

Original author: Oliwier Woźniak

Sheet: /  
File: uMule\_board.kicad\_sch

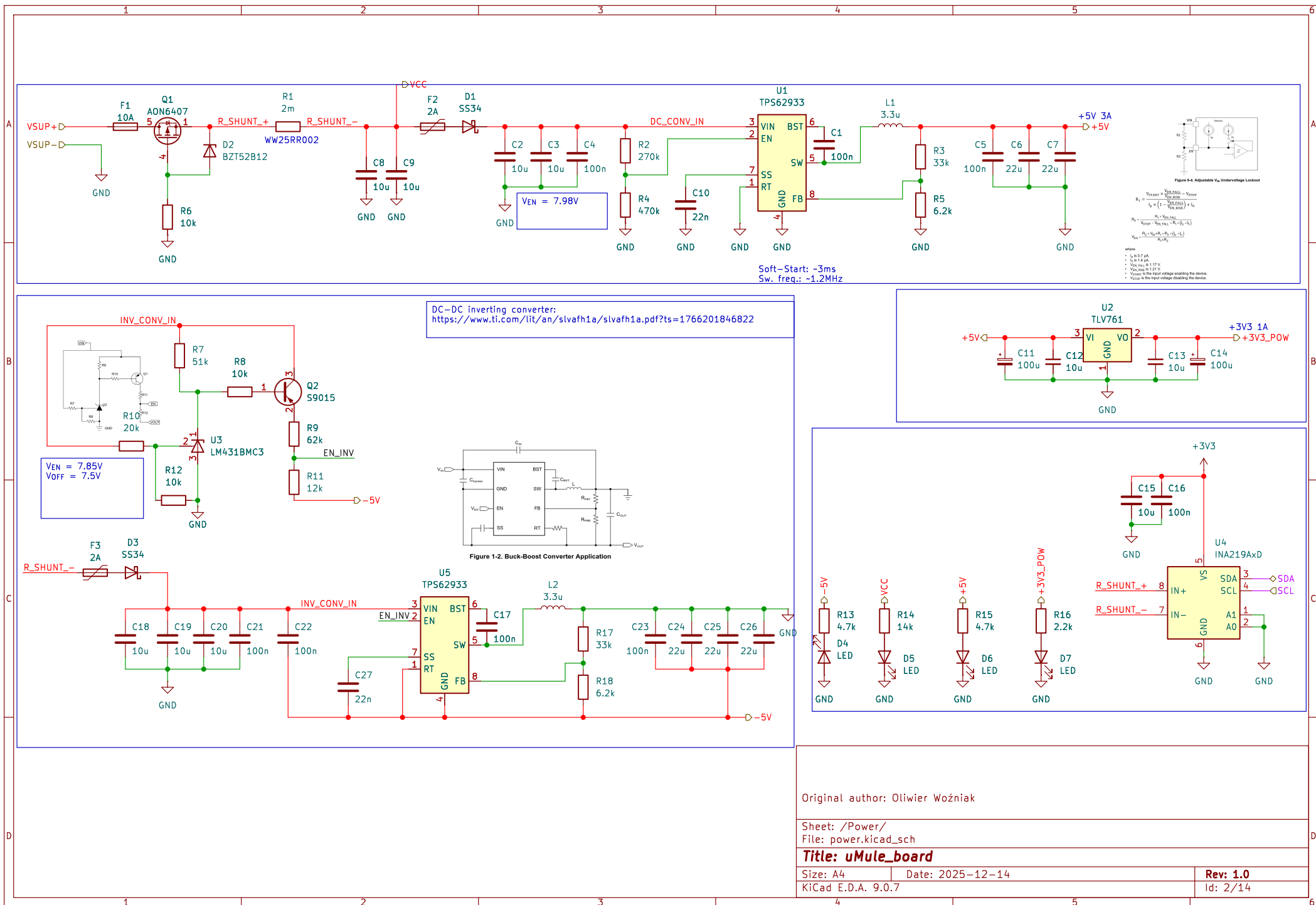
**Title: uMule\_board**

Size: A4      Date: 2025-12-14

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**Rev: 1.0**

Id: 1/14



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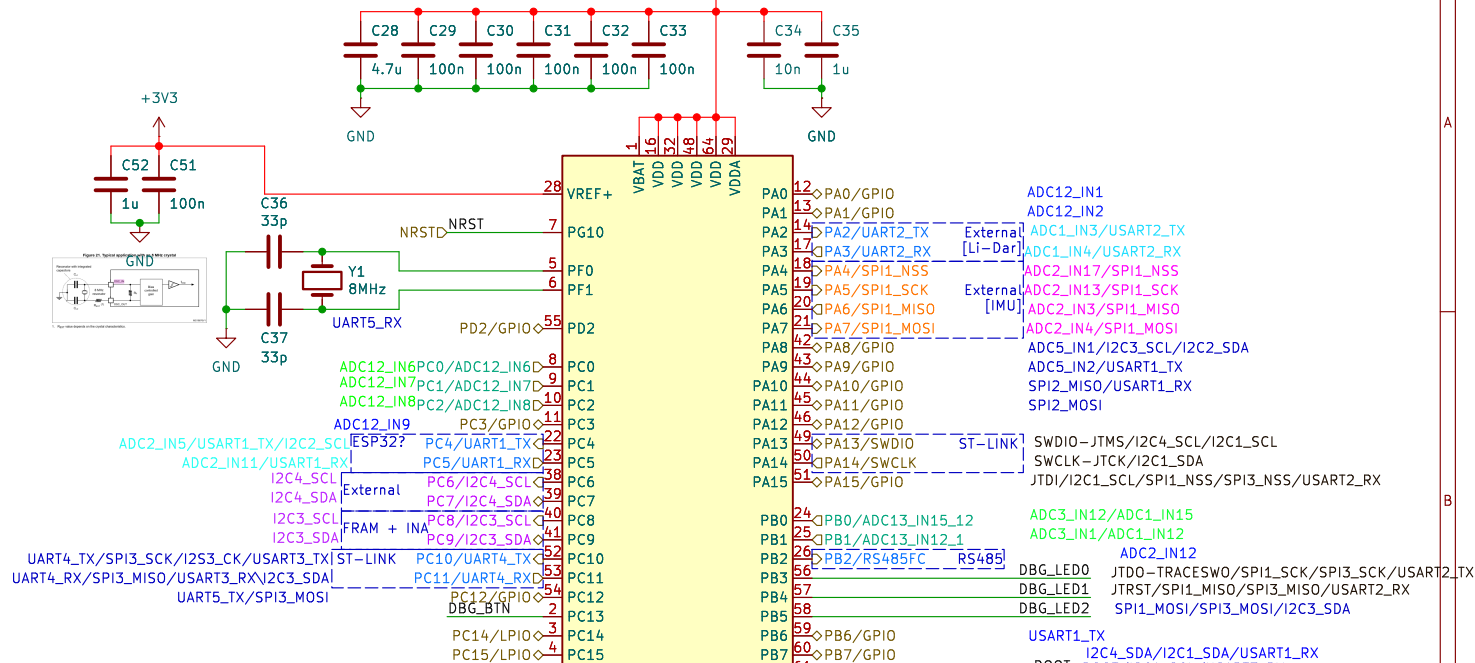
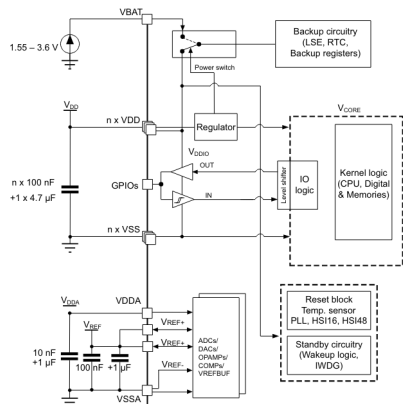
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**Title: uMule\_board**

