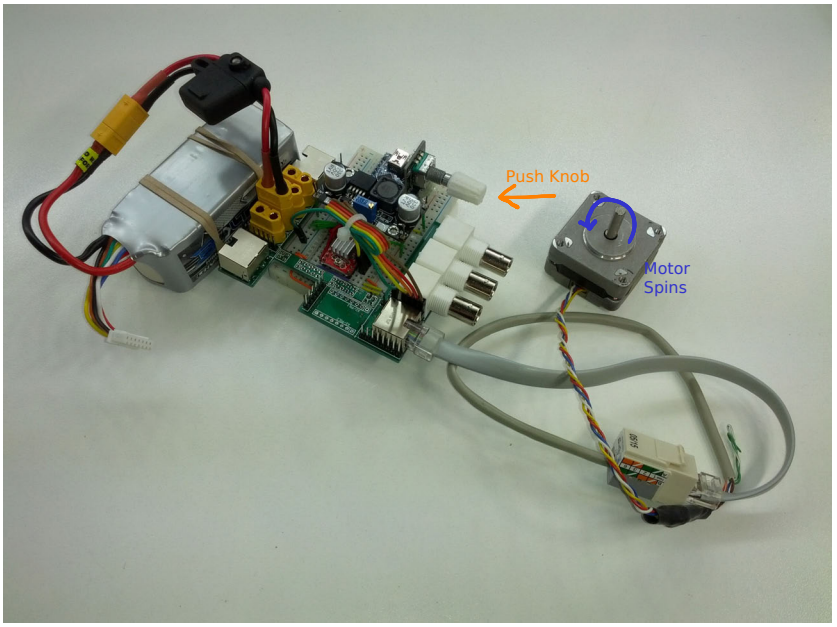
Stepper Tester with PatchRap

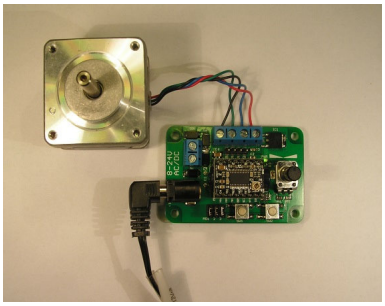
Stepper Tester implements a programmable Arduino compatible platform for testing stepper motors.

Integrating commodity modules, inserted into a solderless breadboard, repairs are quick and painless. This gives develoepers confidence to work with expendable hardware, before endangering expensive equipment.

Widely used connectors allow maximum flexibility. Accessories, including an automotive fuse holder, can be placed inline. Existing machinery may be connected to the motor test equipment as needed. Through the breadboard or BNC connectors, diagnostic metering equipment may be attached to resolve problems.

Quick connection to existing, comprehensive CNC machinery, was a primary driver for this technology.

