Setting up the MMA7660FC to do Orientation Detection

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ACRONYMS

ODR: Output Data Rate
AMSR: Auto Sleep Sample Rate
FILT: Debounce filter bits of orientation detection debounce filter
PLINT: Portrait/Landscape Interrupt
FBINT: Front/Back Interrupt
INT: Interrupt
TILT: Tilt (0x03) Register
INTSU: Interrupt Setup (0x06) Register
SR: Sample Rate (0x08) Register

ABSTRACT

The MMA7660FC has the built in capability to do orientation detection. This feature gives the customer the capability to do applications such as portrait/landscape in mobile phones/PMP/PDAs. The tilt orientation of the device is in 3 dimensions and is identified in its last known static position. This allows a product to set its display orientation appropriately to either portrait or landscape mode or to turn off the display when the device is placed upside down. The sensor provides 6 different positions: left, right, up, down, back, and front, defined in Table 1 and Figure 1. This application note will explain how to configure the MMA7660FC to do orientation detection given the desired sample rate or targeted power consumption.

Table 1. Orientation Detection Logic of when Interrupt will Occur

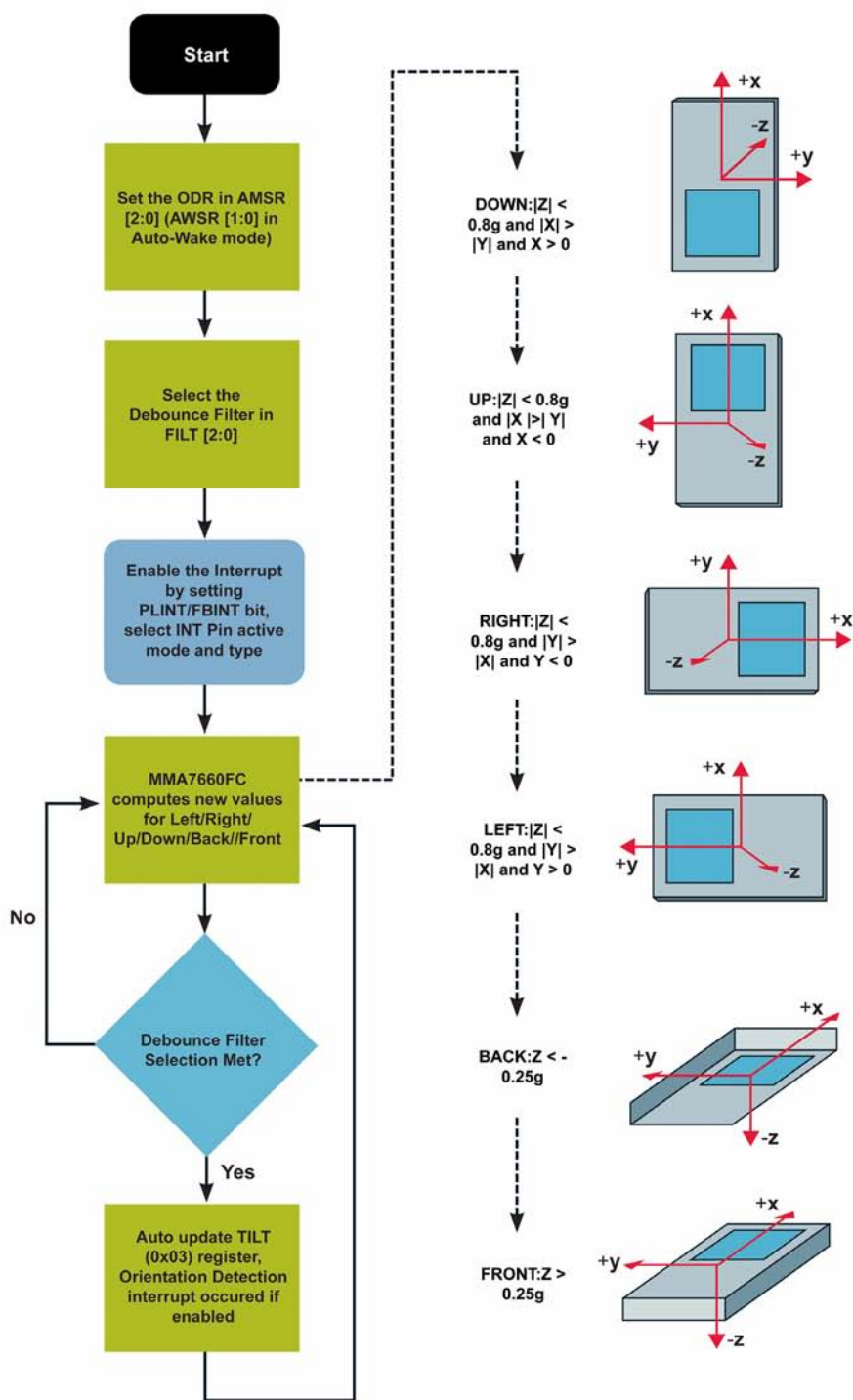| Orientation	Xg	Yg	Zg
Up	|Z| < 0.8g and |X| > |Y| and X < 0		
Down	|Z| < 0.8g and |X| > |Y| and X > 0		
Right		|Z| < 0.8g and |Y| > |X| and Y < 0	
Left		|Z| < 0.8g and |Y| > |X| and Y > 0	
Back			Z < -0.25g
Front			Z > 0.25g

