Motion Control Solutions for Industrial and Robotic Applications

From integrated motors to CANopen masters with ROS interface, Nanotec offers innovative drive solutions for diverse industries.

Integrated Motors - it's Plug & Drive

- Brushless DC servo systems
- Programmable, step & direction, analog control
- Precise position, speed and torque control

All-In-One!
Integrated Brushless DC Servos

Integrated brushless DC servo motors from Nanotec are available in three sizes from Nema 17 to Nema 34 and different stack lengths. They feature:

- Precise position, velocity and torque control
- Integrated fully programmable controller
- Single-turn absolute encoder
- Controlled by fieldbus, step & direction, and analog I/O
- USB or CANopen, and CiA 402
- Digital and analog inputs, digital outputs

**NEMA 17**

**PD2-C (High-Pole Servo/Stepper)**

Operating voltage: 12–48 V
Rated torque: up to 0.5 Nm
Rated speed: 4,000 rpm

**PD6-C (High-Pole Servo/Stepper)**

Operating voltage: 12–48 V
Rated torque: up to 8.8 Nm
Rated speed: 3,000 rpm

**PD4-C (High-Pole Servo/Stepper)**

Operating voltage: 12–48 V
Rated torque: 1–3.5 Nm

**PD6-CB (Brushless DC Servo)**

Operating voltage: 12–24 V
Rated power: 105 W
Rated torque: 0.25 Nm
Peak torque: 0.75 Nm
Rated speed: 4,000 rpm

**PD6-CB87S (Brushless DC Servo)**

Operating voltage: 12–48 V
Rated power: 220 W
Rated torque: 0.7 Nm
Peak torque: 2.1 Nm
Rated speed: 3,000 rpm

**PD6-CB80M (Brushless DC Servo)**

Range size: 80 mm
Operating voltage: 12–48 V
Nominal output: 534 W
Rated torque: 1.7 Nm
Peak torque: 5 Nm
Rated speed: 3,000 rpm

**NEMA 23/24**

**PD4-CB (Brushless DC Servo)**

Operating voltage: 12–24 V
Rated power: 135 W
Rated torque: 0.37 Nm
Peak torque: 0.92 Nm
Rated speed: 3,500 rpm

**PD6-CB87S (Brushless DC Servo)**

Operating voltage: 12–48 V
Rated power: 220 W
Rated torque: 0.7 Nm
Peak torque: 2.1 Nm
Rated speed: 3,000 rpm

**NEMA 34**

**PD2-CB (Brushless DC Servo)**

Operating voltage: 12–48 V
Rated power: 105 W
Rated torque: 0.25 Nm
Peak torque: 0.75 Nm
Rated speed: 4,000 rpm

**PD6-CB87S (Brushless DC Servo)**

Operating voltage: 12–48 V
Rated power: 220 W
Rated torque: 0.7 Nm
Peak torque: 2.1 Nm
Rated speed: 3,000 rpm

**PD6-CB80M (Brushless DC Servo)**

Range size: 80 mm
Operating voltage: 12–48 V
Nominal output: 534 W
Rated torque: 1.7 Nm
Peak torque: 5 Nm
Rated speed: 3,000 rpm

**Technology**

The Linux-based Robot Operating System ROS is becoming more and more popular in service robotics applications. Therefore, our engineers have chosen ROS for the semi-autonomous service robot we have developed to test our wheel drives in everyday use. However, two obstacles needed to be overcome – firstly, the integration of CANopen devices is not yet standardized, and secondly, Linux is not real-time capable without modifications. For this reason we split the tasks: The motors and sensors are connected to Nanotec’s newly developed CAN master EM5 (this way the motors will be controlled in real time). ROS will calculate the target positions of the wheels with the help of kinematics and a map, and send it to the EM5 via Ethernet. The master will then interpolate and control the path of the wheels in real time. In addition, the integrated touchscreen of the EM5 will allow the user to call up diagnostic data.

**ROS and CANopen make a perfect team**

The controller can be accessed from a PC via a variety of field buses (CANopen, Ethernet or Modbus). For setup, the object directory holding the controller configuration can be read and written via a table. Pre-defined filters enable the user to only display the parts of CiA 402 objects that pertain to a certain task, such as setup or a certain operating mode (i.e. speed). Experienced users can configure the objects via an integrated command line. The entire communication can be recorded and played back later so that lengthy command sequences only need to be entered once during setup. To tune the controller parameters, an integrated oscilloscope displays up to eight objects simultaneously with a resolution of up to one millisecond. Furthermore, Plug & Drive Studio allows the user to program the controller in Nanotec V2 in an IDE with syntax highlighting and a debugger.

