1 TS_Error Latching

See: AMS Master - TSAL Logic

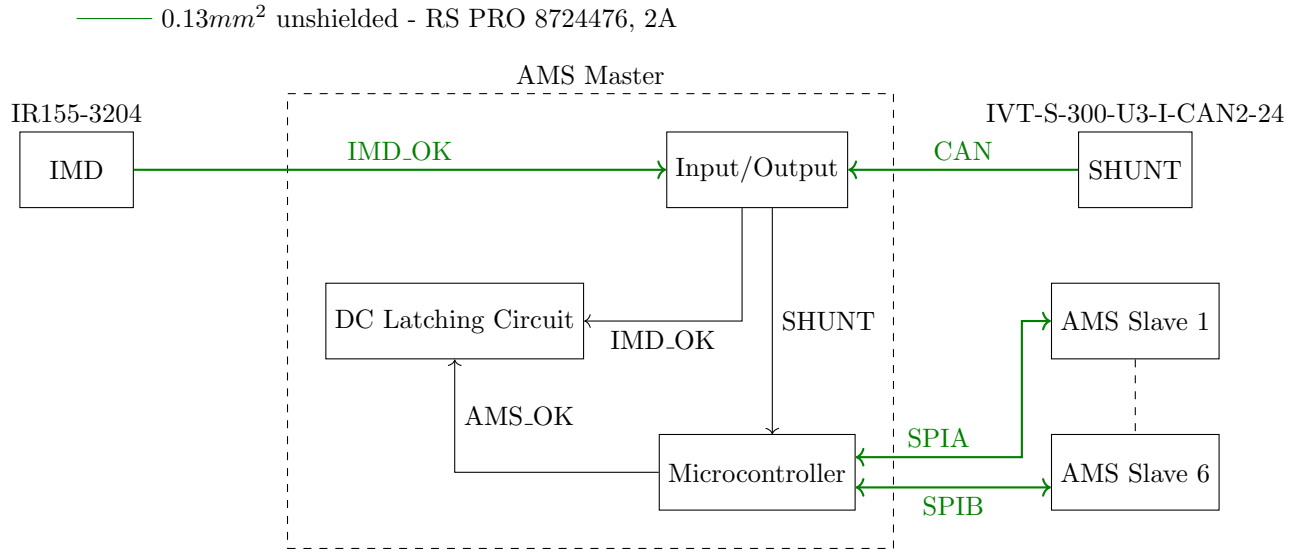
Once the state of $\overline{\text{TS\_Error}}$ is reached for more then $1s$ (to prevent noise from causing an error), the latch U8 (74LVC1G74 [1]) will be triggered. This cannot be reset, unless a LVS power cycle is carried out. The backup pull-down resistor R9 for discharging the capacitor can also be placed if the CLR pin does not discharge fast enough.

1.1 IMD Latching

- The `IMD_OK` signal is pulled high approximately 1.5 seconds after startup for the IR155-3204 IMD. [3]
- Therefore the Power-on Reset (PoR) lasts approximately 2 seconds.

1.2 AMS Latching

- The `AMS_OK` signal is pulled low until the following conditions are met:
  - The AMS Master communicates with all six AMS Slaves, each providing valid voltage and temperature measurements.
  - The AMS Master communicates with the shunt sensor (IVT-S-300-U3-I-CAN2-12/24)



2 SCS signal implementation

2.1 Relay states

See: AMS Master - AIR Relay State Detection

The relay state is measured through a set of voltage dividers and window comparator circuits. The `Closed` signal is used for the state detection logic (which controls the TSAL green LEDs). When the aux cable are open, it is the same as the $\overline{\text{Closed}}$ state, which will keep the green TSAL off. The "short to GND" state can be ruled out by the comparator which compares the signal with a 0.3 V reference.

See: AMS Master - Precharge State Detection

Since we do not have aux connections with our precharge relay, the circuit works differently then the AIRs. Here, the TS voltage on the inverter side is measured to check whether the precharge or AIR+ is closed or not. This signal is then compared with the AIR+ and precharge control signal to check if a mismatch is present. The rule T11.9.2 does not apply here since no additional wires are used (all circuits are integrated on the PCB.)

2.2 TS_Off / TSAL_Green

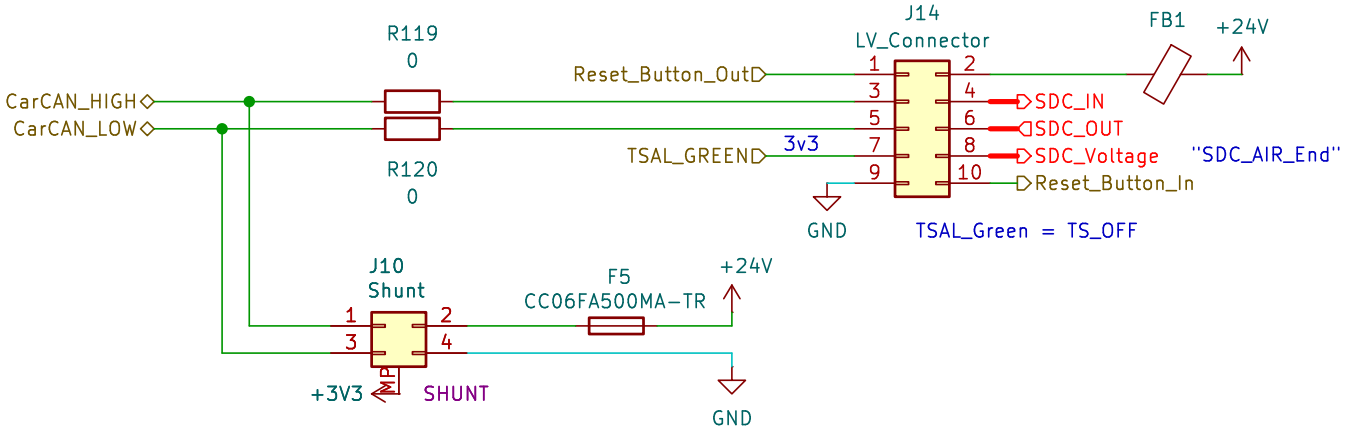
See: Discharge Circuit

The `TS_Off` signal (also labeled as `TSAL_Green` in the schematics) is transmitted to the TSAL system via a dedicated wire connection. If this wire becomes disconnected, the pull-down resistor R16 ensures that the constant current driver (IS32LT3178 [5]) is disabled, preventing unintended LED activation.

See: Dashboard

The `TS_Off`, `AMS_Error`, and `IMD_Error` LEDs on the dashboard are controlled by a microcontroller. In its default state (i.e., after a reset or communication failure), the `TS_Off` LED remains off, while the `AMS_Error` and `IMD_Error` LEDs are turned on due to the inclusion of an additional NOT gate.

All three status signals are transmitted via the CAN bus every 50 ms. If the dashboard does not receive a valid CAN message from the AMS Master within 150 ms, it will enter a timeout condition and revert to the default LED states. Due to the CAN protocol's built-in checksum mechanism, this timeout condition will also occur in cases of persistent data corruption.

