



SBT30EDU

Sensor and prototyping board

Plug-in sensor and prototyping board for IEEE 802.15.4/Zigbee compliant TelosB wireless motes for education and prototyping purposes

Three Sensor channels including Visual Light, Infrared and Low Pass Filtered Acoustic Signal Envelope; Prototyping Area for Up to Three User-Selected Channels; Experimental Board for University Lab/Classroom Use

Product Description

The SBT30EDU is a low-power, multi-channel sensor and prototyping board designed for use with IEEE 802.15.4 compliant TelosB^[1] wireless sensor network platforms. The SBT30EDU features visual light, infrared and a low pass filtered acoustic signal envelope which allows the user to sample at a much lower speed to detect “activities” on the acoustic channel. Its prototyping area allows up to three user selected additional channels, as desired in experiments and customized application development. It can be directly connected to the expansion connectors of the TelosB platform using an IDC header.



The SBT30EDU is accompanied by tested TinyOS and Java code that can be used to gather data across all associated sensor channels, display sensor readings on a computer, and to switch the SBT30EDU into a power saving “sleep” mode. The SBT30EDU has a smaller form-factor than TelosB platforms. By leveraging industry standard wireless sensor platforms and specially designed prototyping areas, the SBT30EDU enables a wide variety of customized sensor applications and experiments for labs and classrooms.

Key Features

- Prototyping area and external connector with 3 open analog channels for soldering custom sensors or connecting external signals
- Visual light, infrared and acoustic sensors on board
- Rectified acoustic envelope output with adjustable time constant and adjustable low-pass filter for customized applications
- Can be directly plugged in to the external connector of IEEE 802.15.4 / Zigbee compatible TelosB motes
- Smaller form factor than TelosB motes
- Power saving mode

[1] CrossBow Inc, TelosB (TPR2400CA) Product Datasheet, http://www.xbow.com/Products/Product_pdf_files/Wireless_pdf/TelosB_Datasheet.pdf

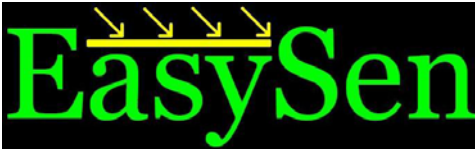


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1. Board Description

The SBT30EDU is a low power, flexible sensor board with multiple sensor modalities (visual light, infrared and low pass filtered acoustic signal envelope) and a prototyping area that allows the users to read three additional sensor channels. SBT30EDU is specifically designed to be plugged into TelosB wireless nodes for use in sensor networks, data fusion, rapid application prototyping and monitoring applications. A front layout of SBT30EDU is shown in Figure 1.

