

1 TS_Error Latching

See: AMS Master - TSAL Logic

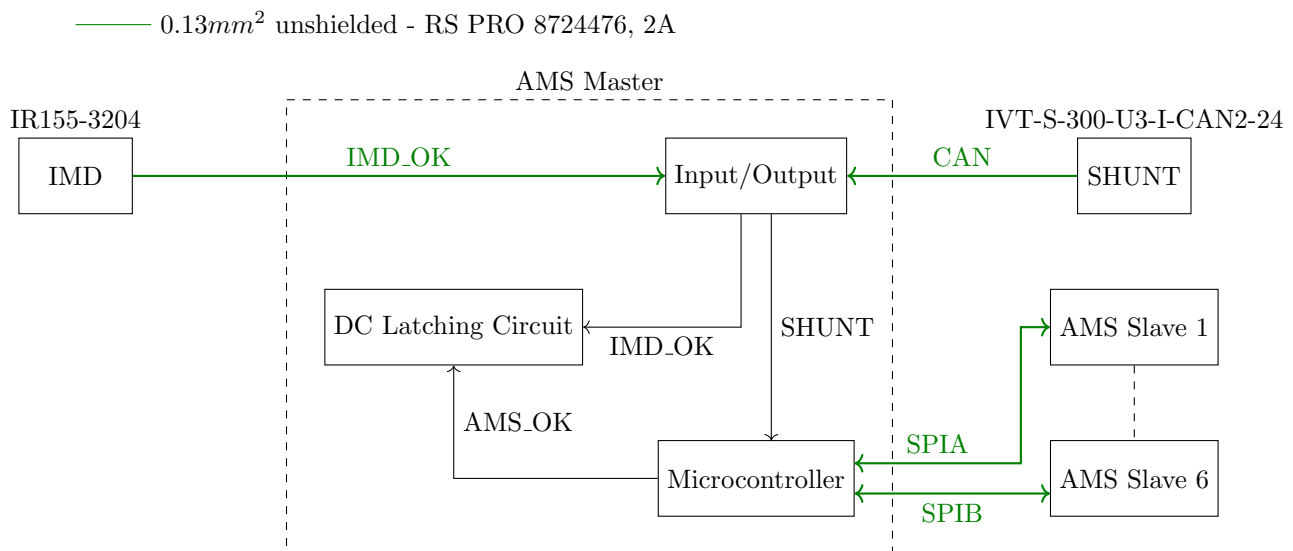
Once the state of $\overline{\text{TS_Error}}$ is reached for more then 1s (to prevent noise from causing an error), the latch U8 (74LVC1G74[1]) will be triggered. This cannot be reset, unless a LVS power cycle is carried out. The backup pull-down resistor R9 for discharging the capacitor can also be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

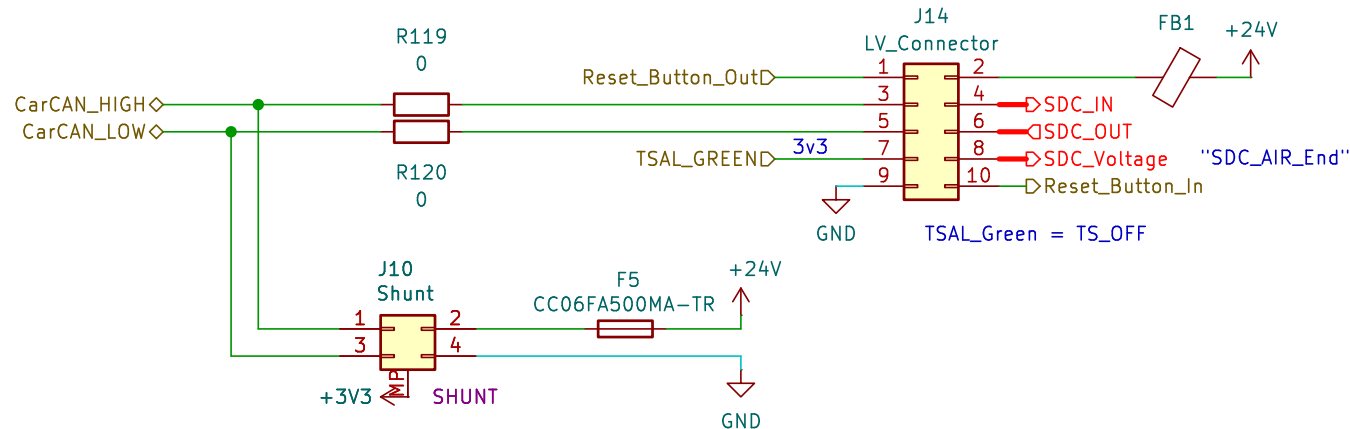
See: Discharge Circuit

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.

