   TRIGGER reference (overshoot/undershoot)

Unlike the references ABSOLUTE, FINAL FORCE and REFERENCE LINE, with the TRIGGER reference, recording of measurements does not start until readings go above or below the configured threshold (e.g. force threshold). Then the DIGIFORCE® 9307 writes the subsequent value pairs of the measurement curve to the curve memory. Therefore the DIGIFORCE® 9307 does not save any curve data in the period between the start of the measurement phase and the trigger event (it merely captures a few measurement points immediately prior to the event, known as the pretrigger). In this case, the point at which measurements go above or below the trigger threshold is used as the reference point (X = 0).

The TRIGGER reference helps to eliminate allowed component tolerances from the X/Y curve. For instance, when inserting a straight pin into a shaft coupling, the force/displacement recording is started when the press head touches the component. The DIGIFORCE® 9307 simultaneously references the force/displacement recording to the configurable contact force.

Press touches the part at different displacement positions (trigger point)

Tolerances of part B would cause the press-fit curve to shift along the displacement axis
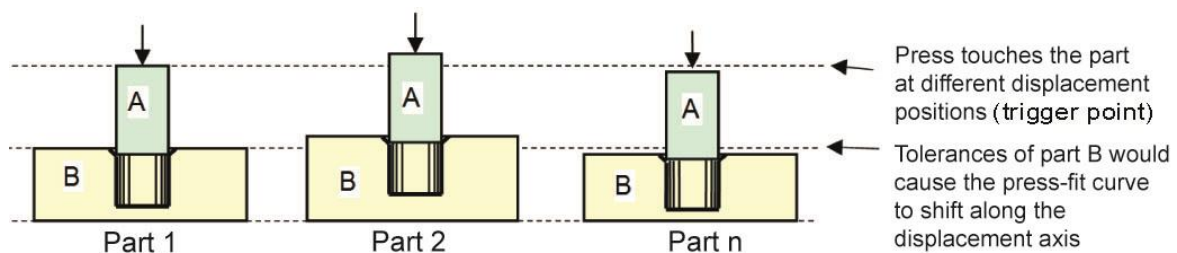
Diagram 10: TRIGGER reference
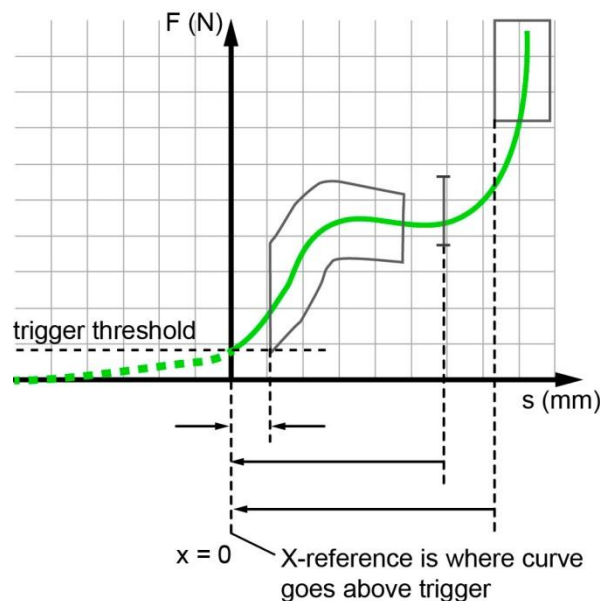
Diagram 11: Measurement curve with TRIGGER reference (example)

Note: The measurement must have started before the trigger event happens!
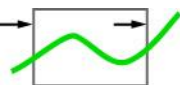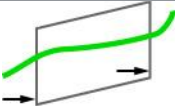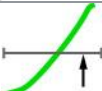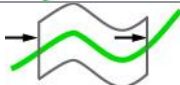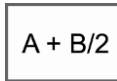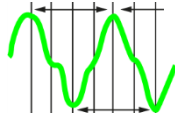
3.6   Evaluation methods

As a truly multi-purpose evaluation tool, the DIGIFORCE® 9307 offers a wide selection of configurable evaluation elements. These can be used for OK/NOK classification of a vast range of curve types.

In addition to traditional evaluation windows with defined entry and exit sides, you can also use thresholds, trapezoids of type X or Y and envelopes as graphical evaluation tools. These give you the extra flexibility you need when evaluating signal waveforms that differ so widely.

The graphical evaluation elements can be configured numerically or graphically using one or more recorded measurement curves.

Summary of evaluation elements
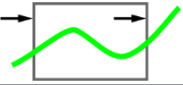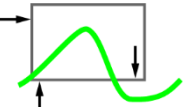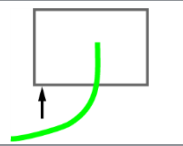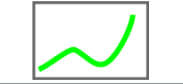
Symbol	Evaluation element	Max. number
	Evaluation window with configurable entry/exit sides, online signal, entry/exit, min/max values, mean value ...	10
	Trapezoid window of type X or Y, configurable entry/exit side	4
	Schwelle Typ X oder Y, konfigurierbarer Durchlauf	4
	Threshold of type X or Y, configurable crossing	2
A + B/2	Mathematical function, basic operation (+, - , x , ÷) including evaluation (comparison with min/max)	10*
	Rotary-switch evaluation for monitoring periodic cycles between maxima and minima	2

* DIGIFORCE® 9307 can evaluate up to 6 results.

3.6.1 Evaluation windows

You can enable up to ten windows in one measurement program. You define the "Window evaluation element" by the corner points of a rectangle: X_{MIN}, X_{MAX}, Y_{MIN} and Y_{MAX}. You can specify almost any criteria for how the measurement curve enters or exits the window. For instance, the block situation of a press-insertion process can be monitored using "Entry bottom" and "No exit".

Examples of evaluation elements

	Window with "Left" entry side and "Right" exit side (pass-through window)
	Window with two entry sides, "Left" or "Bottom", and one exit side, "Bottom", (pass-through window)
	Window with one entry side, "Bottom" (block window)
	Window without entry or exit; measurement curve lies entirely within window limits
	Window without entry or exit; measurement curve lies entirely outside window limits (Not window)

You can assign an online signal to up to two windows per measurement program. If there is any infringement of the window entry/exit criteria, the DIGIFORCE® 9307 will immediately enable the associated online signal at the process interface during the measurement. This lets you intervene directly and rapidly in the process as soon as the DIGIFORCE® 9307 has registered a deviation from the desired curve.

After the measurement phase, the Window evaluation element outputs an OK/NOK result. In addition, the DIGIFORCE® 9307 calculates the extra information listed below. The DIGIFORCE® 9307 can display this information and also process and/or evaluate it with user-definable mathematical functions.
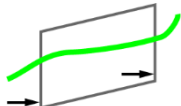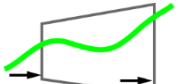
- Entry and exit coordinates (measurement-value pairs)
- Local minimum/maximum
- Absolute minimum/maximum
- Mean value
- Integral (area to lower window limit)
- Curve gradient
- Inflexion point
- Additional results when recording two curves Y1(x) and Y2(x) (see section 0 "
- Additional results when recording two curves Y1(x) and Y2(x)" on page 137)

3.6.2 Trapezoid window
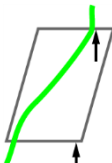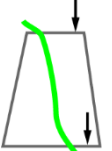
The DIGIFORCE® 9307 classifies trapezoid windows into two types: the X trapezoid and the Y trapezoid. The X trapezoid uses fixed X limits, X_{MIN} and X_{MAX}; the Y trapezoid uses fixed Y limits, Y_{MIN} and Y_{MAX}.

You can enable up to four trapezoid windows in one measurement program. They output an OK/NOK result after the measurement phase. In addition, the DIGIFORCE® 9307 calculates the entry and exit points.

Examples of X trapezoids

	X trapezoid with "Left" entry side and "Right" exit side
	X trapezoid with "Left" entry side and "Right" exit side

Examples of Y trapezoids

	Y trapezoid with "Bottom" entry side and "Top" exit side
	Y trapezoid with "Top" entry side and "Bottom" exit side
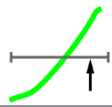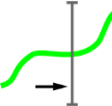
3.6.3 Tresholds

The "Threshold" evaluation element can be used to calculate and monitor where the measurement curve passes through a defined X-value or Y-value. As user, you can choose between threshold type X (vertical) or Y (horizontal).

You can enable up to four thresholds at once in one measurement program.

Thresholds output an OK/NOK result after the measurement phase. In addition, if the curve crosses the threshold, the DIGIFORCE® 9307 calculates the crossing point.

Examples of thresholds
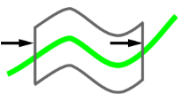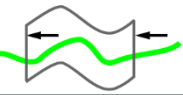
	Y threshold with passage from „Bottom" to „Top"
	X threshold with passage from „Left" to „Right"
	X threshold without crossing

3.6.4 Envelopes

The DIGIFORCE® 9307 can use one or more measurement curves to generate up to two envelopes per measurement program. Once you have created your envelope in this way, you can then customize it in the X-domain and also set tolerances in the Y-domain. For a measurement curve comprising a forward and return curve section, the envelope must **not** lie over the turning point.

In measurement mode, the DIGIFORCE® 9307 checks whether the measurement curve lies inside the defined envelope band. If this is the case, the measurement curve is assessed as OK. If, however, the measurement curve has strayed outside the band of the envelope even once, the DIGIFORCE® 9307 will give the curve an NOK assessment.

Examples of envelopes

	Envelope with passage from "Left" to "Right"
	Envelope with passage from "Right" to "Left"
	Envelope with passage from "Bottom" to "Top"

3.6.5   Mathematical functions

You can use the mathematical functions to perform up to ten basic operations (addition, subtraction, multiplication and division). These can be applied, for instance, to the results of the graphical evaluation elements. The DIGIFORCE® 9307 can display the results of these functions as values in a measurement window. It can also monitor these results for compliance with Min/Max limits. The evaluation is fed into the global OK/NOK evaluation result.

Example

The haptic behavior in the latching of a switch is a quality criterion. This is why the force/displacement curve during switch actuation must be monitored when measuring the mechanical characteristics of an electrical switch. Window [F1] is used to fix the curve at the first local maximum, while window [F2] performs the same function at the next local minimum. The DIGIFORCE® 9307 then uses an extra mathematical function to find the difference value A of the two extreme values, and checks that it lies between the Min./Max limits.

Operation:

$[F1]Y_{MAX} - [F2]Y_{MIN} = A$

Evaluation:

$10.5 << A << 12.5$
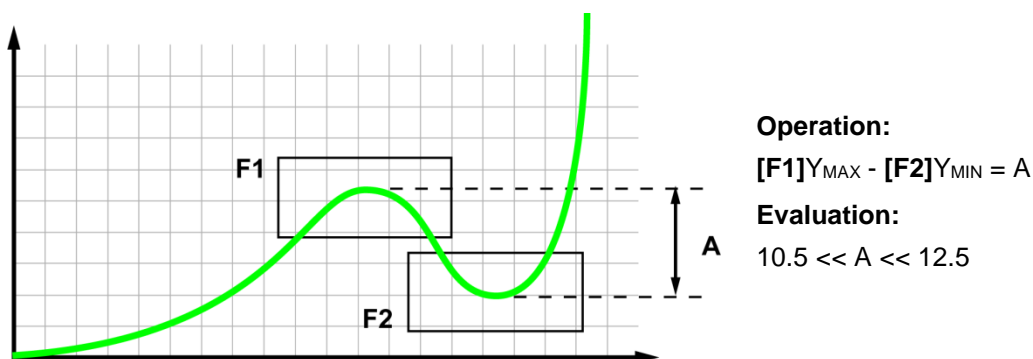
Diagram 12: Mathematical functions

3.6.6   Rotary switch evaluation

The DIGIFORCE® 9307 can use the "Rotary switch evaluation" function to monitor periodic cycles between maxima and minima. These periodic variations arise, for instance, when measuring the torque and angle for rotary controls. To monitor such curves, in the rotary switch evaluation elements you can define up to two independent tolerance bands per measurement, each band containing up to 32 maxima and 32 minima respectively.

Inside the rotary switch evaluation elements, the DIGIFORCE® 9307 monitors the following criteria:

- Number of maxima inside the rotary switch element

- Number of minima inside the rotary switch element

- X distance between maxima

- X distance between minima

- Delta Y across all maxima

- Delta Y across all minima
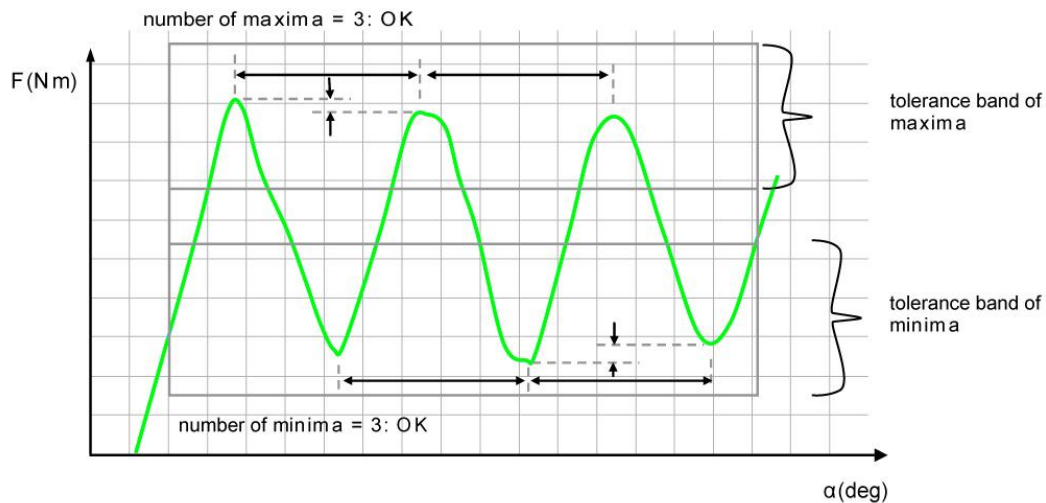
Diagram 13: Rotary switch evaluation

3.7   Tare function

You can use the Tare function to correct for static offsets on the sensor channels. For instance you can correct for a varying base load, e.g. produced by a tool changeover system, before each measurement. For strain gage sensors you can also define a warning limit. This warning limit is useful for identifying signs of wear early, thereby avoiding any associated measurement errors. If, with the Tare function enabled, the active measurement value exceeds the saved warning limit, the DIGIFORCE® 9307 outputs the "OUT_TARE_WARNING" signal.

Actuating the Tare function:

- Manually in the "Test operation simple" menu (numerical)

- Manually with customized assignment of the Function keys [F1] to [F5].

- Automated via the control interface (PLC I/O or Fieldbus)

- Automatically at the start of a measurement

3.8   Sensor test

Regular checking of sensors plays a crucial role in the test reliability of a quality control system. This is done by applying defined physical quantities to the sensors. The DIGIFORCE® 9307 then evaluates the resultant electrical signals.

To program the values for these checks, a feed unit, for example, moves into a reproducible position, such as the top end stop on a press, or onto a master part. In this position, the DIGIFORCE® 9307 records the values measured on the channels and gives them tolerance ranges.

During a routine check of the sensors, measurements are performed again precisely at these positions. Then a PLC control signal ("IN_STEST") initiates a check of the readings given by the sensors. If a sensor lies outside the tolerance range, the DIGIFORCE® 9307 sends a warning signal to the PLC ("OUT_OK_ STEST" = 0). This practically eliminates any erroneous measurements from faulty or drifting sensors.

3.9   Online switching points

Online switching points are used to output a signal to the control interface (PLC I/O or PROFIBUS) in real time if a measurement exceeds a set signal level. Four switching points S1...S4 are required for this function: you are free to set their polarity and assign them to the three measurement channels X, Y_1 and Y_2 in any way you wish.

When assigning a switching signal to the X-channel, the set level (limit) can be referenced to the absolute or relative zero point (trigger event).

These switching points are updated both during and outside an active measurement cycle in real time.

3.10   Visualization, signaling and transfer

Immediately a measurement has finished the DIGIFORCE® 9307 shifts into the evaluation phase. In this phase, it checks whether the measurement curve satisfies the conditions set by the evaluation elements such as windows and envelopes or by the mathematical functions. If this is the case, the DIGIFORCE® 9307 assesses the measurement as OK. If, however, it detects any infringement of the evaluation elements, it assesses the measurement as NOK.

Along with updating the global OK or NOK result at the end of the measurement, the DIGIFORCE® 9307 also refreshes the active measurement window in the display, the relevant PLC I/O signals and also any relevant status signals and event values on the Fieldbus interface. After a measurement you can retrieve curve and measurement result values from the communications interfaces (Ethernet, USB or RS-232). This data can then be logged automatically after each measurement using the DigiControl PC software. This process can also run synchronously with a bank of DIGIFORCE® 9307 instruments.

3.11 Setup tools

The DIGIFORCE® 9307 provides a setup mode to help you configure the entire measurement chain ready for use. This setup mode includes a numerical setup mode and a graphical setup mode that lets you set and edit evaluation elements graphically.

For sensors that you have newly connected or set up, numerical setup mode helps you get a first impression by displaying the live signals from all active measurement channels. You can also use this mode for calibrations by looking at static measurement values. In addition, the digital PLC I/O signals are displayed in this mode. Here you have the facility to set or reset the individual signals.

In graphical setup mode you can create and edit the individual evaluation elements, such as windows, graphically. The DIGIFORCE® 9307 can help you here by displaying one or more measurement curves, which you can then use to set the evaluation elements or to adjust their position and size. The graphical setup mode provides a cursor function as a tool for looking at curves in detail or for measuring individual curve sections.

The complex setup mode lets you record multiple measurements in different measurement programs. You can then edit the evaluation elements of the individual measurement programs. This function is particularly useful in an automated environment in which different measurements are running in a sequence of different measurement programs.

DIGIFORCE® 9307

4 Controls and connections

4.1 Front panel
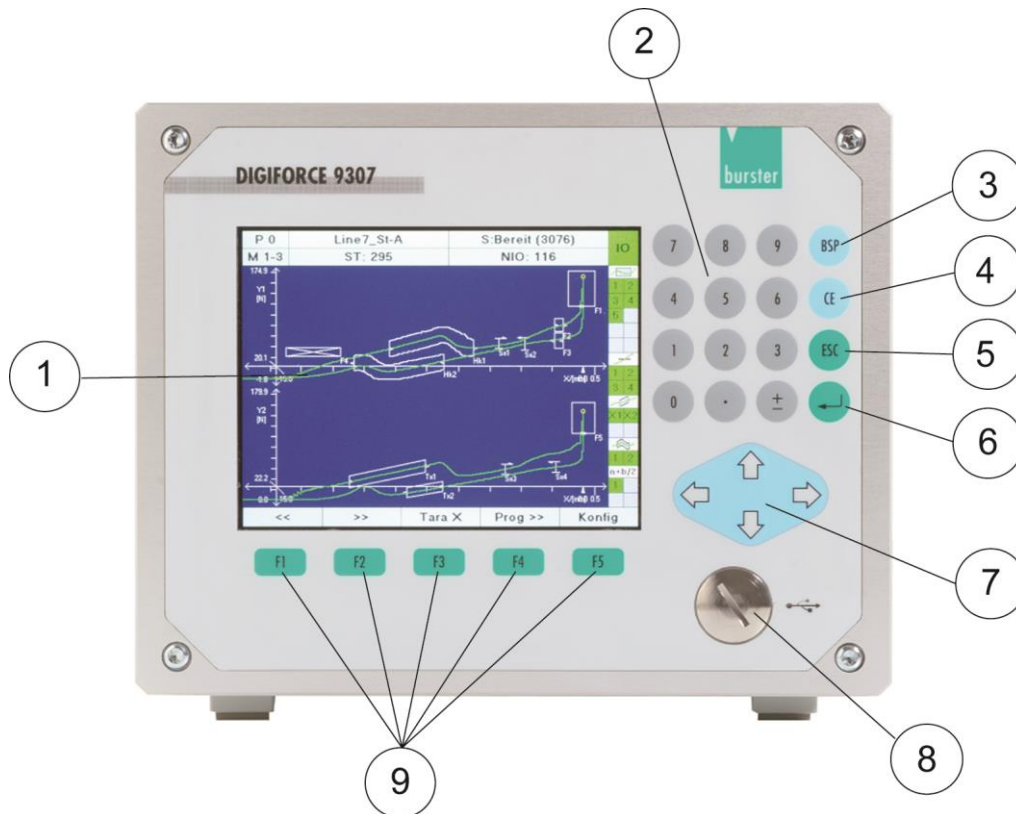
Diagram 14: Front panel DIGIFORCE® 9307

Number	Meaning
1	Screen
2	Number keys
3	**[BSP]**, Backspace key
4	**[CE]**, Delete key
5	**[ESC]**, Escape key (back to measurement mode)
6	↵ , **[Enter],** Enter key
7	Arrow buttons ⇦, ⇨, ⇧, ⇩
8	USB port (below screw)
9	**[F1]** - **[F5]**, Function keys

4.2 Rear view
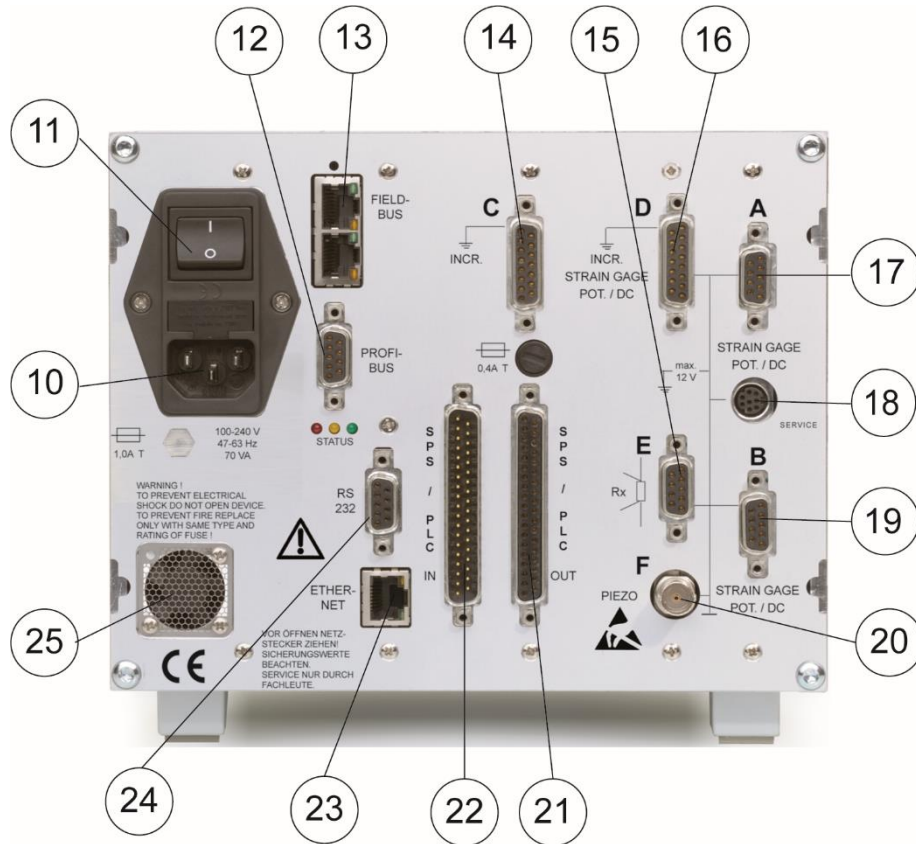
Diagram 15: Rear view DIGIFORCE® 9307

Number	Meaning
10	Power connection
11	Power switch
12	PROFIBUS DP-V0 / DP-V1 (optional)
13	Ethernet based fieldbus (optional)
14	C, Incremental connector (EnDat, SSI)
15	E, Resistance measurement connector (optional)
16	D, Combined connector (incremental, strain gage, potentiometer, Process signal) (optional)
17	A, Standard analog connector (strain gage, potentiometer, Process signal)
18	Service connector (only for servicing)
19	B, Standard analog connector (strain gage, potentiometer, Process signal)
20	Piezo input (optional)
21	PLC output 24 VDC
22	PLC input 24 VDC
23	Ethernet interface
24	RS232-interface
25	Fan with built-in temperature monitoring (activated once the internal temperature is ≥ 60 °C)

4.3 Grounding and shielding

The DIGIFORCE® 9307 is grounded via the PE conductor connected to the cooling unit (Class I appliance). All metal conducting parts are grounded in accordance with IEC60204 / EN60204. This grounding prevents dangerous voltages occurring on these parts in the event of unexpected and unnoticed insulation faults.

Use suitable cables for connecting the sensors, for connections to the communications ports and Fieldbus ports and for the PLC I/O control signals. These cables should be double shielded (aluminum foil and braid). Ideally you should connect the sensors using burster connecting cables, using as short a length as possible.

We strongly recommend the following points:

- Use metallic or metal-plated connectors. Connect the braid shield of shielded cables to the connector casing.

- As a general rule, keep sensor connecting cables as short as possible. This is particularly important for connectors C (for 11µASS signals), D (resistance measurement) and F (piezoelectric).

- For connector F (piezoelectric), it is best to use a suitable connecting cable from the sensor manufacturer.

- When using control lines from remote PLC systems, make sure that all system components are grounded.

- When using detachable extension leads, make sure that shielding is continuous.

4.4 Connections

4.4.1 PLC input

!	**NOTICE**
	+24 VDC supply voltage! Only connect devices that are designed for this supply voltage.

The PLC inputs on the DIGIFORCE® 9307 all have a fixed function and cannot be re-assigned.
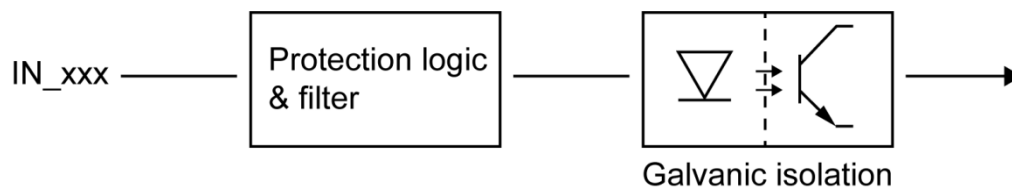
Diagram 16: Block diagram of the PLC inputs on the DIGIFORCE® 9307

	Unit	Min	typically	Max
Input inactive	V	0	0	5
Input active	V	15	24	30
Input current	mA	2	-	5

PLC input
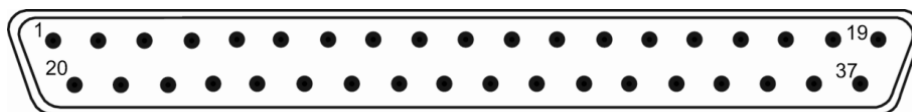
Pin	Signal name	Meaning
1	IN_STEST	Sensor Test
2	IN_START	External start / stop for measurement
3	+24VDC_INT	24 V DC / 300 mA auxiliary power (linked to PLC outputs: pin 1)
4	IN_STROBE	Read measurement program no. on IN_PROG[ ]
5	IN_PROG0	Measurement program no. bit 0 (binary coded)
6	IN_PROG1	Measurement program no. bit 1 (binary coded)
7	IN_PROG2	Measurement program no. bit 2 (binary coded)
8	IN_PROG3	Measurement program no. bit 3 (binary coded)
9	IN_PROG4	Measurement program no. bit 4 (binary coded)
10	IN_RESET	Reset all statistical data
11	IN_LTEST	Line test (set all PLC outputs to "high")
12	IN_AUTO	Instrument is kept in measurement mode (AUTO mode)
13	IN_TAREX	Tare the X-channel
14	IN_TAREY1	Tare Y-channel 1
15	-	Reserved
16	-	Reserved
17	-	Reserved
18	IN_ACK_OK	Signal light: OK acknowledgement
19	GND_EXT	GND (ground reference)
20	+24VDC_EXT	+24 V DC external supply voltage (linked to PLC outputs)
21	-	Reserved
22	-	Reserved
23	-	Reserved
24	-	Reserved
25	-	Reserved
26	-	Reserved
27	-	Reserved
28	IN_PROG5 *	Measurement program no. bit 5 (binary coded)
29	IN_PROG6 *	Measurement program no. bit 6 (binary coded)
30	IN_TEST_OP	Setup mode (evaluation without counter)
31	IN_TEST_OPC	Setup mode (recording a set of curves)
32	IN_TAREY2	Tare Y-channel 2
33	-	Reserved
34	-	Reserved
35	IN_REF_MEAS	Reference travel for incremental sensors with distance coding
36	IN_ACK_NOK	Signal light: NOK acknowledgement
37	GND_EXT	GND (ground reference)

*) IN_PROG 6…5 in firmware with 128 measurement programs

4.4.2 PLC output

The PLC outputs of the DIGIFORCE® 9307 are positive switching (current sourcing logic).
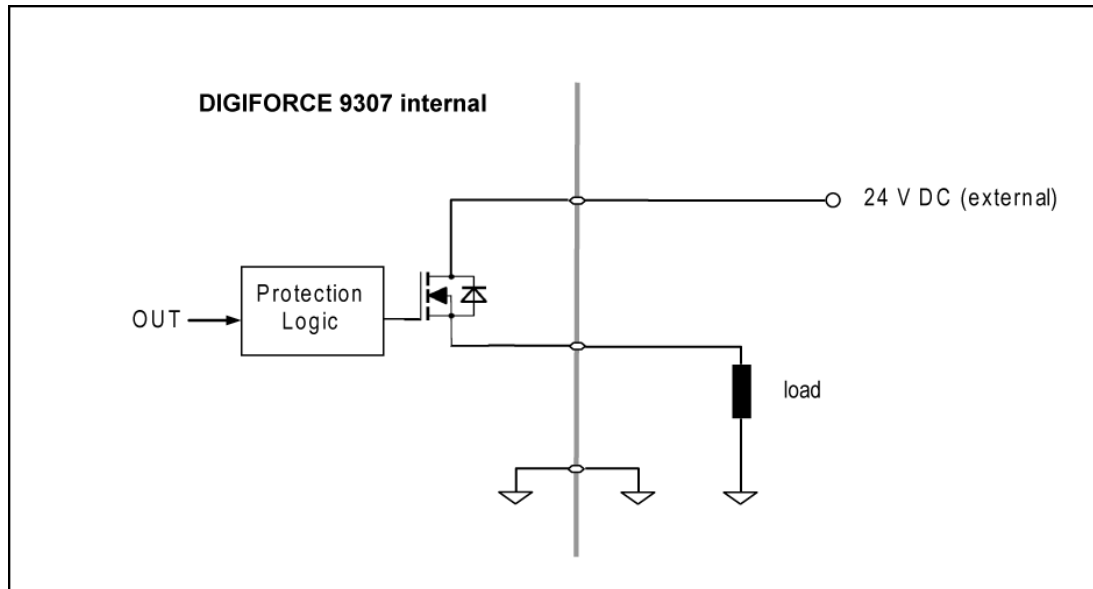
Diagram 17: PLC output

A total of eight outputs have a fixed assignment to the main functions such as "OUT_OK", "OUT_NOK", "OUT_READY".

You can assign the other 23 outputs to different functions, for instance to the single result from a selected evaluation element. The instrument is shipped so that the user-definable outputs have the same assignments as in the forerunner DIGIFORCE® 9306.

You can re-assign these outputs in the menu "Assignment of the PLC outputs" under the Basic setup menu (see section 5.3.9 "Assigning PLC outputs" on page 58. The outputs will only work properly if the external 24 V DC supply is suitably rated. As an option, you can use the auxiliary voltage provided to supply the outputs (connection of pin 1 with pin 20).

PLC output
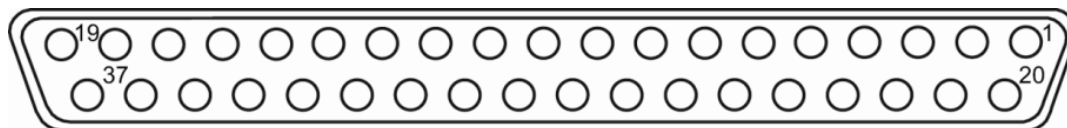
4.4.2.1 PLC outputs with fixed assignment

Pin	Signal name	Meaning
1	+24VDC_INT	24 V DC / 300 mA auxiliary power (reference GND_EXT, pin 19, 37)
3	OUT_READY	Ready for the measurement
4	OUT_OK	Overall measurement result was OK
5	OUT_NOK	Overall measurement result was NOK
7	OUT_NOK_ONL1	Online- NOK 1, online signal for "Window" evaluation element
14	OUT_S1	Online switching signal 1
15	OUT_S2	Online switching signal 2
18	-	-
19	GND_EXT	GND (ground reference) for 24 V DC EXT (pin 20)
20	+24VDC_EXT	24 V DC external supply voltage
34	OUT_NOK_ONL2	Online- NOK 2, online signal for "Window" evaluation element
35	OUT_ERROR	FAULT *
36	OUT_BUZZER	PWM signal for external buzzer
37	GND_EXT	GND (ground reference) for 24 V DC EXT (pin 20)

* Cause of fault:

- Start measurement when READY = Ø

- Measurement-channel overdrive

- Device error during boot-up procedure

4.4.2.2 PLC output with configurable assignment

Pin	PLC output	Factory settings
2	Output 1	OUT_STROBE; validity of echoed measurement program
6	Output 2	OUT_OK_SENSORTEST; sensor test result
8	Output 3	OUT_NOK_WINDOW_9 (Window 9 evaluation element NOK)
9	Output 4	OUT_PROG0 (bit 0 of echoed measurement program)
10	Output 5	OUT_PROG1 (bit 1 of echoed measurement program)
11	Output 6	OUT_PROG2 (bit 2 of echoed measurement program)
12	Output 7	OUT_PROG3 (bit 3 of echoed measurement program)
13	Output 8	OUT_PROG4 (bit 4 of echoed measurement program)
16	Output 9	OUT_S3 (online switching signal S3)
17	Output 10	OUT_S4 (online switching signal S4)
21	Output 11	OUT_NOK_WINDOW_8 (Window 8 evaluation element NOK)
22	Output 12	OUT_NOK_WINDOW_7 (Window 7 evaluation element NOK)
23	Output 13	OUT_NOK_WINDOW_6 (Window 6 evaluation element NOK)
24	Output 14	OUT_NOK_WINDOW_5 (Window 5 evaluation element NOK)
25	Output 15	OUT_NOK_WINDOW_4 (Window 4 evaluation element NOK)
26	Output 16	OUT_NOK_WINDOW_3 (Window 3 evaluation element NOK)
27	Output 17	OUT_NOK_WINDOW_2 (Window 2 evaluation element NOK)
28	Output 18	OUT_NOK_WINDOW_1 (Window 1 evaluation element NOK)
29	Output 19	OUT_WARNING_TARE (Tare warning active)
30	Output 20	OUT_WARNING_TOOLCOUNT (tool counter reading above warning limit)
31	Output 21	OUT_WARNING_TOTAL (Warning active)
32	Output 22	OUT_TEST_OP_SIMPLE (instrument in setup mode)
33	Output 23	OUT_TEST_OP_COMPLEX (instrument in complex setup mode)

Note: Please look in section 6.3.9 "Assigning PLC outputs" on page 67 to find out how to re-assign these settings

4.4.3   Connectors A, B: Strain gage, potentiometer, normalized signal

!	**NOTICE**
	+24 VDC supply voltage! Only connect devices that are designed for this supply voltage.

Connector A and B

PIN	Meaning
1	+ excitation for strain gage, potentiometer
2	+ Sense
3	+24 VDC / 300 mA transmitter excitation*[1]
4	- Sense
5	- excitation for strain gage, potentiometer
6	+ signal (input)
7	burster TEDS: 1-Wire® EEPROM*[2]
8	Ground for transmitter excitation*[1]
9	- signal (input)
Enclosure	Shield (ground potential)

*[1] You can use the software to enable/disable transmitter excitation. Transmitter excitation is factory-set to disabled.

*[2] The 1-Wire® interface uses the shield as the ground potential (available for serial number 530000 and above (Q2/2018)).

4.4.3.1 Connector A, B: Connection guidance for strain gage sensors without sensor leads

You can connect strain gage sensors without sensor leads to connector "A" and "B".

+ excitation	1
+ sense	2
+ signal	6
- sense	4
- excitation	5
- signal	9
casing	
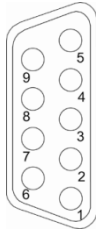
strain gauge

Connector A, B, view towards rear of unit (female connector)
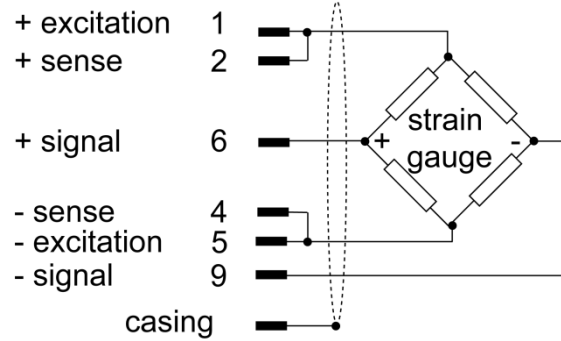
4.4.3.2 Connector A, B: Connection guidance for strain gage without sensor leads, fitted with burster TEDS

You can connect strain gage sensors without sensor leads, fitted with burster TEDS to connector "A" and "B".

+ excitation	1
+ sense	2
+ signal	6
- excitation	4
- sense	5
- signal	9
	7
shield	

strain gauge

1-Wire® EEPROM
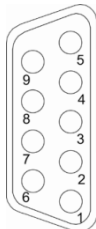
Connector A, B, view towards rear of unit (female connector)
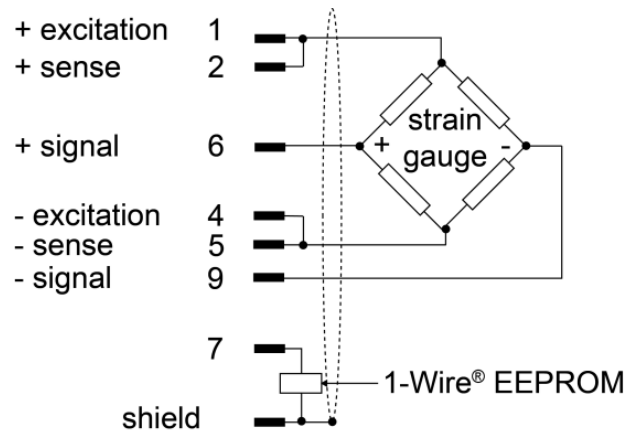
4.4.3.3 Connector A, B: Connection guidance for strain gage sensors with sensor leads

You can connect strain gage sensors with sensor leads to connector "A" and "B".

+ excitation 1
+ sense   2

+ signal   6

- sense   4
- excitation 5
- signal   9
casing

strain gauge

extension cable   sensor
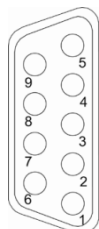
Connector A, B, view towards
rear of unit (female connector)
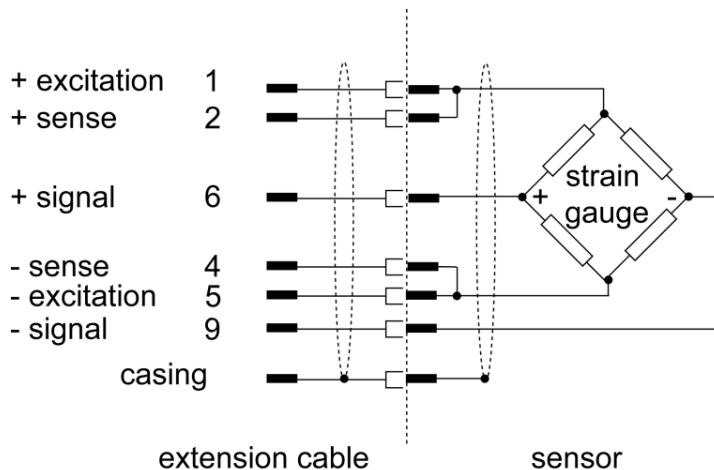
Make the connections between the sense lines and excitation lines as close as possible to the sensor.

We recommend using here the burster extension lead, model 99209 609A xxxyyyy (e.g. 099209-609A-0150030 for fixed cable runs, length 3 m).

4.4.3.4 Connector A, B: Connection guidance for strain gage sensors with sensor leads, fitted with burster TEDS

You can connect strain gage sensors with sensor leads, fitted with burster TEDS to connector "A" and "B".

+ excitation 1
+ sense   2

+ signal   6

- sense   4
- excitation 5
- signal   9
              7

strain gauge

1-Wire® EEPROM

shield

extension cable*   sensor
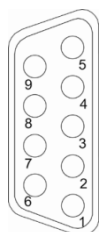
Connector A, B, view towards
rear of unit (female connector)
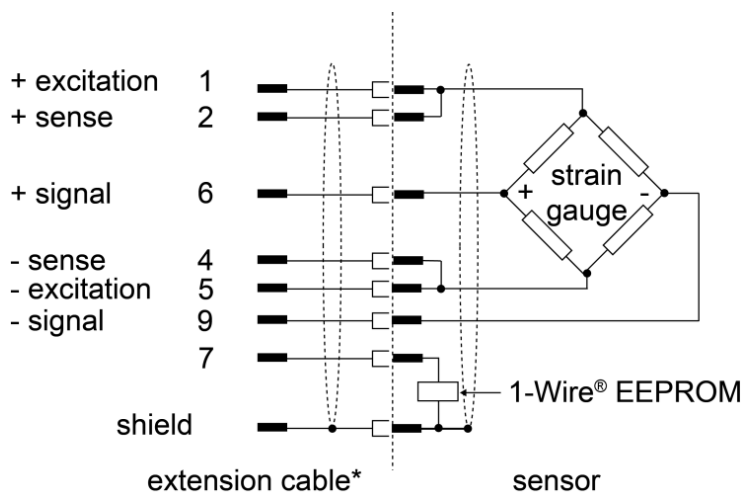
*Please ensure, that the 1-Wire® signal has to be connected when using an extension cable.

4.4.3.5 Connector A, B: Connection guidance for potentiometric sensors

You can connect potentiometric sensors to connector "A" and "B".
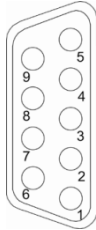
Connector A, B, view towards
rear of unit (female connector)
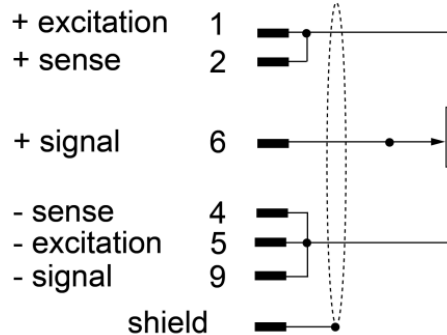
4.4.3.6 Connector A, B: Connection guidance for potentiometric sensors, fitted with burster TEDS

You can connect potentiometric sensors, fitted with burster TEDS to connector "A" and "B".
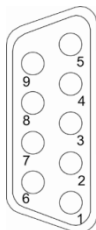
Connector A, B, view towards
rear of unit (female connector)
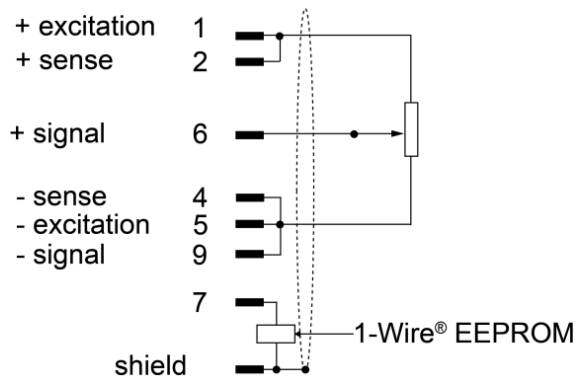
4.4.3.7 Connector A, B: Connection guidance for normalized-signal sensors

You can connect normalized-signal sensors to connector "A" and "B".
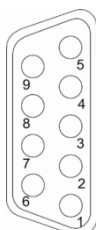
Connector A, B, view towards
rear of unit (female connector)
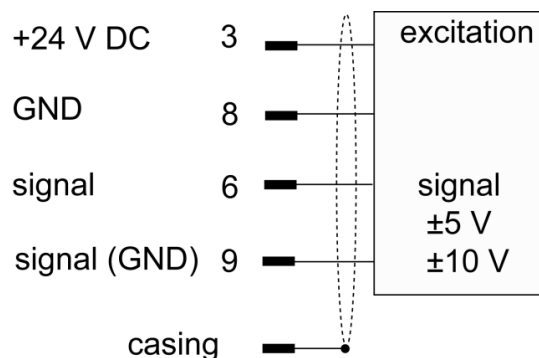
The +24 VDC transmitter supply can be switched on/off in the "Channel settings**Fehler! Verweisquelle konnte nicht gefunden werden.**" menu.

4.4.3.8 Connector A, B: Connection guidance for normalized-signal sensors, fitted with burster TEDS

You can connect normalized-signal sensors, fitted with burster TEDS to connector "A" and "B".
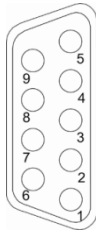
Connector A, B, view towards
rear of unit (female connector)
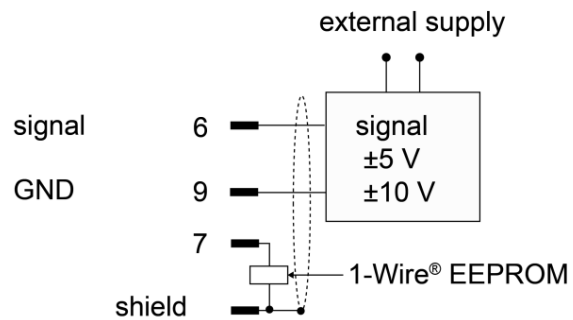
4.4.4   Connector C: Incremental sensors, EnDat, SSI

!	## NOTICE
	±5 VDC supply voltage! Only connect devices that are designed for this supply voltage.

Connector C
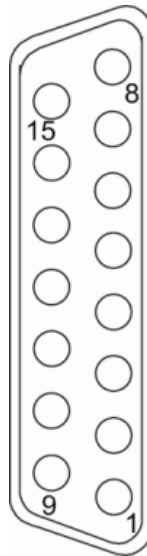
PIN	Meaning
1	T+ / ENDAT / SSI
2	T- / ENDAT / SSI
3	Reference ground ENDAT / SSI, ENDAT-GND
4	- transmitter excitation -5 V DC / 300 mA
5	+ transmitter excitation +5 V DC / 300 mA*
6	A+ / TTL, Sine 1 Vss, Sine 11 µAss, RS-422
7	B+ / TTL, Sine 1 Vss, Sine 11 µAss, RS-422
8	R+ / TTL, Sine 1 Vss, Sine 11 µAss, RS-422
9	D+ / ENDAT / SSI
10	D- / ENDAT / SSI
11	ENDAT- / SSI excitation +5 V DC / 300 mA
12	Reference ground for transmitter excitation, GND
13	A- / TTL, Sine 1 Vss, Sine 11 µAss, RS-422
14	B- / TTL, Sine 1 Vss, Sine 11 µAss, RS-422
15	R- / TTL, Sine 1 Vss, Sine 11 µAss, RS-422

*) +5 VDC transmitter excitation to connector C and D; 300 mA max. in total. The transmitter excitation +5 VDC can be switched on and off in the "Channel Settings" menu.

