PROJECT NAME

QUADRATRON

aion
DIY GUITAR EFFECTS

BASED ON
Lovetone Doppelganger

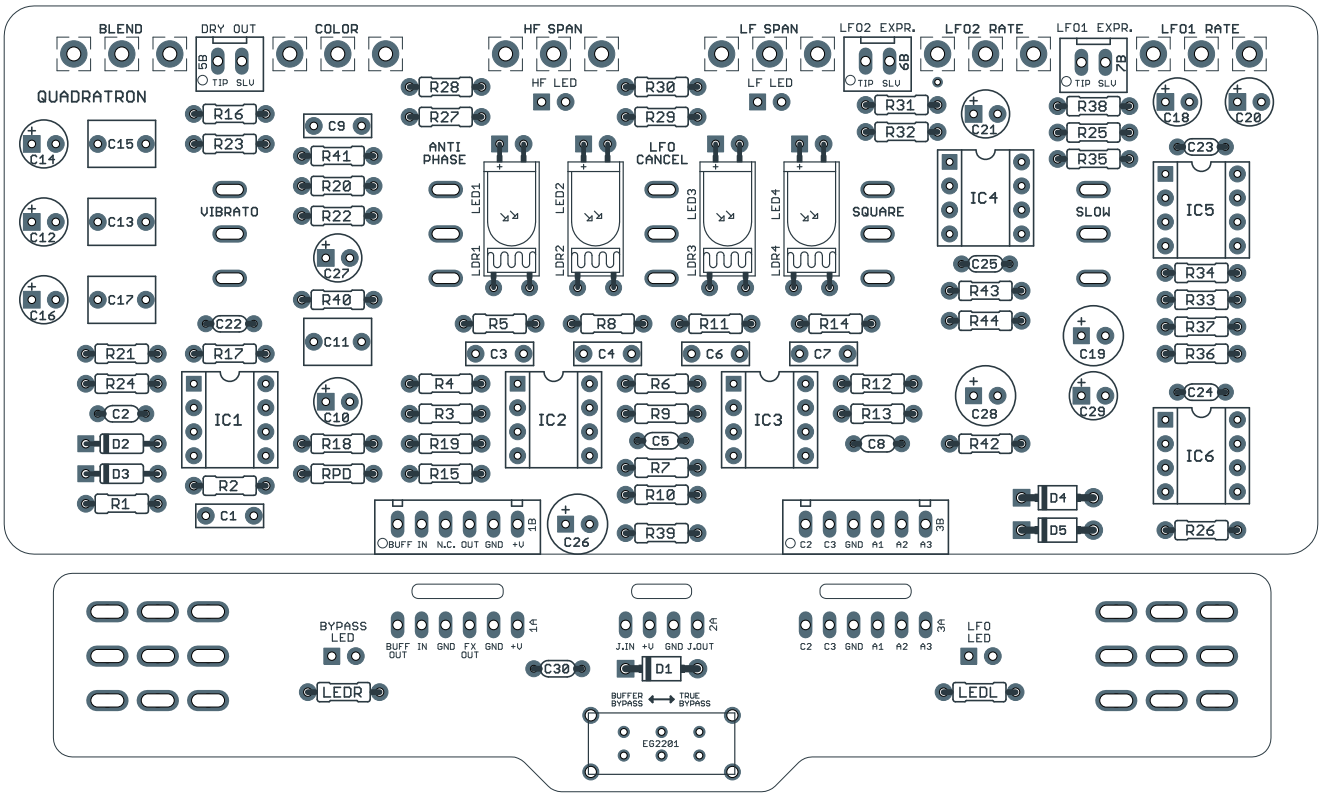
BUILD DIFFICULTY
Advanced

EFFECT TYPE
Optical phaser & vibrato

DOCUMENT VERSION
1.0.3 (2021-08-10)

PROJECT SUMMARY

A stunningly unique four-stage optical phaser with two LFOs allowing independent control over each pair of stages. Used by The Edge, Johnny Marr, and Ed O'Brien among others.



Actual size is 5.48" x 2.29" (main board) and 5.08" x 0.77" (bypass board).

IMPORTANT NOTE

This is a complex circuit and it takes experience and attention to detail in order to build it successfully. If you've never built a guitar pedal before, this shouldn't be your first! Please read all of the build documentation to familiarize yourself with the project before you begin. Aion FX cannot provide direct technical support.

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INTRODUCTION

The Quadratron Twin Phaser is based on the Lovetone Doppelganger, a four-stage optical phaser first released in 1995.

As with most Lovetone pedals, it's a traditional topology at its core, but with a huge twist. In this case, each of the four optical phase stages have different filter frequencies, with each stage having a capacitor twice as large as the previous stage. Each pair of stages has its own depth (intensity) control, called Low Frequency Span and High Frequency Span, and each pair of stages can be controlled by a single LFO, separate LFOs, or a single LFO with each pair out of phase with the other (i.e. when stages 1 and 2 are off, stage 3 and 4 are on). Each pair has its own rate/depth LED, so throughout each of the modes there is always a visual representation showing how the signal is being modulated.

The Doppelganger was updated in 1999 with three new features: a Dry Out jack, allowing for stereo operation when combined with the wet signal in the other output; a Square Wave toggle to give the first LFO a "chop" or on/off effect; and a Slow toggle that modifies the first LFO's range so the slow speeds are even slower. Both of these features are backwards-compatible, so with Square and Slow turned off, it's identical to the V1 circuit.

