Stage 1
Microcontroller

The microcontroller is currently an ESP32-DEVKITC-V4 in this design. But that is suprisingly easy to change out...

The Microcontroller will handle all internet based functionality, including RFID badge swipes from members. The website/database handles authorization, and the microcontroller can act on the web-based asynchronous data, when fetched.

Local Cache data is recommended for the commonly used tools [such as entry doors].

The staff bypass key works here, by always turning on the 'set' relay for mains level.

Some level of transformer is used to power the microcontroller circuit at 5 Volts, but no specific opinion is made here... The 3.3V microcontroller uses it's own LDO, but a 5V version microcontroller would work.

Stage 2
Mains Power

The "Mains" relay has a coil that is activated by 110-240VAC. This is in the style of the past boxes. The relay at the heart of this must be a DPST or DPDT style.

The quintessential circuit design is the classic set/reset self-latching relay. With more than one reset.

If a member is authorized to use a tool, they can press a green button to activate. A green light shows this 'active' state.

If the member finishes with the tool, they can pres a red button to deactivate.

There is an E-stop button for quick access.

The microcontroller can also time-out the tool [perhaps a fixed time after it no longer senses current from the tool being in use].

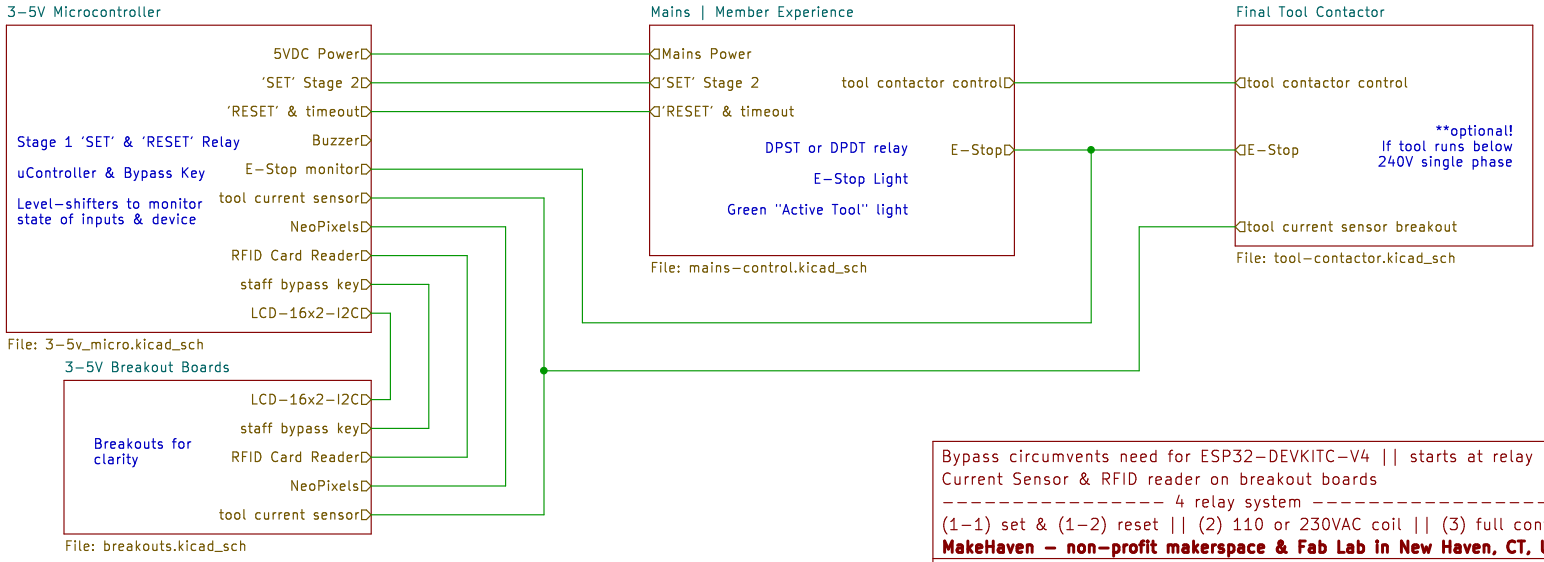
Stage 3
Final Contactor

The final relay is a contactor for the tool itself. This can be any size, and any number of phases. so long as it can be activated by the voltage available from the previous stage.