4.4.4.1   Connector C: Connection guidance for incremental sensors

- transmitter excitation -5 V	4
+ transmitter excitation+5 V	5
A+ /TTL, Sine1 Vss, Sine 11 µAss, RS422	6
B+ /TTL, Sine1 Vss, Sine 11 µAss, RS422	7
R+ /TTL, Sine1 Vss, Sine 11 µAss, RS422	8
ref. ground for transmitter excitation, GND	12
A- /TTL, Sine1 Vss, Sine 11 µAss, RS422	13
B- /TTL, Sine1 Vss, Sine 11 µAss, RS422	14
R- /TTL, Sine1 Vss, Sine 11 µAss, RS422	15

TTL

casing
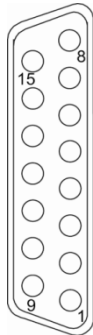
Connector C, view towards
rear of unit (female connector)
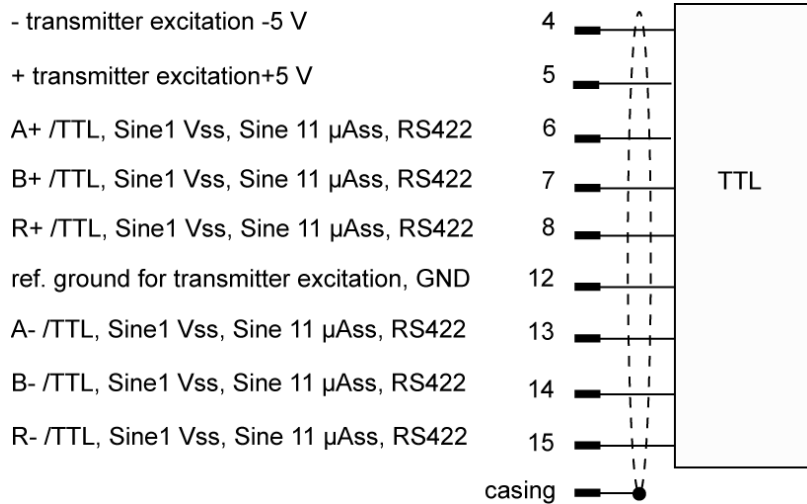
4.4.4.2   Connector C: Connection guidance for EnDat / SSI

T+ / EnDat / SSI	1
T- / EnDat / SSI	2
ref. ground EnDat / SSI, EnDat-GND	3
D+ / EnDat / SSI	9
D- / EnDat / SSI	10
EnDat / SSI transmitter excitation +5 V	11

EnDat / SSI

casing
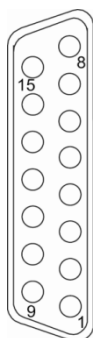
Connector C, view towards
rear of unit (female connector)
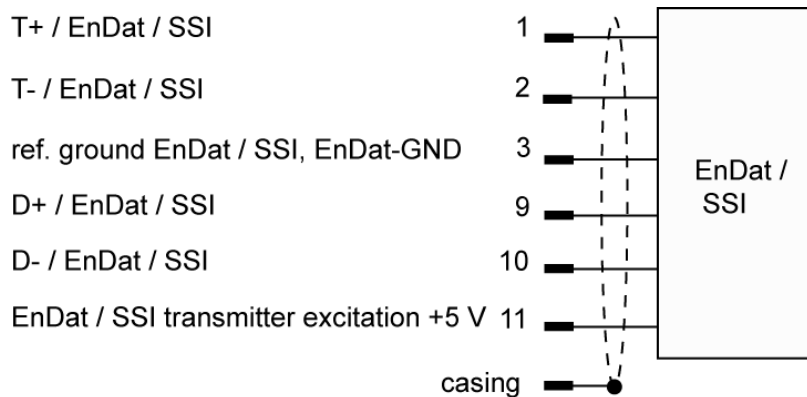
4.4.5 Connector D: Incremental sensors, strain gage, potentiometer and normalized-signal sensors

	NOTICE
!	**+15 VDC and +5 VDC supply voltage!** Only connect devices that are designed for this supply voltage.

Connector D
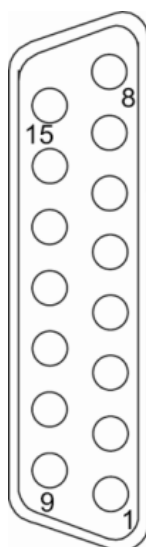
PIN	Meaning
1	+ excitation for strain gage, potentiometer
2	+ Sense
3	- Sense
4	+ transmitter excitation +15 V DC / 200 mA
5	+ transmitter excitation +5 V DC / 300 mA*
6	A+, A-TTL, RS-422
7	B+, B-TTL, RS-422
8	R+, R-TTL, RS-422
9	+ signal input for strain gage, normalized signal, potentiometer sensors
10	- signal input for strain gage, normalized signal, potentiometer sensors
11	- excitation for strain gage, potentiometer
12	Reference ground for transmitter excitation (5 / 15 V), GND
13	A-, RS-422
14	B-, RS-422
15	R-, RS-422

*) +5 VDC transmitter excitation to connector C and D; 300 mA max. in total. The transmitter excitation +5 VDC can be switched on and off in the "Channel Settings" menu.

4.4.5.1 Connector D: Connection guidance for torque sensors that have analog process signal and integral angle measurement (e.g. 8661)

You can connect EnDat / SSI to connector "D".

Connector D, view towards
rear of unit (female connector)
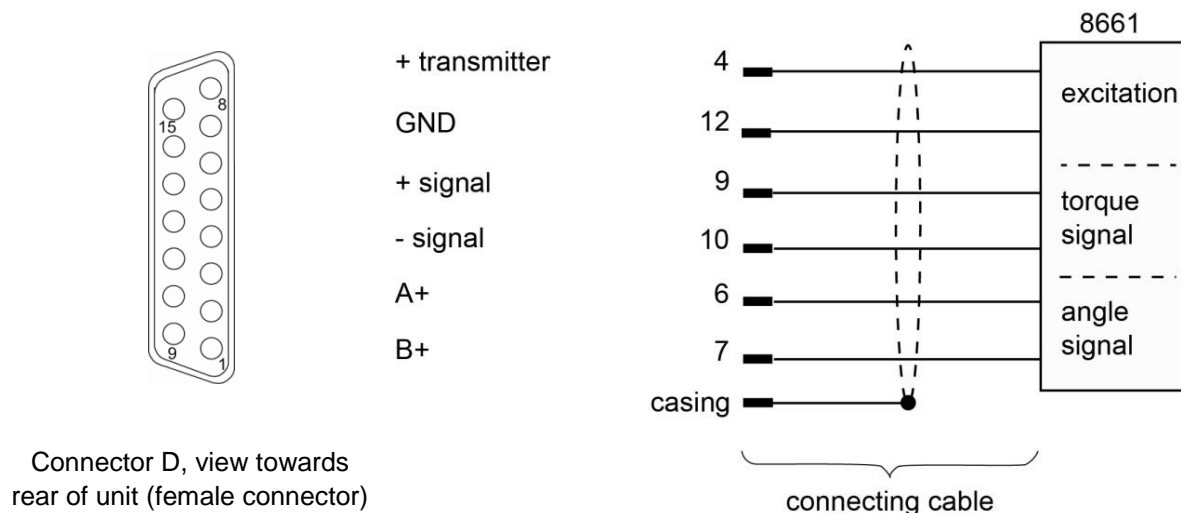
We recommend using the burster connecting cable, model 99163-540A-0150030 (length 3 m).

4.4.5.2 Connector D: Connection guidance for strain-gage torque sensors that have integral angle measurement (e.g. 86043, 86413)

Connector D, view towards
rear of unit (female connector)
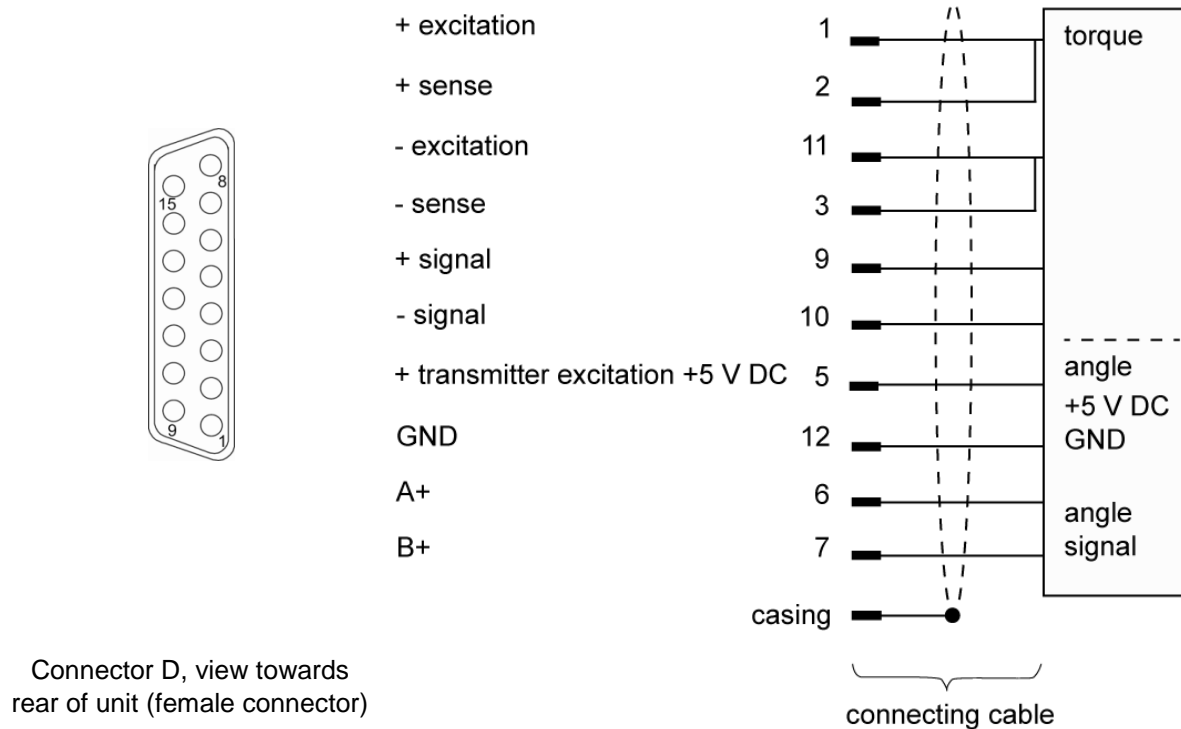
4.4.6   Connector E: Connection guidance for resistance measurement

Connector E
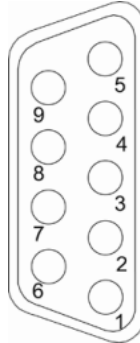
PIN	Meaning
1	+ I (current output)
2	+ I (current output)
3	Not used
4	- I (current output)
5	- I (current output)
6	+ U (signal input)
7	Not used
8	Not used
9	- U (signal input)
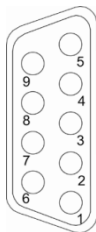
Connector E, view towards
rear of unit (female connector)
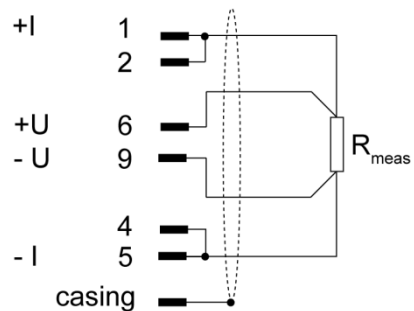
Note: In the 200 mΩ range, use two dual conductors of large cross-section to connect the "+I" and "-I" excitation to R_{meas} t.

4.4.7 Connector F: Connection guidance for piezoelectric sensors

⚠ **WARNING**
Electrostatic discharge. Do not touch!
Electrostatic discharge can damage the piezoelectric input.
Take precautionary measures against static discharge.

You can connect piezoelectric sensors to connector "F" (standard BNC socket).

charge input
(invertig)

functional ground
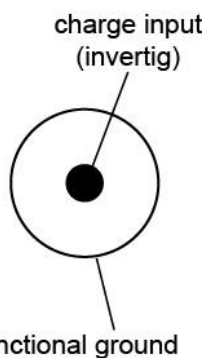
Connector F, view towards
rear of unit (female connector)
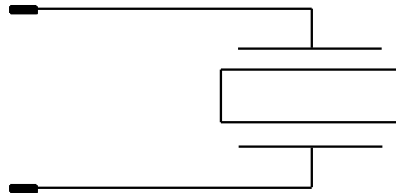
4.4.8   RS232 interface

RS232 interface
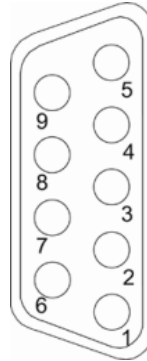
PIN	Meaning
1	-
2	TxD; transmit data
3	RxD; receive data
4	-
5	GND
6	-
7	-
8	-
9	-

You can fully configure the DIGIFORCE® 9307 via the RS232 interface, and retrieve all measurement and evaluation results, including complete measurement curves, from this port. The DIGIFORCE® 9307 can communicate with the DigiControl PC software (part number 9307-P101 or 9307-P100 PLUS Version) via the RS232 interface. You can specify the baud rate and data format in the "General settings" menu.

Use a 1:1 connecting cable (burster part number 9900-K333, length 1.8 m) to connect to a PC-COM port.

The protocol specification for the serial RS232 interface is given in the separate "DIGIFORCE® 9307 interface manual".

4.4.9   USB interface
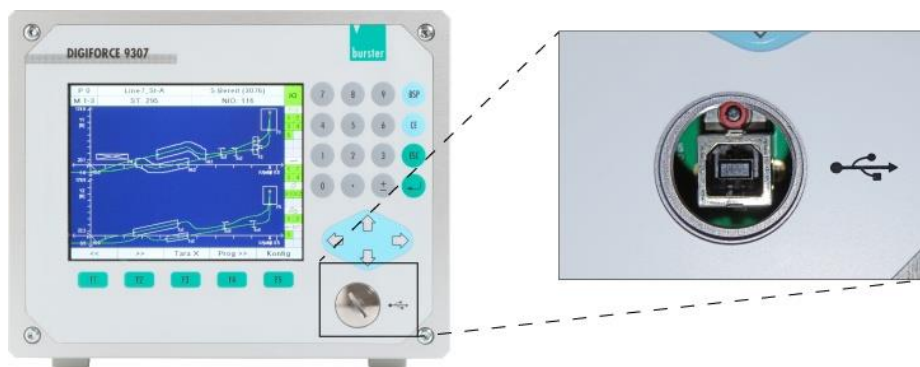
Diagram 18: USB interface

The USB port is located on the instrument front panel behind the PG screw fitting.

Note that the higher IP degree of protection is only guaranteed when the PG screw fitting is closed.

You can fully configure the DIGIFORCE® 9307 via the USB port, and retrieve all measurement and evaluation results, including complete measurement curves, from this port. The DIGIFORCE® 9307 can communicate with the DigiControl PC software (part number 9307-P101 or 9307-P100 PLUS Version) via USB port.

Use a connecting cable with back-to-back male connectors (burster part number 9900-K349, length 1.5 m) to connect to a PC USB port.

The protocol specification for the USB port is given in the separate "DIGIFORCE® 9307 interface manual".

4.4.10   Ethernet interface

You can fully configure the DIGIFORCE® 9307 via the Ethernet port, and retrieve all measurement and evaluation results, including complete measurement curves, from this port. The DIGIFORCE® 9307 can communicate with the DigiControl PC software (part number 9307-P101 or 9307-P100 PLUS-Version) via Ethernet port. You can specify Ethernet parameters such as the IP address in the "General settings" menu.

Use standard patch cables of category "CAt5e" or higher to connect to an Ethernet network.

The protocol specification for the Ethernet interface is given in the separate "DIGIFORCE® 9307 interface manual".

4.4.11 PROFIBUS interface

PROFIBUS interface
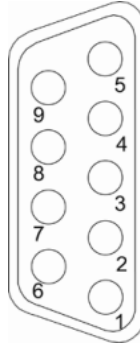
PIN	Meaning
1	Shield
2	NC
3	RxD/TxD-P
4	NC
5	DGND
6	VP +5 V (bus termination)
7	NC
8	RxD/TxD-N
9	NC

The protocol specification for the PROFIBUS interface is given in the separate "DIGIFORCE® 9307 PROFIBUS manual".

4.4.12 Ethernet-based fieldbus interface (dual RJ45)

The details of the available Ethernet-based fieldbus interfaces are contained in a separate document (can be obtained from info@burster.de or by phoning +49-7224-6450).

5   Using the instrument for the first time

⚠⚡	**DANGER**
	Electrical shock hazard
	Never switch on the DIGIFORCE® 9307 if it shows signs of damage incurred in transit. Only ever use the DIGIFORCE® 9307 under the conditions specified in this operating manual.

5.1   Panel-mounting

!	**NOTICE**
	Excessive tightening torque may result in damage.
	Overtightening may damage the mounting section.
	Use the screws supplied to cut the thread. Insert screws until they reach the surface of the mounting section. Do not exceed a torque of 0.7 Nm when tightening the screws "F" with precut thread.

5.1.1   Panel cut-out
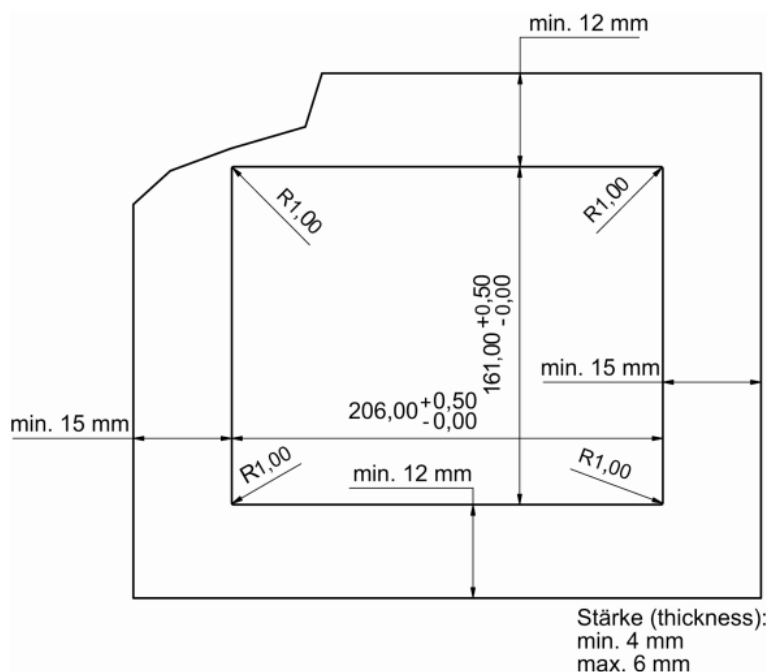
Diagram 19: Panel cut-out

5.1.2 Instrument installation
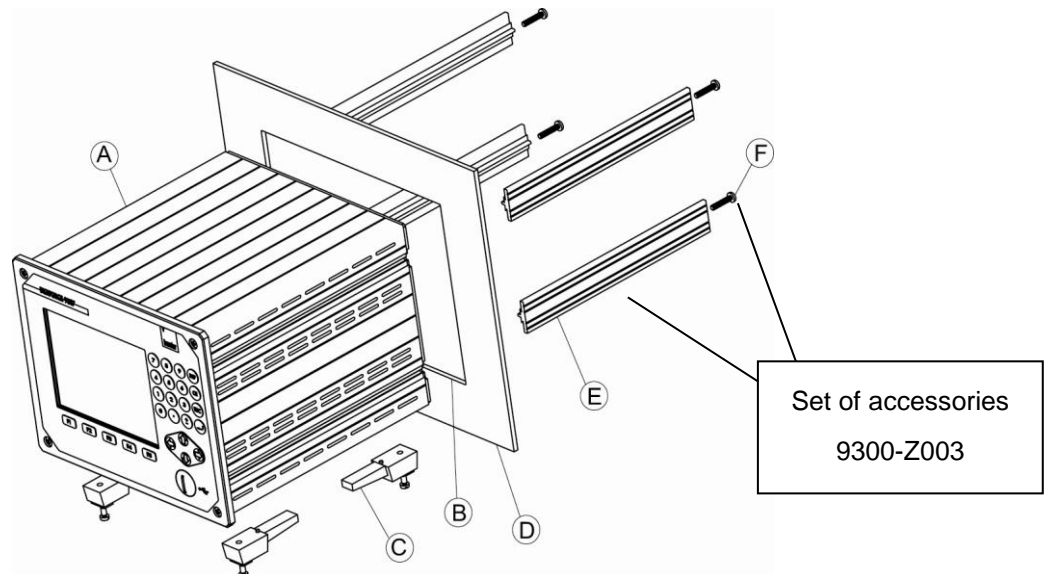
Diagram 20: Instrumen installation

Name	Description
A	DIGIFORCE® 9307
B	Cut-out in the instrument panel
C	Case feet
D	Instrument panel
E	Fixing rail (4x)
F	Self-tapping Torx screw (4x)

5.2 User language

When switching on the DIGIFORCE® 9307, you can press the function key **[F2]** during boot-up in order to select the user-interface language (default: German). During normal operation, the language can also be selected in the "Language" menu of the General settings (see section 6.3.7 "Operating language" on page 65).
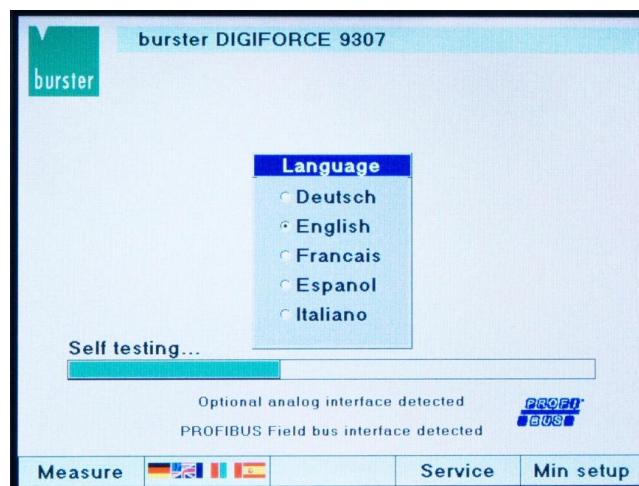
Diagram 21: Select user language

6   Instrument configuration

If you wish to configure setup values for the DIGIFORCE® 9307, you must switch from measurement mode, which is automatically active after Power-On, to Configuration mode using the **[F5]** function key

Menu structure
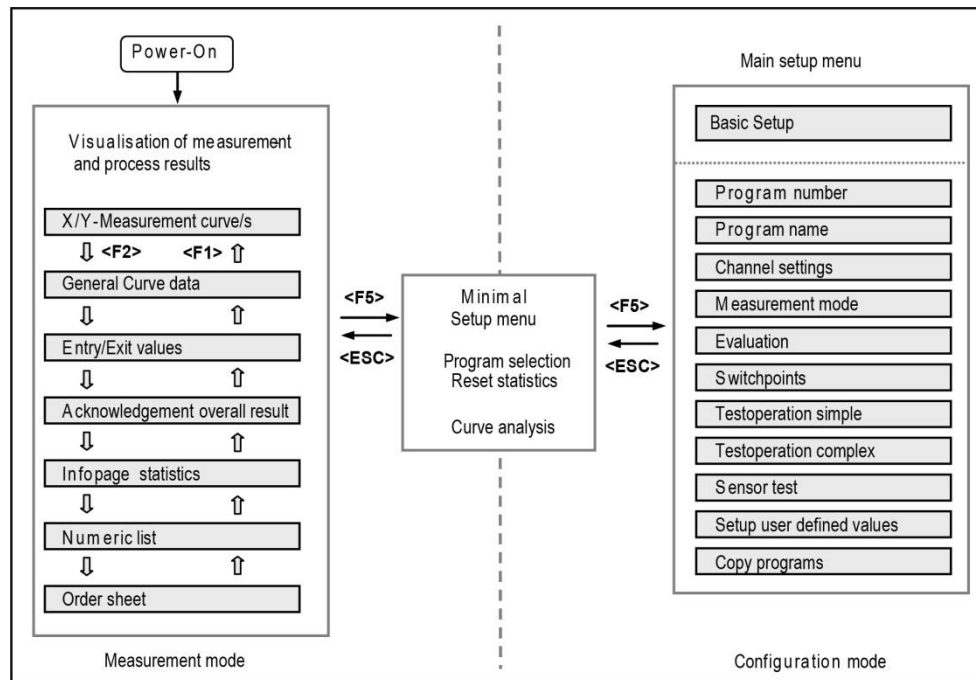
Diagram 22: Menu structure DIGIFORCE® 9307

Tip

Pressing **[ESC]** repeatedly takes you back into measurement mode from any submenu.

6.1 Minimal setup menu
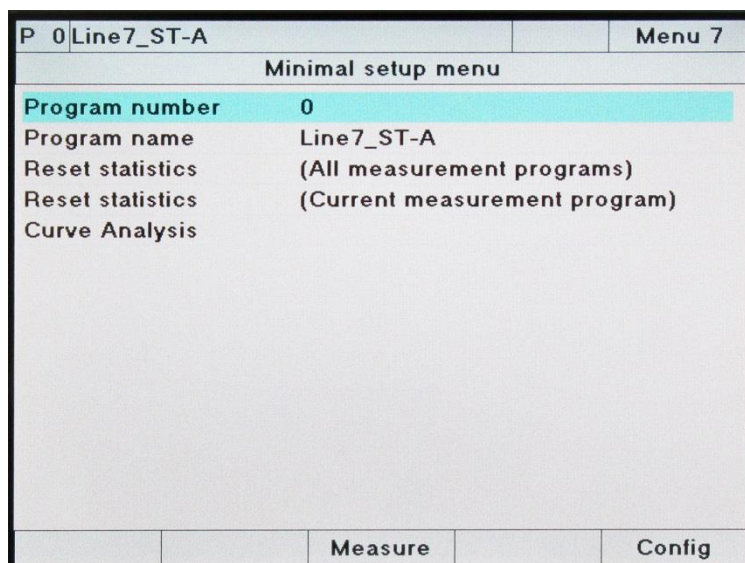
Diagram 23: Minimal setup menu

You can make the following settings and analyses in this menu:

- Select a measurement program

- Edit a measurement program name

- Reset statistics for all measurement programs

- Reset statistics for the current measurement program

- Curve analysis – shows up to 50 of the most recent measurements as a single curve or curve array (see section 8 "Curve analysis (Viewer)" on page 195) – function available for firmware version V201801 (32)/(128) and above

You can access the "Minimal setup menu" from measurement mode by pressing the **[F5]** function key.

If you press the **[F5]** key again from the Minimal setup menu, you access the "Main setup menu" containing all the configuration settings for the DIGIFORCE® 9307 controller.

[ESC] takes you back to measurement mode.

6.2   Main setup menu


```
P  0 Line7_ST-A                          Master   Menu 9
                    Main setup menu
Basic setup menu

Program number          0
Program name            Line7_ST-A
Channel settings
Measurement mode
Evaluation
Realtime switchpoints
Test operation simple
Test operation complex
Sensor test
Setup user-defined values
Copy programs

                                                 Enter
```
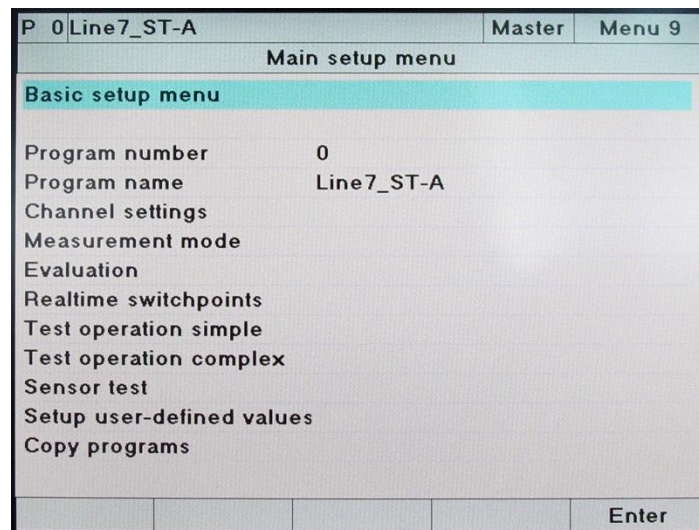
Diagram 24: Main setup menu

Note: When password protection is enabled, the display to the left of "Menu 9" shows whether you are logged in as User or Master.

From the "Main setup menu" you can make all the universal basic settings and configure settings that are specific to a measurement program.

If password protection is enabled, a status field showing current login details (User or Master) is displayed in the header (top right).

6.3 Basic setup menu

The "Basic setup menu" contains all the universal settings i.e. settings that are not specific to a particular measurement program.

To access the menu:

This is how it works

1 In measurement mode, press the **[F5]** key twice.

2 Press the **[Enter]** key to open the "Basic setup menu".

6.3.1 Function keys assignment

You can customize the assignment of the function keys **[F1]** to **[F4]** for the measurement mode. The **[F5]** function key, however, has a fixed assignment. It is used in measurement mode to switch into the configuration platform.

The following functions can be assigned:

Name	Meaning
Off	Not used
Page >>	Scroll info page forwards in measurement mode
Page <<	Scroll info page backwards in measurement mode
P >>	Measurement program selection
P <<	Measurement program selection
Tare X	Tare X-channel
Tare Y1	Tare Y1-channel
Tare Y2	Tare Y2-channel
Start/stop	Start measurement / stop measurement
Acknowledge OK parts	Confirm OK-parts (Acknowledgement function)
Acknowledge NOK parts	Confirm NOK-parts (Acknowledgement function)
Sensor Test	Perform sensor test
Reference Measurement	Perform sensor reference travel
Editing mode	Enable Editing mode *

* Using editing mode you can switch the DIGIFORCE® 9307 into the configuration level and edit parameters even while the DigiControl software is actively logging data.

This is how it works

1 In the Basic setup menu, open the menu "Measurement menu function key definition".

2 Select a key.

3 Assign a function.

6.3.2   Password protection and access authorization

Factory-set Master Password: 2609

Factory-set User Password: 2201

DIGIFORCE® 9307 has a facility for managing Master/User access levels. With password protection enabled, specific configuration levels can be locked for the User application. A Master performs the role of an administrator for the instrument and has full access permissions. The Master is also able to define the permissions of the User and a user password.

The following levels can be released/locked for the User application.

- Basic setup menu
- Minimal setup menu
- Main setup menu
- Channel settings
- Measurement mode
- Evaluation
- Real time switching points
- Test operation simple
- Test operation complex
- Sensor Test
- Setup user-definable values
- Copy programs

The "Access authorization" menu in the Basic setup menu contains all the settings that relate to password protection and access permissions.

These include:

- Defining a Master password
- Defining a User password
- Defining access levels
- Enabling password protection

6.3.3 Controlling the measurement display menus

In measurement mode, you can switch between several menus for displaying process results. With the DIGIFORCE® 9307, you can enable/disable a total of eight different display menus. You can also specify whether or not the DIGIFORCE® 9307 displays the last 10 measurement curves as a curve array in the graphical view of the measurement curve.

These menus include:

- Graphical display of measurement curve or curve array
- General curve data
- Overall result as Pass/Fail or as a smiley
- Entry and Exit points
- User-definable values
- Statistics
- Order sheet
- Rotary switch evaluation

The menu "Measurement menu display control" in the Basic setup menu contains all the settings relating to enabling/disabling these displays.

6.3.4 Info menu

This menu is located in the Basic setup menu.

The "Info menu" contains various device information about the DIGIFORCE® 9307, including the DIGIFORCE® 9307 serial number, software version and a tool counter. You can also save the station name here or reset the tool counter.

The DIGIFORCE® 9307 increments the tool counter by one for every measurement made, both in measurement mode and test operation. This means that the tool counter counts all measurements that you make using the DIGIFORCE® 9307 regardless of measurement program. When the tool counter reaches a configurable preset value, the DIGIFORCE® 9307 sets the PLC output signal "OUT_WARNING_TOOLCOUNT".

The signal is reset when you reset the tool counter using the "Reset tool counter" function in the "Info menu".

6.3.5 Screen brightness and background color

On the DIGIFORCE® 9307 you can adjust the brightness level of the screen in 10 levels. You can also select two different background colors (white or blue) for the measurement curve display in measurement mode.

The "LCD setup" menu in the Basic setup menu contains all the settings relating to screen brightness and background.

6.3.6 Date and time

The "Basic setup menu" contains all the data and time settings.

6.3.7 Operating language

The operating language settings are located in the "Language" menu in the "Basic setup menu".

The following languages are possible:

- German
- English
- French
- Spanish
- Italian

This is how it works

1   Open the "Language" menu.

2   Use the ⇦ and ⇨ buttons to set the language.

6.3.8   Interfaces

In the "Interfaces" menu, select the active communications interface and specify the required interface settings.

The Ethernet interface is always enabled, even when you have selected RS232 or USB as the active port.

Press the **[F5]** key to configure the port concerned.

6.3.8.1 RS232 interface settings

Baudrate	9600 baud …. 115K2 baud (in discrete steps)
Data Bits	Fixed data format, 8 bits
Stop Bits	Number of stop bits, 1 or 2
Parity	None, even, odd
Block check*	Off, On
Address	0 (the DIGIFORCE® 9307 uses only address 0)

* The separate interface specification contains information about the block check.

6.3.8.2 Standard data format for the RS232 interface:

- 8 data bits
- 1 stop bit
- No parity.

6.3.8.3 USB interface settings

A PC recognizes the USB port of the DIGIFORCE® 9307 as a virtual COM port. The drivers required for this are installed with the DigiControl PC software. If you wish to use PC-based communication without the DigiControl software, you can request the interface drivers from service@burster.com.

Baud rate	921600 (fixed setting)
Data bits	Fixed data format, 8 bits
Stop bits	Number of stop bits: 1
Parity	None
Block check*	Off, On
Address	0 (the DIGIFORCE® 9307 uses only address 0)

* The separate interface specification contains information about the block check.

6.3.8.4 Ethernet interface settings

DHCP	Off, On When DHCP is active (Dynamic Host Configuration Protocol), the DIGIFORCE® 9307 is given an IP address by the DHCP server.
IP address	Enter here the IP address for the unit. Obtain a valid address from your network administrator. Please note: The IP address must be unique within a network.
Subnet mask	Enter the subnet mask here. Obtain a valid mask from your network administrator. The subnet mask is used to define whether an IP address lies in the same sub network.
Gateway	Enter the gateway here. Obtain a valid address from your network administrator. It is possible to communicate with other networks via the gateway.
Port	UDP port selection (default: 7292) Please note: If a firewall is used, the UDP protocol must be enabled on this port. On a PC, only one active UDP connection (socket) is allowed on the same port.
Communication*	Ethernet communication ENCODED: UDP datagrams are encoded for transmission. ENCODED + OPEN: UDP datagrams are transmitted in encoded and in not encoded form
MAC address	Displays the unique MAC address
Host IP restriction	By enabling the HOST IP restriction, access can be limited to up to three defined HOST addresses. This can be used to prevent unwanted accesses, which might change the device configuration for instance. The HOST IP restriction is factory-set to disabled.

* The separate interface specification contains details of UDP encoding.

6.3.9 Assigning PLC outputs

You can customize the signals assigned to certain PLC outputs.

Factory settings

PIN.	PLC output	Factory setting
2	Output 1	OUT_STROBE
6	Output 2	OUT_OK_SENSORTEST
8	Output 3	OUT_NOK_WINDOW_9
9	Output 4	OUT_PROG0
10	Output 5	OUT_PROG1
11	Output 6	OUT_PROG2
12	Output 7	OUT_PROG3
13	Output 8	OUT_PROG4
16	Output 9	OUT_S3
17	Output 10	OUT_S4
21	Output 11	OUT_NOK_WINDOW_8
22	Output 12	OUT_NOK_WINDOW_7
23	Output 13	OUT_NOK_WINDOW_6
24	Output 14	OUT_NOK_WINDOW_5
25	Output 15	OUT_NOK_WINDOW_4
26	Output 16	OUT_NOK_WINDOW_3
27	Output 17	OUT_NOK_WINDOW_2
28	Output 18	OUT_NOK_WINDOW_1
29	Output 19	OUT_WARNING_TARE
30	Output 20	OUT_WARNING_TOOLCOUNT
31	Output 21	OUT_WARNING_TOTAL
32	Output 22	OUT_TEST_OP_SIMPLE
33	Output 23	OUT_TEST_OP_COMPLEX

You can assign one of the following signals to each of these outputs.

Signal	Meaning
"OUT_S3"	Switching signal S3
"OUT_S4"	Switching signal S4
"OUT_STROBE"	Validity signal for echoed measurement-program number
"OUT_PROG0"	Bit 0 of echoed measurement-program number
"OUT_PROG1"	Bit 1 of echoed measurement-program number
"OUT_PROG2"	Bit 2 of echoed measurement-program number
"OUT_PROG3"	Bit 3 of echoed measurement-program number
"OUT_PROG4"	Bit 4 of echoed measurement-program number
"OUT_WARNING_TARE"	Tare warning limit has been reached
"OUT_WARNING_TOOLCOUNT"	Tool counter alarm limit has been reached
"OUT_WARNING_TOTAL"	Composite warning (at least one device warning is active)
"OUT_OK_STEST"	Sensor test OK
"OUT_TEST_OP_SIMPLE"	The 9307 is in test operation (simple)
"OUT_TEST_OP_COMPLEX"	The 9307 is in test operation (complex)
"OUT_MEAS_ACTIVE"	Measurement in progress (Start measurement is active)
"OUT_CONFIGURATION"	The 9307 is in configuration mode
"OUT_ACK_ALARM"	Alarm output for Acknowledgement function
"OUT_ACK_LOCK"	Lock output for Acknowledgement function
"OUT_ACK_OK"	OK output for Acknowledgement function
"OUT_ACK_NOK"	NOK output for Acknowledgement function
"OUT_NOK_WINDOW_1"	NOK window 1
"OUT_NOK_WINDOW_2"	NOK window 2
"OUT_NOK_WINDOW_3"	NOK window 3
"OUT_NOK_WINDOW_4"	NOK window 4
"OUT_NOK_WINDOW_5"	NOK window 5
"OUT_NOK_WINDOW_6"	NOK window 6
"OUT_NOK_WINDOW_7"	NOK window 7
"OUT_NOK_WINDOW_8"	NOK window 8
"OUT_NOK_WINDOW_9"	NOK window 9
"OUT_NOK_WINDOW_10"	NOK window 10
"OUT_NOK_TRAPEZE_X1"	NOK trapezoid window X1
"OUT_NOK_TRAPEZE_X2"	NOK trapezoid window X2
"OUT_NOK_TRAPEZE_Y1"	NOK trapezoid window Y1
"OUT_NOK_TRAPEZE_Y2"	NOK trapezoid window Y2
"OUT_NOK_THRESHOLD_1"	NOK threshold 1
"OUT_NOK_THRESHOLD_2"	NOK threshold 2
"OUT_NOK_THRESHOLD_3"	NOK threshold 3
"OUT_NOK_THRESHOLD_4"	NOK threshold 4

Signal	Meaning
"OUT_NOK_ENVELOPE_1"	NOK envelope 1
"OUT_NOK_ENVELOPE_2"	NOK envelope 2
"OUT_NOK_MATHE_1"	NOK mathematical evaluation, operand 1
"OUT_NOK_MATHE_2"	NOK mathematical evaluation, operand 2
"OUT_NOK_MATHE_3"	NOK mathematical evaluation, operand 3
"OUT_NOK_MATHE_4"	NOK mathematical evaluation, operand 4
"OUT_NOK_MATHE_5"	NOK mathematical evaluation, operand 5
"OUT_NOK_MATHE_6"	NOK mathematical evaluation, operand 6
"OUT_NOK_CURVE_Y1"	NOK measurement curve Y1(x)
"OUT_NOK_CURVE_Y2"	NOK measurement curve Y2(x)
"OUT_OK_CURVE_Y1"	OK measurement curve Y1(x)
"OUT_OK_CURVE_Y2"	OK measurement curve Y2(x)
"OUT_NOK_ROTSWITCH_1"	NOK rotary switch evaluation 1
"OUT_NOK_ROTSWITCH_2"	NOK rotary switch evaluation 2
"OUT_PC _LOGGING"	PC-based data logging (DigiControl measurement mode) active
"OUT_REF_MEAS_OK"	Reference travel OK (for sensors with distance coding)
"OUT_PROG5"	Bit 5 of echoed measurement-program number
"OUT_PROG6"	Bit 6 of echoed measurement-program number

6.3.10 Acknowledgement function

The DIGIFORCE® 9307 can display the result of a measurement immediately and unambiguously by showing a red/green screen or the smiley face depending on the setup; see section 7.4 "Info page overall result (M3)" on page 186. It can also drive external indicator lamps and an audible alarm directly.

You can specify that an operator needs to confirm NOK and/or OK parts. This function is combined with the lock output OUT_ACK_LOCK. The DIGIFORCE® 9307 can use this function, for instance, as an immediate way of activating the lock output for a hand-press travel lock when a measurement is NOK. You must configure the Acknowledgement function of the DIGIFORCE® 9307 to use these function options. You can set the volume level of the external audible alarm using the "External buzzer volume" menu option.

The following PLC outputs can be used for the Acknowledgement function:

OUT_ACK_OK	Signal for the external "GOOD acknowledgement" (OK measurements)
	If the acknowledgement prompt for OK parts is enabled, this signal flashes until acknowledged
OUT_ACK_NOK	Signal for the external "BAD acknowledgement" (NOK measurements)
	If the acknowledgement prompt for NOK parts is enabled, this signal flashes until acknowledged
OUT_ACK_LOCK	Lock output e.g. for external return-stroke lock
OUT_ACK_ALARM	If acknowledge-request is enabled and the acknowledge is performed incorrectly, the alarm output is set.
OUT_BUZZER	PWM signal for external audible alarm

If the acknowledgement prompt is enabled, you have the option to assign the acknowledgement to the respective PLC inputs "IN_ACK_OK" and "IN_ACK_NOK".

| IN_ACK_OK | Acknowledgement input for OK measurements |
| IN_ACK_NOK | Acknowledgement input for NOK measurements |

This is how it works

1 Open the "Acknowledgement function" in the Basic setup menu.

2 Use the ⇦ and ⇨ buttons to enable the Acknowledgement function.

3 If the values for the entries "Acknowledge OK-parts" and/or "Acknowledge NOK-parts" are still set to "-", they are currently set to the value "Off".

4 Now enable the required acknowledgement function options. To do this, use the ⇩ and ⇧ buttons to select the relevant option, then use the ⇦ and ⇨ buttons to enable this option.

5 Now adjust the volume of the external audible signal by entering a volume between 0 and 10 using the number keys.

6.3.11 Order sheet

In the order sheet you can save/retrieve a wide range of information relating to the measurement, for instance:

- Name of worker
- Shift number
- Shift name
- Number of OK parts
- Number of NOK parts
- Order (job) number
- Batch
- Component
- Serial numbers

You can retrieve the order sheet in the measurement menus while the measurement is in progress. All the settings relating to the order sheet are located in the Basic setup menu.

You can find further information on the order sheet in the section 6.9 "Info page, Order sheet (M7)" on page 168.

This is how it works

1. Open the "Order sheet" menu option.
2. Select the entry you require.
3. Enter the new data. You can use the **[CE]** button to delete the entire entry. You can enter characters using the arrow buttons.
4. Once you have finished entering the information, confirm with the **[F5]** button.

6.3.12 PROFIBUS settings (option)

Note: The "PROFIBUS field bus setup" basic setup menu is only available if your
          DIGIFORCE® 9307 has the Vxxx2 option.

Control via	**PROFIBUS**: DIGIFORCE® 9307 responds solely to control signals (inputs) on the PROFIBUS interface.
	PLC: DIGIFORCE® 9307 responds solely to control signals (inputs) on the PLC I/O interface.
	When controlled via PLC I/O, data is still transferred in the cyclical PROFIBUS DP protocol.
SW-version of Fieldbus interface	Displays the software version of the optional Fieldbus hardware
Serial number of Fieldbus interface	Serial number of the Fieldbus module
Stations address	Enter here the PROFIBUS address for the unit
	Valid address range: 1 … 126
Cyclic data exchange	Displays the active mode in the cyclical PROFIBUS DP service
	You can find details in the PROFIBUS manual

Note: The documentation for the PROFIBUS interface is given in the separate "DIGIFORCE® 9307
          PROFIBUS manual".

6.3.13 PROFINET settings (option)

Note: The "PROFINET field bus setup" basic setup menu is only available if your DIGIFORCE®
9307 has the Vxxx3 option.

Control via	**PROFINET**: the DIGIFORCE® 9307 responds solely to control signals (inputs) from the PROFINET interface.
	PLC: the DIGIFORCE® 9307 responds solely to control signals (inputs) from the PLC I/O interface.
	When control via PLC I/O is selected, data is still transferred on the PROFINET real-time channel.
SW-version of Fieldbus **interface**	Displays the software version of the optional Fieldbus hardware
Serial number of Fieldbus interface	Serial number of the Fieldbus module
Device MAC	Address for identifying the Fieldbus module in the PROFINET network.
Port1 MAC	Port 1 MAC address
Port2 MAC	Port2 MAC address
Name of station	The station name assigned by the PROFINET host.
IP address	Assigned IP address **Please note**: this parameter cannot be changed in the DIGIFORCE® 9307.
Subnet mask	Assigned subnet mask **Please note**: this parameter cannot be changed in the DIGIFORCE® 9307.
Gateway	Assigned gateway address **Please note**: this parameter cannot be changed in the DIGIFORCE® 9307.

Note: The documentation for the PROFINET interface is given in the separate "DIGIFORCE® 9307
PROFINET manual".

6.3.14 EtherNet/IP settings (option)

Note: The "EtherNet/IP field bus setup" basic setup menu is only available if your DIGIFORCE® 9307 has the Vxxx4 option.

Control via	**EtherNet/IP**: the DIGIFORCE® 9307 responds solely to control signals (inputs) from the EtherNet/IP interface. **PLC**: the DIGIFORCE® 9307 responds solely to control signals (inputs) from the PLC I/O interface. When control via PLC I/O is selected, data is still transferred on the EtherNet/IP real-time channel.
SW-version of Fieldbus interface	Displays the software version of the optional Fieldbus hardware
Serial number of Fieldbus interface	Serial number of the Fieldbus module
MAC address	Address for identifying the Fieldbus module in the EtherNet/IP network.
IP configuration	Network configuration type (BOOTP, DHCP, static) **Please note**: this parameter cannot be changed in the DIGIFORCE® 9307. [1]
IP address	IP address **Please note**: this parameter cannot be changed in the DIGIFORCE® 9307.
Subnet mask	Subnet mask **Please note**: this parameter cannot be changed in the DIGIFORCE® 9307.
Gateway	Gateway address **Please note**: this parameter cannot be changed in the DIGIFORCE® 9307.

