maxon
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# High Efficiency Joint

*HEJ 50-48-30*

## 30 V – 60 V | 30 Nm | 26 rad/s

This is a highly compact, integrated and efficient robotic drive system that contains all subsystems to provide a full motion solution, such as controller, motor, gearing and sensing. This drive is highly enclosed, impact-rated, and designed for continuous operation and active thermal cooling if necessary. It offers high robustness and a long operating lifetime. Controlled via *EtherCAT*, it features an advanced impedance controller, rendering it suitable for modern robotics applications. Simulation models enable dependable robotic system designs.

EtherCAT

All data are provided for $U_{DC}$ = 48 V and $T_{amb}$ = 25°C, unless otherwise specified.
Specifications for different voltage levels or other operating limits, and corresponding simulation models, are available upon request.

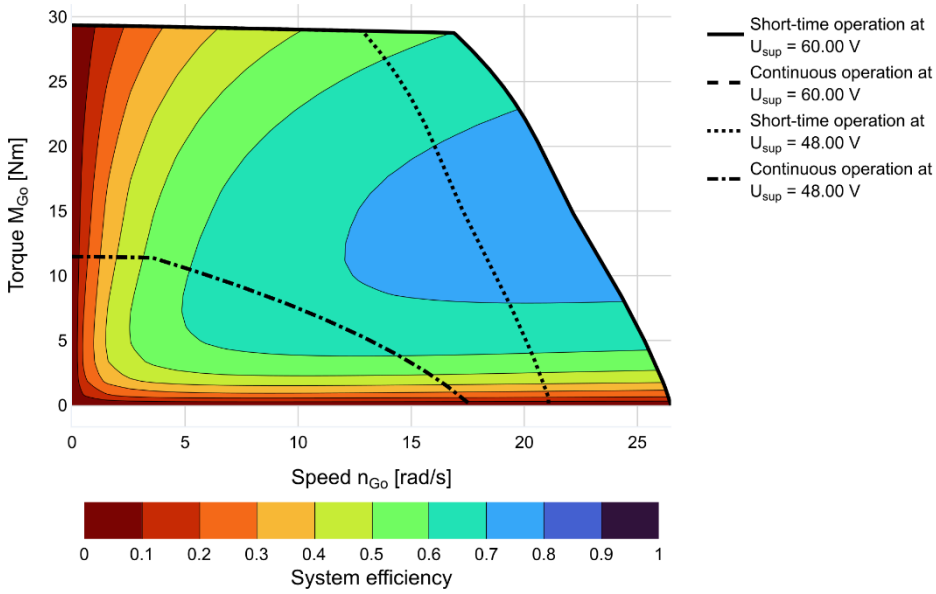
| OUTPUT CHARACTERISTICS | | |
|---|---|---|
| Maximum joint velocity | $U_{DC}$ = 48V | +/- 21 rad/s |
| | $U_{DC}$ = 60V | +/- 26 rad/s |
| Maximum joint torque, actively controlled & repetitive<br>This torque can be applied for several seconds (e.g., approx. 1s - 3s). The duration and intervals are thermally limited. | | +/- 30 Nm |
| Nominal joint torque<br>This torque can be maintained indefinitely without external forced air cooling. Conditions: Actuator mounted in free space (to allow convective cooling), and with a joint velocity of 2 rad/s. | | +/- 11 Nm |

**POWER CONVERSION CHARACTERISTICS** Motor Operating Quadrants

| $U_{DC}$ (V)<br>DC-Link Voltage | $V_{joint}$ (rad/s)<br>Joint Velocity | $M_{joint}$ (Nm)<br>Joint Torque | $I_{in}$ (A)<br>DC-Link Input Curr. | $P_{loss}$ (W)<br>Total System Loss | Efficiency (%)<br>$P_{out,mech}$ / $P_{in,elec}$ | |
|---|---|---|---|---|---|---|
| 48 | 0 | 0 | 0.04 | 2.0 | 0 | ● |
| 48 | 0 | 29 | 3.1 | 184 | 0 | ▲ |
| 48 | 0 | 20 | 1.1 | 65 | 0 | ● |
| 48 | 0 | 15 | 0.6 | 36 | 0 | ● |
| 48 | 0 | 10 | 0.3 | 17 | 0 | ● |
| 48 | 0 | 5 | 0.1 | 6 | 0 | ● |
| | | | | | | |
| 48 | 10 | 0 | 0.3 | 19 | 0 | ● |
| 48 | 10 | 25 | 7.3 | 190 | 57 | ▲ |
| 48 | 10 | 20 | 5.2 | 114 | 64 | ▲ |
| 48 | 15 | 0 | 0.5 | 30 | 0 | ● |
| 48 | 15 | 20 | 7.2 | 133 | 69 | ▲ |
| 48 | 15 | 10 | 3.5 | 61 | 71 | ● |
| 48 | 20 | 0 | 0.7 | 43 | 0 | ● |
| 48 | 20 | 5 | 2.6 | 56 | 64 | ● |
| | | | | | | |
| 60 | 25 | 0 | 0.96 | 58 | 0 | ● |
| 60 | 25 | 10 | 3.8 | 77 | 66 | ▲ |

