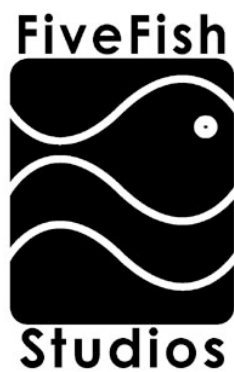


# **X-12 Mic Preamp Kit**

**Solid State, Discrete OpAmp Mic Preamplifier  
with Input and Output Transformers**



*Simplicity Counts, Detail Matters.*

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## **X-12 Mic Preamp**

### **Solid State, Discrete OpAmp Mic Preamplifier with Input and Output Transformers**

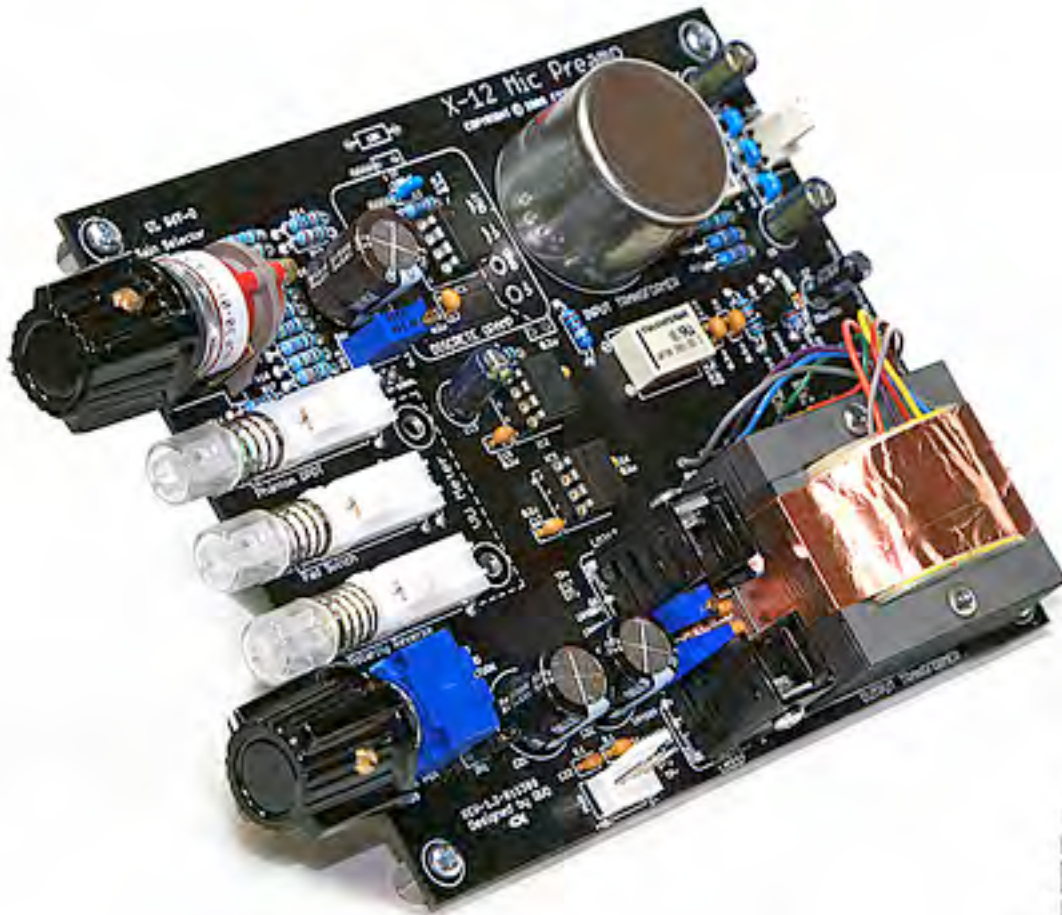
Congratulations and thank you for your purchase of the X-12 Mic Preamp Kit. The X12 Mic Preamp is my version of a classic preamplifier circuit made popular in the 70s. Some people call it the "L.A. Sound", referring to the huge mixing consoles used by L.A. recording studios back in the 70s era.

Hundreds of hours have been spent in the design, manufacturing and packaging of this kit to deliver to you a great preamp, with the same features and performance found in high-end boutique preamps. All at a very affordable price!

There are no special, expensive tools or techniques required to assemble this kit. All you need is the ability to follow instructions, use common sense, and the confidence in knowing that YOU can do this.

**PLEASE READ THIS DOCUMENT COMPLETELY BEFORE YOU ASSEMBLE YOUR PREAMP KIT.**

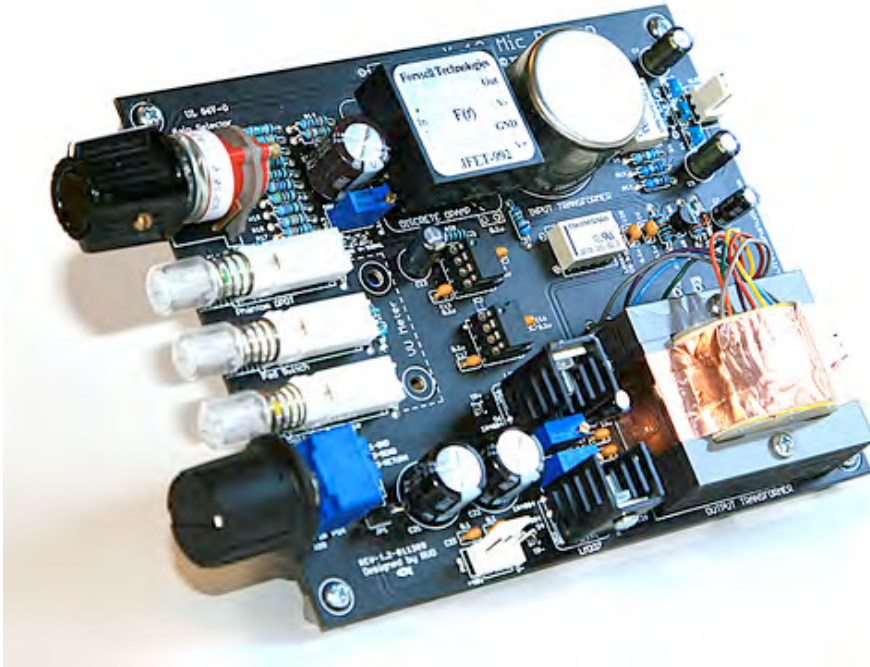
I know people sometimes don't want to read manuals. But unlike software, there is NO UNDO for this project. **READ THIS ASSEMBLY GUIDE COMPLETELY FIRST.** Take your time, and ask questions if you are unsure of something. Work methodically and carefully. I promise you, you'll be rewarded with a great preamp when you're finished. And you'll have pride and joy when you tell others that "Yes, I built this!"



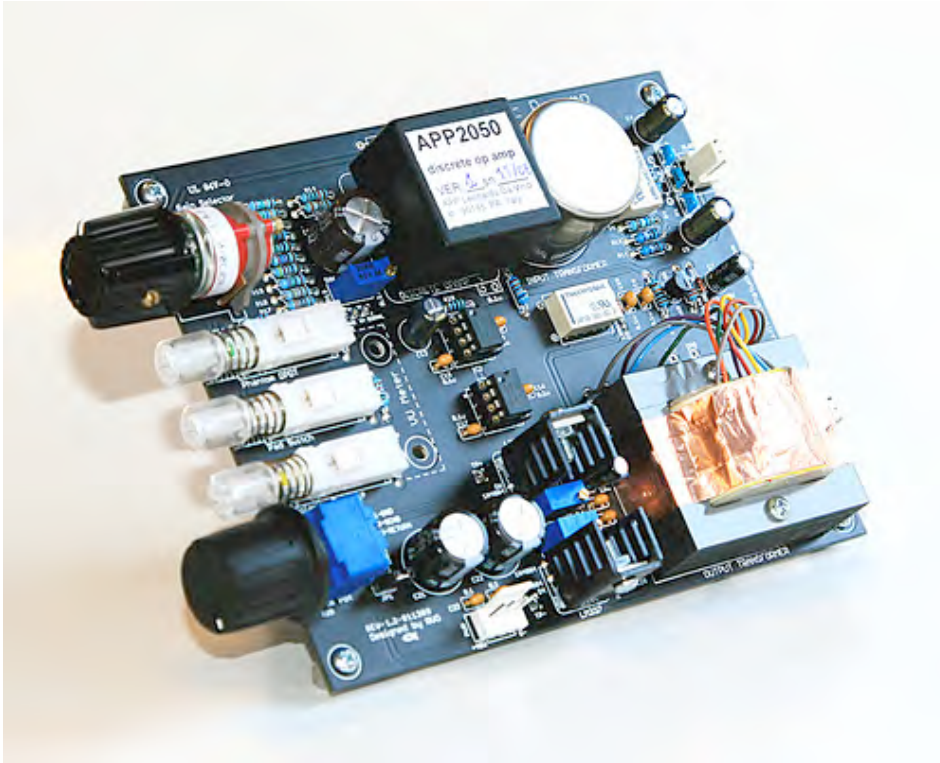
## X-12 Mic Preamp Variations (Using Discrete OpAmps)

The X-12 Mic Preamp has provisions for using discrete opamps if the user so desired. It uses the standard API 2520 OpAmp package and pin-footprint. Many compatible 2520 opamps can be used with the X-12 board. These are also sometimes called 990 OpAmps, or Discrete OpAmps. Here are some photos showing different discrete OpAmps installed:

Shown with a Forsell Technologies JFET-992.

