HEIDENHAIN

Touch Probes

For Machine Tools

July 2016

Touch probes 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.

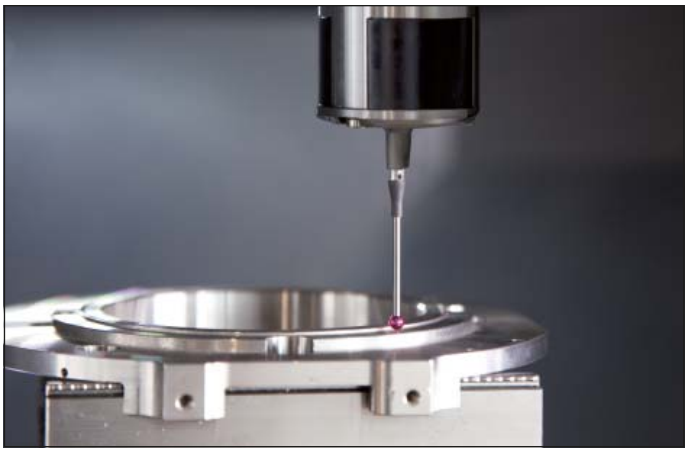
Workpiece measurement
HEIDENHAIN offers **TS triggering touch probes** for workpiece measurement right on the machine. The probe is inserted in the tool holder either manually or by the tool changer. They enable you to use the probing functions offered by your NC control to automatically or manually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

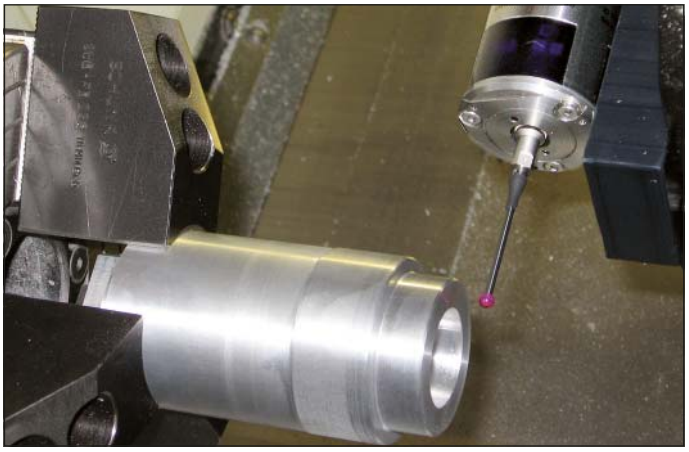
- Workpiece alignment
- Datum setting
- Workpiece measurement
- Digitizing or inspecting 3-D surfaces

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 touch probes 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.





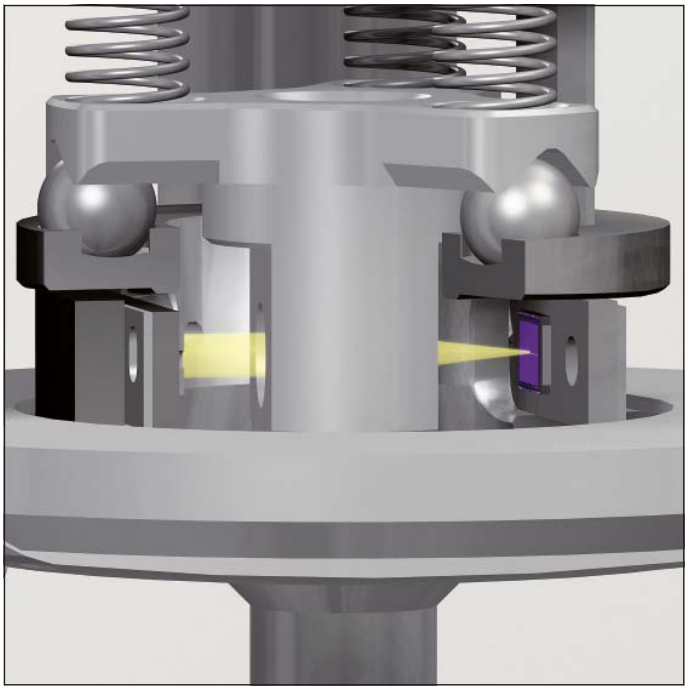
Contents

Experience and profile

HEIDENHAIN has been developing touch probes for workpiece and tool measurement on machine tools for over 30 years now. It has set standards, for example with

- the wear-free optical sensor,
- the integrated cleaning flushing/blowing feature for cleaning the measuring point,
- the SE 540—the first transmitter/receiver unit capable of being fully integrated in the spindle housing, and
- the TS 444—first battery-free touch probe without cable connection.

Of course, many years of experience in continuous development have contributed to these achievements. Numerous improvements make working with the touch probes easier and more reliable, so that their use by the operator becomes more efficient.



Wear-free optical sensor
The optical sensor is free of wear, and so provides the specified probing repeatability even after a large number of probing processes (over 5 million switching cycles). This means that touch probes from HEIDENHAIN are excellently suited for grinding machines. The optical sensor features an optimized lens system and an integrated preamplifier for stable output signals.

Reliable measurement results
Clean measuring points are a prerequisite for high process reliability. That is why all TS workpiece touch probes from HEIDENHAIN have blower/flusher jets for cleaning the workpiece, either with coolant or compressed air.

Collision protection and thermal decoupling (option for TS 460)
Collision protection is a major topic at HEIDENHAIN. The touch probes feature a large deflection path and offer additional safety with rated breaking points in the stylus or the connecting pin to the probe contact. For expanded collision protection to include the touch probe housing of the TS 460, HEIDENHAIN offers an optional mechanical adapter between the touch probe and taper shank. In the event of a light collision against a fixture or workpiece, the touch probe can absorb the shock. At the same time, the integrated switch deactivates the ready signal and the control stops the machine.

Furthermore, the collision protection adapter functions as a thermal decoupler. This protects the touch probe from being heated by the spindle.

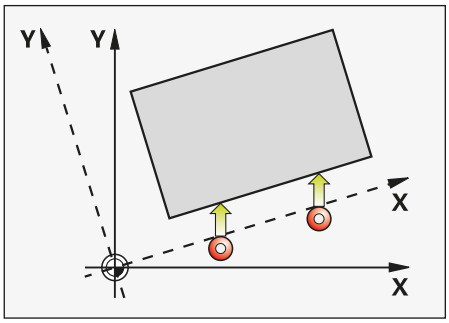
Battery-free TS 444 touch probe
While HEIDENHAIN touch probes rarely need a battery exchange (operating time up to 800 hours), in many cases it can be of advantage to opt for permanent readiness without the need for a battery. The TS 444 features an air turbine generator driven by compressed air to ensure its energy supply. Additional rechargeable or nonrechargeable batteries are not required.

Worldwide presence
Along with the technical advantages, HEIDENHAIN and its subsidiaries also offer reliable service in over 50 countries: Regardless of the country in which the machine with the touch probe finally lands, HEIDENHAIN supports you on site.

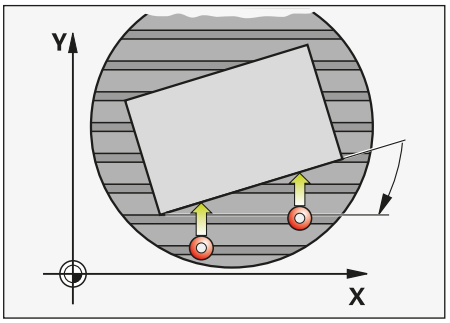
Application examples
Aligning the workpiece and setting the datum

Workpiece alignment
Exact workpiece alignment parallel to the axes is particularly important for partially machined workpieces to ensure that existing reference surfaces are in an accurately defined position. With the TS touch probes 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.

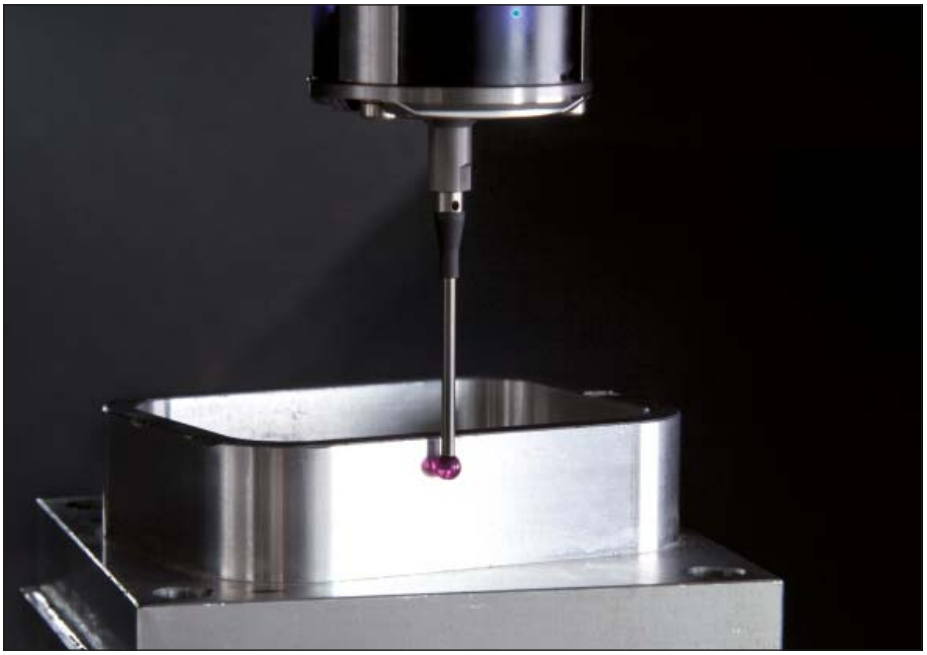


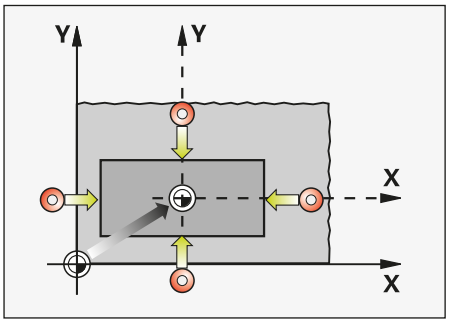
Compensating for misalignment through a basic rotation of the coordinate system



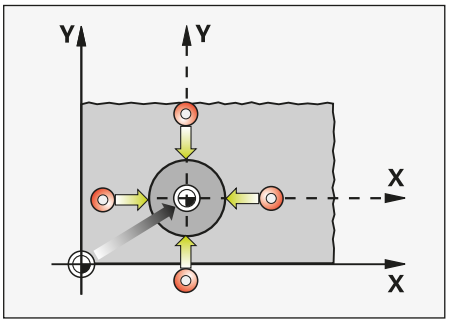
Compensating for misalignment by rotating the table

Setting a datum
Programs for workpiece machining are based on datums. 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 datums automatically.

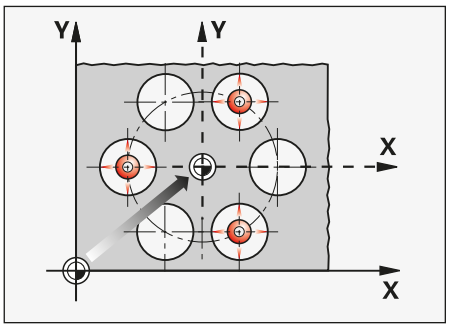




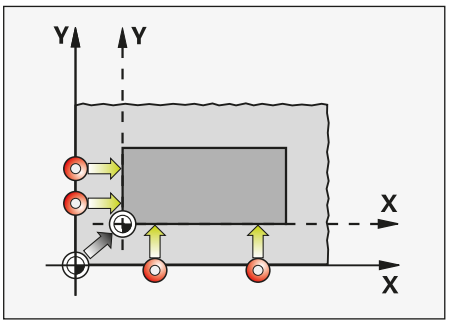
Center of a rectangular stud



Center of a circular stud



Center of a bolt hole circle



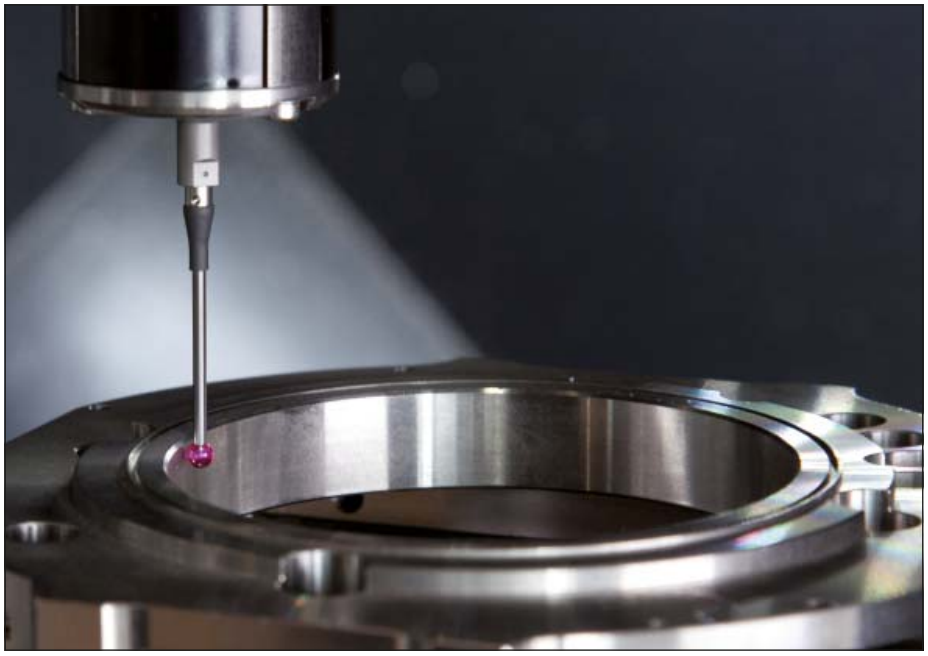
Outside corner

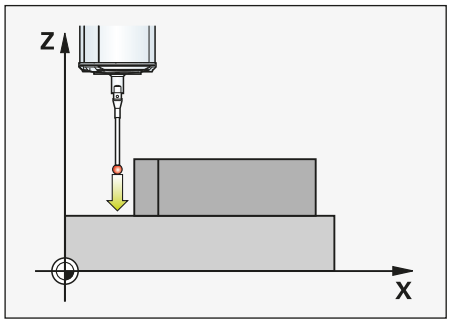
Workpiece measurement

The TS 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.

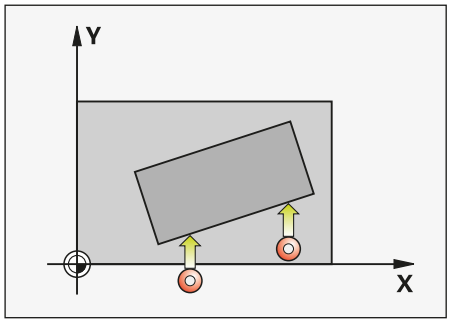
When the workpiece is done, the measured values can document dimensional accuracy or serve to record machining trends. The CNC can output the results of measurement through the data interface.

With the aid of external software—e.g. FormControl (software package from Blum-Novotest) or digitizing software—you can digitize models or measure free-form surfaces right in 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.

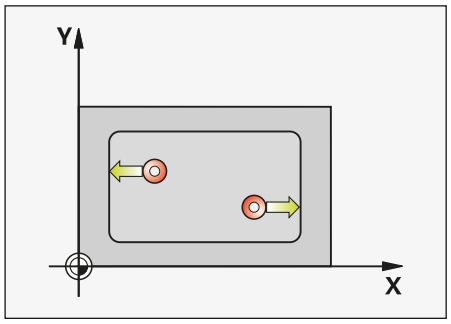




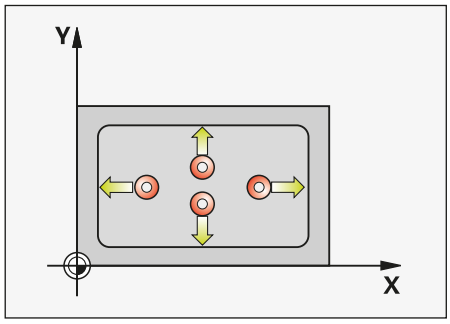
Measuring individual positions in an axis



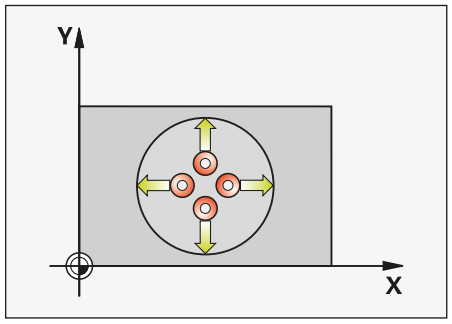
Measuring the angle of a line



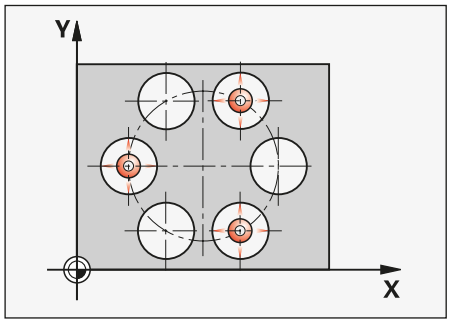
Length measurement



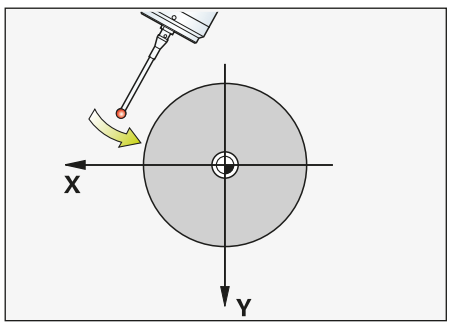
Measuring a rectangular pocket



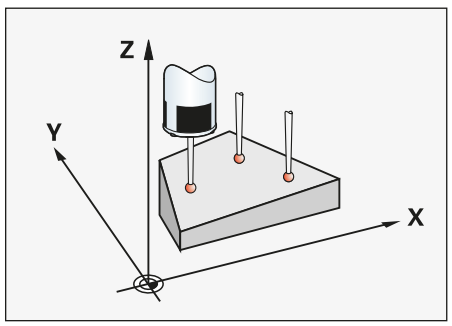
Measuring a circular pocket/hole



Measuring a bolt hole circle



Measuring a diameter

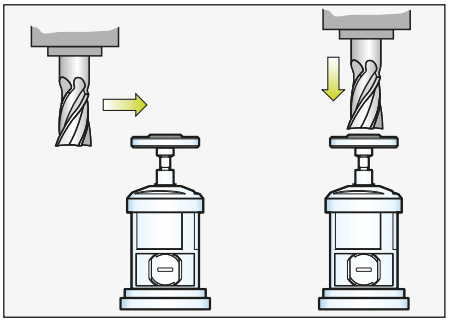


Measuring the angle of a plane

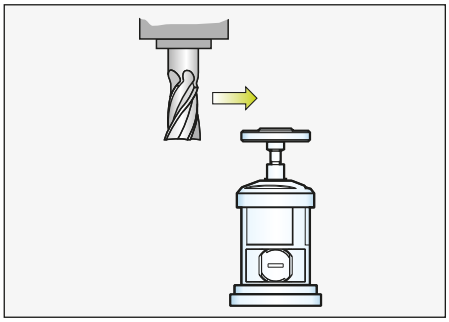
Tool measurement with TT touch probes

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.

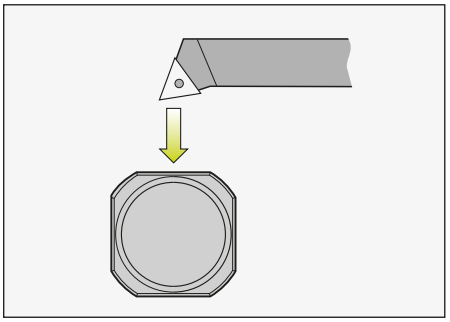
Using a cuboid probe contact, you can also measure turning tools and check them for breakage. For effective tool-tip radius compensation you only need to add the cutter radius to your entries in the CNC.



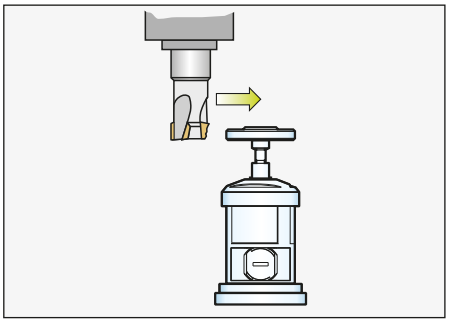
Tool length and radius measurement with stationary or rotating spindle



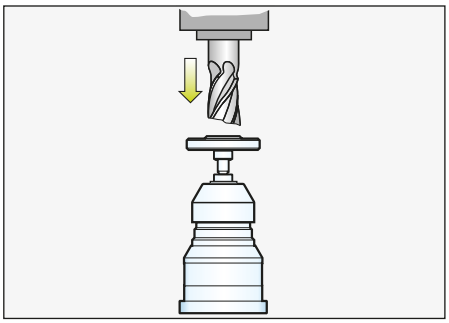
Individual tooth measurement, e.g. for inspecting indexable inserts (not for breakable materials)



Turning tool measurement



Tool wear measurement



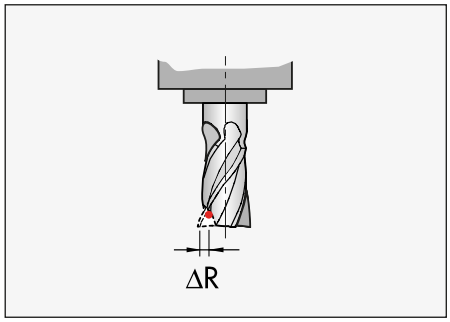
Tool breakage monitoring

Tool measurement with TL laser systems

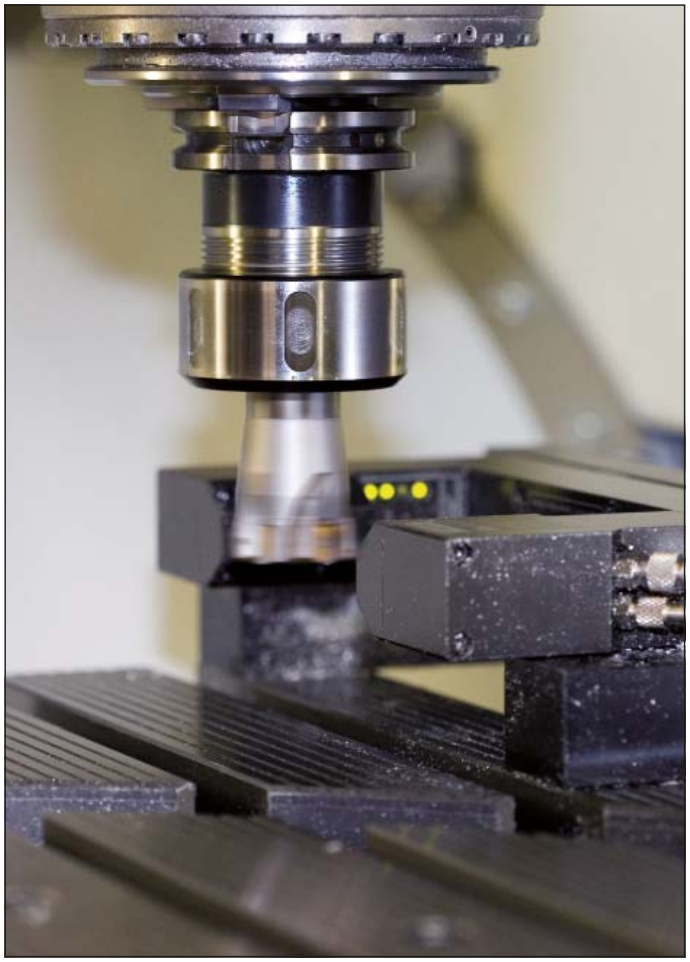
Tool measurement with the TL laser systems offers special benefits. The contact-free measuring method by laser beam enables you to check even the smallest tools rapidly, reliably and without collision.

