UCI FSAE EV:
The Latchboard

Luv Kumar

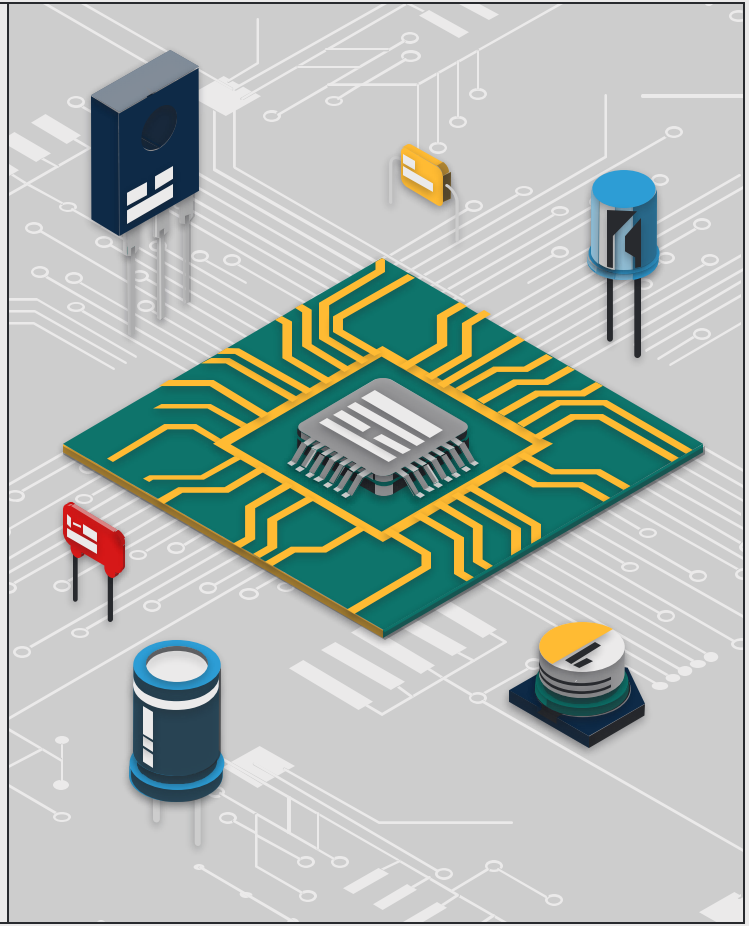


Table of contents

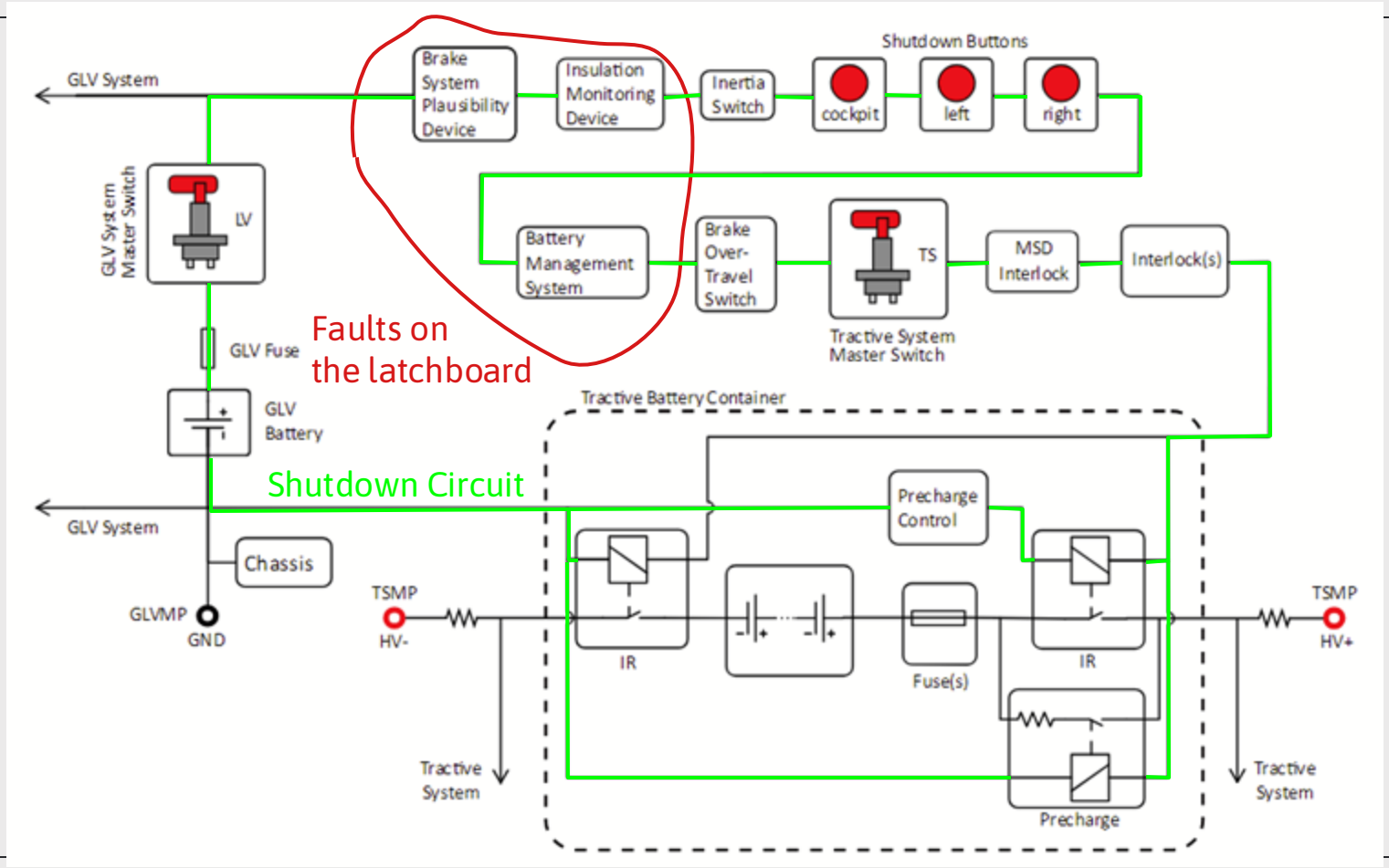
01

Purpose

What does the latchboard do?

Latchboard Overview

- Shutdown Circuit
  - Circuit to shut down the Tractive System
    - When it is broken, Isolation Relays open and Tractive System shuts off
- Latchboard is part of Shutdown Circuit
- Shutdown Circuit goes through relays on the latchboard
- When a fault occurs, the respective relay opens and the Shutdown Circuit opens
- Latchboard has switches to reset relays and close Shutdown Circuit again


GLV System
Brake System Plausibility Device
Insulation Monitoring Device
Inertia Switch
Shutdown Buttons
cockpit
left
right
GLV System Master Switch
LV
Battery Management System
Brake Over-Travel Switch
TS
Tractive System Master Switch
MSD Interlock
Interlock(s)
Faults on the latchboard
GLV Fuse
GLV Battery
Tractive Battery Container
Shutdown Circuit
Precharge Control
GLV System
Chassis
GLVMP
GND
TSMP
HV-
IR
Fuse(s)
IR
TSMP
HV+
Tractive System
Precharge
Tractive System

Latchboard in the Rules

EV.7.2.3 When the BMS, IMD or BSPD Open the Shutdown Circuit:

a. The Tractive System must stay disabled until manually reset

b. The Tractive System must be reset only by manual action of a person directly at the vehicle

c. The driver must not be able to reactivate the Tractive System from inside the vehicle

