

The battery holder goes on the bottom side. Inspect all of the connections that it will cover up BEFORE soldering it in place and correct any errors. Its leads fit the pads marked B+ and B-. Test its fit before soldering and trim any leads underneath it that interfere. Use the screws and nuts included to fasten the battery holder to the PCB securely. Clamping the board will make installing the screws easier.

**Speaker (optional)** A speaker can be connected directly to the board. Connect its leads to the pads labeled SPK. The speaker must be mounted in an acoustic enclosure to perform well. Devising the enclosure is left up to you.

**Testing and calibration**

Install a 9V battery and verify the LED comes on when the power switch is actuated. Set the volume control to its lowest position (slider near power switch). Plug in headphones and listen while turning up the volume slowly. You should hear humming from the room lights.

You must calibrate the automatic gain control (AGC) circuit by adjusting the trimmer potentiometer. Aim the photodiode away from any bright lights. Adjust the trimmer until you find the point where it begins to affect the volume. (The flat edge of the trimmer's knob will be aimed toward the LED.) The audio should not distort or cut out when you bring the sensor near a bright light bulb. If the circuit cannot be calibrated properly, check that the photodiode is installed in the proper orientation.

If the circuit does not work properly, inspect all the solder joints and be sure there is no solder bridging adjacent points. You may need to de-solder the battery holder to access all areas. Re-heat any suspicious connections with the soldering iron until you see the solder liquefy and become shiny all over. You can add a little bit of fresh solder here for the benefit of fresh rosin flux.

Touching the solder points on the underside of the board can cause unwanted noises. You can use hot glue to insulate the solder points near the sensor to prevent audio interference due to handling.

**FAQ**

**Q. What does the sun sound like?**  
A. Sunlight sounds like the wind. When the sky is very clear with no clouds or haze, point the sensor at the sun and you will hear the wind move.

**Q. Do different colors make different sounds?**  
A. No, but it can seem that way. LITE2SOUND is color-blind by nature. Different colored lights can still produce different tones however, depending on the nature of the light source technology.

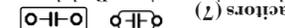
**Q. Do brighter lights always make louder sound?**  
A. Not necessarily true. The loudness you hear is related to how strongly the light source is modulated.



**1. Resistors (13)** Bend the leads at a 90-degree angle to the resistor's body, then slip them into the holes on the board. Both legs are equivalent so it doesn't matter which way they go in.



**2. Diode** Bend the leads at a 90-degree angle. Be sure the striped end of the diode matches the printing on the board.



**3. Non-polarized Capacitors (7)** Mount the polyester and ceramic capacitors. Both legs are equivalent so it doesn't matter which way they go in.



**4. Chips (2)** Sockets aren't needed. The TL074 is a 14-pin DIP type. Rotate it so its printed markings match the orientation of the board where it will sit. In fitting it to the board, it helps to bend both rows of leads inward slightly. The NJM866 is an 8-pin DIP type. Orient it so the printed markings match the printing on the board.



**5. LED** Orient the LED so its short leg goes in the hole with the white bar printed next to it.



**6. Photodiode** The flat edge of the photodiode must face the white bar printed on the board. Its round end must face outward away from the board. Identify the proper orientation, then bend both leads of the QSD2030 photodiode at a right angle to its body, insert it, and solder in place.



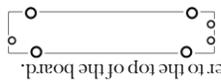
**7. Output Jack** Solder the output jack to the top of the board.



**8. Electrolytic Capacitors (7)** The longer lead must go in the hole marked with a plus sign.



**9. Switches (2)** Solder the switches to the top of the board.



**10. Potentiometers (2)** Solder the small TRIM potentiometer and the larger VOLUME slider to the top of the board.

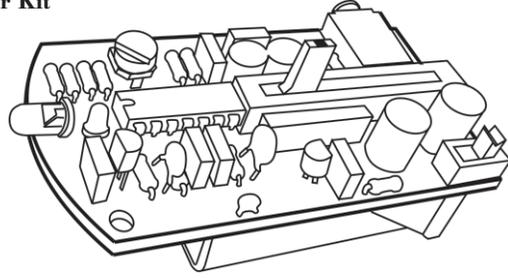


**11. JFET** The J113 JFET is static-sensitive so do not handle it unnecessarily. Orient it so its flat edge matches the printing on the board, solder it in place, and trim its leads.

LITE2SOUND is a portable sensing device that extracts audio from ambient light. Not a synthesizer at all, it is more like a microphone that detects a hidden layer of your environment.

LITE2SOUND reveals unusual sounds by responding to rapid but invisible changes in brightness. A sensitive amplifier boosts this information to audio level and delivers it to your headphones or line input, and can drive a speaker directly with its built-in 1-watt amp.

