Good looking, low cost signals that really work.

If your are modeling in HO scale and are looking for cost effective, high quality color light signals that have a prototypical look about them and that actually work then read on.

Most model signals that appear on the market just don't have that clear crisp look about them. For the most part they are grossly out of scale and are not in that typical dilapidated and weathered state. Working models also tend to be a bit expensive.

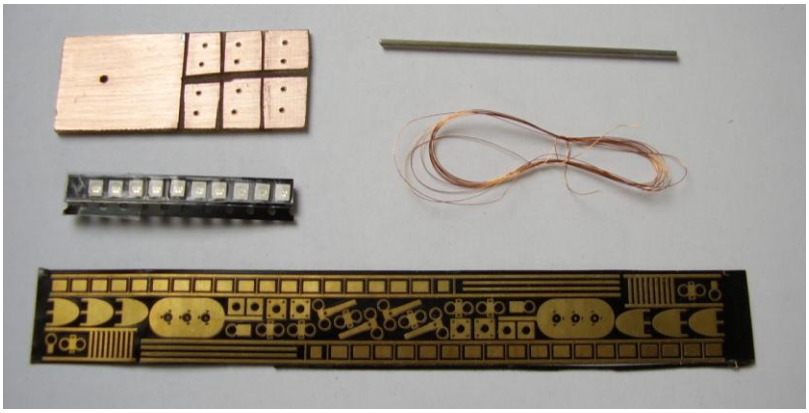
Welcome to a solution that is cost effective and flexible. Years ago a home project inspired by the late "Oddie" Odegard of MR magazine was used as a basis for constructing beautifully detailed color light signals out of etched brass parts. These flat parts are formed and soldered (possibly glued) to a 1/16 diameter brass tube. This tube serves as a signal mast and a conduit for up to twelve 5 mil enameled transformer wires that connect the signal aspect light emitting diodes (LEDs) to the signal control device in use. These thin wires are perfectly adequate to carry the low currents required.

The brass parts, target, hoods, brackets, mast buckles, straps and ladders come on a rubber sheet straight out of the etching vat. This kit has enough parts to build two model signals of varying detail and costs about $10 plus postage and handling. It does not however include the brass tubing for the masts, the LEDs, any enameled wire or the PC boards for the bases. These items can be purchased at your local hardware and electronics supply store. The LEDs can be purchased through mail. (Refer to the parts list at the end of these instructions). The detailed versions of the signals include fancy ladder, handrail, service platform and target mounting buckles and allow for close up admiration while the non-detailed ones omit these items and can be viewed from a distance. Even up close these resemble the prototypes that have been welded together.

The signal design focuses on the use of LED's because modern technology has really put the grain of wheat lamp out of business. LEDs come in all colors including white and also in a variety of shapes and sizes. The most common colors, red, green and yellow are pure and distinct making them ideal for model railroad signaling applications. The surface mount types measure about 1 x 2 x 3 millimeters which when mounted on the back of the model's target plate look just like the lamp housing used on the real thing. They also are much cheaper and last forever (almost). These instructions then are for the construction of signals that use these very small devices.

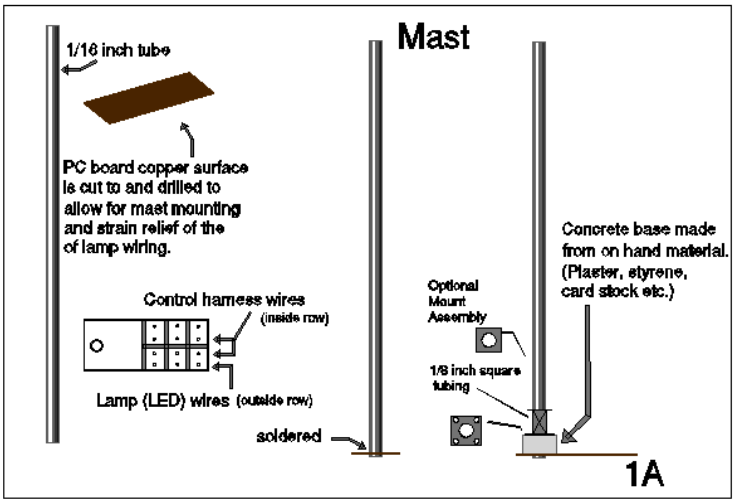
The wiring configuration depends on the control system used but to be safe a six wire configuration (two per LED) for universal applications is recommended. The electrical/electronic interface to any type of control system can be effectively configured at the signal base. The soldering areas there are much larger allowing for heating and reheating without damaging the LEDs.

The advantage of these model signals lies in the low cost and flexibility. Each signal can be tailored to fit any scene and should cost less than $9 to build. The downside is the fact that the modeler builds it himself implying that some soldering skills will be needed. Also needed are some basic tools such as tweezers, a fine tipped 30 Watt soldering iron and standard supplies such as solder, solder paste, cotton swabs and cleaning fluids. Essential is also some patience. Below is a photo of the parts. Note that the base has been prepared for a six wire configuration.



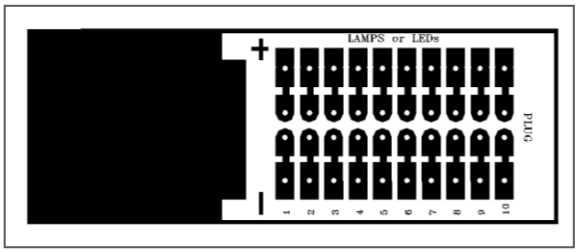
Construction

Diagram 1A shows the construction of the mast assembly. The 1/16th diameter tube should accommodate the target so that the center of the lowest aspect (RED) is exactly 14 scale feet from the rail head. A piece of tubing that is 2 ¼ inches long should do it. Any excess can be carefully cut off later.



The PC base copper foil side should be divided into seven insulated areas (as shown) that will accommodate the mast tubing and six wires that power the lamps or LEDs. These smaller areas are also used as stress relief between the very fine LED wires and the heavier wires that connect the signal to the control device. A sharp knife or file can be used to cut the copper cladding so that seven distinct electrically isolated areas are created. Drill two holes in each of the smaller 'islands' so that both the thin lamp wires from the target and the heavier control wires can be attached (soldered) to form both a firm base and a harness stress relief point, The large area at the end of the board is reserved for mounting the mast and ladder to firm ground.

