Length Gauges
Length gauges from HEIDENHAIN provide high accuracy over long measuring ranges. They are also robust and practical. They can be used in a wide range of applications, including production metrology, multi-gauging fixtures, measuring equipment monitoring, and position measurement.

This brochure supersedes all previous editions, which thereby become invalid. The basis for ordering from HEIDENHAIN is always the brochure edition valid when the order is placed.

Further information:
For detailed descriptions of all available interfaces, cables, and connecting elements, as well as general electrical information, please refer to the interfaces of HEIDENHAIN Encoders and the Cables and Connectors brochures.

* After linear length error compensation in the evaluation electronics.
Areas of application
In quality assurance

Metrology and production control

Length gauges from HEIDENHAIN play a role in incoming goods inspection, fast dimension checking during production, statistical process control in production or quality assurance, or in any application where fast, reliable and accurate length measurement is required. Their large measuring lengths are a particular advantage: whether the part measures 5 mm or 95 mm, it is measured immediately with one and the same length gauge.

Whatever the application, HEIDENHAIN has the appropriate length gauge for the required accuracy. The HEIDENHAIN-CERTO length gauges offer a very high accuracy of ±0.1 µm/±0.05 µm/±0.03 µm* for extremely precise measurement. Length gauges from the HEIDENHAIN-METRO program have accuracy grades as fine as ±0.2 µm, while the HEIDENHAIN-SPECTO length gauges, with ±1 µm accuracy, offer particularly compact dimensions.

* After linear length-error compensation in the evaluation electronics

Gauge block calibration and measuring device inspection

The regular inspection of measuring equipment called for by standards, and the inspection of gauge blocks in particular, necessitate a large number of reference standard blocks if the comparative measurement is performed using inductive gauges. The problem is the small measuring range of inductive gauges: they can measure length differences of only up to 10 µm. Length gauges, which offer large measuring ranges together with high accuracy, greatly simplify the calibration of measuring devices required to ensure traceability.

The length gauges of the HEIDENHAIN-CERTO product portfolio with measuring ranges of 25 mm with ±0.1 µm/±0.05 µm/±0.03 µm* accuracy and 60 mm with ±0.1 µm/±0.05 µm* accuracy are especially well suited for this task. They permit a significant reduction in the required number of reference standard blocks, and recalibrating becomes much simpler.

In production metrology

Multi-gauging fixtures

Multi-gauging fixtures require durable length gauges with small dimensions. They should also have relatively large measuring ranges of several millimeters with consistent linear accuracy in order to simplify the construction of inspection devices—for example by enabling the construction of one device for several masters. A large measuring length also provides benefits in master production, because simpler masters can be used.

Thanks to their small dimensions, the HEIDENHAIN-ACANTO absolute length gauges, like the HEIDENHAIN-SPECTO incremental length gauges, are specially designed for multi-gauging fixtures. They feature accuracy grades of down to ±1 µm over measuring ranges up to 30 mm. More stringent accuracy requirements of down to ±0.2 µm can be met with similarly compact HEIDENHAIN-METRO length gauges.

Unlike inductive gauges, HEIDENHAIN length gauges provide stable measurement over long periods—eliminating recalibration.

Position measurement

Length gauges from HEIDENHAIN are also ideal for position measurement on precision linear slides and X-Y tables. Working with measuring microscopes, for example, becomes much easier thanks to the digital readout and the flexible datum setting.

Here, length gauges from the HEIDENHAIN-METRO and HEIDENHAIN-SPECTO program come into use with large measuring ranges of 30 mm, 60 mm or 100 mm at consistently high accuracy grades of ±0.5 µm or ±1 µm.

In this application as a linear measuring device, the length gauge’s fast installation in accordance with the Abbe measuring principle by its clamping shank or plane mounting surface is of special benefit.
Length gauges from HEIDENHAIN

Wide range of applications
HEIDENHAIN length gauges are suited for many applications. Automatic inspection equipment, manual measuring stations or positioning equipment—wherever lengths, spacing, thickness, height, or linear motion are to be measured, HEIDENHAIN length gauges function quickly, reliably, and accurately.

Long measuring ranges
HEIDENHAIN length gauges are available for measuring ranges of 12 mm, 25 mm, 30 mm, 60 mm, or 100 mm. This lets you measure a wide variety of parts with a single measuring setup without frequently changing cost-intensive gauge blocks or masters.

Absolute position measurement
The HEIDENHAIN-ACANTO length gauges operate with absolute measurement over a range of 12 mm or 30 mm and with high repeatability. Their particular advantage is that the measured value is available immediately after switch-on.

Expertise
The high quality of HEIDENHAIN length gauges is no coincidence. HEIDENHAIN has been manufacturing high-accuracy scales for over 70 years, and for many years it has developed measuring and testing devices for length and angle measurement for national standards laboratories. This know-how makes HEIDENHAIN an extraordinarily qualified partner for metrology questions.

Worldwide presence
HEIDENHAIN is represented in all important industrial countries—in most of them with wholly owned subsidiaries. Sales engineers and service technicians support the user on-site with technical information and servicing in the local language.

High accuracy
The high accuracy of HEIDENHAIN length gauges applies over the entire measuring range. Regardless of whether the part measures 10 mm or 100 mm, its actual dimensions are always measured with the same high quality. The high repeatability of HEIDENHAIN length gauges is beneficial during comparative measurements, such as in serial production.

The HEIDENHAIN-CERTO length gauges, in particular, exhibit high accuracy and offer nanometer-level resolution.

Robust design
HEIDENHAIN length gauges are built for an industrial environment. Their long-term consistent accuracy and high thermal stability make them ideal for use in production equipment and machines.

Length gauges from HEIDENHAIN feature high accuracy over long measuring ranges. These sensors are used whenever lengths need to be measured with speed, reliability, and accuracy.
### Overview of length gauges

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<th>Measuring range</th>
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<th>60 mm</th>
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<td>±0.1 µm</td>
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<td>ST 3087 1 Vpp</td>
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<td>ST 1288 1 Vpp</td>
<td>ST 3078 TTL</td>
<td>ST 3088 1 Vpp</td>
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</tbody>
</table>

*) After linear length error compensation in the evaluation electronics
Measuring standard

HEIDENHAIN length gauges are characterized by long measuring ranges and consistently high accuracy. The basis for both is the photoelectrical scanning principle.

HEIDENHAIN length gauges use material measuring standards consisting of absolute or incremental graduations on substrates of glass or glass ceramic. These measuring standards permit large measuring ranges, are insensitive to vibration and shock, and have a defined thermal behavior. Changes in atmospheric pressure or relative humidity have no influence on the accuracy of the measuring standard—which is the prerequisite for the high long-term stability of HEIDENHAIN length gauges.

HEIDENHAIN manufactures the precision graduations in specially developed, photolithographic processes.

- ALRODUR: matte-etched lines on gold-plated steel tape with typical graduation period of 40 µm
- METALLUR: contamination-tolerant graduation of metal lines on glass, with typical graduation period of 20 µm
- DIADUR: extremely robust chromium lines on glass (typical graduation period of 20 µm) or three-dimensional chromium structures (typical graduation period of 8 µm) on glass
- SUPRADUR phase grating: optically three-dimensional, planar structure; particularly tolerant to contamination; typical graduation period of 8 µm and finer
- OPTODUR phase grating: optically three-dimensional, planar structure with particularly high reflectance, typical graduation period of 2 µm and finer

Along with these very fine grating periods, these processes permit a high definition and homogeneity of the line edges. Together with the photoelectric scanning method, this high edge definition is a precondition for the high quality of the output signals.

