

**ADC Reference is 4.096V**

$$V_{out} = V * R_1 / (R_1 + R_2)$$

$$4.096V = 5V * R_1 / (R_1 + R_2)$$

$$0.8192 = R_1 / (R_1 + R_2)$$

$$0.8192 * R_1 + 0.8192 * R_2 = R_1$$

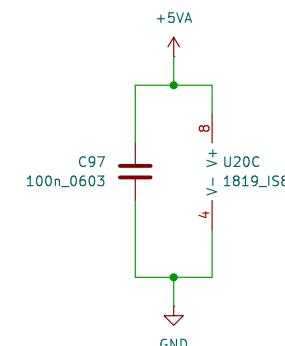
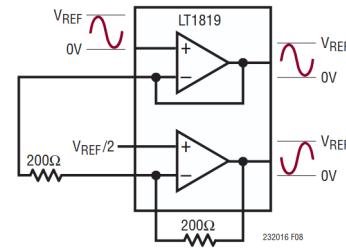
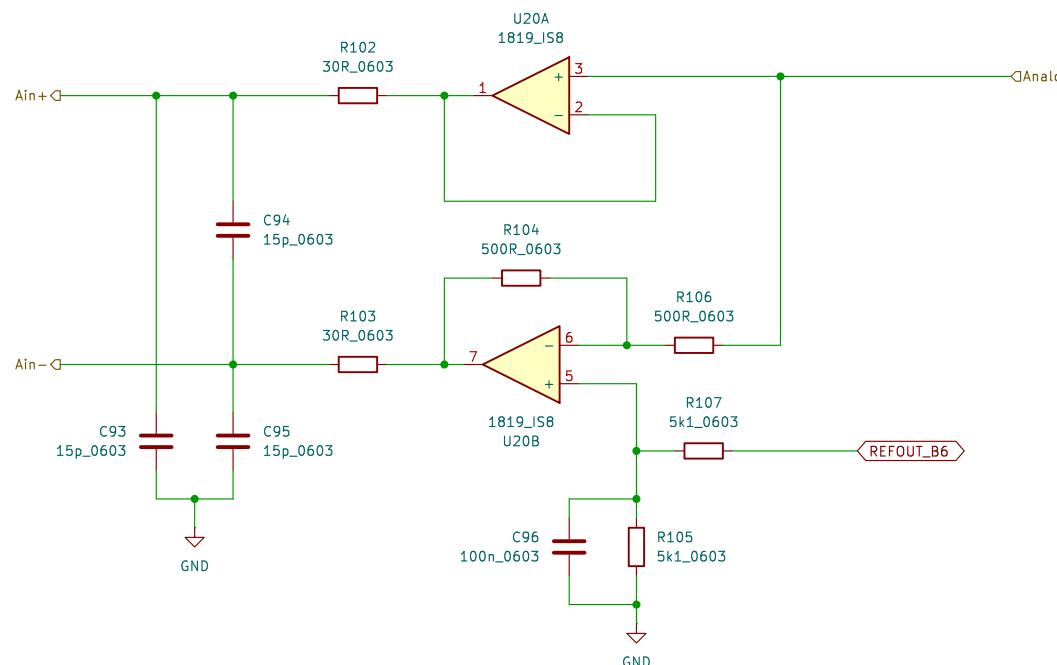
$$0.1808 * R_1 = 0.8192 * R_2$$

$$R_1 / R_2 = 4.53097$$

$R_1 := 9.1k \parallel 9.1k = 4.55k$   
 $R_2 = 1k$   
 $R_1/R_2 = 4.55$

$V_{out\_max} = 5V * 4.55 / 5.55 = 4.099V$   
 $\rightarrow$  very little saturation

Single ended to differential for B6



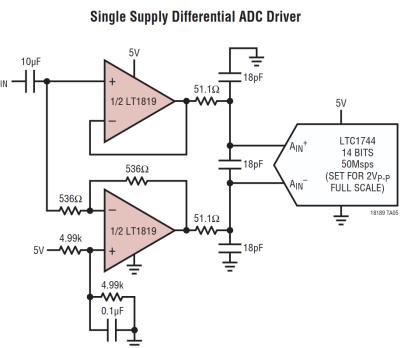
Sheet: /ADC for B6/Diffamp\_2/  
File: diffamp\_.kicad\_sch

**Title:**

Size: A4 | Date:

KiCad E.D.A. 9.0.6

**Rev:**  
Id: 20/50



**ADC Reference is 4.096V**

$$V_{out} = V * R_1 / (R_1 + R_2)$$

$$4.096V = 5V * R_1 / (R_1 + R_2)$$

$$0.8192 = R_1 / (R_1 + R_2)$$

$$0.8192 * R_1 + 0.8192 * R_2 = R_1$$

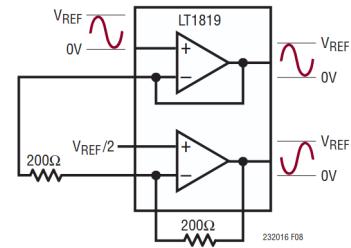
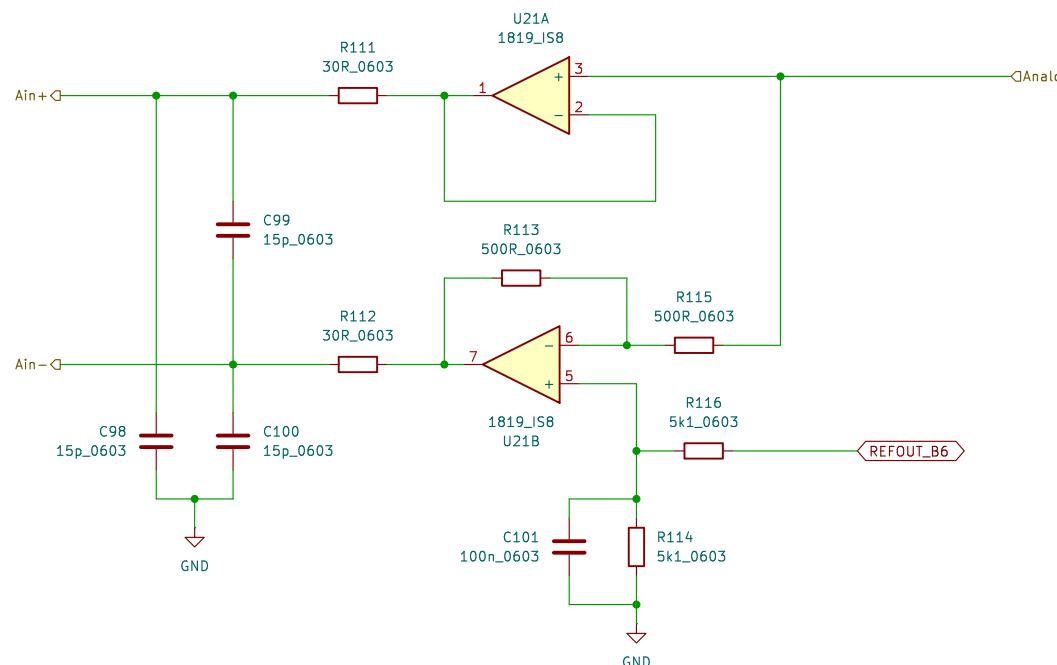
$$0.1808 * R_1 = 0.8192 * R_2$$

$$R_1 / R_2 = 4.53097$$

$R_1 := 9.1k \parallel 9.1k = 4.55k$   
 $R_2 = 1k$   
 $R_1/R_2 = 4.55$

$V_{out\_max} = 5V * 4.55 / 5.55 = 4.099V$   
 $\rightarrow$  very little saturation

Single ended to differential for B6



Sheet: /ADC for B6/Diffamp\_3/  
File: diffamp\_.kicad\_sch

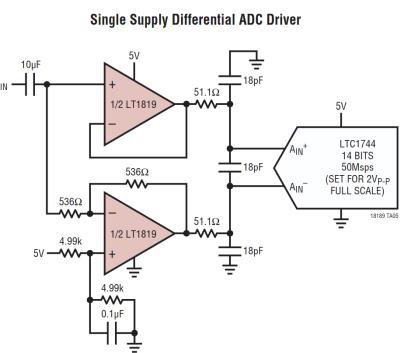
**Title:**

Size: A4 | Date:

KiCad E.D.A. 9.0.6

**Rev:**

Id: 21/50



**ADC Reference is 4.096V**

$$V_{out} = V * R_1 / (R_1 + R_2)$$

$$4.096V = 5V * R_1 / (R_1 + R_2)$$

$$0.8192 = R_1 / (R_1 + R_2)$$

$$0.8192 * R_1 + 0.8192 * R_2 = R_1$$

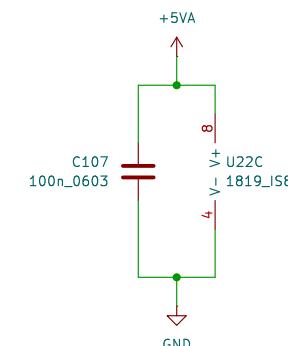
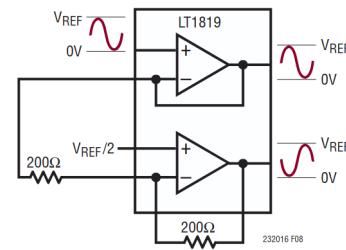
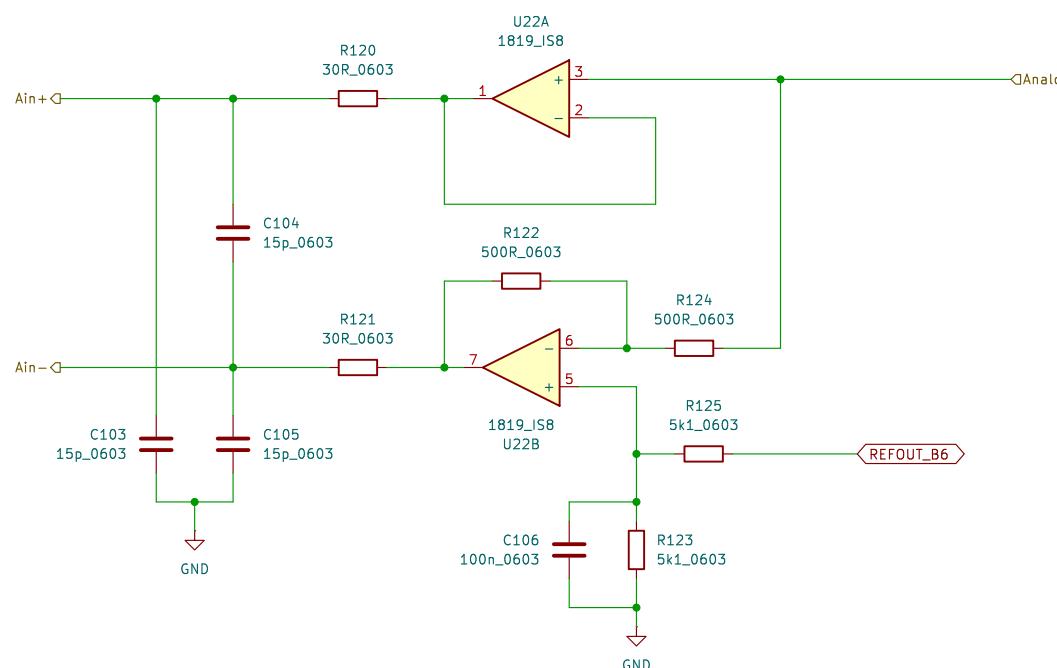
$$0.1808 * R_1 = 0.8192 * R_2$$

$$R_1 / R_2 = 4.53097$$

$R_1 := 9.1k \parallel 9.1k = 4.55k$   
 $R_2 = 1k$   
 $R_1/R_2 = 4.55$

$V_{out\_max} = 5V * 4.55 / 5.55 = 4.099V$   
 $\rightarrow$  very little saturation

