

LPR530AL

MEMS motion sensor: dual axis pitch and roll ±300°/s analog gyroscope

Preliminary data

Features

- 2.7 V to 3.6 V single-supply operation
- Wide operating temperature range (-40 °C to +85 °C)
- High stability overtemperature
- Analog absolute angular-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*)

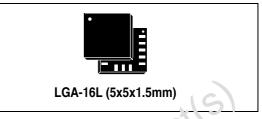
Applications

- Pointing devices, remote and game controllers
- Motion control with user interface
- GPS navigation systems
- Industrial ar a robotics

Description

The LPR530AL is a low-power dual-axis micromachined gyroscope capable of measuring angular rate along pitch and roll axes.

It provides excellent temperature stability and high resolution over an extended operating temperature range (-40 $^{\circ}$ C to +85 $^{\circ}$ C).



The LPR530AL has a full scale of $:300^{\circ}$ /s and is capable of detecting rates with ::: dB bandwidth up to 140 Hz.

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

It includes a sensing element composed by single driving mass, kept in continuous oscillating included 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's 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.

LPR530AL 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	
LPR530AL	-40 to +85	LGA-16 (5x5x1.5)	Tray	
LPR530ALTR	-40 to +85	LGA-16 (5x5x1.5)	Tape and reel	

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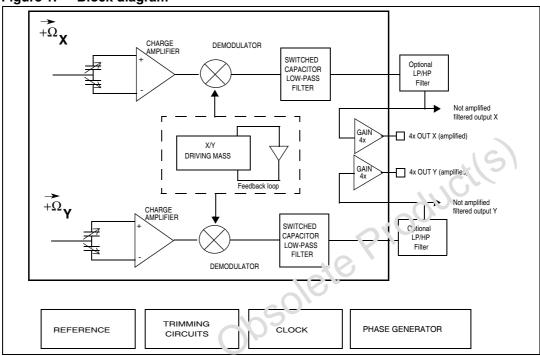
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Block diagram and pin description 1

Figure 1. **Block diagram**



Pin description 1.1

Figure 2. Pin connection

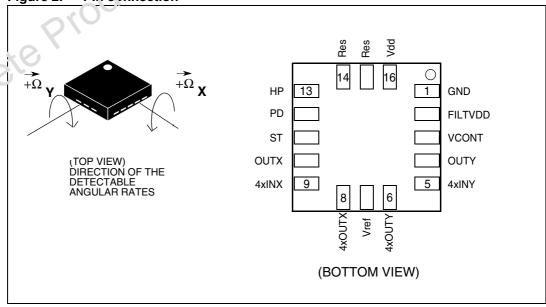


Table 2. Pin description

14510 21	T III description	T
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	OUTY	Not amplified output
5	4xINY	Input of 4x amplifier
6	4xOUTY	Y rate signal output voltage (amplified)
7	Vref	Reference voltage
8	4xOUTX	X rate signal output voltage (amplified)
9	4xINX	Input of 4x amplifier
10	OUTX	Not amplified output
11	ST	Self-test (logic 0: normal moc'e, logic 1: self-test)
12	PD	Power-down (logic 0: norma' mode; logic 1: power-down mode)
13	HP	High pass filter recet (logic 0: normal operation mode; logic1: external high pass filter is reset)
14,15	Res	71e. 5 ℃ d. Connect to Vdd
16	Vdd	Fower supply
ate Pr	oducils	
3,60		

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)		±300		°/s
FS	illeasurement range	OUT (not amplified)		±1200		°/s
SoA	Sensitivity ⁽³⁾	4x OUT (amplified)		3.33		mV/ °/s
So	Sensitivity	OUT (not amplified)		0.83		m`v'/ °/s
SoDr	Sensitivity change vs temperature	Delta from 25°C		0.03	, ci	%/°C
Voff	Zero-rate level ⁽³⁾			1.23	AU	V
Vref	Reference voltage			1.23	20,	V
OffDr	Zero-rate level change Vs temperature	Delta from 25°C		0. 15		°/s/°C
NL	Non linearity	Best fit straight line	10	±1		% FS
BW	Bandwidth ⁽⁴⁾		20/0	140		Hz
Rn	Rate noise density		15	0.035		°/s / √Hz
Тор	Operating temperature range		-40		+85	°C

^{1.} The product is factory calibrated at 3 V. The operatic nal power supply range is specified in *Table 4*.

^{2.} Typical specifications are not guaranteed

^{3.} Sensitivity and zero-rate level are not ratio netric to supply voltage

^{4.} The product is capable of measuring angular rates extending from DC to the selected BW.

