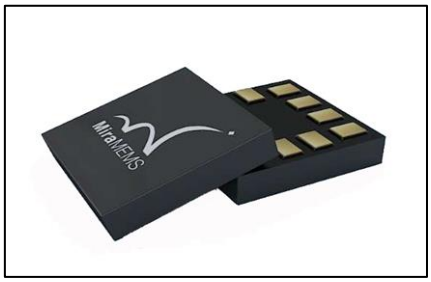
da228

MEMS digital output motion sensor

low-power high performance 3-axes “DSC-XYZ” accelerometer



Key Features

- Supply voltage, 1.62V to 3.6V
- For 2x2x1.1 mm LGA-12 package
- User selectable range, ±2g, ±4g, ±8g
- User selectable data output rate
- Digital I^2C output interface
- 12 bit resolution
- Low power consumption
- 1 Programmable interrupt generators with independent function for motion detection
- Factory programmable offset and sensitivity
- RoHS compliant

Applications

- User interface for mobile phone and PMP
- Gesture recognition
- Active monitoring
- Power management
- Vibration monitoring

Product Overview

The da228 sensor is a low power high performance capacitive three-axis linear accelerometer developed by micro-machined technology. The device is available in a 2x2x1.1 mm land grid array (LGA) and it is guaranteed to operate over an extended temperature range from -40°C to +85°C. The sensor element is fabricated by single crystal silicon with DRIE process and is protected by hermetically sealed silicon cap from the environment. The device features user selectable full scale of ±2g/ ±4g/ ±8g measurement range with data output rate from 1Hz to 1 kHz with signal condition, active detection imbedded. The da228 has a power-down mode that makes it good for handset power management. One independent and flexible interrupts provided greatly simplify the algorithm for various motion status detections. Standard I^2C interface is used to communicate with the chip.

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1. Block diagram and pin description

1.1. Block diagram

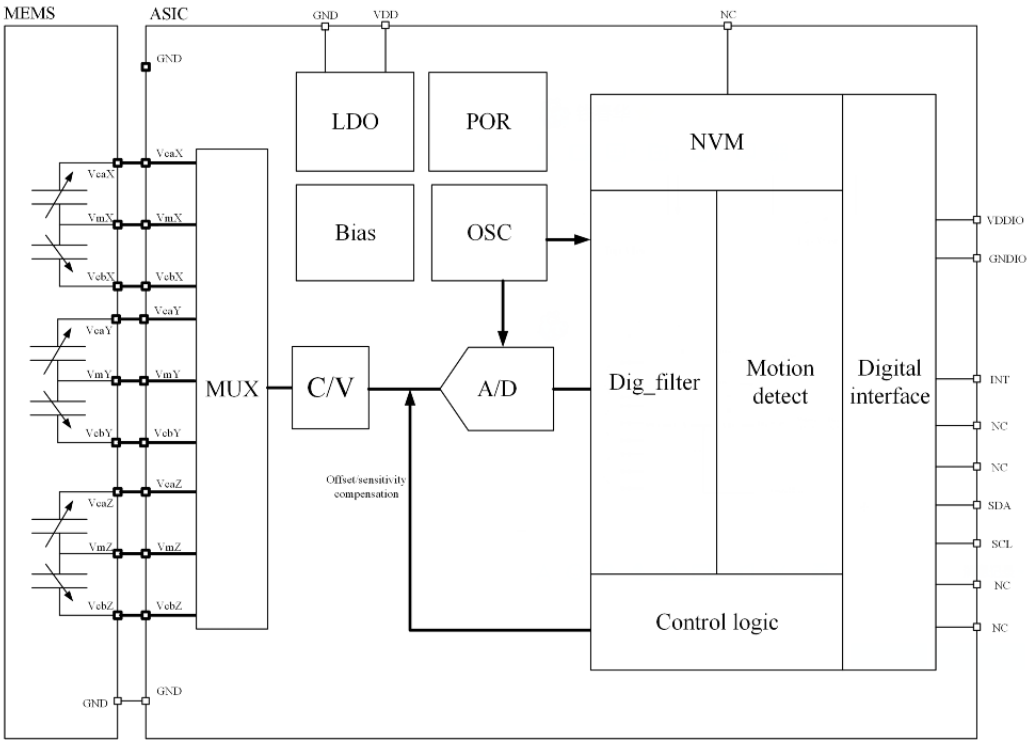


Figure 1 Block diagram

1.2. Pin description

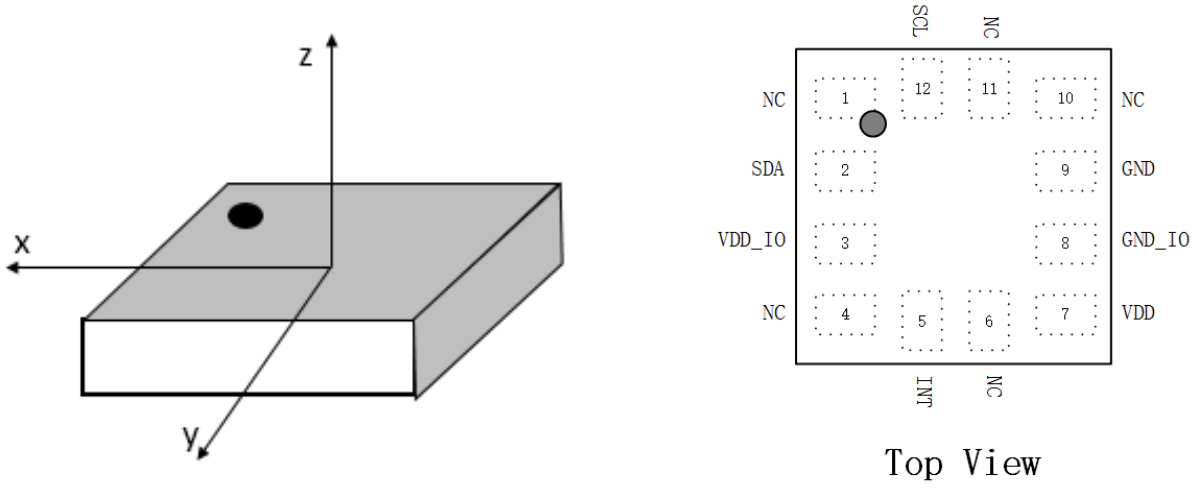


Figure 2 Pin description

Table 1.Pin description

Pin#	Name	I/O Type	Function
1	NC	--	NO internal connection
2	SDA	Digital I/O	I2C serial data input/output(SDA)
3	VDD_IO	Supply	Power supply for I/O pins
4	NC	--	NO internal connection
5	INT	Digital out	Interrupt pin
6	NC	--	NO internal connection
7	VDD	Supply	Power supply
8	GND_IO	Ground	Ground supply for I/O pins
9	GND	Ground	Ground supply
10	NC	--	NO internal connection
11	NC	--	NO internal connection
12	SCL	Digital in	I2C serial clock

NOTE: NC- NO internal connection

2. Mechanical and electrical specifications

2.1. Mechanical characteristics

VDD = 2.5 V, T = 25 °C unless otherwise noted.

