LPY550AL

MEMS motion sensor:
dual axis pitch and yaw ±500°/s analog output gyroscope

Preliminary data

Features

- 2.7 V to 3.6 V single supply operation
- Very extended operating temperature range (-40°C to +85°C)
- High stability overtemperature
- Absolute analog rate output
- Two separate outputs for each axis (1x and 4x amplified)
- Integrated low-pass filters
- Low power consumption
- Embedded power-down
- Embedded self-test
- High shock and vibration survivability
- ECOPACK® RoHS and "Green" compliant (see *Section 5*)

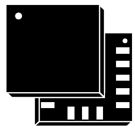
Applications

- Pointing devices, remote and game controllers
- Gaming applications
- Motion control with user interface
- Industrial and robotics

Description

The LPY550AL is a low-power two-axis micromachined gyroscope able to measure angular rate along pitch and yaw axes.

It provides excellent temperature stability and high resolution over extended operating temperature range (-40°C to +85°C).



LGA-16L (5x5x1.5mm)

The LPY550AL has a full scale of ±500 °/s and is capable of detecting rates with a -3 dB bandwidth up to 140 Hz.

The gyroscope is the combination of one actuator and one accelerometer integrated in a single micromachined structure.

It includes a sensing element composed by single driving mass, kept in continuos oscillating movement and able to react when an angular rate is applied based on the Coriolis principle.

A CMOS IC provides the measured angular rate to the external world through an analog output voltage, allowing high level of integration and production trimming to better match sensing element characteristics.

ST gyroscope family leverages on robust and mature manufacturing process already used for the production of micromachined accelerometers.

ST is already in the field with several hundreds million sensors with excellent acceptance from the market in terms of quality, reliability and performance.

LPY550AL is provided in plastic land grid array (LGA) package. Several years ago ST pioneered successfully the usage of this package for accelerometers. Today ST has the widest manufacturing capability and strongest expertise in the world for production of sensor in plastic LGA package.

Table 1. Device summary

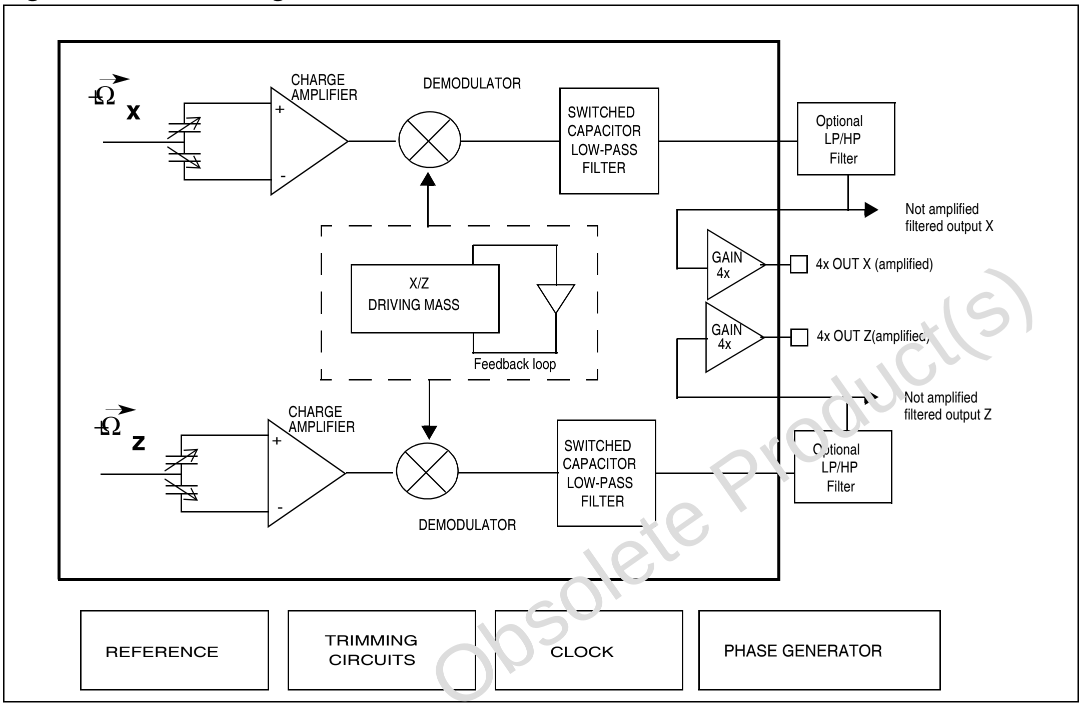
Order code	Temperature range (°C)	Package	Packing
LPY550AL	-40 to +85	LGA-16 (5x5x1.5)	Tray
LPY550ALTR	-40 to +85	LGA-16 (5x5x1.5)	Tape and reel

