Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Data sheet

BMI055

Small, versatile 6DoF sensor module

Bosch Sensortec

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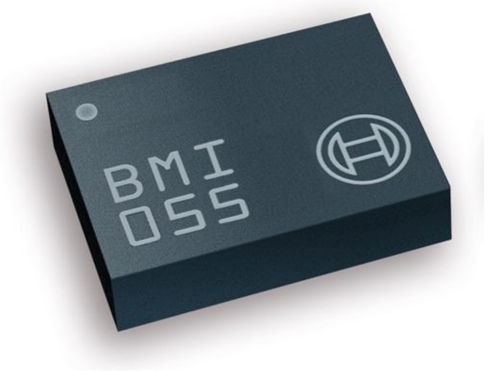

BMI055: Data sheet

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BMI055

Basic Description

Key features

• 2 inertial sensors in one device	an advanced triaxial 16bit gyroscope and a versatile, leading edge triaxial 12bit accelerometer for reduced PCB space and simplified signal routing
• Small package	LGA package 16 pins footprint 3.0 x 4.5 mm², height 0.95mm
• Common voltage supplies	V_{DD} voltage range: 2.4V to 3.6V
• Digital interface	SPI (4-wire, 3-wire), I²C, 4 interrupt pins V_{DDIO} voltage range: 1.2V to 3.6V
• Smart operation and integration	Gyroscope and accelerometer can be operated individually
• Consumer electronics suite	MSL1, RoHS compliant, halogen-free Operating temperature: -40°C ... +85°C 9DoF software compatible

Accelerometer features

• Programmable functionality	Acceleration ranges ±2g/±4g/±8g/±16g Low-pass filter bandwidths 1kHz - <8Hz
• On-chip FIFO	Integrated FIFO with a depth of 32 frames
• On-chip interrupt controller	Motion-triggered interrupt-signal generation for - new data - any-motion (slope) detection - tap sensing (single tap / double tap) - orientation- & motion inactivity recognition - flat/low-g/high-g detection
• On-chip temperature sensor	factory trimmed, 8-bit, typical slope 0.5K/LSB.
• Ultra-low power IC	130µA current consumption, 1.3ms wake-up time, advanced features for system power management

Gyroscope features

• Programmable functionality	Ranges switchable from ±125°/s to ±2000°/s Low-pass filter bandwidths 230Hz - 12Hz Fast and slow offset controller (FOC and SOC)
• On-chip FIFO	Integrated FIFO with a depth of 100 frames
• On-chip interrupt controller	Motion-triggered interrupt-signal generation for - new data - any-motion (slope) detection - high rate
• Low power IC	< 5mA current consumption, 30ms start-up time wake-up time in fast power-up mode only 10ms

Typical applications

- Advanced gaming & HMI
- Advanced gesture recognition
- Indoor navigation
- Image stabilization
- Display profile switching
- Advanced system power management for mobile applications
- Menu scrolling, tap / double tap sensing
- Pedometer / step counting
- Free-fall detection
- E-compass tilt compensation
- Drop detection for warranty logging

General description

The BMI055 is an inertial measurement unit (IMU) for the detection of movements and rotations in 6 degrees of freedom (6DoF). It reflects the full functionality of a triaxial, low-g acceleration sensor and at the same time it is capable to measure angular rates. Both – acceleration and angular rate – in three perpendicular room dimensions, the x-, y- and z-axis.

The BMI055 is designed to meet all requirements for consumer applications such as gaming and pointing devices, HMI and image stabilization (DSC and camera-phone). It also senses tilt, motion, inactivity and shock vibration in cell phones, handhelds, computer peripherals, man-machine interfaces, virtual reality features and game controllers.

An evaluation circuitry (ASIC) converts the output of the micro-electromechanical sensing structures (MEMS), developed, produced and tested in BOSCH facilities. The corresponding chip-sets are packed into one single LGA 3.0mm x 4.5mm x 0.95mm housing. For optimum system integration the BMI055 is fitted with digital bi-directional SPI and I^2C interfaces. To provide maximum performance and reliability each device is tested and ready-to-use calibrated.

Package and interfaces of the BMI055 have been defined to match a multitude of hardware requirements. Since the sensor features a small footprint, a flat package and very low power consumption it is ingeniously suited for mobile-phone and tablet PC applications.

The BMI055 offers a variable V_{DDIO} voltage range from 1.2V to 3.6V and can be programmed to optimize functionality, performance and power consumption in customer specific applications. In addition it features on-chip interrupt controllers enabling motion-based applications without use of a microcontroller.

