

INPUT PROTECTION

Variant: PRELIMINARY

2026-02-09
Rev + (Unreleased)

Page	Index	Page	Index	Page	Index	Page	Index
1	Cover Page	11		21		31	
2	ARCHITECTURE	12		22		32	
3	1. INTERCONNECTS	13		23		33	
4	2. POLARITY PROTECTION	14		24		34	
5	3. SENSING	15		25		35	
6	4. POWER	16		26		36	
7	5. COMPARATOR	17		27		37	
8	6. PASS ELEMENT	18		28		38	
9	9. MISCELLANEOUS	19		29		39	
10	REVISION HISTORY	20		30		40	

TOP VIEW

BOTTOM VIEW

NOTES

Comment

Not fitted components are marked as **X**

- DRAFT – Very early stage of schematic, ignore details.
- PRELIMINARY – Close to final schematic.
- CHECKED – There shouldn't be any mistakes. Contact the engineer if found.
- RELEASED – A board with this schematic has been sent to production.

DESIGN CONSIDERATIONS


DESIGN NOTE:
Example text for informational design notes.

DESIGN NOTE:
Example text for debug notes.

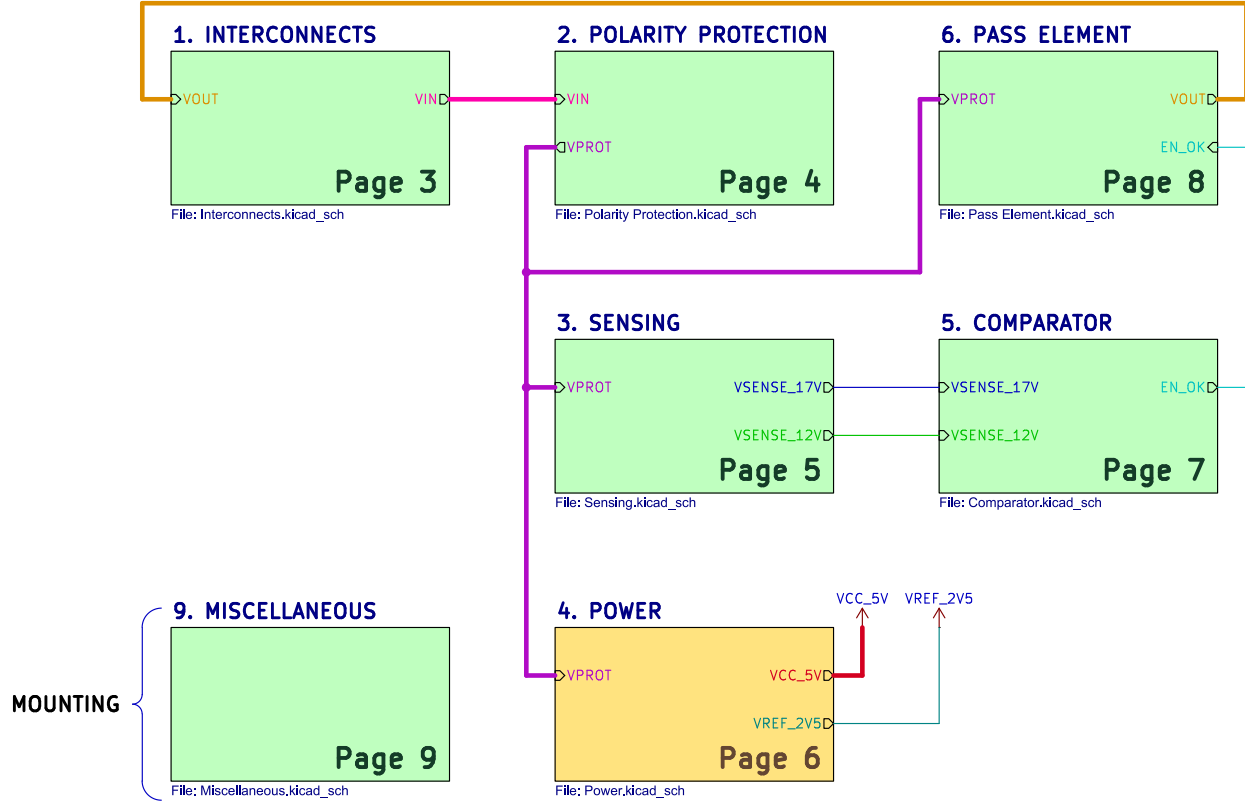
DESIGN NOTE:
Example text for cautionary design notes.


