PROJECT NAME

XENOTRON

DIY GUITAR EFFECTS

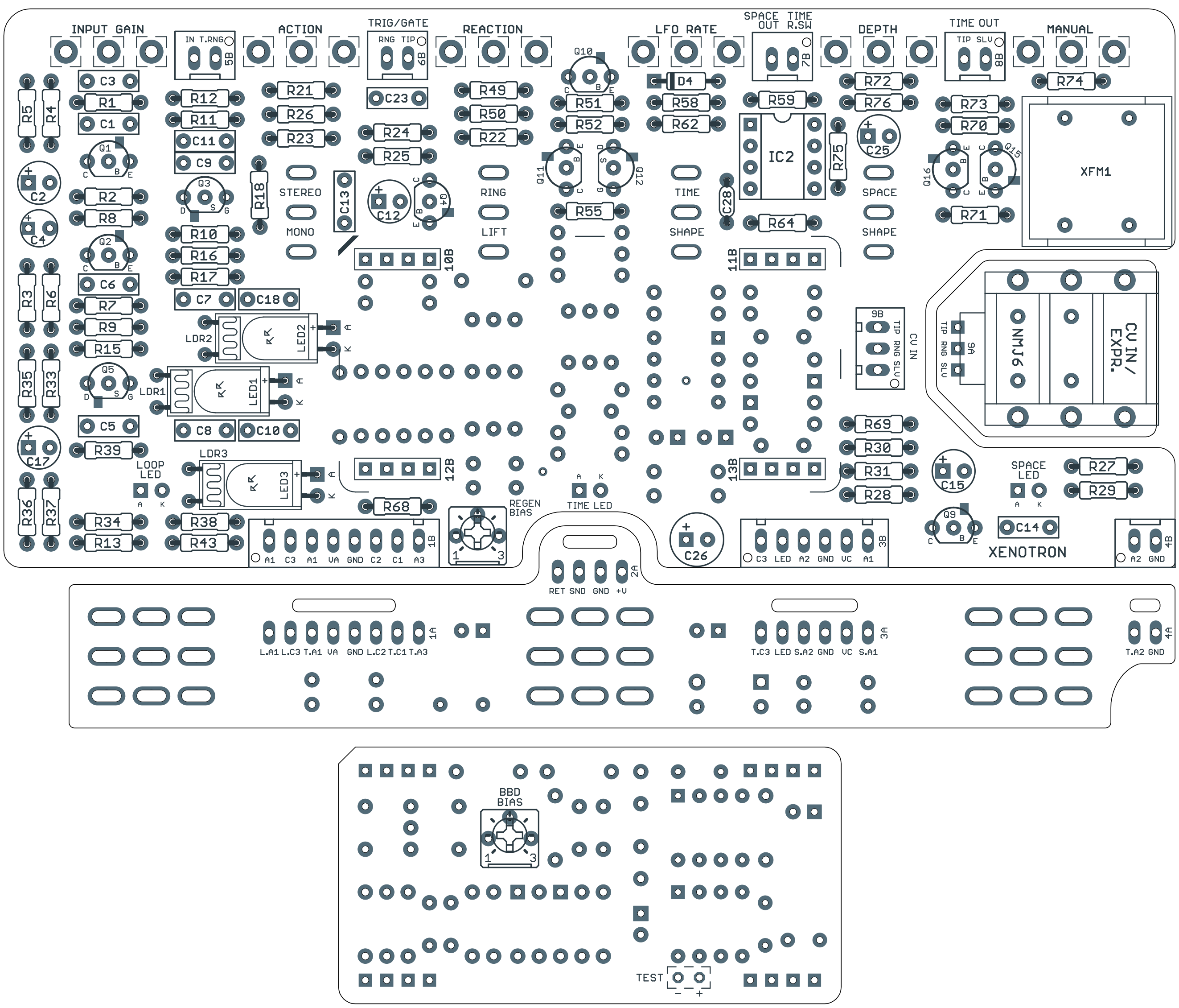
BASED ON
Lovetone ? Flange With No Name

BUILD DIFFICULTY
Expert

EFFECT TYPE
Tremolo / flanger / modulation

DOCUMENT VERSION
1.0.3 (2024-08-28)

PROJECT SUMMARY
A flanger, chorus, tremolo and everything in between, with synth-like controls, regeneration and self-oscillation for unique and otherworldly sounds.



Actual size is 5.48" x 2.61" (main board), 5.17" x 0.68" (bypass board), and 2.35" x 1.20" (BBD daughterboard).

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WARNING / DISCLAIMER

The Xenotron is an expert-level circuit and it takes experience and attention to detail in order to build it successfully. Please read the entire build document to familiarize yourself with every aspect of the project before you begin. You're much more likely to have a successful journey if you study the map carefully beforehand.

Here are a few warnings and precautions to keep in mind before you start:

It's complex. If you've never built a guitar pedal before, this shouldn't be your first. Or your fifth, or even your tenth. It has 200 components that are spread across four PCBs and mounted to both sides of each board. There are a lot of wires. It uses entire categories of components such as LDRs and transformers not often seen in beginner or intermediate circuits, and it requires fine-tuning for proper operation.

It will take awhile. Expect four to eight hours from start to finish. Double-check all component values before soldering. One easy mistake—for example, using a 100k resistor instead of 10k—may cost hours of troubleshooting later.

You've got to build it as intended. Everything is designed to fit together in a very particular way. If you don't want to use the specified enclosure size and control layout, this probably isn't the right version of the circuit for you, and there are other adaptations that might be better choices.

It's not cheap. Components will be well over USD$125 when ordering from reputable suppliers like Mouser. The parts are all fairly commonplace and easy to source, but it still may be tempting to cut costs wherever you can. Just keep in mind that a single fake or low-quality part may be the difference between a successful build and something that ends up in the scrap pile.

We do not offer direct technical support. If there's anything we can do to improve the clarity of this build document, or if you notice any errors, we're happy to hear suggestions. But our role is to design projects and sell PCBs and components. It's up to you to turn these into a working pedal. The staff at Aion FX is minimal, and time spent helping individuals in private is time away from new projects.

With that out of the way: it is an incredibly rewarding build and there's nothing else quite like it. Just take your time and go slowly. All the information you need can be found either in this document or in the original user's manual, but it's up to you to read and understand it.

INTRODUCTION

The Xenotron Modulation Machine is an adaptation of Lovetone's legendary "?" Flange With No Name, probably the most well-known of Lovetone's lineup, and particularly notable for its complexity both inside and outside. It was the last of the Lovetone effects to be designed, released in early 2000 shortly before the company ramped down production. As a result, it's also the rarest of their effects.

The "?" was called a flanger, but this is just a simplification for lack of a more accurate term. The basic premise is that it has two primary modulation functions: Space (optical tremolo) and Time (BBD-driven flange, chorus, doubling, and pseudo-phasing). These can either be used in stereo with separate outputs for each type of modulation, or summed to mono for a variety of hybrid tones from the two types of modulation working in tandem.

But the real magic is in the array of knobs and added features. The "Action" (mix) and "Reaction" (regeneration) controls work with in-phase and out-of-phase copies of the signal, meaning they can either add or subtract from the signal in their respective areas. Along with this, the delay path has an optional effects loop for external effects. Together with the CV input and external triggering, it creates the possibility of sounds that are utterly without comparison in the world of guitar effects.

Also interesting is the design philosophy. If you look at the schematic, the only ICs in use are two for the LFO and two for the delay section (a BBD and clock), which is really the bare minimum. The rest is driven by transistors and JFETs, 17 in total—almost as though the designer, Dan Coggins, challenged himself to do it the hard way without the convenience of op-amps. (Whatever the case, Dan said this was the design that pushed him over the edge and caused him to quit Lovetone shortly afterward.)

The Xenotron is a faithful recreation of the Flange With No Name, with all the features of the original in a much smaller package. We've done the hard work to make a clean and efficient layout that is as straightforward to build as it could possibly be, and written this extensive 30-page build document—but even still, it's a challenging project and not for the faint of heart.

Due to the complexity of operation, we've made the effort to recreate the original Lovetone user manual as a separate document, and the controls are only described briefly in this main build document. Keep the manual handy when using it, because if you don't know how it works then there's a good chance it will sound broken the first time you plug it in!

We have also created an Interactive BOM tool for this project to help with the build process. Components are grouped by value, and you can click any component to see which other parts have the same value and where they're located. (Chrome-based browsers only)

Special thanks to Ian (LaceSensor / Gigahearts FX), the DIY community's resident Lovetone expert, for help verifying the Xenotron prototype against an original Flange With No Name for accuracy.

CIRCUIT DESIGN NOTES

When designing the Xenotron, we started with an ambitious idea: what if we could fit the full circuit with all of its features in a 1590XX enclosure, all using the same components as the original unit? Some past DIY implementations used larger enclosures, while others eliminated features so it would fit.

But with a whole lot of planning, some creative space-saving solutions, and several revisions, we made it work. It ended up being by far the most challenging and time-consuming layout we've ever done, but also the one we're most proud of.

We don't have a lot of design notes on this one because we didn't really change anything from the original design or add anything new like we've done with the other Lovetone projects. However, here are some high-level things to be aware of that are different than most other pedals.

Bypass

The original Flange With No Name does not have a master bypass. The "Space" footswitch cancels the LED modulation, which essentially reduces the tremolo depth to zero. The "Time" footswitch makes it so the "Time" jack output is taken from the tremolo path rather than the delay path, which is then mixed down to mono if only the Space output is used. In both cases, the signal passes through the full tremolo path. (The effects loop is contained within the "Time" sub-circuit, so when Time is disabled, Loop also has no effect.) This means the Input Gain control also impacts the signal level in bypass mode.

All of the original Lovetone pedals used DPDT footswitches, so none of them are true bypass. However, even with a 3PDT, true bypass is not really possible for this particular circuit due to the stereo operation. Therefore, unlike our other Lovetone adaptations, for the Xenotron we opted to leave the bypass switching exactly as in the original. (We still specify 3PDTs due to standard availability, but only two poles are used in each.) When both modes are active, you have to hit two footswitches to fully bypass the effect. They're close enough that they can be pressed at the same time, but it's a little more complicated than most effects.

