Drake Heterodyne Oscillator Crystal Eliminator Construction Notes

Current as of: 20 March 2005

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PLEASE NOTE

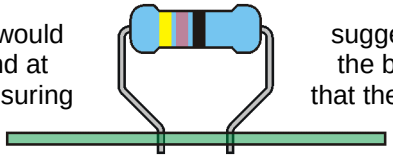
These are my PERSONAL construction notes. They have NOT been approved by Steve Hageman, the author of the original author. If you have comments or corrections, please send to me at the e-mail address shown above.

- **FIRST AND FOREMOST - READ** Steve Hageman's FAQ at: http://www.geocities.com/hagtronics/r4.html

- Although it is generally best to install the ICs as late in the assembly as possible, accessing the pads for U1 (the SMD IC) becomes rather difficult once a number of the nearby components have been installed. So consider installing this device a little earlier in the assembly process.

- In the article, the author states that the completed project dissipates about 1.4W of heat through R100 (47 Ohms 3W) when the VFD fluorescent display is used. My tests indicate that this resistor dissipates about 2.1W of power (10.0V drop across 47 Ohms = 213mA (.213 A), P = E * I = 10.0 * .213 = 2.12W). This (3W) resistor WILL become HOT! In fact, a 5W (Mouser 286-47) resistor at this position would probably be a better choice. Regardless of which resistor you choose to use, BE SURE to follow the author's recommendations about spacing the body of this resistor away from the PC board. I removed the VFD display from the circuit and checked the current drawn through R100... about 6mA. Reattaching the VFD display brought the current through R100 back up to about 213mA, so the sole cause of the added dissipation in R100 is the VFD display. This higher current draw has now been verified with two different VFD displays.

  If you do install a 5W resistor at R100, I would suggest you consider bending the leads similar to those shown here. The 45-degree bend at the bottom allows a bit more strength in the leads for supporting the resistor while ensuring that the wire at the bottom of the bend does not short out against the grounded copper on the top side of the PC board.



- **<u>Regarding the Jameco aluminum shielding box. Verify that the mounting holes for this box are correctly positioned BEFORE you install ANY components on the PC board</u>**. Once the PC board is populated, it's virtually impossible to cleanly adjust the mounting hole position because the box can no longer be positioned flush against the PC board. Select one of the four mounting holes as the 'master' mounting hole, and assemble the box halves on each side of the PC board, using one(!) of the supplied screws and the master hole. Then make any adjustments required to be made to the other three holes, to ensure proper mounting hole alignment.

- While you have the box attached to the bare PC board, take the time NOW to determine each point (on the TOP side of the PC board) where a land, or a component, must run from the inside of the box to the outside. There are nine (9) components (6 resistors and 3 RF chokes), and three (3) PCB lands for which you must cut slots in the side of the box. Using a felt-tipped permanent marker, mark those points on the side of the box and then grind away enough of the aluminum to allow either the PC board land or the component to pass. The grinding can be accomplished later (once components are mounted), but the marking should be done now, when you can easily hold the edge of the box against the PC board for easy marking.
- **<u>Regarding the Voltage regulators (Vregs)</u>**, if you received the 5V Vregs from FAR Circuits, note that they may be 'house numbered' as "8432 / 29M62" devices. They ARE 5-volt regulators, and SHOULD work, even though they may not indicate "7805". Though recent reading of Hageman's FAQ notes has indicated that some of these Vregs have been found to oscillate, thus causing severe spurs in the otherwise clean output of the xtal. eliminator. It is probably BEST to NOT USE these house-numbered Vregs if you happen to have them.

- **Install the three voltage regulator ICs last.** These devices MUST use the aluminum shielding box as a heatsink, so their positioning (relative to the mounting holes molded into the box) is critical. This can only be accomplished once you have the shielding box notched to pass the components and PC board lands which must pass from the inside of the box to the outside. Once so modified, temporarily install the box, then install the voltage regulators, bending their leads to allow each Vreg to fit flush against the side of the aluminum box, mark, drill (0.089" #43) & tap (4-40) the mounting holes for 4-40 screws. Secure the Vregs to the box with 4-40 X 1/4" screws, and THEN solder the Vregs into place.

- Install the components which mount flush against the PC board first, the work your way up to the taller components.

- **Before you solder and trim component leads, DOUBLE-CHECK to confirm whether a component lead must be soldered on BOTH sides of the PC board**. One missed connection (particularly if it's a top-of-the-board connection) can mean failure of an otherwise perfectly assembled project. Solder the lead on bottom / top / both and THEN trim.

