PROJECT NAME

SPECTRON

BASED ON
Lovetone Meatball

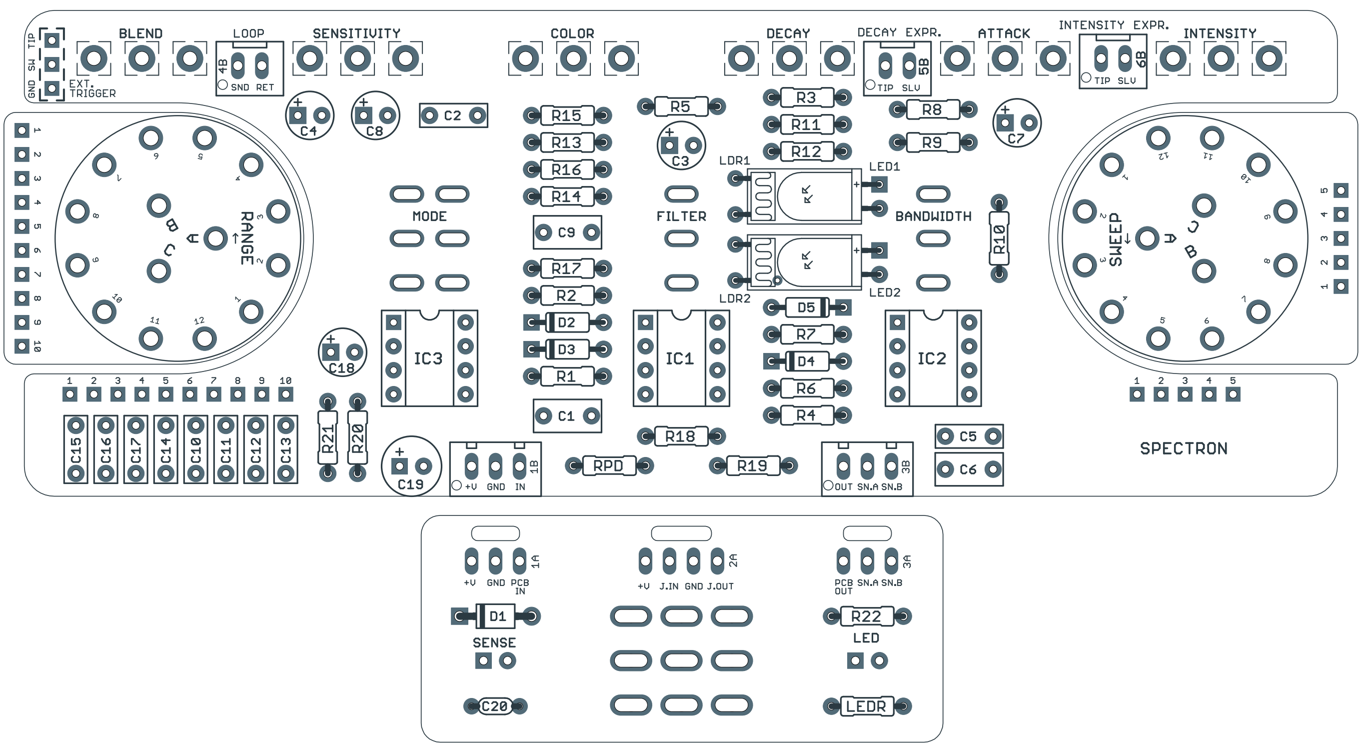
BUILD DIFFICULTY
Advanced

EFFECT TYPE
Envelope filter / auto-wah

DOCUMENT VERSION
1.0.1 (2021-07-21)

PROJECT SUMMARY

A full-featured envelope filter originally based on the Mu-Tron III with several modifications and additions. Used by The Edge, J Mascis, and Kevin Shields among others.



Actual size is 5.48" x 2.03" (main board), 2.18" x 0.95" (bypass board), and 1.05" x 1.23" (rotary switch daughterboards).

IMPORTANT NOTE

This is a complex project and it requires experience and attention to detail. If you've never built a guitar pedal before, this shouldn't be your first! Please read all of the documentation to familiarize yourself with the project before you begin so you can avoid mistakes that can potentially ruin the build. Aion FX cannot provide direct technical support.

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INTRODUCTION

The Spectron Envelope Filter is based on the Lovetone Meatball, the first of Lovetone's legendary big-box modulation effects that was initially released in 1995. It has been used by a number of high-profile artists including Kirk Hammett, Dan Auerbach, The Edge, Kevin Shields and J Mascis.

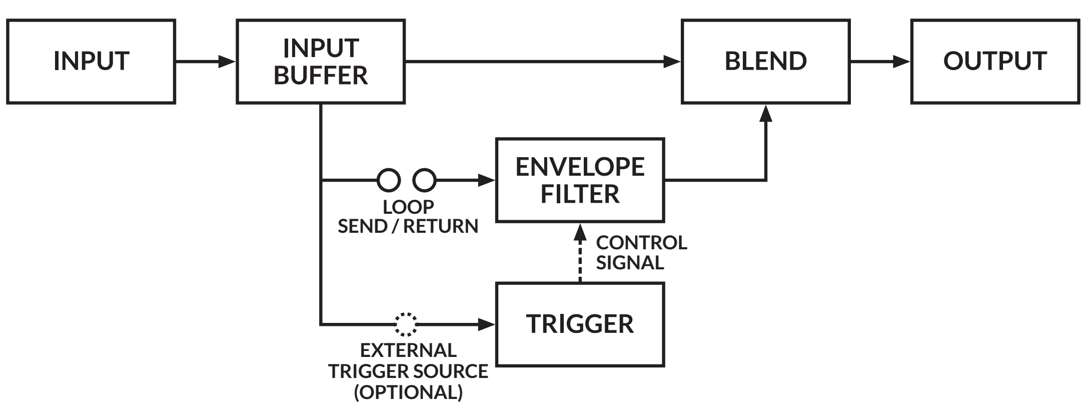
Unlike Lovetone's later offerings, the Meatball was not a fully original circuit, but rather a heavily tweaked version of the very first commercial envelope filter pedal, the Mu-tron III. While the core circuit is the very similar, the Meatball adds several new features including a clean blend, attack/decay controls, two extra range modes in between Hi and Lo, two expression controls, and an effects loop.

