

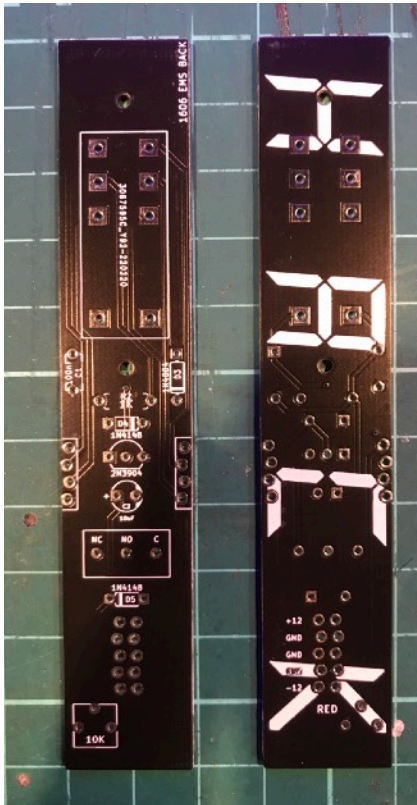
# 1606 Electro-Magnetic Switch

## Build Document

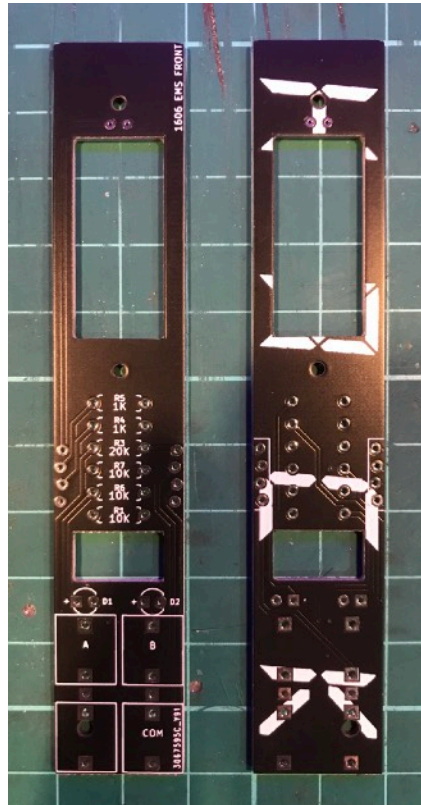
You will find a 1606 EMS build video to help guide you through the steps in this document on the Hack Modular Youtube channel.

The **TOP** sides of each board have the module labels along the edge. **BOTTOM** sides have the big HACK logo. Some components are mounted on the top side, some on the bottom. This is indicated by the silkscreen symbols. The component lies on the side with the silkscreen symbol, the leads poke through pads to the other side where you solder them in place.

