Product Information

**KCI 120 Dplus**
Absolute Inductive Rotary Encoder with Additional Functionality:

Position measurement at the output side

With additional measures: suitable for safety-related applications with up to SIL 3
KCI 120 D plus
Absolute inductive rotary encoder with additional functionality

- Robust inductive scanning principle
- Consisting of an AE scanning unit and two rotor units (disk/hub assembly)
- Additional position measurement at the output side

M1 = Measuring point for operating temperature; ensure electrical isolation for the mounted temperature sensor
M2 = Measuring point for vibration

1 = 15-pin PCB connector
2 = Cylinder head screw
   DIN EN ISO 4762 – M2.5 x12 – 8.8 – MKL* or
   DIN EN ISO 14583 – M2.5 x12 – 8.8 – MKL (ID 202264-61);
   tightening torque: 0.7 Nm ±0.05 Nm, with spring washer: DIN 6796 – 2.5 – FSt,
   and washer: ID 1334899-01

Pay attention to the installation position of the spring washer!

3 = Ensure installation space for cable
4 = Direction of shaft rotation for ascending position values
5 = TKN for Rotor A, separate; for mounting, see the respective mating dimensions
6 = TKN for Rotor B, separate; for mounting, see the respective mating dimensions
7 = Holes as an option for aligning the scanning unit by means of a device
   centered position relative to reference (3) after mounting
8 = Room for supporting flange for Rotor A; avoid collision with the scanning unit
9 = Ensure > 1 mm gap for air and creepage distances

* Instructions for use: screw with material bonding anti-rotation lock as per DIN 267-27;
see general mechanical information in the Rotary Encoders brochure (screw not included in delivery!)

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General information

Specifications | KCI 120 Dplus
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**Interface** | EnDat 2.2
**Ordering designation** | EnDat22
**Calculation time** $t_{\text{calc}}$ | ≤ 5 µs
**Clock frequency** | ≤ 16 MHz
**Clock frequency** | 5 µs
**Ordering designation** | 16 MHz
**Electrical connection** | EnDat22
**Supply voltage** | DC 3.6 V to 14 V (for both axes together)
**Power consumption (max.)**
- At 3.6 V: ≤ 1.2 W
- At 14 V: ≤ 1.4 W
**Angular acceleration of rotors** | ≤ 1 · 10^5 rad/s^2
**Vibration**
- 55 Hz to 2000 Hz
  - AE scanning unit: ≤ 400 m/s^2; rotors: ≤ 600 m/s^2 (EN 60068-2-6)
- ≤ 2000 m/s^2 (EN 60068-2-27)
**Shock** | 6 ms
**Operating temperature** | –40 °C to 115 °C
**Trigger threshold for exceeded temperature error message** | 125 °C (measuring accuracy of the internal temperature sensor: ±1 K at 125 °C)
**Relative humidity** | ≤ 93% (40 °C/21 d as per EN 60068-2-78), condensation excluded
**Protection rating** | EN 60529
- IP00 (read about insulation under Electrical safety in the Interfaces of HEIDENHAIN Encoders brochure)
**Mass** | ≤ 0.1 kg (scanning unit and rotors)
**ID number**
- Individual packaging:
  - ID: 1362005-02 (AE scanning unit)
  - ID: 1362006-01 (disk/hub assembly: Encoder A)
  - ID: 1362007-01 (disk/hub assembly: Encoder B)
- Collective package:
  - ID: 1362005-52 (AE scanning unit)
  - ID: 1362006-51 (disk/hub assembly: Encoder A)
  - ID: 1362007-51 (disk/hub assembly: Encoder B)

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1) See pin layout for encoder
2) See General electrical information in the Interfaces of HEIDENHAIN Encoders brochure, or visit www.heidenhain.com
3) Scanning unit: 10 Hz to 55 Hz, 6.5 mm constant peak to peak
   Rotors: 10 Hz to 55 Hz, 10 mm constant peak to peak

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= Bearing of mating shaft
\(\) = Mating dimensions on the customer side; mounting with centering collar
\(\) = Mating dimension on the customer side; mounting with cylindrical pins (not available as an accessory)
\(\) = Customer-side mating dimensions; mounting with mounting device (not available as an accessory)
= Ensure space for electronics; see also the mating dimension model
= Flange surface: ensure full-surface, burr-free contact!
= Chamfer at start of thread is obligatory for material bonding anti-rotation lock
= For thread dimensions, see \(\)
Position measurement

