Welcome to Low Voltage!!!

This page is under construction btw lol, some descriptions are a little long
Also this is "heavily inspired" by Val's welcome page from last year

W e l c o m e   to the Low Voltage subgroup!

What we make on the car:

Wire harnesses + connectors

Low voltage wire harnesses distribute power and communications to various devices and sensors across the car. Our low voltage system is powered by 12 volts DC, and our devices communicate through the CAN protocol. To make our harness modular, we commonly use two main types of "Deutsch" connectors, Deutsch (DT) and Deutsch Mini (DTM).

Control circuit design

Develop the logic behind circuits that control vehicle function. One good example would be our Vehicle Control Unit, which requires the Brake System Plausibility Device (BSPD) per FSAE rules. The BSPD is a critical device that monitors brake position and throttle position. If it detects the driver is pressing both petals simultaneously past a certain threshold, it shuts down the motor. This is in case of a stuck throttle. Per rules, this cannot be done using code, so clever use of electrical logic gates are used in our VCU.

PCB design and soldering

To bring our circuit design into a robust, compact form, we design custom PCBs using Altium Designer (will go over how to access Altium student license during an LV class). Our boards are exported from Altium and purchased from a manufacture called JLCPCB. Components on the board are purchased from a reputable electronic component store such as Digikey and Mouser. To reduce costs, all of our boards are **assembled and soldered by hand.**

Work with Data Acquisition (to make their wishes come true)

Data acquisition requires readings from multiple sensors across the car in real time. While DAQ deals with how to obtain and interpret the data using firmware, our low voltage subgroup deals with **how to integrate these necessary sensors into our wiring.**

"Per Formula SAE rules, any electrical system within the car that operates with **less than 60 volts** is considered low voltage. However, many of the low voltage systems we design interact with high voltage (above 60v)"

Things we've built in the past:

Shut Down Circuit (SDC)

Our vehicle has seven "E-Stop" switches as well as two code-controlled relays in the ACU that are all wired in series. This is so if one of these switches is latched (and therefore disconnects), the entire "shut down circuit loop" is disconnected. Our shut down circuit is defined with a purple wire. This creates a very robust shut down system.

Tractive Control Unit (TCU)

Controls the isolation relays, which connect and disconnect the high voltage battery from the rest of the car. Power to the TCU is provided by the shut down circuit loop, so if any of the aforementioned E-stop switches is latched, power to the TCU will be lost, and therefore the isolation relays will be opened.

Accumulator Control Unit (ACU)

Monitors battery cell temperatures from our Module Distribution Boards (MDB) and any faults from our Isolation Monitoring Device (IMD). If a cell reaches too high of a temperature, or the IMD detects insufficient isolation between high voltage and the chassis, the ACU will disconnect our shutdown circuit (SDC), shutting off the TCU.

Dashboard

Corner Board

A small board that interprets sensor data across the car and sends that data over CAN communication lines. Sensors it is designed to monitor include wheel speeds, suspension displacement, load cells, brake pad temperature, brake line pressure, and the ability to upgrade in the future.

===TUTORIAL===

Sunday, October 05, 2025   11:10 AM

Altium Student License
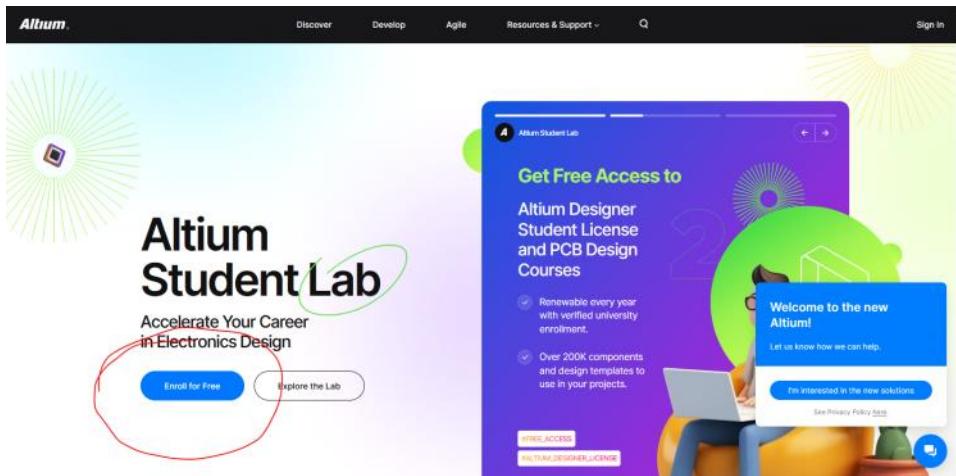
Sunday, October 05, 2025   11:11 AM

Step 1:
Search "Altium Student Lab" and select the first link
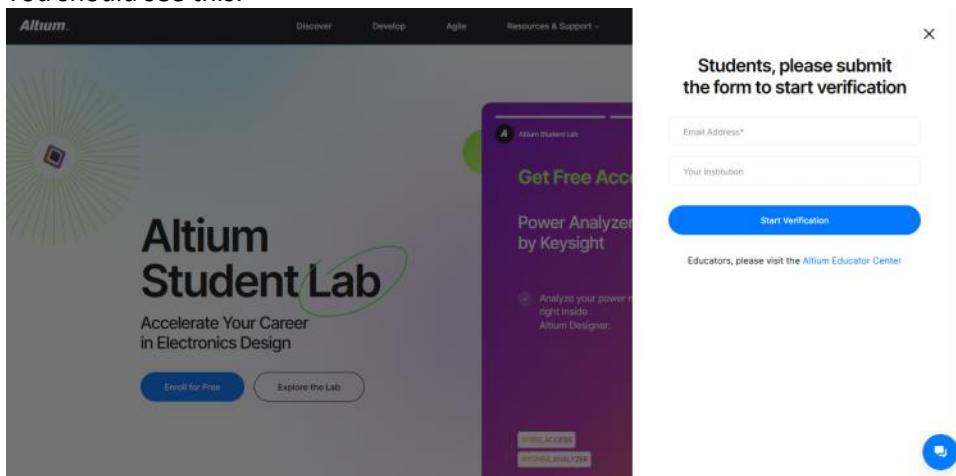
Step 2:
Select "Enroll for Free" as shown below
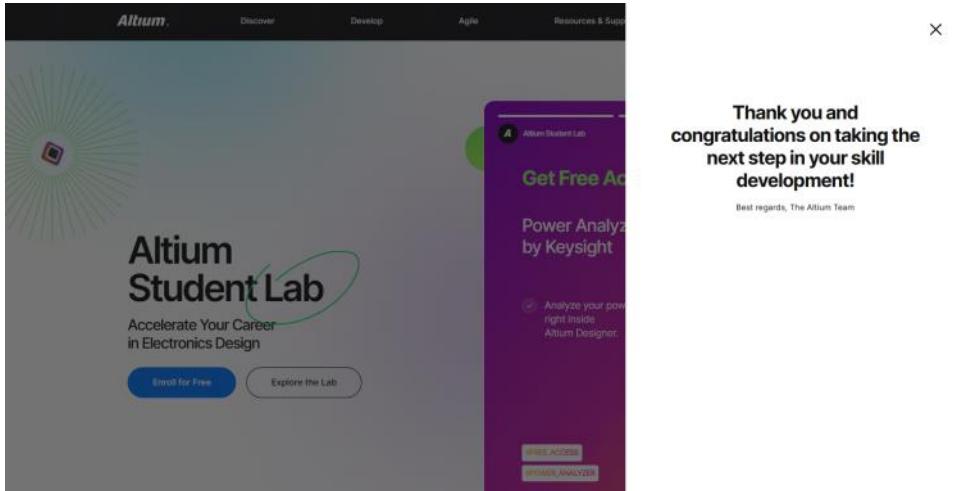

Step 3:
You should see this:
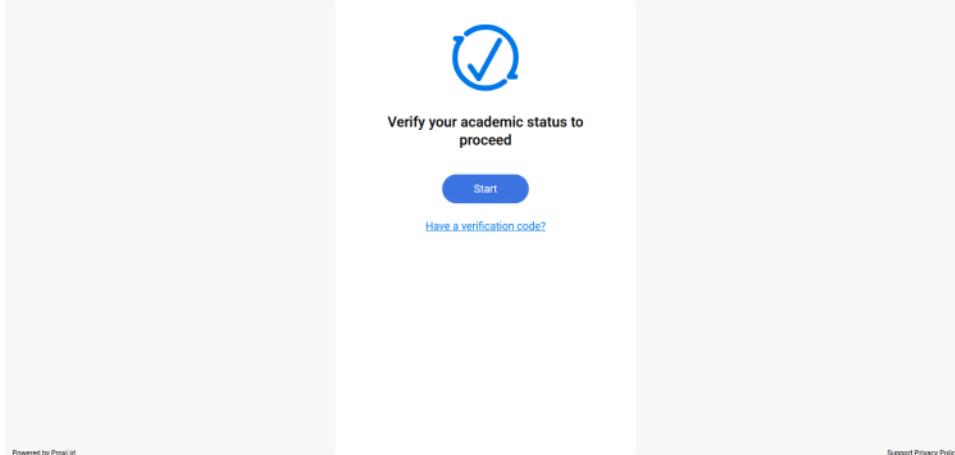
Fill out the information. Make sure you use your KSU email.

NOTE: If you don't see this and you see this screen below, use a different browser or try incognito mode
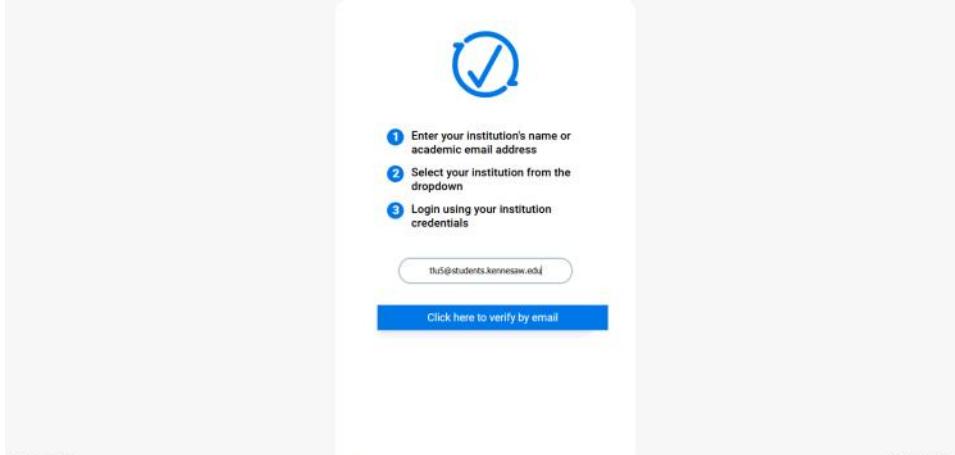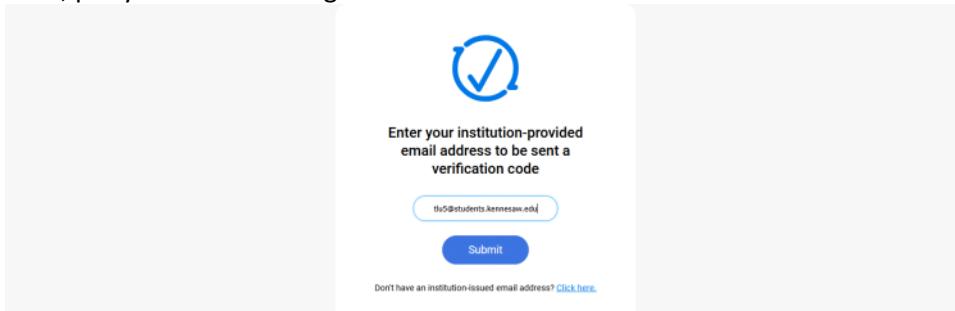
Step 4:
Once you input your KSU email and our school's name, you should see this start page.
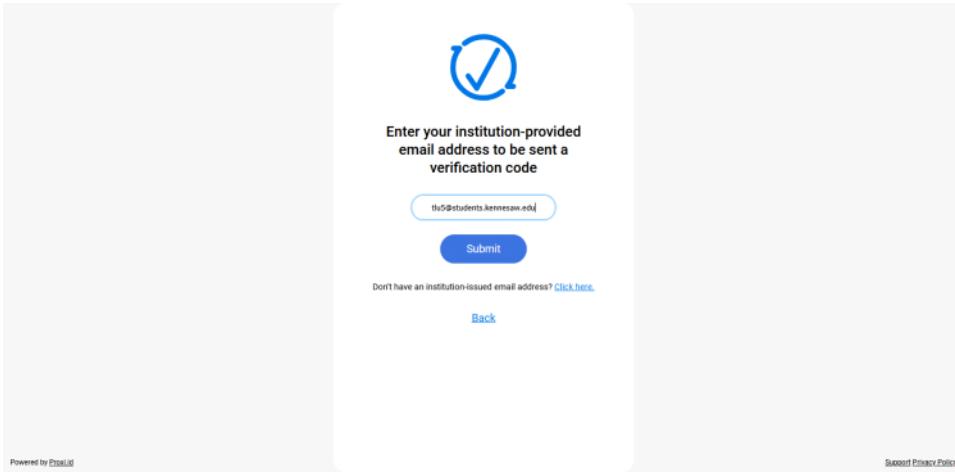

