



# LSM320DL

## Linear sensor module 3D accelerometer sensor and 2D gyroscope sensor

Preliminary data

### Features

- Analog supply voltage 2.4 V to 3.6 V
- Digital supply voltage IOs, 1.8 V
- Low power mode
- Power-down mode
- 3 independent acceleration channels and 2 angular rate channels (pitch and yaw)
- $\pm 2g/\pm 4g/\pm 8/\pm 16g$  dynamically selectable full-scale
- $\pm 250/\pm 500/\pm 2000$  dps dynamically selectable full-scale
- Embedded temperature sensor
- SPI/I<sup>2</sup>C serial interface (16-bit data output)
- Programmable interrupt generator for free-fall and motion detection
- ECOPACK<sup>®</sup> RoHS and “Green” compliant

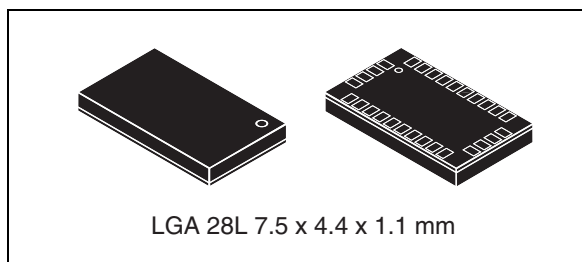
### Applications

- GPS navigation systems
- Impact recognition and logging
- Gaming and virtual reality input devices
- Motion activated functions
- Intelligent power saving for handheld devices
- Vibration monitoring and compensation
- Free-fall detection
- 6D orientation detection

### Description

The LSM320DL is a system-in-package featuring a 3D digital accelerometer and a 2D digital gyroscope.

The ST modules family uses a robust and mature manufacturing process already used for the production of micromachined accelerometers.



The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are realized using a CMOS technology that allows to design a dedicated circuit which is trimmed to better match the sensing element characteristics.

LSM320DL has a dynamic user selectable full-scale acceleration range of  $\pm 2g/\pm 4g/\pm 8/\pm 16g$  and angular rate of  $\pm 250/\pm 500/\pm 2000$  deg/sec.

The accelerometer and gyroscope sensors can be either activated or put in low power/power-down mode separately for application optimized power saving.

The LSM320DL is available in a plastic land grid array (LGA) package.

Several years ago ST successfully pioneered the use of this package for accelerometers. Today, ST has the widest manufacturing capability and strongest expertise in the world for production of sensors in a plastic LGA package.

**Table 1. Device summary**

| Order codes | Temperature range [°C] | Package | Packing       |
|-------------|------------------------|---------|---------------|
| LSM320DL    | -40 to +85             | LGA 28L | Tray          |
| LSM320DLTR  |                        |         | Tape and reel |

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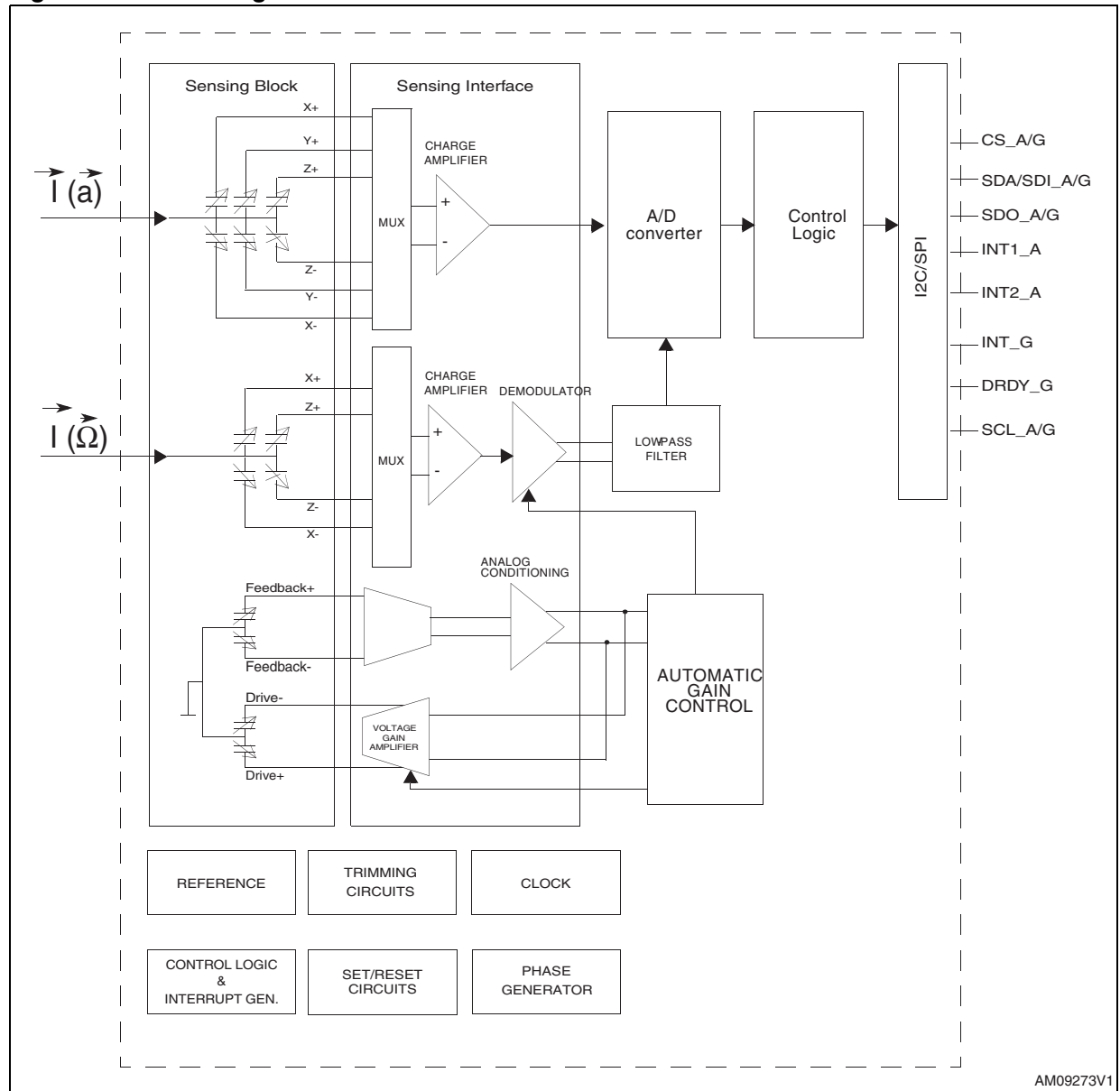
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# 1 Block diagram and pin description

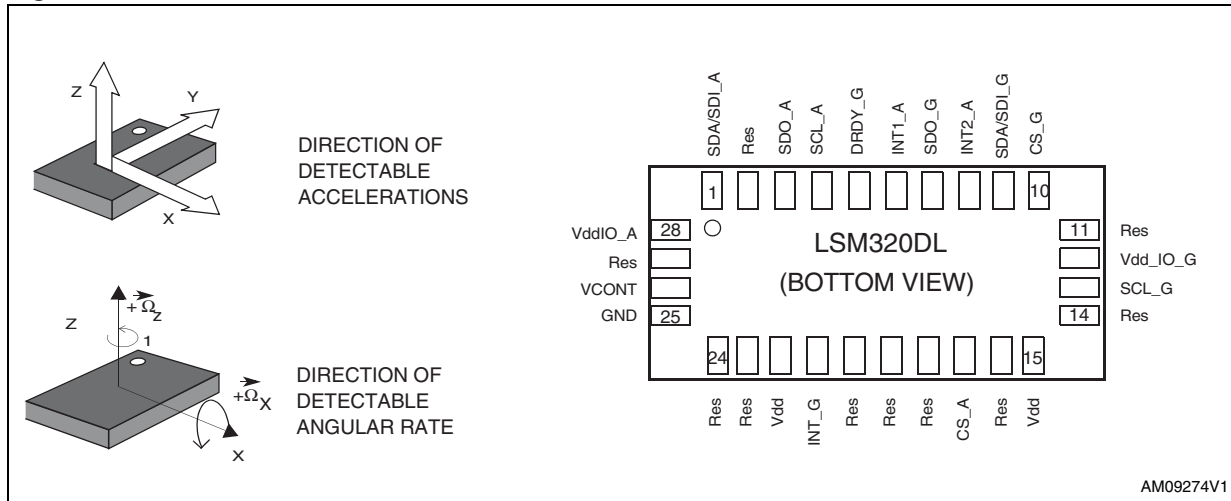
## 1.1 Block diagram

Figure 1. Block diagram



## 1.2 Pin description

**Figure 2. Pin connection**



**Table 2. Pin description**

| Pin# | Name      | Function                                                                                                                         |
|------|-----------|----------------------------------------------------------------------------------------------------------------------------------|
| 1    | SDA/SDI_A | Accelerometer:<br>I <sup>2</sup> C serial data (SDA)<br>SPI serial data input (SDI)<br>3-wire interface serial data output (SDO) |
| 2    | Res       | Reserved connect to GND                                                                                                          |
| 3    | SDO_A     | Accelerometer:<br>SPI serial data output (SDO)<br>I <sup>2</sup> C least significant bit of the device address (SA0)             |
| 4    | SCL_A     | Accelerometer:<br>I <sup>2</sup> C serial clock (SCL)<br>SPI serial port clock (SPC)                                             |
| 5    | DRDY_G    | Gyroscope data ready                                                                                                             |
| 6    | INT1_A    | Accelerometer interrupt signal                                                                                                   |
| 7    | SDO_G     | Gyroscope:<br>SPI serial data output (SDO)<br>I <sup>2</sup> C least significant bit of the device address (SA0)                 |
| 8    | INT2_A    | Accelerometer interrupt signal                                                                                                   |
| 9    | SDA/SDI_G | Gyroscope:<br>I <sup>2</sup> C serial data (SDA)<br>SPI serial data input (SDI)<br>3-wire interface serial data output (SDO)     |

**Table 2. Pin description (continued)**

| Pin# | Name    | Function                                                                                                                                                                               |
|------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10   | CS_G    | Gyroscope:<br>SPI enable<br>I <sup>2</sup> C/SPI mode selection (1: SPI idle mode / I <sup>2</sup> C communication enabled; 0: SPI communication mode / I <sup>2</sup> C disabled)     |
| 11   | Res     | Reserved connect to GND                                                                                                                                                                |
| 12   | VddIO_G | Gyroscope power supply for IO pins                                                                                                                                                     |
| 13   | SCL_G   | Gyroscope:<br>I <sup>2</sup> C serial clock (SCL)<br>SPI serial port clock (SPC)                                                                                                       |
| 14   | Res     | Reserved connect to GND                                                                                                                                                                |
| 15   | Vdd     | Power supply                                                                                                                                                                           |
| 16   | Res     | Reserved connect to GND                                                                                                                                                                |
| 17   | CS_A    | Accelerometer:<br>SPI enable<br>I <sup>2</sup> C/SPI mode selection (1: SPI idle mode / I <sup>2</sup> C communication enabled; 0: SPI communication mode / I <sup>2</sup> C disabled) |
| 18   | Res     | Reserved connect to GND                                                                                                                                                                |
| 19   | Res     | Reserved connect to GND                                                                                                                                                                |
| 20   | Res     | Reserved connect to GND                                                                                                                                                                |
| 21   | INT_G   | Gyroscope interrupt signal                                                                                                                                                             |
| 22   | Vdd     | Power supply                                                                                                                                                                           |
| 23   | Res     | Reserved connect to GND                                                                                                                                                                |
| 24   | Res     | Reserved connect to GND                                                                                                                                                                |
| 25   | GND     | 0 V power supply                                                                                                                                                                       |
| 26   | VCONT   | PLL filter connection                                                                                                                                                                  |
| 27   | Res     | Reserved connect to GND                                                                                                                                                                |
| 28   | VddIO_A | Accelerometer power supply for IO pins                                                                                                                                                 |

## 2 Module specifications

### 2.1 Mechanical characteristics

@ Vdd = 3V, T = 25 °C unless otherwise noted<sup>(a)</sup>.

**Table 3. Mechanical characteristics**

| Symbol   | Parameter                                              | Test conditions                                      | Min. | Typ. <sup>(1)</sup> | Max. | Unit       |
|----------|--------------------------------------------------------|------------------------------------------------------|------|---------------------|------|------------|
| LA_FS    | Linear acceleration measurement range <sup>(2)</sup>   | FS bit set to 00                                     |      | ±2.0                |      | g          |
|          |                                                        | FS bit set to 01                                     |      | ±4.0                |      |            |
|          |                                                        | FS bit set to 10                                     |      | ±8.0                |      |            |
|          |                                                        | FS bit set to 11                                     |      | ±16.0               |      |            |
| G_FS     | Angular rate measurement range <sup>(2)</sup>          | FS bit set to 00                                     |      | ±250                |      | dps        |
|          |                                                        | FS bit set to 01                                     |      | ±500                |      |            |
|          |                                                        | FS bit set to 10                                     |      | ±2000               |      |            |
| LA_So    | Linear acceleration sensitivity                        | FS bit set to 00                                     |      | 1                   |      | mg/digit   |
|          |                                                        | FS bit set to 01                                     |      | 2                   |      |            |
|          |                                                        | FS bit set to 10                                     |      | 4                   |      |            |
|          |                                                        | FS bit set to 11                                     |      | 12                  |      |            |
| G_So     | Angular rate sensitivity                               | FS bit set to 00                                     |      | 8.75                |      | mdps/digit |
|          |                                                        | FS bit set to 01                                     |      | 17.5                |      |            |
|          |                                                        | FS bit set to 10                                     |      | 70                  |      |            |
| LA_So    | Linear acceleration sensitivity change vs. temperature | FS bit set to 00                                     |      | ±0.05               |      | %/°C       |
| G_So     | Angular rate sensitivity change vs. temperature        | From -40 to +85 °C                                   |      | ±2                  |      | %          |
| LA_TyOff | Typical Zero-g level offset accuracy <sup>(3)</sup>    | FS bit set to 00                                     |      | ±60                 |      | mg         |
| G_TyOff  | Typical zero-rate level <sup>(4)</sup>                 | FS bit set to 00                                     |      | 10                  |      | LSb        |
| LA_TCOff | Zero-g level change vs. temperature                    | Max. delta from 25 °C                                |      | ±0.5                |      | mg/°C      |
| G_TCOff  | Zero-rate level change vs. temperature                 | FS bit set to 00<br>from -40 to +85 °C               |      | ±0.03               |      | dps/°C     |
| An       | Acceleration noise density                             | FS bit set to 00<br>Normal mode, ODR bit set to 1001 |      | 220                 |      | μg/√Hz     |
| Rn       | Rate noise density                                     | FS bit set to 00                                     |      | 0.03                |      | °/s/√Hz    |
| Top      | Operating temperature range                            |                                                      | -40  |                     | +85  | °C         |

a. The product is factory calibrated at 3 V. The operational power supply range is from 2.4 V to 3.6 V.