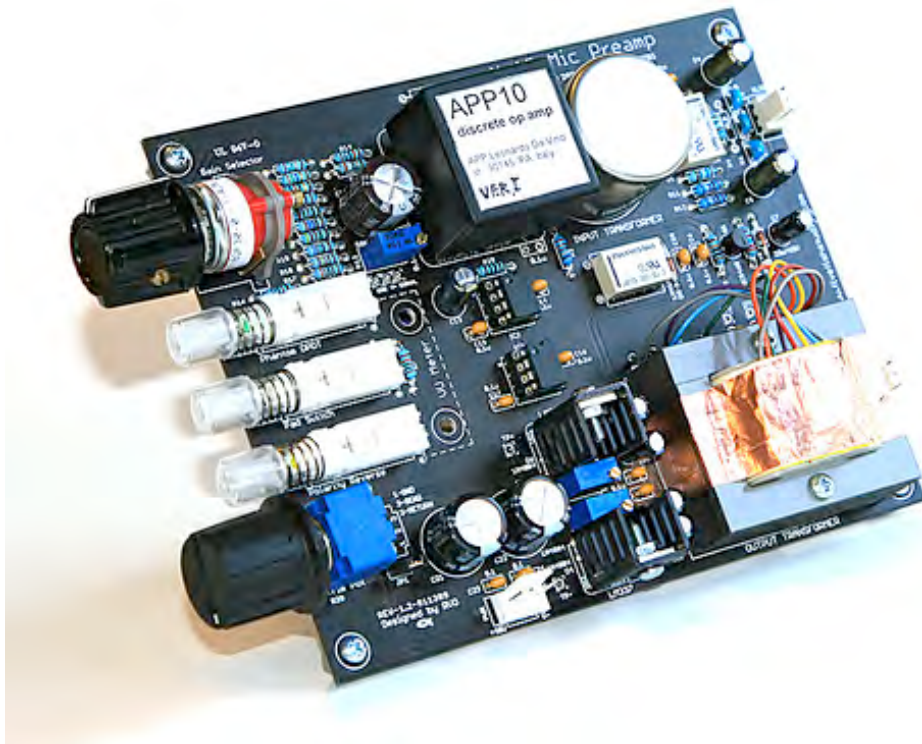


Shown with an APP2050 Discrete OpAmp from Italy.





Shown with an APP10 Discrete OpAmp from Italy.



Shown with a Melcor 1730 DIY Discrete OpAmp.



These are just a very small sampling of what Discret OpAmps you can use with the X-12 Preamp Kit.

## Features, Advantages and Benefits of the X-12 Mic Preamp

- Uses High-Nickel Mic Input Transformer with MuMetal Shielding
- Uses Output Transformer for additional 6dB gain and balancing duty
- 12-step Gain control from +22 to +66dB, in 4dB increments
- 5-LED VU Meter Monitoring
- Low-Noise, High-Quality, 600-ohm capable Monolithic OpAmp chip
- Option to use Discrete 2520/990 footprint OpAmp instead of Monolithic OpAmp chips
- Chipsets from National Semiconductors, Burr-Brown
- Using high-current, high-speed, video buffer driver at 2000V/us slew rate
- Soft-start, slow ramp-on +48V phantom power, controlled by illuminated push button
- Transformer balanced input and output stage
- 12-position Grayhill gain selector switch
- Input RFI protection
- Transformer isolated inputs
- Transformer isolated outputs
- Reduced clicking and popping when changing gains
- Voltage offset adjustment trimmer
- High quality Bourns, sealed, conductive plastic potentiometer for trim control
- High quality PCB Mounted, LED-illuminated Push Button Switches
- -20dB Pad, relay controlled
- Polarity Reverse switch, relay controlled
- Gold-plated, machined, low-profile IC sockets
- Use of high quality 1% Metal Film resistors, and high-quality ceramic and electrolytic capacitors
- On-board jumper terminals
- On-board and local voltage regulation section
- Easy to assemble, easy to troubleshoot design
- Each component carefully labeled, protected and packed in separate zip bags
- Thick PCB board with 2oz. copper
- Very affordable!!! No, this is not "cheap junk" but a high quality product that is reasonably affordable! (i.e. because there is no middlemen, and we don't do expensive glossy magazine advertising!)

## Basic Tools Required

A few basic tools are required to build this kit.

1. Soldering iron - adjustable temperature recommended, but not necessary. Your soldering iron must have a sharp conical tip. I do not recommend a "flat-head, screwdriver-type" soldering iron. DO NOT USE A SOLDERING GUN. They are usually rated at 100Watts and are overkill for this project.



2. Mini Pliers Cutter - to cut component leads, wires, strip insulation off wires (if you don't have a wire-stripper tool).
3. Mini Long Nose Pliers - to bend component leads, use as a heatsink, hold components, tighten bolts.



4. Manual Solder sucker pump or desoldering gun- sucks up solder when you made a mistake soldering components on the PCB. Pictured below is a Hakko model.



5. Multitester - A simple meter/tester to measure resistance, and voltages. A digital read-out is a big help.



6. Soldering Lead - 60/40 lead or lead-free solder.



7. Magnifying glass - to see what you're doing! Especially when soldering IC pins and the Grayhill selector switch.



8. Clean and well-lighted work area - Lots of good lighting, clean work area. You want to be able to leave your work-in-progress without packing everything away.

#### Extra Tools (Nice to have, but not required)

1. Vacuum desoldering pump - if you make a mistake, you need to pull out the component from the PCB
2. Component lead bender - bend component leads like resistors uniformly and evenly
3. PanaVise - to hold PCB while you're working on it
4. Tweezers - to pick tiny things
5. Masking tape - to hold components on the PCB while working
6. Wire-stripper - for cutting wires and stripping its insulation

## X-12 Parts Identification and Assembly Notes

For the newbies, this is not meant to be a full tutorial about electronics. But I want you to be able to identify components, recognize them and know what their basic functionality is.

In these sections, you'd also find instructions on how to use the INSERT jacks, and other geeky stuff. You'd also learn why I chose certain parts for this kit, even though they may be 3x more expensive than another equivalent part.

### Resistors

All resistors used in the X-12 Kit are 1/4 watt resistors. All of them are 1% tolerance, Metal-Film type resistors. These are high quality resistors, way much better than carbon composition type resistors (which usually 10-20% tolerance).

Resistors provide resistance, and are measured in OHMS, the unit of resistance.

1,000 OHMS = 1 KOhms (pronounced KiloOhms, where kilo = 1,000)

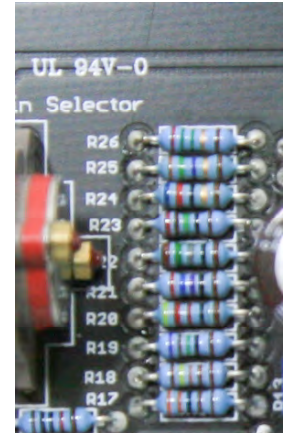
If you see a resistor value marked "1K", it means 1 KiloOhm. Sometimes, you would see values written as 6K8, or 3K3.

6K8 is also the same as writing 6.8 Kohm. The decimal point position is implied by the "K" letter.

3K3 is also the same as 3.3 KOhm, or 3,300 Ohms.

I don't need to teach you how to read resistor color codes since all the X-12 parts are already labeled for you. But if you're curious on what those bands of wonderful technicolors mean, you can go here.

[http://www.samengstrom.com/nxl/10116/5\\_band\\_resistor\\_color\\_code\\_page.en.html](http://www.samengstrom.com/nxl/10116/5_band_resistor_color_code_page.en.html)



### Capacitors

There are many types of capacitors used in the X-12 Mic Preamp project. Some are big, some small, some are polarized, some are non-polarized. We'll discuss the different types here.

#### Ceramic Capacitors

Ceramic capacitors look like the picture on the left. On the X-12 kit, these are colored "yellow" and "blue" and are very small in size. Ceramic capacitors are non-polarized, and therefore it does not matter what orientation they go in. They can go



in either way.

They are rated in microfarads (abbreviated as "uf"). They also have a voltage rating (abbreviated as "V"). In a design, the voltage rating must not be exceeded. Otherwise, you'll ruin the capacitor. Either short it out, or blow it open.

Capacitor parts are therefore rated with their capacitance (in microfarads, uf) and voltage... specified like this:

0.1uf 100V

Capacitance values may be expressed in microfarads (uf), nanofarad (nf) or picofarads (pf). The conversion between these units are shown on the table above.

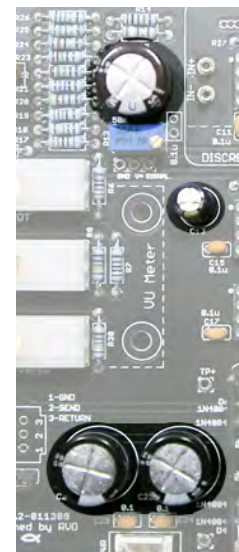
Microfarads (μF)	Nanofarads (nF)	Picofarads (pF)
0.000001	0.001	1
0.00001	0.01	10
0.0001	0.1	100
0.001	1	1000
0.01	10	10000
0.1	100	100000
1	1000	1000000
10	10000	10000000
100	100000	100000000

#### Electrolytic Capacitors

Electrolytic capacitors are cylindrical in construction. They look like the picture on the right. Unlike ceramic capacitors, electrolytic capacitors USUALLY/MOSTLY have polarity. One side is marked with the (-) sign, also called the Cathode, or negative side. The unmarked side is the (+) or Anode.