2.2 **Electrical characteristics**

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

Symbol	Parameter	Test condition	Min.	Typ. ⁽²⁾	Max.	Unit		
Vdd	Supply voltage		2.7	3	3.6	V		
ldd	Supply current	PD pin connected to GND		6.8		mA		
IddPdn	Supply current in power-down mode	PD pin connected to Vdd		1	5	μΑ		
Vst	Colf toot input	Logic 0 level	0		0.2*Vdd	V		
VSI	Self-test input	Logic 1 level	0.8*Vdd		Vdd			
VPD	Power-down input	Logic 0 level	0		0.2*\'לוני	9		
VPD	Power-down input	Logic 1 level	0.8*Vdd	_	/ˈdr.	V		
Тор	Operating temperature range		-40	010C	+85	°C		
1. The produc	1. The product is factory calibrated at 3 V							
2. Typical specifications are not guaranteed								
 The product is factory calibrated at 3 V Typical specifications are not guaranteed Absolute maximum ratings 								

^{1.} The product is factory calibrated at 3 V

Absolute maximum ratings 2.3

Stresses above those listed as "Abso ute 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		Supply voltage	-0.3 to 6	V
	√in	Input voltage on any control pin (PD, ST)	-0.3 to Vdd +0.3	V
	T _{STG}	Storage temperature range	-40 to +125	°C
Opsor	Α	Acceleration	3000 g for 0.5 ms	
	A	Acceleration	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

^{2.} Typical specifications are not guaranteed

LPR530AL Terminology

3 Terminology

3.1 Sensitivity

An angular rate gyroscope is a device that produces a positive-going output voltage for counterclockwise rotation around the sensitive 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. The 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 of 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 origin to 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 specifications.

3.4 Yoh pass filter reset (HP)

The LPR530AL provides the possibility to reset the optional external high pass filter by applying a high logic value to the HP pad. This procedure ensures faster response, especially during overload conditions. Moreover, this operation is suggested each time the device is powered.

Application hints LPR530AL

4 Application hints

C2 10nF GND **GND** Vdd 10kOhm 470nF (TOP VIEW) DIRECTION OF THE DETECTABLE ANGULAR RATES R1 100 nF 10 uF C1 1161 | 11141 GND <u>13</u> Not amplified LPR530AL Not amplified filtered output X filtered output Y (Top View) Ó R2 5 1611 118 R1 GND GND Vref Recomended Optional Vref Low-pass filter High-pass filter Typical values: R1 = 1MOhm C1 = 4.7 uF R2 = 33kOhm $C2 = 2.2 \text{ nF to } 2.2 \text{ } \mu\text{F}$

Figure 3. LPR530AL electrical connections and external component 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 LF $_{10}$ COAL 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).

*xOUTX and 4xOUTY are respectively OUTX and OUTY 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 non-amplified outputs are used (OUTX/Y), it is suggested to set pads 5 and 9 to fixed reference voltages (GND/Vref).

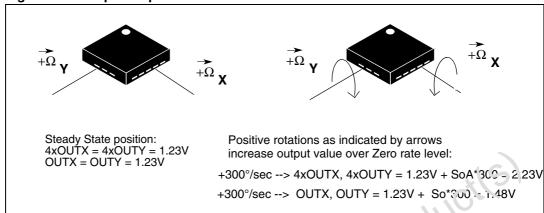
When high pass filter is applied to not amplified output (OUTx), it is recommended to buffer the line before entering ADC for performance optimization.

The LPR530AL 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.

LPR530AL Application hints

4.1 Output response vs. rotation

Figure 4. Output response vs. rotation



4.2 Soldering information

The LGA package is compliant with the ECOPACir^(c) FioHS and "Green" standard. It is qualified for soldering heat resistance ac craining to JEDEC J-STD-020C.

Leave "pin 1 indicator" unconnected (jurit g soldering.

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

Package information LPR530AL

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.

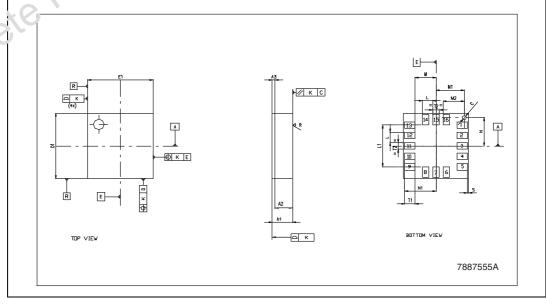
Figure 5. LGA-16: mechanical data and package dimensions

		Di	mensi	ons		
Ref.	mm			inch		
Rei.	Min.	Тур.	Max.	Min.	Тур.	Max.
A1	1.46	1.5	1.6	0.057	0.059	0.063
A2			1.33			0.052
А3	0.16	0.2	0.24	0.006	0.008	0.009
С		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	
М		1.6			0.062	
M1	2.15	2.175	2.20	0.085	0.086	0.087
M2		1.625			0.064	8
N		2.175			0.086	
N1		2.4			0.094	
T1		0.8			0.031	
T2	0.475	0.5	0.525	(.019	0.020	0.021
R	1.2		1.0	0.047		0.063
S		0.1	O.		0.004	
h		U.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



LPR530AL Revision history

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 <i>Table 4</i>

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