Table 2.Mechanical characteristic

Symbol	Parameter	Test conditions	Min	Type	Max	Unit
FS	Measurement range	FS bit set to 00		±2		g
		FS bit set to 01		±4		g
		FS bit set to 10		±8		g
So	Sensitivity	FS bit set to 00		1024		LSB/g
		FS bit set to 01		512		LSB/g
		FS bit set to 10		256		LSB/g
TCSo	Sensitivity change vs. temperature	FS bit set to 00		±0.01		%/°C
Tyoff	Typical zero-g level offset accuracy			±80		mg
Tcoff	Zero-g level change vs. temperature	Max delta from 25°C		±0.6		mg/°C
Noise	XYZ RMS noise	FS bit set to 00, normal mode， BW = 100Hz		1.5		mg
Nonlinearity	XYZ Nonlinearity			0.5		%FS
Top	Operation temperature range		-40		85	°C

2.2. Electrical characteristics

Vdd = 2.5 V, T = 25 °C unless otherwise noted

Table 3.Electrical characteristics

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
VDD	Supply voltage		1.62	2.5	3.6	V
VDD_IO	I/O Pins supply voltage		1.62		3.6	V
IDD	current consumption in normal mode	Top=25℃, ODR=125Hz		95		uA
IDD_SM	current consumption in suspend mode	Top=25℃		0.7		uA
TVDD	VDD&VDDIO power up time				100	ms
VIH	Digital high level input voltage	I2C	0.7*Vdd_IO			V
VIL	Digital low level input voltage	I2C			0.3*Vdd_IO	V
VOH	high level output voltage		0.9*Vdd_IO			V
VOL	Low level output voltage				0.1*Vdd_IO	V
BW	System bandwidth		1.95		500	Hz
ODR	Output data rate		1		1000	Hz
TWU	Wake-up time	From stand-by		1		ms
TSU	Start-up time	From power off		3		ms
PSRR	Power Supply Rejection Rate	Top=25℃			20	mg/V

2.3. Absolute maximum ratings

Stresses below 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 4.Absolute maximum ratings

Parameter	Test conditions	Min	Max	Unit
Storage Temperature		-45	125	℃
Supply Voltage VDD	Supply pins	-0.3	4.25	V
Supply Voltage VDD_IO	Logic pins	-0.3	Vdd_IO+0.3	V
ESD Rating	HMB,R=1.5k,C=100pF		±2	kV
Mechanical Shock	Duration<200us		10,000	g

Note: *Supply voltage on any pin should never exceed 4.25V*


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


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

3. Communication interface

3.1. Communication interface Electrical specification

3.1.1. I2C Electrical specification

Table 5.Electrical specification of the I2C interface pins

Symbol	Parameter	Min	Max	Unit
fscl	Clock frequency		400	kHz
t_{LOW}	SCL low pulse	1.3		us
t_{HIGH}	SCL high pulse	0.6		us
t_{SUDAT}	SDA setup time	0.1		us
t_{HDDAT}	SDA hold time	0.0		us
t_{SUSTA}	Setup Time for a repeated start condition	0.6		us
t_{HDSTA}	Hold time for a start condition	0.6		us
t_{SUSTO}	Setup Time for a stop condition	0.6		us
t_{BUF}	Time before a new transmission can start	1.3		us

The figure below shows the definition of the I2C timing given in the above table:

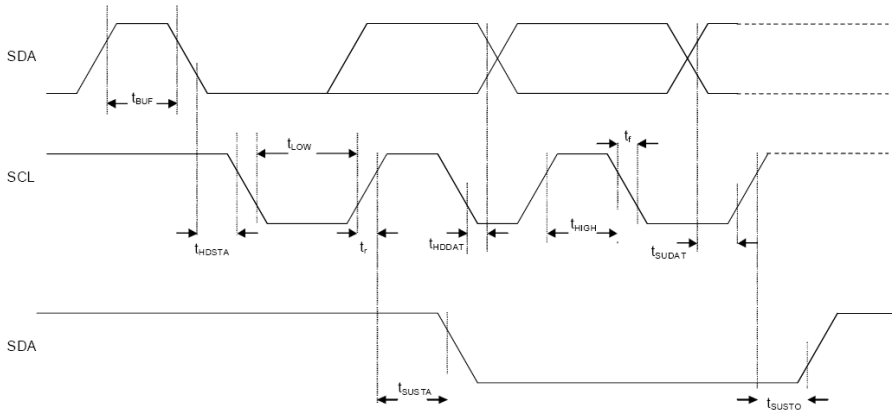


Figure 3 I2C Slave timing diagram

3.2. Digital interface operation

The da228 supports the serial digital interface protocols for communications as slave with a host device: I2C. The interface pin is given in the following table:

Table 6.The interface pins

PIN name	I2C
SCL	Serial clock
SDA	Serial Data

3.2.1.I2C Operation

I2C bus uses SCL and SDA as signal lines. Both lines are connected to VDDIO externally via pull-up resistors so that they are pulled high when the bus is free. The I2C device address of da228 is shown below.

Table 7.I2C Address

SAD6	SAD5	SAD4	SAD3	SAD2	SAD1	SAD0	W/R
0	1	0	0	1	1	1	0/1

Table 8.SAD+Read/Write patterns

Command	SAD[6:0]	R/W	SAD+R/W
Read	0100111(27h)	1	01001111(4fh)
Write	0100111(27h)	0	01001110(4eh)

The I2C interface protocol has special bus signal conditions. Start (S), stop (P) and binary data conditions are shown below. At start condition, SCL is high and SDA has a falling edge. Then the slave address is sent. After the 7 address bits, the direction control bit R/W selects the read or write operation. When a slave device recognizes that it is being addressed, it should acknowledge by pulling SDA low in the ninth SCL (ACK) cycle.