The Quadratron is based on this second version of the Doppelganger, but with a few tweaks to the bypass modes to correct some of what could be considered design flaws in the original unit. You'll find more on this in the pages that follow if you're curious. The signal path is unchanged, the only differences are in the bypass configurations.

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

CIRCUIT DESIGN NOTES

Bypass modes

The Quadratron can be set to either true bypass or buffered bypass using an internal slide switch. (The "Spectral" bypass mode from the original Doppelganger has been modified. See next section for more information on this.)

Buffered bypass: This is the recommended mode for most scenarios. The high-quality input buffer is always active, and when in bypass mode, the dry buffered signal is split between Effect Out and Dry Out to preserve the stereo signal.

True bypass: This fully bypasses the unit in bypass mode. The Dry Out jack is muted because there is no input signal. Therefore, it's not recommended to use this mode if you are running the unit in stereo. The unit is also more susceptible to LFO ticking in this mode in certain scenarios, such as when connected directly to the guitar, whereas buffered mode does not pick up any.

It's worth mentioning that neither of these two modes are identical to the original unit's "True" bypass mode. In the original, the input signal is not actually disconnected from the input of the circuit in bypass.

This has the advantage of preserving the Dry Out functionality even in bypass mode, and the 2.2M input impedance is extremely high so signal loading is negligible—but purists would take issue with its claim of being true bypass.

In addition, in stereo mode, the Dry Out is buffered while the main output is not, creating possible impedance mismatches between the two outputs in bypass mode depending on the source of the input signal and the pedals that follow.

Therefore, instead of having one mode that is *partially* buffered and *almost* true bypass, the Quadratron has two distinct modes: buffered bypass, where both Dry and Out are buffered, and "true" true bypass, which fully bypasses the effect.

Since the main circuit does not see an input signal in true bypass mode, the Dry Out jack is muted. Because of this, it's not recommended to use true bypass mode in stereo operation. Buffered bypass is suitable for either stereo or mono mode and is recommended for the most straightforward operation in a broader array of setups.

Spectral mode

The original Doppelganger has a mode called Spectral Bypass, selectable via a rotary switch on the front. This mode disables the LFO but still passes the signal through the effect path and its phase-swept stages. This was intended to replicate a design quirk of the vintage Univox Uni-Vibe pedal, whose "Cancel" mode did the same thing in lieu of actual bypass. Producers used the Uni-Vibe in cancel mode as a studio trick on occasion because the static phase-shifting adds a subtle sheen to the tone.

However, in the Doppelganger, spectral mode has one critical flaw: the Blend and Color knobs and the Vibrato switch all have an impact on the bypass tone. There is a cardinal rule of effects pedals that the knob settings should never affect bypass mode in any way, and the way this feature was implemented goes against that rule. It is possible, especially if you use the Blend knob at all, that the bypass mode will not be usable unless you adjust the knobs, which defeats the purpose.

Due to the fact that the knobs impact the bypass signal, it seemed as though Spectral mode was more useful as an effect mode than as a bypass mode.

Since Spectral mode only disables the LFO without bypassing the effect, the Quadratron adds a new toggle called “LFO Cancel”. When the effect is engaged and the LFO is canceled, it’s in spectral mode, but can still be fully bypassed as normal.

Vibrato mode

In the original unit, Vibrato mode was a footswitch rather than a toggle. Another cardinal rule of effects pedals is that a footswitch is not justified unless the mode has some sort of control to go along with it—for example, a gain boost with its own independent gain control that is activated with the footswitch. If the footswitched mode will always or usually need some sort of knob adjustments to dial in the right sound, then it defeats the purpose of a footswitch.

In the Doppelganger, the Vibrato mode is only really useful when Blend is set to 100%, otherwise there is a volume drop. In addition, the vibrato mode doesn’t really sound like a true vibrato except on high speeds. Since it will usually need to be adjusted when switching from normal mode, the Vibrato feature has been converted into a standard toggle switch.

Stereo operation

The Quadratron can be used as a true stereo effect, with the wet and dry signals being split into two outputs. As with many stereo effects, there are a few caveats.

First, this pedal only accepts a mono input signal, meaning that this must be the unit that splits the signal into stereo. If you have other mono-stereo splitter effects such as a chorus pedal, they will need to be run in mono mode. If this isn’t an option, you could just run one channel of the stereo signal through the Quadratron, but this is not ideal due to the possibility for impedance mismatches.

Second, for the best stereo image, it’s recommended to run the unit in Vibrato mode. A mono phaser mixes the phase-swept audio with the dry signal to create the phasing effect. Vibrato mode kills the dry signal from the mix. (It’s technically not true vibrato, which requires pitch change, but it sounds similar.)

The Dry Out jack is a fully dry signal, so by combining the dry signal in one output with the vibrato mode’s 100% phase-swept signal in the other, it produces a typical phaser sound.

USAGE

The Quadratron has the following controls.

Potentiometers

- **LFO 1 Rate** and **LFO 2 Rate** control the speed of the LFOs.
    - In single LFO mode, LFO 2 is disabled and LFO 1 controls all four stages.
    - In dual LFO mode, LFO 1 controls the first two stages and LFO 2 controls the last two stages.
- **HF Span** sets the depth (intensity) of the first two stages that sweep higher frequencies, with an LED to indicate the effect visually.
- **LF Span** sets the depth (intensity) of the last two stages that sweep lower frequencies, with an LED to indicate the effect visually.
- **Color** (also called Feedback, Resonance or Regeneration in other phasers) sets how much of the phased signal is fed back into the input to amplify the phasing effect. Since it's fed back to the 2nd stage, it only impacts the 3rd and 4th stages (the LF pair).
- **Blend** controls how much of the phase signal is blended with the dry signal. In vibrato mode, which cuts off the dry signal entirely, it acts as a volume control.

