Outputs

Amber LED connector

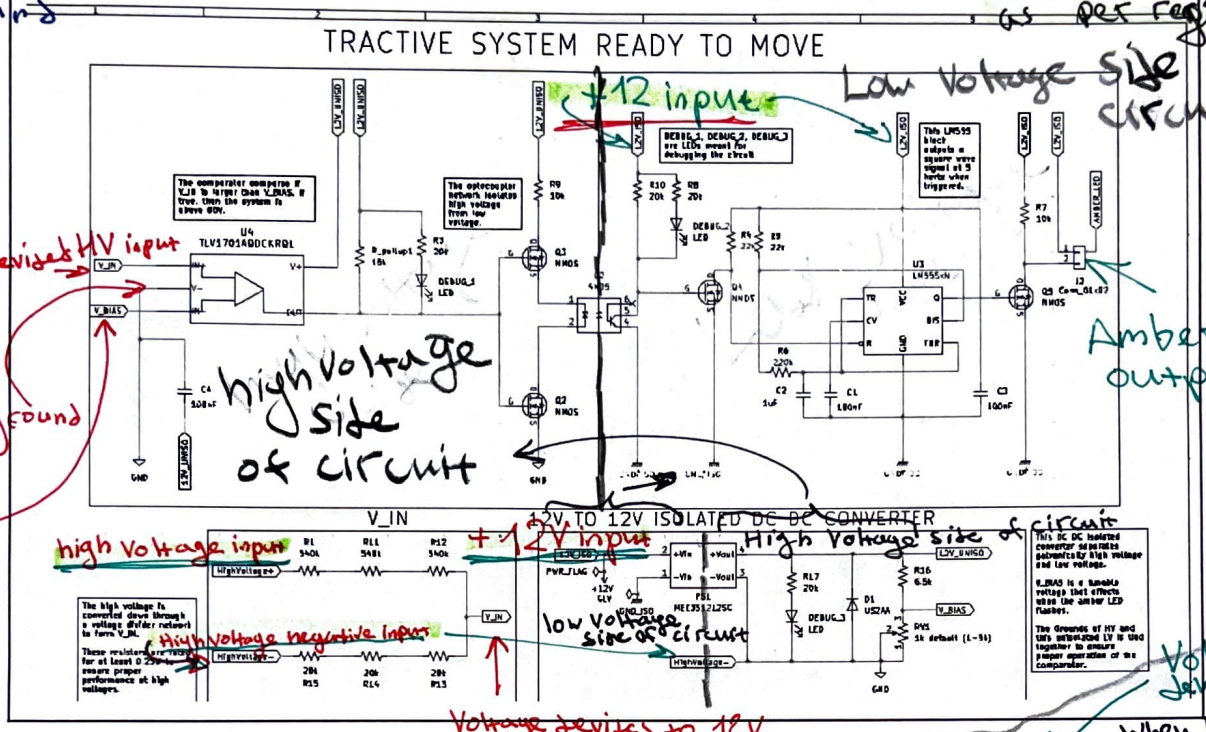
inputs

- High voltage +
- High voltage −
- +12 input
- ground

Schematic

Labeling inputs / Outputs

can see circuit is fully seperated into high voltage side and low voltage side as per regulations



