User Manual: NexBot Robotics 311-001 6-Axis Force/Torque Sensor 500N/20Nm

SKU: NXB-SNS-311-001 | Version: 1.0 | Brand: NexBot Robotics

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1. Safety Information

READ ALL SAFETY INSTRUCTIONS BEFORE OPERATION. Failure to follow safety procedures may result in serious injury or equipment damage.

DANGER: Risk of fatal injury. Disconnect and lockout all power sources before installation or maintenance. Stored energy in the robot arm can cause unexpected movement.

WARNING: Exceeding the specified maximum force (500N) or torque (20Nm) limits can cause permanent sensor damage and lead to inaccurate measurements or catastrophic failure.

WARNING: Improper mounting or loose bolts can cause the sensor or end-of-arm-tooling to detach during operation, creating a high-velocity projectile hazard.

> **CAUTION:** The sensor contains sensitive electronics. Always wear an ESD wrist strap when handling the sensor or its connectors to prevent damage from electrostatic discharge.

> **NOTICE:** The NexBot Robotics 311-001 is factory calibrated. Do not attempt to open the housing or adjust any internal components, as this will void the warranty and calibration.

2. Product Overview

The NexBot Robotics 311-001 is a compact, high-precision six-axis force and torque sensor designed to provide robotic systems with tactile sensing capabilities for advanced automation applications. This sensor measures forces and torques along all three spatial axes (Fx, Fy, Fz, Tx, Ty, Tz), enabling sophisticated force control strategies. Its primary use case is in applications requiring delicate interaction between the robot's end-of-arm-tooling and the workpiece, such as intricate assembly, surface finishing, and quality inspection. Key features include a robust, monolithic transducer design made from high-strength anodized aluminum, which provides excellent durability and resistance to industrial environments. The sensor is equipped with integrated electronics that handle signal conditioning and processing, outputting clean, high-speed data over a standard EtherCAT communication interface. This high data rate is critical for real-time force feedback loops, allowing the robot controller to make micro-adjustments to its path for smoother, more consistent results in tasks like deburring or polishing. The NXB-SNS-311-001 has a nominal capacity of ±500 N in Fz and ±20 Nm in Tz, making it suitable for a wide range of robot payloads. Engineered for reliability, the sensor features built-in overload protection, safeguarding the unit from damage in the event of unexpected collisions. Its IP67 environmental rating ensures it is fully protected against dust ingress and can withstand temporary immersion in water, making it ideal for deployment in challenging factory conditions where coolants or particulates are present. Installation is straightforward, with a standard ISO 9409-1 flange pattern for mounting between the robot arm wrist and the end effector. This sensor empowers robots to perform tasks that were previously difficult to automate, improving product quality, reducing cycle times, and increasing operational flexibility.

3. Getting Started

1. Software Integration via ESI File

To integrate the 311-001 sensor with your EtherCAT master, you must first download the corresponding EtherCAT Slave Information (ESI) file from the NexBot Robotics support website. This XML file describes the sensor's identity, parameters, and process data mapping for your control software.

2. Establishing a Data Link

After installing the ESI file, configure your EtherCAT master to scan the network. The sensor should be automatically detected. Add the sensor to your project's active device list to begin cyclic data exchange.

3. Performing an Initial Zero-Offset

Before starting any application, it is critical to perform a zero-offset (tare) operation. This function, typically executed from the robot controller, records the weight of the attached tooling and establishes it as the zero-force/torque baseline for all subsequent measurements.

4. Operation

Interpreting Measurement Data

The sensor continuously streams six 32-bit floating-point values: three forces (Fx, Fy, Fz) in Newtons and three torques (Tx, Ty, Tz) in Newton-meters. These values correspond to the coordinate system printed on the sensor's housing.

> **Tip:** For applications with high vibration, apply a digital low-pass filter to the incoming data stream in your robot program to achieve a more stable signal for your control loop.

Implementing Force-Limited Moves

Use the real-time data from the sensor as a condition for robot motion. Program the robot to stop or alter its path when a specific force or torque threshold is detected, which is essential for assembly, insertion, and material finishing tasks.

