

OpenShop Hardware | Overview

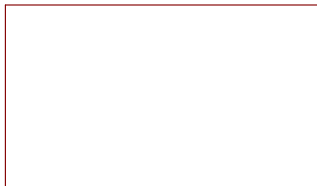
This 'OpenShop' device is intended to help simplify the process of setting up and managing tool authorization control, in a shared workshop environment. Specifically, this is designed for use at MakeHaven, in New Haven, Connecticut, USA from a previous solution. The circuit board shown here includes a place for an ESP32-DEVKITC-V4+ microcontroller (with wifi) to sit into place, and manage the functions of the board and ultimately control access to power a tool. However, through experience, MakeHaven knows it is also important to have a completely analog work-around to enable tools when the network-based system goes down. For that reason, the tool can be granted unfiltered access with a bypass key, and this works regardless of the microcontroller, even if the microcontroller is completely absent.

This schematic is broken into several pages to better clarify the circuit surrounding each of the components. Global Labels have been heavily used to show connections that span across sections and pages. Some of the components are shown for reference to be used with the circuit board, but are not themselves on the circuit board design.

Microcontroller

This section of the schematic covers everything that happens at 3.3VDC or 5VDC, including the microcontroller, peripherals, and some of the simple circuits needed to support the operation of the device while in full operation. Power for this section of the circuit is provided by a sealed switching transformer soldered onto the board. The one other crossover circuit is the bypass switch, which operates on a 5VDC circuit, but activates a relay that enables the entirety of the mains level control.

microcontroller

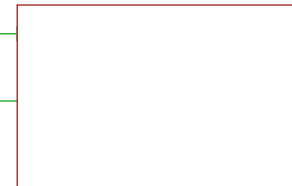


File: microcontroller.kicad_sch

Mains Level Control

This section of the schematic covers everything that happens at the AC power level, and this can be at anywhere from 100VAC to 240VAC, provided the correct configuration. There is only a single relay that needs changed to cover this range, and all the other components in this section are tolerant of this span of voltages. The things included here are all the panel-mount buttons, relays and Emergency Stops that ensure the ToolAuth system can function safely in a workshop.

mainslevelcontrol



File: mainslevelcontrol.kicad_sch

Based Around ESP32-DEVKITC-V4+ board

Highest Level Overview

Corey Rice & MakeHaven

Sheet: /

File: mh-custom-v1.3.kicad_sch

Title: ToolAuth Hardware | Overview | ESP32-DEVKITC-V4

Size: USLetter | Date: 2022-10-09

KiCad E.D.A. kicad (6.0.10)

Rev: 3

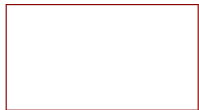
Id: 1/10

Microcontroller Overview

This shows the relationships between all components running at 3.3VDC or 5VDC on the board. These are all on the ‘low voltage’ side of the board. These are all united in their service to the ESP32–DEVKITC–V4+ board, but that board itself is removable (for ease of programming and switching out the controller, without needing to rewire the tools).

ESP32 Core

esp32core



File: esp32core.kicad_sch

This shows a component to represent the ESP32–DEVKITC–V4+ board, as it will be seated in place. However, the component itself is not included on the circuit board, instead seating into some breakout headers for easy replacement. This page is for reference only, not design.

ADE7953

ade7953



File: ade7953.kicad_sch

The ADE7953 is a high accuracy current, voltage and power measurement chip that communicates with the ESP32 via I2C. There are three 3.1mm audio jacks to enable connecting CT split–ring clamp sensors. These CT sensors can be clamped around the wires that run power to the tool, to monitor the current and voltage draw throughout use. Additionally, there are a number of jumpers that can be soldered to modify the filtering circuits if necessary.

Breakout Board Connections

breakoutboards



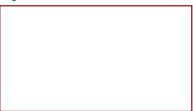
File: breakoutbaords.kicad_sch

These are the connections for I2C, SPI, and the ESP32 headers. There is also a 3.3V linear regulator to power these daughter boards, without placing more draw on the ESP32’s onboard linear regulator (this includes powering the ADE7953).

