

6-axis inertial measurement unit (IMU) and AI sensor with 32 g accelerometer and embedded sensor fusion, Qvar for high-end applications



LGA-14L
(2.5 x 3.0 x 0.83 mm) typ.



Features

- Triple-channel architecture for UI, EIS, and OIS data processing
- "Always-on" experience with low power consumption for both accelerometer and gyroscope
- Smart FIFO up to 4.5 KB
- Android compliant
- $\pm 4/\pm 8/\pm 16/\pm 32$ g full scale
- $\pm 125/\pm 250/\pm 500/\pm 1000/\pm 2000/\pm 4000$ dps full scale
- SPI / I²C & MIPI I3C[®] v1.1 serial interface with main processor data synchronization
- Auxiliary SPI for OIS data output for gyroscope and accelerometer
- OIS configurable from aux. SPI, primary interface (SPI / I²C & MIPI I3C[®] v1.1)
- EIS dedicated channel on primary interface with dedicated filtering
- Advanced pedometer, step detector, and step counter
- Significant motion detection, tilt detection
- Standard interrupts: free-fall, wake-up, 6D/4D orientation, click and double click
- Programmable finite state machine for accelerometer, gyroscope, and external sensor data processing with high rate @ 960 Hz
- Machine learning core with exportable features and filters for AI applications
- Embedded adaptive self-configuration (ASC)
- Embedded Qvar (electrostatic sensor) for user interface functions (tap, double tap, triple tap, long press, L/R – R/L swipe)
- Embedded analog hub for ADC and processing analog input data
- Embedded sensor fusion low-power algorithm
- Embedded temperature sensor
- Analog supply voltage: 1.71 V to 3.6 V
- Independent IO supply (extended range: 1.08 V to 3.6 V)
- Power consumption: 0.65 mA in combo high-performance mode
- Compact footprint: 2.5 mm x 3 mm x 0.83 mm
- **ECOPACK** and RoHS compliant

Product status link

[LSM6DSV32X](#)

Product summary

Order code	LSM6DSV32X	LSM6DSV32XTR
Temperature range [°C]	-40 to +85	
Package	LGA-14L (2.5 x 3.0 x 0.83 mm)	
Packing	Tray	Tape and reel

Product resources

[TN0018](#) (design and soldering)

Product label



Applications

- [Wearables](#)
- Smartphones and handheld devices
- [IoT and connected devices](#)
- Motion tracking and gesture detection, [augmented reality \(AR\)](#) / [virtual reality \(VR\)](#) / [mixed reality \(MR\)](#) applications & [metaverse](#) applications
- Indoor navigation
- EIS and OIS for camera applications
- Vibration monitoring and compensation

Description

The LSM6DSV32X is a high-performance, low-power 6-axis small IMU, featuring a 3-axis digital accelerometer at 32 g and a 3-axis digital gyroscope, that offers the best IMU sensor with a triple-channel architecture for processing acceleration and angular rate data on three separate channels (user interface, OIS, and EIS) with dedicated configuration, processing, and filtering.

The LSM6DSV32X enables processes in edge computing, leveraging embedded advanced dedicated features such as a finite state machine (FSM) for configurable motion tracking and a machine learning core (MLC) for context awareness with exportable AI features for IoT applications.

The LSM6DSV32X supports the adaptive self-configuration (ASC) feature, which allows the FSM to automatically reconfigure the device in real time based on the detection of a specific motion pattern or based on the output of a specific decision tree configured in the MLC, without any intervention from the host processor.

The LSM6DSV32X embeds Qvar (electric charge variation detection) for user interface functions like tap, double tap, triple tap, long press, or L/R – R/L swipe.

The LSM6DSV32X embeds an analog hub able to connect an external analog input and convert it to a digital signal for processing.

1 Overview

The LSM6DSV32X is a system-in-package featuring a high-performance 3-axis digital accelerometer and 3-axis digital gyroscope.

