Saturn V Distortion

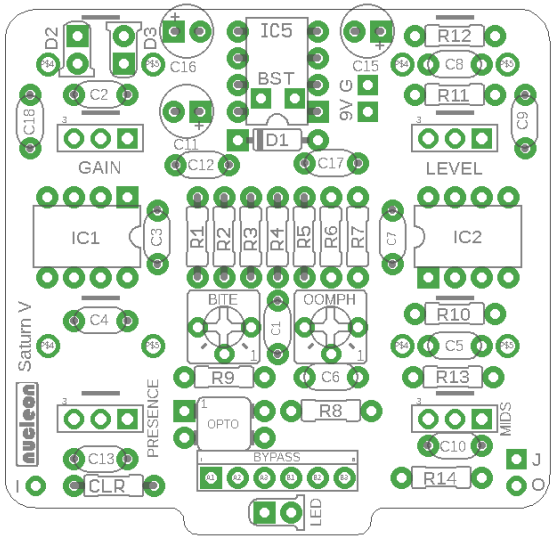
Date modified: August 3 2018

The Saturn V delivers everything from thick blues/rock leads (think Gary Moore) to extremely scooped death metal. It was developed for the live rig of Graceless guitarist Björn who requested a modern, mid heavy sound to fill the audio spectrum to compliment the scooped tones of the other guitarist in the band.

Going through the circuit, the pre-EQ section focusses on the mid frequencies, with a 1kHz centered hump. The Gain knob controls an amplifier followed by a clipping stage well known from Marshall pedals from the late 80s/early 90s.

Next is an active EQ that I've milked for everything is has to offer. In the stock version the Mid control is set to scoop out the pre-EQ mids, though it can be modified to boost as well. The Presence pot controls a 2 kHz shelving treble boost. The Oomph trimpot gives you some (subtle) control over the bass frequencies.. The Bite trimmer passively shaves off the ultra highs.

The design is split rail 18V, sporting a charge pump on board. The circuit is very responsive to the guitar's volume control: it cleans up really nicely to 'edge of break up' sounds.



BOM

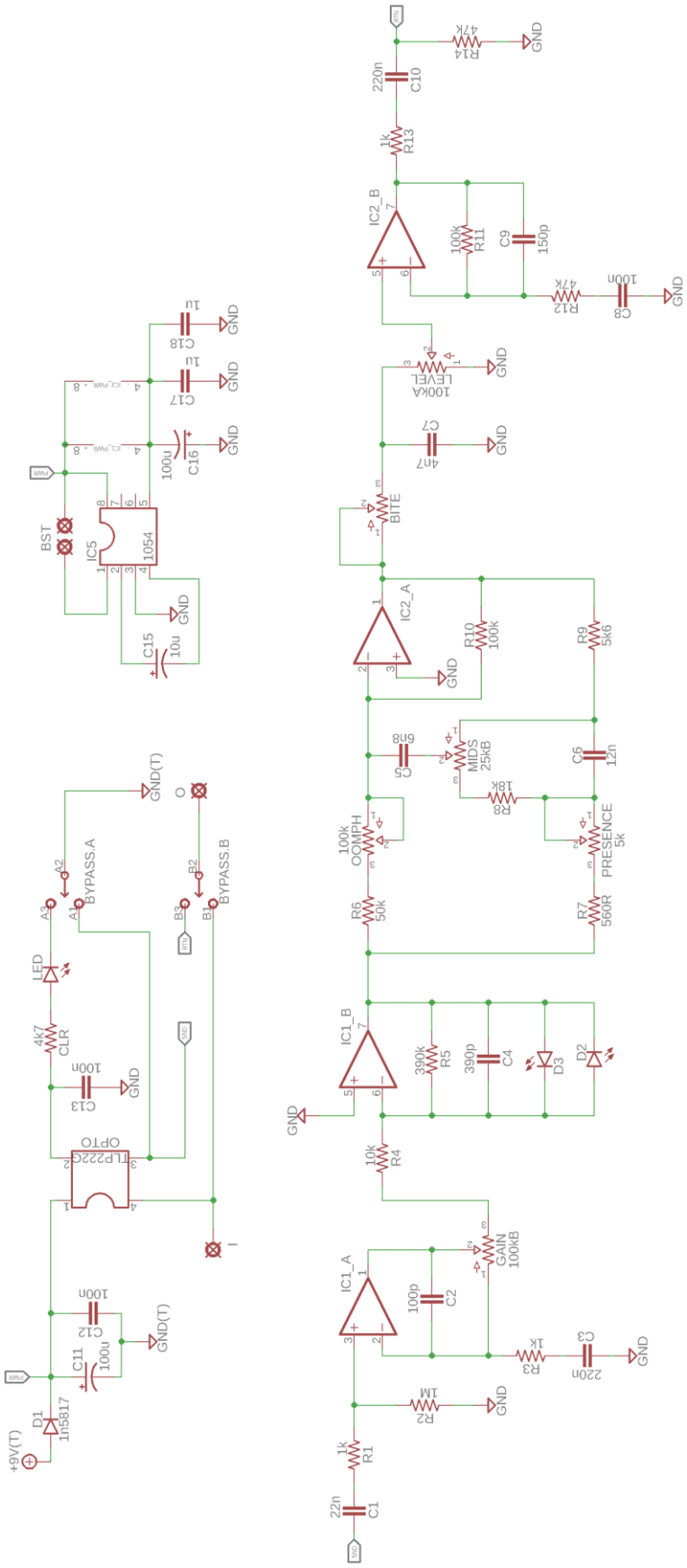
Resistors	
R1	1k
R2	1M
R3	1k
R4	10k
R5	390k
R6	50k
R7	560R
R8	18k
R9	5k6
R10	100k
R11	100k
R12	47k
R13	1k
R14	47k
CLR	3k3