Switches

- **Vibrato** cancels the clean signal, which results in a pitch vibrato effect. Note that the Blend knob becomes a straight volume control in this mode, so you'll likely want to turn it all the way up.
- **Antiphase** sweeps the last two stages inversely to the first two, causing the high frequencies and low frequencies to be modulated in an alternating pattern similar to a harmonic tremolo.
- **Slow** changes the timing capacitor of LFO1, allowing for extra-long sweep cycles of up to 16 seconds at the slowest speed setting. LFO 2 is unaffected. See build notes for a modification that allows the slow time to be extended even more.
- **Square** converts LFO 1 from a triangle wave (ramping up and down) to a square wave (full on & off). LFO 2 is unaffected.
- **LFO Cancel** disables the LFO entirely, equivalent to the spectral mode of the original unit. The signal still passes through the phase stages which changes the tone slightly, but there is no modulation.
- **Dual LFO** (footswitch) engages the second LFO, which makes the HF and LF phase stages fully unsynchronized with each other and controlled by their own Rate knobs.

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	4k7	Metal film resistor, 1/4W	
R2	2M2	Metal film resistor, 1/4W	
R3	220k	Metal film resistor, 1/4W	
R4	220k	Metal film resistor, 1/4W	
R5	220k	Metal film resistor, 1/4W	
R6	220k	Metal film resistor, 1/4W	
R7	220k	Metal film resistor, 1/4W	
R8	220k	Metal film resistor, 1/4W	
R9	220k	Metal film resistor, 1/4W	
R10	220k	Metal film resistor, 1/4W	
R11	220k	Metal film resistor, 1/4W	
R12	220k	Metal film resistor, 1/4W	
R13	220k	Metal film resistor, 1/4W	
R14	220k	Metal film resistor, 1/4W	
R15	270k	Metal film resistor, 1/4W	
R16	100k	Metal film resistor, 1/4W	
R17	91k	Metal film resistor, 1/4W	
R18	330R	Metal film resistor, 1/4W	
R19	4k7	Metal film resistor, 1/4W	
R20	100k	Metal film resistor, 1/4W	
R21	330R	Metal film resistor, 1/4W	
R22	4k7	Metal film resistor, 1/4W	
R23	10k	Metal film resistor, 1/4W	
R24	10k	Metal film resistor, 1/4W	
R25	10k	Metal film resistor, 1/4W	
R26	10k	Metal film resistor, 1/4W	
R27	330R	Metal film resistor, 1/4W	
R28	330R	Metal film resistor, 1/4W	
R29	330R	Metal film resistor, 1/4W	
R30	330R	Metal film resistor, 1/4W	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
R31	330R	Metal film resistor, 1/4W	
R32	330R	Metal film resistor, 1/4W	
R33	10k	Metal film resistor, 1/4W	
R34	10k	Metal film resistor, 1/4W	
R35	2k2	Metal film resistor, 1/4W	
R36	10k	Metal film resistor, 1/4W	
R37	10k	Metal film resistor, 1/4W	
R38	2k2	Metal film resistor, 1/4W	
R39	47R	Metal film resistor, 1/4W	
R40	10k	Metal film resistor, 1/4W	
R41	10k	Metal film resistor, 1/4W	
R42	47R	Metal film resistor, 1/4W	
R43	10k	Metal film resistor, 1/4W	
R44	10k	Metal film resistor, 1/4W	
RPD	2M2	Metal film resistor, 1/4W	
LEDL	4k7	Metal film resistor, 1/4W	
LEDR	4k7	Metal film resistor, 1/4W	
C1	22n	Film capacitor, 7.2 x 2.5mm	
C2	47pF	MLCC capacitor, NP0/C0G	
C3	4n7	Film capacitor, 7.2 x 2.5mm	
C4	10n	Film capacitor, 7.2 x 2.5mm	
C5	47pF	MLCC capacitor, NP0/C0G	
C6	22n	Film capacitor, 7.2 x 2.5mm	
C7	47n	Film capacitor, 7.2 x 2.5mm	
C8	47pF	MLCC capacitor, NP0/C0G	
C9	6n8	Film capacitor, 7.2 x 2.5mm	
C10	OMIT	Electrolytic capacitor, 5mm	Use 10uF electrolytic if you can't find 2.2uF film for C11. See build notes.
C11	2.2uF	Film capacitor, 7.2 x 5mm	
C12	OMIT	Electrolytic capacitor, 5mm	Use 10uF electrolytic if you can't find 2.2uF film for C13. See build notes.
C13	2.2uF	Film capacitor, 7.2 x 5mm	
C14	OMIT	Electrolytic capacitor, 5mm	Use 10uF electrolytic if you can't find 2.2uF film for C15. See build notes.
C15	2.2uF	Film capacitor, 7.2 x 5mm	
C16	OMIT	Electrolytic capacitor, 5mm	Use 10uF electrolytic if you can't find 2.2uF film for C17. See build notes.
C17	2.2uF	Film capacitor, 7.2 x 5mm	
C18	10uF	Electrolytic capacitor, 5mm	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C19	220uF	Electrolytic capacitor, 6.3mm	
C20	1uF	Electrolytic capacitor, 4mm	
C21	10uF	Electrolytic capacitor, 5mm	
C22	100n	MLCC capacitor, X7R	
C23	100n	MLCC capacitor, X7R	
C24	100n	MLCC capacitor, X7R	
C25	100n	MLCC capacitor, X7R	
C26	220uF	Electrolytic capacitor, 6.3mm	
C27	47uF	Electrolytic capacitor, 5mm	
C28	220uF	Electrolytic capacitor, 6.3mm	
C29	47uF	Electrolytic capacitor, 5mm	
C30	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	1N4001	Rectifier diode, DO-41	
D5	1N4001	Rectifier diode, DO-41	
IC1	TL072	Operational amplifier, dual, DIP-8	
IC1-S	DIP8 socket	IC socket, DIP-8	
IC2	TL072	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	
IC4	TL022	Operational amplifier, dual, DIP-8	
IC4-S	DIP8 socket	IC socket, DIP-8	
IC5	TL022	Operational amplifier, dual, DIP-8	
IC5-S	DIP8 socket	IC socket, DIP-8	
IC6	TL022	Operational amplifier, dual, DIP-8	
IC6-S	DIP8 socket	IC socket, DIP-8	
COLOR	100kB	16mm right-angle PCB mount pot	
BLEND	100kB	16mm right-angle PCB mount pot	
LF SPAN	1kB	16mm right-angle PCB mount pot	
HF SPAN	1kB	16mm right-angle PCB mount pot	
LFO1 RATE	100kB	16mm right-angle PCB mount pot	
LFO2 RATE	100kB	16mm right-angle PCB mount pot	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
ANTIPHASE	SPDT	Toggle switch, SPDT on-on	
LFO CANCEL	SPDT	Toggle switch, SPDT on-on	
SLOW	SPDT	Toggle switch, SPDT on-on	
SQUARE	SPDT	Toggle switch, SPDT on-on	
VIBRATO	SPDT	Toggle switch, SPDT on-on	
MODE	DPDT slide	Slide switch, DPDT	E-Switch EG2201
LED	5mm red	LED, 5mm, red diffused	
LFO_LED	5mm red	LED, 5mm, red diffused	
HF_LED	5mm green	LED, 5mm, green diffused	
LF_LED	5mm green	LED, 5mm, green diffused	
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.
DRY OUT	1/4” mono	1/4” phone jack, closed frame	Switchcraft 111X or equivalent.
LFO 1 EXPR.	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
LFO 2 EXPR.	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
LDR1-4	GL5537-1	LDR, 20-30k light, 2M dark	See build notes for LED/LDR information.
LED1-4	5mm green	LED, 5mm, green diffused	See build notes for LED/LDR information.
DC	2.1mm	DC jack, 2.1mm panel mount	Mouser 163-4302-E or equivalent.
BYPASS	3PDT	Stomp switch, 3PDT	
DUAL LFO	3PDT	Stomp switch, 3PDT	
ENC	1590XX	Enclosure, die-cast aluminum	1790NS equivalent.

