

Send Music over a Laser Beam

by [navaburo](#) on July 12, 2006

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Author: navaburo [author's website](#)

I am a student and hobbyist. I'm into physics, linguistics, sailing, electronics, hacking (not cracking), music, and the like.

I post most of my project stuff on my blog: <http://hotwigati.wordpress.com/>

Whenever one of my projects becomes, er..., repeatable I will make an instructable for it.

Happy Hacking!

Intro: Send Music over a Laser Beam

WARNING: this project involves the use and modification of laser devices. While the lasers I suggest using (store-bought red pointers) are relatively safe to handle, NEVER LOOK DIRECTLY INTO A LASER BEAM, BEWARE OF REFLECTIONS, and be EXTREMELY CAREFUL when MODIFYING a laser product. Also, I am not liable for anything stupid you do.

Here is yet another thing to do with those promotional laser pointers: send music (or data) from point A to point B over the laser beam using amplitude modulation. All it takes is pointing the moded laser at a detector, and music can be heard from an attached amplifier. The range and quality (or data speed) can vary, but I have gotten a HALF MILE of range with excellent audio quality and around 300bps of throughput.

The image shown here is the transmitter and receiver working across my desk during a test.

TO SEE HOW TO USE TWO LASERS TO TRANSMIT TWO MUSIC CHANNELS AND MIX THEM WITH A PAIR OF SUNGLASSES, [check out the blog post here.](#)

A video of the system working can be found here: <http://video.google.com/videoplay?docid=689504876032879458&hl=en>

Much inspiration for this project came from http://sci-toys.com/scitoys/scitoys/light/light.html#laser_communicator

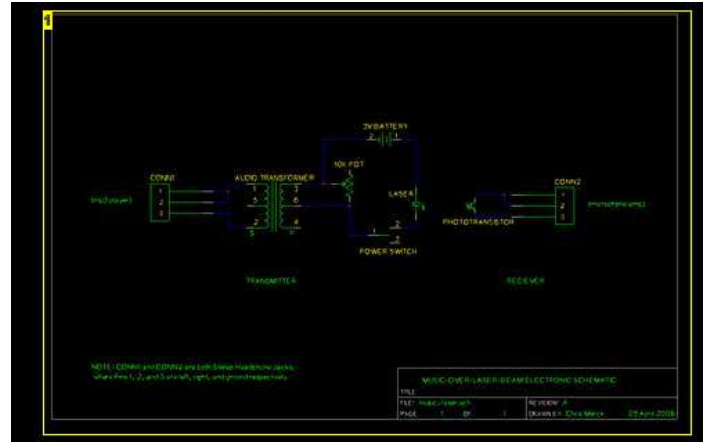
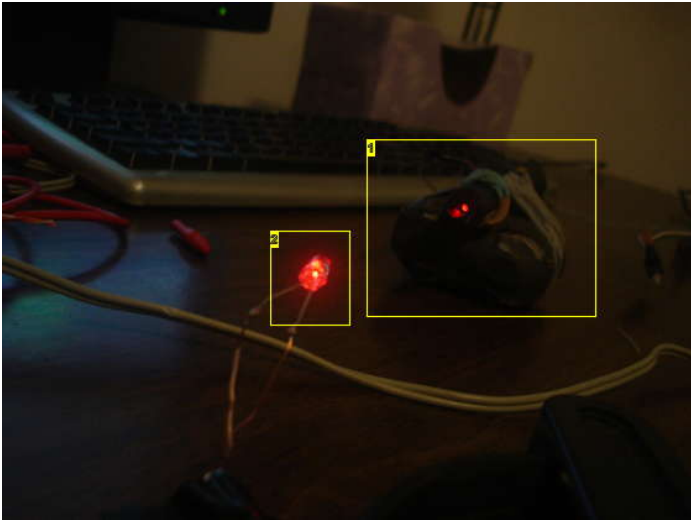


Image Notes

1. for a high-res schematic, use the following URL:
http://personal.stevens.edu/~cmerck/downloads/music_laser.png

Image Notes

1. laser pointer
2. phototransistor

Step 1: Gather Materials

To send music over a laser beam you will need the following parts, most of which can be gotten for less than 5 dollars at radioshack total (besides the pointer, which probably costs \$15). If you are on a tight budget, try replacing the laser with a red LED and a 100ohm resistor attached in series.

for the transmitter:

- a laser pointer
- batteries (D-cell work best)
- potentiometer (variable resistor) 50k ohm or less
- audio source (iPod, cd player, mic preamp, PC line-out, etc.)
- some wire (cat5 aka ethernet cabling works best)
- toggle switch (a turbo switch from an old PC works well)
- audio transformer (can be pulled from audio equipment)
- 1/8" audio jack (can be gotten from the end of a headphones cable)

for the receiver:

