OR21-BSPD

Brake System Plausibility Device - BSPD

A standalone nonprogrammable circuit must be used to monitor the electronic throttle control.

The BSPD must be provided in addition to the plausibility checks in the ETC which interpret the drivers throttle request and control the engine throttle position.

IC.4.8.2 Signals from any sensors must be sent directly to the BSPD. Outputs from other modules may not be used in place of the raw sensor signals.

IC.4.8.3 The BSPD must monitor for the following conditions:

a. Both of the following for more than one second:
   - Hard braking (for example >0.8 g deceleration but without locking the wheels)
   - Throttle greater than 10% open

b. Loss of signal from the braking sensor(s) for more than 100 msec

c. Loss of signal from the throttle sensor(s) for more than 100 msec

d. Removal of power from the BSPD circuit

IC.4.8.4 When any of the above conditions exist, the BSPD must:

- Shut off power to the electronic throttle
- Shut off fuel flow
- Close the throttle to the idle position

IC.4.8.5 The BSPD must only be reset by cycling the Primary Master Switch **IC.8.4.3** OFF and ON

IC.4.8.6 The BSPD must not reset when the Cockpit Master Switch **IC.8.4.4** is turned OFF

IC.4.8.7 The BSPD signals and function must be able to be checked during Technical Inspection by having one of:

a. A separate set of detachable connectors for any signals from the braking sensor(s), throttle sensor(s) and removal of power to only the BSPD device.

b. An inline switchable breakout box available that allows disconnection of the brake sensor(s), throttle sensor(s) individually and power to only the BSPD device.

IC.4.8.3

IC.4.8.3a

a. Both of the following for more than one second:

- Hard braking (for example >0.8 g deceleration but without locking the wheels)
- Throttle greater than 10% open

To meet condition **IC.4.8.3a.1**, an AND gate will have the following inputs:

1. *Voltage comparator* will compare the ***FRONT*** *Brake System Encoders* against the corresponding value of appx. **590 PSI**. (appx. 1.48V). This value is determined from previous data, acquired while the brakes were rear brake biased, meaning this value is the "lowest" it'll ever be. An example is shown below:

    a. *Braking at appx. 0.8g*
    b. *Front Brake Pressure: 590 PSI*
    c. Rear Brake Pressure: 301 PSI

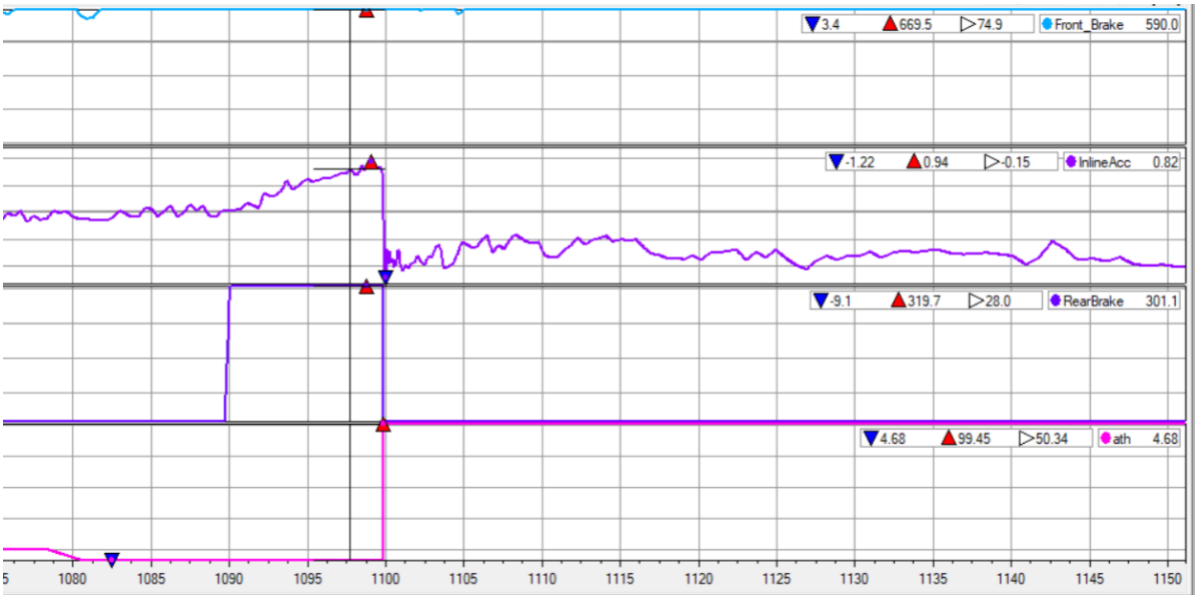


Figure 1: Heavy braking data example

2. Accelerometer ADXL337 analog output, compared with the according value of appx. 0.8g in the direction opposite to braking. (appx. 2.1V)

To meet condition **IC.4.8.3a.2**, a *voltage comparator* will compare **one** of the *Throttle Position Sensors* against the corresponding value of 10% throttle. (appx. 1V).

