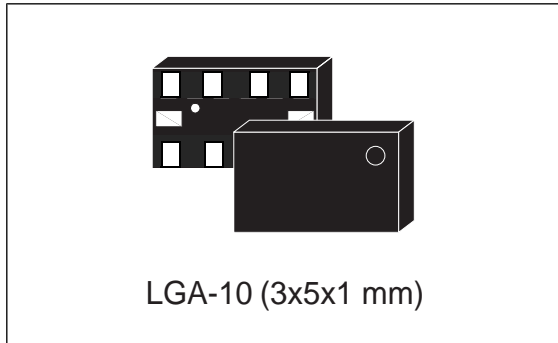


MEMS motion sensor: high performance ± 300 dps analog yaw-rate gyroscope



Features

- 2.7 V to 3.6 V single-supply operation
- Wide operating temperature range (-40 °C to +85 °C)
- High stability over temperature
- Analog absolute angular-rate outputs
- Integrated low-pass filters
- Low power consumption
- Sleep mode
- Embedded power-down
- Embedded self-test
- High shock and vibration survivability
- ECOPACK[®] RoHS and “Green” compliant

Applications

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

Description

The LY330ALH is a high performance low-power single-axis micro-machined gyroscope capable of measuring angular rate along the yaw axis.

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

The LY330ALH has a full scale of ± 300 dps and is capable of detecting rates with a -3 dB bandwidth up to 140 Hz.

The device includes a sensing element composed of a single driving mass, kept in continuous oscillation and capable of reacting, based on the Coriolis principle, when an angular rate is applied.

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

ST's family of gyroscopes leverages on the mature and robust manufacturing process already used for the production of micro-machined accelerometers.

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

The LY330ALH is available in a plastic land grid array (LGA) package, which ST successfully pioneered for accelerometers. Today ST has the widest manufacturing capability and strongest expertise in the world for production of sensors in plastic LGA packages.

Table 1: Device summary

| Order code | Temperature range (°C) | Package | Packing |
|------------|------------------------|----------------|---------------|
| LY330ALH | -40 to +85 | LGA-10 (3x5x1) | Tray |
| LY330ALHTR | -40 to +85 | LGA-10 (3x5x1) | Tape and reel |

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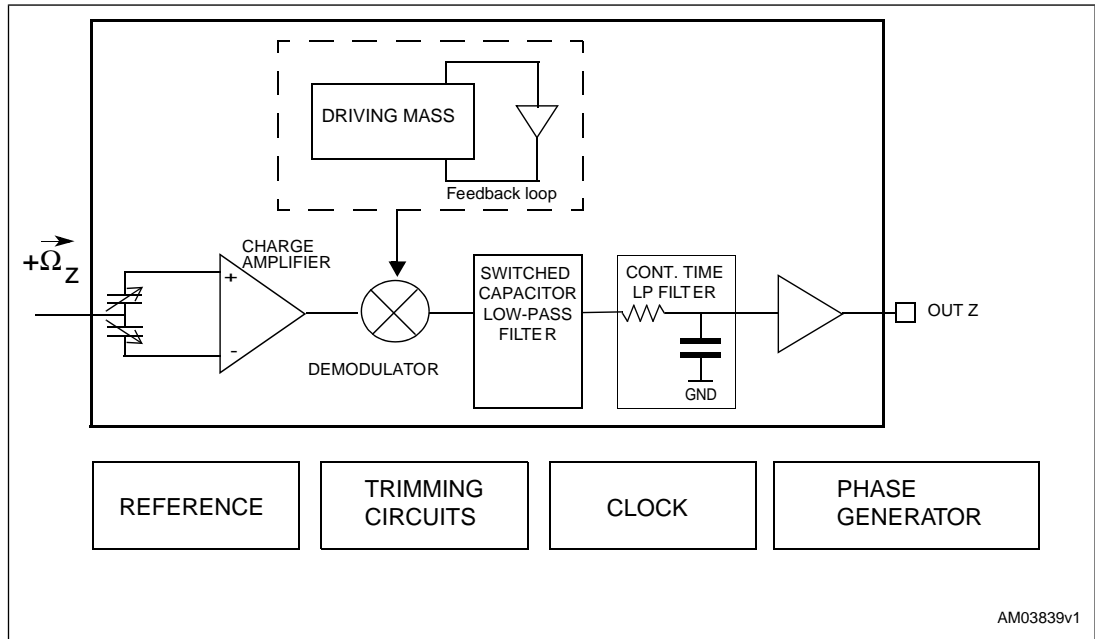
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1 Block diagram