1. Typical specifications are not guaranteed.
2. Verified by wafer level test and measurement of initial offset and sensitivity.
3. Typical Zero-*g* level offset value after MSL3 preconditioning.
4. Offset can be eliminated by enabling the built-in high pass filter.

## 2.2 Electrical characteristics

@ Vdd = 3 V, T = 25 °C unless otherwise noted.

**Table 4. Electrical characteristics**

| Symbol     | Parameter                                   | Test conditions | Min.       | Typ. <sup>(1)</sup> | Max.       | Unit |
|------------|---------------------------------------------|-----------------|------------|---------------------|------------|------|
| Vdd        | Supply voltage                              |                 | 2.4        |                     | 3.6        | V    |
| Vdd_IO     | Power supply for I/O                        |                 | 1.71       |                     | Vdd+0.1    | V    |
| LA_Idd     | LA current consumption in normal mode       | ODR = 50Hz      |            | 11                  |            | μA   |
|            |                                             | ODR = 1Hz       |            | 2                   |            |      |
| LA_IddLowP | LA current consumption in low power mode    | ODR = 50Hz      |            | 6                   |            | μA   |
| LA_IddPdn  | LA current consumption in power-down mode   | T = 25°C        |            | 0.5                 |            | μA   |
| G_Idd      | AR current consumption in normal mode       |                 |            | 6                   |            | mA   |
| G_IddSL    | Supply current in sleep mode <sup>(2)</sup> |                 |            | 1.5                 |            | mA   |
| G_IddPdn   | AR current consumption in power-down mode   | T = 25 °C       |            | 5                   |            | μA   |
| VIH        | Digital high level input voltage            |                 | 0.8*Vdd_IO |                     |            | V    |
| VIL        | Digital low level input voltage             |                 |            |                     | 0.2*Vdd_IO | V    |
| VOH        | High level output voltage                   |                 | 0.9*Vdd_IO |                     |            | V    |
| VOL        | Low level output voltage                    |                 |            |                     | 0.1*Vdd_IO | V    |
| Top        | Operating temperature range                 |                 | -40        |                     | +85        | °C   |

1. Typical specifications are not guaranteed.
2. Sleep mode introduces a faster turn-on time compared to power-down mode.

## 2.3 Temperature sensor characteristics

@ V<sub>dd</sub> = 3.0 V, T = 25 °C, unless otherwise noted.<sup>(b)</sup>

**Table 5. Temperature sensor characteristics**

| Symbol | Parameter                                        | Test condition | Min. | Typ. <sup>(1)</sup> | Max. | Unit     |
|--------|--------------------------------------------------|----------------|------|---------------------|------|----------|
| TSDr   | Temperature sensor output change vs. temperature | -              |      | -1                  |      | °C/digit |
| TODR   | Temperature refresh rate                         |                |      | 1                   |      | Hz       |
| Top    | Operating temperature range                      |                | -40  |                     | +85  | °C       |

1. Typical specifications are not guaranteed.

b. The product is factory calibrated at 3.0 V.

## 2.4 Communication interface characteristics

### 2.4.1 SPI - serial peripheral interface

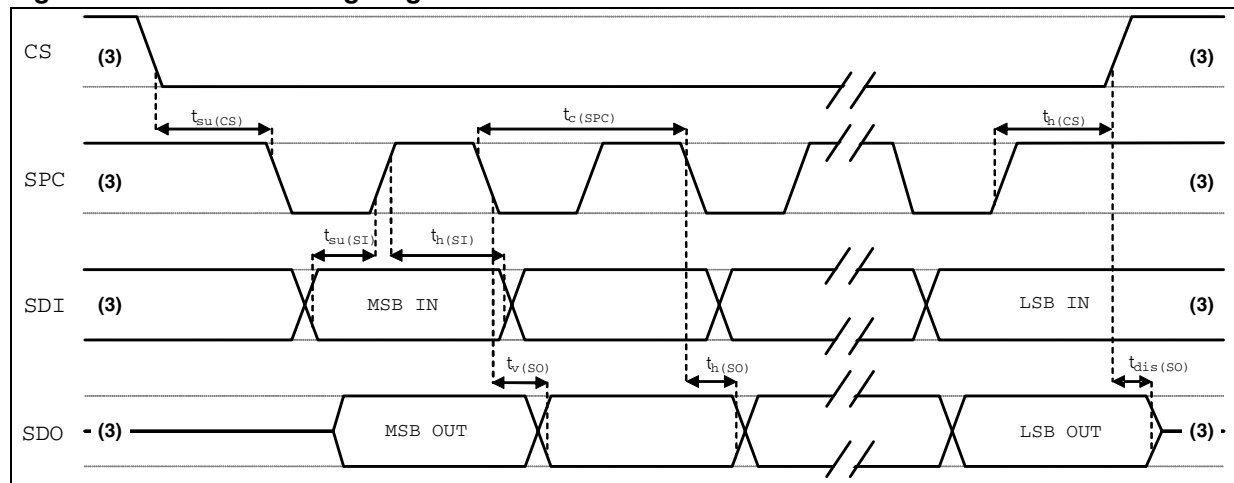
Subject to general operating conditions for Vdd and Top.

**Table 6. SPI slave timing values**

| Symbol   | Parameter               | Value <sup>(1)</sup> |      | Unit |
|----------|-------------------------|----------------------|------|------|
|          |                         | Min.                 | Max. |      |
| tc(SPC)  | SPI clock cycle         | 100                  |      | ns   |
| fc(SPC)  | SPI clock frequency     |                      | 10   | MHz  |
| tsu(CS)  | CS setup time           | 6                    |      | ns   |
| th(CS)   | CS hold time            | 8                    |      |      |
| tsu(SI)  | SDI input setup time    | 5                    |      |      |
| th(SI)   | SDI input hold time     | 15                   |      |      |
| tv(SO)   | SDO valid output time   |                      | 50   |      |
| th(SO)   | SDO output hold time    | 9                    |      |      |
| tdis(SO) | SDO output disable time |                      | 50   |      |

1. Values are guaranteed at 10 MHz clock frequency for SPI with both 4 and 3 wires, based on characterization results, not tested in production.

**Figure 3. SPI slave timing diagram <sup>(c)</sup>**



3. When no communication is on-going, data on CS, SPC, SDI, and SDO are driven by internal pull-up resistors.

c. Measurement points are done at 0.2·Vdd\_IO and 0.8·Vdd\_IO, for both input and output ports.

## 2.4.2 I<sup>2</sup>C - inter IC control interface

Subject to general operating conditions for Vdd and Top.

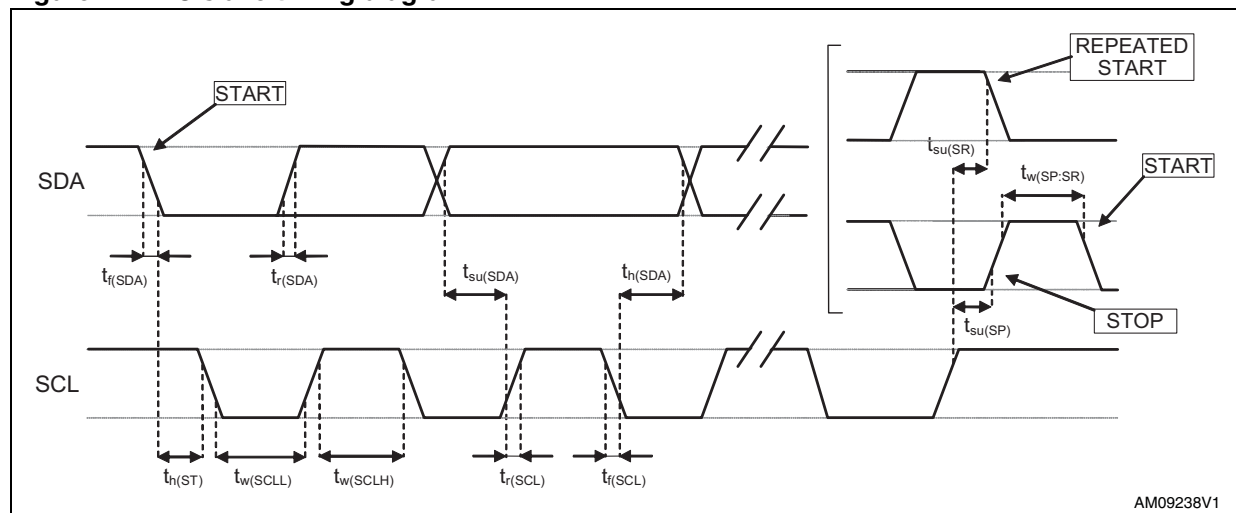
**Table 7. I<sup>2</sup>C slave timing values**

| Symbol                | Parameter                                      | I <sup>2</sup> C standard mode <sup>(1)</sup> |      | I <sup>2</sup> C fast mode <sup>(1)</sup> |      | Unit    |
|-----------------------|------------------------------------------------|-----------------------------------------------|------|-------------------------------------------|------|---------|
|                       |                                                | Min.                                          | Max. | Min.                                      | Max. |         |
| $f_{(SCL)}$           | SCL clock frequency                            | 0                                             | 100  | 0                                         | 400  | KHz     |
| $t_{w(SCLL)}$         | SCL clock low time                             | 4.7                                           |      | 1.3                                       |      | $\mu$ s |
| $t_{w(SCLH)}$         | SCL clock high time                            | 4.0                                           |      | 0.6                                       |      |         |
| $t_{su(SDA)}$         | SDA setup time                                 | 250                                           |      | 100                                       |      | ns      |
| $t_h(SDA)$            | SDA data hold time                             | 0,01                                          | 3.45 | 0                                         | 0.9  | $\mu$ s |
| $t_r(SDA) \ t_r(SCL)$ | SDA and SCL rise time                          |                                               | 1000 | $20 + 0.1C_b^{(2)}$                       | 300  | ns      |
| $t_f(SDA) \ t_f(SCL)$ | SDA and SCL fall time                          |                                               | 300  | $20 + 0.1C_b^{(2)}$                       | 300  |         |
| $t_h(ST)$             | START condition hold time                      | 4                                             |      | 0.6                                       |      | $\mu$ s |
| $t_{su(SR)}$          | Repeated START condition setup time            | 4.7                                           |      | 0.6                                       |      |         |
| $t_{su(SP)}$          | STOP condition setup time                      | 4                                             |      | 0.6                                       |      |         |
| $t_{w(SP:SR)}$        | Bus free time between STOP and START condition | 4.7                                           |      | 1.3                                       |      |         |

1. Data based on standard I<sup>2</sup>C protocol requirement, not tested in production.

2.  $C_b$  = total capacitance of one bus line, in pF.

**Figure 4. I<sup>2</sup>C slave timing diagram (d)**



d. Measurement points are done at 0.2·Vdd\_IO and 0.8·Vdd\_IO, for both ports.

## 2.5 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 8. Absolute maximum ratings**

| Symbol             | Ratings                                                 | Maximum value                   | Unit |
|--------------------|---------------------------------------------------------|---------------------------------|------|
| V <sub>dd</sub>    | Supply voltage                                          | -0.3 to 4.8                     | V    |
| V <sub>dd_IO</sub> | I/O pins supply voltage                                 | -0.3 to 4.8                     | V    |
| V <sub>in</sub>    | Input voltage on any control pin (SCL, SDA/SDI)         | -0.3 to V <sub>dd_IO</sub> +0.3 | V    |
| A <sub>POW</sub>   | Acceleration (any axis, powered, V <sub>dd</sub> = 3 V) | 3000 g for 0.5 ms               |      |
|                    |                                                         | 10000 g for 0.1 ms              |      |
| A <sub>UNP</sub>   | Acceleration (any axis, unpowered)                      | 3000 g for 0.5 ms               |      |
|                    |                                                         | 10000 g for 0.1 ms              |      |
| T <sub>OP</sub>    | Operating temperature range                             | -40 to +85                      | °C   |
| T <sub>STG</sub>   | 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

## 2.6 Terminology

### 2.6.1 Sensitivity

Linear acceleration sensitivity can be determined, for example, by applying 1 *g* acceleration to the device. As the sensor can measure DC accelerations this can be done easily by pointing the axis of interest towards the center of the Earth, noting the output value, rotating the sensor by 180 degrees (pointing to the sky) and noting the output value again. By doing so,  $\pm 1$  *g* acceleration is applied to the sensor. Subtracting the larger output value from the smaller one, and dividing the result by 2, leads to the actual sensitivity of the sensor. This value changes very little over temperature and also very little over time. The sensitivity tolerance describes the range of sensitivities of a large population of sensors.

Angular rate sensitivity describes the angular rate gain of the sensor and can be determined by applying a defined angular velocity to it. This value changes very little over temperature and also very little over time.