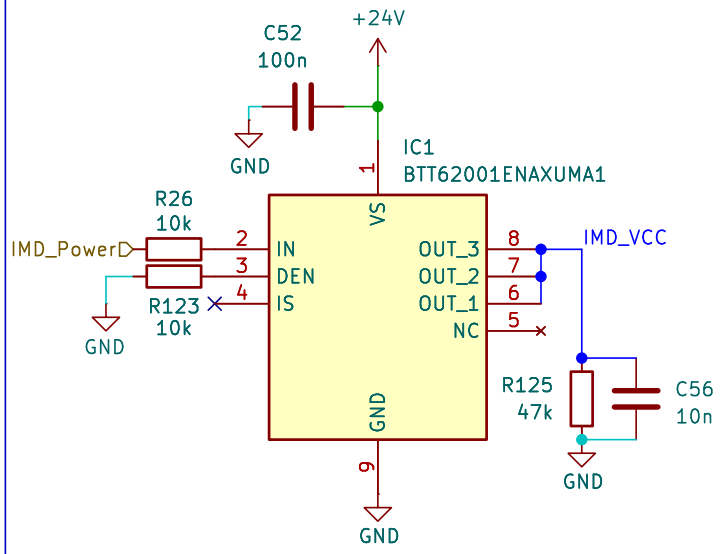


SHUNT:
IVT-S-300-U3-I-CAN1-12/24
max. 80mA

Datasheet
https://www.isabellenhuetteusa.com/wp-content/uploads/2022/07/Datasheet-IVT-S-V1.03.pdf

Main Connector

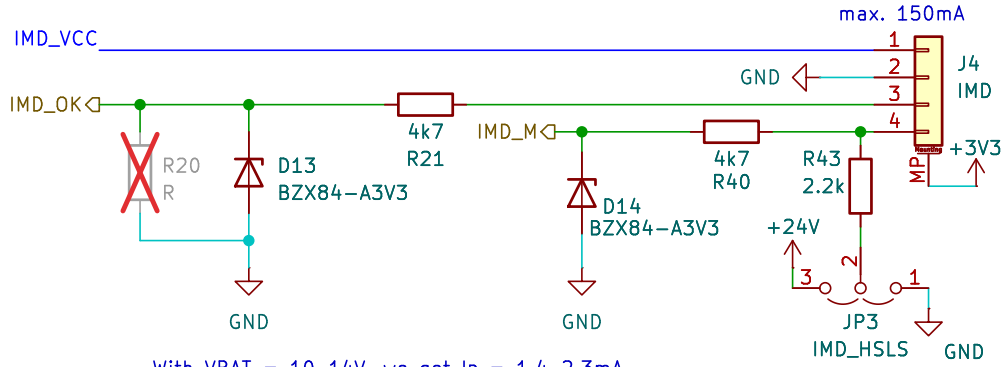
IMD Supply



IMD – Datasheet

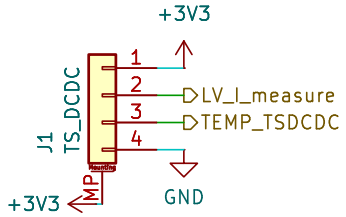
https://www.bender.de/fileadmin/content/Products/d/e/IR155-32xx-V004_D00115_D_XXEN.pdf

IMD Connector

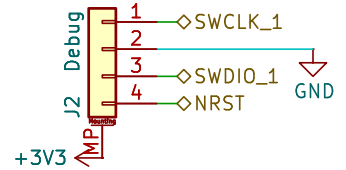


With VBAT = 10..14V, we get I_R = 1.4..2.3mA.
This should™ put the Zener at ~3V.

