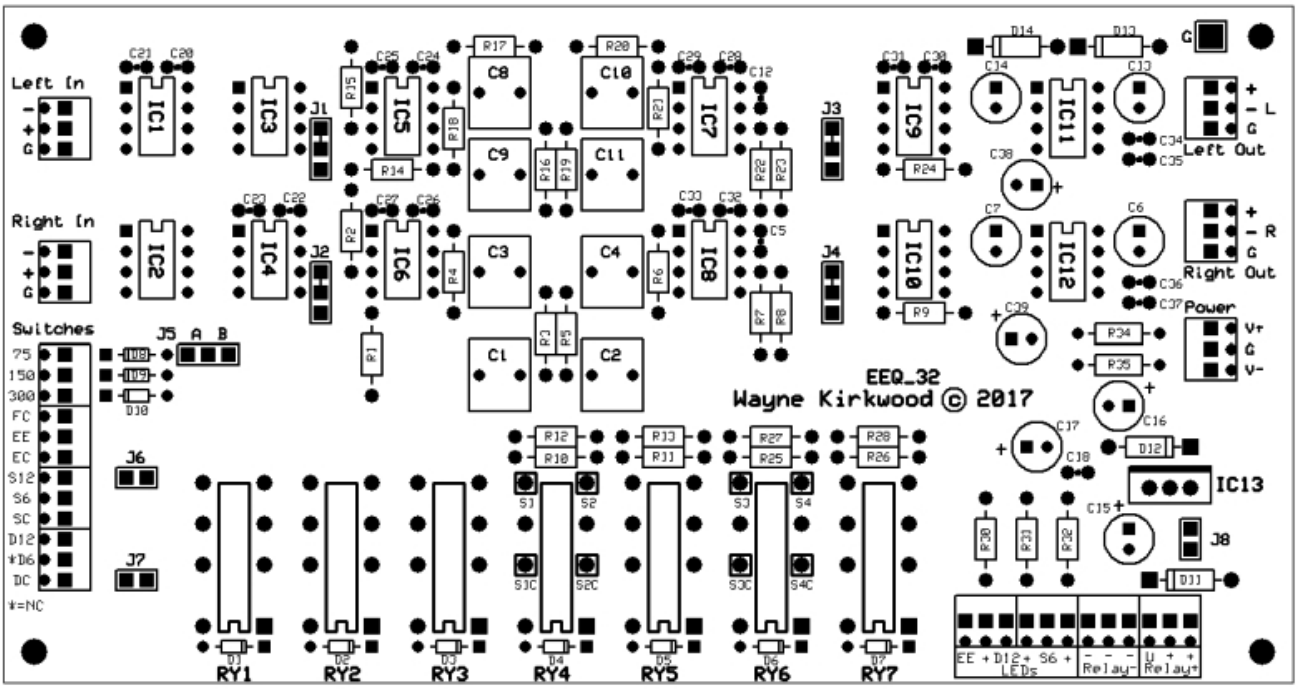
Assembly Instructions for the KA Electronics Elliptic Equalizer



Elliptic Equalizer PC Board Stuffing Guide

Install IC sockets

Place the PC Board on the work bench silkscreen side face up.

Place **twelve** 8 pin IC sockets into their respective locations. Observe orientation of the notch. Make sure that you do not place the sockets in the bypass capacitor holes.

Tip: Lift the board up and place a piece of cardboard on top of the board to form a sandwich of PC board, sockets and cardboard. The cardboard is used to hold the sockets in place so the board can be turned over without the sockets dropping out.

Flip the board over.

Tack Solder only two of the corner IC pins. Put downward pressure on the PC board to make certain the sockets are seated on the board as you solder.

Once all the IC sockets are tack soldered, flip the board over.

Make certain that each socket is correctly oriented, fully seated on the board and square.

If you're satisfied with the placement of the sockets, solder all of the remaining pins. Do not overfill the connection with solder because it can run underneath the socket and form a short between pins.

