HEIDENHAIN

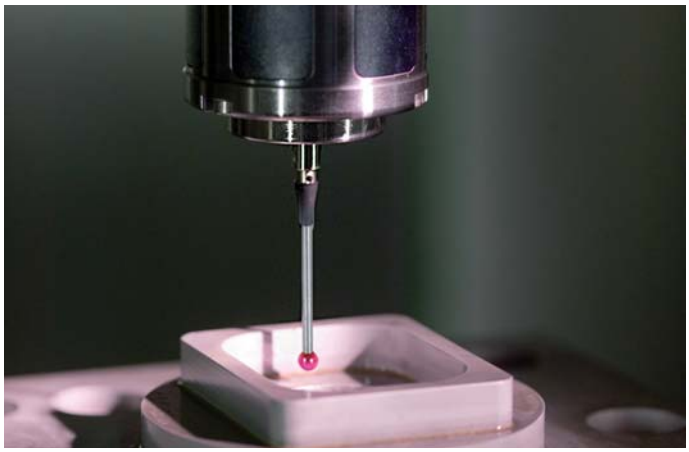
Touch Probes

for Machine Tools

October 2010

Touch Probe Systems for Machine Tools

Touch probes from HEIDENHAIN were conceived for use on machine tools—in particular milling machines and machining centers. Touch probes help to reduce setup times, increase machine usage time and improve the dimensional accuracy of the finished workpieces. Setup, measuring and monitoring functions can be performed manually or—in conjunction with most CNC controls—under program control.

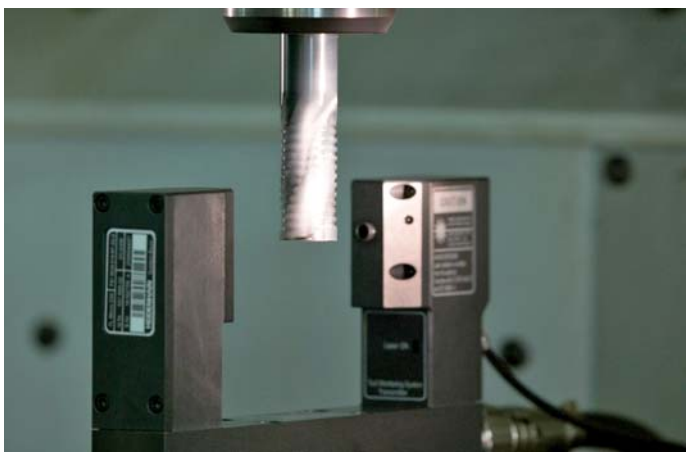


Workpiece measurement
HEIDENHAIN offers **TS triggering touch probes** for workpiece measurement right on the machine. The probe is inserted in the tool holder either manually or by the tool changer. They enable you to use the probing functions offered by your NC control to automatically or manually perform the following functions:

- Workpiece alignment
- Workpiece presetting
- Workpiece measurement
- Digitizing or inspecting 3-D surfaces

Tool measurement
Successful series production hinges on the prevention of scrap or rework and the attainment of consistently good workmanship. The tool is a decisive factor here. Wear or tool breakage that go undetected for extended periods, especially during unattended operation, result in defective parts and unnecessarily increase costs. Therefore, exact measurement of tool dimensions and periodic control of wear are absolutely essential. For tool measurement on the machine, HEIDENHAIN offers the TT three-dimensional touch probe and the TL laser systems.

With the **TT triggering touch probes,** the contact plate is deflected from its rest position, sending a trigger signal to the NC control, during probing of the stationary or rotating tool.



The **TL laser systems** operate without any contact. A laser beam probes the length, diameter or contour of the tool. Special measuring cycles in the NC control evaluate the information.

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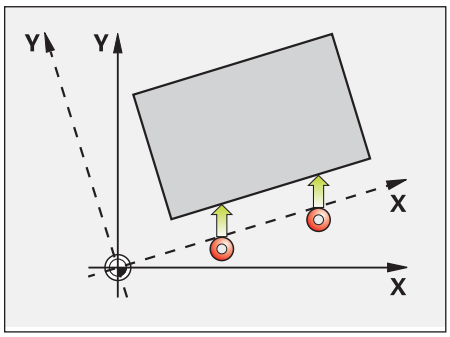
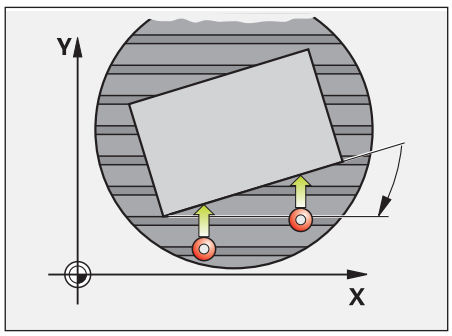
Application Examples
Workpiece Alignment

Exact workpiece alignment parallel to the axes is particularly important for partially machined workpieces to ensure that existing datum surfaces are in an accurately defined position. With the TS touch probe systems from HEIDENHAIN you can avoid this time consuming procedure and do without the clamping devices otherwise required.

- The workpiece is clamped in any position.
- The touch probe ascertains the workpiece misalignment by probing a surface, two holes, or two studs.
- The CNC compensates for the misalignment by rotating the coordinate system. It is also possible to compensate for it mechanically by rotating the table.



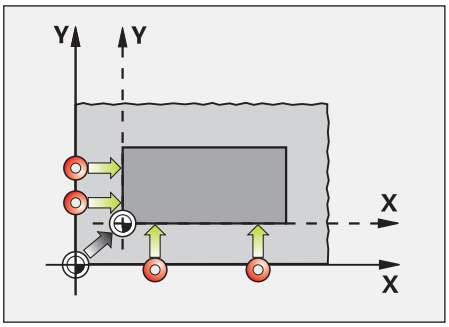
Compensating for misalignment through a basic rotation of the coordinate system



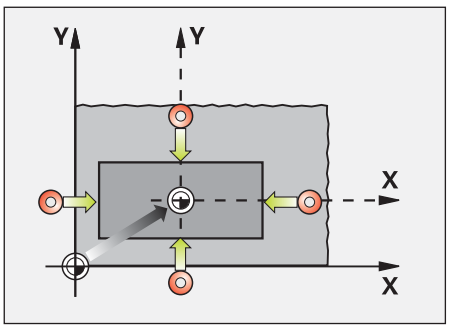
Compensating for misalignment by rotating the table

Workpiece Presetting

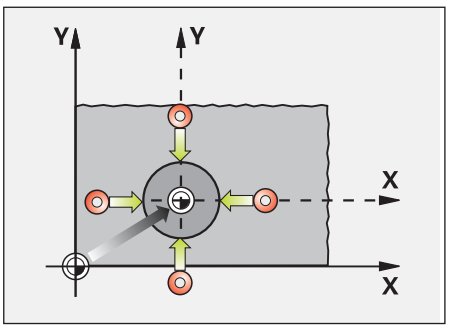
Programs for workpiece machining are based on reference points. Finding this point quickly and reliably with a workpiece touch probe reduces nonproductive time and increases machining accuracy. If probing functions are available on the CNC, the TS touch probes from HEIDENHAIN make it possible to set reference points automatically.



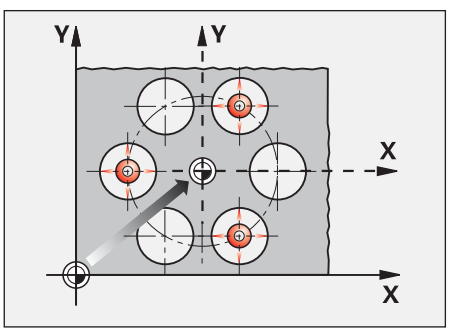
Outside corner



Center of a rectangular stud



Center of a circular stud

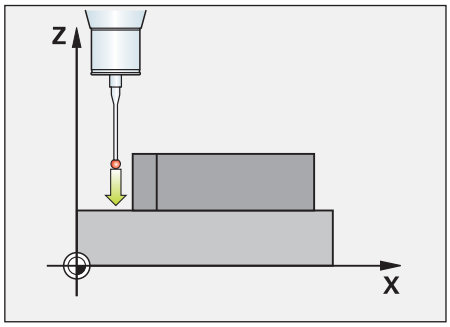


Center of a bolt hole circle

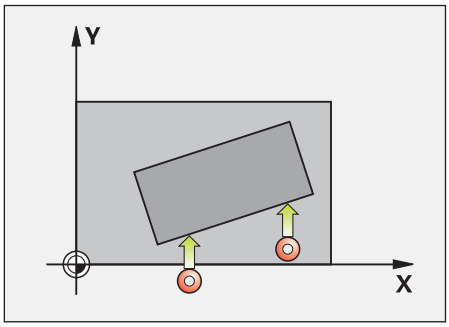
Workpiece Measurement

Touch probes from HEIDENHAIN are suited for program-controlled workpiece measurement between two machining steps. The resulting position values can be used for tool wear compensation.

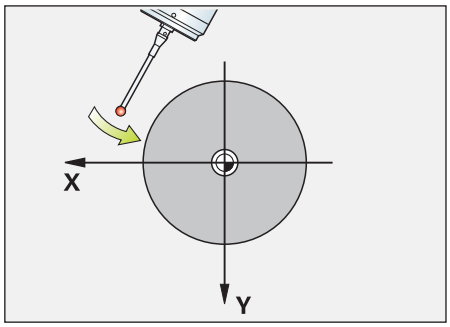
When the workpiece is done, the measured values can document dimensional accuracy or serve to record machining trends. The CNC can output the results of measurement through the data interface.



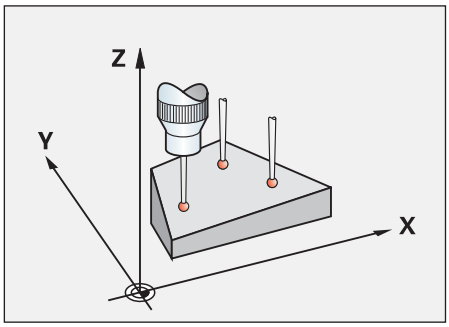
Measuring individual positions in an axis



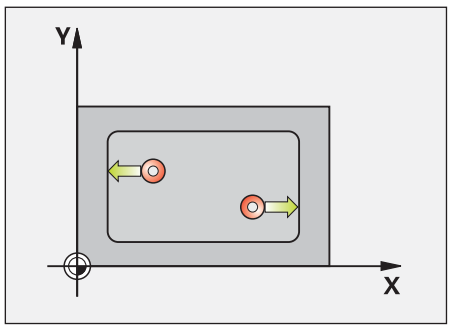
Measuring the angle of a line



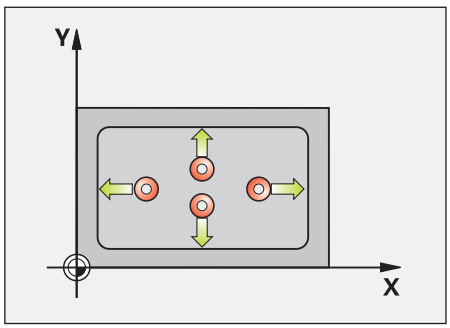
Diameter measurement (with TS 249)



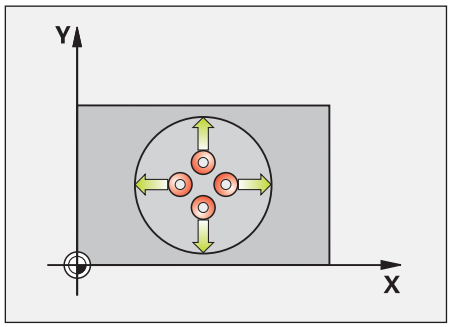
Measuring the angle of a plane



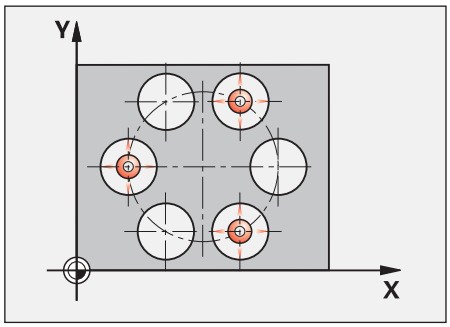
Length measurement



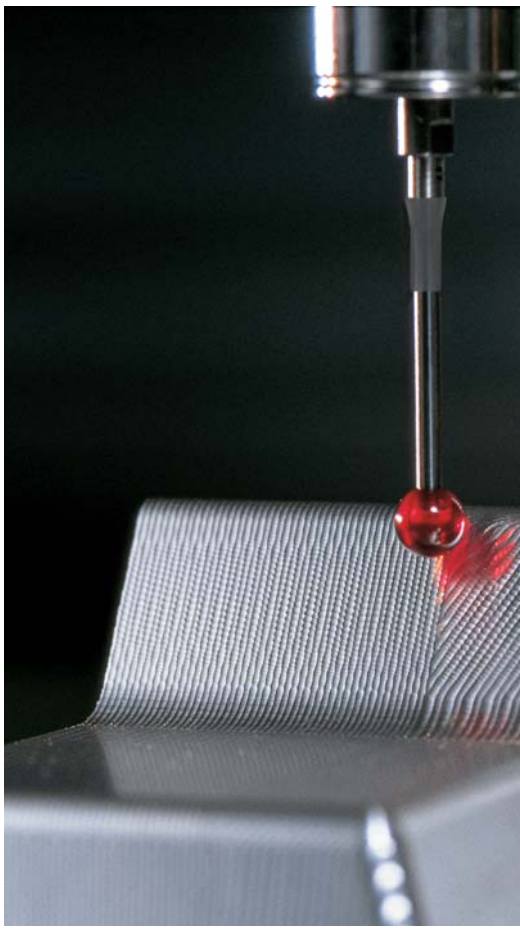
Measuring a rectangular pocket



Circular pocket/hole measurement



Measuring a bolt hole circle

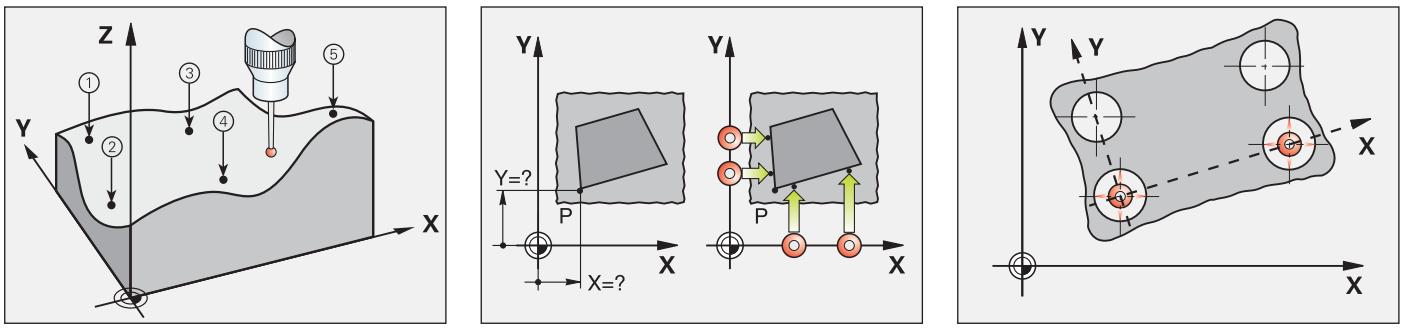


Practical Examples: Reducing Nonproductive Time

With the aid of external software—e.g. FormControl (software package from Blum-Novotest) or digitizing software—you can digitize models or measure freeform surfaces right at the machine tool. In this way you can detect machining errors immediately and correct them without reclamping. Thanks to their mechanical design and wear-free optical switch, TS touch probes from HEIDENHAIN are ideal for this purpose.

Touch probes from HEIDENHAIN can reduce non-cutting time, improve production quality, prevent scrap, and increase productivity.

To give you a quantitative indication of savings in nonproductive time, two examples of workpiece setup using either a dial gauge or a HEIDENHAIN touch probe are described below.



Measuring free-form surfaces

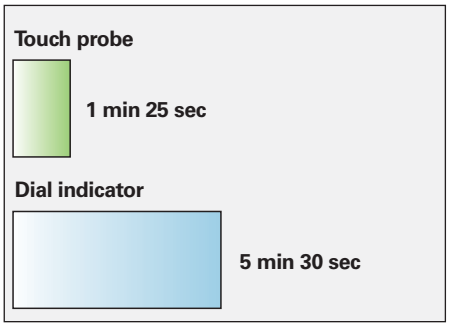
The task

- Align the workpiece blank parallel to the axes
- Set the datum in the working plane at a corner
- Set the tool axis datum at the top surface of the blank

The time saved

With a TS touch probe from HEIDENHAIN, this setup operation is performed with a time saving of about four minutes, or approx. 72 %.

You can easily calculate the annual return on investment from your hourly machine cost, the number of workdays per year, and the number of setups performed per day.



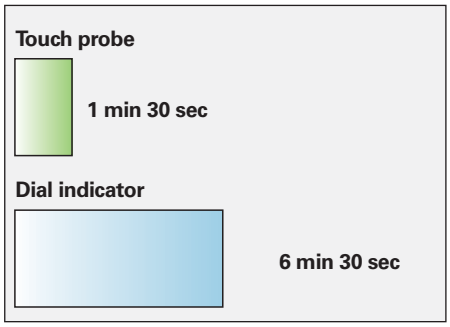
The task

- Align a workpiece paraxially using two holes
- Set the datum of the working plane in the center of the first hole.
- Set the tool axis datum at the top surface of the blank

The time saved

With a TS touch probe from HEIDENHAIN, this setup operation is performed with a time saving of about five minutes, or approx. 77 %.

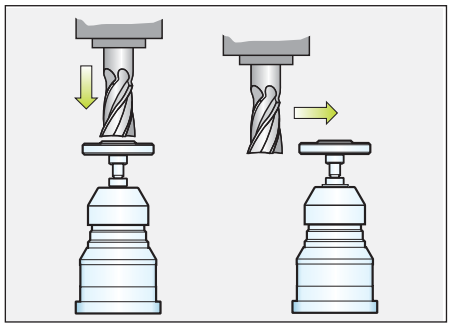
You can easily calculate the annual return on investment from your hourly machine cost, the number of workdays per year, and the number of setups performed per day.



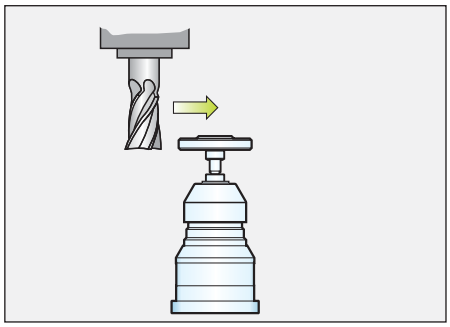
Tool Measurement with TT Touch Probes

Consistently high machining accuracy requires an exact measurement of tool data and cyclical inspection of tool wear. The TT tool touch probes measure almost any type of tool right on the machine. For milling cutters, it can be used to measure length and diameter, including the dimensions of individual teeth. The CNC automatically saves the results of measurement in the tool memory for use with the part program.

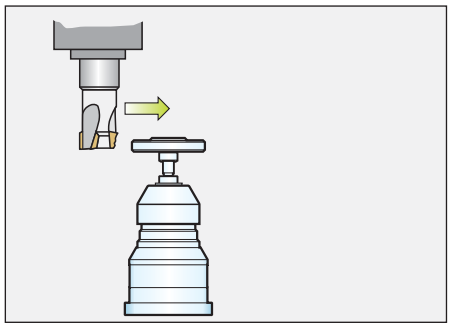
Using a cuboid probe contact, you can also measure turning tools and check them for breakage. For effective tool-tip radius compensation you only need to add the cutter radius to your entries in the CNC.



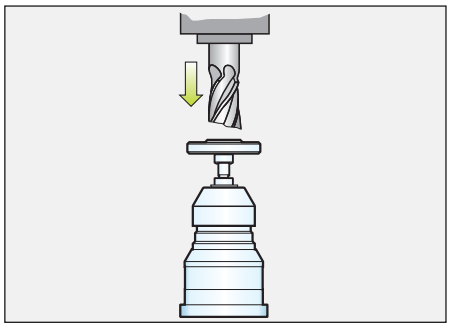
Measuring tool length and radius with stationary or rotating spindle



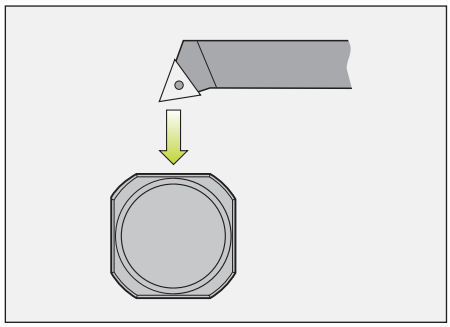
Individual tooth measurement for inspecting indexable inserts (not for hard, brittle teeth)



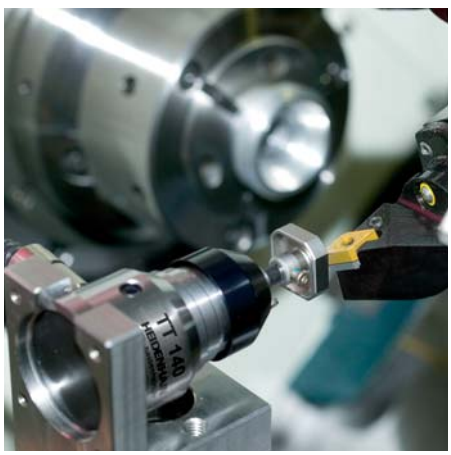
Tool wear measurement



Tool breakage monitoring



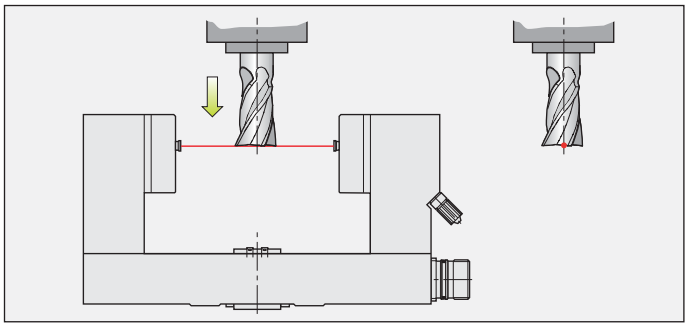
Turning tool measurement



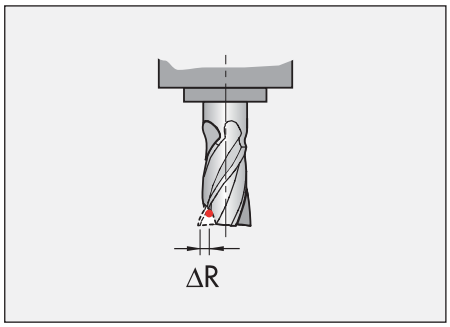
Tool Measurement with TL Laser Systems

Workpiece measurement with the TL laser system offers special benefits for workpiece measurement. The contact-free measuring method by laser beam enables you to check even the smallest tools rapidly, reliably and without collision. And modern cutting materials of hard, brittle materials are no problem for the TL laser systems.

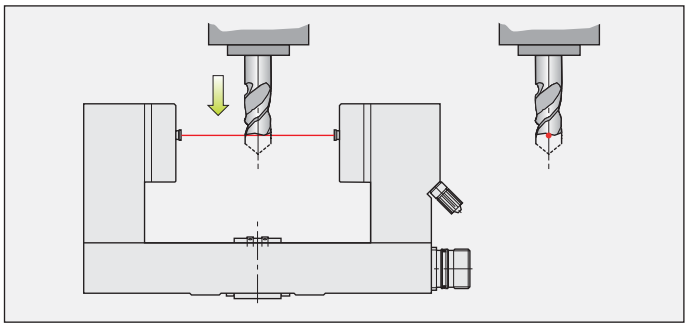
Because the tool is measured at rated speed, errors on the tool, spindle and holder are detected and corrected directly.



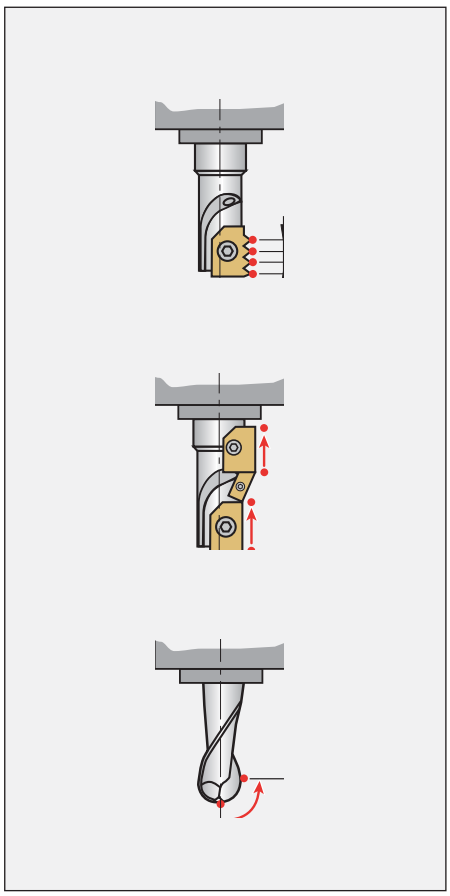
Tool length measurement



Tool radius measurement, detection of tooth breakage



Detection of tool breakage



Single tooth and shape inspection

Selection Guide

The TS workpiece touch probes from HEIDENHAIN help you perform setup, measuring and inspection functions directly on the machine tool.

The stylus of a TS touch trigger probe is deflected upon contact with a workpiece surface. At that moment the TS generates a trigger signal that is transmitted either by cable or over an infrared beam to the control. The control simultaneously saves the actual position values as measured by the machine axis encoders, and uses this information for further processing. The trigger signal is generated through a wear-free optical switch that ensures high reliability.

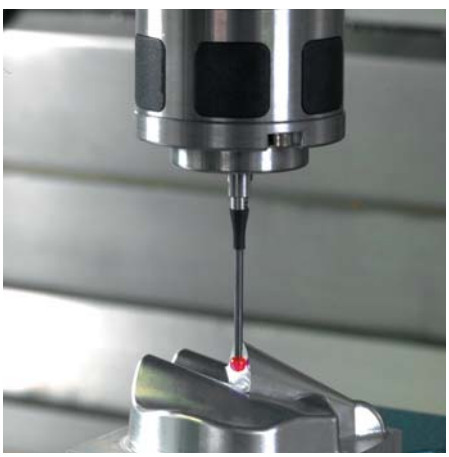
	TS Touch Probe			
Machine type	**CNC machine tool for milling, drilling and boring**			
Tool change	**Automatic**			
Signal transmission	Infrared to SE 540, SE 640, SE 642 transmitter/receiver unit			
Power supply	Batteries, rechargeable or nonrechargeable	Air turbine generator	Batteries, rechargeable or nonrechargeable	
Switching on/off	By infrared signal			Switch in taper shank
Probe repeatability	2 σ ≤ 1 µm			
Interface to control	HTL signal levels via SE transceiver unit			
Type	**TS 440**	**TS 444**	**TS 640**	**TS 642**

HEIDENHAIN touch probes for workpiece measurement on milling, drilling, boring machine and machining centers are available in various versions:

Touch probes with **infrared signal transmission** for machines with automatic tool change:
TS 440 – Compact dimensions
TS 444 – Compact dimensions, battery-free power supply through integrated air turbine generator over central compressed air supply
TS 640 – Standard touch probe with wide-range infrared transmission
TS 642 – Same as TS 640, but activated by switch in taper shank
TS 740 – High probing accuracy and repeatability, low probing force

Touch probes with **cable connection for signal transmission** for machines with manual tool change:
TS 220 – TTL version
TS 230 – HTL version

Touch probes for CNC grinding machines or lathes:
TS 249 – Especially compact dimensions



				CNC grinding machine or lathe
		Manual		
		Cables		
		5 V DC	15 to 30 V DC	
	By infrared signal	–		
	2 σ ≤ 0.25 µm	2 σ ≤ 1 µm		
		TTL	HTL	
	TS 740	**TS 220**	**TS 230**	**TS 249**

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Principle of Function
Sensor

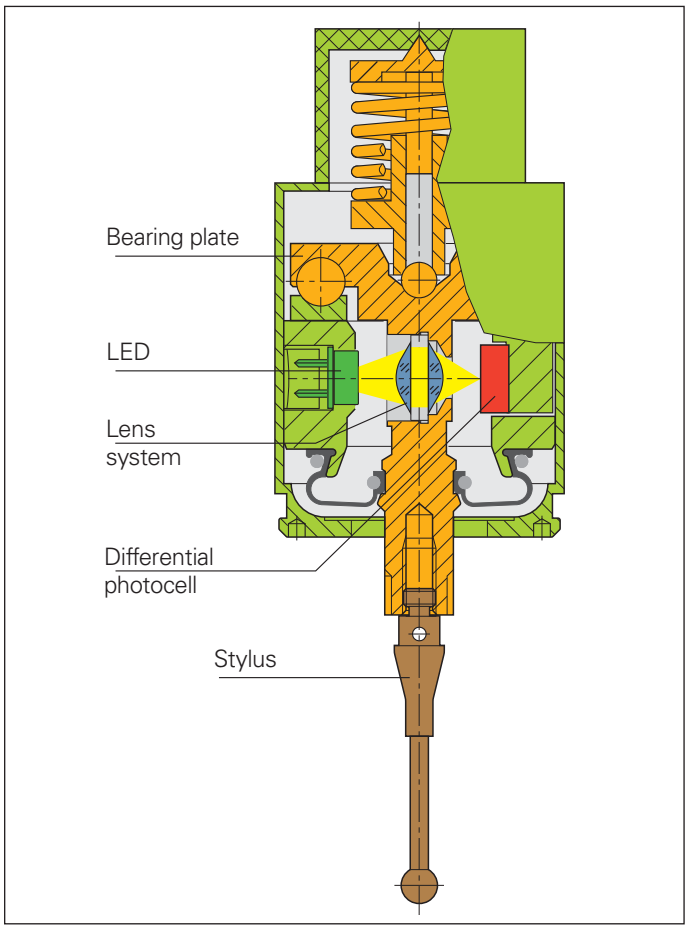
TS 2xx, TS 44x, TS 64x
Touch probes from HEIDENHAIN operate with an optical switch as sensor. A lens system collimates the light generated from an LED and focuses it onto a differential photocell. When the stylus is deflected, the differential photocell produces a trigger signal.

