olixSense™

X1 Pro

Inertial measurement. Onboard fusion. Native ROS 2.



olixAI
Sensor fusion

olixOS
Embedded platform

USB-C
Power + IP data

Multi-Redundant MEMS with olixAI sensor fusion. Fused orientation, angular velocity and acceleration in a compact, USB-powered enclosure.

IMU + AHRS

Relative orientation · two fusion profiles

ROS 2 native

DDS topics · TCP / UDP JSON
Browser configuration

1,000 Hz

Maximum publish-rate setting[1]
100 Hz nominal default

NETWORK / POWER

Ethernet-over-USB · USB-C power

NOMINAL ENVELOPE[2]

40 × 40 × 10 mm · 32 g nominal

[1] Configurable publication rate; effective throughput depends on the host and configuration. [2] Bare enclosure, excluding cable. Rounded characterization results and test conditions appear on pages 3–4.

02 Architecture 03 Performance 07 Connection 11 Mechanical 13 Disclaimer

01 / SENSING AND OPERATING MODES

Architecture and operating modes

Redundant sensing, onboard processing and native ROS 2 output in one device.

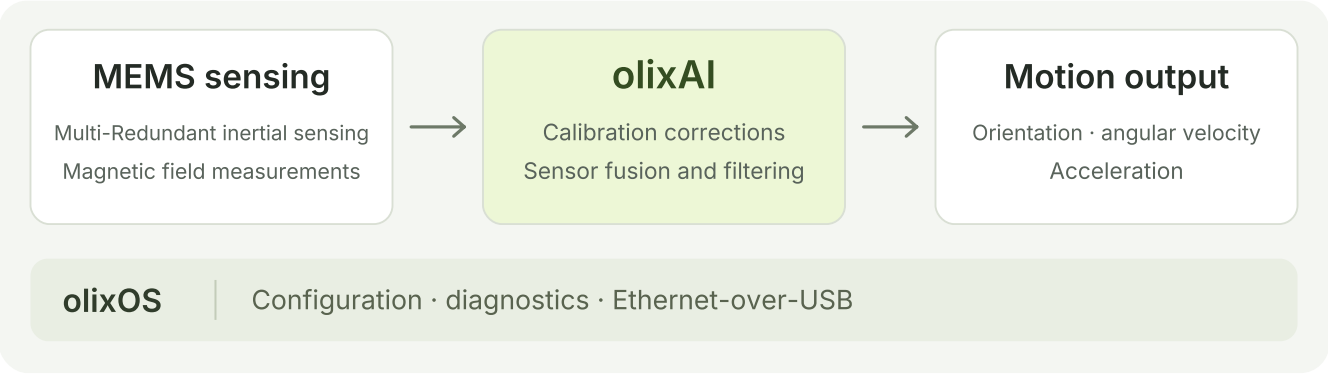


Figure 1. Product-level sensing and software architecture.

Function	Description
Sensing technology	Multi-Redundant MEMS with inertial and magnetic sensing
Sensor fusion	olixAI combines redundant measurements, calibration corrections and filtering into unified motion data
Operating system	olixOS manages sensor services, configuration, diagnostics and network access
Measurement reference	Fused data expressed in the configured sensor output frame
Published data	Orientation quaternion, angular velocity, acceleration and auxiliary streams

IMU and AHRS modes

Characteristic	IMU mode	AHRS mode
Orientation reference	Relative to the initialized or user-defined orientation	Onboard attitude solution; relative yaw in the characterized configuration
Fusion inputs	Inertial acceleration and angular-rate measurements	Inertial measurements with onboard bias estimation and filtering
Magnetic field	Auxiliary measurement stream available	Magnetometer excluded from the characterized orientation solution
Typical application	Relative motion tracking and externally aided estimation	Onboard attitude estimation and robot-state integration

IMU and AHRS are the device mode names. The characterized configuration uses inertial fusion without magnetometer aiding in either mode. Yaw results describe relative rotations; an absolute magnetic-north accuracy is not specified. Apply external heading aiding where the application requires it.

02 / ORIENTATION PERFORMANCE

Orientation performance

Orientation characterization under defined test conditions.

