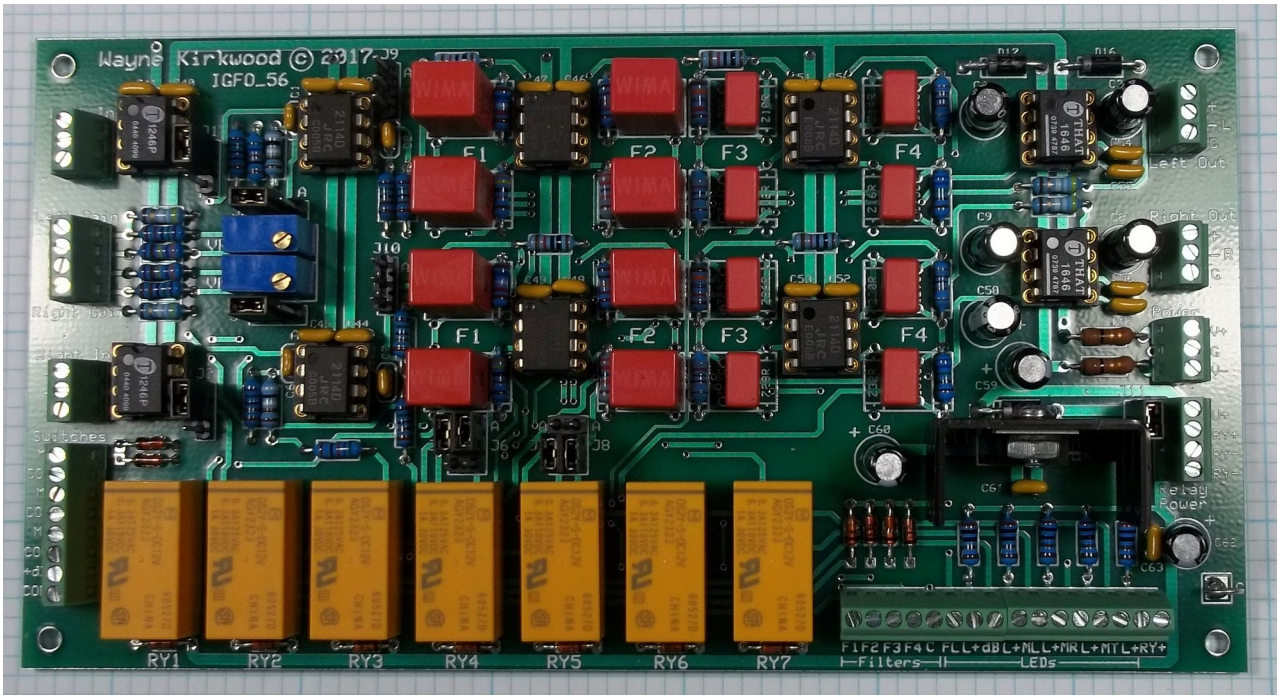
Assembly Instructions for the KA Electronics "IGFO" Input Gain Filter Output Board



IGFO PC Board

Install IC sockets

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

Place **ten** 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 and diodes

Install **eight** 7K5Ω 1% resistors at R1, R4, R7, R8, R11, R14, R17 and R18.

Install **two** 9K09Ω 1% resistors at R2 and R12.

Install **two** 562Ω 1% resistors at R3 and R13.

Install **two** 3K74Ω 1% resistors at R5 and R15.

Install **four** 49R9Ω 1% resistors at R6, R9, R16 and R19.
(R9 and R19 are between IC9 and IC10.)

Install **four** 10KΩ 1% resistors at R20-R23.

Note: If you already know what switch and LED you are using check to see what LED current looks best. The following instructions assume 5 mA current.

Install optional LED current limiting resistors R40–R44. If 12V relays are used, install **five** 2KΩ 1/4W for an LED current of approximately 5 mA. If 24 relays are used install 4K99 1/4W.

Install **two** 1R 1W fusible resistors at R46 and R47.

Install the Filter Frequency-setting Resistors

The MTC-IGFO board offers four stereo pairs of filter frequencies which can be a combination of high-pass and low-pass responses.

Two MTC-IGFO boards can be cascaded to have eight stereo pairs of filters.

A single MTC-IGFO board is usually configured with two high-pass and two low-pass filters.

Two cascaded MTC-IGFO boards are usually configured as four high-pass and four low-pass.

Cascaded MTC-IGFO boards can be assembled which have only the input or output circuitry needed for that board or they can be built with identical input/output circuitry to provide an optional balanced insert point between filter groups.

The filters are configured for high or low-pass response by the placement of the tuning resistors and capacitors.

The filter frequencies are set by the value of the resistors.

The PC board component designation for the filter resistors and capacitors are labeled “Z” rather than the conventional “R” or “C.”

Resistors R24-R39 set the filter frequencies.

The tuning capacitors will be installed in a later step. For most filters and the examples shown use the standard values of 0.33 µF for the high-pass sections (two per filter) and 1000pF/470pF (one each) for the low-pass sections.

In the Appendix there are example instructions for a **single** MTC-IGFO with 20 and 30 Hz high-pass and 22 and 27 kHz low-pass responses.

Note: This document generally describes a single board built with two high-pass and two low-pass filters.

An example of two cascaded MTC-IGFO for vinyl mastering is also shown having values of 20/30/40/50 Hz high-pass and 12/14/16/18 kHz low-pass.

The schematics also contain links to an online calculator for custom filter frequencies.

Please refer to the Appendix and schematic pages 4 and 5 to install resistors R24-R39 and the capacitors.

Install R24-R39 and then return to the following step.

Install diodes

Install **thirteen** 1N4148 diodes at D1-D13. Observe polarity.

Install **four** 1N4004 diodes at D14-D17. Observe polarity.

Install ceramic capacitors

Install **twenty** 100 nF (0.1uF) at C40-C57, C61 and C63.

*Note: On two board cascaded IGFO systems the values of C1 and C6 are different. Install 100 pF for the first board and 22 pF for C1 and C6 on the second.

Install **two** 100 pF at C1 and C6. (22 pF on board #2.)

Install **two** 22 pF at C2 and C7.

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 **eleven** 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. Some shunts also have openings on the sides to retain the internal pins. When shunts are installed side-by-side, make sure the openings are not both on the inside to prevent shorting between shunts.

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 **six** 3 pin headers at J1-J4, J9 and J10.

The shunts on J1-J2 should be in the top “A” position.

Shunts on J3-J4 should be in the left-hand “B” position.

Temporarily put shunts on J9 and J10 in either position. J9 and J10's shunts are used only for special configurations. After soldering, remove J9 and J10s shunts and store them on the top pins so they do not connect to the middle pin.

