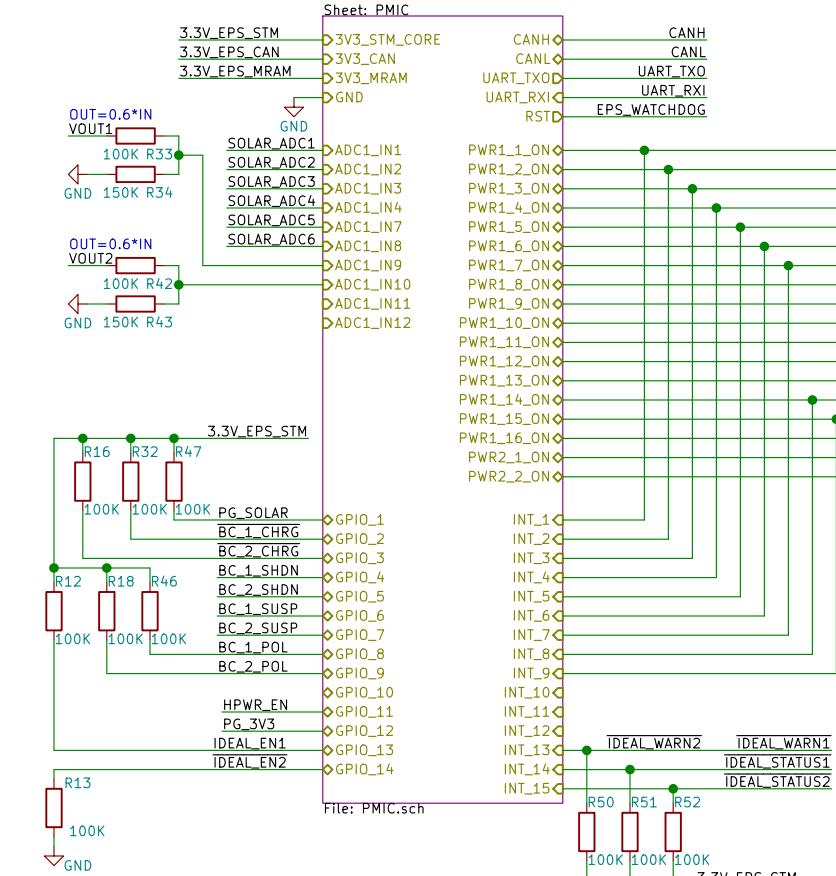
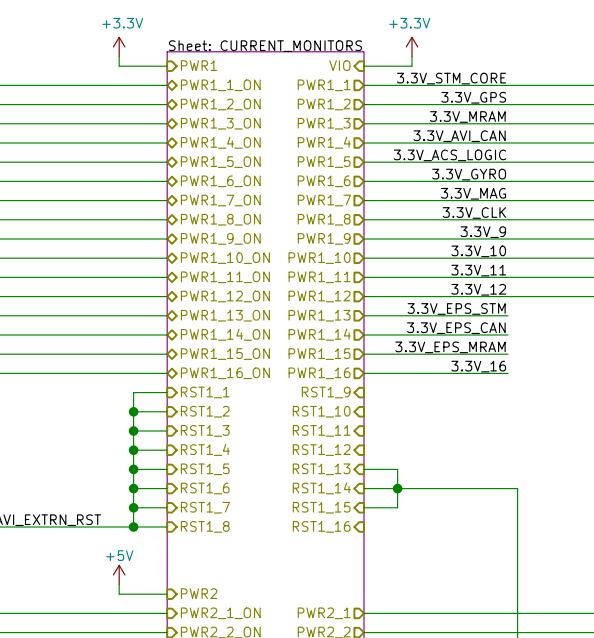


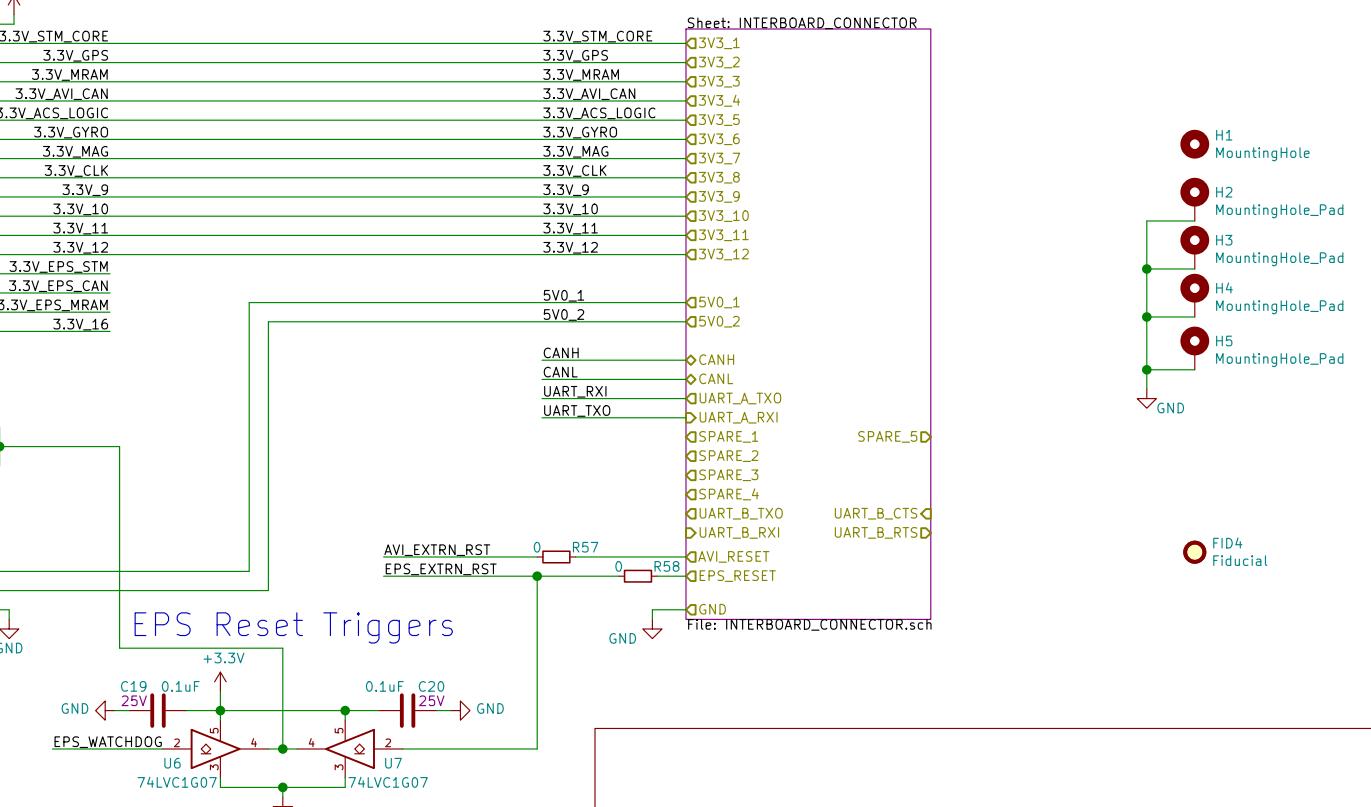
# Power Management IC (PMIC)



# Current Monitors & Load switching



# Interboard Connector



Sheet: /  
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KiCad E.D.A. kicad 5.1.7~a382d34a88/ubuntu16.04.1 | Id: 1/39

NRVB120VLSFT1G

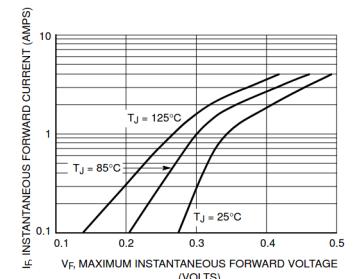


Figure 2. Maximum Forward Voltage

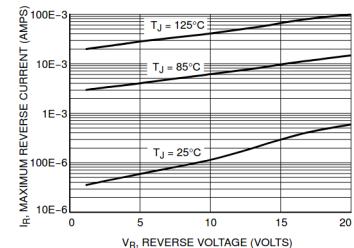
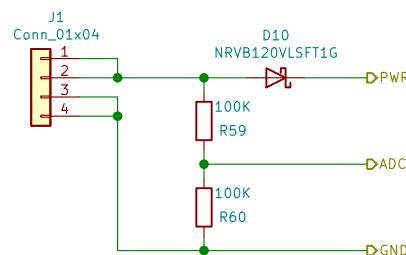


Figure 4. Maximum Reverse Current

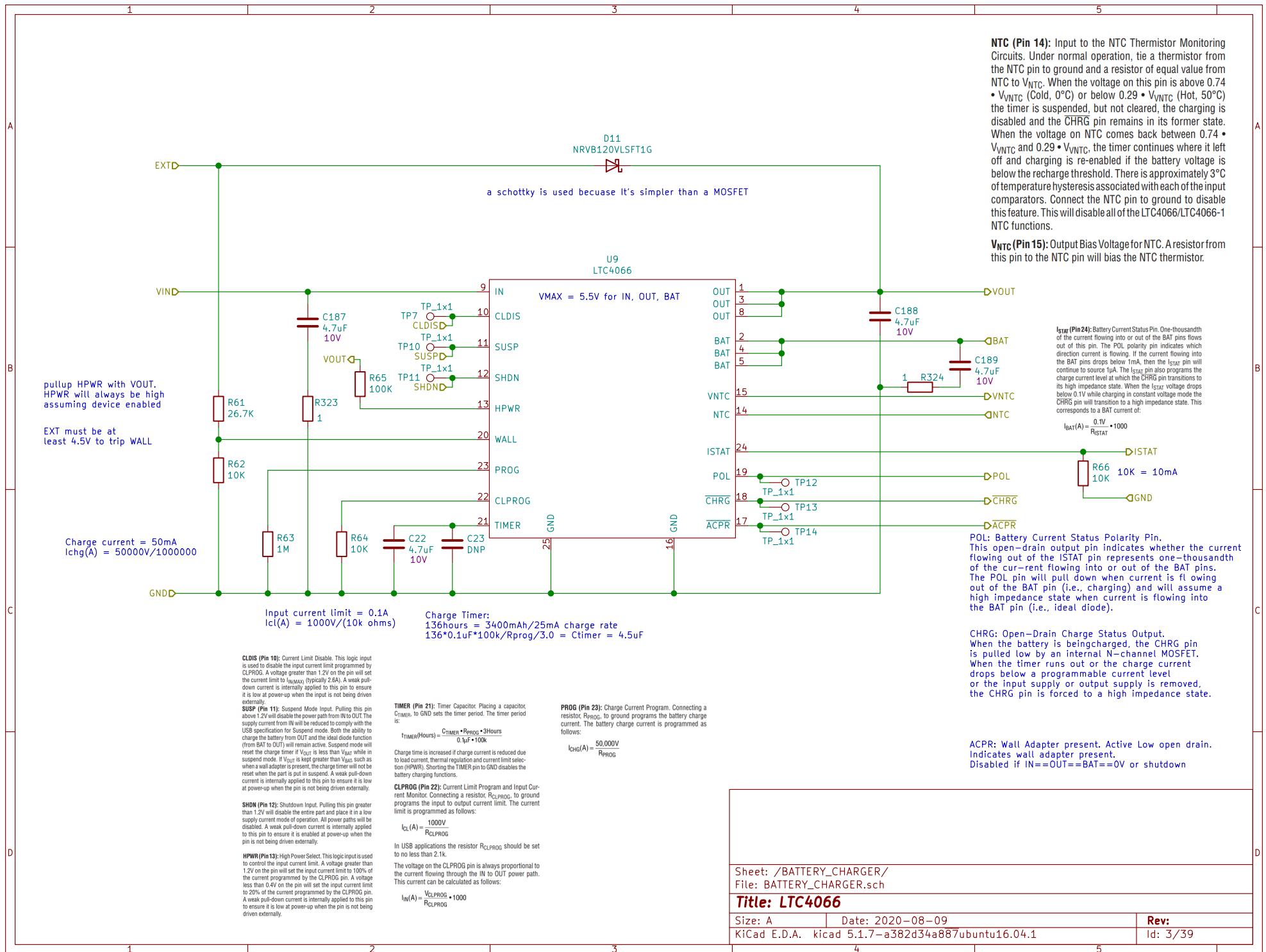
I used to use Molex Pico Lock:  
5040500491  
<https://www.digikey.com/en/products/detail/molex/5040500491/4357649>

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File: SOLAR\_INPUT.sch

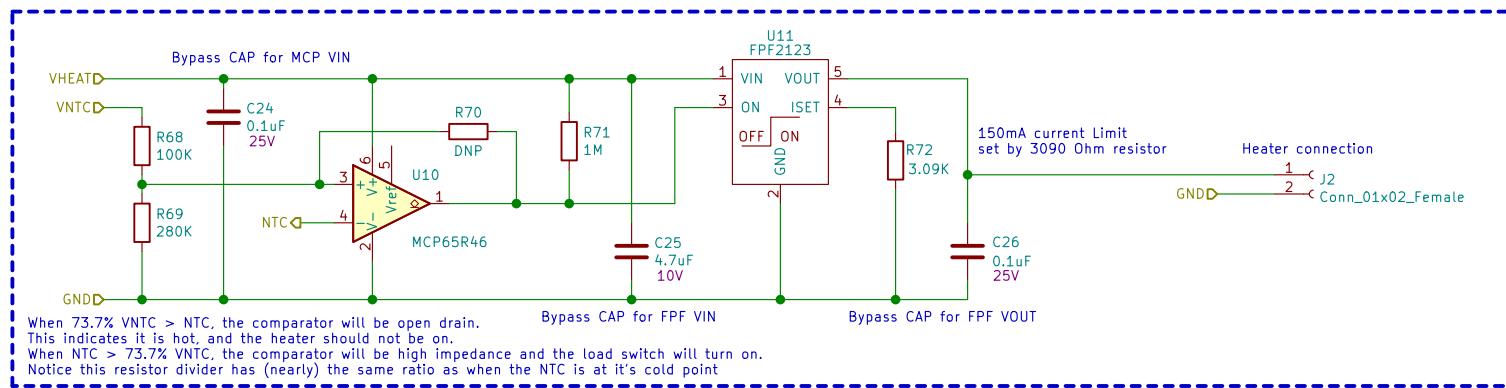
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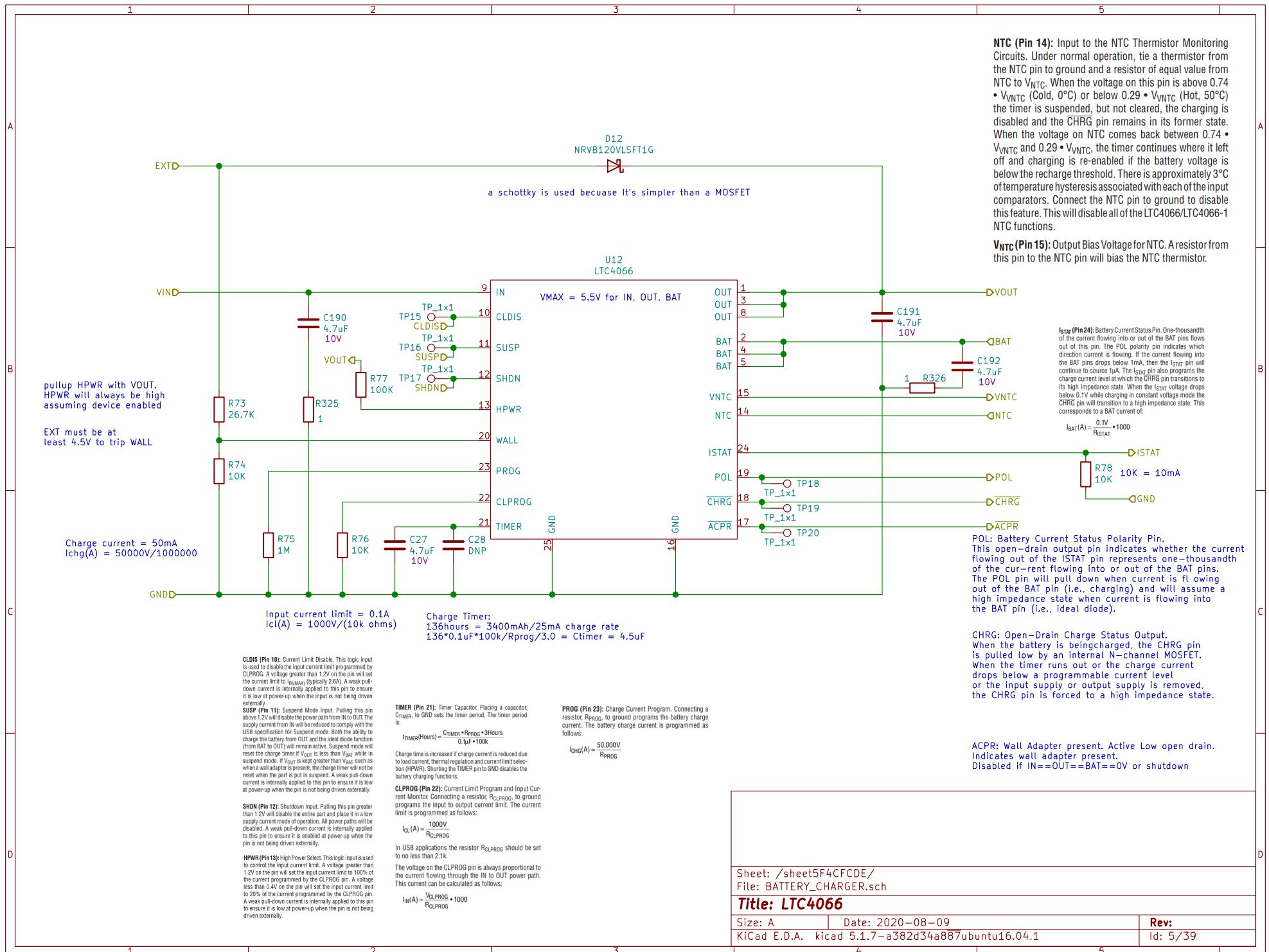
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KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu16.04.1