Connect to GND for -3204
Connect to +24V for -3203



TSDCDC Connector

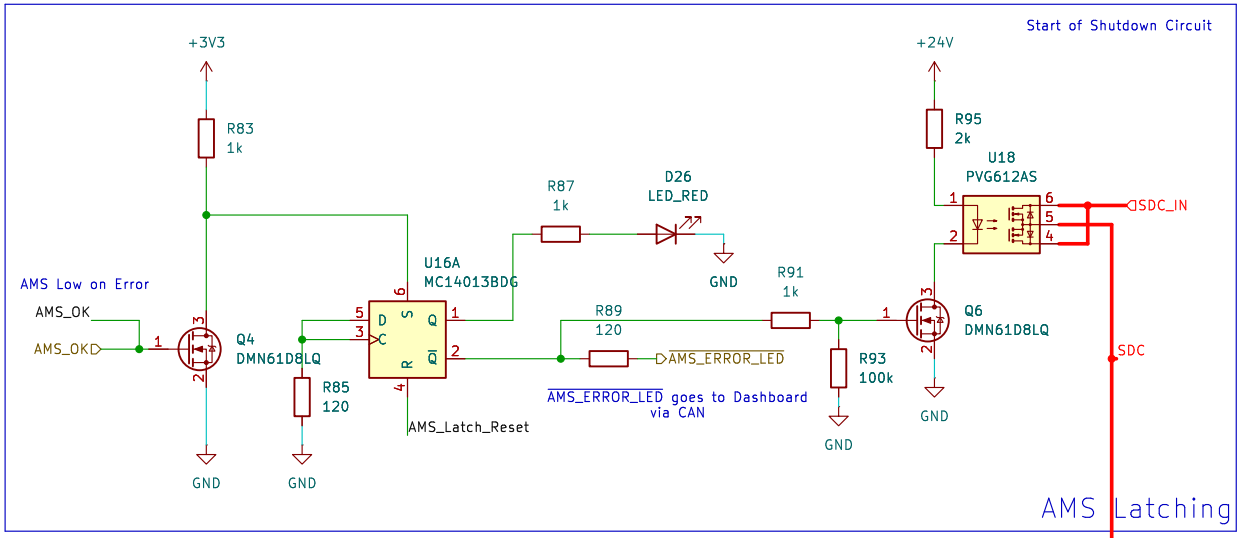


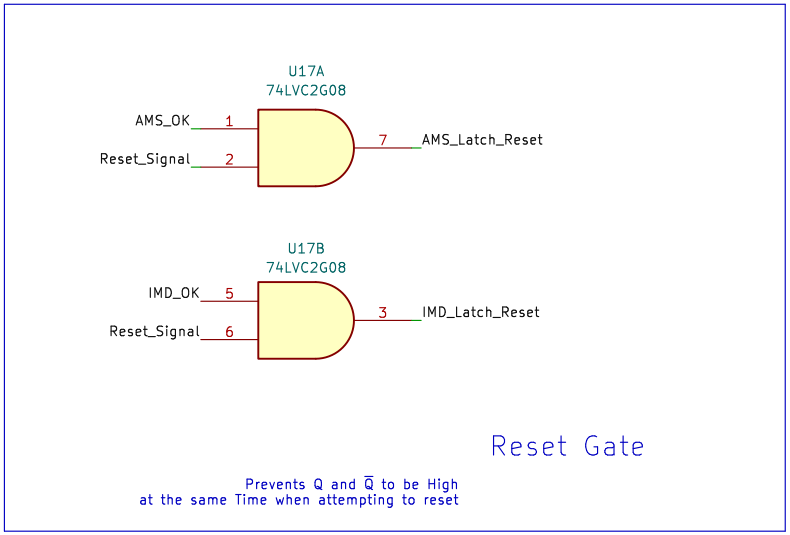
Debug Connector

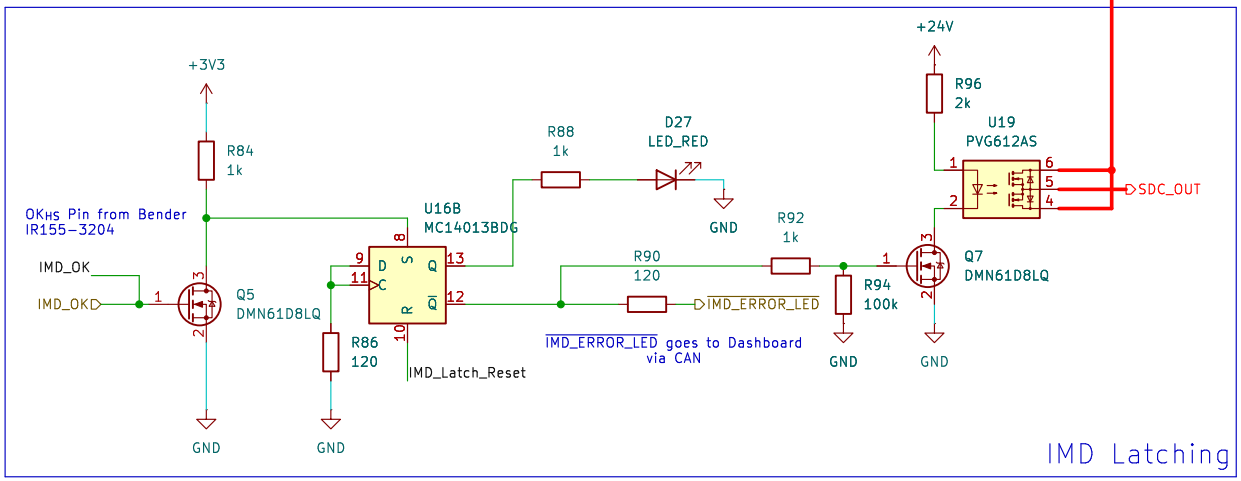
FASTTUBE

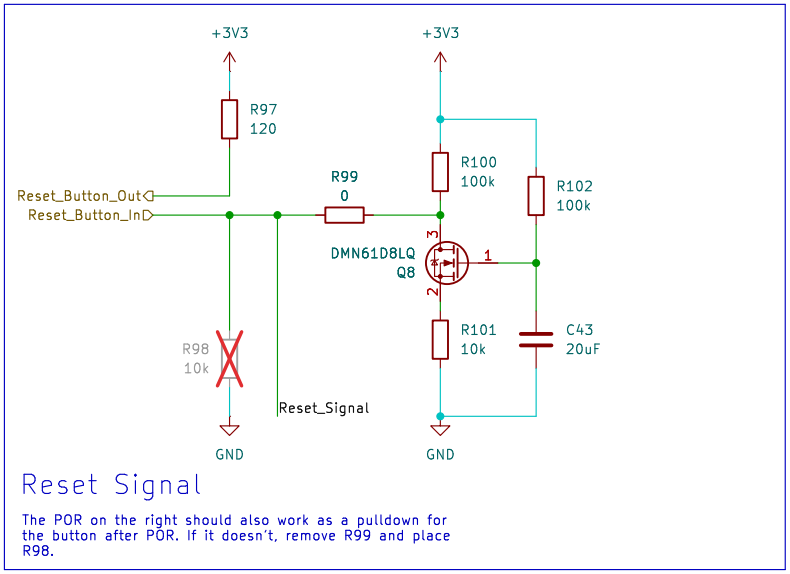
Title: Input/Output

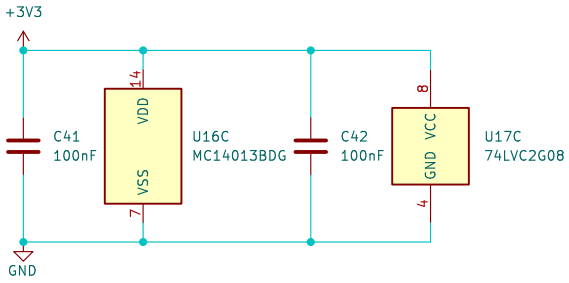
Project: Master_FT25	Rev: V1
Author: Lene Marquardt	Date: 2025-03-09
	Exp. Date: 2025-05-01
	Size: A5 | Page: 13/15





