Arduino Tone Library

Description

This is an Arduino Library to produce square-wave of the specified frequency (and 50% duty cycle) on any Arduino pin.

A duration can optionally be specified, otherwise the wave continues until `stop()` is called.

The pin can be connected to a piezo buzzer or other speaker to play tones.

Be sure to try out the RTTTL (RingTone Text Transfer Language) example!

Arduino Core Version

A simplified version of the Tone library has been incorporated into the Arduino core since 0018. It only provides a single tone (since only one timer is used). You can find the core documentation here.

Check out the tutorial by Tom Igoe at NYU's Interactive Telecommunications Program (ITP). It demonstrates how to use the core `tone()` and`noTone()` commands.

WARNING

Do not connect the pin directly to some sort of audio input. The voltage is considerably higher than a standard line level voltages, and can damage sound card inputs, etc. You could use a voltage divider to bring the voltage down, but you have been warned.

You MUST have a resistor in line with the speaker, or you WILL damage your controller.

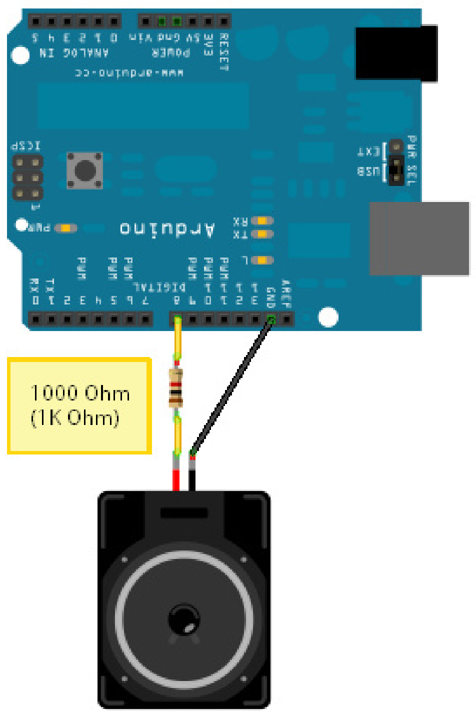
Download and Installation

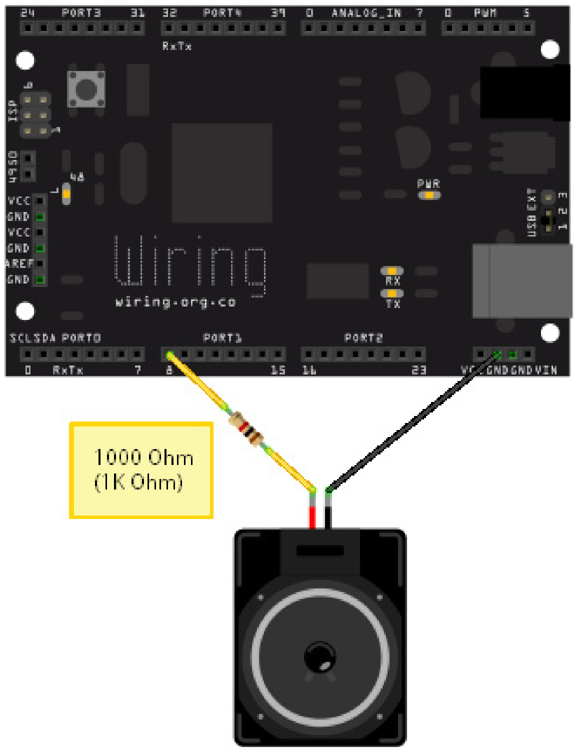
Tone Library - Latest Version

For installing the library, see: InstallingArduinoLibraries

Hardware Connections/Requirements

- Just connect the digital pin to a speaker (with a resistor - say 1K - in line), and the other side of the speaker to ground (GND).





- You can use a potentiometer to control the volume. Use a 10K Ohm potentiometer (variable resistor) in line with the 1K Ohm resistor connected to the speaker.
- Using this library will affect usage of the PWM outputs, so be aware.
- Also, although it's the last timer to be allocated, timer 0 (which is used for `millis()` among other things) will be affected if used.

Library Usage

Instantiation/Creation

```
Tone tone1;

void setup(void)
{
  tone1.begin(13);
}
```

Properties

- No properties.

Methods

- `begin(`***`pin`***`)` - prepares a pin for playing a tone.
  -
- `isPlaying()` - returns `true` if tone is playing, `false` if not.
- `play(`***`frequency`***` [, `***`duration`***`])` - play a tone.
  - ***`frequency`*** is in Hertz, and the ***`duration`*** is in milliseconds.
  - ***`duration`*** is optional. If ***`duration`*** is not given, tone will play continuously until ***`stop()`*** is called.
  - `play()` is non-blocking. Once called, `play()` will return immediately. If ***`duration`*** is given, the tone will play for that amount of time, and then stop automatically.