There is also a USB plug to provide access to 5VDC – this is primarily available so a panel mount USB power port can be added. MakeHaven can foresee wanting to add an external ESP32 to control an E–Paper display, and this USB port could provide easy access to power.

Lights, Sounds & Buttons

lightsounds



File: lightsounds.kicad_sch

This is a collection of the simple circuits that translate between voltage levels, break out the programming buttons for the ESP32, describe the DIP switches for configuration self–description, control the buzzer, and control the indicator LEDs. Many of these circuits use the 3.3V from the ESP32’s onboard regulator.

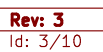
Corey Rice & MakeHaven

Sheet: /microcontroller/
File: microcontroller.kicad_sch

Title:

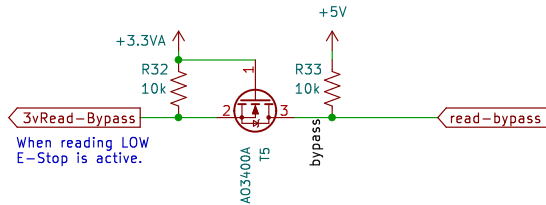
Size: USLetter Date: 2022–10–09
KiCad E.D.A. kicad (6.0.10)

Rev: 3
Id: 2/10



Read the Bypass Key

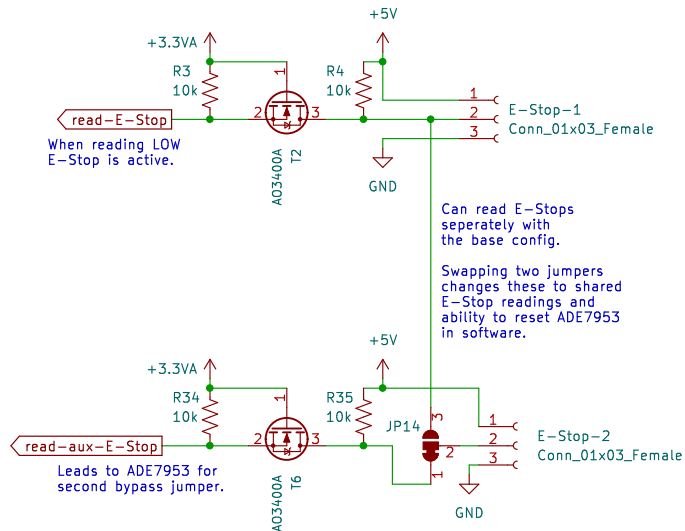
To have a quick, hardware workaround a bypass locking key is implemented in the 'set' stage 1 relay. This allows the ESP32 to read the state of that key to see if the system is in bypass mode.



Read the E-Stop

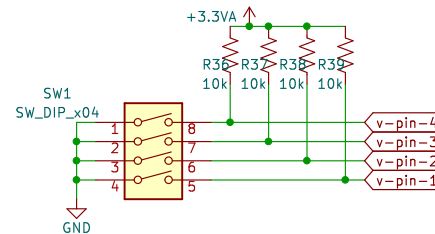
An E-Stop is an essential Safety Measure in any workshop. This is a secondary switch on the E-Stop assembly (totaling 3 switches and an LED in the standard config). This circuit allows the ESP32 to read the state of the E-Stop.

! A second E-Stop low voltage circuit can be put in ! parallel on one JST if an Auxiliary E-Stop in use. !



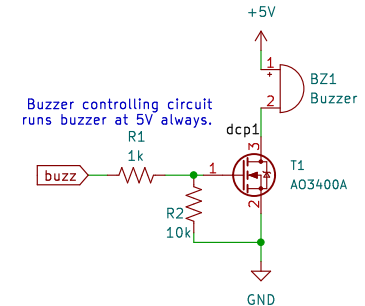
4-DIP Switches

Using a few 'spare' pins, we can read the state of 4 dip switches to get feedback in software about the board configuration (that we assume is correct) ! see Docs for how to set switches !



