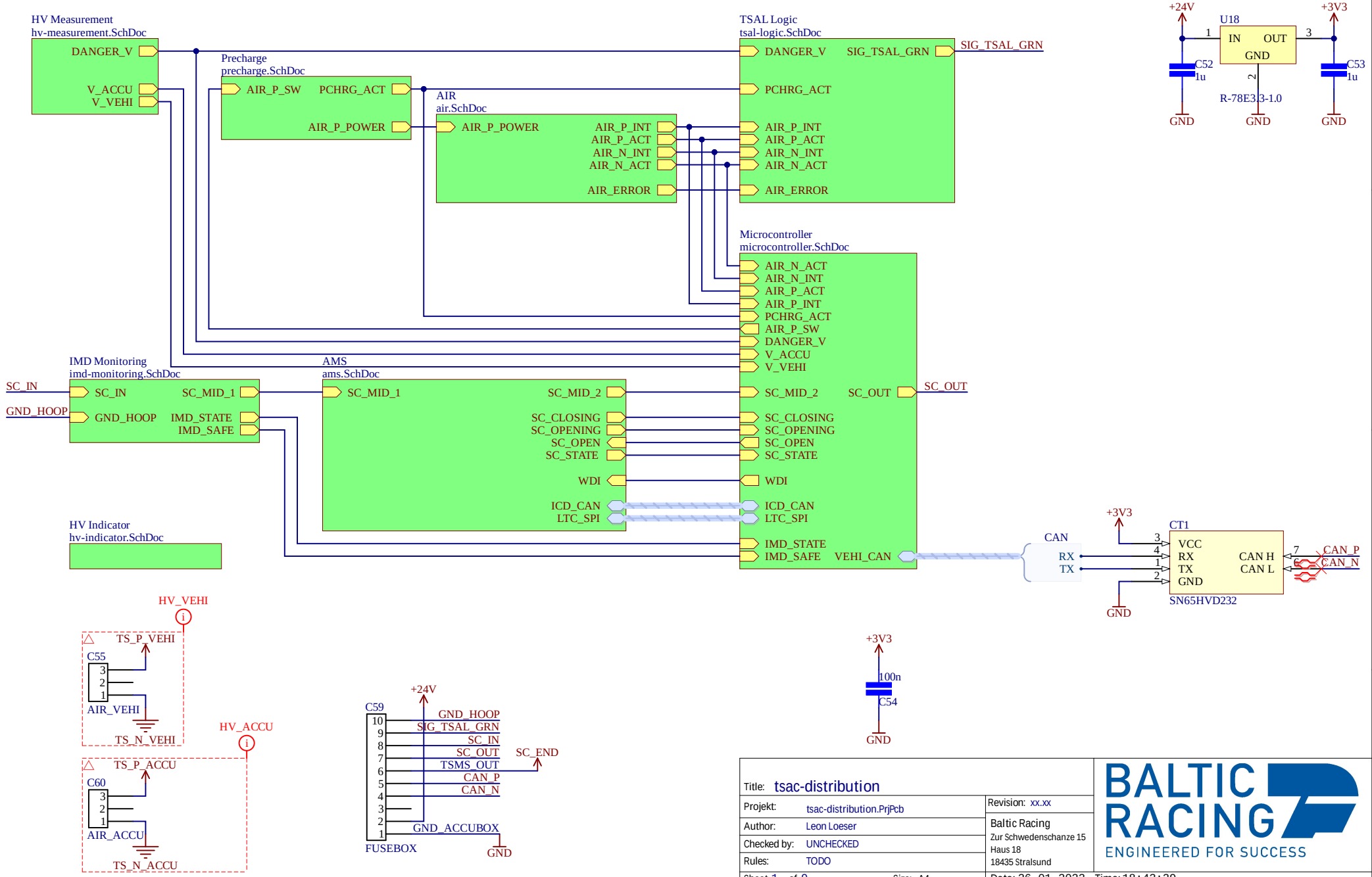
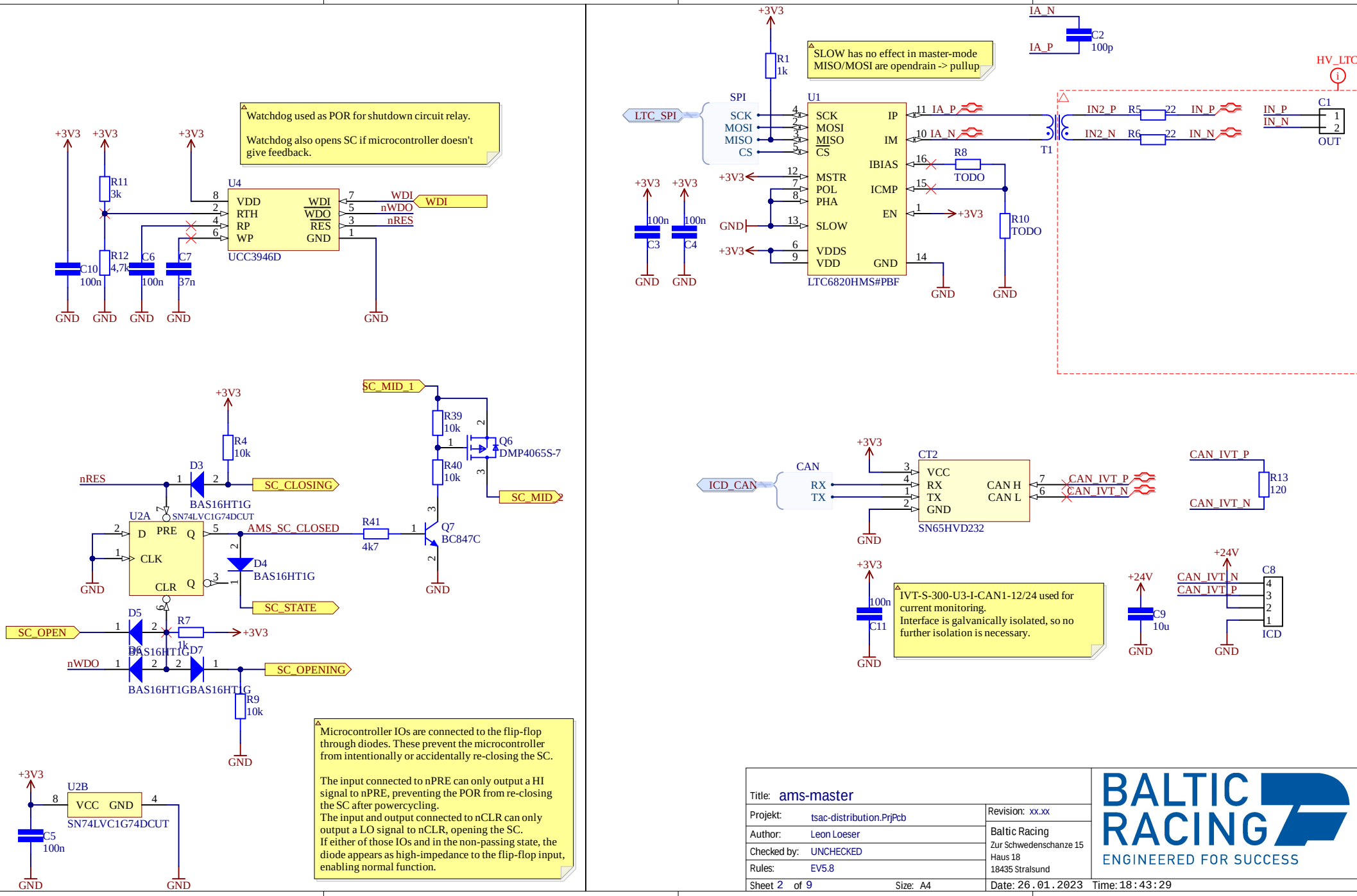

