soft (electronics) harvard GSD fall 2003 prof. sheila kennedy

# 1 sensors + example circuits

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"welcome to the lecture notes for the second session of our class.

here we will discuss:

a. types

b. basic applications

c. note on batteries

d. appendix : circuit symbols"

NOTE : The following substances should not be used in your projects, especially if you plan to install them in a remote outdoor site, since they contain harmful heavy metal pollutants:

* Lead-Acid batteries
* NiCd (nickel cadmium) batteries
* CdS (cadmium sulfide) photodiodes"
* Mercury (tilt) switches

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# sensor types

vary primarily on the phenonmena you are trying to measure - for instance, if you would like to build an object which operates on a *human scale*, you may want to look for sensors which measure things such as:

i. light
solar panels, photo-diodes, -transitors,-resistors
*www.acroname.com*
*www.solarbiotics.com*

ii. heat
thermistors, thermocouples, pyroelectrics sensors
*www.digikey.com*
*www.acroname.com*
*www.solarbiotics.com*

iii. pressure / touch / movement
mechanical switches, spring sensors, ball-bearing tilt sensors (no mercury), capacitive touch sensors, motors (used as generators)
*www.digikey.com*
*www.acroname.com*
*www.solarbiotics.com*
*Radioshack*
*www.qprox.com*

iv. sound
condenser microphones
*www.digikey.com*
*Radioshack*

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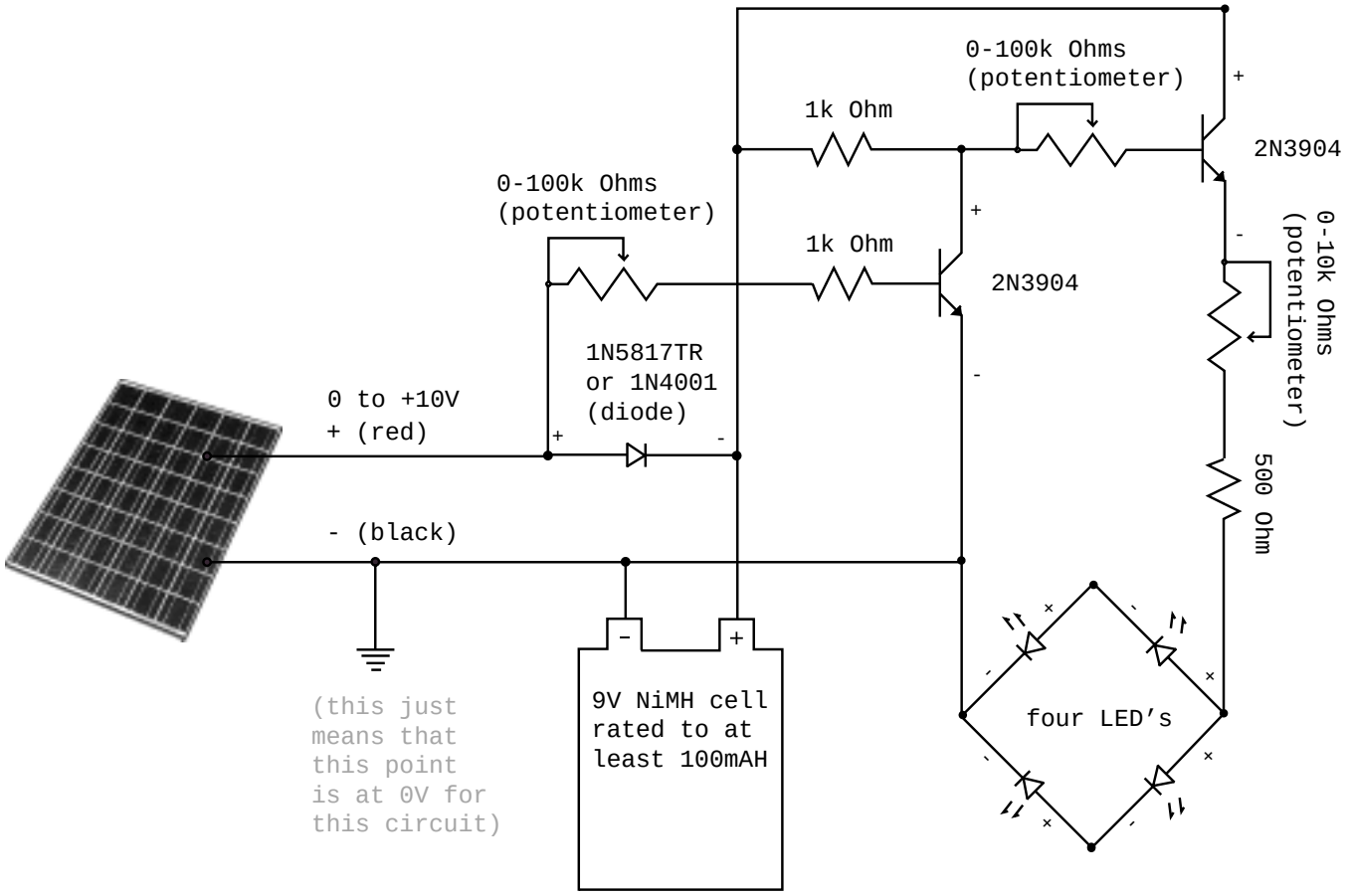
# basic applications

