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Performing Offset Calibration using the MMA7660FC

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ACRONYMS

PMP: Portable Media Player
PDA: Personal Digital Assistant

ABSTRACT

Offset calibration is very important for applications such as tilt for gaming and hand gesturing on mobile phones/PMP/PDA devices. There are a number of proponents when it comes to offset errors such as trim errors, mechanical stresses due to package and mounting, shifts due to temperature and aging. This application note will describe how to do offset calibration for the MMA7660FC with a Microcontroller.

NOTE: For more information on the importance of offset calibration, please refer to AN3447, “Implementing Auto Zero Calibration Technique for Accelerometers”.

REGISTER DEFINITIONS

The following are the registers that will be used when performing offset calibration with the MMA7660FC.

Address = 0x31

D7	D6	D5	D4	D3	D2	D1	D0
XOFF[0]	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Address = 0x32

D7	D6	D5	D4	D3	D2	D1	D0
XOFF[8]	XOFF[7]	XOFF[6]	XOFF[5]	XOFF[4]	XOFF[3]	XOFF[2]	XOFF[1]

Address = 0x33

D7	D6	D5	D4	D3	D2	D1	D0
YOFF[5]	YOFF[4]	YOFF[3]	YOFF[2]	XOFF[1]	YOFF[0]	XOFF[10]	XOFF[9]

Address = 0x34

D7	D6	D5	D4	D3	D2	D1	D0
ZOFF[2]	ZOFF[1]	ZOFF[0]	YOFF[10]	YOFF[9]	YOFF[8]	YOFF[7]	YOFF[6]

Address = 0x35

D7	D6	D5	D4	D3	D2	D1	D0
ZOFF[10]	ZOFF[9]	ZOFF[8]	ZOFF[7]	ZOFF[6]	ZOFF[5]	ZOFF[4]	ZOFF[3]

Polarity

	Bit[10]
0	+ value
1	- value

NOTE: XOFF [10], YOFF [10] and ZOFF [10] are the polarity bits of the offset value (0 = + Value, 1 = - Value). The values to be written to the device are not 2's complement.

$07: Mode Register (Read/Write)
MODE

D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	X	TON	—	MODE
0	0	0	0	0	0	0	0

MODE
0: Standby mode or Test Mode depending on state of TON
1: Active mode
Existing state of TON bit must be 0, to write MODE = 1. Test Mode must not be enabled. MMA7660FC always enters Active Mode using the samples per second specified in AMSR[2:0] of the SR (0x08) register. When MMA7660FC enters Active Mode with [ASE:AWE] = 11, MMA7660FC operates Auto-Sleep functionality first.

TON
0: Standby Mode or Active Mode depending on state of MODE
1: Test Mode
Existing state of MODE bit must be 0, to write TON = 1. Device must be in Standby Mode.
In Test Mode (TON = 1), the data in the XOUT, YOUT and ZOUT registers is not updated by measurement, but is instead updated by the user through the I^2C interface for test purposes. Changes to the XOUT, YOUT and ZOUT register data is processed by MMA7660FC to change orientation status and generate interrupts just like Active Mode. Debounce filtering and shake detection are disabled in Test Mode.

Table 1. Modes of Operation

Mode of Operation	D0 - MODE	D2 - TON
Standby Mode	0	0
Test Mode	0	1
Active Mode	1	0

NOTE: For further description of the MODE (0x07) register, please refer to the MMA7660FC Data Sheet.

OVERVIEW OF STEPS FOR OFFSET CALIBRATION

1. Read values in the offset registers. Registers 0x31 – 0x35
2. Calculate updated value to be written to offset calibration registers
3. Set up the device to be put into factory test mode so that the offset registers can be re-written and stored to NVM
4. Write new offset register values and store in MCU

NOTE: DO NOT read calibration registers after new values are written. When the read occurs, it compares the register values to the factory programmed values, which are fused into the device, since they do not match, it clears the register values and uses the factory programmed values.

CALCULATING THE UPDATED OFFSET VALUES

1. Hold the device on the horizontal plane, the position of X = 0g, Y = 0g and Z = +1g.
2. Capture multiple readings (i.e. 64 times) and then take the averages. This yields 'actual' values of X_{0g}, Y_{0g} and Z_{1g}.
3. Take the values and see how far from 0 X and Y are and how far from 21 Z is from the averaged values. The offset shift values are: X_Shift = -2* X_{0g}, Y_Shift = -2* Y_{0g}, and Z_Shift = -2* (Z_{1g} - 21). The value must be multiplied by 2 because when writing offset value, 1 count = 1/2 count in offset registers and the (-) is because of opposite polarity.
4. Separate the XOFF[10:0], YOFF[10:0]and ZOFF[10:0]code from the values of registers 31 to 35. Compensate offset codes by adding the shift value to each axis individually: XOFF[10:0]+ X_Shift; YOFF[10:0]+ Y_Shift and ZOFF[10:0]+ Z_Shift. Please take care of the value polarity.
5. Using the steps above, offset calibration is achieved by obtaining the new offset code and writing it to registers 31 to 35.

