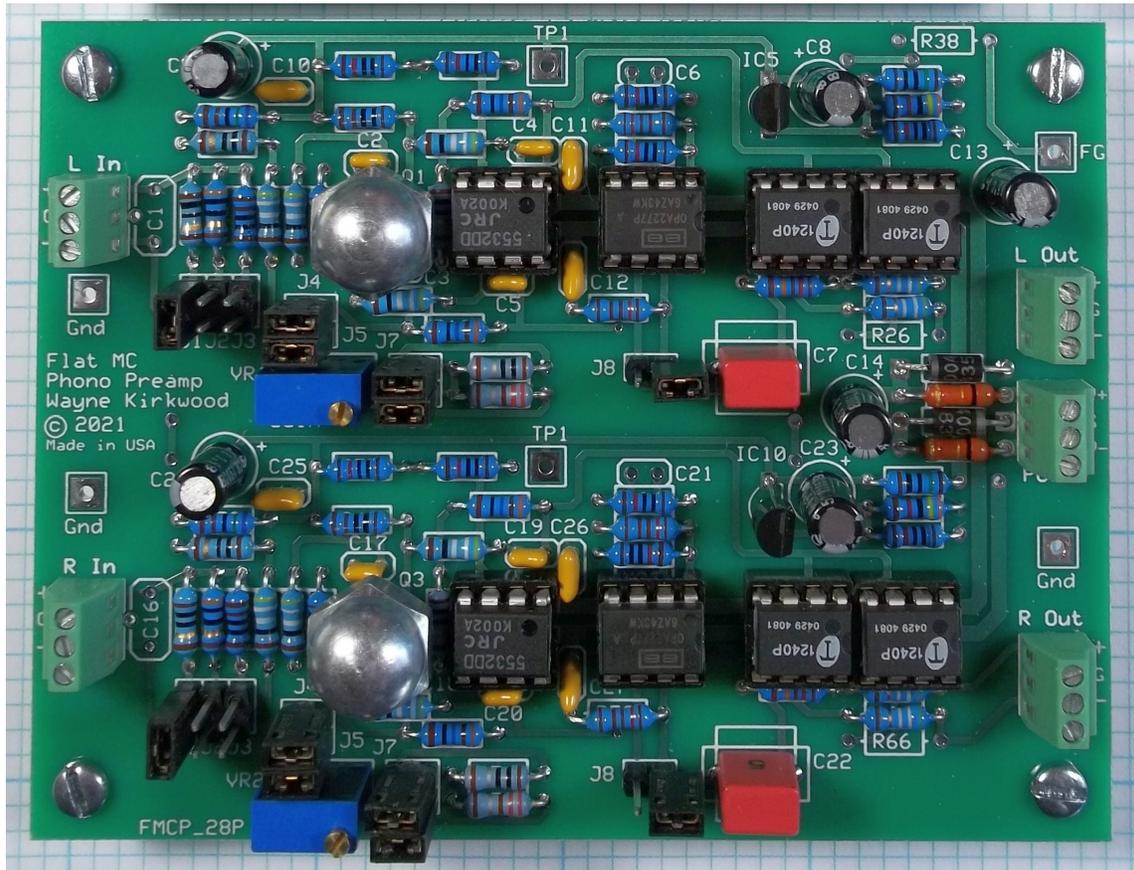


Assembly Instructions for the KA Electronics Flat MC Phono Preamplifier

FMCP-28 1/26/2022



Flat MC Phono Preamp PC Board

Install IC sockets

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

Place 8 IC sockets (8 pin) into their respective locations. Observe orientation of the notch which should point to the right with the PC board oriented as shown above. Verify that socket IC1 and IC6 are not inserted into the capacitor holes.

Lift the board up and place a small piece of cardboard the same approximate size as the PC 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. With the sandwich held in place flip the board over to the solder side.

Tack solder only two of the corner IC pins.

Once all the IC sockets are tack soldered in place on two pins, flip the board over to the component side. Make certain that each socket is correctly oriented, fully seated on the board and square.

If you're satisfied with the positioning of the sockets, solder all of the remaining pins.

Visually check each pin's connection particularly those to the ground plane. Reheat any pins if needed.

Install resistors and diodes

In some of the following steps you will be asked to install "ratio matched" resistors to maximize common mode rejection and reduce even-order distortion. The resistors are installed in matched pairs.