Strictly speaking, this is not necessary for some of the smaller tools that operate in single phase power at voltages used in stage 2.

The E-Stop acts as a 'reset' in the previous stage, and will cut power to the coil of the final contactor. The E-stop will have a light that comes on then the tool is stopped, so a member can see why a tool does not work (in that scenario).

E-stop monitoring by microcontroller is added with a 2nd NOFF switch on button: [2xN-ON] [2xN-OFF] [1xLED]



EN-000-1520 box 160mmx210mmx100mm 6.30"x8.27"x3.93"
Mount PCB with 4mm screws (holes all drilled to 5mm dia)
http://dsebox.com/eng/02/list.php?b_category1=3

Bypass circumvents need for ESP32-DEVKITC-V4 || starts at relay (1-1)
Current Sensor & RFID reader on breakout boards
---------- 4 relay system ----------
(1-1) set & (1-2) reset || (2) 110 or 230VAC coil || (3) full contactor [1-3 phase]
MakeHaven - non-profit makerspace & Fab Lab in New Haven, CT, USA

Sheet: /
File: makehaven-tools-esp32.kicad_sch

Title: Revised Tool Controller

Size: USLetter	Date: 2022-07	**Rev: v1**
KiCad E.D.A. kicad (6.0.5)		Id: 1/5

Stage 1 || ESP32 contol circuits

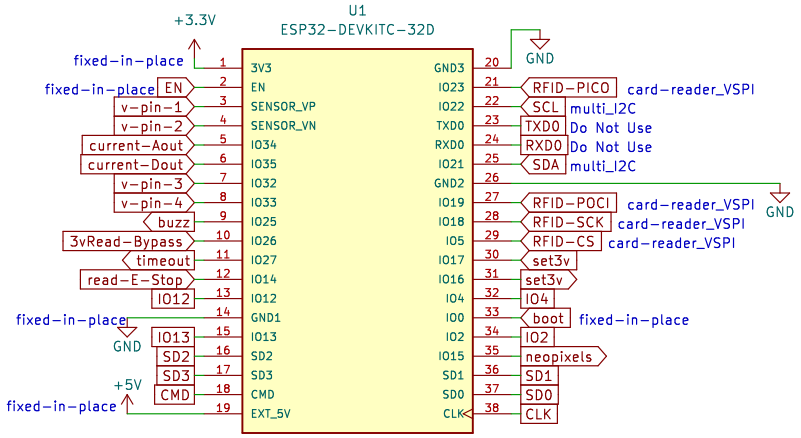
Relay 1–1 [set] and Relay 1–2 [reset] {5v coil activation}

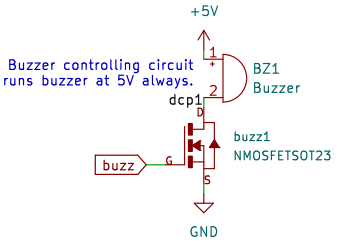
This circuit can switch any tool that doesn't need an E–Stop, without the stage 2 relay.
The 'reset' relay will do the switching, and can switch anything controlled by a single hot phase.

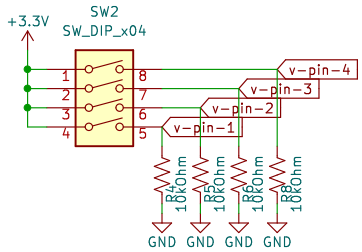
In theory, it should be fairly easy to change this design for any new 3.3–5.0V WiFi device.
All of the circuit segments shown here are independent of the ESP32, except pin assignments.
The Stage 2 circuit is able to run the core function without the ESP32 microcontroller.

