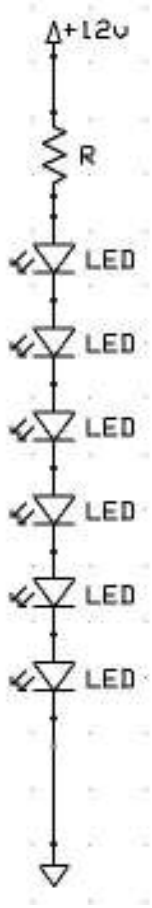
Driving multiple LEDS



(always on)

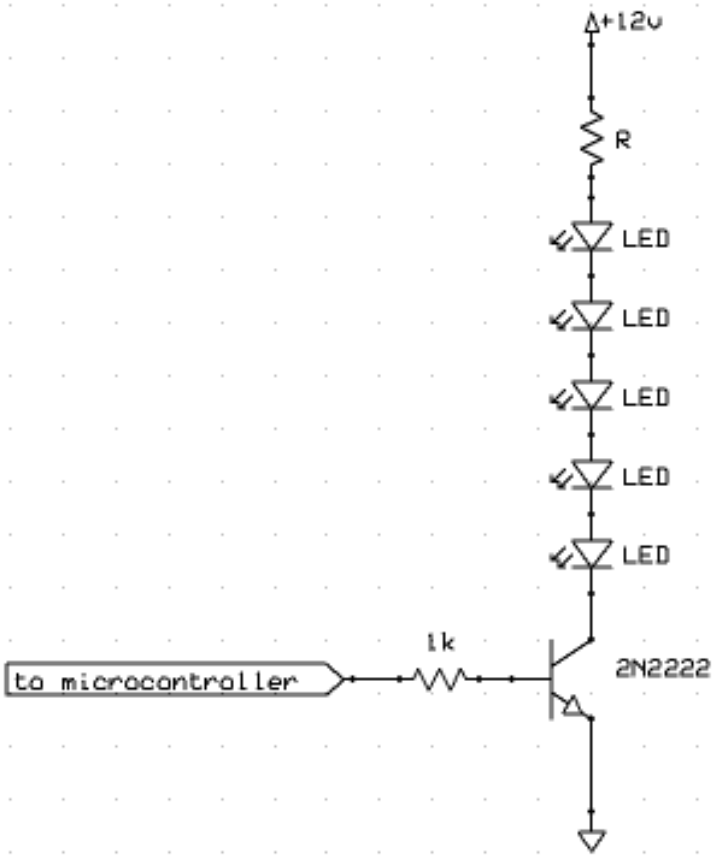
- Voltage (V) must be greater than the number of LEDS (n) times their characteristic voltage (about 1.5V each)
- Resistor should set current to about 20mA
- Calculate resistor value:

  R = (V-n*1.5)/0.02
- In this example:

  R = (12-6*1.5)/0.02 = 150Ω
- On line calculator:

  http://led.linear1.org/led.wiz

Controlling multiple LEDS



- Voltage (V) must be greater than the number of LEDS (n) times their characteristic voltage (about 1.5V each)
- Resistor should set current to about 20mA
- Calculate resistor value:

  R = (V-n*1.5)/0.02
- In this example:

  R = (12-5*1.5)/0.02 = 225Ω
- On line calculator:

  http://led.linear1.org/led.wiz

Serial Communications

- Practical way to connect to peripheral devices
  - Gather sensor data
  - Control transducers or output devices
- Information is sent over one wire
  - Simplifies interconnections
  - Total wires to device < 4 (power, GND, data in, data out)
- Can be synchronous or asynchronous
- Common protocols:
  - RS232 (asynchronous, 1 transmitter – 1 receiver)
  - I2C (synchronous, 1 transmitter – multiple receivers)
  - SPI (synchronous, 1 transmitter – 1 receiver)

RS232

The common PC “serial port”

Important parameters:

- Levels (15V or TTL)?
- Inverted?
- Baud?
- Total bits, stop bits, parity?
- Connectors 25 or 9 pin?

