

# Some Modifications for the Behringer CAT

## Synthesizer

(V1, maffez, May 2022)



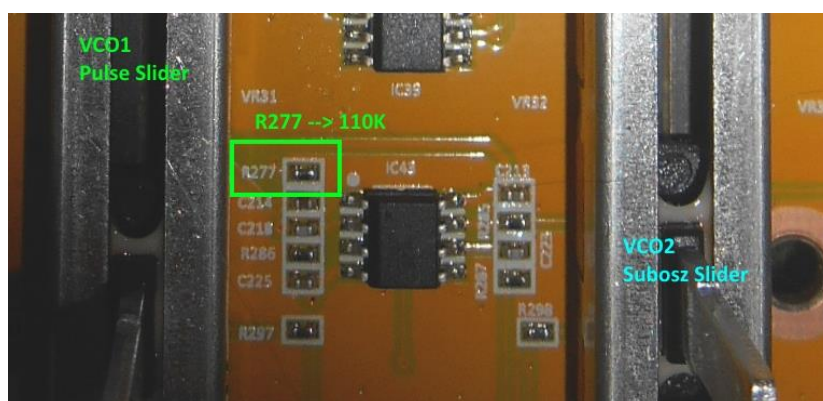
[CAT SRM Service manual](#) (not the actual version Behringer used but still very helpful!).

The so-called [factory modifications](#) are not considered here although it could be that in one or two cases I reinvented the wheel, as it were. At any rate, the modifications described in this document here are for non-commercial and fair use only.

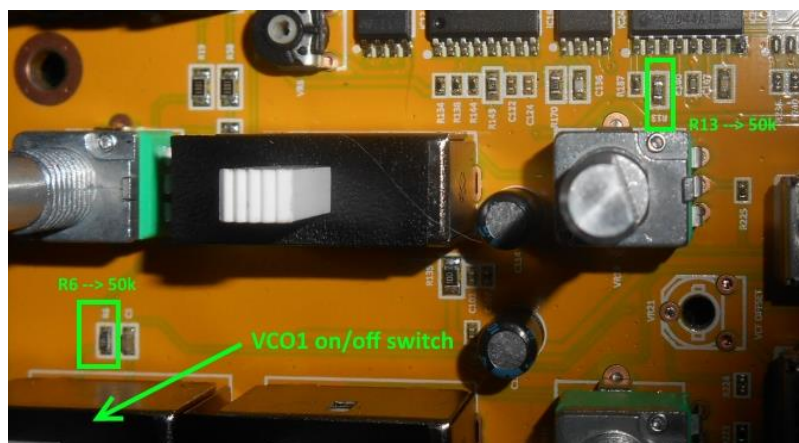
## Essential tweak: CHONKIFY your CAT!

The Cat's internal gain staging and parameter scaling are chosen to be on the sweet side. This is sweet, since most settings are in a wide sweet spot, and the cat never clips, regardless of full tilt square wave and sub oscillator action. Now, in feline terms, this sonic character may well count as a fine kitty, yet what if you want it to sound chonkier? There's quite some leeway in this regard!

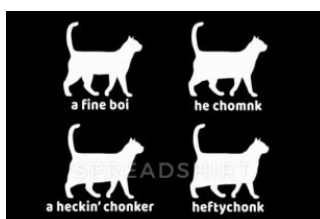
If you want to keep your resulting cat between "chomnk" and "heftychonk," first of all, **increase your VCO levels**. For **VCO 2**, simply reduce R277 from 150k to 110k.



