

Freescale Semiconductor Application Note

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MMA845x Driver: Quick Start Guide

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Introduction 1

This quick start guide demonstrates how to load the MMA845x driver and also outlines some of the elementary function commands available. For a more in-depth look at the function commands, please refer to AN4076, Data Manipulation and Basic Settings of the MMA8451, 2, 3Q. The purpose of the driver is to give the customer the capability to access the device registers and to be able to configure the driver with a Freescale microcontroller. For this particular driver, the following hardware is used: the Sensor Toolbox Board (RDDMA845x) and the Freescale 8-bit microcontroller (MC9S08QE8). The HyperTerminal program was used for the examples listed in this document, but any terminal emulation tool may be used. To make modifications to the program, the user will need a USB BDM multilink cable and Freescale's CodeWarrior HCS08.

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2 MMA8451, 2, 3Q Consumer 3-axis Accelerometer 3 by 3 by 1 mm

The MMA8451, 2, 3Q has a selectable dynamic range of $\pm 2g$, $\pm 4g$, and $\pm 8g$. The device has eight different output data rates, selectable high-pass filter cutoff frequencies, and high-pass filtered data. The available resolution of the data and the embedded features are dependent on the specific device selected.

Note: The MMA8450Q has a different memory map and has a slightly different pinout configuration.



Figure 1. MMA8451, 2, 3Q Consumer 3-axis Accelerometer 3 by 3 by 1 mm

2.1 Key Features of the MMA845xQ

The key features of the MMA845xQ are:

- Current consumption:
 - Standby Mode: 1.8 mA
 - Low-power Mode (1.56 Hz 800 Hz): 6 mA 165 mA
 - Normal Mode (1.56 Hz 800 Hz): 24 mA 165 mA
- I²C digital output interface (operates to 2.25 MHz with 4.7 k Ω pullup)
- 14/12/10-bit and 8-bit data or high-pass filtered data
- $\pm 2g/\pm 4g/\pm 8g$ dynamically selectable full-scale
- Noise: 99 mg/Hz
- 14-bit and 8-bit digital output
- Self-Test



2.2 Programmable Interrupt Pins for eight Interrupt Sources

- 1. Embedded four channels of Motion detection
 - a) Freefall or Motion detection: two channels
 - b) Tap detection: one channel
 - c) Transient detection: one channel
- 2. Embedded orientation (Portrait/Landscape) detection with hysteresis compensation
- 3. Embedded automatic ODR change for auto-wakeup and return-to-sleep
- 4. Embedded 32-sample FIFO
- 5. Data-ready interrupt setup for example code and driver program

Table 1. Features of the MMA845xQ devices

Feature List	MMA8451	MMA8452	MMA8453
Digital Resolution (Bits)	14	12	10
Digital Sensitivity (Counts/g)	4096	1024	256
Data-Ready Interrupt	Yes	Yes	Yes
Single-Pulse Interrupt	Yes	Yes	Yes
Double-Pulse Interrupt	Yes	Yes	Yes
Directional-Pulse Interrupt	Yes	Yes	Yes
Auto-WAKE	Yes	Yes	Yes
Auto-SLEEP	Yes	Yes	Yes
Freefall Interrupt	Yes	Yes	Yes
32 Level FIFO	Yes	No	No
High-Pass Filter	Yes	Yes	Yes
Low-Pass Filter	Yes	Yes	Yes
Orientation Detection Portrait/Landscape = 30°, Landscape to Portrait = 60°, and Fixed 45° Threshold	Yes	Yes	Yes
Programmable Orientation Detection	Yes	No	No
Motion Interrupt with Direction	Yes	Yes	Yes
Transient Detection with High-Pass Filter	Yes	Yes	Yes
Low-Power Mode	Yes	Yes	Yes



2.3 Necessary tools and software

To access the driver program with the HyperTerminal program, the user will need to have a RDMMA845X Sensor Toolbox kit, CodeWarrior version 6.3 and a USB BDM multilink cable. The RDMMA845X will need to be reprogrammed with the MMA845x driver.

http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MMA8451Q&fpsp=1&tab=Design _Tools_Tab