At stop condition, SCL is also high, but SDA has a rising edge. Data must be held stable at SDA when SCL is high. Data can change value at SDA only when SCL is low.

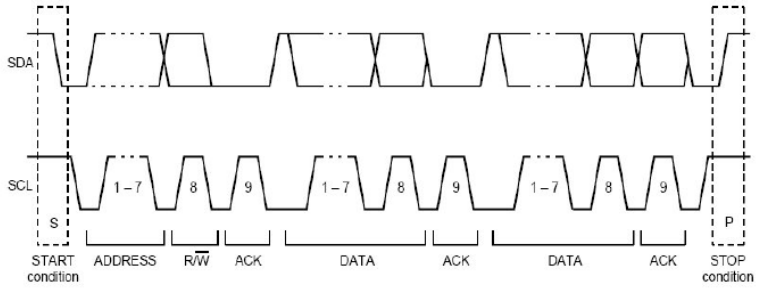


Figure 4 I2C Protocol

Table 9.Transfer when master is writing one byte to slave

Master	S	SAD+W		SUB		DATA		P
Slave			SAK		SAK		SAK	

Table 10.Transfer when master is writing multiple bytes to slave

Master	S	SAD+W		SUB		DATA		DATA		P
Slave			SAK		SAK		SAK		SAK	

Table 11.Transfer when master is receiving (reading) one byte of data from slave

Master	S	SAD+W		SUB		SR	SAD+R			NMASK	P
Slave			SAK		SAK			SAK	DATA		

Table 12.Transfer when master is receiving (reading) multiple bytes of data from slave

Master	S	SAD+W		SUB		SR	SAD+R			MAK		MAK		NMASK	P
Slave			SAK		SAK			SAK	DATA		DATA		DATA		

Note：

Symbol	Symbol explain	Symbol	Symbol explain
SAD	slave address	SAK	slave acknowledge
W	write	MAK	master acknowledge
R	read	NMASK	no master acknowledge
S	start	SUB	Sub-address(register address)
P	stop	DATA	Read or write data
SR	start		

4. Terminology and functionality

4.1. Terminology

4.1.1. Sensitivity

Sensitivity describes the gain of the sensor and can be determined e.g. by applying 1 *g* acceleration to it. 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, ±1 *g* acceleration is applied to the sensor. Subtract 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 time. The sensitivity tolerance describes the range of sensitivities of a large population of sensors.

4.1.2. Zero-*g* level

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 measure 0 *g* in X axis and 0 *g* in Y axis whereas the Z axis measure 1 *g*. The output is ideally in the middle of the dynamic range of the sensor (content of output data registers are 00h, data expressed as 2's complement number). A deviation from ideal value in this case is called Zero-*g* offset. Offset is to some extent a result of stress to 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. 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.

4.2. Functionality

4.2.1. Power mode

The da228 has two different power modes: normal and suspend mode.

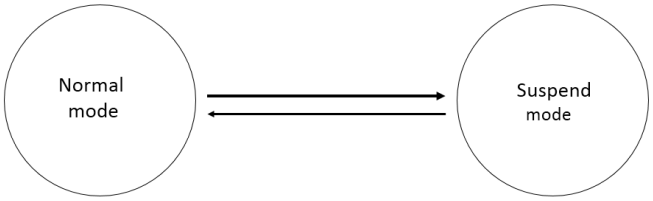


Figure 5 power mode

In the normal mode, the device is periodically switching between a sleep phase and a wake-up phase. The wake-up phase essentially corresponding to operation in measure state with complete power-up of the circuitry at the current setting ODR when "autosleep_en"bit of "MODE_BW" (11H) register is set to 0, but "autosleep_en"bit is set to 1, the measure state works at 12.5hz in inactive state and auto

switched to operation mode during active state. During the sleep phase the analog part except the oscillator is powered down.

During the wake-up phase, if an enabled interrupt is detected, the device stays in the wake-up phase as long as the interrupt condition endures (non-latched interrupt), or until the latch time expires (temporary latched interrupt), or until the interrupt is reset (latched interrupt). If no interrupt detected, the device enters the sleep phase.

Suspend mode: power-down mode.

4.2.2.Sensor data

The width of acceleration data is 12bits given in two's complement representation. The 12bits for each axis are split into an MSB part (one byte containing bits 11 to 4) and an LSB lower part (one byte containing bits 3 to 0)

4.2.3.Factory calibration

The IC is factory calibrated for sensitivity (So) and Zero-g level (TyOff). The trimming values are stored inside the chip's nonvolatile memory. The trimming parameters are loaded to registers while da228 reset (POR or software reset). This allows using the device without further calibration.

4.3. Interrupt controller

Interrupt engines are integrated in the da228. Each interrupt can be independently enabled and configured. If the condition of an enabled interrupt is fulfilled, the corresponding status bit is set to 1 and the interrupt pin is activated. The pin state is a logic 'or' combination of all mapped interrupts to the interrupt pin.

4.3.1.General features

An interrupt is cleared depending on the selected interrupt mode, which is common to all interrupts. There are three different interrupt modes: non-latched, latched and temporary. The mode is selected by the 'latch_int' bits according to the following table.

Table 13.Interrupt mode selection

latch_INT	Interrupt mode
0000	non-latched
0001	temporary latched 250ms
0010	temporary latched 500ms
0011	temporary latched 1s
0100	temporary latched 2s
0101	temporary latched 4s
0110	temporary latched 8s
0111	latched
1000	non-latched

1001	temporary latched 1ms
1010	temporary latched 1ms
1011	temporary latched 2ms
1100	temporary latched 25ms
1101	temporary latched 50ms
1110	temporary latched 100ms
1111	latched

An interrupt is generated if its activation condition is met. It can't be cleared as long as the activation condition is fulfilled. In the non-latched mode the interrupt status bit and the interrupt pin are cleared as soon as the activation condition is no more valid. Exceptions to this behavior are the new data which is automatically reset after a fixed time.