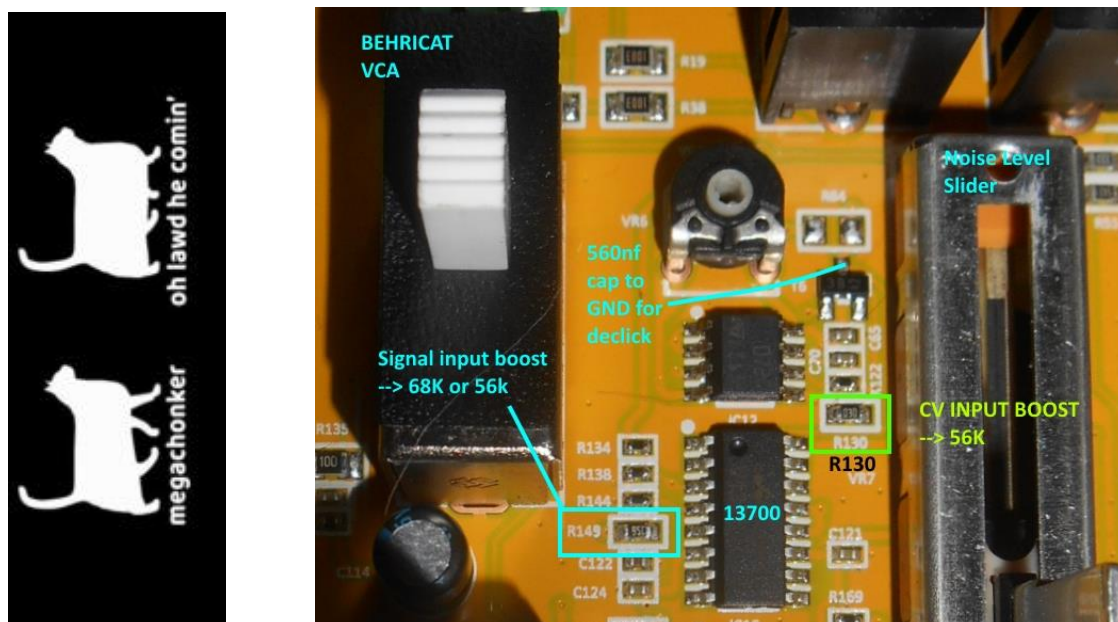
For **VCO 1**, the setup has an extra step on account of the Cat's on/off switch for that oscillator: reduce R6 and R13 (each 68k) to 50k each (these, together with R285, which is 10k, give you 110k in total, just like for your new VCO2 level).



In addition, **increase the VCA control voltage** from the internal envelope by reducing R130 to 56k, and while you're at it, reduce the resistor just above R85 from 51k1 to 33k (that's for the VCA CV INPUT socket).

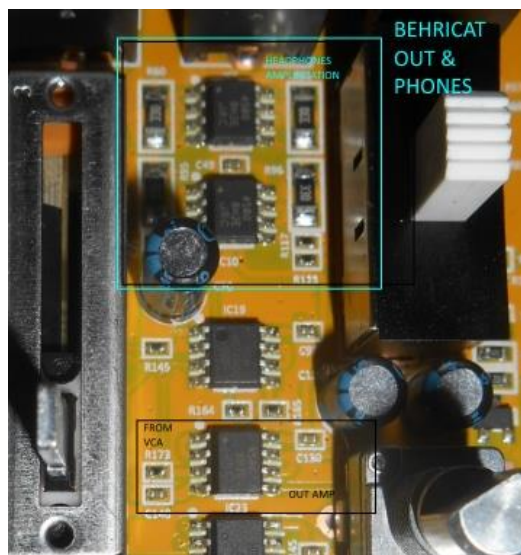


Now, if you want to go “megachonker,” also **increase the VCA signal input level** by changing the value of R149 (95k). You can use a switch or pot (best range is between a total of 22k-100k) – on my unit I simply replaced R149 with a 56K resistor. Your output turns rather loud that way and, especially in the second setting, conveys almost a sense of “oh lawd he comin!”



