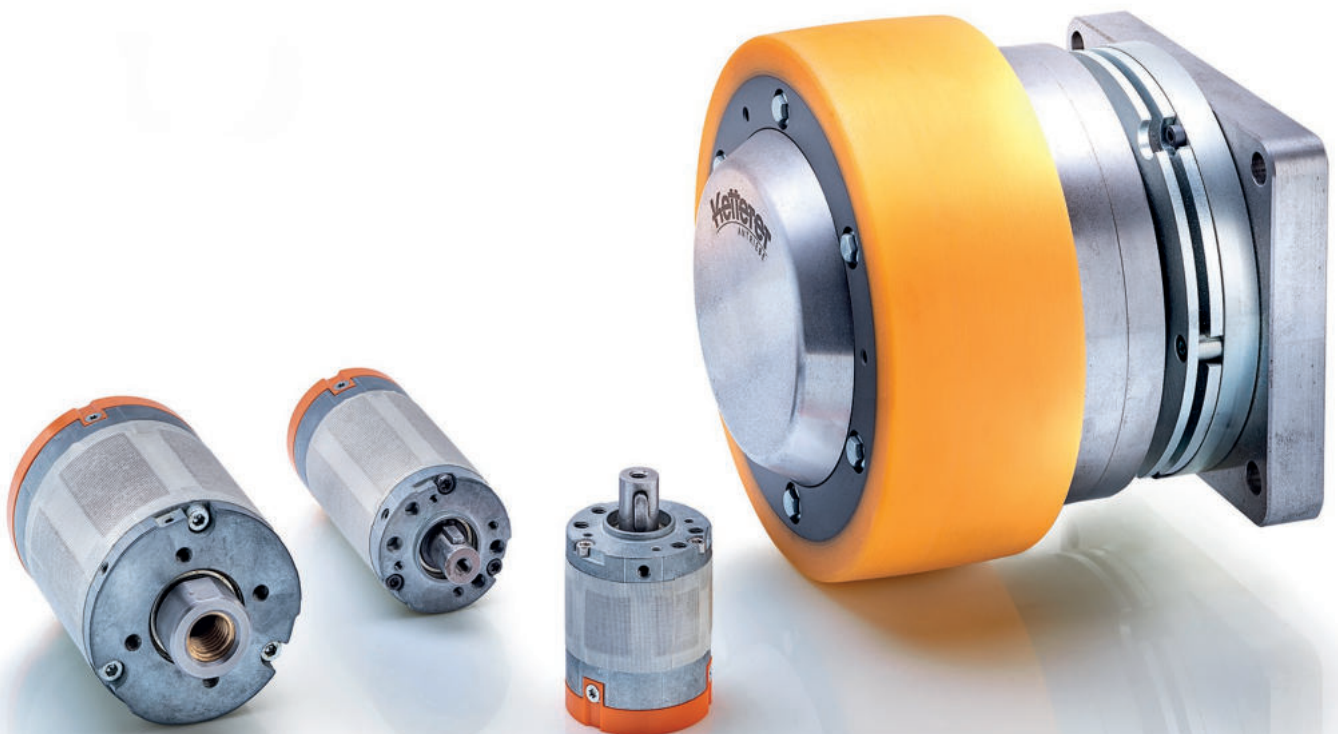


BLDC-Technology

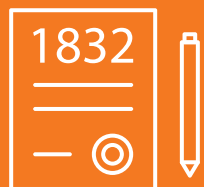


WE GET IDEAS MOVING

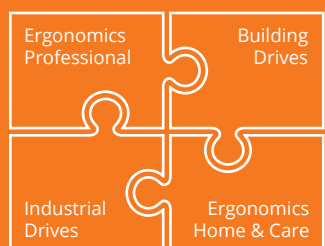
The spirit of innovation and a sense of ideas beyond the familiar has made us into a pioneering company over more than 185 years.

For a quarter of a century, we have been offering customized drive solutions for office and workplace workstations, as well as for shading systems and building technology.

Through our tradition of innovation, we have succeeded in establishing ourselves as a specialist and problem-solver in numerous areas.



Over 185 years' experience



More than 60 standard solutions for four different market segments



100% Made in Black Forest

THE RIGHT PRODUCT FOR EACH APPLICATION

BLDC-Motors

| | |
|---------|--------------------------------|
| Page 04 | 3200 - t-Rex- I-44-47-L21S2 |
| Page 06 | 3200 - t-Rex- I-44-47-L41S2 |
| Page 08 | 3200 - t-Rex- I-44-89-L41S2 |
| Page 10 | 3200 - t-Rex- I-44-89-L12S2 |
| Page 12 | 3206 - t-Rex- I-65-51-L36S2 |
| Page 14 | 3206 - t-Rex- I-65-86-L36S2 |
| Page 16 | 3207 - i-Rex-A-130-70 |
| Page 18 | 3213.00-1XXX - i-Wheel |
| Page 20 | 3213.00-2XXX - i-Wheel |
| Page 22 | 3213.00-3XXX - i-Wheel |
| Page 24 | 3213.00-21XX - i-Wheel C |
| Page 26 | Ket-Rob - platform for AGV/AGC |

t-Rex 3200 (short version, focus rotational speed)

I-44-47-L21 S2



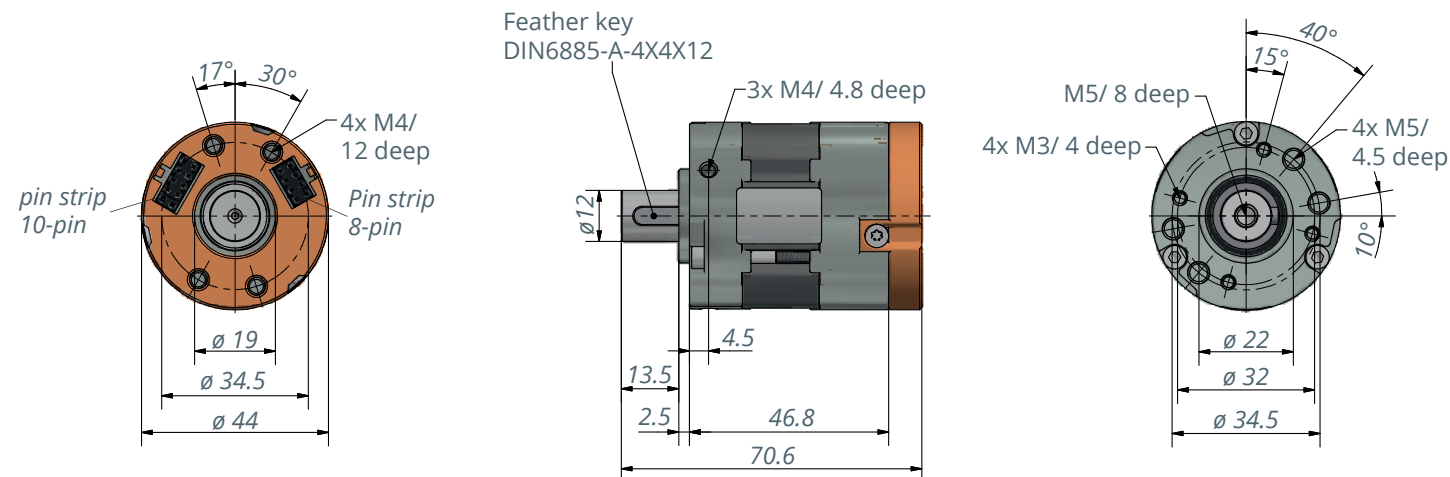
Description

14-pole BLDC motor with high-performance neodymium magnets and three digital Hall sensors to detect the rotor position. The electrical connections are designed as a plug-in system. Additional power electronics are required to operate the motor. Motor design with a hollow shaft is also available upon request. This allows the cables to run through the motor or the implementation of output on both sides.

Special features

- Designed with **focus on rotational speed**
- Enormous performance density – 3 times stronger than motors of comparable size
- High overload resistance
- Ideally suited as direct drive, or generator for gearless applications
- Special winding upon request
- Design and manufacture of motor to specified operating point is possible

3200.00-3002 with shaft



Digital Hall-sensors

Supply of sensors

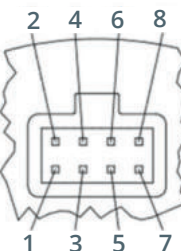
Voltage range: 4.5 to 5.5 V DC
Optional: voltage regulator for 5 V
Input current: < 70 mA

Output signals of sensors

Differential output
(RS422 standard, datasheet AM26 C31-TI)
Typical voltage range: 0.2/ 3.4 V @ 20 mA
Output current: max. 20 mA

Signal structure: The Hall sensors have a 120° phase shift to each other
Due to the 14-pole design the **Signal frequency** is seven times higher than the speed

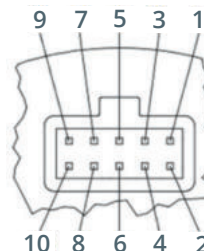
Hall-sensors



Socket strip RM 2.54 / 8 PIN
W+P 3491-08

- 1= H3-
- 2= H1-
- 3= 5 V
- 4= H3+
- 5= H1+
- 6= GND
- 7= H2+
- 8= H2-

Motor phases



n.c.= please do not connect
RM 2.54 / 10 PIN
W+P 3491-10

- 1= U-Phase
- 2= n.c.
- 3= U-Phase
- 4= U-Phase
- 5= V-Phase
- 6= V-Phase
- 7= W-Phase
- 8= V-Phase
- 9= W-Phase
- 10= W-Phase

| t-Rex 3200-I-44-47 L21 S2 DH | 3200.00-3002 | |
|--------------------------------|--------------|-----------|
| Rated voltage | 24 VDC | 36 VDC |
| Rated current | 3.4 A | 2.4 A |
| Rated torque | 0.1 Nm | 0.05 Nm |
| Rated speed | 4600 rpm | 7400 rpm |
| Shaft power (output) | 48 W | 38 W |
| Max. efficiency | 65 % | 71 % |
| Idle speed | 5168 rpm | 7778 rpm |
| No-load current | 1.2 A | 1.3 A |
| Stall torque | 1.1 Nm | 0.9 Nm |
| Starting current at idle speed | 24 A | 18 A |
| Torque constant | 0.047 Nm/A | 0.05 Nm/A |
| Speed constant | 215 rpm/V | 216 rpm/V |

Motor parameters

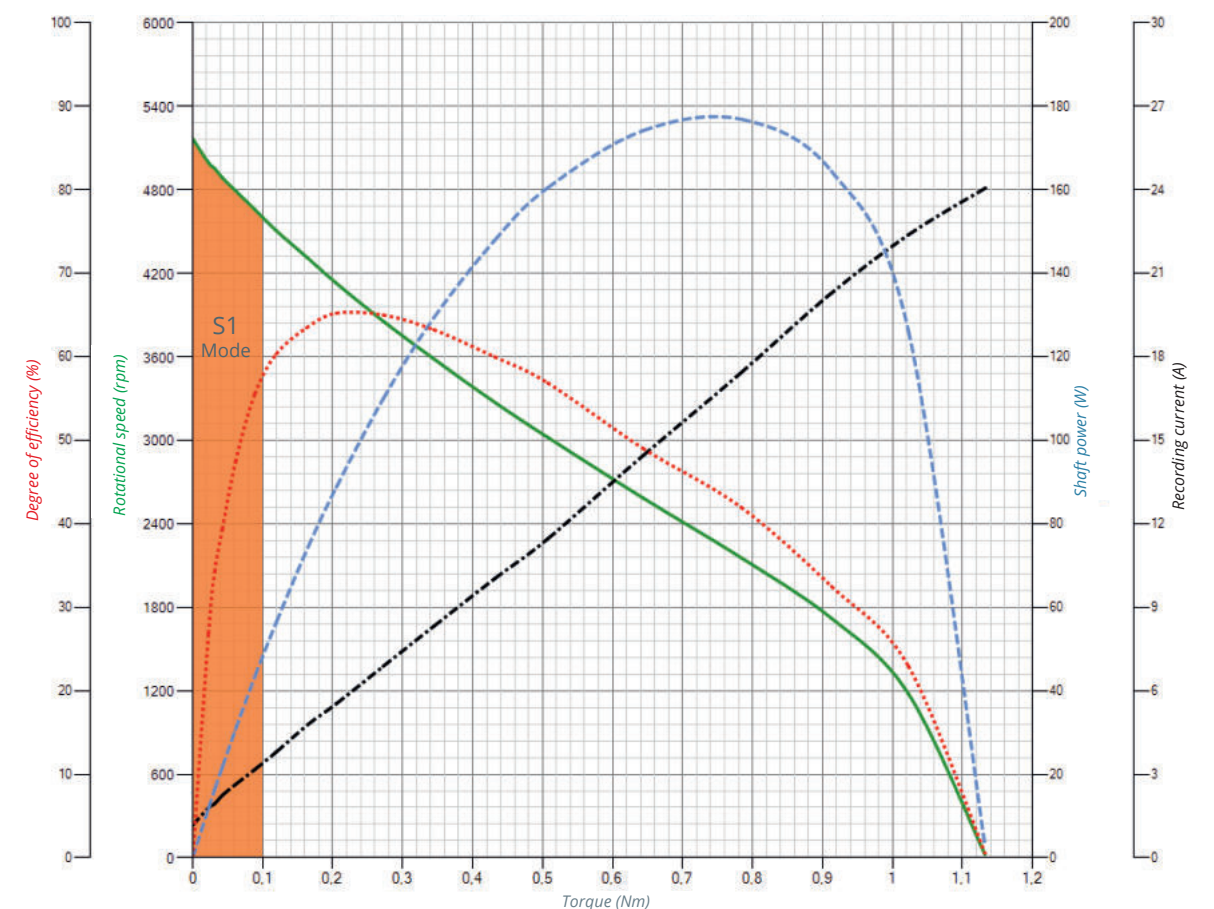
| | |
|--------------------------------------|-------------------------|
| Terminal resistance (phase to phase) | 0.29 Ohm |
| Terminal inductance (phase to phase) | 171 mH |
| Rotor inertia | 9.5 kg* mm ² |
| Number of poles | 14 |
| Interconnection of the motor | Star |
| Number of coils per phase | 2 |
| Interconnection of coils | 2 Series |
| Direction of rotation | bidirectional |

Note: Max. ambient temperature = 40 °C, controller-specific
At the nominal point (TU = 20°C), controller-specific

Motor characteristics at 24 V

Motor cable approx. 1,5 m

Item number: 3200.53-05



t-Rex 3200 (short version, focus torque)

I-44-47-L41 S2



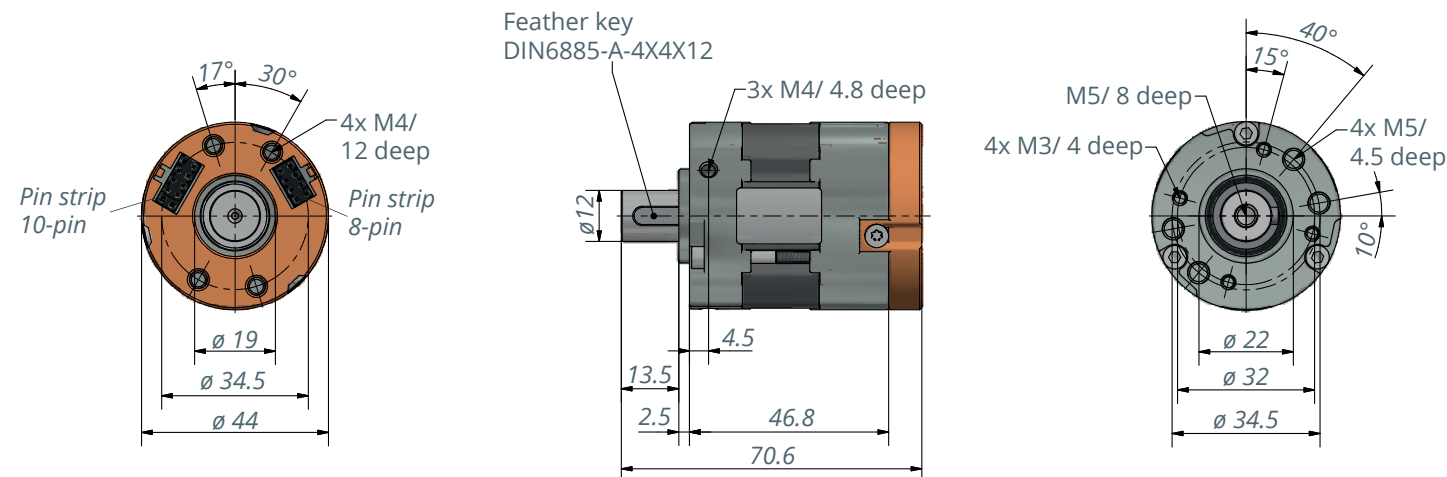
Description

14-pole BLDC motor with high-performance neodymium magnets and three digital Hall sensors to detect the rotor position. The electrical connections are designed as a plug-in system. Additional power electronics are required to operate the motor. Motor design with a hollow shaft is also available upon request. This allows the cables to run through the motor or the implementation of output on both sides.