[1] If you wish to assign a manual IP address to the EtherNet/IP interface, you must change the "IP configuration" parameter to "Static". Changing the automatic assignment (BOOTP or DHCP) to "Static" can only be performed via the interface itself, however. You can use the "BOOTP/DHCP Server" tool from Rockwell Automation, for instance, to do this ("Disable BOOTP/DHCP" function).

Note: The documentation for the EtherNet/IP interface is given in the separate "DIGIFORCE® 9307 EtherNet/IP manual".

6.3.15 EtherCAT settings (option)

Note: The "EtherCAT field bus setup" basic setup menu is only available if your DIGIFORCE® 9307 has the Vxxx1 option.

Control via	EtherCAT: the DIGIFORCE® 9307 responds solely to control signals (inputs) from the EtherCAT interface. PLC: the DIGIFORCE® 9307 responds solely to control signals (inputs) from the PLC I/O interface. When control via PLC I/O is selected, data is still transferred on the EtherCAT Process Data Objects (PDO).
State machine	EtherCAT state machine INIT The device is in the INIT state PRE-OP The device is in the PRE-OPERATIONAL state SAFE-OP The device is in the SAFE-OPERATIONAL state OP The device is in the OPERATIONAL state
SW-version of Fieldbus interface	Displays the software version of the optional Fieldbus hardware

Note: The documentation for the EtherCAT interface is given in the separate "DIGIFORCE® 9307 EtherCAT manual".

6.4   Selecting a program number

Select the measurement program for which you want to make program-specific settings.

On entering configuration mode, the DIGIFORCE® 9307 always presents the measurement program that was last active.

6.5   Specifying the program name

Define a name for the selected measurement program. You can define these program names in the dialog window "Enter program name". A maximum of 20 alphanumeric characters and special characters are allowed.

You can delete single characters using the **[BSP]** button.

You can delete the entire name using the **[CE]** button.

6.6   Channel settings

In the "Channel settings" menu you can assign the physical connections (terminals A to F) to the active measurement channels X, Y1 and Y2. You have full flexibility in these assignments, i.e. you can assign an active measurement channel to each terminal. You can also define a pure time axis instead of a terminal, letting you record and evaluate synchronously up to two signal/time curves (Y1=f(t) and Y2=f(t)).
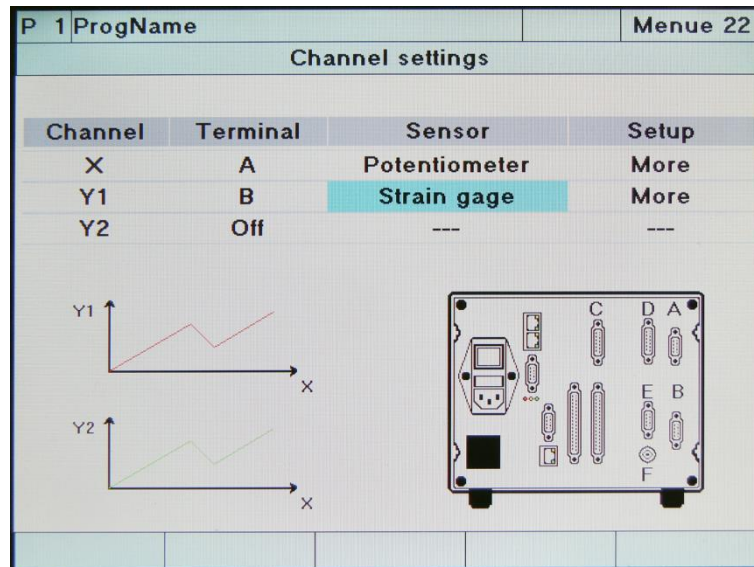
Diagram 25: Channel settings
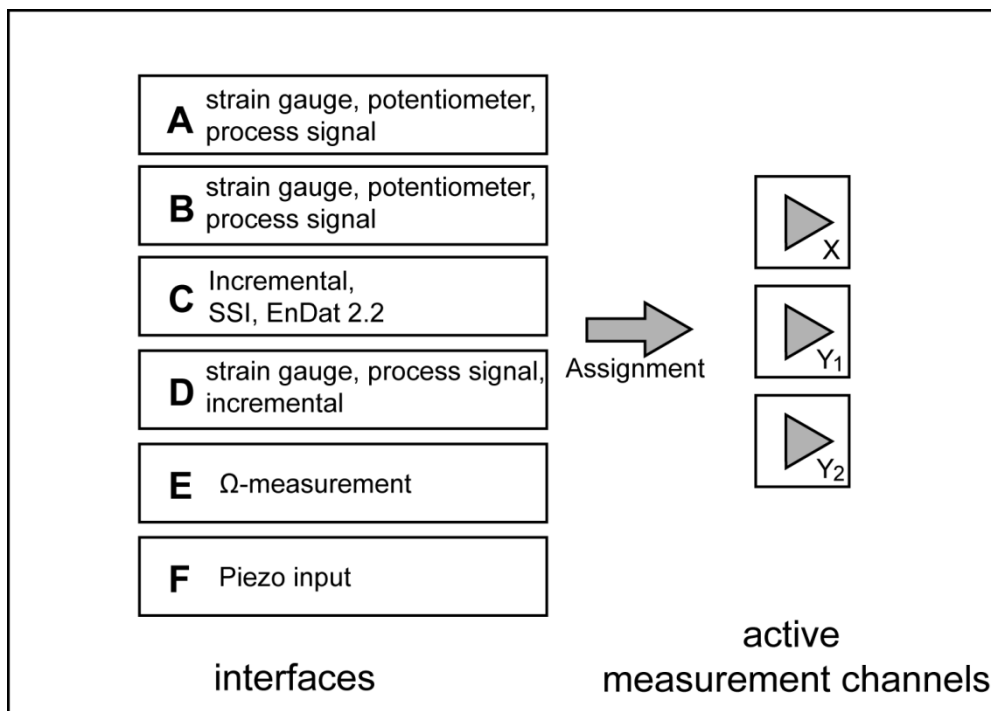
Diagram

Diagram 26: Channel settings - diagram

Parameters in the "Channel settings" menu (menu 22)

Channel	X, Y₁, Y₂	Active measurement channel X, Y_1 and Y_2 You cannot edit this parameter
Terminal	A to F, t (time)	Assignment of a physical terminal to the measurement channel X, Y_1 or Y_2. (You can also specify a time axis here.)
Sensor		Terminals A to F; assignment of sensor technology (e.g. terminal A: strain gage, potentiometer or standard signal)
Setup		Submenu for sensor-specific channel settings

6.6.1 Scaling of analog sensors (strain gage, potentiometer and standard signal)

The electrical measurement signals are assigned to the physical measurements using a 2-point scaling operation. In this process, you assign a LOWER and UPPER CALIBRATION VALUE (electrical value) to a LOWER and UPPER SCALE VALUE of the measurement. You can enter the electrical values LOWER and UPPER CALIBRATION VALUE using the number keys, or measure them using a Teach-in function (**[F1]** key in the relevant setup menu).
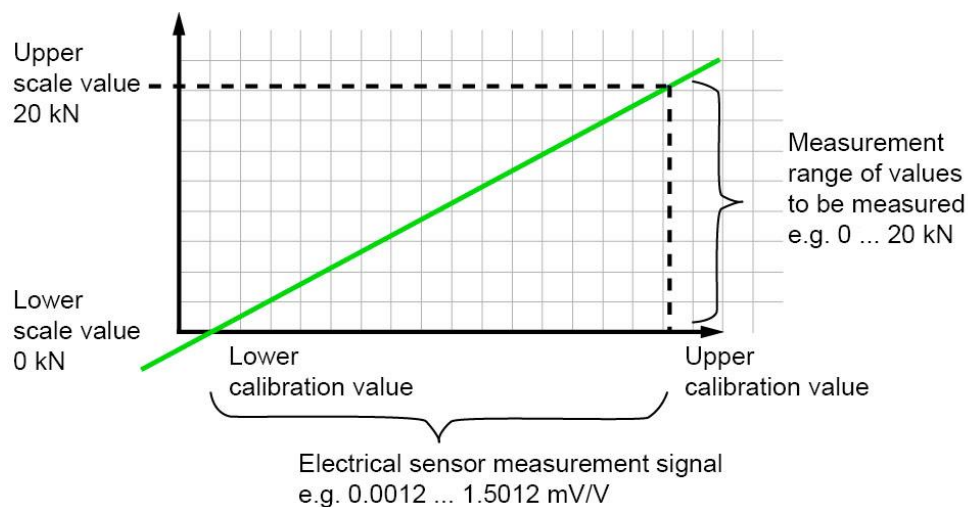
Diagram 27: Scaling of analog sensors

6.6.2   Inverting measurement signals

You can invert a measurement signal simply by changing the sign of the scaling values LOWER and UPPER SCALE VALUE.
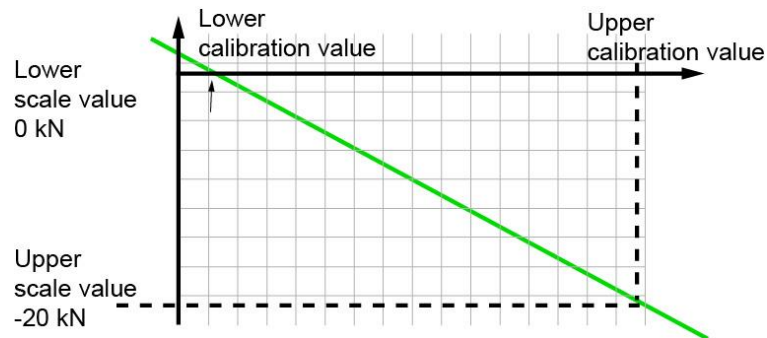
Diagram 28: Inverting measurement signals

6.6.3   Configuring sensors fitted with burster TEDS

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

If a connected sensor is equipped with burster TEDS, you can use the **[Read TEDS]** function in the channel settings to get the DIGIFORCE® 9307 to upload the sensor specification. Further information on this feature appears below in the subsections dealing with the particular sensors. The DIGIFORCE® 9307 does support the burster TEDS function only in the standard channels A and B..

Note: If when using burster TEDS sensors you wish to invert a signal, you can do this by changing the sign in the scaling values. You must make the change after importing the TEDS data.

6.6.4   Strain gage sensors

You can connect strain gage sensors to the connectors **A**, **B** and **D** (Option):

Parameters in the „Strain gage sensor" channel settings menu (menu 23)

Excitation	2.5 V, 5 V, 10 V	Strain-gage excitation voltage
		You can find the correct value for the strain-gage excitation voltage from the sensor datasheet or the test certificate.
Sensitivity	0.01 .. 100 mV/V	Input of strain-gage sensitivity
		This value is used solely for calculating and displaying the electrical drive level.
		This parameter has no relevance to the internal channel configuration.
Input range	1,2,4,10,20,40 mV/V	Selection of strain-gage input range.
		In order to be able to use 100% of the measurement range of the connected sensor, the selected input range must be ≥ the sensor sensitivity.
Level (el.)	Value in %	Displays the electrical drive level
Transmitter supply	ON / OFF	Enable/disable additional sensor DC supply
		Terminal A,B: + 24 V DC
		Terminal D: + 15 V DC

Unit		Dimensional units of measurement channel
		The units can be selected from a list.
		Or you can specify user-defined units via the **[F2]** key
Filter	OFF, 5, 10, 25, 50, 100, 200, 400, 800 Hz	Filter setting for measurement channel (Default value = 50 Hz)
Lower scale value		Input of lower scale value for 2-point scaling (typical value = 0)
Upper scale value		Input of upper scale value for 2-point scaling (typical value = 100% of sensor measurement range)
Lower calibration value		Input or measurement (using **[F1]** teach-in) of lower calibration value for 2-point scaling.
		You can only use the Measure (Teach-in) function properly when the sensor is connected and the channel settings are correct
Upper calibration value		Input or measurement (using **[F1]** teach-in) of upper calibration value for 2-point scaling.
		You can only use the Measure (Teach-in) function properly when the sensor is connected and the channel settings are correct

This is how it works

1 In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2 Select the strain gage as the sensor type for the relevant terminal.
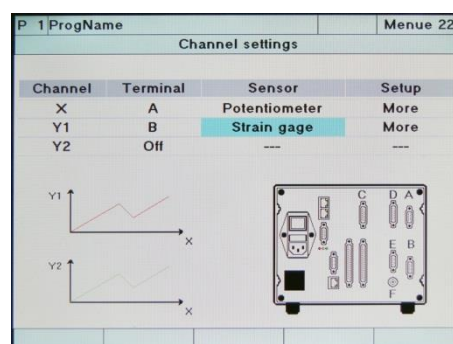
3 Go to the "More" menu option and select this option.

4 In this menu (menu 23), configure the sensor-specific settings for the strain-gage sensor.

```
P  1 ProgName                              Menue 23
Channel Y1   Terminal B   Strain gage sensor
Excitation voltage      5.00000        V
Sensitivity             1.50000        mV/V
Input range             2.00000        mV/V
Level (el.)             75             %

Transmitter supply      Off
Unit                    N
Filter                  50 Hz

Lower scale value       0.00000        N
Upper scale value       10.0000        N
Lower calibration val   0.00000        mV/V
Upper calibration val   10.0000        mV/V


       -        Unit                      TareSetup
```

5 Exit the "Channel settings" menu and confirm your settings with **[Enter]**.

Tare settings for strain gage sensors

In menu 23, "Strain gage sensor" channel settings, you can use the **[F5]** key to make additional tare settings for this channel. Pressing the **[F5]** key again takes you back to the channel settings menu.

Tare at meas. start	ON / OFF	ON: When a measurement is started, the channel is automatically tared to the tare default value (Standard value for tare)
Standard value for tare	<value input>	A typical tare value is 0.0
OUT_WARNING_TARE	ON / OFF	ON: If the signal to be tared exceeds the Tare warning limit, the control output OUT_WARNING_TARE is set (Indication that the sensor may be faulty)
Tare warning limit	--- / 1...20%	Definition of Tare warning limit between 1% and 20% with respect to the upper scale value (usually equals the sensor measurement range)

6.6.5 Reading strain-gage sensors programmed with burster TEDS

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

If a connected sensor is programmed with burster TEDS, you can use the **[Read TEDS]** function to get the DIGIFORCE® 9307 to upload the sensor specification. The device can then use this specification to make the necessary channel settings automatically.

The burster TEDS data of a strain-gage sensor includes, amongst other information, the zero point (zero output) measured during production and testing, and the rated output in the reference direction (output signal at measuring range with balanced zero). The sensor zero point measured in the DIGIFORCE® 9307 may differ from the stored burster TEDS data if the sensor is supplied with assembled connector and any additional connecting cable. Furthermore, the zero point will vary depending on the specific installation situation for the strain-gage sensor. We recommend that you do not change the imported burster TEDS data (scaling and calibration values) in the DIGIFORCE® 9307, but instead use the "TARE" function to zero the zero point in your own specific environment. A tare operation can be initiated as follows:

- Manually in the "Numerical test operation" menu

- Manually using a function key in measurement mode

- Controlled via a PLC input (PLC 24V signal or via Fieldbus)

- Automatically at the start of a measurement (see "Tare settings for strain-gage sensors")

If you are using the strain-gage sensor in an opposite direction to the reference direction, e.g. with a tension and compression load cell, you will obtain measured values with a negative sign. If you want to display a positive value, you can invert the entry "Upper scale value" in the DIGIFORCE® 9307 (e.g. from 500.0 N to -500.0 N). Press **[Enter]** to adopt the changed setting when closing the Channel settings.

This is how it works

1   In measurement mode, press the **[F5]** "Config" button twice and then go to the "Channel settings" menu (menu 22).

2   Select Strain gage as the sensor type for the connector you require.

3   Switch to the "More" menu option and disable this option.

4   Press **[F3]** "Read TEDS". The burster TEDS data is imported.

5   If the device detected a strain-gage sensor programmed with burster TEDS, it displays the "TEDS Info" function **[F4]**.

Note: Once it has imported the burster TEDS data, the device overwrites the relevant parameters such as the scaling and calibration values. These parameters can be post-edited, for instance to set signal inversion.

Note: If the permitted excitation voltage for the strain-gage sensor (entry in the burster TEDS data) is less that the excitation voltage provided by the DIGIFORCE® 9307, the burster TEDS data is not imported.

6   Press **[F4]** "TEDS Info" to display the data from the strain-gage sensor. Press **[Enter]** to close the display.

Note: If the device did not detect a strain gage sensor programmed with TEDS, it displays a window containing the message "No TEDS data found".

7   Close the "Channel settings" menu and confirm the settings with [**Enter**].

6.6.6 Potentiometric sensors

Potentiometric sensors can be connected to the interfaces **A, B** and **D** (option).

Parameters in the "Potentiometric sensor" menu (menu 24)

Excitation	5 V, 10 V	Potentiometer excitation voltage
Transmitter supply	ON / OFF	Enable/disable additional sensor DC supply Terminal A,B: + 24 V DC Terminal D: + 15 V DC
Unit		Dimensional units of measurement channel The units can be selected from a list. Or you can specify user-defined units via the **[F2]** key
Filter	OFF, 5, 10, 25, 50, 100, 200, 400, 800 Hz	Filter setting for measurement channel (Default value = 50 Hz)
Lower scale value		Input of lower scale value for 2-point scaling (typical value = 0)
Upper scale value		Input of upper scale value for 2-point scaling (typical value = 100% of sensor measurement range)
Lower calibration value		Input or measurement (using **[F1]** teach-in) of lower calibration value for 2-point scaling. You can only use the Measure (Teach-in) function properly when the sensor is connected and the channel settings are correct
Upper calibration value		Input or measurement (using **[F1]** teach-in) of upper calibration value for 2-point scaling. You can only use the "Measure..." (Teach-in) function properly when the sensor is connected and the channel settings are correct

Note: The mechanical travel of potentiometric displacement sensors is greater than the specified mechanical travel. Therefore there is usually an electrical dead zone at each end. Within this zone, you cannot measure any change in the electrical output signal even if a movement is made.

The upper and lower calibration values can be measured using the "Measure..." function (teach-in using **[F1]** function key). For this task, use a calibrated gauge block that matches the full measurement range of the sensor as closely as possible.

Make sure that the two measurement points do not lie inside the specified dead zone. The measurement points must lie at a certain distance from the mechanical limits of travel of the sensor.

This is how it works

1   In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2   Select the "Potentiometer" sensor type for the relevant terminal.
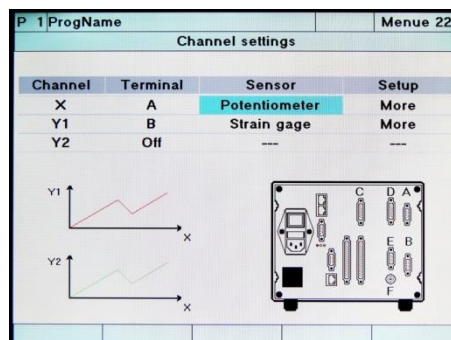
3   Go to the "More" menu option and select this option.

4   In this menu (menu 24), configure the sensor-specific settings for the potentiometric sensor.
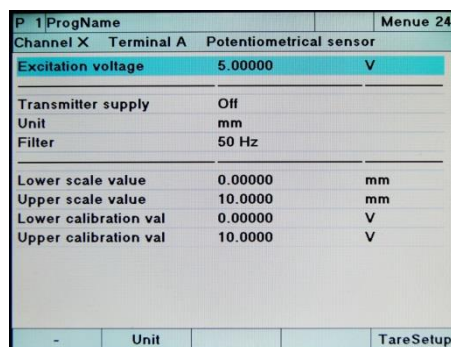
5   Exit the "Channel settings" menu and confirm your settings with **[Enter]**.

Tare settings for potentiometric sensors

In menu 24, "Potentiometric sensor" channel settings, you can use the **[F5]** key to make additional tare settings for this channel. Pressing the **[F5]** key again takes you back to the channel settings menu.

Tare at meas. start	ON / OFF	ON: When a measurement is started, the channel is automatically tared to the tare default value (Standard value for tare)
Standard value for tare	<value input>	A typical tare value is 0.0

6.6.7 Reading potentiometric sensors programmed with burster TEDS

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

If a connected sensor is programmed with burster TEDS, you can use the **[Read TEDS]** function to get the DIGIFORCE® 9307 to upload the sensor specification. The device can then use this specification to make the necessary channel settings automatically. For potentiometric displacement sensors, this means that the teach-in procedure using a calibrated gage block or a master part can be omitted.

This is how it works

1   In measurement mode, press the **[F5]** "Config" button twice and then go to the "Channel settings" menu (menu 22).

2   Select Potentiometer as the sensor type for the connector you require.
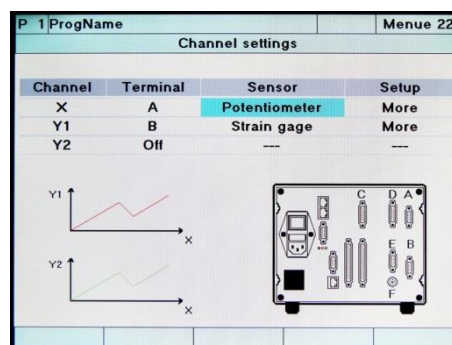
3   Switch to the "More" menu option and disable this option.

4   Press **[F3]** "Read TEDS". The burster TEDS data is imported.
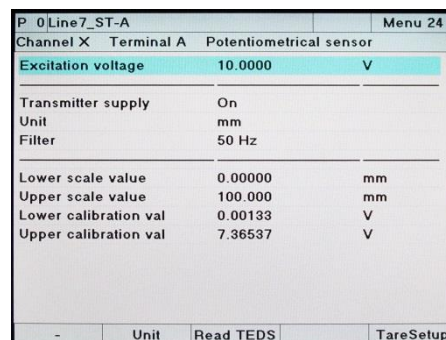
5   If the device detected a potentiometric sensor programmed with burster TEDS, it displays the "TEDS Info" function **[F4]**.

Note: Once it has imported the burster TEDS data, the device overwrites the relevant parameters such as the scaling and calibration values. These parameters can be post-edited, for instance to set signal inversion.
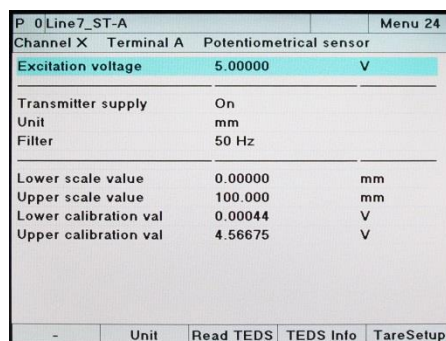
6   Press **[F4]** "TEDS Info" to display the data from the potentiometric sensor. Press **[Enter]** to close the display.

Note: If the instrument did not detect a potentiometric sensor programmed with burster TEDS, it displays a window containing the message "No TEDS data found".

```
P  0 Line7_ST-A                          Menu 24
Channel X    Terminal A    Potentiometrical sensor
Excitation voltage              5.00000        V
            8718-100  S/N 87101100956
Transmi      Nominal distance  100.000000 mm
Unit           Lower scale value  0.000000 mm
Filter        Upper scale value  100.000000 mm
             Lower calibration val  0.000088 V/V
Lower s      Upper calibration val  0.911277 V/V
Upper s        Reference excitation  5.000000 V
Lower c        Maximal excitation  24.000000 V
Upper c
                        Enter

    -        Unit    Read TEDS  TEDS Info  TareSetup
```
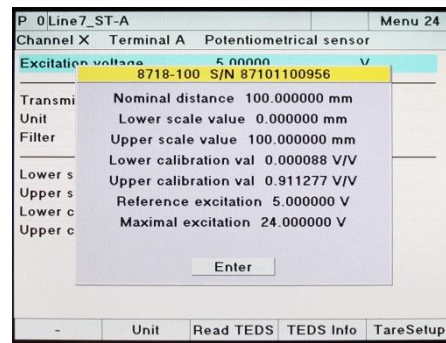
7   Close the "Channel settings" menu and confirm the settings with [**Enter**].

6.6.8 Sensors with standard signal

Sensors with standard signal can be connected to the interfaces **A, B** and **D** (option).

Parameters in the "Standard signal sensor" menu (menu 25)

Input range	5 V / 10 V	Selection of input range: 5 V or 10 V
Transmitter supply	ON / OFF	Enable/disable additional sensor DC supply Terminal A,B: + 24 V DC Terminal D: + 15 V DC / +5 V DC
Unit		Dimensional units of measurement channel The units can be selected from a list. Or you can specify user-defined units via the **[F2]** key
Filter	OFF, 5, 10, 25, 50, 100, 200, 400, 800 Hz	Filter setting for measurement channel (Default value = 50 Hz) When set to OFF: 5 kHz RC filter
Lower scale value		Input of lower scale value for 2-point scaling (typical value = 0)
Upper scale value		Input of upper scale value for 2-point scaling (typical value = 100% of sensor measurement range)
Lower calibration value		Input or measurement (using **[F1]** teach-in) of lower calibration value for 2-point scaling. You can only use the Measure (Teach-in) function properly when the sensor is connected and the channel settings are correct
Upper calibration value		Input or measurement (using **[F1]** teach-in) of upper calibration value for 2-point scaling. Typical value: 5 V or 10 V You can only use the Measure (Teach-in) function properly when the sensor is connected and the channel settings are correct

Tare settings for sensors with standard signal

In menu 25, "Standard signal sensor" channel settings, you can use the **[F5]** key to make additional tare settings for this channel. Pressing the **[F5]** key again takes you back to the channel settings menu.

Tare at meas. start	ON / OFF	ON: When a measurement is started, the channel is automatically tared to the tare default value (Standard value for tare)
Standard value for tare	<value input>	A typical tare value is 0.0

1   In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2   Select "Standard signal" as the sensor type for the relevant terminal.

P 1 ProgName			Menue 22
	Channel settings		
Channel	Terminal	Sensor	Setup
X	A	Standard signal	More
Y1	B	Strain gage	More
Y2	Off	---	---
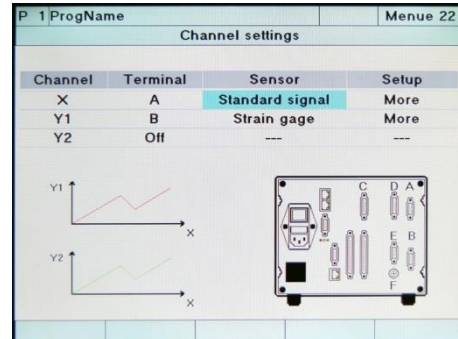
3   Go to the "More" menu option and select this option.

4   In this menu (menu 25), configure the sensor-specific settings for the standard-signal sensor.

P 1 ProgName			Menue 25
Channel X	Terminal A	Standard signal sensor	
Input range	5.00000	V	
Transmitter supply	Off		
Unit	mm		
Filter	50 Hz		
Lower scale value	0.00000	mm	
Upper scale value	10.0000	mm	
Lower calibration val	0.00000	V	
Upper calibration val	10.0000	V	
-	Unit		TareSetup
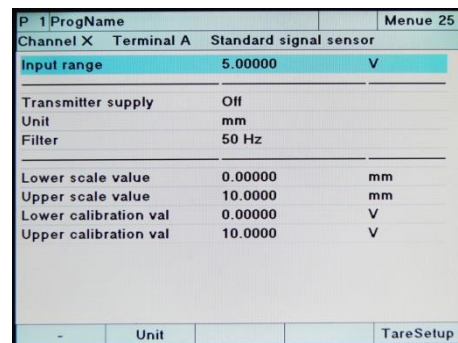
5   Exit the "Channel settings" menu and confirm your settings with **[Enter]**.

6.6.9 Reading a standard-signal sensor programmed with burster TEDS

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

If a connected sensor is programmed with burster TEDS, you can use the **[Read TEDS]** function to get the DIGIFORCE® 9307 to upload the sensor specification. The device can then use this specification to make the necessary channel settings automatically.

This is how it works

1   In measurement mode, press the **[F5]** "Config" button twice and then go to the "Channel settings" menu (menu 22).

2   Select Standard signal as the sensor type for the connector you require.
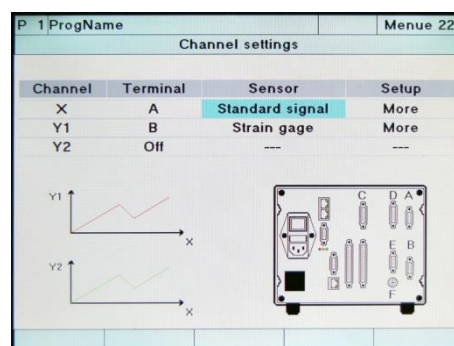
3   Switch to the "More" menu option and disable this option.

4   Press **[F3]** "Read TEDS". The burster TEDS data is imported.

5   If the device detected a standard-signal sensor programmed with TEDS, it displays the "TEDS Info" function **[F4]**.

Note: Once it has imported the burster TEDS data, the device overwrites the relevant parameters such as the scaling and calibration values. These parameters can be post-edited, for instance to set signal inversion.

6   Press **[F4]** "TEDS Info" to display the data from the standard-signal sensor. Press **[Enter]** to close the display.

Note: If the instrument did not detect a standard-signal sensor programmed with burster TEDS, it displays a window containing the message "No TEDS data found".

7   Close the "Channel settings" menu and confirm the settings with [**Enter**].

6.6.10 Piezoelectric sensors

Piezoelectric sensors can only be connected to the optional terminal **F.**

Note: For this function, your DIGIFORCE® 9307 must be fitted with the **optional** "Terminal F".

Parameters in the "Piezo sensor" menu (menu 26)

Input range	1, 2, 5, 10, 20, 40, 80, 200, 400, 1000 nC	Selection of input range for the piezoelectric charge input e.g. 100 kN (measurement range) x 3.9 pC/N (sensitivity) = 390 nC -> Input range = 400 nC
Unit		Dimensional units of measurement channel The units can be selected from a list. Or you can specify user-defined units via the **[F2]** key
Filter	OFF, 5, 10, 25, 50, 100, 200, 400, 800 Hz	Filter setting for measurement channel (Default value = 50 Hz)
Lower scale value		Input of lower scale value for 2-point scaling (typical value = 0)
Upper scale value		Input of upper scale value for 2-point scaling. (Typical value is 100 % of the sensor measurement range or a calibrated measurement range, see test certificate)
Lower calibration value		Measurement (using **[F1]** teach-in) of lower calibration value for 2-point scaling. You can only use the Measure (Teach-in) function properly when the sensor is connected and the channel settings are correct Numeric input is **not** possible.
Upper calibration value		Input or measurement (using **[F1]** teach-in) of upper calibration value for 2-point scaling. You can only use the "Measure..." (Teach-in) function properly when the sensor is connected and the channel settings are correct.

Note: The charge input for piezoelectric sensors (terminal F) is always short-circuited when a measurement is not active. The DIGIFORCE® 9307 does not enable the charge amplifier until the measurement is started. This allows the DIGIFORCE® 9307 to measure a change in charge (change in measurement value). The DIGIFORCE® 9307 does this by measuring a change in value relative to the start of the measurement.

The sensitivity of piezoelectric sensors (quartz crystals) is specified in pC/N for load cells (e.g. 3.9 pC/N). When selecting the correct input range, you must multiply the measurement range by this sensitivity, i.e. input range in [pC] = measurement range [N] x sensitivity [pC/N]

This is how it works

1   In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2   Select terminal "F" (piezoelectric).
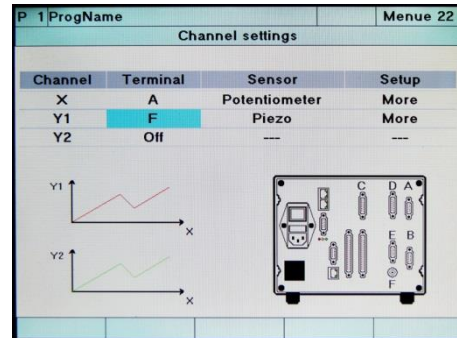
3   Go to the "More" menu option and select this option.

4   In this menu (menu 26), configure the sensor-specific settings for the piezoelectric sensor.
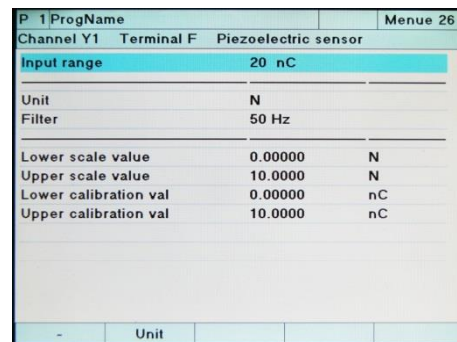
5   Exit the "Channel settings" menu and confirm your settings with **[Enter]**.

6.6.11 Sensors with incremental interface

You can connect incremental sensors to terminals "**C**" and "**D**" (option).

Note: Terminal "D" can only be connected to digital incremental sensors using TTL or RS-422 levels. Since both channels "C" and "D" (option) use the same hardware counter, you can only ever enable just one of the two in each measurement program.

Parameters for an incremental sensor

Reference mark	ON / OFF / distance-coded	"**OFF**" for sensors without reference mark or where reference signal is not evaluated "**ON**" for sensors with one or more reference marks (Multipoint) "**distance-coded**" for sensors with distance-coded reference marks for making absolute measurements (e.g. Heidenhain LS 4x7C)
Std value at reference mark	\<value input\>	Input of a counter setting (only when Reference mark = "ON")
Reference Measurement	YES / NO	**NO**: If Reference mark is set to "ON" or "distance-coded", each reference pulse forces the counter to the set counter setting. The DIGIFORCE® 9307 sets the counter cyclically for sensors with multiple reference marks or distance coding. **YES:** reference pulses are only evaluated when the sensor is performing a reference travel. A reference travel is initiated via the I/O or Fieldbus control signal IN_REF_MEAS. Reference travels are standard practice for sensors with reference marks or distance coding.
Set to value at start	YES / NO	**NO:** free-running counter; not affected by a measurement start (Reset at Power On). In Numeric Test Operation, you can set the counter values manually, or in measurement mode to a defined counter setting via the "IN_TARE" control input (e.g. "IN_TARE_X"). **YES: The** DIGIFORCE® 9307 sets the counter at the measurement start to a defined counter setting (typically 0)
Set value	\<value input\>	The default value for the function "Set to value at start" or for loading the counter with a tare reading (Numerical Test Operation or via the IN_TARE control inputs).
Nominal increment	\<value input\>	Only when Reference mark set to "distance coded" (for sensors with distance coding) Nominal increment: distance between two **fixed** reference marks (specified in mm or degrees)
Grating period	\<value input\>	
Interpolation	\<value input\>	Interpolation factor for the external interpolation unit or interpolation unit integrated in the sensor

Signal period	<display value>	Display value: = grating period / interpolation factor
Resolution	<display value>	Display value: = signal period / 4
Direction of Counting	Positive/ Negative	Switches the direction of measurement
Transmitter supply	ON / OFF	ON: +5 V transmitter supply active
Unit	Selection	
Termination resistor	ON / OFF	**OFF:** no termination resistor **ON:** RS-422 termination resistor 120 Ohms (recommended for long connecting leads)

This is how it works

1 In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2 Select one of the following senor types.

- Incr TTL/RS422
- Sine 1 V SS
- Sine 11 µA SS
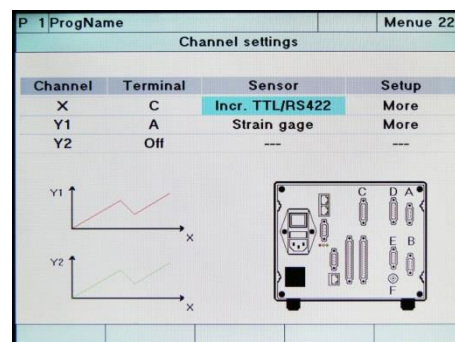
3 Go to the "More" menu option under Setup and select this option.

4 In this menu (menu 27), configure the sensor-specific settings for the incremental sensor.

5 Exit the "Channel settings" menu and confirm your settings with **[Enter]**.

Example: Settings for an 8738-DK8xxxx sensor

Reference mark	ON	Reference signal when sliding shaft extended by 1 mm
Std value at reference mark	<0.0000>	
Reference Measurement	NO	
Set to value at start	NO	Counter is set to counter setting ("Std value at reference mark") when sensor travels over reference mark.
Std. value at start	----	
Nominal increment	----	
Grating period	0.020 mm	Scale graduation
Interpolation	1	
Signal period	0.020 mm	Display value: = grating period / interpolation factor
Resolution	0.005 mm	Display value: = signal period / 4
Direction of Counting	Positive	
Transmitter supply	ON	ON: +5 V transmitter supply active
Unit	mm	
Termination resistor	OFF	

6.6.12 Connecting sensors that have a SSI interface

You can connect sensors that have an SSI interface to connector **C.**

Pulse diagram

LSB	least significant bit of complete SSI data
MSB	most significant bit of complete SSI data
Process data	The least significant bit of the displacement/angle information is received on the LSB of the SSI data (right-aligned format)
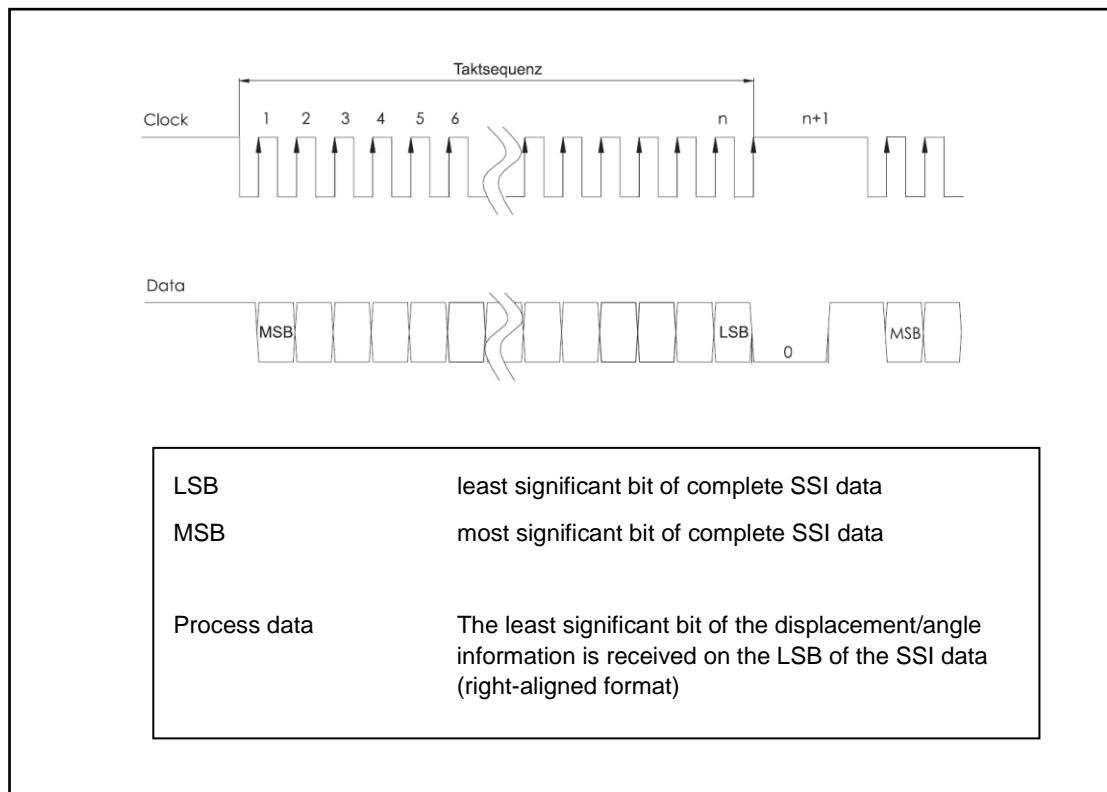
Parameters in the "Terminal C SSI" menu (menu 76)

6.6.12.1 SSI linear encoder

Sensor type	Linear encoder	Sensor type: linear encoder
Code	Binary, Gray	Binary or Gray coding of SSI data bits
Format	Right-aligned	The least significant bit of the displacement data is assigned to the LSB of the SSI data. DIGIFORCE® 9307 only supports the "right-aligned" format (the parameter cannot be changed).
Parity	OFF, even	OFF: no parity bit Even: parity bit has even parity
Clock frequency	100 kHz, 200 kHz, 1 MHz	Frequency for the SSI clock signal
Resolution	<input value>	Displacement resolution
Total number of bits	<input value>	Range 0 to 48: total number of data bits in a single SSI transmission
Number of bits (length)	<input value>	Range 0 to 32: Number of data bits that contain the displacement information

-----		
Units	\<selection\>	Measurement units for the display on the DIGIFORCE® 9307
Lower scale value	\<input value\>	The lower scale value for 2-point scaling (typical value: "0")
Upper scale value	\<input value\>	The upper scale value for 2-point scaling. The default value of 10 mm can be used in most applications (see note below)
Lower calibration value	\<input value\>	Value of the lower calibration value for 2-point scaling. Can be entered or trained (using **[F1]** teach-in function) (typical value: "0") The teach-in function only works if the sensor is connected and the correct channel parameters have been set.
Upper calibration value	\<input value\>	Value of the upper calibration value for 2-point scaling. Can be entered or trained (using **[F1]** teach-in function): The default value of 10 mm can be used in most applications (see note below). The teach-in function only works if the sensor is connected and the correct channel parameters have been set.

In most cases, 2-point scaling for SSI linear encoders is performed with a 1:1 assignment (e.g. upper/lower scale value 0/10 mm and upper/lower calibration value 0/10 mm). Alternatively, 2-point scaling could be used to translate values up or down (typically for rotating applications).

6.6.12.2 SSI singleturn encoder

Sensor type	Singleturn encoder	Sensor type: singleturn rotary encoder
Code	Binary, Gray	Binary or Gray coding of SSI data bits
Format	Right-aligned	The least significant bit of the angle data is assigned to the LSB of the SSI data. DIGIFORCE® 9307 only supports the "right-aligned" format (the parameter cannot be changed).
Parity	OFF, even	OFF: no parity bit Even: parity bit has even parity
Clock frequency	100 kHz, 200 kHz, 1 MHz	Frequency for the SSI clock signal
-------	-------	
Total number of bits	\<input value\>	Range 0 to 48: total number of data bits in a single SSI transmission
Number of bits / 360°	\<input value\>	Range 0 to 32: Number of data bits that contain the angle information
-------	-------	

Units	<selection>	Measurement units for the display on the DIGIFORCE® 9307
Lower scale value	<input value>	The lower scale value for 2-point scaling (typical value: "0")
Upper scale value	<input value>	The upper scale value for 2-point scaling (see note below).
Lower calibration value	<input value>	Value of the lower calibration value for 2-point scaling. Can be entered or trained (using **[F1]** teach-in function) (typical value: "0") The teach-in function only works if the sensor is connected and the correct channel parameters have been set.
Upper calibration value	<input value>	Value of the upper calibration value for 2-point scaling. Can be entered or trained (using **[F1]** teach-in function). See note below. The teach-in function only works if the sensor is connected and the correct channel parameters have been set.

With SSI rotary encoders, 2-point scaling lets you convert a rotational movement into a linear movement, for example.

Example

Ball screw with pitch of 10.08 mm.

Lower scale value	0 mm
Upper scale value	10.08 mm
Lower calibration value	0 degrees
Upper calibration value	360 degrees

6.6.12.3 SSI multiturn encoder

Sensor type	Multiturn encoder	Sensor type: multiturn rotary encoder
Code	Binary, Gray	Binary or Gray coding of SSI data bits
Format	Right-aligned	The least significant bit of the angle data is assigned to the LSB of the SSI data DIGIFORCE® 9307 only supports the "right-aligned" format (the parameter cannot be changed).
Parity	OFF, even	OFF: no parity bit Even: parity bit has even parity
Clock frequency	100 kHz, 200 kHz, 1 MHz	Frequency for the SSI clock signal
-------	-------	
Total number of bits	<input value>	Range 0 to 48: total number of data bits in a single SSI transmission

Number of bits / 360°	<input value>	Range 0 to 32: Number of data bits that contain the angle information
-------	-------	
Units	<selection>	Measurement units for the display on the DIGIFORCE® 9307
Lower scale value	<input value>	The lower scale value for 2-point scaling (typical value: "0")
Upper scale value	<input value>	The upper scale value for 2-point scaling (see note below).
Lower calibration value	<input value>	Value of the lower calibration value for 2-point scaling. Can be entered or trained (using [F1] teach-in function) (typical value: "0") The teach-in function only works if the sensor is connected and the correct channel parameters have been set.
Upper calibration value	<input value>	Value of the upper calibration value for 2-point scaling. Can be entered or trained (using [F1] teach-in function). See note below. The teach-in function only works if the sensor is connected and the correct channel parameters have been set.

With SSI rotary encoders, 2-point scaling lets you convert a rotational movement into a linear movement, for example.

Example

Ball screw with pitch of 10.08 mm.

Lower scale value	0 mm
Upper scale value	10.08 mm
Lower calibration value	0 degrees
Upper calibration value	360 degrees

This is how it works

1   In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2 Select for the relevant channel (the channel on the coordinate axis) the connector **C** and the sensor type SSI.

3 Go to the "More" menu option under Setup and select this option.

4 In this menu (menu 76) make the sensor-specific settings for the SSI sensor.
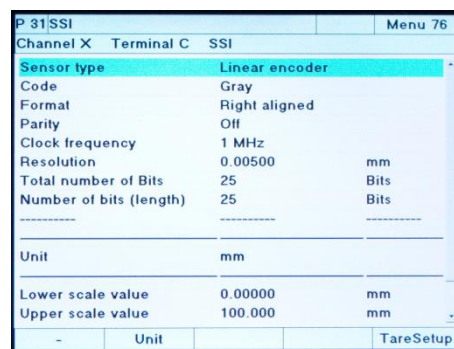
5 Close the Channel setup menu and confirm the settings with [**ENTER**].

Example

Settings for a GEFRAN MK4-S sensor with SSI interface.

Sensor type	Linear encoder	GEFRAN Typ MK4-S-F-0200-G-4 0.005 mm resolution
Code	Gray	
Format	Right-aligned	
Parity	OFF	no parity bit
Clock frequency	200 kHz	Frequency for the SSI clock signal
Resolution	0.005	Displacement resolution in mm
Total number of bits	25	
Number of bits (length)	25	
-------	-------	
Units	mm	
Lower scale value	0	
Upper scale value	10.0	
Lower calibration value	0	
Upper calbration value	10.0	

6.6.13 Connecting sensors that have an EnDat 2.2 interface

You can connect sensors that have an EnDat 2.2 interface to connector **C**.

Data acquisition is performed solely via the EnDat communications channel and not from any other additional incremental encoder signals that may be present.

