

# *Magwitch Modular*

## *Zener Wave Folder*

### *Eurorack Module*

#### *Build Guide*



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# Specification

<b>Width</b>	8 HP
<b>Depth</b>	35 mm
<b>Power 12V</b>	+32 mA, -32 mA
<b>Power 5V</b>	0 mA
<b>Channels</b>	2
<b>Inputs per channel</b>	1 folds CV, 1 offset CV, 1 signal
<b>Outputs per channel</b>	1
<b>Channel modes</b>	Separate or chained
<b>Input Signal</b>	-5V to +5V
<b>Folds CV Signal</b>	0V to 5V
<b>Offset CV signal</b>	-5V to +5V

## Components

### Suggested Suppliers

- [uk.farnell.com](http://uk.farnell.com)
- [www.mouser.com](http://www.mouser.com)
- [www.thonk.co.uk](http://www.thonk.co.uk) – for jack sockets, Alpha and Song Huei pots
- [www.toby.co.uk](http://www.toby.co.uk) – for pin headers & shrouded sockets

### Component Notes

Except where noted in the BOMs below, the following apply:

- Resistors are 1% thick film 1206 surface mount.
- Capacitors are ceramic 1206 surface mount, at least 16V.
- Electrolytic capacitors are 25V, 4mm diameter radial can, e.g. Panasonic EEEFP1E100AR.

Other variants of the given op-amps and voltage regulators will likely work. Googling the supplied part numbers should produce results with more information and links to suppliers.

- There are many alternatives available for the suggested pin headers, sockets and power header items.

You could substitute TL074 or TL084 for U2 and U4 if you wish; it will reduce the cost a little. However you may find this introduces some bias into the offset, or distortion as folding levels increase.

The footprint for panel potentiometer should fit any vertical 9mm Alpha style pot. The suggested combination of T18 alpha and Song Huei 9mm tall trimmer pots allows for slim knobs.

## Zener Diode Variation

Diodes D3 to D18 are 5.1V Zener diodes of the type BZT52B5V1. These are 2% tolerance parts.

Beware if using such diodes from a less expensive manufacturer; you may find the wave fold effect is not as intense because these diodes actually have a higher than expected Zener voltage and don't clip the signal as early.

The Nexperia (NXP) brand of BZT52B5V1 is known to work fine in this circuit. Other manufacturers include Vishay and Changjiang Electronics Tech. Diodes from the former are untested at time of writing; diodes from the latter require a higher resistance for R6 and R30 of around 30.9K.

## Main PCB Bill of Materials

Parts	Description	Quantity	Package	Recommended
C1-10	100nF Capacitor	10	1206	
C11, C12	10uF Electrolytic Capacitor, 25V	2	Radial can, 4mm diameter	EEEFP1E100AR
D1, D2	Schottky rectifier diode	2	SMB	STPS1L30U
D3-D18	5.1V Zener	16	SOT-123	BZT52B5V1
J1, J2	2.54mm socket, 7 x 1 row	2		90147-1107
J3	Shrouded power header	1		302-S-10-D1R1
L1, L2	Ferrite bead	2	Thru-hole	BL01RN1A1F1J
L1, L2	Ferrite bead (alternative)	2	0805	BLM21PG221SN1D
R3, R4, R27, R28	470R resistor, 1%	4	1206	
R13, R19, R20, R37, R43, R44	1K resistor, 1%	6	1206	
R7, R8, R14, R21, R31, R32, R38, R45	4K99 resistor, 1%	8	1206	
R9, R15, R22, R33, R39, R46	10K resistor, 1%	6	1206	
R23, R47	27K resistor, 1%	2	1206	
R6, R30	30K resistor, 1%	2	1206	
R5, R29	36K resistor, 1%	2	1206	
R17, R41	39K resistor, 1%	2	1206	
R1, R2, R25, R26	47K resistor, 1%	4	1206	
R10, R12, R18, R24, R34, R36, R42, R48	82K resistor, 1%	8	1206	
R11, R35	100K resistor, 1%	2	1206	
R16, R40	130K resistor, 1%	2	1206	
U1	LM13700	1	SOIC	LM13700/NOPB
U2, U4	OPA4171	2	SOIC	OPA4171AIDR
U3, U4	TL072 op-amp	2	SOIC	TL072IDT

The footprints for L1 and L2 allow for both the through hole and 0805 SMT components. You should solder just one or the other type.