The master graduations are manufactured by HEIDENHAIN on custom-built high-precision dividing engines.

Measurement procedure

With the incremental measuring method, the graduation consists of a periodic grating structure. The position information is obtained by counting the individual increments (measuring steps) from some point of origin. Since an absolute reference is required to ascertain positions, the measuring standard is provided with an additional track that bears a reference mark. The absolute position on the scale, established by the reference mark, is gauged with exactly one signal period.

The reference mark must therefore be scanned to establish an absolute reference or to find the last selected datum.

With the absolute measuring method, the position value is available from the encoder immediately upon switch-on and can be called at any time by the subsequent electronics. There is no need to move the axes to find the reference position. The absolute position information is read from the measuring standard, which is formed from a serial absolute code structure. A separate incremental track is interpolated for the position value and at the same time—depending on the interface version—is used to generate an optional incremental signal.

Photoelectric scanning principle

Most HEIDENHAIN encoders operate using the principle of photoelectric scanning. Photoelectric scanning of a measuring standard is contact-free, and as such, free of wear. This method detects even very fine lines, no more than a few micrometers wide, and generates output signals with very small signal periods.

The finer the grating period of a measuring standard is, the greater the effect of diffraction on photoelectric scanning. HEIDENHAIN linear encoders use two scanning principles:

- The imaging scanning principle for grating periods of 20 µm and 40 µm
- The interferential scanning principle for very fine graduations with grating periods of, for example, 8 µm.

Imaging principle

To put it simply, the imaging scanning principle functions by means of projected light signal generation: two scale gratings with equal or similar grating periods are moved relative to each other—the scale and the scanning reticle. The carrier material of the scanning reticle is transparent, whereas the graduation on the measuring standard may be applied to a transparent or reflective surface.

When parallel light passes through a grating, light and dark surfaces are projected at a certain distance. An index grating is located here. When the two graduations move in relation to each other, the incident light is modulated: if the gaps are aligned, light passes through. If the lines of one grating coincide with the gaps of the other, no light passes through. A photocell array converts these variations in light intensity into electrical signals. The specially structured grating of the scanning reticle filters the light to generate nearly sinusoidal output signals.

The smaller the period of the grating structure is, the closer and more tightly tolerated the gap must be between the scanning reticle and scale.

The HEIDENHAIN ACANTO and HEIDENHAIN SPECTO length gauges, as well as the HEIDENHAIN METRO length gauges, use the imaging principle.

Interferential scanning principle

The interferential scanning principle exploits the diffraction and interference of light on a fine graduation to produce signals used to measure displacement.

A step grating is used as the measuring standard: reflective lines 0.2 µm high are applied to a flat, reflective surface. In front of that is the scanning reticle—a transparent phase grating with the same grating period as the scale.

When a light wave passes through the scanning reticle, it is diffracted into three partial waves of the orders –1, 0, and +1, with approximately equal luminous intensity. The waves are diffracted by the scale such that most of the luminous intensity is found in the reflected diffraction orders +1 and –1. These partial waves meet again at the phase grating of the scanning reticle where they are diffracted again and interfere. This produces essentially three waves that leave the scanning reticle at different angles. Photovoltaic cells convert this alternating light intensity into electrical signals.

A relative motion of the scanning reticle to the scale causes the diffracted wave fronts to undergo a phase shift. When the grating moves by one period, the wave front of the first order is displaced by one wavelength in the positive direction, and the wavelength of diffraction order –1 is displaced by one wavelength in the negative direction. Since the two waves interfere with each other when exiting the grating, the waves are shifted relative to each other by two wavelengths. This results in two signal periods from the relative motion of just one grating period.

Interferential encoders function with grating periods of, for example, 8 µm, 4 µm, and finer. Their scanning signals are largely free of harmonics and can be highly interpolated. These encoders are therefore especially suited for high resolution and high accuracy.

The HEIDENHAIN CERTO length gauges, as well as the MT 1200 and MT 1600 HEIDENHAIN METRO length gauges, use the interferential principle.
Measuring accuracy

The linear measurement accuracy is mainly determined by the following factors:

- The quality of the graduation
- The scanning quality
- The quality of the signal-processing electronics
- The eccentricity of the graduation relative to the bearing
- The guideway error of the scale relative to the scanning unit
- The orthogonality of the length gauge relative to the bearing surface.

These factors can be divided into encoder-specific errors and application-specific factors. For assessment of the attainable overall accuracy, all of these individual factors must be taken into account.

Error specific to the measuring device

The error that is specific to the measuring device is stated in the specifications as the system accuracy:

- The extreme values of the total error F of a position are, on average, within the system accuracy ±a along the entire measuring range. They are measured during final inspection and documented in the calibration chart.
- The system accuracy includes the following:
  - The homogeneity and period definition of the graduation
  - The alignment of the graduation
  - The error of the bearing
  - The position error within one signal period.

The interpolation error within one signal period

The interpolation error within one signal period results from the scanning quality and, for encoders with integrated pulse-shaping or counter electronics, the quality of the signal-processing electronics. For encoders with sinusoidal output signals, however, the error from the signal processing electronics is dictated by the subsequent electronics.

The following factors influence the outcome:

- The fineness of the signal period
- The homogeneity and period definition of the graduation
- The quality of the scanning filter structures
- The characteristics of the sensors
- The stability and dynamic performance of the analog signal processing

These sources of error must be considered when specifying the interpolation error within one signal period.

- The interpolation error within one signal period ±e is specified as a percentage of the signal period. For length gauges, this value is typically better than ±1 % of the signal period. You will find the specified values in the Specifications.

Short-range accuracy

The short-range accuracy describes the amount of error that occurs within a distance of ±100 µm from a measuring point and includes electronic and mechanical influences of the gauge on the measurement. The values for short-range accuracy typically lie below the specified values.

Application-dependent error

Other factors besides the system accuracy also influence the attainable total accuracy of measurement. These include in particular the ambient temperature and temperature fluctuations during measurement as well as a stable, orthogonal measuring setup.

All components included in the measuring loop, such as the holder for the measured object, the gauge stand with holder, and the length gauge itself, influence the result of measurement. Expansion or deformation of the measuring setup through mechanical or thermal influences adds directly to the error.

Mechanical design

A stable measuring assembly must be ensured. Long lateral elements within the measuring loop are to be avoided. HEIDENHAIN offers a stable gauge stand as an accessory. The force resulting from the measurement must not cause any measurable deformation of the measuring loop.

Length gauges from HEIDENHAIN operate with small gauging force and have very little influence on the measuring setup.

Orthogonal mounting

The length gauge must be mounted such that its plunger is exactly orthogonal to the measured object or the surface on which it rests. Deviations result in measuring error.