- On a related subject. I have found it to be MUCH easier (and so far, safer) to use IC sockets at the three dual in-line IC installation points. In fact, I specifically use Mill-Max DIP IC sockets, because they offer machined pins which have a brass shoulder that extends down past the bottom of the socket itself and which can be much more easily soldered directly to the few top-of-PC board connections which require both top and bottom soldering. This shoulder sits cleanly against the pad on the top of the PC board and readily accepts solder to ensure to securely-soldered connection. The Mill-Max part numbers (from Mouser) are:

U2	8-Pin	575-193308	U4	14-Pin	575-193314	U101	28-Pin	575-193328

  These are not 'economy' IC sockets, but they work extremely well for this particular purpose... much better than the lower cost, formed-strip-pin DIP sockets. They also much IC removal much safer should you have to remove or replace a defective IC.

- **For devices which must be soldered on both sides of the PC board**, if the component mounts vertically, where access to one or both leads can be obscured by the body of the component (e.g. the large 4700uF electrolytic capacitor), *raise* that component about 3/32"-1/8" above the board and then solder it on the bottom side of the PC board. Once firmly attached on the bottom, proceed to solder the lead(s) UNDER the component. Note that for large devices, such as the electrolytics, it's easy to bend them to one side or the other, solder their lead(s) and then bend them back upright.

- By the way, regarding the large electrolytic cap in the P/S of the eliminator (noted above) and the fact that you must raise it off the board about 3/32"-1/8" in order to solder it on both sides... the thing I didn't comment upon, and which should probably be noted, is that this makes it susceptible to being beaten back 'n forth during handling following its installation. To combat this, I cut a couple 1/2" pieces of fairly heavy insulation from a piece of RED-BLACK DC wire (like the type of insulation which covers the 12-gauge CD lead on JA 2M rigs), removed the wire and wedged one of the empty pieces of the insulation between the bottom of the 'lytic and the PC board or either side of the cap. I slightly bent the cap to one side, slid one piece of insulation up against the two component leads, bent the 'lytic other way (more difficult now) and slid in the other piece. The cap is now easily as stable is if it was flush against the PC board.

- Note that there is a component value discrepancy for C23 between the schematic and the parts list. The Parts List indicates that this device should be a 120pF C0G 50VDC ceramic, while the schematic (incorrectly) indicates 82pF. The correct value is 120pF, though the author states that using 82pF at this location will not significantly effect operation of the circuit.

- If you used the Excel spreadhseet which I may have supplied (prior to 02/24/2005), note that there was a parts count discrepancy for the 4.99k Ohm resistors in the parts list. There should be six (6) 4.99k Ohm 1% 1/4W resistors, ***not*** five (5) resistors as may have been indicated in the spreadsheet. However all is not lost. A 4.7k (or 5.1k) 1/4W 5% resistor may be easily substituted for R12 in the circuit. The component count for the 4.99k 1/4W resistors has been corrected in the spreadsheet counts as of 02/24/2005.

- Although it is mentioned in the article, pay particular attention to the polarity of the POS100 assembly when it is installed. On the TOP of case of this assembly, the letters "MCL" are located over PIN 2, and on the BOTTOM of this assembly, PIN 1 is indicated my a BLUE ceramic filler around the pin (the other pins are mounted in white ceramic).

- C33 & C35 do not exist! Don't bother trying to find them on either the PC board or the schematic.

- The 12" SMB cable specified in the article, available from Jameco, may turn out to not be long enough to reach to the heterodyne oscillator xtal bank. If you are careful, you can 'extend' the length of the RG-174 cable by adding additional length to it. Furthermore, if you are ***very*** careful, you can remove the SMB plug on one end of the cable by grinding a slit in the crimp tubing securing the RG-174 to the SMB plug, push out the center pin, and recycle the connector itself for installation onto another (longer) piece of RG-174. I used small diameter brass hobby tubing, available from a local Ace Hardware store, to replace the crimp tubing which had to be sacrificed to remove the 2nd connector from the original cable. **NOTE (new)**: SMB Cables recently purchased (Jan 2005) from Jameco have been crimped and then the crimp has been indented to prevent it coming loose. This makes safe removal of the connector from the coax ***VERY*** difficult. You would be well advised to purchase and install your own SMB cable connectors instead of trying to remanufacture the existing cable.

- Here's a point from Steve Farhat (WA8GLE) worth noting: "I have finished 2 of the projects now and both work well. I would highly recommend is replacing C3 with a 5pF to 60pF trimmer. This allows the 10 MHz oscillator to be adjusted to zero against WWV, and then all of the rest of the divided outputs are right on frequency. Once the dial is calibrated, it needs no further calibration on the other bands."