Install **two** 6 pin headers at J5/J6 and J7/J8.

When installing shunts on J5-J8 make certain that openings on the sides of the shunts point outwards. Otherwise the left and right channels may touch and short together.

Install J5/J6's shunts vertically on the top two pins. (Position A)

Install J7/J8's shunts vertically on the bottom two pins. (Position B)

Install **one** 2 pin header with shunt at J11.

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 Left In, Right In, Left Out, Right Out and Audio Power connector locations.

Note: External gain connections are usually not installed on the second cascaded filter board. Installation of the Phoenix Gain connector is optional on those boards.

Install **two** 4 pin Phoenix connectors at the Gain and Relay Power connector locations.

Install **three** 8 pin Phoenix connectors at the Switches, Filter and LED locations.

Install electrolytic capacitors

Note: The + 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 be installed in four locations. Make certain that you have the right type of capacitor before soldering it.

Install **four** 10uF 35V (or 50V) bipolar electrolytic capacitors at C3, C4, C8 and C9.

Install **two** 47uF 35V polarized electrolytic capacitors at C58 and C59. The polarity of these capacitors are critical.

Install **two** 10uF 50V polarized electrolytic capacitors at C60 and C62. The polarity of these capacitors are critical.

Install film capacitors

Sixteen film capacitors, C20-C35, set the filter frequencies. Please refer to schematic sheets 4 and 5 for the values and the Appendix for the installation locations to be used in your particular configuration.

High pass filter capacitors are usually 0.33 µF. Low pass film capacitors are 1000 pF and 470 pF.

Install C20-C35 according to the Appendix and then return here.

Install the relays

The IGFO can be built as either an input with gain trim or cascaded filter board. The number of relays installed depends on the configuration. In most cases seven relays are installed on the input board and four relays are installed on cascaded filter boards.

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 IC11 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.

For an input board install **seven** relays at RY1-RY7.

For a cascaded filter board, without mute and +5dB gain, install **three** relays at RY4-RY7.

Install trim pots

IGFO boards with input gain trim require calibration of the -5.5 dB step and installation of VR1 and VR2.

Install 500Ω trim pots at VR1 and VR2 with the screw adjustment on the right-hand side.

Install optional relay voltage regulator

If 12V relays are used in a 24V system an LM7812 regulator may be installed at IC11.

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 and heat sink assembly onto the circuit board making sure that the lower edge of the regulator's leads, where they widen, are flush with the board. The bottom of the heat sink should clear the top of the PC board by about 0.1” and may contact the body of D15.

Solder only the center pin of IC11 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.

J11 must be linked for the regulator to supply power to the relay coils. If an external 12V relay supply is used and the on-board regulator is not needed open J11.

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 re-flow 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 and IC2. It should be +15V. The voltages at pin 4 should be -15V.

Check the voltage at pin 8 of IC3-IC8. It should be +15V. The voltages at pin 4 should be -15V.

Check the voltage at pin 6 of IC9 and IC10. 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 "RY-." J8 should be linked. Measure the voltage between "RY-" and "RY+." 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 two NJM2114 at IC3 and IC4.

Install dual op amps at IC5-IC8.

Note: OPA2134s (or other FET-input op amps) must be used in the high pass filters. (IC5 and IC6.) NJM2114 (or NJM5532) should be installed in the low pass filters.

OPA2134s however may be installed in any filter location.

NJM2114 or NE5532 should not be installed in the high pass filter stages because they produce higher offset.

For a PC board consisting of high-pass and low-pass filters:

Install two OPA2134PA at IC5 and IC6.

Install two NJM2114 at IC7 and IC8.

Install two THAT1646 at IC9 and IC10.

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 and IC2 pin 6.

IC3, IC4, IC5, IC6, IC7, IC8 pins 1 and 7.

IC9 and IC10 pins 1 and 8.

Measure the voltages across R46 and R47. 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 66 mA.

Signal Tests

The MTC-IGFO board has numerous routing and jumper options. A schematic is provided at the end of this document.

The first group of tests are made with the relays un-powered. When the MTC-IFGO relays are in the un-powered "normally-closed" state, the Inputs route to the Outputs at unity gain through all of the primary path active circuitry.

The second group of tests verify proper relay switching of the Mute and Gain switches.

A third set of tests check the filters and the filter insert relays.

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 should be in the upper "A" position.

J3 and J4 should be in the left-hand "B" position.

Note: If the jumpers have openings on the side which expose metal, make certain that the exposed sides are pointing outward at J5-J8. Otherwise Left and Right may short together.

J5 and J6 should be vertical in the upper position.

J7 and J8 should be vertical in the lower position.

J9 and J10 should be **stored** with only the top pin inserted into the shunt.

Note: J9 and J10 should only be used if the THAT1646 balanced output stages are not used and removed from their sockets at IC9 and IC10.

J11 should be installed if a 78XX-series regulator is installed at IC11.

Test the Active Circuitry

The level adjustments performed here check the board for unity gain signal passage, operation of the mute and gain relays and low-gain level calibration.

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 level should measure 0 dBu.

Connect as short length of wire from the "R" to the "S" terminals on the Gain Phoenix connector.

Move J3 and J4 to the "A" positions. The output gain should drop about -5.5 dB.

Adjust VR1 and VR2 so that the outputs drop exactly -5.50 dB. If an external gain switch is already installed and it is not set to the lowest position, 0Ω or -5.5 dB, then VR1 and VR2 will have little effect at settings greater than about -4.5 dB.

Move J3 and J4 back to the "B" position. The output level should again read 0 dBu.

Test the Mute and Gain Relays

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

To activate the Mute and Gain 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.

The inputs should be fed with 1 kHz 0 dBu tone.

Check the Mute relay by connecting Phoenix terminal "MT" to "Com." The outputs should mute. Un-mute the output.

Check the individual Left and Right Mute functions by connecting "ML" and "MR" to "Com."

Check the +5 dB Gain relay. Connect the Phoenix terminal "dB" to "Com." The outputs should increase by +5 dB.

Test the Filters and Filter Insert Relays

The first group of filter tests check the filters at 1 kHz within their pass band. This verifies the active stages and filter insert relays.

The filters are engaged by connecting the "F1" through "F4" Phoenix terminals to the "C" terminal.

The following tests are for a MTC-IGFO configured as two high-pass and two low-pass filters. F1 = 20 Hz, F2 = 30 Hz, F3 = 22 kHz, F4 = 27 kHz.

For other configurations of high and low pass or frequency the tests are similar.

J5 and J6 should be in the "A" position and J7 and J8 in the "B" position so that the filters are split into high-pass and low-pass groups.

Filter F1 (or F2) and filters F3 (or F4) may be engaged at the same time to provide a combined high-pass and low-pass response.

