LSM6DSK320X

Data brief

6-axis IMU (inertial measurement unit) with enhanced vibration immunity, dual accelerometer up to ±320 *g* and embedded AI

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

Product status
LSM6DSK320X

Product summary	
Order code	LSM6DSK320XTR
Temp. range [°C]	-40 to +85
Package	LGA-14L (2.5 x 3.0 x 0.83 mm)
Packing	Tape and reel

Features

- Enhanced vibration immunity
- Quad-channel architecture for UI, EIS, OIS, and high-*g* data processing
- "Smart, always-aware" experience for system power optimization
- Dual accelerometer channels
  - Low-*g* channel ±2/±4/±8/±16 *g* full scale
  - High-*g* channel ±32/±64/±128/±256/±320 *g* full scale
- Gyroscope full scale: ±250/±500/±1000/±2000/±4000 dps
- SPI / I²C & MIPI I3C® v1.1 serial interface with main processor data synchronization
- Auxiliary SPI & MIPI I3C® v1.1 for OIS data output for gyroscope and accelerometer
- Programmable finite state machine for accelerometer (high-*g* & low-*g*), 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 sensor fusion low-power (SFLP) algorithm
- OIS configurable from the auxiliary or primary interface
- 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, high-*g* wake-up and high-*g* shock
- Smart FIFO up to 4.5 KB
- Embedded temperature sensor
- Independent I/O supply
  - I²C voltage range: 1.62 V to 3.6 V
  - SPI / MIPI I3C® extended voltage range: 1.08 V to 3.6 V
- Supply current
  - 6-axis configuration @ 0.67 mA in combo high-performance mode
  - 9-axis configuration @ 0.80 mA in combo high-performance mode
- Compact footprint: 2.5 mm x 3 mm x 0.83 mm
- ECOPACK and RoHS compliant

Applications

- Smartphones
- Wearables
- Smart tags
- Drones
- Asset monitors
- Event data recorders (EDRs)
- Structural health monitoring (SHM) of buildings and bridges
- Personal protective equipment (severity of falls or impacts)
- Gaming controllers

Description

The LSM6DSK320X is a high-end, low-noise, low-power, small IMU featuring a 3-axis digital low-*g* accelerometer at ±16 *g*, a 3-axis digital high-g accelerometer at ±320 *g*, and a 3-axis digital gyroscope. It offers the best IMU sensor architecture for processing acceleration and angular rate data on four separate channels (User Interface, OIS, EIS, and high-*g* accelerometer). This IMU enables a new range of applications targeting intense movement tracking, concussion monitoring, and more.

The LSM6DSK320X adopts a new gyroscope design with a fully differential reading chain and enhanced mechanical symmetry for outstanding vibration immunity and resilience to external perturbations. The device supports edge AI computing, leveraging a finite state machine (FSM) for configurable motion tracking and a machine learning core (MLC) for context awareness, with exportable AI features for personal electronics, IoT, sports and wearable devices, and drone applications.

The LSM6DSK320X features adaptive self-configuration (ASC) to optimize power consumption. The sensor can automatically adjust its settings in real time upon detecting a specific motion pattern or signal from the MLC, without intervention from the host processor. The digital circuitry also includes ST's sensor fusion low-power (SFLP) technology for spatial orientation.

The device embeds a dedicated accelerometer sensor with an independent channel and filtering for high-*g* acceleration detection, perfectly matching shock requirements for sports, concussion detection, shock detection, emergency call and drone applications.

1 Overview

The LSM6DSK320X is a system-in-package IMU featuring a high-performance 3-axis digital low-*g* accelerometer, a 3-axis digital high-*g* accelerometer, and a 3-axis digital gyroscope. It delivers best-in-class motion sensing that can detect orientation and gestures, empowering application developers and consumers with features more sophisticated than simply orienting devices to portrait or landscape mode.

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 LSM6DSK320X sensor, enabling consistent power consumption reduction.

The LSM6DSK320X supports main OS requirements, offering real, virtual, and batch mode sensors. It is designed to implement hardware features such as significant motion detection, stationary/motion detection, tilt, pedometer functions, timestamping, and support for data acquisition from external sensors.

The device offers hardware flexibility to connect pins in different modes to external sensors, expanding functionalities such as adding a sensor hub or auxiliary SPI/I3C®.

