maxon
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High Efficiency Joint

HEJ 90-48-140

30 V – 60 V | 140 Nm | 13 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 electronics, motor, gearing and sensing. This drive is fully enclosed, ingress- and 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 can implement various internal control and gain topologies, rendering it suitable for all 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.

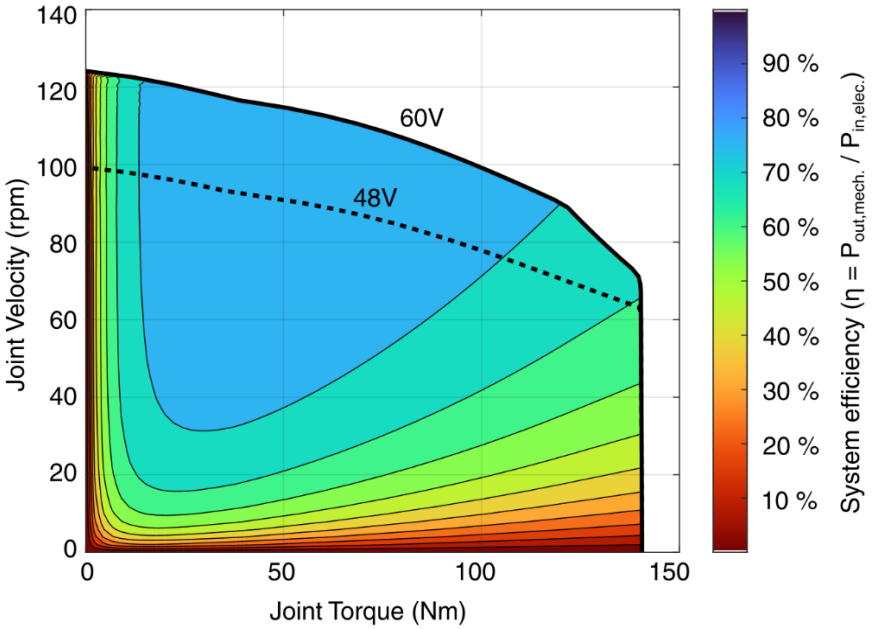
OUTPUT CHARACTERISTICS		
Max. Joint velocity	U_{DC} = 48V	+/- 10.4 rad/s
	U_{DC} = 60V	+/- 13.0 rad/s
Max. Joint torque, actively controlled & repetitive Note: With (custom) design modifications values up to 180 Nm are achievable. Details are available upon request.		+/- 140 Nm

POWER CONVERSION CHARACTERISTICS Motor Operating Quadrants

U_{DC} (V) DC-Link Voltage	V_{joint} (rad/s) Joint Velocity	M_{joint} (Nm) Joint Torque	I_{in} (A) DC-Link Input Curr.	P_{loss} (W) Total System Loss	Efficiency (%) $P_{out,mech}$ / $P_{in,elec}$	
48	0	0	0.04	2.2	0	●
48	0	140	13.8	664.1	0	▲
48	0	80	3.6	172.9	0	●
48	0	60	1.9	92.0	0	●
48	0	30	0.5	24.2	0	●
48	5	100	17.7	350.4	59	▲
48	5	140	30.1	744.0	48	▲
48	6	50	8.4	105.2	74	▲
48	6	100	20.0	362.1	62	▲
48	6	135	31.3	693.5	54	▲
48	8	50	10.8	119.8	77	▲
48	8	100	24.7	385.7	67	▲
48	10	25	6.5	66.1	79	●
60	6	135	25.0	693.5	54	▲
60	10.5	100	23.7	396.5	72	▲
60	12	50	12.5	150.0	80	▲
60	13	0	0.6	38.1	0	●

Operating points with a triangle (▲) can only be maintained for short times (some seconds, due to thermal limitations (mainly: continuous input current limited to 6 A_{RMS})).
Operating points marked with a circle (●) can be maintained continuously, but potentially require adequate external forced air cooling.
Simulation models are available upon request.

