

PROJECT NAME

# HEXATRON



BASED ON

Mu-tron® Phasor II

BUILD DIFFICULTY

■■■■□ Advanced

EFFECT TYPE

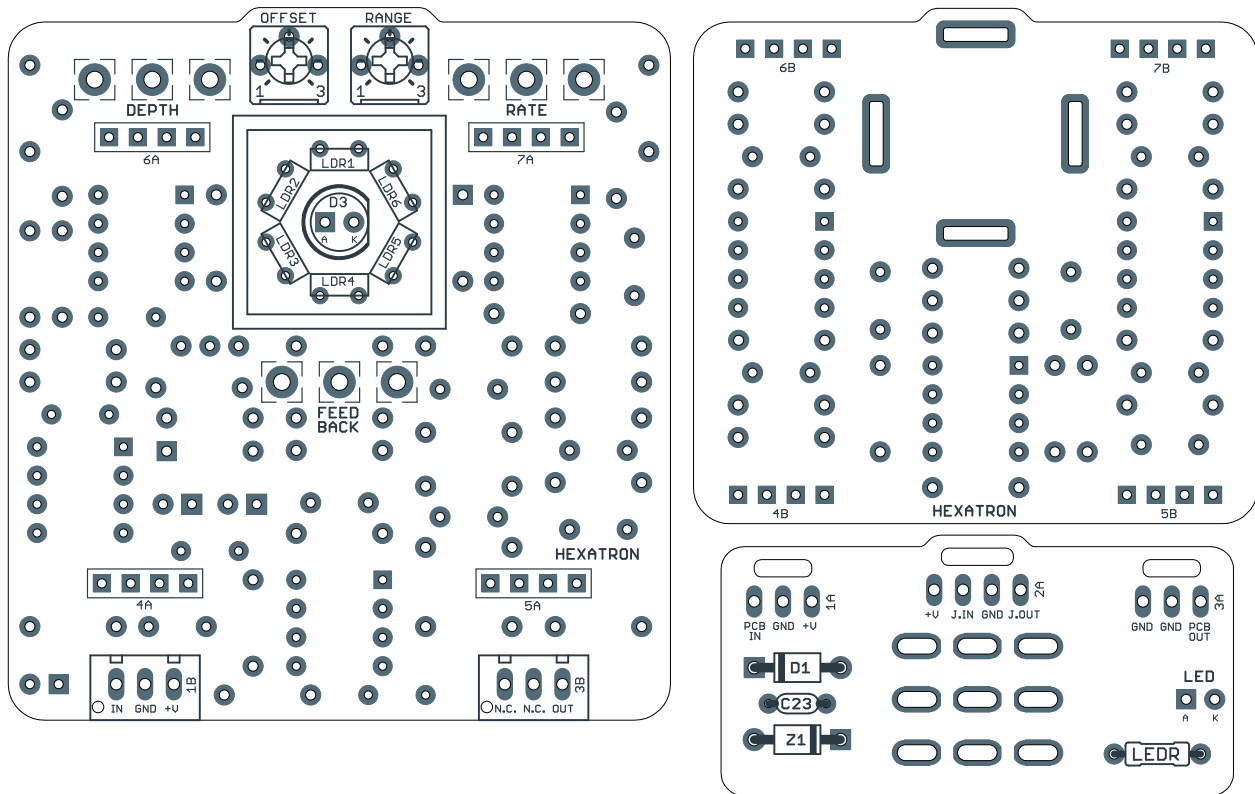
Phaser

DOCUMENT VERSION

1.0.0 (2026-07-03)

## PROJECT SUMMARY

A six-stage optical phaser that captures the swirly psychedelia of the 1970s.



Actual size is 2.3" x 2.48" (bottom board), 1.96" x 1.79" (top board), and 1.78" x 0.87" (bypass board).

Since most of the components are mounted on the back, a reverse-side diagram can be found on page 13.

### IMPORTANT NOTE

This project has a specialized method of assembly that is different from most DIY builds, and because of this there are a lot of ways to make mistakes that are hard to fix. Please familiarize yourself with the assembly instructions on pages 7-8 before installing any of the components.

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## INTRODUCTION

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The Hexatron Optical Phaser is an adaptation of the Mu-tron Phaser II, an LDR-based phaser originally released in 1977.

The Phaser II was originally designed as a simplified version of the Bi-Phase, a sprawling circuit that could be operated as a single 12-stage phaser or two independent six-stage phasers. The Phaser II is essentially one-half of a Bi-Phase, with a nearly identical LFO and phase-shift topology, but without the complex routing and LFO control options.

The Phaser II was the successor to the Phaser I, which was in production from 1974-1976. The Phaser I utilized CA3080 operational transconductance amplifiers (OTAs) which were relatively new technology at the time. This OTA phase topology predated the [EHX Small Stone](#) and was almost certainly the inspiration for both that circuit and the Maestro MP-1.

However, for the Bi-Phase and subsequently the Phaser II, they drew inspiration from the [Uni-Vibe](#) and replicated its LDR and lamp setup. They added two additional phase stages (six instead of four) and modernized the phase stages by using op-amps instead of transistors. They changed the incandescent lamp to an LED and redesigned the LFO to optimize the sweep for the new setup. By all accounts, it was a significant improvement, and it's become legendary as one of the most organic, colorful, and vocal phaser effects ever made.

The Hexatron is a near-direct clone of the original Phaser II, but with a charge pump to get bipolar power from a standard 9V supply. Due to the size of the circuit, this project utilizes a stacked PCB layout in order to fit in a 125B enclosure. See pages 7-8 for instructions and assembly diagrams.

