MPPT charge controller with HS load switch and CAN

Sheet: DC/DC

J1 MKDS 5/ 2-9,5
MPPT: 60V 10A

1 DCDC_HV+
2 DCDC_HV-

DCDC_HV+
DCDC_HV-

DCDC_LV+

File: dcdc.sch

VBUS   PWR_FLAG

DCDC_LV+

F1
25A
XF1
Fuse_Holder

BAT+

C8
10nF

GND   PWR_FLAG

J2 MKDS 5/ 2-9,5
1
2
Battery: 12V/24V 20A

Sheet: MCU

V_DCDC_HD — ADC1_IN15
V_DCDC_LD — ADC1_IN12

I_DCDC — ADC12_IN1
I_DCDC_REF — DAC1

PWM_HS — TIM1_CH1
PWM_LS — TIM1_CH1N

ADC12_IN2 — I_LOAD
COMP2_INP — I_LOAD_COMP
GPIOB_2 — LOAD_DIS

GPIOB_10 — PWR_INFO

FDCAN1_TX
FDCAN1_RX

GPIOB_11

DCDC_HV+ — HV+
DCDC_LV+ — LV+

TIM8_CH2 — CP_PWM

File: mcu.sch

Sheet: Load switch

DCDC_LV+   LOAD+

MEAS_LV+

CP_OUT

File: load-switch.sch

LOAD+
GND

J3 MKDS 5/ 2-9,5
1
2
Load output: 20A

MEAS_LV+

Monitored peripheral
power supply
(e.g. for GSM board)

J6
3
2
1
JST PH
LS.pwr

PWR_INFO

GND

Sheet: Power supply

CP_OUT

File: power-supply.sch

Sheet: CAN

CAN_TX — CAN_TX
CAN_RX — CAN_RX

CAN_H
CAN_L

CAN_PWR1
CAN_PWR2
CAN_GND

CAN_STB

File: can.sch

8P8C   J4
1
2
3
4
5
6
7
8

CAN_H
CAN_L

CAN_GND

8P8C   J5
1
2
3
4
5
6
7
8

MPPT 2420 HC

Libre Solar Technologies GmbH
Author: Martin Jäger
Website: https://libre.solar

Sheet: /
File: mppt-2420-hc.sch

Size: A4   Date: 2020-12-11   Rev: 0.2
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DC/DC power stage

TP7

DCDC_HV+

RV2 82V
C17 10nF

LS_DRV
D7 SS14FL
R56 1M

TP5

Q3
IPA045N10N3G

DCDC_HV−
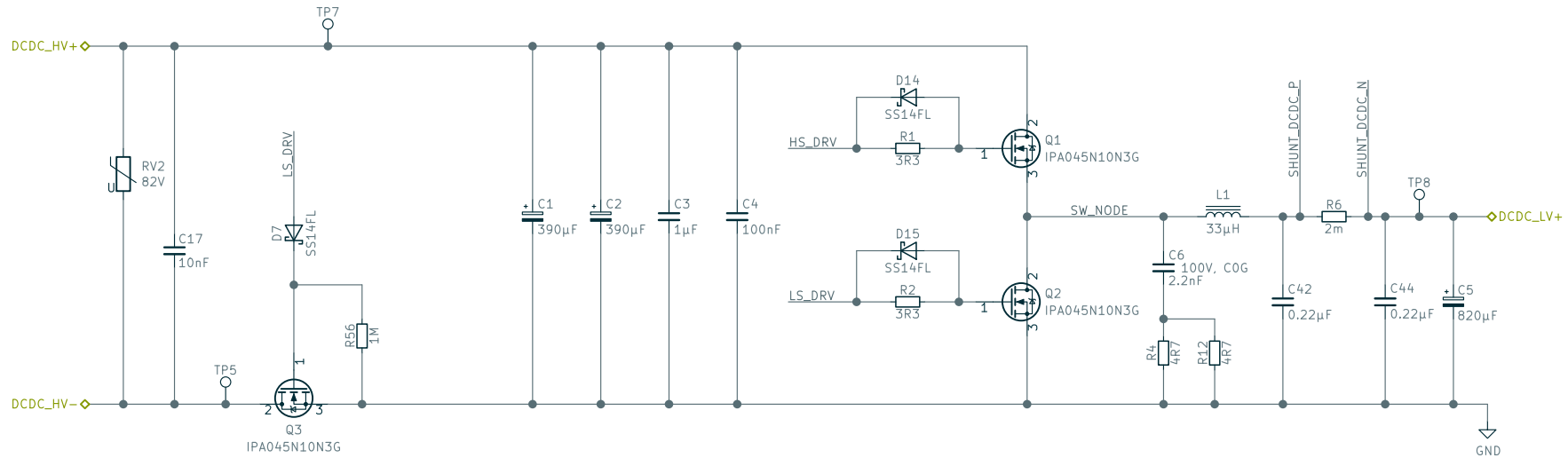
Reverse polarity protection and
PV reverse current blocking