Just like ceramic capacitors, they are also measured in microfarads (uf). have a maximum voltage rating.

**WARNING:** It is VERY IMPORTANT not to insert Electrolytic capacitors backwards, or in the wrong polarity orientation. Doing so may/will cause the capacitor to explode. Yes, you read that right... EXPLODE. Do not let the small size of an electrolytic capacitor fool you. Even a tiny electrolytic capacitor can explode with a lot of force.





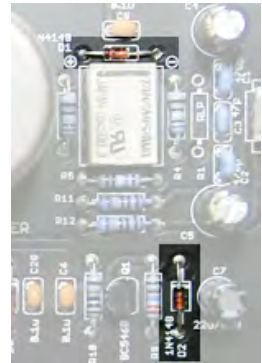
### Diodes

Diodes are semiconductor devices that permit current flow only in one direction. Think of it as a one-way valve.

The X-12 preamp kit uses 2 different kinds of diodes.

1. The first type of diode we're using is the SIGNAL DIODE. They have glass body, and used around the relays and the soft-start phantom power.
2. The second type of diode we use is the General Purpose, Rectifier Diode. They are black, with a white/silver band. They're used for the local on-board voltage regulator as protection diodes.

NOTE: Diodes have polarities just like electrolytic capacitors. One side is denoted as the ANODE (or positive side) and the other side is the CATHODE (or negative side). If you soldered these diodes in the wrong position, your phantom power or preamp may not work. Follow the band markings on the PCB silkscreen layout.



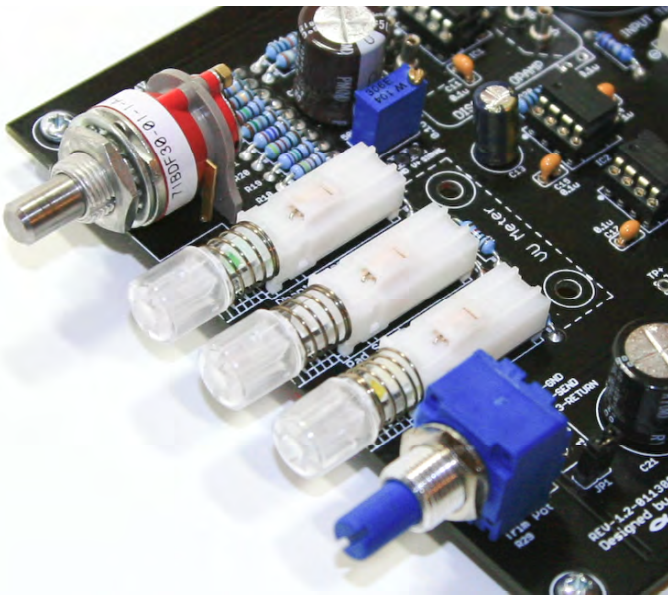
### Transistor

We're using a transistor as a switching device in the X-12 Mic Preamp Kit. The transistor has (3) legs, the Collector, Base and Emitter terminals. Looking from the top, the transistor has a half-circle shape, like a half-moon.

Take note when inserting transistors that you do not insert them backwards. Otherwise, phantom power will not work, and possibly even ruin the transistor. The flat side should be facing to the right.

### Grayhill Selector Switch

The X-12 uses a sealed, high-performance, high-quality, 12-position, Grayhill selector switch. It's the RED Selector switch below.



Some boutique preamp manufacturers also use Grayhill selector switches for their preamps. They are durable, reliable, have a nice solid feel to it, and provide good resistance to RF Interference. This switch will be the most commonly used/abused mechanical device on the X-12 preamp. I want this part to withstand being turned and turned and turned and is just one of the expensive parts in this kit.

### LED-Illuminated Push Button Switch

The X-12 also use a high quality, PCB mounted LED-Illuminated Push Button switch. From left to right, the functions are 48V Phantom Power, -20dB Pad, and Polarity Reverse. Each switch has it's own color. If you re-arrange the switches, make sure to re-arrange the LED current-limiting resistors too.



### Bourns Sealed Potentiometer

This is another high-priced item in this kit because it is another mechanical component and I want this part to withstand the use and abuse of being rotated constantly. I want it to provide a smooth feel, and not wear out easily, and become “scratchy” like a cheap, carbon potentiometer. I want it to have a longer life than plain “guitar potentiometers.” This is also sealed from the elements so dirt, grime, oil, and impurities will not contaminate the resistive element and produce a “scratchy” volume control. The resistive element inside is made of conductive plastic. Unlike carbon potentiometers, these will last a very long time even after repeated rotations.

### Integrated Circuit (IC) Chips

#### IC1

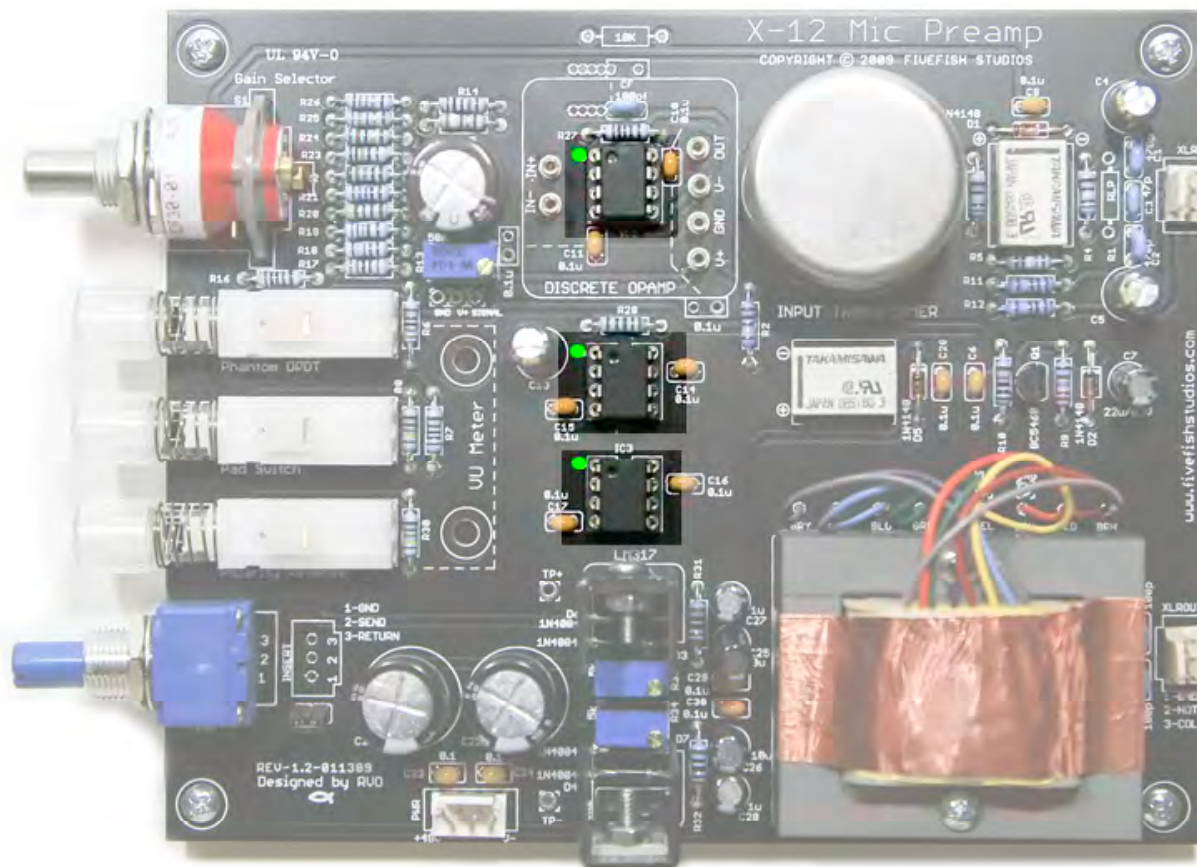
IC1 is a DIP-8 high performance, high fidelity Operational Amplifier chip. It can easily drive 600-ohm loads and has superior audio signal fidelity, output short circuit protection and with PSRR and CMRR exceeding 120dB (typ). Slew rate is 20V/us with a Gain-Bandwidth product of 55MHz. THD+N of 0.00003% is listed in the specifications. In simple terms, IC1 is an ultra-low distortion, low noise, high slew rate OpAmp designed for use on high performance applications like this microphone preamp.

#### IC2

IC2 is a Burr-Brown OPA134 chip. This is another ultra-low distortion, low noise chip designed for audio applications. This FET-input chip has high output drive capability, excellent DC performance and wide output swing, capable to within +/- 1V of the power supply voltage, which allows increased headroom.

#### IC3

IC3 is a high speed unity-gain open-loop driver. It has 250mA output drive capability, 2000V/us slew rate and 30MHz Bandwidth. Output circuitry is fully protected by internal current limiting and thermal shutdown. IC3 is used as a dedicated line driver for the X-12 Mic Preamp.



Above is a photo showing the locations of IC1, IC2 and IC3. Note the proper orientation of the chips.

The green dot in the photo above marks the location of PIN 1 of the IC chip. There is also a notch on the IC body to show the proper orientation of the IC chips.