Parameters in the "Terminal C EnDat" menu (menu 77)

6.6.13.1 EnDat linear encoder

Status	Ready, Error	When the "Terminal C EnDat" menu is opened, the instrument tries to communicate with the sensor. If an EnDat 2.2 sensor is detected successfully, the <Ready> status is displayed, otherwise <Error>.
EnDat	2.2	
Name	<XYZ>	Displays the type read from the sensor (e.g. AT 1218)
Serial number	<12345678>	Displays the serial number read from the sensor
Sensor type	Linear encoder	Displays the sensor type
Number of bits	xx bits	Displays the process data length in bits
Measuring length	xx mm	Displays the measurement length for the connected sensor
Resolution	xx.yyyy mm	Displays the displacement resolution for the connected sensor
Max. clock rate	xx MHz	Displays the maximum EnDat clock frequency supported by the sensor
Clock frequency	100 kHz, 200 kHz, 1 MHz, 2 MHz	Selection of EnDat clock frequency
-------		
Units	<selection>	Measurement units for the display on the DIGIFORCE® 9307 Pressing **[F2]** also lets you set custom units.
Lower scale value	<input value>	The lower scale value for 2-point scaling (typical value: "0")
Upper scale value	<input value>	The upper scale value for 2-point scaling. The default value of 10 mm can be used in most applications (see note below).

Lower calibration value	<input value>	Value of the lower calibration value for 2-point scaling. Can be entered or trained (using [F1] teach-in function) (typical value: "0")
		The teach-in function only works if the sensor is connected and the correct channel parameters have been set.
Upper calibration value	<input value>	Value of the upper calibration value for 2-point scaling. Can be entered or trained (using [F1] teach-in function):
		The default value of 10 mm can be used in most applications (see note below).
		The teach-in function only works if the sensor is connected and the correct channel parameters have been set.

In most cases, 2-point scaling for EnDat linear encoders is performed with a 1:1 assignment (e.g. upper/lower scale value 0/10 mm and upper/lower calibration value 0/10 mm). Alternatively, 2-point scaling could be used to translate values up or down (typically for rotating applications).

6.6.13.2 EnDat singleturn encoder

Status	Ready, Error	When the "Terminal C EnDat" menu is opened, the instrument tries to communicate with the sensor. If an EnDat 2.2 sensor is detected successfully, the <Ready> status is displayed, otherwise <Error>.
EnDat	2.2	
Name	<XYZ>	Displays the type read from the sensor (e.g. ECN 425)
Serial number	<12345678>	Displays the serial number read from the sensor
Sensor type	Singleturn encoder	Displays the sensor type
Number of bits / 360°	xx bits	Displays the angular resolution of the sensor
Max. clock rate	xx MHz	Displays the maximum EnDat clock frequency supported by the sensor
Clock frequency	100 kHz, 200 kHz, 1 MHz, 2 MHz	Selection of EnDat clock frequency
-------		
Units	<selection>	Measurement units for the display on the DIGIFORCE® 9307 Pressing **[F2]** also lets you set custom units.
Lower scale value	<input value>	The lower scale value for 2-point scaling (typical value: "0")
Upper scale value	<input value>	The upper scale value for 2-point scaling. The default value of 10 mm can be used in most applications (see note below).
Lower calibration value	<input value>	Value of the lower calibration value for 2-point scaling. Can be entered or trained (using **[F1]** teach-in function) (typical value: "0") The teach-in function only works if the sensor is connected and the correct channel parameters have been set.
Upper calibration value	<input value>	Value of the upper calibration value for 2-point scaling. Can be entered or trained (using **[F1]** teach-in function): The default value of 10 mm can be used in most applications (see note below). The teach-in function only works if the sensor is connected and the correct channel parameters have been set.

With EnDat rotary encoders, 2-point scaling lets you convert a rotational movement into a linear movement, for example.
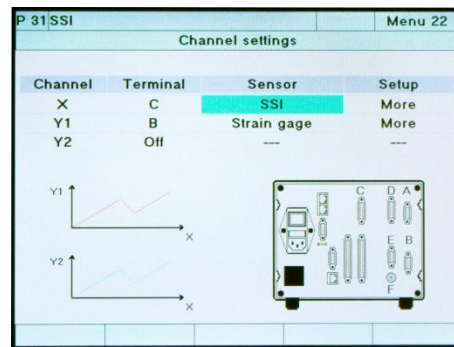
Example

Ball screw with pitch of 10.08 mm.

Lower scale value	0 mm
Upper scale value	10.08 mm
Lower calibration value	0 degrees
Upper calibration value	360 degrees

6.6.13.3 EnDat multiturn angle sensor

Status	Ready, Error	When the "Terminal C EnDat" menu is opened, the instrument tries to communicate with the sensor. If an EnDat 2.2 sensor is detected successfully, the <Ready> status is displayed, otherwise <Error>.
EnDat	2.2	
Name	<XYZ>	Displays the type read from the sensor (e.g. ECN 425)
Serial number	<12345678>	Displays the serial number read from the sensor
Sensor type	Multiturn encoder	Displays the sensor type
Number of bits/360°	xx bits	Displays the angular resolution of the sensor
Singleturn res (bits)	xx bits	Displays the number of distinguishable turns in the sensor
Max. clock rate	xx MHz	Displays the maximum EnDat clock frequency supported by the sensor
Clock frequency	100 kHz, 200 kHz, 1 MHz, 2 MHz	Selection of EnDat clock frequency
-------		
Units	<selection>	Measurement units for the display on the DIGIFORCE® 9307 Pressing **[F2]** also lets you set custom units.
Lower scale value	<input value>	The lower scale value for 2-point scaling (typical value: "0")
Upper scale value	<input value>	The upper scale value for 2-point scaling. The default value of 10 mm can be used in most applications (see note below).
Lower calibration value	<input value>	Value of the lower calibration value for 2-point scaling. Can be entered or trained (using [F1] teach-in function) (typical value: "0") The teach-in function only works if the sensor is connected and the correct channel parameters have been set.
Upper calibration value	<input value>	Value of the upper calibration value for 2-point scaling. Can be entered or trained (using [F1] teach-in function):

| | | The default value of 10 mm can be used in most applications (see note below). |
| | | The teach-in function only works if the sensor is connected and the correct channel parameters have been set. |

With EnDat rotary encoders, 2-point scaling lets you convert a rotational movement into a linear movement, for example.

Example

Ball screw with pitch of 10.08 mm.

Lower scale value	0 mm
Upper scale value	10.08 mm
Lower calibration value	0 degrees
Upper calibration value	360 degrees

This is how it works

1 In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2 Select for the relevant channel (the channel on the coordinate axis) the connector **C** and the sensor type EnDat.

3 Go to the "More" menu option under Setup and select this option.

4 When the menu is opened, the instrument communicates with the EnDat sensor. It reads out and displays the relevant sensor data. You additionally need to set the parameters for the EnDat clock frequency, measurement units and any scaling required.
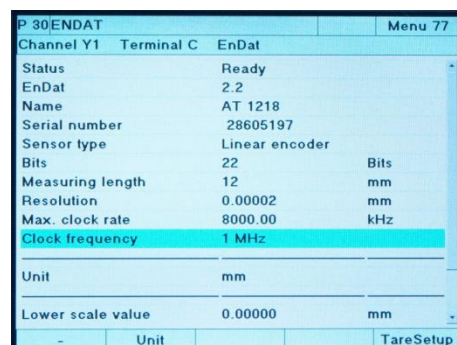
5 Close the Channel setup menu and confirm the settings with [**ENTER**].

Example

Settings for a Heidenhain AT 1218 sensor with EnDat interface.

Status	Ready	
EnDat	2.2	
Name	AT 1218	
Serial number	<12345678>	Serial number of connected sensor
Sensor type	Linear encoder	
Number of bits	22 bits	
Measuring length	12 mm	
Resolution	0.00002 mm	
Max. clock rate	8 MHz	
Clock frequency	1 MHz	Selected clock frequency (max. 2 MHz)

Units	mm	
Lower scale value	0.0	
Upper scale value	10.0	
Lower calibration value	0.0	
Upper calibration value	10.0	

6.6.14 Resistance measurement

You can connect resistances to connector **E** (option).

Note: For this function, your DIGIFORCE® 9307 must be fitted with the **optional** "Channel E".

Parameters in the "Resistance" channel settings menu (menu 28)

Input range	200 mΩ, 2 kΩ, 100 kΩ	Selection of required resistance range
Filter	OFF, 5, 10, 25, 50, 100, 200, 400, 800 Hz	Filter setting for measurement channel (Default value = 50 Hz)

This is how it works

1 In measurement mode, press the **[F5]** "Config" key twice and then open the "Channel settings" menu (menu 22).

2 Select terminal "E" for the resistance measurement.
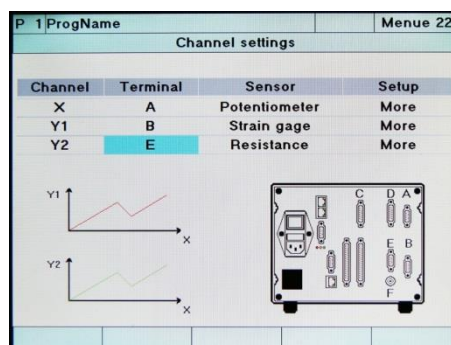
3 Use the "Setup" menu option to switch to the "Resistance" channel settings menu (menu 28).

4 In the "Resistance" channel settings menu (menu 28), make the relevant settings for the resistance measurement.
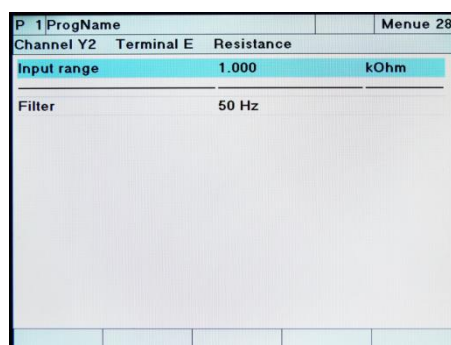
5 Exit the "Channel settings" menu and confirm your settings with **[Enter]**.

6.6.15 Torque sensors with integral angle measurement

You can connect torque sensors with integral angle measurement, such as sensor model 8661, to the DIGIFORCE® 9307 either to the standard terminals using an additional Y-cable (e.g. terminal A for the analog torque signal and terminal C for the incremental angle signal) or directly to the optional combined terminal D. You must, however, make the relevant channel settings independently for channel X (X-axis) and channel Y (Y-axis).

Summary of channel settings when a torque sensor with integral angle measurement (e.g. model 8661) is connected to the standard terminals A and C using an Y-cable.

Channel	Terminal	Sensor	Setup
X	C	Incr. TTL/RS422	See 5.6.6
Y1	A	Standard signal	See 5.6.3

Summary of channel settings when a torque sensor with integral angle measurement (e.g. model 8661) is connected to the optional combined terminal D.

Channel	Terminal	Sensor	Setup
X	D	Incr. TTL/RS422	See 5.6.6
Y1	D	Standard signal	See 5.6.3

6.7 Measurement mode

In the "Measurement mode" menu (menu 20) you specify the conditions for signal recording in the measurement phase. To do you this you essentially need to set signal-sampling parameters, configure the X-reference for the measurement curve, the curve segment (forward curve segment or complete measurement curve) and the start/stop condition for the measurement phase.

6.7.1 Measurement-channel sampling

The DIGIFORCE® 9307 supports signal sampling from a combination of time interval (Δt), X-interval and Y-interval (ΔX, ΔY). This ensures a highly flexible yet also compressed measurement recording. For instance, you can use just a few measurement points to save curve regions where signals are constant or change in a constant manner, whereas a large number of points can be saved in order to record steep signal edges or alternating signals reproducibly.

Note: When specifying the signal sampling, remember the maximum memory depth for storing measurement curve data. The DIGIFORCE® 9307 can store up to 5000 value pairs or value triplets per measurement for two Y-channels. When sampling at the fastest possible rate (0.1 ms for each sample interval), this means that the curve memory is full after 0.5 seconds.

Parameters in the "Measurement mode (signal sampling)" menu (menu 20)

X sampling	ON / OFF	
X sample rate	<value input>	Input of X sample interval
		For values smaller than the channel resolution, the smallest possible sample interval is used automatically.
		Range 0 … 999999
Y1 sampling	ON / OFF	
Y1 sample rate	<value input>	Input of Y1 sample interval
		For values smaller than the channel resolution, the smallest possible sample interval is used automatically.
		Range 0 … 999999
Y2 sampling	ON / OFF / ---	ON / OFF is only offered if channel Y2 is enabled in the Channel settings menu.
Y2 sample rate	<value input>	Input of Y2 sample interval
		For values smaller than the channel resolution, the smallest possible sample interval is used automatically.
		Range 0 … 999999
t sampling	ON / OFF	Time-based sampling ON / OFF
t sample rate	<value input>	Input of t sample interval
		Range 0.0001 (100µs) … 99999 sec

6.7.2   Measurement curve reference

The DIGIFORCE® 9307 provides the following X-references for referencing the measurement curve. Further details are explained in section 3.5.3 "Specifying the X-axis reference**Fehler! Verweisquelle konnte nicht gefunden werden.**" on page 22.

- Absolute
- Final force
- Y1 or Y2 reference line overrun
- Y1 or Y2 reference line underrun
- Y1 or Y2 trigger overrun
- Y1 or Y2 trigger underrun

Note: For the "Trigger overrun/underrun" reference, the DIGIFORCE® 9307 does not start saving curve data until after the trigger event.

When recording two curves $Y_1(X)$ and $Y_2(X)$, the curves always share one common reference point.

6.7.2.1 "Absolute" reference

See also section 3.5.3.1 "ABSOLUTE reference" on page 23.

Parameters in the "Measurement mode", Reference "Absolut" (menu 20)

Reference	Absolute	The DIGIFORCE® 9307 references the measurement curve to the absolute zero point of the X-measurement system (e.g. displacement sensors).
		For incremental sensors that make relative measurements, standard practice is to set the X-channel to zero at the start of the measurement. See also section **Fehler! Verweisquelle konnte nicht gefunden werden.** "**Fehler! Verweisquelle konnte nicht gefunden werden.**" on page **Fehler! Textmarke nicht definiert.**.
-----	----	
-----	----	

6.7.2.2 "Final force" reference

See also section 3.5.3.2 "FINAL FORCE reference" on page 24.

Parameters in the "Measurement mode", Reference "Final force" (menu 20)

Reference	Final force	The last measurement point of the measurement curve as it this final measurement is the reference point (X = 0). For a forward-and-return curve, this is the curve turning point.
-----	----	
-----	----	

6.7.2.3 "$Y_{1/2}$ reference line overrun / underrun" reference

See also section 3.5.3.3 "REFERENCE LINE reference (overshoot/undershoot)" on page 25.

Parameters in the "Measurement mode", Reference "Reference line" (menu 20)

Reference	Y1 reference line overrun, Y1 reference line underrun, Y2 reference line overrun, Y2 reference line underrun	The reference point is where the curve crosses above or below the set Y-level (Y1/2 reference line).
Y1/2 reference line	<value input>	Value input for the Y-level
-----	----	

6.7.2.4 Y$_{1/2}$ trigger overrun / underrun" reference

See also section 3.5.3.4 "TRIGGER reference (overshoot/undershoot)" on page 26.

Parameters in the "Measurement mode", Reference "Trigger" (menu 20)

Reference	Y1 trigger overrun, Y1 trigger underrun, Y2 trigger overrun, Y2 trigger underrun	The reference point is where the curve crosses above or below the set Y-level (Y1/2 trigger).
Y1/2 trigger	<value input>	Value input
Pretrigger display	ON / OFF	**ON:** The curve prior to the trigger event is displayed as a blue curve. It is not possible to analyze this part of the curve with evaluation elements. **OFF:** no curve display prior to trigger event

6.7.3 Curve recording, return point

The DIGIFORCE® 9307 divides a recorded measurement curve into two curve segments: the forward and return segments.

Using the "Record curve to" parameter, you can specify whether the DIGIFORCE® 9307 records and evaluates only the "forward" curve segment or the "complete curve" (forward and return segments).

The "Return point" parameter is used to define which point of the curve is the last value pair of the forward segment of curve, i.e. the turning point. The DIGIFORCE® 9307 marks this turning point in the M1 graphical view in the Measurement menu with a yellow circle.

Parameters in the "Measurement mode", Reference "Return point" (menu 20)

Return point	X$_{MIN}$, X$_{MAX}$, Y1$_{MIN}$, Y1$_{MAX}$	You make the setting for the turning point (= return point) on the Y1 curve. The DIGIFORCE® 9307 then uses your setting to determine the last measurement point of the forward curve segment and hence the turning point
Record curve to	Return point / Complete curve	**Return point**: The DIGIFORCE® 9307 displays and evaluates only the forward curve segment. **Complete curve**: The DIGIFORCE® 9307 displays and evaluates the entire measurement curve (forward and return segments).

Example

Define the turning point and record the complete curve or record up to the turning point.

Record curve to: Return point

Return point: $Y1_{MAX}$
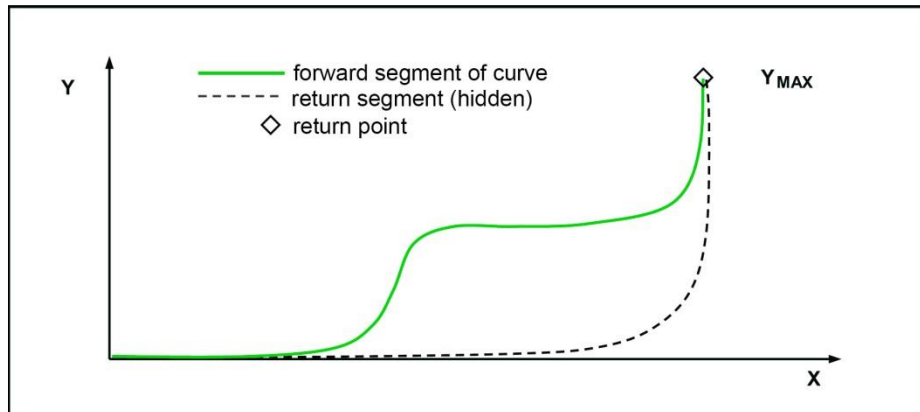
Diagram 29: Return point $Y1_{MAX}$

Record curve to: Return point

Return point: X_{MAX}
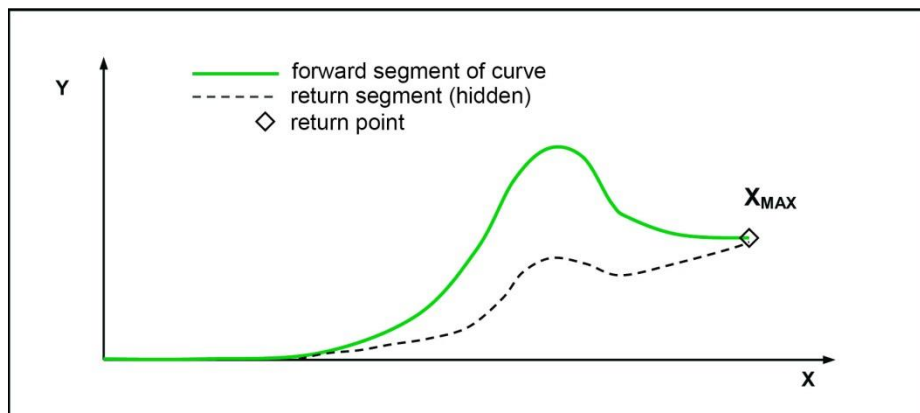
Diagram 30: Return point X_{MAX}

6.7.4 Start/Stop mode

The DIGIFORCE® 9307 lets the user set independent start/stop parameters for recording a measurement curve. Apart from the standard method using an external control signal to start or stop a measurement, it is also possible to use sensor signals as the start/stop control.

Parameters in "Measurement mode (Start/stop measurement)" menu (menu 20)

Start mode		External:
	External X internal overrun X internal underrun $Y_{1/2}$ internal overrun $Y_{1/2}$ internal underrun	The measurement starts on the rising edge of the control signal "IN_START". **X internal overrun/underrun:** You also need to define the X-channel start threshold (X start value). **Y_1/Y_2 internal overrun/underrun:** You also need to define the Y_1/Y_2-channel start threshold (Y_1 or Y_2 start value).
X/Y_1/Y_2 start value	----- / <value input>	
Stop mode		**External:** The measurement is stopped on the falling edge of the control signal IN_START. **X internal overrun/underrun:** You also need to define the X-channel stop threshold (X stop value). **$Y_{1/2}$ internal overrun/underrun:** You also need to define the Y_1/Y_2-channel stop threshold (Y_1 or Y_2 stop value). **Timeout:** The measurement is only stopped when the defined time has elapsed Number of readings: The measurement is stopped as soon as the defined number of measurement-value-pairs have been recorded.
	External X internal overrun X internal underrun $Y_{1/2}$ internal overrun $Y_{1/2}$ internal underrun Timeout Number of readings	
X/Y_1/Y_2 stop value; **Number of readings**	----- / <value input>	
Timeout	<value input>	Range: 0 < timeout ≤ 99999 seconds **Using the timeout to stop a measurement is always active,** so you must enter a suitable length of time.

6.7.5   Bend-up factor

By entering a bend-up factor, you can compensate for any inherent elasticity in the application (linear compensation of X-channel). With joining processes, there are often system configurations in which the applied forces cause the structure to bend (e.g. C-frame press). A strain-gage load cell is also based on the principle of elastic deformation and experiences over its rated measurement range a typical deformation of about 20 … 80 μm (rated measurement travel). This bending affects the recorded force/displacement data, because the displacement measurement includes components of the total elasticity.

In many cases you can ignore this behavior, because you are dealing with a reproducible variable. In this case leave the "Bend-up factor" parameter with the value 0.00000.

If, however, the DIGIFORCE® 9307 is meant to be used for monitoring a precise and absolutely accurate X-position, you can use this parameter to compensate for the system elasticity.

Bend-up factor	<value input> 0.00000 [default]	Enter the Bend-up factor to compensate for the system elasticity (linear compensation of X-channel)

Example

A ball bearing is pressed into a bearing cup with maximum force until the limit of travel is reached. The system design can mean that the maximum insertion force varies by up to 25 %.
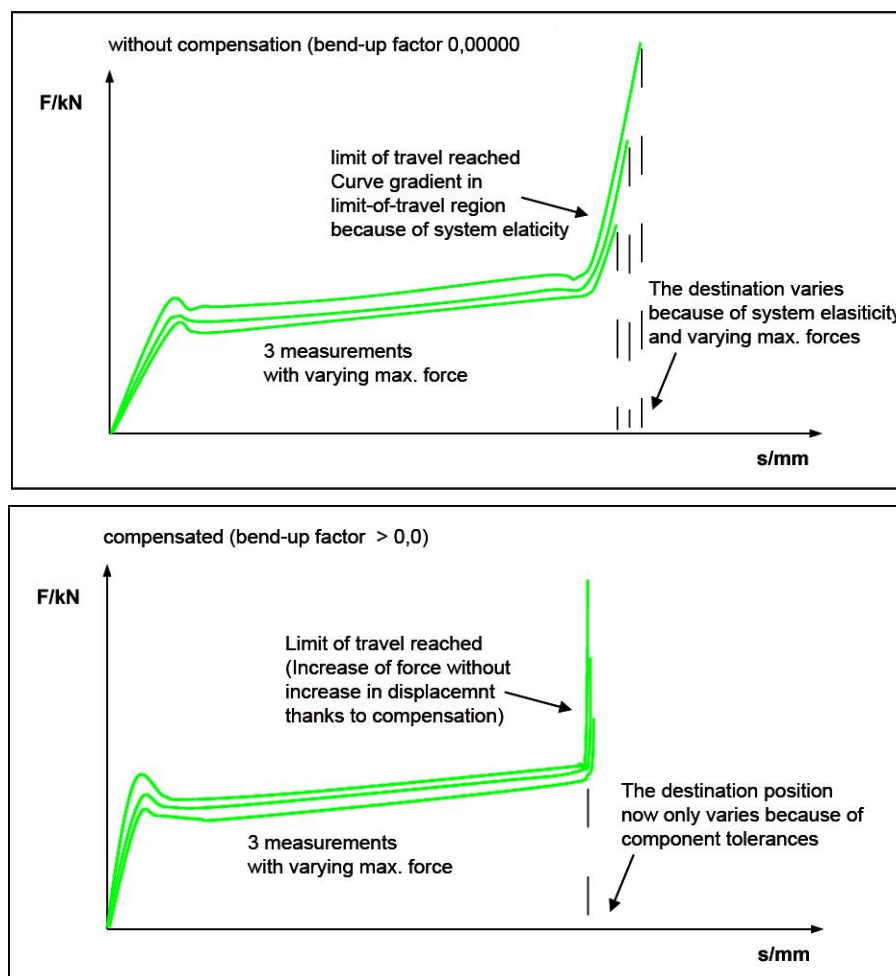
Diagram 31: Example ball bearing

6.7.5.1 Finding the bend-up factor

You can find the bend-up factor from the gradient of a measurement curve in Graphical test operation. You the cursor tool to help you measure the curve gradient.

This is how it works

1 In measurement mode, press the **[F5]** key twice.

2 Switch to the "Simple Test Operation" menu.

3 Pressing **[F5]** switches you between numerical and graphical test operation.

Method 1: Finding the bend-up factor from a real measurement curve

In the limit-of-travel region of the curve, use the cursor tool to find the X/Y coordinates of two measurement points that are spaced apart from each other. Calculate the difference values ΔX and ΔY. The bend-up factor is the quotient of ΔX/ΔY.
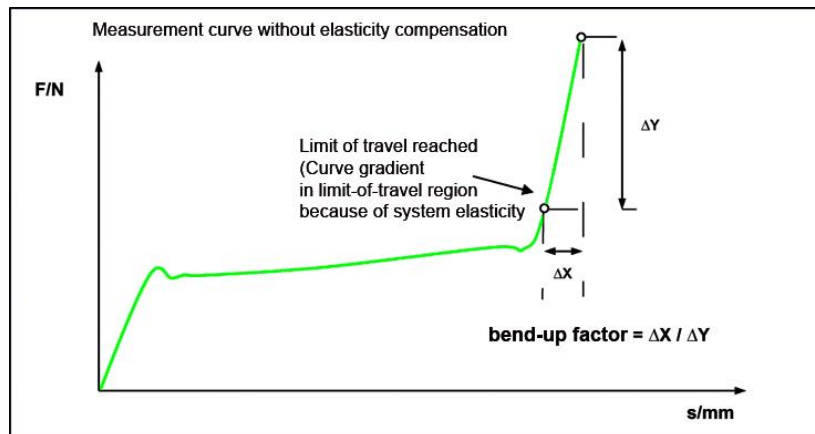
Diagram 32: Finding the bend-up factor from a real measurement curve

Method 2: Finding the bend-up factor from a limit-of-travel measurement without workpiece

In the limit-of-travel region of the curve, use the cursor tool to find the X/Y coordinates of two measurement points that are spaced apart from each other. Calculate the difference values ΔX and ΔY. The bend-up factor is the quotient of ΔX/ΔY.
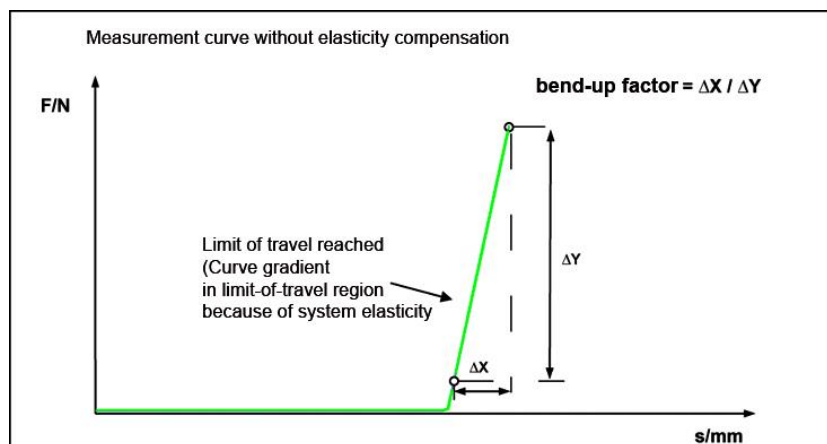
Diagram 33: Finding the bend-up factor from a limit-of-travel measurement without workpiece

6.8 Configuring evaluation

You have two ways of enabling and configuring evaluation elements on the DIGIFORCE® 9307.

In the "Evaluation" configuration menu you can enable the evaluation elements and configure them by entering numeric values. This menu does not provide immediate visualization of how the evaluation element will look in the X/Y graph.

All evaluation elements apart from the envelope can be configured by entering numeric values. For an envelope you need at least one measurement curve. (To generate an envelope, use Graphical test operation and select the menu "Simple test operation")

Graphical test operation provides you with an alternative way of configuring the evaluation elements, by graphical means. You can find further information on Graphical test operation in section 6.10 "Simple test operation" on page 150.

6.8.1 Window

One of the most commonly used evaluation elements is the evaluation window. You can use up to ten of these windows at once in one measurement program. You can assign an online signal to up to two of these windows. The DIGIFORCE® 9307 enables this online signal immediately if any of the window transit criteria are infringed.

Not every evaluation element is included in the overall result. You can also use a window simply for data capture. To do this, you simply need to set the "Evaluation" parameter for the window concerned to "OFF".

Regardless of whether Evaluation is enabled or disabled for a specific window, the DIGIFORCE® 9307 captures the following data for each window that is active in a measurement program:

Single evaluation
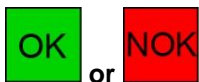
OK or **NOK**	The DIGIFORCE® 9307 can also output the evaluation result from an individual window to the I/O interface or Fieldbus interface.

Entry

	The DIGIFORCE® 9307 linearly interpolates the window entry coordinate from the last measurement point outside the window limits and the first measurement point inside the window limits.
	If the measurement curve starts from inside the window area, the DIGIFORCE® 9307 outputs the first measurement point (start value).
	If the entire measurement curve lies outside the window area, the DIGIFORCE® 9307 will pass the pair of values 909090/909090 to the interface and display "<<<>>>" on the screen.

Exit

	The DIGIFORCE® 9307 linearly interpolates the window exit coordinate from the last measurement point inside the window limits and the first measurement point outside the window limits.
	If the measurement curve ends inside the window area, the DIGIFORCE® 9307 outputs the last measurement point.
	If the entire measurement curve lies outside the window area, the DIGIFORCE® 9307 will pass the pair of values 909090/909090 to the interface and display "<<<>>>" on the screen.

Note: If you have defined an entry side and/or exit side, at least one value pair must lie within the window limits. If this is not the case, the DIGIFORCE® 9307 assesses the window as "NOK".

6.8.1.1 Configuring an evaluation window

This is how it works

1   In measurement mode, press the **[F5]** key twice, open the "Evaluation" configuration menu.

2   Open the "Window" menu. The DIGIFORCE® 9307 then displays the "Window configuration" menu.
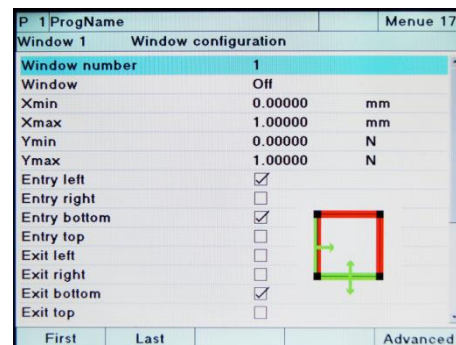
3   Select a particular window by entering the number of the window concerned. If this window has already been configured, the DIGIFORCE® 9307 will overwrite this data with the new configuration. In total you can activate up to 10 different windows at once.

4   Enable the window function by placing the cursor on the "Window" option then using the ⇦ and ⇨ buttons to enable the window.

5   Then specify the position and size of the window. You do this using the points Xmin, Xmax, Ymin and Ymax, for which you can enter the respective coordinates.

6 Define the entry and exit sides of the window. To do this, place the cursor on the option you require and enable it using the ⇦ and ⇨ buttons. You can choose how many entry sides and exit sides there are. In each case you can select:

- one side
- more than one side
- none at all

Note: If there is neither an entry nor exit side specified, the curve can run completely within the window or completely outside the window ("not window"). Every conceivable combination of entry and exit side is allowed.
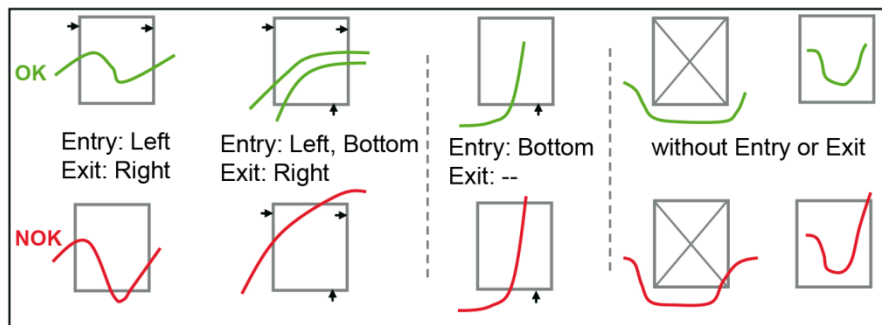
7 Now define whether the DIGIFORCE® 9307 is meant to include the window in the evaluation.
When Evaluation is set to "OFF", this window does not affect the overall result. The DIGIFORCE® 9307 simply calculates the entry and exit points and optionally the advanced results.

8 Specify the curve segment for which the window is active. You can choose here between the forward curve, return curve and the complete curve.

9 Configure online evaluation. You have the following options here:

- OFF
- Left > Right
- Right > Left
- Bottom > Top
- Top > Bottom

When online evaluation is active, the DIGIFORCE® 9307 enables the assigned online signal immediately on detecting that the curve has exited the window incorrectly.

Note: The entry/exit sides defined above are changed by activating online evaluation. Where "Final force" or "Reference line" is used for the X reference, the online evaluation is always based on the absolute X value, i.e. the position of the window may lie in a different region of the X/Y graph. In this case, set "Evaluation" (OK/NOK) to "OFF".

10 If you haveenabled online evaluation, assign one of the two online signals using the "Online Signal Number" option.

- 1: OUT_NOK_ONL1
- 2: OUT_NOK_ONL2

11 In this case, specify the active level of the PLC I/O signal under the "Online Signal" option. Here you can choose between "High active" and "Low active".

12 Specify whether the DIGIFORCE® 9307 is only meant to evaluate the first pass-through.

YES means that the measurement curve must pass through the window once correctly. Once that has happened, the DIGIFORCE® 9307 stops the evaluation algorithm (equivalent to evaluation method used in the DIGIFORCE® 9306).

NO means that the curve must only pass through the window correctly once, and once only, for the DIGIFORCE® 9307 to evaluate the window as "OK". If the curve enters the window again, the result is always "NOK" (equivalent to evaluation method used by the DIGIFORCE® 9310).

Parameter: „Evaluate only first passage"

Yes   No
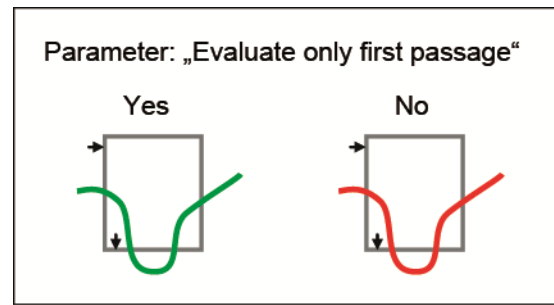
13 Specify whether the evaluation window is active on channel Y_1 or Y_2.
That completes the basic configuration of the evaluation window. In the "Advanced" section you can activate additional parameters for recording extra information.

Menu parameters "Window configuration" menu (menu 17)

Window number	1 … 10	Selection of window 1 to 10
Window	ON / OFF	Enable / Disable
Xmin	<value input>	Window-position coordinate Xmin
Xmax	<value input>	Window-position coordinate Xmax
Ymin	<value input>	Window-position coordinate Ymin
Ymax	<value input>	Window-position coordinate Ymax
Entry	Left, Right, Bottom, Top	Side on which the curve enters the window Options: one entry side more than one entry side no entry
Exit	Left, Right, Bottom, Top	Side on which the curve exits the window Options: one exit side more than one exit side no exit Note: If there is no entry side and no exit side specified, the curve can run completely outside the window ("not window") or completely within the window.
Evaluation	ON / OFF	When Evaluation is set to OFF, this element does not affect the overall result. The instrument only calculates the entry and exit points and optionally the advanced results.
Curve segment	Forward, Return, Complete curve	Defines which curve segment the window applies to.
Online evaluation	OFF Left > Right Right > Left Bottom > Top Top > Bottom	When online evaluation is active, the assigned online signal is enabled immediately on detecting an illegal curve exit from the window. Note: The entry/exit sides defined above are changed by activating online evaluation. Where "Final force" or "Reference line" is used for the X-reference, the online evaluation is always based on the absolute X-value, i.e. the position of the window may lie in a different region of the X/Y graph. In this case, "Evaluation" (OK/NOK) must be set to OFF.
Online Signal Number	1 ... 2	Assignment of relevant online signal 1: OUT_NOK_ONL1 2: OUT_NOK_ONL2

Online Signal	High active Low active	Active level of PLC I/O signal (OUT_NOK_ONL1/2)
Evaluate only first passage	YES / NO	**YES**: The curve must pass through the window once correctly, then the evaluation algorithm is stopped (equivalent to evaluation method used in the DIGIFORCE® 9306) **NO**: The measurement curve is only allowed to pass through the window once correctly for the window to be assessed as OK. If the curve enters the window again, the result is always NOK (equivalent to evaluation method used by the DIGIFORCE® 9310) - see explanation
Y channel	Y1 / Y2	Specifies whether the evaluation element is active on $Y_1(X)$ or $Y_2(X)$

6.8.1.2 Advanced window results

Apart from the entry and exit values, which the DIGIFORCE® 9307 automatically measures for each active window, you can also retrieve additional data. To do this, you must enable the relevant function in the "Advanced window configuration" menu. For some functions you need to enter additional parameters.

Diagram 34: Advanced window results

The advanced window results are only calculated, if the global window result is OK.

To access this "Advanced window configuration" menu, press **[F5]** "Advanced" in the "Window configuration" menu. You can then enable the following functions

Bend

Note: For this option you need to specify the two parameters "Delta gradient for bend" and "Delta Y bend".
If the measurement curve is very noisy or has been damped for a gradual change in gradient, it may not be possible to find any bend in the curve.

For "Delta Y bend", select a value that is greater than any Y-fluctuations that may be present (for instance caused by vibrations, electromagnetic interference…). This is essential for the DIGIFORCE® 9307 to find the inflexion point (bend) correctly.

	When the curve enters the window area, the DIGIFORCE® 9307 checks whether the delta value from the first value pair to the next value pair has exceeded the set delta value for "Delta Y bend". If so, then these two value pairs are used to calculate the actual gradient. If not, the delta value to the third or subsequent value pair is checked. As soon as the delta value exceeds "Delta Y bend", the actual gradient is calculated. The same algorithm is used along the rest of the curve to determine the next gradient result. If the newly obtained gradient differs from the previously calculated value by the value "Delta gradient", then this situation is identified as a bend and further analysis is terminated. If the newly obtained gradient is less than the value "Delta gradient" then it is used as the actual gradient and compared with the next gradient result. As long as no bend is identified, this procedure is continued until the curve exits the window area. If the DIGIFORCE® 9307 does not detect a bend inside the window, the DIGIFORCE® 9307 outputs the value pair 909090/909090 and shows "<<<>>>" in the display.

Absolute maximum

	The DIGIFORCE® 9307 finds the absolute maximum of the Y-coordinate between entry and exit as an X/Y value pair. The DIGIFORCE® 9307 only looks at curve points inside the window limits.

Absolute minimum
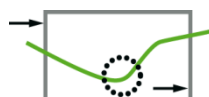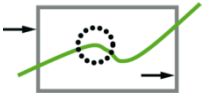
	Set the option "Absolutes minimum" to "ON". The DIGIFORCE® 9307 now finds the absolute minimum of the Y coordinate between entry and exit as an X/Y value pair. The DIGIFORCE® 9307 only looks at curve points inside the window limits.
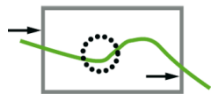
Local maximum

Note: For this option you need to specify the parameter "Delta Y local maximum". Select a value for this that is greater than any Y-fluctuations that may be present (for instance caused by vibrations, electromagnetic interference…). This is essential for the DIGIFORCE® 9307 to find the local maximum correctly.

	The DIGIFORCE® 9307 finds the **first** local maximum of the Y-coordinate in the window area as an X/Y value pair.
	If the DIGIFORCE® 9307 does not detect a local maximum, the DIGIFORCE® 9307 outputs the value pair 909090/909090 and shows "<<<>>>" in the display.
	The DIGIFORCE® 9307 only looks at curve points inside the window limits.

Local minimum

Note: For this option you need to specify the parameter "Delta Y local minimum". Select a value for this that is greater than any Y-fluctuations that may be present (for instance caused by vibrations, electromagnetic interference…). This is essential for the DIGIFORCE® 9307 to find the local minimum correctly.

	The DIGIFORCE® 9307 finds the **first** local minimum of the Y-coordinate in the window area as an X/Y value pair.
	If the DIGIFORCE® 9307 does not detect a local minimum, the DIGIFORCE® 9307 outputs the value pair 909090/909090 and shows "<<<>>>" in the display.
	The DIGIFORCE® 9307 only looks at curve points inside the window limits.

Mean value Y

	The window outputs the mean value of the Y-values available between entry and exit.
	The DIGIFORCE® 9307 only looks at curve points inside the window limits for this result.

Gradient

	The DIGIFORCE® 9307 measures the gradient between the calculated entry and exit coordinates.

Area

	The DIGIFORCE® 9307 measures the area between the measurement curve and the bottom window limit (Y_{MIN} limit).
	The DIGIFORCE® 9307 only includes the curve region enclosed by the window limits X_{MIN} and X_{MAX}.

6.8.1.3 Additional results when recording two curves Y₁(x) and Y₂(x)

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

When two curves Y_1 and Y_2 are being recorded simultaneously over a shared X-axis, the window, type-Y threshold and Y-trapezoid evaluation elements can provide not only results for the associated Y_1 or Y_2 curve but also a result for the corresponding curve at the identical X-position. If the evaluation element on the Y_1 curve is enabled, this can be used to obtain a relevant value for the Y_2 curve as well, and vice versa. You can use the obtained value in the "User-defined values" result table or as an operand in the mathematical functions.

Example

A test on a switch measures not only the mechanical variables of force and displacement but also the contact resistance of the normally open (n.o.) contact. The DIGIFORCE® 9307 performs the following synchronous acquisition:

- X-axis: Displacement signal from switch actuation

- Y_1-axis: Force of actuation

- Y_2-axis: Ohmic resistance of the switch n.o. contact
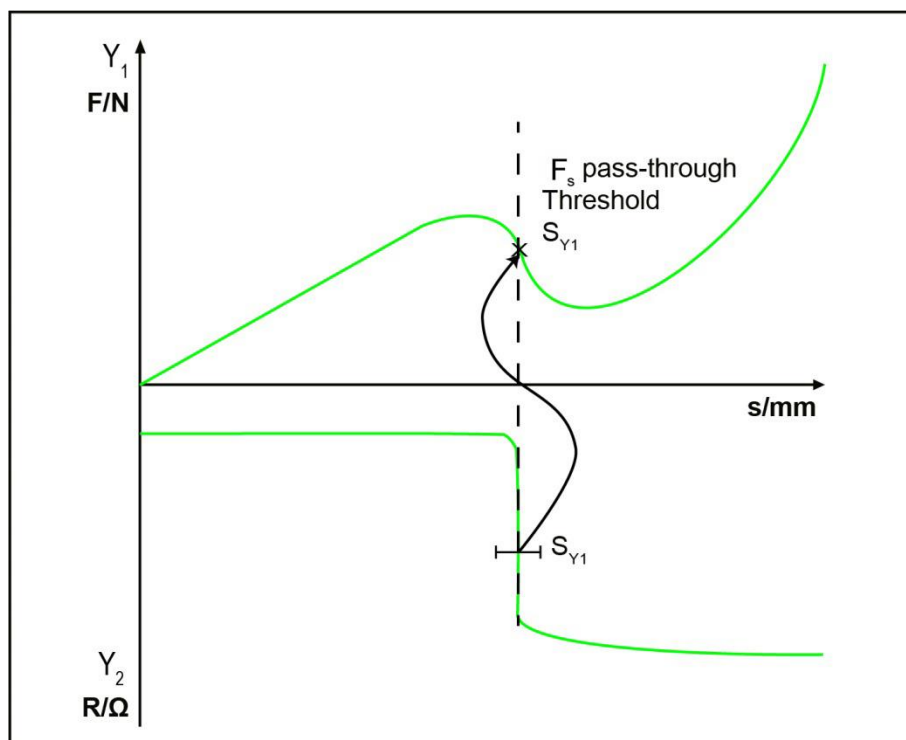
Diagram 35: Example in switch testing – determining the force at the point where the resistance curve Y_2 passes through the threshold S_{y1} (horizontal type-Y threshold)

The following values can be obtained:

Entry Y@	Corresponding Y-value at window entry point Note: This value is obtained only for a "bottom" or "top" entry.
Exit Y@	Corresponding Y-value at window exit point Note: This value is obtained only for a "bottom" or "top" exit.
Abs. minimum Y@	Corresponding Y-value at the point where the absolute minimum is found Note: Calculating the absolute minimum must be enabled.
Abs. maximum Y@	Corresponding Y-value at the point where the absolute maximum is found Note: Calculating the absolute maximum must be enabled.
Local minimum Y@	Corresponding Y-value at the point where the local minimum is found Note: Calculating the local minimum must be enabled.
Local maximum Y@	Corresponding Y-value at the point where the local maximum is found Note: Calculating the local maximum must be enabled.
Bend Y@	Corresponding Y-value at the point where the inflection point (bend) is found Note: The bend calculation must be enabled.

6.8.2 Trapezoid window

You can define a trapezoid window by first defining two fixed values. Whether you need to define X-values or Y-values depends on the type of trapezoid window (X or Y). Once you have specified the position of the trapezoid window in this way, you can then define the position of each of the four corners.

Unlike a simple evaluation window, the measurement curve is only allowed to pass through each type of trapezoid.
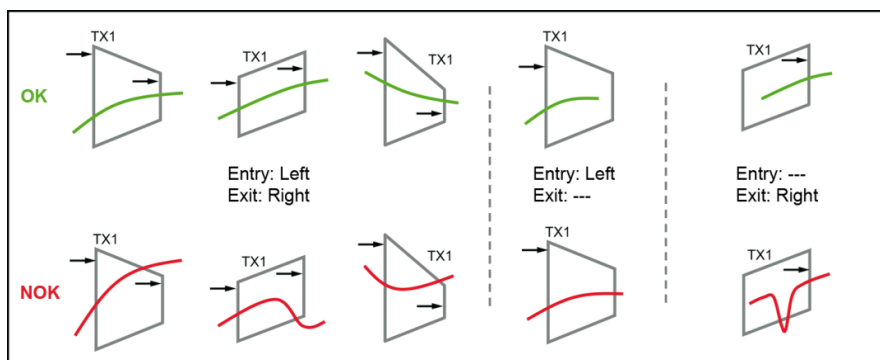
Diagram 36: Type trapezoid window X (examples)

For a Y trapezoid window, however, the measurement curve is only allowed to run from bottom to top or vice versa.
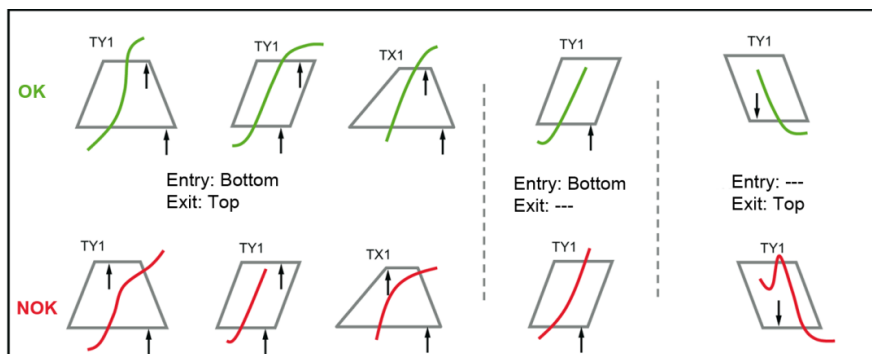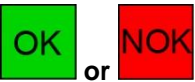
Diagram 37: Type trapezoid window Y (examples)
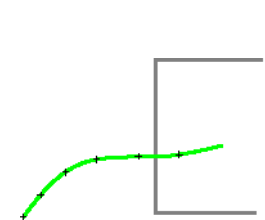
If the curve crosses the trapezoid window concerned in a different direction, this counts as an infringement and is evaluated by the DIGIFORCE® 9307 as "NOK".

