# Yana – The Build

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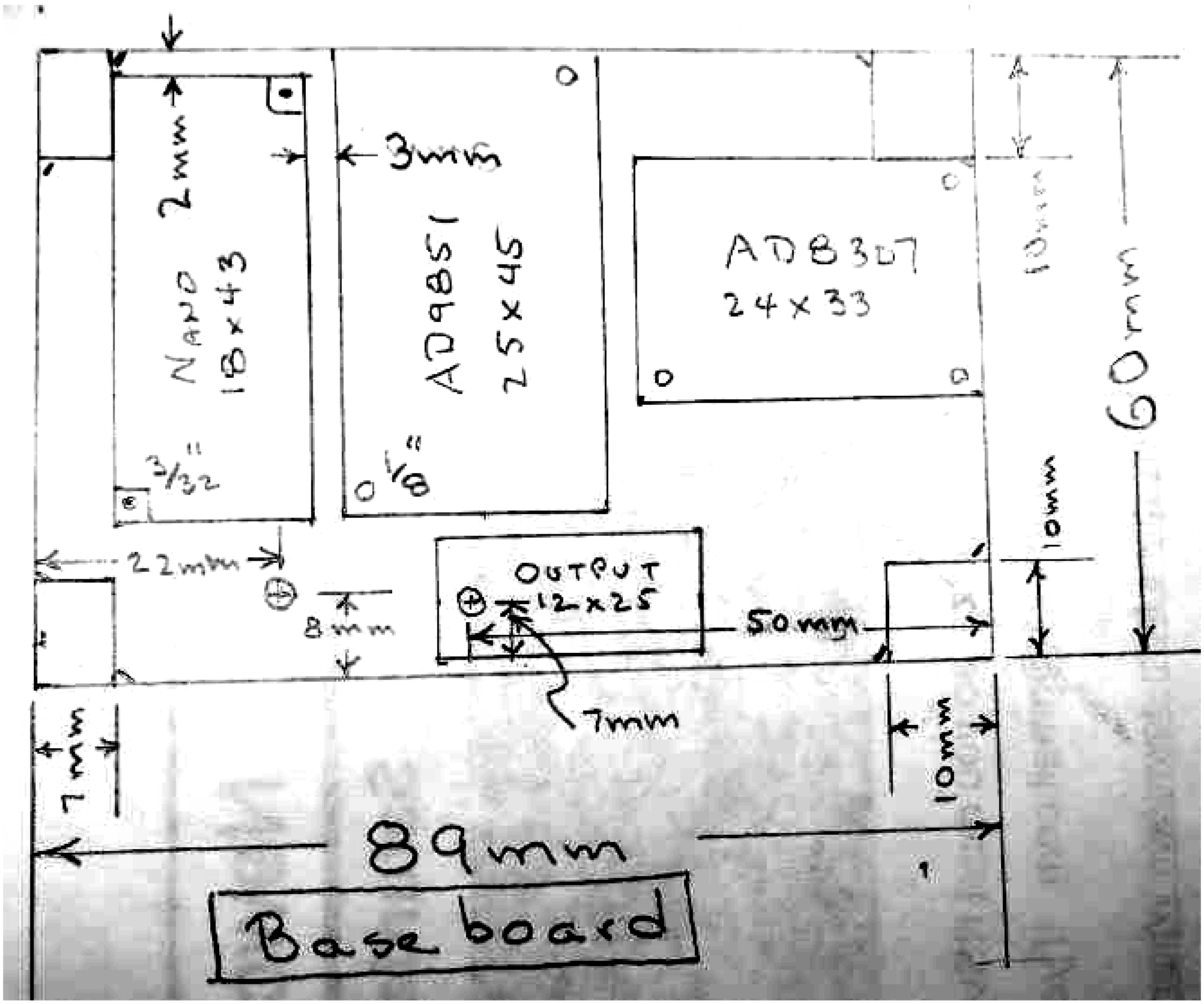
(Rudi DL5FA suggested modifications which improve Yana. These are added to these notes.)

**I. The Modules**

**A. The Baseboard Modules**

These procedures are essential for getting the modules ready for use. Read all instructions with parts in hand before doing anything (i.e. become used to the parts and how they fit together).

**1. Baseboard**

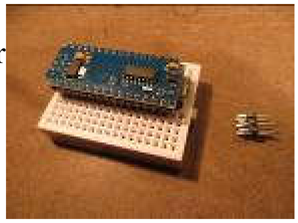



The Baseboard is made from PCB. If the PCB is single sided, work with the copper side up. I used double sided board. Using a millimeter ruler and a clean sheet of paper, draw the Baseboard, the module positions, the holes in the baseboard, and the corner cut-outs. Notice that each outward corner is nipped off so that the board will fit into the rounded-out corners of the project box. I used diagonal cutters to nip off the corners. Refer to my drawing and the picture of my Baseboard. Cut out your drawing.

Using the drawing, cut a 60 x 89 mm piece of PCB, mark off the corner cuts and the holes. Draw the modules onto the board. Mark the holes by putting the module into position on the board and marking the hole. Note that the two holes for the Nano are 3/32nd inch (unless, of course, you have M1.6 screws) and all other holes are 1/8th inch. Observe that the Nano is set back 2mm from the board edge to make the USB socket flush with the edge. Cut the corners and drill the holes. Finally, nip off the 8 corners. Drop the Baseboard into the project box to see if it fits. Push the board to the AD8302 end of the box. Extra clearance was allowed at the other end to ease removal. File the sides of the baseboard for a nice fit. See that the mounting hole on the PCB aligns with the pad it's over in the box. Adjust the hole in the PCB if necessary.

**Note:** The center of the sma connector is set in 22 mm from the top edge of the baseboard. This will be important if your AD8307 module is different from the one I chose. That module should be positioned so the sma connector position is the same as mine.

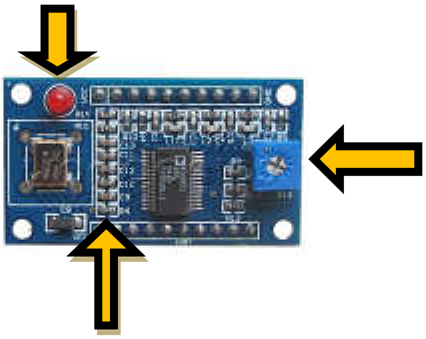
## 2. Nano



The Nano comes with pin-headers unattached. Insert the two long rows of male pin-headers into a breadboard about half way. The usb connector needs more clearance so do not push the pin headers all the way down. Put the Nano board, usb connector down, onto the pins. Be sure the pins are not in the corner mounting holes. Solder opposite ends of each pin-header row. Then finish soldering all the pins. Save the double pin-header row for some other project (or to install a boot loader).

Lay the Nano, pins up, on the Baseboard in its final position. Note which diagonal corners will have mounting screws: see the picture. With diagonal cutters, nip out the two diagonal corners so the mounting screws can pinch the board between washers. See the picture.

**Note:** The Nano mounts with tiny M1.6 metric screws. If you can easily get these, use them instead of the method described here (i.e. no need to nip the corners).



**Alert:** It is time to program the Nano. Go to the **Yana -- Programming** section and install necessary firmware.

## 3. DDS Module

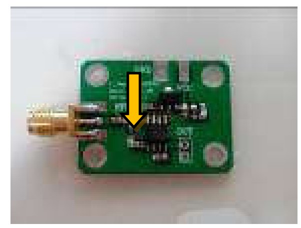
Unfortunately, the DDS Module comes with mounted pin-headers pointing out the backside. Since the pin-headers must point up from the Baseboard, the DDS is mounted face down.

Turn the blue pot screw (right arrow) all the way clockwise. This will ensure the comparator does not trigger. Do this now since the pot will be inaccessible once the DDS Module is on the Baseboard. If the comparator fires, it will create a good deal of RF noise.