The accessory HEIDENHAIN gauge stands with holders for an 8 mm clamping shank ensure orthogonal mounting. Length gauges, that provide planar mounting surfaces must be set parallel to the mounting surface (Y) and perpendicularly to the measuring plate. A quick and reliable adjustment is possible with the aid of a gauge block or a parallel block. The perpendicularity to the measuring table (X) is already ensured by the gauge stand.

Thermal characteristics

Temperature variations during measurement cause changes in length or deformation of the measuring setup. After a change in temperature of 5 K, a steel bar of 200 mm length expands by 10 µm.

Length changes resulting from a uniform deviation from the reference temperature can largely be compensated by resetting the datum on the measuring plate or a master; only the expansion of the scale and measured object go into the result of measurement.

Temperature changes during measurement cannot be ascertained mathematically. For critical components, HEIDENHAIN therefore uses special materials with low coefficients of expansion, such as are found in the HEIDENHAIN-CERTO gauge stand. This makes it possible to guarantee the high accuracy of HEIDENHAIN-CERTO even at ambient temperatures of 19 °C to 21 °C and variations of ±0.1 K during measurement.

In order to measure with complete accuracy, the length gauge should be switched on approximately 15 minutes before the first measurement.

Position error a along the measuring length ML

Accuracy of the interpolation

The measuring loop: All components involved in the measuring assembly, including the length gauge

Orthogonal mounting

Thermal length change: Expansion of the measuring loop components as a result of heat
All HEIDENHAIN length gauges are inspected before shipping for accuracy and proper function. They are calibrated for accuracy during retraction and extension of the plunger. For the HEIDENHAIN-CERTO, the number of measuring positions is selected to ascertain very exactly not only the long-range error, but also the position error within one signal period.

The Quality Inspection Certificate confirms the specified system accuracy of each length gauge. The calibration standards ensure the traceability—as required by EN ISO 9001—to recognized national or international standards.

For the HEIDENHAIN-METRO and HEIDENHAIN-CERTO series, a calibration chart documents the position error over the measuring range. It also shows the measuring step and the measuring uncertainty of the calibration measurement.

For the HEIDENHAIN-METRO the calibration chart shows the mean value of one forward and one backward measuring stroke. The HEIDENHAIN-CERTO calibration chart shows the envelope curve of the measured error. The HEIDENHAIN-CERTO length gauges are supplied with two calibration charts, each for different operating orientations.

Temperature range
The length gauges are inspected at a reference temperature of 20 °C. The system accuracy given in the calibration chart applies at this temperature. The operating temperature range indicates the ambient temperature limits between which the length gauges will function properly. The storage temperature range of –20 °C to 60 °C applies for the device in its packaging.

Whereas the system accuracy applies over the entire measuring range, for some applications the repeatability is the decisive factor. It plays an important role in repeated measurements.

Repeatability is defined in the standards DIN 32876 and DKD-R 4-3, and describes a length gauge’s capability to supply very similar measured values for identical measurands and conditions.

HEIDENHAIN ascertains the repeatability of the length gauges with five measurements near the lower plunger stop. The plunger is completely extended and retracted at medium speed. Since the length gauge was already in operation for at least 10 minutes before this, it is already in a stable thermal state.

The repeatability of the length gauges is usually better than the values listed in the table. The characteristic statistical distribution is shown in the diagram, using the ST 1200 as an example.

Repeatability depends on the:
• combinations of materials used in the components,
• installed electronics,
• optomechanics used, and the
• bearing of the plunger.

<table>
<thead>
<tr>
<th>Series</th>
<th>Repeatability</th>
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<tr>
<td>AT 1200</td>
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<tr>
<td>AT 3000</td>
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<td>CT 2500</td>
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<td>CT 6000</td>
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<td>MT 1200</td>
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<td>0.25 µm</td>
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<td>ST 3000</td>
<td>0.7 µm</td>
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</table>
HEIDENHAIN length gauges enable you to work according to the Abbe measuring principle: the measured object and scale must be in alignment to avoid additional measuring error.

**Fastening**

The CT 6000, MT 60, and MT 101 length gauges are fastened by two screws onto a plane surface. This ensures a mechanically stable installation of even these large length gauges. Special holders are available for fastening the MT 60 and MT 101 to the MS 100 guide stand for the HEIDENHAIN METRO (see Accessories).

The CT 2500 is mounted by its standard clamping shank with 16h8 diameter. A holder is available for fastening the HEIDENHAIN-CERTO to the gauge stand (see Accessories).

The AT, ST, MT 1200, and MT 2500 length gauges feature a standard clamping shank with 8h6 diameter. These HEIDENHAIN length gauges can therefore easily be used with existing measuring fixtures and stands.

HEIDENHAIN offers the choice of a special clamping sleeve or a clamping bush with one screw each. These accessories make it easier to fasten the length gauge without overloading the 8h6 clamping shank or damaging the ball-bush guide. The clamping bush also enables a wide tolerance field for overloading the 8h6 clamping shank or easier to fasten the length gauge without one screw each. These accessories make it possible to guarantee its high measuring accuracy over a relatively large temperature range.

**Operating orientation for HEIDENHAIN-CERTO**

The HEIDENHAIN-CERTO can be operated at any attitude. However, the mounting position with horizontal length gauge and upward facing mounting surface should be avoided because in such a case no guarantee can be made for accuracy.

**Clamping bush**

- ID 388611-01
- Clamping bush: ID 1177968-02

**Clamping sleeve**

- ID 386811-01
- the tightening torque and improves fastening.

**Clamping**

- HEIDENHAIN offers the choice of a special clamping sleeve or a clamping bush with one screw each. These accessories make it easier to fasten the length gauge without overloading the 8h6 clamping shank or damaging the ball-bush guide. The clamping bush also enables a wide tolerance field for overloading the 8h6 clamping shank or easier to fasten the length gauge without one screw each. These accessories make it possible to guarantee its high measuring accuracy over a relatively large temperature range.

**Abbe principle**

HEIDENHAIN length gauges function according to the Abbe measuring principle, i.e. the measuring standard and the plunger are exactly aligned. All components comprising the measuring loop, such as the measuring standard, plunger, holder, and scanning head are designed in terms of their chemical and thermal stability for the highest possible accuracy of the length gauge.

The plungers of the HEIDENHAIN length gauges are locked against rotation. Their optimally round form stays unchanged while stability and thermoconductivity remain unimpaired. They are provided with an M2.5 thread to hold measuring contacts (see Accessories).

The plungers of the HEIDENHAIN-CERTO and HEIDENHAIN-SPECTO ST 1200 length gauges are protected by a rubber bellows. The bellows is characterized by high resistance to chemical and thermal influences and have a relatively low stiffness. Its influence on the gauge’s mechanical behavior and the measuring force is therefore low.