To ratio match resistors pick one, measure it with an Ohmmeter, and then find another resistor that is the same exact (or nearly so) value. It is not important that the resistors be near the ideal "absolute" value, only that they are nearly-identical values. Chose a meter range that will provide the maximum number of digits. To provide consistent readings make certain that the test and resistor leads are clean. Do not shunt the resistor with your fingers by holding the leads because your skin resistance will affect the measurement. If you have difficulty finding a match for the reference resistor chose another one and repeat the selection process.

Install four 10 Ω 1% resistors at R1, R33, R41 and R73.

Install two 30 Ω 1% resistors at R2 and R42.

Install two 110 Ω 1% resistors at R3 and R43.

Install two matched 499 Ω 1% resistors at R4 and R5.

Install two matched 499 Ω 1% resistors at R8 and R9.

Install two matched 499 Ω 1% resistors at R44 and R45.

Install two matched 499 Ω 1% resistors at R48 and R49.

Install two matched 1K Ω 1% resistors at R6 and R7.

Install two matched 1K Ω 1% resistors at R46 and R47.

Install four 1 Ω 1% metal film resistors at R10, R11, R50 and R51. These are metal film precision resistors, not the 1 Ω 1W metal oxide fusible resistors that will be installed in a later step.

Install two 2.21 Ω 1% resistors at R12 and R52.

Install two matched 316 Ω 1% resistors at R13 and R14.

Install two matched 316 Ω 1% resistors at R53 and R54.

Install ten 10K Ω 1% resistors at R15, R16, R24, R25, R30, R55, R56, R64, R65, and R70.

Install two matched 1K21 Ω at R19 and R20.

Install two matched 1K21 Ω at R59 and R60.

The preamp can be configured for "line level" output or "head amp" low-level output.

For line level output: Install four 49.9 Ω 1% resistors at R21, R22, R61 and R62. Do not use R26 and R66.

For head amp level output: Install four 2K4 Ω resistors at R21, R22, R61 and R62. Install two 100 Ω resistors at R26 and R66.

Install two 121K Ω 1% resistors at R23 and R63.

Install two 34K Ω 1% resistors at R31 and R71.

Install two 7.5K Ω 1% resistors at R32 and R72.

Install two 150 Ω 1% resistors at R34 and R74.

Install two 1 Ω 1W fusible resistors at R36 and R37. (These fusible resistors are metal film 1W resistors in a 1/4W size.)

Note: Component designations R17, R18, R35, R57 and R58 are not used.

Note: You will have several resistors left over. The 4K99 Ω resistors will be used in final test.

Install two 1N4004 diodes at D1 and D2. Observe polarity.

Install ceramic capacitors

In some of the following steps you will be asked to install matched 220 pF capacitors. These capacitors can be supplied as a kit with the matched transistors, they can be matched using loose tolerance parts by the builder using an RLC meter or 1% values can be installed as shown in the BOM. If only 5% values are available it is also possible to trim R8/R9 and R48/R49 by padding them in final test to compensate for capacitor tolerance.

Install four 220 pF ceramic capacitors at C2, C3, C17 and C18.

Install two matched 220 pF ceramic capacitors at C4 and C5.

Install two matched 220 pF ceramic capacitors at C19 and C20.

Install six 100 nF (0.1 μ F) at C10, C11, C12, C25, C26 and C27.

Note: C6 and C21 not used.

Install jumper headers

Before soldering the headers, install jumper shunts onto the pins. The shunts serve as insulators which allows you to position them while soldering without burning your fingers.

When installing the jumpers, 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.

Note that the left and right channels use the same jumper designations and the instructions for installing them should be repeated for both channels.

You will need twelve shunts to install on the headers.

Install two 6 pin headers in J1-J3. Link J2 with a shunt while soldering and keep it installed.

4 pin headers are used for jumpers J4/J5 and J6/J7.

There are four headers in the following step because there are two channels.

Install two shunts on each 4 pin header. Orient the shunts so that when installed they are horizontal as shown in the assembly photo. When installing shunts on the 4 pin headers make sure that the openings in the side of both shunts are pointing outwards. (If both are inside they can short together.)

Install four 4 pin headers at J4/J5 and J6/J7.

Install two 2 pin headers at J8. After soldering remove the shunt and install it in the "stored" open position. (Only one pin inserted.)

Install electrolytic capacitors

Note: The + (positive) terminals for the electrolytic capacitors have a square pad.

Install six 47 μ F 35V at C8, C9, C13, C14, C23 and C24. The polarity of these capacitors are critical.

Install Phoenix three pin connectors

When installing the Phoenix connectors make sure that the wire openings point to the outside edge of the PC board.

