LASER TRIP SENSOR KIT

Ramsey Electronics Model No. LTS1

Have you every been startled by someone sneaking up on you? Do you need to protect your privacy or alert yourself to the presence of incoming intruders?
Never be surprised by unwanted guests again when you let the power of Laser Technology protect your private space!
This little educational kit applies many of the basic principles of transistor circuitry while providing you with a fun and useful tool!

- **Set up a security fence for over 500 yards of continuous coverage!**
- **Includes both Visible LED and Audible Alert trip indicators!**
- **5 Amp External Trigger Relay Output for custom drive applications!**
- **Reconfigurable circuit board for 9 Volt battery operation of the remote sensor; detector draws only 10 μA when illuminated!**
- **Small Circuit Board lends itself well to discrete mounting locations!**
- **Works with almost any hi-intensity light source or included Laser!**
- **Runs on 9 to 18 VDC for easy operation!**
- **Rugged PVC enclosure included!**
- **Build it tonight and you'll sleep tight!**

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LTS1 KIT INSTRUCTION MANUAL

Ramsey Electronics publication No. MLTS1 Rev 1.1
First printing: January 2002

Ramsey Publication No. MLTS1
Price $5.00

KIT ASSEMBLY
AND INSTRUCTION MANUAL FOR

LASER TRIP SENSOR KIT

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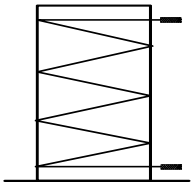
IMPORTANT SAFTEY NOTE

As with any other laser device, great care should be taken to avoid direct exposure of the emitted laser light in anyone's eyes. Direct exposure to the laser beam may cause serious eye damage to you or your animals!

INTRODUCTION

The original development of the laser (Light Amplification by Stimulated Emission of Radiation) in 1958 quickly lead to the growth of a multi-billion dollar industry. Lasers of all types can now be found in many of the day-to-day consumer products we all use. For years hobbyists have been intrigued by the possibility of using a 'beam of light' to control devices or even set up communications systems! The abundance of inexpensive laser elements that have now become available has further pushed the demand for useful products and experimental kits. The LTS1 Laser Trip Sensor was developed with the intention of providing a fun and educational kit that can actually be used constructively upon completion.

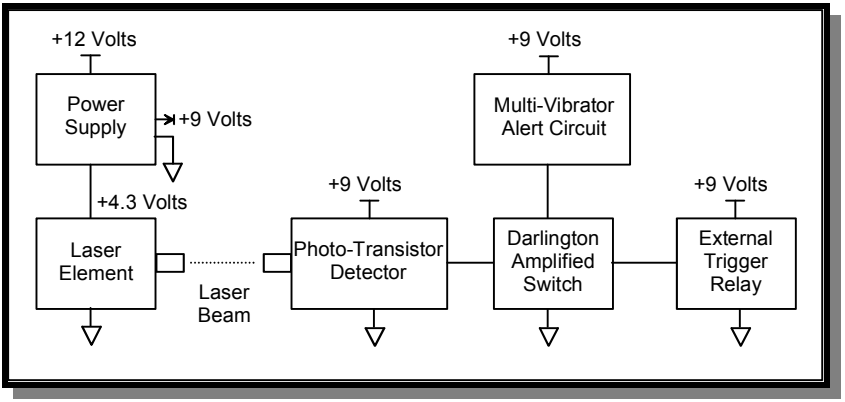
The LTS1 can be used in a number of different ways. The break-away circuit board gives the user the flexibility of remotely mounting the detector circuit (optionally powered with a standard 9 Volt battery) over 500 yards away without the need for mirrors. If mirrors are used, arrangements in a doorway or as a perimeter fence can almost guarantee detection of any unwanted guests. For added functionality, the relay output can be used to drive other devices such as an event counter, lights, or even camera modules!



Doorway Alert

We hope you have as much fun using it as we have; you can't pass through a single doorway here at the shop without hearing an alarm buzzer go off! A little puff of smoke (from a can of course) is enough to view the laser grid array bouncing off the mirrors mounted in the door frames. It's just like the movies, "Laser beam Mr. Bond"! (kind of loses something in print)

LTS1 Block Diagram



CIRCUIT DESCRIPTION

The LTS1 is composed of six functional blocks; the power supply, laser element, photo-transistor detector, Darlington amplified switch, multi-vibrator alert circuit, and an external trigger relay. This combination of circuits offers the builder a chance to learn about a few of the most common transistor configurations in use. Let's take a closer look at the basic workings of the blocks.

Power Supply - The power supply section of the LTS1 is located on the smaller break-away board. It takes the incoming DC voltage (9 to 18 Volts) and conditions it for use by the laser pen (4.3 Volts) and the detector circuitry (9 Volts).

Laser Element - A laser pen is used to project an intense beam of red light (630-670 nm) up to 500 yards, or so the manufacturer says! This is our trigger source. When the light beam is blocked from illuminating the photo-detector, which we're about to get to, our alarm circuit activates and warns us of an intruder.

Photo-Transistor Detector - A simple NPN photo-transistor and a resistor to control its gain. Under normal conditions, the laser light strikes the transistor and turns it on. The low current draw in this state saves power (important if powered by a battery) and keeps the alerting circuitry from turning on. When the light beam is broken, the photo-transistor turns off and the alert starts to sound.

Darlington Amplified Switch - Two NPN transistors are wired in such a fashion as to achieve extremely high current gain to turn on the alert circuitry. The low current drive level from the photo-detector circuit would not be enough to turn on the alert sections by itself so the amplification characteristics of the Darlington pair give us the extra punch we need for solid performance.