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1. Specification

If not stated otherwise, the given values are over lifetime and full performance temperature and voltage ranges, minimum/maximum values are ±3σ.

1.1 Electrical specification

Table 1: Electrical parameter specification

OPERATING CONDITIONS						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Supply Voltage Internal Domains	V_{DD}		2.4	3.0	3.6	V
Supply Voltage I/O Domain	V_{DDIO}		1.2	2.4	3.6	V
Voltage Input Low Level	$V_{IL,a}$	SPI & I²C			$0.3V_{DDIO}$	-
Voltage Input High Level	$V_{IH,a}$	SPI & I²C	$0.7V_{DDIO}$			-
Voltage Output Low Level	$V_{OL,a}$	I_{OL} = 3mA, SPI & I²C			$0.23V_{DDIO}$	-
Voltage Output High Level	V_{OH}	I_{OH} = 3mA, SPI	$0.8V_{DDIO}$			-
Operating Temperature	T_A		-40		+85	°C

1.2 Electrical and physical characteristics, measurement performance

Table 2: Electrical characteristics accelerometer

OPERATING CONDITIONS ACCELEROMETER						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Units**
Acceleration Range	g_{FS2g}	Selectable via serial digital interface		±2		g
	g_{FS4g}			±4		g
	g_{FS8g}			±8		g
	g_{FS16g}			±16		g
Total Supply Current in Normal Mode	I_{DD}	see[1]		130		µA
Total Supply Current in Suspend Mode	I_{DDsum}	see[1]		2.1		µA
Total Supply Current in Deep Suspend Mode	I_{DDdsum}	see[1]		1.0		µA
Total Supply Current in Low-power Mode 1	I_{DDlp1}	see[1] sleep duration ≥ 25ms		6.5		µA
Total Supply Current in Low-power Mode 2	I_{DDlp2}	see[1] sleep duration ≥ 25ms		66		µA
Total Supply Current in Standby Mode	I_{DDsbm}	see[1]		62		µA
Wake-Up Time 1	$t_{w,up1}$	from Low-power Mode 1 or Suspend Mode or Deep Suspend Mode bw = 1kHz		1.3		ms
Wake-Up Time 2	$t_{w,up2}$	from Low-power Mode 2 or Stand-by Mode bw = 1kHz		1		ms
Start-Up Time	$t_{s,up}$	POR, bw = 1kHz			3	ms
Non-volatile memory (NVM) write-cycles	n_{NVM}				15	Cycles

[1] Conditions of current consumption if not specified otherwise: T_A=25°C, BW_Accel=1kHz, V_{DD} = V_{DDIO} = 2.4V, digital protocol on, no streaming data

Output Signal Accelerometer						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Units**
Sensitivity	S_{2g}	g_{FS2g}, T_A=25°C		1024		LSB/g
	S_{4g}	g_{FS4g}, T_A=25°C		512		LSB/g
	S_{8g}	g_{FS8g}, T_A=25°C		256		LSB/g
	S_{16g}	g_{FS16g}, T_A=25°C		128		LSB/g
Sensitivity Temperature Drift	TCS	g_{FS2g}, Nominal V_{DD} supplies		±0.02		%/K
Sensitivity Supply Volt. Drift	S_{VDD}	g_{FS2g}, T_A=25°C, $V_{DD\ min} \le V_{DD} \le V_{DD\ max}$		0.05		%/V
Zero-g Offset (x,z)	$Off_{x,z}$	g_{FS2g}, T_A=25°C, nominal V_{DD} supplies, over life-time		±70		mg
Zero-g Offset (y)	Off_y	g_{FS2g}, T_A=25°C, nominal V_{DD} supplies, over life-time		±70		mg
Zero-g Offset Temperature Drift	TCO	g_{FS2g}, Nominal V_{DD} supplies		±1		mg/K
Zero-g Offset Supply Volt. Drift	Off_{VDD}	g_{FS2g}, T_A=25°C, $V_{DD\ min} \le V_{DD} \le V_{DD\ max}$		0.5		mg/V
Bandwidth	bw_8	2nd order filter, bandwidth programmable		8		Hz
	bw_{16}			16		Hz
	bw_{31}			31		Hz
	bw_{63}			63		Hz
	bw_{125}			125		Hz
	bw_{250}			250		Hz
	bw_{500}			500		Hz
	bw_{1000}			1,000		Hz
Nonlinearity	NL	best fit straight line, g_{FS2g}		±0.5		%FS
Output Noise Density	n_{rms}	g_{FS2g}, T_A=25°C Nominal V_{DD} supplies Normal mode		150		µg/√Hz
Temperature Sensor Measurement Range	T_S		-40		85	°C
Temperature Sensor Slope	dT_S			0.5		K/LSB
Temperature Sensor Offset	OT_S			±2		K