There is also an optional [light shield](#) that fits between the stacked PCBs. It seals the LDRs from outside light and also provides a reflective surface on the inside to better disperse the light from the LED.

## USAGE

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The Hexatron has the following controls:

- **Rate** controls the speed of the modulation effect.
- **Depth** sets the depth or intensity of the modulation effect.
- **Feedback** recycles the signal through the phase stages for added resonance or color.

## DESIGN NOTES

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### Power supply

The Phasor II was powered by direct wall power, which was converted to +/-12V internally via a transformer. The Hexatron project includes a charge pump to generate negative voltage from a standard 9V supply. Most Phasor II clones use this method, and the circuit runs identically on +/-9V.

If you do want the extra voltage of the original, you can safely power the circuit with 12V as long as you use a LT1054CP for IC7, which is safe up to 15V. Just make sure it's a regulated supply such as the 12V output from a Pedal Power 2+, and ensure Z1 is a 13V zener (e.g. a 1N4743A) so that it doesn't activate during standard usage.

Note that the different voltage may affect the bias, so if you switch between 9V and 12V supplies, you may need to re-bias the circuit.

### LDRs and LED

The original Phasor II used a custom photocell module from Hamamatsu labeled "HTV-P653". This same module was also used in the Bi-Phase. There is no datasheet for this part, so it was likely custom-made for Mu-tron. You can see a photo of the disassembled module on [this Obsolete Technology blog post](#) if you're curious.

Inside, it has three dual LDRs with a single LED in the middle. These dual LDRs are configured like a potentiometer, with a single resistive track that is center-tapped in the middle with pins on each end. This means the two sides can't be used fully independently unless the center-tap goes to ground, which it does in this circuit.

Dual LDRs are rare today, and even moreso when you need them to have particular specifications, so as with many Phasor II adaptations, we've adapted the Hexatron to use six single LDRs.

### Light shield

The photocell module had a reflective interior to disperse the light, so we've adapted the light shield originally developed for the [Straylight](#) project so that it fits in between the top and bottom PCBs. In this case, the top PCB acts as the lid and an additional reflective surface.

This shield is not perfectly sealed from outside light. The reflective interior is the more significant feature. With that said, it still blocks ~98% of the light when the enclosure lid is open, and 100% when it's closed.

The light shield is not a requirement for the build. It will work fine with no light shield at all, but the slotted pads on the PCB can fit a variety of other solutions. If you're handy with sheet metal, you could cut a 0.44" x 3" strip and bend it into a square (0.74" to a side). If the metal is solderable, it can be soldered in place. Otherwise, you could cut tabs the size of the slots and bend them outward on the underside of the board to secure it in place. The slotted pads have no electrical connection to the rest of the circuit.

## 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	390k	Metal film resistor, 1/4W	
R2	3k9	Metal film resistor, 1/4W	
R3	390k	Metal film resistor, 1/4W	
R4	4k7	Metal film resistor, 1/4W	
R5	4k7	Metal film resistor, 1/4W	
R6	4k7	Metal film resistor, 1/4W	
R7	8k2	Metal film resistor, 1/4W	
R8	4k7	Metal film resistor, 1/4W	
R9	4k7	Metal film resistor, 1/4W	
R10	220k	Metal film resistor, 1/4W	
R11	4k7	Metal film resistor, 1/4W	
R12	4k7	Metal film resistor, 1/4W	
R13	220k	Metal film resistor, 1/4W	
R14	4k7	Metal film resistor, 1/4W	
R15	4k7	Metal film resistor, 1/4W	
R16	220k	Metal film resistor, 1/4W	
R17	4k7	Metal film resistor, 1/4W	
R18	4k7	Metal film resistor, 1/4W	
R19	220k	Metal film resistor, 1/4W	
R20	4k7	Metal film resistor, 1/4W	
R21	4k7	Metal film resistor, 1/4W	
R22	220k	Metal film resistor, 1/4W	
R23	4k7	Metal film resistor, 1/4W	
R24	4k7	Metal film resistor, 1/4W	
R25	220k	Metal film resistor, 1/4W	
R26	10k	Metal film resistor, 1/4W	
R27	10k	Metal film resistor, 1/4W	
R28	8k2	Metal film resistor, 1/4W	
R29	8k2	Metal film resistor, 1/4W	
R30	18k	Metal film resistor, 1/4W	
R31	100k	Metal film resistor, 1/4W	
R32	560R	Metal film resistor, 1/4W	

## PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
R33	68K	Metal film resistor, 1/4W	
R34	47k	Metal film resistor, 1/4W	
R35	120R	Metal film resistor, 1/4W	
R36	39k	Metal film resistor, 1/4W	
R37	560R	Metal film resistor, 1/4W	
R38	68k	Metal film resistor, 1/4W	
R39	3k6	Metal film resistor, 1/4W	
R40	47k	Metal film resistor, 1/4W	
R41	2K2	Metal film resistor, 1/4W	
R42	2K2	Metal film resistor, 1/4W	
R43	220k	Metal film resistor, 1/4W	
R44	68k	Metal film resistor, 1/4W	
R45	10k	Metal film resistor, 1/4W	
R46	220R	Metal film resistor, 1/4W	
RPD	2M2	Metal film resistor, 1/4W	Input pulldown resistor. Can be as low as 1M.
LEDR	10k	Metal film resistor, 1/4W	LED current-limiting resistor. Adjust value to change LED brightness.
C1	47n	Film capacitor, 7.2 x 2.5mm	
C2	33pF	MLCC capacitor, NP0/C0G	
C3	100n	Film capacitor, 7.2 x 2.5mm	
C4	1n	Film capacitor, 7.2 x 2.5mm	
C5	3n3	Film capacitor, 7.2 x 2.5mm	
C6	6n8	Film capacitor, 7.2 x 2.5mm	
C7	6n8	Film capacitor, 7.2 x 2.5mm	
C8	6n8	Film capacitor, 7.2 x 2.5mm	
C9	6n8	Film capacitor, 7.2 x 2.5mm	
C10	6n8	Film capacitor, 7.2 x 2.5mm	
C11	6n8	Film capacitor, 7.2 x 2.5mm	
C12	470n	Film capacitor, 7.2 x 3mm	
C13	1uF	Film capacitor, 7.2 x 5mm	
C14	820pF	MLCC capacitor, NP0/C0G	
C15	1uF	Film capacitor, 7.2 x 5mm	
C16	470n	Film capacitor, 7.2 x 3mm	
C17	10uF	Electrolytic capacitor, 5mm	Charge pump capacitor.
C18	47uF	Electrolytic capacitor, 5mm	Power supply filter capacitor.
C19	470n	MLCC capacitor, X7R	Power supply filter capacitor.
C20	470n	MLCC capacitor, X7R	Power supply filter capacitor.
C21	100uF	Electrolytic capacitor, 6.3mm	Power supply filter capacitor.

## PARTS LIST, CONT.

PART	VALUE	TYPE	NOTES
C23	100n	MLCC capacitor, X7R	Power supply filter capacitor.
D1	1N5817	Schottky diode, DO-41	
D2	1N914	Fast-switching diode, DO-35	
D3	5mm red LED	LED, 5mm, red diffused	Can also be yellow or orange. See build notes.
D4	1N914	Fast-switching diode, DO-35	
Z1	1N4743A	Zener diode, 13V, DO-41	
Q1	2N3904	BJT transistor, NPN, TO-92	
IC1	RC4558P	Operational amplifier, dual, DIP8	
IC1-S	DIP-8 socket	IC socket, DIP-8	
IC2	RC4558P	Operational amplifier, dual, DIP8	
IC2-S	DIP-8 socket	IC socket, DIP-8	
IC3	RC4558P	Operational amplifier, dual, DIP8	
IC3-S	DIP-8 socket	IC socket, DIP-8	
IC4	RC4558P	Operational amplifier, dual, DIP8	
IC4-S	DIP-8 socket	IC socket, DIP-8	
IC5	RC4558P	Operational amplifier, dual, DIP8	
IC5-S	DIP-8 socket	IC socket, DIP-8	
IC6	RC4558P	Operational amplifier, dual, DIP8	
IC6-S	DIP-8 socket	IC socket, DIP-8	
IC7	LT1054CP	Charge pump / voltage converter, DIP8	
IC7-S	DIP-8 socket	IC socket, DIP-8	
LDR1-6	PDV-P9203	LDR, 10-30k light, 5M dark	6 needed. See build notes for LDR selection.
RANGE	1k trimmer	Trimmer, 10%, 1/4"	Bourns 3362P or similar.
OFFSET	10k trimmer	Trimmer, 10%, 1/4"	Bourns 3362P or similar.
RATE	25kA	16mm right-angle PCB mount pot	
DEPTH	10kA	16mm right-angle PCB mount pot	
FDBK.	10kA	16mm right-angle PCB mount pot	
LED	5mm red	LED, 5mm, red 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.
DC	2.1mm	DC jack, 2.1mm panel mount	Mouser 163-4302-E or equivalent.
FSW	3PDT	Stomp switch, 3PDT	
ENC	125B	Enclosure, die-cast aluminum	Can also use a Hammond 1590N1.

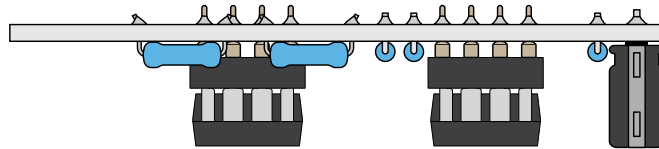
# ASSEMBLY INSTRUCTIONS

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The Hexatron uses a stacked “sandwich” PCB design so that it can fit inside a 125B enclosure. It’s not difficult to put together, but there’s only one right way to do it 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.

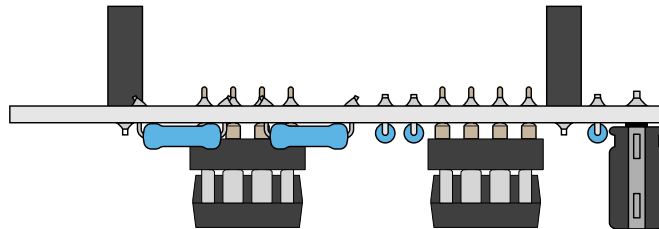
## Step 1

Populate the PCBs according to the silkscreen. Unlike most other Aion FX projects, the components mount on the underside of both the main and secondary boards, the same side as the potentiometers. (The components on the bypass PCB mount on the top side as with other projects.)



