EE43/100 Smart Dust Lab Report

Name:___________________

Name:___________________

TA: __________Section:________

1. Testing your pair of motes

The motes have been programmed to respond to each other in pairs; you and your lab partner have been given one such pair. The sending mote is marked S, the receiving mote R.

Turn on the sending mote. Note which LEDs flash. Now turn on the receiving mote as well. Observe and record any synchronous flashing of lights on the two motes. What are the motes doing?

Measure the range of your pair of motes by taking them out in the hallway and moving apart until the synchronous behavior stops. This is the maximum range in this environment. If weather permits, measure the range outdoors where it may be larger. Try mote operation around a corner, from inside a room to the hallway, etc Determine the distance by pacing it off (a meter stick or tape measure is available if you don't know the length of your stride). Try turning one mote until its antenna is perpendicular to the other mote's antenna; does this make a difference in the range? Repeat while holding one mote's antenna close to the metal door of a hall locker. Does it make a difference whether the S or the R mote's antenna is placed next to the metal door while the other is held in the middle of the hallway?

2. Demonstration of the frequency spectrum of your motes

The TA will use a "spectrum analyzer" to demonstrate how often a mote transmits, the center frequency of transmission, and some of the frequencies used in transmission. The TA will explain what the equipment does and what its displays mean.

To do this demonstration, connect to the input of the spectrum analyzer a BNC cable that has alligator clips on one end. Turn on a mote and place its antenna near the "hot" (center conductor) of the BNC cable. Adjust the range covered by the spectrum analyzer to sweep from roughly 100 to 1000 MHz. You should see an intermittent increase in the amplitude at one point on the trace, whose frequency corresponds to the frequency at which the mote is transmitting. Since mote communication occurs in bursts, the transmission that you detect on the spectrum analyzer will also be intermittent. Measure the frequency of transmission and compare it with the value you predicted in Question 1 of the Pre-Lab.

3. Laptop display of the Smart Dust network topology

When motes are dispersed in an area, they automatically set up a wireless network along which data can be transferred to a mote that that is connected to the serial port of a computer and has been configured as a base station. Figure 1 in the Theory part of this lab illustrated such a network. If possible, the TA will demonstrate a display of network topology. As motes join or leave the network you should be able to see the network change.

4. Dynamic oscilloscope display of the temperature and/or illumination data collected by a mote (note that this display may not be available in your lab owing to a lack of motes programmed to serve as a "base station" for the sensor network).

The mica2dot motes incorporate two standard sensors – a temperature sensor (analog thermistor, or possibly a digital temperature sensor) and an illumination sensor (photodiode). The packets sent over the mote network are composed of a header that identifies at least the sending mote, and then data from the sensors located on the mote. If the network display is working, identify one of the motes in the room and note its illumination data. Now cover that mote and observe the effect on its illumination data. Test the temperature sensing capability by putting your hand on the box holding the mote. (Since there is air between the inside of the box and the thermistor on the mote, heating of the thermistor occurs mostly via radiation, so you may not be able to observe a change of temperature even after waiting for several minutes.)

5. Mote transmission under "difficult" conditions

Investigate the effect upon mote-to-mote transmission of putting one mote in a cardboard box, a metal cabinet, and a non-functioning microwave oven to see whether it communicates through the closed door (which is designed to prevent the microwaves at 2.45GHz from leaking out).
Results:____

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Note: it has been found experimentally that motes can communicate from inside a closed refrigerator, suggesting a temperature measuring application in a computer-controlled dwelling.

6. Temperature sensing with thermistors

First, measure and record the resistance of your thermistor (round brown dot with two leads) to determine the air temperature from the calibration plot of R vs. T in the Experiment Guide. Now measure and record the resistance corresponding to your body temperature by holding the thermistor between your thumb and forefinger. What body temperature does this indicate? Are your results reasonable?

Wire up a localized heater consisting of a 22 Ω resistor set on a white ceramic tile. Using the HP E3631A triple DC power supply to apply 5.0V to the heating resistor.

a. Put the thermistor in contact with the heating resistor for 30 seconds and record the magnitude and direction of the change of its resistance. What temperature does the thermistor reach? (We'll discuss semiconductors later in the course.)
b. Put the small lightbulb in contact with the heating resistor for 30 seconds. By what percentage and in what direction did the resistance of its thin metallic filament change?

7. Illumination sensor -- photodiode or solar cell

a. The single-crystal silicon solar cells in the transparent plastic boxes have a continuous back metallic contact to which one small insulated wire is soldered, and a comb-like metallic contract on the other side that lets most of the incident light pass through into the cell.

First, record the number of your solar cell: __________

Use your DMM to determine the polarity of the voltage from the top, comb-like contact to the continuous back contact. Now switch your DMM to current mode and measure the current flowing from the comb-like contact, through the ammeter – which acts like a short-circuit – to the continuous back contact. If you need more light, use the small halogen* lamp, powered from the HP E3631A triple DC power supply; set the voltage at 6.0V (the current will be about 0.6A. When you get ready to measure the solar cell current and voltage you can set the lamp BRIEFLY on the solar cell package and make a QUICK measurement – 3 seconds should suffice, and not melt the plastic box containing the solar cell.
* There's a halogen gas inside the bulb that helps keep the glass bulb free of metal that evaporated from the hot filament

Record your data, including the direction of current flow at the contact that is positive with respect to the other contact. From your investigation, what do you conclude about the device as a deliverer or dissipater of energy?

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To test whether the short-circuit current of a solar cell is proportional to the intensity of the light incident on the cell, illuminate the cell and measure its short-circuit current, then put the piece of transparency material between the light and the cell and find the new short-circuit current. Check the proportionality (the relative transparency of each of the three sections of the transparency should be marked on it).

Data and conclusions:

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8. LED

Set the Fluke or HP DMM on its diode-check setting and apply the leads to an LED. NOTE 1: The AC-powered multimeters in the lab have a diode symbol setting but that won't work for determining the turn-on voltage of a typical LED, though it does work for a regular pn-diode, which turns on at a lower voltage. NOTE 2: The + lead is the longer of the two leads. Does the LED light up? Record the LED type (small red, large red, etc.) and record the voltage displayed on the DMM. This is the voltage at which the LED current is about 0.40 mA, so this can be taken roughly as the LED turn-on voltage.

Wire up the small red LED with the series resistance you calculated in Question 3 of the Pre-Lab and measure the current. By what percentage does it differ from your expected current?