ML12 DISCRETE MIC PRE
PCB MANUAL

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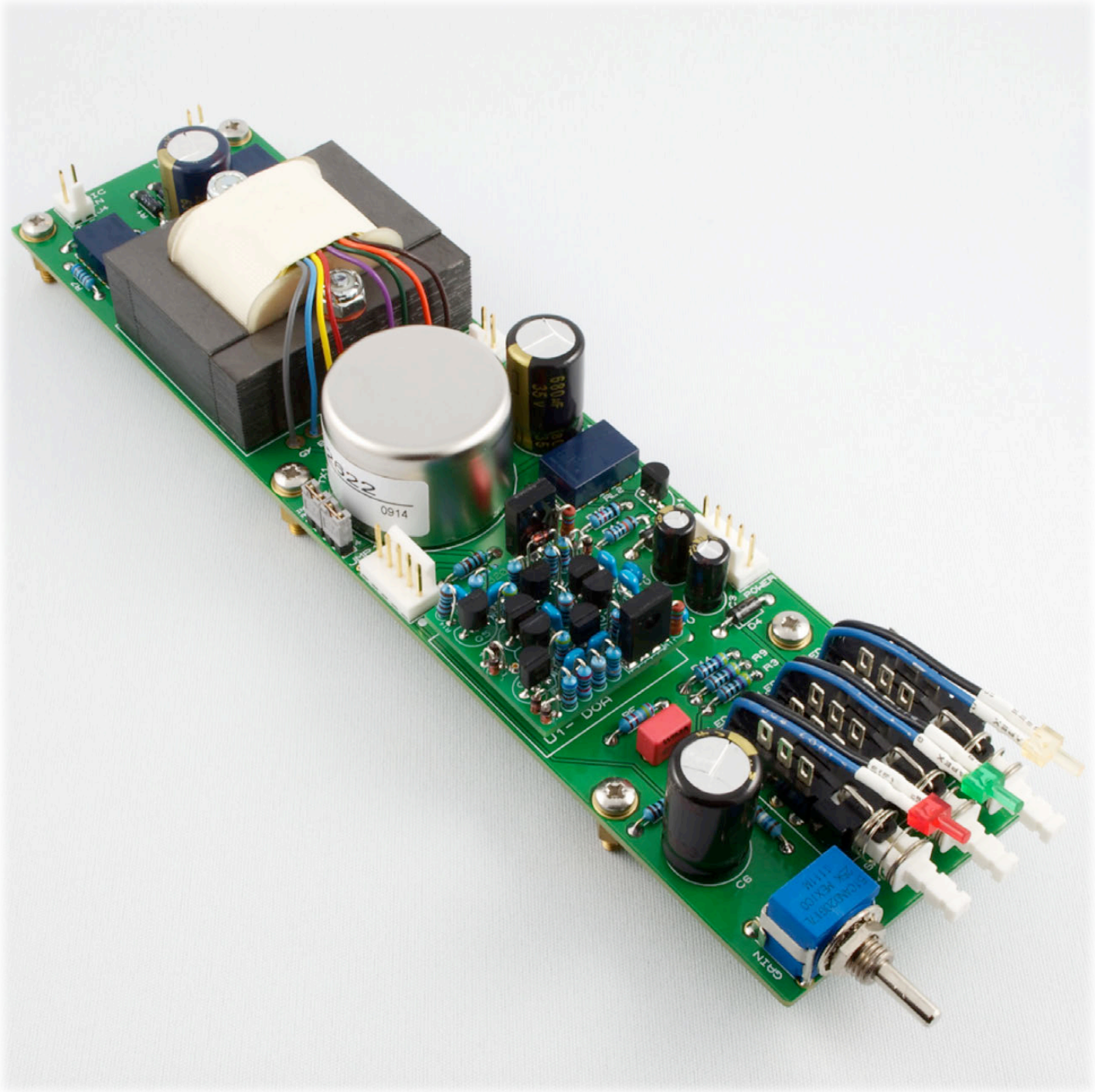

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INTRODUCTION

FOREWORD

Thank you for purchasing the ML12 PCB.

This simple project is ideal for those looking for an easy-to-build and great sounding preamp without breaking the bank. With a wide range of transformers and op-amps to choose from, this preamp can be built in various combinations to meet your personal tonal requirements.

This document is to help you with the different aspects of this build and give you all the information required to assemble a working unit. Only basic soldering skills are required.

Have fun and happy DIY!

Sincerely,

Mike Lebon

Contact: mike@whistlerockaudio.com

DISCLAIMER

I am not liable for any damage, harm or loss of any kind resulting from the assembly and/or use of this kit. This kit contains small parts that may be easily swallowed by a child. Keep all components of the kit AWAY from children and animals. Finally, always take necessary precautions when handling potentially dangerous tools such as cutters, scissors and soldering iron.

BILL OF MATERIALS

The following is a list of all components required to build a complete preamp module. Remember to check the resistor values with a multimeter before soldering. The recommended manufacturer part numbers are listed for your reference. Note that the list does not include the Discrete Op-Amp (DOA).

CAPACITORS

Ref.	Value	Tol.	Type	Rating	Lead Spacing	Manufacturer	Manufacturer Part #	Qty.
C1	100n	10%	X7R	50V	5.0mm	Murata	RPER71H104K2K1A03B	2
C2	100n	10%	X7R	50V	5.0mm	Murata	RPER71H104K2K1A03B	
C3	68u	20%	Elec.	35V	2.5mm	Panasonic	EEU-FM1V680	2
C4	68u	20%	Elec.	35V	2.5mm	Panasonic	EEU-FM1V680	
C5	220u	20%	Elec.	63V	5.0mm	Panasonic	EEU-FC1J221S	1
C6	680u	20%	Elec.	35V	5.0mm	Panasonic	EEU-FM1V681	2
CB1	680u	20%	Elec.	35V	5.0mm	Panasonic	EEU-FM1V681	
CB2	10n	5%	Film	400V	5.0mm	Wima	MKP2G021001C00JSSD	1
CF	47p	5%	Film	1000V	5.0mm	Wima	FKP2O100471D00JSSD	1
CZ	220p	2.5%	Film	100V	5.0mm	Wima	FKP2D002201D00HSSD	1

RESISTORS

Ref.	Value	Tol.	Type	Rating	Manufacturer	Manufacturer Part #	Qty.
R1	6.81K	0.1%	Metal Film	0.25W	IRC	66-RC55LF-D-6.81K	2
R2	6.81K	0.1%	Metal Film	0.25W	IRC	66-RC55LF-D-6.81K	
R3	470Ω	1%	Metal Film	0.25W	Xicon	271-470-RC	3
R9	470Ω	1%	Metal Film	0.25W	Xicon	271-470-RC	
R14	470Ω	1%	Metal Film	0.25W	Xicon	271-470-RC	
R4	100Ω	1%	Metal Film	0.25W	Xicon	271-100-RC	1
R5	1.69K	1%	Metal Film	0.25W	Xicon	271-1.69K-RC	1
R6	150Ω	1%	Metal Film	0.25W	Xicon	271-150-RC	2
R12	150Ω	1%	Metal Film	0.25W	Xicon	271-150-RC	
R7	681Ω	0.1%	Metal Film	0.25W	Vishay/Dale	CMF55681R00BHEB	2
R8	681Ω	0.1%	Metal Film	0.25W	Vishay/Dale	CMF55681R00BHEB	
R10	10K	1%	Metal Film	0.25W	Xicon	271-10K-RC	1
R11	100K	1%	Metal Film	0.25W	Xicon	271-100K-RC	1
R13	1M	1%	Metal Film	0.25W	Xicon	271-1.0M-RC	1
RF	24.9K	1%	Metal Film	0.25W	Xicon	271-24.9K-RC	1
RL	150K	1%	Metal Film	0.25W	Xicon	271-150K-RC	1
RZ	5.1K	1%	Metal Film	0.25W	Xicon	271-5.1K-RC	1

DIODES

Ref.	Type	Application	$V_{R(max)}$	$I_{F(max)}$	Manufacturer	Manufacturer. Part #	Qty.
D1	1N4148	Relay Back EMF Suppress	100V	0.3A	Fairchild	1N4148	3
D2	1N4148	Relay Back EMF Suppress	100V	0.3A	Fairchild	1N4148	
D3	1N4148	Relay Back EMF Suppress	100V	0.3A	Fairchild	1N4148	

D4	1N4007	V+ Supply Protection	1000V	1A	Fairchild	1N4007	2
D5	1N4007	V- Supply Protection	1000V	1A	Fairchild	1N4007	

TRANSISTORS						
Ref.	Type	Application	Comments	Mfr.	Mfr. Part #	Qty.
Q1	BC560C - PNP	General Purpose	DI Input Relay	Fairchild	BC560C	1

ELECTROMECHANICAL				
Ref.	Description	Manufacturer	Manufacturer Part #	Qty.
RL1	-20dB Input PAD Relay	Panasonic EW	TQ2-12V	3
RL2	MIC/DI Auto-Switching Relay	Panasonic EW	TQ2-12V	
RL3	Polarity Reversal Relay	Panasonic EW	TQ2-12V	
RV1	25K CCW AT Gain Pot	Bourns	51CAN-D20-G17L	1
SW1	DPDT Push Button for +48V	C&K	F2UEE	3
SW2	DPDT Push Button for PAD	C&K	F2UEE	
SW3	DPDT Push Button for POL	C&K	F2UEE	