Visually check each pin's connection particularly those to the ground plane. Reheat any pins if needed. Do not trim the IC socket leads.

Install resistors

Install **four** 10KΩ 1% resistors at R1, R7, R14 and R22.

Install **four** 1KΩ 1% resistors at R2, R4, R6 and R15.

Install **four** 2KΩ 1% resistors at R17, R18, R20 and R21.

Install **four** 3K74Ω 1% resistors at R3, R5, R16, R19.

Install **two** 4K99Ω 1% resistors at R8 and R23.

Install **two** 49R9Ω 1% resistors at R9 and R24.

Install **two** 1R 1W fusible resistors at R34 and R35.

R29 is not used.

*Note: If you are using relay tuning install the resistors below. If the EEQ will be tuned by an external rotary switch do not install the following resistors: R10, R12, R25, R27, R11, R13, R26 and R28.

Install **four** 3K74Ω 1% resistors at R10, R12, R25 and R27.

Install **four** 7K5Ω 1% resistors at R11, R13, R26 and R28.

Install LED current limiting resistors R30-R32. If 12V relays are used, install **three** 2KΩ 1/4W for an LED current of approximately 5 mA. If 24 relays are used install three 4K99 1/4W.

Install diodes

Install **ten** 1N4148 diodes at D1-D10. Observe polarity.

Install **four** 1N4004 diodes at D11-D14. Observe polarity.

Install ceramic capacitors

Install **nineteen** 100 nF (0.1uF) at C18 and C20-C37.

Install **two** 22 pF at C5 and C12.

Note: Designation C19 is not used.

Install jumper headers

Install the jumper shunts onto the header pins before you solder them. (The shunts serve as insulators that allow you to position them while soldering without burning your fingers.)

You will need **eight** shunts. The shunts are positioned during installation in the locations that will be used in final test.

The shunts should be installed with small openings on the bottom.

When installing the headers, tack solder only one pin and reheat it to adjust the position of the header so that its square and flush with the board. Once you're satisfied with the orientation of the headers solder the remaining pins.

Install **five** 3 pin headers at J1-J5. The shunts on J1-J4 should be in the top position. Install J5's shunt in the "A" position.

Install **two** 2 pin headers at J6-J8. Install shunts on J6-J8.

Install Phoenix connectors

When installing the Phoenix connectors make sure the openings for the wires point outward to the edge of the board. When installing the connectors, tack solder only one pin and reheat it to adjust the position of the connector so that its square and flush with the board. Once you're satisfied with the orientation of the connector, solder the remaining pins.

Install **five** 3 pin Phoenix connectors at the "IN," "OUT," and "Power" locations.

Install **two** 12 pin Phoenix connectors at the "Switches" and LED/Relay Power" locations.

Install electrolytic capacitors

Note: The + (positive) terminals for the electrolytic capacitors have a square pad. Where space permits there is also a "+" silkscreen marking. The longer capacitor lead is the positive lead.

Bipolar capacitors, which do not have a polarity, will also be installed in four locations. Make certain that you have the right type of capacitor before soldering it.

Install **four** 10uF 25V bipolar electrolytic capacitors at C6, C7, C13 and C14.

Install **two** 47uF 35V polarized electrolytic capacitors at C38 and C39. The polarity of these capacitors are critical.

Install **three** 10uF 35V polarized electrolytic capacitors at C15, C16 and C17. The polarity of these capacitors are critical.

Note: Film capacitors C1-C4 and C8-C11 will be installed in a later step.

Install the relays

The EEQ can be built using relay frequency tuning or an external 4 pole multi-position rotary switch.

The relay coils can be either 12 or 24V DC. The Mouser BOM specifies 12V coils. An optional 7812 regulator can be installed, in a later step, at IC13 for use with 24V supplies.

Tip: When installing the relays place all of them on the circuit board and align them. When you're satisfied with the alignment place a strip of adhesive masking tape across the tops of all of them. This allows the relays to be soldered as a unit. Solder the corner pins making sure that each relay is flush with the PC board. Remove the masking tape. If the alignment is correct and the relays are flush with the board solder the remaining pins.