Figure 1. Flow Chart of Orientation Detection Setup and Algorithm

SAMPLE RATE

The sampling rate can be selected based on the targeted power consumption per the application specification or the desired response rate of the orientation detection. When deciding on the response rate, keep in mind that the faster the sampling rate, the faster the interrupt will occur. The trade-off is that the higher the sampling rate, the higher the power consumption is. The following are the sample rates available in the MMA7660FC sensor with the corresponding approximate power consumption rates.

NOTE: These current drain rates were tested in the factory and could vary given PCB board design.

Table 2. Sample Rate vs. Current Consumption

Sampling Rate	Current Consumption
Stand By	2.33 μA
1 SPS	46.9 μA
2 SPS	49.3 μA
4 SPS	54 μA
8 SPS	65.8 μA
16 SPS	89.2 μA
32 SPS	133 μA
64 SPS	221 μA
120 SPS	294 μA

REGISTER OVERVIEW FOR ORIENTATION DETECTION

The following are the registers that will be used and/or configured for orientation detection.

$03: Tilt Status (Read only)
TILT

D7	D6	D5	D4	D3	D2	D1	D0
X	Alert	X	PoLa[2]	PoLa[1]	PoLa[0]	BaFro[1]	BaFro[0]
0	0	0	0	0	0	0	0

$06: Interrupt Setup Register
INTSU - Read/Write

D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	X	X	PLINT	FBINT
0	0	0	0	0	0	0	0

$08: Auto-Wake and Active Mode Portrait/Landscape Output data rates register (Read/Write)
SR – Sample Rate Register

D7	D6	D5	D4	D3	D2	D1	D0
FILT[2]	FILT[1]	FILT[0]	X	X	AMSR[2]	AMSR[1]	AMSR[0]
0	0	0	0	0	0	0	0

AN3840

Setting up the INTSU [0x06] Register for Orientation Detection Only

Based on the application specification of the MMA7660FC, the sensor can be configured to report back/front interrupts and/or up/down/left/right interrupts. If the application targets to use back and front the FBINT bit must be set to 1. If the back and front interrupt is not desired then set the FBINT bit to 0. If the application targets Up/Down/Left/Right interrupts then the PLINT bit must be set to 1. If the Up/Down/Left/Right interrupt is not desired then set the PLINT bit should be set to 0.

INTSU- Read/Write

D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	X	X	PLINT	FBINT
0	0	0	0	0	0	0	0

FBINT

0:Front/Back position change does not cause an interrupt
1:Front/Back position change causes an interrupt

PLINT

0:Up/Down/Right/Left position change does not cause an interrupt
1:Up/Down/Right/Left position change causes an interrupt

NOTE: For further description of the INTSU (0x06) register, please refer to the MMA7660FC Data Sheet.