Rotary switch

The original unit has a rotary switch for the LFO shape. This is a 4-position switch that selects between pairings of LFO modes for Space and Time. Rotary switches are a sort of signature aesthetic for Lovetone, with each of their pedals having at least one. However, in this circuit, it's really performing two separate functions in a logic-table setup (i.e. AA, AB, BA and BB). It's much more straightforward, not to mention space-efficient, to control these features with two 2-position toggle switches.

Power handling

As mentioned in the user manual of the original pedal, this circuit is designed for 9V supply with a maximum voltage of 12V. There is no overvoltage protection, so be very careful to ensure that the correct power supply is used.

If you accidentally plug in an 18V supply and it stops working, the most likely culprit is the BBD (IC3) and possibly the clock (IC4). All the other components should be able to handle 18V with no trouble, but the BBD has a strict maximum of 10V. The BBD supply voltage is dropped by a 330R resistor (R77), which is enough to keep a 12V supply safely below 10V, but not an 18V supply.

USAGE

The Xenotron has the following controls. This is only a very surface-level overview and is not a substitute for reading the full user's manual for the original unit, which includes extensive information on each control as well as a block diagram that is crucial for understanding the high-level functionality.

Potentiometers

- **Input Gain** sets the signal level of the input for the purpose of optimizing the signal-to-noise ratio. This remains part of the signal path in bypass mode. If you want to set it for unity gain, you'll either need a true-bypass looper or a good auditory memory when removing it from the signal chain.
- **Action** sets the mix level of the delay path. At the center position, the modulation is essentially out of the mix. To the left, the signal is mixed out-of-phase, and to the right, it's mixed in-phase.
- **Reaction** sets the amount of regeneration (feedback) for the delay path, which also passes through the FX loop (called Loopage on the original). As with the Action control, at the center position there is no feedback. To the left, odd harmonics are emphasized, with even harmonics to the right.
- **Rate** sets the speed of the LFO. The rate is shared by both Space and Time modes.
- **Depth** sets the depth or intensity of the Time mode. Space mode is always fixed at maximum depth.
- **Manual** sets the delay offset, which changes the modulation character from phasing at low settings, to flanging at medium setting, and into chorusing and doubling at higher settings. At either extreme, modulation depth will be reduced since the delay can only go in one direction rather than wavering above and below a set delay time.

Switches

- **Space Shape** (toggle switch) selects between sine wave and square wave LFO for the space mode (tremolo).
- **Time Shape** (toggle switch) selects between sine wave and square wave LFO for the time mode (flanger/chorus).
- **Mono/Stereo** (toggle switch) selects the phase of the "Time Out" jack in bypass mode. If both outputs are being used, then it should typically be set to Stereo, but some setups may need Mono depending on the phase of the rest of the signal chain.
- **Ring Lift** (toggle switch) disconnects the ring (middle) terminal of the Time jack, which is equivalent to the "C" solution in the user manual under the "Time Out" heading without requiring a specially-modified cable. Note that this prevents the Time signal from being mixed to mono when only the Space output is used, so it should only be engaged when both outputs are used and only if you notice a buzz or weak signal from the Time output.
- **Space** (footswitch) engages or disengages the tremolo effect.
- **Time** (footswitch) engages or disengages the time-based modulation effect.
- **Loop** (footswitch) engages or disengages the effects loop, which is only active when Time is enabled.

External jacks

- **Loop Send/Return** is the effects loop that is engaged with the Loop footswitch. When nothing is connected, the send is normalized to the return, so the Loop footswitch has no effect. This is where a lot of the circuit's magic comes from, so get creative. Try putting a delay pedal in the FX loop as a good starting point.
- **Trig/Gate** is a stereo jack with two functions.
    - If the plug is inserted all the way (i.e. signal is applied to the jack's tip connection), then the Gate function is activated. A positive DC voltage of at least 0.7V will cause the LFO to lock in place. Brief voltage spikes will cause the LFO to sync to an external signal.
    - If the plug is inserted halfway (i.e. signal is applied to the jack's ring connection) then the Trigger function is activated. This works the opposite of Gate, with the LFO resetting when a static positive voltage is periodically grounded, which is how most tap tempo pedals are wired.
    - For tempo sync functionality, you'll want to first manually set the rate as close as possible to the actual tempo. The trigger and gate only reset the LFO, they don't impact the rate of sweep. It's a great way to close the gap from "almost" to "perfect", but if the manual setting is too far off the trigger tempo, the transition will be very abrupt every time it is reset.
- **CV In/Pedal** allows the modulation to be controlled with either an external control voltage or with an expression pedal. The Manual control impacts the range of the CV or expression pedal, and should be set low when using an external source to give the widest possible range.

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 → Interactive BOM →

PART	VALUE	TYPE	NOTES
R1	10k	Metal film resistor, 1/4W	
R2	1M2	Metal film resistor, 1/4W	
R3	4k7	Metal film resistor, 1/4W	
R4	330R	Metal film resistor, 1/4W	
R5	10k	Metal film resistor, 1/4W	
R6	2M2	Metal film resistor, 1/4W	
R7	4k7	Metal film resistor, 1/4W	
R8	1k	Metal film resistor, 1/4W	
R9	330R	Metal film resistor, 1/4W	
R10	39k	Metal film resistor, 1/4W	
R11	470k	Metal film resistor, 1/4W	
R12	100k	Metal film resistor, 1/4W	
R13	2k2	Metal film resistor, 1/4W	
R14	2k2	Metal film resistor, 1/4W	
R15	2M2	Metal film resistor, 1/4W	
R16	470k	Metal film resistor, 1/4W	
R17	2M2	Metal film resistor, 1/4W	
R18	470k	Metal film resistor, 1/4W	
R19	68k	Metal film resistor, 1/4W	
R20	1M2	Metal film resistor, 1/4W	
R21	2k2	Metal film resistor, 1/4W	
R22	1k	Metal film resistor, 1/4W	
R23	1k	Metal film resistor, 1/4W	
R24	330R	Metal film resistor, 1/4W	
R25	39k	Metal film resistor, 1/4W	
R26	39k	Metal film resistor, 1/4W	
R27	1M2	Metal film resistor, 1/4W	
R28	2k2	Metal film resistor, 1/4W	
R29	1k	Metal film resistor, 1/4W	
R30	100R	Metal film resistor, 1/4W	
R31	1k	Metal film resistor, 1/4W	
R32	470k	Metal film resistor, 1/4W	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
R33	39k	Metal film resistor, 1/4W	
R34	470k	Metal film resistor, 1/4W	
R35	4k7	Metal film resistor, 1/4W	
R36	39k	Metal film resistor, 1/4W	
R37	330R	Metal film resistor, 1/4W	
R38	3k9	Metal film resistor, 1/4W	
R39	100k	Metal film resistor, 1/4W	
R40	4k7	Metal film resistor, 1/4W	
R41	10k	Metal film resistor, 1/4W	
R42	39k	Metal film resistor, 1/4W	
R43	4k7	Metal film resistor, 1/4W	
R44	22k	Metal film resistor, 1/4W	
R45	2M2	Metal film resistor, 1/4W	
R46	4k7	Metal film resistor, 1/4W	
R47	330R	Metal film resistor, 1/4W	
R48	4k7	Metal film resistor, 1/4W	
R49	10k	Metal film resistor, 1/4W	
R50	100k	Metal film resistor, 1/4W	
R51	100k	Metal film resistor, 1/4W	
R52	39k	Metal film resistor, 1/4W	
R53	10k	Metal film resistor, 1/4W	
R54	100k	Metal film resistor, 1/4W	
R55	1M2	Metal film resistor, 1/4W	
R56	10k	Metal film resistor, 1/4W	
R57	4k7	Metal film resistor, 1/4W	
R58	39k	Metal film resistor, 1/4W	
R59	100R	Metal film resistor, 1/4W	
R60	10k	Metal film resistor, 1/4W	
R61	39k	Metal film resistor, 1/4W	
R62	22k	Metal film resistor, 1/4W	
R63	39k	Metal film resistor, 1/4W	
R64	100k	Metal film resistor, 1/4W	
R65	39k	Metal film resistor, 1/4W	
R66	1k	Metal film resistor, 1/4W	
R67	1k	Metal film resistor, 1/4W	
R68	2k2	Metal film resistor, 1/4W	
R69	10k	Metal film resistor, 1/4W	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
R70	47R	Metal film resistor, 1/4W	
R71	47R	Metal film resistor, 1/4W	
R72	330R	Metal film resistor, 1/4W	
R73	120k	Metal film resistor, 1/4W	
R74	68k	Metal film resistor, 1/4W	
R75	100k	Metal film resistor, 1/4W	
R76	100k	Metal film resistor, 1/4W	
R77	330R	Metal film resistor, 1/4W	
R78	10k	Metal film resistor, 1/4W	
R79	100k	Metal film resistor, 1/4W	
R80	4k7	Metal film resistor, 1/4W	
R81	120k	Metal film resistor, 1/4W	
R82	100k	Metal film resistor, 1/4W	
R83	10k	Metal film resistor, 1/4W	
R84	100k	Metal film resistor, 1/4W	
R85	10k	Metal film resistor, 1/4W	
R86	470k	Metal film resistor, 1/4W	
R87	100k	Metal film resistor, 1/4W	
R88	2k2	Metal film resistor, 1/4W	
R89	2k2	Metal film resistor, 1/4W	
R90	39k	Metal film resistor, 1/4W	
R91	10k	Metal film resistor, 1/4W	
R92	100k	Metal film resistor, 1/4W	
R93	39k	Metal film resistor, 1/4W	
R94	22k	Metal film resistor, 1/4W	
R95	47R	Metal film resistor, 1/4W	
R96	47R	Metal film resistor, 1/4W	
C1	100n	Film capacitor, 7.2 x 2.5mm	
C2	10uF	Electrolytic capacitor, 5mm	
C3	10n	Film capacitor, 7.2 x 2.5mm	
C4	10uF	Tantalum capacitor, 044A	Can also use electrolytic, but the original unit uses tantalum here.
C5	100n	Film capacitor, 7.2 x 2.5mm	
C6	100n	Film capacitor, 7.2 x 2.5mm	
C7	100n	Film capacitor, 7.2 x 2.5mm	
C8	100n	Film capacitor, 7.2 x 2.5mm	
C9	100n	Film capacitor, 7.2 x 2.5mm	
C10	100n	Film capacitor, 7.2 x 2.5mm	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C11	47n	Film capacitor, 7.2 x 2.5mm	
C12	10uF	Electrolytic capacitor, 5mm	
C13	100n	Film capacitor, 7.2 x 2.5mm	
C14	100n	Film capacitor, 7.2 x 2.5mm	
C15	10uF	Electrolytic capacitor, 5mm	
C16	47n	Film capacitor, 7.2 x 2.5mm	
C17	10uF	Electrolytic capacitor, 5mm	
C18	100n	Film capacitor, 7.2 x 2.5mm	
C19	1n	Film capacitor, 7.2 x 2.5mm	
C20	3n3	Film capacitor, 7.2 x 2.5mm	
C21	100n	Film capacitor, 7.2 x 2.5mm	
C22	10uF	Electrolytic capacitor, 5mm	
C23	10n	Film capacitor, 7.2 x 2.5mm	
C24	470n	Film capacitor, 7.2 x 3mm	
C25	47uF	Electrolytic capacitor, 5mm	Reference voltage filter capacitor.
C26	220uF	Electrolytic capacitor, 6.3mm	BBD supply filter capacitor.
C27	47uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C28	100n	MLCC capacitor, X7R	Power supply filter capacitor.
C29	2n2	Film capacitor, 7.2 x 2.5mm	
C30	100n	Film capacitor, 7.2 x 2.5mm	
C31	100pF PP	Film capacitor, polypropylene, 1%	See build notes for capacitor selection.
C32	100n	MLCC capacitor, X7R	BBD supply filter capacitor.
C33	100n	MLCC capacitor, X7R	BBD supply filter capacitor.
C34	10uF	Electrolytic capacitor, 5mm	Must be low-profile (7mm) or else be folded over adjacent parts.
C35	2n2	Film capacitor, 7.2 x 2.5mm	
C36	100n	Film capacitor, 7.2 x 2.5mm	
C37	100n	Film capacitor, 7.2 x 2.5mm	
C38	100n	Film capacitor, 7.2 x 2.5mm	
C39	220uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C40	220uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.
C41	100n	MLCC capacitor, X7R	Power supply filter capacitor.
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	
D6	1N914	Fast-switching diode, DO-35	