The LSM6DSV32X delivers best-in-class motion sensing that can detect orientation and gestures in order to empower application developers and consumers with features and capabilities that are more sophisticated than simply orienting their devices to portrait and landscape mode.

The event-detection interrupts enable efficient and reliable motion tracking and context awareness, implementing hardware recognition of free-fall events, 6D orientation, click and double-click sensing, activity or inactivity, stationary/motion detection and wake-up events. Machine learning and finite state machine processing allow moving some algorithms from the application processor to the LSM6DSV32X sensor, enabling consistent reduction of power consumption.

The LSM6DSV32X supports the main OS requirements, offering real, virtual, and batch mode sensors. In addition, the LSM6DSV32X can efficiently run the sensor-related features specified in Android, saving power and enabling faster reaction time. In particular, the LSM6DSV32X has been designed to implement hardware features such as significant motion detection, stationary/motion detection, tilt, pedometer functions, timestamping and to support the data acquisition of external sensors.

The LSM6DSV32X offers hardware flexibility to connect the pins with different mode connections to external sensors to expand functionalities such as adding a sensor hub, auxiliary SPI, and so forth.

The LSM6DSV32X offers advanced design flexibility for OIS and EIS applications. Both channels have a dedicated processing path with independent filtering and enhanced EIS channel gyroscope data are read over the primary interfaces I²C/ MIPI I³C[®] v1.1 / SPI.

Channel 1 has been designed for user interface data processing for motion tracking. Data are available on the primary output of I²C / SPI / I³C[®] for the accelerometer and gyroscope with independent ODR and FS.

Channel 2 has been designed for OIS applications. Data are available on the aux SPI at 7.68 kHz with accelerometer/gyroscope processing with independent FS at $\pm 4 g - \pm 32 g$ (accelerometer) / $\pm 125 dps - \pm 2000 dps$ (gyroscope). The accelerometer is also available as standalone with dedicated filtering.

Channel 3 has been design for enhanced EIS. Data are available in freerun mode in the output registers or in FIFO with dedicated tag and timestamp.

Up to 4.5 KB of FIFO with compression and dynamic allocation of significant data (that is, external sensors, timestamp, and so forth) allows overall power saving of the system.

The LSM6DSV32X embeds a sensor fusion low-power (SFLP) algorithm able to provide a 6-axis (accelerometer + gyroscope) game rotation vector represented as a quaternion. The X, Y, Z quaternion components are stored in FIFO.

Like the entire portfolio of MEMS sensor modules, the LSM6DSV32X leverages the robust and mature in-house manufacturing processes already used for the production of micromachined accelerometers and gyroscopes. The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are developed using CMOS technology that allows the design of a dedicated circuit, which is trimmed to better match the characteristics of the sensing element.

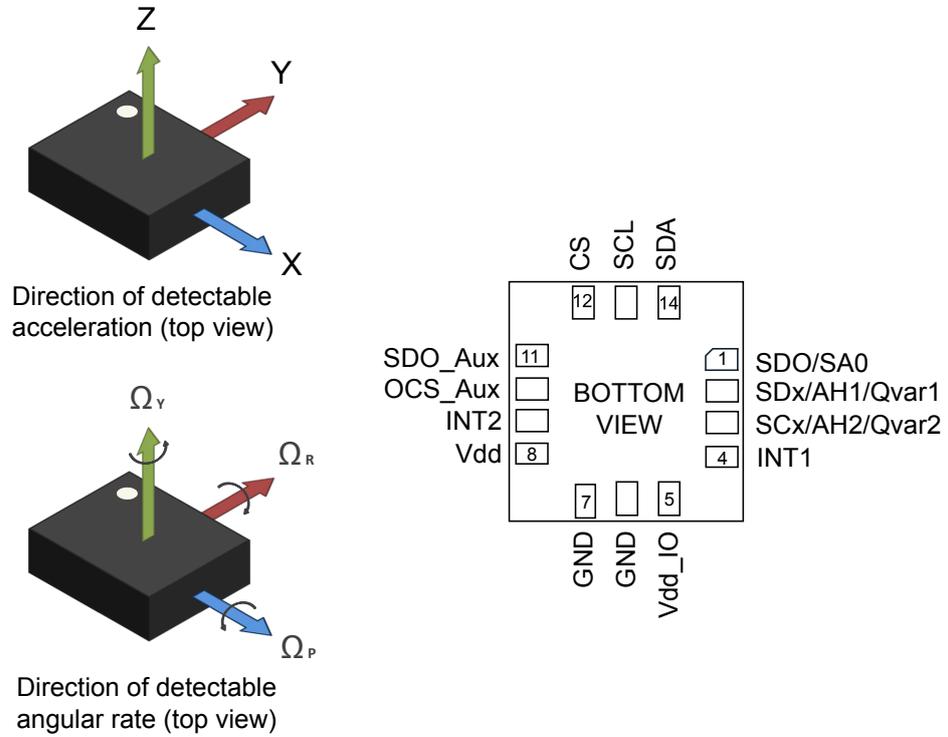
The LSM6DSV32X embeds an analog hub, which is able to connect an external analog input and convert it to a digital signal for processing as well as advanced dedicated features like a finite state machine and data filtering for OIS, EIS, and motion processing.