of sensors are meant to pull a few parameters from the environment, translate them into a voltage which varies predicatably and use them as inputs to a circuit which controls outputs such as lights, sounds, mechanical movement, *etc*. A few examples of these are as follows:

i. light
solar yard light - adjustably charges during the day and lights up at night (note that the LED's below may be replaced with an EL sheet, but requires additional circuitry)




(see appendix for circuit symbol key)

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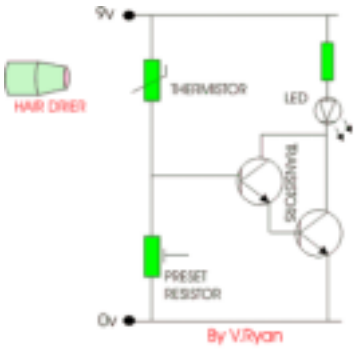
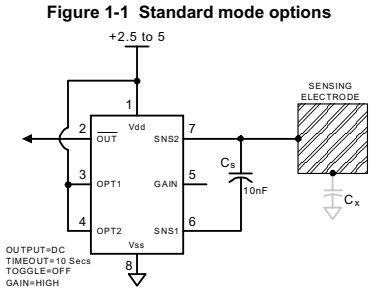
# other sensors

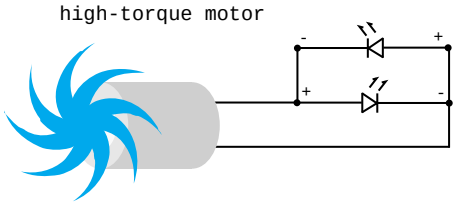
can be implemented in circuits such as:




ii. heat
thermistors turns on an LED when exposed to high temp. (see www.digikey.com or search for 'thermistor circuit')

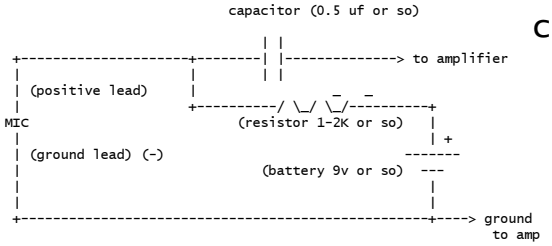



iii. pressure / touch / movement
typical capacitive coupling circuit for detecting human touch (see www.qprox.com for datasheets)




wind speed / direction detection circuit using a motor with a windmill-like attachment and LEDs

iv. sound
condenser microphone circuit"