Voltage devider calculation 1

When high voltage is

High Voltage Input

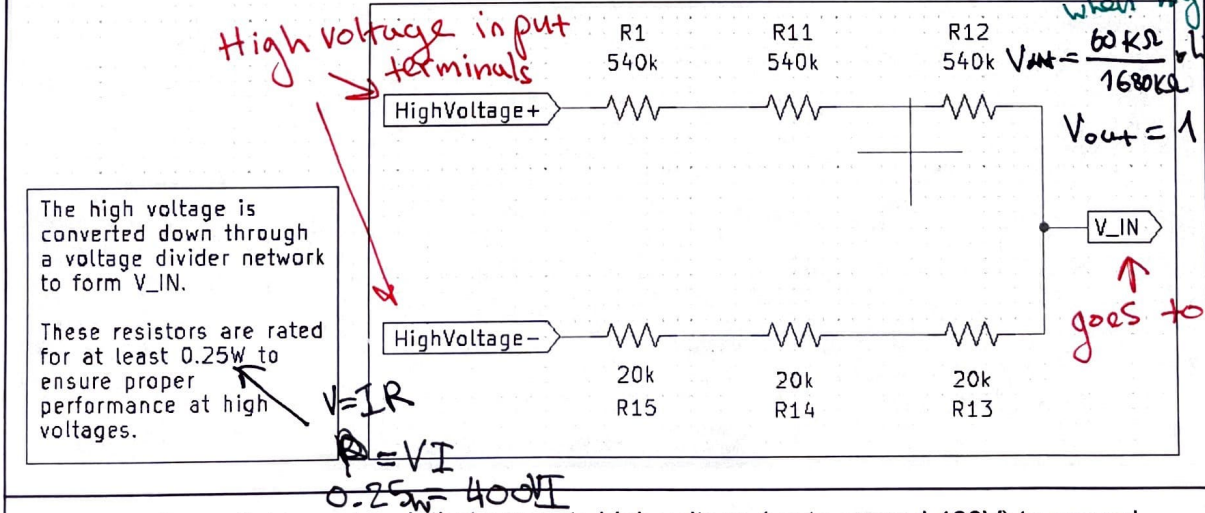
Voltage devider

$V_{out} = \left(\frac{R_2}{R_1+R_2}\right) V_{in}$

this circuit

$V_{out} = \frac{60K\Omega}{1680K\Omega} \cdot (60V)$

$V_{out} = 2.14V$



When high voltage is 400V

$V_{out} = \frac{60K\Omega}{1680K\Omega} \cdot 400V$

$V_{out} = 14.2V$

$V = IR$

$P = VI$

$0.25W = 400I$

This is a voltage divider network that converts high voltage (up to around 460V) to around

$R_{total} = 1680{,}000\Omega$

Max I through circuit is 0.625 mA at 400V in order for resistors to with stand

$V = IR$

$400 = I\,1680{,}000\Omega$

at 400V $I = 0.238\,mA$ through this circuit which means 0.25w is more than enough

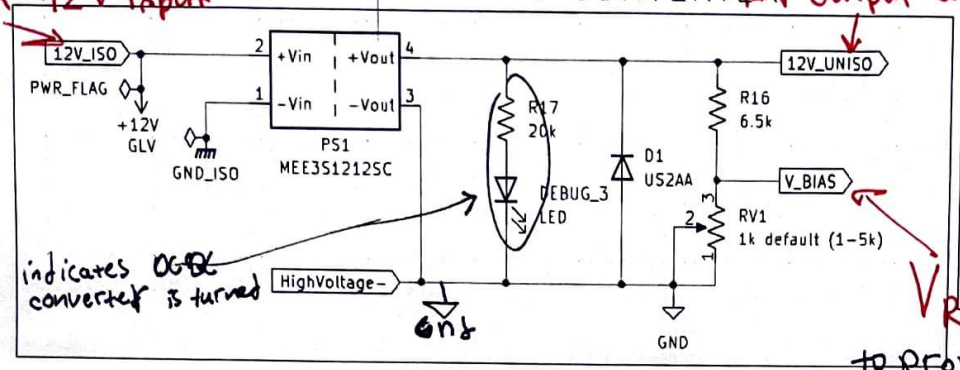
→ Electronically isolates two grounds
input ground and output ground are not electronically connected
• Noise on input ground doesn't pass to output ground

12V-12V Isolated DC-DC Converter

converter will block short circuit currents from entering low voltage side
thus if there is short circuit on low voltage side high current from high voltage side will not pass

12V TO 12V ISOLATED DC DC CONVERTER

Regular 12V input



12V output used for comparator high voltage isolated

indicates OCPC converter is turned

V_{ref} for comparator to provide sufficient reference (2.14V)

A 12V to 12V Isolated DC-DC Converter ensures that high voltage and low voltage are sufficiently isolated. Make sure to choose one with a voltage isolation of over 500V.

The Zener diode D1 is used as an ESD protection diode. Make sure it triggers at 15V to prevent excessive voltage.

There is a potentiometer (from 1 to 5k) that will be used to vary the bias voltage.

~~= 2.14V~~

$12V \cdot \frac{2k}{8.5k} = 2.8V$

RV1 should be set to slightly below 2K

note that V_Bias (V_{reff} for comparator) has ground ~~from~~ shared from High Voltage side

Zener diode designed to conduct current in reverse direction at specific "Zener Voltage"