The diagram on the right shows a deluxe version of the signal PC base. It allows for the connection of up to twenty wires. (In case you want to build a multi target signal or gantry). This PC board is etched to accept a 10 to 20 pin, 1/10 inch centered double header (plug). This allows the signal to be connected to its control device via a 3M type plug and a flat ribbon cable. (a ten pin plug is the minimum size) As with the signal parts the base is also available from FOTOCUT. Alternatively, this diagram can be sized to (0.8 x 2.2 inches) and used as a mask for a home etching project.



The brass tube and PC card copper clad surface should be cleaned with some emery cloth and tinned. It should also be noted that the ladder has to be soldered to the boards foil side and that the wiring is attached through holes from underneath. This means that the copper clad surface is on top. Drill a 1/16 inch hole as indicated in the large area and insert the tube. Apply a pool of solder at the base of the tube to secure the mast at an angle of choice. 90 degrees looks nice but 5 degrees to the right away from the track is OK too.

At this point the mast assembly is ready for the concrete base. A teaspoon of plaster of Paris and a dollop of white glue work quite well. Apply enough of this mixture to the base of the mast. After it sets and is still wet it can be carved and filed to shape. The next day it will be hard as a rock and look like it too. For a detailed signal an optional base plate casting can now be installed at the base of the mast (fig 1A). For this purpose the kit contains four square casting plates. Slip the two larger ones on top of each other to simulate extra thickness onto the mast and slide them down to the top of the 'concrete' base. Now cut a ¼ inch piece of 1/8 inch square tubing (also from the hardware store) and slip that on top followed by the two smaller plates. Line these five parts up and using tweezers to hold them in place solder or glue them together. The filled corners look nice and simulate a cast iron mast mounting bracket nicely. Lay the mast assembly aside.

The signal parts from FOTOCUT come attached to a rubber sheet and need to be removed. This can be accomplished by soaking the sheet in paint thinner or alcohol for about a minute. The parts then just peel off. Before bending them into shape it's a good idea to tin them with a very, very thin layer of solder. To do this carefully wrap the soldering iron handle in a cloth and clamp it carefully in a vice. Clean the hot tip before applying a small bead of solder to barely cover it. Holding the part with tweezers, clean it and apply a tiny bit of solder paste before applying the part to the little pool of hot solder. While still hot, wipe the excess solder off the part with a cotton swab. Repeat this process with all the parts including the mast. Pay special attention to the areas which come in contact with other parts. It makes soldering much easier and gobs of solder won't mar the looks of the finished signal.

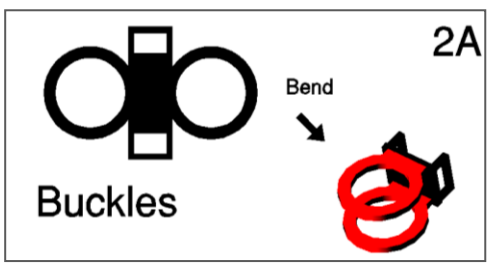


Diagram 2A shows how the mast buckled are formed. These buckles are not required for the non-detailed version because target and ladder fixtures are soldered directly to the mast. Many prototype signals use buckles to allow for easy on site assembly and adjustment. So for the detailed version four tiny buckles are included in the kit. If these are bent into the shape as shown they should slip onto the mast. If they don't quite fit then some emery cloth can be used to reduce the diameter somewhat. A round jeweler's file can also be used to ream the holes in the buckle. One will be needed for mounting the maintenance platform, another for the ladder handrails, and one for a ladder support strap. An extra one is for the optional order board. The ends of the platform side supports, handrails etc are just fed through the two square holes in the 'wings' and soldered into place. An extra 'half' buckle is supplied in case the imagination runs wild. Naturally not all need be used. Note that the target has a different mounting system (diagram 4B). Slip the buckles onto the mast and lay aside again.

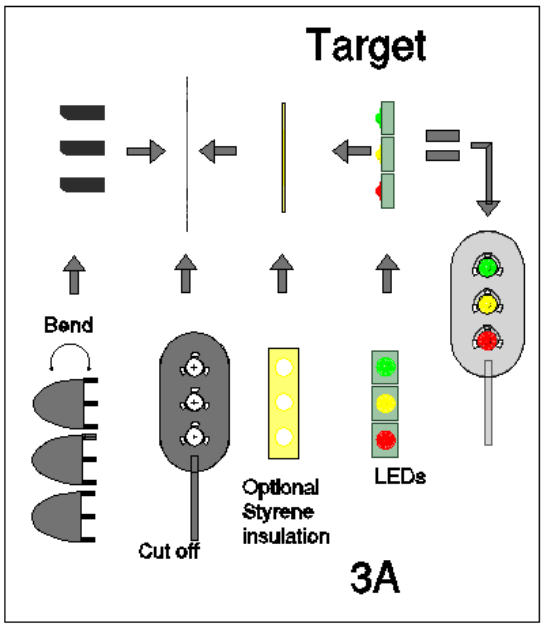


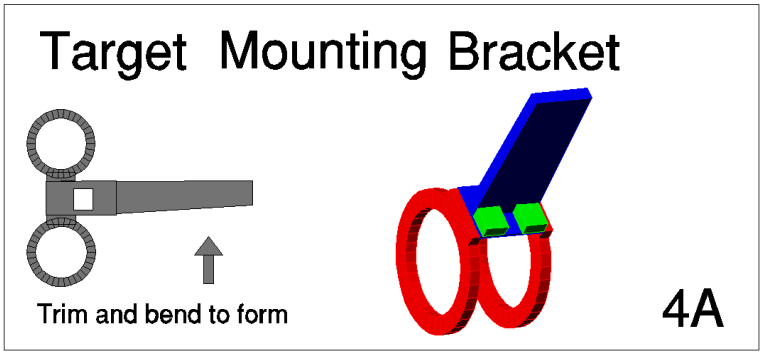
Diagram 3A takes a bit of patience. Irrespective of the type of signal being built do not cut off the target tail strap yet. First bend the three lamp hoods over a piece of 1/8 inch diameter rod or tube. Temporarily solder a holding tool to the tip of the hood. A long 1/8 inch tube, a brass rod or piece of wire will do. This will allow much better control when soldering it to the target plate. The three tabs should fit into the three slots over each aspect hole. Clamp the target in a small vice by its tail strap and guide the hood's tabs through the three holes. Once inserted trim and bend them back so the hood will stay in place. Remove the hood's temporary holding tool and repeat the process for the other two hoods. The flattened tabs can now be reheated and soldered to the back of the target. Once all three hoods are mounted and their tabs filed fairly flat the target is ready for mounting the aspect lamps. But we should talk about this.