Rev:  
Id: 2/39

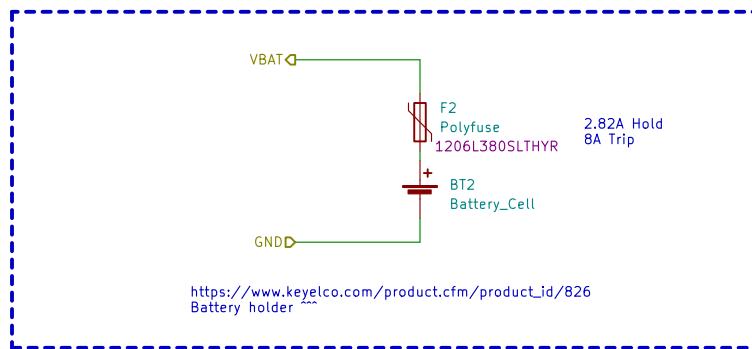
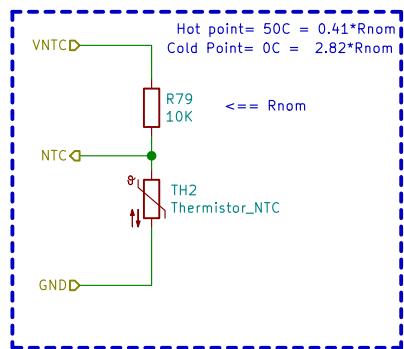
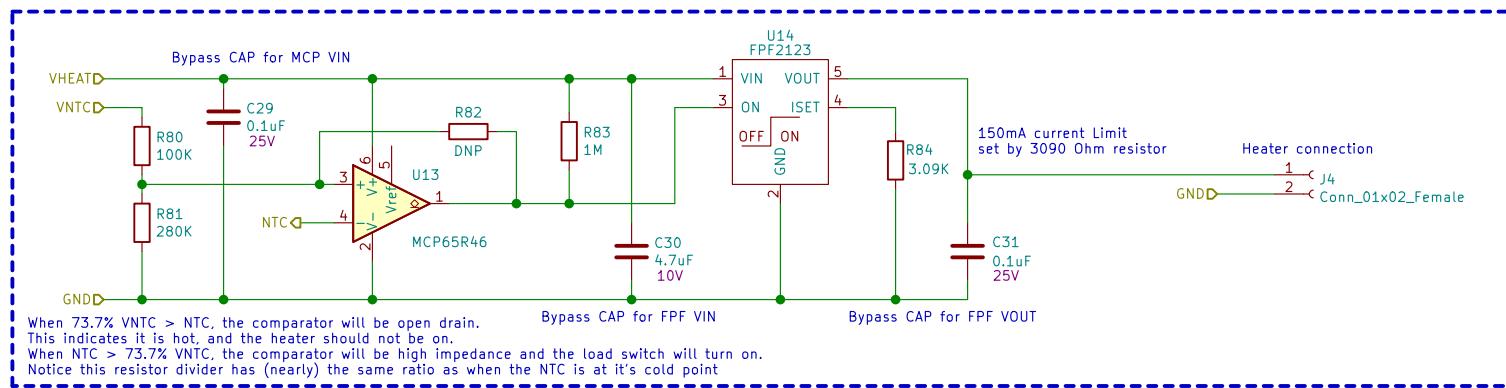


## Battery heater control circuit





## Battery heater control circuit



NTC output for battery charger  
and heater circuit (see above)

## Battery & Fuse

Sheet: /sheet5F4CFCDF/  
File: BATTERY.sch

**Title: Battery, Battery Heater, NTC**

Size: A Date: 2020-08-11  
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu16.04.1

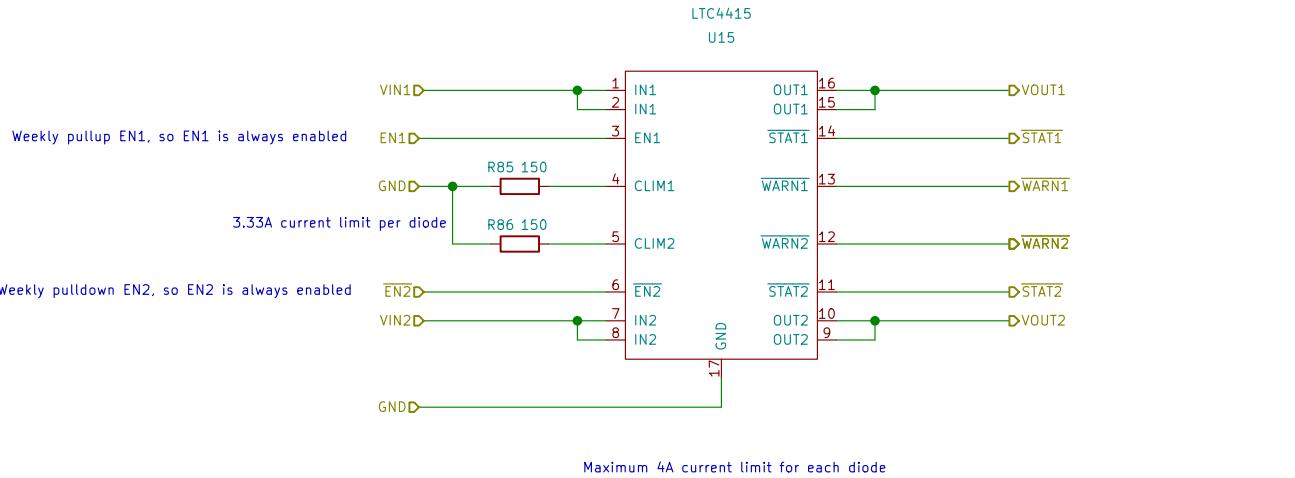
Rev:  
Id: 6/39

A

A

**STAT**  
Open-drain output pulls down during forward diode conduction.  
This pin can be left open or grounded when not used.

**WARN**  
Open-drain output pulls down when the diode current exceeds its  
current limit or die temperature is close to thermal shutdown.



Voltage Thresholds for the Enable pins:  
V<sub>enth</sub> = 0.8V with V<sub>ehyst</sub> = 0.055V

#### Current Limit Setting

The output current limit of each diode can be set independently by connecting resistors from the current limit adjust pins CLIM1 and CLIM2 to ground. The current set of the CLIM1 and CLIM2 pins are 1/1000 of the ideal diode output currents I<sub>Q1</sub> and I<sub>Q2</sub> respectively. When the load currents increase so that the CLIM1 or CLIM2 pin voltages exceeds 0.5V the LTC4415 detects an overcurrent condition and regulates the current to a fixed value. The required value of resistor R<sub>CLIM</sub> for output current limit of I<sub>Q</sub> is calculated as follows:

$$R_{CLIM} = \frac{0.5V}{I_{Q}}$$

The allowed range of R<sub>CLIM</sub> is 125Ω to 1000Ω unless the CLIM1/CLIM2 pins are shorted to GND, in which case the LTC4415 limits the load current using a fixed internal current limit of 6A.

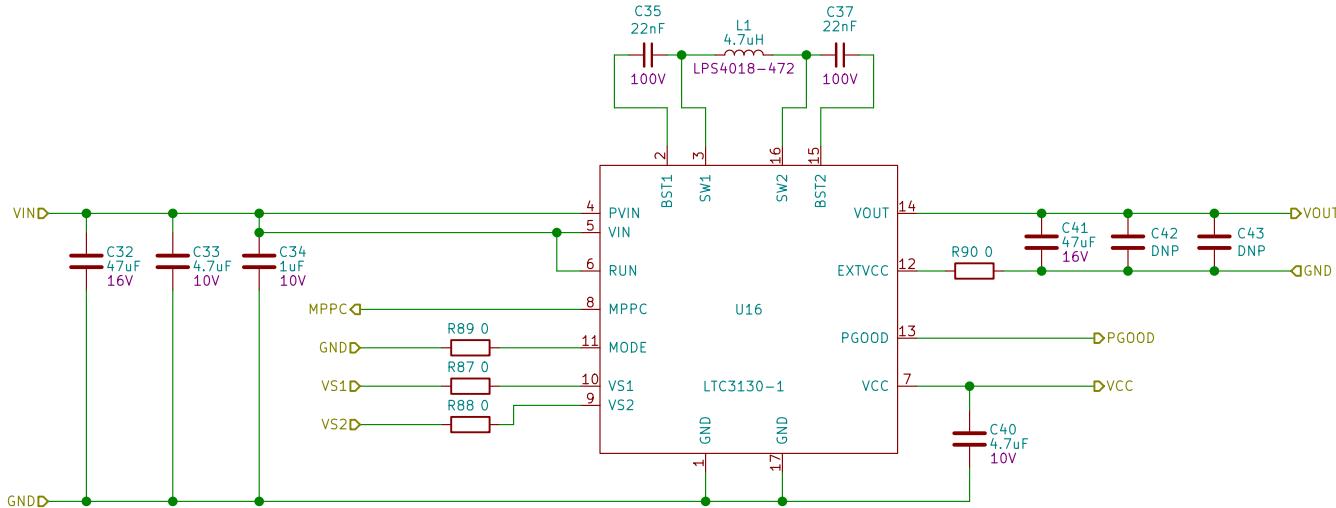
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Title: LTC4415

Size: A Date: 2020-09-06  
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu16.04.1

Rev:  
Id: 7/39

A



B

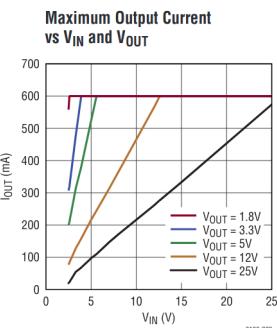
**MODE (Pin 11/Pin 11): Mode Select Pin.**

MODE = Low (ground): Enables automatic Burst Mode operation

MODE = High (tie to  $V_{CC}$ ): Fixed frequency PWM operation

**Table 1.  $V_{OUT}$  Program Settings for the LTC3130-1**

$V_{S2}$	$V_{S1}$	$V_{OUT}$
0	0	1.8V
0	$V_{CC}$	3.3V
$V_{CC}$	0	5.0V
$V_{CC}$	$V_{CC}$	12V



PGOOD is open drain.  
Pulled low when  $V_{OUT}$  is less than 7.5% programmed value  
High-Z when  $V_{OUT}$  is within 5% programmed value

#### Maximum Power Point Control (MPPC)

The MPPC input of the LTC3130/LTC3130-1 can be used with an optional external voltage divider to dynamically adjust the commanded inductor current in order to maintain a minimum input voltage when using high resistance sources, such as photovoltaic panels, so as to maximize input power transfer and prevent  $V_{IN}$  from dropping too low under load.

Referring to Figure 4, the MPPC pin is internally connected to the noninverting input of a  $g_m$  amplifier, whose inverting input is connected to the 1.0V reference. If the voltage at MPPC, using the external voltage divider, falls below the reference voltage, the output of the amplifier pulls the internal VC node low. This reduces the commanded average inductor current so as to reduce the input current and regulate  $V_{IN}$  to the programmed minimum voltage, as given by:

$$V_{IN(MPPC)} = 1.00V \left( 1 + \frac{R5}{R6} \right)$$

Note that external compensation should not be required for MPPC loop stability if the input filter capacitor,  $C_{IN}$ , is at least 22uF.

The MPPC divider resistor values can be in the  $M\Omega$  range so as to minimize the input current in very low power applications. However, stray capacitance and noise pickup on the MPPC pin must also be minimized. If the MPPC function is not required, the MPPC pin should be tied to  $V_{CC}$ .

Beware of adding a noise filter capacitor to the MPPC pin, as the added filter pole may cause the MPPC control loop to be unstable.

Note that because Burst Mode operation will be inhibited if the MPPC loop takes control, the converter will be operating in fixed frequency mode, and will therefore require a minimum of about 6mA of continuous input current to operate. For operation from weaker sources, such as small indoor solar panels, refer to the Applications Information section to see how to add an external voltage divider to control the converter in a hysteretic manner while providing an effective MPPC function by maintaining  $V_{IN}$  at the desired voltage. This technique can be used with sources as weak as 3uA (enough to power the IC in UVLO and the external RUN divider).

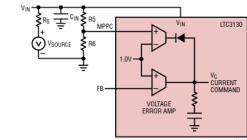


Figure 4. MPPC Amplifier with External Resistor Divider

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Size: A Date: 2020-08-09  
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu16.04.1

Rev:  
Id: 8/39

A

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B

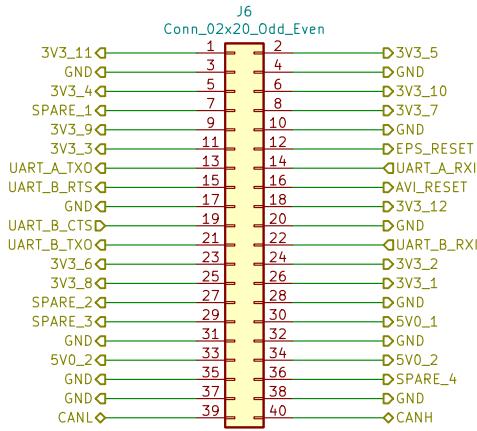
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C

C

D

D



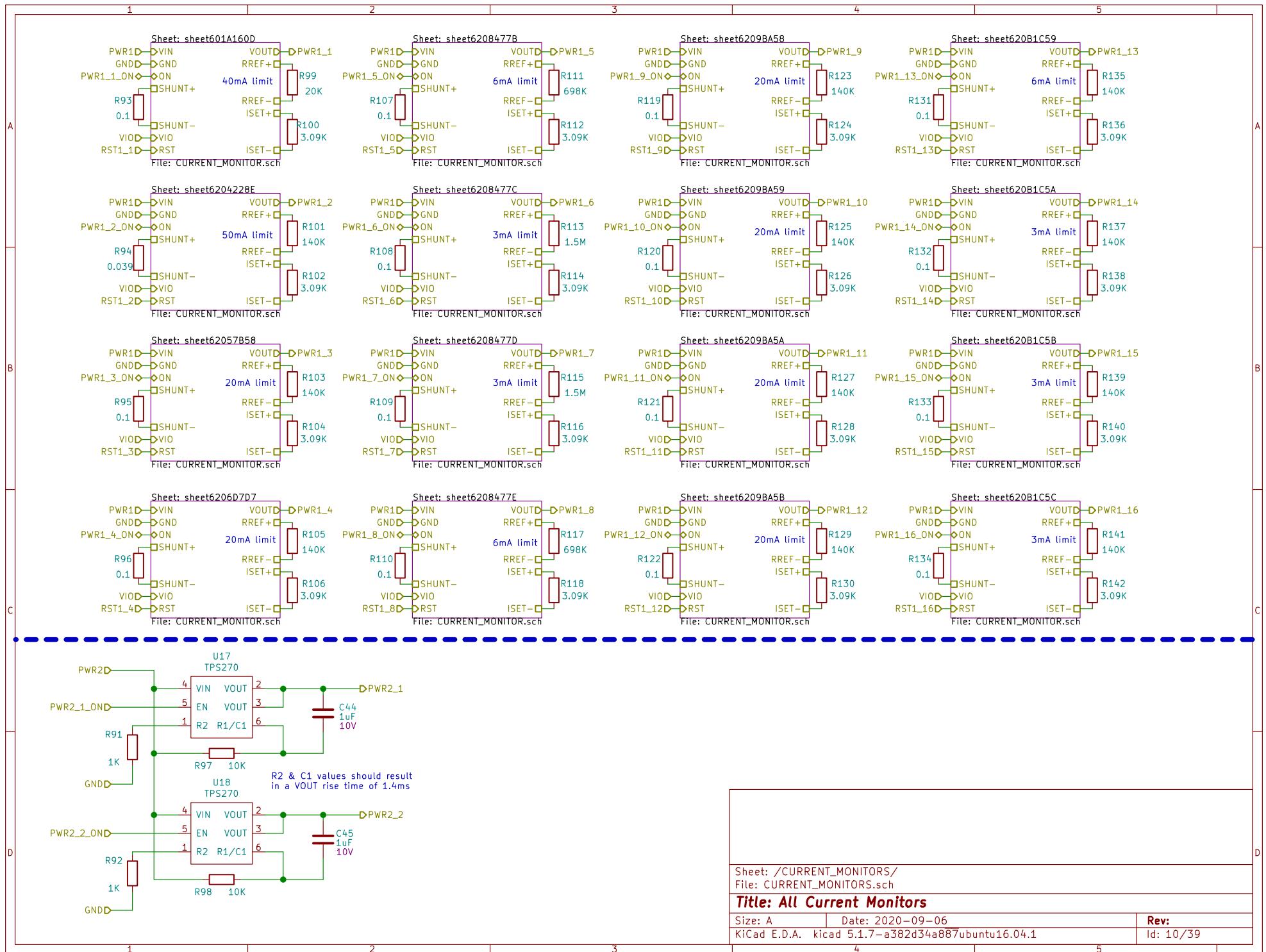
There are a lot of options that could work:  
<https://www.digikey.com/short/znc31r>