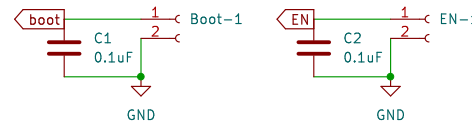
Piezo Buzzer Audio Feedback

A small piezo buzzer is loud enough to provide some auditory feedback through the toolauth box.



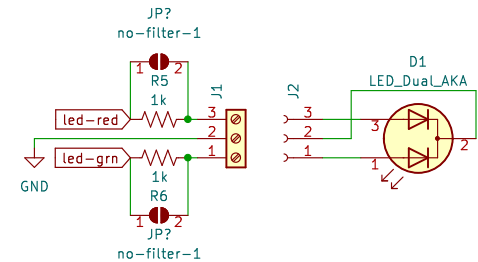
Programming Buttons for ESP32

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



Panel Mount Status LED

A single panel mounted Red/Green LED will indicate states of the system for every card read. These LEDs are cheap and relatively easy to find in pre-made panel mount packages.



Breakout connections for the EN & Boot pins, for possible panel mount DIP switches to describe hardware state
Logic Level shifters to read states of E-Stop(s) and Bypass Key
Buzzer and Panel Mount LED for Audio feedback to user

Corey Rice & MakeHaven

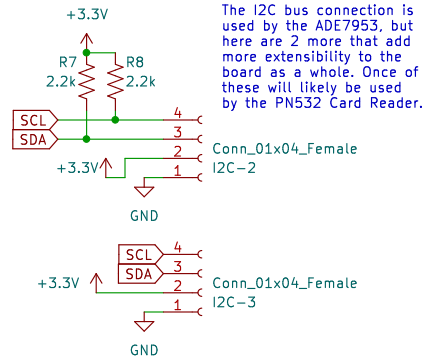
Sheet: /microcontroller/lightsounds/
File: lightsounds.kicad_sch

Title: Onboard Lights, Sounds and Logic Level Converters

Size: USLetter Date: 2022-10-09
KiCad E.D.A. kicad (6.0.10)

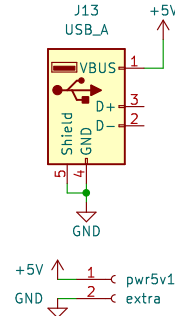
Rev: 3
Id: 4/10

Dual I2C Connections



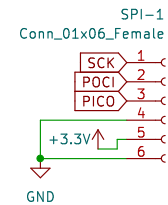
Power-only USB out

For ePaper or other 5V daughter boards that don't need data.



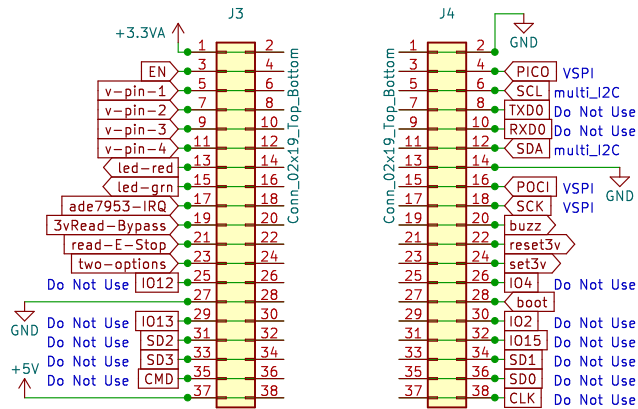
Single SPI Bus

There are only enough pins to configure a single SPI connection by pulling the 'chip select' to GND with all the other pins needed on the board. For this reason, choose your SPI friends wisely.



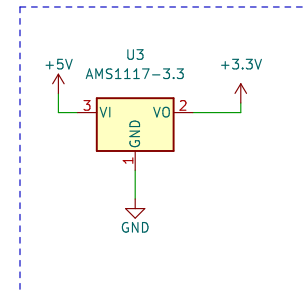
Headers for easy access to all of the ESP32 Pins

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 :)



Linear Regulator

Power demands on the ESP32 can be handled by its own linear regulator. This one is added to handle all breakouts, including the ADE7953, in hopes that the draw of the microcontroller is isolated from these.