**USING DISCRETE OPAMPS**

You may also use discrete opamps instead of the supplied PDIP8 opamp chip in the kit for IC1. Whether discrete opamps (DOA) are better than today's current IC chip designs is up for debate. Let your ears (and pockets) decide. © Either way, there is provision on the board to use either discrete opamp or PDIP8 chips.

You'll see the big square outline of a Discrete OpAmp chip on the PCB, with pads for IN-, IN+, OUT, V-, GND and V+.

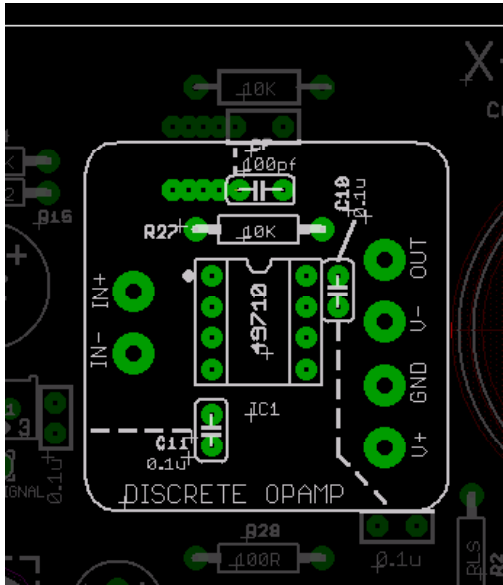
You have (2) Options for assembly:

Option A. Use Socket Pins for IN-, IN+, OUT, V-, GND and V+ pads. The Discrete Opamp pins are then inserted into the sockets. (Note: Millmax DOA Socket pins are not provided in the kit, but may be purchased separately. Contact us.)

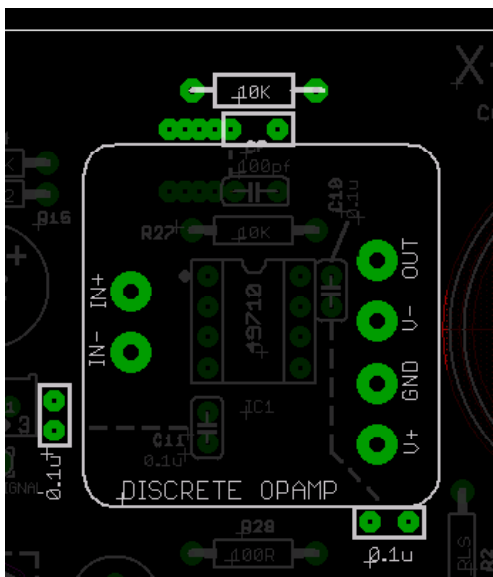
Option B. Solder the OpAmp directly to the board. (If you'll be using Yamaha Discrete Opamps, this is your only option.)

**OPTION A**

This is the recommended method if you'll be using the typical 2520/990 discrete opamp. If you'll be doing Option A, i.e. using Millmax DOA Socket pins, you can solder the PDIP8 IC socket, Cf, C10, C11 and R27 in their original locations on the PCB.

**OPTION B**

If you won't be using Millmax DOA Socket pins, you can solder the Discrete OpAmp directly to the board. Note that this is more risky and will also be more difficult to remove the opamp from the board later.



### RELAY

We're using two Fujitsu sealed, small signal relays to perform  $-20\text{dB}$  padding and polarity reverse switching on the preamp. This avoids running the signal wires to the front of the board toward the switches. Instead, we keep the signal path short and sweet, and only run the relay control lines to the switch located on the front panel. Switching the front panel switch energizes the relay, which causes it to switch and reverse the polarity on the balanced output signals.

Take note of the POLARITY of the Relay. The "black line" on the relay part should align with the "silkscreen line" on the PCB.

See photo below for proper orientation of the Relay.

Failure to follow this orientation will result in the relay not working, and possibly damaging the relay too.



### VU METER BOARD

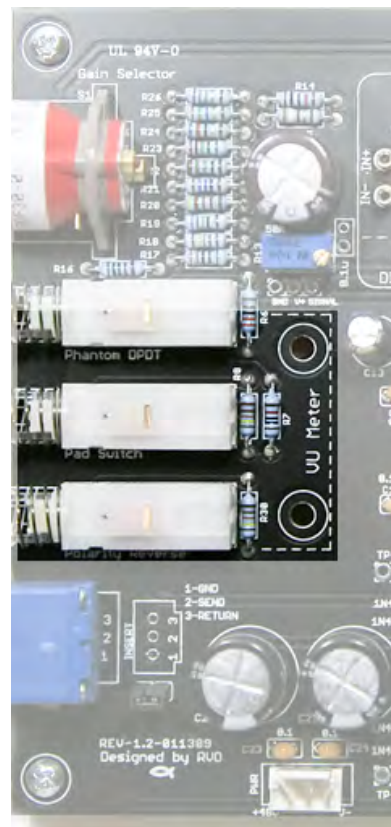
The X-12 preamp kit includes a 5-LED VU Meter kit for some basic metering. This is also useful for gauging the strength of the signal and if there is any signal present during troubleshooting.

Please note that the accuracy of this VU meter is not 100%, and therefore, rely on you're A/D meters or DAW VU meters for the exact dB value of your signal.

This onboard VU meter is just meant for a rough estimate of the signal strength, not an accurate dB meter.

Some aluminum hex spacers, nut and bolts are included in the kit. Attach the VU Meters to the main preamp board using the aluminum spacers, and nut and bolts.

Note how the VU meter is installed. The component side of the VU meter is facing upside down, and the copper portion is facing towards you.



**INPUT TRANSFORMER**

The Input Transformer we're using provides impedance matching, signal isolation, and "flavor enhancement" to our signal. It's a High-Nickel Input Transformer with Mu-Metal shielding.

Note: There is a resistor R2/RLS near the Input Transformer. This is a loading resistor. Changing this value will allow you to experiment with the sound of the unit. The included R2/RLS resistor in the kit I think gives the best balance of gain and sound quality.

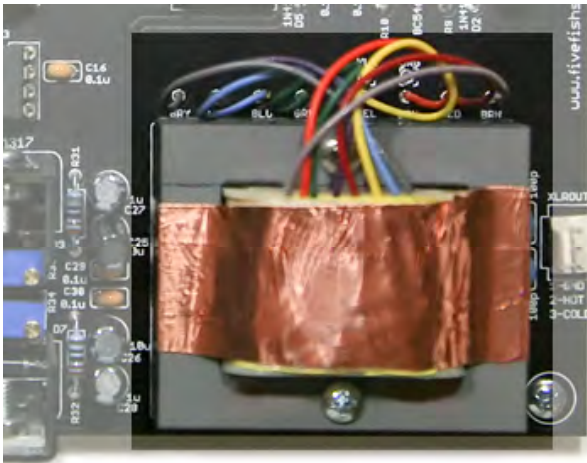
**OUTPUT TRANSFORMER**

Our output transformer provides signal isolation, and is wired as 1:2, which provides 6dB gain. Since it's also in the signal path, it will also give some coloration to the signal.

Strip the wires and solder the different colored wires to it's correct location on the PCB. The PCB is labeled with the wire color it should accept. Make sure to solder the colors in the right location, otherwise, your preamp may not work.

From left to right, the colors are:

GRAY, VIOLET, BLUE, GREEN, YELLOW, ORANGE, RED, BROWN



Try to keep the wiring clean and organized.

OPTIONAL: You may want to wrap it around with copper tape as shown above in the photo. (Copper tape not included in kit.) It makes for a more nicer look, in my opinion.



**NULL OFFSET TRIMMER**

I provided a trimmer resistor to allow you to trim any output offset voltage to 0V or as close as possible to 0V. One may not be able to achieve exactly 0.00Volt trim, but it's possible to get it close to less than 1mV of offset.

A too-high offset voltage will result in audible clicks and pops when you make gain adjustments (even at low-gain settings). Adjust the trimmer and you'll be rewarded with a click and pop-free performance when making gain changes via the selector switch.

Note: At very high gain settings, you may still get some pops due to the audio signal being switched when it's at a non-zero crossing point.



Further information about the Null Offset Trimmer will be discussed later in the assembly guide.

**VOLTAGE REGULATOR**

There is an onboard, local voltage regulator section for the V+ and V- supply lines. Two voltage regulators provide both positive and negative voltage regulation. Even then, I still recommend using a regulated power supply to feed voltages to the X-12 Mic Preamp.

**IMPORTANT:** The (2) regulators included in the zip bag are DIFFERENT. One is an **LM317 (Positive)** and the other one is an **LM337 (Negative)**. **DO NOT INTERCHANGE THE TWO REGULATORS!**

**POSITIVE VOLTAGE V+ ADJUSTMENT**

The top trimmer is used for adjusting the V+ voltage. Turn the screw to adjust the voltage up or down. We want a reading of +18Volts on the TP+ test point. (See photo above.)

**NEGATIVE VOLTAGE V- ADJUSTMENT**

The bottom trimmer is used for adjusting the V- voltage. Turn the screw to adjust the voltage up or down. We want a reading of -18Volts on the TP- test point. (See photo above.)

## X-12 Parts Kit

I've taken the time to individually package and label every component used in the kit. Just read the part # printed on the zip bag.

Some bags will contain 2, 3 or 5 different components. Other bags will contain just one part#. I want you to be able to build this kit, without sorting through hundreds of parts and not know what to do. This will save you a lot of time, and headaches! Some of you may not even have a multimeter (buy one, okay?) so I'm assuming even if you don't have one, or don't know how to use one, you'd still be able to figure out which is the 680-ohm resistor from the 6K8 resistor. It's all labeled!