Capacitors	
C1	22n
C2	100p
C3	220n
C4	390p
C5	6n8
C6	12n
C7	4n7
C8	100n
C9	150p
C10	220n
C11	100u
C12	100n
C13	100n
C14	Not there
C15	10u
C16	100u
C17	1u
C18	1u

Diodes and misc	
D1	1N5817
D2	LED 3mm red
D3	LED 3mm red
Opto	TLP222G
IC 1	TL072 (similar)
IC 2	TL072 (similar)
IC 5	Charge pump

Controls	
GAIN	100kB (9mm)
LEVEL	100kA (9mm)
MIDS	25kB (9mm)
PRESENCE	5k (9mm)
OOMPH	10k trim
BITE	100k trim
Bypass	DPDT Stomp

Schematic


R14 47k
GND
C10 220n
R13 1k
IC2_B
R11 100k
C9 150p
R12 47k
C8 100n
LEVEL 100kA
C7 47n
BITE
IC2_A
R10 100k
R9 5k6
C5 6n8
MIDS 25kB
C6 12n
R8 18k
OOMPH 100k
PRESENCE 5k
R6 50k
R7 560R
IC1_B
R5 390k
C4 390p
D3
D2
R4 10k
GAIN 100kB
IC1_A
C2 100p
R3 1k
C3 220n
R2 1M
R1 1k
C1 22n
C18 1u
C17 1u
C16 100u
BST
IC5 1054
C15 10u
GND(T)
BYPASS_A
BYPASS_B
LED
R_CLR 4k7
C13 100n
OPTO TLP222G
C12 100n
C11 100u
D1 1n5817
+9V(T)
I
O