If you don't mind wasting several milliamps, just leave the LED on the board (top arrow). Otherwise, pinch the LED with two fingers. Simultaneously melt both LED solder joints from the opposite side of the DDS module. When the solder flows, pull out on the LED. It may take several passes, allowing the board to cool, before the LED comes all the way out.

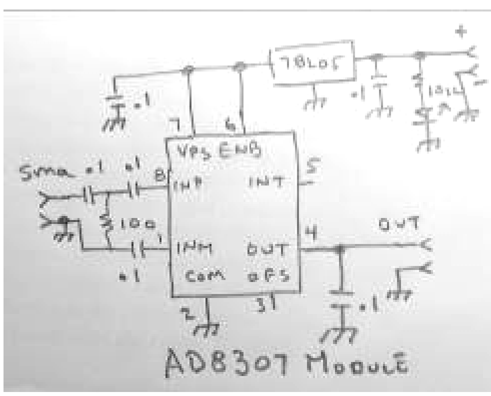
About 6db is added to the signal power by putting a 3.9K 0805 smd resistor in parallel with R6 (bottom arrow). This extra 6db turns out to be important in the proper functioning of Yana. If you do not have component tweezers, go to the medicine cabinet and borrow tweezers. Put a dab of solder on the tip of the iron. Hold the 3.9K resistor over R6 (ends aligned) with the tweezers and heat one end of R6 just enough to melt the solder. Given my old shakey hands, I braced the wrist of the tweezer hand against the table top. My soldering arm was braced against the edge of the table. One end of the 3.9K resistor will solder to an end of R6. Get off quickly since melting both ends will move R6. After one end is tacked in place, tack the othe end. It does not have to look beautiful. One of my 3.9K resistors on R6 is tipped over the side of R6. But it works.

## 4. Detector Module



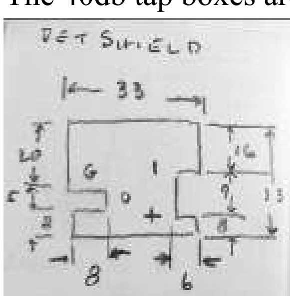
The detector must be 50 ohms. A 100 ohm 0805 smd resistor must be put in parallel with the 100 ohm resistor marked by the yellow arrow. Be sure to measure the value of the installed resistor to make certain it is 100 ohms. The modification is done the same way as R6 on the AD9851 module. If the resistance is around 50 ohms skip this modification.

Cut a 2-pin and a 3-pin male pin-header. Just use diagonal cutters to snip them from a long strip. Remove the center pin on the 3-pin header.

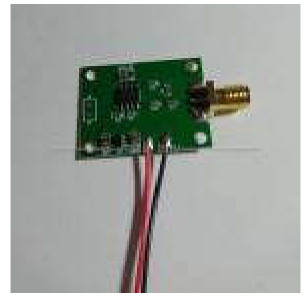



Push the pin-headers into a breadboard so that the Detector Module fits face down over the headers. Position the headers so that the sma fitting hangs off the end of the breadboard. Put a small piece of perfboard or other 1/16th-inch material between the module and the breadboard near the sma fitting. This will hold the module level while you solder. Solder the two different pin-headers to the module.

The AD8307 is extremely sensitive so it needs to be well shielded. The following method of shielding works for shielding plastic project boxes. The 40db tap boxes are insulated this way.




A piece of flexible clear plastic is needed to build the AD8307 module shield. I used a clear mylar overhead projector sheet. Teachers use and rewash these for the classroom. Possibly your child or grandchild can get a sheet from a teacher. Polyethelene from a very heavy trash bag would work. Use your imagination. This sketch is for the module pictured above. An alternate module is shown below.



Cut a rectangle of plastic 33mm by L where L is the length of your module: 30 or 33mm. Cover one side with foil tape. Trim off the excess tape. Punch holes (with an awl or punch) in the four corners for screws. With scissors, as in the sketch, trim where the pin headers for output and power come from the module. Make sure the foil does not short the pins. When mounted, the narrow dimension is too large so the shield will bulge upward over the board. This is good. Three screws hold the shield and module on the baseboard. The fourth corner is held by a piece of solid copper wire bent in a loop and squeezed with pliers (16-20awg wire). The sheet is installed, aluminum foil outward on the module (the plastic sheet is insulation to keep the foil from shorting out the module).

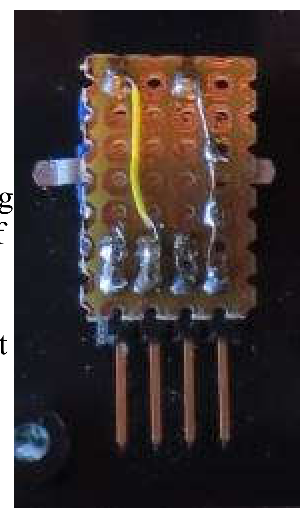
The ground pin for the output is toward the edge of the board. The power pins are less obvious. You will see where I put +/- on the foil with a magic marker to indicate the positive and negative power pins.

**5. TFT Module**

If a pin-header is not already mounted, push the 8-pin male pin-header into a breadboard. Put the display, face up onto the header. Shim the board so that it sits level. Solder the two ends, then the rest of the pins.

The SD-card slot is not used, so no pin-header is necessary at the opposite end of the module.

**6. Rotary Encoder Module**



Bend the two mounting tabs on the rotary encoder outward so that they are level with the back of the rotary.

Cut a piece of perfboard 4 x 7 holes. I do this by clamping the perfboard in a vice with the 8th row of holes just visible. Then I score heavily along the vice surface line to cut into the 8th row of holes. I score both sides of the perfboard with special attention to the copper side. Scoring can also be done on a flat surface with a ruler placed on the cut line. Then with flat pliers (I have a metal bending vice-grip, and a wide-welder pliers, but the flat side of long nose pliers should work) bend and break the board along the scored seam. Turn the strip and clamp along the 5th row of holes. Similarly, break off the board along this line. The result is a rectangle of 4 x 7 holes.

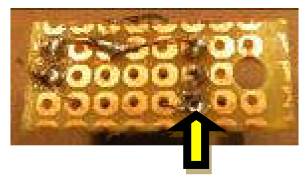
See the picture for help here. Cut a strip of 4 right angle male pin-headers. Push the short pins into the 4 holes along the edge of the perfboard. Lay the pins and perfboard on a flat surface and shim the unsupported end to level the pins and perfboard. Shove a female pin-header onto the four pins. You can use one that will be on the Wire Harness. The female header will keep the pins from distorting. Solder the 4 pins.

Onto the same side as the 4-pin header, push the rotary encoder onto the perfboard with the 2-pin side along a 4-hole edge and the 3-pin side adjacent to the pin-header. If the pin-header is pointing toward you, and the rotary pins are up, the rotary should be on the left side of the board. (See the picture.) Solder the rotary pins to the perfboard.

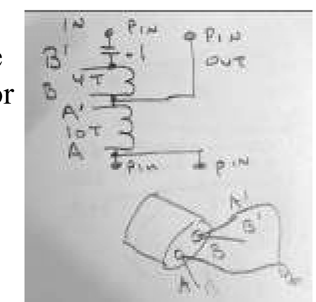
Keeping the pin-header pins pointing toward you, run wires from the rotary pins to the adjacent pin-header pins. The middle rotary pin wire should be long and reach the upper corner pin of the rotary. A wire should run from the pin-header pin not adjacent to a rotary pin to the far right rotary pin. (Note the picture.) Solder the wires as you get them into position. I tack soldered the bare wire to hold it in place.