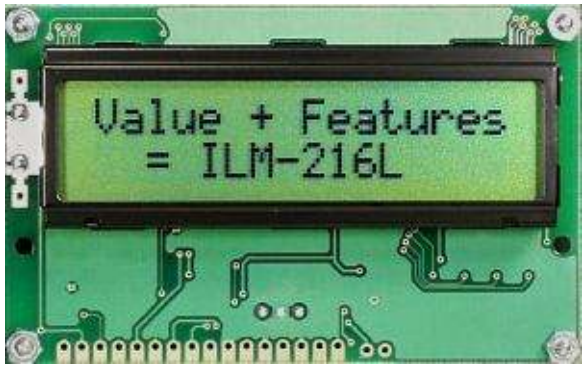
RS232
Voltage Levels

- +/-15V or TTL (5V)
- The standard serial port uses +/-15V
- **Do not** connect a standard port directly to a microcontroller!
- Arduino pins 0 (receive) and 1 (transmit) are used for serial communications
- Information can be sent to or received from PC
- Information can be sent to peripheral devices:
  - LCD displays
  - Voice synthesizers
  - Video text overlay

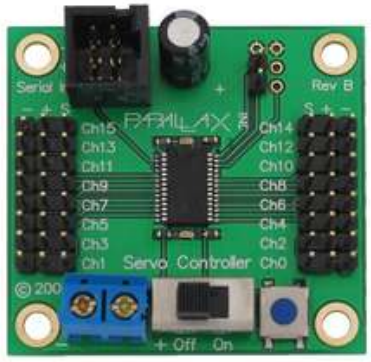
RS232
Example Serial Modules

- Speech http://www.rcsys.com/modules.htm
- Text (LCD display)
- Video overlay
- Multiple servo motor control

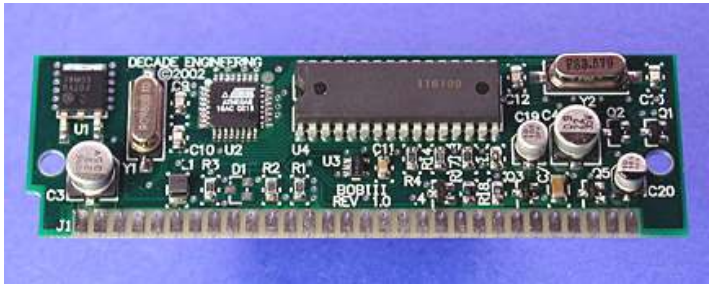
http://www.seetron.com/ilm216_1.htm



http://www.seetron.com/ssc.htm



http://www.decadenet.com/bob4/bob4.html



http://www.sparkfun.com/commerce/product_info.php?products_id=8897

RS232
Important Parameters

These parameters will be specified for any RS232 module:

- Baud (connection speed)
- Inverted signal (yes for TTL, no for standard RS232)
- Total bits per symbol (usually 8)
- Number of stop bits (usually 1)
- Parity (error checking, usually not used)
- Most common: "**9600 baud 8N1**"

Bidirectional Serial Example

```
/*  continuously streams sensor data to PC */
/* monitors serial port for 'a' or 'b' bytes to control LED */

 void setup()
 {
  Serial.begin(9600);
  pinMode(13,OUTPUT);
 }

 void loop()
 {
   // read the analog input into a variable:
   int analogValue = analogRead(0);

   // Send the result to the PC:
   Serial.println(analogValue);

   // Read a character from the PC
   byte inByte = Serial.read();

   if (inByte == 'a') digitalWrite(13,HIGH);   // if the letter “a” is sent turn
         on the LED
   if (inByte == 'b') digitalWrite(13,LOW);    // if the letter “b” is sent turn
         off the LED

         // note the use of the single quote ‘ above

    delay(100);
 }
```

