HEIDENHAIN

Preliminary
Product Information

TCI 2090

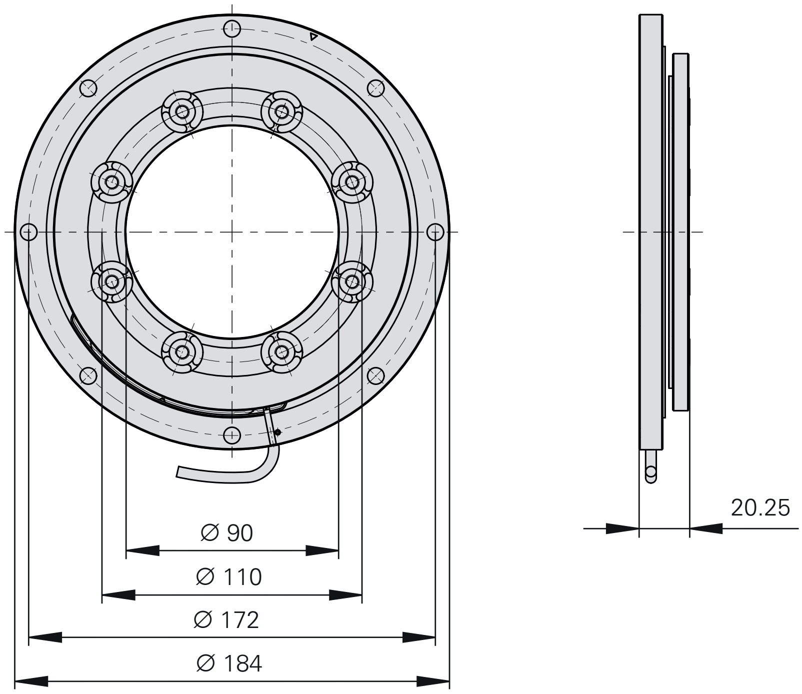
Absolute Inductive
Angle Encoder without
Integral Bearing

08/2025

TCI 2090

- **Absolute angle encoder with inductive scanning**
- **High immunity to contamination**
- **High system accuracy, even at limits of mounting and operating tolerances**
- **Compact modular device comprising a rotor and a stator**

Main dimensions



Technical drawings at www.heidenhain.com/documentation

Mating dimensions
1464698 (upon request)

Specifications	TCI 2090 M	TCI 2090 F
System accuracy[1]	±2"/±5"	
Interpolation error	≤ ±0.7"	
Number of signal periods	182	
Number of poles	364	
Interface	Mitsubishi high speed interface	Fanuc Serial Interface; αi Interface
Ordering designation	Mit03-4	Fanuc05
Positions/revolution	33 554 432 (25 bits)	
Maximum speed	≤ 12 000 rpm	
Analog delay time (typical)	20 µs	
Electrical connection	Cable (2 m) with 8-pin M12 coupling (male)	
Cable length[2]	≤ 30 m	
Power supply	DC 3.6 V to 14 V	
Current consumption (typical)	At 5 V:< 300 mA (without load)	
Power consumption (maximum)	1.5 W	
Natural frequency	> 1000 Hz	
Vibration 55 Hz to 2000 Hz **Shock** 11 ms	≤ 300 m/s^2 (IEC 60068-2-6) ≤ 1000 m/s^2 (IEC 60068-2-27)	
Permissible axial movement[3]	±0.15 mm	
Permissible radial movement[3]	0.05 mm eccentricity (for rotor and stator separately)	
Operating temperature	–10 °C to 70 °C	
Protection EN 60529	Rotor, stator: each IP64 (stator when engaged)	
Moment of inertia of rotor	$1.5 \cdot 10^{-3}$ kgm^2	
Mass	≈ 0.58 kg (stator) ≈ 0.62 kg (rotor)	

1) Attainable system accuracy depends on mounting surface of rotor (see *Measurement accuracy*)
2) With HEIDENHAIN cable
3) Combination of mounting and operating tolerances

General information

Temperature range
The **operating temperature range** indicates the ambient temperature limits between which the angle encoders will function properly.
The **storage temperature range** of –20 °C to +70 °C applies when the unit remains in its packaging.