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
Q1	BC549C	BJT transistor, NPN, TO-92	
Q2	BC549C	BJT transistor, NPN, TO-92	
Q3	J113	JFET, N-channel	
Q4	BC549C	BJT transistor, NPN, TO-92	
Q5	J113	JFET, N-channel	
Q6	J113	JFET, N-channel	
Q7	BC549C	BJT transistor, NPN, TO-92	
Q8	BC549C	BJT transistor, NPN, TO-92	
Q9	BC549C	BJT transistor, NPN, TO-92	
Q10	BC549C	BJT transistor, NPN, TO-92	
Q11	BC559C	BJT transistor, PNP, TO-92	NOTE: Q11 is the only PNP transistor. See build notes.
Q12	J113	JFET, N-channel	
Q13	BC549C	BJT transistor, NPN, TO-92	
Q14	BC549C	BJT transistor, NPN, TO-92	
Q15	BC549C	BJT transistor, NPN, TO-92	
Q16	BC549C	BJT transistor, NPN, TO-92	
Q17	J113	JFET, N-channel	
IC1	TL022	Operational amplifier, dual, DIP-8	Can also use LM358 or other low-current types.
IC1-S	DIP8 socket	IC socket, DIP-8	
IC2	TL022	Operational amplifier, dual, DIP-8	Can also use LM358 or other low-current types.
IC2-S	DIP8 socket	IC socket, DIP-8	
IC3	v3207	BBD, 1024-stage, DIP-8	Original uses Panasonic MN3207.
IC3-S	DIP8 socket	IC socket, DIP-8	
IC4	v3102	Two-phase clock generator, DIP-8	Original uses Panasonic MN3102.
IC4-S	DIP8 socket	IC socket, DIP-8	
BBD BIAS	22k trimmer	Trimmer, 10%, 1/4"	Can also substitute 25k.
REGEN BIAS	22k trimmer	Trimmer, 10%, 1/4"	Can also substitute 25k.
XFM1	LM-NP-1001-B1L	Transformer, line matching, 600:600	Bourns LM-NP-1001-B1L. See build notes.
LED1	5mm green	LED, 5mm, green diffused	See build notes for LED/LDR information.
LED2	5mm green	LED, 5mm, green diffused	See build notes for LED/LDR information.
LED3	5mm green	LED, 5mm, green diffused	See build notes for LED/LDR information.
LED4	5mm green trans.	LED, 5mm, green transparent	Mouser 604-WP7113GT or similar. See build notes.
LDR1	NSL-19M51	LDR, 20-100k light, 20M dark	See build notes for LED/LDR information.
LDR2	NSL-19M51	LDR, 20-100k light, 20M dark	See build notes for LED/LDR information.
LDR3	NSL-19M51	LDR, 20-100k light, 20M dark	See build notes for LED/LDR information.
LDR4	NSL-19M51	LDR, 20-100k light, 20M dark	See build notes for LED/LDR information.
10A-13A	40-pin header	Header strip, 40-pin male	One strip that can be split into four 4-pin male headers.

PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
10B	4-pin header	Header, 4-pin female	See build notes and assembly instructions for more information on headers.
11B	4-pin header	Header, 4-pin female	
12B	4-pin header	Header, 4-pin female	
13B	4-pin header	Header, 4-pin female	
INPUT GAIN	100kB	16mm right-angle PCB mount pot	
ACTION	100kB	16mm right-angle PCB mount pot	
REACTION	100kB	16mm right-angle PCB mount pot	
LFO RATE	100kA	16mm right-angle PCB mount pot	
DEPTH	100kA	16mm right-angle PCB mount pot	
MANUAL	100kB	16mm right-angle PCB mount pot	
SPACE SHAPE	SPDT	Toggle switch, SPDT on-on	
TIME SHAPE	SPDT	Toggle switch, SPDT on-on	
MONO/STEREO	SPDT	Toggle switch, SPDT on-on	
RING LIFT	SPDT	Toggle switch, SPDT on-on	
IN	1/4" mono	1/4" phone jack, closed frame	Switchcraft 111X or equivalent.
SPACE OUT	1/4" mono	1/4" phone jack, closed frame	Switchcraft 111X or equivalent.
TIME OUT	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
SEND	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
RETURN	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
TRIG/GATE	NMJ6HC-S	1/4” phone jack, stereo, switched	Neutrik NMJ6HC-S
CV IN/PEDAL	NMJ6HCD2	1/4” phone jack, stereo, switched	Neutrik NMJ6HCD2 (PCB-mount variant of the HC-S).
DC	2.1mm	DC jack, 2.1mm panel mount	Mouser 163-4302-E or equivalent.
SPACE	3PDT	Stomp switch, 3PDT	
TIME	3PDT	Stomp switch, 3PDT	
LOOP	3PDT	Stomp switch, 3PDT	
SPACE LED	5mm red	LED, 5mm, red diffused	
TIME LED	5mm green	LED, 5mm, green diffused	
LOOP LED	5mm yellow	LED, 5mm, yellow diffused	
ENCLOSURE	1590XX	Enclosure, die-cast aluminum	1790NS equivalent.

SETTING THE BBD BIAS

Bias adjustments should be made in a dimly lit room, and it's recommended to cover the pedal with a towel or T-shirt in such a way that the four LDRs are prevented from picking up ambient light. The top of the BBD sub-board can be partially exposed for adjustment since the LDR is on the bottom side.

To start with, set the BBD bias trimmer to the 12:00 position, and then down *just slightly* (the equivalent of 15 minutes in clock terms, or 11:45). We tested both Panasonic MN3207 and Coolaudio v3207 and found that they both had the exact same optimal bias point when changing between the two types.

Component tolerances have improved greatly since the unit was first released in 2000, so it's likely that the ideal bias range will be much narrower than on original units. You may not need to change the bias at all from this point.

To verify it's set properly, first set the controls as follows:

- **Input Gain**, **Action**, **Manual**, **Depth**, and **LFO Rate** fully clockwise (all the way up)
- **Reaction** at center (12:00)
- **Space Shape** and **Time Shape** toggles to triangle wave (switch down)
- **Stereo/Mono** set to Mono (switch down)
- **Time** mode on, **Space** mode off, **Loop** off (or nothing connected to send/return jacks)
- **Regen Bias** (trimmer) to 2:00

Connect a guitar to the input of the pedal, and connect the Space Out/Mono jack to the amp. Set the amp volume to zero, power it on, and then turn up the volume until the guitar volume is normal when strumming. (With "Input Gain" set fully up, the pedal output will be higher than a normal guitar signal.)

Now, listen for distortion, static and clock noise as you adjust the knobs. First turn the "Rate" control down slowly to zero. Then turn "Manual" to 12:00 and turn "Rate" up slowly until you're back up at full rotation. If at any time you hear any clock ticking, or if you hear distortion, static or hum, make small adjustments to the trimmer until it goes away, and then sweep the controls again to ensure that it's been eliminated across the full range.

The goal is a complete range of control with no clock ticking and minimal distortion. The BBDs have a fixed amount of headroom, so there will eventually be distortion if the input signal is hot enough, but the "Input Gain" control can compensate for high input levels so the distortion can be dialed out.

Oscilloscope adjustment

If you have an oscilloscope, the bias adjustment procedure is similar to other BBD circuits. The optimal bias point is where the two halves of the waveform are symmetrical, measured at the "TEST -/+" pads of the BBD board. It's recommended to use a test signal with enough amplitude to intentionally overload the BBD so you can more easily identify the flat-topped symmetry in the scope output as the trimmer is adjusted.

SETTING THE REGEN TRIMMER

The regen trimmer sets the maximum amount of regeneration or feedback in the "Time" circuit, which is adjusted by the Reaction control (no feedback at the 12:00 position, odd harmonics emphasized to the left, and even harmonics emphasized to the right). The feedback path also includes the effects loop.

Feedback is increased with longer delay times, so you'll want the Manual control turned up somewhat in order to get the most out of this feature. The circuit is designed to oscillate when the "Reaction" control is turned down past 9:00 or up past 3:00.