Put your KSU email in the next screen.
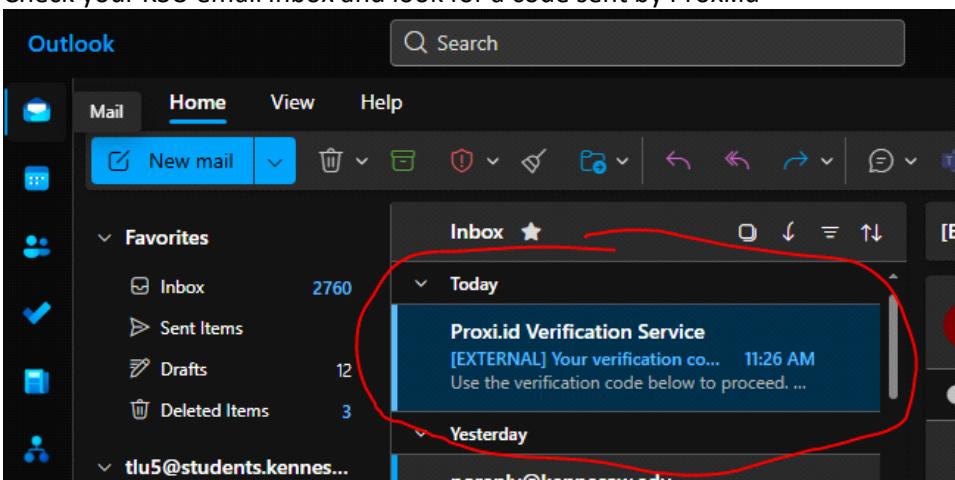
Next, put your KSU email again lol
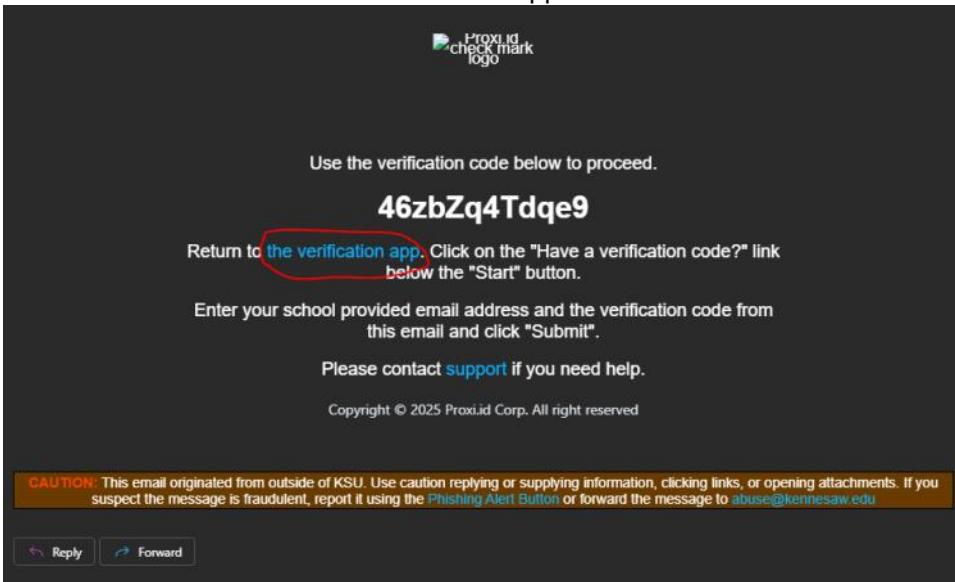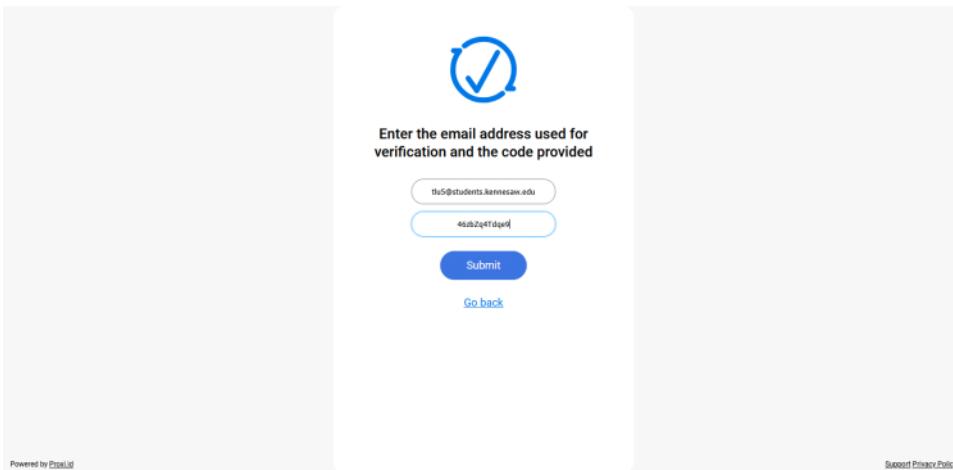
Step 5:
Check your KSU email inbox and look for a code sent by Proxi.id

Click the link for return to "the verification app"

And put your KSU email along with the verification code
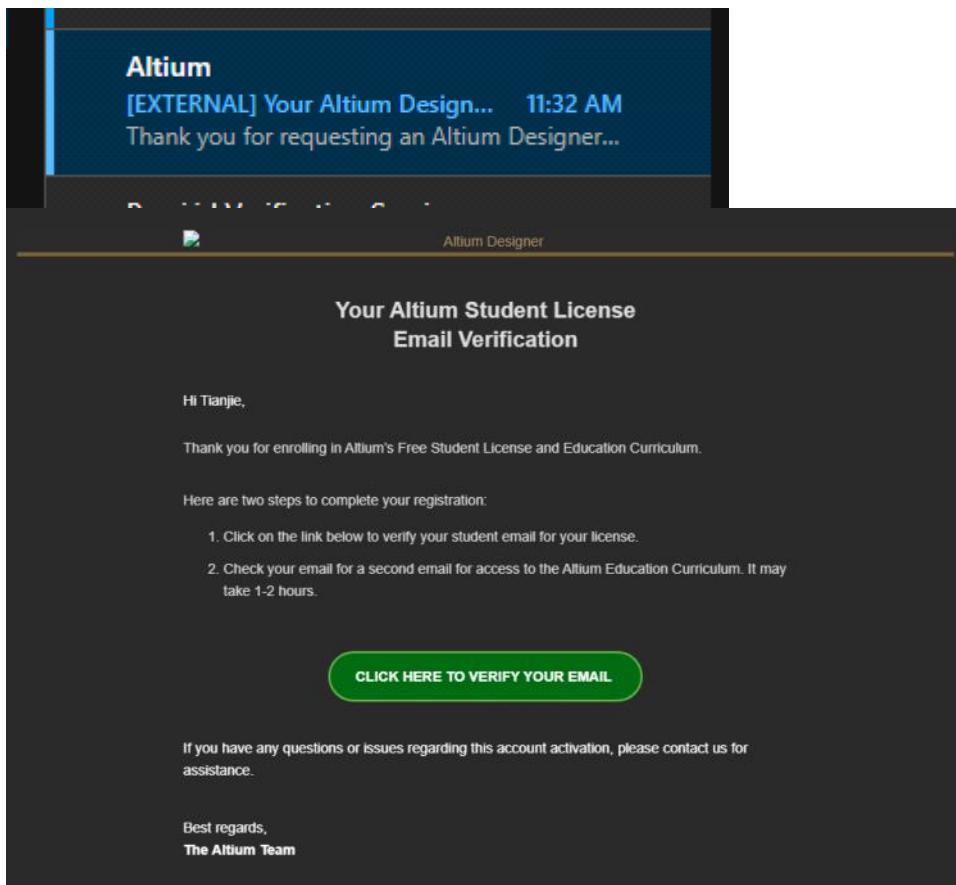
Step 6:
You should be sent to this screen. Fill out the information. The zip code for the Marietta campus is 30060.

Once completed you will be sent to this screen:

Step 7:
You will get an email from Altium. This email usually takes up to 5 minutes to send.

Altium

[EXTERNAL] Your Altium Design... 11:32 AM

Thank you for requesting an Altium Designer...

**Your Altium Student License
Email Verification**

Hi Tianjie,

Thank you for enrolling in Altium's Free Student License and Education Curriculum.

Here are two steps to complete your registration:

1. Click on the link below to verify your student email for your license.

2. Check your email for a second email for access to the Altium Education Curriculum. It may take 1-2 hours.

CLICK HERE TO VERIFY YOUR EMAIL

If you have any questions or issues regarding this account activation, please contact us for assistance.

Best regards,
The Altium Team

Clicking the green verify button will lead you to this page:

Your Email was Verified. The Student Altium Designer license information
will be delivered to your email shortly.

THANK YOU

Step 8:
You should also receive two other emails from noreply Altium.

One of these is for your Altium Designer license and the other is for an included tool called Power Analyzer by Keysight.

In the Altium Designer email, follow the instructions:

Once completed, a file called AltiumDesignerSetup_date_.exe will be downloading.