## 7. Output Module

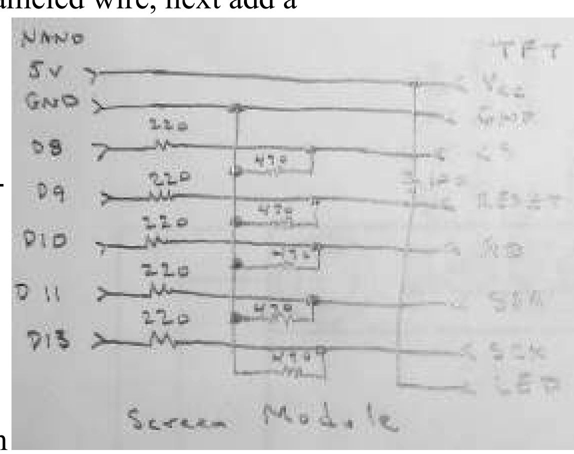
The output module is built on a piece of 3x9 perfboard. On one end, drill a 1/8" hole in the middle hole second row in. Put 2-pin male pin headers in the third and last rows as in the picture (on my board the first row of holes is just oversize board edge). With a fine magic marker, mark the edge side of the pin header black (for ground) as in top the picture. This module was built using an 0803 .1uF capacitor. However, a disk .1uF capacitor can be used and would be on the top between the transformer and the pin header on the screw end of the perf board. The pictures show the board flipped over end for end with the black-marked pins at the top in the lower picture.



On the back side of the board, connect the two black marked pins with some bare wire soldered to the 2 black-marked pins. On the back side of the board, solder one end of the .1uF capacitor to the pin marked by a yellow arrow in the picture. The other end of the capacitor will connect to the transformer. If an 0803 capacitor is used, both ends can be soldered to pads on the board. The smd capacitor is barely visible at the yellow arrow running from a pin to an adjacent pad. For a disk capacitor placed on the top of the board, both wires come through the board and one is soldered to the pin header on the backside.




Using 7” of enameled wire, the transformer is wound with 10 turns of wire. Mark the ends A, A' of the 10-turn winding so that it will not be confused with the 4-turn winding. Using 4” of enameled wire, next add a 4 turn winding with ends B, B'. A and B come out of the same hole and A' and B' come out of the other hole. If the wire is not solder-ease (i.e. solder melts the enamel), strip and tin all four wires. Connect A' to B. That is, the end of the 10-turn winding connects to the beginning of the 4-turn winding. Twist the leads and solder them.




End A, the beginning of the 10-turn winding, connects to ground (the two black-marked pins on the board top in the top picture). The tap, (A'B, twisted pair), is connected to the right hand bottom pin in the picture (out). The end B' of the winding connects to the .1uF capacitor coming from the IN pin.  The wiring should be the same as in the schematic.

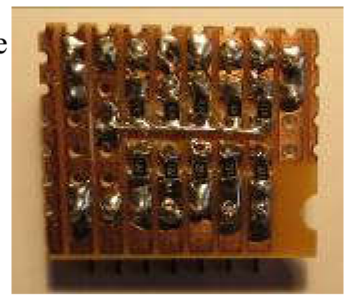
## B.  Other Internal Modules

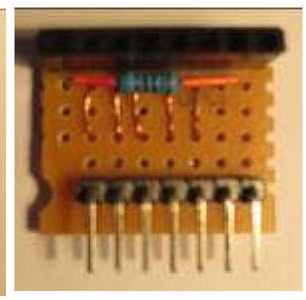
### 1.  TFT Divider Module

The screen divider module (whose schematic is above) may be made with smd or leaded 1/4 watt resistors.  The pictures show both versions.  The LED resistor is a leaded 1/4 watt 100 ohm resistor in both the smd and leaded resistor versions of the module.

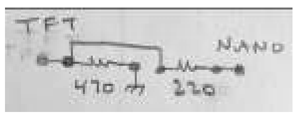
The smd version uses a 6x8 hole perfboard, and the leaded version a 8x8 hole perfboard.

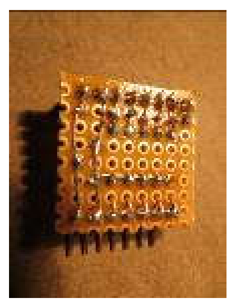
I used strip-board for the smd module, but I recommend perfboard instead.  I used insulation from a wire as spaghetti tubing on the leads of the 100 ohm resistor which crosses the whole board.  On the left side where there are two strips, with perfboard, wire is used to make the runs.  These are the Vcc and Gnd lines.

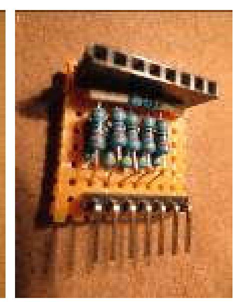




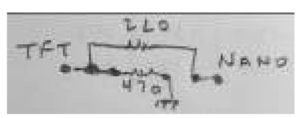
**Case 1:** smd resistors (6x8 perfboard):  The smd parts are placed serially on the copper side of the board with the 220 ohm resistors adjacent to the male (Nano) pin-header and the 470 ohm resistors adjacent to the female (TFT) pin-header.  The 470 ohm resistors are grounded by a wire that runs across the board to the GND connection on the end away from the female pin header.  A drawing shows one 220/470 wire run edge-on.  On the pin-header side of the board, wires jump over the 470 ohm resistors to reach the 220 ohm resistors.



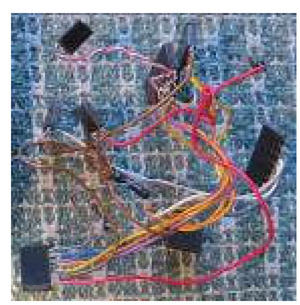





**Case 2:** leaded resistors (8x8 perfboard): The leaded parts are stacked with the 220 ohm resistor bridging over the 470 ohm resistor.  The drawing shows one 220/470 wire run edge-on.  There are two empty holes beneath the 470 ohm resistor.  On this module you can see the wire runs on the left for Vcc and Gnd.




### 2.  The Wiring Harness



The key to simplicity in Yana is the wiring harness.  With it, Yana is “just plugged” together.  Further, removing Yana parts later is easy since the harness is unplugged on removal and replugged after replacement.

A Fritzing graphic below shows the wire harness with color coded wires.  My prototype used individual wires with these color codes.  The helter-skelter arrangement of wires actually reduces transfer of signals from one wire to another.  But it turns out not to be a problem.  Therefore, for simplicity I urge you to obtain flat computer ribbon cable and use that instead. These instructions all assume cable is being used. The DL5FA modifications are covered below. However, if you chose to use a 40pcs pack of female to female pin header jumpers, then you will need to adapt the wiring to fit what you have. Jumpers of 10cm probably can be used as is, without cutting to the specified length.

### i. Cutting Wires

The female pin headers in the main harness are labeled J1-J8. Cut headers as in the table below.

| Label | J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 |
|---|---|---|---|---|---|---|---|---|
| **Pins** | 12 | 12 | 10 | 7 | 2 | 7 | 4 | 2 |

Smooth the ends with minimum overhang since these headers may be adjacent and there may be adjacent unused pins. Cut three additional female headers of lengths 2, 2, and 3 for input and power. Lay the headers in their final positions on the harness drawing. The photograph is not exactly correct since it is for an earlier version of the harness, but shows the headers in position on the diagram.

Next cut cable (or wire bundles) to the following lengths. If wires are used, try to adhere to the Fritzing diagram color codes so that you don't become totally lost. The photographs show the cables laid out straight and twisted after removal from Yana. The lengths duplicate those shown below.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| J6 | J5 | J7 | J3 | Pwr | J3 | J4 | Pwr | J2 | J4 |
| 115 | 90 | 90 | 90 | 90 | 70 | 70 | 45 | 40 | 40 |
| 7 | 2 | 4 | 5 | 2 | 2 | 1 | 2 | 1 | 1 |

The top row tells the origin header. The second row is length in mm and the bottom row is the number of wires in the cable. Also cut a jumper to bridge the two ends of J4. Most cables end on the Nano headers. I used a sharp magic marker to blacken the ground wire at each end of a cable. Strip a few mm from the end of each wire. Tin all the ends.

