Technical Document

How to generate freefall interrupt using BMA400

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Table of contents

1 INTRODUCTION 3

2 SAMPLE CODE 3

3 TEST RESULT 5

4 LEGAL DISCLAIMER 7

4.1 ENGINEERING SAMPLES 7

4.2 PRODUCT USE 7

4.3 APPLICATION EXAMPLES AND HINTS 7

5 DOCUMENT HISTORY AND MODIFICATION 8

1 Introduction

Freefall interrupt is the unique feature of an accelerometer, which means that other motions cannot fake it. Whenever the accelerometer X/Y/Z axis acceleration all enter the predefined threshold zone simultaneously, the freefall event occurs. If the freefall event lasts longer than the predefined amount of time duration, then the freefall interrupt will be generated. The relationship between the freefall duration and freefall height can be found at https://www.grc.nasa.gov/WWW/k-12/airplane/mofall.html.

BMA400 is an ultra-low current consumption 3-axis 12-bit digital accelerometer. It consumes about 3.5uA at normal mode from 12.5Hz to 800Hz output data rate (ODR). At normal mode BMA400 continuously measures the X/Y/Z axis acceleration without duty-cycling and can still achieve such low current consumption. Therefore, there is no aliasing issue for BMA400 at normal mode.

BMA400 has two generic interrupts. They are designed to detect activity (beyond threshold) or inactivity (within threshold). The generic interrupt monitors acceleration change with respect to a reference. The difference between actual acceleration measurement and reference acceleration is calculated and compared against a threshold. The comparison is de-noised using a hysteresis. An interrupt is then triggered if these conditions last for a minimum time duration.

Generic interrupt 1 and 2 both have the same implementation but have different registers to configure them individually. Each of the interrupt has a set of 11 registers for configuration of this interrupt.

This technical document uses BMA400 generic interrupt 1 (Gen1) as an example to implement freefall interrupt. The threshold and time duration can be fine-tuned to meet the requirements of different products.

2 Sample code

Below is the pseudo code to initialize the BMA400 for freefall interrupt.

```
void init_BMA400(void)
{
        // configure common control registers

        Write 0x02 to register 0x19;        // bring BMA400 to normal mode form sleep mode
        Write 0x49 to register 0x1A;        // set BMA400 to 200Hz ODR, +/-4g full scale range
                                            and 0 over sampling rate (OSR) meaning one single
                                            measurement without averaging. The current
                                            consumption is about 3.5uA
        Write 0x00 to register 0x1B;        // select acc_filt1 200Hz as source for data registers

        // configure generic interrupt 1 parameters

        Write 0xF0 to register 0x3F;        // enable X/Y/Z axis for interrupt evaluation. Gen1
                                            interrupt engine data source is acc_filt2 which is
```

	fixed 100Hz ODR or 10ms time interval. Manual update and hysteresis 0mg
Write 0x01 to register 0x40;	// select inactivity detection which means the interrupt will be generated within the positive and negative threshold zone. Select AND logic meaning that when all enabled axes enter the threshold zone simultaneously an interrupt will be generated
Write 0x3F to register 0x41;	// set inactivity threshold to 0x3F = 63LSBs = 63LSBs * 8mg/LSB = 504mg (can be fine-tuned). So the threshold zone is +/-504mg
Write 0x00 to register 0x42;	// set MSB of Gen1 interrupt duration to 0x00
Write 0x0C to register 0x43;	// set LSB of Gen1 interrupt duration to 0x0C = 12LSBs = 12 * 10ms =120ms (can be fine-tuned). This corresponds to about 7cm height freefall. H = 0.5 * g * t^2 = 0.5 * 9.81m/s^2 * (0.12s)^2
Write 0x00 to register 0x44;	
Write 0x00 to register 0x45;	// set X axis reference to 0mg
Write 0x00 to register 0x46;	
Write 0x00 to register 0x47;	// set Y axis reference to 0mg
Write 0x00 to register 0x48;	
Write 0x00 to register 0x49;	// set Z axis reference to 0mg. Because the manual update is selected for Gen1, every 10ms BMA400 Gen1 will compare the X/Y/Z measurement data against the X/Y/Z references respectively to check if the differences are all within the threshold or not. If yes, then the duration timer will start counting. If not, then the duration timer will be reset to 0.
// configure interrupt registers	
Write 0x04 to register 0x1F;	// enable generic interrupt 1 (Gen1)
Write 0x04 to register 0x21;	// route Gen1 interrupt signal to INT1 pin
Write 0x22 to register 0x24;	// set INT1 pin and INT2 pin both to push-pull and active-high

}

Now when the freefall event happens and lasts for certain amount of time duration, BMA400 INT1 pin will have a pulse signal. The external MCU can pick up this interrupt signal and take action on it.