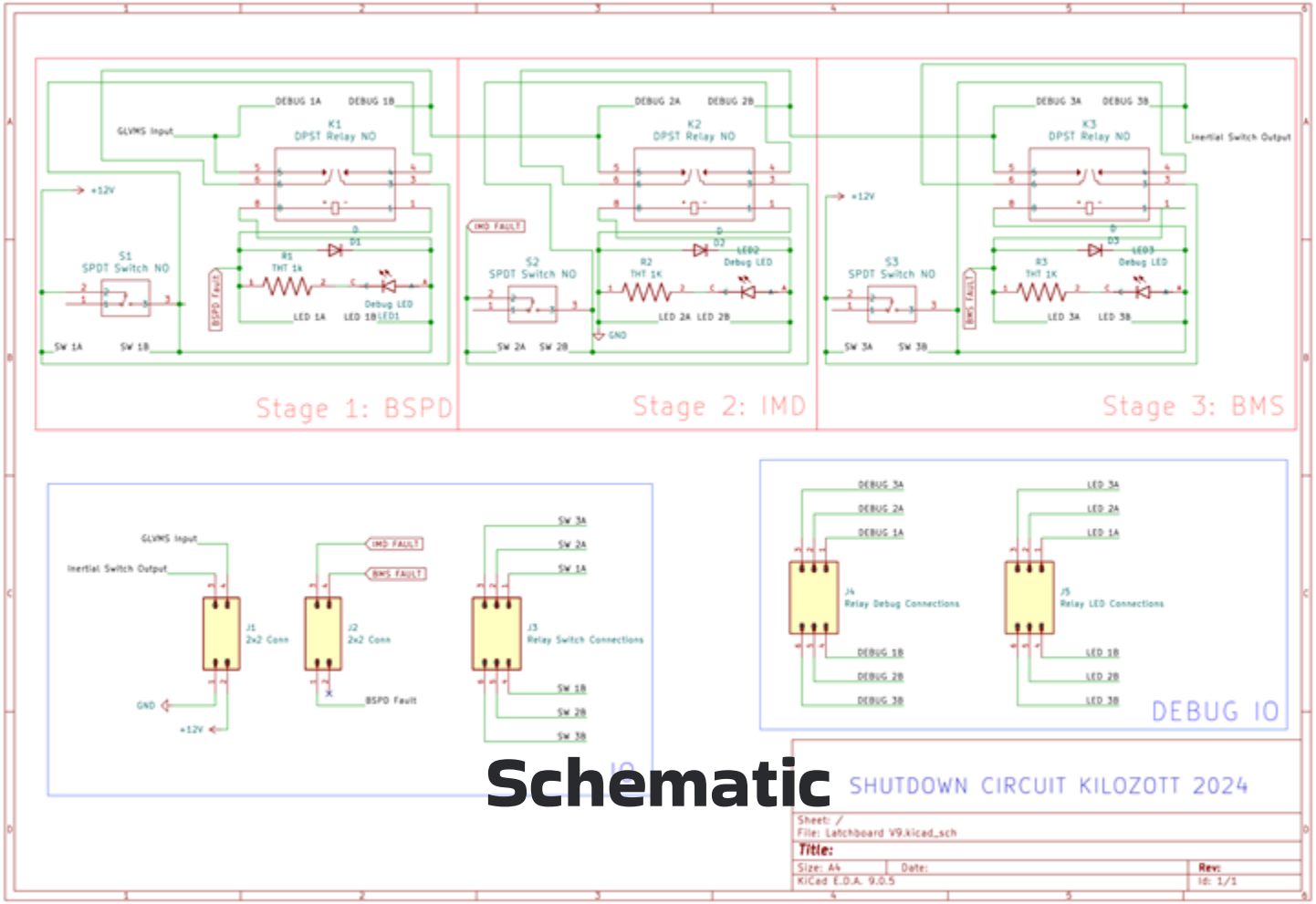
d. Operation of the Shutdown Buttons or TSMS must not let the Shutdown Circuit Close

- Latchboard has circuits to keep relays open when BMS, IMD, or BSPD faults trigger, as well as switches that can be used to reset the relays to make them close again

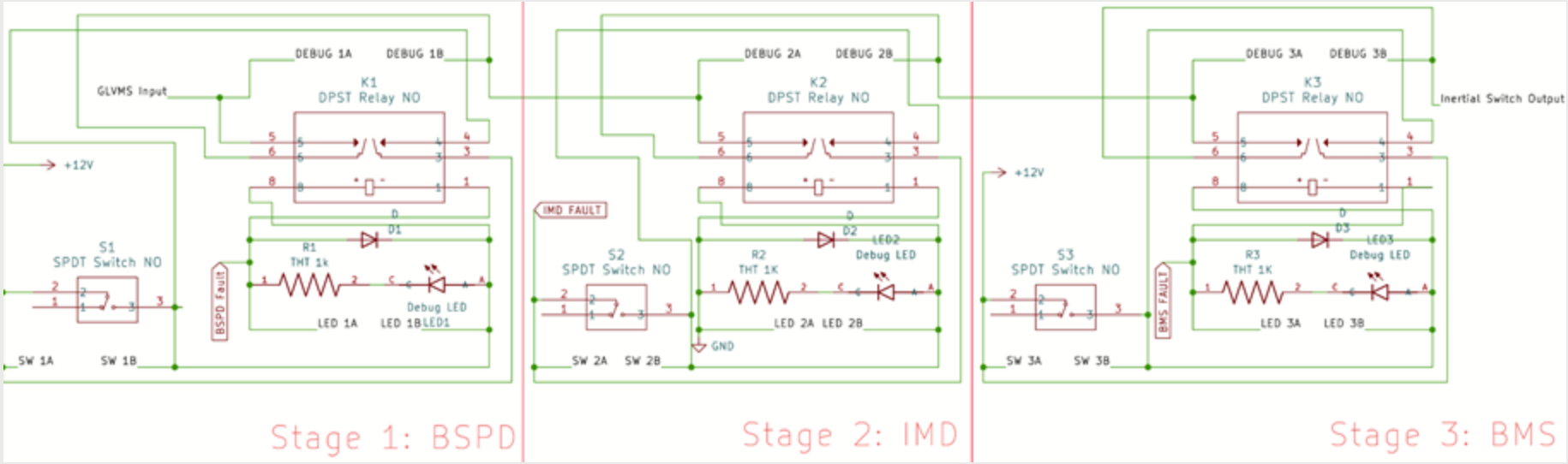
02

Schematic

How the latchboard do what it does?


Stage 1: BSPD
Stage 2: IMD
Stage 3: BMS
DEBUG IO
SHUTDOWN CIRCUIT KILOZOTT 2024
Sheet: /
File: Latchboard V9.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 9.0.5
Id: 1/1

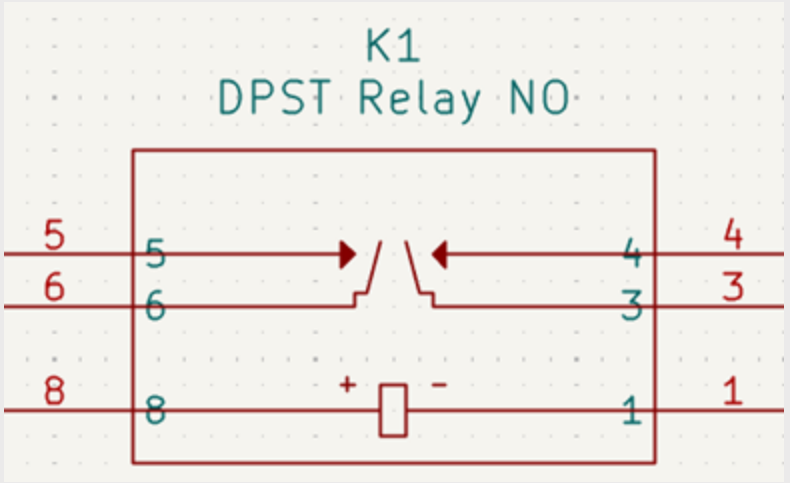
Schematic


DEBUG 1A
DEBUG 1B
GLVMS Input
K1
DPST Relay NO
+12V
S1
SPDT Switch NO
BSPD Fault
R1
THT 1k
D1
Debug LED
LED 1A
LED 1B
LED1
SW 1A
SW 1B
Stage 1: BSPD
DEBUG 2A
DEBUG 2B
K2
DPST Relay NO
IMD FAULT
S2
SPDT Switch NO
R2
THT 1K
D2
LED2
Debug LED
LED 2A
LED 2B
GND
SW 2A
SW 2B
Stage 2: IMD
DEBUG 3A
DEBUG 3B
K3
DPST Relay NO
Inertial Switch Output
+12V
S3
SPDT Switch NO
BMS FAULT
R3
THT 1K
D3
LED3
Debug LED
LED 3A
LED 3B
SW 3A
SW 3B
Stage 3: BMS