Settled relative rotation · pooled RMSE

Mode	Roll	Pitch	Yaw
AHRS	<0.4°	<0.6°	<0.5°
IMU	<0.4°	<0.4°	<0.2°

200 Hz, single-axis ±45° and ±90° rotations. Angles are averaged over settled 2 s windows starting 0.5 s after each stop, against a fixture encoder. Values pool the tested angles; they are not limits at every pose. At −90° pitch, the AHRS per-angle RMSE was <1.1°.

Moving platform · settled-angle RMSE

Mode	Roll	Pitch	Yaw
AHRS	<1.1°	<1.2°	<1.8°
IMU	<1.1°	<1.3°	<1.4°

200 Hz, fixture on a moving robot, with ±45° and ±90° rotations referenced to optical motion capture. One relative-angle error per movement is calculated between settled windows. This metric describes the change between holds, rather than continuous tracking during rotation.

Continuous tracking · pooled sample RMSE

Mode	Roll	Pitch	Yaw
AHRS	<1.2°[1]	<3.5°	<3.5°[2]
IMU	<2.5°	<3.0°	<2.5°[2]

200 Hz, evaluated at host receipt against optical orientation, without removing orientation delay. [1] AHRS roll is the off-axis result during pitch-driven runs, evaluated within ±60° pitch. [2] Yaw removes heading wander with a 10 s moving average; it is not absolute-heading accuracy.

Specification basis. Each "<" value is a rounded upper bound on the applicable reported aggregate RMSE in the available tests. It is a characterization result under the stated conditions, not a maximum individual-sample error or a guaranteed production limit. Results depend on mode, filtering, motion and reference quality. IMU-mode figures use manufacturer recordings and their independent recalculation.

Orientation and reference frames

All three tables describe relative orientation. Use the configured output frame and the installed sensor-to-robot transform. For real-time estimation, account for signal delay as well as timestamp alignment; integration guidance appears on page 9.

03 / INERTIAL AND PRODUCT CHARACTERIZATION

Inertial characterization

Rounded noise, stability and functional-test results.

Fused inertial noise and stability

Parameter	Rounded bound[1]	Unit
Gyroscope noise density	<0.01	°/s/√Hz
Angle random walk	<0.6	°/√h
Gyroscope bias instability	<7	°/h
Accelerometer noise density	<200	µg/√Hz
Velocity random walk	<0.12	m/s/√h
Accelerometer bias instability	<0.001	m/s²

[1] Three-axis mean statistics, rounded above the reported results; individual axes can be higher. Stationary, room-temperature AHRS recordings at 200 Hz and 1 kHz, including a >23 h independent recording with filters disabled. White-noise coefficients use Allan analysis around 1 s; bias instability uses the Allan minimum divided by 0.664. These are configuration-dependent characterization bounds, not guaranteed maxima. Bias results also depend on analysis window and long-term stability.

Fitted reference comparison

Fused output	Residual RMSE	Correlation
Acceleration	<0.25 m/s²	R^2 >0.997
Angular rate	<0.02 rad/s	R^2 >0.999

Approximately 120 s and >23,000 paired samples at nominal 200 Hz. Sign, scale, offset and time alignment were fitted on the same recording. Values describe fitted residuals, not an independent accuracy validation.

Functional and electrical characterization

Test	Conditions	Observed result
Ambient temperature	Approximately 4 h ramp-and-soak cycle, −20 to +80 °C; 200 Hz	Publication maintained; no gap >1 s recorded
USB power	Manufacturer streaming tests and witnessed unit readings	<1.1 W normal-operation readings; <1.3 W recorded peak
Redundant sensing	Staged input-freeze demonstrations	Fused output followed the remaining live input

Ambient-temperature testing verifies functional publication, rather than orientation accuracy over temperature. Internal MEMS temperature is reported separately. The supply-design power rating remains 1.8 W. Apply data-validity and status checks after service restart and before using motion data.

04 / SENSING / REFERENCE

Measurement characteristics

Nominal sensing-front-end specifications and output-frame conventions.



Sensor and output frames

Use the enclosure axis marking as the physical installation reference. Select the output convention in olixOS and apply the sensor-to-robot transform consistently.

FLU: forward, left, up. FRD: forward, right, down. Legacy frame support is retained for existing integrations.