- Regret Box
- Poetron
- Coin op

RS232
Important Parameters

These parameters will be specified for any RS232 module:

- AnalogInSerial
- Connect speaking board

- Inverted signal (yes for TTL, no for standard RS232)
- Total bits per symbol (usually 8)
- Number of stop bits (usually 1)
- Parity (error checking, usually not used)
- Most common: "**9600 baud 8N1**"

Ping Distance Sensor

- 5V DC power (Vdd) goes to “5V”
- GND (Vss) connects to “GND”
- Signal pin connects to microcontroller I/O pin

Ping Sensor Code

```
// The PING))) is triggered by a HIGH pulse of 2 or more microseconds.
// Give a short LOW pulse beforehand to ensure a clean HIGH pulse:

  pinMode(pingPin, OUTPUT);       // pin acts as an output in this part
  digitalWrite(pingPin, LOW);
  delayMicroseconds(2);
  digitalWrite(pingPin, HIGH);
  delayMicroseconds(5);
  digitalWrite(pingPin, LOW);

// The same pin is used to read the signal from the PING))): a HIGH
// pulse whose duration is the time (in microseconds) from the sending
// of the ping to the reception of its echo off of an object.

  pinMode(pingPin, INPUT);       // pin does double duty – switch to input here
  distance = pulseIn(pingPin, HIGH);       // pulseIn measures pulse duration
```

http://arduino.cc/en/Tutorial/Ping?from=Tutorial.UltrasoundSensor

Sharp IR Distance Sensor

- 5V DC power (Vdd) goes to “5V”
- GND (Vss) connects to “GND”
- Signal pin connects to any Arduino analog input pin
- To read distance:

  Just use the **analogRead(pin)** command

IR distance sensor w/cable (10cm-80cm) - GP2Y0A21YK0F

IR Distance Sensor Code

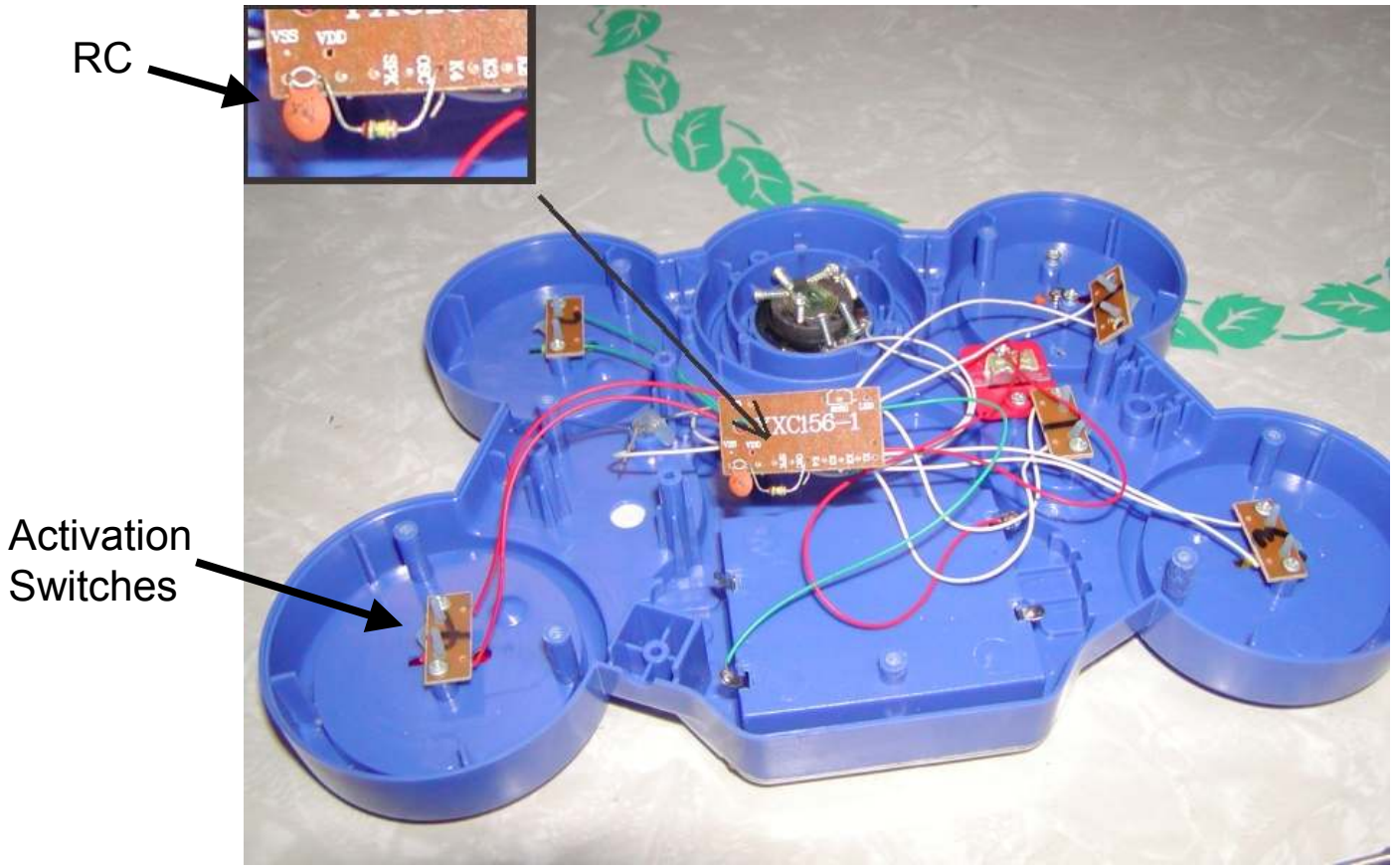
```
void loop()
{
  long distance;
  distance = analogRead(1);   // sensor on pin 1

  // make a sound, frequency based on distance
  delayMicroseconds(distance);
  digitalWrite(3,LOW);
  delayMicroseconds(distance);
  digitalWrite(3,HIGH);
}
```