Install **three** relays at RY1-RY3.

If the EQ is going to be tuned using on-board relays, install **four** relays at

RY4-RY7.

For external rotary switch tuning the relay pads labeled S1-S4 and S1C-S4C are the connections to the 4 pole switch.

Install optional relay voltage regulator

If 12V relays are used in a 24V system an LM7812 regulator may be installed at IC13. If 24V relays are used and a higher voltage relay supply is going to be used (e.g. 30V) then install a 7824 regulator.

Mount a small TO-220 heat sink onto the LM7812 before installing it with a 1/4" 4-40 screw, #4 fiber washer and 4-40 nut. Thermal grease is not required.

Insert the LM7812 or 7824) and heat sink assembly onto the circuit board making sure that the lower edge of the heat sink clears C18. The bottom of the heat sink should clear the top of the PC board by about 0.2".

Solder only the center pin of IC13 making certain that the regulator is mounted square. If you are satisfied with the orientation of the regulator solder the remaining pins. If it is not square re-heat the pin and adjust it.

J8 must be linked for the regulator to supply power to the relay coils. If an external 12V (or 24V) relay supply is used and the on-board regulator is not needed open J8.

Install film capacitors

Install six 220nF (0.22uF) film capacitors at C3, C4 and C8-C11.

Install a single 330nF (0.33uF) film capacitor at C1.

Install a single 68nF (0.068uF) film capacitor at C2.

Note: Do not install the ICs at this time.

Check all solder connections and reheat or re-flow them if necessary

When component leads are trimmed after soldering the solder joint becomes fractured. It is always a good idea to reflow all solder connections after lead trimming while checking for bridges or pins which may have missed being soldered.

If you add solder during this step do so sparingly particularly under IC sockets. Solder can flow through the PC board vias to the underside of the IC socket and cause shorts between pins.

If you prefer to remove the solder flux residue from the PC board now is a very good time to do it.

When you're finished cleaning inspect every joint under magnification.

Install spacers

Install **four** 4-40 threaded hex spacers at the board mounting holes. Place the **four** fiber washers between the PC board and the hex spacer and secure using four 4-40 1/4" screws. Four additional screws and fiber washers are in the bill-of-materials for securing the PC board to the chassis.

Initial Tests

The board should be tested on a power supply before installing the ICs.

Initial DC Tests

Connect a source of bipolar DC power.

If a variable power supply is used, slowly raise the voltage to about +/-15V.

There should be no measurable current draw. If excess current is drawn check the board for solder bridges and correct polarity of D13, D14 and all the electrolytic capacitors.

Check the voltages at pin 7 of IC1-IC4 and IC9-IC10. It should be +15V. The voltages at pin 4 should be -15V.

Check the voltage at pin 8 of IC5-IC8. It should be +15V. The voltages at pin 4 should be -15V.

Check the voltage at pin 6 of IC11 and IC12. It should be +15V. The voltages at pin 5 should be -15V.

Check the relay power supply if it is installed. Connect the +15V supply to Phoenix connector terminal "U." Connect the -15V supply to Phoenix terminal "Relay -." J8 should be linked. Measure the voltage between "Relay -" and "Relay +." It should measure approximately 12V or 24V depending on the voltage regulator installed.

If any of the voltages are out of range look for solder bridges or an un-soldered pin or component lead.

Remove power.

Install the ICS

Install two THAT1246 at IC1 and IC2.

Install four THAT1240 at IC3, IC4, IC9 and IC10.

Install four NJM2114 at IC5-IC8.

Install two THAT1646 at IC11 and IC12.

Offset and Current Draw Tests

Reconnect power.

If a variable power supply is used slowly raise the voltage to about +/-15V.

Measure the DC voltages of the IC pins listed below. No input or output should be pinned to a supply rail.

IC1-IC4, IC9 and IC10 pin 6 should measure less than 10 mV.

