Time to start building your legends

attention | disclaimer

all analogvibes projects are presented as artwork, and are solely intended as such.

build at your own risk

although our content can help you to build (legendary) functioning tube studio gear - due to the high voltages and possibilities of human error , analogvibes | martin zobel hereby assumes no liability for injury/damage/loss which might unintentionally occur.

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Before we start...

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I can understand if you have concerns building tube gear as there are serious voltages involved.
So as always when dealing with electronic circuits and with tube gear in particular, you have to work carefully.

PRECAUTIONS

There are some essential rules which, if followed, should make building your own tube gear a safe ride.

1. ALWAYS unplug the unit from the mains before touching the circuit.

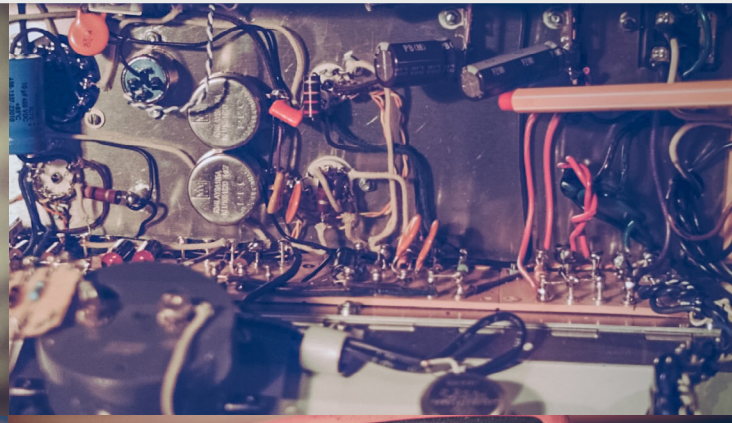
2. BE AWARE:
Capacitors act pretty much like a battery - they can hold their voltages for a pretty long time - longer than you might expect.

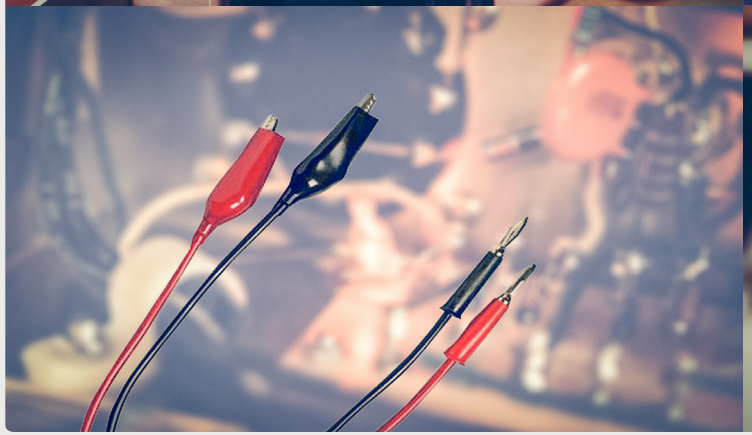
3. SO IF YOU'RE NOT SURE:
Go measure with a digital multimeter (DMM).

4. IF THERE IS VOLTAGE:
Use your DMM and a capacitor discharger/ bleed resistor to discharge the cap.
There's more info on this on the next page.

5. IF IT SHOULD BE REQUIRED
to measure a live unit, use a crocodile clip, at least for one probe so you don't have to fumble around inside the box with both hands.

6. ALWAYS DOUBLE CHECK
your components before soldering them in - this can save you a lot of trouble later...





Safety first!

After the massive feedback I received on what the major concerns are when building your own tube gear, I decided to extend the "Precautions" article by one more page.

I totally understand your doubts and reservations in regards to the high voltage existing in these circuits, and while DIY is not only A LOT of fun but even kind of addictive, it's certainly not worth getting injured or even killed for.

But also there's absolutely no need to panic! :D

It's very uncommon to build your gear while having it plugged to the mains, so there should be absolutely no voltage present while building ;)

With the basic rules in mind mentioned on the last page working with these high voltages only becomes relevant in case we need to a) troubleshoot or b) calibrate a live unit (if that is necessary at all).