**Clamping bush**

- ID 1177968-02

**Clamping sleeve**

- ID 386811-01

**Operating orientation for HEIDENHAIN-CERTO**

The HEIDENHAIN-CERTO can be operated at any attitude. However, the mounting position with horizontal length gauge and upward facing mounting surface should be avoided because in such a case no guarantee can be made for accuracy.
Gauging force and plunger actuation

The HEIDENHAIN length gauges contain components that are subject to wear, depending on the application and manipulation. These include in particular the following parts:

- Low friction, which makes versions of length gauges with reduced gauging force possible
- Safe plunger extension and retraction even with high radial force
- High precision of the measuring loop thanks to a guide that is free of play (the bearing and plunger are specially fitted during manufacture)

The HEIDENHAIN-METRO, HEIDENHAIN-CERTO, and HEIDENHAIN-SPECTO length gauges are equipped with a ball-bush guide. The following are some of the basic properties of ball-bush guides in HEIDENHAIN length gauges:

- Sturdiness thanks to few moving parts
- Impervious to shock and vibration
- High plunger speeds and long service life thanks to high-quality ceramic bearings
- Less sensitivity to improper clamping

The HEIDENHAIN-METRO, HEIDENHAIN-CERTO, and HEIDENHAIN-SPECTO length gauges are available with various plunger guides. The plungers of the HEIDENHAIN-ACANTO length gauges work with sliding guides. The sliding guides have the following properties:

- Low friction, which makes versions of length gauges with reduced gauging force possible
- Safe plunger extension and retraction even with high radial force
- High precision of the measuring loop thanks to a guide that is free of play (the bearing and plunger are specially fitted during manufacture)

Plunger actuation via a cable release (MT 12x1, MT 25x1)

In this method, the plunger is manually raised and lowered onto the measured object by means of a cable release. This measurement is performed with plunger extension.

The gauging forces can be divided into the following classes:

- Reduced MR: approx. half the gauging force of the standard variant
- Low MW: gauging force at the beginning of the measuring range, approx. 0.01 N
- Springless MG: constant gauging force over the entire measuring range

So as not to influence the gauging force, the ST 1288 MR and ST 1288 MG variants are provided without a bellows.

Gauging force

Gauging force is the force that the plunger exerts on the measured object. If the gauging force is too high, then the measuring contact or measured object may deform in response. If the gauging force is too low, then a layer of dust or contamination may prevent the plunger from fully contacting the measured object. The gauging force depends on the type of plunger actuation.

Spring-based plunger actuation

For the AT 1218, AT 3018, MT 12x1, MT 25x1, ST 12x8, and ST 30x8, a built-in spring extends the plunger to the measuring position and produces the gauging force. The plunger is extended when at rest. The gauging force depends on the following criteria:

- The operating orientation
- The plunger position (the force changes over the course of the measuring range)
- The direction of measurement (whether extension or retraction of the plunger is used)

The graphs show the gauging force across the measuring range during horizontal retraction and extension of the plunger.

The MT 1281 and ST 1288 length gauges are available with various gauging forces. Delicate materials can therefore be measured without deformation.

Plunger actuation via a measured object

The complete length gauge is moved by the measuring device toward the measured object, or vice versa. The measurement is usually performed via plunger retraction.

Built-in, adjustable pneumatic damping reduces the plunger extension speed so as to prevent rebound (e.g., on very hard materials). This prevents measuring error due to bouncing.

Plunger actuation via a cable release (MT 12x1, MT 25x1)

In this method, the plunger is manually raised and lowered onto the measured object by means of a cable release. This measurement is performed with plunger extension.

Gauging forces can be divided into the following classes:

- Reduced MR: approx. half the gauging force of the standard variant
- Low MW: gauging force at the beginning of the measuring range, approx. 0.01 N
- Springless MG: constant gauging force over the entire measuring range

So as not to influence the gauging force, the ST 1288 MR and ST 1288 MG variants are provided without a bellows.

Gauging force

Gauging force is the force that the plunger exerts on the measured object. If the gauging force is too high, then the measuring contact or measured object may deform in response. If the gauging force is too low, then a layer of dust or contamination may prevent the plunger from fully contacting the measured object. The gauging force depends on the type of plunger actuation.

Spring-based plunger actuation

For the AT 1218, AT 3018, MT 12x1, MT 25x1, ST 12x8, and ST 30x8, a built-in spring extends the plunger to the measuring position and produces the gauging force. The plunger is extended when at rest. The gauging force depends on the following criteria:

- The operating orientation
- The plunger position (the force changes over the course of the measuring range)
- The direction of measurement (whether extension or retraction of the plunger is used)

The graphs show the gauging force across the measuring range during horizontal retraction and extension of the plunger.

The MT 1281 and ST 1288 length gauges are available with various gauging forces. Delicate materials can therefore be measured without deformation.

Plunger actuation via a cable release (MT 12x1, MT 25x1)

In this method, the plunger is manually raised and lowered onto the measured object by means of a cable release. This measurement is performed with plunger extension.

Gauging forces can be divided into the following classes:

- Reduced MR: approx. half the gauging force of the standard variant
- Low MW: gauging force at the beginning of the measuring range, approx. 0.01 N
- Springless MG: constant gauging force over the entire measuring range

So as not to influence the gauging force, the ST 1288 MR and ST 1288 MG variants are provided without a bellows.

Plunger actuation via a cable release (MT 12x1, MT 25x1)

In this method, the plunger is manually raised and lowered onto the measured object by means of a cable release. This measurement is performed with plunger extension.

Gauging forces can be divided into the following classes:

- Reduced MR: approx. half the gauging force of the standard variant
- Low MW: gauging force at the beginning of the measuring range, approx. 0.01 N
- Springless MG: constant gauging force over the entire measuring range

So as not to influence the gauging force, the ST 1288 MR and ST 1288 MG variants are provided without a bellows.
Pneumatic plunger actuation

The pneumatically actuated plungers of the AT 121x, AT 301x, MT 12xx, MT 25xx, ST 12xx, and ST 30xx length gauges are extended by the application of compressed air. When the air connection is ventilated, the integral spring retracts the plunger to a protected resting position within the housing.

The gauging force can be adjusted to the measuring task through the level of air pressure. When the air pressure is constant, it depends on the operating orientation and the plunger position.

The diagrams show the respective gauging force for a horizontal operating orientation depending on the working pressure applied with the plunger fully extended and fully retracted. These are approximate values that are subject to changes due to tolerances and depend on seal wear.

Note

The compressed air introduced directly into the length gauges must be properly conditioned and must comply with the following quality classes as per ISO 8573-1 (1996 edition):

- Solid contaminant: Class 1 (max. particle size 0.1 µm and max. particle density 0.1 mg/m³ at 1·10⁵ Pa)
- Total oil content: Class 1 (max. oil concentration 0.01 mg/m³ at 1·10⁵ Pa)
- Max. pressure dew point: Class 4 but with reference conditions of +3 °C at 2·10⁵ Pa

HEIDENHAIN offers the DA 400 compressed air unit for purifying compressed air. The minimum flow rate is 10 l/min.

For more information, ask for our DA 400 Product Information Sheet.

Motorized plunger actuation

The CT 2501, CT 6001, MT 60M, and MT 101M length gauges feature an integral motor that moves the plunger. It is operated through the switch box either by push button or over the connection for external actuation. The plungers of the CT 2501, CT 6001, and MT 60M length gauges must not be moved by hand if the switch box is connected.

The gauging force of the CT 2501, CT 6001, and MT 60 M motorized length gauges is adjustable in three stages through the switch box. The force remains constant over the measuring range but depends on the operating orientation.

Regardless of the operating orientation—whether it measures vertically downward (with the SG 101 V switch box) or horizontally (with the SG 101 H switch box)—the MT 101 M exercises a constant gauging force.