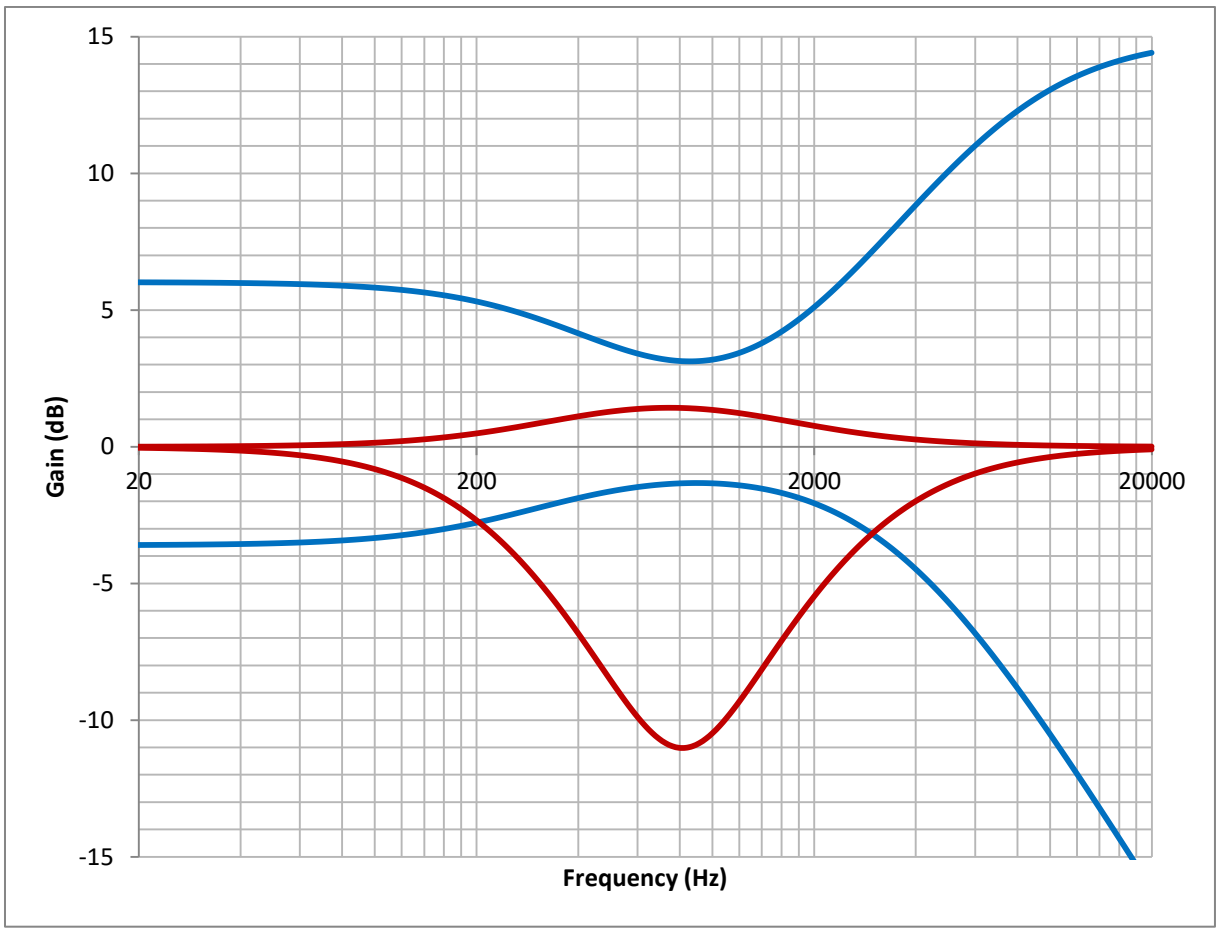
NOTES

See the General Build Doc on the website for general tips on building pedals.

Frequency Response

Below is a trace of various settings of the EQ controls:

- Bass & Treble boost and cut (max) with the Presence, Oomph and Bite controls in blue
- Mid cut and boost with the Mids control in red



As you can see the mids are mostly scooped, see the next section for an explanation why this works well. If you want less scoop and more boost, reduce R8. A value like 10k comes to mind. Keep in mind that this is only the EQ response. It may seem very very mid scooped (it is) but it follows a decidedly mid heavy distortion stage.

Preamp or Pedal?

The challenge here was to design a distortion circuit that is flexible enough to be used as a pedal or as a preamp (into a power amp). Power amps don't really color the sound a lot (in linear mode) but preamps do: most every guitar amp out there has a mid scoop built in. To be specific, setting the B, M and T controls on your amp all at noon does not result in a flat response. This is one of the big misunderstandings in guitar land. A flat EQ setting would be roughly B and T at 1 and M at 10.

So when plugging the Saturn V into the front of an amp there's already some scoop and treble/bass emphasis upstream. You probably want to keep the Oomph centered, the mids between half way and fully up and the presence control low, in the first half of the pot travel.

If you run the Saturn V as a preamp, plugging into a power amp either directly or through the Return of an FX loop you need to dial in more scoop (mid control below noon), more presence and maybe some extra bass through the Oomph trimpot.

Additionally, driving a power amp requires a line level signal, about 1.25V. The clipping LEDs have a threshold voltage roughly that, but add EQ and resistive losses into the mix and the Saturn V would not be powerfull enough be barely powerful enough to drive a power amp efficiently. That's why IC2B is setup as an amplifier, boosting the signal by a factor of three. If your intention is to use the Saturn stricly as a pedal, you want undo this for a more usable range of the level pot: jumper R11 and omit R12, C8 and C9. IC2B now acts as an output buffer with gain of 1.

IC1 and IC2

These can be most any dual opamp that follows the same pinout as a TL072. The TL072 sounds really good in this circuit especially because the 18V operation prevents the first opamp stage from clipping (usually a nasty sound). If you socket the ICs you can experiment with others, like maybe the RC4559 or LM1458

IC5 – Charge pump

This IC generates a -9V supply for the split rail design. I suggest using a socket here also. Pick one of the ICs below. I've not found a bullet proof recipe. I've had seemingly identical builds where one worked well with the 7660S while the other one needed the 1054. In other words: YMMV.