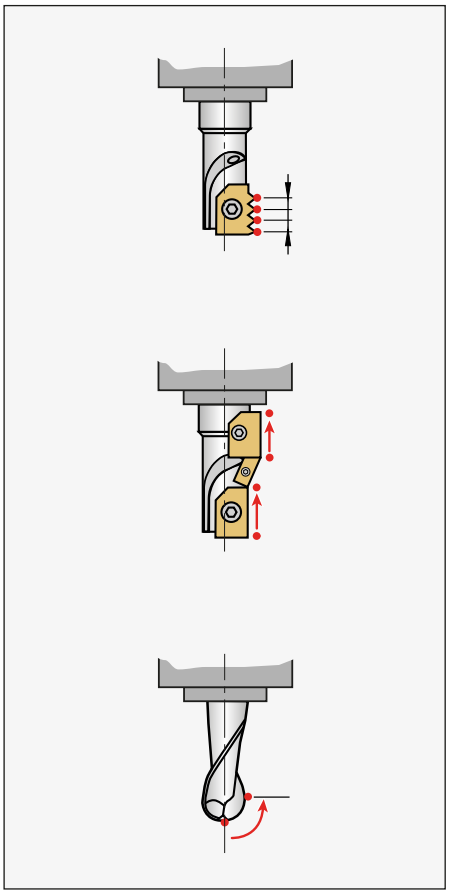
And modern cutting materials of hard, brittle materials are no problem for the TL laser systems.

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

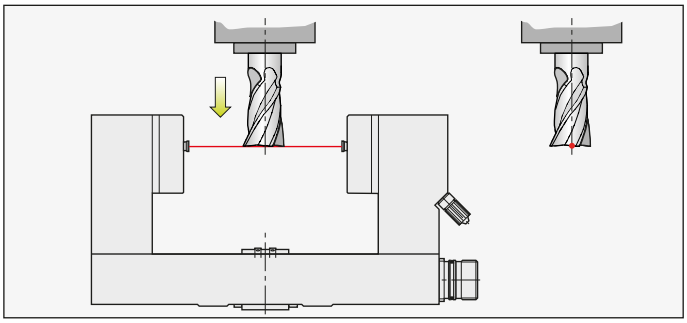


Tool radius measurement, detection of tooth breakage

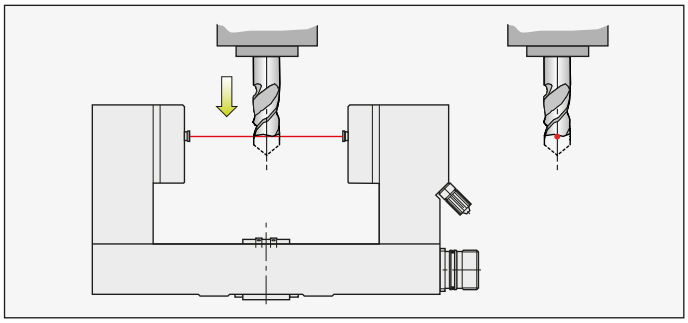




Single tooth and shape inspection



Tool length measurement



Detection of tool breakage

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, an infrared or radio 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.

	TS workpiece touch probes		
	TS 460	**TS 444**	**TS 642**
Area of application	Machining centers, milling, drilling and boring machines, lathes with automatic tool change		
Signal transmission	Radio or infrared	Infrared	Infrared
Suitable SE	SE 660, SE 540[1)], SE 642[1)]	SE 540, SE 642	SE 540, SE 642, SE 660
Probe repeatability	2 σ ≤ 1 µm		
Voltage supply	Batteries, rechargeable or nonrechargeable	Air turbine generator	Batteries, rechargeable or nonrechargeable
Interface to control	HTL via SE		
Cable outlet	–		

[1)] Only for infrared transmission

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

Touch probes with **wireless signal transmission** for machines with manual tool changer:

TS 460 – New generation standard touch probe for radio and infrared transmission, with compact dimensions
TS 444 – Battery-free voltage supply through integrated air turbine generator from compressed air, for infrared transmission, with compact dimensions
TS 642 – Infrared transmission, activation by switch in the taper shank; compatible with previous generations of touch probes
TS 740 – High probe accuracy and repeatability, low probing force, with infrared transmission

Touch probes with **cable connection for signal transmission** for machines with manual tool change, as well as for grinding machines and lathes:

TS 260 – New generation, axial or radial cable
TS 248 – New generation, axial or radial cable, with reduced deflection force

	TS 740	TS 248 TS 260
		Milling, drilling and boring machines with manual tool change, lathes and grinding machines
	Infrared	Cable
	SE 540, SE 642	–
	2 σ ≤ 0.25 µm	2 σ ≤ 1 µm
		DC 15 V to 30 V
		HTL and floating switching output
		Axial or radial

Contents

Principle of function
Sensor

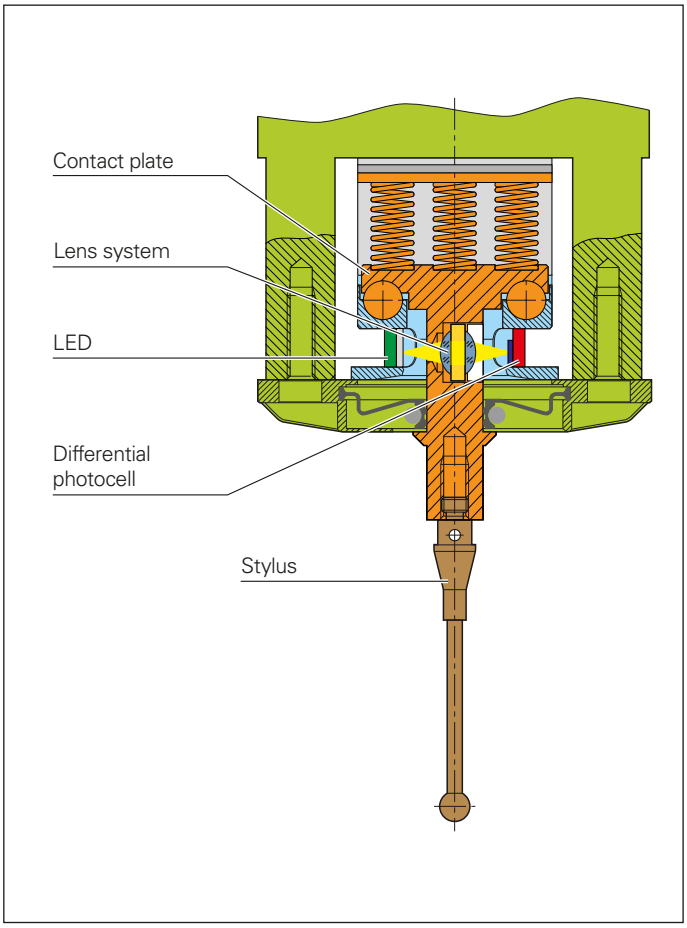
TS 248, TS 260, TS 460, TS 642
These touch probes from HEIDENHAIN operate with an optical switch as sensor. A lens system collimates the light generated from an LED and focuses it onto a differential photocell. When the stylus is deflected, the differential photocell produces a trigger signal.

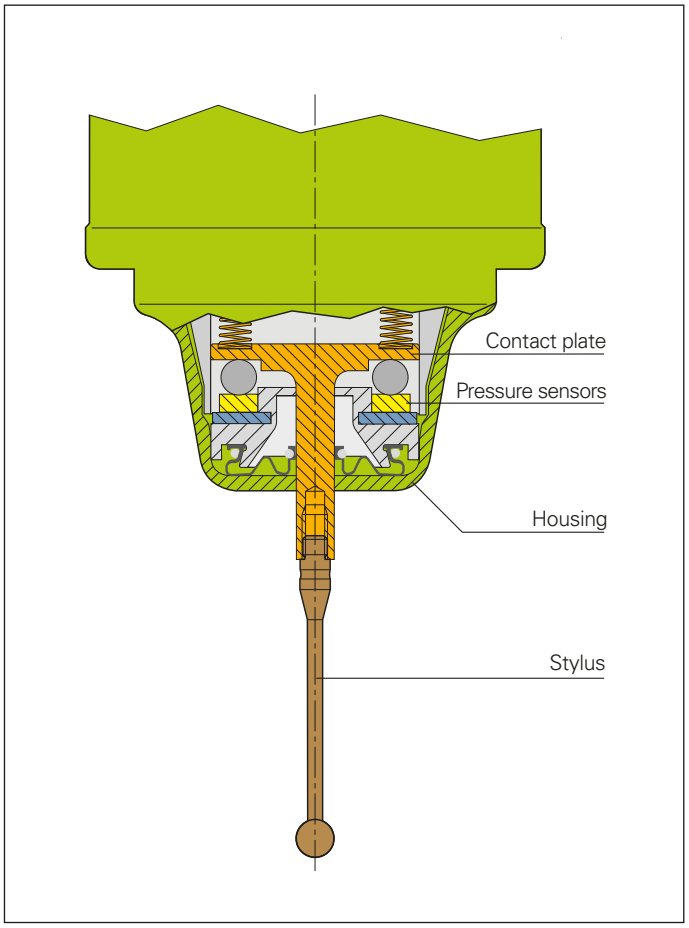
The stylus of the TS is rigidly connected to a plate integrated in the probe housing on a three-point bearing. The three-point bearing ensures the physically ideal rest position.

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 constant 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 probe 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 probe 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**.

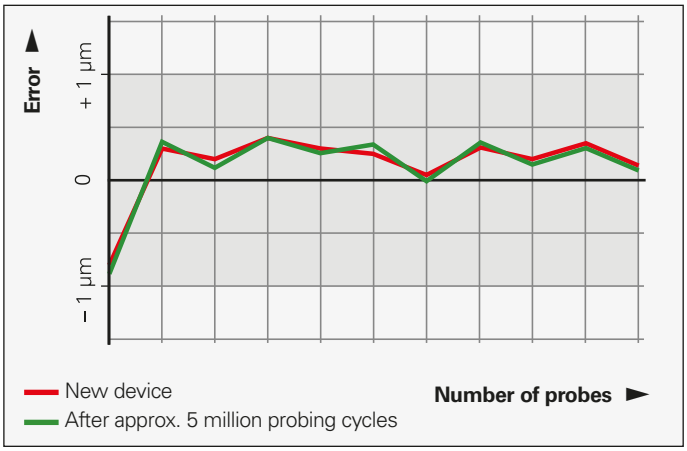
The probe accuracy also includes the effective ball radius. The effective ball radius is calculated from the actual ball radius and the stylus deflection required to produce the trigger signal. This also includes stylus bending.

The probe 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 probe accuracy and repeatability. These features, together with the low probing force of the TS 740, make it 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 probe accuracy grade of better than ±5 µm.



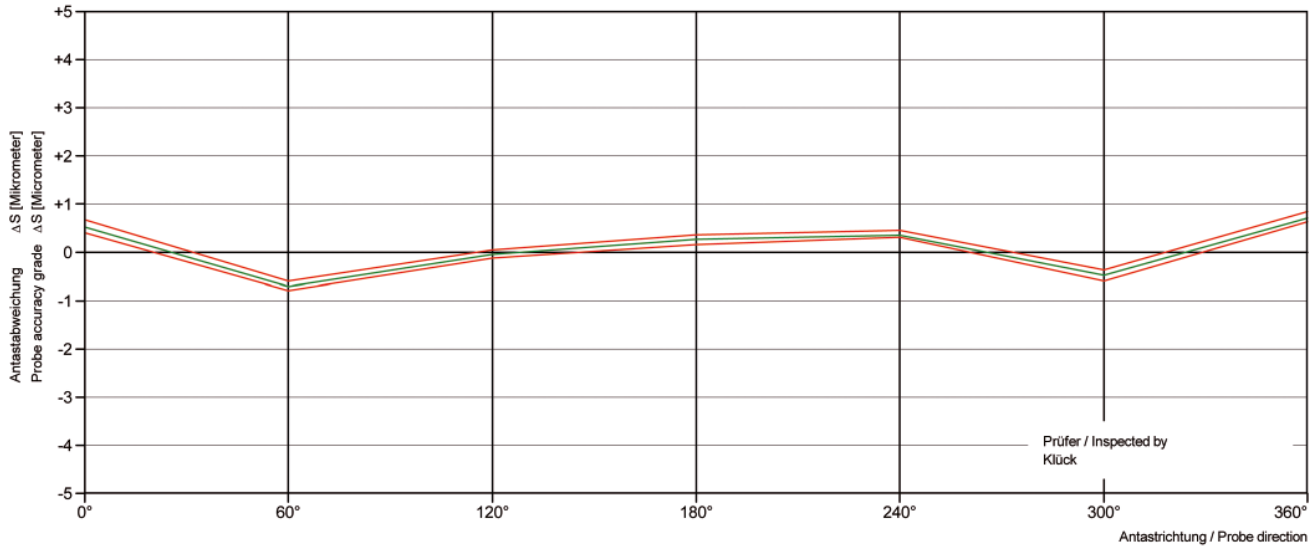
Typical repeatability curve of a TS 2xx/4xx/6xx touch probe: results of repeated probing from one direction at a defined spindle orientation

HEIDENHAIN

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: 2 σ 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	2 σ 0,25 µm	**Kalibrierzeichen**	4120 PTB 02

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.

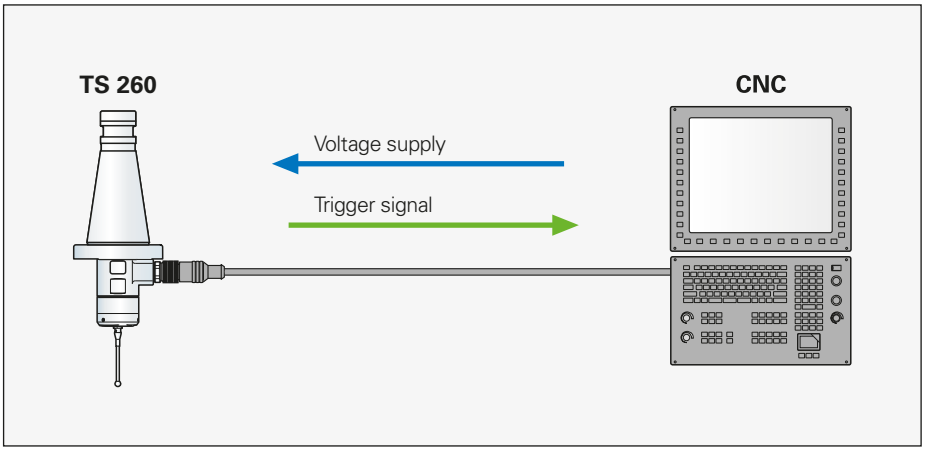
Accuracy grade	± 1,0 µm	**Calibration standard**	Laser interferometer
Probe repeatability	2 σ 0,25 µm	**Calibration mark**	4120 PTB 02

Signal transmission

Signal transmission by cable

The TS 260 and TS 248 touch probes features a plug-in cable that both provides the power supply and transmits the trigger signal.

When the TS 260 is used for milling, drilling and boring machines, the machine operator inserts the touch probe 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.



Wireless signal transmission

The signals are transmitted from wireless touch probes to the SE transmitter/receiver unit via

- radio or infrared for the **TS 460**
- infrared for the **TS 444, TS 642, TS 740**

This makes these touch probes ideal for use on machines with automatic tool changers.

The following transmitter/receiver units are available:

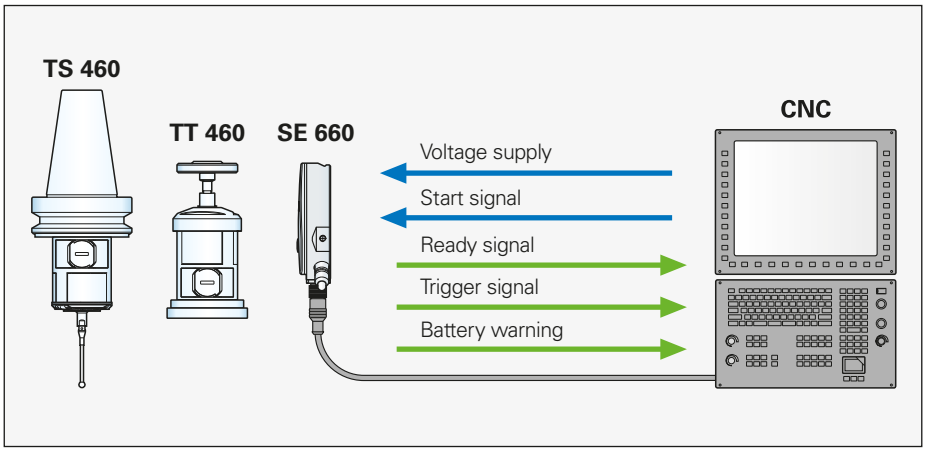
- **SE 660** for radio and infrared transmission; shared SE for TS 460 and TT 460
- **SE 540** only for infrared transmission, for integration in the spindle head
- **SE 642** only for infrared transmission, shared SE for TS and TT

The SE 660 communicates with the TS 460 and TT 460. The SE 540 and SE 642 can be used in any combination with the TS 4xx, TS 642 and TS 740 touch probes.

The following signals are transmitted: The **start signal** activates the touch probe. The touch probe indicates operability with a **ready signal**. A deflection of the stylus produces the **trigger signal**. If the TS 460/ TS 642/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.

	SE 660	SE 540	SE 642
TS 460	Radio/infrared	Infrared	Infrared
TS 444	–	Infrared	Infrared
TS 642	Infrared	Infrared	Infrared
TS 740	–	Infrared	Infrared

Signal transmission types and combinations of TS and SE



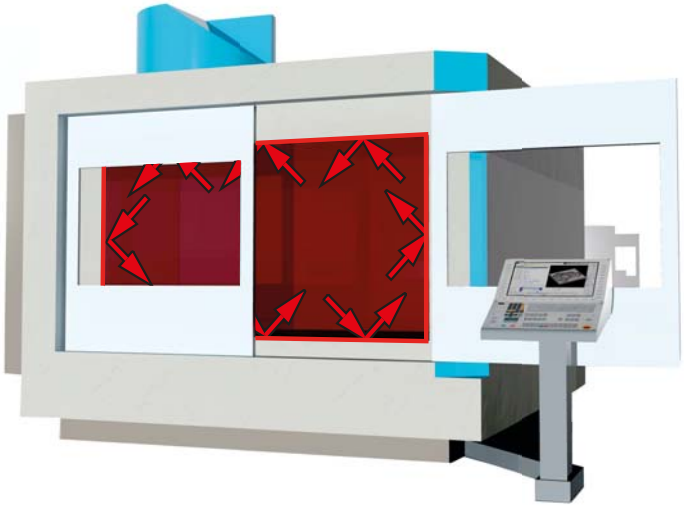
Infrared transmission
Infrared transmission is ideal for compact machines with closed working spaces. Thanks to reflection, the signal is received even in hidden areas. Infrared transmission has a range of up to 7 meters. The carrier frequency method applied by the TS 460 offers very strong noise immunity with extremely short transmission times of approx. 0.2 ms for the trigger signal. This permits exact measurement results, regardless of the probing velocity.

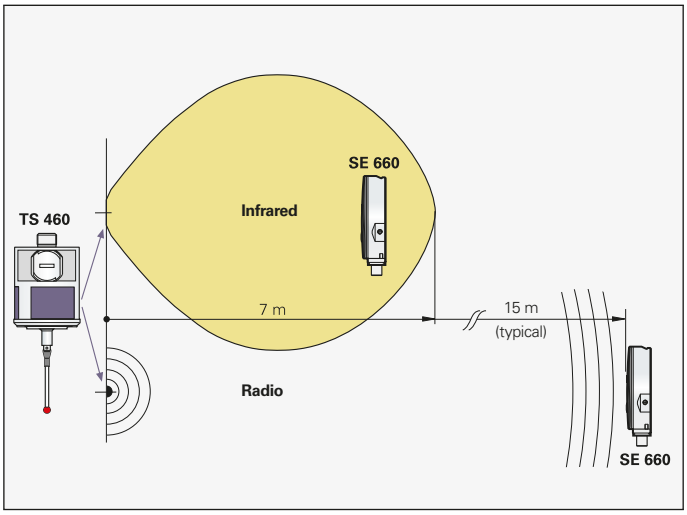
Radio transmission (only TS 460, TT 460)
Radio transmission is used mainly for large machine tools. The range is usually 15 m, but in practice much larger ranges are possible under ideal circumstances. Radio transmission operates in the free ISM band at 2.4 GHz and offers 16 channels. The transmission times for the trigger signal are approx. 10 ms. Each touch probe is uniquely addressed.

Hybrid technology: Signal transmission via radio or infrared signals (only TS 460, TT 460)
The dual signal transmission of the TS 460 combines the advantages of radio waves (high range and large amounts of data) with infrared signals (highest accuracy and fast signal transmission). You can switch between three possibilities: pure infrared transmission (factory default setting), pure radio transmission, or mixed operation. This offers the following benefits:

- You save time per measuring cycle without sacrificing accuracy if you activate the touch probe by radio while it's still in the tool changer—i.e. outside of the working space. The measurement is made with fast—and therefore more accurate—infrared transmission.
- You can operate one version of a touch probe on different types of machines (milling machines, lathes, grinding machines) and any machine sizes (from small and enclosed to large and open).

No matter whether you work with radio or infrared transmission, you need only one SE 660 transmitter/receiver unit.





Range of transmission

Infrared transmission

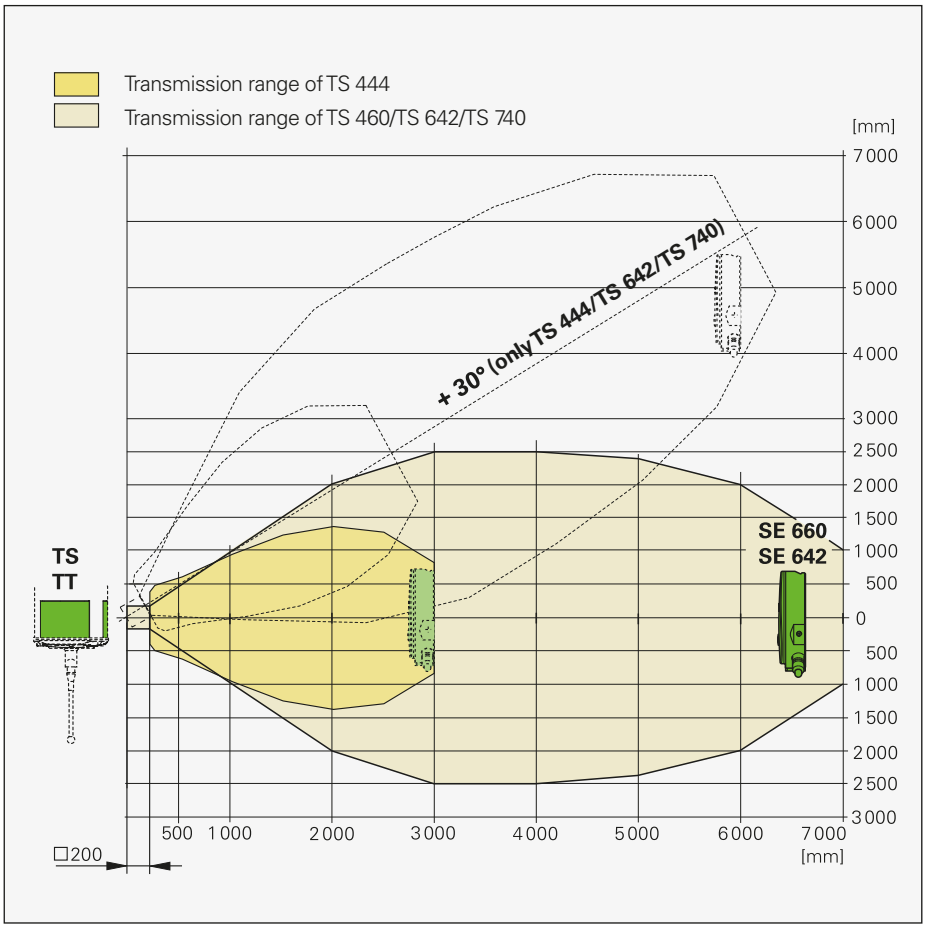
The transmission areas between the SE transmitter/receiver unit and the touch probes have a lobe form. In order to ensure an optimum signal transmission in both directions, the transceiver should be mounted so that the touch probe is within this range during all operating positions.
If the infrared transmission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

360° transmission range

The LEDs and receiver modules for infrared transmission are distributed so that even transmission is available over the entire circumference (360°). This ensures a 360° transmission range for reliable reception without previous spindle orientation.