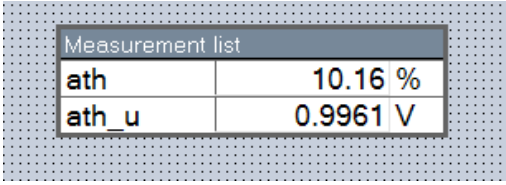


Figure 2: Voltage at 10% throttle

Both (**IC.4.8.3a.1 & IC.4.8.3a.2**) are connected to an AND gate. A subsystems level diagram is shown below

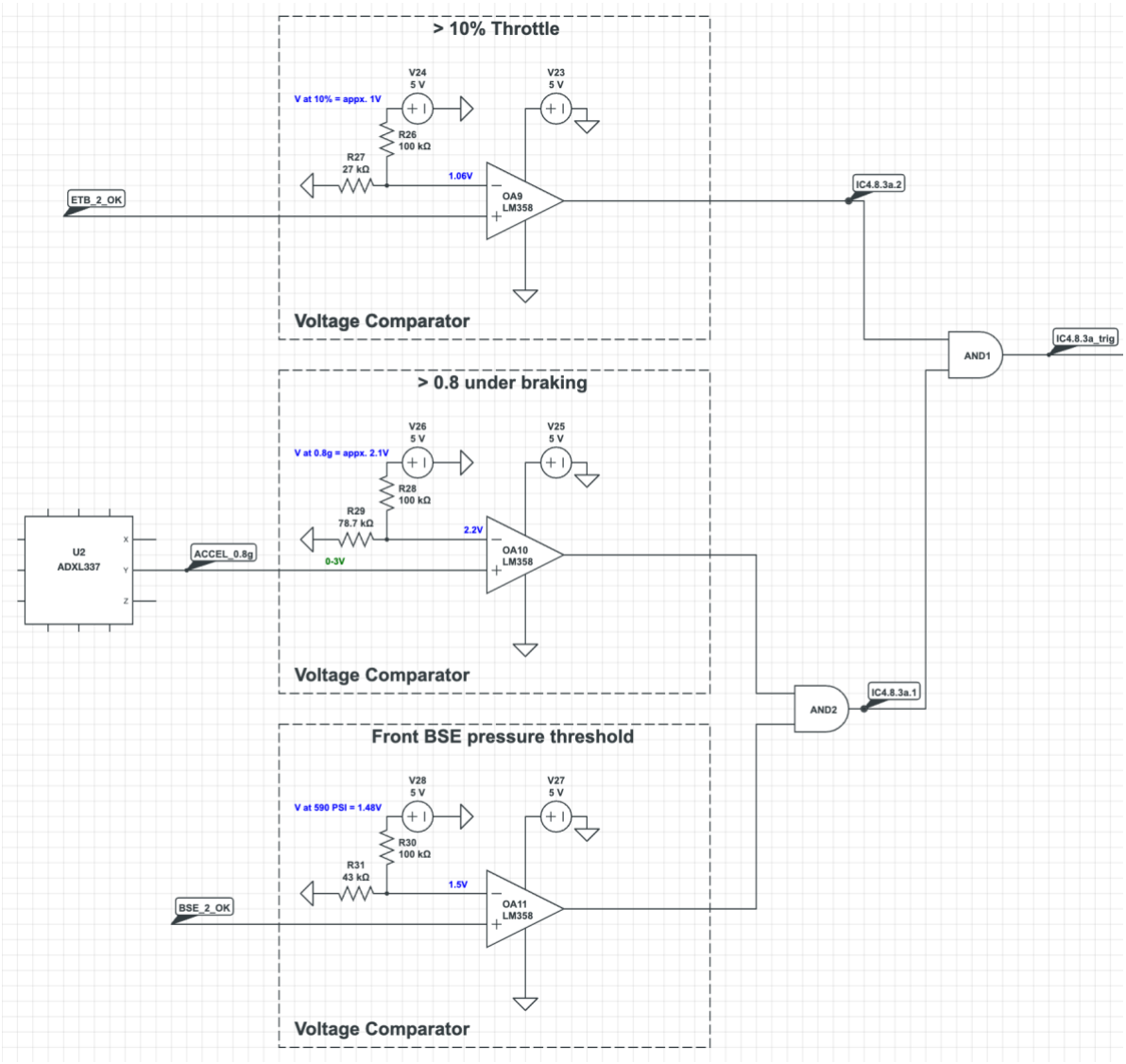
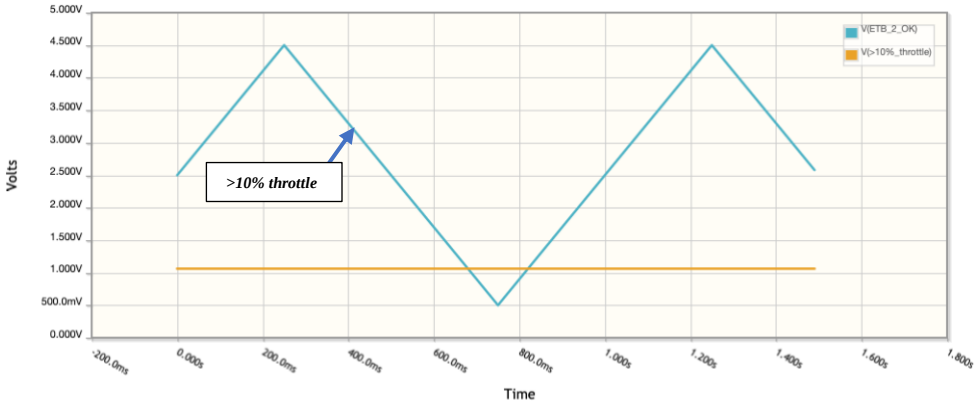
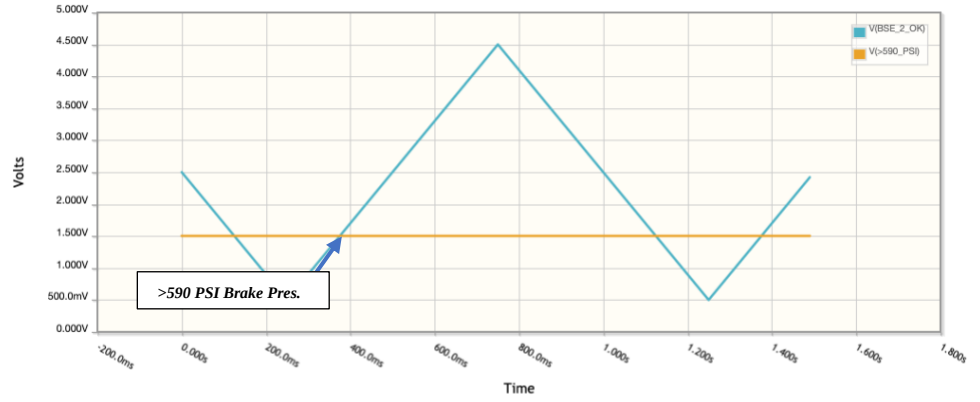
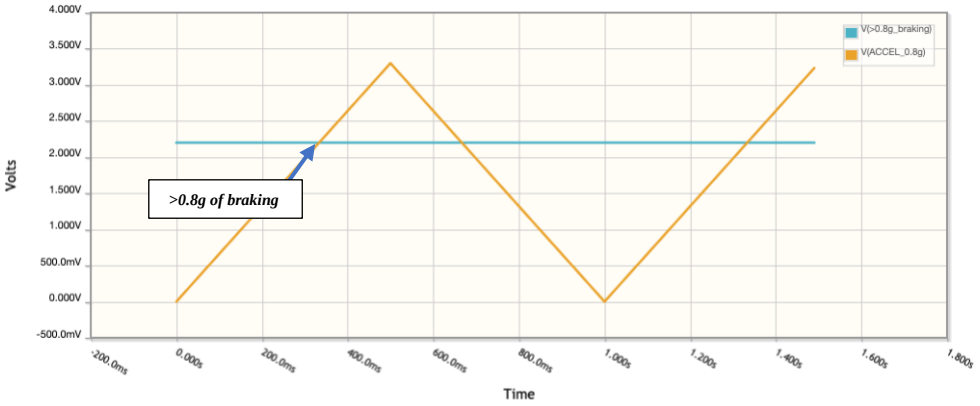