Single ended to differential for B6

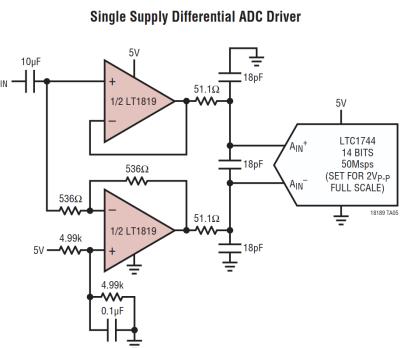


Sheet: /ADC for B6/Diffamp\_4/  
File: diffamp\_.kicad\_sch

**Title:**

Size: A4 Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 22/50



**ADC Reference is 4.096V**

$$V_{out} = V * R_1 / (R_1 + R_2)$$

$$4.096V = 5V * R_1 / (R_1 + R_2)$$

$$0.8192 = R_1 / (R_1 + R_2)$$

$$0.8192 * R_1 + 0.8192 * R_2 = R_1$$

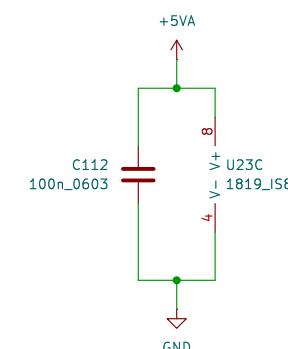
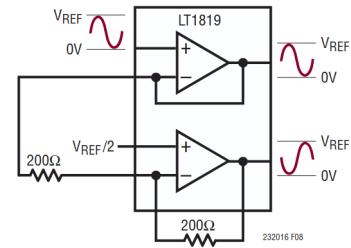
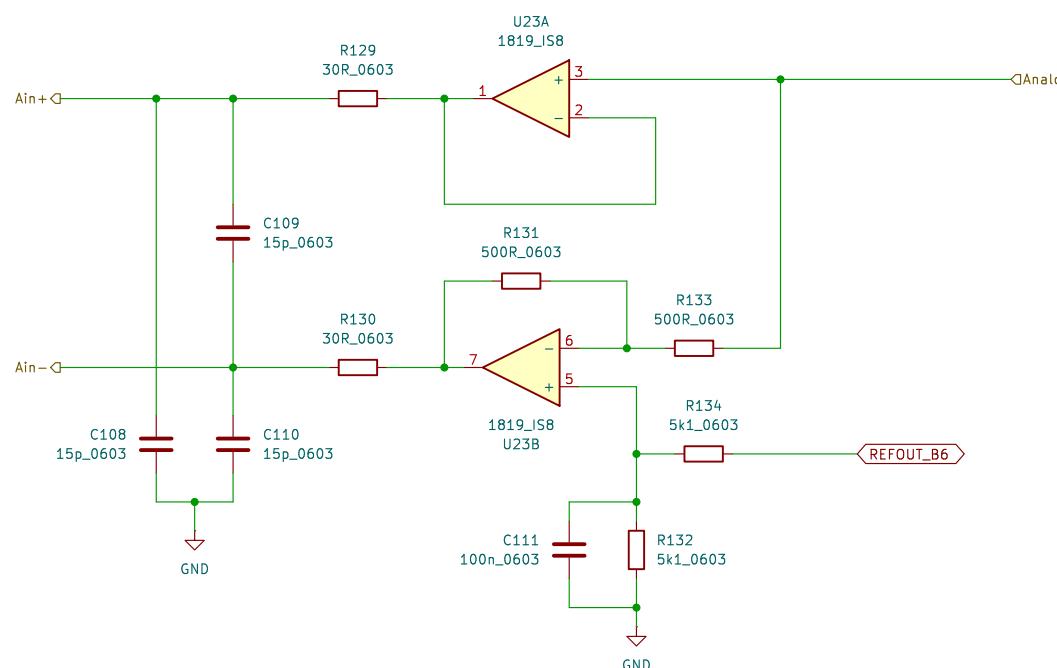
$$0.1808 * R_1 = 0.8192 * R_2$$

$$R_1 / R_2 = 4.53097$$

$R_1 := 9.1k \parallel 9.1k = 4.55k$   
 $R_2 = 1k$   
 $R_1/R_2 = 4.55$

$V_{out\_max} = 5V * 4.55 / 5.55 = 4.099V$   
 $\rightarrow$  very little saturation

Single ended to differential for B6

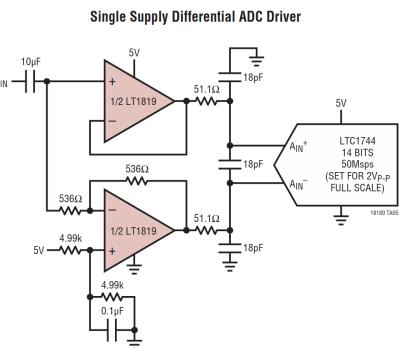


Sheet: /ADC for B6/Diffamp\_5/  
File: diffamp\_.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 23/50



**ADC Reference is 4.096V**

$$V_{out} = V * R_1 / (R_1 + R_2)$$

$$4.096V = 5V * R_1 / (R_1 + R_2)$$

$$0.8192 = R_1 / (R_1 + R_2)$$

$$0.8192 * R_1 + 0.8192 * R_2 = R_1$$

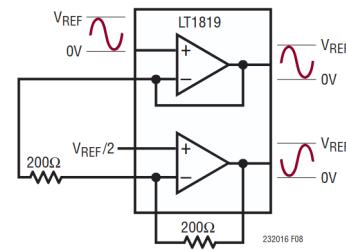
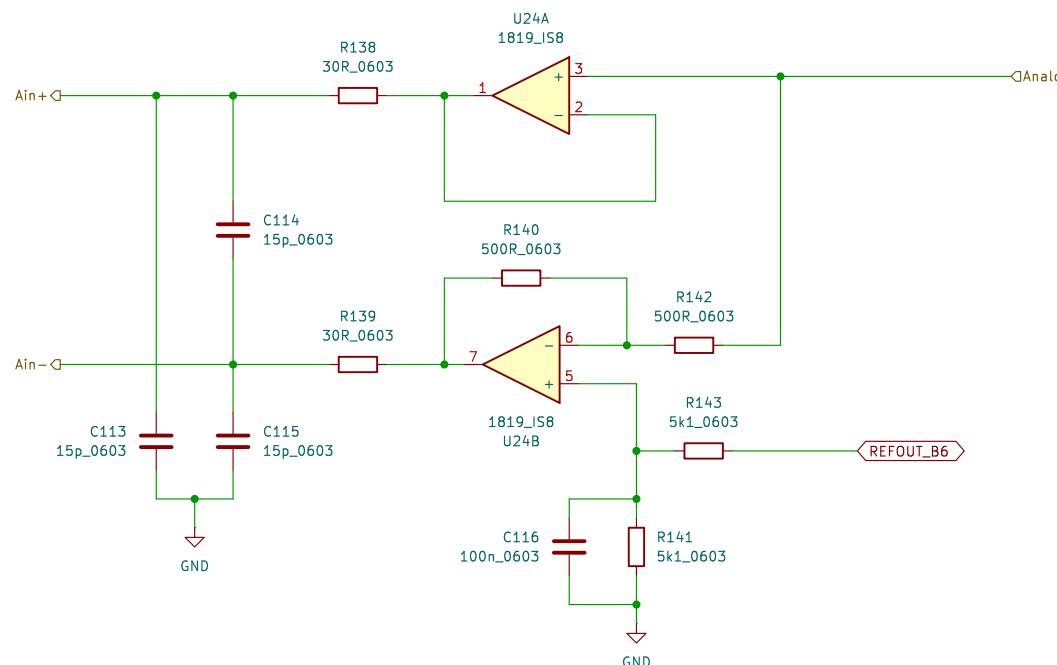
$$0.1808 * R_1 = 0.8192 * R_2$$

$$R_1 / R_2 = 4.53097$$

$R_1 := 9.1k \parallel 9.1k = 4.55k$   
 $R_2 = 1k$   
 $R_1/R_2 = 4.55$

$V_{out\_max} = 5V * 4.55 / 5.55 = 4.099V$   
 $\rightarrow$  very little saturation

Single ended to differential for B6



Sheet: /ADC for B6/Diffamp\_6/  
File: diffamp\_.kicad\_sch

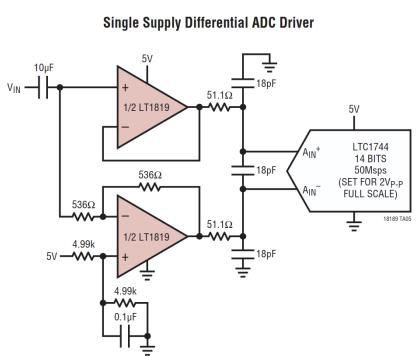
**Title:**

Size: A4 | Date:

KiCad E.D.A. 9.0.6

**Rev:**

Id: 24/50



**ADC Reference is 4.096V**

$$V_{out} = V * R_1 / (R_1 + R_2)$$

$$4.096V = 5V * R_1 / (R_1 + R_2)$$

$$0.8192 = R_1 / (R_1 + R_2)$$

$$0.8192 * R_1 + 0.8192 * R_2 = R_1$$

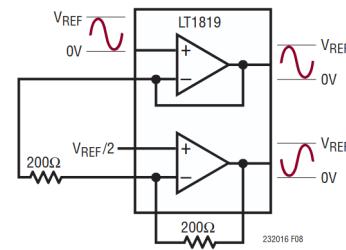
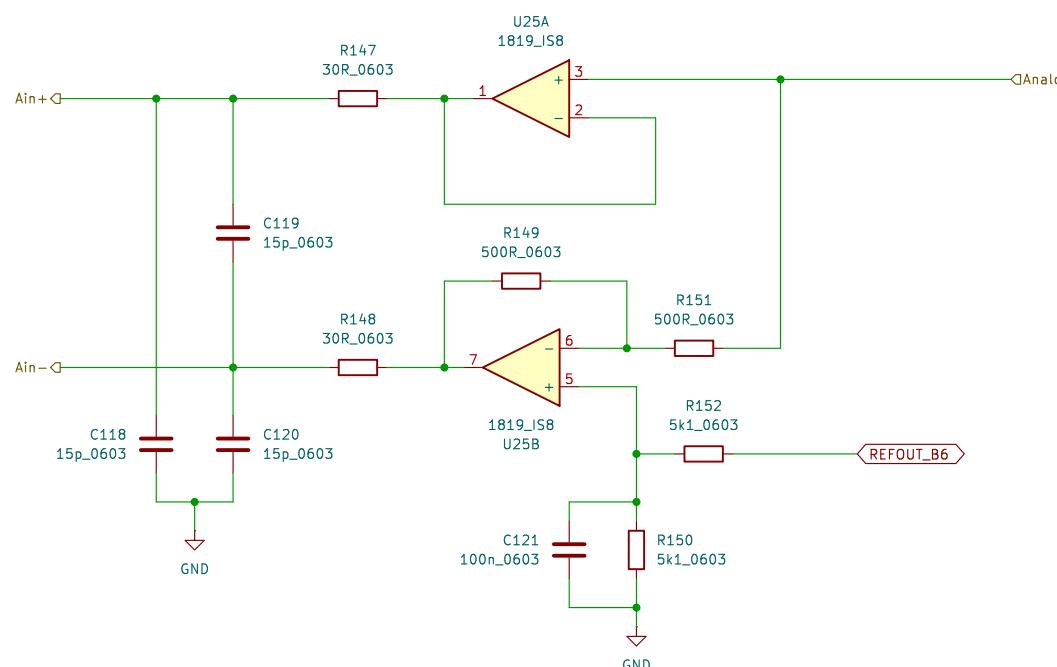
$$0.1808 * R_1 = 0.8192 * R_2$$

$$R_1 / R_2 = 4.53097$$

$R_1 := 9.1k \parallel 9.1k = 4.55k$   
 $R_2 = 1k$   
 $R_1/R_2 = 4.55$

$V_{out\_max} = 5V * 4.55 / 5.55 = 4.099V$   
 $\rightarrow$  very little saturation