POWER CONVERSION PERFORMANCE MAP Motor Operating Quadrants



Note: This graphic shows the maximum achievable joint torque/velocities for the given supply voltages. Continuous operating points depend on system cooling and DC link input current limits. Refer to the *Power Conversion Characteristics* table above for potential feasible continuous operating points. Further details are available upon request.

Highest efficiency, motor quadrant: ca. 30 Nm, 85 RPM, 86.1%.
Highest efficiency, generator quadrant: 74%

ELECTRICAL CHARACTERISTICS	
Operating input voltage range (voltages as low as 20V are possible but might 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	165 µF
Max. power supply input current 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 (This is a conservative limit – please approach us if you plan on exceeding this limit)	6.0 A_{RMS}

CONTROL CHARACTERISTICS	
Control modes	Joint position, velocity, torque, motor current (FOC) Joint impedance controller (simultaneous control of position, velocity, torque) PDO-mappable control gains
Joint position sensor	Resolution: 12 bit. Absolute angular error: < 0.007 rad (0.4°) 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 Via electric motor current, compensated	Absolute error, steady-state: < 2 Nm
Joint velocity filtering	Configurable lowpass
Controller execution rate	Current controller (FOC): 25 kHz All others: 2.5 kHz PWM frequency: 50 kHz
Max. *EtherCAT* communication rate	1 kHz
Internal temperature sensors Also used for internal protection like i2t	Motor winding and power electronics, PDO-mappable
Motor temperature i2t protection	Configurable
Mechanical backlash Fixed motor position, movement of the joint	Avg: 0.48°. Min – Max: 0.35° – 0.61° 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	0.05 kgm^2
Backdriving torque (system disabled, including joint seal friction)	< 1.5 Nm
Acceleration time	< 8 ms Time it takes to accelerate the joint from standstill to its maximum velocity.

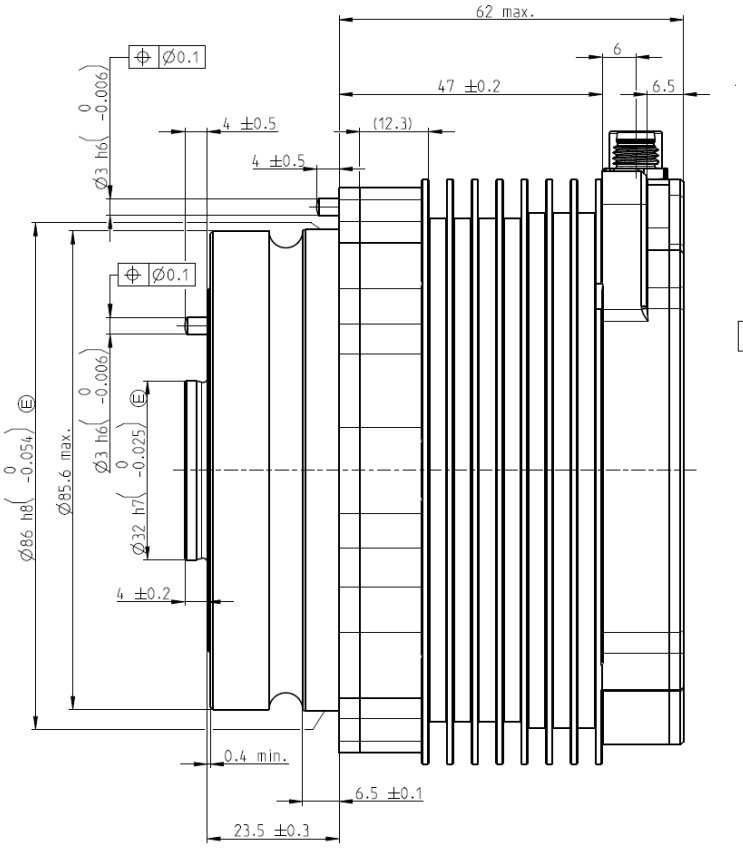
ENVIRONMENTAL CHARACTERISTICS	
Ingress protection	IP67, also with rotating joint and applied bending moments
Ambient operating temperature	-20°C to +60°C (might require adequate cooling if the system exhibits losses)
Thermal interface Note: The thermal dissipation capability serves only as an indication. Actual performance depends on external heat transfer system and environment. Details are available upon request.	Integrated heat sinks for forced air cooling. Continuous thermal dissipation (active cooling) up to ca. 250 W. Integrated and user-controllable fan power supply.

