olive™ IMU

OLVX™ IMU-U02X09D Series, Inertial Measurement Unit For High-Performance Robotics Applications

Powered by ROS 2

Document OLVX™ IMU-U02X09D Revision V0.3 - June 2024

olive
Interoperable Embedded **ROBOTICS**

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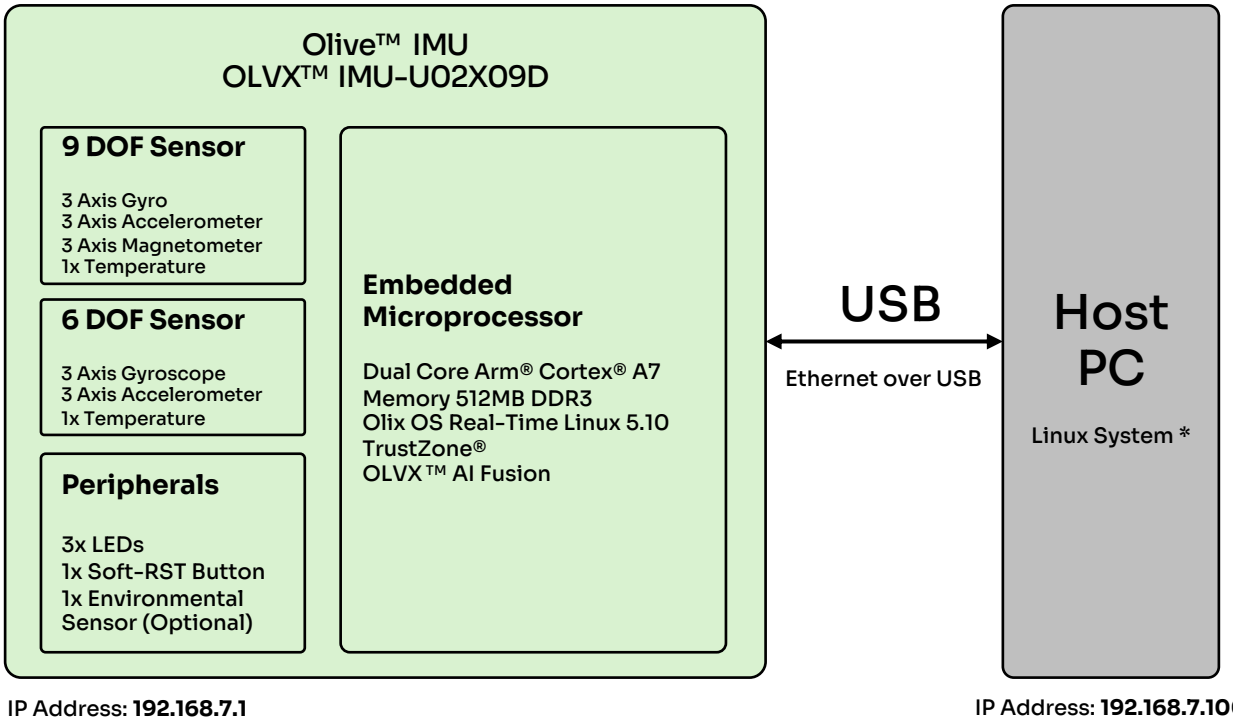
Figure 1: olive™ OLVX IMU-U02X09D series. Left to right: front view, perspective view, top view

Brief Description

The Olive™ OLVX IMU-U02X09D Series stands at the forefront of inertial measurement technology, specifically engineered for high-performance robotics. Featuring native ROS 2 support through DDS protocol, it delivers seamless integration and real-time data synchronization. This IMU combines redundant sensor fusion with high frame rates and advanced filtering techniques, offering unmatched precision and reliability for dynamic robotic applications across various industries.

Sensor System Architecture

Figure 2: system architecture



* This device requires a host PC with RNDIS driver support; please verify compatibility before use.

Key Features

•**Native ROS 2 Support**: Out-of-the-box compatibility with ROS 2 and DDS (Data Distribution Service) ensures easy integration and robust data handling within robotics ecosystems.

•**Industry-Proven Inertial Sensors**: Equipped with high-precision accelerometers, gyroscopes, and a magnetometer to deliver accurate motion and orientation data.

•**Redundant Sensor Fusion**: Features dual 3-DoF accelerometers and gyroscopes, plus a single magnetometer for enhanced data integrity and error minimization.

•**Ethernet over USB Interface**: Offers a reliable and high-speed connection, simplifying the setup and data transmission processes.