Single ended to differential for B6



Sheet: /ADC for B6/Diffamp\_7/  
File: diffamp\_.kicad\_sch

**Title:**

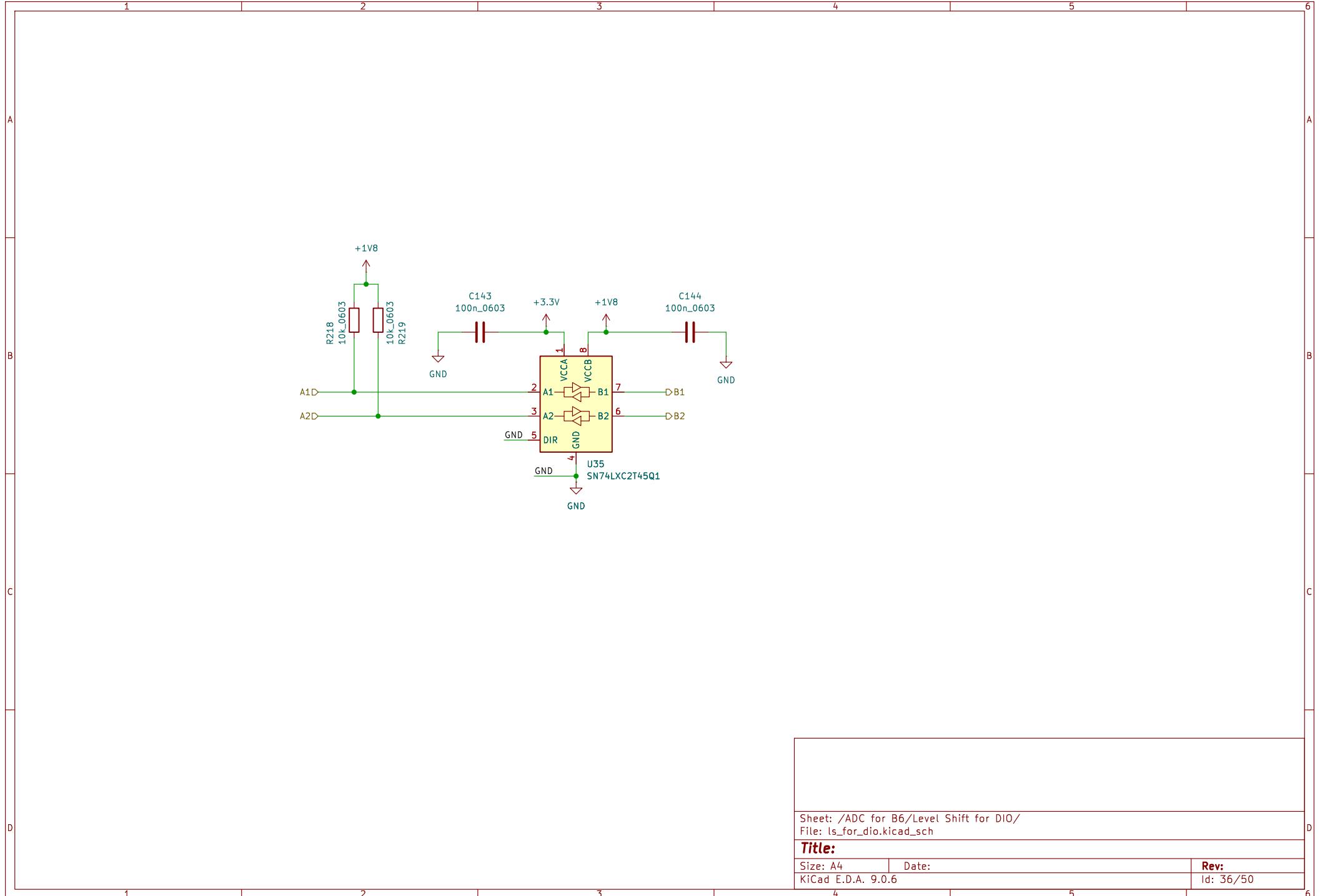
Size: A4 | Date:

KiCad E.D.A. 9.0.6

**Rev:**

Id: 25/50

1 2 3 4 5 6



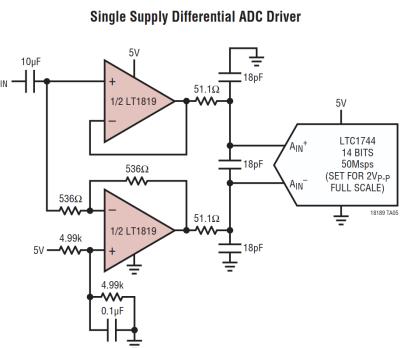
Sheet: /ADC for B6/Level Shift for DIO/  
File: ls\_for\_dio.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 36/50

1 2 3 4 5 6



**ADC Reference is 4.096V**

$$V_{out} = V * R_1 / (R_1 + R_2)$$

$$4.096V = 5V * R_1 / (R_1 + R_2)$$

$$0.8192 = R_1 / (R_1 + R_2)$$

$$0.8192 * R_1 + 0.8192 * R_2 = R_1$$

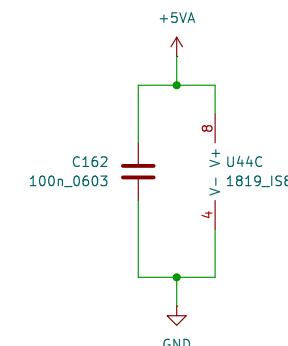
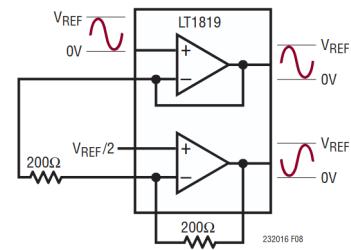
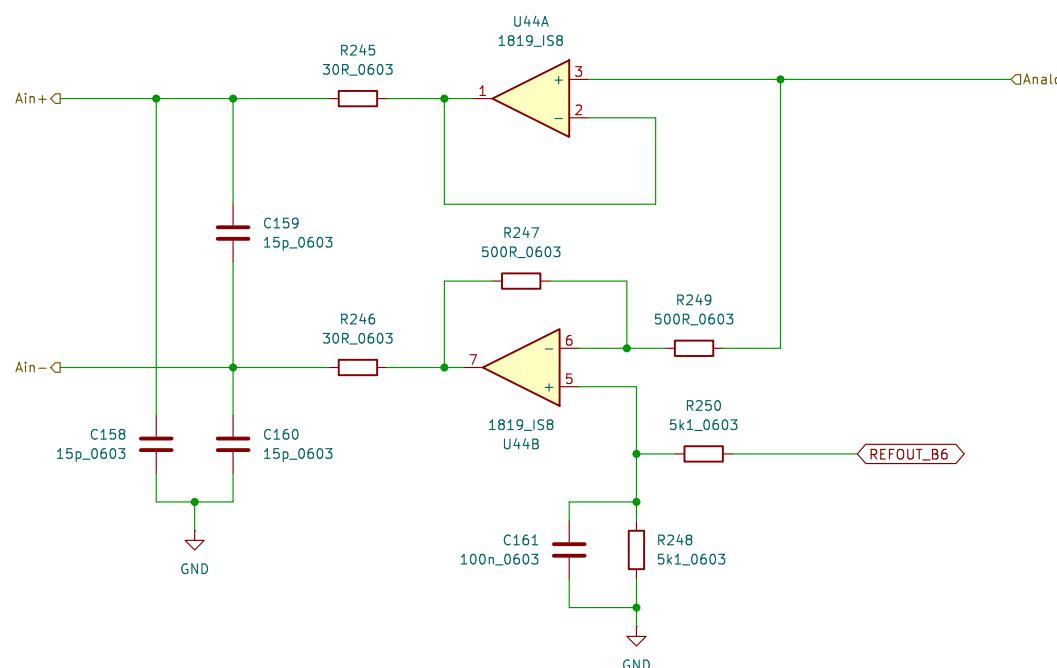
$$0.1808 * R_1 = 0.8192 * R_2$$

$$R_1 / R_2 = 4.53097$$

$R_1 := 9.1k \parallel 9.1k = 4.55k$   
 $R_2 = 1k$   
 $R_1/R_2 = 4.55$

$V_{out\_max} = 5V * 4.55 / 5.55 = 4.099V$   
 $\rightarrow$  very little saturation

Single ended to differential for B6



Sheet: /ADC for B6/Diffamp\_1/  
File: diffamp\_.kicad\_sch

**Title:**

Size: A4 | Date:

KiCad E.D.A. 9.0.6

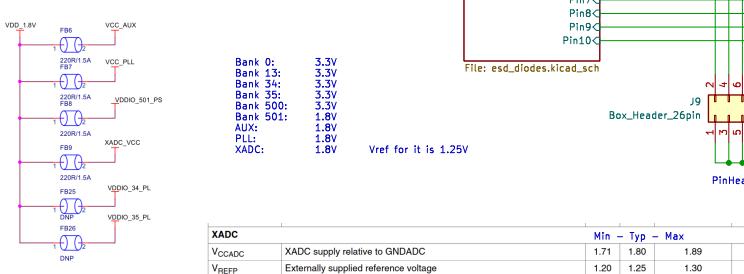
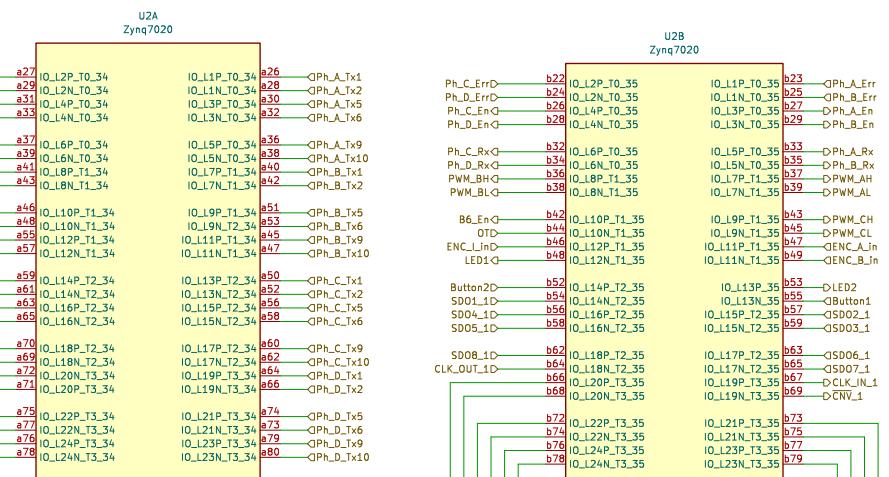
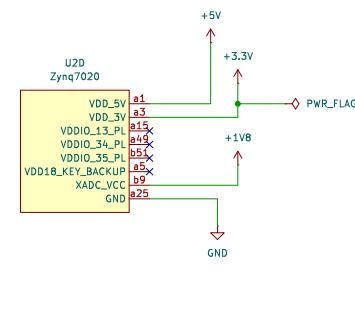
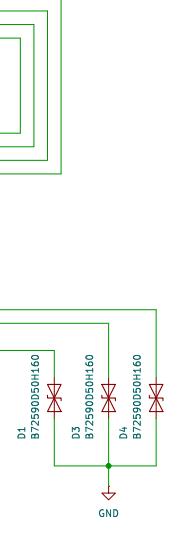
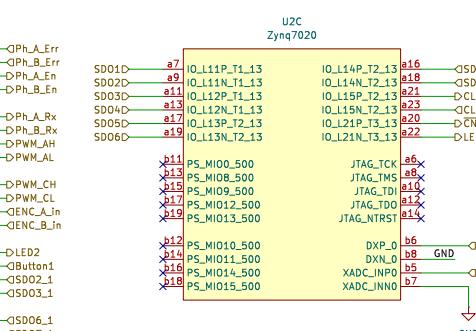
**Rev:**  
Id: 50/50

Table 1: Absolute Maximum Ratings<sup>(1)</sup> (Cont'd)

