LSM6DSV16X

Data brief

iNEMO 3D accelerometer and 3D gyroscope: always-on inertial module with embedded machine learning core and Qvar electrostatic sensor

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

Product status link
LSM6DSV16X

Product summary		
Order code	LSM6DSV16X	LSM6DSV16XTR
Temperature range [°C]	-40 to +85	
Package	LGA-14L (2.5 x 3.0 x 0.83 mm)	
Packing	Tray	Tape & Reel

Product resources
TN0018 (Design and soldering)

Product label
SUSTAINABLE TECHNOLOGY

Features

- Triple core for UI, EIS and OIS data processing
- Power consumption: 0.65 mA in combo high-performance mode
- “Always-on" experience with low power consumption for both accelerometer and gyroscope
- Smart FIFO up to 4.5 kbyte
- Android compliant
- ±2/±4/±8/±16 *g* full scale
- ±125/±250/±500/±1000/±2000/±4000 dps full scale
- Analog supply voltage: 1.71 V to 3.6 V
- Independent IO supply (extended range: 1.08 V to 3.6 V)
- Compact footprint: 2.5 mm x 3 mm x 0.83 mm
- 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, wakeup, 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 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
- S4S data synchronization
- Embedded temperature sensor
- ECOPACK, RoHS and “Green” compliant

Applications

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

Description

The LSM6DSV16X is a system-in-package featuring a 3D digital accelerometer and a 3D digital gyroscope with a triple core for processing acceleration and angular rate data on 3 separate channels with dedicated configuration, processing and filtering.

The LSM6DSV16X boosts performance at 0.65 mA in high-performance mode and enables always-on low-power features for an optimal motion experience for the consumer.

The LSM6DSV16X embeds advanced dedicated features and data filtering for OIS, EIS and motion processing like filtering, finite state machine and MLC with an exportable AI feature for IoT applications.

The LSM6DSV16X embeds Qvar (electric charge variation detection) for user interface functions: tap, double-tap, triple-tap, long press, L/R – R/L swipe.

The LSM6DSV16X embeds an analog hub which is able to connect an external analog input and convert it to a digital signal for processing.

1 Overview

The LSM6DSV16X is a system-in-package featuring a high-performance 3-axis digital accelerometer and 3-axis digital gyroscope.

The LSM6DSV16X 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 contextual awareness, implementing hardware recognition of free-fall events, 6D orientation, click and double-click sensing, activity or inactivity, stationary/motion detection and wakeup events. Machine learning and finite state machine processing allows moving some algorithms from the application processor to the LSM6DSV16X sensor, enabling consistent reduction of power consumption.

The LSM6DSV16X supports main OS requirements, offering real, virtual and batch mode sensors. In addition, the LSM6DSV16X can efficiently run the sensor-related features specified in Android, saving power and enabling faster reaction time. In particular, the LSM6DSV16X 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 LSM6DSV16X 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, etc.

The LSM6DSV16X offers advanced design flexibility for OIS and EIS applications. Both channels have a dedicated processing path with independent filtering and enhanced EIS channel gyro data are read over the primary interfaces I²C/ MIPI I3C® v1.1 / SPI.

Core 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.

Core 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 ±2 *g* - ±16 *g* (accelerometer) / ±125 dps - ±2000 dps (gyroscope). The accelerometer is also available as standalone with dedicated filtering.

Core 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 kbytes of FIFO with compression and dynamic allocation of significant data (i.e. external sensors, timestamp, etc.) allows overall power saving of the system.

Like the entire portfolio of MEMS sensor modules, the LSM6DSV16X 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.

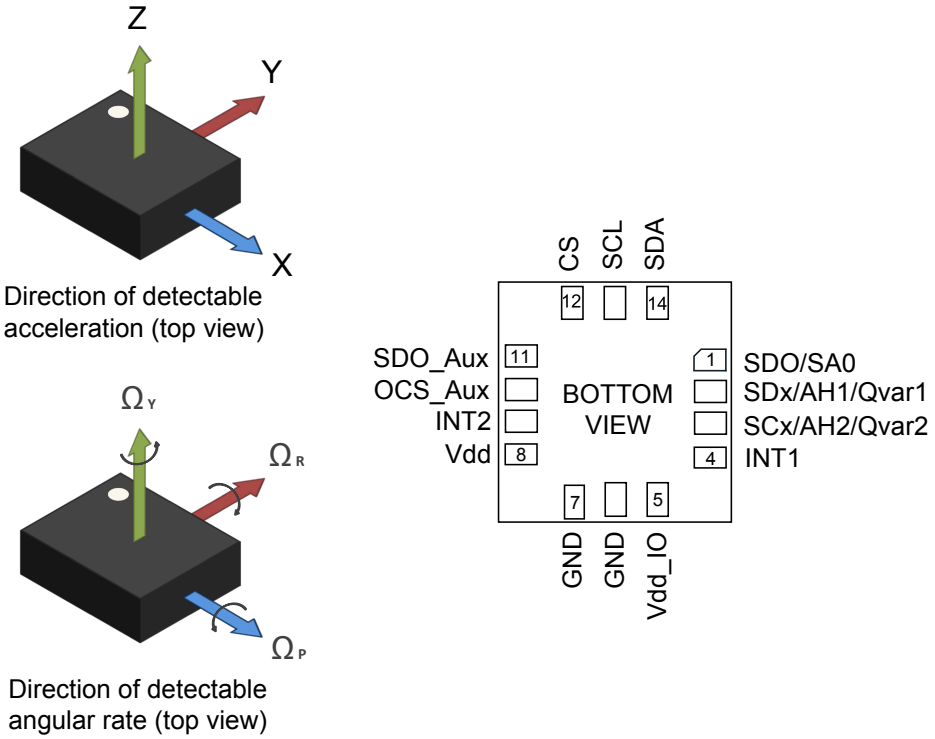
The LSM6DSV16X embeds an analog hub which is able to connect an external analog input and convert it to a digital signal for processing as well as advanced dedicated features like a finite state machine and data filtering for OIS, EIS and motion processing.