Multi-Vibrator Alert Circuit - By using two cross coupled RC networks and two NPN transistors, a simple oscillator is constructed that drives the audible (speaker) and visual (LED) alert indicators. When the Darlington amplified switch activates, the circuit path for the multi-vibrator is completed and the buzzing begins!

External Trigger Relay - To add to the kit's functionality, a relay output is provided giving the user a contact closure anytime the light beam is broken. The PNP relay driver is also activated by the Darlington amplified switch.

Now that we know a little about the LTS1's main blocks, let's get into a bit more detail about the circuitry being used. Look at the schematic as we progress through the kit and don't be afraid to do a bit more research! The purpose of the kit is to expose you to the wonders of electronics… not to provide you with an engineering degree (it would take too many pages!).

The power supply is composed of a +5 Volt regulator (VR1: 78L05), two electrolytic capacitors, a diode, and a few optional resistors. The regulator takes the voltage on its input terminal, which is too high, and provides us with a super clean output at a fixed voltage. The support capacitors (C1 & C2) help the regulator to do its job and remove any unwanted noise that may be on the line. The laser pen unfortunately cannot handle the full 5 Volt level so a series dropping diode (D1) is used to present the needed 4.3 Volts (connected via pads P1 & P2). A perfect match! The optional resistors (R1 & R2) are used when the LTS1 is operated from a single power supply. If the boards are not broken apart, the 12 Volt supply is a bit too high for the detector's circuitry. The two resistors are used to drop a few volts and keep the rest of the detector circuitry in their happy place (about 9 volts)! When the boards are separated, R1 and R2 are removed allowing the detector board to be directly run from a 9 Volt battery (connected via pads P3 & P4).

Plenty of theory on laser elements is available on the internet today; keywords: "Laser Diode". To try and explain its operation is a bit beyond the scope of this kit. For the most part however, our laser element is a Gallium Arsenide (GaAs) LED that is constructed in a special way as to stimulate the release of photons in a tightly collimated high energy beam. Ooh, sounds like 'Buck Rogers' technology (I'm dating myself here aren't I). The beam is used to illuminate our photo-detector and sense when a person or object passes through.

The photo-transistor in the two leaded translucent package (Q1) is an NPN transistor whose 'Base' (remember the Collector, Base, and Emitter from your basic electronics class?) is exposed for outside stimulation by light. As light strikes the Base portion of the transistor, the photonic energy causes current to flow and turns on the transistor pulling the Collector near the 0 Volt ground potential. Resistor R3 sets the overall gain of the amplifier and gives us a light activated switch! Lowering the value of R3 will reduce its sensitivity to light and could be a beneficial modification if you plan on using your LTS1 in a brightly lit

environment (R3 from 1 Meg ohm to a 470K ohm or less). The value of R3, 1 Meg ohm, was selected as a good general purpose value providing the user with an extended operating range and moderate ambient light rejection. More on this later.

Once the laser beam has been broken and the light no longer hits the Base of the photo-transistor, Q1 turns off causing the Collector voltage to go high (no longer be pulled to ground).

$$I = \frac{V}{R}$$

$$= \frac{\text{9V (power supply) - 1.4V (forward bias voltage of Q3 \& Q4)}}{\text{1 Meg ohm (R3)}}$$

$$= 7.6\ \mu A$$

Here is where the Darlington amplified switch comes in. The 9 Volt source and R3 (1 Meg ohm) turn on transistor Q3 and Q4. The current through R3 is very low, about 7.6 μA , which is not enough to fully drive our alert circuitry with a regular transistor. By using a Darlington pair transistor configuration, the current gain capability is dramatically improved. With a normal transistor, a Common Emitter gain (Beta) of 100 times the input current would yield a drive of about 0.83 mA. Not even close to the 70 mA or so that we need. With a Darlington pair, the gain (Beta) is the product of both transistors (Beta = B1 x B2) so gains of 1,000 to 10,000 are easy to obtain with standard parts. In our case, the 7.6 μA x 1,000 ($B1_{Q3}$ x $B2_{Q4}$) gives us a minimum combined Collector current of 76 mA. More than enough to turn on the multi-vibrator alert circuitry and the external trigger relay. Pretty neat stuff! We'll leave it up to you to figure out why the Base current for the switching transistor is 8.3 μA if one transistor was used versus 7.6 μA if a Darlington pair is used (remember, 0.7 Volts per transistor to turn them 'on').

The transistor astable multivibrator formed by R4, R5, R6, R8, D2, SP1, C4, C5, Q2, and Q5 generates the visual (D2) and audible (SP1) alerts that warn you of an intruder. An astable multivibrator is an RC (Resistor / Capacitor) controlled free running oscillator. The frequency of the oscillator is set by the time constants of R5 - C5 and R6 - C4 which works out to about 700 Hz (1 / 1.4 x C x R). As each transistor alternately turns on and off, D2 and SP1 are also turned on and off at the same rate. D2 suddenly becomes brightly lit and SP1 emits a tone loud enough to warn that an intruder has just penetrated the laser fence!

To make the LTS1 more versatile, an external trigger relay circuit composed of R7, R9, Q6, D3, and K1 was added. When the laser beam is interrupted, Q1 turns off and the Darlington pair switch turns on (pulling the Q3 & Q4 Collector junction voltage down to about 0.9V {VCE_{Q3} + VBE_{Q4}}). The Base-Emitter junction of Q6 is in turn forward biased through R7 and the Relay K1 turns on to trigger your external circuit (connected via pads P5 & P6).