## Panel PCB Bill of Materials

Parts	Description	Quantity	Package	Recommended Part
C1-4	100nF Capacitor	4	1206	
D1-4, D6-7, D12-D17	Schottky diode	12	SOD-123	BAT48ZFILM
D5, D8	5V reference	2	SOT-23	LM4040DBZ-5
D10-11, D19- 20	2.4V Zener	4	SOD-123	BZT52C2V4
D9, D18	5.1V Zener	2	SOD-123	BZT52C5V1
J5, J6	2.54mm pin header, 7 x 1 row	2		VMHS-1x16-120-065-030
J1-4, J7-10	3.5mm mono switched jack socket	8		PJ398SM or PJ301M-12
R1, R7	4K7 resistor, 1%	2	1206	
R9, R10, R19, R23	10K resistor, 1%	4	1206	
R8, R20	56K resistor, 1%	2	1206	
R3, R11, R15, R21	91K resistor, 1%	4	1206	
R2, R4, R5, R6, R14, R16, R17, R18	100K resistor, 1%	8	1206	
R13, R24	150K resistor, 1%	2	1206	
R12, R22	174K resistor, 1%	2	1206	
R25-R32	10K resistor, 1%	8	1206	
SW1	Sub-miniature DPDT switch	1		B22AP_DPDT
U1	TL084 op-amp	1	SOIC	TL084BCD
U2	TL082 op-amp	1	SOIC	TL082IDR
RV1, RV3	B100K potentiometer	2		RD901F-40-15K-B100K- 057
RV2, RV4	B100K potentiometer	2		R0904N-B100K,L-25 KQ

# Assembly

This module requires both surface mount and through-hole soldering. You can use various methods for the surface mount soldering, such as hand soldering, heat gun or the hotplate method. If you haven't attempted these before, it is highly recommended to study them and practice first.

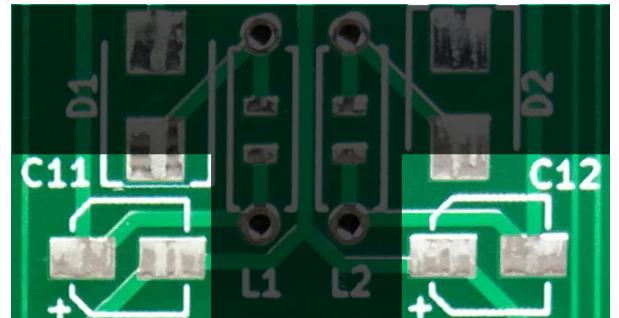
- [Hotplate method by Hobbytronics](#) – this shows the basics
- [Surface Mount Soldering](#) – this shows the heat gun method, both with and without a stencil.

The steps to follow for this module using the heat gun method are as below. Start with the main PCB first, then the panel PCB.

## Orienting Components

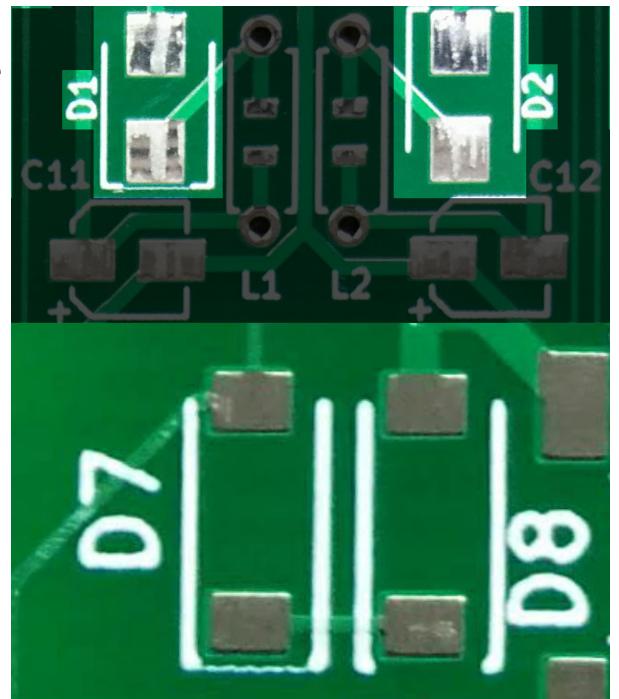
Pay attention to the silkscreen printing around component footprints; this gives an indication of how certain polarised components (capacitors, diodes) and ICs should be placed.