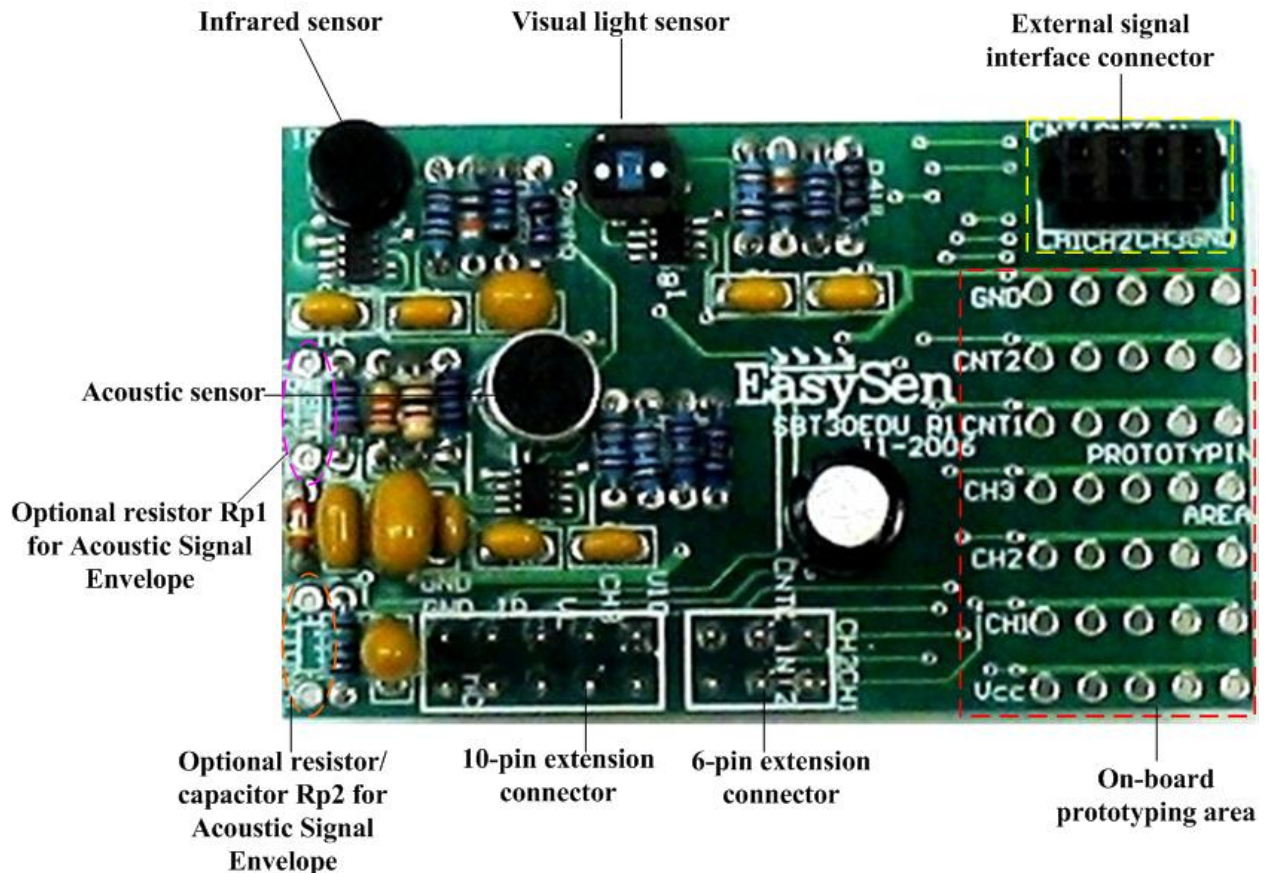
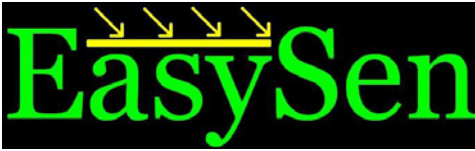


Figure 1. Top view of SBT30EDU

2. Sensor Channel Description

2.1. Visual Light Sensor

The visual light sensor (VTB9412B, <http://optoelectronics.perkinelmer.com/>) is a small area planar silicon photodiode in a recessed ceramic package. The package incorporates an infrared rejection filter. The sensor has very high shunt resistance and good blue response. It has a wide viewing angle, high sensitivity, and excellent linearity. The spectral response of the visual light sensor is depicted in Figure 2.



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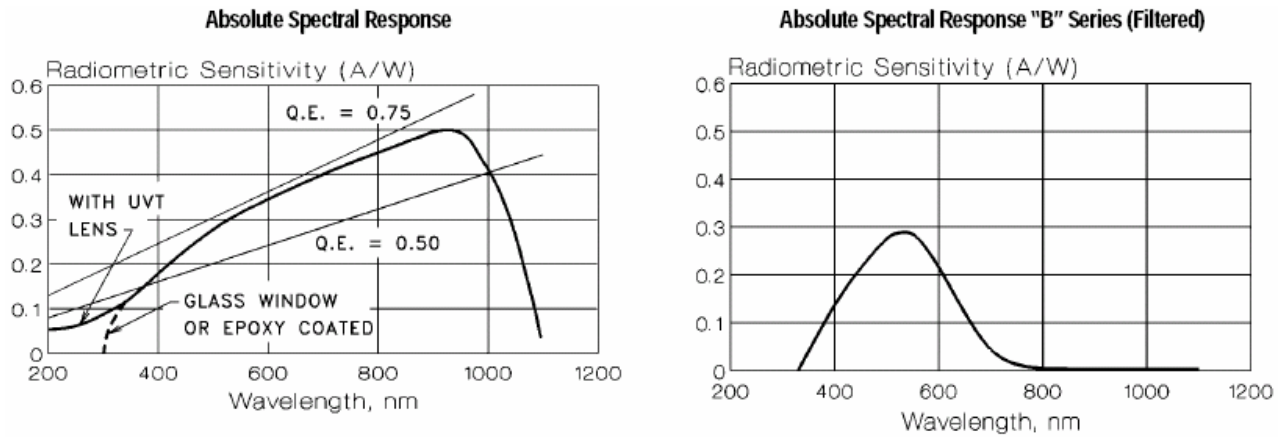


Figure 2. Spectral Response of the Visual Light Sensor

2.2. Infrared Sensor

The infrared sensor (PDB-C139F-ND) is a blue enhanced PIN silicon photodiode in a photoconductive mode with a daylight filter, packaged in a T1 3/4 plastic package. It has a large active area and high responsive speed. The spectral response of the infrared sensor is given in Figure 3.

