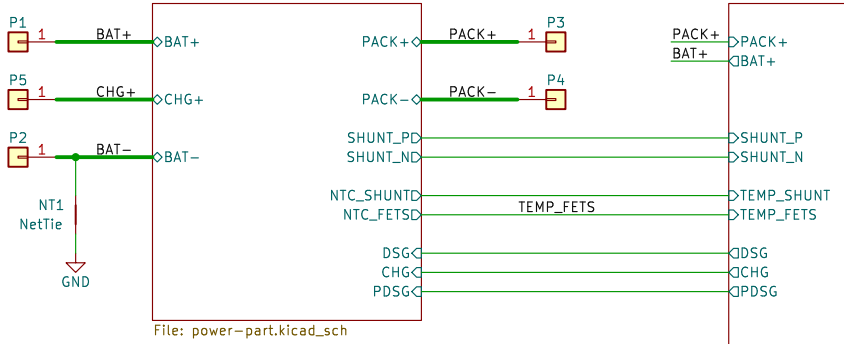
Libre Solar BMS for 3–16 cells

Based on TI bq76952 and ESP32-C3

Development funded by EnAccess Foundation.

https://enaccess.org

Power Part



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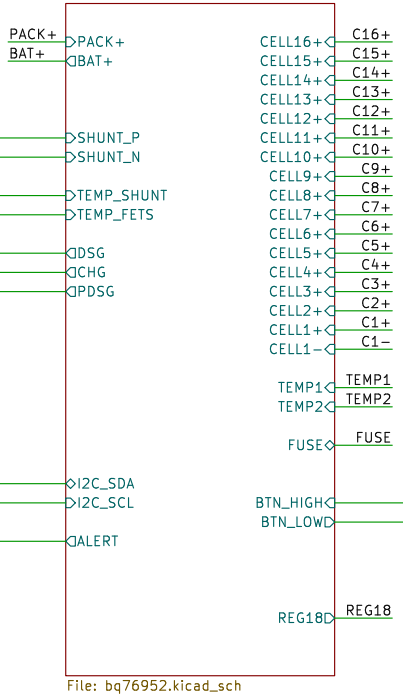
BQ76952



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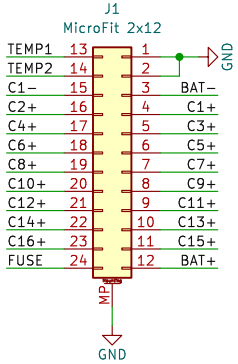
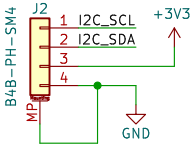
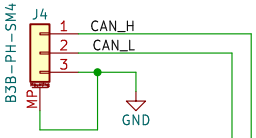
Cell Connector