- `stop()` - stop playing a tone.

Constants

Below is a list of constant values of frequencies for notes. (These are included in the library).

e.g.

```
tone1.play(NOTE_B3);
```

Musical Notes

Constant Name	Frequency (Hz)
NOTE_B2	123
NOTE_C3	131
NOTE_CS3	139
NOTE_D3	147
NOTE_DS3	156
NOTE_E3	165
NOTE_F3	175
NOTE_FS3	185
NOTE_G3	196
NOTE_GS3	208
NOTE_A3	220
NOTE_AS3	233
NOTE_B3	247
NOTE_C4	262
NOTE_CS4	277
NOTE_D4	294
NOTE_DS4	311
NOTE_E4	330
NOTE_F4	349
NOTE_FS4	370
NOTE_G4	392
NOTE_GS4	415
NOTE_A4	440
NOTE_AS4	466
NOTE_B4	494
NOTE_C5	523
NOTE_CS5	554
NOTE_D5	587
NOTE_DS5	622
NOTE_E5	659

NOTE_F5	698
NOTE_FS5	740
NOTE_G5	784
NOTE_GS5	831
NOTE_A5	880
NOTE_AS5	932
NOTE_B5	988
NOTE_C6	1047
NOTE_CS6	1109
NOTE_D6	1175
NOTE_DS6	1245
NOTE_E6	1319
NOTE_F6	1397
NOTE_FS6	1480
NOTE_G6	1568
NOTE_GS6	1661
NOTE_A6	1760
NOTE_AS6	1865
NOTE_B6	1976
NOTE_C7	2093
NOTE_CS7	2217
NOTE_D7	2349
NOTE_DS7	2489
NOTE_E7	2637
NOTE_F7	2794
NOTE_FS7	2960
NOTE_G7	3136
NOTE_GS7	3322
NOTE_A7	3520
NOTE_AS7	3729
NOTE_B7	3951
NOTE_C8	4186
NOTE_CS8	4435
NOTE_D8	4699
NOTE_DS8	4978

Quick example

Play a 440 Hz - musical note of 4th octave A - on pin 13:

```
#include <Tone.h>

Tone tone1;

void setup()
{
  tone1.begin(13);
  tone1.play(NOTE_A4);
}

void loop()
{
}
```

Ugly Details

The library uses the hardware timers on the microcontroller to generate square-wave tones in the audible range.

You can output the tones on any pin (arbitrary). The number of tones that can be played simultaneously depends on the number of hardware timers (with CTC capability) available on the microcontroller.

- ATmega8: 2 (timers 2, and 1)
- ATmega168/328: 3 (timers 2, 1, and 0)
- ATmega1280: 6 (timers 2, 3, 4, 5, 1, 0)

The timer order given above is the order in which the timers are allocated. Timer 0 is a sensitive timer on the Arduino since it provides `millis()`and PWM functionality.

The range of frequencies that can be produced depends on the microcontroller clock frequency and the timer which is being used:

MCU clock	8 bit timer F_{low}	16 bit timer F_{low}	F_{high}
8 MHz	16 Hz	1 Hz (1/16 Hz)	4 MHz
16 MHz	31 Hz	1 Hz (1/8 Hz)	8 MHz

Although F_{high} can go as high as 8 MHz, the human hearing range is typically as high as 20 kHz.

Tone accuracy is dependent on the timer prescalar. Frequency quantization occurs as the frequencies increase per prescalar.

If you used a 16 bit timer (e.g. timer 1, or timers 3,4,5 on '1280), you could generate "tones" down to 1/8 Hz (one cycle every 8 seconds), although the library only accepts integers for frequency.

After all is said and done, because `play()` only accepts unsigned integers for frequency, the maximum frequency that can be produced is 65535 Hz - which, after rounding, results in a 65573.77 Hz "tone" on a 16 MHz part. Even if play accepted larger values for frequency, you couldn't achieve better than around 80KHz with the Tone library because the pin toggling is done in software. Each toggle, in software, requires *AT LEAST* 50+ cycles.

Links

Projects/Examples Using Tone Library and Core `tone()`

- Tom Igoe - Tone Output using an Arduino
- Interactive painting

RTTTL Sites

- http://merwin.bespin.org/db/rts/index.php
- http://www.cellringtones.com/
- http://nokiatone.ifrance.com/nokiatone/rtttf.htm
- http://www.ringtones4all.com/index.php?page=freetone&catr=20&cnt=0
- http://ringtones.frostzone.com/
- http://www.2thumbswap.com/members/tones/nokia/tones_nokia_main.html

- http://hem.passagen.se/klas2/vgtones/
- http://arcadetones.emuunlim.com/

Other

- Arduino sketch for high frequency precision sine wave tone sound synthesis