MISCELLANEOUS				
Ref.	Description	Manufacturer	Manufacturer Part #	Qty.
LED1	+48V RED LED – 2.2V, 20mA	Panasonic – SSG	LN222RPH	1
LED2	PAD GRN LED – 2.2V, 20mA	Panasonic – SSG	LN322GPH	1
LED3	POL AMB LED – 2.2V, 20mA	Panasonic – SSG	LN422YPH	1
JMP1	4 Pin Header – TX1 Ratio	FCI	68001-104HLF	1
JMP2	2 Pin Header – DOA DC Block	FCI	68001-102HLF	1
JUMPERS	Shunts for JMP1 & JMP2	3M	929953-30	3
SOCKETS	PCB Sockets for DOA	Mill-Max	0357-0-15-01-34-27-10-0	6
TX-HDWR	Mounting Hardware for TX2	Whistle Rock Audio	TX-HDWR	1
SW1-CAP	White PB cap for SW1	C&K	F0102	1
SW2-CAP	Gray PB cap for SW2	C&K	F0104	1
SW3-CAP	Black PB cap for SW3	C&K	F0101	1
KNOB	Knob for RV1 - 1/8” shaft	-	-	1
TX1	Input TX API 2622 type	-	-	1
TX2	Output TX API 2503 type	-	-	1
PCB	ML12 v3.1 PC Board	Whistle Rock Audio	ML12V3-PCB	1

MOLEX CONNECTION KIT				
Ref.	Description	Manufacturer	Manufacturer Part #	Qty.
J1	5 conn friction-fit PCB (M) header	Molex	22-11-2052	2
J2	5 conn friction-fit PCB (M) header	Molex	22-11-2052	
J3	2 conn friction-fit PCB (M) header	Molex	22-11-2022	3
J4	2 conn friction-fit PCB (M) header	Molex	22-11-2022	
J5	2 conn friction-fit PCB (M) header	Molex	22-11-2022	
HS-2PIN	2 conn wire terminal (F) housing	Molex	22-01-2027	3
HS-5PIN	5 conn wire terminal (F) housing	Molex	22-01-2057	2
Crimp Terminals	Gold contact crimp terminals	Molex	08-55-0102	16

CHOOSING THE TRANSFORMERS

The choice of transformers used for this project is a personal one. The input transformer will have the most impact on the sound of the preamp while the output transformer will have a less dramatic effect.

The following transformers are great choices and will give you a good place to start. Because of the subjective nature of sound, please take my sonic descriptions with a grain of salt. They are meant to serve as a rough guideline and not gospel.

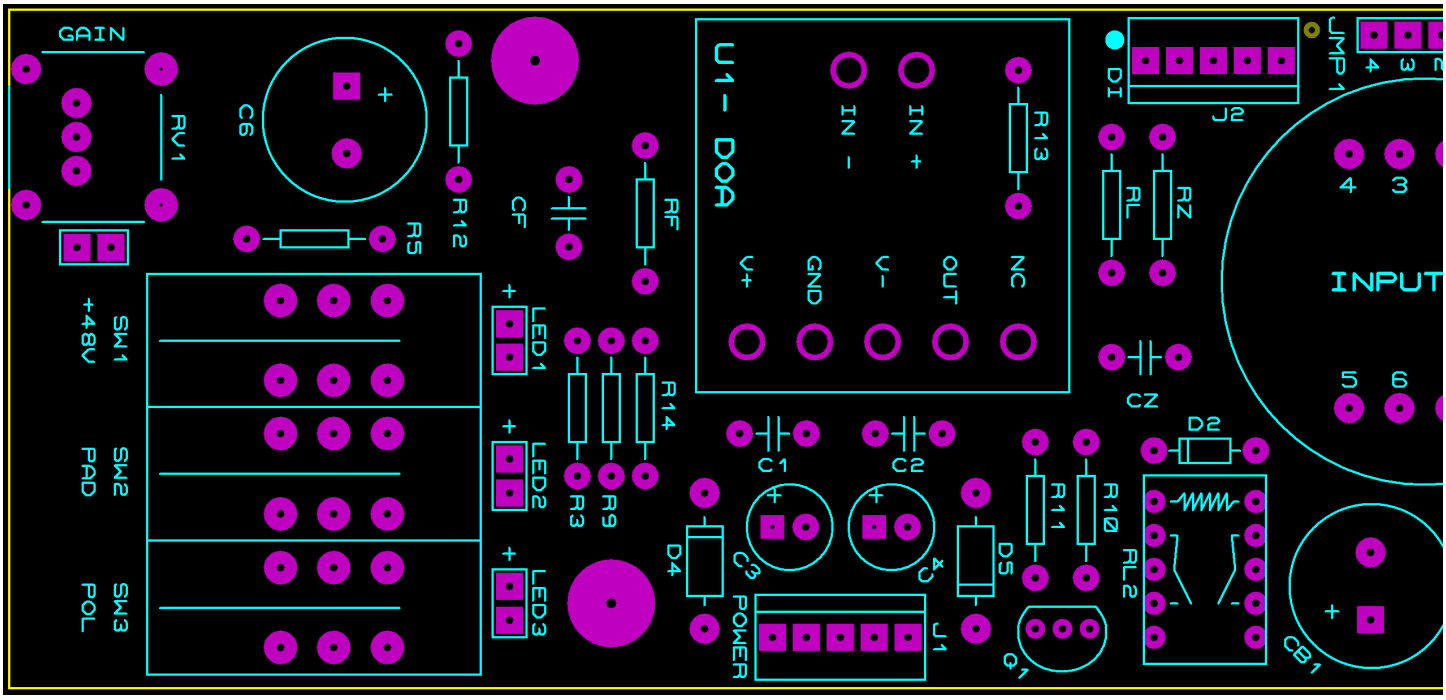
INPUT TRANSFORMERS			
Manufacturer	Model	Comments	Available From
Cinemag	CM-75101APC	Modern Sounding – Ratio can be set for 1:10 or 1:5.	Cinemag Inc.
	CMMI-8PCA	Vintage Sounding – 1:8 Ratio	
	CMMI-10PCA	Vintage Sounding – 1:10 Ratio	
Jensen	JT-110K-HPC	Cleaner Sounding – 1:8 Ratio	Jensen Transformers
	JT-115K-EPC	Cleaner Sounding – 1:10 Ratio	
Ed Anderson	EA2622	Vintage Sounding – AP2622 Replica, 1:7 or 1:3.5 Ratio	Classic API
Altran	C-3402-2	Cleaner Sounding – Ratio can be set for 1:8 or 1:4	Altran Transformers

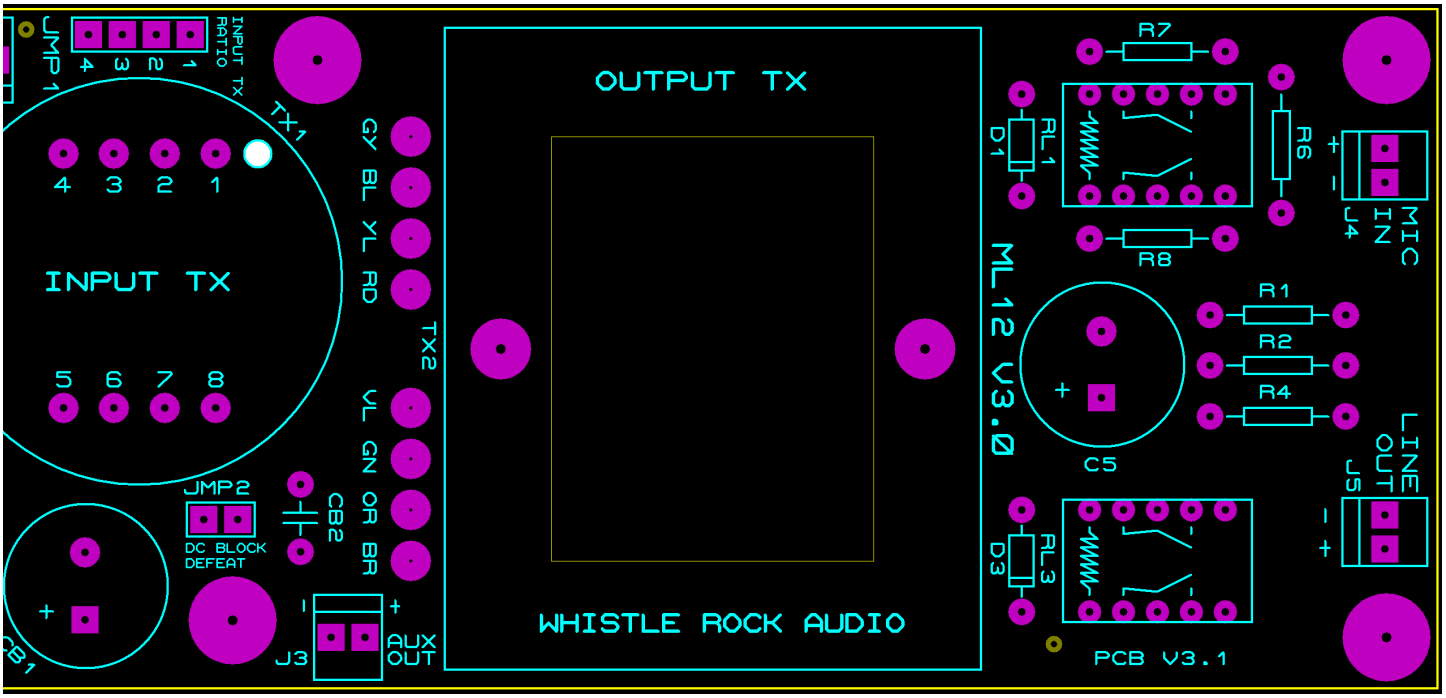
When it comes to output transformers, the nickel content of the core will have a great impact on the transparency of the transformer. Simply put, the greater the nickel content, the less noticeable the transformer becomes. Steel core transformers on the other hand have a more vintage sound to them and are a popular choice for projects of this type.