- phototransistor (photodiodes or IR detectors also work)
- 1/8" audio jack
- some more wire
- high-gain amplifier (laptop with mic input, or mic preamp plus amplifier)
- magnifying glass (helps at great distances)

tools:

- wire cutter/stripper
- soldering iron and electronics solder
- tape (clear and/or electrical)
- digital multimeter (can be useful... not really required)

<http://www.instructables.com/id/Send-Music-over-a-Laser-Beam/>

tripod (helps for aiming laser at a distance)
empty pizza boxes with white backs (for finding beam and for adjustments)
some assistants

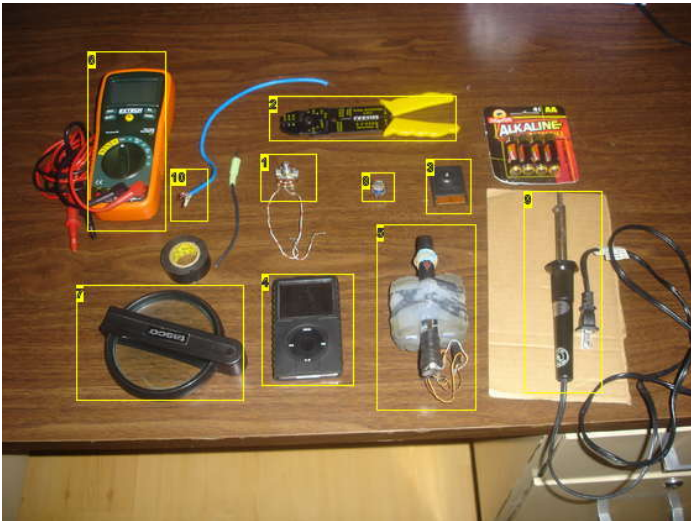


Image Notes

1. 50k ohm potentiometer
2. multi-tool (stripper/cutter/crimper)
3. phototransistor from RadioShack kit
4. duh
5. laser with attached 2xD battery pack
6. digital multimeter
7. large magnifying glass to refocus signal after a distance of travel
8. audio transformer
9. \$8 soldering iron
10. cat5 ethernet cable the small wires work great for projects like this

Step 2: Hack the Laser

First the laser pointer needs to be modified. Remove all batteries and total up the voltage of the batteries to find the voltage required by the laser. For instance, mine takes two AAA batteries, so that is 2×1.5 or 3 volts. Now solder wires on to the positive and negative terminals inside the laser. This might require cutting open the case a bit (a dremmel is sometimes necessary).

Next, figure out how to hold down the button on the pointer that makes it light. A shaved-down pencil eraser and a rubberband works for me.

Now test the modified laser by connecting batteries of appropriate voltage to the newly attached wires. If it doesn't work, try connecting them in the opposite direction. Laser pointers use laser diodes which only take current in one direction.

This mod will allow us to control the brightness of the laser by varying the voltage and current supplied to it.

In the photo below you can see my pointer, with two D-cell batteries attached.



Image Notes

1. make sure to secure the wires running to the terminals so they don't fall out
2. this button needs to be held down

Step 3: Create Transmitter Circuitry

Use the schematic below as a guide in soldering together the transmitter circuit. Everything to the left of the laser is the transmitter circuit.

Tape or glue the compents down to a piece of cardboard, or use a breadboard.

Check out the photo of my finished board. I used an 1/8th inch female jack to make connections easier.

To test the circuit, turn up the iPod volume to MAX, play some music with alot of bass, and turn the potentiometer all the way down. The laser dot should appear to pulsate with the music, since this is an amplitude modulated (AM) circuit.

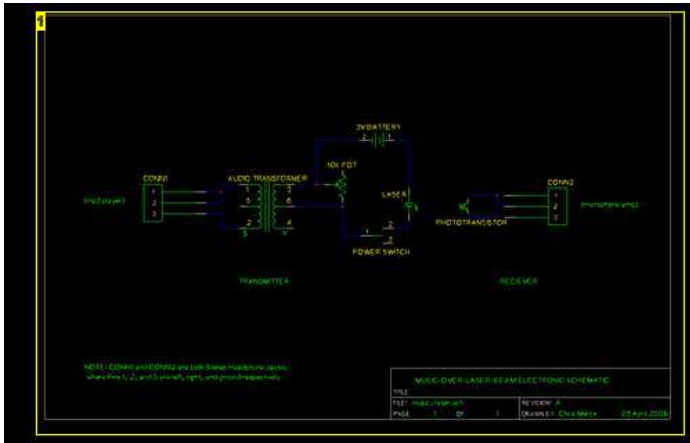


Image Notes

1. for a high-res schematic, use the following URL:
http://personal.stevens.edu/~cmerck/downloads/music_laser.png

