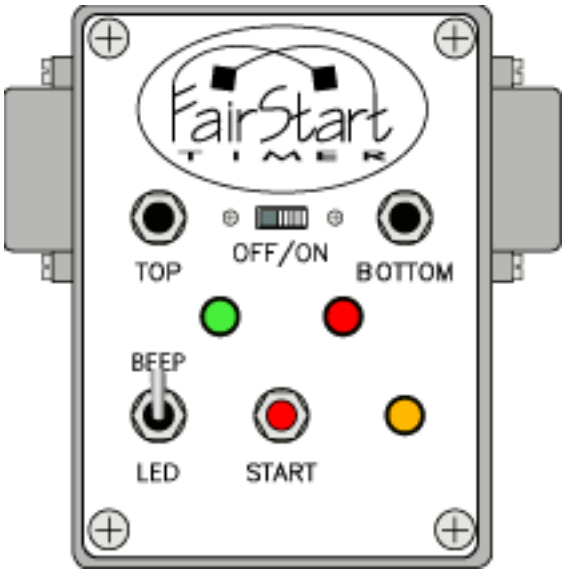
FairStart Conversion Instructions to Convert Original Units to Switchable Output Units

(Buzzer or LED)



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Background Information

This conversion option was developed after a request from Bruce Lambert following the 2006 NAFKA World Cup competition. Apparently some competitors were having difficulties hearing the high pitched tones and the judges were calling out the 'point' (top or bottom) after the relevant tones were sounded by the standard unit. This gave the 'hearing able' competitors a slight advantage over the hearing impaired as they could hear the tones directly whereas the hearing impaired flier had to wait until the judge reacted to the tones and then called out the 'point'. That slight advantage could easily translate into a won point depending on the situation and skill of the competitors.

Bruce asked if it would be possible to make the unit switchable between the buzzers and a LED indicator so that, in the case of a hearing impaired flier, the tones could be switched off and the 'point' (top or bottom) indicated on the LED so that the judge could call out the 'point' to **both** fliers. This would ensure that both fliers achieved a fair start!

After some experimentation I developed the following conversion to do just that!

Note: It is assumed that anyone attempting this conversion has some basic skills in the use of hand tools and can solder small components together in the correct manner. I have tried to give as much detail as possible with regard to the build process so that those FairStart owners with less than perfect soldering skills can feel confident enough to attempt the conversion. For those of you with lots of electronic project experience please feel free to jump straight to the wiring diagram in Appendix A on page 17 (clickable link) to see how it all fits together.

I have not called out specific components as I have no idea what is available in your local area so I have provided the formula for calculating the required resistor value based on your LED selection and I have also recommended some suitable switch types.

This conversion should only take 1-2 hours to complete for people with the basic skills but I highly recommend that you **read and understand** this entire document before attempting the conversion. I cannot be held responsible for errors/damage caused by failure to follow the instructions. Basic hand tool and electrical safety practices should be observed at all times to ensure no harm comes to either yourself or the FairStart unit. Tools are sharp and soldering irons are **HOT!**

With all the above said let's get on with the conversion!

Components Required

1 x Single pole double throw switch (SPDT) of the ON-ON type.

Note: I recommend a miniature or sub-miniature toggle type switch rather than a slide switch as it makes mounting the switch easier to perform. A slide switch can be used but that means that you will have to make a rectangular slot in the lid and drill two holes to accept the switch rather than drilling a single hole for a toggle switch. In either case the smaller the switch the better as it will be mounted in the lid directly over the battery case and space is extremely limited there.

A double pole double throw switch (DPDT) can be used if a SPDT switch is not available provided that it is of the ON-ON type.

1 x 5mm Round **Non-Flashing** LED (colour optional).

Note: I would suggest **NOT** using red or green as they are already in use. You can use either a standard LED or a high-intensity LED but a high-intensity LED will make it easier to see in sunlight if one is available to you. **DO NOT** buy a flashing LED as that will negate the ability to tell a top point from a bottom point!

1 x 1/4 Watt resistor

Note: The value will be determined based on LED selection, see P. 6 for details (clickable link).

1 Length of stranded, insulated, hook-up wire of a size to fit into the holes in the circuit board.

1 Length of heat-shrink tubing to fit over the hook-up wire.

1 Length of heat-shrink tubing to fit over the resistor.

Note: It may be possible to get a single length of heat-shrink tubing that will fulfil both requirements depending on the sizes of the resistor, hook-up wire and tubing available.

Small cable ties to secure the new wires to the existing wiring harness.

Optional Components

1 x 5mm LED panel mounting collar.

Note: Radio Shack normally sells these in packs of 10 which is a bit excessive if you only need one! I will provide instructions on how to mount the LED if you do not have a suitable mount available.

The mounting collars are also available as one-piece and two-piece versions, make sure that you follow the correct instructions for the type you have.