Angle of transmission

The wireless TS 444, TS 642 and TS 740 touch probes are available for adaptation to the machine design with a horizontal transmission angle of 0° or +30°. The TS 460 permits communication with the SE 540 in the normal version.

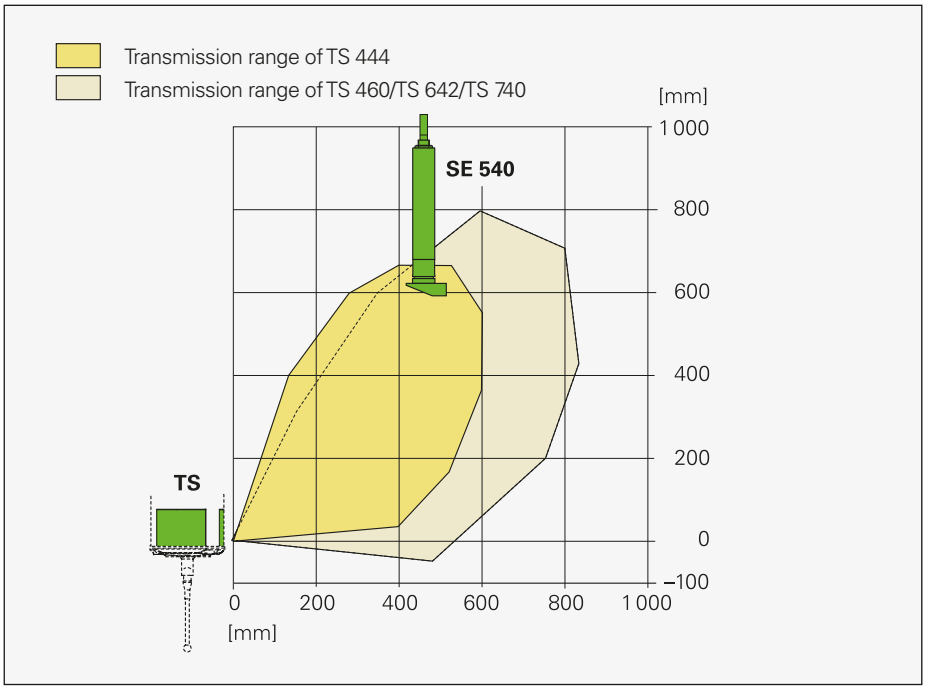


Radio transmission

The TS 460 touch probe's radio transmission depends on direction. The transmission range is typically 15 m, and in practice much larger ranges are possible under ideal circumstances.

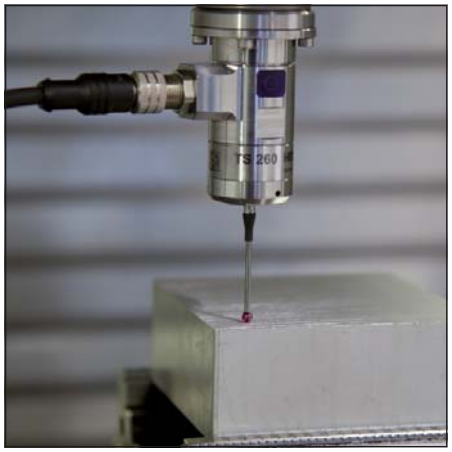
Quality of signal transmission

The signal quality of the infrared or radio transmission is displayed on the SE by a multicolor LED (see "Optical status indicator"), so you can see at a glance whether the touch probe is still in the transmission range of the SE.



Optical status indicator

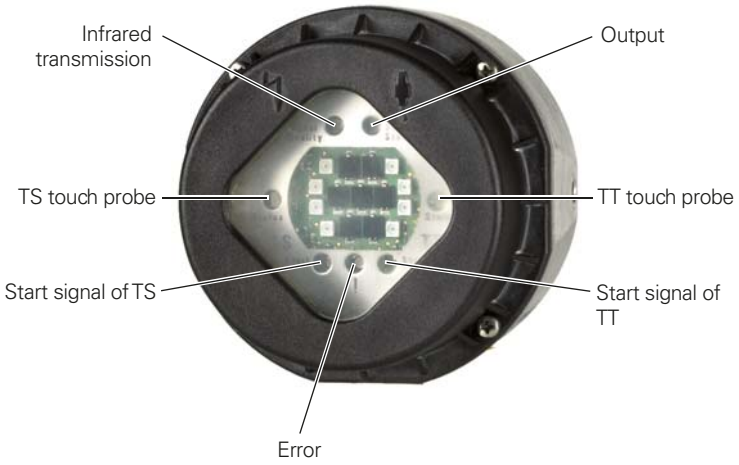
Touch probes and transmitter/receiver units from HEIDENHAIN are equipped with LEDs that also indicate the respective condition of the output signals (stylus deflection, readiness, etc.). This enables you to check the touch probe status and the transmission path at a glance, which simplifies both installation and operation.



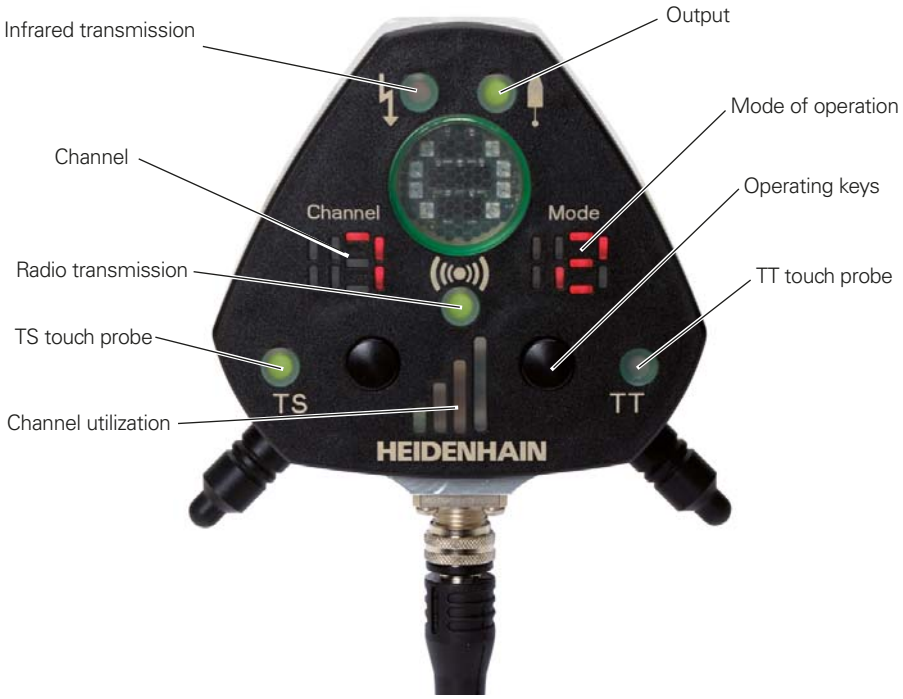
TS touch probes
Multiple LEDs are arranged on the circumference of the TS touch probes so that they are visible from any angle. They indicate stylus deflection. For the wireless versions they also show readiness.

SE 540 transmitter/receiver unit
The SE 540 transceiver features one multicolor LED indicator that continuously displays the condition of the touch probe (deflection and battery capacity).

SE 642 transmitter/receiver unit
The SE 642 features several multicolor LED indicators that, in addition to status indication, also make comprehensive diagnostics possible. They display:
- Standby
- Active touch probe
- Deflection
- Battery capacity
- Quality of infrared transmission
- Disturbances and faults



SE 660 transmitter/receiver unit
Besides LEDs, the SE 660 for radio and infrared transmission features segment and bar displays. They provide comprehensive information on commissioning, operation and diagnostics:
- Standby
- Active touch probe
- Deflection
- Battery capacity
- Quality of the radio or infrared signal
- Connection setup
- Channel utilization for radio signal
- Collision and faults
- Channel
- Mode of operation



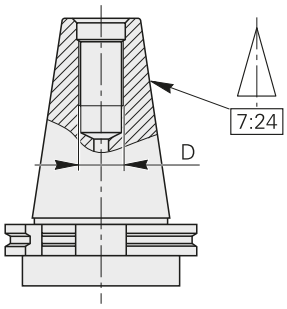
Mounting
TS workpiece touch probes

The TS workpiece touch probes from HEIDENHAIN are suitable for use on all sorts of machine tools. They offer all the necessary mounting options:

- **Clamping shanks** for machining centers, milling, drilling, and boring machines
- **Tool holders** for special solutions
- **Fastening screw threads** for individual mounting solutions, e.g. on lathes or grinding machines

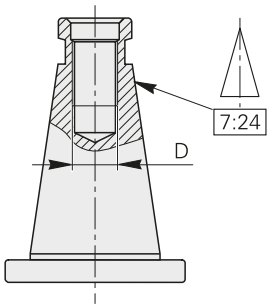
Taper shanks

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. A complete selection is listed here. All other commercially available taper shanks are available on request.



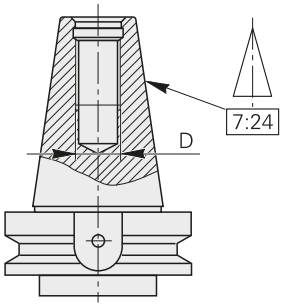
DIN 69871

Taper	D
SK-A 40	M16
SK-A 45	M20
SK-A 50	M24
SK-AD/B 30	M12
SK-AD/B 40	M16
SK-AD/B 45	M20
SK-AD/B 50	M24
SK-AD/B 60	M30



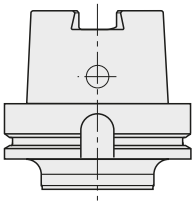
DIN 2080

Taper	D
SK-A 40	M16
SK-A 45	M20
SK-A 50	M24
SK-A 50	UNC 1.000-8



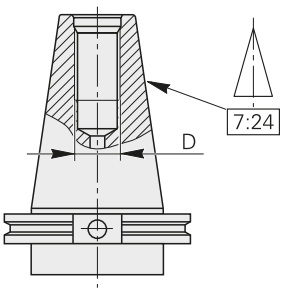
JIS B 6339

Taper	D
BT 30	M12
BT 40	M16
BT 50	M24



DIN 69893

Taper
HSK-E 25
HSK-E 32
HSK-A 40
HSK-E 40
HSK-A 50
HSK-E 50
HSK-A 63
HSK-B 63
HSK-F 63
HSK-A 80
HSK-A 100



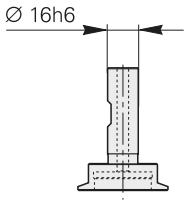
ASME B5.50

Taper	D
SK 40	UNC 1x000-8
SK 50	UNC 1x000-8

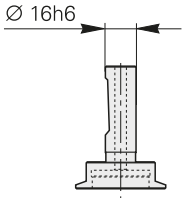
Tool holders

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

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



DIN 6535-HB16
Cylindrical shank for Weldon tool holder



DIN 6535-HE16
Cylindrical shank for whistle-notch tool holder

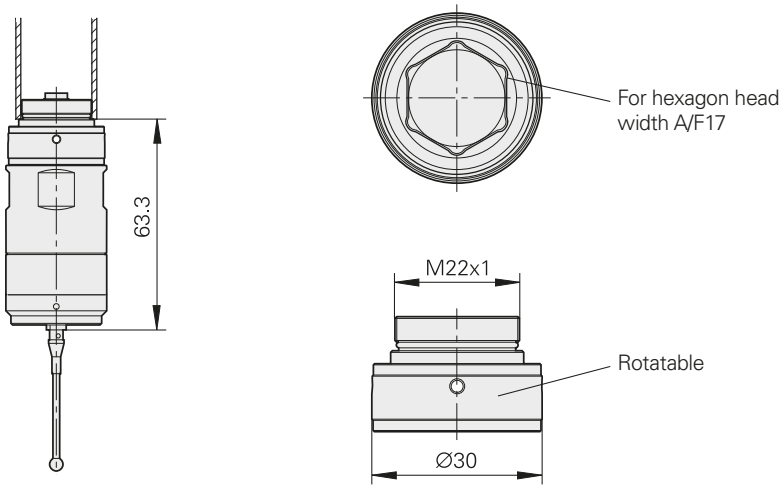
Threaded mounting hole

The TS touch probes can also be supplied without taper shank. In this case, connection is through a thread.

- M28 x 0.75 for TS 260/TS 248
- M30 x 0.5 for TS 460/TS 444
- M30 x 0.5 for TS 642/TS 740

Accessories:
Coupling joint for TS 260/TS 248
ID 643089-01

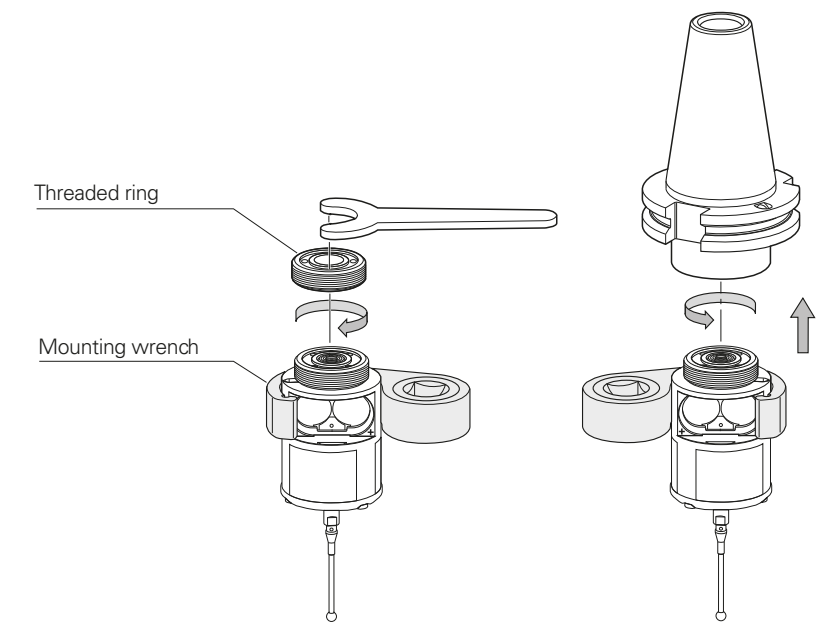
The M22x1 coupling joint with external thread is used for simple attachment of the TS 260/TS 248 to a machine element, mounting base or by a tilting device, e.g. on lathes or grinding machines. With the aid of the coupling joint, the TS can also be rotated as desired on a rigid fastening element. This enables you, for example, to align the TS with an asymmetric or cuboid probe contact exactly parallel to the machine axes.



M12/M30 threaded ring
ID 391026-01

The threaded ring serves to adapt the taper shanks and tool holders with an M30 thread to the TS 4xx (M12 x 0.5)

Mounting wrench
For mounting a taper shank on the
TS 460: ID 1034244-01
TS 740/TS 642: ID 519833-01



Transmitter/receiver unit

The SE transceiver for infrared transmission is to be mounted so that it remains within the transmission range of the touch probe over the machine's entire range of traverse. For radio transmission, sufficient clearance from sources of interference must be ensured. The lateral clearance to metal surfaces must be at least 60 mm.

SE 660, SE 642 transmitter/receiver unit
Thanks to their high IP67 degree of protection, these units can be mounted as desired in the working space and can be exposed to coolant. If the SE is to be used both for a workpiece touch probe and the TT 460 tool touch probe, it must be ensured during mounting that it can communicate with both touch probes.

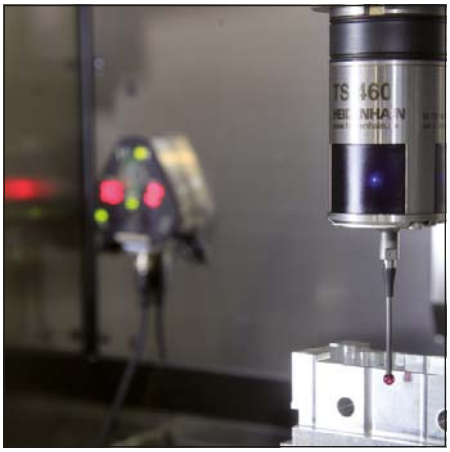
It is fastened from the side by two M5 threaded holes. Appropriate holders are available as accessories for simple mounting. It is also easily to retrofit.

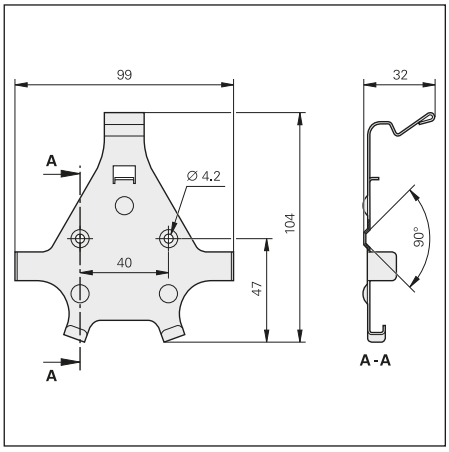
Accessories
Holder for SE 660
ID 744677-01

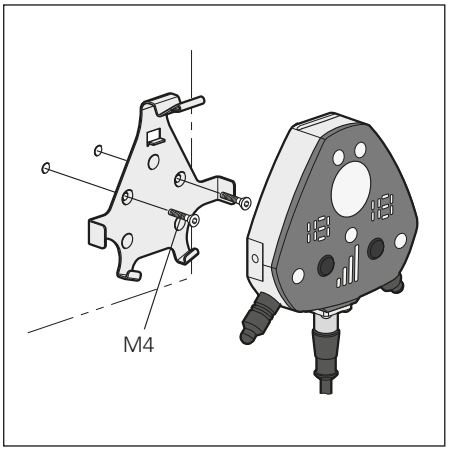
The holder for the SE 660 is secured to a machine element via two M4 screws, and the SE is simply clipped in.

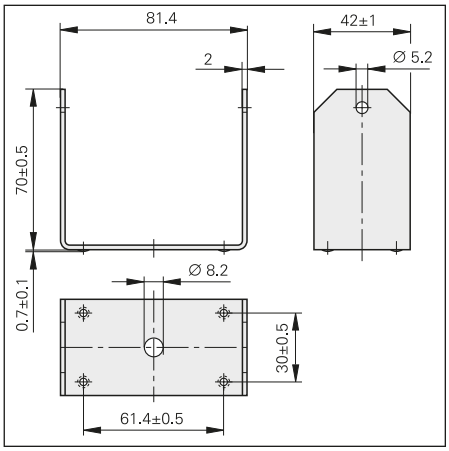
Holder for SE 642
ID 370827-01

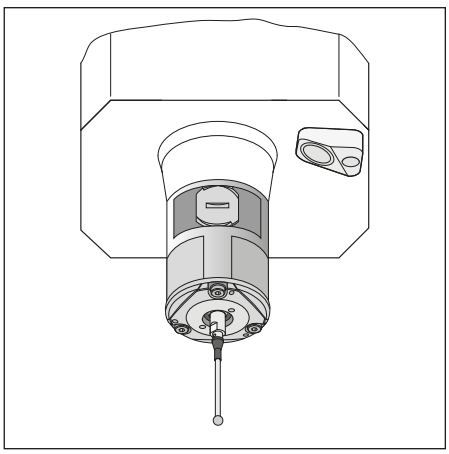
SE 540 transmitter/receiver unit
The SE 540 is intended for integration in the spindle head. Except for a few cases, for example on machines with quills, this ensures transmission on machines with very large traverse ranges or with swivel heads. The transmission range of the infrared signal is appropriate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











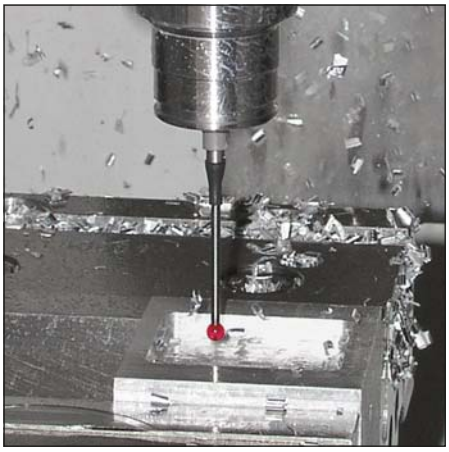
Probing

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 on the circumference of the touch probe.

The wireless touch probes 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 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.

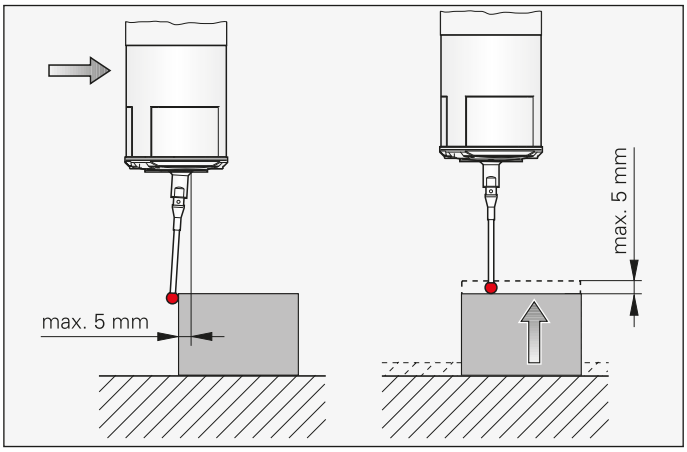
On the battery-free TS 444 touch probe, the compressed air is used at the same time for charging the capacitors.



Probing velocity
Signal propagation times in the CNC as well as infrared transmission and especially radio transmission influence the 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.

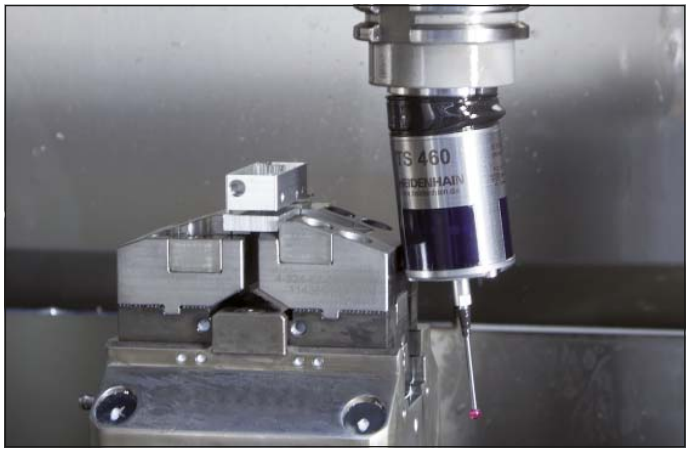
Deflection of the stylus



Collision protection and thermal decoupling (option with TS 460)

Mechanical collision protection
A mechanical adapter between the touch probe and taper shank serves as collision protection. The touch probe can slightly dodge light collisions of its housing against a fixture or workpiece. At the same time, an integrated switch deactivates the ready signal and the control stops the machine. This collision protection therefore functions only if the touch probe has been activated.

The undamaged touch probe is recalibrated (via the control's calibration cycle) and you can continue working. The collision protection adapter does not cause any additional error, not even at high accelerations, e.g. during tool change.



The collision protection adapter protects the touch probe from physical damage...

Thermal decoupling
Furthermore, the collision protection adapter functions as a thermal decoupler. This protects the touch probe from being heated by the spindle.

If the spindle gets very warm due to machining, the touch probe can also warm up—particularly in measuring cycles of long duration. This can lead to faulty measurements. Thanks to its collision protection, the touch probe with thermal decoupling prevents heat from being conducted from the spindle to the touch probe.

... and serves as thermal decoupler (at left with collision protection adapter)

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 following styli are included in delivery with the TS touch probes:

- For TS 260/TS 248
  2 x T404
- For TS 460
  T404 and T409
- For TS 444, TS 642 and TS 740
  T404 and T424

By using the coupling joint, the TS 260/ TS 248 can be rotated into position in order to align asymmetric or cuboid probe contacts exactly.