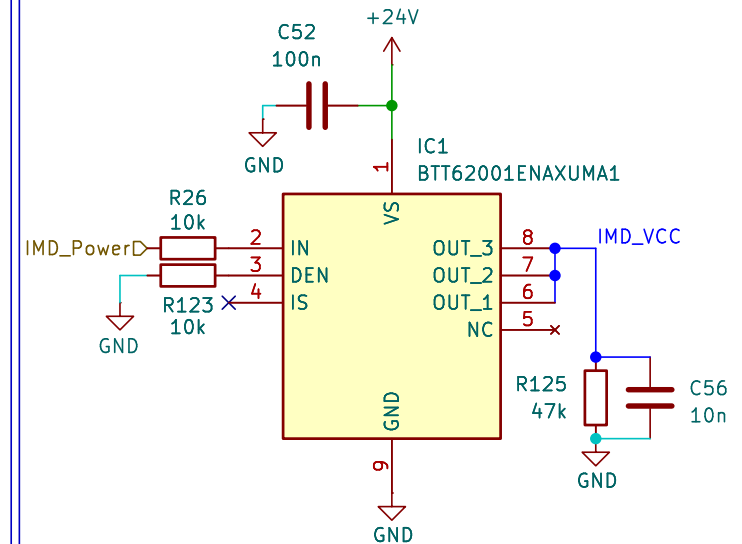


SHUNT:
IVT-S-300-U3-I-CAN1-12/24
max. 80mA

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

Main Connector

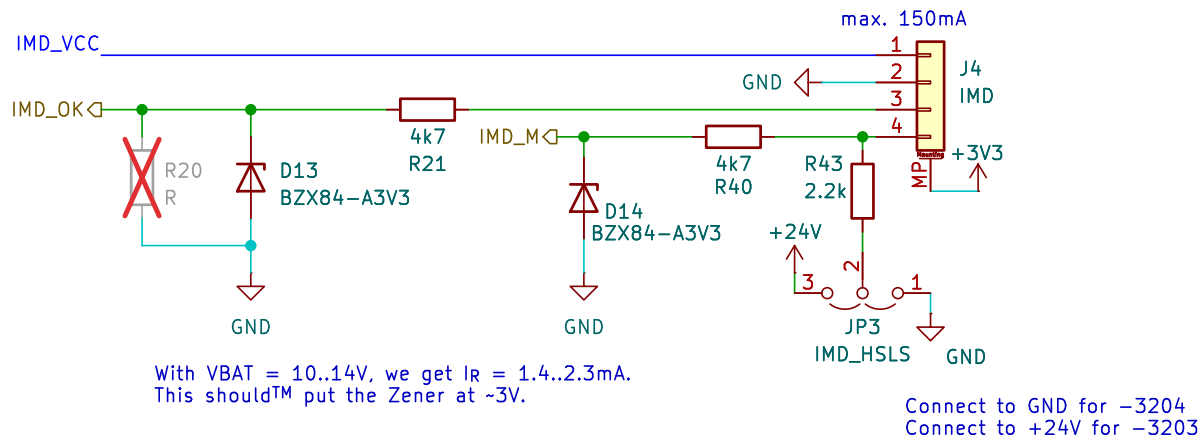
IMD Supply



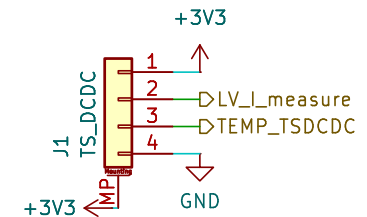
IMD - Datasheet

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

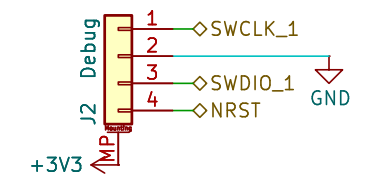
IMD Connector



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



TSDCDC Connector



Debug Connector

FASTTUBE

Title: Input/Output

Project: Master_FT25

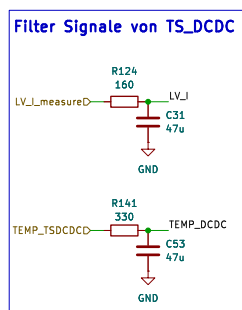
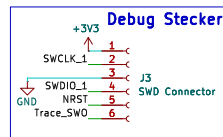
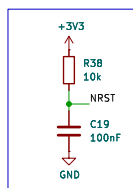
Author: Lene Marquardt