Install five 3 pin Phoenix connectors on the PC board.

Install Trim Pots

Preamp final test is simplified if the gain pots are preset to a known value. Orient the pot before soldering it so that the screw adjustment is on the right and the leads are facing you.

With an Ohmmeter measure the resistance between the middle and left pin. Due to the low Ohm measurement make sure that you measure and subtract out any lead resistance.

Adjust two trim pots to 13 Ω . Clockwise rotation decreases the value.

Install two 20 Ω Ohm trim pots adjusted to 13 Ω at VR1 and VR2. The screw adjustment should be on the right-hand side.

Note: These may not be the best gain settings for the final preamp but provide a known gain of +40 dB for electrical test.

Install Input Transistors and Shunt Regulators

When installing the transistors and regulators fan the two outside leads slightly to increase their lead pitch to 0.1 inches. The bottom of the device case, when installed, should be about 0.3" off the surface of the PC board.

Install two TL431 shunt regulators at IC5 and IC10. Be careful to observe device orientation.

In the following steps two pairs of matched devices are installed in Q1/Q2 and Q3/Q4. To match transistor pairs follow the steps in the appendix.

Q1/Q2 and Q3/Q4 are installed back-to-back to improve thermal tracking. The long flat sides should be touching each other with the rounded corners of the TO-92 "E-Line" profile on the outside.

In a later step, the two transistors will be bonded together with epoxy and common "acorn" nut glued on top of them. When Q1/Q2 and Q3/Q4 are installed make certain that the two devices are at identical height off the board and precisely aligned with one another.

Install Q1/Q2 and Q3/Q4.

Install film capacitors

Install two 68 nF film capacitors at C7 and C22.

C1 and C16, not in the BOM, can be used for capacitive termination or RF filtering. In most cases they are not required.

Note: Do not install the ICs at this time.

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

It is recommended that the PC board be stripped and cleaned of flux. When removing flux make sure that areas near the input IC and its components are very clean and that no flux bridges exist that could, under some conditions, make the input noisy. Acetone used sparingly on a Q-tip works well but make sure that it does not contact any plastic on the top side of the PC board or contaminate the IC sockets, jumpers and trim pots.

Initial Tests

In this section DC and signal tests check basic functionality. Final gain setting will be required when the preamp is installed and connected to a cartridge.

You will need a DC voltmeter capable of reading mV levels and a source of DC power to perform the following tests.

DC Tests

Connect a source of bipolar DC power.

Ground is in the middle of the three pin power connector. Observe polarity.

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

There should be a current draw, about 55 mA from the TL431 regulators. If high current is drawn stop immediately and check the board for solder bridges and for correct polarity of D1, D2, C8, C9, C13, C14, C23 and C24. If all is well, then proceed.

Check the voltages at pin 8 of IC1, IC2, IC6 and IC7. They should be +15V. The voltages at pin 4 should be -15V.

Check the voltages at pin 7 of IC3, IC4, IC8 and IC9. They should be +15V. The voltages at pin 4 should be -15V.

If the voltages are correct on some pins but absent on others check to make sure the IC socket pins were actually soldered.

Read the DC voltages from ground to TP1 on both channels. The voltage at TP1 should be $11V \pm 0.25V$.

Temporarily remove power.

Install the ICS

Install two NJM5532 ICs at IC1 and IC6.

Install two OPA2277 ICs at IC2 and IC7.

Install four THAT1240 (INA134) ICs at IC3, IC4, IC8 and IC9.

Install the jumper links

The jumper designations for the left and right channels are identical. When instructed to install or remove a jumper do it on both channels. Many of the jumpers will have been installed during assembly.

Confirm the following:

J1 linked. (Terminate 10 Ω .)
J2 open.
J3 open.
J4 linked.
J5 linked. (Variable low gain.)
J6 linked. (Gain 2.2 Ω .)
J7 linked. (Gain 1 Ω .)
J8 open, with shunt stored on one pin. (Servo on.)

Operating Current, Voltage and DC Offset Tests

Reconnect power.

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

Measure the DC voltage drop across R36 and R37.

The voltage drop across R36 should be about 50 mV indicating a current draw of 50 mA.

The voltage drop across R37 should be about 75 mV for a current drain from the positive supply of about 75 mA.

Measure the DC voltages relative to ground at pins 2 and 6 of IC1 and IC6. The voltages should read approximately +5.5 V.

Measure the DC voltages relative to ground at pins 1 and 7 of IC1 and IC6. The voltages should read approximately -2.48 V.