HV Measurement
hv-measurement.SchDoc
DANGER_V
V_ACCU
V_VEHI
Precharge
precharge.SchDoc
AIR_P_SW
PCHRG_ACT
AIR_P_POWER
AIR
air.SchDoc
AIR_P_POWER
AIR_P_INT
AIR_P_ACT
AIR_N_INT
AIR_N_ACT
AIR_ERROR
TSAL Logic
tsal-logic.SchDoc
DANGER_V
SIG_TSAL_GRN
SIG_TSAL_GRN
PCHRG_ACT
AIR_P_INT
AIR_P_ACT
AIR_N_INT
AIR_N_ACT
AIR_ERROR
+24V
U18
+3V3
IN
OUT
GND
C52
1u
C53
1u
R-78E3.3-1.0
GND
GND
GND
Microcontroller
microcontroller.SchDoc
AIR_N_ACT
AIR_N_INT
AIR_P_ACT
AIR_P_INT
PCHRG_ACT
AIR_P_SW
DANGER_V
V_ACCU
V_VEHI
SC_MID_2
SC_OUT
SC_OUT
SC_CLOSING
SC_OPENING
SC_OPEN
SC_STATE
WDI
ICD_CAN
LTC_SPI
IMD_STATE
IMD_SAFE
VEHI_CAN
IMD Monitoring
imd-monitoring.SchDoc
SC_IN
GND_HOOP
SC_IN
GND_HOOP
SC_MID_1
IMD_STATE
IMD_SAFE
AMS
ams.SchDoc
SC_MID_1
SC_MID_2
SC_CLOSING
SC_OPENING
SC_OPEN
SC_STATE
WDI
ICD_CAN
LTC_SPI
HV Indicator
hv-indicator.SchDoc
CAN
RX
TX
+3V3
CT1
VCC
RX
TX
GND
CAN H
CAN L
CAN_P
CAN_N
SN65HVD232
GND
HV_VEHI
TS_P_VEHI
C55
AIR_VEHI
TS_N_VEHI
HV_ACCU
TS_P_ACCU
C60
AIR_ACCU
TS_N_ACCU
C59
+24V
GND_HOOP
SIG_TSAL_GRN
SC_IN
SC_OUT
TSMS_OUT
CAN_P
CAN_N
GND_ACCUBOX
SC_END
FUSEBOX
GND
+3V3
100n
C54
GND
Title: tsac-distribution
Projekt: tsac-distribution.PrjPcb
Author: Leon Loeser
Checked by: UNCHECKED
Rules: TODO
Sheet 1 of 9
Size: A4
Revision: xx.xx
Baltic Racing
Zur Schwedenschanze 15
Haus 18
18435 Stralsund
BALTIC RACING
ENGINEERED FOR SUCCESS
Date: 26.01.2023
Time: 18:43:29