Orient electrolytic cap bases with the outline on the PCB, as highlighted here:



Orient all diodes correctly; the cathode is the closed end of any diode outline on the PCB, and should line up with the cathode marking on the diode itself, usually a line). The closing line may not be fully present on the silk screen – in that case, place the diode with the cathode on the pad where the silk screen lines outside it extend furthest.

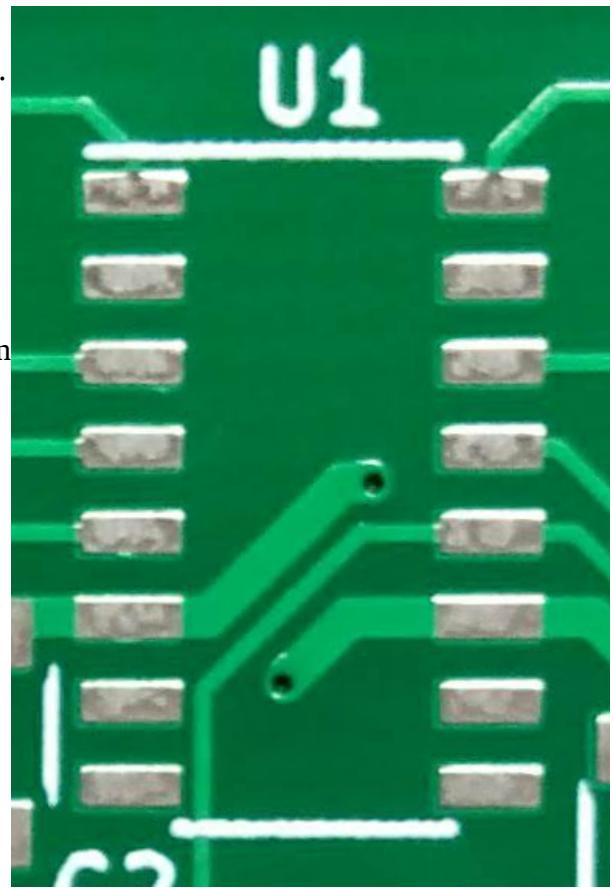
This applies to all types and sizes of diodes – the large rectifier diodes on the power inputs (D1, D2) and the various signal diodes (e.g. D7, D8)



Orient all ICs properly – pin one should be on the pad with the adjacent extended line on the silkscreen.

The ICs in this circuit will have pin one marked by one or more of the following:

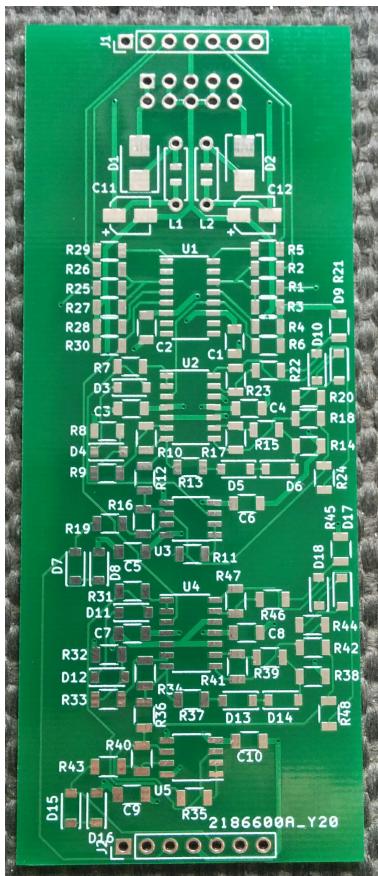
- A short line across the IC body indicating its top, where pin 1 is located.
- A circle, dot or dimple at the corner where pin 1 is located.
- A chamfer on the body (sloped edge) which marks the side on which pin 1 is located.