Tools Required

Fine point, pencil type soldering iron with at least a 25 Watt rating.

Multi-core electronic/TV/computer grade solder.

Damp sponge or damp piece of rag for cleaning soldering iron tip.

Ashtray or small tin lid to catch excess solder.

400 grit wet and dry paper.

Hand power/battery drill and suitably sized bits.

Micrometer, caliper, drill gauge or rule to measure the diameter of the switch threads and LED.

Needle nose pliers.

Flat nose pliers or wrench to fit nut on toggle switch.

Wire strippers.

Wire cutters.

Small vice or small vice grips.

Small Phillips screwdriver.

Half-round needle file (plus a flat needle file if using a slide switch).

Multi-meter capable of performing ‘continuity’ tests.

Note: If the meter also has a ‘diode check’ function it can be used to find out the forward voltage of the LED if that information is not available to you on the package or on a datasheet.

Hot glue gun and glue sticks.

Soft pencil and a fine tipped marker (OHP markers or similar are ideal).

Nail, large screw or an awl.

Halogen desk lamp.

Magnifying glass.

1 Length of fighter kite bridle line (used for finding the length of wires).

Basic LED Primer

LEDs have become the indicator of choice in electronic devices due to their low cost, low power consumption and long life (life expectancy of 'standard' LEDs is in excess of 100,000 hours or 11.4 years of continuous use!)

They are very robust and will stand quite a lot of mishandling but can be 'blown up' in less than a second if they are exposed to a current greater than their design rating hence the need for current limiting resistors of the correct value.

Different LED colours have different current requirements and likewise high-intensity LEDs require different current values compared to 'standard' LEDs. When you select your LED the package/datasheet should indicate the 'forward voltage' of the LED (usually between 1.5 and 4 Volts [V]) and the maximum current rating (usually around 20 milliamps [mA]). If you are using an LED that you happen to have lying around and you don't know what it's forward voltage is you can measure it using a digital multi-meter if it is capable of carrying out diode checks. Read the manual for your particular meter to find out how to do this as all meters are different in their settings/operation. Finding out what the LED's maximum current rating is might be more difficult but as a general rule of thumb 20 mA can be used but if you want to be extra safe use 15 mA (the only difference will be a slightly lower light level from the LED).

You now need to find out what current limiting resistor you require to limit the supplied current to the LED to ensure that it operates within it's design limitations.

Selecting The Current Limiting Resistor

To determine the value of the current limiting resistor you need to do a little math! The formula you will use is shown below and is a variation on Ohm's Law.

$$R = \frac{V_S - V_{LED}}{I_{MAX}}$$

Where R = Resistance required
V_S = Supply voltage
V_{LED} = Voltage through LED (forward voltage)
I_{MAX} = Max. current through LED (in Amps)

Now let's try plugging in some figures to see how it works. Assuming you have a supply voltage of 6V (VS) from the four AA batteries (only likely to happen if the batteries are brand new) and your selected LED has a forward voltage (VLED) of 2.2V and it's maximum operating current (IMAX) is 20mA (.02A) you get the following:

Resistor Required (R) = (6 - 2.2) / .02 = 190 Ohms

Standard resistor values are 1.0, 1.2, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8 and 8.2 and multiples of 10 thereof so for safety you would need to go to the next highest value which would be **220 Ohms**.

If you wanted to play safe you could use the 15mA maximum current figure and then the required resistor would be 270 Ohms (the nearest higher value) but with a slight drop in light output.

Using the above formula and examples you should now be able to calculate the value of the current limiting resistor to work with your selected LED.

Basic Soldering Primer

It is assumed that the person making the modifications has some soldering skills but a brief run through on basic soldering techniques may help those who have little experience working with small components and ‘strip board’.