### ii. The Power and Input Wiring

In the Fritzing drawing, the top run is power. Solder the DC coaxial jack to the power wires and the pin headers to the other ends. The next run is RF Out. Get the sma connector with coax pigtail and cut it to 70mm. Strip the end, separating the ground braid and center conductor. Solder a 2-pin female header to the coax. Below these runs is the picture of the main harness.

### iii. The Main Harness

Wires join at connections A and B. The wire from J6 to A is not short as shown: it is 115mm. Strip these ends a few more mm, lay them beside each other all in the same direction, twist them, and solder them. These ends will be loose so they should be covered with tape or heat shrink tubing. I used black on the ground wire and red on the 5v wire.

Using the diagram and the positioning of headers on the diagram, carefully solder each wire to its correct header pin. **After soldering is complete, get an ohmmeter and check that each pair of ends of a wire are connected to the correct header pins.** This is critically important. An error here means Yana will not work and may fry a part. If the wires are correctly routed, then Yana is almost certain to work correctly on first try. Below are the header identifications.

| J1 | J2 | J3 | J4 | J5 | J6 | J7 | J8 |
|---|---|---|---|---|---|---|---|
| Nano D-side | Nano A-side | AD9851 Out side | AD9851 D-side | AD8307 | Display | Rotary | In to Output |

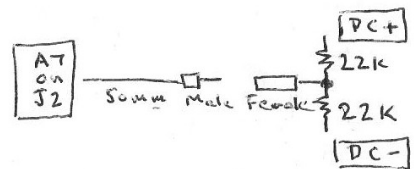
Below are the pin header and wire connections. The top row gives the origin header and below it the pin. The third row is the destination header and below that the destination pin.

| J7 | J7 | J7 | J7 | J3 | J3 | J3 | J3 | J3 | J3 | J3 | J4 | J4 | J5 | J5 | J6 | J6 | J6 | J6 | J6 | J6 | J6 | J1 | J2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clk | Gnd | DT | Btn | 5v | W_Clk | FQ_UD | Data | Rst | Gnd | Zout2 | D2 | Gnd | Gnd | Out | 5v | Gnd | CS | Rst | A0 | SDA | SCK | Gnd | 5v |
| J1 | **B** | J1 | J2 | **A** | J1 | J1 | J1 | J1 | J8 | J8 | **B** | **B** | **B** | J2 | **A** | **B** | J1 | J1 | J1 | J1 | J2 | **B** | **A** |
| D2 | **B** | D3 | A0 | **A** | D4 | D5 | D6 | D7 | Gnd | Zout | **B** | **B** | **B** | A1 | **A** | **B** | D8 | D9 | D10 | D11 | D13 | **B** | **A** |

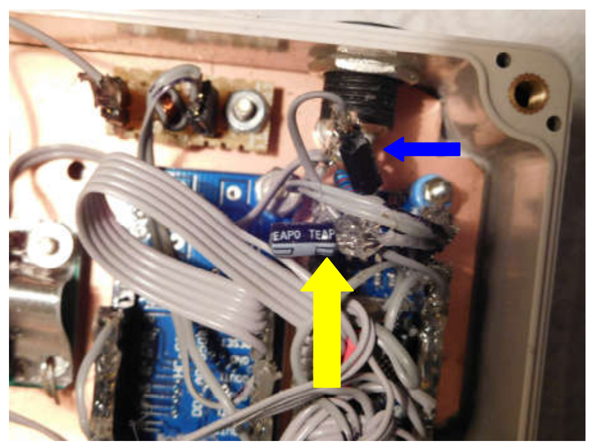
Next is a Fritzing drawing of the wiring harness. I'm sorry the Fritzing pins are dark and difficult to see in a header.

This harness omits two modifications by Rudi DL5FA: A battery voltage monitor and a DTR hold-off capacitor for attachment to a PC

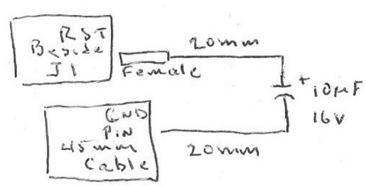
and vna/J.




1. **Battery voltage mod**: Check the schematic. Cut a 50mm piece of wire. Put a single male pin header on one end and attach the other end to A7 on J2 (next to the red 5v wire).



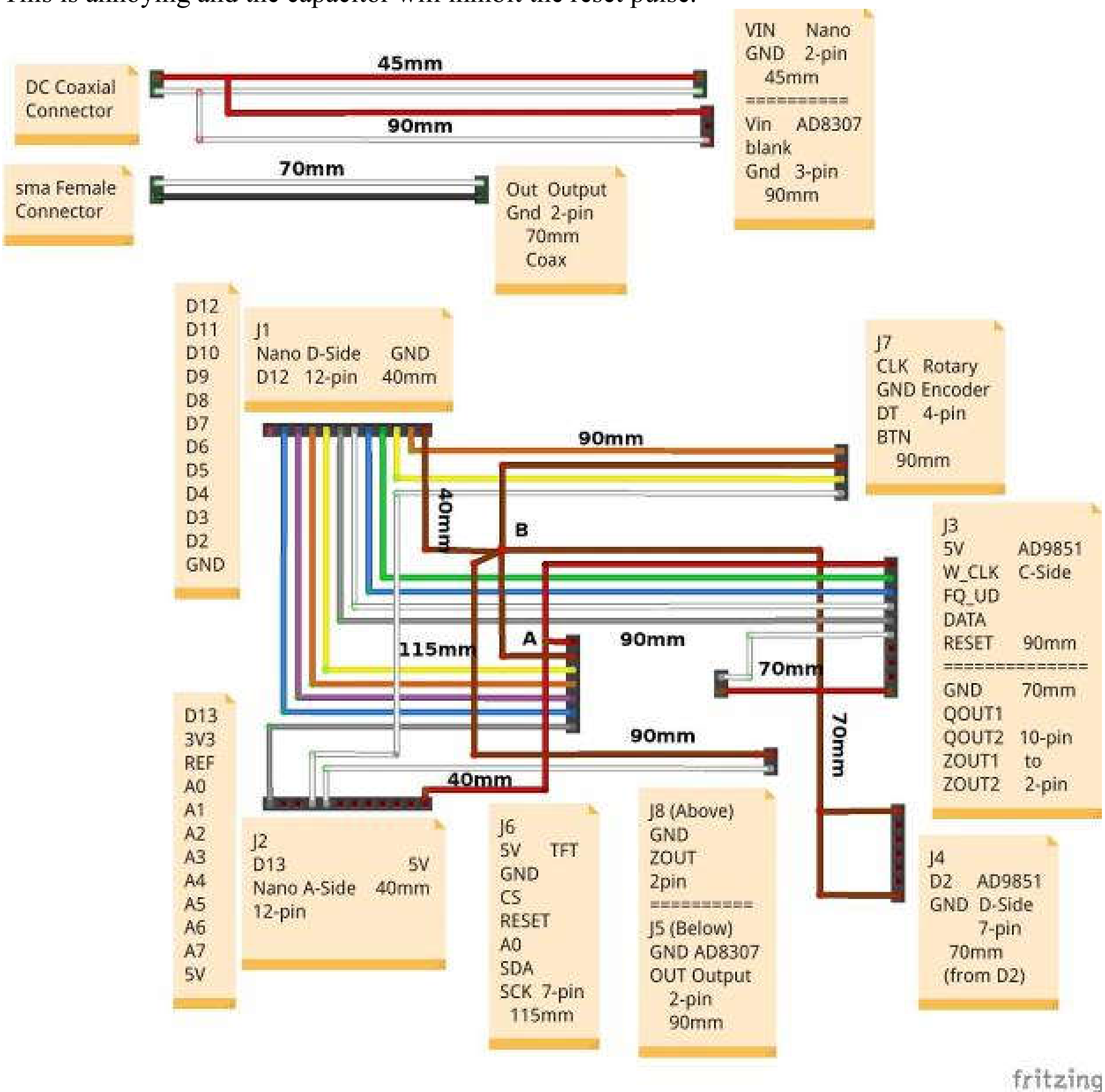
From several 22k resistors, chose two closest to equal. (A small difference will lead to a voltage error that is probably too small to be significant.) Solder the resistors end to end and attach a single female pin header to the junction. The connections should all be short. Solder one 22k resistor to the plus side of the DC coaxial connector and the other 22k resistor to the ground side of the DC coaxial connector. The connection should be flexible but leads should be short. The A7 wire and pin plug will plug into the pin header on the 22k resistors. The blue arrow points to the voltage pin plug.