C1 390µF
C2 390µF
C3 1µF
C4 100nF

D14 SS14FL
HS_DRV
R1 3R3
Q1 IPA045N10N3G

SW_NODE

D15 SS14FL
LS_DRV
R2 3R3
Q2 IPA045N10N3G

L1 33µH

SHUNT_DCDC_P
SHUNT_DCDC_N

TP8

R6 2m

DCDC_LV+

C6 100V, C0G 2.2nF
R4 4R7
R12 4R7
C42 0.22µF
C44 0.22µF
C5 820µF

GND

Voltage measurement

TP3

DCDC_HV+
R13 100k
V_DCDC_H

C14 10nF
R14 2.2k

GND
GND

TP6

DCDC_LV+
R17 100k
V_DCDC_L

C16 10nF
R18 5.6k

GND
GND

Inductor current measurement
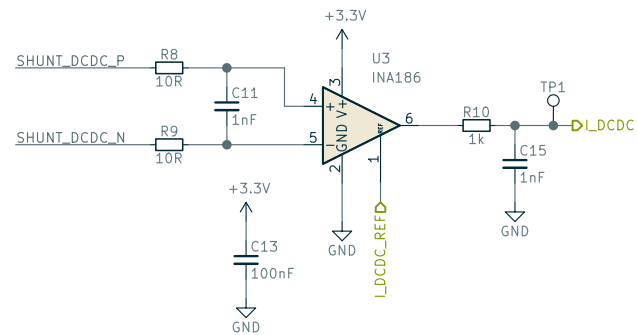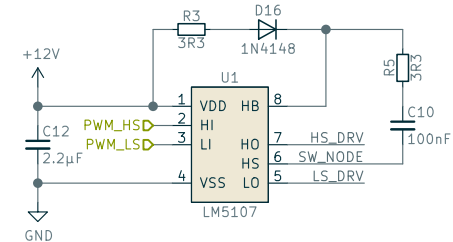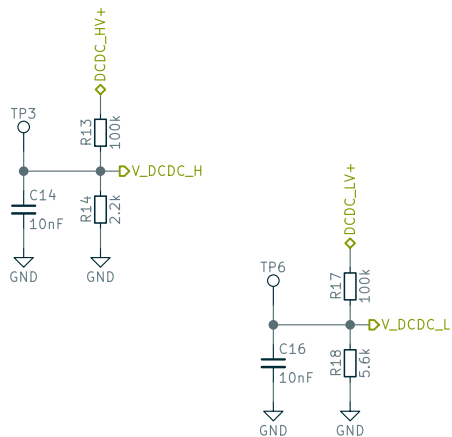
+3.3V