Other than that I'd say there's one very important rule you should follow while building your legend:

DOUBLE CHECK your components before soldering them in. It can save you a lot of trouble. I know I already mentioned that, but I remember when I started building my own gear I was over-meticulous measuring the components sometimes even 3 times to be absolutely sure and I always crossed out or checked that particular component I just placed in my BOM to prevent any confusion.
Of course it took a little longer but it worked very well - my first LA2A worked from the spot.

And one more advise: FOCUS.

Don't prepare the favorite dish for your wife/girlfriend/lover/kids or watch the NBA finals while building your legend or you're asking for trouble!

If you follow the above mentioned you should be fine. That said there can be a situation where troubleshooting is necessary, but I will cover that in an extra chapter. What I can certainly give you to take with you for now: Even if troubleshooting is necessary at some point: **Don't panic - you're unit will work eventually!** So far the success rate for analogvibes projects has been 100% which is not too bad ;)

Returning back to our main topic of this chapter, please allow me one last piece of advise even though I might have said that already:

Stay calm, stay focused and don't rush it!
Like I said, I've been through all of that. Even though DIY is a lot of fun, there can be a situation where you can lose patience - either because you're so excited about the gear you're building and you want to use it as soon as possible or even because you're frustrated at times that things don't work as expected:

STAY CALM & FOCUSSED

All situations I can remember when I messed up or even got an electric shock were when I lost patience.

I have to add though I barely had any instructions when I started other than schematics, so I needed to find out a lot about what's important and how to go by it on my own - **so in this regard you are in a very luxurious situation my friend :)**

Basics

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Before we jump right into it, I want to turn towards the basics one more time. If you are already experienced and already know how to measure etc. you can skip this page and go straight to the next one. If you are new to DIY, this can hopefully help you to get going:

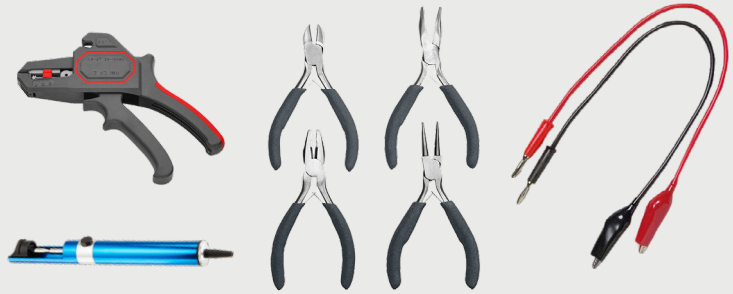
TOOLS

Obviously some tools are needed in order to build your own studio gear. Some of them are absolutely essential while others are nice to have Here are my recommendations :

Essentials:

- **soldering iron**, adjustable temp. recommended
- **solder:** check the next pages for detailed information on which type of solder to choose
- **wire clipper** and **electronic pliers**
- **digital multimeter** (DMM)
- **screwdriver** and **spanners** to mount the hardware

Nice To Have:

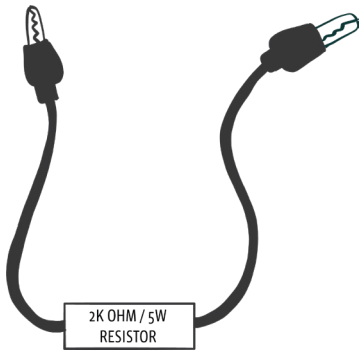


- **strip-off pliers**
- **desoldering pump**
- **more electronic pliers**
- **alligator clip wires** (+ alligator clips for your DMM)

Good To Do:

Follow this link to learn how you can easily build yourself a capacitor discharging tool:

CAP DISCHARGER DIY ›



HOW TO:

Measure the voltage in your project:

Set your Multimeter to read AC or DC voltage. Connect the black probe to ground (use one with alligator clip here, so you don't have to focus on two probes at the same time).
Measure with the red probe. **Focus** - slipping off and causing a short can damage your gear!