NOTE: The new offset codes are stored in registers 31-35, they will be erased if the MMA7660FC has a loss of power or AVDD is shut off. The values are still there if the device is put into standby mode. Therefore, the user should store the shift values in the Microcontroller, and re-write to(31-35) registers if the MMA7660FC is powered on or AVDD is power cycled.

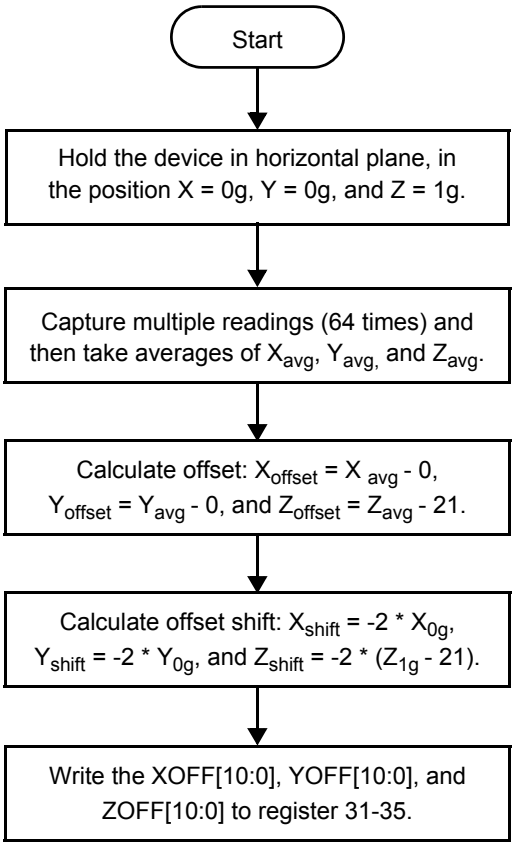

Figure 1. Offset Calibration Flow Chart

PSEUDOCODE FOR OFFSET CALIBRATION

NOTE: Register 22 has to be set to 0xFF before writing to an offset register. After writing, Register 22 must be set to 0xFE and then back to 0xFF. Only 1 register can be written at a time.

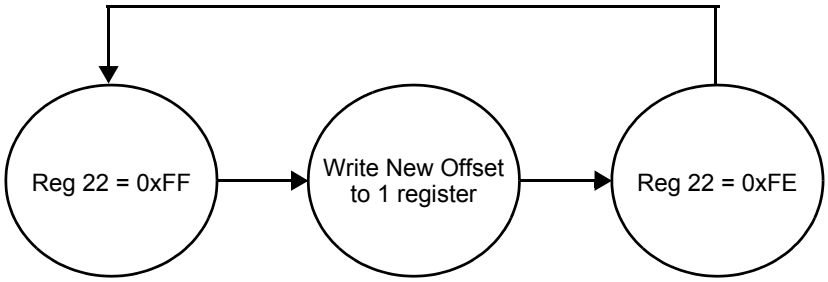

Figure 2. Write New Offset Values

```
//Hold MMA7660FC on horizontal plane, put it in active mode and get the shift value
X_Shift = (64 times reading sum)/64*(-2)
Y_Shift = (64 times reading sum)/64*(-2)
Z_Shift = ((64 times reading sum)/64-21) *(-2)
//Put Device in Standby Mode
Write to the MODE register = 0x00
//Put Device in Factory Test Mode
Write to 0x20 register = 0x01
Write to 0x20 register = 0x02
Read 0x20 register = 0x03 //If all done correctly this register should read 0x03
// Set Device to Active Mode
Write to the MODE register = 0x01
//Read OFFSET Registers
Reg31 = Read 0x31 register
Reg32 = Read 0x32 register
Reg33 = Read 0x33 register
Reg34 = Read 0x34 register
Reg35 = Read 0x35 register
//Unpack XOFF[10:0], YOFF[10:0] and ZOFF[10:0], calculate the new offset code by adding X/Y/Z
shift values.
New_XOFF[10:0] = XOFF[10:0]+ X_Shift
New_YOFF[10:0] = YOFF[10:0]+ Y_Shift
New_ZOFF[10:0] = ZOFF[10:0]+ Z_Shift
//Write New OFFSET Reg Values
Write to 0x22 register = 0xFF
Write to 0x31 register = New Offset code
Write to 0x22 register = 0xFE
Write to 0x22 register = 0xFF
Write to 0x32 register = New Offset code
Write to 0x22 register = 0xFE
Write to 0x22 register = 0xFF
Write to 0x33 register = New Offset code
Write to 0x22 register = 0xFE
Write to 0x22 register = 0xFF
Write to 0x34 register = New Offset code
Write to 0x22 register = 0xFE
Write to 0x22 register = 0xFF
Write to 0x35 register = New Offset code
Write to 0x22 register = 0xFE
```

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