Special features

- Designed with **focus on torque**
- Enormous performance density – 3 times stronger than motors of comparable size
- High overload resistance
- Ideally suited as direct drive, or generator for gearless applications
- Special winding upon request
- Design and manufacture of motor to specified operating point is possible

3200.00-3000 with shaft



Digital Hall-sensors

Supply of sensors

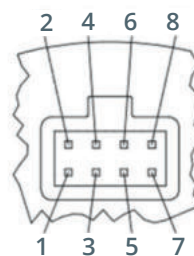
Voltage range: 4.5 to 5.5 V DC
Optional: voltage regulator for 5 V
Input current: < 70 mA

Output signals of sensors

Differential output
(RS422 standard, datasheet AM26 C31-TI)
Typical voltage range: 0.2/ 3.4 V @ 20 mA
Output current: max. 20 mA

Signal structure: The Hall sensors have a 120° phase shift to each other
Due to the 14-pole design the **Signal frequency** is seven times higher than the speed

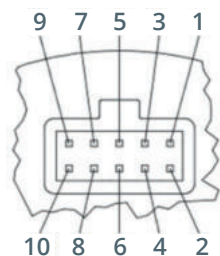
Hall-sensors



- 1= H3-
- 2= H1-
- 3= 5 V
- 4= H3+
- 5= H1+
- 6= GND
- 7= H2+
- 8= H2-

Socket strip RM 2.54 / 8 PIN
W+P 3491-08

Motor phases



- 1= U-Phase
- 2= n.c.
- 3= U-Phase
- 4= U-Phase
- 5= V-Phase
- 6= V-Phase
- 7= W-Phase
- 8= V-Phase
- 9= W-Phase
- 10= W-Phase

n.c.= please do not connect
RM 2.54 / 10 PIN
W+P 3491-10

| t-Rex 3200-I-44-47 L41 S2 DH | 3200.00-3000 | | |
|---------------------------------------|--------------|------------|------------|
| Rated voltage | 24 VDC | 36 VDC | 48 VDC |
| Rated current | 2.6 A | 2.6 A | 2.8 A |
| Rated torque | 0.2 Nm | 0.2 Nm | 0.2 Nm |
| Rated speed | 2000 rpm | 3187 rpm | 4437 rpm |
| Shaft power (output) | 42 W | 67 W | 93 W |
| Max. efficiency | 70 % | 72 % | 72 % |
| Idle speed | 2702 rpm | 4089 rpm | 5483 rpm |
| No-load current | 0.4 A | 0.4 A | 0.4 A |
| Stall torque | 1.0 Nm | 1.3 Nm | 1.5 Nm |
| Starting current at idle speed | 14 A | 18 A | 20 A |
| Torque constant | 0.077 Nm/A | 0.073 Nm/A | 0.073 Nm/A |
| Speed constant | 113 rpm/V | 114 rpm/V | 114 rpm/V |

Motor parameters

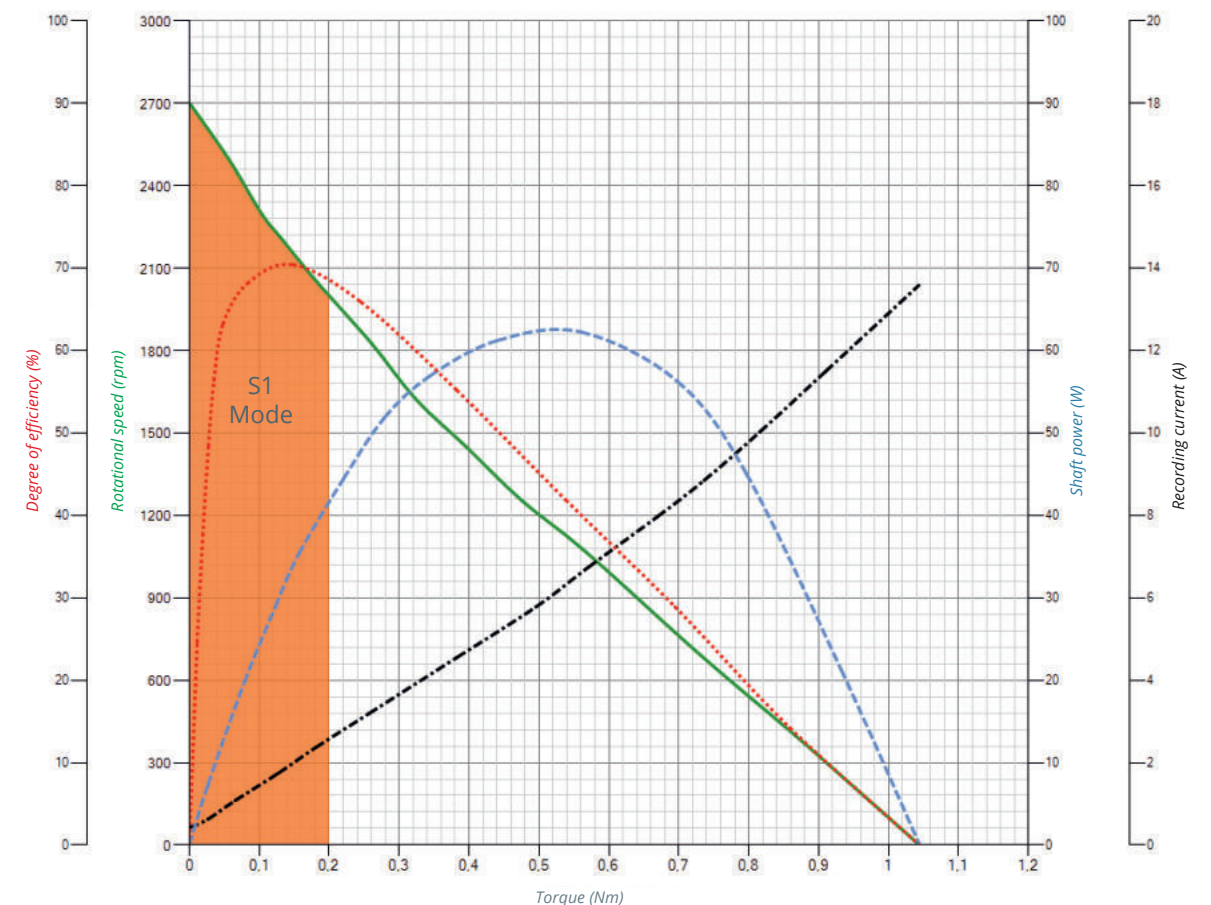
| | |
|---|-------------------------|
| Terminal resistance (phase to phase) | 1.09 Ohm |
| Terminal inductance (phase to phase) | 98 mH |
| Rotor inertia | 125 kg* mm ² |
| Number of poles | 14 |
| Interconnection of the motor | Star |
| Number of coils per phase | 2 |
| Interconnection of coils | 2 Series |
| Direction of rotation | bidirectional |

Note: Max. ambient temperature = 40 °C, controller-specific
At the nominal point (TU = 20°C), controller-specific

Motor characteristics at 24 V

Motor cable approx. 1.5 m

Item number: 3200.53-05



t-Rex 3200 (long version, focus torque)

I-44-89-L41 S2



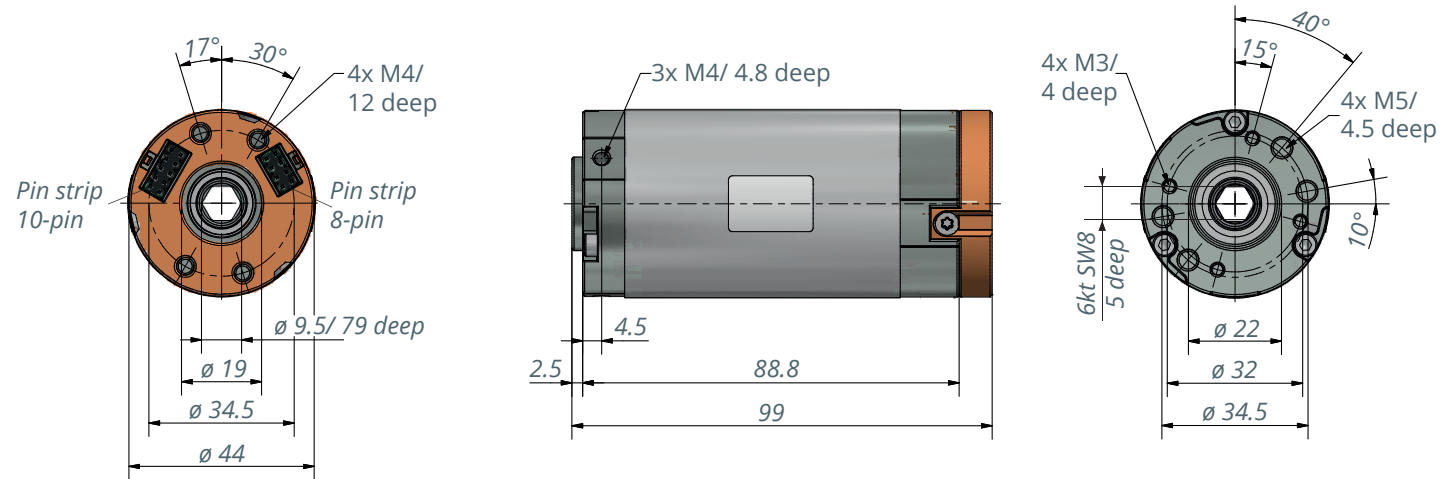
Description

14-pole BLDC motor with high-performance neodymium magnets and three digital Hall sensors to detect the rotor position. The electrical connections are designed as a plug-in system. Additional power electronics are required to operate the motor. The design of the motor with a hollow shaft allows the cables to run through the motor or output on both sides.

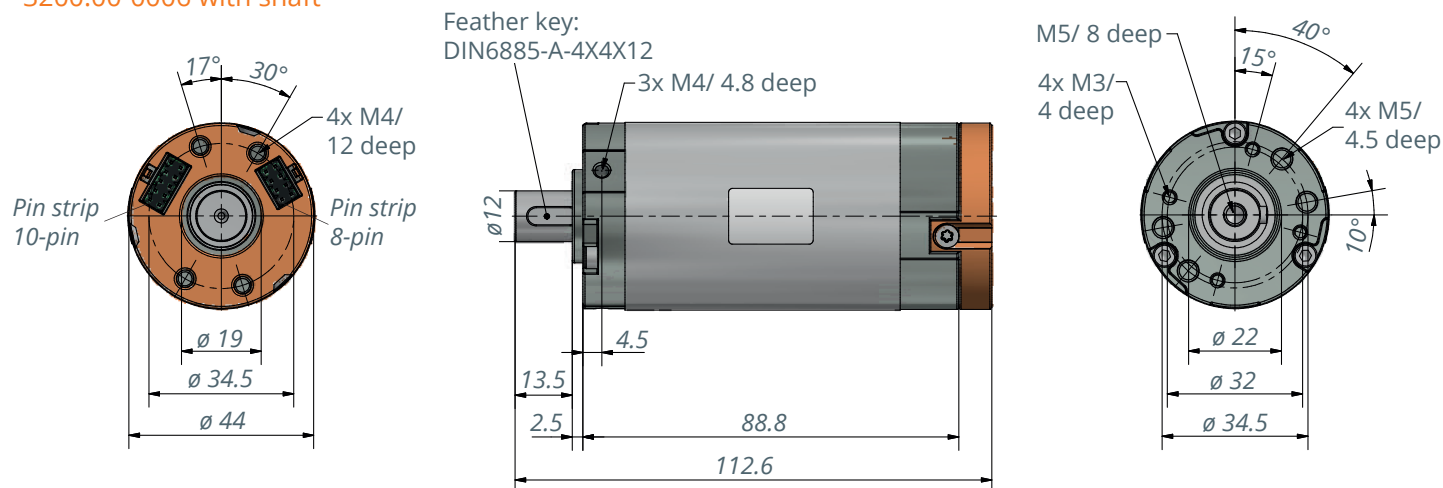
Special features

- Designed with **focus on max. torque**
- Enormous performance density – 3 times stronger than motors of comparable size
- High overload resistance
- Ideally suited as direct drive, or generator for gearless applications
- Special winding upon request
- Design and manufacture of motor to specified operating point is possible

3200.00-0005 with hollow shaft



3200.00-0006 with shaft



| t-Rex 3200 I-44-89 L41 S2 DH | 3200.00-0005 / 3200.00-0006 | | |
|--------------------------------|-----------------------------|------------|------------|
| Rated voltage | 24 VDC | 36 VDC | 48 VDC |
| Rated current | 1.7A | 1.8 A | 1.7 A |
| Rated torque | 0.5 Nm | 0.5 Nm | 0.5 Nm |
| Rated speed | 600 rpm | 960 rpm | 1347 rpm |
| Shaft power (output) | 31 W | 50 W | 70 W |
| Max. efficiency | 83 % | 83 % | 83 % |
| Idle speed | 812 rpm | 1221 rpm | 1653 rpm |
| No-load current | 0.3 A | 0.2 A | 0.2 A |
| Stall torque | 1.8 Nm | 2.3 Nm | 2.9 Nm |
| Starting current at idle speed | 6.6 A | 8.7 A | 11.2 A |
| Torque constant | 0.279 Nm/A | 0.264 Nm/A | 0.261 Nm/A |
| Speed constant | 34 rpm/V | 34 rpm/V | 34 rpm/V |