Sensing ranges and characteristics

Parameter	Accelerometer	Gyroscope	Magnetometer
Full-scale range	±2, ±4, ±8, ±16 g	±125, ±250, ±500, ±1,000, ±2,000 °/s	x/y: ±1,300 µT z: ±2,500 µT
Digital resolution	16 bit; 0.061 mg/LSB at ±2 g	16 bit; 0.0038 °/s/LSB at ±125 °/s	0.3 µT
Sensitivity	2,048 LSB/g at ±16 g	262.144 LSB/(°/s) at ±125 °/s	—
Sensitivity / gain error	±0.4% at 25 °C, ±8 g	±2% at 25 °C	±5% typ.; ±8% max. after compensation, 25 °C
Zero-input offset	±20 mg at 25 °C	±0.5 °/s at 25 °C	±40 µT at 25 °C
Nonlinearity	0.5% FS at ±2 g, 25 °C	0.01% FS at ±250 or ±2,000 °/s, 25 °C	1% FS

These are sensing-front-end specifications, not validated fused-output limits. Range availability depends on mode; AHRS uses ±4 g acceleration. The native ±0.4% accelerometer gain figure applies at ±8 g and 25 °C; the characterized fused ±4 g output showed a rounded gain-error magnitude <1% at room temperature. Orientation and inertial characterization appear on pages 3–4.

Published motion quantities

Quantity	Representation / units
Orientation	Quaternion x, y, z, w in the configured output convention
Angular velocity	rad/s; configurable sensor frame
Acceleration	m/s^2; main inertial output plus a separate gravity-compensated stream
Magnetic field	tesla; auxiliary topic available in IMU mode

05 / ELECTRICAL AND PROCESSING

Power, USB and processing

Power and IP data share a USB-C connection to the host computer.

Interface / power	Specification	Detail
Physical connector	USB Type-C	Dual screw cable retention
Data interface	Ethernet-over-USB 2.0	ECM / RNDIS virtual network profiles
Input voltage	4.6–5.5 V DC	USB-C power input
Typical power	0.9 W	Normal operating power
Specified maximum power	1.8 W	Size the host supply for this requirement
Measured operating power	<1.1 W	Rounded normal-operation readings across the available tests
Indicators / control	3 status LEDs; soft reset	Heartbeat, user and system indicators

Embedded Physical AI for Sensors & Robots.

Processing and software platform

olixAI sensor fusion
olixOS device services

Resource	Specification
Operating system	olixOS, real-time Linux platform
Sensor fusion	olixAI
Processor	Dual-core application processor
Memory	512 MB DDR3
Storage	32 GB eMMC, nominal
Configuration	Integrated browser interface
Device services	Sensor streaming, calibration, diagnostics and software maintenance

Recorded power peaks were <1.3 W; 1.8 W remains the specified supply-design allowance. This rating is not a measured worst-case startup peak. The 0.9 W typical figure describes nominal normal operation.

Use a data-capable USB port or powered hub and provide cable strain relief. Supply-voltage limits are specified input ratings.

06 / CONNECTION

Ethernet-over-USB connection

A single USB connection provides power and network access.

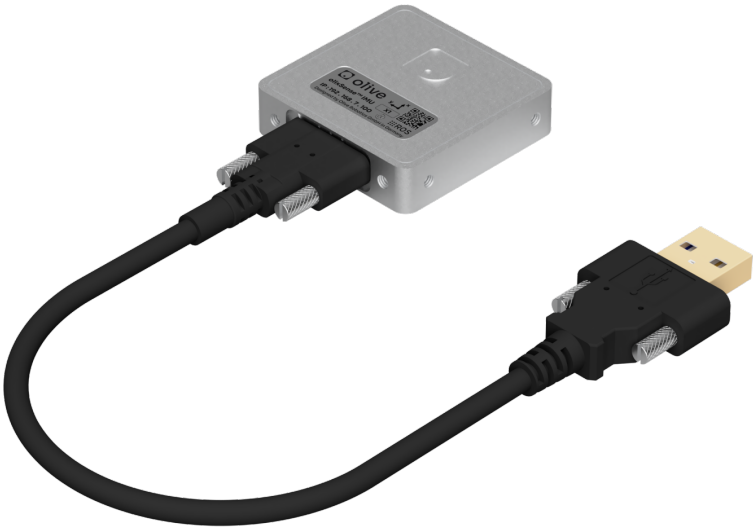


Figure 2. X1 Pro with a USB data cable. Host connector and cable length follow the ordered configuration.