BUILD NOTES

LDR selection

While the original LDR used in the Doppelganger is unknown, the GL5537-1 LDR has been tested extensively in this circuit and has been found to perform identically. As of this writing, Amazon sells a 20-pack for $5 with free 2-day 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 Doppelganger circuit works best with 5mm diffused green LEDs, and these ones from Tayda Electronics have been tested and work perfectly. You can also use other green diffused LEDs, 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, and in testing it against a real Doppelganger, it was found that only the unsealed LED/LDR combos sounded exactly like the original. While this is anecdotal, the best explanation is that there must be some crosstalk between the four LEDs and LDRs. As one LED lights up, its corresponding LDR reacts the strongest, but the other three react slightly as well.

Therefore, to be as accurate to an original Doppelganger as possible, it's recommended to leave 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 Doppelganger unit since there is no equivalent vactrol with the same specifications as the LED/LDR used in the Doppelganger. However, if you do use a VTL5C3, you will want to reduce the values of R27, R28, R30 and R31 to 100R to compensate for the different type of LED in the vactrol.

HF/LF Span pot values

The original Doppelganger uses 1kB potentiometers for the HF and LF Span controls, which set the intensity of the high and low frequency stages. By increasing the pot value to 2kB, the intensity range is expanded, with more intense settings available at the upper end of the range. The original Doppelganger's tones are all present in the lower end of the sweep.

Note: Some builders have noticed that the LEDs will "freeze" or stop modulating on the upper end of the range with this mod. This did not happen in our prototype unit, so it's likely related to variances in the type of LED being used, but since more than one person has experienced this, we are including the precaution. You may need to revert back to 1kB or try different LEDs if this happens with the 2kB pot.

Expression jacks

The LFO1 and LFO2 rate 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 expression pedals are in series with their corresponding rate knobs, so the range of the expression pedal will be determined by the knob setting on the main unit. Turn the rate knob all the way down to allow the expression pedal to control the full range of the knob.

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

LFO ticking in bypass mode

The input and output jacks can pick up LFO ticking noise in bypass mode in certain setups. The most likely scenario is if the Quadratron is set to true bypass mode and plugged directly into the guitar without a buffer or any other active pedals in between.

This is because when the source impedance of the input signal is high, it's more susceptible to picking up the LFO ticking as the output signal wire passes near the expression jacks, which are strong sources of ticking noise. If the source impedance is low, e.g. from the Quadratron's buffered mode or from a buffer earlier in the chain, there should be no ticking.

If you are still having issues, check your wiring and ensure the input and output wires are kept as far from the two LFO expression jacks as possible.

