OPERATION MANUAL

Torque sensor
model 8661

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Präzisionsmessgeräte, Sensoren und Messsysteme
für elektrische, thermische und mechanische Größen

QM-System zertifiziert ISO 9001

Konformitätserklärung (nach EN ISO/IEC 17050-1:2010)

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, 76593 Gernsbach, Germany
Issuer's address:

Gegenstand der Erklärung: Präzisions-Drehmomentsensor, rotierend
Object of the declaration: *Precision Torque Sensor for rotating applications*

Modellnummer(n) (Typ): 8661
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/Ausgabedatum** *Edition/Date of issue*
2006/95/EC	Elektrische Betriebsmittel zur Verwendung innerhalb bestimmter Spannungsgrenzen *Electrical Equipment designed for use within certain voltage limits*	2006
2004/108/EC	Elektromagnetische Verträglichkeit *Electromagnetic Compatibility*	2004
EN 61010-1	Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte, Messkategorie 1, Schutzklasse III *Safety requirements, CAT 1, Safety class 3*	2001
EN 31326-2-3	Elektrische Mess-, Steuer-, Regel- und Laborgeräte – Klasse A *EMC Generic emission*	2006
EN 61326-2-3	Elektrische Mess-, Steuer-, Regel- und Laborgeräte - EMV-Anforderungen - Teil 2-3: Messgrößenumformer mit integrierter oder abgesetzter Signalaufbereitung – industrielle Umgebung *EMC Generic immunity*	2006

Zusätzliche Angaben:
Additional information:

Das Produkt wurde in einer typischen Konfiguration getestet.
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Gernsbach	11.02.2011	i.V. Christian Karius
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1. For your safety

1.1 Warnings and Notes

The symbol on the instrument denotes that the user should refer to the operating instructions

DANGER!

in this manual warns of immediate hazards which result in severe personal injury or death.

WARNING!

in this manual refers to a hazard or unsafe practice which can result in severe personal injury or death.

CAUTION!

in this manual refers to a hazard or unsafe practice which can result in personal injury or product or property damage.

Note

This indicates precautions which should be observed to ensure proper handling of the equipment

1.2 General warnings

The torque sensor is state of the art, and is safe to operate. However, if the torque sensor is used or operated incorrectly, it may present a danger.

WARNING

The following instructions must be followed to prevent electric shock and injuries:

- ➔ In order to achieve high measuring characteristic value, the torque sensor is **not** designed with the usual safety factors (2…20) for machine designs. For applicable overload factors, see the technical data (data sheet).
- ➔ Observe accident prevention regulations, including for accessories used.
- ➔ Use torque sensor only in **non-safety-critical applications.**
- ➔ Only use torque sensor **outside** of **potentially explosive areas** (Ex protected areas)

CAUTION!

The following points must be observed to prevent injuries and damage to property:

- The limits for permissible mechanical, thermal and electrical loads are shown in the data sheet. These limits must not be exceeded. Take these limits into account when planning the measuring arrangement, and during installation (preferably with the display for the torque connected) and operation.
- Impacts and shocks may damage the sensor (e.g. if it is dropped). Exercise the necessary care when transporting and fitting the sensor.
- Torque peaks in excess of the permissible overload may destroy the torsion shaft. Make sure that such peaks do not occur, or ensure that they are absorbed.

2. Introduction

2.1 Intended use

The torque sensor measures static and dynamic torques on rotating or stationary machine parts in either direction of rotation. You have the option of measuring rotational speed or angular displacement. The respective upper range value is shown on the type plate.

Both the low mass of the sensor and its high torsional rigidity are an advantage when measuring dynamic torques. However, you need to pay attention to the torsion spring constant and the sensor's cut-off frequency with such measurements. You can find both of these in the data sheet. For more information on estimating the resonant frequency and measuring dynamic torques see section "0
Dynamic torques“ on page 34.

The torque sensor is maintenance-free thanks to its contactless transmission of the measurement signal. The electrical measurement signals can be transmitted to remote measuring stations where they can be displayed, recorded, processed and used for control and regulation tasks.

Use the type 8661 torque sensor only for measuring torque and rotational speed or angular displacement.

Only use the torque sensor for **non-safety-critical applications**.

The torque sensor is **not intended for use as a safety device.**

2.2 Personnel

Personnel must be familiar with the respectively applicable regulations. They must follow these regulations.

2.3 Operating environment

- Avoid radiant heat or cooling on one side.
- Protect the torque sensor from damp.
- The torque sensor is **not** resistant to chemical agents. Only use it **outside** of aggressive environments.
- Keep the bearings and connectors free of dust, dirt and other foreign matter.

2.4 Conversions and modifications

If you open up the torque sensor or dismantle it during the warranty period, the warranty will be **immediately** voided.

The torque sensor may only be opened by our technical personnel.

We will not accept liability for any modifications made to the torque sensor without our written agreement.

2.5 Definitions

Test side

The measurement test is where the torque sensor is mechanically connected. Apply the torque to be measured to this end of the sensor.

This end normally has the smallest moment of inertia. Torque sensors with measuring ranges up to 2 Nm have a smaller and therefore lower-friction ball bearing fitted at this end.

You will see these markings on the measurement end of the sensor:

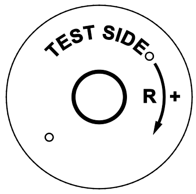

fig. 1.: Sensor Test side

Drive side :

The drive end is the opposite end to the measurement end. The torque sensor is also mechanically connected at this end.

This end normally has the larger moment of inertia.

You will see these markings on the drive end of the sensor:

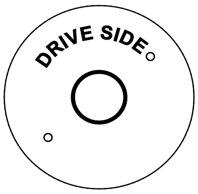

fig. 2.: Sensor Drive side

The torque direction

A torque is clockwise (clockwise torque) if the torque is exerted clockwise **when looking at the measurement end.** In this case you will get a positive electrical signal at the sensor output.

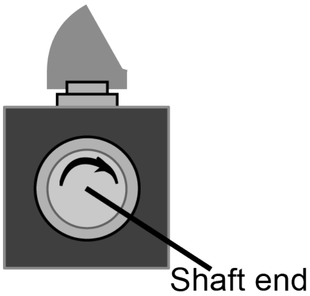

fig. 3.: Torque, clockwise (looking at the measurement end)

You can use model 8661 torque sensors to measure both clockwise and counterclockwise torques. If the torque is exerted in an anticlockwise direction (looking at the measurement end), you will get a negative signal at the output.

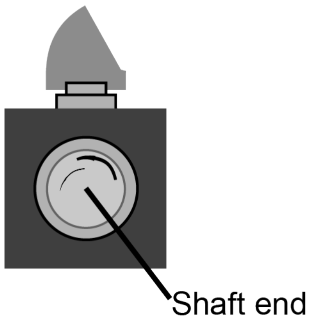

fig. 4.: Torque, anti clockwise (looking at the measurement end)

Sign convention for measuring angular displacement

If the sensor shaft rotates clockwise (**looking at the drive end**), channel A leads channel B by 90°.

If the sensor shaft rotates anticlockwise (looking at the drive end), channel B leads.

Static and quasi-static torques

Static and quasi-static torques change their value only slowly or not at all. As long as they are below the rated torque, these torques can take any value.

Dynamic torques

A dynamic torque changes very rapidly and can even oscillate. In this case the frequency of the torque must remain well below the resonant frequency of the mechanical structure as a whole.

We recommend that you only measure dynamic torques if they reach a maximum 70% of the rated torque.

When measuring dynamic torques, take the characteristics of your measuring amplifier into account.

For more information on estimating the resonant frequency and measuring dynamic torques, see the section 7.3 "Dynamic torques" on page 34.

3. Preparing for use

3.1 Unpacking

- Only transport the model 8625 sensors in their original packaging or in packaging of equivalent quality.
- The sensor must not be able to move within the packaging.
- Protect the sensor from damp.
- Inspect the sensor carefully for damages.

If you suspect that the unit has been damaged during shipping, notify the delivery company within 72 hours. The packaging should be retained for examination by a representative of the manufacturer and/or the delivery company.

3.2 Scope of delivery

- Torque sensor
- Mating connector
- Manual
- Data sheet

3.3 Storage

- Pack the sensor in clean packaging.
- Only store the sensor under the following conditions:
  - dry
  - no Condensation
  - Temperatures between 0° C and 60° C

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4. Principle of operation

4.1 Mechanical design

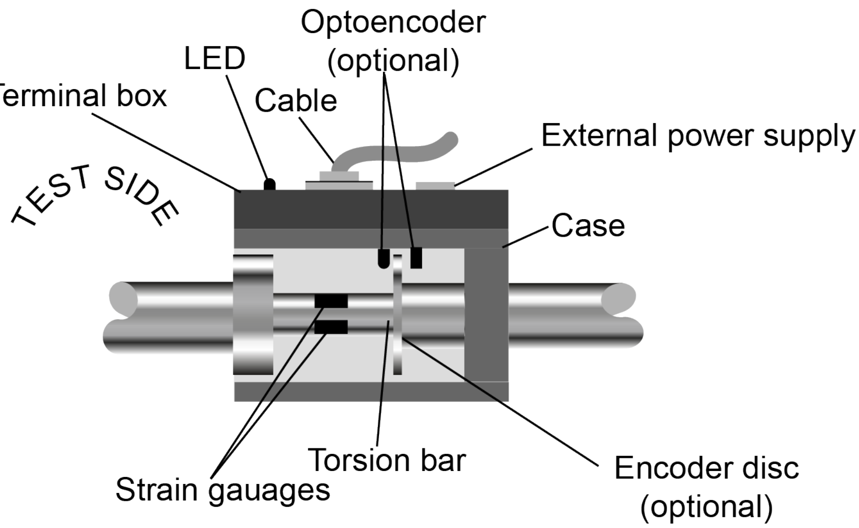

fig. 5.: Design principle of the torque sensor

The torque sensor essentially comprises three subassemblies: the body, the connection box and the rotor. The latter comprises the torsion bar, the strain gauges, the measurement amplifier and the power and signal transmission. If the torque sensor is fitted with the rotational speed or angular displacement option, an incremental encoder disk is also fitted for measuring rotational speed or angular displacement.

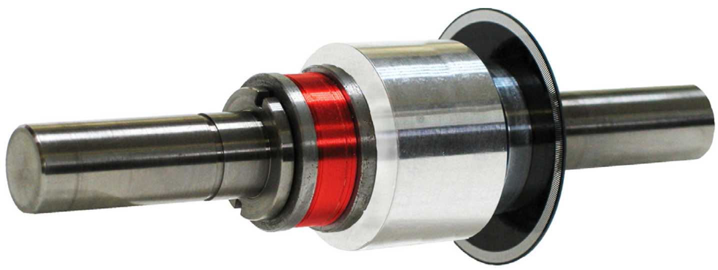

fig. 6.: Shaft from a sensor with rotational speed and angle measurement

In addition to the plug and the connection for the external power supply, the connection box also contains the electronics. The standard version supplies an output voltage that is proportional to the torque.

If the torque sensor is fitted with the “rotational speed” or “angular displacement” option, the standard version supplies a 5 V TTL signal. However, you can also use this output as an open collector output.

The body houses the rotor and two grooved ball bearings.

Speed/angular displacement measurement (option)

An opto encoder scans a rotating encoder disk. This incremental encoder disk is made from a transparent material with opaque lines on it. This design is basically a high-resolution and fast light barrier. In operation, it generates a certain number of electrical pulses with each rotation. The frequency of these pulses is therefore dependent on the rotational speed of the shaft and the number of lines on the encoder disk.

Depending on the model, encoder disks with a different number of lines may be fitted. The maximum pulse frequency is somewhat higher than 100 kHz

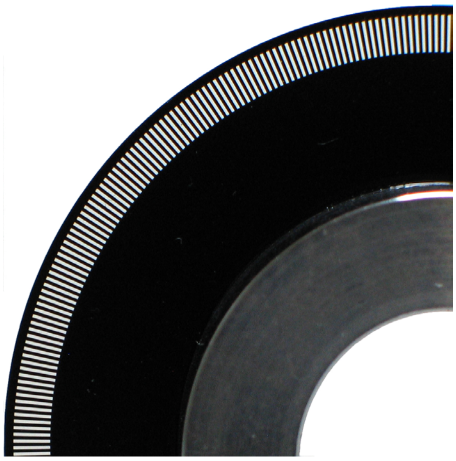

fig. 7.: Close-up view of the encoder disk

4.2 Electrical design

Torque measurement

Torque deforms the torsion shaft and, as it does so, also elastically and reversibly deforms the strain gauges that are fitted. Their electrical resistance changes proportionally to their deformation.

The torque sensor has a total of four strain gauges. These are arranged as a Wheatstone bridge circuit and are supplied with DC voltage by the sensor. The output voltage from the strain gauges is proportional to the measured torque. An amplifier multiplies this voltage before it is digitized by an analog/digital converter (16-bit resolution).

A 16-bit microprocessor processes these digital signals, encodes them and relays them to infrared LEDs, which send the signals to the stator as a serial light signal.

The stator receives this light signal and converts it back into electrical pulses before sending it to another microprocessor. This microprocessor controls a digital/analog converter which generates an analog voltage again (16-bit resolution). This analog voltage is the sensor's measurement signal. It is also proportional to the measured torque.

Rotational speed measurement (option)

An encoder disk generates a certain number of pulses, e.g. 1,024 pulses, for every revolution of the torsion shaft. To ensure that this signal does not exceed the output frequency of 100 kHz, the rotational speed should not exceed 100 revolutions per second. This is equivalent to 6,000 revolutions per minute.

Angular displacement measurement (option)

The principle of measuring angular displacement is the same as for measuring rotational speed. However, in this case the sensor reads two channels. The electrical pulses from the two channels A and B are offset by 90°, which also allows the shaft's direction of rotation to be identified.

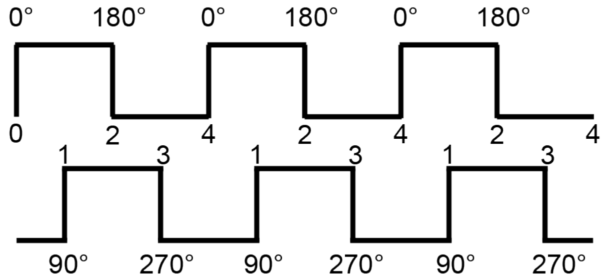

fig. 8.: Angular displacement measurement, channel offset 90°

To do this you have to evaluate the rising and falling pulse edges for both channels. Hence the angular resolution is four times the number of lines on the encoder disk. An encoder disk with 1,024 lines therefore gives a resolution of 360 / (4 x 1024) = 0.09°.

For more information on the sign convention, see section 2.5 "Definitions" on page 11.

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5. Installation

5.1 Preparing for installation

Shafts

- Use shaft diameters with tolerance j6.

  This results in an H7/j6 fit

Couplings and misalignments

Even if you align the sensor exactly, there will always be a small misalignment between the shafts.

- Therefore, when fitting a torque sensor, always use balanced couplings with misalignment compensation.
- Before fitting the coupling, check the speed it will be operating at.

  The respective couplings must be designed for these speeds.

We recommend using torsionally rigid lamellar couplings or bellows couplings which will enable you to compensate for the misalignments. Always use the coupling's full clamping length.

You can distinguish three misalignments. :

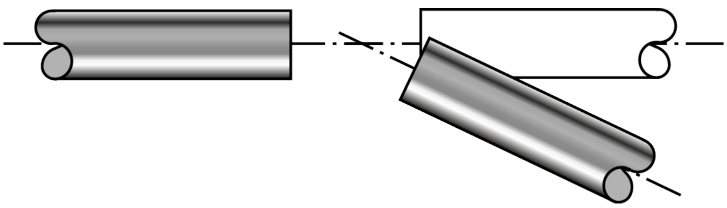

fig. 9.: Angular misalignment

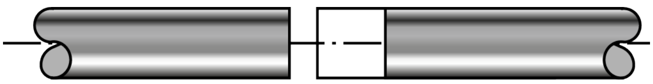

fig. 10.: Axial misalignment, e.g. due to thermal expansion

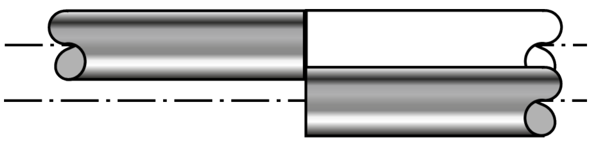

fig. 11.: Radial misalignment

Both angular and axial misalignments can be corrected using “half-couplings”. Full couplings are needed, however, to correct any radial misalignment To find suitable couplings refer to the datasheet 8690.

5.2 Mechanical installation

5.2.1 Free-floating installation

> **WARNING!**
>
> **Beware of vibrations!**
>
> **Operating the overall system close to its natural resonance frequencies will result in permanent damage!**
>
> **Make sure that NO resonance occurs throughout the entire speed range.**

The sensor is positioned between two balanced half-couplings. Installed in this way, the torque sensor and the two half-couplings form a full coupling. Hence it helps to compensate for the inevitable axial offset between the mechanical connections.

> **CAUTION**
>
> **Excessive torques, bending moments or axial forces will damage the torque sensor!**
>
> **Make electrical connections to the torque sensor during installation and monitor the measurement signal. It must stay within the permitted range.**
>
> **Support the sensor when fitting it.**
>
> **Do not drop the sensor.**
>
> **Do NOT use hammers during installation**

- Ensure that the sensor is aligned precisely.

  It is usually sufficient, at low rotational speeds (< 2000 min^{-1}), to align the coupling using a straight edge in two perpendicular planes. However, we recommend using a dial gauge or laser to align the coupling and shaft ends.
- Only use half-couplings for free-floating installation.

  (You'll find suitable couplings on datasheet 8690.)

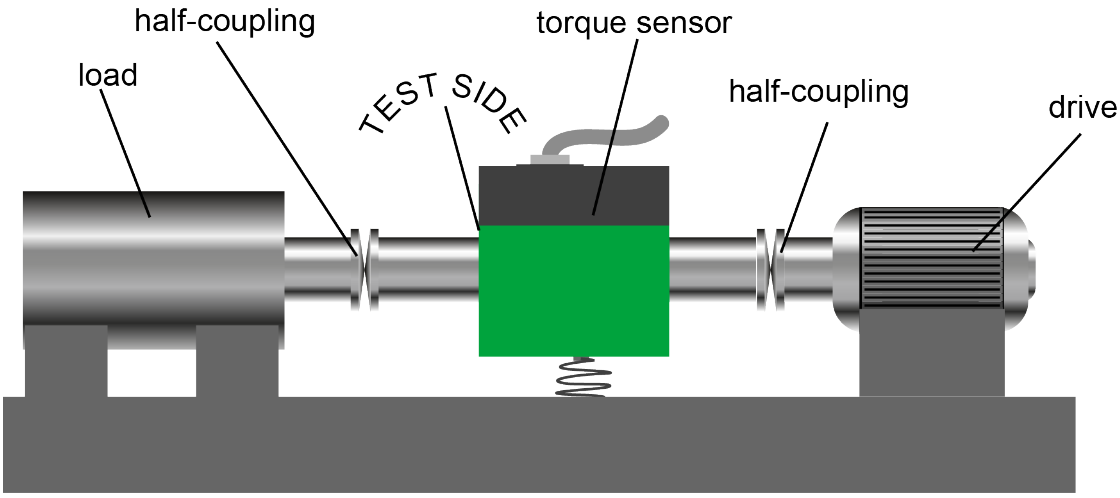

fig. 12.: Schematic measuring arrangement with free-floating installation

- Support the torque sensor or hold it still during installation.
- Clean and deburr shafts and hubs.

  There must be no foreign matter, burrs, oil or grease on the shafts or hubs when fitted.
- Now slide the half-couplings onto the shafts.

  Start on the side that is easier to turn. Usually this will be the measurement side.

  The half-couplings must slide easily onto the shaft. Use the full clamping length of the half-couplings.
- Initially fit all parts together **loosely**.
- Precisely align the shaft ends and couplings of the measurement arrangement.

  This avoids any unnecessarily high reaction forces, while also reducing the load on the coupling and any spurious forces acting on the sensor.

It is often adequate to use a straight edge to align the arrangement in two mutually perpendicular planes. However, we recommend using a dial gauge and laser for alignment.

Once you have fitted all shafts into the coupling hubs and correctly aligned all parts:

- Clamp the coupling onto the shaft.

  Observe the following points when clamping the coupling:

  - Start on the side that is easier to turn. Usually this will be the measurement side.
  - Use a torque wrench.
  - Hold screws from the other end when tightening.
  - Be aware of the maximum forces that you apply. The resultant torques must lie below the rated torque of the sensor. The relevant values are listed in the data sheet.

- Secure the body of the torque sensor against rotation using a flexible connection.

  The cable connection is not suitable for this purpose.

5.2.2 Installation with mounting block

You can also fit the torque sensor on a mounting block. In this case you will need to fit **balanced full couplings** at both shaft ends.

For suitable mounting blocks, see data sheet 8661. You'll find suitable couplings on datasheet 8690.

CAUTION!

Avoid excessive torques, bending moments or axial forces.

These will damage the torque sensor!

Make electrical connections to the torque sensor during installation and monitor the measurement signal. This signal must remain within the permitted range.

Support the sensor when fitting it.

Do not drop the sensor.

Do NOT use hammers during installation.

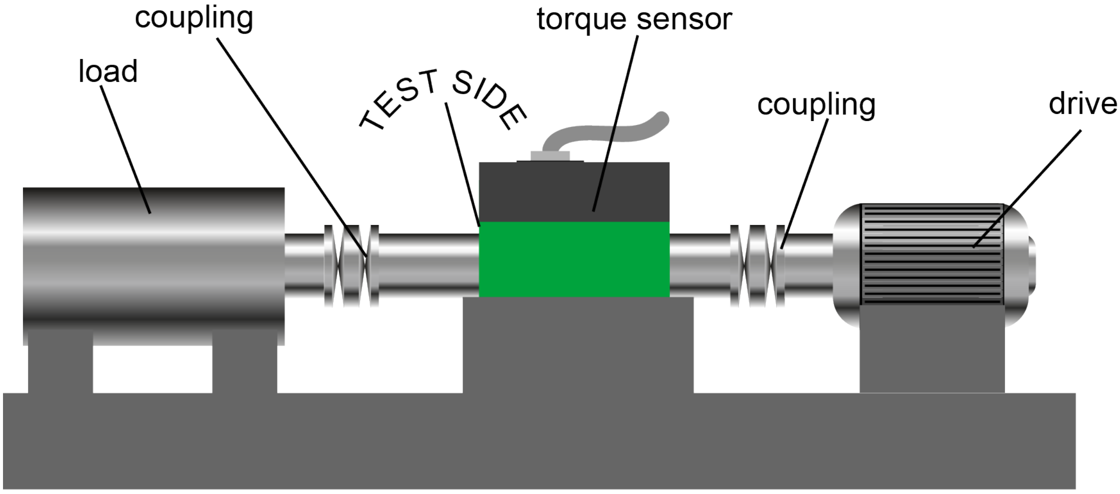

fig. 13.: Schematic measuring arrangement, fitted with a mounting block

- Support the torque sensor or hold it still during installation.
- Clean and deburr shafts and hubs.