Without a microcontroller present, the following circuits are lost:
- –RFID card reader –– cannot process card reads
- –Current sensing –– cannot process current data
- –only Bypass mode is possible to run the tool

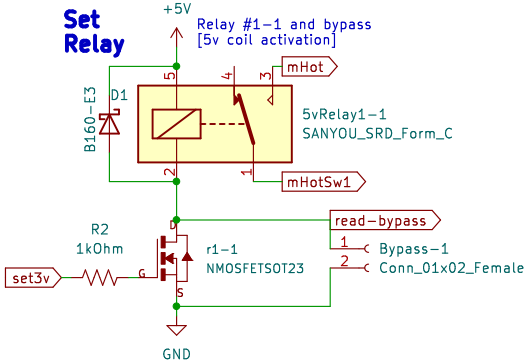
All DEVKITC–V4 pins are broken out in case plans change abruptly...



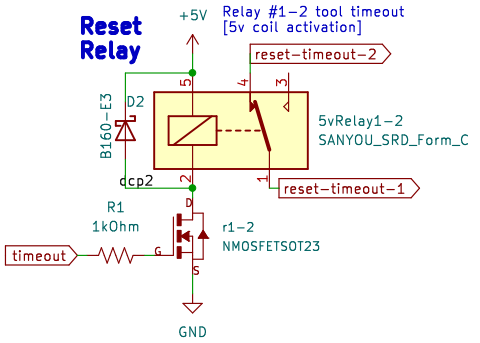


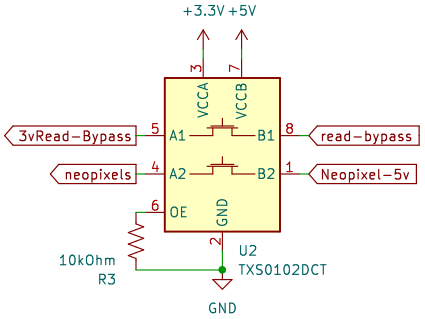


The 'SET' relay allows the tool to be turned on with the additional press of the green button by the human operator. Bypass locks this relay 'ON'

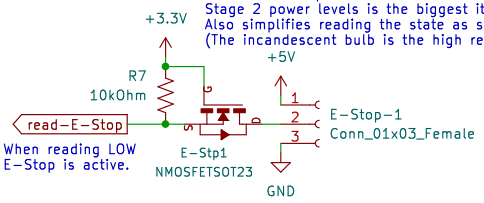


The 'RESET' relay will break the active latch on the Stage 2 relay. This is used as a way to auto shut off the tool – after end of observed current.





Running the E–Stop indicator light at 5V solves several problems. Ambivalence to Stage 2 power levels is the biggest item. Also simplifies reading the state as shown. (The incandescent bulb is the high resistor)



!!! Bypass will allow the 'core' system to work without the microcontroller
All circuit segments shown can be controlled by a 3.3–5V microcontroller
Mainboard is: ESP32–DEVKITC–V4+ [considering: ESP32–WROOM–32UE]
MakeHaven – non–profit makerspace & Fab Lab in New Haven, CT, USA

Sheet: /3–5V Microcontroller/
File: 3–5v_micro.kicad_sch

Title: 3–5V Microcontroller

Size: USLetter	Date: 2022–07	**Rev: v1**
KiCad E.D.A. kicad (6.0.5)		Id: 2/5

Stage 2 || Core Functions run at full 110-230VAC

Relay 2 [main function] {110VAC or 240VAC coil activation}

active self-latching of a relay https://electronics.stackexchange.com/questions/223691/self-latching-relay