Mechanical Characteristics Accelerometer						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Units**
Cross Axis Sensitivity	S	relative contribution between any two of the three axes		1		%
Alignment Error	E_A	relative to package outline		±0.5		°

Table 3: Electrical characteristics gyroscope

Operating Conditions Gyroscope						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Range	R_{FS125}	Selectable via serial digital interface		125		°/s
	R_{FS250}			250		°/s
	R_{FS500}			500		°/s
	R_{FS1000}			1,000		°/s
	R_{FS2000}			2,000		°/s
Supply Current in Normal Mode	I_{DD}	see[2]		5		mA
Supply Current in Fast Power-up Mode	I_{DDfpm}	see[2]		2.5		mA
Supply Current in Suspend Mode	I_{DDsum}	see[2], digital and analog (only IF active)		25		µA
Supply Current in Deep Suspend Mode	I_{DDdsum}	see[2]		<5		µA
Start-up time	t_{su}	to ±1°/s of final value;from power-off		30		ms
Wake-up time	t_{wusm}	From suspend- and deep suspend-modes		30		ms
Wake-up time	t_{wufpm}	From fast power-up mode		10		ms
Non-volatile memory (NVM) write-cycles	n_{NVM}				15	cycles

[2] Conditions of current consumption if not specified otherwise: T_A=25°C, BW_Gyro=1kHz, V_{DD}=2.4V, V_{DDIO}=1.8V, digital protocol on, no streaming data

Output Signal Gyroscope						
Parameter	**Symbol**	**Condition**	**Min**	**Typ**	**Max**	**Unit**
Sensitivity		Ta=25°C, R_{FS2000}		16.4		LSB/°/s
		Ta=25°C, R_{FS1000}		32.8		LSB/°/s
		Ta=25°C, R_{FS500}		65.6		LSB/°/s
		Ta=25°C, R_{FS250}		131.2		LSB/°/s
		Ta=25°C, R_{FS125}		262.4		LSB/°/s
Sensitivity tolerance		Ta=25°C, R_{FS2000}		±1		%
Sensitivity Change over Temperature	TCS	Nominal V_{DD} supplies -40°C ≤ T_A ≤ +85°C R_{FS2000}		±0.03		%/K
Sensitivity Supply Volt. Drift	S_{VDD}	T_A=25°C, $V_{DD\ min} \le V_{DD} \le V_{DD\ max}$		<0.4		%/V
Nonlinearity	NL	best fit straight line R_{FS1000}, R_{FS2000}		±0.05		%FS
g- Sensitivity		Sensitivity to acceleration stimuli in all three axis (frequency <20kHz)			0.1	°/s/g
Zero-rate Offset	Off Ω_x Ω_y and Ω_z	Nominal V_{DD} supplies T_A=25°C, slow and fast offset cancellation off		±1		°/s
Zero-Ω Offset Change over Temperature	TCO	Nominal V_{DD} supplies -40°C ≤ T_A ≤ +85°C R_{FS2000}		±0.015		°/s per K
Zero-Ω Offset Supply Volt. Drift	OffΩ $_{VDD}$	T_A=25°C, $V_{DD\_min} \le V_{DD} \le V_{DD\_max}$		<0.1		°/s /V
Output Noise	n_{rms}	rms, BW=47Hz (@ 0.014°/s/√Hz)		0.1		°/s

Bandwidth BW	f_{-3dB}			unfiltered 230 116 64 47 32 23 12		Hz
Data rate (set of x,y,z rate)				2000 1000 400 200 100		Hz
Data rate tolerance (set of x,y,z rate)				±0.3		%
Cross Axis Sensitivity		Sensitivity to stimuli in non-sense-direction		±1		%

2. Absolute maximum ratings

Table 4: Absolute maximum ratings

Parameter	Condition	Min	Max	Units
Voltage at Supply Pin	V_{DD} Pin	-0.3	4.25	V
	V_{DDIO} Pin	-0.3	4.25	V
Voltage at any Logic Pin	Non-Supply Pin	-0.3	V_{DDIO}+0.3	V
Passive Storage Temp. Range	≤ 65% rel. H.	-50	+150	°C
None-volatile memory (NVM) Data Retention	T = 85°C, after 15 cycles	10		y
Mechanical Shock	Duration ≤ 200µs		10,000	g
	Duration ≤ 1.0ms		2,000	g
	Free fall onto hard surfaces		1.8	m
ESD	HBM, at any Pin		2	kV
	CDM		500	V
	MM		200	V

Note: Stress above these limits may cause damage to the device. Exceeding the specified electrical limits may affect the device reliability or cause malfunction.