Size: A4  
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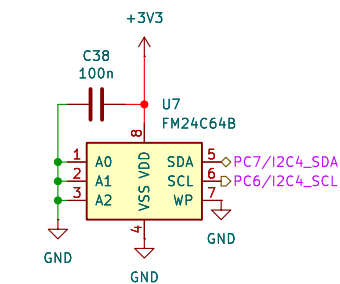
Rev: 1.0  
 Id: 2/14

Dodać więcej kondensatorów, spróbować przenieść piny na lepszą STMkę

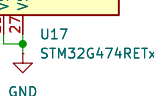
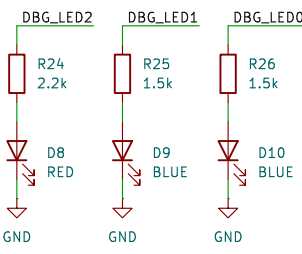
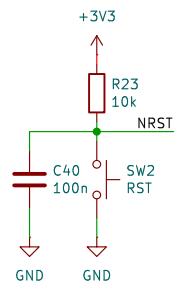
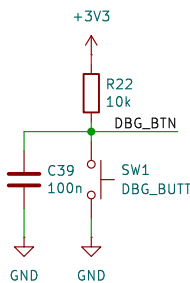
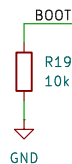


