Modular integrated Robot Joint
High torque and low cogging for excellent performance
Robot Joint Overview

Introduction
maxon’s compact EC frameless motors combined with an EPOS4 positioning controller delivers a highly dynamic, powerful drive package with field-oriented control (FOC), high efficiency, and maintenance-free components in a high-quality industrial housing. High torque and low cogging effect provide excellent performance. Zero Backlash gearheads in combination with a double feedback system allows for excellent positioning movements. To ensure safety during operation a brake system can be added.

Design of the Robot Joint
The compact modular design of the robot joint series is optimal for performance and size. Various options are available such as a hollow shaft, torque sensor, brake and electronics.

Positioning Controller (under development)
The next generation of positioning controllers offer impressively superior dynamics and outstanding power density. The modular design opens up a wide range of opportunities regarding communication and feedback encoders. The CANopen and EtherCAT field buses, as well as the adjustable digital and analog inputs and outputs, are matched optimally to the various functions and operating modes of the CiA-402 device profile. In addition to the intuitive commissioning software, there are libraries available free of charge for integration into a wide variety of master systems. With the graphic user interface of the EPOS Studio, the configurable drive system automatically searches for ideal control parameters (auto tuning) and is ready for use at the press of a button.

Commissioning
maxon preconfigures the robot joints before shipping. Motor, encoder, and brake parameters are stored on the positioning controller at the factory. For commissioning at the customer site, maxon provides the auto tuning function via the EPOS Studio. This reduces the installation time dramatically.

Gear
The customized zero backlash gear with its high position accuracy and zero backlash can achieve high precision and optimal position control. Various gear ratios can be selected.

Brake
The drive can be combined with an optional holding brake; this increases the length of the drive. The brake is active when disconnected from power. It is a holding brake, which is not suitable for deceleration. The brake is controlled by the integrated controller.

Encoders
The Robot Joint series has two integrated encoders. The two different encoder signals can be evaluated simultaneously. This allows for dual-loop control which can be tuned automatically to compensate for mechanical backlash and elasticity.

Torque Sensor
The torque sensor can be used to measure torque at the output shaft of the robotic joint.

Robot Joint Selection
maxon Robot Joints are integrated systems and can be build according to the customer requirements. The base joints on the following pages are containing motor, gear, brake, hollow shaft and double feedback system. An optional position controller and torque sensor can be added. Detailed dimensional drawings based on the selected options are available upon request.

High performance
Compact
Easy to use

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Electromate
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www.electromate.com
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Product components

→ maxon brushless EC frameless motors
→ Customized zero backlash gear
→ Double feedback system
→ Brake
→ Positioning Controller (under development)
→ Torque sensor
→ Hollow shaft
Robot Joint 45 ø70 mm, 70 Watt
Modular integrated Robot Joint

Technical data
- Outer diameter: m 70
- Inner diameter: mm 6
- Length: mm L
- Weight: kg 1.16
- Nominal voltage: VDC 24
- Nominal current: A 3.2
- Motor/torque constant: mNm/A 37
- Nominal torque (Gear ratio 101:1): Nm 8
- Acceleration/Deceleration torque (Gear ratio 101:1): Nm 19
- Nominal speed (Gear ratio 101:1): rpm 49
- Brake: YES
- Brake voltage: VDC 24
- Storage temperature: °C 20
- Operation temperature: °C -10 ... +70
- Humidity: 0 ... 70% non-condensing

Other specifications
- Gear
  - Reduction ratio: 51:1, 81:1, 101:1
- Incremental Encoder
  - Resolution of incremental encoder: lines 500
  - Supply voltage: VDC 5 ± 10%
  - Output current: mA 55 ± 10%
  - Rise time: ns 100
  - Fall time: ns 180
  - Max. count frequency: kHz 100
- Absolute Encoder
  - Resolution of absolute encoder: bits 19
  - Maximum speed: rpm 10,000
  - Bandwidth: kHz 9
  - Refresh rate: kHz 18
  - Refresh rate: kHz 4.4
  - Sampling rate: kHz 18
  - Supply voltage: VDC 5 ± 0.5
  - Max. power consumption: mA 150
  - Precision of absolute encoder: ° 0.1
  - Repeated precision of absolute encoder: ° 0.001
  - Running range: ° ± 180
  - Maximum clock frequency: kHz 2000
  - Sample rate: kHz 18
  - Time out: Us 13.5

Joint Cable A

Joint Cable B
- Pin 1: VCC, Pin 2: GND, Pin 3: Clock+, Pin 4: Clock-, Pin 5: DATA+, Pin 6: DATA-, Pin 7: Green, Pin 8: Purple
- RJ45 Cable A (AWG24): Pin 1: Brake+, Pin 2: Brake-, Pin 3: Brake
Technical data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
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<tr>
<td>Outer diameter</td>
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<td>Inner diameter</td>
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<td>Weight</td>
<td>kg</td>
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<td>Nominal voltage</td>
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<tr>
<td>Nominal current</td>
<td>A</td>
<td>5.5</td>
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<tr>
<td>Motor/torque constant</td>
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<td>Acceleration/Deceleration</td>
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<td>Brake voltage</td>
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<tr>
<td>Storage temperature</td>
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<tr>
<td>Operation temperature</td>
<td>°C</td>
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<tr>
<td>Humidity</td>
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<td>0 ... 70 % non-condensing</td>
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Other specifications