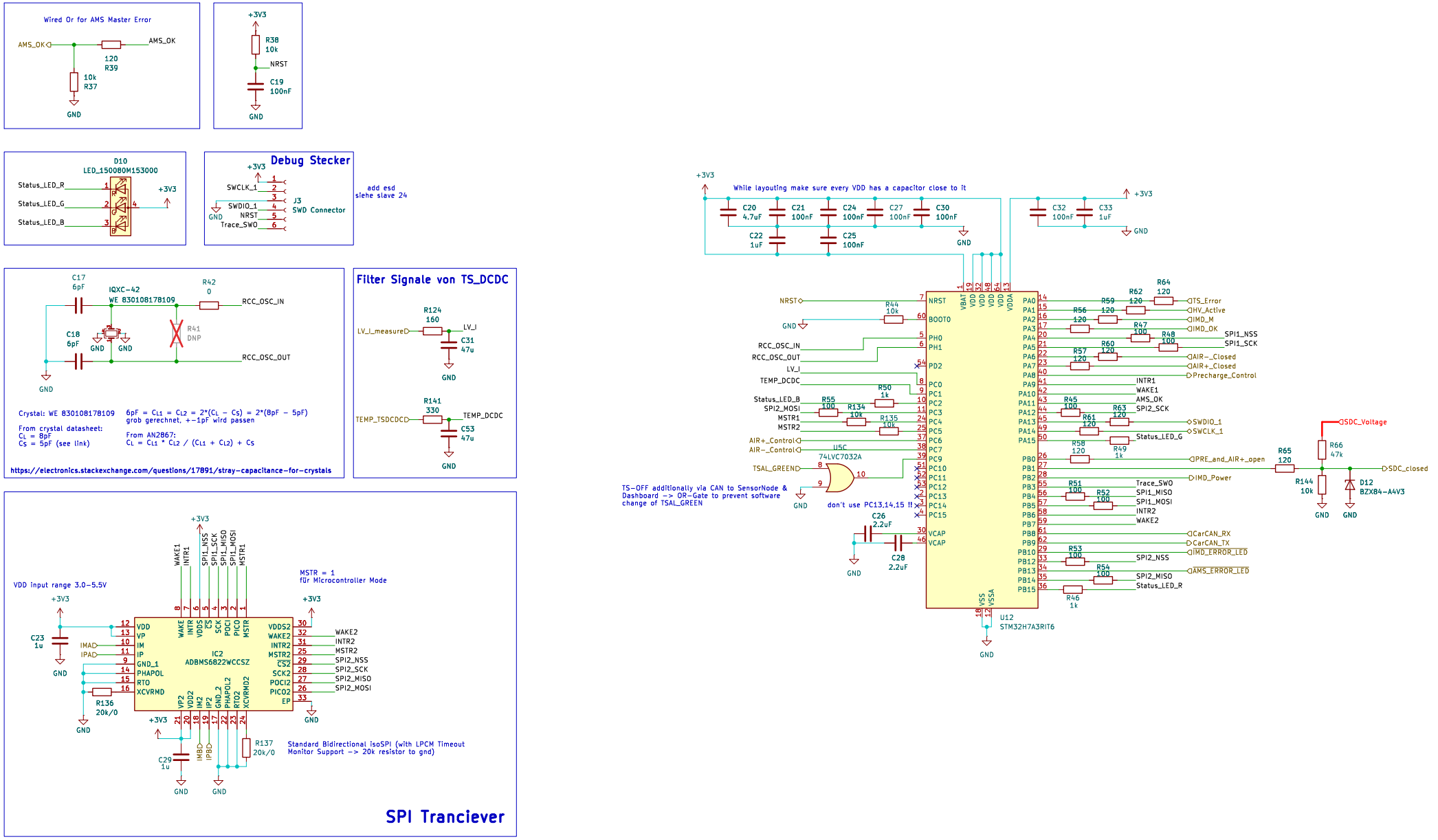




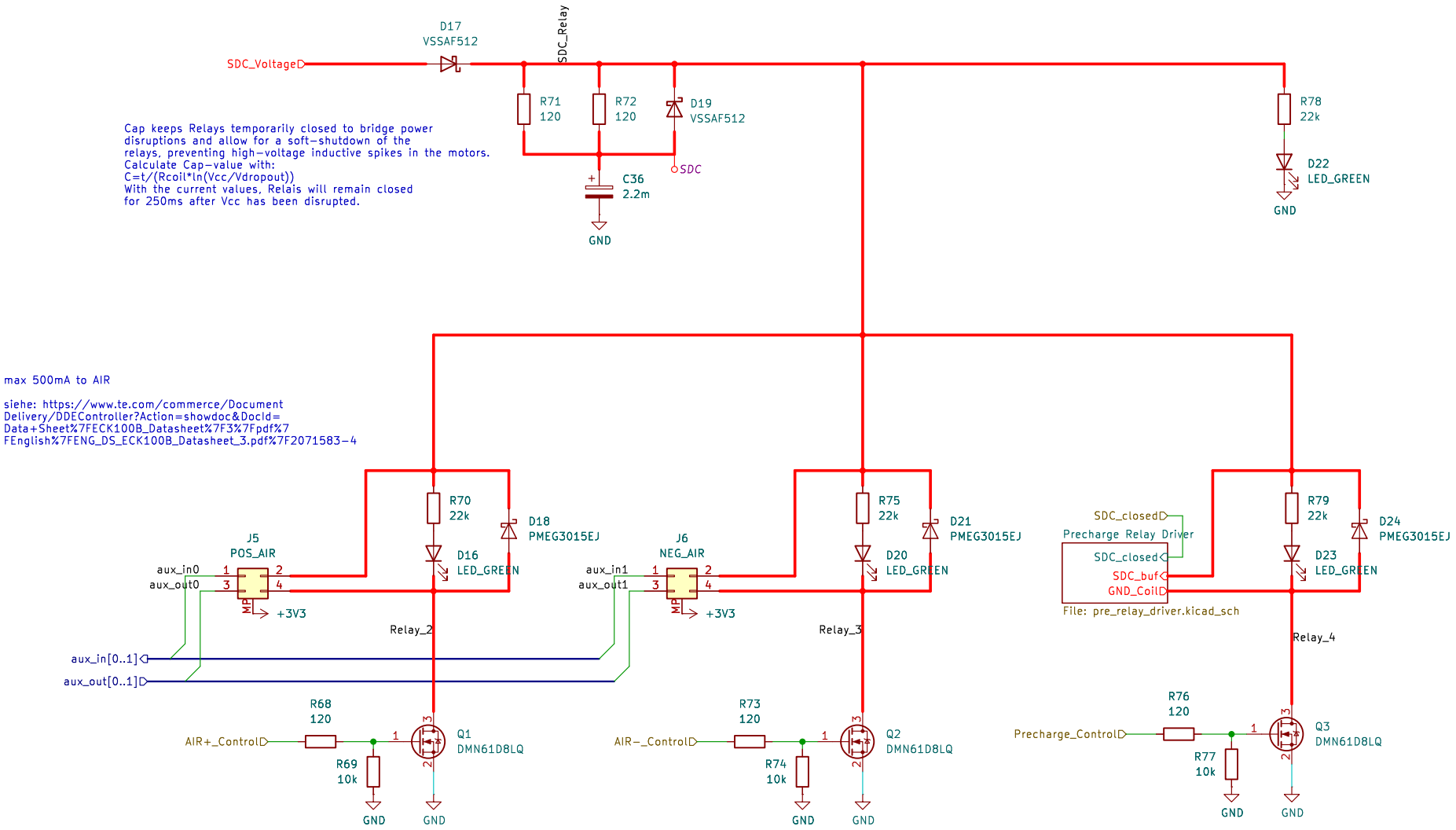


FASTTUBE

Title: SDC Latching	**Rev: V1**
	Date: 2025-03-09
Project: Master_FT25	Exp. Date: 2025-05-01
Author: Lene Marquardt	Size: A4 | Page: 12/15



FASTTUBE	
Title: Microcontroller	Rev: V1
	Date: 2025-03-09
Project: Master_FT25	Exp. Date: 2025-05-01
Author: Lene Marquardt	Size: A3 Page: 7/15



FASTTUBE

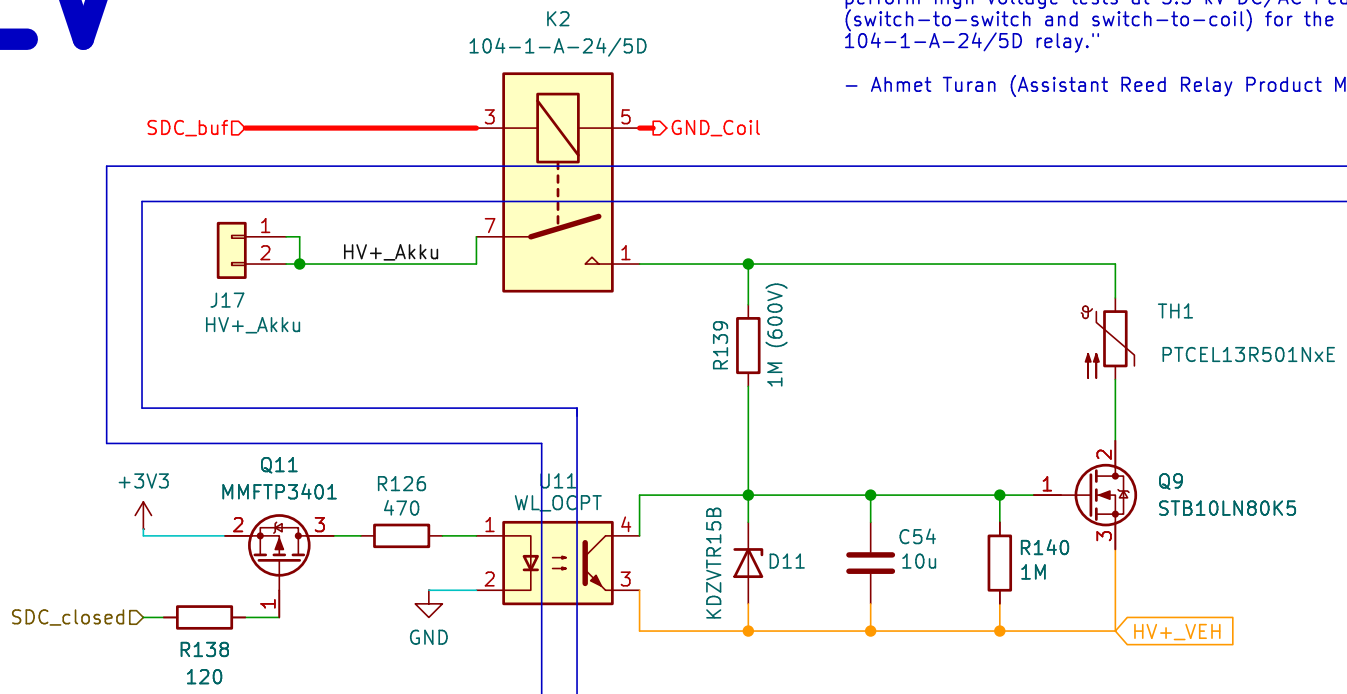
Title: Relay Drivers	**Rev: V1**
	Date: 2025-03-09
Project: Master_FT25	Exp. Date: 2025-05-01
Author: Lene Marquardt	Size: A4 | Page: 9/15

LV

TS–LV isolation via relay pn distance (10.16mm)

"Regarding your questions about our testing process, we perform high voltage tests at 5.5 kV DC/AC Peak (switch–to–switch and switch–to–coil) for the 104–1–A–24/5D relay."