3. Block diagram

Figure 1 shows the basic building blocks of the BMI055:

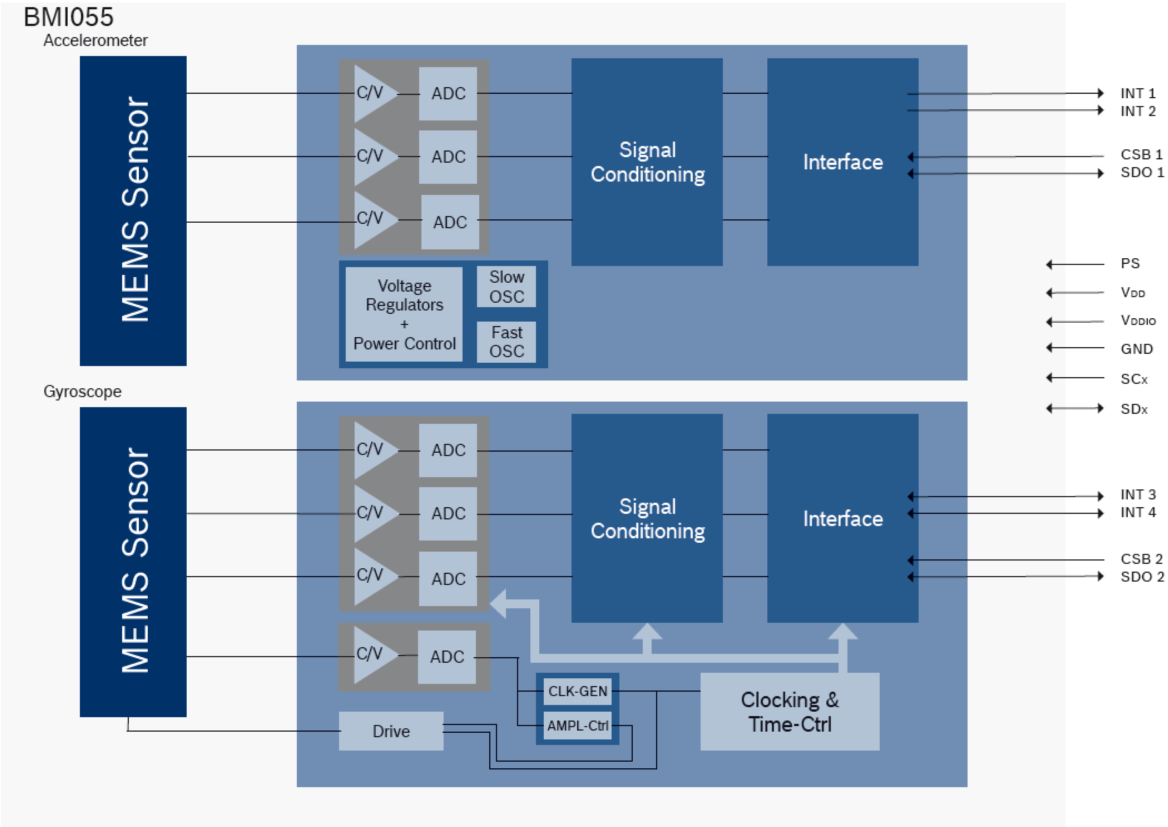

Figure 1: Block diagram of the BMI055

4. Basic power management

The BMI055 has two distinct power supply pins:

- V_{DD} is the main power supply for the internal blocks
- V_{DDIO} is a separate power supply pin mainly used for the supply of the interface

There are no limitations on the voltage levels of both pins relative to each other, as long as each of them lies within its operating range. Furthermore, the device can be completely switched off (V_{DD} = 0V) while keeping the V_{DDIO} supply on (V_{DDIO} > 0V) or vice versa.

When the V_{DDIO} supply is switched off, all interface pins (CSB, SDI, SCK, PS) must be kept close to GND_{IO} potential.

The device contains a power-on reset (POR) generator. It resets the logic part and the register values after powering-on V_{DD} and V_{DDIO}. Please note, that all application specific settings which are not equal to the default settings (refer to 6.2 register map accelerometer and to 8.2 register map gyroscope), must be re-set to its designated values after POR.

In case the I²C interface shall be used, a direct electrical connection between V_{DDIO} supply and the PS pin is needed in order to ensure reliable protocol selection. For SPI interface mode the PS pin must be directly connected to GND_{IO}.