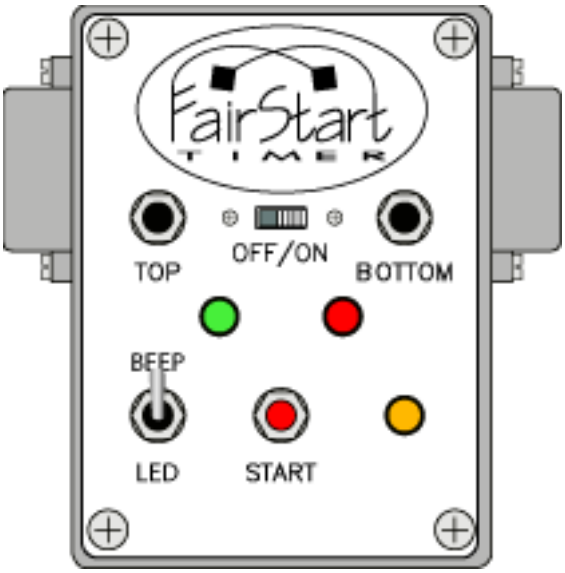
1) The soldering iron is used to heat the components/board not the solder.
2) Too little heat is as harmful as too much.
3) Components/wire get **HOT** take care not to get burned!
4) A dirty soldering iron tip and dirty components will never produce a clean joint.
5) Components/wires need to be ‘tinned’ before they can be soldered together. This is done by coating them with solder prior to making the joint. When tinning the iron **ALWAYS** shake off any excess solder into an ashtray or tin lid before attempting to solder the joint.
6) Take care when soldering the wires to the strip board as an excess of solder can easily form a bridge (and therefore a short circuit) to an adjoining track.
7) When using heatshrink tubing ensure that you slide the tubing onto the wire **before** soldering the last joint! Also make sure that you slide it far enough down the wire that the residual heat from the soldering process does not start to shrink it prematurely.
8) After soldering a joint check it to make sure it is good. A good joint looks shiny and not dull. A good joint is smooth and even and does not have ‘clumps’ or ‘spikes’ on it. A good joint does not have holes or cracks in it.
9) Double check all joints and check the board for solder bridges **before** installing the batteries as it is too late once you have applied voltage/current to the circuit!
10) When soldering always work in a well lit area (use local task lighting if required) and ensure adequate ventilation. Avoid breathing in fumes and smoke.

Carrying Out The Conversion

Once you have all your components and you have all the tools you will need you can begin the conversion process. I have tried to make the instructions as clear as possible and I spent a lot of time thinking out the ‘work flow’ in order to make the assembly process as easy as possible. Please try to follow the order as described as ‘going it alone’ may lead you into ‘unforeseen territory’ and cause more problems than it solves.

Initial Preparation

While your FairStart is still assembled try placing the switch and LED into position on the lid to get an idea of where you would like them located. My personal preference would be for the toggle switch to go on the left side aligned both vertically and horizontally with the 'TOP' and 'START' buttons while the LED would go on the right side aligned both vertically and horizontally with the 'BOTTOM' and 'START' buttons (see diagram below).



By placing them here you are sure of missing the circuit board and any associated short circuit problems. If you are using a slide switch instead of a toggle switch you could still use the same location but you will have more work to do in locating the holes/slot and fitting the switch itself. For the purposes of this conversion I am only going to cover the mounting of a toggle switch in detail with comments where required for the slide switch. If using a slide switch I would recommend a North-South orientation (see 'Mounting The Switch' below for the reasoning).

Once you are happy with the location of the switch and LED mark the position of the centre of each with the soft pencil. Now take your nail, large screw or awl and make a small indentation in the centre of the mark to act as a start point for the drill, this will stop the point of the drill skating across the surface of the lid and chewing up the decal.

Ensure the FairStart is turned off then use a Phillips screwdriver to remove the four screws holding the lid onto the box. Once the screws are out remove the lid and the batteries.

Drilling The Holes

Before you can drill the holes you will need to find out what size drill(s) you need. Measure the toggle switch across the threads to determine the required hole size. For the LED measure the diameter of the body (it is nominally 5mm but they vary slightly in size from manufacturer to manufacturer). If you will be using a 5mm LED mounting collar either use the drill size recommended on the package or measure the diameter of the collar immediately below the 'head'. Once you have established the required sizes you can drill the holes at the locations you marked above. Take care to fully support the lid while drilling and ensure that you do not accidentally drill into the wiring harness under the lid. There will be a tendency for the drill bit to 'snatch' as it breaks through the backside of the lid so ensure the lid is firmly held/clamped and **under no circumstances** allow it to 'spin' on the end of the drill bit as it could tear the wiring harness out of the board!

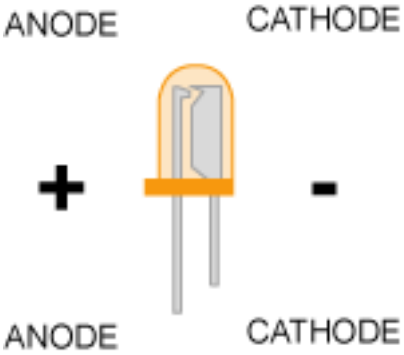
Mounting The Switch

Check the fit of the switch in the correct hole in the lid. If it is too tight to push in easily use the half-round needle file to enlarge the hole slightly. A slightly tight fit is better than a sloppy one! Once you have a good fit insert the switch from the back side of the lid and place the washer and nut on the threads from the front. Align the switch so that it operates in the North-South orientation rather than the East-West orientation as it will assist in identifying the mode of operation (i.e. pointing at the buzzers means the buzzers will sound, pointing at the bottom edge of the lid means the LED will light up). Once the switch is correctly aligned use the wrench or flat-nosed pliers to tighten the nut taking care not to over tighten it.