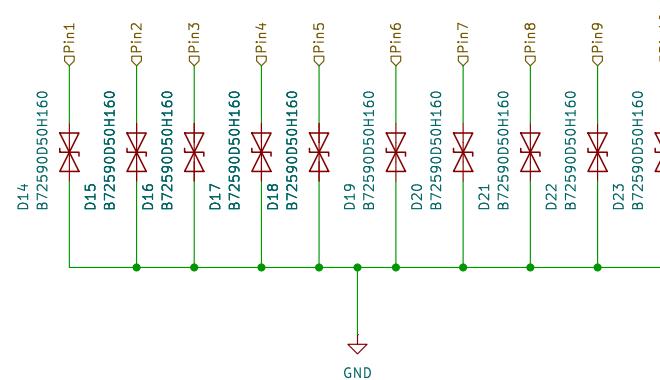
Symbol	Description	Min	Max	Units
V <sub>IN</sub> <sup>(3)(4)(5)</sup>	I/O input voltage for HR I/O banks	-0.40	V <sub>CCO</sub> + 0.55	V
	I/O input voltage (when V <sub>CCO</sub> = 3.3V) for V <sub>REF</sub> and differential I/O standards except TMDS_33 <sup>(6)</sup>	-0.40	2.625	V
V <sub>CCBATT</sub>	Key memory battery backup supply	-0.5	2.0	V

Bank 13: Total 12 pins -> ADC (11pins)  
 Bank 34: Total 48 pins -> Tx Phase A,B,C,D (48 pins)  
 Bank 35: Total 48 pins -> B6 (8pins) + CHB En/Err/Rx (12pins)  
 + User Interactions (5 pins) + ADC\_Machine (11pin) + encoder (3pins)  
 XADC: 2 Pins

Free pins left: 10

Source: <https://docs.amd.com/v/u/en-US/ds187-XC7Z010-XC7Z020-Data-Sheet>

Sheet: /FPGA/  
 File: fpga.kicad\_sch  
**Title:**  
 Size: A3 Date:  
 KiCad E.D.A. 9.0.6 Rev:  
 Id: 3/50



Sheet: /FPGA/esd\_diodes/  
File: esd\_diodes.kicad\_sch

**Title:**

Size: A4 Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 49/50

A

A

B

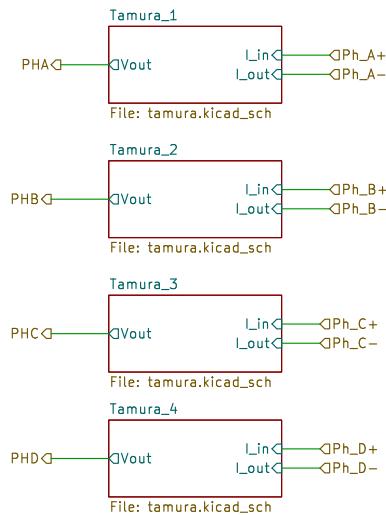
B

C

C

D

D



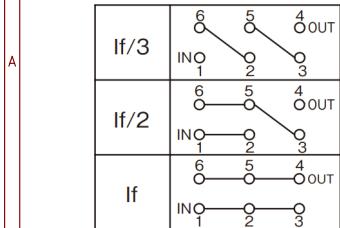
Sheet: /Current measure/  
File: current\_measure.kicad\_sch

**Title:**

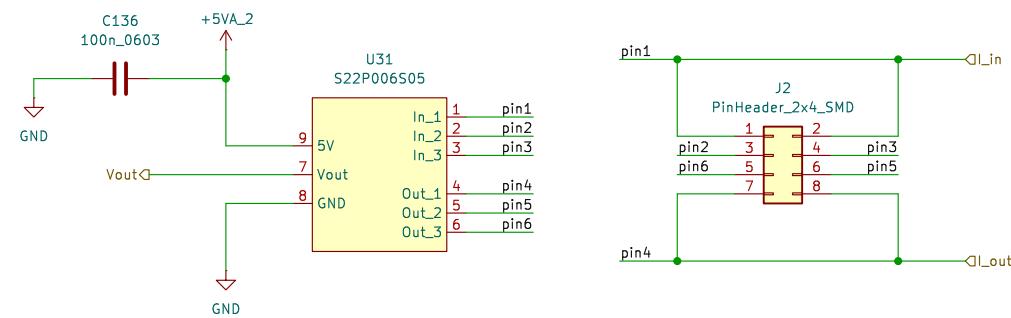
Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 4/50

1 2 3 4 5 6



If for S22P006S05 is 6A



Sheet: /Current measure/Tamura\_2/  
File: tamura.kicad\_sch

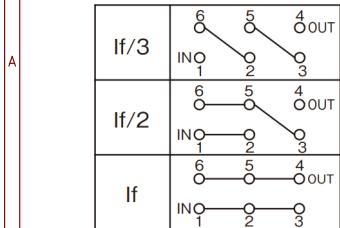
**Title:**

Size: A4 Date:  
KiCad E.D.A. 9.0.6

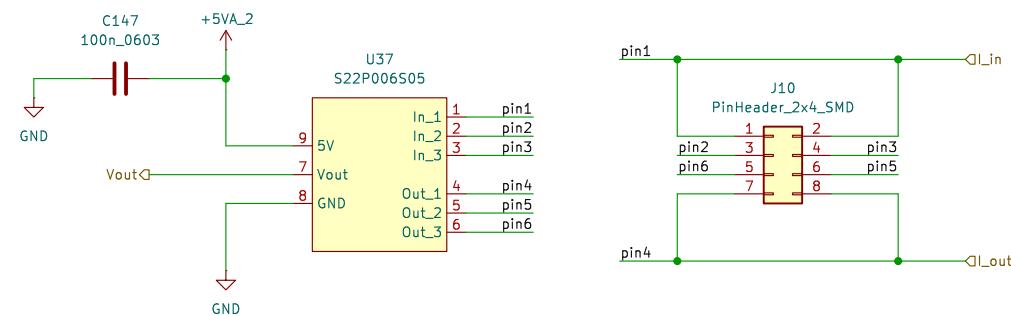
Rev:  
Id: 32/50

1 2 3 4 5 6

1 2 3 4 5 6



If for S22P006S05 is 6A



Sheet: /Current measure/Tamura\_3/  
File: tamura.kicad\_sch

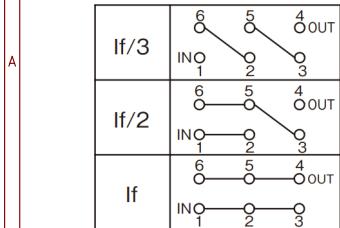
**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

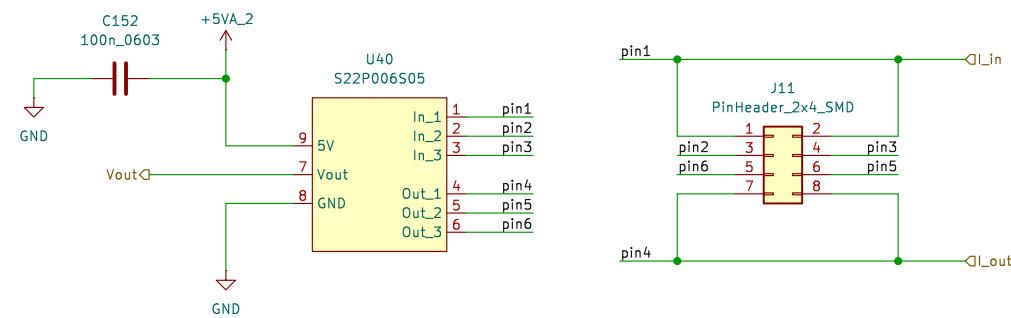
Rev:  
Id: 38/50

1 2 3 4 5 6

1 2 3 4 5 6



If for S22P006S05 is 6A



Sheet: /Current measure/Tamura\_4/  
File: tamura.kicad\_sch

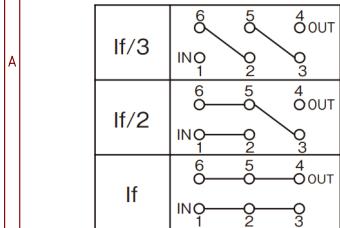
**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

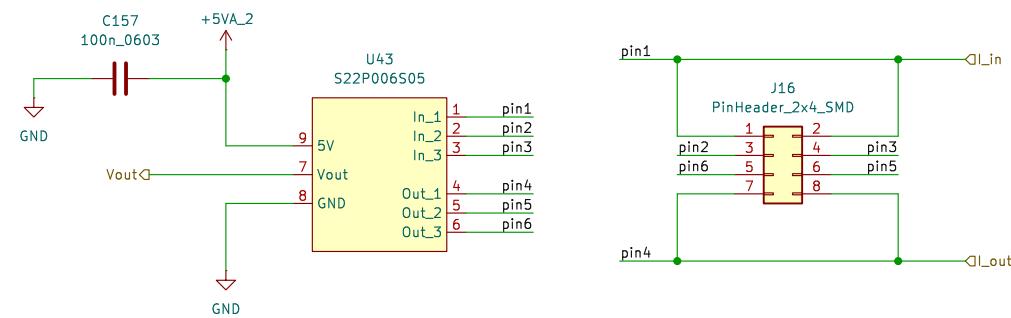
Rev:  
Id: 41/50

1 2 3 4 5 6

1 2 3 4 5 6



If for S22P006S05 is 6A



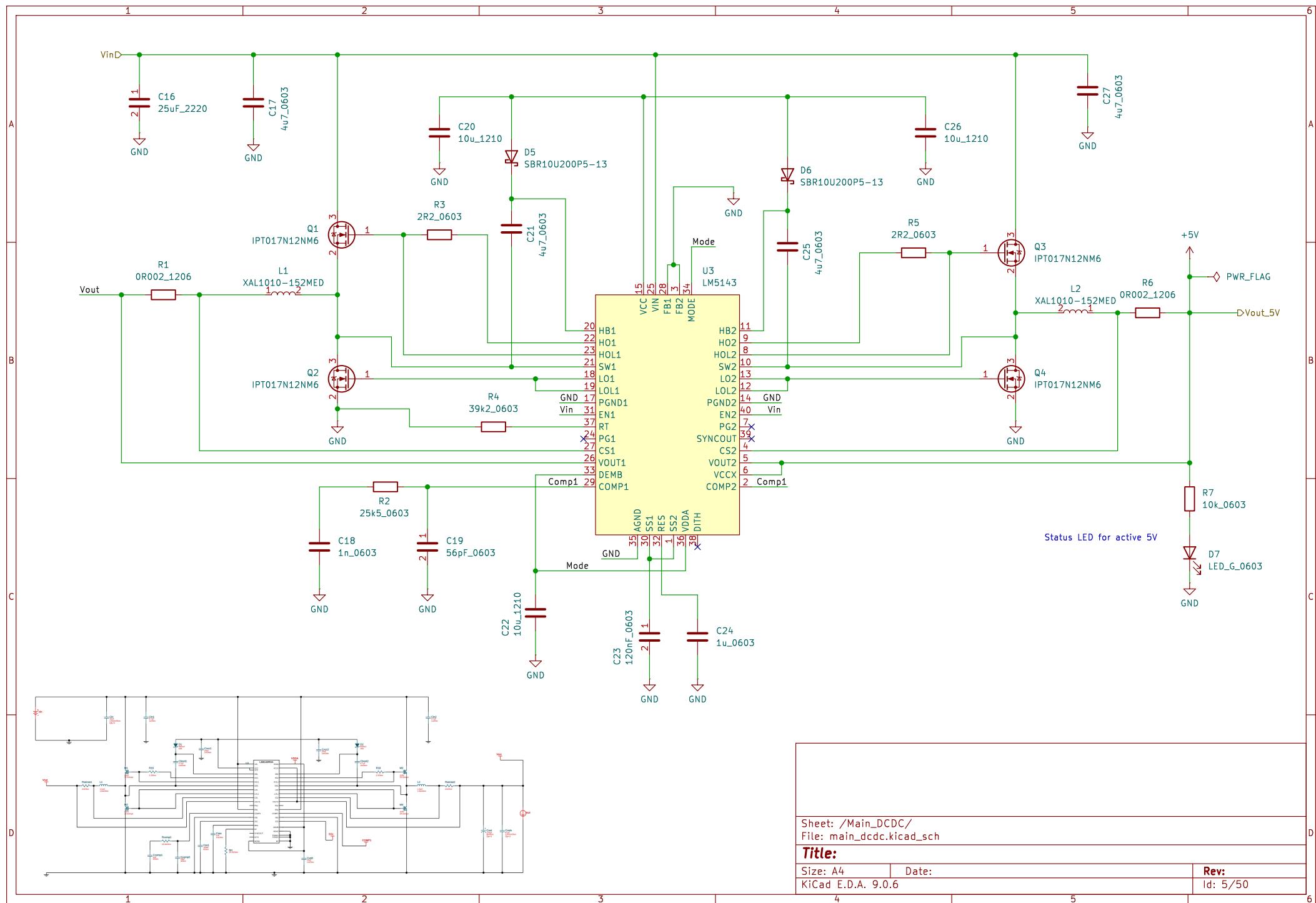
Sheet: /Current measure/Tamura\_1/  
File: tamura.kicad\_sch