If F1 and F2 are both engaged then the highest number filter, F2, is active. The same is also true of F3 and F4.

Feed a 1 kHz 0 dBu tone into both the Left and Right Inputs.

Engage filter F1. The output level should remain constant at 0 dBu within about 0.1 dB.

Dis-engage filter F1 and repeat the step above for filters F2-F4. The output level should remain relatively constant.

Test the Filter Cutoff Frequencies

Feed a 20 Hz 0 dBu tone into both the Left and Right Inputs.

Engage filter F1. The output level should drop by about -3 dB. Disengage filter F1.

Feed a 30 Hz 0 dBu tone into both the Left and Right Inputs.

Engage filter F2. The output level should drop by about -3 dB. Disengage filter F2.

Feed a 22 kHz 0 dBu tone into both the Left and Right Inputs. Note: This may require a signal generator.

Engage filter F3. The output level should drop by about -3 dB. Disengage filter F3.

Feed a 27 kHz 0 dBu tone into both the Left and Right Inputs. Note: This may require a signal generator depending on your D/A converter and the chosen sample rate.

Engage filter F4. The output level should drop by about -3 dB. Disengage filter F4.

Check the LED Outputs

The MTC-IGFO has current-limited LED outputs to indicate the status of the various relays.

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

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

Mute Left = ML
Mute Right = MR
Mute Both = MT

Gain = +dB
Filter On = FL

FL lights when any filter relay is engaged.

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

This completes functional checkout of the MTC-IGFO 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.

Appendix-A Single MTC-IGFO board. Install the filter frequency-setting components.

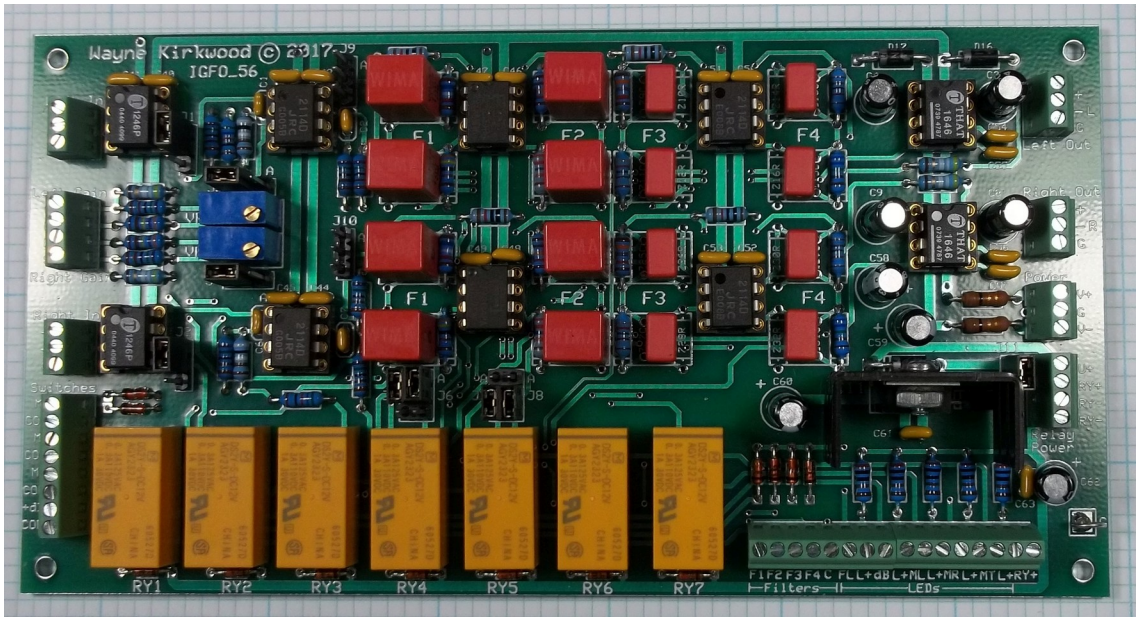
MTC-IGFO board configured with 20 and 30 Hz high-pass and 22 and 27 kHz low-pass filters

In the first step we will install resistors R24-R39 in locations labeled "Z#R."

Refer to the photograph and the PC board stuffing diagram to make certain that you are not installing resistors where a capacitor will eventually need to be placed.

If necessary, use an un-soldered capacitor as a temporary place holder when you install the first set of resistors to provide an example of how the placement is supposed to work.

For example: When a capacitor is installed at Z1C for high-pass it will cover-up Z1R which is not used. Z2R, which is required, will be open so a resistor may be inserted. For low-pass, when a capacitor is installed at Z10C, Z10R is not used.



MTC-IGFO board configured with 20 and 30 Hz high-pass and 22 and 27 kHz low-pass filters.

The following installs the high-pass filter resistors around IC5 and IC6.

Install two 16K9 1% in locations Z2R and Z18R.

Install two 34K0 1% in locations Z4R and Z20R.

Install two 11K3 1% in locations Z6R and Z22R.

Install two 22K6 1% in locations Z8R and Z24R.

The next group of resistors are for the low-pass filters located around IC7 and IC8.

Install two 13K7 1% in locations Z9R and Z25R.

Install two 8K25 1% in locations Z11R and Z27R.

Install two 11K 1% in locations Z13R and Z29R.

Install two 6K65 1% in locations Z15R and Z31R.

This completes installation of the filter-setting resistors.

Return to the main assembly instructions “Install Diodes” and complete all of the remaining steps up to the installation of the filter's film capacitors.

When the instructions ask you to return, complete installation of the capacitors. Do not install the film capacitors at this time.

After the electrolytic capacitors have been installed in the main instructions the film capacitors for the filters may be placed.