Setting up the SR (0x08) register for orientation detection only:

The sample rate must be selected based on target power consumption levels and/or desired response rate for the orientation detection application. To set up the sample rate, the AMSR[3:0] must be configured. Given the selected sample rate a debounce filter setting (FILT[3:0]) must be selected also. Application testing has been done to correlate the sample rate and the recommended debounce filter setting. Refer to Table 3.

SR – Read/Write

D7	D6	D5	D4	D3	D2	D1	D0
FILT[2]	FILT[1]	FILT[0]	X	X	AMSR[2]	AMSR[1]	AMSR[0]
0	0	0	0	0	0	0	0

AMSR[2:0]	NAME	DESCRIPTION
000	AMPD	120 Samples/Second Active and Auto-Sleep Mode **For portrait/landscape detection:** The device takes and averages 32 g-cell measurements every 8.36 ms in Active Mode and Auto-Sleep. The update rate is 120 samples per second. These measurements update the XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.
001	AM64	64 Samples/Second Active and Auto-Sleep Mode **For portrait/landscape detection**: The device takes and averages 32 g-cell measurements every 15.625 ms in Active Mode and Auto-Sleep. The update rate is 64 samples per second. These measurements update the XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.
010	AM32	32 Samples/Second Active and Auto-Sleep Mode **For portrait/landscape detection:** The device takes and averages 32 g-cell measurements every 31.25ms in Active Mode and Auto-Sleep. The update rate is 32 samples per second. These measurements update XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.
011	AM16	16 Samples/Second Active and Auto-Sleep Mode **For portrait/landscape detection:** The device takes and averages 32 g-cell measurements every 62.5ms in Active Mode and Auto-Sleep. The update rate is 16 samples per second. These measurements update the XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.

100	AM8	8 Samples/Second Active and Auto-Sleep Mode **For portrait/landscape detection:** The device takes and averages 32 g-cell measurements every 125ms in Active Mode and Auto-Sleep. The update rate is 8 samples per second. These measurements update the XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.
101	AM4	4 Samples/Second Active and Auto-Sleep Mode **For portrait/landscape detection:** The device takes and averages 32 g-cell measurements every 250ms in Active Mode and Auto-Sleep. The update rate is 4 samples per second. These measurements update the XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.
110	AM2	2 Samples/Second Active and Auto-Sleep Mode **For portrait/landscape detection:** The device takes and averages 32 g-cell measurements every 500ms in Active Mode and Auto-Sleep. The update rate is 2 samples per second. These measurements update the XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.
111	AM1	1 Sample/Second Active and Auto-Sleep Mode **For portrait/landscape detection:** The device takes and averages 32 g-cell measurements every 1000ms in Active Mode and Auto-Sleep. The update rate is 1 samples per second. These measurements update the XOUT (0x00), YOUT (0x01), and ZOUT (0x02) registers also.

| FILT[2:0]	DESCRIPTION
000	Tilt debounce filtering is disabled. The device updates portrait/landscape every reading at the rate set by AMSR[2:0] or AWSR[1:0]
001	2 measurement samples at the rate set by AMSR[2:0] or AWSR[1:0] have to match before the device updates portrait/landscape data in TILT (0x03) register.
010	3 measurement samples at the rate set by AMSR[2:0] or AWSR[1:0] have to match before the device updates portrait/landscape data in TILT (0x03) register.
011	4 measurement samples at the rate set by AMSR[2:0] or AWSR[1:0] have to match before the device updates portrait/landscape data in TILT (0x03) register.
100	5 measurement samples at the rate set by AMSR[2:0] or AWSR[1:0] have to match before the device updates portrait/landscape data in TILT (0x03) register.
101	6 measurement samples at the rate set by AMSR[2:0] or AWSR[1:0] have to match before the device updates portrait/landscape data in TILT (0x03) register.
110	7 measurement samples at the rate set by AMSR[2:0] or AWSR[1:0] have to match before the device updates portrait/landscape data in TILT (0x03) register.
111	8 measurement samples at the rate set by AMSR[2:0] or AWSR[1:0] have to match before the device updates portrait/landscape data in TILT (0x03) register.

Table 3. Sample Rate vs. Debounce Filter Table

Sample Rate	Debounce Filter Setting
1 SPS	4
2 SPS	6
4 SPS	8
8 SPS	8
16 SPS	8
32 SPS	8
64 SPS	External Debounce Filter
120 SPS	External Debounce Filter

NOTE: The recommended values were tested on the RD3803MMA7660FC evaluation board. The values may change given the mounting and position of the sensor on the PCB design.