You can also use shielded wire, either for the wires going to the expression jacks or for the input/output signal wire that passes near them, or for all of them. Just make sure the shield for each wire is only grounded on one end to avoid ground loops.

Dry out jack

The "dry out" jack is included so the unit can operate in stereo mode with the dry signal in one channel and the phase signal in the other. This was added in the second version of the original Doppelganger. If you want to leave it off, you can just omit the wires entirely with no jumpers needed.

LFO Cancel switch

The LFO Cancel toggle switch is a replacement for the "Spectral Bypass" mode on the original Doppelganger. The reason for this change is outlined in the circuit description above. If you want to omit this toggle switch, jumper the top and middle pads of the switch to hard-wire it in active mode.

"Extra slow" modification

There is an interesting trick you can do to get extra slow speeds (around 5 minutes on LFO1 with "Slow" engaged, and around 35 seconds on LFO2). This takes advantage of the fact that the LFO expression controls are in series with the Rate potentiometers.

Take a bare 1/4" phone plug and solder a 1.5M resistor between the tip and sleeve lugs. Cover it with heatshrink so it doesn't short against anything. Then, insert this plug into either the LFO1 or LFO2 expression jacks. This plays the part of a fixed expression pedal, but the extremely high value shifts the speed range into much slower territories that are more useful for ambient textures and pads.

You can also try different resistor values on different plugs to have different presets available.

Electrolytic and film capacitors

The original Doppelganger uses several 10uF electrolytic capacitors in the audio path (C10, C12, C14, C16). Since film is much better quality, we've added space for film capacitors to be used instead (C11, C13, C15, C17). While the spacing allows for box capacitors up to 4.7uF to be used, the parts list calls for 2.2uF since it's somewhat cheaper and easier to source. However, even 1uF is fine too.

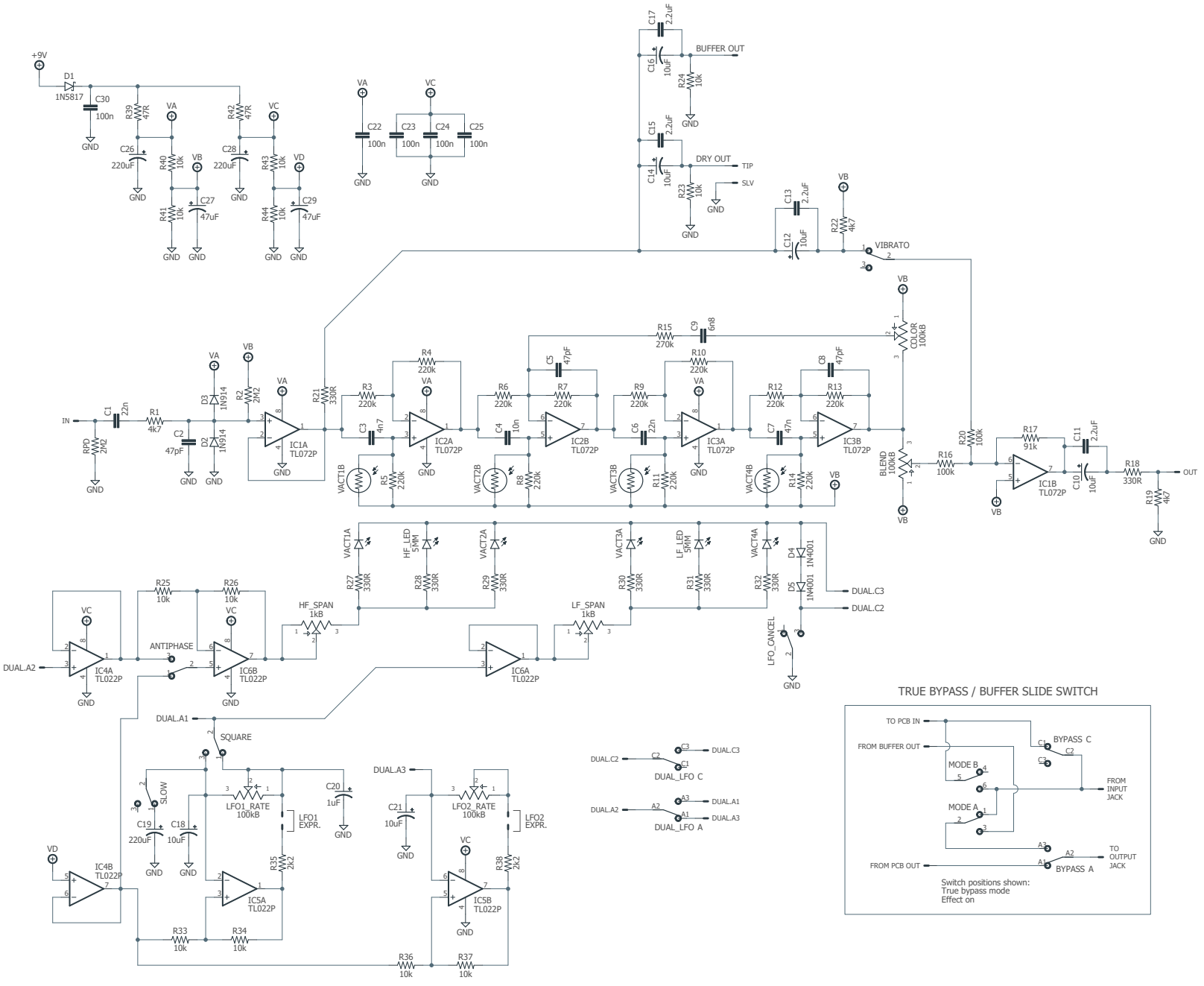
Hard-wiring the buffer switch

If you can't find the correct slide switch for the true bypass/buffer mode selector, or you don't want to use true bypass mode, you can hard-wire it to buffer mode and omit the switch.