**Title:**

Size: A4 Date:  
KiCad E.D.A. 9.0.6

Rev:  
Id: 45/50

1 2 3 4 5 6



1 2 3 4 5 6

A

A

B

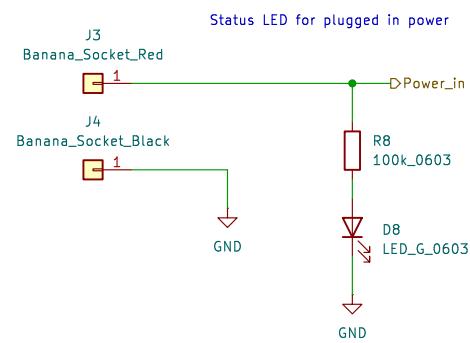
B

C

C

D

D



Sheet: /Connectors/  
File: connectors.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 6/50

1 2 3 4 5 6

A

B

C

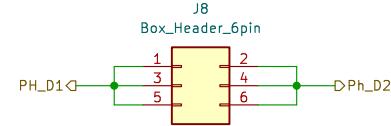
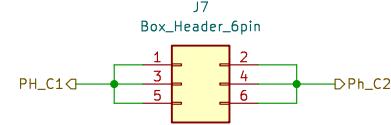
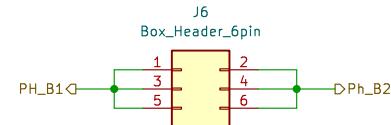
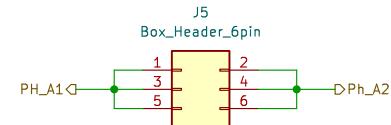
D

A

B

C

D

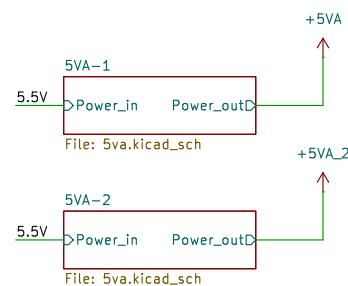
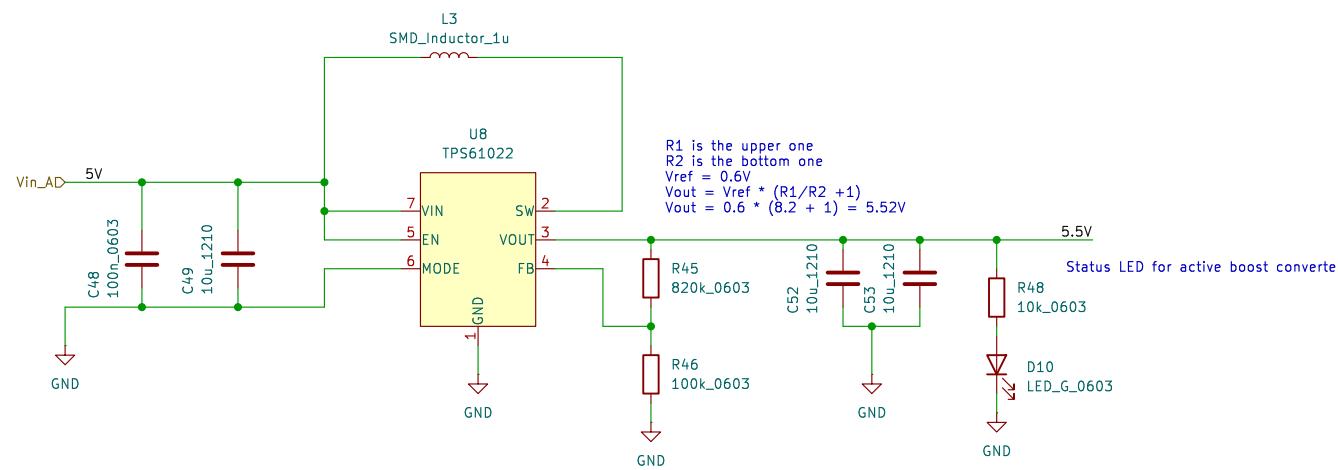
**Wannenstecker für CHB outputs**

Sheet: /Power from CHB/  
File: power\_from\_chb.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 7/50



Driven loads:  
 - Tamura Current Sensor  
 (4x, typ:12.5mA, max:37.5mA)  
 - HV-Probe (4x, TILV197 typ:1mA)  
 - ADC (2x, typ: 31mA)  
 - OpAmp for ADC (16x, Typ:9mA)  
 - Potentiometer (2x, max:1.5mA)

Sum:  
 Maximal Current:

50mA – 150mA  
 4mA  
 62mA  
 144mA  
 3mA  
 263mA – 363mA  
 250mA

Sheet: /Analog Voltage/  
 File: analog\_voltage.kicad\_sch

**Title:**

Size: A4 | Date:  
 KiCad E.D.A. 9.0.6

Rev:  
 Id: 12/50

1 2 3 4 5 6

A

A

B

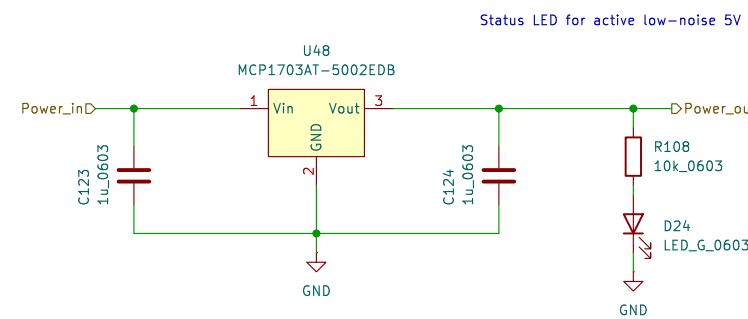
B

C

C

D

D



Sheet: /Analog Voltage/5VA-2/  
File: 5va.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 26/50

1 2 3 4 5 6

1 2 3 4 5 6

A

A

B

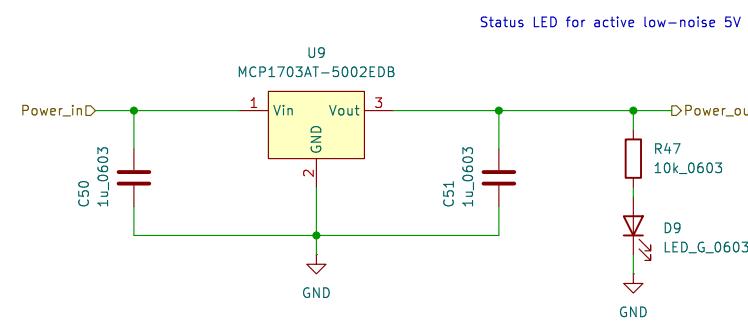
B

C

C

D

D



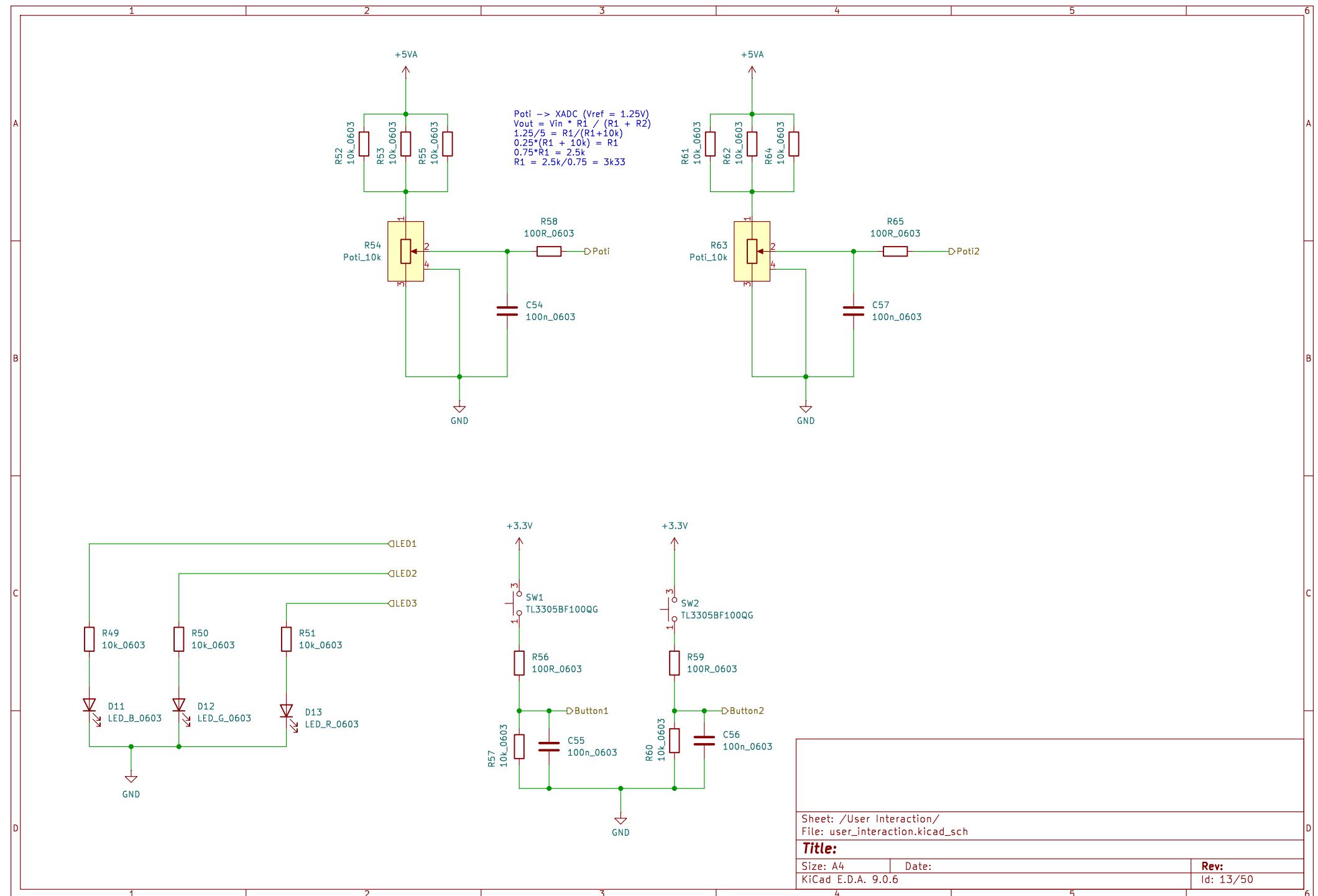
Sheet: /Analog Voltage/5VA-1/  
File: 5va.kicad\_sch