Watchdog used as POR for shutdown circuit relay.
Watchdog also opens SC if microcontroller doesn't give feedback.
U4
UCC3946D
SLOW has no effect in master-mode
MISO/MOSI are opendrain -> pullup
U1
LTC6820HMS#PBF
T1
HV_LTC
OUT
SC_CLOSING
SC_MID_1
SC_MID_2
SC_STATE
SC_OPEN
SC_OPENING
AMS_SC_CLOSED
BAS16HT1G
DMP4065S-7
BC847C
SN74LVC1G74DCUT
Microcontroller IOs are connected to the flip-flop through diodes. These prevent the microcontroller from intentionally or accidentally re-closing the SC.
The input connected to nPRE can only output a HI signal to nPRE, preventing the POR from re-closing the SC after powercycling.
The input and output connected to nCLR can only output a LO signal to nCLR, opening the SC.
If either of those IOs and in the non-passing state, the diode appears as high-impedance to the flip-flop input, enabling normal function.
CT2
SN65HVD232
IVT-S-300-U3-I-CAN1-12/24 used for current monitoring.
Interface is galvanically isolated, so no further isolation is necessary.
Title: ams-master
Projekt: tsac-distribution.PrjPcb
Author: Leon Loeser
Checked by: UNCHECKED
Rules: EV5.8
Sheet 2 of 9
Size: A4
Revision: xx.xx
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Date: 26.01.2023
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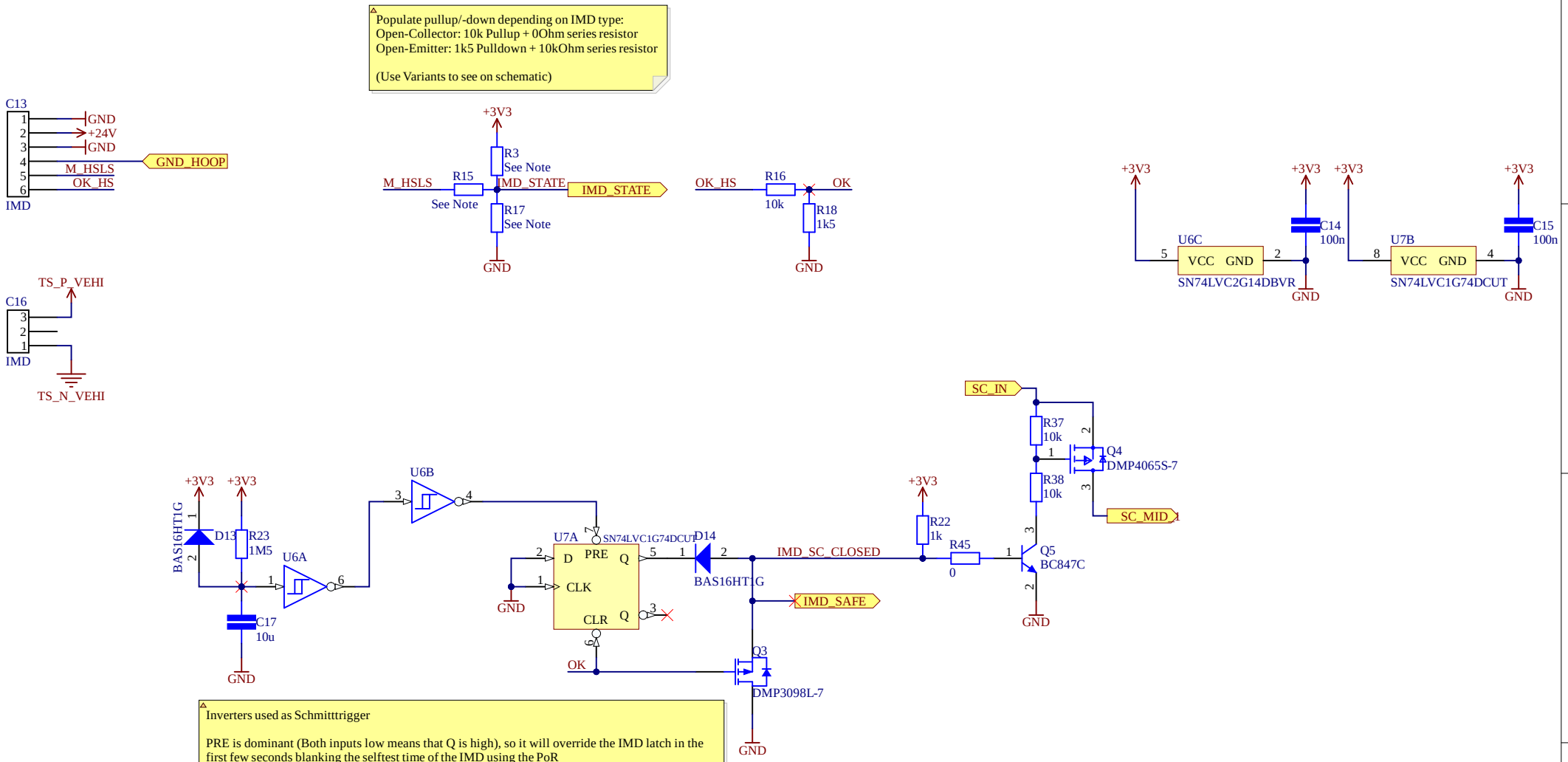
Populate pullup/-down depending on IMD type:
Open-Collector: 10k Pullup + 0Ohm series resistor
Open-Emitter: 1k5 Pulldown + 10kOhm series resistor
(Use Variants to see on schematic)
C13
GND
+24V
GND
M_HSLS
OK_HS
GND_HOOP
IMD
+3V3
R3
See Note
M_HSLS
R15
See Note
IMD_STATE
IMD_STATE
R17
See Note
GND
OK_HS
R16
10k
OK
R18
1k5
GND
+3V3
+3V3
+3V3
+3V3
U6C
VCC GND
SN74LVC2G14DBVR
C14
100n
GND
U7B
VCC GND
SN74LVC1G74DCUT
C15
100n
GND
C16
TS_P_VEHI
IMD
TS_N_VEHI
SC_IN
R37
10k
Q4
DMP4065S-7
R38
10k
SC_MID
+3V3
+3V3
BAS16HT1G
D13
R23
1M5
U6A
U6B
C17
10u
GND
U7A
SN74LVC1G74DCUT
D
PRE
Q
CLK
CLR
Q
GND
D14
BAS16HT1G
IMD_SC_CLOSED
IMD_SAFE
OK
Q3
DMP3098L-7
GND
+3V3
R22
1k
R45
0
Q5
BC847C
GND
Inverters used as Schmitttrigger
PRE is dominant (Both inputs low means that Q is high), so it will override the IMD latch in the first few seconds blanking the selftest time of the IMD using the PoR
Because of the P-Channel MOSFET and the diode, the Q signal is ANDed with the OK signal, so as long as the IMD boots (and tries to reset the latch), the output will be LOW and the SC opened. As soon as the IMD booted up and set's OK to high and the POR elapsed, the latch will drive the MOSFET and hence the SC relay, until OK goes LOW again. Now it can't reopen, since the latch will always pull the P-FET-gate LOW until a power-cycle is completed.
*Monitor OK output, open SC over PORed-FlipFlop if error
*Monitor Status PWM for CAN
Title: imd-monitoring
Projekt: tsac-distribution.PrjPcb
Revision: xx.xx
Author: Leon Loeser
Checked by: UNCHECKED
Rules: EV6.3
Sheet 3 of 9
Size: A4
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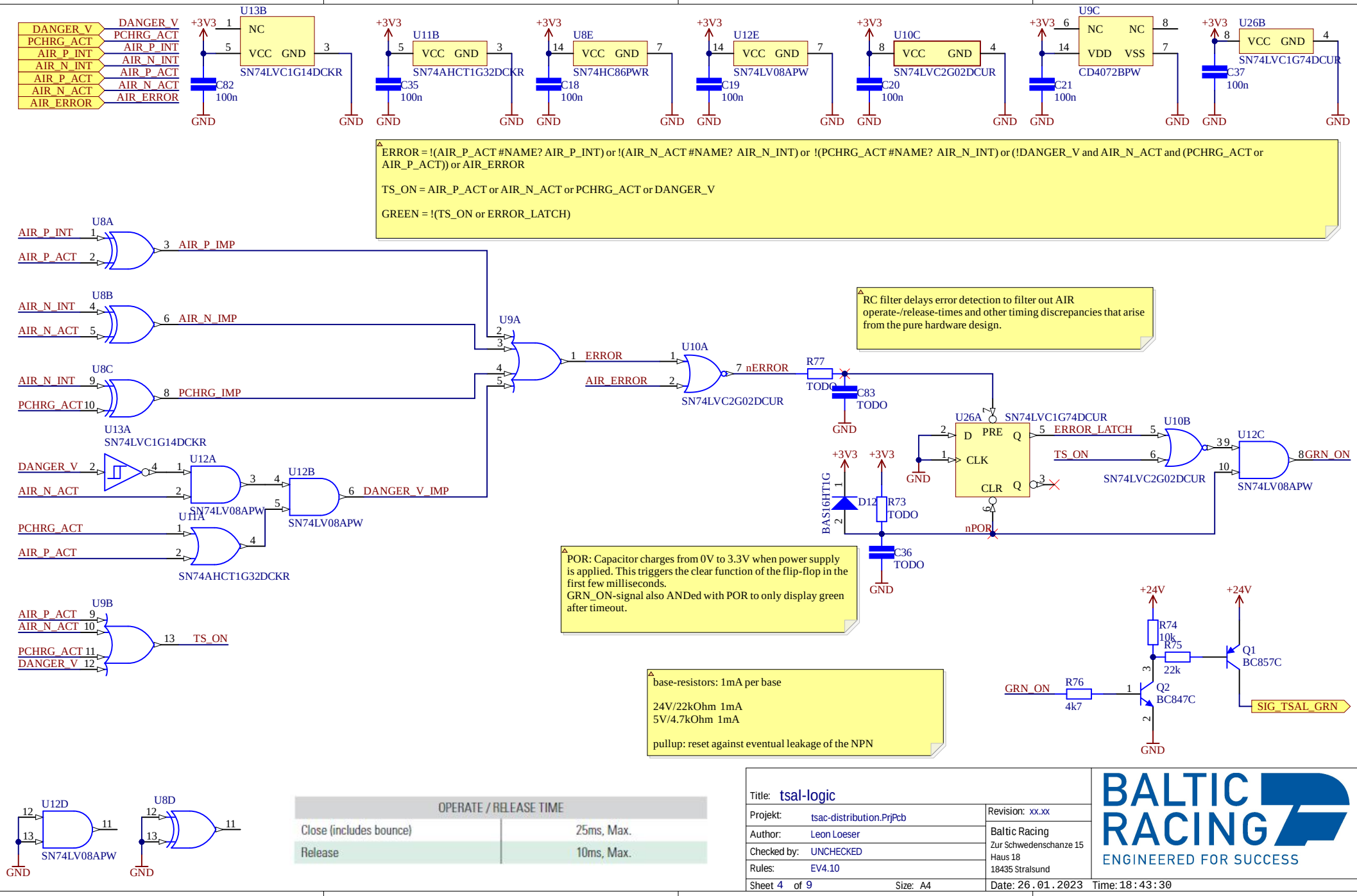
DANGER_V
PCHRG_ACT