As with the BBD bias, regen calibration should be done in a dimly lit room, and it's recommended to cover the pedal with a towel or T-shirt in such a way that the four LDRs are prevented from picking up ambient light. The Regen Bias trimmer is located along the bottom edge of the main board.

To start with, ensure the Regen Bias trimmer is still set to 2:00 from the BBD bias procedure. This was the position where our prototype matched an original Lovetone unit, and due to improved component tolerances since 2000, it's likely that this setting will be all that's needed to make yours sound like ours.

However, the user manual provides information on adjusting the trimmer, both due to personal taste (how much you like oscillation) and due to differences in intended operating voltages, since the oscillation behavior changes when switching between 9V and 12V power.

So while some original units definitely sound better than others, and much or most of this is due to the setting of the Regen trimmer, it's still considered a user-adjustable feature, in contrast with the BBD bias which the manual warns against adjusting.

To verify it's set properly, first set the controls as follows:

- **Input Gain**, **Action**, **Manual**, and **LFO Rate** fully clockwise (all the way up)
- **Reaction** at 12:00
- **Depth** fully counter-clockwise (all the way down)
- **Space Shape** and **Time Shape** toggles to triangle wave (switch down)
- **Stereo/Mono** set to Mono (switch down)
- **Time** mode on, **Space** mode off, **Loop** off (or nothing connected to send/return jacks)

Connect a guitar to the input of the pedal, and connect the Space Out/Mono jack to the amp. Set the amp volume to zero, power it on, and then turn up the volume until the guitar volume is normal when strumming. (With "Input Gain" set fully up, the pedal output will be higher than a normal guitar signal.)

Now, adjust the "Reaction" control toward 3:00. Once you hit that point, if there is self-oscillation then turn the Regen trimmer clockwise very slightly until it goes away. Then turn "Reaction" up very slightly, to about 3:30. If you don't hear oscillation then turn the trimmer very slightly counterclockwise until you hear it. Try to find the trimmer position where it starts just barely after 3:00, but not at 3:00 sharp.

Now, check the 9:00 position and ensure that the same thing happens (oscillation starting just after 9:00 on the rotation as it's turned toward zero). It will sound different, but the oscillation itself should happen at roughly the same spot on the opposite side of the control.

Headers and sockets

The BBD sub-board is attached using standard pin headers and sockets that are also used in many other types of DIY electronics such as Arduino shields. You'll need four 4-pin sockets and one snap-apart male header with at least 16 pins that can be broken into four 4-pin headers.

The best ones we've found are from Tayda Electronics. They're cheaper than the ones from Mouser and also make a much tighter connection with more tension. Here are the links:

- 4-pin female header (4 needed)
- 40-pin snap-apart male header (1 needed)

See pages 19-20 for information and diagrams about how to install this sub-board.

BBD sub-board orientation

The BBD sub-board has a notch in the upper-left corner (looking from the top, not the component side) which lines up with a diagonal line on the main PCB. Always ensure it is re-inserted correctly any time you remove it. Permanent damage could result if it's rotated 180 degrees when power is applied.

Securing the BBD PCB

When the pedal is in playing position, gravity will be pulling against the BBD board, and it could potentially be knocked loose with enough shock. Once the pedal is fully tested and working, you may want to attach some non-conductive adhesive foam to the inside of the lid that is thick enough to press down against the PCB when it's closed. Make sure the offboard wires are routed around it so that they aren't pressed up against the PCB.

Alternately, you could also use some hot glue on the headers, or any other idea you may have. Just ensure you've secured it somehow if you're planning on using the pedal in a live environment.

LDR selection

While the original LDRs used in the Flange With No Name are unknown, the Advanced Photonix NSL-19M51 is a likely candidate that meets the specifications for all four positions. It has been tested extensively in this circuit and has been found to perform identically, and it's readily available from Digikey and Mouser.

LED selection

The first three LED/LDR pairs work 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 or low-current type. There are also some diffused types that have a much higher MCD brightness specification, and these will not work well.

The fourth LED, located on the BBD sub-board, should be a water-clear or semi-transparent high-brightness type. The Kingbright WP7113GT has been tested and works 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/LDR pairs. When developing the Quadratron (Doppelganger), 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.

Therefore, to be as accurate to the original unit as possible, it's recommended to leave the LED/LDR pairs uncovered as in the original unit, angled toward each other and making physical contact.

Having uncovered LDRs 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. This is also an issue when biasing. You can try wrapping it in a towel or putting it in a closed box while testing.

LDR positioning

For the curious: we intentionally laid out the PCB so that LDR1 and LDR2 are adjacent to each other and offset slightly, as they are in the original unit's layout, so LDR1 would pick up a very small amount of direct light from LED2 but not vice-versa. LDR3 is isolated from the other two by the C8 and C10 box-film capacitors which form a wall of sorts, so it will pick up ambient light but not direct light. LDR4 is located farther away, so it will only pick up a small amount of ambient light.

This is most likely unnecessary, but light is a tricky thing to manage in electronic circuits, and LDRs are already temperamental enough as it is. You never know what might make a difference.

What about vactrols?

It may be tempting to use a manufactured optocoupler (vactrol) such as the VTL5C3 for the LED/LDR pairs for convenience and consistency. This will result in a functional effect, but it will not sound the same since there is no equivalent vactrol with the same specifications as the LED/LDRs used in the original flanger.

BBD selection

The original Lovetone unit used Panasonic MN3207 BBDs. The Coolaudio v3207 is a direct clone of the MN3207 with the same specifications.

We tested prototypes with both MN3207 and v3207 against the original unit and they each sounded identical, so we're confident in saying that the Coolaudio reissues are a spot-on replacement.

Most of the MN3207s for sale these days are either fake or pulled from recycled electronics, so if you use one, make sure to test it in another known-working circuit before trying it in this one.

C4 capacitor type

C4 is a 10uF tantalum capacitor in the original unit. Since all of the other 10uF capacitors are electrolytic, this was clearly an intentional choice on the part of the designer, though we're not sure of the purpose. An electrolytic capacitor would work fine here, but if using a tantalum, make absolutely sure it's inserted with the correct polarity. Tantalums are much more susceptible to damage from reversed polarity and may be permanently damaged if installed backwards.

C31 capacitor type

BBD clocks benefit from a high-quality timing capacitor. The original Flange With No Name uses a large axial polystyrene capacitor for C31. These have exceptional temperature stability and generally low tolerances. We've included space for this type of capacitor on the BBD sub-board.

However, we were unable to find a polystyrene 100pF capacitor from Mouser, so we opted for polypropylene 1%, which are available in either axial or box-film formats from Vishay. They aren't cheap, but they are exceptionally high quality, and it's what we used in our prototype that was tested against an original Lovetone unit. This can be found in the parts spreadsheet.

If you would rather use polystyrene, the FSC series from LCR has a suitable 100pF 160V 2.5% capacitor that is available from Newark and Farnell.

Note that C31 is composed of two overlapping footprints on the PCB, one for an axial capacitor and one for a 5mm box film type. The outer pads are connected, so just use the inner or outer set of pads and ignore the other two. No jumper wires are needed in either case.

C34 capacitor orientation

C34 is a 10uF electrolytic capacitor located on the BBD sub-PCB. There's only about 10mm of clearance between the BBD board and the main board, so while a low-profile 7mm capacitor will fit just fine, the standard 11mm height will not. If you only have the 11mm type available, it can easily be folded over the adjacent resistors—just make sure to bend the legs before soldering and install it at a right angle, because the legs won't be long enough to fold the capacitor over after soldering.

Q11 transistor

The Xenotron has 17 transistors in total: five JFETs, 11 NPNs and only one PNP. Be very careful to ensure that Q11 is a BC559C, not BC549C as all the others are. It is very, very easy to overlook this and the LFO will not work if the wrong type is used.

Q11 was a BC307B in the original unit, but these are obsolete. The BC559C is the current-production PNP counterpart to the BC549, so it's recommended to use this for Q11 instead of trying to hunt down the exact type and risk fakes or off-spec parts.

Transistor substitution

The original Lovetone unit used the European BC-series transistors. These are still readily available in through-hole format, so we've specified the BC549C for all NPN transistors and the BC559C for the PNP transistor. If you want to use standard USA types, the 2N5088 is the BC549C equivalent and the

2N5087 is the BC559C equivalent PNP transistor. Just make sure to rotate them 180 degrees from the silkscreen since the pinout is mirrored. Extra pads have also been included so that you can also use SOT-23 (SMD) transistors and JFETs.

Transformer selection

The original Lovetone unit used the OEP1200 for the transformer. These are still possible to find, but they're expensive. It's recommended to use the Bourns LM-NP-1001-B1L, which is cheap and readily available and has the exact same specifications.

Transformer orientation

Both the Bourns transformer and the original OEP1200 are fully symmetrical with no primary and secondary, so it doesn't matter which way it's inserted as long as it lines up with the pads on the PCB.

CV In/Expr. sub-PCB

Take note of the two resistors on the underside of the CV In/Expr. PCB. These should be soldered before the jack. If you do forget to do this, you can trim the legs before insertion and solder them from the component side, but it's tedious.

Please ensure the CV In / Expr. jack is installed the correct way on the sub-PCB since the pin pattern is symmetrical and it will fit either direction. The open end of the jack should face away from the wire pads. This may seem basic, but it's an easy mistake! We do not sell the sub-PCBs separately.

Omitting the CV In/Expr jack

If you don't want to use the CV In/Expr jack, you can just omit the sub-PCB entirely and leave the wire pads disconnected on the main board. No jumpers are necessary. The two resistors on the sub-PCB are only in the circuit when the jack is being used, so they can be left out of the circuit.

Omitting the Trig/Gate jack

If you don't have any need for the Trig/Gate functionality, the jack can be omitted. Leave the Trig/Gate pads unconnected. No jumpers are necessary.

IC1/IC2 selection

The original unit used a single quad op-amp for the LFO, but the back was sanded down so the type is unknown. The LM324 is a likely candidate since it's a low-current type that is often seen in LFOs.

We opted to split this into two 8-pin types because there is a wider selection of op-amps in this format. The TL022 is even more efficient than the LM324, so it's recommended for use in IC1 and IC2, but the LM358 (the dual version of the LM324) can be used as well.

Trimmer values

The original unit used 22k trimmers for Regen and BBD Bias. While these are not hard to find, 25k is a more common value and can be substituted with no change in operation.