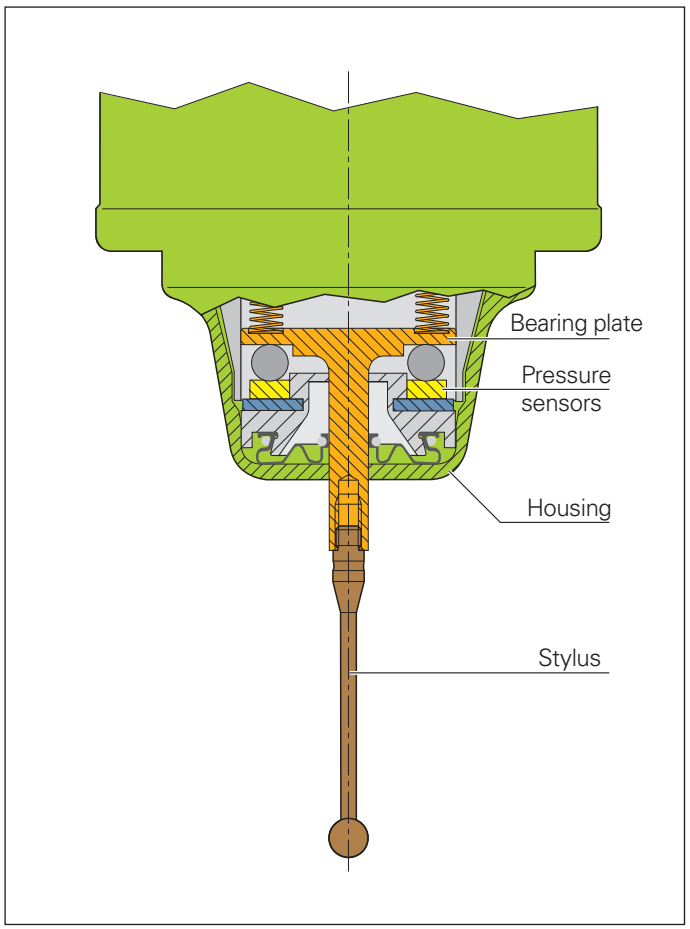
The stylus of the TS is rigidly connected to a plate integrated in the probe housing on a three-point bearing. The three-point bearing ensures the physically ideal rest position.

Thanks to the non-contacting optical switch, the sensor is free of wear. In this way, HEIDENHAIN touch probes ensure high long-term stability with a constantly probe repeatability even after very many measuring processes, as for example with in-process applications.

TS 740
The TS 740 uses a high-precision pressure sensor. The trigger pulse is obtained through force analysis. The forces acting during probing are processed electronically. This method provides extremely homogeneous probing accuracy over 360°.

With the TS 740, the deflection of the stylus is measured by several pressure sensors that are arranged between the contact plate and the probe housing. When probing a workpiece, the stylus is deflected so that a force acts on the sensors. The signals generated are processed and the trigger signal is produced. The relatively low probing forces provide high probing accuracy and repeatability, while offering precise trigger characteristics in all directions.





Accuracy

Probe accuracy
The probe accuracy specifies the error resulting from probing a test component from **various directions**.

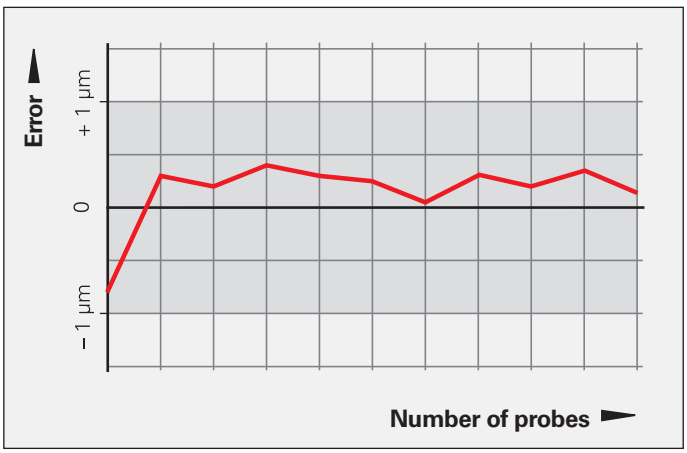
The probing accuracy also includes the effective ball radius. The effective ball radius is calculated from the actual ball radius and the stylus deflection required to produce the trigger signal. This also includes stylus bending.

The probing accuracy of a touch probe is measured at HEIDENHAIN on precision measuring machines. The reference temperature is 22 °C. The stylus used is the T404 (40 mm length, 4 mm ball diameter).

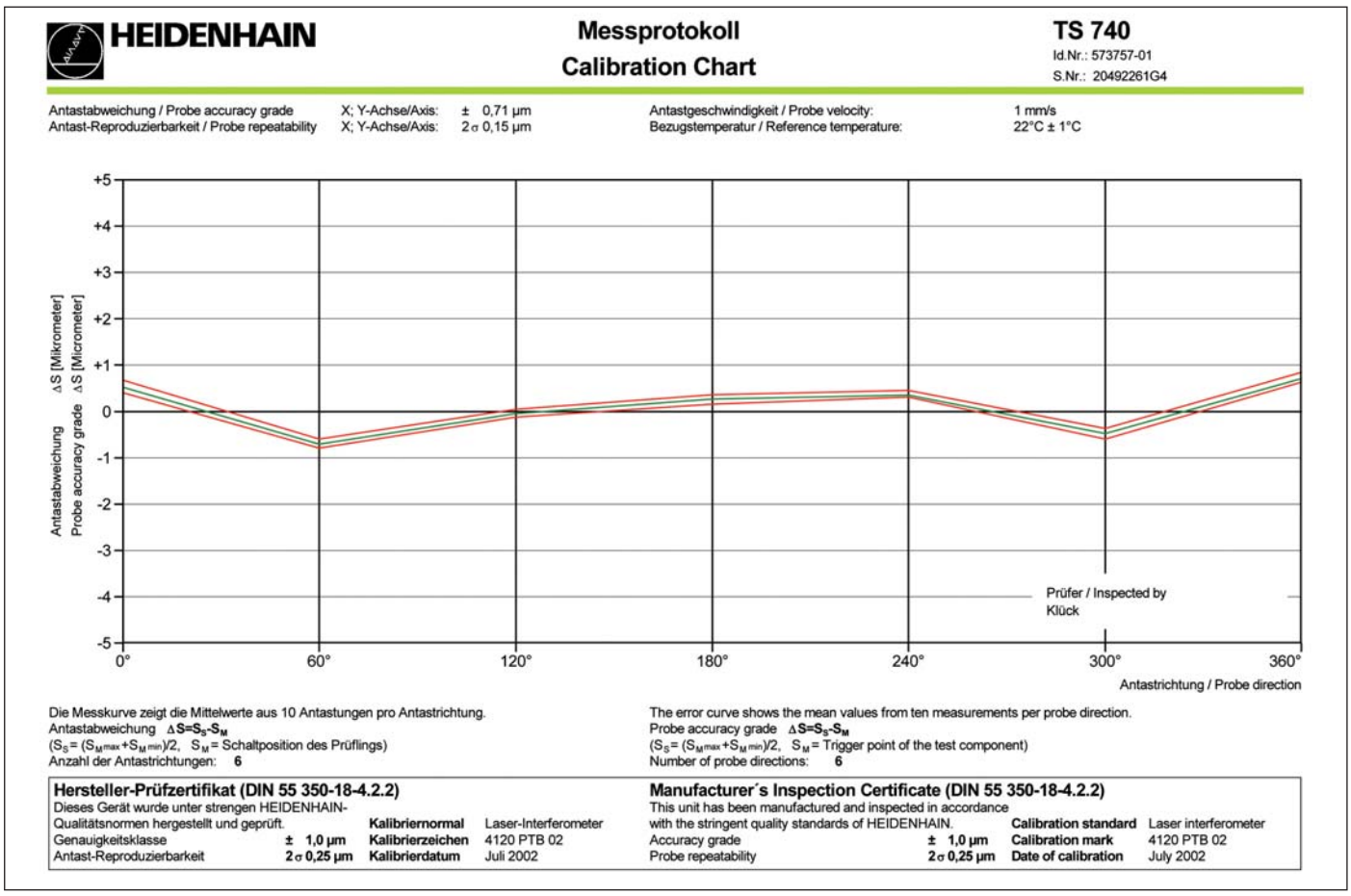
The **TS 740** triggering touch probe is characterized particularly by high probing accuracy and repeatability. These features, together with its low probing force, make the TS 740 suitable for very demanding measuring tasks on machine tools.

Probe repeatability
Probe repeatability is the dispersion of the results derived from repeated probing **from the same direction.**

Influence of probe styli
Stylus length and stylus material directly influence the trigger characteristics of a touch probe. Styli from HEIDENHAIN ensure a probing accuracy grade of better than ± 5 µm.



Typical repeatability curve of a TS 2xx/4xx/6xx touch probe: results of repeated probing from one direction at a defined spindle orientation.



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Messprotokoll
Calibration Chart

TS 740
Id.Nr.: 573757-01
S.Nr.: 20492261G4

Antastabweichung / Probe accuracy grade	X; Y-Achse/Axis: ± 0,71 µm	Antastgeschwindigkeit / Probe velocity:	1 mm/s
Antast-Reproduzierbarkeit / Probe repeatability	X; Y-Achse/Axis: 2σ 0,15 µm	Bezugstemperatur / Reference temperature:	22°C ± 1°C

Die Messkurve zeigt die Mittelwerte aus 10 Antastungen pro Antastrichtung.
Antastabweichung $\Delta S = S_S - S_M$
($S_S = (S_{M\,max} + S_{M\,min})/2$, S_M = Schaltposition des Prüflings)
Anzahl der Antastrichtungen: 6

The error curve shows the mean values from ten measurements per probe direction.
Probe accuracy grade $\Delta S = S_S - S_M$
($S_S = (S_{M\,max} + S_{M\,min})/2$, S_M = Trigger point of the test component)
Number of probe directions: 6

Hersteller-Prüfzertifikat (DIN 55 350-18-4.2.2)
Dieses Gerät wurde unter strengen HEIDENHAIN-Qualitätsnormen hergestellt und geprüft.

Genauigkeitsklasse	± 1,0 µm	Kalibriernormal	Laser-Interferometer
Antast-Reproduzierbarkeit	2σ 0,25 µm	Kalibrierzeichen	4120 PTB 02
		Kalibrierdatum	Juli 2002

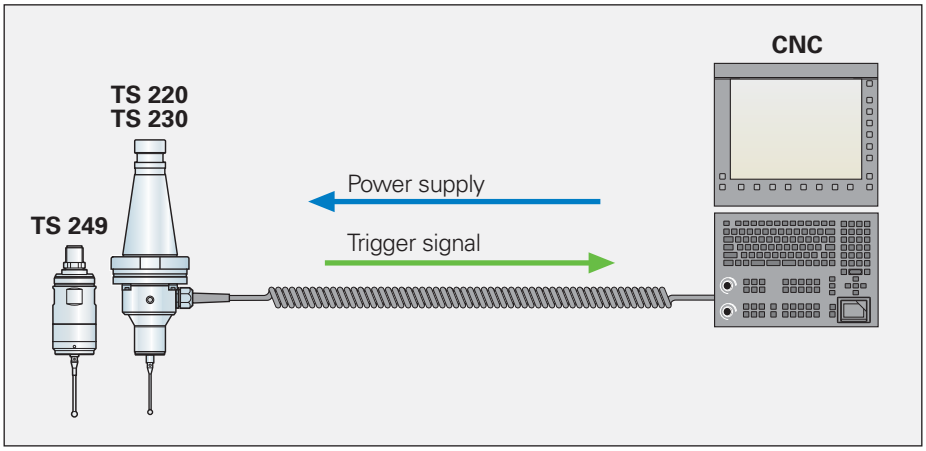
Manufacturer´s Inspection Certificate (DIN 55 350-18-4.2.2)
This unit has been manufactured and inspected in accordance with the stringent quality standards of HEIDENHAIN.

Accuracy grade	± 1,0 µm	Calibration standard	Laser interferometer
Probe repeatability	2σ 0,25 µm	Calibration mark	4120 PTB 02
		Date of calibration	July 2002

Signal Transmission

TS 220, TS 230, TS 249 Touch Probes with Signal Transmission by Cable

For these touch probes, both the power supply and the trigger signal are conducted over the touch probe's cable.
The machine operator inserts the TS 220, TS 230 touch probes by hand into the spindle. The spindle must be locked before the touch probe can be inserted (spindle stop). The CNC's probing cycles can run with both vertical and horizontal spindles.



TS 44x, TS 64x, TS 740 Touch Probes with Infrared Transmission of the Trigger Signal

The TS 44x, TS 64x and TS 740 touch probes transmit the trigger signal through an infrared light beam. This makes them ideal for use on machines with automatic tool changers.

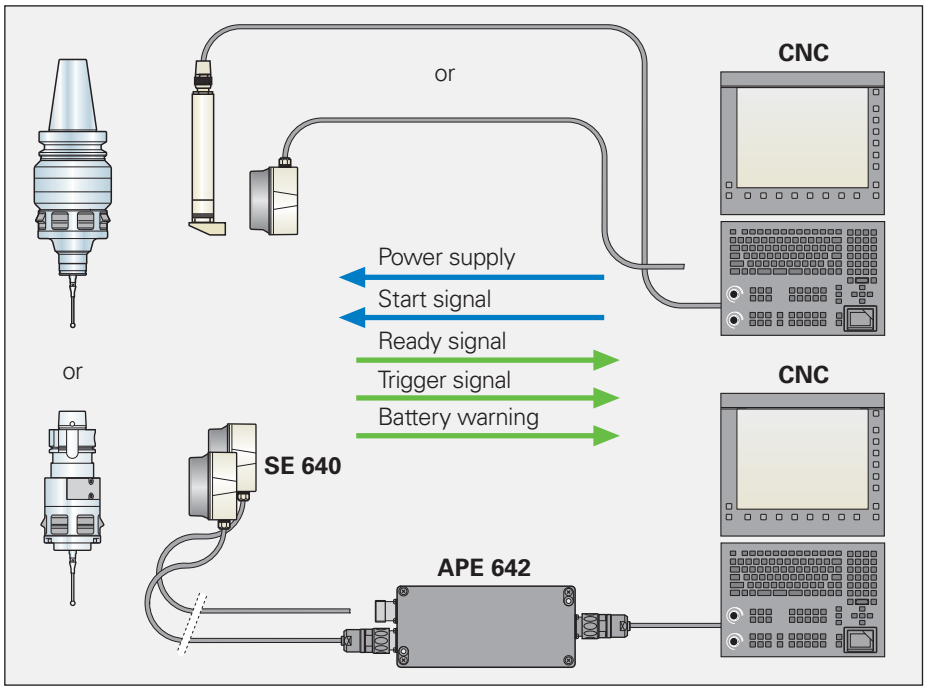
Infrared beam
The infrared transmission is established between the touch probe and the SE transmitter/receiver unit. The following transceivers are available:

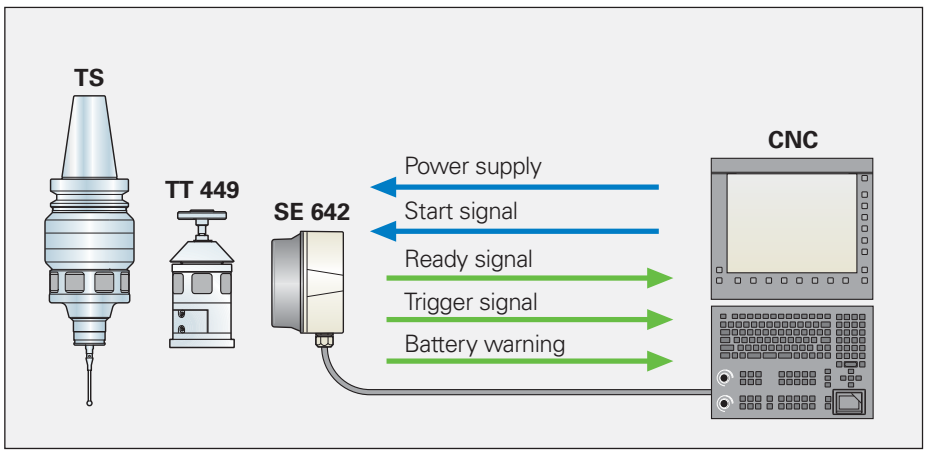
- **SE 540** for integration in the spindle head
- **SE 640** for integration in the machine's workspace
- **SE 642** as common SE for workpiece and tool touch probes

They can be used in any combination with the TS 44x, TS 64x and TS 740.

The infrared transmission is tolerant to noise and even works by reflection. It therefore covers a very broad range of applications. For example, the TS 64x can be used both in vertical and horizontal spindles as well as in swivel heads. An even greater infrared transmission range can be realized by combining two SE 640s through an APE 642 interface unit.

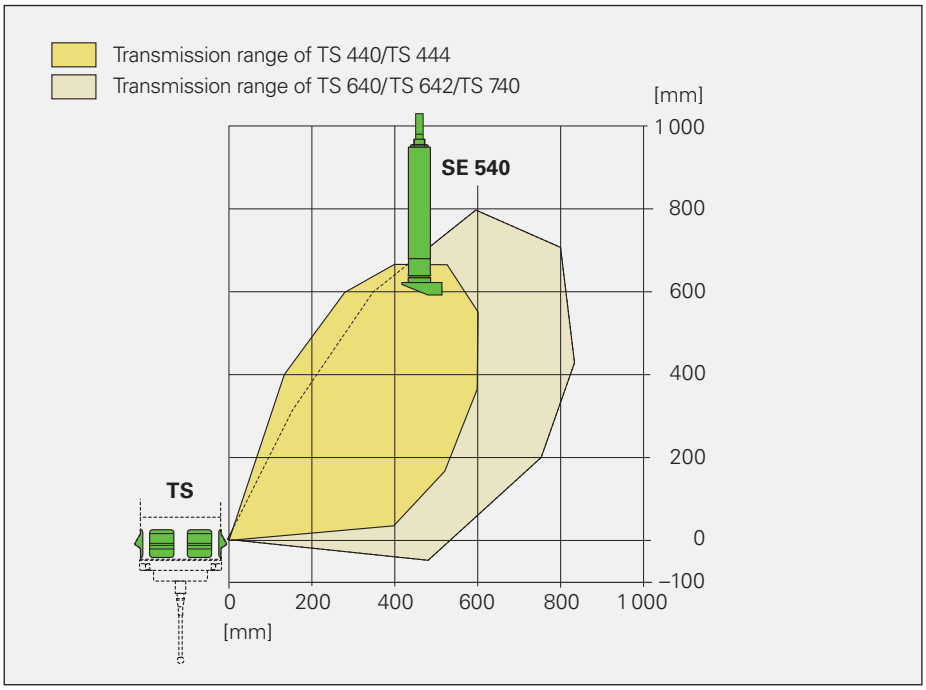
The infrared beam transmits several signals: The **start signal** activates the touch probe. With the **ready signal** the touch probe indicates that it is ready for operation. A deflection of the stylus produces the **trigger signal.** If the TS 64x/TS 740's battery capacity falls below 10 %, it transmits a **battery warning.** The falling edge of the start signal switches the touch probe off again.

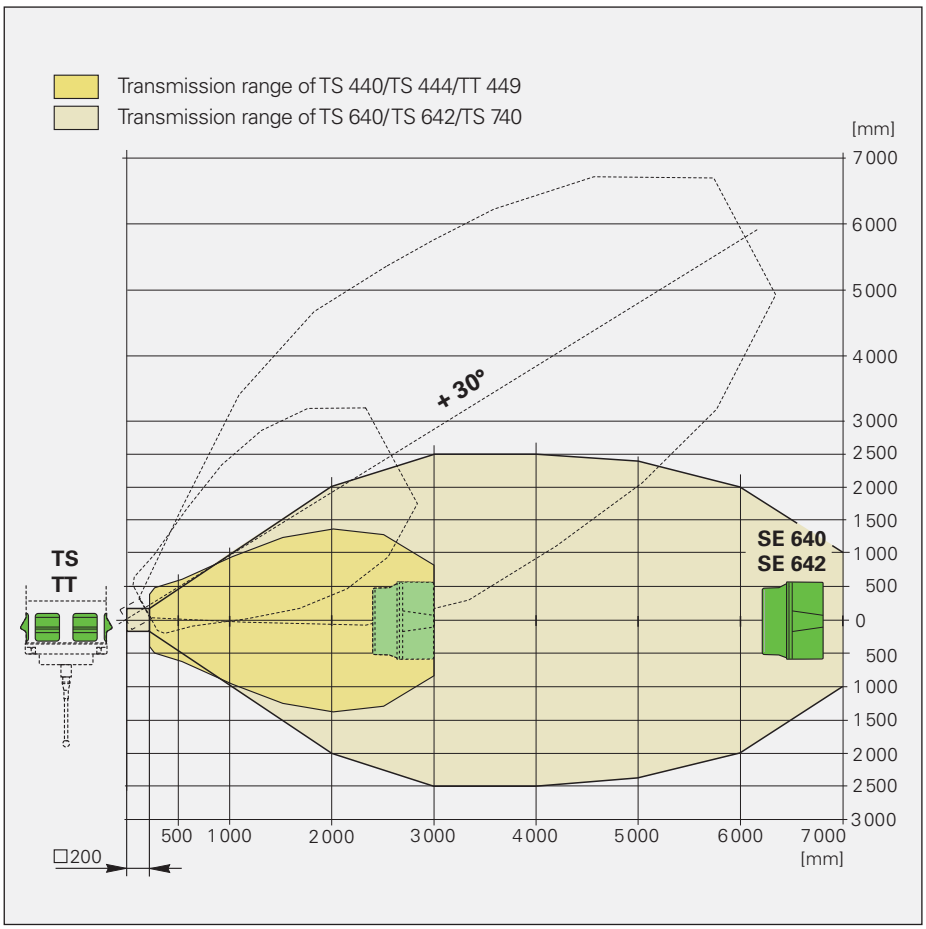




Infrared Transmission Range

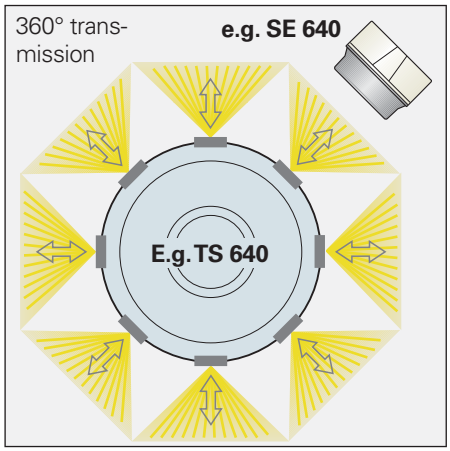
Transmission area
The transmission areas between the SE transmitter/receiver unit and the touch probes have a lobe form. In order to ensure an optimum signal transmission in both directions, the transceiver should be mounted so that the touch probe is within this range during all operation positions. If the infrared transmission is disturbed or the signal becomes too weak, the SE notifies the CNC through the ready signal. The size of the transmission range depends on both the touch probe and the transceiver used with it.



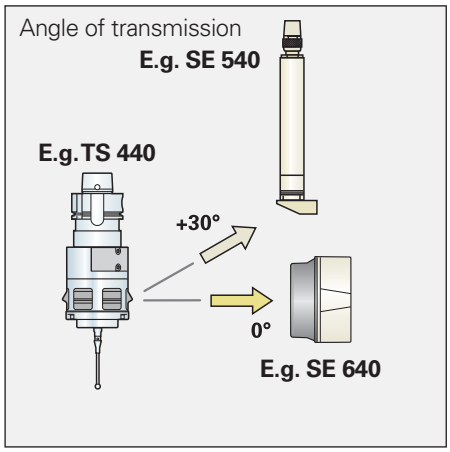


Infrared Transmission

360° transmission range
The LEDs and receiver modules for infrared transmission are evenly distributed on the circumference of the TS touch probe. This ensures a 360° transmission range for reliable reception without previous spindle orientation.



Angle of transmission
To enable the touch probes with infrared transmission to adapt to varying machine designs, they are available with transmission elevations of 0° or + 30°.



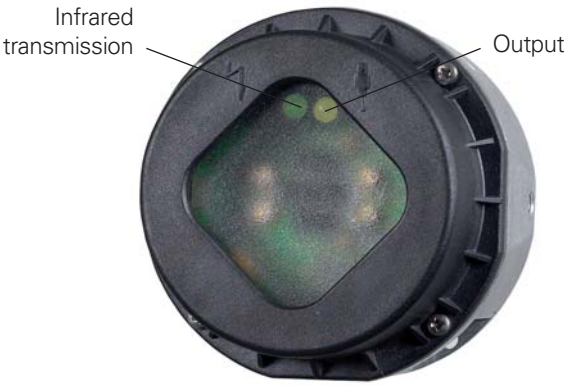
Optical status indicator of the TS
The touch probes with infrared transmission are equipped with LEDs that, in addition to the output signals, optically indicate the status of the touch probe (readiness and deflection):
- Touch probe is ready: LEDs blink slowly
- Touch probe is deflected: LEDs blink quickly.

This enables you to check the touch probe status at a glance.

Optical status indicators on the SE 540
The SE 540 transceiver features one multicolor LED indicator that continuously displays the condition of the touch probe (deflection and battery capacity).

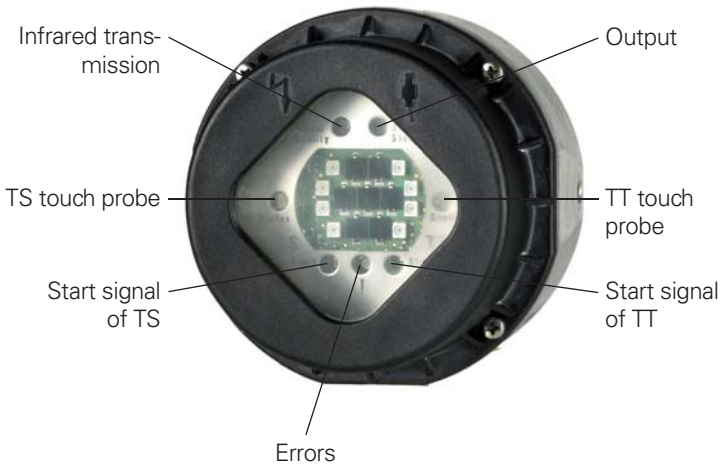
Touch probe or output	
Touch probe ready, stylus at rest	Green
Touch probe ready, stylus deflected	Orange
On continuously: Battery capacity < 10 % / Battery exchange *Blinking:* Touch probe is not ready	Red

Optical status indicators on the SE 640
The SE 640 transceiver features two multicolor LED indicators that continuously display the condition of the infrared transmission and the touch probe (deflection and battery capacity). Because they show at a glance the status of the transmission beam, they are particularly helpful during installation of the receiver units.