Schematic

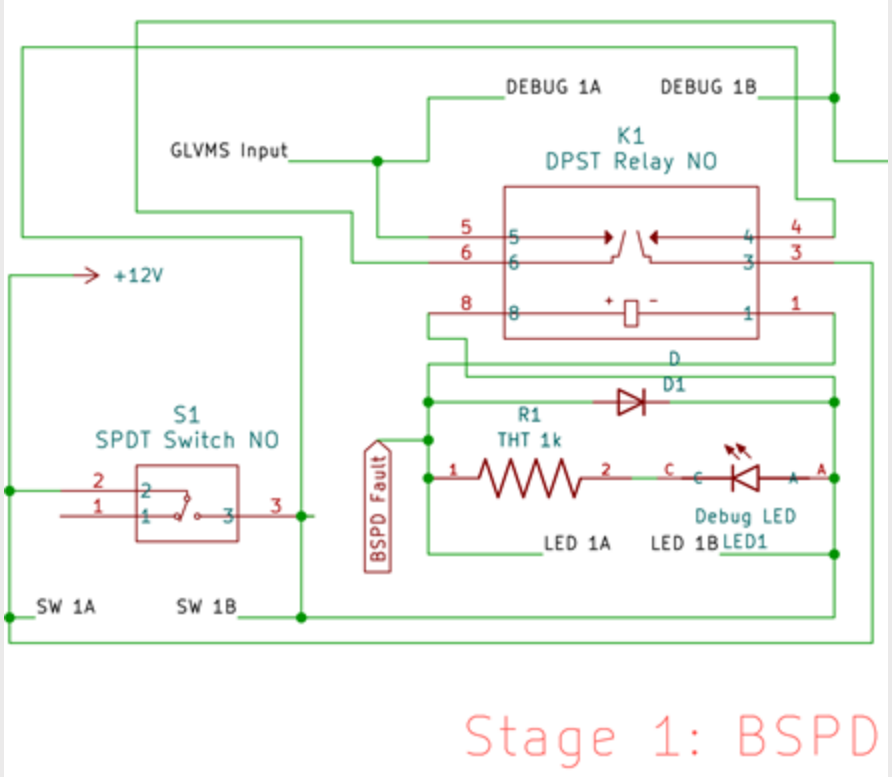
About Relays

- Electromechanical switches
- Function with magnetics basically
- When current flows from pin 8 to pin 1, a coil turns on and becomes an electromagnet, pulling contacts and closing pins 5-6 and 3-4
- Other way around if normally closed
- Typically have diode in parallel so that the voltage spike when it turns off gets absorbed and doesn't damage anything else
  - Flyback diode
- **TL;DR: When current flows from pin 8 to pin 1, pins 3-4 and 5-6 connected here**



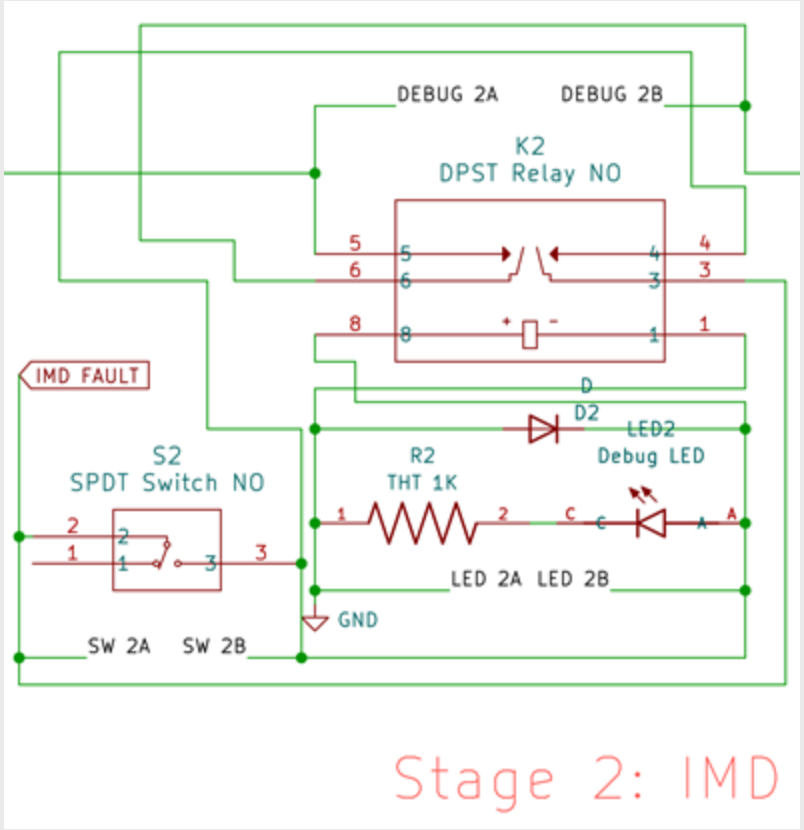
Stage 1: BSPD

- BSPD Fault: Ground normally, floating when there's a fault
- When relay is closed, +12V flows through pins 3-4, then back around to BSPD Fault (Ground) to power the relay and keep it closed
- Pins 5-6 carry Shutdown Circuit onward to next stage of Latchboard



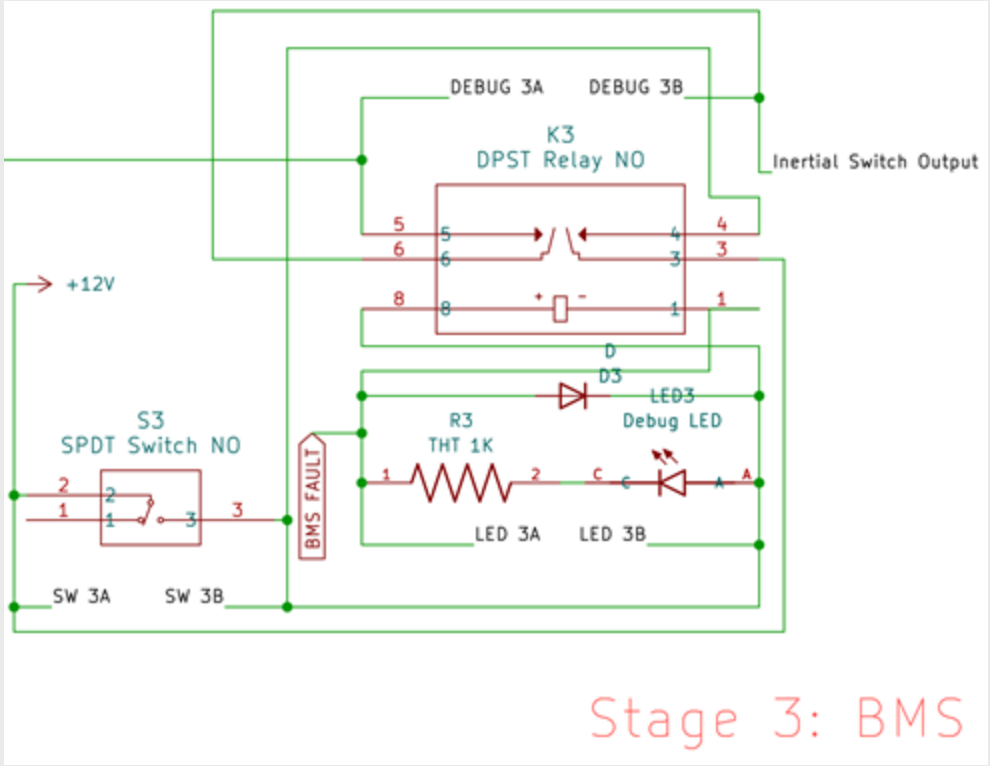
Stage 2: IMD

- IMD Fault: +12V normally, Ground when fault
- Same deal as Stage 1, but now IMD Fault is going through pins 3-4 and powering the relay