The LSM6DSV16X 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, L/R – R/L swipe.

The LSM6DSV16X is available in a small plastic land grid array (LGA) package of 2.5 x 3.0 x 0.83 mm to address ultra-compact solutions.

2 Pin description

Figure 1. Pin connections

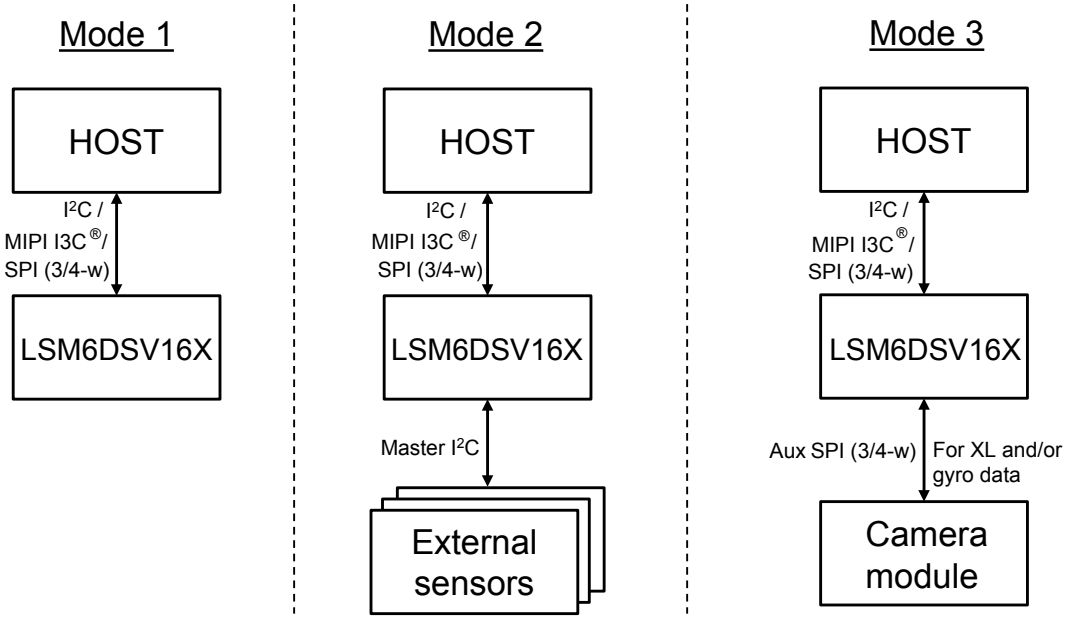


2.1 Pin connections

The LSM6DSV16X 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;
- **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. LSM6DSV16X connection modes



The analog hub and Qvar functionalities are available in mode 1 with I²C interface only.
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) I²C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I²C least significant bit of the device address (SA0)	SPI 4-wire interface serial data output (SDO) I²C 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	I²C serial data master (MSDA)	Auxiliary SPI 3/4-wire interface serial data input (SDI) and SPI 3-wire serial data output (SDO)
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	I²C serial clock master (MSCL)	Auxiliary SPI 3/4-wire interface serial port clock (SPC_Aux)
4	INT1	Programmable interrupt in I²C 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) / I²C 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 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)	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(1)	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(1)	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)

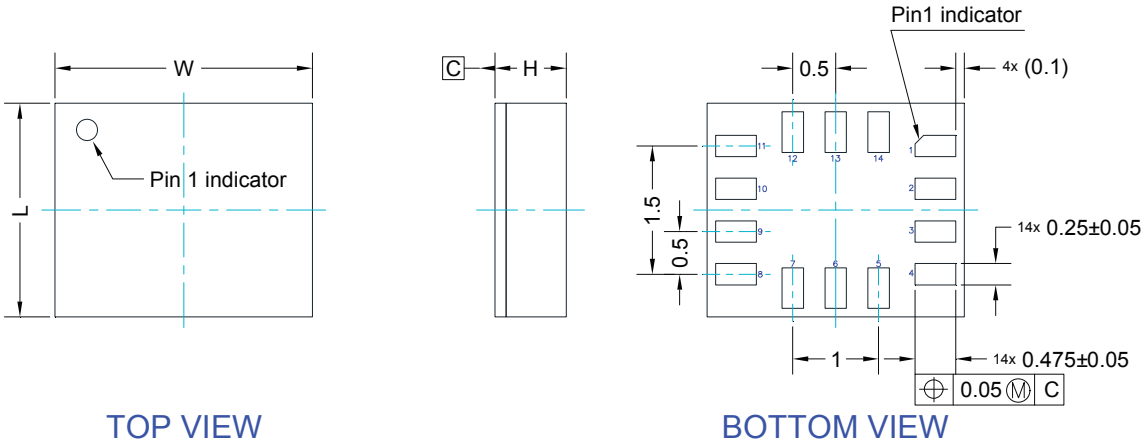
1. *SPI 3/4-wire interface not available with the analog hub / Qvar functionality enabled.*
2. *Recommended 100 nF filter capacitor.*
3. *Leave pin electrically unconnected and soldered to PCB.*

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 +/-0.1mm 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

Revision history

Table 2. **Document revision history**

Date	Version	Changes
16-Dec-2021	1	Initial release
21-Dec-2021	2	Textual update