Protection from contact
After installation of the encoder, all rotating parts must be protected from accidental contact during operation.

Acceleration
Angle encoders are subject to various types of acceleration during operation and installation.

- The indicated maximum values for **vibration resistance** are valid in accordance with EN 60068-2-6.
- The maximum values for the permissible acceleration (sinusoidal shock) for **shock and impact loads** apply at 6 ms (EN 60068-2-27). Under no circumstances should a hammer or similar implement be used to adjust or position the encoder.

Shaft speeds
The maximum permissible shaft speeds were determined in accordance with the FKM guideline. This guideline serves as a mathematical attestation of component strength with regard to all relevant influences, and it reflects the current state of the art. The requirements for fatigue strength (10^7 million reversals of load) were considered in the calculation of the permissible shaft speeds. Because installation has a significant influence, all requirements and directions in the specifications and mounting instructions must be followed in order for the shaft-speed data to be valid.

RoHS
HEIDENHAIN has tested its products to ensure the use of non-hazardous materials in accordance with the European Directives 2002/95/EC (RoHS) and 2002/96/EC (WEEE). For a Manufacturer's Declaration on RoHS, please consult your sales agency.

Parts subject to wear
Encoders from HEIDENHAIN are designed for a long service life. Preventive maintenance is not required. However, they do contain components that are subject to wear depending on the application and how they are deployed. This especially applies to cables that are subject to frequent flexing.

System tests
Encoders from HEIDENHAIN are usually integrated as components into complete systems. Applications of this type require full-system, **comprehensive testing**, regardless of the encoder's specifications. The specifications provided in this brochure apply only to the encoder and not to the complete system. Any operation of the encoder outside of the specified range or outside of its proper and intended use is solely at the user's own risk.
In safety-related systems, the encoder's position value must be tested by the higher-level system after switch-on.

Mounting
The steps and dimensions that must be complied with during mounting are specified solely in the mounting instructions supplied with the device.
All mounting-related information in this brochure is therefore only provisional and non-binding, and will not become the subject matter of a contract.

Measuring principles

Inductive scanning principle
This angle encoder operates according to the inductive measuring principle. Here, moving graduation structures modulate a high-frequency signal in its amplitude and phase. By means of multiple scanning points, the position value is always generated based on the signals from the receiver coils that are distributed along the circumference. This permits wide mounting and operating tolerances while maintaining high resolution and system accuracy.

Measuring standard
Encoders that use the inductive scanning principle employ metal graduations or copper/nickel-based graduation structures. The graduation structures of the TCI 2000 are applied to a carrier made of steel.

Absolute measuring method
In the absolute measuring method, the position value is available immediately upon encoder power-on and can be requested by the downstream electronics at any time. There is therefore no need to search for the reference position by jogging the axes. This absolute position information is ascertained from the graduation of the circular scale, which contains a code structure or consists of multiple parallel graduation tracks. A separate incremental track, or the track with the finest grating period, is interpolated for the position value.

Measurement accuracy
Encoder-specific error

The accuracy of angular measurement is mainly determined by:
- The quality of the graduation
- The stability of the graduation carrier
- The scanning quality
- The quality of the signal processing electronics
- The eccentricity of the graduation relative to the bearing
- The bearing-related error
- The coupling to the measured shaft

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

Encoder-specific error
The encoder-specific error includes:
- The graduation accuracy
- The interpolation accuracy
- The position noise

Graduation accuracy
The graduation accuracy results from the quality of the graduation. It includes:
- Homogeneity and period definition of the graduation
- The alignment of the graduation on the graduation carrier
- For encoders with solid graduation carriers: the stability of the graduation carrier, ensuring accuracy even after mounting

Interpolation accuracy
The interpolation error has an effect even at very low traversing speeds and causes speed fluctuations, especially in the speed control loop. Within the application, the interpolation error affects the machining results, such as the surface quality.