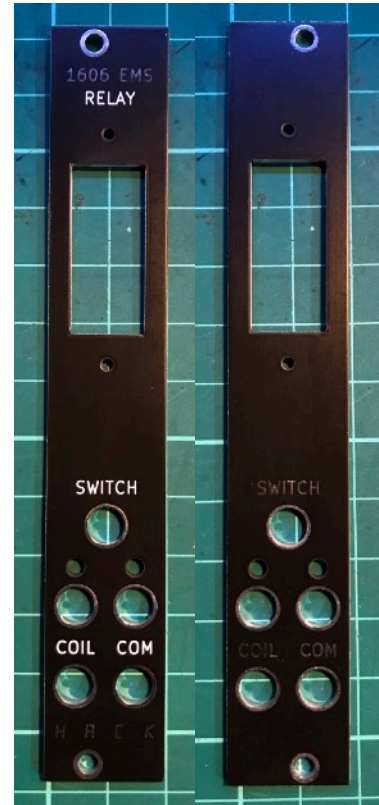
### BACK BOARD



### FRONT BOARD



### PANEL



**Essential Tools** - soldering iron, wire cutters, pliers, screwdriver, lighter.

## Bill Of Materials

Reference	Package	Value	Quantity
R2,R4,R5	1/4W 1% Metal Film Resistor	1K	3
R1,R6,R7	1/4W 1% Metal Film Resistor	10K	3
R3	1/4W 1% Metal Film Resistor	20K	1
C1	Multilayer Ceramic Capacitor	100nF	1
C2	Electrolytic Radial Capacitor	10uF	1
D4,D5	Signal Diode	1N4148	2
D3	Rectifier Diode	1N4004	1
D1,D2	Flat Top LED	3mm Diffused Red	2
	Miniature Bulb	3mm	1
Q1	Transistor TO-92	2N3904	1
	Finder 40.52.7.012/Omron G2R-2 Relay	12V DPDT	1
	Finder 95 Relay Socket	DPDT 95.15	1
	Momentary Miniature Push Switch	SPST	1
	Heatshrink	8mm	3
J1	3.5mm Jack Socket	THONKICONN	4
	Socket/Switch Nuts		5
	3362P Trimmer	10K (103)	1
J5	Male Pin Header	4 PIN	2
J8	Female Pin Header	4 PIN	2
U2	Male Pin Header	2 x 5 PIN	1
	Female to Female Threaded Standoff	M2 x 10mm	2
	Male to Female Threaded Standoff	M2 x 11mm	2
	Slotted Screw	M2 x 6mm	4
	Ribbon Cable		1

## Let's begin with the **BACK** Board

1. We'll start with the smallest components - the **diodes**. **Save three of the cut off legs for later.** D5 & D4 are 1N4148, D3 is a 1N4004.

- **Make sure their orientation is correct.** The line on the diodes aligns with the silkscreen symbol and faces towards the circular pad.

2. **Resistor R2** (1K) next. It doesn't matter which way round this goes.

3. Solder in the 10K **trimmer**.

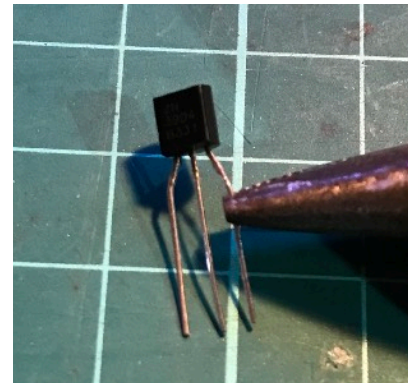
4. **Ceramic Capacitor C1** now. This can go either way round.

5. Solder in the **transistor**.

- **Bend** the legs out as shown in the picture.
- Make sure it's orientation matches the silkscreen symbol.

6. C2, the **electrolytic capacitor** next. This must be soldered the correct way round. The long leg is positive so align that with the little plus sign on the silkscreen symbol.

7. Turn the board over to the **BOTTOM** side, insert in the 10 pin **power header** on top of the rectangular silkscreen outline and solder it in place.