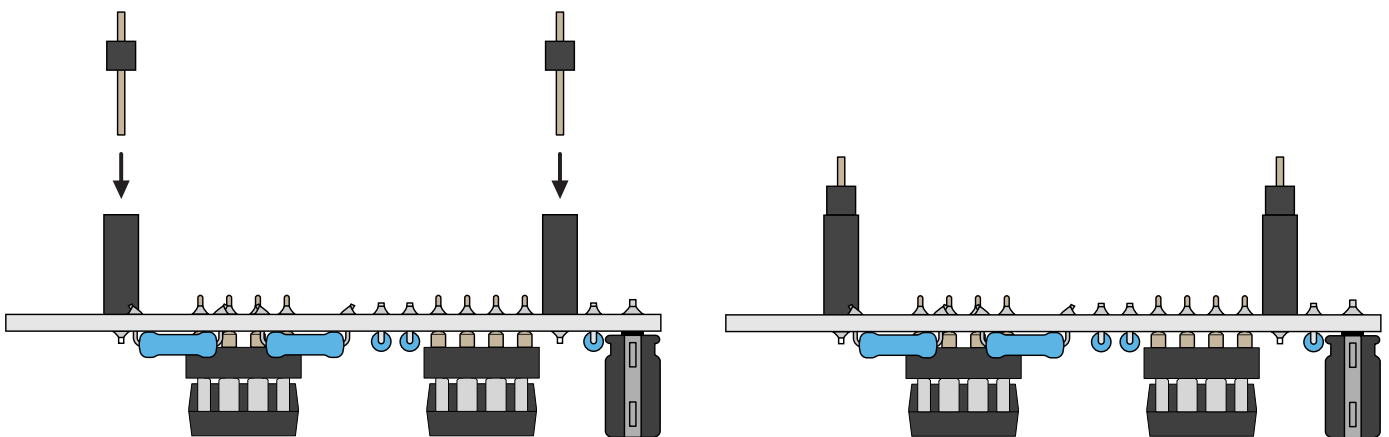
## Step 2

Install the header sockets on the bottom 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

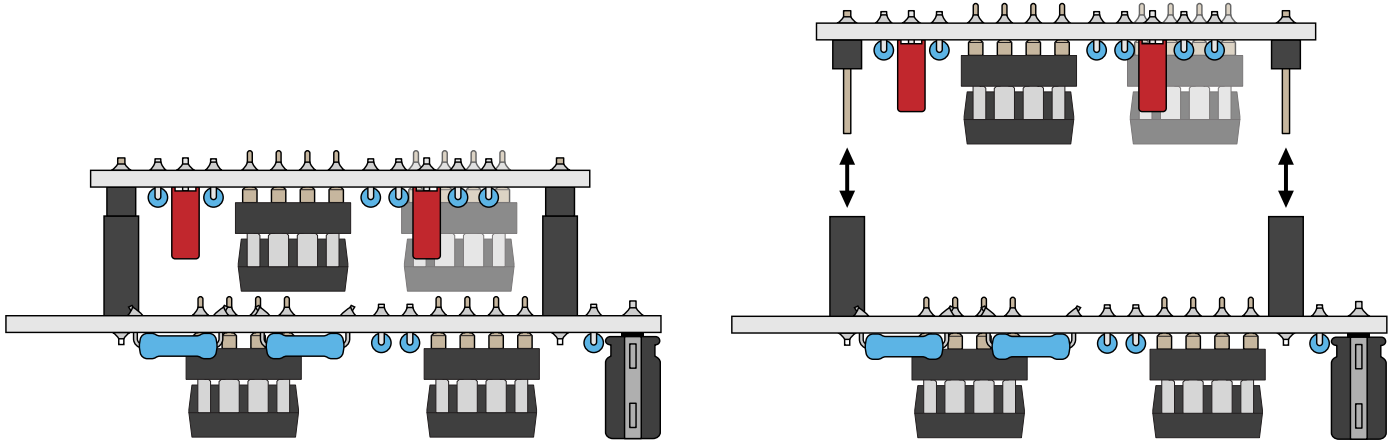
With the header sockets installed to the bottom PCB, insert the male headers. The long side goes into the socket and the short side faces up.



## ASSEMBLY INSTRUCTIONS, CONT.

### Step 4

With the male header sockets in place, put the top PCB in position, components facing down. (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.



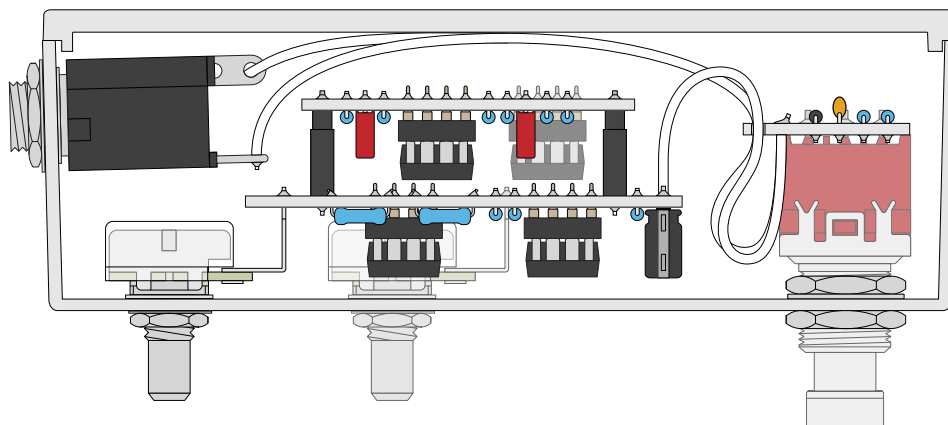
It's done in this order so that that the pins are perfectly coupled with the headers. If they were soldered separately from each other, the slight misalignments between the pins and headers would create stress that could potentially cause cracked solder joints over time.

From here, you can proceed with the rest of the build as normal. It's recommended to first attach the potentiometers to the drilled enclosure and then solder the lower 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 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 diagram of the completed pedal once it's installed and wired in the enclosure. (Shown without optional light shield.)