To purchase a USB BDM multilink cable:

http://www.pemicro.com/products/product_viewDetails.cfm?product_id=33&CFID=8416068&CFTOK EN=69663eb1f8907b16-C474EE01-FD08-E31E-64D23BB70CDEA46



Figure 2. USB BDM multilink cable

To download CodeWarrior:

http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=CW-MICROCONTROLLERS



2.4 How to program the RDMMA845x with the driver program

Once the necessary tools are installed, the driver program will need to be programmed into the RDMMA845xQ Sensor Toolbox board:

- 1. Plug the BDM cable into the J1 of the RDMMA845X Sensor Toolbox board. Make sure that pin 1 is connected to the red part of the ribbon cable on the BDM connector.
- 2. Using CodeWarrrior
 - a) Select Project > Debug (F5)
 - b) The True-Time Simulator & Real-Time Debugger will appear with the PEMICRO Connection Manager. Select Connect (Reset)

PEMICRO Connection Manager								
You have selected to display this dialog on startup. Specify communications parameters and click OK.								
Connection port and Interface Type								
Interface: USB HCS08/HCS12/CFV1 Multilink - USB Port								
Port: USB-ML-12 Rev C on USB1 (Name=PE5515086) (Autodetected)								
Interface Detected : Firmware Version : Socket Programming Adapter Settings								
Target CPU Information								
CPU: HCS08 Processor - Autodetect								
MCU reset line: MCU Voltage:								
Cyclone Pro Power Control (Voltage> Power-Out Jack)								
Provide power to target Regulator Output Voltage Power Down Delay 250 mS								
Power off target upon software exit 5V Power Up Delay 250 mS								
Default trim reference frequency is : 32768.00 Hz (Valid Range: 31250.00 to 39062.50 Hz) Image: Use custom trim reference frequency : 36000.00 Hz Click for trim details.								
Connect (Beset) Hotsvinc Abort								
Show this dialog before attempting to contact target [Utherwise only display on Error]								

Figure 3. PEMICRO connection manager



c) Select Yes when prompted to Erase and Program flash?



Figure 4. Erase and Program flash

d) Once programmed, select the green arrow to run the program

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THE VIEW KUN MUITUIINKLYCODEPTD COMPONENT NIEMONY WINDOW TEEP			
		<u></u>	
S Source	23	Assembly	
C:\Users\R65136\Documents\Accelerometer Product\Veyron\Vicks Veyron Code for Customers\\main.c Line: 71	100	main	
<pre>* Main Control Loop void main (void) {## /* ** Initialize system variables. // /* /* mildlize system variables. // // /* /* Main for user input before proceeding. // // /* /* Main for user input before proceeding. // /* /* Initiate terminal interface. // /* /* Terminal Int(); /* /* Verify IIC communications with the accelerometer // // /* /* Verify IIC communications with the accelerometer // // /* /* Verify IIC communications with the accelerometer // // /* /* Performant Communications with the accelerometer // // // /* // /* //</pre>		(753 C23 0x60) 173 JSR 0xED1 2739 SCL 2739 SCL 2739 SCL 2738 C38 2739 SCL 2738 C38 2738 C48 2739 C48 2738 C48 2739 C48 2738 C48 2739 C48 <td>- - - - -</td>	- - - - -
E David		Will Manuar	
La contra la con	by by	and memory	
B SystemFlag (1) SIT_FILD SlavEAdsteanIIC 138 unipped char functional_Dlock 250 unipped char B velue (40 array[8] of unsigned char B RegisterIng (10 InT_FILD B RegisterIng (10 array[1] of unsigned char B adsteag in (4) array[1] of unsigned char B adsteag out (4) array[1] of tilo_sample B filo_data (192) array[10] of tilo_sample B filo_data (192) array[10] of const unsigned char		0000 27 C6 18 25 A4 40 27 F9 86 81 01 42 E9 42 E9 42 8.8'8.B. 0000 26 39 E9 42 E9 42 E5 38 75 42 E0 79 ED 5E 54 42 8.8'8.B. 0000 27 67 42 E9 42 E4 42 54 24 A2 54 20 77 ED 6E 59 42 8.8'8.B. 8.7.B.S.J. 0000 27 67 42 E9 42 E4 42 54 24 A2 54 22 E9 76 70 E6 50 8.7.B.S.J.	
Data2	83	Command	
I main Auto Symb Le	cal	done .\cmd/BEM_FAE_Maltilmk_CycloneFro_postload.cmd Postload.command file correctly executed. main DATUIT Frequency change to -9239130hz. STAREE HUNDING Prease breakpoint encountered. Breakpoint inb 	

