

Volume

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TINY OS GROUP  
UNIVERSITY OF CALIFORNIA, BERKELEY

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The Mica Platform

# TinyOS Developers Guide

MICA SENSORBOARD

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? Regents of the University of California  
TinyOS Group  
Computer Science Division • University of California, Berkeley  
[webs.cs.berkeley.edu/tos](http://webs.cs.berkeley.edu/tos)

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## The Mica Sensorboard

*This is a work in progress. - 09/23/2002*

**T**he Mica Sensorboard (micasb) is a sensor platform designed for the Berkeley Mica mote. A fully-populated micasb has five different sensor modules in order to support a wide variety of potential sensor networks applications. These sensors include: light, temperature, acceleration, magnetic field, and acoustic, and each of these sensors can be purchased off-the-shelf.

A photo-resistor and thermistor are used to sense light and temperature. An Analog Devices ADXL202JE accelerometer is capable of delivering 2-axis acceleration sensing. For magnetic field, the board is equipped with a Honeywell HMC1002 2-axis magnetometer. An omni-directional microphone, Panasonic WM-62A, is used to capture acoustic signal, which is amplified and bandpass-filtered to the voice band before being sampled.

In addition to the above sensors, the board is capable of generating acoustic output, using its 4kHz single tone buzzer. Optional hardware support to detect the generated tone on a receiving node is provided by an active bandpass filter and a LMC567 tone decoder from National Semiconductor, which has built in phase lock loop and adjustable threshold detection.

All modules in the sensor board can be power cycled independently, and are power isolated from the Mica's processor through an analog switch. Finally, gain of the magnetometer and the microphone amplification is adjustable by tuning the two digital potentiometers over the I<sup>2</sup>C bus.

### Identifying Your Sensorboard

As of May 2002, there are a number of different sensor boards that you might have in your collection. The following picture will help you identify which board you have identifying your sensorboard.

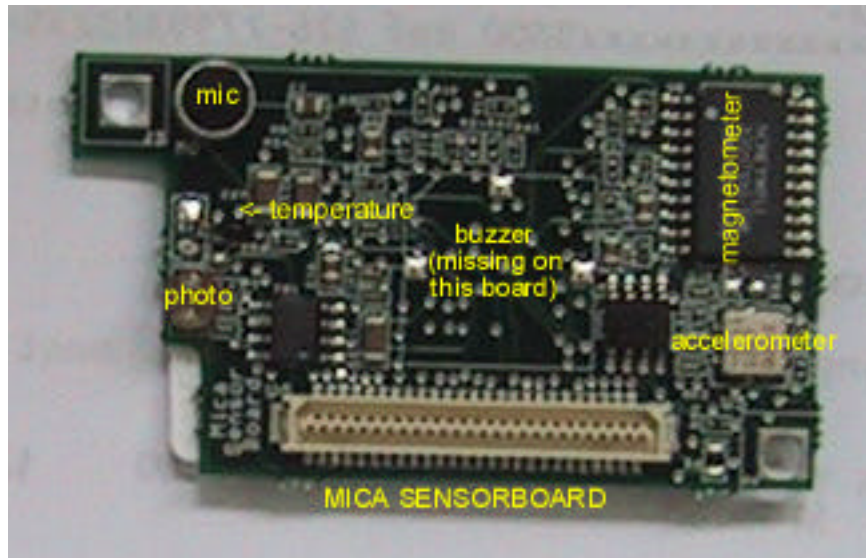


FIGURE 1 The fully-populated Mica Sensorboard (micasb) has five sensors and a single tone buzzer.

Some mica sensorboards do not have all of the possible components. For example, the board shown above does not have the sounder. If it did, the sounder would be soldered onto the large square in the middle. Other boards do not have the magnetometer or accelerometer, but do have the buzzer. The reason for this is cost: and supply: the magnetometer and accelerometer are relatively expensive, and the buzzer was in short supply during early 2002.

A predecessor to the micasb was the Basic Sensorboard. The Basic Sensorboard has only a thermistor and photo cell. While the Basic Sensorboard can run on the Mica mote, a few precompilation steps must be taken. See DEFAULT SENSORBOARDS for more information. Alternatively, the micasb is not compatible with mote platforms other than Mica.