Rev: V1

Date: 2025-03-09

Exp. Date: 2025-05-01

Size: A5 Page: 13/15

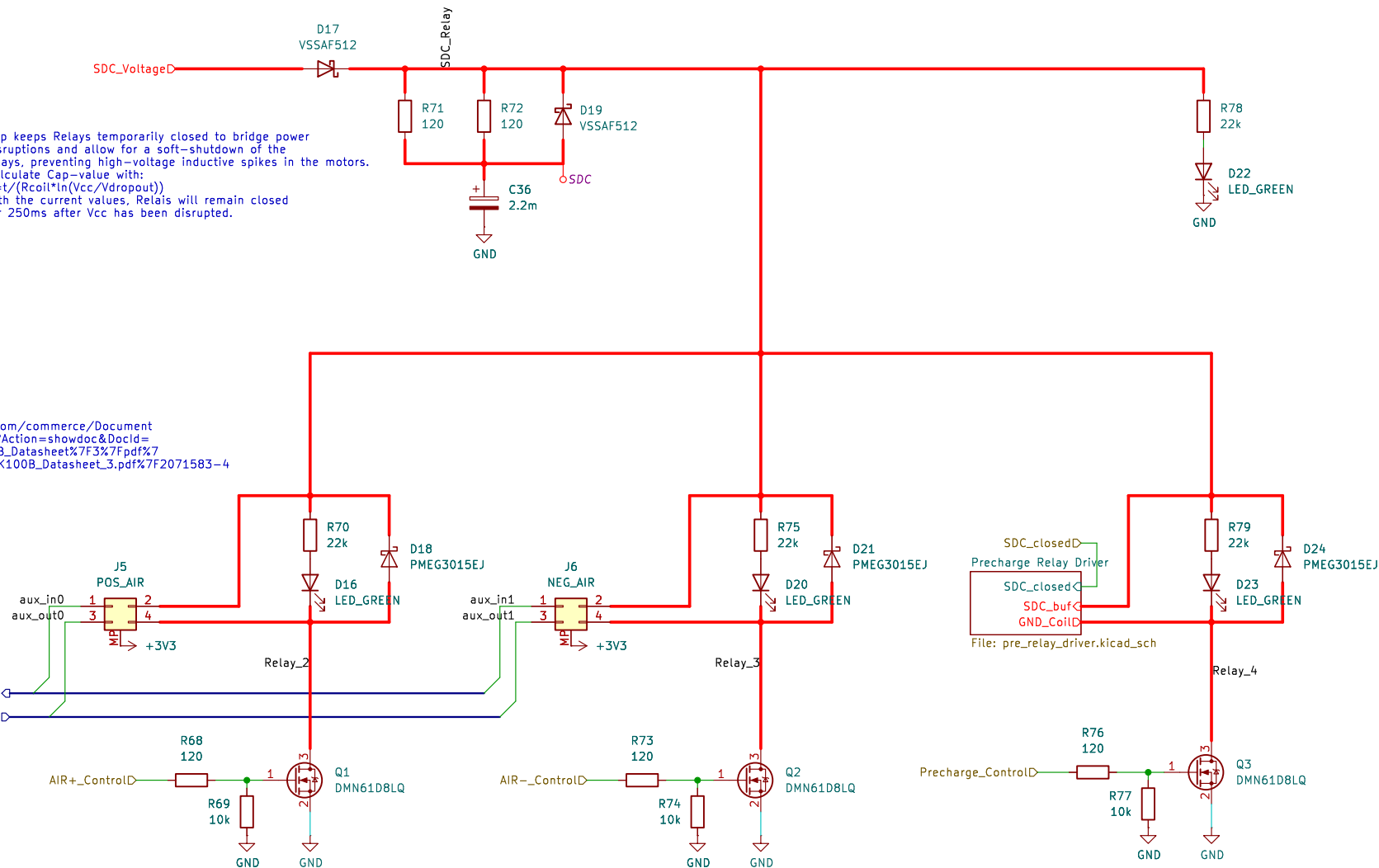


Cap keeps Relays temporarily closed to bridge power disruptions and allow for a soft-shutdown of the relays, preventing high-voltage inductive spikes in the motors.
Calculate Cap-value with:
 $C = t / (R_{coil} * \ln(V_{cc} / V_{dropout}))$
With the current values, Relais will remain closed for 250ms after Vcc has been disrupted.

max 500mA to AIR

siehe: https://www.te.com/commerce/DocumentDelivery/DDEController?Action=showdoc&DocId=Data+Sheet%7FECK100B_Datasheet%7F3%7Fpdf%7FEnglish%7FENG_DS_ECK100B_Datasheet_3.pdf%7F2071583-4

The MOSFETs act as a low-side switch for the Power-relais used. The diodes protect the MOSFETs from inductive voltage spikes caused by the Relais-coils when powered off.