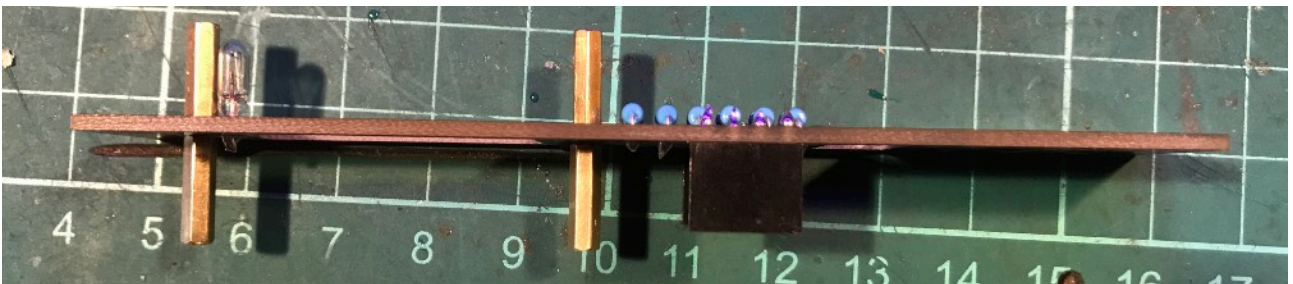
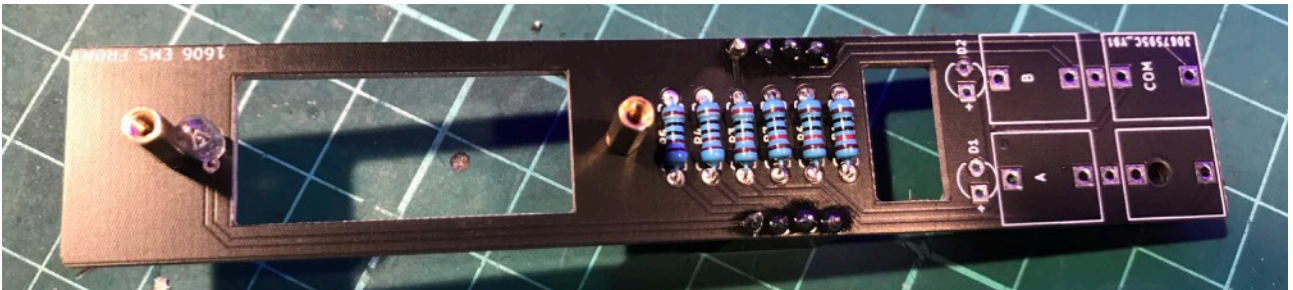


Don't worry about the push switch, relay socket or board connection headers for now. Put the **BACK** board aside for the moment. You should have something that looks like this:



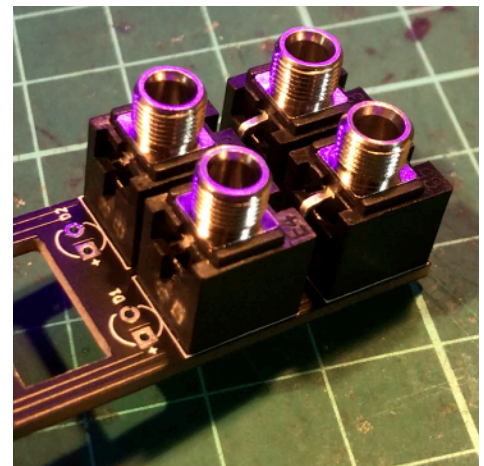
## FRONT Board

1. Start with the **resistors**.
2. **Solder** in the **female pin headers** on the **BOTTOM** of the board where their silkscreen outline is. Make sure they are pushed in flush to the board surface.
3. **Thread** the **11mm standoffs** through their holes from the **BOTTOM** side of the **FRONT** board and **tightly screw** on the **10mm standoffs** on the **TOP** side.
4. **Solder** in the **bulb** on the **TOP** of the board, beneath the standoff.
  - Make sure it is stood up straight vertically, pushed down so it will fit under the panel and back from the edge of the relay slot.
  - It does not matter which way round the legs are soldered.