DESIGN NOTE:
Example text for critical design notes.

LAYOUT NOTE:
Example text for critical layout guidelines.

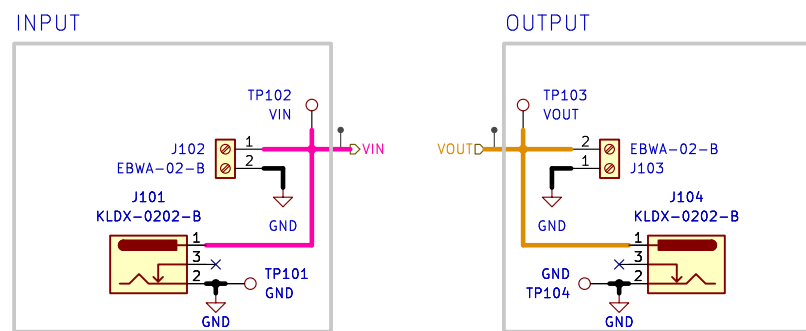
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DRN 2025-01-12 R. HICKS			
CHK			
ENG APP	INPUT PROTECTION		
MFR APP			
SHEET PATH	GIT HASH 3eaf265	DRAWING No	A3
FILENAME Input-Protection.kicad_sch	VARIANT PRELIMINARY	REVISION + (Unreleased) SHEET 1 OF 10	

[2] ARCHITECTURE



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FILENAME Project Architecture.kicad_sch	VARIANT PRELIMINARY	REVISION + (Unreleased) SHEET 2 OF 10	

[3] 1. INTERCONNECTS



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/ARCHITECTURE/1. INTERCONNECTS/

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1. INTERCONNECTS

A4

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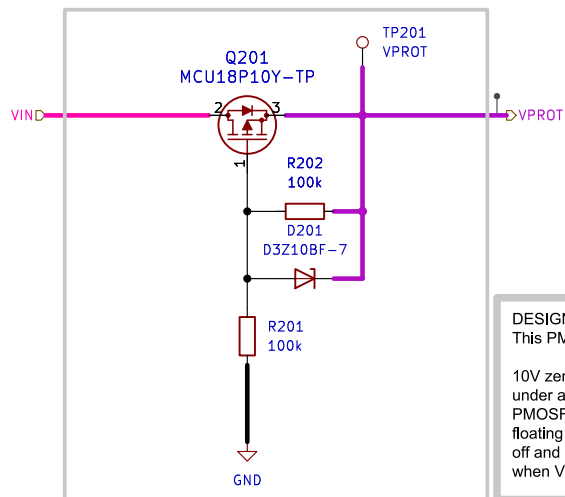
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SHEET

3 OF 10


[4] 2. POLARITY PROTECTION



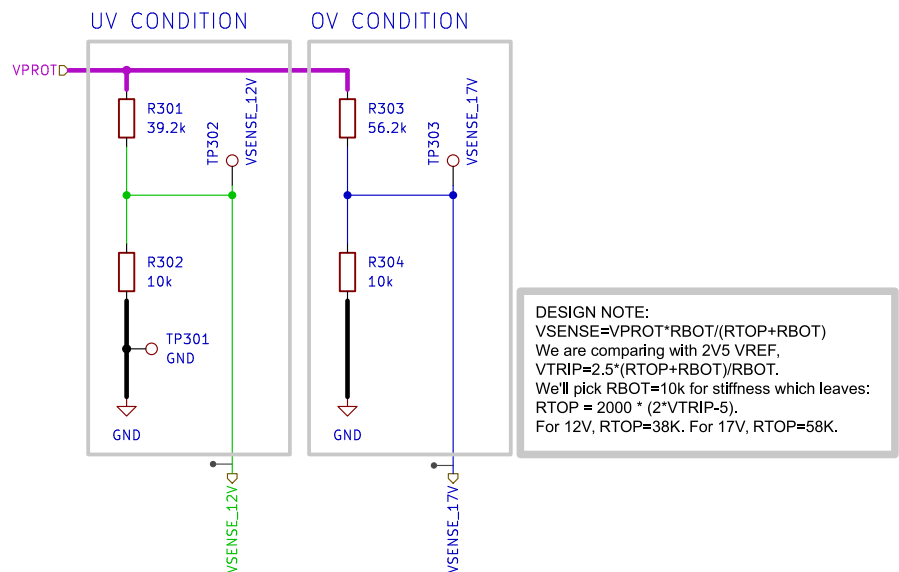
DESIGN NOTE:
This PMOSFET is acting as an ideal diode [1].