AIR_P_INT
AIR_N_INT
AIR_P_ACT
AIR_N_ACT
AIR_ERROR
U13B
SN74LVC1G14DCKR
U11B
SN74AHCT1G32DCKR
U8E
SN74HC86PWR
U12E
SN74LV08APW
U10C
SN74LVC2G02DCUR
U9C
CD4072BPW
U26B
SN74LVC1G74DCUR
C82 100n
C35 100n
C18 100n
C19 100n
C20 100n
C21 100n
C37 100n
+3V3
GND
ERROR = !(AIR_P_ACT #NAME? AIR_P_INT) or !(AIR_N_ACT #NAME? AIR_N_INT) or !(PCHRG_ACT #NAME? AIR_N_INT) or (!DANGER_V and AIR_N_ACT and (PCHRG_ACT or AIR_P_ACT)) or AIR_ERROR
TS_ON = AIR_P_ACT or AIR_N_ACT or PCHRG_ACT or DANGER_V
GREEN = !(TS_ON or ERROR_LATCH)
U8A
U8B
U8C
U13A
SN74LVC1G14DCKR
U12A
U12B
SN74LV08APW
U11A
SN74AHCT1G32DCKR
U9A
U9B
AIR_P_IMP
AIR_N_IMP
PCHRG_IMP
DANGER_V_IMP
TS_ON
ERROR
nERROR
U10A
SN74LVC2G02DCUR
R77
TODO
C83
TODO
RC filter delays error detection to filter out AIR operate-/release-times and other timing discrepancies that arise from the pure hardware design.
U26A
SN74LVC1G74DCUR
D
PRE
Q
CLK
CLR
ERROR_LATCH
U10B
U12C
GRN_ON
D12
BAS16HT1G
R73
TODO
C36
TODO
nPOR
POR: Capacitor charges from 0V to 3.3V when power supply is applied. This triggers the clear function of the flip-flop in the first few milliseconds.
GRN_ON-signal also ANDed with POR to only display green after timeout.
+24V
R74
10k
R75
22k
Q1
BC857C
Q2
BC847C
R76
4k7
GRN_ON
SIG_TSAL_GRN
base-resistors: 1mA per base
24V/22kOhm 1mA
5V/4.7kOhm 1mA
pullup: reset against eventual leakage of the NPN
U12D
U8D
SN74LV08APW
OPERATE / RELEASE TIME
Close (includes bounce) 25ms, Max.
Release 10ms, Max.
Title: tsal-logic
Projekt: tsac-distribution.PrjPcb
Author: Leon Loeser
Checked by: UNCHECKED
Rules: EV4.10
Sheet 4 of 9
Size: A4
Revision: xx.xx
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Date: 26.01.2023
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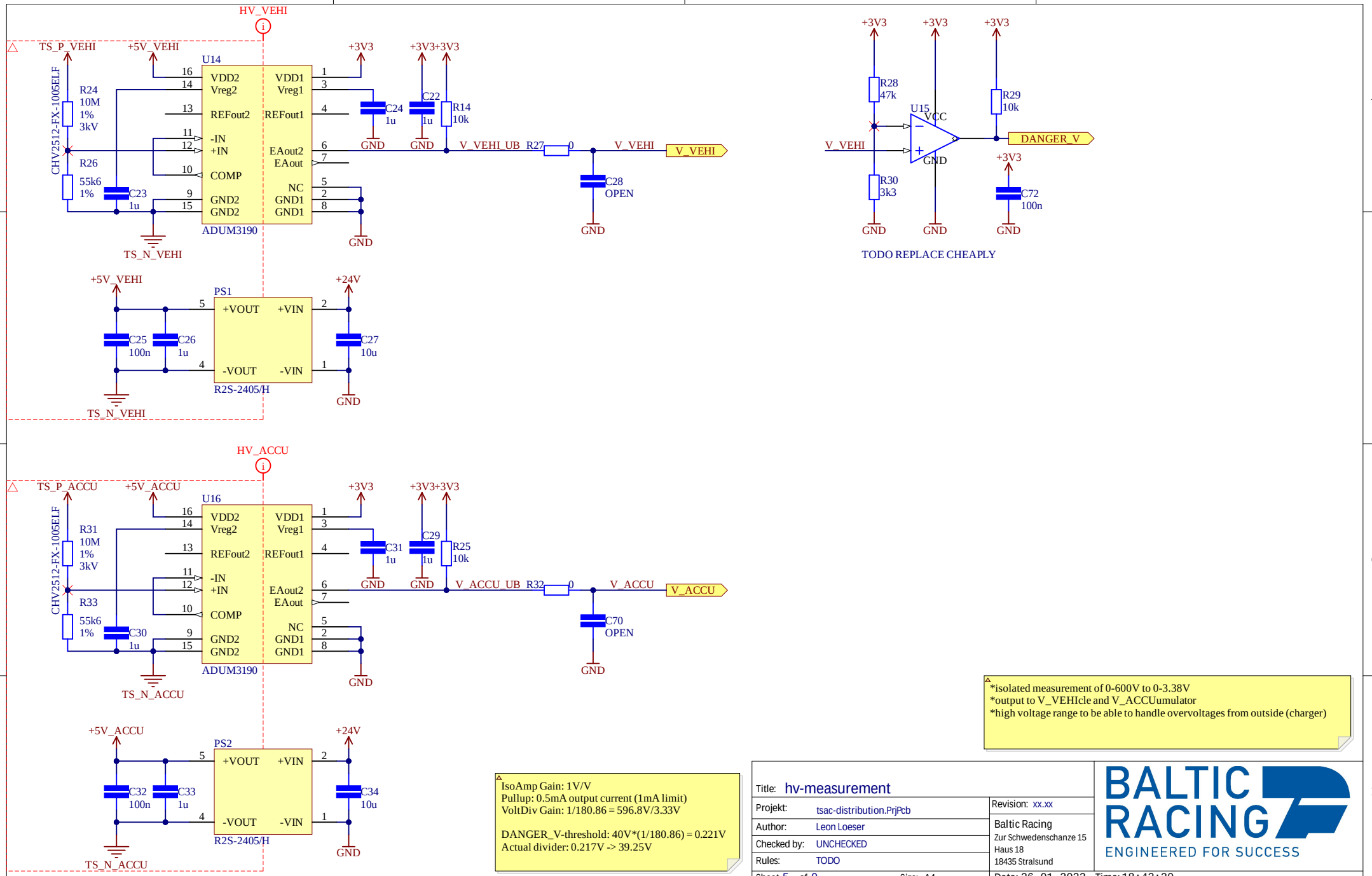
HV_VEHI
TS_P_VEHI
+5V_VEHI
U14
CHV2512-FX-1005ELF
R24
10M
1%
3kV
R26
55k6
1%
C23
1u
VDD2
Vreg2
REFout2
-IN
+IN
COMP
GND2
GND2
VDD1
Vreg1
REFout1
EAout2
EAout
NC
GND1
GND1
ADUM3190
TS_N_VEHI
+3V3
+3V3+3V3
C24
1u
C22
1u
R14
10k
GND
V_VEHI_UB
R27
0
V_VEHI
C28
OPEN
+5V_VEHI
PS1
C25
100n
C26
1u
+VOUT
-VOUT
+VIN
-VIN
R2S-2405/H
+24V
C27
10u
TS_N_VEHI
+3V3
+3V3
+3V3
R28
47k
U15
VCC
R29
10k
V_VEHI
DANGER_V
GND
R30
3k3
C72
100n
TODO REPLACE CHEAPLY
HV_ACCU
TS_P_ACCU
+5V_ACCU
U16
CHV2512-FX-1005ELF
R31
10M
1%
3kV
R33
55k6
1%
C30
1u
ADUM3190
TS_N_ACCU
C31
1u
C29
1u
R25
10k
V_ACCU_UB
R32
0
V_ACCU
C70
OPEN
+5V_ACCU
PS2
C32
100n
C33
1u
R2S-2405/H
C34
10u
TS_N_ACCU
*isolated measurement of 0-600V to 0-3.38V
*output to V_VEHIcle and V_ACCUumulator
*high voltage range to be able to handle overvoltages from outside (charger)
IsoAmp Gain: 1V/V
Pullup: 0.5mA output current (1mA limit)
VoltDiv Gain: 1/180.86 = 596.8V/3.33V
DANGER_V-threshold: 40V*(1/180.86) = 0.221V
Actual divider: 0.217V -> 39.25V
Title: hv-measurement
Projekt: tsac-distribution.PrjPcb
Author: Leon Loeser
Checked by: UNCHECKED
Rules: TODO
Sheet 5 of 9
Size: A4
Revision: xx.xx
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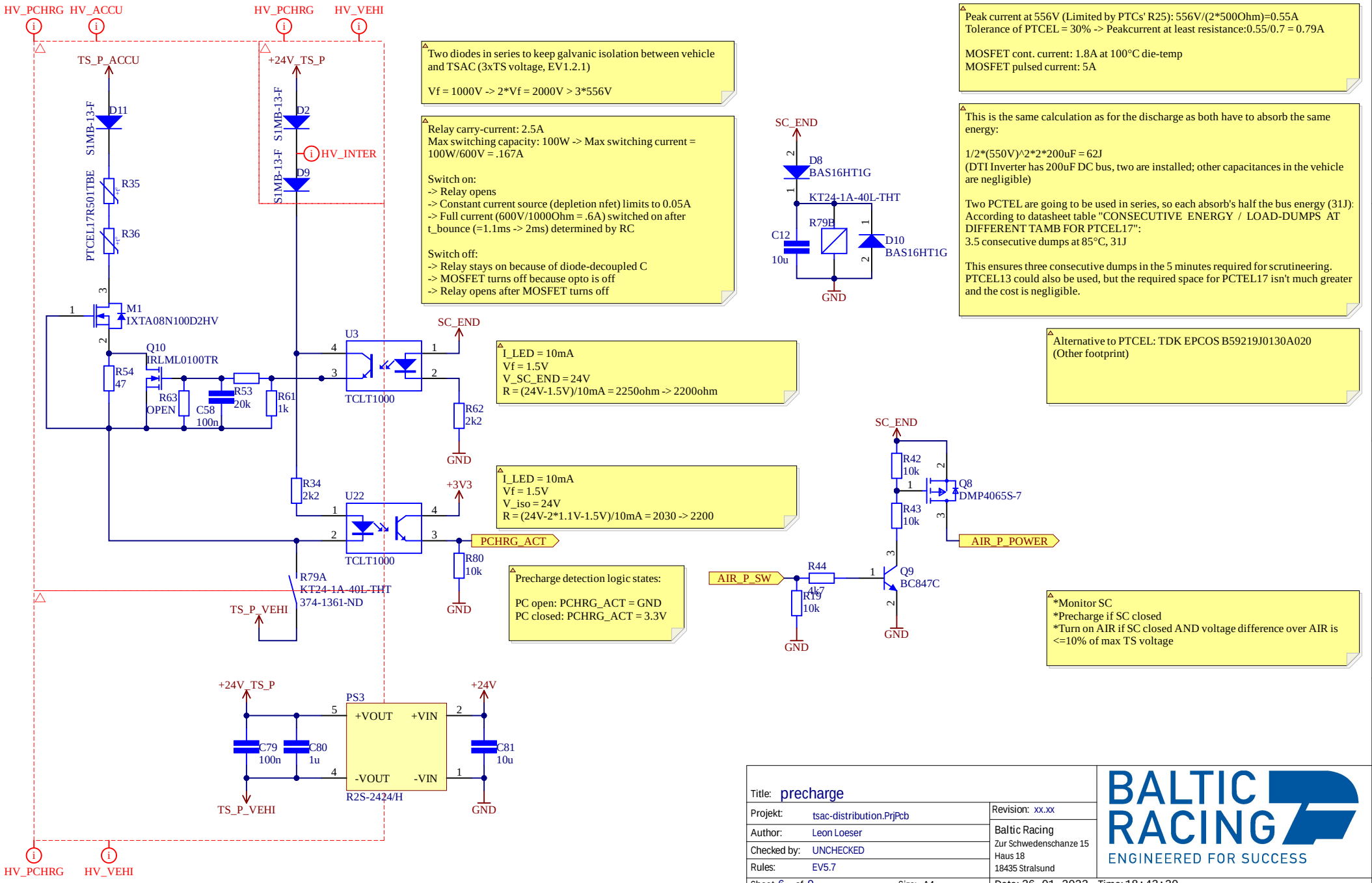