## Orienting the PCBs

The PCBs are taller than they are wide; they should be oriented to match the text

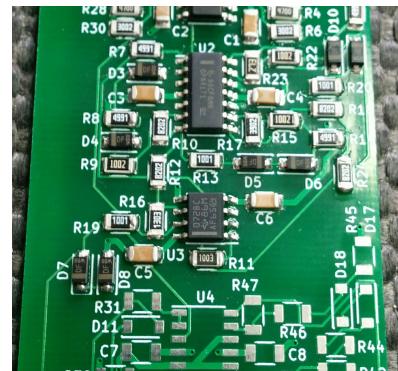
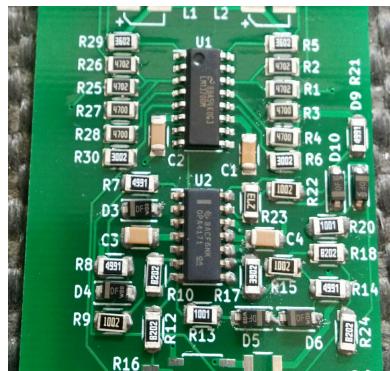
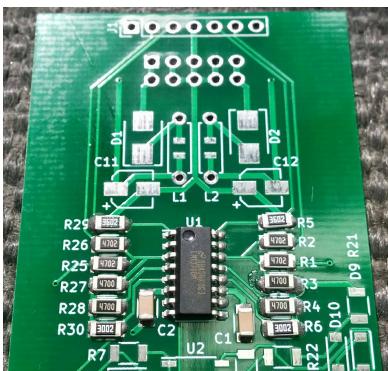
For reference, the Eurorack power connector is at the top of the main PCB.



## Main PCB

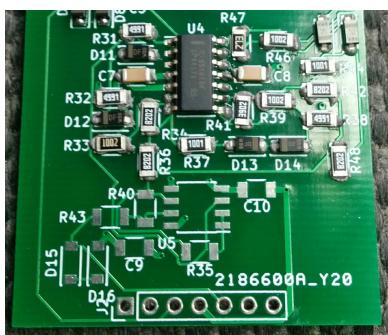
Work in stages as shown the the following pictures. Apply paste to the pads, place all the components and then heat with a heat gun until all the solder has melted and gone shiny. Check the joints visually, and also check critical joints (IC pins for adjacent shorts, power pins) for continuity with a multimeter.

Begin with the LM13700 (U1) and the components around it; paste, place and solder. Then move on to the components around U2 in the same way. And then do the same for U3 and its neighbours, as shown in these images:



Take a break and inspect your work so far.

Now repeat the process again for the components around U4, then for the components around U5:



Then do the final surface mount components at the power input: C11, C12, D1 and D2.

Solder the through-hole jumpers J1 and J2 onto the front side of the board, and J3 onto the rear of the board. You will need to secure these using tape or blu-tak or a small dab of glue as they are soldered from the reverse. Ensure J1 and J2 are vertical so they line up with the headers on the panel board – solder just one pin on each to begin, then check they are vertical before soldering the rest. If not, heat the solder up again and adjust the jumper position.