External plunger actuation via coupling

For the CT 2502, CT 6002, MT 60K, MT 101K, and special versions (without springing) of the MT 1200, MT 2500, and ST 1288, the plunger is freely movable. For position measurement, the plunger is connected by a coupling with a moving machine element. The force needed to move the plunger is specified as the required moving force. It depends on the operating orientation.
HEIDENHAIN-ACANTO
Absolute length gauges with EnDat interface
• Online diagnostics
• Protection rating of up to IP67
• Serial data transmission with CRC

### Mechanical data

<table>
<thead>
<tr>
<th></th>
<th>AT 1218</th>
<th>AT 3018</th>
<th>AT 1217</th>
<th>AT 3017</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plunger actuation</strong></td>
<td>Via measured object</td>
<td>Pneumatic</td>
<td>Extended</td>
<td>Retracted</td>
</tr>
<tr>
<td><strong>Position of plunger at rest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measuring standard</strong></td>
<td>DIADUR grating on glass; grating period: 188.4 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System accuracy</strong></td>
<td>±1 µm</td>
<td>±2 µm</td>
<td>±1 µm</td>
<td>±2 µm</td>
</tr>
<tr>
<td><strong>Position error per signal period</strong></td>
<td>≤ ±0.7 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measuring range</strong></td>
<td>12 mm</td>
<td>30 mm</td>
<td>12 mm</td>
<td>30 mm</td>
</tr>
<tr>
<td><strong>Working pressure</strong></td>
<td>–</td>
<td>0.7 bar to 1.8 bar</td>
<td>1.1 bar to 1.8 bar</td>
<td></td>
</tr>
<tr>
<td><strong>Mech. permissible traversing speed</strong></td>
<td>≤ 80 m/min</td>
<td>≤ 120 m/min</td>
<td>≤ 80 m/min</td>
<td>≤ 120 m/min</td>
</tr>
<tr>
<td><strong>Radial force</strong></td>
<td>≤ 0.5 N (mechanically permissible)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fastening</strong></td>
<td>Clamping shank Ø 8H6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating orientation</strong></td>
<td>Any</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vibration</strong> (55 Hz to 2000 Hz)</td>
<td>≤ 100 m/s² (EN 60068-2-6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shock</strong> (11 ms)</td>
<td>≤ 500 m/s² (EN 60068-2-27)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating temperature</strong></td>
<td>10 °C to 40 °C; reference temperature: 20 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Protection</strong> (EN 60529)</td>
<td>IP67</td>
<td>IP67</td>
<td>IP67</td>
<td>IP67 upon request</td>
</tr>
<tr>
<td><strong>Mass without cable</strong></td>
<td>80 g</td>
<td>100 g</td>
<td>80 g</td>
<td>100 g</td>
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</tbody>
</table>

1) IP67 with sealing air

### Electrical data

<table>
<thead>
<tr>
<th></th>
<th>EnDat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface</strong></td>
<td>EnDat 2.2</td>
</tr>
<tr>
<td><strong>Ordering designation</strong></td>
<td>EnDat 22</td>
</tr>
<tr>
<td><strong>Measuring step</strong></td>
<td>23 nm</td>
</tr>
<tr>
<td><strong>Calculation time tcalc</strong></td>
<td>≤ 5 µs</td>
</tr>
<tr>
<td><strong>Clock frequency</strong></td>
<td>≤ 8 MHz</td>
</tr>
<tr>
<td><strong>Electrical connection</strong></td>
<td>8-pin M12 flange socket (male)</td>
</tr>
<tr>
<td><strong>Cable length</strong></td>
<td>≤ 100 m with HEIDENHAIN cable</td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td>DC 3.6 V to 14 V</td>
</tr>
<tr>
<td><strong>Power consumption (max.)</strong></td>
<td>3.6 V: ≤ 550 mW</td>
</tr>
<tr>
<td></td>
<td>14 V: ≤ 650 mW</td>
</tr>
<tr>
<td><strong>Current consumption (typical)</strong></td>
<td>5 V: 80 mA (without load)</td>
</tr>
</tbody>
</table>
HEIDENHAIN-CERTO
Incremental length gauges with ±0.1 µm/±0.05 µm/±0.03 µm accuracy
• For very high accuracy
• Low thermal expansion through thermally invariant materials
• High-precision ball bearing guide

Mechanical data

<table>
<thead>
<tr>
<th></th>
<th>CT 2501</th>
<th>CT 6001</th>
<th>CT 2502</th>
<th>CT 6002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plunger actuation</td>
<td>Via motor</td>
<td>Via coupling with moving machine part</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring standard</td>
<td>DIADUR phase grating on Zerodur glass ceramic; grating period: 4 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System accuracy</td>
<td>at 19 °C to 21 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT 2501</td>
<td>±0.1 µm, ±0.03 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT 6001</td>
<td>±0.1 µm, ±0.05 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT 2502</td>
<td>±0.1 µm, ±0.03 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT 6002</td>
<td>±0.1 µm, ±0.05 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position error per signal period</td>
<td>≤ ±0.02 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-range accuracy</td>
<td>typically 0.03 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference mark</td>
<td>One, approx. 1.7 mm below upper stop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring range</td>
<td>25 mm, 60 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radial force</td>
<td>≤ 0.5 N (mechanically permissible)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fastening</td>
<td>Clamping shank (Ø 16h8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating orientation</td>
<td>Any (for preferred operating orientation, see Mounting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>65 Hz to 2000 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock</td>
<td>11 ms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>10 ºC to 40 °C; reference temperature: 20 ºC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>IP50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass without cable</td>
<td>520 g, 700 g</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

Electrical data

<table>
<thead>
<tr>
<th></th>
<th>CT 2501</th>
<th>CT 6001</th>
<th>CT 2502</th>
<th>CT 6002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>» 11 µAPP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal period</td>
<td>2 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring velocity</td>
<td>≤ 24 m/min (depending on the subsequent electronics)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical connection*</td>
<td>• Cable 1.5 m with 15-pin D-sub connector (male)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable length</td>
<td>≤ 30 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>DC 5 V ±0.25 V/≤ 170 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Required accessories* | For CT 2501 | For CT 6001 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch box</td>
<td>SG 25 M</td>
<td>SG 60 M</td>
</tr>
</tbody>
</table>

* Please select when ordering
1) After linear length-error compensation in the evaluation electronics
2) Force required to move the plunger or the force of its weight
HEIDENHAIN-METRO
Incremental length gauges with ±0.2 µm accuracy
• High repeatability
• Various gauging force variants
• Various possibilities for plunger actuation

### Mechanical data

<table>
<thead>
<tr>
<th>MT 1271/MT 1281</th>
<th>MT 2571/MT 2581</th>
<th>MT 1287/MT 2587</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>TTL</td>
<td>TTL</td>
</tr>
<tr>
<td>Integrated interp.</td>
<td>5-fold</td>
<td>10-fold</td>
</tr>
<tr>
<td>Signal period</td>
<td>0.4 µm</td>
<td>0.2 µm</td>
</tr>
<tr>
<td>Mech. permissible traversing speed</td>
<td>≤ 30 m/min</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Edge separation at scanning frequency/traversing speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 kHz ≤ 24 m/min</td>
</tr>
<tr>
<td>100 kHz ≤ 12 m/min</td>
</tr>
<tr>
<td>50 kHz ≤ 6 m/min</td>
</tr>
<tr>
<td>25 kHz ≤ 3 m/min</td>
</tr>
</tbody>
</table>