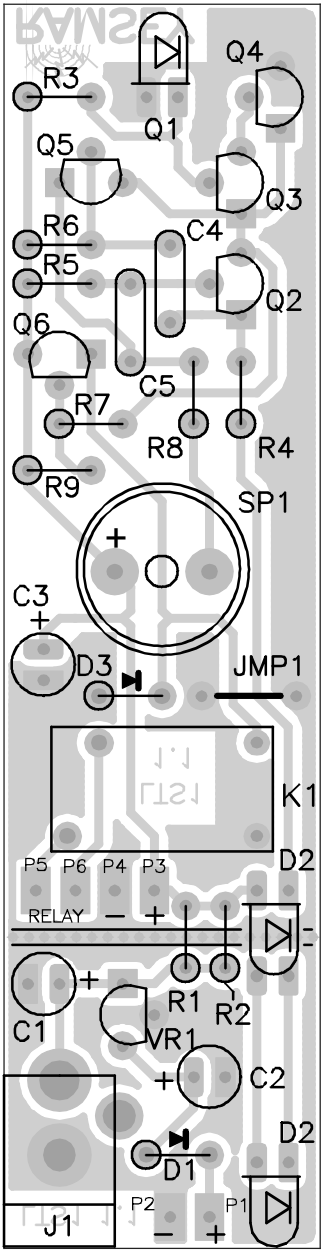
Whew; quite a bit for such a small circuit!

LTS1 PARTS LAYOUT DIAGRAM

Detector >>>

‘Break-Away’ Line >>>

Power Supply >>>



PARTS SUPPLIED WITH YOUR LTS1 KIT

Capacitors

- ❒ 2 .1 µF disc capacitor (marked .1 or 104 or 100 nF) [C4,5]
- ❒ 3 10 µF electrolytic capacitors [C1,2,3]

Resistors

- ❒ 3 220 ohm (red-red-brown) [R1,2,4]
- ❒ 1 470 ohm (yellow-violet-brown) [R8]
- ❒ 3 10K ohms (brown-black-orange) [R5,6,7]
- ❒ 1 47K ohms (yellow-violet-orange) [R9]
- ❒ 1 470K ohms (yellow-violet-yellow) [R3*- Optional (lower gain)]
- ❒ 1 1M ohms (brown-black-green) [R3*- Default]

Semiconductors

- ❒ 2 1N4000 series diodes (black with white band) [D1,3]
  -Note that 1N4002-1N4007 diodes may used.
- ❒ 1 Photo-transistor (two leads, clear body, marked with a green dot) [Q1]
- ❒ 4 2N3904 transistor (three leads TO-92 package marked 3904) [Q2,3,4,5]
- ❒ 1 2N3906 transistor (three leads TO-92 package marked 221334) [Q6]
- ❒ 1 JUMBO red LED [D2]

Miscellaneous Components

- ❒ 1 2.1 mm DC power jack [J1]
- ❒ 1 Mini-speaker [SP1]
- ❒ 1 78L05 +5 Volt regulator (three leads TO-92 package marked 78L05) [VR1]
- ❒ 2 Mini alligator clips [P1,2]
- ❒ 1 9 Volt Relay [K1]
- ❒ 1 9 Volt battery snap, optional configuration [P3 + Red, P4 - Black]
- ❒ 1 Laser pointer
- ❒ 1 2 foot piece of #24 AWG Red and Black hookup wire
- ❒ 1 Pre-cut shrink tube 1”L x 1/4”W
- ❒ 1 Pre-cut shrink tube 1”L x 3/8”W
- ❒ 1 PVC pipe 6” L x 1 1/4” Dia.
- ❒ 1 4” Nylon tie-wrap

RAMSEY "Learn-As-You-Build KIT ASSEMBLY

There are many solder connections on the LTS1 printed circuit board. PLEASE take us seriously when we say that good soldering is essential to the proper operation of your Laser Trip Sensor kit!

- Use a 25-watt soldering pencil with a clean, sharp tip.
- Use only rosin-core solder intended for electronics use.
- Use bright lighting; a magnifying lamp or bench-style magnifier may be helpful.

Do your work in stages, taking breaks to check your work. Carefully brush away wire cuttings so they don't lodge between solder connections.

We have a two-fold strategy for the order of the following kit assembly steps. First, we install parts in physical relationship to each other, so there's minimal chance of inserting wires into wrong holes. Second, whenever possible, we install in an order that fits our "Learn-As-You Build" Kit building philosophy. This entails describing the circuit that you are building, instead of just blindly installing components. We hope that this will not only make assembly of our kits easier, but help you to understand the circuit you're constructing.

For each part, our word "Install" always means these steps:

1. Pick the correct component with the proper value to start with.

2. Insert it into the correct PC board location.

3. Orient it correctly, following the PC board drawing and the written directions for all parts - especially when there's a right way and a wrong way to solder it in. (Diode bands, electrolytic capacitor polarity, transistor shapes, dotted or notched ends of IC's, and so forth.)

4. Solder all connections unless directed otherwise. Use enough heat and solder flow for clean, shiny, completed connections.

5. Trim or nip the excess component lead wire after soldering.

NOTE: Save some of the longer wire scraps nipped from resistors and capacitors. These will be used to form wire jumpers (JMP1, etc.) to be soldered in just like parts during these construction steps.

LTS1 LASER TRIP SENSOR KIT ASSEMBLY

Although we know that you are anxious to complete the assembly of your Laser Trip Sensor kit, it is best to follow the step-by-step instructions in this manual. Try to avoid the urge to jump ahead installing components.