Ball-tip styluses with steel shaft

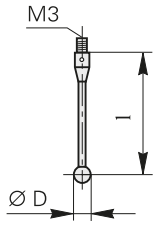
Model	ID	Length l	Ball dia. D
T421	295770-21	21 mm	1 mm
T422	295770-22	21 mm	2 mm
T423	295770-23	21 mm	3 mm
T424	352776-24	21 mm	4 mm
T404	352776-04	40 mm	4 mm
T405	352776-05	40 mm	5 mm
T406	352776-06	40 mm	6 mm
T408	352776-08	40 mm	8 mm
T409	352776-09	60 mm	4 mm

Ball-tip styli with steel shaft

Model	ID	Length l	Ball dia. D
T510	805228-01	100 mm	5 mm
T515	805228-02	150 mm	5 mm
T520	805228-03	200 mm	5 mm
T610	805228-07	100 mm	6 mm

Further styli, including special shapes, are available upon request.

Styli



Star-type inserts
For up to five styli, e.g.
T404 or T421
ID 1090725-01

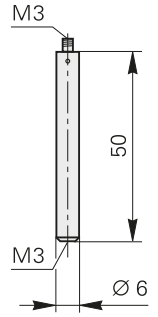
Stylus adapters
For fastening styli with M4 thread
ID 730192-01

Stylus extension

Model	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).

Extension

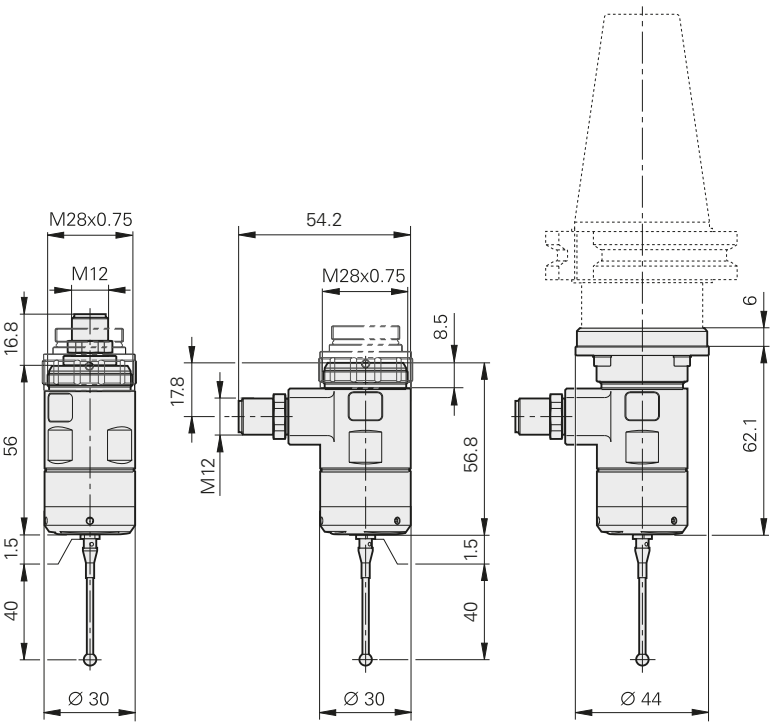


TS 248, TS 260 and TS 460
Workpiece touch probes

TS 248, TS 260

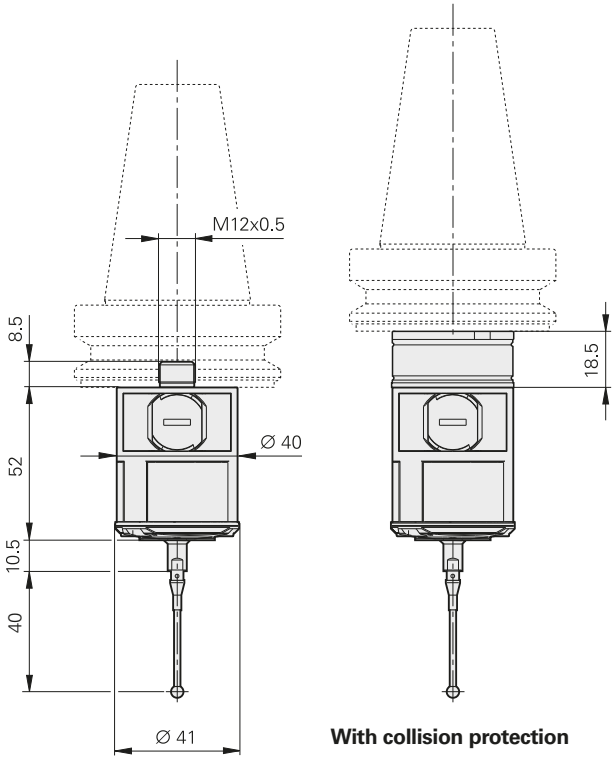
Axial flange socket

Radial flange socket



TS 460

With collision protection



With collision protection

Workpiece touch probe	Cable TS 248 TS 260	Radio and infrared TS 460
Probe accuracy	≤ ± 5 µm with use of the standard stylus T404	
Probe repeatability Repeated probing from one direction	2 σ ≤ 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 (*TS 248:* approx. 4 N) *Radial:* approx. 1 N (*TS 248:* approx. 0.5 N)	
Probing velocity	≤ 5 m/min	
Collision protection*	–	Optional
Protection EN 60 529	IP68	
Operating temperature	10 °C to 40 °C	
Storage temperature	–20 °C to 70 °C	
Mass without taper shank	≈ 0.15 kg	≈ 0.2 kg
Fastening*	• With taper shank[1] (only with radial flange socket) • By M28 x 0.75 external thread • By coupling joint with M22 x 1 external thread	• With taper shank[1] • By M12 x 0.5 external thread
Electrical connection*	M12 flange socket, 8-pin; axial or radial	–
Cable length	≤ 25 m	–
Voltage supply	DC 15 V to 30 V/≤ 100 mA (without load)	2 batteries (rechargeable or non-rechargeable) $^1/_2$ AA or size LR2, each 1 V to 4 V
Operating time	–	Continuous operation for typically 400 h[2] with lithium batteries
Output signals	• Trigger signals S and $\overline{S}$ (square-wave signal and its inverted signal) • Floating trigger output	–
HTL signal levels	$U_H \geq 20$ V at $-I_H \leq 20$ mA $U_L \leq 2.8$ V at $I_L \leq 20$ mA at DC 24 V rated voltage	–
Signal transmission	Cable	Radio and infrared transmission (selectable) with 360° range to SE
Transmitter/receiver unit*	–	• SE 660 for radio and infrared transmission[3] • SE 642 for infrared transmission[3] • SE 540 for infrared transmission; for integration in the spindle head
TS switch-on/off	–	Radio or infrared signal (selectable) from SE

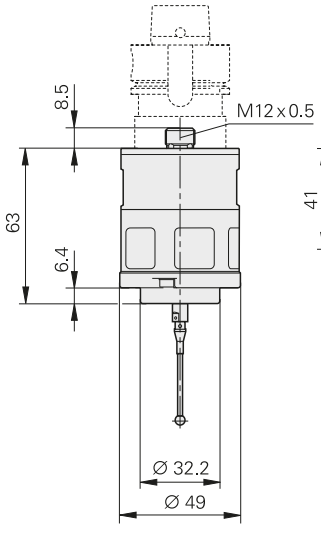
* Please select when ordering
[1] See overview, page 18
[2] Reduced operating time if there is much surrounding radio traffic, or short but frequent probing intervals
[3] As shared SE for TS 460 and TT 460

TS 444, TS 642 and TS 740
Workpiece touch probes

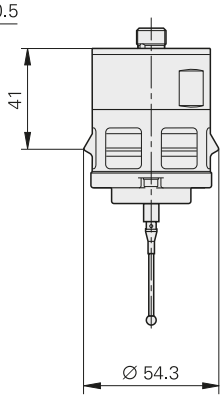
TS 444

TS 642

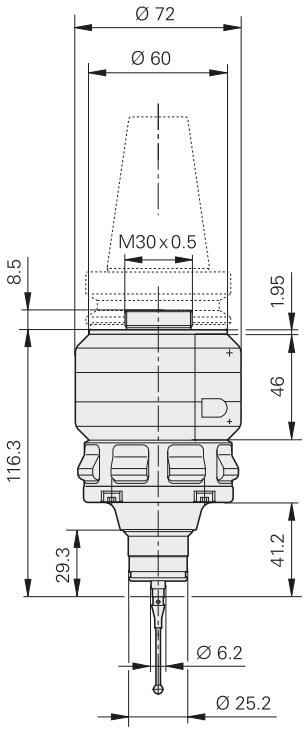
TS 740

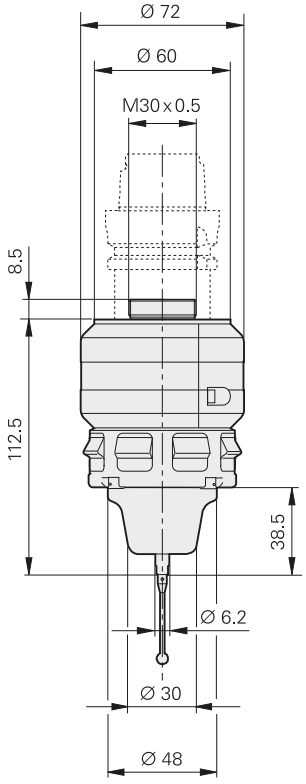


Angle of transmission 0°



Angle of transmission 30°





mm

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

Workpiece touch probe	Infrared TS 444	TS 642	TS 740
Probe accuracy	≤ ±5 µm with use of the standard stylus T404		≤ ±1 µm with use of the standard stylus T404
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	IP68		
Operating temperature	10 °C to 40 °C		
Storage temperature	–20 °C to 70 °C		
Mass without taper shank	≈ 0.4 kg	≈ 1.1 kg	
Fastening*	With taper shank* (overview on page 18)		
	Without taper shank (connecting thread M12 x 0.5)	Without taper shank (connecting thread M30 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 642	SE 540, SE 642 or SE 660 (only infrared)	SE 540 or SE 642
TS switch-on/off	Infrared signal from SE	Via switch in the taper shank or infrared signal from SE	Infrared signal from SE
Energy supply/voltage supply	Compressed air Recommended operating pressure $5.5 \cdot 10^5$ to $8 \cdot 10^5$ Pa	Batteries, rechargeable or nonrechargeable	
Energy buffer	Integrated high-power capacitors, charging time typically 3 s at $5.5 \cdot 10^5$ Pa	Two rechargeable or nonrechargeable batteries, 1 V to 4 V each, size C or size A[1)]	
Operating time	Typically 120 s	Typically 800 h[2)] (reduced operating time as replacement for TS 632)	Typically 500 h[2)]

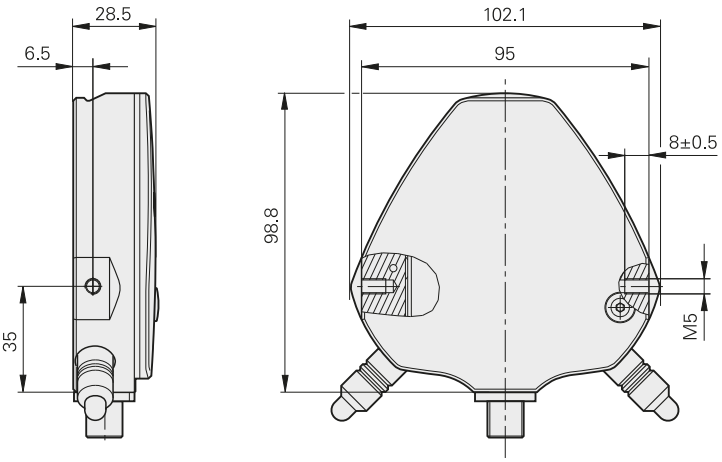
***** Please select when ordering
[1)] Via adapter, included in delivery
[2)] In continuous operation with 3.6 V/6000 mAh lithium batteries; with the size A lithium batteries included in delivery, only half the service life is reached

10^5 Pa ≙ 1 bar

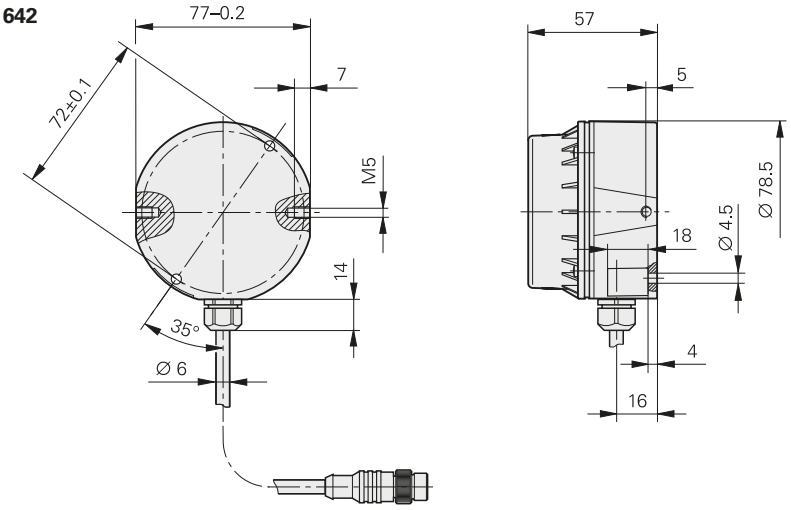
SE 660, SE 642 and SE 540

Transmitter/receiver units

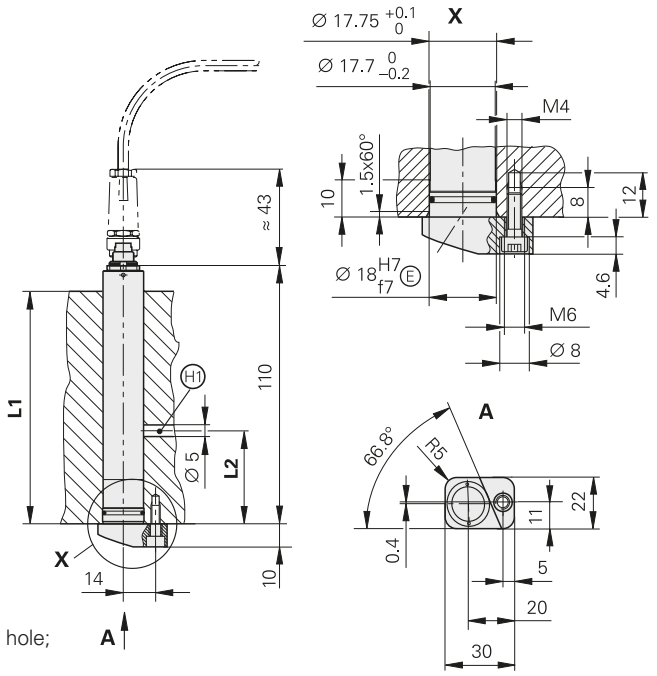
SE 660



SE 642



SE 540



mm

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

H1 = For L1 > 100: Provide a drain hole;
L2 = 10 mm to 100 mm

Transceiver unit	Radio and infrared SE 660	Infrared SE 642	 SE 540
Use	TS 460, TT 460 Communicates both with TS 460 and TT 460	TS 460, TS 444, TS 642, TS 740 and TT 460, communicates both with TS and TT	TS 460, TS 444, TS 642 or TS 740
Signal transmission	Radio or infrared	Infrared	
Area of application	In working space of machine	In working space of machine	In location hole in the spindle
Input/output signals	Square-wave signals at HTL level • Start signals R(-TS) and R(-TT) • Ready signal R(-TS) and R(-TT) • Trigger signals S and $\overline{S}$ • Battery warning $\overline{W}$	Square-wave signals at HTL level • Start signals R(-TS) and R(-TT) • Ready signal R(-TS) and R(-TT) • Trigger signals S and $\overline{S}$ • Battery warning $\overline{W}$	Square-wave signals at HTL level • Start signal R • Ready signal B • Trigger signal $\overline{S}$ • Battery warning $\overline{W}$
Optical status indicator	For infrared transmission, radio transmission, radio channel quality, channel, operating mode and whether workpiece or tool touch probe	For infrared transmission, errors and whether workpiece or tool touch probe	For touch probe
Electrical connection	M12 flange socket, 12-pin	Cable, 0.5/2 m, with M12 connector, 12-pin	M9 flange socket, 8-pin
Cable length	≤ 20 m with Ø 6 mm adapter cable ≤ 50 m with Ø 6 mm adapter cable and Ø 8 mm adapter cable for extension		≤ 30 m with Ø 4.5 mm adapter cable ≤ 50 m with Ø 4.5 mm adapter cable and Ø 8 mm adapter cable for extension
Voltage supply	DC 15 V to 30 V		
Current consumption without load Infrared Normal operation Transmission Radio	 3.4 W_{eff} (≤ 200 mA_{eff} [1]) 10.7 W_{PK} (≤ 680 mA_{PK} [1]) 2.1 W_{eff} (≤ 120 mA_{eff} [1])	 5.1 W_{eff} (≤ 250 mA_{eff} [1]) 8.3 W_{PK} (≤ 550 mA_{PK} [1]) –	 3.7 W_{eff} (≤ 150 mA_{eff} [1]) 4.3 W_{PK} (≤ 210 mA_{PK} [1]) –
Protection EN 60529	IP68		
Operating temperature	10 °C to 40 °C	10 °C to 40 °C	*U_P = 15 V:* 10 °C to 60 °C *U_P = 24 V:* 10 °C to 40 °C
Storage temperature	–20 °C to 70 °C	–20 °C to 70 °C	–20 °C to 70 °C
Mass without cable	≈ 0.3 kg	≈ 0.2 kg	≈ 0.1 kg

***** Please select when ordering
[1] With minimum supply voltage

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 160 and TT 460 tool touch probes are touch trigger probes for the measurement and inspection of tools. The TT 160 features signal transmission by cable, while the TT 460 communicates wirelessly over aradio or infrared beam with the SE 660 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 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 a 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**			
	TT 160	**TT 460**	**TL Nano**	**TL Micro 150**	**TL Micro 200**	**TL Micro 300**
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	Cable	Radio/infrared to SE 660; infrared to SE 642	Cable			
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)]

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

Contents

TT touch probes for tool measurement

Together with the measuring cycles of the CNC control, the TT tool touch probes enable the control 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 460**, all signals are transmitted to the control via radio or infrared beam. Benefits:

- Greatly increased mobility
- Fast installation at any location
- For use also on rotary and tilting tables

Your benefit: With the TT 160 or TT 460 tool touch probe you can have your CNC machine operate unattended without losing accuracy or increasing scrap rates.

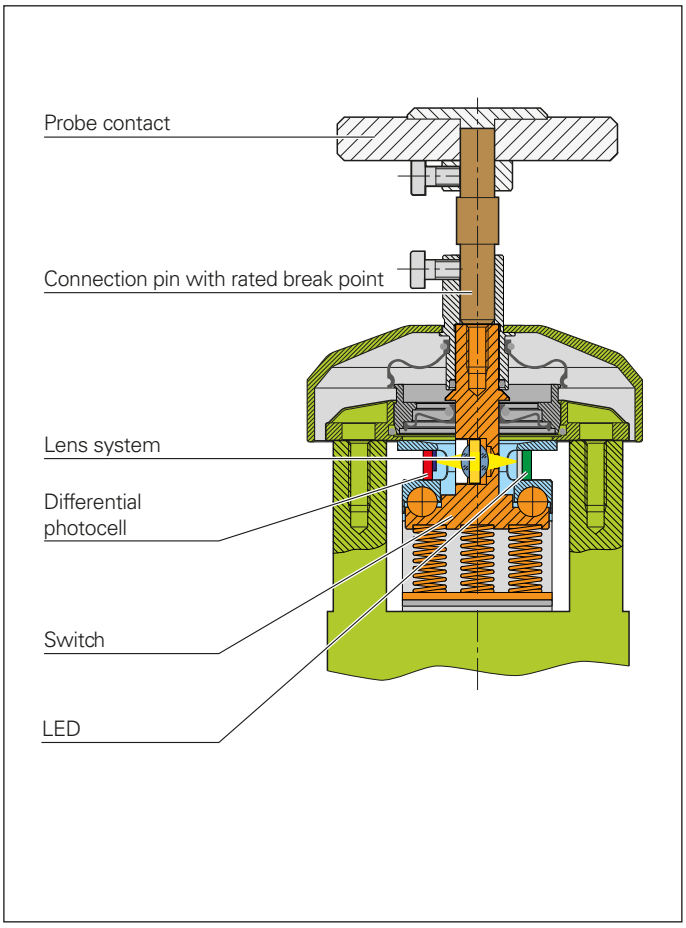
Principle of function

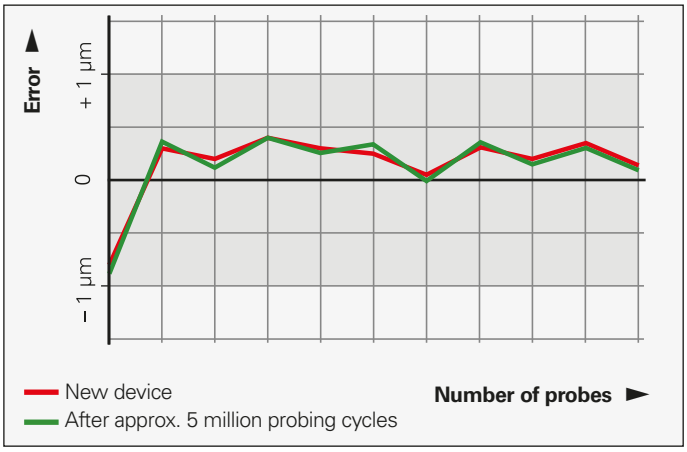
Sensor
Touch probes from HEIDENHAIN operate with an optical switch as sensor. A lens system collimates the light generated from an LED and focuses it onto a differential photocell. When the probe contact is deflected, the differential photocell produces a trigger signal. The probe contact of the TT is 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 repeatability of the probing process is of primary importance. The probe repeatability specifies the error resulting from repeatedly probing a tool from one direction at 20 °C ambient temperature.

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





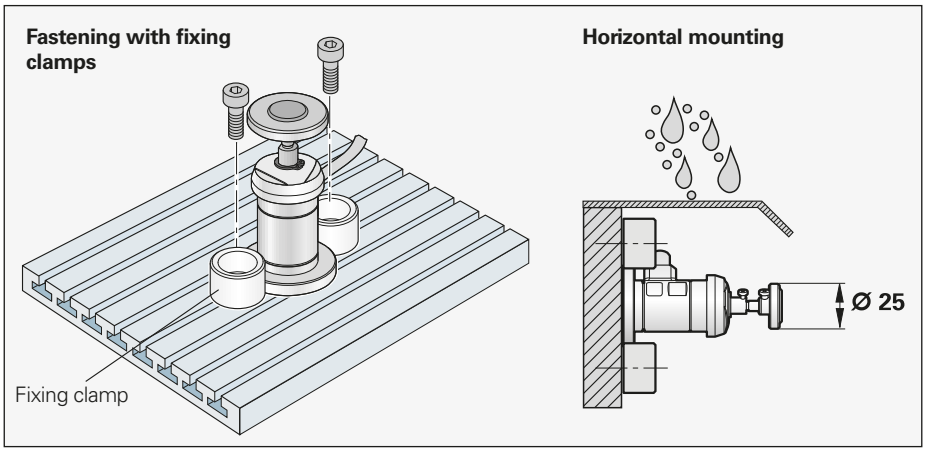
Typical repeatability curve of a touch probe: results of repeated probing from one direction.