### Electrical data

<table>
<thead>
<tr>
<th>MT 1271/MT 2571</th>
<th>MT 128x/MT 258x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage supply</td>
<td>DC 5 V ±0.5 V/≤ 160 mA (without load)</td>
</tr>
<tr>
<td></td>
<td>DC 5 V ±0.25 V/≤ 130 mA</td>
</tr>
</tbody>
</table>

* Please select when ordering  
1) At the corresponding cutoff or scanning frequency
HEIDENHAIN-METRO
Incremental length gauges with ±0.5 µm/±1 µm accuracy
• Large measuring ranges
• Plunger actuation by motor or coupling
• Ball-bush guided plunger

Mechanical data

<table>
<thead>
<tr>
<th></th>
<th>MT 60 M</th>
<th>MT 101 M</th>
<th>MT 60 K</th>
<th>MT 101 K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plunger actuation</td>
<td>Via motor</td>
<td>Via coupling with moving machine part</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring standard</td>
<td>DIADUR grating on silica glass; grating period: 10 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System accuracy</td>
<td>±0.5 µm</td>
<td>±1 µm</td>
<td>±0.5 µm</td>
<td>±1 µm</td>
</tr>
<tr>
<td>Position error per signal period</td>
<td>≤±0.1 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference mark</td>
<td>≈1.7 mm from top</td>
<td>≈10 mm from top</td>
<td>≈1.7 mm from top</td>
<td>≈10 mm from top</td>
</tr>
<tr>
<td>Measuring range</td>
<td>60 mm</td>
<td>100 mm</td>
<td>60 mm</td>
<td>100 mm</td>
</tr>
<tr>
<td>Radial force mechanically permissible</td>
<td>≤0.5 N</td>
<td>≤2 N</td>
<td>≤0.5 N</td>
<td>≤2 N</td>
</tr>
<tr>
<td>Fastening</td>
<td>Plane surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating orientation</td>
<td>Any</td>
<td>Vertically downward with SG 101 V</td>
<td>Horizontal with SG 101 H</td>
<td>Any</td>
</tr>
<tr>
<td>Vibration</td>
<td>55 Hz to 2000 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock</td>
<td>≤100 m/s² (EN 60068-2-6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>10 °C to 40 °C; reference temperature: 20 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>IP50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass without cable</td>
<td>700 g</td>
<td>1400 g</td>
<td>600 g</td>
<td>1200 g</td>
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Electrical data

<table>
<thead>
<tr>
<th></th>
<th>MT 60 M</th>
<th>MT 101 M</th>
<th>MT 60 K</th>
<th>MT 101 K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface</td>
<td>»11 µA/pC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal period</td>
<td>10 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring velocity</td>
<td>≤18 m/min</td>
<td>≤60 m/min</td>
<td>≤18 m/min</td>
<td>≤60 m/min</td>
</tr>
<tr>
<td>Electrical connection*</td>
<td>Cable, 1.5 m, with 15-pin D-sub connector (male) or with 9-pin M23 connector (male)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable length</td>
<td>≤30 m with HEIDENHAIN cable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>DC 5 V ±0.25 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current consumption</td>
<td>&lt;120 mA</td>
<td>&lt;70 mA</td>
<td></td>
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Required accessories*

<table>
<thead>
<tr>
<th></th>
<th>For MT 60 M</th>
<th>For MT 101 M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch box</td>
<td>SG 60 M</td>
<td>Vertical orientation: SG 101 V</td>
</tr>
<tr>
<td>Power adapter</td>
<td>–</td>
<td>Required (see Accessories)</td>
</tr>
</tbody>
</table>

* Please select when ordering
HEIDENHAIN-SPECTO
Incremental length gauges with ±1 µm accuracy
- Very compact dimensions
- Protection rating of up to IP67
- Especially durable ball-bush guide

**Mechanical data**

<table>
<thead>
<tr>
<th>ST 127x</th>
<th>ST 307x</th>
<th>ST 128x</th>
<th>ST 308x</th>
</tr>
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<tbody>
<tr>
<td>Interface</td>
<td>«TTL» 1 Vpp</td>
<td>«TTL» 1 Vpp</td>
<td>«TTL» 1 Vpp</td>
</tr>
<tr>
<td>Integrated interpolation*</td>
<td>6-fold</td>
<td>10-fold</td>
<td>-</td>
</tr>
<tr>
<td>Signal period</td>
<td>4 µm</td>
<td>2 µm</td>
<td>20 µm</td>
</tr>
<tr>
<td>Edge separation a at scanning frequency/ traverse speed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Hz to 60 m/min</td>
<td>≥ 0.48 µs</td>
<td>≥ 0.48 µs</td>
<td>≥ 0.48 µs</td>
</tr>
<tr>
<td>25 kHz to 30 m/min</td>
<td>≥ 0.98 µs</td>
<td>≥ 0.98 µs</td>
<td>≥ 0.98 µs</td>
</tr>
<tr>
<td>Electrical connection*</td>
<td>Cable 1.5 m with 15-pin D-sub connector (male, integrated interface electronics)</td>
<td>Cable 1.5 m with 15-pin D-sub connector (male) or 12-pin M23 connector (male)</td>
<td></td>
</tr>
<tr>
<td>Cable outlet*</td>
<td>Axial or radial</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cable length</td>
<td>≤ 30 m with HEIDENHAIN cable</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>DC 5 V ±0.5 V</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Current consumption</td>
<td>&lt; 100 mA (without load)</td>
<td>≤ 55 mA</td>
<td></td>
</tr>
</tbody>
</table>

* Please select when ordering
1) Mechanically limited
2) At a corresponding cutoff or scanning frequency

**Electrical data**

- **ST 1200, ST 3000**

**ST 127x**
- Plunger actuation: Via measured object
- Measuring standard: DIADUR grating on glass; grating period: 20 µm
- System accuracy: ±1 µm
- Position error per signal period: ≤ ±0.2 µm
- Short-range accuracy: typically 0.3 µm
- Reference mark: ≈ 5 mm below upper stop
- Measuring range: 12 mm, 30 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g

**ST 307x**
- Measuring range: 12 mm, 30 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g

**ST 128x**
- Measuring range: 12 mm, 30 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g

**ST 308x**
- Measuring range: 12 mm, 30 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g

**ST 1277**
- Measuring range: 12 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g

**ST 3077**
- Measuring range: 30 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g

**ST 1287**
- Measuring range: 12 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g

**ST 3087**
- Measuring range: 30 mm
- Working pressure: – 0.8 bar to 2.5 bar
- Radial force: ≤ 0.8 N (mechanically permissible)
- Fastening: Clamping shank Ø 8h6
- Operating orientation: Any
- Vibration: 55 Hz to 2000 Hz
- Shock: 11 ms
- Operating temperature: 10 °C to 40 °C; reference temperature: 20 °C
- Protection: EN 60529 IP67/IP64 IP64
- Mass: without cable 40 g, 50 g
Length gauges with low measuring forces

Incremental length gauges
- Ball-bush guided plunger
- Same specifications as for standard products