### 2.6.2 Zero level

Linear acceleration Zero-*g* level offset (TyOff) describes the deviation of an actual output signal from the ideal output signal if no acceleration is present. A sensor in a steady-state on a horizontal surface measures 0 *g* in the X axis and 0 *g* in the Y axis, whereas the Z axis measures 1 *g*. The output is ideally in the middle of the dynamic range of the sensor (content of OUT registers 00h, data expressed as 2's complement number). A deviation from the ideal value in this case is called Zero-*g* offset. Offset is, to some extent, a result of stress to the MEMS sensor and therefore the offset can slightly change after mounting the sensor onto a printed circuit board or exposing it to extensive mechanical stress. The offset changes little over temperature, see "Zero-*g* level change vs. temperature". The Zero-*g* level tolerance (TyOff) describes the standard deviation of the range of Zero-*g* levels of a population of sensors.

Angular rate zero-rate level describes the actual output value 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 also very little over time.

## 3 Functionality

The LSM320DL is a system-in-package featuring a 3D digital accelerometer and a 2D digital gyroscope.

The complete device includes specific sensing elements and two IC interfaces able to measure both the acceleration and angular rate applied to the module and to provide a signal to the external world through an SPI/I<sup>2</sup>C serial interface.

The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are realized using a CMOS technology that allows to design a dedicated circuit which is trimmed to better match the sensing element characteristics.

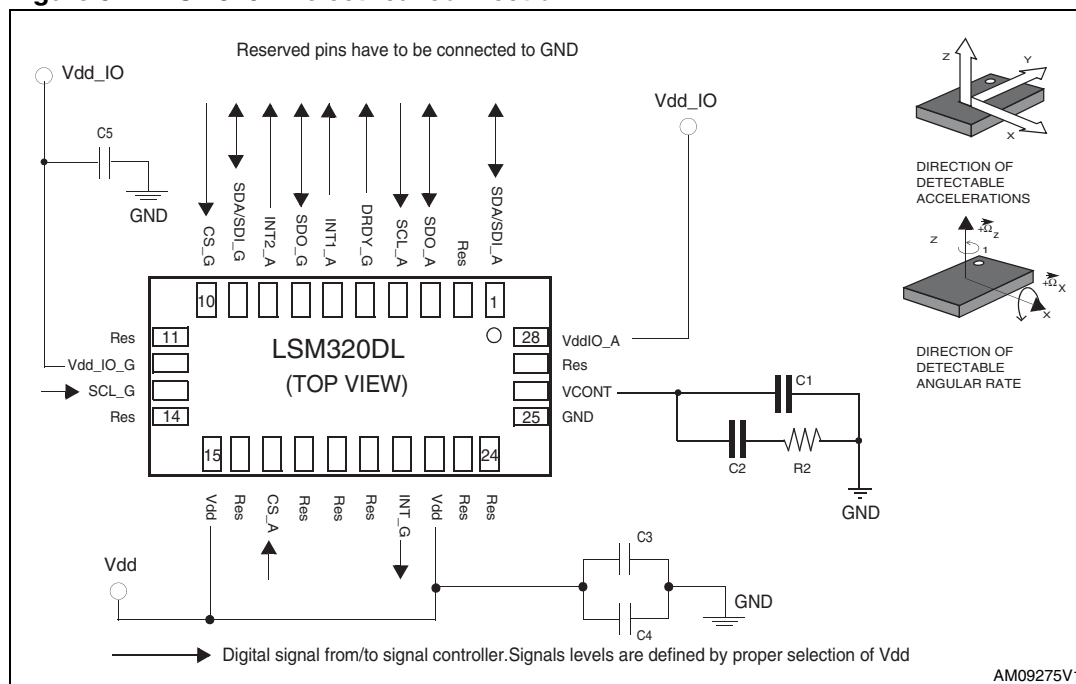
The LSM320DL may also be configured to generate an inertial wake-up and free-fall interrupt signal according to a programmed acceleration event along the enabled axes.

### 3.1 Factory calibration

The IC interface is factory calibrated for sensitivity and zero level. The trimming values are stored inside the device by a non-volatile memory. Any time the device is turned on, the trimming parameters are downloaded into the registers to be used during the normal operation. This allows the user to use the device without further calibration.

4

### Figure 5. LSM320DL electrical connection

**Table 9. Part list**

| Component | Typical value |
|-----------|---------------|
| C1        | 10 nF         |
| C2        | 470 nF        |
| C3        | 10 $\mu$ F    |
| C4        | 100 nF        |
| C5        | 100 nF        |
| R2        | 10 kOhm       |

## 4.1

The device core is supplied through Vdd line. Power supply decoupling capacitors (C4=100 nF ceramic, C3=10  $\mu$ F Al) should be placed as near as possible to the supply pin of the device (common design practice).

All the voltage and ground supplies must be present at the same time to have proper behavior of the IC (refer to [Figure 5](#)).

The functionality of the device and the measured acceleration/angular rate data is selectable and accessible through the SPI/I<sup>2</sup>C interface.

The functions, the threshold, and the timing of the two interrupt pins for each sensor can be completely programmed by the user through the SPI/I<sup>2</sup>C interface.

## 4.2 Soldering information

The LGA package is compliant with the ECOPACK<sup>®</sup>, RoHS and “Green” standard. It is qualified for soldering heat resistance according to JEDEC J-STD-020D.

Leave “Pin 1 Indicator” unconnected during soldering.

Land pattern and soldering recommendations are available at [www.st.com/mems](http://www.st.com/mems).

## 5 Digital interfaces

The registers embedded inside the LSM320DL may be accessed through both the I<sup>2</sup>C and SPI serial interfaces. The latter may be SW configured to operate either in 3-wire or 4-wire interface mode.

To select/exploit the I<sup>2</sup>C interface, CS line must be tied high (i.e. connected to Vdd\_IO).

**Table 10. Serial interface pin description**

| Pin name               | Pin description                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| CS_A                   | Linear acceleration SPI enable<br>Linear acceleration I <sup>2</sup> C/SPI mode selection (1: I <sup>2</sup> C mode; 0: SPI enabled) |
| CS_G                   | Angular Rate SPI enable<br>Angular Rate I <sup>2</sup> C/SPI mode selection (1: I <sup>2</sup> C mode; 0: SPI enabled)               |
| SCL_A<br>SCL_G         | I <sup>2</sup> C serial clock (SCL)<br>SPI serial port clock (SPC)                                                                   |
| SDA/SDI_A<br>SDA/SDI_G | I <sup>2</sup> C serial data (SDA)<br>SPI serial data input (SDI)<br>3-wire interface serial data output (SDO)                       |
| SDO_A<br>SDO_G         | I <sup>2</sup> C less significant bit of the device address (SA0)<br>SPI serial data output (SDO)                                    |

### 5.1 I<sup>2</sup>C serial interface

The LSM320DL I<sup>2</sup>C is a bus slave. The I<sup>2</sup>C is employed to write the data into the registers whose content can also be read back.

The relevant I<sup>2</sup>C terminology is given in the table below.

**Table 11. Serial interface pin description**

| Term        | Description                                                                              |
|-------------|------------------------------------------------------------------------------------------|
| Transmitter | The device which sends data to the bus                                                   |
| Receiver    | The device which receives data from the bus                                              |
| Master      | The device which initiates a transfer, generates clock signals and terminates a transfer |
| Slave       | The device addressed by the master                                                       |

There are two signals associated with the I<sup>2</sup>C bus: the serial clock line (SCL) and the serial data line (SDA). The latter is a bidirectional line used for sending and receiving the data to/from the interface.

### 5.1.1 I<sup>2</sup>C operation

The transaction on the bus is started through a START (ST) signal. A START condition is defined as a HIGH to LOW transition on the data line while the SCL line is held HIGH. After this has been transmitted by the master, the bus is considered busy. The next byte of data transmitted after the start condition contains the address of the slave in the first 7 bits and the eighth bit tells whether the master is receiving data from the slave or transmitting data to the slave. When an address is sent, each device in the system compares the first seven bits after a start condition with its address. If they match, the device considers itself addressed by the master.

Data transfer with acknowledge is mandatory. The transmitter must release the SDA line during the acknowledge pulse. The receiver must then pull the data line LOW so that it remains stable low during the HIGH period of the acknowledge clock pulse. A receiver which has been addressed is obliged to generate an acknowledge after each byte of data received.

The I<sup>2</sup>C embedded inside the LSM320DL behaves as a slave device and the following protocol must be adhered to. After the start condition (ST), a slave address is sent, once a slave acknowledge (SAK) has been returned, an 8-bit sub-address (SUB) is transmitted: the 7 LSb represent the actual register address while the MSB enables address auto increment. If the MSb of the SUB field is '1', the SUB (register address) is automatically increased to allow multiple data read/write.

**Table 12. Transfer when master is writing one byte to slave**

|        |    |         |     |     |     |      |     |    |
|--------|----|---------|-----|-----|-----|------|-----|----|
| Master | ST | SAD + W |     | SUB |     | DATA |     | SP |
| Slave  |    |         | SAK |     | SAK |      | SAK |    |

**Table 13. Transfer when master is writing multiple bytes to slave:**

|        |    |         |     |     |     |      |     |      |     |    |
|--------|----|---------|-----|-----|-----|------|-----|------|-----|----|
| Master | ST | SAD + W |     | SUB |     | DATA |     | DATA |     | SP |
| Slave  |    |         | SAK |     | SAK |      | SAK |      | SAK |    |

**Table 14. Transfer when master is receiving (reading) one byte of data from slave:**

|        |    |         |     |     |     |    |         |     |      |      |    |
|--------|----|---------|-----|-----|-----|----|---------|-----|------|------|----|
| Master | ST | SAD + W |     | SUB |     | SR | SAD + R |     |      | NMAK | SP |
| Slave  |    |         | SAK |     | SAK |    |         | SAK | DATA |      |    |

**Table 15. Transfer when master is receiving (reading) multiple bytes of data from slave**

|        |    |       |     |     |     |    |       |     |      |     |      |     |      |      |    |
|--------|----|-------|-----|-----|-----|----|-------|-----|------|-----|------|-----|------|------|----|
| Master | ST | SAD+W |     | SUB |     | SR | SAD+R |     |      | MAK |      | MAK |      | NMAK | SP |
| Slave  |    |       | SAK |     | SAK |    |       | SAK | DATA |     | DATA |     | DATA |      |    |

Data are transmitted in byte format (DATA). Each data transfer contains 8 bits. The number of bytes transferred per transfer is unlimited. Data is transferred with the most significant bit (MSb) first. If a receiver can't receive another complete byte of data until it has performed some other function, it can hold the clock line, SCL LOW, to force the transmitter into a wait

state. Data transfer only continues when the receiver is ready for another byte and releases the data line. If a slave receiver doesn't acknowledge the slave address (i.e. it is not able to receive because it is performing some real time function), the data line must be left HIGH by the slave. The master can then abort the transfer. A LOW to HIGH transition on the SDA line while the SCL line is HIGH is defined as a STOP condition. Each data transfer must be terminated by the generation of a STOP (SP) condition.

In order to read multiple bytes, it is necessary to assert the most significant bit of the sub-address field. In other words, SUB(7) must be equal to 1 while SUB(6-0) represents the address of the first register to be read.

In the presented communication format, MAK is Master Acknowledge, and NMAK is No Master Acknowledge.

Default address:

The **SDO/SA0** pad can be used to modify less significant bits of the device address. If the SA0 pad is connected to voltage supply, LSb is '1' (ex. address 0011001b), or else, if the SA0 pad is connected to ground, the LSb value is '0' (ex address 0011000b).

The slave address is completed with a Read/Write bit. If the bit is '1' (Read), a repeated START (SR) condition must be issued after the two sub-address bytes; if the bit is '0' (Write) the master transmits to the slave with direction unchanged. [Table 16](#) and [Table 17](#) explain how the SAD+Read/Write bit pattern is composed, listing all the possible configurations.

**Linear acceleration address: the default (factory) 7-bit slave address is 001100xb.**

**Table 16. Linear acceleration SAD+Read/Write patterns**

| Command | SAD[6:1] | SAD[0] = SA0 | R/W | SAD+R/W        |
|---------|----------|--------------|-----|----------------|
| Read    | 001100   | 0            | 1   | 00110001 (31h) |
| Write   | 001100   | 0            | 0   | 00110000 (30h) |
| Read    | 001100   | 1            | 1   | 00110011 (33h) |
| Write   | 001100   | 1            | 0   | 00110010 (32h) |

**Angular rate sensor: the default (factory) 7-bit slave address is 110100xb.**

**Table 17. Angular rate SAD+Read/Write patterns**

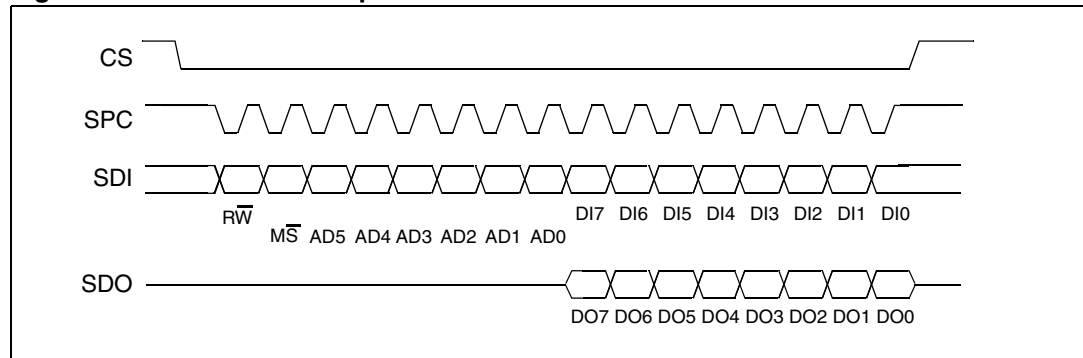
| Command | SAD[6:1] | SAD[0] = SA0 | R/W | SAD+R/W        |
|---------|----------|--------------|-----|----------------|
| Read    | 110100   | 0            | 1   | 11010001 (F1h) |
| Write   | 110100   | 0            | 0   | 11010000 (F0h) |
| Read    | 110100   | 1            | 1   | 11010011 (F3h) |
| Write   | 110100   | 1            | 0   | 11010010 (F2h) |

## 5.2 SPI bus interface

The LSM320DL SPI is a bus slave. The SPI allows to write and read the registers of the device.