Mounting

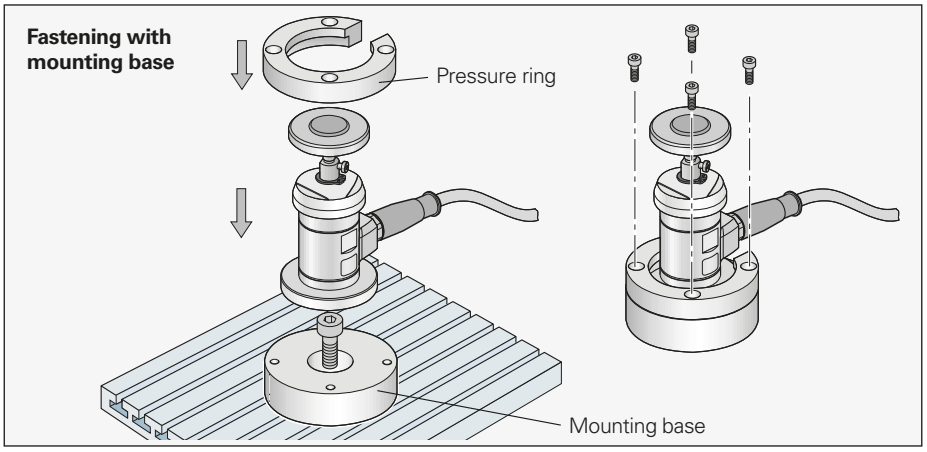
The tool touch probes feature IP67 protection and can therefore be fixed within the working space of the machine. The TT is mounted with two fixing clamps or on an accessory space-saving mounting base.

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.

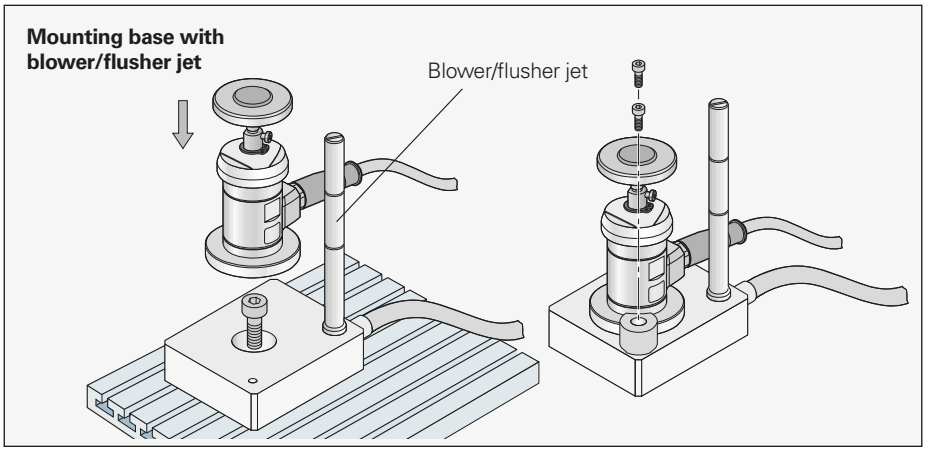
During workpiece machining, the TT must be switched off to ensure that the vibrations that accompany normal machining do not trigger a probe signal and cause an interruption.



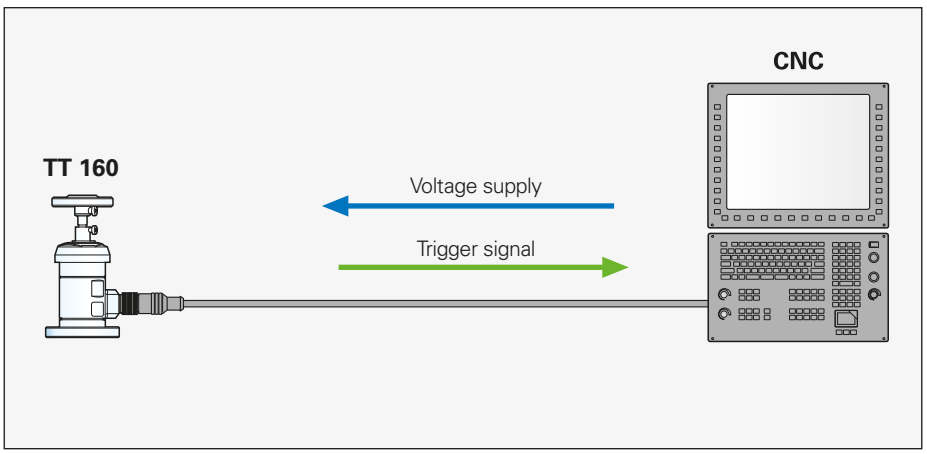
Accessories:
Mounting base for TT
For fastening with a central screw
TT 160, ID: 332400-01
TT 460, ID: 651586-01



Mounting base with blower/flusher jet
For cleaning the tool
Air connection for Ø 4/6 tube
ID 767594-01



Power supply and signal transmission
For the TT 160 touch probe, both the voltage supply and the trigger signal are conducted over the touch probe's cable. The TT 460 transmits the trigger signal by infrared beam to the SE 660 transceiver (see page 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 1000 rpm 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.

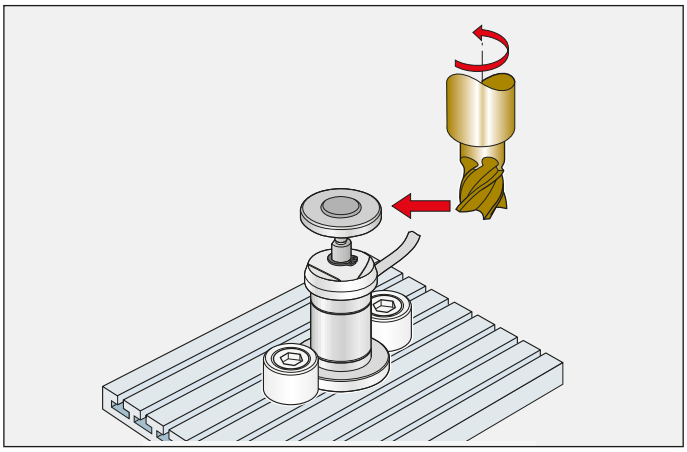
The probe contact of the TT features a **rated break point** in order to protect the touch probe from physical damage due to operator error. The rated break point is effective in all probing directions. A rubber sleeve offers protection from splinters. A defective connection pin can easily be replaced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

Optical deflection display
LEDs on the TT 160 additionally indicate deflection of the probe contact. On the TT 460, the condition of the touch probe is visible through LEDs on the SE transmitter/receiver unit. This is especially useful for testing correct operation. You can see at a glance whether the TT is currently deflected.

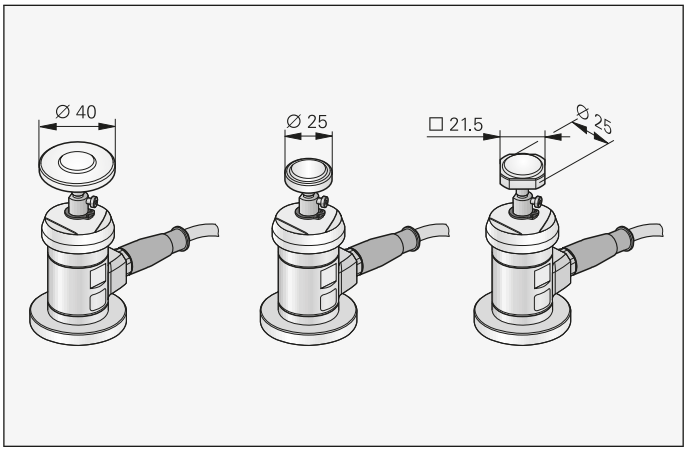
Probe contacts
To probe **milling cutters**, the tool touch probes are equipped, for example, with a disk-shaped probe contact with 40 mm diameter. A disk-shaped probe contact with a 25 mm diameter is available as an accessory. Because of its small weight, it is particularly recommended for horizontal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

The TT tool touch probe can also be used to calibrate **lathe tools**. 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. They can easily be replaced without requiring readjustment of the TT.



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



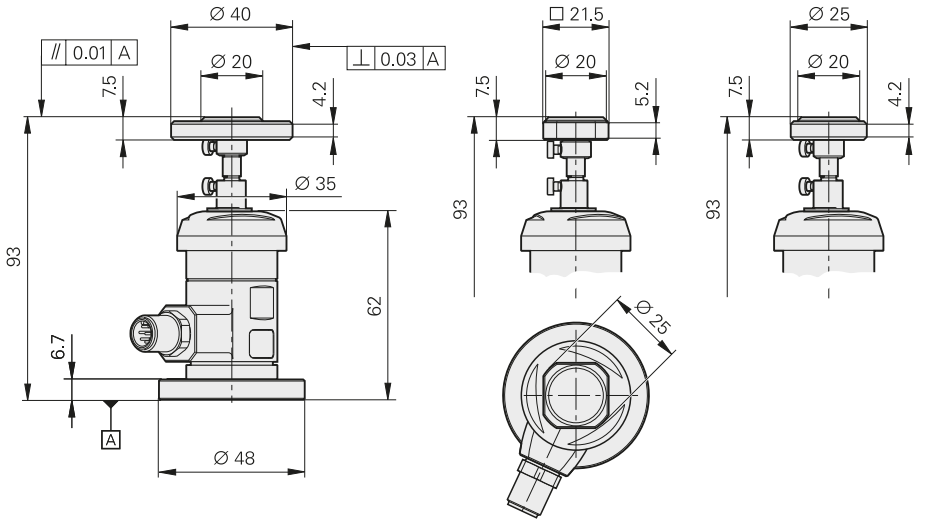
Accessory:
Probe contact SC02 Ø 25 mm
ID 574752-01

Probe contact SC01 Ø 40 mm
ID 527801-01

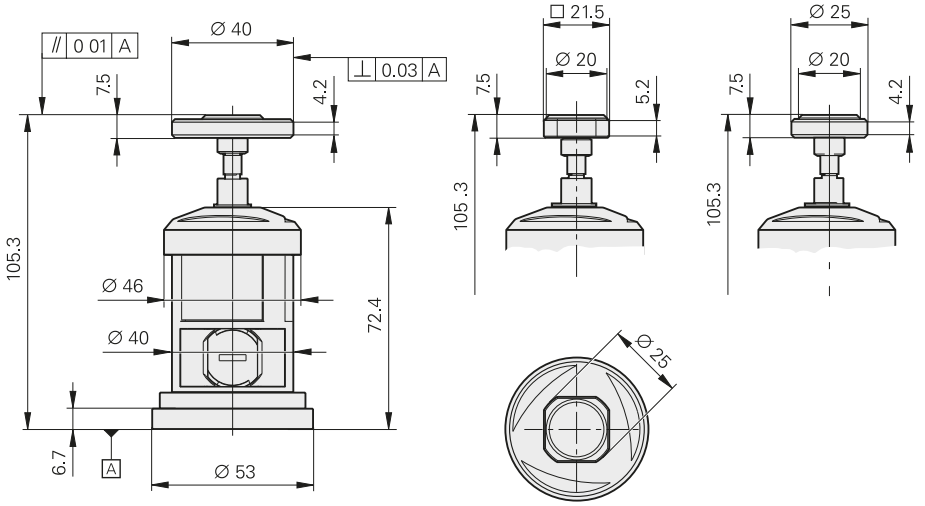
Probe contact cuboid
ID 676497-01

TT 160 and TT 460
Tool touch probes

TT 160



TT 460



Tool touch probe	Cable TT 160	Radio and infrared TT 460
Probe accuracy	≤ ±15 µm	
Probe repeatability Repeated probing from one direction	2 σ ≤ 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	
Deflection force	*Axial:* approx. 8 N *Radial:* approx. 1 N	
Probing velocity	≤ 5 m/min	
Protection EN 60529	IP68	
Operating temperature	10 °C to 40 °C	
Storage temperature	–20 °C to 70 °C	
Mass	≈ 0.3 kg	≈ 0.4 kg
Mounting on the machine table	• Fastening by fixing clamps (included in delivery) • Fastening with mounting base (accessory)	
Electrical connection	M12 flange socket, 8-pin	–
Cable length	≤ 25 m	–
Voltage supply	DC 10 V to 30 V/≤ 100 mA (without load)	2 batteries (rechargeable or non-rechargeable) $^1/_2$ AA or size LR2, each 1 V to 4 V
Operating time	–	Continuous operation for typically 400 h[1] with lithium batteries
Output signals	• Trigger signals S and $\overline{S}$ (square-wave signal and its inverted signal) • Floating trigger output	–
HTL signal levels	$U_H \geq 20$ V at $-I_H \leq 20$ mA $U_L \leq 2.8$ V at $I_L \leq 20$ mA at DC 24 V rated voltage	–
Signal transmission	Cable	Radio or infrared transmission (selectable) with 360° range to SE
Transceiver unit	–	• SE 660[2] for radio and infrared transmission • SE 642 [2] for infrared transmission
TT switch-on/off	–	Radio or infrared signal (selectable) from SE

[1] Reduced operating time if there is much surrounding radio traffic, or short but frequent probing intervals
[2] SE shared by TS 460 and TT 460, see page 28

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.

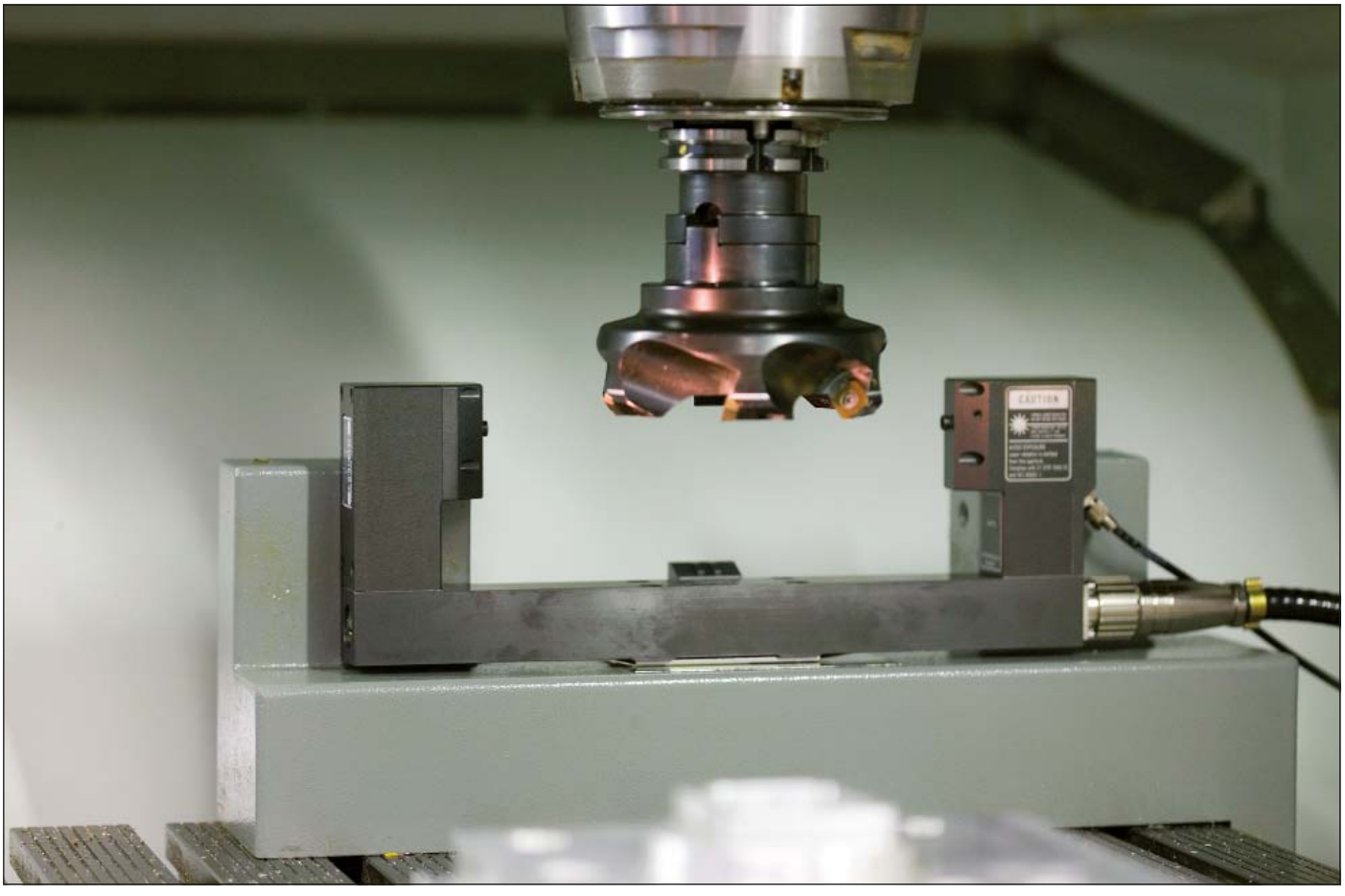
The precise determination of the length and radius at the rated shaft speed ensures your high production quality. At the same time this integrated tool setting with automatic updating of tool data eliminates the need for separate tool setting, reducing costs and non-productive times.

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 30 000 rpm).

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 make the necessary calculations. Measuring cycles for the TNC 320/620/640 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.

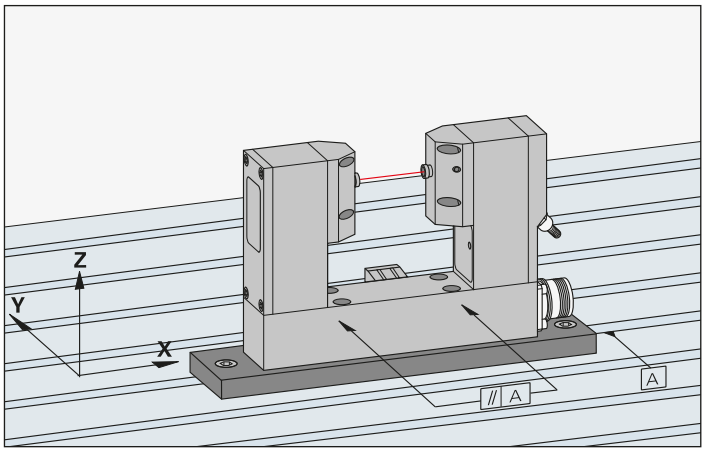
Accessories
The accessories simplify the mounting and maintenance of the TL laser systems.

Mounting

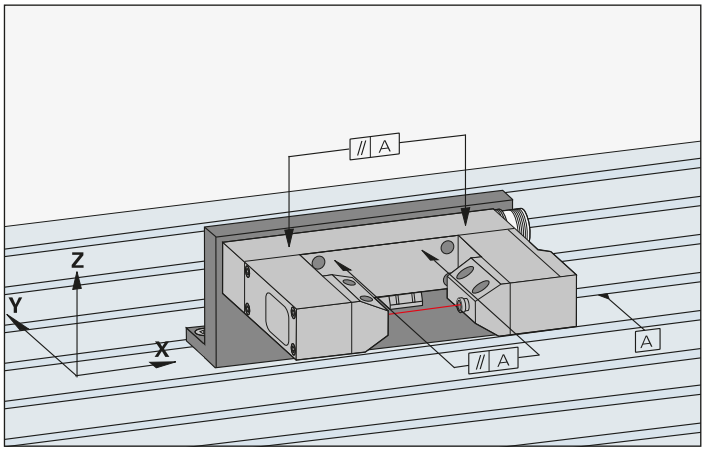
Mounting attitude
The TL laser systems fulfill the requirements for IP68 and can therefore be fixed directly in the machine's working space. For smooth operation, even with coolant and chips, the transmitter and receiver feature a pneumatically activated sealing system. The additional introduction of 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.

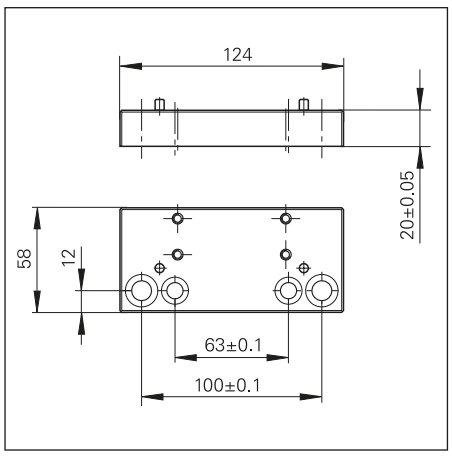


Aligning the TL
In order to achieve the best possible repeatability, the laser system must be mounted exactly parallel to two NC axes. For upright mounting on the machine table, the horizontal alignment is ensured by the mounting surface. The mounting tolerances are included in the dimension drawings. 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 plate 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.

Accessories:
Mounting plate for TL Micro
ID 560028-01

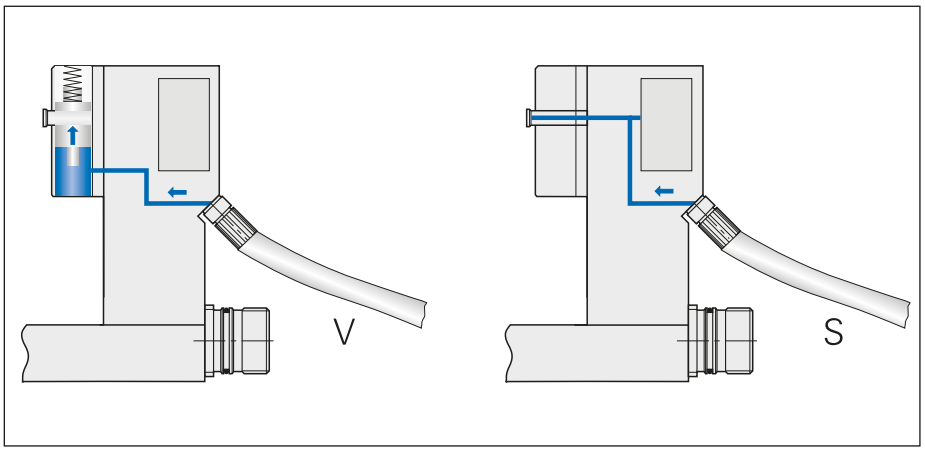


Protection from contamination

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

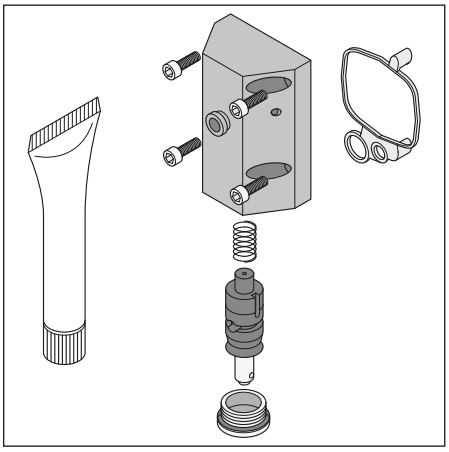
Mechanical protection
The lenses of the laser systems are perfectly sealed against coolant and chips by contamination shutters with an integrated mechanical seal system. The seal enables the optical system only for the duration of the measurement. The shutter is actuated pneumatically by the DA 301 TL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

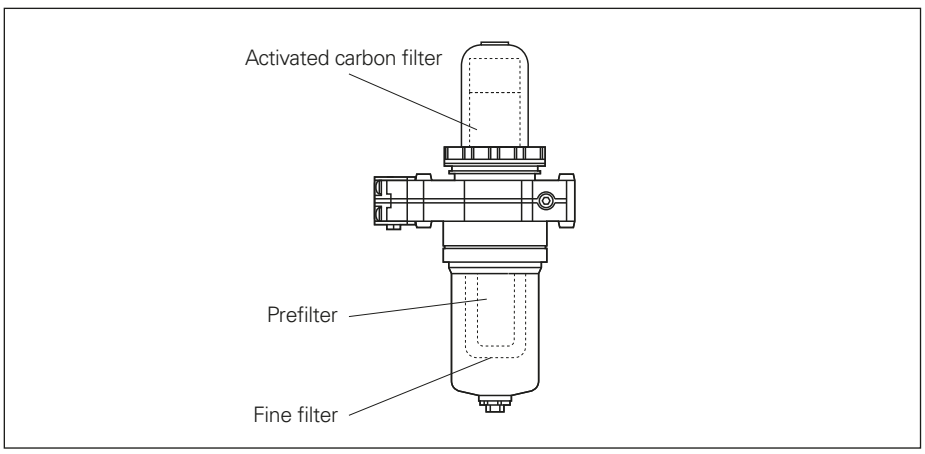


Pneumatic systems in the TL with connections for sealing air (S) and seal control (V)

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



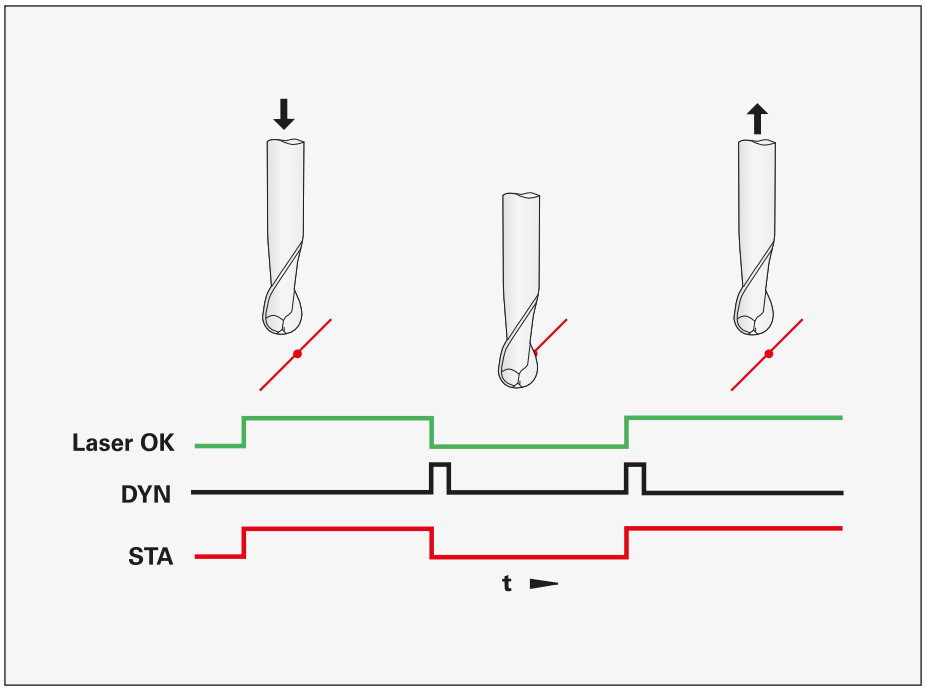
Replacement filters
ID 560036-01
Complete filter set for the DA 301 TL consisting of prefilter, fine filter, and activated carbon filter.