A separate Linear Regulator to better supply 3.3VDC where needed
Headers for the ESP32 to seat into the board
Breakouts for I2C and SPI communication with external boards.

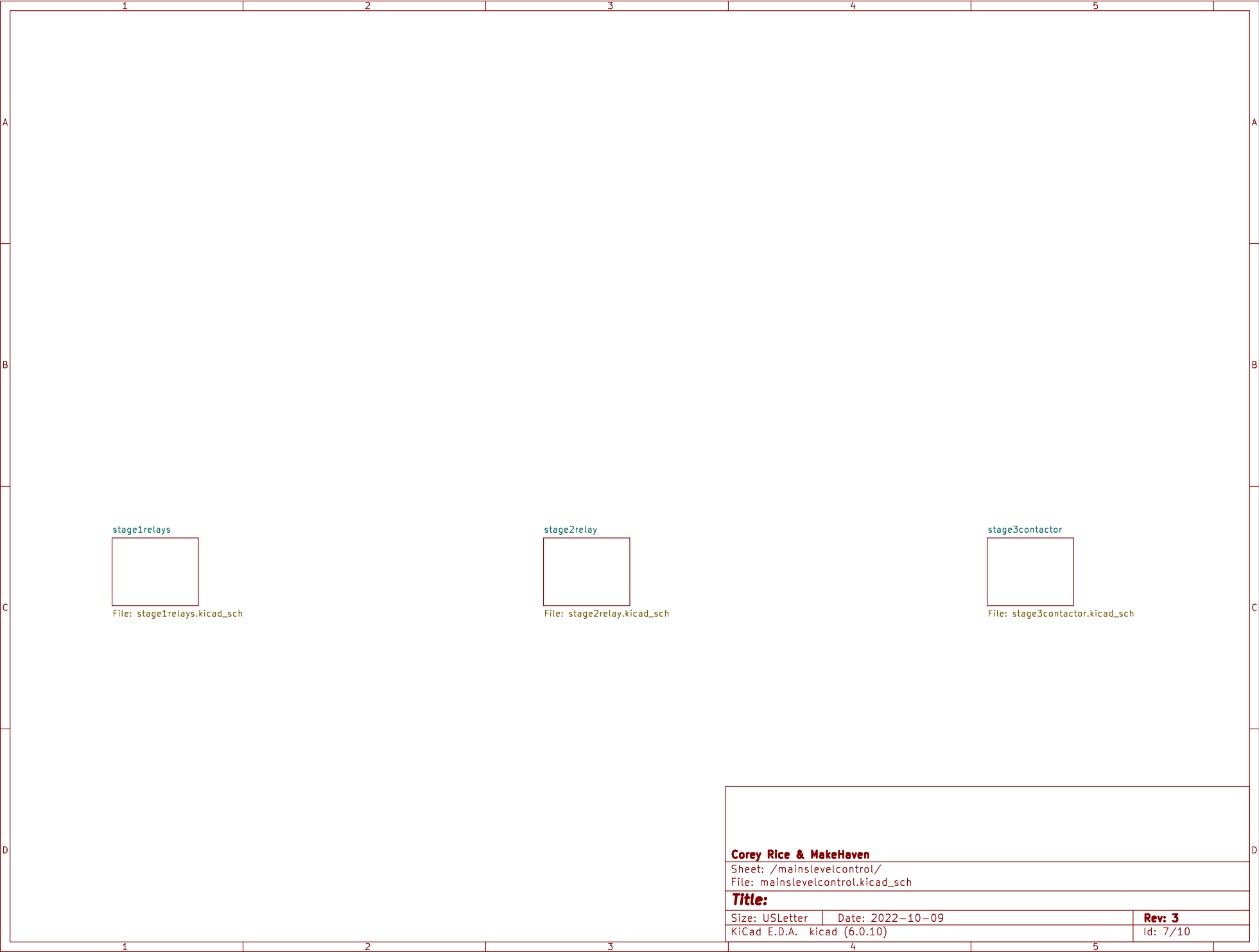
Corey Rice & MakeHaven

Sheet: /microcontroller/breakoutboards/
File: breakoutboards.kicad_sch

Title: Breakout Connections & Power

Size: USLetter Date: 2022-10-09
KiCad E.D.A. kicad (6.0.10)