- PC13, PC14 and PC15 are supplied through the power switch. Since the switch only sinks a limited amount of current (3 mA), the use of GPIOs PC13 to PC15 in output mode is limited.
  - The speed should not exceed 2 MHz with a maximum load of 30 pF
  - These GPIOs must not be used as current sources (e.g. to drive an LED).
- After a backup domain power-up, PC13, PC14 and PC15 operate as GPIOs. Their function then depends on the content of the RTC registers which are not reset by the system reset. For details on how to manage these GPIOs, refer to the Backup domain and RTC register descriptions in the reference manual RM0449 "STM32G4 Series advanced Arm®-based 32-bit MCUs".

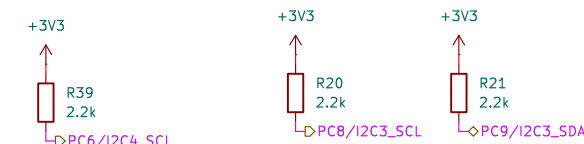
FRAM



ADDR: 0b1010000 0x50



New cortex (STM32G474RET6) :  
<https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.st.com>



Original author: Oliwier Woźniak

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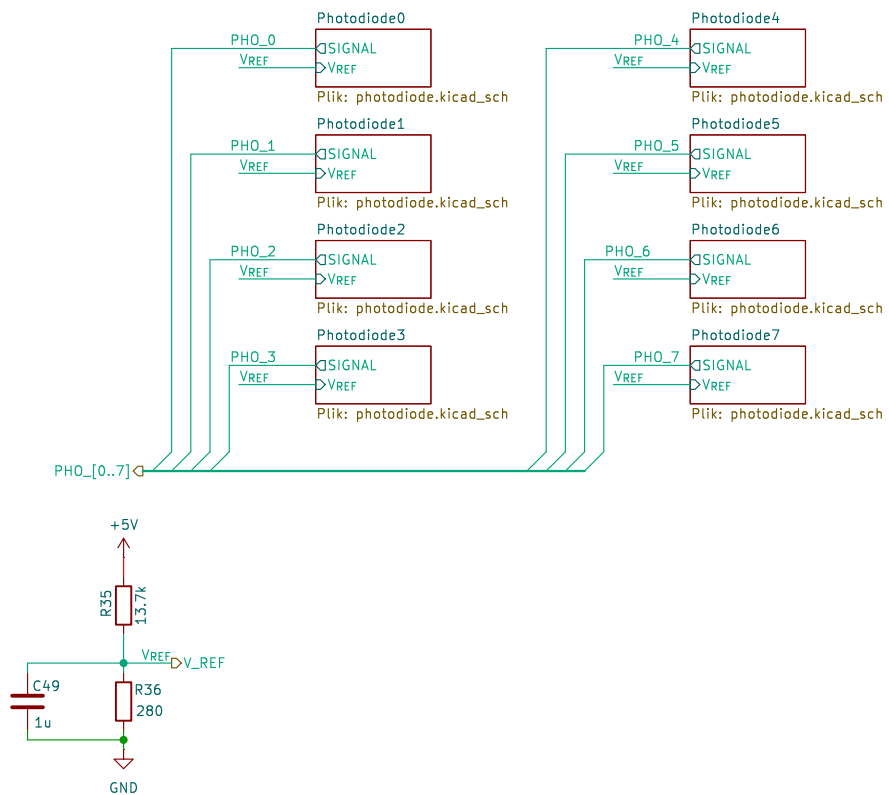
Title: uMule\_board

Size: A4 Date: 2025-12-14

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Rev: 1.0

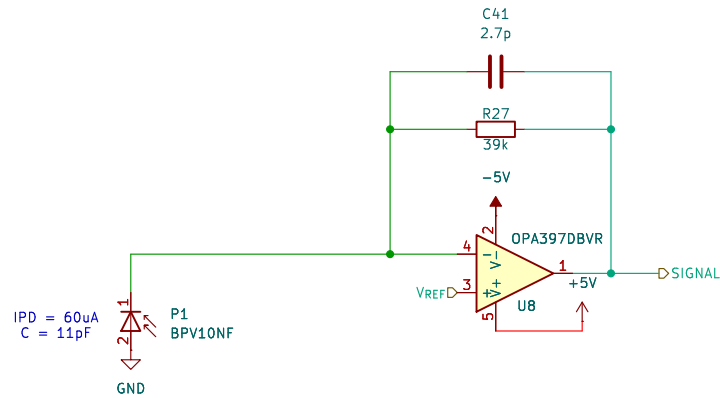
Id: 3/14



Original author: Oliwier Woźniak		
Sheet: /Photodiodes/ File: photodiodes_all.kicad_sch		
<b>Title: uMule_board</b>		
Size: A4	Date: 2025-12-14	Rev: 1.0
KiCad E.D.A. 9.0.7	Id: 21/14	

Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$



IPD = 60uA  
C = 11pF  
GND

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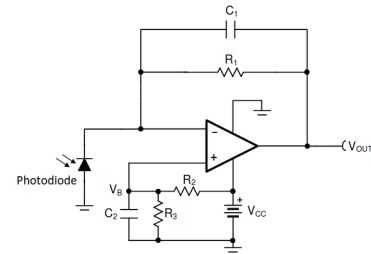


Figure 4: A bias voltage is applied to the op amp's non-inverting input to prevent saturation at the negative power supply

The output transfer function including the bias voltage is:

$$V_{OUT} = I_{PD}R_1 + V_B = I_{PD}R_1 + V_{CC}\frac{R_3}{R_3 + R_2} \quad (2)$$

## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

Original author: Oliwier Woźniak

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File: photodiode.kicad\_sch

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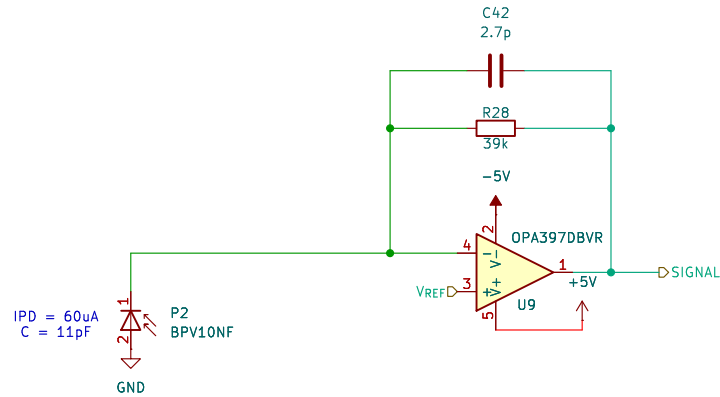
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**Rev: 1.0**

Id: 4/14

Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$



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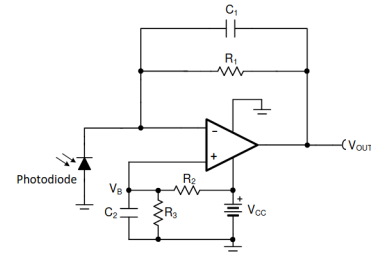


Figure 4: A bias voltage is applied to the op amp's non-inverting input to prevent saturation at the negative power supply

The output transfer function including the bias voltage is:

$$V_{OUT} = I_{PD}R_1 + V_B = I_{PD}R_1 + V_{CC}\frac{R_3}{R_3 + R_2} \quad (2)$$

## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

Original author: Oliwier Woźniak

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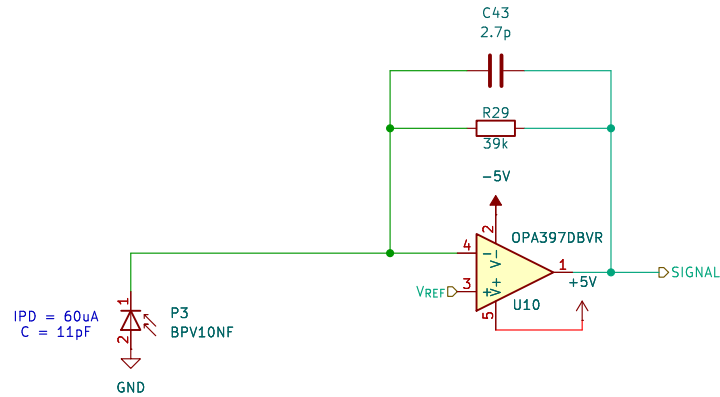
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Id: 5/14

Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$



IPD = 60uA  
C = 11pF  
GND

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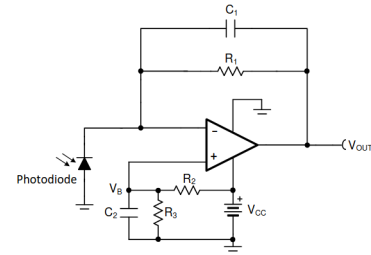