Wiring The LED Assembly

It will be easier to build the LED assembly prior to mounting it into the lid. First of all let's identify the key parts on a LED as the device is 'polarized' and will only work if it is wired up in the correct manner. Please refer to the diagram below while reading the relevant text.

Looking from the top of the LED one side is sometimes 'flattened' to indicate the negative (-ve) or cathode leg of the device.



Looking at the 'internals' through the side of the LED the negative (-ve) or cathode side is sometimes wider than the positive (+ve) or anode side.

Still looking from the side the positive (+ve) or anode leg is generally longer than the negative (-ve) or cathode side.

For reference this is how a LED is displayed on a circuit diagram.

Note: Unfortunately some of the LED manufacturers do not use all the of the above visible indicators but it is generally taken as a 'standard' that the longer leg is the positive (+ve) or anode leg.

It is now time to plug in the soldering iron so that it can heat up while you perform the next step.

The legs on a LED are generally much longer than required so you are going to have to cut them down to suit your requirements. As space is extremely limited under the lid (the LED will be sitting over the battery case don't forget) you need to cut the legs down to a maximum of 3/8" (10mm) long. Use the wire cutters to snip off the legs to the required length while ensuring that you maintain the 'long leg-short leg' aspect. Once the legs are cut you can **gently** grip the LED body in a small vice or a pair of vice grips to assist you in the next step. **DO NOT** over tighten the clamping device or you will crush the LED, you only need to stop it waggling around while you try to solder it.

Note: If you have a 'third hand' device you can use that instead or get an assistant to hold the LED with a pair of needle-nose pliers while you solder.

Before you can start soldering you need to clean and 'tin' the soldering iron tip. Take your damp sponge or damp rag and place it on a saucer near your iron and place your ashtray or tin lid along side it. Test if the iron is up to temperature by applying solder to the tip. If it is hot enough the solder will melt almost instantly, if it doesn't melt wait for 30 seconds and try again. Once the iron is up to temperature wipe the tip of the iron on the sponge/rag until all the black 'crud' has 'boiled off' and the tip is clean. To 'tin' the tip apply solder to the tip and then shake off any excess into the ashtray or tin lid. Use either a back and forth 'stabbing' action or a motion similar to tapping the ash off a cigarette to get the excess solder to drop off the iron. Do not allow the tip of the iron to touch the ashtray or tin lid or it could become contaminated and you will have to clean it again.

Now you have a clean iron it's time to move onto soldering components. Check the legs of the LED to see if they are shiny and clean. If they are you can start soldering but if they are grey and dull looking they will need cleaning by rubbing them lightly with 400 grit wet and dry paper. Blow the dust off when you have the legs clean.

When clean place the tip of the iron on a leg and move it slightly from side to side. Apply solder to the leg next to the iron, **BUT NOT** on the iron directly, in order to 'tin' it. Once the solder starts to melt remove the iron to prevent over heating followed by the solder. You should now have a nicely 'tinned' leg where the solder has flowed all around the leg in the area where you applied the heat.

If you have 'crusty' clumps then either there was not enough heat to melt the solder correctly or the iron or component was dirty. If you have sharp spikes sticking off the component there was either too much heat and you 'boiled off' the flux or the iron or component was dirty. In either of the above cases you need to clean off the mess and start again. The easiest way to clean off the solder if you don't have a 'solder sucker' or 'de-soldering braid' is to get it up to melting point again and wipe it off with a damp rag or paper towel.

When you have both legs tinned you can move on to the resistor. Like LEDs resistors are supplied with very long legs and they will need to be shortened to 3/8" (10mm) using wire cutters. When you have cut them down to size check to see if they need cleaning and if so clean and then tin them. You can now solder the resistor to the positive (long) leg of the LED. With the LED still clamped in the vice or vice grips hold one end of the resistor (it doesn't matter which end) in a pair of needle-nose pliers so that you don't burn your fingers. Offer up the other side of the resistor to the LED and position it so that it aligns along the positive leg and then place the tip of the iron on the joint and hold it on until the solder in the 'tinning' melts. As soon as you see the solder starting to 'flow' remove the iron but **DO NOT** allow the resistor to move until the solder has solidified again (blowing on the joint will cool it more quickly). You do not need to add more solder to the joint as there is more than enough solder in the tinning to form a good bond between the two components. Check your joint and make sure it is shiny and bright and that the components are correctly aligned, if it is pat yourself on the back for getting your first joint done. If it is dull or the components are misaligned then you will have to unsolder it and try again. Try not to unsolder the joint too many times otherwise you will have to clean and re-tin the legs to get a good joint.