In the latched mode an asserted interrupt status and the interrupt pin are cleared by writing 1 to (0x20) 'reset_int' bit. If the activation condition still holds when it is cleared, the interrupt status is asserted again with the next change of the acceleration registers.

In the temporary mode an asserted interrupt and selected pin are cleared after a defined period of time. The behavior of the different interrupt modes is shown in the following figure.

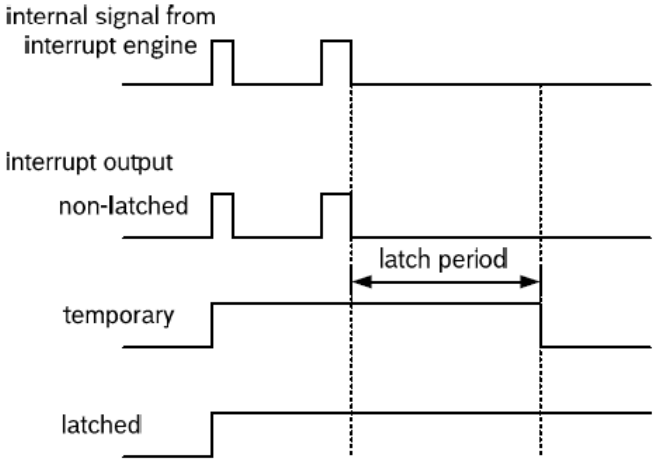


Figure 6 Interrupt mode

4.3.2.Mapping

The mapping of interrupts to the interrupt pins is done by registers 'INT_MAP' (0x19 and 0x1a), setting *INT_inttype* (e.g. INT_active) to 1 can map this type of interrupt to the interrupt pin.

4.3.3.Electrical behavior (INT to open-drive or push-pull)

The interrupt pin can be configured to show desired electrical behavior. The active level for each pin is set by register bit INT_lvl, if INT_lvl = 0 (1), then the pin INT is 0 (1) active.
Also the electric type of the interrupt pin can be selected. By setting INT_od = 1 (0), the interrupt pin output type can be set to be open-drive (push-pull).

4.3.4.New data interrupt

This interrupt serves for synchronous reading of acceleration data. It is generated after an acceleration data was calculated. The interrupt is cleared automatically before the next acceleration data is ready.

4.3.5.Active detection

Active detection uses the slope between successive acceleration signals to detect changes in motion. An interrupt is generated when the slope (absolute value of acceleration difference) exceeds a preset threshold. The threshold is set with the value of 28H register with the LSB corresponding to 255LSB of acceleration data that is 3.9mg in 2g-range, 7.8mg in 4g-range, and 15.6mg in 8g-range. And the maximum value is 1g in 2g-range, 2g in 4g-range, and 4g in 8g-range.

The time difference between the successive acceleration signals depends is fixed to 1ms.
Active detection can be enabled (disabled) for each axis separately by writing ‘1’ to bits ‘active_int_en_x/y/z’. The active interrupt is generated if the slope of any of the enabled axes exceeds the threshold for [‘active_dur’+1] consecutive times. As soon as the slopes of all enabled axes fall below this threshold for [‘active_dur’+1] consecutive times, the interrupt is cleared unless the interrupt signal is latched.

The interrupt status is stored in the (0x09) ‘active_int’ bit. The (0x0b) bit ‘active_first_x/y/z’ records which axis triggered the active interrupt first and the sign of this acceleration data that triggered the interrupt is recorded in the (0x0b) bit ‘active_sign’.

5. Application hints

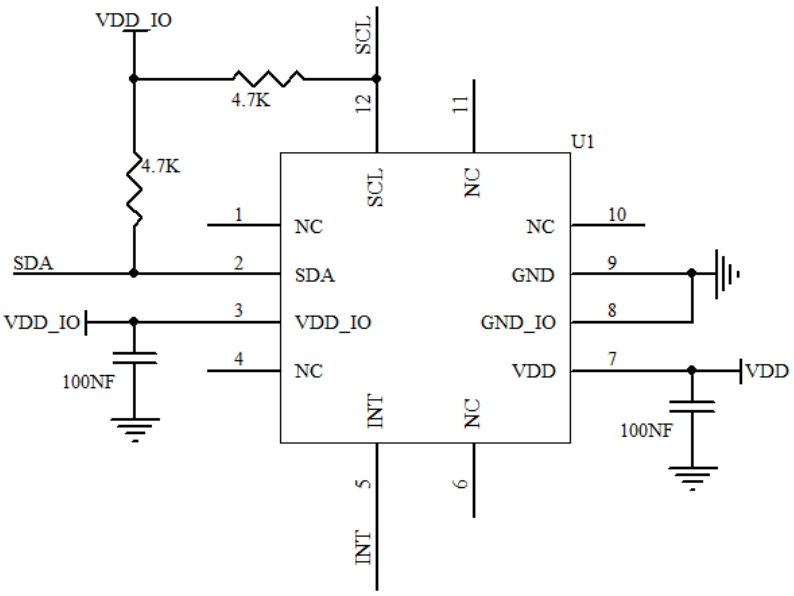


Figure 7 da228 I2C electrical connect

The device core is supplied through VDD line while the I/O pads are supplied through VDD_IO line. Power supply decoupling capacitors (100 nF ceramic) should be placed as near as possible to the pin 7 and pin 3 of the device (common design practice).

The functionality of the device and the measured acceleration data is selectable and accessible through the I2C.The functions, the threshold and the timing of the interrupt pin (INT) can be completely programmed by the user through the I2C interface.