The Spectron is a faithful adaptation of the Meatball, with the only changes being cosmetic. The rotary switches are certainly part of Lovetone's trademark aesthetic, but two of the switches can easily be replaced with standard toggles, so we've simplified the switching accordingly.

The Spectron also includes a new optional modification for an external trigger source. The original Meatball allows similar functionality with the Send/Receive loop, but there are a few limitations with the way it is implemented. Because of this, we've added the capacity for an external signal source to be fed to the trigger circuit. The limitations of the original and the benefits of the external trigger modification are described on the next page if you're curious about the particulars.

Special thanks to Ian (LaceSensor / Gigahearts FX), the DIY community's resident Lovetone expert, for help verifying the Spectron prototype against an original Meatball for accuracy.

BLOCK DIAGRAM



External Trigger modification

Simple envelope filters have one major weakness. When they're fed a signal whose dynamics have been reduced (e.g. by drive or compression), they become somewhat less lively and reactive, because the circuit relies on those dynamics for its effect.

However, the envelope effect pairs very well with drive tones, which creates a bit of a conundrum. How can we apply dynamics-driven filtering to an undynamic signal?

The solution to this problem is called *external triggering* or *sidechaining*, meaning the envelope detector is activated by a different signal than the one to which the envelope effect is applied.

The original Meatball has limited external trigger capability via some creative circuit-bending, described in the Meatball manual. A trigger source can be fed into the input of the effect, and the audio to be effected can be fed into the Return jack, with Send left unconnected. The trigger source will activate the envelope, which will then be applied to the audio signal independently.

However, if you trace this out on the block diagram on the previous page, the weakness is evident: the trigger occupies the place of the dry signal, meaning you lose the ability to blend between wet and dry. If the Blend knob is not set to 100% wet, the trigger audio will be mixed into the output. It's better than nothing, but it's not ideal.

The other limitation is that the Return input has an impedance of around 10k, which could cause loss of highs if the source signal is unbuffered. The main effect input is much better quality since it's designed for a variety of signal sources.

Because of this, it seemed useful to add a true external trigger (sidechain) jack that could be used without removing the existing dry blend functionality. The block diagram illustrates this with the dotted circle showing the signal source, breaking the connection from the input and allowing the envelope detector to be operated independently from the rest of the effect.

The typical use case is to feed a split copy of the clean signal into the trigger input (e.g. coming from the Tuner Out jack of the Boss TU-2), apply whatever compression or distortion you want to the main signal, and then send it to the Meatball's main input—so the filter effect is applied to the distorted tone, but it tracks the dynamics of the clean tone.

However, you can also get creative and feed a fully external source such as a metronome or bass drum for a rhythmic filter tone that is independent of playing dynamics. Just be aware that if you have two independent dynamic sources (i.e. rhythmic trigger filtering a rhythmic guitar) then it will typically result in a weaker effect as the dynamics won't always line up with each other. It works much better on keyboards or pads, a continuous signal with less of its own dynamics, to add a rhythmic dimension.

This is an opt-in modification, so you must first cut a trace on the PCB in order to use it (described later in the build notes). The envelope detector is split off from the rest of the circuit and given its own input. Then, a switching jack is used to restore the connection if no jack is inserted to the sidechain input.

If the external trigger jack is not needed, the three offboard wire pads can be ignored. Unless the trace is cut, the external trigger pads are jumpered together already and have no effect.

USAGE

The Meatball circuit is extremely touch-sensitive and allows control over every aspect of its operation to make it work best with your instrument. However, this also means that there are some combinations of settings that don't work at all—for example, if the Attack knob is set higher than the Decay knob.

Because of this, it's important to understand not only what each individual control does, but how each of them interact with the other controls. Many people have built the Meatball circuit and thought at first that it didn't work, only to realize that the knobs just needed to be set differently.

Potentiometers

- **Color** sets the resonance of the filter. On higher settings, it can get pretty extreme, especially when the resonant frequency aligns with the fundamental of the note being played on the instrument, so it's best to keep this control turned down when adjusting other settings and then turn it up to the desired level. Expect some windows to rattle if you're not careful!
- **Intensity** sets the depth of the effect by adjusting the brightness of the LEDs. With the trigger switch set to Off, it has a secondary function of tuning the static filter frequency.
  - An expression pedal can be connected to allow the intensity to be foot-controlled. The expression is connected in parallel with the on-board Intensity control, so if the knob on the pedal is turned all the way up then the expression pedal will have no effect.
- **Blend** blends the output signal between the clean and effect signal. Full CCW is 100% clean, full CW is 100% wet, and at center, the mix ratio is 50/50.
- **Attack** sets the speed of the envelope's "rise" to the peak of the filter. It must be set lower than the Decay knob or there will be no envelope effect because the filter will decay before it even starts.
- **Decay** sets the amount of time that the filter takes to fall back to the resting state (either up or down depending on the Sweep switch setting). This must be set higher than the Attack knob or the envelope will not trigger.
  - There is also an optional expression control for this knob. Unlike Intensity, in this case the expression pedal is in series with the Decay control, so it will have the widest range of effect when the Decay knob is turned down.
- **Sensitivity** sets the envelope detector's reactivity to the input signal. The higher the sensitivity level, the lower the signal level needs to be to trigger the envelope. Higher-output instruments such as keyboards or active pickups will work best when Sensitivity is turned low.

Switches

- **Sweep** (rotary switch) selects whether the effect is in a low state by default and the filter sweeps upward on attack and back down on decay (traditional auto-wah sounds), or whether it's in a high state by default and the filter sweeps downward and back up for a reverse-wah effect. In the downward sweep mode, the sense indicator LED is on when no signal is applied.
- **Bandwidth** (3-position toggle) sets the frequency of the envelope detector. It can be either full bandwidth (sensing the dynamics of all frequencies), half bandwidth (sensing the dynamics of high

frequencies only, ignoring low frequencies) or the envelope detector can be turned off entirely in the center position. When the envelope detector is off, the circuit it acts as a static filter, with Intensity and Color setting the tone.