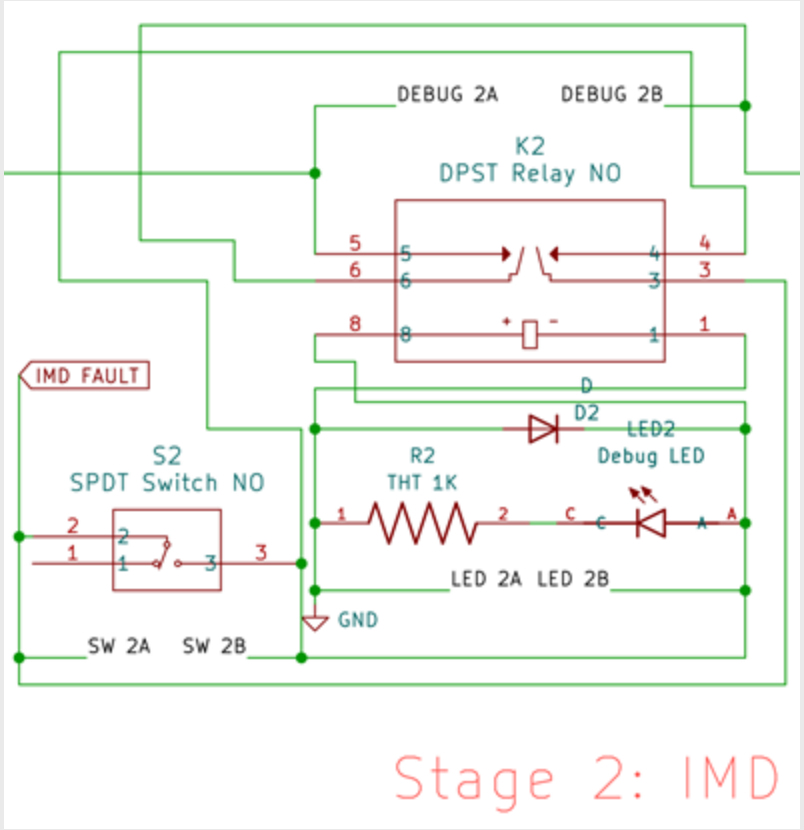
Stage 3: BMS

- BMS Fault: Ground normally, floating when fault
- The exact same idea as Stage 1 with the BSPD since both faults are open drain



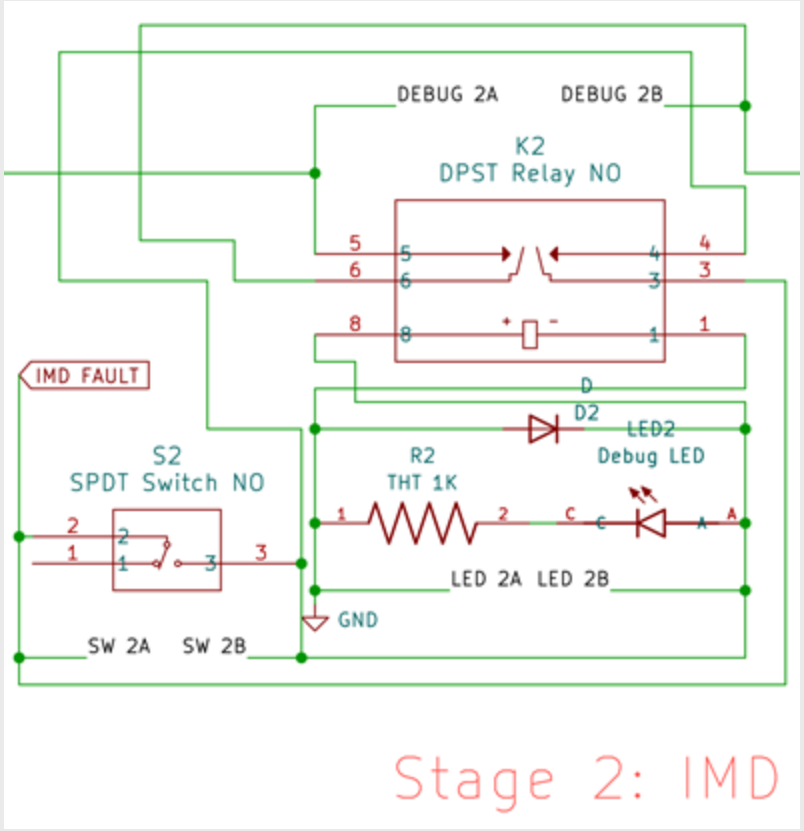
Resetting a Relay

- Example: IMD Fault
- When the IMD has a fault, IMD Fault becomes grounded, and so the relay is no longer powered
- Once fault is cleared, switch on latchboard or GLVMP enclosure can be used to reset the relay
- Bypasses the relay temporarily to power it on, then power starts flowing through the relay again



Debug LEDs

- Example: IMD Fault
- Debug LEDs present on Latchboard PCB
- When power is flowing normally, they get powered
- Fault interrupts power and LEDs turn off



Example Video

Latchboard Video Demo.MOV

(didn’t want to embed it through Google Drive b/c then the resolution tanks)

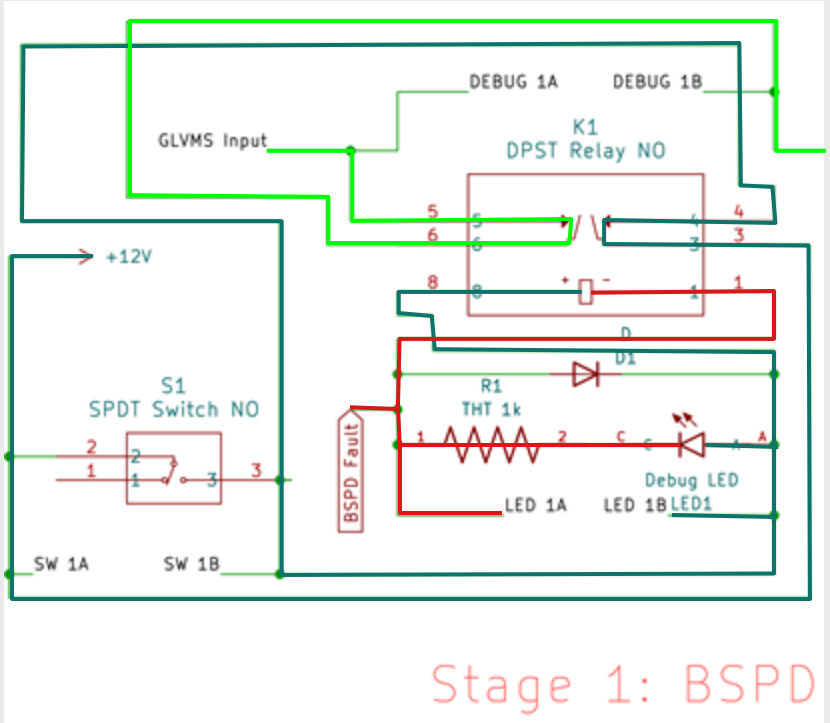
03

Scenarios

What does the latchboard do in every scenario?