A trapezoid window provides the following data whatever the orientation type:
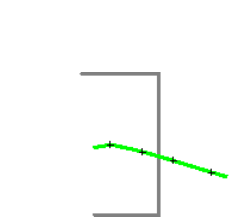
Single evaluation

OK or NOK	The DIGIFORCE® 9307 can also output the evaluation result from an individual trapezoid window to the I/O interface or Fieldbus interface.

Entry

	The DIGIFORCE® 9307 linearly interpolates the window entry coordinate from the last measurement point outside the window limits and the first measurement point inside the window limits
	If the measurement curve starts from inside the window area, the DIGIFORCE® 9307 outputs the first measurement point (start value).
	If the entire measurement curve lies outside the window area, the DIGIFORCE® 9307 will pass the pair of values 909090/909090 to the interface and display "<<<>>>" on the screen.

Exit

	The DIGIFORCE® 9307 linearly interpolates the window exit coordinate from the last measurement point inside the window limits and the first measurement point outside the window limits
	If the measurement curve ends inside the window area, the DIGIFORCE® 9307 outputs the last measurement point.
	If the entire measurement curve lies outside the window area, the DIGIFORCE® 9307 will pass the pair of values 909090/909090 to the interface and display "<<<>>>" on the screen.

Note: If you have defined an entry side and/or exit side, at least one value pair must lie within the window limits. If this is not the case, the DIGIFORCE® 9307 assesses the trapezoid window as "NOK".

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6.8.2.1 Configuring a trapezoid window

This is how it works

1   In measurement mode, pressing the **[F5]** key twice, opens the "Evaluation" configuration menu.

2   Either open the "Trapezoid window X" menu or the "Trapezoid window Y" menu. The DIGIFORCE® 9307 then displays the "Trapezoid window configuration" menu.

P 1 ProgName			Menue 13
Window 2	Trapezoid window X configuration		
Window number		2	
Window		On	
Xmin		119983	mm
Xmax		146082	mm
Ymin left		135713	N
Ymin right		100000	N
Ymax left		234424	N
Ymax right		190309	N
Entry left		☑	
Entry right		☐	
Exit left		☐	
Exit right		☑	
Evaluation		On	
First	Last		

3   Select a particular trapezoid window by entering the number of the window concerned. If this trapezoid window has already been configured, the DIGIFORCE® 9307 will overwrite this data with the new configuration. In total you can enable up to two trapezoid windows at once of each type (i.e. two per orientation).

4   Enable the trapezoid window function by placing the cursor on the "Window" option then using the ⇦ and ⇨ buttons to enable the trapezoid window.

5   Then specify the position and size of the trapezoid window. You can do this by entering the respective coordinates.

6   Define the entry and exit sides of the trapezoid window. To do this, place the cursor on the option you require and enable it using the ⇦ and ⇨ buttons. For trapezoid windows orientated in the X-direction, you can only use either right or left side as the entry or exit side, but not both right or both left. For trapezoid windows orientated in the Y-direction, you can only use the top or bottom sides.

7   Now define whether the DIGIFORCE® 9307 is meant to include the trapezoid window in the evaluation. When Evaluation is set to OFF, this trapezoid window does not affect the overall result. The DIGIFORCE® 9307 calculates only the entry and exit points. Specify the curve segment for which the trapezoid window is active. You can choose here between the forward curve, return curve and the complete curve.

8   Finally, specify whether the trapezoid window is active on channel Y_1 or Y_2.

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Menu parameters in "Trapezoid window X configuration" menu (menu 13)

Number	1 … 2	Selection of X trapezoid window 1 to 2
Window	ON / OFF	Enable / Disable
Xmin	<value input>	Trapezoid-position coordinate Xmin
Xmax	<value input>	Trapezoid-position coordinate Xmax
Ymin left	<value input>	Trapezoid-position coordinate Ymin left
Ymin right	<value input>	Trapezoid-position coordinate Ymin right
Ymax left	<value input>	Trapezoid-position coordinate Ymax left
Ymax right	<value input>	Trapezoid-position coordinate Ymax right
Entry	Left, Right	Side on which the curve enters the X trapezoid window Options: one entry side more than one entry side no entry
Exit	Left, Right	Side on which the curve exits the X trapezoid window Options: one exit side more than one exit side no exit
Evaluation	ON / OFF	When Evaluation is set to OFF, this element does not affect the overall result. Only the entry/exit values are calculated.
Curve segment	Forward, Return, Complete curve	Defines which curve segment the trapezoid window applies to.
Evaluate only first passage	YES / NO	YES: The curve must pass through the trapezoid window once correctly, then the evaluation algorithm is stopped NO: The measurement curve is only allowed to pass through the trapezoid window once correctly for the window to be assessed as OK. If it enters the trapezoid again, the result is always NOK
Y channel	Y1 / Y2	Specifies whether the evaluation element is active on $Y_1(X)$ or $Y_2(X)$

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Menu parameters in "Trapezoid window Y configuration" menu (menu 14)

Number	1 … 2	Selection of Y trapezoid window 1 to 2
Window	ON / OFF	Enable / Disable
Ymin	<value input>	Trapezoid-position Ymin
Ymax	<value input>	Trapezoid-position Ymax
Xmin bottom	<value input>	Trapezoid-position coordinate Ymin left
Xmin top	<value input>	Trapezoid-position coordinate Ymin right
Xmax bottom	<value input>	Trapezoid-position coordinate Ymax left
Xmax top	<value input>	Trapezoid-position coordinate Ymax right
Entry	Bottom, Top	Side on which the curve enters the Y trapezoid window Options: one entry side more than one entry side no entry
Exit	Bottom, Top	Side on which the curve exits the Y trapezoid window Options: one exit side more than one exit side no exit
Evaluation	ON / OFF	When Evaluation is set to OFF, this element does not affect the overall result. Only the entry/exit values are calculated.
Curve segment	Forward, Return, Complete curve	Defines which curve segment the trapezoid window applies to.
Evaluate only first passage	YES / NO	YES: The curve must pass through the trapezoid window once correctly, then the evaluation algorithm is stopped NO: The measurement curve is only allowed to pass through the trapezoid window once correctly for the window to be assessed as OK. If it enters the trapezoid again, the result is always NOK
Y channel	Y1 / Y2	Specifies whether the evaluation element is active on $Y_1(X)$ or $Y_2(X)$

6.8.2.2 Additional results when recording two curves $Y_1(x)$ and $Y_2(x)$

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

When two curves Y_1 and Y_2 are being recorded simultaneously over a shared X-axis, the Y-trapezoid evaluation element can provide not only results for the associated Y_1 or Y_2 curve but also a result for the corresponding curve at the identical X-position. If the evaluation element on the Y_1 curve is enabled, this can be used to obtain a relevant value for the Y_2 curve as well, and vice versa. You can use the obtained value in the "User-defined values" result table or as an operand in the mathematical functions.

The following values can be obtained:

Entry Y@	Corresponding Y-value at trapezoid entry point
Exit Y@	Corresponding Y-value at trapezoid exit point
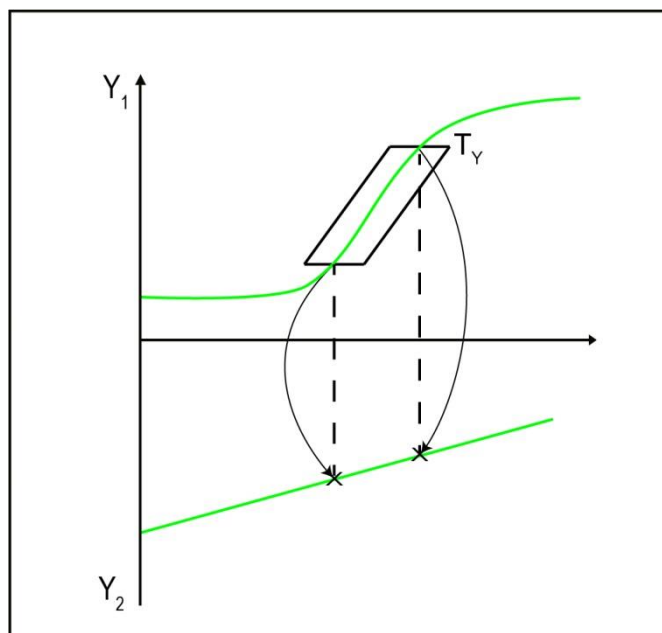
Diagram 38: Example for a trapezoid window – determining the resultant Y_2-values at the entry and exit points of the T_y evaluation element (Y-trapezoid enabled on curve $Y_1(x)$)

6.8.3 Threshold

The DIGIFORCE® 9307 classifies thresholds into two types. Threshold type X is orientated vertically at a defined X position. You can, however, set a range for the Y-values (Y_{MIN} to Y_{MAX}).

It is the exact opposite for threshold type Y. In this case, it is anchored horizontally at a defined Y-position, whereas the X-values can vary within a set range (X_{MIN} to X_{MAX}).

With threshold type Y, in addition to the Pass point (intersection point), you can define advanced values such as Bend (inflexion point), absolute and local minima and maxima, Y-mean, gradient and area under the curve.
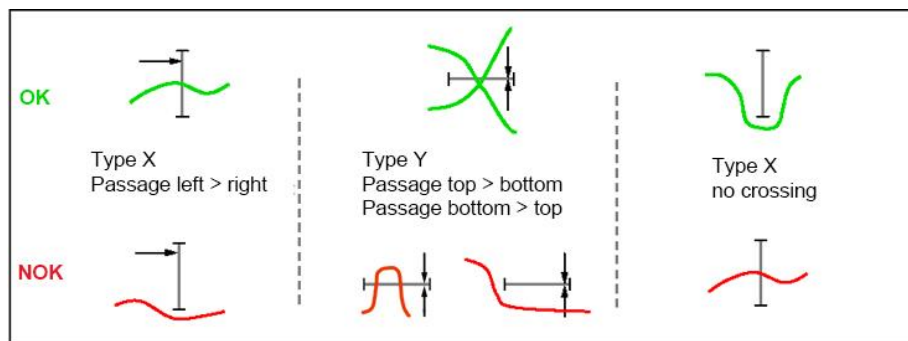
Diagram 39: Thresholds (examples)
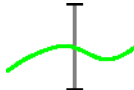
Note: The evalutation element "Threshold" is only allowed to be passed once.

Regardless of whether Evaluation is enabled or disabled for a specific threshold, the DIGIFORCE® 9307 captures the following data for each threshold that is active in a measurement program:

Single evaluation

OK or NOK	The DIGIFORCE® 9307 can also output the evaluation result from an individual threshold to the I/O interface or Fieldbus interface.

Pass (intersection point of measurement curve and threshold)

	The DIGIFORCE® 9307 linearly interpolates the intersection point from the last measurement point before the threshold and the first measurement point after the threshold. If the DIGIFORCE® 9307 cannot find an intersection point, the DIGIFORCE® 9307 will pass the pair of values 909090/909090 to the interface and display "<<<>>>" on the screen.

6.8.3.1 Configuring a threshold

This is how it works

1 In measurement mode, pressing the [F5] key twice, opens the "Evaluation" configuration menu.

2 Open the "Threshold" menu.
The DIGIFORCE® 9307 then displays the "Threshold configuration" menu.

P 1 ProgName		Menue 15
Threshold 2	Threshold configuration	
Threshold number	2	
Threshold	On	
Threshold type	Y threshold	
Y value	1.00000	N
Xmin	0.00000	mm
Xmax	1.00000	mm
Passage bottom > top	☑	
Passage top > bottom	☑	
Evaluation	On	
Curve segment	Forward	
Evaluate only first passage	No	
Y channel	Y1	
		Advanced

3 First select a particular threshold by entering the number of the threshold concerned.
If this threshold has already been configured, the DIGIFORCE® 9307 will overwrite this data with the new configuration. You can enable up to four thresholds at once.

4 Enable the threshold by placing the cursor on the "Threshold" option then using the ⇦ and ⇨ buttons to enable the threshold.

5 Specify the threshold type.
The threshold type defines whether it is an X or Y threshold. Simply use the two ⇦ and ⇨ buttons to do this.
Once you have set the new threshold type, the DIGIFORCE® 9307 automatically adjusts all the other input fields.

6 Set the position of the threshold. Depending on the threshold type, you need to specify an X-value (threshold type X) or an Y-value (threshold type Y).

7 Once you have set the threshold position, enter the limits for the threshold. These parameters also depend on the given threshold type. For threshold type X you need to enter "Y_{min}" and "Y_{max}"; for threshold type Y you need to enter "X_{min}" and "X_{max}".

8 Now specify the direction in which the measurement curve passes across the threshold. You have the following options here: the measurement curve can cross the threshold from either side or just from one side. You also have the option to specify that the measurement curve must not cross the threshold at all. If the measurement curve infringes the setting made here, the DIGIFORCE® 9307 assesses the measurement as "NOK" (see above).

9 Now define whether the DIGIFORCE® 9307 is meant to include the threshold in the evaluation.
When Evaluation is set to OFF, this threshold does not affect the overall result. The DIGIFORCE® 9307 simply calculates the intersection point and optionally the advanced results.

10 Specify the curve segment for which the threshold is active.
You can choose here between the forward curve, return curve and the complete curve.

11 Finally, specify whether the threshold is active on channel Y_1 or Y_2.

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Menu parameters in "Threshold configuration" menu" (menu 15)

Threshold number	1 … 4	Selection of threshold 1 to 4
Threshold	ON / OFF	
Threshold type	X threshold, Y threshold	Selection of whether threshold type X or Y is active
X value, Y value	<value input>	For type X threshold: X-position of X threshold
		For type Y threshold: Y-position of Y threshold
Xmin / Ymin	<value input>	For type X threshold: Bottom Y-limit Ymin
		For type Y threshold: Left-hand X-limit Xmin
Xmax / Ymax	<value input>	For type X threshold: Top Y-limit Ymax
		For type Y threshold: Right-hand X-limit Xmax
Pass	Left > Right Right > Left Bottom > Top Top > Bottom	Selection of direction in which the curve crosses the threshold Options: does not cross (no passage) crosses from one side crosses from both sides
Evaluation	ON / OFF	When Evaluation is set to OFF, this element does not affect the overall result. The instrument only calculates the intersection point (pass) and optionally the advanced results for type Y.
Curve segment	Forward, Return, Complete curve	Defines which curve segment the threshold applies to.
Evaluate only first passage	YES / NO	YES: The curve must cross the threshold once correctly, then the evaluation algorithm is stopped. NO: The measurement curve is only allowed to cross the threshold once correctly for the window to be assessed as OK. If it crosses the threshold again, the result is always NOK
Y channel	Y1 / Y2	Specifies whether the evaluation element is active on $Y_1(X)$ or $Y_2(X)$

6.8.3.2 Advanced results for threshold of type Y

Apart from the intersection point (Pass), which the DIGIFORCE® 9307 automatically measures for each active threshold, you can also retrieve additional data. To do this, you must enable the relevant function in the "Advanced threshold configuration" menu. For some functions you need to enter additional parameters.

Diagram 40: Advanced results for threshold type Y

The advanced results for threshold of type Y are only calculated, if the global threshold result is OK. To access this "Advanced threshold configuration" menu, press **[F5]** "Advanced" in the "Threshold configuration" menu.
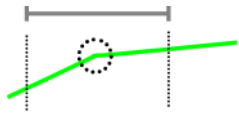
You can then enable the following functions:

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Bend

Note: For this option you need to specify the two parameters "Delta gradient for bend" and "Delta Y bend".
If the measurement curve is very noisy or has been damped for a gradual change in gradient, it may not be possible to find any bend in the curve.
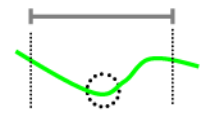
For "Delta Y bend", select a value that is greater than any Y-fluctuations that may be present (for instance caused by vibrations, electromagnetic interference…). This is essential for the DIGIFORCE® 9307 to find the inflexion point (bend) correctly.

	When the curve enters the threshold region, the DIGIFORCE® 9307 checks whether the delta value from the first value pair to the next value pair has exceeded the set delta value for "Delta Y bend". If so, then these two value pairs are used to calculate the actual gradient. If not, the delta value to the third or subsequent value pair is checked. As soon as the delta value exceeds "Delta Y bend", the actual gradient is calculated. The same algorithm is used along the rest of the curve to determine the next gradient result. If the newly obtained gradient differs from the previously calculated value by the value "Delta gradient", then this situation is identified as a bend and further analysis is terminated. If the newly obtained gradient is less than the value "Delta gradient" then it is used as the actual gradient and compared with the next gradient result. As long as no bend is identified, this procedure is continued until the curve exits the window area.
	If the DIGIFORCE® 9307 does not identify an inflexion point (bend) within this span, the DIGIFORCE® 9307 will pass the pair of values 909090/909090 to the interface and display "<<<>>>" on the screen.

Absolute maximum

	The DIGIFORCE® 9307 finds the absolute maximum of the Y-coordinate within the span of the type-Y threshold and outputs the coordinates as an X/Y value pair. The DIGIFORCE® 9307 takes into account only those curve points within the limits X_{MIN} and X_{MAX}.

Absolute minimum

	The DIGIFORCE® 9307 finds the absolute minimum of the Y-coordinate within the span of the type-Y threshold and outputs the coordinates as an X/Y value pair. The DIGIFORCE® 9307 takes into account only those curve points within the limits X_{MIN} and X_{MAX}.

Local maximum

Note: For this option you need to specify the parameter "Delta Y local maximum".
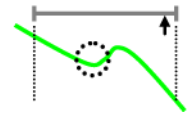
Select a value for this that is greater than any Y-fluctuations that may be present (for instance caused by vibrations, electromagnetic interference…). This is essential for the DIGIFORCE® 9307 to find the local maximum correctly.

	he DIGIFORCE® 9307 finds the **first** local maximum of the Y-coordinate within the span of the type-Y threshold and outputs the coordinates as an X/Y value pair. The DIGIFORCE® 9307 takes into account only those curve points within the limits X_{MIN} and X_{MAX}.

Local minimum

Note: For this option you need to specify the parameter "Delta Y local maximum".
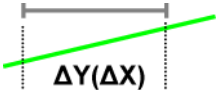
Select a value for this that is greater than any Y-fluctuations that may be present (for instance caused by vibrations, electromagnetic interference…). This is essential for the DIGIFORCE® 9307 to find the local minimum correctly.

	The DIGIFORCE® 9307 finds the **first** local maximum of the Y-coordinate within the span of the type-Y threshold and outputs the coordinates as an X/Y value pair. If the DIGIFORCE® 9307 does not identify a local maximum, the DIGIFORCE® 9307 will pass the pair of values 909090/909090 to the interface and display "<<<>>>" on the screen. The DIGIFORCE® 9307 takes into account only those curve points within the limits X_{MIN} and X_{MAX}.

Mean value Y

	The threshold outputs the mean value of the Y-values available within its span. The DIGIFORCE® 9307 takes into account only those curve points within the limits X_{MIN} and X_{MAX}.

Gradient

	The DIGIFORCE® 9307 measures the gradient within the span of the type-Y threshold.

Area
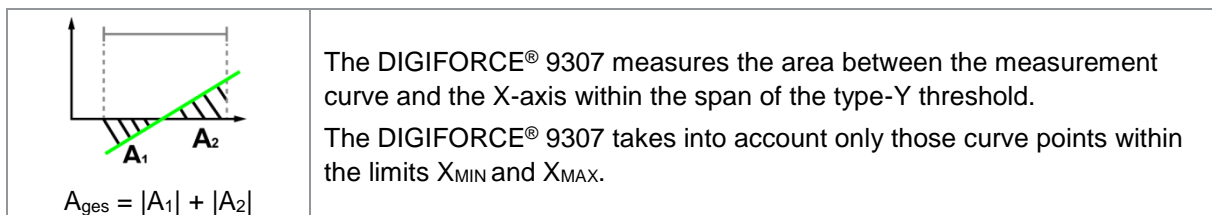
 $A_{ges} = |A_1| + |A_2|$	The DIGIFORCE® 9307 measures the area between the measurement curve and the X-axis within the span of the type-Y threshold. The DIGIFORCE® 9307 takes into account only those curve points within the limits X_{MIN} and X_{MAX}.

6.8.3.3 Additional results when recording two curves $Y_1(x)$ and $Y_2(x)$

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

When two curves Y_1 and Y_2 are being recorded simultaneously over a shared X-axis, the threshold (type Y) evaluation element can provide not only results for the associated Y_1 or Y_2 curve but also a result for the corresponding curve at the identical X-position. If the evaluation element on the Y_1 curve is enabled, this can be used to obtain a relevant value for the Y_2 curve as well, and vice versa. You can use the obtained value in the "User-defined values" result table or as an operand in the mathematical functions.

The following values can be obtained:

Pass Y@	Corresponding Y-value at point where curve passes through the threshold Note: The value is obtained only for a type-Y threshold (horizontal).
Abs. minimum Y@	Corresponding Y-value at the point where the absolute minimum is found Note: Calculating the absolute minimum must be enabled (only possible for type-Y threshold).
Abs. maximum Y@	Corresponding Y-value at the point where the absolute maximum is found Note: Calculating the absolute maximum must be enabled (only possible for type-Y threshold).
Local minimum Y@	Corresponding Y-value at the point where the local minimum is found Note: Calculating the local minimum must be enabled (only possible for type-Y threshold).
Local maximum Y@	Corresponding Y-value at the point where the local maximum is found Note: Calculating the local maximum must be enabled (only possible for type-Y threshold).
Bend Y@	Corresponding Y-value at the point where the inflection point (bend) is found Note: The bend calculation must be enabled (only possible for type-Y threshold).

6.8.4 Envelopes

In the DIGIFORCE® 9307 you can only generate an envelope in Graphical Test Operation (Simple Test Operation menu), and you need to have at least one measurement curve available from which to generate the envelope.

If you have an existing envelope available, you can modify the position of the envelope and also set the tolerance (Delta).
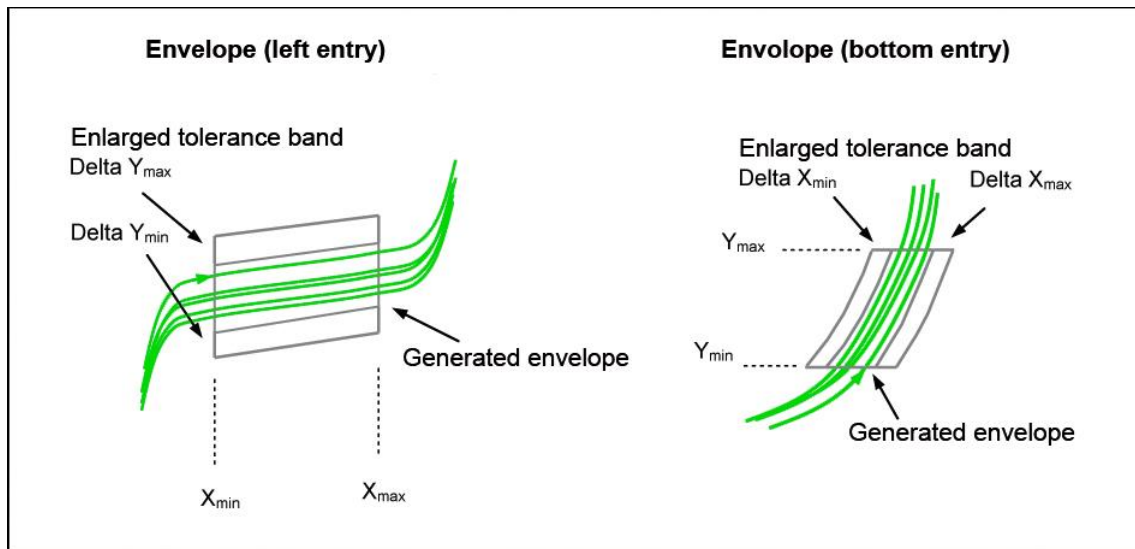
Diagram 41: Envelopes

Envelope number	1 … 2	Selection of envelope 1 or 2
Envelope	ON / OFF	
Xstart / Ystart	<value input>	
Xend / Yend	<value input>	
Delta Ymin / Xmin	<value input>	
Delta Ymax / Xmax	<value input>	
Evaluation	ON / OFF	When Evaluation is set to OFF, this element does not affect the overall result.
Entry	Left, Right, Top, Bottom	Defines in which direction the curve passes through the envelope.
Curve segment	Forward, Return	Defines which curve segment the envelope applies to.
Y channel	Y1 / Y2	Specifies whether the evaluation element is active on $Y_1(X)$ or $Y_2(X)$

The DIGIFORCE® 9307 can only generate an envelope when the entire curve segment (forward or return) is continuous i.e. for a Left or Right entry, only one Y-value must be associated with each X-coordinate, or for Bottom or Top entry, only one X-value must be associated with each Y-coordinate.

6.8.5 Mathematical functions

You can enable up to 10 mathematical functions in one measurement program. The DIGIFORCE® 9307 provides the basic arithmetic operators of addition, subtraction, multiplication and division for defining these functions. You can use the result of one function as the operand for a subsequent function. The DIGIFORCE® 9307 saves the result in a memory for this purpose.

You can use the following values as an operand:

- Intermediate results (memory)

- Constants

- General curve data

- Window entry/exit coordinates or advanced window results

- Trapezoid window entry/exit coordinates

- Intersection point (Pass) from thresholds

- Advanced results from thresholds

- Envelope entry/exit coordinates

- Additional results from the window, type-Y threshold and Y-trapezoid elements when recording two curves $Y_1(x)$ and $Y_2(x)$

The DIGIFORCE® 9307 can check up to six result values for compliance with Min/Max limits. If one of these result values lies outside the limits, the result is assessed as NOK.

In addition, the DIGIFORCE® 9307 can place the result values from the mathematical operations in the results list of the "User-definable values" or provide them as outputs at interfaces. You can find further information on user-definable values in section 6.13 "User defined values" on page 172.

Diagram 42: Calculation of the mathematical compositions

Diagram 43: Evaluation

Specifying constants

1   In measurement mode, press the **[F5]** key twice, open the "Evaluation" configuration menu.

2   Open the "Mathematical function" menu.

3   Press the **[F4]** button "Constant".
You can now select one of the constants and enter the new value.

Configuring a mathematical function

Prerequisite: You must already have specified the constants and/or evaluation elements you require.

1   In measurement mode, press the **[F5]** key twice, open the "Evaluation" configuration menu.

2   Open the "Mathematical function" menu.

3   Place the cursor over one of the functions and press **[Enter]**.
The DIGIFORCE® 9307 now opens a window in which you can define the mathematical function.

4   Select the source of the first operand (e.g. constant, intermediate result etc.) and the operand itself.

5   Use the ⇦ and ⇨ buttons to switch to the mathematical operator and then select it.

6   Switch to the second operand and set this too.
The mathematical function has now been defined.

This is how it works

Evaluating a mathematical function

Prerequisite: First you need to define all the mathematical functions that you require.

1   In measurement mode, press the **[F5]** key twice, open the "Evaluation" configuration menu.

2   Open the "Mathematical function" menu.

3   Press the **[F5]** button "Evaluation".

4   Select an operand (e.g. memory containing intermediate result).

5   Use the ⇦ and ⇨ buttons to switch to the Min and Max values and enter each of these values using the numeric keypad.

6   You have now finished defining the evaluation.

6.8.6 Evaluation specific for rotary-switch testing

The rotary switch evaluation facility lets you monitor curves that are periodic in nature and alternate between minima and maxima. You can find further information in section 3.6.6 "Rotary switch evaluation" on page 32.
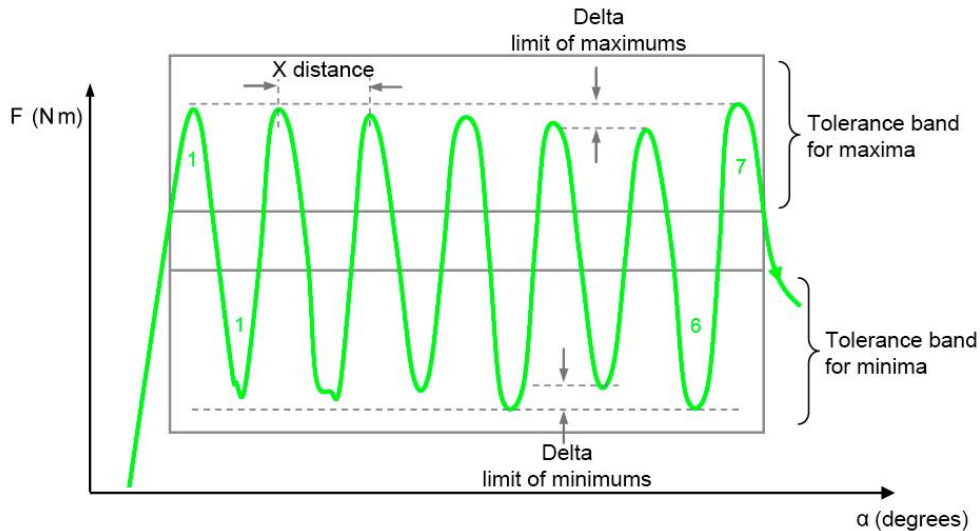
Diagram 44: Rotary-switch testing

6.8.6.1 Configuring rotary-switch evaluation

This is how it works

1 In measurement mode, press the **[F5]** key twice, open the "Evaluation" configuration menu.

2 Open the "Rotary switch" menu. Within a measurement program, you can define up to two tolerance bands at once for rotary switch evaluation.

P 1 ProgName		Menue 73
Element 1 Rotary switch configuration		
Rotary switch element number	1	
Rotary switch element	Off	
Xmin	900012	mm
Xmax	970021	mm
Passage	Left > Right	
Number of minimums	6	
Number of maximums	7	
Ymin limit of minimums	352001	N
Ymax limit of minimums	527648	N
Ymin limit of maximums	475530	N
Ymax limit of maximums	692589	N
Delta Y limit of minimums	0.50000	N
Delta Y limit of maximums	0.50000	N
Xmin distance of minimums	1.00000	mm
First	Last	

3 Select one of the two possible tolerance bands by placing the cursor on "Rotary switch element number" and then specifying the number of the element concerned (1 or 2). If this element has already been configured, the DIGIFORCE® 9307 will overwrite this data with the new configuration. You can enable up to two rotary switch elements at once.

4 Enable the rotary switch element by placing the cursor on the "Rotary switch element" option then using the ⇦ and ⇨ buttons to enable the element.

5 Specify the range for the rotary switch element in the X-direction using the two menu options X_{min} and X_{max}. First place the cursor over X_{min} and then set the value for the left-

most limit of the rotary switch element. Then place the cursor over X_{max} and set here the value for the right-most limit of the element.

6 Specify the number of minima and number of maxima that are meant to lie within the range of the rotary switch element. To do this, place the cursor over the relevant menu option and enter the number.

7 Define the limits of the tolerance band within which the minima are allowed to vary. To do this, specify the values "Y_{min} limit of minimums" and "Y_{max} limit of minimums", between which the minima of the measurement curve are allowed to lie.

8 Define the limits of the tolerance band within which the maxima are allowed to vary. To do this, specify the values "Y_{min} limit of maximums" and "Y_{max} limit of maximums", between which the maxima of the measurement curve are allowed to lie.

9 Set the allowed difference between the maxima and minima respectively in the Y-direction using the two parameters "Delta Y limit of minimums" and "Delta Y limit of maximums".

10 Define the permitted minimum distance and maximum distance in the X-direction between the maxima and the respective distances between the minima. Enter these values for the parameters "X_{min} distance of minimums" and "X_{max} distance of minimums" and the respective parameters "X_{min} distance of maximums" and "X_{max} distance of maximums".

11 Specify a value for the hysteresis in the Y-direction. This value must be greater than any spurious interference (for instance caused by vibration) in the Y-axis direction. The DIGIFORCE® 9307 needs this value so that it can distinguish between the legitimate variations in the measurement curve and any interference. If you make this value too small, the DIGIFORCE® 9307 will also interpret smaller fluctuations as extreme points and include them in the evaluation.

12 Define whether the DIGIFORCE® 9307 is meant to include the rotary switch element in the evaluation.
If you disable evaluation, the rotary switch element concerned has no effect whatsoever on the overall result of the measurement.

13 Define whether the DIGIFORCE® 9307 is meant to include the forward or return segment of the measurement curve in the evaluation.
Unlike other evaluation elements, the only choice for the rotary switch evaluation is between forward and return.

14 Specify whether the rotary switch element is meant to evaluate the $Y_1(X)$ curve or the $Y_2(X)$ curve.

15 This completes configuration of the rotary switch element.

Menu parameters configuring rotary switch evaluation menu (menu 73)

Rotary switch element number	1 … 2	Selection of element 1 or 2
Rotary switch element	ON / OFF	
Xmin	<value input>	Defines the left-most X-position e.g. start of angle range
Xmax	<value input>	Defines the right-most X-position e.g. end of angle range
Passage	Left > Right, Right > Left	Defines the direction in which the curve passes through the element. The measurement curve is not allowed to enter the rotary switch element from below or above; if it does, it is assessed as NOK.
Number of minimums	0 … 32	Defines the required number of minima in the tolerance band
Number of maximums	0 … 32	Defines the required number of maxima in the tolerance band
Ymin limit of minimums	<value input>	Lower window limit for minima
Ymax limit of minimums	<value input>	Upper window limit for minima
Ymin limit of maximums	<value input>	Lower window limit for maxima
Ymax limit of maximums	<value input>	Upper window limit for maxima
Delta Y limit of minimums	<value input>	Permitted Y-difference across all minima
Delta Y limit of maximums	<value input>	Permitted Y-difference across all maxima
Xmin distance of minimums	<value input>	Minimum X distance between adjacent minima
Xmax distance of minimums	<value input>	Maximum X distance between adjacent minima
Xmin distance of maximums	<value input>	Minimum X distance between adjacent maxima
Xmax distance of maximums	<value input>	Maximum X distance between adjacent maxima
Y hysteresis	<value input>	Select a value that is greater than any Y-fluctuations that may be present (for instance caused by vibrations, electromagnetic interference…) in order to ensure the extreme points are identified correctly.
Evaluation	ON / OFF	When Evaluation is set to OFF, this element does not affect the overall result.
Curve segment	Forward, Return	Defines which curve segment the element applies to.
Y channel	Y1 / Y2	Specifies whether the evaluation element is active on $Y_1(X)$ or $Y_2(X)$

6.8.6.2 Evaluation results for rotary switch evaluation

Single evaluation	OK/NOK
Number of minimums	Number of minima found
Number of maximums	Number of maxima found
Y average of minimums	Mean of Y-values for all identified minima
Y average of maximums	Mean of Y-values for all identified maxima
Max. Y-difference of minimums	Difference between the smallest and largest minimum
Max. Y-difference of maximums	Difference between the smallest and largest maximum

The results from the rotary switch evaluation also appear in a separate dialog window in Measurement mode (M8).

6.8.7   Tolerance band for evaluation elements

You can use the tolerance band for graphical evaluation elements to configure an additional hysteresis band around the limit values, for instance the entry and exit side of a window. Within this hysteresis band, the measurement curve can cross the boundary line of the evaluation element to and fro any number of times without causing an NOK evaluation. If, for example, a machine experiences mechanical interference such as vibrations or even slip-stick effects in the hydraulics, then fluctuations or "outliers" will occur sporadically in the recorded measurement curve. If these fluctuations occur at the limits of an evaluation window, the DIGIFORCE® 9307 will give the measurement an NOK evaluation if it detects that the curve re-enters/re-exits the window. By defining a tolerance band, the DIGIFORCE® 9307 evaluates such a curve as OK, provided the curve fluctuation lies within the hysteresis band.
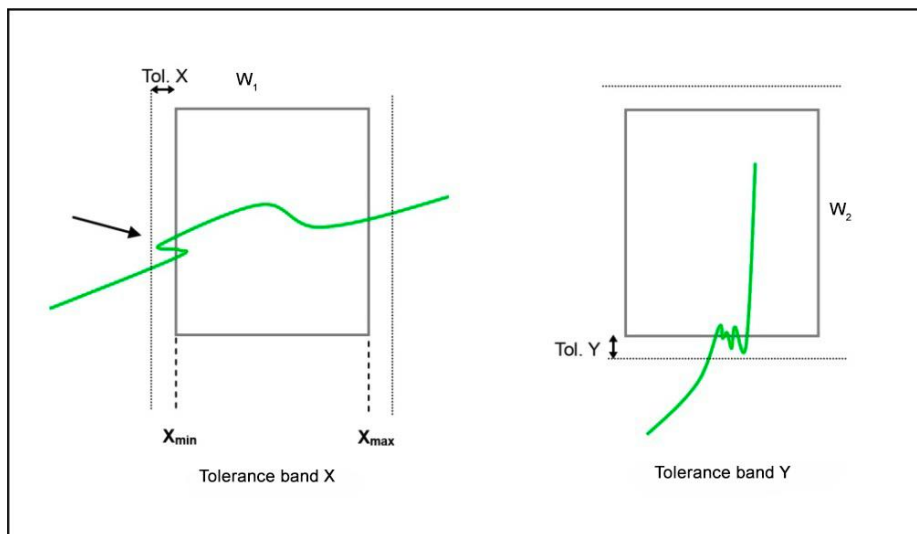
Diagram 45: Tolerance band for evaluation elements

Note: The tolerance band X, Y1 and Y2 parameters apply to all the graphical evaluation elements. They cannot be defined for just one specific graphical evaluation element.

Note: For evaluation elements with an exit, the curve must also pass beyond the region of the active tolerance band.

![This is how it works]

This is how it works

1.   In measurement mode, press the **[F5]** key twice.

2.   Press **[Enter]** to open the "Evaluation" menu (menu 10).
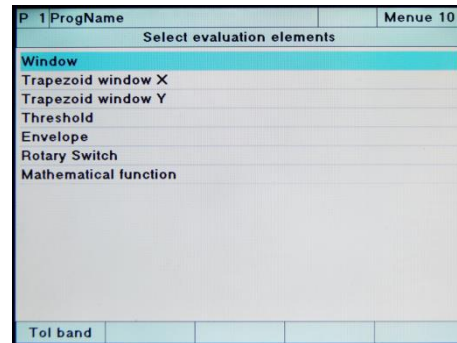
3.   Press the **[F5]** key (Tol band).

4.   In this menu (menu 75) you specify the values for the tolerance band you require. Values are entered separately for tolerance band X, Y1 and Y2 (tolerance band Y2 does not appear if this channel is disabled).

6.9 Online switching points

⚠	**WARNING**
	NOT a substitute for safety devices and protective equipment
	The online switching signals S1 to S4 are NOT a substitute for safety devices and protective equipment.
	Use safety devices and protective equipment.

Note: The switching signals S1 to S4 do not meet the requirements of a safety switch. It is the duty of the owner of a complete system, such as a press, to fit the system with the required safety devices and to take necessary protective measures.

The four switching signals S1 to S4 at the PLC I/O interface or the Fieldbus interface can be used to signal in real time that a reading has exceeded a limit. You can assign the four signals to the active measurement channels X, Y_1 and Y_2 in any way you wish and you can set the limit threshold. In addition, you can select whether the four I/O signals are active-high or active-low.

The limit thresholds for the X measurement channel can be referenced to the absolute measurement signal or to the relative zero point (Measurement mode reference: Y-trigger). The DIGIFORCE® 9307 enables the switching signals only in the "Measure" operating mode and in "Test Operation".

P 1 ProgName				Menue 12
Setup realtime switchpoints				

	Value	Unit	Channel	Active	Reference
S1	5.00000	mm	X	High	Absolute
S2	10.0000	mm	X	High	Absolute
S3	15.0000	mm	X	High	Absolute
S4	20.0000	mm	X	High	Absolute

Diagram 46: Setup realtime switchpoints

Menu parameters for "Setup real time switch points S1 ... S4" (menu 12)

Value	Limit threshold	Input of limit threshold
Unit	Units display	Shows the units for the measurement channel
Channel	X, Y_1, Y_2	Selection of active measurement channel for respective switching signals S1 … S4
Active	High / Low	Selection of active-high or active-low
Reference	Absolute / Y-Trigger	Reference for X measurement channel
		Absolute: the limit threshold is referenced to the absolute value of the measurement channel X
		Y-trigger: the limit threshold is referenced to the trigger event.

Note: You can only select the Y-Trigger reference if the "Reference" parameter in the "Measurement mode" menu is set to Y_1 trigger overrun/underrun or Y_2 trigger overrun/underrun.

6.10 Simple test operation

The "Simple test operation" menu is split into two sub-menus: "Numerical test operation" and "Graphical test operation". You can switch between these two sub-menus using the **[F5]** key.

In the "Numerical Test Operation" menu you can retrieve the live actual values of the active measurement channels X, Y_1 and Y_2 and retrieve the status of the PLC control signals (inputs and outputs). You can stimulate the PLC outputs manually in order to test the cable to the connected PLC. Your DIGIFORCE® 9307 also includes the option here to check strain-gage sensors using a shunt calibration resistor.

In the "Graphical Test Operation" menu you can actually perform measurements and use the recorded measurement curve(s) to define the graphical evaluation elements such as windows, thresholds, trapezoids and envelopes. In addition, you can set the scaling (zoom) for the displayed coordinate axes.

Simple test operation
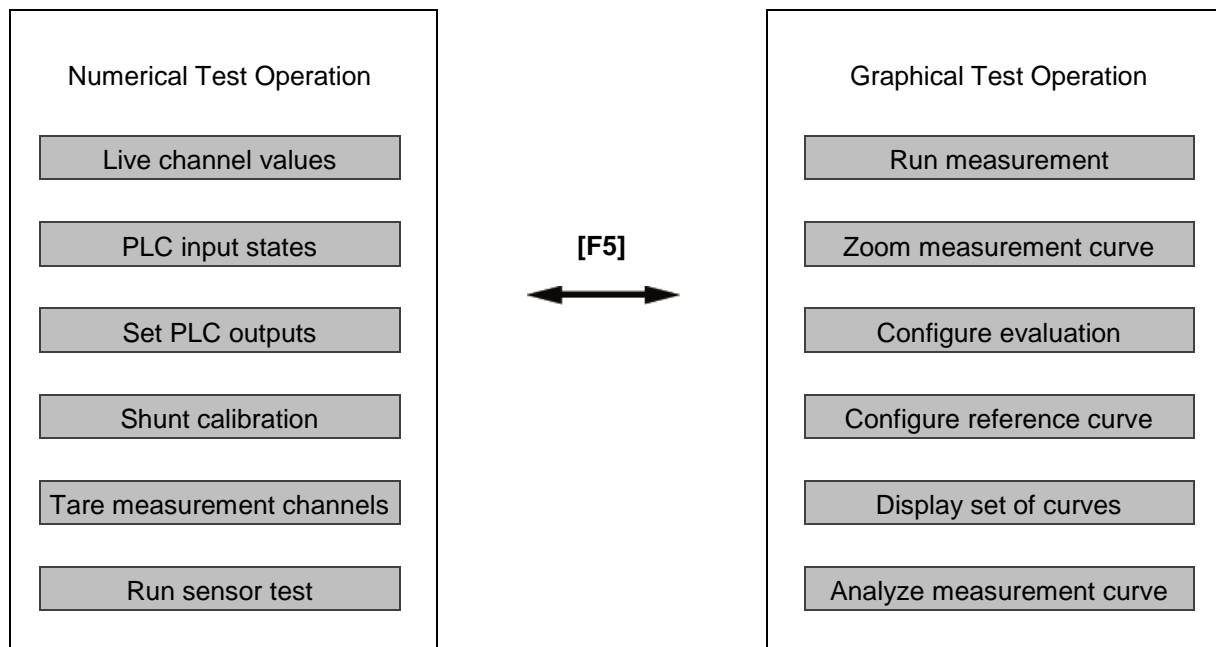
Diagram 47: Simple Test Operation

Numerical Test Operation screen
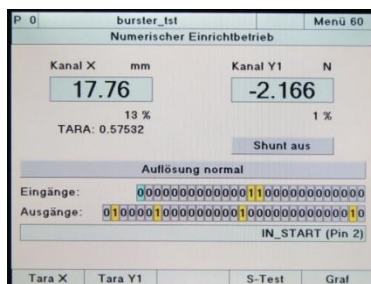
Graphical Test Operation screen
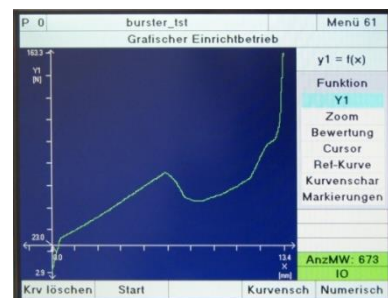
DIGIFORCE® 9307

This is how it works

1   Press the **[F5]** key twice in measurement mode.
The DIGIFORCE® 9307 switches to the "Main setup menu".

2   Select here the option "Test operation simple" and confirm your selection with the **[Enter]** button.

3   The "Simple Test operation" menu contains two pages: the "Numerical test operation" page and the "Graphical test operation" page. You can switch between these two pages using the **[F5]** key.