Motor parameters

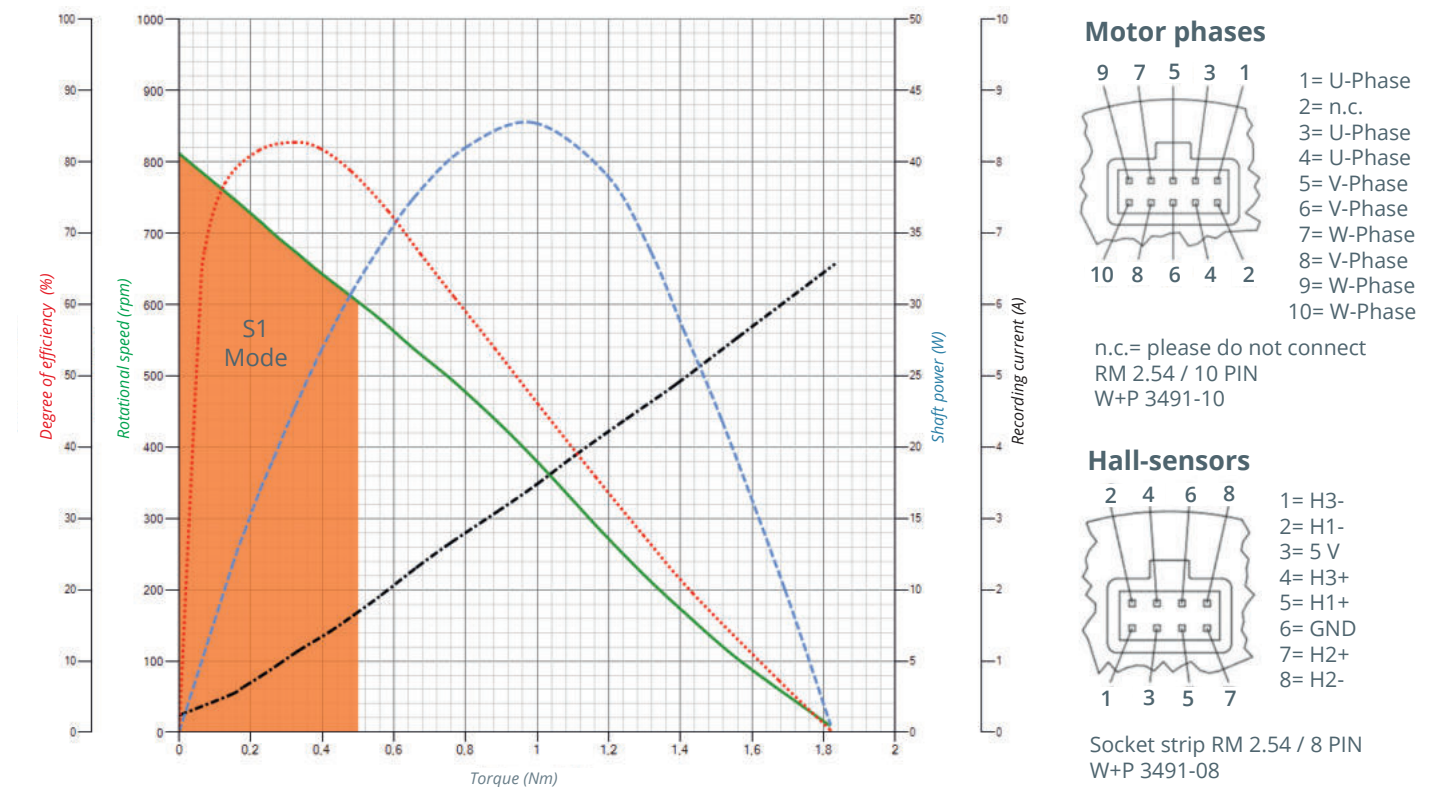
| | |
|--------------------------------------|--------------------------|
| Terminal resistance (phase to phase) | 2.6 Ohm |
| Terminal inductance (phase to phase) | 1.6 mH |
| Rotor inertia | 26.5 kg* mm ² |
| Number of poles | 14 |
| Interconnection of the motor | Star |
| Number of coils per phase | 2 |
| Interconnection of coils | 2 Series |
| Direction of rotation | bidirectional |

Note: Max. ambient temperature = 40 °C, controller-specific
At the nominal point (TU = 20°C), controller-specific

Motor cable approx. 1.5 m

Item number: 3200.53-05

Motor characteristics at 24 V



Digital Hall-sensors

Supply of sensors: Voltage range: 4.5 to 5.5 V DC / Optional: voltage regulator for 5 V, Input current: < 70 mA

Output signals of sensors: Differential output, (RS422 standard, datasheet AM26 C31-T1)

Typical voltage range: 0.2/ 3.4 V @ 20 mA / Output current: max. 20 mA

Signal structure: The Hall sensors have a 120° phase shift to each other. Due to the 14-pole design the

Signal frequency is seven times higher than the speed

t-Rex 3200 (long version, focus rotational speed)

I-44-89-L12 S2



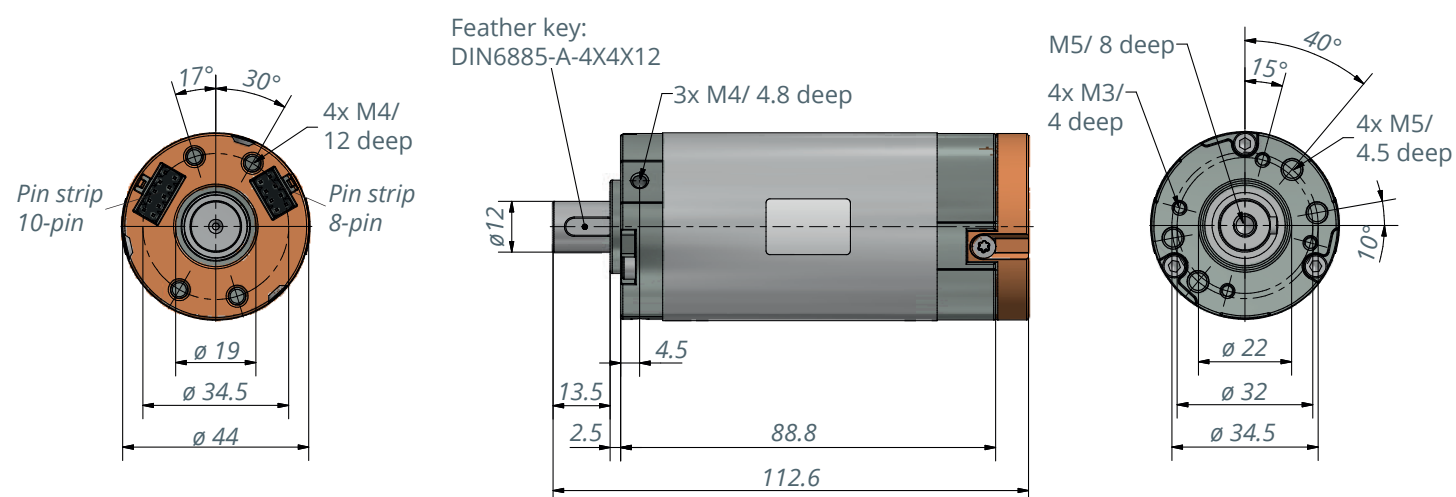
Description

14-pole BLDC motor with high-performance neodymium magnets and three digital Hall sensors to detect the rotor position. The electrical connections are designed as a plug-in system. Additional power electronics are required to operate the motor. Motor design with a hollow shaft is also available upon request. This allows the cables to run through the motor or the implementation of output on both sides.

Special feature

- Designed with **focus on rotational speed**
- Enormous performance density – 3 times stronger than motors of comparable size
- High overload resistance
- Ideally suited as direct drive, or generator for gearless applications
- Special winding upon request
- Design and manufacture of motor to specified operating point is possible

3200.00-0004 with shaft



Motor cable approx. 1.5 m

Item number: 3200.53-05

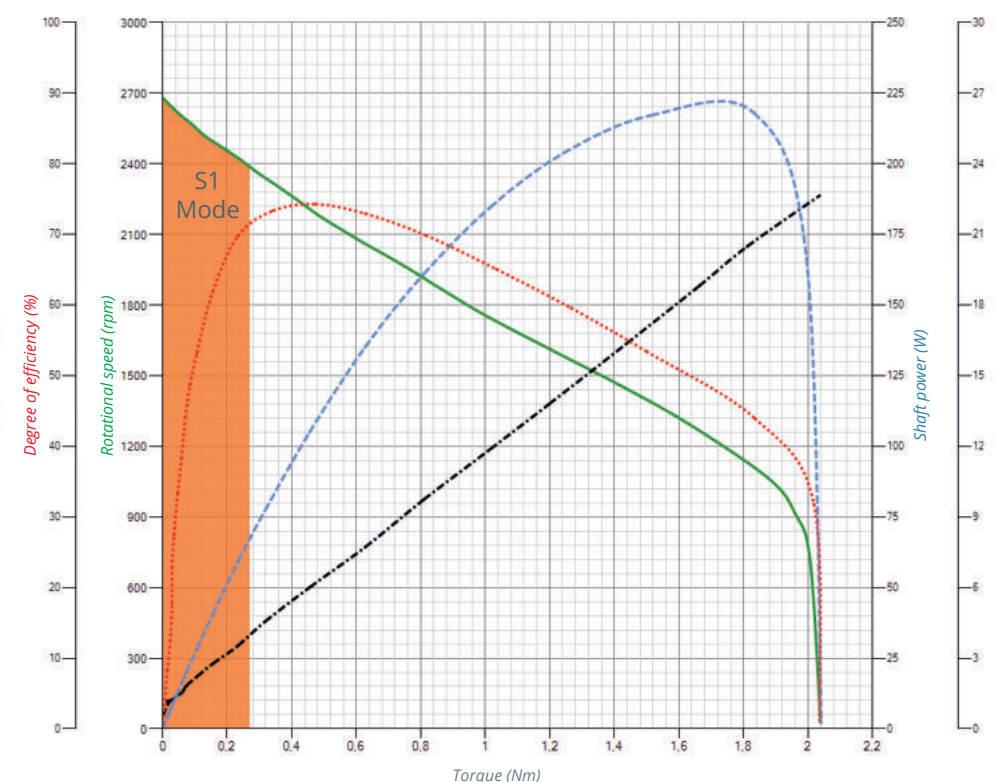
| t-Rex 3200 I-44-89 L12 S2 DH | 3200.00-0004 | |
|--------------------------------|--------------|-----------|
| Rated voltage | 24 VDC | 36 VDC |
| Rated current | 4.0 A | 4.0 A |
| Rated torque | 0.3 Nm | 0.2 Nm |
| Rated speed | 2418 rpm | 3767 rpm |
| Shaft power (output) | 67 W | 79 W |
| Max. efficiency | 74 % | 76 % |
| Idle speed | 2680 rpm | 4053 rpm |
| No-load current | 0.55 A | 0.56 A |
| Stall torque | 2 Nm | 2 Nm |
| Starting current at idle speed | 22.7 A | 21.6 A |
| Torque constant | 0.09 Nm/A | 0.09 Nm/A |
| Speed constant | 112 rpm/V | 113 rpm/V |

Motor parameters

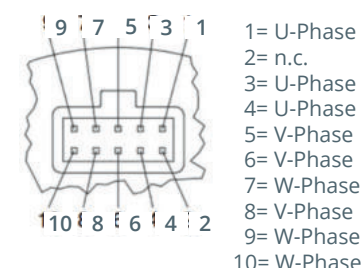
| | |
|--------------------------------------|--------------------------|
| Terminal resistance (phase to phase) | 0,027 Ohm |
| Terminal inductance (phase to phase) | 45 mH |
| Rotor inertia | 26.5 kg* mm ² |
| Number of poles | 14 |
| Interconnection of the motor | Star |
| Number of coils per phase | 2 |
| Interconnection of coils | 2 Series |
| Direction of rotation | bidirectional |

Note: Max. ambient temperature = 40 °C, controller-specific
At the nominal point (TU = 20°C), controller-specific

Motor characteristics at 24 V

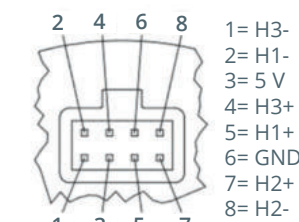


Motor phases



n.c.= please do not connect
RM 2.54 / 10 PIN
W+P 3491-10

Hall-sensors



Socket strip RM 2.54 / 8 PIN
W+P 3491-08

Digital Hall-sensors

Supply of sensors: Voltage range: 4.5 to 5.5 V DC / Optional: voltage regulator for 5 V, Input current: < 70 mA
Output signals of sensors: Differential output (RS422 standard, datasheet AM26 C31-T1)
Typical voltage range: 0.2/ 3.4 V @ 20 mA, Output current: max. 20 mA
Signal structure: The Hall sensors have a 120° phase shift to each other. Due to the 14-pole design the **Signal frequency** is seven times higher than the speed

t-Rex 3206 (short version, focus rotational speed)

I-65-51-L36 S2



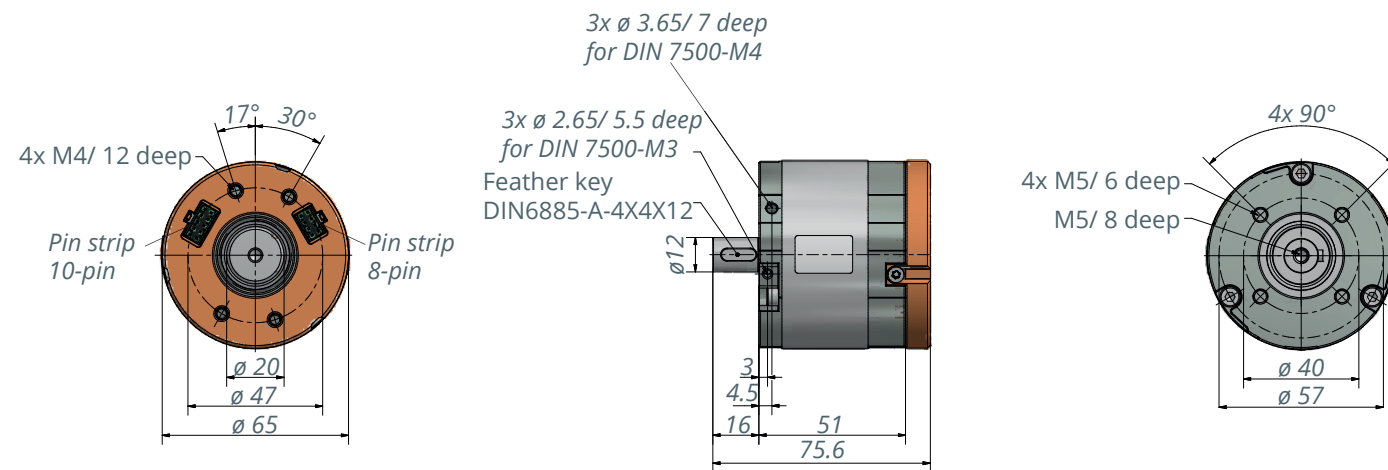
Description

14-pole BLDC motor with high-performance neodymium magnets and three digital Hall sensors to detect the rotor position. The electrical connections are designed as a plug-in system. Additional power electronics are required to operate the motor. Motor design with a hollow shaft is also available upon request. This allows the cables to run through the motor or the implementation of output on both sides.