The first thing to do before soldering any parts on the board is to choose which configuration the LTS1 will be used in. The break-away circuit board allows you to remote mount the detector circuitry and power it separately from a 9V battery should you choose. This mode will also give you the greatest possible range without the need to use cumbersome mirrors.

If you know now that you want the boards together so they operate from a single power supply, do not snap the boards apart. If you change your mind at a later date, the modification is quick and easy to do.

If you plan on using the boards separately, the 'break-away' line between the laser power supply section and the detector board is perforated for easy division **(make sure to protect your eyes by pointing the boards away from you when you break them apart)**. To do this, hold the board with your thumbs on either side of the perforation and snap the boards apart. The building instructions are the same for either configuration minus the last few steps (R1, R2, D2 jumpers, and the 9V battery snap).

Since you may appreciate some warm-up soldering practice as well as a chance to put some landmarks on the PC board, we'll first install one of the larger sized components. This will also help us to get acquainted with the up-down, left-right orientation of the circuit board. Remember that all of the components will be mounted on the component side of the circuit board (the side with the silk-screen writing) and soldered on the solder side of the circuit board (the side that contains the printed circuit traces). Have a look at the parts layout diagram to help with your assembly.

Make sure to use the boxes to check off your progress as you go!

Finally, check all received parts against the parts list. The parts list describes the various markings that may be found on the kit parts. Carefully sort the parts into small piles (an empty egg tray does nicely for this purpose) to aid in finding the correct ones at the required time.

We will begin by installing the DC power input connector. This is a standard power jack that is designed to work with any 2.1 mm, 12 VDC (9 - 18 VDC actual output under load) transformer with a positive tip that is capable of sourcing at least 200 mA.

Enough of that ... let's get started!

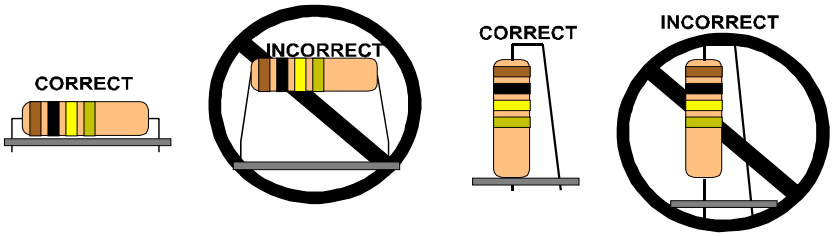
❒ 1. Identify and install the power connector J1, the 2.1 mm DC power jack at the edge of the 'Power Supply' end of printed circuit board. Gently slide the leads through the component side of the circuit board until the connector is mounted flush. Solder all three connections using enough heat to flow the ground connection completely. This may take a little while depending on the wattage of your soldering pencil. Use caution when soldering the other leads so that too much time or heat is not applied; it may cause the printed circuit trace to lift away from the circuit board.

❒ 2. Install VR1, the LM78L05 voltage regulator (+5 Volts). This three leaded device looks like the transistors packed in the kit so make sure to read the numbers on the flat side of the case. It is very important to install the regulator with the proper orientation so that it can step the incoming voltage supply down to the stable +5 V we need for the laser. Match up the case body with that of the silk-screen on the circuit board; look at the parts layout diagram if needed.

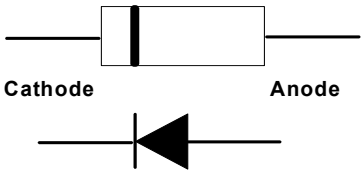
❒ 3. Identify C1, the 10 uF electrolytic capacitor (small cylindrical component coated with plastic and marked 10 uF). Electrolytic capacitors are polarized with a (+) and (-) lead and must be installed in the correct orientation. Ordinarily, only the negative side is marked on the capacitor body with a band and the (-) sign clearly shown. PC boards on the other hand will usually show the (+) hole location. Use care to ensure proper polarity. See the parts diagram for proper placement. The capacitor should fit snugly down to the PC board. Save those long leads that you trim off to fashion jumper connections later in the assembly.

❒ 4. In the same manner, install C2, another 10 uF electrolytic (small cylindrical component coated with plastic and marked 10 uF). Electrolytic capacitors store a large amount of charge and keep the supply voltage from "sagging" when a large current is momentarily required. Notice on the schematic how C2 is used in this manner; the cap stores energy so that when the LED and mini speaker pulse on and off, they are not starved for power. Use care to ensure proper polarity. See the parts diagram for proper placement. The capacitor should fit snugly down to the PC board.

All of the diodes and resistors used in the kit will be installed in a stand up fashion. This means one lead will go straight into the board while the other is bent around to go back down into the other hole. The straight lead goes into the hole with the silk-screened circle around it on the circuit board.



❒ 5. Install D1, the 1N4002 diode (black with white band). The body of the part should be placed in the hole with the silk-screened circle around it. The banded end should be away from the board and the wire lead needs to be bent over to into position for the other hole.



Good Job, we're well on the way! Take a moment to check your work up to this point and re-touch any questionable solder joints.

So far we have assembled the power supply section used to drive the laser pointer. Lasers are very sensitive when it comes to their power requirements so a good regulator like VR1 is a must! The only problem is that the 5 Volt output is too high for the laser pointer's internal circuitry, it needs to have about 4.3 Volts or it will burn out and you'll wind up with an expensive red LED!!! Hey… remember that diode you just installed (D1)? It's a PN junction so it's forward voltage drop needs to be taken into account. Bam (not normally a good sound in electronics), it lowers the 5 Volt drive voltage to the laser by 0.7 Volts giving you your clean 4.3 Volt source!