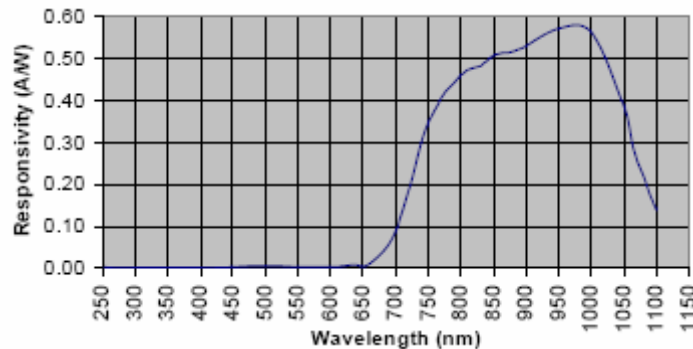


Figure 3. Spectral Response of the Infrared Sensor

2.3. Low Pass Filtered Acoustic Signal Envelope

This channel provides an acoustic signal envelope that is generated from the low pass filtered audio signal of the raw acoustic signal. It allows the user to sample at a lower speed to detect the "activity" on the acoustic channel. The time constant is preset to 3 seconds, so that acoustic activity can be checked with very low sampling rates (in the order of hundreds of ms or even seconds). The cutoff frequency of the low pass filter can easily be increased from the nominal 50Hz by adding the resistor Rp1 as shown on Figure 1. The circuitry is illustrated in Figure 4 below. Since the filter is a simple first order RC filter, adding a resistor of 20K would move the 3db frequency to 100Hz. (Rp1 is in parallel with the 20K resistor R1 and the capacitor of the RC filter is 0.16uF). One may also change the RC time constant envelop detector by either adding a resistor in the position of Rp2 (see Figure 1) or adding a capacitor in this position. If a resistor is added, it reduces the time constant since it is in parallel with R2=1MΩ. If a capacitor is added, it increases the time constant since it is in parallel with the capacitor C2=3uF. The frequency response of the RC low pass filter and the typical acoustic envelope signal are shown in Figure

5 and 6.

In summary, the equations for the LP cutoff frequency and the time constant τ of the acoustic envelope detector are:

$$f_c = \frac{1}{2\pi \cdot (20K\Omega \parallel R_{p1}) \cdot 0.16\mu F}$$

$$\tau = \begin{cases} (1M\Omega \parallel R_{p2}) \cdot 3\mu F & \text{if } R_{p2} \text{ is a resistor} \\ 1M\Omega \cdot (R_{p2} + 3\mu F) & \text{if } R_{p2} \text{ is replaced by a capacitor} \end{cases}$$

It should be noted that the output signal of acoustic signal 2 (acoustic envelop) will stay between approximately 1600 (no signal) to 3500 (strong signal in the passband).

