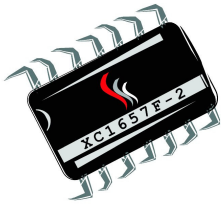
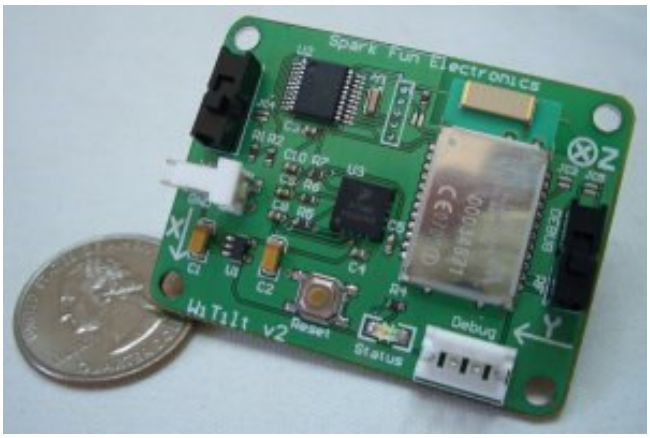


Wireless Tilt Sensing



WiTilt v2
2.4GHz Wireless Dual-axis Tilt Sensor
10/12/2005

1 Overview

The original WiTilt v1 started out as a controller for a toy robot. But it soon grew into a precision remote sensing device, giving 2 axes of acceleration measurement over a wireless link. However, growing customer need and popular demand spurred us on to develop the next generation: the WiTilt v2.

The new WiTilt v2 now employs a Freescale MMA7260Q *triple-axis* accelerometer and a class 1 Blue Tooth link for more robust communications ove a more universal platform. Features on the WiTilt v2 include:

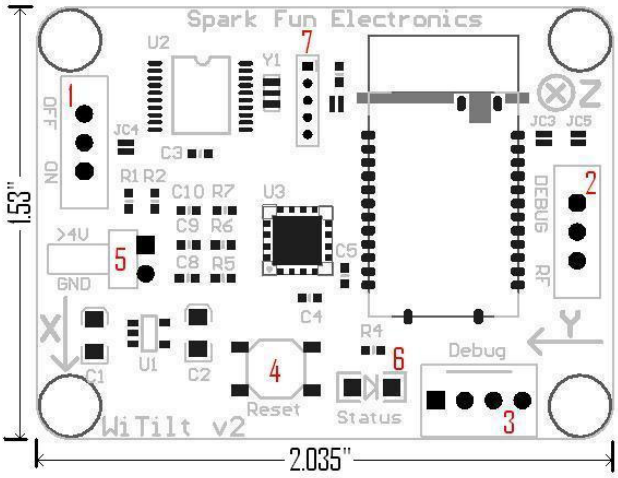
- Selectable channels for sampling (X, Y or Z axes)
- Adjustable sensor range and calibration (1.5g, 2g, 4g, 6g)
- Can display calculated gravity or raw ADC values in ASCII format
- Can output in binary format
- Adjustable report threshold
- Adjustable output frequency

  -135Hz max in gravity mode

  -220Hz max in raw ADC mode

  -610Hz max in binary mode

2 Hardware Layout



There are only a few things that the reader should be familiar with before using the WiTilt v2 (indicated by the red numbers above):

1) Power Switch.
2) Debug/RF Switch, switches the PIC16LF88 UART between the Blue Tooth module and the debug header.
3) Debug header. **Note:** The reader must take care to switch the Debuf/RF switch before connecting to the debug header to avoid a UART

conflict.

4) uC reset button (does not reset the Blue Tooth module).
5) Power connector (4 to 6V).
6) Status LED
7) ICSP port for custom development

3 Connecting to the WiTilt v2

3.1 Blue Tooth

Ensure that the Debug/RF switch is set to "RF" and turn the unit on. From your base Blue Tooth device, connect to the WiTilt v2 in serial mode and open a terminal program to which ever port your Blue Tooth device is set to. Set the connection speed at 57600 (necessary for the higher speed reporting rates). Upon making the connection, hit the reset button on the WiTilt v2 and you should see the configuration menu come up.

3.2 Debug Header

The user has the option of connecting directly to the UART on the PIC16LF88. This is a TTL signal, not RS232 so conversion is necessary. First ensure that the Debug/RF switch is set to debug. Once connected to the header at TTL levels, start your terminal program with port settings of 57600/8/1/none. Once the terminal is open, hit the reset button on the WiTilt v2 and you should see the configuration menu come up.

4 Configuration Menus

4.1 Top Menu and Start/Stop

The top-level menu for the WiTilt v2 can be seen at the top of the next column.

To start the WiTilt v2, just hit '1' and values will start pouring out. To stop, hit spacebar.

```
WiTilt Firmware v3 - Configuration Menu:
========================
 [1] Start Tri-Ax detection (hit spacebar to stop)
 [2] Set Active Channels (XYZ Active)
 [3] Calibrate
 [4] Sensor Range (+/-1.5g)
 [5] Display Mode (Gravity)
 [6] Set Threshold (Currently +/-0.0g)
 [7] Set Output Frequency (135Hz)
```

4.2 Active Channel Select

Selection #2 is for setting the active channels that the unit will report. If the channel isn't selected as active, it will generate no report. Hitting '2' will get the active channel select mode. You will be prompted for each channel (X, Y and Z) to be set. Just hit 'y' or 'n' to make your selection.