- **Filter** (toggle) is an optional modification that applies a Moog-style quality factor to the filter with frequency-variable Q instead of the constant Q of the Meatball.
- **Mode** (3-position toggle) selects whether the filter acts as high pass, bandpass, or low pass. HP and LP modes are inverted, so there may be some phase-cancellation effects when using the Blend knob in these two modes. This is part of the Meatball sound.
- **Range** sets the frequency of the filter effect in increments of one octave. Standard guitars will benefit more from the upper two settings while bass guitars will typically use the lower two.

Initial settings

When you first plug in the Spectron for testing, try one of the following sets of control positions to be sure it's working properly. Both of these are taken from the original Meatball manual.

STANDARD AUTO-WAH

- **Sensitivity:** 4:00
- **Attack:** 7:00
- **Decay:** 10:00
- **Color:** 5:00
- **Intensity:** 5:00
- **Blend:** 5:00
- **Sweep:** up (left position)
- **Bandwidth:** full (up position)
- **Range:** second from highest (right)
- **Mode:** low pass (up)

PURE MEATBALL

- **Sensitivity:** 5:00
- **Attack:** 8:00
- **Decay:** 3:00
- **Color:** 5:00
- **Intensity:** 5:00
- **Blend:** 5:00
- **Sweep:** down (right position) ** VERIFY
- **Bandwidth:** full (up position)
- **Range:** second from lowest (left)
- **Mode:** low pass (up)

PARTS LIST

This parts list is also available in a spreadsheet format which can be imported directly into Mouser for easy parts ordering. Mouser doesn't carry all the parts (most notably potentiometers) so the second tab lists all the non-Mouser parts as well as sources for each.

View parts list spreadsheet →

PART	VALUE	TYPE	NOTES
R1	1k5	Metal film resistor, 1/4W	
R2	1M8	Metal film resistor, 1/4W	
R3	100k	Metal film resistor, 1/4W	
R4	330R	Metal film resistor, 1/4W	
R5	4k7	Metal film resistor, 1/4W	
R6	22k	Metal film resistor, 1/4W	
R7	1M8	Metal film resistor, 1/4W	
R8	100R	Metal film resistor, 1/4W	
R9	1k5	Metal film resistor, 1/4W	
R10	330R	Metal film resistor, 1/4W	
R11	330R	Metal film resistor, 1/4W	
R12	330R	Metal film resistor, 1/4W	
R13	10k	Metal film resistor, 1/4W	
R14	10k	Metal film resistor, 1/4W	
R15	1k5	Metal film resistor, 1/4W	
R16	100k	Metal film resistor, 1/4W	Part of the Moog filter mod. See build notes.
R17	10k	Metal film resistor, 1/4W	
R18	220k	Metal film resistor, 1/4W	
R19	120k	Metal film resistor, 1/4W	
R20	22k	Metal film resistor, 1/4W	
R21	22k	Metal film resistor, 1/4W	
R22	330R	Metal film resistor, 1/4W	
RPD	2M2	Metal film resistor, 1/4W	
LEDR	4k7	Metal film resistor, 1/4W	
C1	470n	Film capacitor, 7.2 x 3mm	
C2	2n2	Film capacitor, 7.2 x 2.5mm	
C3	10uF	Electrolytic capacitor, 5mm	
C4	10uF	Electrolytic capacitor, 5mm	
C5	22n	Film capacitor, 7.2 x 2.5mm	
C6	470n	Film capacitor, 7.2 x 3mm	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C7	10uF	Electrolytic capacitor, 5mm	
C8	10uF	Electrolytic capacitor, 5mm	
C9	470n	Film capacitor, 7.2 x 3mm	Part of the Moog filter mod. See build notes.
C10	2n2	Film capacitor, 7.2 x 2.5mm	
C11	3n3	Film capacitor, 7.2 x 2.5mm	
C12	6n8	Film capacitor, 7.2 x 2.5mm	
C13	15n	Film capacitor, 7.2 x 2.5mm	
C14	2n2	Film capacitor, 7.2 x 2.5mm	
C15	3n3	Film capacitor, 7.2 x 2.5mm	
C16	6n8	Film capacitor, 7.2 x 2.5mm	
C17	15n	Film capacitor, 7.2 x 2.5mm	
C18	47uF	Electrolytic capacitor, 5mm	
C19	100uF	Electrolytic capacitor, 6.3mm	
C20	100n	MLCC capacitor, X7R	
D1	1N5817	Schottky diode, DO-41	
D2	1N914	Fast-switching diode, DO-35	
D3	1N914	Fast-switching diode, DO-35	
D4	1N914	Fast-switching diode, DO-35	
D5	1N914	Fast-switching diode, DO-35	
IC1	TL072	Operational amplifier, dual, DIP-8	
IC1-S	DIP8 socket	IC socket, DIP-8	
IC2	LM358N	Operational amplifier, dual, DIP-8	
IC2-S	DIP8 socket	IC socket, DIP-8	
IC3	TL072	Operational amplifier, dual, DIP-8	
IC3-S	DIP8 socket	IC socket, DIP-8	
ATK.	5kB	16mm right-angle PCB mount pot	
BLEND	10kB	16mm right-angle PCB mount pot	
COLOR	100kB	16mm right-angle PCB mount pot	
DECAY	100kA	16mm right-angle PCB mount pot	
INT.	1kB	16mm right-angle PCB mount pot	
SENS.	10kB	16mm right-angle PCB mount pot	
RANGE	3P4T rotary	Rotary switch, 3 pole / 4 position	Must be Alpha SR2612F. See parts spreadsheet (2nd tab) for sources.
SWEEP	3P4T rotary	Rotary switch, 3 pole / 4 position	Stop washer must be changed to 2-position mode. See build notes.
BAND.	SPDT cntr off	Toggle switch, SPDT on-off-on	
FILTER	SPDT	Toggle switch, SPDT on-on	Optional modification. See build notes if you want to omit it.