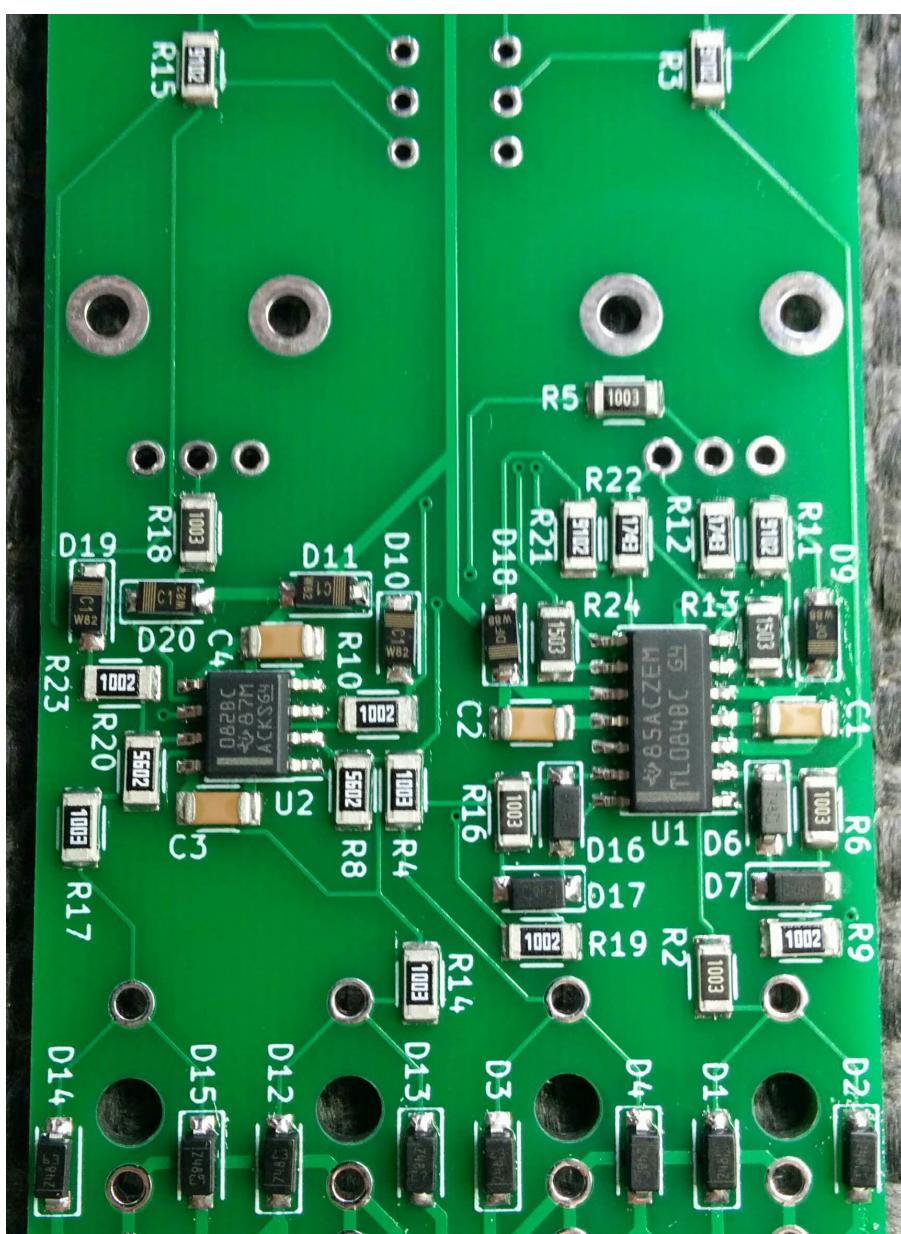
Note that the slot in the shrouded header should align with the gap between the two horizontal lines on the PCB – the slot should be facing down the board.