USB-C connector panel

Connection overview

Interface	Function
USB-C on sensor	Power input and Ethernet-over-USB data
Retention positions	Dual screw retention for the approved locking cable
USB host end	Connect to a data-capable host port or powered hub
Diagnostics	Network access to olixOS configuration and status

Installation sequence

Step	Action
01 · Mount	Secure the base to a rigid surface and establish the installed pose.
02 · Connect	Attach the approved USB data cable; secure the cable and connect it to the host.
03 · Configure network	Allow the USB network interface to enumerate. Set the host adapter to the sensor subnet.
04 · Integrate	Open olixOS at the device IP address; verify output mode, frame, timestamp and data stream.

Example setup: sensor `192.168.7.100` and host USB adapter `192.168.7.1/24`. Use the configured address on a commissioned unit. A USB data connection is required for network communication.

07 / CONNECTIVITY

Data interfaces and protocols

Native ROS 2 integration and timestamped JSON streaming operate over the USB network interface.

ROS 2 topic suffix[1]	Message type	Output
`imu`	sensor_msgs/msg/Imu	Quaternion, angular velocity, acceleration and covariance
`acceleration`	geometry_msgs/msg/AccelStamped	Gravity-compensated acceleration
`velocity`	geometry_msgs/msg/TwistStamped	Integrated velocity estimate[2]
`magneticfield`	sensor_msgs/msg/MagneticField	Magnetic field in tesla; auxiliary stream in IMU mode
`temperature`	sensor_msgs/msg/Temperature	Mean MEMS temperature; °C
`status`	diagnostic_msgs/msg/DiagnosticStatus	System diagnostics, including CPU temperature
`/tf`	tf2_msgs/msg/TFMessage	Optional transform publication

[1] Example namespace: `/olive/olixSense/x1/id001/`. Device identifier and namespace are configurable. Topic availability follows the selected operating mode. [2] Use external aiding for sustained velocity estimation.

TCP / UDP data export

Setting	Specification
Transport	TCP or UDP server; configurable port, default **5600**
Data format	JSON; schema `olive_imu.v1`; TCP uses one newline-delimited object per sample
Timestamp and frame	`stamp.sec`, `stamp.nanosec`, `frame_id`
Orientation	Quaternion `x, y, z, w`
Motion units	Angular velocity: rad/s · acceleration: m/s²
Covariance	3 × 3 arrays for orientation, angular velocity and acceleration
UDP registration	An initial client packet registers the stream destination

Native ROS 2 integration

olixOS provides browser configuration, calibration, diagnostics and software updates. ROS 2 host reception was verified on Humble and Jazzy with Fast DDS. Cyclone DDS and Zenoh are documented integration options; validate the selected host configuration before deployment.

08 / HOST INTEGRATION

Network and host integration

Connect ROS 2, data loggers and custom applications through the USB network interface.

Access and addressing

Item	Integration detail
Sensor address	Default: `192.168.7.100`. Use the configured address after commissioning.
Host USB adapter	Example: `192.168.7.1/24`; keep host and sensor in the same subnet.
Browser access	Open `http://192.168.7.100` after the USB network interface is available.
Multiple sensors	Use unique addresses and ROS namespaces; configure USB subnets and host routes to avoid conflicts.
Host environment	ROS 2 Humble; match topic names and QoS. Verify host support for the selected ECM / RNDIS profile.

Select the data interface

Interface	Typical use	Connection behavior
ROS 2 / DDS	Robot state estimation	Topics, services, frame IDs and covariance
UDP / JSON	Live data and visualization	Initial client registration packet; receiver handles sample loss
TCP / JSON	Data logging and custom apps	Client opens a connection; newline-delimited samples; buffering possible

Read the main ROS 2 stream

```
ros2 topic echo /olive/olixSense/x1/id001/imu \
  --qos-reliability best_effort
```

Replace the example topic path with the configured namespace and device identifier. Match subscriber reliability to publisher QoS.