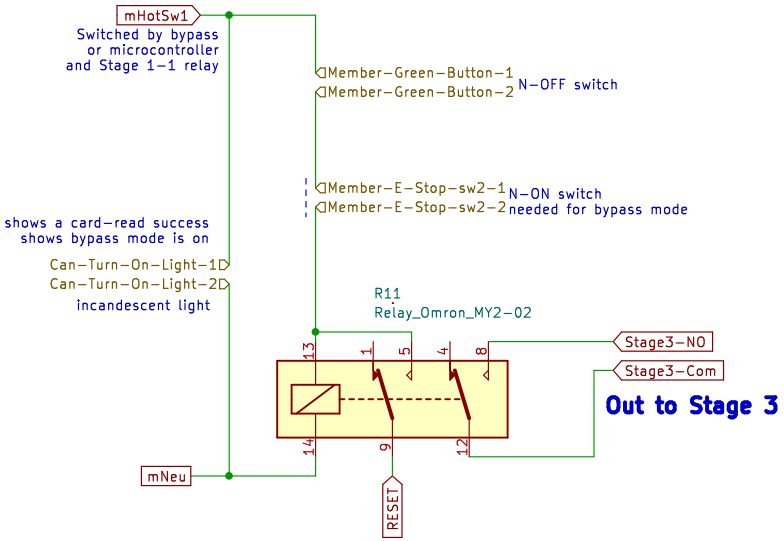
If there is a Stage 3 relay, then Stage 2 relay can have a lowered switching current -> down to approximately 2amps

Provides the majority of the Member's interface experience

The previous Tool-Controller design was almost this section of the circuit (with simpler Microcontroller connection).

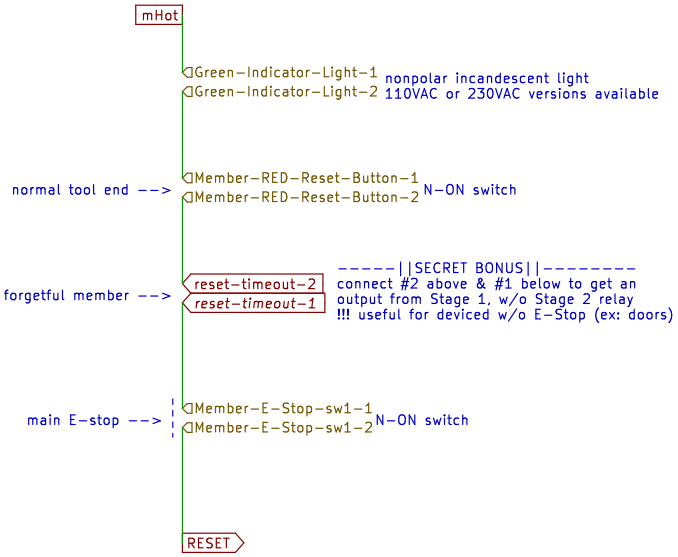
'Set' & 'Latch' circuit on Stage 2 relay

This portion of the circuit allows the Stage 2 Relay to turn on & stay on.
When enabled [by ESP32 or Bypass] a person can turn on the relay with the green button.
Once activated, the link from relay pin 5_to_13 'latch' the relay on while powered, until reset.
The "Can-Turn-On" light will shine if it is possible to 'set' the relay for any reason.
The light is important, because it shows a working system or if bypass mode is enabled by a key.



'Reset' circuit on Stage 2 relay

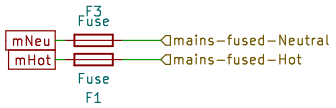
These are all the ways to 'reset' the Stage 2 relay.
[Not including overall loss of power, which also causes reset.]
Normally a member will press the red button. But they may also use the E-Stop to temporarily pause function, or the timeout could trigger automatically if programmed correctly...

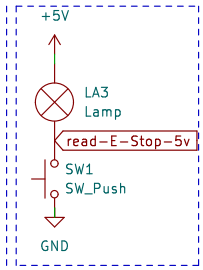


Fuse Protected Power Inputs

Mains power needs connected here, and will power the whole box.
Except, perhaps, the tool. If more exotic power is needed.