- **PSU before the rectifiers: AC**
- **Tube heater supply (H+) and audio signal: AC**
- **B+ voltage after the rectifiers: DC**

Solder and start with electronics:

GREAT TUTORIAL ON SOLDERING AND BASICS ›

Discharge a capacitor:

Either connect your DMM across both legs of the cap to be measured or connect the black probe to ground and the other one to the positive side of the cap. Connect your cap discharger across both legs of the capacitor until the voltage is down.
Again - alligator clips come in handy here.

we were solderers

This time it's not a movie starring Mel Gibson - this time it's real and guess who's starring...right - YOU!

JUST GO WITH THE FLOW

Ok now that we went through all the basics, let's take a closer look at some of the ingredients for mastering your build mentioned on the last page. First of all and one of the most important ones: soldering. I know if you haven't done any soldering before it might seem very difficult and some kind of vodoo - but I assure you it's not. It's actually fairly easy and if you know some fundamentals it's actually much more difficult to mess up, but let me explain...

On the last page is a very helpful YouTube link to a great tutorial on how to start soldering and I highly recommend you watch it - at least certain parts of it. I'll reference to them as we move along.

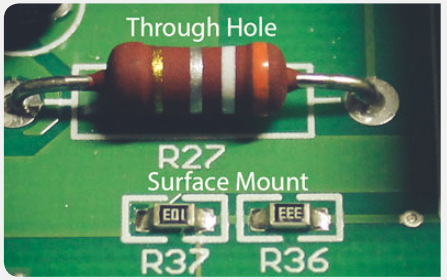
First of all you'll need a good soldering iron, but don't worry they're not as expensive as you might think, respectively you can get a great one for around $100.00 new or even a lot cheaper used. **Two things that are important here**: buy one with variable temperature - you won't regret it!
And secondly don't buy a cheap no name one - you would definitely regret it!

Any solid brand like Weller, Ersa or Hakko will do fine!
Also it doesn't have to be a new one. My first soldering station was a 25 year old Weller and I did most of the gear I built with it and I bought it for around EUR 35.00 on ebay.
The EEV Blog youtube tutorial I mentioned earlier you should definitely watch **from the beginning until minute 5:52** - he's talking about basic tools and also about how to choose the right soldering iron.
Also worth watching is the part from minute 17:45 - 19:20 where he explains the different tips that can be used on a soldering iron.

If you already watched the video - there are some things I'd recommend differently - let me explain:

Even if we're not dealing with microprocessors where components are not even visible without a microscope (one single Core i7 quad processor consists of around 1.000.000 transistors) nowadays electronics are all made with SMD components - tiny resistors and capacitors soldered on very small pcbs.

Before that there were somewhat larger pcbs with so-called **"through-hole"** components - meaning the components with wire legs that are fed through the holes of the pcbs and then soldered.
The pcb on the right shows two tiny SMD resistors (surface-mounted) next to a regular "through-hole" resistor - what a difference, right?



Even with "through-hole" only pcbs, the solder joints can be so close to each other that it can be quite challenging not to merge holes by accident.

Why am I writing all of that?

Because luckily all the legendary pieces of gear we'll cover here are neither SMD nor PCB but "**Point-To-Point**" (P2p) instead. Which means **our components are mostly huge** and a we'll have lot **more space** while working! **Hoorayy!**

In regards to the choice of the right solder that means - even though Dave Jones in that EEVblog video recommends not to use solder above 0.5mm in diameter - for our projects I'd recommend a diameter of 0.75mm - 1.0mm (0.03in - 0.04in).

In terms of the actual process of soldering I highly recommend to **watch minute 2:00 - 5:00 of Part 2 of the EEVblog video** - he's explaing it very well and I couldn't add anything else to it.

What I'm trying to say: It is really not as complicated as it looks and a lot easier than you might expect!

CHOOSING THE RIGHT SOLDER

One more thing in regards to choosing the right solder.
On the previous page I talked about the right diameter for point-to-point projects. The term ***"point-to-point"*** simply refers to all components e.g. in an LA2A or Pultec EQP-1 a being hand-wired - some of them even soldered together directly.
If you choose to do any kind of PCB based design I'd also recommend to not go beyond 0.5mm (0.02in) in diameter.