There must be no foreign matter, burrs, oil or grease on the shafts or hubs when fitted.

Start on the side that is easier to turn. Usually this will be the test side.

The coupling must slide easily onto the shaft. Use the full clamping length of the couplings.

- Initially fit all parts together **loosely**.
- Precisely align the shaft ends and couplings of the measurement arrangement.

This avoids any unnecessarily high reaction forces, while also reducing the load on the coupling and any spurious forces acting on the sensor.

It is often adequate to use a straight edge to align the arrangement in two mutually perpendicular planes. However, we recommend using a dial gauge and laser for alignment.

Once you have fitted all shafts into the coupling hubs and correctly aligned all parts:

- Clamp the coupling onto the shaft.

Observe the following points when clamping the coupling:

- Start on the side that is easier to turn. Usually this will be the measurement side.
- Use a torque wrench.
- Hold screws from the other end when tightening.
- Be aware of the maximum forces that you apply. The resultant torques must lie below the rated torque of the sensor. The relevant values are listed in the data sheet.

5.3 Electrical connection

5.3.1 Sensor-supply

- Supply power to the sensor either via the 12-pin built-in plug or via the jack socket.

  NEVER connect power via both connections simultaneously.

Example:

If the evaluation device were to supply 15 V DC to the 12-pin built-in plug at the same time as the connected mains adapter supplied 24 V to the jack socket – which shouldn't happen – this could destroy the evaluation device.

5.3.2 Connector pin assignments (standard sensor, 1 range)

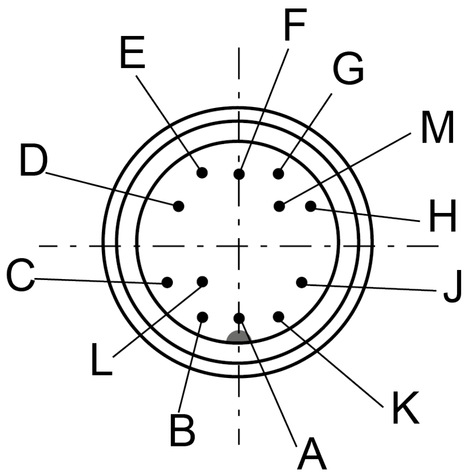

fig. 14.: View of the plug

12-pin plug	Function
A	Not used
B	Angular displacement, channel B (option)
C	Torque, voltage output
D	Torque, output ground
E	Sensor supply, ground
F	Sensor supply, voltage
G	Angular displacement, channel A (option)
H	Not used
J	Not used
K	Control input
L	Not used
M	Not used

5.3.3 Connector pin assignments (2-range-sensor)

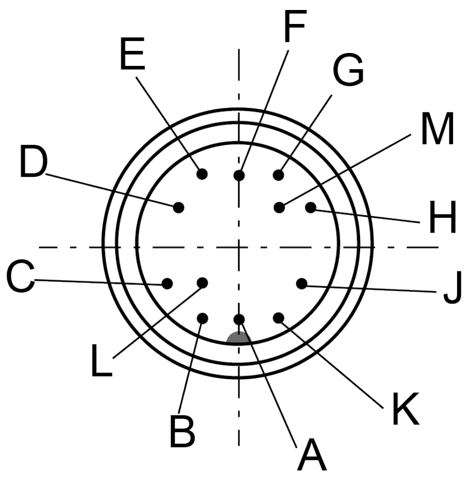

fig. 15.: View of the plug

12-pin plug	Function
A	Not used
B	Angular displacement, channel B (option)
C	Torque, voltage output
D	Torque, output ground
E	Sensor supply, ground
F	Sensor supply, voltage
G	Angular displacement, channel A (option)
H	Not used
J	Not used
K	Control input
L	Switching between measuring ranges
M	Not used

With the USB-version the switching is activated via the USB interface.

5.3.4 The connections in detail

Voltage output for torque

This consists of an operational amplifier with a downstream low pass filter.

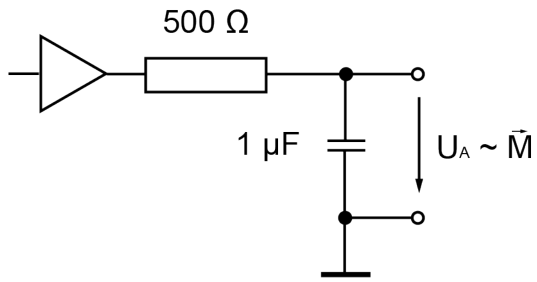

fig. 16.: Voltage output for torque

The connected evaluation circuit should be high impedance (> 10 MΩ).

The reference is the potential separated torque output ground. You can connect this to the supply ground on the evaluation device.

TTL output for rotational speed / angular displacement

Both channels are designed the same way.

A TTL signal is available directly, without additional external circuitry.

The reference here is the supply ground. You can connect this to the torque output ground on the evaluation device.

Note

In conjunction with the internal pull-up resistor, the cable capacitances form a low-pass filter. You should therefore use the shortest possible, high quality, low capacitance cable for maximum transmission quality.

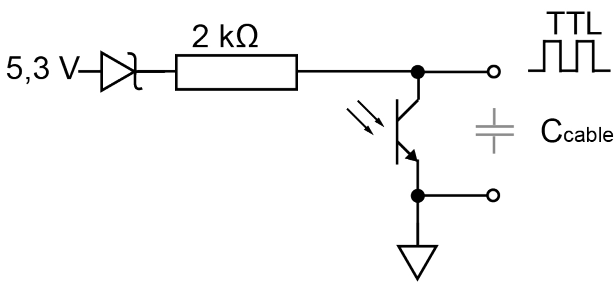

fig. 17.: TTL output

Open collector output for rotational speed and angular displacement

CAUTION

Danger of excessive heating.

When connected to a voltage source, the sensor heats up too much. This heating can damage the sensor.

ALWAYS connect the voltage source with a pull-up resistor.

Note

The PLC input is designed for positive logic. It is **not** suitable for American PLCs.

Here the external voltage is superimposed on the internal voltage source. As a result, for example, you can connect the torque sensor directly to a PLC input with positive logic (**not for American PLCs**).

Using the same connection method you can reduce problems with transmission quality with longer cables.

Pay attention to the maximum current and voltage values. The external pull-up resistor dissipates a considerable amount of power.

Guide value 12 V / 1 kΩ (0.5 W).

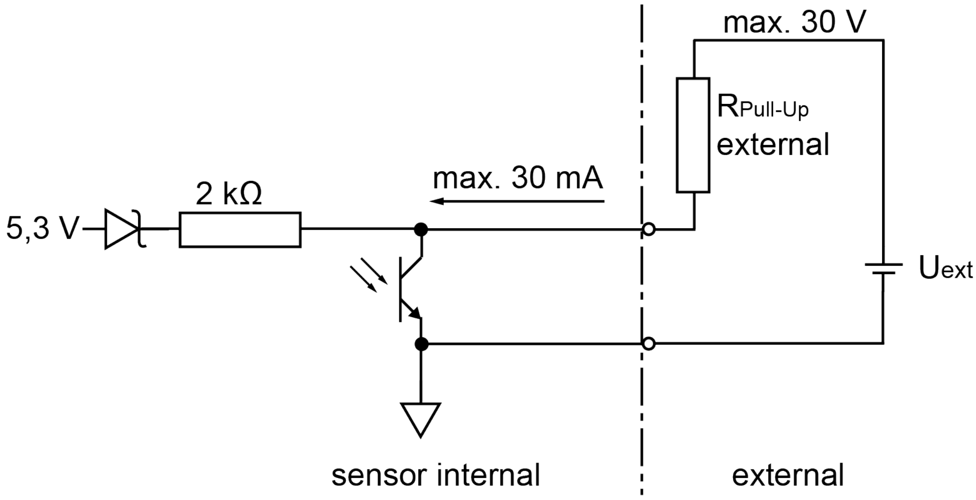

fig. 18.: Open collector output

TTL output on 3.3 V or other logic

The diagram shows adaptation for 3.3 V logic. For other logic levels, appropriate Zener diodes need to be used.

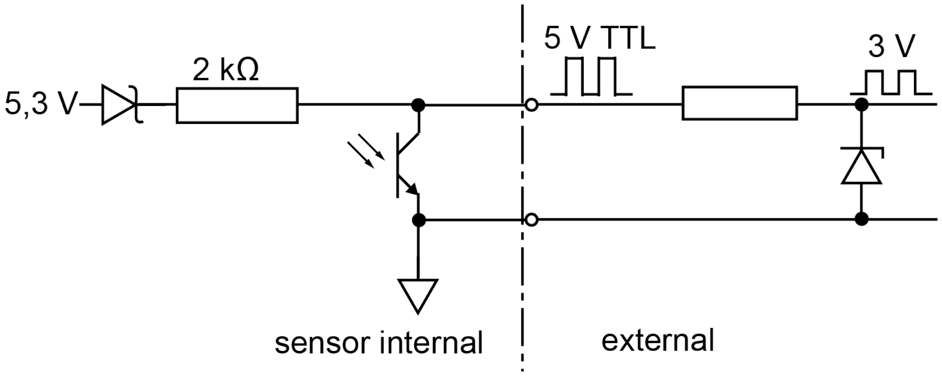

fig. 19.: Resistance 10 kΩ, Zener diode 3,3 V

Longer transmission paths up to approx. 10 m

CAUTION!

Danger of excessive heating.

When connected to a voltage source, the sensor heats up too much. This heating can damage the sensor.

ALWAYS connect the voltage source with a pull-up resistor.

Depending on the cable type, cable cross-section, cable length and frequency, you may need to select a somewhat smaller pull-up resistor.

Pay attention to the maximum current and voltage values, and to the fact that considerable power is dissipated at the pull-up resistor and Zener diode.

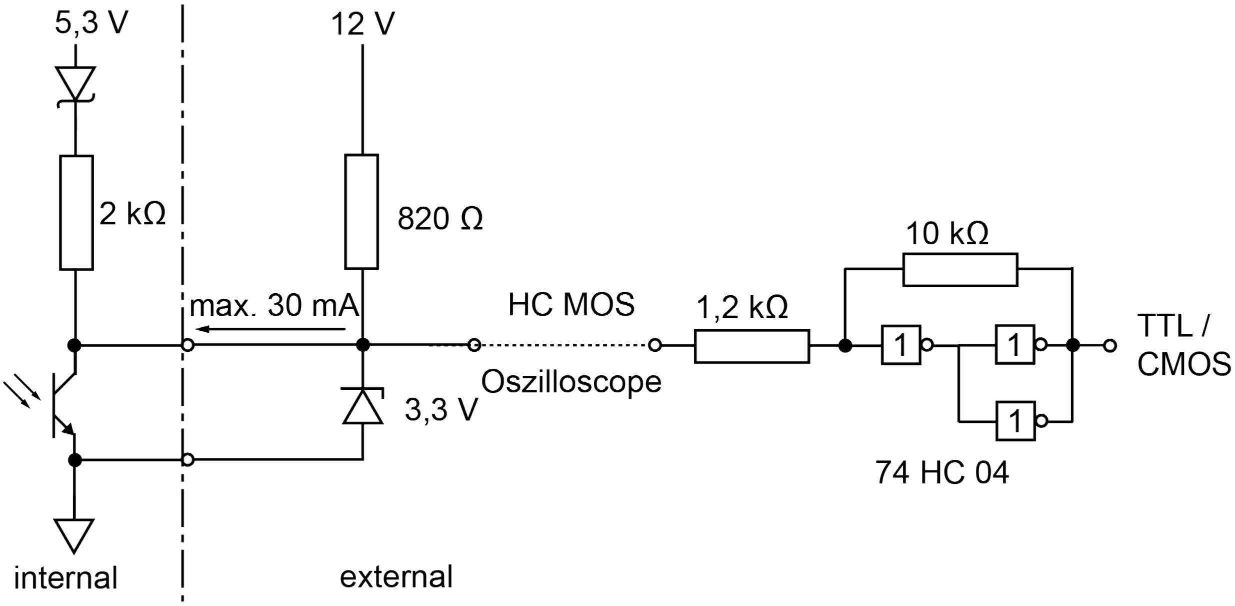

fig. 20.: Longer transmission paths

5.3.5 Running cables

- Run cables loosely in the shape of a gooseneck.

  This will allow enough play in the cable to compensate for any movement.
- Avoid excessive lengths.

  If that is not possible, snake the cable. This will reduce the effective induction area.

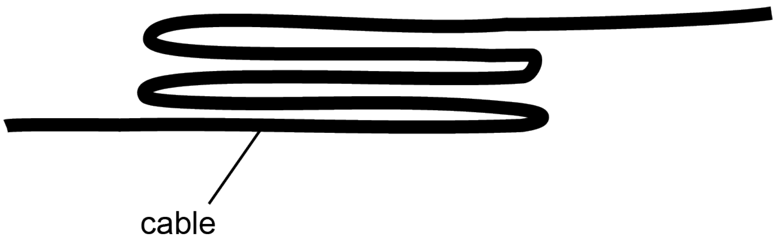

fig. 21.: Layout of a cable with excess length

- Locate the sensor, cable and measuring instrument outside the field of high-energy equipment.

  These include transformers, motors, contactors, frequency converters and so forth. Otherwise the electromagnetic fields from such equipment will act with their full effect on the measuring chain, causing incorrect measurements.
- Lay the measuring lines separately from high-power cables.

  If the measuring lines are laid parallel to such cables, interference will be coupled in inductively and capacitively.

In some cases it will be helpful to place an extra screen as additional protection over the measuring cable, or to lay it in a metal tube or pipe.

5.3.6 Extension cables

- Always use shielded, low-capacitance cables.

  We recommend using cables supplied by us. These cables meet the requirements.
- For extension cables, make sure that the connection is flawless with good insulation.
- Make sure that cable cross-section is sufficient.

Note
If you use extension cables it is not necessary to recalibrate the sensor. However, you will need to adjust the entire measuring chain.

6. Calibration and adjustment

Torque sensors from burster präzisionsmesstechnik are already traceably adjusted and tested in the factory. As an option we offer factory calibration of the sensor.

6.1 Factory calibration

Factory calibration involves checking sensor data against traceably calibrated measuring instruments. We record various measurements for this.

Factory calibration produces a calibration report.

6.2 DAkkS (DKD) / ISO 17025 calibration

DKD calibration involves calibrating the sensor in accordance with DAkkS (or DKD) directives in a calibration laboratory that is accredited by DAkkS (or by the DKD accreditation body). With this calibration we define the measurement uncertainty of the sensor.

Please contact us if you require further information.

6.3 Recalibration

➢ Have the sensor recalibrated at the factory after 26 months at the latest.

Shorter intervals are recommended in the following cases:

- Sensor overload
- After repair
- After improper use of the sensor
- When required by quality standards
- Where there is a specific traceability requirement

6.4 Mechanical adjustment

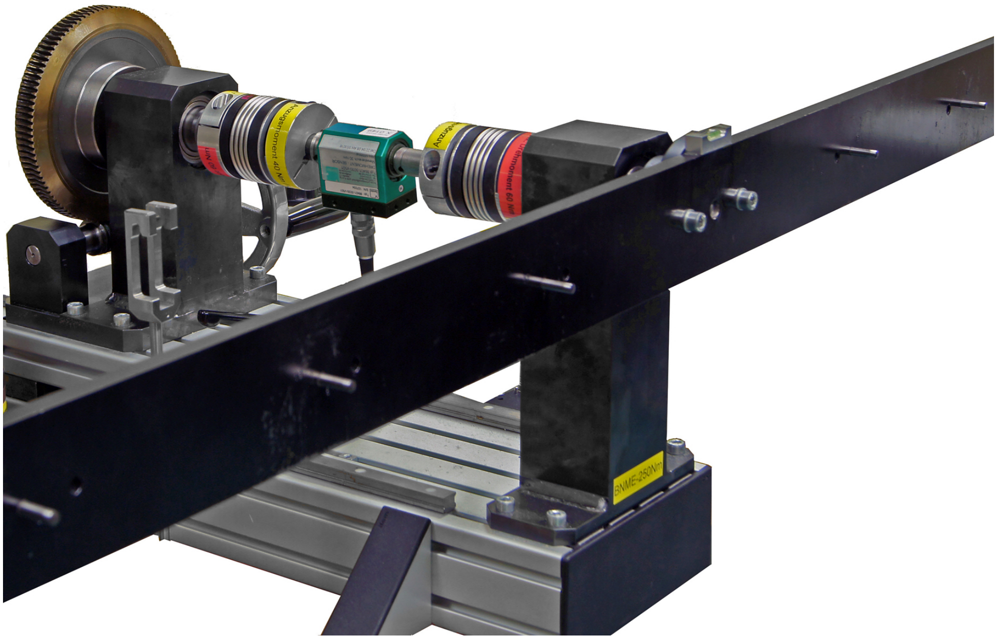

fig. 22.: Sensor adjustment with calibration equipment

For mechanical adjustment you will require calibration equipment with which you can generate a known torque via a lever arm and weights.

Adjustment

- Apply the rated torque to the sensor then release the torque again.
- Precisely adjust the zero point.
- Apply a known torque to the sensor.
- Adjust the display accordingly.

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7. Measurement

7.1 Switching on

- Apply the operating voltage to the sensor.

  When the operating voltage is present at the sensor, all three LEDs on the status display will light up simultaneously for approx. 0.5 seconds.

  Once they go out, the sensor switches into its normal operating state. It is now ready for operation.

7.2 Static and quasi-static torques

Static and quasi-static torques change their value only slowly or not at all. As long as they are below the rated torque, these torques can take any value

7.3 Dynamic torques

CAUTION!

Danger of resonant frequencies.

Operating the torque sensor or the entire test setup close to its resonant frequency will result in permanent damage.

Keep torque frequencies WELL below the resonant frequency of the mechanical test setup.

Limit the peak-to-peak torque variation to 70% of the rated torque.

Note

Calibration carried out for static torques is also valid for measuring dynamic torques. However, you must take into account the characteristics of the measurement amplifier you are using.

Determination of the resonant frequency

The resonant frequency of the entire test setup is related to the sensor's spring constant "c" and to the two moments of inertia "J_1" and "J_2", each with the connected molding body.

$$f_0 = \frac{1}{2 \cdot \pi} \cdot \sqrt{c\left(\frac{1}{J_1} + \frac{1}{J_2}\right)}$$

f_0:	Resonant frequency in Hz
J_1:	Moment of inertia 1 in $kg * m^2$
J_2:	Moment of inertia 2 in $kg * m^2$
c:	Spring constant in Nm / rad

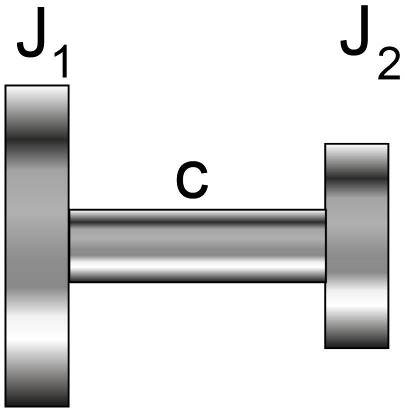

fig. 23.: resonant frequency model

The Holzer-Tolle method is another way to determine the resonant frequency.

7.4 Switching between ranges (2-range-sensor)

Appropriate builds of the sensor can measure over two ranges.

This option is available for measuring ranges between 0 ... ± 5 Nm and 0 to ± 200 Nm.

7.4.1 Possible range extension of the nominal torque

The sensor electronics switch between the two ranges.

The following extensions are available: 1:10, 1:5, 1:4 of the nominal torque.

Upper range value	Range extension 1:10	Range extension 1:5	Range extension 1:4
± 5 Nm	± 0,5 Nm	± 1 Nm	–
± 10 Nm	± 1 Nm	± 2 Nm	–
± 20 Nm	± 2 Nm	–	± 5 Nm
± 50 Nm	± 5 Nm	± 10 Nm	–
± 100 Nm	± 10 Nm	± 20 Nm	–
± 200 Nm	± 20 Nm	–	± 50 Nm

7.4.2 Switching at the voltage output

The measuring range is switched by applying a voltage level whose magnitude and whose ground reference correspond to the control signal.

The voltage is to be applied to pin L of the connector.

	Logical status	Voltage level
Range 1:1	PIN L = 0	$U_{PIN\ L,\ D}$ = 0V ... 3V
Extended range	PIN L = 1	$U_{PIN\ L,\ D}$ = 10V ... 30V

The logical level at pin L must be maintained continuously for each range.