Step 9:

Run the .exe file.
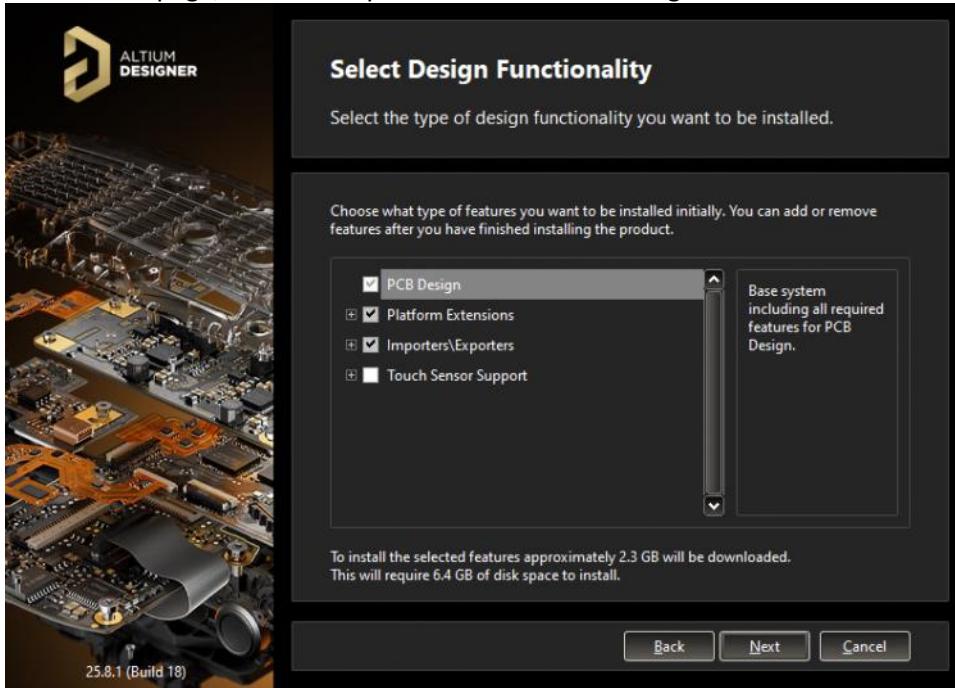
You should see this:
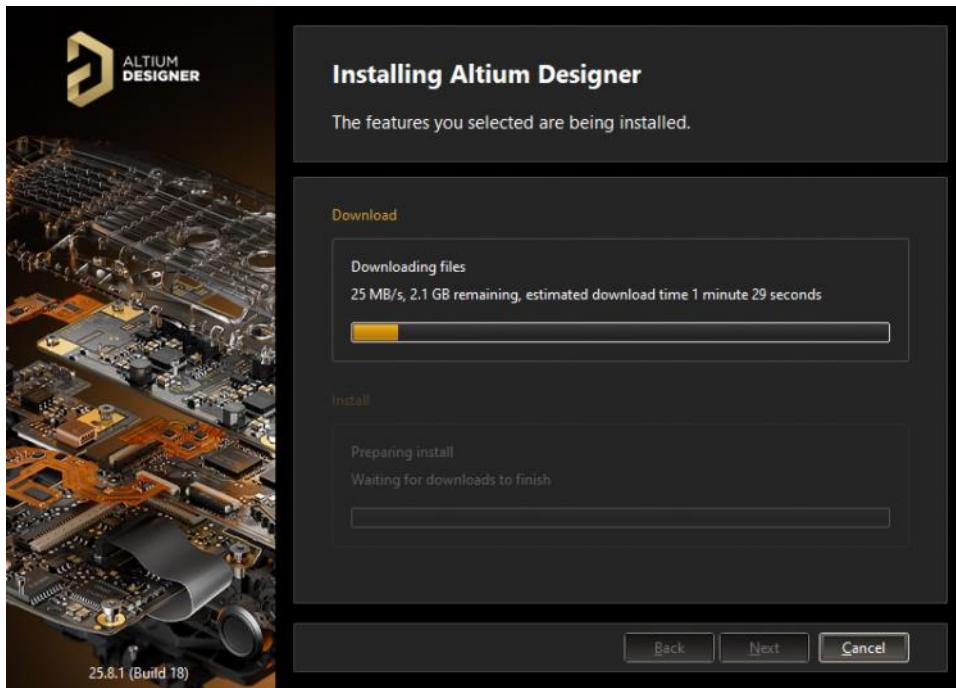
After accepting the License Agreement, you might be prompted to your browser to sign into your Altium account.

For the next page, the default pre-selected will be enough:
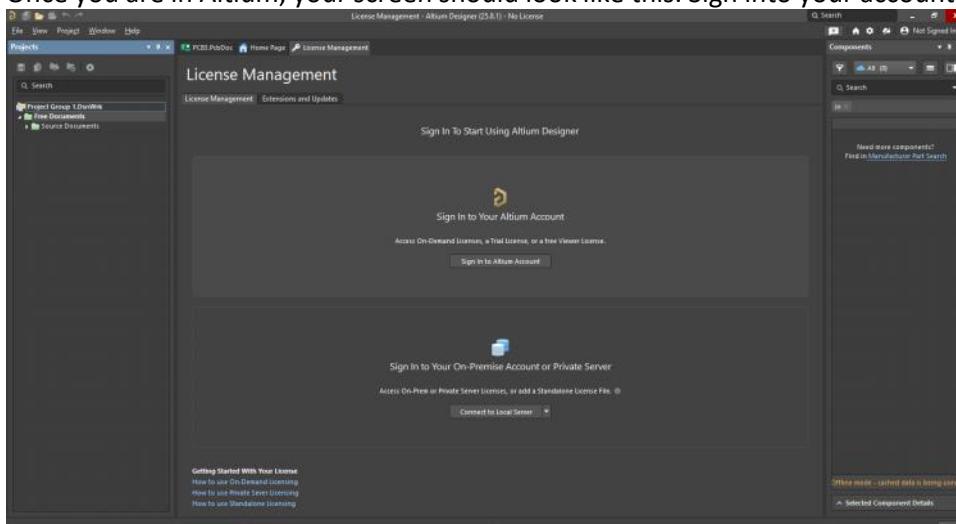
After a few more pages, Altium should be downloading/installing
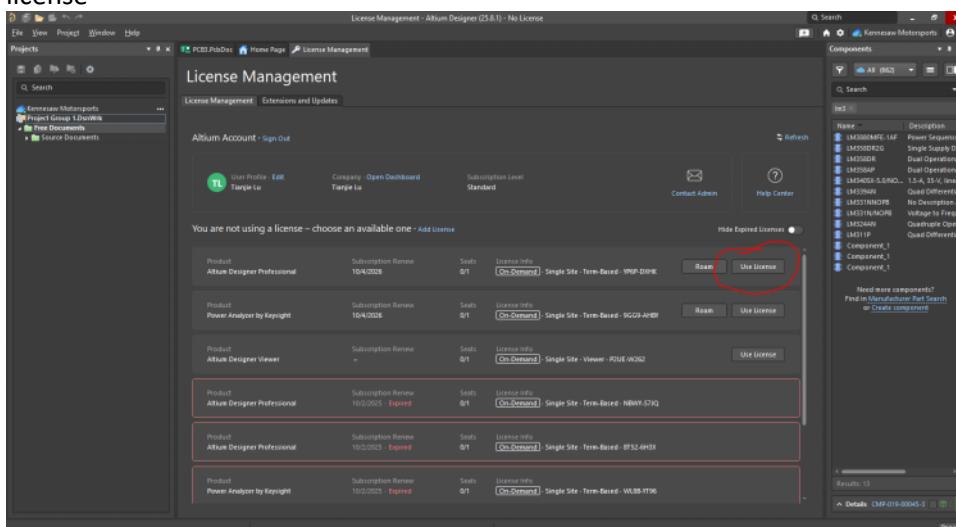
Step 10:
Once you are in Altium, your screen should look like this. Sign into your account.

In order for you to create and edit documents, you need to select the Altium Designer Professional license
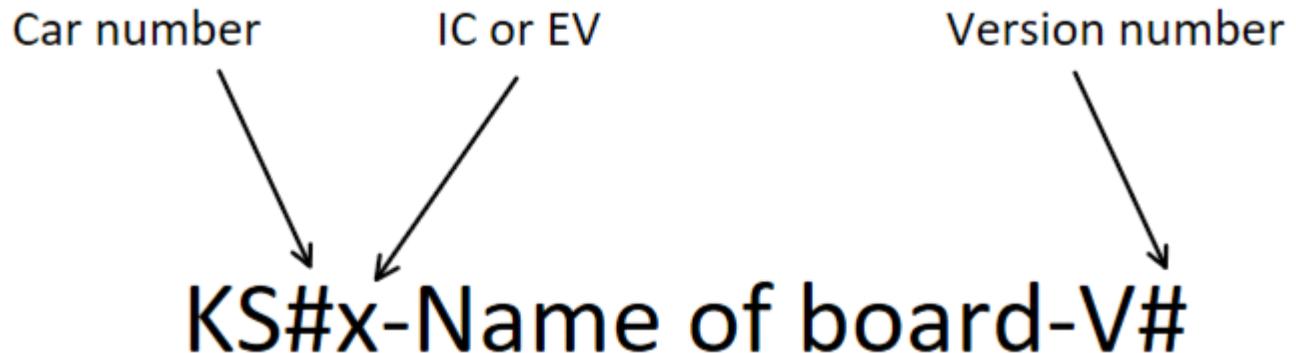
Great! You now have Altium. Let your subgroup lead know what email you used so they can add you to the Kennesaw Motorsports cloud workspace. This cloud workspace will allow you to save your projects to the cloud and view all projects directly on the Altium website.

Note, I have a lot of expired licenses because these student licenses only last for 1 year.