### Direct VCA output/ rearrange headphones output

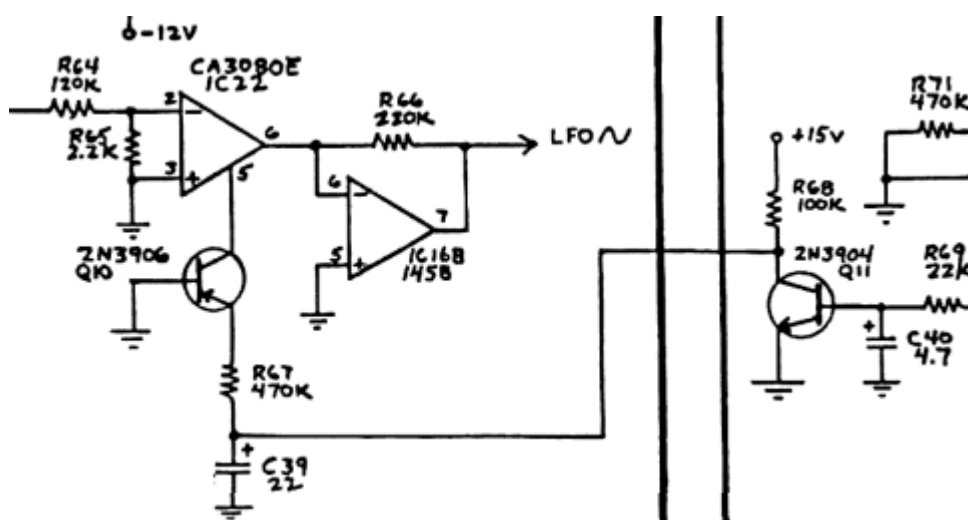
The VCA output (PIN5 of the V13700 OTA) goes directly to a dual op-amp buffer (IC23, an NJM45080 is in place where the original sports a TL082). Amplification for the headphones is done per two 4580 op-amps left of the VCA mode switch. On my unit I took these two amps out as well as the HP socket and have in its place an output socket for VCO1 signal. The latter, in conjunction with a slightly rewired external input, serves me as an insert point for using a different filter.



## Low Frequency Oscillator

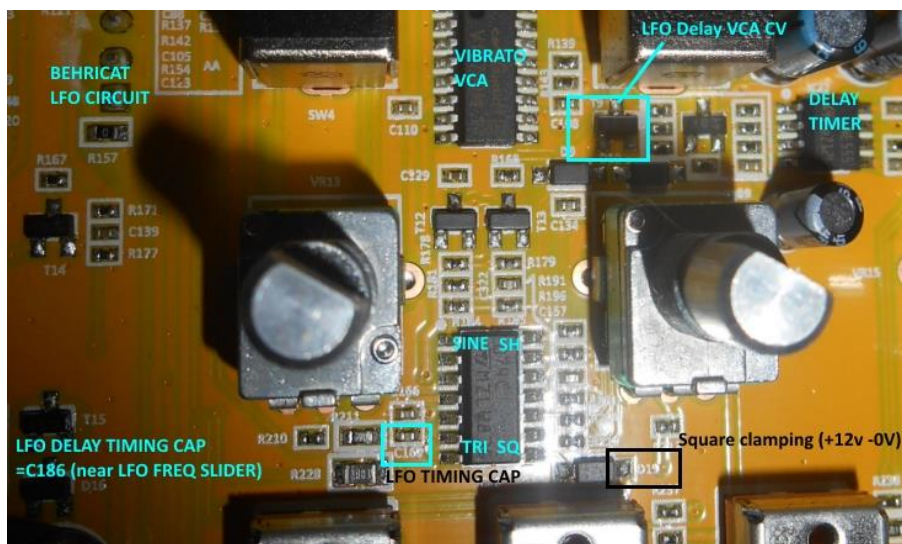
The LFO is analogue, with **C169** (100nf) as timing cap. At IC28, a quad op-amp, you get IC28-A-sine, IC28-B-tri, IC28-C-square, and D is the S&H input buffer amp. The individual waveforms can be fed to individual output sockets. (NB that square swings between -12v and +12v, so if need be clip the negative part with a diode.)