The switching time takes at most 50 milliseconds

7.4.3 Connection diagram (2 range sensor)

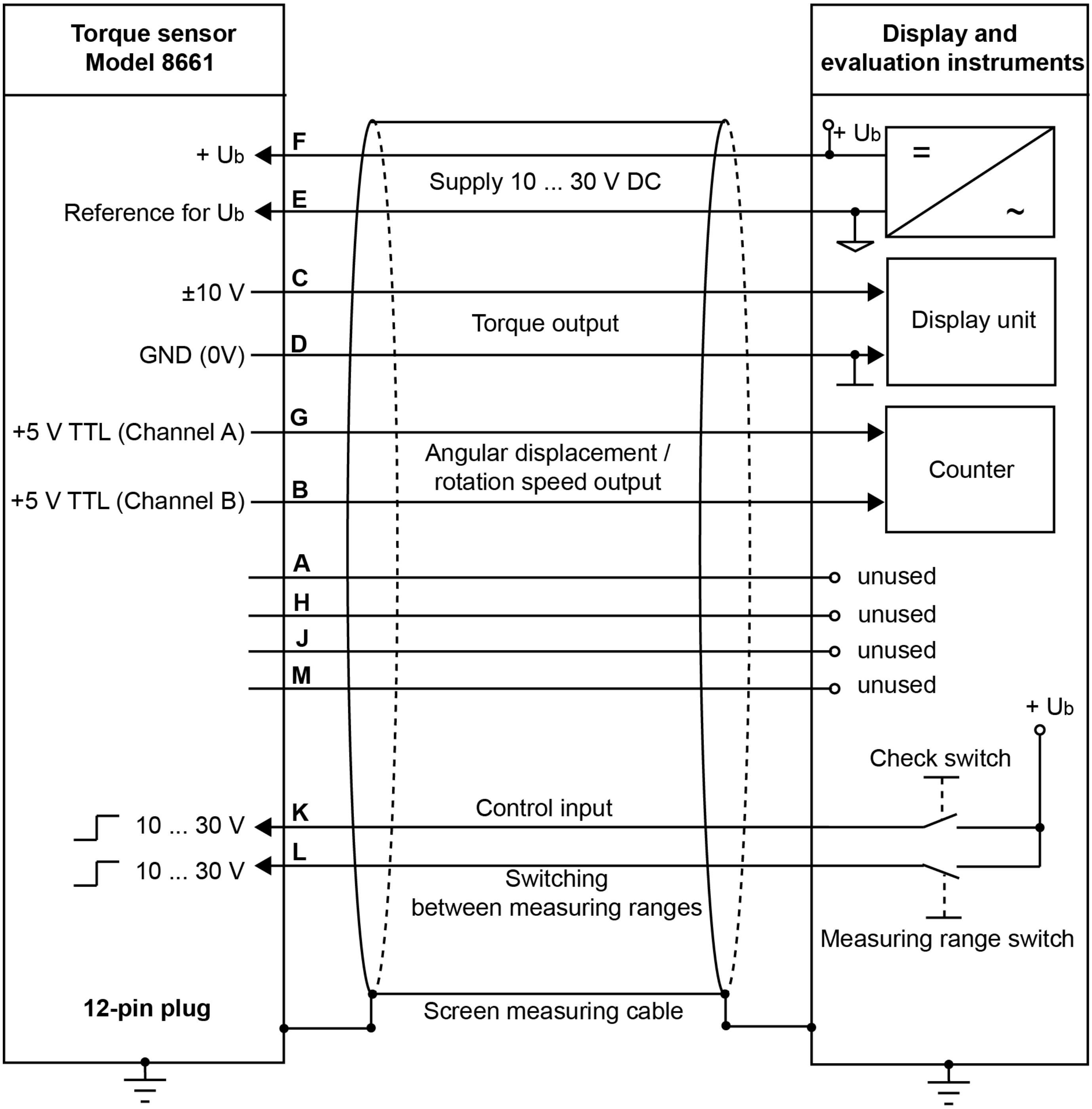

fig. 24.: Connection diagram for 2 range sensor

Pin E is the reference for U_B, rotation speed and angular position.
Pin D is the reference for the torque output, control input and range switching.

7.5 Status display (sensor, 1 range, standard)

Status display	Cause / meaning
Green LED flashes	Torque is less than 5% of the rated torque.
Green LED lit	Torque is between 5% and 90% of the rated torque.
Yellow LED lit	Torque is between 90% and 100% of the rated torque.
Red LED flashes	**Overload!** Torque is between 100% and 150% of the rated torque.
Red LED lit	**Overload!** Torque is greater than 150% of the rated torque.
LEDs flash: green yellow red	**Fault!** Please contact us. (In addition to the LEDs you can measure an alternating signal at the output: 5 Hz, 0 and 10 V))

7.6 Status display (2-range-sensor)

The status display differs from its appearance with only one measuring range, as the active measuring range is now displayed.

The active measuring range is indicated by the yellow LED.

Status display	Cause / Meaning
Green LED flashes	Torque is less than 10% of the set range
Green LED lit	The torque is between 10 % and 100 % of the set range.
Red LED lit	**Overload!** The torque is greater than 100 % of the set range.
Yellow LED is off	Range 1:1
Yellow LED lit	Other extended range

7.7 Speed Limits

CAUTION!

Excessive speeds will damage the sensor.

Excessive forces arise above the maximum speed.

Always operate the sensor below the maximum speed (see data sheet).

7.8 Interference

Possible sources of interference:

- Temperature change
- Temperature gradient
- Vibration
- Spurious forces
- EMC
- Electrical interference
- Magnetic interference

➢ Take counter-measures against these sources of interference.

Otherwise they may falsify the measurement result.

7.9 Check function

When a signal of between 10 and 30 V is applied to the control input, the sensor returns a signal of exactly 10,000 V.

8. Type 8661 with USB connection

8.1 General information

8.1.1 Power supply

The sensor is powered via the USB interface. In keeping with the USB convention, the sensor first determines if it can connect to the PC as a high power device drawing a maximum current of 495 mA. Usually this is not a problem. In rare cases you may need a USB hub with its own 5 V power adapter, in which case it will usually supply power to the sensor without going through the configuration process. Make sure that any power adapter you use with the hub meets your applicable safety regulations.

Actual power consumption is typically: P = 5 V * 0.35 A = 1.75 VA.

8.1.2 Wiring

Electrical and magnetic fields can often cause interference in the test leads. Such interference mainly stems from power cables running parallel to the test leads, but can also be caused by contactors, thyristor controllers, frequency converters and electric motors in the vicinity. Ensure sufficient distance and route test leads through a grounded steel pipe if necessary.

Galvanic interference can also occur, particularly if the measurement chain is grounded at multiple points creating differences in electrical potential. These ground loop currents can be avoided either by disconnecting the double grounding or bypassing it by running a particularly low-resistance ground cable (6-10 mm²) parallel to the test lead.

The main points to remember are:

- The torque sensor must be grounded via its assembly bolts.
- The cable length should not exceed 2 m.

8.1.3 Ground connection

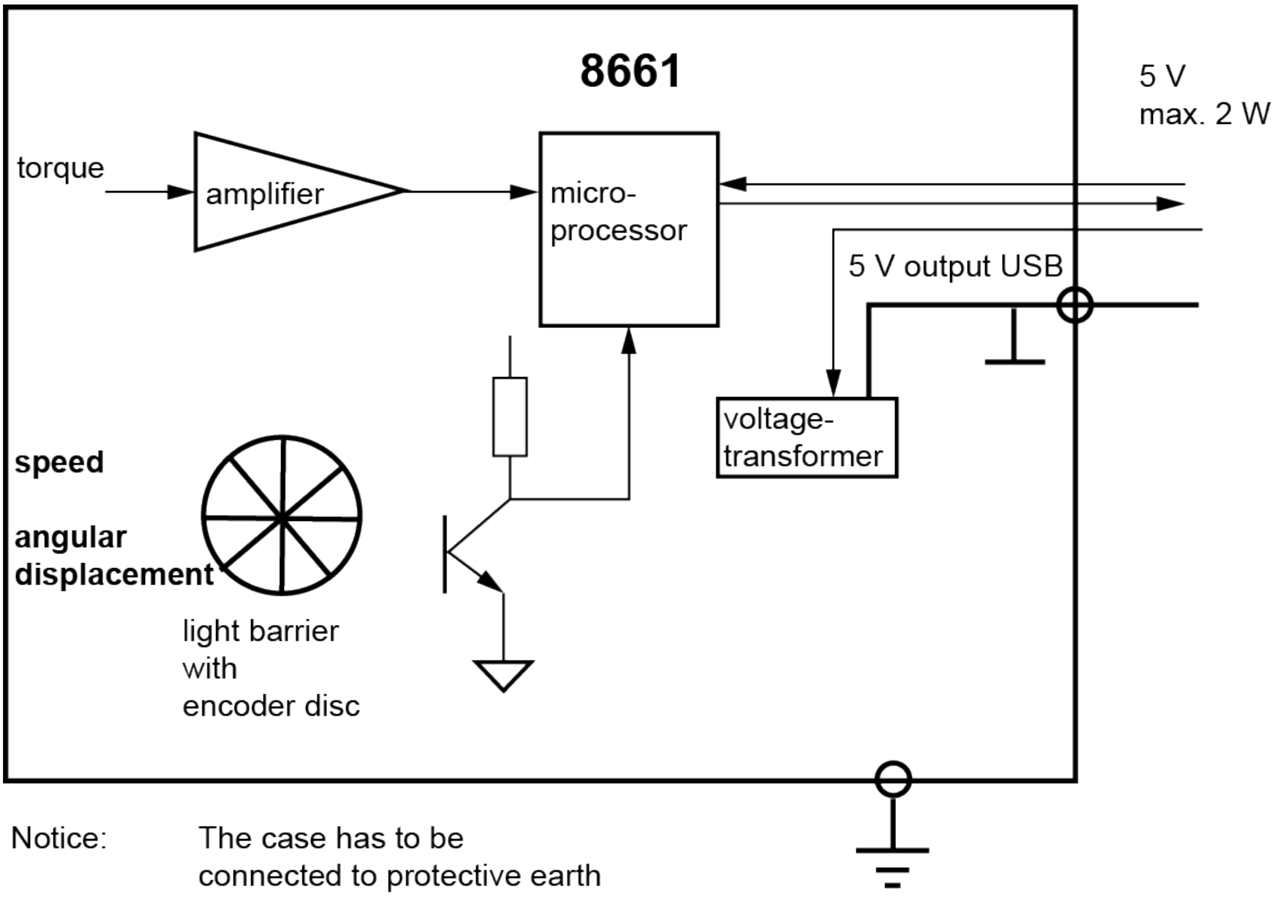

fig. 25.: Ground connection

USB connector shell = shield = sensor housing = digital ground GND = protective earth

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8.1.4 USB 2.0 pin assignment

The USB interface complies with the USB 2.0 standard and the pin assignment is as usual.

The built-in connector on the sensor is suitable for a USB Mini B plug.

Pin	Name
1	+ 5 V
2	Data -
3	Data +
4	ID (not used)
5	GND

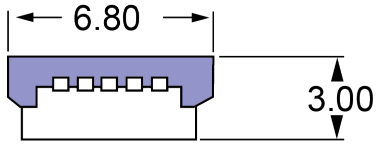

fig. 26.: USB Mini B [mm]

The supplied cable has a USB A type connector.

Pin	Name
1	+ 5 V
2	Data -
3	Data +
4	GND

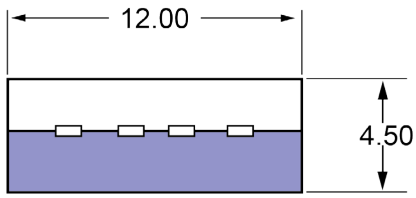

fig. 27.: USB A [mm]

8.2 Preparing for use

8.2.1 System requirements

Operating systems	Windows 2003, Windows XP, Windows 7
Processor:	Pentium 1200 MHz minimum, Pentium 2.0 GHz recommended
Graphics card:	At least VGA 800 x 600, minimum 256 colors
Memory:	At least 256 MB RAM (Win XP), at least 512 MB RAM (Win 2003, Win 7)
Hard disk:	Approx. 500 MB free space
Input devices:	MS-compatible mouse, standard keyboard
Font setting:	Small fonts

8.2.2 Software installation

To install DigiVision, the user needs to be logged on as an administrator.

To start installation of the configuration and analysis software, insert the supplied CD-ROM in the CD-ROM drive.

- Switch to the directory of your CD-ROM drive and run the Setup wizard by double-clicking on "setup.exe".

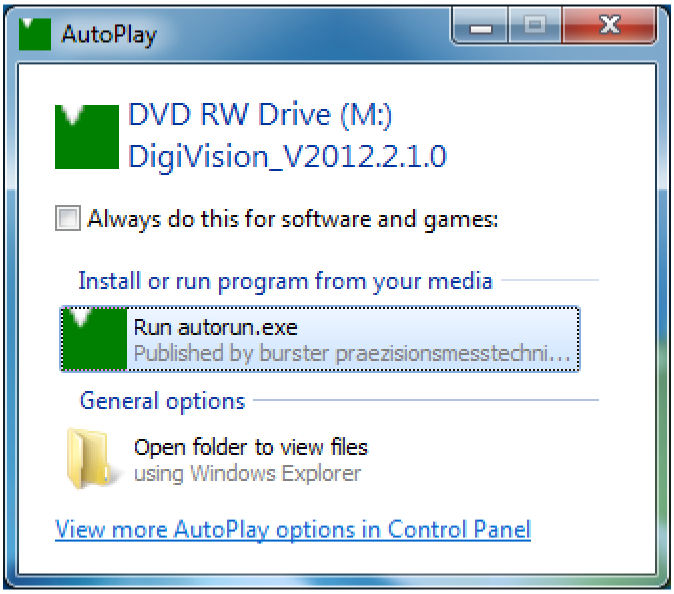

fig. 28.: Installing DigiVision, autorun.exe

fig. 29.: Installing DigiVision, startup screen

- Double-click to choose a language and start installation:

  If Microsoft .NET Framework 4.0 is not already installed on the PC, it is installed automatically.

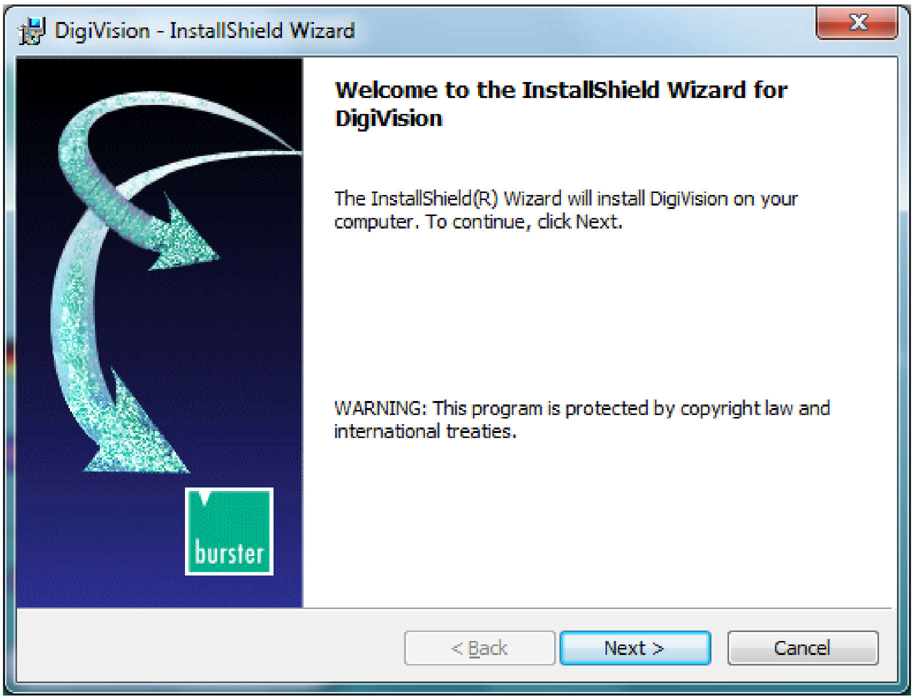

fig. 30.: Installing DigiVision, Welcome screen

- Click the "Next >" button.

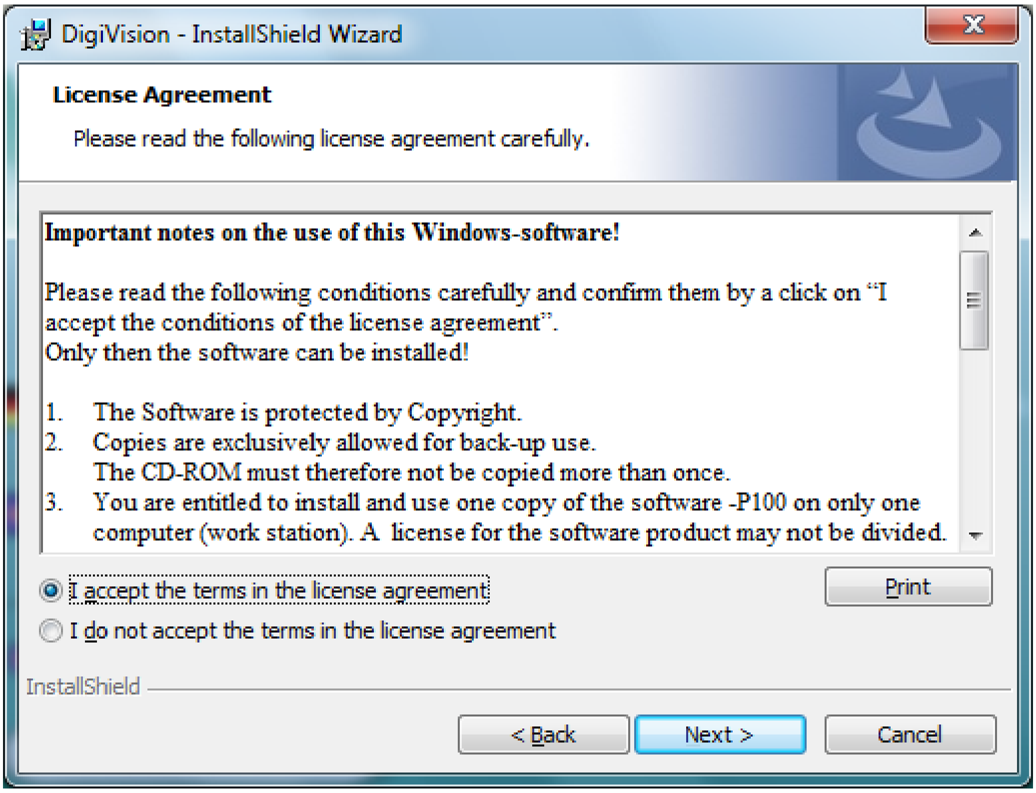

fig. 31.: Installing DigiVision, License Agreement

- Accept the license agreement then confirm by clicking "Next >".

  The installation will terminate if you do not accept the license agreement.

  The next installation screen lets you review all the relevant information about the software version you are installing. After installation, you can view this information in the "readme.txt" file.

- Click "Next >" to confirm.

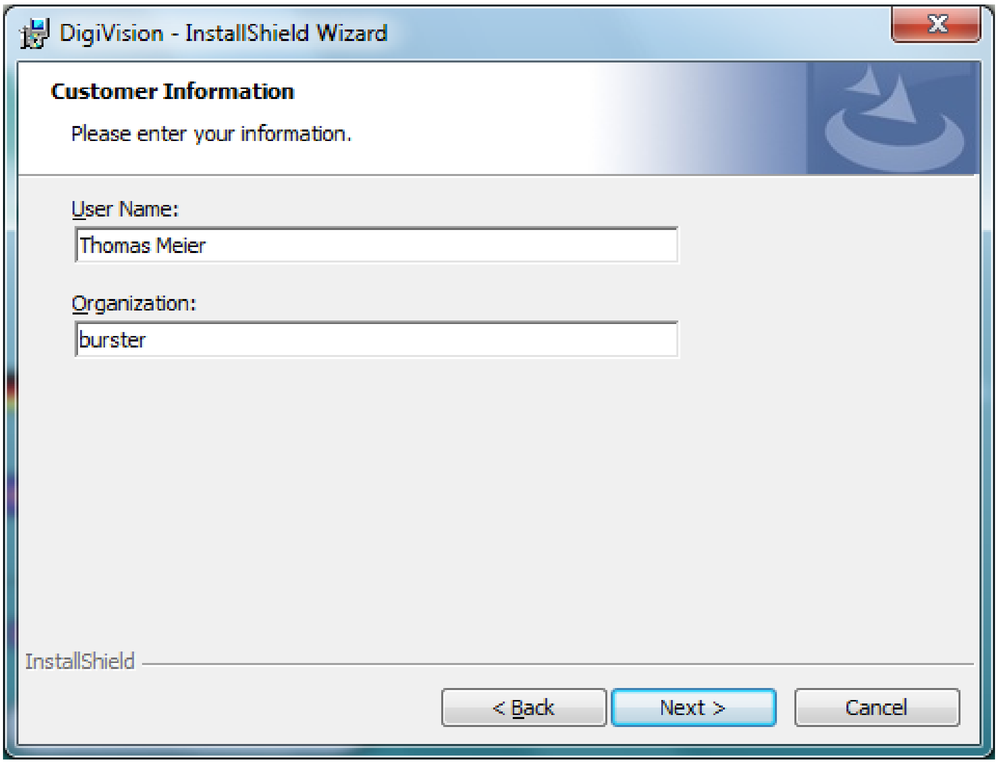

fig. 32.: Installing DigiVision, Customer Information

- Enter a user name and the name of your organization or company.
- Select which users to install the software for.
- Click "Next >" to confirm.

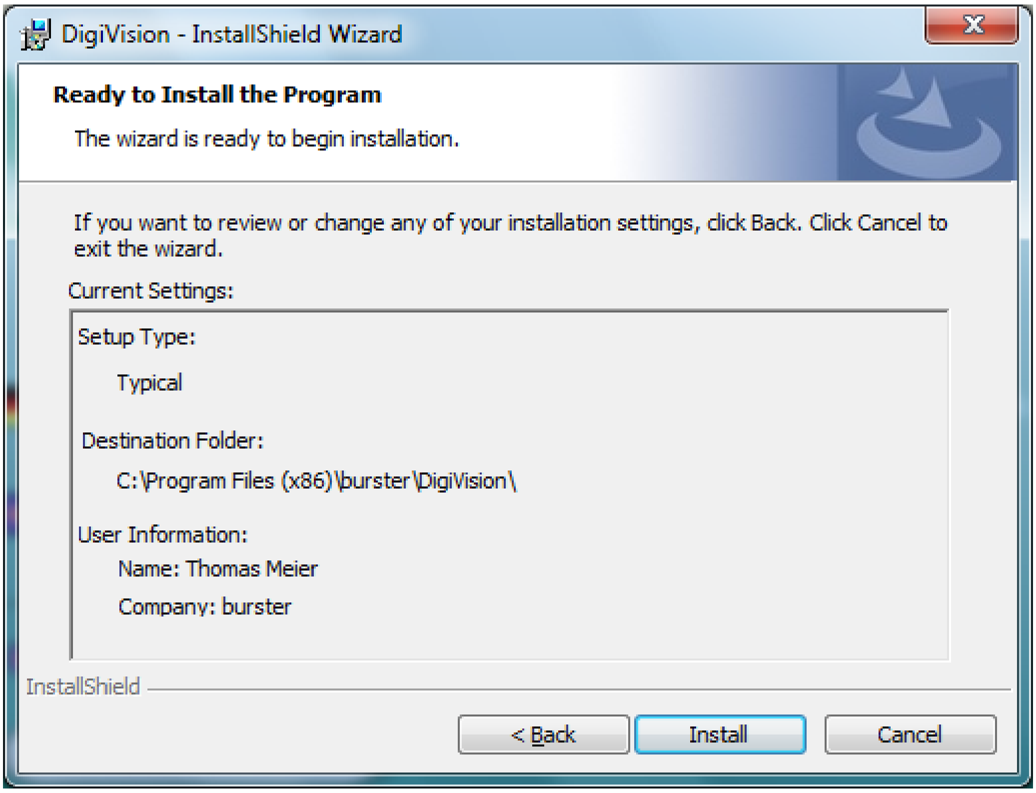

fig. 33.: Installing DigiVision, installation path

- **Make a note of the installation path.** The sensor driver is located in a subdirectory. You will need to know this path later when you install the driver.