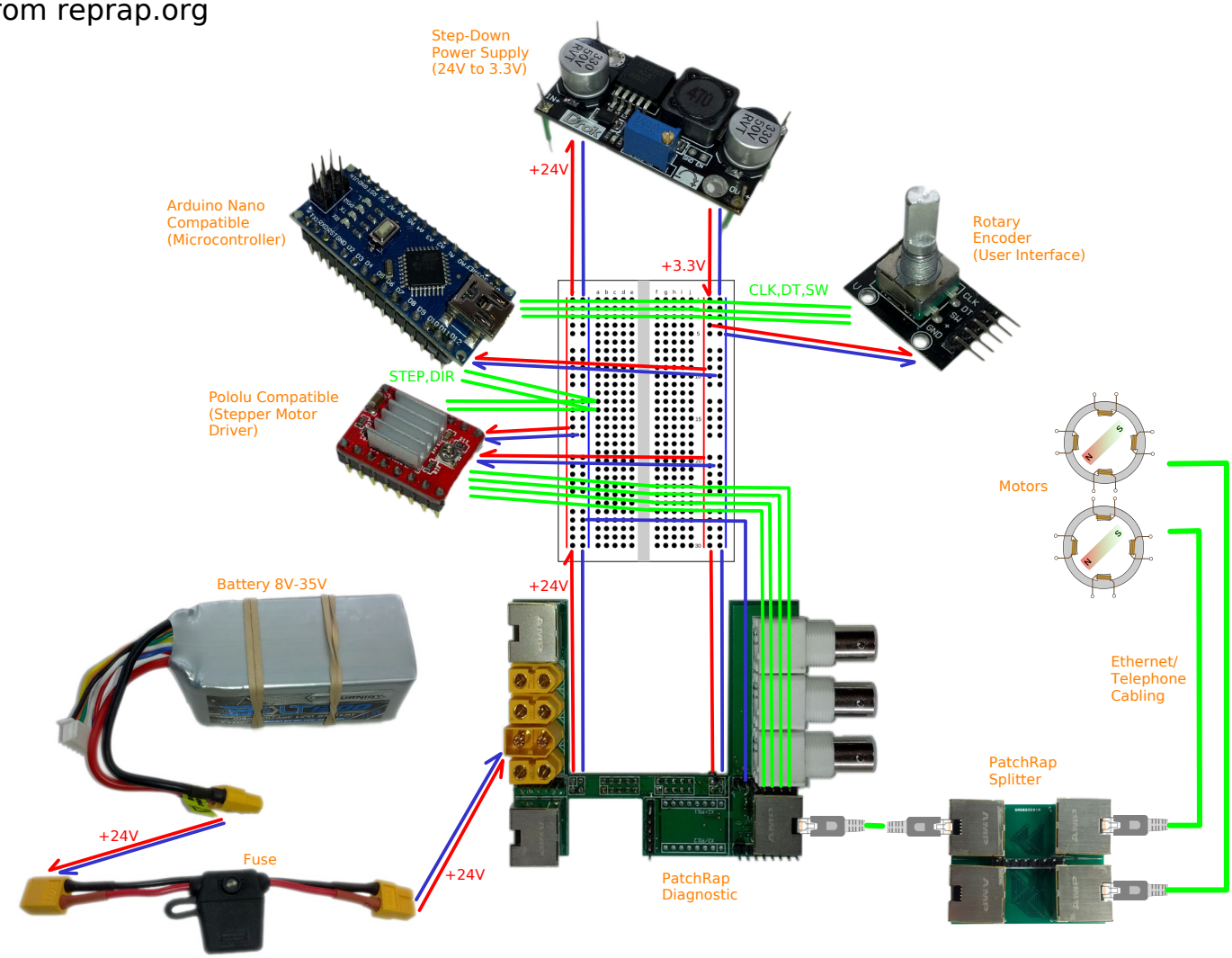




EasyStepper
from reprap.org

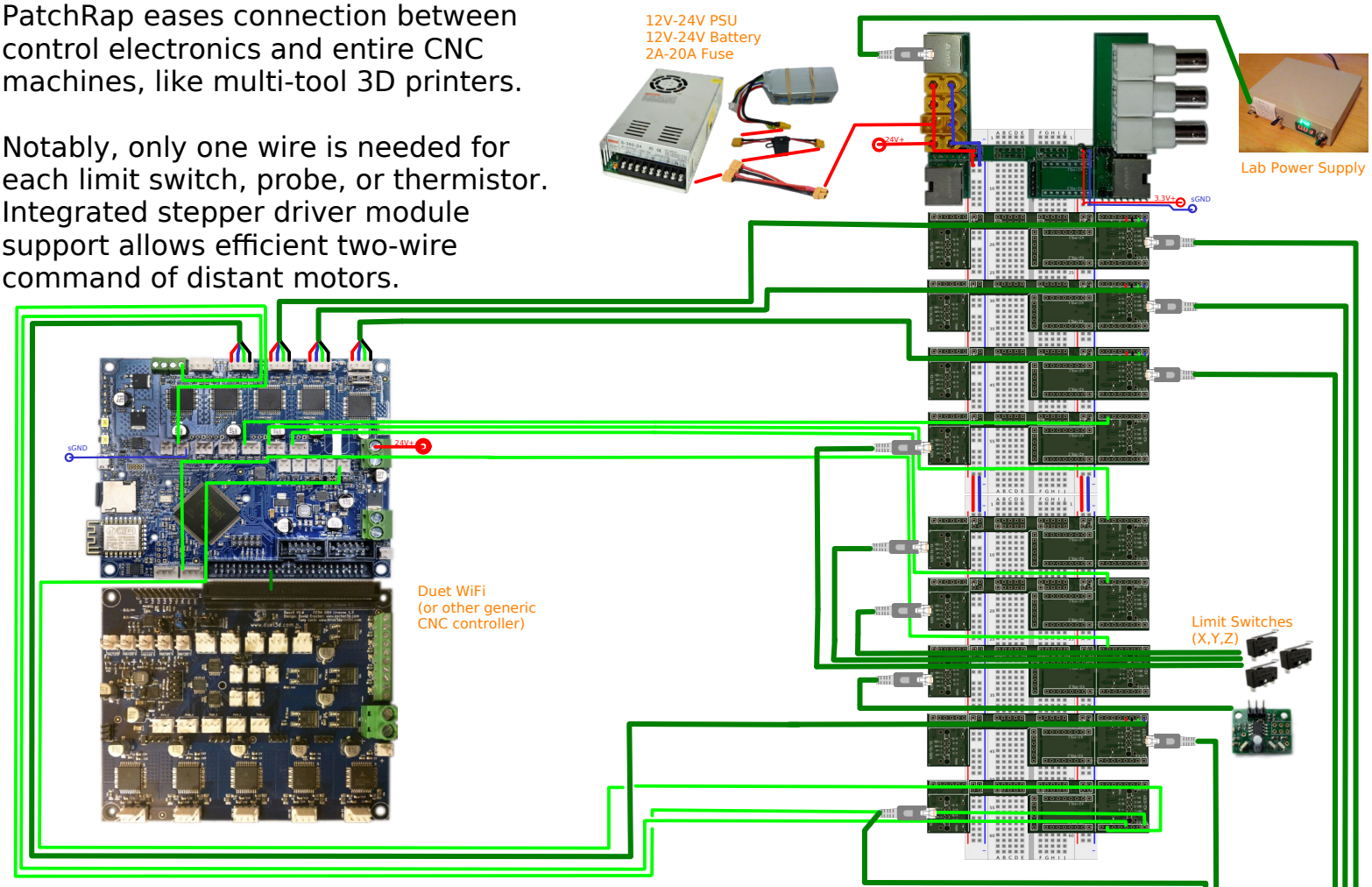
For comparison, an off-the-shelf stepper motor tester circuit does exist. Inexpensive, versatile, simple to use for a specific purpose, and nevertheless quite relevant. However, through PatchRap, similar functionality is implemented without any specialized circuit board. Attachment of different power supplies (including batteries), in-line accessories, diagnostic equipment, additional motors, or comprehensive CNC machinery, might require wire splicing. Severe damage due to short circuit of systems outside the stepper motor driver module may be more difficult to repair in the field.

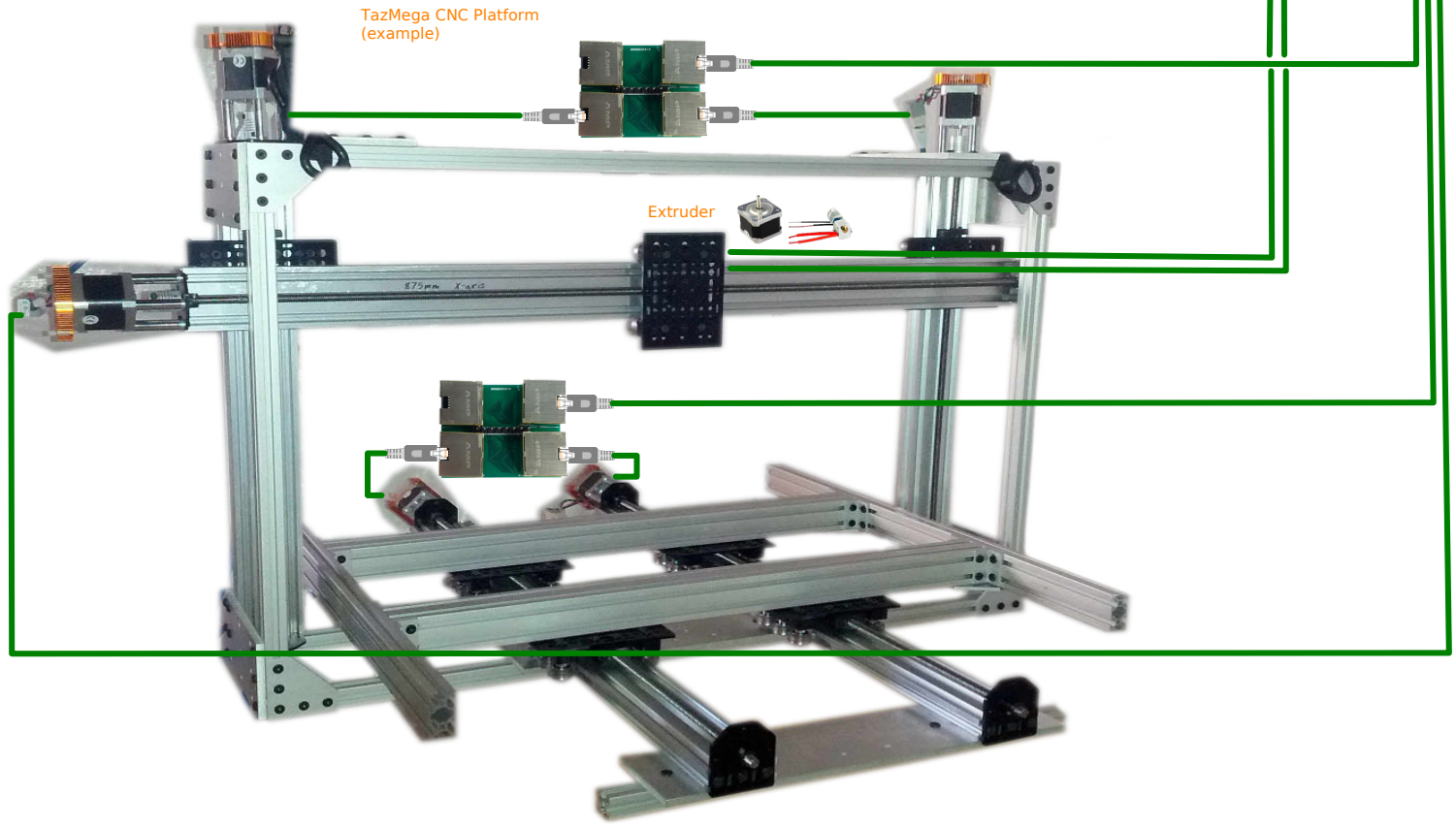
PatchRap also includes its own innovative features. For stepper motors, extra pairs in Ethernet/ Telephone cabling are used for redundancy and power delivery. Diagnostic and protective components are integrated as well, notably optional LEDs at the RJ45 jacks, and surge suppressors. In some cases, these features may be repurposed for other common applications, such as conventional Ethernet/Telephone line protection.