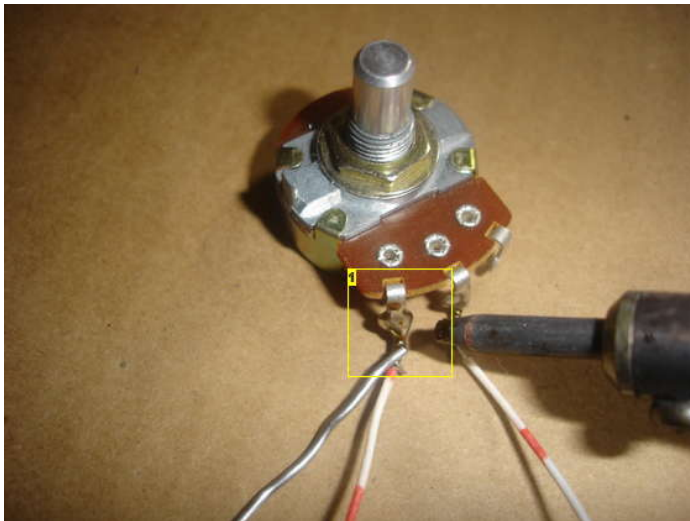


Image Notes

1. use plenty of solder!

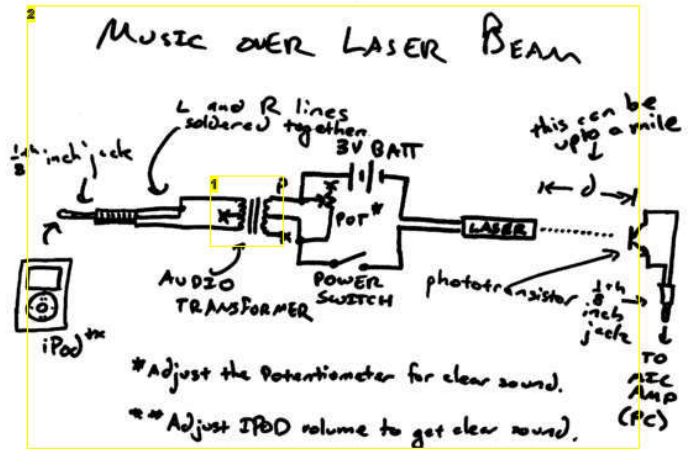


Image Notes

1. by using the center-tap on the primary side of the audio transformer a 1:1 ratio can be attained
2. This is very unclear... use the other schematic

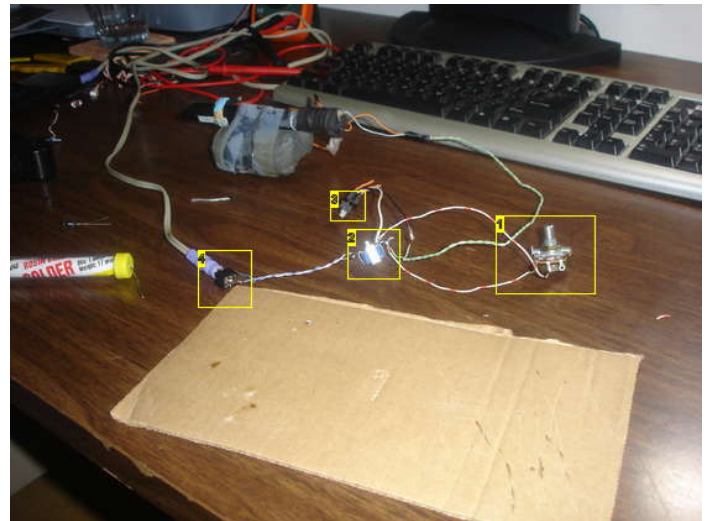
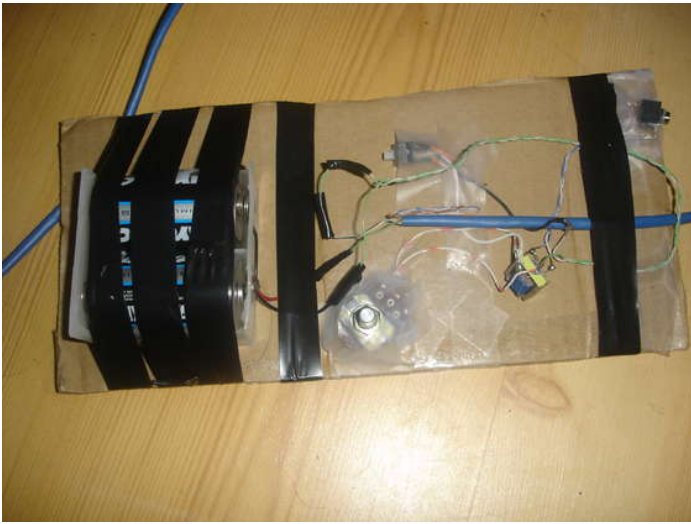