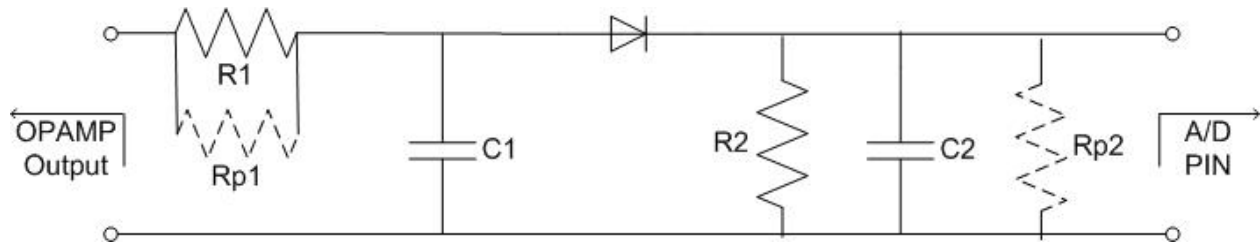


Figure 4. Circuitry for Acoustic Channel II

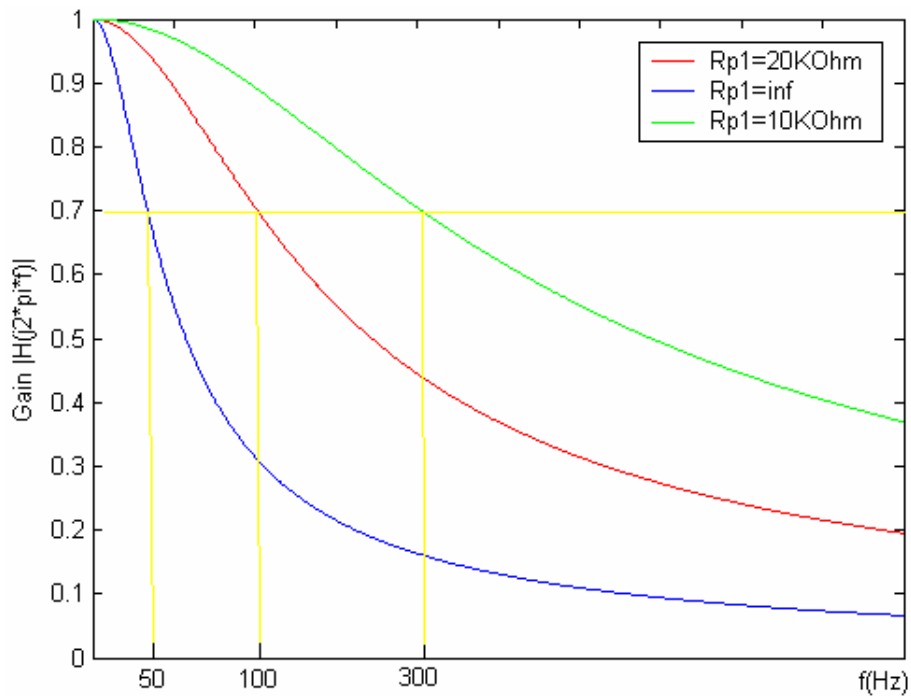


Figure 5. Frequency Response of the RC low pass for acoustic channel



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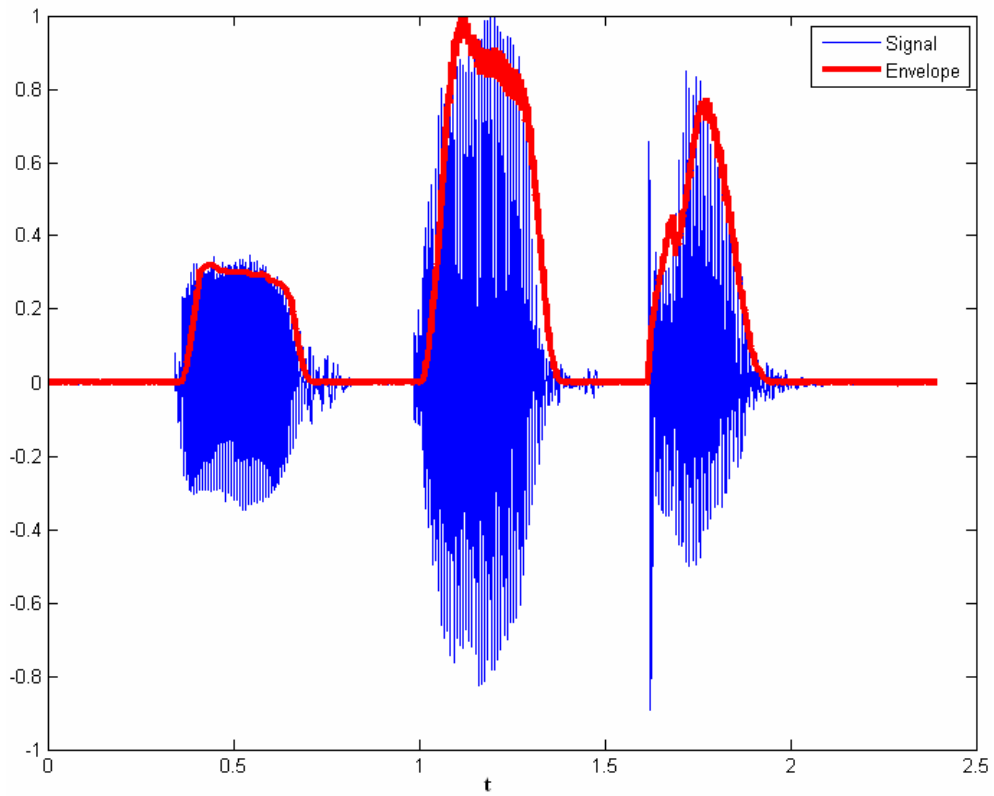
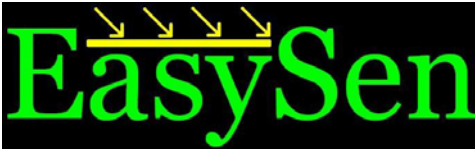


Figure 6. Typical output of acoustic envelope channel



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3. Prototyping Area

The prototyping area provides access to the following:

- Three (3) analog input channels (CH1, CH2, CH3)
- Two digital output channels (CNT1, CNT2)
- Voltage supply (Vcc) of the Telos and the ground (GND).