# BUILD NOTES

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## Headers and sockets

The Hexatron uses 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 female sockets and one snap-apart male header that can be broken in to the matching sizes.

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)

## Securing the top PCB

When the pedal is in playing position, gravity will be pulling against the top PCB, and it could potentially be knocked loose with enough shock. Once the pedal is fully biased and tested, 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 the foam.

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

## LDR selection

As mentioned in the design notes on page 3, the Hexatron converts the three dual LDRs in the original Phasor II into six single LDRs. The exact specs of the LDRs in the original unit are not known, but many different types have been used successfully in DIY clones.

Above all, the important characteristic for the LDRs is a high dynamic range, around 10k to 100k under illumination, with a dark resistance of 5M to 20M. The **PDV-P9203** is the easiest type to find that meets these specifications and is readily available from Mouser and Digikey. The **NSL-5542** is another option with similar specs, but as of this writing is only available from RS (formerly Allied) and is more expensive.

The rise and fall time is also important, particularly if you plan to use it at fast settings, but don't be too concerned with this specification since most LDRs fall in similar ranges.

## Do the LDRs need to be matched?

Since it's a phaser, the question often comes up whether the LDRs need to be matched in any way. Unlike JFETs in other types of phasers, there does not seem to be any clear benefit to matching LDRs, and as long as you use the same part number with the same nominal resistance range, it will sound great.

However, if you still want to try matching them, it's not terribly difficult as long as you have a batch of ten or twenty of them to choose from. Install them on their own rows on a breadboard, all legs electrically isolated, LDR pointing upward, exposed to the same light from the same angle. Then measure the resistance between the legs and choose the six whose resistance value is closest.

## BUILD NOTES, CONT.

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### LDR placement

The LDRs are installed in a hexagonal pattern around the LED. They should be bent 90 degrees so that they are facing inward, positioned near the top of the LED but a little lower.

If you're using the mini light shield, make sure the LDRs are installed so that the legs go straight up from the pads and are not bent backward at all. The white outline shows where the inside of the light shield will be. Since the inside of the light shield is exposed metal, if any of the legs short against it, it will cause issues. If you want to be extra cautious, you can always use heat shrink on the legs of the LDR.

### LED selection

It's recommended to use a vintage-style diffused 5mm LED, either red, yellow or orange. Do not use the more modern water-clear super-bright type. They respond much differently to voltage and won't cause the LDRs to have the same resistance curve.

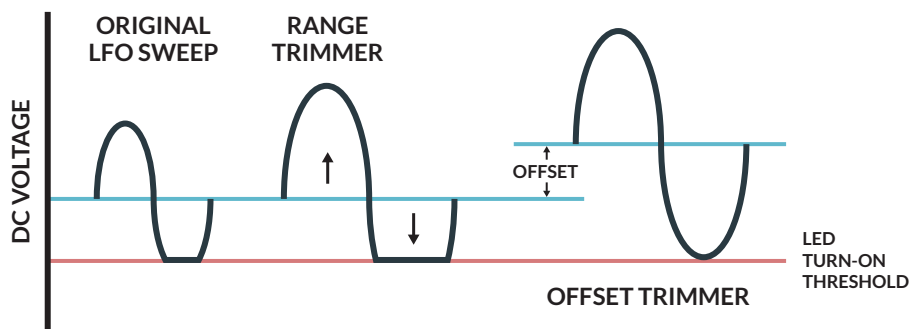
The original Phasor II optocoupler module used a red LED with a diffused white lens (see the [Obsolete Technology blog post](#) for a photo; the color is not stated in the post, but the author stated [elsewhere](#) that the LED was red when illuminated). We do not recommend trying to find the same type of red LED with white diffused lens. Nearly all of them available today are the super-bright type, which didn't exist in the 1970s and will not function the same.

### Biasing

There are two trimmers on the PCB that are used to calibrate the circuit. **Range** and **Offset** directly control the LED brightness and behavior and can be used to compensate for different LEDs as well as different LDRs.

In our prototype unit, we started with both trimmers at 12:00 and they did not need further adjustment. It's recommended to start there. Keep reading if you want to know more about how the trimmers work or if it doesn't sound right at the default setting.

The behavior of these two trimmers is illustrated in the following diagram:



On the next page, the two trimmers' functions are discussed in more detail.

## BUILD NOTES, CONT.

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### Range trimmer

This adjusts the overall amplitude range of the LED's sweep, making it both brighter at the top end of the sweep and darker at the bottom. As you turn it up, the LED will increase in average brightness.

Start with this trimmer at 50% rotation, or 12:00. Ensure the Offset trimmer is also at 12:00. Set Rate to minimum, then adjust the trimmer until the LED is completely off at the very bottom of the sweep. Ensure that it is continually changing in brightness and that there are no dead zones at the top or bottom (i.e. points where it stays dark, or where it stops at a fixed brightness). Then slowly turn the Rate control to faster settings and make sure it sounds good across the range.

Note that even with the light shield installed, a small amount of light will still get in if you are testing in direct light with the enclosure lid removed, and this may impact the sound. It's recommended to replace the lid loosely when listening.

This trimmer is the primary way of compensating for different types of LDRs, so the LED may need to be brighter or dimmer than this recommendation in order to get the LDR resistance into the correct range. Ultimately, just use your ears and leave it where it sounds best.

### Offset trimmer

This adjusts the DC bias point of the LFO going into the LED driver. This trimmer allows the LFO voltage range to be shifted until the LED cuts off only at the very bottom of the sweep.