Special features

- Designed with **focus on rotational speed**
- Enormous performance density – 3 times stronger than motors of comparable size
- High overload resistance
- Special winding upon request
- Design and manufacture of motor to specified operating point is possible

3206.00-1000 with shaft



Motor cable approx. 1.5 m

Item number: 3200.53-05

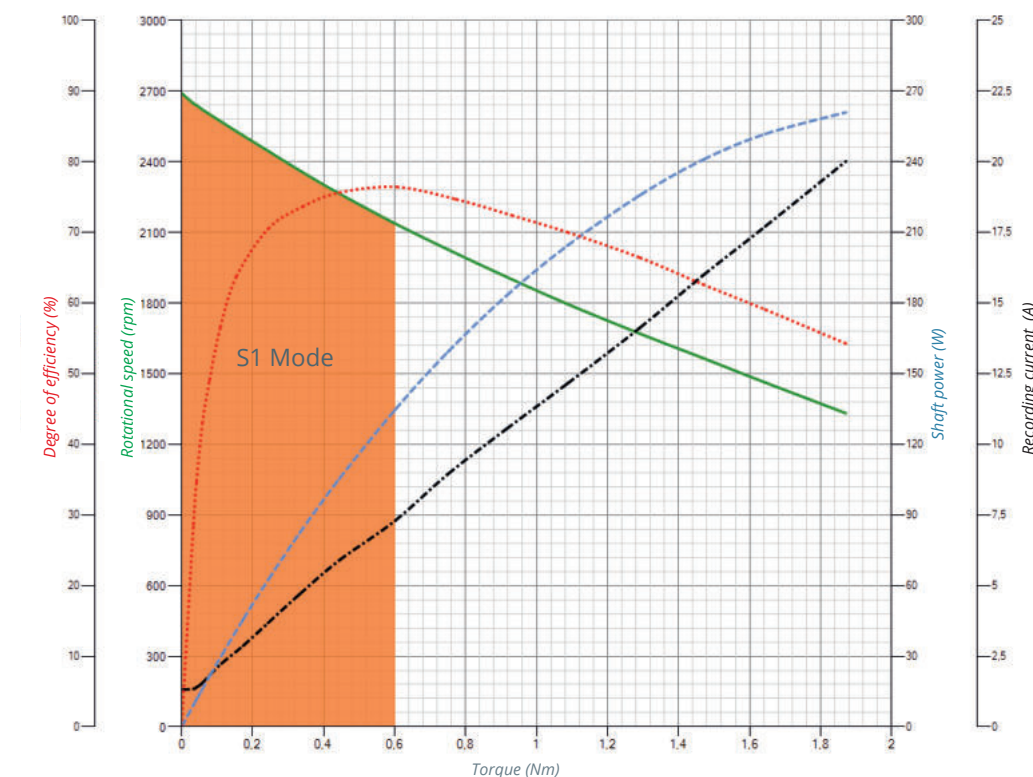
| t-Rex 3206 I-65-51 L36 S2 DH | 3206.00-1000 | | |
|--------------------------------|--------------|------------|------------|
| Rated voltage | 24 VDC | 36 VDC | 48 VDC |
| Rated current | 7.3 A | 5.6 A | 5.6 A |
| Rated torque | 0.6 Nm | 0.6 Nm | 0.6 Nm |
| Rated speed | 2139 rpm | 3208 rpm | 4812 rpm |
| Shaft power (output) | 134 W | 201 W | 301 W |
| Max. efficiency | 76 % | 77 % | 77 % |
| Idle speed | 2680 rpm | 4053 rpm | 6054 rpm |
| No-load current | 0.5 A | 0.6 A | 0.6 A |
| Stall torque* | 1.9 Nm | 1.9 Nm | 1.9 Nm |
| Starting current at idle speed | 20 A | 20 A | 20 A |
| Torque constant | 0.094 Nm/A | 0.094 Nm/A | 0.094 Nm/A |
| Speed constant | 112 rpm/V | 112 rpm/V | 126 rpm/V |

Motor parameters

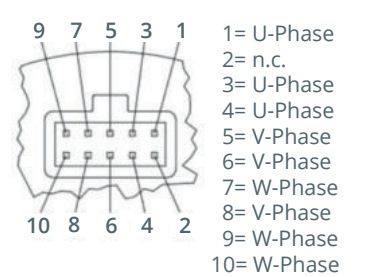
| | |
|--------------------------------------|------------------------|
| Terminal resistance (phase to phase) | 0.348 Ohm |
| Terminal inductance (phase to phase) | 0.36 mH |
| Rotor inertia | 65 kg* mm ² |
| Number of poles | 14 |
| Interconnection of the motor | Star |
| Number of coils per phase | 2 |
| Interconnection of coils | 2 Series |
| Direction of rotation | bidirectional |

* Is limited by the current carrying capacity of the coils
 Note: Max. ambient temperature = 40 °C, controller-specific
 At the nominal point (T_u = 20°C), controller-specific

Motor characteristics at 24 V

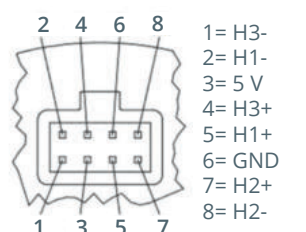


Motor phases



n.c.= please do not connect
 RM 2.54 / 10 PIN
 W+P 3491-10

Hall-sensors



Socket strip RM 2.54 / 8 PIN
 W+P 3491-08

Digital Hall-sensors

Supply of sensors: Voltage range: 4.5 to 5.5 V DC / Optional: voltage regulator for 5 V, Input current: < 70 mA
Output signals of sensors: Differential output, (RS422 standard, datasheet AM26 C31-TI)
Typical voltage range: 0.2/ 3.4 V @ 20 mA / Output current: max. 20 mA
Signal structure: The Hall sensors have a 120° phase shift to each other. Due to the 14-pole design the
Signal frequency is seven times higher than the speed

t-Rex 3206 (long version, focus torque)

I-65-86-L36 S2



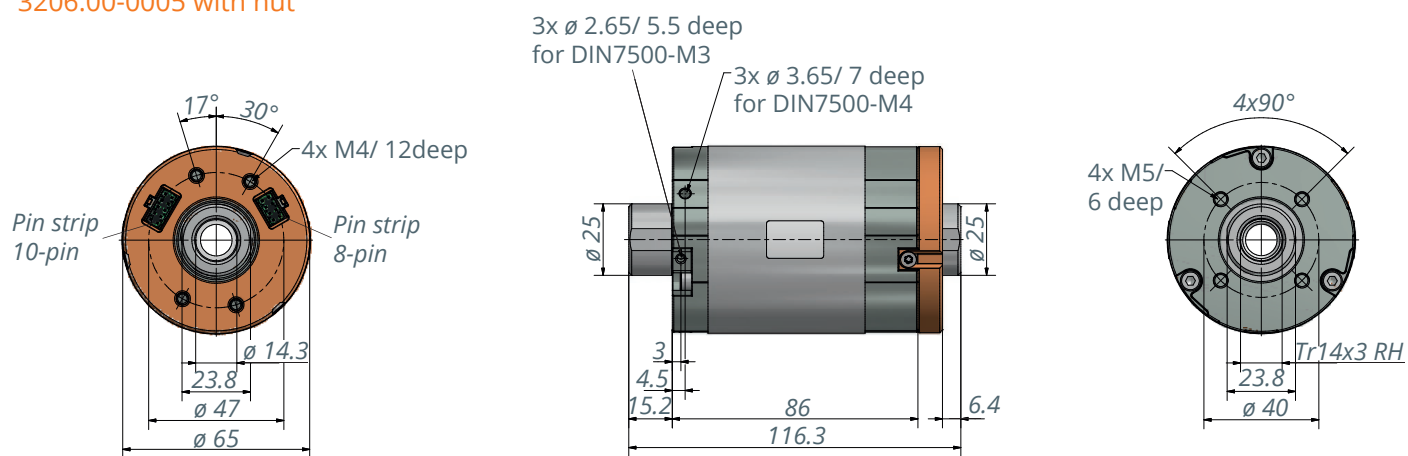
Description

14-pole BLDC motor with high-performance neodymium magnets and three digital Hall sensors to detect the rotor position. The electrical connections are designed as a plug-in system. Additional power electronics are required to operate the motor. The design of the motor with a hollow shaft allows the cables to run through the motor or output on both sides.

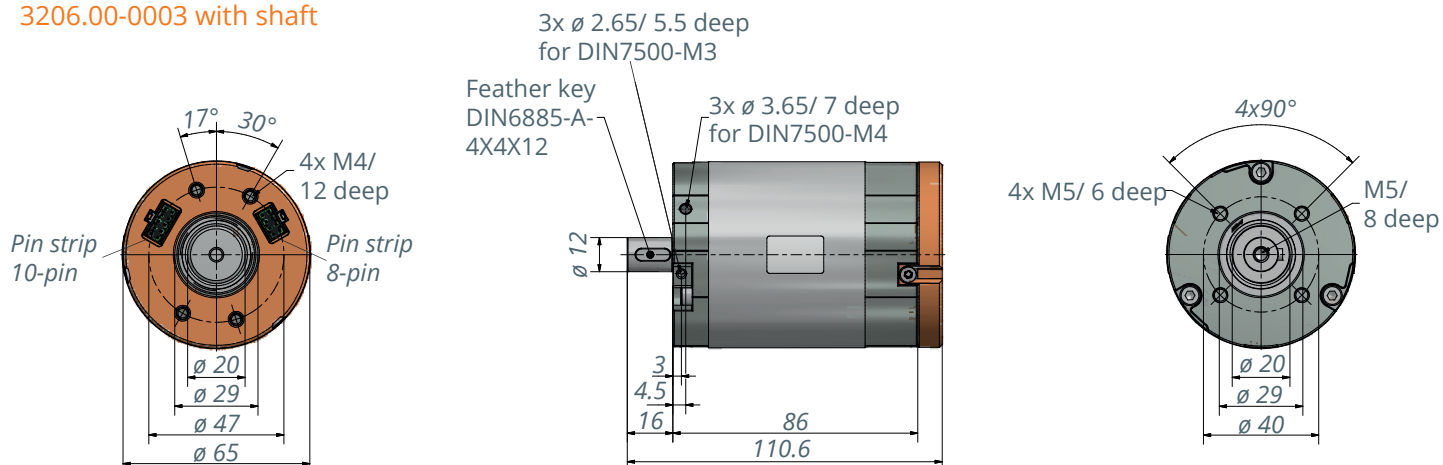
Special features

- Designed with **focus on max. torque**
- Enormous performance density – 3 times stronger than motors of comparable size
- High overload resistance
- Ideally suited as direct drive, or generator for gearless applications
- Special winding upon request
- Design and manufacture of motor to specified operating point is possible

3206.00-0005 with nut



3206.00-0003 with shaft



| t-Rex 3206 I-65-86 L36 S2 DH | 3206.00-0005/ 3200.00-0003 | | |
|--------------------------------|----------------------------|------------|------------|
| Rated voltage | 24 VDC | 36 VDC | 48 VDC |
| Rated current | 5.4 A | 5.6 A | 5.6 A |
| Rated torque | 1.9 Nm | 1.9 Nm | 1.9 Nm |
| Rated speed | 535 rpm | 865 rpm | 1185 rpm |
| Shaft power (output) | 106 W | 167 W | 232 W |
| Max. efficiency | 84 % | 82 % | 83 % |
| Idle speed | 702 rpm | 1052 rpm | 1390 rpm |
| No-load current | 0.45 A | 0.43 A | 0.43 A |
| Stall torque | 8 Nm | 9 Nm | 9 Nm |
| Starting current at idle speed | 27 A | 28 A | 26.5 A |
| Torque constant | 0.308 Nm/A | 0.330 Nm/A | 0.343 Nm/A |
| Speed constant | 29 rpm/V | 29 rpm/V | 29 rpm/V |

Motor parameters

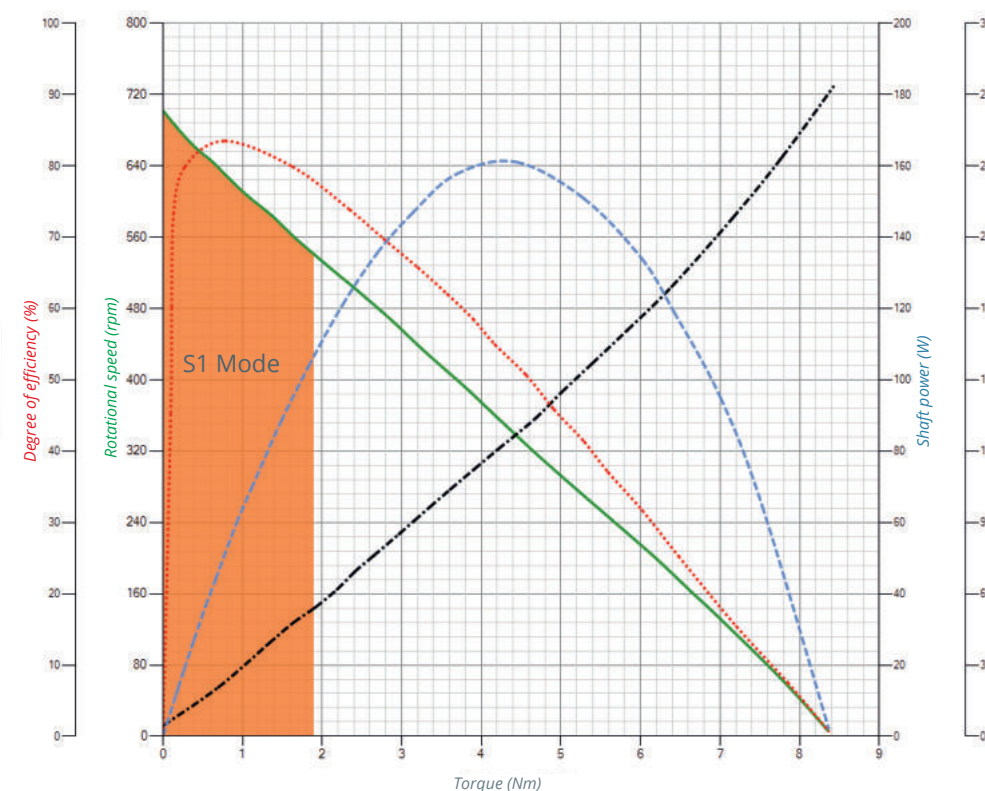
| | |
|--------------------------------------|-------------------------|
| Terminal resistance (phase to phase) | 0,121 Ohm |
| Terminal inductance (phase to phase) | 0.9 mH |
| Rotor inertia | 104 kg* mm ² |
| Number of poles | 14 |
| Interconnection of the motor | Star |
| Number of coils per phase | 2 |
| Interconnection of coils | 2 Series |
| Direction of rotation | bidirectional |

Note: Max. ambient temperature = 40 °C, controller-specific
At the nominal point (TU = 20°C), controller-specific

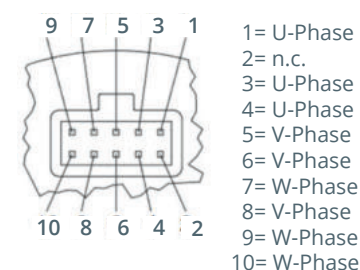
Motor cable approx. 1.5 m

Item number: 3200.53-05

Motor characteristics at 24 V

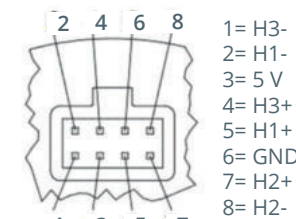


Motor phases



n.c.= please do not connect
RM 2.54 / 10 PIN
W+P 3491-10

Hall-sensors



Socket strip RM 2.54 / 8 PIN
W+P 3491-08

Digital Hall-sensors

Supply of sensors: Voltage range: 4.5 to 5.5 V DC / Optional: voltage regulator for 5 V, Input current: < 70 mA

Output signals of sensors: Differential output, (RS422 standard, datasheet AM26 C31-TI)

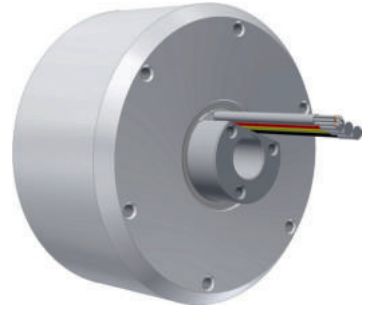
Typical voltage range: 0.2/ 3.4 V @ 20 mA / Output current: max. 20 mA

Signal structure: The Hall sensors have a 120° phase shift to each other. Due to the 14-pole design the Signal frequency is seven times higher than the speed

i-Rex 3207

Description

The 32-pole BLDC outrunner motor with its compact design is perfectly suited for a direct drive.