These 5 connections are available to outside, both via the prototyping area for soldering and via the 8-pin connector for external wire connections as shown in Figure 7 below.

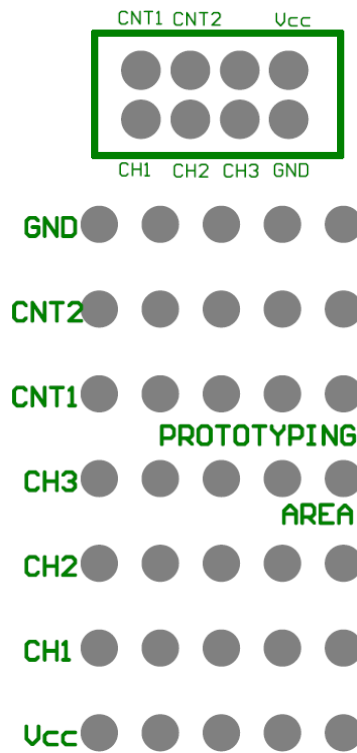


Figure 7. Prototyping area



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4. Connection of SBT30EDU to TelosB

SBT30EDU provides two interfacing male connectors to Telos motes, a 6-pin IDC header at position U6 and a 10-pin IDC header at U10. After soldering the female parts on expansion connectors of the Telos motes, the SBT30EDU can be directly plugged into the mote (please see section 3.1 for soldering instructions). The functionality layouts of these two IDC connectors are shown in Figure 8 and 9.

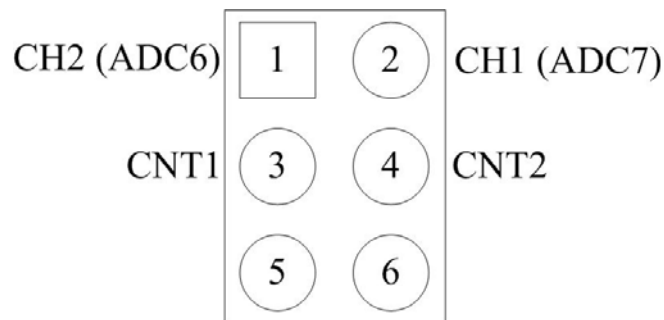


Figure 8. Functionality of the 6-pin IDC connector (U6) (top view)

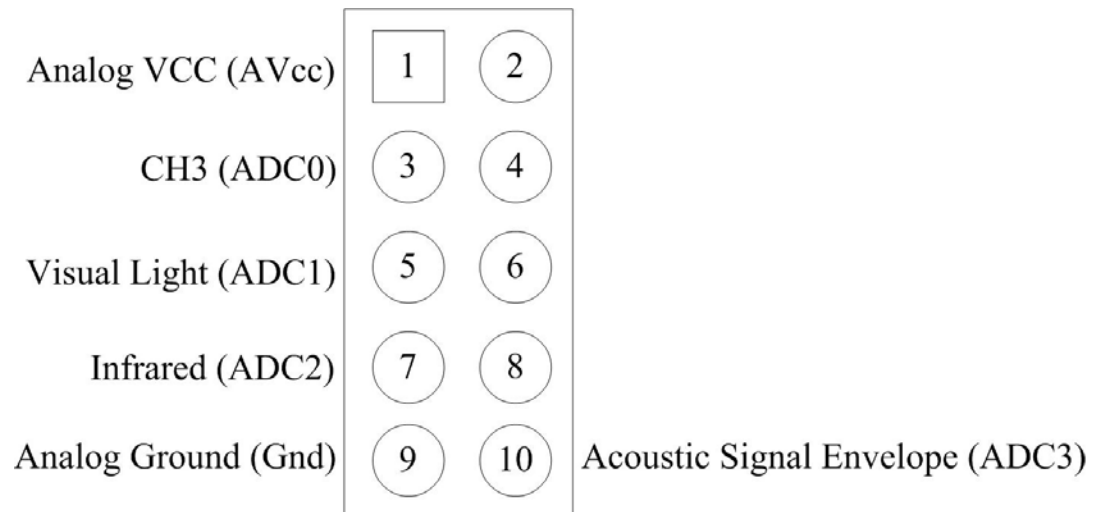


Figure 9. Functionality of the 10-pin IDC connector (U10) (top view)

Note: The ADC channel labels correspond to the expansion connector layout of the TelosB mote. The power of SBT30EDU is supplied by the connected radio mote (through pin 1 and 9 of U10).