That said I haven't talked about the compound of the solder itself.
In the first part of his soldering tutorial (minute 10:20 - minute 17:00) Dave Jones actually shares some great insights on that subject - the thing is that he recommends leaded solder because it's much easier to work with than lead-free solder.

Even though I had the same opinion and actually used leaded solder for the most part of my DIY life as well there is one problem to it - at least for those of you living in the EU:

In order to comply with ROHS standards manufacturers must only use lead-free solder in their products since 2007/2008. And as off 2017 leaded solder must not be sold by retailers based in the EU.

Now there a a few ways to cope with it - at least for people like you and me who only build the gear for themselves:

1. leaded solder is still available outside of the EU, so if you need to buy parts from e.g. Mouser you can get your leaded solder there, too. I don't know for how long but here's a Mouser link to one of the proven classics of leaded solder:

AIM Solder Sn60/Pb40 ››

2. Even though it's still a very wide-spread assumption that lead-free solder is much more difficult to work with, manufacturers have made quite some progress in the recent years to get to a point where **lead-free solder is pretty much as easy to handle as the classic leaded one.**

Especially in light of the challenges we're facing right now and we'll definitely be facing in the future we can't deny the fact, that lead is a heavy metal and bad for the environment - and for you if should decide to eat or inhale it.
(It's pretty obvious that good air circulation is must when soldering, right?)

So if you still have leaded solder laying around, it's still better using it than throwing it in the trash, **but if you're new here and you're still looking for the right solder to use for your projects, I recommend you use this one:**

AIM lead-free Solder SAC305 ››

To close this chapter let me say something about setting the right temperature.
Even though lead-free solder supposedly requires a higher temperatur I found that both solders mentioned above work perfectly fine when **setting the soldering iron to 350°C (662°F).**

Keep in mind that components vary in terms of temperature sensitivity and while the golden rule is **"as short as possible - as long as necessary"** - the mostly huge components we work with in these projects are far more robust than the tiny SMD components mentioned earlier. And **if there are especially sensitive parts I will let you know explicitly in the guides.**

Parts

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I know this has been one of the major concerns for many of you:
Where to get the parts & components , do they still exist at all and how to find good replacements...

ORIGIN

As mentioned before: I totally hear you and I've been through all of that. When I started to build my first studio classic I spent a very long time trying to find out which components were actually used and where I could source them. Believe me the fact that most of that gear originated from the USA, while living in Germany myself, didn't make it any easier. Except for maybe when building my Neumann U47 with original parts - but that's a different story ;)

So I found myself scrounging surplus parts shops, hunting on ebay and later as the community evolved I even got help from an initial analogvibes group member and now friend to get my hands on original parts to build new prototypes for analogvibes projects - **big thanks and shoutout to Jonathan fom California!!**

All of that made it possible to test, measure and learn - and eventually even find suppliers and manufacturers who could make substitutes and replacements following original specifications .
Of course that has been a process of several years and while even today not all analogvibes projects are on the same level in terms of guides and documentation they're all heading in the same direction.

FOR YOU

that means depending on the project you choose - something between **most** and **all** of the work has already been done for you in order to find what you need to complete your build.

These are the different stages of analogvibes projects in regards to finding the critical parts you need:

BOM:

Tube-Midrange EQ
176 Vari-Mu Limiter
Tube Program EQ

- **detailed list with parts & components you'll need**
- **critical vintage parts are listed but also modern replacements and where to get them**
- **you know what to look for and in most regards also where to look but you have to do it yourself**

LINKED BOM:

Tube Opto Comp

- **complete list with all components you'll need**
- **EVERY single part & component is directly linked to an online shop** (yes also the T4B opto cell ;))
- **Mouser cart for 80% of the parts in the BOM - 1-click and you'll have it all in your shopping cart.** Free worldwide shipping within 3 business days
- **In case a certain part from the Mouser cart is out of stock - check this short clip on how to find the right subsitute ››**
- **you have to buy the parts yourself, but sourcing them has already been done for you :)**

KIT:

Tube Program EQ
complete kit

- **ALL INCLUSIVE - please check the next page for more details ;)**

Parts 2

If you followed the 2nd Build Your Legends Series you already know that with one particular project we're taking it to the next level.
And since that might be something to become reality for other projects as well in the future, I'll use where we're at now as an example:

TUBE PROGRAM EQUALIZER

THE COMPLETE KIT

I've been asked it a lot lately - *"Hey Martin what's actually included in the complete kit for the Tube Program Equalizer?"*

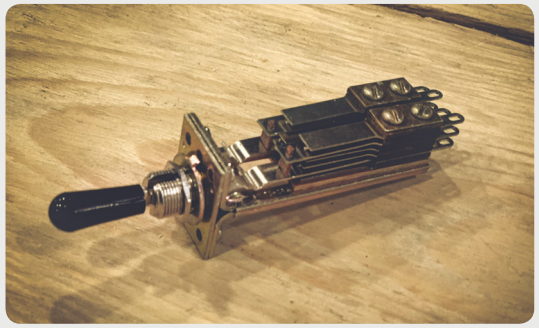
Mmmh...let me give you a hint - if I didn't include everything you need to build a fully functioning unit, I would have called it:

TUBE PROGRAM EQUALIZER

THE ALMOST COMPLETE KIT

Ok I'm sorry :D but yes, the plan is to include EVERYTHING - even the wires.
It's been a huge undertaking for me and so far I've been working on it for the better part of one year to bring it to life. So in regards to the Tube Program EQ project I guess you won't have to worry anymore.

The challenge was to remain as close to vintage units as possible while at the same time sourcing parts that are readily available for all of us.
Which in case of the Tube Program EQ meant some parts would have to be custom made...



Of course in a project like this we're talking very small quantities, so obviously we hit some boundaries. Like some manufacturers would have been glad to helps us - **if we ordered at least 10.000 pieces...**
uhm...let me think...uhm...**NOPE.**

The good news is we also found some suppliers that really wanted to support this project. Like I'm very happy to have found a good manufacturer with **Blore Edwards from the UK** who custom make all rotary switches and pots for the kit - their build quality is absolutely stunning and **the log curves of the pots are even modeled after Allen&Bradley pots used in vintage units!**
What? What the heck is a "log curve"?! Maybe that's a bit too nerdy for this e-paper **but believe me it's crucial!! :D**

Also we managed to get Switchcraft who was the manufacturer of the original Pultec Bypass switches, to do a reissue for us - even though these massive switches went out of production almost 20 years ago! (see pic on the left)

And finally Moby Electronics agreed to custom make one of the most critical parts - the inductor - following original specifications - even potted in bees wax just like the original!

Long story short: complete kit means one box - everything in there ;)

Troubleshooting

It seems like the need to troubleshoot a unit for many is like the ultimate nightmare - like *"please no troubleshooting, please! I'll do everything you want but please spare me troubleshooting!"*

Now seriously - let me tell you something - just between the both of us:
In all the years since I started to DIY my own studio gear, I never learned as much about electronics and how a particular piece of gear works, as when it didn't work - period.

Of course the feeling of switching on a unit you've built with your own two hands for the very first time and it works from the spot is hard to beat - no doubt about it! Especially if it's legendary piece of equipment you've always dreamed of having in your rack.
I've seen people going all crazy in that situation, running around the block all naked screaming like a weirdo only because they were not prepared for the impact that very moment would have on their being! **It's true - trust me - you have to be prepared**.

But to be completely honest with you, of course I didn't like it too much when I was in the situation where troubleshooting was necessary.

From my personal experience with my own builds the general stages of self-perception while troubleshooting are:

1. Oh my god it doesn't work - no no no
2. What shall I do - I have no clue - I'm lost!
3. Panic
4. Calming down
5. Visually expecting wiring & components
6. Finding possible culprits
7. Hope
8. Nope that wasn't it
9. Devastation & Panic II
10. Calming down & re-inspection
11. The ultimate believe I made no mistake - it has to be a faulty component
12. Oh my god I found it - how in the world could I've missed that?!
13. It works! It works! I'm the f**ing greatest!
14. running around the block scr...