5. Functional description accelerometer

Note: Default values for registers can be found in chapter 6.

5.1 Power modes accelerometer

The accelerometer has six different power modes. Besides normal mode, which represents the fully operational state of the device, there are five energy saving modes: deep-suspend mode, suspend mode, standby mode, low-power mode 1 and low-power mode 2.

The possible transitions between the power modes are illustrated in figure 2:

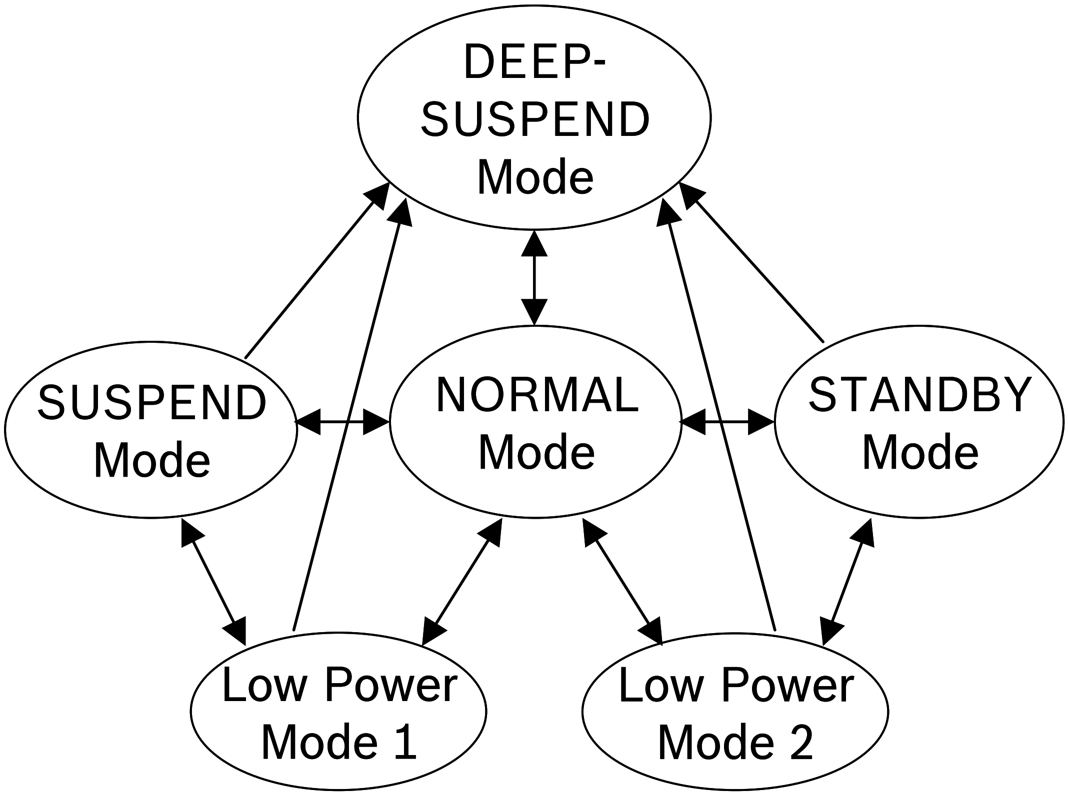

Figure 2: Power mode transition diagram

After power-up accelerometer is in normal mode so that all parts of the device are held powered-up and data acquisition is performed continuously.

In **deep-suspend** mode the device reaches the lowest possible power consumption. Only the interface section is kept alive. No data acquisition is performed and the content of the configuration registers is lost. Deep suspend mode is entered (left) by writing '1' ('0') to the *(ACC 0x11) deep_suspend* bit while *(ACC 0x11)* suspend bit is set to '0'. The I^2C watchdog timer remains functional. The *(ACC 0x11) deep_ suspend* bit, the *(ACC 0x34) spi3* bit, *(ACC 0x34) i2c_wdt_en* bit and the *(ACC 0x34) i2c_wdt_sel* bit are functional in deep-suspend mode. Equally the interrupt level and driver configuration registers *(ACC 0x20) int1_lvl*, *(ACC 0x20)* *int1_od*, *(ACC 0x20) int2_lvl*, and *(ACC 0x20) int2_od* are accessible. Still it is possible to enter normal mode by performing *a* softreset as described in chapter 5.7. Please note, that all application specific settings which are not equal to the default settings (refer to 6.2 register map accelerometer), must be re-set to its designated values after leaving deep-suspend mode.