IC3-IC6 pins 1 and 7 should measure less than 10 mV.

IC11 and IC12 pins 1 and 8 less than 15 mV.

Measure the voltages across R34 and R35. They should be less than 100 mV indicating a total current draw of less than 100 mA. The typical current draw under no signal conditions is approximately 60 mA.

Signal Tests

The EEQ-12 board has numerous operational and jumper options.

On-board relays allow the EEQ-12 to be soft-bypassed for comparison of processed and unprocessed material, modification of the filter slopes and vertical crossover frequencies.

The first group of tests are made with the relays un-powered. When the EEQ-12 relays are in the un-powered "normally-closed" state, the Inputs route to the Outputs at unity gain through the Mid/Side Encode/Decode active input-output circuitry.

The second group of tests verify proper relay switching of the Side High-pass and Mid All-pass filters.

A signal generator (or DAC output) and level meter (or A/D inputs) are required. The instrument connections may be balanced, un-balanced or a combination of both.

The relay supply for the board should be connected to the +/-15V rails as described in the section "Initial Tests."

Jumper Positions for Test

The jumpers should have been installed in the proper location during assembly. Please confirm in the following steps they are in the correct position.

J1 and J2 installed in the upper position. (Internal MS encoder.)

J3 and J4 installed in the upper position. (Internal MS decoder.)

J5 installed in left-hand position A. (EEQ In on Frequency selection.)

J6 installed. (When 6/12 dB per octave vertical switch not used.)

J7 installed. (When All-pass defeat switch not used.)

J8 installed. (Use internal relay regulator.)

Test the Input-Output and Mid-Side Encoder-Decoder Circuitry

The level adjustments performed here check the board for unity gain signal passage and correct operation of the internal MS Encoder-Decoder.

Tip: It is important to note that when testing an MS Encoder-Decoder that mono test signals do not, by definition, produce a Side signal. Put simply two things cannot be different if they are the same. Test signals in only one channel produce the Side or difference signal needed for internal tests. For this reason pay particular attention when instructed to feed tone into only one channel.

When making level measurements on THAT1646 outputs use a high impedance or

"bridging" (approx. 10KΩ or greater) loading. A THAT1646 loaded in 600Ω will read approximately -0.7 dB less. If a 600Ω load is anticipated in final use, take this into account.

Apply power.

Feed a 0 dBu (775 mV) 1 kHz tone into the Left and Right **Inputs**. The generator can be either balanced or unbalanced. If unbalanced, ground both the G and "-" inputs.

Measure the output level at the Left and Right **Outputs**. If a single-ended unbalanced instrument is used, ground the "-" output. The output levels for both channels should measure 0 dBu.

Remove the tone feeding the Left Channel. Continue feeding tone into the right channel. The Right channel output should continue to read 0 dBu. The Left output should read below -60 dBu typically -70 dBu.

Reconnect tone to the Left channel input and remove tone from the right channel input. The Left channel output should continue to read 0 dBu. The Right output should read below -60 dBu typically -70 dBu.

Verify switching of the Side High-pass and Mid All-pass filters

Make certain that the relay power supply is connected to the audio bipolar supply as described in the "Initial Tests" section.

To activate the various relays the Phoenix terminal for that function is connected to the relay "Com" terminal.

Note: When the relay power is supplied from the bipolar audio supply (for testing) the "Com" terminal is at -15V. The relay supply regulator will either be 12 or 24V higher than the -15V supply. When measured relative to ground, the relay supply will read either -3V (7812 regulator) or +9V (7824 regulator). Keep this in mind when troubleshooting because "Com" is not at ground potential.

Feed a 1 kHz 0 dBu tone into the Left Channel Input. **Do not feed tone into the Right input.**

The Left channel output should read 0 dBu. The right channel output will be very low in level approximately -70 dBu or less.

Methodology: In the next step we will check the Side high-pass filter operation and frequency response both indirectly, at the outputs, and directly at jumper J4.