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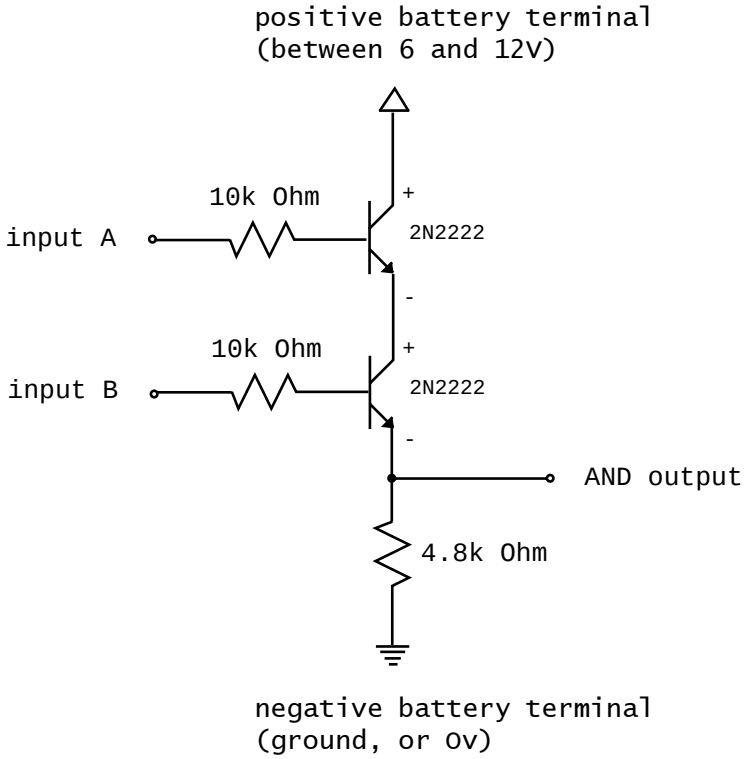
# combinations

of simple sensor circuits are used to create more specific output behavior in a device. For instance, a rain detector may prove difficult to implement, but high winds and darkness during daylight hours could imply a rainstorm. One way to combine inputs is to use an AND gate, such as:




This circuit takes two sensor inputs and output high voltage only when both are above 5V. If your sensor operates in a lower range, you can use a comparator circuit to boost it (see *Electronics for Inventors*, or ask me).

Feel free to adjust the values of the 10k Ohm resistors above between 1k and 100K Ohm as your circuit requires."

# NiMH rechargeable batteries

are recommended for the projects you are building in this class, over SLA (sealed lead-acid), NiCd (nickel-cadmium) and lithium ion for the following reasons:

1. they are more or less environmentally friendly as far as batteries go, esp. in comparison to NiCd, which contains highly toxic cadmium and should not be used in unobserved outdoor applications. See http://www.npi.gov.au/database/substance-info/profiles/17.html for a hazardous materials datasheet.

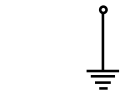
2. NiMH should operate for 1 to 2 years on a daily charge / discharge cycle without much loss of performance (though I have to admit I've never tried). However, an additional charge controller circuit may be necessary if you are charging batteries from a large (high wattage) solar panel.

3. NiMH should operate fine between the temperatures of -20C and 60C, according to information from: http://www.buchmann.ca/default.asp
(note this is an excellent battery resource site)

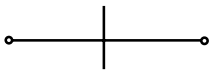
4. they are available in AA / AAA (1.5V), 9V, and other sizes, voltages and mAH (milliamp-hours). (note that the number of watts delivered by the battery if drained in one hour, mWH, [milliWatt-hours] is given by volts*mAH = mWH), and are relatively inexpensive.

...and that's it for now :]"

voltage source (power)



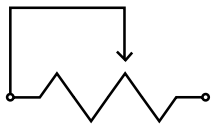
zero volts (ground)



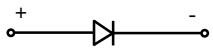
wire crossing without connection

wire connection

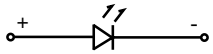
resistor



variable resistor (potentiometer with center pin connected to an outer pin)

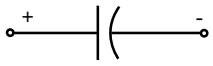



diode (white stripe is negative end)

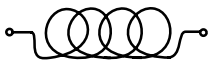



LED (long leg is positive end)

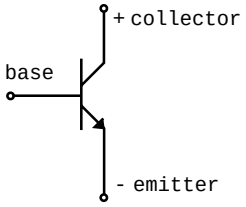
zener diode (predefined reverse voltage)




capacitor (also avail. as nonpolarized)

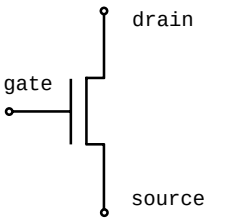


inductor




bipolar junction transistor (BJT - see other reference material for application notes)

**2N3904**


MOSFET (alternate, low input-current transitor)