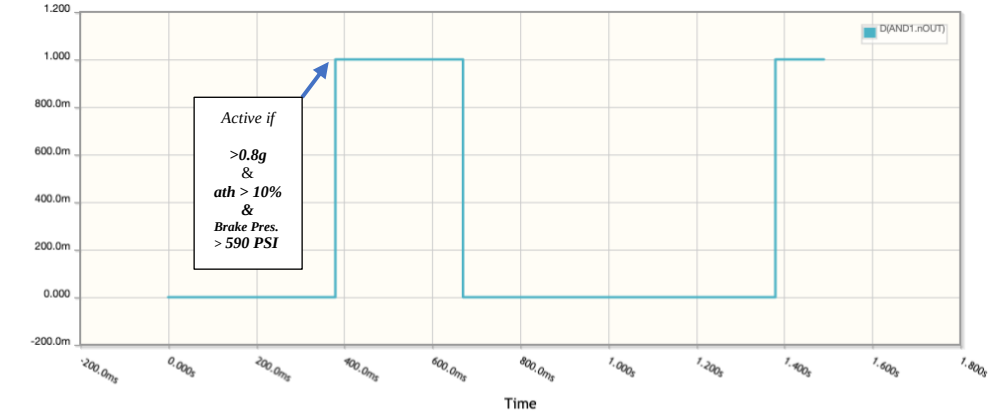
Figure 3: IC 4.8.3a sub-systems diagram 1

Simulation of IC.4.8.3a sub-system









The output of this AND gate is connected to an RC circuit, with a charge up time of around 1 second. If the fault persists for more than 1 second, a comparator will output a fault, and trigger a ***one-time pulse.***

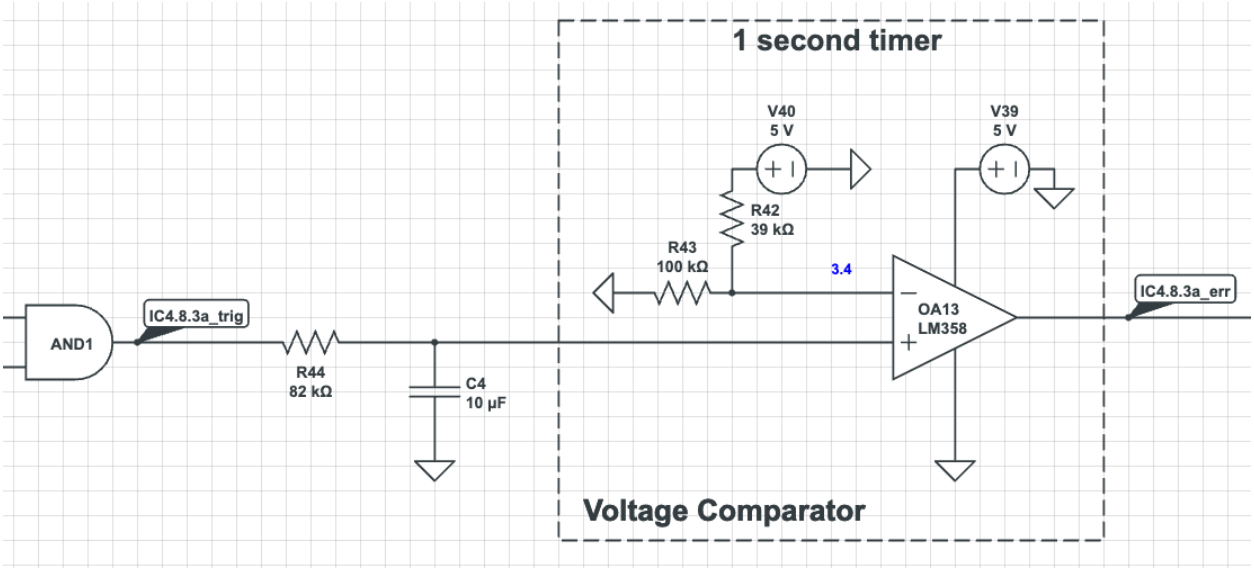
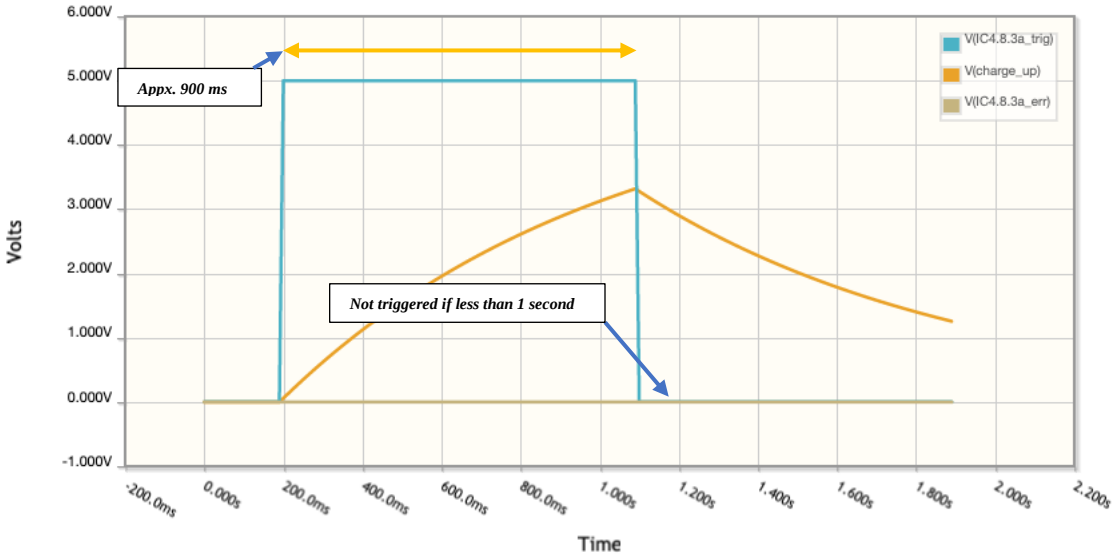