Lower the generator frequency to 75 Hz while still feeding only the Left channel. Recheck the levels which should be about the same as those measured in the previous step.

Engage the EEQ. Use a short jumper wire to connect between the Phoenix connector "75" terminal and terminal "FC." You should hear relays RY1 and RY2 click. (There should be 12V across D1 and D2.)

The Left channel output should drop to about -1.3 dBu. The right channel output should be about -16.5 dBu.

Measure the level at the center pin of jumper J4. The level should read -9

dBu.

Raise the generator frequency to 150 Hz while still feeding only the Left channel.

Engage the EEQ at 150 Hz. Use a short jumper wire to connect between the Phoenix connector “150” terminal and terminal “FC.” You should hear relays RY1, RY2, RY5 and RY7 click. (There should be 12V across D1, D2, D5 and D7.)

The Left channel output should read about -1.3 dBu. The right channel output should be about -16.5 dBu.

Measure the level at the center pin of jumper J4. The level should read -9 dBu.

Raise the generator frequency to 300 Hz while still feeding only the Left channel.

Engage the EEQ at 300 Hz. Use a short jumper wire to connect between the Phoenix connector “300” terminal and terminal “FC.” You should hear relays RY1, RY2, RY4 and RY6 click. (There should be 12V across D1, D2, D4 and D6.)

The Left channel output should read about -1.3 dBu. The right channel output should be about -16.5 dBu.

Measure the level at the center pin of jumper J4. The level should read -9 dBu.

The following steps check the Side high-pass filter with a 6 dB per octave slope.

Remove shunting link J6. Install a short jumper wire between Phoenix terminal “S6” and “SC.” You should have relays RY1, RY3, RY4 and RY6 engaged. RY2 should be off.

The Left channel output should read about -2 dBu. The right channel output should be about -9 dBu.

Measure the level at the center pin of jumper J4. The level should read -9 dBu.

Re-install the shunt onto J6 and remove the jumper wire between “S6” and “SC.”

In the final steps we check the All-pass filter performance.

The EEQ should have Phoenix terminals “FC” and “300” linked.

Remove linking shunt J7. Relays RY1, RY4 and RY6 should be engaged.

Raise the generator frequency to 3 kHz and feed only the left channel at 0 dBu.

The Left channel output should read about 0 dBu. The right channel output should read approximately -24 dBu.

Install a short jumper between Phoenix terminals “D12” and “DC.” RY2 should click.

The right channel output should decrease from about -24 dBu to about -53 dBu indicating the reduction in cross talk provided by the all-pass filter's phase correction.

Lower the generator frequency to 1.5 kHz and feed only the left channel at 0 dBu.

Set the EEQ to 150 Hz by moving the jumper from "300" to "150."

The Left channel output should read about 0 dBu. The right channel output should read approximately -24 dBu.

Install a short jumper between Phoenix terminals "D12" and "DC." RY2 should click.

The right channel output should decrease from about -24 dBu to about -53 dBu.

Lower the generator frequency to 750 Hz and feed only the left channel at 0 dBu.

Set the EEQ to 75 Hz by moving the jumper from "150" to "75."

The Left channel output should read about 0 dBu. The right channel output should read approximately -24 dBu.

Install a short jumper between Phoenix terminals "D12" and "DC." RY2 should click.

The right channel output should decrease from about -24 dBu to about -53 dBu.

Check the LED Outputs

The EEQ-12 has current-limited LED outputs to indicate the status of the various relays.

The "+" outputs on the Phoenix connector LED group have current-limiting resistors connected to the positive regulated relay supply. The "+" terminal should connect to an LED anode.