Chip	BST pads	Comments
ICL7660S	Jumper	Cheap and confirmed to be silent in this circuit
TC1044	Jumper	Use as improvement over 7660S if that generates audible whine
LT1054	Leave open	Best performance, highest current consumption and expensive

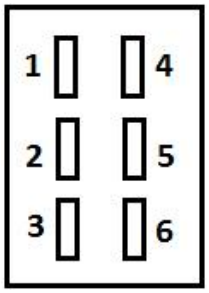
I recommend to NOT socket IC5 if you plan to install the power jack center top of the enclosure. It may sit too high and interfere with the installation of the power jack.

Wiring

I - tip of input jack
O - tip of output jack
J - sleeve of output jack
9V - sleeve of power jack
G - center of power jack

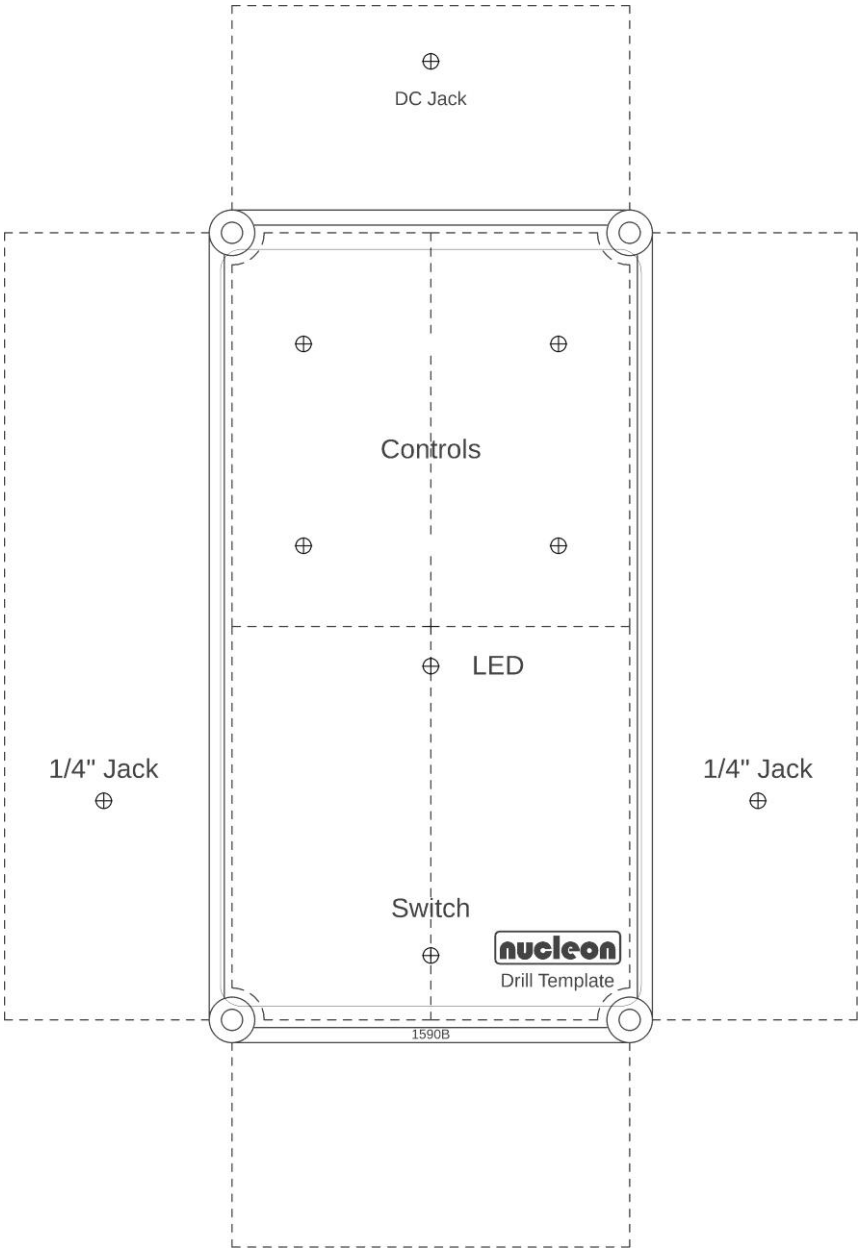
Bypass DPDT

Two sets of three (1 + 2 + 3 and 4 + 5 + 6) corresponding to columns on a DPDT switch.
1 and 4: top lug
2 and 5: center lug
3 and 6: bottom lug



For quick and easy wiring consider using the Nucleon Bypass board.