Zener diodes are used in Voltage regulation
↳ for low current tasks

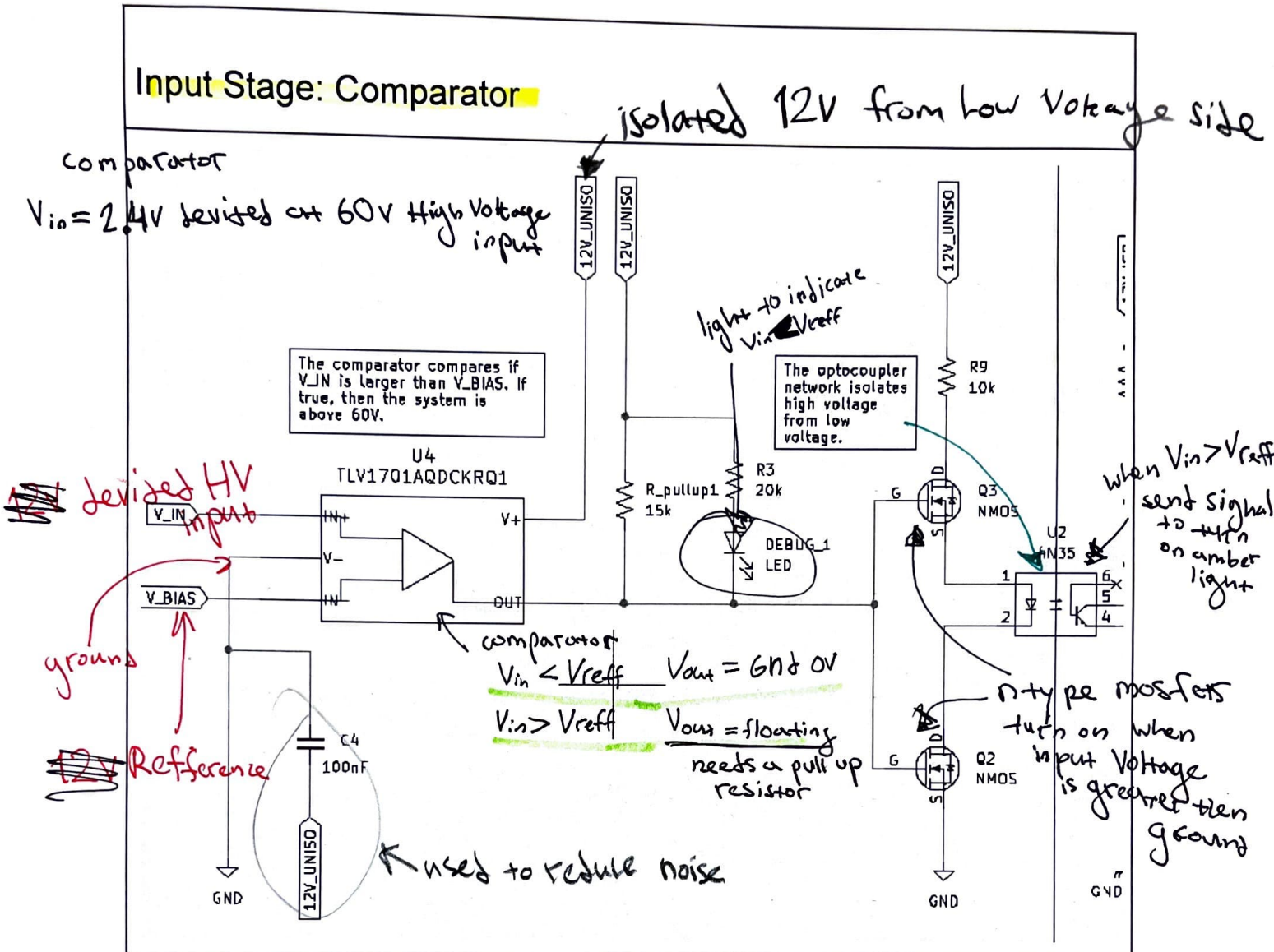
Zener diode Voltage regulator

+ $V_{regulated}$

Zener diode will regulate Voltage across it by sending access voltage ~~if~~ if it is higher than zener Voltage to be dropped by resistor in series

in this case zener diode pulls outputs to ground on high side 12V unISO and V_Bias when Vout from converte exceeds zener voltage threshold preventing comparator from reciving measurments to compare

Input Stage: Comparator



If V_IN is higher than V_BIAS, then it means that the high voltage is larger than 60 volts. Thus, this comparator will produce a high signal and turn on NMOS Q3 and NMOS Q2, which will turn on the optocoupler.