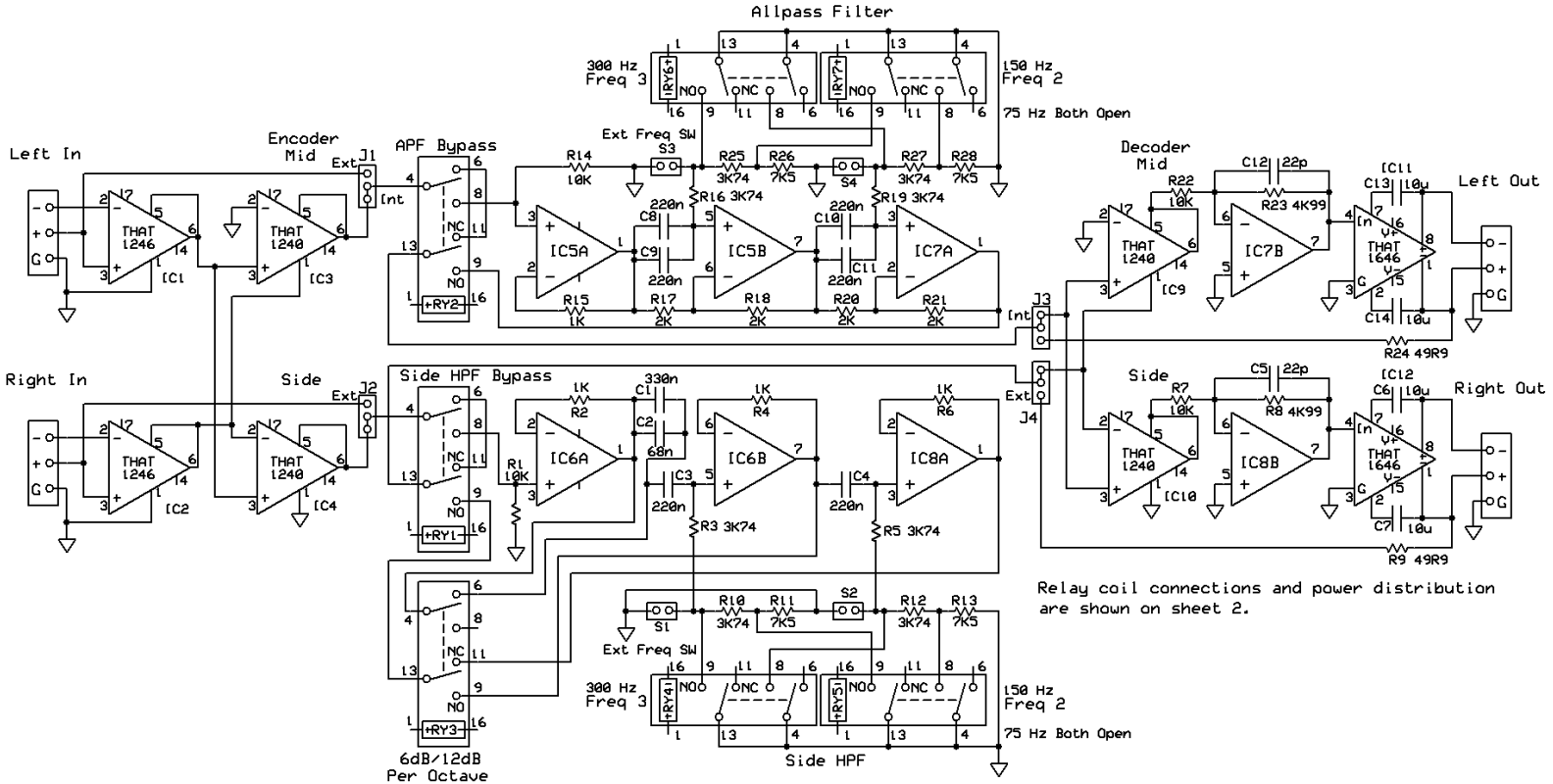
There are connections on the Phoenix connector for the LED cathodes labeled:

EEQ Engaged = EE
All-pass Corrected Second Order EEQ = D12
Single-Order EE = S6

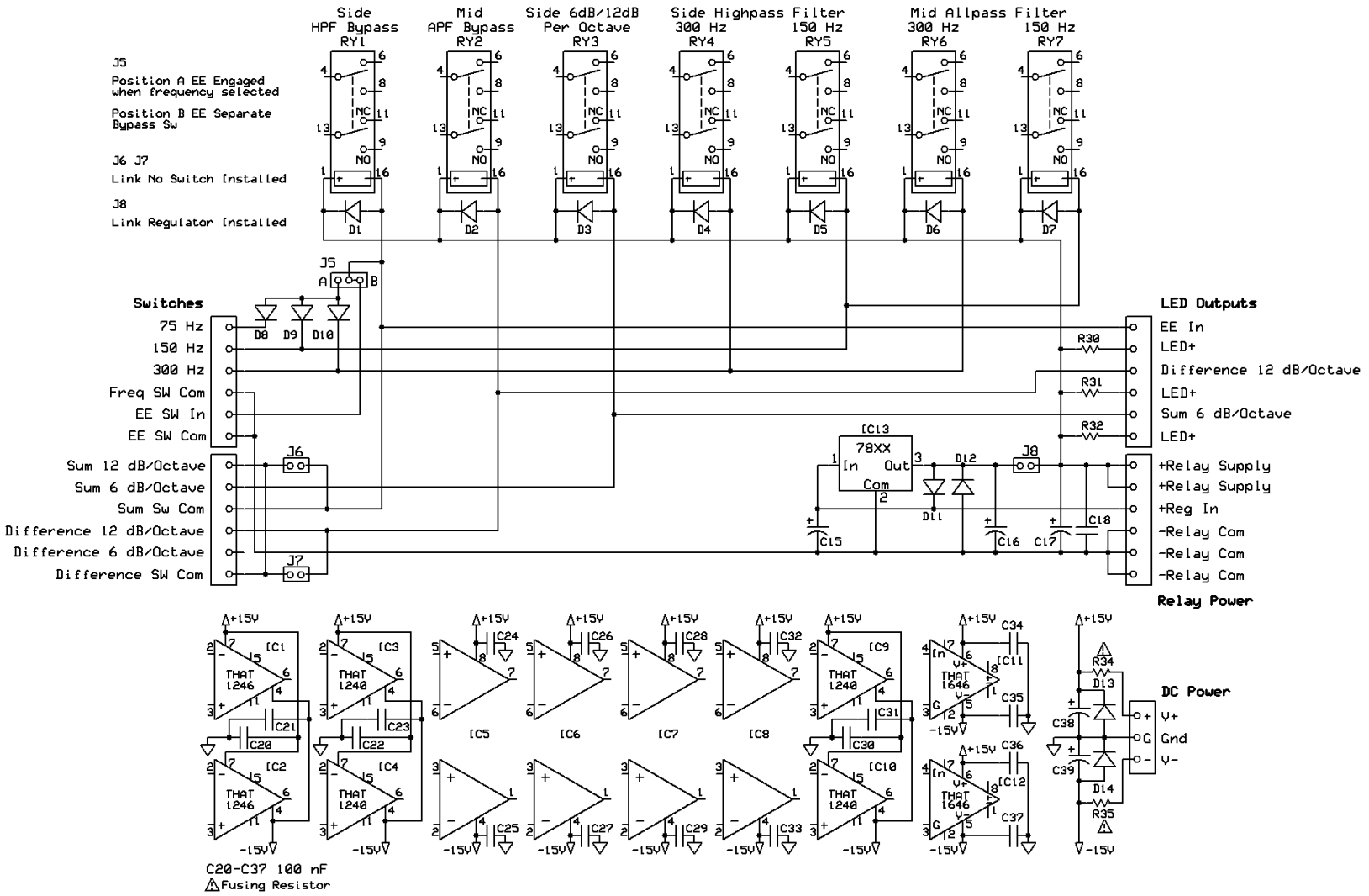
Check each LED output by connecting an LED to the proper terminals and actuating the corresponding function.

This completes functional checkout of the EEQ-12 circuitry.