2. **DTR hold-off**: The pin header should be removed when programming the Nano. After that, it is installed. The yellow arrow marks the capacitor.

Check the schematic Select a 10uF 16V small electrolytic capacitor. Cut two 20mm wires. Cut and shave thin a single female pin header. Connect the wires to the two leads of the capacitor. Connect the wire on the (-) side of the capacitor to the ground pin on the pin header end of the 45mm power cable. Connect the wire on the (+) side of the capacitor to the single female pin header. This pin header should plug onto a RST pin on the Nano board. There is no room on the J2 side of the Nano board. However, with J1 plugged in, bend the RST pin on the Nano slightly away from J1. Then the pin header will plug onto this pin.

Unplug this pin header to program the Nano. Plug the pin header after programming is complete. Without this capacitor, vna/J will cause Yana to reset every time vna/J is started. This is annoying and the capacitor will inhibit the reset pulse.

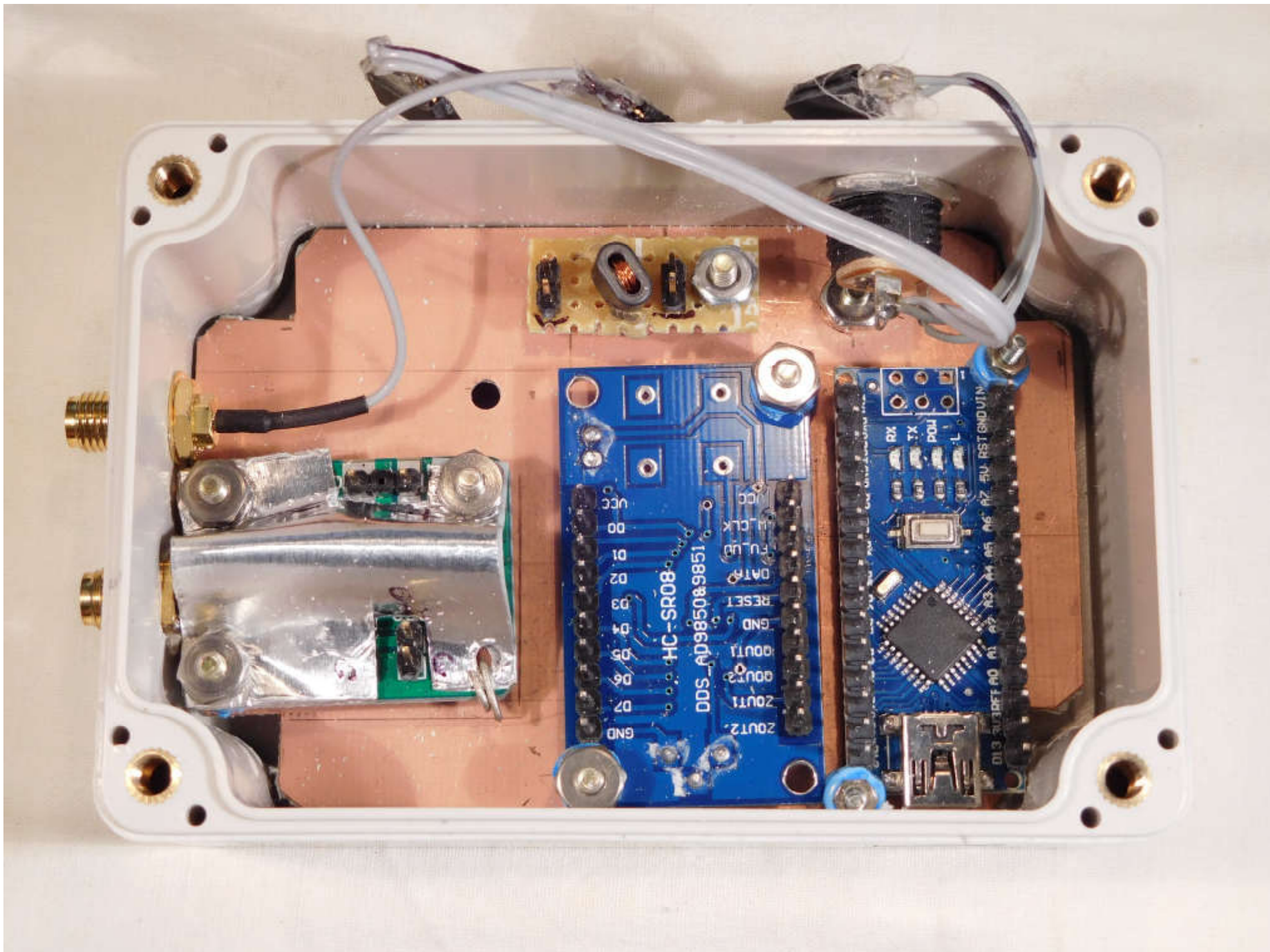



After Yana has had a thorough test of all features and you know the cable is correct, run a row of hot melt glue along the soldered connections on each header. This will keep the wires from breaking with repeated plugging and unplugging.

You now have completed wiring Yana. Congratulations.

**Test Drive Yana:** At this point Yana can be plugged together and tested. The picture at the right shows my test drive of the bare Yana modules with an 80m bandpass filter. You will need to calibrate Yana if a complete test like this is anticipated. With no calibration you can see if Yana boots and shows you the frequency setting screen. That's probably all that is needed at this point. If Yana does not work, there is probably an error in the harness wiring or the headers are not plugged correctly.

## II. Assembling the Baseboard




Follow the picture above. If PCB spacer washers are used, be sure to use an insulating shim washer between copper foil on a washer and a module.

**A.** The modules are screwed to the baseboard. A screw is inserted from the back of the board. Two spacer washers are put on the screw and pushed against the board. A module is pushed down over its screws onto the spacer washers. A third washer is placed over the board. Finally, a nut tightens and holds the board securely.

**B.** The Nano is mounted with 2-56 screws, all other modules with 4-40 screws. The Nano screws do not go through the corner holes. Instead they fit in the wedges cut out of two corners of the Nano. The Nano board is wedged between two screws and pinched by two washers.

**C.** The Nano board sits back a bit from the edge of the board. Thus the USB socket is flush with the board edge. If the socket sticks out, the baseboard will not fit in the case.

**D.** The AD9851 module sits upside down on the baseboard. The end with the blue trim pot is near the board edge and the Nano USB socket. That is, the control lines (W_CLK, FQ_UD, …) on the AD9851 module are adjacent to the data lines (D4, D5, …) on the Nano. When the mounting screws are tightened, there must be some clearance between the blue trim pot and the baseboard. If there is none, add shim washers to the AD9851 module mounting screws. The AD9851 module and Nano will sit side by side with neither on top of the other.