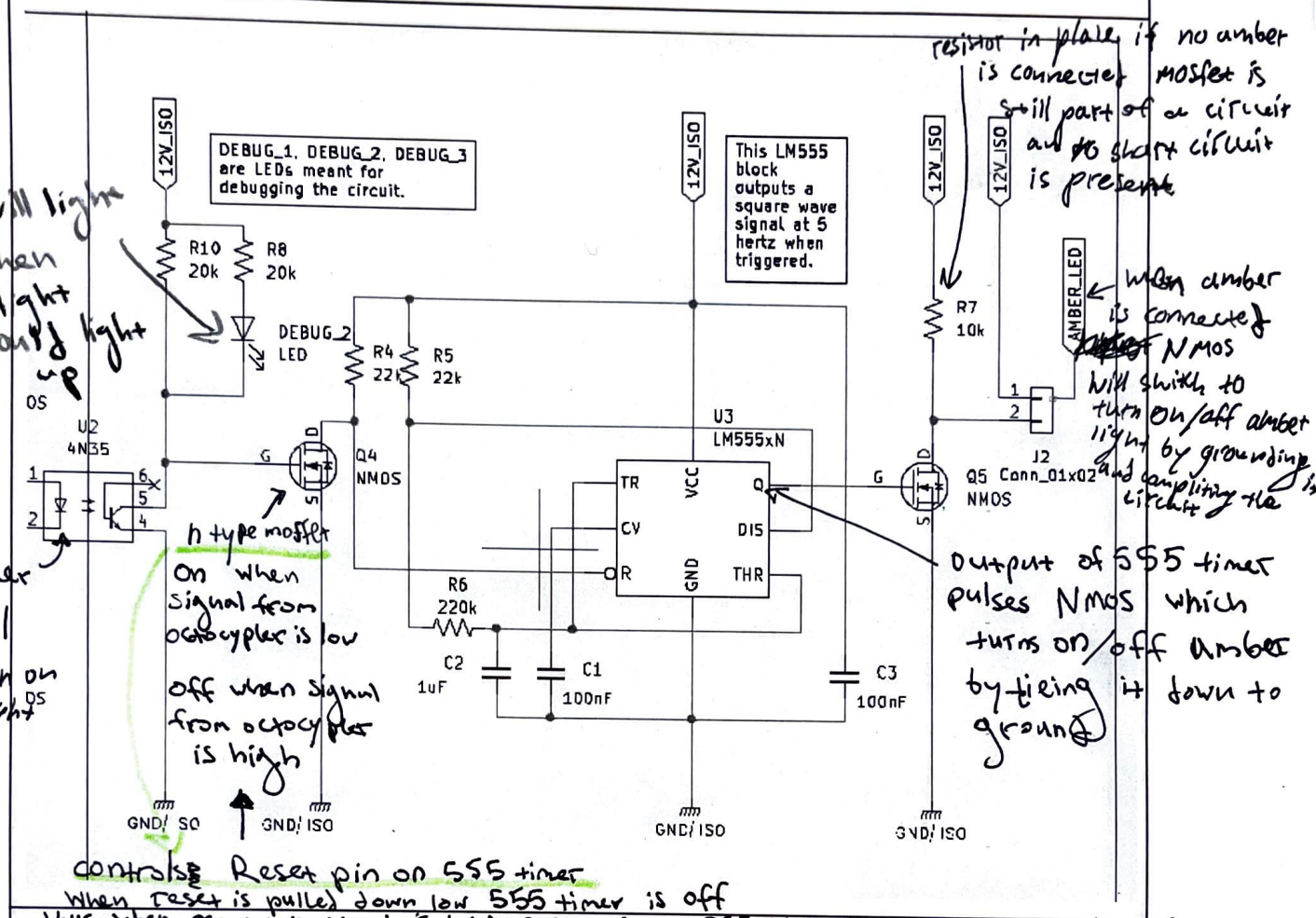
This NMOS Q2 and Q3 network helps to isolate the optocoupler when HV is floating, off, and on.

Resistor values (10k, 15k, 20k) can all be set to 22k (or any other **larger value**) for convenience.

Both inputs Vreff and Vin (devided high Volt input) have same ground ← thus op amp comparator can compute voltages correctly (need to share common ground)

highside ground

Output Stage: Amber LED



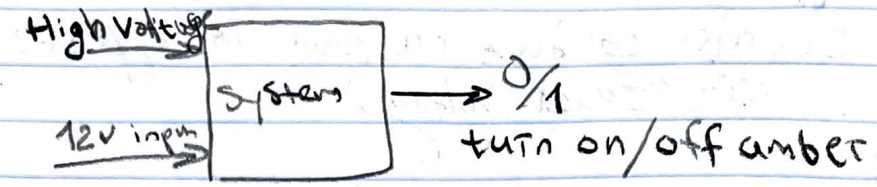
The 555 timer block produces a 5 Hz signal to trigger the AMBER LED.