Figure 1: Block diagram



AM03839v1

2 Pin description

Figure 2: Pin connection

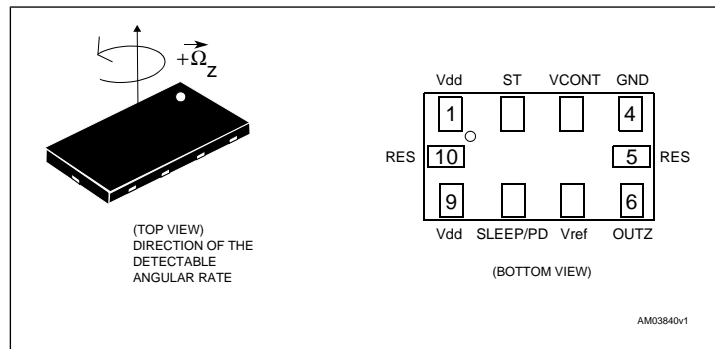


Table 2: Pin description

| Pin # | Pin name | Analog function |
|-------|----------|--|
| 1 | Vdd | Power supply |
| 2 | ST | Self-test (see "Sleep mode, self test and power-down mode configuration" table) |
| 3 | VCONT | PLL filter connection |
| 4 | GND | 0 V supply voltage |
| 5 | Res | Leave unconnected or connect to Vdd |
| 6 | OUTZ | Z axis output voltage |
| 7 | Vref | Reference voltage |
| 8 | SLEEP/PD | Sleep mode / power-down mode (see "Sleep mode, self test and power-down mode configuration" table) |
| 9 | Vdd | Power supply |
| 10 | Res | Leave unconnected or connect to Vdd |

3 Mechanical and electrical characteristics

3.1 Mechanical characteristics

Table 3: Mechanical characteristics @ Vdd = 3 V, T = 25 °C unless otherwise noted

| Symbol | Parameter | Test condition | Min. | Typ. ⁽¹⁾ | Max. | Unit |
|--------|--|------------------------|------|---------------------|------|-----------|
| FS | Measurement range | | | ±300 | | dps |
| So | Sensitivity ⁽²⁾ | | | 3.752 | | mV/dps |
| SoDr | Sensitivity change vs. temperature | Delta from 25°C | | 0.01 | | %/°C |
| Voff | Zero-rate level ⁽³⁾ | | | 1.5 | | V |
| OffDr | Zero-rate level change vs. temperature | Delta from 25°C | | 0.02 | | dps/°C |
| NL | Non linearity | Best fit straight line | | ±1 | | % FS |
| BW | Bandwidth ⁽³⁾ | | | 140 | | Hz |
| Vst | Self-test output change | | | 400 ⁽⁴⁾ | | mV |
| Rn | Rate noise density | | | 0.014 | | dps / √Hz |
| Top | Operating temperature range | | -40 | | 85 | °C |

(1) Typical specifications are not guaranteed.

(2) Sensitivity and zero-rate level are not ratiometric to supply voltage.

(3) The product is capable of measuring angular rates extending from DC to the selected BW.

(4) Self test typical absolute value.

 **Note:**

The product is factory calibrated at 3 V. The operational power supply range is specified in the Electrical characteristics table.

3.2 Electrical characteristics

Table 4: Electrical characteristics @ Vdd =3 V, T=25 °C unless otherwise noted

| Symbol | Parameter | Test condition | Min. | Typ. ⁽¹⁾ | Max. | Unit |
|--------|-----------------------------------|----------------|---------|---------------------|---------|------|
| Vdd | Supply voltage | | 2.7 | 3 | 3.6 | V |
| Idd | Supply current | | | 4.2 | | mA |
| IddSI | Supply current sleep mode | | | 2.2 | | mA |
| IddPdn | Supply current in power-down mode | | | 5 | | μA |
| Vst | Self-test input | Logic 0 level | 0 | | 0.2*Vdd | V |
| | | Logic 1 level | 0.8*Vdd | | Vdd | |
| Vpd | 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⁾Typical specifications are not guaranteed

 **Note:**

The product is factory calibrated at 3 V.

3.3 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 (Sleep/PD, ST) | -0.3 to Vdd +0.3 | V |
| A | Acceleration | 3000 for 0.5 ms | g |
| | | 10000 for 0.1 ms | g |

| Symbol | Ratings | Maximum value | Unit |
|------------------|------------------------------------|---------------|------|
| T _{STG} | Storage temperature range | -40 to +125 | °C |
| 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.

4 Terminology

4.1 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.

4.2 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.

4.3 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 definite Coriolis force. In this case the sensor output exhibits 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 the Mechanical characteristics table, then the mechanical element is working properly and the parameters of the interface chip are within the defined specifications.