<table>
<thead>
<tr>
<th>Specifications</th>
<th>KCI 120 Dplus singletum Output side (Encoder A)</th>
<th>KCI 120 Dplus singletum Motor side (Encoder B)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functional safety</strong></td>
<td>As a single-encoder system for monitoring functions and control-loop functions:</td>
<td></td>
</tr>
<tr>
<td>for applications with up to</td>
<td>• SIL 2, as per EN 61508 (further basis for testing: IEC 61800-5-3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Category 3, PL d, in accordance with EN ISO 13849-1:2015</td>
<td></td>
</tr>
<tr>
<td></td>
<td>With additional measures as per document 1000344, suitable for safety-related applications with up to SIL 3 or Category 4, PL e</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safe in the singletum range of both axes</td>
<td></td>
</tr>
<tr>
<td><strong>PFH (each encoder)</strong></td>
<td>SIL 2: ≤ 15 · 10⁻⁹ (probability of dangerous failure per hour)</td>
<td>SIL 3: ≤ 2 · 10⁻⁸</td>
</tr>
<tr>
<td><strong>Safe position</strong>¹</td>
<td>Encoder: ±0.44° (safety-related measuring step SM = 0.176°)</td>
<td>Mechanical coupling for shaft: 0° (fault exclusion for the loosening of the shaft coupling and stator coupling, designed for accelerations at the stator: ≤ 400 m/s²; at the rotor: ≤ 600 m/s²)</td>
</tr>
<tr>
<td><strong>Shaft</strong></td>
<td>Hub with an inside diameter of 29 mm</td>
<td>Hub with an inside diameter of 34 mm</td>
</tr>
<tr>
<td><strong>Shaft speed</strong></td>
<td>≤ 6000 rpm</td>
<td>≤ 15 000 rpm</td>
</tr>
<tr>
<td><strong>Moment of inertia of rotor</strong></td>
<td>17 · 10⁻⁶ kgm²</td>
<td>15 · 10⁻⁶ kgm²</td>
</tr>
<tr>
<td><strong>Axial motion</strong>²</td>
<td>±0.3 mm</td>
<td>±0.5 mm</td>
</tr>
<tr>
<td><strong>Position values per revolution</strong></td>
<td>1 048 576 (20 bits)</td>
<td>524 288 (19 bits)</td>
</tr>
<tr>
<td><strong>System accuracy</strong></td>
<td>±40”</td>
<td>±120”</td>
</tr>
</tbody>
</table>

¹ Further tolerances may arise in the downstream electronics after position value comparison (contact mfr.)
² Including thermal linear expansion and mounting tolerance

Mounting

Mounting and protection rating

Mounting the KCI 120 Dplus consists of the following: alignment and mounting of the scanning unit, and press-fitting the two disk/hub assemblies. The disk/hub assemblies are press-fitted onto the respective shaft, and the scanning unit is mounted to the mating surface via the four holes. Alignment can optionally be performed with a centering collar, with cylindrical pins or with a mounting device.

The press-fitting process may be performed only once for each disk/hub assembly. For press-fitting, adhere to the material properties and the conditions for the mating surfaces stated in the relevant documents for use. These requirements must be followed, even when new disk/hub assemblies are press-fitted onto a mating shaft that has already been used.

Once the lower limit of the press-fit force has been exceeded, the press-fit force being applied must remain within the specified range for the rest of the procedure, including until the final position is reached. If the application features functional safety, then, after the mounting or installation of the encoder onto the mating surface, the device must be protected from at least the ingress of solid foreign objects in accordance with an IP6x protection rating, as well as from the ingress of liquids (the protection rating for liquids depends on the application; e.g., IPx5: protection from water jets). If exposure to contamination, such as dust and liquids, can be excluded, then a protection rating of at least IP40 when mounted is sufficient.

Mounting and protection rating

For more information:

Follow the measures for electromagnetic compatibility described in the General electrical information in the Interfaces of HEIDENHAIN Encoders brochure to ensure disturbance-free operation.
For the design of the fault exclusion, the following material properties and conditions for the mating surfaces are assumed.