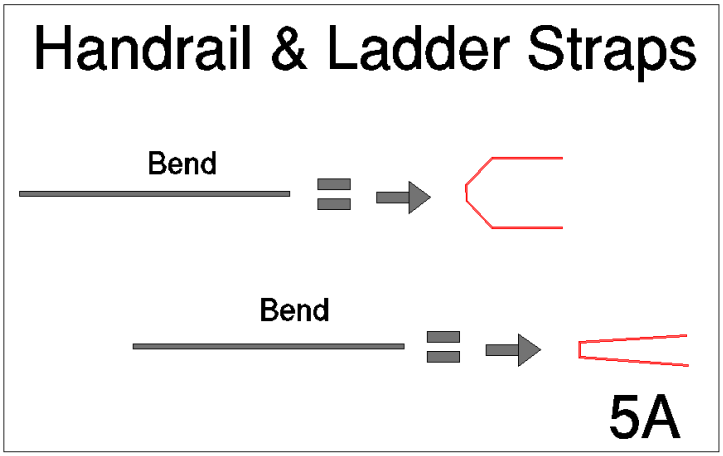
For the most flexible wiring option (two wires per LED) there is plenty room for six wires inside the mast. In fact there is enough room to put twelve wires down a 3 inch length of tubing for a double target signal. It can be done. But there is no way four to six 'grain of wheat lamp wires can be fed down this narrow tube. To be sure the large diameter wires can be cut off and fine wires attached to the stubs but it really doesn't warrant the trouble. Light emitting diodes (LEDs) are the way to go. They produce no heat so fine paint work won't fry. They cost less than bulbs and use little power. A 7 milli amp operating current is about right. LEDs also have a working life of about 100 years. BUT ---, they are diodes and only conduct current in one direction. Reversing DC polarity reduces them to "permanent off", ornamental status. On the other hand if AC is used it won't matter much because if the LED doesn't light up on the positive cycle it will on the negative one. DC or AC light emitting diodes need a current limiting resistor. At 16 volts AC a 1 to 1.5 kilo ohm resistor in series with each lamp (LED) should be OK. If a 5 volt DC supply is used then this value should only be 680 ohms. The controller documentation should be referred to here. If the LED looks too bright the resistors can always be changed to a higher value. 4.7 Kilo ohms still gives good results.

LEDs also come in a host of shapes and sizes but the very best for this application is what the industry calls the 'surface mount' type. These are tiny (2 x 3 x 1 millimeter) box shaped devices which look the part when installed on the back of the target and painted. They come in little strip packages and must be handled with care. They can snap out of a pair of tweezers very easily and land in the most inappropriate places. Each LED has two tabs at the edges meant for soldering to a PC board. For this project the very fine (5 mil) wires are soldered to these tabs then fed down the mast (slowly) and soldered to the base PC board.

There is one possible problem with these LEDs that should be addressed here. These devices are sometimes manufactured in a way that allows them to be mounted upside down so that the light shines through a hole underneath the LED to the other side of the PC board. These LEDs have the connector tabs wrapped around to the lens side of the LED. It is the lens side that is glued to the brass target. Should the layer of epoxy be too thin the brass target plate could cause confusing electrical shorts. To prevent this, a thin piece of styrene, also available from FOTOCUT, big enough to cover the three aspect holes should be glued to the back of the target to act as an insulating layer. Holes in the styrene are then drilled out and filed. The LEDS are then affixed to the styrene with epoxy. When set and dry any excess styrene can be trimmed off. It looks nice and prototypical too. Set the target assembly aside.

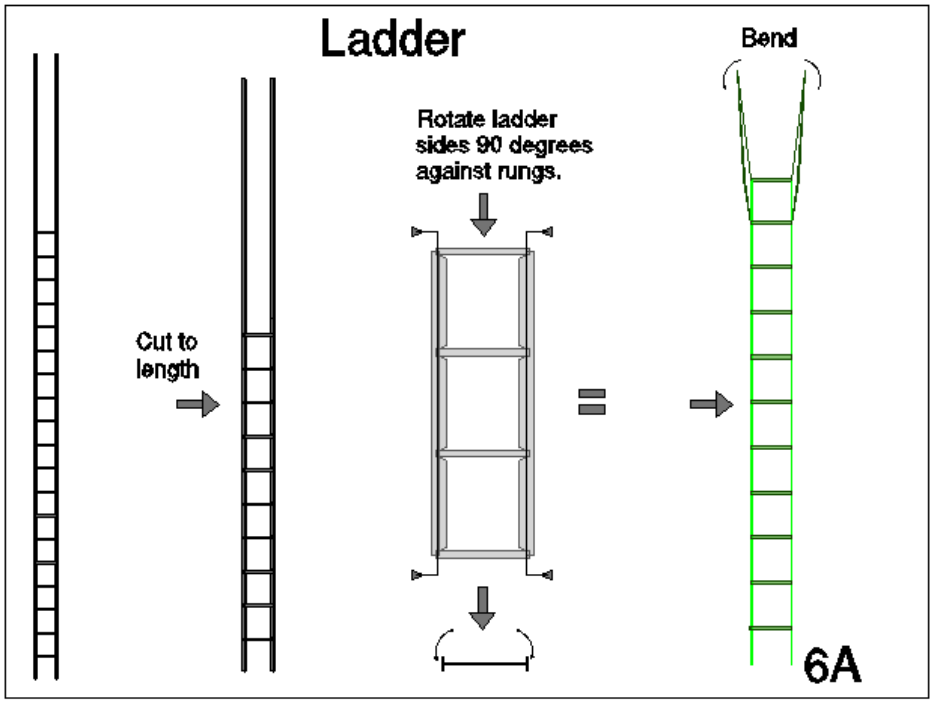
If you are building a detailed signal then take a look at fig 4A. If not then skip this step too because the target is then mounted directly to the top of the mast by bending the target tail strap and soldering it directly to the top of the mast. For the detailed version figure 4A shows how the mounting assembly is folded and refolded into a specialized buckle with a bracket already attached. Fold the strap over itself and back so that it sticks out at right angles. Then fold the buckle rings as before and apply a small amount of solder to these folds to strengthen them. When done slip on the mast with the others and again set aside. Two of these mounting devices are supplied. Some signals are attached to the mast by two brackets; one on the bottom of the target as shown and one on top. This implies that the mast must be about 4 scale feet (or about ¾ inch) longer and a hole must be drilled into the side of the mast for the wiring. This can be done by filing the mast through half its diameter with a small jeweler's file. The wires are then fed through the side of the mast. The hole can then be covered with a spot of glue or, even better, the half buckle plate supplied with the kit.