Find the mode switch in the center of the bypass sub-PCB. Solder a jumper wire (e.g. a clipped resistor lead) between the top-left and top-center pads, and another between the bottom-left and bottom-center pads. Leave the top-right and bottom-right pads unconnected.

Conversely, if you want to hard-wire the true bypass mode, do the opposite and jumper the center and right pads, leaving the left pads empty. However, this is strongly discouraged since true bypass mode has some limitations described on page 3.

SCHEMATIC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D1
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C30
100n
R39
47R
R42
47R
C26
220uF
C28
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R43
10k
R41
10k
C27
47uF
R44
10k
C29
47uF
VA
VB
VC
VD
GND
C22
100n
C23
100n
C24
100n
C25
100n
C17
2.2uF
C16
10uF
R24
10k
BUFFER OUT
C15
2.2uF
C14
10uF
R23
10k
DRY OUT
TIP
SLV
C13
2.2uF
C12
10uF
R22
4k7
VIBRATO
IN
C1
22n
RPD
2M2
R1
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220k
R13
220k
C8
47pF
C7
47n
IC3B
TL072P
R15
270k
C9
6n8
COLOR
100kB
BLEND
100kB
R16
100k
R20
100k
R17
91k
C11
2.2uF
C10
10uF
IC1B
TL072P
R18
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R19
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VACT1B
R5
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5MM
R27
330R
R28
330R
R29
330R
R30
330R
R31
330R
R32
330R
D4
1N4001
D5
1N4001
DUAL.C3
DUAL.C2
HF_SPAN
1kB
LF_SPAN
1kB
LFO_CANCEL
R25
10k
R26
10k
ANTIPHASE
IC4A
TL022P
IC6B
TL022P
IC6A
TL022P
DUAL.A2
DUAL.A1
DUAL.A3
SQUARE
SLOW
LFO1_RATE
100kB
LFO1
EXPR.
C20
1uF
C19
220uF
C18
10uF
R35
2k2
IC4B
TL022P
IC5A
TL022P
R33
10k
R34
10k
LFO2_RATE
100kB
LFO2
EXPR.
C21
10uF
R38
2k2
IC5B
TL022P
R36
10k
R37
10k
DUAL_LFO C
DUAL_LFO A
TRUE BYPASS / BUFFER SLIDE SWITCH
TO PCB IN
FROM BUFFER OUT
BYPASS C
MODE B
MODE A
FROM
INPUT
JACK
TO
OUTPUT
JACK
FROM PCB OUT
BYPASS A
Switch positions shown:
True bypass mode
Effect on

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.

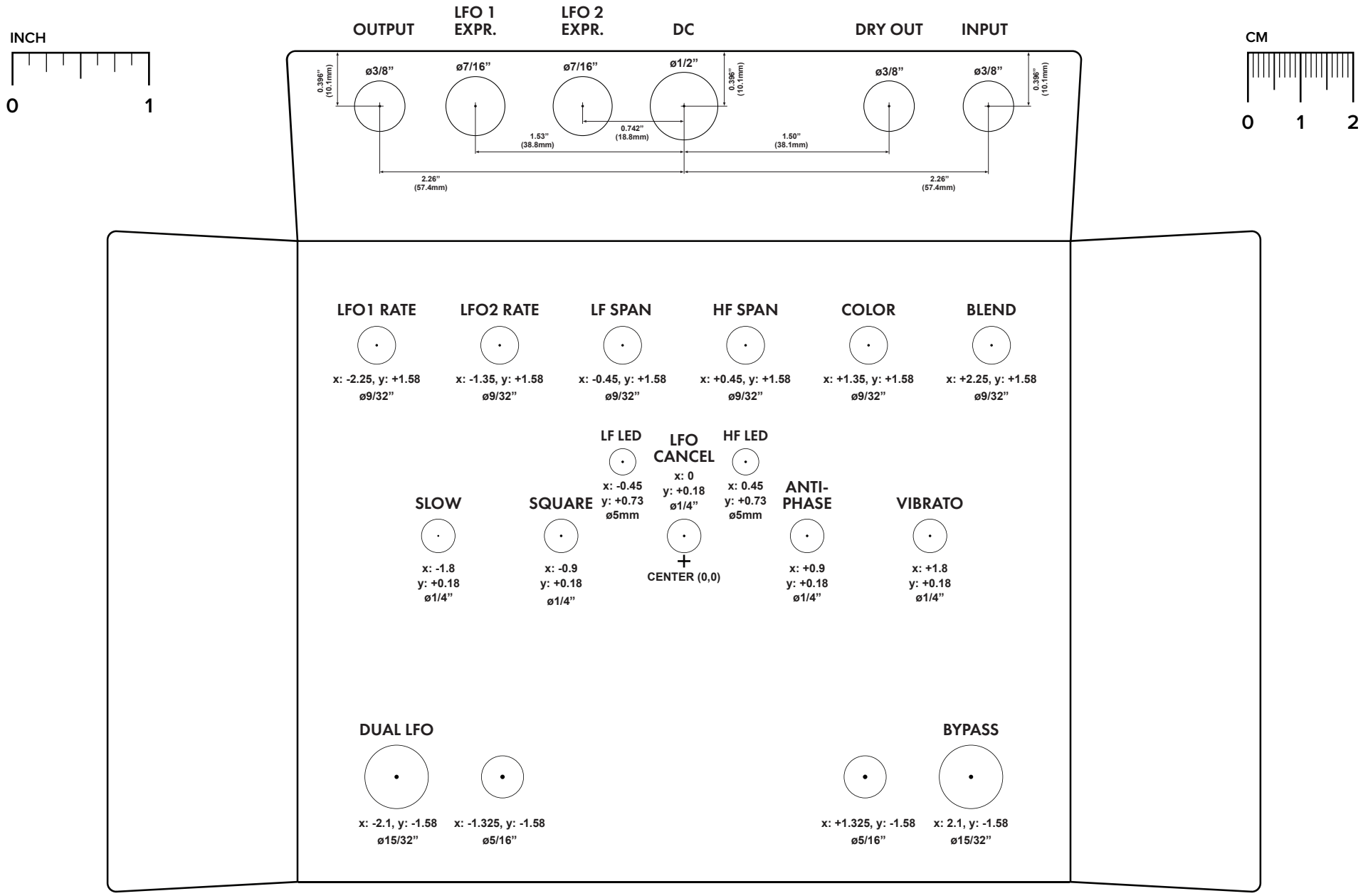
The LEDs next to the footswitches are sized for a 5mm LED bezel, available from several parts suppliers. Adjust the drill size accordingly if using something different, such as a 3mm bezel, a plastic snap-in bezel, or just a plain LED.