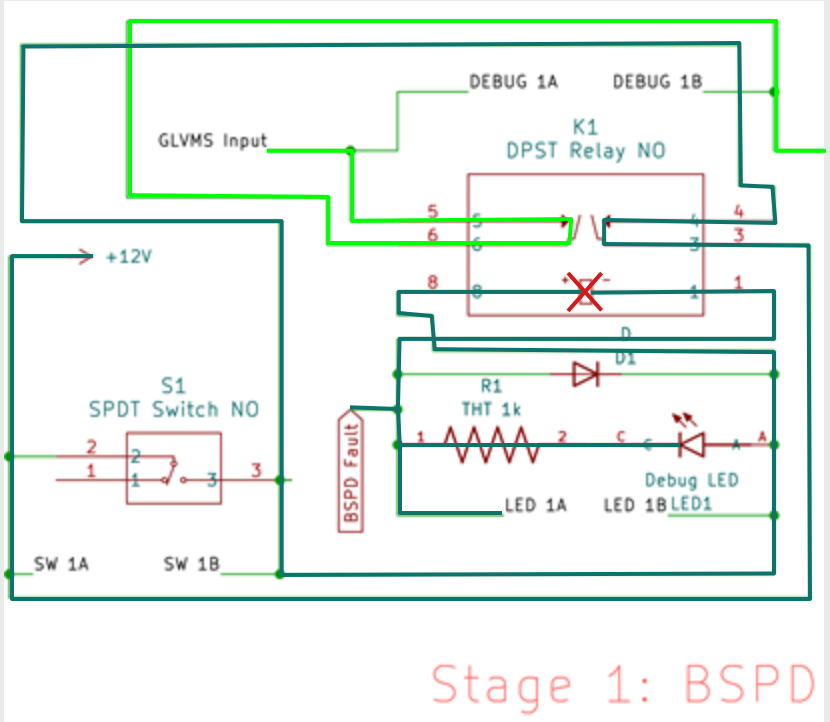
Scenario 1.1: BSPD/BMS Working Normally

- BSPD Fault: Ground normally
- Relay already working, so +12V is going through pins 3-4
- Shutdown Circuit connected through pins 5 and 6
- Flows through the relay to BSPD Fault since the latter is grounded
- Debug LEDs also on and show that BSPD is currently functioning normally
- BMS works the exact same



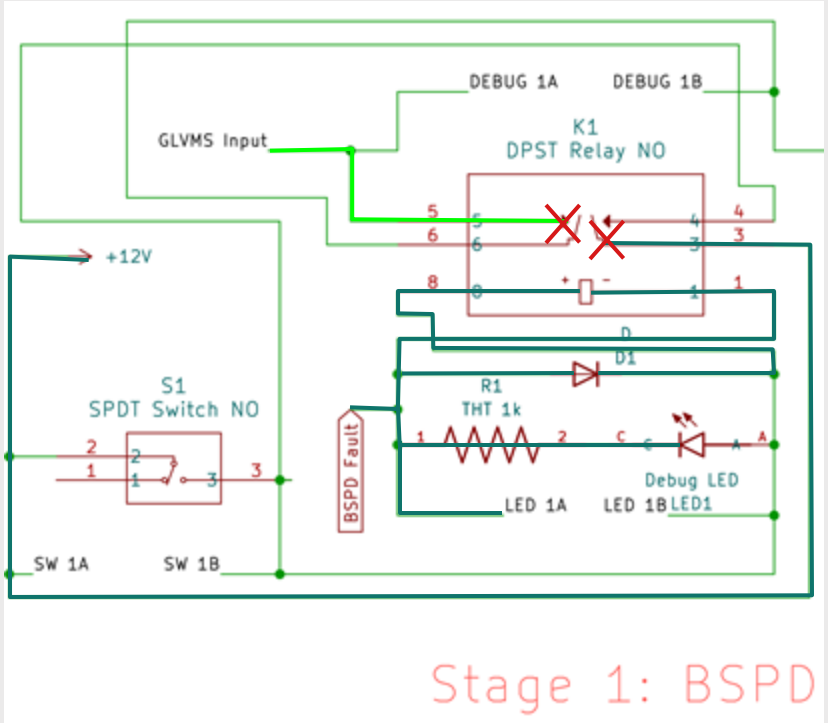
Scenario 1.2: BSPD Fault

- BSPD Fault: Floating when there's a fault
- +12V runs into floating fault and pulls it up → evens out across the relay, so current stops flowing and relay opens



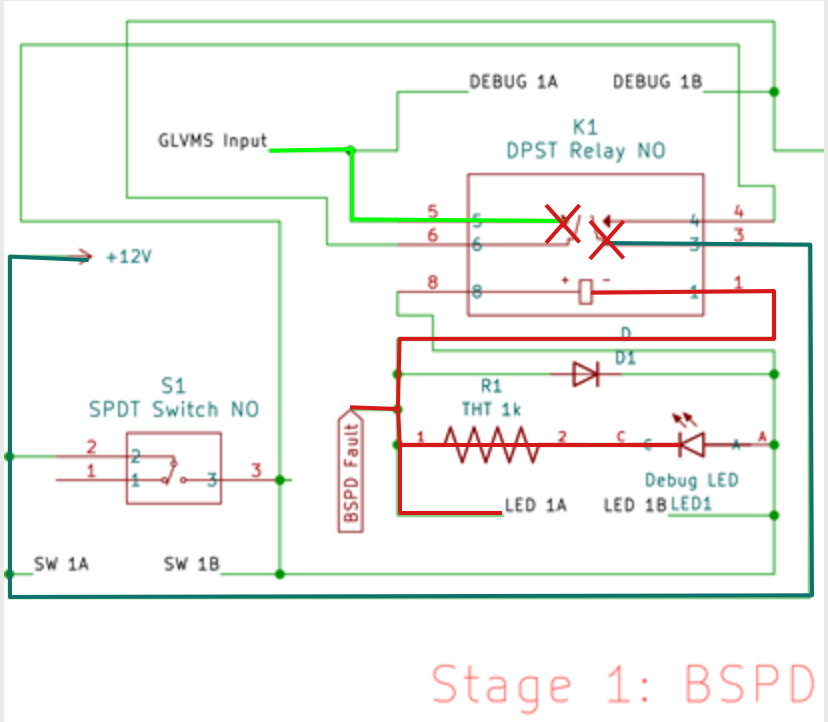
Scenario 1.2: BSPD Fault

- BSPD Fault: Floating when there's a fault
- +12V runs into floating fault and pulls it up → evens out across the relay, so current stops flowing and relay opens
- Flyback from coil wants to keep flowing and goes through diode