## Assembly and Soldering Tips

Use a clean soldering iron tip. Heat the component lead and PCB pad, then apply the solder to the component lead while heating both with your iron. Do not apply the solder only to the iron.

Do not remove all the parts from the zip bags until you are ready to solder them. I've taken the time to sort them out; do not make a big unsorted pile out of them.

The holes on the PCB are plated through. This is also a double-sided PCB. Solder needs to make good contact inside the holes and on both sides of the PCB. Check that some solder flowed on the other side of the PCB, or that the holes are completely filled.

Be careful that you do not solder resistors in the wrong locations. For example: The resistors near the Grayhill switch are the gain staging resistors. It is important not to swap the locations of any of these resistors. Otherwise, your gain steps will be out of order depending on which resistors you swapped locations with each other... For Example: 6dB, 12dB, **24dB**, **18dB**, 30dB  
The resistors for the 18dB and 24dB were swapped with each other in this example.

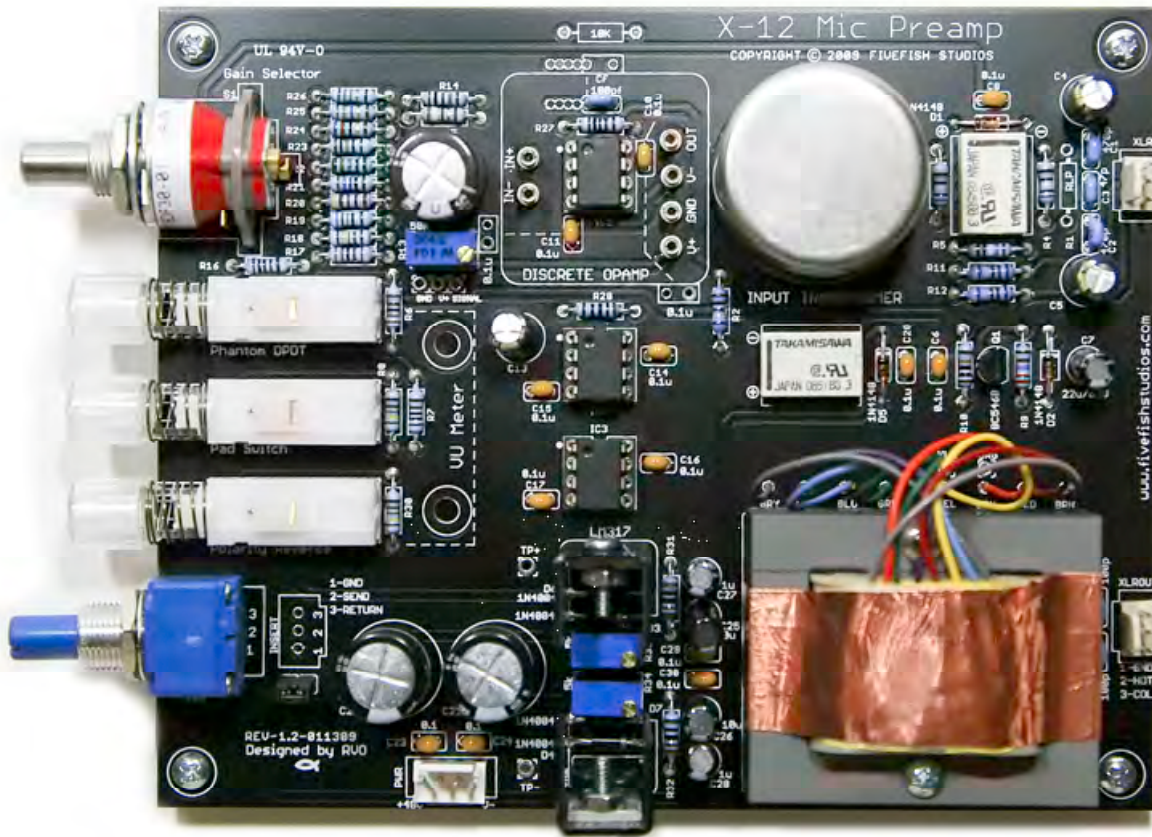
Note the orientation of diodes, and electrolytic capacitors. There is only one correct way to mount them. Do NOT mount electrolytic capacitors backwards.

When soldering multiple-pin devices (like IC sockets, jumper pins, Grayhill switches, DPDT Switches, Pots) solder one leg/pin first. Then check if the device is still flushed to the board, straight and not crooked. If crooked, re-heat the leg and straighten with your fingers while the solder is still soft/melted. (DO NOT STRAIGHTEN THE PINS AFTER THE SOLDER BECOMES HARD. You'd risk ruining the PCB or breaking the part.)

I sometimes use masking tape to hold the component in place on the board, while I solder the leads on the other side. This is very useful when soldering resistors, inductors, jumper connectors, IC sockets, small parts, etc...

Use a magnifying glass when soldering. This prevents you from using too much solder and let's you see what you're doing. Also, the Grayhill switch has very fine pin spacing. You need good eyesight to solder all pins properly without shorting them together.

## X-12 Assembly Guide



The general guideline in electronics assembly is to solder the smallest/shortest component first (resistors, diodes, inductors), and solder the bigger/taller components last (ceramic capacitors, electrolytic capacitors, switches, etc).

The last step is inserting the IC chips into the board.

**Follow this checklist during your construction.**

STEP 1. Solder all 1/4-watt resistors and inductors to the PCB. The orientation does not matter.

**ERRATA:** R23 should be a 93R1 resistor, not 215R, as marked on the PCB. Sorry for the mistake! The silkscreen will be corrected on later PCB revisions.

R27 should be a 22K6 resistor.

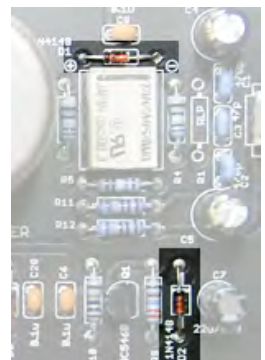
R38 should be a 10K resistor.

See ERRATA Notes on page 30.

STEP 2. Solder all signal and general purpose diodes to the PCB. Note the orientation of the diodes. Follow the orientation of the diode as printed on the silkscreen of the PCB.

Don't forget to solder the signal diodes located near each relay (white box component).

The General purpose diodes are the black diodes nearest the positive and negative voltage adjustment trimmers.



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[www.fivefishstudios.com](http://www.fivefishstudios.com)

STEP 3: Solder all IC sockets and Relays to the PCB. Make sure to mount all IC sockets in the correct orientation. (This will serve as a reminder on how IC chips will be inserted.) TIP: Use masking tape to hold the IC sockets in place while soldering.



Also make sure the Relay is oriented in the correct direction. Follow the "line marking" on the component with the printed silkscreen on the board.

STEP 4: Solder all ceramic capacitors to the PCB. These are the yellow and blue capacitors. The orientation does not matter.



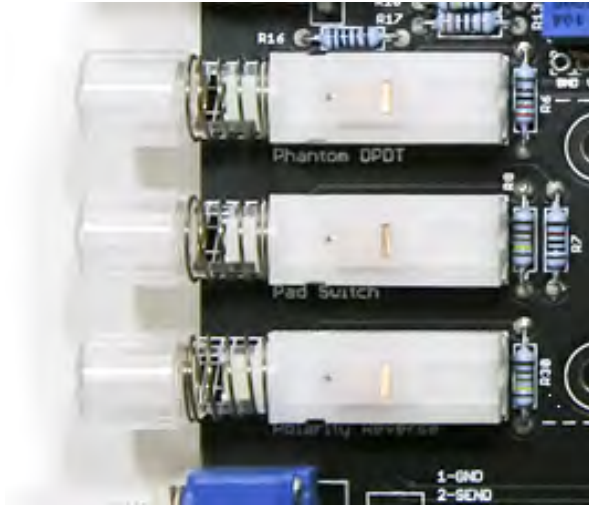
STEP 5: Solder the Transistor. Note orientation of the transistor. The flat side should be facing to the right. You will need to bend the middle pin backwards to go through the hole.



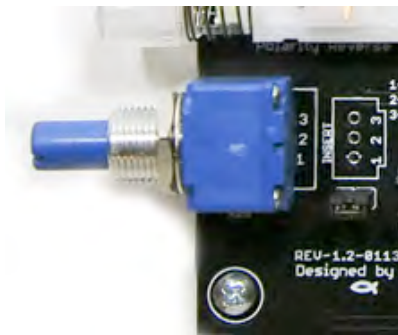
STEP 6: Solder all electrolytic capacitors. Note the orientation of where the (-) and (+) leg should be inserted. The unmarked leg of the capacitor is the (+) leg. All (+) legs are positioned either to the right, or up.



STEP 7: Solder the (3) Push button switches. This switch has 8 legs. They will “snap-in” to the holes in the PCB. Push firmly down until you hear it snap-in.



STEP 8: Solder the Bourns potentiometer. Solder the middle leg first, check alignment, and then solder the 2 outer legs.



Cut this tab on the potentiometer



**IMPORTANT:** Make sure you cut/snip the tab located on one side of the blue potentiometer. Cutting this tab will make the potentiometer stay straight and perpendicular to the Front Panel as you tighten the nut.