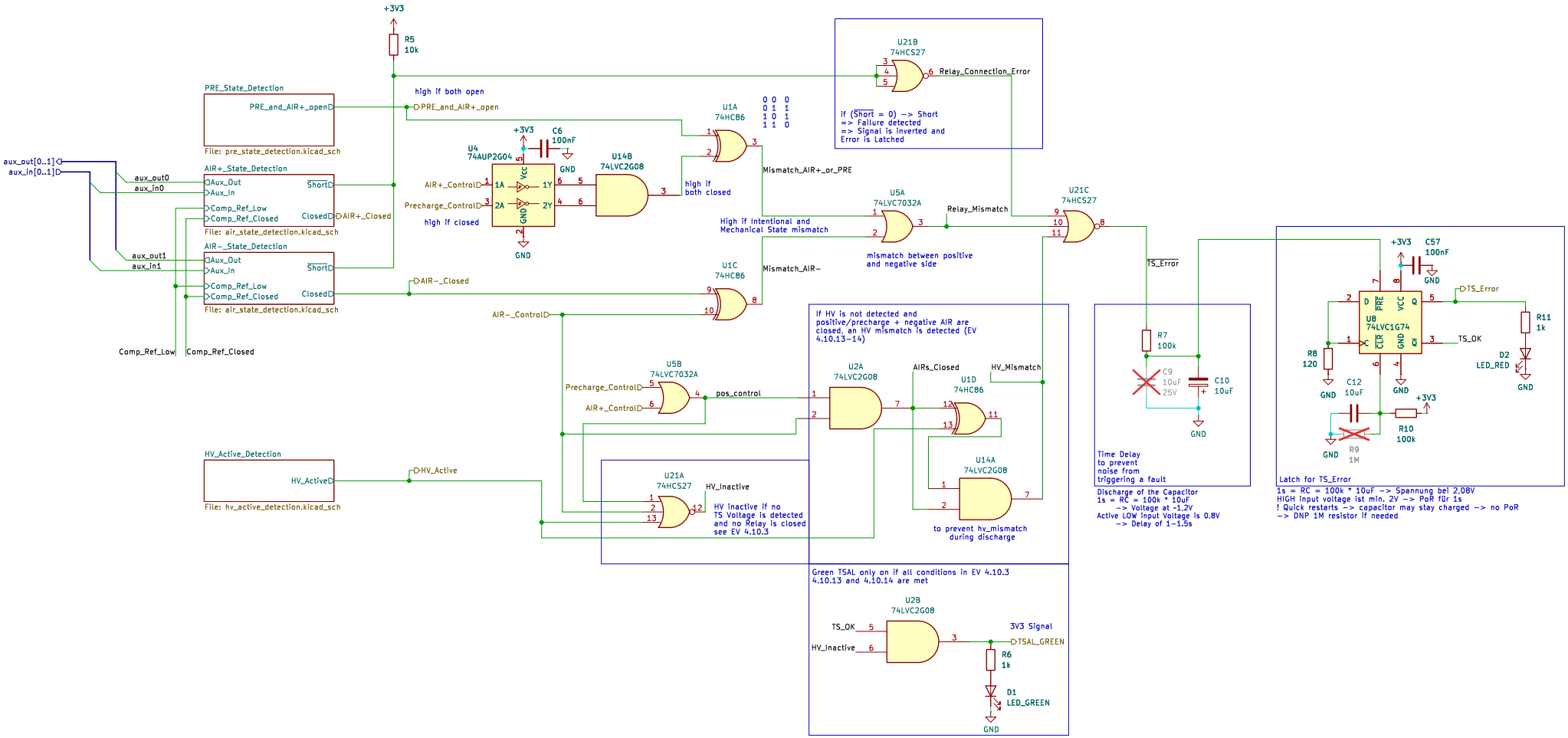
– Ahmet Turan (Assistant Reed Relay Product Manager)



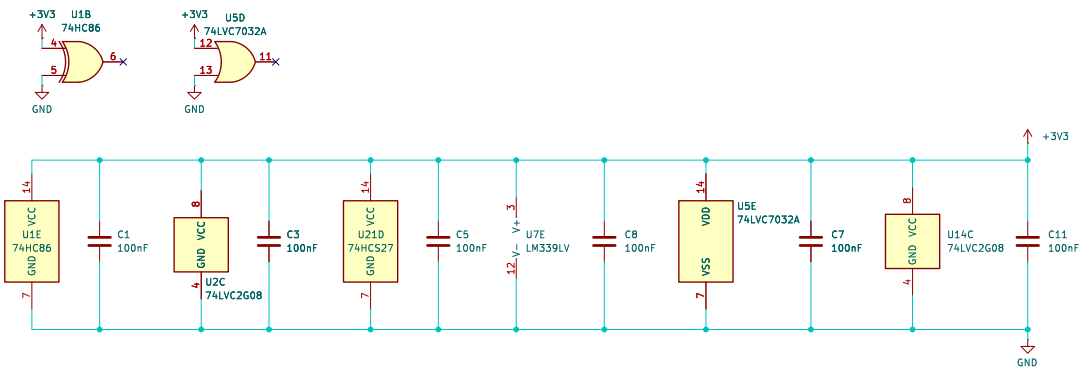
TS

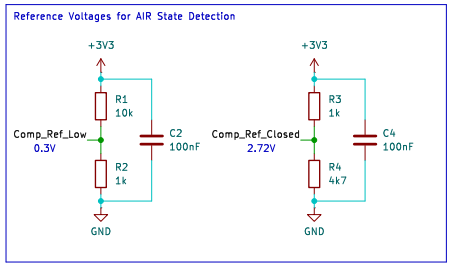
FASTTUBE

Title: Precharge Relay Driver	**Rev: V1**
	Date: 2025–03–09
Project: Master_FT25	Exp. Date: 2025–05–01
Author: Lene Marquardt	Size: A5 | Page: 10/15



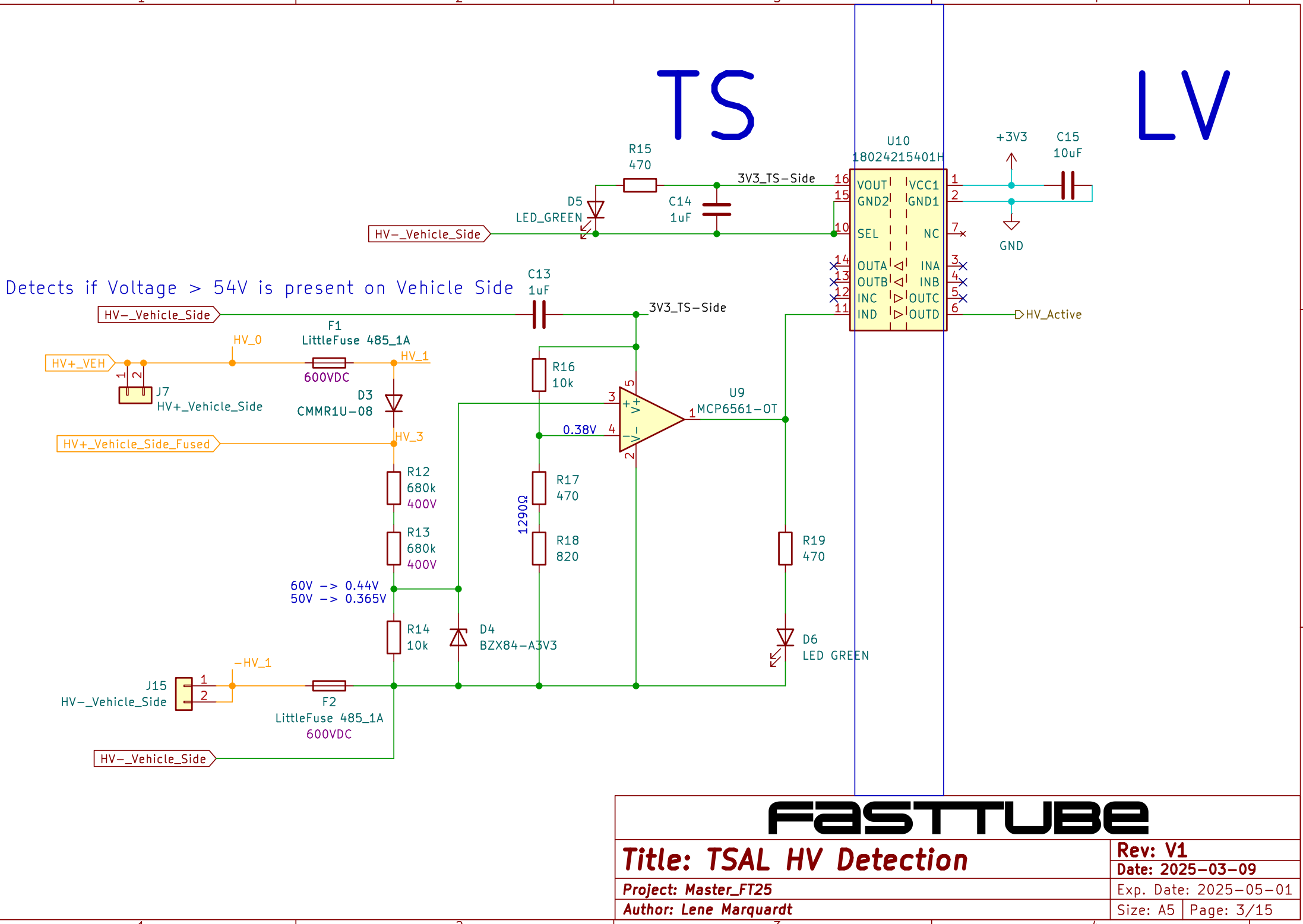
TSAL_GREEN signal leads dashboard
and to the TSAL driver board