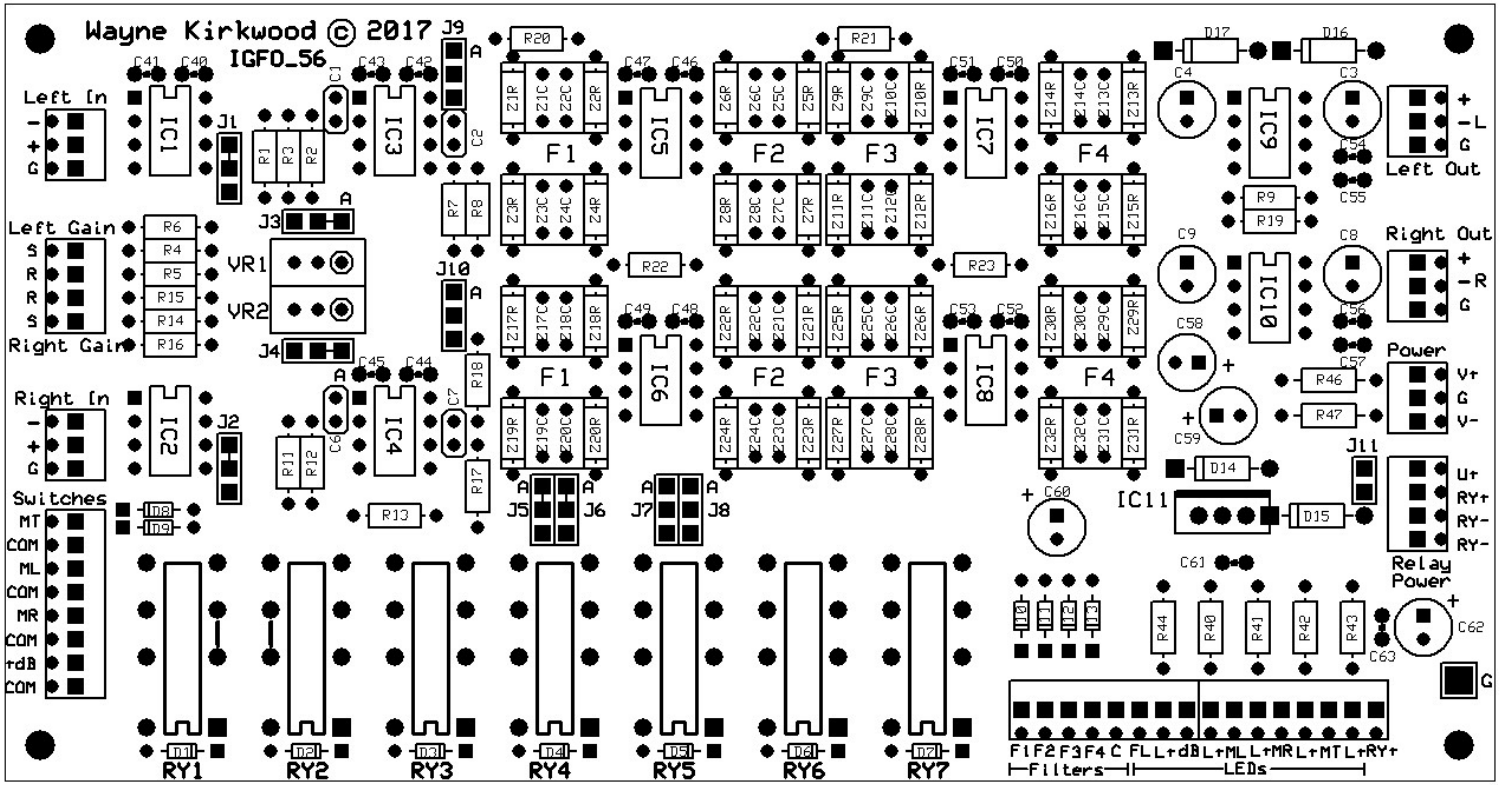
Install Filter Film Capacitors

Install eight 0.33 µF film capacitors at Z1C, Z3C, Z5C, Z7C, Z17C, Z19C, Z21C and Z23C.

Install four 1000 pF film capacitors at Z10C, Z14C, Z26C and Z30C.

Install four 470 pF film capacitors at Z12C, Z16C, Z28C and Z32C.

This completes installation of the filter frequency-setting capacitors. Please return to the main installation instructions to complete assembly.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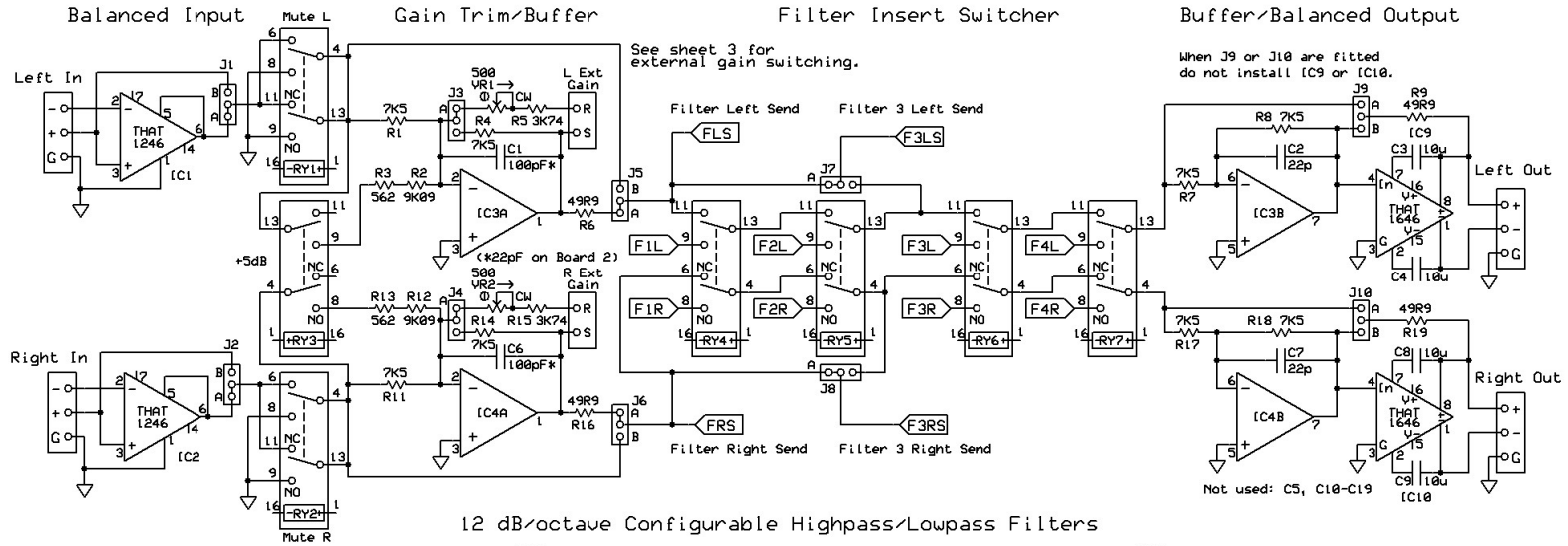
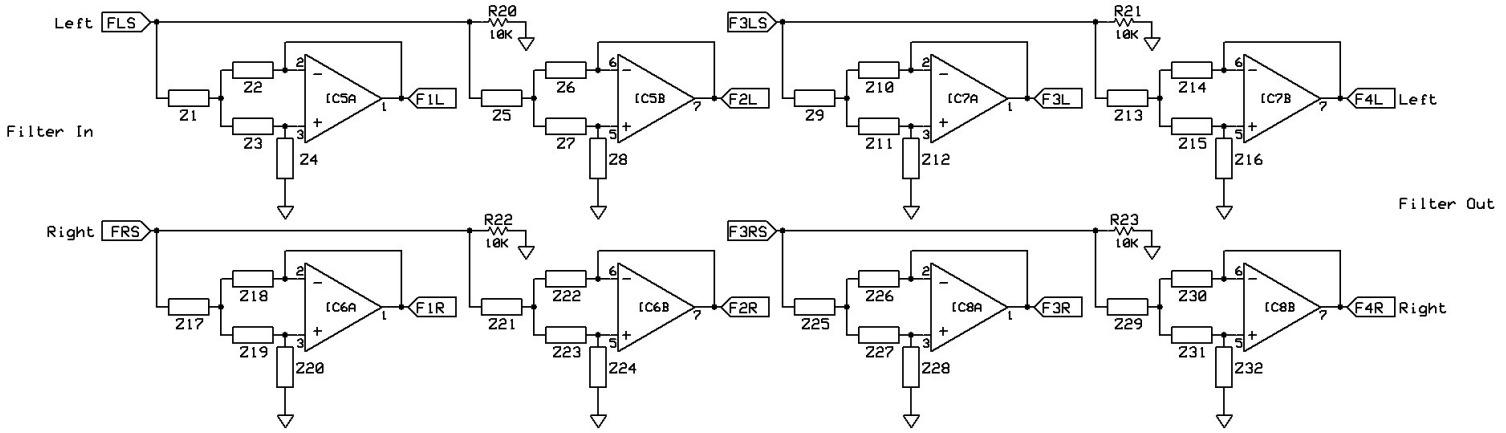
IGFO_56
Left In
Left Gain
Right Gain
Right In
Switches
MT
COM
ML
COM
MR
COM
rdB
COM
VR1
VR2
F1
F2
F3
F4
IC1
IC2
IC3
IC4
IC5
IC6
IC7
IC8
IC9
IC10
IC11
RY1
RY2
RY3
RY4
RY5
RY6
RY7
Left Out
Right Out
Power
Relay Power
F1 F2 F3 F4 C FL L+dB L+ML L+MR L+MT L+RY+
Filters
LEDs