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
MODE	DPDT on-on-on	Toggle switch, DPDT on-on-on	See build notes to make sure you use the correct toggle type.
LED	5mm	LED, 5mm, red diffused	
SENSE	5mm green	LED, 5mm, green diffused	
LED1-2	5mm green	LED, 5mm, green diffused	See build notes for LED/LDR information.
LDR1-2	GL5537-1	LDR, 20-30k light, 2M dark	See build notes for LED/LDR information.
IN	1/4" mono	1/4" phone jack, closed frame	Switchcraft 111X or equivalent.
OUT	1/4" mono	1/4" phone jack, closed frame	Switchcraft 111X or equivalent.
LOOP SND.	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
LOOP RET.	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
INT. EXPR.	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
DEC. EXPR.	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
EXT. TRIGR.	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S, for optional External Trigger mod.
DC	2.1mm	DC jack, 2.1mm panel mount	Mouser 163-4302-E or equivalent.
BYPASS	3PDT	Stomp switch, 3PDT	
ENC	1590XX	Enclosure, die-cast aluminum	1790NS equivalent.

BUILD NOTES

LDR selection

While the original LDR used in the Meatball is unknown, the GL5537-1 LDR has been tested extensively in this circuit and has been found to perform identically. At the time of this writing, Amazon sells a 20-pack for $5 with free Prime shipping, so if you're in the USA it will be hard to find a better source.

Aside from that, there are dozens of other listings on eBay or AliExpress. It's found under a variety of brand names or even no brand name at all, but they're all the same. Just search for "GL5537-1" without the manufacturer name and evaluate the seller's reputation before buying. They are extremely affordable, but allow for extended shipping times since almost all of them ship from China.

The PDV-P8104 photocell from Advanced Photonix appears to be a good substitute as well based on the specifications, but we haven't tested it in this circuit to know for sure. It is available from Digikey and Small Bear Electronics among others.

LED selection

The Meatball circuit works best with 5mm diffused green LEDs to pair with the LDRs, and these ones from Tayda Electronics have been tested and work perfectly. You can use green diffused LEDs from other sources, just make sure they're not the high-brightness type. There are some diffused types that have a much higher MCD specification, and these will not work well.

What about heat shrink?

Homemade optocouplers are very common among DIYers since they can be made for less than 50 cents compared to true vactrols that can cost around $6 to $8 USD each. This involves using heat shrink to seal the LED and LDR from outside light, as shown in this Instructable.

However, the original Lovetone unit does not use any sort of light seal on the LED and LDR. When developing the Quadratron (Doppelganger), which also uses the same LED/LDRs, it was found when testing against a real Doppelganger that the clone only sounded exactly like an original when they were unsealed. While this is anecdotal, it seemed as though there was some crosstalk between the LEDs and LDRs such that as one LED lights up, it affects the other LDRs slightly as well.

This likely matters less in the Meatball since the two LEDs always light up at the same time. But, to be as accurate to an original Meatball as possible, consider leaving the LEDs and LDRs uncovered as in the original unit, angled toward each other and making physical contact.

This does present a problem for those who like to test the effect outside of the enclosure before boxing it up, because it will only work properly if the environment is as dark as the inside of the enclosure would be. You can try wrapping it in a towel or putting it in a closed box while testing.

What about vactrols?

It may be tempting to use a manufactured optocoupler (vactrol) such as the VTL5C3 for the four phase stages. This will result in a functional effect, but it won't sound the same as the original Meatball unit since there is no equivalent vactrol with the same specifications as the LED/LDR used in the Meatball. However, if you do use a VTL5C3, you will want to reduce the values of R11 and R12 to 100R to compensate for the different type of LED in the vactrol.

Expression jacks

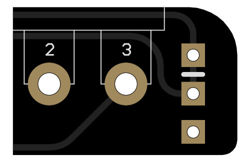
The Intensity and Decay expression jacks can be used with external pedals such as the Boss FV-50. They are wired using switching jacks, so when nothing is plugged in, the expression jacks are bypassed.

The Decay pedal is in series with the corresponding knob, so the range of the expression pedal will be determined by the knob setting on the main unit. Turn the Decay knob all the way down to allow the expression pedal to control the full range of the knob. Intensity is wired in parallel, so in contrast, this expression works best if the knob on the pedal is all the way up.

If you want to omit these expression jacks, you just need to jumper the two pads for each control.

Enabling the external trigger jack

The external trigger jack modification is disabled by default. To enable it, you need to use a razor blade or utility knife to cut the trace between the top and middle pads to the jack located on the underside of the PCB. There is a white silkscreen mark showing where to cut. Use a multimeter to verify there is no continuity between the two pads after making the cut.



Envelope detector IC

Most Meatball clones use the LM1458 for IC2, the envelope detector. Since the ICs on original Lovetone units have the top sanded off, it's not known for sure whether the original pedal even used the LM1458. Someone tried it early on and it worked, and continues to work for most people, so it's become the accepted envelope detector IC for the DIY community's various Meatball clones.

When developing the Spectron, we built two prototypes and found that one worked fine with the LM1458 and the other did not. All the other parts were the same, but even with different 1458 chips (including the MC1458 and an old-stock one) it wouldn't trigger.

Once IC2 was changed to LM358, it fired up right away and worked perfectly. Since the LM358 is much better suited for this type of application with voltage swings to ground, it's strongly recommended to use it in all cases instead of the LM1458.

Filter switch

The Filter toggle switch adds a "Moog filter" modification. The Meatball has a constant Q throughout the sweep, but part of the signature sound of the Moog ladder filter is its frequency-variable Q. This tweak was developed by the DIY community to add a Moog-like quality to the sweep.

Some people swear by it and others don't hear much of a difference, although it's more noticeable on bass guitar. To omit this control, jumper the top two pads of the switch.

Color pot modification

It is strongly recommended to jumper pins 2 and 3 of the Color pot for better control of this parameter. The range is unchanged from the original Meatball, but it's much more even across the rotation. This modification will be incorporated into a future version of the Spectron.

Rotary switches

The rotary switch sub-PCBs are designed for the Alpha SR2612F 3P4T PCB-mount rotary switch. We are not aware of any other brands with this form factor, so there are no substitutes. It's available from Mouser, Small Bear, Tayda and several more. See the parts list spreadsheet (2nd tab) for links.