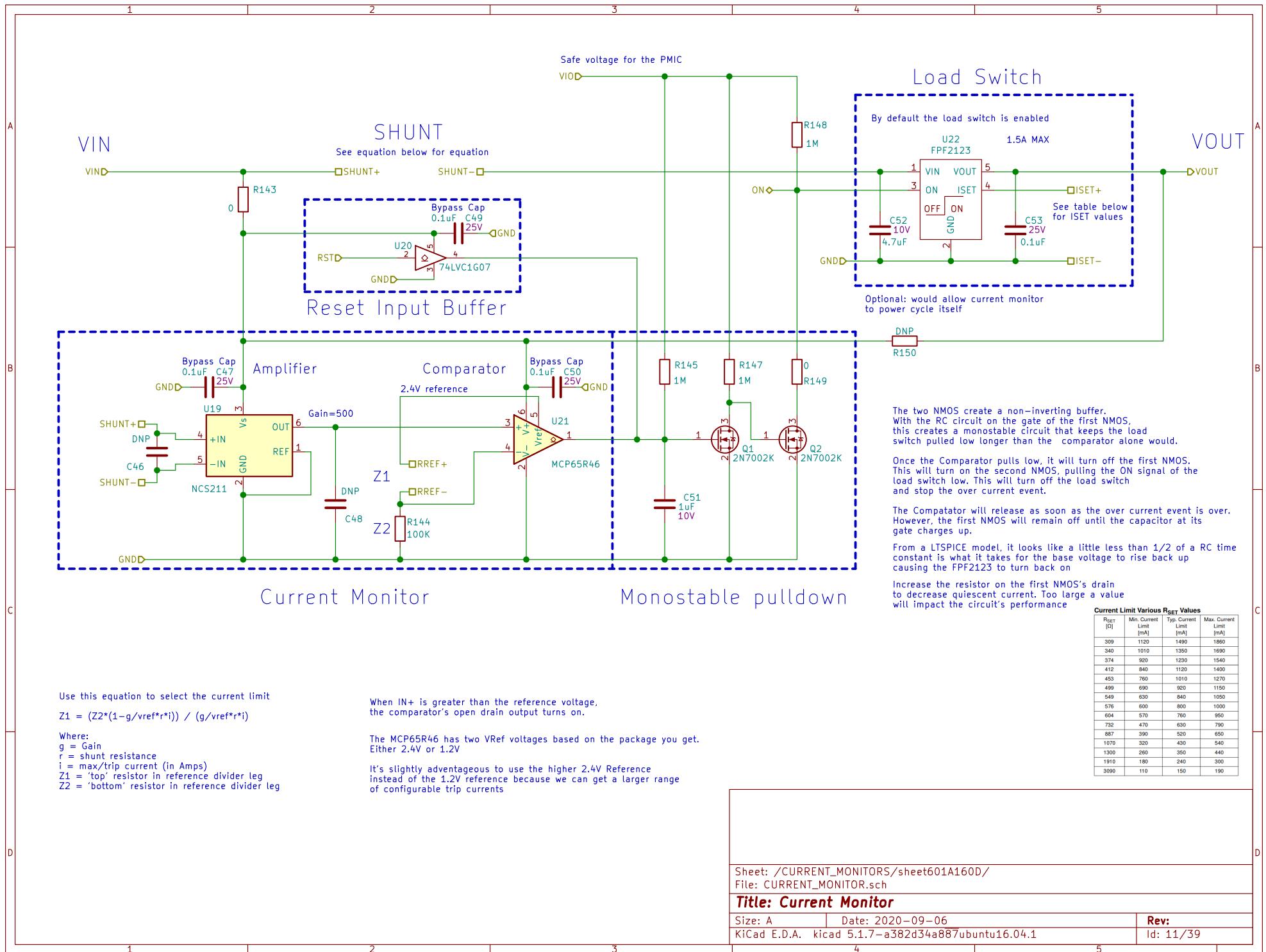
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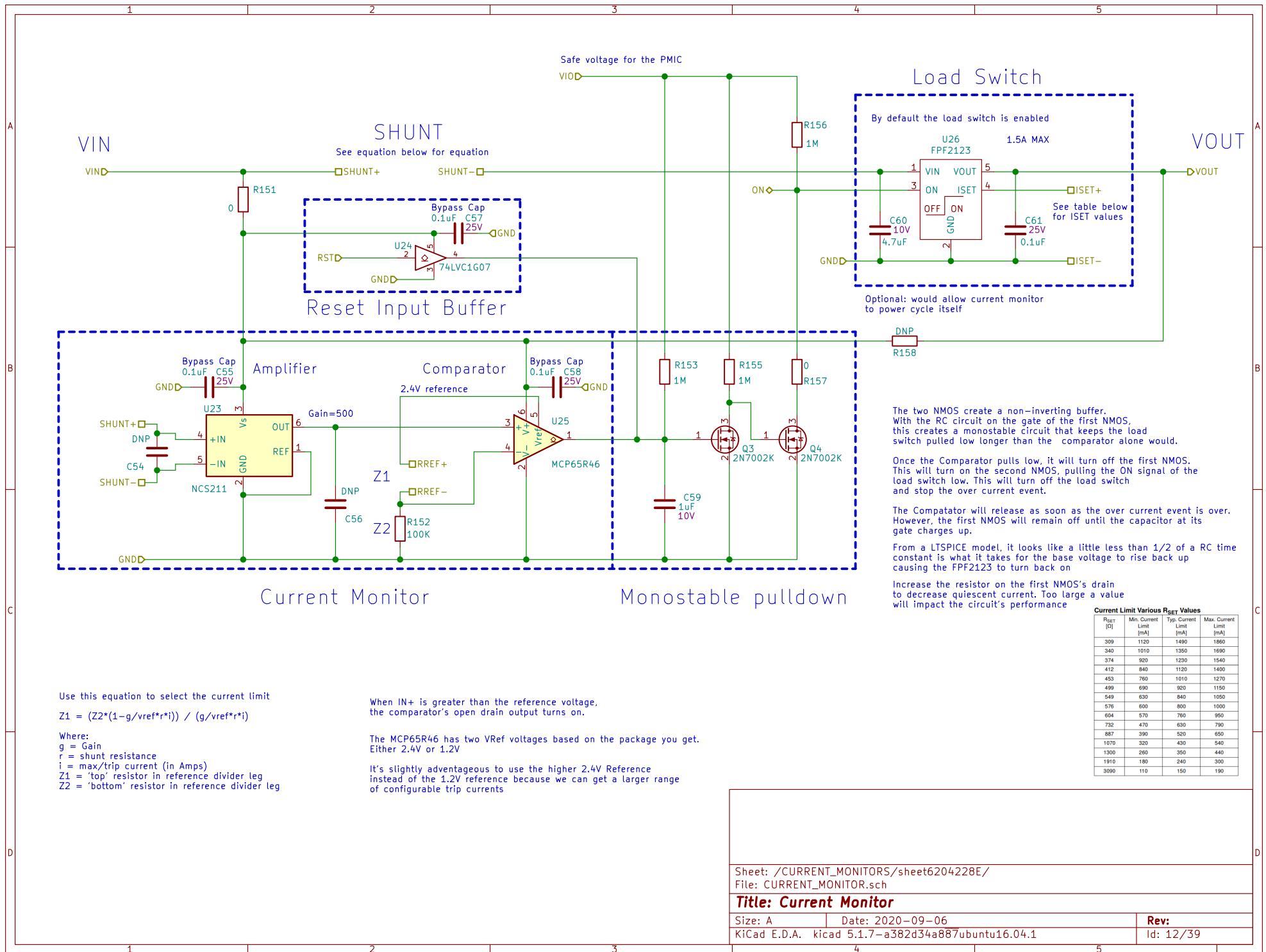
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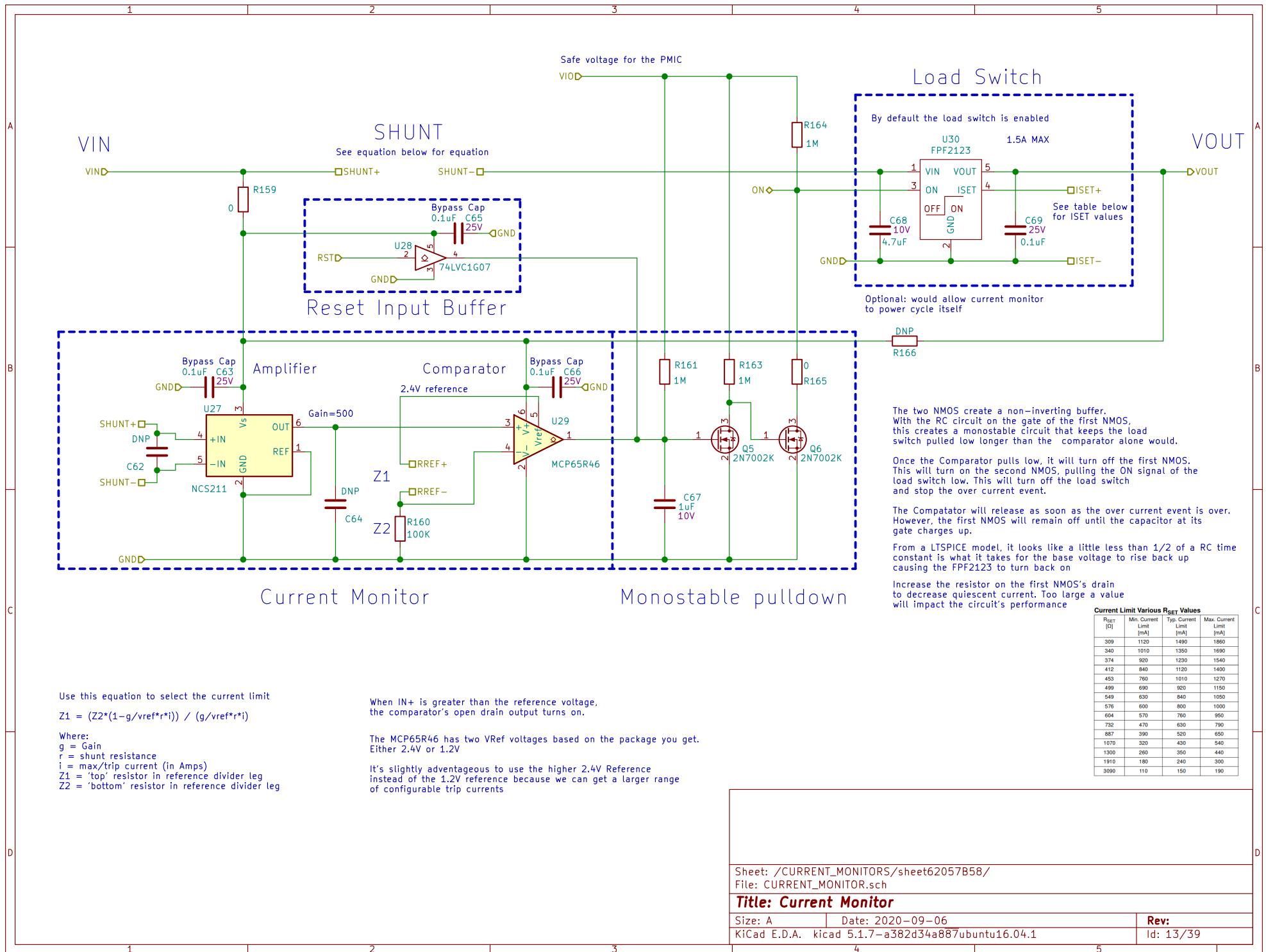
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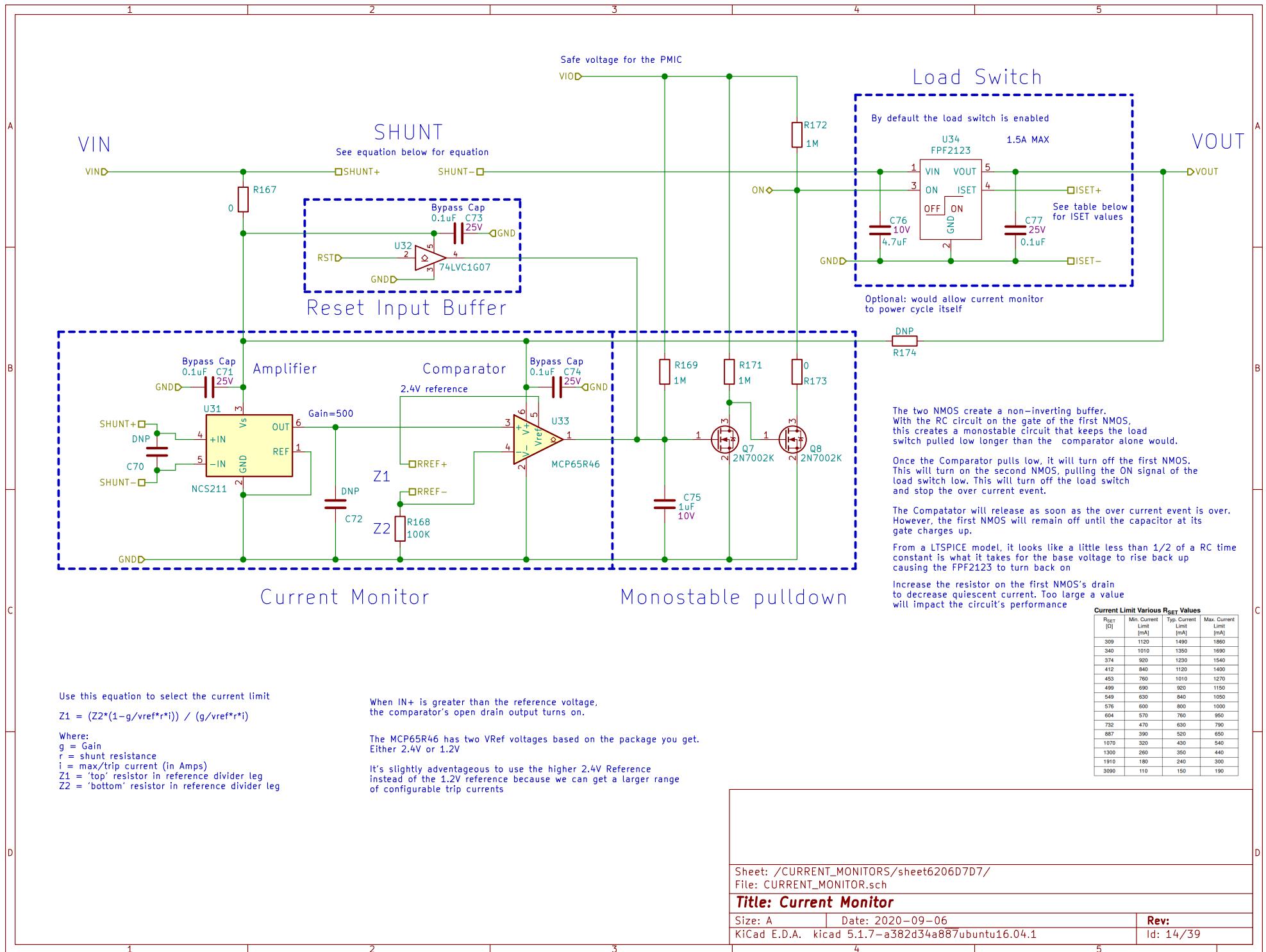
Rev:  
Id: 9/39