The LSM6DSV32X embeds Qvar functionality, which is an electrostatic sensor able to measure the variation of the quasi-electrostatic potential. The Qvar sensing channel can be used for user interface applications like tap, double tap, triple tap, long press, and L/R – R/L swipe.

The LSM6DSV32X is available in a small plastic land grid array (LGA) package of 2.5 x 3.0 x 0.83 mm to address ultracompact solutions.

2 Pin description

Figure 1. Pin connections

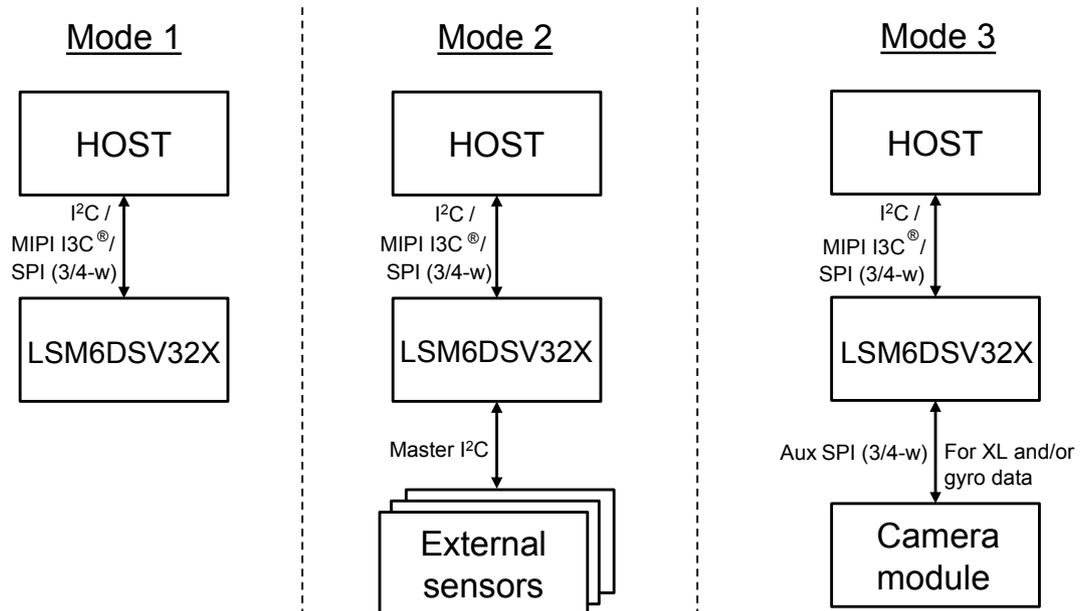


2.1 Pin connections

The LSM6DSV32X offers flexibility to connect the pins in order to have three different mode connections and functionalities. In detail:

- **Mode 1:** I²C / MIPI I3C[®] slave interface or SPI (3- and 4-wire) serial interface is available. The analog hub and Qvar functionalities are available in mode 1 with I²C interface only.
- **Mode 2:** I²C / MIPI I3C[®] slave interface or SPI (3- and 4-wire) serial interface and I²C interface master for external sensor connections are available.
- **Mode 3:** I²C / MIPI I3C[®] slave interface or SPI (3- and 4-wire) serial interface is available for the application processor interface while an auxiliary SPI (3- and 4-wire) serial interface for external sensor connections is available for the accelerometer and gyroscope.

Figure 2. LSM6DSV32X connection modes



In the following table, each mode is described for the pin connections and function.

Table 1. Pin description

Pin#	Name	Mode 1 function	Mode 2 function	Mode 3 function
1	SDO/SA0 ⁽¹⁾	SPI 4-wire interface serial data output (SDO) I ² C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I ² C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I ² C least significant bit of the device address (SA0)
2	SDx/AH1/ Qvar1	Connect to Vdd_IO or GND if the analog hub and Qvar are disabled. AH input 1 (or Qvar electrode 1) is connected if the analog hub (or Qvar functionality) is enabled.	I ² C serial data master (MSDA)	Auxiliary SPI 3/4-wire interface serial data input (SDI_Aux) and SPI 3-wire serial data output (SDO_Aux)
3	SCx/AH2/ Qvar2	Connect to Vdd_IO or GND if the analog hub and Qvar are disabled. AH input 2 (or Qvar electrode 2) is connected if the analog hub (or Qvar functionality) is enabled.	I ² C serial clock master (MSCL)	Auxiliary SPI 3/4-wire interface serial port clock (SPC_Aux)
4	INT1	Programmable interrupt in I ² C and SPI		
5	Vdd_IO ⁽²⁾	Power supply for I/O pins		
6	GND	0 V supply		
7	GND	0 V supply		
8	Vdd ⁽²⁾	Power supply		
9	INT2	Programmable interrupt 2 (INT2) / Data enable (DEN)	Programmable interrupt 2 (INT2) / Data enable (DEN) / I ² C master external synchronization signal (MDRDY)	Programmable interrupt 2 (INT2) / Data enable (DEN)
10	OCS_Aux	Connect to Vdd_IO or leave unconnected ⁽³⁾	Connect to Vdd_IO or leave unconnected ⁽³⁾	Enable auxiliary SPI 3/4-wire interface
11	SDO_Aux	Connect to Vdd_IO or leave unconnected ⁽³⁾	Connect to Vdd_IO or leave unconnected ⁽³⁾	Auxiliary SPI 3-wire interface: leave unconnected ⁽³⁾ Auxiliary SPI 4-wire interface: serial data output (SDO_Aux)
12	CS ⁽¹⁾	I ² C / MIPI I3C [®] / SPI mode selection (1: SPI idle mode / I ² C / MIPI I3C [®] communication enabled; 0: SPI communication mode / I ² C / MIPI I3C [®] disabled)	I ² C / MIPI I3C [®] / SPI mode selection (1: SPI idle mode / I ² C / MIPI I3C [®] communication enabled; 0: SPI communication mode / I ² C / MIPI I3C [®] disabled)	I ² C / MIPI I3C [®] / SPI mode selection (1: SPI idle mode / I ² C / MIPI I3C [®] communication enabled; 0: SPI communication mode / I ² C / MIPI I3C [®] disabled)
13	SCL ⁽¹⁾	I ² C / MIPI I3C [®] serial clock (SCL) SPI serial port clock (SPC)	I ² C / MIPI I3C [®] serial clock (SCL) SPI serial port clock (SPC)	I ² C / MIPI I3C [®] serial clock (SCL) SPI serial port clock (SPC)
14	SDA ⁽¹⁾	I ² C / MIPI I3C [®] serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I ² C / MIPI I3C [®] serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I ² C / MIPI I3C [®] serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)