1590B Drilling template (side mounted jacks)

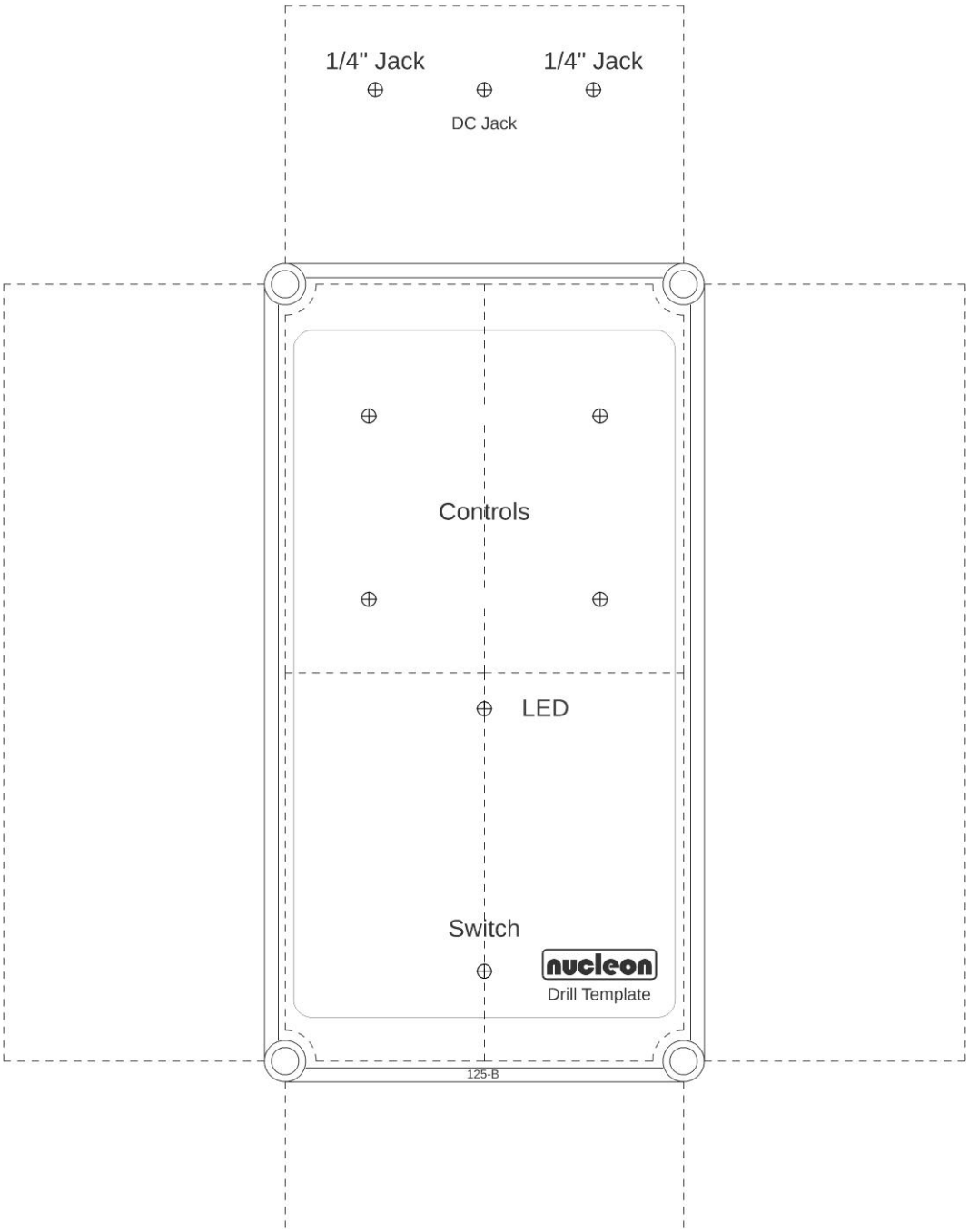


Drill Sizes

Pots: 7 mm minimum (use 8mm if you need some wiggle room)
Toggle switch: 6mm (7mm for extra wiggle room)
Jacks: 9 or 10 mm
Stomp: 12 or 13 mm (5 inches usually)
DC Jack: 7 mm (small barrel, no switch) to 13 mm (round 'Boss style' switched jacks)

125B Drilling template (top mounted jacks)

(unverified)



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