For mobile, foldable tablets or cameras, the device provides advanced design flexibility for OIS and EIS applications. Both channels have dedicated processing paths with independent filtering. Enhanced EIS channel gyroscope data are read over primary interfaces I²C, MIPI I3C® v1.1, or SPI.

Channel 1 is designed for user interface data processing for motion tracking, with data available on I²C/SPI/I3C for accelerometer and gyroscope with independent ODR and FS.

Channel 2 is designed for OIS applications, with data available on auxiliary SPI or I3C at 7.68 kHz, supporting accelerometer/gyroscope processing with independent FS.

Channel 3 is designed for enhanced EIS, with data available in free-run mode or FIFO with dedicated tag and timestamp.

Channel 4 is designed for high-*g* applications with accelerometer processing and independent FS at ±32 *g* to ±320 *g*.

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

The LSM6DSK320X embeds a sensor fusion low-power (SFLP) algorithm providing a 6-axis (accelerometer + gyroscope) game rotation vector represented as a quaternion. The X, Y, Z quaternion components are stored in FIFO.

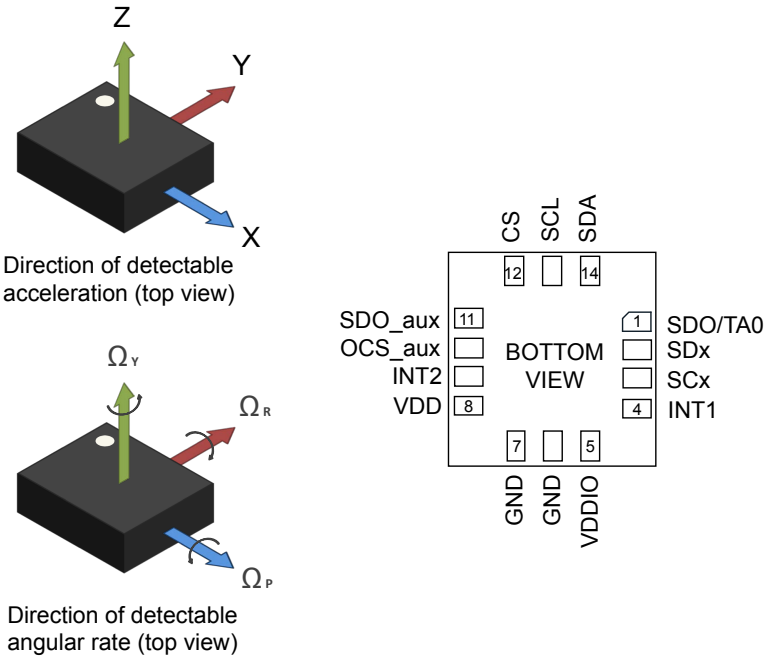
The sensor leverages robust in-house manufacturing processes for micromachined accelerometers and the gyroscopes is based on the new symmetric architecture to filtering the effect process variation enhancing the vibration immunity against external aggressor, combining specialized micromachining with CMOS technology for optimized sensor characteristics.

It embeds advanced features like a finite state machine, machine learning core, ASC, sensor fusion low power and data filtering for OIS, EIS, and motion processing.

The LSM6DSK320X is available in a small plastic, land grid array (LGA) package of 2.5 x 3.0 x 0.83 mm, suitable for ultracompact solutions.