OUTPUT TRANSFORMERS			
Manufacturer	Model	Comments	Available From
Cinemag	CMOQ-2S	Vintage Sounding – Steel Core, Quadfilar	Cinemag Inc.
	CMOQ-2L	Cleaner Sounding – 50% Nickel/50% Steel Core, Quadfilar	
	CMOQ-2H	Clean Sounding – High Nickel Core, Quadfilar	
Jensen	JT-11-DMCF	Clean Sounding – High Nickel Core, Bifilar	Jensen Transformers
	JT-11SS-DLCF	Cleaner Sounding – 50% Nickel/50% Steel Core, Split Bifilar	
Ed Anderson	EA2503	Vintage Sounding – AP2503 Replica, Quadfilar	Classic API
Ed Anderson	EA2623	Vintage Sounding – AP2623 Replica, Trifilar	Classic API

COMPONENT LAYOUT

Here is your reference map to the ML12 PCB. You may refer to it whenever necessary.





PCB STUFFING ORDER

The following is only a recommendation. Feel free to improvise whichever way you feel most comfortable with. The exception is input transformer TX1 that should ideally be installed before the output transformer TX2. See page 15 for more details.

Notice that the stuffing order goes from the lowest to highest laying components on the PCB. This is a good rule of thumb to follow when stuffing most PCBs.

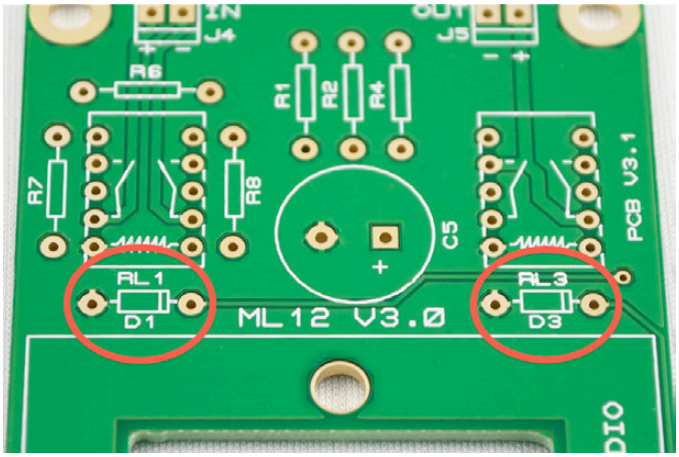
STEP	COMPONENT	MORE DETAILS
1	**Diodes D1, D2 & D3**	See Page 9
2	**DOA Sockets**	See Page 10
3	**All Resistors**	See Page 9
4	**Diodes D4 & D5**	See Page 9
5	**Capacitors C1 & C2**	-
6	**Relays RL1, RL2 & RL3**	See Page 11
7	**Capacitors CF & CZ**	-
8	**Transistor Q1**	-
9	**Capacitor CB2**	-
10	**Headers JMP1 & JMP2**	See Page 12
11	**Molex Headers J1 to J5**	-
12	**Capacitors C3 & C4**	-
13	**Potentiometer RV1**	See Page 13
14	**Push Buttons SW1, SW2 & SW3**	See Page 14
15	**Capacitors C5, C6 & CB1**	-
16	**Input Transformer TX1**	See Page 15
17	**Output Transformer TX2**	See Page 16
18	**LEDs LED1 to LED3**	See Page 17

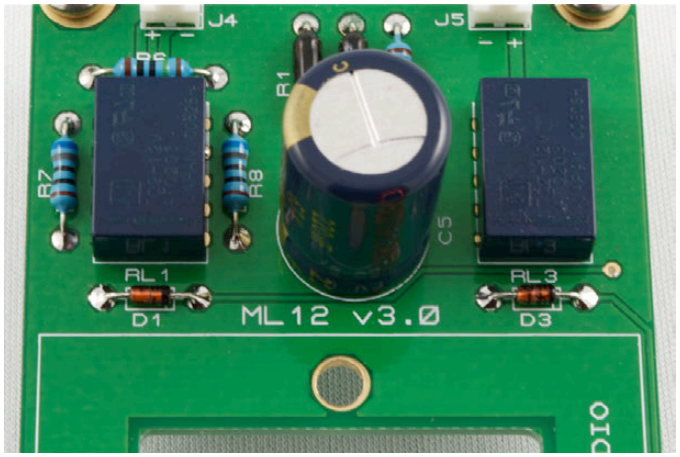
TIP: Components such as resistors, diodes and ceramic caps may be soldered from the top and touched up at the bottom afterwards. Using a device such as a Panavise (Google it… seriously) to hold the board up, this method solves the problem of holding the parts in place while soldering. It also allows you to create a successful solder joint connecting through from the bottom to the top layer for a more reliable interconnection. Finally, you can stuff and solder more parts at once!

ASSEMBLY TIPS

INSTALLING THE DIODES AND RESISTORS

DIODES - Diodes are polarized components and as such, they MUST be inserted the correct way around. A band on the body of the diode indicates the 'cathode' connection, which must correspond to the similar marking on the PCB's silkscreen.

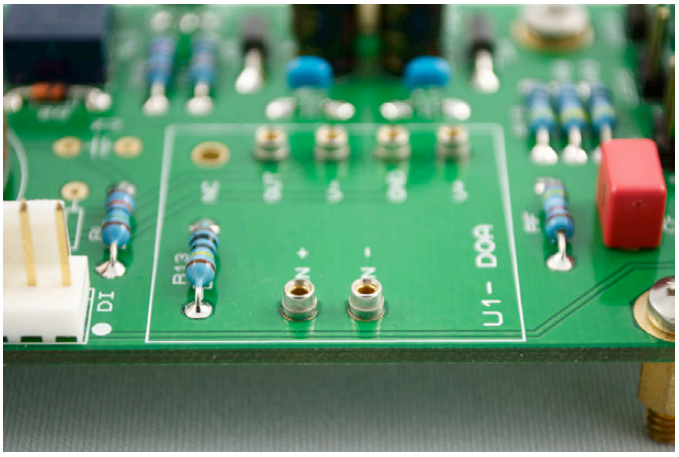




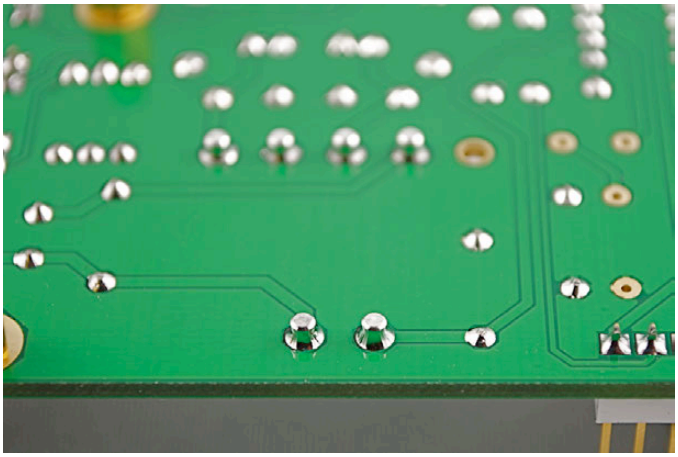
RESISTORS - Resistors are not polarized but make sure that you check each value with a digital multimeter before soldering them on. You can avoid many headaches with a bit of prevention.