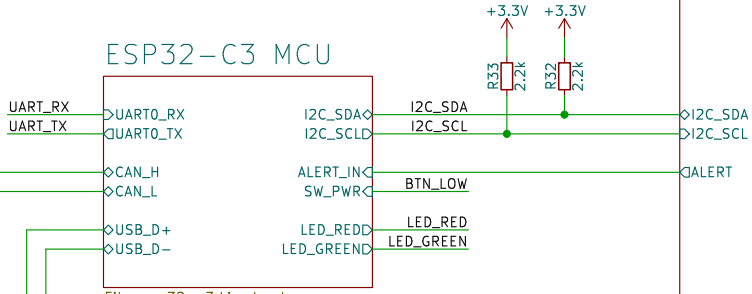
Internal I2C



CAN / RS-485

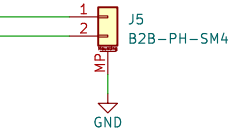


ESP32-C3 MCU

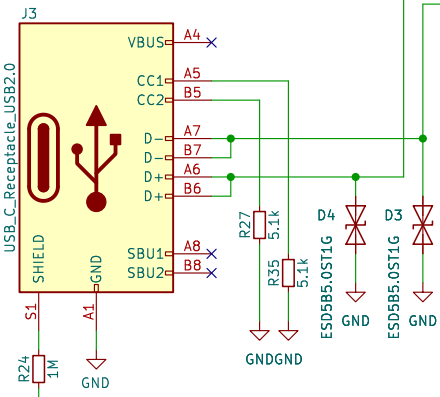


File: esp32-c3.kicad_sch

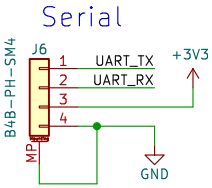
On/Off button

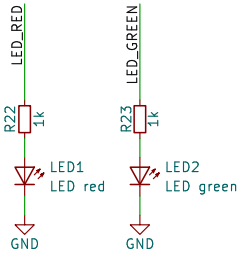


USB

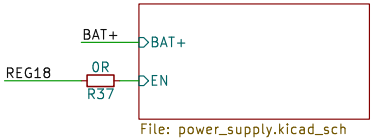


Serial





Power Supply



FID1 Fiducial

FID2 Fiducial

H1 MountingHole

H2 MountingHole

H3 MountingHole

H4 MountingHole

H5 MountingHole

H6 MountingHole

LOGO2 LIBRE_SOLAR

LOGO1 OPEN_HARDWARE

Libre Solar BMS C1		LIBRESOLAR
Libre Solar Technologies GmbH Author: Martin Jäger	Website: https://libre.solar	
Sheet: File: bms-c1.kicad_sch		
License: CERN-OHL-W		
Size: A4	Date: 2023-11-03	Rev: 0.4.0
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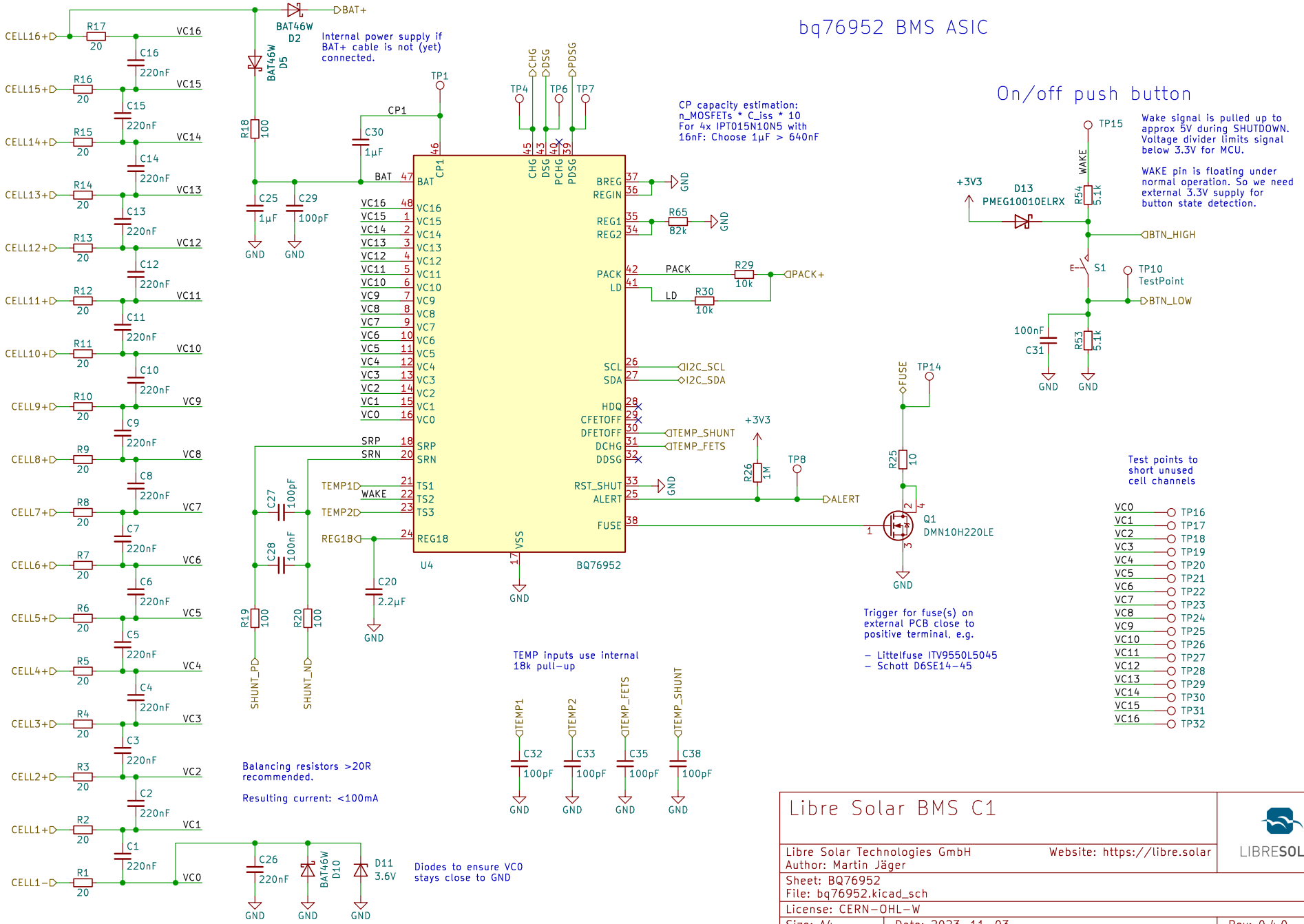
bq76952 BMS ASIC
On/off push button
BAT+
BAT46W D2
Internal power supply if BAT+ cable is not (yet) connected.
BAT46W D5
CP1
C30 1µF
CP capacity estimation:
n_MOSFETs * C_iss * 10