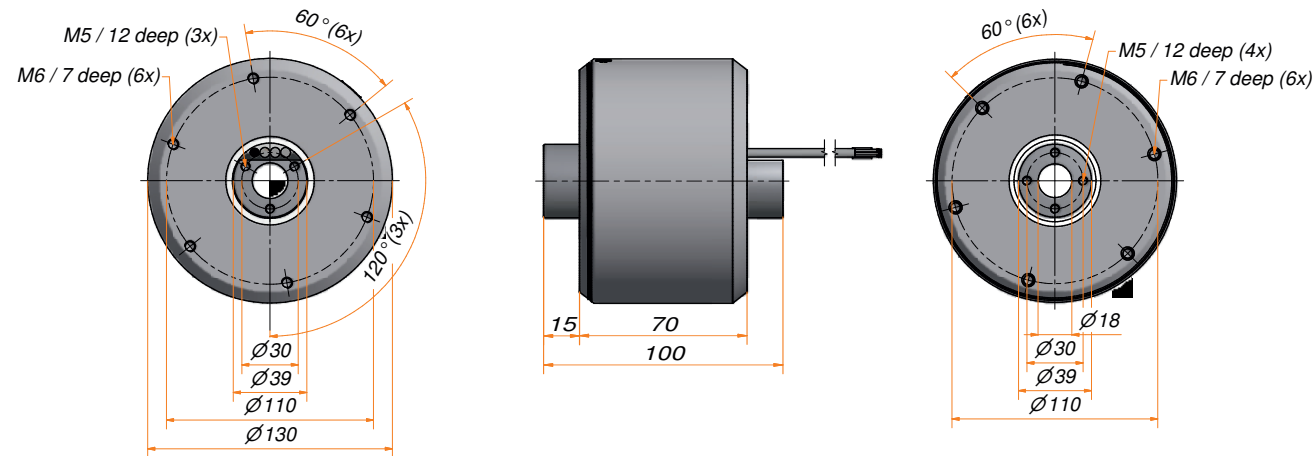
Direct drive - Benefits in a nutshell

- No gearbox – no wear
- Much longer service life compared to conventional drive technology with a gear stage
- Excellent running properties with barely perceptible noise level
- Ultra-compact with extremely high power density

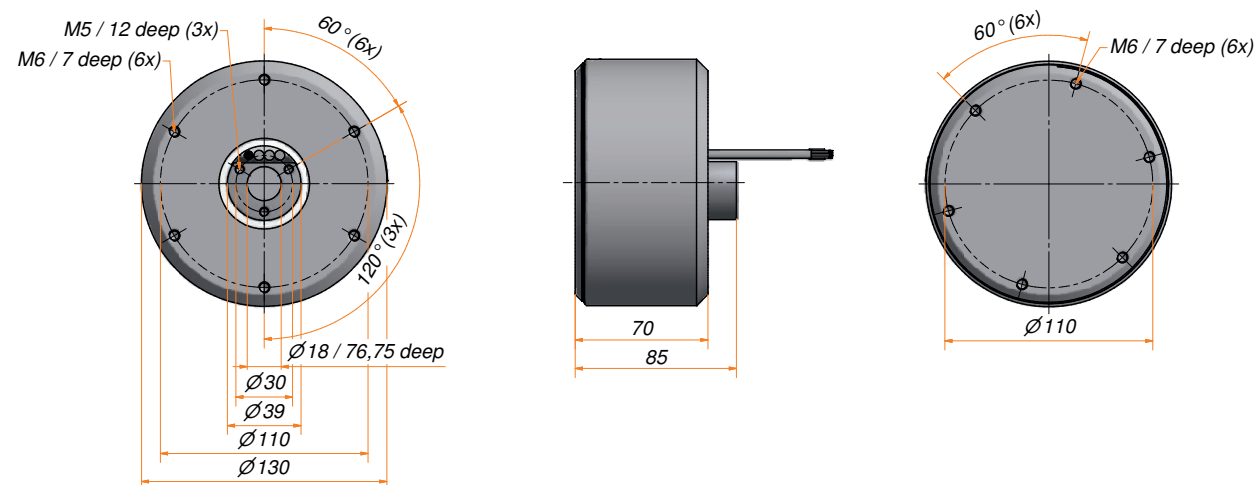
The choice is yours - we implement it

- Two analog Hall sensors as standard
Other encoder types are available on request
- Brake optional
- Combinable with various controllers
- Customized mechanical integration or system connection

3207.48-2001: With throughgoing hollow shaft

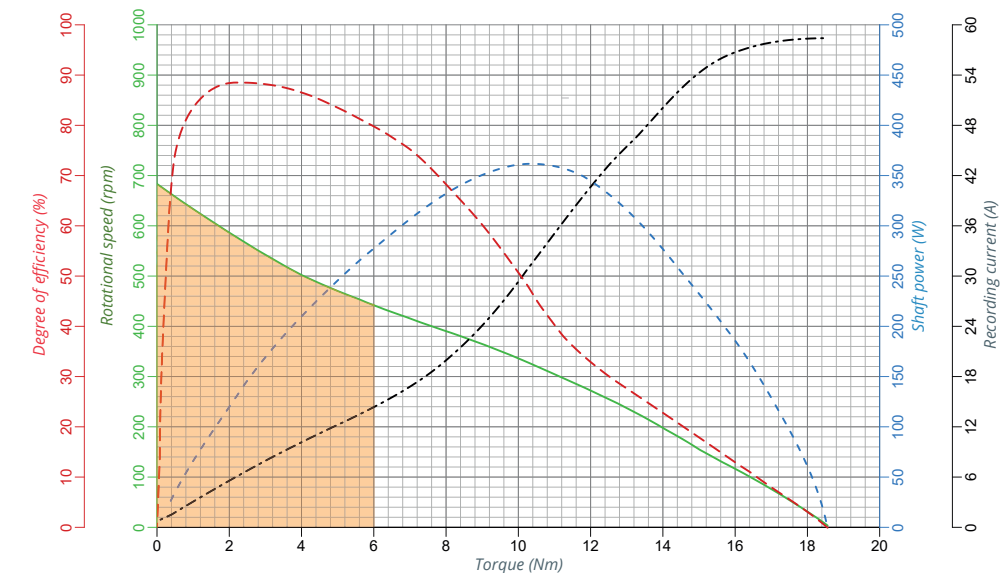


3207.48-2010: With hollow shaft



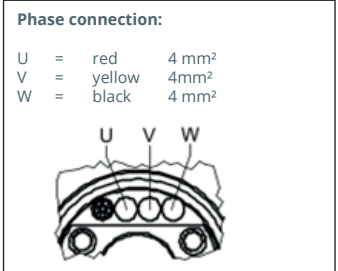
| | 3207.48-2001 / 3207.48-2010 i-Rex-A-130 | | |
|--|--|---------------------------|------------|
| Voltage range | 48 VDC | 48 VDC | 48 VDC |
| Rated voltage | 24 VDC | 36 VDC | 48 VDC |
| Rated current | 14.5 A | 14 A | 14 A |
| Rated torque¹⁾ | 6 Nm | 6 Nm | 6 Nm |
| Rated speed | 440 rpm | 670 rpm | 880 rpm |
| Shaft power (output) | 270 W | 420 W | 550 W |
| Max. efficiency | 89 % | 89 % | 88 % |
| Idle speed²⁾ | 680 rpm | 1,000 rpm | 1,360 rpm |
| No-load current²⁾ | 1 A | 1 A | 1 A |
| Stall torque²⁾ | 18.5 Nm | 17.9 Nm | 17.8 Nm |
| Starting current at idle speed²⁾ | 58 A | 39.5 A | 33 A |
| Torque constant³⁾ | 0.43 Nm/A | 0.43 Nm/A | 0.43 Nm/A |
| Speed constant³⁾ | 28.3 rpm/V | 27.8 rpm/V | 28.3 rpm/V |
| Terminal resistance (phase to phase) | | 0.12 Ohm | |
| Terminal inductance | | 0.88 mH | |
| Rotor inertia | | 1,713 kg* mm ² | |
| Number of poles | | 32 | |
| Interconnection of the motor | | H36S4 | |
| Encoder type | | 2x Halls analog | |

- 1) At the nominal point (TU = 20°C), controller-specific
- 2) Max. ambient temperature = 40 °C, controller-specific
- 3) Radial and axial forces apply to the nominal service life
L10h = 20,000h according to DIN ISO 281



Sensor connection:

| | |
|---------------------|--------------|
| 1 Sensorsignal cos+ | brown |
| 2 Sensorsignal cos- | brown-white |
| 3 5 V | orange |
| 4 Sensorsignal sin+ | green |
| 5 Sensorsignal sin- | brown |
| 6 GND | orange-white |



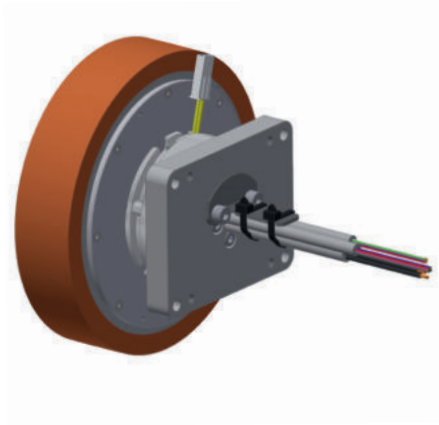
Analoge Hall-sensors

Supply of sensors:
Voltage range: 5 V DC
Input current: < 70 mA

Output signals of sensors:
Differential output
Typical voltage range: 1 ± 0.2 V DC
Output current: Max. 20 mA

Signal structure: The hall sensors have a 90° phase shift to each other. Due to the 32-pole design the **signal frequency is 16 times higher** than the speed.

i-Wheel 3213.00-1XXX



Direct drive - Benefits in a nutshell

- No gearbox – no wear
- Much longer service life compared to conventional drive technology with a gear stage
- Excellent running properties with barely perceptible noise level
- Safe operation due to permanent temperature monitoring
- Ultra-compact with extremely high power density
- Easy replacement of the the wheel coating on site possible thanks to the patented Ketterer solution



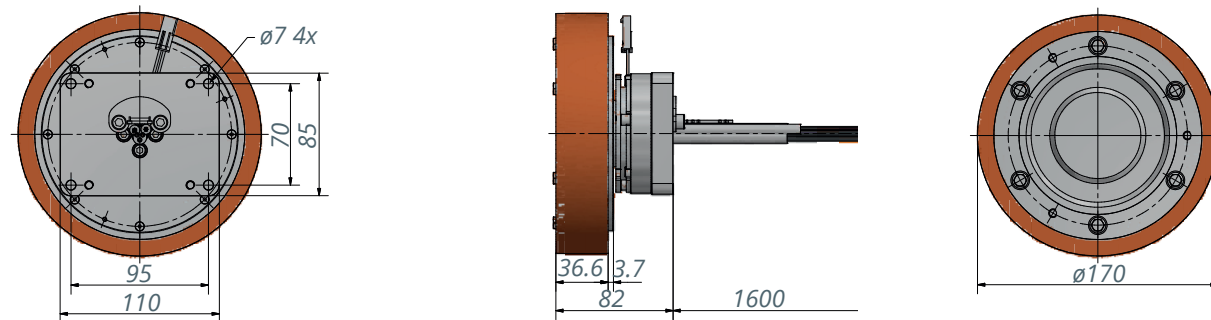
Safety first

- Rotational control system using diverse redundancy
- PL-d** safety level achievable with suitable controller
- Safe production processes, as there are no risks of contamination from gear oils and greases (no gearbox)

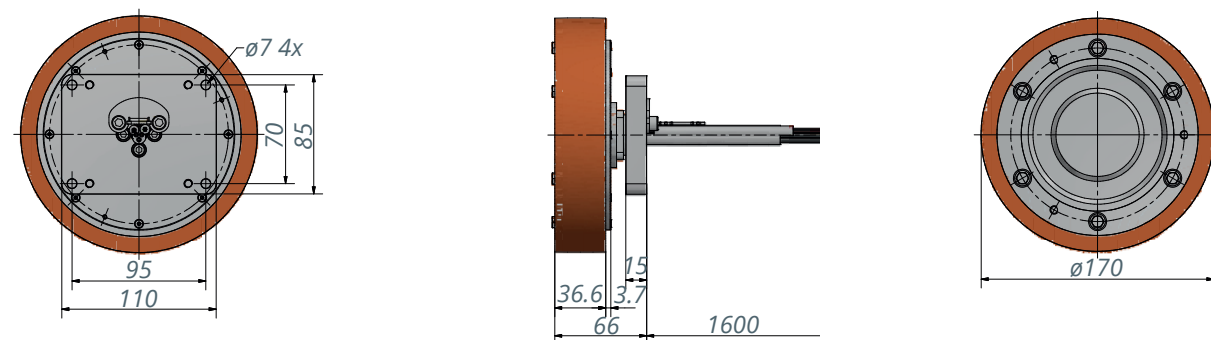
The choice is yours - we implement it

- Encoder optional: BiSS, SSI, TTL incremental (various resolutions)
- Brake optional: Permanent magnetic brake or spring-operated brake
- Can be combined with various controllers
- Customer-specific mechanical integration and system connection

3213.00-1XX1 with brake

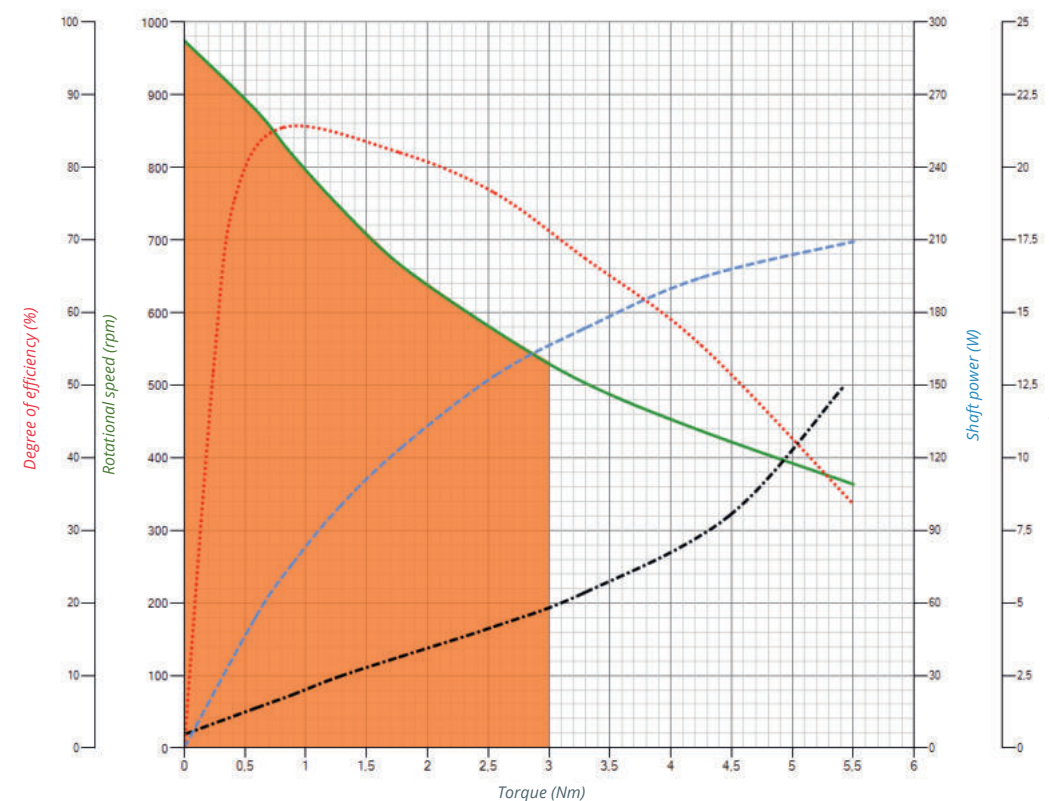


3213.00-1XX2 without brake



| 3213.00-1XXX i-Wheel-A-170 | |
|--|---------------|
| Rated voltage | 48 VDC |
| Rated current ¹⁾ | 5 A |
| Rated torque ¹⁾ | 3 Nm |
| Rated speed ¹⁾ | 530 rpm |
| Max. speed at rated torque ¹⁾ | 17 km/h |
| Shaft power (output) ¹⁾ | 165 W |
| Idle running speed ²⁾ | 975 rpm |
| No-load current ²⁾ | 0.5 A |
| Achievable max. speed ²⁾ | up to 31 km/h |
| Max. efficiency ²⁾ | 86 % |
| Standstill torque ²⁾ | 5.4 Nm |
| Starting current at idle speed ²⁾ | 12,4 A |
| Torque constant ²⁾ | 0.6 Nm/A |
| Speed constant ²⁾ | 11 rpm/V |
| Terminal resistance (phase to phase) | 0.65 Ohm |
| Terminal inductance | 3.7 mH |