6.10.1 Numerical test operation - Overview

In this section you find an explanation of the display and information to the function key assignments in numerical test operation.
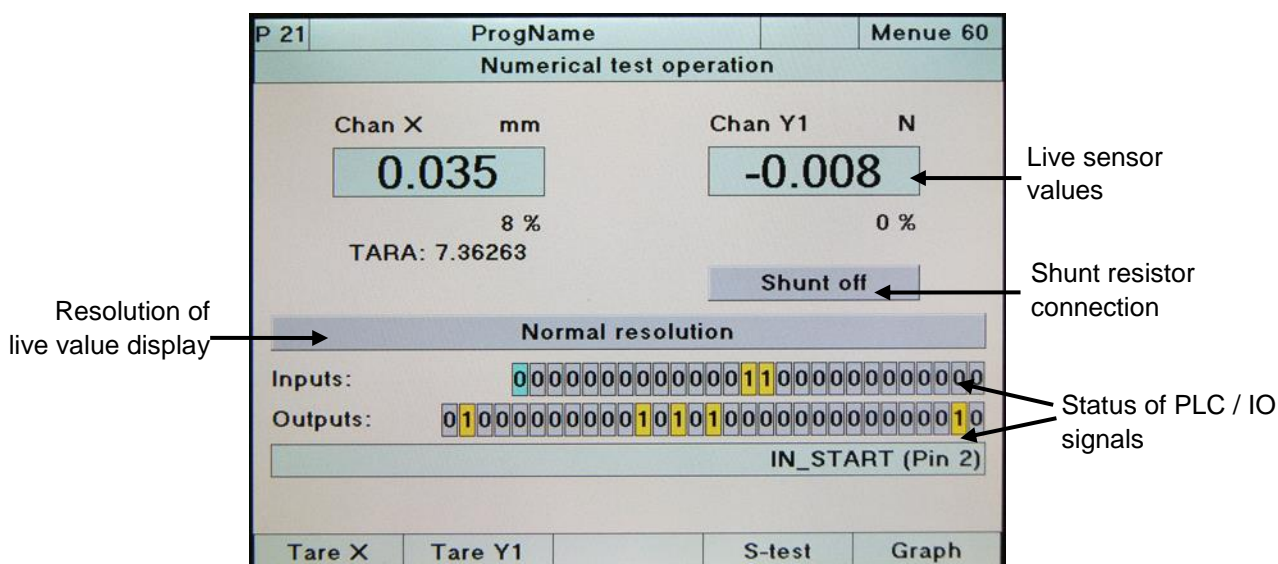
Function keys in numerical test operation

Function key	Function
[F1]	**Tare X** or **Std valueX** For absolute value sensors such as strain gages, potentiometers or standard-signal sensors, the Tare X function can be used to zero the live actual sensor value of channel X, or set it to a definable tare default value. The tare default value can be set in the channel settings menu. For incremental sensors that make relative measurements, **[F1]** is assigned the **Std valueX** function. In this case, the incremental counter can be set to a definable "standard value" (reference value). The standard value can be set in the channel settings menu.
[F2]	**Tare Y1** or **Std valueY1** Function is same as **[F1]** but for channel Y1
[F3]	**Tare Y"** or **Std valueY2** This function is only offered if channel Y2 is active. Function is same as **[F1]** but for channel Y2
[F4]	**S-test** - Run sensor test You can use **[F4]** to run a sensor test (see section 6.12 "Sensor test" on page 170).
[F5]	**Graph** Switches to Graphical test operation

6.10.2 Numerical test operation – Live sensor values

In Numerical test operation you can view the live sensor values. For analog sensor signals such as strain gage, potentiometer or standard signals, you can set the resolution for the reading to either a four-digit or five-digit display. The resolution can be changed by selecting between "Normal resolution" (four-digit display with dynamic decimal point) and "High resolution" (five-digit display with dynamic decimal point).

6.10.3 Numerical test operation – PLC signals
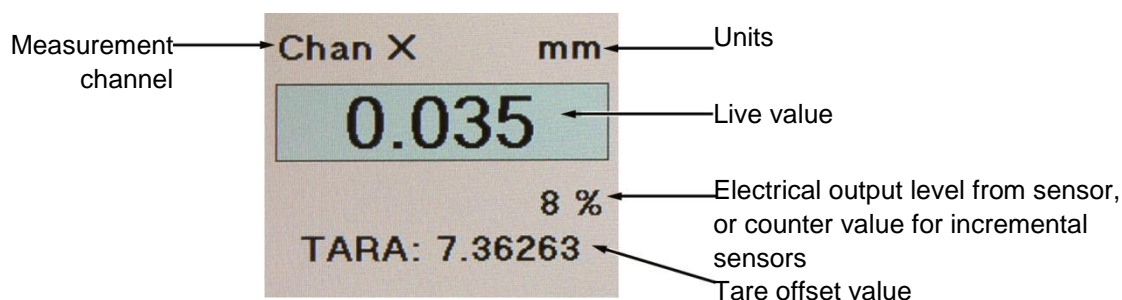
You can retrieve the live signal states of the PLC inputs and outputs in the "Numerical test operation" menu, and also set/reset the outputs. You can also use this function when the instrument is controlled via the PROFIBUS Fieldbus option: the corresponding signals are displayed and set/reset. Note that on activating the IN_AUTO control input, the "Numerical test operation" menu will close automatically and the DIGIFORCE® 9307 switches to measurement mode.

The cursor (light blue) is highlighting the first input IN_START (pin 2) and the live state is displayed (0 / LOW in this case)

The cursor sits over the first PLC input IN_START when you first open the menu. The signal assigned to the input/output concerned is displayed in plain text together with the assigned pin number. You can set/reset the states of the PLC outputs here manually.

This is how it works

    1   Open the "Numerical test operation" menu.

    2   Place the cursor on the PLC output in question.

    3   Press the **[Enter]** button. The state of the PLC output concerned is then defined.

Note: You can watch the behavior of the switching signals S1 to S4 here. (See section 6.9 "Online switching points" on page 148).To do this, the cursor must not be sitting on the row of Outputs for manual set/reset.

          Exception: an online switching signal for measurement channel X with trigger reference is enabled solely during a measurement in "measurement mode" or in "Graphical test operation".

          You can assign switching signals S3 and S4 to any of those PLC outputs that are suitable for custom signal assignments (See section 4.4.2 "PLC output" on page 40).

6.10.4 Numerical test operation – Shunt calibration

If you have assigned a strain gage sensor to a measurement channel, you can check the measurement chain using a shunt resistor.

During this check, the DIGIFORCE® 9307 connects a precision resistor (shunt calibration resistor) between the negative line of the signal input and the negative line of the reference supply voltage. The unbalance created by this shunt resistor in the sensor bridge circuit corresponds to the signal for a particular load applied to the load cell. It produces a defined step change in the output signal, which you can use to calibrate the measurement chain.

The magnitude of the change in the output signal, and the value of the associated calibration shunt resistor, can be found in the sensor's test certificate.

This is how it works

1	Open the "Numerical test operation" menu.
2	Position the cursor over the "Shunt off" display and confirm with the **[Enter]** button. The DIGIFORCE® 9307 now displays a choice of possible shunt values: 10 kΩ, 59 kΩ, 80 kΩ, 100 kΩ, 300 kΩ.
3	Select the appropriate value and confirm with the **[Enter]** button. The reading for the channel concerned now shows the new output value.

Note: The shunt resistor is always disconnected (switched off) when you close the "Numerical test operation" menu.

6.10.5 Numerical test operation – Tare

You can use the function keys **[F1]** to **[F3]** to tare the live sensor value or, for relative-measurement incremental sensors, load an offset value into the incremental counter.

Running the tare function will zero the live sensor value or set it to a configurable tare default value. You can also run this function in measurement mode or in graphical test operation using the PLC control signals IN_TARE_X, IN_TARE_Y1 and IN_TARE_Y2.

6.10.6 Numerical test operation – Run sensor test

You can use the **[F4]** function key to run a sensor test (see section 6.12 "Sensor test" on page 170). You can also launch this function in measurement mode or in graphical test operation using the PLC control signal IN_STEST.

6.10.7 Graphical test operation – Overview

In graphical test operation you can perform measurements in one or more measurement programs and use the recorded measurement curve(s) to define the graphical evaluation elements such as windows, thresholds, trapezoids and envelopes. The 10 most recent measurement results from each measurement program are saved. You can use the Curve Array display option to display these saved curves. The DIGIFORCE® 9307 uses these curves as the basis for calculating an envelope.

Note that on activating the IN_AUTO control input, the "Graphical test operation" menu will close automatically and the DIGIFORCE® 9307 switches to measurement mode.
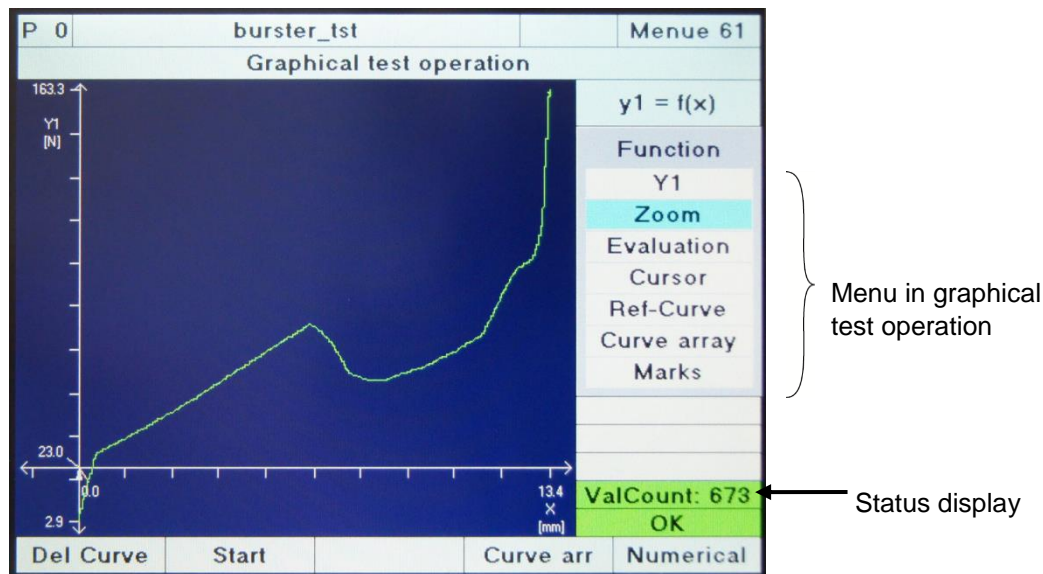
Diagram 48: Graphical test operation

You can use the following functions in graphical test operation:

- Run measurements
- Adjust the zoom for the measurement curve graph
- Configure graphical evaluation elements
- Take readings from the curve using the cursor
- Enable/disable display of set of curves (curve array)
- Display individual measurement points (marks) on a curve
- External control (start, change program, tare, sensor test...)

Function keys in "Graphical test operation" menu (menu 61)

[F1]	**Del Curve** All measurement curves saved in the active measurement program are deleted
[F2]	**Start** Start/Stop measurement The measurement is normally started and stopped automatically according to the trigger condition set; see Measurement Mode section. If, however, during the test operation phase you are not yet able to use control signals to trigger the measurement, you have the option to use **[F2]** to start and stop the measurement.
[F3]	**--**
[F4]	**Curve arr** Enable/Disable display of set of curves
[F5]	**Numerical** Switches to Numerical test operation

6.10.8 Graphical test operationt – Zoom

You can set the X-axis and Y-axis zoom for the measurement curve display in the "Graphical test operation" menu, with a choice of "Manual" or "Auto" zoom modes. In "Auto" zoom mode, the axes are scaled so that the entire measurement curve is visible including all the graphical evaluation elements such as windows, thresholds, trapezoids and envelopes. The zoom may vary in this case from measurement to measurement. If you want a fixed zoom for the X/Y graphs, select the "Manual" zoom mode and specify the Min/Max values for the graphs using the parameters Xmin, Xmax, Ymin and Ymax.

This is how it works

1   In Graphical test operation, use the cursor keys to select the "Zoom" menu.

2   In the "Zoom" menu choose the option "Scale mode".

3   Then press the **[Enter]** button. The DIGIFORCE® 9307 now displays a choice of the two modes "Manual" and "Auto".

4   In "Manual" mode you can define a fixed area for the screen to display. To do this, select the relevant limit from the menu and enter its value from the keypad. If you should define the screen here so that the measurement curve lies outside the visible area, you can adjust the screen to fit the curve using the "Auto" function.

      If you choose instead the "Auto" mode, the DIGIFORCE® 9307 automatically adapts the display to fit the curve that is currently being shown.

5   Confirm your selection with the **[Enter]** button.
      You have now selected the zoom mode. If you have selected "Manual" mode, you can now set the limits for the screen display.

6.10.9 Graphical test operation – Configuring windows

In graphical test operation you can enable the "Window" evaluation element and place it, move it and change its size directly in the measurement curve diagram. To set all the parameters in full you can switch directly into the parameterization menu, "Window configuration" menu 17 (see section 6.8.1 "Window" on page 115).

Diagram 49: Graphical test operation – Configuring windows

This is how it works

1   Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** key "Graph".

2   Select the "Evaluation" menu option and then "Window".
(You can switch to the numerical "Window configuration" view at any time using the "Numerical" menu option. Further details are given in section 6.8.1 "Window" on page 115 and in section 3.6.1 "Evaluation windows" on page 28.

3   Select the "W-Num" option and enter a window number using the ⇦ und ⇨ keys.
If the DIGIFORCE® 9307 is already displaying the selected window, the window will change its on-screen color. The frame of this window is now shown in yellow.

4   Press the ⇩ key once and enable the new window for display using the ⇦ und ⇨ keys.
The DIGIFORCE® 9307 displays the window as soon as you enable it.
If the window number has been assigned before, you may find that the window lies outside the current zoom area. If this happens, switch to the "Zoom" submenu and use the "Auto" zoom function. Further details about the zoom function are given in section 6.10.8 "Graphical test operationt – Zoom" on page 156.

5   Now specify the position of the window. To do this, switch to the "**<<>>**" menu option.
Once you have switched to this option, you can immediately define the position of the window using the arrow keys.

6   Now specify the size of the window. To do this, switch to the "**<>**" menu option. Under this menu option you can specify the window size by setting the two corners top-left and bottom-right. You can switch between these two corners using the **[F1]** and **[F2]** keys. You can use the **[F5]** key "Eval-zoom" to zoom in closer to the window.
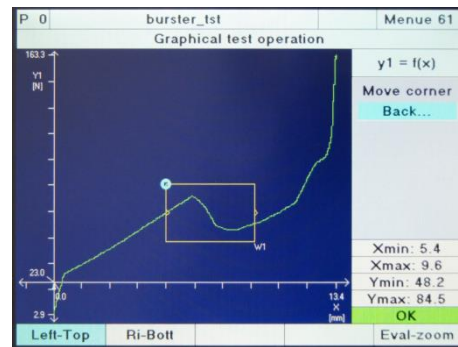
7   Pressing the **[Enter]** button completes the graphical window configuration process. In the "Numerical" submenu you can now specify the entry and exit sides of the window plus other parameters relating to the "Window" evaluation element.

6.10.10 Graphical test operation – Configuring trapezoid windows

In graphical test operation you can enable the "Trapezoid X" or "Trapezoid Y" evaluation element and place it, move it and change its size directly in the measurement curve diagram. To set all the parameters in full you can switch directly into the relevant parameterization menu, "Trapezoid window X configuration" menu 13 or "Trapezoid window Y configuration" menu 14 (see section 6.8.2 "Trapezoid window" on page 125).
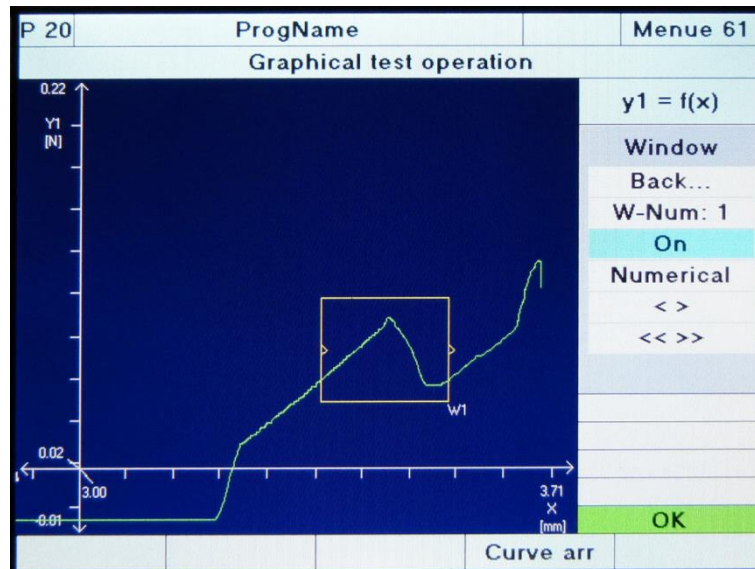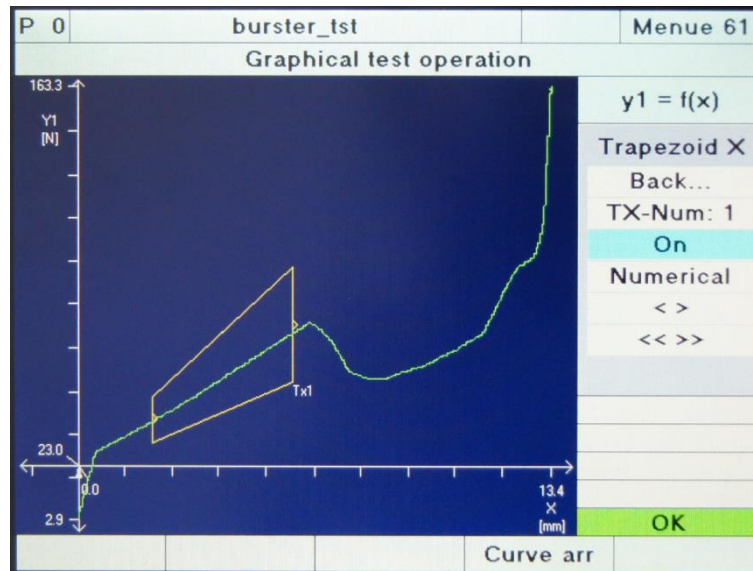

Diagram 50: Graphical test operation – trapezoid windows

This is how it works

1 Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** button "Graph".

2 Select the "Evaluation" menu option. Then select X-trapezoid or Y-trapezoid. You can switch to the numerical "Trapezoid window configuration" view at any time using the "Numerical" menu option. Further details are given in section 6.8.2 "Trapezoid window" on page 125)..

3 Select the "TX-Num" or "TY-Num" option and enter a window number using the ⇦ and ⇨ keys.
If the DIGIFORCE® 9307 is already displaying the selected trapezoid window, the trapezoid window changes its on-screen color. The frame of this trapezoid window is now shown in yellow.

4 Press the ⇩ key once and enable the new trapezoid window for display using the ⇦ and ⇨ keys.
The DIGIFORCE® 9307 displays the trapezoid window as soon as you enable it.
If the number has been assigned before, you may find that the window lies outside the current zoom area. If this happens, switch to the Zoom submenu and use the "Auto" zoom function. Further details about the zoom function are given in section 6.10.8 "Graphical test operationt – Zoom" on page 156.

5 Now specify the position of the trapezoid window. To do this, switch to the "**<<>>**" menu option. Once you have switched to this option, you can immediately define the position of the window using the arrow keys.

6   Now specify the size of the window. To do this, switch to the "**<>**" menu option.
Under this menu option you can specify the trapezoid window size by setting the window corners. You can switch between these corners using the **[F1]**, **[F2]**, **[F3]** and **[F4]** keys. You can use the **[F5]** key "Eval-zoom" to zoom in closer to the trapezoid window.
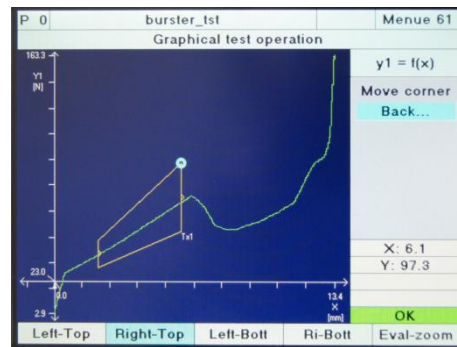
7   Pressing the **[Enter]** button completes the graphical configuration process for the trapezoid window. In the Numerical submenu you can now specify the entry and exit sides of the trapezoid window plus any other parameters relating to the trapezoid window element (see section 6.8.2 "Trapezoid window" on page 125).

6.10.11 Graphical test operation – Configuring thresholds

In graphical test operation you can enable the Threshold evaluation element and place it, move it and change its size directly in the measurement curve diagram. To set all the parameters in full you can switch directly into the parameterization menu, "Threshold configuration" menu 15 (see section 6.8.3 "Threshold" on page 131).
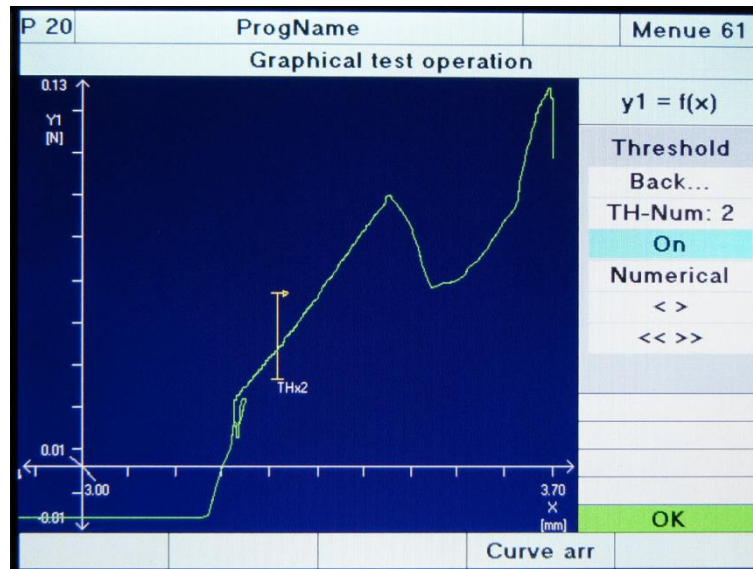

Diagram 51: Graphical test operation – Configuring thresholds

This is how it works

1   Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** key "Graph".

2   Select the "Evaluation" menu option and then "Threshold". You can switch to the numerical "Threshold configuration" view at any time using the "Numerical" menu option. Further details are given in section 6.8.3 "Threshold" on page 131. Select the "TH-Num" option and enter a threshold number using the ⇦ and ⇨ keys. Press the **[Enter]** key. If the DIGIFORCE® 9307 is already displaying the selected threshold, the threshold changes its on-screen color to yellow.

3   Press the ⇩ key once and enable the new threshold for display using the ⇦ and ⇨ keys. The DIGIFORCE® 9307 displays the threshold as soon as you enable it.
If the number has been assigned before, you may find that the threshold lies outside the current zoom area. If this happens, switch to the Zoom submenu and use the "Auto" zoom function. Further details about the zoom function are given in section 6.10.8 "Graphical test operationt – Zoom" on page 156.

4   Define the orientation of the threshold (type X or type Y).
To do this, select the "Numerical" menu and assign the orientation type. The **[ESC]** key takes you straight back into graphical test operation.

5   Now specify the position of the threshold. To do this, switch to the "**<<>>**" menu option. Once you have switched to this option, you can immediately define the position of the threshold using the arrow buttons.

6   Now specify the size of the threshold. To do this, switch to the "**<>**" menu option. Under this menu you can define the threshold size using the two limits Y_{MAX} and Y_{MIN} or X_{MAX} and X_{MIN} respectively. You can switch between the two limits using the **[F1]** and **[F2]** keys. You can use the **[F5]** key to zoom in closer to the threshold.
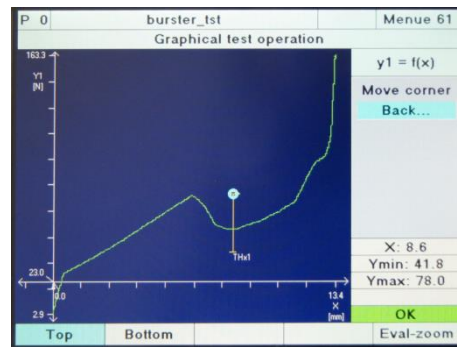
7   Pressing the **[Enter]** button completes the graphical configuration process for the threshold. In the Numerical submenu you can now specify the direction in which the measurement curve crosses the threshold plus any other parameters relating to the Threshold element (see section 6.8.3 "Threshold" on page 131).

6.10.12 Graphical test operation – Configuring envelopes

In graphical test operation you can generate the Envelope evaluation element. To do this, you first need to run at least one measurement. When generating the envelope, all the measurements available in the curve memory (10 measurement curves maximum) are used as the basis for calculating the envelope. In the Curve array submenu of Graphical test operation you can delete individual measurement curves from memory to remove these from the envelope generation process.
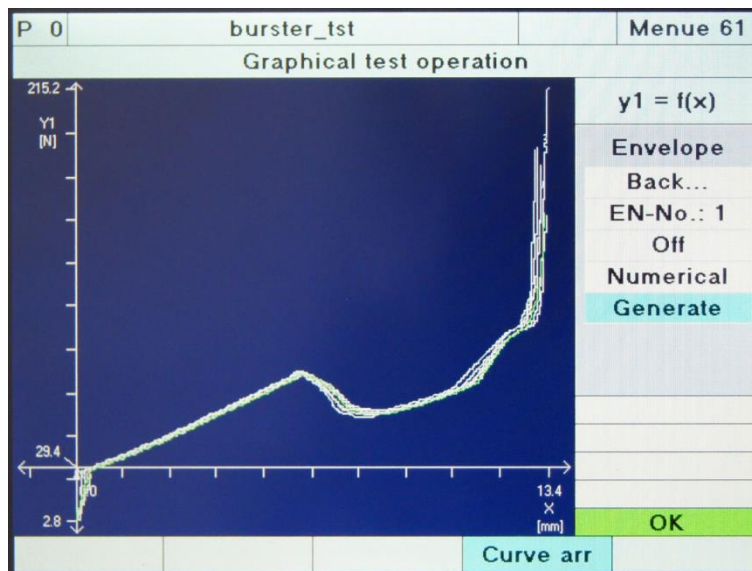
Selecting envelope 1 or 2
Element On/Off
Numerical configuration
Generate envelope

[F4]
Enable/Disable
display of curve array
Diagram 52: Graphical test operation – Configuring envelopes

This is how it works

1 Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** key "Graphical test operation".

2 Use the **[F1]** key to delete old measurement curves if you do not want to use these curves to generate a new envelope. The ten most recent measurement curves are stored in the volatile memory. In the Curve array submenu [Graphical test operation / Curve array] you can delete individual curves that you do not want to use for an envelope.

3 Record at least one measurement curve in order to generate an envelope from the curve. When a series of measurements are made, only the last ten measurements are stored.

4 Select the "Evaluation" menu option and then "Envelope". (You can switch to the numerical configuration view at any time using the "Numerical" menu option. Further details are given in section 6.8.4 "Envelopes" on page 138).

5 Select the "EN-No." option and use the < and > keys to select which of the available envelope elements you want to enable.

Press the "Cursor down" key once and enable the evaluation element using the < and > keys.

Select the "Generate" option and press **[Enter]**. Select the entry side you want from the pop-up window.
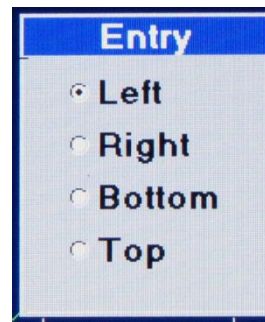
6 In the next pop-up window, specify whether you want the envelope to be generated in the forward or return curve segment and press **[Enter]**.

If the DIGIFORCE® 9307 was able to generate the envelope correctly, the message "Envelope has been generated successfully" is displayed. Press **[Enter]**.

Select the "Limits" option and define the start and end position for the envelope using the cursor keys. You can use **[F1]** and **[F2]** to switch between envelope start and envelope end.
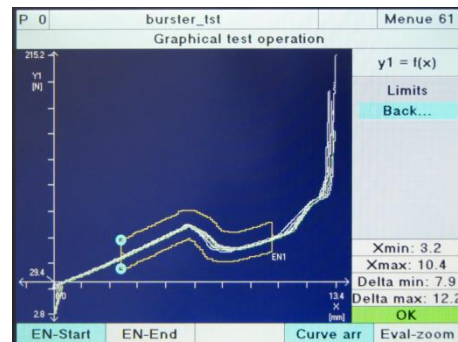
7 Select the "Delta" option and define the additional tolerance band using the cursor keys. You can use **[F1]** and **[F2]** to switch between Delta max and Delta min.
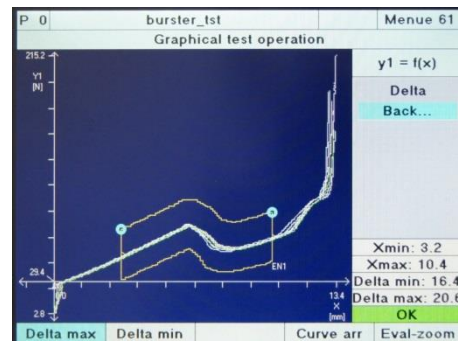
8 That completes the envelope generation process. In the "Numerical" submenu you can make numerical adjustments to the values you have set graphically such as the start and end positions. Press **[ESC]** to exit the menu.

Note: The DIGIFORCE® 9307 can only generate an envelope if the entire curve segment (forward or return) is continuous i.e. for a Left or Right entry, only one Y-value must be associated with each X-coordinate, or for Bottom or Top entry, only one X-value must be associated with each Y-coordinate.

6.10.13 Graphical test operation – Cursor

You can use the cursor in graphical test operation to select each individual measurement pair and read off the associated X/Y values.
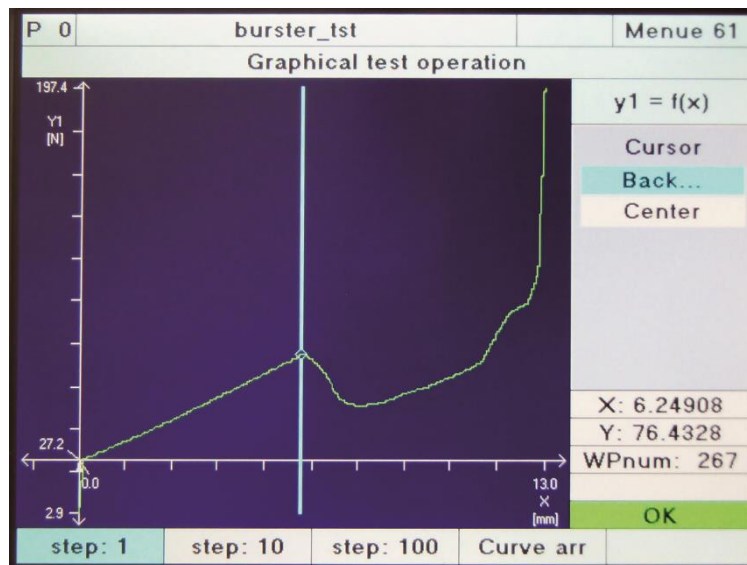
Diagram 53: Graphical test operation - Cursor

Function keys in graphical test operation

Function key	Function
[F1]	Step: 1 The cursor keys < and > are used to select each individual value pair.
[F2]	Step: 10 The cursor keys < and > are used to select every tenth value pairs
[F3]	Step: 100 The cursor keys < and > are used to select every hundredth value pair. This lets you can scroll very quickly through a curve containing several thousand value pairs.
[F4]	Curve array Enable/disable display of the curve array
[F5]	---

6.10.14   Graphical test operation – Reference curve

For each of the measurement curves Y1 and Y2 you can save a live measurement curve as the reference curve and display this curve in the graph in measurement mode. The reference curve is shown as a violet curve and can be used by an operator to identify any differences between the actual curve and ideal curve. A fewer number of measurement value pairs are saved for the reference curve.

This is how it works

1   Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** button "Graph".

2   Select the "Ref curve" option from the menu.

3   If a measurement curve is already available, you can select this curve as the new reference curve using the "Save" function. If there is no measurement curve available or you have previously deleted existing curves, you can run a measurement in this submenu and save the new measurement as the reference curve. You can use the "Switch on"/"Switch off" function to enable the display of a pre-saved reference curve on pressing **[Enter]**.

4   Press **[ESC]** to exit the menu.

6.10.15   Graphical test operation – Displaying a curve array

The DIGIFORCE® 9307 can display the last 10 measurements simultaneously as a curve array. This lets you easily and conveniently identify any trend in the measurements directly from the instrument. In addition, you can highlight and examine individual measurement curves in the curve array.

This is how it works

Enabling the curve array

1   Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** key "Graph".

2   Press the **[F4]** key "Curve array".

3   The DIGIFORCE® 9307 now displays the last 10 measurements as a curve array. The most recent curve is shown in red or green, depending on the evaluation result, and the rest in white.

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This is how it works

Selecting individual curves from the curve array

Prerequisite: The curve array display must be enabled.

1   Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** key "Graph".

2   Select the "Curve array" option from the menu. The DIGIFORCE® 9307 now displays a menu from which you can choose the curve you require using the arrow keys.

3   The DIGIFORCE® 9307 shows the selected curve in violet. All other curves are shown in white.

This is how it works

Deleting individual curves from the curve array

Prerequisite: The curve array display must be enabled.

1   Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** key "Graph".

2   Select the "Curve array" option from the menu.

3   Select the relevant curve from the curve array.

4   Press the **[F1]** key "Delete".

This is how it works

Deleting the curve array

Prerequisite: The curve array display must be enabled.

1   Go to the "Simple test operation" menu; if the "Graphical test operation" page is not displayed already, open it by pressing the **[F5]** key "Graph".

2   Press the **[F1]** key "Del Curve".

6.10.16 Graphical test operation – Marks

You can use the Marks function in Graphical test operation to display the individual measurement value pairs of a measurement curve.
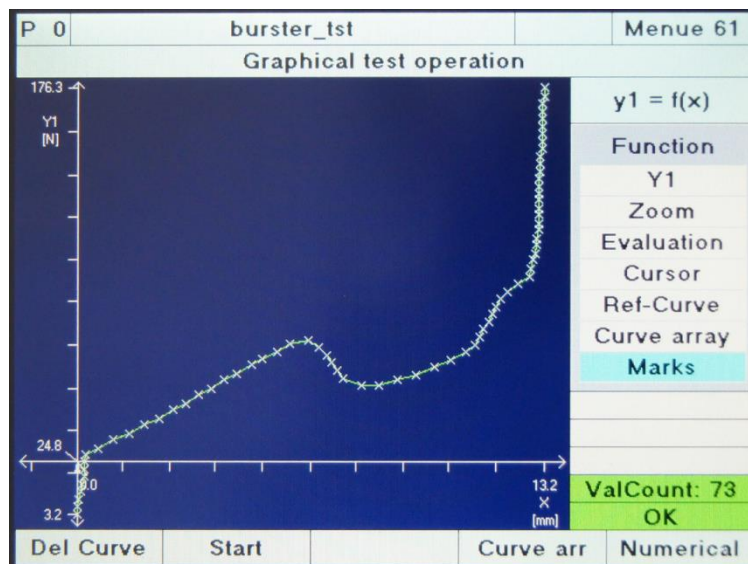
Diagram 54: Graphical test operation - Marks

6.11 Complex test operation

Complex test operation lets you record measurement curves from several measurement programs, and then use these recorded measurement curves to configure the evaluation elements. If, for example, a component in an automated plant is being monitored over four different process steps using four separate measurement programs in the DIGIFORCE® 9307, then once measurements of up to ten components are completed, the evaluation elements can be configured in each of the measurement programs on the basis of the recorded curves.

Diagram 55: Complex test operation

Configuration of the evaluation elements is complete
(check mark set)

Cursor is sitting over measurement program P1
(shown in blue)

Active measurement program P3
(shown in green)

Configuration of the evaluation elements is not complete
(check mark not set)

Number of measurement curves saved per measurement program
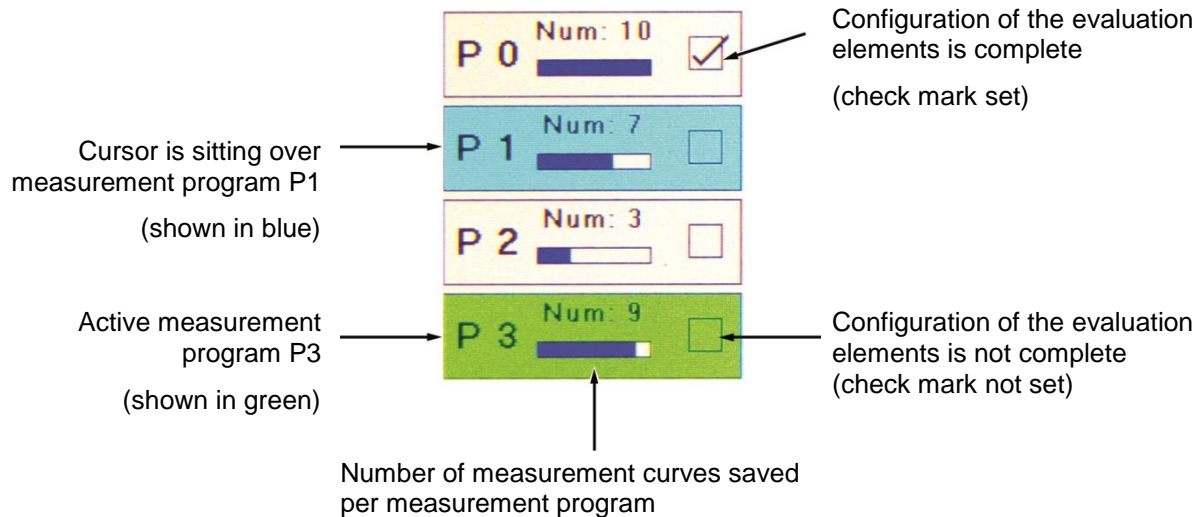
Function key assignment in Complex test operation (menu 67)

[F1]	Reset all	All measurement curves in all measurement programs are deleted
[F2]	Reset prog	All measurement curves in the active measurement program are deleted
[F3]	----	No function
[F4]	Set prog	The program selected by the cursor is selected as the active measurement program. The measurement program can be selected using external selection (PLC I/O or PROFIBUS).
[F5]	Edit	Switches to graphical test operation in order to configure evaluation elements such as windows for the selected measurement program. You are always taken to the measurement program on which the cursor is sitting (shown in blue).

6.12 Sensor test

The "Sensor test" function can be used to run a cyclical test of the active measurement channels. In the test, the DIGIFORCE® 9307 compares the live measurements with stored reference values. The DIGIFORCE® 9307 evaluates the result as "sensor test OK/NOK" depending on whether the measured value lies inside or outside the defined tolerance. (Further details are given in section 3.8 "Sensor test" on page 33).

You can only make settings for the channel Y_2 if this channel has been enabled in the "Channel settings" menu.

6.12.1 Parameters in „Sensor test" for channel X, Y1 und Y2 menu (menu 36)

Sensor Test	ON/OFF	
Measured value	<value>	Reference value measured and recorded for the sensor test. This value is used as the comparison value when running the sensor test. If the value measured during the sensor test lies within the permitted tolerance, the control signal OUT_OK_STEST = 1 is set (sensor test OK).
		If the value lies outside the permitted tolerance, OUT_OK_STEST = 0 (sensor test NOK)
		You can adopt the current live reading as the "Measured value" reference value by pressing the **[F1]** key.
Max allowed deviation +/-	<value>	Set here the permitted +/- tolerance for the OK/NOK decision of the sensor test.

This is how it works

1   Press the **[F5]** key twice in measurement mode to open the "Sensor test" menu.

2   Enable the sensor test for the relevant measurement channel by setting it to "ON"

3   Measure and save the live reading as reference value using the **[F1]** function key.

P 3	bur_03		Menue 36
	Sensor test		
	Channel X		
Sensor test	On		
Measured value	4.05155	mm	
Max allowed deviation +/-	1.00000	mm	
	Channel Y1		
Sensor test	On		
Measured value	-0.00648	N	
Max allowed deviation +/-	1.00000	N	
Measure...			

4   Define the permitted tolerance for the OK/NOK decision.

Running the sensor test

You can launch the sensor test manually in Numerical test operation by pressing the **[F4]** function key, or via the PLC I/O or PROFIBUS control interfaces using the signal IN_STEST (see signal timing for "External actuation of sensor test").

Tip

Do not run the sensor test and tare function cyclically at the same reference value e.g. at the reference position on a machine. If you were to do this, the tare action would prevent reliable identification of any potential sensor fault or sensor drift.

6.13 User defined values

The DIGIFORCE® 9307 can display various measurement values in measurement mode, which you can also output via an interface. These measurement values include sensor live values, entry and exit values for windows, extreme values or the result of a mathematical function. Before the DIGIFORCE® 9307 can display any of these values, they need to be activated in one of the three submenus of the "Setup user-defined values" menu. The submenu in which you activate the value determines where DIGIFORCE® 9307 displays the value.

The two submenus "User defined meas. values (1-12)" and "(13-24)" are absolutely identical. The DIGIFORCE® 9307 will display all the values that you activate here in one of the two tables "User selected values" during the measurement. Further details on the "User selected values" tables are given in section 7.7 "Info page, User defined values (M5-1, M5-2)" on page 189.

The values in the table after the entry "User defined meas. values in curve" are displayed by the DIGIFORCE® 9307 during measurement mode along with the measurement curve. You can also have displayed here the live values of the active measurement channels during a measurement.

The DIGIFORCE® 9307 does this by dividing the "Measurement curve graphs" info page into two parts. In the top section you continue to see the measurement curve graph, while the lower section displays the table containing the activated measurement values (further details on the "Measurement curve graphs" info page are given in section 7.2 "Measurement curve graphs (M1-1 to M1-3)" on page 182).

What measurement values you can activate depends on the evaluation element concerned.

Live values

You can enable live values only in the menu "User defined meas. values in curve" using the **[F1]** function key. You can make a selection only if the relevant value (value1 ... value3) is inactive (OFF).

Intermediate results and constants

Here you can select the contents of ten memory locations or constants in each case.

General curve data

Start X		Abs. Y-Maximum X	
Start Y		Abs. Y-Maximum Y	
End X		Abs. Y-Minimum X	
End Y		Abs. Y-Minimum Y	
Abs. X-Maximum X		Return point X	
Abs. X-Maximum Y		Return point Y	
Abs. X-Minimum X		Reference point	
Abs. X-Minimum Y			

Window

Entry X	Local maximum Y
Entry Y	Bend X
Exit X	Bend Y
Exit Y	Mean value Y
Abs. minimum X	Gradient
Abs. minimum Y	Area
Abs. maximum X	Coordinate Xmin
Abs. maximum Y	Coordinate Xmax
Local minimum X	Coordinate Ymin
Local minimum Y	Coordinate Ymax
Local maximum X	

When two curves $Y_1(x)$ and $Y_2(x)$ are being recorded, there are additional results available (see section 6.8.1.3 "Additional results when recording two curves $Y_1(x)$ and $Y_2(x)$" on page 123).

X trapezoid window

Entry X	Coordinate Xmax
Entry Y	Coordinate YminLe
Exit X	Coordinate YminRi
Exit Y	Coordinate YmaxLe
Coordinate Xmin	Coordinate YmaxRi

Y trapezoid window

Entry X	Coordinate Ymax
Entry Y	Coordinate XminBottom
Exit X	Coordinate XminTop
Exit Y	Coordinate XmaxBottom
Coordinate Ymin	Coordinate XmaxTop

When two curves $Y_1(x)$ and $Y_2(x)$ are being recorded, there are additional results available (see section 6.8.2.2 "Additional results when recording two curves Y1(x) and Y2(x)" on page 130).

Thresholds

Pass X	Local maximum Y
Pass Y	Bend X
Abs. minimum X	Bend Y
Abs. minimum Y	Mean value Y
Abs. maximum X	Gradient
Abs. maximum Y	Area
Local minimum X	Coordinate X-value
Local minimum Y	Coordinate Ymin
Local maximum X	Coordinate Ymax

When two curves $Y_1(x)$ and $Y_2(x)$ are being recorded, there are additional results available (see section 6.8.3.3 "

Additional results when recording two curves Y1(x) and Y2(x)" on page 137).

Envelopes

Entry X	Exit Y
Entry Y	Start X
Exit X	End X

This is how it works

Activating values

Prerequisite: The DIGIFORCE® 9307 can only display the activated values if you have enabled them in the Evalution menu.

1 Press the **[F5]** "Config" function key twice in measurement mode.
You are now in the "Main setup menu".

2 Now open the "Setup user-defined values" menu.
This is where you choose the submenus that determine where the DIGIFORCE® 9307 shall display the values.
The values that you activate in the submenus "Setup user-defined values" (1 to 12)" and "13 to 24)" respectively are displayed by the DIGIFORCE® 9307 in one of the User-selected value tables. The values that you enter in the "User defined meas. values in curve" submenu are displayed by the DIGIFORCE® 9307 on the "Measurement curve graphs" info page.

3 Select an empty cell for the value and press **[Enter]**.
The DIGIFORCE® 9307 now opens a further menu.

4 Select the relevant evaluation element.
Once you have selected an evaluation element, the DIGIFORCE® 9307 immediately displays a list containing the measurement values possible for this element. You can use the **[F1]** function key for each of "value1" to "value3" to enable the respective live values for the display "User defined meas. values in curve".

5 Select the relevant measurement value.
You have now finished activating the display of a measurement value. You can now continue with activating further measurement values. As soon as you close the "Setup user-defined values" menu, the DIGIFORCE® 9307 reminds you that you still need to enable the set values in the evaluation menus. Confirm with **[Enter]**.

6.14 Copying / Deleting a measurement program

6.14.1 Copying a measurement program or sensor settings

If you want to re-use most of the settings in a measurement program, you can make a copy of the measurement program. You can then tweak these copies to suit the new requirements.

If you want to use just the sensor settings of a particular measurement program in other measurement programs, the DIGIFORCE® 9307 also lets you copy these settings into other measurement programs.

Note: Once you have overwritten an existing measurement program or its settings, the overwritten settings in this measurement program are lost.

This is how it works

1	Press the **[F5]** "Config" function key twice in measurement mode. You are now in the "Main setup menu".

2   Open the "Copy program" option.
The DIGIFORCE® 9307 opens the dialog
window for copying measurement programs.

P 3	bur_03	Menue 39
	Copy measurement programs	

Source program number   3
Target program number from   4
Target program number to   4

Initialize target program(s)
Copy sensor setup
Copy whole setup

3   Under "Source program number", enter the measurement program that you want to copy. Use the cursor keys to do this.

4   Under "Target program number from" or "Target program number to", enter a range for the program numbers for the copies.
If you only want to make one copy, enter the same number for "Target program number from" and for "Target program number to".

5   Now select "Copy whole setup".
The DIGIFORCE® 9307 warns you again about accidentally overwriting an existing measurement program.

6   Confirm with **[Enter]**.
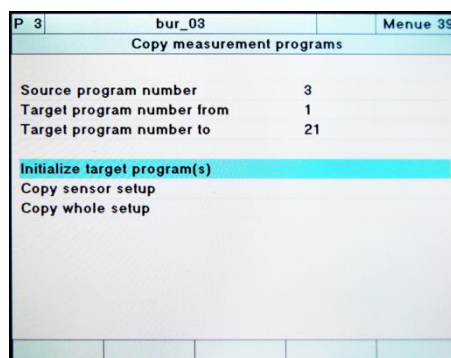
6.14.2 Deleting a measurement program

If you want to discard all the settings of one or more measurement programs, you can do this using the function "Initialize target program(s)". The DIGIFORCE® 9307 then resets the respective measurement programs **irrevocably** to the factory settings. The settings of the selected measurement programs are lost.