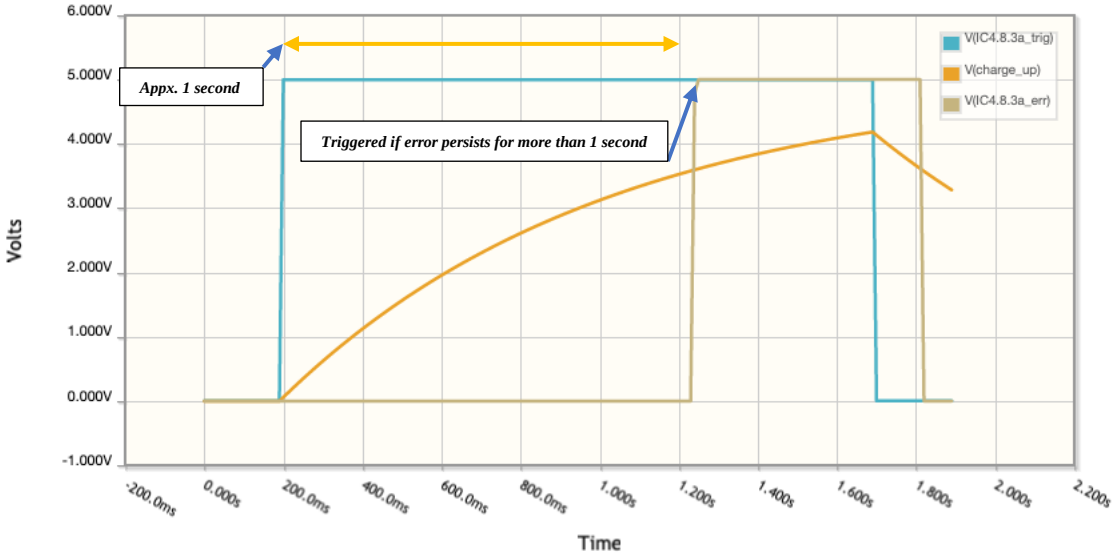
Figure 3: IC 4.8.3a sub-systems diagram 2

IC 4.8.3a sub-system Simulation Results

No-error:



Error:



IC.4.8.3b & IC.4.8.3b

b. Loss of signal from the braking sensor(s) for more than 100 msec

c. Loss of signal from the throttle sensor(s) for more than 100 msec

The ***brake pressure sensors*** output voltage range is 0.5V & 4.5V. To test for open circuit, the signal is put through comparators, with a low-level trigger of 0.455V, & and high-level trigger of 4.55V. A pull down resistor will assure that the **if the circuit is open, the comparator circuit will trigger.**

Similarly, the ***throttle position sensors*** range from 0.5 V to 4.5V, and from 4.5V to 0.5V. The same comparator circuit used for the brake pressure sensors is used to detect open circuit.