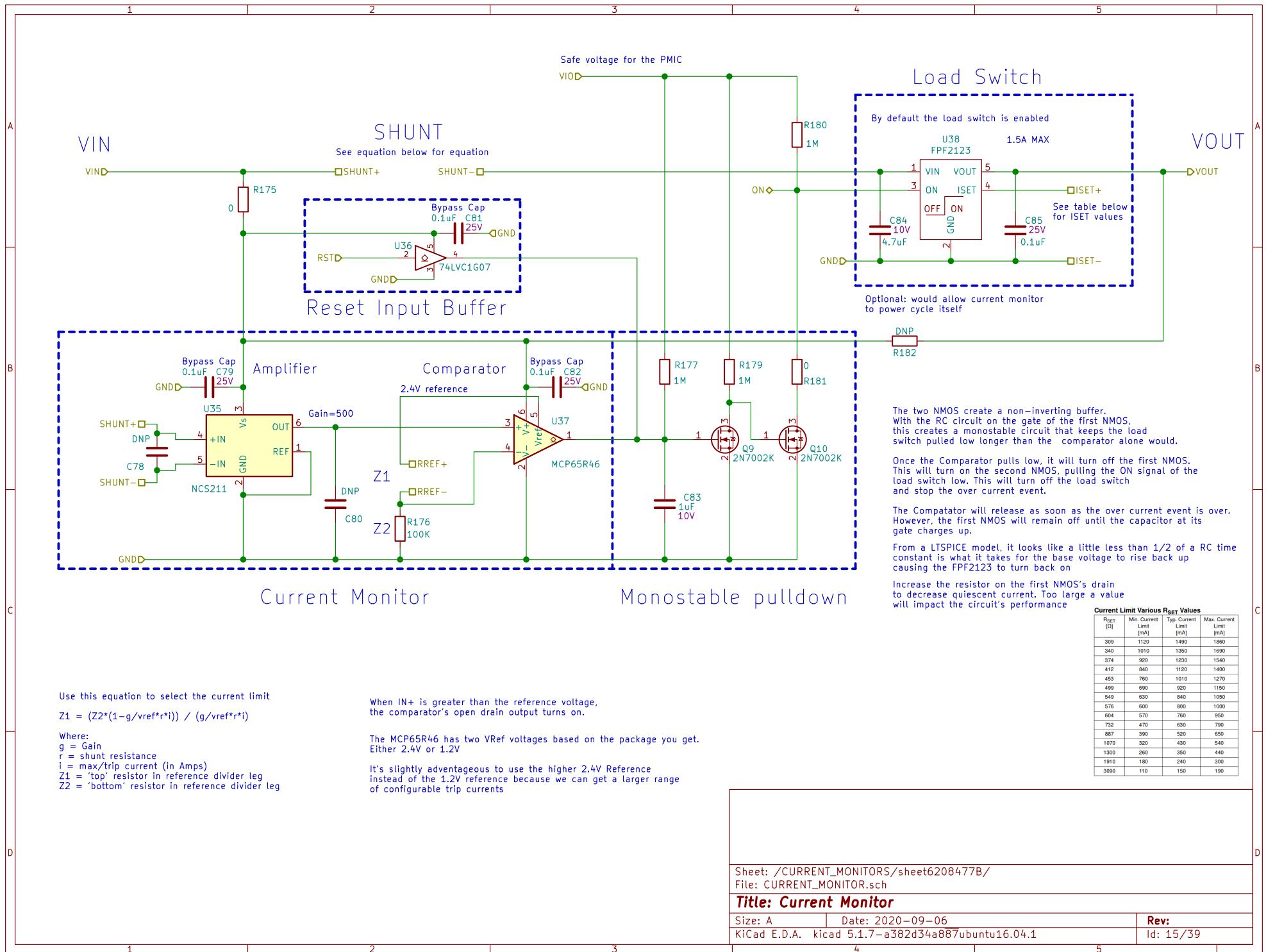


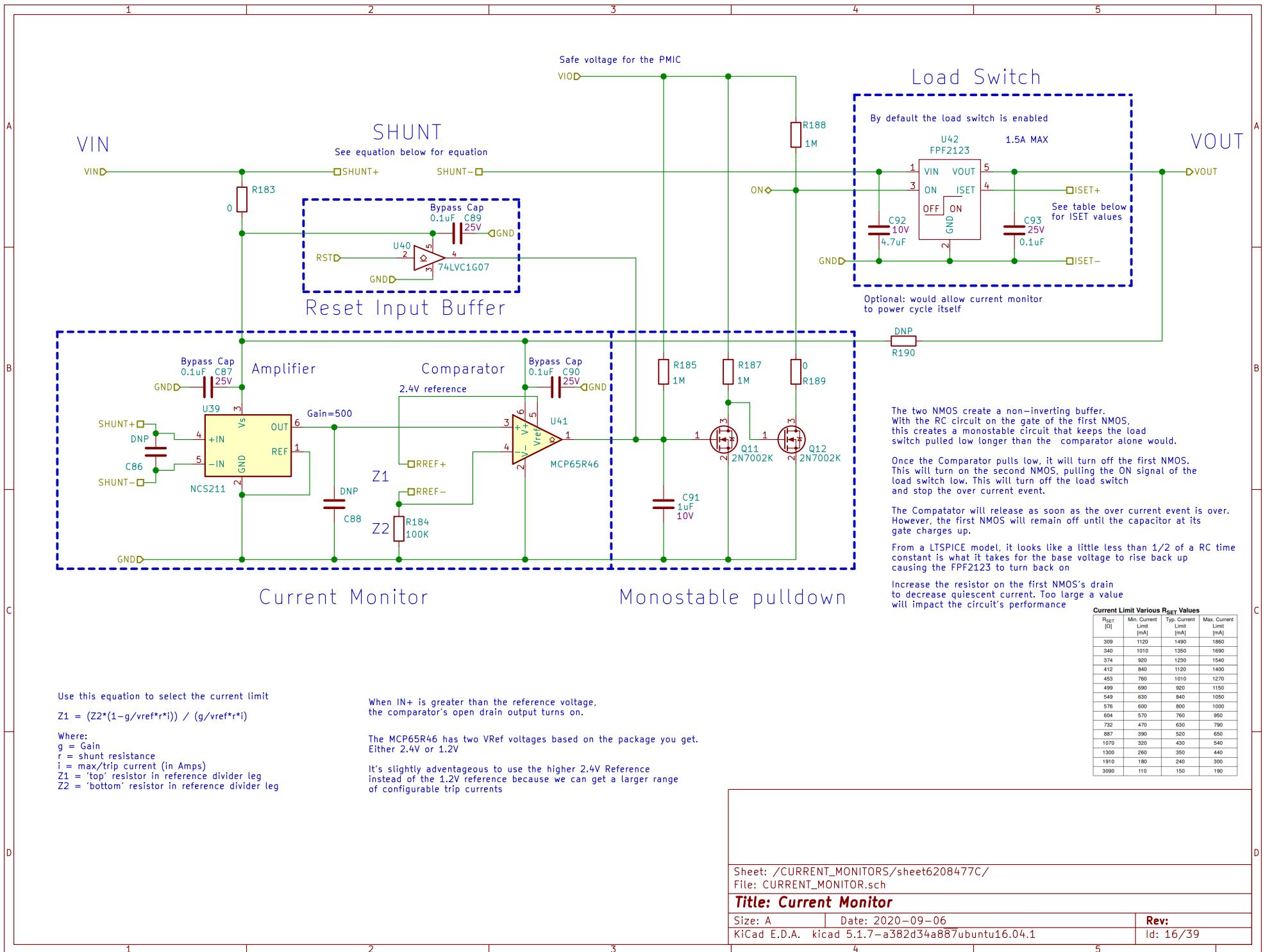


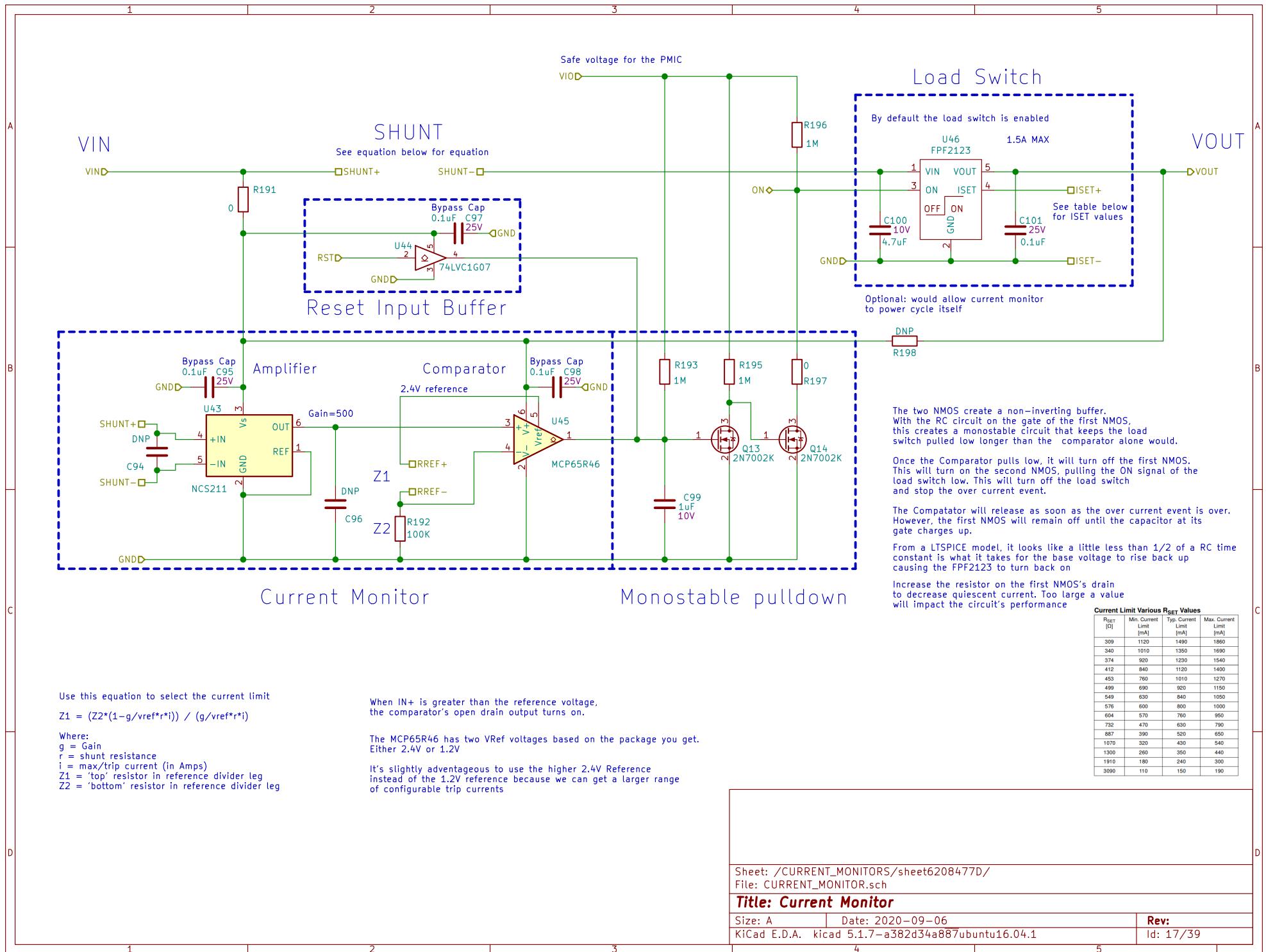


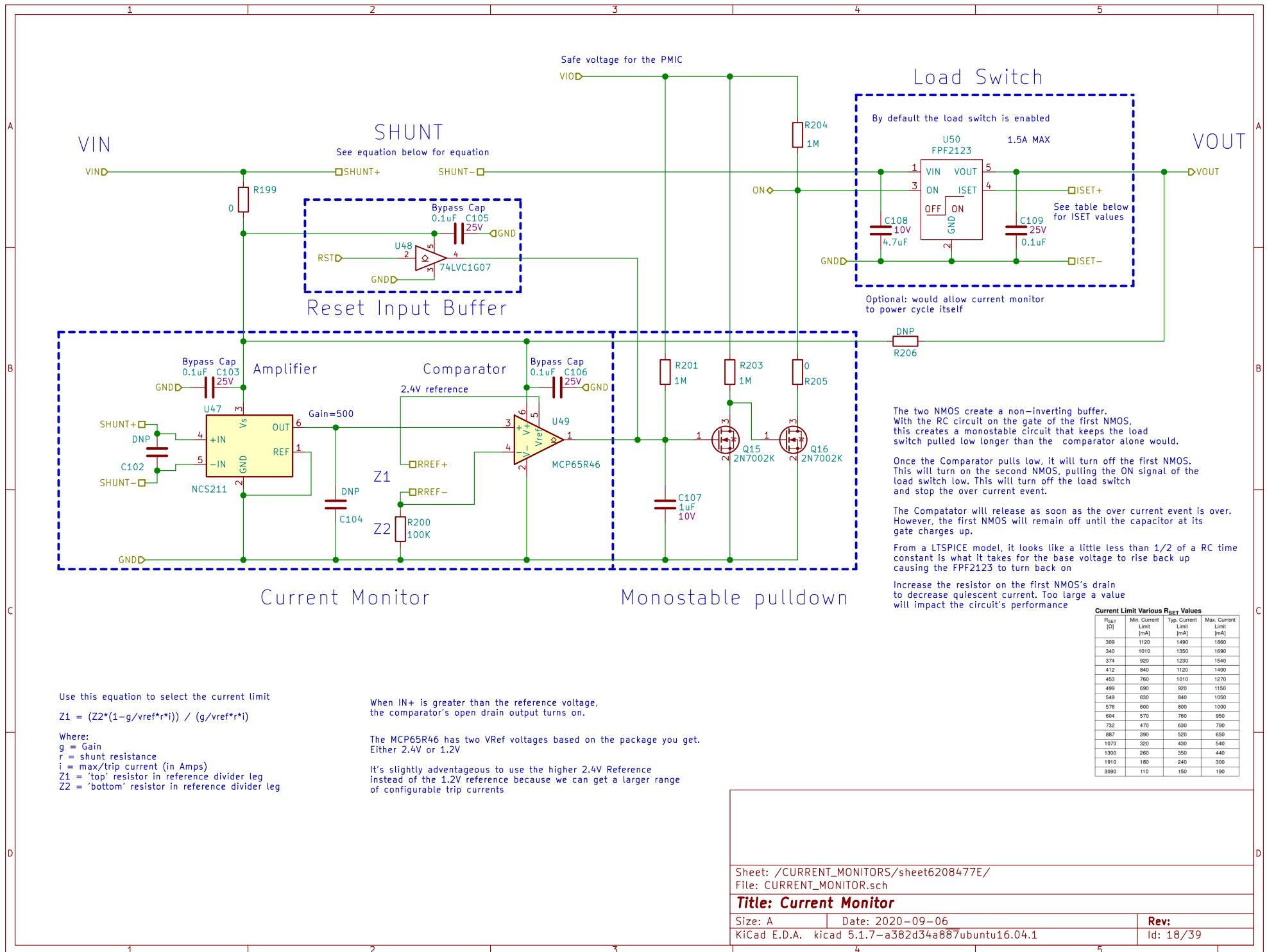


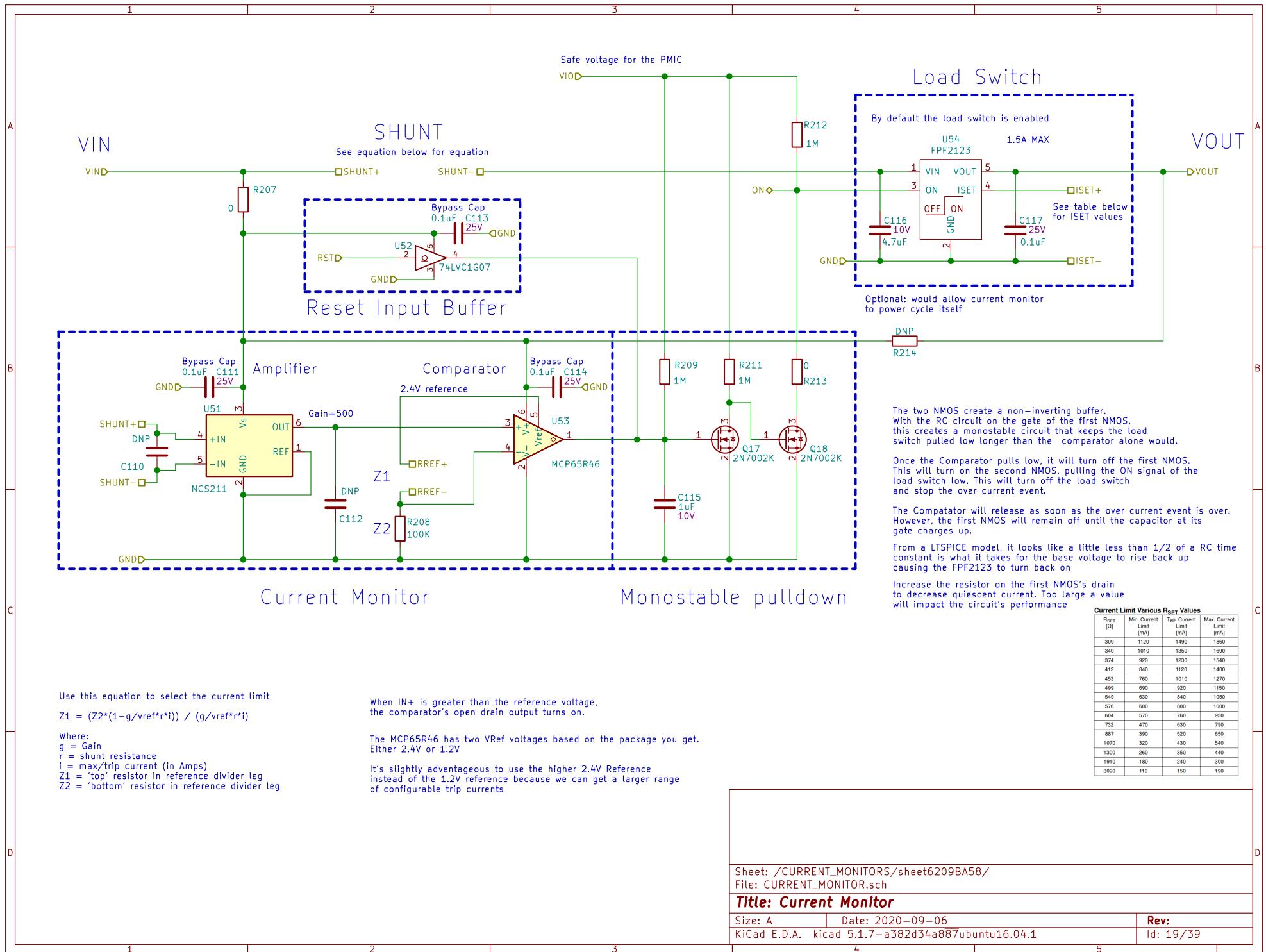


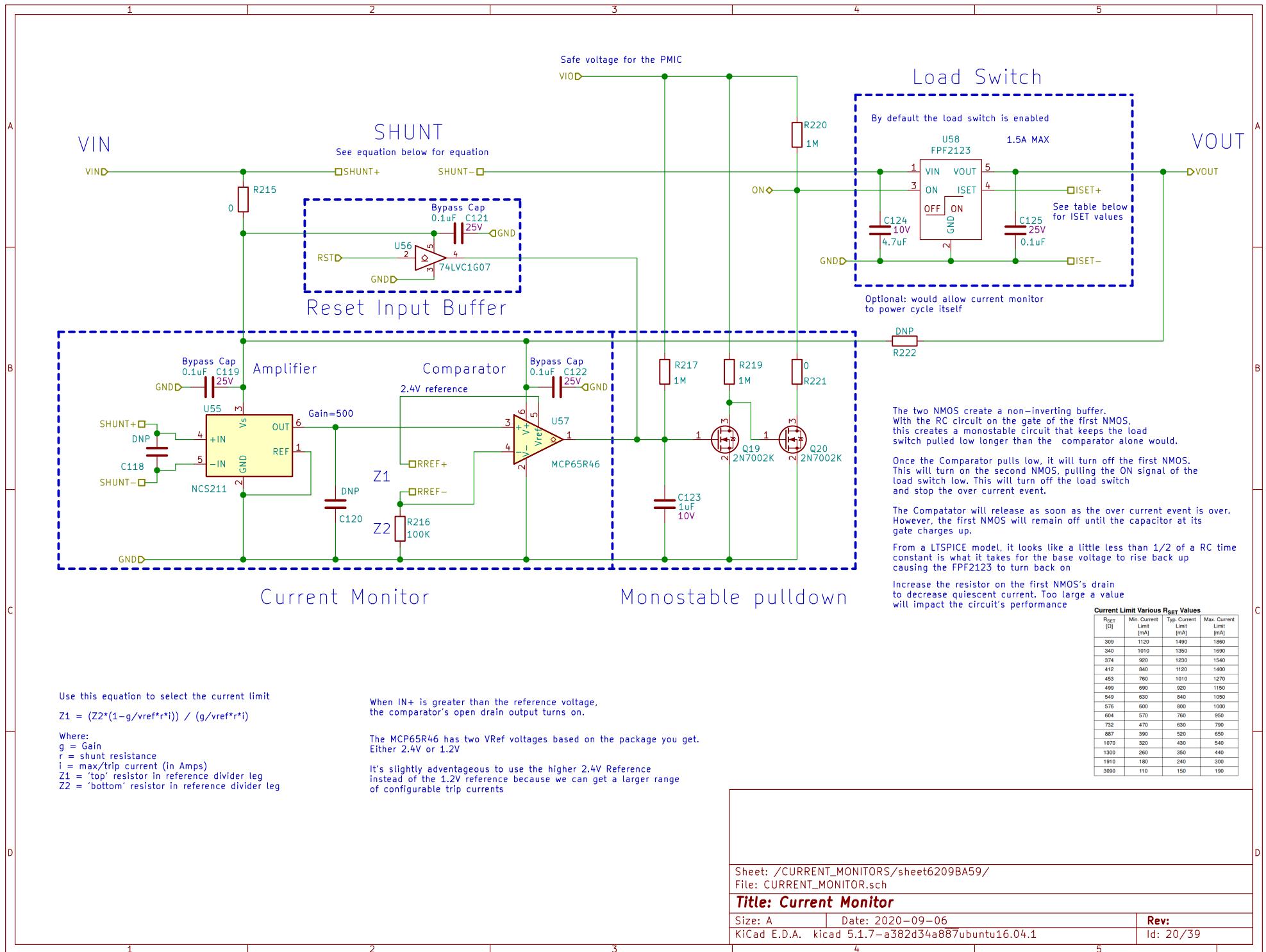