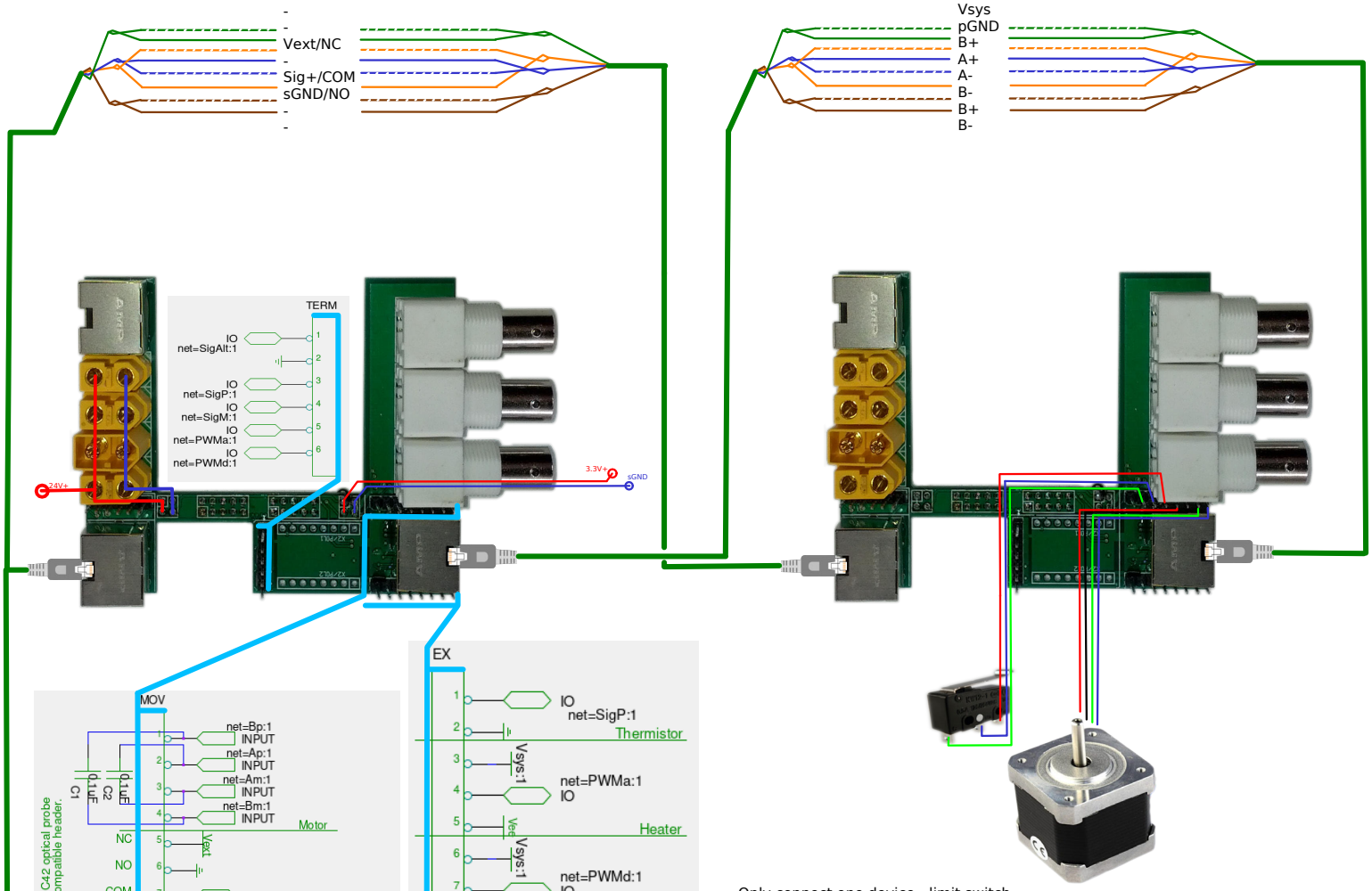
PatchRap eases connection between control electronics and entire CNC machines, like multi-tool 3D printers.

Notably, only one wire is needed for each limit switch, probe, or thermistor. Integrated stepper driver module support allows efficient two-wire command of distant motors.