Note: When you delete an existing measurement program using the "Initialize target program(s)" function, all the settings in this program are lost.
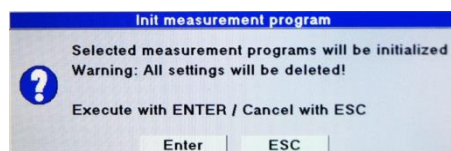
This is how it works

1   Press the **[F5]** "Config" function key twice in measurement mode.
You are now in the "Main setup menu".

2   Now open the "Copy program" option.
The DIGIFORCE® 9307 opens the dialog
window for copying measurement programs.

P 3	bur_03	Menue 39
	Copy measurement programs	

Source program number   3
Target program number from   1
Target program number to   21

Initialize target program(s)
Copy sensor setup
Copy whole setup

3   Under "Target program number from" or "Target program number to", enter the measurement programs that you want to delete.
If you only want to delete one measurement program, enter the same number for "Target program number from" and for "Target program number to".

4   Then select "Initialize target program(s)".
The DIGIFORCE® 9307 warns you again
that all the settings of the selected
measurement programs will be lost.

Init measurement program

Selected measurement programs will be initialized
Warning: All settings will be deleted!

Execute with ENTER / Cancel with ESC

Enter   ESC

5   Confirm with **[Enter]**.
You have now deleted the measurement program.

7   Measurement results display

Note: In the "Basic setup menu", you can change the function-key assignments and the display preferences for the individual measurement menus. The information in this manual, however, relates to the factory settings of the instrument.

The DIGIFORCE® 9307 starts automatically in "Measurement Mode" at power-up. In this operating mode, the DIGIFORCE® 9307 can display measurements and the resultant measurement curve or various results data and statistics. The DIGIFORCE® 9307 uses a number of different info pages to show this information, which you can scroll between using the **[F1]** "<<" and **[F2]** ">>" keys.

All info pages contain the global header, the individual evaluation status of the last completed measurement (right-hand side) and the footer displaying the assignments of the relevant function keys **[F1]** to **[F5]**.

The function key **[F5]** is permanently assigned to the mode-toggle function for switching between measurement mode and configuration mode.

Note: The PLC control signal IN_AUTO is used to inhibit a shift into configuration mode.
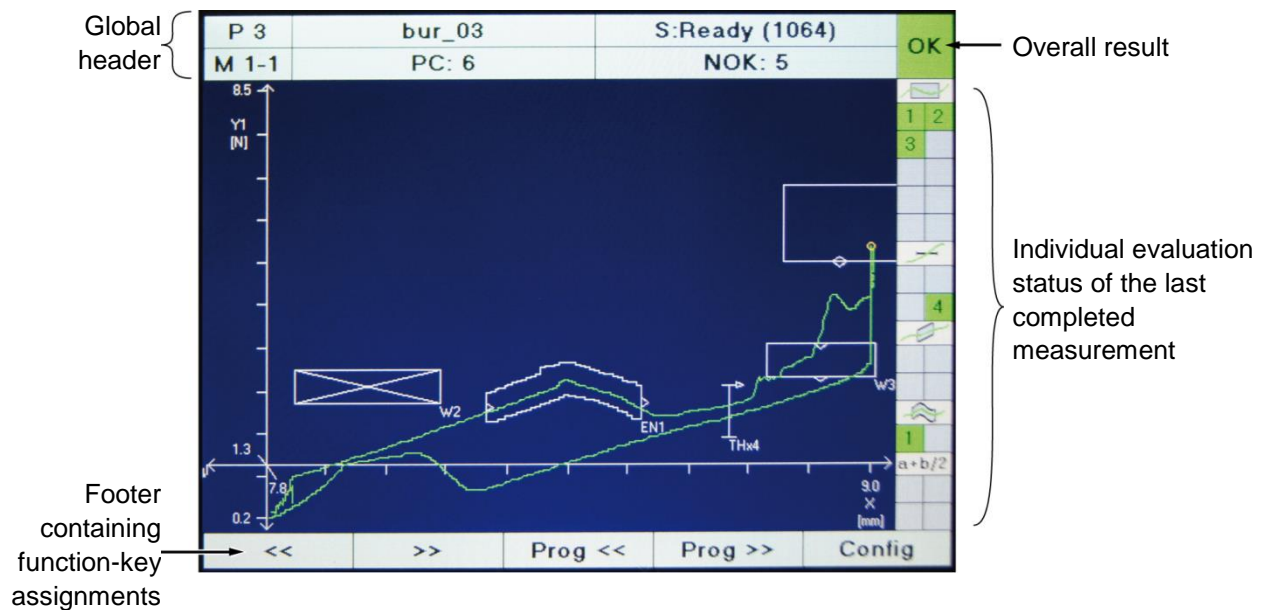
7.1 Top-level view measurement results
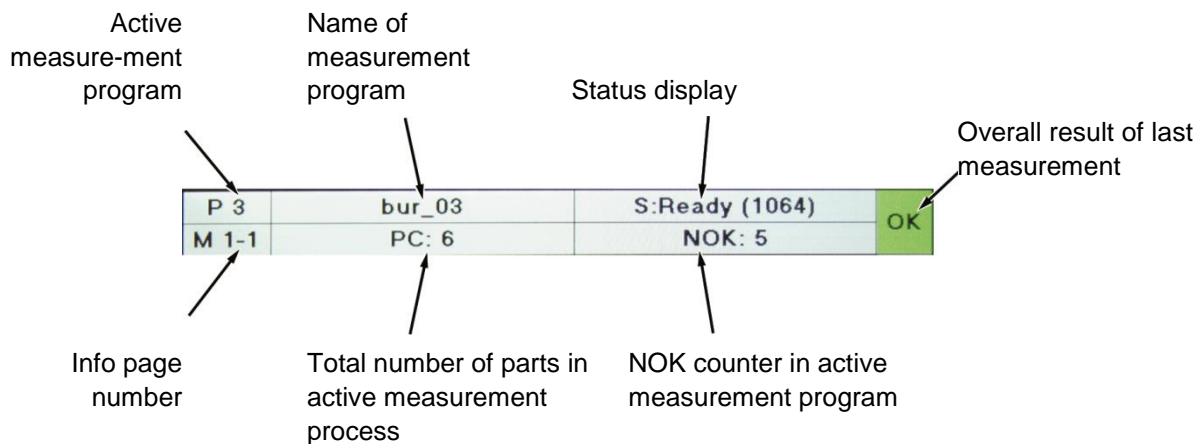

Diagram 56: Top-level view measurement results

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7.1.1 Global header

Diagram 57: Global header

7.1.2 Status display in measurement mode

S:Ready(<value>)	The DIGIFORCE® 9307 is ready for a measurement (PLC signal: "READY=1"); The value in brackets shows the number of measurement value pairs from the last measurement. S:Ready (>>5000) means that during the last measurement the maximum number of permissible measured values has been exceeded. S:Ready (OVER) means that at least one measurement channel has been overdriven during the previous measurement. This results in an overall evaluation of NOK. (Exception: if the resistance measurement channel **E** is overdriven, this does not result in OVER being displayed or an NOK evaluation).
S:Trigger	A measurement has started, but the specified trigger event has not happened yet.
S:Measuring	Measurement in progress (the overall result field changes to yellow)
S:WAIT FOR PC	For the purpose of automated data logging, the DigiControl PC software switches management of the READY signal over to PC control in measurement mode. If a new measurement is available in the DIGIFORCE® 9307, the Ready status and the OUT_READY control signal is not set until data logging has finished The status **S:WAIT FOR PC** is displayed in this phase
S:Temp>>	The operating temperature has exceeded the maximum permitted value (≥ 75 °C in the housing – internal temperature)
S:No Ref. Point	A reference mark has not been detected during the reference travel (see section 7.8 Reference travel - incremental sensors).
S:Acknowledge	Waiting for acknowledgement in acknowledgement mode (background color magenta)
S:Edit Mode active	Edit mode has been opened using the relevant function key in measurement mode. The DIGIFORCE® 9307 can now switch to configuration mode despite active measurement-data logging by the DigiControl software

If the DIGIFORCE® 9307 is integrated in the PC-based measurement data logging of the DigiControl software (DigiControl Measurement mode function), the status is shown in blue lettering. In this state, the DIGIFORCE® 9307 cannot be switched directly into configuration mode using the **[F5]** function key.

7.1.3   Overall result of last measurement

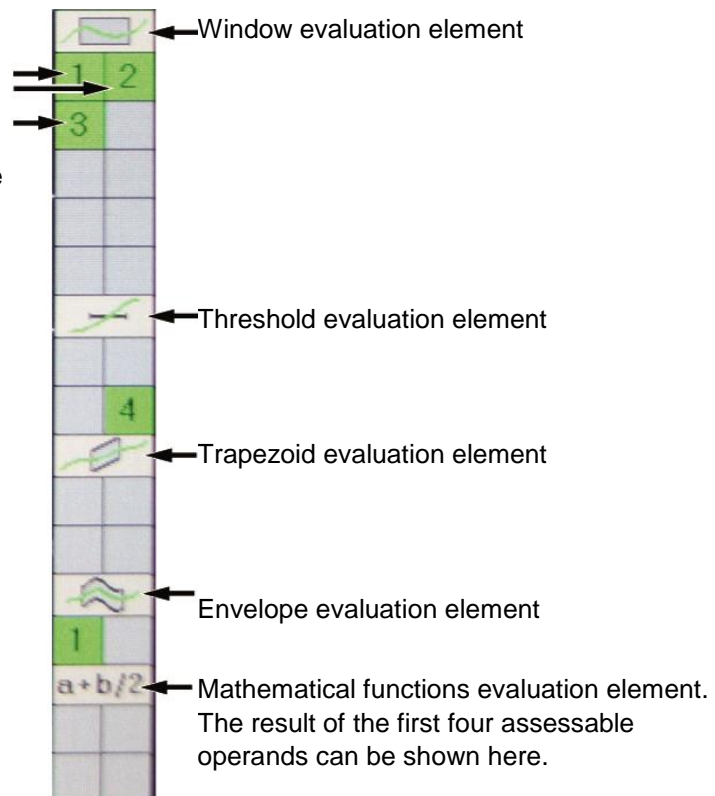| Display	Meaning
OK	Measurement "OK": each active evaluation element enabled for evaluation has been given an "OK" evaluation.
NOK	Measurement "NOK": at least one active evaluation element enabled for evaluation has been given an "NOK" evaluation.
	Measurement in progress

Note: When recording two curves at once $Y_1(X)$ and $Y_2(X)$, you can obtain a separate result, i.e. OK/NOK for $Y_1(X)$ and OK/NOK for $Y_2(X)$, via the I/O interface or Fieldbus interface. In the graph, the respective measurement curve is shown green for an OK evaluation or red for an NOK evaluation.

7.1.4 Individual evaluation status in measurement mode

On the right-hand side of the screen, the DIGIFORCE® 9307 indicates the individual results of the active evaluation elements. The DIGIFORCE® 9307 identifies these results with their corresponding number.

If an evaluation element is defined on the Y2 measurement curve but this curve is disabled (OFF) in the channel settings, the individual status is indicated in yellow.

An active evaluation element is indicated by its corresponding number. An active element that is configured as "Evaluation off" is displayed without the green or red background color

Window evaluation element

Threshold evaluation element

Trapezoid evaluation element

Envelope evaluation element

Mathematical functions evaluation element. The result of the first four assessable operands can be shown here.

You can scroll back and forth between the following information pages using the **[F1]** and **[F2]** function keys:

1	M1-1	Graph of measurement curve Y1
2	M1-2	Graph of measurement curve Y2 (if enabled)
3	M1-3	Dual graph of measurement curve Y1 and Y2 (if Y2 enabled)
4	M2-1	General curve data Y1
5	M2-1	General curve data Y1 (if enabled)
6	M3	PASS/FAIL or smiley representation
7	M4	Entry/exit values for graphical evaluation elements
8	M5	Table of user selected values (if configured)
9	M6	Statistical analysis

| 10 | M7 | Order sheet |
| 11 | M8 | Results of rotary-switch evaluation |

In the Basic setup menu, you can disable those information pages that you do not need in measurement mode, so that you only scroll through the relevant pages with the **[F1]** and **[F2]** function keys.

7.2 Measurement curve graphs (M1-1 to M1-3)

The measurement curve plotted on an X/Y graph is displayed on the "measurement curve graphs" info pages (M1-1 to M1-3). If you have also defined an Y2-channel in the Channel settings, the DIGIFORCE® 9307 not only displays the default measurement curve $Y_1(X)$ but also shows the $Y_2(X)$ measurement curve in the M1-2 info page. In this case the M1-3 info page additionally displays a shared graph containing both curves $Y_1(X)$ and $Y_2(X)$.

The M1-2 and M1-3 info pages only appear if you have enabled the Y_2 channel. In the conventional application with just one measurement channel (Y_1), the DIGIFORCE® 9307 shows solely the M1-1 info page containing the X/Y graph $Y_1(X)$.
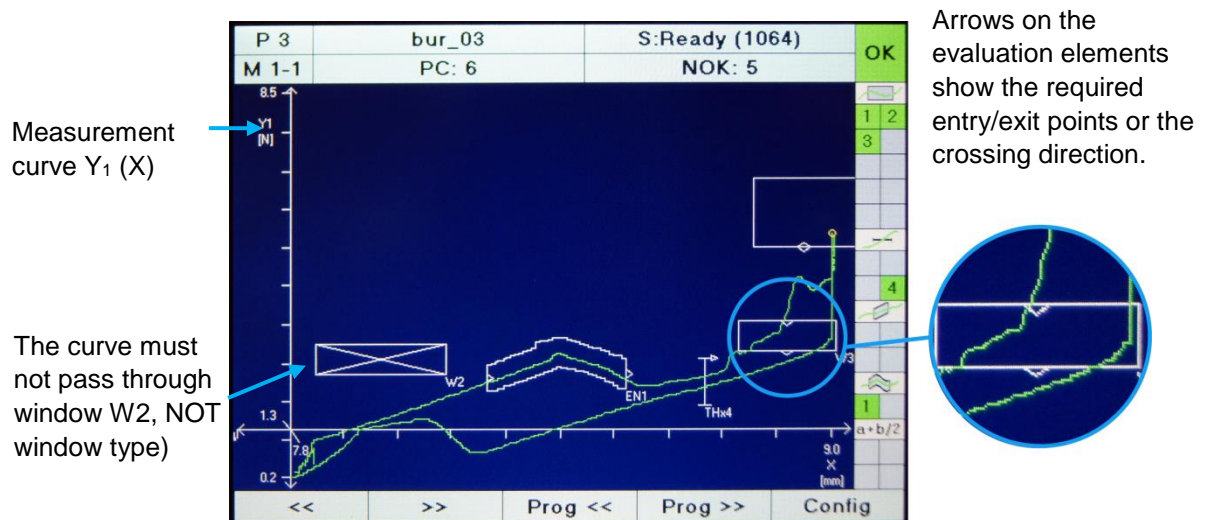
Measurement curve $Y_1(X)$

The curve must not pass through window W2, NOT window type)

Arrows on the evaluation elements show the required entry/exit points or the crossing direction.

Diagram 58: Measurement curve graph (M1-1)

Scaling of X/Y axes (zoom)

The axes are scaled (zoom function) in Graphical test operation (see Configuration > Simple test operation > **[F5]** Graphical test operation). The zoom can be adjusted using auto scaling or set manually.

Displaying a reference curve

A reference curve can be displayed as an aid for assessment and manual analysis of a live measurement curve. This curve must first be saved in Graphical test operation (see Configuration > Simple test operation > **[F5]** Graphical test operation). The reference curve is shown in violet.

7.2.1 Displaying numerical results in the M1-1 and M1-2 curve view

On the M1-1 or M1-2 info page containing the measurement curve graph, you have the option to display additional numerical results or sensor live values. The curve is then shown in the top half of the display, while up to six numerical values can be displayed in the lower half. The values to be displayed are selected in the configuration menu "Setup user-defined values" (see Configuration > Setup user-defined values > M1 User defined meas. values in curve).
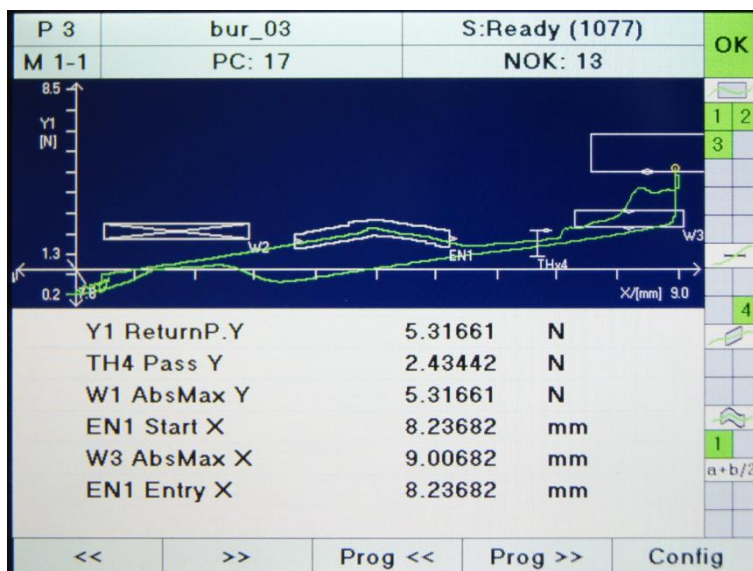

Diagram 59: Numerical results in curve view

You can find further details on selecting the result values in the section 5.13 "User defined values" on page 145 showing two measurement curves in parallel (M1-3).

7.2.2 Measurement curve graphs Y₁ and Y₂ (M1-3)

When you enable the Y_2 measurement channel in the Channel settings, the DIGIFORCE® 9307 immediately configures the M1-3 info page automatically. This page displays the two-curve graph containing both measurement curves.
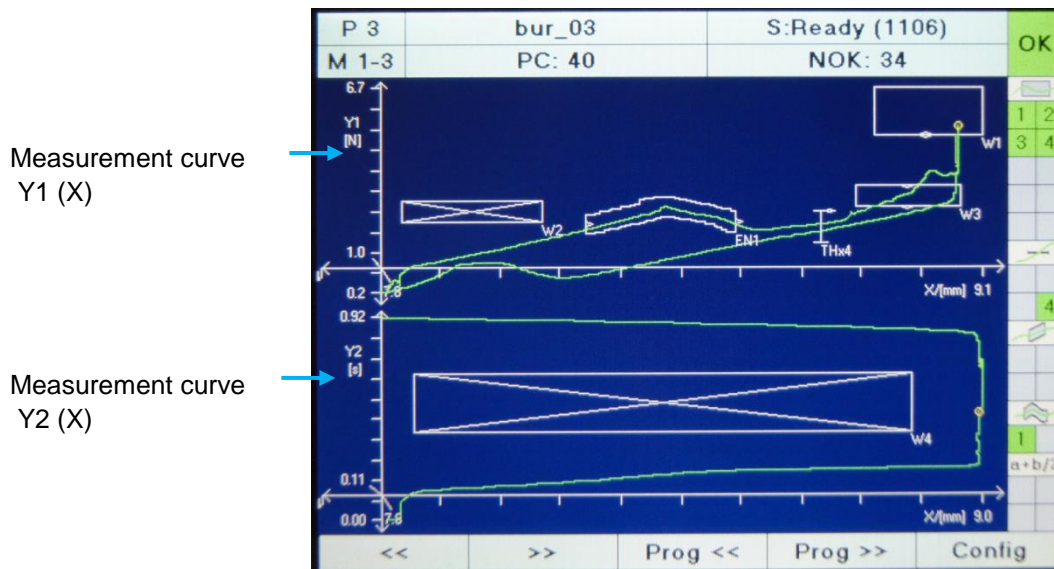
Measurement curve Y1 (X)

Measurement curve Y2 (X)

Diagram 60: Measurement curve graphs Y_1 and Y_2 (M1-3)

7.3 General curve data (M2-1 and M2-2)

The General curve data info page displays coordinate pairs (X/Y value pairs) from the set of results "General curve data" for $Y_1(X)$ or $Y_2(X)$. The M2-2 page for $Y_2(X)$ is only displayed if measurement channel Y_2 has been enabled in the Channel settings.

P 3	bur_03		S:Ready (1106)	OK
M 2-1	PC: 40		NOK: 34	

General curve data [Y1]

Xmin	7.80484	mm	0.25343	N
Xmax	9.01758	mm	5.26851	N
Ymin	7.80484	mm	0.25343	N
Ymax	9.01655	mm	5.51270	N
Start	7.81918	mm	0.39772	N
Final	7.80484	mm	0.25343	N
Return	9.01655	mm	5.51270	N

| << | >> | Prog << | Prog >> | Config |

Diagram 61: General curve data (M2-1)

Definition of values in the "General curve data" set of results

X_{MIN}	X/Y value pair at X-minimum
X_{MAX}	X/Y value pair at X-maximum
Y_{MIN}	X/Y value pair at Y-minimum
Y_{MAX}	X/Y value pair at Y-maximum
Start	X/Y value pair at start of measurement (first measurement value pair)
Ende	X/Y value pair at end of measurement (last measurement value pair)
Umkehr	X/Y value pair at return point (last measurement value pair in forward curve segment)

7.4 Info page overall result (M3)

The M3 info page lets you display the evaluation result as a global Good/Bad result (OK/NOK evaluation). You can opt to display the result as the text Pass/Fail or as a happy/sad smiley face.

You can also add an acknowledgement function to the overall result page, which prompts for confirmation by the operator (see Configuration > Basic setup menu > Acknowledgement function setup).
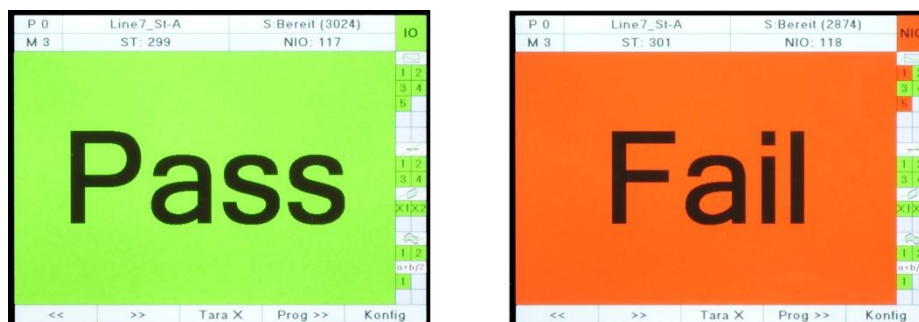
M3 Overall result as text display

Diagram 62: Info page overall result (M3) – text display

M3 overall result using smileys

Diagram 63: Info page over all result (M3) - smileys

7.5 Info page, Entry/Exit for windows (M4-1)

The M4-1 info page displays the Entry/Exit coordinate pairs for the active evaluation elements of type window (W). If evaluation windows are also enabled for the Y2(X) measurement curve, the information is displayed in a top section for the Y1(X) curve and in a bottom section for the Y2(X) curve.

P 3	bur_03		S:Ready (1106)	OK
M 4-1	PC: 40		NOK: 34	

	Entry		Exit	
	X[mm]	Y1[N]	X[mm]	Y1[N]
W1	9.01403	5.20737	9.01706	5.20737
W2	909090	909090	909090	909090
W3	9.01169	3.63920	8.97046	2.96910
	X[mm]	Y2[s]	X[mm]	Y2[s]
W4	909090	909090	909090	909090

<<	>>	Prog <<	Prog >>	Config

Diagram 64: Info page, Entry/Exit for windows (M4-1)

7.6 Info page, Entry/Exit (M4-2)

The M4-2 info page displays the Entry/Exit coordinate pairs for the active evaluation elements of type threshold (TH), trapezoid window (TX or TY) and envelope (EN). If evaluation elements are also enabled for the Y2(X) measurement curve, the information is displayed in a top section for the Y1(X) curve and in a bottom section for the Y2(X) curve.

The M4-2 info page also shows the Entry/Exit value for window evaluation elements, provided all active evaluation elements can be displayed in full.

Diagram 65: Info page, Entry/Exit (M4-2)

7.7 Info page, User defined values (M5-1, M5-2)

You can specify up to 24 measurement values or results for display in the User defined values tables M5-1 and M5-2. These values are selected in the Configuration under "Setup user-defined values" (Configuration > Setup user-defined values > M5-1 or M5-2). Please note that these values are not coordinate pairs.

P 3	bur_03	S:Ready (1049)	OK
M 5-1	PC: 44	NOK: 37	

User selected values1

1	W1 Entry X	9.02014	mm
2	TH4 Pass X	8.72717	mm
3	EN1 Entry X	8.23682	mm

| << | >> | Prog << | Prog >> | Config |

Diagram 66: Info page, User selected values (M5-1, M5-2)

You can export the values in the User selected values tables via the optional Fieldbus interface (e.g. PROFIBUS) and via the standard communications interfaces.

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7.8 Info page, Statistics (M6)

The Statistics info page shows the total percentage of failed parts (NOK evaluations) out of the total number of parts. It also shows the NOK percentage of all active individual evaluation elements with respect to the total number of NOK results. This display can help you quickly deduce the cause of any NOK measurements.

Example of statistics from screenshot

Of the 40 parts in total, 34 were evaluated as NOK. The total NOK percentage is hence 85%. The window1 evaluation element (W1) was the source of 53.4% of all the NOK measurements, and therefore contributed most often to the NOK overall evaluation.

Percentage of NOK results in total

You can use the UP/DOWN cursor keys to select an element and then press [Enter] to display the associated trend diagram or histogram.
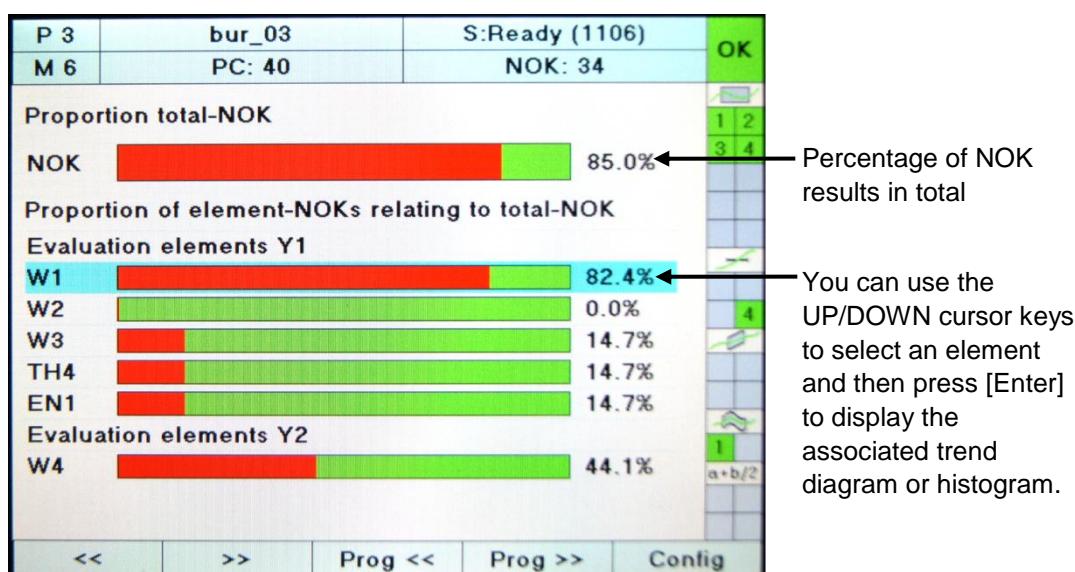
Diagram 67: Info page, Statistics (M6)

To analyze the process reliability more closely, you can display a trend diagram or histogram of the entry-exit coordinates for each active evaluation element. To do this, use the UP/DOWN cursor keys to select the relevant evaluation element and then press **[Enter]**. Press **[ESC]** to return to the Statistics info page (M6) at any time.

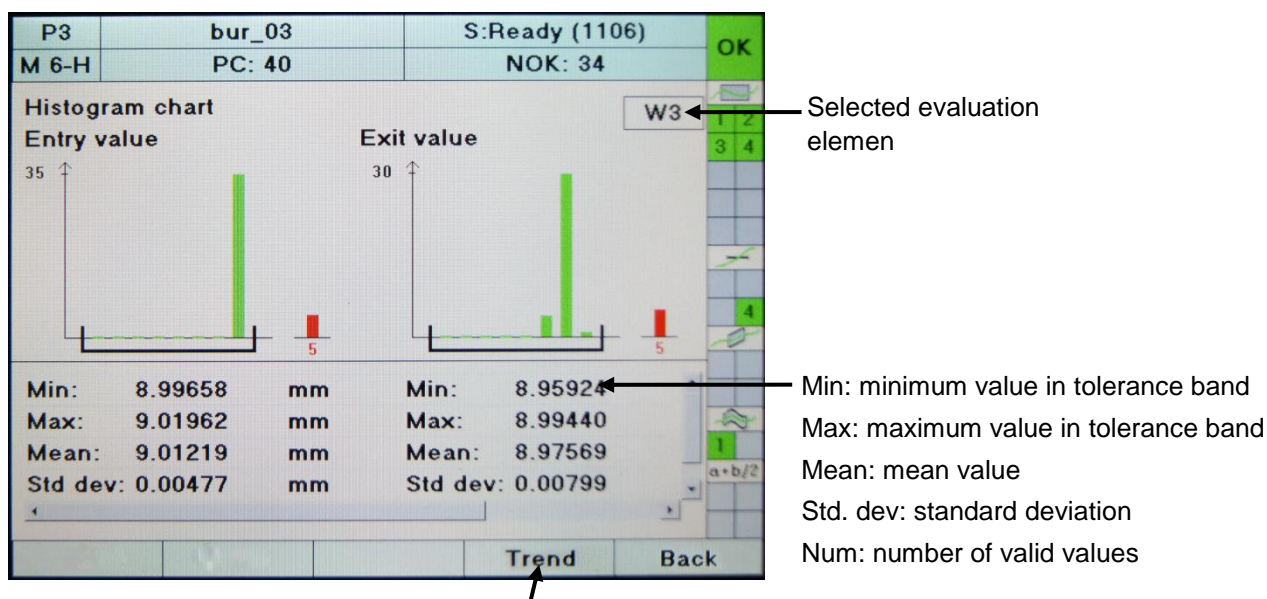The following values are displayed in the trend diagram/histogram:

Evaluation element	Values in the trend diagram/histogram
Window	The window entry and exit values are displayed and analyzed.
	For an entry/exit on the right or left, the frequency distribution between the limits Y_{MIN} and Y_{MAX} is displayed and analyzed.
	For an entry/exit on the bottom or top, the frequency distribution between the limits X_{MIN} and X_{MAX} is displayed and analyzed.
	If an entry side or exit side is not configured, the respective diagram and analysis is not shown.

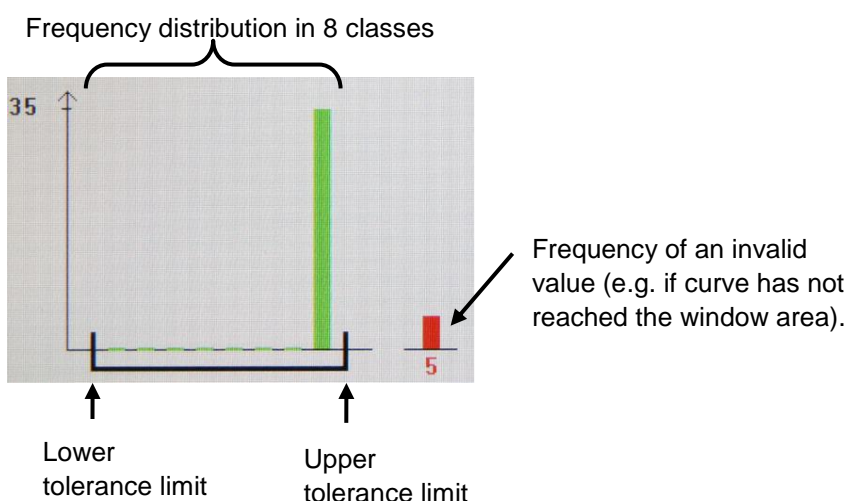|	
Trapezoid X	The trapezoid X entry and exit values are displayed and analyzed.
	The frequency distribution between Y_{MIN} and Y_{MAX} is displayed and analyzed.
	If an entry side or exit side is not configured, the respective diagram and analysis is not shown.
Trapezoid Y	The trapezoid Y entry and exit values are displayed and analyzed.
	The frequency distribution between X_{MIN} and X_{MAX} is displayed and analyzed.
	If an entry side or exit side is not configured, the respective diagram is not shown.
	If neither an entry side nor an exit side is configured, the analysis is not shown.
Threshold	The threshold crossover (intersection) is displayed and analyzed.
	For threshold type X, the frequency distribution between Y_{MIN} and Y_{MAX} is displayed and analyzed.
	For threshold type Y, the frequency distribution between X_{MIN} and X_{MAX} is displayed and analyzed.
	If a crossover direction is not configured, the analysis is not shown.
Envelope	The envelope entry and exit values are displayed and analyzed.
	For an entry on the right or left, the frequency distribution between the limits Y_{MIN} and Y_{MAX} is displayed and analyzed.
	For an entry on the bottom or top, the frequency distribution between the limits X_{MIN} and X_{MAX} is displayed and analyzed.
Rotary switch	No trend/histogram analysis
Mathematical function	Up to six of the assessable operands of the mathematical functions are displayed and analyzed.
	The frequency distribution between the minimum value and the maximum value is displayed and analyzed.

Note: Please note that the saved values for the trend diagram and histogram are stored in the volatile memory, i.e. the data is lost when the power supply is switched off.
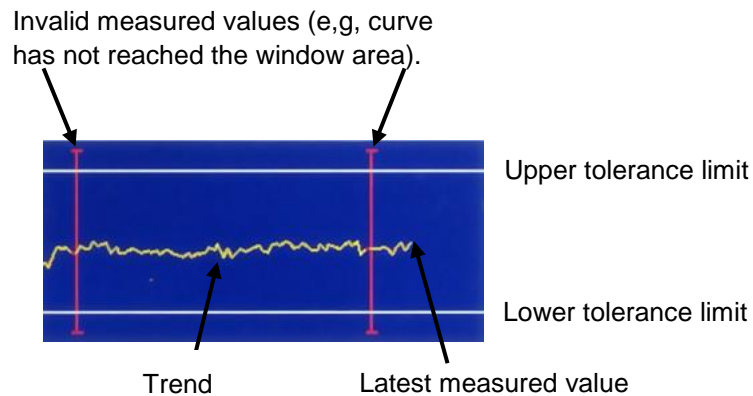
7.8.1 Statistics, Histogram info page (M6-H)

You can use the **[F4]** function key to switch between the Trend and Histogram views. The Histogram view shows the frequency distribution of the measured values (see table above) in eight fixed classes within the min/max limits. If the measured value cannot be found for a measurement, e.g. because the measurement curve does not even reach the window area, the frequency value of the ninth class (invalid value) is incremented. The histogram view can help you assess process reliability more effectively. For instance, if the measured values often lie close to the tolerance limits, then one can expect a higher proportion of NOK results.

Selected evaluation elemen

Min: minimum value in tolerance band

Max: maximum value in tolerance band

Mean: mean value

Std. dev: standard deviation

Num: number of valid values

Toggle key: switch between trend/histogram view **[F4]**

Frequency distribution in 8 classes

Frequency of an invalid value (e.g. if curve has not reached the window area).

Lower tolerance limit

Upper tolerance limit

7.8.2 Statistics, Trend info page (M6-T)

You can use the **[F4]** function key to switch between the Trend and Histogram views. The Trend view displays the relevant measurement value over the last 100 measurements maximum within the min/max limits. A red line is displayed if a measurement does not result in a measurement value.

Selected evaluation element

Min: minimum value in tolerance band
Max: maximum value in tolerance band
Mean: mean value
Std. dev: standard deviation
Num: number of valid values

Toggle key: switch between trend/histogram view **[F4]**

Invalid measured values (e,g, curve has not reached the window area).

Upper tolerance limit

Lower tolerance limit

Trend   Latest measured value
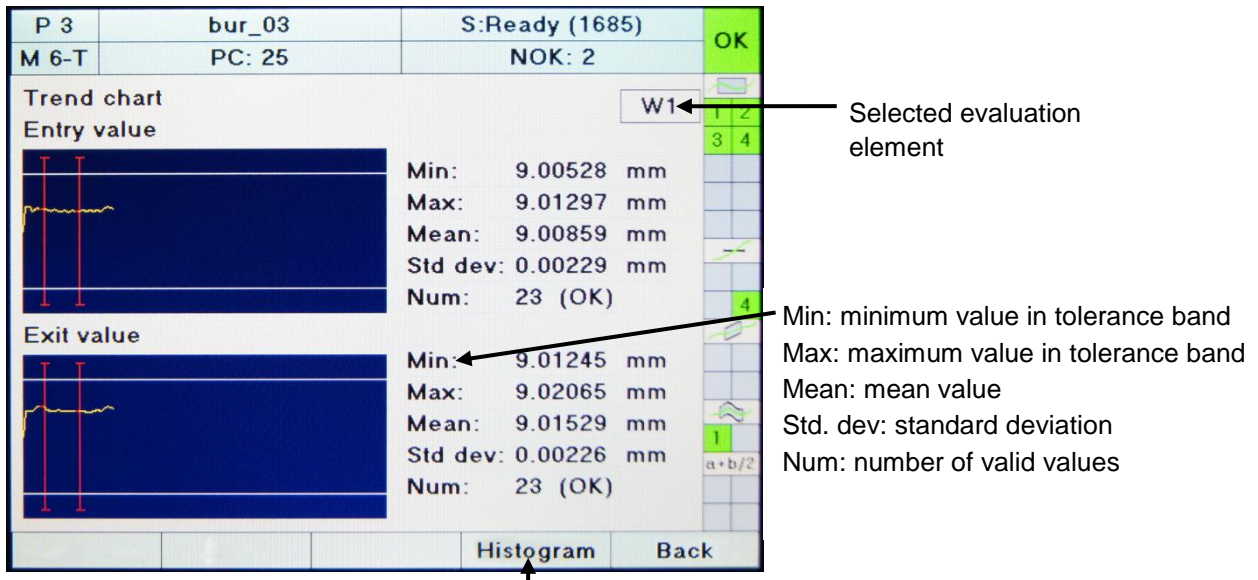
7.9 Info page, Order sheet (M7)

The Order sheet info page is not used for displaying specific measurement data or results. It is a "data container" via which you can transfer administrative or component-specific information for data logging purposes. You can edit the order sheet manually via the Basic setup menu (Configuration > Basic setup menu > Order sheet setup). It is far more efficient, however, to perform reading/writing via the Fieldbus interface to a PLC (e.g. via PROFIBUS). In this case, the PLC can write relevant information to the container, and this information can then be saved with a measurement data log made after the measurement (e.g. using the DigiControl PC software).

The order sheet is created globally and not for a specific program, i.e. the same basic set of data is used whatever the measurement program.

Order sheet parameters

Parameter	Meaning
Operator	Name of operator (string [64 characters])
Shift	Selection from six shifts; shift name (string [64 characters])
Shift counter	Part counter and NOK counter for the active shift. The counter values are incremented in all measurement programs (range 0 ... 4294967296)
Date / Time	Date/time of measurement (updated at end of measurement)
Order number	Order number (string [64 characters])
Batch	Batch name (string [64 characters])
Component	Component name (string [64 characters])
SN1	Serial number SN1 (string [64 characters])
SN2	Serial number SN2 (string [64 characters])

PLC transfers data to the 9307 (e.g. operator, component, order no.)

Digicontrol logs measurement data and additional information
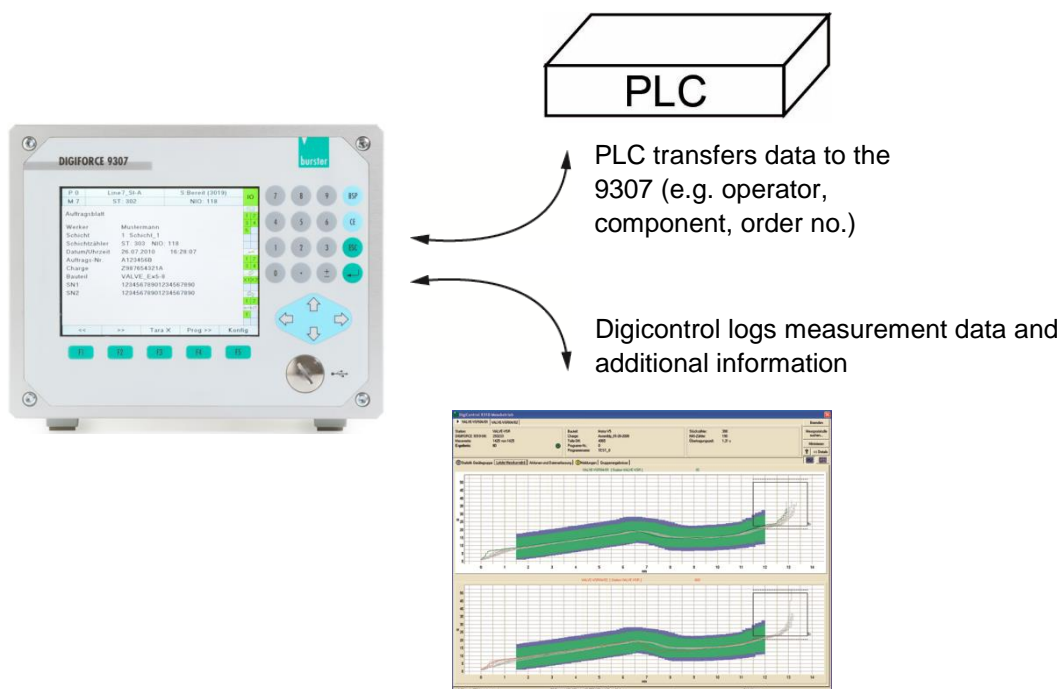
8 Curve analysis (Viewer)

Note: Available for serial number 530000 and above and device software V201801 (32/128) and above.

You can use the "Data Logger Graphic Display" menu (menu 72) 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, for instance individual results from the graphical evaluation elements and the associated measured values such as "Window" entry and exit coordinates.

Note: Be aware that the contents of the curve memory are lost when the DIGIFORCE® 9307 is switched off.
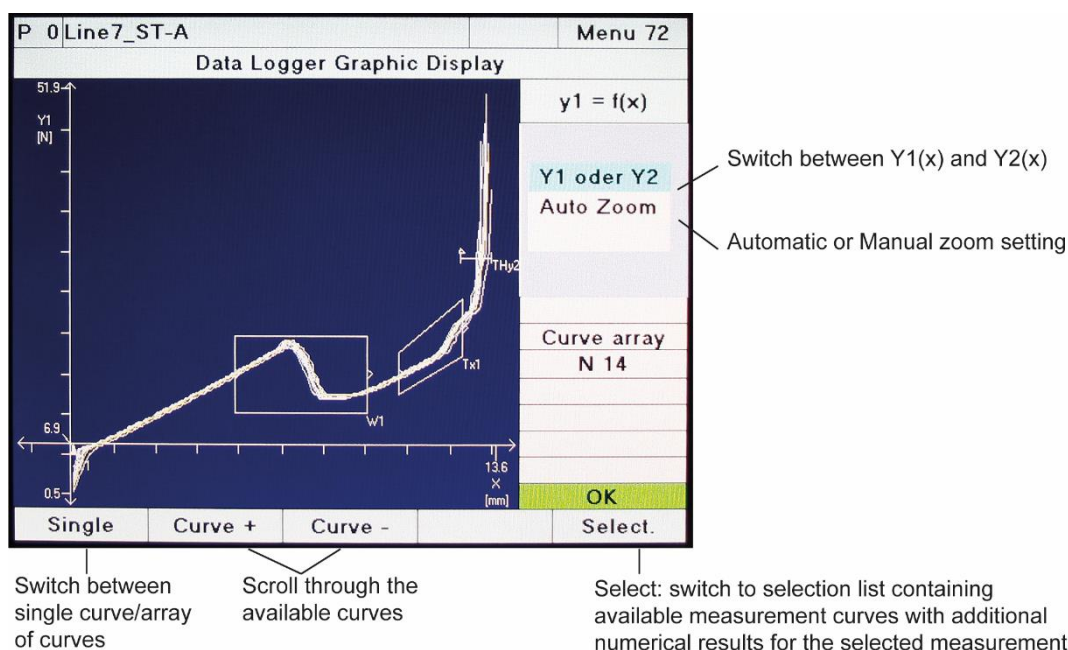
This is how it works

1 Press the **[F5]** "Config" key in measurement mode. This takes you to the "Minimal setup" menu (menu 7).

2 Select "Curve analysis" and press **[Enter]**.

3 This takes you to the "Data logger curve selection (logger active)" menu (menu 70), which displays the list of curves available in the data logger for selection.

4   If you want to display all the curves (max. 50 curves), press "Graphics" **[F5]** to switch to the graphical view ("Data Logger Graphic Display", menu 72).
Pressing **[F5]** "Select" takes you back to the numerical view.
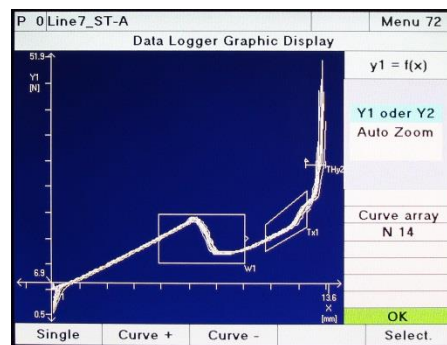
8.1   Curve analysis - Numerical

In the "Data Logger Numeric Display" menu (menu 71), you can open details of the saved measurements. To scroll between the available measurements, press the **[left]** and **[right]** arrow buttons.

You can view the following information:

- Index of the measurement
- Overall evaluation OK or NOK
- Measurement program number
- The number of X/Y coordinates and the position of the return point
- Time stamp for the measurement
- "General curve data" dataset
- Detailed values on the active evaluation elements

This is how it works

1   Press the **[F5]** "Config" key in measurement mode. This takes you to the "Minimal setup menu" (menu 7).

1   Select "Curve analysis" and press **[Enter]**.

2   This takes you to the "Data logger curve selection (logger active)" menu (menu 70), which displays the list of curves available in the data logger for selection.

3 Press "Num!" **[F4]** to switch to the "Data Logger Numeric Display" menu.

P 0 Line7_ST-A	Menu 71
Data Logger Numeric Display	
Measurement number	0
Total evaluation	OK
Measurement program	0
Number of readings	246
Return point (index)	245
Setup changed	91 (valid)
Date/time	22/08/2018 -- 08:39:38
Start X	0.00000 mm
Start Y1	1.11518 N
Start Y2	5000.00 Ohm
Return X	13.2111 mm
Return Y1	50.3755 N
Return Y2	8.95529 Ohm
Final X	13.2111 mm
	Select.

4 Select an active evaluation element and press **[Enter]** to display the OK/NOK result and additional values.

P 0 Line7_ST-A	Menu 71
Data Logger Numeric Display	
Return point (index)	245
Setup changed	91 (valid)
Date/time	Results Window 1 8:39:38
Start X	
Start Y1	Evaluation: OK
Start Y2	Entry (x) 5.29000 mm
Return X	Entry (y) 16.5247 N
Return Y1	Exit (x) 9.52139 mm
Return Y2	Exit (y) 14.3376 N
Final X	
Final Y1	Enter
Final Y2	8.95529 Ohm
Window 1	Y1
Window 2	Off
	Select.