Measure the DC voltages relative to ground at pin 6 of IC3, IC4, IC8 and IC9. The voltages should read 0V \pm 10 mV.

Measure the DC voltage between the Left Balanced Output + and - terminals. The voltage should read 0V \pm 5 mV, typically less than 2 mV.

Tip: To probe the Phoenix connector's top screw its sometime necessary to tighten the screw so it makes good contact.

Link J8 on the left channel to defeat the left channel servo. Measure the DC voltage between the Left Balanced Output + and - terminals. The voltage should rise significantly to several volts or more indicating proper operation of the servo when the link is open.

Restore operation of the servo by removing the link on J8. Store it on one pin so that it is open but available. Recheck the output offset.

Repeat the above procedure for the right channel.

If the voltages above are out of range check the board to make sure that the proper resistor values are installed and that there are no solder bridges or bad connections. Also check for proper IC installation and orientation of Q1-

Q4 and IC5 and IC10.

Check the Input Common Mode and Differential Bias Currents

The input common mode and differential bias currents are measured indirectly by reading the offset voltages developed across the bias resistors.

Remove the shunt on J1. J2 and J3 should also be open.

Make certain that J8 is not linked with the shunt stored only on one post.

Measure the "common mode" DC voltage from ground to the Left Balanced Input + and - terminals. The voltage from the + input to ground, or the - input to ground, should range from -15 mV to + 5 mV.

Repeat the above test for the Right Channel.

Measure the "differential" DC voltage between the Left Channel Balanced Input + and - terminals. The voltage should be less than ± 1 mV.

Install J1 and read the differential voltage. It should be $\ll 1$ mV quite likely in the tens of μ V.

Repeat the above test for the Right Channel.

Note that the common mode input voltage ranges from -15 mV to +5 mV but the differential voltage and input offset current, which is what the cart sees due to a balanced input, is very low. The bias current, I_b , can be up to 50 μ A, but the input offset current, I_{os} , is quite low typically < 1 μ A.

This completes assembly and DC tests.

Signal Tests

You will need an Ohmmeter, an AC-Voltmeter with a balanced and/or floating input (or DVM) capable of reading dBu (preferred) or AC mV, a signal generator with a balanced output and a source of DC power. If a balanced output generator is not available you can use the outputs of the RIAA EQ monitor switcher to balance the generator.

Before beginning this section, please make sure that the Gain trim pots have been adjusted to 13 Ω . If they have not been preset and need to be trimmed in-circuit, make sure that the Ohmmeter's lead resistance is subtracted out.

Signal Test Connections

Install two 4K99 resistors in series with the + and - Inputs. Make certain J1 is linked. When the two 4K99 series resistors are combined with the 10 Ω termination a -60 dB U-pad is formed.

Connect a source of bipolar DC power.

Check jumper installation. J1, J4, J5, J6 and J7 should be installed. J8 should be open.

The following instructions apply to both the left and right channels. Perform the steps for the left channel from beginning to end, then repeat them for the right channel. This reduces test lead movement and speeds testing.

Adjust Generator Level

Connect a balanced signal generator to the 4K99 Ω resistors connected in series to "+" and "-" inputs.

If a balanced signal generator is not available, use the monitor outputs of an RIAA EQ Monitor Switcher PC board. (It also possible to use the second channel of the Moving Coil Preamp as a signal balancer.)

Set the generator to 1 kHz at 0 dBu. (775 mV RMS)

Measure and Adjust Balanced Output Levels

Connect a floating AC voltmeter to read the voltage between the Balanced Output + and - terminals.

With J4, J5, J6 and J7 linked the output level should read approximately +1.6 dBu indicating a gain of +61.6 dB. ("+62" dB gain.)

Remove J5 and adjust the Gain trim pot, VR1 to read -20 dBu. This is a gain of +40 dB. Reinstall J5.

Remove J6. The output level should be approximately -8.4 dBu for a gain of +51.6 dB. ("+52" dB gain.) Reinstall J6.

Remove J7. The output level should be approximately -4.3 dBu for a gain of 55.7 dB. ("+56" db gain.) Reinstall J7.

Check the Servo High Pass Response

Connect a floating AC voltmeter to read the voltage between the Balanced Output + and - terminals.

Set the generator to 1 kHz at 0 dBu. (775 mV RMS)

With J4, J5, J6 and J7 linked reduce the generator level so that the output level reads approximately 0 dBu.

Read the generator level and make a note of its value. (It should be about -1.6 dBu.)