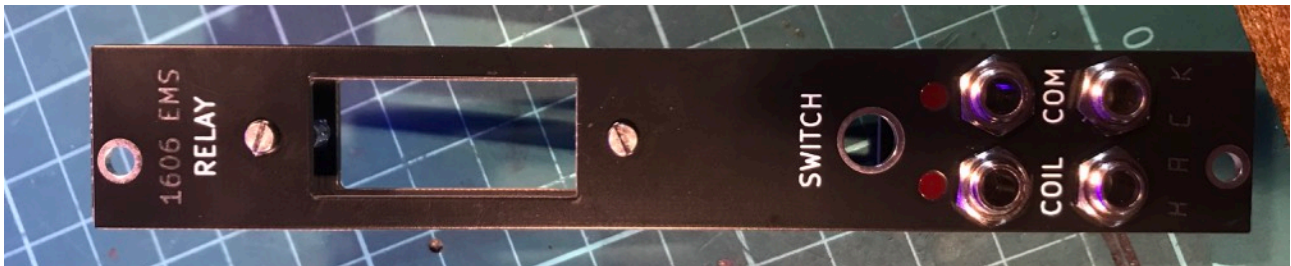


## Mounting the PANEL

1. Without soldering, **slot in** the four **jack sockets**. For **ONLY** the **A** and **B** sockets, **cut off** the outside **ground leg** - they **MUST** be inserted so the cut off leg would be pointing upwards, the same way as the **COIL** and **COM** sockets below!
2. **Drop in** D1 and D2, the **flat top LEDs** - do not solder them in yet. They must go in the correct way. The longer leg is positive.
3. **Place** the **panel** on over the jack sockets. **Thread nuts** onto the sockets and **screws** through the **panel** into the standoffs.

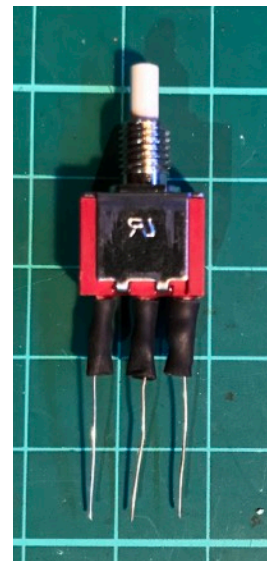
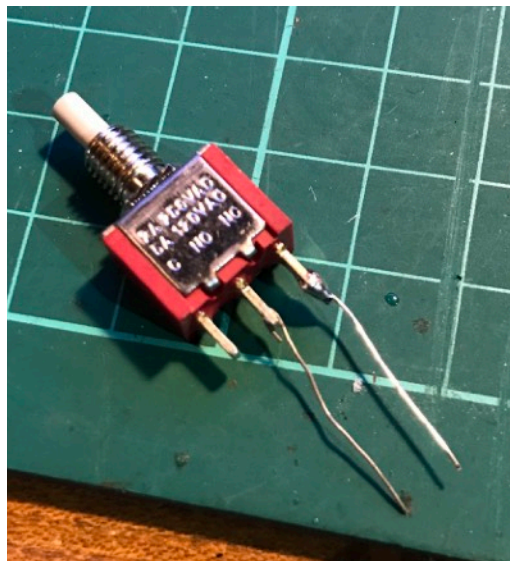
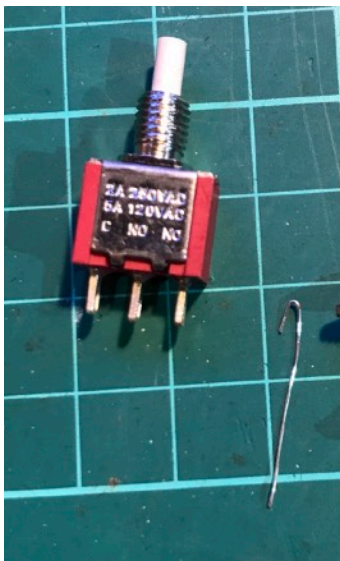


4. **Solder** the **jack sockets** into place, making sure they are pressed flush to the board.
5. **Manoeuvre** the flat top **LEDs** into their panel holes. Make sure they are flush with the panel face and **solder** in place.