Rev: 3
Id: 5/10

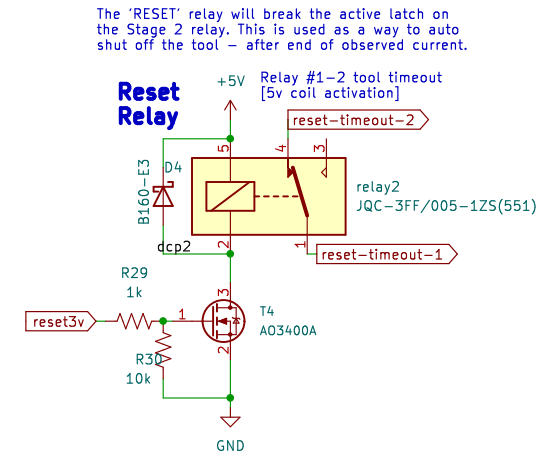
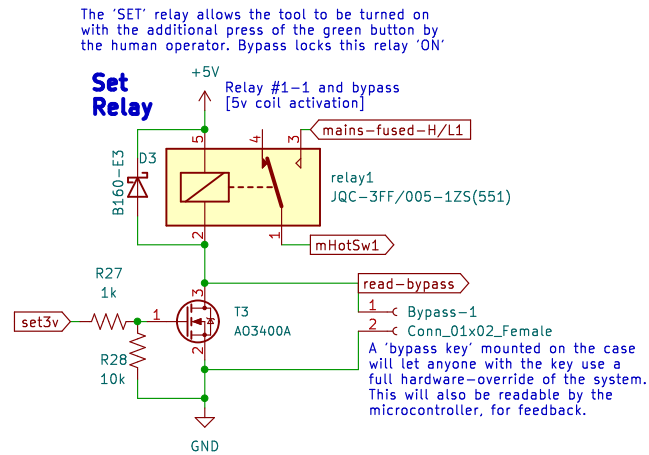


Stage 1 || Control from 5V & 'set' or 'reset' Stage 2 Latch

Relay1 [NOFF 'set' the Stage 2 relay's Latch] {5VDC coil activation}
Relay2 [NON 'reset' the Stage 2 relay's Latch] {5VDC coil activation}

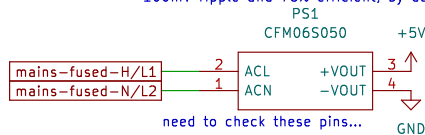
active self-latching of a relay <https://electronics.stackexchange.com/questions/223691/self-latching-relay>

This stage is responsible for allowing the microcontroller to control the actions of the mains level of power switching.

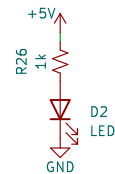


5V supply from mains (In box)

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



sanity check power LED



A 'sanity check' LED is included to see that 5VDC is functioning
Mains voltage is converted to 5VDC for the microcontroller and more
Twin Stage 1 relays 'set' and 'reset' the Stage 2 latching relay

Corey Rice & MakeHaven

Sheet: /mainslevelcontrol/stage1relays/
File: stage1relays.kicad_sch

Title:

Size: USLetter Date: 2022-10-09
KiCad E.D.A. kicad (6.0.10)