As for modifications, I toyed a bit around with LFO reset but don't find that too worthwhile here. What could be more interesting is to lower the LFO frequency by augmenting **C169**, to feed an **alternative input into the sine shaper** part at **R139** (120k) or use some **CV input socket for the vibrato VCA** (the LFO delay) at T9 emitter. The latter can be especially fun!



From cat SRM service manual

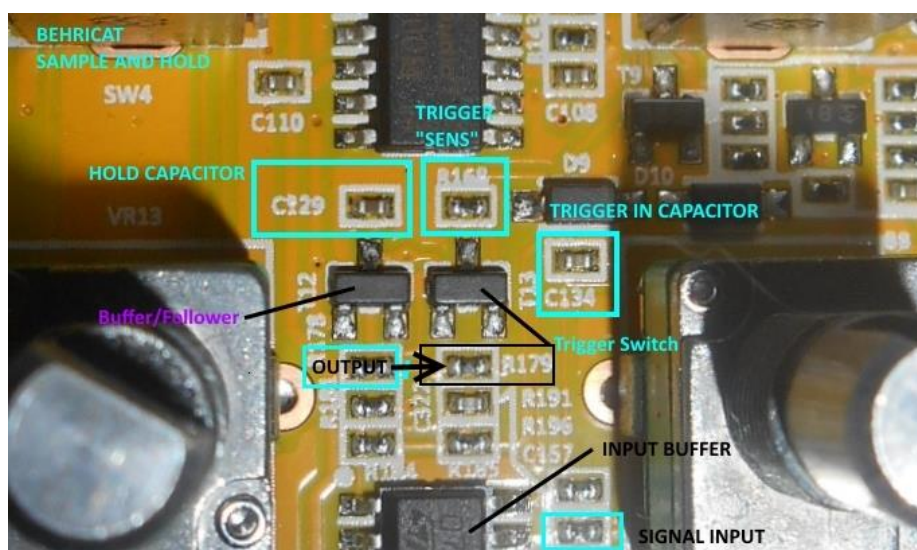
The CA3080 in the CAT is replaced by a V13700 OTA, and the rest of the setup is the same. Between T10 collector and T9 emitter there is a 470k resistor that would be your best insert point if you want to use a switched socket for external VCA CV. NB that your incoming CV is between 0V and +15V, so best clip negative voltages with a diode.



For more ideas, search for my [Behringer Module 150](#) modifications – the LFO delay circuit on the Roland/Behringer 150 is very similar to the Cat's, and you might gain some inspiration from that one for stuff like feeding audio through the “delay” as a sort of ducking VCA. Especially if you're planning on using some sort of Eurorack extension panel for your modded Cat, there's quite a bit which you can play here.

### Sample and Hold

The circuit is analogue and pretty much as per old CAT schematic. The signal that is sampled, as selected per “VCO1/Noise” switch, passes a buffer op-amp (IC28-D). You can modify the **sampled signal input** flow, say by inserting a switched socket between R196 (100k) and your input signal selector “VCO1/Noise” switch.



The **clock signal** that makes the circuit sample a slice of information from the input signal and then hold that value until the next clock trigger, enters the circuit at C134 (100nf). Modifying this clock input so that you can use external triggers or the Cat's own GATE signal requires a bit of effort work in order to work reliably. First of all, the S&H clock input is set for engaging at a rising edge from -12V to +12V, and, secondly, its sensitivity is not super suited for external inputs since a lot of sporadic re-triggering happens when you simply have an insert on C134. So, we first **change the sensitivity** by increasing the value of R169 (220k) to 1M. **So replace R169 with a 1M resistor.**



Secondly, we need an **insert point at C134**. What I find easiest is to remove C134 entirely and have all the added circuitry on a little sub-PCB. On the CAT PCB itself, you need to attach a wire to the **cathode of D9 as your new clock input**, you need to **tap the square LFO** from IC28, PIN8, you need to **tap GATE** output from the collector of T5 (the upper “leg”), and you need ground, +15V and –15V (I tap these from some dual op-amp supply).