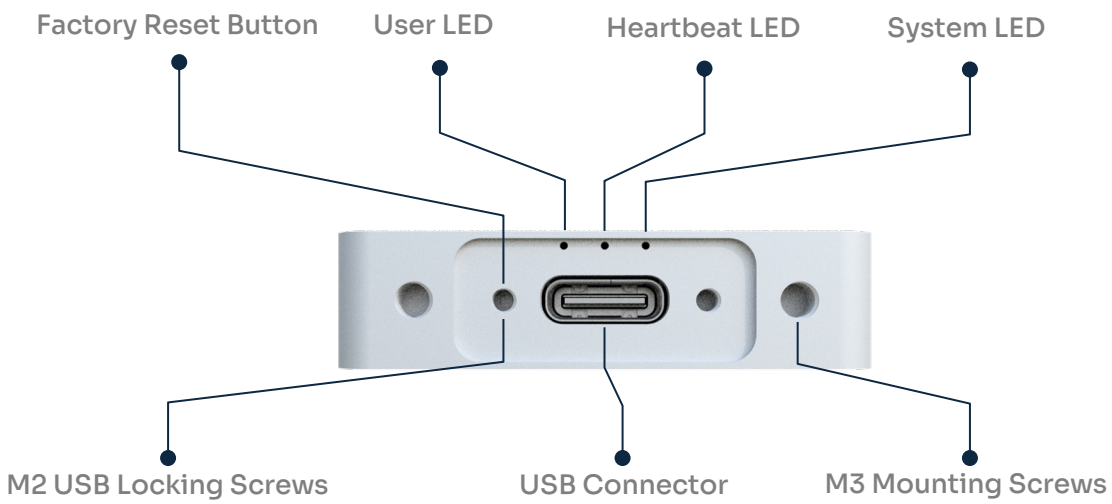
•**Low-Latency Sensor Synchronization**: Achieves synchronization speeds of less than 0.2 milliseconds, critical for real-time applications requiring fast and precise sensor data integration.

•**High Frame Rate**: Supports up to 2000 Hz of filtered data output, facilitating smooth and detailed motion tracking.

•**Advanced EKF Filter and AI Fusion**: Employs Extended Kalman Filtering and artificial intelligence techniques to optimize data accuracy and provide superior motion analysis capabilities.

•**Embedded Real-time Linux Kernel**: Runs on Olix OS, a customizable and programmable real-time Linux kernel developed by Olive Robotics, designed to enhance operational efficiency and adaptability in dynamic setups.

Figure 3: Sensor interface



Applications

The Olive™ OLVX IMU-U02X09D Series is versatile and can be effectively utilized across a wide range of robotics applications:

•**Autonomous Vehicles**: Enhances navigation and stability in self-driving cars, drones, and unmanned aerial vehicles (UAVs) by providing critical real-time data for obstacle avoidance, path planning, and vehicle control.

•**Industrial Automation**: Improves precision and efficiency in robotics systems used in manufacturing, assembly, and material handling, ensuring seamless and accurate automation processes.

•**Marine Robotics**: Supports underwater vehicles and systems with robust inertial data necessary for depth control, orientation, and navigation in challenging aquatic environments.

•**Wearable Robotics**: Integral to the development of exoskeletons and other wearable technologies, providing the necessary motion tracking to augment human movement accurately.

•**Mobile Robotics**: Ideal for robots operating in dynamic environments such as warehouses and logistic centers, offering essential data to execute complex tasks like load balancing and terrain adaptation.

•**Research and Development**: Serves as a critical tool in academic and commercial R&D projects, facilitating the exploration and development of innovative robotics applications and technologies.

Each of these applications benefits significantly from the Olive™ IMU's advanced sensor fusion technology, high frame rates, and low-latency synchronization, making it a key component in advancing the capabilities and performance of robotic systems.

Sensor Specifications

The Olive™ OLVX IMU-U02X09D Series is equipped with high-performance sensors designed to provide precise and reliable data across various robotics applications. Below are the general specifications of the module:

Table 1: System performance

AHRS Accuracy	Specification
Roll, Pitch (Static, AHRS Mode, Max Rate 100 Hz)	0.42°
Roll, Pitch (Dynamic, AHRS Mode, Max Rate 100 Hz)	0.85°
Roll, Pitch (Dynamic, IMU Mode, Max Rate 2000 Hz)	1.05°
Heading (Static, AHRS Mode, Max Rate 100 Hz) *	± 1.2°
Heading (Dynamic, AHRS Mode, Max Rate 100 Hz) *	± 2.8°
Heading (Dynamic, IMU Mode, Max Rate 2000 Hz) *	± 0.8° ±0.06 dps

* The heading accuracy depends on mechanical configuration and calibration. A fully calibrated sensor and ideal tilt compensation are assumed.