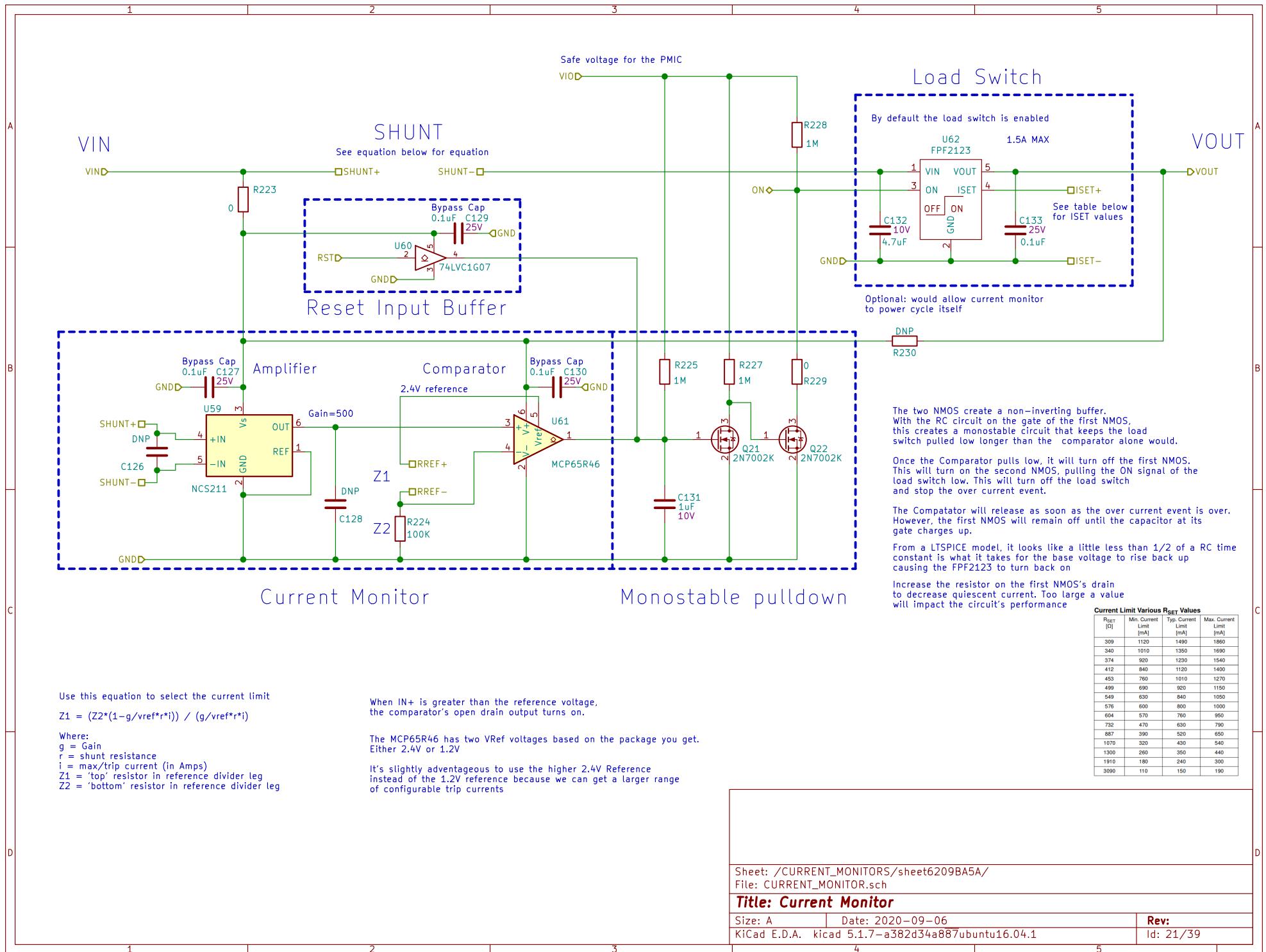


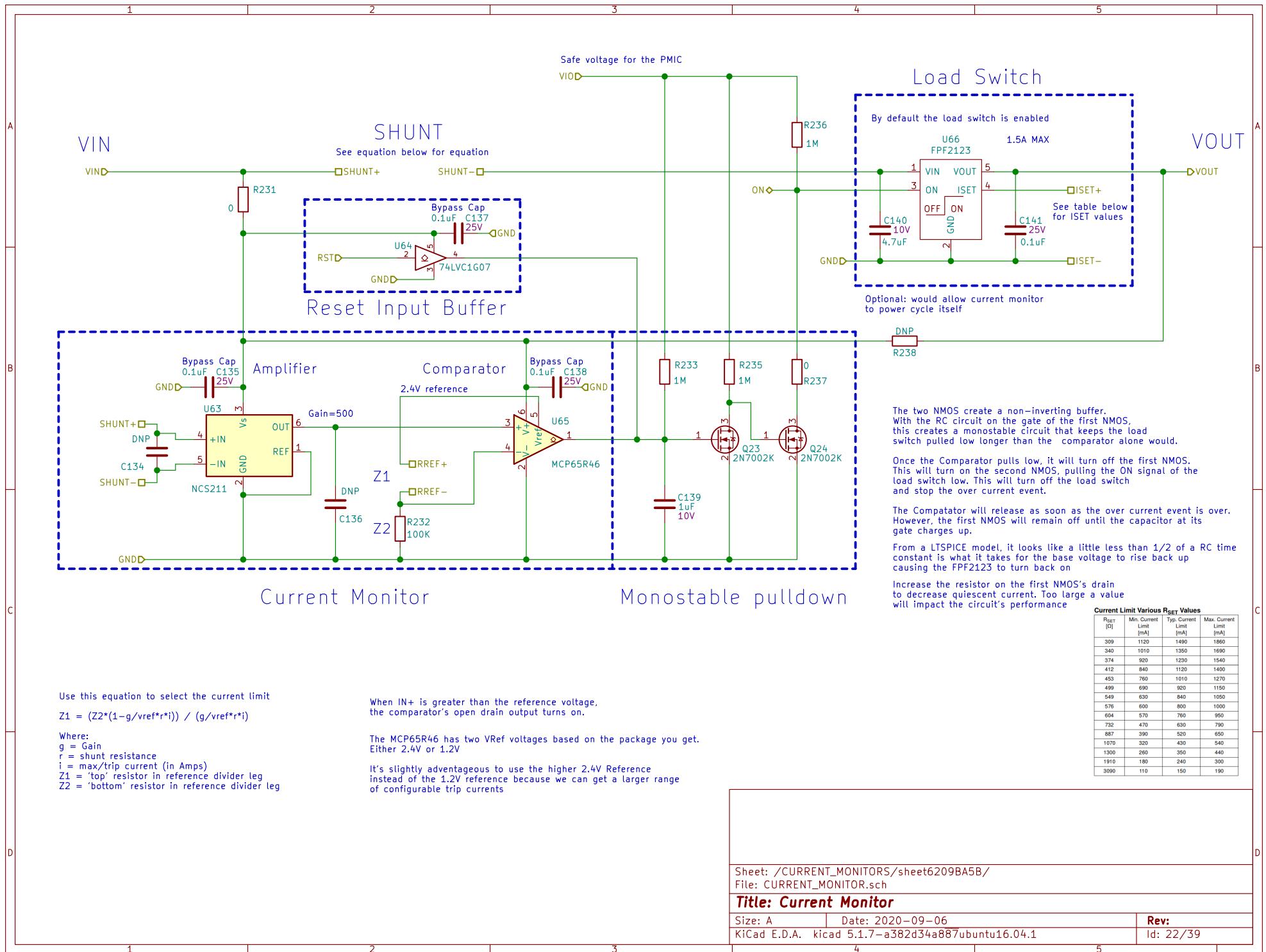


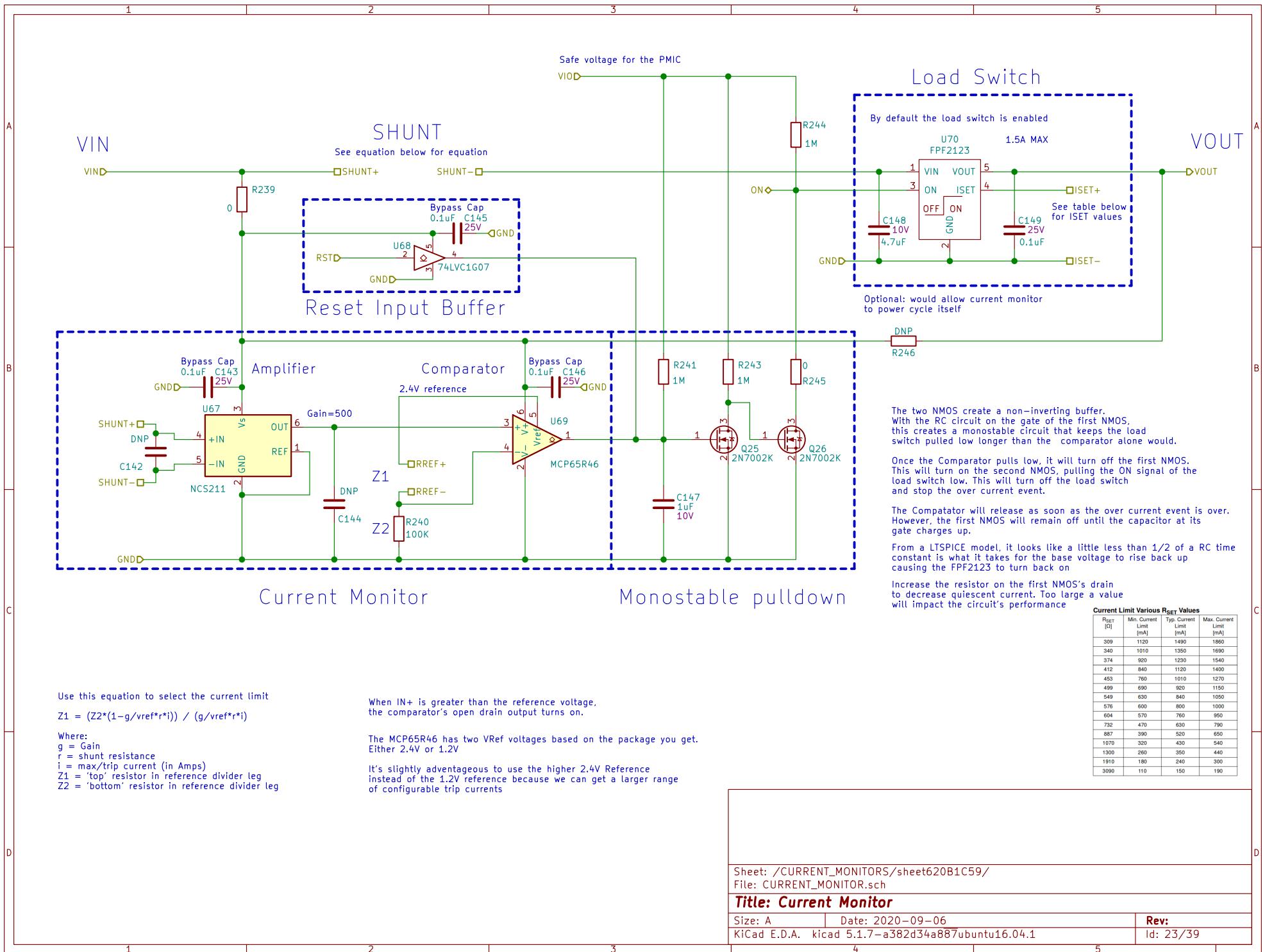


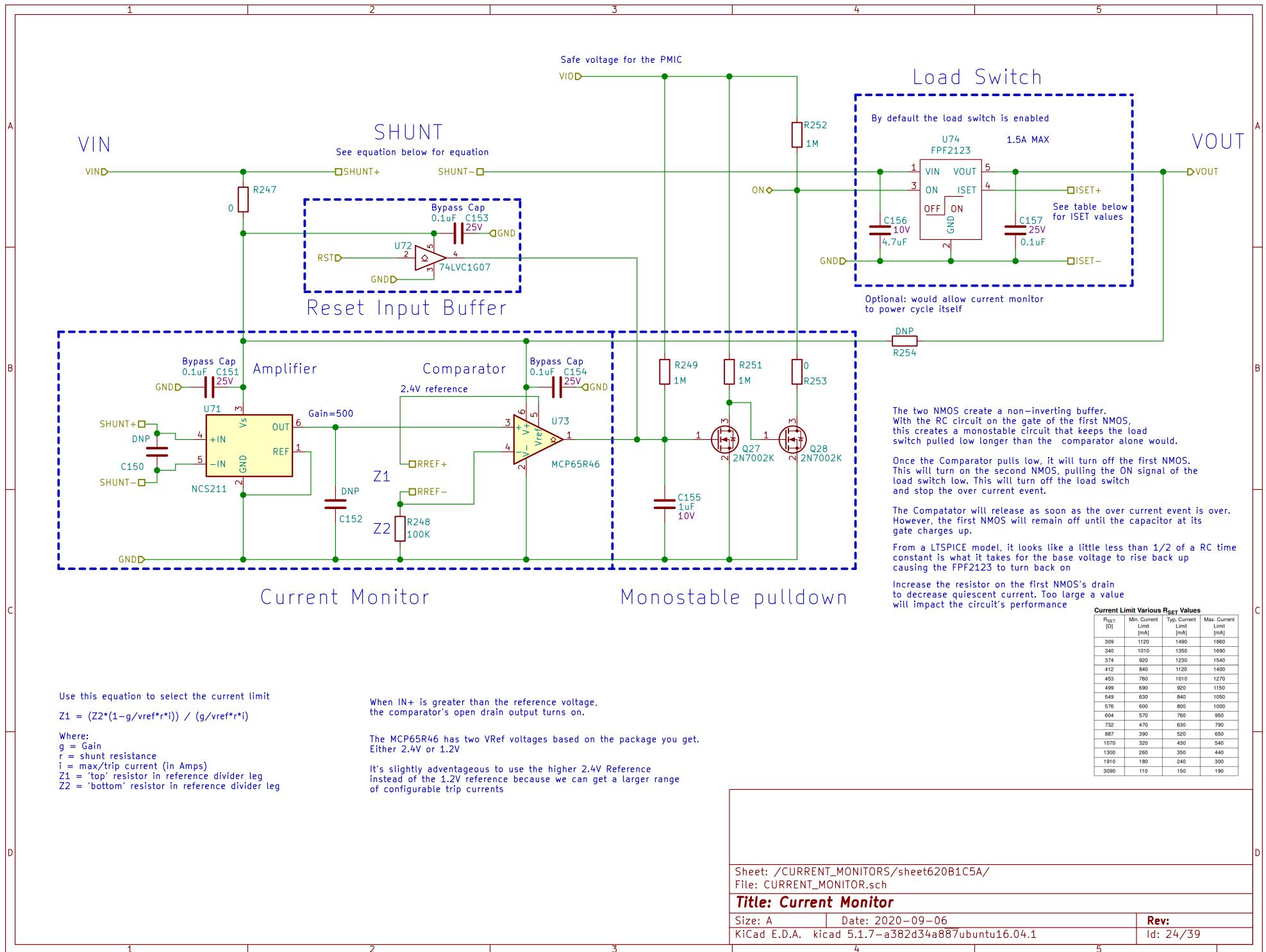


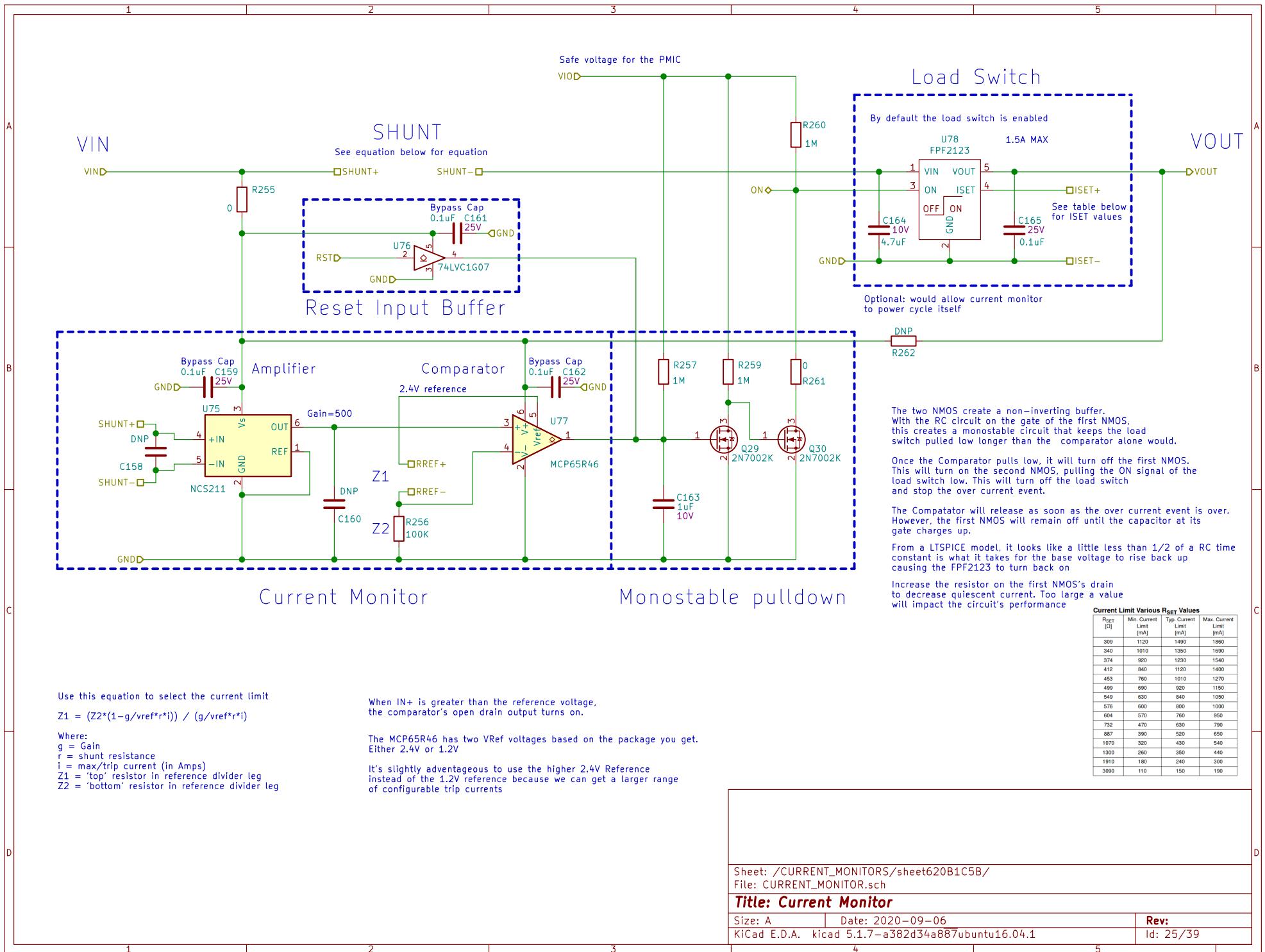