Timing and estimator integration

Quantity	Characterization / integration guidance
Timestamp-to-host callback	Reported median <2 ms at 200 Hz, 400 Hz and 1 kHz. This measures header age at callback, not motion-to-message delay.
Signal delay at 1 kHz	Angular rate <10 ms; orientation <40 ms. Rounded bounds above the reported recording-level alignment estimates.
Signal delay at 200 Hz	Angular rate <10 ms; orientation <100 ms on the tested settings. Signal filtering and mode affect delay.
Time synchronization	NTP over USB networking. Reported peer-offset magnitude <0.3 ms in sampled checks; this is a daemon estimate, not an independently measured clock-error limit.
Frames and covariance	Apply frame_id and the sensor-to-robot transform. Covariance uses fixed native-sensor estimates; configure the host estimator accordingly.

Delay bounds summarize optical-reference alignment estimates for the tested configurations; they are not guaranteed motion-to-host maxima. Output period (5 ms at 200 Hz; 1 ms at 1 kHz) and signal delay are separate quantities. The device acts as the TCP/UDP server; enable the export in olixOS before connecting.

09 / CONFIGURATION

Output configuration and calibration

Configure the sensor response and output convention for the application.

Control	Available configuration
Publication rate	1–1,000 Hz configurable; achieved rate depends on the operating configuration
Publisher QoS	Best effort or reliable; match subscriber policy
Operating modes	IMU / AHRS: relative-orientation profiles; see page 2
Application profiles	Drone / Mobile Robot / Humanoid / Raw
Output convention	FLU / FRD / legacy compatibility
Filtering	Configurable acceleration and angular-rate filtering
Orientation zero	Startup or service action defines the local reference
Time synchronization	NTP over the USB network interface

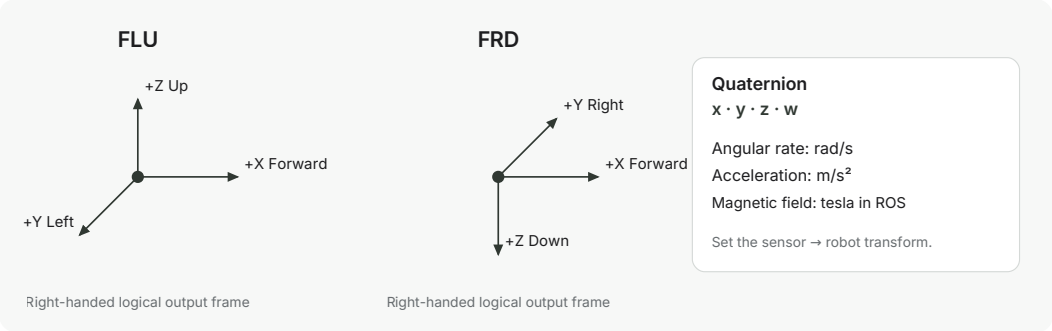


Figure 3. Logical FLU and FRD output conventions. Apply the sensor-to-robot transform for the installed pose.

Publication rate and measurement bandwidth are configured separately. Internal temperature-compensation values are loaded at startup and applied using MEMS temperature. Configure filtering, gravity treatment and covariance consistently with the host estimator.

Calibration and reference setup

Operation	Purpose / method
Bias calibration	Keep the device stationary in its normal mounting pose; run the olixOS bias action or `setBias` service.
Orientation zero	Use `setZeroQuaternion` to define the present orientation as the local reference. This operation is separate from bias calibration.
Magnetic-field setup	Configure the auxiliary magnetic-field output for the installation; it is separate from the characterized inertial orientation solution.

Mode, profile and range changes may request a service restart. Verify active settings and stable output before resuming use by the host estimator.

10 / MECHANICAL

Dimensions and installation

Compact metal enclosure with base and side mounting options and a locking USB-C connection.