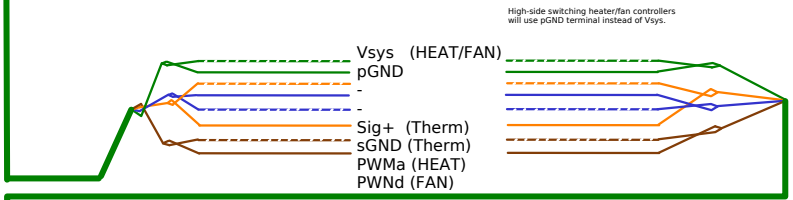


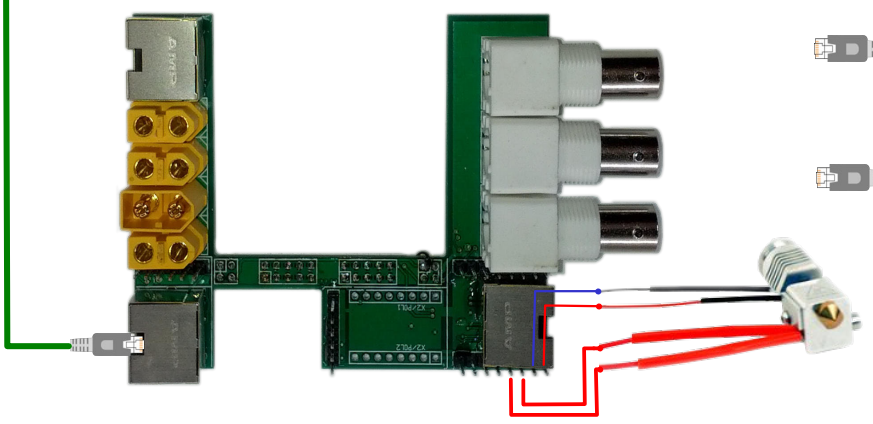


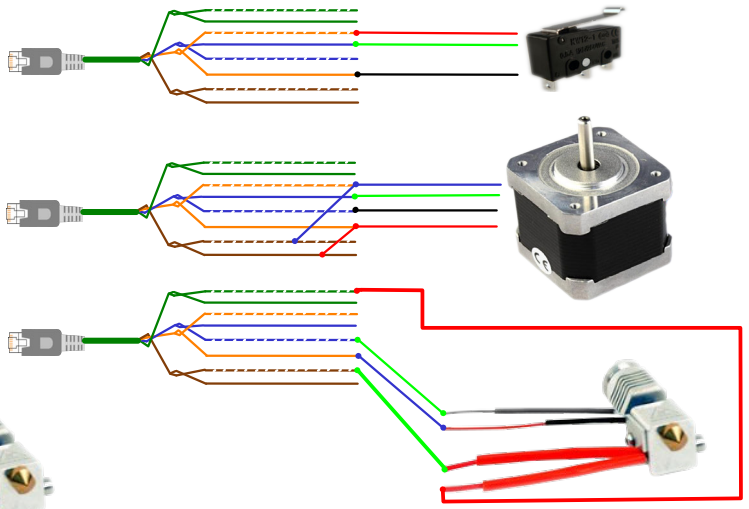
PatchRap generally uses Ethernet cable terminated by RJ45 connectors to carry power and signals from a central hub to peripherials, or between hubs. These cables bundle four pairs of two twisted wires, providing eight wires total, numbered and color coded by the widely accepted T568A standard. PatchRap assigns each of these wires to a specific function. Following these conventions, devices maybe connected through a circuit board, or any off-the-shelf RJ45 jack available at common hardware stores.

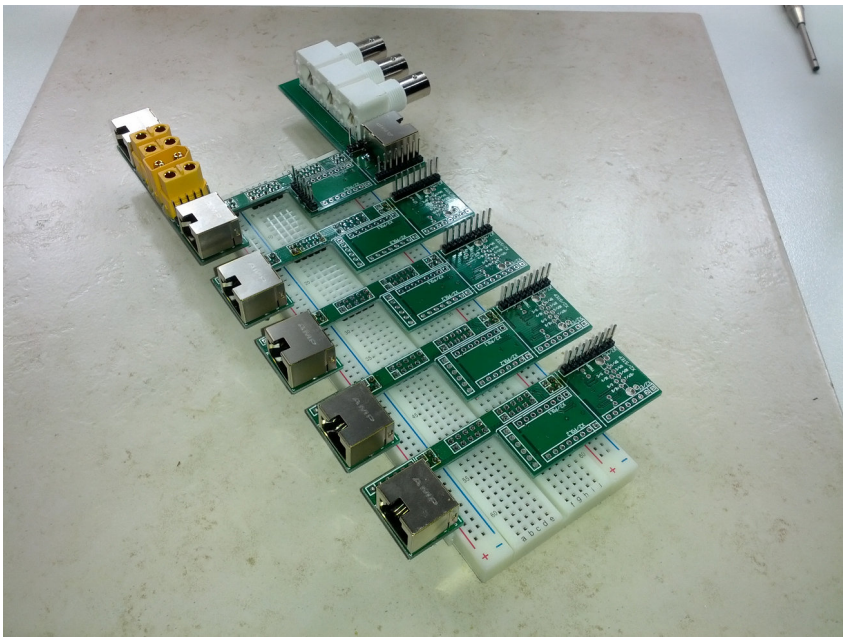


Only connect one device - limit switch, stepper motor, or hotend, to a PatchRap board. Each cable and PCB only has enough wires for one use.









GenericIO (Limit Switch, Depth Probe, Extruder, Stepper Driver, Radio)

```
3 / 1 - Vsys/Vcc
3 \ 2 - pGND/sGnd
2 - 3 - Vext/Vmid/Avcc/SigAlt   (NC)                                    (LO)
1 / 4 - Sig-/SigTx-             (sGND)              (Dir)       (I2C, UART)
1 \ 5 - Sig+/SigTx+             (COM,ANA,Probe)     (Step)      (I2C, UART) (IF)
2 - 6 - sGND                    (NO)
4 / 7 - PWMalternate/SigRx+     (Control, Servo, Heater)        (I2C,UART)  (RF)
4 \ 8 - PWMdirect/SigRx-        (Fan)                           (I2C,UART)
```

DigitalIO (Display, SDCard, SPI)

```
3 / 1 - A0
3 \ 2 - dRST
2 - 3 - Vext
1 / 4 - MOSI            (I2C, UART)
1 \ 5 - MISO            (I2C, UART)
2 - 6 - pGND
4 / 7 - SCK             (I2C, UART)
4 \ 8 - CS
```

Steppers (Stepper Motor)

```
3 / 1 - Vsys
3 \ 2 - pGND
```

```
2 - 3 - B+      Fwd(2A/Blue/Red)        Rev(1A/Green/Blue)
1 / 4 - A+      Fwd(1A/Green/Blue)      Rev(2A/Blue/Red)
1 \ 5 - A-      Fwd(1B/Black/Yellow)    Rev(2B/Red/White)
2 - 6 - B-      Fwd(2B/Red/White)       Rev(1B/Black/Yellow)
4 / 7 - B+      Fwd(2A/Blue/Red)*       Rev(1A/Green/Blue)*
4 \ 8 - B-      Fwd(2B/Red/White)*      Rev(1B/Black/Yellow)*
```