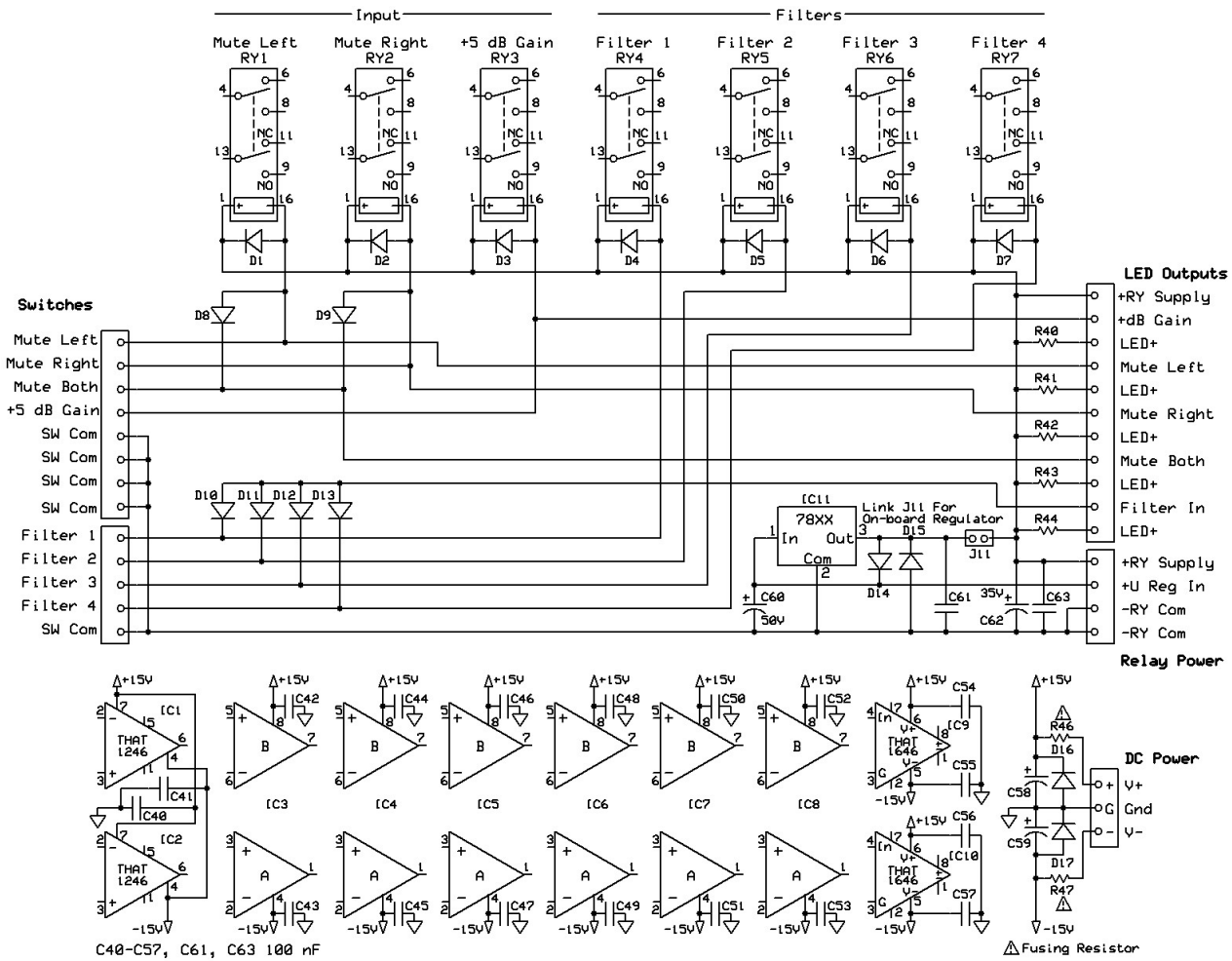


12 dB/octave Configurable Highpass/Lowpass Filters

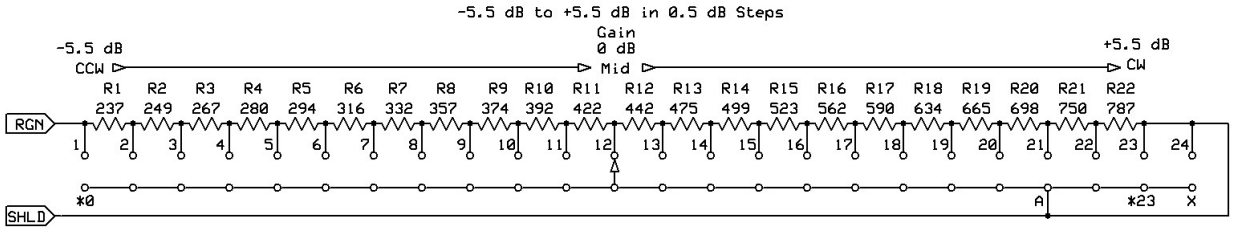


Z1-Z32: See sheets 4 and 5 for one and two board configurations and typical component values.
C20-C39 R20-R39 reserved for filters.