4.4 Sleep mode, self-test and power-down

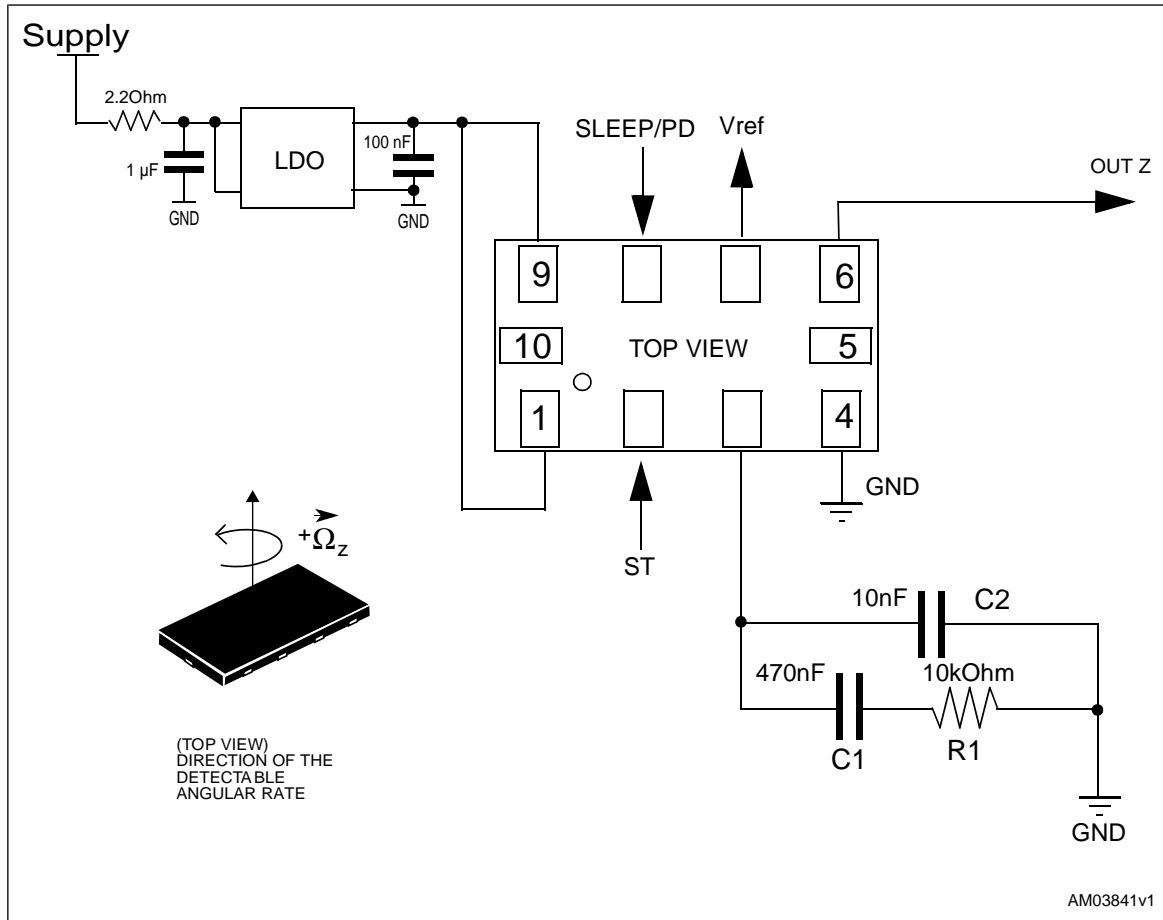
The device enables advanced power-saving features thanks to the availability of three different operating modes. In addition to standard normal mode and Power-down mode, when the device is set in a sleep mode configuration, the reading chain is completely turned off, resulting in low power consumption. In this condition the device turn-on time is significantly reduced, allowing simple external power cycling. In accordance with the table below, the user can select the desired operating mode using two dedicated pins (ST and SLEEP/PD).

Table 6: Sleep mode, self-test and power-down mode configuration

| Operating mode | ST pin | SLEEP/PD pin |
|----------------|--------|--------------|
| Normal mode | 0 | 0 |
| Sleep mode | 0 | 1 |
| Self-test | 1 | 0 |
| Power-down | 1 | 1 |

5 Application hints

Figure 3: Electrical connections and external component values

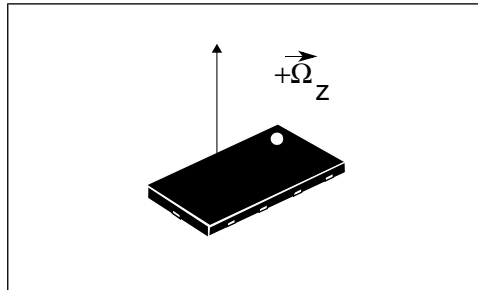


Power supply decoupling capacitors should be placed in combination with an LDO regulator (common design practice).