This is preliminary information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

Contents

1 Block diagram and pin description

Figure 1. Block diagram



1.1 Pin description

Figure 2. Pin connection

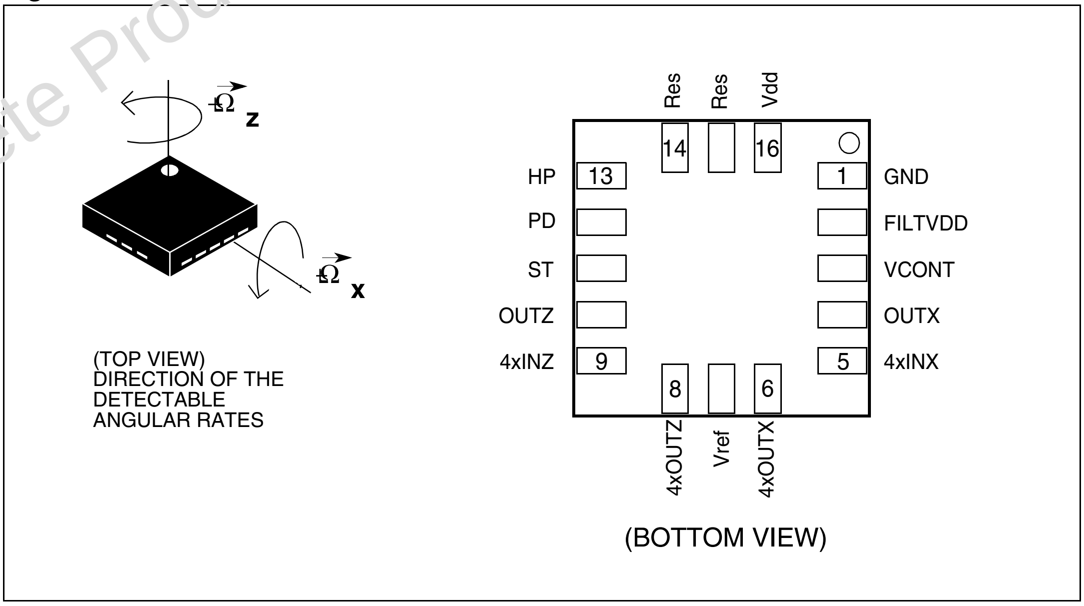


Table 2. Pin description

Pin #	Pin name	Analog function
1	GND	0V supply voltage
2	FILTVDD	PLL filter connection pin #2
3	VCONT	PLL filter connection pin #1
4	OUTX	Not amplified output
5	4xINX	Input of 4x amplifier
6	4xOUTX	X rate signal output voltage (amplified)
7	Vref	Reference voltage
8	4xOUTZ	Z rate signal output voltage (amplified)
9	4xINZ	Input of 4x amplifier
10	OUTZ	Not amplified output
11	ST	Self-test (logic 0: normal mode; logic 1: self-test)
12	PD	Power-down (logic 0: normal mode; logic 1: power-down mode)
13	HP	High pass filter reset (logic 0: normal operation mode; logic1: external high pass filter is reset)
14,15	Res	Reserved. Connect to Vdd
16	Vdd	Power supply

2 Mechanical and electrical specifications

2.1 Mechanical characteristics

Table 3. Mechanical characteristics @ Vdd = 3 V, T = 25 °C unless otherwise noted(1)