FASTTUBE

Title: Relay Drivers

Project: Master_FT25

Author: Lene Marquardt

Rev: V1

Date: 2025-03-09

Exp. Date: 2025-05-01

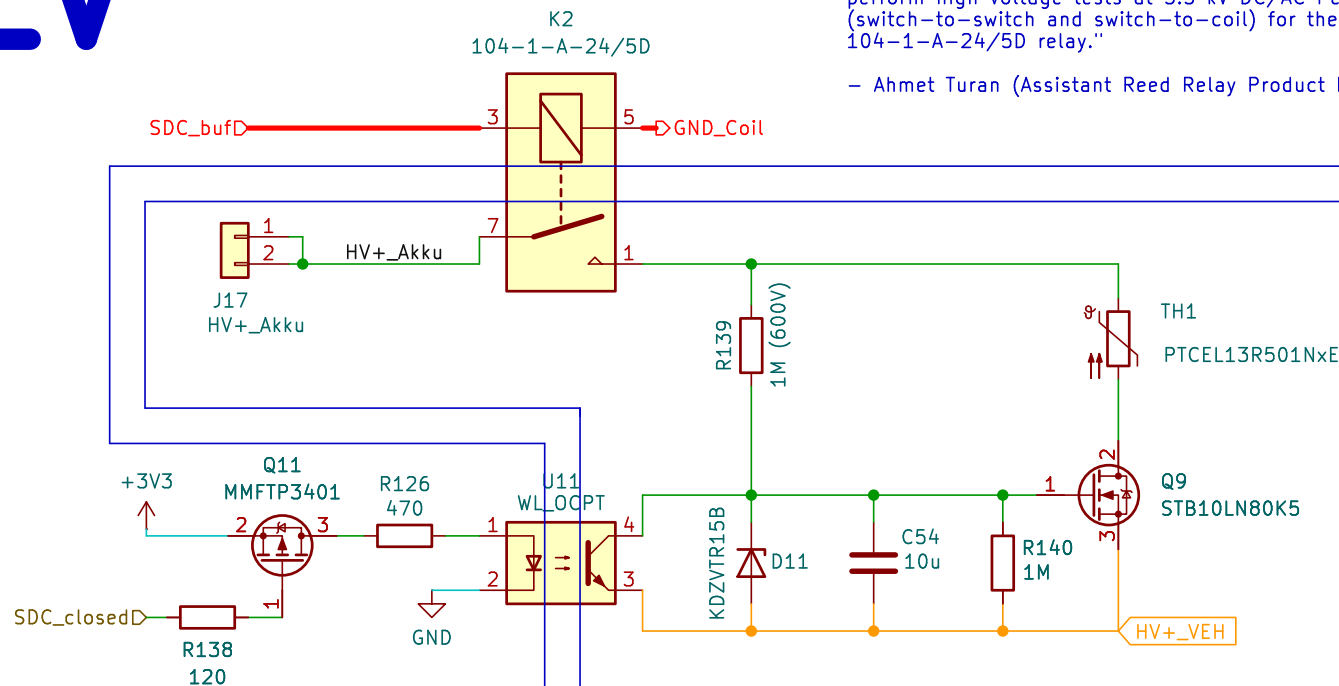
Size: A4 Page: 9/15

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

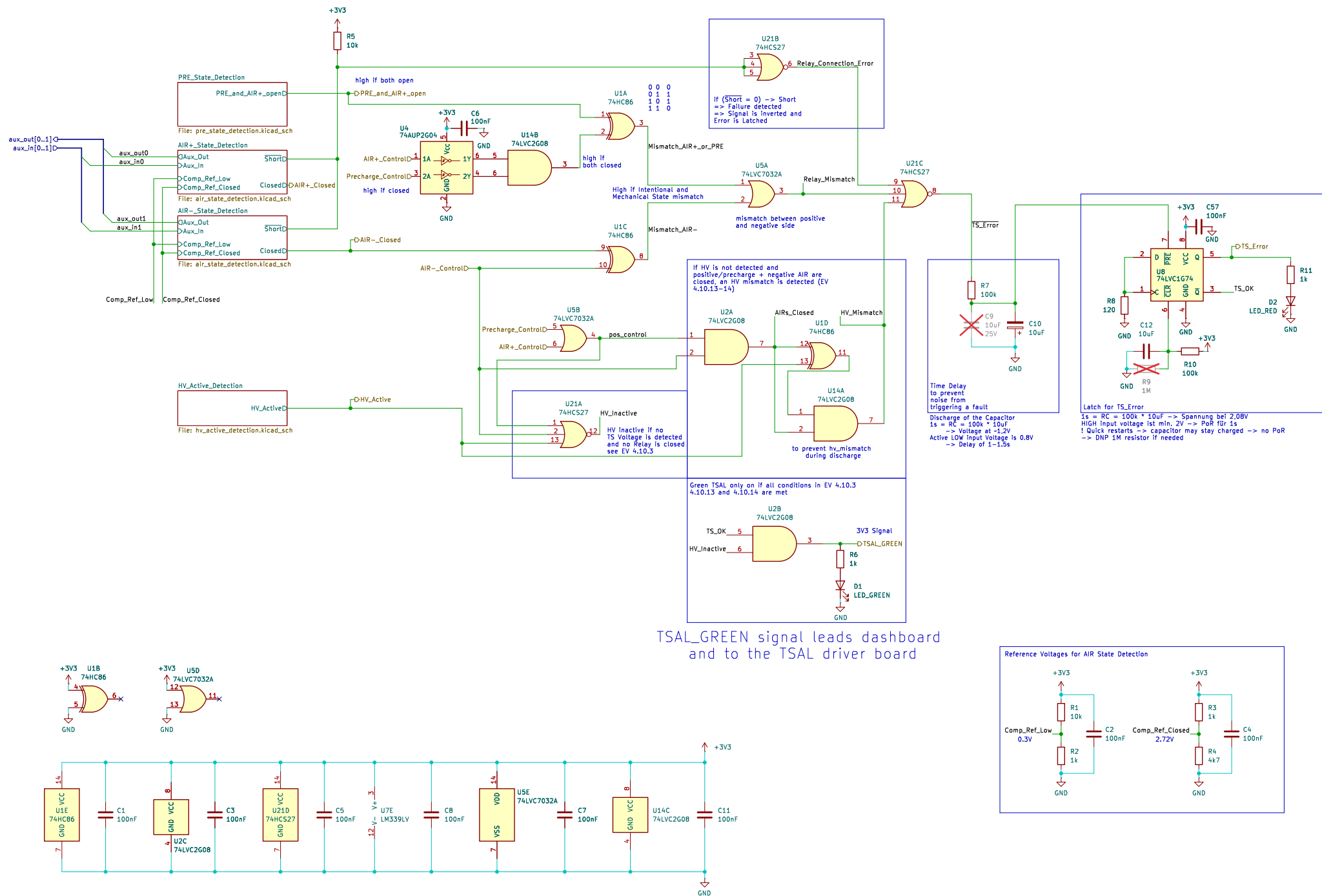
Date: 2025-03-09

Project: Master_FT25

Exp. Date: 2025-05-01

Author: Lene Marquardt

Size: A5 | Page: 10/15



FASTTUBE

Title: TSAL Logic

Project: Master_FT25
Author: Lene Marquardt

Rev: V1