STEP 9: Solder the Grayhill selector switch. You really need a magnifying glass to make this work easy and accurate. The pins are very close together and you don't want to short these pins... otherwise, your gain dB steps will be all wrong.



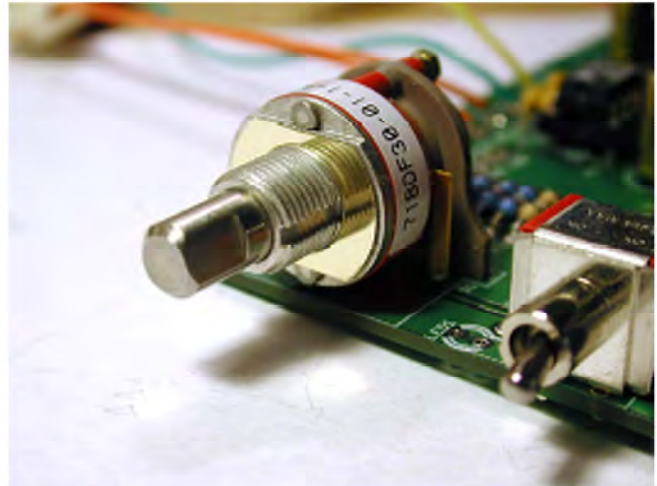
**Build Notes:**

a. Solder one of the end pins of the Grayhill switch, and then check if the switch is still flushed to the board, straight and not crooked. . If crooked, re-heat the pin and straighten the Grayhill switch while the solder is melted. (DO NOT STRAIGHTEN THE COMPONENT AFTER THE SOLDER BECOMES HARD. You'd risk ruining the PCB or breaking the part.)

If the part is flushed and straight (look at it from all angles), then solder another pin located on the opposite side. Check if the device is still flushed and straight. If it is, then solder the remaining pins.

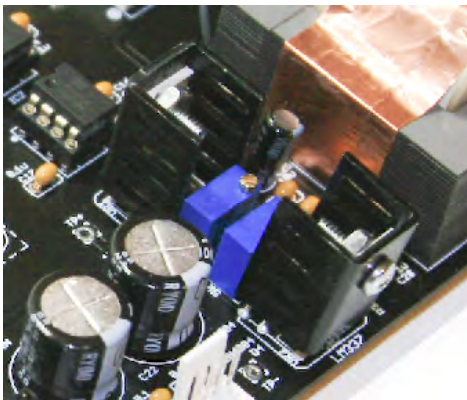
b. Installing the stop pins. The Grayhill switch will come with a metal stop pin rod, and a sticker. Use tweezers to hold this pin rod and push it inside the 12:00 position hole as shown in the photo below. Use the head of a flat-screwdriver on it's side to press the pin inside the hole until it is flush. Then put the sticker over it. Re-attach the washer and the nut and tighten the nut by hand. This will push the pin side and the sticker will keep it in place.

If you lost the included stop pins, don't worry. Just use some cut leads from a resistor.



STEP 10: Solder the TO-220 regulators. You may install the heatsinks before soldering to make the job easier.

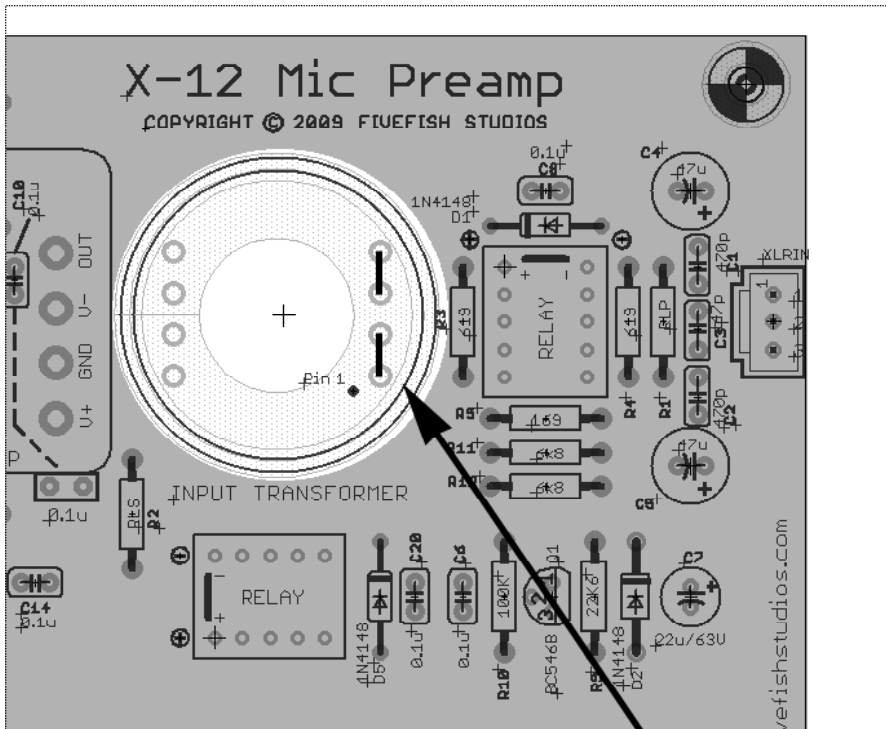
**IMPORTANT:** One of the regulator is an LM317 (Positive) and the other regulator is an LM337 (Negative). DO NOT INTERCHANGE THE TWO. Follow the locations on the PCB on where you should solder the LM317 and LM337.



STEP 11: Install the Input Transformer. For the Input Transformer, orient the “dot” with the printed silkscreen dot on the PCB. Don't forget to also install the R2/RLS resistor located on the lower left corner of the Input Transformer.



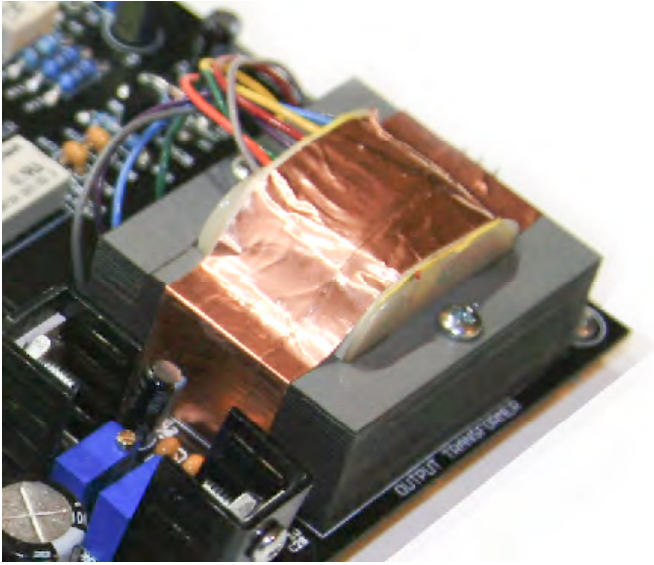
ERRATA: Short pins 1-2, and 3-4 at bottom of PCB.



TOP VIEW



STEP 12: Install the Output Transformer. Cut and trim the wires and solder the corresponding wire color to it's corresponding hole on the PCB board. Mount the Input Transformer using the supplied nuts and bolts.





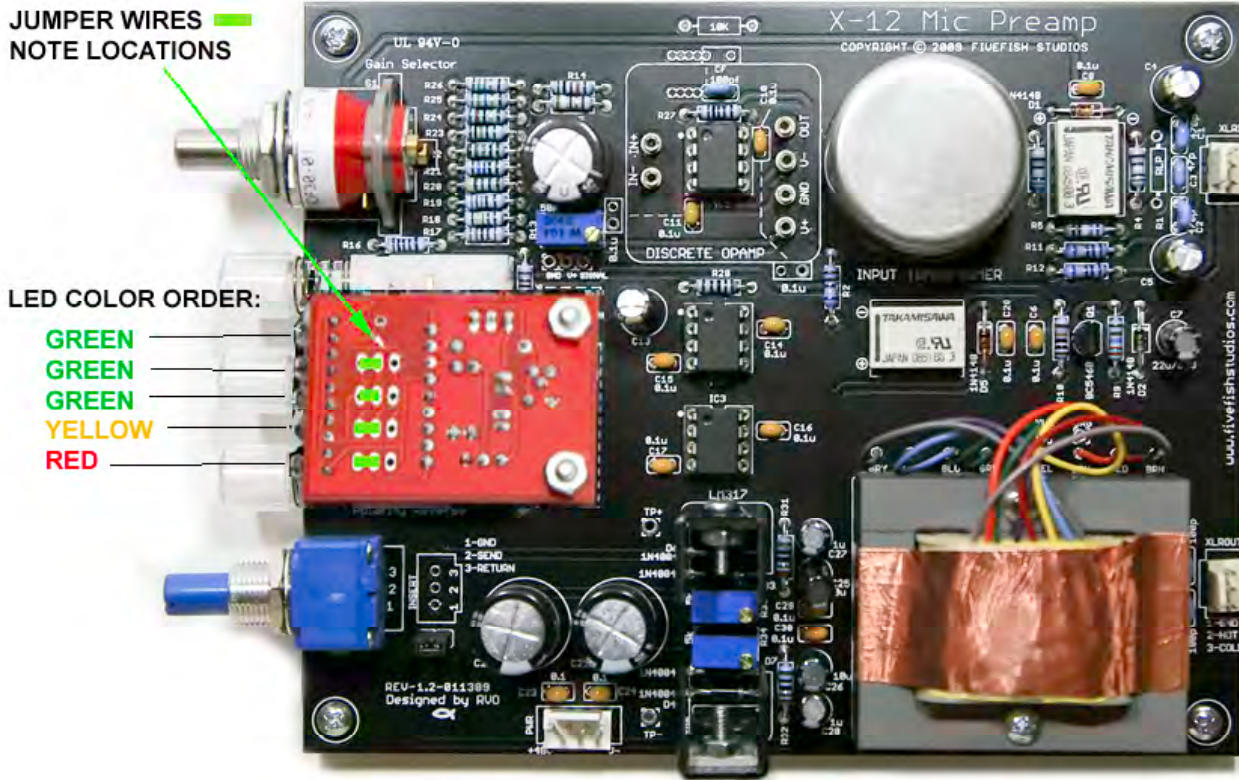


STEP 14: Build the VU Meter Module. Follow the silkscreen layout on the VU meter PCB and insert the components into it's right location.