Labeled on PCB as H/L1 & N/L2 to cover the bases (that both may be live).





E-Stop on modular, panel-mount button

The E-Stop is connected from a 3-wire header:
>> 5V goes 'above' the incadescent bulb
>> Read goes 'between' E-Stop and switch
>> GND goes 'below' switch

The E-Stop light runs at 5V, and is shown here
becuase it conceptually makes sense on the sheet.

This lamp-to-switch connection is done on the
modular E-Stop switches themselves, not any PCB.

The middle 'read-E-stop' informs the microcontroller.

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Sheet: /Mains | Member Experience/
File: mains-control.kicad_sch

Title:

Size: USLetter	Date: 2022-07	**Rev: v1**
KiCad E.D.A. kicad (6.0.5)		Id: 3/5

Final Contactor & other screw terminal I/O

Relay 3 [120-230V contactor activation]

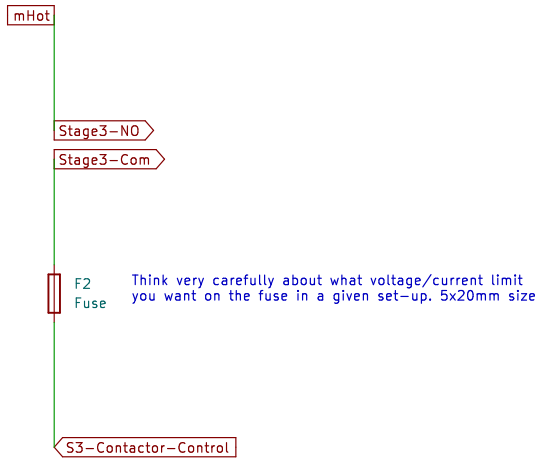
There can be a contactor added here (which is the main intention)

1) The J13-1 and J13-2 screw terminals are the output of the board. These can drive the Stage 3 contactor.
2) This screw terminal can also be the final controls for powering a tool,if that tool runs at the same voltage as Stage 2 and can be switched by a single phase.
3) There is also a 3rd working mode, for any tool (or door) that does not need an E-Stop to function safely. Details noted with the terminal blocks.

Simple Control for Final Contactor

This is the output of the Stage 2 Relay, guarded by a fuse.
This can be used directly to drive the tools or a 3rd Stage.

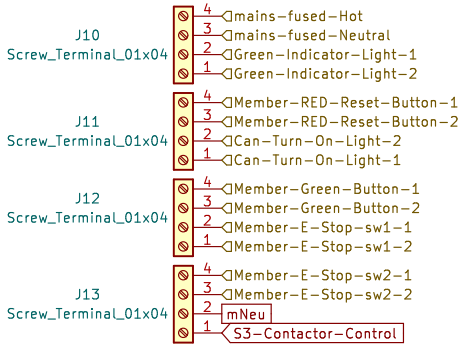
The final contactor must be mounted off-board and can run any voltage or number of phases desired for a tool.
Including Stage 3 is the simplest setup, if not the cheapest.



Screw Terminals for all functions

These screw terminals are broken out for all functions.
The terminals are in pairs, and labeled on the board.

Bonus mode: if you want to use this whole board as a low-current AC "smart switch" you can attach an interrupted 'Hot' line across J12-1 and J11-3.
Just don't exceed the limits of Relay 1-2 in Stage 1.



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Sheet: /Final Tool Contactor/
File: tool-contactor.kicad_sch

Title:

Size: USLetter	Date: 2022-07	**Rev: v1**
KiCad E.D.A. kicad (6.0.5)		Id: 4/5

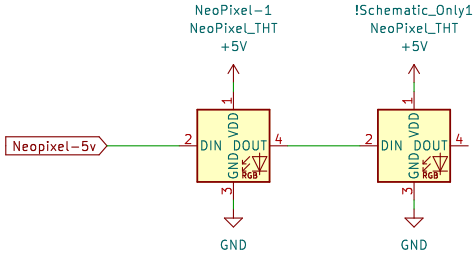
Stage 1 || Breakout Boards

Pin designations for the sundry breakout boards & pins.