4.1. Instruction for Soldering Connector to TelosB

In order to connect a SBT30EDU to a TelosB mote, a 10-pin female connector (S4305-ND, www.digikey.com) and a 6-pin female connector (S4303-ND, www.digikey.com) need to be soldered to the 10-pin (U2) and 6-pin (U28) expansion connectors on the TelosB mote (**These connectors are included in your SBT30EDU purchase**). After soldering these two connectors, the SBT80v2 can be directly plugged into the two connectors and thus interfaced with the TelosB mote, as shown in Figure 10.

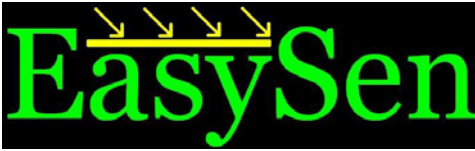


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Figure 10. SBT30EDU plugged into a TelosB mote (top view)



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5. TinyOS and Java code for reading sensors

Sample TinyOS and Java code available for reading sensors in the companion SBT80 multi-sensor board (http://www.easysen.com/support/SBT80v2/samplecode_SBT80v2) will work for the SBT30EDU board with no changes. In this case, users must ignore the last 2 data bytes of each packet displayed on the PC.

For an explanation of this code, users are referred to the programming instructions on the SBT80 datasheet (<http://www.easysen.com/support/SBT80v2/DatasheetSBT80v2.pdf>).

If a customized program and a shorter packet format are preferred, one can be easily adopt and modify the above code as explained below. Minor changes may be required as explained in the following.

- (a) SBT30EDU has 6 sensor channels including VL, Acoustic (MC) and IR sensors and 3 open input channels CH1, CH2, CH3 mapping directly into the 6 ADC channels in the TelosB external connector, as compared to 8 multiplexed channels in SBT80. To accommodate for these, users can simply sample ADC channels 0,1,2,3,6,7. For this, use the following mappings to map the corresponding ADC ports to the sensor components in the configuration file MobileNode.nc :

```
MobileNodeM.CH3      -> ADCC.ADC[TOS_ADC_EXTERNAL_ADC0_PORT];
MobileNodeM.VL       -> ADCC.ADC[TOS_ADC_EXTERNAL_ADC1_PORT];
MobileNodeM.IR       -> ADCC.ADC[TOS_ADC_EXTERNAL_ADC2_PORT];
MobileNodeM.MC       -> ADCC.ADC[TOS_ADC_EXTERNAL_ADC3_PORT];
MobileNodeM.CH2      -> ADCC.ADC[TOS_ADC_EXTERNAL_ADC6_PORT];
MobileNodeM.CH1      -> ADCC.ADC[TOS_ADC_EXTERNAL_ADC7_PORT];
```

and use these components to sample the corresponding sensors in the module file MobileNodeM.nc

- (b) Code related to switching pin of SBT80 is used as the CNT2 of SBT30EDU. Hence, users may use the following code lines from the configuration file MobileNode.nc to access the control pins CNT1 and CNT2,

```
MobileNodeM.CNT1     -> MSP430GeneralIOCI.Port23;
MobileNodeM.CNT2     -> MSP430GeneralIOCI.Port26;
```

and the use corresponding code from the module file MobileNodeM.nc

- (c) Users may use the same data packet format as specified in the header file SBT80Msg.h and the java code used to display data on PC ListenSBT80v2.java, with dummy data for the additional fields. Otherwise, it is straightforward to modify the code in SBT80Msg.h and ListenSBT80v2.java to have a shorter packet format and a display format.

6. Power

SBT30EDU is powered by the attached TelosB mote through the 10-pin interfacing connector. The mote itself is powered by two AA batteries or a host computer that is attached to its USB port. The operating voltage for SBT30EDU falls between 2.4V and 3.6V. At no point should the input voltage exceed 3.6V—doing so may damage certain components.



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7. General Information

7.1. Document History

Revision	Date	Notes
1.0	02/22/2007	Initial Release

7.2. Disclaimer

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7.3. Contact Information

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