**Plug & Drive Studio**

A new software is now available for easy setup and programming of Nanotec’s motor controllers: Plug & Drive Studio. For our controllers, we developed NanoJ, a C++ based programming language in which the user program runs in a “sandbox”, which is executed in a fixed cycle of 1 ms. This way, the controller settings and status values (I/O status, actual current, speed, position, etc.) can be read and written after every 1-ms cycle. As a result, users can react to changes with just a few lines of code. They can also solve complex technical requirements, such as tracking a special acceleration ramp according to a mathematical function, or changing the control parameters of a motor while it is running. Because field bus communication can be operated in parallel, time-critical tasks can be processed directly in the controller.
**Brushless DC Servo Controllers**

- For brushless DC and stepper motors
- Closed-loop (FOC) control with encoder, sensorless or hall feedback
- Precise position, velocity, and torque control
- Quick to parameterize and easy to program with NanoJ V2
- Controlled by fieldbus, step & direction, and analog I/O
- No step losses

**Technology**

**Triple your Speed with Nanotec’s Revolutionary Sensorless**

Increase your production output by switching from open-loop to sensorless control. By using a Nanotec controller, you can almost triple the speed of your CNC machine, as the motors will accelerate much faster and without any resonances. This way you have the advantage of closed-loop servo control without investing into encoder feedback!

Stepper motor technology was long considered to be merely a cost-effective alternative to applications that do not demand the high performance delivered by servo motors. Machine designs in particular, had applications that were increasingly changed over to servo motors, whose ease of integration in small spaces counter their higher procurement costs.

This trend was reversed by the development of field-oriented, closed-loop controlled stepper motors. The core of closed-loop technology is the field-oriented control of stepper motors via encoder signals. This corresponds to the control of a brushless DC motor, turning a classic stepper into a high-pole servo. The resulting system continuously achieves twice or three times the torque at 20–50% of the nominal speed of a servo motor of the same size. In addition, this motor gets rid of the disadvantages of classic open-loop control, such as resonance or excessive heat generation. However, these advantages of field-oriented control do not justify the higher price for the required encoder in classic stepper motor applications, such as small table-top CNC machines used for engraving, dosing, marking or milling.

The positioning accuracy of the open-loop stepper motor is often sufficient, and developers simply require better running behavior and less heat generation to be able to benefit from the advantages of field-oriented control in these applications. Nanotec has developed a sensorless (i.e. encoder-free) control for stepper motors in which the current position and speed of the rotor are calculated by a “virtual encoder” in the controller. An autosetup routine measures the connected motor and automatically determines the required parameters.

The sensorless algorithm recognizes the accuracy with which the speed is currently being estimated. If the signal becomes too imprecise as the speed decreases, the system automatically switches to open-loop control and positioning continues in this mode. When restarted from a standstill, only a few degrees are needed to return to closed-loop mode. Thus, sensorless technology makes it possible to benefit from the advantages of field-oriented control in almost all traditional stepper motor applications.
New Brushless DC Motors and Gears

Nanotec offers a number of new three-phase brushless DC motors with high-energy permanent magnets that provide rapid acceleration and high speeds, paired with excellent efficiency. They are ideally suited for applications that demand very smooth running and a long service life.

Nanotec has developed a number of new gears specially suited for medical, industrial, and robotic applications:

GPLK These gears are especially well suited for applications where the motor will be moved. They are made of plastic and therefore considerably lighter and much quieter than comparable gears made of metal.

GPLEP Planetary precision gears are equipped with reinforced output bearings and withstand high radial and axial loads.

GPLEF Flange planetary gears offer a reasonably priced high-efficiency alternative to cycloidal or harmonic gears with a standard ISO 9409 compliant mounting flange.

From standard solutions to customer-specific designs, Nanotec will supply the perfect drive system for your application. Our motors, linear actuators, gears, brakes and encoders, are part of a modular system with over 4,000 possible combinations. The online configurator at www.nanotec.com will assist you in finding the right product.

Nanotec offers solutions for service robotics and transportation systems that meet a broad spectrum of load, speed, and braking requirements. These include small brushless DC motors for pipe inspection robots. Plug & Drive motors with an output of 50 W that drive a Mecanum platform via planetary gears, or drives for autonomous transportation systems with an output of several hundred watts per wheel.