Figure 5. True-Time Simulator & Real-Time Debugger



2.5 Setting up the Terminal Emulator

A terminal emulator such as HyperTerminal, will be used for the driver program examples.

1. Connect to the COM port being used by the RDMMA845x Sensor Toolbox board. To check the COM port being used, go to the Device Manager and check the Ports. The port being used will be "USB Serial Port".



Figure 6. Device Manager



2. For the Port Settings, the following should be selected: Bits per second = 115200, Data bits = 8, Parity = None, Stop bits = 1, Flow control = None. Select Apply and then OK.

COM5 Properties	8 23
Port Settings	
Bits per second: 115200	•
Data bits: 8	
Panty: None	•
Stop bits: 1	•
Flow control: None	•
	Restore Defaults
ОК Саг	ncel Apply

Figure 7. Port Settings configuration

3. In the terminal window, type any key. This will start the program. A message will appear if everything is configured correctly.

```
I
```

** **	Freesca MMA845 Using	∃le Semic ×Q Driver the MC9S0	conductor 98QE8	** ** **				
××				**				
**	Mar 28	2012	11:29:17	××				
Data	a Flash	JEDEC II) : Manf=BF	Type=2	ō Capacity=4A :	SST25VF032B		
MMA8	8451Q :	0verSa	mple = High	n Res	ODR = 12.5Hz	HP = 16Hz	Mode =	2g
MMA8	3451Q>							

Figure 8. Driver program message

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4. To get the menu of commands type in "? [Enter]"

Data Flash	JEDEC ID : Manf=BF Type=25 Capacity=4A : S\$T25VF032B
MMA8451Q :	OverSample = High Res ODR = 12.5Hz HP = 16Hz Mode = 2g
MMA8451Q>?	List of MMA845x commands:
Mn :	Mode 1=Standby; 2=2g; 4=4g; 8=8g
On :	Oversampling 0=Normal; 1=LNLP; 2=HighRes; 3=LP
RO n :	ODR Hz 0=800; 1=400; 2=200; 3=100; 4=50; 5=12.5; 6=6.25; 7=1.56
RR xx :	Register xx Read
RW xx=nn :	Register xx Write value nn
RH n :	High Pass Filter 0 - 3, 4=off
RF :	Report ODR speed, HP Filter freq and Mode
C a :	XYZ data as signed counts: a=N Normal data; a=H HPF data
G a :	XYZ data as signed g's: a=N Normal data; a=H HPF data
3 aa . : T	aa: CN=counts Normal, CH=counts HPF, GN=g's Normal, GH=g's HPF
1 da n :	aa: CN=counts Normal, CH=counts HPF, GN=g's Normal, GH=g's HPF
;	n: 1=INT1; 2=INT2
⊢ aa ww :	Stream XYZ via F1FU
:	aa: CN=counts Normal, CH=counts HPF, GN=g's Normal, GH=g's HPF
:	ww: Watermark= 1 to 31