## Panel PCB

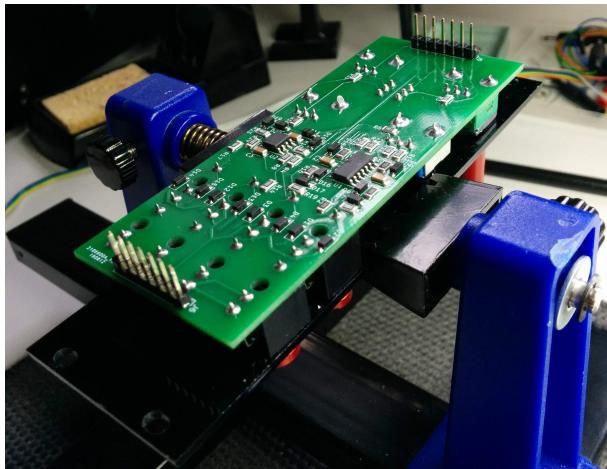
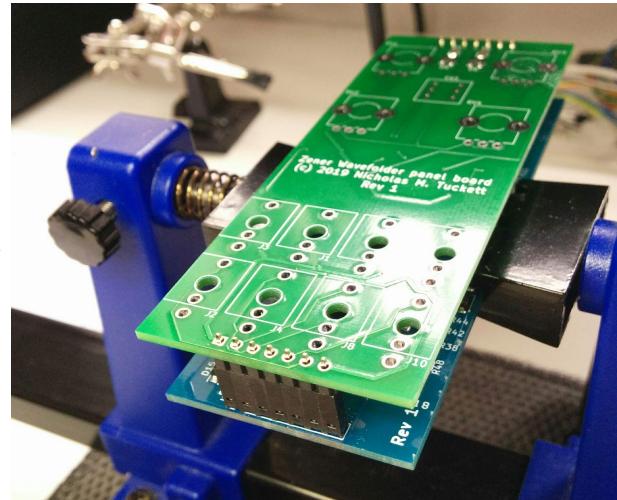
Begin by soldering R1, R7, D5 and D8 onto the front of the board, using a heat gun.



Turn the board over and solder all the surface mount components; paste the pads, place the parts and apply heat from the heat gun as before.



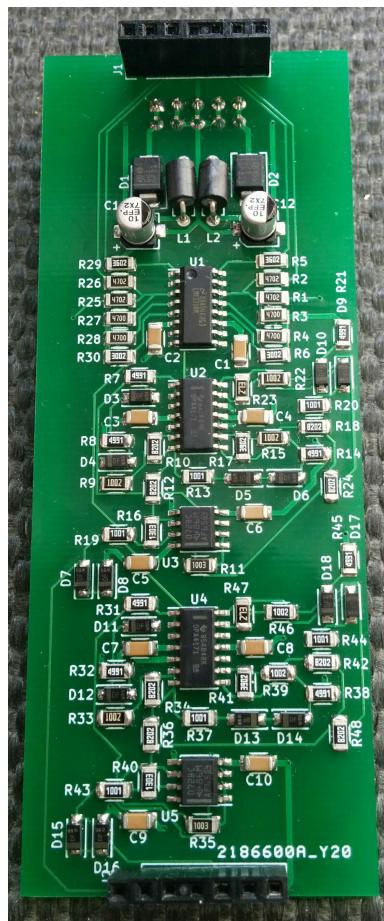
Take the main board and fit the pin headers for the panel PCB into the sockets, then fit the panel PCB on top of it, front side up. Then solder the pin headers to the panel PCB – this will ensure they are properly aligned with the sockets on the main board.



Now fit all four potentiometers, the switch and the eight jack sockets onto the front of the panel PCB, and lay the front panel itself over the top so everything aligns. Turn the panel and PCB over together and clamp the panel. Then solder the pots, switch and jack sockets – they should all align with panel holes as they are held in place with the panel.

## Completed PCBs

You should now have two PCBs looking like this:



## **Final Assembly**

1. Screw the panel onto the panel PCB components firmly.
2. Connect the main board to the back of the panel PCB.
3. It's ready to plug in and use!

## **Alternative Method: Hot Plate**

If you want to use the hot plate method, these are the steps to follow:

1. Apply paste to all pads on the main PCB, place all the components and solder using your hot plate.
2. Solder the through-hole components (pin header sockets, power socket, ferrite beads) onto the main PCB with a soldering iron.
3. Apply paste to all the pads on the reverse of the panel PCB, place all the components and solder using your hot plate.
4. On the front of the panel PCB, solder R1, R7, D5 and D8 either using a heat gun or soldering iron.
5. Solder the pin headers onto the panel PCB using a soldering iron (see above).
6. Solder the switch, jack sockets and pots onto the panel PCB using a soldering iron (see above).