Coordinate System Transformation

For intuitive programming, it is crucial to define a tool frame (TCP) that correctly relates the sensor's coordinate system to the robot's coordinate system. Failure to do so will result in force being detected on an unexpected axis, complicating control logic.

> **Tip:** Many robot platforms have a built-in utility for calculating the tool frame transformation based on a few taught points.

Utilizing the IP67 Rating

The sensor's IP67 rating ensures protection against dust ingress and temporary immersion in water. To maintain this rating, ensure that high-quality, IP67-rated connectors and cables are used and that they are fully tightened to seal the connection points.

5. Maintenance Schedule

Interval	Task	Notes
Daily	Visually inspect the sensor housing and cables for any signs of impact, abrasion, or wear.	Pay close attention to the cable's condition at the robot's major articulation points.
Weekly		

Interval	Task	Notes
	Clean the exterior of the sensor using a soft, lint-free cloth lightly dampened with isopropyl alcohol.	Do not spray cleaning fluids directly onto the sensor or its connectors.
Monthly	Perform a zero-offset calibration to compensate for any thermal or mechanical drift.	This should be done after the system has reached normal operating temperature for best results.
Quarterly	Check the torque of the mounting bolts securing the sensor to the robot and the tool to the sensor.	Re-torque to the original specification if any loosening is detected.
Annually	Disconnect and inspect the power and EtherCAT connectors for any signs of corrosion, bent pins, or seal degradation.	Clean contacts with a dedicated electronic contact cleaner if needed.
As Needed	Update the sensor firmware if a new version is released by NexBot Robotics.	Firmware updates can provide performance enhancements and new features. Always back up your configuration before updating.

6. Troubleshooting

Symptom	Possible Cause	Solution
Sensor is not visible on the EtherCAT network.	Faulty cable, incorrect port connection, or missing ESI file in the controller.	Verify cable integrity and connections. Ensure the correct ESI file for the NXB-SNS-311-001 is loaded into the engineering software and the master is configured to scan for new devices.
Force/torque readings are erratic or noisy.	Loose mounting bolts, high-frequency mechanical vibration, or electrical interference.	Check and re-torque all mounting bolts. Ensure the EtherCAT cable is shielded and grounded properly. Implement a software-based low-pass filter on the signal.
Readings are non-zero when no load is applied.	Zero-offset has not been performed, or a connected cable	Execute the zero-offset (tare) command from the robot controller. Ensure all cables are

Symptom	Possible Cause	Solution
	is exerting a slight force (preload).	routed with sufficient slack so they do not pull on the EOAT.
Sensor status LED is solid red.	Internal fault, over/under voltage condition, or critical temperature.	Power cycle the sensor. Use a multimeter to verify the power supply is stable and providing 24VDC. If the problem persists, contact NexBot Robotics support.
Force applied on X-axis shows up on Y-axis in the data.	Incorrect mounting orientation or an error in the tool frame (TCP) transformation matrix.	Verify the sensor is mounted according to the coordinate system diagram. Review and correct the tool frame configuration in the robot controller software.
Sensor data freezes or communication drops intermittently.	Damaged EtherCAT cable (especially at bend points) or network overload.	Inspect the entire length of the cable for physical damage and replace if necessary. Use a network analysis tool to check for excessive bus load or errors on the EtherCAT network.
A known weight is measured inaccurately.	Sensor has experienced an overload event, or the zero-offset was performed incorrectly.	Re-perform the zero-offset procedure carefully. If inaccuracy persists, the sensor may have been damaged by a force exceeding its 500N/20Nm limits and requires factory recalibration.

7. Technical Specifications

Parameter	Value	Unit
Weight	0.8	kg
Material	Anodized Aluminum 7075-T6	
Voltage	24VDC	
IP Rating	IP67	
Country of Origin	DE	

Parameter	Value	Unit
Protocol	EtherCAT	
Dimensions	95 x 95 x 45 mm	