2 Pin description

Figure 1. Pin connections

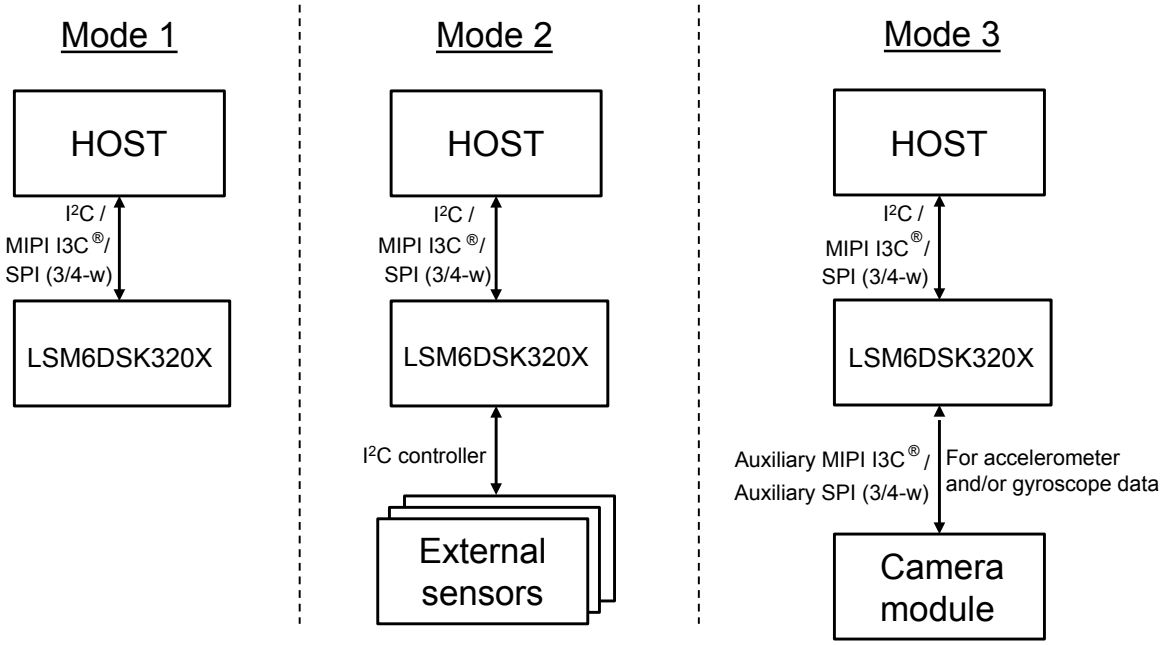


2.1 Pin connections

The LSM6DSK320X offers flexibility to connect the pins in order to have three different mode connections and functionalities. In detail:

- **Mode 1**: I²C / MIPI I3C® target interface or SPI (3- and 4-wire) serial interface is available.
- **Mode 2**: I²C / MIPI I3C® target interface or SPI (3- and 4-wire) serial interface and I²C controller interface for external sensor connections are available.
- **Mode 3:** I²C / MIPI I3C® target interface or SPI (3- and 4-wire) serial interface is available for the application processor interface while an auxiliary MIPI I3C® / SPI (3- and 4-wire) serial interface for external sensor connections is available for the accelerometer and gyroscope.

Figure 2. **LSM6DSK320X 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 TA0	SPI 4-wire interface serial data output (SDO) I²C least significant bit of the device address (TA0)	SPI 4-wire interface serial data output (SDO) I²C least significant bit of the device address (TA0)	SPI 4-wire interface serial data output (SDO) I²C least significant bit of the device address (TA0)
2	SDx	Connect to VDDIO or GND	I²C controller serial data (CSDA)	Auxiliary SPI 3/4-wire interface serial data input (SDI_aux) Auxiliary SPI 3-wire serial data output (SDO_aux) Auxiliary MIPI I3C® serial data (SDA_I3C_aux)
3	SCx	Connect to VDDIO or GND	I²C controller serial clock (CSCL)	Auxiliary SPI 3/4-wire interface serial port clock (SPC_aux) Auxiliary MIPI I3C® serial clock (SCL_I3C_aux)
4	INT1	Programmable interrupt in I²C and SPI		
5	VDDIO(1)	Power supply for I/O pins		
6	GND	0 V supply		
7	GND	0 V supply		
8	VDD(1)	Power supply		
9	INT2	Programmable interrupt 2 (INT2)	Programmable interrupt 2 (INT2) / I²C controller external synchronization signal (CDRDY)	Programmable interrupt 2 (INT2)
10	OCS_aux	Connect to VDDIO or leave unconnected(2)	Connect to VDDIO or leave unconnected(2)	Auxiliary MIPI I3C® / Auxiliary SPI mode selection (1: Aux. SPI idle mode / Aux. MIPI I3C® communication enabled; 0: Aux. SPI communication mode / Aux. MIPI I3C® disabled)
11	SDO_aux	Connect to VDDIO or leave unconnected(2)	Connect to VDDIO or leave unconnected(2)	Auxiliary SPI 3-wire interface: leave unconnected(2) Auxiliary SPI 4-wire interface: serial data output (SDO_aux)
12	CS	I²C / MIPI I3C® / SPI mode selection (1: SPI idle mode / I²C / MIPI I3C® communication enabled; 0: SPI communication mode / I²C / MIPI I3C® disabled)	I²C / MIPI I3C® / SPI mode selection (1: SPI idle mode / I²C / MIPI I3C® communication enabled; 0: SPI communication mode / I²C / MIPI I3C® disabled)	I²C / MIPI I3C® / SPI mode selection (1: SPI idle mode / I²C / MIPI I3C® communication enabled; 0: SPI communication mode / I²C / MIPI I3C® disabled)
13	SCL	I²C / MIPI I3C® serial clock (SCL) SPI serial port clock (SPC)	I²C / MIPI I3C® serial clock (SCL) SPI serial port clock (SPC)	I²C / MIPI I3C® serial clock (SCL) SPI serial port clock (SPC)
14	SDA	I²C / MIPI I3C® serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I²C / MIPI I3C® serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)	I²C / MIPI I3C® serial data (SDA) SPI serial data input (SDI) 3-wire interface serial data output (SDO)