SHUNT_DCDC_P
R8 10R
C11 1nF
SHUNT_DCDC_N
R9 10R

U3 INA186

R10 1k
TP1
I_DCDC
C15 1nF
GND

+3.3V
C13 100nF
GND

I_DCDC_REF

GND

MOSFET driver

+12V

R3 3R3
D16 1N4148
R5 3R3
C10 100nF

U1

C12 2.2µF

PWM_HS
PWM_LS

1	VDD	HB	8
2	HI	HO	7
3	LI	HS	6
4	VSS	LO	5

HS_DRV
SW_NODE
LS_DRV

LM5107

GND

If not stated otherwise, all MLCC 50V X7R

MPPT 2420 HC

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Supply rail selection

R60 100k
D9 47V
GND
R66 1k
Q4 BUK98180-100A
HV+
CP_OUT
R65 100k
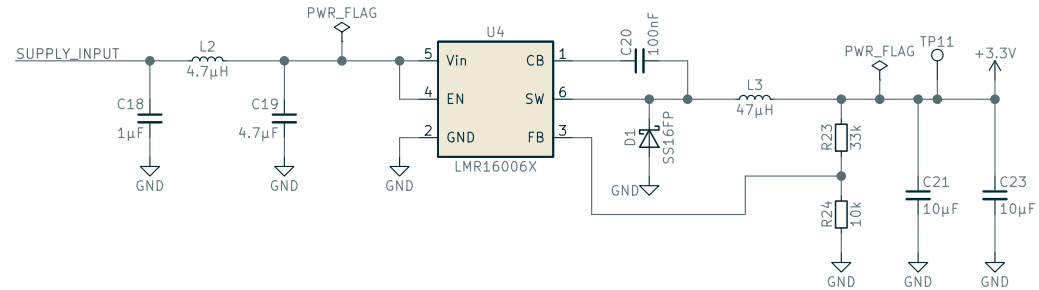T2 BC846B
R19 10k
LV+
D10 1N4148
TP9
SUPPLY_INPUT
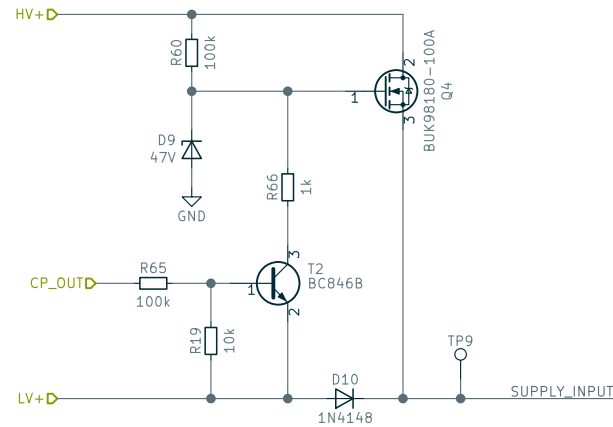
Some applications (e.g. Li-ion batteries) require an internal power supply from the high voltage side (e.g. solar panel input).
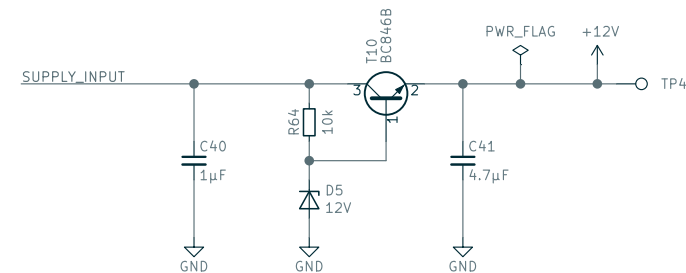
The source follower with Q4 limits the supply input below 60V.