INSTALLING THE DOA (DISCRETE OP-AMP) SOCKETS

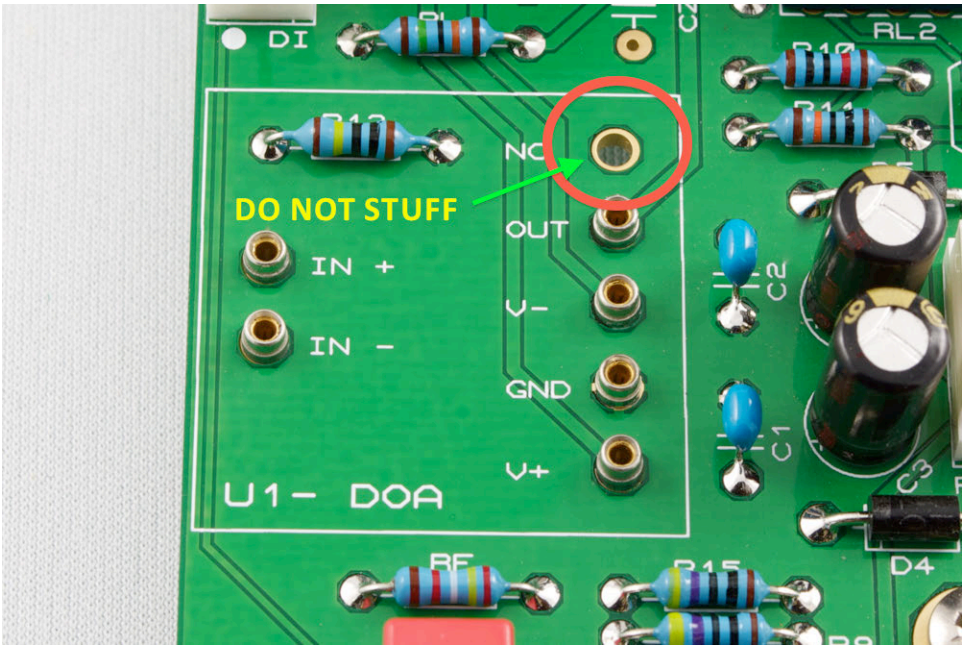
The recommended DOA sockets for this project will fit perfectly in the PCB (see bill of materials). The sockets must sit tight against the PCB when soldering. A few methods exist to accomplish that. My favorite is to use an already built DOA as a jig to hold them in place: Simply install the sockets on the PCB and carefully sit the DOA in (a bit of force may be required to push the DOA all the way in). While holding the DOA, flip the PCB over and solder the sockets from the bottom. Alternatively, a piece of cardboard may be used to hold the sockets in place when flipping the PCB over. The goal is to get the sockets sitting tightly against the top of the PCB.



DOA sockets top PCB view.


DOA sockets bottom PCB view.

Note that the hole on the DOA footprint labeled 'NC' does not require any socket, as it is not connected to any part of the circuit. You may skip it!



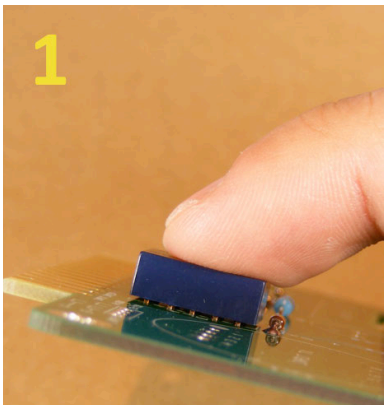
INSTALLING THE RELAYS

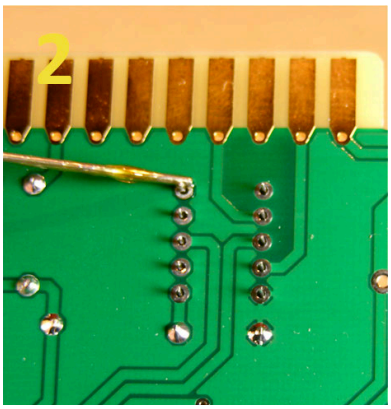
Note that relays are polarized components. The coil side is marked with a line on the relay's body and it must correspond to the coil marking on the PCB.

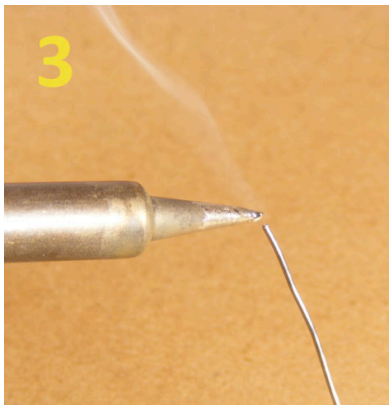
Relays can be tricky to solder properly. Their leads are short which makes them difficult to solder at the bottom without some sort of support mechanism in place. There are a few solutions for this, including bending a couple of leads once inserted or using a rigid piece of cardboard and elastics to keep them in place.

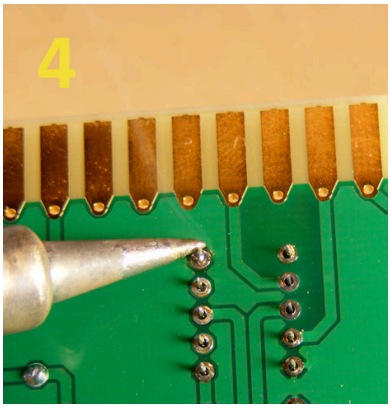
Another solution, which I have used over and over successfully, is as described below:

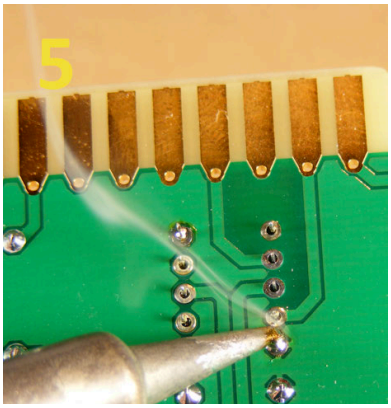
1. First thing is to hold the PCB from the top with one hand and pin the relay down in position with one finger (Figure 1).
2. Turn the PCB over and add some flux (optional) to two opposite leads of the relay (Figure 2).
3. Tin your soldering iron just enough to pickup a dab of solder at the tip (Figure 3).
4. Touch up the fluxed leads and pads of the relay with the solder from your soldering iron as in Figure 4 and 5. The idea here is to form temporary joints to keep the relay in place. This will only happen if the solder sticks to the lead and the pad. The flux helps greatly with this.
5. The relay should now be secured in place by the two opposite leads that were soldered (Figure 6). You can now let go of the PCB and solder/touch up all the leads.

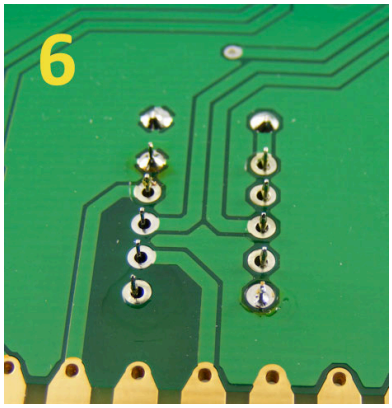






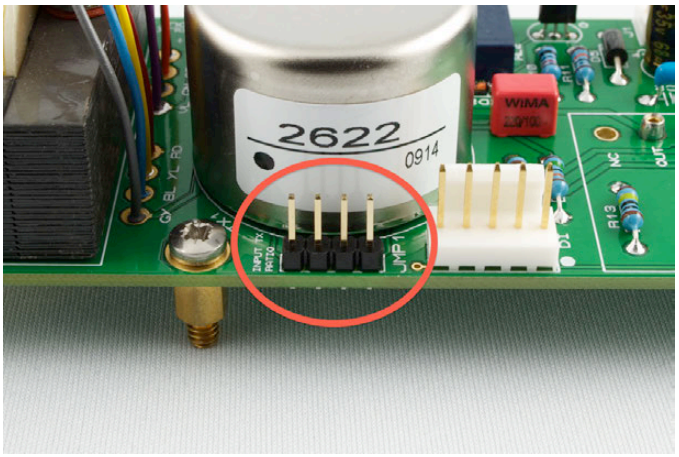




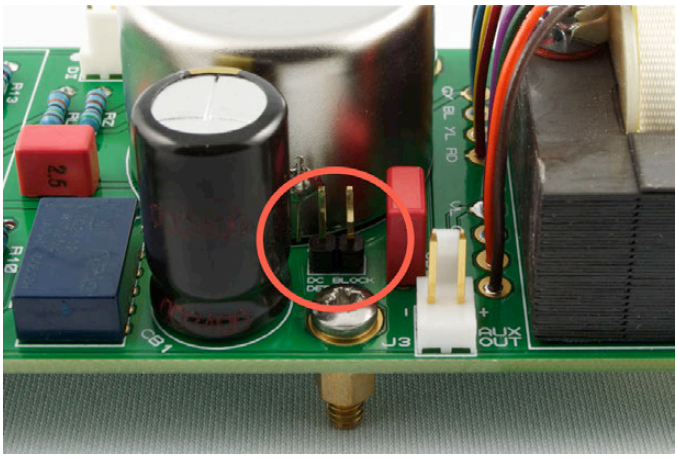


INSTALLING THE HEADERS

The headers (JMP1 and JMP2) can be installed in a similar fashion as the relays. If you can find a way to hold them in place with your finger or nails (without burning yourself of course!), that method will work great. Otherwise, use a piece of Blu-Tack to tack them down on the topside while soldering.



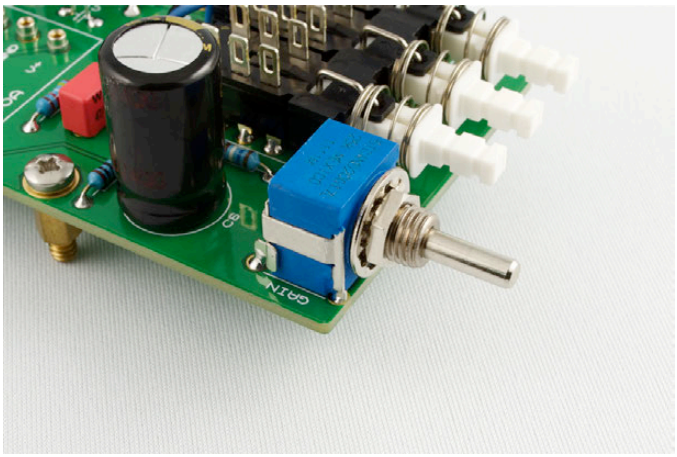
JMP1: Input TX ratio setting.