Image Notes

1. potentiometer to adjust brightness
2. transformer
3. power toggle switch
4. modular 1/8" jack



Step 4: Setup the Receiver

Solder long leads onto the phototransistor (or photodiode). Attach these to an 1/8th inch audio jack (a headphones cable is perfect). Plug this into the MIC port on a laptop or PC or other MIC preamp/amp and turn up the gain and volume to a moderate level. Try to mount the whole setup (with room for a magnifying glass) on a sturdy but portable material (like a wooden board).

For this project the GAIN of the amplifier is critical. It must be very high to pick-up slight variations in input signal (light) to pull out the music. Therefore I build a breadboard preamp from RadioShack's 50-in-1 Sensor Lab breadboard kit, which I highly recommend. Check out the photos and schematics from the included book.



Image Notes

1. IR/red light receiver
2. magnifying glasses or parabolic mirrors work wonders for increasing signal strength

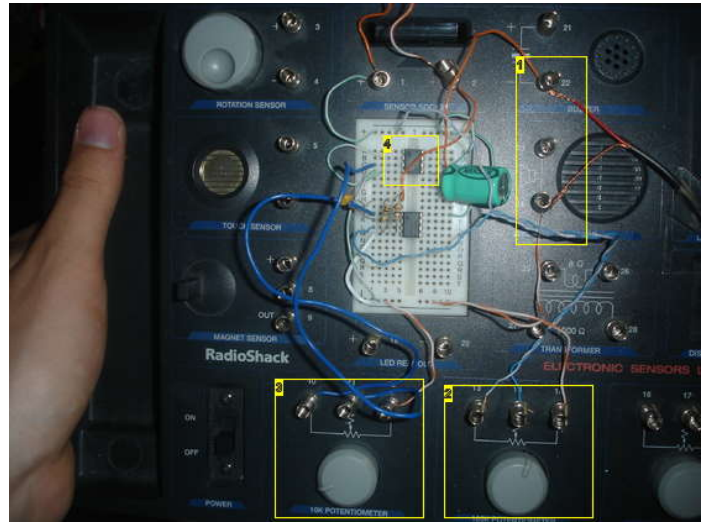
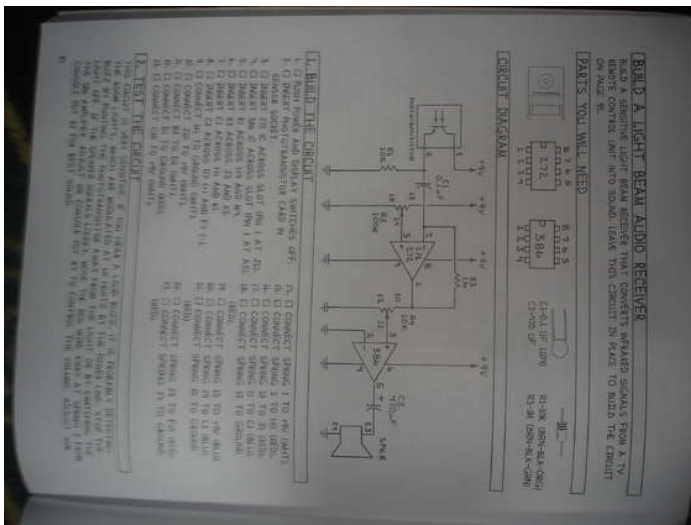


Image Notes

1. bypass onboard speaker to go to a bigger amp
2. i dont know what this does...
3. gain adjustment
4. Im386



Step 5: Give it a try

Point the laser beam at the photodiode, hit play on the iPod, and listen to any and all noises coming from the amp. Play with the iPod volume and potentiometer positions until music can be heard clearly and without distortion on the receiving side. Then turn up the receiver gain as necessary.

Try mounting the laser on a tripod and sending music a longer distance. I recently was able to hear Starway to Heaven clearly at a beam distance of a half mile. This was done over a small lake, with an assistant in a canoe with a pizza box to help with the aiming.