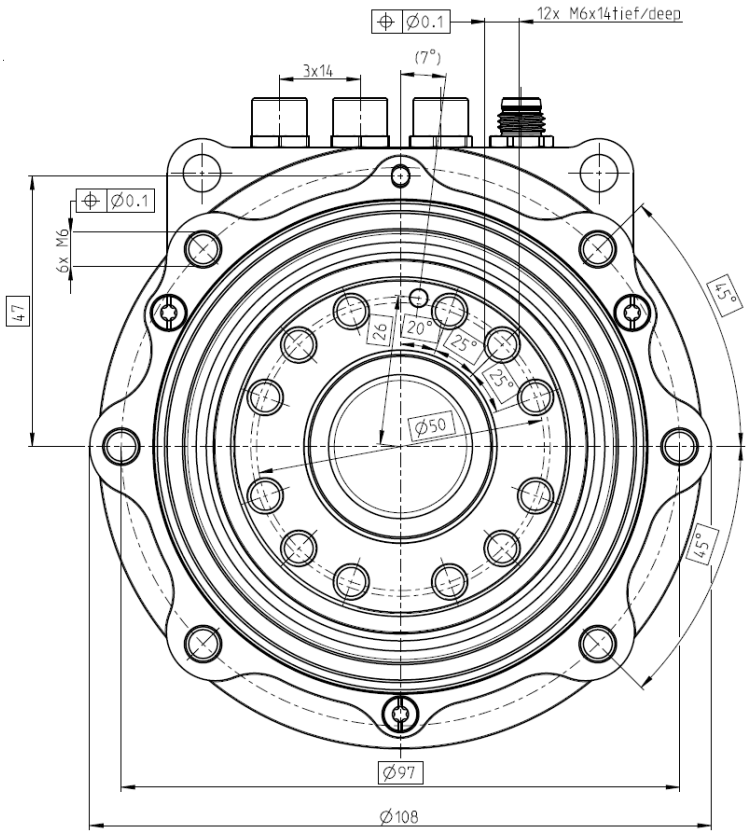
LIFETIME CHARACTERISTICS	
Note: A high emphasis was put on creating a highly reliable and robust product. Nonetheless, the operating lifetime of this drive strongly depends on its load cases and environmental aspects. The indicated values are only a (simplified) guideline. Further details are available upon request.	
High-cycle fatigue: Joint impact/collision events	12e6 impacts at 180 Nm 100e3 impacts at 240 Nm 1e3 impacts at 320 Nm
Lifetime at constant operation Note 1: Depending on environmental factors (e.g., temperature, dust or chemicals exposure), the joint output seal may potentially degrade earlier. 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.	30 Nm, 10 rad/s: 56’000 h 60 Nm, 5 rad/s: 14’000 h