Touch probe or output	
Touch probe ready, stylus at rest	Green
Touch probe ready, stylus deflected	Orange
Battery capacity < 10 % / Battery exchange	Red
Touch probe is not ready	Off
Infrared transmission	
OK	Green
Acceptable	Orange
Not acceptable	Red

Optical status indicators on the SE 642
The SE 642 transmitter/receiver unit features several multicolor LED indicators that make comprehensive diagnostics possible. These include the quality of infrared transmission and the status of the active touch probe, as well as extensive error analysis. The SE 642 also checks whether the signals have actually been transmitted by the touch probe to which the start signal was sent. This can be seen from the "output" status indicator that normally shows the same information as the respective touch probe LED.



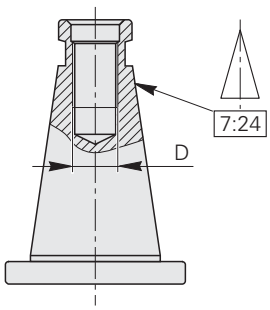
Touch probe or output	
Touch probe ready, stylus at rest	Green
Touch probe ready, stylus deflected	Orange
Battery capacity < 10 % / Battery exchange	Red
Touch probe not ready / output not active	Off
Infrared transmission	
OK	Green
Acceptable	Orange
Not acceptable	Red
Start signal	
Start line active	Orange
Start line not active	Off
Error	
Normal function, no error	Off
Disturbance in received infrared signal	Orange
Temporary interruption of IR connection	Red
More than one touch probe or both start lines active	Blue

Mounting
TS Workpiece Touch Probes

Taper shanks

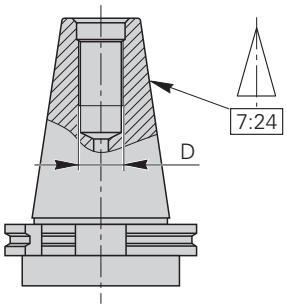
The TS workpiece touch probes are inserted directly into the machine spindle. An assortment of taper shanks is delivered with the TS for use with various clamping systems. Please indicate the model when ordering.

The TS touch probes can also be supplied without clamping shank. In this case, the shank is connected through a thread.
- M30 x 0.5 for TS 220/TS 230, TS 640/ TS 740
- M12 x 0.5 for TS 440/TS 444



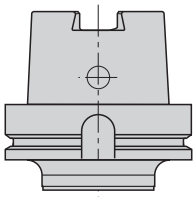
DIN 2080

Taper	D	Type
For TS 220/TS 230		
SK-A 40	M16	S51
SK-A 45	M20	S65
SK-A 50	M24	S52
SK-A 50	UNC 1.000-8	S62



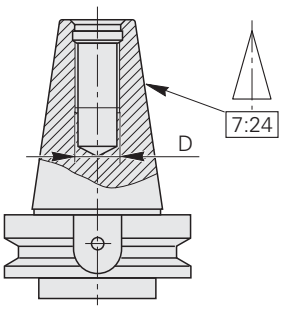
DIN 69871

Taper	D	Type
For TS 220/TS 230		
SK-A 40	M16	S53
SK-A 45	M20	S64
SK-A 50	M24	S55
For TS 44x/TS 64x/TS 740		
SK-AD/B 30	M12	S48/P48
SK-AD/B 40	M16	S81/P81
SK-AD/B 45	M20	S95
SK-AD/B 50	M24	S75/P75



DIN 69893

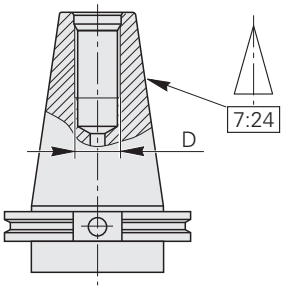
Taper	Type
For TS 2xx	
HSK-A 63	S77
HSK-A 100	S80
For TS 44x/TS 64x/TS 740	
HSK-E 32	S97/P97
HSK-A 40	S92/P92
HSK-E 40	S94
HSK-A 50	S49/P49
HSK-E 50	S68
HSK-A 63	S69/P69
HSK-A 80	S39
HSK-A 100	S72/P72



JIS B 6339

Taper	D	Type
For TS 220/TS 230		
BT 40	M16	S59
BT 50	M24	S54
For TS 44x/TS 64x/TS 740		
BT 40	M16	S88/P88
BT 50	M24	S40/P40

Please note:
Taper shanks identified with **Pxx** (with integrated switch) are available for the **TS 642**.



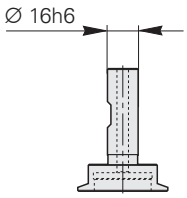
ASME B5.50

Taper	D	Type
SK 50	UNC 1x000-8	S42/P42

Tool holders

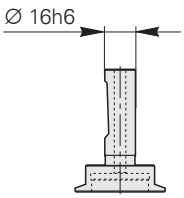
If you use other shanks, the touch probes can be held by standardized straight shanks in commercially available collets. Straight shanks are available for the following tool holders:

- Weldon or shrink-fit chuck as per DIN 6535-HB16
- Whistle notch as per DIN 6535-HE16



DIN 6535-HB16
Cylindrical shank for Weldon tool holder

Type
S30



DIN 6535-HE16
Cylindrical shank for Whistle notch tool holder

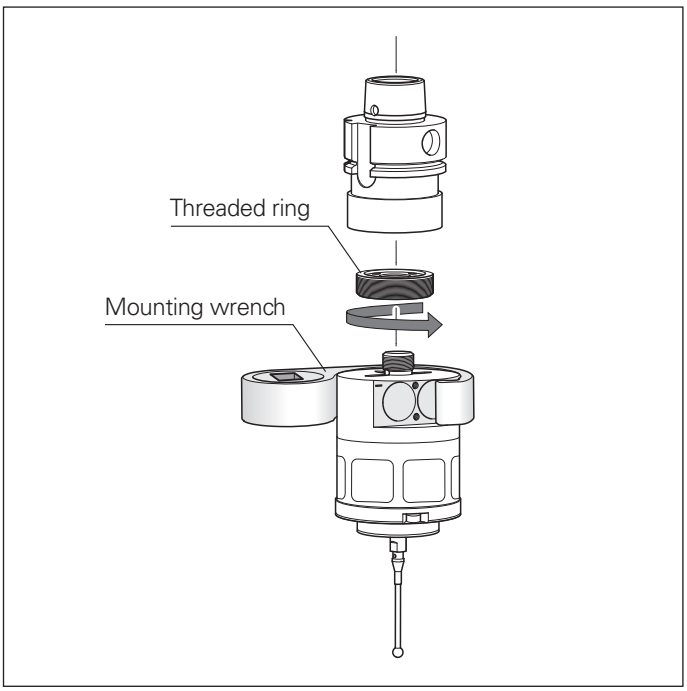
Type
S31

Mounting accessories

If you purchase the touch probe without clamping shank and instead mount the shank by the connecting thread, HEIDENHAIN offers the following mounting accessories:

Mounting wrench
For mounting a clamping shank to the
TS 440/TS 444: ID 519873-01
TS 640/TS 740: ID 519833-01

M12/M30 threaded ring
For adapting the taper shanks and tool holders with an M30 thread to the TS 44x (M12 x 0.5)
ID 391026-01



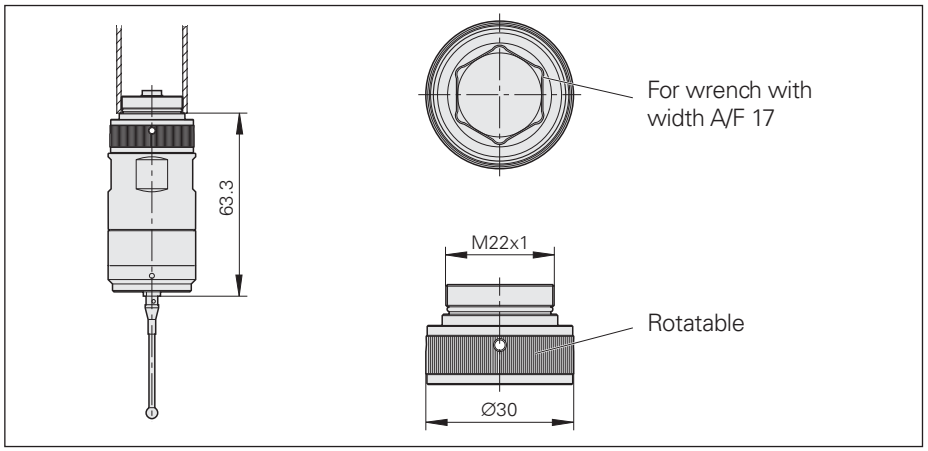
TS 249

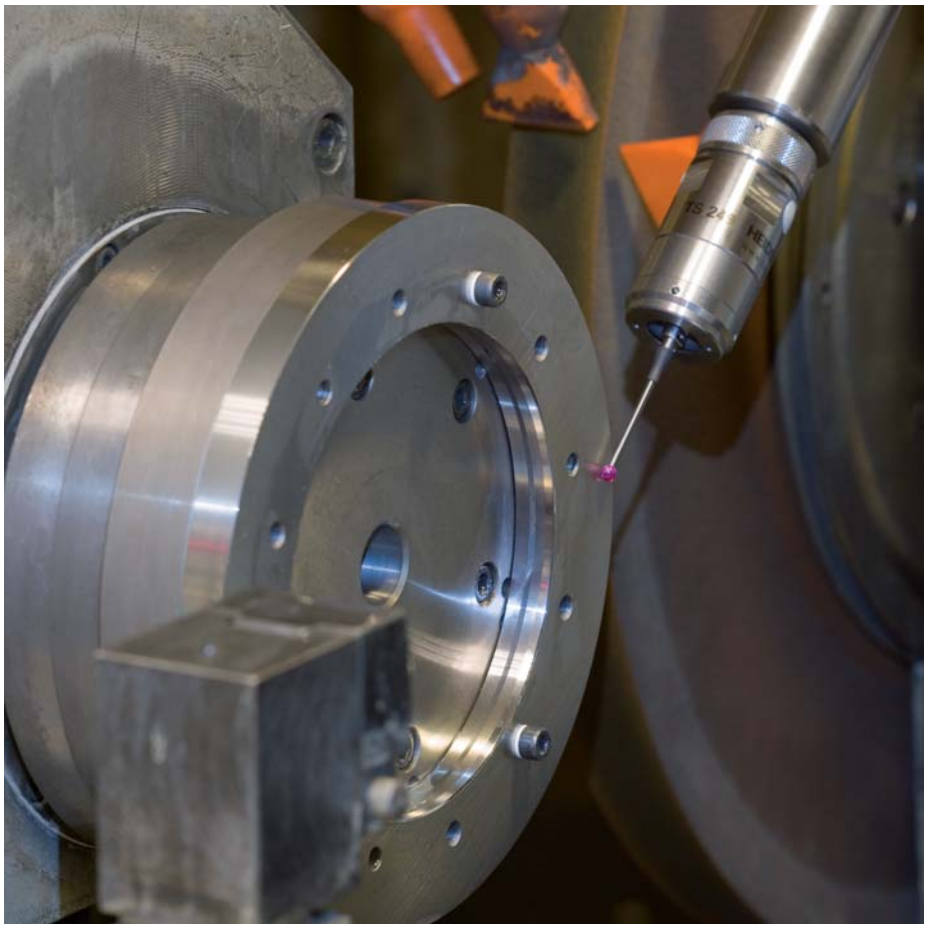
Due to its compact dimensions—the outside diameter is only 30 mm—the TS 249 is even suited for limited installation space. Its high degree of protection (IP 67) and a two-fold sealing system enable its use directly on the machine. The service-friendly design permits quick and easy replacement of the external seal.

The TS 249 is usually mounted to a machine element with the aid of a coupling joint (available as an accessory), a mounting base, or a tilting device. If the fastening element is rotatable, the TT 249 can also be fastened directly with its M28 x 0.75 outside thread.

With the aid of the coupling joint, the TS 249 can also be rotated as desired on a rigid fastening element. This enables you, for example, to align the TS 249 with an asymmetric or cuboid probe contact exactly parallel to the machine axes.

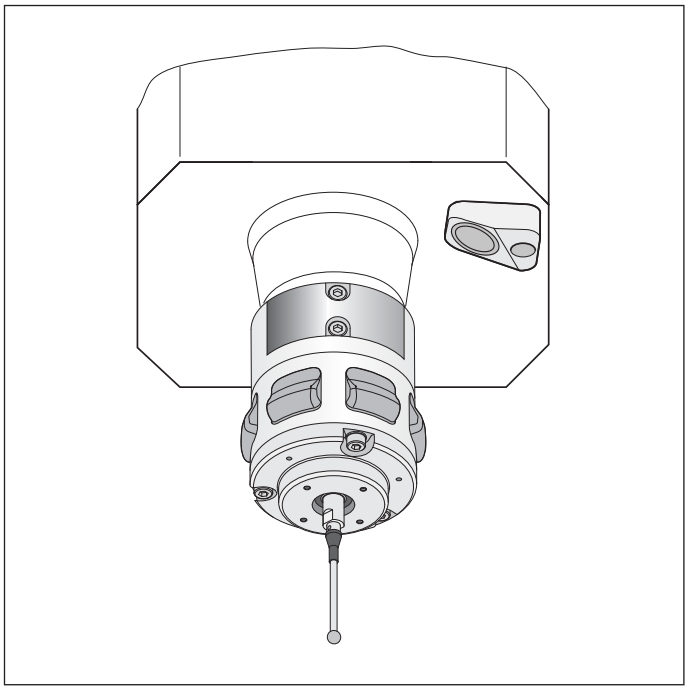
Accessory:
Coupling joint
M22x1 outside thread ID 643089-01



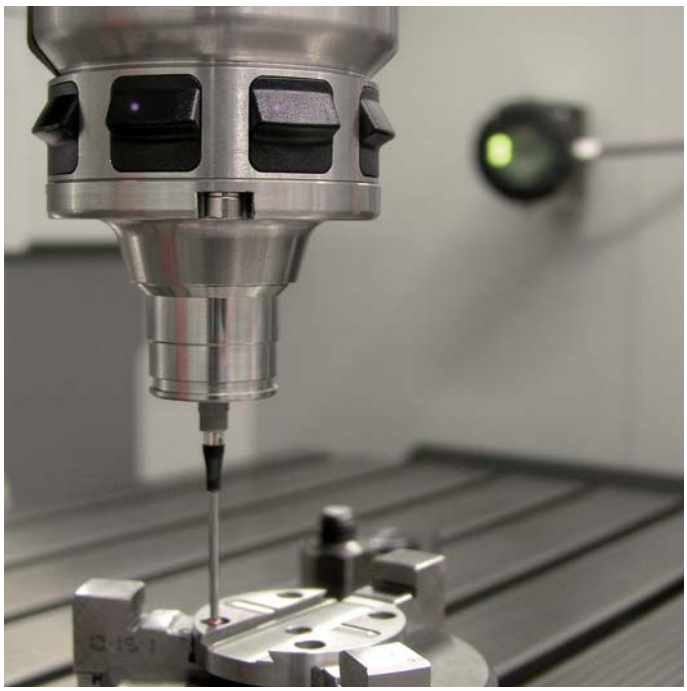


Transceiver Unit

The SE transmitter/receiver unit is to be mounted so that it remains within the transmission range of the touch probe over the machine's entire range of traverse.



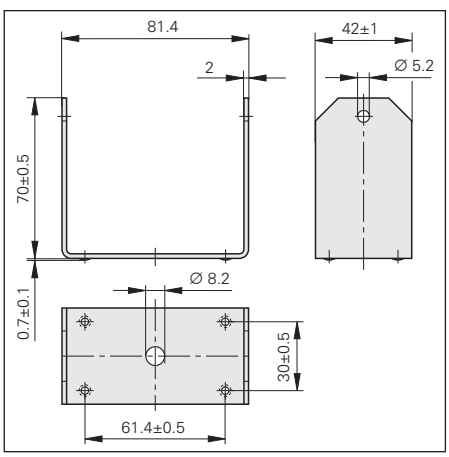
SE 540 transmitter/receiver unit
The SE 540 is intended for integration in the spindle head. Except for a few cases, for example on machines with quills, this ensures transmission on machines with very large traverse ranges or with swivel heads. The transmission range of the infrared signal is appropriate to the mounting location. Because the SE 540 is always above and to the side of the TS, HEIDENHAIN recommends using touch probes with +30° transmission angle. The machine must be designed to support the SE 540.



SE 640, SE 642 transmitter/receiver unit
The SE 64x is mounted at a suitable location in the machine's workspace. It is also easily to retrofit. Thanks to its high IP 67 degree of protection, it can also tolerate coolant. A holder to facilitate mounting is available as an accessory. When mounting the SE 642 it is important to note that it can communicate both with the TS workpiece touch probe and with the TT 449 tool touch probe. The touch probes' very large angular range of transmission (up to 7 m with the TS 640) allows reliable transmission to machines with long axes.

For special applications, for example very large machines, the transmission range can be enlarged by installing a second SE 640. The connected APE 642 interface electronics unit evaluates the infrared signals so that the NC receives only one trigger signal regardless of the working range in which the touch probe is located.

Mounting accessories
Mounting bracket for SE 64x ID 370827-01



Probing

The workpiece geometry or position is ascertained by the TS workpiece touch probe through mechanical probing. To ensure correct measurement, the workpiece should be free of chips and other foreign matter.

Upon deflection of the stylus a trigger signal is transmitted to the control. In addition, the deflection is indicated by LEDs

- with continuous light on the TS 220/ TS 230
- with fast blinking light on the touch probes with infrared transmission.

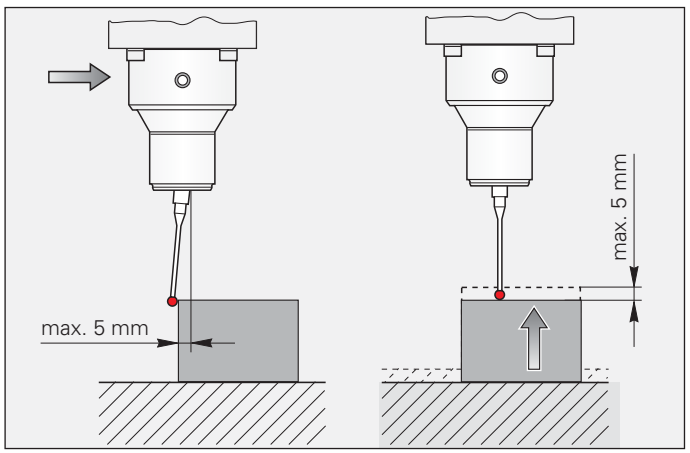
The touch probes with infrared transmission feature an integrated **cleaning blower/flusher:** The probing point can be cleaned of loose particles with the aid of compressed air or cooling liquids through three jets at the bottom of the probe. Even chip accumulation in pockets is no problem. This allows automatic measuring cycles during unattended operation. The cleaning blower can only work on machines with a compressed-air or cooling fluid duct through the spindle.

On the battery-free TS 444 touch probe, the compressed air is used at the same time to charge the capacitors.

Probe velocity
Signal propagation times in the CNC influence the probe repeatability of the touch probe. Besides the signal propagation time, the permissible stylus deflection must also be considered. The mechanically permissible probing velocity is shown in the specifications.

Deflection of probe contact
The maximum permissible deflection of the stylus is 5 mm in any direction. The machine must stop moving within this distance to avoid damaging the touch probe.

Deflection of the stylus



Styli

Styli for TS
HEIDENHAIN offers probe styli with various ball-tip diameters and stylus lengths. All styli are attached to the TS touch probes with an M3 thread. Starting from a ball-tip diameter of 4 mm, a rated breaking point protects the touch probe from mechanical damage caused by operator error. The T404 and T424 styli are included with the TS touch probe.

With the aid of the adapter provided with delivery, M4 styli are also usable on the **TS 249**. By using the coupling joint, the TS 249 can be rotated into position in order to align asymmetric or cuboid probe contacts exactly.

Ball-tip styli

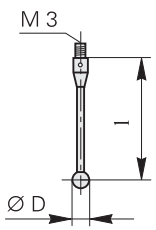
Type	ID	Length l	Ball dia. D
T421	295770-21	21 mm	1 mm
T422	295770-22	21 mm	2 mm
T423	295770-23	21 mm	3 mm
T424	352776-24	21 mm	4 mm
T404	352776-04	40 mm	4 mm
T405	352776-05	40 mm	5 mm
T406	352776-06	40 mm	6 mm
T408	352776-08	40 mm	8 mm

Stylus extension

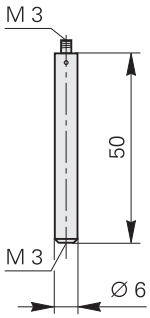
Type	ID	Length l	Material
T490	296566-90	50 mm	Steel

The stylus extension must be used only together with the short styli (21 mm length).

Styli



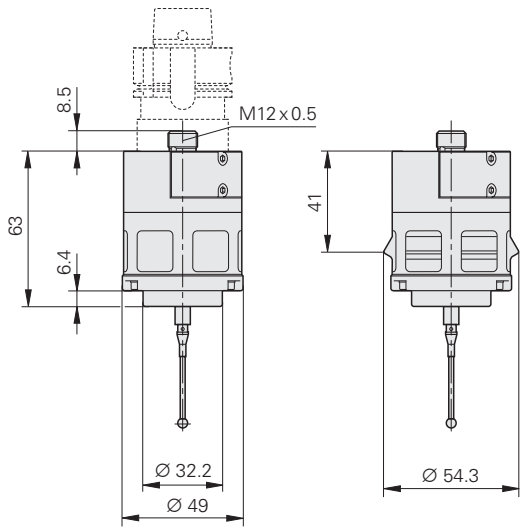
Extension



TS 440 and TS 444
Workpiece Touch Probes with Infrared Transmission

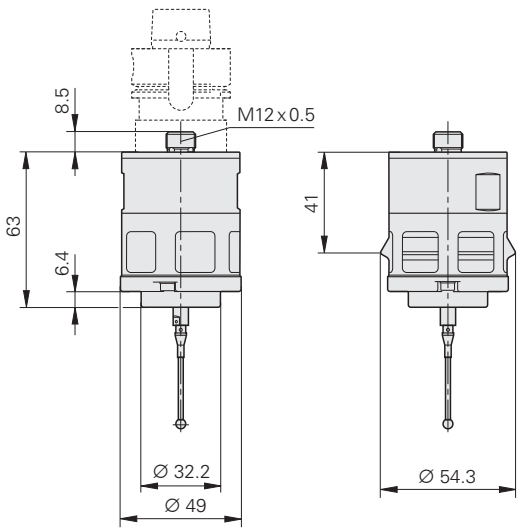
TS 440

TS 444



Angle of transmission 0°

Angle of transmission 30°



Angle of transmission 0°

Angle of transmission 30°

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

Workpiece touch probe	TS 440	TS 444
Probe accuracy	≤ ± 5 µm when using a standard stylus	
Probe repeatability Repeated probing from one direction	2 σ ≤ 1 µm at a probing velocity of 1 m/min *Typical values:* 2 σ ≤ 1 µm at a probing velocity of 3 m/min 2 σ ≤ 4 µm at a probing velocity of 5 m/min	
Deflection of probe contact	≤ 5 mm in all directions (with stylus length L = 40 mm)	
Deflection force	Axial: Approx. 7 N Radial: 0.7 to 1.3 N	
Probe velocity	≤ 5 m/min	
Protection EN 60529	IP 67	
Operating temperature	10 °C to 40 °C	
Storage temperature	–20 °C to +70 °C	
Weight without taper shank	Approx. 0.4 kg	
Taper shank*	• With taper shank***** (overview on page 18) • W/o taper shank (connecting thread M12 x 0.5)	
Signal transmission	Infrared transmission with 360° range	
Transmission angle of infrared signal*	0° or +30°	
Transmitter/receiver unit*	SE 540 or SE 640	
Switching the TS on/off	Infrared signal from SE	–
Power supply:	Batteries, rechargeable or nonrechargeable	Compressed air Recommended operating pressure 5.5 x 10^5 to 8 x 10^5 Pa
Energy buffer	2 batteries (rechargeable or nonrechargeable), size $^2/_3$ AA or size N[1] each 1 V to 4 V	Integrated high-power capacitors; charging time typically 3 s at 5.5 x 10^5 Pa
Operating time	Continuous duty typically 200 h with lithium batteries[2] 3.6 V/1 200 mAh	Typically 120 s

***** Please select when ordering
[1] Via adapter, included in delivery
[2] Included in delivery

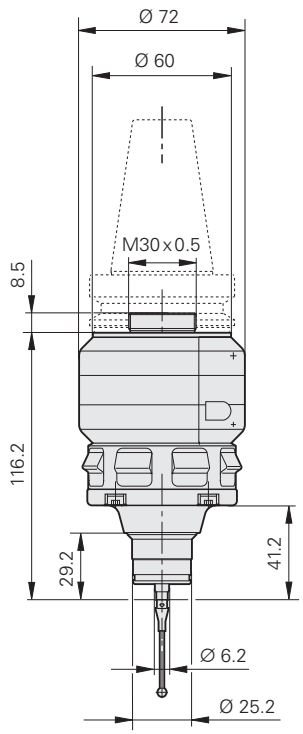
10^5 Pa ≙ 1 bar

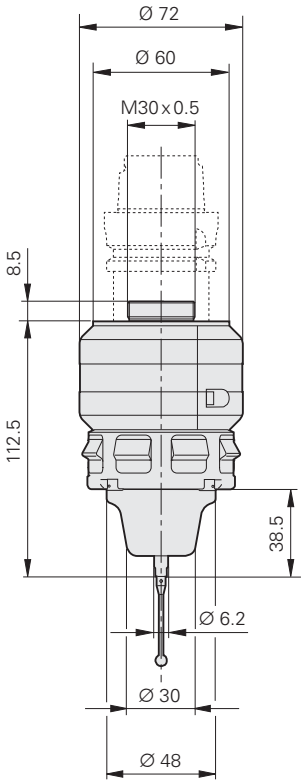
TS 640, TS 642 and TS 740

Workpiece Touch Probes with Infrared Transmission

TS 640/TS 642

TS 740





mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

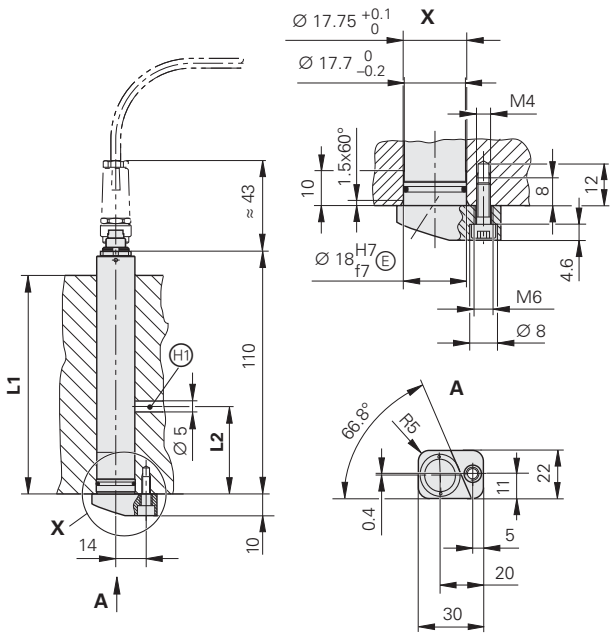
Workpiece touch probe	TS 640	TS 642	TS 740
Probe accuracy	≤ ± 5 µm when using a standard stylus		≤ ± 1 µm when using a standard stylus
Probe repeatability Repeated probing from one direction	2 σ ≤ 1 µm at a probing velocity of 1 m/min *Typical values:* 2 σ ≤ 1 µm at a probing velocity of 3 m/min 2 σ ≤ 4 µm at a probing velocity of 5 m/min		2 σ ≤ 0.25 µm at a probing velocity of 0.25 m/min
Deflection of probe contact	≤ 5 mm in all directions (with stylus length L = 40 mm)		
Deflection force	Axial: Approx. 8 N Radial: approx. 1 N		Axial: Approx. 0.6 N Radial: approx. 0.2 N
Probing velocity	≤ 5 m/min		≤ 0.25 m/min
Protection EN 60529	IP 67		
Operating temperature	10 °C to 40 °C		
Storage temperature	–20 °C to +70 °C		
Weight without taper shank	Approx. 1.1 kg		
Taper shank*	• With taper shank* (overview on page 18) • Without taper shank (connecting thread M30 x 0.5), not with TS 642		
Signal transmission	Infrared transmission with 360° range		
Transmission angle of infrared signal*	0° or +30°		
Transmitter/receiver unit*	SE 540 or SE 640		
TS switch-on/off	Infrared signal from SE	Via switch in taper shank	Infrared signal from SE
Power supply	Two rechargeable or nonrechargeable batteries, 1 V to 4 V each, size C or size A[1)]		
Battery life[2)] (typically)	800 h	800 h[3)]	500 h