If the freefall interrupt signal is very important for the application and cannot be missed, then BMA400 Gen1 interrupt signal can be latched by writing the value of 0x80 to register 0x20. INT1 pin will be high all the time after freefall interrupt is generated. Reading register 0x0E will clear the interrupt signal on INT1 pin.

3 Test result

Below is the screenshot of the Development Desktop 2.0 GUI software. The software works with the APP2.0 application base board that has the BMA400 shuttle board plugged in.

Figure 1 shows that there are two freefall events detected with orange arrows. Both Gen1 and hardware INT1 pin show a pulse for each freefall interrupt.

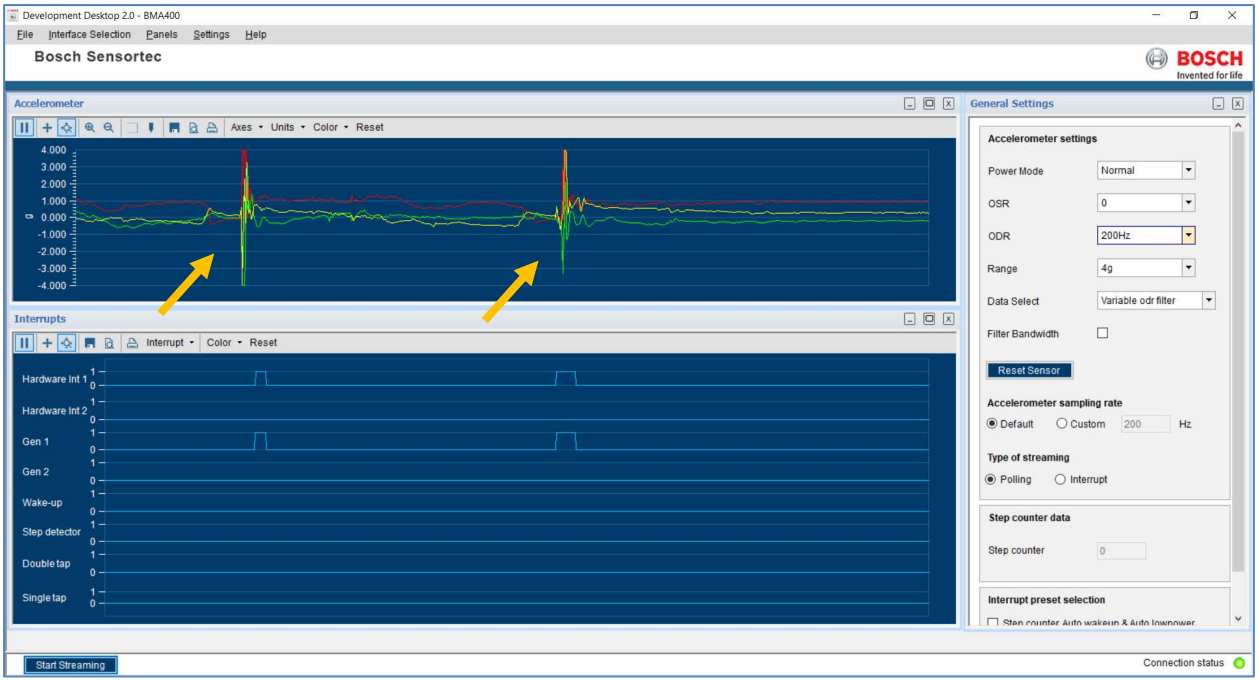

Figure 1: Freefall interrupt happened twice

Figure 2 shows interrupt mapping. After changing selections click “Write” button to make it take effect.