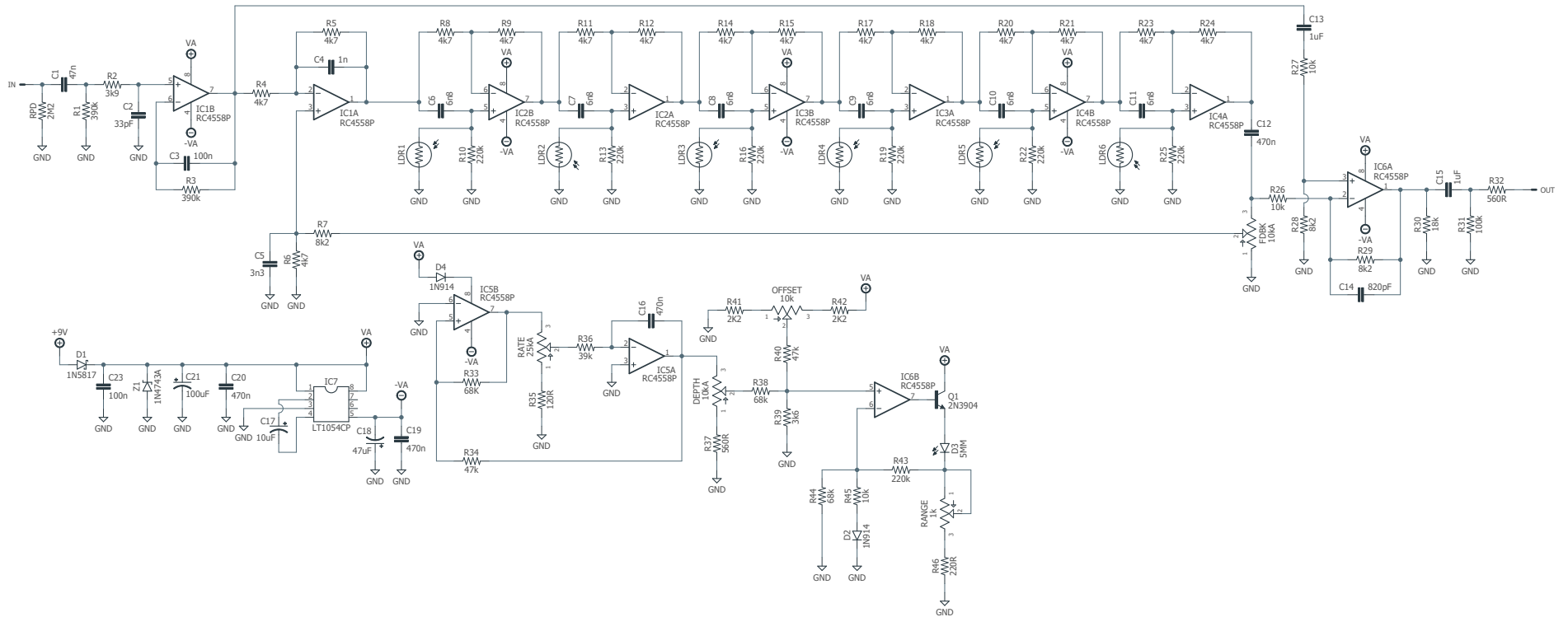
With the Rate control set low, start with the trimmer at around noon and then adjust until the LED goes dark at the bottom of the sweep. The goal is to have the biggest dynamic range between the top and bottom of the sweep. You may need to go back and forth a few times between Range and Offset adjustments before you get it right.

### R38 resistor

In the Phasor II service manual, it mentions that R38 may need to be changed from 68k to 82k if the waveform isn't clean after adjusting the Offset trimmer. However, note that this is from the 1978 version of the pedal after the company was sold to ARP. This version has some changes to the LFO, and so it may not apply the original Mu-tron Phasor II that this project is based on. The Mu-tron service manual is not publicly available.

This resistor change will reduce the intensity slightly at the maximum Depth setting, and should only be done if you can visibly see the waveform clipping with an oscilloscope.