The drill template includes holes for the anti-rotation pins. Precise drilling is needed in order for the anti-rotation pins to work. If you need to drill the hole a size larger because it's slightly out of alignment, then it loses its anti-rotation function.

The rotary switches have daughterboards that snap off the main board. It's recommended to solder these in place once the main PCB has been installed into the enclosure. This way, everything will be at the correct height and will not cause any stress to the joints after everything is together. Think of it as a PCB-mounted pot that requires some assembly.

When soldered to the rotary switch, the pads on the daughterboard should line up perfectly with the pads on the main PCB if the drilling is precise. However, be aware that there is not a lot of clearance between the top PCB and bottom PCB.

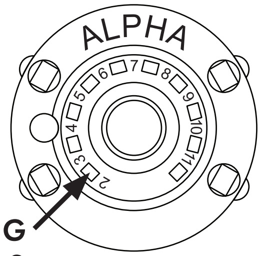
The easiest method for connecting the sub-PCB to the main PCB is via straight wires, e.g. clipped resistor leads. Solder them to the main PCB first, then thread the daughterboard through the wires and down onto the rotary switch. Solder the daughterboard to the rotary pins, then solder each of the wires on the daughterboard.

You can also use a snap-apart wire header. If you do this, the daughterboard PCB will need to sit a little higher on the pins of the rotary switch since there isn't quite the 0.1" clearance needed for the plastic insulators. Be careful because this will be extremely difficult to desolder if you make any mistakes.

Alternately, you can add another 3/8" hex nut (e.g. from 1/4" jack) on the inside of the rotary switch to mount it higher inside the enclosure. You will lose the use of the anti-rotation pin, so it's possible that the rotary switch can come loose over time due to the rotational force, but it gives enough space to run flexible wires between the main board and daughterboard in case they are slightly out of alignment.

Sweep rotary lock washer

For the Sweep rotary, you will need to set the position lock washer to the "2" setting (the first notch).



SET LOCK RING TO POSITION 2

This washer physically prevents the rotary switch from going past position 2. The default setting is 4.

Make sure that the rotary shaft is turned all the way CCW when changing this washer so the shaft is not locked on the other side of the washer setting once it is reassembled.

BUILD NOTES, CONT.

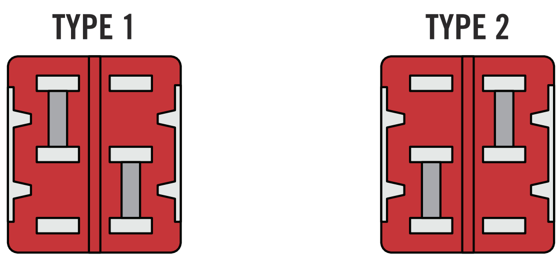
Rotary shaft

You will likely need to cut the shaft of the rotary switches by around 0.4” to match the height of the potentiometer shaft so the knobs sit at the same level.

A rotary tool cutoff wheel works great, but you can do it with normal snippers as well—it just won’t be a clean cut this way so it may need some sanding or filing to level it off.

Mode switch

The mode switch is a DPDT on-on-on toggle. For this type of switch, depending on the manufacturer, there are two different types of configurations for the center position, which are as follows:



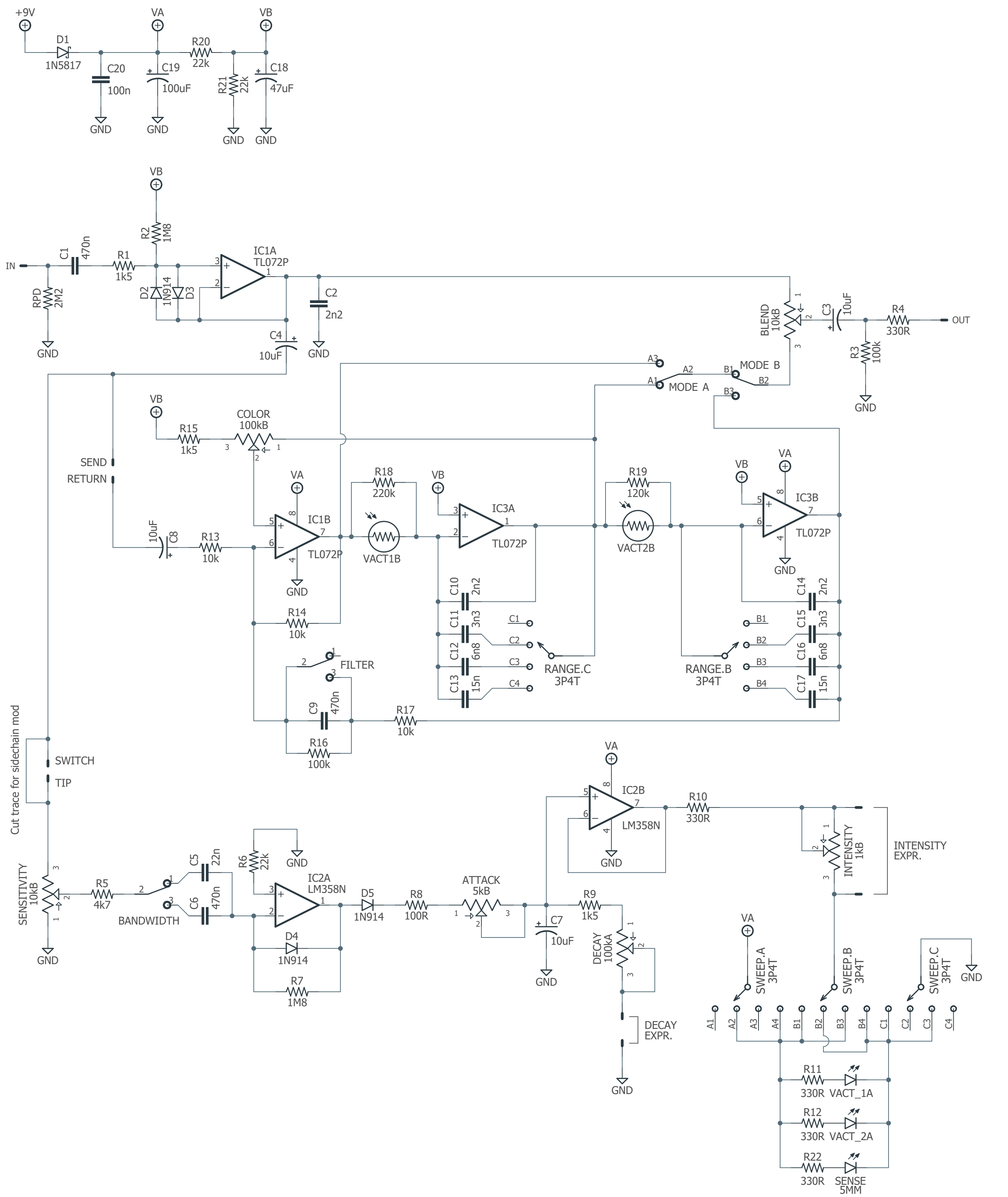
The Spectron requires the **Type 2** configuration, which is used by most major manufacturers such as Taiway. If you’re considering a different brand, make sure to check the configuration of the center position. Many of the on-on-on switches sold by Tayda or Love My Switches are Type 1 and will not work.