- Regarding the Grayhill Rotary Encoders: It seems that many folks are agonizing over the possible lack of availability of the rotary encoder originally specified in the article. This should NOT be a problem! This encoder, or one of its brothers (same manufacturer - Grayhill, still the required quadrature output, but possibly more 'counts per revolution') should be available from a number of vendors, including DigiKey, and Newark. Here are some manufacturer's numbers to look for if the specific encoder you thought you wanted is out of stock, or backordered:

Description (counts/rev)	Grayhill #	DigiKey #	Newark #
8	25LB45-Q	N/A	16F7290
10	25LB36-Q	N/A	N/A
12	25LB30-Q	N/A	16F7288
16	25LB22-Q	GH3073-ND	16F7287
22	25LB18-Q	N/A	16F7286
24	25LB15-Q	GH3072-ND	16F7285

  I'm using the 25LB22-Q (16 counts/rev) and could easily have gone with the 25LB15-Q just so I don't have to turn the knob as much to go from one end of the spectrum to the other.

- For those of you who wish to use it, an adapter PC board is now furnished by FAR Circuits for converting the hard-wired display (either VFD or LCD) to a pluggable display. To use the adapter board, just install a 14-pin (male) header (onto the back of the display, and then install a 14-pin header (female) receptacle onto the adapter PC board and wire directly from the main PC board to the adapter board. A wiring diagram and pictorial is available from FAR Circuits. This adapter board makes it easy to plug and unplug the rather expensive display from the main PC board during those times when you might be working on the main board and don't want to risk damaging the display as a result of handling the main board. In order to use this adapter board, you will want to order a matching 14-pin header (Mouser 571-21032390, cut to 14 pins) and socket (Mouser 649-66951-014).

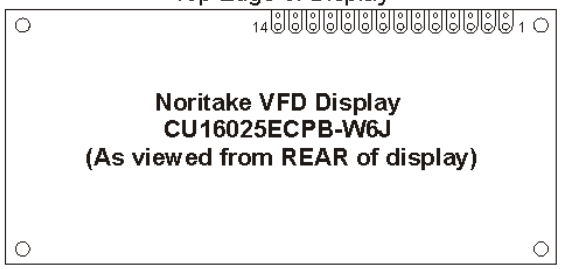
  See the illustration on the following page for more information about the display adapter board.

Drake Het. Osc. Xtal Eliminator

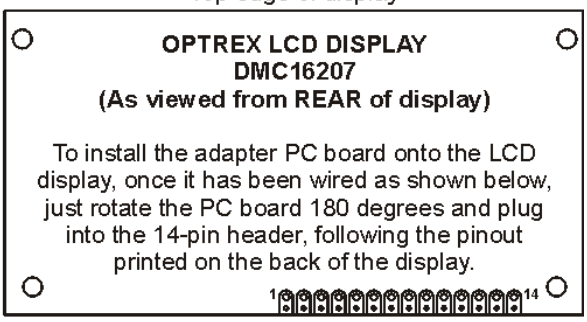
Wiring for Display Connector Cable Adapter

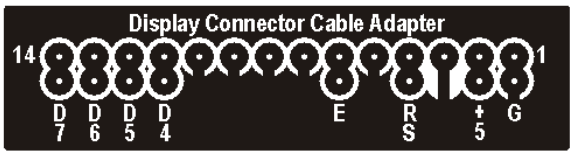
NØSS 07/14/2004

Top Edge of Display



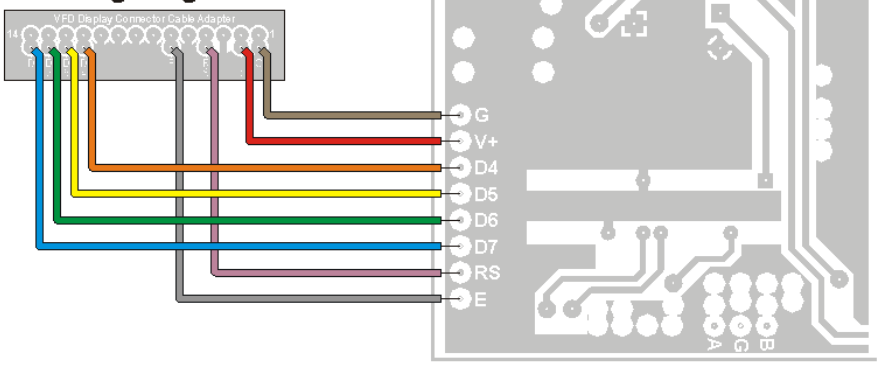
Top edge of display



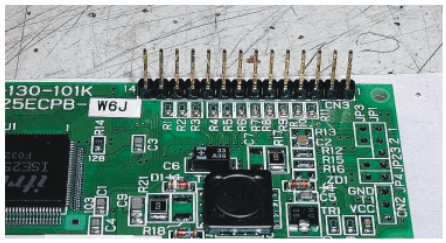


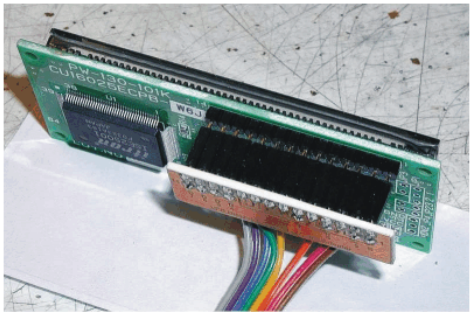
Left portion of S Hageman Drake Xtal Eliminator PC Board