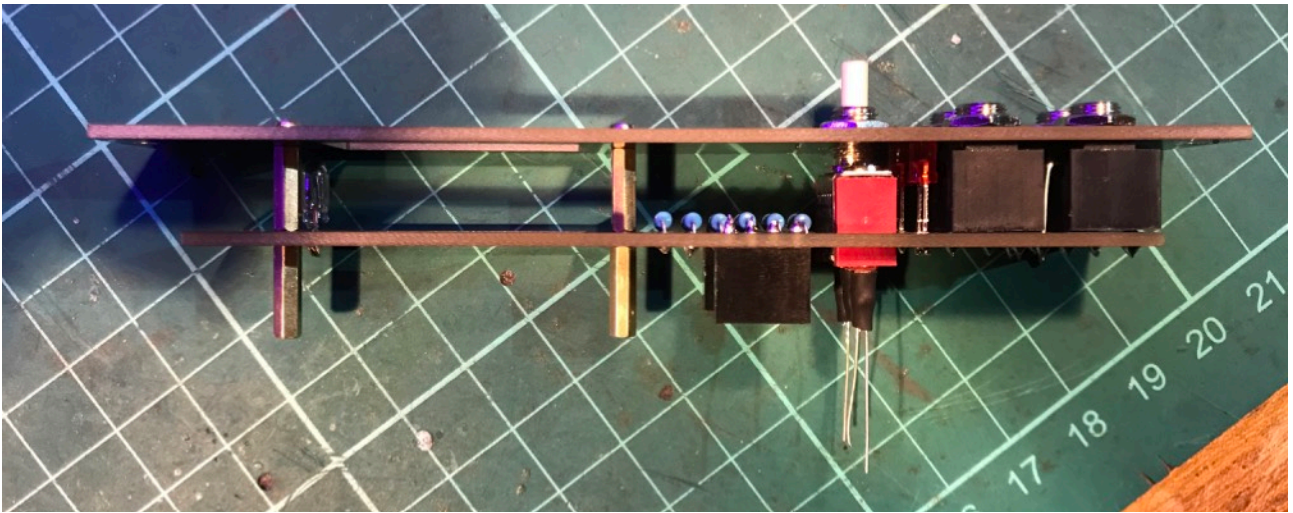


## Connecting the FRONT and BACK boards

1. Take the cut off diode **legs** from earlier and **bend** over the ends into little hooks with pliers. **Solder** these onto the lugs of the **push switch**.
  - Be careful not to heat up the switch too much with the soldering iron - the plastic can melt.
  - Afterwards, straighten the legs with your pliers.