### Customer motor shaft
- **Material:** Unalloyed hardened steel
- **Tensile strength** $R_m$ $\geq 600 \text{ N/mm}^2$
- **Yield strength** $R_{p0.2}$ or **yield point** $R_y$ $\geq 400 \text{ N/mm}^2$
- **Shear strength** $\tau_a$ $\geq 390 \text{ N/mm}^2$
- **Interface pressure** $p_G$ $\geq 660 \text{ N/mm}^2$
- **Modulus of elasticity** $E$ (at 20 °C) $200 \text{ kN/mm}^2$ to $215 \text{ kN/mm}^2$
- **Coefficient of thermal expansion** $\alpha_{thm}$ (at 20 °C) $10 \cdot 10^{-6} \degree \text{C}^{-1}$ to $12 \cdot 10^{-6} \degree \text{C}^{-1}$
- **Surface roughness** $R_z$ $\leq 16 \mu \text{m}$
- **Friction values:** Lubrication at the joint surfaces is recommended. Mounting surfaces must be clean and free of grease. Use screws and washers in their condition as delivered.
- **Tightening procedure:** Use a signal-emitting torque wrench as per DIN EN ISO 6789, with an accuracy of ±6 %
- **Mounting temperature:** 15 °C to 35 °C

### Customer output shaft
- **Material:** Hardenable wrought aluminum alloy
- **Yield strength** $R_{p0.2}$ or **yield point** $R_y$ Not applicable
- **Interface pressure** $p_G$ $\geq 250 \text{ N/mm}^2$
- **Modulus of elasticity** $E$ (at 20 °C) $70 \text{ kN/mm}^2$ to $75 \text{ kN/mm}^2$
- **Coefficient of thermal expansion** $\alpha_{thm}$ (at 20 °C) $\leq 25 \cdot 10^{-6} \degree \text{C}^{-1}$

### Customer stator
- **Material:** Unalloyed hardened steel
- **Tensile strength** $R_m$ $\geq 220 \text{ N/mm}^2$
- **Yield strength** $R_{p0.2}$ or **yield point** $R_y$ Not applicable
- **Shear strength** $\tau_a$ $\geq 130 \text{ N/mm}^2$
- **Interface pressure** $p_G$ $\geq 250 \text{ N/mm}^2$
- **Modulus of elasticity** $E$ (at 20 °C) $70 \text{ kN/mm}^2$ to $75 \text{ kN/mm}^2$
- **Coefficient of thermal expansion** $\alpha_{thm}$ (at 20 °C) $\leq 25 \cdot 10^{-6} \degree \text{C}^{-1}$
- **Surface roughness** $R_z$ $\leq 16 \mu \text{m}$
- **Friction values:** Lubrication at the joint surfaces is recommended. Mounting surfaces must be clean and free of grease. Use screws and washers in their condition as delivered.
- **Tightening procedure:** Use a signal-emitting torque wrench as per DIN EN ISO 6789, with an accuracy of ±6 %
- **Mounting temperature:** 15 °C to 35 °C

#### Integrated temperature evaluation

Each axis of these rotary encoders features an internal temperature sensor integrated into the encoder electronics. The digitized temperature value is transmitted purely serially via the EnDat protocol. Please bear in mind that this measurement and transmission of the temperature is not safe in terms of functional safety.

Regarding the internal temperature sensor, the rotary encoder supports the two-stage cascaded signaling of a temperature exceedance. This consists of an EnDat warning and an EnDat error message.

In accordance with the EnDat specification, an EnDat warning (EnDat memory area “Operating status,” word 1 “Warnings,” bit 21 “Temperature exceeded”) is output when the warning threshold for the temperature exceedance of the internal temperature sensor is reached. This warning threshold for the internal temperature sensor is stored in the EnDat memory area “Operating parameters,” word 6 “Trigger threshold warning bit for excessive temperature” of each axis, and can be individually adjusted.

A device-specific default value is saved here before the encoder is shipped. The temperature measured by the internal temperature sensor is higher by a device- specific and application-specific amount than the temperature at the measuring point, as shown in the dimension drawing.

Each axis of the rotary encoder features a further, albeit non-adjustable trigger threshold for the “Temperature exceeded” EnDat error message of the internal temperature sensor. When this is reached, an EnDat error message is output (EnDat memory area “Operating status,” word 6 “Error messages,” bit 22 “Position” and in additional data 2 “Operating status error sources,” bit 25 “Temperature exceeded”). This trigger threshold may vary depending on the encoder and is stated in the specifications.

HEIDENHAIN recommends adjusting the warning threshold based on the application such that this threshold is sufficiently below the trigger threshold for the “Temperature exceeded” EnDat error message. Compliance with the temperature at the measuring point is required for adherence to the encoder’s intended and proper use.