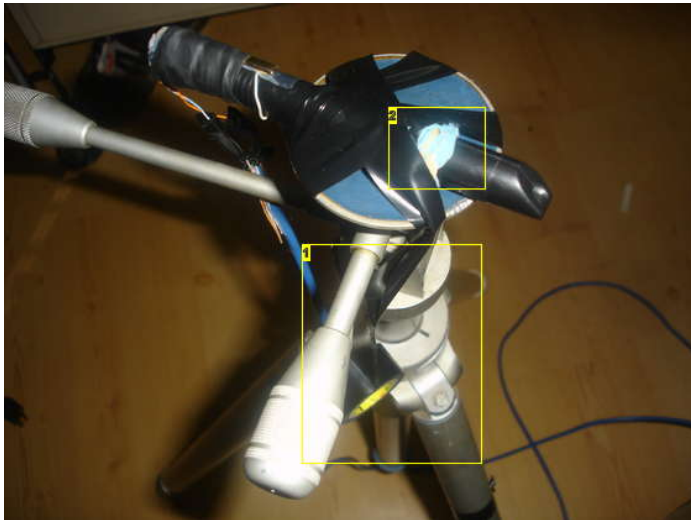


Image Notes

1. tripod is a must for stability
2. power button is jammed ON

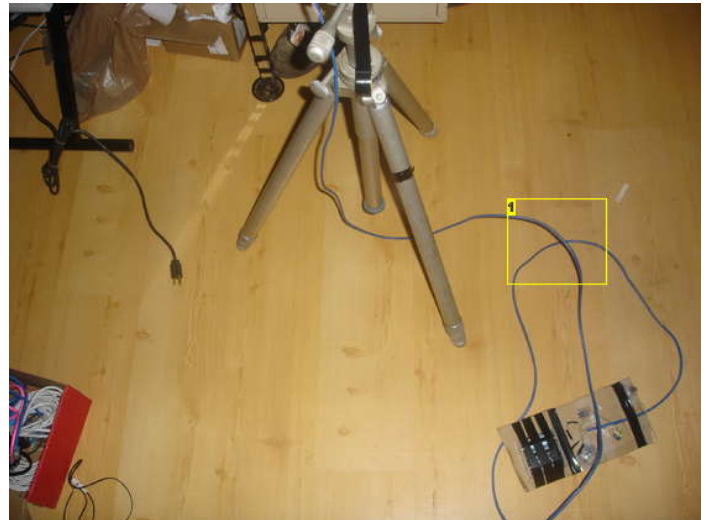


Image Notes

1. more cat5 cable!

Step 6: How does that work? And where do I go from here?

This circuit works using amplitude modulation, exactly like AM radio, except using a visible light wavelength instead of a radio frequency. The audio signal leaves the iPod as a varying voltage which forces a varying current through the laser. Then the laser's varying brightness conveys the musical information. Finally, the phototransistor varies in resistance as the brightness on it changes. The mic amp applies a small voltage to the phototransistor and amplifies the resulting current.

A problem with this system is that at each step there is a non-linear transfer function, that is, there is distortion that occurs because the brightness changes are not always proportional to the change in voltage applied. See the screenshot below for an example, and listen to the attached audio sample.

The next step in this project would be to use pulses (like fast, computer operated morse code) to convey digital information like text, crystal-clear audio, or even video. One could even network computers with laser beams in a manner similar to fiber optics but in open air. I will post C code for my transmitting and receiving programs.



Image Notes

<http://www.instructables.com/id/Send-Music-over-a-Laser-Beam/>



1. healthy signal
2. distortion spikes



Image Notes

1. yes, laptops from the 80s are still useful
2. laser pointer wired into serial port with mosfet and common ground

```



File Edit View Compile Project Options Debug
Line 1 Col 1 Insert Insert Tab GotoLine1.C
~/ LWNET.C - Lightwave TRANSMITTER
~/ by Chris Merck, apr 2005

#include <stdio.h>
#include <stdlib.h>
#include <conio.h>
#include <dos.h>
#define LW 1771 080







void main()
{
    int b=0;
    int c=0;
    int cr=0; /* c remaining (during binary conversion)*/
    int l=0;
    int bit=0;
    int plen = 0;
    int temp = 0;
    int sbl = 59;
    printf("Lightwave Transmitter Program\n");
    printf("\nType to transmit, press the title key (") to quit\n");
    while(c = getch()) != 'q')

```

File Downloads

-  clear.wav (783 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'clear.wav']
-  distorted.wav (651 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'distorted.wav']
-  adjusting.wav (966 KB)
[NOTE: When saving, if you see .tmp as the file ext, rename it to 'adjusting.wav']