Table 2: IMU sensor details

Specification	Accelerometer	Gyroscope	Magnetometer
Range	± 4g, 8g, 16g	± 250 °/s, 500 °/s, 1000 °/s	± 1300 µT
Resolution	16-bit or 0.06 mg/LSB	16-bit or 0.004 dps/LSB	16-bit
Sensitivity	2048 LSB/g @ ±16 g	262.1 LSB/dps @ ±125 deg/sec	± 0.3 µT
Sensitivity Tolerance	±4 % @Ta=25°C, gFS2g	±3 % @ Ta=25°C, RFS2000	±0.03% @ After API compensation - 40°C ≤ TA ≤ +85°C Nominal VDD supplies
Zero-rate Offset	±20 mg	±0.5 dps	-
Output Noise Density	160 µg/√Hz	0.008 dps/√Hz	-
Zero-g Offset (x,y.z)	±150 mg @ gFS2g, TA=25°C, nominal VDD supplies, over life-time	+3 dps @ Nominal VDD supplies T A =25°C, Slow and fast offset cancellation off	-
Nonlinearity	0.5 %FS @ TA=25°C, nominal VDD, best fit straight line gFS2g	0.01 %FS @ TA=25°C, nominal VDD, best fit straight line RFS250, RFS2000	1.2 %FS @ best fit straight line

Table 3: Interface connection

Connector	USB Type-C
Communications Interface	Ethernet Over USB
Output Data Rate (Raw and Fused Data)	1-2000 Hz
Protocols (DDS)	rmw_fastrtps_cpp rmw_cyclonedds_cpp Upgradable to: rmw_connext_cpp & rmw_zenoh

Table 4: ROS 2 topics and services

Topic/Service Name	Type	Role	Description
/filtered_ahrs	sensor_msgs/Imu	Publisher	Acc, Gyro, Quaternion
/filtered_imu	sensor_msgs/Imu	Publisher	Acc, Gyro, Quaternion
/linear_accel	geometry_msgs/msg/AccelStamped	Publisher	Gravity Compensated Accel
/magnetometer	sensor_msgs/MagneticField	Publisher	Magnetic Field
/setBias	std_srvs/srv/Trigger	Service	Calibrating Sensor's Offset
/setZeroQuaternion	std_srvs/srv/Trigger	Service	Resetting Sensor's Axis

Table 5: Environmental sensor details (optional)

Parameter	Technical data
Operation range (full accuracy)	Pressure: 300...1100 hPa Relative Humidity 0...100%
Humidity sensor Accuracy tolerance	± 3 % relative humidity
Humidity sensor Hysteresis	≤ 1.5 % relative humidity
Pressure sensor RMS Noise	0.12 Pa (equiv. to 1.7 cm)
Pressure sensor Sensitivity Error	± 0.25 % (equiv. to 1 m at 400 m height change)
Pressure sensor Temperature coefficient offset	±1.3 Pa/K (equiv. to ±10.9 cm at 1°C temperature change)

Table 6: Additional sensor topics and services (optional)

Topic/Service Name	Type	Role	Description
/temperature	sensor_msgs/temperature	Publisher	Temperature output data in degrees Celsius
/relativehumidity	sensor_msgs/relativehumidity	Publisher	Humidity output data in percent
/pressure	sensor_msgs/fluidpressure	Publisher	Pressure output data in Pascal
/iaq	std_msgs/int16	Publisher	Index for Air Quality, especially recommended for mobile devices, since the auto-trim algorithm automatically adopts to different environments.
CO2 equivalents (ppm)	sensor_msgs/range	Publisher	Estimation of the CO2 level in ppm. The sensor does not directly measure CO2, but derives this from the average correlation between VOCs and CO2 in human's exhaled breath.
Sensor-compensated gas sensor resistance (Ohm)	sensor_msgs/range	Publisher	Raw gas sensor resistance compensated by temperature and humidity influences.