LinearPSU

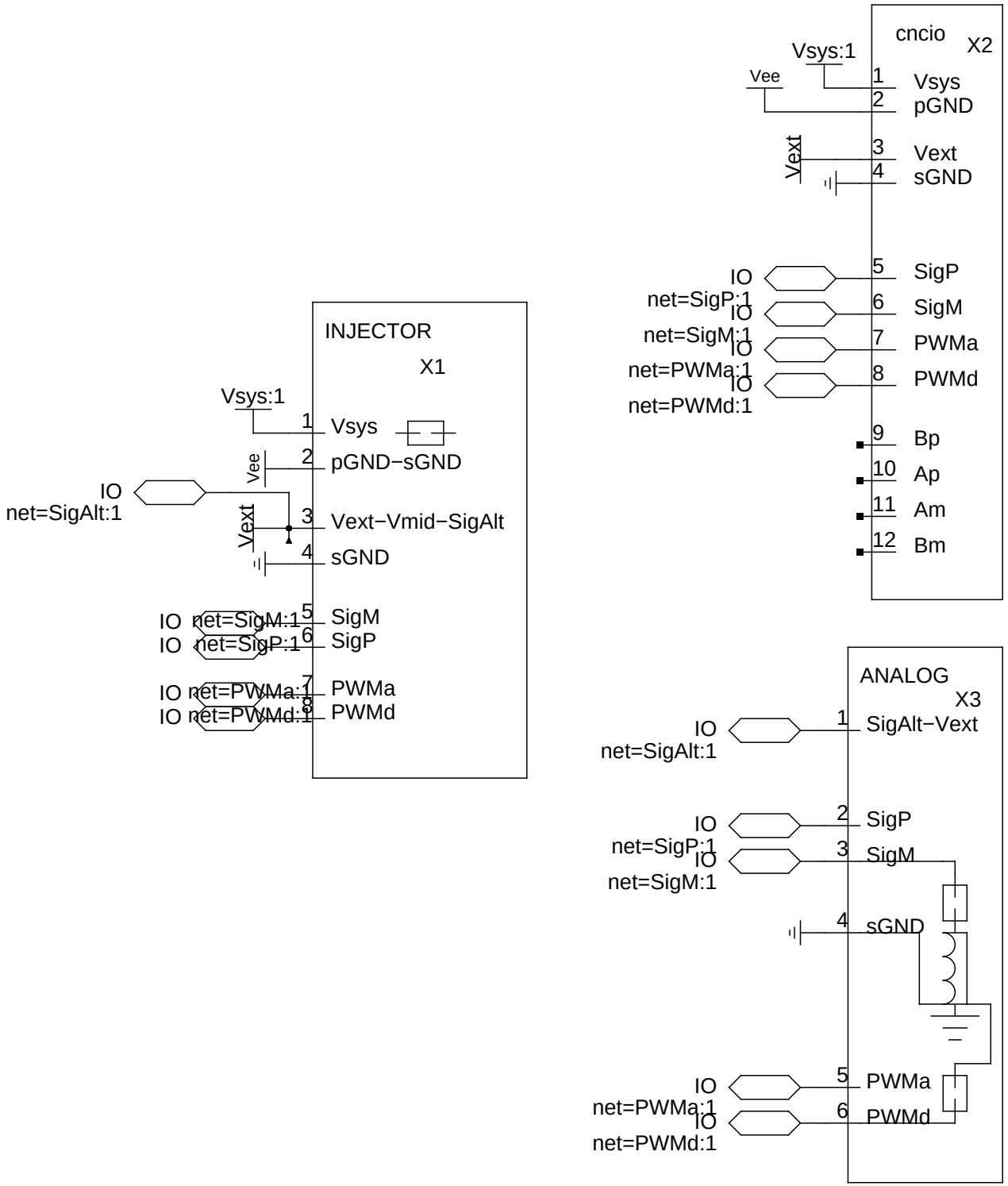
```
3 / 1 - 5V
3 \ 2 - Vee
2 - 3 - Vcc
1 / 4 - GND
1 \ 5 - Vee
2 - 6 - Vee
4 / 7 - 3.3V
4 \ 8 - Vee
```

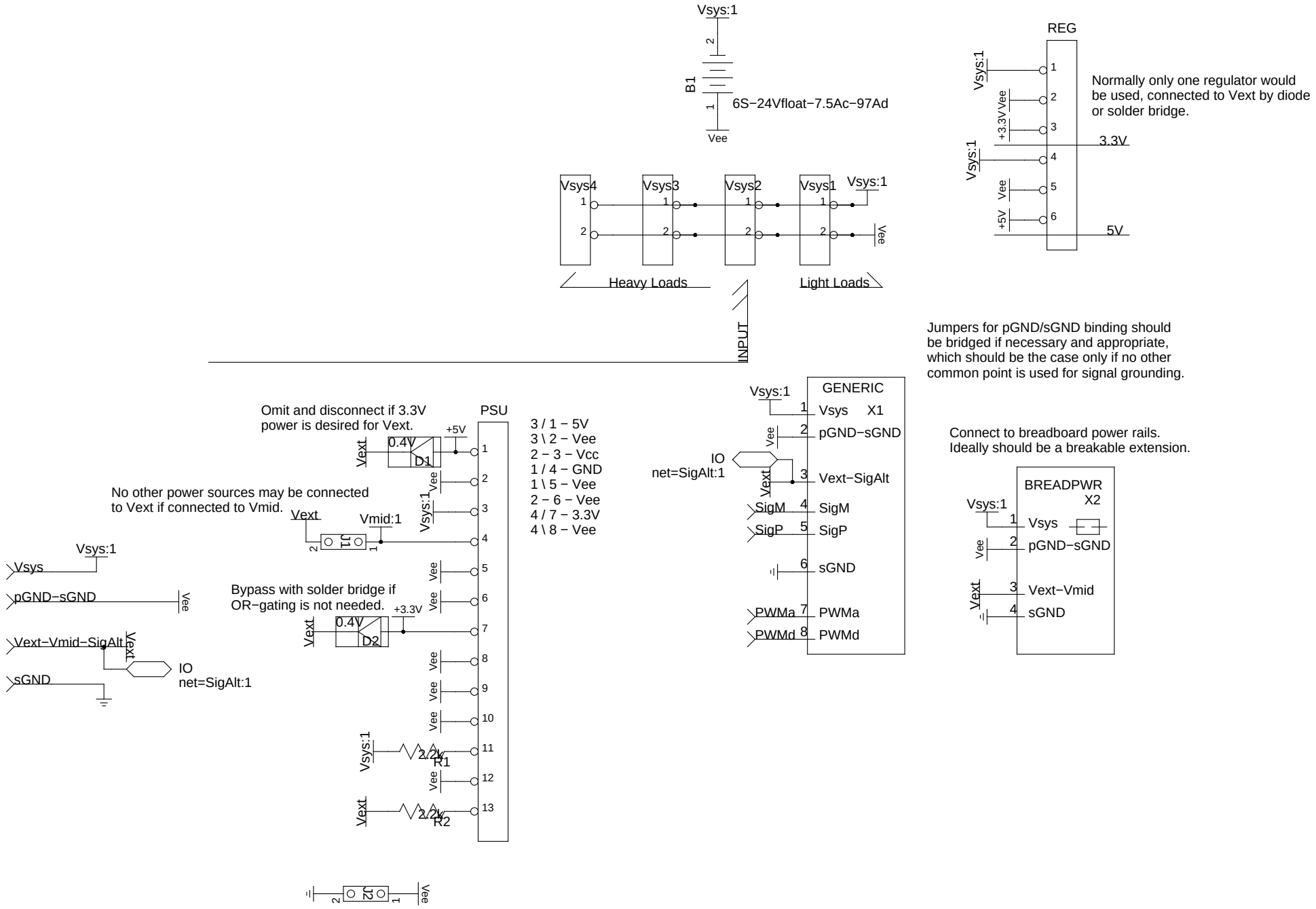
See https://github.com/mirage335/LinearPSU/blob/master/Photo.jpg .