10V zener from Gate to Source to limit VGS \leq 10V under all VIN and transient conditions to protect PMOSFET. 100K Gate to Source resistor to not allow floating Gate. 100K Gate pulldown resistor so Gate is off and not affected by leakage or capacitive coupling when VIN removed or reversed.


[1] <https://www.ti.com/lit/an/slvae57b/slvae57b.pdf?ts=1770319054914>

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/ARCHITECTURE/2. POLARITY PROTECTION/	3ea1265	POLARITY PROTECTION	
FILENAME Polarity Protection.kicad_sch	VARIANT PRELIMINARY	REVISION + (Unreleased)	SHEET 4 OF 10

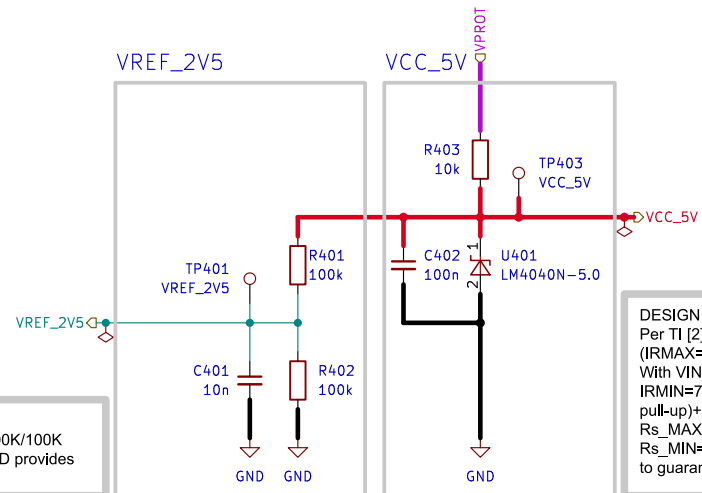
[5] 3. SENSING



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DRN	2025-01-12 R. HICKS
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MFR APP	
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3eaf265		
VARIANT	REVISION + (Unreleased)	SHEET
PRELIMINARY		5 OF 10

[6] 4. POWER



DESIGN NOTE:
VREF_2V5 is generated from VCC_5V with a 100K/100K divider. A 10nF capacitor from VREF_2V5 to GND provides low-pass filtering $f_c = 1/(2\pi \cdot 50K \cdot 10n) = 318Hz$.

DESIGN NOTE:
Per TI [2] choose R_s such that $IR_{MIN} < IR < IR_{MAX}$ ($IR_{MAX} = 15mA$), accounting for VIN range and load. With $V_{IN_MIN} = 12V$, $V_{IN_MAX} = 50V$, $V_{OUT} = 5V$, $IR_{MIN} = 75\mu A$ and $I_{LOAD_MAX} = I(2.5V \text{ divider}) + I(EN_OK \text{ pull-up}) + I_q(AZV3002) \approx 250\mu A + 50\mu A + 9\mu A$, $R_{s_MAX} = (V_{IN_MIN} - V_{OUT}) / (I_{LOAD_MAX} + IR_{MIN}) \approx 18K$, $R_{s_MIN} = (V_{IN_MAX} - V_{OUT}) / IR_{MAX} = 3K$. $R_s = 10K$ is selected to guarantee regulation at 12V & limit shunt current at 50V.