Some of the steps can repeat themselves along the way, but trust me on that one:
IN THE END THE UNIT WORKED. Everytime.

And just to make sure we're on the same page here - I knew absolutely nothing about electronics when I started out - niente - nada. Remember this guy on the right? I bet he was an electronics genious compared to me back then.

What I'm trying to explain here is that even though I started off at zero, and even though it was extremely tedious and time consuming to gather information mostly on my own, **in the end I made it and the learning experience was priceless.**

Now finally back to analogvibes and more importantly - back to you. I just want you to know that in case you need to troubleshoot your unit, you might run into some of the stages listed earlier - but relax - there hasn't been a single analogvibes community member who didn't make it.

The reasons for that are obvious:
#1 I try to guide you as good as I can while enabling you to learn along the way.
#2 You are not alone - we are many.
#3 If you read until here you already know so much more than I did back then.

JUST IN CASE...

Ok now how to proceed in case your unit doesn't work.
First of all relax - your unit will work eventually. Of course you can write me an email and I will try my best to ge back to you as soon as I can. **But** - you might like Facebook or not - until we can find a way to establish a dedicated community board that works **we created a Facebook group and it absolutely kicks ass!** The group has close to 2000 members by now of which at least a dozen are the solid core of extremely helpful and knowledgeable people. **If you post your problem into the group, you'll get help immediately and will be up and running in no time!**
On the final page of this paper you'll find a couple of basics in regards to components which might come in handy while building and troubleshooting.

More basics

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At the end of this e-paper, I want to turn towards the basics one last time. Again If you are already experienced and know the different components you can skip this page. If you are new to DIY here's an overview of components & which wires to choose. **I know this is very basic,** but it might still be helpful to some of you - it certainly would've been for me back then when I started.

COMPONENTS

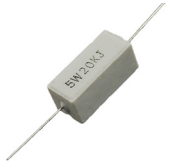
Resistors:

carbon composition

carbon film

metal film

metal oxide



ceramic

wire wound

- if you need replacements for out of stock parts the most important numbers to look for are same **Ohm** value and **Watts**
- in vintage units mostly **carbon comp** or later **carbon film** was used for the most part.
- in newer designs they were replaced with **metal film** resistors as they tend to be less noisy
- **metal oxide, ceramic and wirewound** are used for power supply applications where higher wattage is required
- when measuring set your DMM to read **Ω**

Potentiometers (pots)

mono

stereo

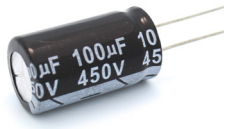
with switch

- a potentiometer is simply a **variable resistor**
- available single gang (mono), dual-gang (stereo) also triple gang and more, with switch or without
- can be **linear** (Lin), **logarithmic** (Log) or **reversed logarithmic** (Rev Log)

Capacitors (caps)

film - axial

film - radial



electrolytic (polarized)

ceramic disc

silver mica

electrolytic can (polarized)

- if you need replacements for out of stock **caps** the most important numbers to look for are same **Capacitance** value and rated **Voltage**
- **film, ceramic disc, silver mica & polystyrene** caps are **not polarized** - you can mount them either way
- **electrolytic and tantalum** caps **are polarized** - you have to **check for correct orientation** before soldering them in
- there's also **variable caps** where you can adjust capacitance (see LA2A guide)
- capacitance is measured in **Farat** (F, µF,nF,pF)

Hook-up wire

Many times I got asked which wire to choose in terms of diameter and composition. It's actually not that difficult. Hook-Up wires are available with solid core or stranded. For our application it's actually completely up to your taste.

Solid core wire can be routed more easily because you can bend it and it remains in that position. Also I find it easier to hook up. **On the other hand** very thin solid core wire can break more easily when moved around a lot.

The wire recommended for our projects isn't that thin though. My recommendation is to use **AWG 20** (0.5mm²) **or AWG 18** max (0.75mm²) for the **power supply and heaters** and **AWG 22** (0.32mm²) **for the rest of the circuit**.