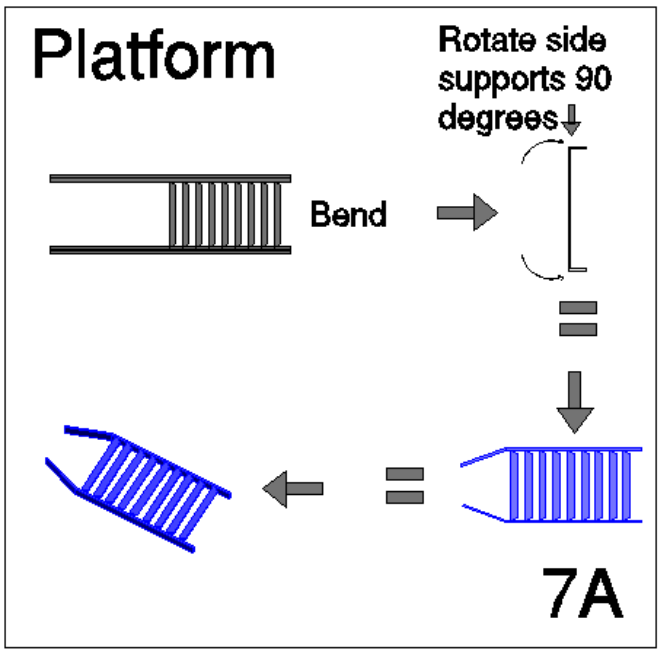




The handrails (fig 5A) and ladder strap construction is self explanatory and it is suggested they be left until needed.

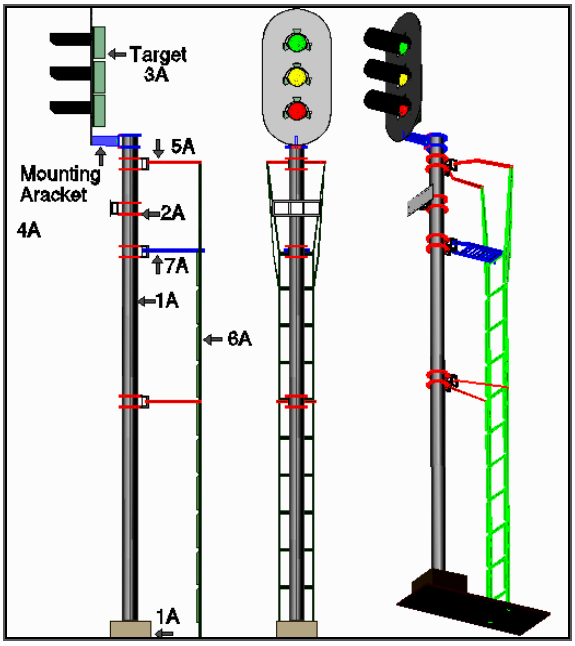
Figure 6A shows how the ladder is formed. The ladder is long enough to fit a twenty foot high signal. (Yes they do exist and usually around stations and yards). Cut the ladder to the right length. Eleven rungs worth should be enough for a 14 foot signal. Now it gets tricky. The ladder sides need to be folded 90 degrees to the rungs. This can be done in a small vice, 5 rungs at a time OR with two pieces of PC card stock in a vice. Care should be taken but if there is a foul up it is fairly easy to correct with tweezers. The ladder hand rail support brackets on each side now need to be folded down as shown. Don't solder the ends to the side of the ladder yet. Set the ladder aside with the mast assembly.



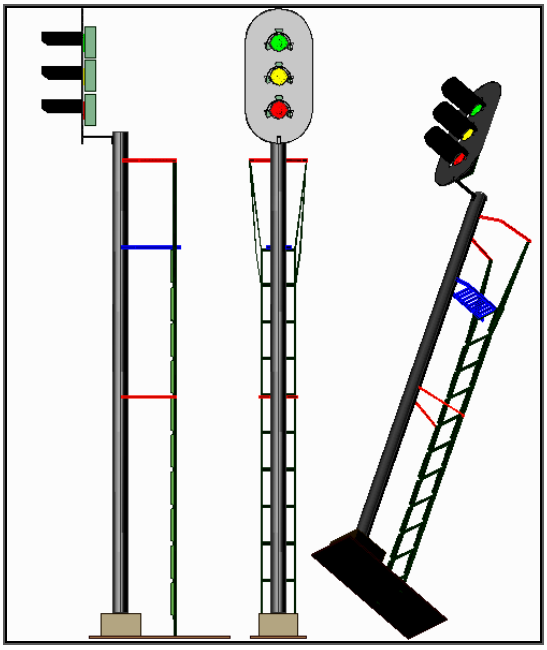


Lastly the platform grille must be folded into shape (Fig 7A). Like the ladder, fold the sides down as shown and bend the support straps inward so that the ends can be soldered directly to the mast or to a buckle. The grille part of the platform, the part that the maintenance guy stands on, usually has the grille bars vertically welded to the sides for rigidity. With tweezers these bars can be rotated 90 degrees to simulate this. Reinforcing the stressed brass with an application of solder is recommended here. The unit is now ready for final assembly.

Assembly



Detailed



Non-Detailed

For the detailed signal the buckles and target mounting brackets should now be adjusted for height. Adjust the target buckle and bracket onto the top of the mast so that it is 1.9 inches from the planned rail head. Once it is in position touch the buckle with the soldering iron for about two seconds. A tiny bit of solder and/or paste can be used to help bind it to the mast.

Cut the target mounting bracket to its correct length. It's up to the modeler how the target is mounted. Some prototype signal have the target mounted close to the mast, others have it mounted about a foot forward of the mast. Bend the last 1/16 inch of the strap at right angles to form a tab so that it can be soldered to the back of the target under the lower (red) aspect lamp. Adjust to straighten. Cut the target plate tail off and file smooth. Three buckles should now be available on the mast to install the ladder assembly. (Four if an order board is to be installed).

Solder the bottom of the ladder to the PC base and let it stand by itself. Take the platform and insert its side bars into its assigned buckle and solder. Don't solder the buckle to the mast yet. Solder the platform grille to the top rung of the ladder. Level the platform and THEN solder the buckle to the mast. At this point straighten everything up a bit. The ladder support strap, half way up the mast, is one part of Fig. 5A which is fed through the square buckle holes and soldered to the sides of the ladder. Finally the hand rails are formed by feeding the other strap through though its buckle wings and bending it to shape. (Fig 5A). and the ends slipped and soldered into the 'crook' of the ladder tops.