- Click "Install".

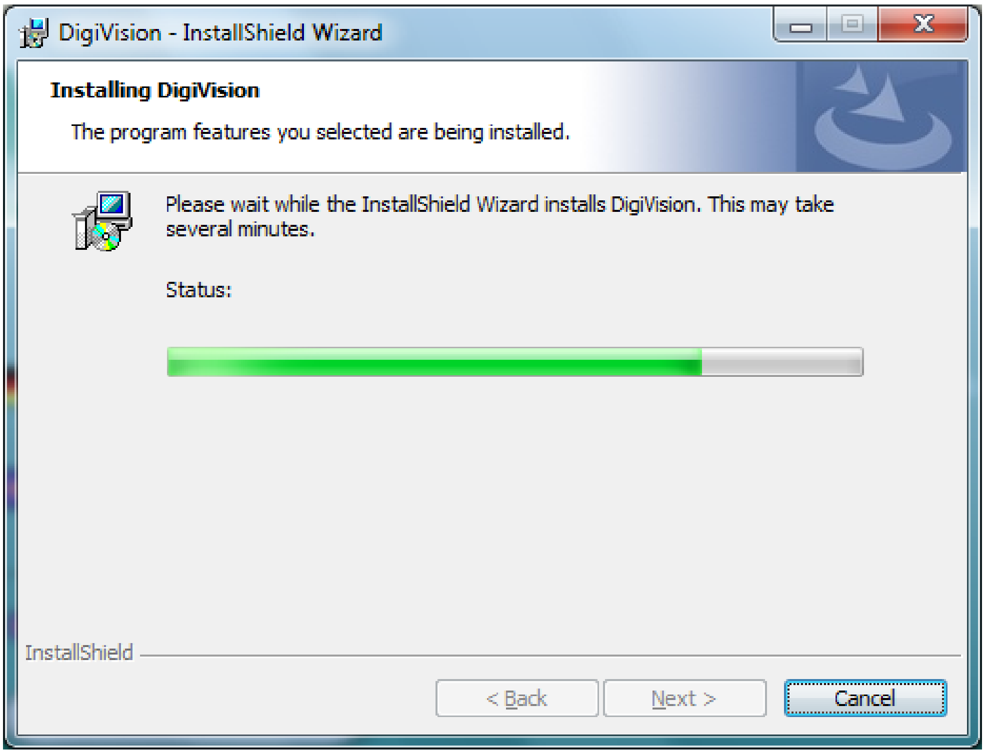

fig. 34.: Installing DigiVision, installation in progress

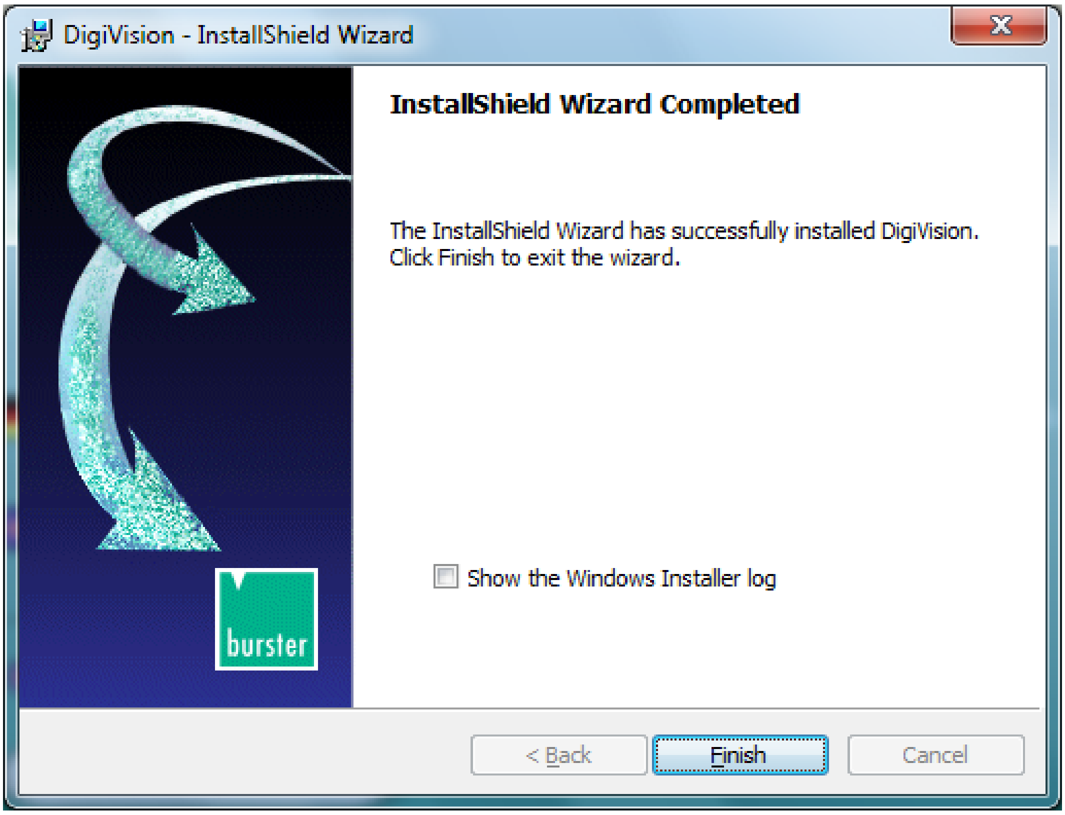

fig. 35.: Installing DigiVision, installation complete

The DigiVision configuration and analysis software has been successfully installed on your system.

- Click the "Finish" button to close the Setup wizard.

8.2.3 Driver installation

This guide describes how to install the driver software under Windows 7. Installation may differ under other operating systems.

Hinweis:

It is a Windows requirement that you must have Administrator rights to install drivers. Please contact your system administrator if you do not have these rights.

- Connect the USB cable to the 8661 sensor and plug the other end of the USB cable into a free USB port on your PC.

  If you are using a USB hub, make sure that it can supply sufficient current.
  Open the Device Manager.
  (Go to Start → Control Panel → Hardware → Device Manager).

➢ In Device Manager, select the sensor's interface.

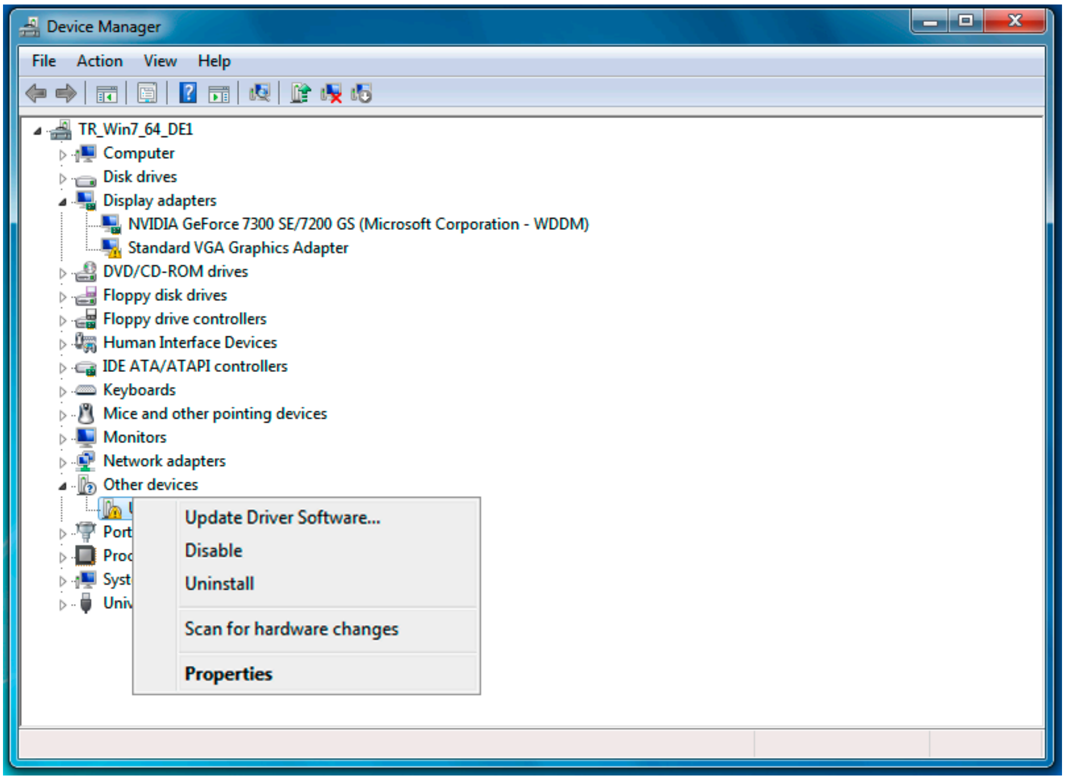

fig. 36.: Installing driver software, Device Manager

➢ Select "Update Driver Software..."

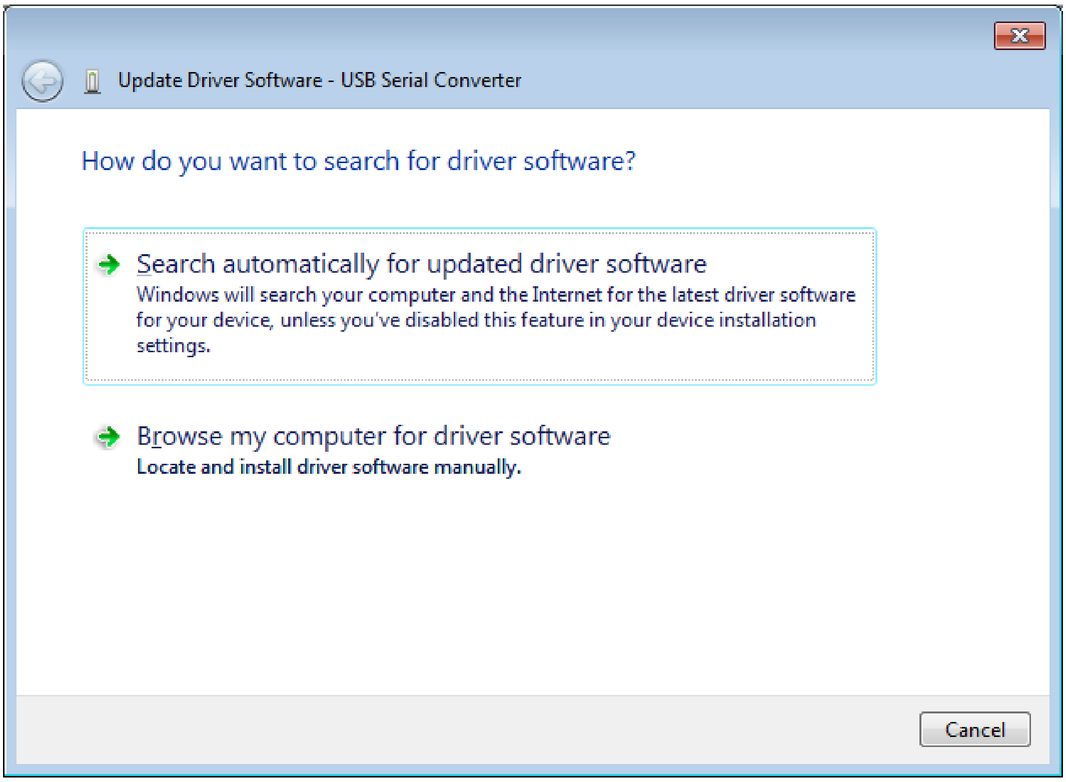

fig. 37.: Installing driver software, select type of search

- Select "Browse my computer for driver software".

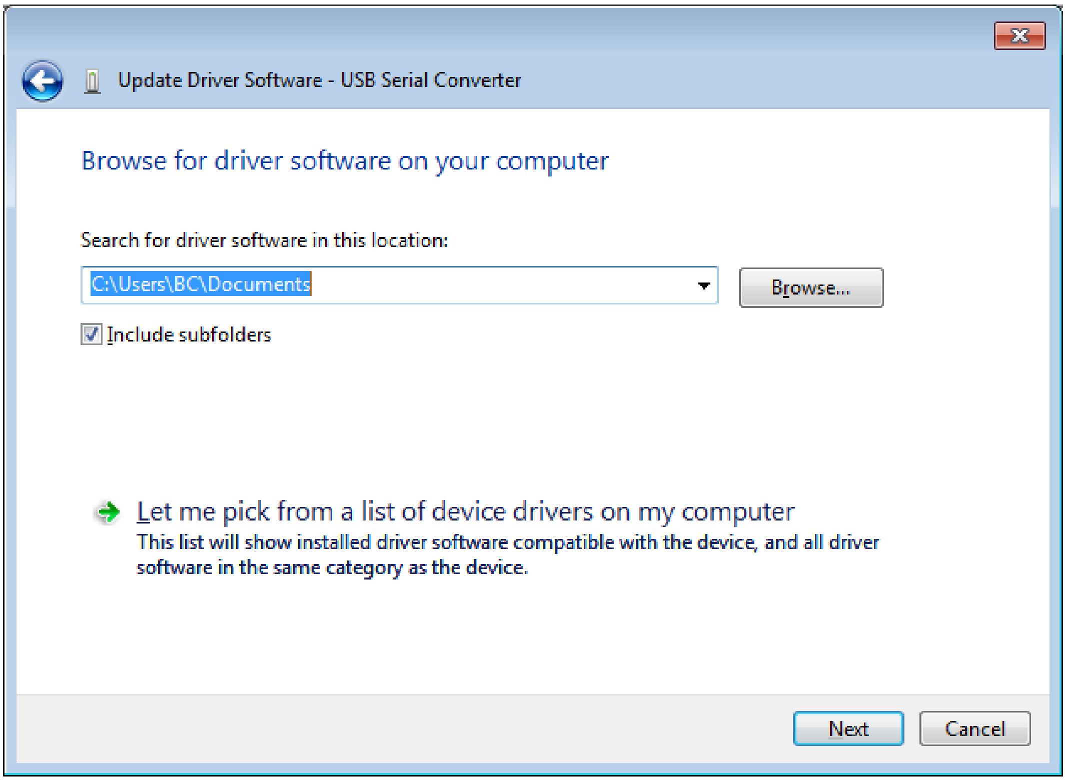

fig. 38.: Installing driver software, search path

- Specify the path to the driver installation files. After installing the DigiVision configuration and analysis software, the driver installation files are located in the folder you specified when installing DigiVision.
- You can use the "Browse" button to select the correct directory.

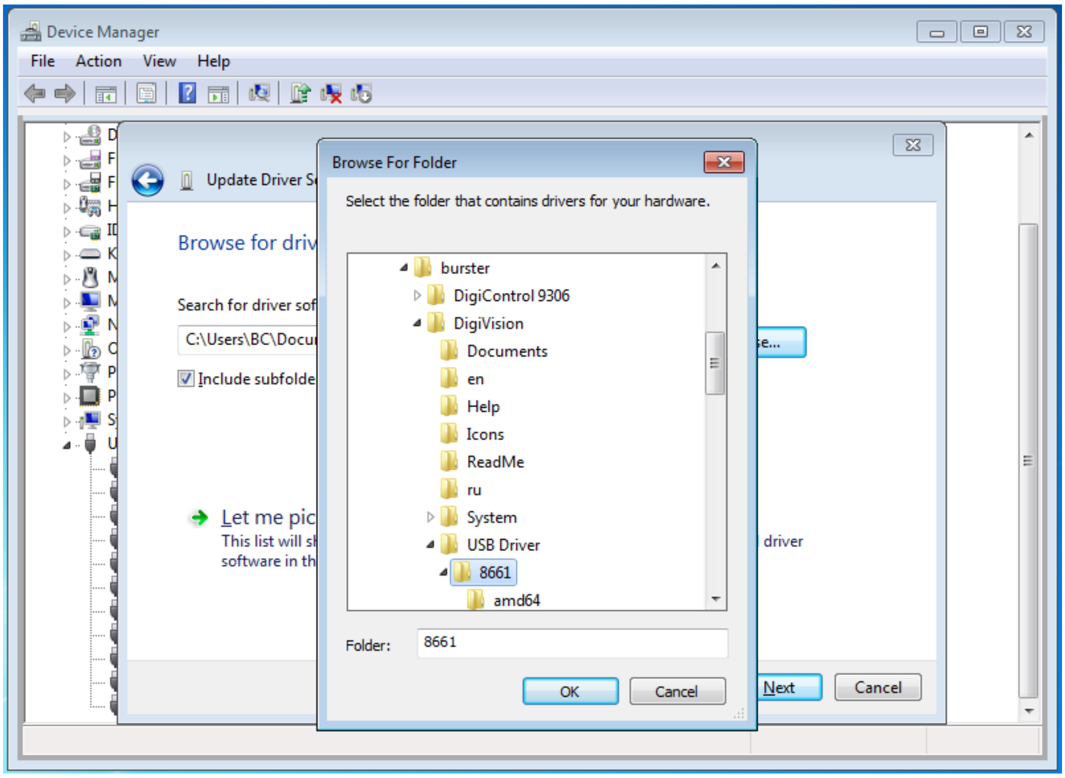

fig. 39.: Installing driver software, selecting the folder that contains the driver software

- Confirm your selection with "OK".

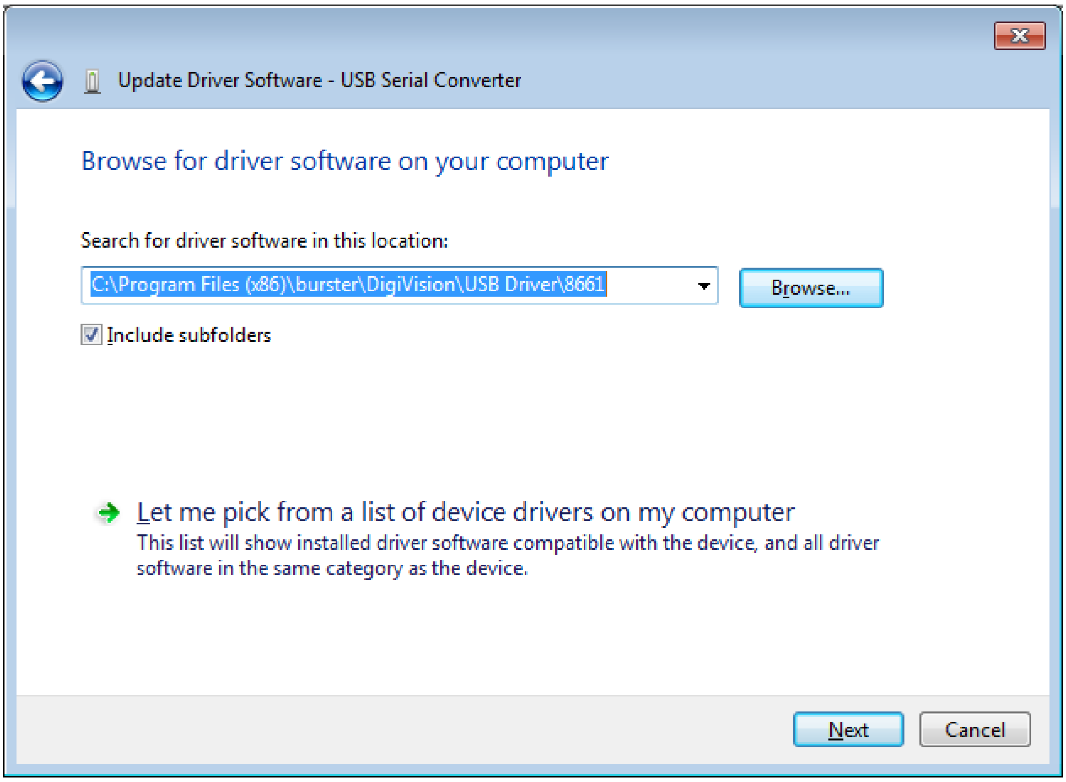

fig. 40.: Installing driver software, confirm path

- Confirm your selection by clicking the "Next" button.