**E.** The AD8307 module sits with its board edge aligned with the baseboard edge. The sma jack sticks out beyond the board edge. No washers are placed above the module on the mounting screws. Instead, the foil shield goes over the three screws and humps up over the module. The fourth corner is secured by looping awg #18 or #20 wire through the mounting hole and foil corner and crimping the wire. The shield is adjusted so that the foil does not contact the header pins.

**F.** The output module extends from its mounting screw toward the sma socket end of the baseboard. No top washer is placed over the mounting screw above the output module.

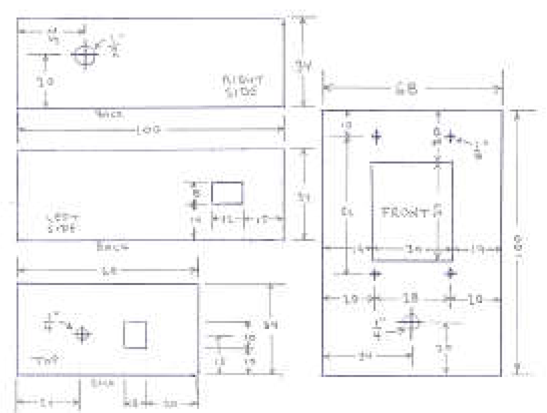
**G.** One hole remains in the baseboard to be used mounting the baseboard in the case. In the picture, my baseboard has an extra hole coming from an earlier version. The final hole is under the DC connecter and has a nut on it.

## III. The Case

The care taken preparing the case will determine how nice your Yana looks: so work slowly, double check, and take care.

### A. Case Bottom




The bottom part of the case contains several mounting points. Note the one under the mounting hole in the baseboard. Drill a 1/8" hole through this mounting point.

Note which end will have holes for sma fittings and which sides have the power connector and USB socket. It will be sad if you punch a hole in the wrong side of the box. The USB socket and DC connector are about in the same position on opposite sides of the box.

The drawings show hole sizes and positions. The dimensions are for the front off the box. The USB hole is oversize since USB plugs have a shoulder that must fit into the hole. The hole was made by drilling a ¼ inch hole then shaping it with a triangular file.

The ½ inch DC connector hole was made by drilling a ¼ inch hole and then enlarging it just the right amount with a ½ inch hand reamer. With some care, a round file can be used to enlarge the hole. The hole for the AD8307 module sma socket is rectangular and is oversize on the bottom. This extra size is necessary in order to put the baseboard into the box. The sma socket goes at an angle into the hole as the baseboard is inserted into the box.

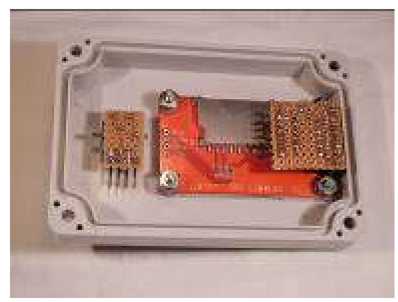
### B. Front Panel

The screen has a white bezel. Inside this, the top of the screen has black wiring not part of the visible screen. The screen hole is cut so that neither of these is visible. The screen probably has a protective clear cover shield you may want to peel off just before the screen is mounted on the panel.

Mark and drill a 3/8 inch hole for the rotary encoder. Mark and drill 1/8 inch holes for the four corners of the screen. Mark the outer edge of the screen hole. I drilled a ¼ inch pilot hole inside the screen hole then used a nibbling tool to cut out close to the hole edges. I finished off the hole with files. Without a nibbling tool, drill many ¼ inch holes near the screen hole edges. Break out the center piece and finish the hole with files. I have somewhat coarse and fine flat files, and a triangular file for corners. The fine file is used to make the finished hole look nice. The plastic is soft enough that a sharp knife can be used to smooth edges and trim off burrs in the hole.

## IV. Assembling Yana

### A. Assembling the Front Panel



The rotary encoder screws onto the panel as shown. Orient the pins as in the picture. Two washers go onto each screen mounting screw. Insert the screen and install a third washer. Test mount the screen to see if the bezel is pressed against the front. Shim the screen with thin washers until, when tight, the bezel just touches the front case. When finished, the front should look as in the picture.


Now is the time to make and apply a label. Mine is at the right. I printed it on white paper then applied many coats of clear spray lacquer. The first several coats must be very fine (just a mist) or the ink will run (doesn't matter: toner or inkjet). I glued the label on to the case between the two top screws above the screen with E6000 adhesive.

Install the knob on the rotary encoder.

### B. Assembling the Case Bottom

The baseboard should slide into the box. Screw it down through the one mounting hole. No washers are needed. Next install the DC coaxial jack and the output coaxial jumper. The DC pin headers, if properly trimmed, should fit through the hole. Do not over-tighten the DC jack nut or the jack will break. The sma jack can also be over-tightened. The sma jack must be tight enough that screwing and unscrewing fittings will not loosen the mounting nut. When finished, the bottom should look as in the picture.

**C. Putting Yana Together**

Finally plug in the wiring harness. Carefully check the orientation of pin plugs, since they are reversible. Check to see that end pins match the end pin header holes in the connection table in the Main Harness section. The picture gives some indication of the final look of wiring.

**Congratulations!** Construction of Yana is complete. To be used, Yana must be calibrated. The SNA is calibrated using a through coax jumper and a 30db attenuator. The SWR meter requires a bridge and is calibrated with a short. The power meter is calibrated using an accurate 50 ohm 10MHz power source. These are described next as external modules. Plug in power and see if Yana boots into its frequency setting screen. If the prior test worked, and Yana does not work now, then some pin header is probably incorrectly plugged.

## V. External Modules

To be of use, Yana must be calibrated. Pin header sma extensions allow loads to be plugged into Yana. The SNA is calibrated with a jumper and a 30db attenuator. The SWR meter needs a bridge and is calibrated with a short. The power meter (PWR) is calibrated with an accurate 10 MHz -10dbm source. These are all external modules.

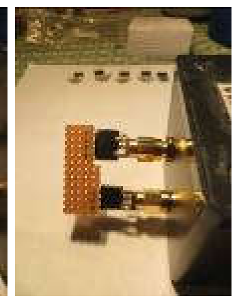
**A. sma Extensions**

To save on costs and simplify construction, sma to female pin header adapters are made to accept attachments made with male pin headers (instead of more sma connectors). These extensions can be used for any attachment where there will be no pulling. Tension will pull out the pin headers, breaking the connection to Yana.

On an extension, the center sma pin is straddled by two ground pins on either side. Resistor attachments are three pins wide and connect the center pin to ground. Therefore, an extra ground pin is added on each fitting: two ground pins on one side, the center pin, and a ground pin on the other side. That is, each adapter requires a 4-pin female strip. **Two extenders** are needed: one for each Yana sma connector. Before it dawned on me that a 4-pin extension was best, I made a 3-pin one. So don't be thrown off by my pictures with that extension.


The two ground pins and center pin of a pin header solder directly to the sma plug. The fourth pin can be connected to the adjacent pin by a solder bridge or a tiny wire jumper. I used solder bridges.

**If a module is to involve both sma connectors on Yana then it is essential to screw the fittings onto Yana and position the module board before soldering.** Failure to do this may lead to a module that cannot be mounted. The picture shows how this was done on the prototype Yana for a pin header attachment.

## B. 30db Attenuator Module

This module is essential for calibration of Yana's SNA and is actually a 28.64db attenuator. This value is entered in the Yana firmware. I suggest that this attenuator be made with male pin headers.

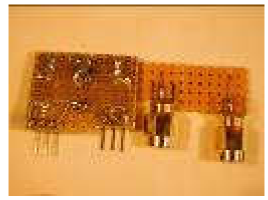
Attenuation of 30db in one pi circuit presents isolation problems between the input and the output. Therefore it is better to obtain this attenuation as the sum of two smaller attenuators in series.