Rockmore-Labs		
MTC Input-Filter-Output		
Wayne Kirkwood (c) 2018	Rev 1.1 1/7/2018	Sheet 1 of 5

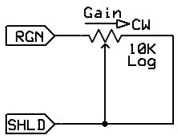


Rockmore Labs		
MTC Relay, LED and Power		
Wayne Kirkwood (c) 2018	Rev 1.1 1/7/2018	Sheet 2 of 5 Relay and Power



From R and S Terminals on Sheet 1
Use shielded cable. Connect shield to switch commutator.

Elma Type 04 24 Pos 15 Degree Shorting Contacts.
* For -5.5 to +5.5 dB Range Install mechanical stop screws at openings 0 and 23.
* For -5.0 to +5.0 dB Range Install mechanical stop screws at openings 1 and 22.
X Position 24 not used.
Shown in center position.
Total Resistance: 10.145K Ohms.



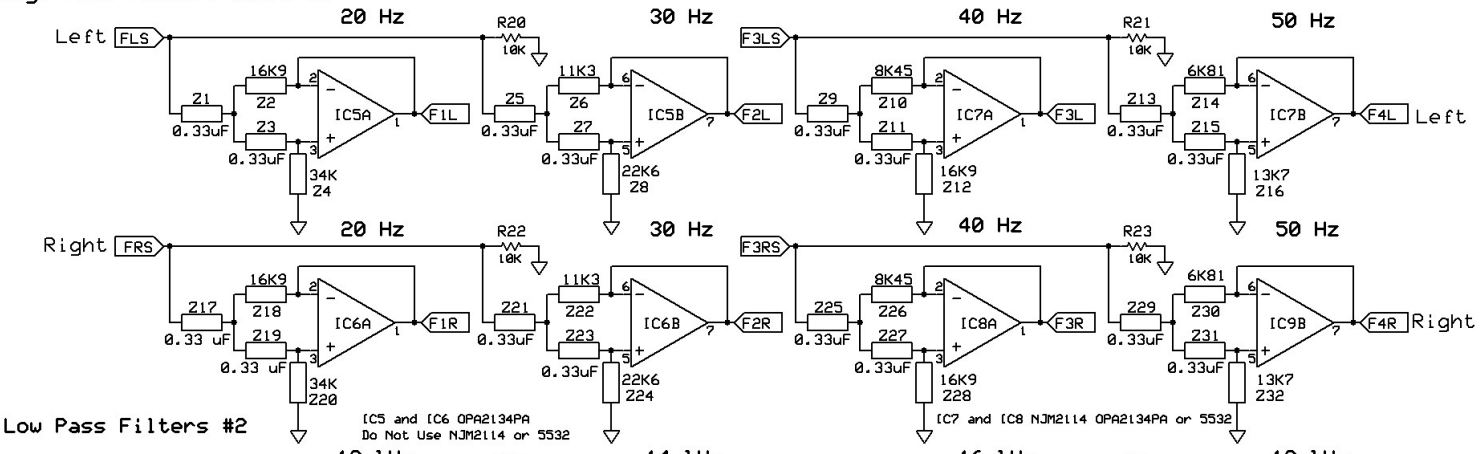
Equivalent Circuit

Rockmore-Labs		
MTC Input Gain Trim Switch		
Wayne Kirkwood (c) 2018	Rev 1.0 1/7/2018	Sheet 3 of 5

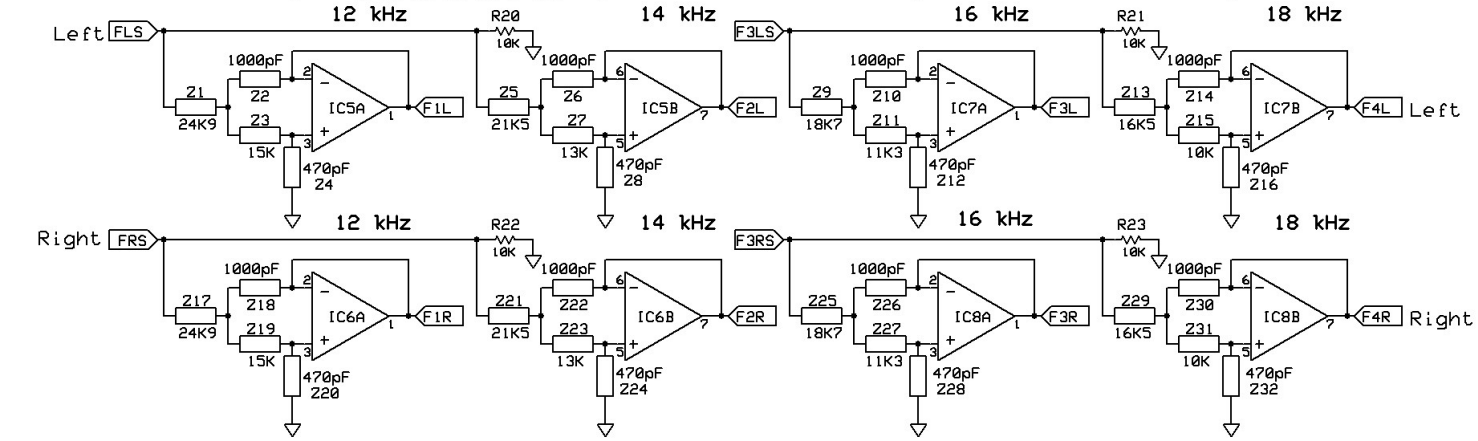
Example of High Pass/Low Pass Filters on Two Cascaded Boards