6. Register mapping

The table given below provides a listing of the 8 bit registers embedded in the device and the related addresses:

Table 14.Register address map

Name	Type	Register address	Default	Soft Reset
CONFIG	RW	0x00	00H	NO
CHIPID	R	0x01	13H	NO
ACC_X_LSB	R	0x02	00H	YES
ACC_X_MSB	R	0x03	00H	YES
ACC_Y_LSB	R	0x04	00H	YES
ACC_Y_MSB	R	0x05	00H	YES
ACC_Z_LSB	R	0x06	00H	YES
ACC_Z_MSB	R	0x07	00H	YES
MOTION_FLAG	R	0x09	00H	YES
NEWDATA_FLAG	R	0x0A	00H	YES
ACTIVE_STATUS	R	0x0B	00H	YES
RANGE	RW	0x0F	40H	YES
ODR_AXIS	RW	0x10	0FH	YES
MODE_BW	RW	0x11	9EH	YES
SWAP_POLARITY	RW	0x12	0EH	YES
INT_SET1	RW	0x16	00H	YES
INT_SET2	RW	0x17	00H	YES
INT_MAP1	RW	0x19	00H	YES
INT_MAP2	RW	0x1A	00H	YES
INT_CONFIG	RW	0x20	01H	YES
INT_LATCH	RW	0x21	00H	YES
ACTIVE_DUR	RW	0x27	00H	YES
ACTIVE_THS	RW	0x28	14H	YES

7. Registers description

7.1. CONFIG (00H)

Table 15.CONFIG register

Default data: 0x00 Type: RW

unused	unused	Soft Reset	unused	unused	Soft Reset	unused	unused

Table 16.CONFIG description

Soft Reset	1: soft reset

7.2. CHIPID (01h)

Table 17.CHIPID register

Default data: 0x13 Type: R

0	0	0	1	0	0	1	1

7.3. ACC_X_LSB (02H), ACC_X_MSB (03H)

X-axis acceleration data, the value is expressed in two complement byte and are left justified.

Table 18.ACC_X_LSB register

Default data: 0x00 Type: R

D[3]	D[2]	D[1]	D[0]	unused	unused	unused	unused

Table 19.ACC_X_MSB register

Default data: 0x00 Type: R

D[11]	D[10]	D[9]	D[8]	D[7]	D[6]	D[5]	D[4]

7.4. ACC_Y_LSB (04H), ACC_Y_MSB (05H)

Y-axis acceleration data, the value is expressed in two complement byte and are left justified.

Table 20.ACC_Y_LSB register

Default data: 0x00 Type: R

D[3]	D[2]	D[1]	D[0]	unused	unused	unused	unused

Table 21.ACC_Y_MSB register

Default data: 0x00 Type: R

D[11]	D[10]	D[9]	D[8]	D[7]	D[6]	D[5]	D[4]

7.5. ACC_Z_LSB (06H), ACC_Z_MSB (07H)

Z-axis acceleration data, the value is expressed in two complement byte and are left justified.

Table 22.ACC_Z_LSB register

Default data: 0x00 Type: R

D[3]	D[2]	D[1]	D[0]	unused	unused	unused	unused

Table 23.ACC_Z_MSB register

Default data: 0x00 Type: R

D[11]	D[10]	D[9]	D[8]	D[7]	D[6]	D[5]	D[4]

7.6. MOTION_FLAG (09H)

Table 24.MOTION_FLAG register

Default data: 0x00 Type: R

unused	unused	unused	unused	unused	active_int	unused	unused

Table 25.MOTION_FLAG register description

active_int	0: no active interrupt 1: active interrupt has occurred

7.7. NEWDATA_FLAG (0AH)

Table 26.NEWDATA_FLAG register

Default data: 0x00 Type: R

unused	unused	unused	unused	unused	unused	unused	new_data_flag

Table 27.NEWDATA_FLAG register description

new_data_flag	new data ready status 0: not ready 1: ready

7.8. ACTIVE_STATUS (0BH)

Table 28.ACTIVE_STATUS register

Default data: 0x00 Type: R

unused	unused	unused	unused	active_sign	active_first_x	active_first_y	active_first_z

Table 29.ACTIVE_STATUS register description

active_sign	active_sign: Sign of the 1st active interrupt 0: positive 1: negative
active_first_x	0: X is not the triggering axis of the active interrupt 1: indicate X is the triggering axis of the active interrupt
active_first_y	0: Y is not the triggering axis of the active interrupt 1: indicate Y is the triggering axis of the active interrupt
active_first_z	0: Z is not the triggering axis of the active interrupt 1: indicate Z is the triggering axis of the active interrupt

7.9. RANGE (0FH)

Table 30.RANGE register

Default data: 0x40 Type: RW

unused	unused	unused	unused	unused	unused	fs[1]	fs[0]

Table 31.RANGE register description

fs[1:0]	full scale 00: +/-2g 01: +/-4g 10: +/-8g

7.10. ODR_AXIS (10H)

Table 32.ODR_AXIS register

Default data: 0x0F Type: RW

unused	unused	unused	unused	ODR[3]	ODR[2]	ODR[1]	ODR[0]

Table 33.ODR_AXIS register description

ODR[3:0]	0000: 1Hz 0001: 1.95Hz 0010: 3.9Hz 0011: 7.81Hz 0100: 15.63Hz 0101: 31.25Hz 0110: 62.5Hz 0111: 125Hz 1000: 250Hz 1001: 500Hz 1010-1111: 1000Hz

7.11. MODE_BW (11H)

Table 34.MODE_BW register

Default data: 0x9E Type: RW

PWR_OFF	unused	unused	unused	unused	BW[1]	BW[0]	autosleep_en

Table 35.MODE_BW register description

PWR_OFF	0: normal mode 1: suspend mode
BW[1:0]	bandwidth 00/11: 1/2 ODR 01: 1/4 ODR 10: 1/10 ODR
autosleep_en	0: working the current ODR state all the way 1: working at 12.5hz in inactive state, automatic switched to normal mode during active state

7.12. SWAP_POLARITY (12H)

Table 36.SWAP_POLARITY register

Default data: 0x0E Type: RW

Swap & Polarity register is OTP register too, OTP address: 0x13

unused	unused	unused	unused	X_polarity	Y_polarity	Z_polarity	X_Y_swap

Table 37.SWAP_POLARITY register description

X_polarity	0: remain the polarity of X-axis 1: reverse the polarity of X-axis
Y_polarity	0: remain the polarity of Y-axis 1: reverse the polarity of Y-axis
Z_polarity	0: remain the polarity of Z-axis 1: reverse the polarity of Z-axis
X_Y_swap	0: don't need swap the output data for X/Y axis 1: swap the output data for X/Y axis

7.13. INT_SET1 (16H)

Table 38.INT_SET1 register

Default data: 0x00 Type: RW

INT_source[1]	INT_source[0]	unused	unused	unused	active_int_en_z	active_int_en_y	active_int_en_x