1) Max. ambient temperature = 40 °C, controller-specific
 2) At the nominal point (TU = 20°C), controller-specific
 3) Radial and axial forces apply to the nominal service life
 L10h = 20,000h according to DIN ISO 281



| 3213.00-1XXX i-Wheel-A-170 | |
|---------------------------------------|--|
| Rotor inertia | 2,900 kg*mm ² |
| Max. radial axle load F ³⁾ | 800 N |
| Max. axial axle load F ³⁾ | 200 N |
| Number of magnets poles | 32 |
| Interconnection of the motor | L63S4 |
| Encoder type in standard | Digital Halls + TTL magnetic incremental ABZ |
| Encoder resolution | 4.096 cpr |
| Material of the coating | Blickle Besthane 92 ±3 Shore A |

| | |
|-------------------------|---------------------------------|
| Braking torque | 5 Nm |
| Power supply brake | 24 VDC / 17,6 W |
| Power consumption brake | 7 W through PWM Power reduction |
| Weight incl. brake | 4,5 kg |

| Brake: | | |
|--------|-------|-------|
| 1 | +24 V | PIN 1 |
| 2 | GND | PIN 2 |

| Motor phases: | | |
|----------------------|----------|--|
| Alpahwire 6716 AWG16 | | |
| U | = red | |
| V | = black | |
| W | = yellow | |

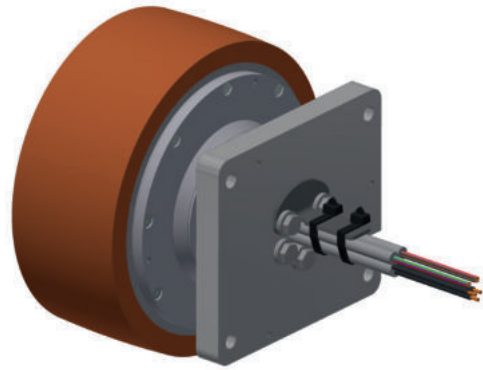
| Hall sensors: | | |
|--------------------------------|--------|-------|
| igus CF240.PUR.01.08 (8x0,14)C | | |
| 1 | +5 V | red |
| 2 | GND | blue |
| 3 | H1 | white |
| 4 | H2 | brown |
| 5 | H3 | green |
| 6 | PT1000 | gray |
| 7 | PT1000 | pink |

Hall output signal: 3 square-wave signals
 The hall signals have a phase shift of 120° to each other.
 Power supply: 5V ± 5%
 Input current: typ. 40 mA

| Encoder: | | |
|--------------------------------|------|--------|
| igus CF240.PUR.01.08 (8x0,14)C | | |
| 1 | +5 V | red |
| 2 | GND | blue |
| 3 | A | gray |
| 4 | A- | pink |
| 5 | B | green |
| 6 | B- | yellow |
| 7 | Z | white |
| 8 | Z- | brown |

Differential encoder output signal:
 3 square-wave signals (RS422)
 Channel A, B (90° phase shift) and Index Z
 Accuracy: ± 0.5°
 Power supply: 5V ± 5%
 Input current: typ. 35 mA

i-Wheel 3213.00-2XXX



Direct drive - Benefits in a nutshell

- No gearbox – no wear
- Much longer service life compared to conventional drive technology with a gear stage
- Excellent running properties with barely perceptible noise level
- Safe operation due to permanent temperature monitoring
- Ultra-compact with extremely high power density
- Easy replacement of the the wheel coating on site possible thanks to the patented Ketterer solution



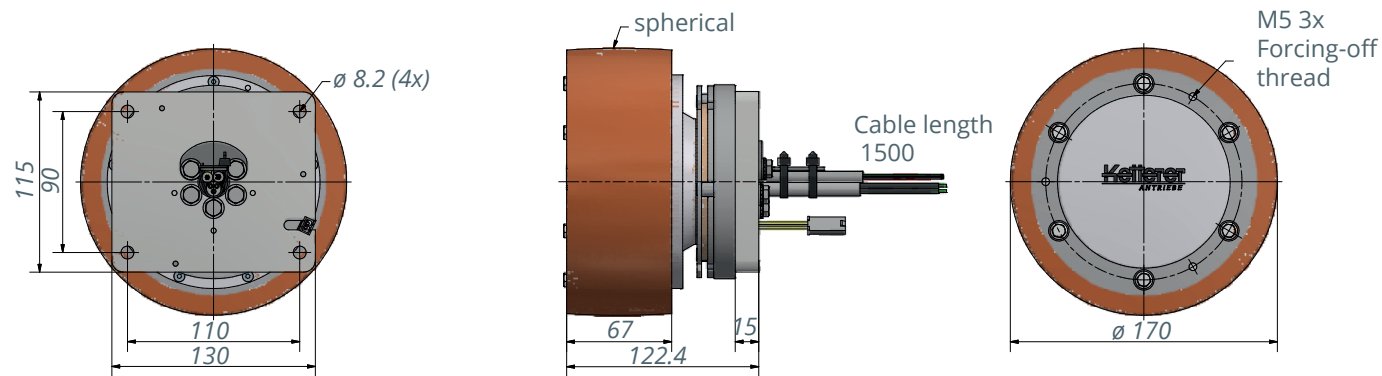
Safety first

- Rotational control system using diverse redundancy
- PL-d** safety level achievable with suitable controller
- Safe production processes, as there are no risks of contamination from gear oils and greases (no gearbox)

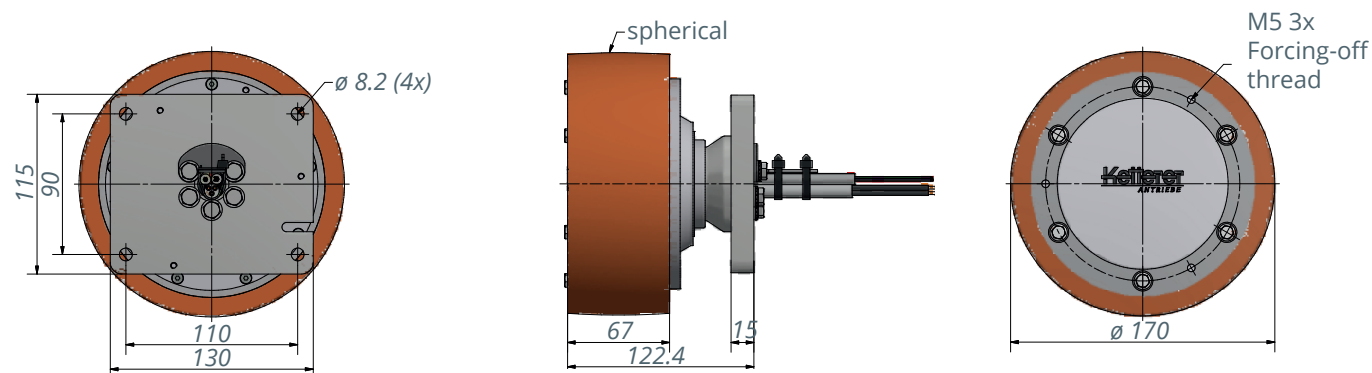
The choice is yours - we implement it

- Encoder optional: BiSS, SSI, TTL incremental (various resolutions)
- Brake optional: Spring-operated brake
- Can be combined with various controllers
- Customer-specific mechanical integration and system connection

3213.00-2XX1 with brake



3213.00-2XX2 without brake

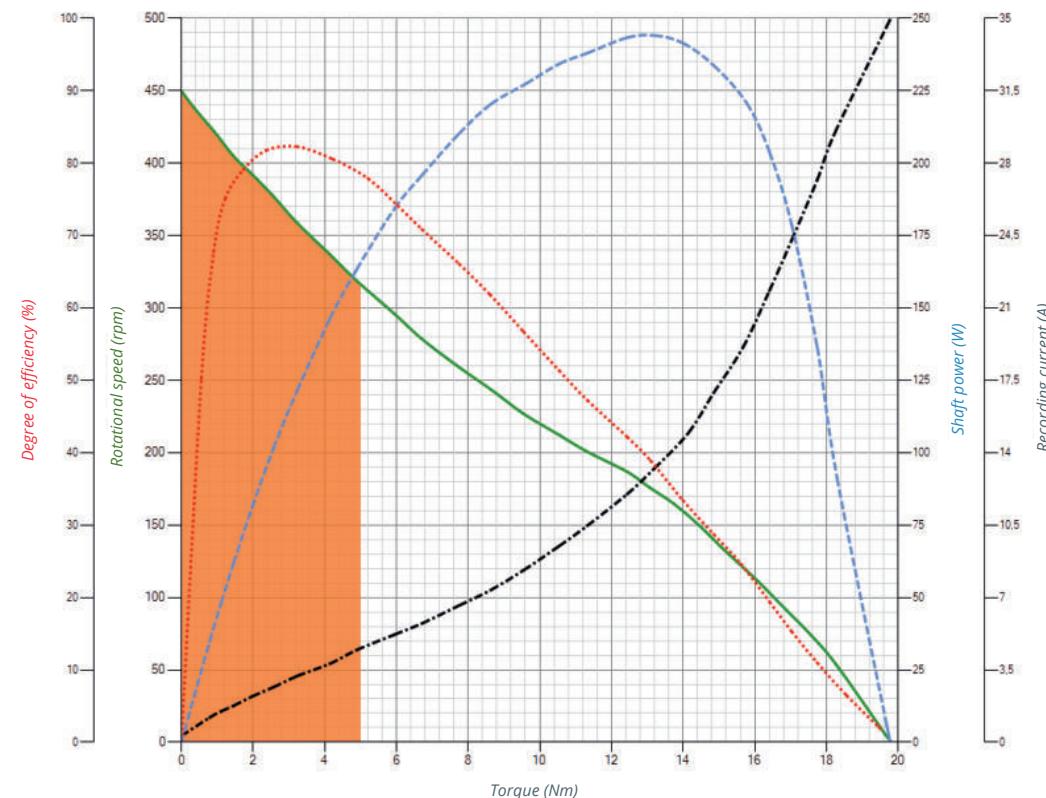


| 3213.00-2XXX i-Wheel-A-170-123 | |
|--|---------------|
| Rated voltage | 48 VDC |
| Rated current ¹⁾ | 4.5 A |
| Rated torque ¹⁾ | 5 Nm |
| Rated speed ¹⁾ | 316 rpm |
| Max. speed at rated torque ¹⁾ | 10 km/h |
| Shaft power (output) ¹⁾ | 165 W |
| Idle running speed ²⁾ | 450 rpm |
| No-load current ²⁾ | 0.3 A |
| Achievable max. speed ²⁾ | up to 14 km/h |
| Max. efficiency ²⁾ | 82 % |
| Standstill torque ²⁾ | 20 Nm |
| Starting current at idle speed ²⁾ | 32 A |
| Torque constant ²⁾ | 1.25 Nm/A |
| Speed constant ²⁾ | 9.4 rpm/V |
| Terminal resistance (phase to phase) | 1.05 Ohm |
| Terminal inductance | 7 mH |

| 3213.00-2XXX i-Wheel-A-170-123 | |
|---------------------------------------|--|
| Rotor inertia | 14,500 kg*mm ² |
| Max. radial axle load F ³⁾ | 2,500 N |
| Max. axial axle load F ³⁾ | 1,250 N |
| Number of magnets poles | 32 |
| Interconnection of the motor | L63S4 |
| Encoder type in standard | Digital Halls + TTL magnetic incremental ABZ |
| Encoder resolution | 4,096 cpr |
| Material of the coating | Blickle Besthane 92 ±3 Shore A |

| | |
|-------------------------|---------------------------------|
| Braking torque | 16 Nm |
| Power supply brake | 24 VDC / 19.4 W |
| Power consumption brake | 7 W through PWM Power reduction |
| Weight incl. brake | 10,3 kg |

1) Max. ambient temperature = 40 °C, controller-specific
 2) At the nominal point (TU = 20°C), controller-specific
 3) Radial and axial forces apply to the nominal service life
 L10h = 20,000h according to DIN ISO 281



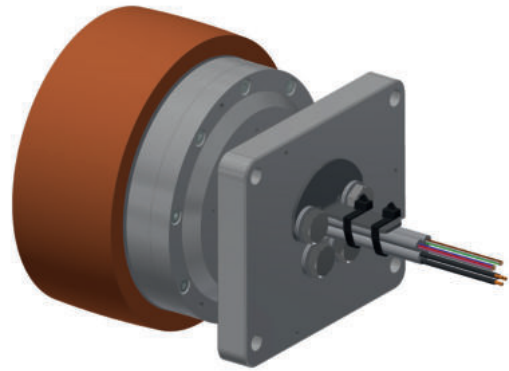
| Brake: | |
|--------|------------|
| 1 | +24 V PIN1 |
| 2 | GND PIN2 |

| Motor phases: | |
|-----------------------------------|--|
| igus CF77.UL.25.04.D (4G2.5) | |
| U = 1 | |
| V = 2 | |
| W = 3 | |
| The PE conductor is not connected | |

| Hall sensors: | |
|--|----------|
| igus CF240.PUR.01.08 (8x0.14)C | |
| 1 | +5 V red |
| 2 | GND blue |
| 3 | A white |
| 4 | H2 brown |
| 5 | H3 green |
| Output signal: 3 square-wave signals The hall signals have a phase shift of 120° to each other. Power supply: 5V ± 5% Input current: typ. 40 mA | |

| Encoder: | |
|--|-----------|
| igus CF240.PUR.01.08 (8x0.14)C | |
| 1 | +5 V red |
| 2 | GND blue |
| 3 | A gray |
| 4 | A- pink |
| 5 | B green |
| 6 | B- yellow |
| 7 | Z white |
| 8 | Z- brown |
| Differential output signal: 3 square-wave signals (RS422) Channel A, B (90° phase shift) and Index Z Accuracy: ± 0.5° Power supply: 5V ± 5% Input current: typ. 35 mA | |

i-Wheel 3213.00-3XXX



Direct drive - Benefits in a nutshell

- No gearbox – no wear
- Much longer service life compared to conventional drive technology with a gear stage
- Excellent running properties with barely perceptible noise level
- Safe operation due to permanent temperature monitoring
- Ultra-compact with extremely high power density
- Easy replacement of the the wheel coating on site possible thanks to the patented Ketterer solution



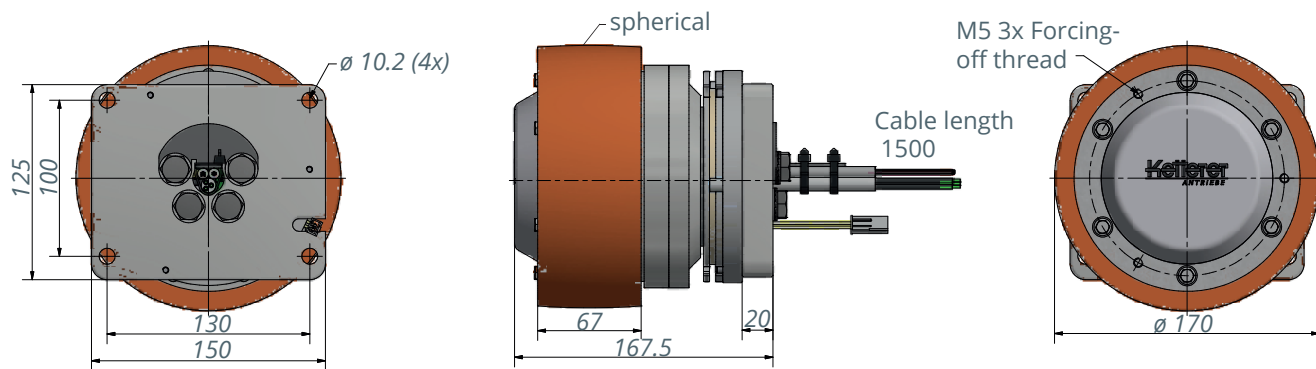
Safety first

- Rotational control system using diverse redundancy
- PL-d** safety level achievable with suitable controller
- Safe production processes, as there are no risks of contamination from gear oils and greases (no gearbox)