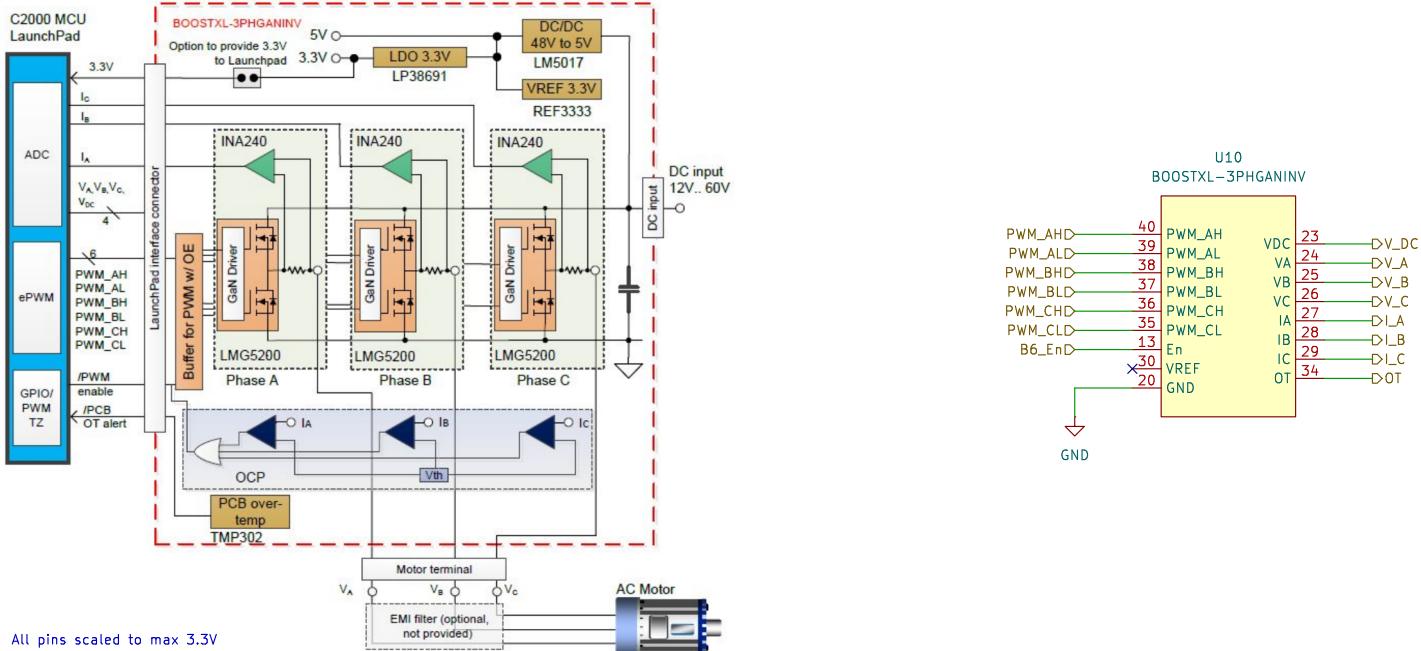
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Size: A4 | Date:  
KiCad E.D.A. 9.0.6

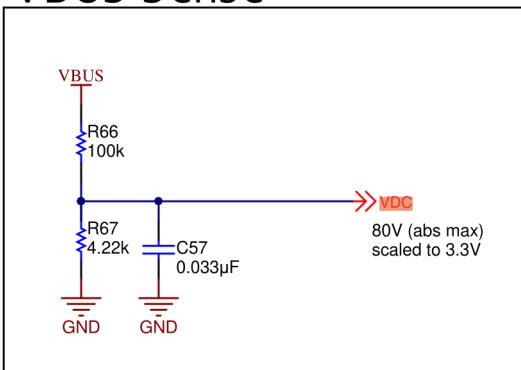
**Rev:**  
Id: 49/50

1 2 3 4 5 6





## VBUS Sense



Sheet: /TI-B6/  
File: ti\_b6.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 13/50

A

A

B

B

C

C

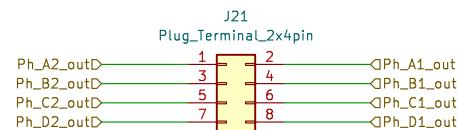
D

D

**To get a Star Configuration**

Connect A2 – B2 – C2 – D2 together (shorted)  
 Connect Electrical Machine to A1-B1-C1-D1

A1: Phase A  
 B1: Phase B  
 C1: Phase C  
 D1: Star Point

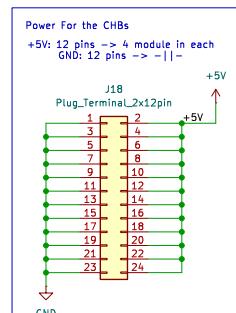
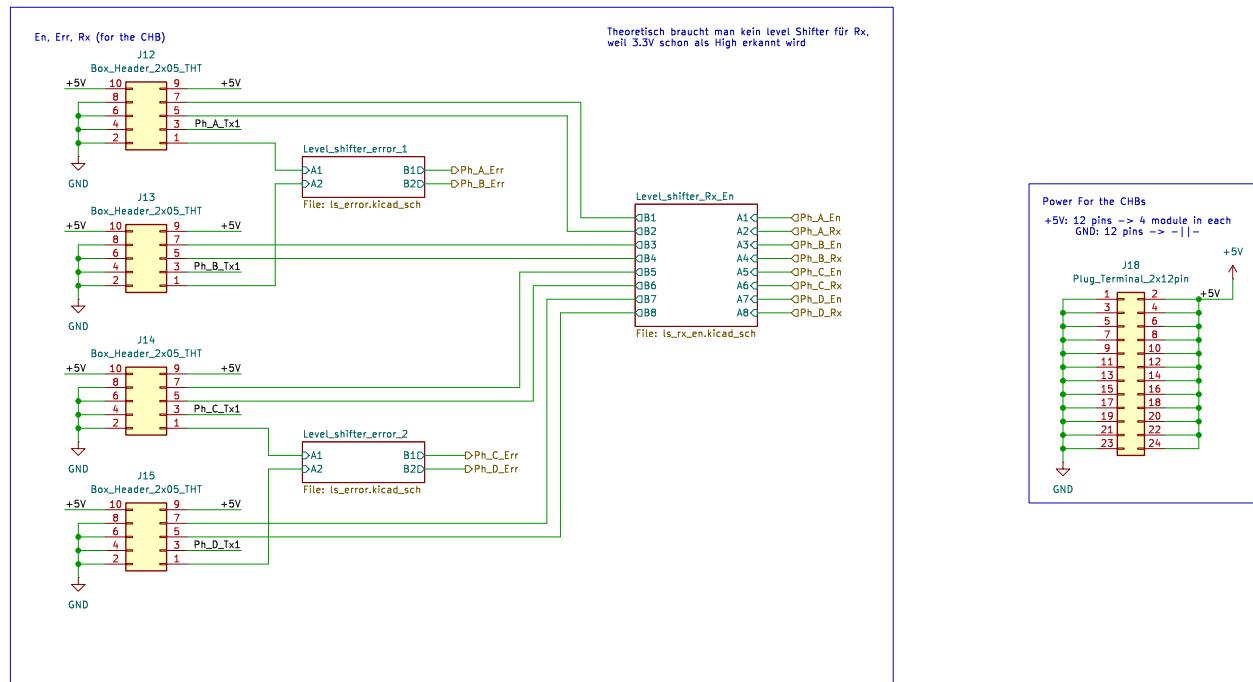
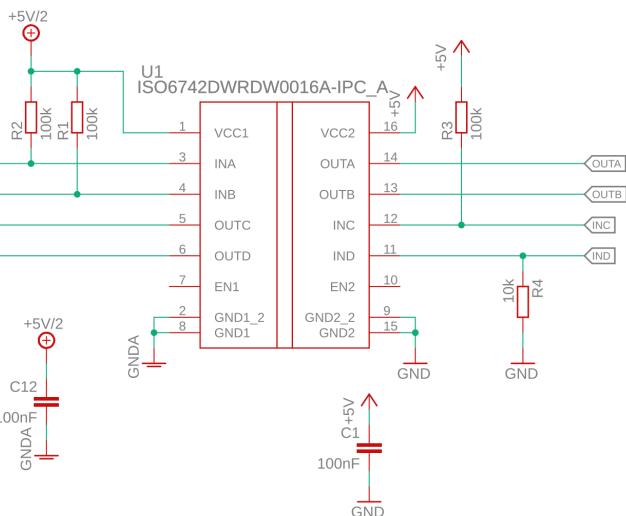
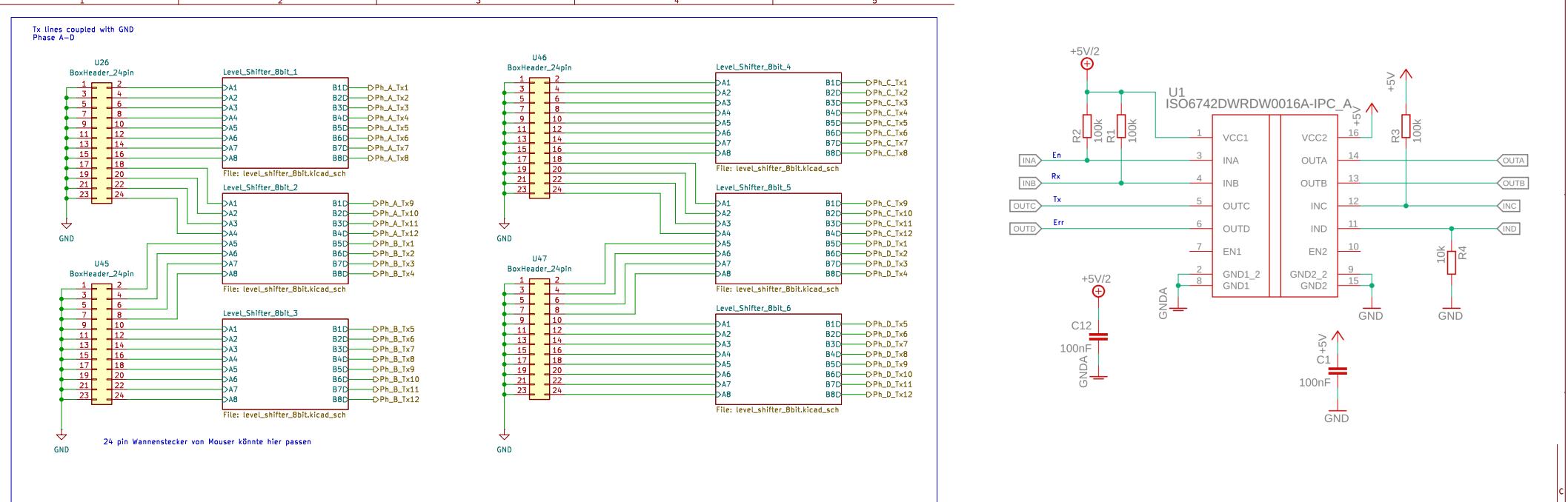