Note: If you have made changes to the device configuration after a measurement, the "Data Logger Numeric Display" menu (menu 71) displays the message "INVALID" in a red box. In this case the displayed results may no longer correspond to the current device configuration and therefore may be invalid or erroneous.

9 Signal timing diagrams

9.1 Selecting a measurement program

9.1.1 Changing the measurement program without program acknowledgement
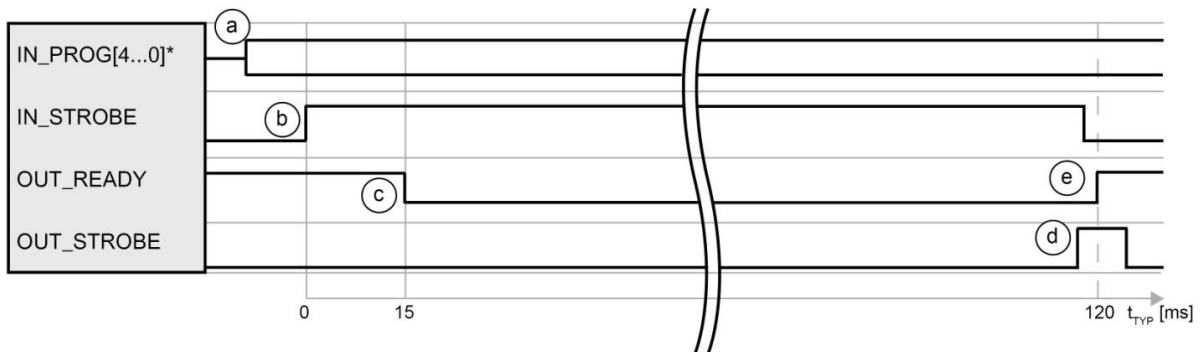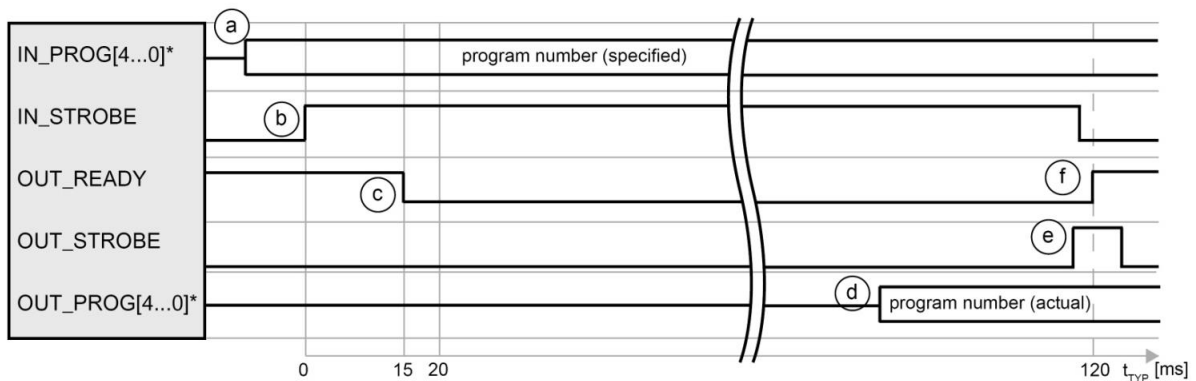

* IN_PROG[6..0] for 128 measurement programs.

Cycle

a. The controller writes the required program number (coded in binary) to the address inputs and checks whether the DIGIFORCE® 9307 is ready (OUT_READY =1).

b. The controller sets the strobe signal (IN_STROBE = 1) for transferring the program number.

c. On detecting the strobe signals, the DIGIFORCE® 9307 sets the READY signal to "0". Once processing is finished, it sets the signal back to "1".

d. At the end of the program-selection cycle, the DIGIFORCE® 9307 enables the output signal OUT_STROBE as the acknowledgment for the external PLC. If the PLC identifies the signal OUT_STROBE from the 9307 the IN_STROBE signal can be reset (IN_STROBE = 0).

e. As soon as the complete cycle has finished, the DIGIFORCE® 9307 sets the READY signal back to "1". Following the withdrawal of the IN_STROBE signal the OUT_STROBE signal will be reset to "0".

Tip

You can hard-wire unused address inputs (IN_PROG[]) to the reference ground.

9.1.2 Changing the measurement program with program acknowledgement

* IN_PROG[6..0] and OUT_PROG[6...0] for 128 measurement programs. You can define a user-configurable PLC output for the signal "OUT_PROG[6..0]".

Cycle

a. The controller writes the required program number (coded in binary) to the address inputs and checks whether the DIGIFORCE® 9307 is ready (OUT_READY =1).

b. The controller transmits the strobe signal (IN_STROBE) for transferring the program number.

c. On detecting the strobe signals, the DIGIFORCE® 9307 sets the READY signal to "0".

d. The DIGIFORCE® 9307 refreshes the echoed program number at the address outputs (OUT_PROG[4..0]*) with the chosen program.

e. At the end of the program-selection cycle, the DIGIFORCE® 9307 enables the output signal OUT_STROBE. If the PLC identifies the signal OUT_STROBE from the 9307, it can assume and validate the acknowledged program number OUT_PROG[4…0]* from DIGIFORCE® 9307.

f. As soon as the complete cycle has finished, the DIGIFORCE® 9307 sets the READY signal back to "1". Following the withdrawal of the IN_STROBE signal the OUT_STROBE signal will be reset to "0".

Tip

You can hard-wire unused address inputs (IN_PROG[]) to the reference ground.

9.2 Starting / stopping a measurement externally

You also have the option of using internal events to start a measurement in the DIGIFORCE® 9307 and stopping them independently. You can configure the settings for this in the Measurement mode configuration menu (see section 6.7.4 "Start/Stop mode" on page 112).

9.2.1 Without measurement data logging

Standard measurement cycle without measurement data logging via the communications port (Ethernet, USB, RS232). For a PROFIBUS connection, all results are available the moment that "OUT_READY" = 1.
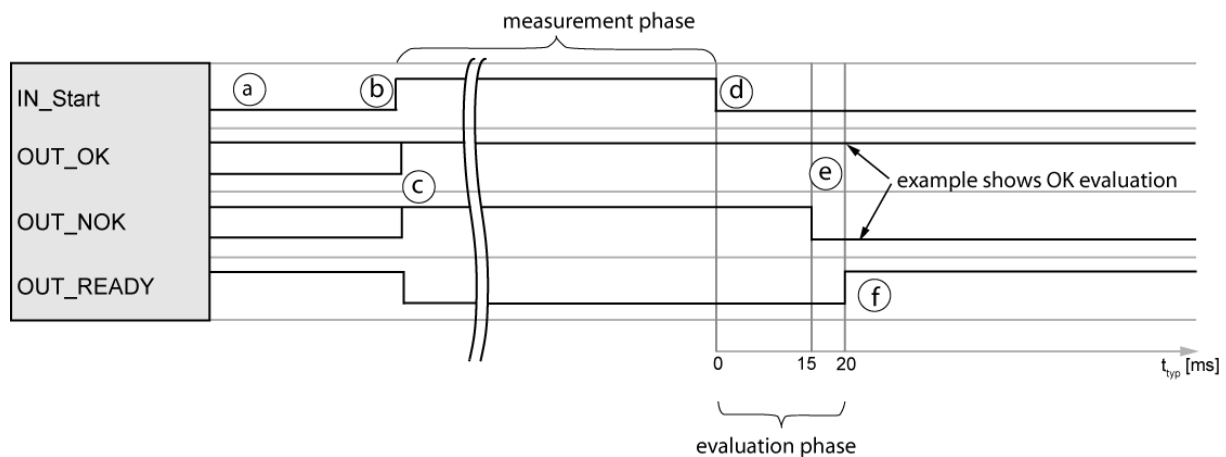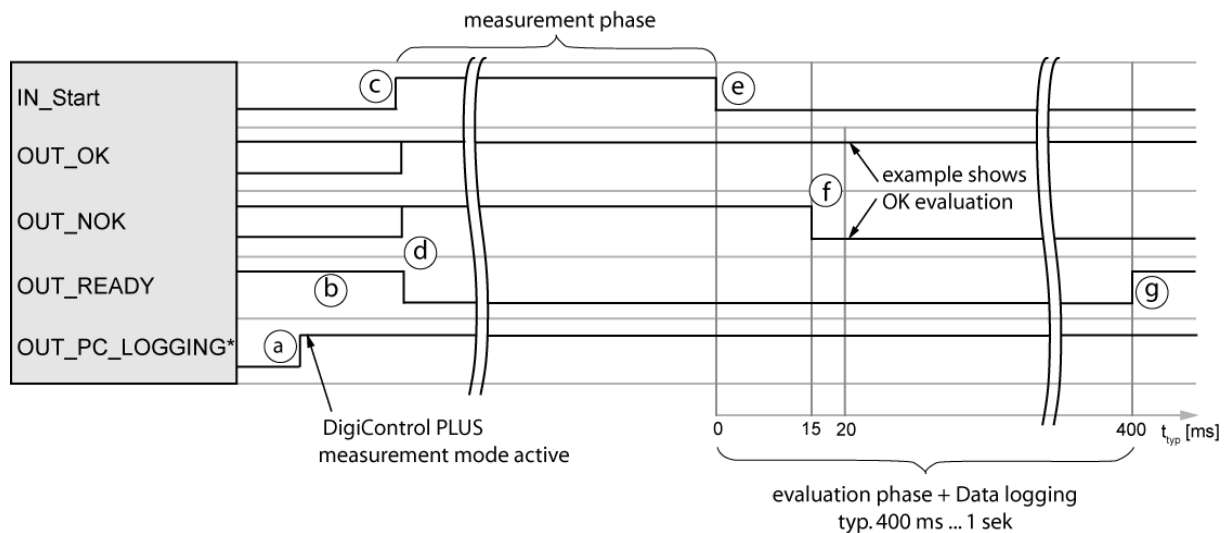

Cycle

    a.   The PLC checks whether the DIGIFORCE® 9307 is ready (OUT_READY =1).

    b.   The PLC starts the measurement with "IN_START" = 1.

    c.   During the measurement phase, the DIGIFORCE® 9307 sets the signals "OUT_OK" and "OUT_NOK" = 1 and "OUT_READY" = 0.

    d.   The PLC stops the measurement by setting the signal "IN_START" = 0.

    e.   The DIGIFORCE® 9307 updates the result during the evaluation phase:
OUT_OK = 1 and OUT_NOK = 0: OK measurement
OUT_OK = 0 and OUT_NOK = 1: NOK measurement

    f.   When the evaluation phase cycle has finished, the DIGIFORCE® 9307 sets the "OUT_READY" signal = 1 (in standby).

9.2.2   With measurement data logging

The DigiControl PLUS software for the DIGIFORCE® 9307 lets you log the data automatically after each measurement. When data logging is enabled, the "OUT_READY" signal, which tells you that the instrument is in standby and ready for measurements, is not set until data transmission is complete. The length of time required for data logging depends on the choice of communications interface and on the size of the measurement curve. The data logging period shown in the signal timing diagram is the time typically taken when the Ethernet port is used.

* You can define a user-configurable PLC output for the signal "OUT_PC_LOGGING".

Cycle

a. At the start of the measurement phase, DigiControl PLUS (PC software) sets the signal "OUT_PC_LOGGING" = 1.

b. The controller (PLC) checks whether the DIGIFORCE® 9307 is ready (OUT_READY =1).

c. The PLC starts the measurement with "IN_START" = 1.

d. During the measurement phase, the DIGIFORCE® 9307 sets the signals "OUT_OK" and "OUT_NOK" = 1 and "OUT_READY" = 0.

e. The PLC stops the measurement by setting the signal "IN_START" = 0.

f. The DIGIFORCE® 9307 updates the result during the evaluation phase:
OUT_OK = 1 and OUT_NOK = 0: OK measurement
OUT_OK = 0 and OUT_NOK = 1: NOK measurement

g. When the evaluation phase cycle has finished, the DIGIFORCE® 9307 sets the "OUT_READY" signal = 1 (in standby).
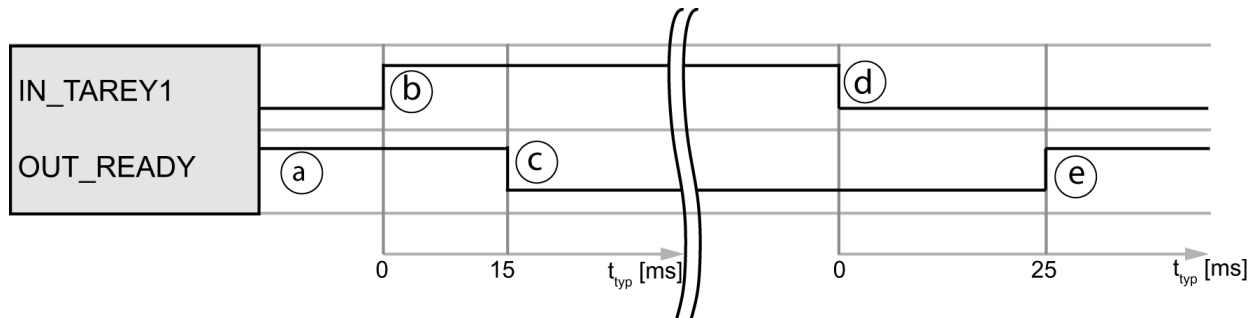
Tip

To optimize cycle times, the PLC can retrieve the OK/NOK evaluation immediately after the measurement rather than waiting for the READY signal, which it can check before the next measurement.

9.3 External tare

9.3.1 Without tare warning

Standard cycle without monitoring of tare warning limit; measuring channel "Y1" used as example.

Cycle

a. The PLC checks whether the DIGIFORCE® 9307 is ready (OUT_READY =1).

b. The PLC starts the tare process with "IN_TAREY1 = 1".

c. The DIGIFORCE® 9307 then sets "OUT_READY" = 0.

d. On detecting "OUT_READY = 0", the PLC can withdraw the tare request ("IN_TAREY1" = 0).

e. On completing the cycle, the DIGIFORCE® 9307 sets "OUT_READY" = 1 (in standby).

9.3.2 With tare warning

For strain gage channels, the DIGIFORCE® 9307 can generate a warning if the sensor signal being tared exceeds a definable threshold. You can enable and set this threshold in the Channel setup menu for strain gage sensors (further details are given in section 6.6.4 "Strain gage sensors" on page 78).
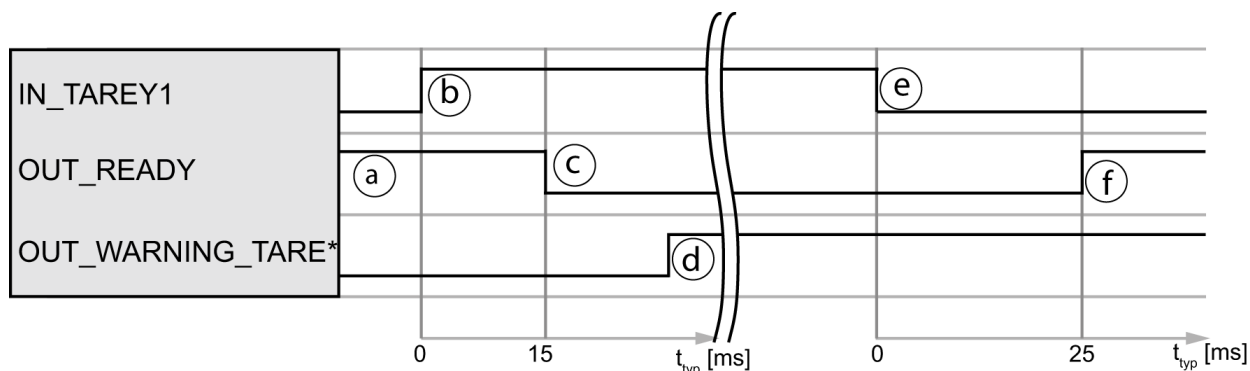
* You can define a user-configurable PLC output for the signal "OUT_WARNING_TARE".
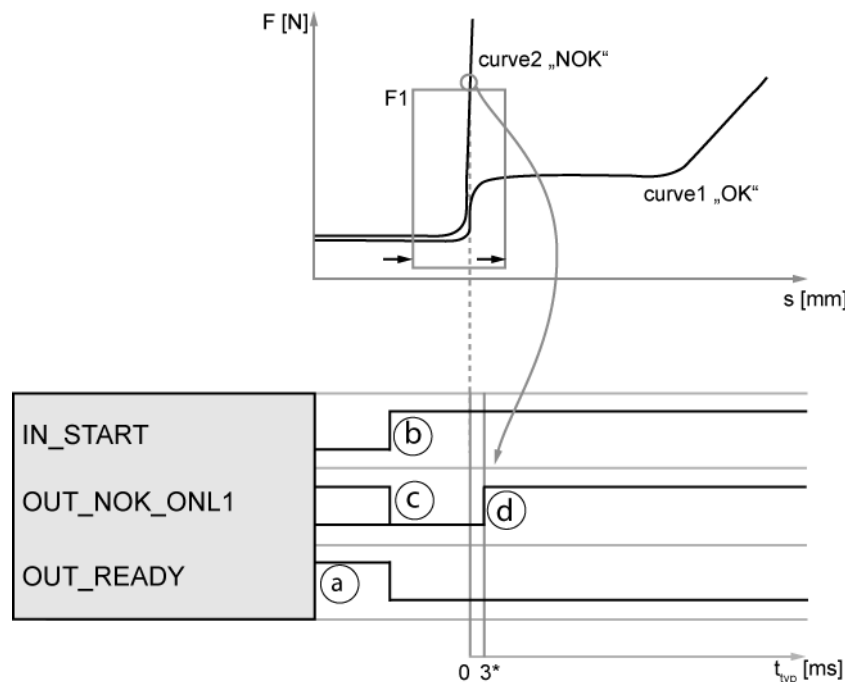
Cycle

    a. The PLC checks whether the DIGIFORCE® 9307 is ready (OUT_READY = 1).

    b. The PLC starts the tare process with "IN_TAREY1 = 1".

    c. The DIGIFORCE® 9307 then sets "OUT_READY" = 0.

    d. If the online sensor signal exceeds the set warning limit, the DIGIFORCE® 9307 sets the output OUT_WARNING_TARE.

    e. On detecting "OUT_READY = 0", the PLC can terminate the tare process with "IN_TAREY1".

    f. When the cycle is finished, the DIGIFORCE® 9307 sets "OUT_READY" = 1 (in standby). The PLC can now evaluate the warning output "OUT_WARNING_TARE".

9.4 Online signals

9.4.1   Window evaluation with online signal

For the "Window" evaluation element, you can specify that the DIGIFORCE® 9307 enables the online signal "OUT_NOK_ONL1" or "OUT_NOK_ONL2" if a window evaluation criterion is infringed. This function is often used to monitor the initial-contact region of press-fit curves.

If the curve exits the window incorrectly, for instance because misalignment of the parts to be joined causes an unexpected rise in force, the DIGIFORCE® 9307 enables the online signal assigned to this window. This can be used to stop the press-insertion process early to pre-empt any damage to the equipment, tools or work pieces. The DIGIFORCE® 9307 resets the online signals "OUT_NOK_ONL1" and "OUT_NOK_ONL2" again once a new measurement starts.

* The signal sampling method used may increase the typical delay shown here.

Cycle

a. The PLC checks whether the DIGIFORCE® 9307 is ready (OUT_READY = 1).

b. The PLC starts the measurement with "IN_START" = 1.

c. During the measurement phase, the DIGIFORCE® 9307 sets "OUT_NOK_ONL1" = 0 and/or "OUT_NOK_ONL2" = 0.

d. If the evaluation window is infringed when online evaluation is being used, the DIGIFORCE® 9307 enables the online signal.

e. Valid transit (e.g. left to right without infringement): "OUT_NOK_ONL1" = 0 or "OUT_NOK_ONL2" = 0.

f. In the event of an infringement (e.g. exit through top of window), the DIGIFORCE® 9307 sets the respective online signal to "1" ("OUT_NOK_ONL1" = 1 or "OUT_NOK_ONL2" = 1).

9.4.2   Online switching signals S1 to S4

The DIGIFORCE® 9307 can enable the switching signals S1 to S4 in measurement mode and in setup mode if a measurement exceeds a set value.

⚠	⚠ **WARNING**
	NOT a substitute for safety devices and protective equipment
	The online switching signals S1 to S4 are NOT a substitute for safety devices and protective equipment. Use safety devices and protective equipment.

Note: The switching signals S1 to S4 do not meet the requirements of a safety switch. It is the duty of the owner of a complete system, such as a press, to fit the system with the required safety devices and to take necessary protective measures.

9.4.2.1   Switching signals for channel "X" with ABSOLUTE reference

The DIGIFORCE® 9307 sets a channel-X switching signal if the X-channel goes beyond the set X-channel value referred to the "Absolute" reference. When the channel goes below the set value, the DIGIFORCE® 9307 resets the signal back to its original level. In the "Absolute" reference case, the DIGIFORCE® 9307 uses the zero point of the configured sensor as the reference. For sensors that make relative measurements, the reference is usually taken as the start of the measurement.

The DIGIFORCE® 9307 can set/reset the signal in measurement mode when in standby (waiting to start measurement) and during an active measurement.
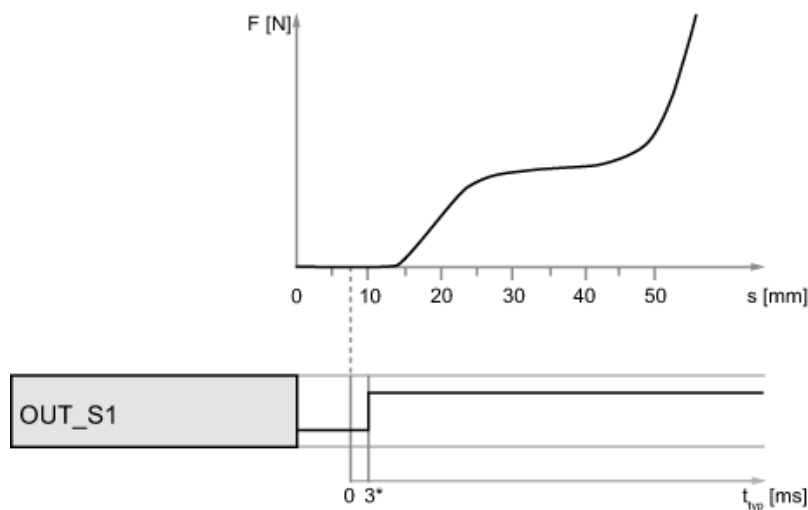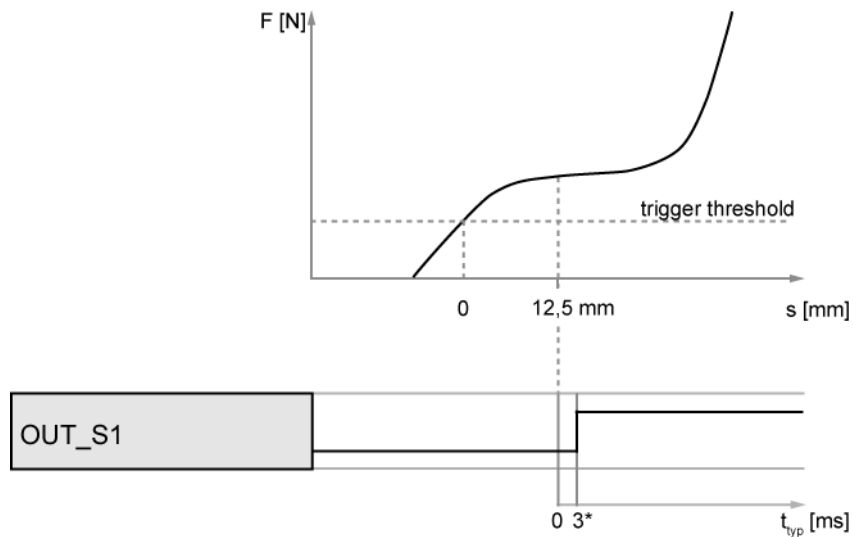

Configuration of "OUT_S1":	
Channel	X
Value	7.5 mm
	High Active
Reference	Absolute

* The signal sampling method used may increase the typical delay shown here.

9.4.2.2 Switching signals for channel "X" with TRIGGER reference

The DIGIFORCE® 9307 can only set/reset the switching signal for channel "X" with trigger reference during an active measurement, i.e. after the trigger event.

The reference used for channel "X" is the trigger event, for instance this may be the contact force of a press ram on a component.
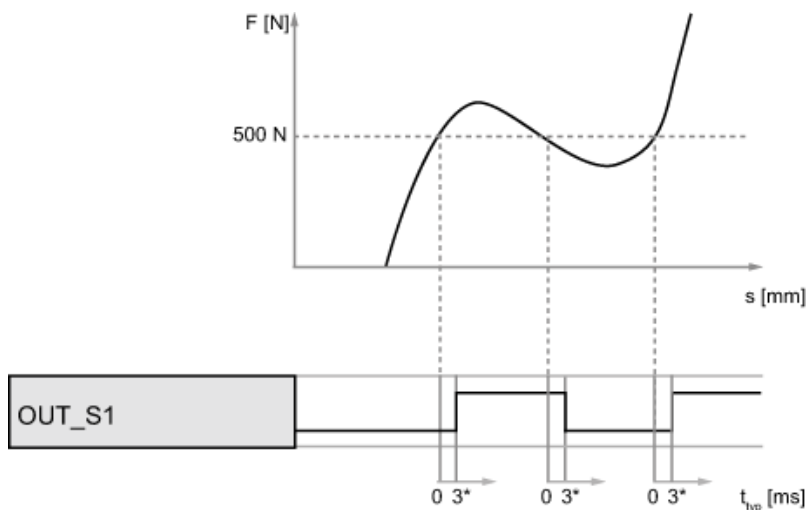

Configuration of "OUT_S1":	
Channel	X
Value	12.5 mm
	High Active
Reference	Y-trigger

* The signal sampling method used may increase the typical delay shown here.

9.4.2.3 Switching signals for channel "Y"

The DIGIFORCE® 9307 sets a channel-Y switching signal when the Y-channel exceeds the specified Y-channel value. When the channel goes below the set value, the DIGIFORCE® 9307 resets the signal back to its original level. The signal can be set/reset in measurement mode when in standby (waiting to start measurement) and during an active measurement.

| Configuration of "OUT_S1":	
Channel	Y
Value	500 N
	High Active

* The signal sampling method used may increase the typical delay shown here.

9.5 Acknowledgement function

You can use the signal-light function with the DIGIFORCE® 9307 to control indicator lights and a buzzer for direct visual and acoustic signaling of the OK/NOK evaluation. In addition, the DIGIFORCE® 9307 can handle an acknowledge input for OK and/or NOK components where this is required. This acknowledge function is combined with the lock output "OUT_ACK_LOCK".

9.5.1 Example of a NOK evaluation using following parameter settings

"Acknowledgement function" configuration	
Acknowledgement function	ON
Acknowledge OK parts	OFF
Acknowledge NOK parts	ON
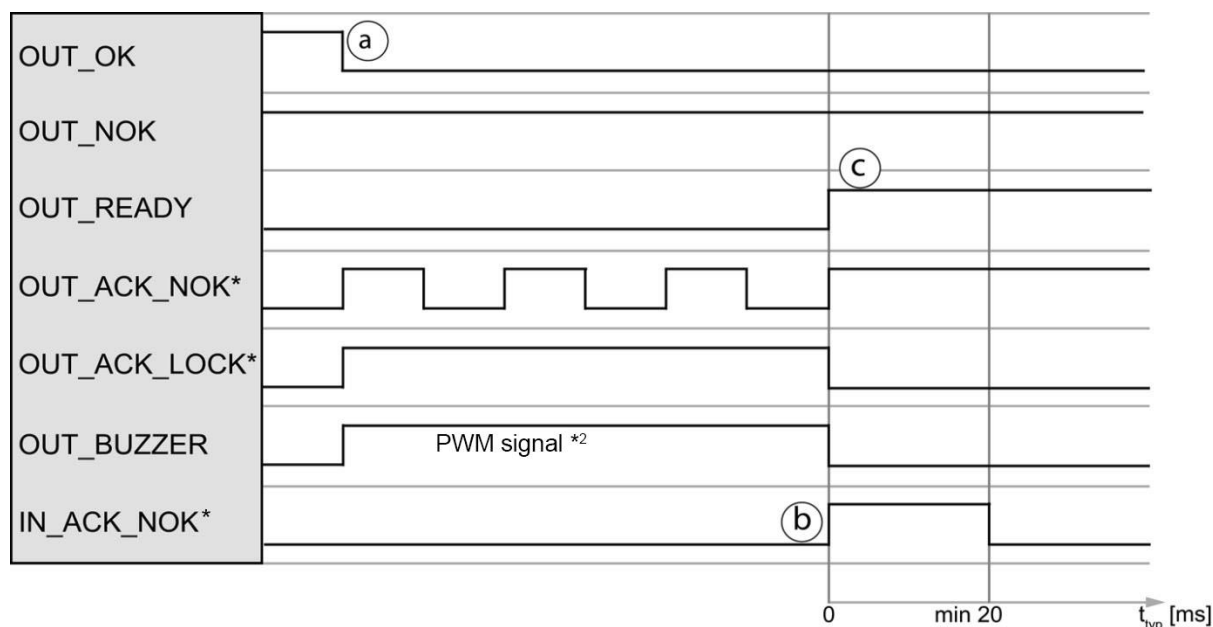
* You can define a user-configurable PLC output for the signals "OUT_ACK_NOK" and "OUT_ACK_LOCK".
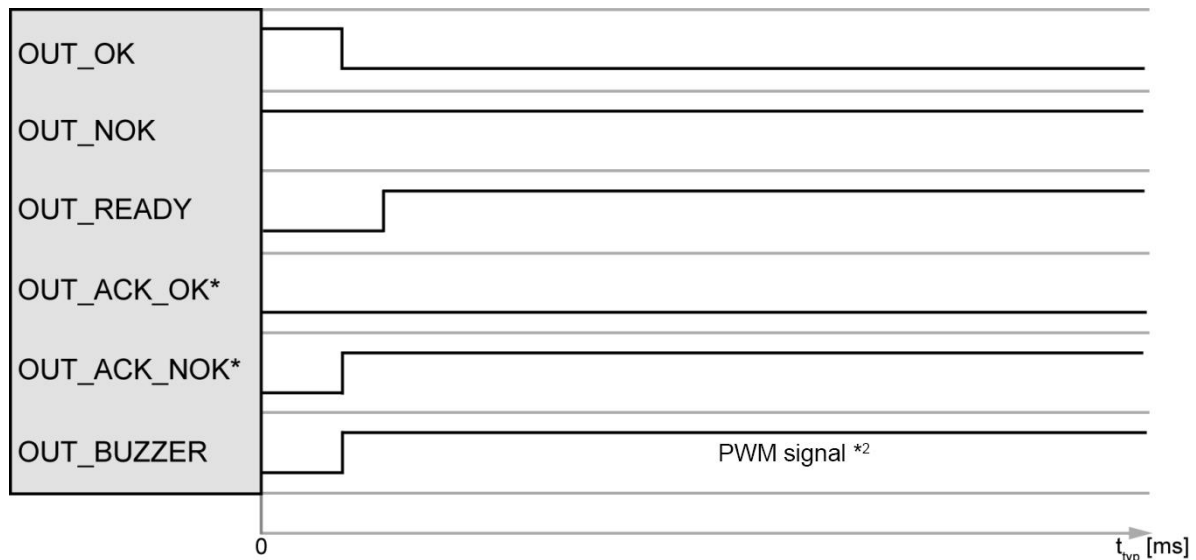
*2 The "OUT_BUZZER" signal is pulse-width modulated to allow volume adjustment of a connected piezoelectric buzzer (see section 6.3.10 "Acknowledgement function" on page 69).

Cycle

a. During the evaluation phase following a measurement, the DIGIFORCE® 9307 refreshes the control signals for the evaluation "OUT_OK" and "OUT_NOK" (in this case OUT_NOK = 1). In addition, the DIGIFORCE® 9307 enables the signal-light signal "OUT_ACK_NOK" (flashing), the lock output "OUT_ACK_LOCK" = 1 and the buzzer output "OUT_BUZZER" (PWM signal).

b. As soon as the DIGIFORCE® 9307 detects the acknowledgement from the user via the signal "IN_ACK_NOK" = 1, it sets the signal-light signal "OUT_ACK_NOK" to 1 (solid light). The DIGIFORCE® 9307 simultaneously sets the lock output "OUT_ACK_LOCK" to 0 and the buzzer output "OUT_BUZZER" to 0.

c. When the cycle is finished, the DIGIFORCE® 9307 sets "OUT_READY" to 1 (in standby). The signal-light signal "OUT_ACK_NOK" remains active until the start of the next measurement.

9.5.2 Example of a NOK evaluation (without acknowledgement)

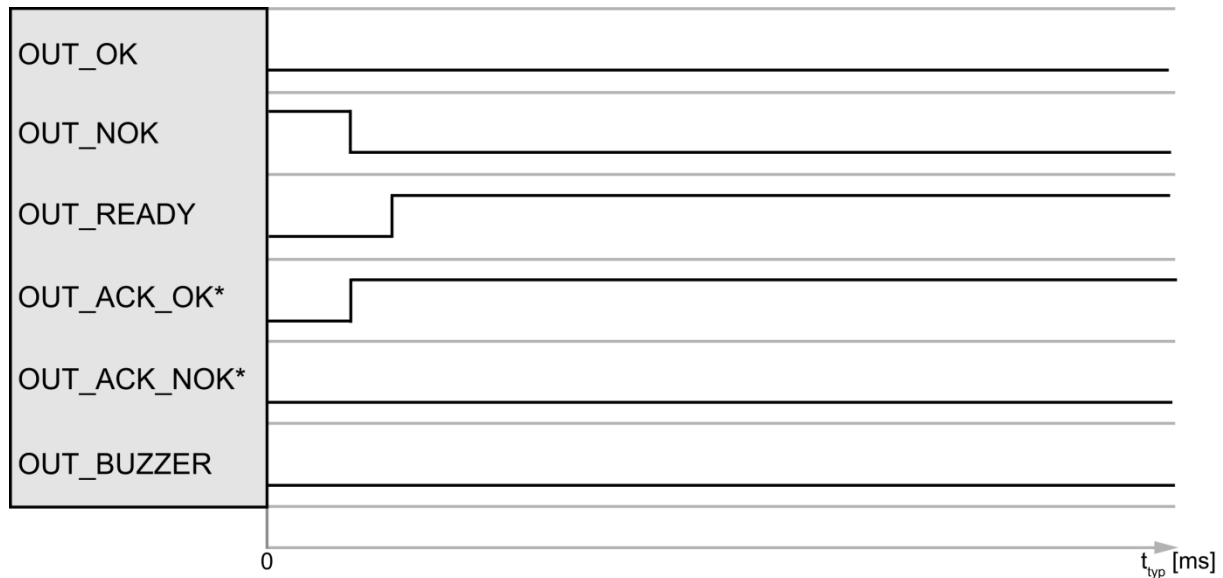| Configuration	
Acknowledgement function	ON
Acknowledge OK parts	OFF
Acknowledge NOK parts	OFF

* You can define a user-configurable PLC output for the signals "OUT_ACK_NOK" and "OUT_ACK_LOCK".

*2 The "OUT_BUZZER" signal is pulse-width modulated to allow volume adjustment of a connected piezoelectric buzzer (see section 6.3.10 "Acknowledgement function" on page 69).

9.5.3 Example of an OK evaluation (without acknowledgement)

Configuration	
Acknowledgement function	ON
Acknowledge OK parts	OFF
Acknowledge NOK parts	OFF

* You can define a user-configurable PLC output for the signals "OUT_ACK_NOK" and "OUT_ACK_LOCK".


9.6 External actuation of a statistics reset

You can use the "IN_RESET" control signal to reset the piece counter and NOK counter and to reset the statistics from the evaluation elements. The DIGIFORCE® 9307 resets the statistics from all the measurement programs in this case.

The following values are reset by this function:

- Piece counter and NOK counter for all measurement programs
- NOK percentage for individual evaluation elements.
- Trend and histogram data for individual evaluation elements
- Shift counter (job sheet)

The function "Reset statistics" does not affect the reading of the total tool counter, which records the measurements from all the measurement programs. For more information on the total tool counter, see section 5.3.3 "Controlling the measurement display menus" on page 55.
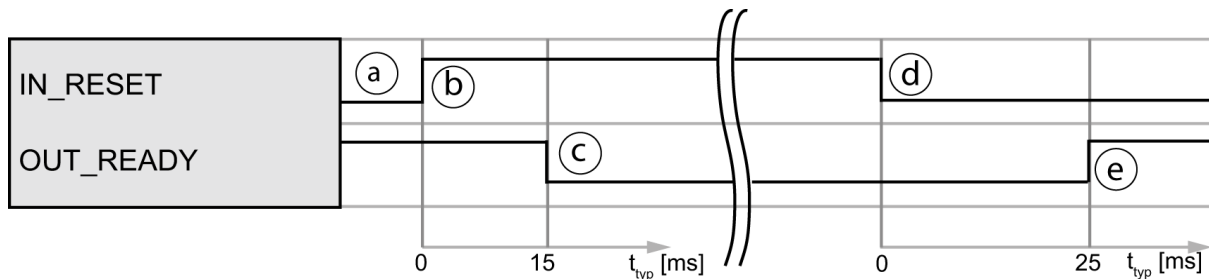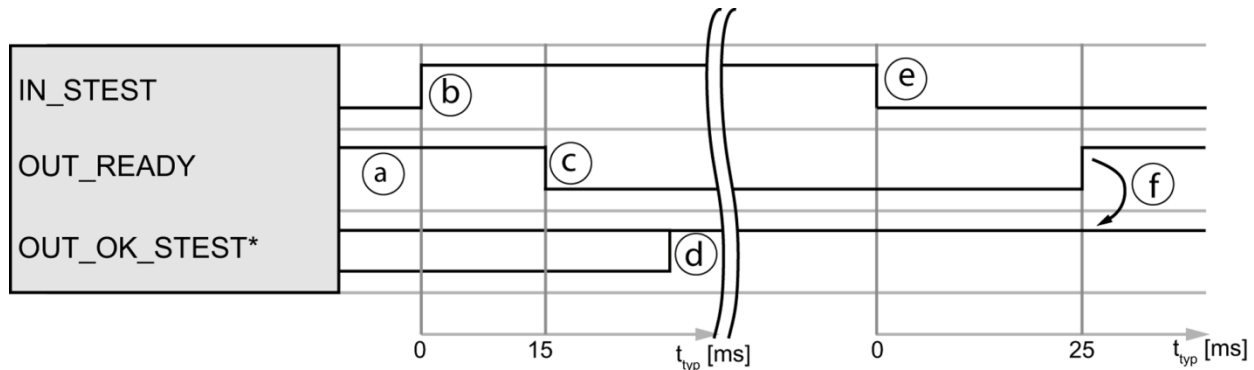

Cycle

a. The PLC first checks whether "OUT_READY = 1" (instrument ready).

b. The PLC starts the reset process with "IN_RESET = 1".

c. The DIGIFORCE® 9307 then sets OUT_READY = 0.

d. On detecting "OUT_READY = 0", the PLC can withdraw the reset request with "IN_RESET" = 0.

e. When the cycle is finished, the DIGIFORCE® 9307 sets "OUT_READY" = 1 (in standby).

9.7 External actuation of sensor test

You can use the "IN_STEST" signal to run the sensor test configured in the DIGIFORCE® 9307. You can configure the sensor test to check the sensor signals from the measurement channels X, Y_1 and Y_2 against a saved value, including a definable tolerance.

* You can define a user-configurable PLC output for the signal "OUT_OK_STEST".

Cycle

    a. The PLC first checks whether "OUT_READY = 1" (instrument ready).

    b. The PLC starts the sensor test with "IN_STEST = 1".

    c. The DIGIFORCE® 9307 then sets "OUT_READY" = 0.

    d. The DIGIFORCE® 9307 refreshes the sensor test result:
       "OUT_OK_STEST = 0"   sensor test = NOK
       "OUT_OK_STEST = 1"   sensor test = OK

    e. On detecting "OUT_READY = 0", the PLC can terminate the process with "IN_STEST = 0".

    f. On completing the cycle, the DIGIFORCE® 9307 sets "OUT_READY" = 1 (in standby); the PLC can now evaluate the result "OUT_OK_STEST".

## 9.8 Reference travel – incremental sensors

For incremental sensors with distance coding you can use the reference travel function to find the absolute sensor position. For this task you need to travel over two adjacent reference marks so that the DIGIFORCE® 9307 can determine the current absolute position.

You need to use the control signals "IN_REF_MEAS" and "OUT_REF_MEAS_OK" to find the absolute position during the reference travel.

Even for multi-point incremental sensors (sensors that have multiple reference marks), it is possible for you to use the reference travel function to travel over the reference marks and thereby set the internal counter to a defined position. In this case each reference pulse results in the counter being set.

In measurement mode, the DIGIFORCE® 9307 does not evaluate the travel across reference marks.

Successful reference travel
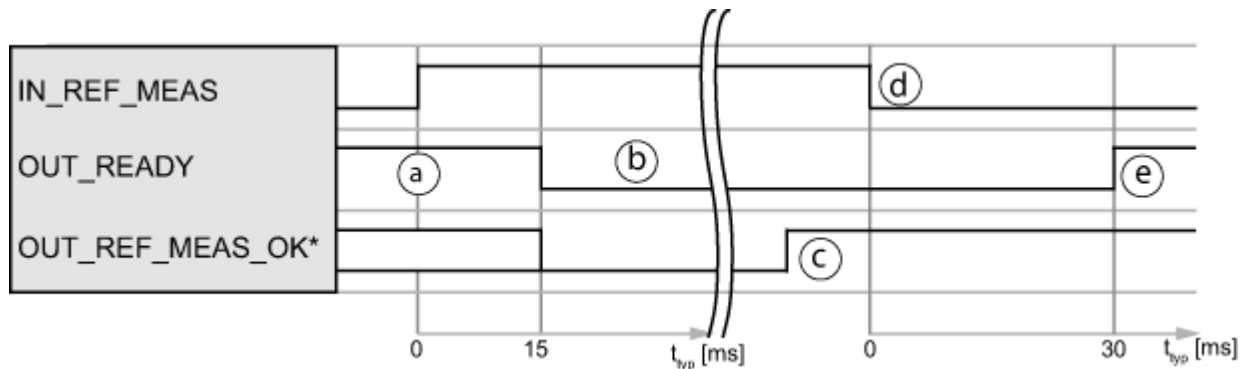
Invalid reference travel
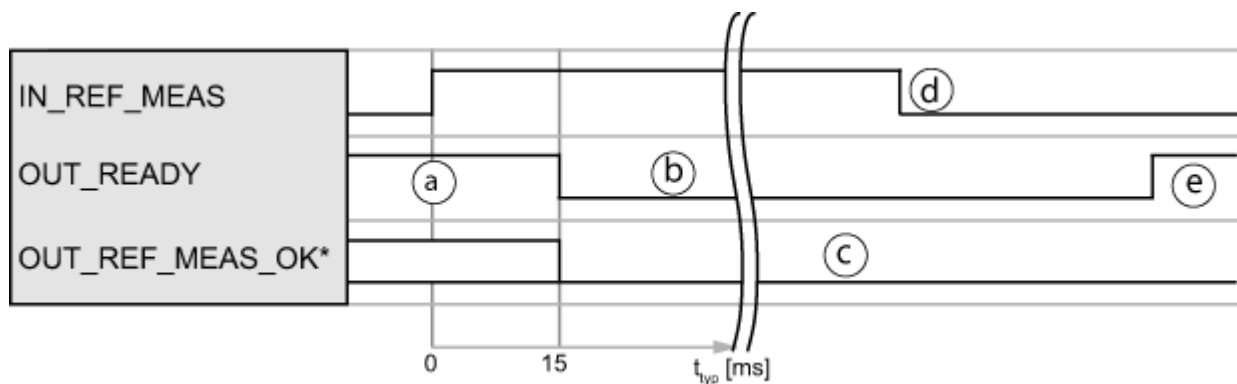
* You can define a user-configurable PLC output for the signal "OUT_REF_MEAS_OK".

In this example of a reference travel cycle, the sensor has reached only one reference mark. For a valid i.e. successful reference travel cycle, however, the sensor would need to have reached at least two reference marks.

Cycle

a. The PLC first checks whether "OUT_READY = 1" (instrument ready) and then sets the signal "IN_REF_MEAS" = 1.

b. The PLC initiates a reference travel operation (e.g. initial travel of press ram).

c. As soon as the DIGIFORCE® 9307 has measured the current absolute position, the output "OUT_REF_MEAS_OK" is set to 1. If it is not possible to find an absolute position, "OUT_REF_MEAS_OK" remains at 0 (timeout managed via PLC).

d. The PLC can then withdraw the "IN_REF_MEAS" request.

e. On completing the cycle, the DIGIFORCE® 9307 sets "OUT_READY" = 1 (in standby).

Tip

Perform a reference travel operation at a lower travel speed to avoid an incorrect measurement of the absolute position.

10 Customer Services for your DIGIFORCE® 9307

To complement the DIGIFORCE® 9307 package you have purchased, burster praezisionsmesstechnik gmhb & co kg offers the following customer services centred on the DIGIFORCE® family:

- On-site support for preparing the instrument for use

- Product training (burster in-house or on-site)

- Initial calibration and recalibration, including sensors

To inquire about our customer services for your DIGIFORCE® 9307, please telephone our Service department on +49-7224-645-53, or email: service@burster.com (Germany only). If you are outside Germany, you should contact your burster agent (see also www.burster.com).

11   Technical data

Please refer to the data sheet for the technical specification. You can obtain the latest data sheet and additional information on the DIGIFORCE® 9307 from https://goo.gl/7ZqwZN or simply use the QR code below:

11.1   Electromagnetic compatibility

11.1.1   Interference immunity

Interference immunity in compliance with EN 61326-1:2013

Industrial environment

11.1.2   Interference emission

Interference emission in compliance with EN 61326-1:2013

12 Accessories available

Please refer to the data sheet for the accessories available. You can obtain the latest data sheet and additional information on the DIGIFORCE® 9307 from https://goo.gl/7ZqwZN or simply use the QR code below:

12.1 Software

Please refer to the data sheet for the software. You can obtain the latest data sheet and additional information on the DIGIFORCE® 9307 from https://goo.gl/7ZqwZN or simply use the QR code below:

13 Disposal

Battery disposal

In Germany, the end user is legally obliged to return all used batteries, and it is illegal to dispose of batteries in the household waste. This law may also affect you as purchaser of the instrument described here. Please dispose of your used batteries properly and in accordance with national statutory regulations. Either take them to the relevant collection point in your organisation or to the collection points provided by your local authority, our company or any battery retail outlet.

To avoid short circuits, mask the poles of the batteries for storage and disposal.

Instrument disposal

If your instrument is no longer usable, please comply with your legal obligations by disposing of the instrument described here in accordance with statutory regulations. You will then be helping to protect the environment!