# START HERE

All of the components will be mounted to the top side of the board - except for the battery holder, which mounts to the bottom side. In order listed below, insert each component's leads through the holes in the board and solder from the opposite side, then trim any excess length.

**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 the resistor is rotated.

**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 (10)**
Mount the polyester and ceramic capacitors. Both legs are equivalent so it doesn't matter which way they go in.

**4. Chips (3)**
Sockets are unnecessary. The TLC2264 is a 14-pin DIP type. Rotate it so its printed markings match the orientation of the text on the board where it will sit. In fitting it to the board, it helps to bend both rows of leads inward slightly. The NJM386BL is an 8-pin SIP type. It has a stripe on one end by pin 1. Orient it so the stripe matches the printing on the board. The TLE2426 is next. *Do not confuse it with the J113! Consult the Identification Guide to be sure you read the markings correctly.* Mount the TLE2426 with its flat edge matching the outline 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 (3)**
The long lead must go in the hole marked with a plus sign.

**9. Switch**
Solder the switch 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.

**12. Battery Holder**
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 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. A background hiss should be audible.

You must calibrate the automatic gain control (AGC) circuit by adjusting the TRIM potentiometer. Aim the unit at a bright lamp (fluorescent, CFL, or incandescent) about 3 inches away, and set the volume slider to about 10 percent of its maximum. Now rotate TRIM so the audio is at its loudest point without being distorted. Move the unit repeatedly near and far from the lamp while listening. The audio should get louder when the unit is near the lamp, but it should not cut-out or make popping sounds. If the circuit cannot be calibrated properly, check to be sure 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 remedy this.

**FAQ**

**Q.** What does the sun sound like?
**A.** Sunlight is a faint, hissing, pink noise type sound. If it reflects off a vibrating object, it can carry audible modulation to LITE2SOUND.

**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.

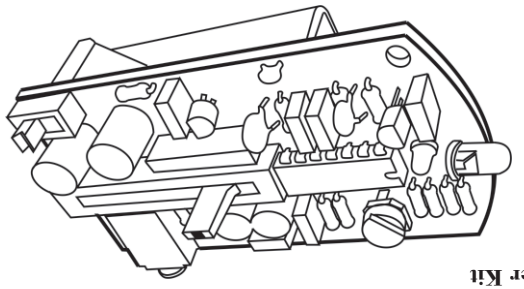
**Q.** Do brighter lights always make louder sound?
**A.** Not necessarily true. The loudness you hear is related to how strongly the light source is modulated. Some lights are very bright but not modulated: for example, the sun or an LED running on DC power. Other lights are invisible but highly modulated, like infrared remote control signals.

SCHEMATIC ▶





LITE2SOUND PX from Rare Waves / Eric Archer
Auto-gain Photodiode Amplifier Kit
v1.2



PCB + all parts included
Requires 9V battery, headphones

MIND-EXPANDING!

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.

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.

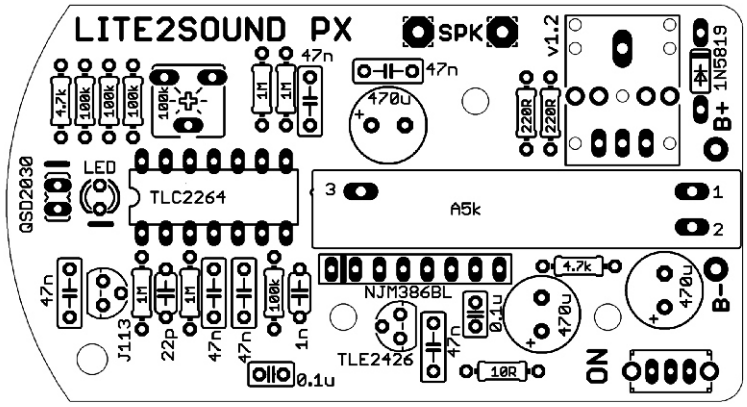
Even nature creates content for LITE2SOUND's reception, if one looks in the right places. Its purpose is to reward your curiosity.

INSTRUCTIONS ▲

**LITE2SOUND PX**
**Bill of Materials**

| | |
|---|---|
| (4) carbon resistor, 5% 1/4-watt, 1 MΩ | brown - black - green - gold |
| (4) carbon resistor, 5%, 1/4-watt, 100 kΩ | brown - black - yellow - gold |
| (2) carbon resistor, 5%, 1/4-watt, 220 Ω (220R) | red - red - brown - gold |
| (2) carbon resistor, 5%, 1/4-watt, 4.7 kΩ | yellow - violet - red - gold |
| (1) carbon resistor, 5%, 1/4-watt, 10 Ω (10R) | brown - black - black -gold |
| | |
| (6) polyester capacitor, 47 nF | plastic rectangular box |
| (2) ceramic capacitor, 0.1 uF | rectangular, marked "104" |
| (1) ceramic disc capacitor, 22 pF | round disc |
| (1) ceramic capacitor, 1 nF | rectangular, marked "102" |
| (3) electrolytic capacitor, 470 uF | large cylinder |
| | |
| (1) 1N5819 Schottky diode | small cylinder with gray stripe |
| (1) NJM386BL audio amplifier IC, SIP-8 | chip with 8 pins in one row |
| (1) TLC2264 quad op amp IC, DIP-14 | chip with two rows of 7 pins |
| (1) TLE2426 virtual ground, TO-92 | marked "2426C TI" |
| (1) J113 N-channel JFET, TO-92 | marked "J113" |
| (1) visible LED, 3mm | colored lens |
| (1) photodiode, QSD2030, 5mm dia | clear lens, looks like an LED |
| | |
| (1) SPDT slide switch | |
| (1) trimmer potentiometer, 100k ohm | |
| (1) slide potentiometer, 5k 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**