### Mechanical data

<table>
<thead>
<tr>
<th>MT 1281</th>
<th>ST 1288</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plunger actuation</strong></td>
<td>Via cable or measured object</td>
</tr>
<tr>
<td><strong>Measuring standard</strong></td>
<td>DIADUR phase grating on Zerodur glass; ceramic; grating period: 4 µm</td>
</tr>
<tr>
<td><strong>System accuracy</strong></td>
<td>±0.2 µm</td>
</tr>
<tr>
<td><strong>Short-range accuracy</strong></td>
<td>Typically 0.03 µm</td>
</tr>
<tr>
<td><strong>Measuring range</strong></td>
<td>12 mm</td>
</tr>
<tr>
<td><strong>Fastening</strong></td>
<td>Clamping shank Ø 8h6</td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>EN 60529 IP50</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>&gt; 1 Vpp</td>
</tr>
<tr>
<td><strong>Signal period</strong></td>
<td>2 µm</td>
</tr>
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</table>

### Version

<table>
<thead>
<tr>
<th>MT 1281</th>
<th>ST 1288</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Default</strong></td>
<td>0.75 N</td>
</tr>
<tr>
<td><strong>MR</strong></td>
<td>0.25 N</td>
</tr>
<tr>
<td><strong>MW</strong></td>
<td>0 N</td>
</tr>
<tr>
<td><strong>MG</strong></td>
<td>0.13 N</td>
</tr>
</tbody>
</table>

1) With nearly fully extended plunger
2) Over the entire measuring range

*The diagram applies for the horizontal operating orientation, except for MT 1281 MW. For compensation values for other orientations, see the table on p. 20.*
Accessories

Measuring contacts

<table>
<thead>
<tr>
<th>Ball-type contact</th>
<th>Domed contact</th>
<th>Flat contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>Carbide</td>
<td>Steel</td>
</tr>
<tr>
<td>ID 202504-01</td>
<td>ID 229232-01</td>
<td>ID 270922-01</td>
</tr>
<tr>
<td>Carbide</td>
<td></td>
<td>Carbide</td>
</tr>
<tr>
<td>ID 202504-02</td>
<td></td>
<td>ID 202506-01</td>
</tr>
<tr>
<td>Ruby</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID 202504-03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pin-type contact

Steel

ID 202505-01

Knife-edge contact

Steel

ID 202503-01

Adjustable contact, carbide

For exact parallel alignment to the measuring plate surface

<table>
<thead>
<tr>
<th>Crowned</th>
<th>Flat</th>
<th>Knife-edged</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 202502-03</td>
<td>ID 202507-01</td>
<td>ID 202508-01</td>
</tr>
<tr>
<td>Cylindrical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID 202502-04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Roller contact, steel

For a low-friction contact with moving surfaces

Crowned

ID 202502-03

Cylindrical

ID 202502-04

Switch boxes, coupling

Switch boxes for CT 2501, CT 6001, MT 60 M, MT 101 M

Switch boxes are required for length gauges with motorized plunger actuation. The plunger is controlled through two push buttons or by external signal. The SG 25 M and SG 60 M switch boxes can adjust the gauging force in three stages.

SG 25 M

ID 317436-01

SG 60 M

ID 317436-02

SG 101 V

For the MT 101 M in vertical operation

ID 361140-01

SG 101 H

For the MT 101 M in horizontal operation

ID 361140-02

Connector (female), 3-pin

For external operation of the switch box

ID 340646-05

1) Separate power adapter required

Power adapter for SG 101 V/H

An adapter connected to the switch box powers the MT 101 M.

Voltage range: AC 100 V to 240 V

Exchangeable plug adapter (European and U.S. connectors included in delivery)

ID 312426-13

Coupling

For connecting the plunger of the length gauge specifically for the MT 60K, MT 10K, CT 2502, and CT 6002 to a moving machine element

ID 200310-01
Accessories for HEIDENHAIN-CERTO

Gauge stand

CS 200 gauge stand
For length gauges CT 2501*
CT 6001
ID 221310-01
Overall height 350 mm
Measuring table Ø 250 mm
Column Ø 58 mm
Mass 15 kg
* With special holder
The flatness of the CS 200 is determined with the aid of a Fizeau interferometer.

Holder for CS 200
For the CT 2501 with Ø 16 mm clamping shank
ID 324391-01

Ceramic suction plate, diaphragm pump

Ceramic suction plate
Wear-resistant working surface with high surface quality specifically for inspecting gauge blocks
ID 223100-01
The gauge block (class 1 or 2) or any other object with a plane surface is drawn by suction onto the top of the ceramic plate. The ceramic plate is likewise drawn onto the granite base and held in place through negative pressure.

Parts for connecting the ceramic suction plate with the diaphragm pump are among the items supplied:

Pressure tubing: 3 m
Tipjet
Connecting piece

Diaphragm pump
Source of suction for drawing the measured object and ceramic suction plate
Power consumption 20 W
Mass 2.3 kg
Line voltage AC 230 V / 50 Hz
ID 754220-01
Line voltage AC 115 V / 60 Hz
ID 754220-02
Accessories for HEIDENHAIN-ACANTO, HEIDENHAIN-METRO, and HEIDENHAIN-SPECTO

Cable release and gauge stands

**Cable release**
For manual plunger actuation on the MT 1200 and MT 2500. Built-in pneumatic damping reduces the plunger extension speed to prevent bouncing (e.g., on very hard materials).

ID 257790-01

**MS 200 gauge stand**
For length gauges AT, ST, MT 1200, MT 2500, MT 60 M1, MT 101 M1

ID 244154-01

- Total height: 346 mm
- Base: Ø 250 mm
- Column: Ø 58 mm
- Mass: 18 kg
1) With special holder

**Holder for the MS 200**
For mounting the length gauge with a clamping shaft (Ø 8 mm), including the AT, ST, MT 1200, and MT 2500

ID 324391-02

- Clamping sleeve and clamping bush
For all length gauges with a Ø 8 mm clamping shaft, including the AT, ST, MT 1200, and MT 2500, for secure attachment of the length gauge without overburdening the 8h6 clamping shank:

Clamping sleeve with screw
ID 386811-01 (qty. 1)
ID 386811-02 (qty. 10)

Clamping bush with screw
ID 1177366-02

Additional protection from damage to the ball guide, as well as a wide tolerance range for the tightening torque.

**MS 45 gauge stand**
For length gauges AT, ST, MT 1200, MT 2500

ID 202162-02

- Overall height: 196.5 mm
- Measuring table: Ø 49 mm
- Column: Ø 22 mm
- Mass: 2.2 kg

**MS 100 gauge stand**
For length gauges AT, ST, MT 1200, MT 2500, MT 60 M1, MT 101 M1

ID 202164-02

- Overall height: 385 mm
- Measuring table: Ø 50 mm
- Column: Ø 50 mm
- Mass: 18 kg
1) With special holder

**Holder for MS 100**
For mounting the length gauge with a clamping shaft (Ø 8 mm), including the AT, ST, MT 1200, and MT 2500

ID 206260-01

- Clamping sleeve and clamping bush
For all length gauges with a Ø 8 mm clamping shaft, including the AT, ST, MT 1200, and MT 2500, for secure attachment of the length gauge without overburdening the 8h6 clamping shank:

Clamping sleeve with screw
ID 386811-01 (qty. 1)
ID 386811-02 (qty. 10)

Clamping bush with screw
ID 1177366-02

Additional protection from damage to the ball guide, as well as a wide tolerance range for the tightening torque.
The signal converters from HEIDENHAIN adapt the encoder signals to the interface of the subsequent electronics. They are used when the subsequent electronics cannot directly process the output signals from HEIDENHAIN encoders or when additional interpolation of the signals is necessary.