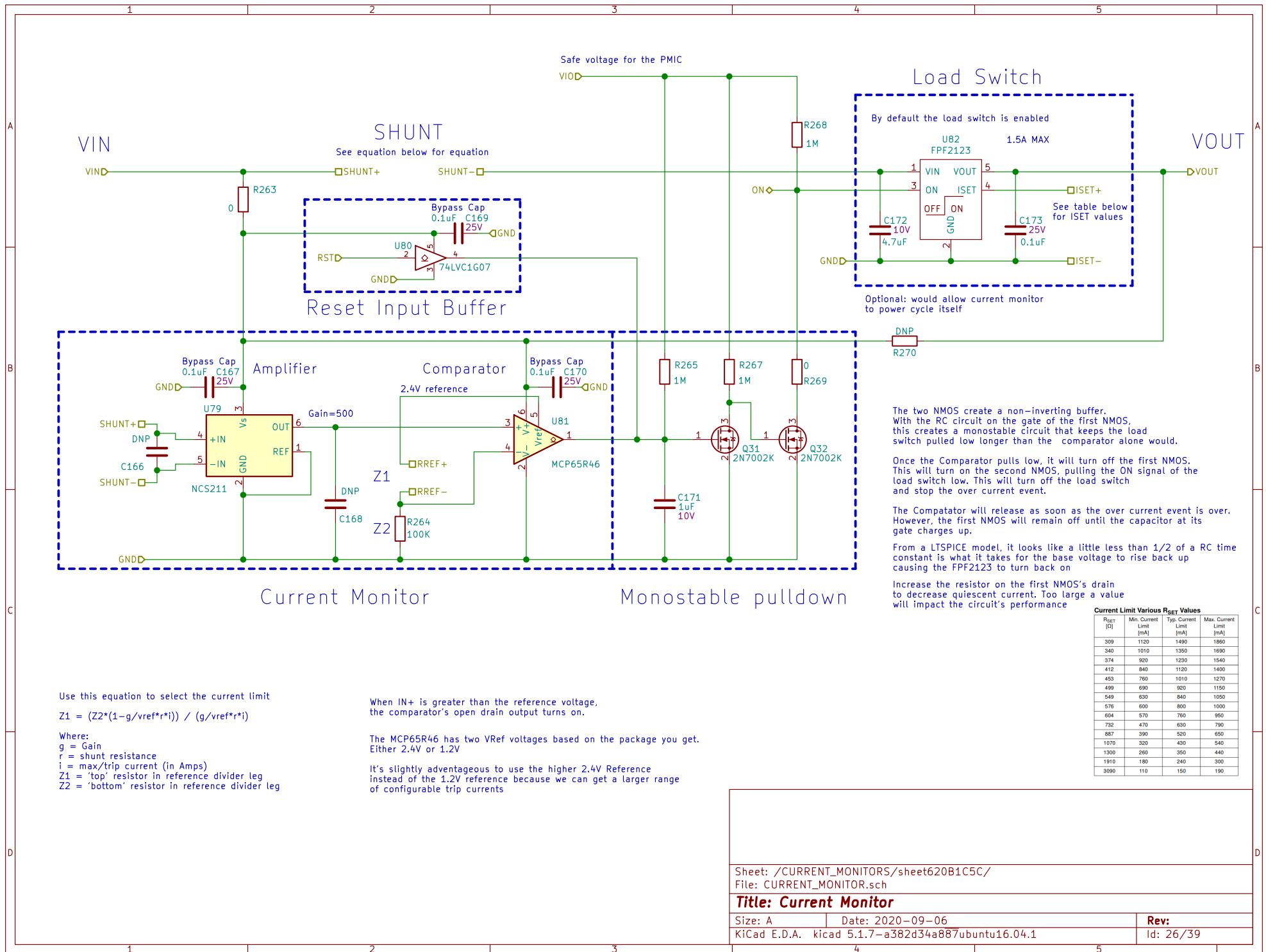


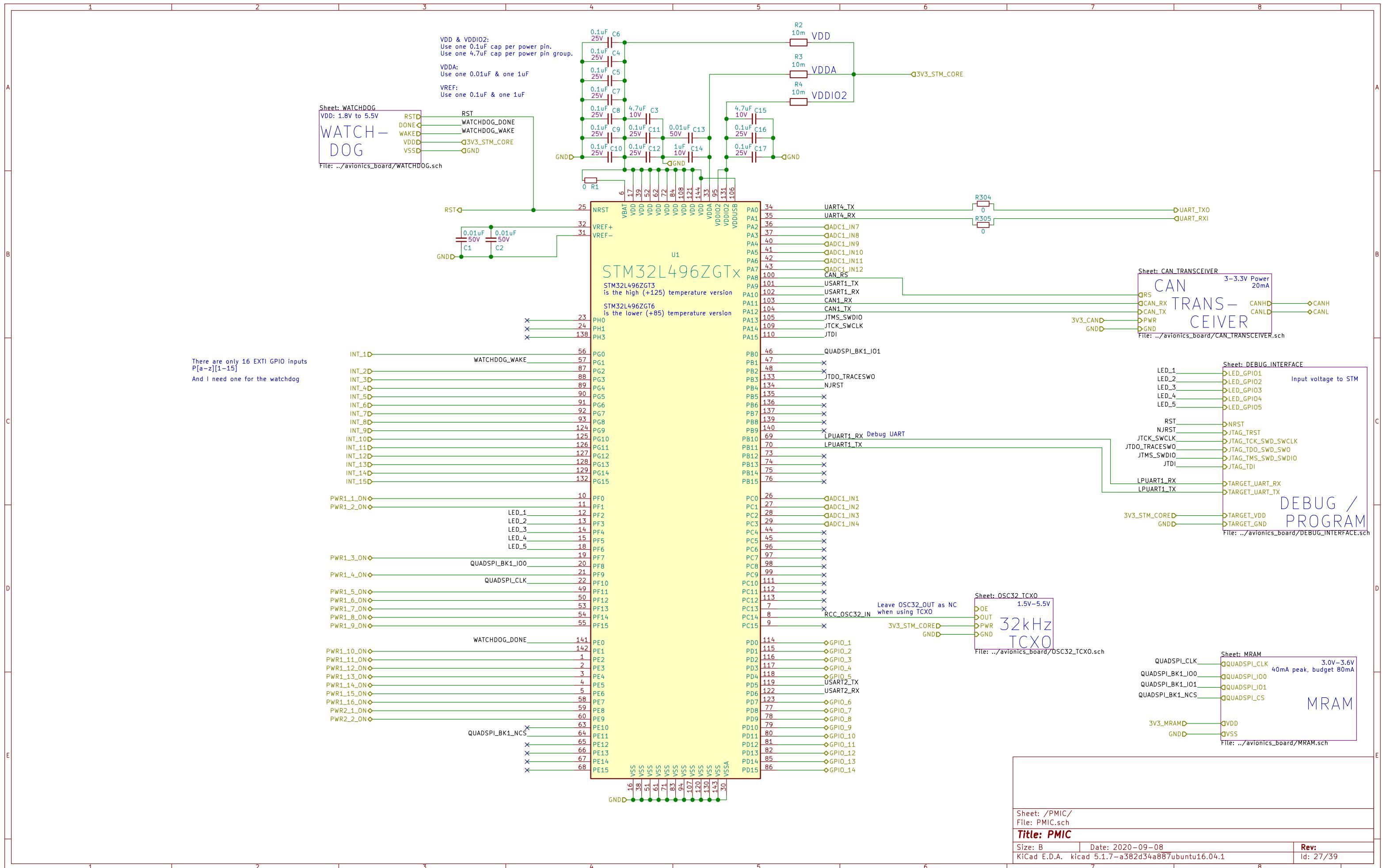




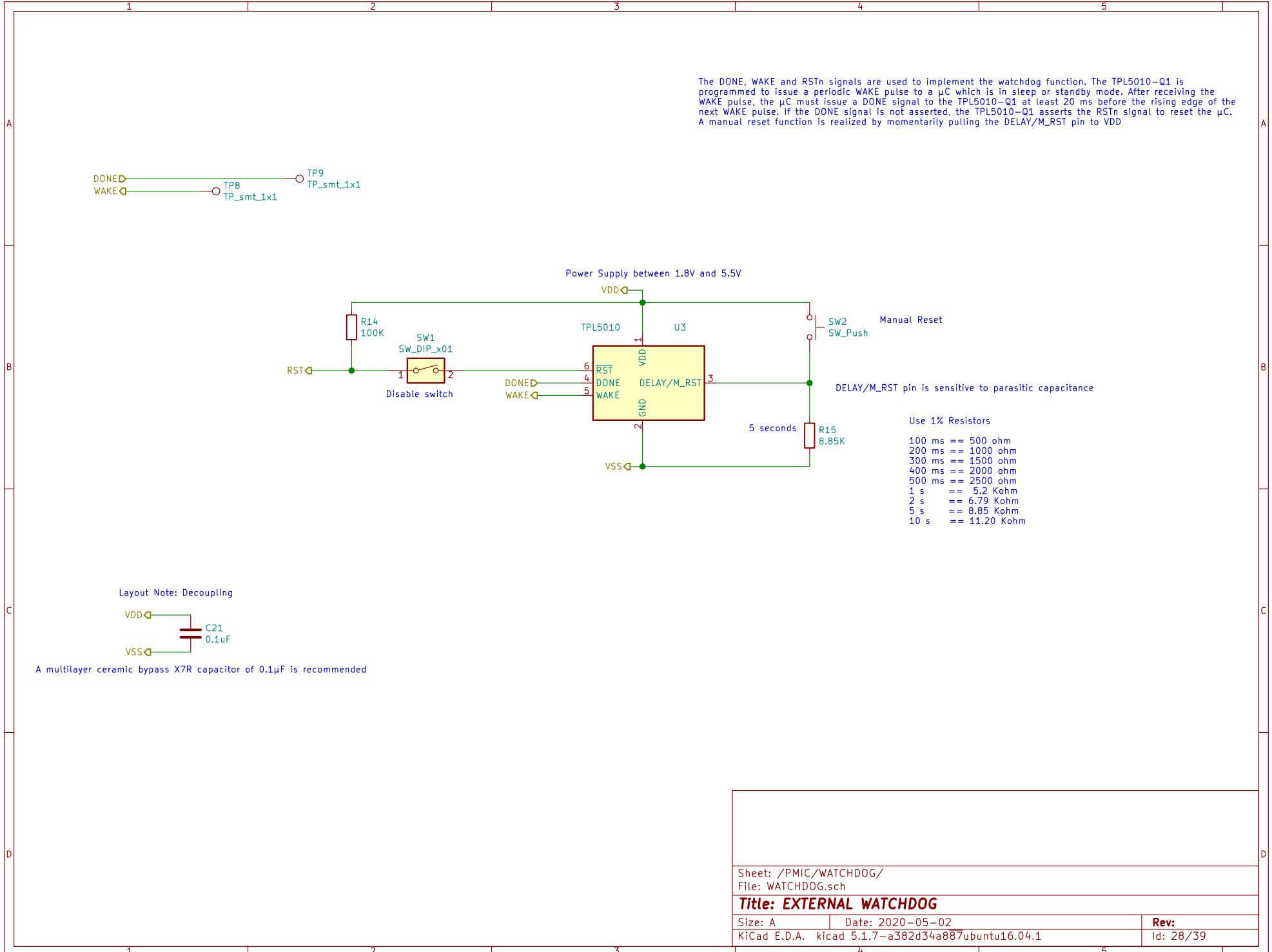




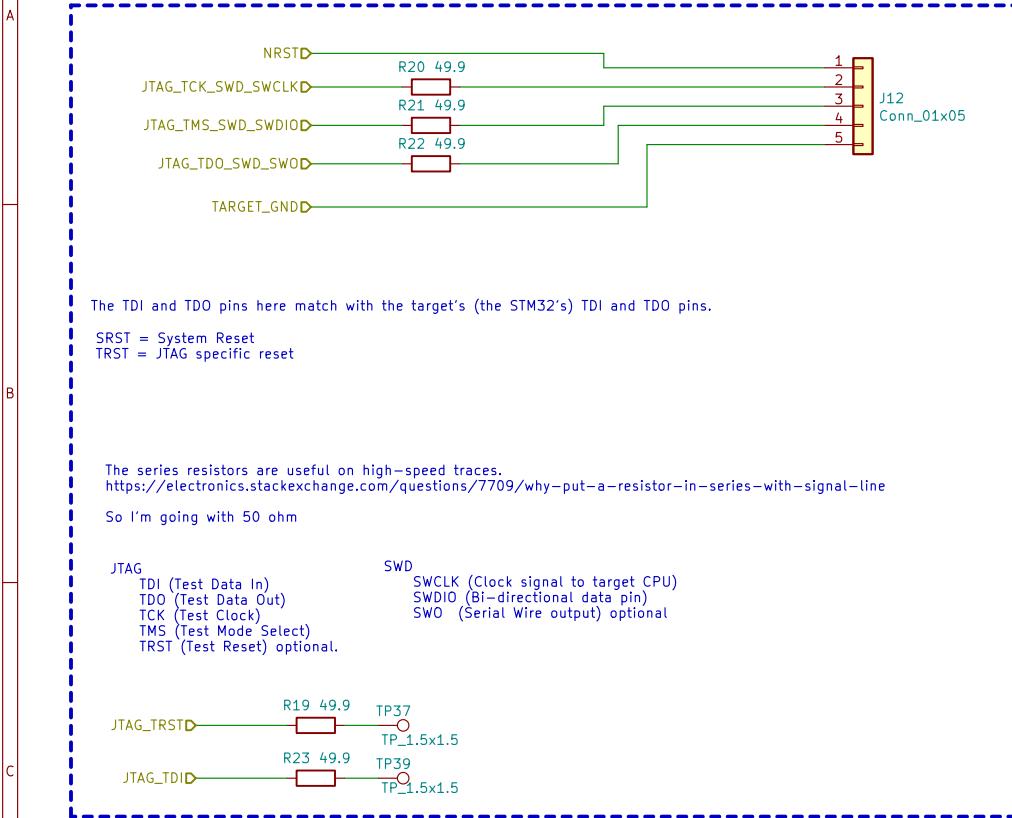
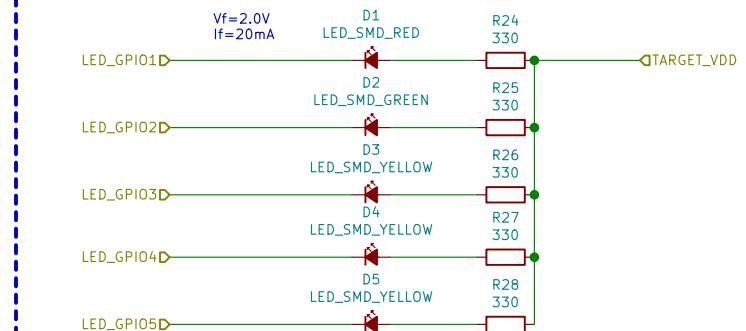
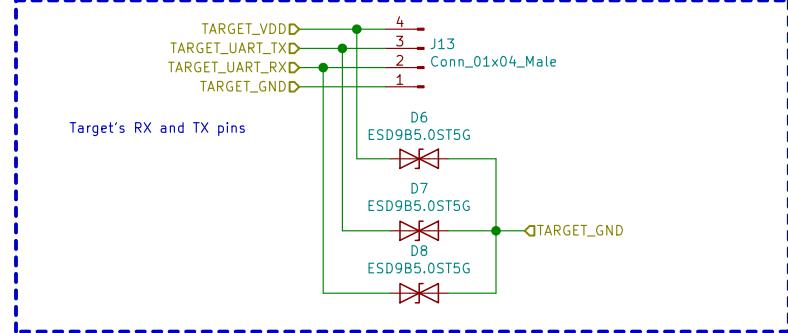