***** Please select when ordering
[1)] Via adapter, included in delivery
[2)] In continuous operation with lithium batteries, 3.6 V/6000 mAh; with the lithium batteries, size A, included in delivery only half the service life is reached
[3)] Reduced service life as replacement for TS 632

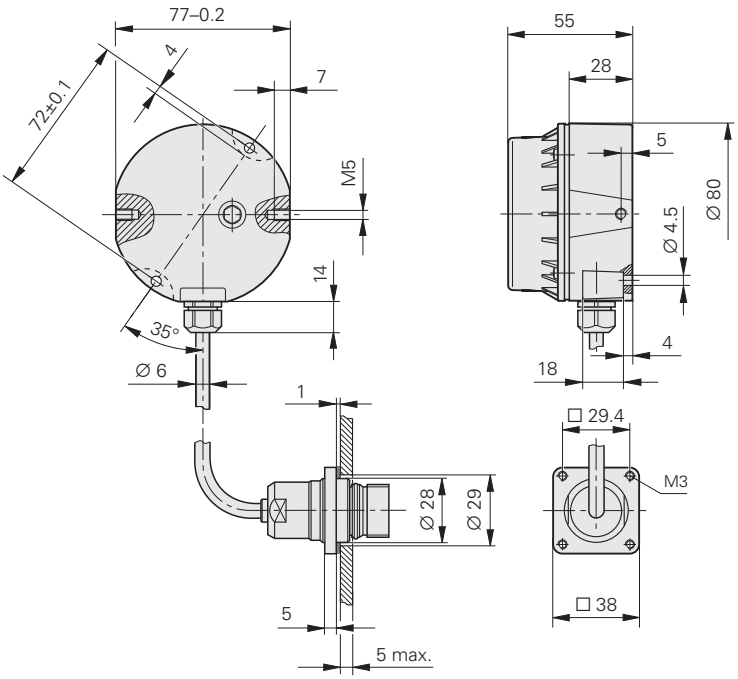
SE 540, SE 640 and SE 642

Transmitter/Receiver Units for Workpiece Touch Probes with Infrared Transmission

SE 540



SE 640/SE 642



H1 = Metal armor
H2 = O-ring 16x1

mm

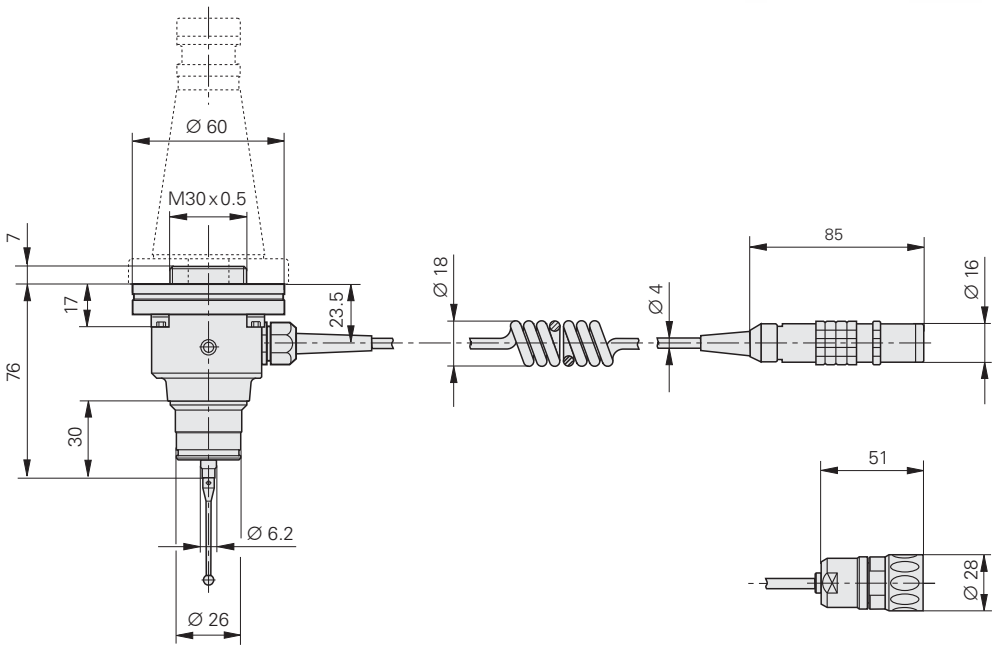
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

Transceiver unit	SE 540	SE 640	SE 642
Area of application	In the mating hole In the spindle	In working space of machine	In the machine's working space; for common communication with TS and TT 449 using infrared transmission
Input/output signals	Square-wave signals at HTL level • Start signal R • Ready signal B • Trigger signal $\overline{S}$ • Battery warning $\overline{W}$		Square-wave signals at HTL level • Start signals R(-TS) and R(-TT) • Ready signals B(-TS) and B(-TT) • Trigger signals S and $\overline{S}$ • Battery warning $\overline{W}$
Optical status indicator	For touch probe	For infrared transmission and touch probe	For infrared transmission, errors and whether workpiece or tool touch probe
Protection EN 60529	IP 67		
Operating temperature	*U_P = 15 V:* 10 °C to 60 °C *U_P = 30 V:* 10 °C to 40 °C	10 °C to 40 °C	
Storage temperature	–20 °C to +70 °C	–20 °C to +70 °C	
Weight without cable	Approx. 0.1 kg	Approx. 0.2 kg	
Power supply	15 to 30 V DC		
Current consumption without load Normal operation Transmission (max. 3.5 s)	≤ 75 mA ≤ 100 mA_{eff}	≤ 170 mA ≤ 250 mA_{eff}	5.1 W_{eff} (≤ 250 mA_{eff} [1)]) 8.3 W (≤ 550 mA [1)])
Electrical connection*	M9 flange socket, 8-pin	• Cable 0.5 m with M23 mounted coupling • Cable 2 m with M23 coupling • Cable in protective sleeve, 3 m, with M23 mounted coupling	Cable 0.5/2 m with 12-pin M12 connector
Max. cable length	30 m with adapter cable Ø 4.5 mm 50 m with adapter cable Ø 4.5 mm and adapter cable Ø 8 mm for extension	50 m	50 m 20 m with iTNC 530

***** Please select when ordering
[1)] At minimum supply voltage

TS 220 and TS 230

Workpiece Touch Probes with Cable Connection



mm

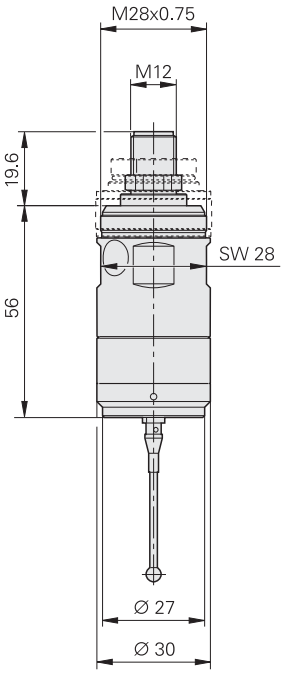
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

Workpiece touch probe	TS 220	TS 230
Probe accuracy	≤ ± 5 µm when using a standard stylus	
Probe repeatability Repeated probing from one direction	2 σ ≤ 1 µm at a probing velocity of 1 m/min *Typical values:* 2 σ ≤ 1 µm at a probing velocity of 3 m/min 2 σ ≤ 4 µm at a probing velocity of 5 m/min	
Deflection of probe contact	≤ 5 mm in all directions (with stylus length L = 40 mm)	
Deflection force	Axial: Approx. 8 N Radial: approx. 1 N	
Probe velocity	≤ 5 m/min	
Protection EN 60529	IP 55	
Operating temperature	10 °C to 40 °C	
Storage temperature	–20 °C to +70 °C	
Weight without taper shank	Approx. 0.7 kg	
Taper shank*	• With taper shank* (overview on page 18) • W/o taper shank (connecting thread M30 x 0.5)	
Power supply Without load	5 V ± 5% DC / ≤ 100 mA	10 V to 30 V DC / ≤ 100 mA
Output signals	One square-wave signal and its inverted signal Trigger signals S and $\overline{S}$	
Signal levels	**TTL** $U_H \geq 2.5$ V at $-I_H \leq 20$ mA $U_L \leq 0.5$ V with $I_L \leq 20$ mA At 5 V rated voltage	**HTL** $U_H \geq 20$ V at $-I_H \leq 20$ mA $U_L \leq 2.8$ V at $I_L \leq 20$ mA at 24 V rated voltage
Electrical connection	Spiral cable, 1.5 m with 6-pin quick disconnect	Spiral cable 1.5 m with M23 connector (male) 7-pin M23

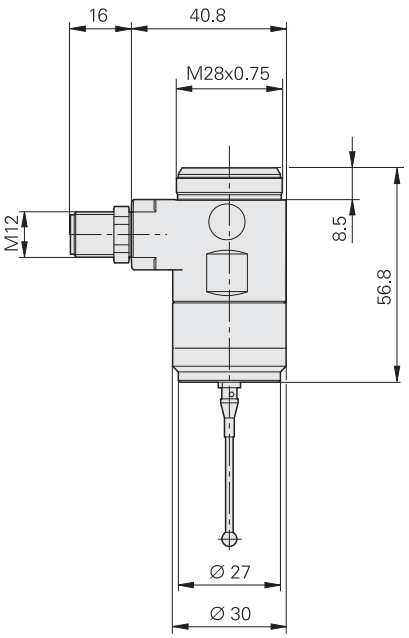
***** Please select when ordering

TS 249

Workpiece Touch Probe for Grinding Machines and Lathes



Axial flange socket



Radial flange socket

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

Workpiece touch probe	TS 249
Probe accuracy	≤ ± 5 µm when using a standard stylus
Probe repeatability Repeated probing from one direction	2 σ ≤ 1 µm at a probing velocity of 1 m/min *Typical values:* 2 σ ≤ 1 µm at a probing velocity of 3 m/min 2 σ ≤ 4 µm at a probing velocity of 5 m/min
Deflection of probe contact	≤ 5 mm in all directions (with stylus length L = 40 mm)
Deflection force	Axial: Approx. 7 N Radial: Approx. 0.7 to 1.3 N
Probe velocity	≤ 5 m/min
Protection EN 60529	IP 67
Operating temperature	10 °C to 40 °C
Storage temperature	–20 °C to +70 °C
Weight	Approx. 0.15 kg
Fastening*	• Via M28x0.75 external thread • Via coupling joint with M22x1 external thread
Power supply Without load	15 V to 30 V DC / ≤ 100 mA
Output signals	One square-wave signal and its inverted signal Trigger signals S and $\overline{S}$ Additional floating switching outputs
Signal levels	**HTL** $U_H \geq 20$ V at $-I_H \leq 20$ mA $U_L \leq 2.8$ V at $I_L \leq 20$ mA at 24 V rated voltage
Electrical connection*	M12 flange socket, 8-pin; axial or radial
Cable length	≤ 25 m

***** Please select when ordering

Selection Guide

Tool measurement on the machine shortens non-productive times, increases machining accuracy and reduces scrapping and reworking of machined parts. With the tactile TT touch probes and the contact-free TL laser systems, HEIDENHAIN offers two completely different possibilities for tool measurement.

With their rugged design and high degree of protection, these tool touch probes can be installed directly within the machine tool's work envelope.

TT touch probes
The TT 140 and TT 449 tool touch probes are touch trigger probes for the measurement and inspection of tools. The TT 140 features signal transmission by cable, while the TT 449 communicates wirelessly over an infrared beam with the SE 642 transmitter/receiver unit.

The disk-shaped probe contact of the TT is deflected during physical probing of a tool. At that moment the TT generates a trigger signal that is transmitted to the control, where it is processed further. The trigger signal is generated through a wear-free optical switch that ensures high reliability.

The probe contact is easy to exchange. The connection pin to the touch probe's contact plate features a rated break point. This protects the touch probe from physical damage due to operator error.

TL laser systems
The TL Micro and TL Nano laser systems can measure tools at the rated speed without making contact. With the aid of the included measuring cycles you can measure tool lengths and diameters, inspect the form of the individual teeth and check for tool wear or breakage. The control automatically saves the results of measurement in the tool table.

The measurement is very fast and uncomplicated. Under program control, the NC control positions the tool and starts the measuring cycle. This is always possible: before machining, between two machining steps, or after machining is done.

The axially focused laser beam measures tools as small as 0.03 mm in diameter at a repeatability of up to ± 0.2 µm.

	TT touch probes		**TL Laser System**			
Probing method	Physical probing		Non-contacting by laser beam			
Probing directions	3-dimensional: ±X, ±Y, +Z		2-dimensional: ±X (or ±Y), +Z			
Probing forces	Axial: 8 N, radial 1 N		No forces, operates without contact			
Tool materials	Breakage-prone teeth are at risk		Any			
Sensitivity to unclean tools	Very small		High (tool must be cleaned with blown air before measurement)			
Possible measuring cycles	Length, radius, breakage, individual teeth		Length, radius, breakage, individual teeth, tooth geometry (also for combined contours)			
Installation effort	Simple connection to NC control		PLC adaptation in the NC control necessary (6 outputs, 3 inputs), compressed air connection			
Signal transmission	Cables	Infrared to SE 642	Cables			
Repeatability	2 σ ≤ 1 µm		2 σ ≤ 0.2 µm		2 σ ≤ 1 µm	
Min. tool diameter	3 mm[1)]		0.03 mm		0.1 mm	
Max. tool diameter	Unlimited		37 mm[2)]	30 mm[2)]	80 mm[2)]	180 mm[2)]
Type	**TT 140**	**TT 449**	**TL Nano**	**TL Micro 150**	**TL Micro 200**	**TL Micro 300**

[1)] Probing force must not result in tool damage
[2)] With centered measurement

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TT Touch Probes for Tool Measurement

Together with the measuring cycles of the CNC control, the TT tool touch probes enable the TNC to measure tools automatically while they are in the machine spindle. The control saves the values measured for tool length and radius in the central tool file. By inspecting the tool during machining you can quickly and directly measure wear or breakage to prevent scrap or rework. If the measured deviations lie outside the tolerances, or if the monitored life of the tool is exceeded, the control can lock the tool or automatically insert a replacement tool.

With the **TT 449**, all signals are transmitted to the control via infrared beam.
Advantages:
- Greatly increased mobility
- Fast installation at any location
- Use also on rotary and tilting axes

Your benefit: With the TT 140 or TT 449 tool touch probe you can have your CNC machine operate unattended without losing accuracy or increasing scrap rates.

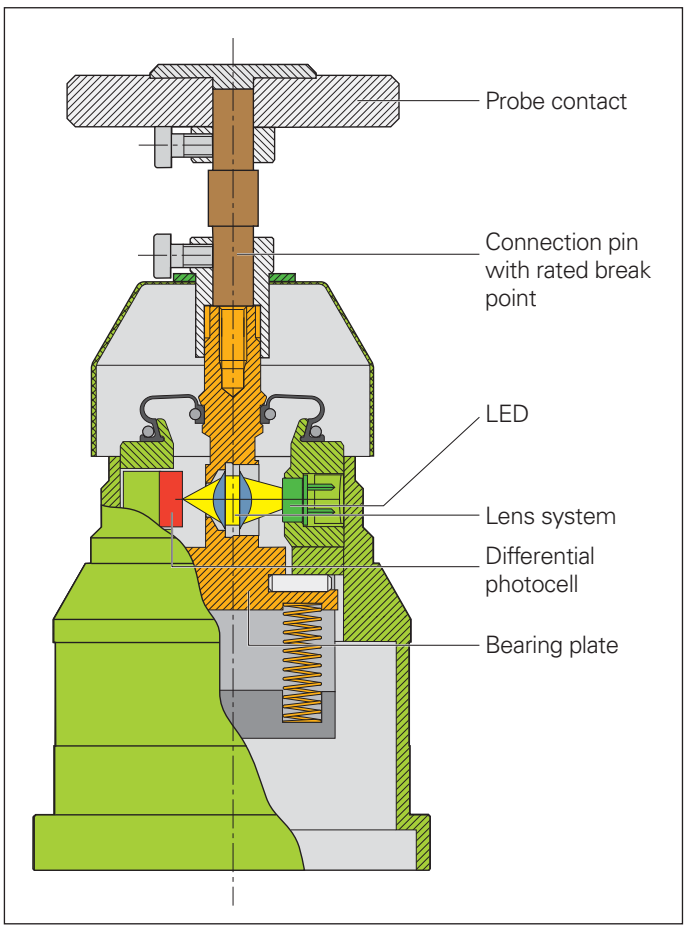
Principle of Function

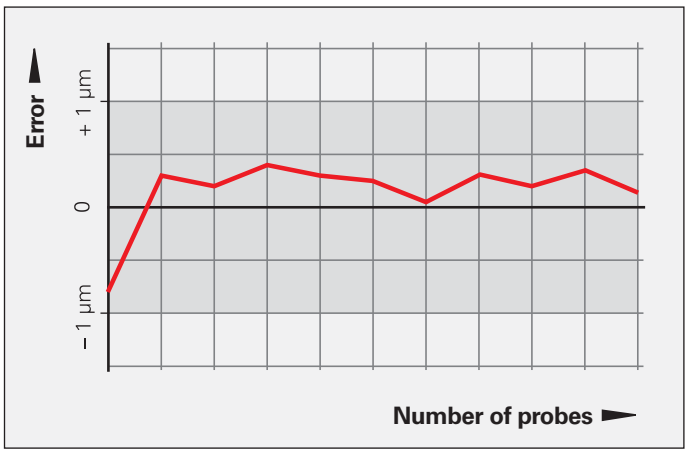
Sensor
Touch probes from HEIDENHAIN operate with an optical switch as sensor. A lens system collimates the light generated from an LED and focuses it onto a differential photocell. When the probe contact is deflected, the differential photocell produces a trigger signal. The probe contact of the TT is rigidly connected to a plate integrated in the probe housing on a three-point bearing. The three-point bearing ensures the physically ideal rest position.

With its contact-free optical switch, the sensor operates without wear to guarantee the high long-term stability of HEIDENHAIN touch probes.

Repeatability
For workpiece measurement, the reproducibility of the probing process is of major importance. The probe repeatability specifies the error resulting from repeatedly probing a tool from one direction at 20 °C ambient temperature.

The probing accuracy of a touch probe is measured at HEIDENHAIN on precision measuring machines.





Typical repeatability curve of a touch probe: results of repeated probing from one direction.

Mounting

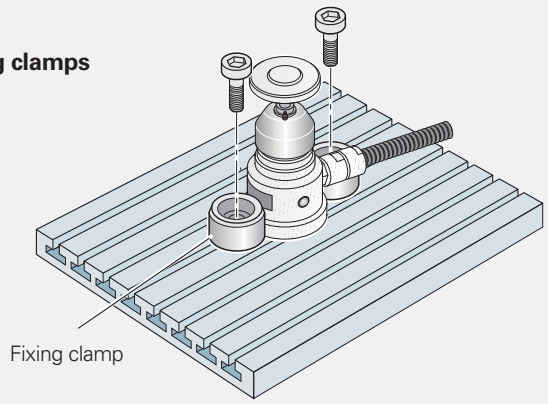
The tool touch probes feature IP 67 protection and can therefore be fixed within the working space of the machine. The TT is mounted with two fixing clamps or on an accessory space-saving mounting base.

The TT with 40-mm probe contact should be operated vertically to ensure reliable probing and optimum protection against contamination. Like the cuboid probe contact, the 25 mm diameter SC02 probe contact can also be operated when mounted in a horizontal position.

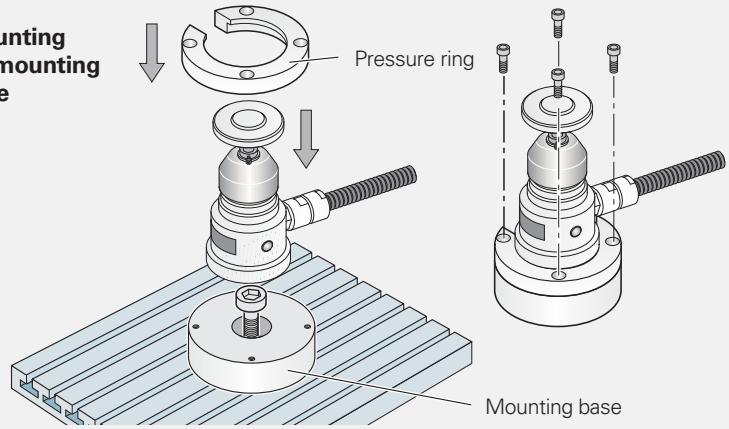
During workpiece machining, the TT must be switched off to ensure that the vibrations that accompany normal machining do not trigger a probe signal and cause an interruption. The working space of the machine tool should be limited in order to prevent collision with the tool touch probe during machining.

Accessory:
Mounting base for TT
For fastening with a central screw
ID 332400-01

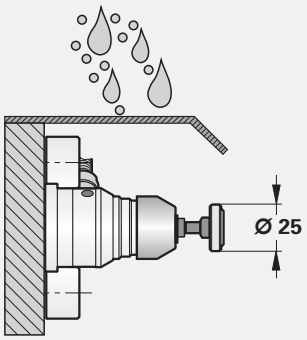
Fastening with fixing clamps



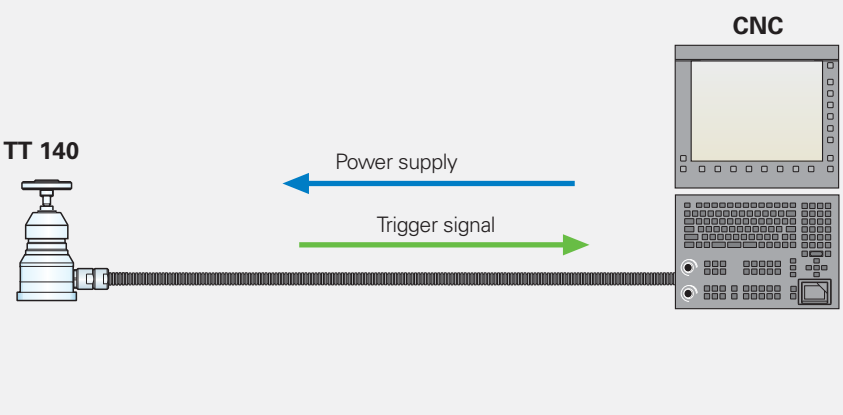
Mounting on mounting base



Horizontal mounting, e.g. with fixing clamps



Power supply and signal transmission
For the TT 140 touch probe, both the power supply and the trigger signal are conducted over the touch probe's cable. The TT 449 transmits the trigger signal by infrared beam to the SE 642 transceiver (see pages 14/15).



Probing

The hardened probe contact of the TT tool touch probe permits direct probing of the tool as it rotates opposite to the cutting direction. Speeds of up to 1 000 min^{-1} are permissible depending on the tool diameter. The probe contact is quickly exchanged: it is simply screwed onto the touch probe through a fit.

The maximum permissible deflection of the probe contact is 5 mm in any direction. The machine must stop moving within this distance.

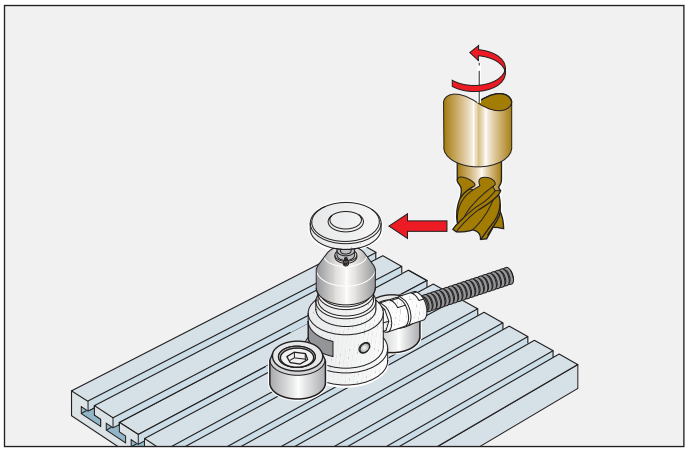
The probe contact of the TT features a **rated break point** in order to protect the touch probe from physical damage due to operator error. The rated break point is effective in all probing directions. A rubber sleeve offers protection from splinters. A defective connection pin can easily be replaced without requiring readjustment of the TT.

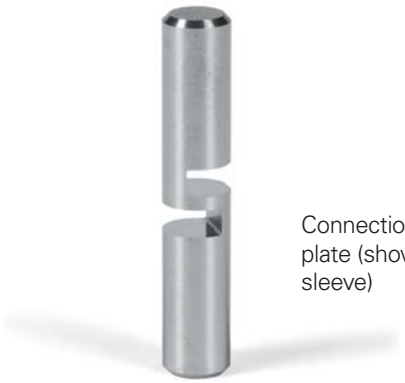
Optical deflection display
Two LEDs on the TT 140 additionally indicate deflection of the probe contact. On the TT 449, the condition of the touch probes is visible through LEDs on the SE 642 transmitter/receiver unit. This is especially useful for testing correct operation. You can see at a glance whether the TT is currently deflected.

Probe contacts
To probe **milling cutters**, the tool touch probes are equipped with a disk-shaped probe contact with 40 mm diameter (example). A disk-shaped probe contact with a 25 mm diameter is available as an accessory. Because of its small weight, it is particularly recommended for horizontal mounting of the TT.

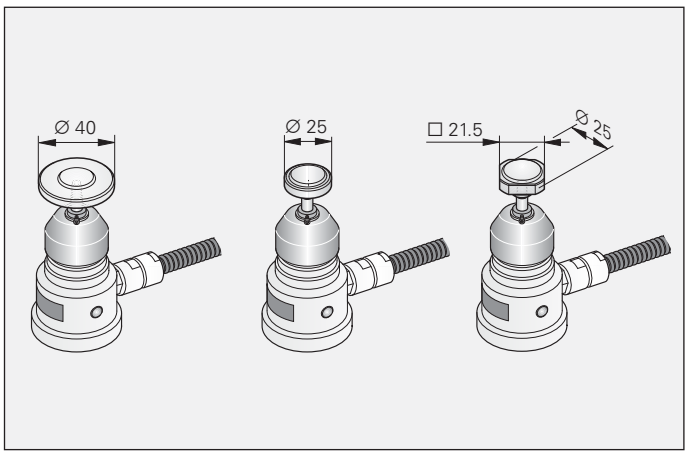
The TT tool touch probe can also be used to calibrate **lathe tools** (example). The flat surfaces of a cuboid probe contact (available as an accessory) are contacted by the edges of the lathe tool. This makes it possible to regularly inspect tools in NC controlled lathes for breakage and wear in order to ensure process reliability.

The probe contacts can be ordered separately for replacement. The can be easily replaced, without requiring readjustment of the TT.