These items are all of the ports for the random or 'smart' devices that are attached to the main board for any reason. These serve many purposes, but are all documented here.

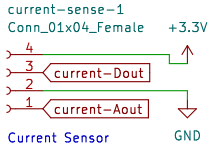
WS2812 NeoPixel Indicator LEDs

Neopixel button PCBs are attached in-line, on wires from 3 pads on main circuit board.
The neopixels are addressable, so you can string together a near-infinite amount.
---> Realistically, you should only include 2 here for a simple use. no more than 5
These designs were intended to be used with a string of the WS2812, but any will work.



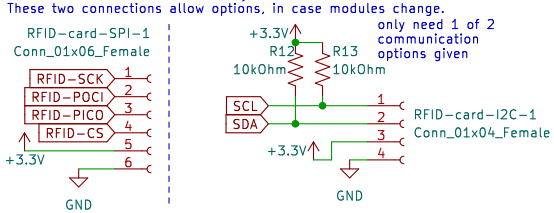
WCS1800 Hall Current Sensor

Indicator that the tool is currently drawing current.
Used to measure tool function & anti-watchdog for timeout.



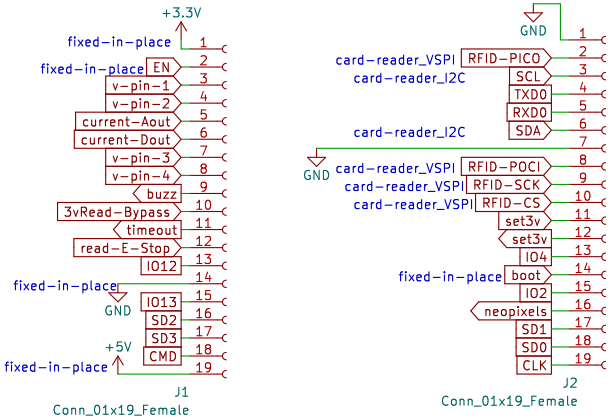
PN532 RFID Card Reader

RFID card reader is run by PN532 chip, which can communicate
in two modes: I2C or SPI and only one is needed at a time.
These two connections allow options, in case modules change.



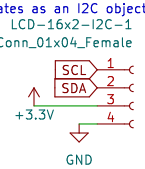
Headers for easy access to all of the ESP32 Pins

All of the connections are broken out to secondary pins, so they can be accessed fairly easily. This will probably not be needed in normal operation, but it definitely helps to diagnose hardware problems or give easy access to the happy matter-hackers that live in our space :)



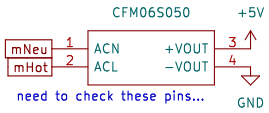
16x2 LCD w/ I2C Backpack

A small screen to show some bacis information as feedback.
Can also show reservations and other things as desired.
Communicates as an I2C object and may be 2nd item on bus.



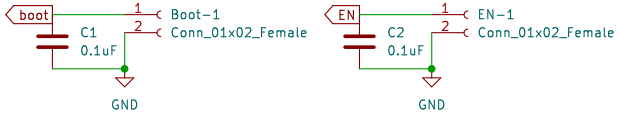
5V supply from mains (in box)

Sealed switching power supply, soldered in place.
Can accept 90-264VAC to generate 5V, up to 6W.
100mV ripple and 78% efficient, by datasheet.



Programming Buttons for ESP32

access to small buttons outside of case
[just for easy reprogramming of ESP32]



Sheet: /3-5V Breakout Boards/		
File: breakouts.kicad_sch		
Title:		
Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad (6.0.5)		Id: 5/5