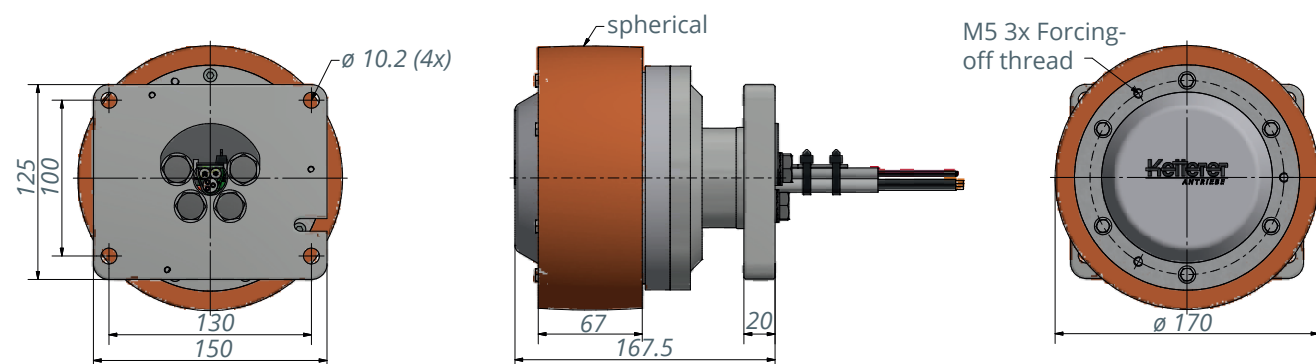
The choice is yours - we implement it

- Encoder optional: BiSS, SSI, TTL incremental (various resolutions)
- Brake optional: Spring-operated brake
- Can be combined with various controllers
- Customer-specific mechanical integration and system connection

3213.00-3XX1 with brake



3213.00-3XX2 without brake

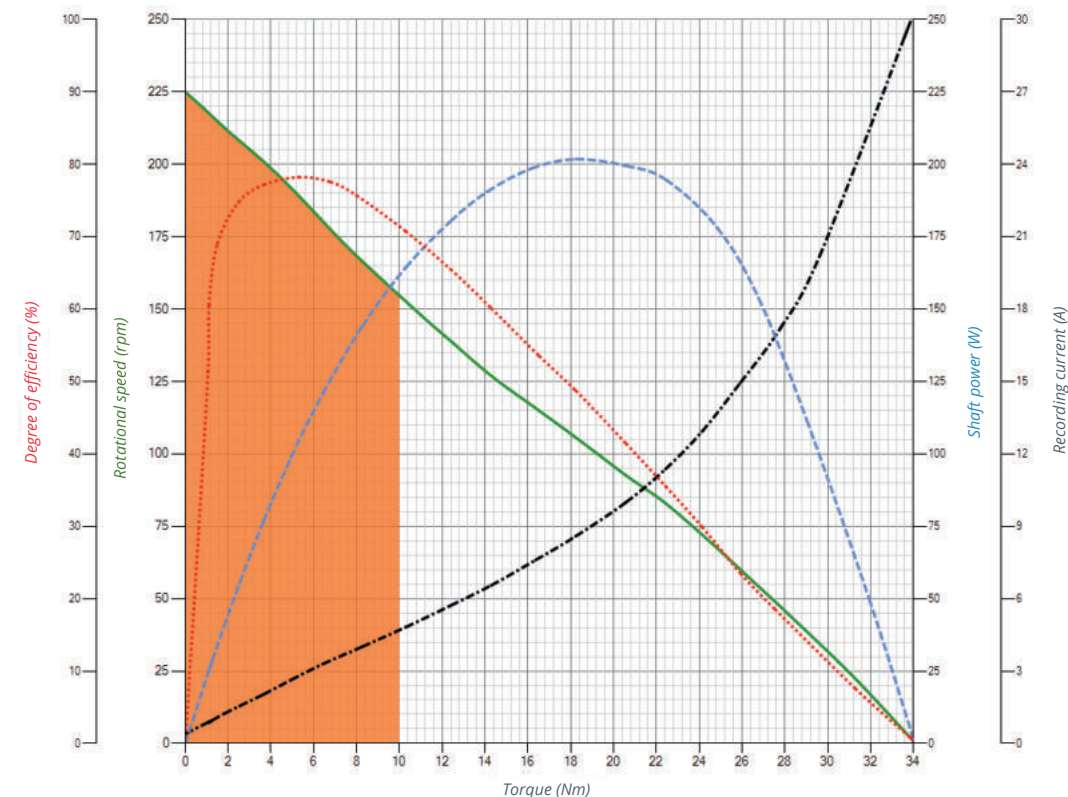


| 3213.00-3XXX i-Wheel-A-170-168 | |
|--|--------------|
| Rated voltage | 48 VDC |
| Rated current ¹⁾ | 4.7 A |
| Rated torque ¹⁾ | 10 Nm |
| Rated speed ¹⁾ | 154 rpm |
| Max. speed at rated torque ¹⁾ | 5 km/h |
| Shaft power (output) ¹⁾ | 161 W |
| Idle running speed ²⁾ | 225 rpm |
| No-load current ²⁾ | 0.4 A |
| Achievable max. speed ²⁾ | up to 7 km/h |
| Max. efficiency ²⁾ | 78 % |
| Standstill torque ²⁾ | 34 Nm |
| Starting current at idle speed ²⁾ | 29 A |
| Torque constant ²⁾ | 2.1 Nm/A |
| Speed constant ²⁾ | 4.7 rpm/V |
| Terminal resistance (phase to phase) | 1.75 Ohm |
| Terminal inductance | 15 mH |

| 3213.00-3XXX i-Wheel-A-170-168 | |
|---------------------------------------|--|
| Rotor inertia | 26,850 kg*mm ² |
| Max. radial axle load F ³⁾ | 7,500 N |
| Max. axial axle load F ³⁾ | 2,500 N |
| Number of magnets poles | 32 |
| Interconnection of the motor | L62S4 |
| Encoder type in standard | Digital Halls + TTL magnetic incremental ABZ |
| Encoder resolution | 4,096 crp |
| Material of the coating | Blickle Besthane 92 ±3 Shore A |

| | |
|-------------------------|---------------------------------|
| Braking torque | 30 Nm |
| Power supply brake | 24 VDC / 21.5 W |
| Power consumption brake | 7 W through PWM Power reduction |
| Weight incl. brake | 17.6 kg |

1) Max. ambient temperature = 40 °C, controller-specific
 2) At the nominal point (TU = 20°C), controller-specific
 3) Radial and axial forces apply to the nominal service life
 L10h = 20,000h according to DIN ISO 281



| Brake: | |
|--------|------------|
| 1 | +24 V PIN1 |
| 2 | GND PIN2 |

| Motor phases: | |
|-----------------------------------|--|
| igus CF77.UL.25.04.D (4G2.5) | |
| U = 1 | |
| V = 2 | |
| W = 3 | |
| The PE conductor is not connected | |

| Hall sensors: | |
|--|----------|
| igus CF240.PUR.01.08 (8x0.14)C | |
| 1 | +5 V red |
| 2 | GND blue |
| 3 | H1 white |
| 4 | H2 brown |
| 5 | H3 green |
| Output signal: 3 square-wave signals The hall signals have a phase shift of 120° to each other. Power supply: 5V ± 5% Input current: typ. 40 mA | |

| Encoder: | |
|--|-----------|
| igus CF240.PUR.01.08 (8x0.14)C | |
| 1 | +5 V red |
| 2 | GND blue |
| 3 | A gray |
| 4 | A- pink |
| 5 | B green |
| 6 | B- yellow |
| 7 | Z white |
| 8 | Z- brown |
| Differential output signal: 3 square-wave signals (RS422) Channel A, B (90° phase shift) and Index Z Accuracy: ± 0.5° Power supply: 5V ± 5% Input current: typ. 35 mA | |

i-Wheel Clever 3213.00-21XX



Wheel hub drive with fully integrated Circulo 9 Motion Controller from Synapticon - a compact, intelligent drive system with minimal integration expenses.

Direct drive: Advantages in a nutshell

- No gearbox – no wear
- Much longer service life compared to conventional drive technology with a gear stage
- Excellent running properties with barely perceptible noise level
- Safer operation through permanent temperature monitoring
- Ultra-compact with extremely high power density
- Easy replacement of wheel coating on site possible thanks to patented Ketterer solution



Overall System: Intelligent - Safe - Ultracompact

- Optimum Performance Scaling: Available in all three Ketterer standard performance classes of the i-Wheel family on request
- Highest performance in drive control in the smallest installation space
- Easy to Use: Seamless Integration in a few easy steps
- Plug & Play: Standard plug & standard cable can be used
- High speed EtherCAT interface, low latency, negligible jitter
- Over 10 certified safety functions (SIL2, PI-d) SIL 3, PL-e on request
- High Resolution Absolute Encoder
- User-friendly Synapticon parameterization and tuning software
- Model predictive field-oriented control for high efficiency, maximum bandwidth
- Optional emergency holding brake with energy saving mode
- Available in the near future: Circulo 9 with Safe Motion Module

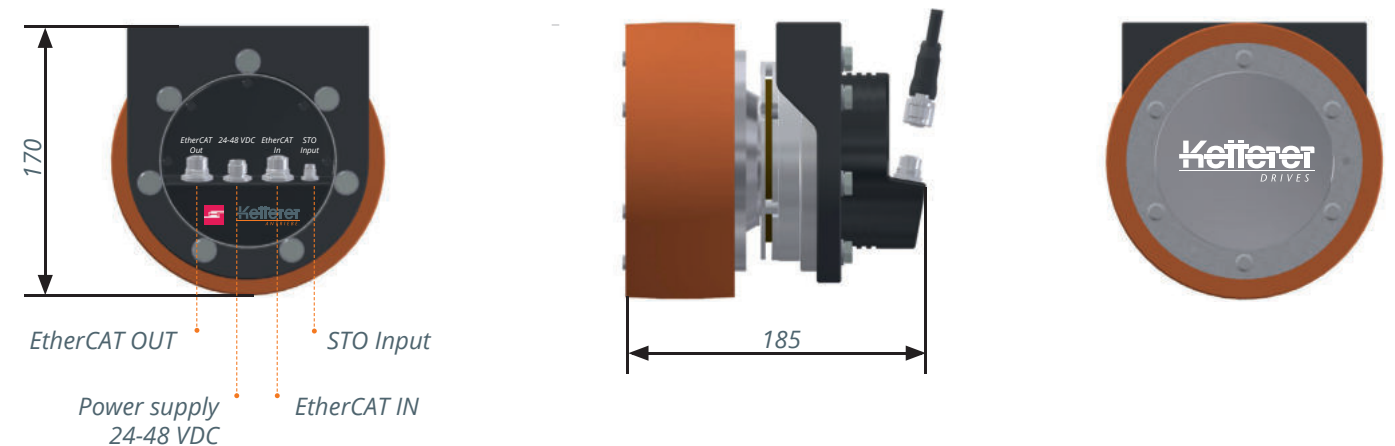


| 3213.00-21XX i-WheelC-A-170-185 | |
|--|----------------------------|
| Rated voltage | 48 VDC |
| Rated current¹⁾ | 4.5 A |
| Rated torque¹⁾ | 5 Nm |
| Rated speed¹⁾ | 316 rpm |
| Max. speed at rated torque¹⁾ | 10 km/h |
| Shaft power (output)¹⁾ | 165 W |
| Idle running speed²⁾ | 450 rpm |
| No-load current²⁾ | 0.3 A |
| Max. efficiency²⁾ | 82 % |
| Standstill torque²⁾ | 19.7 Nm |
| Starting current at idle speed²⁾ | 35 A |
| Max. radial axle load F³⁾ | 2,500 N |
| Max. axial axle load F³⁾ | 1,250 N |
| Encoder resolution | 262,144 cpr |
| Material of the coating | PU-Rad: 92° ±3° Shore A |
| Braking torque of the emergency holding brake | 16 Nm |

1) Max. ambient temperature = 40 °C, controller-specific
 2) At the nominal point (TU = 20°C), controller-specific
 3) Radial and axial forces apply to the nominal service life
 L10h = 20,000h according to DIN ISO 281

| Circulo 9 Motion Controller by Synapticon | |
|--|--|
| Communications interface | EtherCAT, FSoE (FailSafe over EtherCAT) |
| Rated voltage range | 24 - 48 V DC |
| Max. voltage | 60 V DC |
| Continuous phase current RMS | 20 A |
| Max. efficiency | 99 % |
| Hardware Protection | Overcurrent, overvoltage, undervoltage, PW deadtime, overtemperature, PWM shoot through |
| Standard Safety Functions | STO/SBC |
| Safe Motion Modul | FSoE, STO, SBC, SS1/2, SOS, SMS, 4xSLS, Safe Process Data (position, velocity) |
| Certified Safety Functions | STO – SAFE TORQUE OFF SBC – SAFE BRAKE CONTROL SBT – SAFE BRAKE TEST* SS1 – SAFE STOP 1 SS2 – SAFE STOP 2 SLS – SAFELY LIMITED SPEED SLP – SAFELY LIMITED POSITION* SLT – SAFELY LIMITED TORQUE* SAFE VELOCITY PROCESS DATA SAFE POSITION PROCESS DATA SAFE TORQUE PROCESS DATA SAFE DIGITAL GPIO AND ANALOG INPUTS |
| | *The functions must be implemented in the safety controller using secure process data |

i-Wheel Clever 3213 with integrated Circulo 9 Motion Controller by Synapticon



Ket-Rob - Drive platform for AGV/AGC

Description

Tailored to the requirements of autonomous robot technology, Ketterer offers a modular drive platform for **Automated Guided Vehicle** systems or - **Carts (AGV/AGC)**.

All components are designed for simple integration.

Your benefits

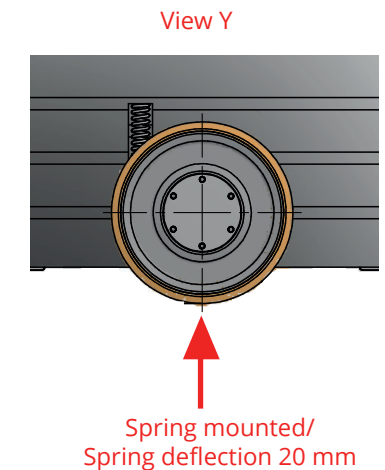
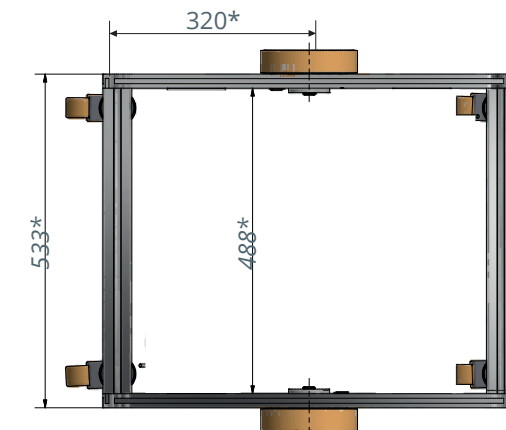
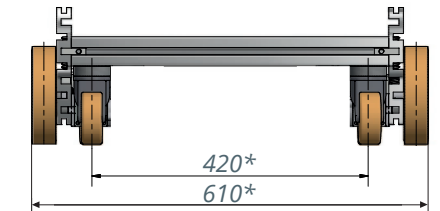
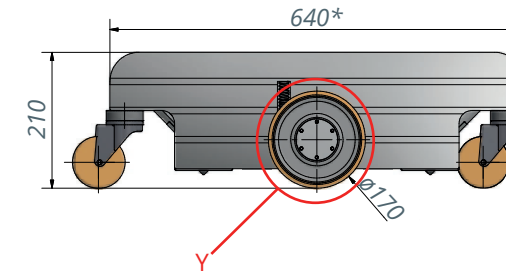
- Complete basic drive module for **Automated Guided Vehicle** systems or - **Carts (AGV/AGC)**
- Dimensioning of the drive platform according to individual requirements
- Gearless BLDC wheel hub drives with a durable Vulkollan or solid rubber wheel
- Noise-reduced direct drive with spring suspension (spring travel 20 mm). Therefore driving on uneven surfaces is not a problem
- Large design scope of the vehicle structure due to very low installation depth of the wheel hub drives
- Very quiet in operation
- Maintenance-free, therefore no maintenance and service needed
- Load platform height adjustment and load platform in accordance with customer-specific requirements optionally possible
- Customer-specific adaptations of the drives or systems are possible