Connection pin to the contact plate (shown without rubber sleeve)



Accessories:
Probe contact SC02 Ø 25 mm
ID 574 752-01

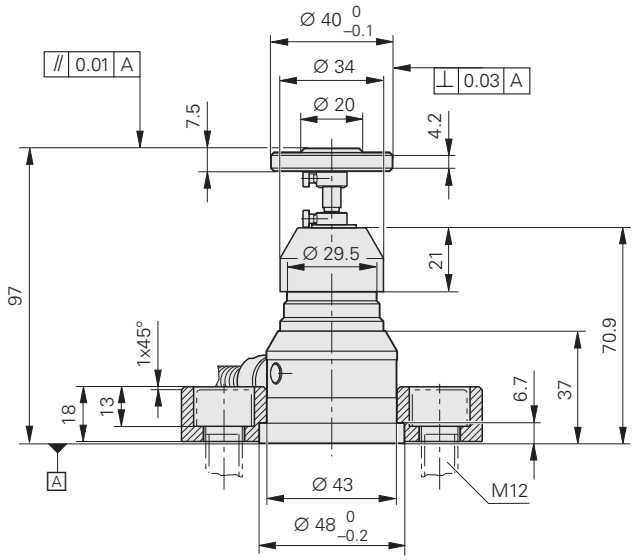
Probe contact SC01 Ø 40 mm
ID 527 801-01

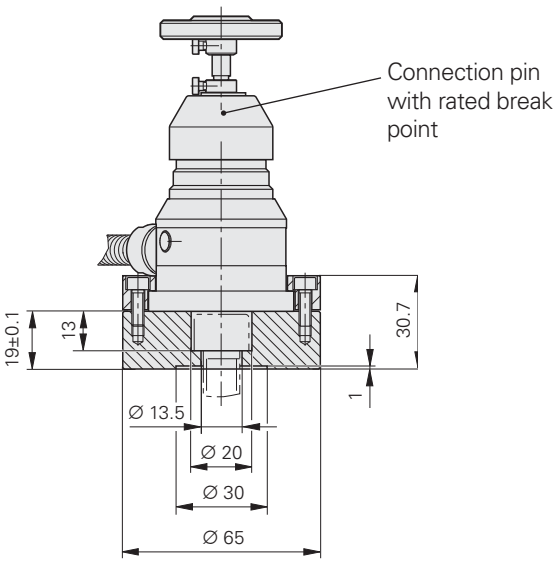
Probe contact cuboid
ID 676 497-01

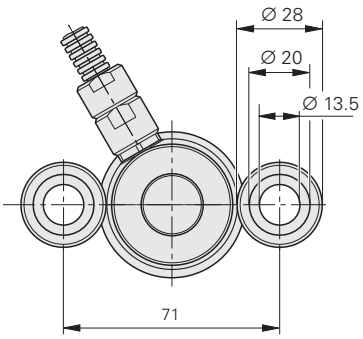
TT 140
Tool Touch Probe with Cable Connection

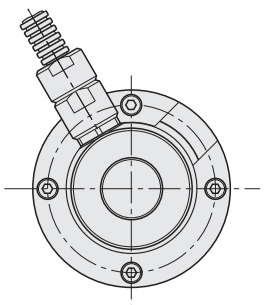
Mounting with fixing clamps included in delivery

Fastening with mounting base accessory









mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

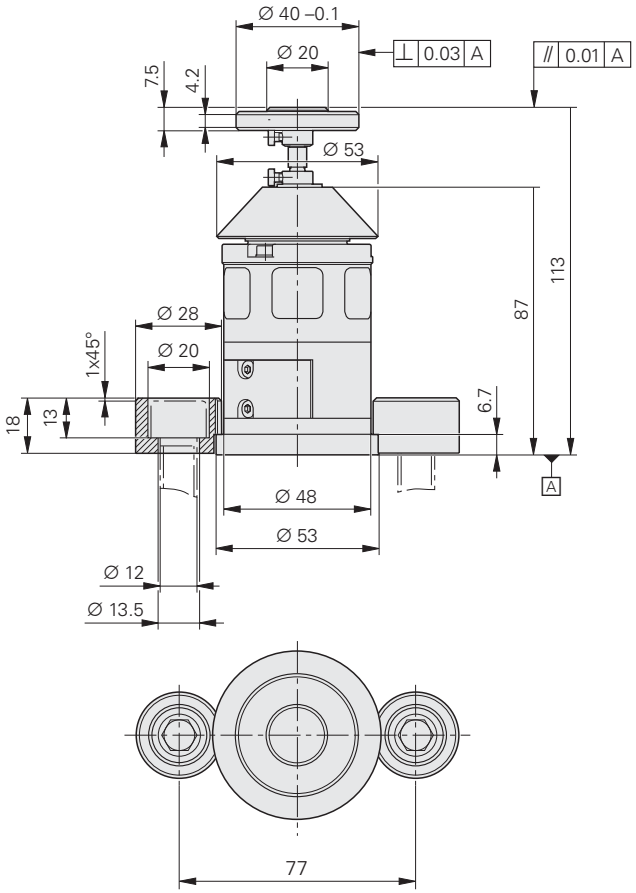
Specifications	TT 140
Probe accuracy	≤ 15 µm
Probe repeatability Repeated probing from one direction	2 σ ≤ 1 µm at a probing velocity of 1 m/min *Typical values:* 2 σ ≤ 1 µm at a probing velocity of 3 m/min 2 σ ≤ 4 µm at a probing velocity of 5 m/min
Deflection of the probe contact	≤ 5 mm in all directions
Deflection force	Axial: approx. 8 N Radial: approx. 1 N
Probe contact*	Ø 40 mm or Ø 25 mm
Probe velocity	≤ 5 m/min
Protection EN 60529	IP 67
Operating temperature	10 °C to 40 °C
Storage temperature	–20 °C to +70 °C
Weight	Approx. 1.0 kg
Mounting on the machine table	Fastening by fixing clamps (included in delivery) Fastening with mounting base (accessory)
Power supply Without load	10 V to 30 V DC / ≤ 100 mA
Output signals	One HTL square-wave signal and its inverted signal Trigger signals S and $\overline{S}$
Signal levels	**HTL** $U_H \geq 20$ V at $-I_H \leq 20$ mA $U_L \leq 2.8$ V at $I_L \leq 20$ mA at 24 V rated voltage
Electrical connection	Cable, 3 m, in metal armor with M23 connector (male), 7-pin
Cable length	≤ 50 m

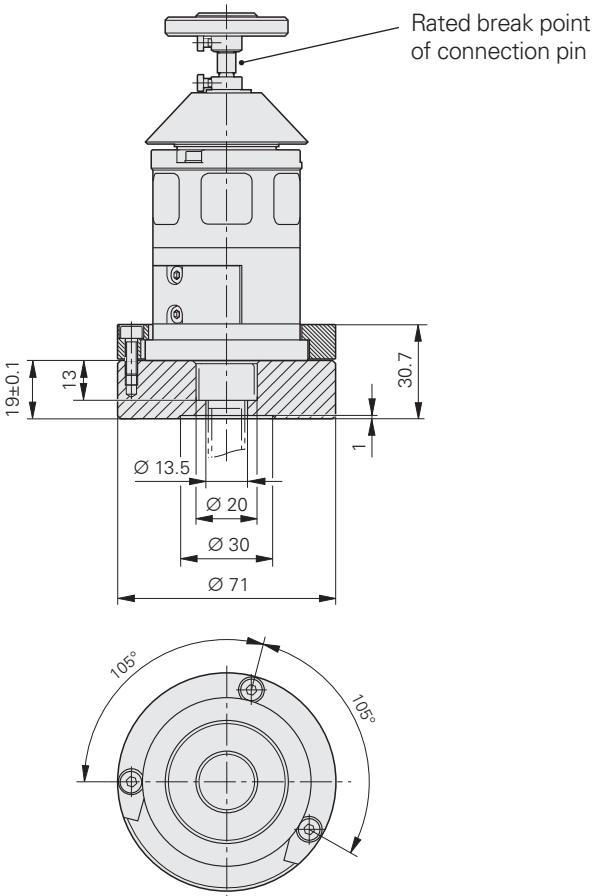
***** Please select when ordering

TT 449
Tool Touch Probe with Infrared Transmission

Mounting with fixing clamps included in delivery

Fastening with mounting base accessory





mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

Specifications	TT 449
Probe accuracy	≤ 15 µm
Probe repeatability Repeated probing from one direction	2 σ ≤ 1 µm at a probing velocity of 1 m/min *Typical values:* 2 σ ≤ 1 µm at a probing velocity of 3 m/min 2 σ ≤ 4 µm at a probing velocity of 5 m/min
Deflection of the probe contact	≤ 5 mm in all directions
Deflection force	*Axial:* approx. 8 N *Radial:* approx. 1 N
Probe contact*	Ø 40 mm or Ø 25 mm
Probe velocity	≤ 5 m/min
Protection EN 60529	IP 67
Operating temperature	10 °C to 40 °C
Storage temperature	–20 °C to +70 °C
Weight	Approx. 0.6 kg
Mounting on the machine table	• Fastening by fixing clamps (included in delivery) • Fastening with mounting base (accessory)
Signal transmission	Infrared transmission with 360° range
Transmission angle of infrared signal	0°
Transceiver unit	SE 642
TT switch-on/off	Infrared signal from SE 642
Power supply	2 batteries (rechargeable or nonrechargeable), size $^{2}/_{3}$ AA or size N[1)] each 1 V to 4 V
Operating time	Continuous duty typically 200 hours with lithium batteries 3.6 V/1 200 mAh (included in delivery)

***** Please select when ordering
[1)] Via adapter, included in delivery

TL Laser Systems for Tool Measurement

Tool monitoring with a TL laser system is a very flexible solution. The contact-free optical measurement enables you to check even the smallest tools rapidly, reliably and without collision. Even the most sensitive tools are completely secure from damage.

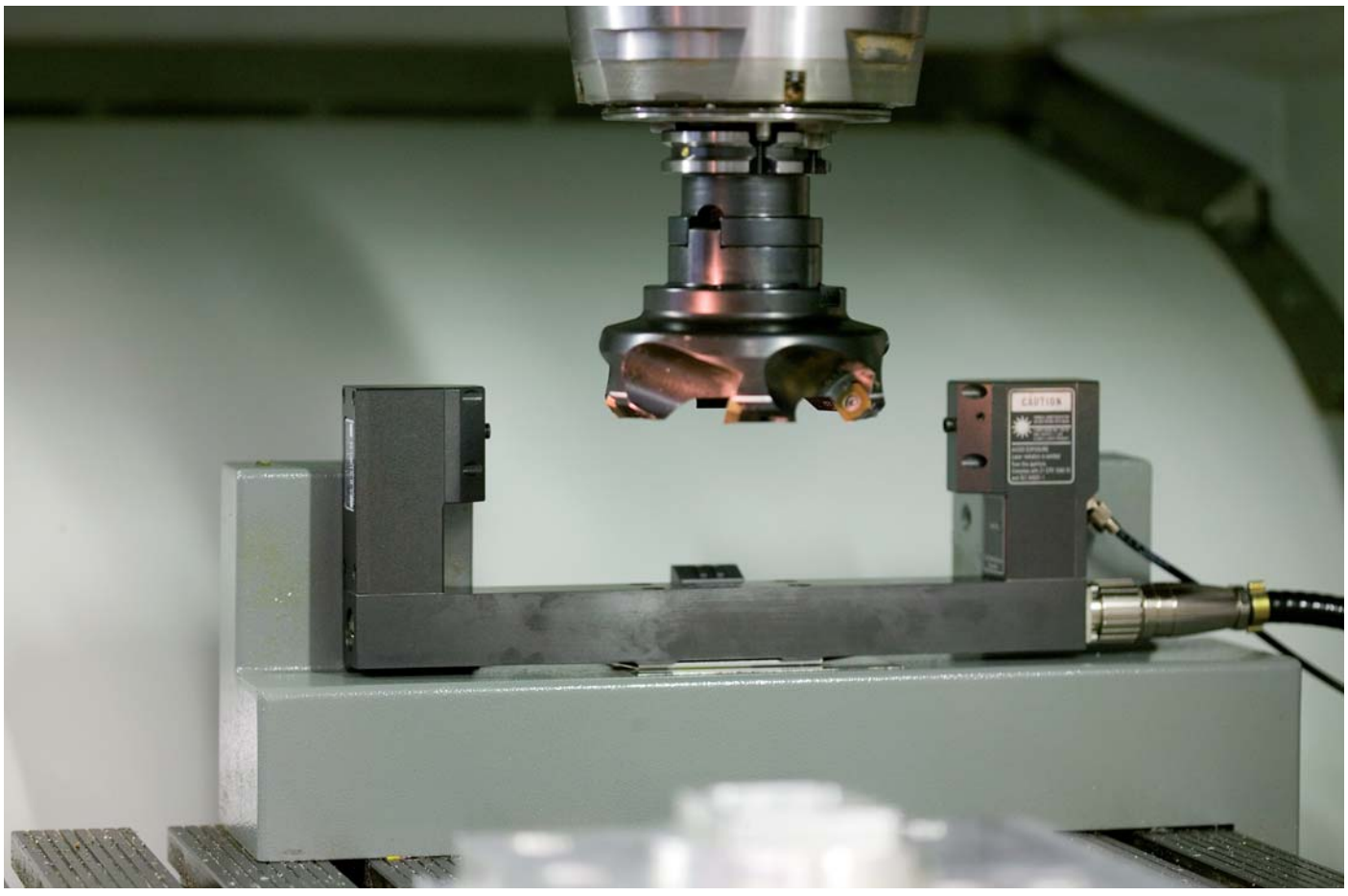
The precise determination of the length and radius at the rated shaft speed ensures your high quality of production. At the same time this integrated tool setting with automatic updating of tool data eliminates the need for separate tool setting, reducing costs and non-productive times.

Tool monitoring occurs at the rated shaft speed in the real clamping system, and as such under real operating conditions. Errors on the tool, spindle and holder can be immediately detected and corrected. Every single tooth is measured at the highest speed. Even the geometry of special tools can automatically be checked on the machine for deviations.

The continual process inspection with monitoring of the tool data detects wear, tooth breakage and tool breakage before damage occurs. This ensures consistent production quality, avoids subsequent damage, and reduces the cost of scrapped or reworked parts. The measuring cycles operate automatically, ensuring optimum monitoring even during unattended operation.

The TL laser systems guarantee reliable tool monitoring, high measuring accuracy, and precise inspection for wear and tear. They offer the following benefits:

- Reduced non-productive times
- Unattended operation
- Less scrap
- Increased productivity
- Consistently high quality of production



Components

TL laser systems
The laser systems are available in different versions for various maximum tool diameters:
- TL Nano
- TL Micro 150
- TL Micro 200
- TL Micro 300

The devices have an integral blowing unit to remove chips and coolant from the tool with a blast of compressed air.

The TL laser systems are optimized to the spindle shaft speed of NC machines for standard spindles and for HSC spindles (over 30000 min^{-1}).

The TL Micro systems are available as versions with cable exits and compressed air connections on the bottom or on the side.

Measuring cycles
The NC control uses measuring cycles to process the output signal of the laser systems and performs the necessary calculations. Measuring cycles for the TNC 426/430 and iTNC 530 controls from HEIDENHAIN are included with the TL laser systems. The measuring cycles contain functions for
- Tool setting with automatic transmission of the data to the tool table
- Inspection of wear and tear with or without correction of the tool data
- Identification with or without correction of the tool data

Compressed air unit
A **DA 301 TL** compressed air unit, specifically designed for these requirements, is necessary for operation of the TL laser systems. It consists of three filter stages (prefilter, fine filter and activated carbon filter), an automatic condensation trap, and a pressure regulator with pressure gauge, as well as three control valves. They activate the sealing unit of the laser optics, supply the laser system with sealing air, and blow the tool clean. The PLC program triggers the control valves.

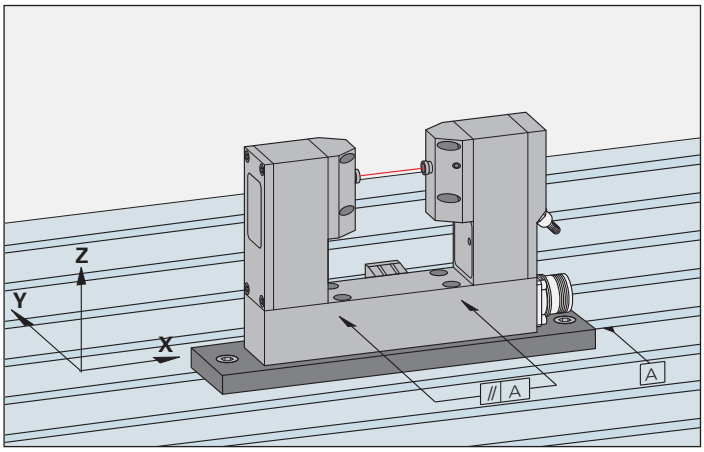
Accessories
A comprehensive series of accessories simplifies the mounting and maintenance of the TL laser systems.

Mounting

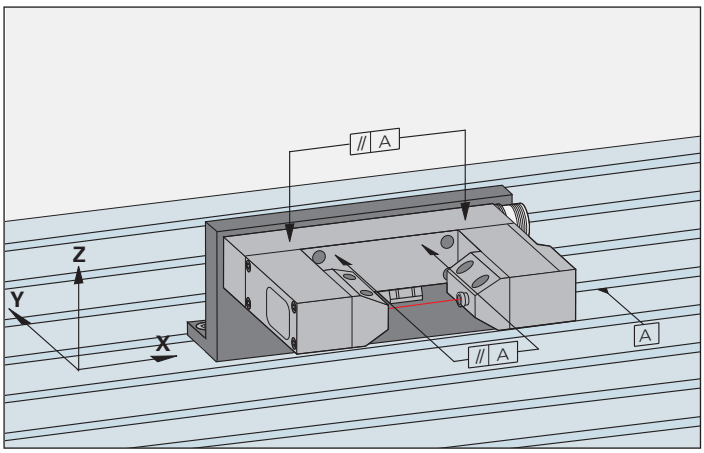
Mounting attitude
The TL laser systems fulfill the requirements for IP 68 and can therefore be fixed directly in the machine's working space. For smooth operation, even with coolant and chips, the transmitter and receiver feature a pneumatically activated sealing system. The additional introduction of sealing air provides a very high degree of protection against contamination.

The TL laser systems can be mounted in both upright and resting positions on or next to the machine table. They must be mounted in a stable enough manner to guarantee high repeatability. The cutting edge should rotate in the appropriate direction for avoiding bothersome reflections and refractions during measurement by the laser beam.

The working space of the machine tool should be limited in order to prevent collision with the laser system during machining.

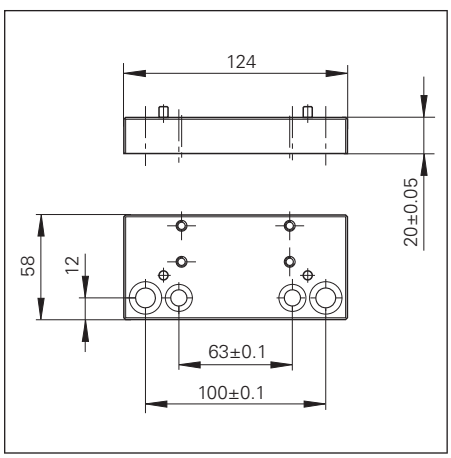


Adjusting the TL
In order to achieve the best possible repeatability, the laser system must be mounted exactly parallel to two NC axes. For upright mounting on the machine table, the horizontal alignment is ensured by the mounting surface. The mounting tolerances are included in the dimension drawings. Deviations in the parallelism are particularly noticeable as linear errors when measuring the length of very different tool diameters. It is therefore recommended that the length of eccentric tools (e.g. end mills, face-milling cutters) be measured on the outside radius outside of the tool axis.



Mounting accessory for TL Micro
The mounting base makes it very easy to install a TL Micro laser system on the machine table. Two stop pins on the base permit you to remove and reinstall the laser system without having to readjust it.

Accessory:
Mounting plate for TL Micro
ID 560028-01

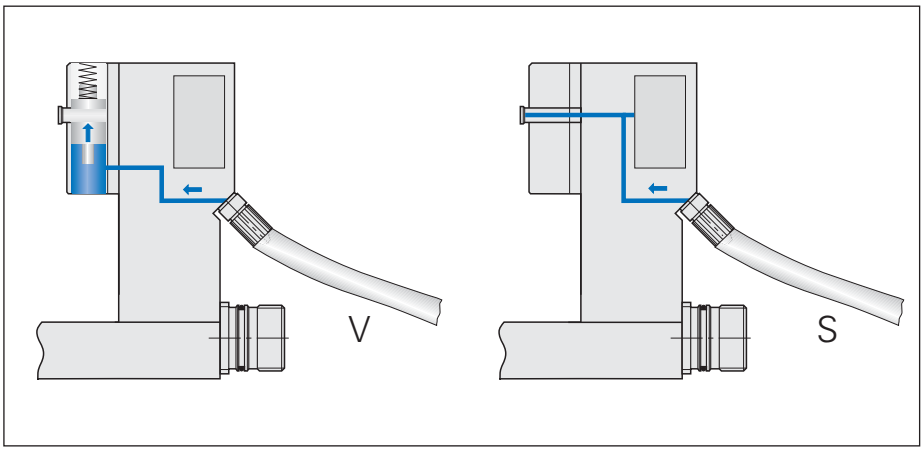


Contamination Protection

The application of laser systems directly on machine tools requires effective measures to protect the sensitive optical system of the laser light barrier.

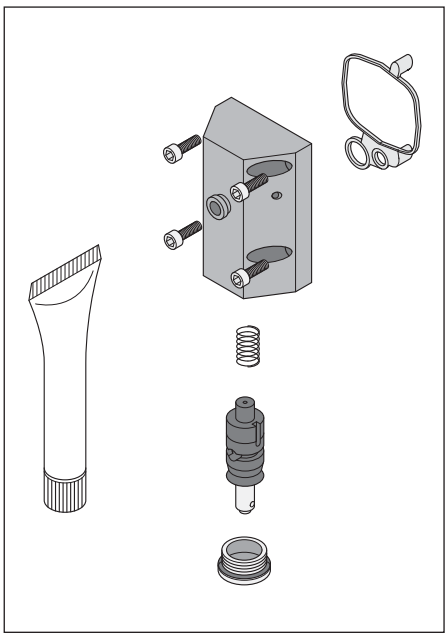
Mechanical protection
The optics of the laser systems are perfectly sealed against coolant and chips by contamination shutters with an integrated mechanical seal system. The seal enables the optical system only for the duration of the measurement. The seal is actuated pneumatically by the DA 301 TL compressed air unit.

Sealing air
The transmitter and receiver of the laser light barrier are protected by very clean sealing air from the DA 301 TL compressed air unit. It prevents contamination of the optical system by coolant spray.

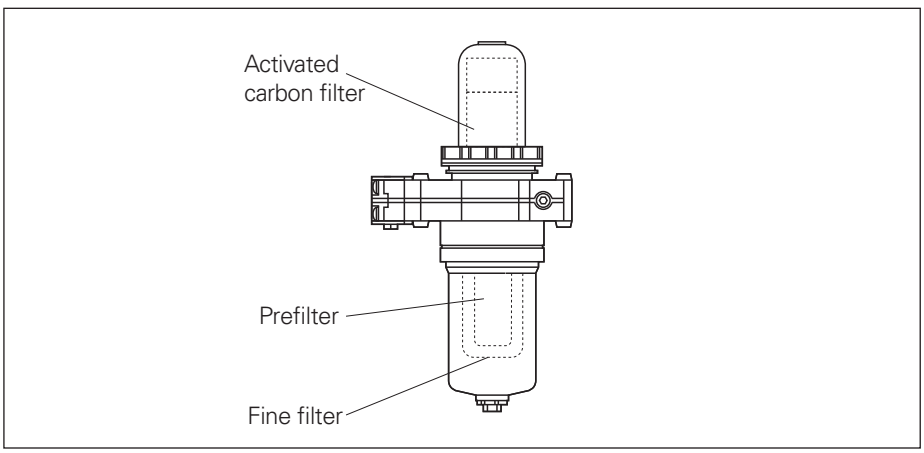


Pneumatic systems in the TL with connections for sealing air (S) and seal control (V)

Accessories
Maintenance kit for protective shutter
ID 560034-01
A maintenance kit consisting of the following items is offered for cleaning the contamination shutters of the laser optics.
- Gasket set
- Sintered sleeves
- Filler plugs
- O-rings
- M3x8 hexagon socket screws
- Special lubricant
- Operating instructions



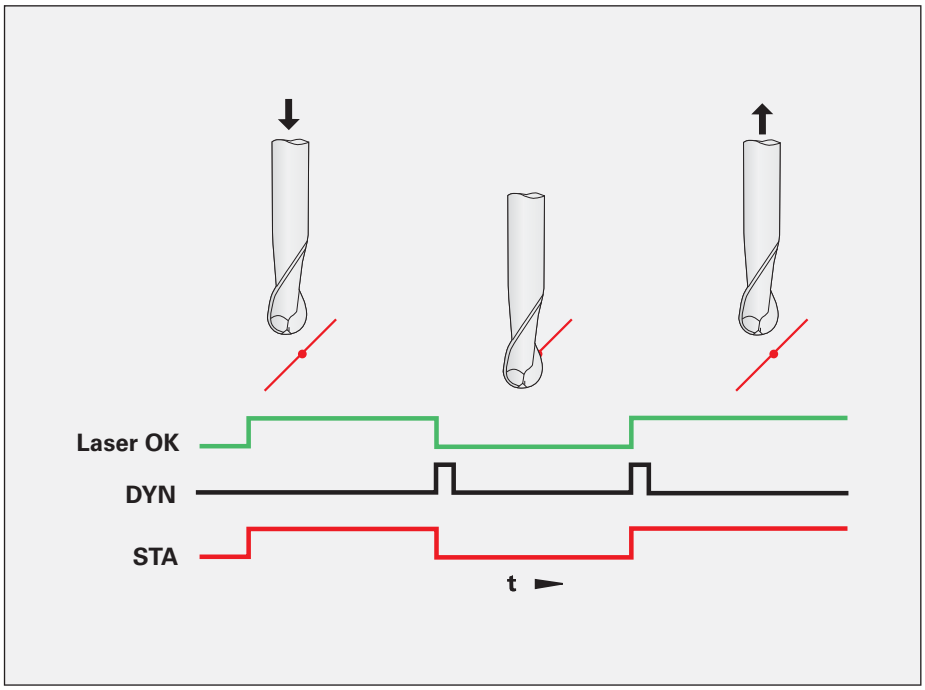
Replacement filters
ID 560036-01
Complete filter set for the DA 301 TL consisting of prefilter, fine filter, and activated carbon filter.



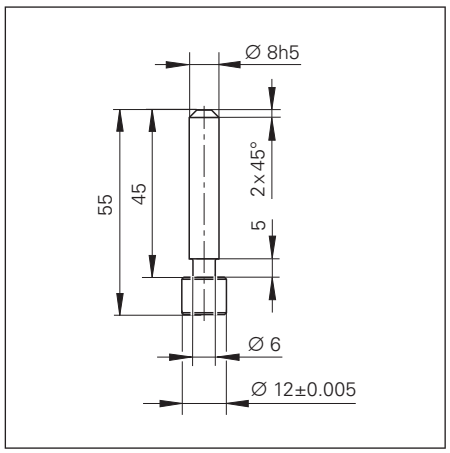
Protective springs
ID 560037-01
Set of spiral springs for protecting the compressed air tubing in the machine envelope
Set: 2 x Ø 6 mm, 1 x Ø 4 mm;
Length each: 1 m

Probing

The TL laser systems operate as high-precision light barriers without any contact. A laser light source (protection class 2 as per IEC 825) emits a laser beam. The opposing receiver unit detects the laser beam and so captures every interruption. For any change in status—such as when a tool interrupts the laser beam or is removed again—the integral electronics generate a trigger pulse for a defined duration. This dynamic signal DYN is transmitted to the NC control, where it is used for capturing the position value. In addition, the laser system outputs the static signal STA for the duration that the laser beam is interrupted.

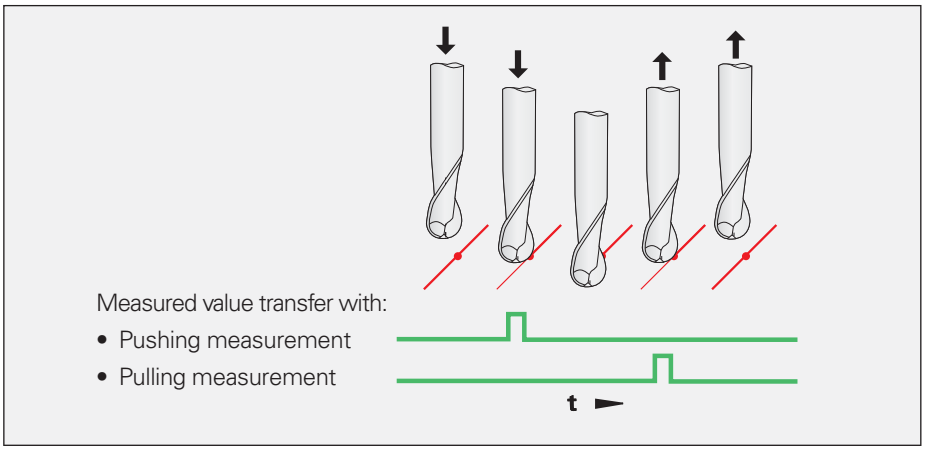


Calibrating
Before measurement with the TL laser system can be started, the system must be calibrated, meaning that the exact position of the trigger points relative to the machine coordinate system must be determined. A reference tool, available as an accessory, is used for this purpose. It has a characteristic shape for calibration, with a cylindrical dowel pin and a stepped inspection diameter for measurement in the positive and negative Z axis directions (for determining the exact position of the center of the laser beam in Z). The reference tool is clamped into the tool holder, and its length, diameter and height are measured very exactly. A cylindrical dowel pin suffices for simple applications. The best possible runout is to be ensured for the calibration measurement.