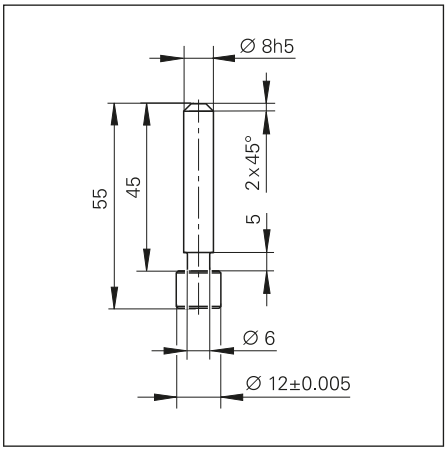
Protective springs
ID 560037-01
Set of spiral springs for protecting the compressed air tubing in the machine envelope
Set: 2 x Ø 6 mm, 1 x Ø 4 mm;
Length each: 1 m

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.

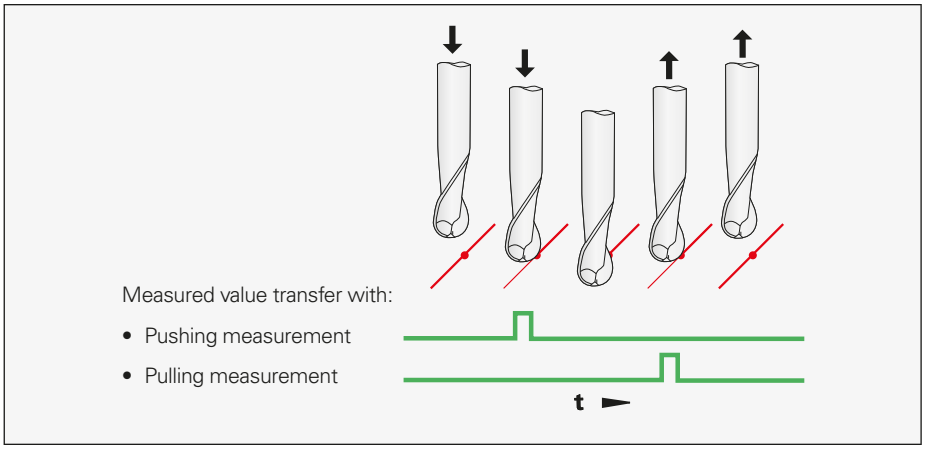


Calibrating
Before measurement with the TL laser system can be started, the system must be calibrated, meaning that the exact position of the trigger points relative to the machine coordinate system must be determined. A reference tool, available as an accessory, is used for this purpose. It has a characteristic 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 can suffice for simple applications. The best possible runout is to be ensured for the calibration measurement.



Accessory:
Reference tool
ID 560032-01

Probing strategies
The selection of the probing strategy also influences the reliability 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 inputs ENABLE 1 and ENABLE 2. The measuring cycles 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 duration 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 a DYN output signal with a defined duration of 20 ms. The positive edge is evaluated. The device is switched between "pushing" and "pulling" measurement over the ENABLE 2 input.

Mode of operation	ENABLE 1	ENABLE 2	Function
0	**0**	**0**	Inspection of individual teeth Base speed 3750 rpm 
1	**0**	**1**	Pushing measurement Base speed ≥ 0 rpm 
2	**1**	**0**	*On version for standard machines** Pulling measurement Base speed 600 to 3000 rpm 
			*On version for HSC machines** Inspection of individual teeth Base speed 42 000 rpm 
3	**1**	**1**	Pulling measurement Base speed ≥ 3000 rpm 

* Please select when ordering

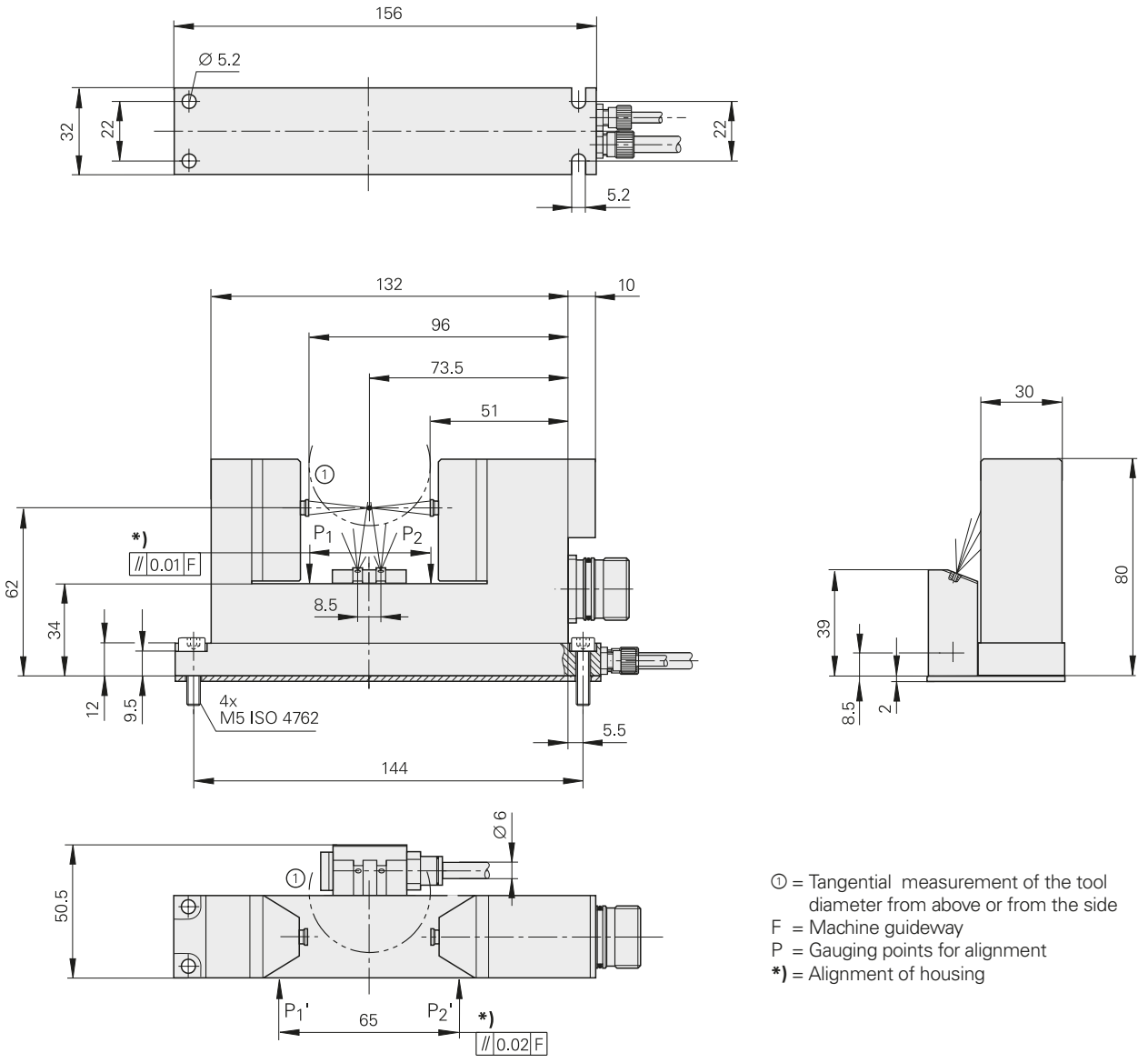
Optical status indicator
LEDs on the receiver side of the laser system make a rapid diagnosis of the status possible. In this way, the operator sees at a glance whether the laser beam path is OK, whether a dynamic trigger signal is being output, and which operating mode of the laser system is active.

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

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.

TL Nano

Laser system for tool measurement



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

mm

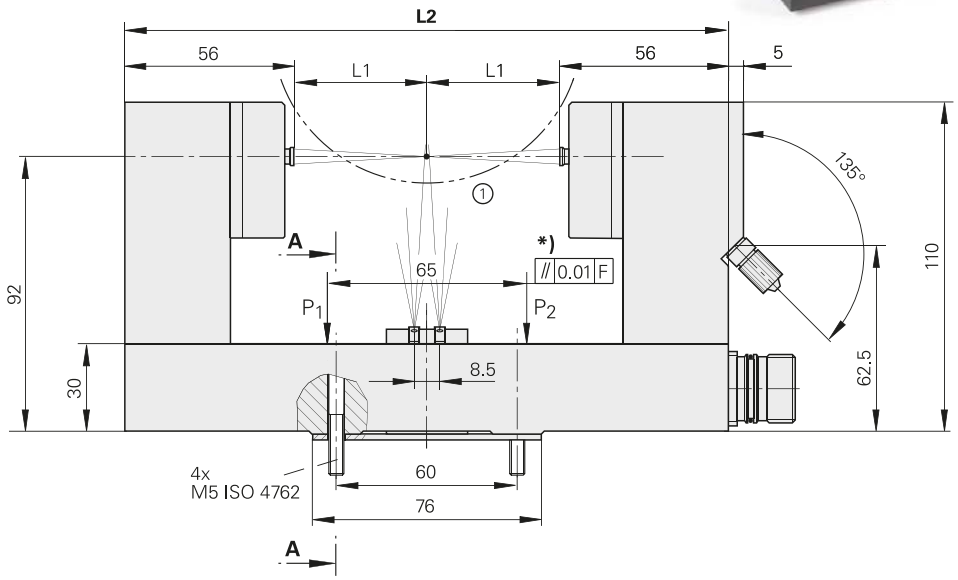
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

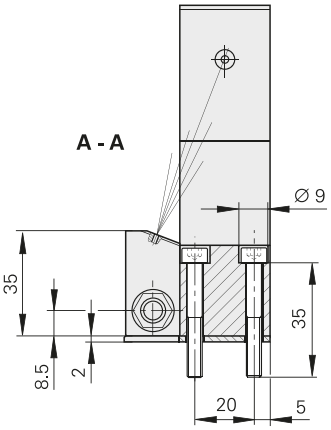
Specifications	TL Nano
Tool diameter Central measurement Tangential measurement	 0.03 mm to 37 mm 0.03 mm to 44 mm
Repeatability	± 0.2 µm
Spindle speed*	For individual tooth measurement, optimized to standard spindles or HSC spindles (> 30000 rpm)
Laser	Visible red-light laser with beam focused at center of system
Wavelength/Power	630 nm bis 700 nm/< 1 mW
Protection class IEC 825	2
Input signals	Square-wave signals DC 24 V • Enable transmitter ENABLE 0 • Enable 1 to receiver ENABLE 1 • Enable 2 to receiver ENABLE 2
Output signals	Square-wave signals DC 24 V • Dynamic triggering signal DYN • Static triggering signal STA • Proper laser function LASER OK
Voltage supply	DC 24 V/160 mA
Electrical connection	M23 flange socket (male),12-pin, at side
Mounting	Within the machine work envelope
Protection EN 60529	IP68 (when connected, with sealing air)
Tool cleaning	Blower
Operating temperature **Storage temperature**	10 °C to 40 °C 0 °C to 50 °C
Mass	≈ 0.70 kg (including blower)

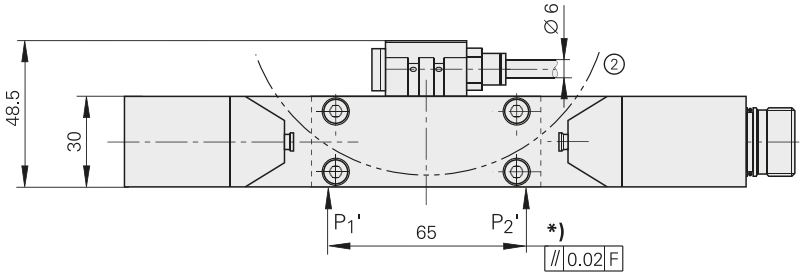
***** Please select when ordering

TL Micro

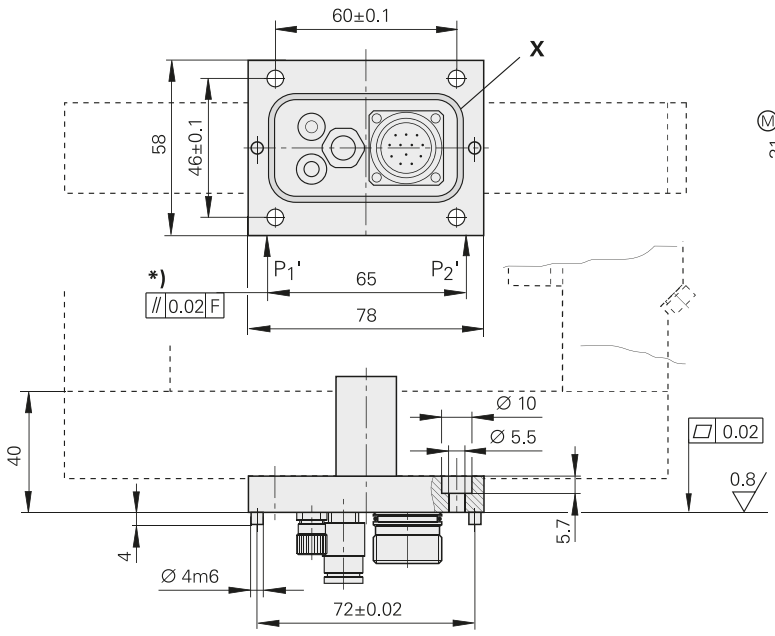
Laser system for tool measurement

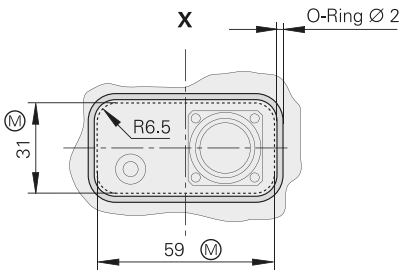






L1	L2	Model
19	150	TL Micro 150
44	200	TL Micro 200
94	300	TL Micro 300





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

mm

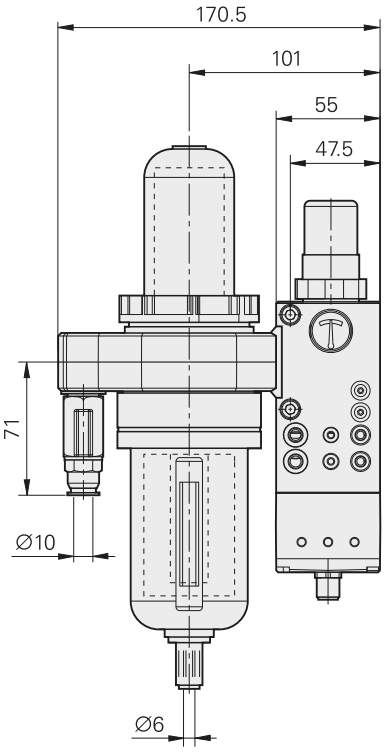
Tolerancing ISO 8015
ISO 2768 - m H
< 6 mm: ±0.2 mm

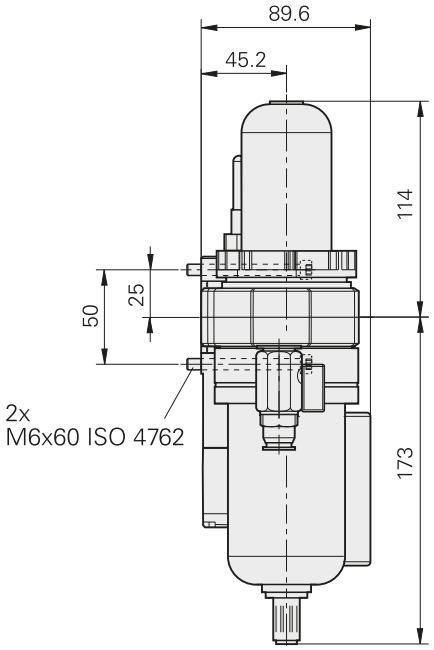
Specifications	TL Micro 150	TL Micro 200	TL Micro 300
Tool diameter Central measurement Tangential measurement from above Tangential measurement from the side	 0.03 mm to 30 mm 0.03 mm to 30 mm 0.03 mm to 30 mm	 0.1 mm to 80 mm 0.1 mm to 98 mm 0.1 mm to 122 mm	 0.1 mm to 180 mm 0.1 mm to 324 mm 0.1 mm to 428 mm
Repeatability	± 0.2 µm	± 1 µm	
Spindle speed*	For individual tooth measurement, optimized to standard spindles or HSC spindles (> 30000 rpm)		
Laser	Visible red-light laser with beam focused at center of system		
Wavelength/Power	630 nm bis 700 nm/< 1 mW		
Protection class IEC 825	2		
Input signals	Square-wave signals DC 24 V • Enable transmitter ENABLE 0 • Enable 1 to receiver ENABLE 1 • Enable 2 to receiver ENABLE 2		
Output signals	Square-wave signals DC 24 V • Dynamic triggering signal DYN • Static triggering signal STA • Proper laser function LASER OK		
Voltage supply	DC 24 V/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	IP68 (when connected, with sealing air)		
Tool cleaning	Blower		
Operating temperature **Storage temperature**	10 °C to 40 °C 0 °C to 50 °C		
Mass	Including blower		
Cable outlet lateral	≈ 0.85 kg	≈ 0.95 kg	≈ 1.15 kg
Cable outlet downward	≈ 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
Configuration	
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 bars to 6 bars
Air quality	
Air in	DIN ISO 8573-1 class 4.3.4
Air out	DIN ISO 8573-1 Class 1.3.1
Flow rate	≥ 400 l/min (without flushing/blowing feature)
Connections	
Compressed air inlet	G 3/8“
Compressed air outlet	Quick disconnects for • Sealing air: Ø 6 mm • Flusher/blower: Ø 6 mm • Sealing unit: Ø 4 mm
Mass	≈ 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

Voltage supply

Cable-connected touch probes
The cable-connected TS 260, TS 248 and TT 160 touch probes, the SE transmitter/receiver unit, and the TL laser systems are powered by the control. The maximum cable lengths shown in the specifications apply for HEIDENHAIN cables.

Wireless touch probes
The **TS 460, TS 642, TS 740** and **TT 460** touch probes are powered by two batteries (rechargeable or nonrechargeable) with a rated voltage of 1 V 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. An operating time of 400 h assumes use over 12 months in triple-shift operation and 5 % usage rate.

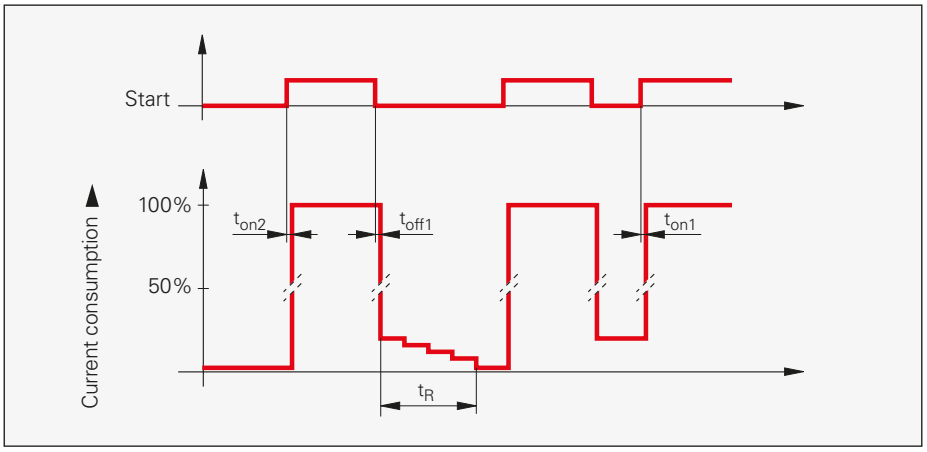
The touch probe electronics automatically detect the type of batteries used. If the battery capacity falls below 10 %, the SE transmits a warning to the control. For operation with rechargeable batteries, the touch probes are provided with deep discharge protection: the probe switches off before the battery charge is exhausted.

The TS 460 and TT 460 touch probes feature intelligent battery management in order to minimize current consumption. The touch probe switches in steps to the stand-by condition: The longer a touch probe has been switched off, the less current it consumes. Activating a touch probe from a low standby level takes only a split second longer. This ensures high, application-oriented availability.

When switched off, the TS 642 and TS 740 touch probes go into stand-by mode, and after eight hours, to the sleep mode. You must then take a longer startup time into account when reactivating the touch probe (see *Switching the TS 642/TS 740 on/off*).

	Battery size	Operating time[1]		
		Lithium battery	Alkaline battery	NiMH battery
TS 460 **TT 460**	$^1/_2$ AA	400 h	120 h	90 h
TS 642	C	800 h	400 h	250 h
	A[2]	400 h	200 h	125 h
TS 740	C	500 h	220 h	140 h
	A[2]	250 h	110 h	70 h

[1] **Note:** These are approximate values that can vary by manufacturer.
[2] Via adapter



TS 460/TT 460 current consumption

Signal times
Switch-on delay
- From stand-by mode: t_{on1} typically 1 s
- From reduced consumption mode: t_{on2} typically 0.25 s

Switch-off delay
- With infrared transmission: $t_{off1} < 1$ s
- With radio transmission: $t_{off1} < 1$ s

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.

Configuration
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.

Procedure
After inserting the TS 444 touch probe, the high-power capacitors are charged through 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 capacitors are fully charged, the TS 444 is ready for 120 seconds of continuous operation. The battery warning signal indicates that the capacitors need to be recharged.

Requirements for compressed air quality
The air turbine generator can operate at pressures as low as 2 x 10^5 Pa. An operating pressure between 5.5 x 10^5 and 8 x 10^5 Pa is recommended. The compressed air does not need to be specially cleaned.