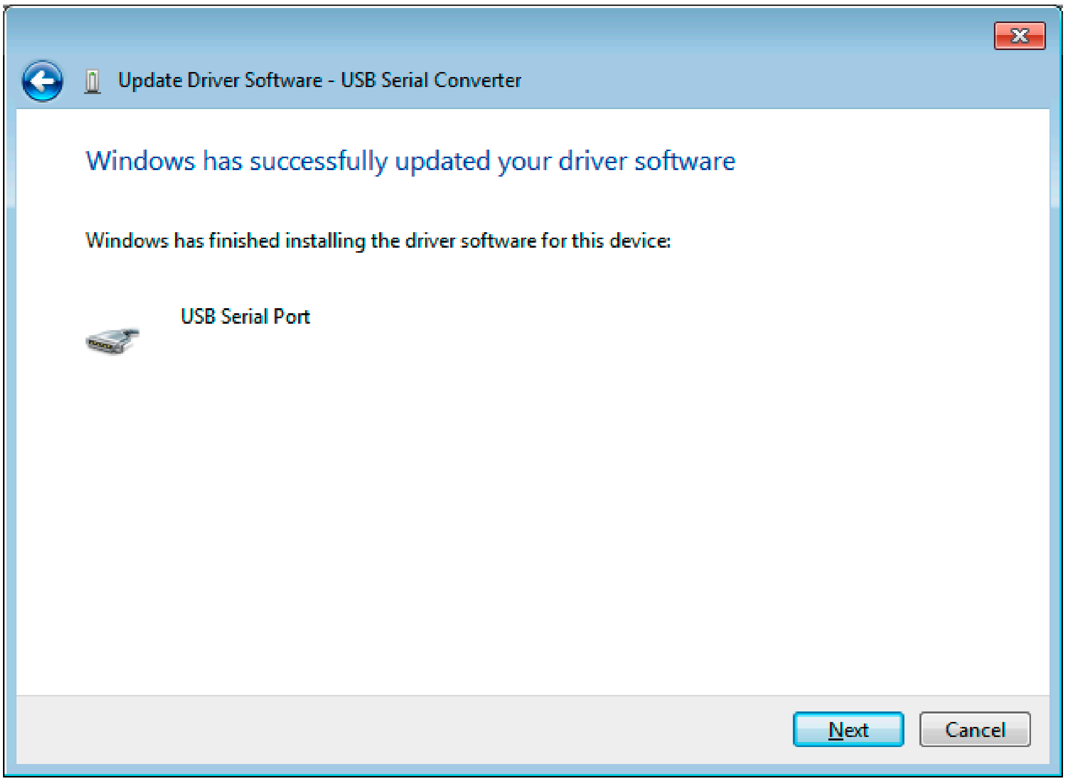

fig. 41.: Installing driver software, installation successful

The operating system now confirms that the driver for the model 8661 sensor has been installed successfully.

The installation procedure for the virtual COM port then starts.

Open the Device Manager again.

(Go to Start → Control Panel → Hardware → Device Manager).

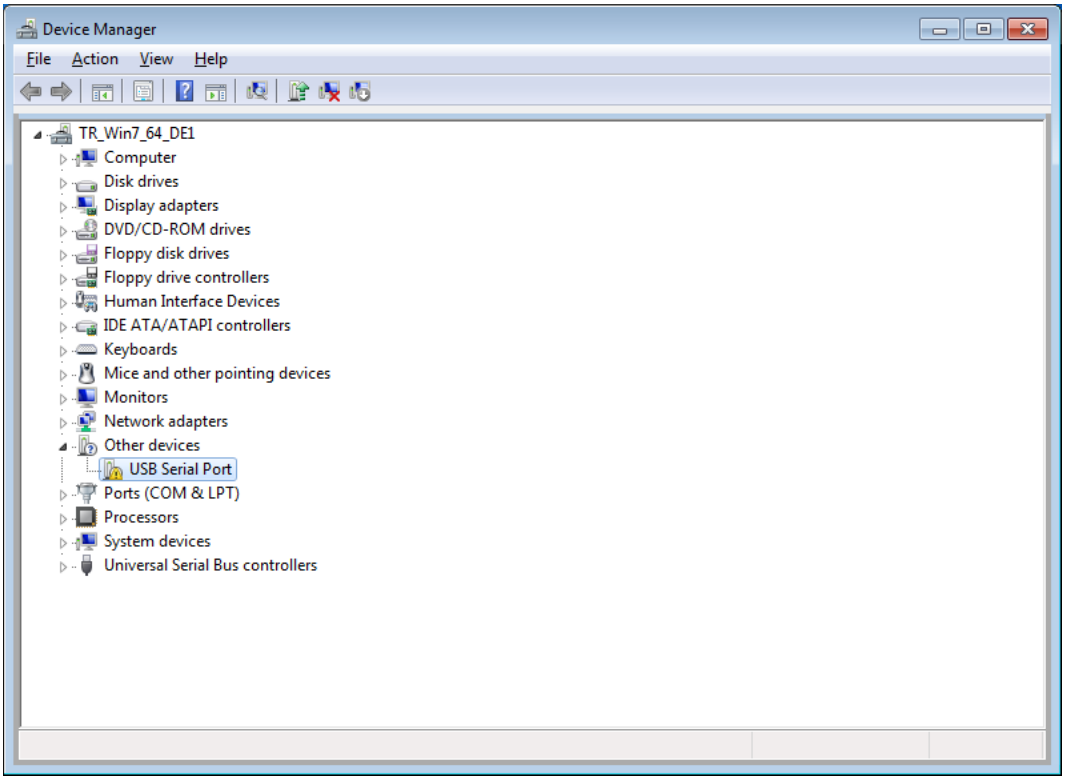

fig. 42.: Port installation, Device Manager

Right-click on USB Serial Port and select Update Driver Software...

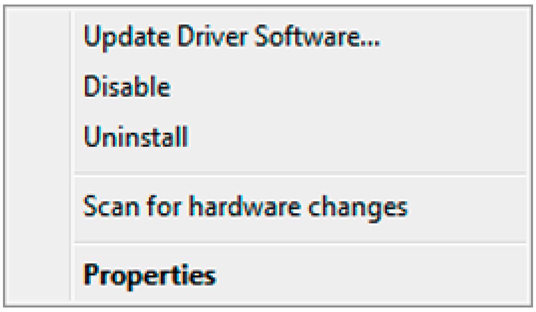

fig. 43.: Port installation, updating the port driver

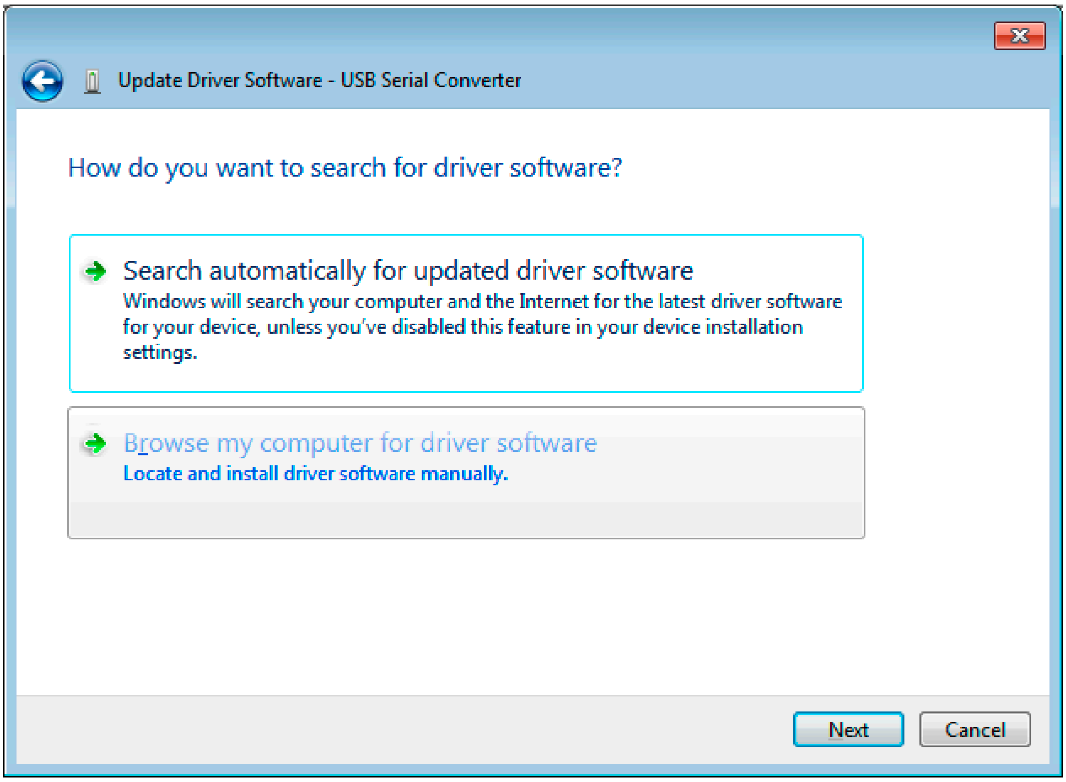

fig. 44.: Installing port driver, install driver, select type of search

- Select "Browse my computer for driver software".

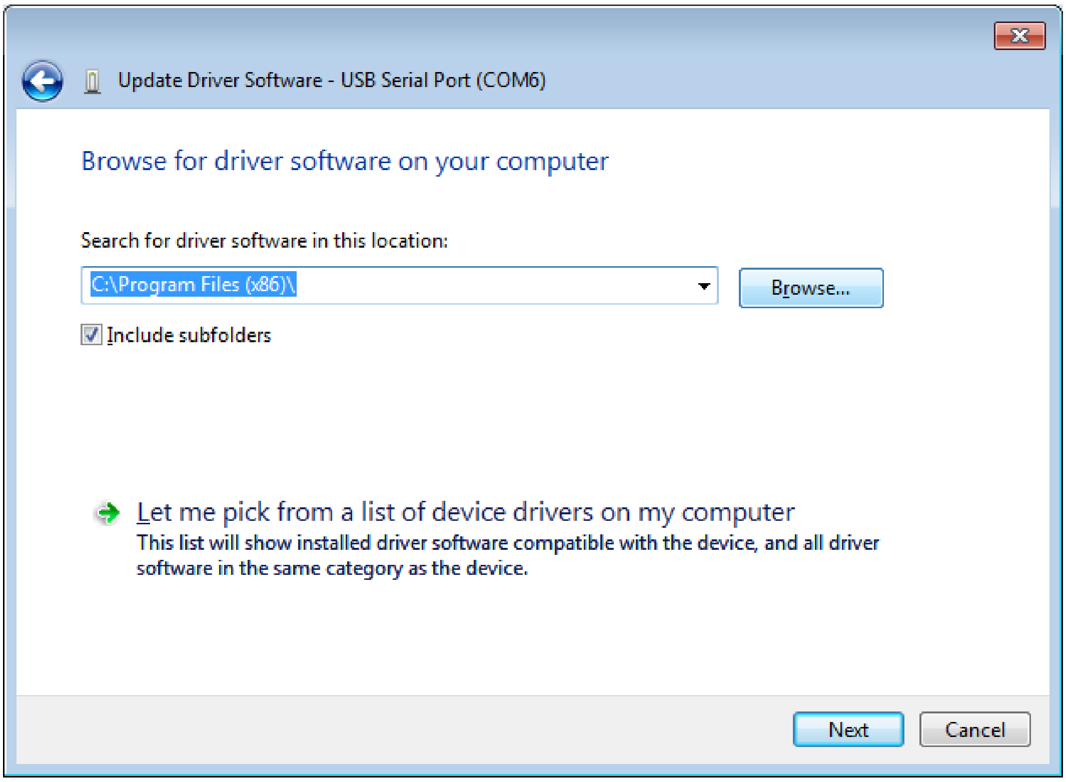

fig. 45.: Installing port driver, search path

- Enter the same file path you specified in the first part of the installation procedure.
- Confirm by clicking the "Next" button.

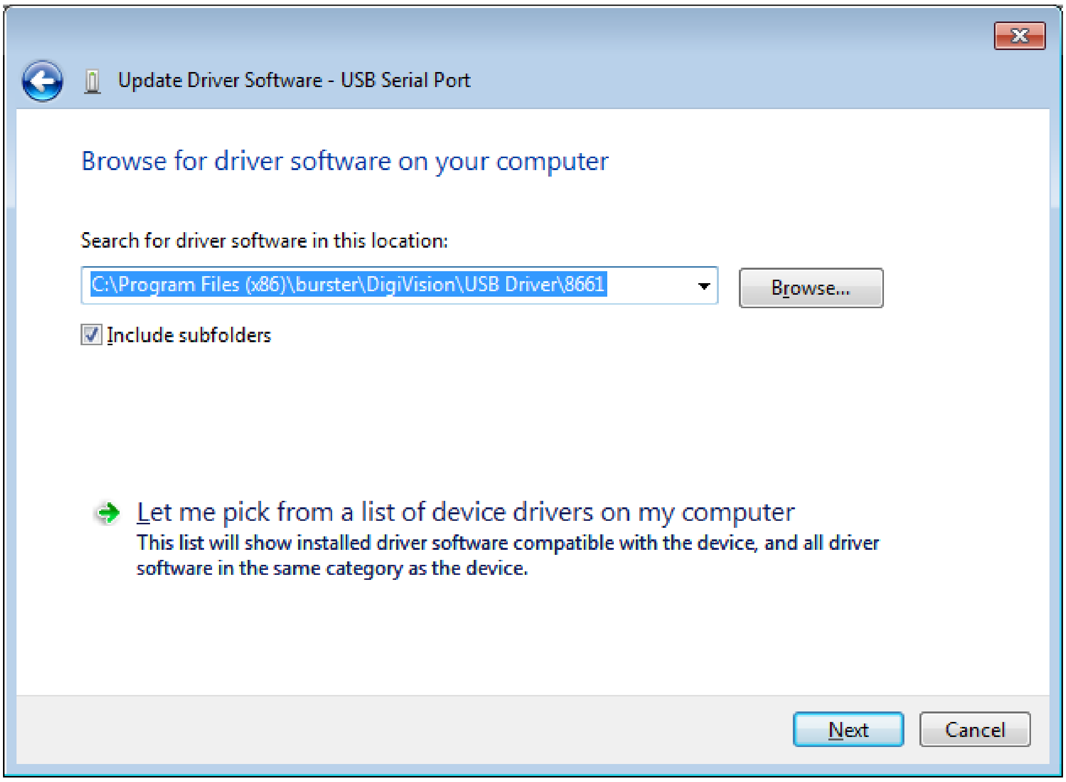

fig. 46.: Installing port driver, confirm path

- Confirm your selection by clicking the "Next" button.

The operating system confirms that the virtual COM port has been installed.

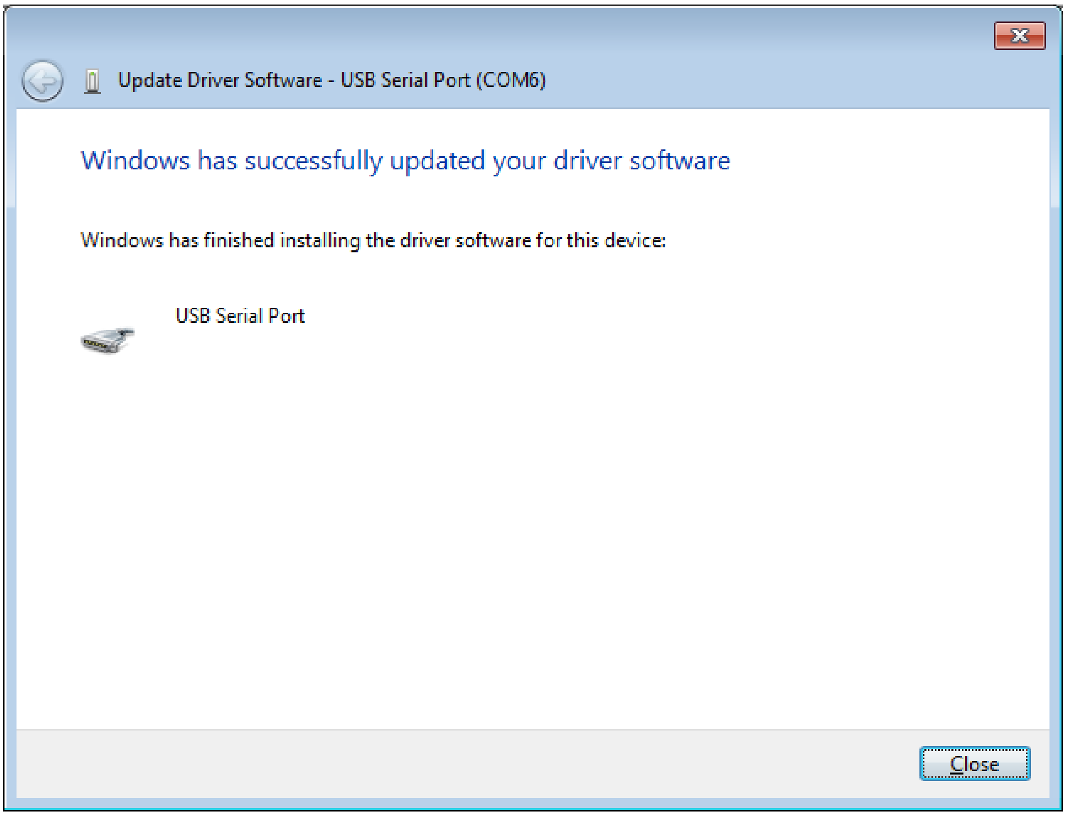

fig. 47.: Installing port driver, installation successful

- Click on "Close" to close this window.

A new device called "USB Serial Port" appears in Device Manager. The COM port listed here is now assigned to the model 8661 USB sensor, and is always visible when the model 8661 USB sensor is plugged into a USB port.

If you are using more than one model 8661 USB sensor at the same time on one computer, then each sensor is assigned a separate COM port.

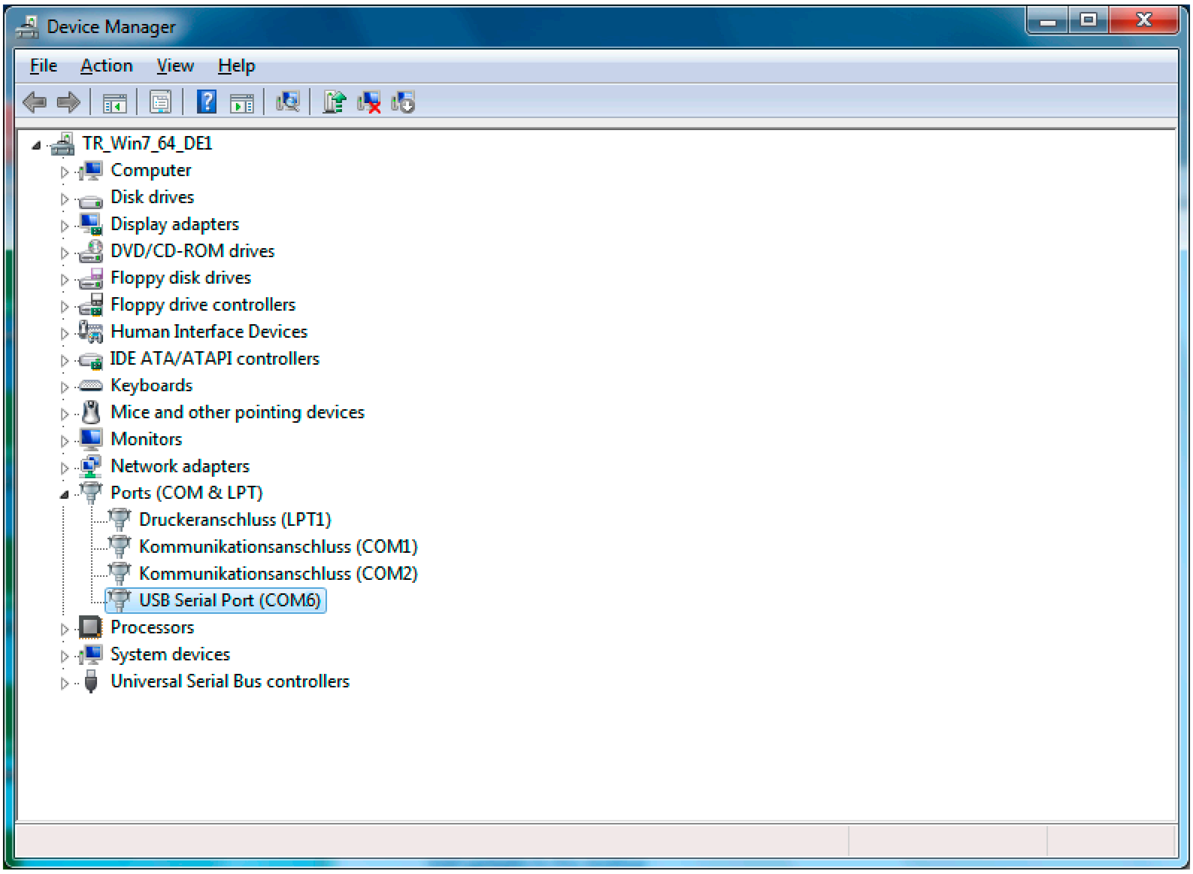

fig. 48.: COM port with USB

Note

If a previously installed model 8661 USB sensor is plugged in again, Administrator rights are no longer needed. You will only need Administrator rights again the first time you connect and install a different model 8661 sensor.

If you wish to connect another model 8661 sensor, you will need to go through the installation procedure again. The virtual COM port is installed on the basis of the serial number, i.e. you can use the same COM port to drive the model 8661 USB sensor on any USB port on the PC.

- Restart the computer.

After the restart:

- Launch the DigiVision configuration and analysis software.

8.2.4 Software licensing for 8661-P100

The licensed version of the software (you can purchase a license at any time) provides a graphical display facility for up to sixteen channels in parallel. The full measurement rate capability of 400 measurements/second is also activated in the licensed version.