Accessory:
Reference tool
ID 560032-01

Probing strategies
The mechanical transfer elements influence the accuracy of the measurement. The measured value can be captured either when the tool is moved into the laser beam ("pushing measurement") or when it is removed ("pulling measurement"). The pulling measurement ensures a high degree of protection against the influence of coolant and swarf, while the pushing measurement is the better method for engraving bits and tools with very small shaft diameters.



Operating modes
The operating mode of the laser system is defined over the receiver-enabling inputs 1 and 2 (ENABLE 1/ENABLE 2). The measuring signals automatically put the receiver in the appropriate operating mode.

During **inspection of individual teeth,** each available tooth generates an output pulse of defined duration. The pulse length and the number of teeth define the basic speed. In the event of error—a missing tooth or a tolerance error—the dynamic output signal (DYN) stays at low level for max. 100 seconds.

In the **measuring** mode, every change of light causes an output signal DYN with a defined duration of 20 ms. The positive edge is evaluated. The device is switched between "pushing" and "pulling" measurement over the receiver-enabling input 2 (ENABLE 2).

Operating mode	ENABLE 1	ENABLE 2	Function
0	**0**	**0**	Inspection of individual teeth Base speed 3750 min^{-1} 
1	**0**	**1**	Pushing measurement Base speed ≥ 0 min^{-1} 
2	**1**	**0**	*On version for standard machine** Pulling measurement Base speed 600 to 3000 min^{-1} 
			*On version for HSC machines** Inspection of individual teeth Base speed 42000 min^{-1} 
3	**1**	**1**	Pulling measurement Base speed ≥ 3000 min^{-1} 

* Please select when ordering

Optical status indicator
LEDs on the receiver side of the laser system make a rapid diagnosis of the status possible. In this way, the operator sees at a glance whether the laser beam path is OK, whether a dynamic trigger signal is being output, and which operating mode of the laser system is active.

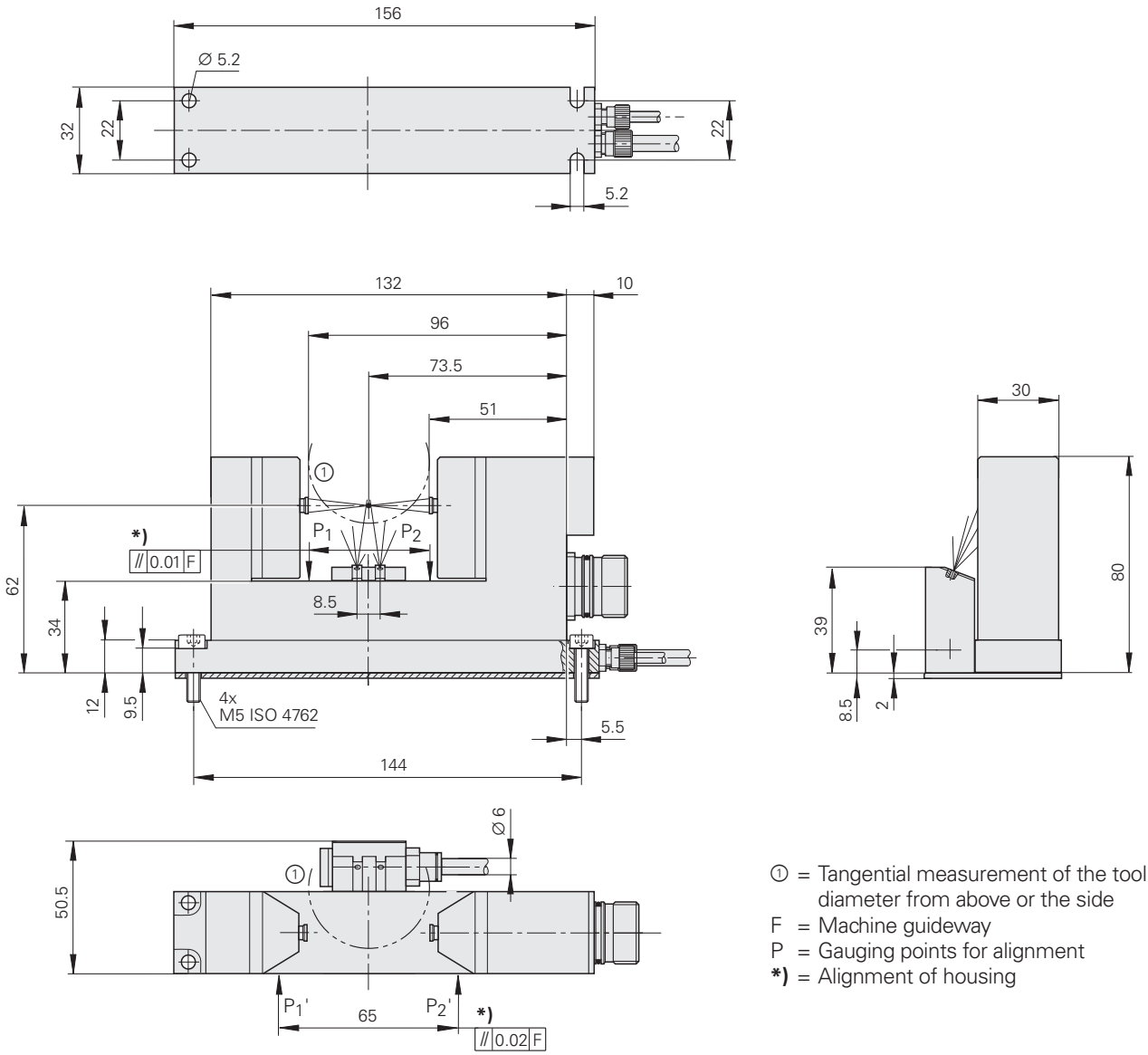
Probing used tools
The optically scanning laser system can of course not distinguish between the actual tool to be measured and any attached chips, coolant coating or falling drops of coolant. In order to avoid faulty measurements, the tool should therefore be cleaned before measuring. This can be done by spinning off any particles at a high rotational velocity or by blowing them off with air. The TL laser systems feature an integral blowing feature for this, which can be used to clean the tool before and during a measuring cycle.

Optical status indicator	LED	Function
Laser ON	●	Input for enabling transmission
Alignment	●	Laser adjustment OK (signal > 95 %)
Laser OK	●	Laser output OK (signal > 75 %)
Output	●	DYN output (signal > 50 %)
Mode	○	Operating mode 0
	●	Operating mode 1
	●	Operating mode 2
	●	Operating mode 3

TL Nano
Laser System for Tool Measurement

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm



① = Tangential measurement of the tool diameter from above or the side
F = Machine guideway
P = Gauging points for alignment
***)** = Alignment of housing

Specifications	TL Nano
Tool diameter Central measurement Tangential measurement	 0.03 to 37 mm 0.03 to 44 mm
Repeatability	± 0.2 µm
Spindle speed*	Optimized for individual tooth measurement on standard or HSC spindles (> 30000 min^{-1})
Lasers	Visible red-light laser with beam focused at center of system
Wavelength/Power	630 to 700 nm / < 1 mW
Protection class IEC 825	2
Input signals	Square-wave signals 24 V DC • Enable transmitter ENABLE 0 • Enable 1 receiver ENABLE 1 • Enable 2 receiver ENABLE 2
Output signals	Square-wave signals 24 V DC • Dynamic triggering signal DYN • Static triggering signal STA • Proper laser function LASER OK
Power supply	24 V DC / 160 mA
Electrical connection	M23 coupling (male),12-pin, at side
Mounting	Within the machine work envelope
Protection EN 60529	IP 68 (when connected, with sealing air)
Tool cleaning	Blower
Operating temperature **Storage temperature**	10 °C to 40 °C 0 °C to 50 °C
Weight	Approx. 0.70 kg (including blower)

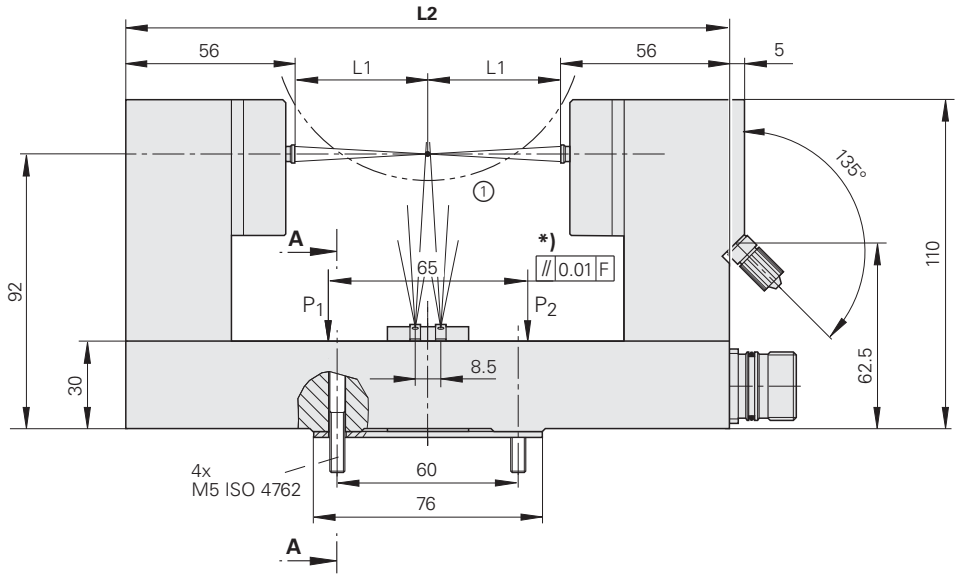
***** Please select when ordering

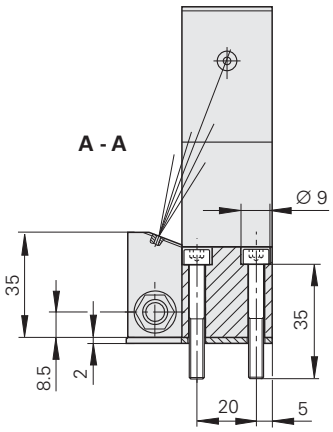
TL Micro

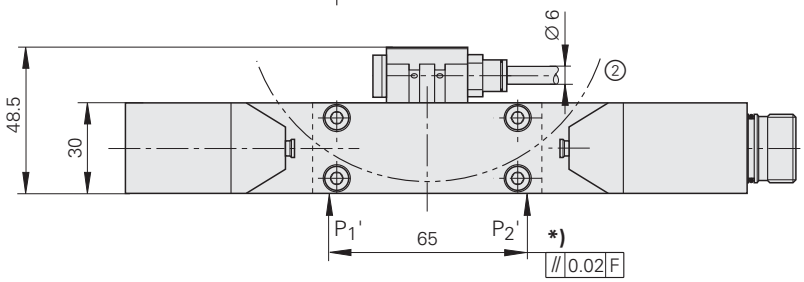
Laser System for Tool Measurement

mm

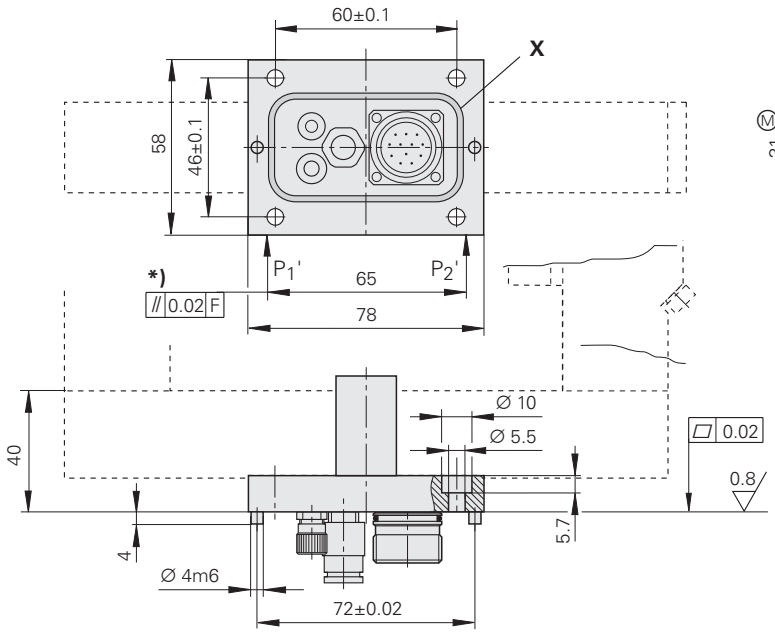
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

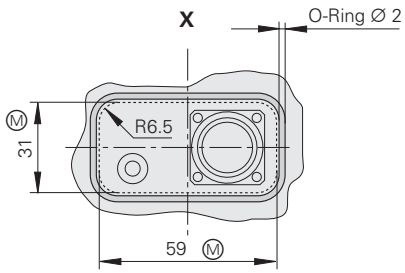






L1	L2	Type
19	150	TL Micro 150
44	200	TL Micro 200
94	300	TL Micro 300





① = Tangential measurement of the tool diameter from above
② = Tangential measurement of the tool diameter from the side
Ⓜ = Cutout for mounting
F = Machine guideway
P = Gauging points for alignment
***)** = Alignment of housing

Specifications	TL Micro 150	TL Micro 200	TL Micro 300
Tool diameter Central measurement Tangential measurement from above Tangential measurement, lateral	 0.03 to 30 mm 0.03 to 30 mm 0.03 to 30 mm	 0.1 to 80 mm 0.1 to 98 mm 0.1 to 122 mm	 0.1 to 180 mm 0.1 to 324 mm 0.1 to 428 mm
Repeatability	± 0.2 µm	± 1 µm	
Spindle speed*	Optimized for individual tooth measurement on standard or HSC spindles (> 30000 min^{-1})		
Lasers	Visible red-light laser with beam focused at center of system		
Wavelength/Power	630 to 700 nm / < 1 mW		
Protection class IEC 825	2		
Input signals	Square-wave signals 24 V DC • Enable transmitter ENABLE 0 • Enable 1 receiver ENABLE 1 • Enable 2 receiver ENABLE 2		
Output signals	Square-wave signals 24 V DC • Dynamic triggering signal DYN • Static triggering signal STA • Proper laser function LASER OK		
Power supply	24 V DC / 160 mA		
Electrical connection*	M23 flange socket (male), 12-pin, either on the side or bottom		
Mounting	Within the machine work envelope		
Protection EN 60529	IP 68 (when connected, with sealing air)		
Tool cleaning	Blower		
Operating temperature **Storage temperature**	10 °C to 40 °C 0 °C to 50 °C		
Weight	Including blower		
Cable outlet on side (approx.)	0.85 kg	0.95 kg	1.15 kg
Cable outlet on bottom (approx.)	0.90 kg	1.00 kg	1.20 kg

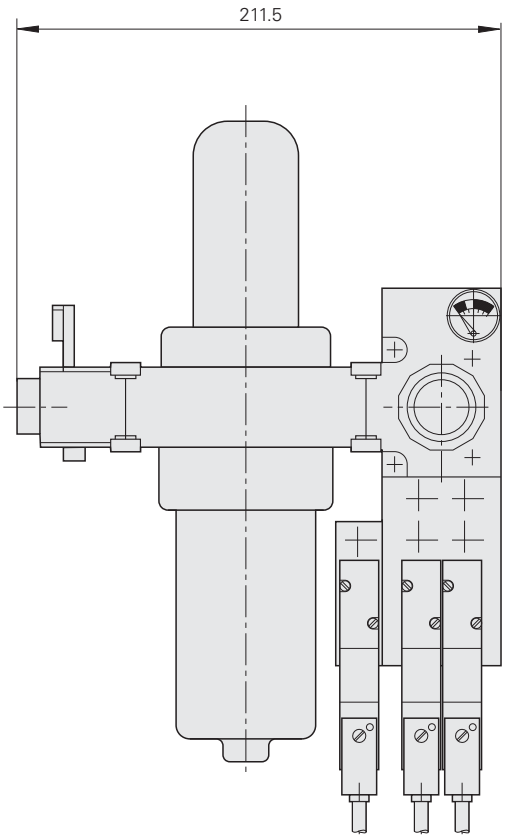
***** Please select when ordering

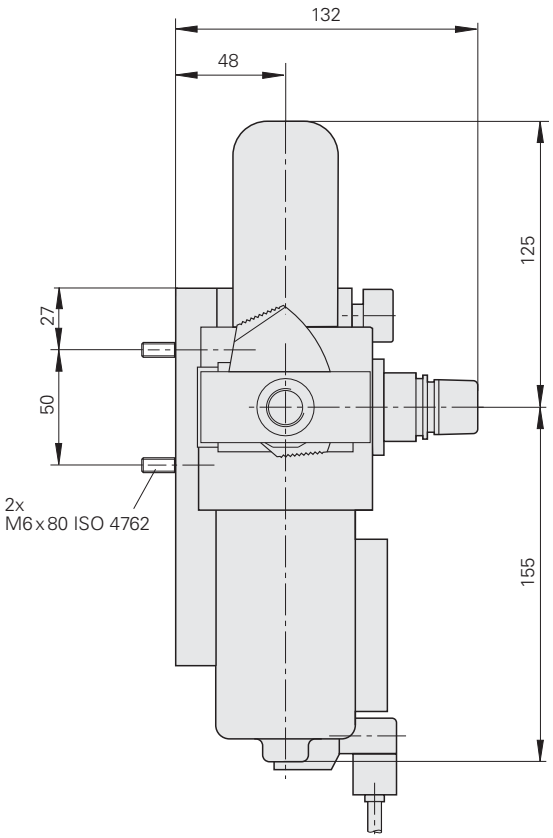
DA 301 TL

Compressed Air Unit for TL Laser System

mm

Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm





Specifications	DA 301 TL
Mechanical Design	
Filter system	• Prefilter for particle sizes down to 5 µm • Fine filter for particle sizes down to 0.01 µm • Activated carbon filter for particle sizes down to 0.001 µm
Pressure regulator with pressure gauge	For setting the output pressure
Control valves	Release compressed air for • Sealing air • Workpiece blower • Sealing unit of the laser optics
Overpressure for operation	4 to 6 bars
Air quality	
Air inlet	DIN ISO 8573-1 class 4.3.4
Air outlet	DIN ISO 8573-1 Class 1.3.1
Flow rate	≥ 400 l/min (without blower)
Connections	
Inlet for compressed air	G 3/8“
Compressed air outlet	Quick disconnects for • Sealing air: Ø 6 mm • Blower: Ø 6 mm • Sealing unit: Ø 4 mm
Weight	Approx. 4.4 kg (without cable)
Items supplied	DA 301 TL compressed air unit 1 x 13 m pressure tubing Ø 4 mm 2 x 13 m pressure tubing Ø 6 mm 3 x 10 m cable for triggering the control valves

Power Supply

The cable-connected touch probes **TS 2xx, and TT 140, the SE** transceiver unit, the **APE 642** interface electronics and the **TL** laser systems are powered by the control. The maximum cable lengths shown in the specifications apply to HEIDENHAIN cables.

The **TS 440, TS 64x, TS 740** and **TT 449** touch probes with infrared transmission are powered by two batteries (rechargeable or nonrechargeable) with a rated voltage of 1 to 4 V. The service life depends heavily on the type and model of batteries used (see table for examples). The typical service life data shown in the specifications apply only to the lithium batteries included in delivery.

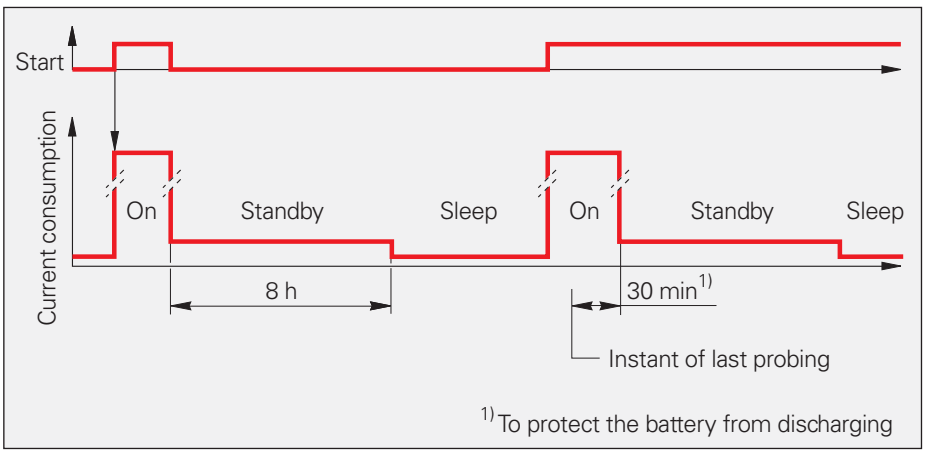
The touch probe electronics automatically detect the type of batteries used. If the battery capacity falls below 10 %, the SE transmits a warning to the control and a red LED simultaneously lights up on the SE.

In order to minimize the current consumption, the touch probe switches to the stand-by mode when the off signal is transmitted, or at the latest, 30 minutes after the last probing. Eight hours later it switches to the sleep mode. You must then take a longer startup time into account when reactivating the touch probe (see *Switching the TS 440/TS 640/TS 740* on/off)

	Size	Operating time (approx.)		
		Lithium battery	**Alkaline battery**	**NiMH battery**
TS 440 **TT 449**	Size $^2/_3$ AA or Size N (by adapter)	200 h with Sonnenschein SL-761	60 h with Panasonic Lady	45 h (no test)
TS 640	Size C	800 h with Saft LS26500	400 h with Duracell plus	250 h with GP 3500
	Size A (via adapter)	400 h with Saft LS17500	200 h[1)]	125 h[1]
TS 740	Size C	500 h with Saft LS26500	220 h with Duracell plus	140 h with GP 3500
	Size A (via adapter)	250 h with Saft LS17500	110 h[1)]	70 h[1)]

[1)] Calculated

Caution: Never mix types or models of batteries!



TS 440/TS 640/TS 740/TT 449 current consumption

TS 444 – Energy Generation through Air Turbine Generator

The **TS 444** touch probe with infrared transmission has an air turbine generator for power generation. Additional rechargeable or nonrechargeable batteries are not required.

Components
The air turbine generator consists of an air turbine, the actual generator and high-power capacitors for energy storage. Compressed air that is supplied through the spindle is required for operating the turbine. The compressed air can also be used for cleaning the workpiece. Charging the capacitors and cleaning the workpiece are thus combined in one work step. This eliminates such additional idle time.

Principle of function
After inserting the TS 444 touch probe, the high-power capacitors are charged by the air turbine generator. This can be done when the touch probe moves from the tool changer to the measuring position, and also when the workpiece is cleaned with compressed air.

Charging times
The charging times of the capacitors depend on the available air pressure: The higher the pressure, the shorter the charging time (see diagram).

Operating time
When the capacitor is fully charged, the TS 444 is ready for 120 seconds of continuous operation. The battery warning signal reports that the capacitors need to be recharged.

Requirements for compressed air quality
The air turbine generator can already operate at a minimum pressure of 2 x 10^5 Pa. An operating pressure between 5.5 x 10^5 and 8 x 10^5 Pa is recommended for effective charging. The compressed air does not need to be specially cleaned.

10^5 Pa ≙ 1 bar

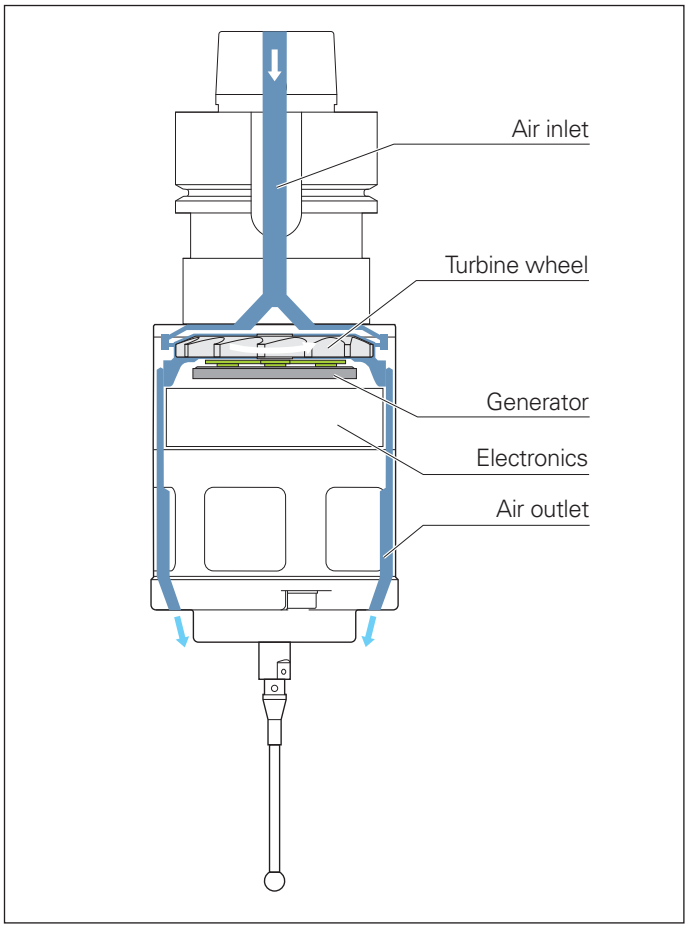
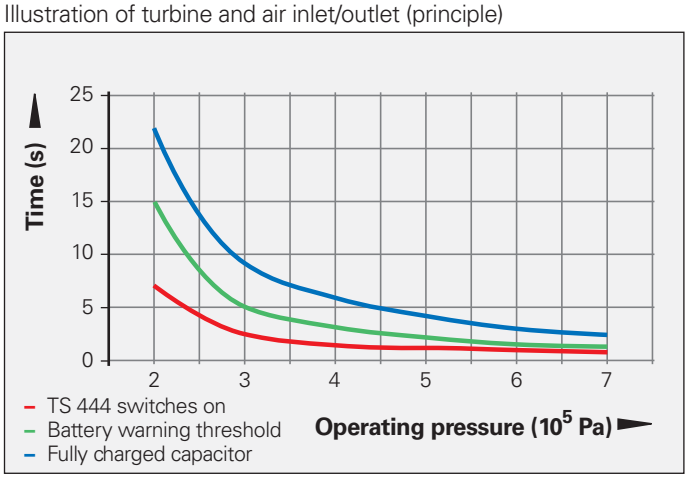


Illustration of turbine and air inlet/outlet (principle)



Charging time as a function of supplied pressure

Touch Probes with Signal Transmission by Cable

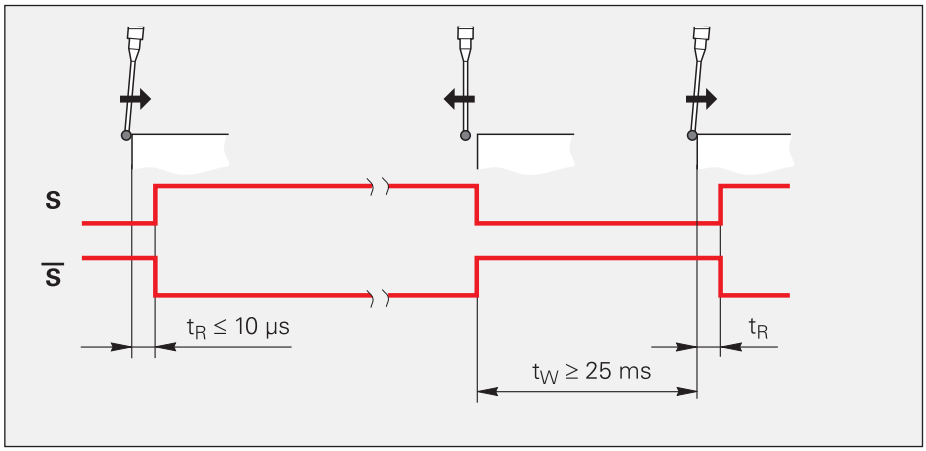
When the stylus is deflected, the square-wave **trigger signal S** and its inverted signal $\overline{\mathbf{S}}$ are generated.