The HF/LF LED drill holes are sized for plain LEDs with no bezel. If you don't have a 5mm bit, use 7/32".

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

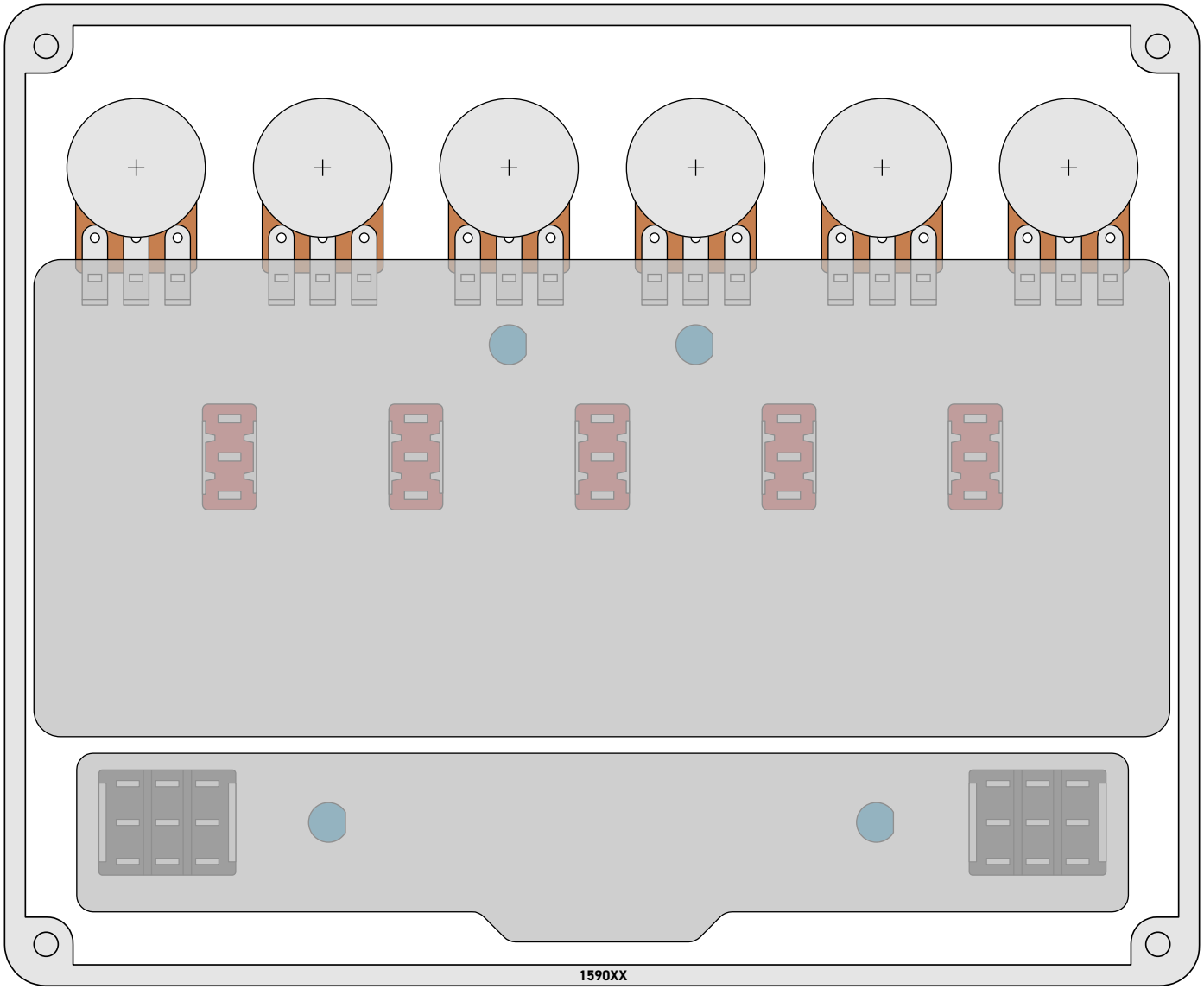
If the toggles don't align to the PCB, you can always drill one step larger (9/32") to allow a little more room correct any errors. The toggle switch washer and nut will still fully cover the hole.