#### Mica Sensorboard Subcomponents

Below is a table of subcomponents. This information comes from the Bill of Materials for the micasb which you can find on the TinyOS web site. For the Bill of Materials spreadsheet and more detailed technical information, please refer to GUIDE TO ADDITIONAL ONLINE Information.

<i>Description</i>	<i>Company</i>	<i>Manufacturer</i>
Microphone	Panasonic	WM-62A
Sounder	Sirius	PS14T40A
Accelerometer	Analog Devices	ADXL202JE

Thermistor	Panasonic	ERT-J1VR103J
Light Sensor	Clairex	CL9P4L
Magnetometer	Honeywell	HMC1002

All of the sensors are sampled by the Mica's ATmega103 which produces 10-bit samples. The semantics of the data depend on the specific sensor. For example, 0x80 is roughly 25 degree celcius for the temperature sensor and varies in a non-linear fashion similar to the light sensor. The microphone is just an AC signal (or relative signal to the center line  $\approx 512$ ) and depends on the GAIN setting (which is set in the microphone component – see Adjusting the Gain for more information). See Subcomponent Specifics for more information on how to interpret each sensor's data.

## Programming Practices

Relevant files  
Sensorboard.h

Default Sensorboards  
Sampling rates  
Ffff

## Subcomponent Specifics

Magnetometer  
Accelerometer  
Microphone  
Sampling

The microphone offers several output options:

~~✗~~ sounder tone detected (binary yes or no)

~~✗~~ voice out (100Hz - 6.5kHz)

~~✗~~ sounder out (3.5kHz - 4.5kHz)

~~✗~~ phase output of sounder

If you read from ADC2, a mux determines whether you get the phase output from (1) the tone detector (which detects 3.5kHz - 4.5kHz) or (2) either the output from the

sounder BP filter or the voice BP filter. The MIC component allows you to choose between (1) or (2).

Within (2), a resistor controls whether the output from the voice BP filter or sounder BP filter is seen. You change which output you see on ADC2 by resoldering. If you look on the mica sensorboard schematic (which you can get off the hardware page easily because the hw page was just reorganized to make finding mica stuff easier), look just above and to the right of the word 'MAGNETOMETER'. You'll see 'mic\_bandpass\_out' and 'mic\_out'. These are labeled as R41 and R42. You'll see that the resistor is currently on R41. You can resolder to put it on R42.

#### Adjusting the Gain

The microphone gain can be set in one of several ways. The way that the tone\_detect and micasb\_test2 apps set it is by wiring a command to the MIC:MIC\_POT\_ADJUST command and calling it from the INIT command. Here are the specifics from the micasb\_test2 app:

micasb\_test2.c:

```
char TOS_COMMAND(MICASB_TEST2_INIT)() {
    (...unrelated code...)
    /* Turn Microphone on and set the pot setting to 64,
       use bandpass filter output, no interrupt*/
    TOS_CALL_COMMAND(MICASB_TEST2_MIC_INIT)();
    TOS_CALL_COMMAND(MICASB_TEST2_MIC_PWR)(1);
    TOS_CALL_COMMAND(MICASB_TEST2_MIC_MUX_SEL)(1);
    TOS_CALL_COMMAND(MICASB_TEST2_POT_ADJUST)(64);
    TOS_CALL_COMMAND(MICASB_TEST2_MIC_TONE_INTR)(0);
    (...unrelated code)
}
```

micasb\_test2.desc:

```
MICASB_TEST2:MICASB_TEST2_POT_ADJUST MIC:MIC_POT_ADJUST
```

Sounder

Thermistor  
Blah blah blah.

Prior to TinyOS 1.0, the thermistor and the photo sensor share the same ADC port and require special handling.

The thermistor and photo cell share the same ADC port due to resource limitations. The definitions of the port illustrate the contention:

```
#define PHOTO_PORT 1 /* TOS_ADC_PORT_1 */
#define TEMP_PORT 1 /* TOS_ADC_PORT_2 */
```

Prior to TinyOS 1.0, you must turn one or the other off and sample the other. To turn off and on, look at code in `tos/system/TEMP.c`. The command `TEMP_INIT` turns the temp on and `TEMP_PWR` turns the pwr off. You can toggle between the two. For the photo sensor, look for the analagous commands in `PHOTO.c`.

Photo cell

## TinyOS Sensor Components

## Sample Code

## Guide to Additional Online Information

Datasheets.

Schematic.

BOM.

Sample code.