KMS PCB Specifications

How we name our PCBs

Car number   IC or EV   Version number

KS#x-Name of board-V#

Example

KS6e-MDB-V1
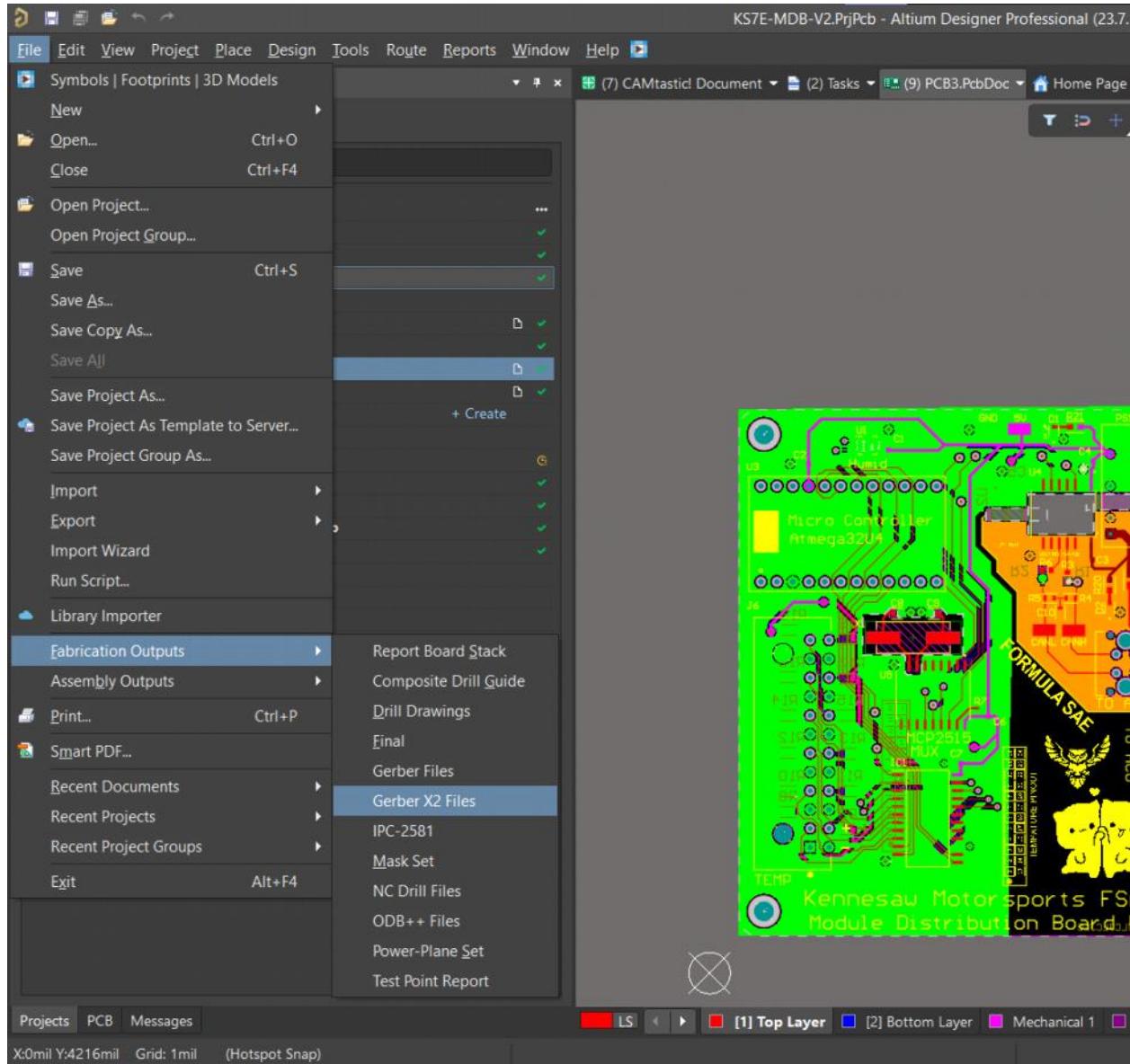
Export Gerber Files

Sunday, October 05, 2025   11:59 AM

(ported over from KS8C-E Onenote)
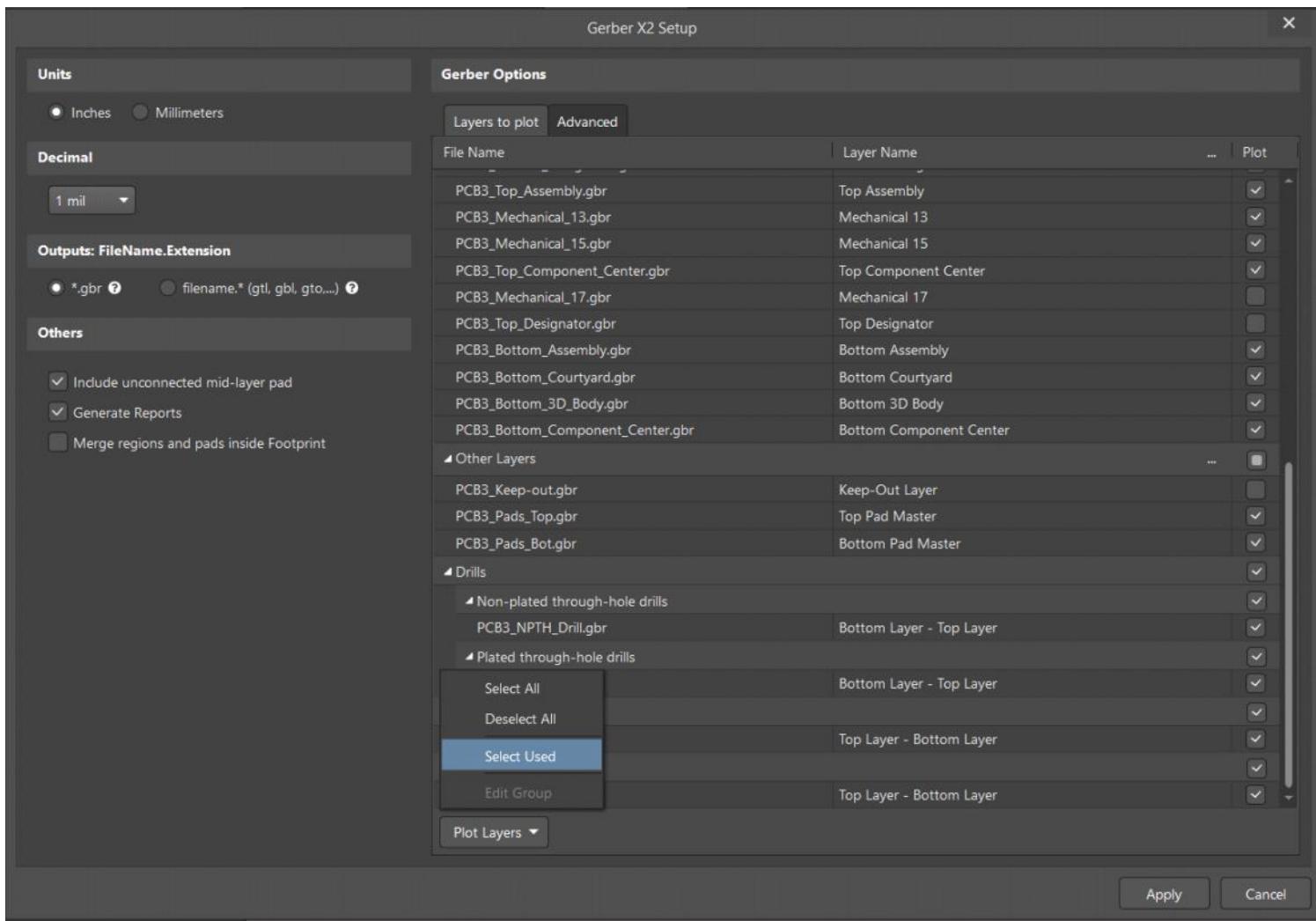
To create a Gerber File, Go to File > Fabrication Outputs > Gerber 2x. Regular Gerber will work but something the NC drill layers aren't Correct making the PCB have no holes.