Let's move on to the detector circuitry now. We'll skip the two largest parts, K1 and SP1, until after the smaller parts are in place.

❒ 6. Install D3, the other 1N4002 diode. Watch your polarity and install it the same way as D1. This part acts as an inductive-kick feedback diode to protect the contacts of the relay from being damage.

❒ 7. Install C3, the last 10 uF electrolytic capacitor (small cylindrical case marked 10 uF). Remember to observe polarity with those electrolytic capacitors! Check the parts placement diagram for correct orientation.

❒ 8. Using a scrap component lead, form a jumper wire and install it in the JMP1 holes. Jumpers act like electronic "bridges" that carry power or signals over active traces on the circuit trace side of the board. Solder both ends of the jumper into place.

❒ 9. Install R9, the 47k ohm (yellow-violet-orange) resistor. This is another standup part like the diodes you've previously mounted. Watch you color code, it's easy to switch your parts around if your not careful. Something I've learned from experience I'm not proud to say!!!

❒ 10. Install R7, 10k ohms (brown-black-orange).

Next, we finish the driver stage for the relay output. The relay will go in shortly!

❒ 11. Locate and install Q6, the 221334 PNP transistor. This transistor has two flat sides, one with writing on it and a larger flat side without writing. The larger flat side with no writing is the one pictured on the silkscreen; orient the part using this as the correct flat side. Solder all three pins.

Whew... half way there! Time for the multivibrator section.

❒ 12. Install R8, 470 ohms (yellow-violet-brown) the limiting resistor for SP1.

❒ 13. Install R4, 220 ohms (red-red-brown) the limiting resistor for D2.

❒ 14. Install C5, .1 µF disc capacitor (marked 104 or .1). Disc capacitors are not polarized so they can be installed in either direction. The reason we call them “disc” caps can be seen in the package. The capacitor itself is two conductive discs separated by a dielectric compound. This one is part of the timing circuit for the oscillator.

❒ 15. Install C4, the other .1 µF disc capacitor (marked 104 or .1). It too is one of the major components that sets the operating frequency of the oscillator with R5 and R6.

❒ 16. Install R5, 10k ohms (brown-black-orange).

❒ 17. Install R6, 10k ohms (brown-black-orange). Remember to keep a few of those clipped off leads, we’ll need a few more jumper wires later if your circuit boards were not separated.

Transistor time! Now we finish the multi-vibrator by mounting Q2 and Q5, then we’ll install Q3 and Q4 to make up the high current gain Darlington pair.

❒ 18. Identify and install transistor Q2, the three leaded component marked 2N3904. The flat side must be placed as shown on the PC board for proper operation. Mount it as close to the board as possible without forcing it. Carefully solder all three leads

❒ 19. Install Q5, one of the 2N3904 transistors.

❒ 20. Install Q3, one of the 2N3904 transistors.

❒ 21. Install Q4, the last of the 2N3904 transistors.

❒ 22. Install R3, 1 Meg ohm (brown-black-green) gain setting resistor for Q1.

Now it’s time to install the photo-transistor (Q1). It looks like a standard LED, but don’t let it’s looks fool you! It’s a common emitter transistor amplifier controlled by photonic excitation! (Wow… there’s a mouthful!)

Pay close attention to the placement instructions. Your kit will not work properly if Q1 is installed backwards. (Q1 and LED D2 are NOT installed the same way!)

❒ 23. Install Q1, the two leaded clear photo-transistor (marked with a green dot). You’ll see a green dot on one side or on the bottom of the part; this corresponds to the cathode or negative lead of the part, which is also longer than the other lead. Simply install the diode so that the long lead is placed in the hole nearest to R3. This will place it on the ground plane. While we’ve instructed you to keep the leads short on every other part on the board you’ll want to leave the leads as long as possible on this part to

give you room to maneuver it around. Be sure the leads are through the board before you solder them, however.

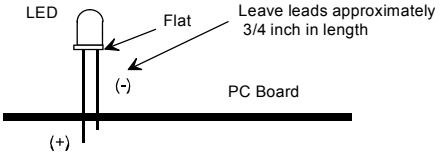
❒ 24. Slide the smaller diameter (1/4") shrink tube over the clear body of Q1 to act as a shroud. This helps to reduce interference from ambient light. It should just slide up even with the back end of the clear body.

Now it's time to mount the two larger parts, SP1 and K1.

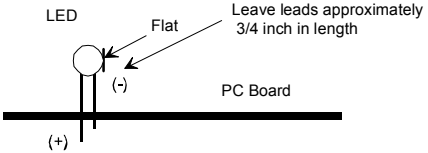
❒ 25. Locate and install SP1, the black mini speaker. The polarity of the pins are marked on the underside of the part. Line up the positive (+) pin of SP1 with the mark (+) on the circuit board.

❒ 26. Install K1, the large plastic relay. Notice the circuit traces on the output of K1 lead to the P5 and P6 solder pads; these are your external trigger contact points.

Here is where the assembly instructions differ depending on your "break away" board configuration. Follow instruction set 'A' if the boards are broken Apart or 'B' if they're Both still together (pretty lame, but you get the point). Either way, the following diagrams show the proper mounting orientation for LED D2.



Board Rear Edge View



Edge View After Bending

A. Assembly Instructions for separated board configuration (Apart)

Next we will install the LED alert display. (L)ight (E)mitting (D)iodes are just that, a diode junction that emits light of a particular wavelength when forward biased. Notice how D2 can be installed in one of two places on the circuit board (dependant on your configuration). When the boards are separated, D2 needs to be mounted next to the trigger relay on the detector board. Look at the parts layout diagram for its location and orientation.