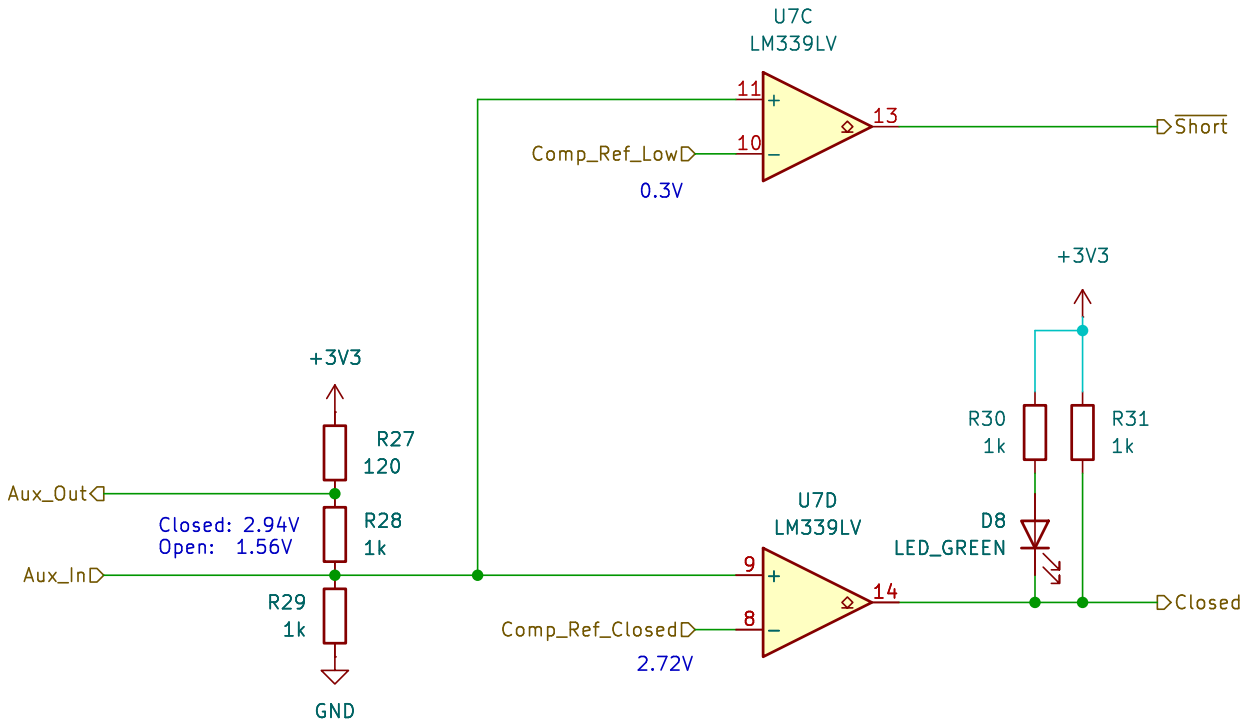


FASTTUBE

Title: TSAL Logic	**Rev: V1**
	Date: 2025-03-09
Project: Master_FT25	Exp. Date: 2025-05-01
Author: Lene Marquardt	Size: A3 | Page: 2/15


TS
LV
Detects if Voltage > 54V is present on Vehicle Side
HV-_Vehicle_Side
HV+_VEH
HV+_Vehicle_Side_Fused
HV-_Vehicle_Side
HV_0
HV_1
HV_3
-HV_1
F1
LittleFuse 485_1A
600VDC
F2
LittleFuse 485_1A
600VDC
J7
HV+_Vehicle_Side
J15
HV-_Vehicle_Side
D3
CMMR1U-08
D4
BZX84-A3V3
D5
LED_GREEN
D6
LED GREEN
R12
680k
400V
R13
680k
400V
R14
10k
R15
470
R16
10k
R17
470
R18
820
R19
470
1290Ω
60V -> 0.44V
50V -> 0.365V
0.38V
C13
1uF
C14
1uF
C15
10uF
3V3_TS-Side
U9
MCP6561-OT
U10
18024215401H
VOUT
GND2
SEL
OUTA
OUTB
INC
IND
VCC1
GND1
NC
INA
INB
OUTC
OUTD
+3V3
GND
HV_Active
FASTTUBE
Title: TSAL HV Detection
Project: Master_FT25
Author: Lene Marquardt
Rev: V1
Date: 2025-03-09
Exp. Date: 2025-05-01
Size: A5
Page: 3/15

Accumulator TSAL – Relay state detection

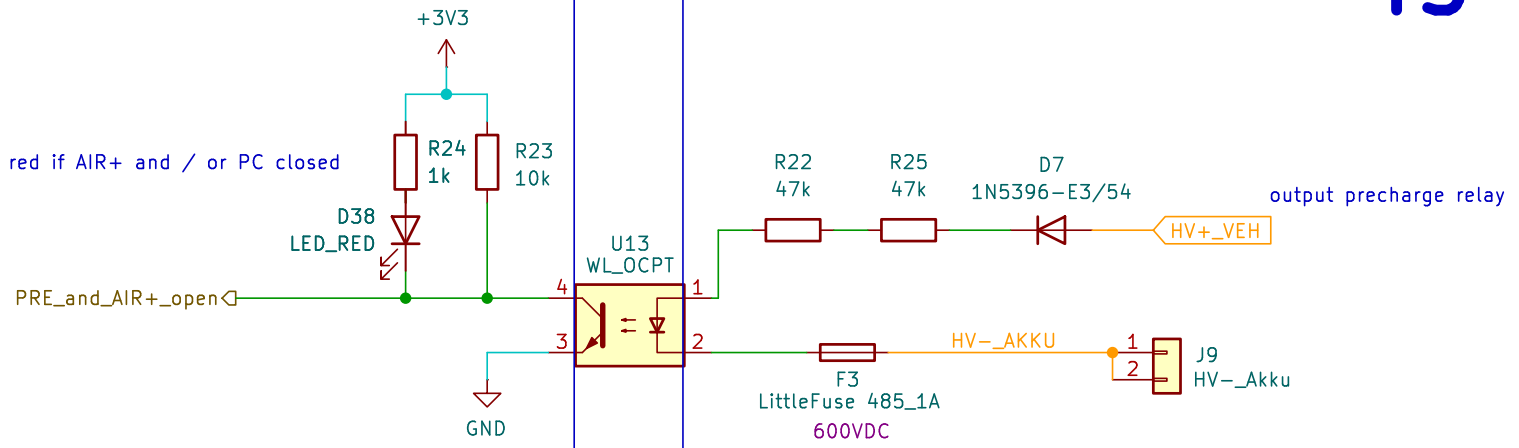


FASTTUBE

Title: AIR Relay State Detection	Rev: V1
	Date: 2025-03-09
Project: Master_FT25	Exp. Date: 2025-05-01
Author: Lene Marquardt	Size: A5 | Page: 4/15