The serial interface interacts with the outside world with 4 wires: **CS**, **SPC**, **SDI**, and **SDO**. (SPC, SDI, SDO are common)

**Figure 6. Read and write protocol**



**CS** is the serial port enable and it is controlled by the SPI master. It goes low at the start of the transmission and returns to high at the end. **SPC** is the serial port clock and it is controlled by the SPI master. It is stopped high when **CS** is high (no transmission). **SDI** and **SDO** are respectively the serial port data input and output. Those lines are driven at the falling edge of **SPC** and should be captured at the rising edge of **SPC**.

Both the read register and write register commands are completed in 16 clock pulses or in multiples of 8 in case of multiple bytes read/write. Bit duration is the time between two falling edges of **SPC**. The first bit (bit 0) starts at the first falling edge of **SPC** after the falling edge of **CS** while the last bit (bit 15, bit 23, ...) starts at the last falling edge of SPC just before the rising edge of **CS**.

**bit 0:** R $\overline{W}$  bit. When 0, the data DI(7:0) is written into the device. When 1, the data DO(7:0) from the device is read. In the latter case, the chip drives **SDO** at the start of bit 8.

**bit 1:** M $\overline{S}$  bit. When 0, the address remains unchanged in multiple read/write commands. When 1, the address is auto incremented in multiple read/write commands.

**bit 2-7:** address AD(5:0). This is the address field of the indexed register.

**bit 8-15:** data DI(7:0) (write mode). This is the data that is written into the device (MSb first).

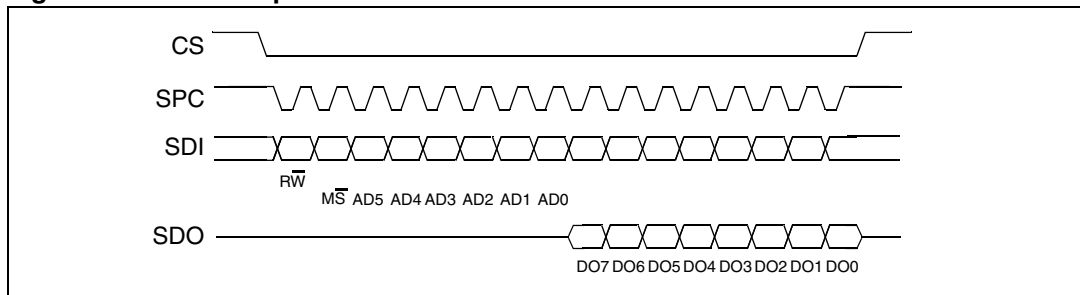
**bit 16-23:** data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

In multiple read/write commands, further blocks of 8 clock periods are added. When the M $\overline{S}$  bit is '0', the address used to read/write data remains the same for every block. When the M $\overline{S}$  bit is '1', the address used to read/write data is increased at every block.

The function and the behavior of **SDI** and **SDO** remain unchanged.

### 5.2.1 SPI read

**Figure 7. SPI read protocol**



The SPI Read command is performed with 16 clock pulses. Multiple byte read command is performed adding blocks of 8 clock pulses at the previous one.

**bit 0:** READ bit. The value is 1.

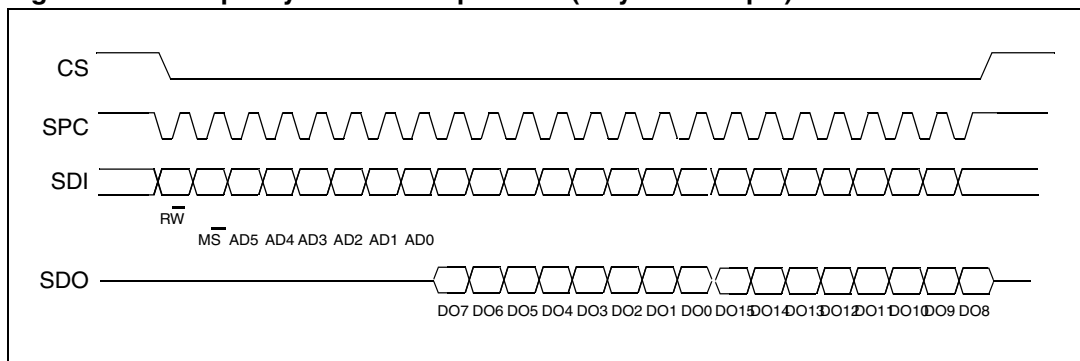
**bit 1:**  $\overline{MS}$  bit. When 0, do not increment address, when 1, increment address in multiple reading.

**bit 2-7:** address AD(5:0). This is the address field of the indexed register.

**bit 8-15:** data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

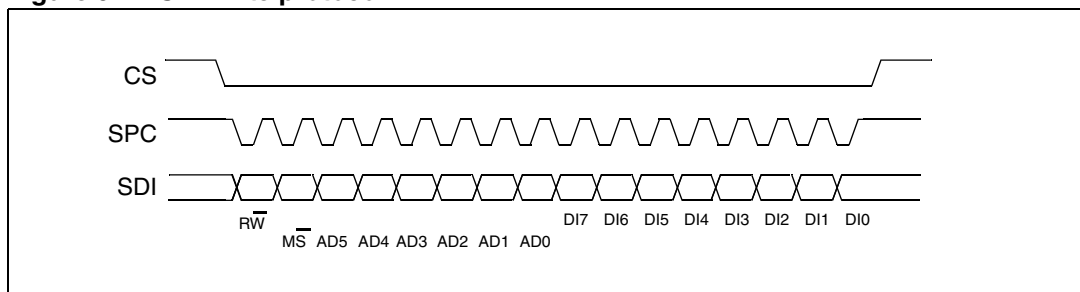
**bit 16-...** : data DO(...-8). Further data in multiple byte reading.

**Figure 8. Multiple bytes SPI read protocol (2 bytes example)**



### 5.2.2 SPI write

**Figure 9. SPI write protocol**



The SPI write command is performed with 16 clock pulses. Multiple byte write command is performed adding blocks of 8 clock pulses at the previous one.

**bit 0:** WRITE bit. The value is 0.

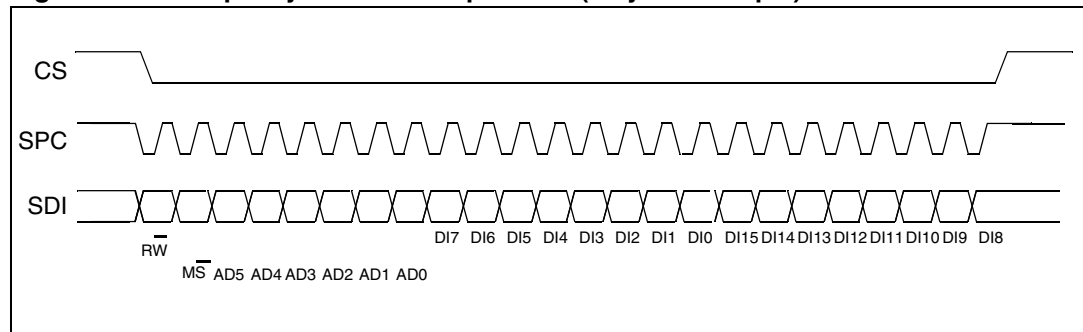
**bit 1:**  $\overline{MS}$  bit. When 0, do not increment address, when 1, increment address in multiple writing.

**bit 2-7:** address AD(5:0). This is the address field of the indexed register.

**bit 8-15:** data DI(7:0) (write mode). This is the data that is written inside the device (MSb first).

**bit 16-...** : data DI(...-8). Further data in multiple byte writing.

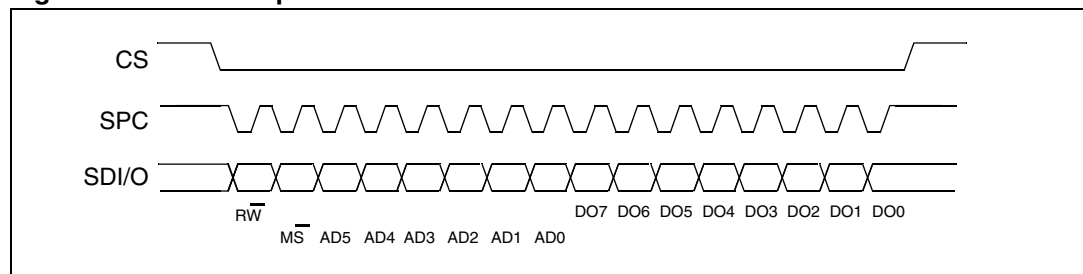
**Figure 10. Multiple bytes SPI write protocol (2 bytes example)**



### 5.2.3 SPI read in 3-wire mode

3-wire mode is entered by setting to '1' bit SIM (SPI serial interface mode selection) in CTRL\_REG4.

**Figure 11. SPI read protocol in 3-wire mode**



The SPI read command is performed with 16 clock pulses:

**bit 0:** READ bit. The value is 1.

**bit 1:**  $\overline{MS}$  bit. When 0, do not increment address, when 1, increment address in multiple reading.

**bit 2-7:** address AD(5:0). This is the address field of the indexed register.

**bit 8-15:** data DO(7:0) (read mode). This is the data that is read from the device (MSb first).

Multiple read command is also available in 3-wire mode.

## 6 Register mapping

*Table 18* below provides a listing of the 8-bit registers embedded in the device and the related addresses:

**Table 18. Register address map**

| Name                     | Slave Address | Type | Register address |          | Default  | Comment  |
|--------------------------|---------------|------|------------------|----------|----------|----------|
|                          |               |      | Hex              | Binary   |          |          |
| Reserved (do not modify) | 001100xb      |      | 00 - 1F          |          |          | Reserved |
| CTRL_REG1_A              | 001100xb      | rw   | 20               | 010 0000 | 00000111 |          |
| CTRL_REG2_A              | 001100xb      | rw   | 21               | 010 0001 | 00000000 |          |
| CTRL_REG3_A              | 001100xb      | rw   | 22               | 010 0010 | 00000000 |          |
| CTRL_REG4_A              | 001100xb      | rw   | 23               | 010 0011 | 00000000 |          |
| CTRL_REG5_A              | 001100xb      | rw   | 24               | 010 0100 | 00000000 |          |
| CTRL_REG6_A              | 001100xb      | rw   | 25               | 010 0101 | 00000000 |          |
| REFERENCE_A              | 001100xb      | rw   | 26               | 010 0110 | 00000000 |          |
| STATUS_REG_A             | 001100xb      | r    | 27               | 010 0111 | 00000000 |          |
| OUT_X_L_A                | 001100xb      | r    | 28               | 010 1000 | output   |          |
| OUT_X_H_A                | 001100xb      | r    | 29               | 010 1001 | output   |          |
| OUT_Y_L_A                | 001100xb      | r    | 2A               | 010 1010 | output   |          |
| OUT_Y_H_A                | 001100xb      | r    | 2B               | 010 1011 | output   |          |
| OUT_Z_L_A                | 001100xb      | r    | 2C               | 010 1100 | output   |          |
| OUT_Z_H_A                | 001100xb      | r    | 2D               | 010 1101 | output   |          |
| FIFO_CTRL_REG            | 001100xb      | rw   | 2E               | 010 1110 | 00000000 |          |
| FIFO_SRC_REG             | 001100xb      | r    | 2F               | 010 1111 |          |          |
| INT1_CFG_A               | 001100xb      | rw   | 30               | 011 0000 | 00000000 |          |
| INT1_SOURCE_A            | 001100xb      | r    | 31               | 011 0001 | 00000000 |          |
| INT1_THS_A               | 001100xb      | rw   | 32               | 011 0010 | 00000000 |          |
| INT1_DURATION_A          | 001100xb      | rw   | 33               | 011 0011 | 00000000 |          |
| INT2_CFG_A               | 001100xb      | rw   | 34               | 011 0100 | 00000000 |          |
| INT2_SOURCE_A            | 001100xb      | r    | 35               | 011 0101 | 00000000 |          |
| INT2_THS_A               | 001100xb      | rw   | 36               | 011 0110 | 00000000 |          |
| INT2_DURATION_A          | 001100xb      | rw   | 37               | 011 0111 | 00000000 |          |
| CLICK_CFG_A              | 001100xb      | rw   | 38               | 011 1000 | 00000000 |          |
| CLICK_SRC_A              | 001100xb      | rw   | 39               | 011 1001 | 00000000 |          |
| CLICK_THS_A              | 001100xb      | rw   | 3A               | 011 1010 | 00000000 |          |
| TIME_LIMIT_A             | 001100xb      | rw   | 3B               | 011 1011 | 00000000 |          |

Table 18. Register address map (continued)

| Name                     | Slave Address | Type | Register address |          | Default  | Comment  |
|--------------------------|---------------|------|------------------|----------|----------|----------|
|                          |               |      | Hex              | Binary   |          |          |
| TIME_LATENCY_A           | 001100xb      | rw   | 3C               | 011 1100 | 00000000 |          |
| TIME_WINDOW_A            | 001100xb      | rw   | 3D               | 011 1101 | 00000000 |          |
| Reserved (do not modify) | 001100xb      |      | 3E-3F            | -        | -        | Reserved |
| Reserved                 | 110100xb      | -    | 00-1E            | -        | -        | Reserved |
| CTRL_REG1_G              | 110100xb      | rw   | 20               | 010 0000 | 00000111 |          |
| CTRL_REG2_G              | 110100xb      | rw   | 21               | 010 0001 | 00000000 |          |
| CTRL_REG3_G              | 110100xb      | rw   | 22               | 010 0010 | 00000000 |          |
| CTRL_REG4_G              | 110100xb      | rw   | 23               | 010 0011 | 00000000 |          |
| CTRL_REG5_G              | 110100xb      | rw   | 24               | 010 0100 | 00000000 |          |
| REFERENCE_G              | 110100xb      | rw   | 25               | 010 0101 | 00000000 |          |
| OUT_TEMP_G               | 110100xb      | r    | 26               | 010 0110 | output   |          |
| STATUS_REG_G             | 110100xb      | r    | 27               | 010 0111 | output   |          |
| OUT_X_L_G                | 110100xb      | r    | 28               | 010 1000 | output   |          |
| OUT_X_H_G                | 110100xb      | r    | 29               | 010 1001 | output   |          |
| Reserved                 | 110100xb      | r    | 2A               | -        | -        | Reserved |
| Reserved                 | 110100xb      | r    | 2B               | -        | -        | Reserved |
| OUT_Z_L_G                | 110100xb      | r    | 2C               | 010 1100 | output   |          |
| OUT_Z_H_G                | 110100xb      | r    | 2D               | 010 1101 | output   |          |
| FIFO_CTRL_REG_G          | 110100xb      | rw   | 2E               | 010 1110 | 00000000 |          |
| FIFO_SRC_REG_G           | 110100xb      | r    | 2F               | 010 1111 | output   |          |
| INT1_CFG_G               | 110100xb      | rw   | 30               | 011 0000 | 00000000 |          |
| INT1_SRC_G               | 110100xb      | r    | 31               | 011 0001 | output   |          |
| INT1_TSH_XH_G            | 110100xb      | rw   | 32               | 011 0010 | 00000000 |          |
| INT1_TSH_XL_G            | 110100xb      | rw   | 33               | 011 0011 | 00000000 |          |
| Reserved                 | 110100xb      | rw   | 34               | -        | -        | Reserved |
| Reserved                 | 110100xb      | rw   | 35               | -        | -        | Reserved |
| INT1_TSH_ZH_G            | 110100xb      | rw   | 36               | 011 0110 | 00000000 |          |
| INT1_TSH_ZL_G            | 110100xb      | rw   | 37               | 011 0111 | 00000000 |          |
| INT1_DURATION_G          | 110100xb      | rw   | 38               | 011 1000 | 00000000 |          |

Registers marked as *Reserved* must not be changed. The writing to those registers may cause permanent damage to the device.