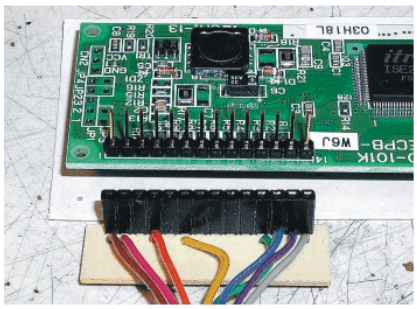
Wiring Diagram

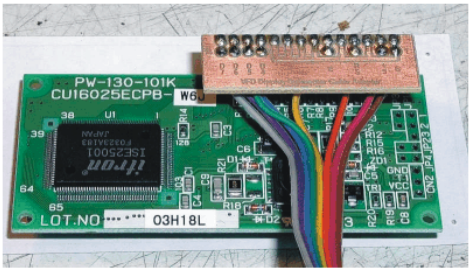


Installation Examples





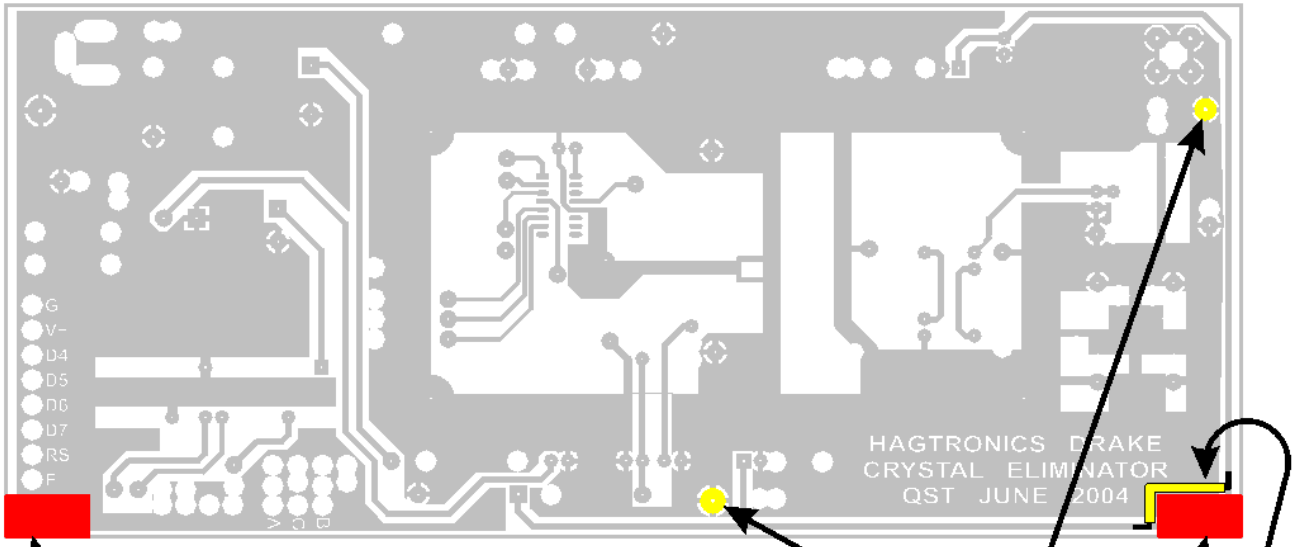




- If you choose to use a Hammond 1598D-type enclosure (see illustration below), you will have to make a couple mods to the PC board in order for it to slide into the enclosure without being obstructed by the two enclosure screw bosses installed in the center of the case, along the left and right sides. See the illustration below for more information on these mods.

Drake Xtal. Eliminator in Hammond 1598DBK Enclosure

Cuts and jumper required when installing PC board into a Hammond 1598D enclosure



When installing the PC board, use thin INSULATED washers at the two (2) indicated PC board mounting holes to eliminate the chance of shorting adjacent copper (current-carrying) lands to ground.

The following modification of the PC board will allow the board to fit easily into a Hammond 1598D plastic enclosure. Without the mods, the screw bosses in the middle of the case will not allow the PC board to be inserted far enough into the bottom of the case.

Remove two 0.5" x .25" rectangular blocks (as shown in red, above) of the PC board, and install an insulated wire (#24 to #20 gauge OK) jumper as shown in yellow, above.