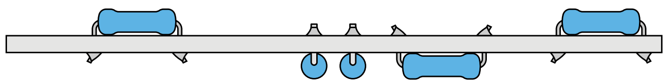
BBD SUB-BOARD ASSEMBLY INSTRUCTIONS

The Xenotron uses a “sandwich” configuration for the BBD sub-board for both space efficiency and signal separation. It’s not particularly difficult, but there’s only one right way to put it together and several wrong ways that may ruin your build if you’re not careful. Make sure you have a good understanding of what the end result should look like before you begin installing any components.

The diagrams show an approximate side profile of the PCB as viewed from the left side. Scale and visible components are not exact.

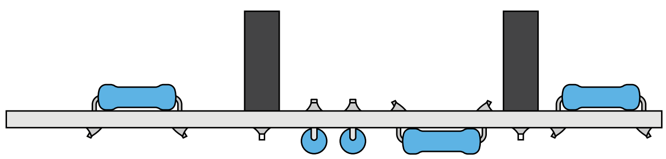
Step 1

Populate the PCBs according to the silkscreen. The Xenotron is composed of four sub-PCBs, and all four boards have components mounted to both the top and bottom sides. Components are always mounted to the side with the silkscreen footprint.



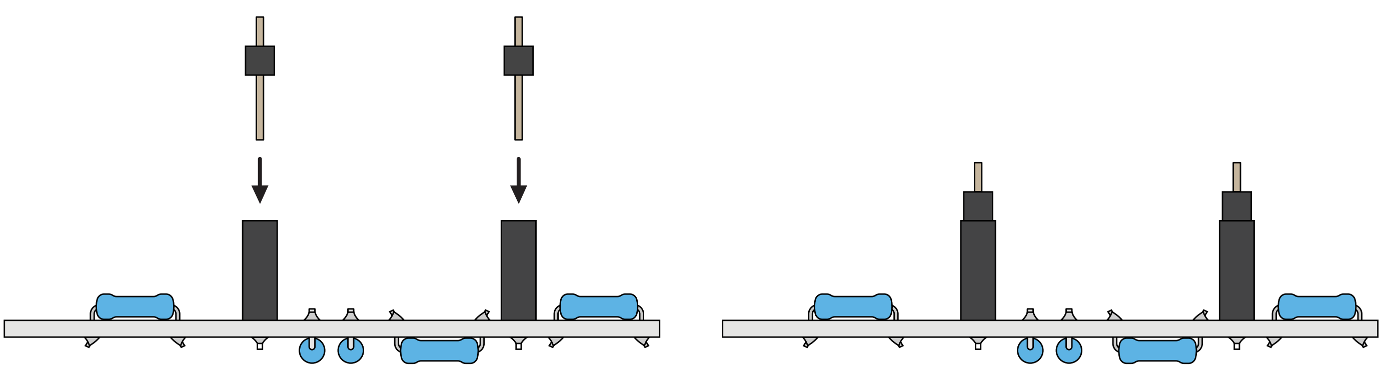
Step 2

Install the header sockets on the top side of the main PCB. It’s recommended to turn the PCB upside down to hold all of them in place while soldering. Solder one leg of each header, then check them from the side to make sure they are straight and perpendicular with the PCB before soldering the remaining legs. If any of them are crooked, reflow the solder and adjust them as needed.



Step 3

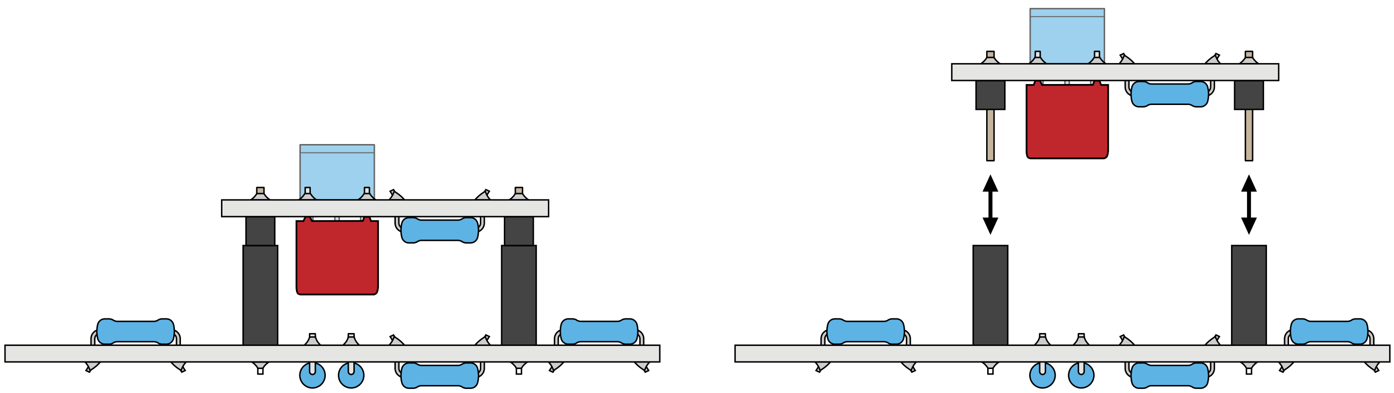
With the header sockets installed to the main PCB, insert the male headers, separated into four 4-pin strips. The long side goes into the socket and the short side faces up.



Step 4

With the male header sockets in place, put the BBD sub-board in position, components facing down. Ensure the angled notch is in the upper-left and lines up with the small diagonal line on the main PCB. (The headers and pins should always mount to the side with the rectangular outline on the PCB silkscreen.)

Once everything is in place, solder the pins to the top PCB. The top PCB can then be removed and set aside until final assembly.

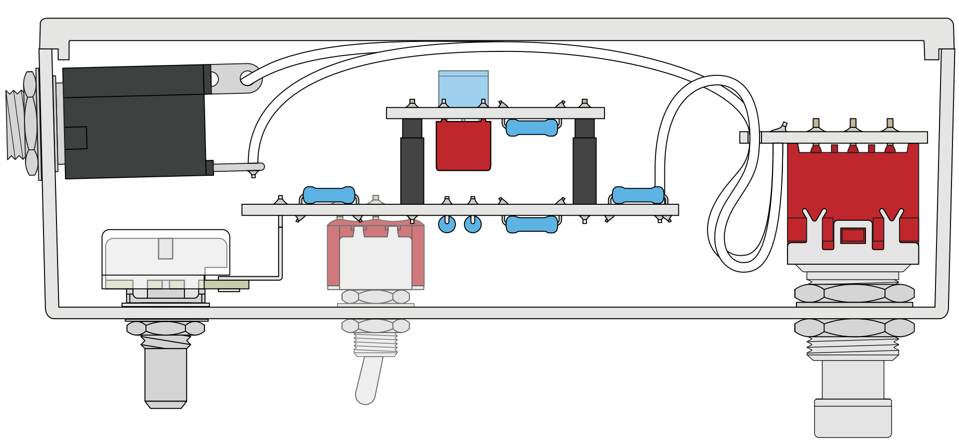


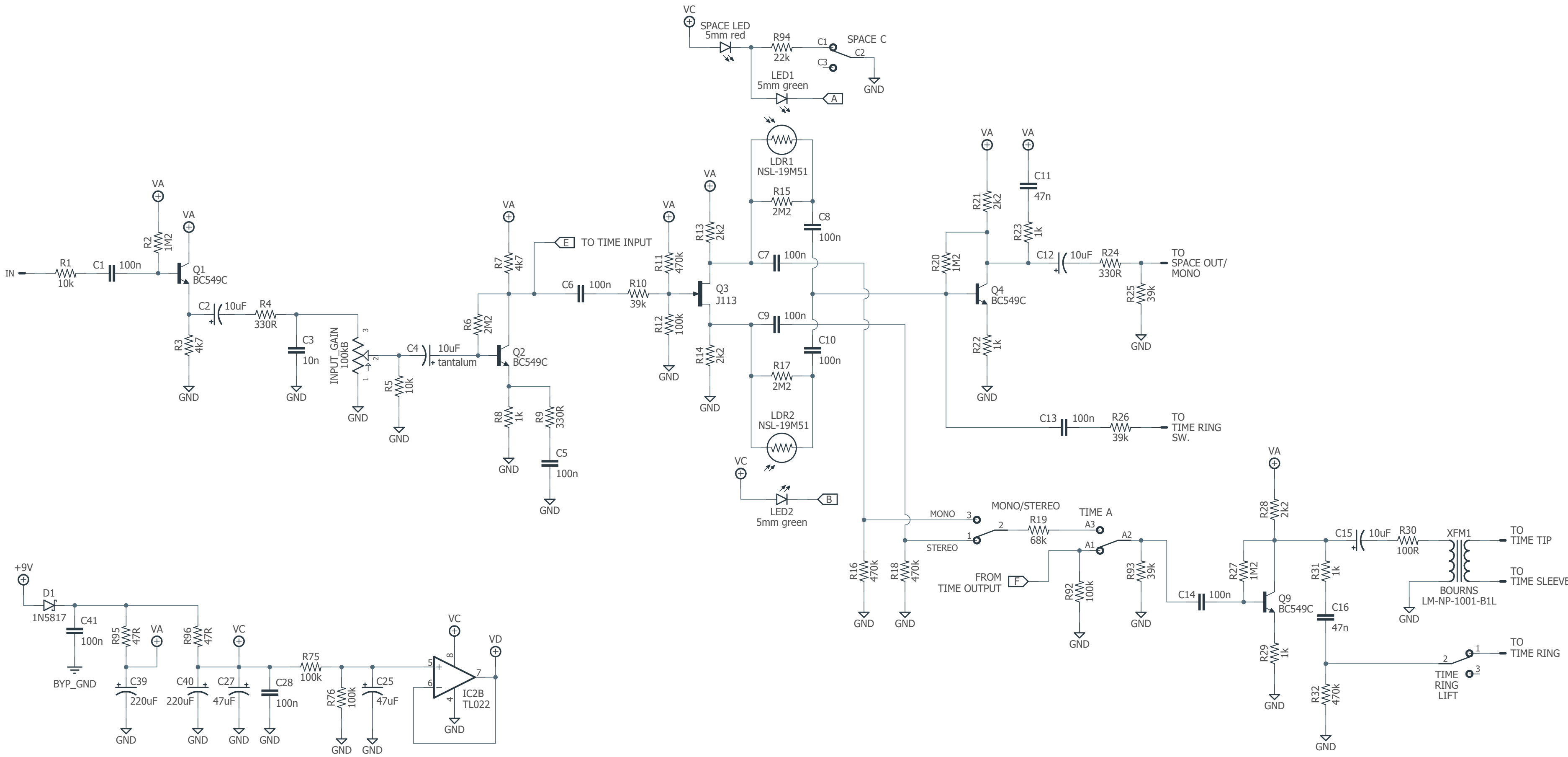
It's done in this order so that that the pins are perfectly coupled with the headers. If they were soldered separately from each other, the slight misalignments between the pins and headers would create stress that could potentially cause cracked solder joints over time.