In addition, make sure you’re using an on-*on*-on switch and not an on-*off*-on switch, which has the same appearance and also has 3 positions, but will not work in this circuit.

Toggle switch height

The Mode switch (DPDT) has a ridge in the middle that causes the PCB to sit about 0.5–1mm higher than on the other two SPDT switches. If you’re following the recommended build process from page 10 and soldering everything in place inside the enclosure, you’ll want to make sure the PCB is level from left to right before soldering. If it’s off-level, the rotary switches will be harder to solder.

SCHEMATIC



+9V
D1
1N5817
C20
100n
VA
C19
100uF
R20
22k
VB
R21
22k
C18
47uF
GND
IN
C1
470n
R1
1k5
R2
1M8
RPD
2M2
D2
1N914
D3
IC1A
TL072P
C2
2n2
C4
10uF
BLEND
10kB
C3
10uF
R4
330R
OUT
R3
100k
MODE A
MODE B
A1
A2
A3
B1
B2
B3
R15
1k5
COLOR
100kB
SEND
RETURN
C8
10uF
R13
10k
IC1B
TL072P
R18
220k
VACT1B
IC3A
TL072P
R19
120k
VACT2B
IC3B
TL072P
R14
10k
C10
2n2
C11
3n3
C12
6n8
C13
15n
RANGE.C
3P4T
RANGE.B
3P4T
C14
2n2
C15
3n3
C16
6n8
C17
15n
FILTER
C9
470n
R16
100k
R17
10k
Cut trace for sidechain mod
SWITCH
TIP
SENSITIVITY
10kB
R5
4k7
BANDWIDTH
C5
22n
C6
470n
R6
22k
IC2A
LM358N
D4
1N914
R7
1M8
D5
1N914
R8
100R
ATTACK
5kB
C7
10uF
R9
1k5
DECAY
100kA
DECAY
EXPR.
IC2B
LM358N
R10
330R
INTENSITY
1kB
INTENSITY
EXPR.
SWEEP.A
3P4T
SWEEP.B
3P4T
SWEEP.C
3P4T
A4
B4
C1
C2
C3
C4
R11
330R
VACT_1A
R12
330R
VACT_2A
R22
330R
SENSE
5MM

DRILL TEMPLATE

Cut out the drill template on the following page, fold the edges and tape it to the enclosure. Before drilling, it's recommended to first use a center punch for each of the holes to help guide the drill bit.

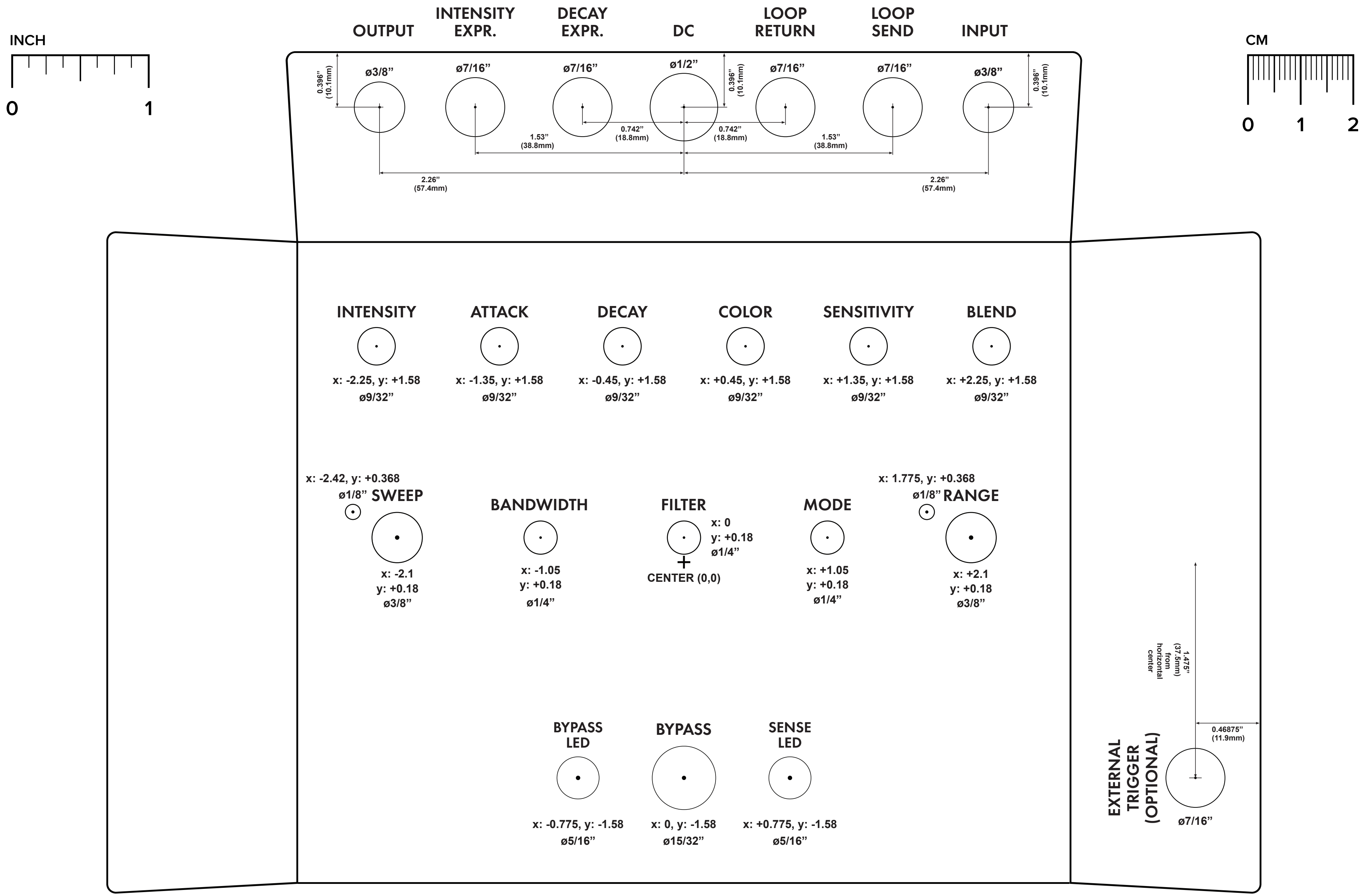
Ensure that the template is printed at 100% or "Actual Size". You can double-check this by measuring the scale on the printed page with a ruler or calipers.