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**Title:**

Size: A4 | Date:  
 KiCad E.D.A. 9.0.6

**Rev:**  
 Id: 13/50

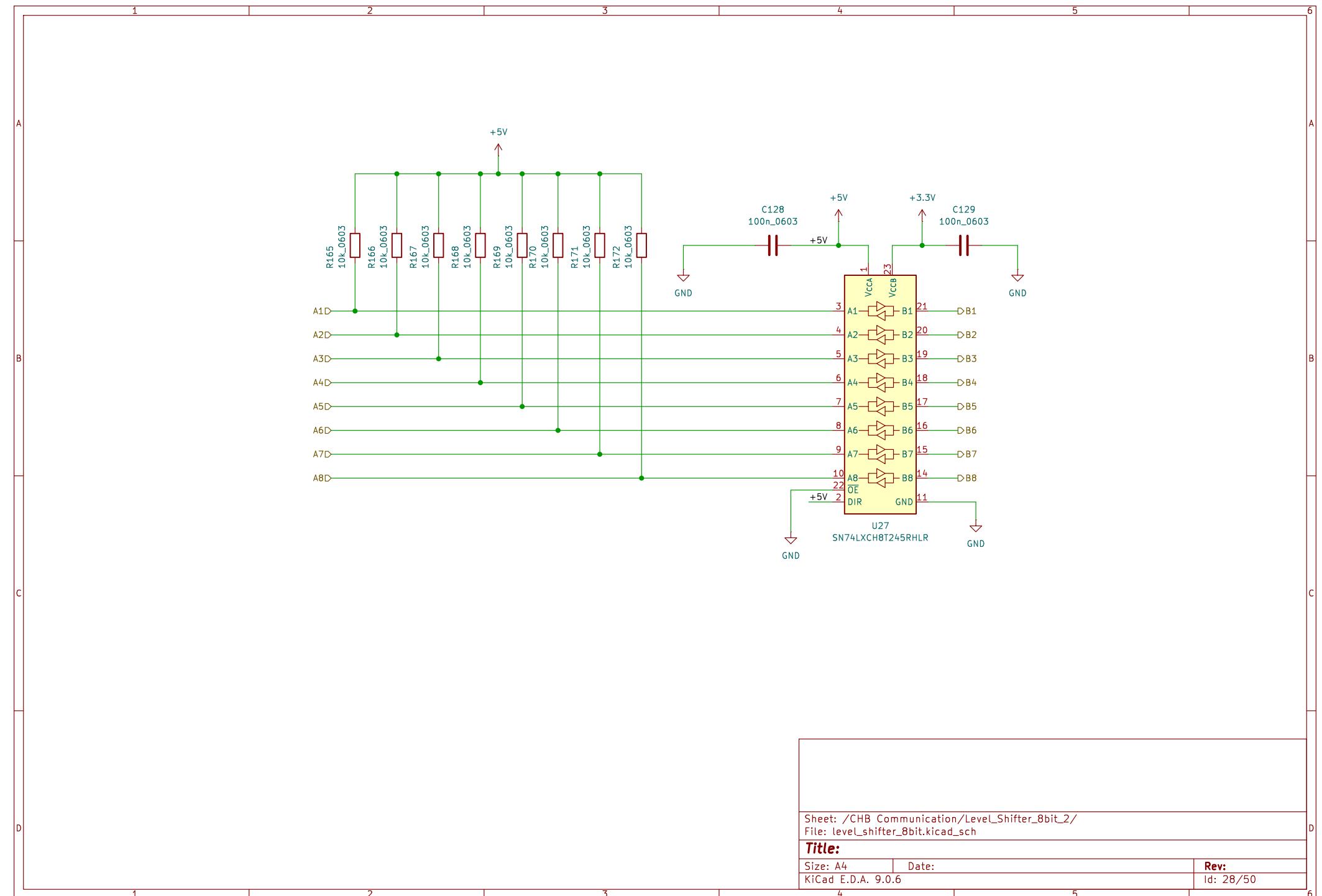


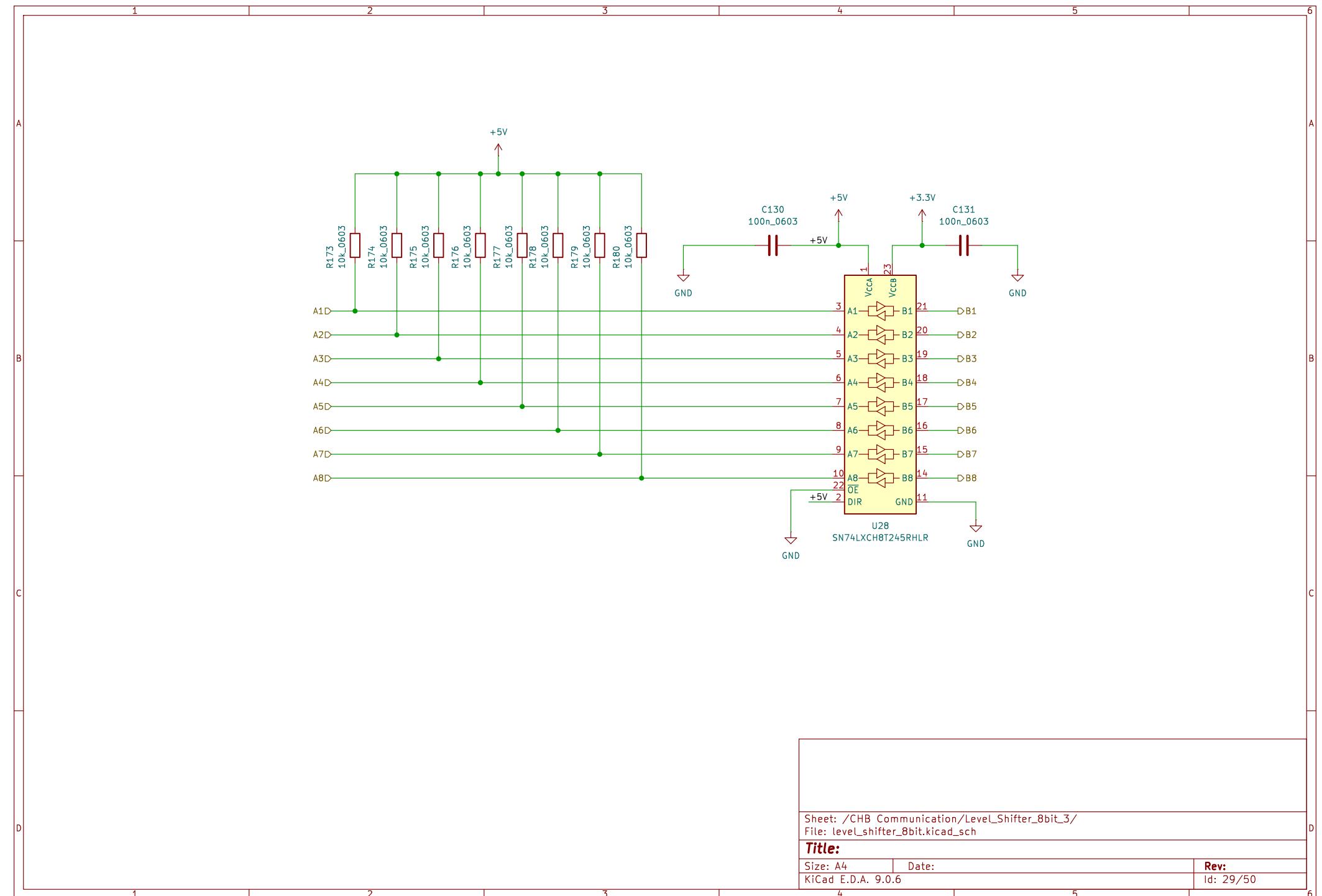
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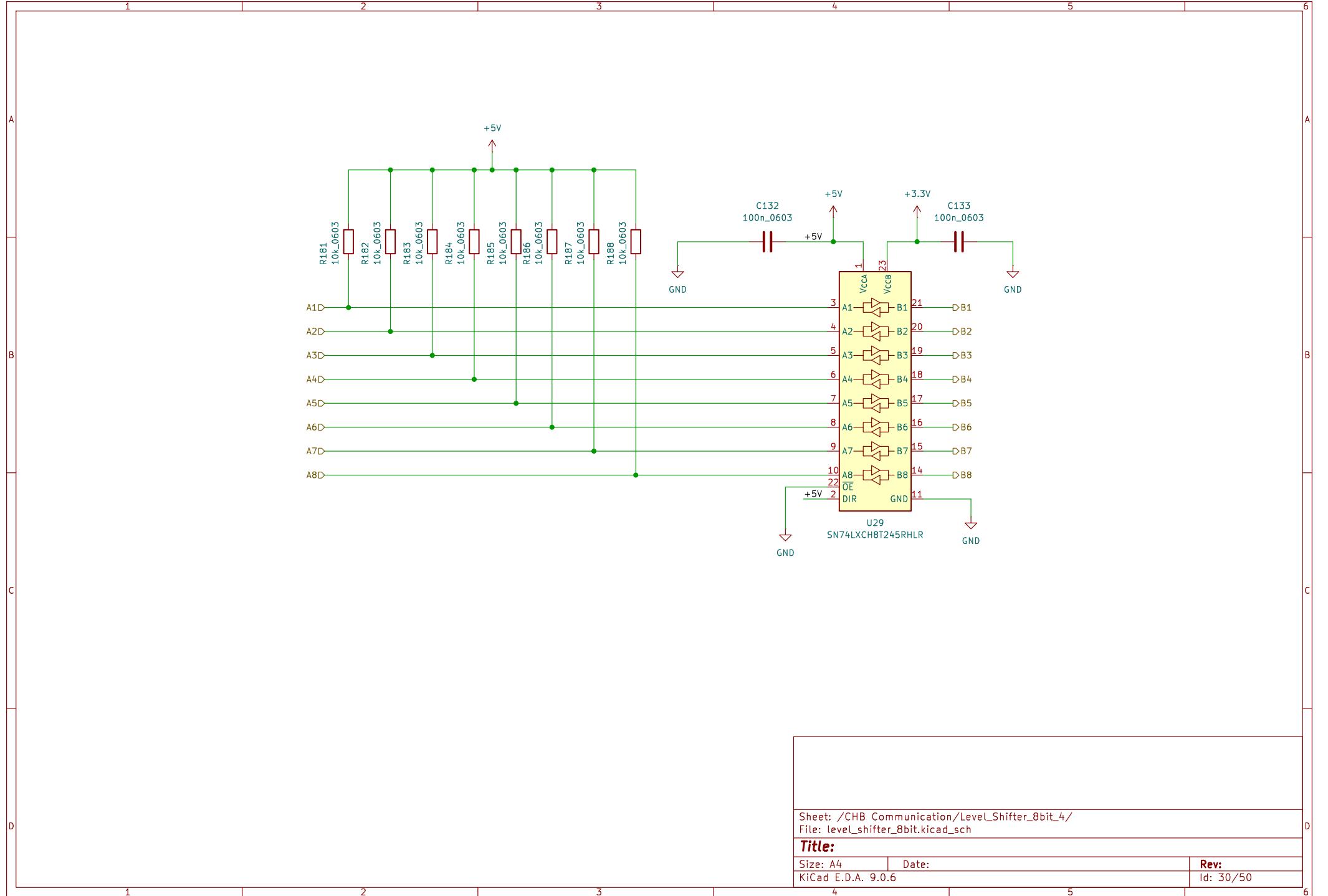
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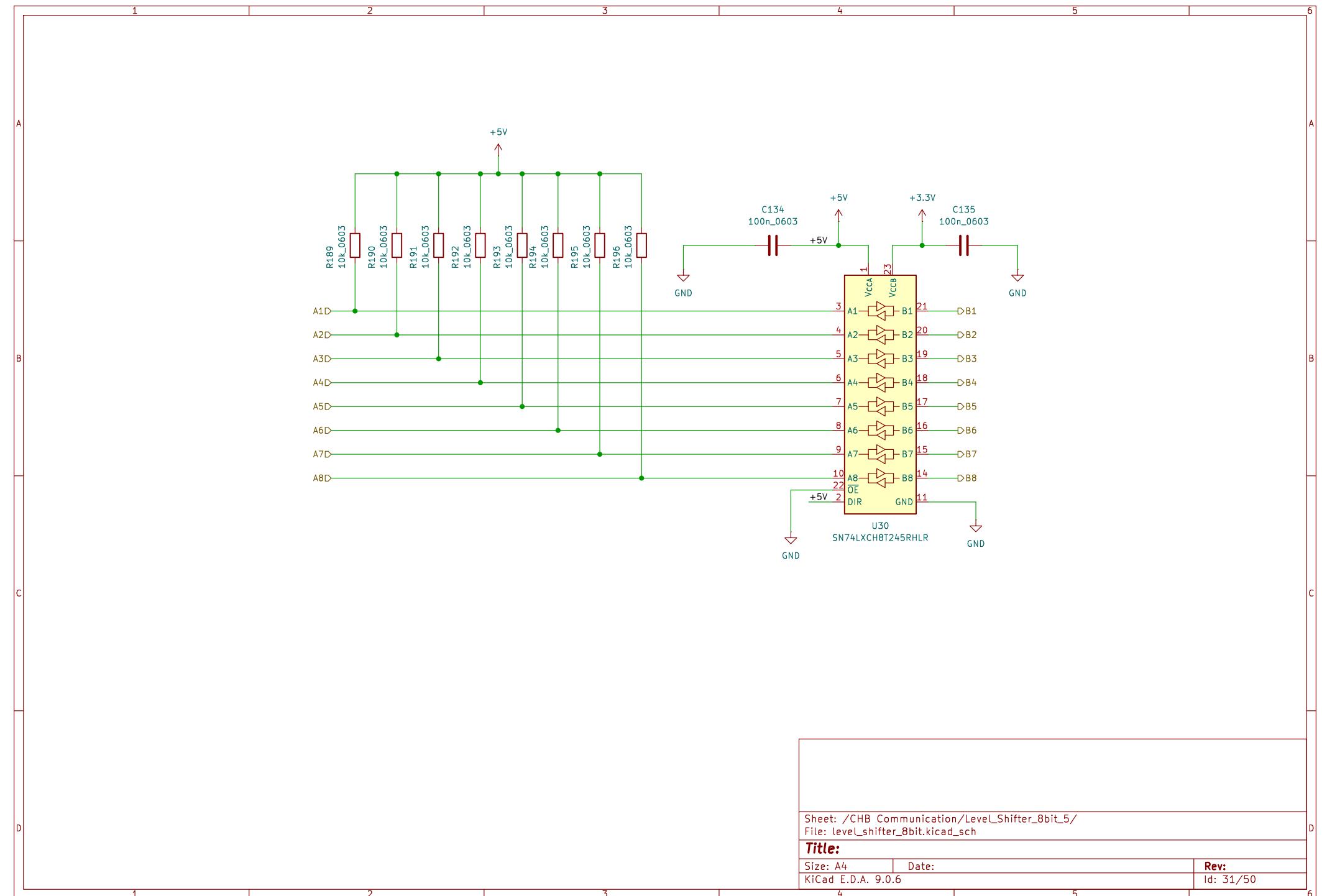
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KiCad E.D.A. 9.0.6