Symbol	Parameter	Test condition	Min.	Typ.(2)	Max.	Unit
FSA	Measurement range	4x OUT (amplified)		±500		°/s
FS		OUT (not amplified)		±2000		°/s
SoA	Sensitivity(3)	4x OUT (amplified)		2		mV/ °/s
So		OUT (not amplified)		0.5		mV/ °/s
SoDr	Sensitivity change vs temperature	Delta from 25°C		0.037		%/°C
Voff	Zero-rate level(3)			1.23		V
Vref	Reference voltage			1.23		V
OffDr	Zero-rate level change Vs temperature	Delta from 25°C		0.08		°/s/°C
NL	Non linearity	Best fit straight line		±1		% FS
BW	Bandwidth(4)			140		Hz
Rn	Rate noise density			0.059		$°/s / \sqrt{Hz}$
Top	Operating temperature range		-40		+85	°C

1. The product is factory calibrated at 3 V. The operational power supply range is specified in *Table 4*.
2. Typical specifications are not guaranteed
3. Sensitivity and Zero-rate Offset are not ratiometric to supply voltage
4. The product is capable of measuring angular rates extending from DC to the selected BW.

2.2 Electrical characteristics

Table 4. Electrical characteristics @ Vdd =3 V, T=25 °C unless otherwise noted[1]

Symbol	Parameter	Test condition	Min.	Typ.[2]	Max.	Unit
Vdd	Supply voltage		2.7	3	3.6	V
Idd	Supply current	PD pin connected to GND		6.8		mA
IddPdn	Supply current in power-down mode	PD pin connected to Vdd		1	5	µA
V_{ST}	Self-test input	Logic 0 level	0		0.2*Vdd	V
		Logic 1 level	0.8*Vdd		Vdd	
V_{PD}	Power-down input	Logic 0 level	0		0.2*Vdd	V
		Logic 1 level	0.8*Vdd		Vdd	
Top	Operating temperature range		-40		+85	°C

1. The product is factory calibrated at 3 V
2. Typical specifications are not guaranteed

2.3 Absolute maximum ratings

Stresses above those listed as “Absolute maximum ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device under these conditions is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

Table 5. Absolute maximum ratings

Symbol	Ratings	Maximum value	Unit
Vdd	Supply voltage	-0.3 to 6	V
Vin	Input voltage on any control pin (PD, ST)	-0.3 to Vdd +0.3	V
T_{STG}	Storage temperature range	-40 to +125	°C
A	Acceleration)	3000 *g* for 0.5 ms	
		10000 *g* for 0.1 ms	
ESD	Electrostatic discharge protection	2 (HBM)	kV

This is a mechanical shock sensitive device, improper handling can cause permanent damage to the part

This is an ESD sensitive device, improper handling can cause permanent damage to the part

3 Terminology

3.1 Sensitivity

An angular rate gyroscope is a device that produces a positive-going output voltage for counterclockwise rotation around the sensible axis considered. Sensitivity describes the gain of the sensor and can be determined by applying a defined angular velocity to it. This value changes very little over temperature and time.

3.2 Zero-rate level

Zero-rate level describes the actual output signal if there is no angular rate present. Zero-rate level of precise MEMS sensors is, to some extent, a result of stress to the sensor and therefore zero-rate level can slightly change after mounting the sensor onto a printed circuit board or after exposing it to extensive mechanical stress. This value changes very little over temperature and time.