Table 39.INT_SET1 register description

INT_source[1:0]	00: oversampling data (ODR_period =ODR*OSR) 01: unfiltered data (ODR_period =ODR) 10/11: filtered data (ODR_period =ODR IIR)
active_int_en_z	0: disable the active interrupt for the z axis 1: enable the active interrupt for the z axis
active_int_en_y	0: disable the active interrupt for the y axis 1: enable the active interrupt for the y axis
active_int_en_x	0: disable the active interrupt for the x axis 1: enable the active interrupt for the x axis

7.14. INT_SET2 (17H)

Table 40.INT_SET2 register

Default data: 0x00 Type: RW

unused	unused	unused	new_data_int_en	unused	unused	unused	unused

Table 41.INT_SET2 register description

new_data_int_en	0: disable the new data interrupt 1: enable the new data interrupt

7.15. INT_MAP1 (19H)

Table 42.INT_MAP1 register

Default data: 0x00 Type: RW

unused	unused	unused	unused	unused	INT_active	unused	unused

Table 43.INT_MAP1 register description

INT_active	0: doesn’t mapping active interrupt to INT 1: mapping active interrupt to INT

7.16. INT_MAP2 (1AH)

Table 44.INT_MAP2 register

Default data: 0x00 Type: RW

unused	unused	unused	unused	unused	unused	unused	unused	INT_new_data

Table 45.INT_MAP2 register description

INT_new_data	0: doesn’t mapping new data interrupt to INT 1: mapping new data interrupt to INT

7.17. INT_CONFIG (20H)

Table 46.INT_CONFIG register

Default data: 0x01 Type: RW

Reset_int	unused	unused	unused	unused	unused	INT_od	INT_lvl

Table 47.INT_CONFIG register description

Reset_int	write'1'to reset all latched int.
INT_od	0: select push-pull output for INT 1: select OD output for INT
INT_lvl	0: select active level low for pin INT 1: select active level high for pin INT

7.18. INT_LATCH (21H)

Table 48.INT_LATCH register

Default data: 0x00 Type: RW

unused	unused	unused	unused	latch_INT[3]	latch_INT[2]	latch_INT[1]	latch_INT[0]

Table 49.INT_LATCH register description

latch_INT[3:0]	0000: non-latched 0001: temporary latched 250ms 0010: temporary latched 500ms 0011: temporary latched 1s 0100: temporary latched 2s 0101: temporary latched 4s 0110: temporary latched 8s 0111: latched 1000: non-latched 1001: temporary latched 1ms 1010: temporary latched 1ms 1011: temporary latched 2ms 1100: temporary latched 25ms 1101: temporary latched 50ms 1110: temporary latched 100ms 1111: latched

7.19. ACTIVE_DUR (27H)

Table 50.ACTIVE_DUR register

Default data: 0x00 Type: RW

inactive_dur[3]	inactive_dur[2]	inactive_dur[1]	inactive_dur[0]	active_dur[3]	active_dur[2]	active_dur[1]	active_dur[0]

Table 51.ACTIVE_DUR register description

inactive_dur[3:0]	inactive duration time = (inactive_dur + 1)* ODR_period
active_dur[3:0]	active duration time = (active_dur + 1)* ODR_period

7.20. ACTIVE_THS (28H)

Table 52.ACTIVE_THS register

Default data: 0x14 Type: RW

active_th[7]	active_th [6]	active_th [5]	active_th[4]	active_th [3]	active_th [2]	active_th [1]	active_th [0]

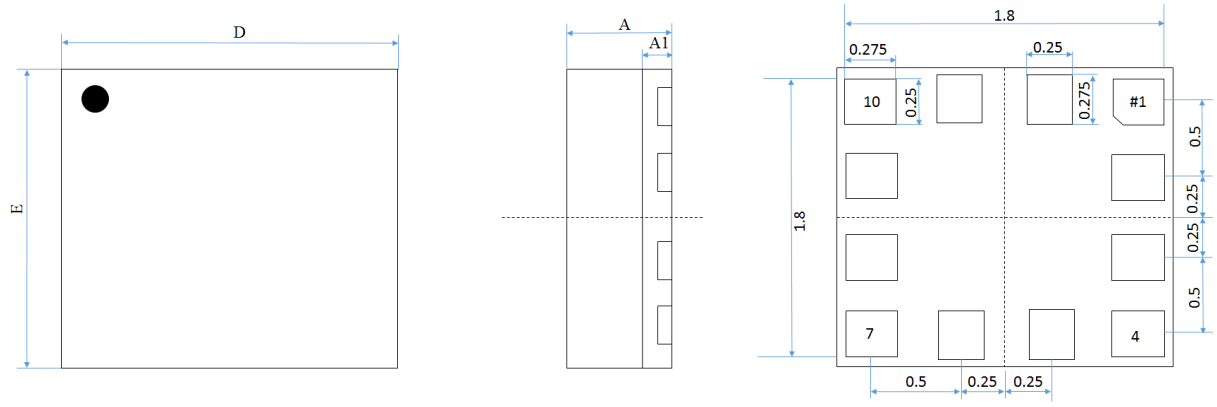
Table 53.ACTIVE_THS register description

active_th[7:0]	threshold of active interrupt=active_th*K(mg) K = 3.91(2g range) K = 7.81(4g range) K = 15.625(8g range)

8. Package information

8.1. Outline dimensions

The sensor housing is a standard LGA package. Its dimensions are the following:



Top View **Side View** **Bottom View**

COMMON DIMENSIONS(MM)			
PKG.	W: VERYVERY THIN		
REF.	MIN	NOM	MAX
A	1	1.1	1.2
A1(SUBSTRATE)	0.2		
D	1.9	2	2.1
E	1.9	2	2.1

Figure 8 12 Pin LGA mechanical data and package dimensions

8.2. Landing pattern recommendation

For the design of the landing patterns, we recommend the following dimensioning:

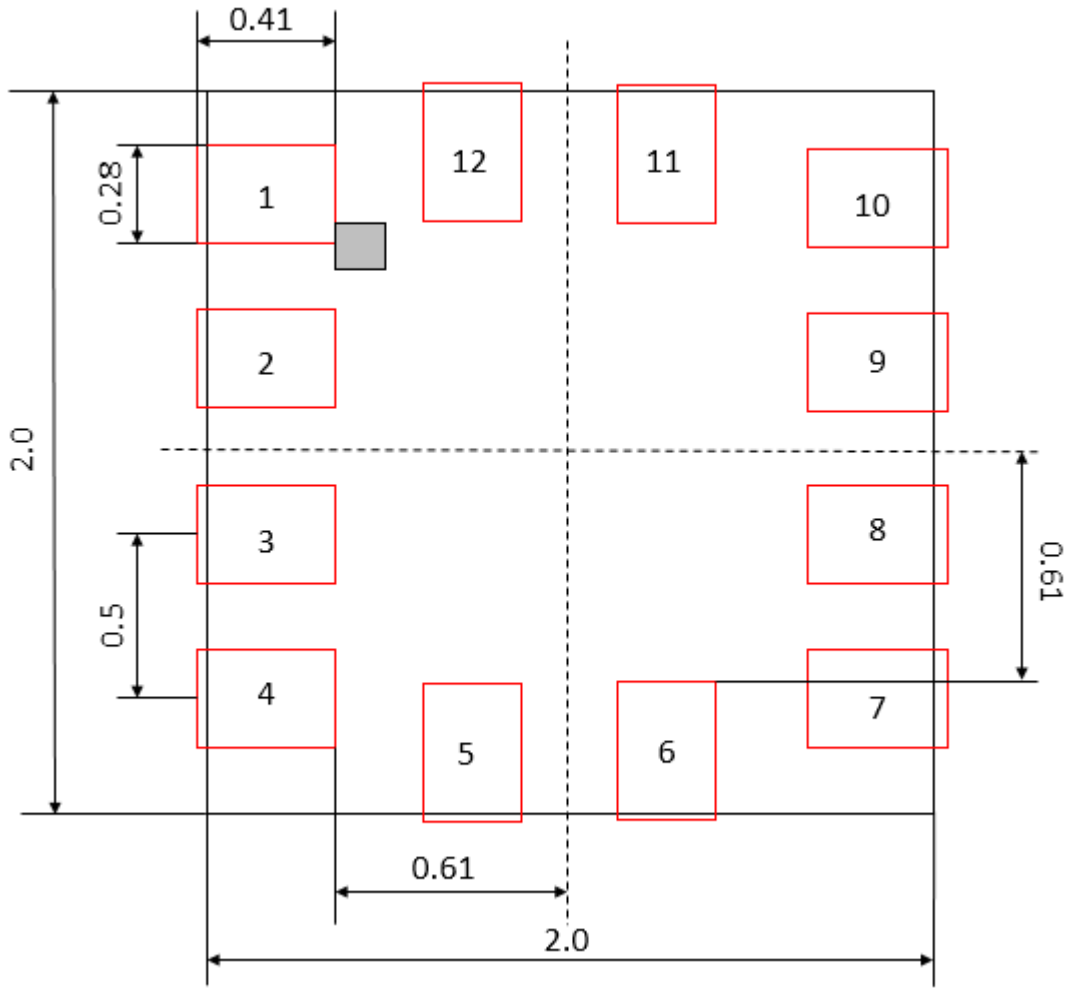


Figure 9 landing patterns; dimensions in mm

8.3. Soldering guidelines

The LGA package is qualified for soldering heat resistance according to IPC/JEDEC J-STD-020,
"Joint industry Standards: Moisture/Reflow Sensitivity Classification for non-hermetic Solid State surface Mount Devices".
Shipping and handling is qualified according to IPC/JEDEC J-STD-033,
"Joint Industry Standard: Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices.

The sensor fulfils the lead-free soldering requirements of the above-mentioned IPC/JEDEC standard, i.e. reflow soldering with a peak temperature up to 260℃.

Profile Feature	Pb-Free Assembly
Preheat/Soak Temperature Min (T_{smin}) Temperature Max (T_{smax}) Time (t_s) from (T_{smin} to T_{smax})	 150 °C 200 °C 60-120 seconds
Ramp-up rate (T_L to T_p)	3 °C/second max.
Liquidous temperature (T_L) Time (t_L) maintained above T_L	217 °C 60-150 seconds
Peak package body temperature (T_p)	For users T_p must not exceed the Classification temp in Table below
Time (t_p)* within 5 °C of the specified classification temperature (T_c), see Figure 5-1.	30* seconds
Ramp-down rate (T_p to T_L)	6 °C/second max.
Time 25 °C to peak temperature	8 minutes max.

Package Thickness	Volume mm^3 <350	Volume mm^3 350 - 2000	Volume mm^3 >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm - 2.5 mm	260 °C	250 °C	245 °C
>2.5 mm	250 °C	245 °C	245 °C