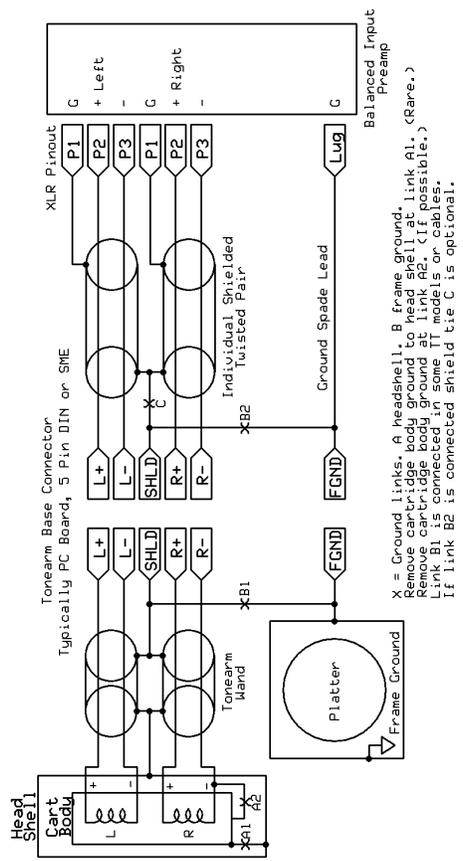
Gradually lower the generator frequency below 20 Hz and read the -3 dB point at the output. The - 3dB point should be between 10 and 12 Hz. When making this measurement confirm that the generator output is flat by comparing its output level at the -3 dB point to the 1 kHz level measured in the step above. If necessary, reset the generator level and repeat the above measurement.

Repeat Tests for the Right Channel

Repeat all of the Signal Tests for the Right Channel.