Ratings

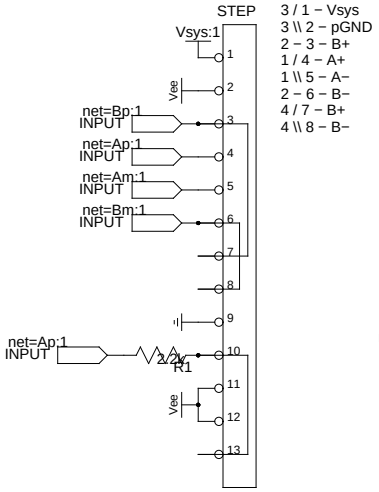
Please beware the following ratings.

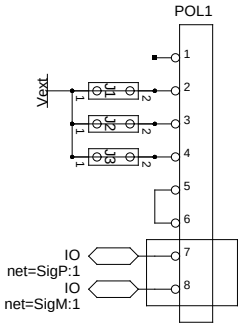
- Vext is intended as logic power, and must never exceed 5.5V. Recommend 3.3V||5V depending on system needs.
- Vext may be used as a diode (eg. CDBU0530) OR-gated power bus if all connected devices can operate at 2.8V-5V.
- Vmid/Avcc are alternate uses for the Vext line, and may exceed 5.5V as appropriate.
- Vsys is intended for high-power delivery, and may be any voltage all attached devices are configured to tolerate. Recommend 12V||24V.
- Ground-referenced voltage (ie. wall current) should only be considered for Vsys. Earth-ground and neutral may be bound to pGND/sGND.
- Maximum current into an RJ45 socket or breadboard is typically around 3A/pin. Consider using high-quality header/jumpers, and redundant pins, as appropriate.
- Voltage drops can be significant, especially across pGND/sGND. Take care to follow star-toplogy grounding to the greatest extent possible when accuracy counts.
- Rough changes to voltages can be made (eg. for fans) by high-power zener diodes (ie. 863-1N5919BG).
- Pins 7/8 of GenericIO may be repurposed for digital I2C/UART if needed, specifically for digital control of stepper driver.

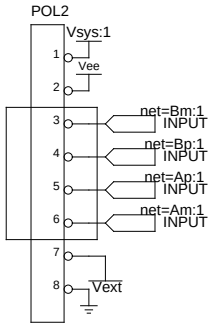

INJECTOR
X1
Vsys:1
1
Vsys
2
pGND−sGND
Vee
IO
net=SigAlt:1
3
Vext−Vmid−SigAlt
Vext
4
sGND
IO net=SigM:1
5
SigM
IO net=SigP:1
6
SigP
IO net=PWMa:1
7
PWMa
IO net=PWMd:1
8
PWMd
cncio
X2
Vsys:1
Vee
1
Vsys
2
pGND
Vext
3
Vext
4
sGND
IO
net=SigP:1
5
SigP
IO
net=SigM:1
6
SigM
IO
net=PWMa:1
7
PWMa
IO
net=PWMd:1
8
PWMd
9
Bp
10
Ap
11
Am
12
Bm
ANALOG
X3
IO
net=SigAlt:1
1
SigAlt−Vext
IO
net=SigP:1
2
SigP
IO
net=SigM:1
3
SigM
4
sGND
IO
net=PWMa:1
5
PWMa
IO
net=PWMd:1
6
PWMd

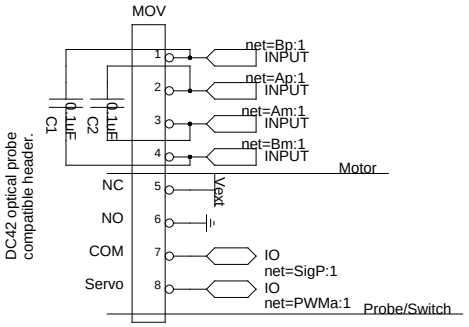

Vsys:1
B1
6S−24Vfloat−7.5Ac−97Ad
Vee
REG
Vsys:1
+3.3V
3.3V
Vee
+5V
5V
Normally only one regulator would be used, connected to Vext by diode or solder bridge.
Vsys4
Vsys3
Vsys2
Vsys1
Heavy Loads
Light Loads
INPUT
Jumpers for pGND/sGND binding should be bridged if necessary and appropriate, which should be the case only if no other common point is used for signal grounding.
Omit and disconnect if 3.3V power is desired for Vext.
PSU
3 / 1 − 5V
3 \ 2 − Vee
2 − 3 − Vcc
1 / 4 − GND
1 \ 5 − Vee
2 − 6 − Vee
4 / 7 − 3.3V
4 \ 8 − Vee
0.4V
D1
D2
Vext
Vmid:1
J1
No other power sources may be connected to Vext if connected to Vmid.
Bypass with solder bridge if OR−gating is not needed.
R1
R2
2.2k
GENERIC
X1
Vsys
pGND−sGND
Vext−SigAlt
SigM
SigP
sGND
PWMa
PWMd
IO
net=SigAlt:1
Connect to breadboard power rails.
Ideally should be a breakable extension.
BREADPWR
X2
Vext−Vmid
J2

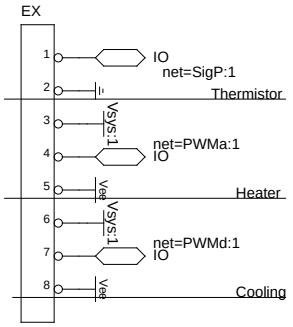

Vsys
Vsys:1
Vext
Vext
pGND
Vee
sGND
SigP
IO
net=SigP:1
SigM
IO
net=SigM:1
net=PWMa:1
PWMa
IO
PWMd
net=PWMd:1
IO
Bp
net=Bp:1
INPUT
Ap
net=Ap:1
INPUT
Am
net=Am:1
INPUT
Bm
net=Bm:1
INPUT