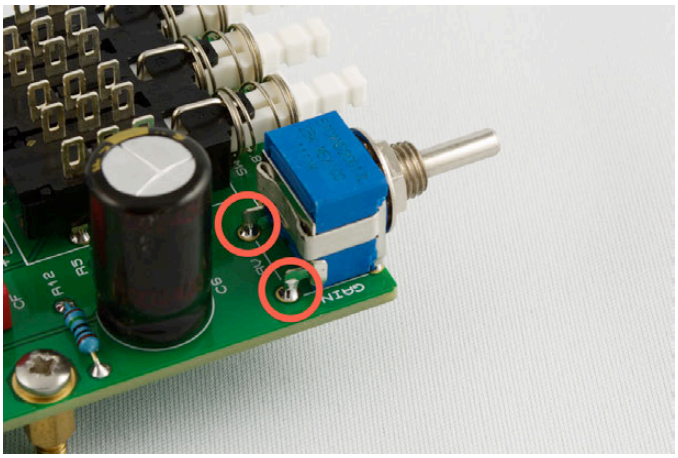
JMP2: DOA DC block defeat.

INSTALLING THE GAIN POTENTIOMETER

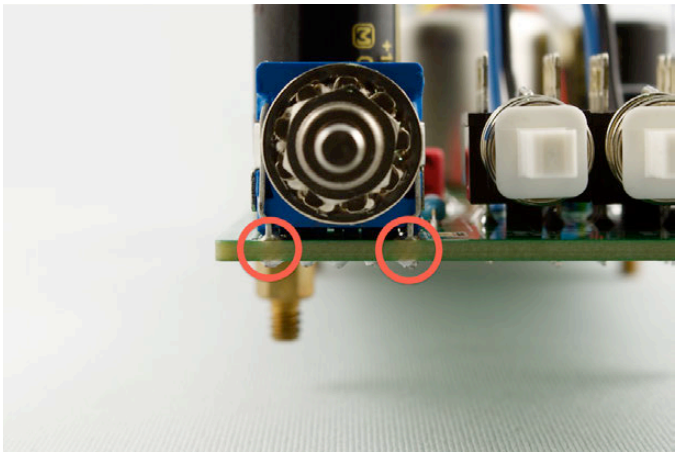
The Bourns potentiometer (RV1) is an easy component to install. Again, you can use the same method as for the relays here. Make sure that the bottom of the pot's blue casing is nice and flat against the PCB. This will insure that the shaft is level (parallel) with the rest of the board.



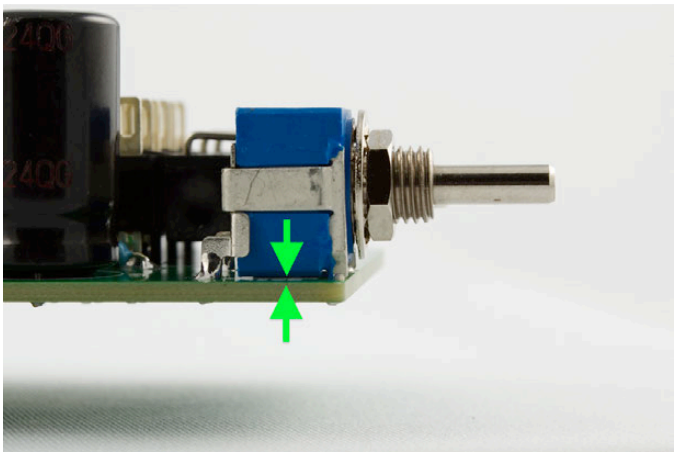
RV1: Gain potentiometer.



Back support brackets soldered.



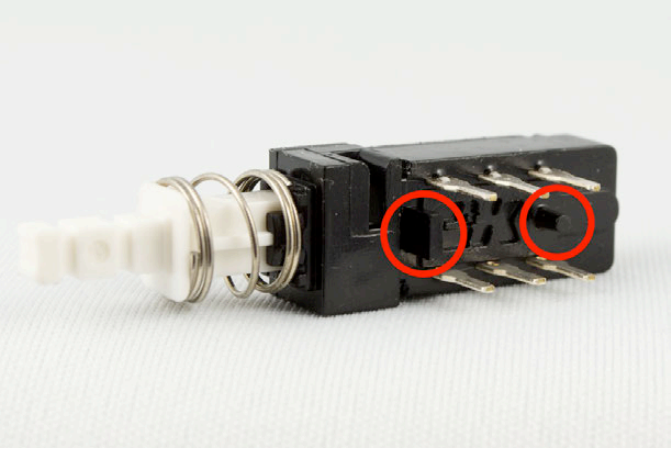
Front support brackets soldered.



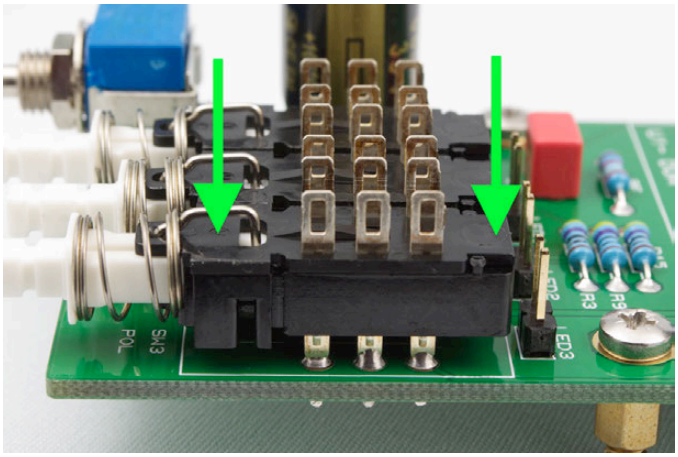
Bottom of the pot must be flat against the PCB.

INSTALLING THE PUSH BUTTONS

The push buttons can be installed in the same fashion as the relays. When soldering down the legs of the push buttons, make sure that the shafts are straight and the two plastic tabs at the bottom are sitting against the PCB (see the photos below). Make sure to have your fingers clear of the top lugs to avoid burning yourself. Always solder down two opposite corner legs of the switch and check the alignment before soldering the rest of the legs. If the switch is not quite straight, you can retouch the corners to re-adjust things.



These two tabs must both be touching the PCB.

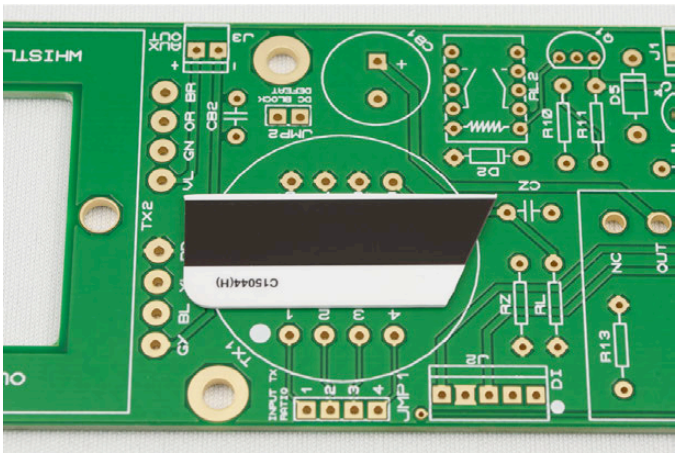


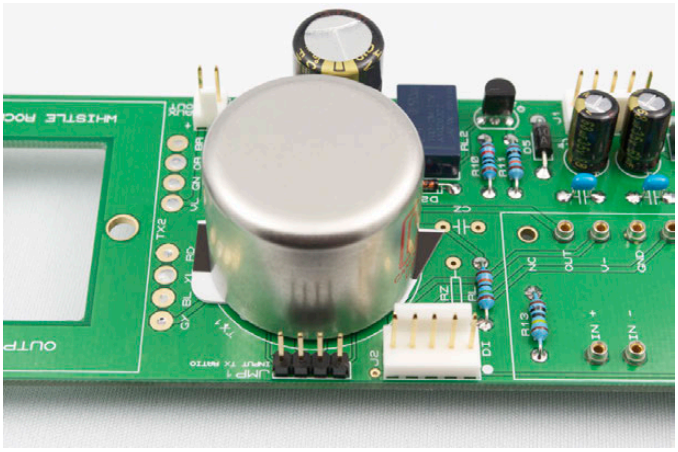
Keep fingers clear of the lugs while soldering!

INSTALLING THE INPUT TRANSFORMER

Again, you can use the 'relay technique' to install the input transformer.

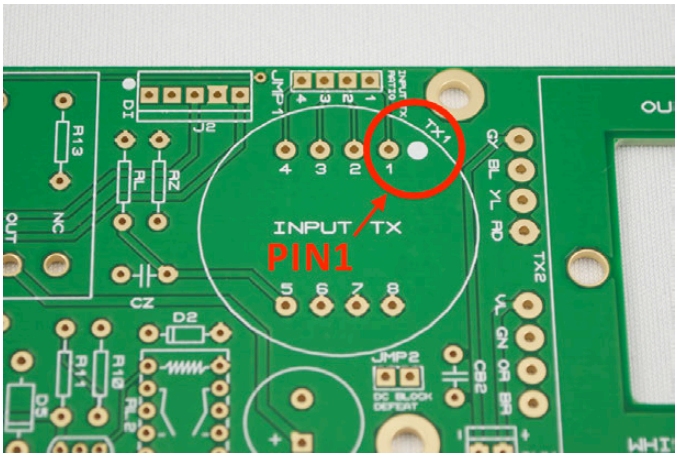
To avoid shorting the transformer case with the top copper of the PCB, you can put a piece of double sided tape at the bottom of the transformer to elevate it off of the PCB (by at least 0.5mm). Alternatively, use a flat piece of rigid material that you can wedge between the transformer and PCB while soldering. A strip of old credit card is useful for this application:





Before reaching for the iron, watch for the correct orientation of the transformer! It is marked to indicate PIN 1. In the case of the Cinemag CM-75101APC, a red dot at the bottom denotes PIN1. Simply match PIN 1 with the marking on the ML12 PCB.