❒ 1A. Install LED D2 in the appropriate holes near K1. The flat (or notched) side should be oriented that same as is shown on the silk screen. Leave it standing about 3/4 of an inch off of the board when soldering. After soldering bend it over at a 90º angle near its midpoint so that it faces the outside of the board. Observe the previous diagrams for proper orientation.

❒ 2A. Locate the 9 volt battery snap included with your kit. Install the Black wire in the "-" hole labeled P4 and the Red wire in the "+" hole labeled P3. Look at the parts placement diagram for further clarification.

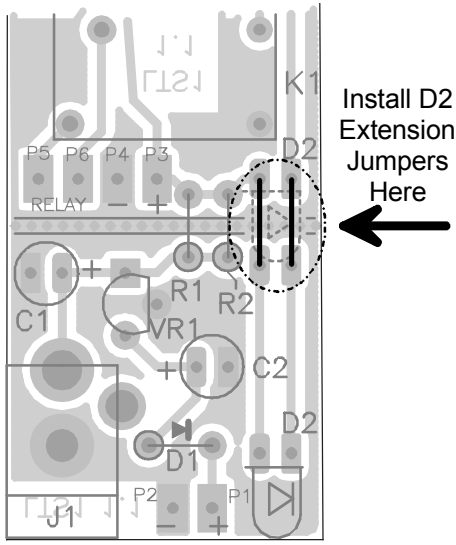
❒ 3A. Put the remaining resistors (R1 and R2) in your work box incase you

ever decide to reconnect the boards. If you do reattach them, make sure you reconnect the ground plane along the 'break-away' row of holes by scraping away the solder mask and soldering the boards together!

B. Assembly Instructions for single board configuration (Both)

Notice how D2 can be installed in one of two places on the circuit board depending on your configuration. When used together, D2 needs to be mounted next to the laser drive terminals P1 & P2 on the edge of the board. Look at the parts layout diagram for its location.

- ❒ 1B. Install LED D2 in the appropriate holes near the edge of the board across from J1. The flat (or notched) side should be oriented that same as is shown on the silk screen. Leave it standing about 3/4 of an inch off of the board when soldering. After soldering bend it over at a 90º angle near its midpoint so that it faces the outside of the board. Observe the previous diagrams for proper orientation.
- ❒ 2B. Install R1, 220 ohms (red-red-brown), across the 'break-away' line. Make sure you do not accidentally insert one of the resistor leads into the grounded row of snap holes!
- ❒ 3B. Install R2, 220 ohms (red-red-brown), in the same way as R1.
- ❒ 4B. Using two pieces of scrap component leads, form two jumper wires and install them in the holes that bridge across the 'break-away' line for D2. In effect you are extending the regular traces for D2 over to the edge of the board for easier viewing. Make sure to solder both ends of the jumpers into place.



Take a moment now to check your previous solder joints for "opens" where the solder did not completely flow around the connection, or solder bridges between closely spaced pads. It seems the best time to identify these types of problems is now when you're focused on this section of the board, saving you

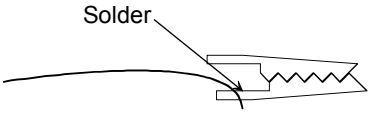
time to try to retrace your steps later.

Assembly Instructions for the laser module

The next step is to attach the laser element to the power supply board. Find the Red and Black twisted hook-up wire, the two alligator clips, and the larger diameter (3/8") shrink tube.

❒ 1L. Strip back 1/4" of insulation from all four ends of the Red and Black hook-up wire.

❒ 2L. Take one end of the stripped hook-up wire pair and tin both the Red and Black conductors with a bit of solder (a light coat of solder over the strands of wire).



❒ 3L. Install the alligator clips on the tinned Red and Black wires. Solder them in place and then crimp the holding flaps around the insulation to prevent them from breaking off while you position the laser.

❒ 4L. Install the other end of the hook-up wire into the holes marked P1 ('+' RED) and P2 ('-' BLACK). Pre-tinning these connections may make it harder for them to pass through the holes in the board. You might not want to add any solder to the wires until after they are in position in order to make things easier.

❒ 5L. Slide the larger diameter (3/8") piece of shrink tube over the alligator clip that is connected to the Black hook-up wire. DO NOT shrink this piece of tubing with any heat source, you want it to stay pliable. It should be positioned so that the alligator clip is completely covered.

❒ 6L. Attach the Black wire's alligator clip to the center spring inside the laser pointer. The shrink tubing helps to keep the power supply clips from accidentally shorting together.

❒ 7L. Attach the Red wire's alligator clip to the body of the laser pointer by clipping it to the open end of the battery cavity where the end plug is normally screwed on.

❒ 8L. The final step is to permanently press in the laser's 'On' button by installing the nylon tie-wrap around the its body and over the switch.

CONGRATULATIONS !

Your LTS1 Laser Trip Sensor is now complete! Have a final look over your work, paying particular attention to the orientation of diodes, capacitors, and transistors. Remember that any problems you find now can save time and effort compared to finding them after the unit has been powered up with an error present.