[2] <https://www.ti.com/lit/ds/symlink/lm4040-n.pdf?ts=1752678691365>

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/ARCHITECTURE/4. POWER/

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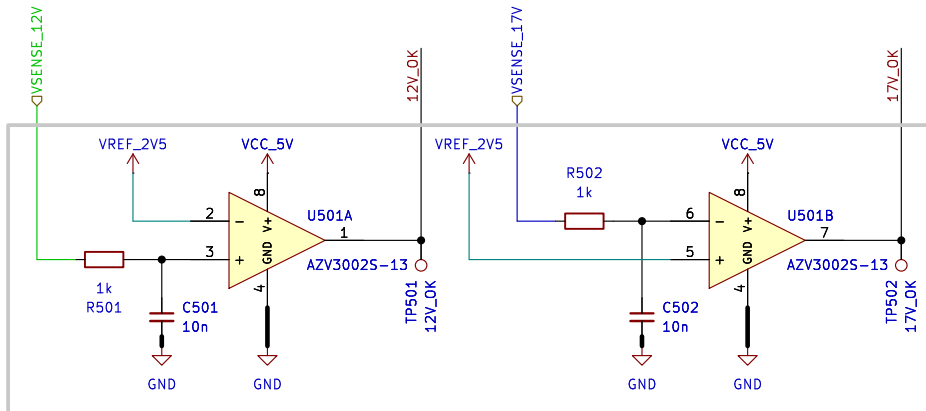
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REVISION + (Unreleased)

SHEET

6 OF 10

[7] 5. COMPARATOR



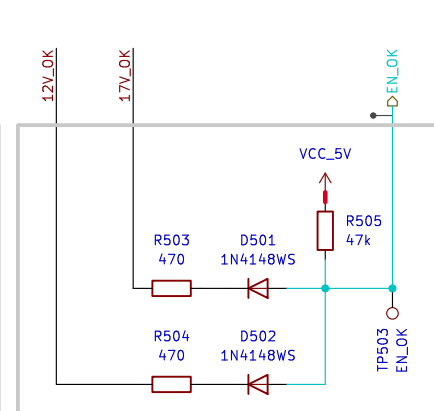
0V & UV COMPARATOR

DESIGN NOTE:

The AZV3002S-13 dual comparator is used to implement the 12-17 V window detector. Each comparator compares a scaled VPROT sense voltage (VSENSE) against VREF_2V5 to generate 12V_OK and 17V_OK signals. The device is selected for its low supply current (10uA worst) and rail-to-rail input.

DESIGN NOTE:

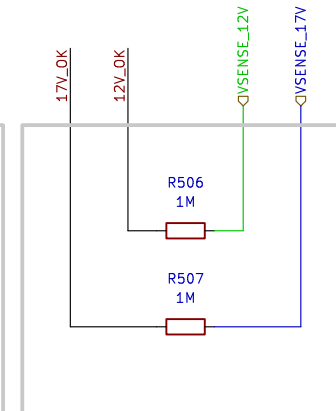
A simple low pass filter is placed on the VSENSE inputs of the comparators to smooth transitions and reduce chatter near the transition points. $f_c = 1/(2\pi \cdot 1k \cdot 10n) = 16Hz$.



DIODE AND

DESIGN NOTE:

EN_OK is generated using diode logic AND combining the 12V_OK and 17V_OK. A pull-up resistor biases EN_OK high, while either comparator output can clamp the node low through its diode, ensuring the pass MOSFET is enabled only when both voltage conditions are satisfied. Series resistors limit output interaction and improve stability with push-pull comparator outputs.



HYSTERESIS

DESIGN NOTE:

1M feedback resistor from comparator output to sense input provides external hysteresis to prevent chatter near the 12 V and 17 V thresholds. With divider $R_{TH} = R_{TOP} || R_{BOT} \approx 8K$ and a 5 V output swing, hysteresis at VSENSE is about $\Delta V_{SENSE} \approx 5 \cdot R_{TH} / R_{HYS} \approx 40mV$, or $\sim 0.2-0.3 V$ seen at VPROT.