With the resistor soldered to the LED you can move onto the wires and you will connect two pieces of the hook-up wire to the LED/resistor assembly. Use a piece of fighter kite bridle line to measure from the LED location in the lid to the new switch location and then add 1 to 1.5" (25-40mm) to that length to give you some 'slack'. Cut a piece of hook-up wire to the length established above. Now use the bridle line to measure from the LED location to the circuit board ensuring that you follow the route of the existing wiring harness. Add 1 to 1.5" (25-40mm) to that dimension and cut a piece of hook-up wire to that length. Using the wire strippers strip off 1/4" (6mm) of the insulation from one end of each of the wires you just cut to size. Twist the exposed copper strands to prevent them from splaying out when you solder them and then clean and tin the iron and then tin the ends of each of the wires.

Before you can solder the shorter wire to the remaining end of the resistor you will need to add a heat-sink to the previous joint to prevent the heat from the iron travelling through the resistor and unsoldering the previous joint. The heat-sink can be any metal mass and typical items include alligator clips, pliers, vice grips etc. Once you have a suitable heat-sink in place you can solder the shorter wire to the end of the resistor and then solder the longer wire to the remaining leg of the LED.

The exposed leads of the LED and resistor now need insulating using the heat-shrink tubing. Take the tubing that just fits over the resistor and cut off a length which is long enough to cover the exposed LED leg, resistor and resistor/wire joint plus 1/4” (6mm). Slip this over the free end of the shorter wire, over the resistor and butt it up against the bottom of the LED. Cut a piece of heat-shrink tubing that just fits over the wire that is long enough to cover the remaining exposed LED leg and the leg/wire joint plus 1/4” (6mm) and slip this over the free end of the longer wire and butt it up against the bottom of the LED. The LED assembly can now be removed from the clamping system and the two sleeves can be shrunk onto the assembly. You can either use a cigarette lighter or the body of the soldering iron to provide the heat required to shrink the tubing into place. If you use a cigarette lighter make sure that you keep the tip of the flame several inches away from the tubing or you could set it alight. If you use the soldering iron do not use the tip of the iron or you will leave solder stuck to the tubing, use a point midway down the barrel and rub it against the sleeve to shrink it. Regardless of the heat source you will need to move it back and forth while rotating the assembly to ensure you shrink the sleeving evenly on all sides. Continue shrinking until the sleeving is a tight fit on the assembly.

With the LED assembly complete you can now mount it into the lid.

Mounting the LED Assembly

If you are using a one-piece 5mm LED mounting collar push this through the hole in the lid from the front side and then insert the LED into the collar from the back side. You should feel/hear a ‘click’ when the LED is correctly located and the ‘ears’ on the collar should be locked behind the ‘flange’ on the LED.

If you are using a two-piece 5mm LED mounting collar push the body piece through the hole in the lid from the front side and then insert the LED into the body piece from the back side. Now take the cylindrical collar and slip it over **both** wires coming from the LED and push it over the resistor (it should fit) and as far as it will go onto the back of the body piece.

If you do not have a mounting collar you are going to have to hot glue the LED into the lid. Plug in your glue gun so that it can get up to temperature and use the 400 grit wet and dry paper to roughen up the surface of the back of the lid in the area around the LED hole. When the glue gun is hot enough insert the LED into the hole from the back side (try to ensure the legs are in the East-West orientation) and run a bead of glue around the LED ensuring you get good coverage of both the LED and the lid. Once the glue has cooled you can test fit the lid to check for interference.

Place a business card or credit card on top of the battery case and try fitting the lid to the box. If you encounter resistance and the lid does not close properly the LED assembly is too long and will hit the batteries. Remove the lid and grip both legs of the LED with a pair of needle-nose pliers as close to the LED as possible and then push on the resistor to form a 90° bend bringing the resistor parallel to the underside of the lid. Depending on your situation you may not be able to bend the legs towards the bottom edge of the lid (the ideal direction) so bend them towards the top edge of the lid instead. When the legs are bent try refitting the lid and if the lid closes properly remove the lid and the business card or credit card. Don’t forget to turn off the glue gun as you are finished with it now!

Wiring The Switch

You already have one of the three leads to the switch on the LED so you need to cut two more. Use the bridle line to measure from the switch location to the circuit board ensuring that you follow the route of the existing wiring harness. Add 1 to 1.5" (25-40mm) to that dimension and cut two pieces of hook-up wire to that length. Using the wire strippers strip off 1/4" (6mm) of the insulation from one end of each of the wires you just cut to size and also do the same to the end of the short wire (the one connected to the resistor) on the LED. Twist the exposed copper strands to prevent them from splaying out when you solder them and then clean and tin the iron and then tin the ends of each of the wires.

Check the terminals on the switch to ensure they are clean and if not clean them using the wet and dry paper as before. Once they are clean you will need to clean and tin the iron and then tin the three switch terminals.