3.3 Self-test

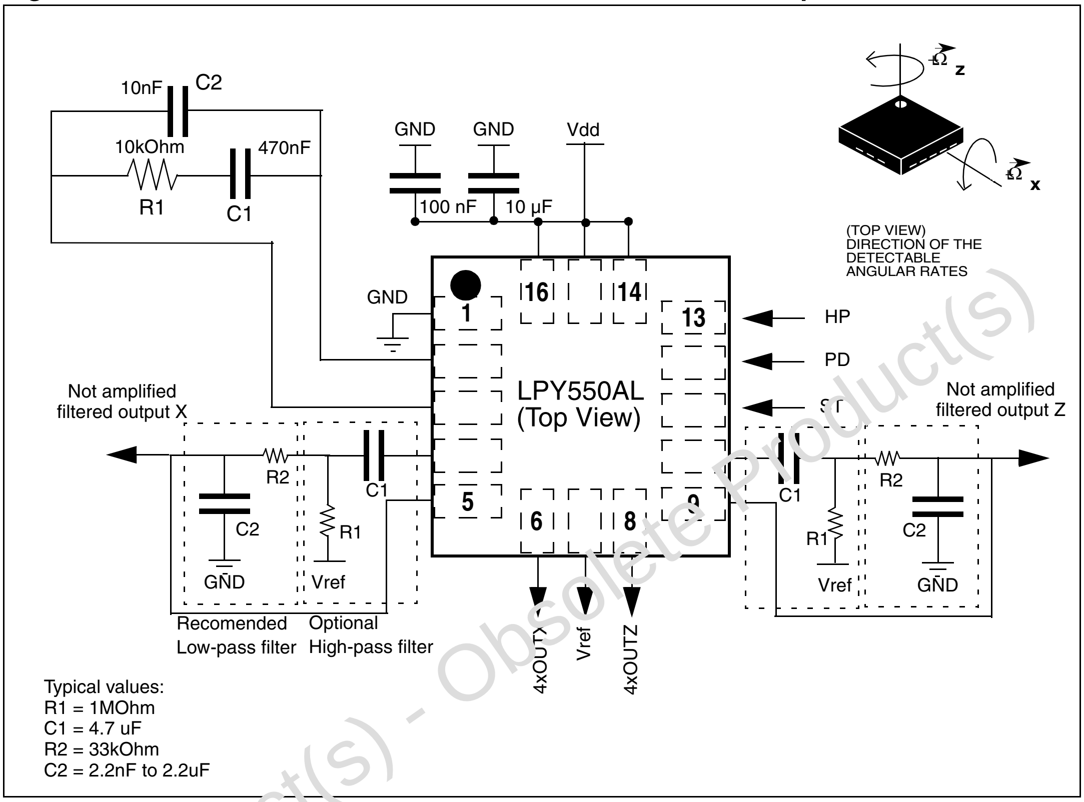
Self-test allows testing the mechanical and electrical part of the sensor, allowing the seismic mass to be moved by means of an electrostatic test-force. The self-test function is off when the ST pin is connected to GND. When the ST pin is tied to Vdd, an actuation force is applied to the sensor, emulating a definite Coriolis force. In this case the sensor output will exhibit a voltage change in its DC level which is also dependent on the supply voltage. When ST is active, the device output level is given by the algebraic sum of the signals produced by the velocity acting on the sensor and by the electrostatic test-force. If the output signals change within the amplitude specified in *Table 3*, then the mechanical element is working properly and the parameters of the interface chip are within the defined specification.

3.4 High pass filter reset (HP)

LPY550AL provides the possibility to reset the optional external high pass filter by applying high logic value to HP pad. This procedure ensures faster response expecially during overload conditions. Moreover, this operation is suggested each time the device is powered.

4 Application hints

Figure 3. LPY550AL electrical connections and external components values



Power supply decoupling capacitors (100 nF ceramic or polyester + 10 µF Aluminum) should be placed as near as possible to the device (common design practice).

The LPY550AL allows band limiting the output rate response through the use of an external low pass filter (suggested) and/or high pass filter (optional) in addition to the embedded low pass filter (f_t = 140 Hz).

4xOUTX and 4xOUTZ are respectively OUTX and OUTZ amplified outputs lines, internally buffered to ensure low output impedance.

If external high pass or low pass filtering is not applied it is mandatory to short-circuit respectively pad 4 to pad 5 and pad 9 to pad 10 when amplified outputs are used.

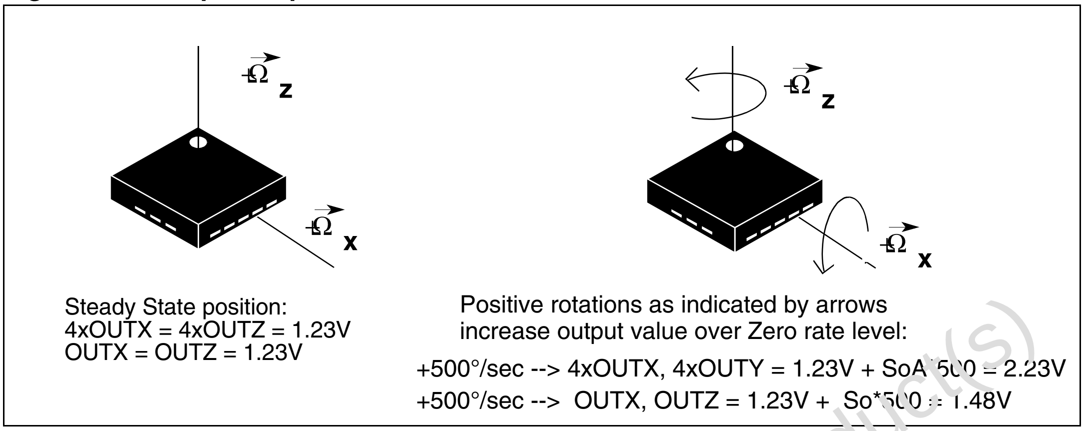
When only not-amplified outputs are used (OUTX/Z), it is suggested to set pads 5 and 9 to fixed reference voltage (Vref).