In **suspend mode** the whole analog part is powered down. No data acquisition is performed. While in suspend mode the latest acceleration data and the content of all configuration registers are kept. Writing to and reading from registers is supported except from the (0x3E) fifo_config_1, (0x30) fifo_config_0 and (0x3F) fifo_data register. It is possible to enter normal mode by performing a softreset as described in chapter 5.7.

Suspend mode is entered (left) by writing ´1´ (´0´) to the *(ACC 0x11) suspend* bit after bit *(ACC 0x12) lowpower_mode* has been set to '0'. Although write access to registers is supported at the full interface clock speed (SCL or SCK), a waiting period must be inserted between two consecutive write cycles (please refer also to section 9.2.1).

In **standby mode** the analog part is powered down, while the digital part remains largely operational. No data acquisition is performed. Reading and writing registers is supported without any restrictions. The latest acceleration data and the content of all configuration registers are kept. Standby mode is entered (left) by writing ´1´ (´0´) to the *(ACC 0x11) suspend* bit after bit *(ACC 0x12) lowpower_mode* has been set to '1'. It is also possible to enter normal mode by performing a softreset as described in chapter 5.7.

In **low-power mode 1**, the device is periodically switching between a sleep phase and a wake-up phase. The wake-up phase essentially corresponds to operation in normal mode with complete power-up of the circuitry. The sleep phase essentially corresponds to operation in suspend mode. Low-power mode is entered (left) by writing ´1´ (´0´) to the *(ACC 0x11) lowpower_en* bit with bit *(ACC 0x12) lowpower_mode* set to '0'. Read access to registers is possible except from the *(0x3F) fifo_data* register. However, unless the register access is synchronised with the wake-up phase, the restrictions of the suspend mode apply.

Low-power mode 2 is very similar to low-power mode 1, but register access is possible at any time without restrictions. It consumes more power than low-power mode 1. In low-power mode 2 the device is periodically switching between a sleep phase and a wake-up phase. The wake-up phase essentially corresponds to operation in normal mode with complete power-up of the circuitry. The sleep phase essentially corresponds to operation in standby mode. Low-power mode is entered (left) by writing ´1´ (´0´) to the *(ACC 0x11) lowpower_en* bit with bit *(ACC 0x12) lowpower_mode* set to '1'.

The **timing behaviour** of the low-power modes 1 and 2 depends on the setting of the *(ACC 0x12) sleeptimer_en* bit. When *(ACC 0x12) sleeptimer_en* is set to '0', the event-driven time-base mode (EDT) is selected. In EDT the duration of the wake-up phase depends on the number of samples required by the enabled interrupt engines. If an 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 interrupt), or until the interrupt is reset (latched interrupt). If no interrupt is detected, the device enters the sleep phase immediately after the required number of acceleration samples have been taken and an active interface access cycle has ended. The EDT mode is recommended for power-critical applications which do not use the FIFO. Also, EDT mode is compatible with legacy BST sensors. Figure 3 shows the timing diagram for low-power modes 1 and 2 when EDT is selected.