T2 selects LV+ as supply to increase efficiency as soon as the charge pump is on.
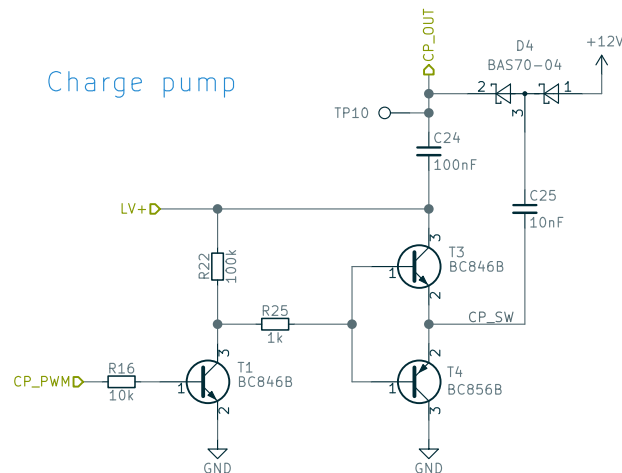
HV/LV side to 3.3V (SMPS)

SUPPLY_INPUT
L2 4.7µH
PWR_FLAG
C18 1µF
GND
C19 4.7µF
GND
GND
U4
5 Vin
4 EN
2 GND
CB 1
SW 6
FB 3
LMR16006X
C20 100nF
D1 SS16FP
GND
L3 47µH
PWR_FLAG TP11 +3.3V
R23 33k
R24 10k
GND
C21 10µF
GND
C23 10µF
GND

Charge pump

CP_OUT
TP10
C24 100nF
D4 BAS70-04
+12V
C25 10nF
LV+
R22 100k
T3 BC846B
CP_SW
R25 1k
CP_PWM
R16 10k
T1 BC846B
GND
T4 BC856B
GND

12V MOSFET driver supply voltage (emitter follower)

SUPPLY_INPUT
T10 BC846B
PWR_FLAG +12V
TP4
C40 1µF
GND
R64 10k
D5 12V
GND
C41 4.7µF
GND

If not stated otherwise, all MLCC 50V X7R

MPPT 2420 HC

Libre Solar Technologies GmbH
Author: Martin Jäger
https://libre.solar
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Sheet: /Power supply/
File: power-supply.sch
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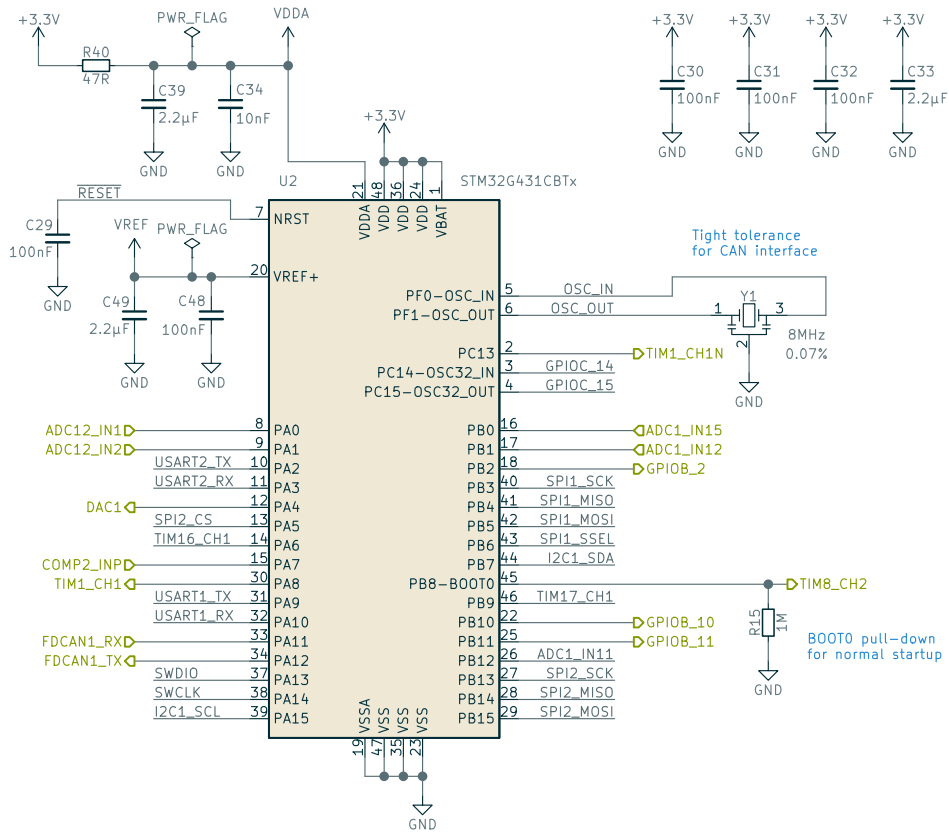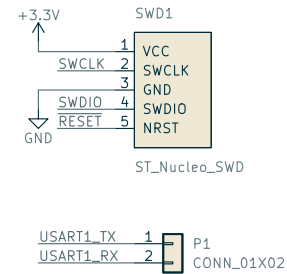Size: A4   Date: 2020-12-11   Rev: 0.2
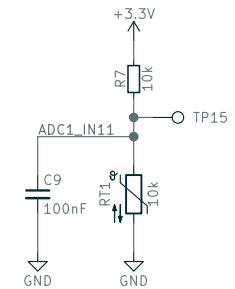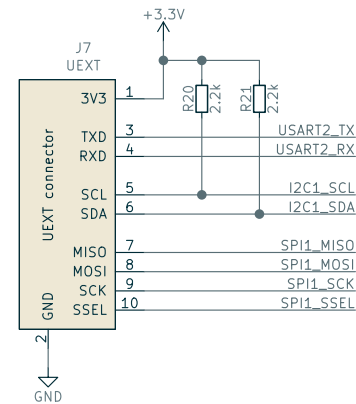KiCad E.D.A. kicad 5.1.5   Page: 3/6