Operating points with a triangle (▲) can only be maintained for short times (some seconds, due to thermal limitations (mainly: continuous input current limited to 4.7 $A_{RMS}$)).
Operating points marked with a circle (●) can be maintained continuously but potentially require adequate external forced air cooling.

## POWER CONVERSION PERFORMANCE MAP Motor Operating Quadrants




Note: This graphic shows the maximum achievable joint torque/velocities for the given supply voltages. Refer to the *Power Conversion Characteristics* table above for details about the continuous operating points. Further details are available on request.

Highest efficiency, motor quadrant: 74.1%.

## ELECTRICAL CHARACTERISTICS

| | |
|---|---|
| Operating input voltage range (voltages as low as 20V are possible but can have implications – contact us.) | 30 V – 60 V |
| Max. allowable transient input voltage (e.g., due to inductive spikes or noise on the supply bus) | 67.0 V |
| DC link input capacitance (MLCC) | 100 µF |
| Max. power supply input current<br>During transients or accelerations, the system can create high current peaks. Capacitive inrush current not considered. Unloaded joint. | < 40 A |
| Max. continuous power supply current<br>Input currents may only exceed this value for very short periods of time to prevent damage to the power connector or internal cabling. | 4.7 $A_{RMS}$ |

## CONTROL CHARACTERISTICS

| | |
|---|---|
| Control modes | Joint position, velocity, torque, motor current (FOC)<br>Joint impedance controller (simultaneous control of position, velocity, torque)<br>PDO-mappable control gains<br>Internal cogging, friction and backlash compensation systems |
| Joint position sensor | Resolution: 14 bit. Absolute angular error: < 0.01 rad (0.6°)<br>Note that the firmware applies sensor fusion techniques to reduce noise and INL error on this encoder signal. This sensor measures the absolute output position (after the gear). |
| Joint torque measurement<br>Via electric motor current, compensated | Absolute error, steady-state: < 0.8 Nm |
| Joint velocity filtering | Configurable lowpass |
| Controller execution rate | Current controller (FOC): 25 kHz<br>All others: 2.5 kHz<br>PWM frequency: 50 kHz |
| Max. *EtherCAT* communication rate | 1 kHz |
| Internal temperature sensors | Motor winding and power electronics, PDO-mappable |
| Motor temperature i2t protection | Configurable |
| Mechanical backlash<br>Fixed motor position, movement of the joint.<br>A low-backlash design is available upon request. | 0.5° (average)<br>Depending on the selected control topology, operating regime and gains, the inherent internal mechanical backlash can potentially affect the controller performance. |
| Tot. mech. moment of inertia, at joint | 56 kgcm$^2$ |
| Backdriving torque<br>(system disabled, including joint seal friction) | < 0.8 Nm |
| Acceleration time | <*TBD*> ms<br>Time it takes to accelerate the joint from standstill to its maximum velocity. |