Match this transformer lead…

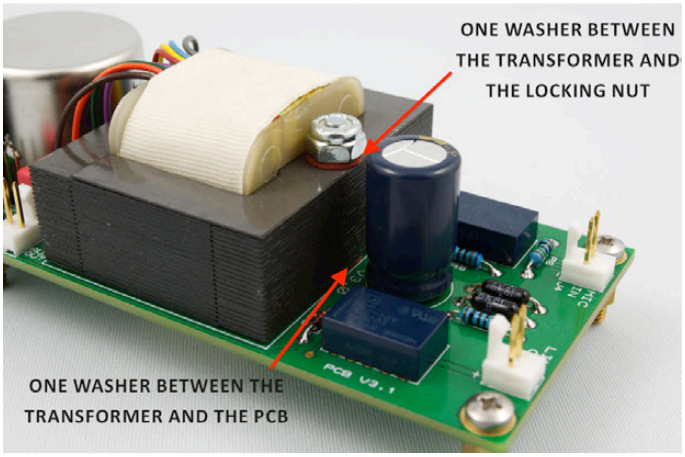


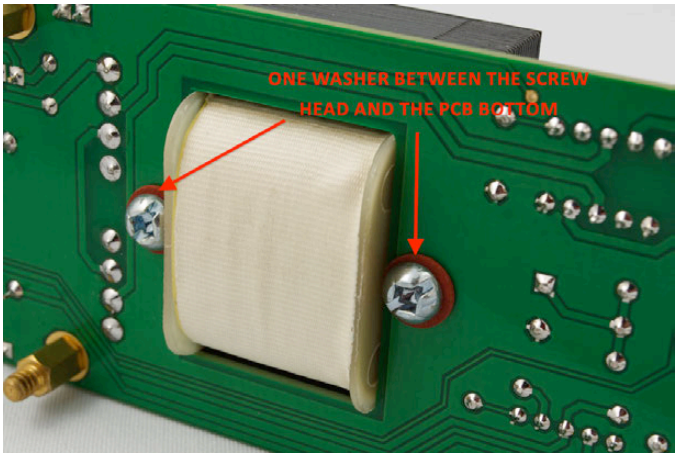
…to this hole.

Slide out the card strip when you're done and keep it somewhere safe for your next ML12 build! ☺

INSTALLING THE OUTPUT TRANSFORMER

The installation of the output transformer is straightforward if you are using the mounting hardware kit available from the WRA webstore. The kit includes six round fiber washers, two 1″ long M4 screws and two nylon locking nuts. The washers serve as spacers and protect the surface of the PCB and transformer laminations.





Once the transformer is securely attached to the PCB, it's time to solder up the leads. The connection points on the PCB are color-coded as per the Cinemag CMOQ quadfilar series lead colors (the EA2622 uses the same color coding). You can cross-reference the connections for your particular transformer using the ML12 schematic if required.

Cinemag CMOQ-2S all wired up.

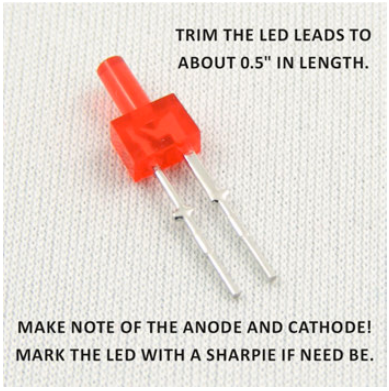
Trim the transformer lead to the appropriate length before soldering but don't trim them too short! About two inches is a good length to start with.

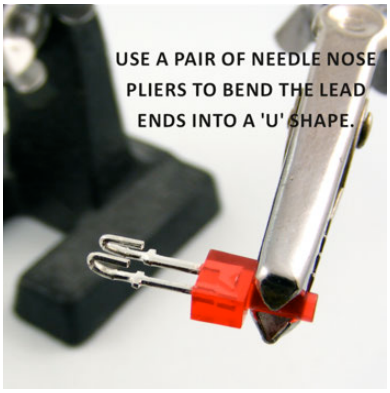
HOOKING UP THE LEDS

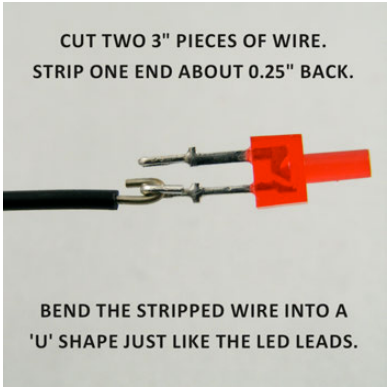
LEDs are polarized and must be wired accordingly to the PCB. The polarity is indicated on the PCB with a '+' denoting the positive lead (anode) of the LED. The anode usually has a longer lead.

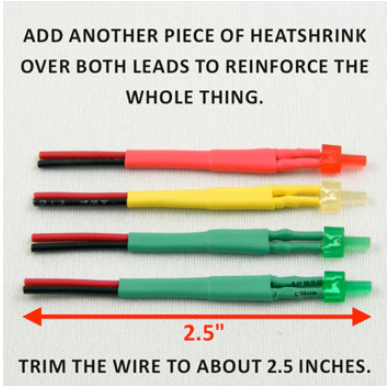
If you decide to use the LEDs suggested in the Bill Of Materials, they can be mounted to the case front panel through a simple 2mm hole. It is best to run solid core hook-up wire between the LEDs and the PCB to create a rigid connection. I've had good success with 22AWG wire.

If you're new to this, here is a quick guide on how I personally do it. You may follow this exactly or improvise to your liking.

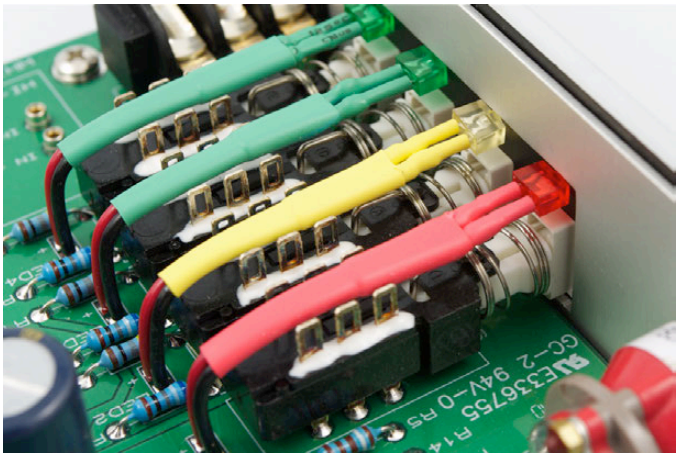








The LEDs can then be wired directly to the PCB and bent over towards their front panel mounting holes. Slide the LEDs in the panel holes when mounting the completed preamp in a case. The rigidity of the assembly will keep the LEDs in place.



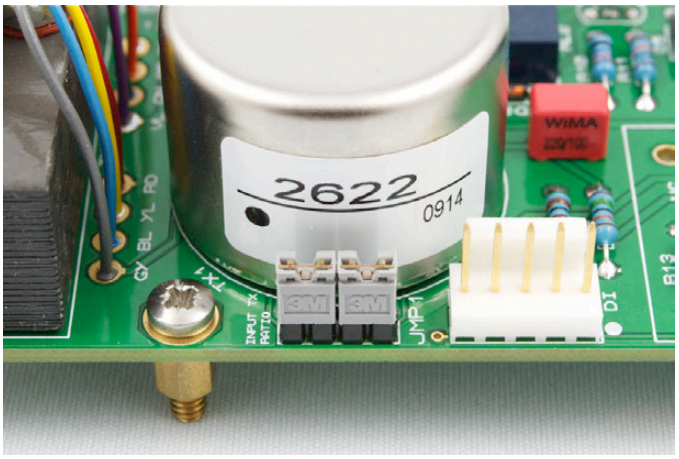
BEFORE POWERING UP

SETTING UP JMP1

JMP1 sets the input transformer ratio. This jumper only has an effect on transformers with two primary windings such as the Cinemag CM-75101APC and the EA2622.