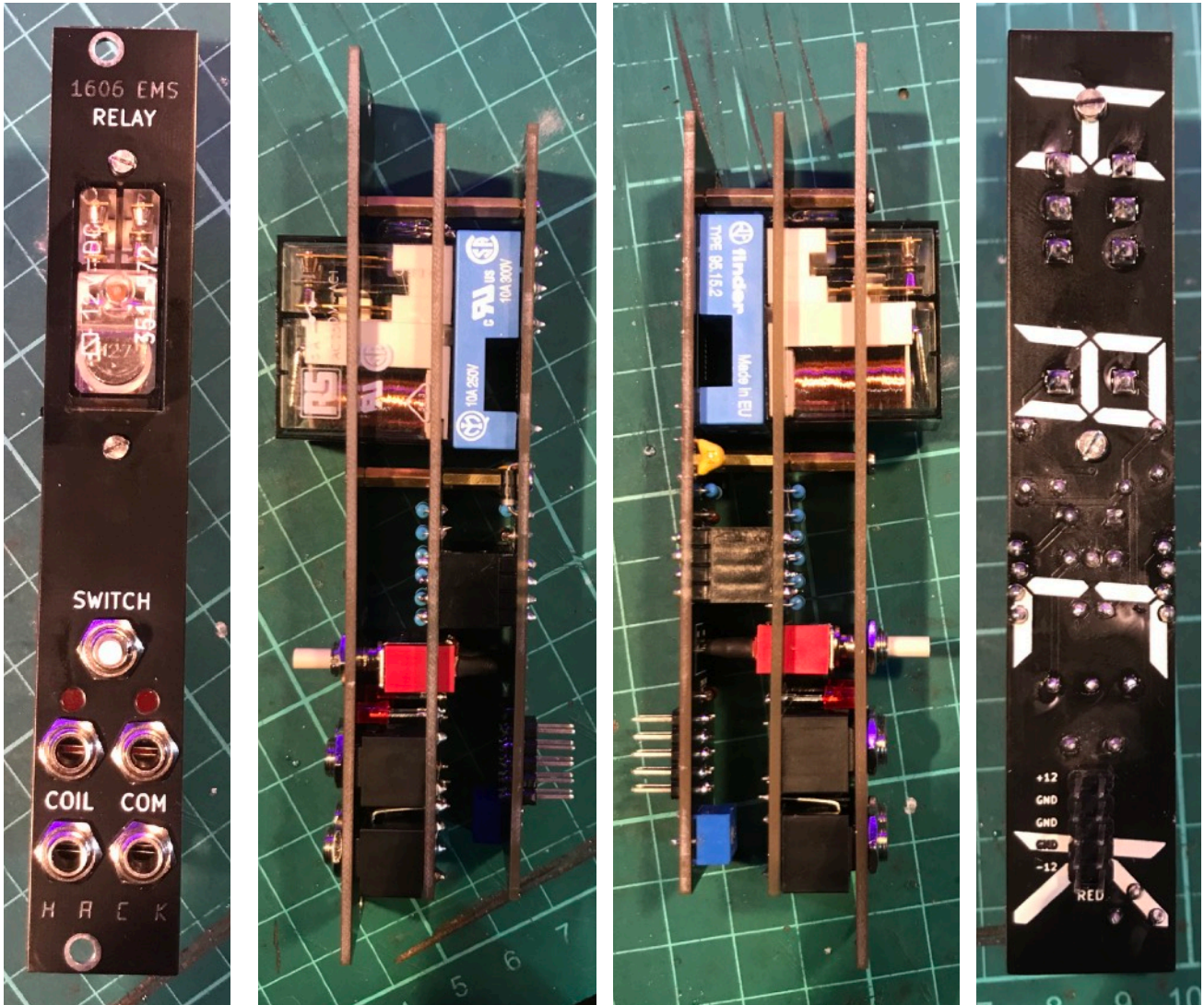


2. **Cover** each solder joint with 8mm of **heat shrink tubing**. Wave a lighter near to shrink it - do not linger too long or it will melt.
3. **Insert** the **push switch** through the **FRONT** board and panel hole - make sure the switch terminal **labels** will match the labels on the **BACK** board silkscreen - they should face upwards. **Thread** a **nut** on.



4. Without soldering, **insert** the **male pin headers** and **relay socket** into place on the **TOP** of the **BACK** board.
5. **Connect** the **FRONT/PANEL** assembly with the **BACK** board. Make sure the push switch legs are poking through their holes.
6. **Thread screws** into the standoffs from the **BOTTOM** of the **BACK** board, check alignment and tighten.
7. **Solder** the **male pin headers** into place, making sure they are pushed flush with the board.
8. **Adjust** the nut on the **push switch** so the threaded bushing will be the same height as the jack sockets.
9. Holding the **push switch** in place, **solder** ONE of the legs on the **BOTTOM** of the **BACK** board.
10. Now **check** the **push switch** is at the correct height and the nut is secure - do not over-tighten. Reheat the solder joint and adjust if necessary.
11. **Solder** the remaining **push switch** legs into place.
12. **Insert** the **relay** through the panel and securely into the **socket** - be careful to put it in the right way round. **Check the alignment** of everything is correct and the socket is pushed flat to the board. **Solder** the **relay socket** in place.

Congratulations, it's complete - enjoy your module!



## Ribbon Cable

**To avoid damage to modules it is important to connect the power cable correctly.** The triangular sign on the black header sockets mark the -12V connection. The RED cable on a standard coloured ribbon cable (and the rainbow cable provided with this kit) should be closest to the **RED** silkscreen text on the PCB.

## Troubleshooting

Firstly, if it's late go to sleep. Normally the problem will be obvious with a clear head.

- Is the ribbon cable connected correctly? Have you tried a different cable?
- If the bulb is not lit, is the trimmer (accessed through the **COIL** jack) turned up?
- Are the diodes, LEDs, electrolytic capacitor, transistor, jack sockets & push switch correctly oriented?
- Are you using the correct relay?
- Check that the push switch is functioning as expected with a multimeter on the continuity setting. It could have been damaged by over heating while soldering.
- Did you miss any solder joints?

For most problems the likely culprit is a bad solder joint. Reflow any that look suspicious.