Then we set up a **comparator** that swings between +15 and -15V. Feed the GATE signal via a diode and a 20k resistor to a +IN of an op-amp. I find inserting a 330k resistor between +IN and the negative power supply also helpful since this pulls the threshold for the op-amp up a bit. –IN is tied to ground, and OUT goes via a 10k resistor to an **A/B switch**. Now, any time your GATE goes high, the comparator swings from close to -15v to close to +15v. NB that you can insert a switched jack socket between the GATE and diode on the input side of your comparator, so you can also feed in external LFOs or other signals. And don't forget to wire the Gate input socket tip lug via a diode to your comparator input too (just where the diode from T5 internal gate is).

On the B terminal of your A/B you wire the **output of the CAT's internal square LFO** (IC28, PIN8). The middle lug of your switch goes to a **100nf capacitor**, which, in turn, is connected to the **cathode of D9** on your CAT. Voila, you can now do the old “Note ON” engages S&H trick!

**INSERT/SWITCH for SH Mod Buss:** Another mod I deem useful is to **switch between S&H output and noise generator output**, so you can modulate your VCOs/filter with noise instead of sample and hold. This is easy! Behringer added a 1k resistor between S&H output and the modulation switches. Simply take out R179 and wire an A/B switch between the left hand PCB terminal for R179 and the right hand terminal for R179 – middle lug of switch goes via a 1k resistor to right hand terminal, and your other switch lug can toggle between left hand terminal and noise out (best tap the S&H input select switch for that). There are through VIAS on the back of the PCB for both terminals of R179.



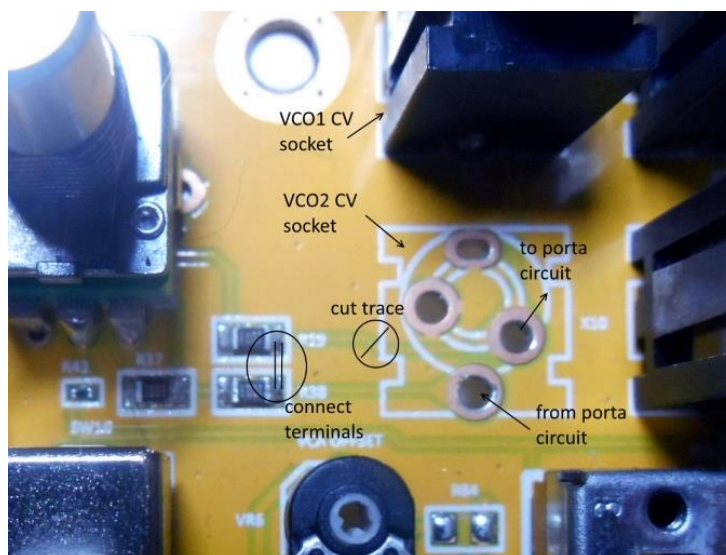
Eventually, you can also put a switched jack socket here, so you can feed external modulation signals into all modulator circuits labelled SH.

## Some VCO Modifications

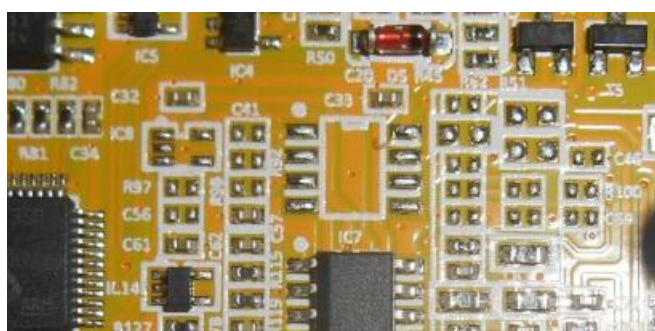
### Portamento for VCO CV Inputs

The existing portamento is digital and only works from internal CV converter. I personally find this short-sighted in terms of potential applications. The glide slider sends control voltage with a span from 0V to +3.3V to CPU. (Possible mod: portamento time per CV input.)