For this Guide im using **Gerber 2x**.
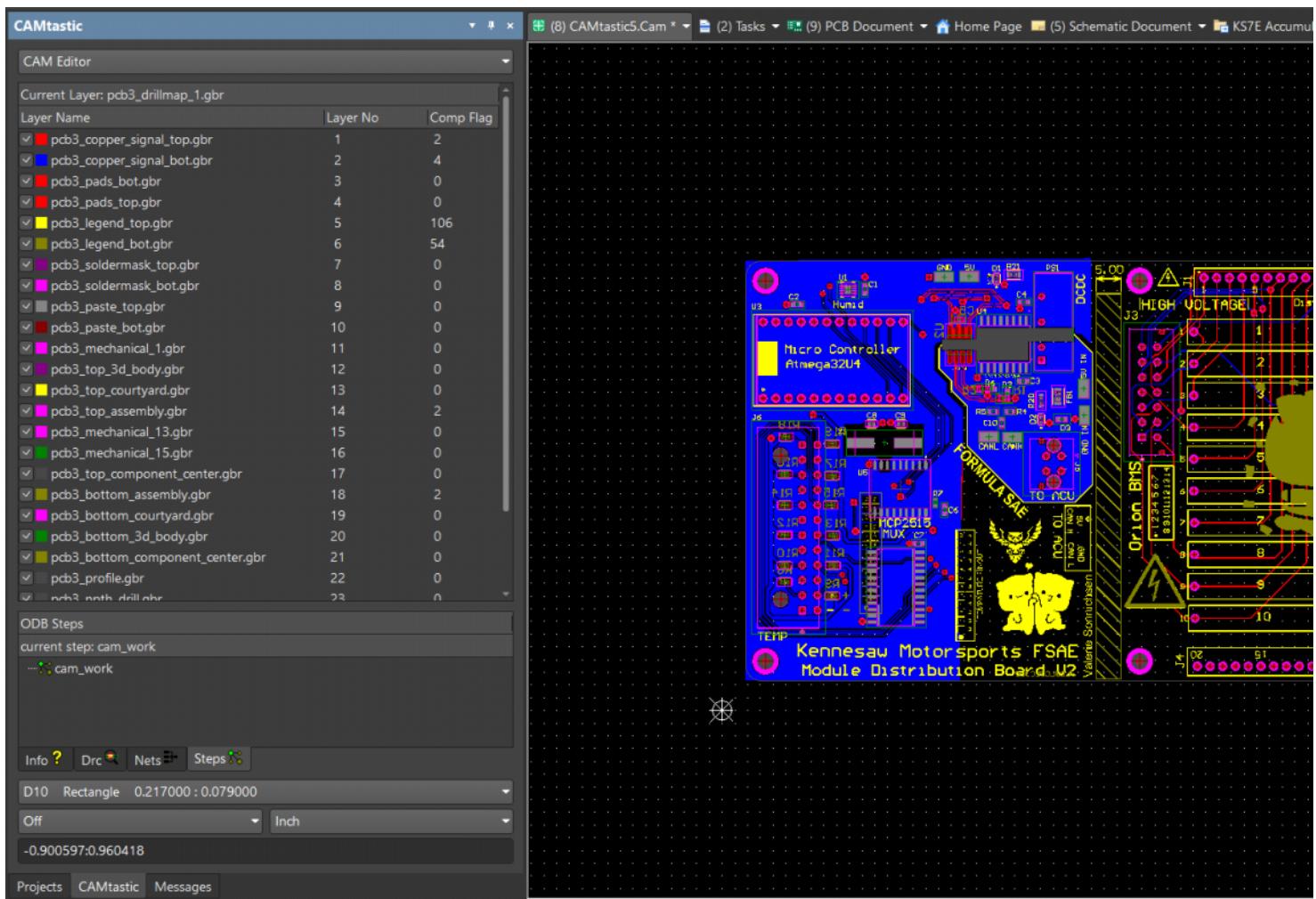
In the Setup menu make sure **Units = Inches**, **Decimal = 1 mil**.
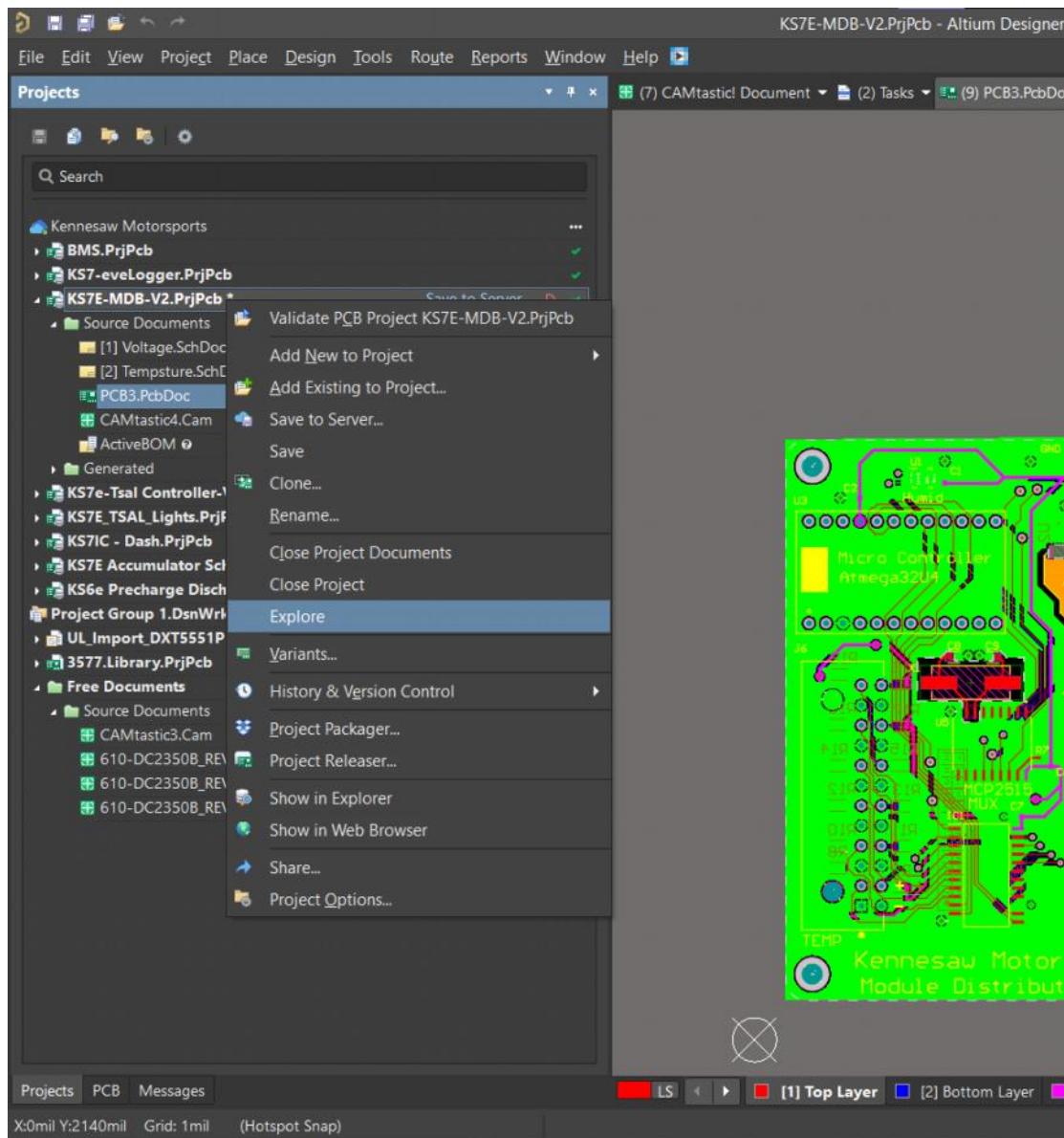
Under plot layers Select , (Select Used). Scroll through the Layers to plot and make sure each layer that u used is present .
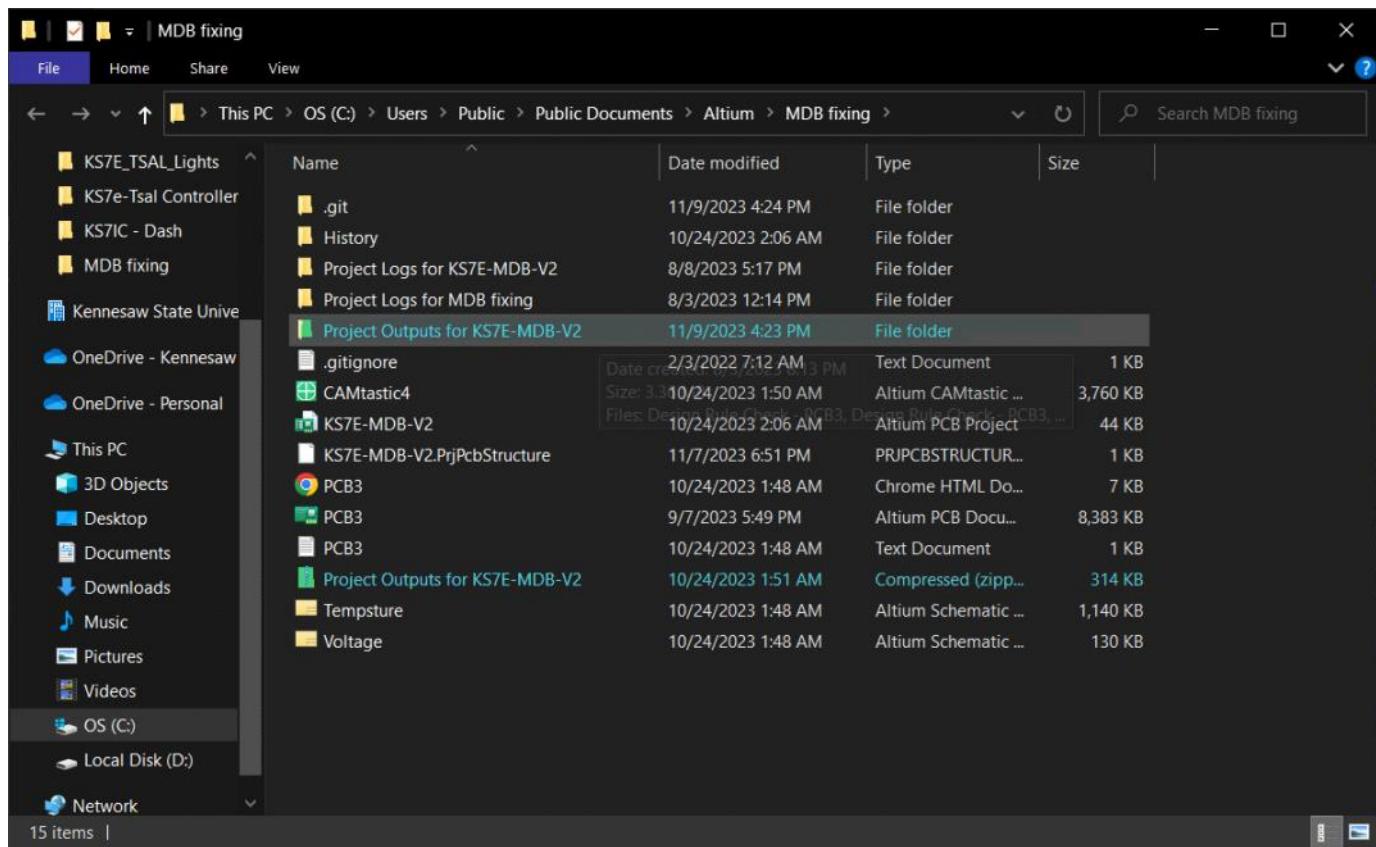
After Applying a file caled CAMtastic should show up in your project. Go to the CAMtastic tab and inviviuly slect each layer checking that everything is correct

Go to Project and open the file path for the project By pressing Explore

Open Project outputs for the Project. Open the project output file and make sure everything looks ok
(see photo bellow). If your outputs look fine, make into a Zip file. This is what JLC is looking for.

Your Outputs should look like this.

MCAP Parser How To

Monday, October 06, 2025   1:00 AM

Download these first:

Download Python (3.8+)
https://www.python.org/downloads/
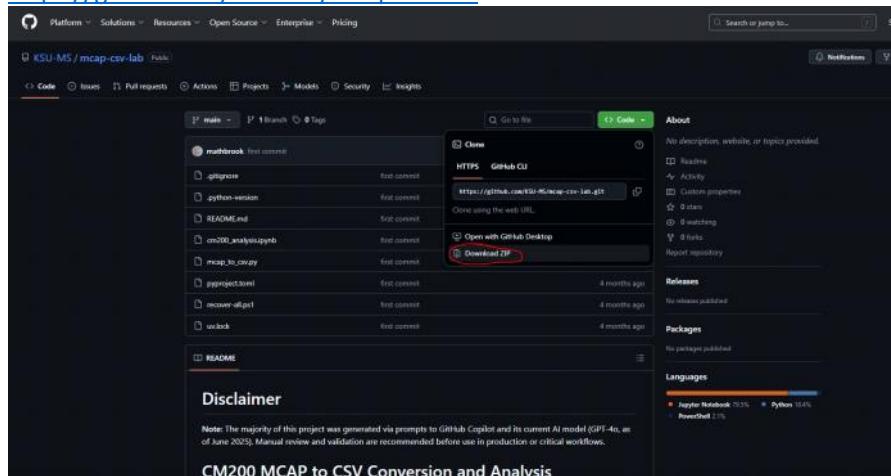
Download UV Sync
https://github.com/astral-sh/uv
OR paste this into Admin Powershell:

```
powershell -ExecutionPolicy ByPass -c "irm https://astral.sh/uv/install.ps1 | iex"
```

Download our MCAP parser's codebase as ZIP
https://github.com/KSU-MS/mcap-csv-lab
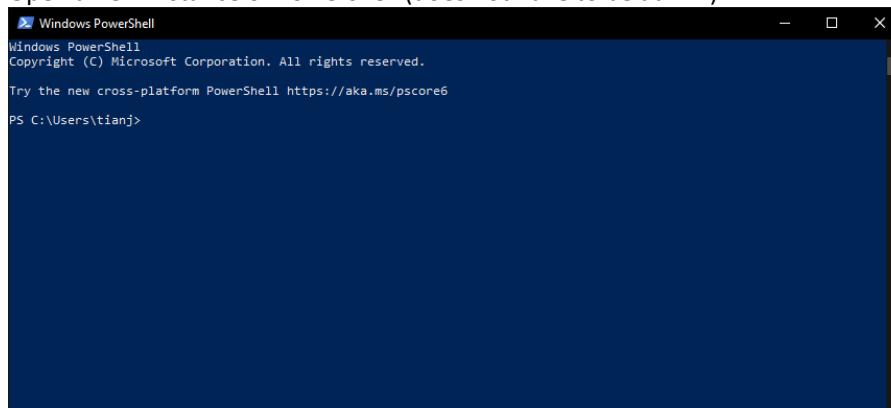
Make sure to extract the folder too.

Code shit:

Step 1:
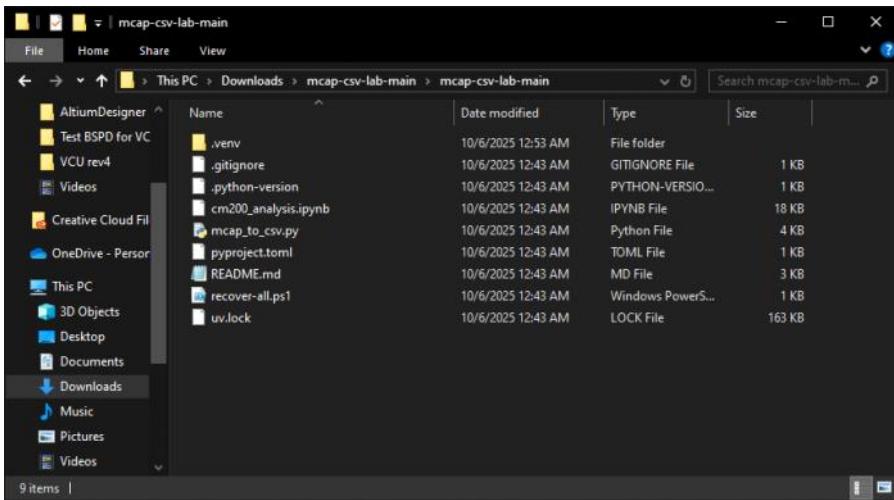
Open a new instance of Powershell (does not have to be admin)

Step 2:
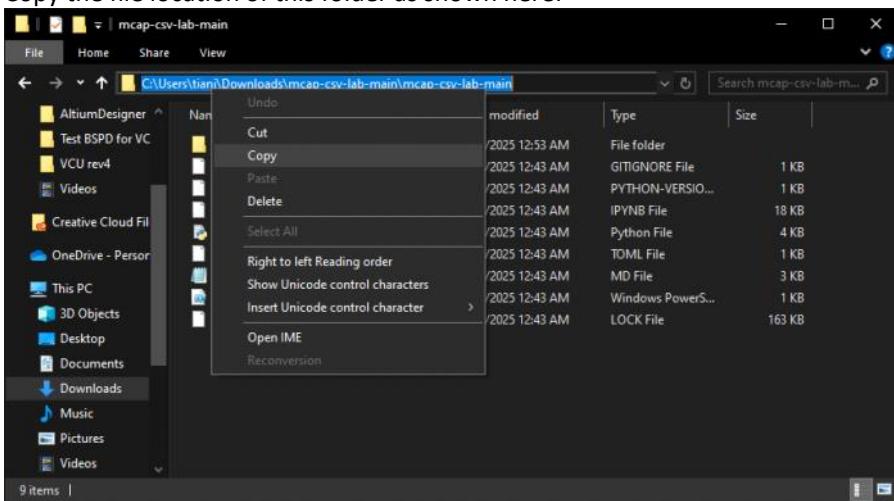
Locate the folder where you extracted the KSU-MS/mcap-csv-lab ZIP folder
Make sure you screen looks like this:

Step 3:

Copy the file location of this folder as shown here:

Step 4:

Now back in powershell, type

```
cd *that file location you just copied*
```
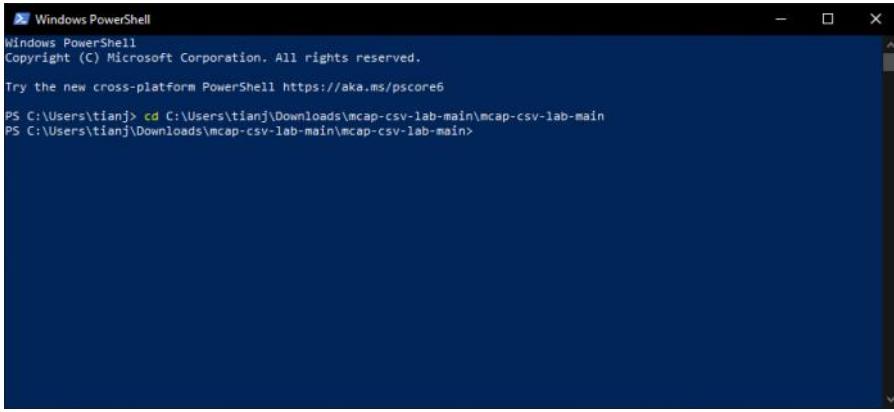
Like this:

When you hit enter it should change to this:

Step 5:

Now type:

```
uv sync
```

A lot of packages should be installing right now.

This process only needs to be done once as it is just for setup.

<mark>REFER TO STEP X IF THIS DOESNT WORK AND GIVES THIS ERROR:</mark>

```
At line:1 char:1
    + uv sync
    + ~~
        + CategoryInfo          : ObjectNotFound: (uv:String) [],
    CommandNotFoundException
        + FullyQualifiedErrorId : CommandNotFoundException
```

Step 6:
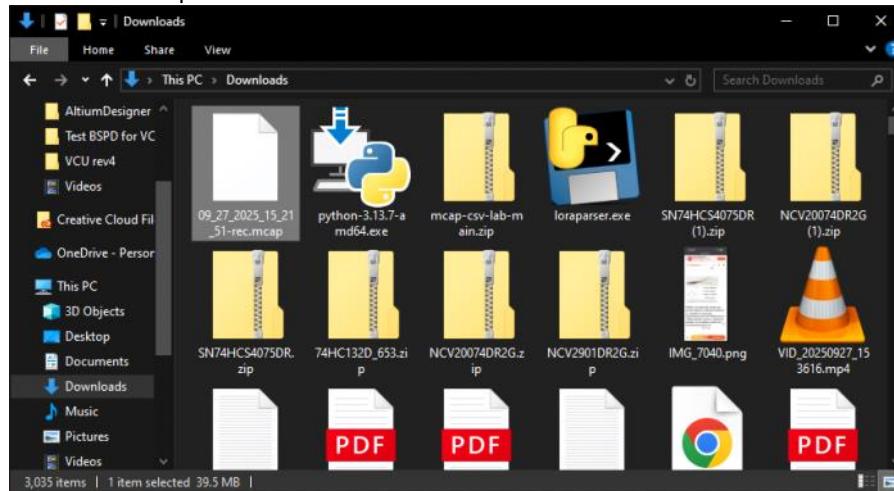
Once the uv sync has completed, now we get to do the fun stuff.

To parse a single mcap file, you type this command with this structure:
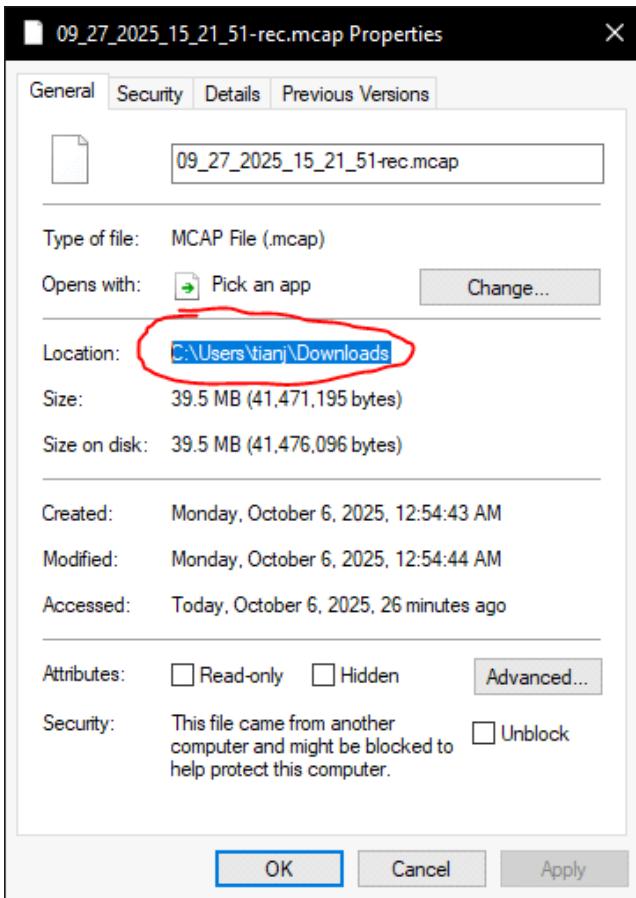
```
uv run mcap_to_csv.py *input.mcap* *output.csv*
```

Here is a step-by-step on how to generate the command:

Locate the mcap file.

Windows doesn't have an easy way to copy the location of a single file. So I copy it from the file properties section:

This gives us this:

```
C:\Users\*your username*\Downloads
```

But this isn't the entire file location because it still needs its file name at the end:

```
C:\Users\*your username*\Downloads\09_27_2025_15_21_51-rec.mcap
```

This gives us the "input.mcap" part of the command.

To get the output.csv, you can do any file location and name the .csv anything.
In this example, I had it parse into my same Downloads folder with the name "gamertest.csv"
Don't forget adding the ".csv" to the end!

Now that we have both inputs and outputs locations sorted, build the command.
Make sure there are parenthesis on the file locations:

```
uv run mcap_to_csv.py "C:\Users\*your username*\Downloads\09_27_2025_15_21_51-
rec.mcap" "C:\*your username*\tianj\Downloads\gamertest.csv"
```
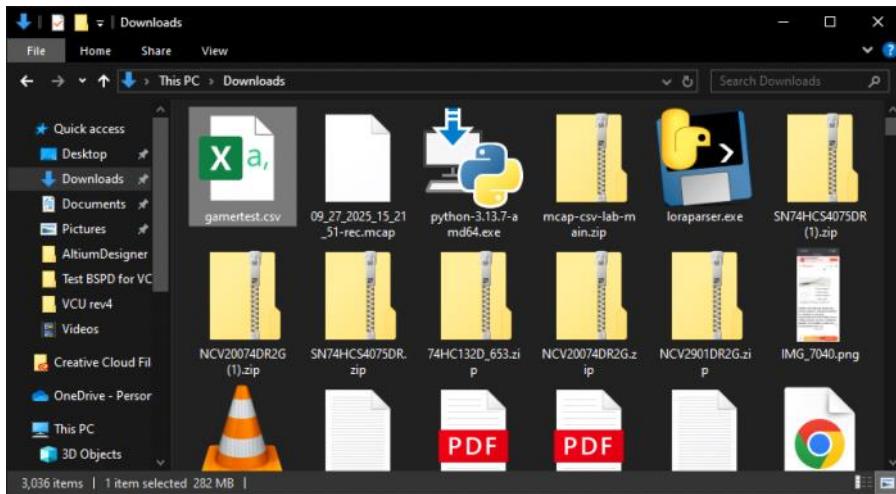
Now hit enter!

The powershell will not give any indication that it is currently/done parsing. Be assured that it is working.

Now your parsed mcap file should appear in your destination folder:

This error is created because Powershell cannot find the UV program you installed because its PATH is not updated. Try restarting Powershell and doing the same steps before.

If this error is still happening, you need to manually update the PATH. Follow these instructions:

In the Windows search bar, type **"Edit the system environment variables"** and open it.

In the window that appears, click the **"Environment Variables..."** button at the bottom.

In the top box ("User variables for *User*"), select the `Path` variable and click **"Edit..."**.

Click **"New"** and paste in the following path. This is the default location where uv is installed:

`C:\Users\*your username*\.cargo\bin`

Click **"OK"** on all three windows to close them and save the changes.

Restart Powershell and continue off. This should fix that error.

Videos

[LV 08/23/2023- Intro class](#)
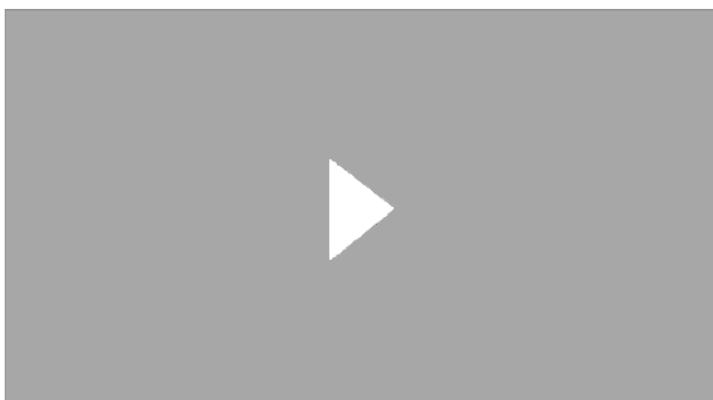
KSU Motorsports

[EV 9/5/2023- HV Safety Class](#)

KSU Motorsports
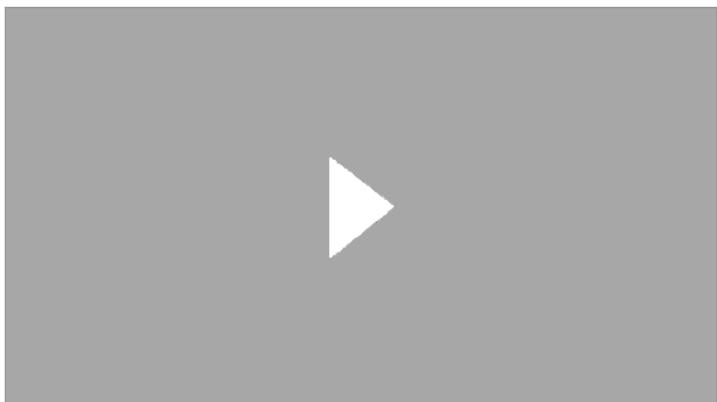
[Kennesaw Motorsports Accumulator Tech Video for 2024](#)

[KENNESAW STATE ACC VIDEO 2023](#)