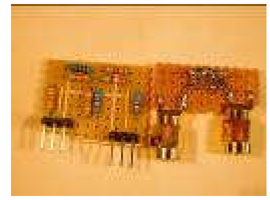
Standard value attenuators require putting several 10% tolerance resistors in parallel to obtain correct values. I moved the attenuation from 30db to 28.64db requiring four fewer resistors and better accuracy. Today 10% tolerance resistors are generally far closer than 10% so it is easy to select good values for the attenuator. Newer smd resistors seem to be especially accurate.

If you have 1% tolerance resistors, check them with your ohmmeter to determine if your meter is accurate enough. I used a Harbor Freight free DVM which matched my accurate hp DVM very closely. A 50 ohm pi attenuator has two equal shunt (parallel) resistors Rp and one series resistor Rs. Two pi sections are used. The values for 28.64db are:

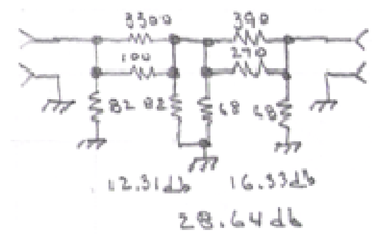
| Rp1 | Rs1 | Rp2 | Rs2 |
|---|---|---|---|
| 12.31db | 12.31db | 16.33db | 16.33db |
| 82 | 97.065 | 68 | 160.07 |
| 82 | 100 \|\| 3300 | 68 | 270 \|\| 390 |

The fourth row of the table shows the resistors used. With an ohmmeter select values as close to the table as possible. Ten of each value will usually lead to very good choices. The two vertical bars (||) mean the resistors are in parallel. Pictures show the attenuator with ¼ watt and smd resistors, also with sma and pin headers. Ignore the sma fittings on my smd version: use pin headers (save $$$).





The two sma sockets on Yana stick out different amounts. Therefore, there must be an offset when two connections are made from the same module. A 0.1” offset is about right, i.e. one row on a perfboard. The offset should be three holes wide. The smd version uses a 4x10 perfboard and the ¼ watt version uses an 8x10 perfboard. The topside lower left corner is cut out for one row at the fourth hole. Use a file or saw to cut at the fourth column. Then score the row of three holes and break it off with flat sided pliers. Trying to cut with wire cutters will shatter the board.

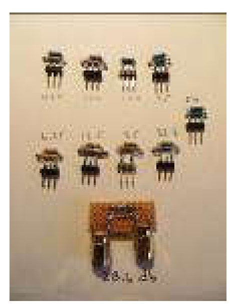



The ¼ watt resistors are installed through holes and the smd resistors are soldered to pads. In a pin header version use two right angle male pin headers of length three. The center pin is input and output while the two outside pins are ground. Thin jumper wire makes the connections. On the pad side, the sma connector legs are soldered to the pads. The smd series resistors are stacked one on top of the other.

Check wiring against the schematic. With nothing connected, the input to ground and output to ground should measure about 50.1 ohms. The center join of the two attenuators to ground should measure about 27.1 ohms. Remember, shorting your meter probes shows the “meter resistance” added to any measure of low ohms. The range switch enters into the measurement on cheap meters so jiggling this switch can change the low reading. I jiggle to get the lowest “short” reading.

I used PCB mount male and female sma fittings purchased on eBay. **Screw on the sma plugs and position the perfboard on the plugs. Solder while the board is in position.** Failure to do this may lead to a module that is difficult to connect to Yana.
Follow the pictures and the schematic.

## C. 50 ohm, Short, and Other Loads



When using Yana’s SWR bridge, a variety of loads is very useful. A short and 50 ohm load are essential. The bridge is calibrated with a short. The pictures show a collection of loads and pairs of resistors twisted together ready to solder and mount. Each load requires a 3 pin male pin header. The table below shows the resistors needed for each load. In the beginning, **50 ohms and short are probably all that are needed**. Many bridge measurements at an input require a 50 ohm termination at the output. The loads pictured provide SWR’s of 8:1, 4:1, 2:1, 1.5:1, and 1:1. A short and open give infinite SWR. The short is not shown: it is just a small jumper wire shorting all three pins on the pin header. The table gives SWR, value, and resistors to place in parallel. Plug the pin header into a female header when soldering to avoid distortion of the pins.

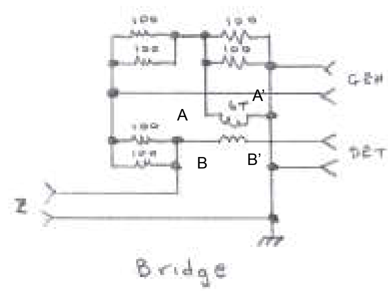
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1:1 | 1.5:1 | 1.5:1 | 2:1 | 2:1 | 4:1 | 4:1 | 8:1 | 8:1 |
| 50 | 75 | 33.3 | 100 | 25 | 200 | 12.5 | 400 | 6.25 |
| 100 || 100 | 150 || 150 | 56 || 82 | 100 | 27 || 330 | 220 || 2200 | 15 || 82 | 470 || 2700 | 6.8 || 82 |

## D. SWR Bridge

### 1. Admonitions:

This module is essential for Yana's SWR meter. The bridge should be made with sma connectors since the output connector will be jiggled by whatever connects to it. The bridge needs a short (see **C.** above) to calibrate Yana's SWR meter. I put shrink wrap around the bridge after it was made. Tape also will work. The bridge can be made with either smd or ¼ watt resistors.

When screwing sma fittings together, do not use a wrench or pliers (except to loosen a tight fitting when removing). Finger tight should be good enough. Ignore what you read in the literature: wrenches damage fittings except in the hands of experts.




**Remember to mount the sma fittings on Yana and position the perfboard on the fittings when soldering the board to the fittings.** Failure to do this may yield a bridge that may not connect to Yana. Even with this precaution, screwing the bridge onto Yana requires alternately tightening each fitting a little bit at a time. The Yana sma sockets stick out different distances, so the perfboard must be notched one row and three holes wide (notched at the fourth hole).

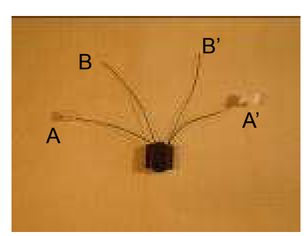
### 2. Choose Resistors:

Since all resistors will be close to 100 ohms, try to choose six resistors of equal value. Equality means balance in the bridge which is more important than value in this case.

### 3. Cut the perfboard:

The schematic is laid out like the board. Both the smd and ¼ watt version have the same layout: they just take different sizes of perfboard. The smd version uses a 6x10 perfboard and the ¼ watt version uses an 12x10 perfboard. Both boards are notched on the "10" side one row deep and three holes wide (cut at the fourth hole). I mistakenly cut my ¼ watt board to 11x10 so the pictures are not quite right. With my layout, this board could have been cut 10x10. See the cut board in **5** and **6.**

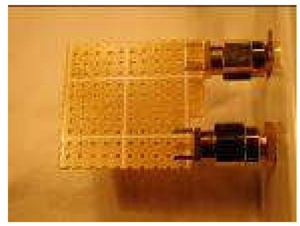
### 4. Prepare the ferrite binocular core:

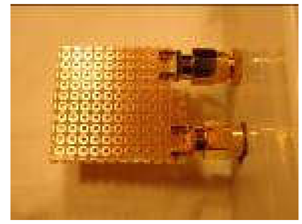



Cut a 12" length of #32 (or finer) enameled wire and fold it in half. Twist until there are at least 4 or so turns per inch. One turn on a BN43-2402 binocular ferrite core is one pass through both holes. Bend the bifilar wire in half and poke each end through the holes in the core. This is one turn. Pull tight, bend both wires back and put both through the holes for a second turn. This second turn is difficult to get tight since the wire wants to "push back" through the core. Work at it and get it tight. Later turns are easier. Now there are two turns on the core. Continue for six (6) turns.