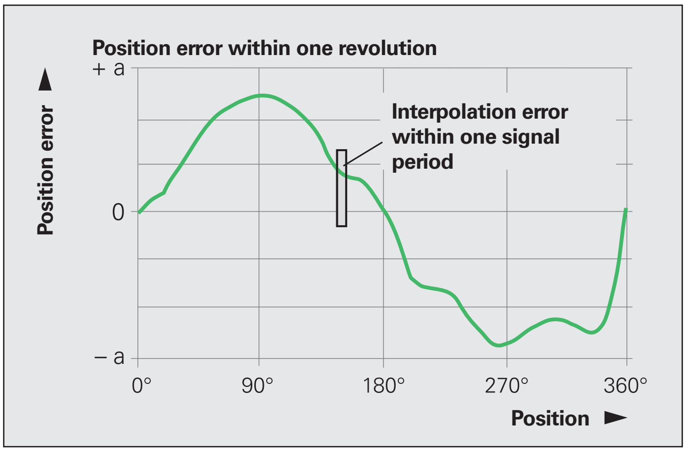
The accuracy of the interpolation is primarily influenced by:
- The fineness of the signal period
- The homogeneity and period definition of the graduation
- The quality of scanning filter structures
- The characteristics of the sensors
- The quality of the signal processing electronics

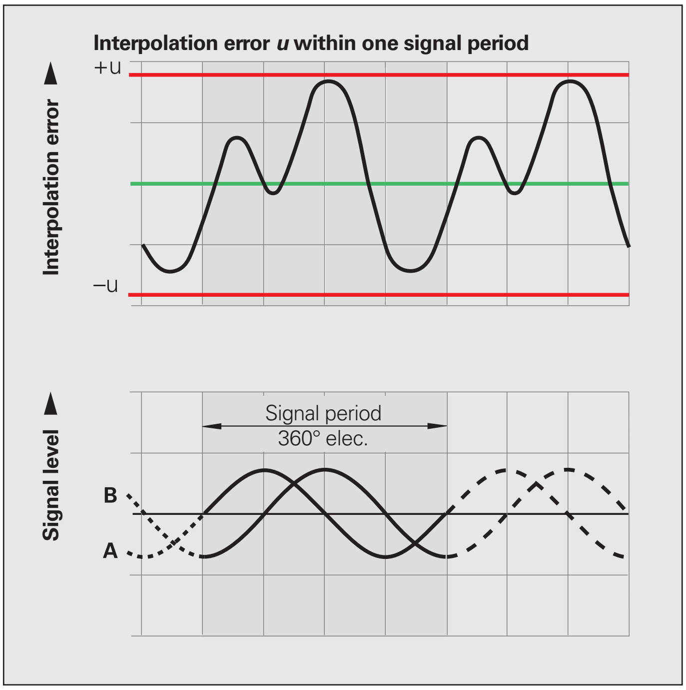
These factors are taken into account in the stated interpolation error within one signal period.

The interpolation accuracy is stated in the form of a maximum value ***u*** of the interpolation error. For specific values, see the technical data.

Position noise
Position noise causes small, random deviations from the expected value. Position noise also depends on the quality of the signal processing. The position noise is taken into account in the interpolation accuracy.

The **system accuracy** defines the upper limit of the position deviations within a given position. It consists of the baseline error combined with the interpolation error. The accuracy grade *a* defines the upper limit of the position error within the measuring range.





Application-dependent errors

Even though the TCI 2000 is an encoder without integral bearing, the mounting has almost no influence on the indicated encoder-specific errors.

Errors due to eccentricity or tilting of the graduation relative to the bearing
Within the ranges for eccentricity and tilting specified in the dimension drawing, even in combination, the resulting signal fluctuations have no negative influence on the attainable accuracy. The indicated system accuracy already takes these influences into account. Due to the design of the TCI 2000 encoder with multiple scanning points, this behavior can also be achieved by an encoder without integral bearing.