MCU STM32G431
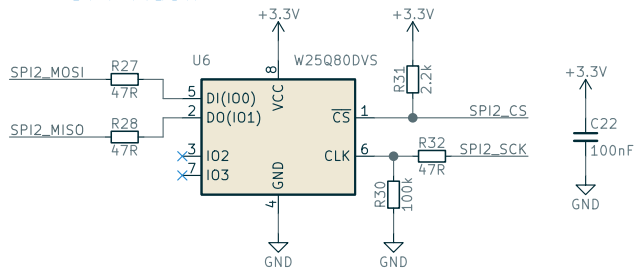
STM32G431CBTx

U2

STM Nucleo SWD and USART

SWD1
ST_Nucleo_SWD

VCC
SWCLK
GND
SWDIO
NRST

P1
CONN_01X02
USART1_TX
USART1_RX

Internal temperature

TP15
ADC1_IN11
C9 100nF
R7 10k
RT1 10k

UEXT

J7
UEXT
UEXT connector

3V3
TXD
RXD
SCL
SDA
MISO
MOSI
SCK
SSEL

R20 2.2k
R21 2.2k

USART2_TX
USART2_RX
I2C1_SCL
I2C1_SDA
SPI1_MISO
SPI1_MOSI
SPI1_SCK
SPI1_SSEL

Status LEDs

LED1
LED_Dual_PLCC4
TP12
TP13
TIM16_CH1
R29 1k
GPIOC_14

LED2
LED_Dual_PLCC4
TP14
TP20
TIM17_CH1
R26 1k
GPIOC_15

SPI flash

U6
W25Q80DVS

SPI2_MOSI
R27 47R
DI(IO0)
SPI2_MISO
R28 47R
DO(IO1)
IO2
IO3
CS
CLK
VCC
GND
R31 2.2k
R32 47R
R30 100k
SPI2_CS
SPI2_SCK
C22 100nF

NRST
VREF+
PF0-OSC_IN
PF1-OSC_OUT
PC13
PC14-OSC32_IN
PC15-OSC32_OUT
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PA8
PA9
PA10
PA11
PA12
PA13
PA14
PA15
VDDA
VDD
VDD
VDD
VBAT
PB0
PB1
PB2
PB3
PB4
PB5
PB6
PB7
PB8-BOOT0
PB9
PB10
PB11
PB12
PB13
PB14
PB15
VSSA
VSS
VSS
VSS