Note: If you bought a double pole double throw (DPDT) switch you will have six terminals on the bottom of the switch and not three. Just pick one row of three terminals to work with (it doesn't matter which) and ignore the other row.

If you mounted the switch in a North-South orientation take the short wire from the LED and position the tinned end on top of the outer switch terminal that is closest to the middle of the lid. Try to pick a neat route that avoids crossing too many other wires and if your wire is excessively long do not be afraid to trim it down and remake the end but **DO NOT** trim it so short that it no longer reaches the switch! Place the tip of the iron on the joint and hold it on until the solder in the tinning melts. As soon as you see the solder starting to flow remove the iron but **DO NOT** allow the wire to move until the solder has solidified again (remember that blowing on the joint will cool it more quickly).

Now take the tinned ends of the two longer wires you cut previously and solder one wire to each of the remaining two switch terminals and the switch wiring is completed.

Wiring The Buzzers

To wire the buzzers you are going to have to de-solder the red wires from the circuit board. Lift the circuit board out of the slots in the box sides and get it into a position where you can work on it easily.

Note: You may find that you have a couple of blobs of hot glue securing the board to the box sides. If that is the case just peel off the hot glue and remove the board.

Follow the red wire from the left hand buzzer (as you look at the box with the buzzers to the top) and find the hole where it goes into the circuit board. Using the fine tipped marker make a mark on the board so that you know which hole the wire goes into as you will be soldering another wire into that same hole later (if necessary draw a circle around the hole so that you can't mistake it). When you have the hole marked you can de-solder the buzzer wires.

Clean the soldering iron tip but this time **DO NOT** tin it! You don't need any more solder on the circuit board tracks at this point as you do not want to form solder bridges to adjacent tracks. Locate the point where the red wire from the left hand buzzer enters the board and hold the tip of the iron on the corresponding solder bead on the back side of the board. As soon as you see the solder starting to flow remove the iron and simultaneously pull on the red wire. It should pop out of the board cleanly. If it does not then re-apply the iron and try again. When you have the wire free repeat the process for the red wire coming from the right hand buzzer.

The exposed ends of the two red wires are going to be too short to work with so use the wire strippers to strip back the insulation to leave 1/4” (6mm) of bare wire on each lead. Put the two wires side by side with the ends even and twist the two wires together then clean and tin the iron and tin the wires so that they form a single unit. Find a length of heat-shrink tubing that just fits over the pair of wires (possibly the same size that fitted over the resistor) and cut off a piece that is roughly 1/2 to 3/4” (12-20mm) long. Take the long wire that comes from the outer switch terminal and make it follow the route of the wiring loom to where the joined buzzer wires are. If the wire is too long trim it back but **DO NOT** cut it too short! Once you have it to a suitable length slip the small piece of heat-shrink tubing over the wire and push it well back down the wire (**DO NOT** forget this step!)

Take the wire strippers and strip back the insulation to leave 1/4” (6mm) of bare wire on the end of the lead, twist the copper strands, clean and tin the iron and then tin the end of the lead. Place the end of the single lead onto the connection on the end of the pair of buzzer leads and solder the three leads together. Once again there should be enough solder in the tinning to ensure you get a good flow of solder through the joint. Once you have checked that you have a good joint and it has cooled to the touch you can slide the heat-shrink tube back up the single wire and over the joint you just made. Position it so that it fully insulates the joint and then shrink it into place.

Note: If you do not push the heat-shrink tubing far enough along the single wire you run the risk of the residual heat from the joint soldering operation starting to shrink the tubing prematurely which will making the task of sliding it over the twin wires much more difficult!

The buzzers are now wired up and you can make the final connections to the board itself.

Circuit Board Connections

You now have just two connections to make to complete the modification to the FairStart. You should have a long wire coming from the central terminal on the switch and a long wire coming from the negative (-ve) leg on the LED. Both of these wires will be attached to the board near to the top edge.

Run the wires alongside the existing wiring harness to double check the lengths and trim them if they are excessively long but **DO NOT** trim them too short! Strip back the insulation to leave 1/4” (6mm) of bare wire on the end of each lead, twist the copper strands, clean and tin the iron and then tin the ends of the leads. Make sure that the tinning is neat and tidy with no blobs or spikes otherwise the wires will not go through the holes in the board. It may even be a good idea to have a trial fit of the wires in a convenient open hole to make sure they do in fact pass through the board easily.

Refer to the wiring diagram in Appendix A on page 17 (clickable link) to make sure you know where the connections are going to be made on the board as it is critical that the wires are connected to the correct points.

The soldering of the wires to the board is the most difficult soldering operation in the modification process and I purposely left them until the last so that you would get as much soldering practice as possible before attempting this stage. It is **very important** that you **DO NOT** allow an excess of solder to build up on the very narrow tracks as it **WILL** bridge the gaps between the tracks which in turn could lead to short circuits and a failure of one or more components (particularly the programmable chip) if the device is turned on while in a short circuit situation.