Title:	precharge
Projekt:	tsac-distribution.PrjPcb
Author:	Leon Loeser
Checked by:	UNCHECKED
Rules:	EV5.7
Sheet 6 of 9	Size: A4
Revision:	xx.xx
Baltic Racing	Zur Schwedenschanze 15 Haus 18 18435 Stralsund
Date: 26.01.2023	Time: 18:43:30

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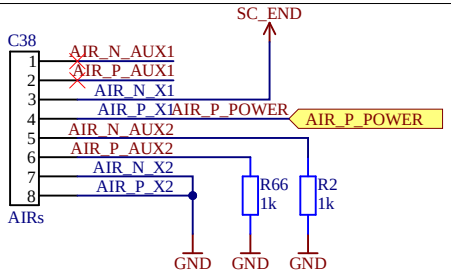
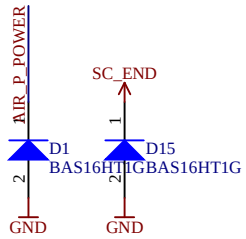
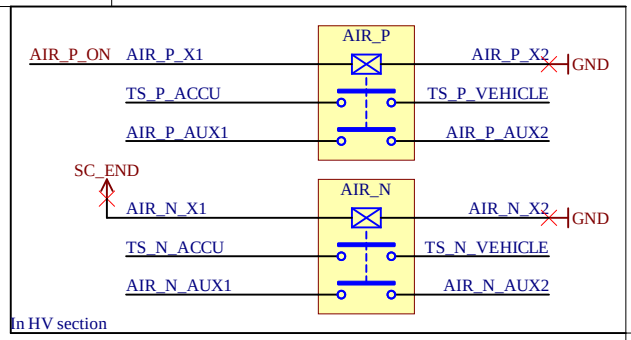