When high pass filter is applied to not amplified output (OUTx), it is recommended to buffer the line before entering ADC for performance optimization.

The LPY550AL IC includes a PLL (phase locked loop) circuit to synchronize driving and sensing interfaces. Capacitors and resistors must be added at **FILTVDD** and **VCONT** pins (as shown in *Figure 3*) to implement a low-pass filter.

4.1 Output response vs. rotation

Figure 4. Output response vs. rotation



4.2 Soldering information

The LGA package is compliant with the ECOPACK®, RoHS and "Green" standard. It is qualified for soldering heat resistance according to JEDEC J-STD-020C.

Leave "pin 1 indicator" unconnected during soldering.

Land pattern and soldering recommendations are available at www.st.com

5 Package information

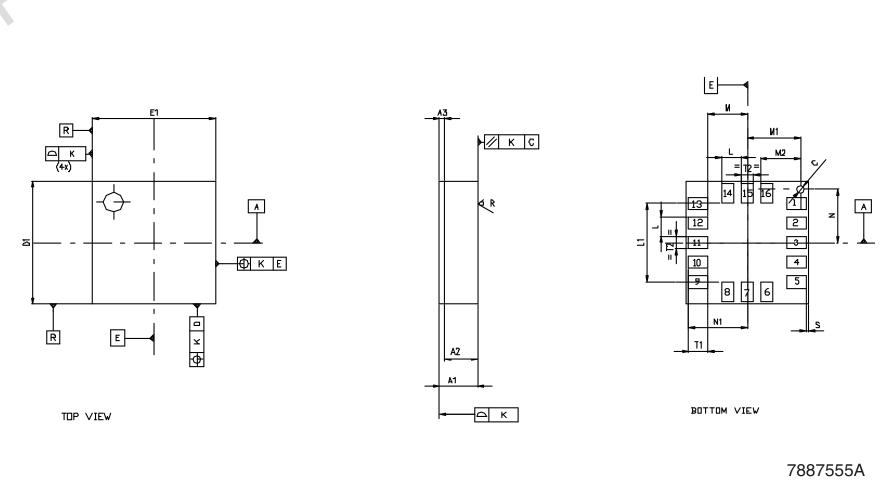
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

Figure 5. LGA-16: mechanical data and package dimensions

Dimensions						
Ref.	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A1	1.46	1.5	1.6	0.057	0.059	0.063
A2			1.33			0.052
A3	0.16	0.2	0.24	0.006	0.008	0.009
C		0.3			0.012	
D1	4.85	5	5.15	0.191	0.197	0.203
E1	4.85	5	5.15	0.191	0.197	0.203
L		0.8			0.031	
L1		3.2			0.126	
M		1.6			0.062	
M1	2.15	2.175	2.20	0.085	0.086	0.087
M2		1.625			0.064	
N		2.175			0.086	
N1		2.4			0.094	
T1		0.8			0.031	
T2	0.475	0.5	0.525	0.019	0.020	0.021
R	1.2		1.6	0.047		0.063
S		0.1			0.004	
h		0.15			0.006	
k		0.05			0.002	
j		0.1			0.004	

Outline and mechanical data

LGA-16 (5x5x1.5mm)
Land Grid Array Package



6 Revision history

Table 6. Document revision history

Date	Revision	Changes
04-Jun-2009	1	Initial release
06-Jul-2009	2	Small text changes to improve readability. Updated *Table 4*

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