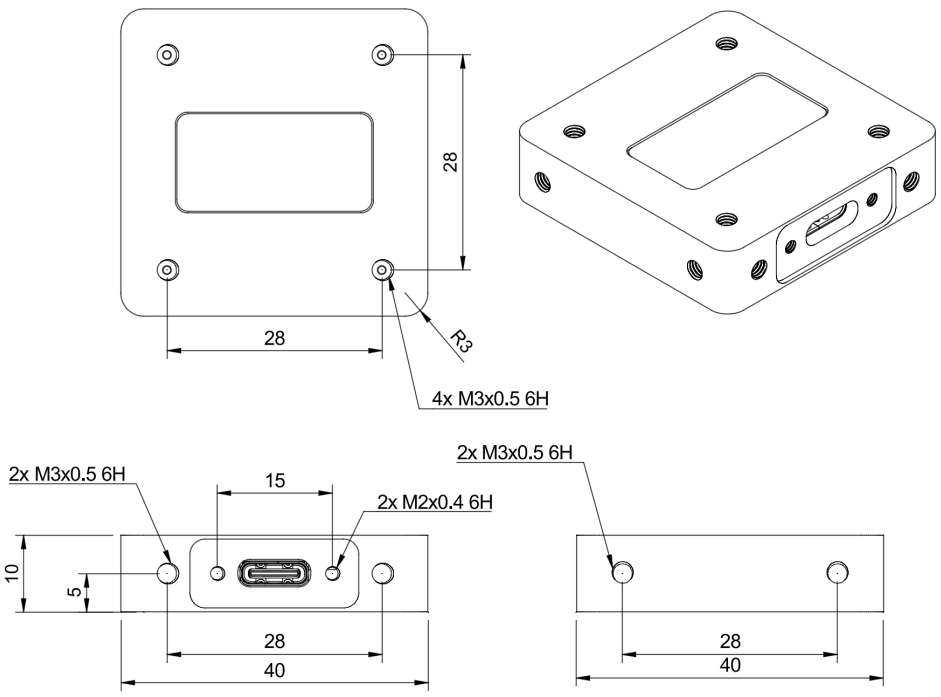


Figure 4. Supplied enclosure drawing. Dimensions in mm; use the controlled drawing for production tolerances.

Mechanical parameter	Nominal value
Overall envelope (W × D × H)	40 × 40 × 10 mm
Bare-unit mass	32 g nominal; <33 g in the available bare-unit measurements
Base mounting threads	4 × M3 × 0.5, tolerance class 6H
Base mounting centres	28 × 28 mm
Side mounting shown in drawing	2 × M3 × 0.5, 6H; 28 mm spacing; 5 mm above base
USB cable-retention threads	2 × M2 × 0.4, 6H; 15 mm spacing
Enclosure corner radius	R3 mm
Data / power connector	USB Type-C

Dimensions exclude the cable and mating plug. Mount on a rigid surface and provide connector access, cable bend clearance and strain relief. Use the controlled drawing for production tolerances and select screw engagement for the actual mounting assembly.

11 / CONDITIONS AND ORDERING

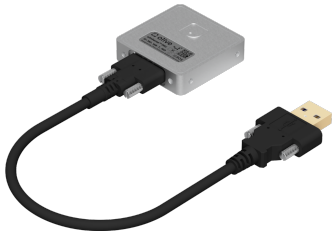
Environment, accessories and ordering

Define the sensor configuration and installation accessories for your application.

Operating conditions

Parameter	Specification / test basis
Ambient operating temperature	−20 to +80 °C
Functional temperature test	Continuous publication through the approximately 4 h ambient ramp-and-soak cycle
Installation reference	Rigid mounting; configured sensor-to-robot transform
Magnetic environment	Assess field conditions when using the auxiliary magnetic measurement

Temperature range describes functional operation in the surrounding environment. Performance measurements on pages 3–4 apply to their stated test conditions.



Locking USB data cable

Specify cable length, host connector and retention hardware. One approved USB cable carries power and Ethernet-over-USB data.

Illustrated cable is a reference accessory; supplied appearance and configuration follow the quotation.

Ordering information

Item	Specify with the order
Product	olixSense™ X1 Pro · Ethernet-over-USB
Platform	olixOS with olixAI; 512 MB memory / 32 GB eMMC
Cable	Length, host connector and matching screw-retention hardware
Integration	IMU or AHRS mode, output frame, namespace and publication rate
Installation	Mounting orientation, connector clearance and environmental requirements
Delivery contents	Sensor and accessories as itemized in the quotation
Documentation	Product documentation and order-specific connection / mechanical details

Confirm cable and mounting accessories with the quotation. Request application-specific environmental and conformity documentation with the quotation.

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Product documentation

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