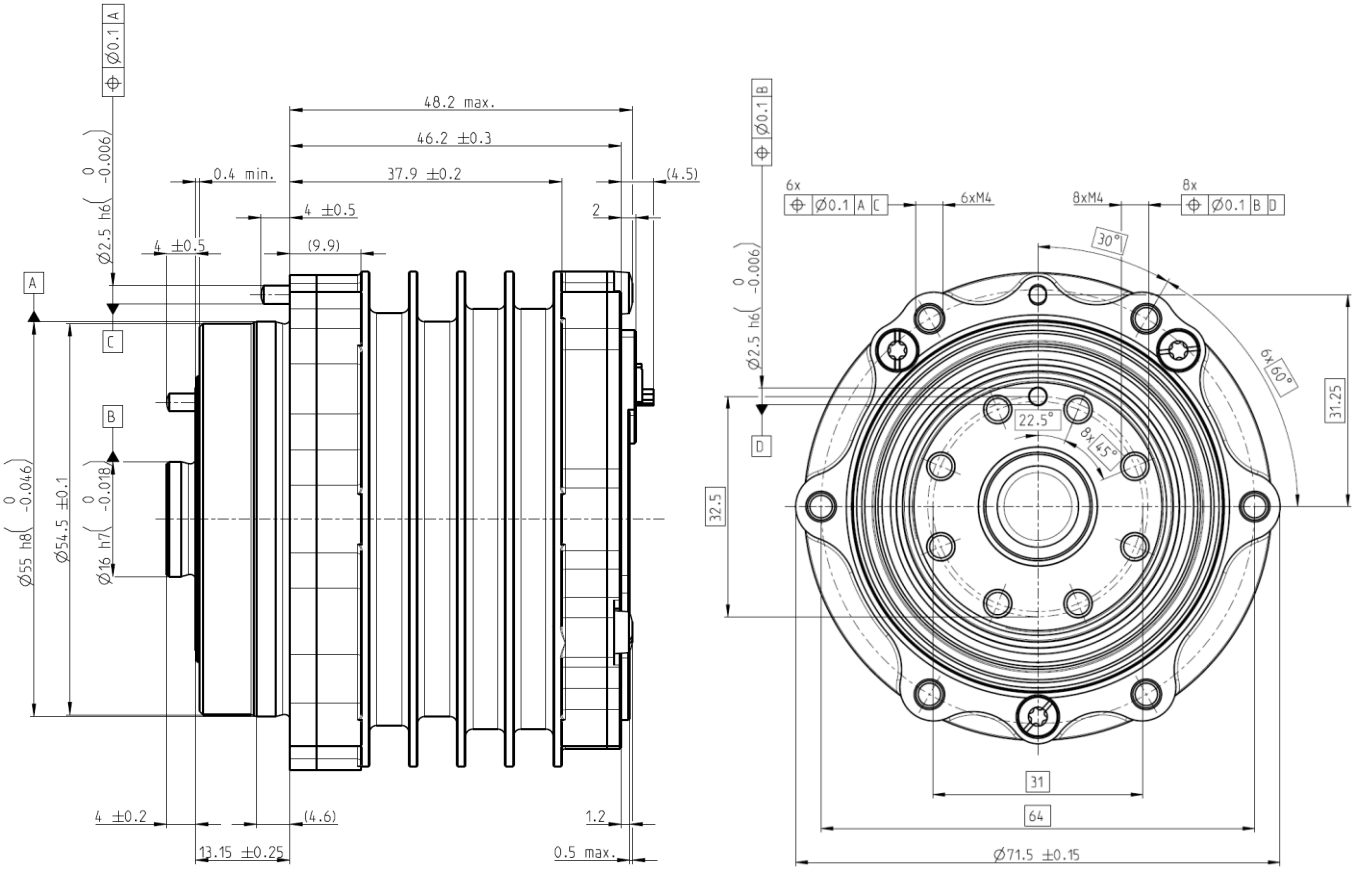
| ENVIRONMENTAL CHARACTERISTICS | |
|---|---|
| Ingress protection | The first samples of the *HEJ 50* will not be ingress-protected due to the PCB-mounted connectors. Future iterations will have an IP67 protected option with industrial connectors. The radial output seal is already available/mounted in the first *HEJ 50* samples. |
| Ambient operating temperature | -20°C to +60°C<br>(might require adequate cooling if the system exhibits losses) |
| Thermal interface<br>Note: The thermal dissipation capability serves only as an indication. Actual performance depends on external heat transfer system and environment. Details are available upon request. | Integrated heat sinks for forced air cooling.<br>Continuous thermal dissipation (passive convective cooling) up to ca. 36 W. |
| Thermal resistance winding-housing | 1.4 K/W |
| Thermal time constant winding | 15.9 s |