4.3 Calibrate

Hit '3' from the top menu to enter calibration mode. You will be prompted to manipulate the WiTilt v2 into various positions that maximize and minimize the readings and to hit <enter> upon achieving those values.

Note: calibration should be performed every time the sensor range is changed. Calculated values that the WiTilt uses depend on the calibration being correct.

4.4 Sensor Range

Hit '4' from the top menu to enter the sensor range setting mode. You will be prompted to set the range of the MMA7260Q to +/-1.5g (hit '1'), +/-2g (hit '2'), +/-4g (hit '3'), or +/-6g (hit '4'). You can also hit 'x' to exit without changing anything.

Note: calibration should be performed every time the sensor range is changed. Calculated values that the WiTilt uses depend on the calibration being correct.

4.5 Display Mode

Hit '5' to set the display mode. You will be prompted to select either calculated gravity values (hit '1'), raw ADC values (hit '2') or binary output format (hit '3'). You can also hit 'x' to exit without changing anything.

Note: each display mode has a different maximum output frequency. After changing display modes, you should enter the output frequency mode. If the current value is too high for the given display mode, the unit will default to the maximum allowed value.

4.5.1 Raw and Gravity output formats

Raw ADC and calculated gravity values are output in ASCII form for ease of reading. For example, here's what you can expect to see in Raw mode with all channels active and threshold set to zero:

```
X=580   Y=485   Z=754
X=570   Y=480   Z=746
X=572   Y=488   Z=747
X=573   Y=488   Z=753
X=575   Y=486   Z=752
X=572   Y=476   Z=749
```

The display for calculated gravity values will be almost identical, except that quiescent values will be something in the range of +/-1g rather than the ADC values in the example.

Inactive channels will simply be omitted from the display, as will any reading that's below a preset threshold value.

4.5.2 Binary Output Format

The WiTilt v2 has a new 'Binary Mode' feature. In Binary mode, it will act very differently. Once attached to a computer, the WiTilt v2 in Binary mode will broadcast the 'Ready' string (**#R$**) and wait for one of three commands from the host:

1) **Ready:** Sending a capitol 'R' character (**0x52**) at any time will cause the WiTilt v2 to respond with the 'Ready' string: **#R$** once it has completed all current measurements.
2) **Abort:** Sending an 'A' character (**0x41**) will cause the WiTilt v2 to stop any data output and respond with the 'Ready' string: **#R$.** From here, you can also hit spacebar to get back into the configuration menu.
3) **Start:** Sending an 'S' character (**0x53**) will cause the WiTilt v2 to respond with the 'Ready' string (**#R$**) and then begin to transmit the following data string:

Binary Output Format	
Byte	**Description**
0	**Start Character - always #**
1	**Data Output Designator - always @**
2	**Sample Number High Byte**
3	**Sample Number Low Byte**
4	**X Axis High Byte**
5	**X Axis Low Byte**
6	**Y Axis High Byte**
7	**Y Axis Low Byte**
8	**Z Axis High Byte**
9	**Z Axis Low Byte**
10	**End Character - always $**

The reader should bear in mind that the length of the data frame can vary depending on the number of active channels. For example, if the X channel is inactive, all following data shift up in the data frame by two bytes.

The threshold setting is also different in binary mode in that a report below the threshold setting will read '1025'. This was left in so as to ensure that the data frame is always a know

length.

The *Sample Number* increases with every output and will roll-over at 65535. The *X, Y, and Z Axis* are in 16 bit binary form. They are numbers directly returned from the ADC conversion.

4.6 Threshold

Hit '6' from the top menu to get into the threshold setting mode. You will then be prompted to hit 'i' to increase or 'd' to decrease the threshold setting in +/-0.1g increments. **Note:** maske sure you're working with a fresh calibration before setting this to a non-zero value.

4.7 Output Frequency

Hit '7' from the top menu to enter the output frequency select mode. You will then be prompted to hit 'i' to increase or 'd' to decrease the output frequency in 5Hz steps.

Each display mode has a maximum output frequency setting: 135Hz for gravity mode, 220Hz for Raw ADC mode and 610Hz for binary mode. You will not be able to exceed the maximum allowed value for the given display mode from the output frequency menu, but it is possible to get an incorrect setting if you don't set the output frequency after changing the display mode.

4.8 Steps for Reliable Operation

A great deal of versatility has been built into the WiTilt v2. And as such, it may be possible to get it into a questionable state (though we've taken great pains to see that it won't). To keep everything running as smoothly as possible, please follow this sequence of steps:

1) Set the sensor range.
2) Calibrate the device.
3) Set the threshold (if any).
4) Set the display mode.
5) Set the output frequency.
6) Set active channels (anytime, really).
7) Go.

5 Sampling Rate and Aliasing

The Freescale MMA7260Q has a BW of 350Hz on its X and Y axes and a BW of 150HZ on its Z axis. These are set by internal switched capacitor filters on the device.

The WiTilt v2 allows the use to se the output frequency of a full frame of data, where one frame is one measurement from each axis. Therefore the output frequency is equivalent to the sampling rate for any given axis. This will be true in all cases, even where channels are inactive or threshold settings prevent a report.

Because of the BW restrictions of the MMA7260Q, some aliasing may be seen at output frequencies lower than about 225Hz. Best results can be realized while operating in binary output format at high frequency.