You need to install a jumper wire across the HORIZ position. See photo below.

NOTE: VU Meter is installed upside down, bottom side up. (Especially important if you're using the X-12 Rack Case).

NOTE #2: Take note of the LED Color Order for Horizontal Mounting of the preamp board. See guide below.



**NOTE: VU METER BOARD IS INSTALLED UPSIDE DOWN**

## VU Meter Calibration Guide

1. Adjust trimmer resistor so that when you feed a 0dB signal to the VU Meter, the 3<sup>rd</sup> LED lamp lights up.

For +4dBu operation, connect a signal generator to the VU meter input, 1Khz, adjust output of Signal generator to 1.22Vrms, and adjust trimmer resistor until 3<sup>rd</sup> LED lights up.

## VU Meter Troubleshooting Guide

Well, hopefully you won't need this part.

"Measure twice, cut once"... as they say. Take your time assembling the kit, don't be in a hurry, work carefully and methodically and you won't need this troubleshooting guide

**Problem: No lights, no LED movement. VU Meter does not work!**

Check if there is power applied to the VU Meter Kit. Supply voltage must be at least 5Volts DC. Check the GND wire is connected.

Check that the LEDs were inserted in the correct orientation. Long leg soldered to the left side.

Check that you installed the jumper headers for JP1, JP2, JP3 and JP4. All jumpers must be in the HORZ position.

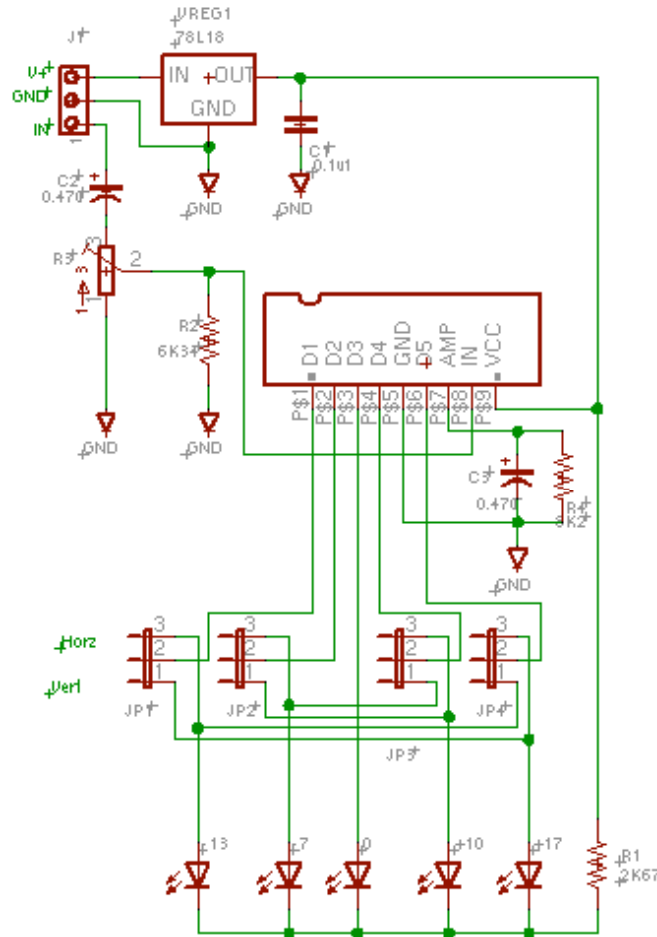
Check that the trimmer resistor is adjusted.

Check that you have signal coming out of your preamp/XLR jack. Make sure it is strong enough to register on the VU Meter Kit.

### VU Meter Bill of Materials

Qty	Part	Desc
1	PCB	Custom PCB
1	VREG1	78L18
5	D1,D2,D3,D4,D5	3mm LED
1	IC1	NTE1866
1	C1	0.1uf 100V
2	C2,C3	0.47uf 50V
1	R1	2K67
1	R2	6K34
1	R3	10K Trimmer
1	R4	8K2

### VU Meter Schematic



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**PRE-FLIGHT CHECK ADJUSTMENTS:**

Review your work. Finished reviewing it? Good.... Now REVIEW IT AGAIN! It's easier and less stressful to review your work now before any problems.

To be specific, make sure components are inserted in the right locations.

Make sure all the diodes are pointing in the right direction.

Make sure all the electrolytic capacitors are inserted in the right direction.

**VERY IMPORTANT:** Make sure there are no SHORTS in your soldering job, especially in the power lines V+, GND, V-. You can use a multimeter to verify this.

PLEASE REVIEW YOUR SOLDERING JOB, MAKE SURE THERE ARE NO SHORTS, especially any shorts in the power supply path.

**POWER SUPPLY WIRING**

Connect the X-12 preamp to your power supply board. If you're using the PSU-2448 kit, please see the PSU-2448 Assembly guide instructions.

There are (4) connections for power. From left to right, they are +48V, +18V, GND and -18V.

Connect the corresponding wires to your power supply PCB.

After wiring the power supply, we'll need to make voltage adjustments.

I recommend that your power supply board be set to +21Volts or higher. The X-12 board will regulate this voltage further down to +/-18Volts. See next step for Voltage Adjustment.

**VOLTAGE ADJUSTMENTS**

The X-12 Preamp uses both a +18 and -18Volts to power the circuitry. (The +48Volts is solely used for microphone phantom powering.)

**POSITIVE VOLTAGE V+ ADJUSTMENT**

The top trimmer is used for adjusting the V+ voltage.

Connect the black lead of your multimeter to Ground. Connect the red lead of your multimeter to the TP+ point on the PCB. See photo above. Turn the screw to adjust the voltage up or down. We want a reading of +18Volts on the TP+ test point. Do not exceed +18Volts.

**NEGATIVE VOLTAGE V- ADJUSTMENT**

The bottom trimmer is used for adjusting the V- voltage. Connect the black lead of your multimeter to Ground. Connect the red lead of your multimeter to the TP- point on the PCB. See photo above. Turn the screw to adjust the voltage up or down. We want a reading of -18Volts on the TP- test point.

### AUDIO TESTING

Connect a dynamic microphone to the input XLRs, connect a monitor speaker to the output XLR, turn power ON, set the gain switch, adjust volume and you should hear sound come out of your preamp.

If using a condenser mic, turn phantom power switch to ON position. Check to see if the LED lights up. Wait a few seconds, and your condenser microphone should start working.

Check that your LED VU meters are working and blinking.

### NULL OFFSET VOLTAGE ADJUSTMENT

Now that we've verified our preamp to be working, let's do some fine-tuning adjustment. Connect the black lead of your multimeter to GND, and the red lead to the OUT pad on the PCB (nearest IC1).



Make sure your multimeter is set for DC voltage.

Adjust the trimmer shown above until you get a reading of close to 0volts on the OUT pad. A reading of 10mV or less should be good. It is possible to get an adjustment reading of 1mV or less. (Just be patient trimming the pot.)

A good trim adjustment will reduce (if not completely remove) clicks and pops when changing gain settings.

## X-12 Troubleshooting Guide

Well, hopefully you won't need this part.

"Measure twice, cut once"... as they say. Take your time assembling the kit, don't be in a hurry, work carefully and methodically and you won't need this troubleshooting guide. I've built several prototype preamps in the course of testing and designing the X-12 and each one of my prototype worked on the 1<sup>st</sup> try.

So I'll try to imagine where are the "critical" areas where somebody might make a mistake.

**Problem: No sound. No thump, no noise, no nothing.**

Check if there is power. Check all wires of the power supply. Check all IC chips are in the correct orientation. Check that volume pot is not at minimum setting. Check that you did not swap the positive and negative voltage regulators.

**Problem: No phantom power. My condenser mic does not work.**

Check if there is 48V power. Check that the transistor is mounted correctly. Did you turn on the phantom power switch? It should be clicked fully to the left (i.e. pointing to the LED).

**Problem: My condenser mic works when I switch on phantom power, but the LED is off.**

Your LED is backwards. Re-orient the other way.

**Problem: Sound is very faint. And very noisy. Distorted sound.**

The IC1 chip is probably damaged. Replace IC1 with another chip of the same model and test again. Check that you're applying the proper voltages to the preamp.

**Problem: My FET condenser mic works, but the sound is very faint. I only hear the sound at the higher gains.**

Check that you're feeding the X-12 preamp with +48V. Some condenser mics will work with voltages as low as 14Volts or 18Volts. But some mics need a higher voltage than that. Measure the voltage between XLR pin2 and XLR pin1. You should be getting close to 48Volts if phantom power is switched on.