1. SPI 3/4-wire interface not available with the analog hub / Qvar functionality enabled.

2. Recommended 100 nF filter capacitor.

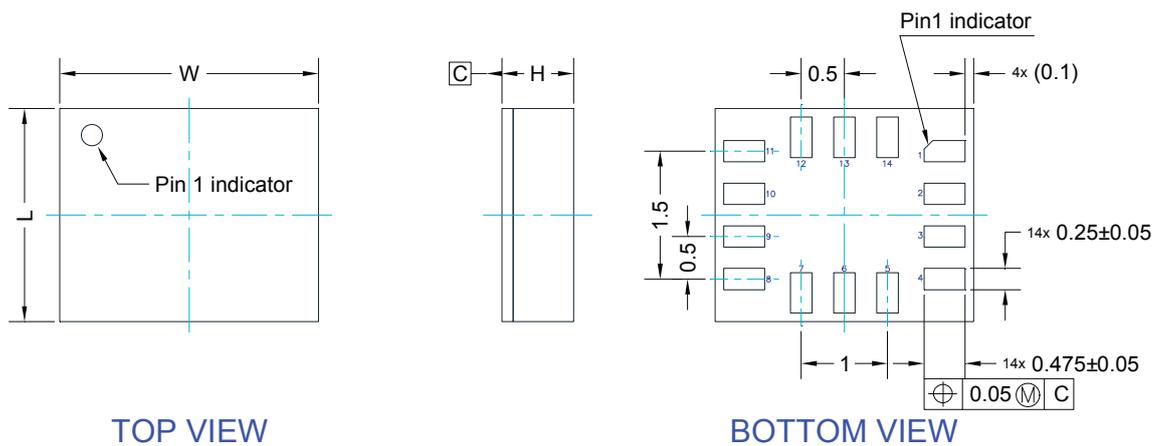
3. Leave pin electrically unconnected and soldered to PCB.

3 Package information

In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK** packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

3.1 LGA-14L package information

Figure 3. LGA-14L 2.5 x 3.0 x 0.86 mm package outline and mechanical data



Dimensions are in millimeter unless otherwise specified
 General tolerance is ± 0.1 mm unless otherwise specified

OUTER DIMENSIONS

ITEM	DIMENSION [mm]	TOLERANCE [mm]
Length [L]	2.50	± 0.1
Width [W]	3.00	± 0.1
Height [H]	0.86	MAX