Figure 4: A bias voltage is applied to the op amp's non-inverting input to prevent saturation at the negative power supply

The output transfer function including the bias voltage is:

$$V_{OUT} = I_{PD}R_1 + V_B = I_{PD}R_1 + V_{CC}\frac{R_3}{R_3 + R_2} \quad (2)$$

## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

Original author: Oliwier Woźniak

Sheet: /Photodiodes/Photodiode2/  
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**Title: uMule\_board**

Size: A4 Date: 2025-12-14

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**Rev: 1.0**

Id: 6/14

Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$

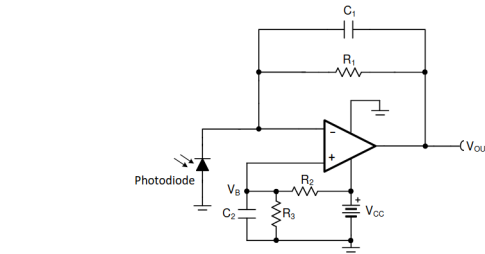
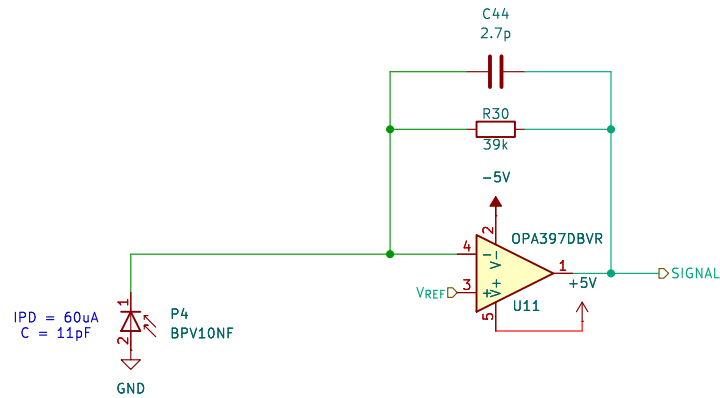


Figure 4: A bias voltage is applied to the op amp's non-inverting input to prevent saturation at the negative power supply

The output transfer function including the bias voltage is:

$$V_{OUT} = I_{PD}R_1 + V_B = I_{PD}R_1 + V_{CC}\frac{R_3}{R_3 + R_2} \quad (2)$$

## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

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Original author: Oliwier Woźniak

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Size: A4 Date: 2025-12-14

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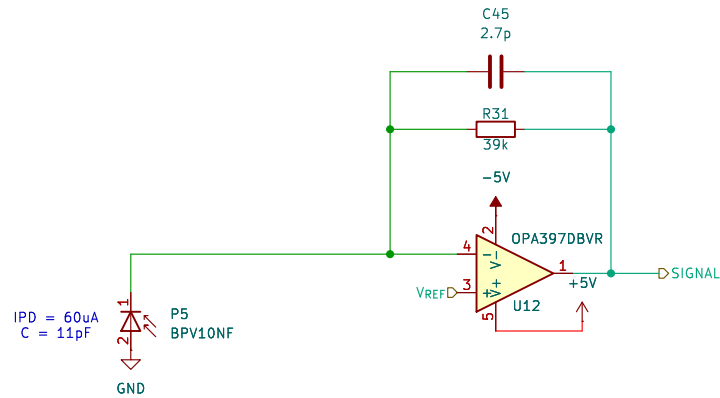
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Id: 7/14



Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$



IPD = 60uA  
C = 11pF  
P5 BPV10NF  
GND

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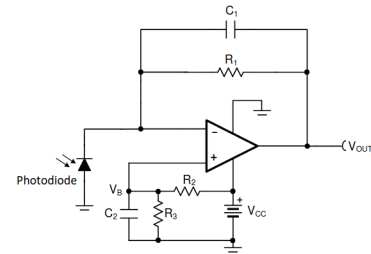


Figure 4: A bias voltage is applied to the op amp's non-inverting input to prevent saturation at the negative power supply

The output transfer function including the bias voltage is:

$$V_{OUT} = I_{PD}R_1 + V_B = I_{PD}R_1 + V_{CC}\frac{R_3}{R_3 + R_2} \quad (2)$$

## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

Original author: Oliwier Woźniak

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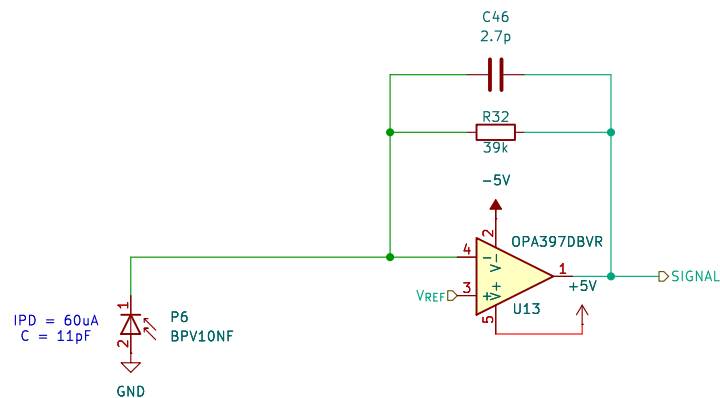
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Id: 8/14

Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$



IPD = 60uA  
C = 11pF

GND

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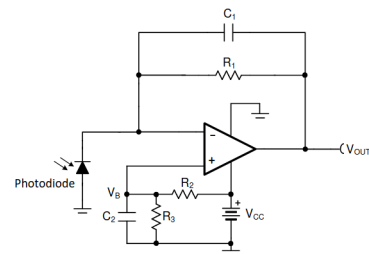


Figure 4: A bias voltage is applied to the op amp's non-inverting input to prevent saturation at the negative power supply

The output transfer function including the bias voltage is:

$$V_{OUT} = I_{PD}R_1 + V_B = I_{PD}R_1 + V_{CC}\frac{R_3}{R_3 + R_2} \quad (2)$$

## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

Original author: Oliwier Woźniak

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File: photodiode.kicad\_sch

**Title: uMule\_board**

Size: A4 Date: 2025-12-14

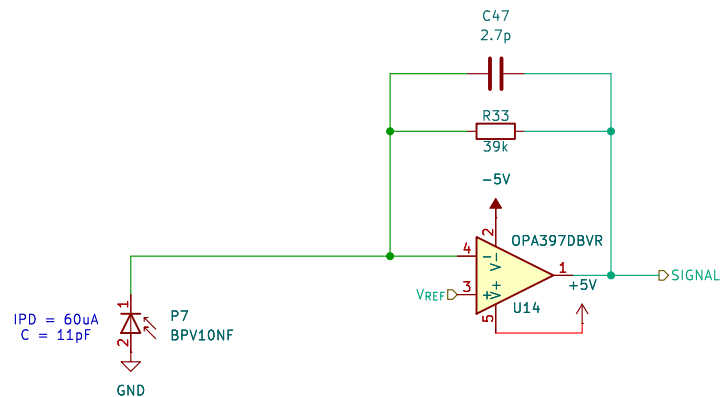
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**Rev: 1.0**

Id: 9/14

Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$



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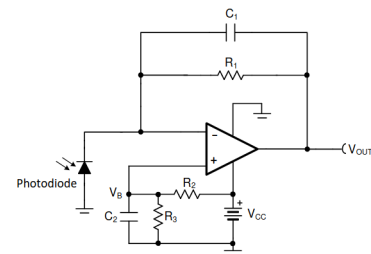


Figure 4: A bias voltage is applied to the op amp's non-inverting input to prevent saturation at the negative power supply

The output transfer function including the bias voltage is:

$$V_{OUT} = I_{PD}R_1 + V_B = I_{PD}R_1 + V_{CC}\frac{R_3}{R_3 + R_2} \quad (2)$$

## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

Original author: Oliwier Woźniak

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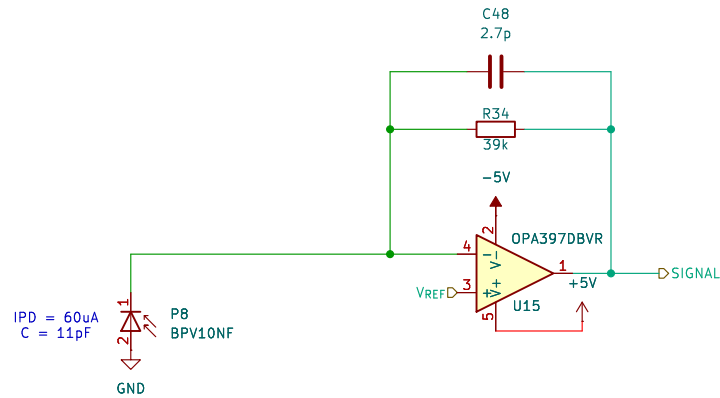
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Id: 10/14