Beyond the ubiquitous mains hum transmitted by lighting, and the static hiss of sunlight, you can find many sounds of different character being produced by high technology.



PCB + all parts included  
Requires 9V battery, headphones

MIND-EXPANDING!

LITE2SOUND PX from Rare Waves LLC  
Auto-gain Photodiode Amplifier Kit  
v1.5

In technology-saturated spaces, musical chords emerge and fade as luminous sources harmonize together into unintended soundscapes.

Suggested listening: metro commute... arcade... carnival midway... highway at night... high street... anywhere you find bold, bright electronic lighting! Results are usually best at night.

Even nature creates content for LITE2SOUND's reception, if one looks in the right places. Its purpose is to reward your curiosity.

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# LITE2SOUND PX v1.5

## Bill of Materials

- (1) carbon resistor, 5% 1/4-watt, 2 MΩ
- (5) carbon resistor, 5%, 1/4-watt, 100 kΩ
- (2) carbon resistor, 5%, 1/4-watt, 220 Ω (220R)
- (4) carbon resistor, 5%, 1/4-watt, 4.7 kΩ
- (1) carbon resistor, 5%, 1/4-watt, 10 Ω (10R)

- (5) polyester film capacitor, 47 nF
- (5) electrolytic capacitor, 10 uF
- (1) ceramic disc capacitor, 47 pF
- (1) ceramic capacitor, 220 pF
- (2) electrolytic capacitor, 470 uF

- (1) 1N5819 Schottky diode
- (1) NJM386 audio amplifier IC, DIP-8
- (1) TL074 quad op amp IC, DIP-14
- (1) J113 N-channel JFET, TO-92
- (1) visible LED, 3mm
- (1) photodiode, QSD2030, 5mm dia

- (2) SPDT slide switch
- (1) trimmer potentiometer, 100k ohm
- (1) slide potentiometer, 50k ohm, audio taper
- (1) audio jack, 3.5mm stereo type

- (1) battery holder, 9V PCB mount
- (3) flat head Philips machine screw, 2-56 x 5/16"
- (3) hex nut, 2-56 x 3/16" dia

## Identification Guide

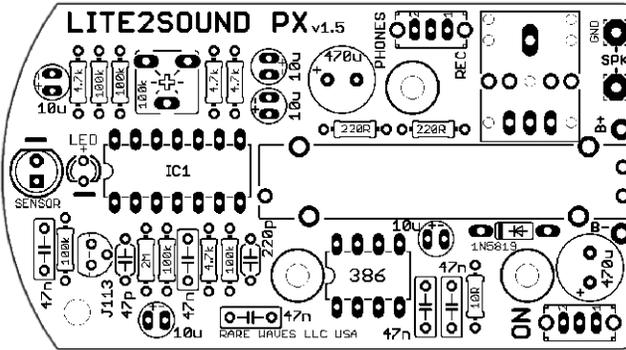
red - black - black - yellow - brown  
 brown - black - yellow - gold  
 red - red - brown - gold  
 yellow - violet - red - gold  
 brown - black - black - gold

plastic rectangular box  
 small cylinder  
 round disc, marked "47"  
 round disc, marked "221"  
 large cylinder

small cylinder with gray stripe  
 chip with two rows of 4 pins  
 chip with two rows of 7 pins  
 marked "J113"  
 colored lens  
 clear lens, looks like an LED

## PHONES/REC Switch

Set the switch to REC position when connecting the output to a recording device. The volume control is disabled, and noise floor is reduced.