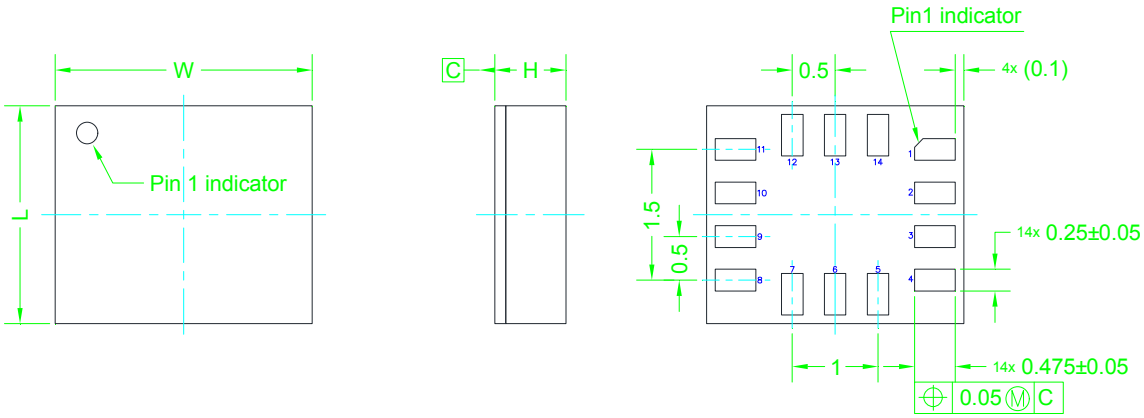
1. *Recommended 100 nF filter capacitor.*
2. *Leave pin electrically unconnected and soldered to PCB.*

3 Package information

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 0.83 mm package outline and mechanical data



Dimensions are in millimeters unless otherwise specified.
General tolerance is +/-0.1mm unless otherwise specified.