#### Electrical resistance

Check the electrical resistance between the customer-side stator and both customer-side shafts. Nominal value: $< 1 \text{ ohm}$

For more mounting information and mounting aids, see the Mounting Instructions and the Encoders for Servo Drives brochure. The mounting quality can be tested with the PWM 21 and the ATS software (see document ID 1082418).
Testing and inspection devices, and diagnostics

This enables the downstream electronics to evaluate the current status of the encoder with little effort, even in closed-loop mode.

For the analysis of these encoders, HEIDENHAIN offers the appropriate PWM inspection devices and PWT testing devices. Based on how these devices are integrated, a distinction is made between two types of diagnostics:

- Encoder diagnostics: the encoder is connected directly to the testing or inspection device, thereby enabling a detailed analysis of encoder functions.
- Monitoring mode: the PWM inspection device is inserted within the closed control loop (via suitable testing adapters as needed). This enables real-time diagnosis of the machine or equipment during operation. The available functions depend on the interface.

PWM 21

The PWM 21 phase-angle measuring unit, in conjunction with the included ATS adjusting and testing software, serves as an adjusting and testing package for the diagnosis and adjustment of HEIDENHAIN encoders.

<table>
<thead>
<tr>
<th>Encoder input</th>
<th>Interface</th>
<th>Supply voltage</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnDat 2.1, EnDat 2.2, or EnDat 3 (absolute value with or without incremental signals)</td>
<td>USB 2.0</td>
<td>AC 100 V to 240 V or DC 24 V</td>
<td>258 mm × 154 mm × 55 mm</td>
</tr>
<tr>
<td>Fanuc Serial Interface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitsubishi high speed interface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yaskawa Serial Interface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panasonic serial interface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Vpp/11 µAPP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTL (via signal adapter)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more information, see the PWM 21/ATS Software Product Information document.

HEIDENHAIN offers two testing cables for this purpose. As a result, either a testing cable for the output-side encoder or a testing cable for the motor-side encoder can be connected to the PWM 21 as needed.

Pin layout of the testing cables

Testing cable for connection to Encoder A: 1310446-xx

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission (Encoder A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>0 V</td>
<td>Sensor A</td>
</tr>
<tr>
<td>White</td>
<td>Green</td>
</tr>
</tbody>
</table>

Up – Power supply
Vacant pins or wires must not be used!

Testing cable for connection to Encoder B: 1310447-xx

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission (Encoder B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>0 V</td>
<td>Sensor B</td>
</tr>
<tr>
<td>White</td>
<td>Green</td>
</tr>
</tbody>
</table>

Up – Power supply
Vacant pins or wires must not be used!

Electrical connection

A special testing cable is attached to the PWM 21 diagnostic and inspection device in order to Encoder A (output side). In order to connect Encoder B (motor side), a different special testing cable must be used.
Cable length > 0.5 m:
To prevent crosstalk, the two EnDat interfaces must be separately shielded from each other. The cable sold by the meter with ID 1347450-xx (PUR, Ø 3.7 mm) can be used for this. Two cables must be attached to the PCB connector in order to transmit the EnDat signals separately. Only one cable is used for the power supply.

When using the cable sold by the meter with ID 1347450-xx, comply with the general information in the Cables and Connectors brochure; use of the cables at temperatures of up to 100 °C is possible, provided that the exposure to hydrolysis and harmful media is low.

Cable length ≤ 0.5 m:
When single wires with up to a maximum length of 0.5 m are used, each data and clock wire combination must be implemented as a twisted wire pair in order to avoid coupled interferences. As an alternative, the cable with ID 605090-51 (EPG, Ø 4.5 mm) and a length of 0.3 m can be used. The general information in the Cables and Connectors brochure must be noted.

Pin layout for the rotary encoder

15-pin PCB connector

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Serial data transmission (Encoder A)</th>
<th>Serial data transmission (Encoder B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 12 13 11</td>
<td>7 8 9 10 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>0 V Sensor</td>
<td>DATA A  DATA A  CLOCK A  CLOCK A</td>
<td></td>
</tr>
<tr>
<td>0 V U_p</td>
<td>DATA B  DATA B  CLOCK B  CLOCK B</td>
<td></td>
</tr>
</tbody>
</table>

U_p = Power supply
Vacant pins or wires must not be used!
The downstream electronics must have a common ground reference!