Related Instructables

					
Laser Surveillance System for under \$20 by navaburo	Control Fluorescent Lights with a Laser Pointer and an Arduino by rmd6502	Transfer Sound on a Laser by saites2001	X Y speaker laser-show by funky alex	The Prism: A Laser Synth-Guitar by jeff-o	Simple Sequencer by randofu

Comments

50 comments [Add Comment](#)

[view all 144 comments](#)



Zack1296 says:
YA CAKE! btw the project is awesome

Mar 21, 2011. 7:32 PM [REPLY](#)



chubyatyahoo says:
can you replace the laser with an led

Apr 11, 2009. 4:45 PM [REPLY](#)



Swishercutter says:
That would be an Optoisolator...at least by the time you actually got the led close enough to eliminate noise and get an effective signal...but basically an optoisolator uses an LED coupled with a phototransistor in order to electrically isolate the control circuit from the circuit being controlled.

Feb 6, 2011. 9:56 AM [REPLY](#)



raykholo says:
i would seriously not recommend doing that will it work? yes is it effective? absolutely not an led is not a focused beam, cannot be used over long distances like a laser can, and it is more prone towards the distortion as the light is more spread out. The laser points light precisely at the photo diode, so that is the light which is converted to audio. Theoretically, using an led would require total darkness so as to eliminate that interference. Give it a shot and tell how it went!

May 22, 2009. 6:44 PM [REPLY](#)



XOII says:
Could you just hook a laser diode to the audio output and a receiver to a microphone input? IT seems like it would make sense.

Jan 28, 2011. 5:08 AM [REPLY](#)



navaburo says:
Short answer, no.

Jan 29, 2011. 4:19 AM [REPLY](#)

This is mainly because laser diodes only conduct electricity in one direction - that is, they work with Direct Current (DC). However, (most) audio outputs have alternating directions of current (AC). So when you hook up a laser diode to the audio output, you only get half of the waveform.

Furthermore, laser diodes have a minimum voltage required to turn them on. So you will actually get less than half of your waveform if you attach the laser diode directly to the output.

That is why there is a battery pack involved: the batteries provide the direct current bias needed to keep the laser on. The audio output (via the transformer) subtly changes the strength of that direct current, and is therefore manifest in the laser's output brightness.

Hope that helps.



Warlrosity says:
what is a duh? is it an iPod knockoff?

Jul 19, 2009. 1:39 AM [REPLY](#)



GameNox says:
No. It is an iPod. It means that you need music. Your'e a duh! =P

Jan 13, 2011. 2:02 PM [REPLY](#)



jelte1234 says:
actually: would ripping apart a wireless cheapy headphone not also work, and then replacing the leds with a laser? or is this a bad idea?

Jun 14, 2010. 9:02 AM [REPLY](#)



inquist says:
No the LEDs are in the transmitter, and they have a wide angle so your headset can receive from anywhere in the room. A laser transmitter has to point straight toward its receiver, in this case William Tell style

Dec 13, 2010. 2:07 PM [REPLY](#)




ep0317 says:
Could you please specify the type of audio transformer that you used? thanks..


Oct 1, 2010. 3:17 PM [REPLY](#)





caseyC088 says:
would it be possible to make a two way radio sort of thing if you made two of these??

Mar 7, 2010. 5:52 AM [REPLY](#)

 **lazer155** says: Nov 8, 2009. 12:20 PM [REPLY](#)
Is the potentiometer absolutely necessary? I dont have one on hand so I want to know if I can use just a resistor. Can I use one of those photocells instead of the phototransistor?

 **navaburo** says: Nov 11, 2009. 11:33 AM [REPLY](#)
Short answer: YES.
Long answer: if you knew exactly what resistance(s) to use, you could substitute the potentiometer(s) for fixed resistor(s). However, these resistances depend on your laser pointer and the voltage of your battery pack, so it is really convenient to use the pots. (They are inexpensive too.... and useful in other projects, so I'd recommend buying/salvaging some.)


 **lazer155** says: Nov 11, 2009. 4:31 PM [REPLY](#)
What is the potentiometer for? I got it working without a pot or a resistor. Does the pot filter out static and background noise?

 **navaburo** says: Nov 13, 2009. 12:36 AM [REPLY](#)
Lasers often have a non-linear response. That is, their brightness depends on the power-supply voltage in a complicated way. The potentiometer(s) along with a control of the input audio amplitude (mp3 player volume) allow you to select which section of the psv-brightness curve to use. So, you should be able to select a linear portion, and get great audio quality. Using a non-linear portion will result in nasty sounding distortion.