Interfaceable Sound Modules

- Wave Shield
- Cheaper solutions:
  - Sound toys
  - Sound greeting cards
  - Talking picture frames
  - Digital voice recorders
  - MP3 players

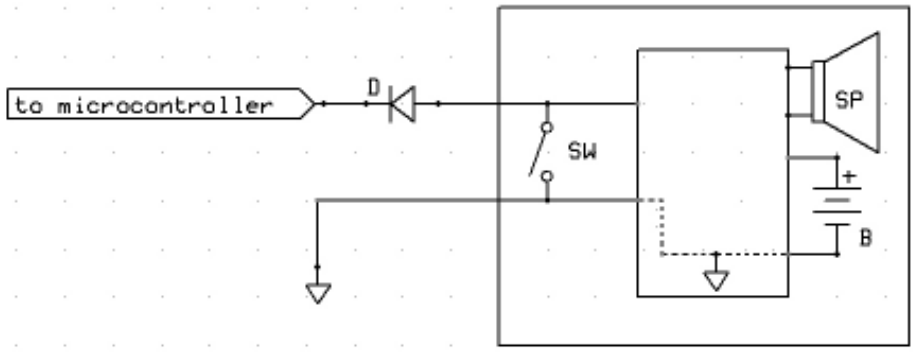
“Circuit bending” Sound Modules



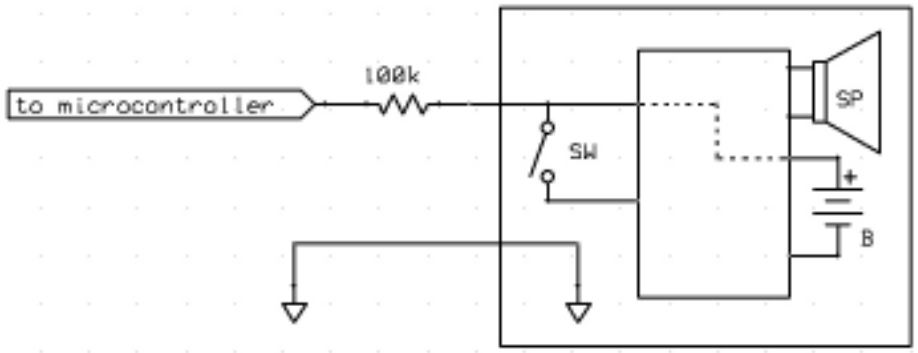
- RC circuit sets playback speed
- Modify R (or C) to change sound
- Microcontroller I/O pins can connect to switches to trigger sounds

Controlling Sound Modules

(hacked toys, “talking picture frames”, etc…)



Active-low Sound Module



Active-high or low Sound Module

Distance Sensing
Drum Machine Code

```
/* PingDrummer */

const int pingPin = 7;  //ping sensor

void setup()
 {
   Serial.begin(9600);
   // hacked toy drum machine connections
   pinMode(13,OUTPUT);  //drum sound #1
   pinMode(12,OUTPUT);  //drum sound #2
   pinMode(11,OUTPUT);  //drum sound #3
 }

void loop()
 {
   long duration;

   // The PING))) is triggered by a HIGH pulse of 2 or more microseconds.
   // Give a short LOW pulse beforehand to ensure a clean HIGH pulse:
   pinMode(pingPin, OUTPUT);
   digitalWrite(pingPin, LOW);
   delay(2);
   digitalWrite(pingPin, HIGH);
   delayMicroseconds(5);
   digitalWrite(pingPin, LOW);

   // The same pin is used to read the signal from the PING))): a HIGH
   // pulse whose duration is the time (in microseconds) from the sending
   // of the ping to the reception of its echo off of an object.
   pinMode(pingPin, INPUT);
   duration = pulseIn(pingPin, HIGH);
   if (duration<1500) Serial.println(duration);

   if (duration<1500) drum1();     // close object detected
   if (duration>1500 and duration<3000) drum2();  // intermediate range object detected
   if (duration>3000 and duration<4500) drum3();  // farther object detected
 }
```

```
void drum1(void)
 {
   digitalWrite(13, HIGH);
   delay(40);  // 40ms high pulse triggers drum
   digitalWrite(13, LOW);
   delay(200);   // wait for sound to finish
 }

 void drum2(void)
 {
    digitalWrite(12, HIGH);
    delay(40);
    digitalWrite(12, LOW);
    delay(200);
 }

 void drum3(void)
 {
    digitalWrite(11, HIGH);
    delay(40);
    digitalWrite(11, LOW);
    delay(200);
 }
```

Window to the Past

A 3 minute audio delay line situated in a public restroom. At any given time the viewer is hearing whatever happened in the room 3 minutes prior. By its nature, the portal can also be used to "leave a message for the next person in (the bathroom) line". *Window to the Past* addresses issues of privacy, surveillance, and the supposed neutrality of technological devices.