Date: 2025-03-09

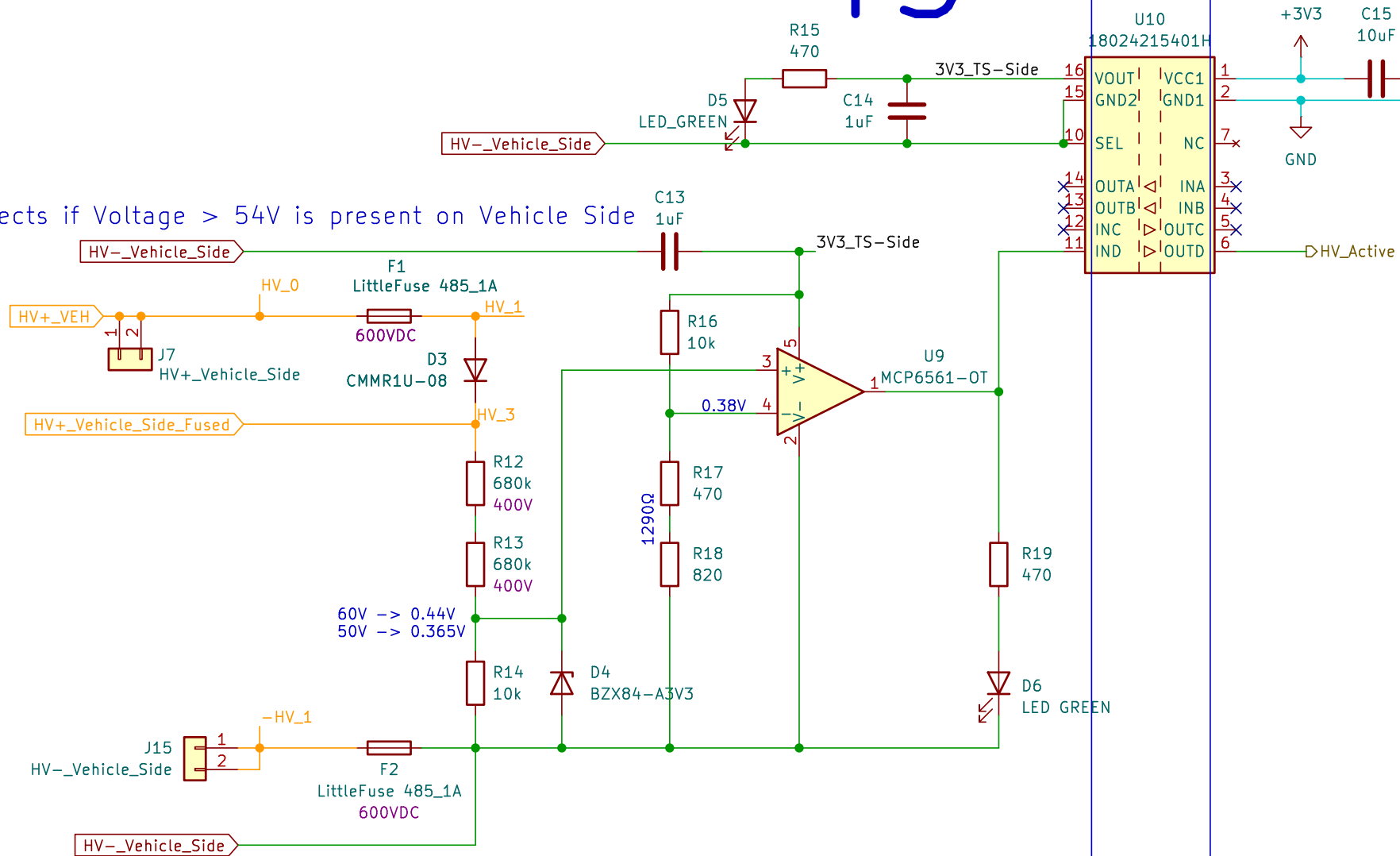
Exp. Date: 2025-05-01

Size: A3 Page: 2/15

TS

LV

Detects if Voltage > 54V is present on Vehicle Side



FASTTUBE

Title: TSAL HV Detection

Rev: V1

Date: 2025-03-09

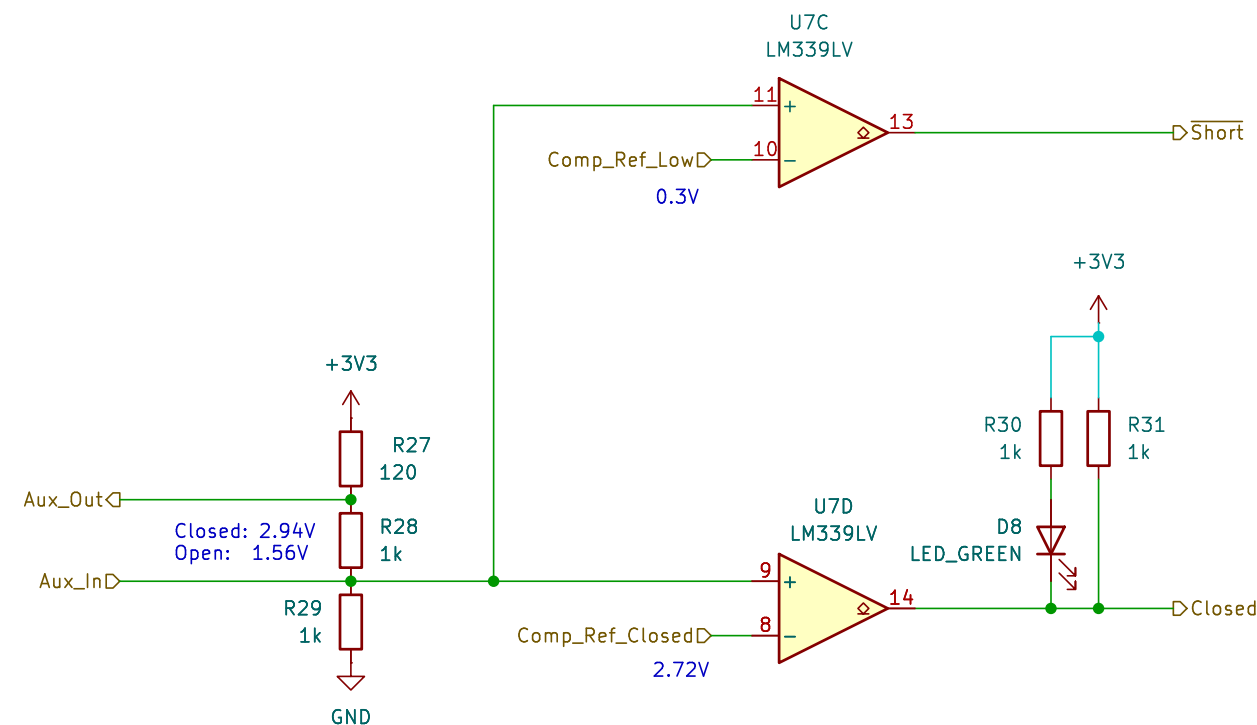
Project: Master_FT25

Exp. Date: 2025-05-01

Author: Lene Marquardt

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

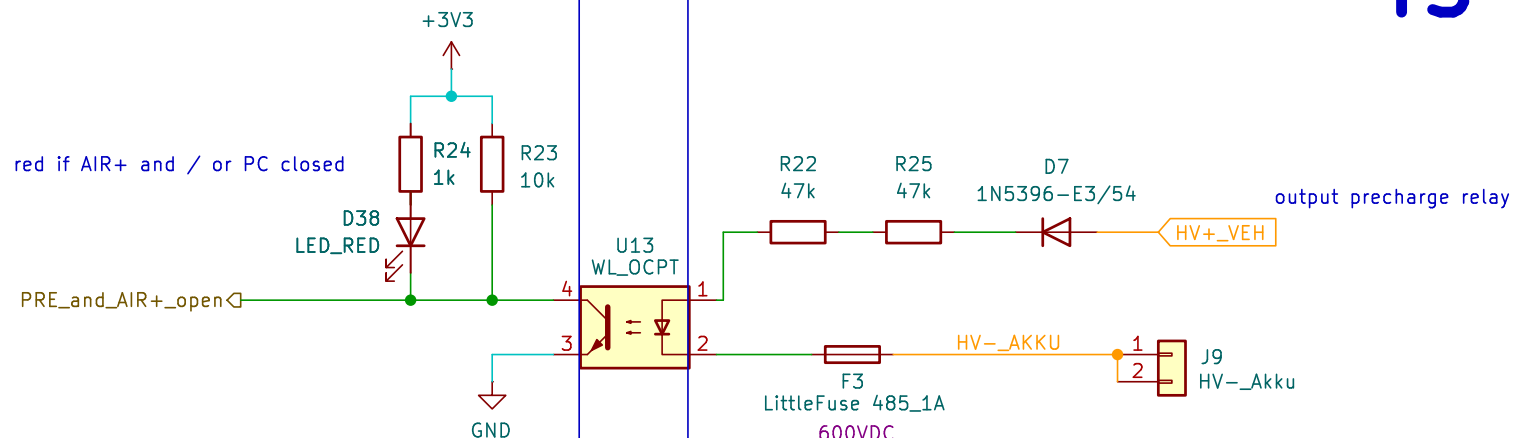
Exp. Date: 2025-05-01

Author: Lene Marquardt