Note that the AMBER LED is configured assuming the ground switching configuration.

Capacitor values must be EXACT to produce a 5 Hz signal.

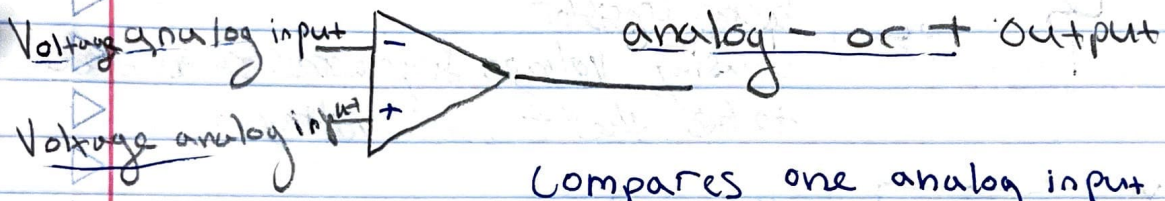
FSAE Notes

tractive system ready to move



indicates weather high voltage is present with flashing amber light

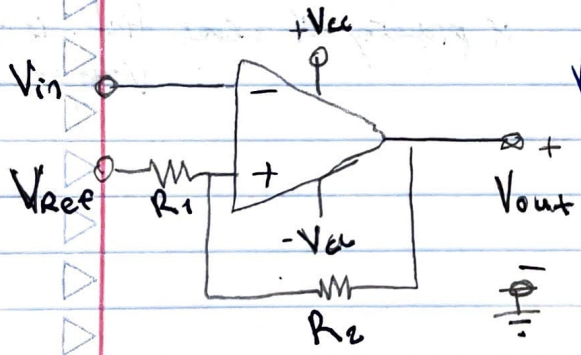
based on Voltage Op amp Comparator



compares one analog input voltage level with Voltage Reference

↓

produces output based on voltage comparis



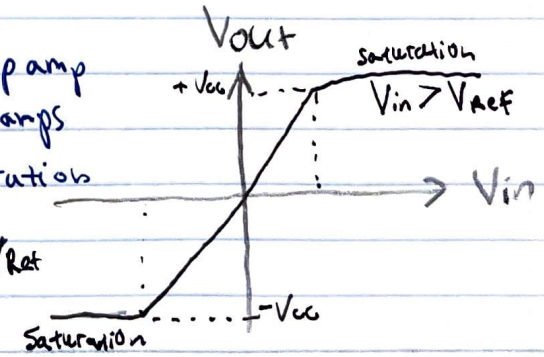
output (analog not digital)

if $V_{in} > V_{REF}$ then $V_{out} = +V_{cc}$

if $V_{in} < V_{REF}$ then $V_{out} = -V_{cc}$

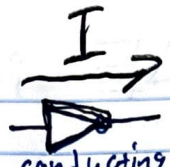
as you can see from graph Op amp Voltage comparator is just op amps set up to easily reach saturation when seeing signal difference

$V_{in} < V_{Ref}$



Value on output is dependent on Vcc voltage

zener diode



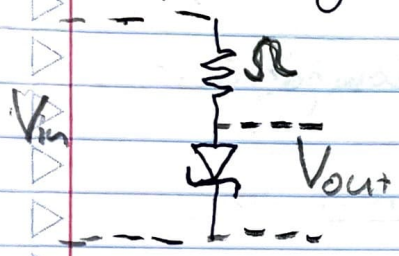
↳ acts like a regular diode — conducting current only in one way

↓

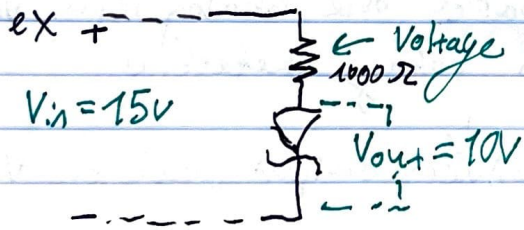
can also conduct current in opposite direction at a specific "zener voltage"

↳ can be used as voltage regulator to maintain a stable voltage

Simple voltage regulator using zener diode



- regulates output voltage across zener diode by dumping acces voltage to voltage drop across resistor causing voltage drop across zener diode to be the "zener voltage"



← Voltage drop 5V

if property of zener diode is zener voltage 10V