Since the spindle must be locked in position before the TS can be inserted, the connecting and adapter cables are equipped with jumpers. This enables the CNC to conduct the required safety check when the touch probe is connected.

Signal levels
⊓⊔ TTL: TS 220
$U_H \geq 2.5$ V at $-I_H \leq 20$ mA
$U_L \leq 0.5$ V with $I_L \leq 20$ mA

⊓⊔ HTL: TS 230/TS 249/TT 140
$U_H \geq (U_P - 4\,V)$ at $-I_H \leq 20$ mA
$U_L \leq 2.8$ V at $I_L \leq 20$ mA

Besides the trigger signal in HTL levels, the **TS 249** also features two additional **floating switching outputs** (triggers), normally open or normally closed. This makes the TS 249 particularly universal in its compatibility.



Trigger signal with TS 220/TS 230/TS 249/TT 140
Response time $t_R \leq 10$ µs
Repeat interval $t_W > 25$ ms

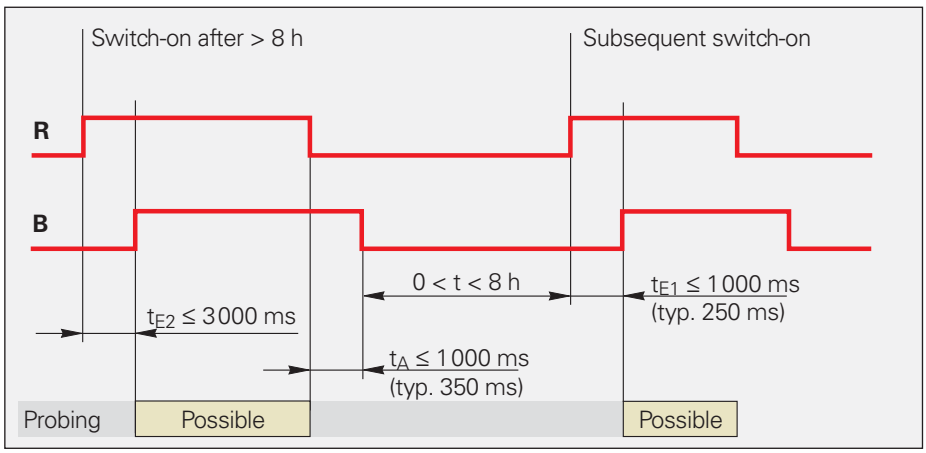
Touch Probe with Infrared Transmission

The **TS 440, TS 640, TS 740** and **TT 449** touch probes are switched on by the CNC over the SE. The rising edge of the **start signal R** activates the TS, and the falling edge deactivates it.

The **TS 642** touch probe is activated by inserting it in the spindle by a microswitch integrated in the taper shank.

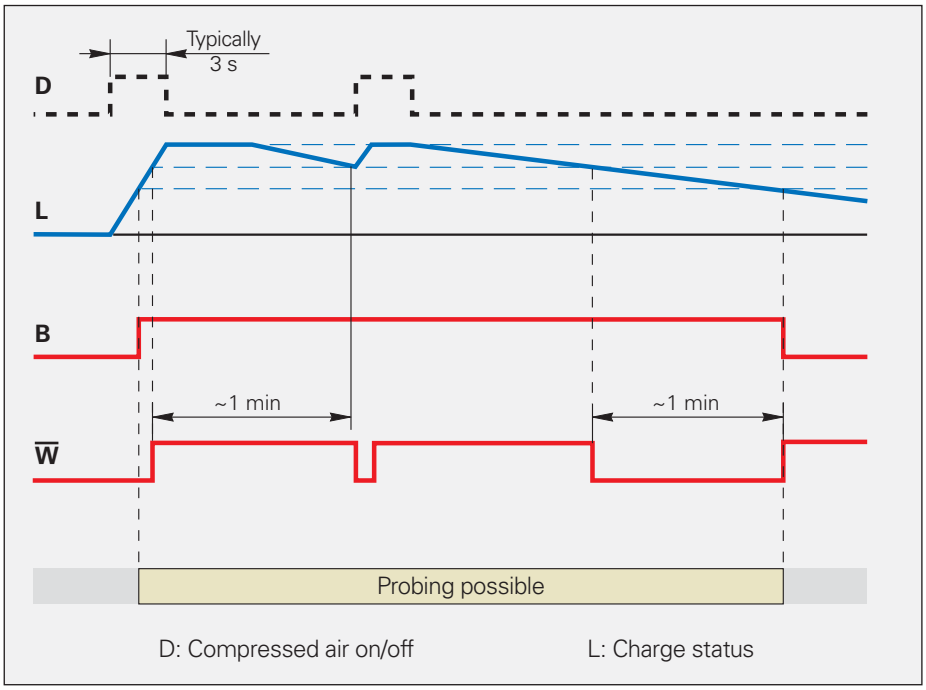
The SE uses the **ready signal B** to report to the control that the touch probe is activated and within the reception area of the SE. The workpiece can now be probed.

The delay t when switching the probe on or off depends on the distance between the SE and TS, as well as the mode of the touch probe's power supply. Subsequent to the initial activation (when the TS is in standby mode) the typical value for activation is 250 ms, and for deactivation 350 ms (1 000 ms for the max. distance). When activating the probe after a longer interval (more than 8 hours—the TS is in the sleep mode), the delay can be up to 3 seconds. If the touch probe does not respond, the SE aborts the switch-on/off attempt after 3.5 seconds.



Switching the TS 440/TS 640/TS 740/TT 449 on and off
Signal times
Switch-on delay
$t_{E1} \leq 1000$ ms (typically 250 ms)
$t_{E2} \leq 3000$ ms
Switch-off delay
$t_A \leq 1000$ ms (typically 350 ms)

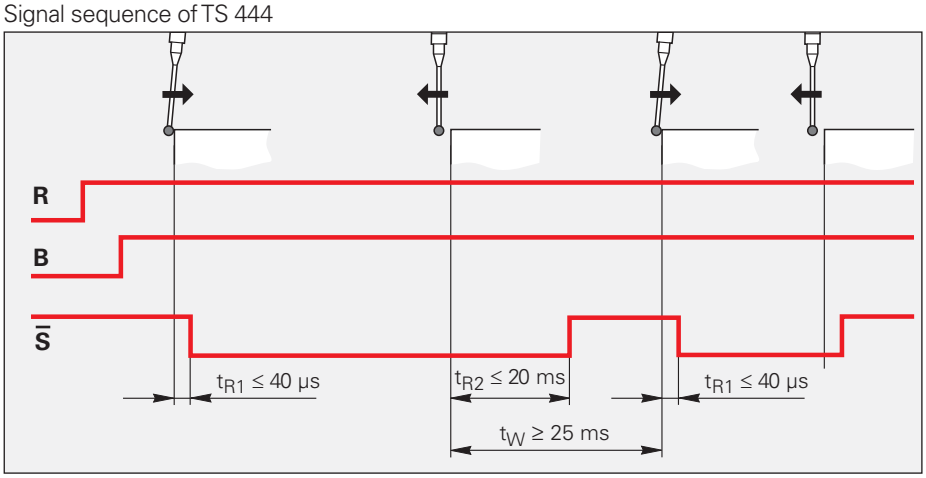
The **TS 444** touch probe switches on automatically as soon as the air turbine generator charges the high-power capacitors when compressed air is applied. The SE reports readiness of the TS 444 with the ready signal B. Almost simultaneously, the battery warning W is switched off. If the charge capacity L drops below the warning threshold after approx. 1 min. operating time, the battery warning signals to the NC that recharging is required. After about another minute, the ready signal is reset, as well.



Signal sequence of TS 444

When the stylus is deflected, it releases the square-wave **trigger signal S**.

Signal times
Response time $t_{R1} \leq 40$ µs
Response time $t_{R2} \leq 20$ ms
Repeat interval $t_W > 25$ ms



Probing with TS 440/TS 64x/TS 740/TT 449

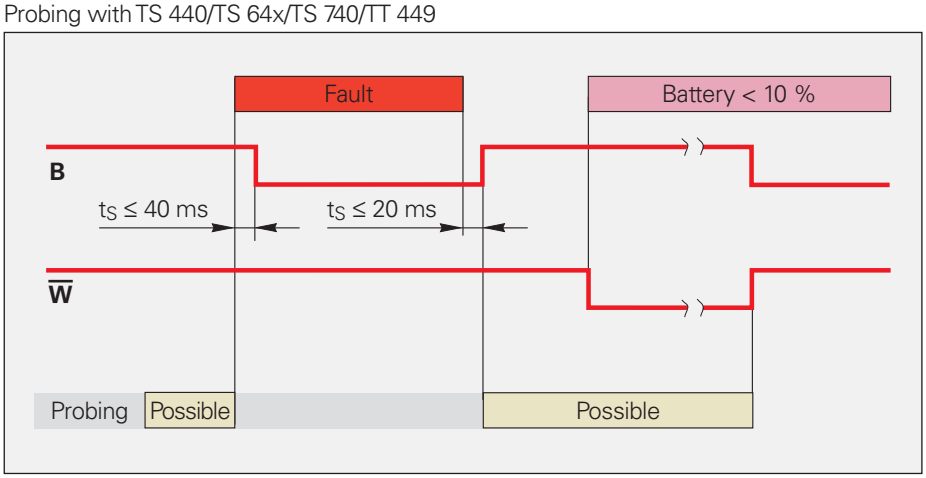
The **battery warning W** reports that the battery capacity has fallen below 10%. The ready signal also resets the battery warning.

Signal times
Response time $t_S \leq 20$ ms

⊓⊔ HTL signal levels
R
U_H = (10...30 V) at $I_H \leq 3$ mA
$U_L \leq 2$ V at $-I_L \leq 0.1$ mA

R in APE 642
$U_H > 0.5 \times U_P$ at $I_H \leq 2$ mA
$U_L < 0.2 \times U_P$ at $-I_L \leq 0.2$ mA

B/S/W
$U_H \geq (U_P - 2.2\ V)$ at $-I_H \leq 20$ mA
$U_L \leq 1.8$ V at $I_L \leq 20$ mA



Behavior during disturbance and battery warning

TL Laser Systems, DA 301 TL

TL inputs
The CNC activates the laser system through three enabling lines:

The **transmitter enabling signal 0** (ENABLE 0) activates or deactivates the transmitter and switches the laser beam on or off. To reduce the power loss (heat generation) to a minimum and increase service life, the laser diode is activated only during the measuring cycle.

The **receiver enabling signals 1** and **2** (ENABLE 1 and ENABLE 2) determine the operating mode of the laser light barrier depending on the respective measuring cycle.

Signal level:
U_H = 24 V at 15 mA

TL outputs
The TL laser systems provide the following output signals:

After the transmitter and receiver are enabled, the laser system provides the information "**Laser OK"** if the luminance at the receiver is at least 75 % of the maximum.

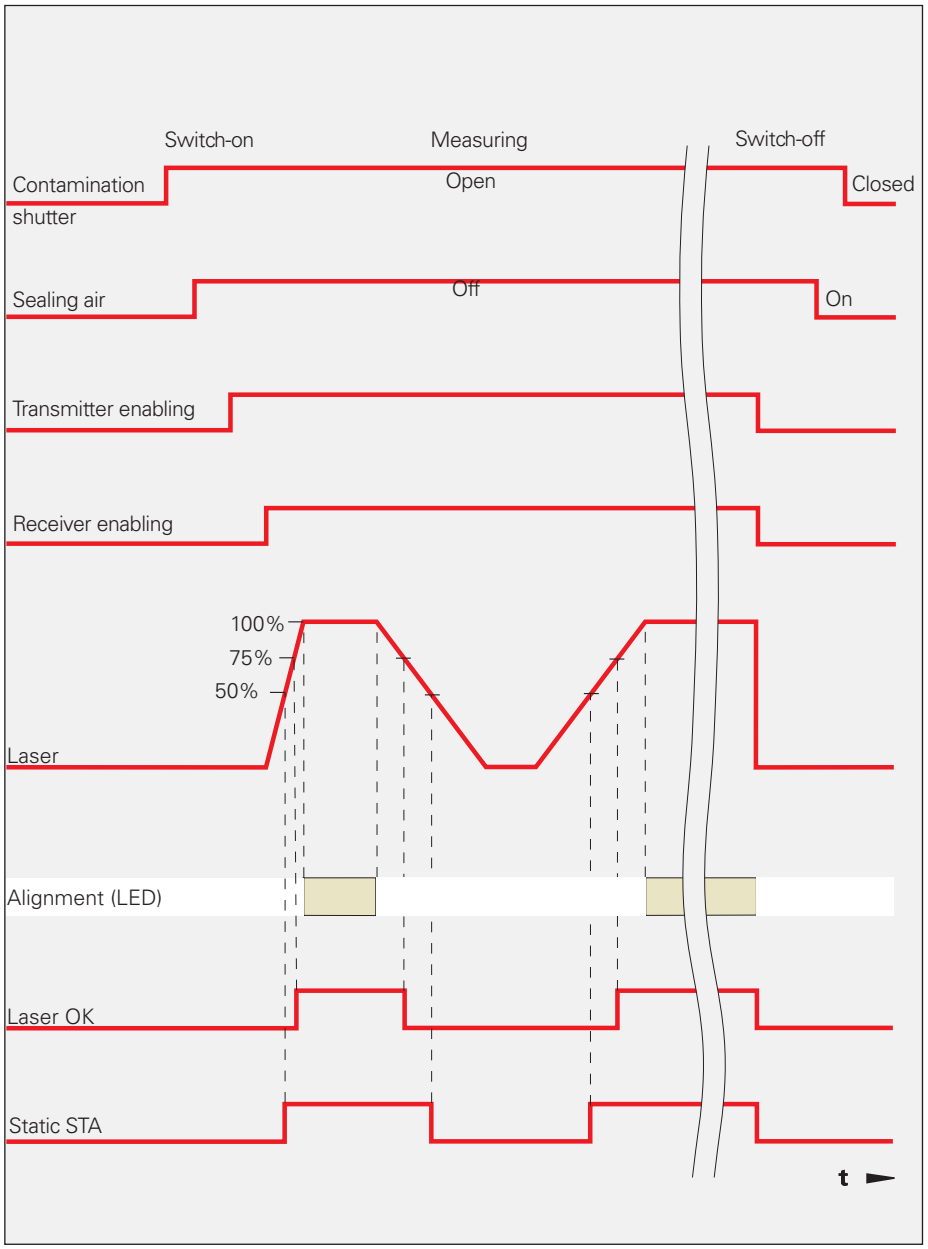
Two output signals are generated when the laser beam is interrupted.

The **measuring signal static STA** output switches to low level if the luminance at the receiver is less than 50 % (= interrupted light beam).

Do not use this output as trigger signal. Fast rotating tools cause spike pulses with extremely short pulse times that cannot be evaluated by the PLC or NC.

The **measuring signal dynamic DYN** output provides a 24 V pulse with a defined duration of 20 ms for every light modulation (light to dark or dark to light). This output serves for the trigger signal.

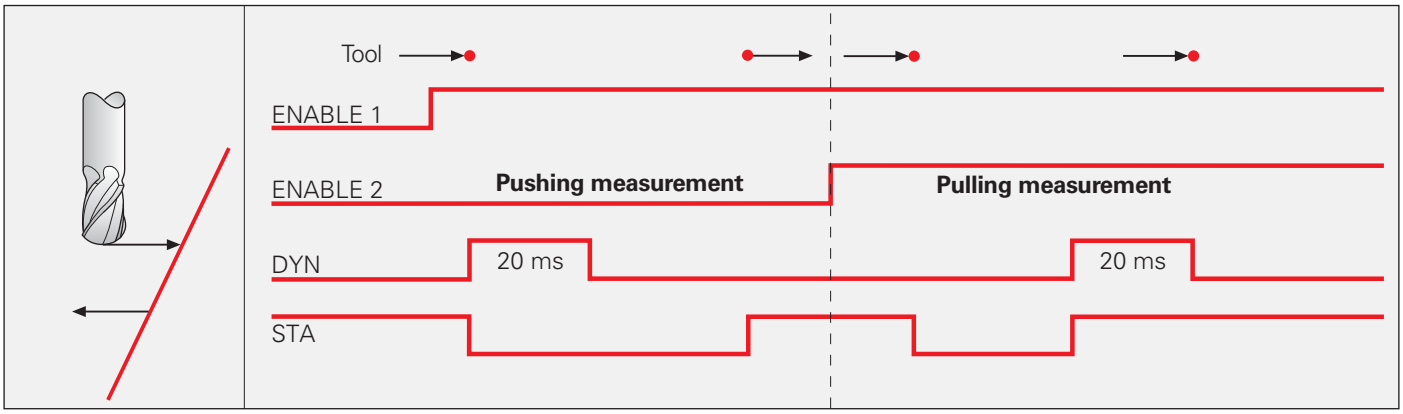
Signal level:
U_H = 24 V at 50 mA



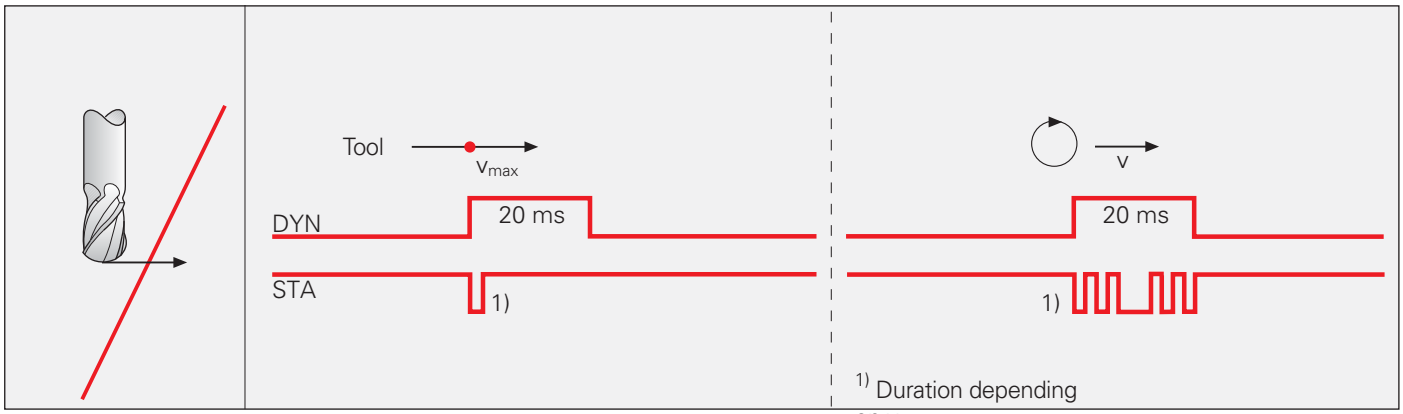
Switch-on/switch-off behavior

DA 301 TL inputs
The DA 301 TL supplies the laser systems with clean compressed air for contamination protection, for opening the seal and cleaning the tool. The respective **pneumatic valves** are controlled by the CNC. The cables to the CNC are included in delivery with the DA 301 TL.

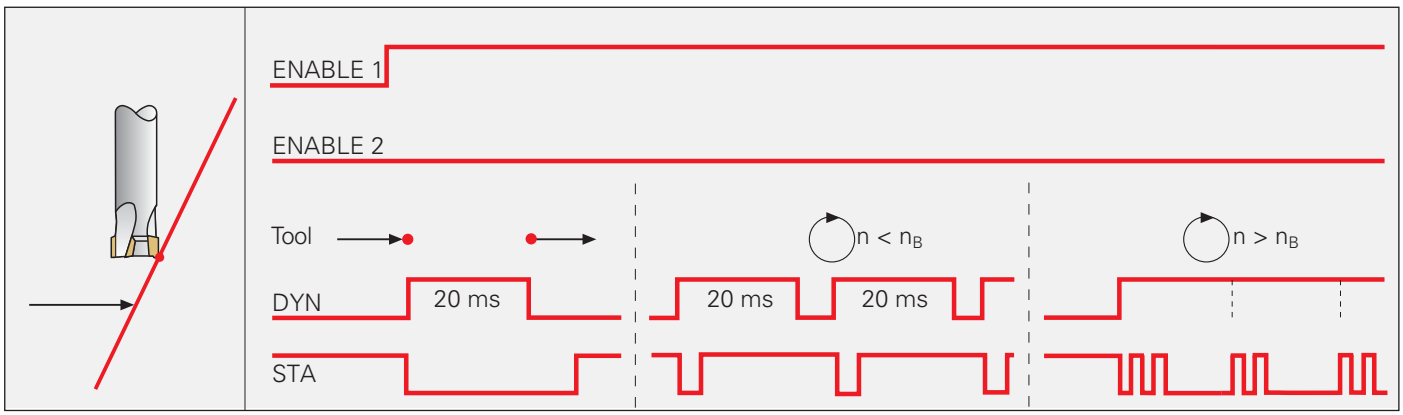
Signal level:
U_H = 24 V at 71 mA



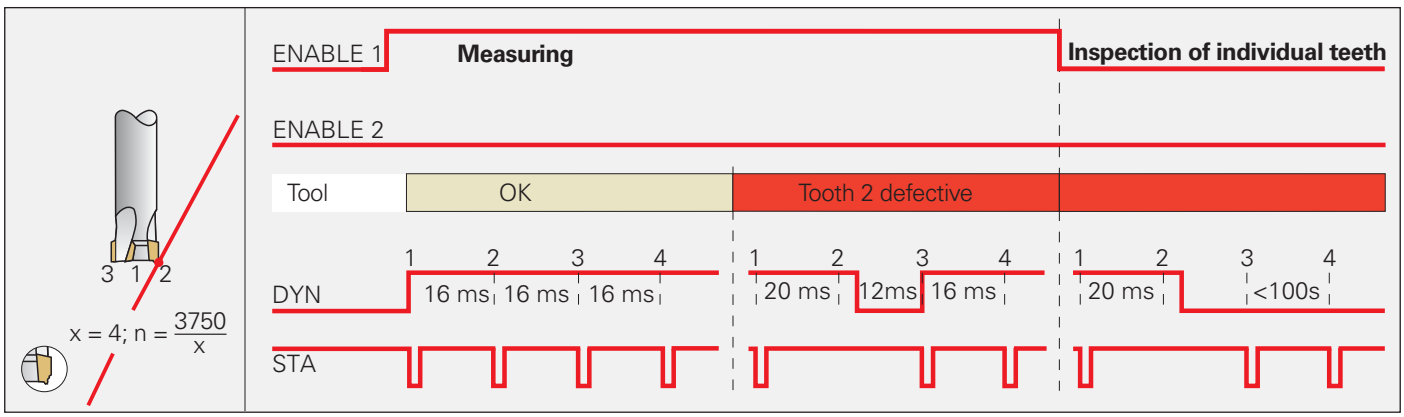
Output signals during length and radius measurement for pushing and pulling measurement



Fast axis feed rates or rotating tools can cause spike pulses in the STA signal



Output signals during shape inspection of individual teeth



Output signals during tooth inspection in the measuring and individual tooth inspection modes.

Universal Touch Probe Interface

The UTI 192 converts the output signals of the HEIDENHAIN touch probe to machine control signals in accordance with DIN EN 61 131-2. It supports two HEIDENHAIN touch probes: TT tool touch probes and TS workpiece touch probes.

Now you can enjoy the benefits of the touch trigger probe from HEIDENHAIN with most NC controls for milling machines, drilling and boring machines, and machining centers.

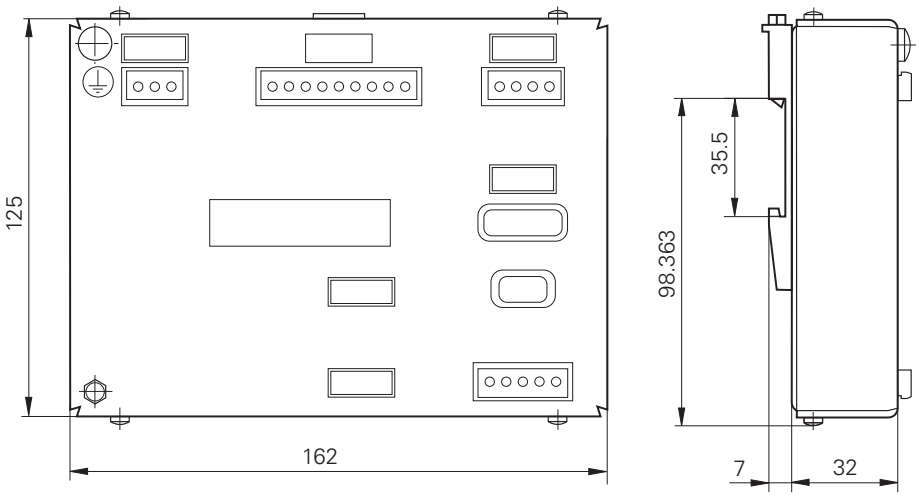
This is possible because with the new UTI 192 universal touch probe interface they are also **compatible with all NC controls** with a fast switching input.

Of course, the probing functions actually available depend on the software cycles implemented in the respective NC control. For certain controls, HEIDENHAIN offers **special probing cycles** for automatic alignment and measurement of workpieces, workpiece presetting, and tool measurement (for more information: *Touch Probe Cycles for FANUC Controls* Product Information).

The UTI 192 features a **compact design.** It can be quickly fastened on a standard mounting rail (DIN 46227 and EN 50022) in the electrical cabinet.

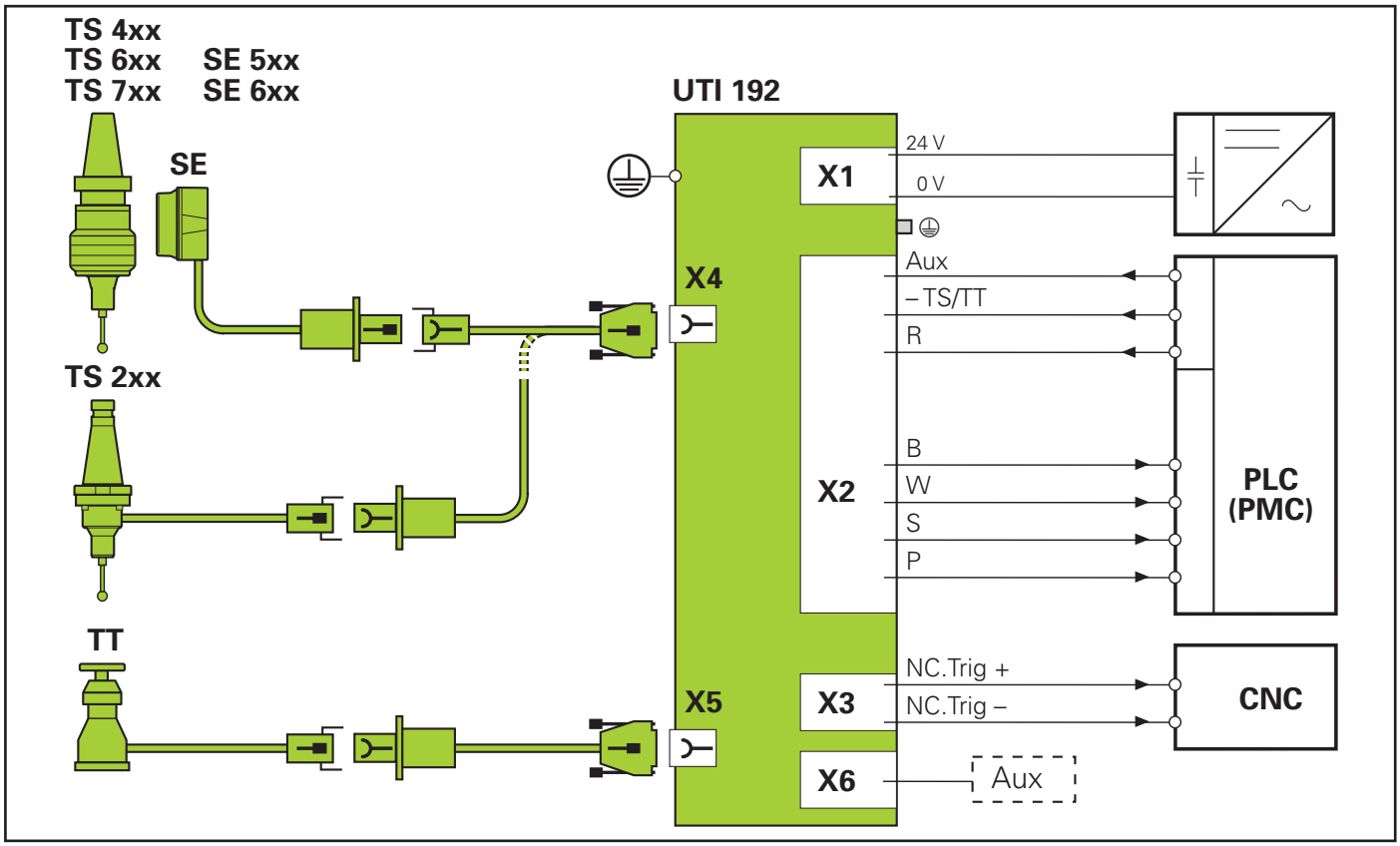
The UTI features a wide range of **interfacing possibilities** so that the touch probes can easily be connected to the different NC controls. It is possible, for example, to configure the output signals as active-high or active-low. In addition, it is possible to connect the inputs or outputs with logical operations. The UTI also provides various routines for switching on the TS 440 and TS 640 infrared touch probes.