Size: A5 **Page:** 4/15

LV

TS



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

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

FASTTUBE

Title: Precharge State Detection

Rev: V1

Date: 2025-03-09

Project: Master_FT25

Exp. Date: 2025-05-01

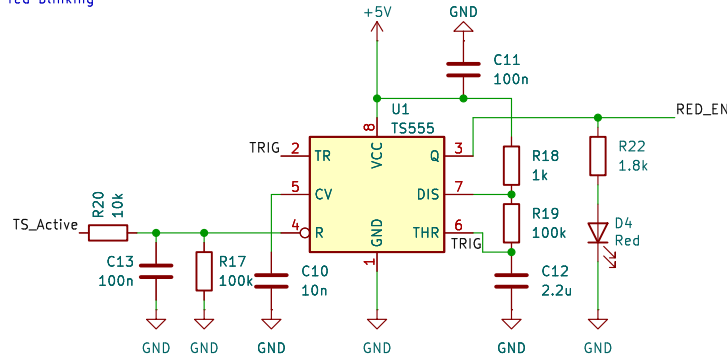
Author: Lene Marquardt

Size: A5 | Page: 6/15

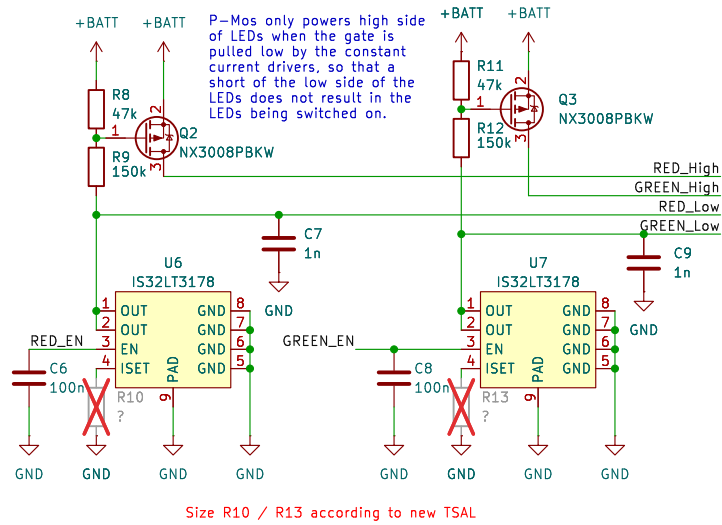
TSAL driver board and DC-link voltage detection

LV TS

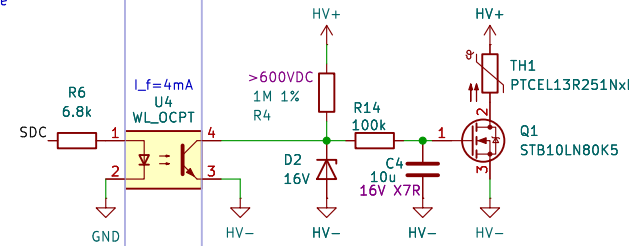