Take the end of the wire that you connected to the central terminal on the switch and place it through the hole that you originally removed the left hand buzzer red wire from. This is the hole that you marked with the fine point marker if you remember (double check the hole location with the wiring diagram if you are at all unsure about which hole to use). If you have difficulty getting the wire through the hole but it goes through an open (unsoldered) hole easily you may have a blob or film of solder left over the hole from when you unsoldered the buzzer lead. If this is the case just push the wire in as far as it will go and as soon as you touch the hot iron to the back side the solder blockage will melt and the wire will easily go in the rest of the way.

Thoroughly clean the soldering iron tip and lightly tin it and then place it on the track on the rear of the board as close as possible to the end of the wire you pushed through. Try to angle the iron so the tip is only touching the one track you are working on to keep solder bridges to a minimum.

As soon as the solder starts to flow remove the iron and make sure the wire is pushed fully into the hole. There should be enough solder in the tinning to form a nice clean joint but if you have holes or gaps around the wire you will have to add more solder. Place the iron on the wire/track interface (or as close as you can get to it) and as the solder starts to melt add a tiny amount of fresh solder to the joint and then remove the iron. **DO NOT** add an excessive amount of solder as you don't want to form a solder bridge.

Once the solder has cooled check the joint to make sure it is a good one. A good joint between a through-hole component and the board surface should fully surround the component leg and 'climb' a short way up the leg. There should also be a slight concave shape to the bead when viewed from the side. Compare your joint to one of the existing ones on the board to make sure it looks the same. If in doubt remake the connection.

Check the tracks on either side of the one you just soldered to make sure you do not have any solder bridges using a magnifying glass if necessary. If you have a multi-meter with a 'continuity' function you can check for shorts by placing one lead on the track you just soldered and the other lead on an adjacent track. You know you have no solder bridges if the meter **DOES NOT** beep. Repeat for the other adjacent track.

Note: You **may** get a beep from the FairStart buzzers depending on which tracks you touch so **DO NOT** confuse this with a beep from the meter and think you have a solder bridge!

If you are unfortunate enough to have a solder bridge thoroughly clean the soldering iron tip but **DO NOT** tin it then drag it down the 'groove' between the tracks to 'cut' through the bridge. You may have to do this a couple of times to clear the bridge depending on how much solder is involved but make sure that you clean the tip before each pass.

When you are absolutely sure that you have a good joint with no solder bridges (or you have fully cleaned up any bridges) take a pair of wire cutters and trim the end of the wire you just soldered flush with the edge of the solder bead. Ensure you know where the tiny piece of wire goes to when you cut it off as you do not want it 'floating around' inside the box or on the back of the circuit board where it can cause short circuits later!

Take your final wire (the one from the LED) and using the wiring diagram locate the correct hole location for it. It should go into the hole vertically below the hole containing the black wire coming from the left hand buzzer. Once you have located the correct hole solder the wire into place using the techniques described above. Double check your solder joint, check for solder bridges (and correct if required) and then trim off the excess wire.

Congratulations you have now completed the modification and it is time to test it out!

Testing Your Work

Now you have completed the build process it is time to test your work.

1) For safety's sake slide the circuit board back into the original slots in the side of the box so that metallic parts do not accidentally touch the back of the circuit board and cause short circuits.
2) Make sure the main 'ON/OFF' switch is in the 'OFF' position and insert the batteries into the battery compartment making sure you have the correct polarity on each one.
3) Make sure the toggle (or slide) switch is pointing towards the buzzers if you set the switch in the North-South configuration as suggested.
4) Hold down the 'TOP' button and turn the unit 'ON' to force the FairStart into it's 10 second timer mode.
5) Press the 'START' button and after a few seconds the FairStart should start sending it's point signal to the buzzers.
6) Repeat step 5 until you have had at least one 'top point' continuous tone and one 'bottom point' beeping tone.
7) Flip the toggle switch (or slide the slide switch) to it's other position.
8) Press the 'START' button and after a few seconds the FairStart should start sending it's point signal to the LED.
9) Repeat step 8 until you have had at least one 'top point' continuously lit LED and one 'bottom point' flashing LED.

Hopefully your FairStart is now working just fine with it's new modification and if it is give yourself a well earned pat on the back! However, if you did not hear any beeps or see any indication on the new LED you are going to have to back-track and check all your connections again to find the fault. Pay particular attention to the connections on the circuit board and the connections to the switch. If you find that the LED lights when the toggle switch is pointing at the buzzers and the buzzers sound when the toggle switch is pointing towards the bottom edge of the lid you have the connections to the switch reversed. You can either unsolder the two outer wires (leave the central 'common' wire as-is) and switch their locations and then re-solder them or you can slacken off the nut holding the toggle switch and turn it through 180° (if you have enough slack in the wires) and re-tighten the nut.