Now, as for using proper portamento on the 1 V/Oct inputs, I am going to replace the VCO2 CV input socket with a pot for a simple slew limiter circuit. This means I lose separate CV for VCO2 but I'm happy to live with this compromise. Basically, you need to insert your portamento circuit between jack socket and R19 and R38 (100k each). My basic portamento circuit looks [pretty much like this](#): op-amp voltage follower with 100ohm resistor on output, to 1m linear pot, to 220nf film box cap to second op-amp voltage follower.



A nifty place for your additional op-amp is IC7, an entirely unpopulated and “free to use” place for a dual amp. No idea what the original plan for that one had been.



At any rate, this may not be the most interesting modification when you use the internal V/Gate anyways, but still might be useful especially when you use external CV/GATE for driving the CAT, which may also give you some benefits for different not priority settings for retriggering etc. (can't remember off the cuff, but CAT is last note priority only or sumfink?).

### Tap VCO 1 Mix Output

IC43, Pin7 via 4.7uf cap and 1k resistor in series to out socket. Actually, you can of course tap all VCO waveforms independently at the respective waveform sliders, yet for this particular synth I prefer tapping the mix signal. Together with a VCA input insert, I can use my Mutable Ripples as a favoured filter and get a very SH-101 like vibe going.



### Tap VCO 2 Mix Output

IC43, Pin1 via 4.7uf cap and 1k resistor in series to out socket

### PWM to VCO2

This is maybe not prim but does the trick! Tap the PWM CV for VCO1 from IC17, PIN1 and feed that via a switch and a 10k resistor to the wiper of the VCO2 DUTY CYCLE Trimmer.



More interesting version: tap PWM CV from the wiper of the PWM1 Pot. Since PWM for VCO1 is summed at an **inverting** op-amp (IC17-A) after that pot, both PWM control signals are in the opposite phase, which can lead to nice effects.

### EXTERNAL VCO SYNC IN/ LINEAR FM IN

At the moment I'm not planning on an extension panel, so I'll keep these on the backburner for now. But these mods are absolutely possible: just check the [3340 Datasheet](#). And, as always, read [this excellent page](#). On my [Neutron mods](#) page, you can also listen to some of these implementations.

## EXTENDED ROUTING SWITCHES FOR VCO1 \*AND\* VCO 2



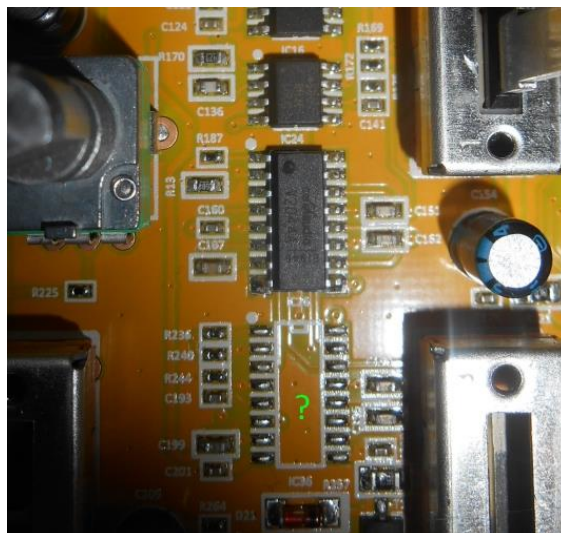
Now, this one I like quite a bit! The VCO1 on/off switch is sweet but immediately made me think why not take the concept further. So what I did was to take the switch out and drill a bit for having two A/OFF/B-Switches by means of which I can direct the respective VCO mix signal either into the filter or **after** the filter directly into the VCA or keep it silent when using that VCO strictly as a modulator. This extends the sonic possibilities quite a bit! Try a high reso sawtooth from VCO2 fattened up with a VCOC2 triangle sub that skips the filter stage and remains full on.