PRIMARIES IN PARALLEL:

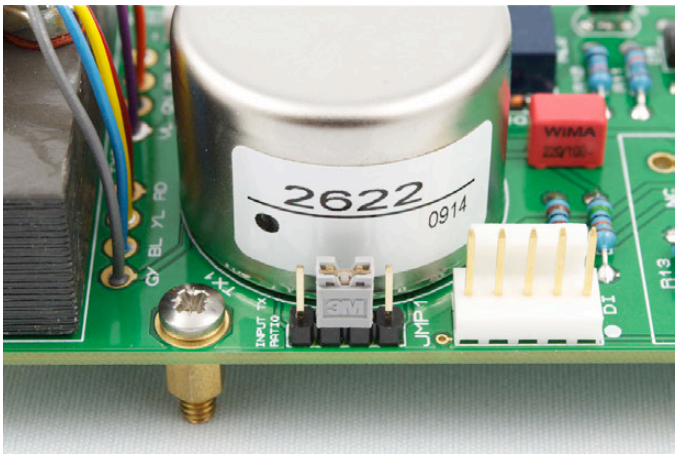
Shorting 1-2 and 3-4 will wire the primaries in parallel. This will provide the higher transformer ratio and therefore the most gain. This is the most popular setting for this type of preamp.



Parallel wired primaries JMP1 setting.

PRIMARIES IN SERIES:

Shorting 2-3 will wire the primaries in series. This will half the transformer ratio and reduce the available gain by 6dB. The input impedance will also be four times higher than the parallel-wired setting.



Series wired primaries JMP1 setting.

Experiment with both settings as they can give your preamp perceivably different tones, especially with dynamic microphones.

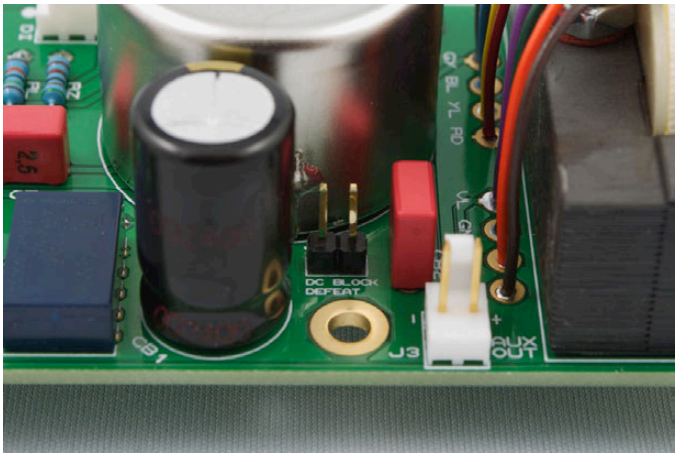
SETTING UP JMP2

Almost all bipolar input DOAs will have a large DC offset (sometimes more than 1V) when a high impedance signal is presented to their input. For instance, the ML12.DI1 is an optional DI module for the ML12; when activated, it feeds the connected instrument signal to the positive input of the op-amp. The output impedance of the instrument may be fairly high (electric guitar, bass, etc..), which will drive the op-amp's offset up.

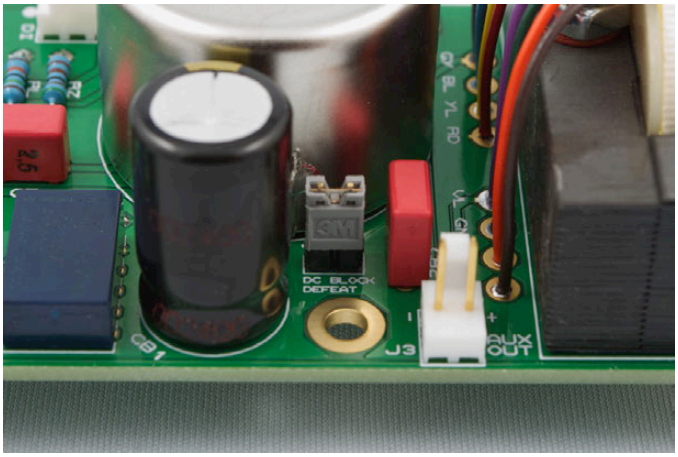
Further more, a faulty or failing DOA can sometimes create a condition where one of the supply voltages find its way to the output terminal of the op-amp. This can be disastrous for the output transformer!

For the above reasons, the ML12 is equipped with two parallel DC blocking capacitors between the DOA and the output transformer. They protect the transformer against potential damage.

Installing a shunt at JMP2 will bypass the DC blocking caps CB1 and CB2. This will direct couple the discrete op-amp's output to the output transformer. Only do this if you have a good reason to!



JMP2 - DC block active (recommended).



JMP2 – DC block defeated.

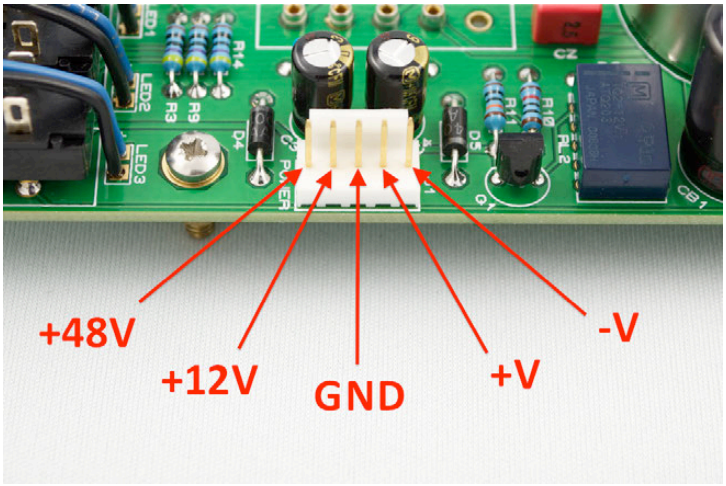
ASSEMBLY CHECK

Now is time to check, double-check and triple-check your work! Verify the correct position and orientation of all components. Also look for bad solder joints and shorts that may require some rework.

MAKING THE CONNECTIONS

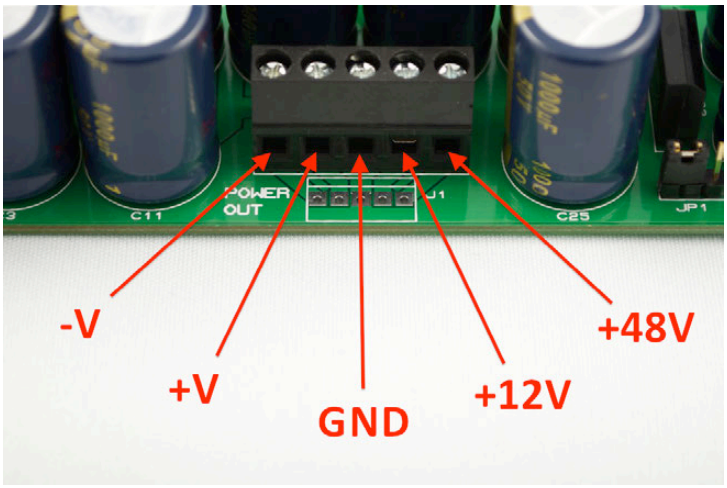
The connections to the ML12 module are fairly straightforward. Below are a series of diagrams that should help with the wiring.

POWER CONNECTION



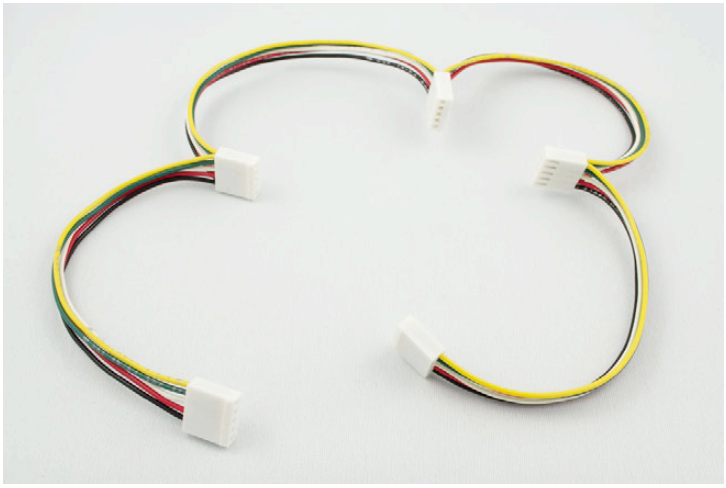
The header connection J1, labeled 'POWER', is where all power supply voltages need to be connected. The required supply voltages of the '+V' and '-V' points are solely determined by the operating voltages of the discrete op-amp that you choose to use in the ML12 preamp.

For example, if you choose to use the ML2520 op-amp, you will have to supply it with +/-16V (or +/-18V for slightly more headroom).



If you are using the suggested ML12 PSU to power the preamp(s), connections from the 'POWER' connector can be made to the block terminal of the PSU labeled 'POWER OUT'.

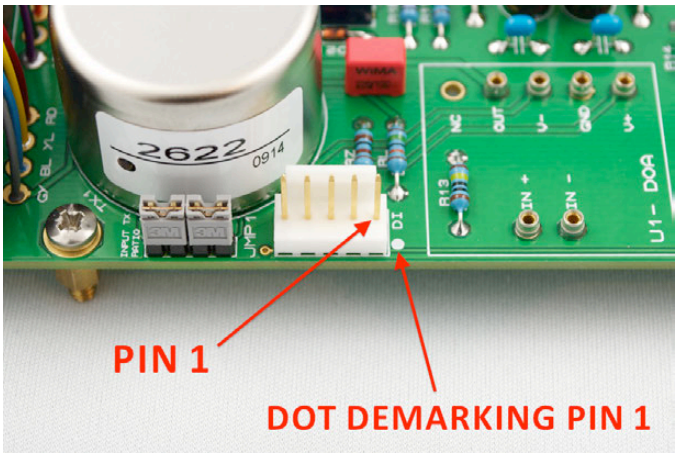
An optional Molex header can be installed at the PSU instead of the block terminal if you wish. See right below for more info.