The UTI 192 is provided with LEDs for configuration and **easy servicing for initial operation.** The LEDs indicate whether power is on and show the levels of the inputs and outputs. The selected touch probe and its status are also displayed.



	UTI 192
Power supply	24 V DC –20/+25% stabilized direct voltage
Current consumption	Without touch probe: max. 180 mA With TS and/or TT: max. 800 mA
Protection IEC 60529	IP 30
Weight	0.35 kg
Operating temperature **Storage temperature**	10 °C to 60 °C –20 °C to 70 °C
Electrical connections	
TS	D-sub female, 15-pin; cable length 50 m[1)]
TT	D-sub female, 9-pin; cable length 50 m[1)]
PLC	COMBICON[2)]; cable length 20 m with Ø ≥ 0.25 mm^2
NC	COMBICON[2)]; cable length 5 m with Ø ≥ 0.25 mm^2 (shielded)
AUX	COMBICON[2)]; cable length 5 m with Ø ≥ 0.25 mm^2
U_P	COMBICON[2)]; cable length 20 m with Ø ≥ 1 mm^2

[1)] With HEIDENHAIN cable
[2)] Phoenix COMBICON connector included in delivery



X1 Power supply

Power supply connection for the UTI and the connected touch probes.

X2 Connection to PLC (PMC)

Output signals according to EN 61 131-2

- Output current max. 0.5 A
- Signal level: high-side driver
- Active level selectable by switch
- Logical combination of output signals possible

S: Trigger signal
The trigger signal is generated upon deflection of the stylus.

P: Pulsed trigger signal

A pulsed trigger signal is generated upon deflection of the stylus.

B: Ready signal
Indicates that touch probe is ready for operation (touch probe is switched on, infrared transmission is active).

W: Warning (with TS 4xx/6xx)
Indicates, for example, low battery charge.

Input signals according to EN 61 131-2

TT/TS: Selection of TT or TS
High level at this control input selects the touch probe at connection X5 (TT). Low level (open) selects the touch probe at connection X4 (TS).

Aux: Selection of Aux or TT/TS
Switching between the touch probe inputs TS (X4) or TT (X5) and the Aux input (X6).

Start (with TS 64x/44x)
With this output you can activate a touch probe at connection X4. The active level is selectable by switch.

Pin	Signal
1	**Aux**
2	**TS/TT**
3	**R**
4*	24 V (max. 10 mA) output
5*	0 V output
6	**B**
7	**W**
8	**S**
9	**P**

* 24 V, 0 V only for fixed assignment of inputs 1 and 2

X3 Connection to NC

Additional floating output of trigger signal (low-active, open collector output)

Pin	Signal
1	5 V in
2	+ NC trigger
3	– NC trigger
4	Cable shield/functional ground

X4 Connection for TS

X5 Connection for TT

X6 Auxiliary

Two universal, electrically isolated switching inputs

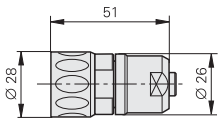
Pin	Signal	
1	+ 5 V	Aux 5 V
2	0 V	
3	+24 V	Aux 24 V
4	0 V	
5	Functional ground	

Cables and Connecting Elements
General Information

Connector (insulated): A connecting element with a coupling ring. Available with male or female contacts.

Symbols

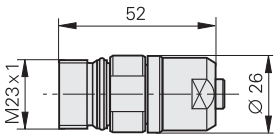
M23



Coupling (insulated): Connecting element with external thread; available with male or female contacts.

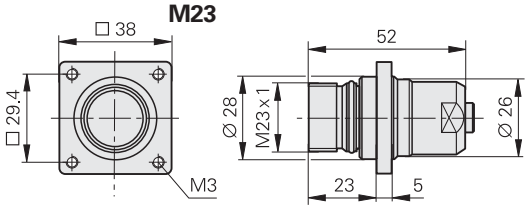
Symbols

M23



Mounted coupling with flange

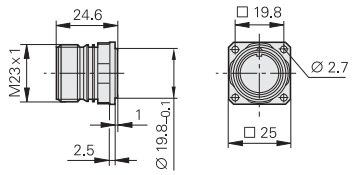
M23



Flange socket: Permanently mounted on the encoder or a housing, with external thread (like a coupling), available with male or female contacts.

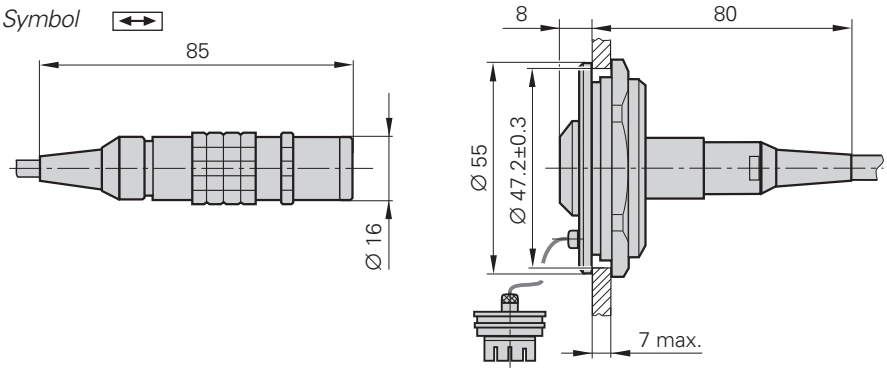
Symbols

M23



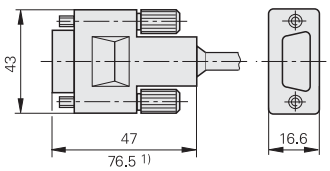
Quick disconnect: Compact connector on TS 220 with push/pull lock

Symbol



D-sub connector: For HEIDENHAIN controls, counters and IK absolute value cards.

Symbols



1) With integrated interpolation electronics

The pins on connectors are **numbered** in the direction opposite to those on couplings or flange sockets, regardless of whether the connecting elements are

Male contacts or

Female

When engaged, the connections are **protected** to IP 67 (D-sub connector: IP 50; EN 60529). When not engaged, there is no protection.

Accessories for flange sockets and M23 mounted couplings

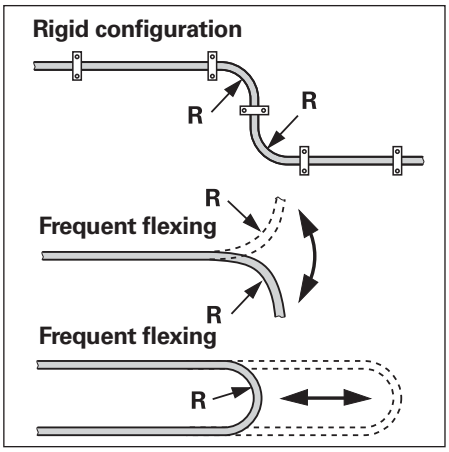
Bell seal
ID 266526-01

Threaded metal dust cap
ID 219926-01

Cables

Durability
All encoders have polyurethane (PUR) cables. PUR cables are resistant to oil, hydrolysis and microbes in accordance with **VDE 0472**. They are free of PVC and silicone and comply with UL safety directives. The **UL certification** AWM STYLE 20963 80 °C 30 V E63216 is documented on the cable.

Bend radius
The permissible bend radii R depend on the cable diameter and the configuration:

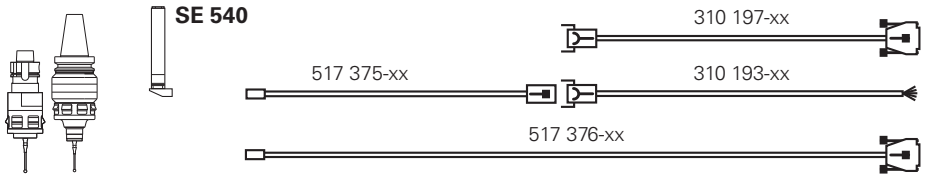


Cables	Bend radius R	
	Rigid configuration	Frequent flexing
Ø 4.5 mm	≥ 10 mm	≥ 50 mm
Ø 6 mm	≥ 20 mm	≥ 75 mm
Ø 10 mm 1)	≥ 35 mm	≥ 75 mm
Ø 8 mm	≥ 40 mm	≥ 100 mm
Ø 14 mm 1)	≥ 100 mm	≥ 100 mm

1) Metal armor

Pin Layouts and Adapter Cables
SE 540, SE 640, APE 642

SE 540



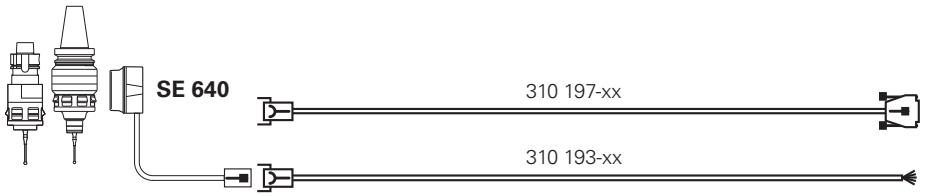
Adapter cable to SE 540, Ø 4.5 mm
With coupling (male), 7-pin
ID 517375-xx

With D-sub connector (male), 15-pin
ID 517376-xx

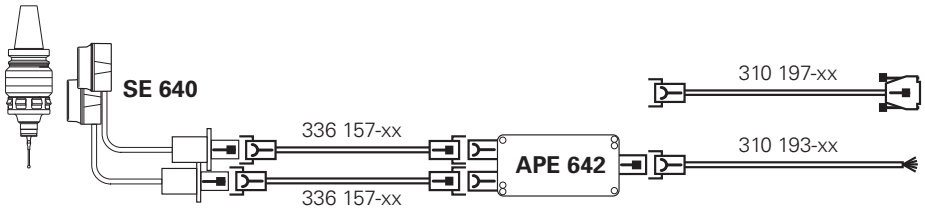
Adapter cable Ø 8 mm
Complete with M23 connector, 7-pin, female and D-sub connector (male), 15-pin
ID 310197-xx

With one M23 connector (female), 7-pin
ID 310193-xx

SE 640



Two SE 640 units to APE 642



Extension cable Ø 8 mm
Complete with M23 connector, 7-pin, female and M23 connector (male), 7-pin
ID 336157-xx

Adapter cable Ø 8 mm
Complete with M23 connector, 7-pin, female and D-sub connector (male), 15-pin
ID 310197-xx

With one M23 connector (female), 7-pin
ID 310193-xx

7-pin M23 **coupling**			**7-pin** M23 **connector**				**15-pin D-sub connector**			
	Power supply			Signals						
	2	**1**	**7**	**3**	**5**	**4**	**6**			
	5	**8**	**1**	**4**	**3**	**10**	**7**			
	U_P	**0 V**	**Internal shield**	**R**	**B**	**$\overline{S}$**	**$\overline{W}$**			
	Brown	White	White/Brown	Yellow	Gray	Green	Blue			

External shield is on housing. Unused pins or wires must not be engaged.
U_P = power supply; **R** = start signal; **B** = ready signal; **$\overline{S}$** = trigger signal; **$\overline{W}$** = battery warning

Adapter Cable
SE 642

Connection to iTNC 530 (MC 4xx)

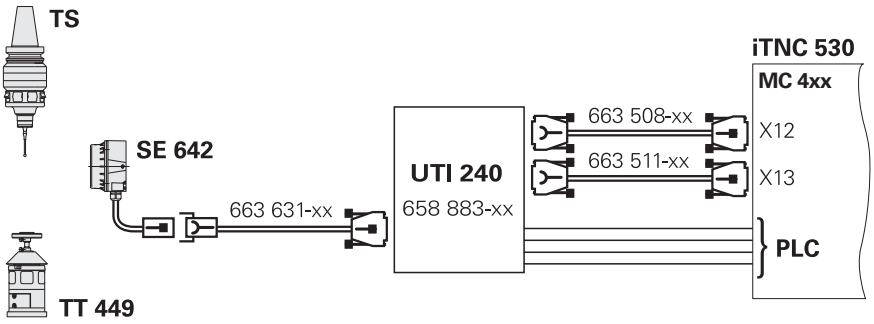
A UTI 240 touch probe interface is required if the SE 642 is driven with TS and TT 449. If the SE 642 is to operate only a TS, it can be connected without UTI over an additional adapter cable to the X12.

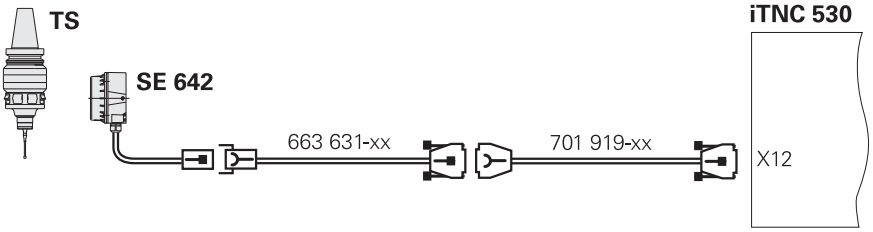
Adapter cable SE 642 with 12-pin M12 connector (female) and D-sub connector (male, 3-row)
15-pin ID 663631-xx

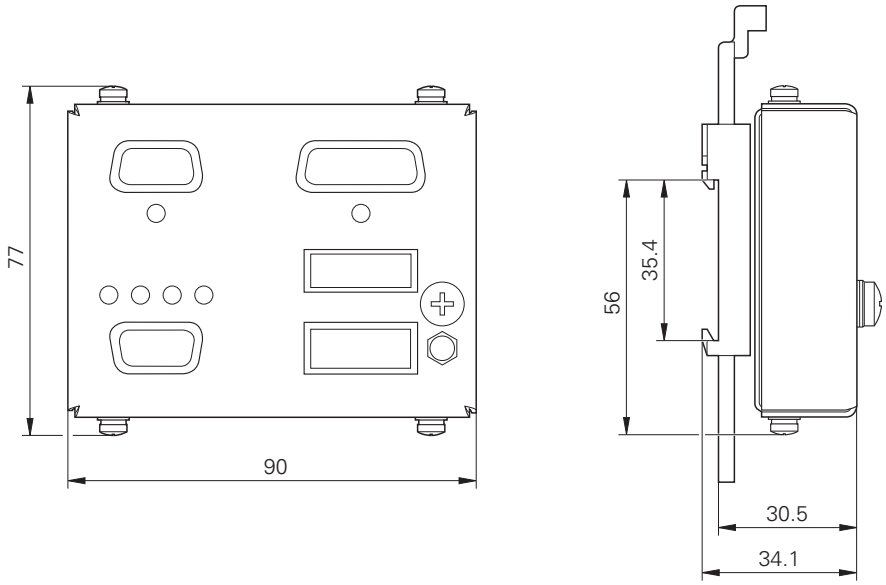
UTI 240 adapter cable – iTNC 530 with D-sub connector (male and female)
X12 (15-pin) ID 663508-xx
X13 (9-pin) ID 663 511-xx

SE 642 adapter cable to X12
D-sub coupling (female, 3-row) and D-sub connector (male)
15-pin ID 701 919-xx

UTI 240 touch probe interface
The UTI 240 touch-probe interface distributes the TS and the TT signals to the corresponding inputs of the iTNC and sets up a connection to the PLC for starting the TT and for transmitting the warning signal. For simple commissioning and configuration, LEDs indicate the active touch probe and the switching states of the inputs and outputs.
UTI 240 ID 658883-xx





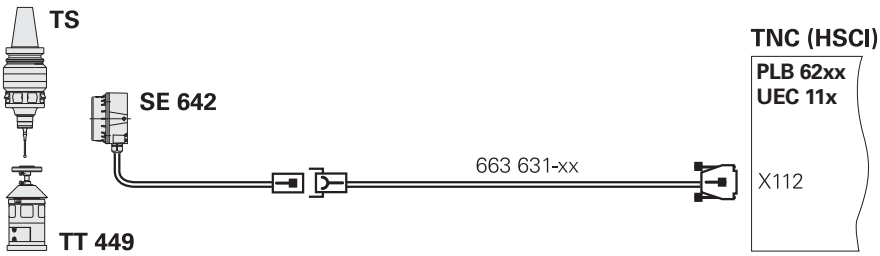


Connection to iTNC 530 HSCI, TNC 6xx

The TNC **with HSCI** can be directly connected to the SE 642 via an SE 642 adapter cable.

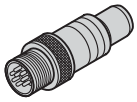
Adapter cable SE 642 with 12-pin M12 connector (female) and D-sub connector (male, 3-row) 15-pin ID 663631-xx

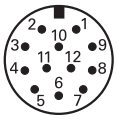
Please note:
At present, the TNC 620 does not yet support the TT 449. Until NC software 60642x-02, the iTNC 530 HSCI cannot be switched between TS and TT on one connection. Until then, in both cases the TT 140 can be used on connection X113.



Pin Layout
SE 642

12-pin coupling, M12



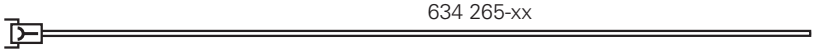


	Power supply		Signals									
	1	**12**	**11**	**5**	**2**	**10**	**3**	**4**	**6**	**9**	**7**	**8**
	U_P	**0 V**	**R(TS)**	**R(TT)**	**B(TS)**	**B(TT)**	**S**	**$\overline{S}$**	**$\overline{W}$**	**/**	**/**	**/**
	Brown/ Green	White/ Green	Blue	White	Green	Brown	Gray	Pink	Violet	Yellow	Red	Black

External shield is on housing. Unused pins or wires must not be engaged.
U_P = power supply; **R** = start signal; **B** = ready signal; **S, $\overline{S}$** = trigger signal; **$\overline{W}$** = battery warning

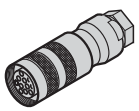
Adapter Cables and Pin Layout
TS 249

TS 249 adapter cable
With M12 connector (female), 8-pin
ID 634265-xx



TS 249

8-pin connector M12

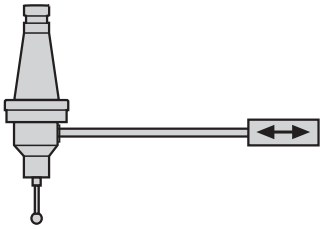


	Power supply		Signals					
	2	**7**	**3**	**4**	**1**	**5**	**6**	**8**
	U_P 15 V to 30 V	**U_N** 0 V	**S**	**$\overline{S}$**	**B**	**Trigger** NO	**Trigger** NC	**Trigger** 0 V
	Blue	Violet	Gray	Pink	White	White/Green	Yellow	Brown/Green

External shield is on housing. Unused pins or wires must not be engaged.
U_P = power supply; **B** = ready signal; **S, $\overline{S}$** = trigger signal;
Trigger = Floating switching outputs (NC = normally closed, NO = normally open)

Pin Layouts and Adapter Cables
TS 220, TS 230

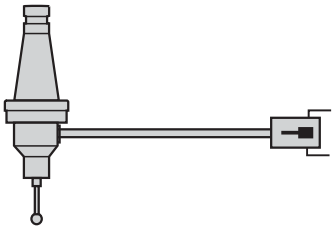
TS 220
Assignment



Adapter cable Ø 8 mm
Complete with mounted coupling for quick disconnect and D-sub connector (male), 15-pin
ID 274543-xx

Adapter cable Ø 8 mm
With one mounted coupling for quick disconnect
ID 274544-xx

TS 230
Assignment



Adapter cable Ø 8 mm
With one M23 mounted coupling (female), 7-pin
ID 310194-xx

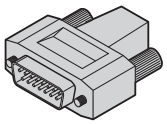
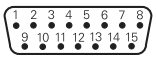
Quick disconnect



	Power supply		Signal		Others	
	2	1	5	6	3	4
	U_P	U_N	S	$\overline{S}$		
	Brown	White	Green	Yellow	/	/

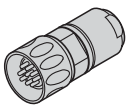
Mounted coupling for quick disconnect


15-pin D-sub connector

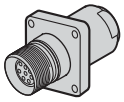
	Power supply		Signal		Others		
	2	1	5	6	3	4	
	U_P	U_N	S	$\overline{S}$	/	/	/
	Brown/ Green	White/ Green	Green	Yellow	Gray	Pink	Gray
	6	8	9	10	5	3	7

7-pin M23 **connector**

	Power supply		Signal		Others		
	2	1	3	4	5	6	7
	U_P	U_N	S	$\overline{S}$			/
	Brown	White	Green	Yellow	/	/	/

7-pin M23 **coupling**

	Power supply		Signal		Others		
	2	1	3	4	5	6	7
	U_P	U_N	S	$\overline{S}$	/	/	/
	Brown/ Green	White/ Green	Brown	Green	Gray	Pink	/

Outside shield on housing; U_P = power supply voltage
S; $\overline{S}$ = trigger signal

TT 140

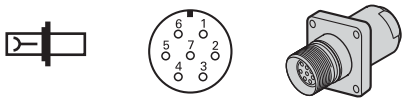
TT 140
Assignment

7-pin M23 **connector**

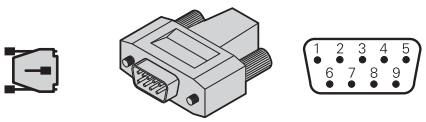
	Power supply		Signal		Others		
	2	**1**	**3**	**4**	**5**	**6**	**7**
	U_P	**U_N**	**S**	**$\overline{S}$**			**/**
	Brown	White	Green	Yellow	/	/	/

Adapter cable Ø 8 mm
Complete with M23 mounted coupling (female), 7-pin and D-sub connector (male), 9-pin
ID 335332-xx

7-pin M23 **coupling**



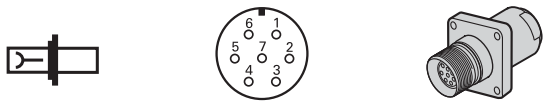
9-pin D-sub connector



	Power supply		Signal		Others		
	2	**1**	**3**	**4**	**5**	**6**	**7**
	U_P	**U_N**	**S**	**$\overline{S}$**	**/**	**/**	**/**
	Brown/ Green	White/ Green	Brown	Green	/	Pink	/
	4	**2**	**8**	**9**	**5**	**1**	**3/6/7**

Adapter cable Ø 8 mm
With one M23 mounted coupling (female), 7-pin
ID 310194-xx

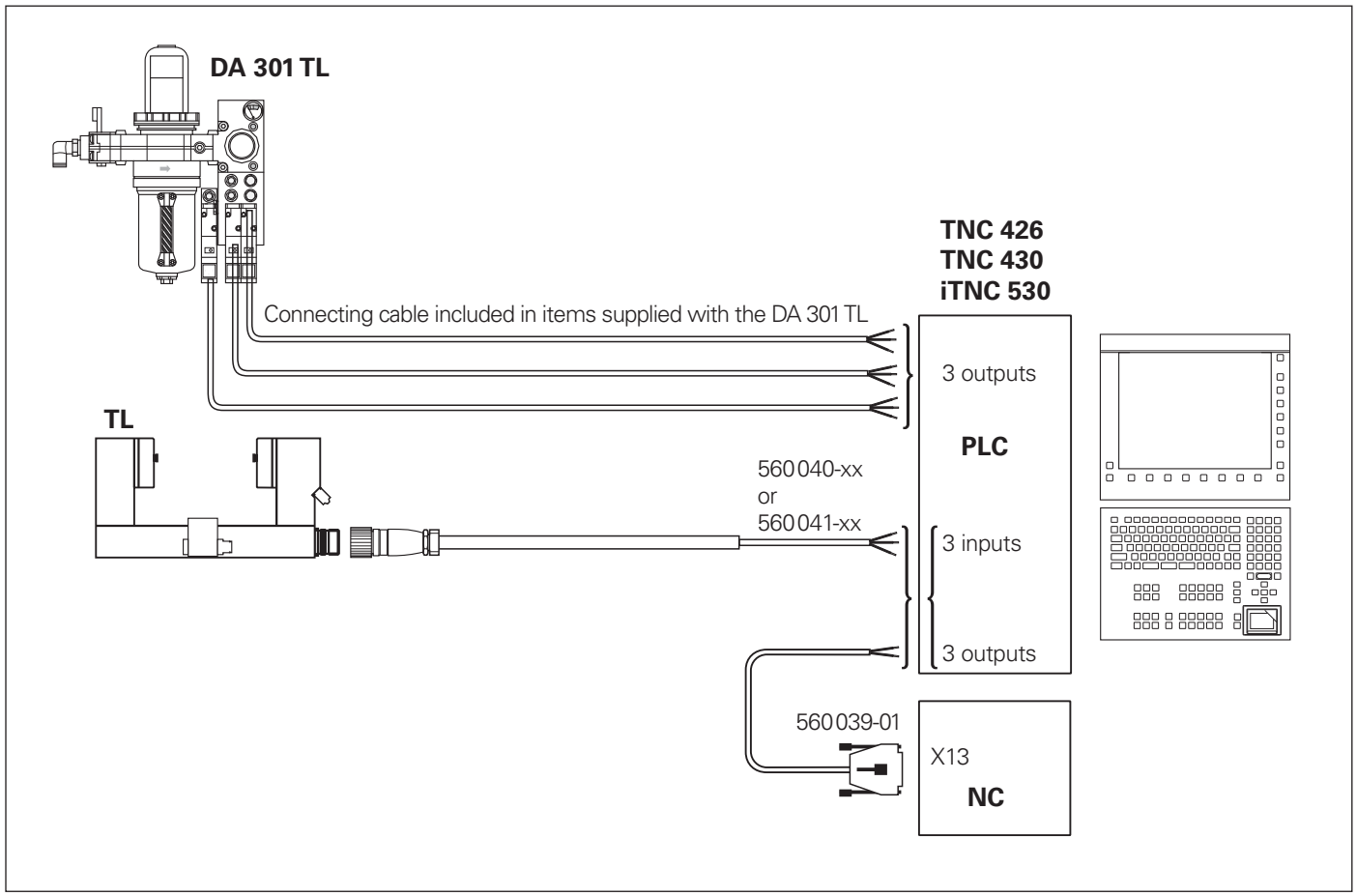
7-pin
M23 **coupling**



	Power supply		Signal		Others		
	2	**1**	**3**	**4**	**5**	**6**	**7**
	U_P	**U_N**	**S**	**$\overline{S}$**	**/**	**/**	**/**
	Brown/ Green	White/ Green	Brown	Green	Gray	Pink	/

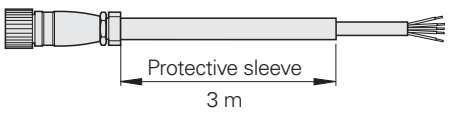
Shield on housing; **U_P** = power supply voltage
S; $\overline{S}$ = trigger signal

Pin Layouts and Adapter Cables
TL, DA 301 TL



Adapter cable Ø 14 mm/Ø 6.5 mm
With one M23 connector (female), 12-pin
Smallest permissible bending radius
60 mm, suitable for use in drag chains

With PUR protective sleeve
ID 560040-xx

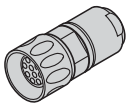


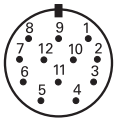
Adapter cable
With one D-sub connector (male), 9-pin
Integrated interface for TNC 426/430,
iTNC 530

Length 5 m
ID 560039-xx

TL Laser System

12-pin connector,
M23





	Power supply		Signals			Outputs		
	2	**1**	**4**	**12**	**6**	**3**	**5**	**7**
	24 V	**0 V**	**ENABLE 0**	**ENABLE 1**	**ENABLE 2**	**DYN**	**STA**	**LASER OK**
	Brown	White	Yellow	Pink	Violet	Green	Gray	Blue

9-pin D-sub connector

	Inputs	
	0 V	**DYN**
	White	Brown

3-pin connector

	Outputs		
	Trigger signal	**0 V**	**Ground**
	Black	Black	Yellow/Green

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