Rev: 3
Id: 8/10

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>

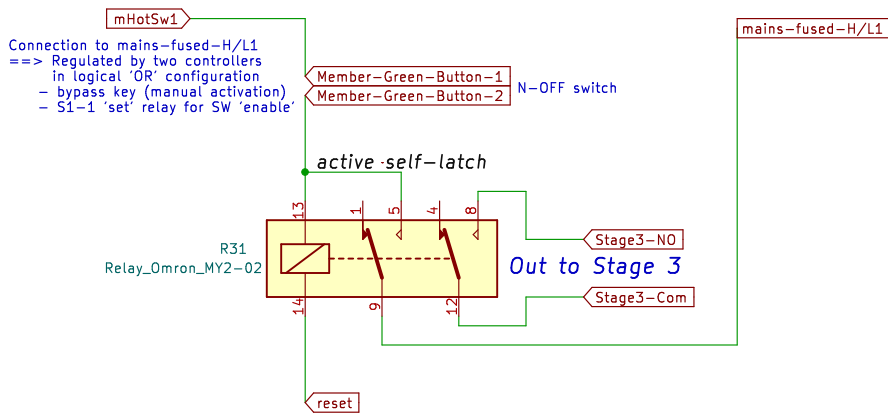
If there is a Stage 3 relay, then Stage 2 relay can have a lowered switching current -> down to approximately 2amps

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).

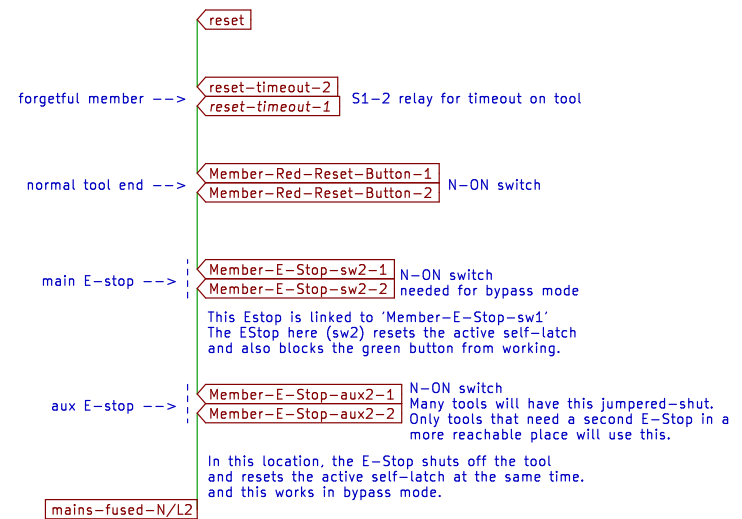
'Set' & 'Latch' circuit on Stage 2 relay

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

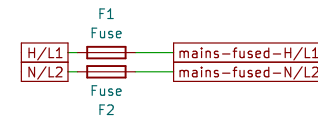
These are all the ways to 'reset' the Stage 2 relay. [Not including overall loss of power, which also causes reset.] Normally a member will press the red button. But they may also use the E-Stop to temporarily pause function, or the timeout could trigger automatically if programmed correctly...



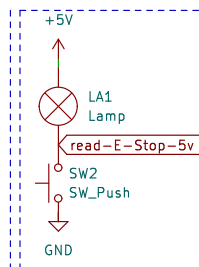
Fuse Protected Power Inputs

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 incandescent bulb
>> Read goes 'between' E-Stop and switch
>> GND goes 'below' switch

The E-Stop light runs at 5V, and is shown here because 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.

E-Stop low voltage light & switch logic shown for reference
Fuses added to power inputs, to protect board from improper wiring
Can be interrupted by E-Stops or the S1/'reset' relay
Once activated, relay holds itself open with power

Corey Rice & MakeHaven

Sheet: /mainslevelcontrol/stage2relay/
File: stage2relay.kicad_sch

Title: Stage 2 | Core 'Active Self-Latching' relay

Size: USLetter Date: 2022-10-09

KiCad E.D.A. kicad (6.0.10)