# SCHEMATIC





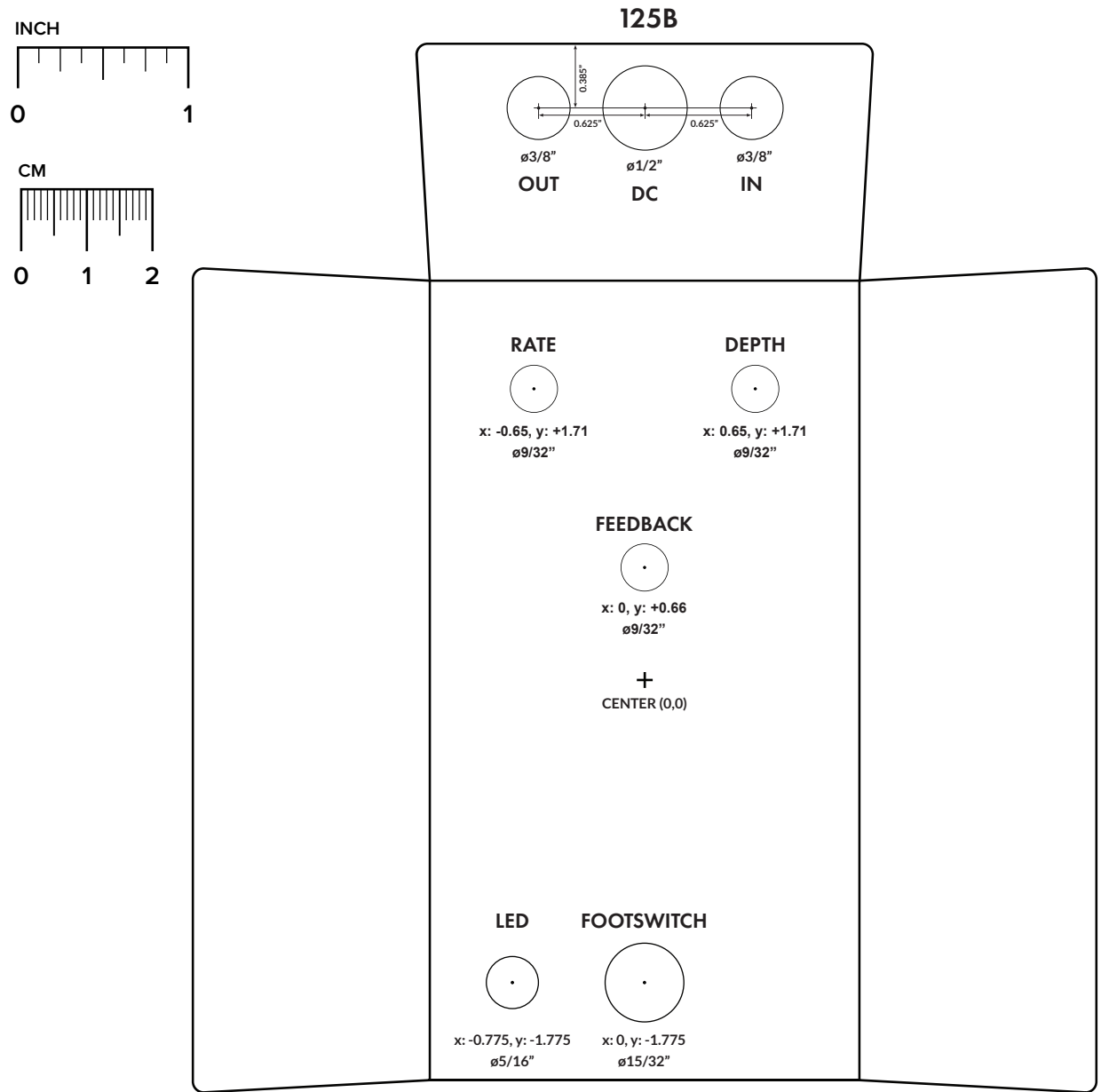
# DRILL TEMPLATE

Cut out this drill template, 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 this template is printed at 100% or "Actual Size". You can double-check this by measuring the scale on the printed page.

**Top jack layout** assumes the use of closed-frame jacks like the [Switchcraft 111X](#). If you'd rather use open-frame jacks, please refer to the [Open-Frame Jack Drill Template](#) for the top side.

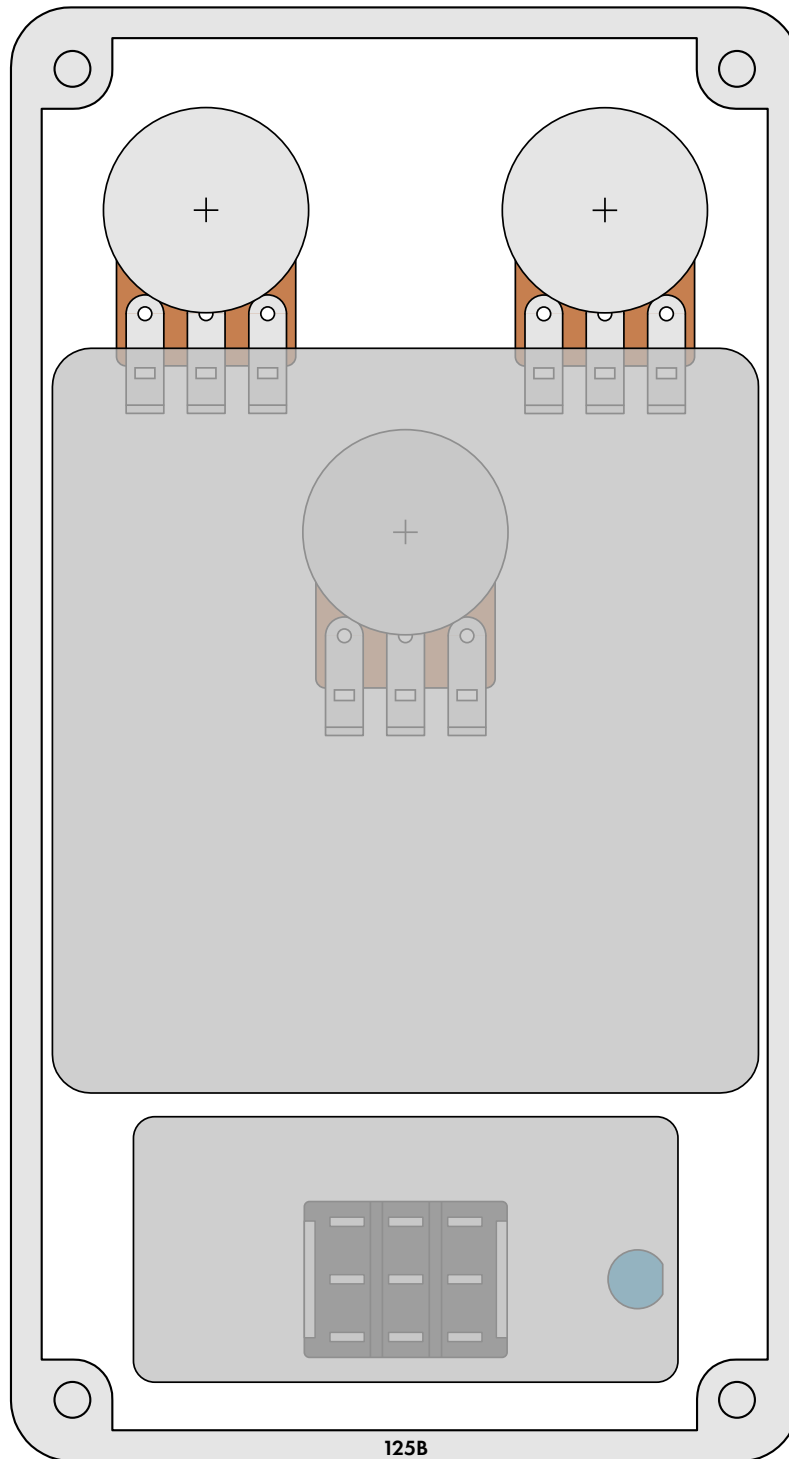
**LED hole drill size** assumes the use of a [5mm LED bezel](#), available from several parts suppliers. Adjust size accordingly if using something different, such as a 3mm bezel, a plastic bezel, or just a plain LED.