From here, you can proceed with the rest of the build as normal. It's recommended to first attach the potentiometers and switches to the drilled enclosure and then solder the main PCB in place. This way, the enclosure acts as a template that ensures the pots and switch are mounted at the correct height, and it will help compensate for any slight drilling inaccuracies in the enclosure.

Even if you decide to then remove the PCB to test outside the enclosure before final boxing, this method will ensure there is no long-term stress on the joints of the PCB-mounted components once everything is reassembled.

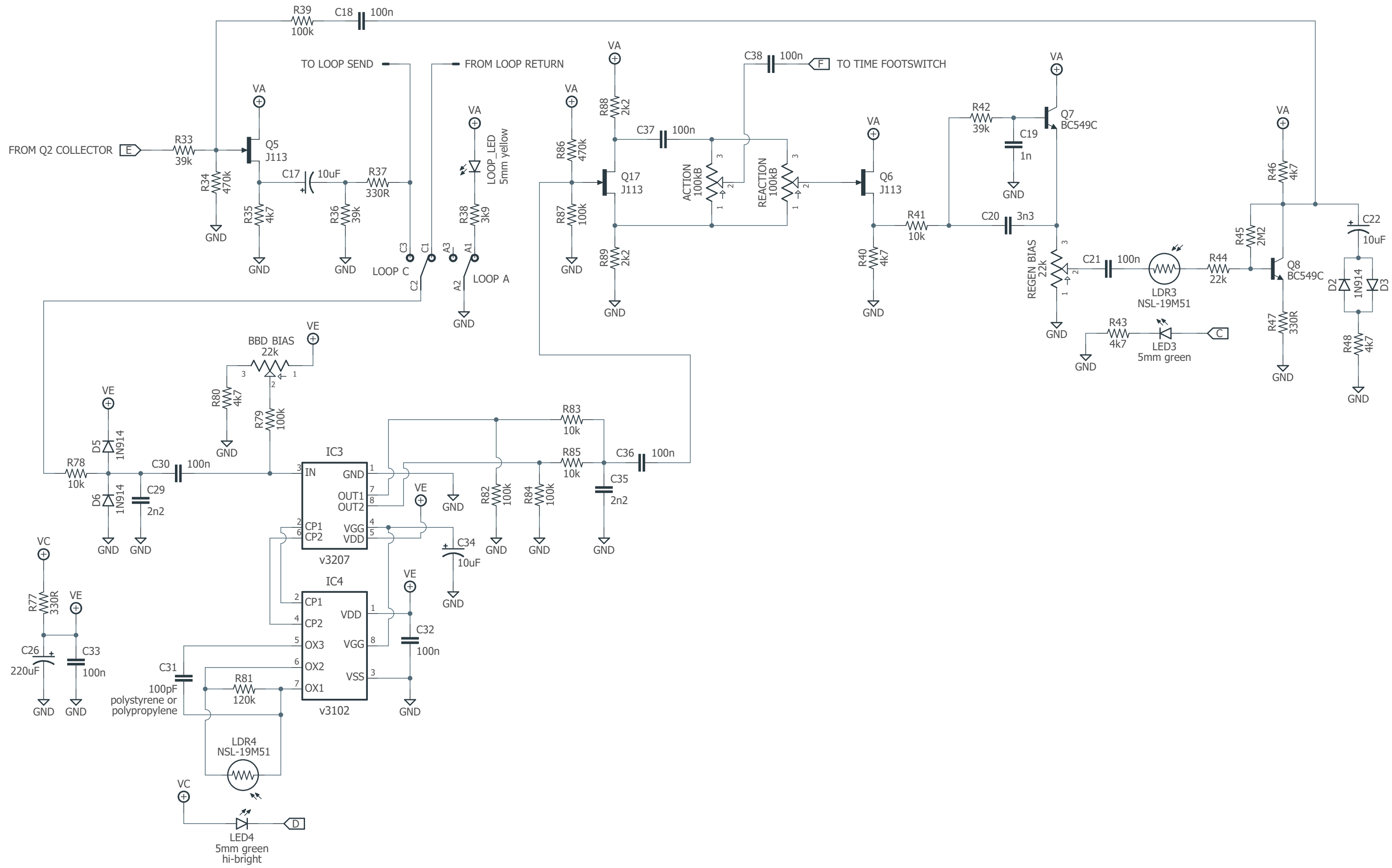
Here is a cross-section view of the completed pedal once it's installed and wired in the enclosure:

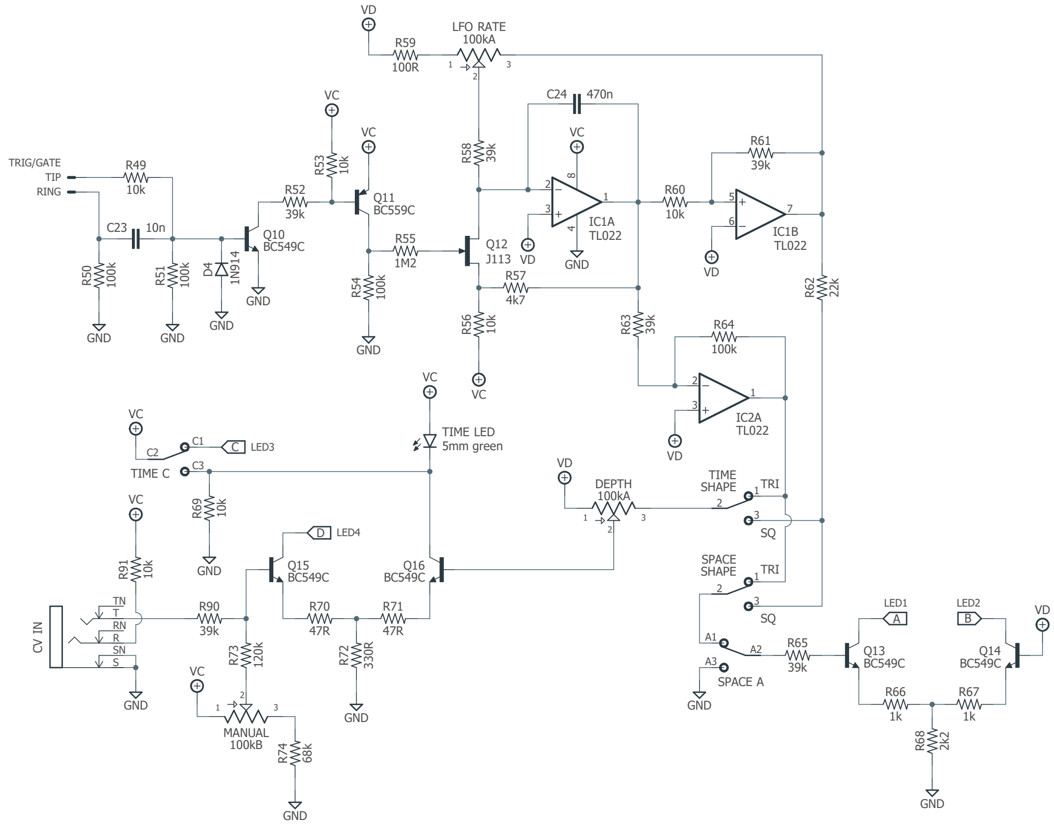




ISOLATED SUPPLY VOLTAGE DESIGNATIONS

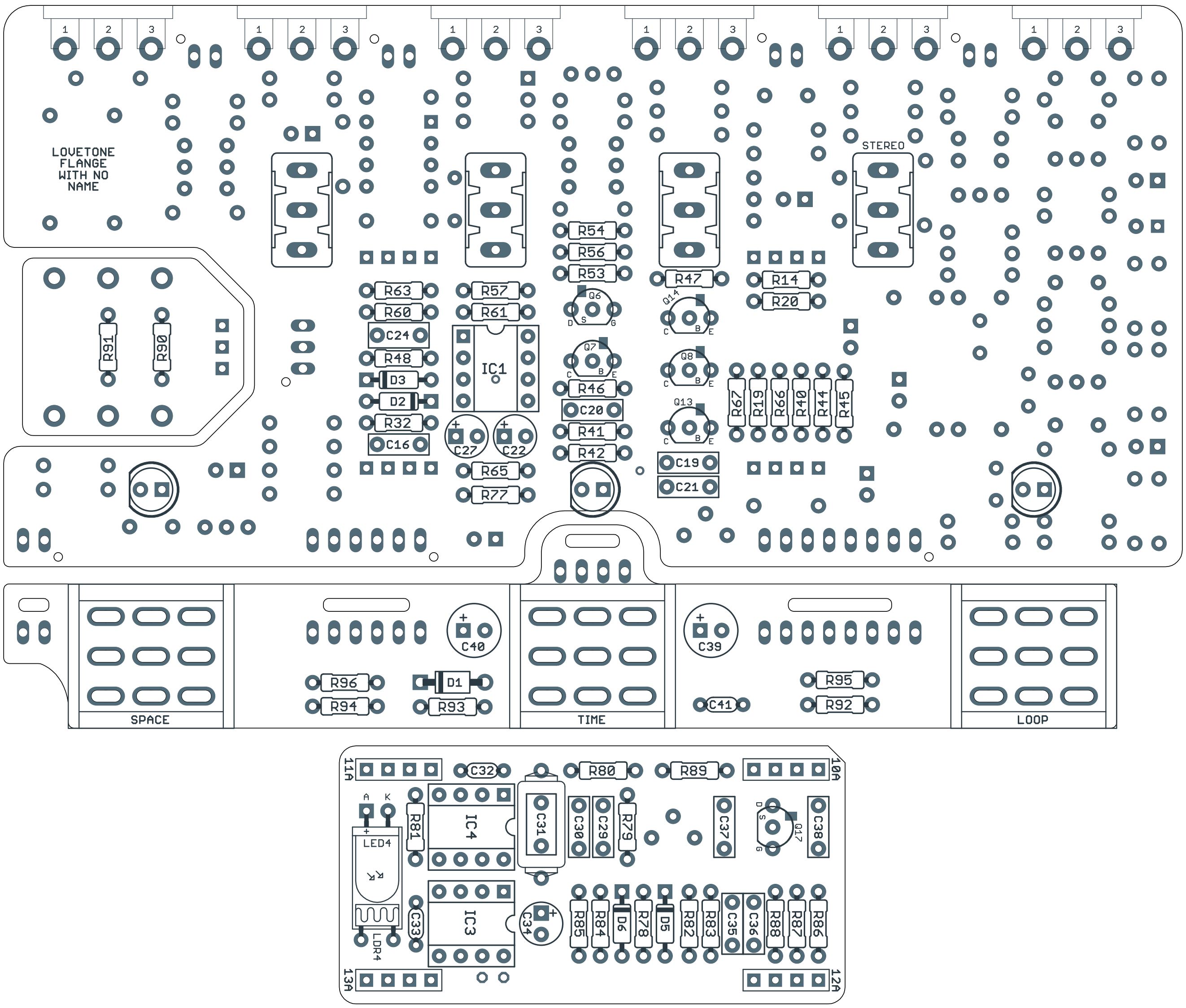
VA: Audio path
VC: LFO
VD: LFO reference voltage
VE: BBD