LV

TS



opto diode current:
@ maximum TS Voltage 403V = 4,27 mA
@ minimum TS Voltage 240V = 2,55 mA

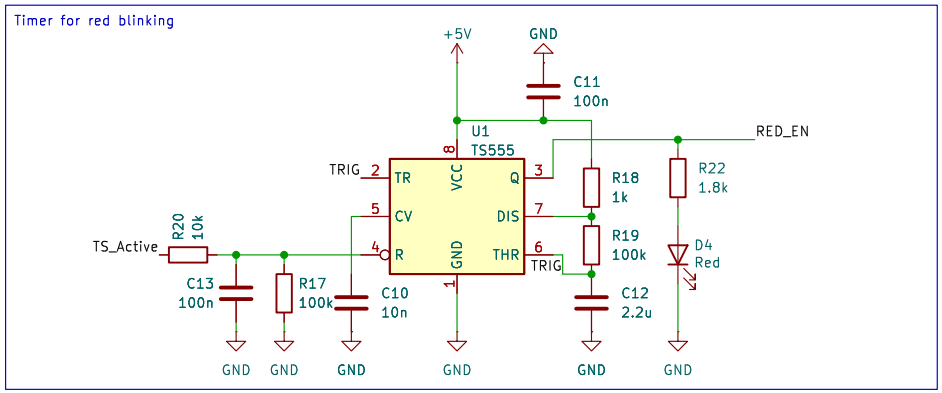
Detects if Precharge or Positive AIR are closed:
PRE_AIR+_open = 3V3 if both Relays are Open
PRE_AIR+_open = 0V if one or both are Closed

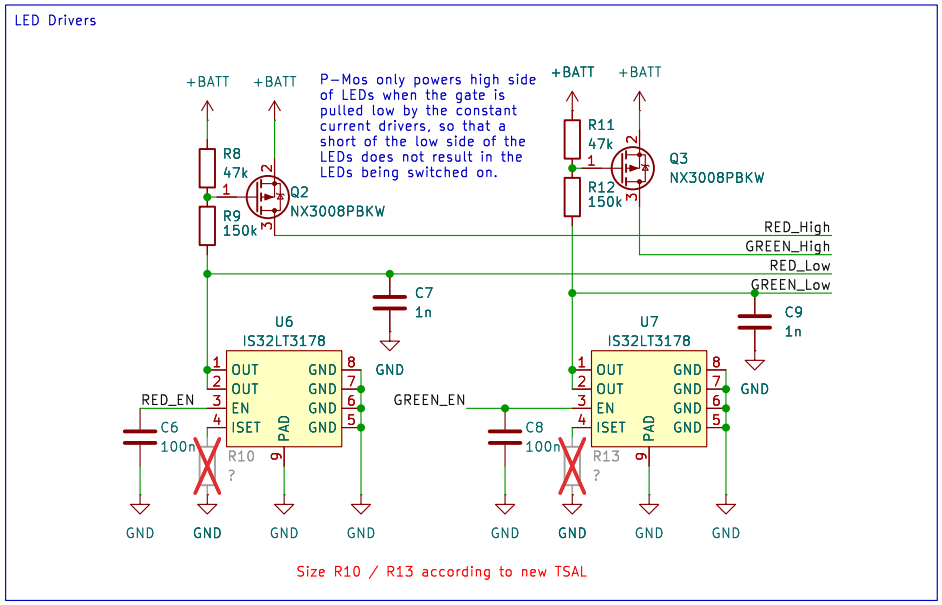
FASTTUBE

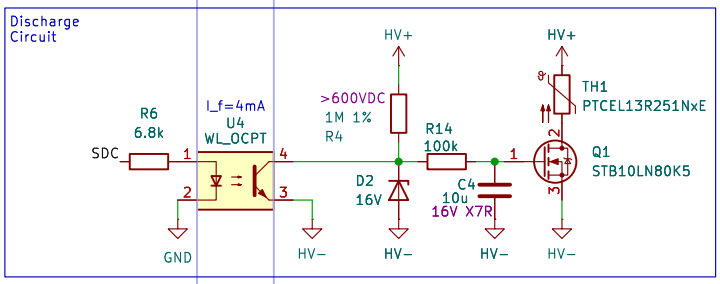
Title: Precharge State Detection	**Rev: V1**
	Date: 2025-03-09
Project: Master_FT25	Exp. Date: 2025-05-01
Author: Lene Marquardt	Size: A5 | Page: 6/15

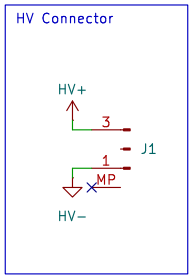
TSAL driver board and DC-link voltage detection

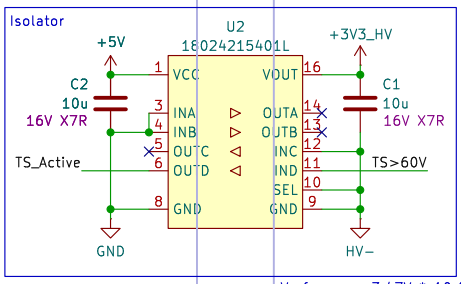
LV TS

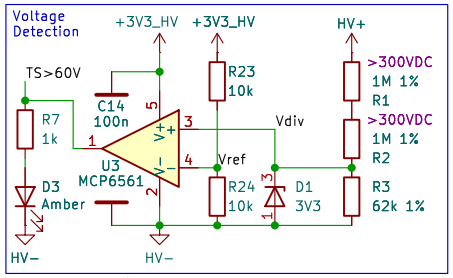




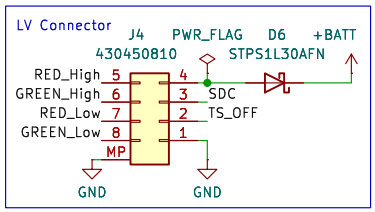


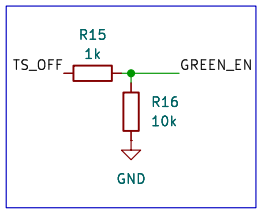


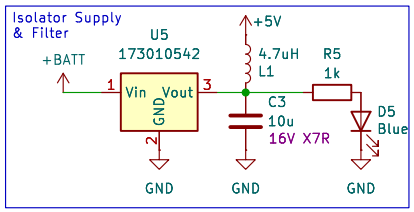




Vref_max = 3.47V * 10.1kΩ / (10.1kΩ + 9.9kΩ) = 1.76V
Vdiv@60V_min = 60V * 61.38Ω / (2*990kΩ + 61.38kΩ) = 1.8V
Vhyst_max@75deg = 6mV < 40mV (1.80V-1.76V)