10^5 Pa ≙ 1 bar

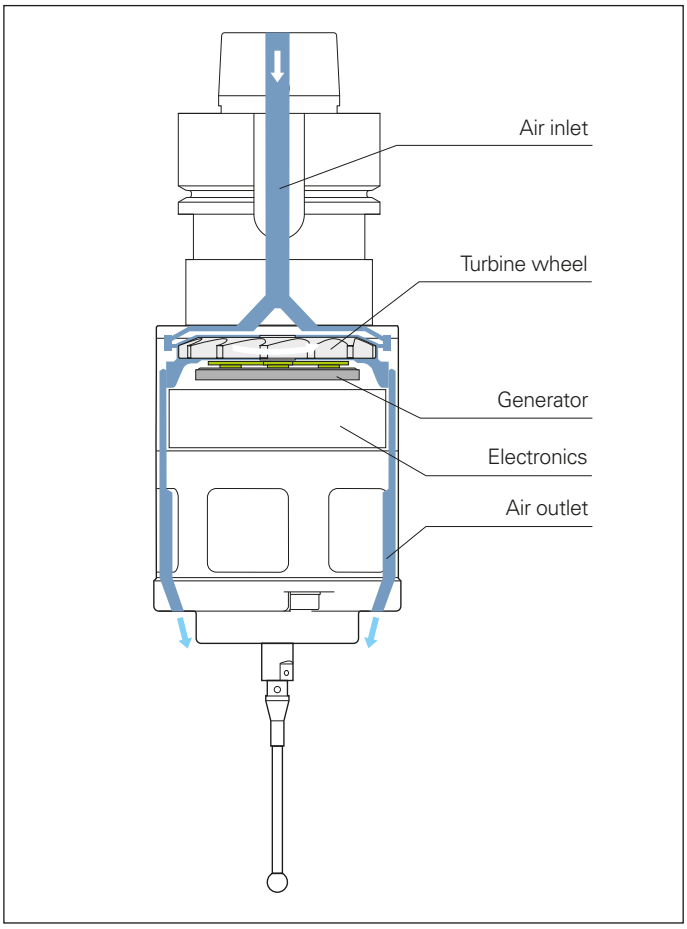
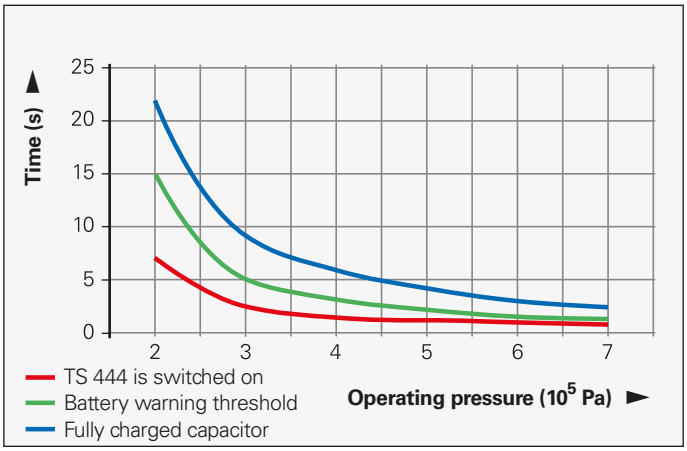


Illustration of turbine and air inlet/outlet (principle)



Charging time as a function of supplied pressure

Interfaces
TS, TT touch probes

Please refer to the *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure.

Touch probes with signal transmission by cable

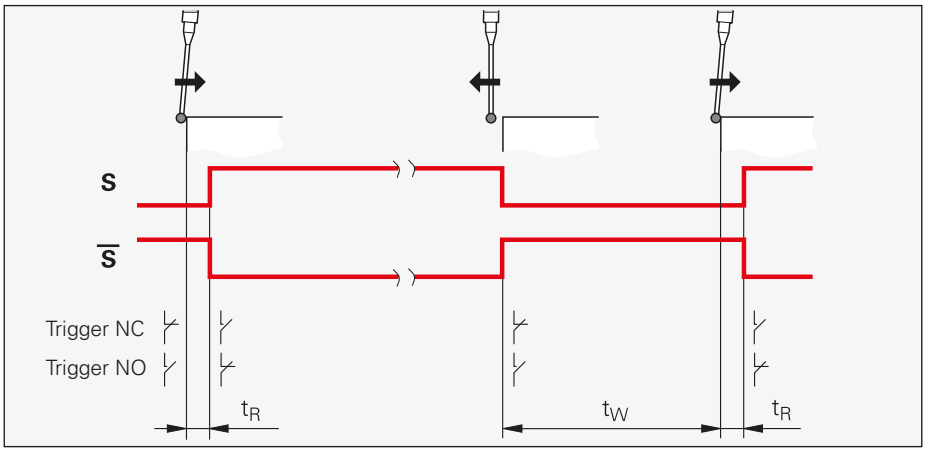
When the stylus of the **TS 260 and TS 248** or the probe contact of the **TT 160** is deflected, it triggers a square-wave signal **S** and its inverted signal $\overline{S}$.

HTL signal levels S, $\overline{S}$
$U_H \geq (U_P - 2.2\,V)$ at $-I_H \leq 20$ mA
$U_L \leq 1.8$ V at $I_L \leq 20$ mA

In addition, the TS 260, TS 248 and TT 160 touch probes feature two floating switching outputs (**Trigger NO** and **Trigger NC**), which serve as normally closed contact and normally open contact via optocoupler.

Load capacity of optocoupler
$U_{max} \leq 15$ V
$I_{max} \leq 50$ mA
$\Delta U \leq 1$ V (typically 0.3 V at I = 50 mA)

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.



Trigger signal for TS 260/TS 248/TT 160
Response time $t_R \leq 10$ µs
Repeat interval $t_W > 25$ ms

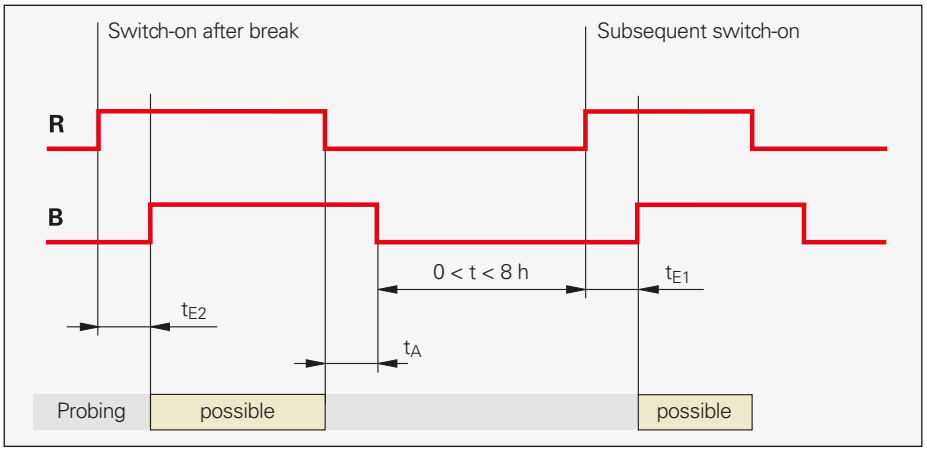
Touch probes with wireless signal transmission

The **TS 460, TS 740** and **TT 460** 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 the microswitch integrated in the taper shank.

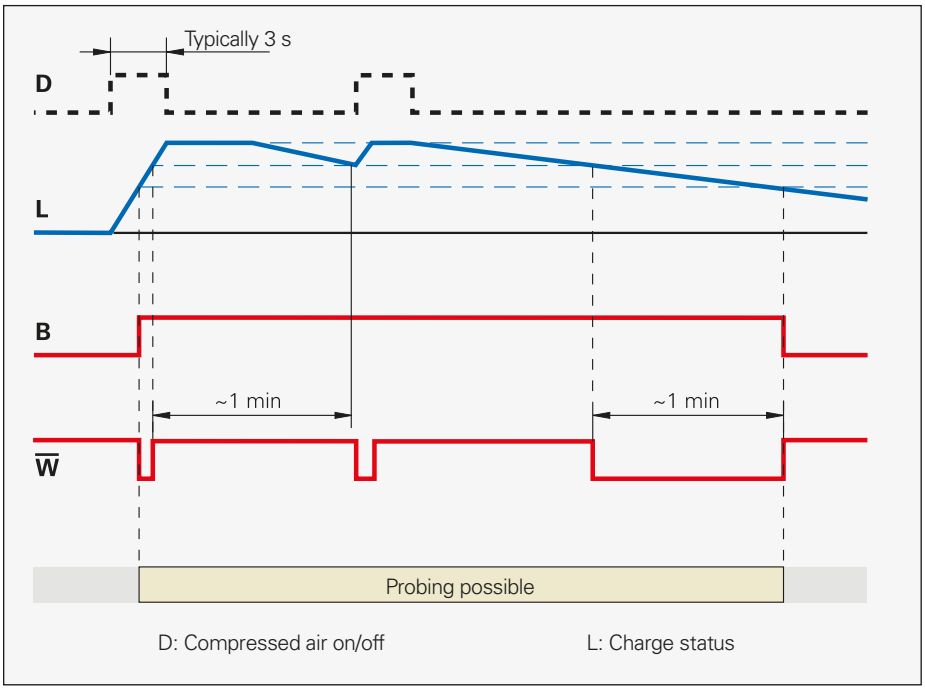
The SE uses the **ready signal B** to report to the control that the touch probe is activated and within the reception area of the SE. The workpiece can now be probed.

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 (1000 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 s. If the touch probe does not respond, the SE aborts the switch-on/off attempt after 3.5 s.



Switching the TS 460/TS 740/TT 460 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 is switched 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.

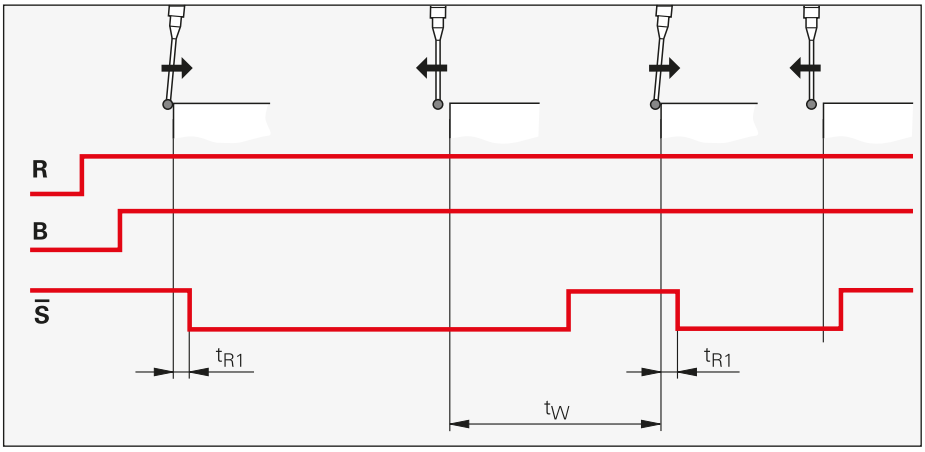


Signal sequence of TS 444

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

Signal times
Response time t_{R1}
- With infrared transmission: 0.2 ms
- With radio transmission: 10 ms

Repeat interval t_W > 25 ms



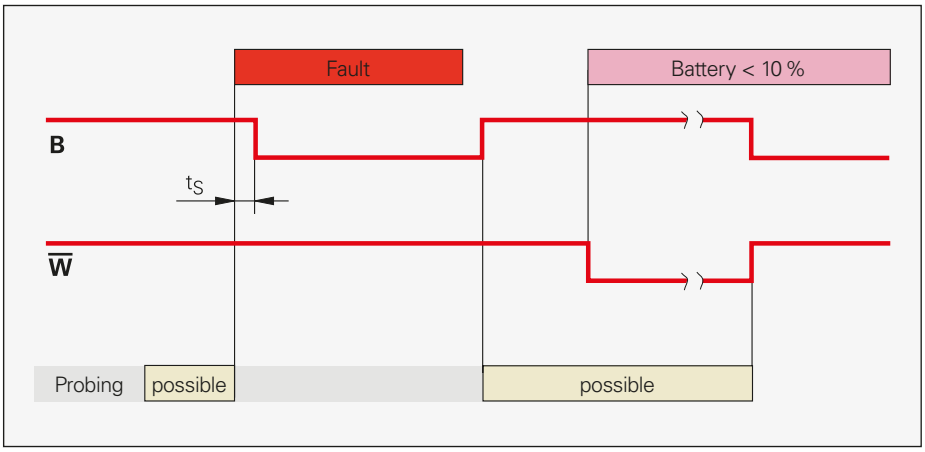
Probing with TS 460/TS 642/TS 740/TT 460

In the event of a disturbance, the ready signal B is reset. The response time between occurrence of the disturbance and the resetting of the ready signal depends on the type of signal transmission.

Signal times
Response time for interrupted signal transmission t_S
- With infrared transmission: ≤ 40 ms
- With radio transmission: ≤ 55 ms

Response time for collision (with collision protection adapter) t_S
- With infrared transmission: ≤ 40 ms
- With radio transmission: ≤ 20 ms

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



Behavior during disturbance and battery warning

⊓⊔ HTL signal levels
R
U_H = (10 V ... 30 V) at I_H ≤ 4 mA
U_L ≤ 2 V at $-I_L$ ≤ 0.1 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

TL, DA 301 TL laser systems

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

The **enable transmitter 0** (ENABLE 0) signal 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 1** and **2** (ENABLE 1 and ENABLE 2) signals determine the operating mode of the laser light barrier depending on the respective measuring cycle.

Signal levels:
U_H = 24 V at 15 mA

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

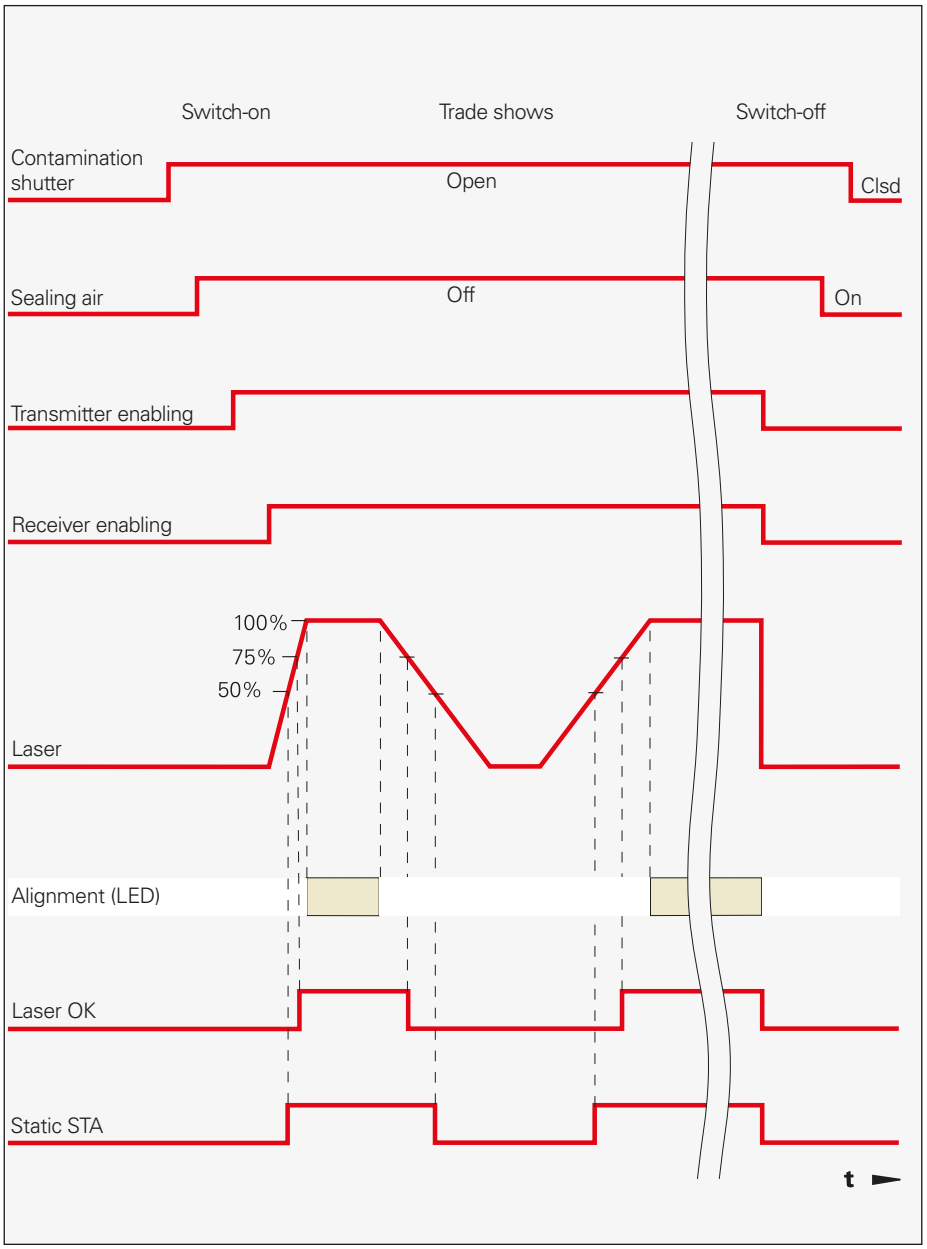
After the transmitter and receiver are enabled, the laser system provides the information **"Laser OK"** if the luminance at the receiver is at least 75 % of the maximum.

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.

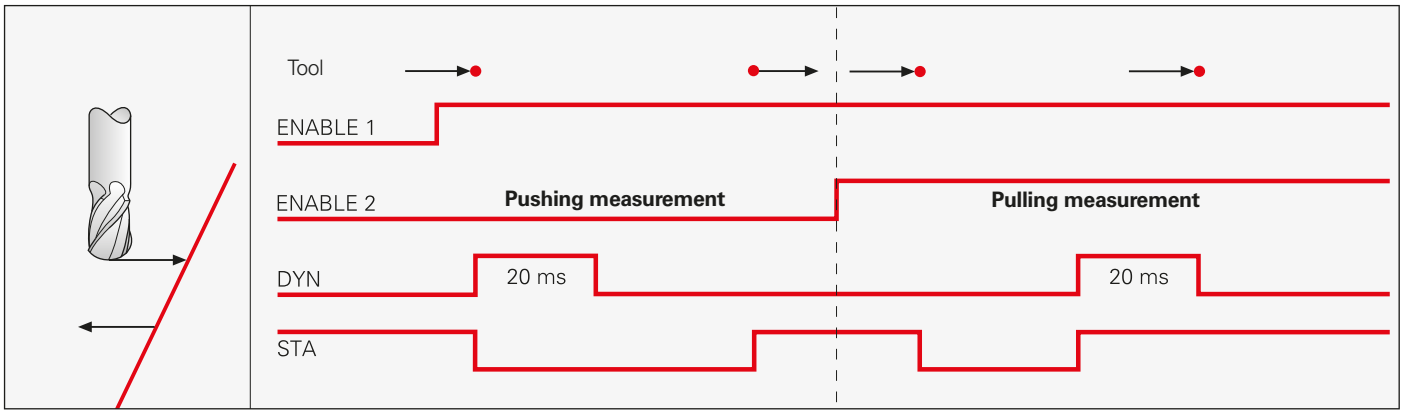
Signal levels:
U_H = 24 V at 50 mA



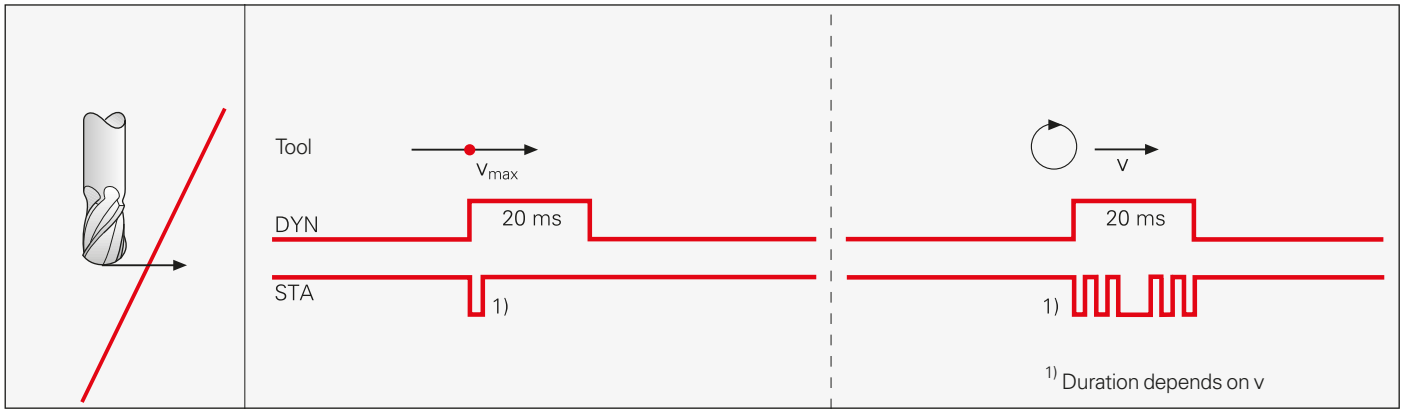
Switch-on/switch-off behavior

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 with the DA 301 TL.

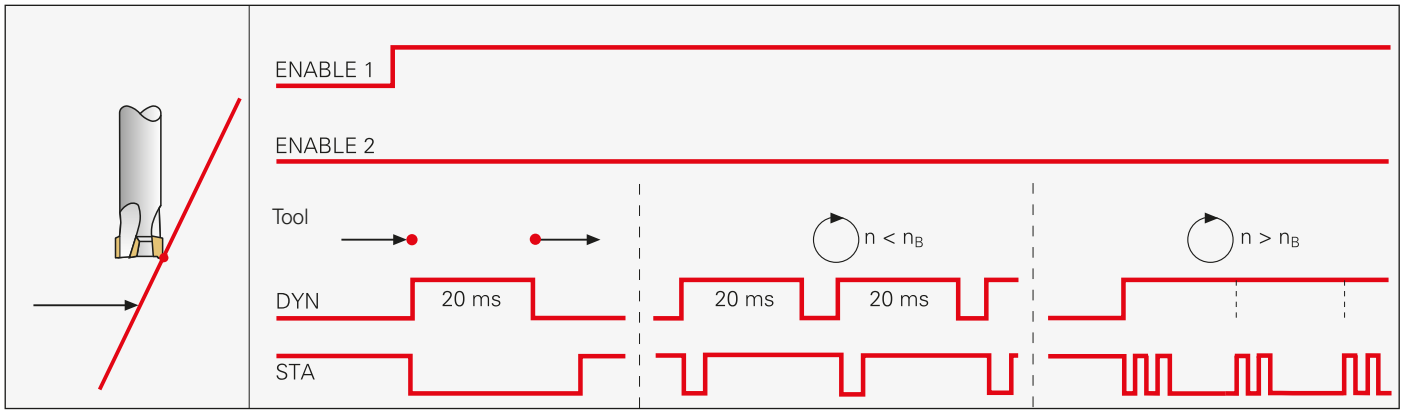
Signal levels:
U_H = 24 V at 71 mA



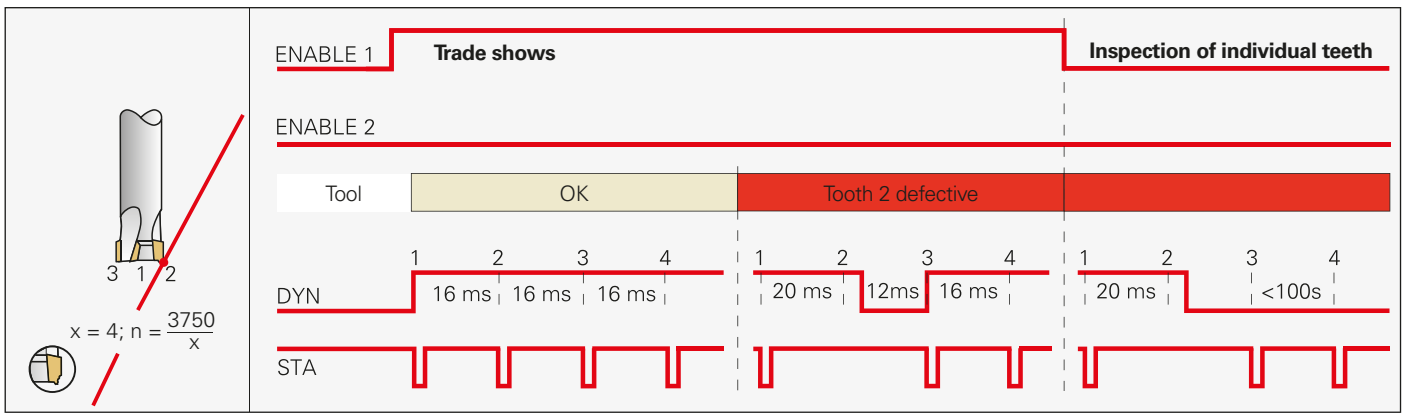
Output signals during length and radius measurement for pushing and pulling measurement



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

Connection to CNC controls

HEIDENHAIN touch probes feature universal interfaces that permit connection with practically all relevant CNC controls for machine tools. Where necessary, HEIDENHAIN offers UTI interface electronics and optional software packages to supplement the touch probe cycles in the control. This ensures a reliable connection and functional application of HEIDENHAIN touch probes regardless of the make of the control.