For a permissive halt signal there should be a spare buckle between the platform and handrails. Use this buckle to mount a small piece of card stock, styrene or unused brass waste (from between the ladder rungs) for the order board.

For the non-detailed signal (as above on the right) all the straps are soldered directly to the mast. The target is mounted by folding its tail and soldering it to the mast so that the tail elbow is flush with the top of the mast

You should now have a nice clean brass rendition of the prototype.

Wiring

The signal wiring configuration depends on the layout's type of control system. Most systems today use electronics that require the signal LEDs to have their anodes (+ elements) connected to the positive terminal of the controllers power supply while the cathodes (- elements) connected to the appropriate controller outputs. The LEDs have unique and distinctive markings which indicate the polarity of these elements. It is suggested that the system's requirements be thoroughly researched so that the LEDs can be wired accordingly. Take particular notice of the value of any current limiting resistors. Most LEDs have an upper limit of about 20 milli amps and drop about 2 volts. At 16 volts an 800 Ohm resister is the lower limit without destroying the LED. However adequate brightness can be obtained from the LEDs by using a 2.4 Kilo Ohm resistor

Method

The wire used for connecting the LEDs to the base is 5 mil single stranded and enameled. Before rushing off and buying a roll of the stuff it is suggested that the layout's junk box be searched for old relays, wall transformers that have died or old fan motors. The fine wire will almost certainly do the job.

Two colors are preferable to indicate the LED elements. Solder one color to the positive side of the LED and the other color to the negative. Two LED wires should be completely installed at a time and tested. When all three LEDS are done the excess wires are folded loosely against the PC base and taped to it with a narrow piece of masking tape.

To wire the signal LEDs to the base clamp the base in a vice so that the signal is horizontal and facing down. With a 15 watt soldering iron touch each LED tab slightly to tin it. Then clean and tin about 1/8 inch of the end of a six inch long strand of enameled wire. This can be tricky because there are different types of enamel. Some enamel is heat resistant and some not. It is possible to carefully scrape the enamel off but usually the stuff melts when covered for 20 seconds or so with hot solder on the end of a 30 watt soldering iron. Lay the tinned wire end in line against each LED tab and touch the wire with the small soldering iron for about a second. Don't panic here because these things are fairly tough and can withstand heat for 10 seconds or more. In actuality the wire and tinned tab melt together in less than a second. Now feed the other end of the wire down the mast tube. Go slow here. The wire is stiff enough to slide down the tube but it is easy to kink it. If it kinks pull it out and try again. Another solution is to feed the wires down the tube in pairs. The two colored wires indicate which wire is connected to which LED tab. Route these fine wires down the center of the LEDs to simulate a cable harness. Cut the excess wire at the base to the appropriate length and repeat the wire tinning process. Push the tinned end through one of the holes in the PC board base and solder each wire to its assigned PC board island. Test each LED before connecting the next one. This is done with a 9 volt battery, two test leads and a 2 kilo Ohm resistor. Connect two wires or test leads to the battery. Connect the resistor to the positive end of the test lead. Touch the negative test lead to the negative tab wire island and the resistor to the positive island. The LED should light. If not then reverse the connection. You may have installed the LED backwards. This is not a problem. Just reverse the connections on the PC base.

Painting

The signal can be decorated according to the modeler's requirements. The LED lenses can be covered and sprayed, or hand painted and weathered. But the modeler should be made aware of one possible minor problem. The little simulated cable harness is just a few enameled wires in close proximity. Some paint may act as a solvent for the enamel. To prevent the enamel melting and causing shorts it should be sealed with some latex paint first. This protects the enamel from the effects of any damaging oil based paint. When all is dry the signal can be installed to the layout using a cable connected to the PC base. The top of the PC base where the soldering was performed can now be covered with gravel weeds and such.

Sources.

LEDs - Digi-Key Corp, 701 Brooks Ave. South, Thief River Falls, MN 56701-0677

475-1026-1-ND	LED pure green
475-1022-1-ND	LED super red
475-1006-1-ND	LED yellow

Note --- Other types may be substituted.

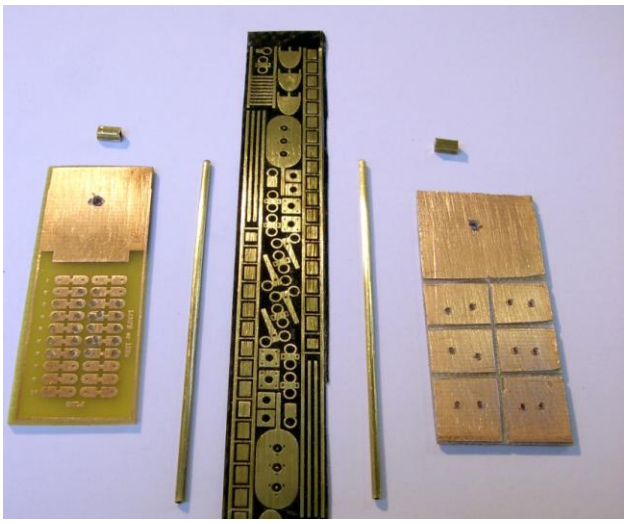
Signal Parts - FOTOCUT, Box 120, Erieville NY13061

Signal base PC Board – Radio Shack or other electronics supply store. The Deluxe version can also be supplied by FOTOCUT.

Styrene for the target/LED insulation layer - Model shop or FOTOCUT.

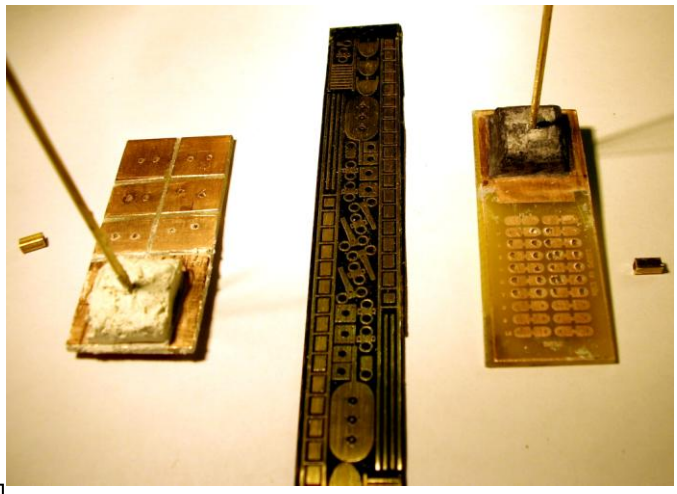
1/16", 1/8" round + 1/8" square Brass tubing – K & S supplies from the nearest model supply or hardware store.