The LEDs are sized for a 5mm LED bezel, available from several parts suppliers. Adjust the drill size accordingly if using something different, such as a 3mm bezel, a plastic snap-in bezel, or just a plain LED.

Important: Due to the high number of PCB-mounted parts, it's crucial that the drilling be accurate, especially the rotary switches. Since the PCB uses slotted holes for the toggles, there's not a lot of room for error.

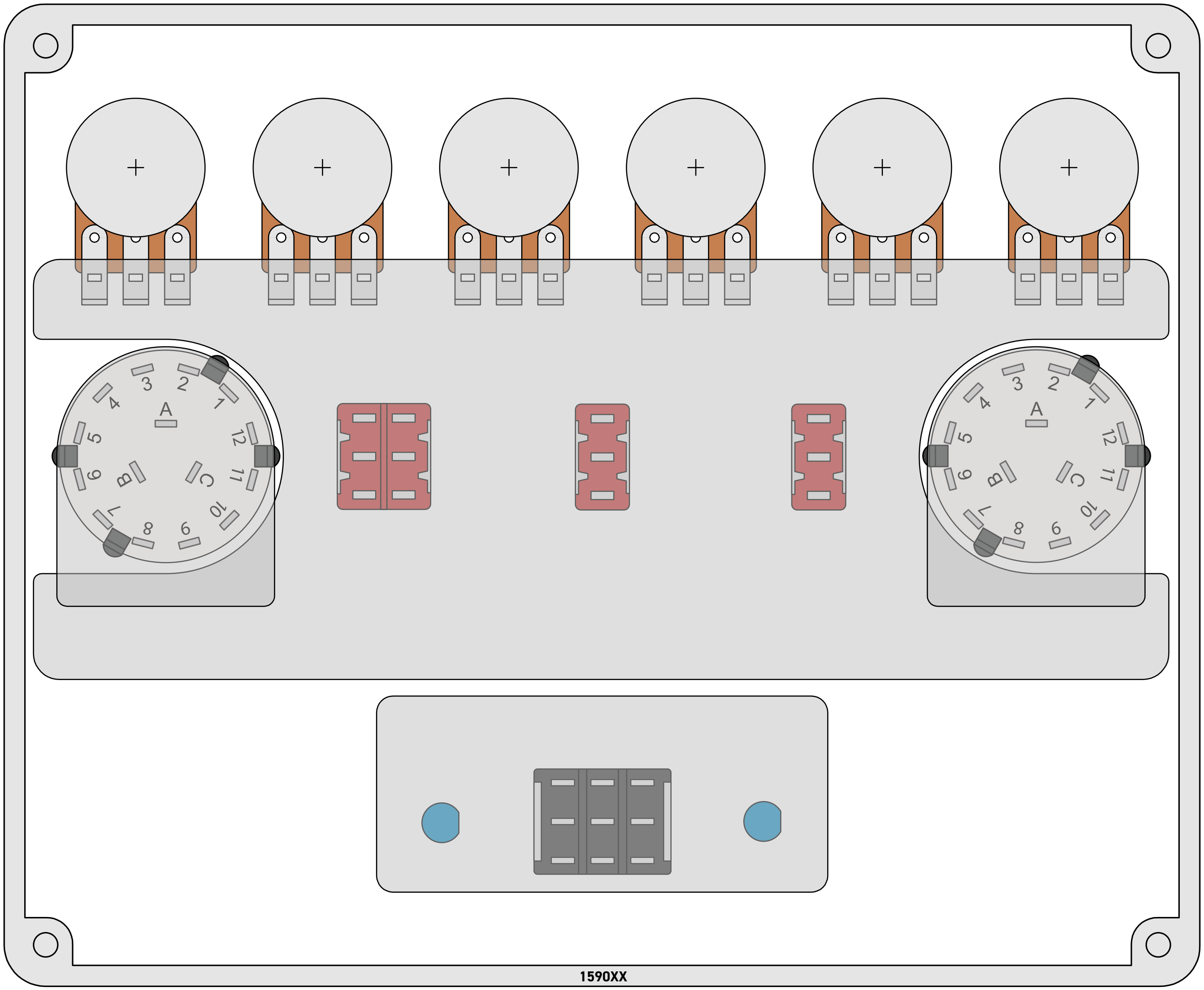
If the toggles don't align to the PCB, you can always drill one step larger (9/32") to allow a little more room correct any errors. The toggle switch washer and nut will still fully cover the hole.