For 4x IPT015N10N5 with 16nF: Choose 1µF > 640nF
R18 100
C25 1µF
C29 100pF
GND
TP1
TP4
TP6
TP7
CHG
DSG
PDSG
PCHG
U4
BQ76952
BAT
CP1
VC16
VC15
VC14
VC13
VC12
VC11
VC10
VC9
VC8
VC7
VC6
VC5
VC4
VC3
VC2
VC1
VC0
SRP
SRN
TS1
TS2
TS3
REG18
VSS
BREG
REGIN
REG1
REG2
PACK
LD
SCL
SDA
HDQ
CFETOFF
DFETOFF
DCHG
DDSG
RST_SHUT
ALERT
FUSE
R65 82k
R29 10k
R30 10k
PACK+
I2C_SCL
I2C_SDA
TEMP_SHUT
TEMP_FETS
C27 100pF
C28 100nF
C20 2.2µF
R19 100
R20 100
SHUNT_PD
SHUNT_ND
TEMP1
TEMP2
WAKE
R26 1M
+3V3
TP8
ALERT
TP14
FUSE
R25 10
Q1
DMN10H220LE
Trigger for fuse(s) on external PCB close to positive terminal, e.g.
– Littelfuse ITV9550L5045
– Schott D6SE14-45
TP15
D13
PMEG10010ELRX
R54 5.1k
BTN_HIGH
S1
TP10
TestPoint
BTN_LOW
C31 100nF
R53 5.1k
Wake signal is pulled up to approx 5V during SHUTDOWN. Voltage divider limits signal below 3.3V for MCU.
WAKE pin is floating under normal operation. So we need external 3.3V supply for button state detection.
Test points to short unused cell channels
VC0 TP16
VC1 TP17
VC2 TP18
VC3 TP19
VC4 TP20
VC5 TP21
VC6 TP22
VC7 TP23
VC8 TP24