DM00249496_5

3.2 LGA-14 packing information

Figure 4. Carrier tape information for LGA-14 package

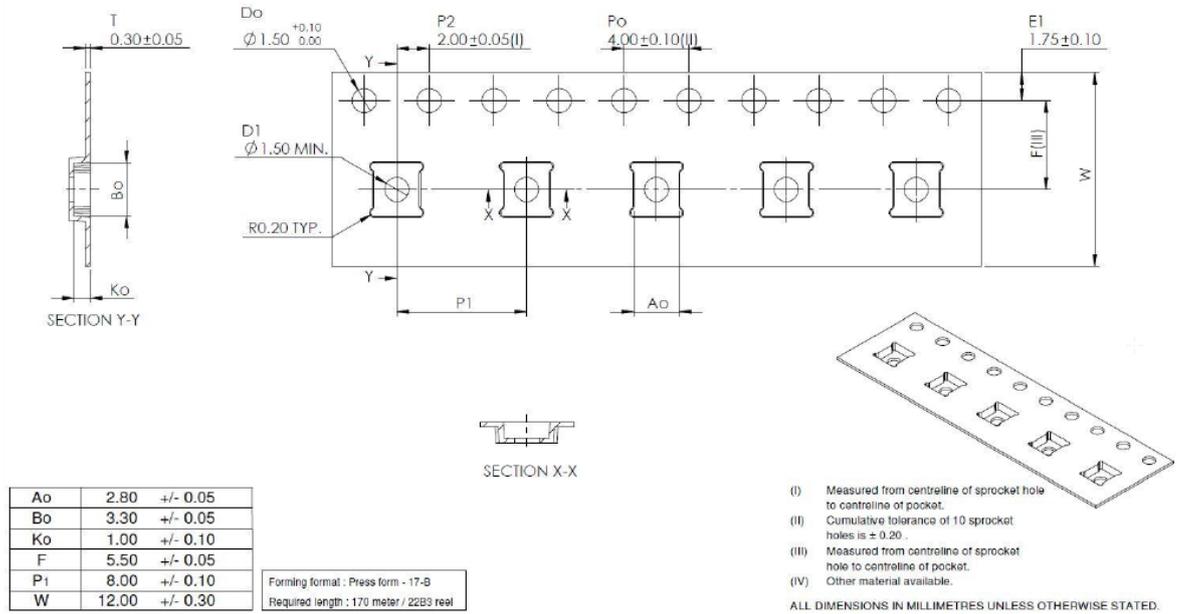


Figure 5. LGA-14 package orientation in carrier tape

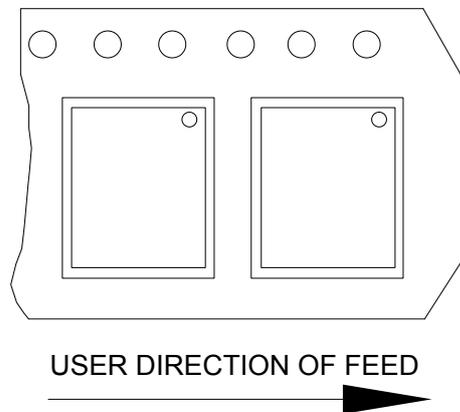


Figure 6. Reel information for carrier tape of LGA-14 package

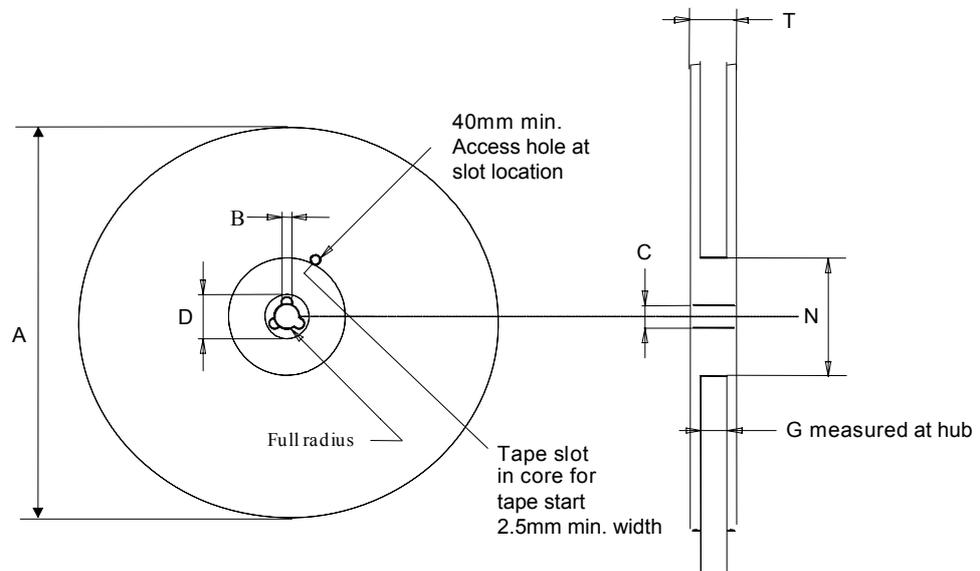


Table 2. Reel dimensions for carrier tape of LGA-14 package

Reel dimensions (mm)	
A (max)	330
B (min)	1.5
C	13 ±0.25
D (min)	20.2
N (min)	60
G	12.4 +2/-0
T (max)	18.4

Revision history

Table 3. Document revision history

Date	Version	Changes
02-Jun-2023	1	Initial release

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