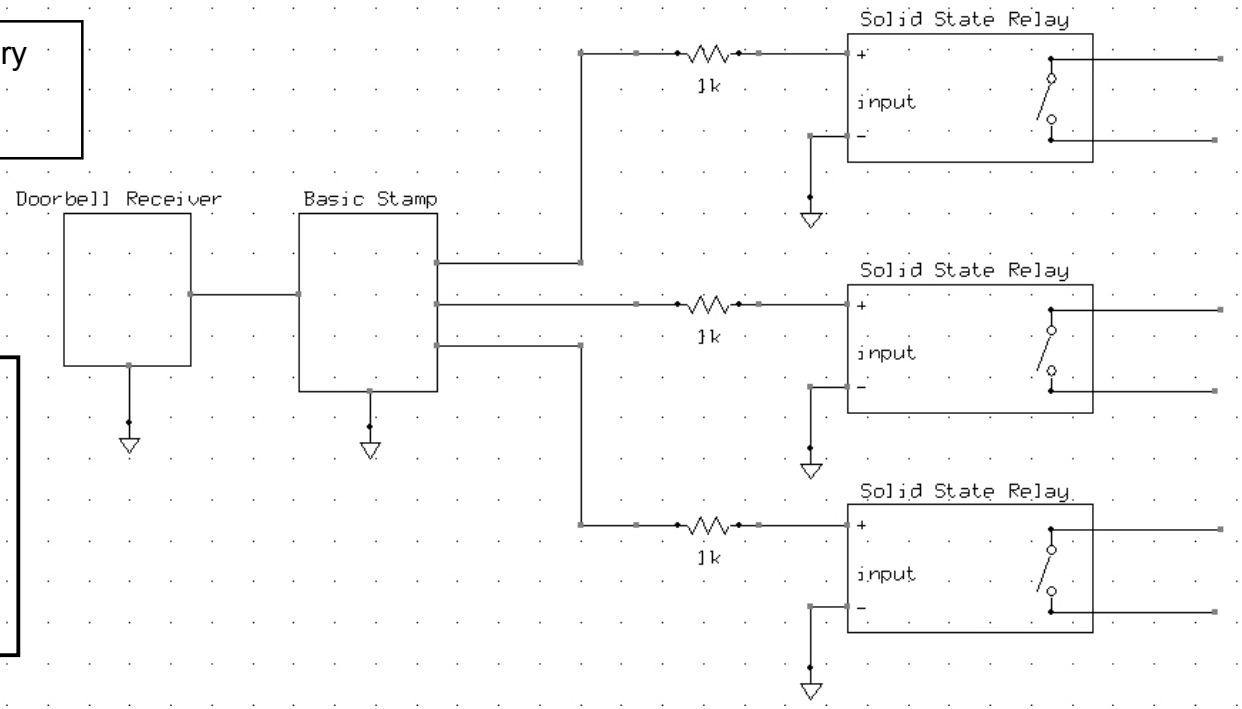
The device is based on two off-the-shelf digital audio recorders controlled by a BasicStamp.

Remote

Wireless doorbell

Relays mounted in circuit breaker box

Pressing the button on the small jewelry box causes the lights in the gallery to begin flashing in an elaborate pattern.



The system is based on an off-the-shelf wireless doorbell and a BasisStamp connected to 3 solid state relays. The relays allow the BasicStamp to control over 3000 Watts of lighting.

General Interface Techniques

Buttons on remote can be controlled
from microcontroller
(Hint: buy a universal remote to hack)

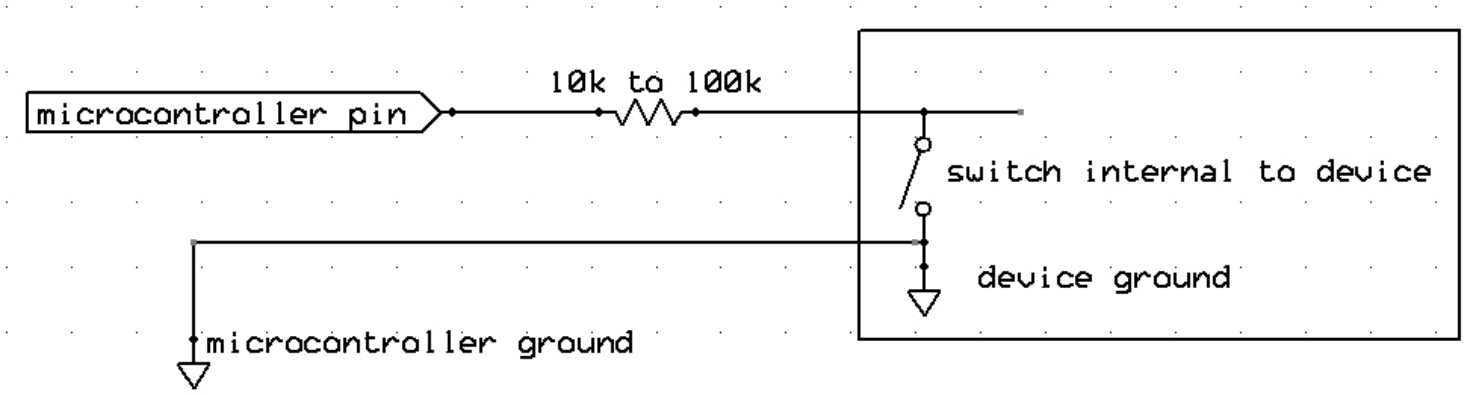
Buttons on device can be
controlled from microcontroller