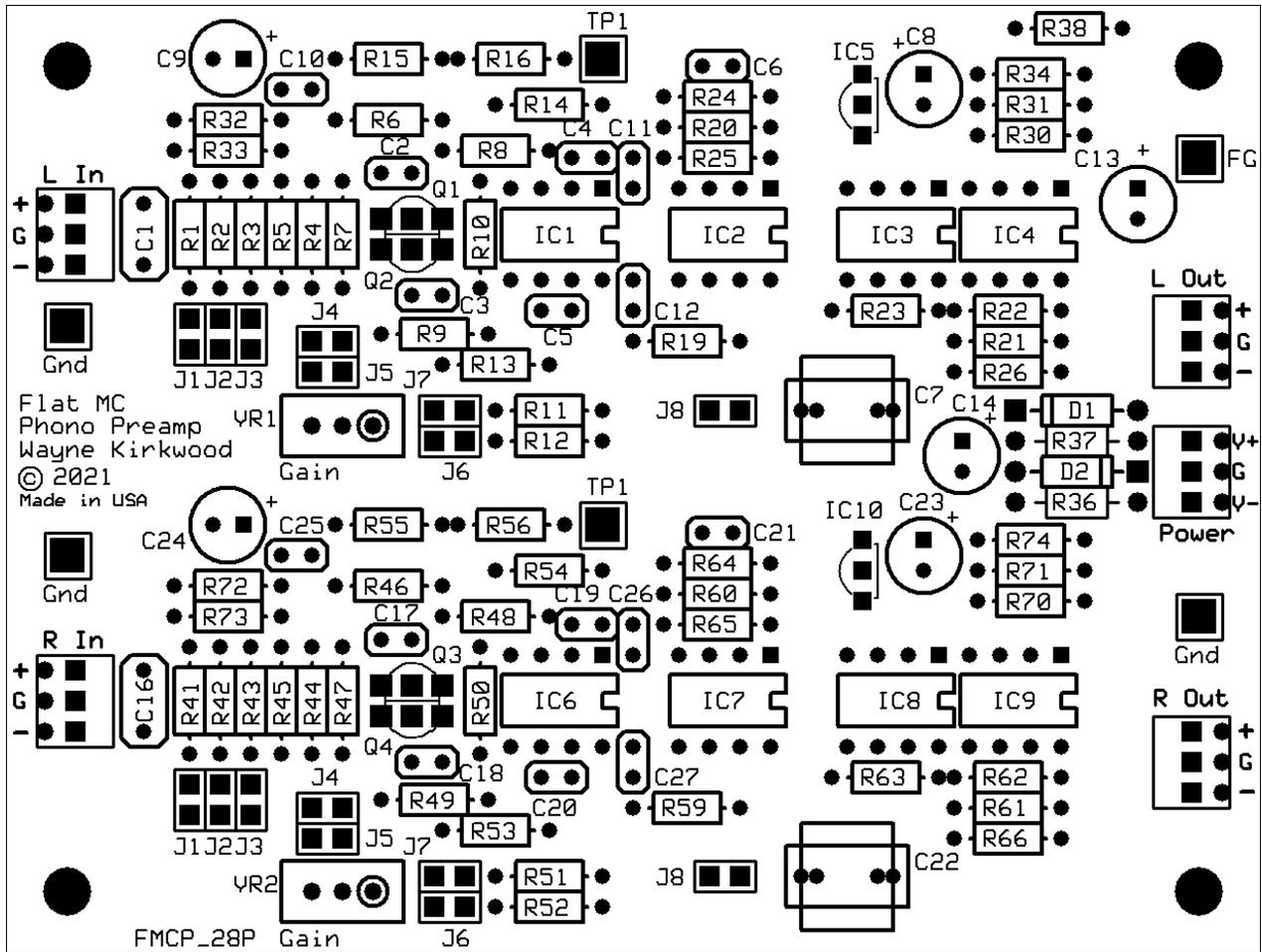
Noise Tests

Noise tests will be performed after the preamp is installed in a metal or foil-lined enclosure and connected to either a sound card or the companion RIAA EQ/Monitor switcher.

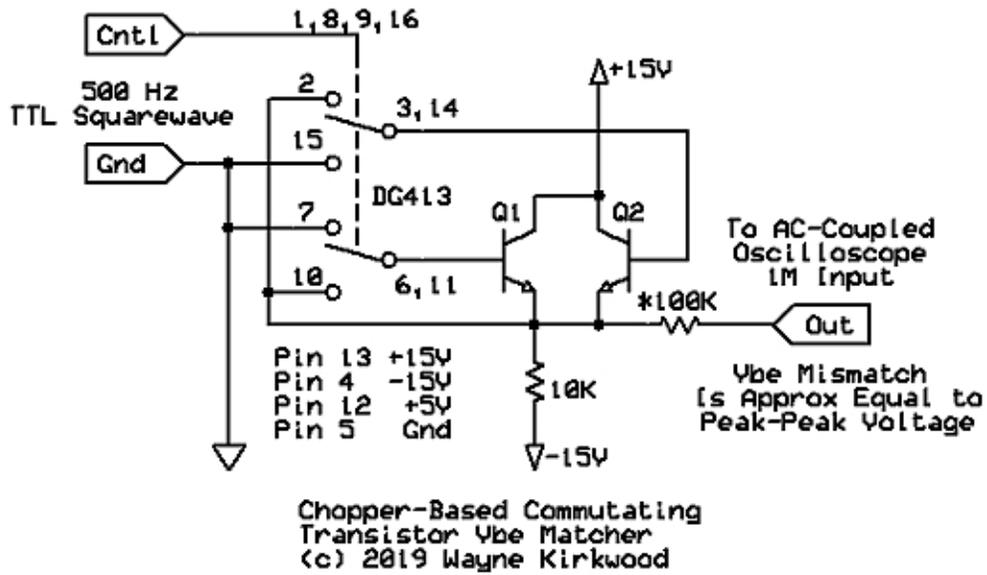


X = Ground links, A headshell, B frame ground.
 Remove cartridge body ground to head shell at link A1. (Rare.)
 Remove cartridge body ground at link B2. (If possible.)
 Link A1 is connected to shield of headshell cable.
 Link B2 is connected to shield of headshell cable.
 If link B2 is connected shield tie C is optional.

KA-Electronics.com	
Balanced Tone Arm Wiring for Balanced Input Preamp	
(c) Mayne Kirkwood	Rev 1.0 1/24/2016



Flat moving coil preamp component and jumper placement.



Commutating Transistor Matcher

For more information on matching transistors using the above circuit or other methods please visit:
<https://proaudiodesignforum.com/forum/php/viewtopic.php?f=6&t=1153>

Detailed Parts List

A complete bill of materials is available from Mouser Electronics:

FMCP-28 BOM with semiconductors:

<https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=e01a329726>

FMCP-28 BOM without semiconductors:

<https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=929e5b9205>

Other Resources

Pro Audio Design Forum Design Thread:

<https://proaudiodesignforum.com/forum/php/viewtopic.php?f=6&t=783>

Pro Audio Design Forum Construction Thread:

<https://www.proaudiodesignforum.com/forum/php/viewtopic.php?f=7&t=1179>

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