Also, I realize now I didn't address your second queston "can you use a photocell instead of a phototransistor". I assume you mean either a Cadmium-Sulfide passive cell or an active solar panel (generates electricity from light). The issue with the photo-cells are that they (typically) have a slower responce-times as compaired to a phototransistor or photodiode. The result is that a photo-cell-based circuit does not pick up on the higher frequencies as well, if at all. It might sound like music through a wall (only bass).


But, you can always try original designs! Do let me know how you get along with this!


Chris


 **lazer155** says: Nov 8, 2009. 12:55 PM [REPLY](#)
Also how would I hook this up directly to a speaker instead of having to put it in a mic port?


 **ayman deabes** says: Nov 3, 2009. 3:39 PM [REPLY](#)
nice project


 **adhwaith** says: Sep 9, 2009. 9:50 AM [REPLY](#)
hey... i don't seem to be able to get any music across... is there any way of testing if the transmitter works???? and i'm using a 10k ohm potentiometer, could that be a reason???

 **Firecrow** says: Aug 18, 2009. 1:15 PM [REPLY](#)
when i point my laser beam at the reciever i get no sound.. Does this mean that my laser beam is not good enough? and if so could i just connect it to a infrared led?

 **navaburo** says: Aug 18, 2009. 6:47 PM [REPLY](#)
Firecrow, You can test the function of your receiver by holding the laser close to the receiver and quickly passing the laser beam across the photodetector. You should here a low-pitched WompWompWomp. If you are using the mic port on a computer to receive and amplify the signal, you can use a recording program (like Audacity) to see if the laser is being detected. If you hear/see the signal from flicking the beam across the detector, then you know the detector works, and you have to work on the transmitter. Best of luck and let me know how it goes! - Chris

 **Gamernotnerd** says: Jun 23, 2009. 5:54 PM [REPLY](#)
Can you post some pics of the sensor lab?

 **UbuntuNinja** says: Jun 17, 2009. 2:29 PM [REPLY](#)
My laser uses 3 button cell batteries (4.5 volts) so can i replace the 3 volts in the diagram with 4.5 volts to give the laser a reasonable brightness?

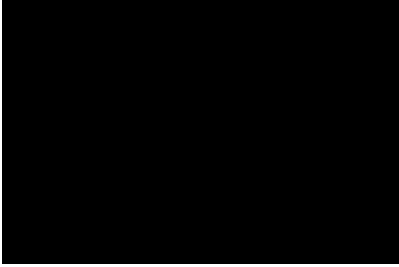
 **navaburo** says: Jun 17, 2009. 6:58 PM [REPLY](#)
Yes. Although remember that you want to maximize your signal to noise ratio (SNR), and that the raw brightness is not the signal strength. The signal strength is roughly proportional to the range of brightnesses the laser exhibits during operation. For a digital signal where the laser goes full-on and then full-off, the raw brightness is the brightness range. However, in an analogue scheme such as this one, one must closely consider the modulation to determine what parameters will maximize signal strength. Put briefly, a dimmer laser beam may result in better transmission because the laser is more sensitive in that brightness region (it can get dimmer and brighter from that mid-point). Hope that helps, Chris



UbuntuNinja says:

Jun 18, 2009. 12:56 PM [REPLY](#)

Can you help me to understand how i should wire up my LM386 amplifier IC? Here is the schematic of the IC:



navaburo says:

Jun 22, 2009. 11:38 AM [REPLY](#)

UbuntuNinja,

I assume you wish to use the LM386 as part of an audio amplifier on the receiving end? I would recommend building an audio amp with it along the lines of MAKE's Crackerbox Amp: <http://makezine.com/09/crackerboxamp/>

You will need to then use a battery in series with the phototransistor (unless you use a small solar cell, which provides its own power), and hook this up to the audio amp.

Viel Spass!
Chris



UbuntuNinja says:

Jun 18, 2009. 12:18 PM [REPLY](#)

Yeah i think it is actually better to use *less* voltage than the laser takes for normal operation (not in audio circuit) because it will be receiving extra voltage from the ipod which which would create a voltage greater than what the laser is build for. Since we are talking about lasers, overvoltage could damage the laser.



navaburo says:

Jun 22, 2009. 11:39 AM [REPLY](#)

Yes, overvoluting the laser could also be a concern! If you burn out a laser let me know! (I think it is harder than you might think)



madscientist167 says:

Oct 20, 2009. 3:27 PM [REPLY](#)

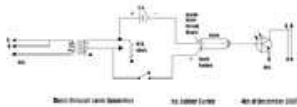
no that's the easy part



ashes63 says:

Dec 19, 2007. 2:57 PM [REPLY](#)

hope this one works!!