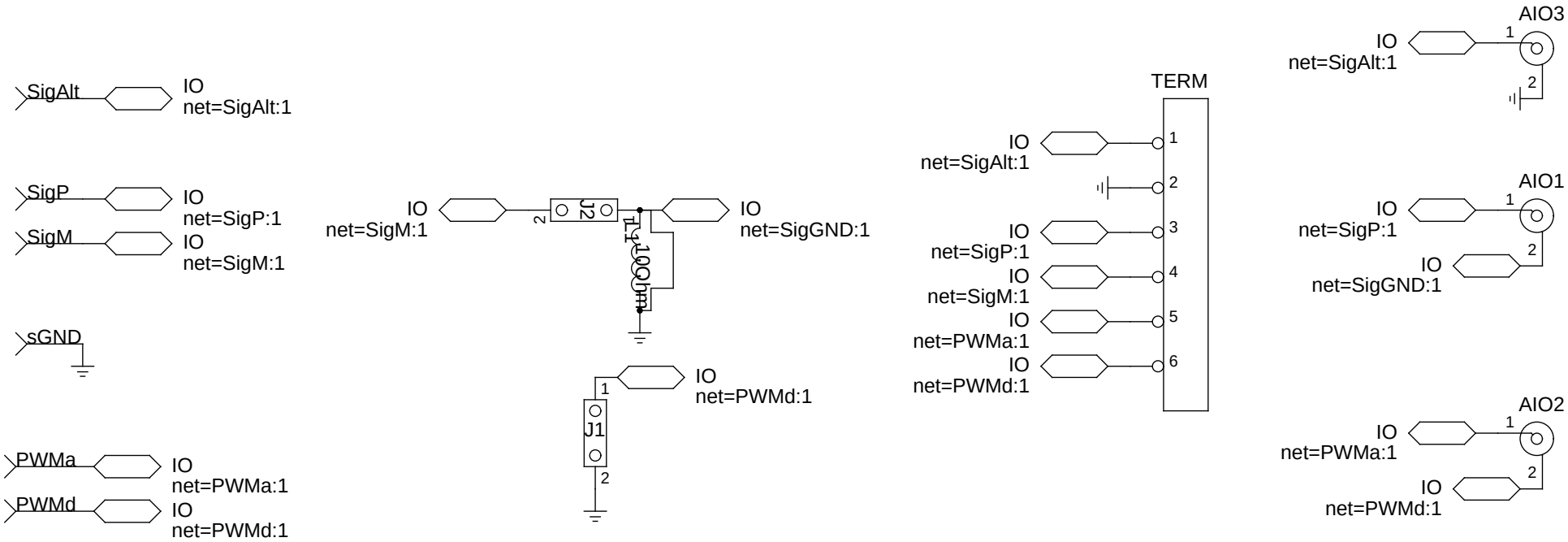

STEP
3 / 1 − Vsys
3 \\ 2 − pGND
2 − 3 − B+
1 / 4 − A+
1 \\ 5 − A−
2 − 6 − B−
4 / 7 − B+
4 \\ 8 − B−
Vsys:1
Vee
net=Bp:1
INPUT
net=Ap:1
INPUT
net=Am:1
INPUT
net=Bm:1
INPUT
net=Ap:1
INPUT
2.2k
R1
Vee