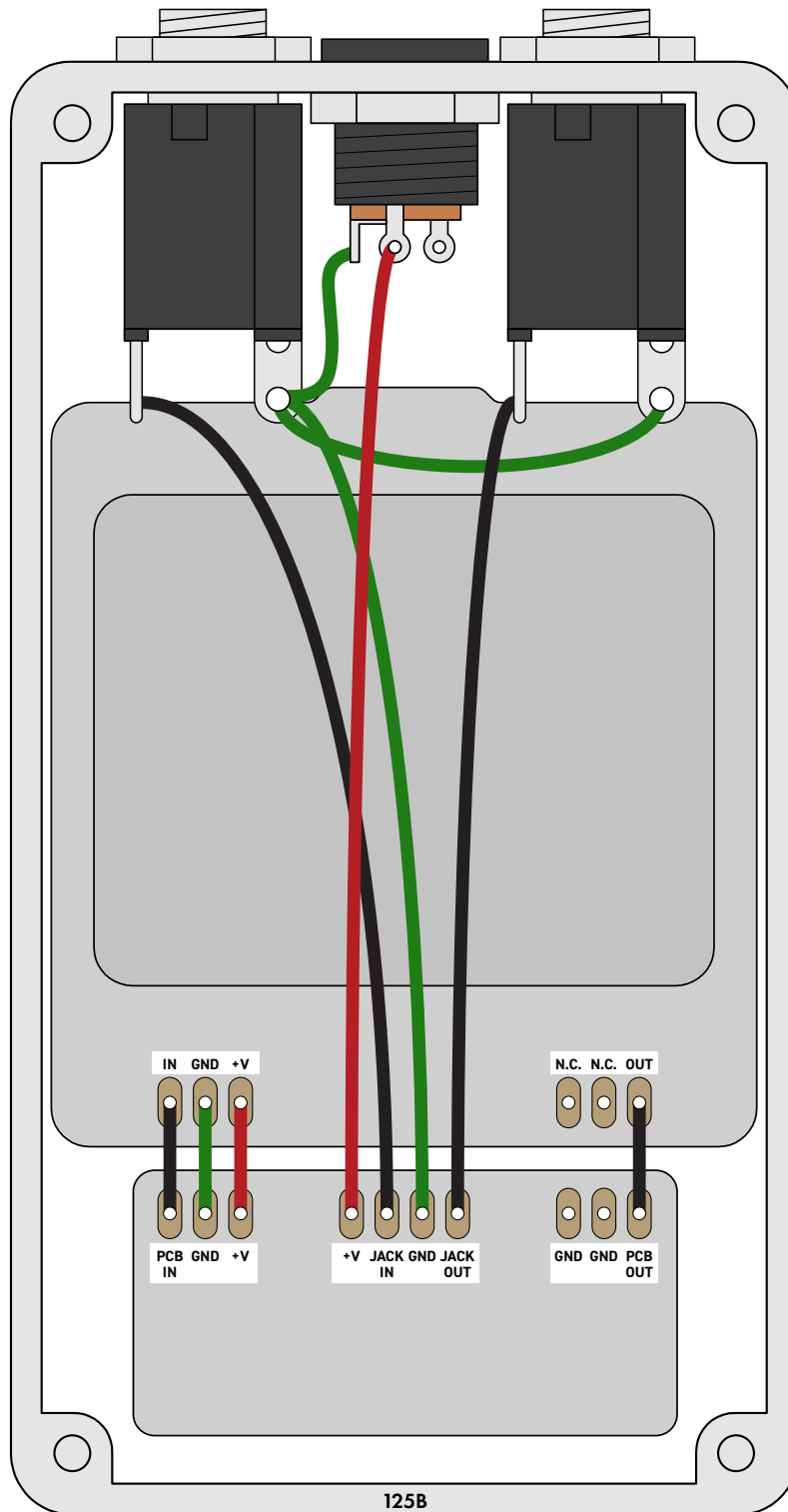
## ENCLOSURE LAYOUT

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Enclosure is shown without jacks and top PCB. See next page for jack layout and wiring, and see page 8 for a full side-profile view of the assembled pedal.



# WIRING DIAGRAM



## LICENSE & USAGE

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**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

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**1.0.0 (2026-07-03)**

Initial release.