DRILL TEMPLATE

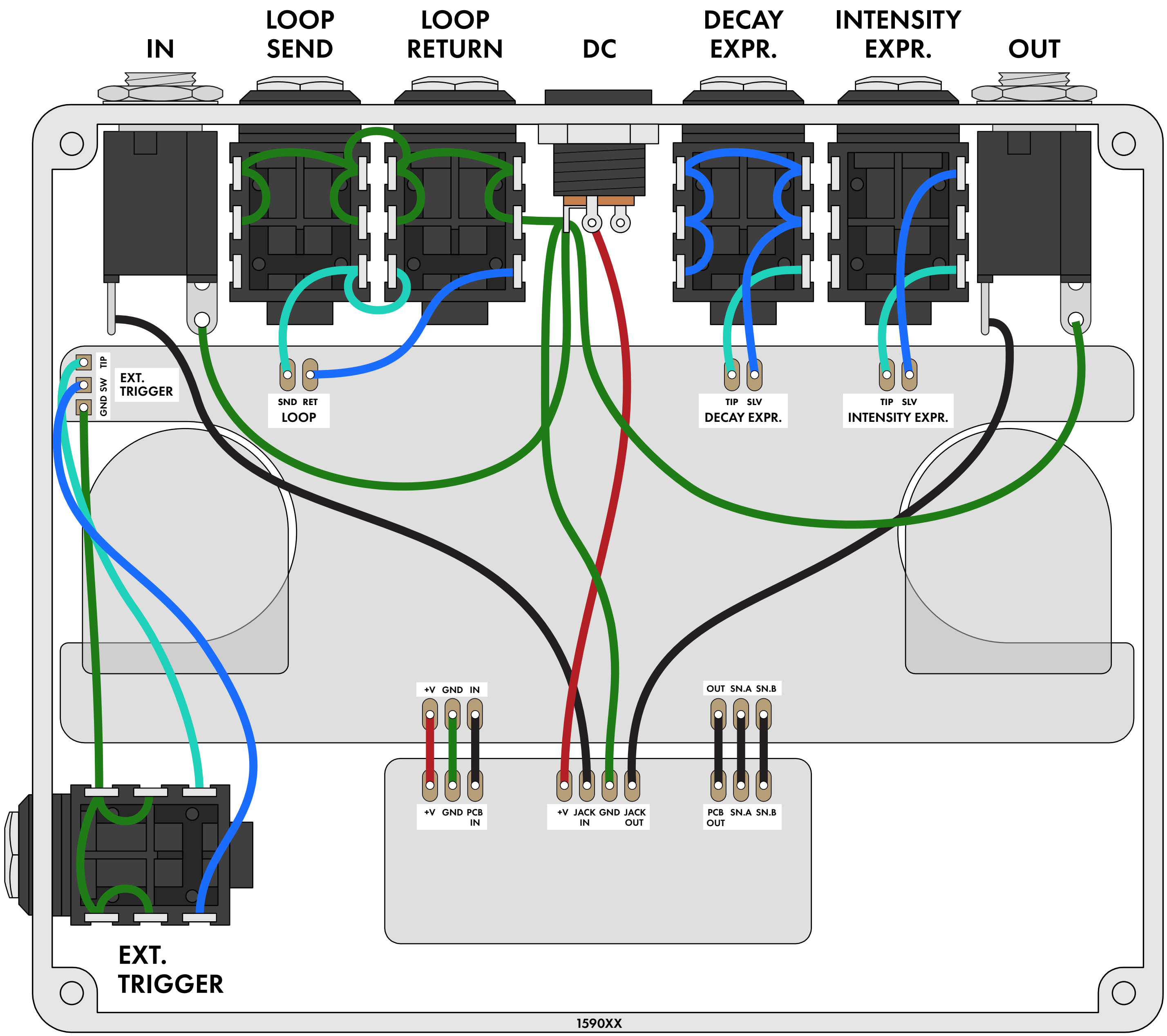


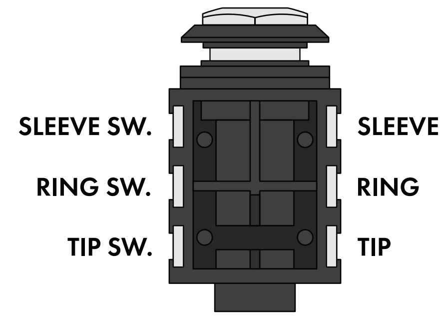
ENCLOSURE LAYOUT

Enclosure is shown without jacks. See next page for jack layout and wiring.

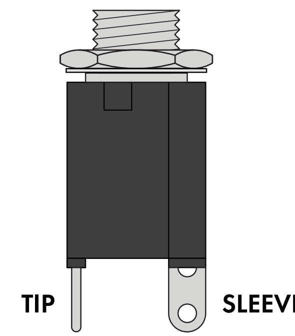


WIRING DIAGRAM





NEUTRIK
NMJ-6



SWITCHCRAFT
111X

The external trigger modification is optional and requires a trace cut on the underside of the PCB. The jack and wires shown in the diagram can be omitted if it's not used. See build notes for details.

LICENSE & USAGE

No direct support is offered for these projects beyond the provided documentation. It's assumed that you have at least some experience building pedals before starting one of these. Replacements and refunds cannot be offered unless it can be shown that the circuit or documentation are in error.

All of these circuits have been tested in good faith in their base configurations. However, not all the modifications or variations have necessarily been tested. These are offered only as suggestions based on the experience and opinions of others.

Projects may be used for commercial endeavors in any quantity unless specifically noted. No attribution is necessary, though a link back is always greatly appreciated. The only usage restrictions are that **(1) you cannot resell the PCB as part of a kit without prior arrangement**, and **(2) you cannot "goop" the circuit, scratch off the screenprint, or otherwise obfuscate the circuit to disguise its source**. (In other words: you don't have to go out of your way to advertise the fact that you use these PCBs, but please don't go out of your way to hide it. The guitar effects industry needs more transparency, not less!)

DOCUMENT REVISIONS

1.0.1 (2021-07-21)
Clarified the type of rotary switches required.

1.0.0 (2021-07-02)
Initial release.