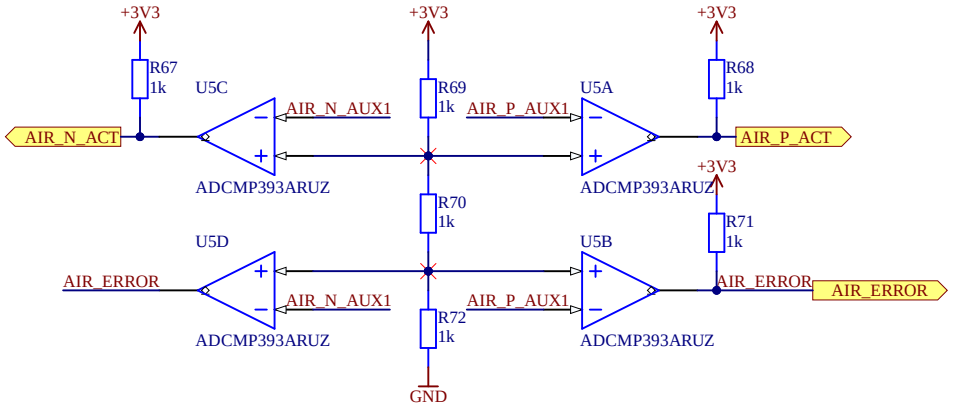


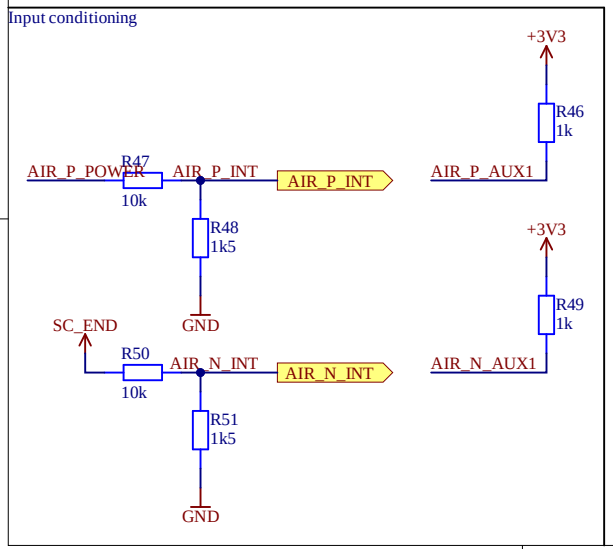
AIR-AUX-voltage level:

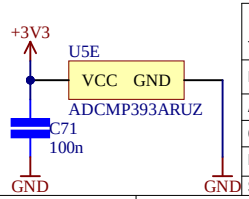
+3.3V: AIR OPEN or OPEN CIRCUIT
+1.65V: AIR CLOSED
+0V: SHORT TO GROUND

AIR plausibility check checks for stuck AIR contacts and detects open circuit.

TSAL safe-mode is entered if either of the following conditions is true:
a) AIRs should be closed and an open AIR (open circuit) is detected.
b) AIRs should be opened and a closed AIR (closed air or short to ground) is detected.







*Monitor AIR state
*Monitor AIR intended state (SC, Precharge)
*Compare states to indicate AIR_CLoSeD and AIR_IMPLausibility

Title: air	
Projekt: tsac-distribution.PrjPcb	Revision: xx.xx
Author: Leon Loeser	Baltic Racing Zur Schwedenschanze 15 Haus 18 18435 Stralsund
Checked by: UNCHECKED	
Rules: TODO	
Sheet 7 of 9 Size: A4	Date: 26.01.2023 Time: 18:43:30

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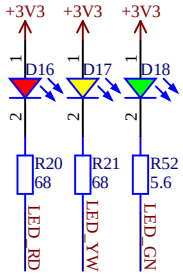
TODO
IMD_STATE an timer input (capture)

WDI an timer output oder auch normales I/O, rtos routine

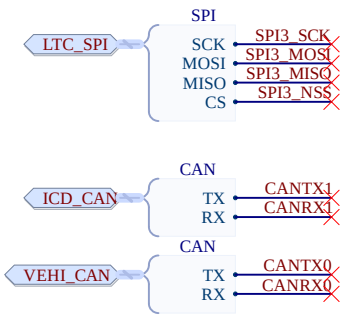
V_X an Analoge pins

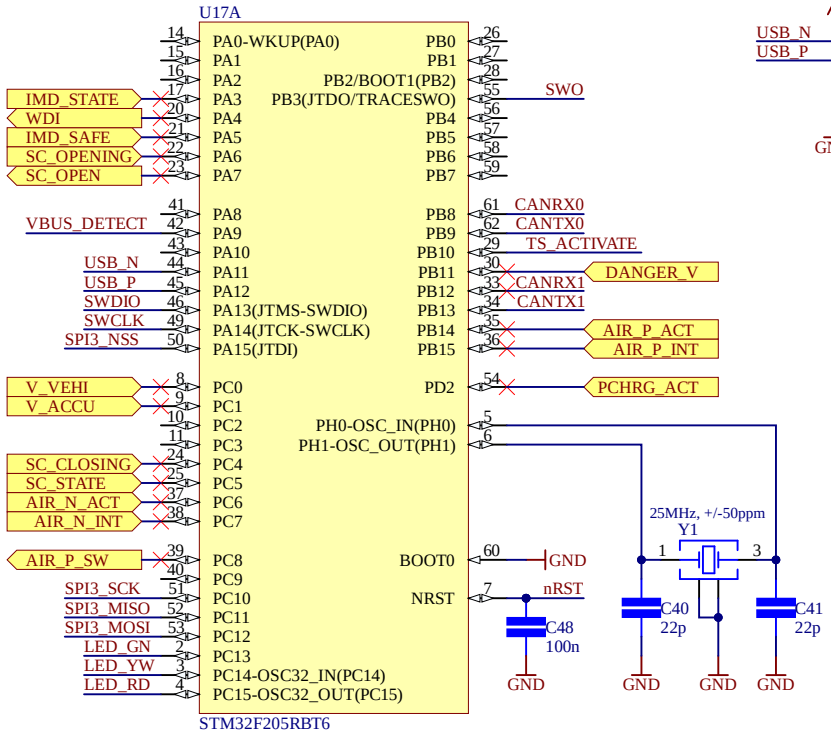
Ansonsten aufpassen, dass POR state nix kaputt macht oder auslöst

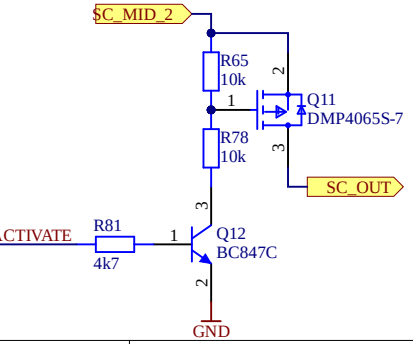


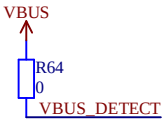
Red/Yellow LED:
Vf = 2V -> R = (3.3-2)V/.02A=65Ohm -> 68Ohm

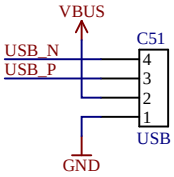
Green LED:
Vf = 3.2V -> R = (3.3-3.2)V/.02A=5Ohm -> 5.6Ohm

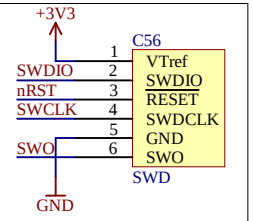


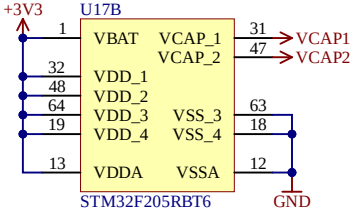


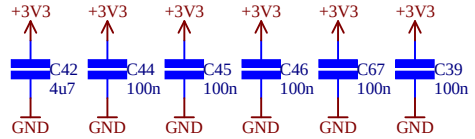


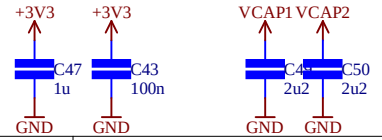












Title:	microcontroller
Projekt:	tsac-distribution.PrjPcb
Author:	Leon Loeser
Checked by:	UNCHECKED
Rules:	TODO
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Revision:	xx.xx
Baltic Racing	Zur Schwedenschanze 15 Haus 18 18435 Stralsund
Date: 26.01.2023	Time: 18:43:30