Here's how you can do it. Remove The VCO1 on/off switch and place your two new switches. Then remove R277, R6, and R13. Bridge the PCB terminals of former R13 with wire or solder. Tap VCO1 signal from the respective Pin of the pitch modulation switch for VCO2 and feed it via a **140k** resistor to your new VCO1 switch. TAP VCO2 at the respective Pin of the pitch modulation switch for VCO1 and feed it via a **150k** resistor to your new VCO2 switch. Wire together the "to filter" lugs of both switches and connect them to where R13 used to be (there is a VIA on the back of the PCB for that too!). Wire together the "to VCA" lugs of your switches and connect them to the VCA signal input post-R149 (there's a VIA).



### **Filter modifications**

Imagine tumbleweed tumbling leisurely along the prairie... maybe one mystery for the road though... IC36 is not populated & have no idea yet what the plan must have been here. Above the vacant slot you see the V2044 IC. Solid filter, although my preference would have been 2040...



### **VCA control boost**

Reduce R130 (105k) (anything below 51k starts sounding meh)

### **VCA signal input boost**

Reduce R149 to anything above 15k.

### **Declick the AR ENVELOPE/ VCA**

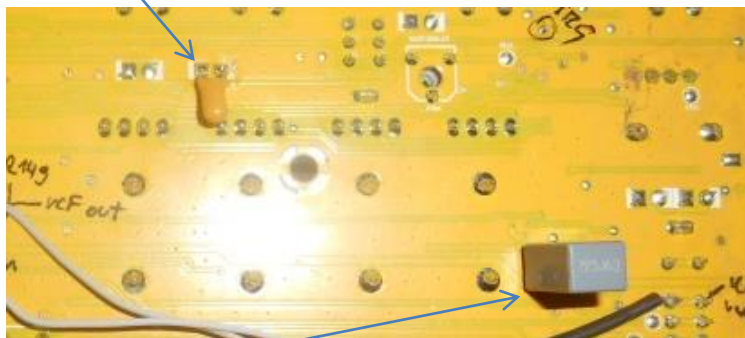
This is something I keep doing with Behringer products, dunno why. Keeping your AR envelope on minimum times can make the overall sound click a bit in certain conditions, so I put, in order to soften this click, put a 560nf capacitor between the collector of T6 and ground. Yes, 560nf read a hecking lot in this place but actually, 1uf wouldn't hurt here too, so this just does the trick! You can test your favourite capacitor value as follows: set cutoff to zero, and ADSR amount to cutoff at full. All ADSR and AR sliders fully down. Welcome to click-fest! Now, test different caps at T9 until you're happy. See page 9 bottom for VIA location on the back of the PCB.

### **Rewire EXTERNAL INPUT to VCA**

Rewire R58 (100k) to VCA input (see R149) – use a switch for selecting VCF IN and VCA IN.

### ADSR Speed

Change C155 (2.2uf). I replaced the one on mine with a 1uf tantalum for snappy decay. What you can also do, of course, is to use a switch for selecting between different capacitor values/envelope times.

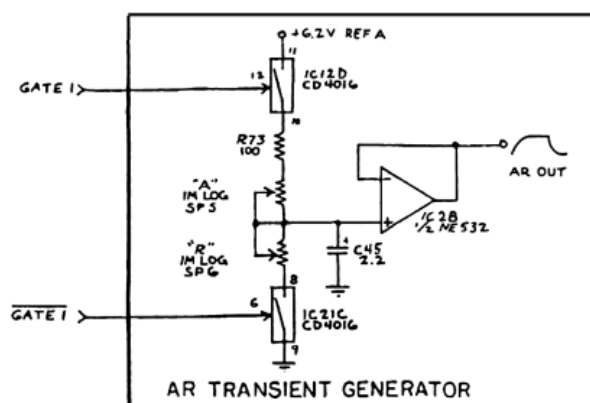


### AR Speed

Change C70 (2.2uf) with anything you like. I kept 2.2uf but put in a film box capacitor (for audiophile reasons lol...). Switching between capacitors is an option here too, of course.