To activate your copy of DigiVision, follow these steps:

Click ? →Licensing

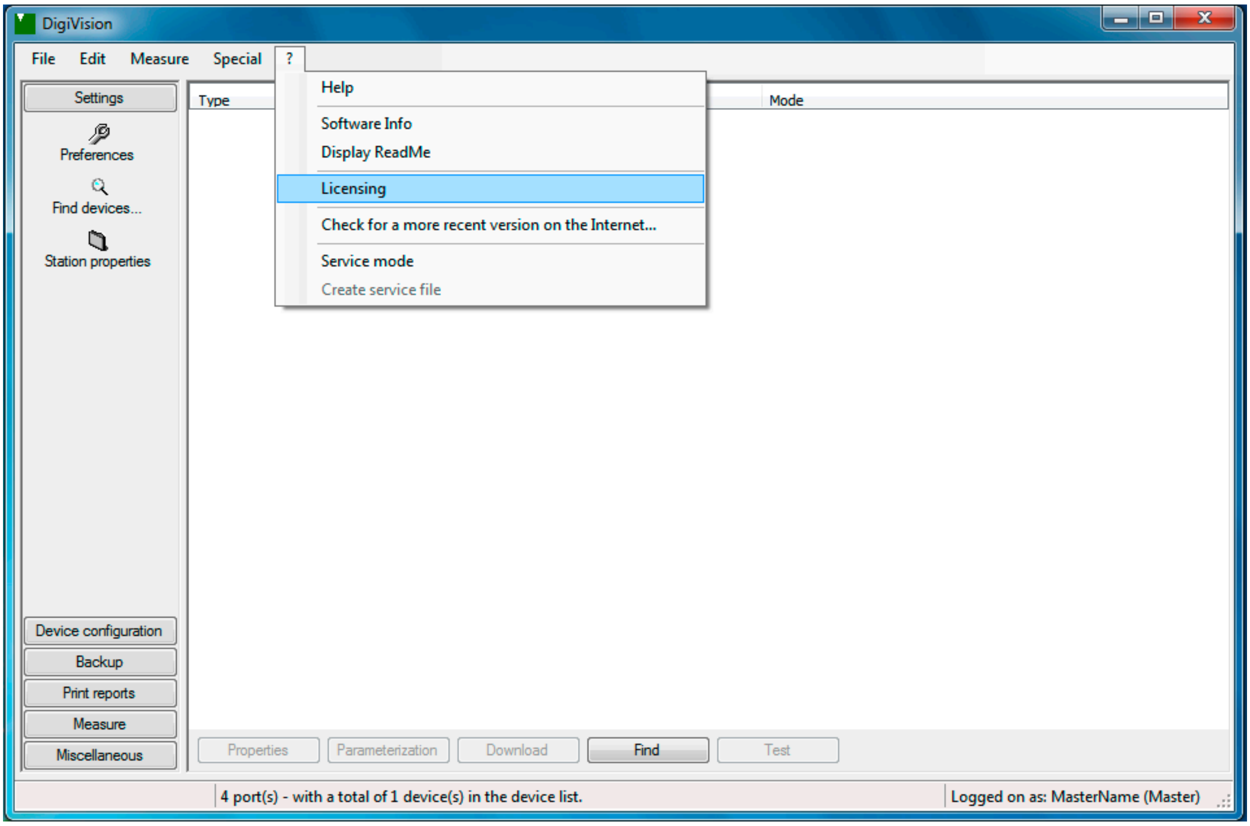

fig. 49.: DigiVision licensing, Licensing menu item

- Enter your activation code.

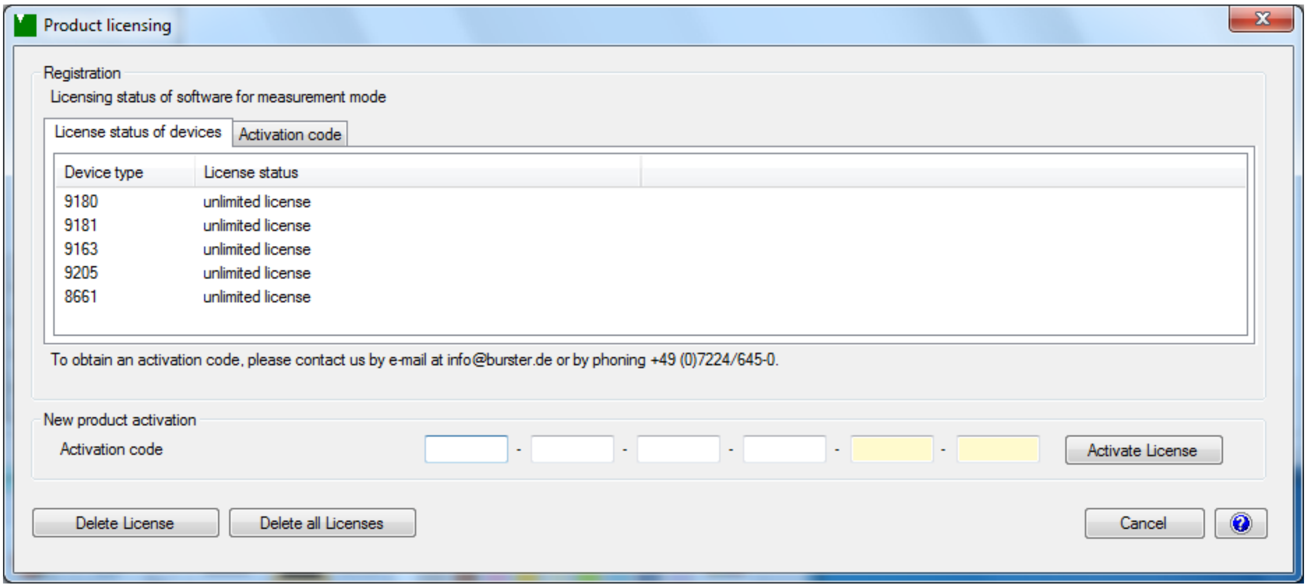

fig. 50.: DigiVision licensing, entering an activation code

This could look like this: 12345-12345-12345-12345

Hinweis:
Make sure that you enter the activation code exactly as it appears in your software licensing documents.

- Click the "Activate License" button.

  When the correct activation code is entered, the corresponding device type is activated.

  If the activation code is invalid, the licensing process is terminated.

8.2.5 Device detection

Device detection is possible in the licensed version of the software.

Depending on the installation situation, DigiVision may already recognize the sensor or it may need to find it. If the sensor is not displayed, run the device detection process.

- Open DigiVision.
- Go to File > Find devices...

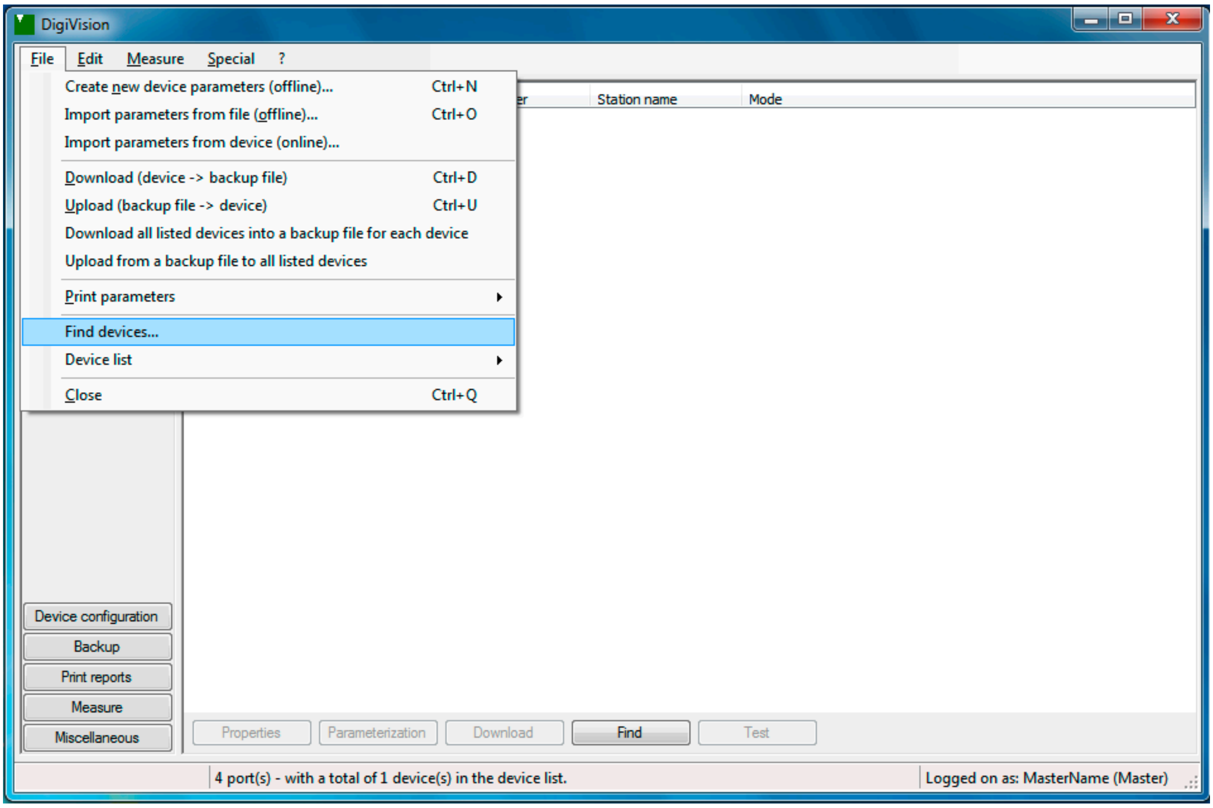

fig. 51.: DigiVision device detection, menu, Find devices...

As soon as the device is detected, it appears under its port.

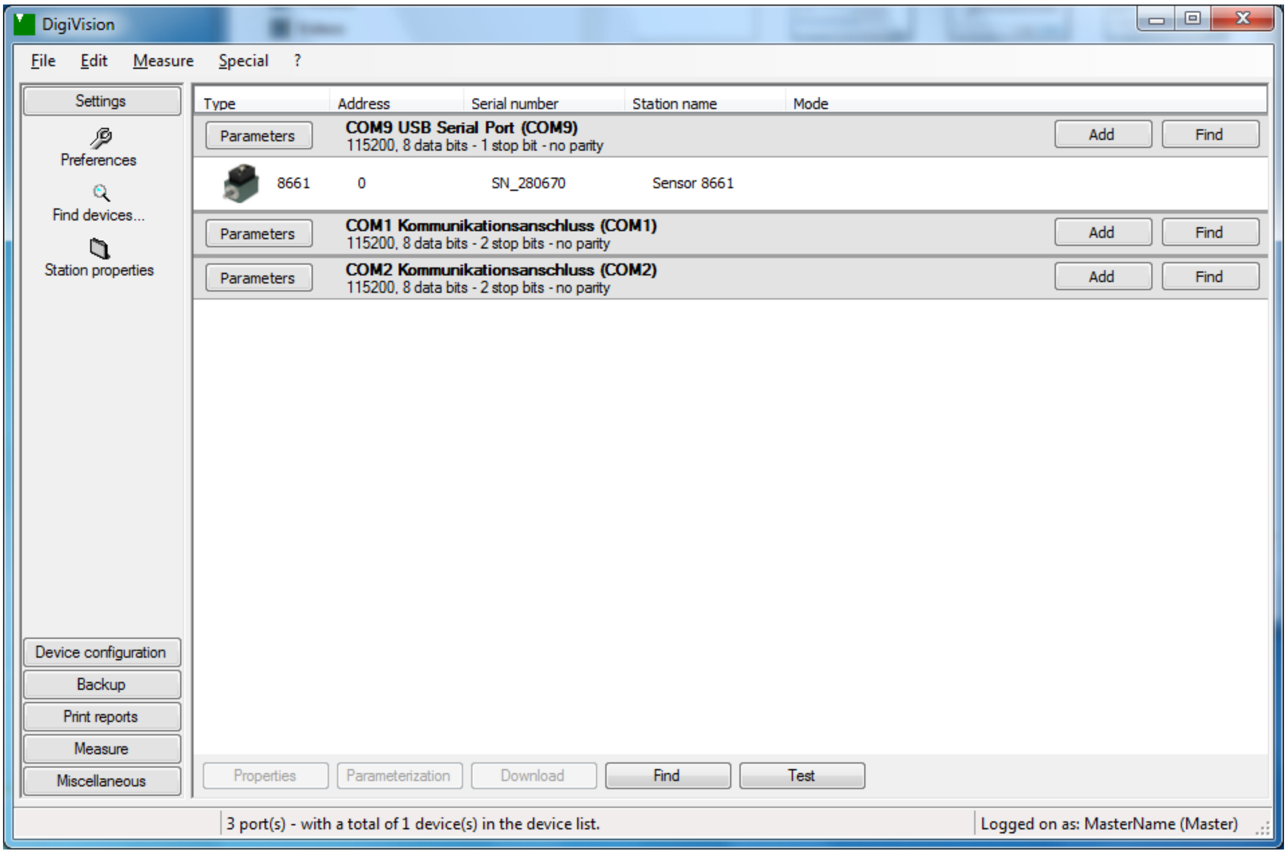

fig. 52.: DigiVision device search, device detected

8.3 Measurement mode, sensor with USB connection

8.3.1 Display

The measurement curve is displayed in a line graph of the measurement value plotted against time. A separate measurement curve is displayed for each measurement channel. The MIN and MAX values are also shown with the curve. The measurement channels can be shown and hidden individually.

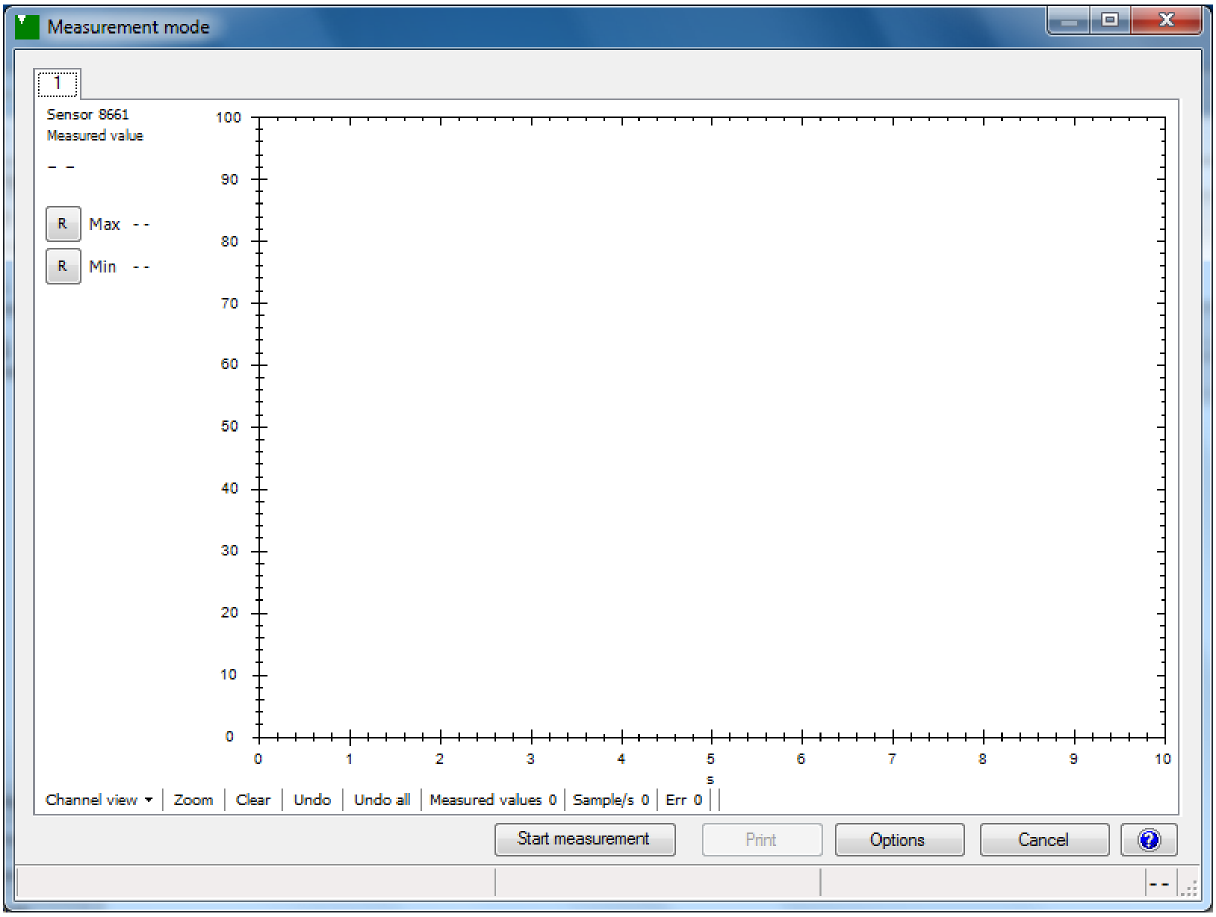

fig. 53.: DigiVision, standard version 8661-P001

The standard version of 8661-P001 is supplied with the sensor.

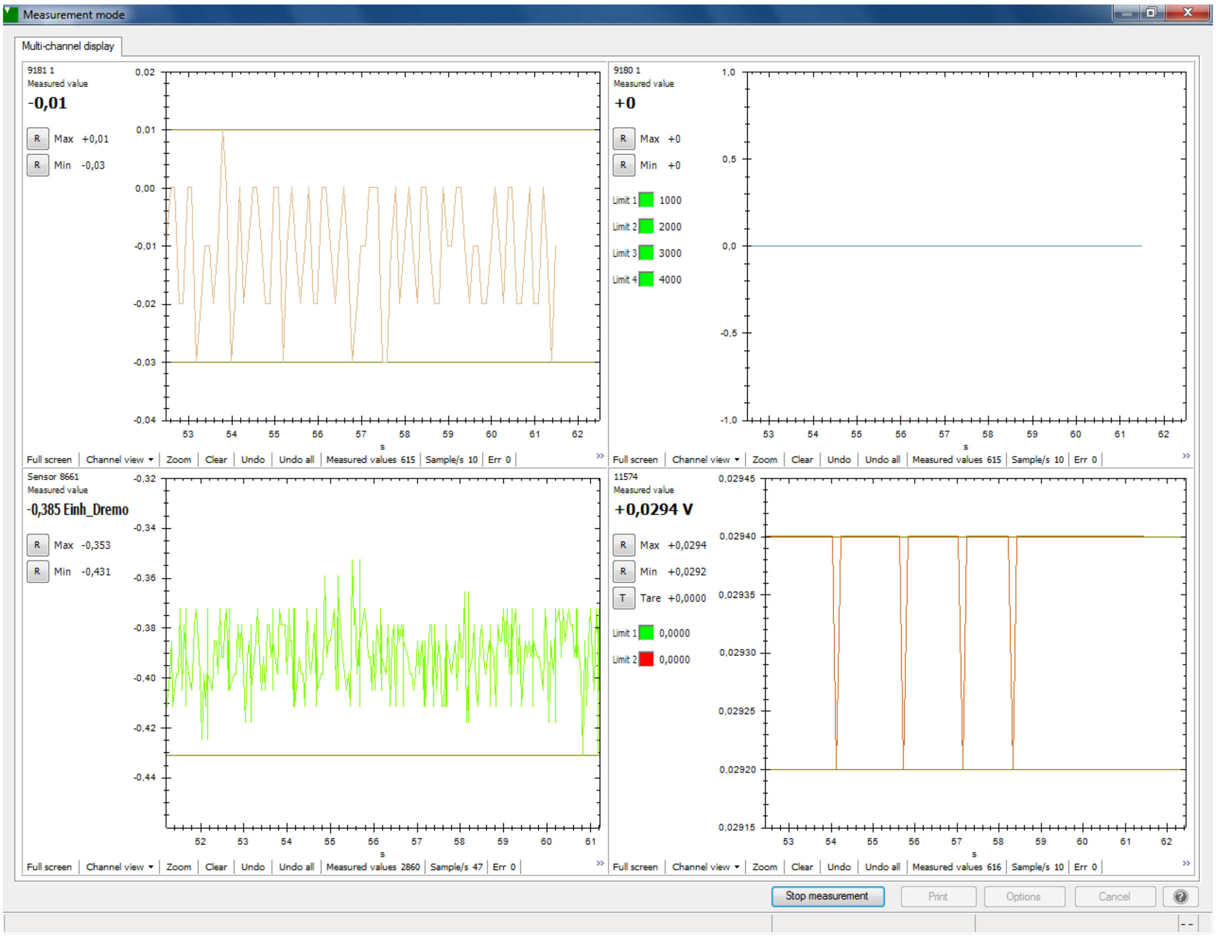

fig. 54.: DigiVision, licensed version of 8661-P100

The paid version of 8661-P100 can display up to 16 measurement channels.

8.3.2 Operation

8.3.2.1 Starting measurement

Hinweis:
If you wish to save the raw data for the measurement data reports, before starting measurement you must tick the "Save raw-data measurement files" box under Preferences > Data storage.

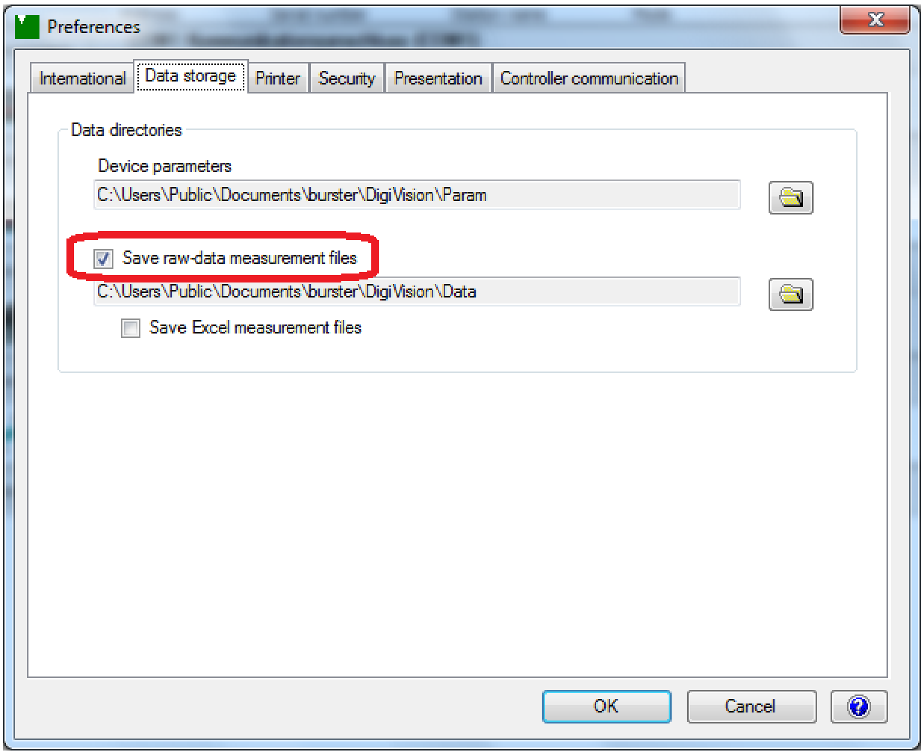

fig. 55.: Preferences, Save raw-data measurement files

- To enter measurement mode, click on "Measure" in the left-hand menu bar.
- This opens the Measurement window; click on the "Start measurement [F5]" button to activate measurement.

During the measurement process, the instantaneous measurement value and minimum and maximum values are displayed and updated at the set measurement rate.

- Click the respective "R" button.

  This resets the minimum or maximum value during the measurement process.

8.3.2.2 Stopping measurement

- Click the "Stop measurement" button.

The measurement can also be stopped using a trigger with a suitable stop condition. (See section 4.3.4 Trigger.)

8.3.2.3 Measurement display

In the 8661-P100 multi-channel version, if you wish to see a larger view of the measurement curve, you can click on the "full-screen" button to enlarge individual graphs to full-screen size during the measurement process. You can revert to the usual size by clicking on the "Normal" button.