R39
100k
C18
100n
TO LOOP SEND
FROM LOOP RETURN
FROM Q2 COLLECTOR
E
R33
39k
VA
Q5
J113
R34
470k
C17
10uF
R37
330R
R35
4k7
R36
39k
GND
C3
C1
A3
A1
LOOP C
C2
A2
LOOP A
LOOP_LED
5mm yellow
R38
3k9
R86
470k
R87
100k
Q17
J113
R88
2k2
R89
2k2
C37
100n
C38
100n
F
TO TIME FOOTSWITCH
ACTION
100kB
REACTION
100kB
Q6
J113
R40
4k7
R41
10k
R42
39k
C19
1n
Q7
BC549C
C20
3n3
REGEN BIAS
22k
C21
100n
LDR3
NSL-19M51
R44
22k
R45
2M2
R46
4k7
Q8
BC549C
R47
330R
C22
10uF
D2
1N914
D3
R48
4k7
R43
4k7
LED3
5mm green
C
BBD BIAS
22k
VE
R80
4k7
R79
100k
IC3
IN
GND
OUT1
OUT2
CP1
CP2
VGG
VDD
v3207
R78
10k
D5
1N914
D6
1N914
C30
100n
C29
2n2
R83
10k
R85
10k
C36
100n
C35
2n2
R82
100k
R84
100k
C34
10uF
IC4
CP1
CP2
OX3
OX2
OX1
VDD
VGG
VSS
v3102
C32
100n
C31
100pF
polystyrene or
polypropylene
R81
120k
LDR4
NSL-19M51
VC
R77
330R
C26
220uF
C33
100n
LED4
5mm green
hi-bright
D


VD
R59
100R
LFO RATE
100kA
C24
470n
VC
R53
10k
VC
R58
39k
VC
TRIG/GATE
TIP
RING
R49
10k
R52
39k
Q11
BC559C
R61
39k
R60
10k
IC1A
TL022
IC1B
TL022
C23
10n
Q10
BC549C
R55
1M2
Q12
J113
VD
GND
R50
100k
R51
100k
D4
1N914
GND
R54
100k
R57
4k7
R62
22k
R56
10k
R63
39k
R64
100k
GND
GND
GND
GND
VC
IC2A
TL022
VC
VC
TIME LED
5mm green
VD
C1
C2
LED3
TIME C
C3
DEPTH
100kA
TIME
SHAPE
TRI
SQ
VC
R69
10k
LED4
GND
R91
10k
Q15
BC549C
Q16
BC549C
SPACE
SHAPE
TRI
SQ
LED1
LED2
VD
CV IN
TN
T
RN
R
SN
S
R90
39k
R70
47R
R71
47R
A1
A2
R65
39k
Q13
BC549C
Q14
BC549C
A3
SPACE A
GND
R73
120k
R72
330R
VC
GND
MANUAL
100kB
GND
R66
1k
R67
1k
R68
2k2
GND
R74
68k
GND

PCB DIAGRAM (REVERSE SIDE)

The diagram on page 1 shows the front or top-facing side of the PCB, but since many of the components are mounted on the underside of each of the four boards, we are also including a reference for the bottom side of the PCB. The interactive BOM tool shows both the top and bottom of each board as well.



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.

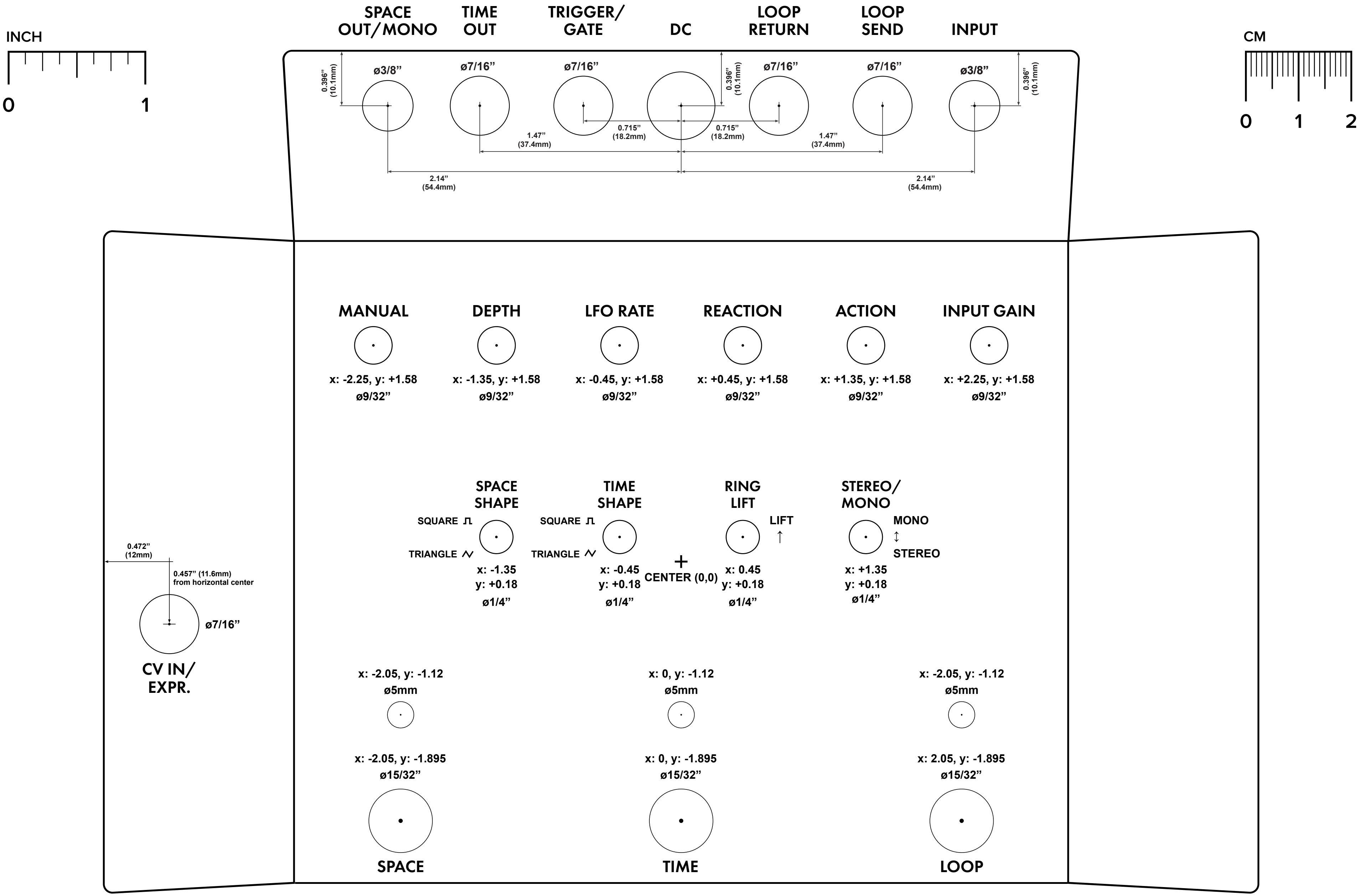
Ensure that the template is printed at 100% or "Actual Size". You can double-check this by measuring the scale on the printed page with a ruler or calipers.

The footswitch LED drill holes are sized for a plain 5mm LED with no bezel. If you don't have a 5mm bit, use 7/32". You can also use a 5mm LED bezel, available from several parts suppliers, in which case the drill size would be 5/16".

Due to the high number of PCB-mounted parts, it's crucial that the drilling be accurate, especially the toggle switches. There's not a lot of room for error.