<table>
<thead>
<tr>
<th>Gear</th>
<th>Reduction ratio</th>
<th>511, 81:1, 1011, 121:1</th>
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<tbody>
<tr>
<td>Incremental Encoder</td>
<td>Lines</td>
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<tr>
<td>Supply voltage</td>
<td>VDC</td>
<td>5 ± 0.5</td>
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<tr>
<td>Output current</td>
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<td>55 ± 10%</td>
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<tr>
<td>Rise time</td>
<td>ns</td>
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<tr>
<td>Fall time</td>
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<td>Max. count frequency</td>
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<td>High level output voltage</td>
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<td>Low level output voltage</td>
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Absolute Encoder

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<td>Bandwidth</td>
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<td>Sampling rate</td>
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<td>Refresh rate</td>
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<tr>
<td>Supply voltage</td>
<td>VDC</td>
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<td>Max. power consumption</td>
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<td>150</td>
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<tr>
<td>Precision of absolute encoder</td>
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<td>0.1</td>
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<tr>
<td>Repeated precision of absolute encoder</td>
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<td>0.001</td>
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<tr>
<td>Running range</td>
<td></td>
<td>+/-180</td>
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<tr>
<td>Maximum clock frequency</td>
<td>kHz</td>
<td>2000</td>
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<tr>
<td>Sample rate</td>
<td>kHz</td>
<td>18</td>
</tr>
<tr>
<td>Time out</td>
<td>Us</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Joint Cable A

- Pin 1: VCC Red
- Pin 2: GND Black
- Pin 3: Hall 1 Yellow
- Pin 4: Hall 2 Brown
- Pin 5: Hall 3 Orange
- Pin 6: CH A Blue
- Pin 7: CH B Green
- Pin 8: CH I Purple

Joint Cable B

- Pin 1: VCC Red
- Pin 2: GND Black
- Pin 3: CLOCK+ Green
- Pin 4: CLOCK- Yellow
- Pin 5: DATA+ Brown
- Pin 6: DATA- Orange

RJ60 Cable A (AWG18)

- Pin 1: Winding 1 Red
- Pin 2: Winding 2 Black
- Pin 3: Winding 3 White

RJ60 Cable A (AWG24)

- Pin 1: Brake+ Brown
- Pin 2: Brake- Blue

SSI timing diagram

Performance curve gear ratio 101:1

Output Waveforms

- Amplitude
- Rotation

- Outputs: ok. a, ok. b

- Clock: 15 Min
- Data: Start

- Sample rate kHz 18
- Maximum clock frequency kHz 2000

- Time out Us 13.5

Graph parameters:

- Velocity/rpm
- Torque/Nm
- Rotation

- Performance curve gear ratio 101:1

Graph options:

- 75% Duty Cycle
- 50% Duty Cycle
- 25% Duty Cycle
Robot Joint 90  Ø110 mm, 260 Watt
Modular integrated Robot Joint

M 1:4

Technical data
- Outer diameter: m 110
- Inner diameter: mm 17
- Length: mm L
- Weight: kg 3.45
- Nominal voltage: VDC 24
- Nominal current: A 6
- Motor/torque constant: mNm/A 71
- Nominal torque (Gear ratio 101:1): Nm 34
- Acceleration/Deceleration torque (Gear ratio 101:1): Nm 103
- Nominal speed (Gear ratio 101:1): rpm 27
- Brake: YES
- Brake voltage: VDC 24
- Storage temperature: °C 20
- Operation temperature: °C -10 ... +70
- Humidity: 0 ... 70 % non-condensing

Other specifications
- Gear Reduction ratio: 51:1, 81:1, 101:1, 121:1, 161:1
- Incremental Encoder
  - Resolution of incremental encoder: lines 2048
  - Supply voltage: VDC 5±10%
  - Output current: mA 55±10%
  - Rise time: ns 180
  - Fall time: ns 49
  - Max. count frequency: kHz 100
- Absolute Encoder
  - Resolution of absolute encoder: bits 19
  - Maximum speed: rpm 10,000
  - Bandwidth: kHz 9
  - Sampling rate: kHz 18
  - Refresh rate: kHz 44
  - Supply voltage: VDC 5±10%
  - Max. power consumption: mA 150
  - Precision of absolute encoder: ° 0.1
  - Repeated precision of absolute encoder: ° 0.001
  - Running range: ° ±180
  - Maximum clock frequency: kHz 2000
  - Sample rate: kHz 18
  - Time out: Us 13.5

Joint Cable A
- Pin 1: VCC: Red
- Pin 2: GND: Black
- Pin 3: Hall 1: Yellow
- Pin 4: Hall 2: Brown
- Pin 5: Hall 3: Orange
- Pin 6: CH A: Blue
- Pin 7: CH B: Green
- Pin 8: CH I: Purple

Joint Cable B
- Pin 1: VCC: Red
- Pin 2: GND: Black
- Pin 3: CLOCK+: Green
- Pin 4: CLOCK-: Yellow
- Pin 5: DATA+: Brown
- Pin 6: DATA-: Orange

RJ90 Cable A (AWG18)
- Pin 1: Winding 1: Red
- Pin 2: Winding 2: Black
- Pin 3: Winding 3: White

RJ90 Cable A (AWG24)
- Pin 1: Brake+: Brown
- Pin 2: Brake-: Blue

SSI timing diagram

Performance curve (gear ratio 101:1)