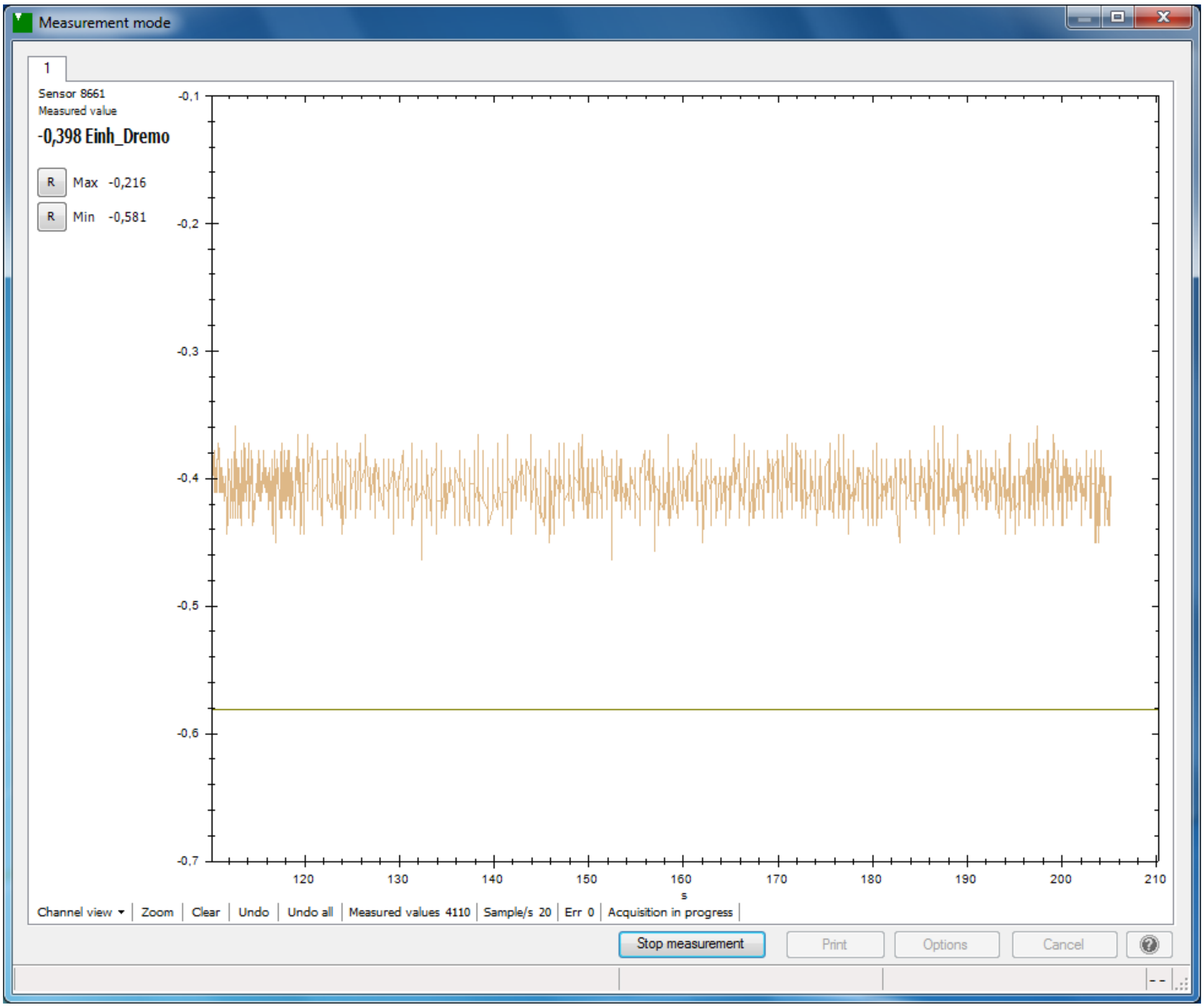

fig. 56.: DigiVision, measurement display

Information such as measurement rate and the number of measurements is also provided for each measurement channel.

8.3.2.4 Options

The channel settings can be changed in measurement mode using the "Options" button.

8.3.3 Basic configuration

On the Basic configuration tab, you can specify how many channels you wish to display.

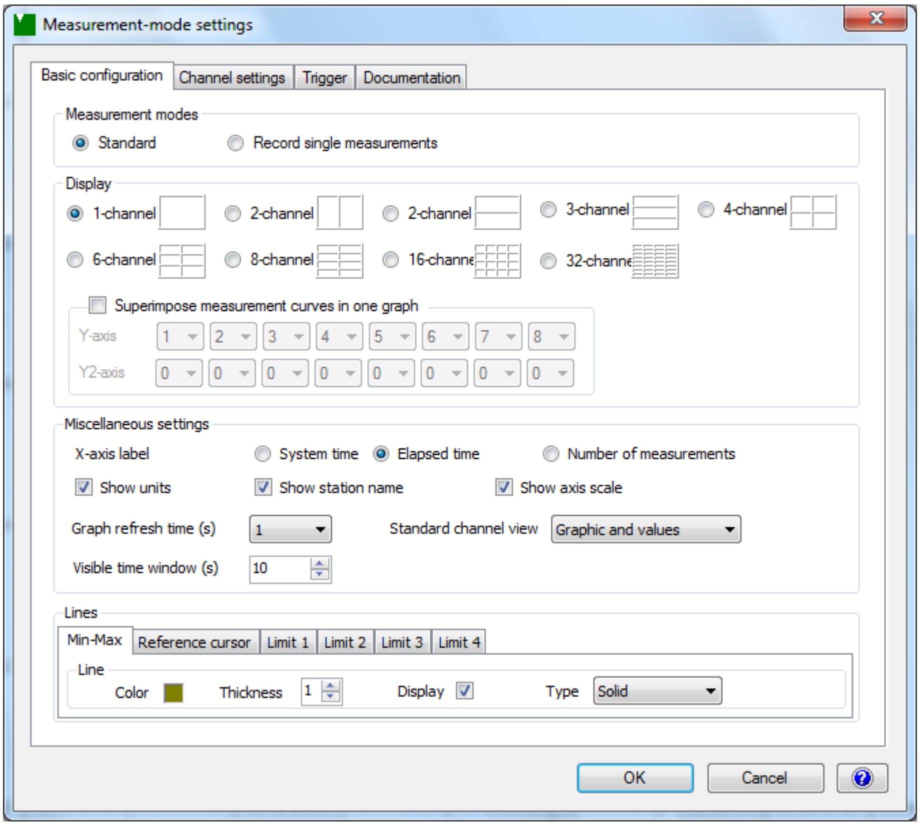

fig. 57.: DigiVision, Basic configuration

You can also make various other settings here for the display and presentation of the curve.

8.3.4 Channel settings

On the Channel settings tab, you can set the parameters for the respective measurement channel.

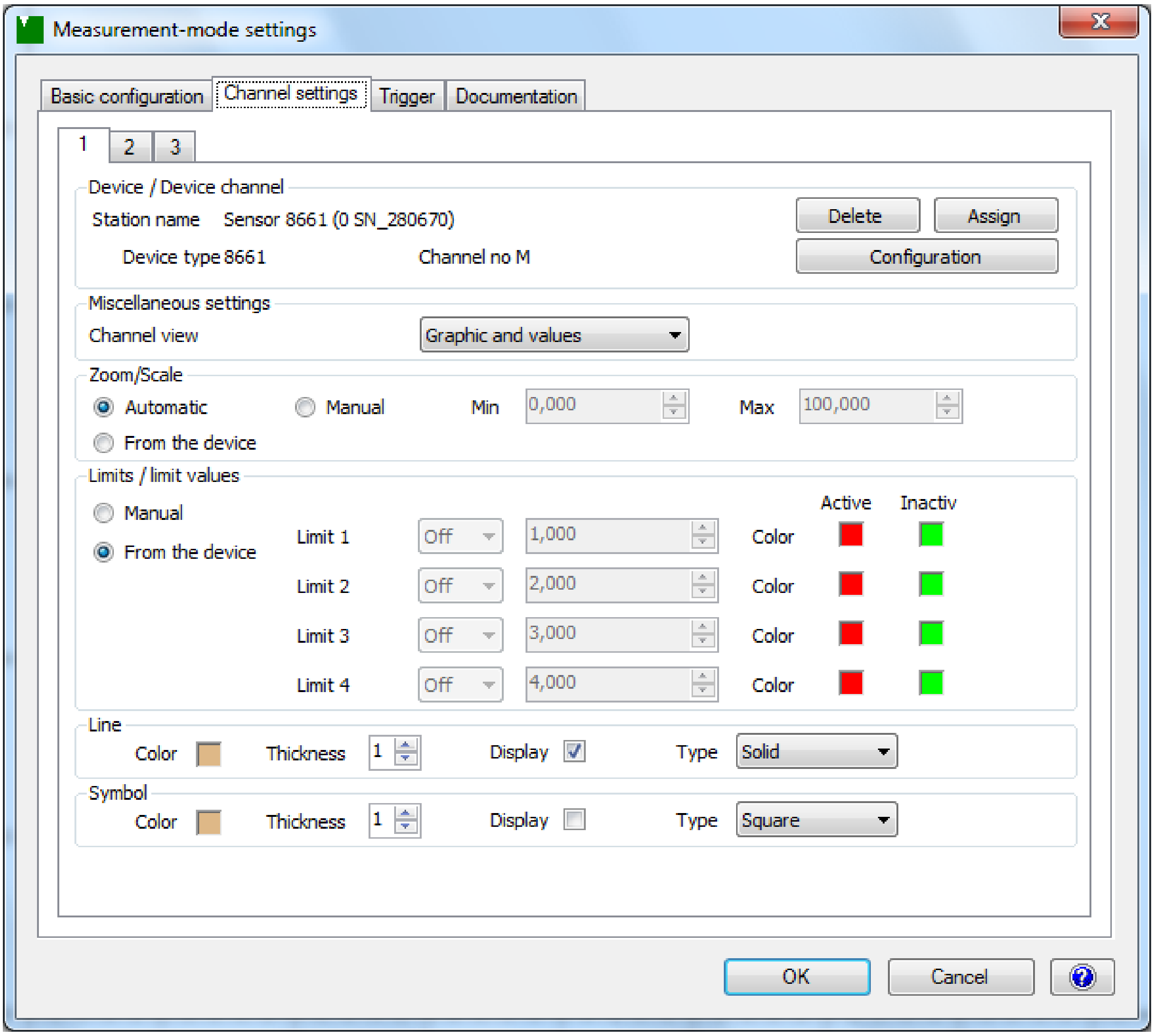

fig. 58.: DigiVision, Channel settings

The default setting is to adopt the parameters from the sensor, although you can also make manual changes to any parameter.

You can also define the limit values here.

You can also specify the color and shape of the measurement curves and displayable symbols here.

You make these settings separately for each measurement channel.

8.3.5 Selecting the measurement rate

There are two different acquisition modes for which you can select the measurement rate.

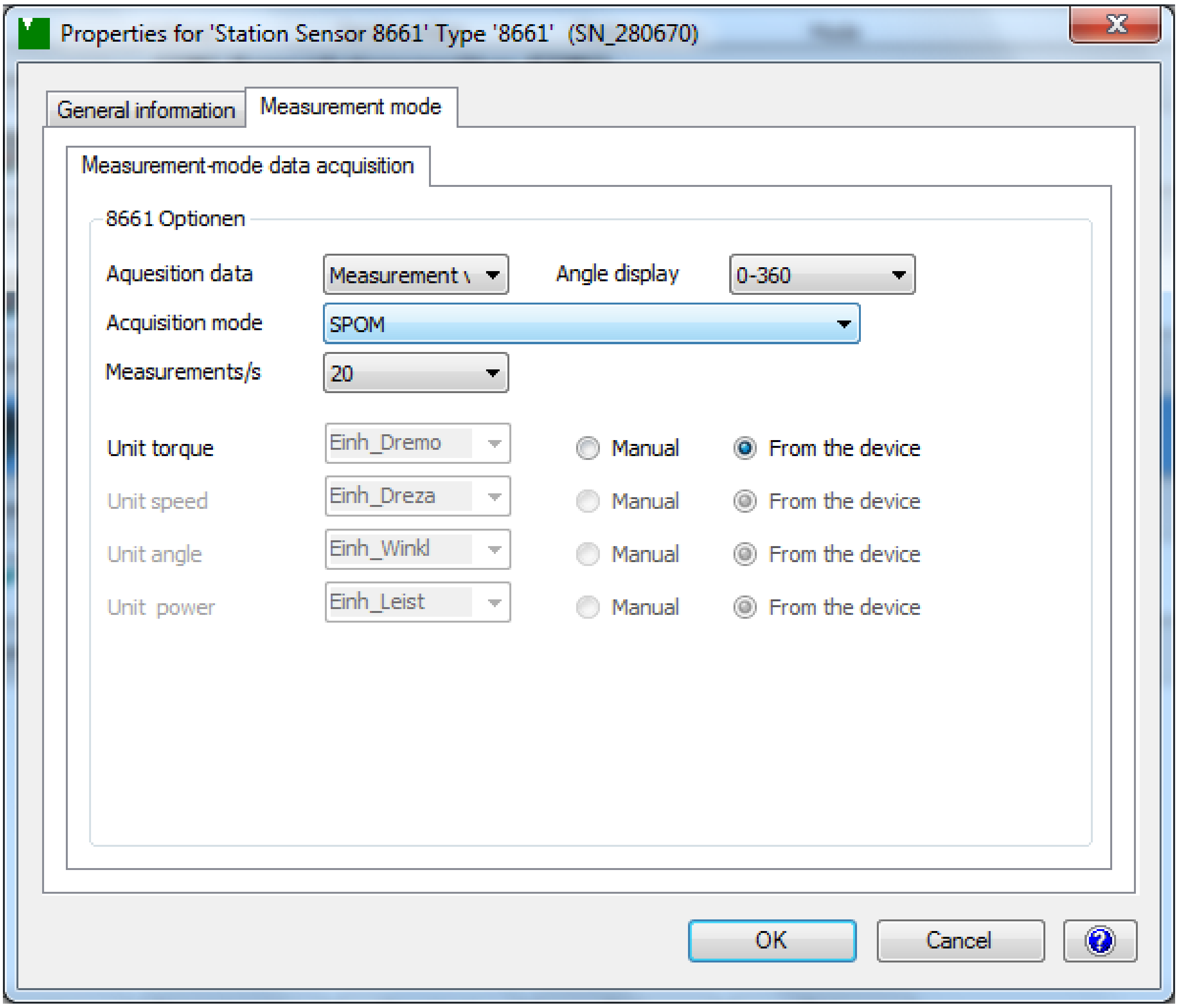

fig. 59.: DigiVision, selecting the measurement rate

The following acquisition modes are available:

- Normal

  Measurement rates of between 0.1 and 20 measurements per second are possible here.

- SOPM – Speed Optimized Polling Mode

  Measurement rates of between 0.1 and 400 measurements per second are possible here.

Follow these steps to select the measurement rate:

- In the Device list, select the relevant 8661 sensor by clicking on it once.
- Then click on the "Properties" button and select the "Measurement mode" tab.
- Now select the acquisition mode and the appropriate measurement rate.
- Confirm your selection with "OK".

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8.3.6 Trigger

Measurement can also be stopped using a trigger with a suitable stop condition.

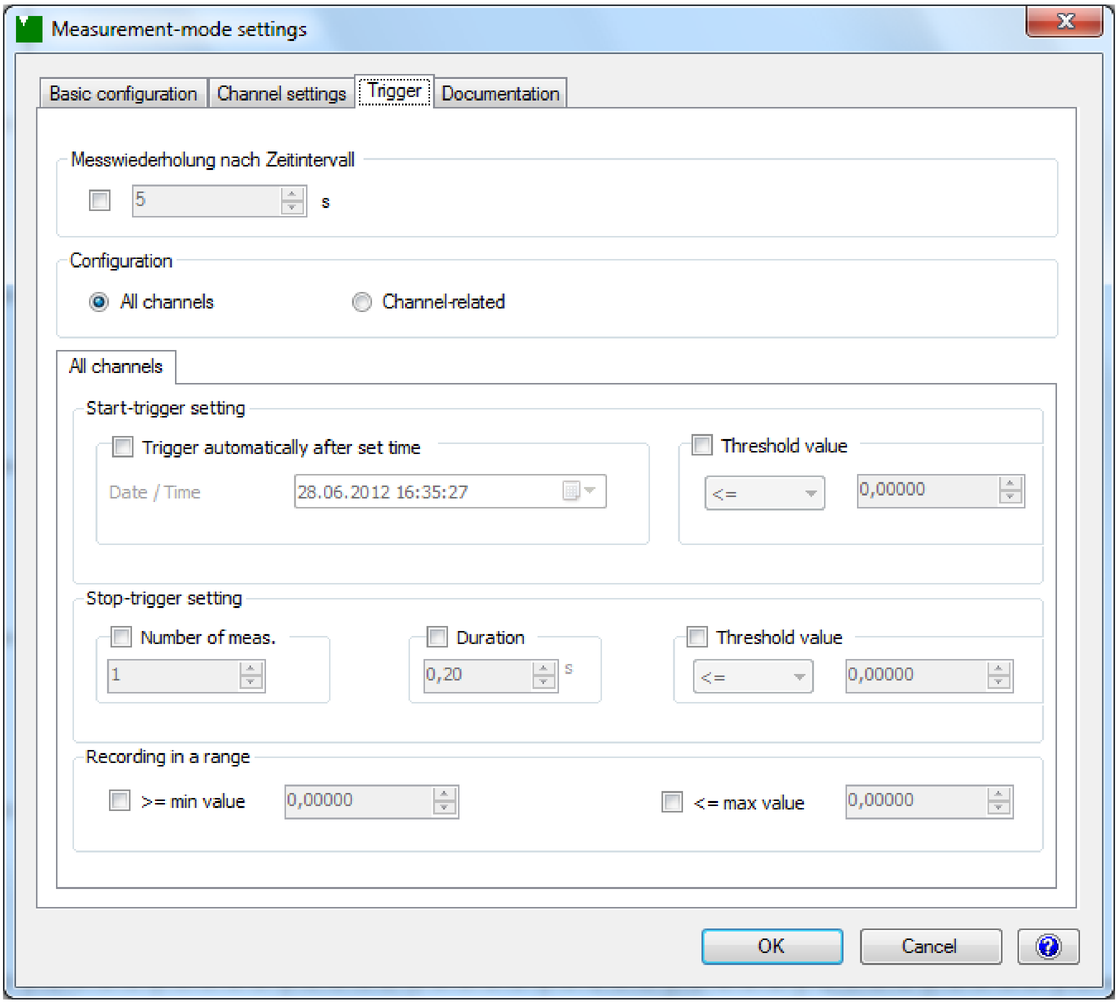

fig. 60.: DigiVision, Trigger

Repeat measurement after time interval

This setting specifies a time interval after which a repeat measurement takes place following the end of a measurement process. For all channels or channel-related.

Start-trigger setting

This defines the start condition.

Stop-trigger setting

Likewise, this defines the stop condition.

Recording in a range

This setting lets you define a range in which measurement is performed.

8.3.7 Documentation

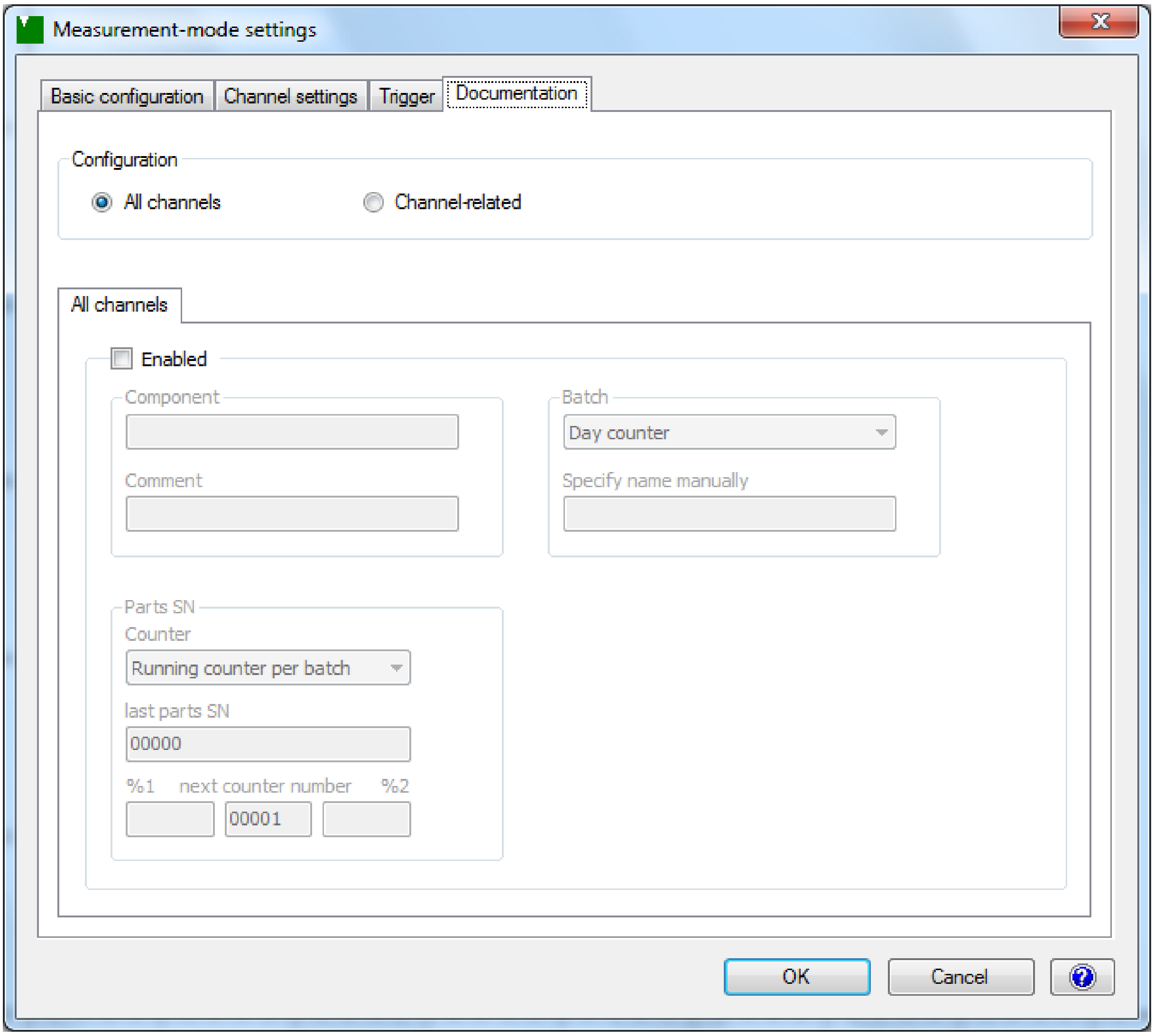

fig. 61.: DigiVision, Documentation

Various documentation settings are available here.