UbuntuNinja says:

Jun 17, 2009. 1:54 PM [REPLY](#)

That schematic is very helpful. I like how you correctly represented the different ways to wire the transformer. I was actually having difficulty figuring out which side of the transformer was supposed to be wired to what looking at the authors diagram.



UbuntuNinja says:

Jun 15, 2009. 4:09 PM [REPLY](#)

Here is the schematic for the circuit without the black background, for easy and efficient printing: <http://www.instructables.com/file/FYUF1DKFVW22CNV/>

Here is that same file in Inkscape SVG (scalable vector graphics) format:

<http://www.instructables.com/file/FW4ZN91FVW22CNW/>



gentry says:

Dec 22, 2008. 3:03 AM [REPLY](#)

Check out this IR sound transceiver from 1961.



alex-sharetskiy says:

Jun 14, 2009. 1:35 PM [REPLY](#)


nice magazine!




astro boy says:

Mar 14, 2009. 6:27 PM [REPLY](#)

hey they stole my idea! gir!!!!!!!!!!!!


 **brian108832** says: Jun 12, 2009. 7:04 PM [REPLY](#)
sooo. i am completely new to this... i have only the basic understanding of circuitry so please excuse my question but. on the schematic it shows the output from the mp3 player with 3 lines. i understand the left and right but what is the ground?

 **navaburo** says: Jun 12, 2009. 8:52 PM [REPLY](#)
There are several ways to answer that question, I will give two of them:


1) The academic answer: Voltages are only defined between TWO points. A single point only has a voltage insofar as a reference (ground) has been established. Any device "communicating" with the mp3 player needs to have a reference to make sense of the left and right signals.


2) The simpler but not totally correct answer: The signal needs to "return" to the source to complete the circuit. The ground allows for this completion.

Electronics is a great hobby to get into. I would recommend getting yourself a copy of the classic intro "Getting Started in Electronics".


 **trebuchet03** says: Jul 15, 2006. 1:34 PM [REPLY](#)
Very cool :D There's software out there to send morse code through your speakers and also interpret code brought in through your microphone/line in... I made a really cheap serial 'radio' that did just this... but the range was not so hot :P


 **navaburo** says: Jul 15, 2006. 5:56 PM [REPLY](#)
could you post the url for the software?


 **astro boy** says: May 25, 2008. 11:09 PM [REPLY](#)
your inspiration web site has how to send mores code in the electronics section
Computers and Electronics Building a computer controlled laser data transmitter

 **navaburo** says: Feb 5, 2009. 9:51 AM [REPLY](#)
oh wow, i never saw that. I think it is a new section of that page. Great find! -- BTW, the best encoding IMHO for digital-over-laser is the so-called "Manchester Encoding". It is the same encoding used in Ethernet. It is highly efficient and somewhat error resistant.

 **TTSDA** says: May 10, 2008. 9:38 AM [REPLY](#)
how can you transmit video trough this system??


 **navaburo** says: May 10, 2008. 5:36 PM [REPLY](#)
Short answer: No. Answer: If it were encoded into a one-wire protocol at a low bandwidth, any information can be transmitted by this technique. The problem is the bandwidth of the setup is less than that which your video requires.

 **TTSDA** says: May 11, 2008. 3:25 AM [REPLY](#)
I asked this because you sayed:
"The next step in this project would be to use pulses (like fast, computer operated morse code) to convey digital information like text, crystal-clear audio, or even **video** "

 **NetReaper** says: May 25, 2008. 9:37 AM [REPLY](#)
the bandwidth would be so low that it would take forever to transmit, maybe it could be used to transmit documents and word files

 **amando96** says: Feb 5, 2009. 7:03 AM [REPLY](#)
word pad, like *hello* my brill idea! laser chat!
lol...

 **TTSDA** says: May 26, 2008. 8:12 AM [REPLY](#)
how can I transmit the Word Files?

 **NetReaper** says: May 26, 2008. 10:41 AM [REPLY](#)
if it's like mores code then it could send a binary signal to transmit the file.
1= light 0= no light. I'm no tech wizard but i think that's possible.

 **admanrocks** says: Jul 15, 2006. 3:01 PM [REPLY](#)
Looks cool, but can you tell me more about the audio transformer?



navaburo says:

Jul 15, 2006. 5:55 PM [REPLY](#)

the audio transformer is a small, six pinned device from Mouser. it reads 0005S and L021. I believe that they are quite standard in audio equipment. It's primary coil is 150ohms and the secondary is 60ohms. I centertapped the primary coil in the circuit.

[view all 144 comments](#)