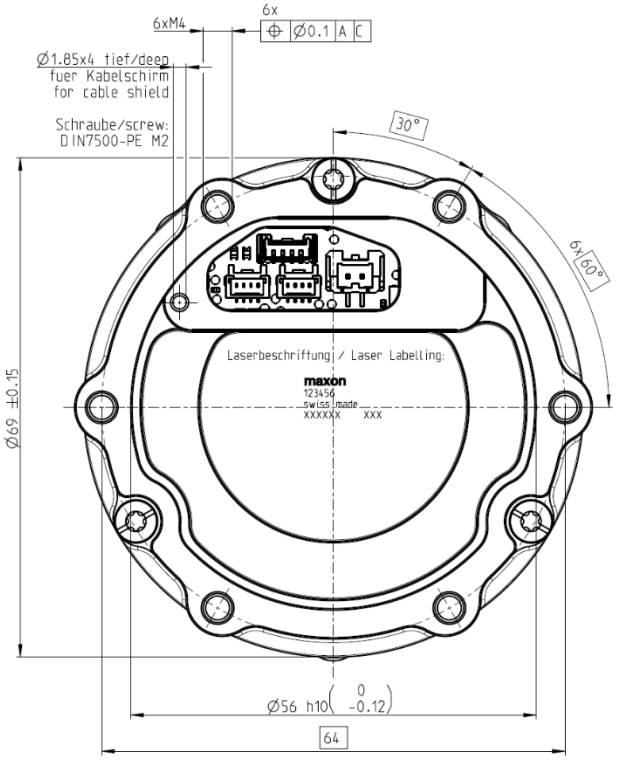
| LIFETIME CHARACTERISTICS | |
|---|---|
| Note: A high emphasis was put on creating a highly reliable and robust product. Nonetheless, the operating lifetime of this drive strongly depends on its load cases and environmental aspects. The indicated values are only a (simplified) guideline. Further details are available upon request. | |
| High-cycle fatigue: Joint impact/collision events | 12e6 impacts at 23 Nm<br>100e3 impacts at 30 Nm<br>1e3 impacts at 40 Nm |
| Lifetime at constant operation<br>Note 1: Depending on environmental factors (e.g., temperature, dust or chemicals exposure), the joint output seal may potentially degrade earlier.<br>Note 2: These operating points are naturally dependent on temperature and specific aspects of the load cycle and gear lubrication life. Details can be provided upon request. | 10 Nm, 22 rad/s: >56'000 h<br>30 Nm, 5 rad/s: >56'000 h |

| MECHANICAL CHARACTERISTICS | |
|---|---|
| Axial length | ca. 65 mm |
| Diameter | ca. 71.5 mm |
| Mass | ca. 570 g |
| Max. joint axial, radial and bending loads, dynamic<br>Note 1: The system provides an integrated cross-roller bearing.<br>Note 2: These load cases can be complex. Higher loads can be possible. Contact us for assistance. | 200 N, axial or radial, 1e6 cycles.<br>500 N, axial or radial, 1e2 cycles.<br>24 Nm, bending, 1e6 cycles.<br>35 Nm, bending, 1e2 cycles. |

| ELECTRICAL INTERFACES | |
|---|---|
| Connectors: | 1x Power supply,<br>2x *EtherCAT* (allows daisy-chaining of several systems),<br>1x USB (only for debugging/testing). |
| *EtherCAT* | Full Duplex, 100 Mbit/s |
| Functional safety | Under development. Please contact us for details. |
| Grounding concept | All housing parts connected to DC link GND.<br>Provision to connect *EtherCAT* shield to housing. |

## MECHANICAL DRAWINGS



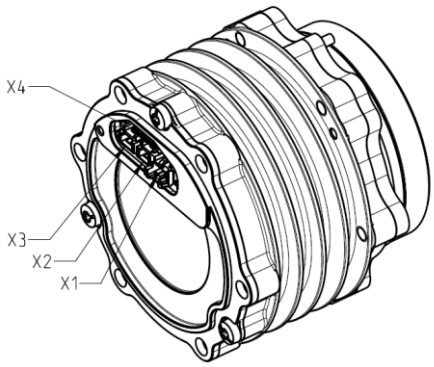

Note 1: maxon can offer customized housing geometries, e.g., different thread sizes, hole patterns, or attachment points. Please contact robotics@maxongroup.com

Note 2: The HEJ 50 can also be mounted solely at its rear interface (6x M4 fasteners). Please contact us at robotics@maxongroup.com to assess your load case (force transmission, housing integrity, high-cycle fatigue).

## ELECTRICAL PINOUTS

| Steckerbelegung / PIN allocation | | |
|---|---|---|
| Stecker/connector | PIN | Signal |
| X1 Power<br>Molex Micro-Lock Plus<br>505575-0281 | 1 | VBUS |
| | 2 | GND |
| | | |
| | | |
| X2 EtherCAT In<br>???? | 1 | TX+ |
| | 2 | RX+ |
| | 3 | RX- |
| | 4 | TX- |

| Steckerbelegung / PIN allocation | | |
|---|---|---|
| Stecker/connector | PIN | Signal |
| X3 EtherCAT Out<br>???? | 1 | TX+ |
| | 2 | RX+ |
| | 3 | RX- |
| | 4 | TX- |
| X4 USB<br>???d | 1 | TX+ |
| | 2 | RX+ |
| | 3 | RX- |
| | 4 | TX- |




Please note: Future iterations will have an IP67 protected option with industrial connectors.