Timer for red blinking



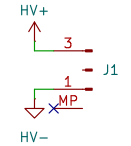
LED Drivers



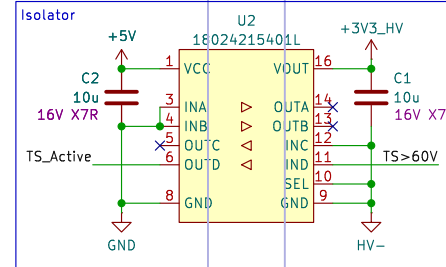
Discharge Circuit



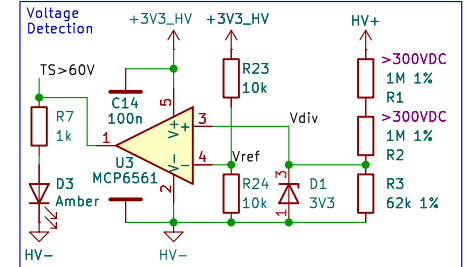
HV Connector



Isolator



Voltage Detection

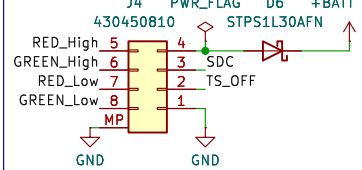


$$V_{ref_max} = 3.47V \cdot 10.1k\Omega / (10.1k\Omega + 9.9k\Omega) = 1.76V$$

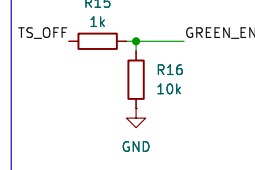
$$V_{div@60V_min} = 60V \cdot 61.38\Omega / (2 \cdot 990k\Omega + 61.38k\Omega) = 1.8V$$