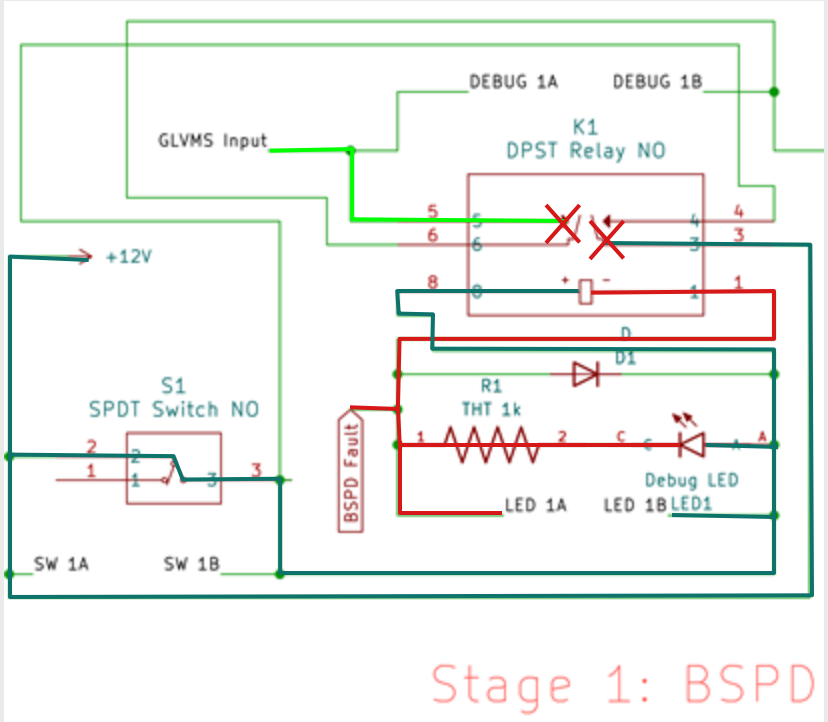
Scenario 1.3: BSPD Fault Reset

- Fault fixed and BSPD Fault goes back to being ground



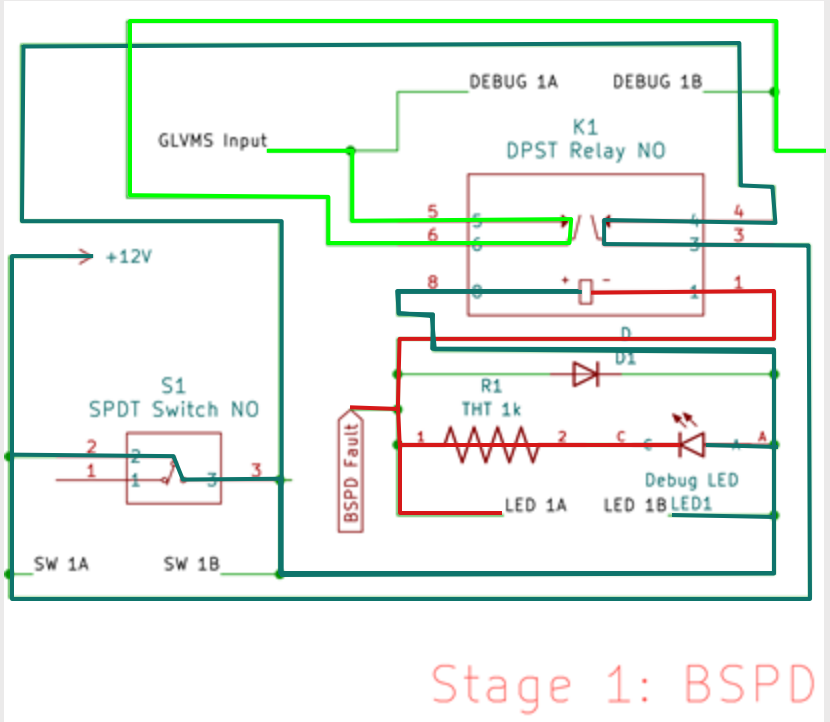
Scenario 1.3: BSPD Fault Reset

- Switch is activated and contacts close, so +12V can flow through and power the relay



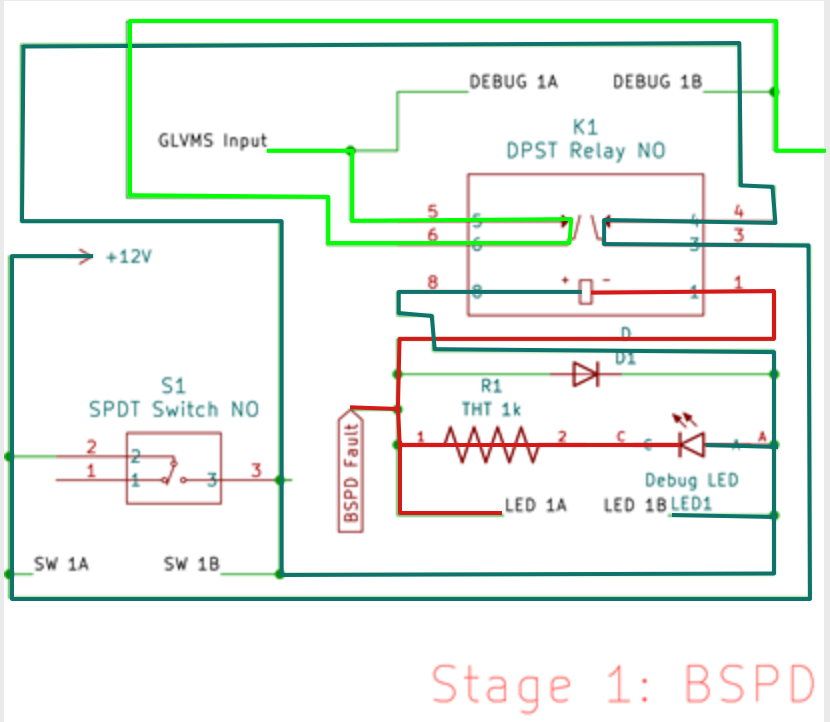
Scenario 1.3: BSPD Fault Reset

- Switch is activated and contacts close, so +12V can flow through and power the relay
- Shutdown circuit and relay power can flow through the relay again



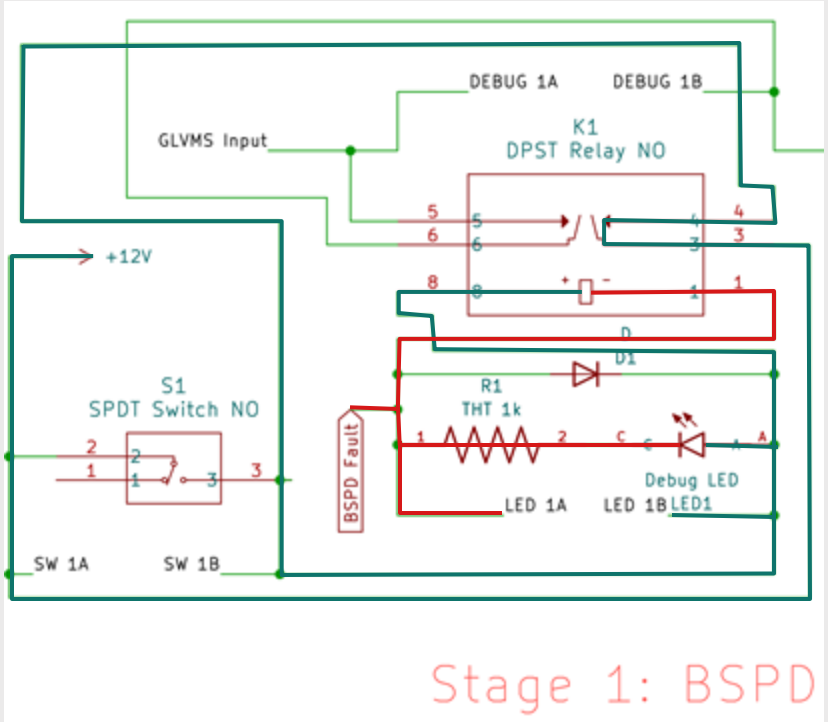
Scenario 1.3: BSPD Fault Reset

- Switch is activated and contacts close, so +12V can flow through and power the relay
- Shutdown circuit and relay power can flow through the relay again
- Switch toggled off again
- Stage 1 of Latchboard returns to normal function



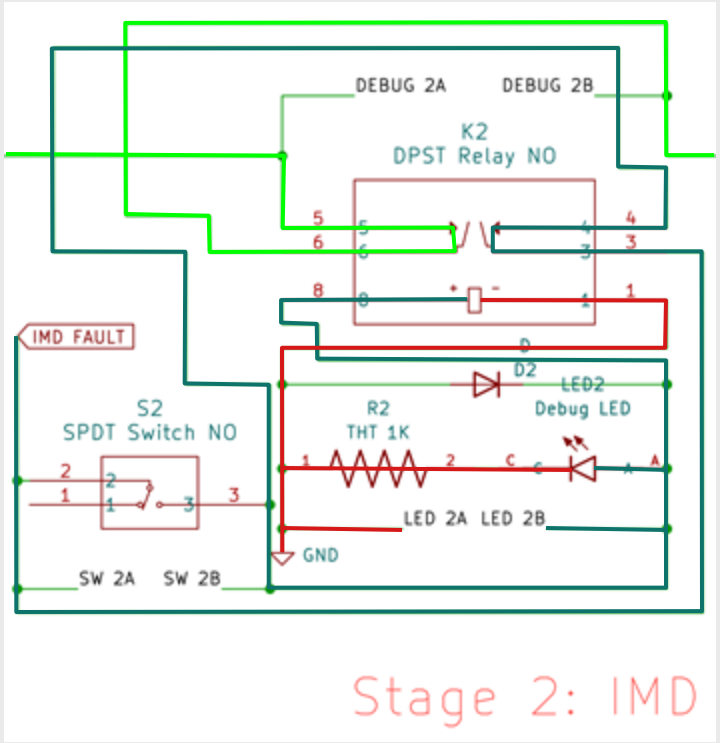
Scenario 1.4: Fault Somewhere Else

- Shutdown Circuit disconnected and stops flowing
- Everything else remains functional so that Shutdown Circuit can return to normal once whatever disconnected is fixed/put back
- Whether or not it's still energized depends on location of the fault/ disconnect