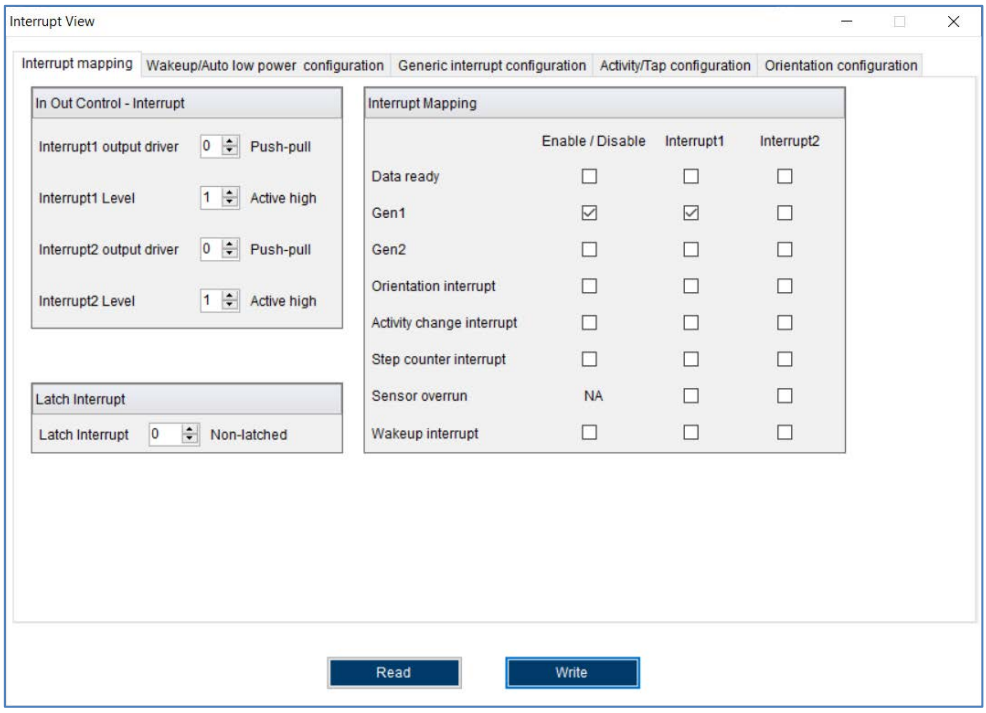

Figure 2 Interrupt mapping configurations

Figure 3 shows Gen1 configurations.

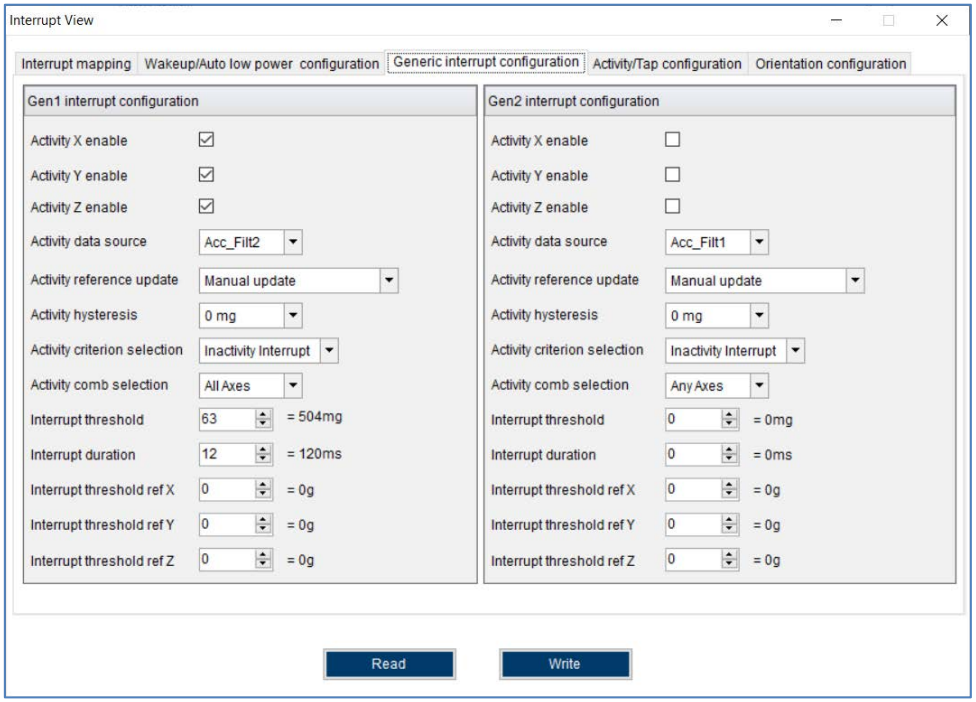

Figure 3 Gen1 configurations

4 Legal disclaimer

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5 Document history and modification

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