$$V_{hyst_max@75deg} = 6mV < 40mV (1.80V - 1.76V)$$

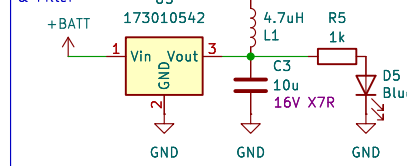
LV Connector



TS Off



Isolator Supply & Filter



FASTTUBE

Title: Discharge Circuit

Project: DC

Author: Karlsson Winkels

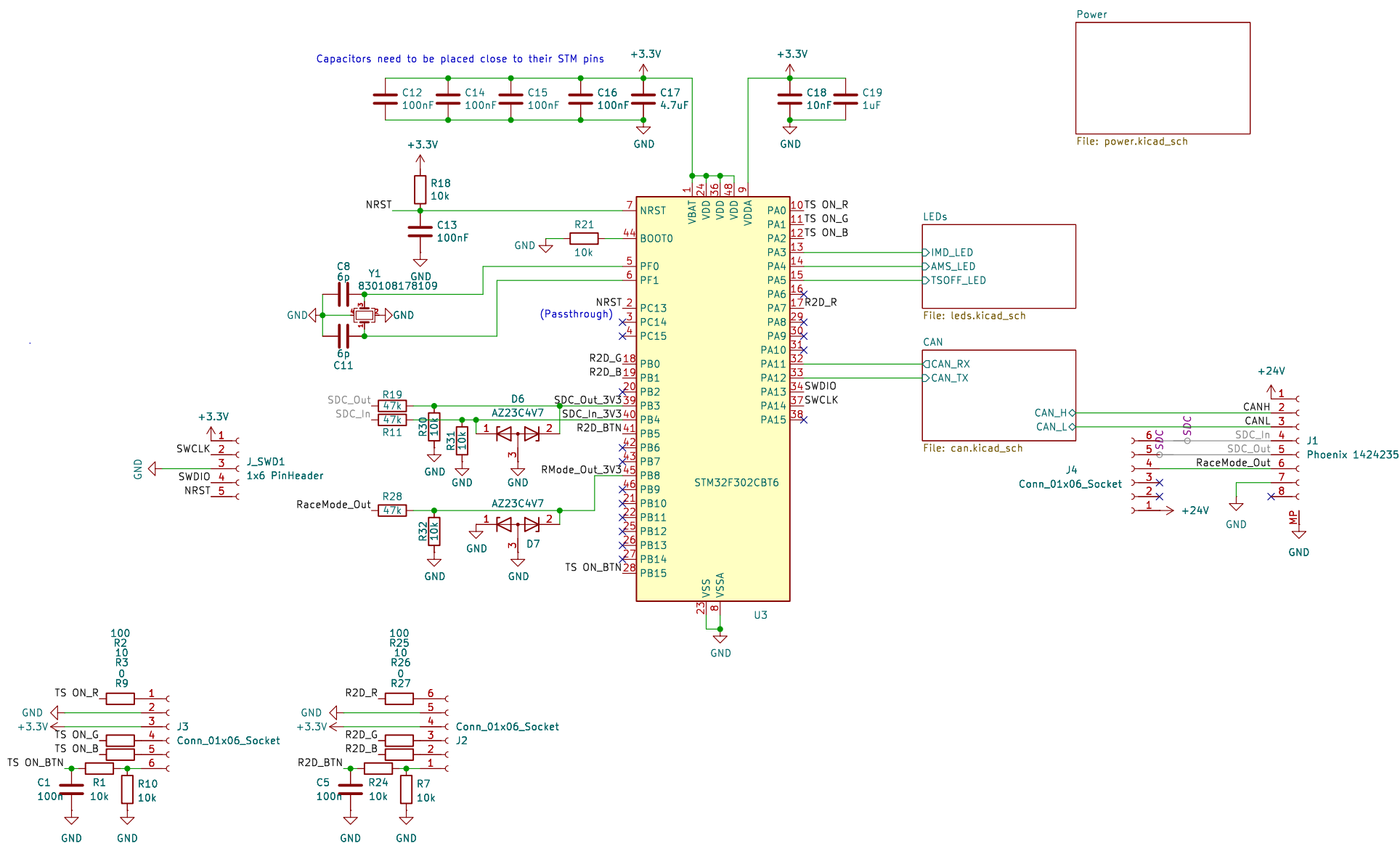
Rev: V1

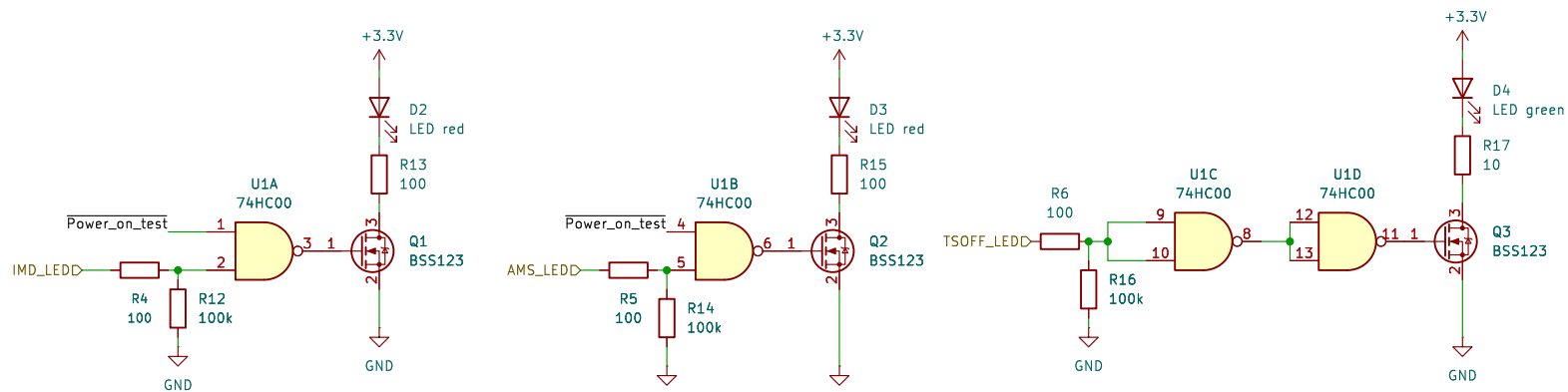
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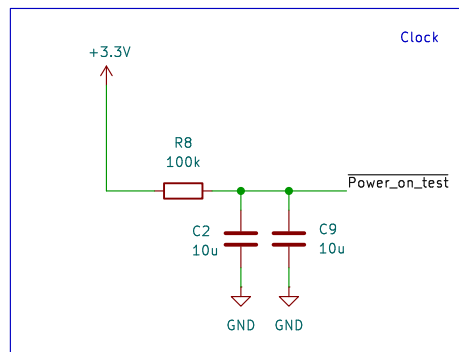
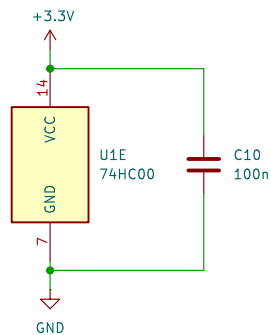
Dashboard





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 functionality of these.

TS Off signal from Acc Tsal



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

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