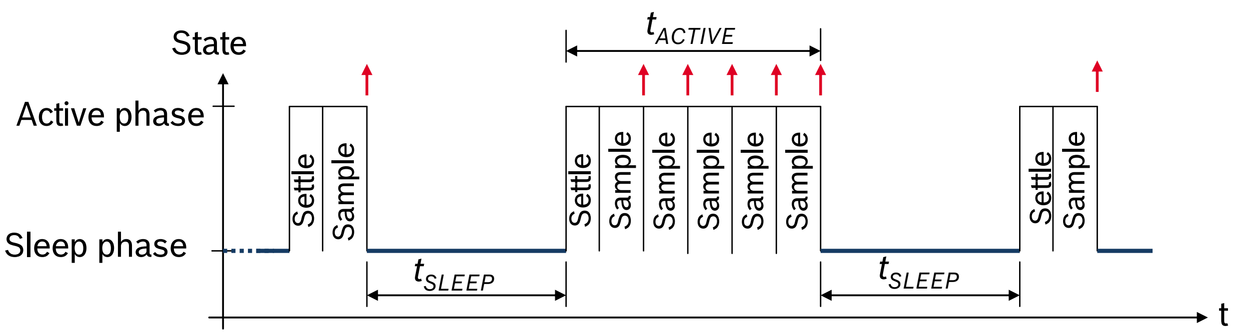

Figure 3: Timing Diagram for low-power mode 1/2, EDT

When *(ACC 0x12) sleeptimer_en* is set to ‘1’, the equidistant-sampling mode (EST) is selected. The use of the EST mode is recommended when the FIFO is used since it ensures that equidistant samples are sampled into the FIFO regardless of whether the active phase is extended by active interrupt engines or interface activity. In EST mode the sleep time t_{SLEEP} is defined as shown in figure 4. The FIFO sampling time t_{SAMPLE} is the sum of the sleep time t_{SLEEP} and the sensor data sampling time t_{SSMP}. Since interrupt engines can extend the active phase to exceed the sleep time t_{SLEEP}, equidistant sampling is only guaranteed if the bandwidth has been chosen such that $1/(2 * bw) = n * t_{SLEEP}$ where n is an integer. If this condition is infringed, equidistant sampling is not possible. Once the sleep time has elapsed the device will store the next available sample in the FIFO. This set-up condition is not recommended as it may result in timing jitter.

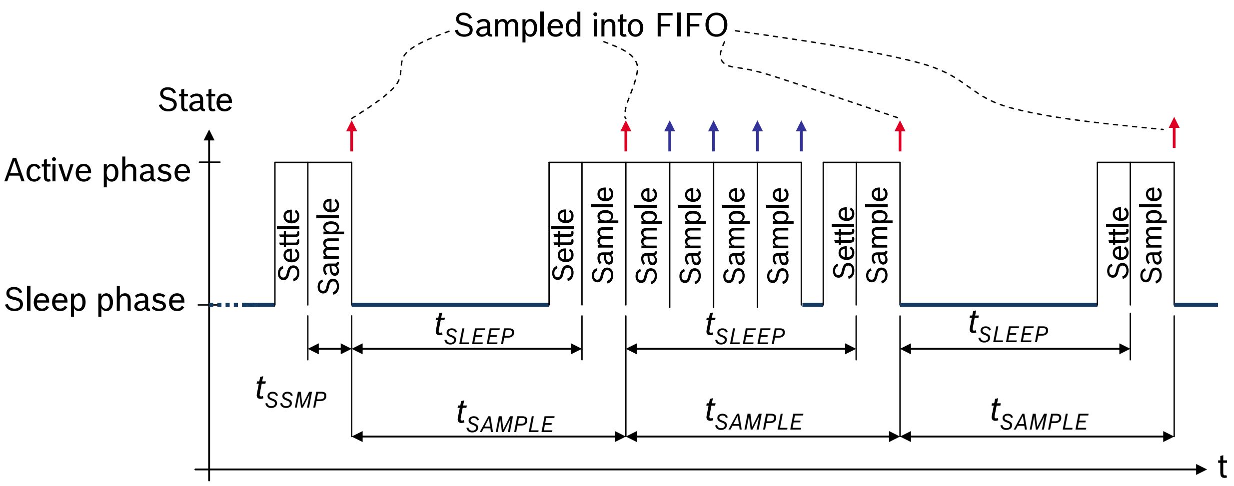

Figure 4: Timing Diagram for low-power mode 1/2, EST

The sleep time for lower-power mode 1 and 2 is set by the *(ACC 0x11) sleep_dur* bits as shown in the following table:

Table 5: Sleep phase duration settings

(ACC 0x11) sleep_dur	Sleep Phase Duration t_{sleep}
0000b	0.5ms
0001b	0.5ms
0010b	0.5ms
0011b	0.5ms
0100b	0.5ms
0101b	0.5ms
0110b	1ms
0111b	2ms
1000b	4ms
1001b	6ms
1010b	10ms
1011b	25ms
1100b	50ms
1101b	100ms
1110b	500ms
1111b	1s

The current consumption of the accelerometer in low-power mode 1 (I_{DDlp1}) and low-power mode 2 (I_{DDlp2}) can be estimated according to the following formulae:

$$I_{DDlp1} \approx \frac{t_{sleep} \cdot I_{DDsum} + t_{active} \cdot I_{DD}}{t_{sleep} + t_{active}} .$$

$$I_{DDlp2} \approx \frac{t_{sleep} \cdot I_{DDsbm} + t_{active} \cdot I_{DD}}{t_{sleep} + t_{active}}$$

When estimating the length of the wake-up phase t_{active}, the corresponding typical wake-up time, $t_{w,up1}$ or $t_{w,up2}$ and t_{ut} (given in table 6) have to be considered:

If bandwidth is >=31.25 Hz:
$t_{active} = t_{ut} + t_{w,up1} - 0.9\ ms$ (or $t_{active} = t_{ut} + t_{w,up2} - 0.9\ ms$)
else:
$t_{active} = 4\ t_{ut} + t_{w,up1} - 0.9\ ms$ (or $t_{active} = 4\ t_{ut} + t_{w,up2} - 0.9\ ms$)

During the wake-up phase all analog modules are held powered-up, while during the sleep phase most analog modules are powered down. Consequently, a wake-up time of more than $t_{w,up1}$ ($t_{w,up2}$) ms is needed to settle the analog modules so that reliable acceleration data are generated.