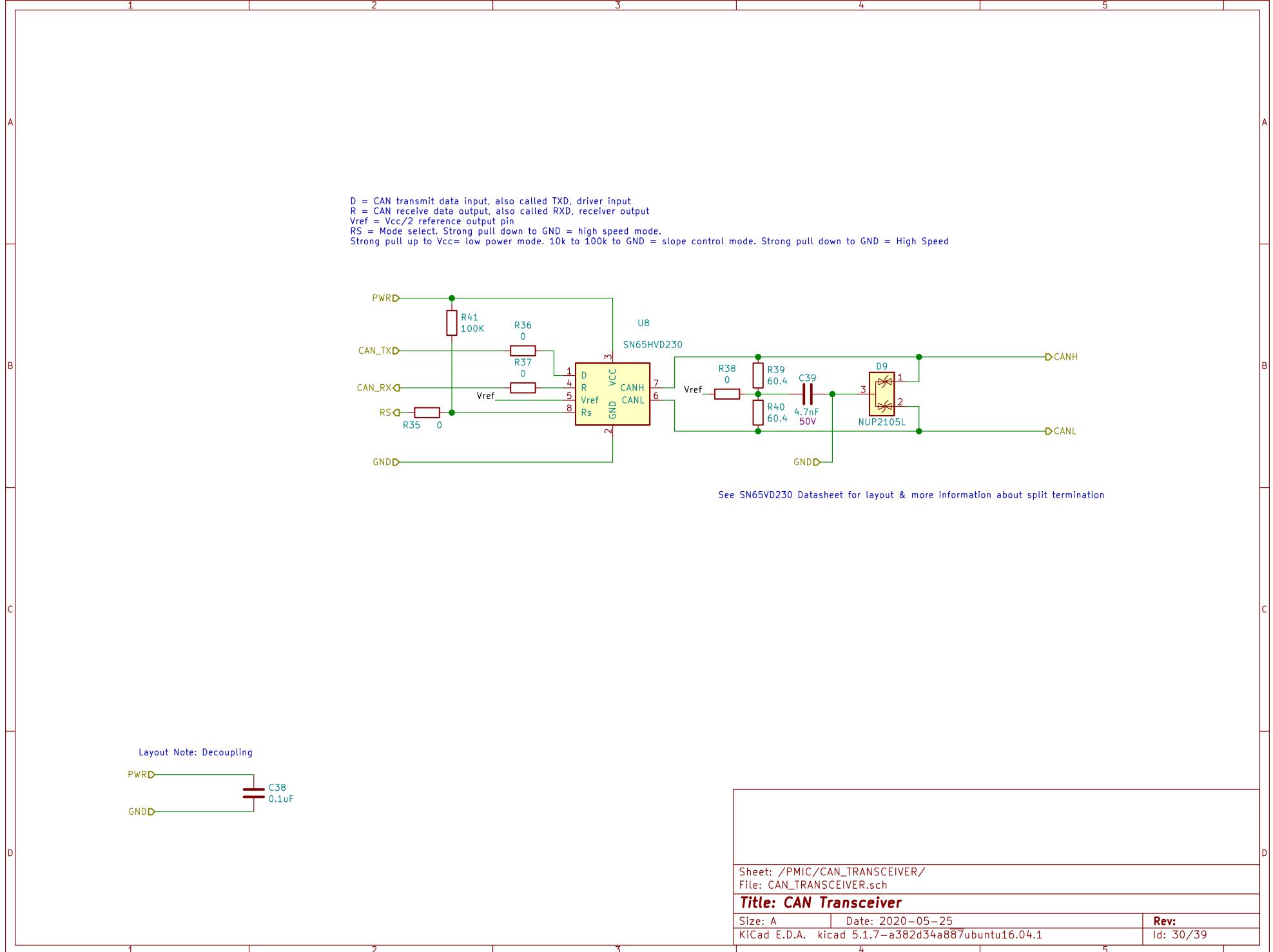


1 2 3 4 5

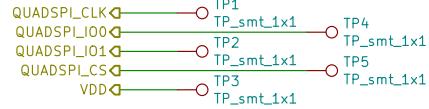


1 2 3 4 5

**JTAG / SWD****DEBUG LED****DEBUG UART**



A



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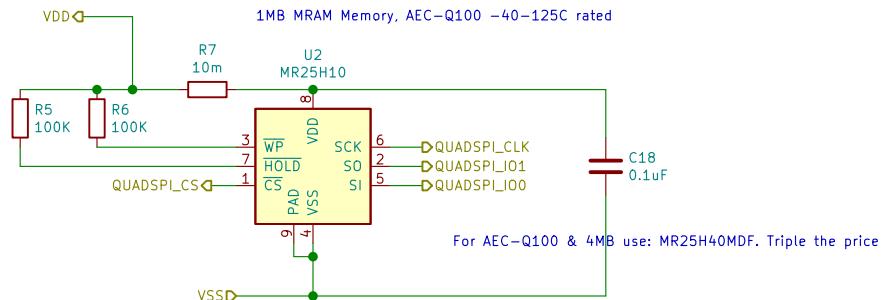
WP is write protect. Low active  
 HOLD suspends operation. Low active. Only available when CS is low  
 CS is chip select. Low active  
 SCK is SPI clock  
 SO is output  
 SI is input  
 VDD is from 3.0V to 3.6V  
 Connect pad only to VSS

<https://www.cypress.com/file/196526/download> for layout guide

0.1uF decoupling cap

B

B



C

C

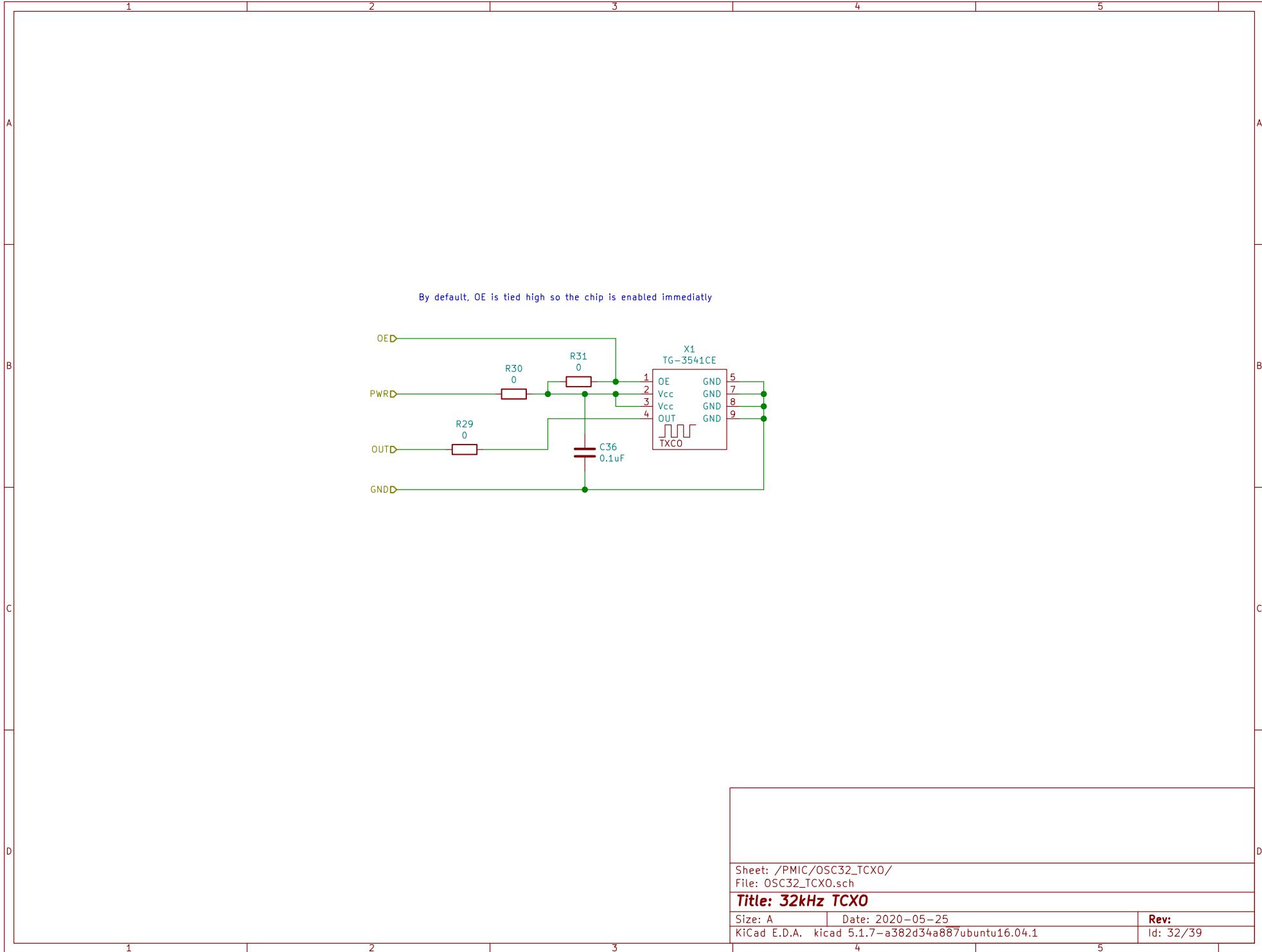
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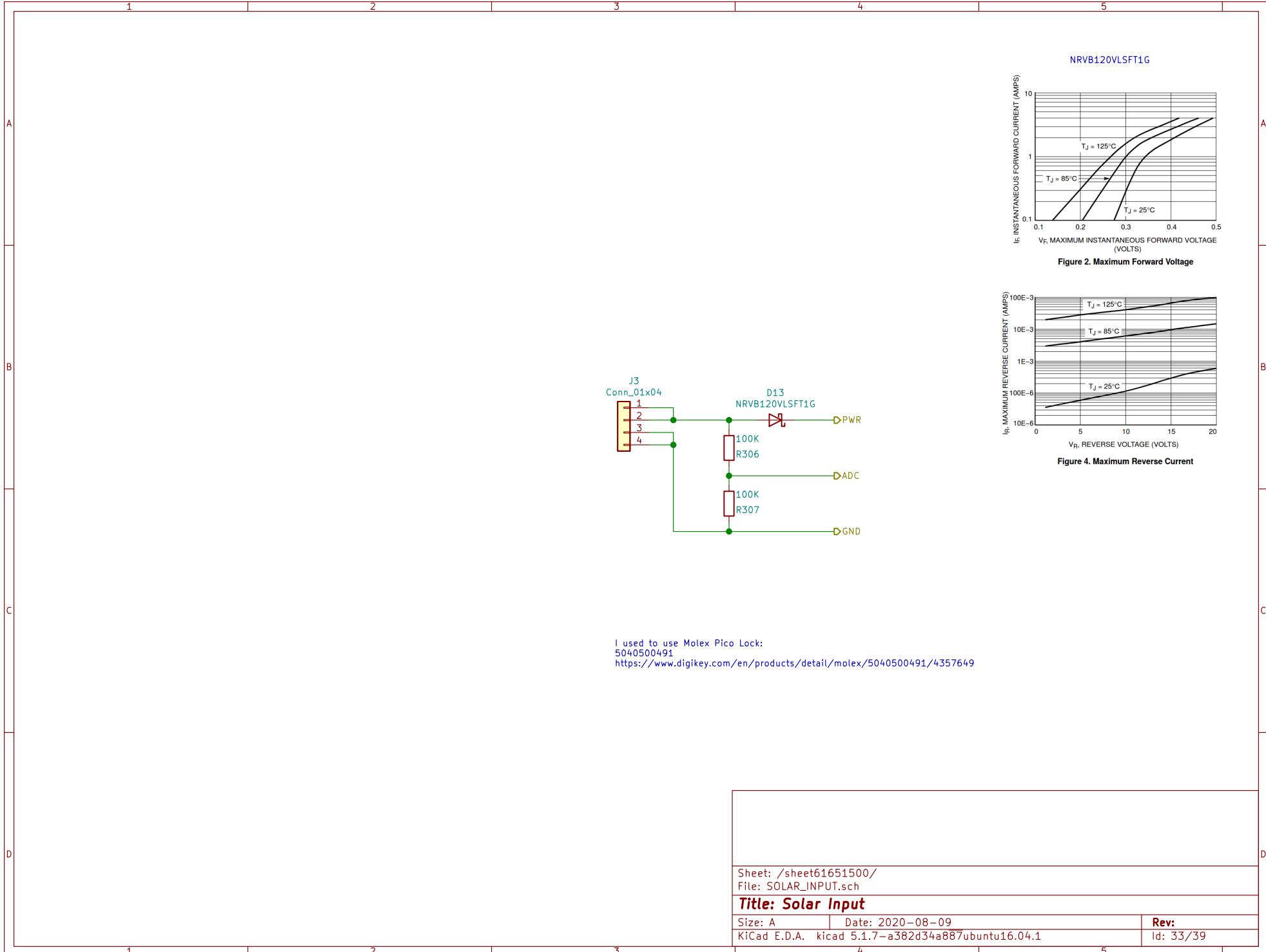
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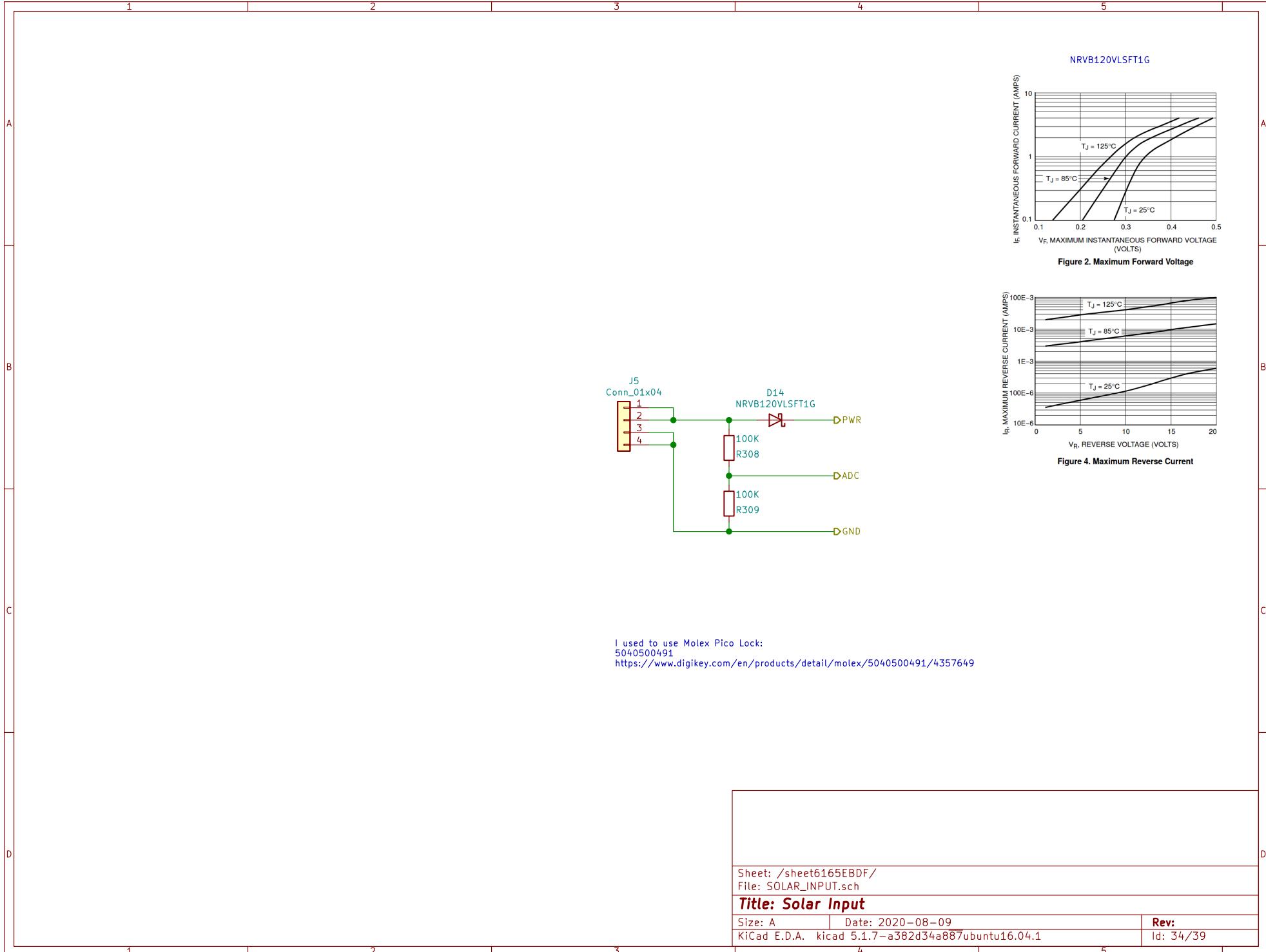
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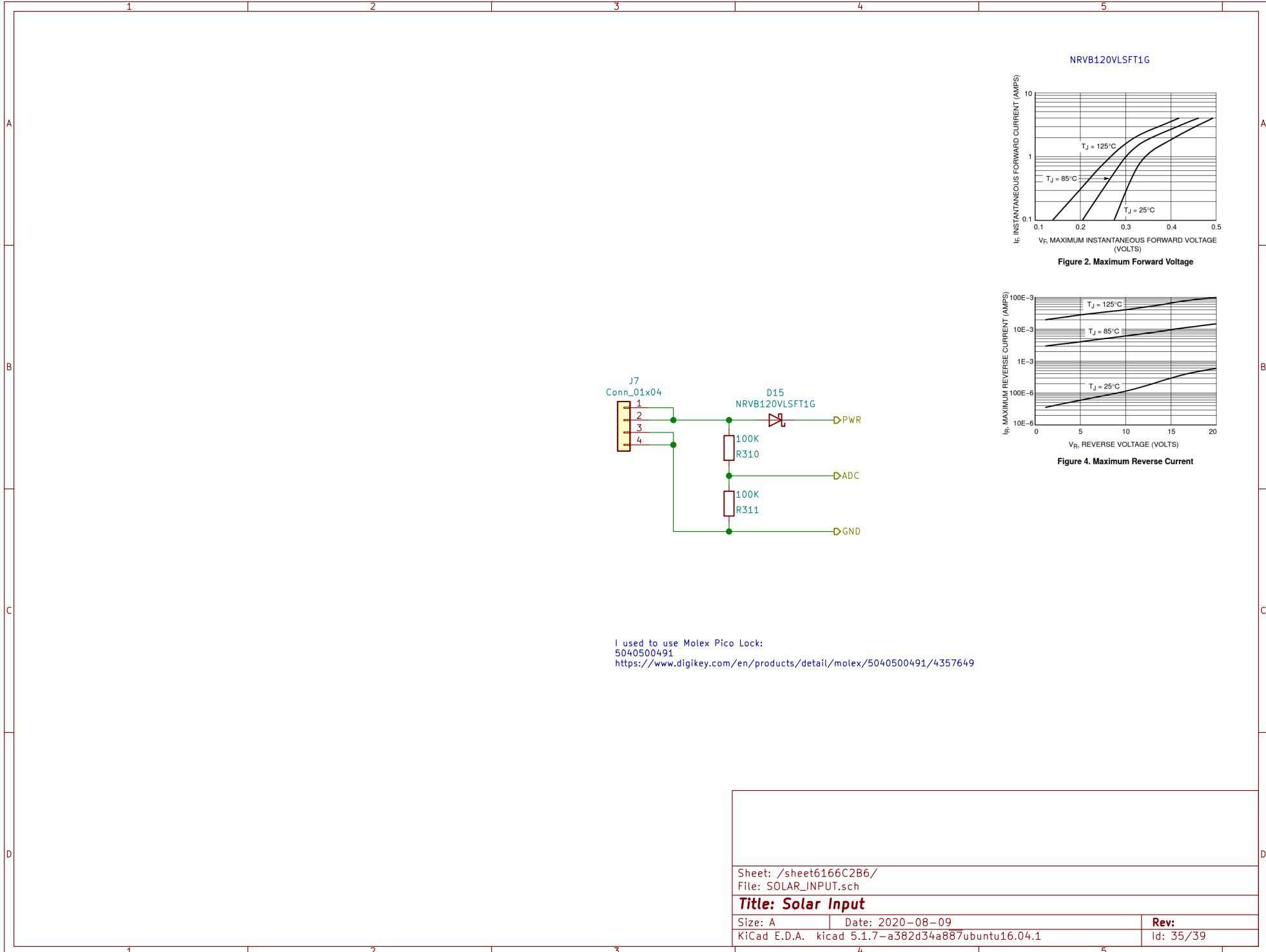
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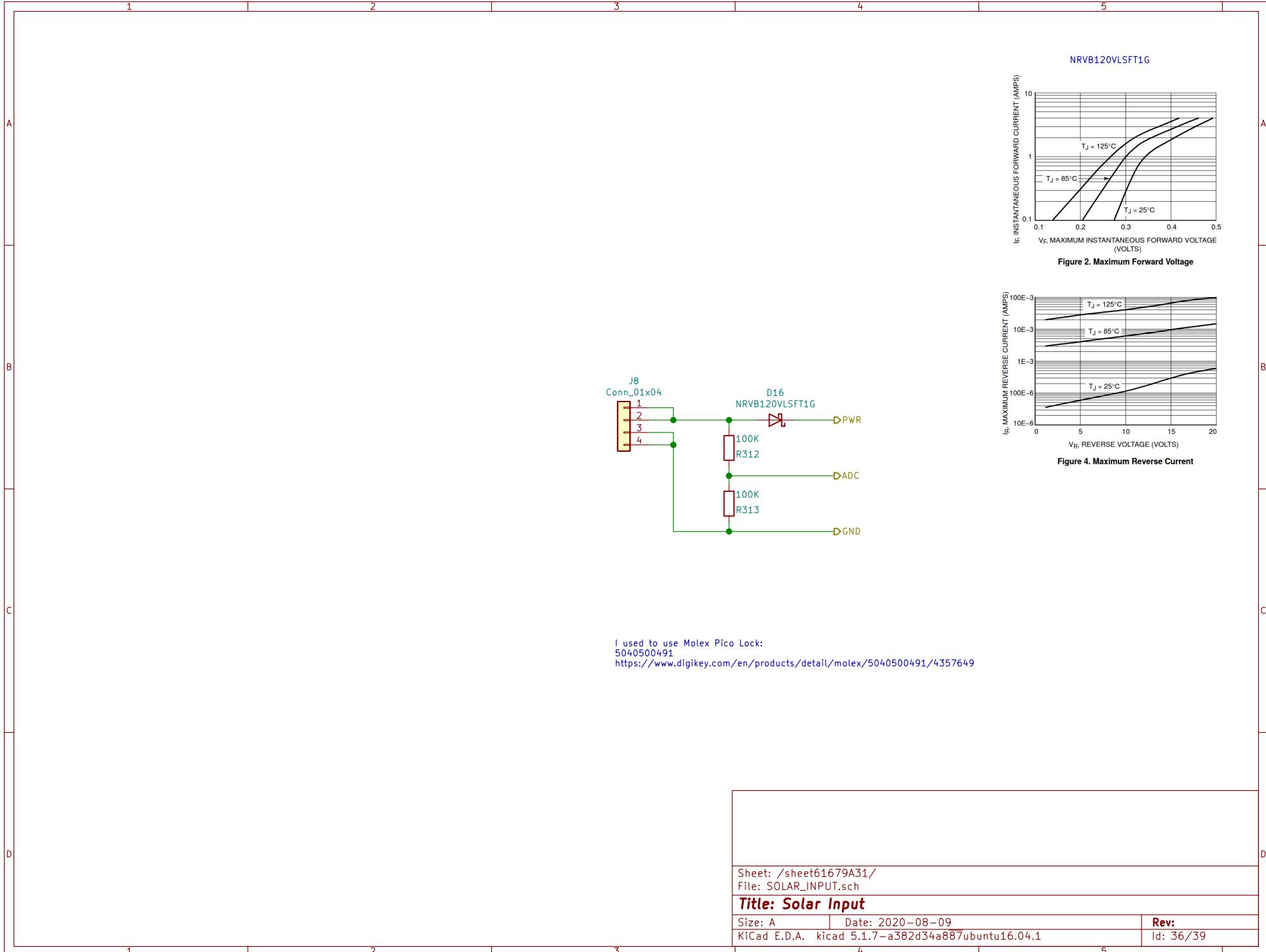
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KiCad E.D.A.	kicad 5.1.7-a382d34a887ubuntu16.04.1	Id: 31/39