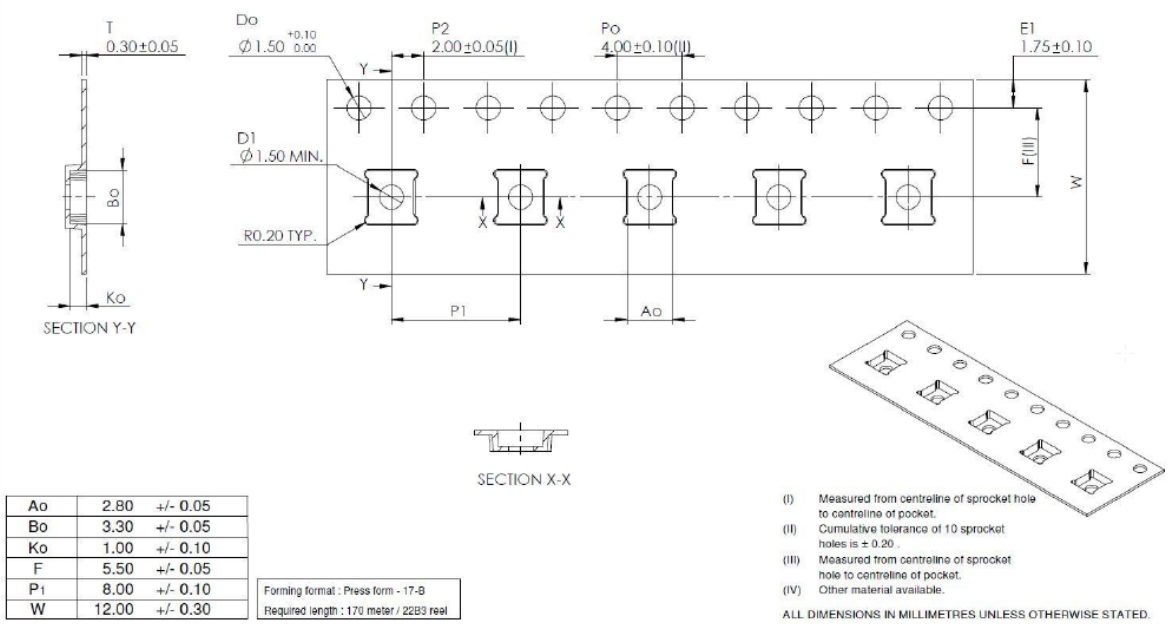
OUTER DIMENSIONS

ITEM	DIMENSION [mm]	TOLERANCE [mm]
Length [L]	2.50	±0.05
Width [W]	3.00	±0.05
Height [H]	0.83	±0.03

DM01021587_2

3.2 LGA-14L packing information

Figure 4. **Carrier tape information for LGA-14L package**



Ao	2.80	+/- 0.05
Bo	3.30	+/- 0.05
Ko	1.00	+/- 0.10
F	5.50	+/- 0.05
P1	8.00	+/- 0.10
W	12.00	+/- 0.30

Forming format : Press form - 17-B
Required length : 170 meter / 22B3 reel

Figure 5. **LGA-14L package orientation in carrier tape**

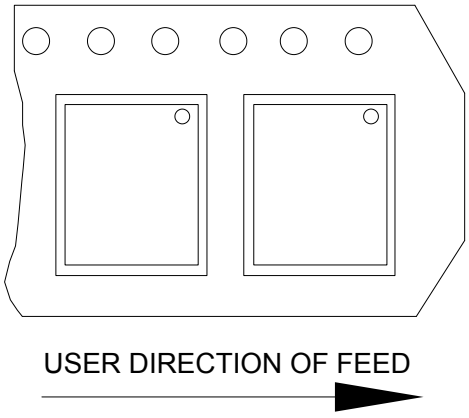


Figure 6. **Reel information for carrier tape of LGA-14L package**

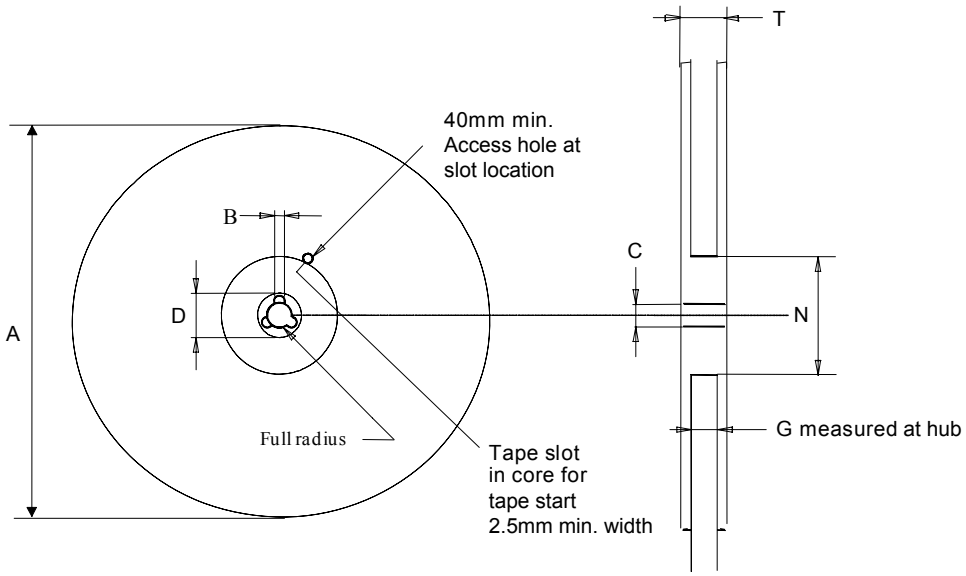


Table 2. **Reel dimensions for carrier tape of LGA-14L package**

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
07-Jan-2026	1	Initial release

Contents

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