POL1
Vext
1
2
3
4
5
6
7
8
IO
net=SigP:1
IO
net=SigM:1


POL2
Vsys:1
Vee
net=Bm:1
INPUT
net=Bp:1
INPUT
net=Ap:1
INPUT
net=Am:1
INPUT
Vext

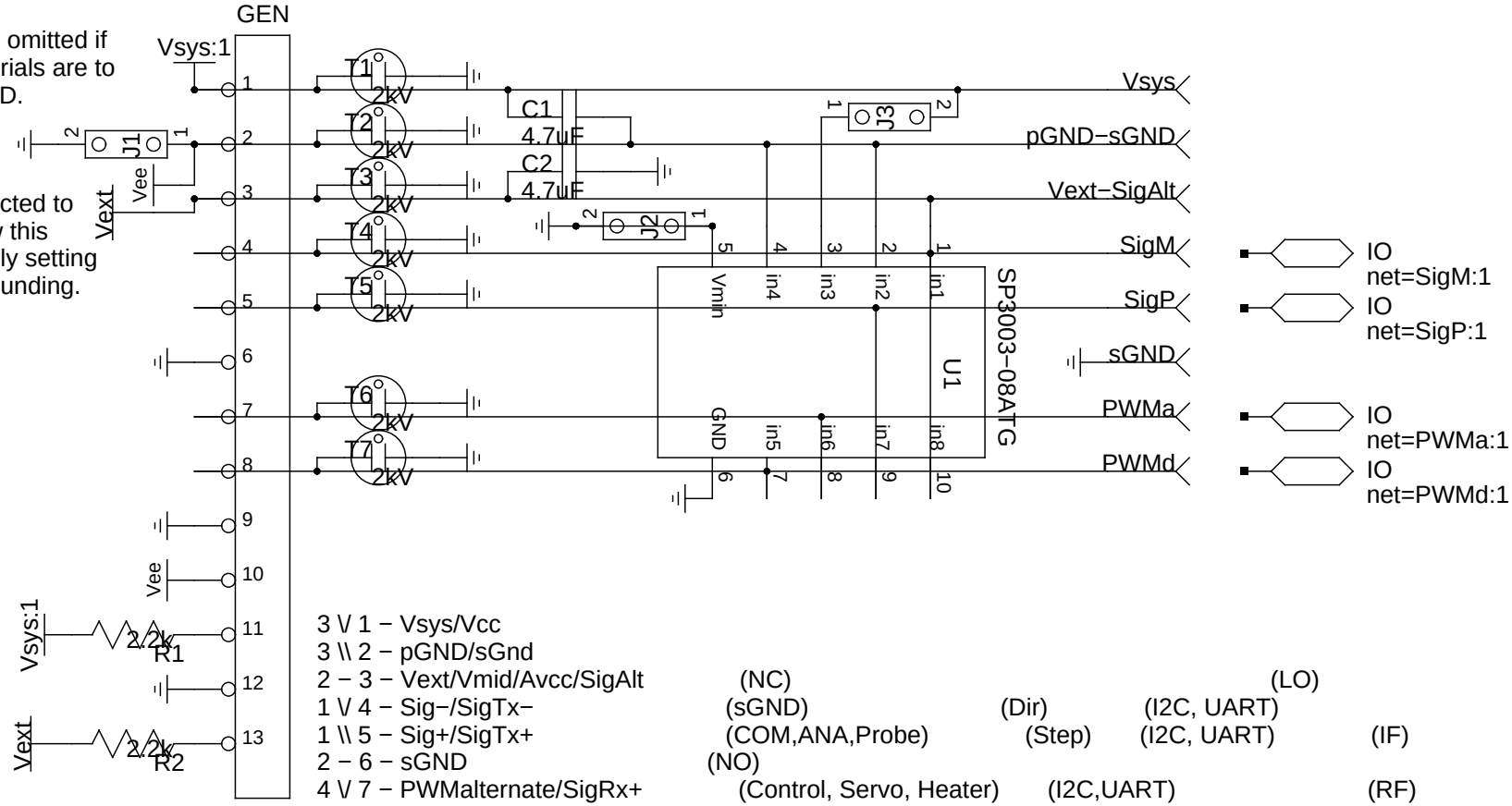

MOV
DC42 optical probe
compatible header.
C1
0.1uF
C2
0.1uF
net=Bp:1
INPUT
net=Ap:1
INPUT
net=Am:1
INPUT
net=Bm:1
INPUT
Motor
NC
NO
COM
Servo
Vext
IO
net=SigP:1
IO
net=PWMa:1
Probe/Switch


EX
IO
net=SigP:1
Thermistor
Vsys:1
net=PWMa:1
IO
Vee
Heater
Vsys:1
net=PWMd:1
IO
Vee
Cooling


SigAlt
IO
net=SigAlt:1
SigP
IO
net=SigP:1
SigM
IO
net=SigM:1
sGND
PWMa
IO
net=PWMa:1
PWMd
IO
net=PWMd:1
IO
net=SigM:1
2
J2
IO
net=SigGND:1
TL1 100Ohm
IO
net=PWMd:1
1
J1
2
TERM
IO
net=SigAlt:1
1
2
IO
net=SigP:1
3
IO
net=SigM:1
4
IO
net=PWMa:1
5
IO
net=PWMd:1
6
AIO3
IO
net=SigAlt:1
1
2
AIO1
IO
net=SigP:1
1
IO
net=SigGND:1
2
AIO2
IO
net=PWMa:1
1
IO
net=PWMd:1
2

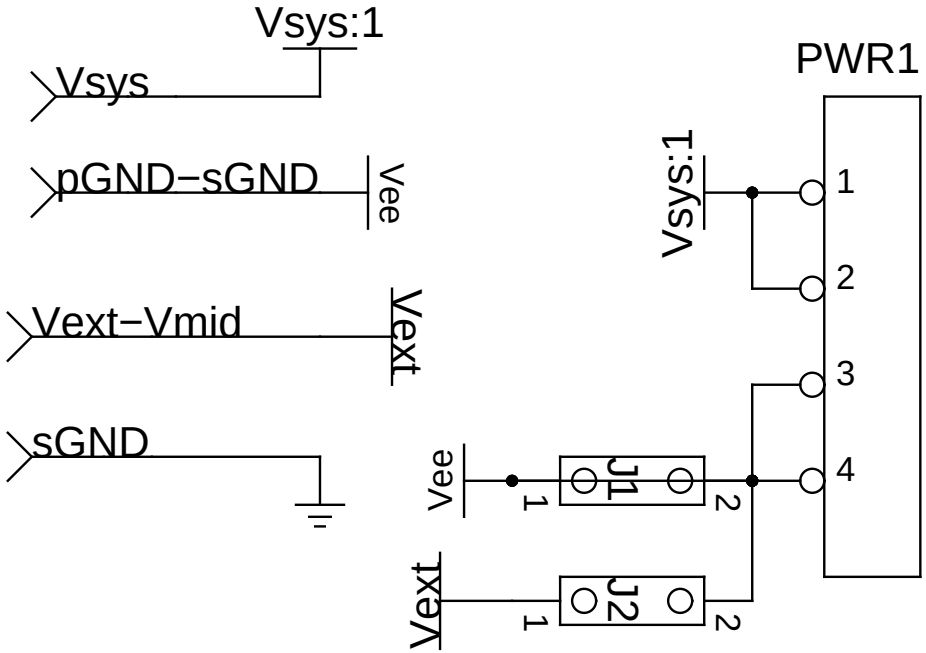
Vext capacitor should be omitted if any downstream peripherials are to sink Vext current to pGND.

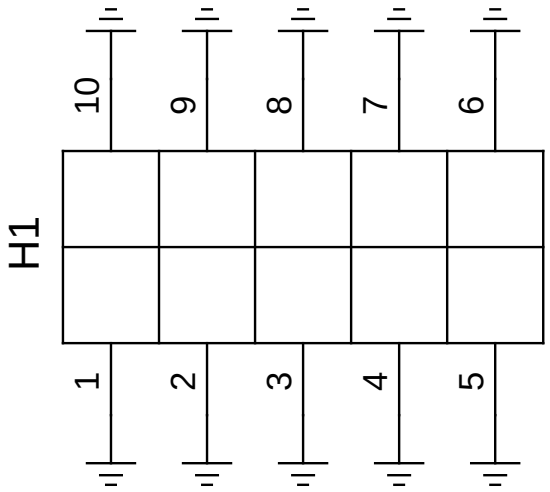
If pGND−sGND is connected to ground, netlists will show this jumper shorted, effectively setting minimum impedance grounding.

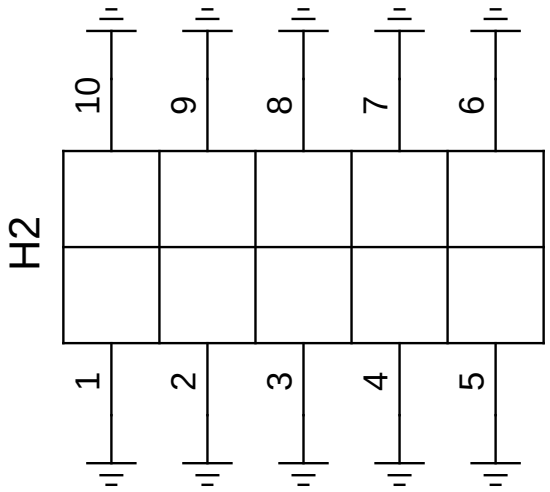


3 \/ 1 − Vsys/Vcc
3 \\ 2 − pGND/sGnd
2 − 3 − Vext/Vmid/Avcc/SigAlt (NC) (LO)
1 \/ 4 − Sig−/SigTx− (sGND) (Dir) (I2C, UART)
1 \\ 5 − Sig+/SigTx+ (COM,ANA,Probe) (Step) (I2C, UART) (IF)
2 − 6 − sGND (NO)
4 \/ 7 − PWMalternate/SigRx+ (Control, Servo, Heater) (I2C,UART) (RF)
4 \\ 8 − PWMdirect/SigRx− (Fan) (I2C,UART)

Connect to breadboard power rails.







Mechanical supports.