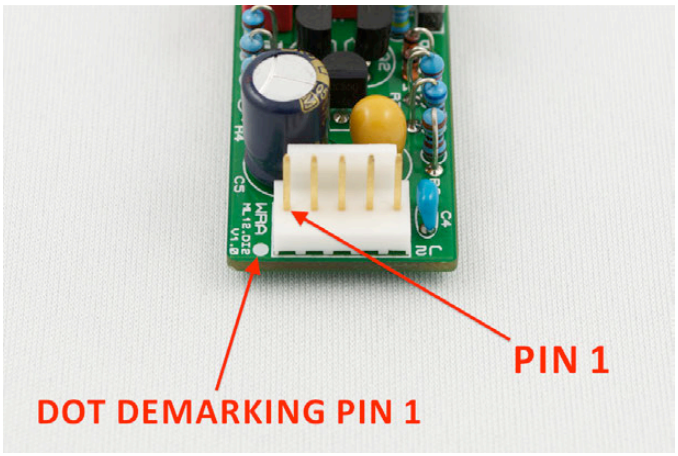
If you use Molex headers throughout the build, you can build a wiring harness to daisy chain several ML12 preamps to one ML12 PSU. This is an elegant solution to power distribution and also makes assembly / disassembly / troubleshooting much easier. See the BOM for a listing of the harness parts required per ML12 preamp.
A ready-made wiring harness is also available from Whistle Rock Audio if you don't feel like making your own.

DI INPUT MODULE CONNECTION

If you are using the optional ML12.DI modules, they simply connect to the header labeled 'DI' (J2) on the ML12 PCB. PIN 1 of the header is marked with a dot next to it. This is the case on the DI module header as well.



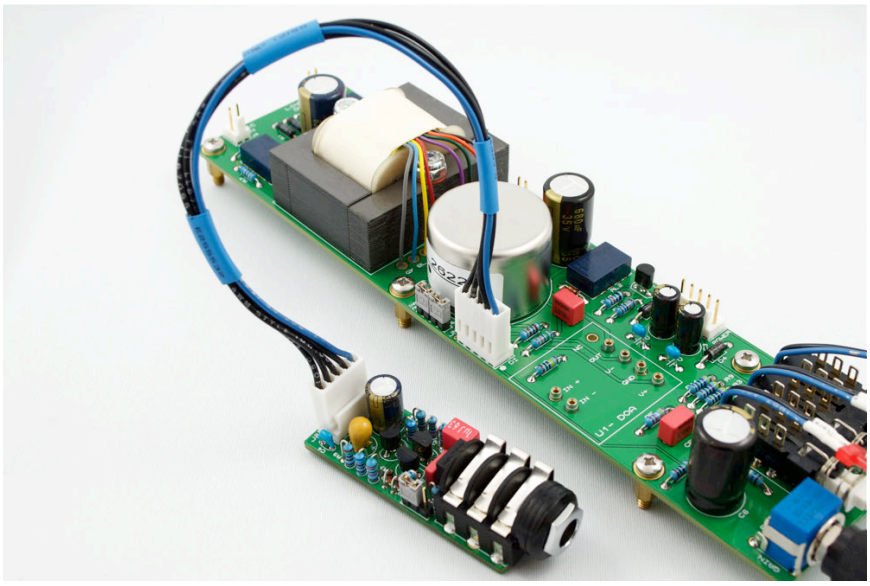
DI connector on the ML12 PCB.



Connector on the ML12.DI2 module.

Note: The DI signal coming from the ML12.DI modules is carried to the preamp via the pin 1 connection. When using the ML12.DI1 (passive input module) you may only wire pin 1, pin 2 and pin 4 (GND). The other connections on the header are not used in this case. Furthermore, it is preferred to use a shielded cable to minimize noise pickup between the ML12.DI1 and the ML12.

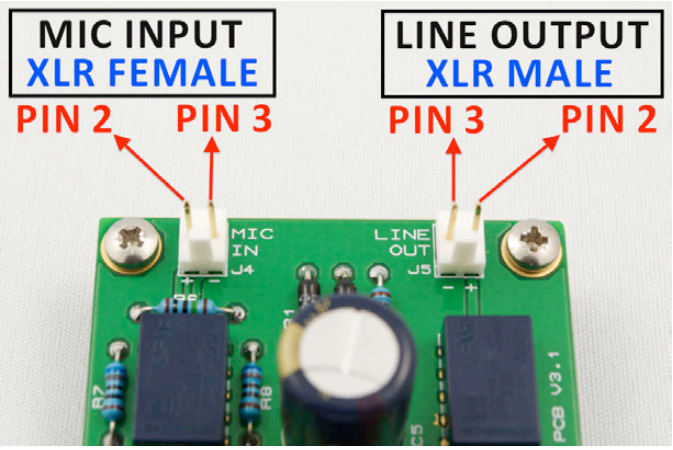
The ML12.DI2 (active JFET buffered input module) does not require a shielded connection.



ML12.DI2 connected via Molex harness.

MIC INPUT AND LINE OUTPUT

The microphone input header (J4) and line output header (J5) connect to their respective XLR jacks as described below.

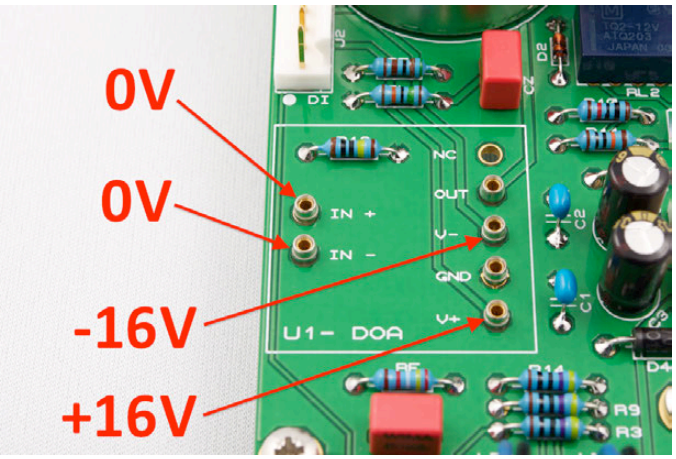


PIN 1 of both XLR jacks should be connected together using thick gauge wire (16AWG or larger) and tied to the systems star ground. The ML12 PSU provides a convenient connection point for this purpose.

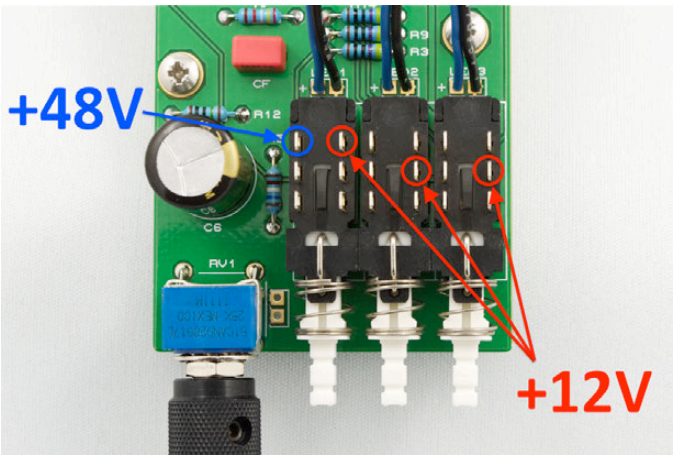
VOLTAGE CHECK AND SMOKE CHECK

Once all your connections have been made, it is time to verify the main voltages around the board when power is applied. This is done BEFORE inserting a discrete op-amp in the sockets. You don't want to fry it if something is wrong!

Turn on the power and check for the following voltages on the board:



Voltages at the DOA sockets.



Voltages at the push buttons.

The correct voltage measurements at the V- and V+ sockets of the discrete op-amp (U1) can differ and depend completely on the op-amp you plan to use. Here, +/-16V is suitable for the ML2520 DOA.

If all the voltages check out fine:

- Turn off the PSU and wait a couple of minutes (or until you measure less than +/-2V at the V- and V+ points).
- Make sure that JMP2 is **not** installed. (You may install it later. See page 19 for details.)
- Install your DOA of choice on the ML12. You may have to press firmly down to seat the pins completely.
- Turn on the PSU and wait 30 seconds.

If nothing has gone up in smoke within 30 seconds, you likely have a working preamp. Now it's time for the final test!

FINAL TEST

The final test consists of plugging in a microphone at the XLR input and trying out all the features of the ML12 preamp:

- Verify the gain pot response.
- Verify the +48V phantom power switch with a condenser microphone.
- Verify the -20dB PAD switch. You should hear a relay clicking when activated.
- Verify the POL switch. You should hear a relay clicking when activated.
- Verify the DI input by plugging in an unbalanced guitar cable. The preamp should automatically switch to the DI signal.

If all went well, you should have a great sounding preamp ready to help you capture some great tones!

Any questions or issues regarding the ML12 build can be addressed to mike@whistlerockaudio.com.

Happy recording!

Last modified on September 3rd, 2015.