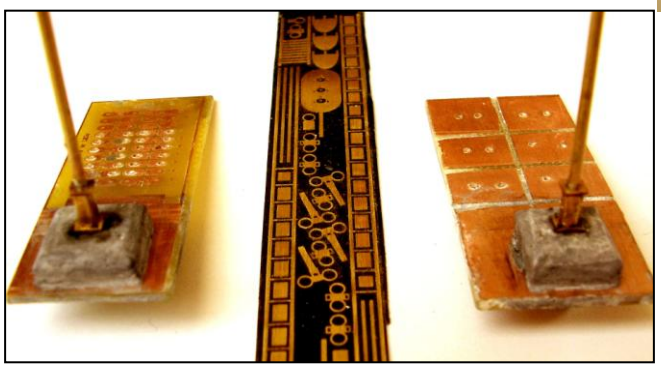
Enameled copper wire – old transformer or relay coil. (Green and Orange are normal colors)



Left shows the parts laid out for constructing two signals. The PC board on the left is used for connecting the fine signal wires to riser which can be connected to a ribbon cable.

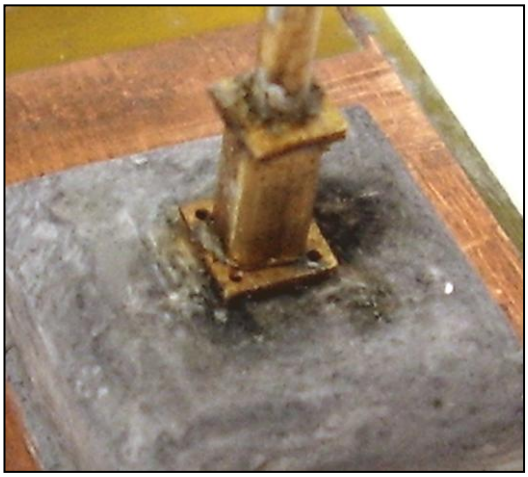
After the masts have been soldered to the PC board t he signal bases are constructed from instant 'concrete' made from diluted white glue and plaster of paris. The 'concrete ' is just formed around the mast and shaped with a razor knife. After firming up it is shaped by trimming and the edges. A small file can be used to chamfer the edges.

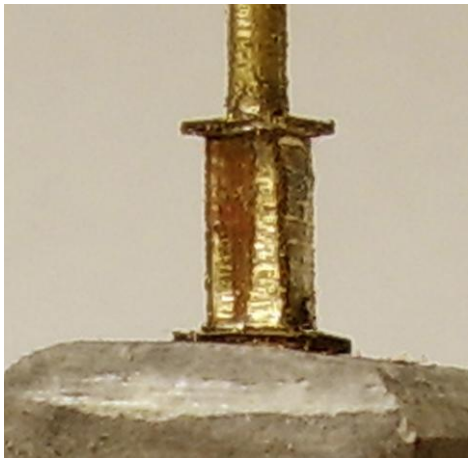




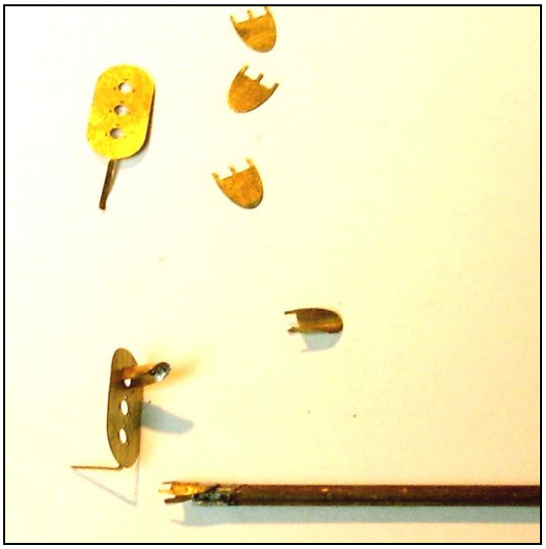
The mast base casting parts are slid down the mast, soldered in place .....

..... and filed smooth.

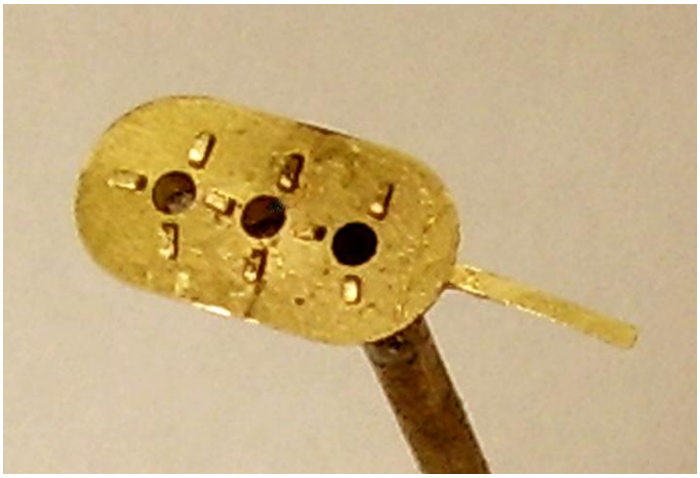




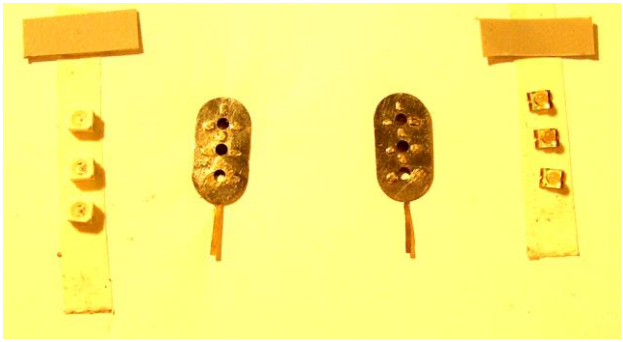
The buckles and mounting brackets are then removed from the rubber backing and slipped down the mast assembly. The sequence depends on the desired configuration but in general the ladder support strap buckle is first followed by the optional order board support, the platform attachment buckle, the target bracket and finally the handrail support buckle. Only the signal target bracket(s) and the order board buckles will be soldered into lace. The others can 'float' and stay loose. After painting they look sharp and crisp. The paint will also tend to keep them in place.