Set J8 to A Position to Parallel Feed Filters

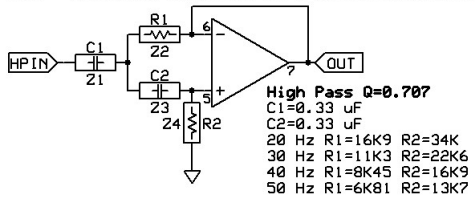
High Pass Filters Board #1



Low Pass Filters #2

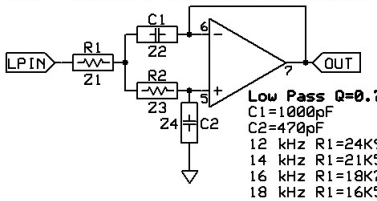


http://sim.okawa-denshi.jp/en/OPseikiHikeisan.htm



High Pass Q=0.707
C1=0.33 uF
C2=0.33 uF
20 Hz R1=16K9 R2=34K
30 Hz R1=11K3 R2=22K6
40 Hz R1=8K45 R2=16K9
50 Hz R1=6K81 R2=13K7

http://sim.okawa-denshi.jp/en/OPseikiLowkeisan.htm



Low Pass Q=0.707
C1=1000pF
C2=470pF
12 kHz R1=24K9 R2=15K
14 kHz R1=21K5 R2=13K
16 kHz R1=18K7 R2=11K3
18 kHz R1=16K5 R2=10K

Rockmore-Labs		
MTC Filter Examples		
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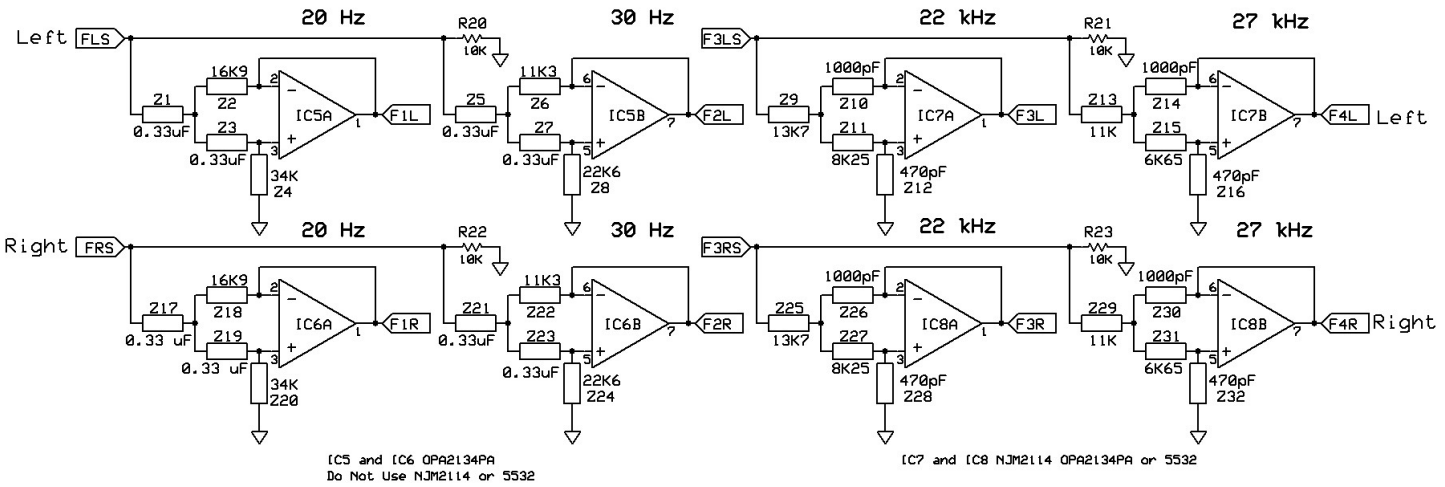
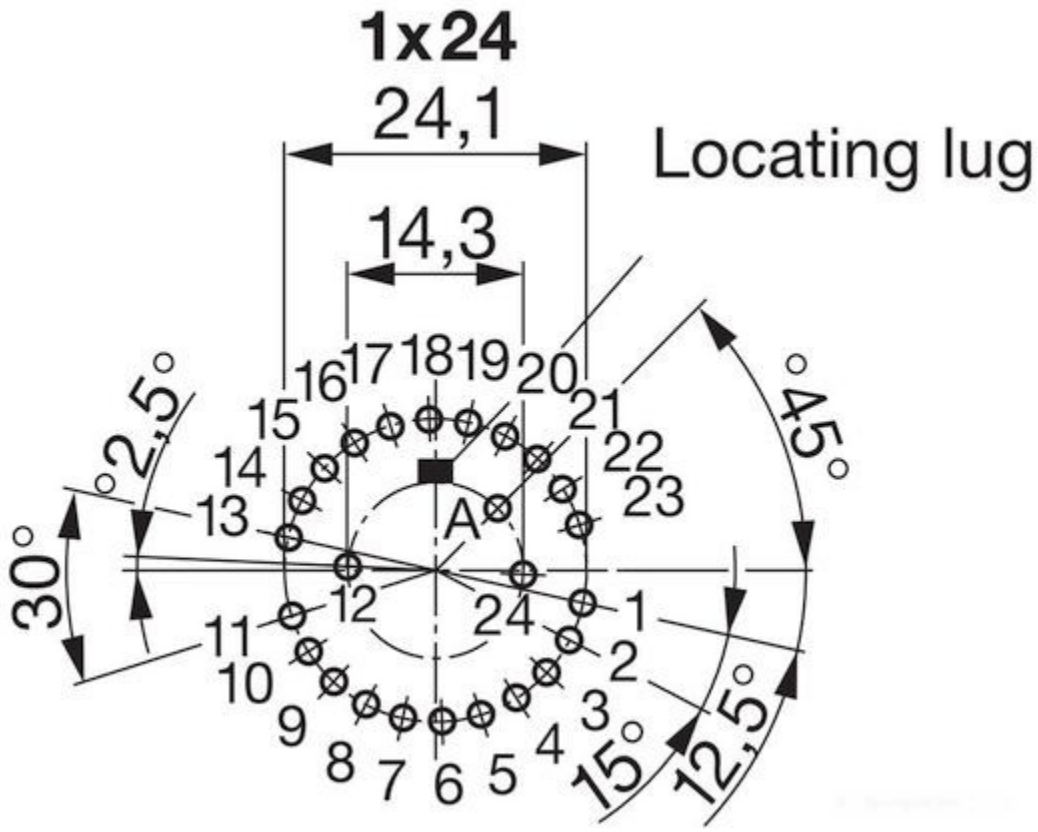
Example of High Pass/Low Pass Filters on One Board