Technical data

| | <i>Ket -Rob</i> |
|--|--|
| Power supply | 24 V- 48 V |
| Utilize speed | 7 km/ h |
| Acceleration | 0.5 m/s ² |
| Max. Engine power (per drive unit) | 210 W |
| Load capacity | 100 kg |
| Starting torque (per drive unit) | 6 Nm |
| Braking torque (per brake) | 9 Nm |
| Power supply brake (per drive unit) | 24 V/ 18 W |
| Driving direction | forward and backward |
| Ground clearance | 30 mm |
| Max. incline | 4 % |
| Protection class | IP 20 |
| Operating temperature | 5 to 40 °C (Humidity 10-90 % non-condensing) |

Basis: Without height adjustment for transport platform



* Dimensions can be customized

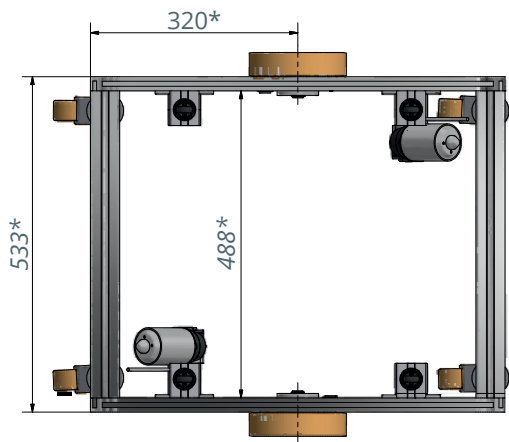
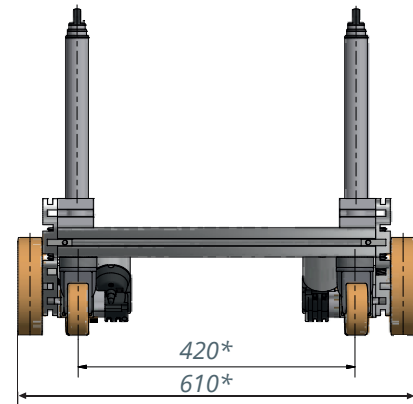
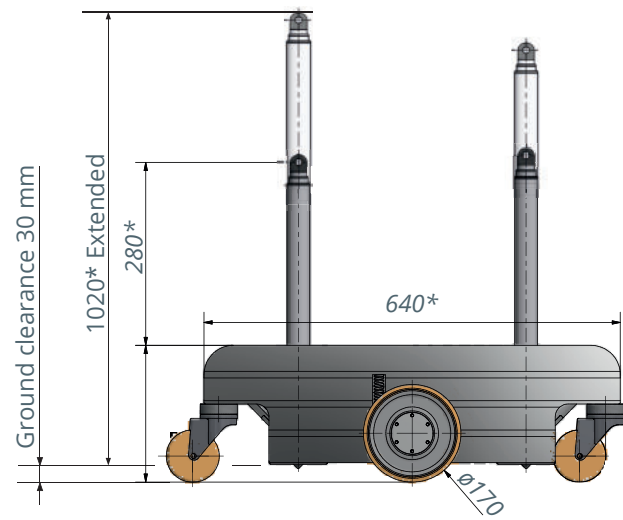
Ket Rob consists in the standard version of:

- 2 x BLDC wheel hub drives with encoder and brake (without regulation/control)
- 4 x load bearing steering wheels
- Frame

Additional options:

- Height adjustment for transport platform
- Transport platform

Additional option: Height adjustment for transport platform



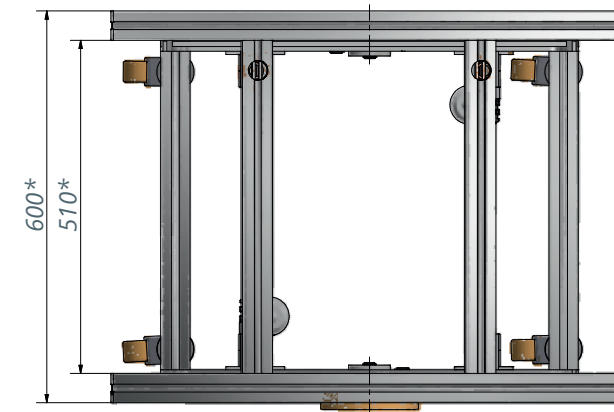
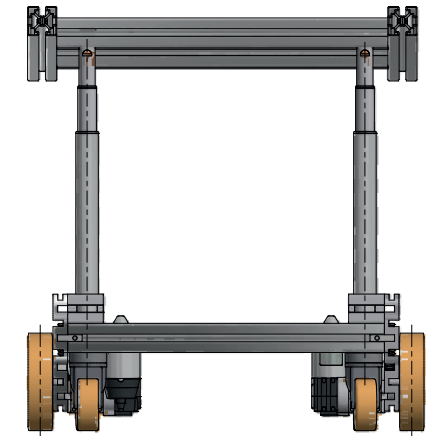
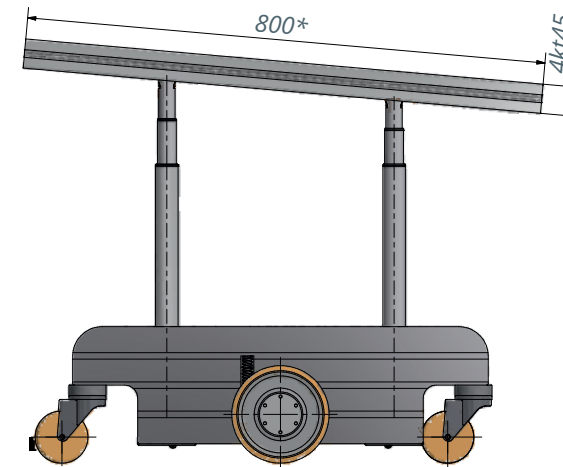
* Dimensions can be customized

Technical notes

- For the linear height adjustment many Ketterer standard solutions conceivable: e.g. 3120, 4643, 4114, Information about these products can be found at www.ketterer-drives.com/products
- Customer-specific adaptations are possible



Additional option: Transport platform



* Dimensions can be customized

Orientation aid

In the era of Industry 4.0 and Big Data, it is unimaginable to do without Automated Guided Vehicle Systems (AGVS) and Automated Guided Vehicles (AGV). They have become a component of modern intralogistics solutions.

Automated Guided Vehicle Systems (AGVS)

Automated Guided Vehicle Systems are floor-bound systems that are used in-plant, inside and/or outside of buildings. They essentially consist of one or more automatically controlled vehicles, guided without contact, with their own travel drive and, if necessary, of

- a master controller,
- a device for location determination and position detection
- a device for data transmission and
- infrastructural and peripheral devices

The main task of an AGVS is the automatic transport of materials. In the broader sense, AGVSs also include systems that are used for service tasks such as handling, monitoring, cleaning, mobile information and guidance – including in areas accessible to the general public.

VDI guideline 2510

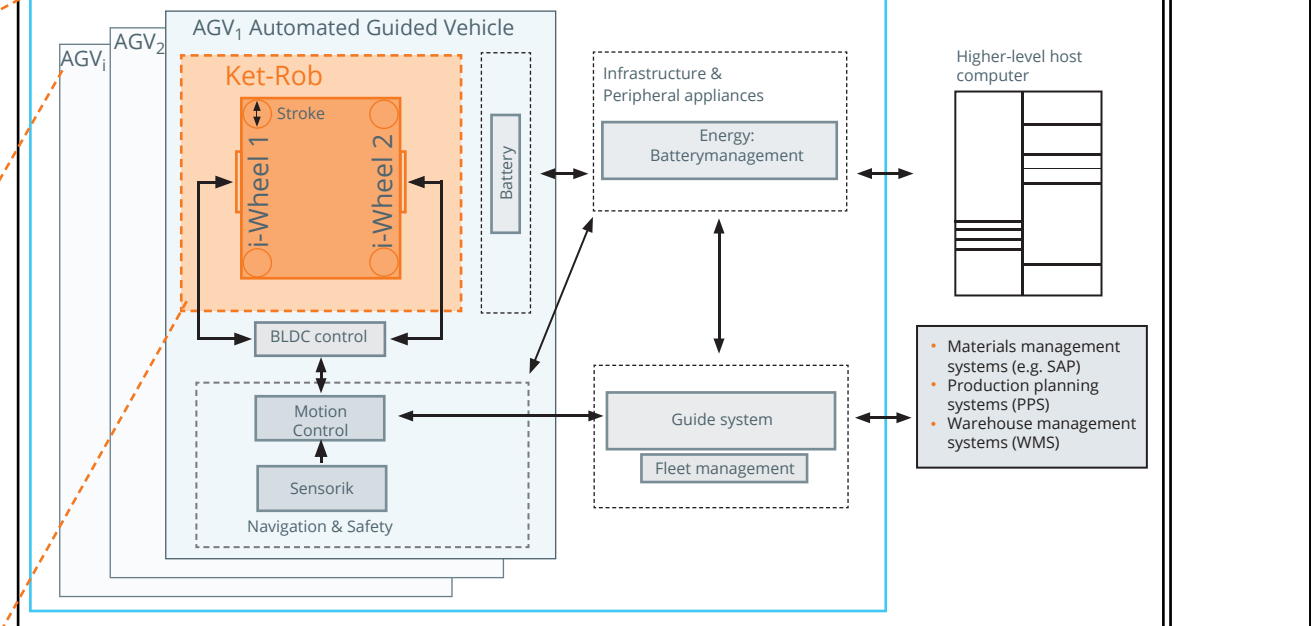
Automated Guided Vehicles (AGVs)

Automated Guided Vehicles (AGVs) are floor-bound conveyances with their own travel drive, which are automatically controlled and guided without contact.

They are used for the transport of materials, i.e. for pulling and/or carrying conveyed goods with active or passive load handling devices. This guideline deals with vehicles with wheel drives. Rail-guided vehicles, air-cushion vehicles and walking machines are excluded.

VDI guideline 2510

FTS - Automated Guided Vehicle System

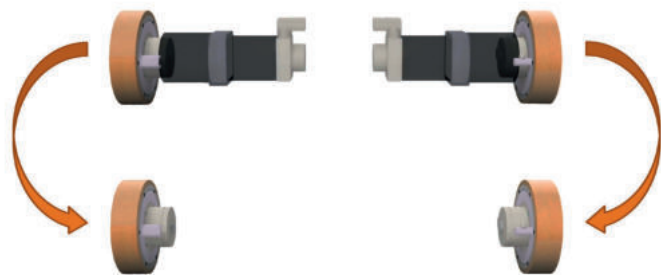


Ker-Rob – more time for essentials

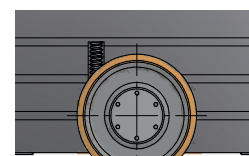
Ketterer's drive platform „Ker-Rob“ enables the project manager, in the development of an AGV / AGVS, to concentrate on the complex part of the work, i.e. the proprietary application and idea, including the programming and coordination of the necessary control systems. If the controller is to be evaluated, the Ketterer platform enables a prototype for an AGV / AGVS to be created and tested very quickly. The time saved can be used in the development of system variants in order to find the optimum solution for the in-house AGV / AGVS.



More space due to gearless configuration



Drives with spring suspension – uneven surfaces are not a problem



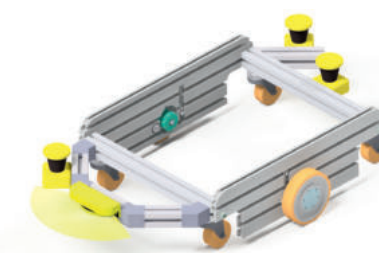
Spring-loaded/
Spring deflection 20 mm



Variable dimensioning



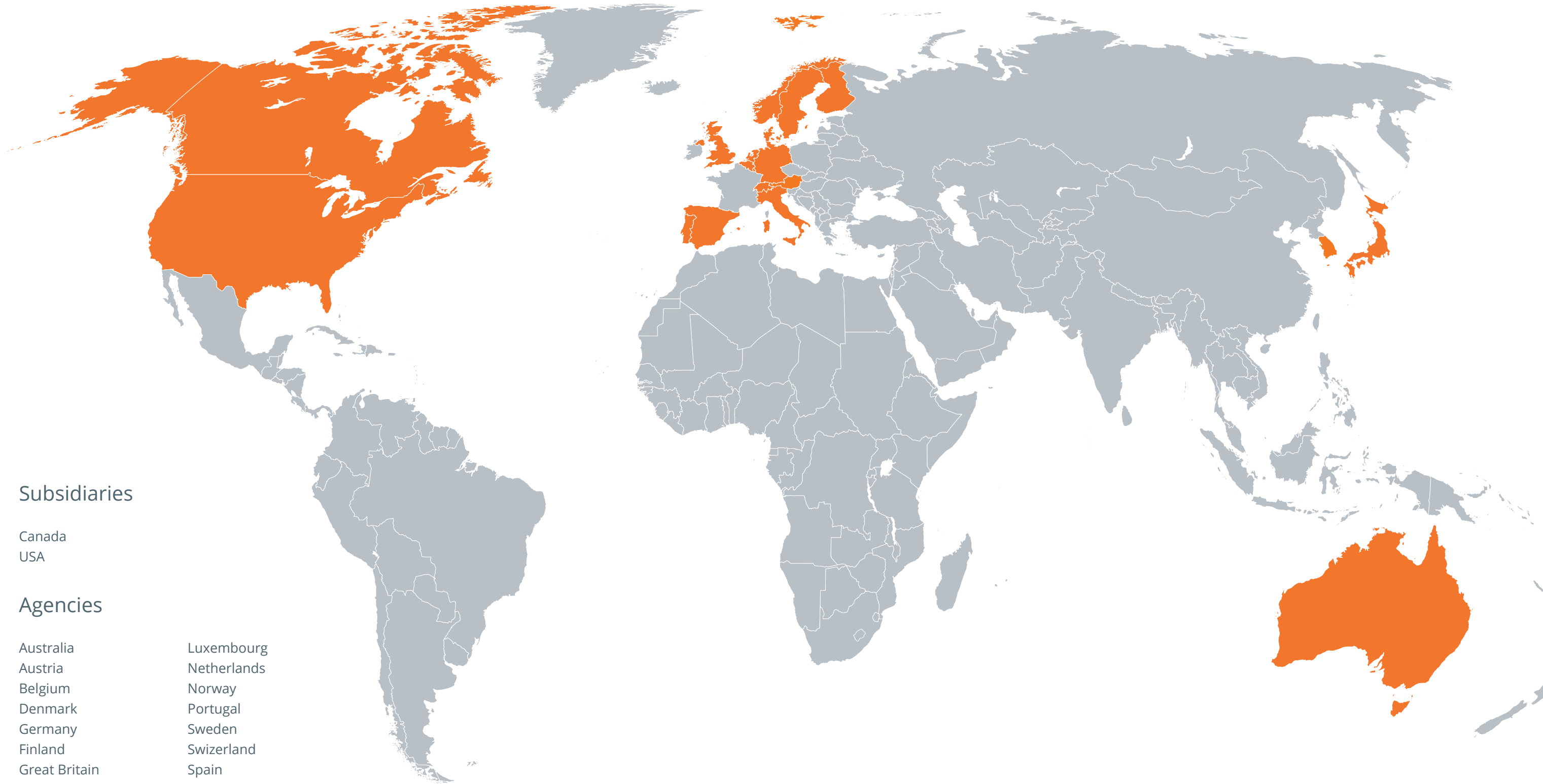
Frame prepared for the mounting of sensors



Optionally with lifting and/or tilting unit



USED AROUND THE WORLD



Subsidiaries

Canada
USA

Agencies

Australia
Austria
Belgium
Denmark
Germany
Finland
Great Britain
Italy
Japan
Luxembourg
Netherlands
Norway
Portugal
Sweden
Swizerland
Spain
South Korea

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