ADC12_IN1
ADC12_IN2
USART2_TX
USART2_RX
DAC1
SPI2_CS
TIM16_CH1
COMP2_INP
TIM1_CH1
USART1_TX
USART1_RX
FDCAN1_RXD
FDCAN1_TX
SWDIO
SWCLK
I2C1_SCL

ADC1_IN15
ADC1_IN12
GPIOB_2
SPI1_SCK
SPI1_MISO
SPI1_MOSI
SPI1_SSEL
I2C1_SDA
TIM8_CH2
TIM17_CH1
GPIOB_10
GPIOB_11
ADC1_IN11
SPI2_SCK
SPI2_MISO
SPI2_MOSI

OSC_IN
OSC_OUT
Y1
8MHz
0.07%

TIM1_CH1N

Tight tolerance
for CAN interface

R15 1M
BOOT0 pull-down
for normal startup

R40 47R
PWR_FLAG
VDDA
C39 2.2µF
C34 10nF
RESET
C29 100nF
VREF
PWR_FLAG
C49 2.2µF
C48 100nF

+3.3V
C30 100nF
C31 100nF
C32 100nF
C33 2.2µF

If not stated otherwise, all MLCC 50V X7R

MPPT 2420 HC

Libre Solar Technologies GmbH
Author: Martin Jäger
https://libre.solar

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File: mcu.sch
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Size: A4   Date: 2020-12-11
KiCad E.D.A.   kicad 5.1.5
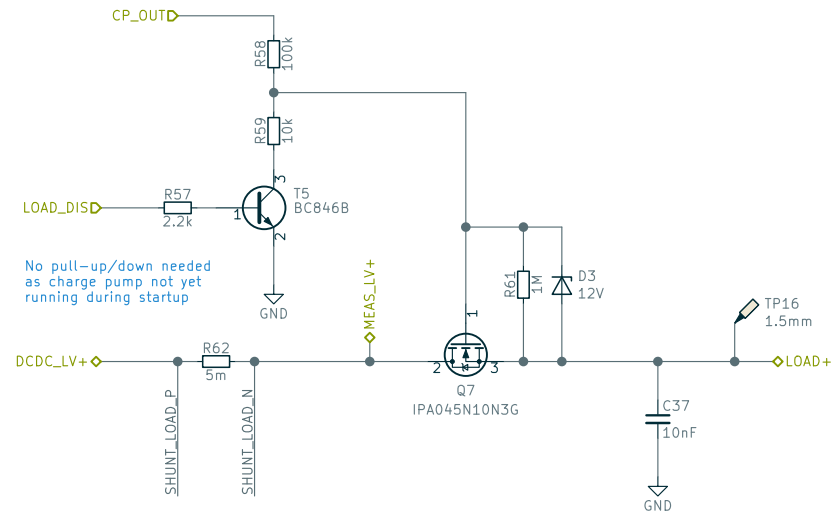Rev: 0.2
Page: 4/6
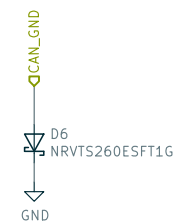
High-side load switch