MMA8451Q>

Figure 9. Menu Command List



Function:	PC to S08	S08 to PC	Notes/comments	
Read XYZ as signed counts	CN (Normal Data) or CH (High-Pass Filter Data)	X = nn Y = nn Z = nn	Example of response: X = -250 Y = -126 Z = +968	
Read XYZ as signed g's	GN (Normal Data) or GH (High-Pass Filter Data)	X = nng Y = nng Z = nng	Example of response: X = -0.1992g Y = -0.0577g Z = +0.9473g	
Stream XYZ, polling	S aa: (aa: CN = counts Normal, CH = counts HPF, GN = g's Normal, GH = g's HPF)	X = nn Y = nn Z = nn, repeated	Example of response: X = -250 Y = -126 Z = +968, repeated.	
Stream XYZ, interrupts	I aa n (aa: $CN = counts$ Normal, $CH = counts$ HPF, $GN = g$'s Normal, GH = g's HPF n: 1 = INT1; 2 = INT2)	X = nn Y = nn Z = nn, repeated	Example of response: X = -250 Y = -126 Z = +968, repeated.	
Stream XYZ, FIFO	F aa ww: (aa: CN = counts Normal, CH = counts HPF, GN = g's Normal, GH = g's HPF, ww: Watermark = 1 to 31)	FIFO Watermark Samples = x group = xx X = xx Y = xx Z = xx	Example of response: FIFO Watermark Samples = 3 group = 3B, repeated. X = -214 Y = -39 Z = +968 X = -216 Y = -40 Z = +967 X = -212 Y = -37 Z = +970	

Table 2. Menu commands



3 Capturing XYZ data

To assist in algorithm development or to check parameters of the sensor, the driver has the capability to stream XYZ data in both counts/g's. In order to capture the data for post processing, HyperTerminal has a "Capture Text" feature and Microsoft Excel can be used to view the data.

- 1. In HyperTerminal, select Transfer > Capture Text. The Capture Text box appears.
- 2. Select the Browse button and save the file to a known location. Then click the Start button.



- 3. Select one of the stream commands. The data will log.
- 4. Once a satisfactory amount of data has been collected, select Transfer > Capture Text > Stop
- 5. Open Microsoft Excel and locate and open the log file.

Note: If the file does not appear select the Files Of Type drop down menu and select All Files (*.*)

Open		2 🗙
Look in:	🞯 Desktop	💌 🕲 • 🗈 🗙 📷 •
My Recent Documents Documents My Documents R65136-12 My Network Places	Wy Documents R65136 on R65136-12 My Network Places FSL Quick Links Cock Workstation Sagit 9 Snagit 9 Documentation MMA955X Test Tool MMA7660 Noise Application RIM Analysis Unused Desktop Shortcuts capture.txt test.TXT File name:	
	Files of type: All Files (*.*)	~
Tools		Open Cancel

- 6. The Text Import Wizard will appear, select the Delimited option and select Next.
- 7. Select the Semicolon option and in Other type in "=". Then select Finish.
- 8. The data set will have 6 columns: X, X data, Y, Y data, Z, Z data

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Х	X data	Y	Y data	Z	Z data
Х	-20	Y	181	Z	970
Х	-22	Y	185	Z	972
Х	-23	Y	183	Z	975
Х	-22	Y	187	Z	970
Х	-25	Y	181	Z	972
Х	-21	Y	185	Z	969
Х	-19	Y	183	Z	972
Х	-19	Y	180	Z	968
Х	-21	Y	186	Z	973
Х	-22	Y	182	Z	970
Х	-23	Y	183	Z	971
Х	-17	Y	183	Z	969
Х	-22	Y	181	Z	970
Х	-19	Y	183	Z	971
Х	-25	Y	183	Z	969
Х	-20	Y	183	Z	968
Х	-24	Y	184	Z	969
Х	-23	Y	184	Z	969
Х	-23	Y	183	Z	970
Х	-22	Y	185	Z	969
Х	-20	Y	184	Z	970
Х	-24	Y	182	Z	968
Х	-21	Y	180	Z	970
Х	-22	Y	182	Z	973
Х	-20	Y	183	Z	973
Х	-22	Y	183	Z	972
Х	-22	Y	184	Z	972
Х	-21	Y	181	Z	970
Х	-20	Y	181	Z	969
Х	-25	Y	184	Z	971
Х	-20	Y	182	Z	971
X	-23	Y	184	Z	970
X	-22	Y	181	Z	971
Х	-21	Y	181	Z	969
Х	-21	Y	184	Z	971
X	-20	Y	181	Z	971
X	-22	Y	184	Z	972
X	-24	Y	182	Z	970
X	-22	Y	181	Z	970
X	-22	Y	182	Z	971
X	-20	Y	183	Z	969
Х	-26	Y	184	Z	970
Х	-23	Y	182	Z	970

Table 3. X, X data, Y, Y data, Z, Z data

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