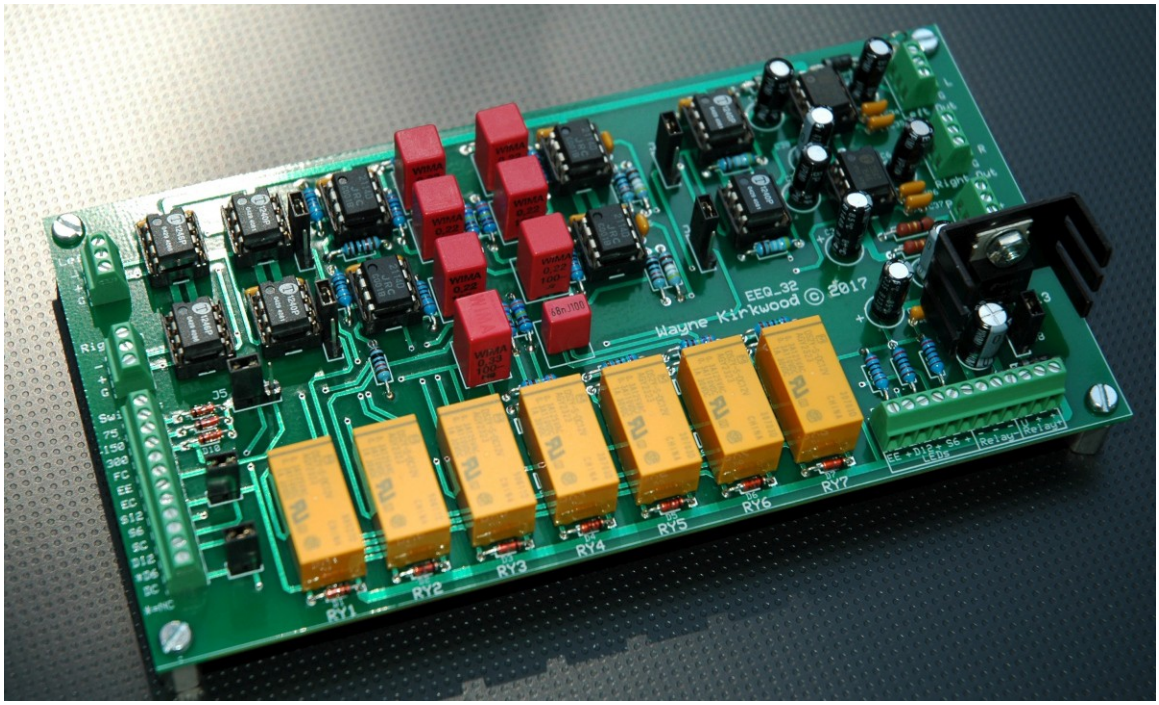
For those that wish to do so we recommend also performing noise and distortion measurements using software-based tools and audio converters. Extended tests should be performed when the unit is installed in a shielded enclosure due to the possibility of fields being picked up by the board's film capacitors and gain switch wiring.



Rockmore Labs		
Elliptic Equalizer 12dB/Oct		
Wayne Kirkwood (c) 2017	Rev 1.2 8/22/2017	Sheet 1 of 2 Audio Flow



Rockmore Labs		
Elliptic Equalizer 12dB/Oct		
Wayne Kirkwood (c) 2017	Rev 1.2 8/22/2017	Sheet 2 of 2 Relay and Power



Completed EEQ-12 Elliptic Equalizer

Detailed Parts List

A complete bill of materials is available from Mouser Electronics:

EEQ-12 BOM with THAT and NJR ICs and 12V relays:
https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=f06782454f

EEQ-12 BOM with THAT and NJR ICs and 24V relays:
https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=470f9f152e

Other Resources

Pro Audio Design Forum EEQ-12 Build Thread:

https://www.proaudiodesignforum.com/forum/php/viewtopic.php?f=7&t=911

EEQ-12 Circuit Description:

https://www.proaudiodesignforum.com/forum/php/viewtopic.php?f=6&t=828&start=46

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