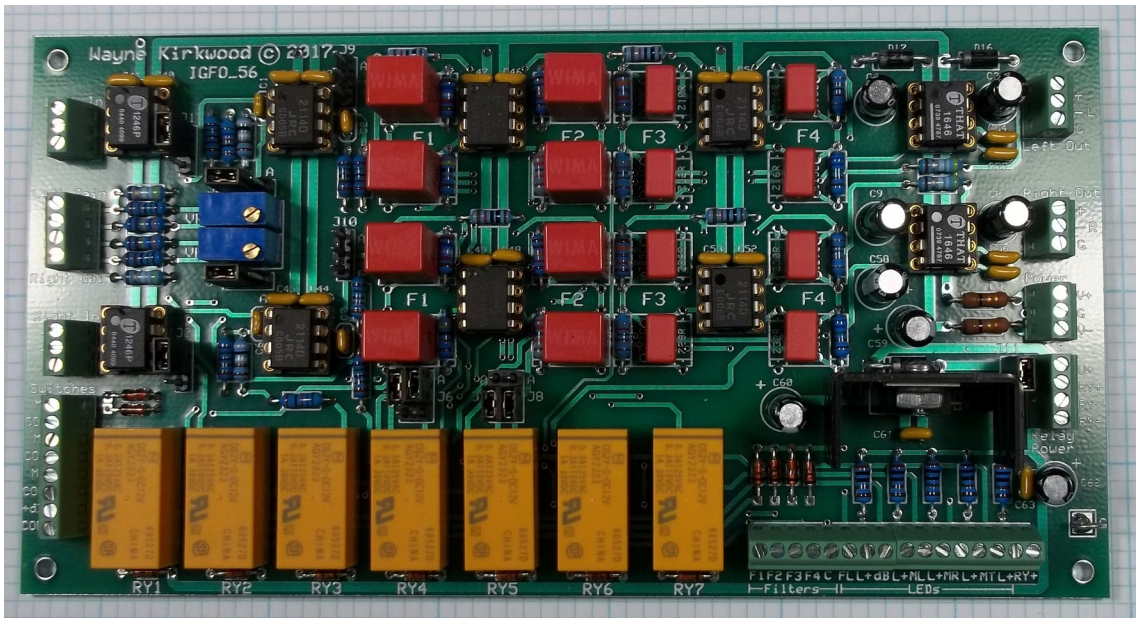
Set J8 to B Position to Cascade Filters



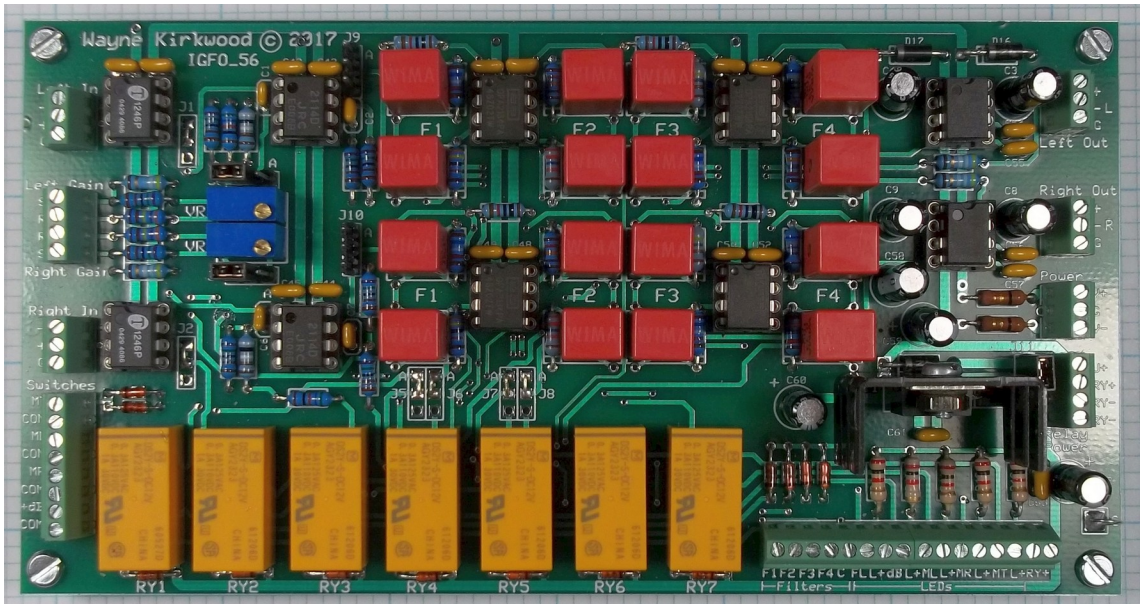
Rockmore-Labs		
MTC Filter Examples		
Wayne Kirkwood (c) 2018	Rev 1.1 1/7/2018	Sheet 5 of 5



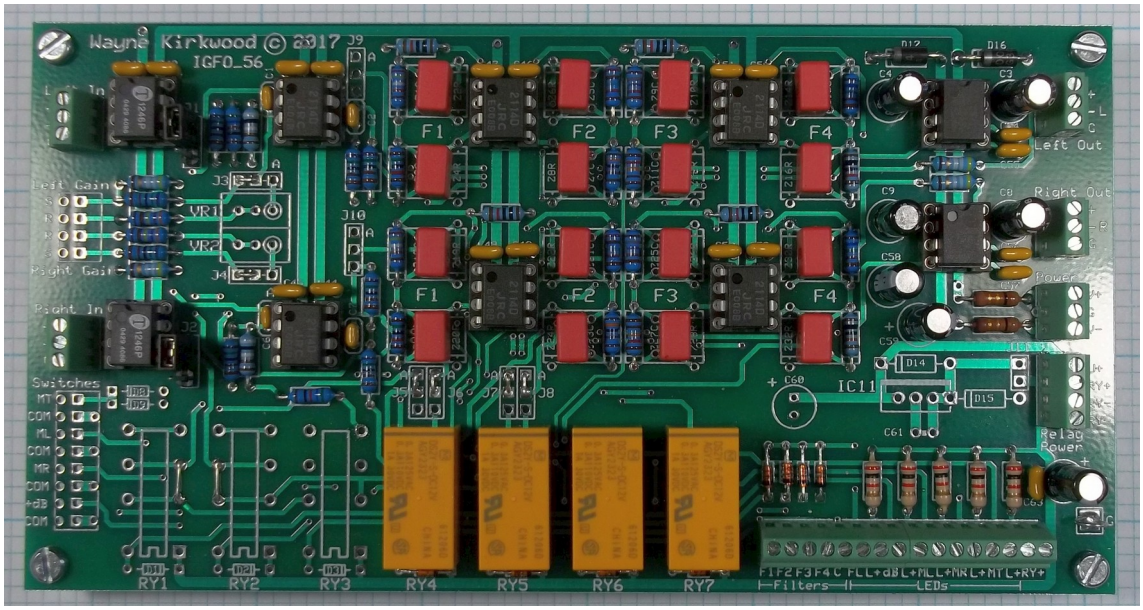
Elma Switch Pin out



IGFO Single Board, 20, 30 Hz HPF, 22, 27 kHz LPF.



IGFO Input Board, 20, 30, 40 50 Hz HPF.



IGFO Cascaded Filter Board for Vinyl, 12, 14, 16, 18 kHz HPF.