One end of the bifilar wire is a small loop. Cut this loop. Untwist and smooth the wire back to the core. Strip the enamel of the wire and tin the leads. With an ohmmeter determine the two ends of one of the wires. Mark the ends with dabs of tape (A, A'). The other ends are labeled B, B'. I believe my wire is #32 and the sixth turn is tight. I know #30 is too fat for six turns. This method of winding a binocular core keeps the two free ends of wire equal sized.

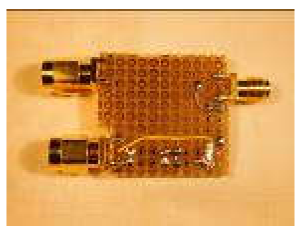
**5. Mount the sma fittings on the board:**

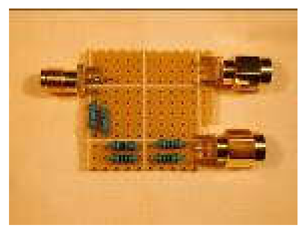




The generator sma fits in the notch on the board. Ground legs of the sma fittings fit over pads on the board and the center pin is on top of the board. Mount the male sma fittings on Yana and position the board on the fittings. Solder the ground legs to their pads. Once soldered, the module can be unscrewed from Yana. Mount and solder the female sma fitting on the opposite end of the board as in the pictures.

**6. Mount the resistors:**

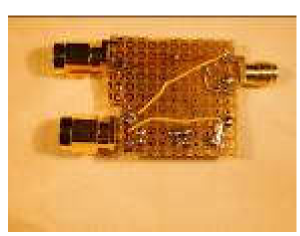


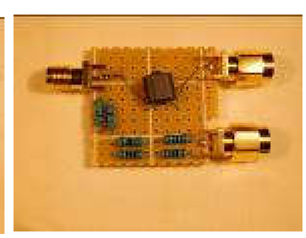


On the smd board, all components are on the pad side, while on the ¼ watt version all components are on the top side (opposite the pads). The schematic is laid out in the same way as the components on the board. Mount and solder the resistors and connect everything except the ferrite core. Wire the three pairs of resistors together as in the schematic.

My 11x10 layout moves the female sma fitting two holes up toward the top edge: perfectly ok, but not as aesthetic. In the 12x10 version, the two 100 ohm resistors nearest the female sma fitting can move down two holes lower than in the picture, freeing two more holes near the center of the board for the female sma fitting to move down. The 12x10 board puts the female sma fitting close to the center of the board.

**7. Connect resistors to the sma fittings:**





The generator center pin wire crosses the board. In the smd version, the crossing wire bends around the edge to connect to the right point between two pairs of 100 ohm resistors.

The Z center pin connects to one end of the resistor chain (three pairs of 100 ohm resistors in series). The other end of the resistor chain connects to a ground leg on the generator sma.

**8. Mount the core**

In the ¼ watt version, core wires are threaded through the board. In the smd version, the core is already on the pad side of the board. One taped core wire (A) connects to the point midway across the board between two pairs of 100 ohm resistors (not the same pair as the generator pin). The other taped end (A') connects to a ground leg of the detector sma. The untaped core wire (B) on the A side connects to the center pin of the Z sma. The last wire (B') on the A' side connects to the center pin of the detector sma. Follow the schematic.

Solder direct jumper wires connecting the ground legs on the three sma fittings. Since at RF, direct connections are best, I soldered the grounds in a triangle. I glued the ferrite core with E6000.

Verify the wiring against the schematic. Finally, glue the core to the board. The bridge can be protected with tape or shrink wrap (or just "run rugged").

This bridge is similar to "Design 1" analyzed by Jack Smith K8ZOA at http://www.cliftonlaboratories.com/6_db_hybrid_combiner.htm

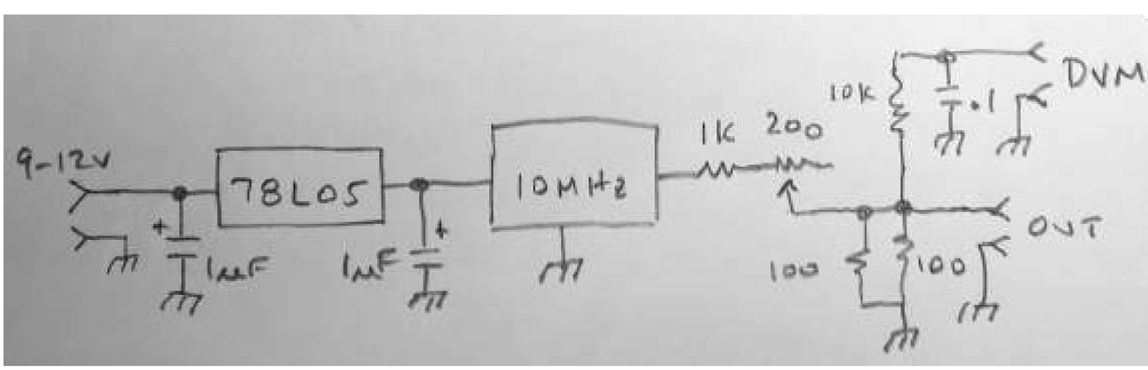
## E. Power Calibrator

This is a separate project described by other hams.

If no other accurate power source is available, this -10dbm calibrator module is essential for calibrating Yana's power meter. The calibrator should be attached to Yana's detector as directly as possible. Mismatch leads to ringing on the square wave which means a big error in calibration.

This calibrator was created by Bob Kopski (QEX Jan/Feb, 2004, pp. 51-54 and Tech Notes, QEX May/June, 2010, pp. 44-45). Mine was built using an earlier Kopski design then modified to fit the Tech Notes changes. I have not found the QEX and Tech Notes articles on the web, however, the circuit appears in the QRP/Homebuilder (qrppops) by Todd Gale VE7BPO (a great experimenter) available from Jason Mildrum NT7S (another amazing homebrewer) at

http://nt7s.com/files/QRPHomebuilder.pdf.




(This set of notes is an incredible resource for homebrewers.)

In this file, search for "CTX772-ND". The schematic is shown above the search destination. Most 10 MHz CMOS crystal oscillators swing rail to rail, so I would be surprised if someone got a 5 volt oscillator that didn't do the calibration right. (Don’t get a 3 volt oscillator.) Mismatch at the input to Yana is a more serious impediment to using square waves to calibrate Yana. VE7BPO builds the calibrator ugly style and explains how to calibrate the calibrator (and much more). I recommend more robust construction using perfboard.

VE7BPO uses a bootstrap technique. A sine wave calibrator is built in addition to the square wave calibrator. The power meter is calibrated from the square wave calibrator. The sine wave calibrator is then calibrated using the power meter. In further calibrations, the sine wave calibrator is used. The sine and square wave calibrators can be checked for ballpark values using an oscilloscope. The sine wave calibrator is more tolerant of slight mismatches.

My square wave calibrator is in a PCB case. This is not necessary, the calibrator can be built on perfboard and used only when needed. My crystal oscillator is by Abracon and the calibration matches what I get from my HP8656 and Wavetek 178 generators. Tayda sells a 10.00 Mhz CMOS crystal oscillator.

If you calculate the power from the calibrator, there is a gottcha. The AD8307 responds to peak sinusoidal voltage so that a crest factor must be considered when computing power for the square wave.

**Congratulations!** All Yana is now complete and ready to calibrate and use. Calibration is covered in the **Yana -- Calibration** section.