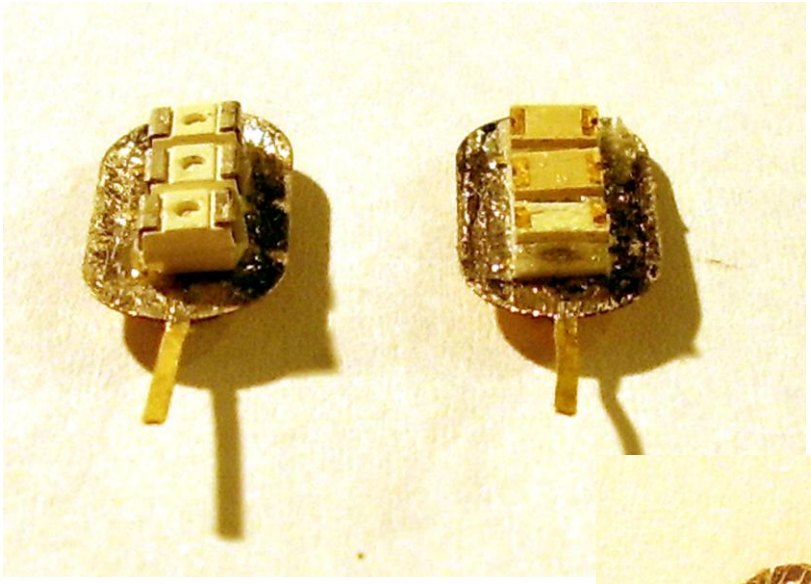
Assembling the target is made easier by first bending the hoods around an 1/8 inch brass tube. Each bent hood is then temporarily (soldered) to the end of the tube by its tip. The three tabs can then be easily maneuvered into the slots around each aspect on the target plate.



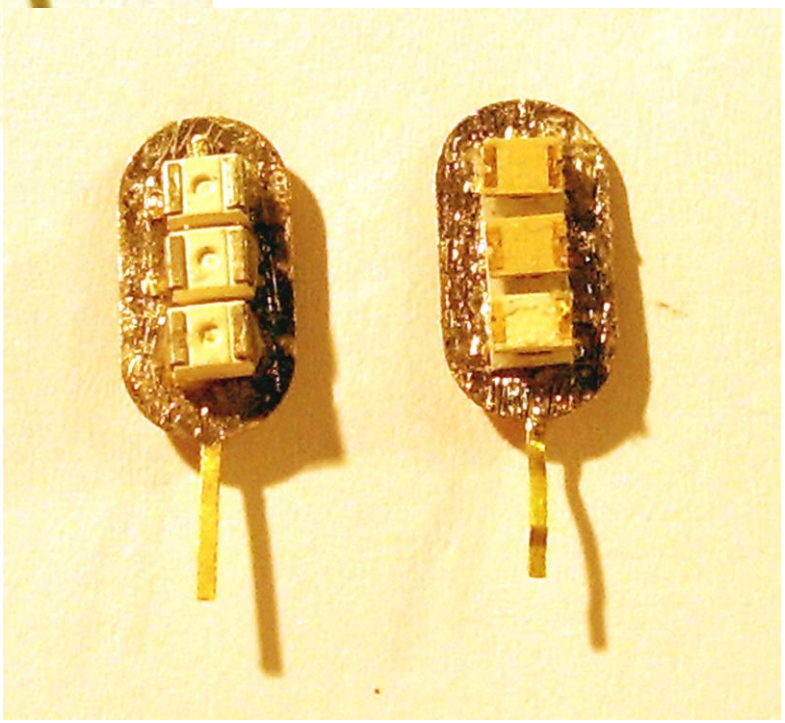
After the tabs of each hood are inserted (patience, patience) they are bent flat as shown. Once each hood is in place it is unsoldered from the brass tube. Solder the tabs in place and then tin the whole area with a thin layer of solder. Wipe as much solder off the surface as possible. File flat but not too deep. The tabs still have to do their job.



Mounting the LEDs takes a little organizing. The parts are laid out and fixed into place by pushing the target front into some polystyrene. The LEDs are aligned polarity wise so that the right side tabs are the anodes (+) and the left the cathodes (-). They are temporarily held in place with double sided 'carpet' tape. Playdo also works. The two patches of styrene are optional items depending on the type of LEDs used. The ones on the right have soldering tabs on the 'back' of each LED. Their faces can be glued directly to the target plate. The ones on the left have their tabs 'wrapped around' to the front. In the industrial world this allows the LED to be mounted upside down with the lens showing through to the other side of the PC board. That is what we are actually doing. However our 'PC board' is made of brass and is electrically conductive. So an insulating layer has to cover the mounting area of the LEDs.



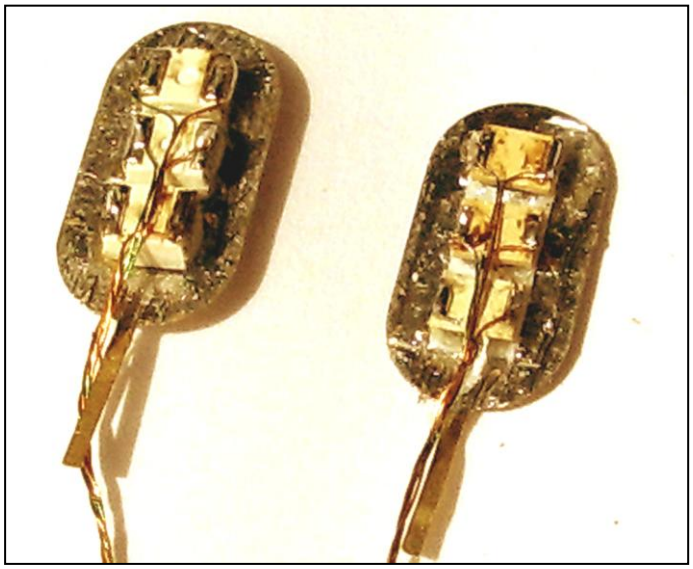
The LEDs on the left target are glued directly to the brass plate. The tabs can be seen to have been folded down the sides of the square housing but not around to the front. Although it can't be seen on the right image the gold plated tabs on the back of the LEDs are connected to a similar set on the face of the each LED. To prevent the target plate from shorting the LEDs an insulating layer of styrene is glued to the surface and drilled out to allow the LED lenses to shine through.



It is possible to either paint or cover the surface with a thin layer of glue before mounting the LEDs but there is a risk that during the soldering of the wires to the tabs and the consequent heating of the material a short could be created.