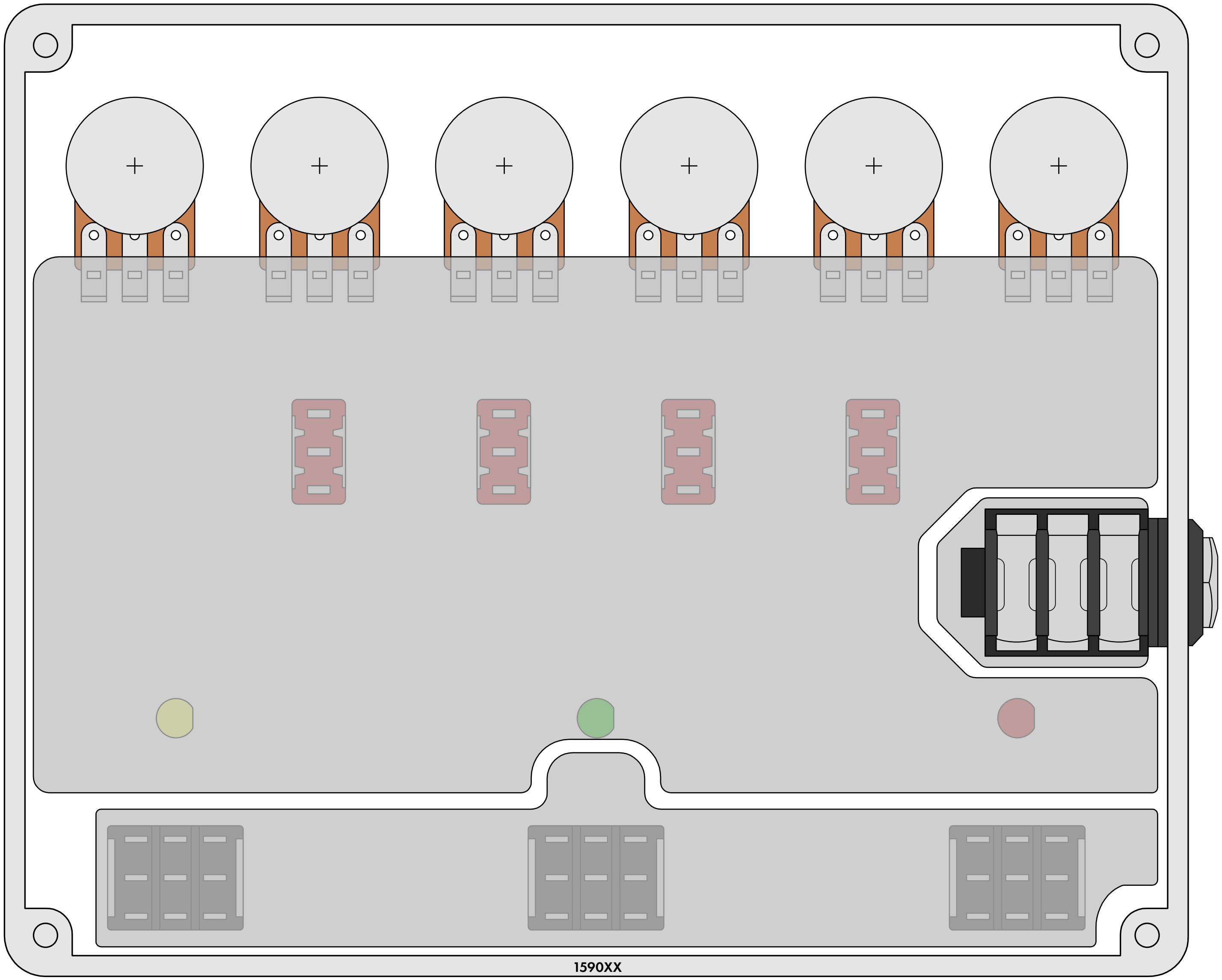
If any of the toggle switches don't align to the PCB, you can always drill one step larger (9/32") to allow more room correct any misalignment. The toggle switch washer and nut will still fully cover the hole.

DRILL TEMPLATE

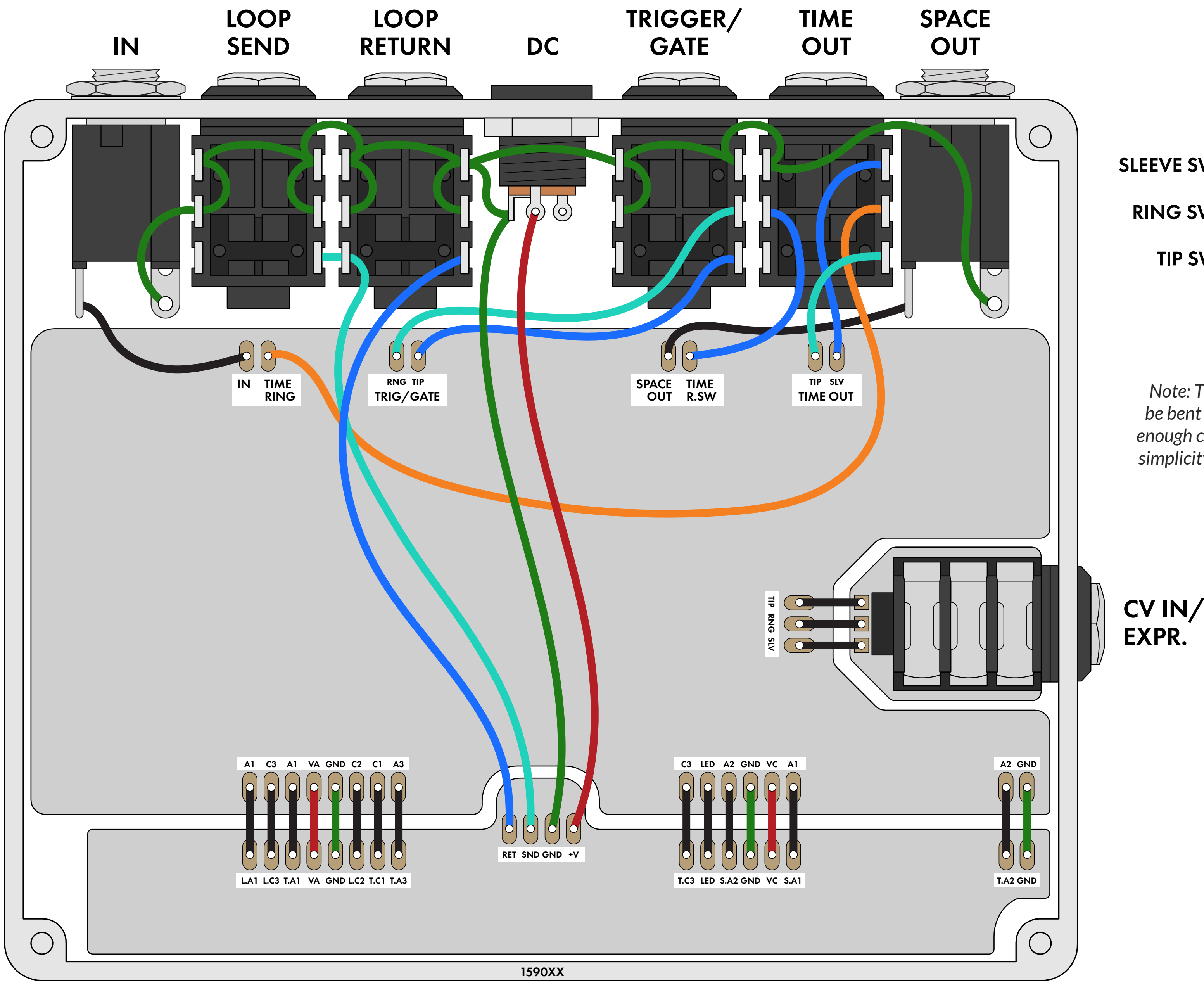


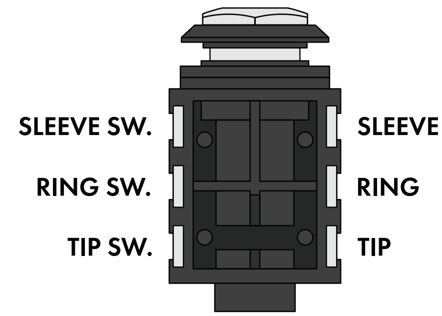
ENCLOSURE LAYOUT

Enclosure is shown without the north-side jacks. See next page for jack layout and wiring.



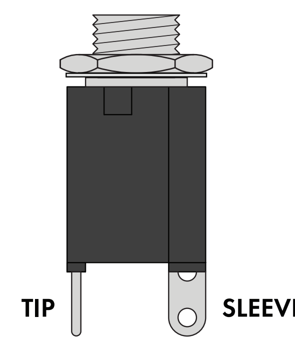
WIRING DIAGRAM





NEUTRIK NMJ-6

Note: The lugs of the NMJ-6 jack should be bent inwards before soldering to allow enough clearance for the lid. For clarity and simplicity, this is not shown in the diagram.



SWITCHCRAFT 111X

TROUBLESHOOTING CHECKLIST

Between this build document and the original user manual, there is an overwhelming amount of information about this circuit. All of what follows has been covered elsewhere, but these are the specific parts of the build that are most likely to cause issues if they are overlooked.

1. Did you read the manual for the original unit?

The Xenotron is an exact functional clone of the Flange With No Name, so other than some differences in terminology, everything in the user manual applies to this project as well. If you don't know how it works, it may sound broken in some of the control settings. For example, there is a loud percussive effect when "Time Shape" is in square wave mode and "Depth" is turned up, resulting from the BBD being pushed past its limits. This is considered a feature by the original designer.

2. Did you really, really read the whole manual?

We cannot emphasize this enough. Another important topic covered in the manual is the operation of the "Time Out" jack, and when you should use the "Ring Lift" and "Mono/Stereo" switches to prevent buzzing. Once again, the pedal is going to seem broken in some configurations if you don't know what to listen for!

3. Is the BBD sub-board inserted fully and correctly?

The diagonal notch should be in the upper left, as viewed from the inside of the enclosure. If C34 (10uF electrolytic) is too tall, it will prevent the board from pressing down all the way on one side and the pins won't make a solid connection.

4. Is Q11 a PNP transistor? (BC559C or similar)

Out of 17 transistors, all but this one are NPNs or JFETs, so it's easy to miss that Q11 is different. If it's not a PNP transistor, the LFO will not work.

5. Did you install the two resistors on the bottom side of the "CV In" PCB? (R90 and R91)

This should ideally be done before the jack is soldered, but they can still be soldered from the component side if you have already installed the jack.

6. Are all of the wires connected properly?

The wiring diagram is complicated, and some of the connections are easy to miss (for example, the short wire going between the Loop Send and Loop Return jacks).

7. Is the wiring clean?

All the wires should be as short as possible, while still allowing enough room to be routed around sensitive areas such as the BBD board. Make sure you know where the wires are positioned when the enclosure lid is in place.

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 (2024-08-28)

- Adjusted jack drill template slightly to accommodate a wider variety of enclosures.
- Corrected switch labeling for the Stereo/Mono switch in the drill template.

1.0.2 (2024-08-23)
Added note about alternate values for Bourns trimmers.

1.0.1 (2024-04-16)
Added note to wiring diagram about bending the Neutrik jack lugs inward.

1.0.0 (2023-05-20)
Initial release.