Almost any consumer electronic device can be controlled this way:

- DVD players
- MP3 players
- Receivers
- Ceiling fans, fireplaces!
- etc…

Interfacing Approaches

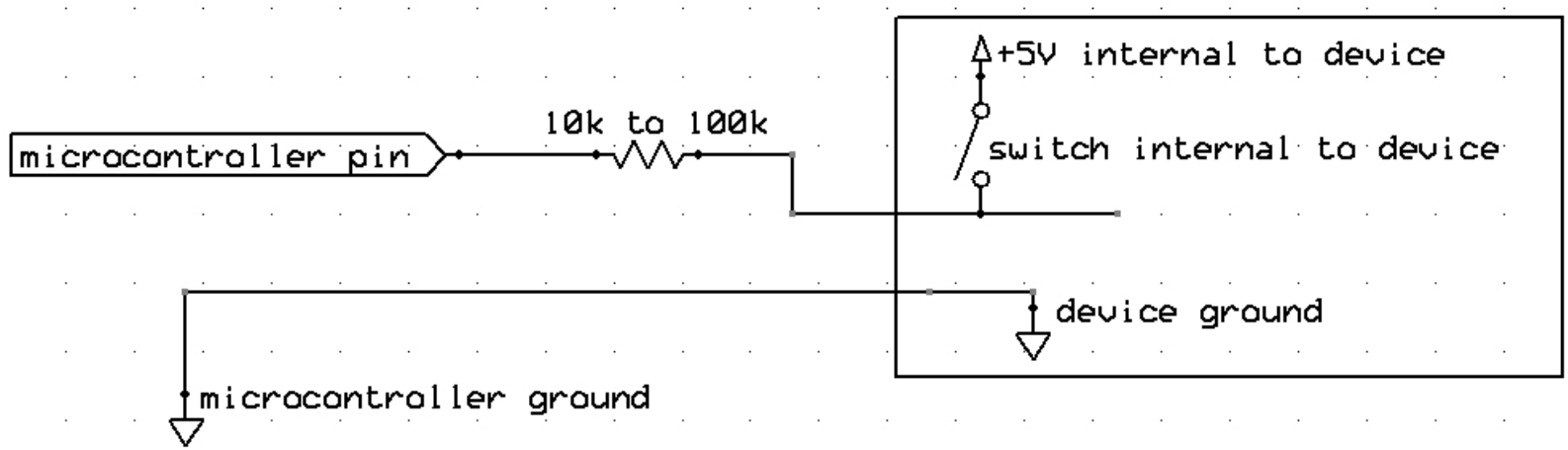
- active low



- **Microcontroller pin goes low to activate**
- **Make sure voltage across switch does not exceed 5V**
- **If voltage across switch is less than 5V, add a diode in series with resistor**