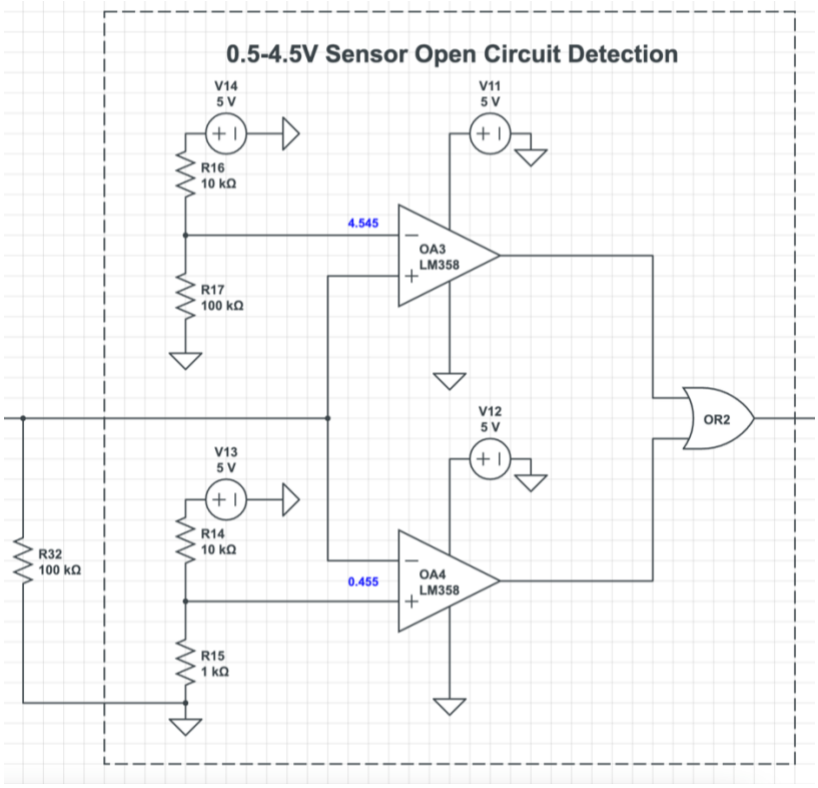


Figure 4: IC 4.8.3b & IC 4.8.3c sub-systems diagram

The circuit shown in **Figure 4** is replicated for all 4 sensors, 2 brake pressure sensors & 2 throttle position sensors. The outputs are then connected to a 4 input OR gate, who's output cause the ***one-time pulse*** to activate.