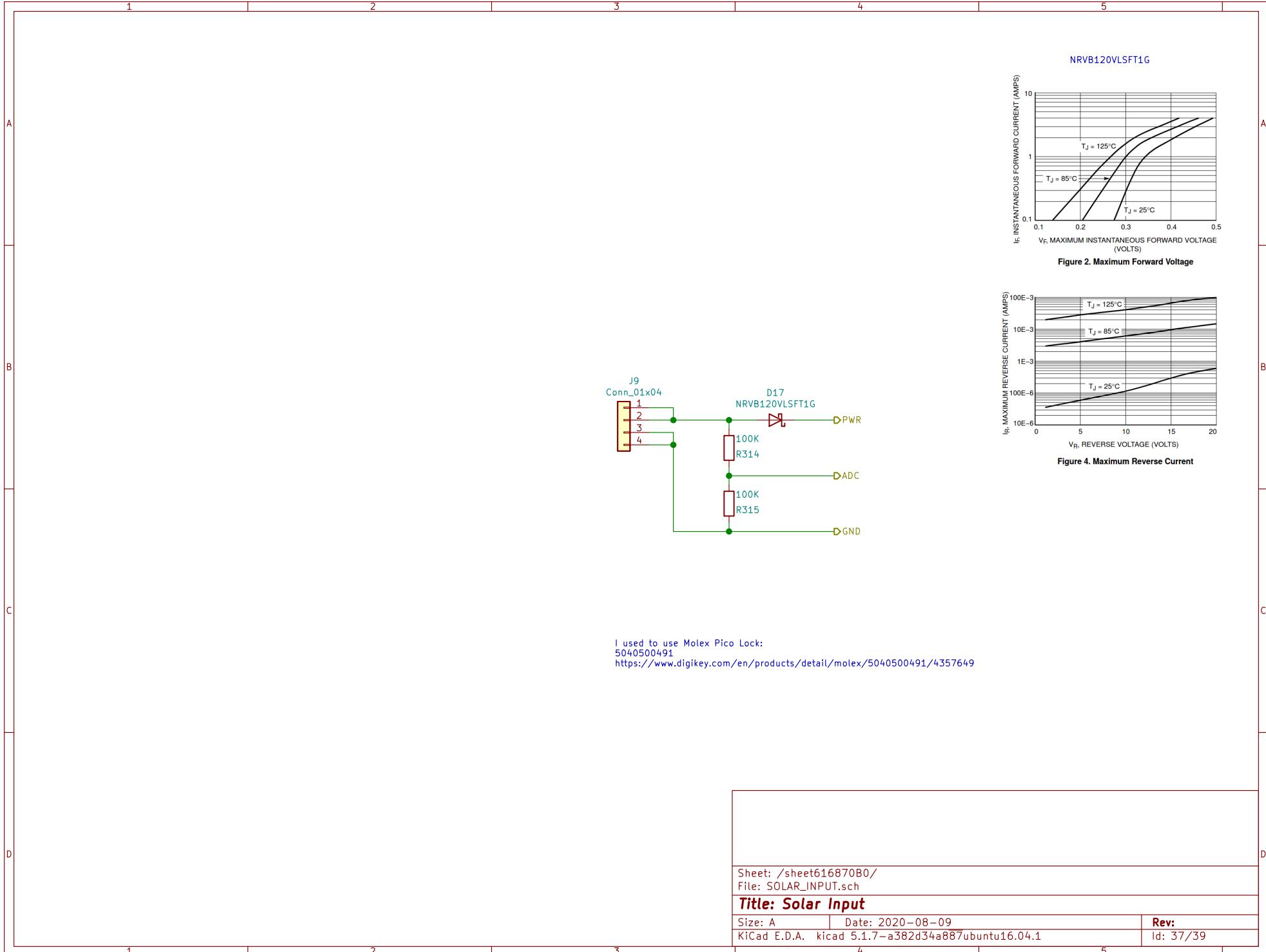


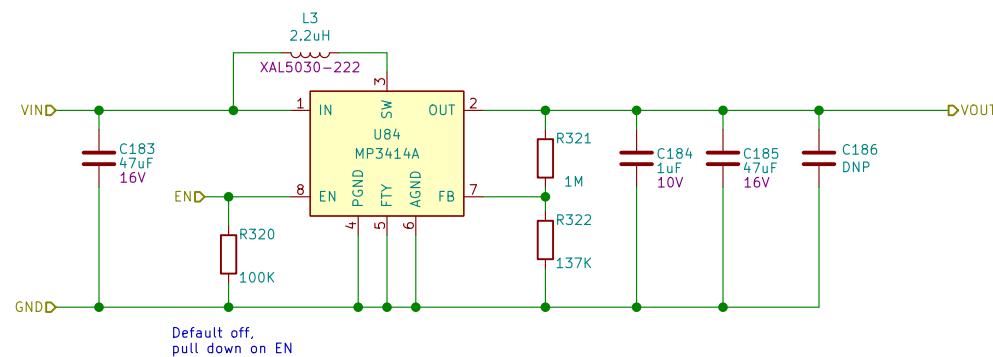
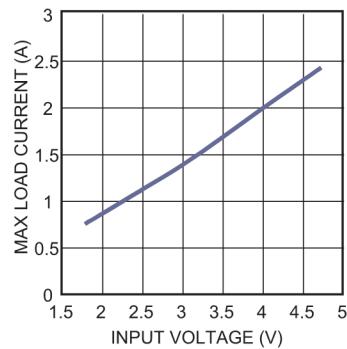










**Load Capability  
vs. Input Voltage<sup>(7)</sup>**


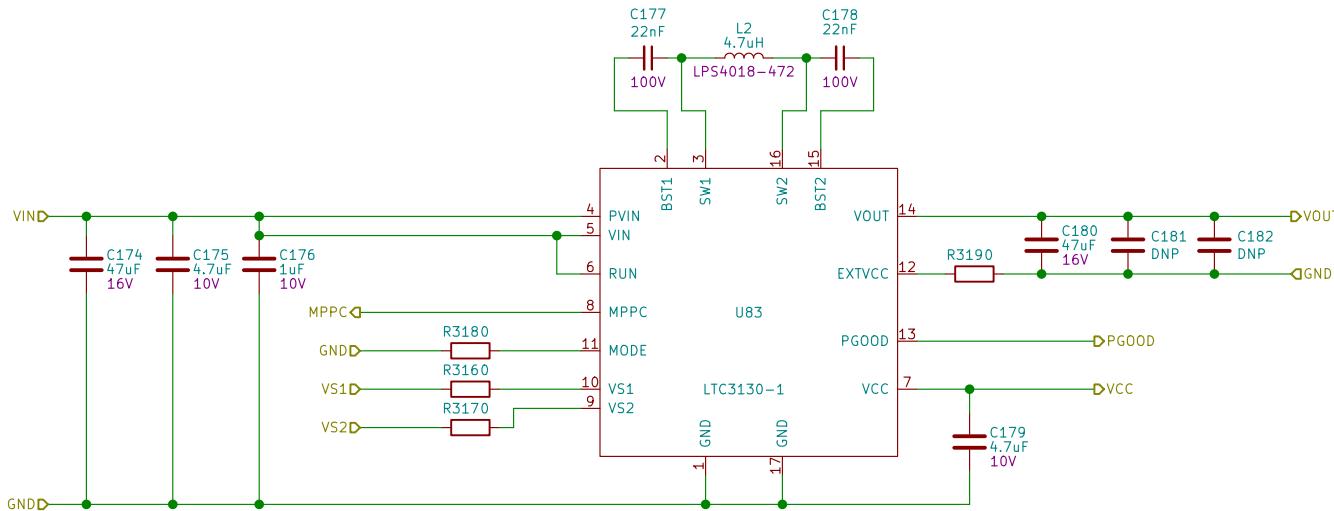
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**Title: 5V Boost**

Size: A Date: 2020-10-04  
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu16.04.1

Rev:  
Id: 38/39

A



B

**Maximum Power Point Control (MPPC)**

The MPPC input of the LTC3130/LTC3130-1 can be used with an optional external voltage divider to dynamically adjust the commanded inductor current in order to maintain a minimum input voltage when using high resistance sources, such as photovoltaic panels, so as to maximize input power transfer and prevent  $V_{IN}$  from dropping too low under load.

Referring to Figure 4, the MPPC pin is internally connected to the noninverting input of a  $g_m$  amplifier, whose inverting input is connected to the 1.0V reference. If the voltage at MPPC, using the external voltage divider, falls below the reference voltage, the output of the amplifier pulls the internal VC node low. This reduces the commanded average inductor current so as to reduce the input current and regulate  $V_{IN}$  to the programmed minimum voltage, as given by:

$$V_{IN(MPPC)} = 1.00V \left( 1 + \frac{R_5}{R_6} \right)$$

Note that external compensation should not be required for MPPC loop stability if the input filter capacitor,  $C_{IN}$ , is at least 22μF.

The MPPC divider resistor values can be in the MΩ range so as to minimize the input current in very low power applications. However, stray capacitance and noise pickup on the MPPC pin must also be minimized. If the MPPC function is not required, the MPPC pin should be tied to  $V_{CC}$ .

Beware of adding a noise filter capacitor to the MPPC pin, as the added filter pole may cause the MPPC control loop to be unstable.

Note that because Burst Mode operation will be inhibited if the MPPC loop takes control, the converter will be operating in fixed frequency mode, and will therefore require a minimum of about 6mA of continuous input current to operate. For operation from weaker sources, such as small indoor solar panels, refer to the Applications Information section to see how to maintain the MPPC function and control the converter in a hysteretic manner while providing an effective MPPC function by maintaining  $V_{IN}$  at the desired voltage. This technique can be used with sources as weak as 3.5V (enough to power the IC in UVLO and the external RUN divider).

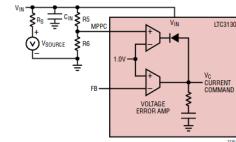
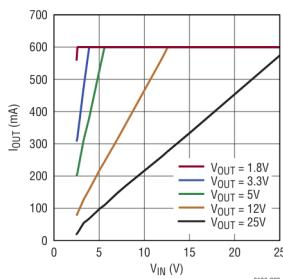


Figure 4. MPPC Amplifier with External Resistor Divider

Maximum Output Current vs  $V_{IN}$  and  $V_{OUT}$ 

PGOOD is open drain.  
Pulled low when  $V_{OUT}$  is less than 7.5% programmed value  
High-Z when  $V_{OUT}$  is within 5% programmed value

**MODE (Pin 11/Pin 11): Mode Select Pin.**

MODE = Low (ground): Enables automatic Burst Mode operation

MODE = High (tie to  $V_{CC}$ ): Fixed frequency PWM operation

Table 1.  $V_{OUT}$  Program Settings for the LTC3130-1

$VS_2$	$VS_1$	$V_{OUT}$
0	0	1.8V
0	$V_{CC}$	3.3V
$V_{CC}$	0	5.0V
$V_{CC}$	$V_{CC}$	12V

Sheet: /sheet5FCD3934/  
File: LTC3130.sch

**Title: LTC3130**

Size: A Date: 2020-08-09  
KiCad E.D.A. kicad 5.1.7-a382d34a887ubuntu16.04.1

Rev:  
Id: 39/39