Rev: 3

Id: 9/10

Stage 3 || Final Contactor & Screw Terminals

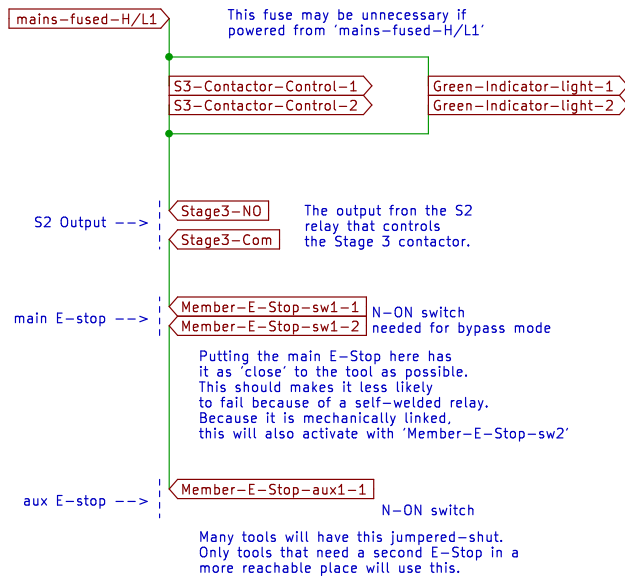
Output to control the Contactor, and a light to show the state.

Control for Final Contactor

With a separate connection, in parallel to everything else, this will power the stage 3 contactor. A green indicator light is used to show the state of power.

The primary E-Stop (sw1) works on this line, to directly cut power to the contactor and by extension the tool. This is mechanically activated at the same time as the sw2 Estop (on page 9) that resets the active latch held on the S2 relay.

The auxiliary EStop is also here to ensure it can directly turn-off the tool, and the firmware will reset the S2 relay's active self-latch.



Use this board as Active and Passive door controller

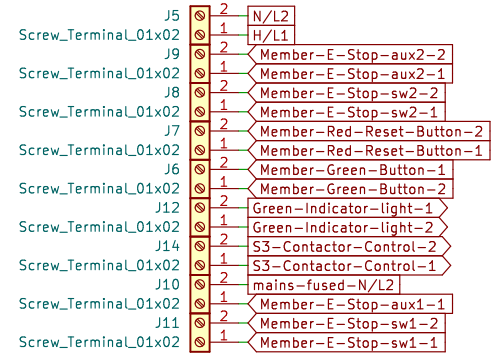
Active Door Control [such as to power a solenoid activation directly]
***** Used nearly as intended as a tool, follow most labels
***** SW: requires 'set' and 'reset' relays to open/close door
--> Jumper shut as labeled: G.btn, R.btn, [both]EStpA, [both]EStpB
--> Use G.light as normal to indicate when door is open-able
--> Connect solenoid across OUT screw terminals

Passive Door Control [when contact between wires is all that is needed]
***** Includes Green Light for open-able indication (optional)
***** Needs S2 relay installed for the correct voltage
***** SW: requires 'set' and 'reset' relays to open/close door
--> Jumper shut as labeled: R.btn, [top/ starred on bottom] EStpA, EStpB
--> DO NOT connect in any way: G.light, [bottom/ unstarred] EStpA, EStpB
--> Attach the green indicator light in screw terminals labeled: G.btn to show when the door is open-able
**A light or jumper MUST be installed across G.btn terminals
**Revert to jumper if LED Green light blocks operation of S2 relay (or a parallel reverse-bias diode may allow LED light use)
--> Connect door-activation wires as labeled on back of board pins labeled with '*DOOR' [bottom] EStpA & [top] OUT

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.



Jumper the EStp3 if there will not be any secondary EStop used
Screw-terminals shown here, to connect to mains-level devices
A fuse is added to protect the board from improper wiring
The contactor actually controls the tool, and is activated from J12 (or J11).

Corey Rice & MakeHaven

Sheet: /mainslevelcontrol/stage3contactor/
File: stage3contactor.kicad_sch

Title: Stage 3 | Contactor to power the Tool

Size: USLetter Date: 2022-10-29
KiCad E.D.A. kicad (6.0.10)

Rev: 3
Id: 10/10