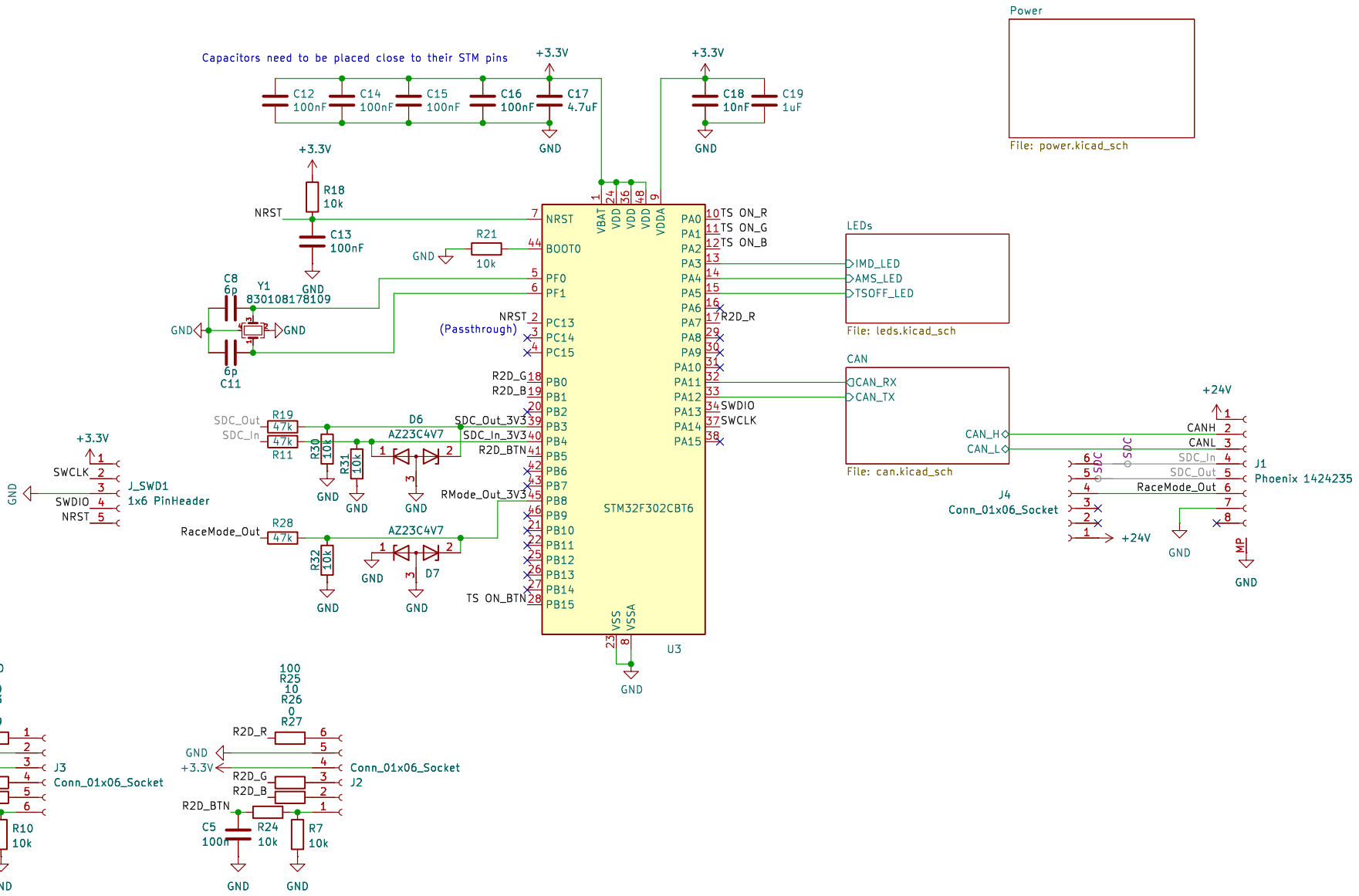




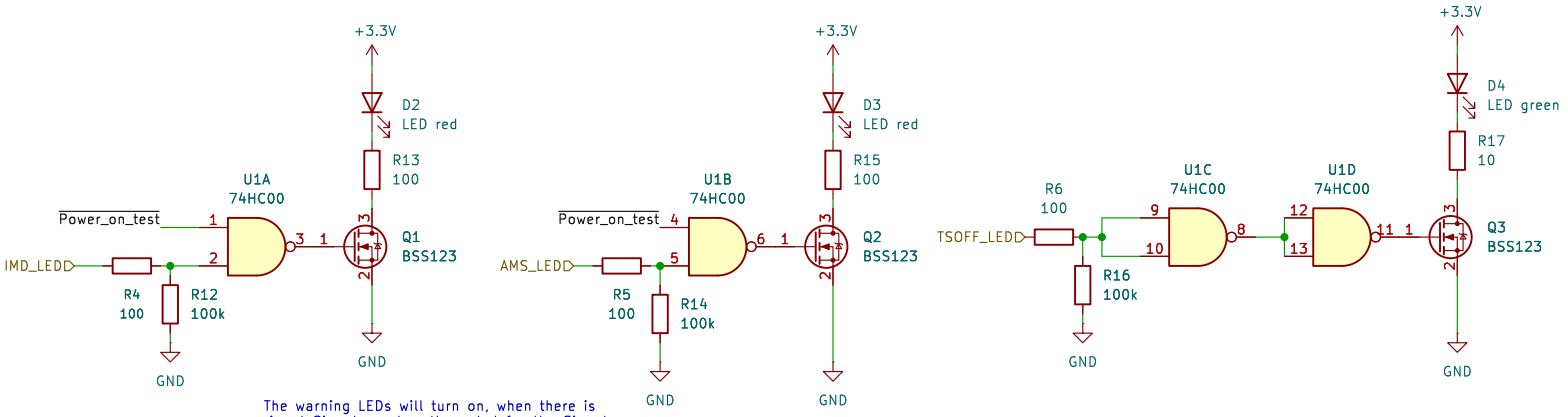
FASTTUBE

Title: Discharge Circuit	**Rev: V1**
	Date: 2024-11-10
Project: DC	Exp. Date: 2025-05-01
Author: Karlsson Winkels	Size: A4 | Page: 1/1

Dashboard

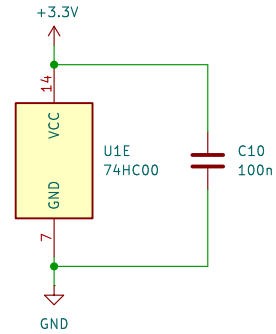


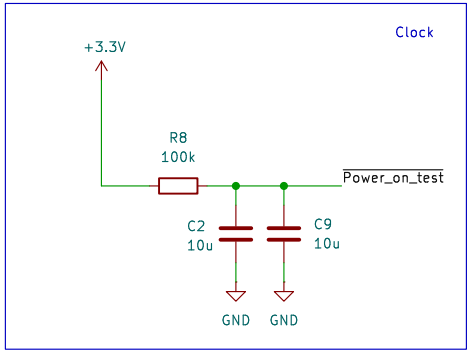
FASTTUBE	
Title: Dashboard Rootsheet	**Rev: V1**
	Date: 2025-03-26
Project: dashboard-FT25	Exp. Date: 2025-05-01
Author: Finley Troalic	Size: A4 | Page: 1/4



The warning LEDs will turn on, when there is
no input Signal or when the cabel for the Signal
is shorted to ground or disconnected.
Initially the LEDs for the AMS and the IMD will turn on,
to show the functionallity of these.

TS Off signal from Acc Tsal





Timer sequence ~2s to light up the LEDs at the beginning

FASTTUBE

Title: Cockpit LED Driver	**Rev: V1**
	Date: 2025-03-26
Project: dashboard-FT25	Exp. Date: 2025-05-01
Author: Finley Troalic	Size: A4 | Page: 2/4

Reference

[1] *74LVC1G74 Datasheet*. www.ti.com, 09.2021

[2] *IVT-S-300-U3-I-CAN2-12/24 Datasheet*. www.isabellenhuetteusa.com, 06.2022

[3] *IR155-3204 Datasheet*. www.bender.de, 06.2024

[4] *RS PRO 8724476 Datasheet*. media.distrelec.com

[5] *IS32LT3178 Datasheet*. lumissil.com 06.2024