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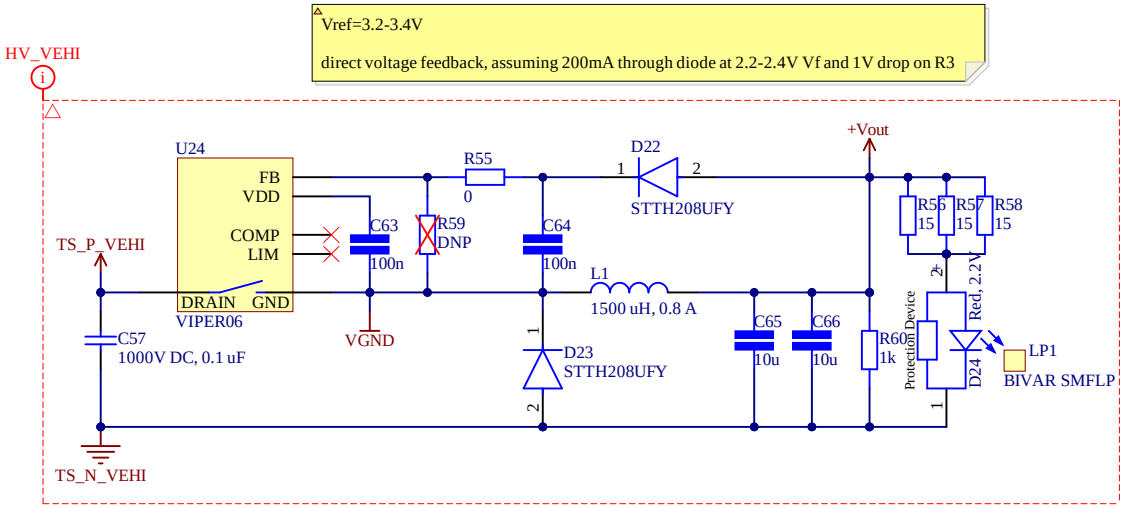

Title: hv-indicator			
Projekt:	tsac-distribution.PrjPcb	Revision: xx.xx	
Author:	Leon Loeser	Baltic Racing Zur Schwedenschanze 15 Haus 18 18435 Stralsund	
Checked by:	UNCHECKED		
Rules:	EV5.4.8, EV5.4.9, EV5.4.10		
Sheet 9 of 9	Size: A4	Date: 26.01.2023	Time: 18:43:30

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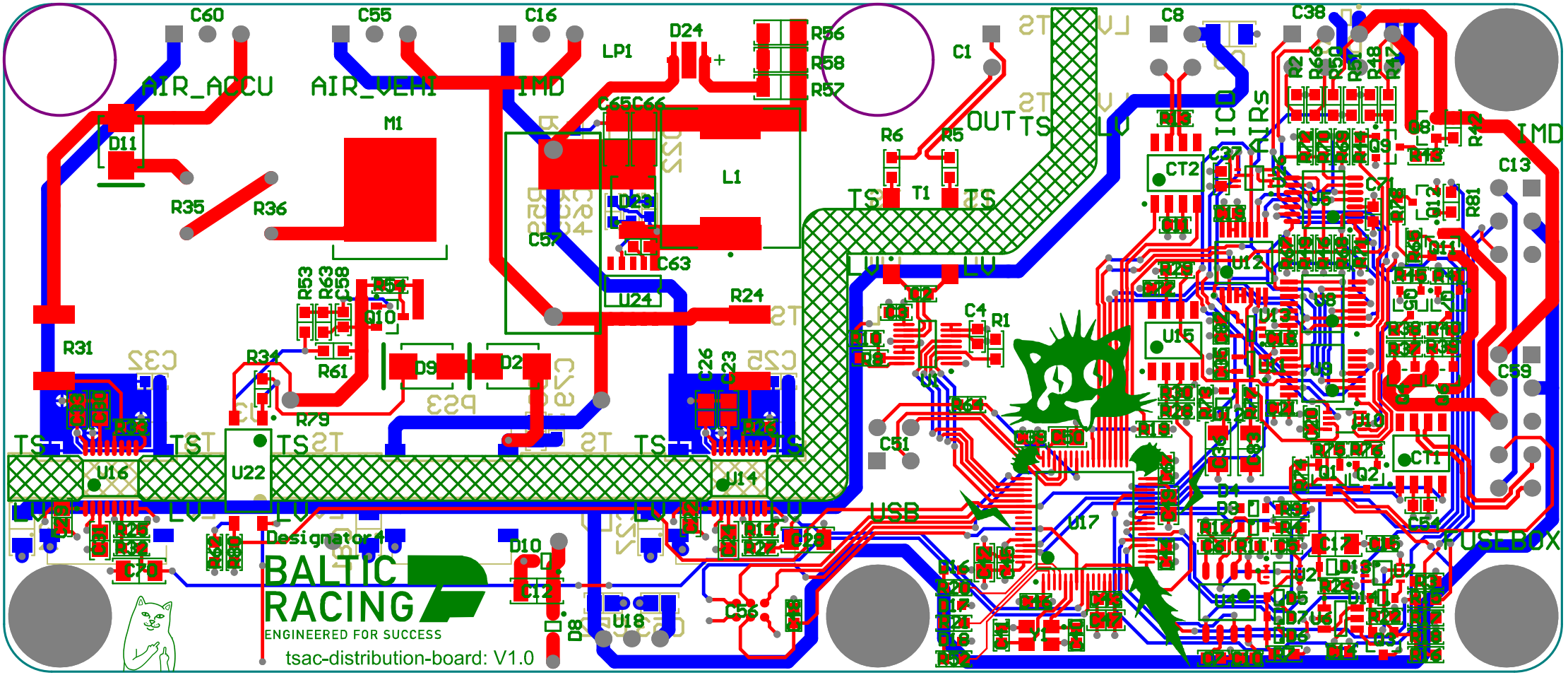
AIR_ACCU
AIR_VEHI
IMD
OUTTS
BALTIC
RACING
ENGINEERED FOR SUCCESS
tsac-distribution-board: V1.0
USB
USEBOX