Można zastanowić się nad zmianą wartości rezystora R1, ale to po zmianie procka i sprawdzeniu czy będzie działać. Obecnie jest zakres 0.1V–2.4V (chyba)

$$\frac{V_{OUT(MAX)} - V_{OUT(MIN)}}{I_{IN(MAX)}} = R_1 \rightarrow \frac{4.9V - .1V}{90\mu A} = 53333.3\Omega \rightarrow 53.6k\Omega$$



IPD = 60uA  
C = 11pF

GND

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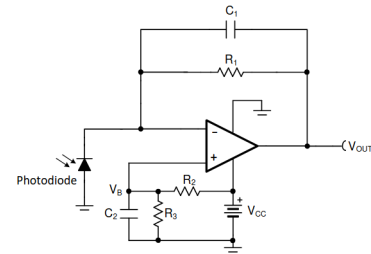


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The output transfer function including the bias voltage is:

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## KEY OPA128 SPECIFICATIONS

Bias current ..... 75fA max  
Offset voltage ..... 500μV max  
Drift ..... 5μV/°C max  
Noise ..... 15nV/√Hz at 10kHz

Original author: Oliwier Woźniak

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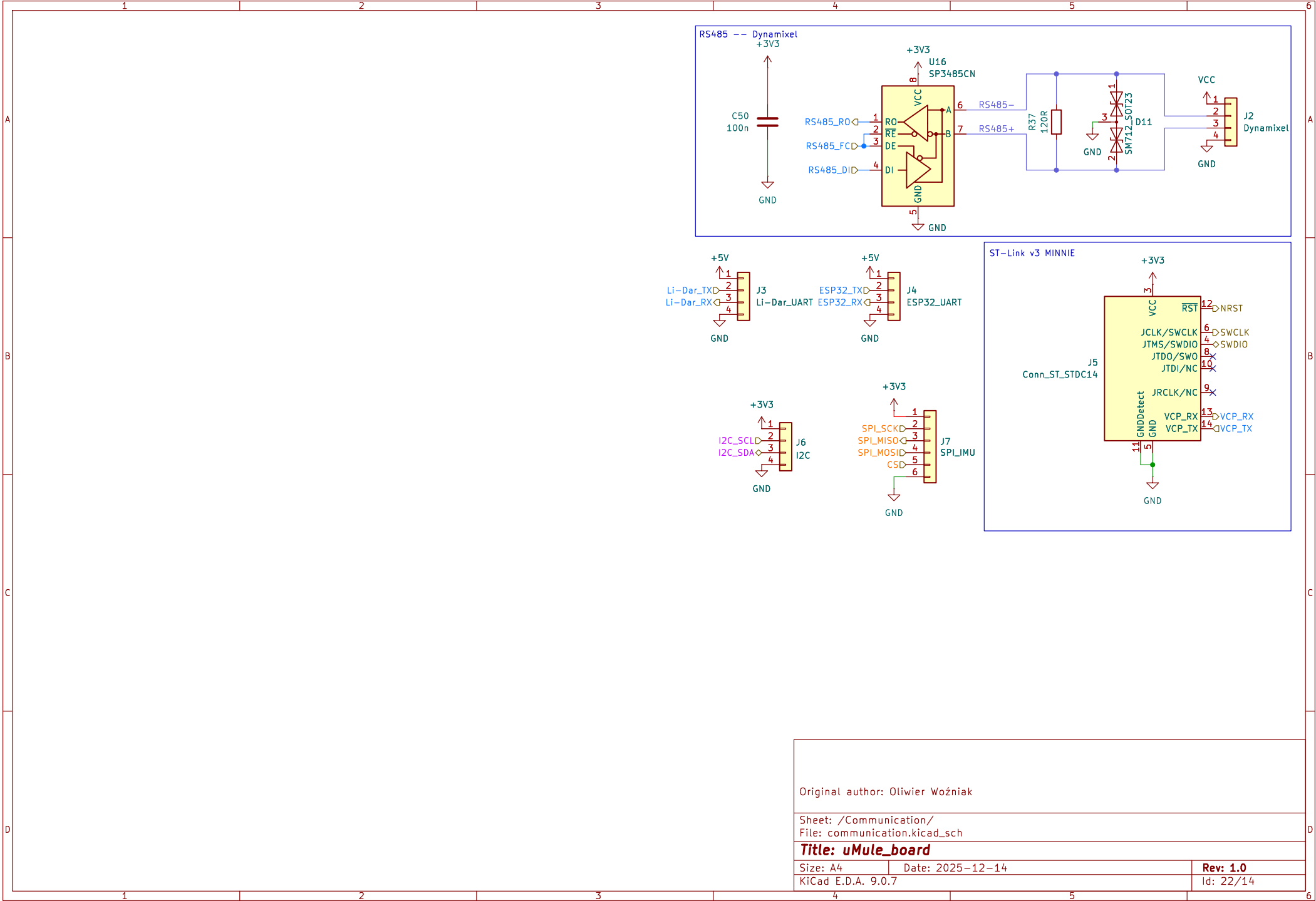
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Size: A4 Date: 2025-12-14