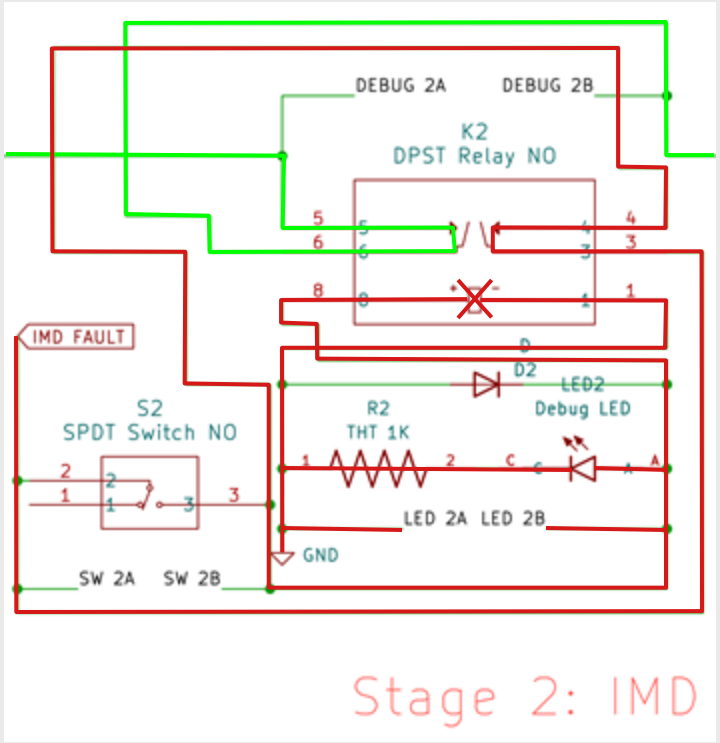
IMD Scenario 2.1: Normal

- IMD Fault: +12V normally
- Going through the relay to power the relay
- Shutdown circuit stays connected



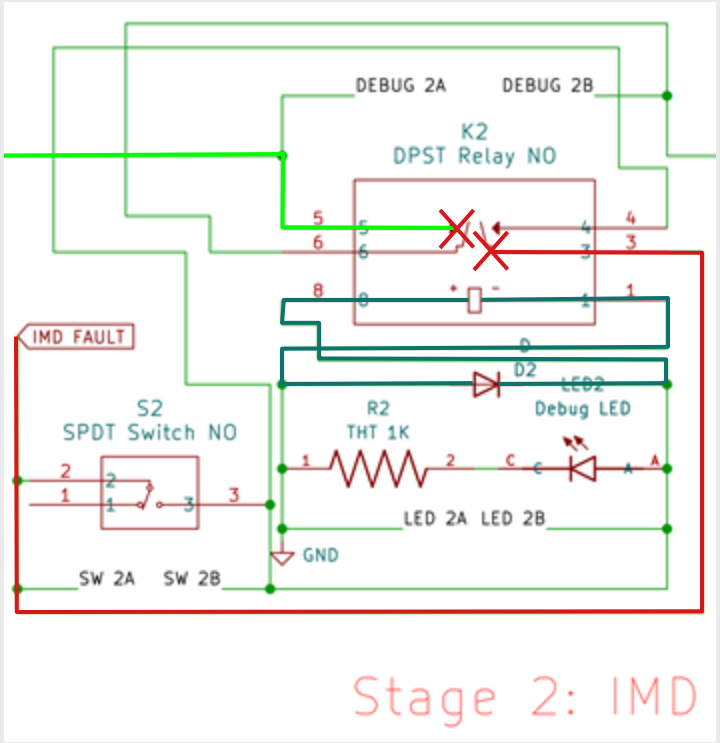
IMD Scenario 2.2: Fault

- IMD Fault goes to ground when there's a fault
- No current flowing through relay



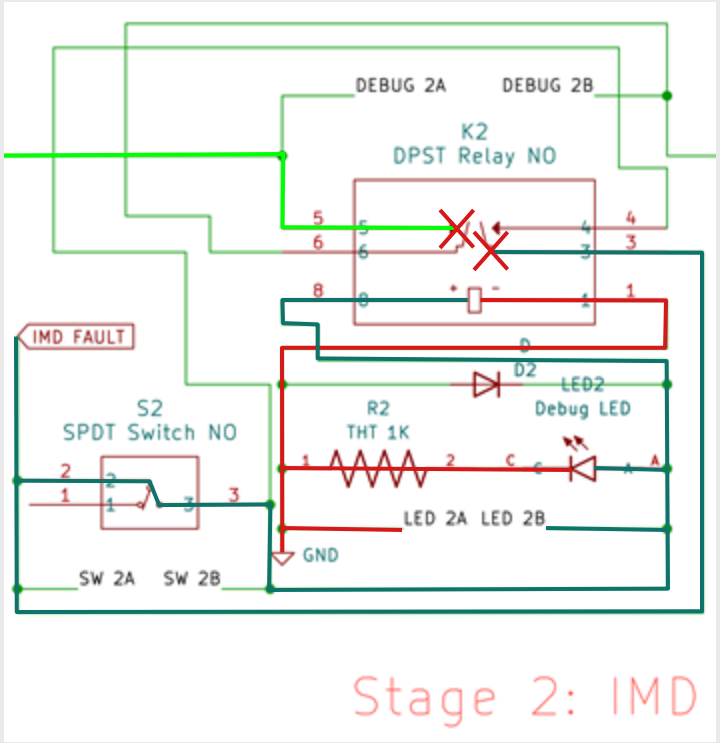
IMD Scenario 2.2: Fault

- IMD Fault goes to ground when there's a fault
- No current flowing through relay
- Shutdown circuit is broken
- Flyback voltage absorbed by flyback diode