8.4 Measurement reports

Hinweis:

If you wish to save the raw data for the measurement data reports, before starting measurement you must tick the "Save raw-data measurement files" box under Preferences > Data storage.

8.4.1 Measurement report finder

The DigiVision software has a convenient archiving facility for measurement reports. It lets you save all the measurements that have been made, and then retrieve them again as required. You can use the "Find reports" facility to perform the following actions for one or more reports: view, analyze, print, save as a PDF document or export to an Excel file.

- To access the report search, click on "Measure" in the left-hand menu bar and then on "Find and manage measurement reports".

  The Find reports window now opens.

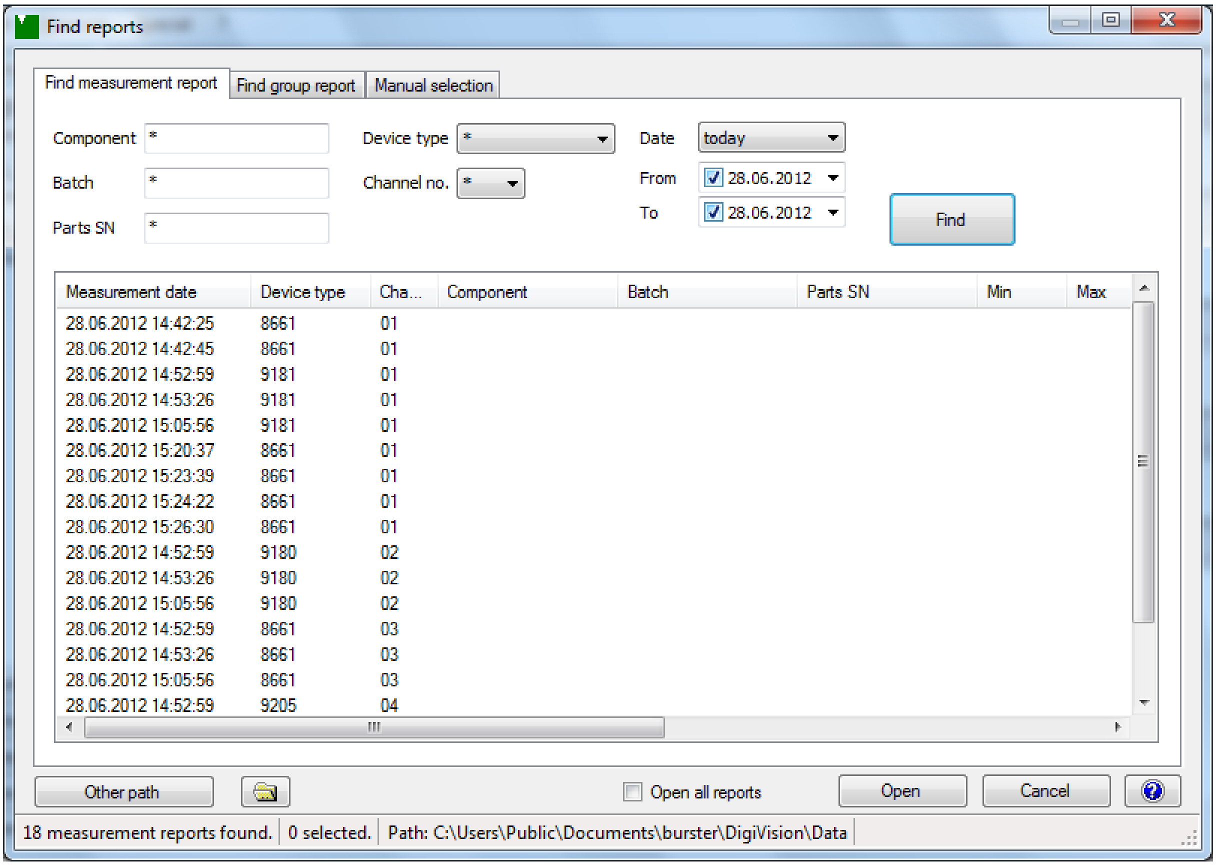

fig. 62.: DigiVision, Find reports

You can choose between two types of reports:

- Measurement report

  Measurement report for each individual physical variable (M, α, n, P). This is displayed as a series of measurements.

- Group report

  Report for all measurement series. The individual measurement reports involved in the measurement series are held here. This facilitates assignment to the measured variable.

Various filters such as device type, date and channel no. can be used to reduce the number of reports displayed for a clearer picture.

➢ Select the required report by left-clicking on it. If you wish to select more than one report, hold down the "CTRL" key on your keyboard at the same time.

➢ Once you have selected the report(s) you require, click on "Open".

8.4.2 Archive viewer

Once you have selected the measurement reports from the Find reports window, the Archive viewer opens. This gives you detailed information on your measurement.

The Archive viewer is also the management center for viewing and editing reports.

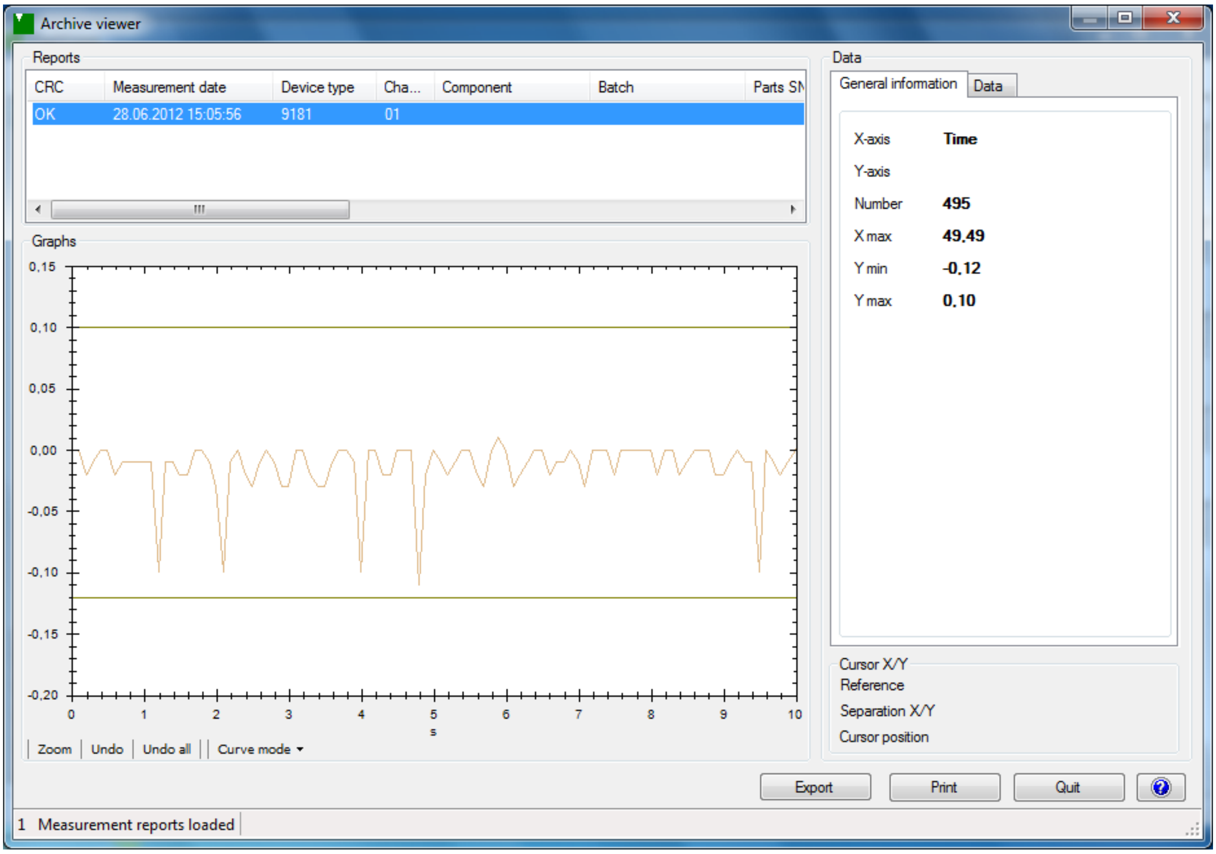

fig. 63.: DigiVision, Archive viewer

View each measurement report separately

- Left-click on the required report.

Combine multiple measurement reports to superimpose the measurement curves

- Select the required reports by left-clicking them. If you wish to select more than one report, hold down the "CTRL" key on your keyboard at the same time.

8.4.3 Exporting reports to Excel

Hinweis:

To export measurement reports in Excel format, it is not necessary for Microsoft Excel or an equivalent program to be installed.

Once you have selected the reports you require in the Archive viewer, you can export them into an XLS file by clicking on the "Export" button. Follow the steps below:

- Select the required report by left-clicking on it. If you wish to select more than one report, hold down the "CTRL" key on your keyboard at the same time.
- Click on the "Export" button.
- Specify whether you wish to export all the reports or just those you have selected.
- Specify the path to the required directory for saving the file.

  The default setting is to save the Excel files in the same directory as the measurement reports. You can also specify an alternative path here.

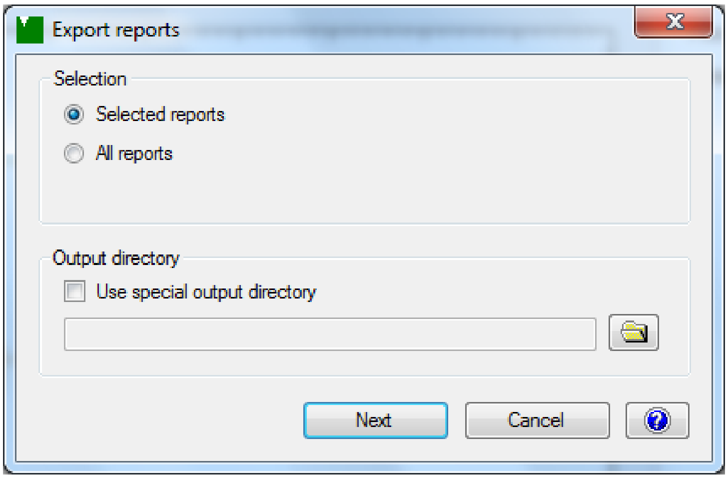

fig. 64.: DigiVision, Export reports

- Click on "Next".

  The data is now converted and saved in the specified directory.

8.4.4 Print reports

Once you have selected the reports you require in the Archive viewer, you can print them by clicking the "Print" button.

Follow the steps below:

- Select the required report by left-clicking on it. If you wish to select more than one report, hold down the "CTRL" key on your keyboard at the same time.
- Click on the "Print" button.

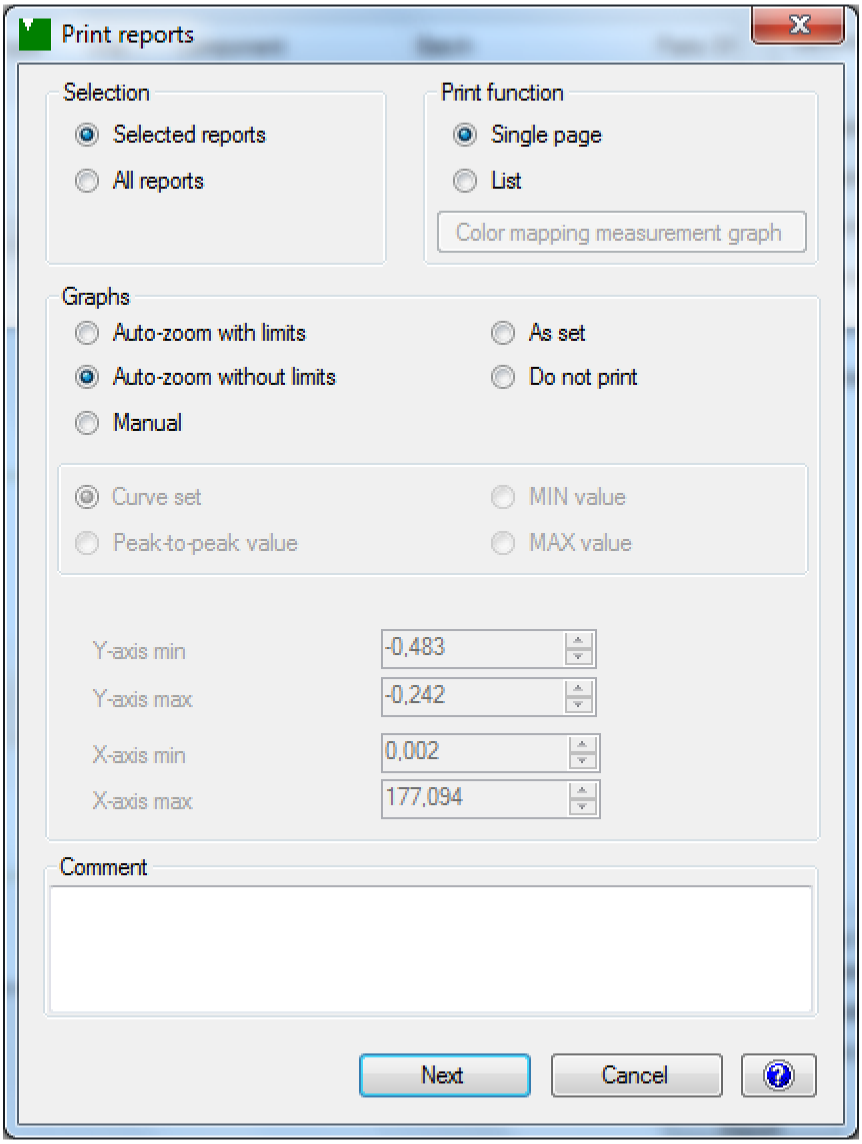

fig. 65.: DigiVision, Print reports

- Now select how you want the reports printed.
- Click on "Next".

The Print Options window opens.

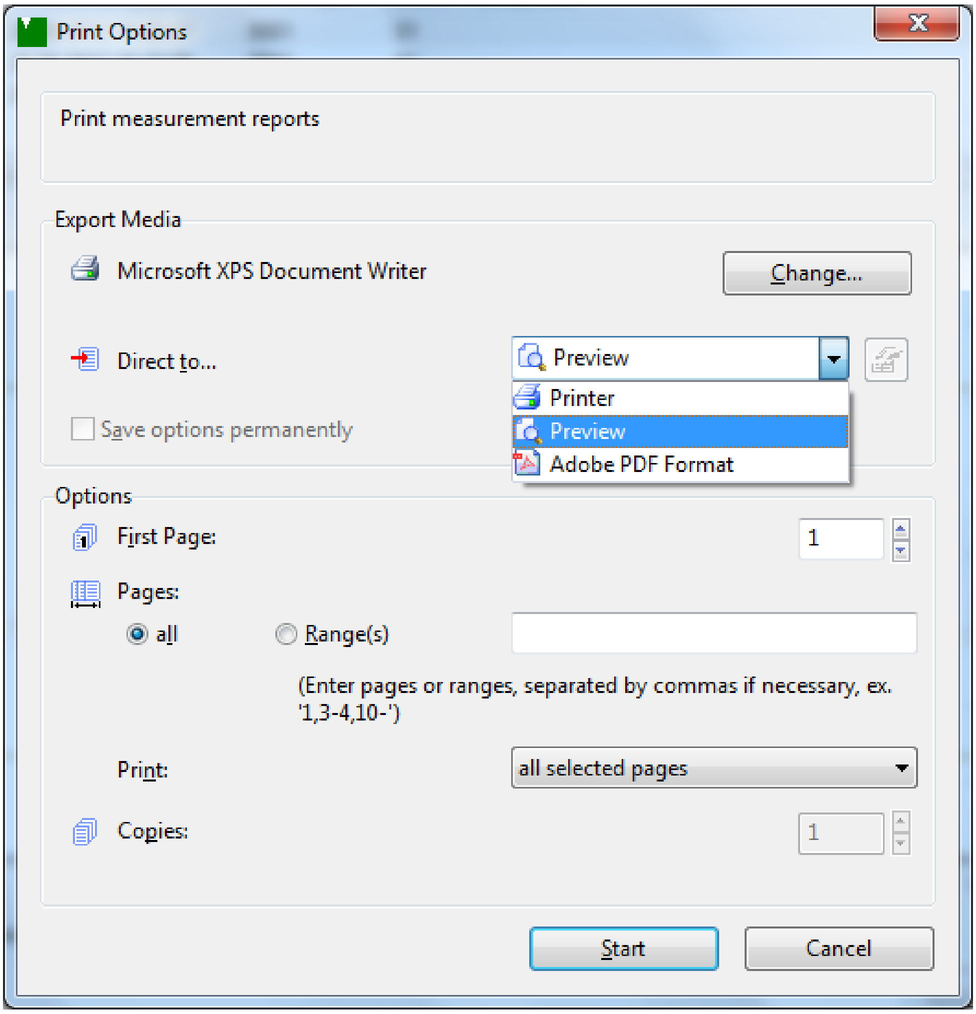

fig. 66.: DigiVision reports, Print Options

- Now specify how you want the data to be output.

  You have the option to choose a printer, print preview or output as a PDF document.
- Click on the "Start" button.

  The data is now output in the specified form.

9. Cleaning and maintenance

There are **no** parts in the torque sensor that you can service as a customer or user. The transmission system in this torque sensor is completely maintenance-free.

However, we recommend that you:

- Check the bearings at least once a year to see that they move freely.
- Replace the low-friction special bearings after a maximum of approx. 20,000 hours of operation. In continuous operation at high speeds it may be necessary to replace the bearings sooner.
- Check cables and connectors annually.

It is up to you as the user to determine the recalibration interval. We recommend that you check/recalibrate the sensor after a maximum of 26 months in normal use.

10. Taking out of use

- Remove the sensors correctly.
- Protect the sensor from knocks.
- Protect the sensor against bending moments.
- Support the sensor.
- Do not drop the sensor **under any circumstances.**

11. Technical Data

Electrical values

Rated supply voltage range U_b .... 10 ... 30 V DC
Power consumption (without option): .... approx. 2 W
Output voltage at ± rated torque: .... ± 10 V
Output impedance: .... 1 kΩ
Insulation resistance: .... > 5 MΩ
-3 dB cut-off frequency: .... 200 Hz
Ripple: .... < 50 mVss
Calibration signal: .... 10.00 V DC
Drive signal (pin K): .... 10 ... 30 V DC

Supply and measurement channel are galvanically isolated.

Power supply built-in connector: .... hole diameter 5.7 mm
.... center pin 2.0 mm

Speed/angular displacement measurement (option)

Output without external circuit: .... TTL level
Output with external circuit: .... Open Collector
Internal pull-up resistor: .... 2 kΩ (5 V level)
External circuit (Open Collector output): .... Umax = 30 V /
.... Imax = 30 mA

Both pulse channels A and B are always available. Only one channel is needed for the speed measurement. Two channels are used for measuring the angular displacement (or detecting the direction of rotation).

Direction is detected by 2 pulse output channels; channel A leads channel B by 90° for clockwise rotation viewed from the drive end.

Angular displacement measurement:

Resolution for encoder disk with 1024 increments .... 0.09°
Resolution for encoder disk with 400 increments .... 0.225°

Speed measurement:

max. rotational speed for an encoder disk with 400 increments .... 15,000 rpm
max. rotational speed for an encoder disk with 1,024 increments .... 6,000 rpm
(mechanical limit, see table 2: "Max. rotary speed" on datasheet 8661)

Environmental conditions

Operating temperature range: .... 0 °C ... 60 °C
Rated temperature range: .... 0 °C ... 60 °C

Effect of temperature on the zero signal:

range 1:1 (standard sensor) .... ± 0.015 % F.S./K
extendend range (dual range sensor)..... ± 0.03 % F.S./K

Effect of temperature on the sensitivity

range 1:1 (standard sensor) .... ± 0.01% F.S./K
extendend range (dual range sensor)..... ± 0.02 % F.S./K

Mechanical values

Relative linearity deviation (standard sensor):

Measuring range 0 ... 0.05 Nm .... < ± 0.1 % F.S.
Measuring range 0 ... 0.1 to 0 ... 200 Nm. < ± 0.05 % F.S.

Relative linearity deviation (dual range sensor)
.... < ± 0.1 % F.S.

Relative reversal error (standard and dual range sensor):
.... < 0.1 % F.S.

Tolerance of the sensitivity (standard sensor): ±0.1 % F.S.
Tolerance of the sensitivity (dual range sensor): ±0.2 % F.S.

Max. operating torque (standard sensor):
.... 200 % of rated torque

Max. operating torque (dual range sensor):
.... 150 % of rated torque

Failure torque: .... 300 % of rated torque

Alternating load, referred to rated torque: .... up to 70 %

Material: .... housing made of anodized aluminum

Measurement range

≤ 0.2 Nm aluminum measuring shaft, shaft ends made of stainless steel 1.4542
≥ 0.5 Nm measuring shaft made of stainless steel 1.4542

Degree of protection to EN 60529: IP40

Electrical connection: .... 12-pin plug-in connection
.... (type 9940 mating connector is supplied)

Fixing method: mounting holes are located on the end faces and the base. (See table 1 and dimensional drawing on datasheet 8661.)

Mounting instructions

When fitting the sensor, make sure that the measuring shaft is aligned as precisely as possible with the connecting shafts. Couplings must be employed to avoid strain on the sensor from parallel or angular displacement of the shafts.

The permitted axial and radial forces (see table 2 and 3 on data sheet) must not be exceeded during fitting or operation, see section 5.2 Mechanical installation on page 19.

12. Disposal

	**Equipment Disposal** Please fulfill your legal obligations and dispose of unserviceable equipment in accordance with applicable legal requirements. Thus you contribute to environmental protection.

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