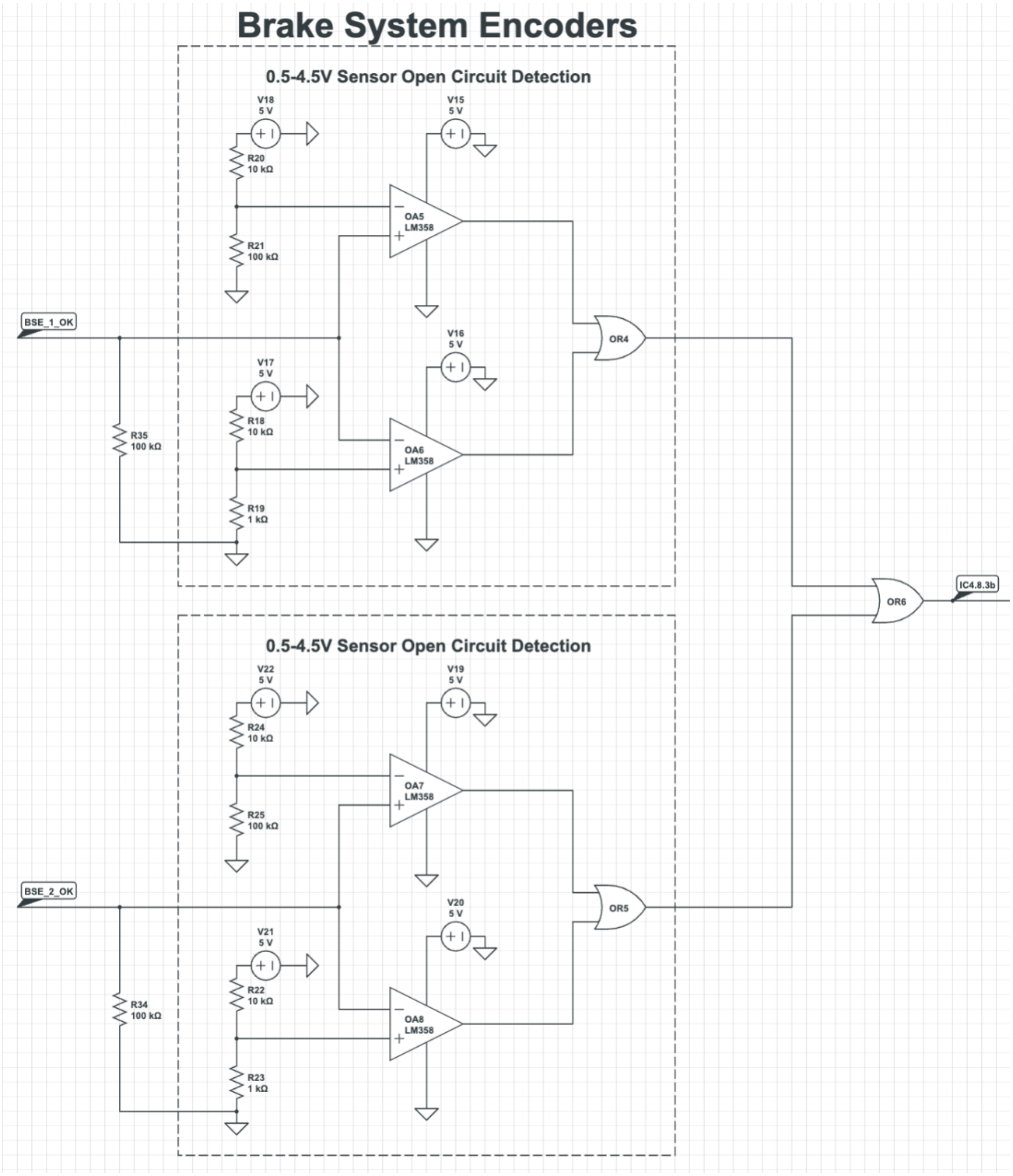


Figure 4: IC 4.8.3b sub-systems diagram

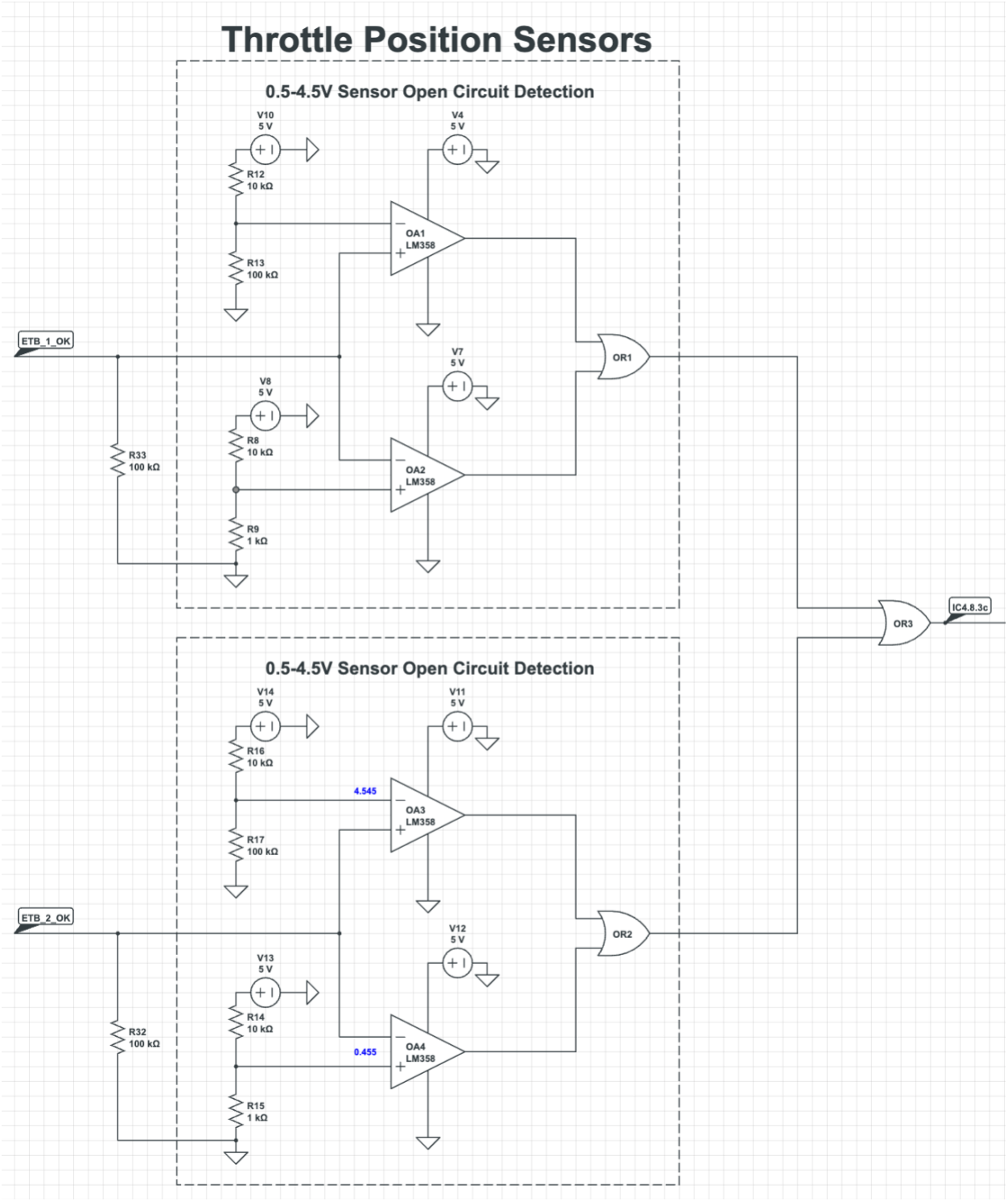
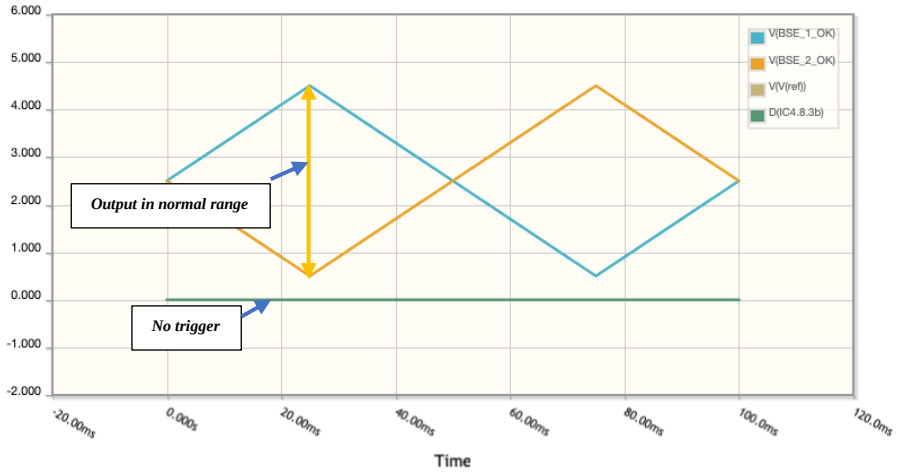