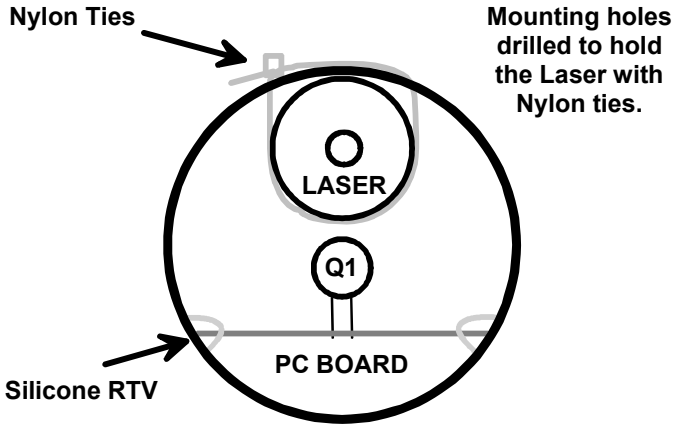
MOUNTING CONSIDERATIONS FOR A CUSTOM CASE

The enclosure is a rugged 6" long piece of 1 1/4" PVC pipe. The mounting possibilities for the LTS1 are numerous so a "one size fits all" approach won't work for this one. The suggested setup is to slide the Detector Module (and Power Supply if still attached) into the pipe with the rear end of the board (making D2 easy to see) flush with the back of the PVC enclosure. Use a few dabs of silicone RTV (non-conductive - the clear non-paintable kind) to hold it in place. This will further shield the detector element from unintended illumination and protect it from being bumped out of alignment. Use Velcro or a couple of PVC 1 1/4" 'U-shaped' pipe clamps to permanently attach the enclosure to a wall or door frame.

If you plan on using mirrors to reflect the beam around, the laser can also be mounted inside the PVC pipe to protect it as well. A few holes in the PVC and a couple of nylon tie-wrap will allow you to position the laser inside the pipe and above the detector transistor (Q1) to form a nicely self-contained alarm system.

Your PVC pipe has not been pre-drilled since it would look like a piece of Swiss-cheese if we tried to cover all the possibilities. Make sure you use a vise to hold the tube if you decide to drill any holes of your own!

All-in-one mounting option



USING YOUR LTS1 LASER TRIP SENSOR

The LTS1 is a pretty simple kit to use. Whether you use mirrors to reflect the beam back to the detector (we've set up a trip fence that was more than 500 yards long using mirrors!) or you remote mount the detector using the 'break-away' configuration, the operation is the same. The main thing is to line up the laser beam with the detector transistor and make sure they don't move around easily after you mount them. Here are a few other factors to consider:

1) When selecting mirrors (if used), try to use "first surface" types. These mirrors are meant to be orientated so that the coated surface is nearest the incident light, not like a typical mirror that has a reflective back coating. "First surface" mirrors minimize the energy loss that is found with conventional ones where the light must pass through the glass substrate. These will increase the coverage range of your trip sensor!

2) The external trigger relay (see specifications below) can be used to switch on a variety of devices. The relay will only be closed however, while the light beam is blocked. You will need to add your own external latch circuitry if you need a continuous trigger for your application.

LTS1 LASER TRIP SENSOR SPECIFICATIONS

Complete LTS1 using a single power supply (boards together):
- Input (J1) working voltage between 9 - 18 VDC @ 90 to 100 mA.
- Full PCB Dimensions: 4" L x 1" W (max component height: 5/8")

Laser Module (break-away configuration):
- Power requirements:
    a. 9 - 18 VDC @ 50 mA (J1 input power range)
    b. 4.3 VDC @ 40 mA (laser pen terminal measurements).
- Laser Light Wavelength 630 - 670 nm , < 5 mW.
- Low light range over 500 yards (as specified by the manufacturer).
- Power Supply PCB Dimensions: 1" L x 1" W (max component height: 1/2")

Detector module (break-away configuration):
- Power requirements (R1 and R2 not used):
    a. 9 VDC to P3 (+ Red) & P4 (- Black) @ 70 mA - Alerting.
    b. 9 VDC to P3 & P4 @ 10 μA - Standby (Q1 illuminated).
- Detector PCB Dimensions: 3" L x 1" W (max component height: 5/8")

External Relay Trigger (P5 & P6 - 0.035" Dia. holes):
- Contact Rating: 5 A, 250 VAC / 28 VDC (Resistive)
- Rated Contact Current: 5 A
- Max. Contact Capacity: 1250VA AC, 150W DC

TROUBLESHOOTING GUIDE

If your LTS1 works except for the relay output in the break-away configuration, check the following:

- Verify integrity of the ground plane near the break-away line (see PC board layout diagram). Scrape away the solder mask and bridge potential cracks with solder if needed. Those darn holes are awful close!

If your LTS1 does not work at all, recheck the following:

- correct orientation of all transistors (see PC board layout diagram)
- correct polarity of all electrolytic capacitors.
- correct orientation of diodes D1, D2, and D3
- all solder connections
- Jumper wires at all JMP locations.
- P3 (+) to P4 (-) test voltage is about 9.0 VDC +/- 1.5 VDC.
- Verify the orientation of the laser power supply wires (P1/RED & P2/Black) and their connection to the laser (center spring is negative - Black).
- P1 (+) to P2 (-) test voltage is about 4.3 VDC +/- 0.2 VDC.
- Make sure the laser's on switch is pushed in far enough by the nylon tie.
- Avoid pointing the detector directly at any light source other than your intended illumination source. If your LTS1 seems to be too sensitive to ambient light, reduce the value of R3 from the default 1 Meg value down to the optionally provided 470K ohm resistor value (or less if needed). Covering the front end of the PVC pipe with a slightly opaque lens (a piece of lightweight colored paper works well) will also help improve the trip sensor's ambient light rejection, should you have problems.

Still having trouble?