All of our standard products can be combined according to our customers’ requirements and supplemented by application-specific components. With our integrated motors and GPLEP planetary gears, we offer a standard solution for a variety of wheel drive requirements. Our product range is complemented by custom solutions, from actual wheels delivered with the gear motor to active safety brakes, bringing an AGV from full speed to a complete standstill in no time.

<table>
<thead>
<tr>
<th>Model</th>
<th>Size (Ø mm)</th>
<th>Operating voltage (V)</th>
<th>Rated power (W)</th>
<th>Peak torque (Nm)</th>
<th>Rated torque (Nm)</th>
<th>Rated speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF32</td>
<td>Ø 32 mm</td>
<td>24 V</td>
<td>7.4 W</td>
<td>0.076/0.175</td>
<td>0.025/0.055</td>
<td>2,760</td>
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<tr>
<td>DF45</td>
<td>Ø 43 mm</td>
<td>24 V</td>
<td>30-65 W</td>
<td>0.15-0.39</td>
<td>0.05-0.13</td>
<td>4,840</td>
</tr>
<tr>
<td>DB41</td>
<td>NEMA 17</td>
<td>24 V</td>
<td>53-138 W</td>
<td>0.24-1.23</td>
<td>0.07-0.36</td>
<td>3,000</td>
</tr>
<tr>
<td>DB43</td>
<td>NEMA 17</td>
<td>24 V</td>
<td>283-440 W</td>
<td>0.51-3.12</td>
<td>0.17-0.44</td>
<td>3,000</td>
</tr>
<tr>
<td>DB80</td>
<td>Flange size 80 x 80 mm</td>
<td>48 V</td>
<td>24 V</td>
<td>2.5-8.5 Nm</td>
<td>0.9-3 Nm</td>
<td>3,000</td>
</tr>
</tbody>
</table>

Characteristics: low noise, low weight, high radial and axial loads, high stiffness.

Motor flange size (mm/NEMA): 42/17, 42/17, 56/23, 86/34, 56/23.

Max. load radial/axial (N): up to 65/40, up to 900/190, up to 1,050/1,350, up to 1,900/2,000, up to 560/1,200.

Max. input speed (rpm): 5,000, 15,000, 13,000, 13,000, 13,000.

Efficiency: min. 70 %, min. 95 %, min. 95 %, min. 95 %, min. 95 %.

New: Robot Wheel Drives

<table>
<thead>
<tr>
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<th>Rated torque (Nm)</th>
<th>Rated speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPLK42</td>
<td>42/17</td>
<td>24 V</td>
<td>6 up to 15</td>
<td>0.025/0.055</td>
<td>0.012/0.025</td>
<td>6,000</td>
</tr>
<tr>
<td>GPLEP50</td>
<td>42/17</td>
<td>24 V</td>
<td>6 up to 33</td>
<td>0.05/0.13</td>
<td>0.02/0.04</td>
<td>6,000</td>
</tr>
<tr>
<td>GPLEP70</td>
<td>56/23</td>
<td>48 V</td>
<td>80/100 up to 150</td>
<td>0.25/0.5</td>
<td>0.12/0.25</td>
<td>10,000</td>
</tr>
<tr>
<td>GPLEP90</td>
<td>86/34</td>
<td>48 V</td>
<td>400/500 up to 1,500</td>
<td>1.5/3</td>
<td>0.75/1.5</td>
<td>15,000</td>
</tr>
<tr>
<td>GPLEF64</td>
<td>56/23</td>
<td>48 V</td>
<td>400/500 up to 1,500</td>
<td>1.5/3</td>
<td>0.75/1.5</td>
<td>15,000</td>
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Turnkey For Your Application

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In addition, you can order our motors with application-specific shafts and cable assemblies. We also develop completely new solutions based on your individual requirements. When designing a new product, we always keep economical production in mind, from first samples, through ramp up, and up to high volume series. Let us know how we can make it turnkey for your application!
Nanotec Electronic specializes in precise, high-performance drive solutions. We manufacture a broad range of integrated motors, brushless DC motors and stepper motors, as well as controllers and linear actuators for automation and robotic applications. Twenty-five years of engineering and production experience allow us to offer our customers valuable support in system design and selecting the best motion control solution for their application.

For additional information, technical assistance, and off-the-shelf delivery, please contact us at (781) 219-3343 or info@us.nanotec.com.