CP_OUT

R58
100k

R59
10k

R57
2.2k

T5
BC846B

LOAD_DIS

No pull-up/down needed
as charge pump not yet
running during startup

GND

MEAS_LV+

R62
5m

DCDC_LV+

SHUNT_LOAD_P

SHUNT_LOAD_N

R61
1M

D3
12V

Q7
IPA045N10N3G

TP16
1.5mm

C37
10nF

GND

LOAD+

Load current monitoring
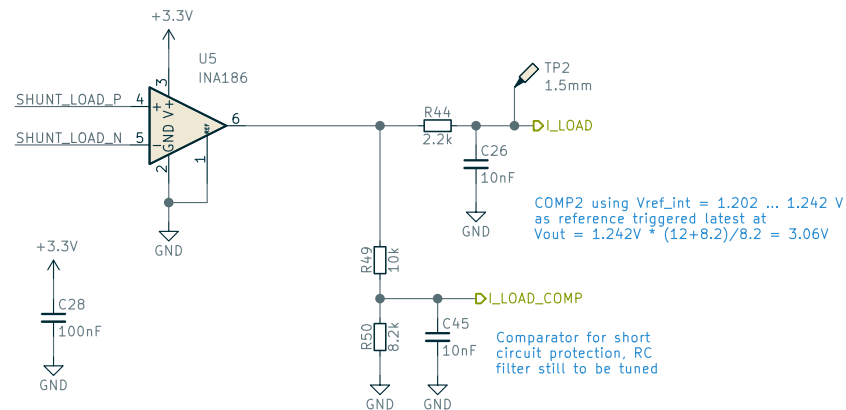
+3.3V

U5
INA186

SHUNT_LOAD_P   4

SHUNT_LOAD_N   5

GND

6

R44
2.2k

TP2
1.5mm

C26
10nF

GND

I_LOAD

COMP2 using Vref_int = 1.202 ... 1.242 V
as reference triggered latest at
Vout = 1.242V * (12+8.2)/8.2 = 3.06V

+3.3V

C28
100nF

GND

R49
10k

R50
8.2k

GND

C45
10nF

GND

I_LOAD_COMP

Comparator for short
circuit protection, RC
filter still to be tuned

If not stated otherwise,
all MLCC 50V X7R

MPPT 2420 HC

LIBRESOLAR

+3.3V

C7
100nF

GND

TP17
TP19

CAN_TX
CAN_RX

U7   TCAN334

1 TXD   VCC 3
4 RXD
              CANH 7
5 SHDN
8 STB   CANL 6
   SHDN
   GND 2

GND

TP18

CAN_STB

CAN_H

JP1
Jumper_NC_Small

R11
120R

CAN_L

VBUS

D2
NRVTS260ESFT1G

F2
500mA   CAN_PWR1

F3
500mA   CAN_PWR2

CAN_GND

D6
NRVTS260ESFT1G

GND
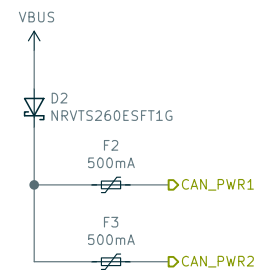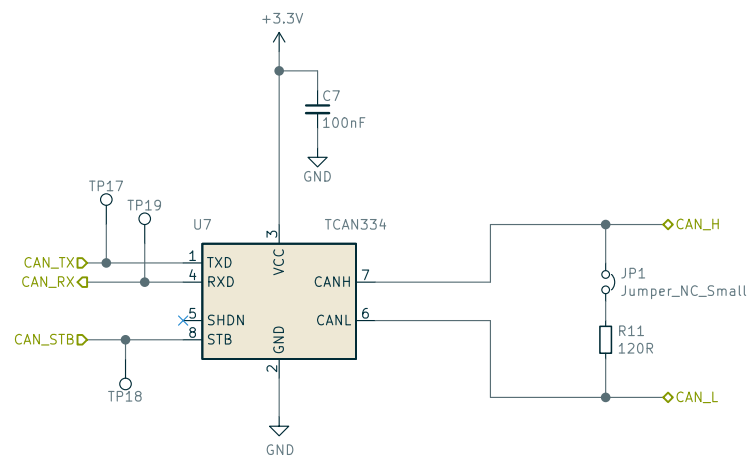
CAN bus power supply
– 10V–32V
– 600 mA (like PoE)

Diodes necessary to prevent
separate GND loops.

Polyfuse to prevent
over–current in daisy–chained
bus with multiple sources and
sinks.