Deformation of the graduation resulting from mounting
Despite the solid design of the rotor, the influence of waviness on the mounting surface cannot be ruled out regarding the expected position deviation. Therefore, the specified system accuracy can be guaranteed only under stricter requirements for flatness. However, if lower system accuracies are sufficient, then the flatness requirements can be loosened. The exact values and relations are stated in the dimension drawing. The interpolation accuracy is not affected by this.

Dependency of the system accuracy on the flatness of the rotor mounting surface:

Flatness	System accuracy
5 µm	±2″
20 µm	±5″

Calibration chart

For all angle encoders from HEIDENHAIN, proper functioning is checked and accuracy is measured during final acceptance prior to shipment.
For angle encoders in the TCI 2000 series, HEIDENHAIN creates quality inspection documents that are included with the encoders.

The **Quality Inspection Document** confirms the **system accuracy** of each angle encoder. This is determined by rotating the encoder through a complete revolution and is provided in the form of a measurement curve and the value of the maximum deviation. The maximum **interpolation error** from this measurement is also stated. The mounting-specific error is not included,

By including the **calibration standard**, the quality inspection document establishes the link to national and international standards and ensures traceability.
The measurement parameters and the measurement uncertainty are also provided.

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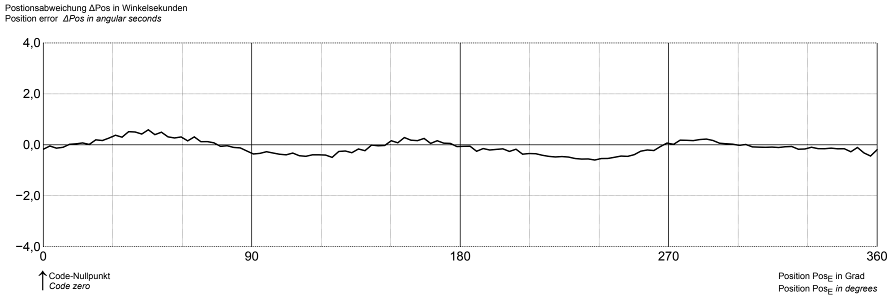
Qualitätsprüfbescheinigung ***Quality Inspection Document***

TCI 2090M
ID 1425017-01
SN X 646634592



Die Messkurve zeigt die Positionsabweichungen bei einer Umdrehung.

The error curve shows the positioning errors from one revolution.

Die Anzahl der Signalperioden des Wnkelmessgerätes beträgt 182.
Dies entspricht der Anzahl von Polen von 364.

The angle encoder has 182 signal periods.
This corresponds to a number of poles of 364.

Positionsabweichung ΔPos des Winkelmessmodules:
$\Delta Pos = Pos_S - Pos_E$
Pos_S = Position des Vergleichsnormals (Standard)
Pos_E = Position des Prüflings

Position error ΔPos of the angular encoder module:
$\Delta Pos = Pos_S - Pos_E$
Pos_S = *position measured by the reference standard*
Pos_E = *position measured the measured encoder*

Maximale Positionsabweichung	
der Messkurve innerhalb 360°	± 0,59"
in einer Signalperiode	± 0,63"

Maximum position error	
of the error curve within 360°	*± 0.59"*
within one signal period	*± 0.63"*

Unsicherheit der Messmaschine
$U_{95\%}$ = 0,05 "

Uncertainty of the measuring machine
$U_{95\%}$ = *0,05 "*

Messparameter	
Messgeschwindigkeit	± 10 rpm
Anzahl der Messpositionen pro Umdrehung	3200

Measurement parameters	
Measuring speed	*± 10 rpm*
Number of measuring positions per revolution	*3200*

Dieses Winkelmessgerät wurde unter den strengen HEIDENHAIN-Qualitätsnormen hergestellt und geprüft.
Die Positionsabweichung liegt bei einer Bezugstemperatur von 22°C innerhalb der Genauigkeitsklasse ±2,00".