External Debounce Filter:

When using the MMA7660FC and sample rates higher than 32 SPS an external debounce filter must be added to avoid flickering between positions due to involuntary human movement. The external debounce filter must be added to the application microcontroller. Below is a flow chart and Pseudocode for the debounce filter.

Figure 2. External Debounce Filter
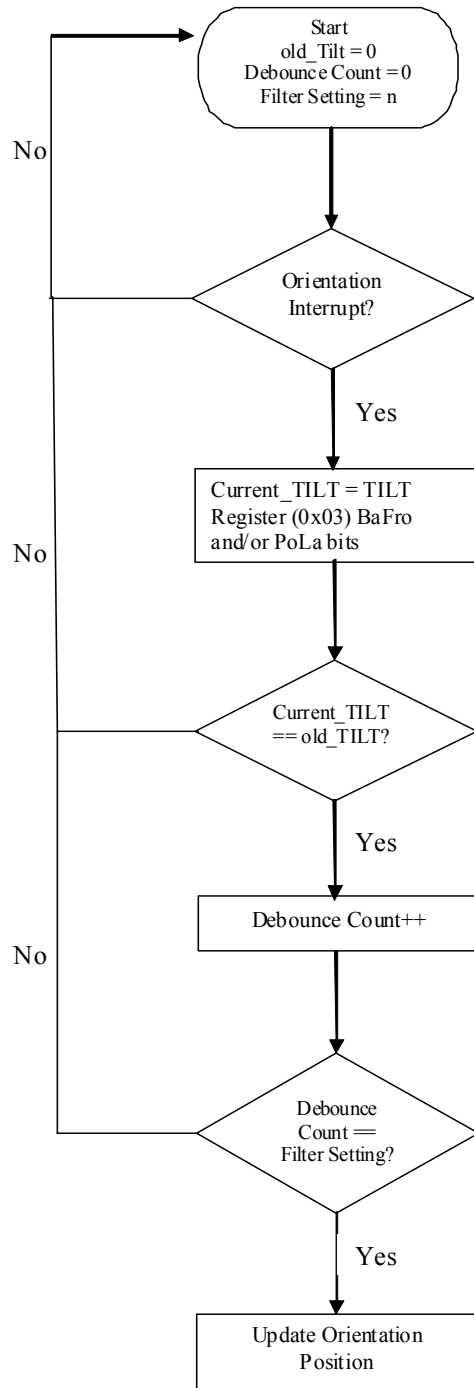
PSEUDOCODE:

```
//Configure Orientation Detection
Interrupts
FILTER_SETTING = n
If(TILT_Interrupt occurs)
          read TILT Register
          if(old_TILT ==
current_TILT)
                     Debounce
Count++
If(Debounce Count == FILTER_SETTING)
          //orientation =
current_TILT
```

HANDLING THE ORIENATION DETECTION INTERRUPT

When an interrupt occurs, the application must respond and read the TILT (0x03) register. When reading the TILT register the bits of interest are the following POLA[4:2] and BAFRO[1:0]. The interrupt will be cleared when the TILT register is read.

NOTE: If the register is read and the Alert bit is high, the register must be read again.

TILT – Read Only

D7	D6	D5	D4	D3	D2	D1	D0
X	Alert	X	PoLa[2]	PoLa[1]	PoLa[0]	BaFro[1]	BaFro[0]
0	0	0	0	0	0	0	0

BaFro[1:0]
00:Unknown condition of front or back
01:Front:Equipment is lying on its front
10:Back:Equipment is lying on its back

PoLa[2:0]
000:Unknown initial condition of up or down or left or right
001:Left:Equipment is in landscape mode to the left
010:Right:Equipment is in landscape mode to the right
101:Down:Equipment standing vertically in inverted orientation (any markings are the wrong way up)
110:Up:Equipment standing vertically in normal orientation (any markings are the right way up)

Alert
0:Register data is valid
1:The register was read at the same time as MMA7660FC was attempting to update the contents. Re-read the register

AN3840

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