**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

**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

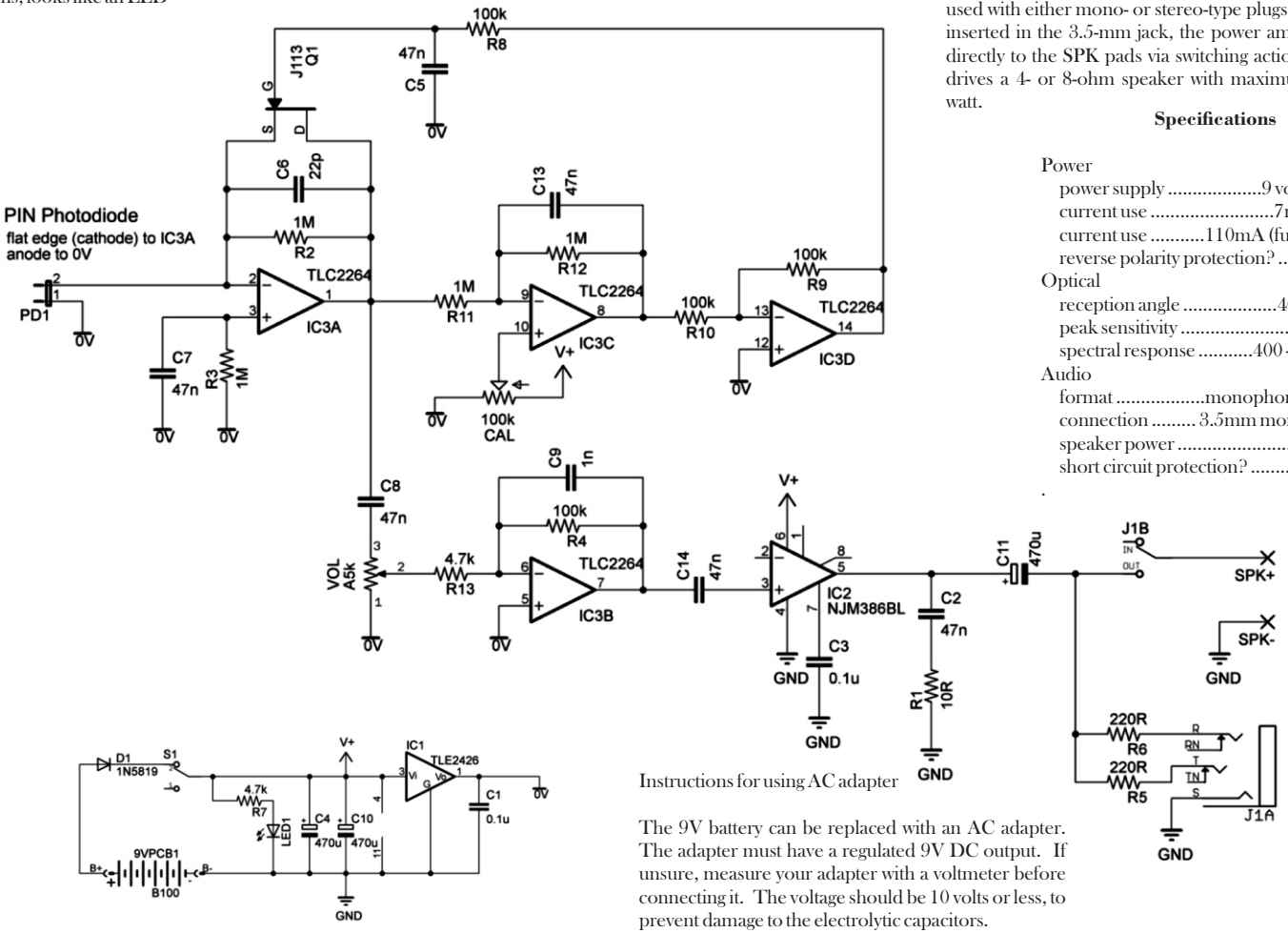
**TIA** transimpedance amplifier

**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 analogous to a photovoltaic cell.

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




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, to prevent damage to the electrolytic capacitors.

**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, IC1D, 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 gives the unit hands-free operation.

The analog signal from the TIA is AC-coupled to a gain stage IC1B providing up to 25dB of boost. A volume slider lets the user adjust the gain. The boosted signal drives a '386 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. IC2 drives a 4- or 8-ohm speaker with maximum power of 1 watt.

**Specifications**

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

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

Audio
- format .....monophonic analog
- connection ..... 3.5mm mono/stereo
- speaker power .....1 W max
- short circuit protection? .....YES

.