**Problem: My gain settings are out of order. It will get loud, very loud, then soft, then loud.**

Check there are no shorts in the Grayhill selector pins. Check that the resistors nearest the Grayhill selector are the proper values and that you did not "swap" any 2 of them.

**Problem: I turn on phantom power but I don't hear a thump and it takes a few seconds before I can hear sound.**

This is normal. This is due to the soft-start phantom power. It takes anywhere from 15 seconds to 30 seconds to stabilize and reach full power. I'm not applying the full 48V at full blast to your expensive mics. Rather, I feed phantom power to the mic gradually and raise the voltage gradually. It also protects your speakers from the thumping sound, and your expensive mics.

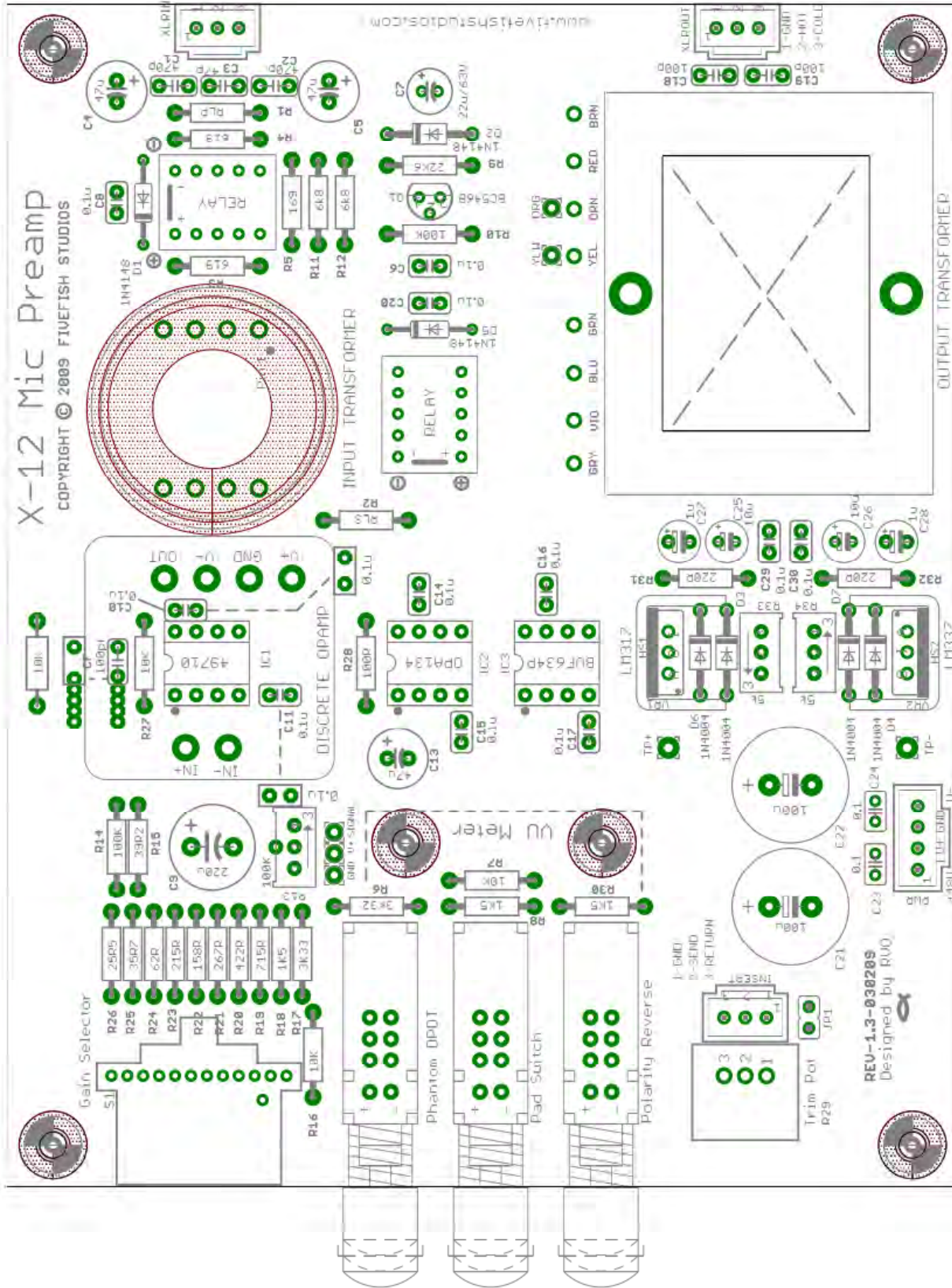
**Problem: I don't have any mic connected, but I'm hearing hissing noise at +66dB gain.**

First, let's talk in real numbers instead of decibels (dB). A gain of 66dB is 2000x amplification. Without any mic connected to the preamp, you're leaving the inputs unterminated. In normal use, the preamp should see a 150-ohm load at the inputs, and there will be less noise/hiss. At these high gain settings, and without any mic or load connected, what you're hearing is called "Johnson noise." You're basically hearing the random movement of electrons in the circuit. The hotter the temperature, the more the electrons are agitated, and the higher the hissing noise you'll hear. See this article in wikipedia. [http://en.wikipedia.org/wiki/Thermal\\_noise](http://en.wikipedia.org/wiki/Thermal_noise). I've attempted to reduce this Johnson or thermal noise phenomena by using metal film instead of carbon resistors as much as possible. Another method of reducing this type of noise is cryonic freezing. Wear a warm jacket.

**Problem: I want to record in stereo, but I only have (1) X-12 preamp.**

Buy another kit ☺

# X-12 PCB Component Layout Guide



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## X-12 Parts List (1u format)

Part	Qty	Value
PCB	1	X-12 PCB
<b>Capacitors</b>		
C1,C2	2	470pf/50V
C3	1	47pf/50V
C4,C5,C13	3	47uf / 50V
C6,C8,C10,C11,C14,C15,C16, C17,C20,C23,C24,C29,C30	15	0.1uf / 100V
C7	1	22uf / 63V
C9	1	220UF/50V
Cf, C18,C19	3	100pf / 50V
C21,C22	2	100UF/ 100V
C25,C26	2	10uf/ 63V
C27,C28	2	1UF / 100V
<b>All resistors 1/4 watt, metal film when available</b>		
R1/RLP	0	Not Used
R11,R12	2	6K8
R3/R4	2	619R
R5	1	169R
R6,R17	2	3K32
R7,R16, R30	3	10K
R9, R27	1	22K6
R10,R14	2	100K
R13	1	100K Top Adjust Trimmer
R15	1	39R2
R8,R18	2	1K5
R19	1	715R
R20	1	122R
R21	1	267R
R22	1	158R
R23	1	93R1 Note: Marked on PCB as 215R
R24	1	62R
R25	1	35R7
R26	1	25R5
R28	1	100R
R29	1	10K POT, LINEAR TAPER
R31,R32	2	220R
R33,R34	2	5K Top Adjust Trimmer
R2/RLS	1	150K
<b>Semiconductors</b>		
IC1	1	LME49710
IC2	1	OPA134P
IC3	1	BUF634
D1,D2,D5	3	1N4148
D3,D4,D6,D7	4	1N4004
VR1	1	LM317T
VR2	1	LM337T

Q1	1 BC546B NPN transistor
<b>Miscellaneous</b>	
RELAY	2 Fujitsu Mini Signal 12VDC
IC Sockets	3 8-pin IC socket .300 GOLD
S1	1 GRAYHILL 1-DECK, 12-POS SWITCH
SW1	1 Push button switch with Green LED
SW2	1 Push button switch with Blue LED
SW3	1 Push button switch with Yellow LED
CAP1,CAP2,CAP3	3 Caps for push buttons
T1	1 Mic Input Transformer
T2	1 Line Output Transformer
HS1,HS2	2 Heatsinks TO-220
XLR-F	1 Neutrik XLR Female
XLR-M	1 Neutrik XLR Male
JP1	1 Conn Header 2Pos 0.100 vert
ST1	1 Conn Jumper Shorting Tin
Bolts for heatsinks	2 Phillips pan, Zinc plated steel, 4-40 x 1/4
Nuts for heatsinks	2 Hex machine screw nuts, Zinc steel, 4-40
Bolts for Output Trafo	2 Phillips pan, Zinc plated steel, 4-40 x 3/8
Hex Spacer for Output Trafo	6 HEX .187X.250 ALUM

**VU-1B Rev1.2 Meter for X-12**

Part	Qty Desc
PCB	1 Custom PCB
VREG1	1 78L18
D1,D2,D3	3 GREEN LED
D4	1 Yellow LED
D5	1 RED LED
IC1	1 NTE Chip
C1	10.1uf 100V
C2,C3	20.47uf 50V
R1	12K67
R2	16K32
R3	110K Trimmer Vishay
R4	18K2
Spacer	2 Aluminum 0.75" spacer
Phillips pan head 4-40 x 1/4	2 Zinc plated steel, 4-40 x 1/4
Hex machine screw nuts	2 Zinc plated steel, 4-40

# X-12 Preamp Errata

Some last minute corrections in the assembly instructions.

1 .The new batch of Yellow Push Button switches I got have super bright LEDs.

To make the LED brightness match the Green and Blue switches, please USE A 10K RESISTOR FOR THE YELLOW LED current limiting resistor.

2. For an additional 6dB gain, and extending the low freq. response of the X12 preamp, please use a 22K6 resistor for R27 shown below.