The content of the registers that are loaded at boot should not be changed. They contain the factory calibration values. Their content is automatically restored when the device is powered up.

## 7 Registers description

The device contains a set of registers which are used to control its behavior and to retrieve acceleration, angular rate and temperature data. The registers address, made of 7 bits, is used to identify them and to write the data through serial interface.

### 7.1 CTRL\_REG1\_A (20h)

**Table 19. CTRL\_REG1\_A register**

| ODR3 | ODR2 | ODR1 | ODR0 | LPen | Zen | Yen | Xen |
|------|------|------|------|------|-----|-----|-----|
|------|------|------|------|------|-----|-----|-----|

**Table 20. CTRL\_REG1\_A description**

|        |                                                                                                                                    |
|--------|------------------------------------------------------------------------------------------------------------------------------------|
| ODR3-0 | Data rate selection. Default value: 0<br>(0000: power-down; Others: refer to <a href="#">Table 21</a> , "Data rate configuration") |
| LPen   | Low power mode enable. Default value: 0<br>(0: normal mode; 1: low power mode)                                                     |
| Zen    | Z axis enable. Default value: 1<br>(0: Z axis disabled; 1: Z axis enabled)                                                         |
| Yen    | Y axis enable. Default value: 1<br>(0: Y axis disabled; 1: Y axis enabled)                                                         |
| Xen    | X axis enable. Default value: 1<br>(0: X axis disabled; 1: X axis enabled)                                                         |

**ODR<3:0>** is used to set power mode and ODR selection. In [Table 21](#) all the frequencies resulting in a combination of ODR<3:0> are reported.

**Table 21. Data rate configuration**

| ODR3 | ODR2 | ODR1 | ODR0 | Power mode selection                            |
|------|------|------|------|-------------------------------------------------|
| 0    | 0    | 0    | 0    | Power down mode                                 |
| 0    | 0    | 0    | 1    | Normal / low power mode (1 Hz)                  |
| 0    | 0    | 1    | 0    | Normal / low power mode (10 Hz)                 |
| 0    | 0    | 1    | 1    | Normal / low power mode (25 Hz)                 |
| 0    | 1    | 0    | 0    | Normal / low power mode (50 Hz)                 |
| 0    | 1    | 0    | 1    | Normal / low power mode (100 Hz)                |
| 0    | 1    | 1    | 0    | Normal / low power mode (200 Hz)                |
| 0    | 1    | 1    | 1    | Normal / low power mode (400 Hz)                |
| 1    | 0    | 0    | 0    | Low power mode (1.620 kHz)                      |
| 1    | 0    | 0    | 1    | Normal (1.344 kHz) / Low Power mode (5.376 kHz) |

## 7.2 CTRL\_REG2\_A (21h)

**Table 22. CTRL\_REG2\_A register**

|      |      |       |       |     |         |       |       |
|------|------|-------|-------|-----|---------|-------|-------|
| HPM1 | HPM0 | HPCF2 | HPCF1 | FDS | HPCLICK | HPIS2 | HPIS1 |
|------|------|-------|-------|-----|---------|-------|-------|

**Table 23. CTRL\_REG2\_A description**

|               |                                                                                                                                           |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| HPM1 -HPM0    | High pass filter mode selection. Default value: 00<br>Refer to <a href="#">Table 24</a>                                                   |
| HPCF2 - HPCF1 | High pass filter cut-off frequency selection                                                                                              |
| FDS           | Filtered data selection. Default value: 0<br>(0: internal filter bypassed; 1: data from internal filter sent to output register and FIFO) |
| HPCLICK       | High pass filter enabled for CLICK function.<br>(0: filter bypassed; 1: filter enabled)                                                   |
| HPIS2         | High pass filter enabled for AOI function on interrupt 2,<br>(0: filter bypassed; 1: filter enabled)                                      |
| HPIS1         | High pass filter enabled for AOI function on interrupt 1,<br>(0: filter bypassed; 1: filter enabled)                                      |

**Table 24. High pass filter mode configuration**

| HPM1 | HPM0 | High pass filter mode                       |
|------|------|---------------------------------------------|
| 0    | 0    | Normal mode (reset reading HP_RESET_FILTER) |
| 0    | 1    | Reference signal for filtering              |
| 1    | 0    | Normal mode                                 |
| 1    | 1    | Autoreset on interrupt event                |

## 7.3 CTRL\_REG3\_A (22h)

**Table 25. CTRL\_REG3\_A register**

|          |         |                  |          |          |        |            |    |
|----------|---------|------------------|----------|----------|--------|------------|----|
| I1_CLICK | I1_AOI1 | 0 <sup>(1)</sup> | I1_DRDY1 | I1_DRDY2 | I1_WTM | I1_OVERRUN | -- |
|----------|---------|------------------|----------|----------|--------|------------|----|

1. This bit must be set to '0' for correct operation.

**Table 26. CTRL\_REG3\_A description**

|          |                                                                      |
|----------|----------------------------------------------------------------------|
| I1_CLICK | CLICK interrupt on INT1. Default value 0.<br>(0: disable; 1: enable) |
| I1_AOI1  | AOI1 interrupt on INT1. Default value 0.<br>(0: disable; 1: enable)  |

**Table 26. CTRL\_REG3\_A description (continued)**

|            |                                                                               |
|------------|-------------------------------------------------------------------------------|
| I1_DRDY1   | DRDY1 interrupt on INT1. Default value 0.<br>(0: disable; 1: enable)          |
| I1_DRDY2   | DRDY2 interrupt on INT1. Default value 0.<br>(0: disable; 1: enable)          |
| I1_WTM     | FIFO Watermark interrupt on INT1. Default value 0.<br>(0: disable; 1: enable) |
| I1_OVERRUN | FIFO Overrun interrupt on INT1. Default value 0.<br>(0: disable; 1: enable)   |

## 7.4 CTRL\_REG4\_A (23h)

**Table 27. CTRL\_REG4\_A register**

|                  |     |     |     |    |                  |                  |     |
|------------------|-----|-----|-----|----|------------------|------------------|-----|
| 0 <sup>(1)</sup> | BLE | FS1 | FS0 | HR | 0 <sup>(1)</sup> | 0 <sup>(1)</sup> | SIM |
|------------------|-----|-----|-----|----|------------------|------------------|-----|

1. This bit must be set to '0' for correct operation.

**Table 28. CTRL\_REG4\_A description**

|         |                                                                                                                  |
|---------|------------------------------------------------------------------------------------------------------------------|
| BLE     | Big/little endian data selection. Default value 0.<br>(0: data LSB @ lower address; 1: data MSB @ lower address) |
| FS1-FS0 | Full scale selection. default value: 00<br>(00: +/- 2G; 01: +/- 4G; 10: +/- 8G; 11: +/- 16G)                     |
| HR      | High resolution output mode: default value: 0<br>(0: high resolution disable; 1: high resolution enable)         |
| SIM     | SPI serial interface mode selection. Default value: 0<br>(0: 4-wire interface; 1: 3-wire interface).             |

## 7.5 CTRL\_REG5\_A (24h)

**Table 29. CTRL\_REG5\_A register**

|      |         |    |    |          |          |                  |                  |
|------|---------|----|----|----------|----------|------------------|------------------|
| BOOT | FIFO_EN | -- | -- | LIR_INT1 | D4D_INT1 | 0 <sup>(1)</sup> | 0 <sup>(1)</sup> |
|------|---------|----|----|----------|----------|------------------|------------------|

1. This bit must be set to '0' for correct operation.

**Table 30. CTRL\_REG5\_A description**

|          |                                                                                                                                                                                                |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| BOOT     | Reboot memory content. Default value: 0<br>(0: normal mode; 1: reboot memory content)                                                                                                          |
| FIFO_EN  | FIFO enable. Default value: 0<br>(0: FIFO disable; 1: FIFO enable)                                                                                                                             |
| LIR_INT1 | Latch interrupt request on INT1_SRC register, with INT1_SRC register cleared by reading INT1_SRC itself. Default value: 0.<br>(0: interrupt request not latched; 1: interrupt request latched) |
| D4D_INT1 | 4D enable: 4D detection is enabled on INT1 when 6D bit on INT1_CFG is set to 1.                                                                                                                |

## 7.6 CTRL\_REG6\_A (25h)

**Table 31. CTRL\_REG6\_A register**

|            |         |                  |         |                  |    |           |    |
|------------|---------|------------------|---------|------------------|----|-----------|----|
| I2_CLICKen | I2_INT1 | 0 <sup>(1)</sup> | BOOT_I2 | 0 <sup>(1)</sup> | -- | H_LACTIVE | -- |
|------------|---------|------------------|---------|------------------|----|-----------|----|

1. This bit must be set to '0' for correct operation.

**Table 32. CTRL\_REG6 description**

|            |                                                    |
|------------|----------------------------------------------------|
| I2_CLICKen | Click interrupt on INT2. Default value 0.          |
| I2_INT1    | Interrupt 1 function enabled on INT2. Default 0.   |
| BOOT_I2    | Boot on INT2.                                      |
| H_LACTIVE  | 0: interrupt active high; 1: interrupt active low. |

## 7.7 REFERENCE/DATACAPTURE\_A (26h)

**Table 33. REFERENCE\_A register**

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| Ref7 | Ref6 | Ref5 | Ref4 | Ref3 | Ref2 | Ref1 | Ref0 |
|------|------|------|------|------|------|------|------|

**Table 34. REFERENCE register description**

|            |                                                            |
|------------|------------------------------------------------------------|
| Ref 7-Ref0 | Reference value for interrupt generation. Default value: 0 |
|------------|------------------------------------------------------------|

## 7.8 STATUS\_REG\_A (27h)

**Table 35. STATUS\_REG\_A register**

|       |     |     |     |       |     |     |     |
|-------|-----|-----|-----|-------|-----|-----|-----|
| ZYXOR | ZOR | YOR | XOR | ZYXDA | ZDA | YDA | XDA |
|-------|-----|-----|-----|-------|-----|-----|-----|

**Table 36. STATUS\_REG\_A register description**

|       |                                                                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------|
| ZYXOR | X, Y, and Z axis data overrun. Default value: 0<br>(0: no overrun has occurred; 1: a new set of data has overwritten the previous ones) |
| ZOR   | Z axis data overrun. Default value: 0<br>(0: no overrun has occurred; 1: a new data for the Z-axis has overwritten the previous one)    |
| YOR   | Y axis data overrun. Default value: 0<br>(0: no overrun has occurred; 1: a new data for the Y-axis has overwritten the previous one)    |
| XOR   | X axis data overrun. Default value: 0<br>(0: no overrun has occurred; 1: a new data for the X-axis has overwritten the previous one)    |
| ZYXDA | X, Y, and Z axis new data available. Default value: 0<br>(0: a new set of data is not yet available; 1: a new set of data is available) |

**Table 36. STATUS\_REG\_A register description (continued)**

|     |                                                                                                                                               |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------|
| ZDA | Z axis new data available. Default value: 0<br>(0: a new data for the Z-axis is not yet available; 1: a new data for the Z-axis is available) |
| YDA | Y axis new data available. Default value: 0<br>(0: a new data for the Y-axis is not yet available; 1: a new data for the Y-axis is available) |

## 7.9 OUT\_X\_L\_A (28h), OUT\_X\_H\_A (29h)

X-axis acceleration data. The value is expressed in 2's complement.

## 7.10 OUT\_Y\_L\_A (2Ah), OUT\_Y\_H\_A (2Bh)

Y-axis acceleration data. The value is expressed in 2's complement.

## 7.11 OUT\_Z\_L\_A(2Ch), OUT\_Z\_H\_A (2Dh)

Z-axis acceleration data. The value is expressed in 2's complement.