[Solder Joint inline](#)
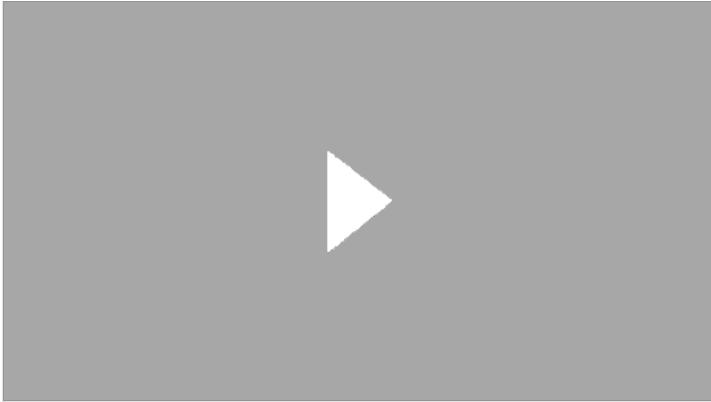
[But Solder Joint](#)

[Sheathing of a connector wire.](#)

[Dt Connector Assembly](#)
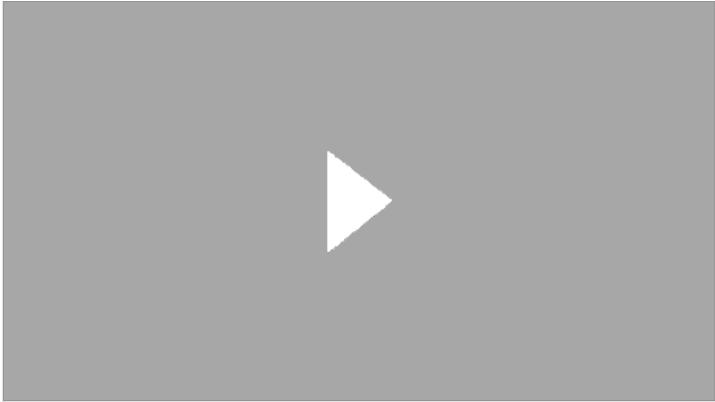
[Types Of Crimps](#)

[DT Crimp](#)
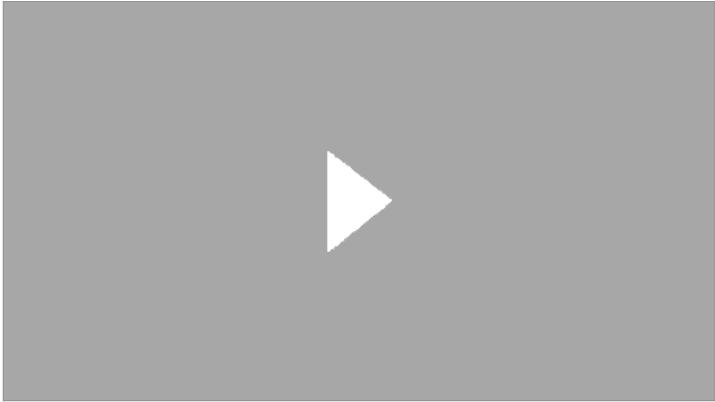
[Depin DT](#)

[Hydraulic Crimp & large gauge wire.](#)

[Sheathing of a connector wire.](#)
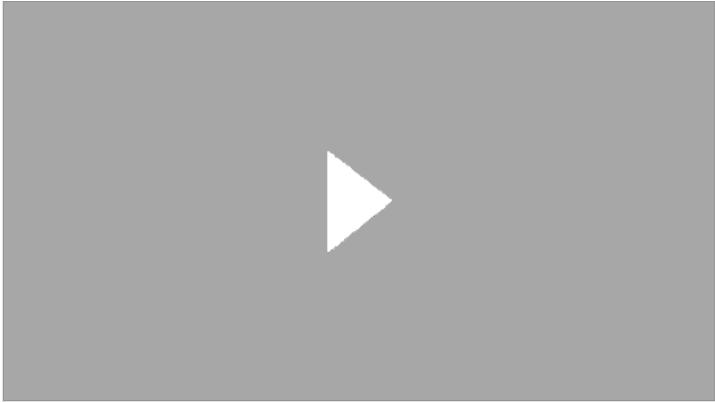
ACU

PRE DIS LTSPICE

PRE DIS Voltage Stepdown

[Voltage Measuring PRE DIS](#)

[Electronics Intro Meeting](#)

KSU Motorsports

-

[#231 Kennesaw Motorsports Accumulator Tech Video for 2025](#)

KSU Motorsports

===MEETING NOTES===

Friday, August 08, 2025   12:23 AM

Docket:

1 - Seek opinions on our Project Priority document
2 - Plan and schedule future DAQ/LV classes and HV safety classes
3 - Future meeting structures (HV, DAQ/LV combined?) (fall was separate, spring was combined etc)
4 - Discuss how corner board will be handled between LV and DAQ subgroups
5 - Seek opinions on the current structure of LV OneNote

1 - Seek opinions on our Project Priority document

Email is thinking of a new dash design, simpler, only three required lights, but other people might want something else

- having it modular? the rules required is its own thing
- Different mounting?
- an/cannot be can

Email apparently also has a potential new steering design

- possibly have an SMD PCB adhered to the back of the steering wheel
- yap with email once design process of the wheel is started, discord messages at first

TCU

- Precharge and discharge don't need to be together
- The discharge does have to be within 150mm to AIRs but does have to be for anything post-MSD tractive
- Keep power to teensy if SDC gets broken
- Move the AIRs to lower part of container? - chanic
- Put the Precharge below lid to shrink - chanic
- Would be nice to have Precharge and Discharge separated for reliability- chanic
- Resize the resistor for the LED and keep it in the next design /s
- DCDC footprint need rotation
- Rapid on off of sdc prevention

RTML/AVI

- Could have the oscillatory blinking and activation circuit all TS
- Use optocoupler for isolating the output
- Simplify

VCU

- If VCU is split, one half will contain a lot and the other won't have much
- Need to iron out the multitude of SDC failure modes
- Possibly keep the same board, but change BSPD in little daughterboard
- Small micro for BSPD monitoring

ACU

- Galvanic isolators are discontinued

Split BMS senior design

- fuck kyle
- Would appreciate more eyes on split BMS senior design project?

In the chance that smaller gauge ends up being a want, ordering wire needs to happen soon. New wiring harness is like $500, can restock empty spools

2 - Plan and schedule future DAQ/LV classes and HV safety classes

- Val will be conducting her EV class on the 11th
- Will also be doing EV safety classes in the future
- DAQ/LV classes will be schedule another meeting

3 - Future meeting structures (HV, DAQ/LV combined?)

- DAQ and LV is good
- EV power should come to DAQ/LV when needed but otherwise should stay with driveline

4 - Discuss how boards will be handled between LV and DAQ subgroups

- DAQ has ctrl

5 - Seek opinions on the current structure of LV OneNote

- OneNote mobile doesn't show the indentation for subpages, so beware
- Need to port over old education materials and update the outdated
- REMEMBER TO SHARE YOUR SCREEN BEFORE MEETING

Bonus – Additional items discussed in this meeting

Data Aquisition

- stm32 eval board (aka the "hypergizmoid") handles any microcontroller need for DAQ
- Custom pi hat? Will reduce a lot of weight and wires
- Send some emails for foxglove and other shit
- Watchamacall it antennas mount the antenna amount the antenna and make a mount make car look stupid LOL
- [Garrett] DAQ battery (aka split BMS test battery) is not ready, Chanic might build one himself
- Split BMS firmware once DAQ battery is operational is expected to take 1-2 business weeks

EV Powertrain

- For the 2026 year, we are not 100% confident to have the split BMS by itself for 2026 comp
- Must have the Orion in the car as a backup even if not used

UNDERGLOW

- *"Now all of FSAE knows you're IMD tripped"*
- I really want this to happen lol

Things to improve next time

- Make sure screen is shared
- Have something for online fellows to engage in
- Have a presentation prepared for structure

14 AUGUST

Docket:
1 – Discuss corner board
2 – Briefly talk about the problem with daq pack last night

1 – Discuss future

Corner Board
- Front corner board is functional, but rear is experiencing some issues
- Rear corner board was communicating, but sensors were nonfunctional. 5V LDO was bridged between 5V lines on the board and that fixed the sensor readouts, but soldering a wire between the bridge caused everything to not communicate
- Will spend all of today troubleshooting the rear corner board

Project Priority
- Need to compile a list of projects we are certainly doing this year
-

DAQ
- Issues with DAQ pack last night were likely skill issue
- New router was gotten by Chanic, will hopefully make the daq pack wireless again
- Lap delta sims as project

Bonus – Additional items discussed in this meeting

Placehoder
- placeholder

21 AUGUST

Docket:
1 – What happened at Michelin this weekend
2 – Briefly talk about the problem with daq pack last night

1 – Discuss future

Michelin
- Orion BMS 2 CCL keeps thinking its done charging, auto sets to 0 and charge fault is existed
- Overdischarge fault happened, limited phase amps
- Rear right shock pot has connection issues
- Pi needs better buck
- NEVER DO A MEETING IN SHOP

Low Volage subgroup
- Port all the old educational materials to this oneonte as well as documents to the new teams
- Reduce wordiness of current landing page
- DAQ and LV ssr due 22nd
- Fix corner board and unfuck AN1

TCU
- KS9E will have TCU broken out into modular areas
- Only precharge and discharge has to be within 150mm but was combined into TCU for space constrains

Future
- Will have to do harness routing analysis
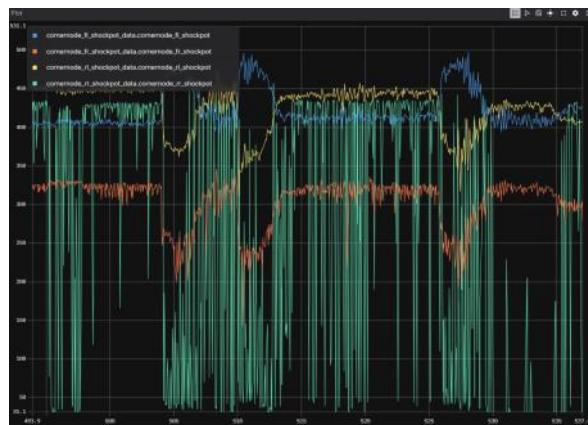
DAQ
- **Nick** helping with DAQ wiki LLM
- **Pettris** is working on file front end
- Need to discover all issues and document them on **AN1**
- HyperGizmoid name will also be referred as "AN1"
- **PI** hat is confirmed to be developed for rthis year
- Future developments for the PI include
- Need to further develop real time simulation, currently using assetto corsa
- Theory is to involve daq with real time simulation to allow for development without the car
- Also help drivers configure cars without a car
- Need to design a decent structure for documentation of code

Bonus – Additional items discussed in this meeting

Placehoder
- placeholder

https://lettucemeet.com/l/vGPV3

27 AUGUST

Wednesday, August 27, 2025   10:56 PM

Next DAQ/LV meeting will be the intro to LV class
Need to direct people to work on TCU and VCU ASAP

Quick Meeting with Val:

Dash:
- Have something looked at on 8th
- Questions ready by 3rd
- Can be postponed on 10th
- Driver interfaces will determine everything on dash in the end
- Ask clinton if he still has old design files of first dash

Testing battery (aka DAQ pack)
- Since the battery is now functioning as a BMS test bench, it would not make sense to have it just for daq pack
- Should fall under EV powertrain as it is BMS
- Wouldn't want expensive boards in the daq pack 😊

Altium
- I can now add members 😊
- For people that need altium experience earlier than altium classes, can point them to already made altium classes from last year

VCU
- TJ will be doing VCU wooooo
- VCU cant work on 24v
- VCU has unused IMUs
- DAQ connections can be removed
- Steering can be moved elsewhere
- Have ready to drive governed by VCU instead of dash

TCU
- Need to decide if anything on the board (specifically SDC) needs to have added design
- Can use the removal and fixing of footprints as a tool to teach altium
- SDC could receive an inline relay to halt the SDC powering the airs
- Val can do a redesign but will not like to design new systems
- TCU is still tbd

Other
- DRS will require new lv battery solution
- We have 300 pcs 3 pin smd molex male
- If half devices run on 12v and half on 24v, will need new PDU
- RTML light has documentation on fsaeonline
- Steering wheel buttons will probably be a week behind dash

3 september

Next DAQ/LV meeting will be the intro to LV class
Need to direct people to work on TCU and VCU ASAP

===PROJECTS===

Friday, August 08, 2025 6:12 PM

ETS Harness

PDU:

DEUTCH DT06-123 (DT-12 M)

PIN #1 -> INJS

PIN #2 -> COILS

PIN #3-> SHIFTING

PIN #4 -> O2

PIN #5 -> none

PIN #6 -> GROUND (SENOR = GREY)? (T3)

PIN #7 -> CLT FAN

PIN #8 -> FUEL INJECTOR

PIN #9 -> CLT PUMP

PIN #10 -> none

PIN #11 -> ?