Once you have the FairStart working as it should turn it off so that you do not drain the batteries.

Finishing The Job

If your FairStart is now working as it should you can turn off your soldering iron as it is no longer needed. After you have turned it off give it one last cleaning and tin it using the residual heat in the iron. You should always clean and tin your iron before putting it away as it will prevent the tip from oxidizing in storage.

Tidy up the loose wiring by running it alongside the existing harness and either add extra cable ties or remove the original ones and replace them with new ones that enclose all the wires.

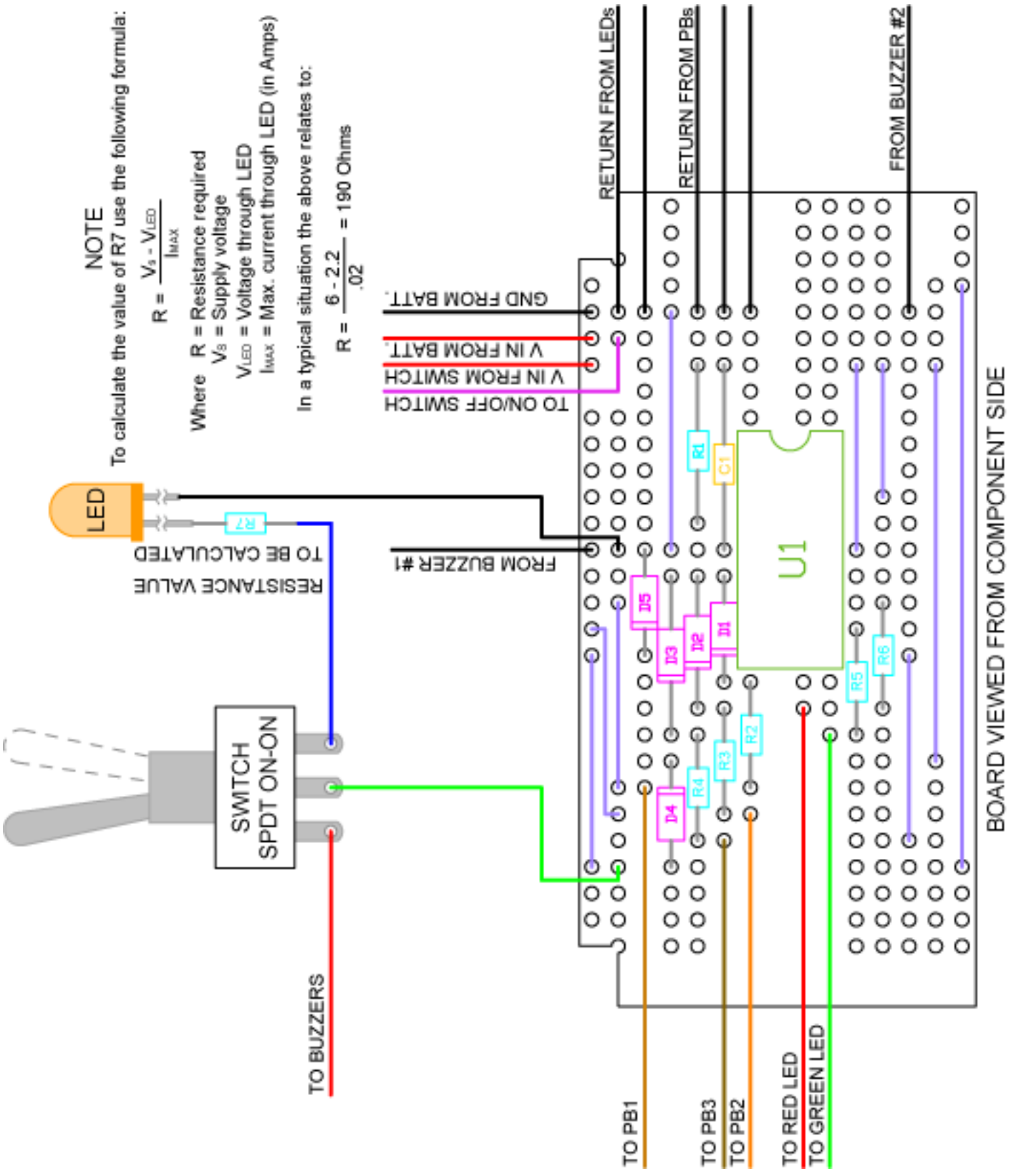
Fit the lid onto the box ensuring that you do not pinch any wires between the two and replace the four Phillps head screws. DO NOT over tighten the screws as you can very easily strip out the holes.

Give the unit a final test to make sure it still works correctly then.....

GO FLY A KITE!

Appendix A

Wiring Diagram



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