## 7.12 FIFO\_CTRL\_REG\_A (2Eh)

**Table 37. FIFO\_CTRL\_REG\_A register**

|     |     |    |      |      |      |      |      |
|-----|-----|----|------|------|------|------|------|
| FM1 | FM0 | TR | FTH4 | FTH3 | FTH2 | FTH1 | FTH0 |
|-----|-----|----|------|------|------|------|------|

**Table 38. FIFO\_CTRL\_REG\_A register description**

|         |                                                                                                                                               |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| FM1-FM0 | FIFO mode selection. Default value: 00 (see <a href="#">Table 39</a> )                                                                        |
| TR      | Trigger selection. Default value: 0<br>0: trigger event linked to trigger signal on INT1<br>1: trigger event linked to trigger signal on INT2 |
| FTH4:0  | Default value: 0                                                                                                                              |

**Table 39. FIFO mode configuration**

| FM1 | FM0 | FIFO mode    |
|-----|-----|--------------|
| 0   | 0   | Bypass mode  |
| 0   | 1   | FIFO mode    |
| 1   | 0   | Stream mode  |
| 1   | 1   | Trigger mode |

## 7.13 FIFO\_SRC\_REG\_A (2Fh)

**Table 40. FIFO\_SRC\_REG\_A register**

|     |           |       |      |      |      |      |      |
|-----|-----------|-------|------|------|------|------|------|
| WTM | OVFN_FIFO | EMPTY | FSS4 | FSS3 | FSS2 | FSS1 | FSS0 |
|-----|-----------|-------|------|------|------|------|------|

## 7.14 INT1\_CFG\_A (30h)

**Table 41. INT1\_CFG\_REG\_A register**

|     |    |               |                 |               |                 |               |                 |
|-----|----|---------------|-----------------|---------------|-----------------|---------------|-----------------|
| AOI | 6D | ZHIE/<br>ZUPE | ZLIE/<br>ZDOWNE | YHIE/<br>YUPE | YLIE/<br>YDOWNE | XHIE/<br>XUPE | XLIE/<br>XDOWNE |
|-----|----|---------------|-----------------|---------------|-----------------|---------------|-----------------|

**Table 42. INT1\_CFG\_REG\_A description**

|                 |                                                                                                                                                        |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| AOI             | AND/OR combination of interrupt events. Default value: 0. Refer to <a href="#">Table 43</a>                                                            |
| 6D              | 6-direction detection function enabled. Default value: 0. Refer to <a href="#">Table 43</a>                                                            |
| ZHIE/<br>ZUPE   | Enable interrupt generation on Z high event or on direction recognition. Default value: 0 (0: disable interrupt request; 1: enable interrupt request)  |
| ZLIE/<br>ZDOWNE | Enable interrupt generation on Z low event or on direction recognition. Default value: 0 (0: disable interrupt request; 1: enable interrupt request)   |
| YHIE/<br>YUPE   | Enable interrupt generation on Y high event or on direction recognition. Default value: 0 (0: disable interrupt request; 1: enable interrupt request.) |
| YLIE/<br>YDOWNE | Enable interrupt generation on Y low event or on direction recognition. Default value: 0 (0: disable interrupt request; 1: enable interrupt request.)  |
| XHIE/<br>XUPE   | Enable interrupt generation on X high event or on direction recognition. Default value: 0 (0: disable interrupt request; 1: enable interrupt request.) |
| XLIE/XDOWNE     | Enable interrupt generation on X low event or on direction recognition. Default value: 0 (0: disable interrupt request; 1: enable interrupt request.)  |

Content of this register is loaded at boot.

Write operation at this address is possible only after system boot.

**Table 43. Interrupt mode**

| AOI | 6D | Interrupt mode                      |
|-----|----|-------------------------------------|
| 0   | 0  | OR combination of interrupt events  |
| 0   | 1  | 6-direction movement recognition    |
| 1   | 0  | AND combination of interrupt events |
| 1   | 1  | 6-direction position recognition    |

Difference between AOI-6D = '01' and AOI-6D = '11'.

AOI-6D = '01' is movement recognition. An interrupt is generated when orientation moves from unknown zone to known zone. The interrupt signal stays for a duration ODR.

AOI-6D = '11' is direction recognition. An interrupt is generated when orientation is inside a known zone. The interrupt signal stays until orientation is inside the zone.

## 7.15 INT1\_SRC\_A (31h)

**Table 44. INT1\_SRC\_A register**

|   |    |    |    |    |    |    |    |
|---|----|----|----|----|----|----|----|
| 0 | IA | ZH | ZL | YH | YL | XH | XL |
|---|----|----|----|----|----|----|----|

**Table 45. INT1\_SRC\_A description**

|    |                                                                                                                           |
|----|---------------------------------------------------------------------------------------------------------------------------|
| IA | Interrupt active. Default value: 0<br>(0: no interrupt has been generated; 1: one or more interrupts have been generated) |
| ZH | Z high. Default value: 0<br>(0: no interrupt, 1: Z high event has occurred)                                               |
| ZL | Z low. Default value: 0<br>(0: no interrupt; 1: Z low event has occurred)                                                 |
| YH | Y high. Default value: 0<br>(0: no interrupt, 1: Y high event has occurred)                                               |
| YL | Y low. Default value: 0<br>(0: no interrupt, 1: Y low event has occurred)                                                 |
| XH | X high. Default value: 0<br>(0: no interrupt, 1: X high event has occurred)                                               |
| XL | X low. Default value: 0<br>(0: no interrupt, 1: X low event has occurred)                                                 |

Interrupt 1 source register. Read only register.

Reading at this address clears the INT1\_SRC IA bit (and the interrupt signal on the INT 1 pin) and allows the refreshment of data in the INT1\_SRC register if the latched option is chosen.

## 7.16 INT1\_THS\_A (32h)

**Table 46. INT1\_THS\_A register**

|   |      |      |      |      |      |      |      |
|---|------|------|------|------|------|------|------|
| 0 | THS6 | THS5 | THS4 | THS3 | THS2 | THS1 | THS0 |
|---|------|------|------|------|------|------|------|

**Table 47. INT1\_THS\_A description**

|             |                                                |
|-------------|------------------------------------------------|
| THS6 - THS0 | Interrupt 1 threshold. Default value: 000 0000 |
|-------------|------------------------------------------------|

## 7.17 INT1\_DURATION\_A (33h)

**Table 48. INT1\_DURATION\_A register**

|   |    |    |    |    |    |    |    |
|---|----|----|----|----|----|----|----|
| 0 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|----|----|----|----|----|----|----|

**Table 49. INT1\_DURATION\_A description**

|         |                                         |
|---------|-----------------------------------------|
| D6 - D0 | Duration value. Default value: 000 0000 |
|---------|-----------------------------------------|

**D6 - D0** bits set the minimum duration of the interrupt 1 event to be recognized. Duration steps and maximum values depend on the ODR chosen.

## 7.18 CLICK\_CFG\_A (38h)

**Table 50. CLICK\_CFG\_A register**

|    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|
| -- | -- | ZD | ZS | YD | YS | XD | XS |
|----|----|----|----|----|----|----|----|

**Table 51. CLICK\_CFG\_A description**

|    |                                                                                                                                                                                |
|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ZD | Enable interrupt double CLICK on Z axis. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |
| ZS | Enable interrupt single CLICK on Z axis. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |
| YD | Enable interrupt double CLICK on Y axis. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |
| YS | Enable interrupt single CLICK on Y axis. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |
| XD | Enable interrupt double CLICK on X axis. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |
| XS | Enable interrupt single CLICK on X axis. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |

## 7.19 CLICK\_SRC\_A (39h)

**Table 52. CLICK\_SRC\_A register**

|    |    |        |        |      |   |   |   |
|----|----|--------|--------|------|---|---|---|
| -- | IA | DCLICK | SCLICK | Sign | Z | Y | X |
|----|----|--------|--------|------|---|---|---|

**Table 53. CLICK\_SRC\_A description**

|        |                                                                                                                               |
|--------|-------------------------------------------------------------------------------------------------------------------------------|
| IA     | Interrupt active. Default value: 0<br>(0: no interrupt has been generated; 1: one or more interrupts have been generated)     |
| DCLICK | Double CLICK-CLICK enable. Default value: 0 (0: double CLICK-CLICK detection disable, 1: double CLICK-CLICK detection enable) |
| SCLICK | Single CLICK-CLICK enable. Default value: 0 (0: single CLICK-CLICK detection disable, 1: single CLICK-CLICK detection enable) |
| Sign   | CLICK-CLICK Sign. 0: positive detection, 1: negative detection                                                                |
| Z      | Z CLICK-CLICK detection. Default value: 0<br>(0: no interrupt, 1: Z high event has occurred)                                  |
| Y      | Y CLICK-CLICK detection. Default value: 0<br>(0: no interrupt, 1: Y high event has occurred)                                  |
| X      | X CLICK-CLICK detection. Default value: 0<br>(0: no interrupt, 1: X high event has occurred)                                  |

## 7.20 CLICK\_THS\_A (3Ah)

**Table 54. CLICK\_THS\_A register**

|    |      |      |      |      |      |      |      |
|----|------|------|------|------|------|------|------|
| -- | Ths6 | Ths5 | Ths4 | Ths3 | Ths2 | Ths1 | Ths0 |
|----|------|------|------|------|------|------|------|

**Table 55. CLICK\_SRC\_A description**

|           |                                                |
|-----------|------------------------------------------------|
| Ths6-Ths0 | CLICK-CLICK threshold. Default value: 000 0000 |
|-----------|------------------------------------------------|

## 7.21 TIME\_LIMIT\_A (3Bh)

**Table 56. TIME\_LIMIT\_A register**

|    |      |      |      |      |      |      |      |
|----|------|------|------|------|------|------|------|
| -- | TLI6 | TLI5 | TLI4 | TLI3 | TLI2 | TLI1 | TLI0 |
|----|------|------|------|------|------|------|------|

**Table 57. TIME\_LIMIT\_A description**

|           |                                                 |
|-----------|-------------------------------------------------|
| TLI7-TLI0 | CLICK-CLICK time limit. Default value: 000 0000 |
|-----------|-------------------------------------------------|

## 7.22 TIME\_LATENCY\_A (3Ch)

**Table 58. TIME\_LATENCY\_A register**

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| TLA7 | TLA6 | TLA5 | TLA4 | TLA3 | TLA2 | TLA1 | TLA0 |
|------|------|------|------|------|------|------|------|

**Table 59. TIME\_LATENCY\_A description**

|           |                                                   |
|-----------|---------------------------------------------------|
| TLA7-TLA0 | CLICK-CLICK time latency. Default value: 000 0000 |
|-----------|---------------------------------------------------|

## 7.23 TIME\_WINDOW\_A (3Dh)

**Table 60. TIME\_WINDOW\_A register**

|     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|
| TW7 | TW6 | TW5 | TW4 | TW3 | TW2 | TW1 | TW0 |
|-----|-----|-----|-----|-----|-----|-----|-----|

**Table 61. TIME\_WINDOW\_A description**

|         |                         |
|---------|-------------------------|
| TW7-TW0 | CLICK-CLICK time window |
|---------|-------------------------|

## 7.24 CTRL\_REG1\_G (20h)

**Table 62. CTRL\_REG1\_G register**

|     |     |     |     |    |     |                  |     |
|-----|-----|-----|-----|----|-----|------------------|-----|
| DR1 | DR0 | BW1 | BW0 | PD | Zen | 0 <sup>(1)</sup> | Xen |
|-----|-----|-----|-----|----|-----|------------------|-----|

1. This bit must be set to '0' for correct operation.

**Table 63. CTRL\_REG1\_G description**

|         |                                                                                                |
|---------|------------------------------------------------------------------------------------------------|
| DR1-DR0 | Output data rate selection. Refer to <a href="#">Table 64</a>                                  |
| BW1-BW0 | Bandwidth selection. Refer to <a href="#">Table 64</a>                                         |
| PD      | Power-down mode enable. Default value: 0<br>(0: power-down mode, 1: normal mode or sleep mode) |
| Zen     | Z axis enable. Default value: 1<br>(0: Z axis disabled; 1: Z axis enabled)                     |
| Xen     | X axis enable. Default value: 1<br>(0: X axis disabled; 1: X axis enabled)                     |

**DR<1:0>** is used to set ODR selection. **BW <1:0>** is used to set Bandwidth selection.

[Table 64](#) shows all frequencies resulting in combination of DR / BW bits.

**Table 64. DR and BW configuration setting**

| DR <1:0> | BW <1:0> | ODR [Hz] | Cut-off |
|----------|----------|----------|---------|
| 00       | 00       | 100      | 12.5    |
| 00       | 01       | 100      | 25      |
| 00       | 10       | 100      | 25      |
| 00       | 11       | 100      | 25      |
| 01       | 00       | 200      | 12.5    |
| 01       | 01       | 200      | 25      |
| 01       | 10       | 200      | 50      |
| 01       | 11       | 200      | 70      |
| 10       | 00       | 400      | 20      |
| 10       | 01       | 400      | 25      |
| 10       | 10       | 400      | 50      |
| 10       | 11       | 400      | 110     |
| 11       | 00       | 800      | 30      |
| 11       | 01       | 800      | 35      |
| 11       | 10       | 800      | 50      |
| 11       | 11       | 800      | 110     |

Combination of **PD**, **Zen**, **Xen** are used to set the device in different modes (power-down/normal/sleep mode) according to the following table.