PIN #12 -> ECU

DEUTCH IPD-USA DT04-12P (DT-12 F)

PIN #1 -> none

PIN #2 -> T1

PIN #3 -> F13

PIN #4 -> GND

PIN #5 -> GND

PIN #6 -> GND

PIN #7 -> TM

PIN #8 -> T2

PIN #9 -> T3

PIN #10 -> GND

PIN #11 -> none

PIN #12 -> none

COILS:

COIL B

COIL C

COIL A

COIL D

HyperGizmoid Universal DAQ board

Friday, August 08, 2025   6:12 PM

Bring-Up

July 30
- 50 pcbs board received
- All components

August 6
- Omron switches and USB-C port soldered on
- Stress tests of the FR-4 were done

August 7
- All QFN packages soldered
- RP2350 crystal and inductor soldered
- 3v3 reg and 12v buck auxiliary components soldered

==Troubleshooting==
- 3v3 outputting about 0.77v
- A resistor was accidentally bridged but that didn't solve anything
- USB-C correctly outputting 5.12v
-

August 12 findings-kali
- IO_VDD not connected to 3.3v
- USB_OTP_VDD is connected to 5v rather than 3.3v
- $\overline{RUN}$/reset btn needs a pull-up
- $\overline{QSPI\_CS}$/boot btn needs a pull-up

2025-10-02

Pull up resistors - very fucked
Replaced (incorrect) 1k pull-downs with 0Ω resistor
Bodge wire from push buttons to 1k pull-up
Bodge wire from RP2350 pin 53 to 3.3v
IOVDD bodged to 3.3v
Cut 5v trace from USB-C
Cut 5v connection to USB_OTP_VDD

- 12v synchronous buck is being back-fed without VIN power Theres no path to gnd on VIN (figure 3)
- **The 3.3v regulator is not a regulator, but rather a temperature to voltage IC (Fig 2)**
-

MCP970X

Note: Unless otherwise indicated, **MCP9700/9700A/9700B:** GND = Ground, C_{bypass} = 0.1 μF.
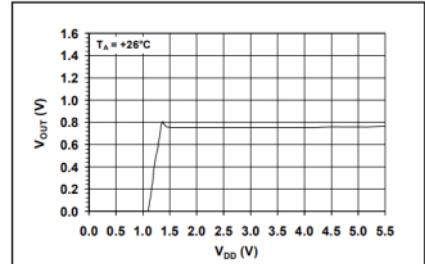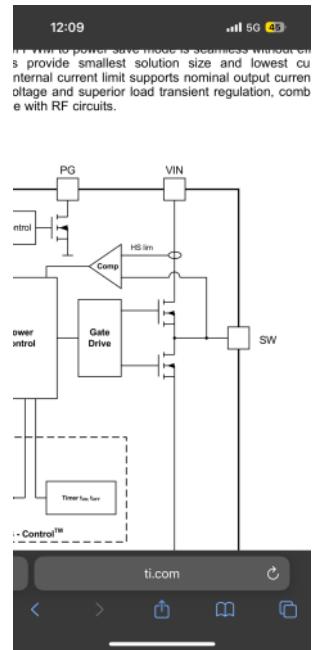
FIGURE 2-14: Output Voltage vs. Power Supply.

Figure 2, at around ambient (26 C), the IC will output roughly 0.75v

TPS62177DQCT

FigUTR 3

Pre-Budget Estimation #1

Monday, August 25, 2025   9:36 PM

Tractive Control Unit KS9 Estimation

ITEM	QUANT	TOTAL	NOTES
PCBs	5	$39.67	Standard pricing for 2 layer. Based on mm^2
Digikey MAX	1	$215.45	Reusing costly items such as AVI, TSMP, etc
Digikey MIN	1	$324.14	New everything, no reusing
TOTAL MAX		$255.12	
TOTAL MIN		$363.81	

Module Distribution Board KS9 Estimation

ITEM	QUANT	TOTAL	NOTES
PCBs	10	$108.85	Required $24 engineering fee due to size
Digikey	6	$1168.12	Not easy to reuse old MDB components
Pogos	324	$161.55	Money spreading. Springs were $44.76
2512	140	$19.6	2W, inrush preventing measures
MOS	140	$70	
IsoSPI	10	$54.49	Money spread
Trans	10	$32.7	Required for isoSPI to be iso
Other	1	$10	Tolerance
TOTAL		$1,625.31	

Vehicle Control Unit

ITEM	QUANT	TOTAL	NOTES
PCBs	5	$30	Typical cost for this size
Digikey	1	$300	Cant find BOM but have heard it to be $300
Padding	1	$70	
TOTAL	1	$400	

Tractive CTRL Unit KS9 Estimation
JLCPCB: $13.80 + $25.87
DIGIKEY: min $208.46 + $6.99 max $317.15 + $6.99

Module DISTRO Board KS9 Estimation
10x JLCPCB: $84.70 + $42.15
DIGIKEY: $1,168.12 + $161.55
Split BMS components:
2512: $19.6 - $30.47
MOSFETS: $70 - $100
IsoSPI CTRLer: $54.49 - $81.75
Isolator: $32.70
Additional Resistor: $10

KS7e VCU Analysis

What we know:

- One of the LM2904 op-amps were blown-up
- **The 5v regulator was discovered to be loose on the PCB.**
- There was a constant short on the 5v rail, but no resistance value was given.
- **The pedal potentiometers were questionable and were replaced shortly after.**
- The logic level shifter's MISO, MOSI, and CLK pins to the MCP3204 were not functioning.
- The Teensy 4.1 was still okay and a clock signal was still being read.

The IC's deemed faulty and replaced were all of the MAX7480ESA (u3, u4, u5, u6), the MCP3204 ADC (u7), the LM2904 opamps with outputs tied to the MAX7480ESA (u1, u2), and lastly the TXB0108PWR logic level shifter (u9).

"The 5v regulator was discovered to be loose on the PCB. "
An LDO's lack of a ground reference can cause its output to potentially rise up to its input voltage (12v)
LDO's react nearly instantaneously to its own feedback, the speed of the voltage change is purely mechanical contact
Vibrations from car cause its ground to disconnect and reconnect rapidly, potentially causing voltage spikes up to 12v
    Devices most likely affected and their VCC input Absolute Max Ratings:

- ○ MAX7480ESA Low pass Filters (U3, U4, U5, U6): 6v
- ○ MCP3204 ADC (U7): 7v
- ○ TXB0108PWR Logic Level Shifter (U9): port A is 4.6v and port B is 6.5v

This does not explain why the LM2904 (U1 and U2) op amps, which are rated up to 20v, blew up. Running theory is that there was a short from the MAX7480ESA to the output of the LM2904. Due to propagation delay and a much smaller parasitic capacitance on the output of the LM2904 vs its VCC pin, it likely experienced a brief backfeed of current into its output pin, causing a runaway event as the op-amp attempts to correct its output.

"The pedal potentiometers were questionable and were replaced shortly after "
This theory relies on the floating GND of the 5v LDO, the MAX7480ESA and the LM2904 experience an internal short, and the PTC fuse being too slow.
The pedal potentiometers are 5k ohms with a wiper connected to signal output.
At resting position, say about 5%, there is 5% of 5k ohms in between signal output and GND.

$$5000 \text{ ohm} * 0.05 = 250 \text{ ohms}$$

Pedal pot is rated for 0.15 watts of dissipation across its entire wiper (most likely)

$$0.15w * 0.05 = 0.0075w \text{ of actual dissipation between 0-5\% wiper}$$

If a short were to be made between 5% and GND, it would produce:

$$12v/250ohms = 0.048 \text{ amps}$$
$$12v * 0.048a = 0.576 \text{ watts}$$

Over half a watt over the max rating.
Very likely instantly burned the pot in that range, or maybe increased PTC resistance until no further damage.
Could also be a mix of both?

"**Why did the car produce 100% torque during the event?**"
The pedal inputs are read by an automotive-grade 12-bit MCP3204 which communicates over SPI.
SPI, at least from what I've gathered, is a very basic protocol with no data integrity confirmation.
The Teensy sends a clock pulse and reads "voltage or no voltage ".
Assuming it communicates a 12 bit string of 1s and 0s, if the over voltage caused the ADC to short its data out pin to +VCC, the Teensy would have received 111111111111 (aka the highest number represented by 12 bits) once it cycles the clock enough times.
The Teensy has no way to tell if that data is legit or not due to SPI's simplicity, but I have not confirmed this with the MCP library.
The car's BSPD shutdown circuit activated successfully as a result of brake input (I assume), which could confirm that the BSPD was fully functional at that time.

Since this issue happened the day before we were leaving for a shootout event, we had to complete many of these fixes at the shootout event. When running through an EV active inspection, we first learned that the BSPD circuit was no longer functioning. Therefore we have no idea if this happened from the same pedal box incident or from human error during fixes.

Upon diagnosis at the shootout event, we determined the only two IC's that were dysfunctional. This included the entire 4 channel NAND gate (u24) and the SR latch (IC1). Everything else on the board, including the CAN transceivers which operate on 3.3v, were functioning fine. The issue was never fully understood. The damaged ICs were replaced and the same board is still working to this day.

"Why were CD4011BM96 and CD4043BD found dysfunctional at Pitt EV Active?"
Probably the most puzzling problem, as the timeline isn't super clear.
Both of these chips were designed in 1970s -> probably worse input protection, but they were built on a stronger process
Both of these chips are CMOS based -> lesser Electrostatic Discharge resistance
Both of these chips are not ESD rated in any form, but similar era chips on the VCU were rated up to 2kv
2kv ESD is very low by today's standards and can occur without feeling anything

Conclusion:
During the lengthy process of replacing U1-U7 and U9, an unnoticed ESD event may have occurred.
Since the rest of the chips were already blown up or were in the process of getting replaced, the only CMOS-based devices left were these chips.
I also do recall us not having another logic level shifter and having to spend a long time retrofitting a different one using bodge wire.

"Why didn't the OR gate blow up too?"
The OR gate is a slightly newer made chip, so maybe it included some form of input protection.
The OR gate had a much smaller footprint and could've been less likely to capture ESD or experience large voltage gradients.