Table 7: Physical and electrical

Weight	32g
Size	40.0 mm x 40.0 mm x 10.0 mm
Power Consumption	0.9 W (Typical), 1.8 W (Max)
Operating Voltage	4.6 to 5.5 VDC (USB PD 2.0 Standard)
Operating Temperature	0°C to 85°C
Interface LEDs	3x (Heartbeat, User, System)

Figure 4: Mechanical overview

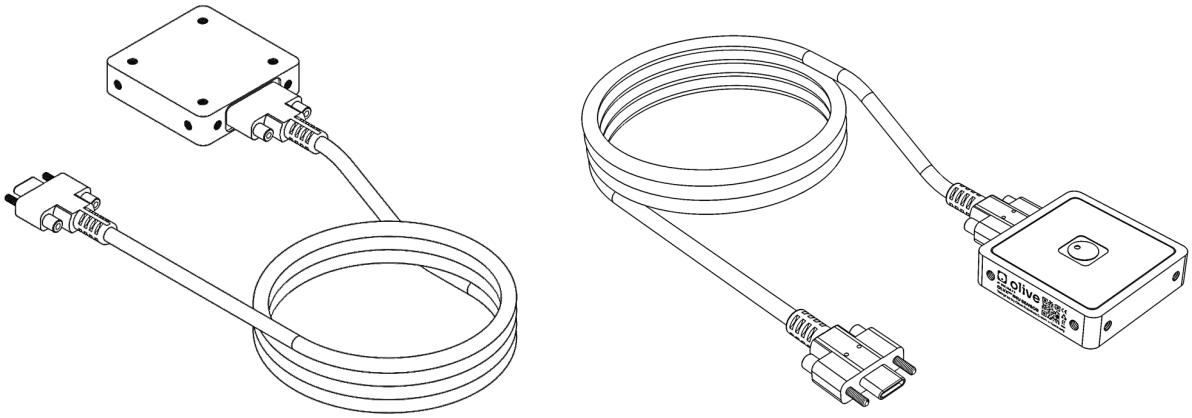


Figure 5: Physical dimensions

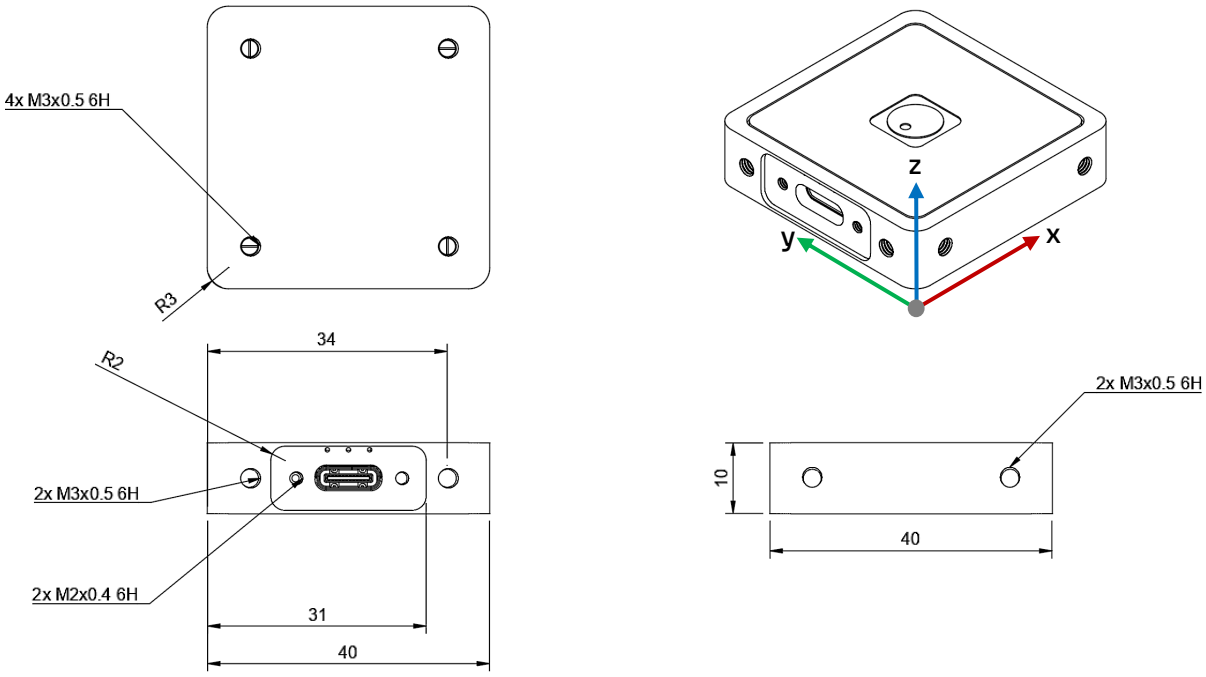


Figure 6: USB Connector specification