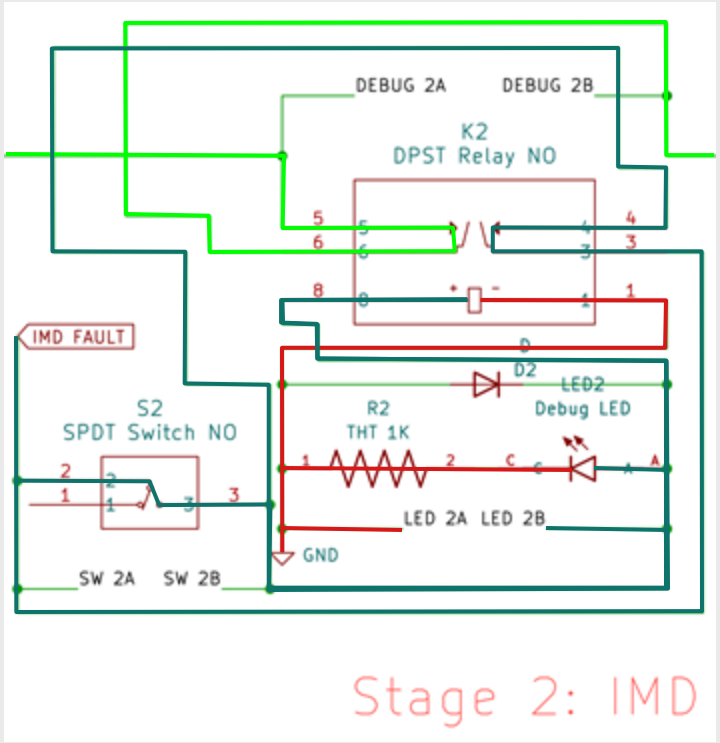
IMD Scenario 2.3: Reset

- Switch toggled so IMD Fault can bypass the relay to power the relay



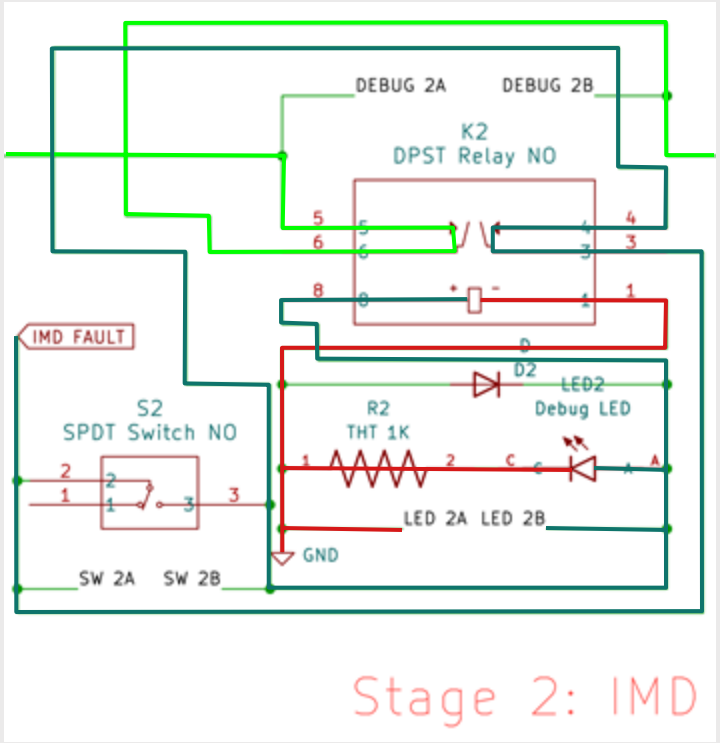
IMD Scenario 2.3: Reset

- Switch toggled so IMD Fault can bypass the relay to power the relay
- Shutdown circuit is connected again



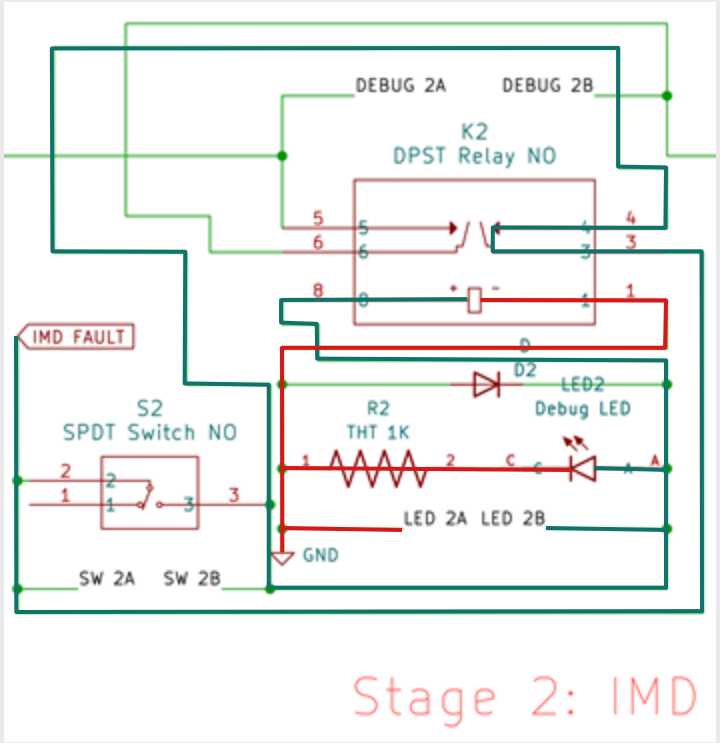
IMD Scenario 2.3: Reset

- Switch toggled so IMD Fault can bypass the relay to power the relay
- Shutdown circuit is connected again
- Switch toggled off, Stage 2 of Latchboard back to running as normal



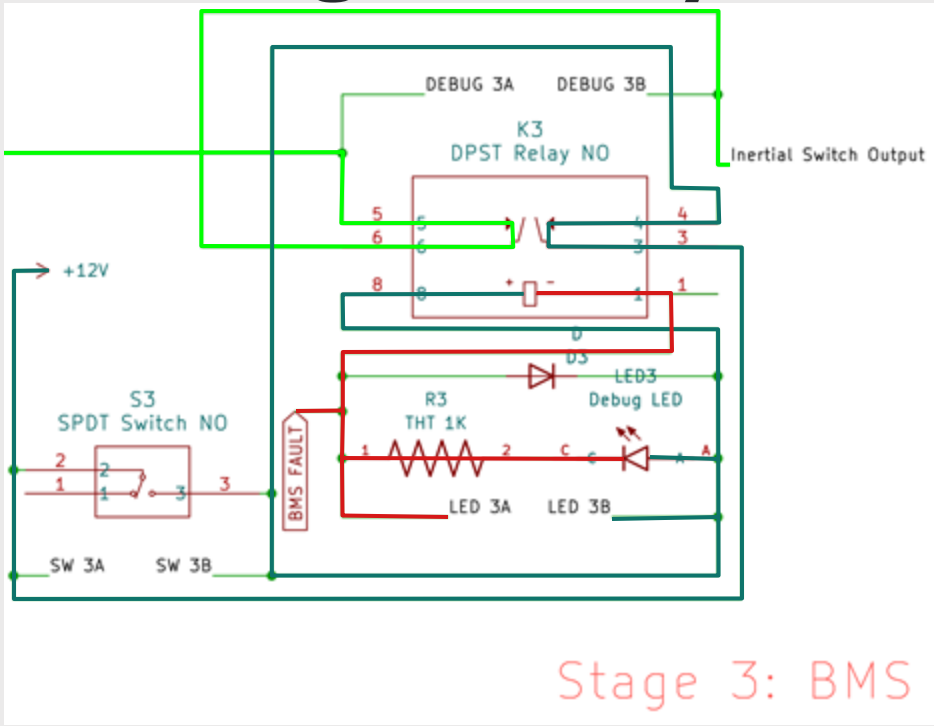
IMD Scenario 2.4: Fault Somewhere Else

- Shutdown Circuit stops flowing
- Everything else remains functional so that Shutdown Circuit can return to normal once whatever disconnected is fixed/put back
- Whether or not it's still energized depends on location of the fault/ Disconnect
- You get the picture...



Scenario 3.1: BMS Working Normally

- Exact same as BSPD



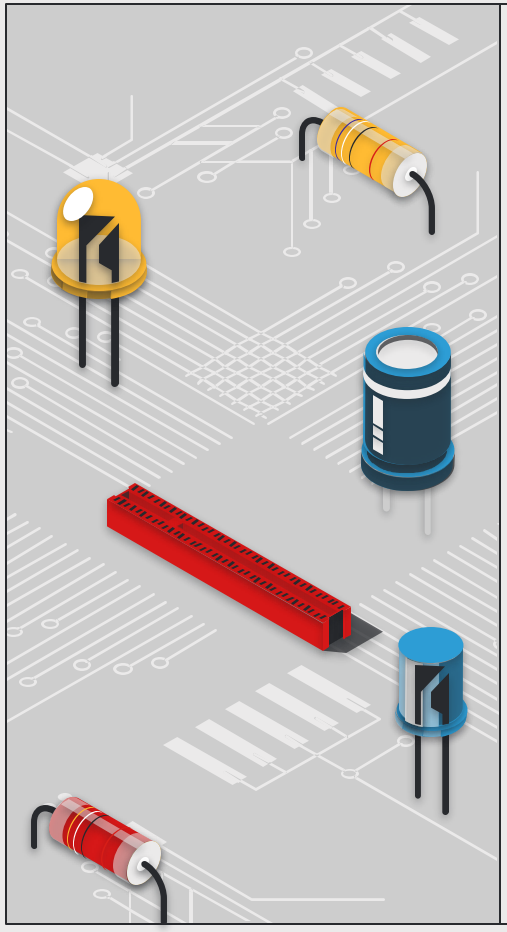
04

Improvements

How can the latchboard be improved?

Potential Improvements

- I have no clue
- This seems relatively simple already as far as complexity is concerned?
- Can transistors be used instead of relays?
  - I have been told they're faster, but not sure how they can be used in this case to replace a DPST relay?
  - No, EV 7.1.3 says "they must be Normally Open," i.e. relay or contactor, not transistor
- Do we need three relays?
  - Could we do an AND-gate setup and have the output drive a single relay?
  - No because EV 7.1.4 wants "completely independent circuits"
- **TL;DR: idk it seems good to me**



Thanks!

Do you have any questions?

CREDITS: This presentation template was created by **Slidesgo**, and includes icons by **Flaticon**, and infographics & images by **Freepik**