This angle encoder module has been manufactured and inspected in accordance with the stringent quality standards of HEIDENHAIN. The position error at a reference temperature of 22°C lies within the accuracy grade ±2.00".

In der Applikation entstehen zusätzliche Positionsabweichungen.
Beachten Sie hierzu die Angaben im Prospekt.

Additional position errors arise in the application. Please note the information about this in the brochure.

Kalibriernormal	Kalibrierzeichen
ERP 880	870 D-K-19057-01-00 2021-08

Calibration standard	Calibration mark
ERP 880	*870 D-K-19057-01-00 2021-08*

02.07.2025
Prüfer/*Inspected by* M. Kohler

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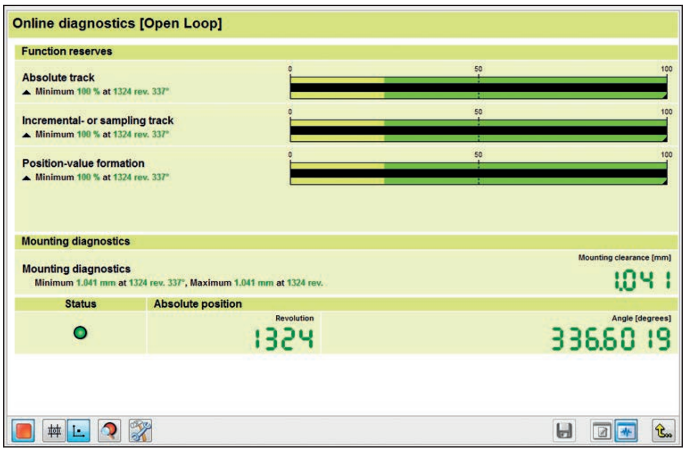
Mounting
Functional testing and diagnostics

HEIDENHAIN provides various aids for ensuring easy and optimal initial setup of modular angle encoders.

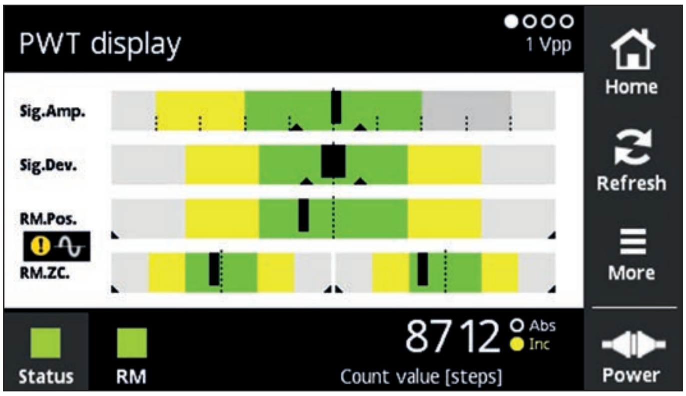
Mechanical mounting
High-quality physical mounting within tolerance is essential for ensuring the high reliability of the angle encoder. Please follow the mounting instructions.

Functional testing with the PWT 101 and PWM 21
The PWT 101 and the PWM 21 with the ATS software provide basic functions for all angle encoders. For absolute encoders, warnings, alarms, and the function reserves can be output.

Diagnostics in the control loop
The TCI absolute encoders transmit valuation numbers to the downstream electronics, thereby enabling diagnostics for the encoders' status or determination of the function reserve, including directly within the control loop at the numerical control (if the control supports this). The scaling is the same for all HEIDENHAIN encoders; it is indicated as function reserve (0% to 100%).



Example: Diagnostics with PWM 21 and ATS software



Example: Functional testing with PWT 101

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

More information:

To ensure proper and intended use, comply with the specifications in the following documents:
- Brochure: *Interfaces of HEIDENHAIN Encoders* 1078628-xx
- Brochure: *Cables and Connectors* 1206103-xx
- Operating Instructions Upon request

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