5.2 IMU data accelerometer

5.2.1 Acceleration data

The width of acceleration data is 12 bits given in two´s complement representation. The 12 bits for each axis are split into an MSB upper part (one byte containing bits 11 to 4) and an LSB lower part (one byte containing bits 3 to 0 of acceleration and a *(ACC 0x02, 0x04, 0x06) new_data* flag). Reading the acceleration data registers shall always start with the LSB part. In order to ensure the integrity of the acceleration data, the content of an MSB register is locked by reading the corresponding LSB register (shadowing procedure). When shadowing is enabled, the MSB must always be read in order to remove the data lock. The shadowing procedure can be disabled (enabled) by writing ´1´ (´0´) to the bit *shadow_dis*. With shadowing disabled, the content of both MSB and LSB registers is updated by a new value immediately. Unused bits of the LSB registers may have any value and should be ignored. The *(ACC 0x02, 0x04, 0x06) new_data* flag of each LSB register is set if the data registers have been updated. The flag is reset if either the corresponding MSB or LSB part is read.

Two different streams of acceleration data are available, unfiltered and filtered. The unfiltered data is sampled with 2kHz. The sampling rate of the filtered data depends on the selected filter bandwidth and is always twice the selected bandwidth (BW = ODR/2). Which kind of data is stored in the acceleration data registers depends on bit *(ACC 0x13) data_high_bw*. If *(ACC 0x13) data_high_bw* is ´0´ (´1´), then filtered (unfiltered) data is stored in the registers. Both data streams are offset-compensated.

The bandwidth of filtered acceleration data is determined by setting the *(ACC 0x10) bw* bit as followed:

Table 6: Bandwidth configuration

bw	Bandwidth	Update Time t_{ut}
00xxx	*)	-
01000	7.81Hz	64ms
01001	15.63Hz	32ms
01010	31.25Hz	16ms
01011	62.5Hz	8ms
01100	125Hz	4ms
01101	250Hz	2ms
01110	500Hz	1ms
01111	1000Hz	0.5ms
1xxxx	*)	-

*) Note: Settings 00xxx result in a bandwidth of 7.81 Hz; settings 1xxxx result in a bandwidth of 1000 Hz. It is recommended to actively set an application specific and an appropriate bandwidth and to use the range from ´01000b´ to ´01111b´ only in order to be compatible with future products.

The accelerometer supports four different acceleration measurement ranges. A measurement range is selected by setting the *(ACC 0x0F)* range bits as follows:

Table 7: Range selection

Range	Acceleration measurement range	Resolution
0011	±2g	0.98mg/LSB
0101	±4g	1.95mg/LSB
1000	±8g	3.91mg/LSB
1100	±16g	7.81mg/LSB
others	reserved	-

5.2.2 Temperature Sensor

The width of temperature data is 8 bits given in two´s complement representation. Temperature values are available in the *(ACC 0x08) temp* register.

The slope of the temperature sensor is 0.5K/LSB, its center temperature is 23°C [*(ACC 0x08) temp* = 0x00].

5.3 Self-test accelerometer

This feature permits to check the sensor functionality by applying electrostatic forces to the sensor core instead of external accelerations. By actually deflecting the seismic mass, the entire signal path of the sensor can be tested. Activating the self-test results in a static offset of the acceleration data; any external acceleration or gravitational force applied to the sensor during active self-test will be observed in the output as a superposition of both acceleration and self-test signal.

Before the self-test is enabled the g-range should be set to 8 g. The self-test is activated individually for each axis by writing the proper value to the *(ACC 0x32) self_test_axis* bits (´01b´ for x-axis, ´10b´ for y-axis, ´11b´ for z-axis, ´00b´ to deactivate self-test). It is possible to control the direction of the deflection through bit *(ACC 0x32) self_test_sign*. The excitation occurs in negative (positive) direction if *(ACC 0x32) self_test_sign* = ´0b´ (´1b´). The amplitude of the deflection has to be set high by writing *(ACC 0x32) self_test_amp*=´1b´. After the self-test is enabled, the user should wait 50ms before interpreting the acceleration data.

In order to ensure a proper interpretation of the self-test signal it is recommended to perform the self-test for both (positive and negative) directions and then to calculate the difference of the resulting acceleration values. Table 8 shows the minimum differences for each axis. The actually measured signal differences can be significantly larger.