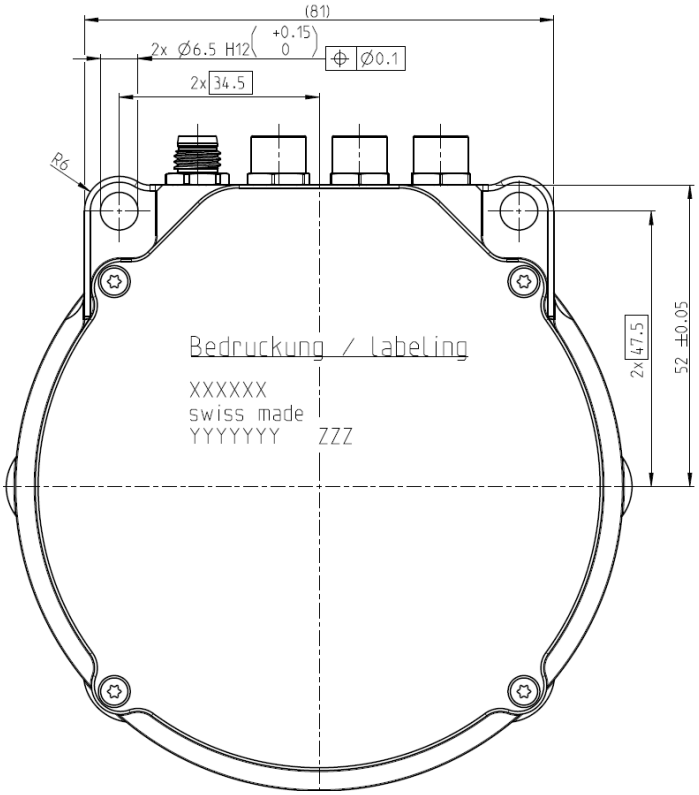
MECHANICAL CHARACTERISTICS	
Axial length, overall	90 mm
Diameter, excluding connectors	110 mm
Mass	1.96 kg
Max. joint axial, radial and bending loads, dynamic Note 1: The system provides an integrated cross-roller bearing. Note 2: Higher loads are possible, but might reduce structural lifetime (high-cycle fatigue). Details are available upon request.	1’000 N 100 Nm

ELECTRICAL INTERFACES	
Connectors: 4x M8	1x Power supply, 2x *EtherCAT* (allows daisy-chaining of several systems), 1x fan power and control
EtherCAT	Full Duplex, 100 Mbit/s
Grounding concept	All housing parts connected to DC link GND. *EtherCAT* shield connected to housing/GND.
Fan power and control	Power: 12 V, max. 700 mA. Control: PWM (Open Drain, 25 kHz). Tacho input: Pull-up, 10 kΩ.

MECHANICAL DRAWINGS

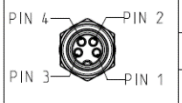


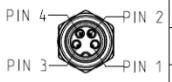


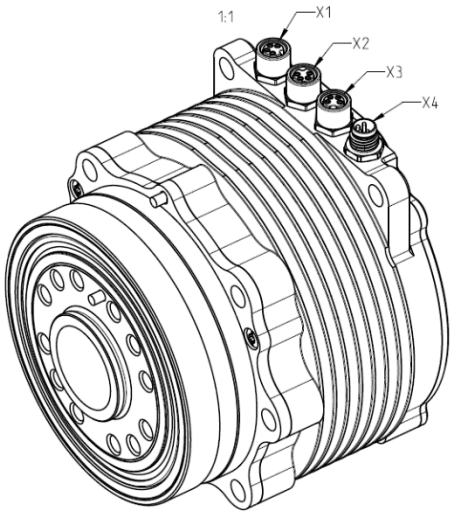


Please note: maxon can offer customized housing geometries, e.g., different thread sizes, hole patterns, attachment points, or heat sinking geometries. Please contact robotics@maxongroup.com

ELECTRICAL PINOUTS

Steckerbelegung / PIN allocation		
Stecker/connector	PIN	Signal
X1 Fan TE T4033014041-000 	1	Vcc 12V
	2	GND
	3	PWM-Fan
	4	Tacho-Fan
X2 EtherCAT Out TE T4033014041-000 	1	TX+
	2	RX+
	3	RX-
	4	TX-

Steckerbelegung / PIN allocation		
Stecker/connector	PIN	Signal
X3 EtherCAT In TE T4033014041-000 	1	TX+
	2	RX+
	3	RX-
	4	TX-
X4 Power TE T4032014041-000 	1	VBUS
	2	VBUS
	3	GND
	4	GND



Please note:

1) Due to technical limitations and design decisions, the mounting orientation (rotation) of the 4x connectors X1-X4 is arbitrary and cannot be changed (rotated). This means that the keys of these connectors can point in any direction.
2) maxon can offer customized connectors or cabling solutions. Please contact robotics@maxongroup.com