The device IC includes a PLL (phase-locked loop) circuit to synchronize driving and sensing interfaces. Capacitors and resistor must be added at **VCONT** pin 3 (see figure above) to implement a low-pass filter.

5.1 Output response vs. rotation

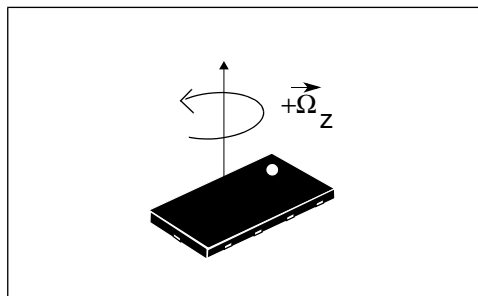
Figure 4: Steady state position



 **Note:**

$$\text{OUTZ} = 1.5 \text{ V}$$

Figure 5: Output response vs. rotation



 **Note:**

Positive rotations as indicated by arrows increase output value over zero-rate level:

$$\text{OUTZ} = 1.5 \text{ V} + \text{SoA} \cdot 300 = 2.62 \text{ V}$$

5.2 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-020.

Leave "pin 1 indicator" unconnected during soldering.

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

6 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.

6.1 LGA-10 package mechanical data

Figure 6: LGA-10 (3x5x1 mm) mechanical data

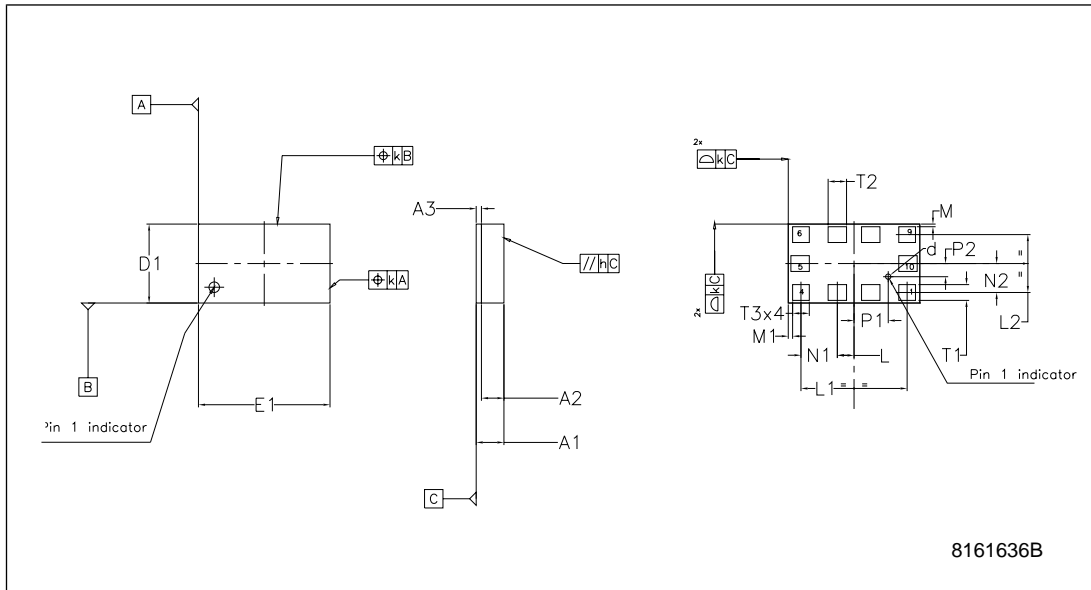


Table 7: LGA-10 (3x5x1 mm) package dimensions

| Ref. | Dimensions | | |
|------|------------|-------|-------|
| | mm | | |
| | Min. | Typ. | Max. |
| A1 | | | 1.100 |
| A2 | | 0.855 | |
| A3 | | 0.200 | |
| D1 | 2.850 | 3.000 | 3.150 |
| E1 | 4.850 | 5.000 | 5.150 |
| L | | 0.635 | |
| L1 | | 4.035 | |
| L2 | | 2.200 | |
| N1 | | 1.382 | |

| Ref. | Dimensions | | |
|------|------------|-------|------|
| | mm | | |
| | Min. | Typ. | Max. |
| N2 | | 1.100 | |
| M | | 0.100 | |
| P1 | | 1.300 | |
| P2 | | 0.500 | |
| T1 | | 0.600 | |
| T2 | | 0.700 | |
| T3 | | 0.635 | |
| d | | 0.200 | |
| k | | 0.050 | |
| h | | 0.100 | |

7 Revision history

Table 8: Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 29-Oct-2009 | 1 | Initial release. |
| 19-Feb-2010 | 2 | Minor text changes and updated package information. |

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