Input signals of the interface electronics
HEIDENHAIN signal converters can be connected to encoders with 1 Vpp sinusoidal signals (voltage signals) or 11 µAPP sinusoidal signals (current signals). Encoders with the EnDat or SSI serial interface can be connected to various signal converters as well.

Output signals of the signal converters
The signal converters are available with the following interface to the subsequent electronics.
- TTL square-wave pulse trains
- EnDat 2.2
- DRIVE-CLiQ
- Fanuc Serial Interface
- Mitsubishi high speed interface
- Yaskawa Serial Interface
- Profinet

Interpolation of the sinusoidal input signals
In addition to performing signal conversion, the signal converters also interpolate the sinusoidal encoder signals. This permits finer measuring steps, resulting in higher control quality and superior positioning behavior.

Generation of a position value
Various signal converters feature an integrated counter function. Starting from the last set reference point, an absolute position value is generated and output to the subsequent electronics when the reference mark is crossed.

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Qty.</th>
<th>Inputs</th>
<th>Qty.</th>
<th>Design – Protection class</th>
<th>Interpolation or subdivision</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLJTL</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Box design – IP65</td>
<td>5/10-fold</td>
<td>IBV 101</td>
</tr>
<tr>
<td></td>
<td></td>
<td>~ 1 Vpp</td>
<td></td>
<td></td>
<td>20/25/50/100-fold</td>
<td>IBV 102</td>
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<tr>
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<td></td>
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<td></td>
<td></td>
<td>Without interpolation</td>
<td>IBV 600</td>
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<tr>
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<td></td>
<td></td>
<td>25/50/100/200/400-fold</td>
<td>IBV 660B</td>
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<tr>
<td>FLJTL/</td>
<td>2</td>
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<td>Box design – IP65</td>
<td>5/10-fold</td>
<td>IBV 6072</td>
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<tr>
<td>~ 1 Vpp</td>
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<td>~ 11 µAPP</td>
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<td></td>
<td>2-fold</td>
<td>IBV 6172</td>
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<td>5/10-fold and 20/25/50/100-fold</td>
<td>IBV 6272</td>
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<td>1</td>
<td>1</td>
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<td>≤ 16 384-fold subdivision</td>
<td>EIB 192</td>
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<tr>
<td></td>
<td></td>
<td>~ 1 Vpp</td>
<td></td>
<td></td>
<td>16 384-fold subdivision</td>
<td>EIB 192</td>
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<tr>
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<td>1</td>
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</tr>
<tr>
<td></td>
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<td>~ 1 Vpp</td>
<td></td>
<td></td>
<td>16 384-fold subdivision</td>
<td>EIB 1592F</td>
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<td>Mitsubishi high speed interface</td>
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<td>EIB 192M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>~ 1 Vpp</td>
<td></td>
<td></td>
<td>16 384-fold subdivision</td>
<td>EIB 192M</td>
</tr>
<tr>
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<td>16 384-fold subdivision</td>
<td>EIB 192M</td>
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<tr>
<td>Yaskawa Serial Interface</td>
<td>1</td>
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<td>1</td>
<td>Box design – IP65</td>
<td>≤ 16 384-fold subdivision</td>
<td>EIB 1592M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EnDat 2.2</td>
<td>1</td>
<td>Plug design – IP40</td>
<td>≤ 16 384-fold subdivision</td>
<td>EIB 3391Y</td>
</tr>
</tbody>
</table>

| PROFIBUS-DP | 1 | 1 | 1 | Top-hat rail design | - | PROFINET Gateway |

1) Switchable
2) Only LIC 4100, measuring step 5 nm; LIC 2100, measuring step 50 nm and 100 nm
The ISO 9001 quality management standard requires quality-relevant inspection equipment to be regularly monitored and traceable to a national standard in accordance with the International System of Units (SI). HEIDENHAIN supports its customers in this with its own calibration lab for digital linear and angle encoders, which has been accredited since 1994.

The HEIDENHAIN calibration lab operates in accordance with DIN EN ISO/IEC 17025 and is accredited by the German Accreditation Body (DAkkS). HEIDENHAIN calibration certificates granted by the Accreditation Body (DAkkS) are recognized in most industrialized countries.

The DAkkS is a signatory to the multilateral agreement of the European co-operation for Accreditation (EA) and to the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates. Calibration certificates from HEIDENHAIN are recognized in most industrialized countries.

The calibration certificate from HEIDENHAIN gives the user certainty about the accuracy of the encoder, and also certifies the traceability to the International System of Units (SI) required for ISO 9001.

The calibration lab at HEIDENHAIN is equipped for all digital linear and angle measuring systems requiring high accuracy:
- AT, CT, MT, and ST length gauges (including in conjunction with ND 28x, EXE, or IBV subsequent electronics)
- LC, LF, LIDA, LIP and LS linear encoders
- ECN, ROC, ROD, and RON angle encoders

Length gauges from HEIDENHAIN can be calibrated regardless of their interface. If the measuring chain includes subsequent electronics from HEIDENHAIN, then they can be included in the calibration as well.

The following information can be measured and certified:
- Error span for plunger retraction
- Error span for a part of the measuring span
- Repeatability with five measurements (extended plunger)

Calibration according to DAkkS

Related documents

Related to length gauges

- Brochure Cables and Connectors
  Contents: Technical characteristics, cable overviews, and cable lists

- Brochure Evaluation Electronics
  For Metrology Applications
  Contents: ND, GAGE-CHEK, EIB, IK

Further HEIDENHAIN products

- Brochures TNC 128 Straight-Cut Control
  TNC 320 Contouring Control
  iTNC 530 Contouring Control
  TNC 620 Contouring Control
  TNC 640 Contouring Control
  Contents: Information for the user

- Brochure Encoders for Servo Drives
  Contents: Rotary encoders
  Linear encoders

- Brochure Angle Encoder Modules
  Contents: Angle encoder modules
  MRP2000, MRP5000, MRP8000
  Incremental torque motor SRP6000, AccurET

- Brochure Touch Probes
  Contents: Tool touch probes
  TT
  Workpiece touch probes
  TS

- Brochure Interfaces of HEIDENHAIN Encoders
  Contents: Information on serial interfaces, sinusoidal signals, square-wave signals, and commutation signals

- Brochure Digital Readouts/Linear Encoders
  For Manually Operated Machine Tools
  Contents: Digital readouts
  ND, POSITIP
  Linear encoders
  LS

- Brochure Modular Angle Encoders
  With Optical Scanning
  Contents: Incremental angle encoders
  ERP, ERO, ERA

- Brochure Measuring Devices For Machine Tool Inspection and Acceptance Testing
  Contents: Incremental linear encoders
  KGM, VM