**Table 65. Power mode selection configuration**

| Mode       | PD | Zen | Xen |
|------------|----|-----|-----|
| Power-down | 0  | -   | -   |
| Sleep      | 1  | 0   | 0   |
| Normal     | 1  | -   | -   |

## 7.25 CTRL\_REG2\_G (21h)

**Table 66. CTRL\_REG2\_G register**

|                  |                  |      |      |       |       |       |       |
|------------------|------------------|------|------|-------|-------|-------|-------|
| 0 <sup>(1)</sup> | 0 <sup>(1)</sup> | HPM1 | HPM1 | HPCF3 | HPCF2 | HPCF1 | HPCF0 |
|------------------|------------------|------|------|-------|-------|-------|-------|

1. Value loaded at boot. This value must not be changed.

**Table 67. CTRL\_REG2\_G description**

|             |                                                                                         |
|-------------|-----------------------------------------------------------------------------------------|
| HPM1-HPM0   | High pass filter mode selection. Default value: 00<br>Refer to <a href="#">Table 68</a> |
| HPCF3-HPCF0 | High pass filter cut-off frequency selection<br>Refer to <a href="#">Table 69</a>       |

**Table 68. High pass filter mode configuration**

| HPM1 | HPM0 | High pass filter mode                       |
|------|------|---------------------------------------------|
| 0    | 0    | Normal mode (reset reading HP_RESET_FILTER) |
| 0    | 1    | Reference signal for filtering              |
| 1    | 0    | Normal mode                                 |
| 1    | 1    | Autoreset an interrupt event                |

**Table 69. High pass filter cut-off frequency configuration [Hz]**

| HPCF-0 | ODR = 100 Hz | ODR = 200 Hz | ODR = 400 Hz | ODR = 800 Hz |
|--------|--------------|--------------|--------------|--------------|
| 0000   | 8            | 15           | 30           | 56           |
| 0001   | 4            | 8            | 15           | 30           |
| 0010   | 2            | 4            | 8            | 15           |
| 0011   | 1            | 2            | 4            | 8            |
| 0100   | 0.5          | 1            | 2            | 4            |
| 0101   | 0.2          | 0.5          | 1            | 2            |
| 0110   | 0.1          | 0.2          | 0.5          | 1            |
| 0111   | 0.05         | 0.1          | 0.2          | 0.5          |
| 1000   | 0.02         | 0.05         | 0.1          | 0.2          |
| 1001   | 0.01         | 0.02         | 0.05         | 0.1          |

## 7.26 CTRL\_REG3\_G (22h)

**Table 70. CTRL\_REG1\_G register**

|         |         |           |       |         |        |         |          |
|---------|---------|-----------|-------|---------|--------|---------|----------|
| I1_Int1 | I1_Boot | H_Lactive | PP_OD | I2_DRDY | I2_WTM | I2_ORun | I2_Empty |
|---------|---------|-----------|-------|---------|--------|---------|----------|

**Table 71. CTRL\_REG3\_G description**

|           |                                                                           |
|-----------|---------------------------------------------------------------------------|
| I1_Int1   | Interrupt enable on INT1 pin. Default value 0. (0: disable; 1: enable)    |
| I1_Boot   | Boot status available on INT1. Default value 0. (0: disable; 1: enable)   |
| H_Lactive | Interrupt active configuration on INT1. Default value 0. (0: high; 1:low) |

**Table 71. CTRL\_REG3\_G description (continued)**

|          |                                                                                  |
|----------|----------------------------------------------------------------------------------|
| PP_OD    | Push-pull/open drain. Default value: 0. (0: push-pull; 1: open drain)            |
| I2_DRDY  | Date ready on DRDY/INT2. Default value 0. (0: disable; 1: enable)                |
| I2_WTM   | FIFO watermark interrupt on DRDY/INT2. Default value: 0. (0: disable; 1: enable) |
| I2_ORun  | FIFO overrun interrupt on DRDY/INT2. Default value: 0. (0: disable; 1: enable)   |
| I2_Empty | FIFO empty interrupt on DRDY/INT2. Default value: 0. (0: disable; 1: enable)     |

## 7.27 CTRL\_REG4\_G (23h)

**Table 72. CTRL\_REG4\_G register**

|     |     |     |     |    |                  |                  |     |
|-----|-----|-----|-----|----|------------------|------------------|-----|
| BDU | BLE | FS1 | FS0 | -- | 0 <sup>(1)</sup> | 0 <sup>(1)</sup> | SIM |
|-----|-----|-----|-----|----|------------------|------------------|-----|

1. This bit must be set to '0' for correct operation.

**Table 73. CTRL\_REG4\_G description**

|         |                                                                                                                          |
|---------|--------------------------------------------------------------------------------------------------------------------------|
| BDU     | Block data update. Default value: 0<br>(0: continuous update; 1: output registers not updated until MSB and LSB reading) |
| BLE     | Big/little endian data selection. Default value 0.<br>(0: data LSB @ lower address; 1: data MSB @ lower address)         |
| FS1-FS0 | Full scale selection. Default value: 00<br>(00: 250 dps; 01: 500 dps; 10: 2000 dps; 11: 2000 dps)                        |
| SIM     | SPI serial interface mode selection. Default value: 0<br>(0: 4-wire interface; 1: 3-wire interface).                     |

## 7.28 CTRL\_REG5\_G (24h)

**Table 74. CTRL\_REG5\_G register**

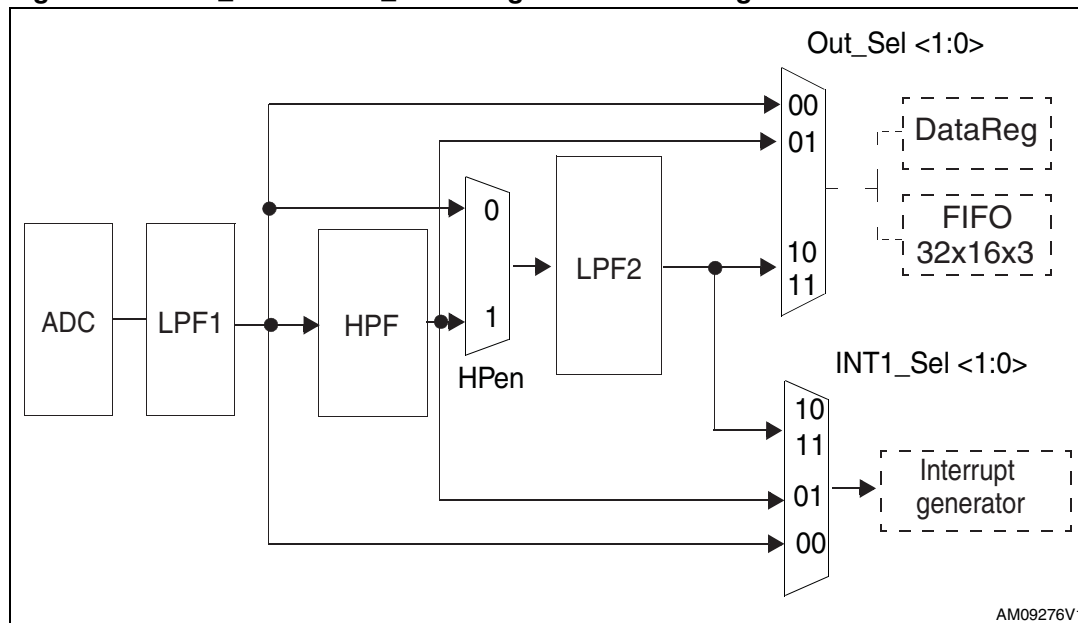
|      |         |    |      |           |           |          |          |
|------|---------|----|------|-----------|-----------|----------|----------|
| BOOT | FIFO_EN | -- | HPen | INT1_Sel1 | INT1_Sel0 | Out_Sel1 | Out_Sel0 |
|------|---------|----|------|-----------|-----------|----------|----------|

**Table 75. CTRL\_REG5\_G description**

|         |                                                                                                                |
|---------|----------------------------------------------------------------------------------------------------------------|
| BOOT    | Reboot memory content. Default value: 0<br>(0: normal mode; 1: reboot memory content)                          |
| FIFO_EN | FIFO enable. Default value: 0<br>(0: FIFO disable; 1: FIFO enable)                                             |
| HPen    | High pass filter enable. Default value: 0<br>(0: HPF disabled; 1: HPF enabled, see <a href="#">Figure 12</a> ) |

**Table 75. CTRL\_REG5\_G description (continued)**

|                         |                                                                                   |
|-------------------------|-----------------------------------------------------------------------------------|
| INT1_Sel1-<br>INT1_Sel0 | INT1 selection configuration. Default value: 0<br>(see <a href="#">Table 77</a> ) |
| Out_Sel1-<br>Out_Sel0   | Out selection configuration. Default value: 0<br>(see <a href="#">Table 76</a> )  |

**Figure 12. INT1\_Sel and Out\_Sel configuration block diagram****Table 76. Out\_Sel configuration setting**

| Hpen | OUT_SEL1 | OUT_SEL0 | Description                                                          |
|------|----------|----------|----------------------------------------------------------------------|
| x    | 0        | 0        | Data in DataReg and FIFO are non-high-pass-filtered                  |
| x    | 0        | 1        | Data in DataReg and FIFO are high-pass-filtered                      |
| 0    | 1        | x        | Data in DataReg and FIFO are low-pass-filtered by LPF2               |
| 1    | 1        | x        | Data in DataReg and FIFO are high-pass and low-pass-filtered by LPF2 |

**Table 77. INT\_SEL configuration setting**

| Hpen | INT_SEL1 | INT_SEL2 | Description                                                   |
|------|----------|----------|---------------------------------------------------------------|
| x    | 0        | 0        | Non-high-pass-filtered data are used for interrupt generation |
| x    | 0        | 1        | High-pass-filtered data are used for interrupt generation     |

**Table 77. INT\_SEL configuration setting (continued)**

| Hpen | INT_SEL1 | INT_SEL2 | Description                                                            |
|------|----------|----------|------------------------------------------------------------------------|
| 0    | 1        | x        | Low-pass-filtered data are used for interrupt generation               |
| 1    | 1        | x        | High-pass and low-pass-filtered data are used for interrupt generation |

## 7.29 REFERENCE/DATACAPTURE\_G (25h)

**Table 78. REFERENCE\_G register**

| Ref7 | Ref6 | Ref5 | Ref4 | Ref3 | Ref2 | Ref1 | Ref0 |
|------|------|------|------|------|------|------|------|
|------|------|------|------|------|------|------|------|

**Table 79. REFERENCE\_G register description**

|            |                                                            |
|------------|------------------------------------------------------------|
| Ref 7-Ref0 | Reference value for interrupt generation. Default value: 0 |
|------------|------------------------------------------------------------|

## 7.30 OUT\_TEMP\_G (26h)

**Table 80. OUT\_TEMP\_G register**

| Temp7 | Temp6 | Temp5 | Temp4 | Temp3 | Temp2 | Temp1 | Temp0 |
|-------|-------|-------|-------|-------|-------|-------|-------|
|-------|-------|-------|-------|-------|-------|-------|-------|

**Table 81. OUT\_TEMP\_G register description**

|             |                                                                                             |
|-------------|---------------------------------------------------------------------------------------------|
| Temp7-Temp0 | Temperature data (1LSB/deg - 8 bit resolution). The value is expressed as two's complement. |
|-------------|---------------------------------------------------------------------------------------------|

## 7.31 STATUS\_REG\_G (27h)

**Table 82. STATUS\_REG\_G register**

| ZXOR | ZOR | - | XOR | ZXDA | ZDA | -- | XDA |
|------|-----|---|-----|------|-----|----|-----|
|------|-----|---|-----|------|-----|----|-----|

**Table 83. STATUS\_REG\_G description**

|      |                                                                                                                                           |
|------|-------------------------------------------------------------------------------------------------------------------------------------------|
| ZXOR | X, Z-axis data overrun. Default value: 0<br>(0: no overrun has occurred, 1: new data has overwritten the previous one before it was read) |
| ZOR  | Z-axis data overrun. Default value: 0<br>(0: no overrun has occurred, 1: a new data for the Z-axis has overwritten the previous one)      |
| XOR  | X-axis data overrun. Default value: 0<br>(0: no overrun has occurred, 1: a new data for the X-axis has overwritten the previous one)      |

**Table 83. STATUS\_REG\_G description (continued)**

|      |                                                                                                                                               |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| ZXDA | X, Z-axis new data available. Default value: 0<br>(0: a new set of data is not yet available; 1: a new set of data is available)              |
| ZDA  | Z-axis new data available. Default value: 0<br>(0: a new data for the Z-axis is not yet available; 1: a new data for the Z-axis is available) |
| XDA  | X-axis new data available. Default value: 0<br>(0: a new data for the X-axis is not yet available; 1: a new data for the X-axis is available) |

### 7.32 OUT\_X\_L\_G (28h), OUT\_X\_H\_G (29h)

X-axis angular rate data. The value is expressed as 2's complement.

### 7.33 OUT\_Z\_L\_G (2Ch), OUT\_Z\_H\_G (2Dh)

Z-axis angular rate data. The value is expressed as 2's complement.

### 7.34 FIFO\_CTRL\_REG\_G (2Eh)

**Table 84. REFERENCE\_G register**

|     |     |     |      |      |      |      |      |
|-----|-----|-----|------|------|------|------|------|
| FM2 | FM1 | FM0 | WTM4 | WTM3 | WTM2 | WTM1 | WTM0 |
|-----|-----|-----|------|------|------|------|------|

**Table 85. REFERENCE\_G register description**

|           |                                                                        |
|-----------|------------------------------------------------------------------------|
| FM2-FM0   | FIFO mode selection. Default value: 00 (see <a href="#">Table 86</a> ) |
| WTM4-WTM0 | FIFO threshold. Watermark level setting                                |

**Table 86. FIFO mode configuration**

| FM2 | FM1 | FM0 | FIFO mode             |
|-----|-----|-----|-----------------------|
| 0   | 0   | 0   | Bypass mode           |
| 0   | 0   | 1   | FIFO mode             |
| 0   | 1   | 0   | Stream mode           |
| 0   | 1   | 1   | Stream-to-FIFO mode   |
| 1   | 0   | 0   | Bypass-to-stream mode |

### 7.35 FIFO\_SRC\_REG\_G (2Fh)

**Table 87. FIFO\_SRC\_G register**

|     |      |       |      |      |      |      |      |
|-----|------|-------|------|------|------|------|------|
| WTM | OVRN | EMPTY | FSS4 | FSS3 | FSS2 | FSS1 | FSS0 |
|-----|------|-------|------|------|------|------|------|

**Table 88. FIFO\_SRC\_G register description**

|           |                                                                                                                |
|-----------|----------------------------------------------------------------------------------------------------------------|
| WTM       | Watermark status. (0: FIFO filling is lower than WTM level; 1: FIFO filling is equal or higher than WTM level) |
| OVRN      | Overflow bit status.<br>(0: FIFO is not completely filled; 1: FIFO is completely filled)                       |
| EMPTY     | FIFO empty bit.<br>(0: FIFO not empty; 1: FIFO empty)                                                          |
| FSS4-FSS1 | FIFO stored data level                                                                                         |

## 7.36 INT1\_CFG\_G (30h)

**Table 89. INT1\_CFG\_G register**

|        |     |      |      |                  |                  |      |      |
|--------|-----|------|------|------------------|------------------|------|------|
| AND/OR | LIR | ZHIE | ZLIE | 0 <sup>(1)</sup> | 0 <sup>(1)</sup> | XHIE | XLIE |
|--------|-----|------|------|------------------|------------------|------|------|

1. This bit must be set to '0' for correct operation.

**Table 90. INT1\_CFG\_G description**

|        |                                                                                                                                                                                    |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AND/OR | AND/OR combination of interrupt events. Default value: 0<br>(0: OR combination of interrupt events 1: AND combination of interrupt events)                                         |
| LIR    | Latch interrupt request. Default value: 0<br>(0: interrupt request not latched; 1: interrupt request latched)<br>Cleared by reading INT1_SRC reg.                                  |
| ZHIE   | Enable interrupt generation on Z high event. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |
| ZLIE   | Enable interrupt generation on Z low event. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value lower than preset threshold)   |
| XHIE   | Enable interrupt generation on X high event. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value higher than preset threshold) |
| XLIE   | Enable interrupt generation on X low event. Default value: 0<br>(0: disable interrupt request; 1: enable interrupt request on measured accel. value lower than preset threshold)   |

Configuration register for interrupt source.