CNC	Touch probes	Control input	Interface required	Cycles	
				CNC internal	Separate software from HEIDENHAIN
HEIDENHAIN TNC 640 TNC 620 iTNC 530 TNC 320 TNC 128	*Cable:* TS 248 TS 260 TT 160 *Radio/infrared:* TS 460 TT 460 Via SE 660	*HSCI:* X112, X113	–	**Workpiece measurement** • Workpiece alignment • Datum setting • Workpiece measurement **Tool measurement** • Length, radius • Wear, breakage • Individual teeth	–
		Other: X12, X13	– [1]		
Siemens 828D 840D 840D sl	*Infrared:* TS 460 TS 444 TS 642 TS 740 TT 460 Via SE 642, SE 540	X121, X122 or X132	–	**Workpiece measurement** • Workpiece alignment • Datum setting • Workpiece measurement **Tool measurement** • Length, radius • Wear, breakage	
Fanuc 0 0i 16 18 21 30 31 32		*Recommended:* HIGH SPEED SKIP	UTI 491 (only for connection of an SE)	–	**Workpiece measurement** • Workpiece alignment • Datum setting • Workpiece measurement **Tool measurement** • Length, radius • Wear, breakage
		Possible: SKIP (24 V)	–		
Mitsubishi M70/M700 series M64/M640 series		SKIP (24 V)		**Basic cycle** for • Setting a datum • Tool length	
Mazak Mazatrol Fusion Mazatrol Matrix Mazatrol Smart					

[1] UTI 240 required if TS 460 and TT 460 are operated together

Interface electronics for integration

To adapt the touch probe signals to the CNC control, a UTI interface unit might be required under certain circumstances. This applies in particular for connecting SE transmitter/receiver units to Fanuc controls or for retrofitting old CNC controls with a touch probe.

UTI 491
Die UTI 491 interface unit is a simple optocoupler relay. It serves to galvanically isolate the touch probes at the High Speed Skip input from Fanuc controls.

ID 802467-01

UTI 192
The UTI 192 interface unit is used when additional adaptation is required, such as logical gating of signals or automatic starting of a touch probe, etc., that cannot be realized in the CNC control. The UTI 192 is therefore usually used for retrofitting touch probes (see the product overview *Touch Probes for Retrofitting on Machine Tools*).

ID 579092-01

UTI 240
The UTI 240 interface unit is required when the TS and TT are to be retrofitted with a common SE on the TNC 320 or other old HEIDENHAIN controls. It distributes the TS and the TT signals to the corresponding inputs of the TNC and sets up a connection to the PLC for starting the TT and transmitting the warning signal.

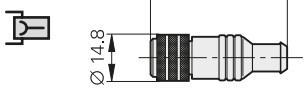
ID 658883-01

Connecting elements and cables
General information

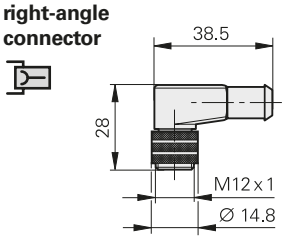
Connector insulated: Connecting element with coupling ring, available with male or female contacts (see symbols).

Symbols

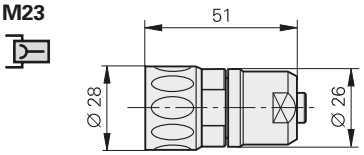
M12



M12 right-angle connector



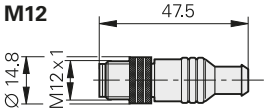
M23



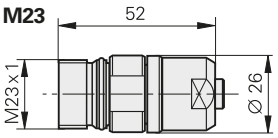
Coupling insulated: Connecting element with outside thread, available with male or female contacts (see Symbols).

Symbols

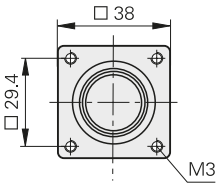
M12



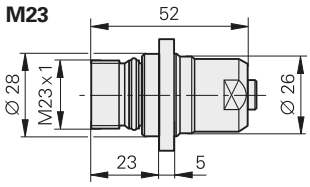
M23



Mounted coupling with flange



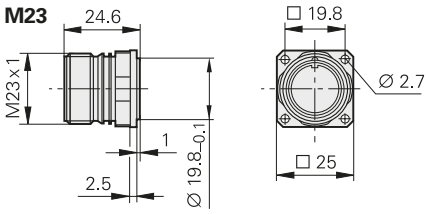
M23



Flange socket: With external thread; permanently mounted on a housing, available with male or female contacts.

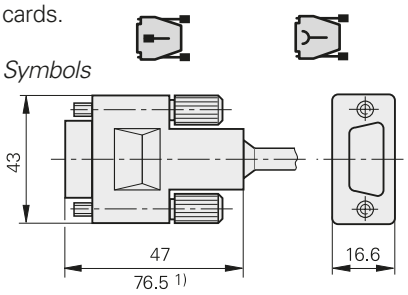
Symbols

M23



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

Symbols



1) Interface electronics integrated in connector

The **pin numbering** on connectors is in the direction opposite to those on couplings or flange sockets, regardless of whether the connecting elements have

male contacts or

female contacts.

When engaged, the connections provide **protection** to IP67 (D-sub connector: IP50; EN 60529). When not engaged, there is no protection.

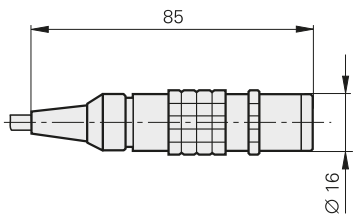
Accessory for flange sockets and M23 mounted couplings

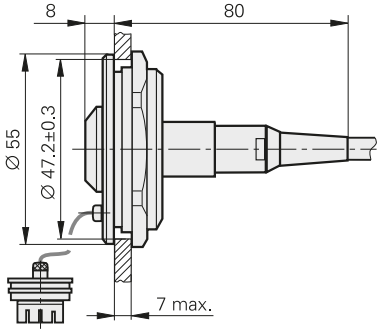
Threaded metal dust cap
ID 219926-01

Accessory for M12 connecting element Insulation spacer
ID 596495-01

Quick disconnect: Compact connector with push/pull lock

Symbol



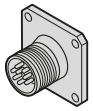
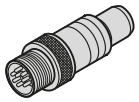


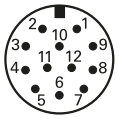
You will find information on cable routing and bend radii under *General electrical information* in the *Interfaces of HEIDENHAIN encoders* brochure.

TS, TT, and SE pin layouts

SE 660, SE 642

12-pin flange socket or coupling M12

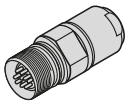


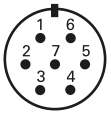
	Voltage supply		Signals									
	1	**12**	**11**	**5**	**2**	**10**	**3**	**4**	**6**	**9**	**7**	**8**
	U_P	**0 V**	**R(TS)**	**R(TT)**	**B(TS)**	**B(TT)**	**S**	**$\overline{S}$**	**$\overline{W}$**	**/**	**/**	**/**
	Brown/ Green	White/ Green	Blue	White	Green	Brown	Gray	Pink	Violet	Yellow	Red	Black

External shield is on housing. Unused pins or wires must not be engaged.
U_P = Voltage supply; **R** = Start signal; **B** = Ready signal; **S, $\overline{S}$** = Trigger signal; **$\overline{W}$** = Battery warning

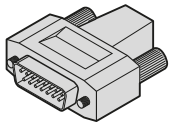
SE 540 (adapter cable)

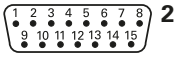
7-pin coupling, M23

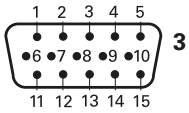




15-pin D-sub connector, 2 or 3 rows





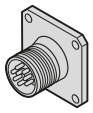


	Voltage supply			Signals			
	2	**1**	**7**	**3**	**5**	**4**	**6**
2	**5**	**8**	**1**	**4**	**3**	**10**	**7**
3	**10**	**9**	**/**	**6**	**3**	**2**	**4**
	U_P	**0 V**	**Internal shield**	**R**	**B**	**$\overline{S}$**	**$\overline{W}$**
	Brown	White	White/Brown	Yellow	Gray	Green	Blue

External shield is on housing. Unused pins or wires must not be engaged.
U_P = Voltage supply; **R** = Start signal; **B** = Ready signal; **$\overline{S}$** = Trigger signal; **$\overline{W}$** = Battery warning

TS 248, TS 260, TT 160

8-pin connector , M12

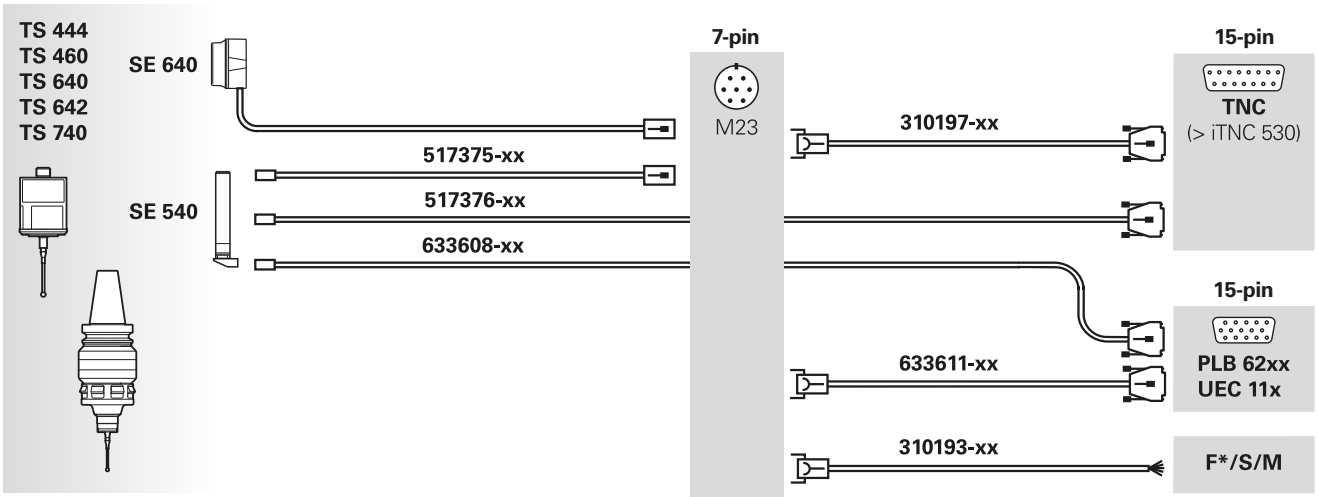


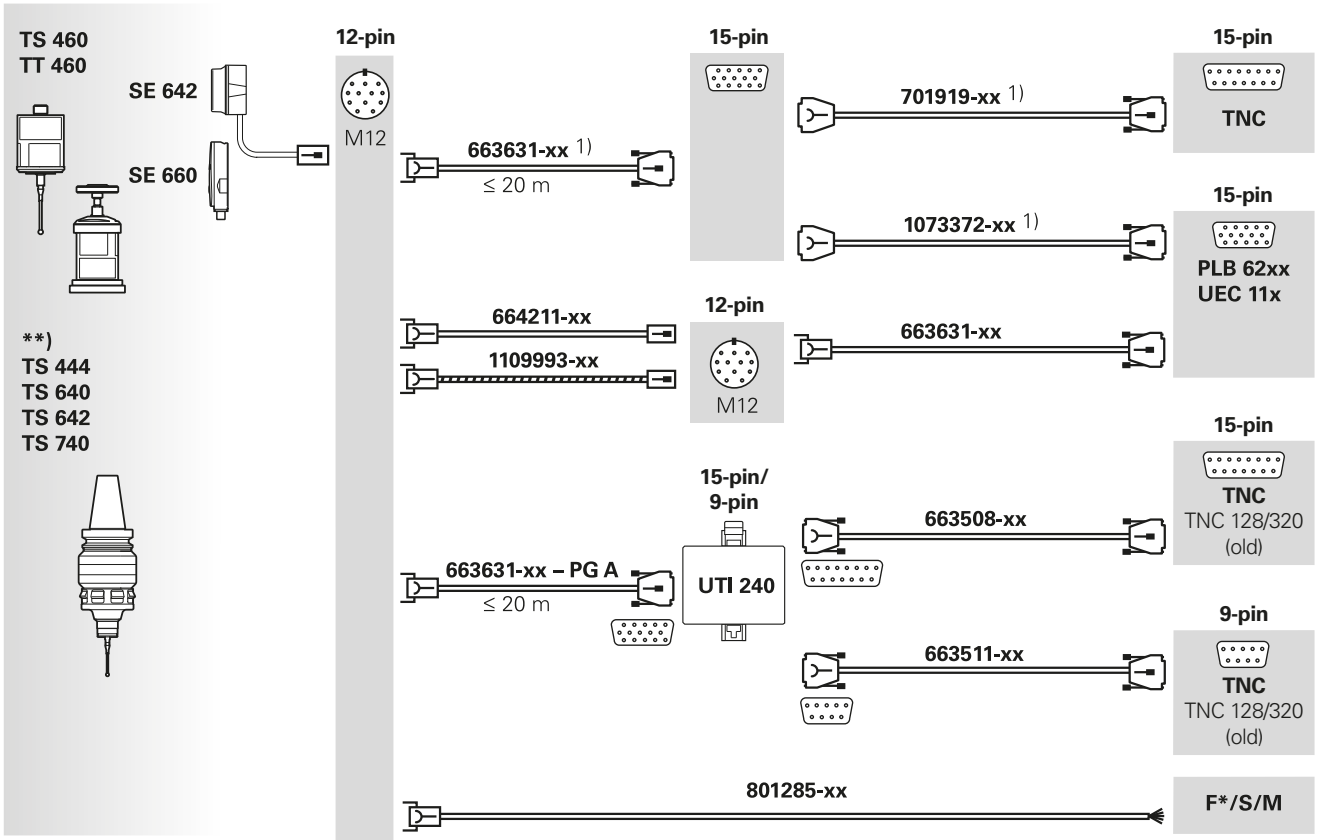
	Voltage supply		Signals					
	2	**7**	**3**	**4**	**1**	**5**	**6**	**8**
	U_P	**0 V**	**S**	**$\overline{S}$**	**B**	**Trigger** NO	**Trigger** NC	**Trigger** 0 V
	Blue	Violet	Gray	Pink	White	White/Green	Yellow	Brown/Green

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

Please note: Important information on electrical connection, voltage supply and cable routing is available under *General electrical information* in the *Interfaces of HEIDENHAIN Encoders* brochure.

SE 660, SE 642, SE 540 connecting cables

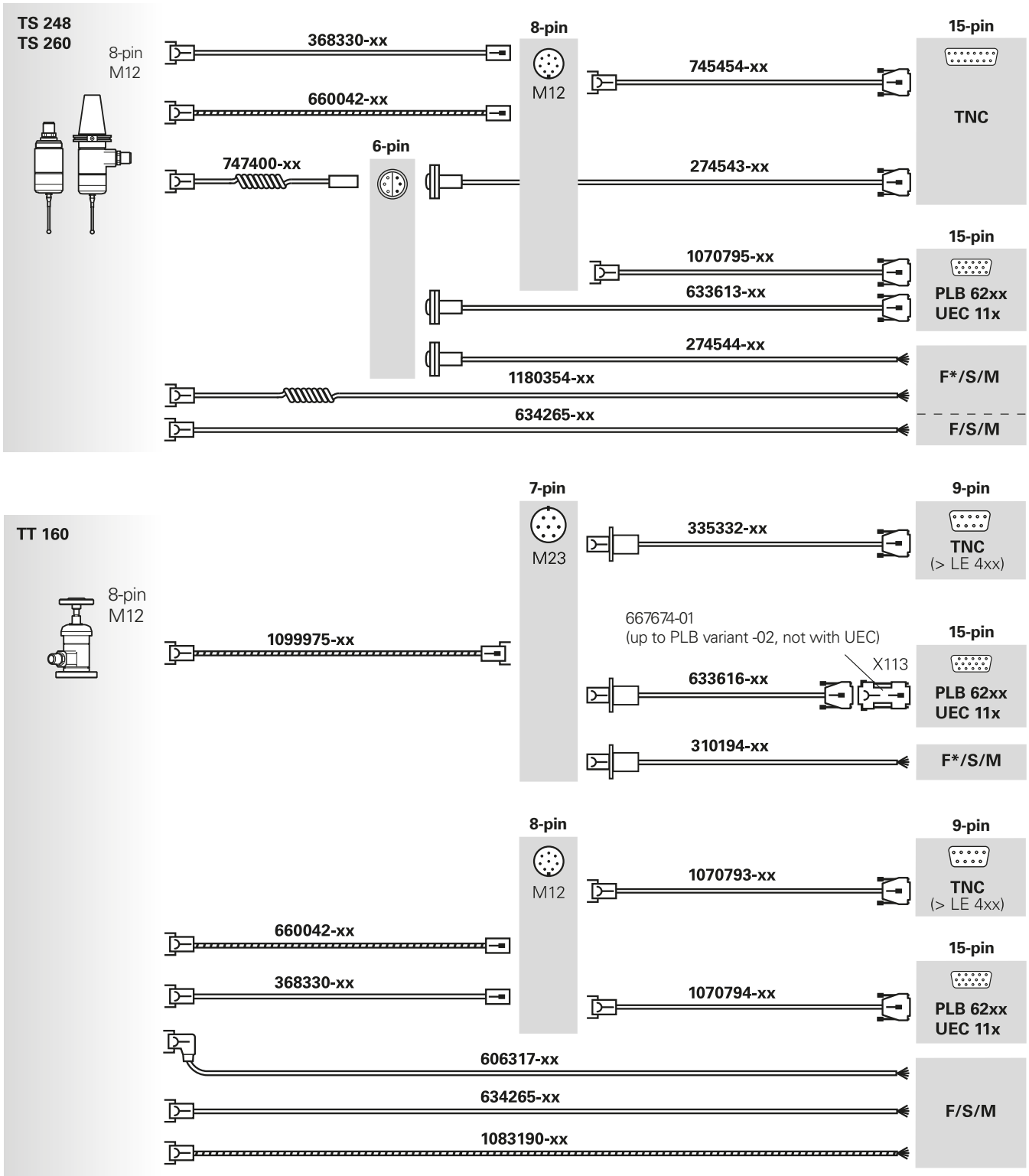




1) If total cable length is greater than 20 m, use ID 663631-xx for the first max. 10 m and for the remaining length use ID 701919-xx/1073372-xx.

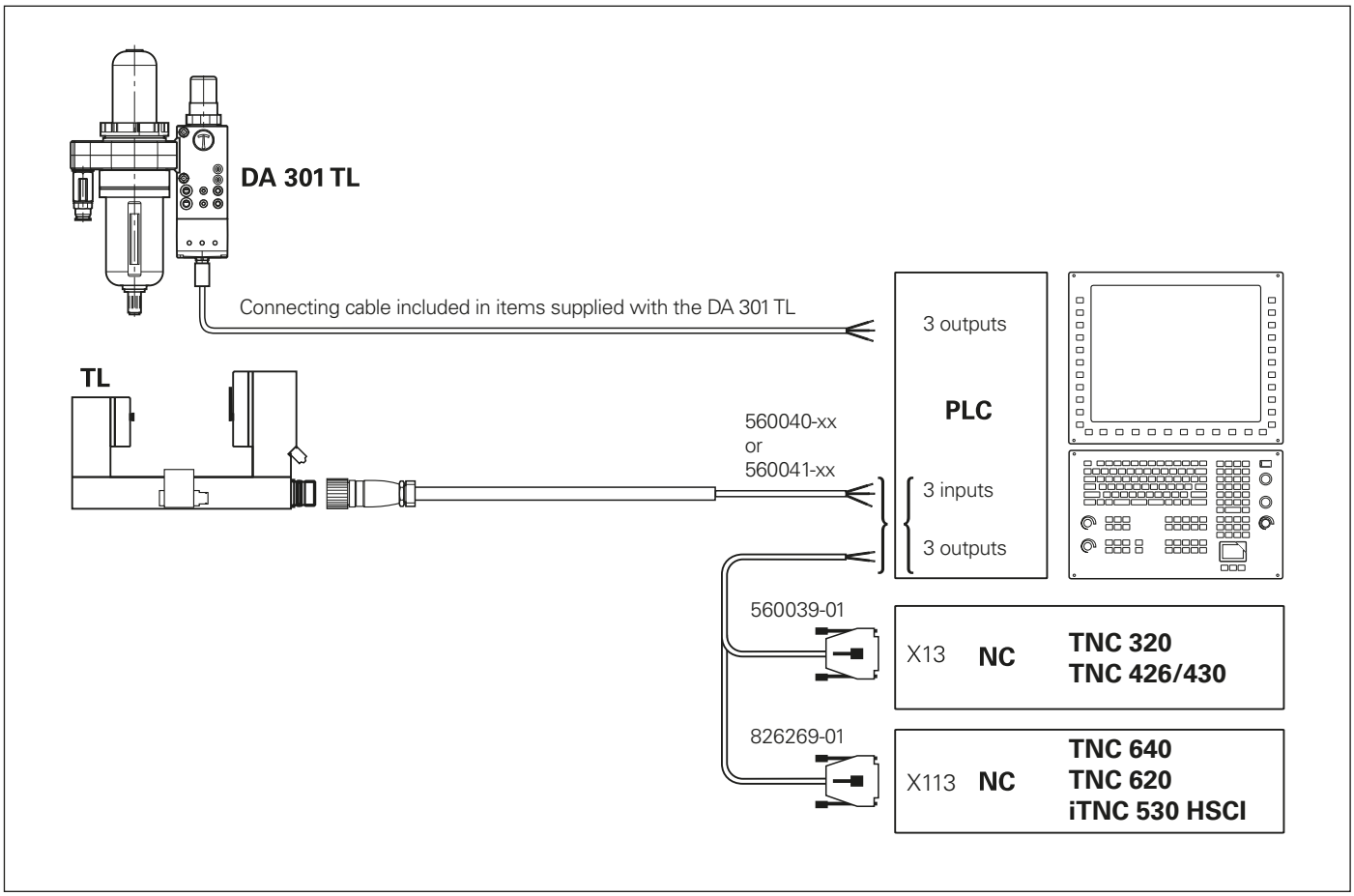
****)TS 444/64x/740** not possible in connection with **SE 660**.
F/S/M = Fanuc/Siemens/Mitsubishi/Mazak, **F*** Fanuc High Speed Skip via UTI 491

TS 248, TS 260, TT 160 connecting cables

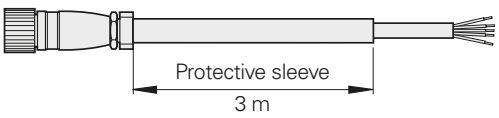


F/S/M = Fanuc/Siemens/Mitsubishi/Mazak, **F*** Fanuc High Speed Skip via UTI 491

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 length 5 m
With one D-sub connector (male), 9-pin
Integrated interface for TNC 320/426/430, iTNC 530

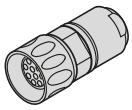
ID 560039-01

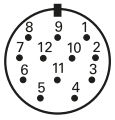
With one D-sub connector (male), 15-pin, 3-row
Integrated interface for TNC 620/640, iTNC 530 HSCI

ID 826269-01

TL laser system

12-pin connector M23





	Voltage 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

	Channel inputs	
	0 V	**DYN**
	White	Brown

3-pin connector

	Outputs		
	Trigger signal	**0 V**	**Protective conductor**
	Black	Black	Yellow/Green

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