DRILL TEMPLATE

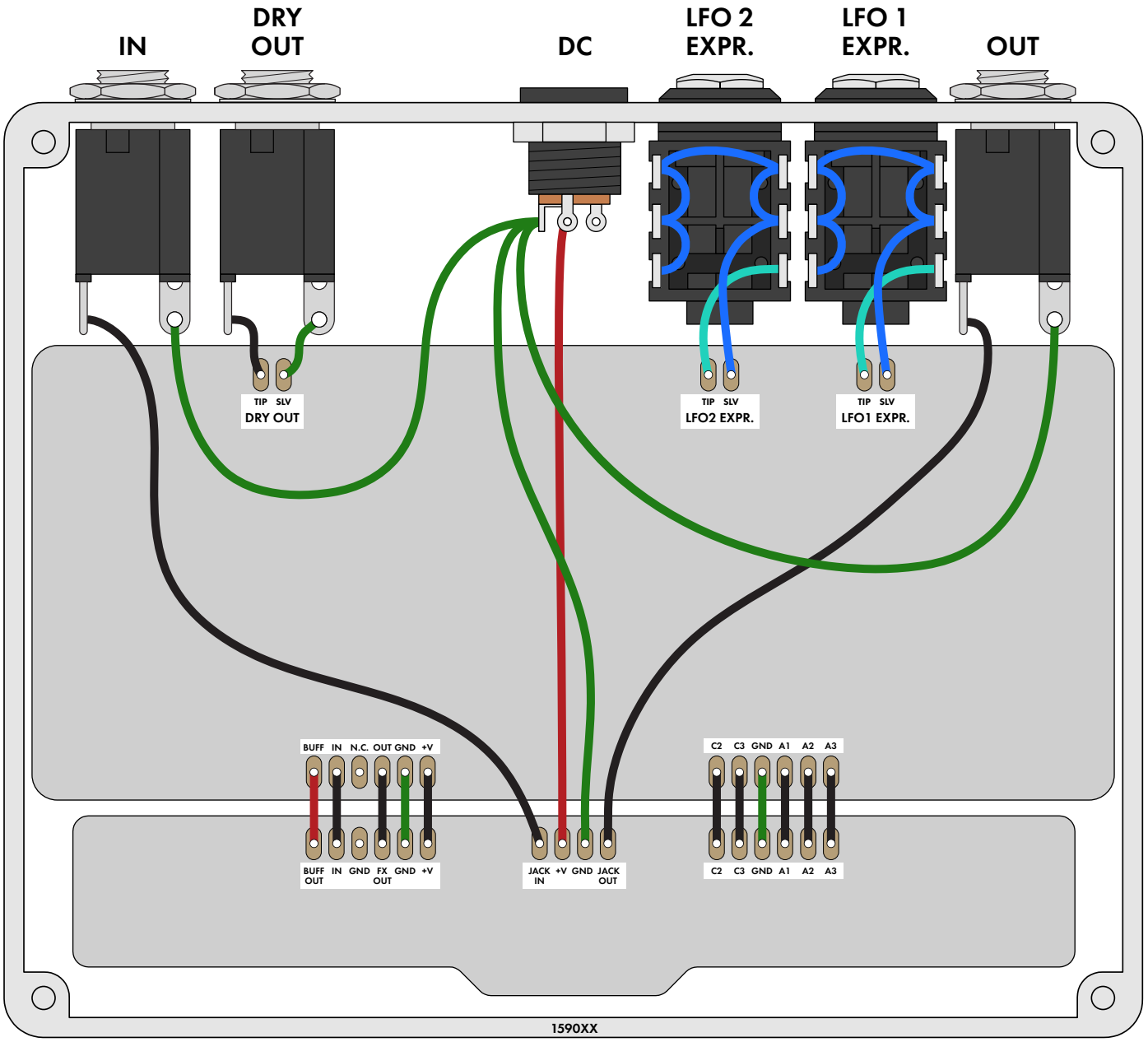


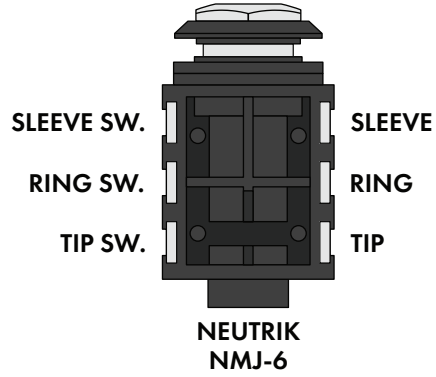
ENCLOSURE LAYOUT

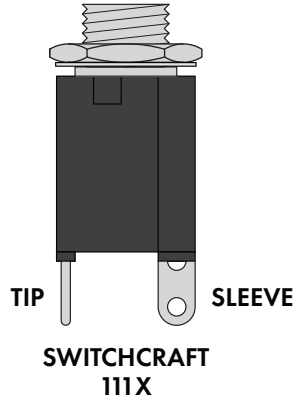
Enclosure is shown without jacks. See next page for jack layout and wiring.



WIRING DIAGRAM







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

1.0.3 (2021-08-10)
Added more information about the 2kB span pot modification.

1.0.2 (2021-07-23)
Updated drill template to correct some of the listed X/Y coordinates. The physical positions were correct.

1.0.1 (2021-07-05)
Added missing mode switch from parts list (E-Switch EG2201). Added notes about hard-wiring the slide switch for buffer mode.

1.0.0 (2021-07-02)
Initial release.