## 7.37 INT1\_SRC\_G (31h)

**Table 91. INT1\_SRC\_G register**

|   |    |    |    |    |    |    |    |
|---|----|----|----|----|----|----|----|
| 0 | IA | ZH | ZL | -- | -- | XH | XL |
|---|----|----|----|----|----|----|----|

**Table 92. INT1\_SRC\_G description**

|    |                                                                                                                           |
|----|---------------------------------------------------------------------------------------------------------------------------|
| IA | Interrupt active. Default value: 0<br>(0: no interrupt has been generated; 1: one or more interrupts have been generated) |
| ZH | Z high. Default value: 0 (0: no interrupt; 1: Z high event has occurred)                                                  |
| ZL | Z low. Default value: 0 (0: no interrupt; 1: Z low event has occurred)                                                    |
| XH | X high. Default value: 0 (0: no interrupt; 1: X high event has occurred)                                                  |
| XL | X low. Default value: 0 (0: no interrupt; 1: X low event has occurred)                                                    |

Interrupt source register. Read only register.

Reading at this address clears the INT1\_SRC IA bit (and eventually the interrupt signal on the INT1 pin) and allows the refreshment of data in the INT1\_SRC register if the latched option is chosen.

## 7.38 INT1\_THS\_XH\_G (32h)

**Table 93. INT1\_THS\_XH\_G register**

|    |        |        |        |        |        |       |       |
|----|--------|--------|--------|--------|--------|-------|-------|
| -- | THSX14 | THSX13 | THSX12 | THSX11 | THSX10 | THSX9 | THSX8 |
|----|--------|--------|--------|--------|--------|-------|-------|

**Table 94. INT1\_THS\_XH\_G description**

|                |                                               |
|----------------|-----------------------------------------------|
| THSX14 - THSX9 | Interrupt threshold. Default value: 0000 0000 |
|----------------|-----------------------------------------------|

## 7.39 INT1\_THS\_XL\_G (33h)

**Table 95. INT1\_THS\_XL\_G register**

|       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|
| THSX7 | THSX6 | THSX5 | THSX4 | THSX3 | THSX2 | THSX1 | THSX0 |
|-------|-------|-------|-------|-------|-------|-------|-------|

**Table 96. INT1\_THS\_XL\_G description**

|               |                                               |
|---------------|-----------------------------------------------|
| THSX7 - THSX0 | Interrupt threshold. Default value: 0000 0000 |
|---------------|-----------------------------------------------|

## 7.40 INT1\_THS\_ZH\_G (36h)

**Table 97. INT1\_THS\_ZH\_G register**

|    |        |        |        |        |        |       |       |
|----|--------|--------|--------|--------|--------|-------|-------|
| -- | THSZ14 | THSZ13 | THSZ12 | THSZ11 | THSZ10 | THSZ9 | THSZ8 |
|----|--------|--------|--------|--------|--------|-------|-------|

**Table 98. INT1\_THS\_ZH\_G description**

|                |                                               |
|----------------|-----------------------------------------------|
| THSZ14 - THSZ9 | Interrupt threshold. Default value: 0000 0000 |
|----------------|-----------------------------------------------|

## 7.41 INT1\_THS\_ZL\_G (37h)

**Table 99. INT1\_THS\_ZL\_G register**

|       |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|-------|
| THSZ7 | THSZ6 | THSZ5 | THSZ4 | THSZ3 | THSZ2 | THSZ1 | THSZ0 |
|-------|-------|-------|-------|-------|-------|-------|-------|

**Table 100. INT1\_THS\_ZL\_G description**

|               |                                               |
|---------------|-----------------------------------------------|
| THSZ7 - THSZ0 | Interrupt threshold. Default value: 0000 0000 |
|---------------|-----------------------------------------------|

## 7.42 INT1\_DURATION\_G (38h)

**Table 101. INT1\_DURATION\_G register**

|      |    |    |    |    |    |    |    |
|------|----|----|----|----|----|----|----|
| WAIT | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|------|----|----|----|----|----|----|----|

**Table 102. INT1\_DURATION\_G description**

|         |                                                       |
|---------|-------------------------------------------------------|
| WAIT    | WAIT enable. Default value: 0 (0: disable; 1: enable) |
| D6 - D0 | Duration value. Default value: 000 0000               |

**D6 - D0** bits set the minimum duration of the interrupt event to be recognized. Duration steps and maximum values depend on the ODR chosen.

**WAIT** bit has the following meaning:

Wait = '0': the interrupt falls immediately if signal crosses the selected threshold

Wait = '1': if signal crosses the selected threshold, the interrupt falls only after the duration has counted a number of samples at the selected data rate, written into the duration counter register.

Figure 13. Wait disabled

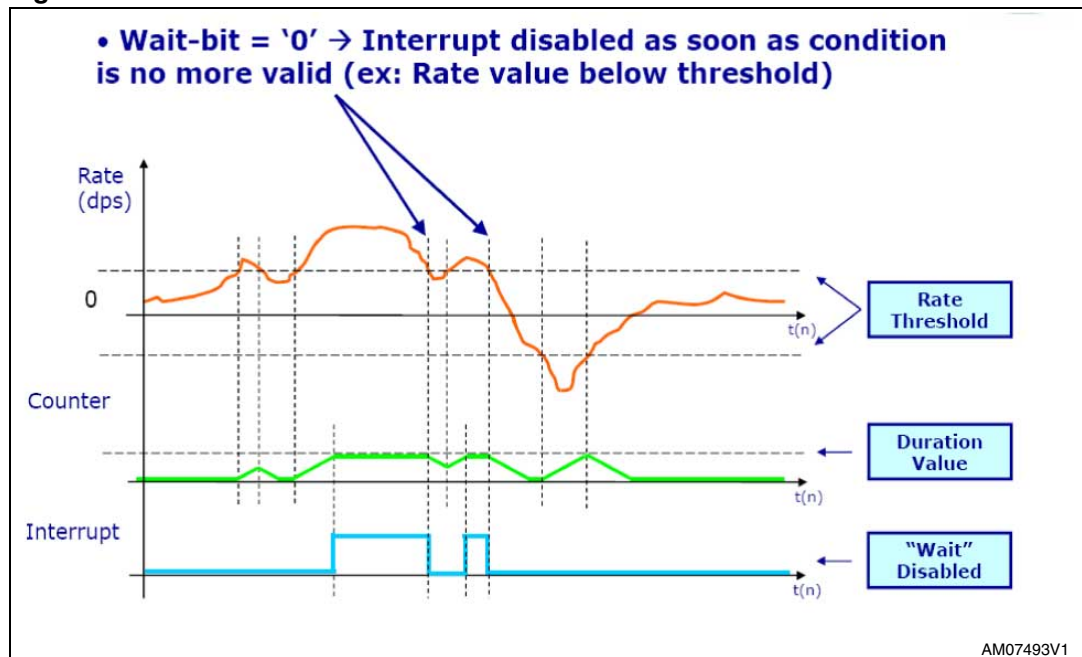
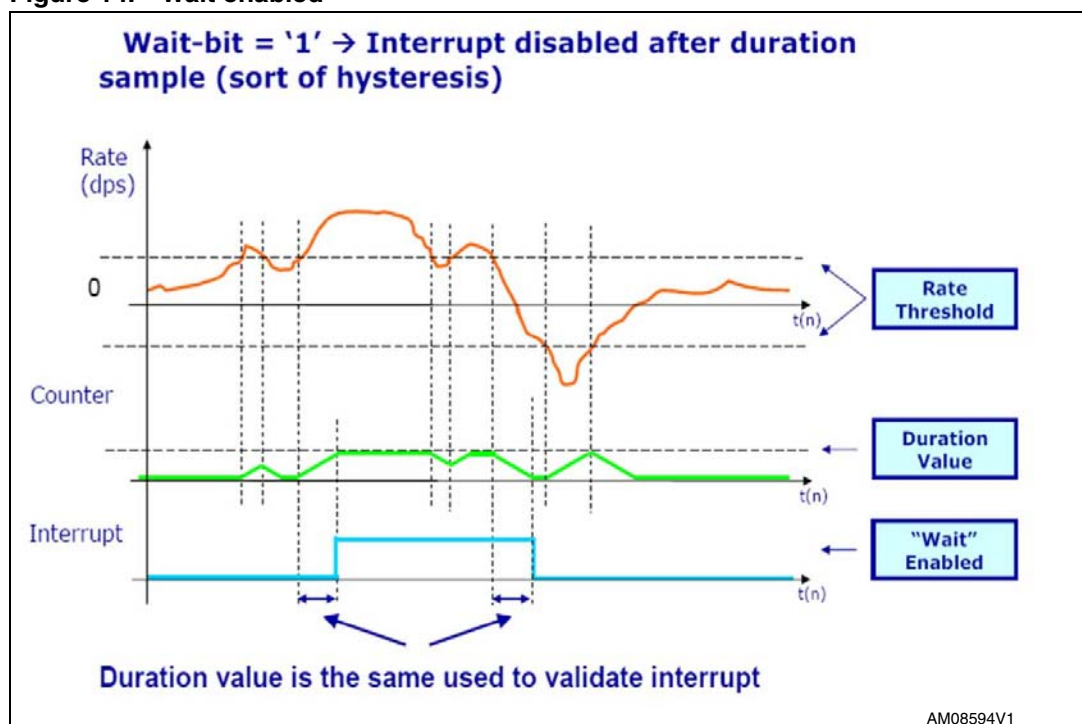


Figure 14. Wait enabled



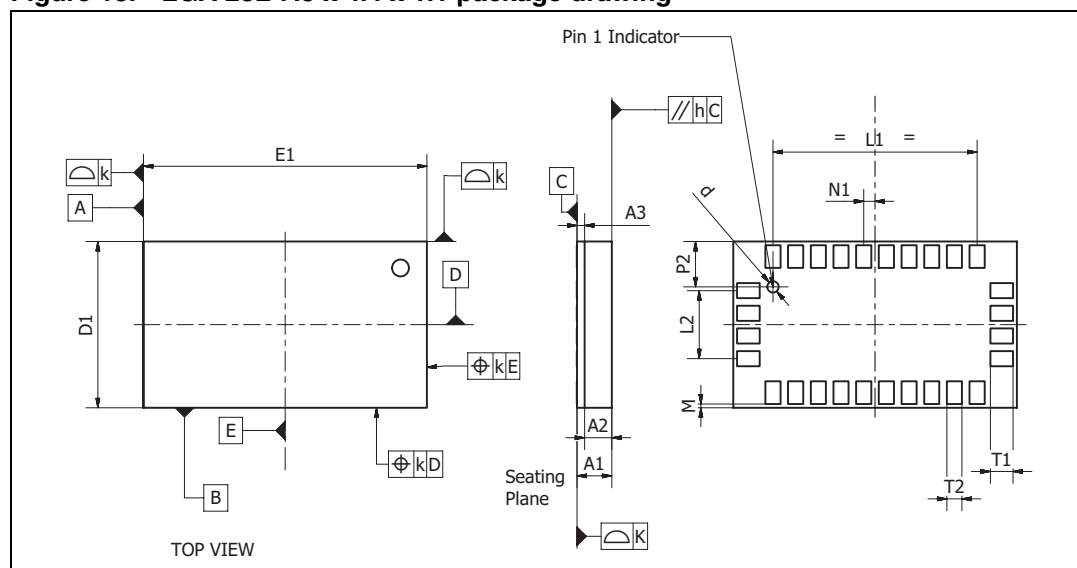
## 8 Package information

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

Table 103. LGA 28L 7.5 x 4.4 x 1.1 mechanical data

| Dim. | mm   |       |      |
|------|------|-------|------|
|      | Min. | Typ.  | Max. |
| A1   |      |       | 1.1  |
| A2   |      | 0.855 |      |
| A3   |      | 0.2   |      |
| D1   | 4.25 | 4.4   | 4.55 |
| E1   | 7.25 | 7.5   | 7.55 |
| N1   |      | 0.3   |      |
| L1   |      | 5.4   |      |
| L2   |      | 1.8   |      |
| P2   |      | 1.2   |      |
| T1   |      | 0.6   |      |
| T2   |      | 0.4   |      |
| M    |      | 0.1   |      |
| d    |      | 0.3   |      |
| k    |      | 0.05  |      |
| h    |      | 0.1   |      |

Figure 15. LGA 28L 7.5 x 4.4 x 1.1 package drawing



## 9 Revision history

**Table 104. Document revision history**

| Date        | Revision | Changes          |
|-------------|----------|------------------|
| 18-May-2011 | 1        | Initial release. |

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