Figure 5: IC 4.8.3c sub-systems diagram

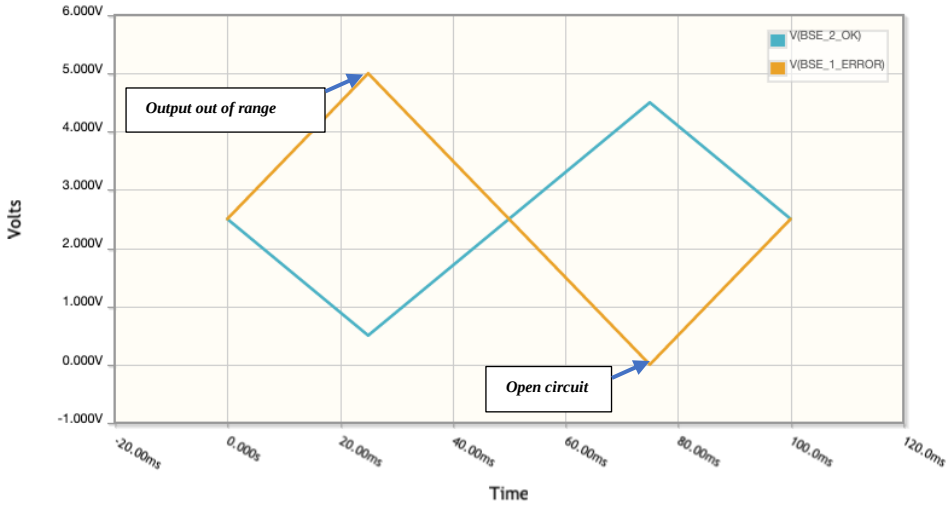
Note: Only the brake pressure sensor simulation is shown below, since the throttle position sensors share this circuit.

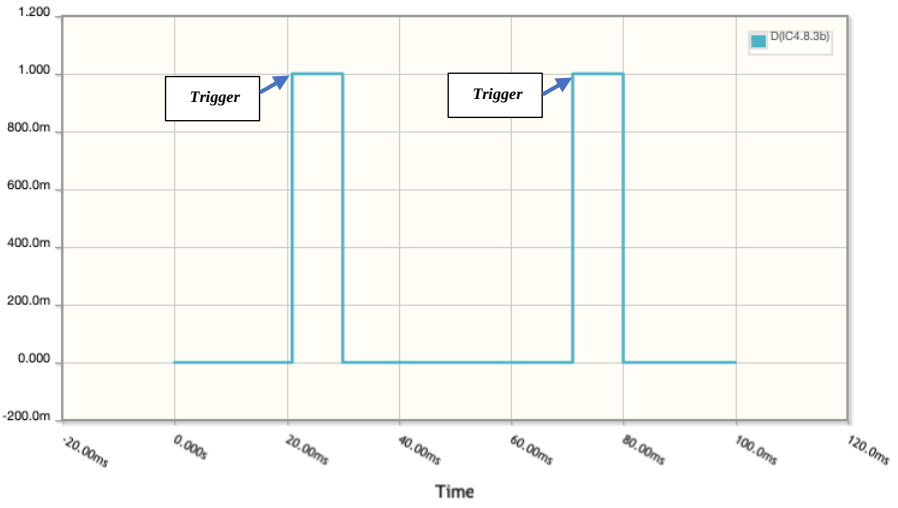
IC 4.8.3b sub-system Simulation Results

No Error:



Error:





IC.4.8.3d

d. Removal of power from the BSPD circuit

The final stage of the ***one-time pulse*** is a N-Channel MOSFET. This turns-on a relay that connects one of the ETB motor signals from the ECU to the throttle body.

The relay will only be on if the base is high-level voltage. which can only be provided through a pull up resistor if there's power to the BSPD.