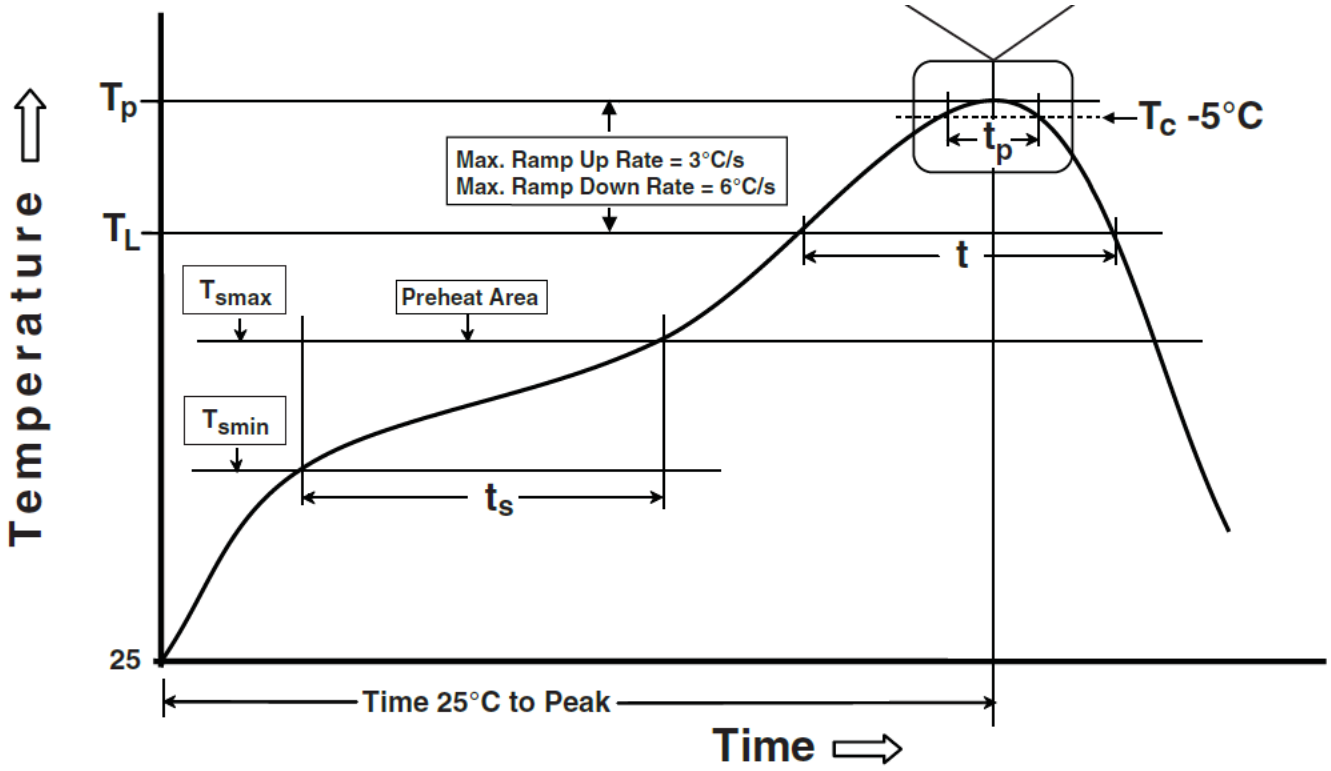


Figure 10 Soldering profile

8.4. Tape and reel specification

The da228 is shipped in a standard pizza box

The box dimension for 1 reel is: L x W x H = 355mm x 335mm x 50mm

da228 quantity: 5000pcs per reel, please handle with care.

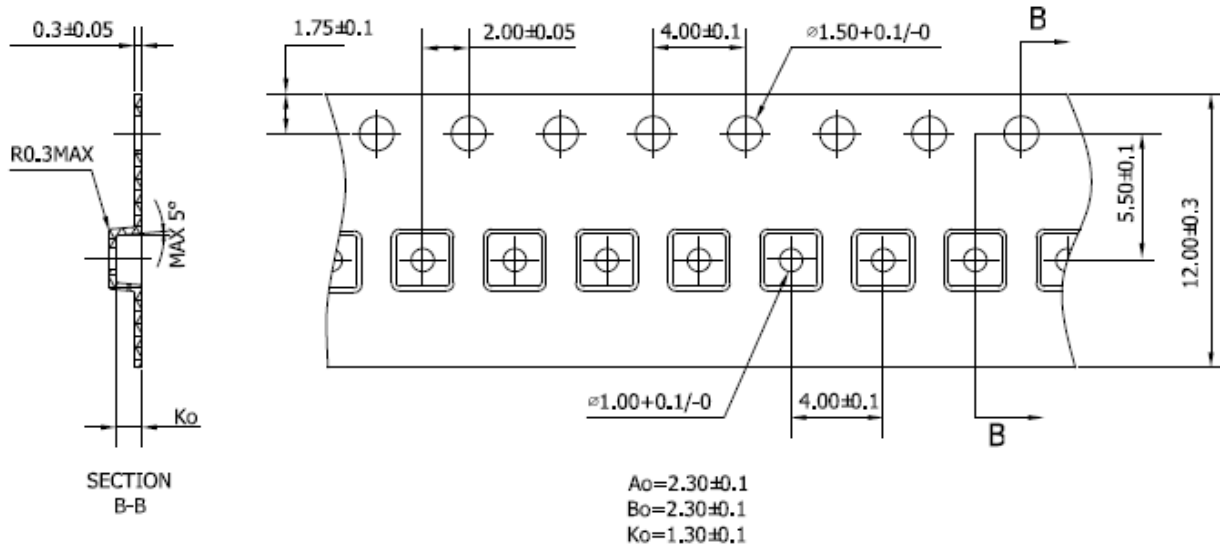


Figure 11 Tape and reel dimension in mm

9. Reliability

The qualification condition of MiraMEMS's products is based on the stress test qualification for integrated circuits, JEDEC JESD47H.01 Standard. The test summary is listed below.

Table 54.Accelerated Life Tests

Test	Condition	Qty/lot	Lot	Acc/Rej	Result
High Temperature Storage (HTS)*	150C, 1000hrs JEDEC JESD22-A103D Condition A	77	3	0/1	PASS
High Temperature Operating Life Test (HTOL)*	125C, 1000hrs, 3.63V biased JEDEC JESD22-A108D	77	3	0/1	PASS
Highly Accelerated Stress Test (uHAST)*	130C/85%, 96hrs JEDEC JESD22-A118A Condition A	77	3	0/1	PASS

*Tests are preceded by MSL3 preconditioning in accordance with JEDEC JESD22-A113F

Table 55.Component Level Tests

Test	Condition	Qty/lot	Lot	Acc/Rej	Result
Preconditioning(MSL3)	24hrs HTSL (125C) ->192Hrs WHTSL (30C/60%RH) + 3x PbFree Reflow, 260C max JEDEC JESD22-A113F	77	3	0/1	PASS
Temperature Cycle*	-40C~85C (air to air) 500 cycles JEDEC JESD22-A104D Condition N	77	3	0/1	PASS
Shock Test	10000G/0.2ms, X/Y/Z 5 time/ direction JEDEC JESD22-B104C	10	3	0/1	PASS
Vibration Test	sweep 20-2000Hz, 4 times/direction JEDEC JESD22-B103B Condition 1 60Hz_32h/direction	10	2	0/1	PASS
ESD Susceptibility	2000V (HBM) JEDEC JS-001-2012	6	1	0/1	PASS
	200V (MM) JEDEC JESD22-A115C	6	1	0/1	PASS
	500V (CDM) JEDEC JESD22-C101E	6	1	0/1	PASS
Latch-up	>+/-2Vcc, max >+/-2Icc, max JEDEC JESD-78D	6	1	0/1	PASS

*Tests are preceded by MSL3 preconditioning in accordance with JEDEC JESD22-A113F

10. Revision history

Table 56.Document revision history

Date	Revision	Changes
18-Sept.-2019	0.1	Initial release