VC9 TP25
VC10 TP26
VC11 TP27
VC12 TP28
VC13 TP29
VC14 TP30
VC15 TP31
VC16 TP32
TEMP inputs use internal 18k pull-up
C32 100pF
C33 100pF
C35 100pF
C38 100pF
Balancing resistors >20R recommended.
Resulting current: <100mA
C26 220nF
D10
D11 3.6V
Diodes to ensure VC0 stays close to GND
CELL16+
CELL15+
CELL14+
CELL13+
CELL12+
CELL11+
CELL10+
CELL9+
CELL8+
CELL7+
CELL6+
CELL5+
CELL4+
CELL3+
CELL2+
CELL1+
CELL1-
R17 20
R16 20
R15 20
R14 20
R13 20
R12 20
R11 20
R10 20
R9 20
R8 20
R7 20
R6 20
R5 20
R4 20
R3 20
R2 20
R1 20
C16 220nF
C15 220nF
C14 220nF
C13 220nF
C12 220nF
C11 220nF
C10 220nF
C9 220nF
C8 220nF
C7 220nF
C6 220nF
C5 220nF
C4 220nF
C3 220nF
C2 220nF
C1 220nF
VC16
VC15
VC14
VC13
VC12
VC11
VC10
VC9
VC8
VC7
VC6
VC5
VC4
VC3
VC2
VC1
VC0
Libre Solar BMS C1
Libre Solar Technologies GmbH
Author: Martin Jäger
Website: https://libre.solar
LIBRESOLAR
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Date: 2023-11-03
Rev: 0.4.0
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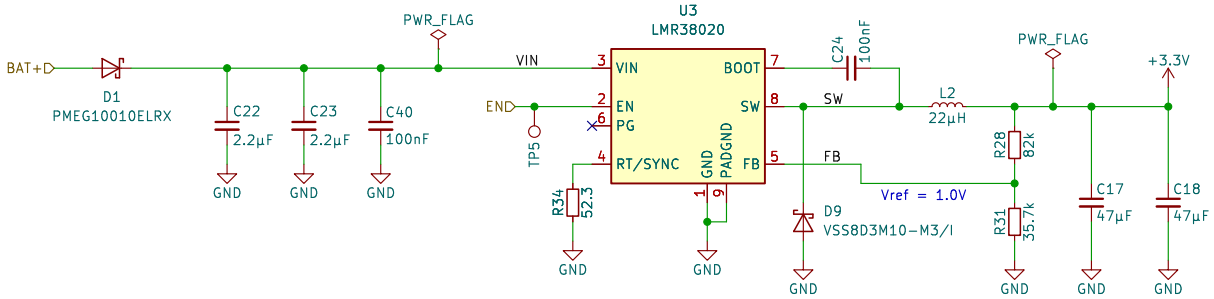
Page: 2/5