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/ARCHITECTURE/5. COMPARATOR/

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5. COMPARATOR

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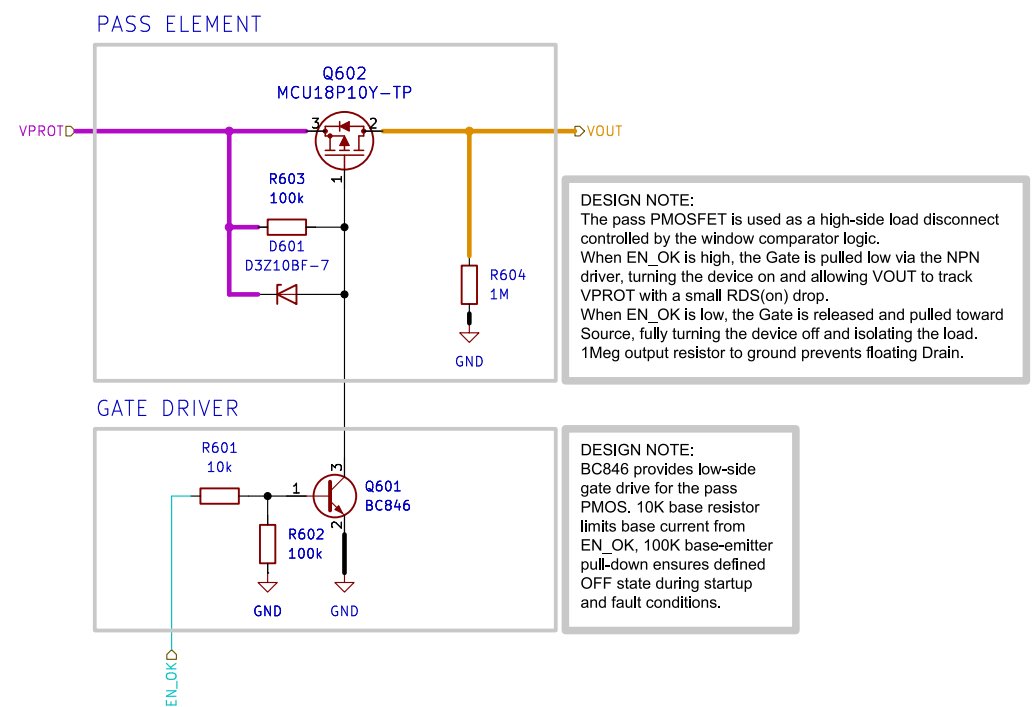
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REVISION + (Unreleased)

SHEET

7 OF 10

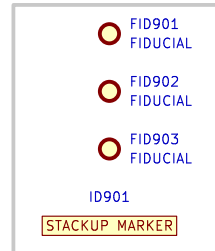
[8] 6. PASS ELEMENT



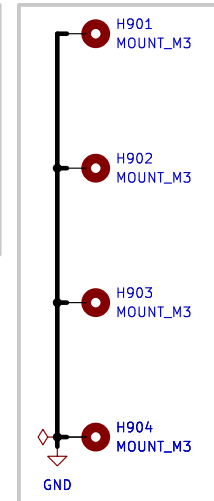
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MFR APP			
SHEET PATH	GIT HASH	DRAWING No	A4
/ARCHITECTURE/6. PASS ELEMENT/	3eaf265	6. PASS ELEMENT	
FILENAME Pass Element.kicad_sch	VARIANT PRELIMINARY	REVISION + (Unreleased)	SHEET 8 OF 10


[9] 9. MISCELLANEOUS

MARKINGS




MOUNTING



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MFR APP						
SHEET PATH		GIT HASH	DRAWING No		A4	
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FILENAME	Miscellaneous.kicad_sch	VARIANT	PRELIMINARY	REVISION + (Unreleased)		SHEET

[10] REVISION HISTORY

PROJECT	ASSIGNMENT 1
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VARIANT	PRELIMINARY	REVISION + (Unreleased)	SHEET
			10 OF 10