Use a methodical, logical troubleshooting technique. Most problems can be solved using common sense. A volt-ohm meter and a clear head are usually all that are needed to correct any problem. Most problems are due to misplaced parts and/or bad solder connections. Working backwards through the assembly steps will often lead you to the problem. Revisit the extensive theory of operation include in this manual, and try to apply to your specific problem.

Have another set of eyes look through your work. Here at the shop we have often run into a "stone wall" of a problem only to have a fellow technician see our obvious error. Also, make sure that you have "checked" all the assembly steps boxes. You may have forgotten one or two of them.

CONCLUSION

We sincerely hope that you enjoy the use of this Ramsey product. As always, we have tried to compose our manual in the easiest, most user-friendly format that is possible. As our customers, we value your opinions, comments, and additions that you would like to see in future publications. Please submit comments or ideas to:

Ramsey Electronics Inc.
Attn. Hobby Kit Department
590 Fishers Station Drive
Victor, NY 14564

Please also feel free to visit our Website at www.ramseyelectronics.com and offer your observations to other kit enthusiasts as well.

And once again, thanks from the folks at Ramsey!

The Ramsey Kit Warranty

Please read carefully BEFORE calling or writing in about your kit. Most problems can be solved without contacting the factory.

Notice that this is not a "fine print" warranty. We want you to understand your rights and ours too! All Ramsey kits will work if assembled properly. The very fact that your kit includes this new manual is your assurance that a team of knowledgeable people have field-tested several "copies" of this kit straight from the Ramsey Inventory. If you need help, please read through your manual carefully. All information required to properly build and test your kit is contained within the pages!

1. DEFECTIVE PARTS: It's always easy to blame a part for a problem in your kit, Before you conclude that a part may be bad, thoroughly check your work. Today's semiconductors and passive components have reached incredibly high reliability levels, and it's sad to say that our human construction skills have not! But on rare occasions a sour component can slip through. All our kit parts carry the Ramsey Electronics Warranty that they are free from defects for a full ninety (90) days from the date of purchase. Defective parts will be replaced promptly at our expense. If you suspect any part to be defective, please mail it to our factory for testing and replacement. Please send only the defective part(s), not the entire kit. The part(s) MUST be returned to us in suitable condition for testing. Please be aware that testing can usually determine if the part was truly defective or damaged by assembly or usage. Don't be afraid of telling us that you 'blew-it', we're all human and in most cases, replacement parts are very reasonably priced.

2. MISSING PARTS: Before assuming a part value is incorrect, check the parts listing carefully to see if it is a critical value such as a specific coil or IC, or whether a RANGE of values is suitable (such as "100 to 500 uF"). Often times, common sense will solve a mysterious missing part problem. If you're missing five 10K ohm resistors and received five extra 1K resistors, you can pretty much be assured that the '1K ohm' resistors are actually the 'missing' 10 K parts ("Hum-m-m, I guess the 'red' band really does look orange!") Ramsey Electronics project kits are packed with pride in the USA. If you believe we packed an incorrect part or omitted a part clearly indicated in your assembly manual as supplied with the basic kit by Ramsey, please write or call us with information on the part you need and proof of kit purchase.

3. FACTORY REPAIR OF ASSEMBLED KITS:

To qualify for Ramsey Electronics factory repair, kits MUST:

1. NOT be assembled with acid core solder or flux.
2. NOT be modified in any manner.
3. BE returned in fully-assembled form, not partially assembled.
4. BE accompanied by the proper repair fee. No repair will be undertaken until we have received the MINIMUM repair fee (1/2 hour labor) of $25.00, or authorization to charge it to your credit card account.
5. INCLUDE a description of the problem and legible return address. DO NOT send a separate letter; include all correspondence with the unit. Please do not include your own hardware such as non-Ramsey cabinets, knobs, cables, external battery packs and the like. Ramsey Electronics, Inc., reserves the right to refuse repair on ANY item in which we find excessive problems or damage due to construction methods. To assist customers in such situations, Ramsey Electronics, Inc., reserves the right to solve their needs on a case-by-case basis.

The repair is $50.00 per hour, regardless of the cost of the kit. Please understand that our technicians are not volunteers and that set-up, testing, diagnosis, repair and repacking and paperwork can take nearly an hour of paid employee time on even a simple kit. Of course, if we find that a part was defective in manufacture, there will be no charge to repair your kit (But please realize that our technicians know the difference between a defective part and parts burned out or damaged through improper use or assembly).

4. REFUNDS: You are given ten (10) days to examine our products. If you are not satisfied, you may return your unassembled kit with all the parts and instructions and proof of purchase to the factory for a full refund. The return package should be packed securely. Insurance is recommended. Please do not cause needless delays, read all information carefully.

LTS1 LASER TRIP SENSOR KIT

Quick Reference Page Guide

REQUIRED TOOLS

- Soldering Iron — Ramsey WLC-100,
- Thin Rosin Core Solder — Ramsey RTS12
- Needle Nose Pliers — Ramsey RTS05
- Small Diagonal Cutters — Ramsey RTS04

<OR> Complete Soldering Tool Set RS64-2801

ADDITIONAL SUGGESTED ITEMS

- Optivisor Magnifier Headband — Ramsey OPMAG
- Holder for PC Board/Parts — Ramsey RTS13,
- Desoldering Braid — Ramsey RTS08

Price: $5.00
Ramsey Publication No. MLTS1
Assembly and Instruction manual for:

RAMSEY MODEL NO. LTS1

TOTAL SOLDER POINTS
72

ESTIMATED ASSEMBLY TIME
Beginner ..... 2.0 hrs
Intermediate..... 1.5 hr
Advanced..... 1.0 hrs

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