Battery to 3.3V (SMPS)

ESP32-C3 requires power supply with at least 500 mA



Layout for 500 kHz, 1A output

Libre Solar BMS C1		
Libre Solar Technologies GmbH Author: Martin Jäger	Website: https://libre.solar	LIBRESOLAR
Sheet: Power Supply File: power_supply.kicad_sch		
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Size: A4	Date: 2023-11-03	Rev: 0.4.0
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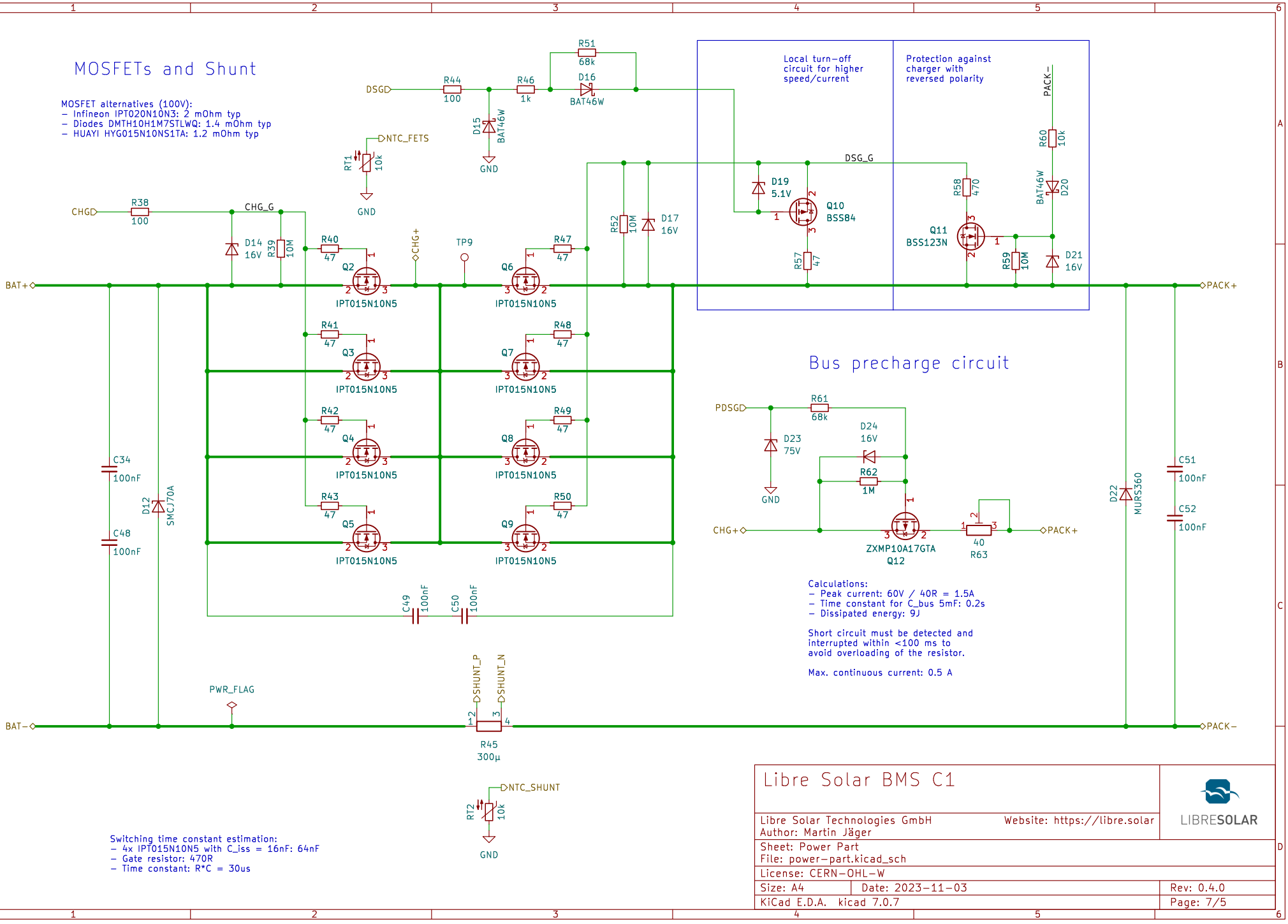
MOSFETs and Shunt
MOSFET alternatives (100V):
– Infineon IPT020N10N3: 2 mOhm typ
– Diodes DMTH10H1M7STLWQ: 1.4 mOhm typ
– HUAYI HYG015N10NS1TA: 1.2 mOhm typ
Local turn–off circuit for higher speed/current
Protection against charger with reversed polarity
Bus precharge circuit
Calculations:
– Peak current: 60V / 40R = 1.5A
– Time constant for C_bus 5mF: 0.2s
– Dissipated energy: 9J
Short circuit must be detected and interrupted within <100 ms to avoid overloading of the resistor.
Max. continuous current: 0.5 A
Switching time constant estimation:
– 4x IPT015N10N5 with C_iss = 16nF: 64nF
– Gate resistor: 470R
– Time constant: R*C = 30us
Libre Solar BMS C1
Libre Solar Technologies GmbH
Website: https://libre.solar
Author: Martin Jäger
Sheet: Power Part
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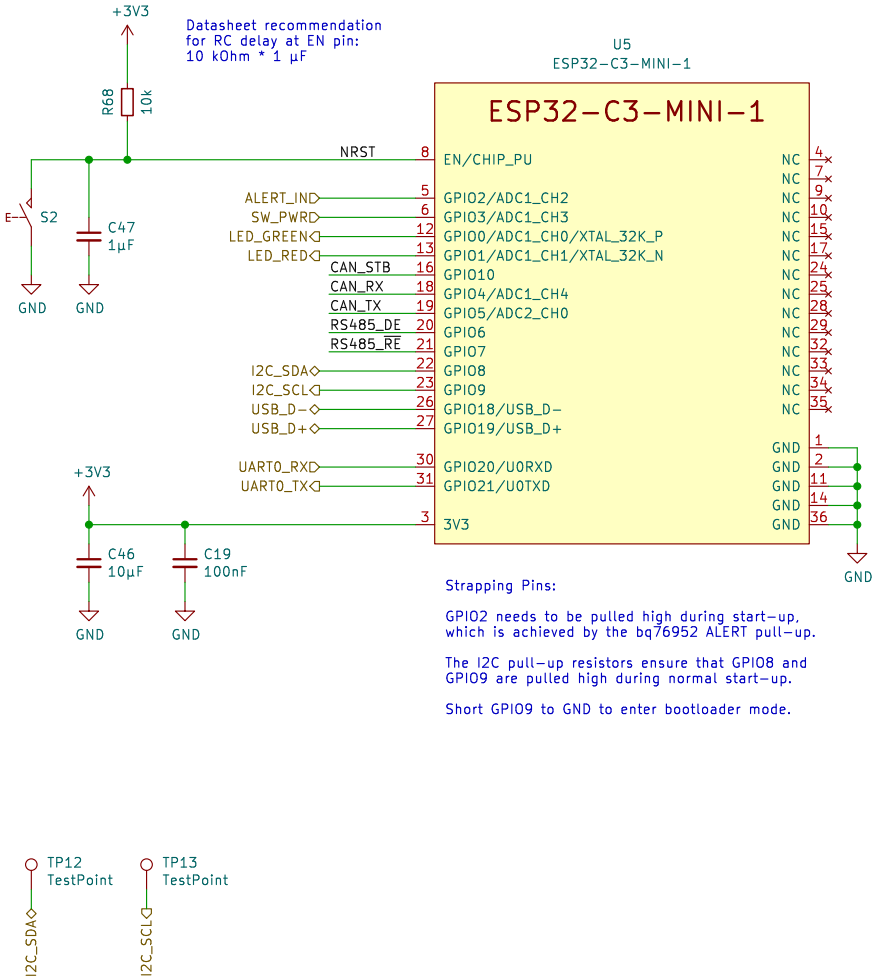
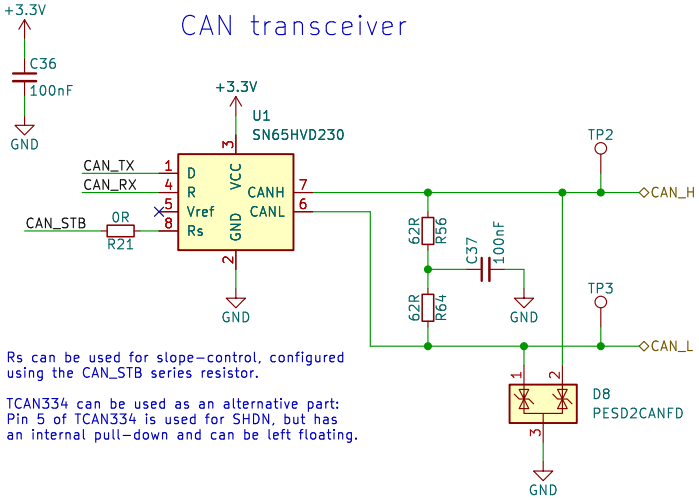
LIBRESOLAR

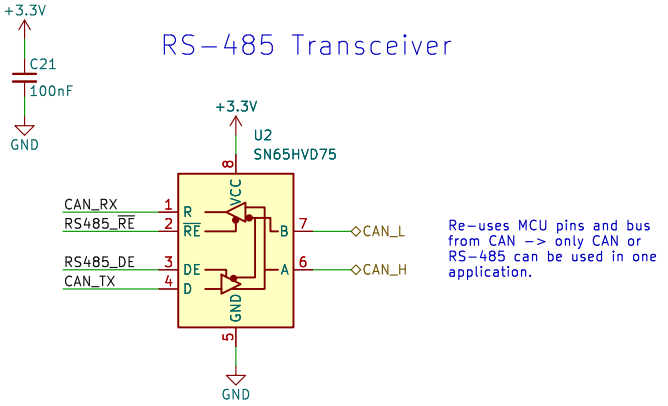
ESP32-C3 module



CAN transceiver



RS-485 Transceiver



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