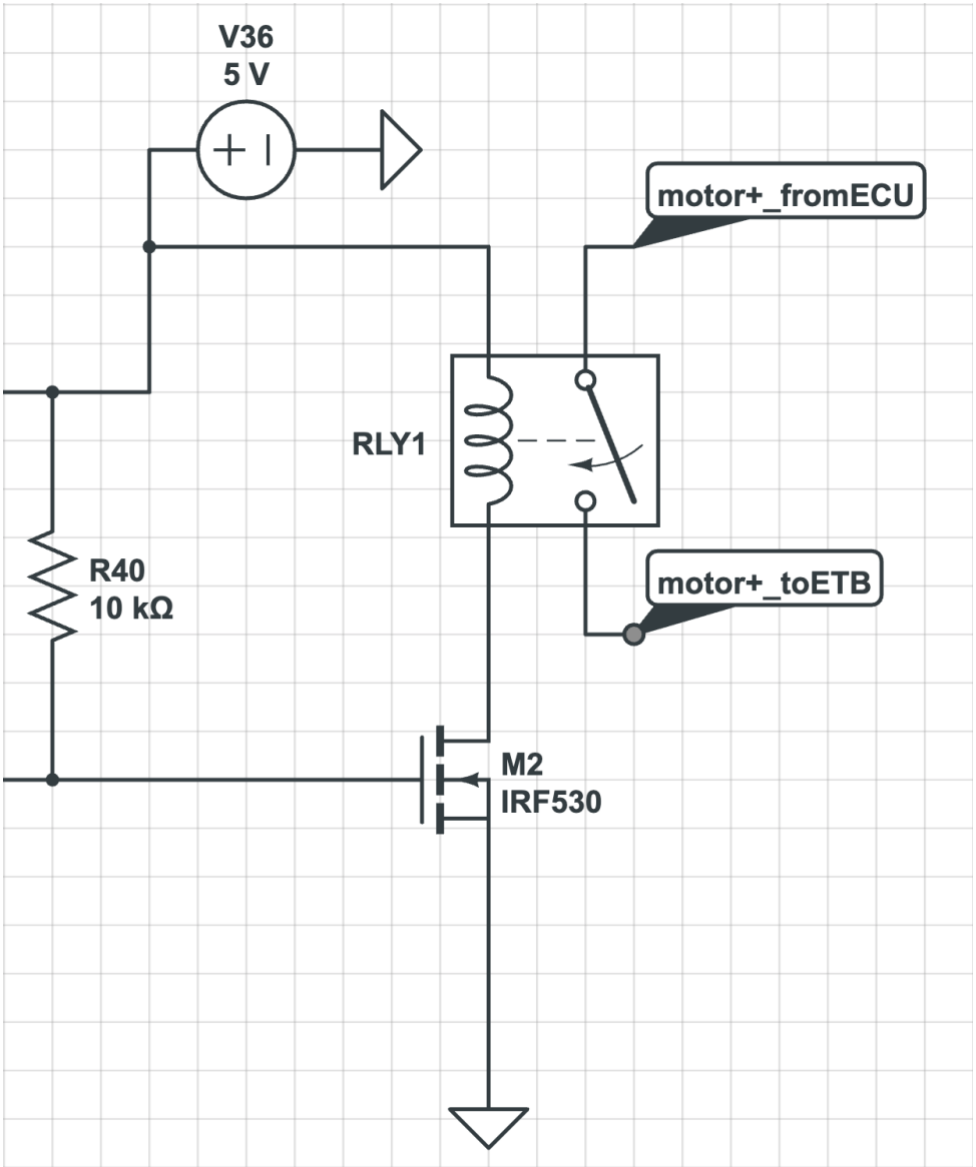


Figure 6: IC 4.8.3d sub-systems diagram

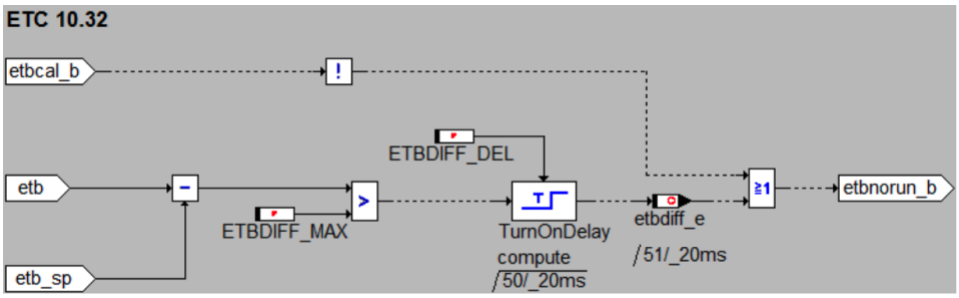
IC.4.8.4

IC.4.8.4 When any of the above conditions exist, the BSPD must:

- Shut off power to the electronic throttle
- Shut off fuel flow
- Close the throttle to the idle position

Since one of the motor driver signals is cut when the BSPD detects an error, the ECU will detect a mismatch between the expected ETB position & the feedback from the throttle position sensor.

This will activate a flag ***etbnorun_b,*** causing ignition & injection outputs to be shut off, and the power to the ETB is interrupted by the ECU, causing it to return to idle position.



Definitions:
ETBDIFF_MAX: maximal system deviation error
ETBDIFF_DEL: Timer delay system deviation error

etb: Electronic Throttle Current Position
etb_sp: ETB set point
etbnorun_b: Condition ignition/injection off

IC.4.8.5 & IC.4.8.6

IC.4.8.5 The BSPD must only be reset by cycling the Primary Master Switch **IC.8.4.3** OFF and ON

IC.4.8.6 The BSPD must not reset when the Cockpit Master Switch **IC.8.4.4** is turned OFF

The final stage of the BSPD the ***one-time pulse,*** that is activated by the output of a flip-flop. This means once the flip flop is set, it can only be reset by a power-recycle.

The power to the BSPD is given directly by the Main Kill Switch (1A fuse). The cockpit kill switch has no connection to the BSPD. In case of failure, even if the driver reset's the ECU with the cockpit kill switch, the ECU will detect open circuit on the output signal of the motor driver, and leave the ***etb_e*** flag on, preventing any ignition or injection outputs from happening.

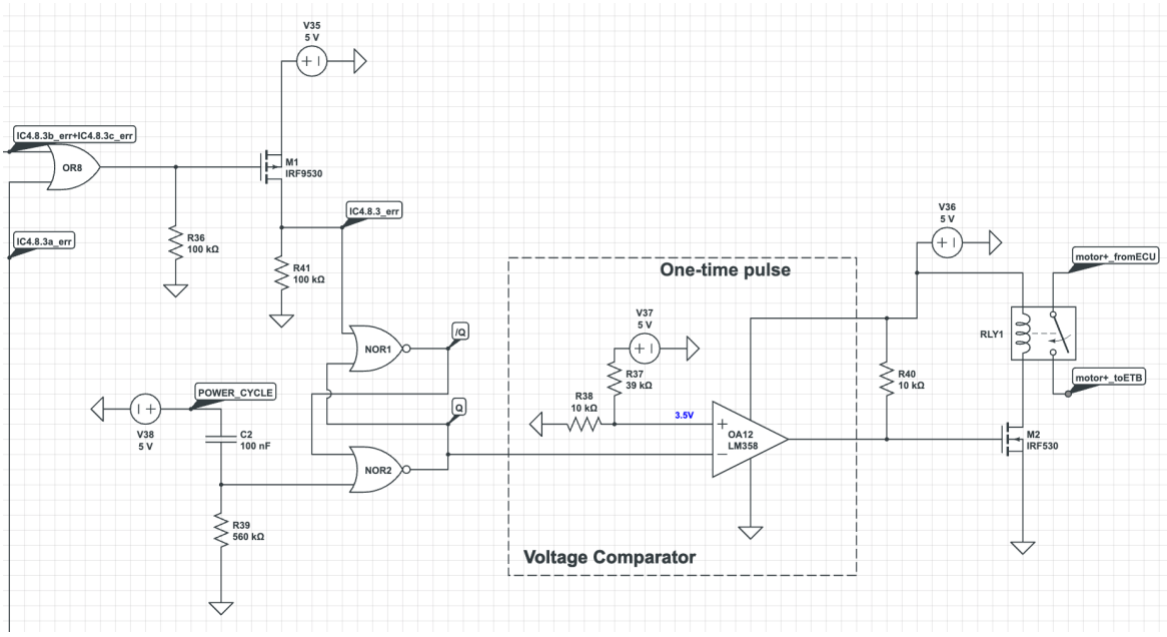


Figure 6: IC 4.8.3 final stage sub-system diagram

Final stage simulation