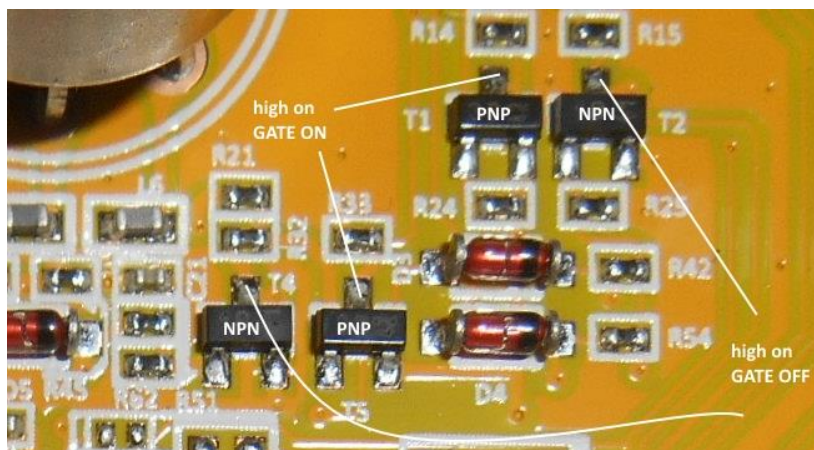
### Separate GATE IN for AR GENERATOR – some initial thoughts (no real dev for my part)

**Some background:** in very basic terms, the AR generator is some variant of a LAG/Portamento circuit with separate dials for fade-in and fade-out. Incoming voltage is charging a capacitor (with “attack” determining how long it takes for the cap to charge fully), and as soon as the incoming voltage stops, the capacitor discharges (with “release” setting how long that process takes). We know this AR thing famously from ARP synthesizers, by which and with which the CAT was as inspired and competing. Yet, the latter’s version has also has some improvement over the ARP version. In the ARPs, incoming voltage from the GATE itself charges the circuit, which means different GATEs (+9V vs +14V and such) result in different AR output levels. In the Kitty, the GATE IN signal itself only serves for opening and closing two separate IC switches that let and let out a fixed voltage (Roland does this similarly with transistor switches).



Actually, there are two gates at work here. GATE 1 is high when keyboard is struck and one ~~GATE 1~~ is high when no key is held. This way the sustain voltage of your AR does not slowly drain through the release fader since on GATE the ~~GATE~~ switch is open and the connection between release fader and ground is broken. Conversely, when the ~~GATE~~ switch is closed, the GATE switch is open, so no further gate voltage comes in.

Now, GATE on the Behricat is done per NPN-PNP transistor switches as seen here:



Internal gate on T4 pulls the voltage present on the collector of T4 to ground, which, in turn, engages T5 emitting voltage. This inverted action means that when your midi gate is off, you get high voltage on the NPN collector. I have not yet traced the circuit completely and still don't know for sure why this is doubled at T1 and T2. The Collector of T1, however, connects to IC41, Pin5 and Pin13 which two of the IC-switches at the ADSR/AR section (I guess the GATE??). Also, not sure yet about the ADSR trigger... Anyways, sorry to end on a potentially frustrating note, but hey, that's where you might come in, friend! If you got the solution, shoot me an email via my contact from here:

My webpage: <https://maffez.com/>



Here is Maffez' chief product inspector at work with Jamie Lidell's RD8. No traces of tuna or cheese were found.