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**Rev: 1.0**

Id: 11/14



Original author: Oliwier Woźniak

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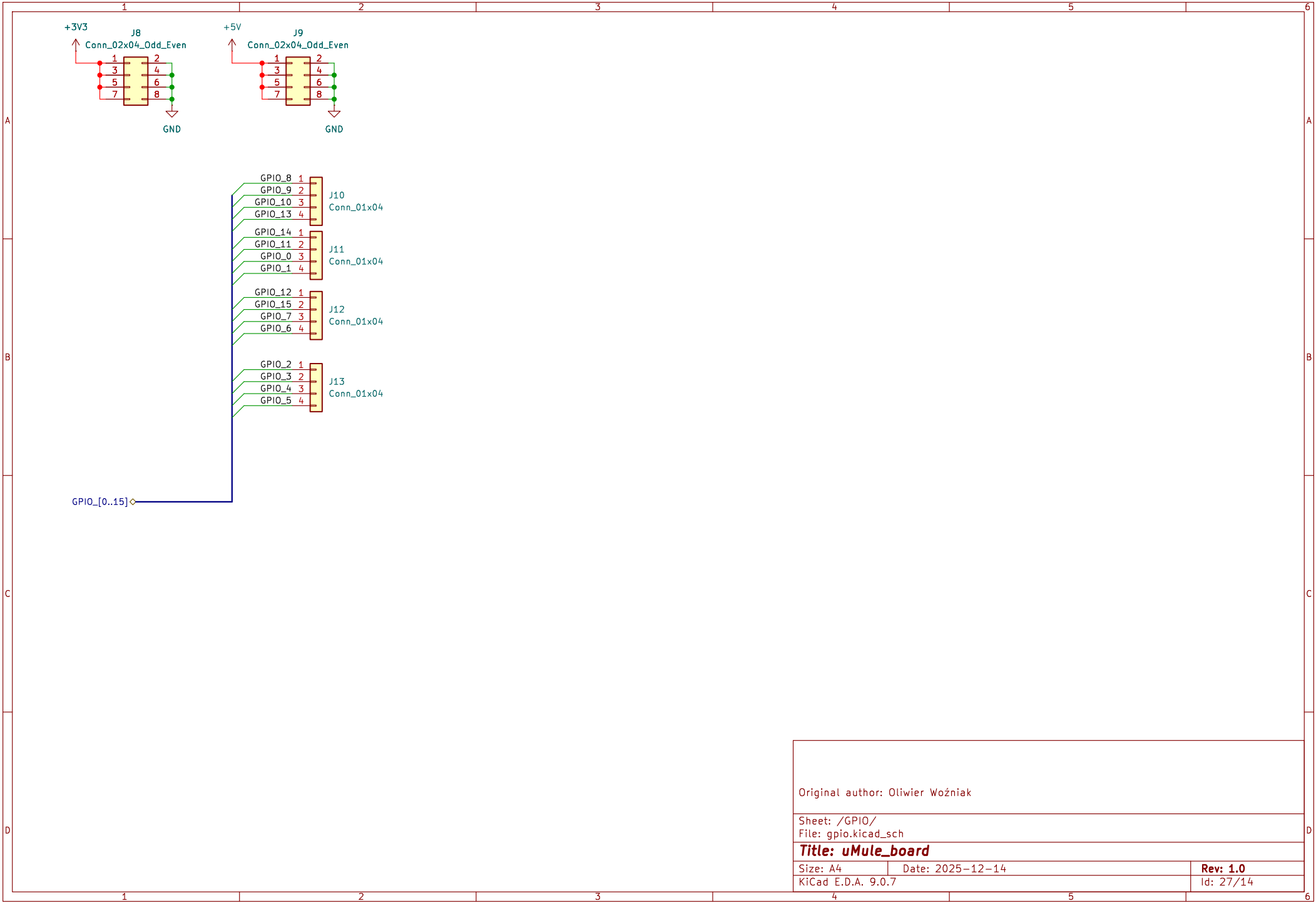
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Id: 22/14



Original author: Oliwier Woźniak

Sheet: /GPIO/  
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**Title: uMule\_board**

Size: A4 Date: 2025-12-14

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**Rev: 1.0**

Id: 27/14