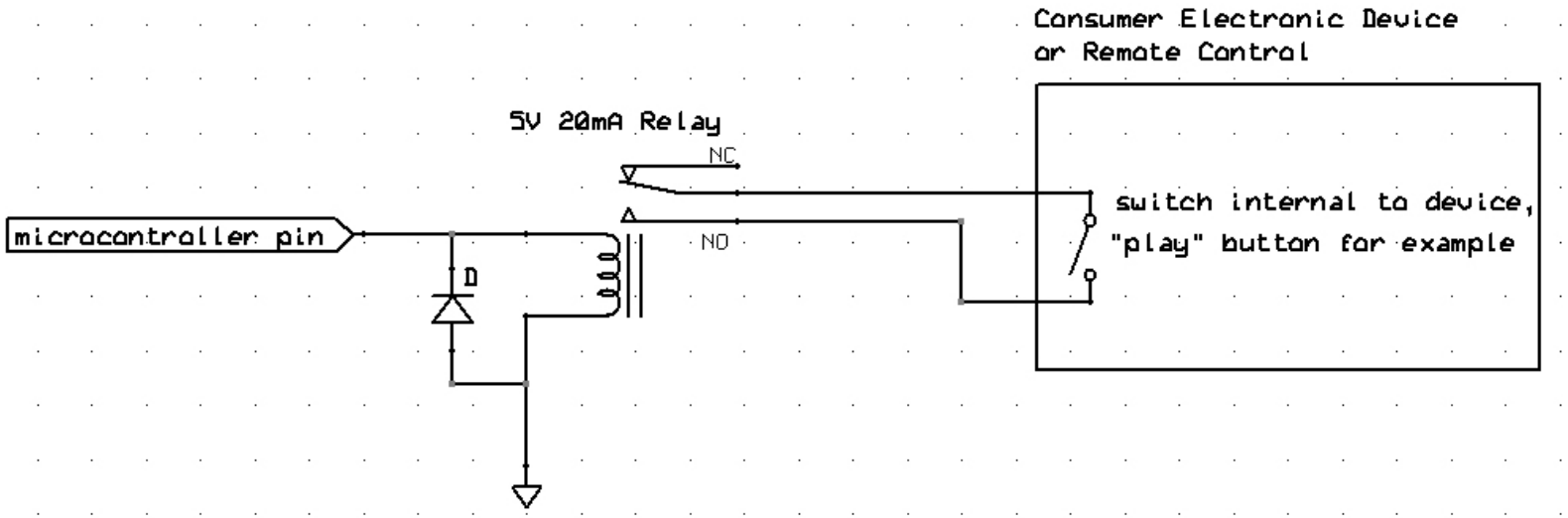
Interfacing Approaches

- active high



- **Microcontroller pin goes high to activate**
- **Make sure voltage across switch does not exceed 5V**

A Universal Interfacing Approach



Small 5V, 20mA reed relays can be driven directly by an Arduino output

Multiple instances of this circuit can be used to control multiple functions:

- **Play**
- **Stop**
- **Next track**
- **Etc…**

Interleaving Operations

Why won't this program work?

```
/* Flash LED and make sound */

void setup()
{
  pinMode(2, OUTPUT);  // connect speaker to pin 2
  pinMode(13, OUTPUT); // LED
}

void loop()
{
  // make sound by sending pin 2 high and low every 1000 microseconds
  digitalWrite(2, HIGH);
  delayMicroseconds(500);
  digitalWrite(2, LOW);
  delayMicroseconds(500);

  // flash LED on pin 13 every second
  digitalWrite(13, HIGH);
  delay(1000);
  digitalWrite(13, LOW);
  delay(1000);
}
```

Technical Assignment
For Thursday March 4th

- Create a program that makes a continuous 1000Hz tone and simultaneously flashes an LED – on for 1 second, off for 1 second. Hint: modify the BlinkWithoutDelay example.
- Then modify the program so that the LED can be turned on or off using 'a' or 'b' characters sent from the serial terminal. Please email your two versions of this program to me or bring a hardcopy with you to class. You can test your code using a small speaker or one of the piezo speakers we have used in class. If you can't get access to these or are having trouble with the assignment please contact me.

Remember, many code examples are also available here:
http://arduino.cc/en/Tutorial/HomePage

And some more serial communications information can be found here:
http://www.ladyada.net/learn/arduino/lesson4.html