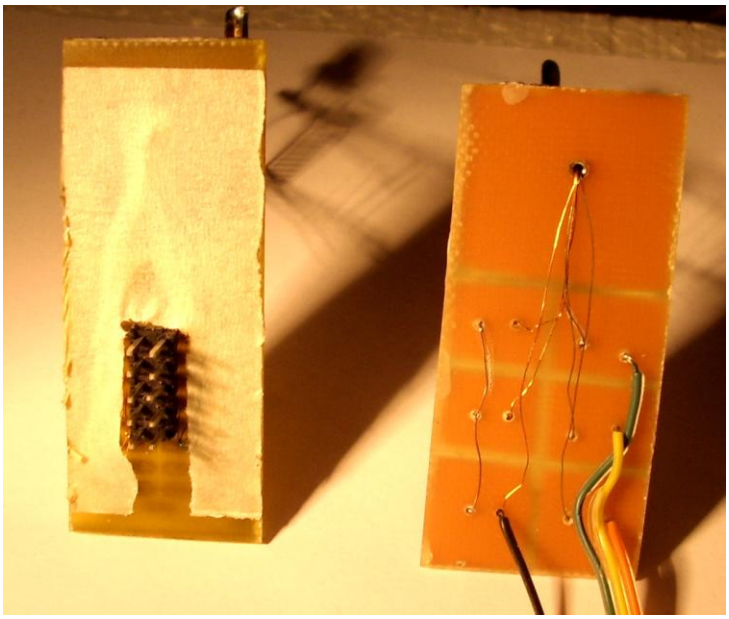
NOTE *******

For ease of wiring all the LEDS are aligned so that the anodes tabs are on the right.



Soldering the fine enameled wire to the tabs seems a daunting task. But it is made easier by careful preparation. With a 30 watt, fine tipped soldering iron tin the LED tabs. This should take about half a second for each tab. Smear a thin layer of soldering paste over each tab to help here if you must. Use very, very little solder for this. Then cut your lengths of wire. Use six inches for the green (top) pair, five inches for the center (yellow) and four inches for the bottom (red) pairs. Use different colored enameled wire. Brown for the anodes and green for the cathodes should do it. Those are the most common colors available.

To solder a wire to each tab, first scrape (or melt) off about 1/8th inch of enamel and tin the bare copper. Then apply the end of the wire to the correct tab (brown on the right) and heat for about 1 second with a 30 watt fine tipped soldering iron. It goes very fast. Align all the wires as shown on the left and twist them together for about a half inch.



After feeding the wires down the mast solder them according to your configuration to the inside holes of the base (on the right of the photo). The longest pair is the green. The shortest is the red.

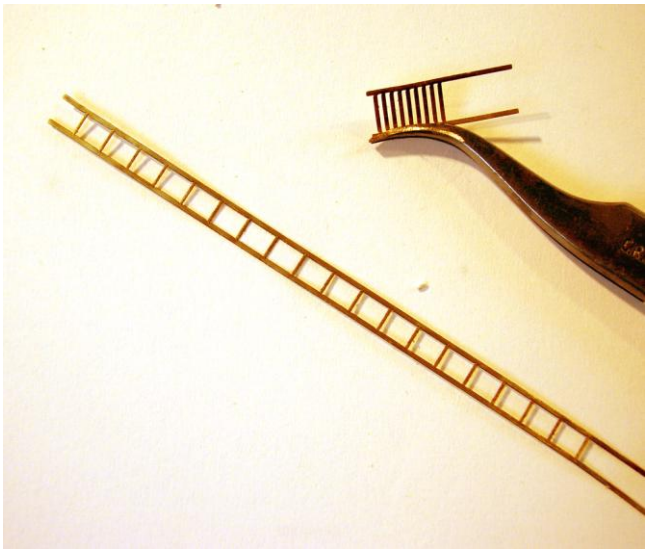
Notic e that this configuration uses a common anode configuration. The black wire is strapped to all three anodes while green, yellow and red wires go to the individual outputs of the control device. If common cathode is used then the cathodes are strapped together.

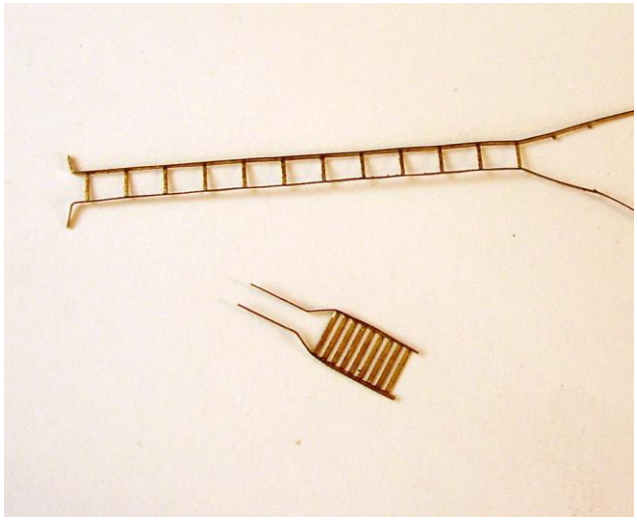
The left photo image uses a riser that connects to a ribbon cable. Again the configuration can be strapped on the PC board base or at the controller.

After soldering the target to the mounting bracket(s) and then soldering the brackets into place the signal should be tested. The photo on the left shows what they should look like.

Note the two styles of signals. The one on the left is the most common and uses a single mounting bracket while the one on the right uses two (one soldered to the bottom of the target and one on top). Sometimes a cone shaped cap is used to cover the top of the mast. This style also requires that the cable is fed down the mast via a hole in the side with a harness hanging from under the target. Feeding the wires down the mast of this type of signal is a bit more difficult but patience usually pays off.

The ladder parts are removed from the rubber backing and straightened. With a pair of curved tweezers or long nosed pliers the ladder sides are folded 90 degrees inwards to the rungs. The ladder is long enough to be fitted onto a 22 foot high signal mast. So usually the ladder has to be trimmed to size to fit the standard 14 feet high signal. (It is 14 feet from the rail head to the center of the red aspect.)





Bend the end of the ladder supports outwards to provide a solid soldering base. The platform side rails should be treated the same way. Affix (don't solder) the platform to its assigned buckle and then align the ladder and solder its base to the PC base. Solder the top rung of the ladder to the platform edge and bend the handrail supports to shape. Feed the handrail strap through its assigned buckle and insert the ends into the fold of the supports. Apply a tiny amount of solder to keep it all together.

Install the optional order board. (a filler square from inside one of the ladder rungs is about right.) It is wise to spend some time at this point to straighten things out a little. Gobs of solder can be removed, burrs can be carefully filed down and buckles straightened.

Before final painting they should look something like this on the right.