## Glossary of Terms

**Pads** metallic points on the PCB where components and wires can be connected by soldering.

**Pink noise** A random signal with equal power per octave of frequency.

**LED** light emitting diode

**EMI** electromagnetic interference

**DIP** dual inline package

**SPDT** single pole, double-throw switch

**SIP** single inline package

**IC** integrated circuit

**PCB** printed circuit board, aka the board

**IR** infrared light

**near IR** infrared light from 750-1400nm

**TO-92** D-shaped package with three leads

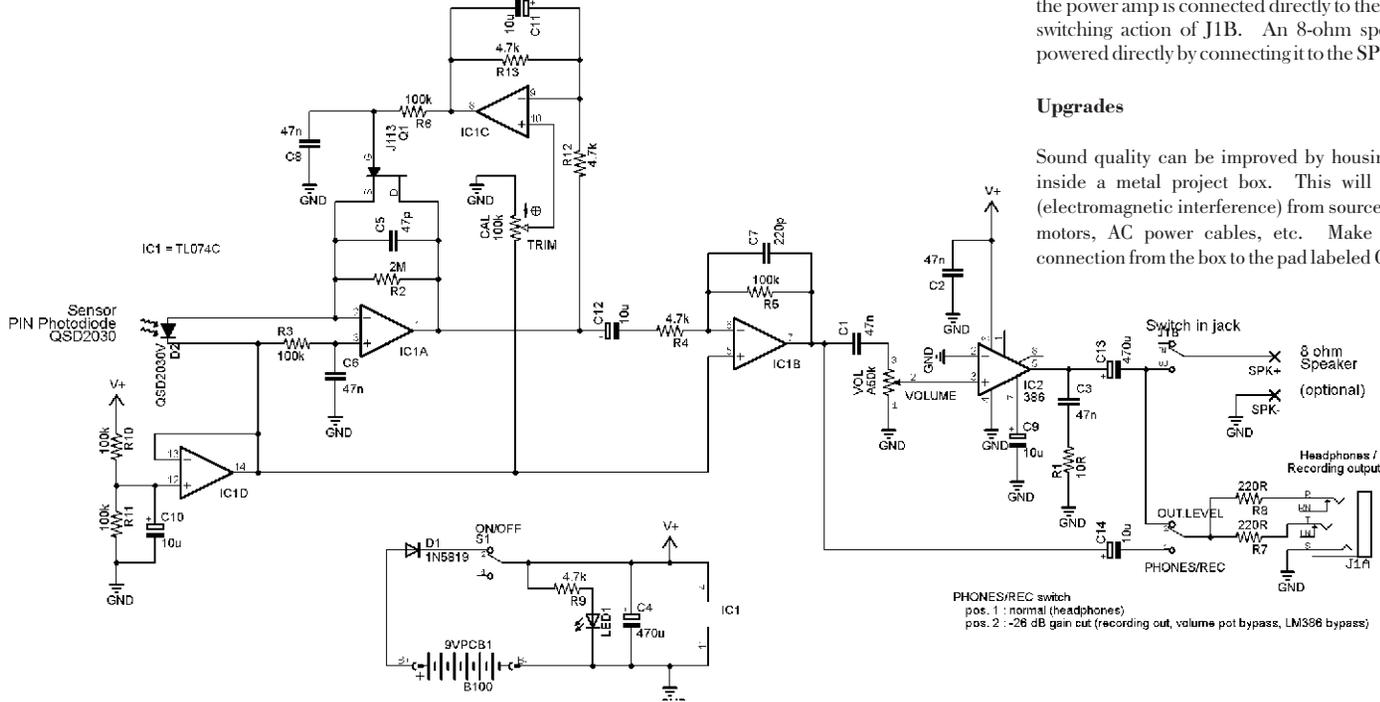
**TIA** transimpedance amplifier

**AGC** automatic gain control

**JFET** junction field-effect transistor

**Photodiode** a semiconductor which produces electrical current from light. It is used as the sensor. It is similar to a solar photovoltaic cell.

**nm (nanometers)** a unit of light wavelength, related to color



## Theory of Operation

The transimpedance amplifier (TIA) IC1A converts current from the photodiode into an analog signal representing the instantaneous light intensity. The photodiode responds to visible light and infrared (IR). It is most sensitive to red light and near IR. The gain of the TIA is controlled with a JFET across the TIA's negative feedback resistor. An automatic gain circuit (AGC) comprised of IC1C, trim pot, and Q1 generates a control voltage in proportion to the integrated DC level of the incoming signal. This voltage is applied to the JFET's gate, creating a control loop that reduces TIA gain as ambient light level increases. This makes the unit automatically adapt to changes in ambient light.

The analog signal from the TIA is AC-coupled to a gain stage IC1B providing up 25dB of boost. It is followed by a volume control. The post-volume control signal drives an LM386 type power amplifier IC2. The power amp is configured with 220-ohm series resistors on the headphone output jack J1A. This doubles as a line output, and can be used with either mono- or stereo-type plugs. With no plug inserted in the 3.5-mm jack, the power amp is connected directly to the SPK pads via switching action of J1B. An 8-ohm speaker can be powered directly by connecting it to the SPK pads.

## Upgrades

Sound quality can be improved by housing the project inside a metal project box. This will exclude EMI (electromagnetic interference) from sources like electric motors, AC power cables, etc. Make an electrical connection from the box to the pad labeled GND.

## Instructions for using AC adapter

The 9V battery can be replaced with an AC adapter. The adapter must have a regulated 9V DC output. If unsure, measure your adapter with a voltmeter before connecting it. The voltage should be 10 volts or less, since the electrolytic capacitors are rated for 10 volts max.

## Power

- power supply .....9 volt battery
- current use .....7mA (idle)
- current use .....110mA (full output)
- reverse polarity protection? .....YES

## Specifications

## Specifications

### Optical

- reception angle .....40 degrees
- peak sensitivity .....880nm
- spectral response .....400 - 1100nm

### Audio

- format .....monophonic analog
- connection ..... 3.5mm mono/stereo
- max. power ..... 1W