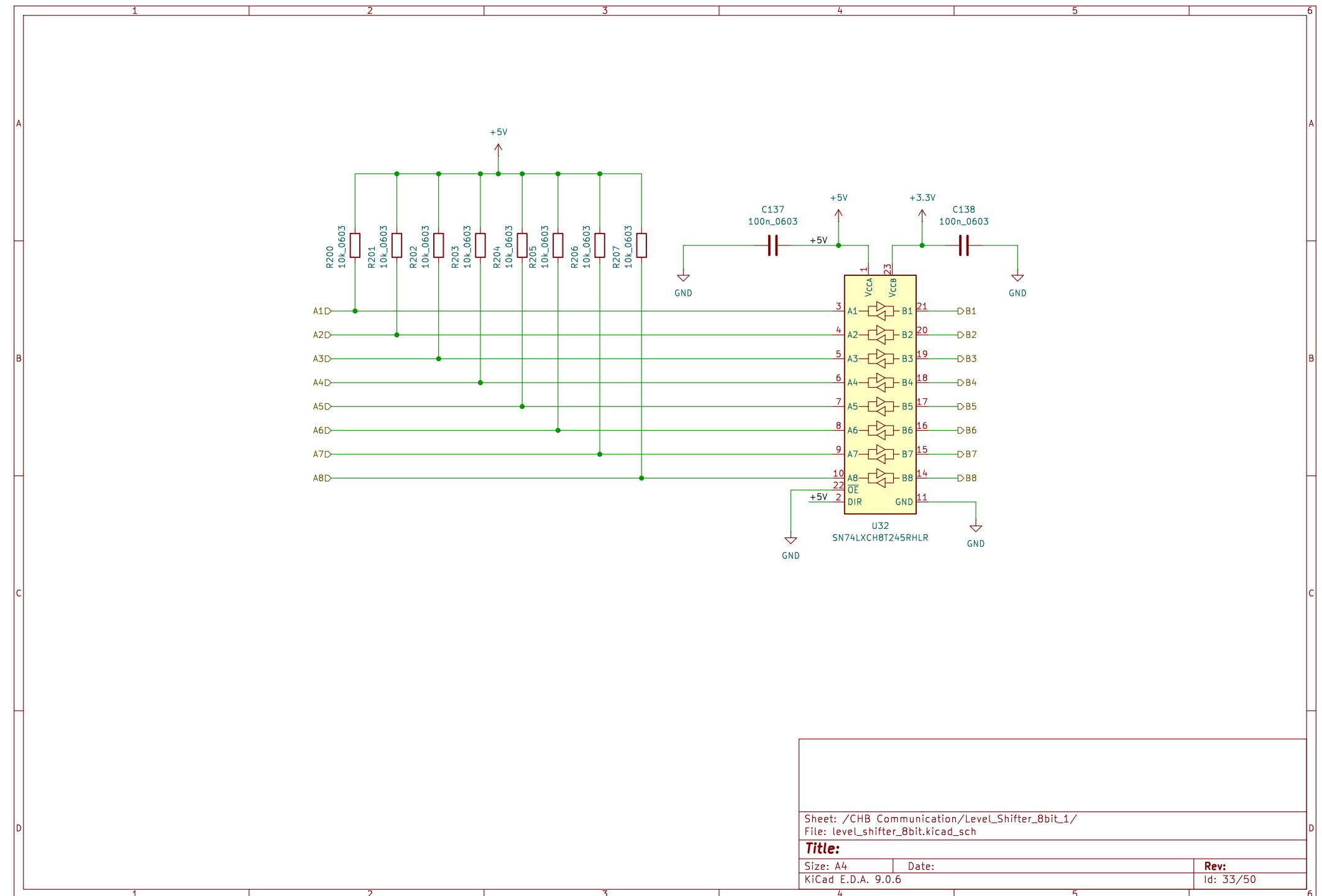
Rev:  
Id: 14/50

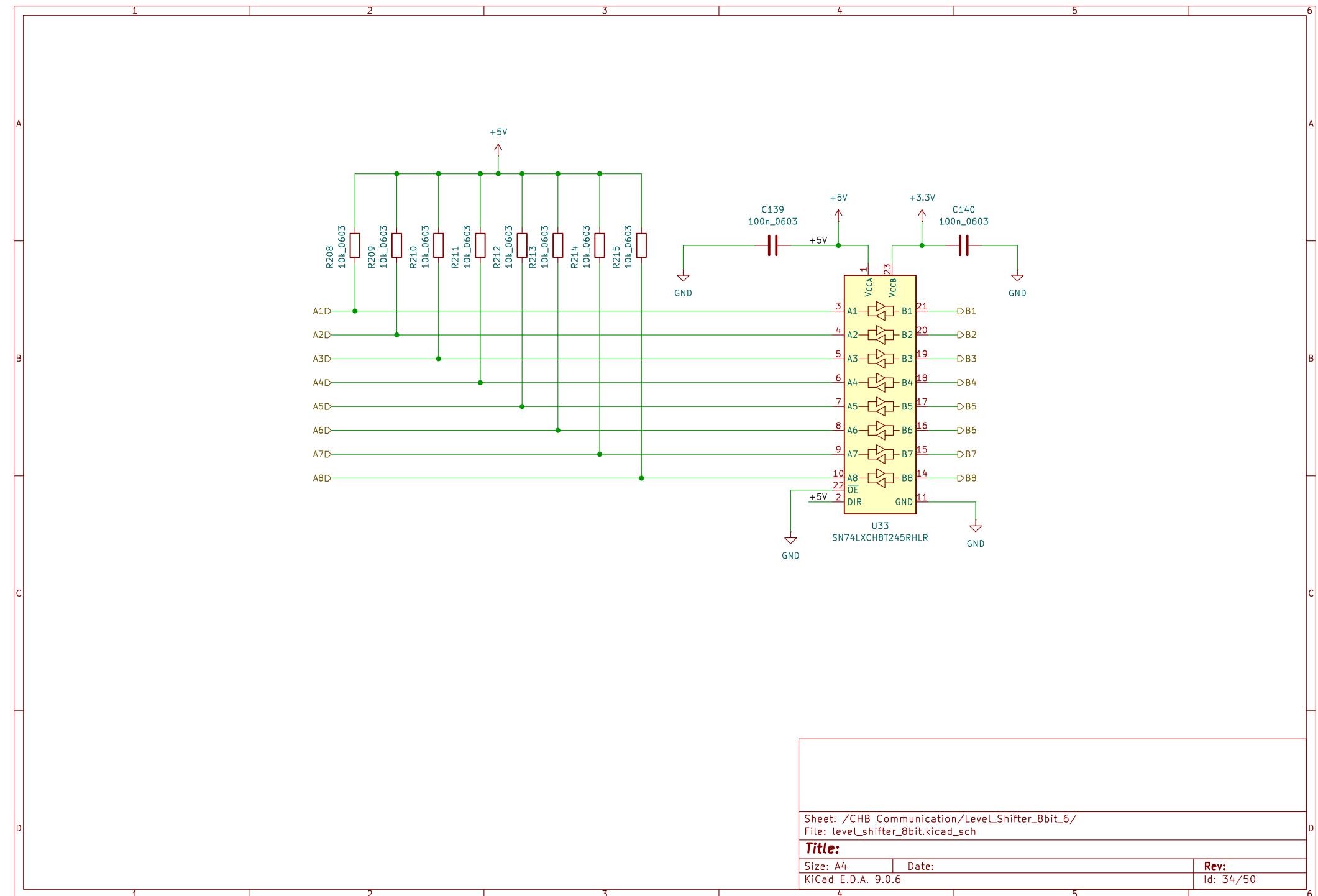


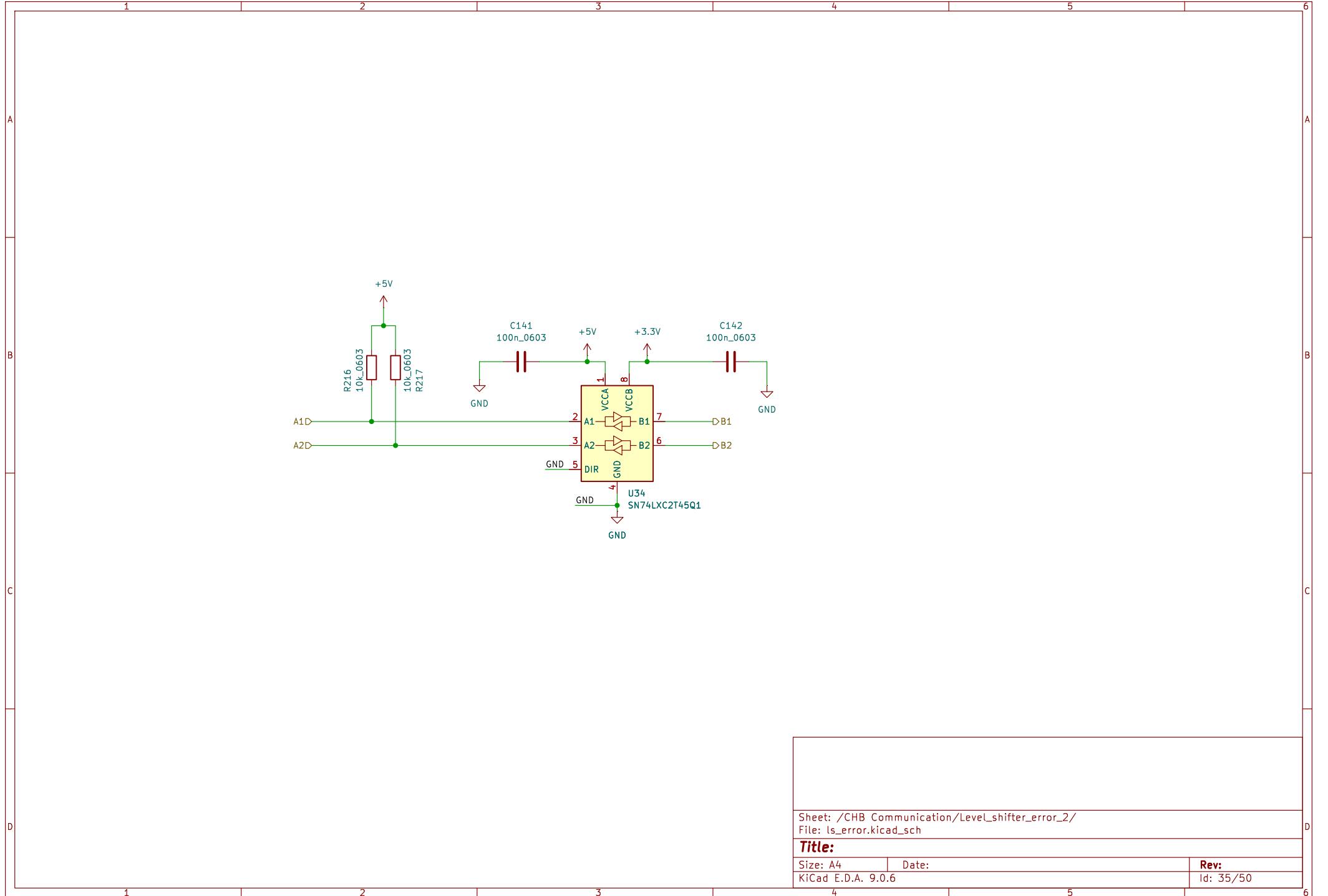










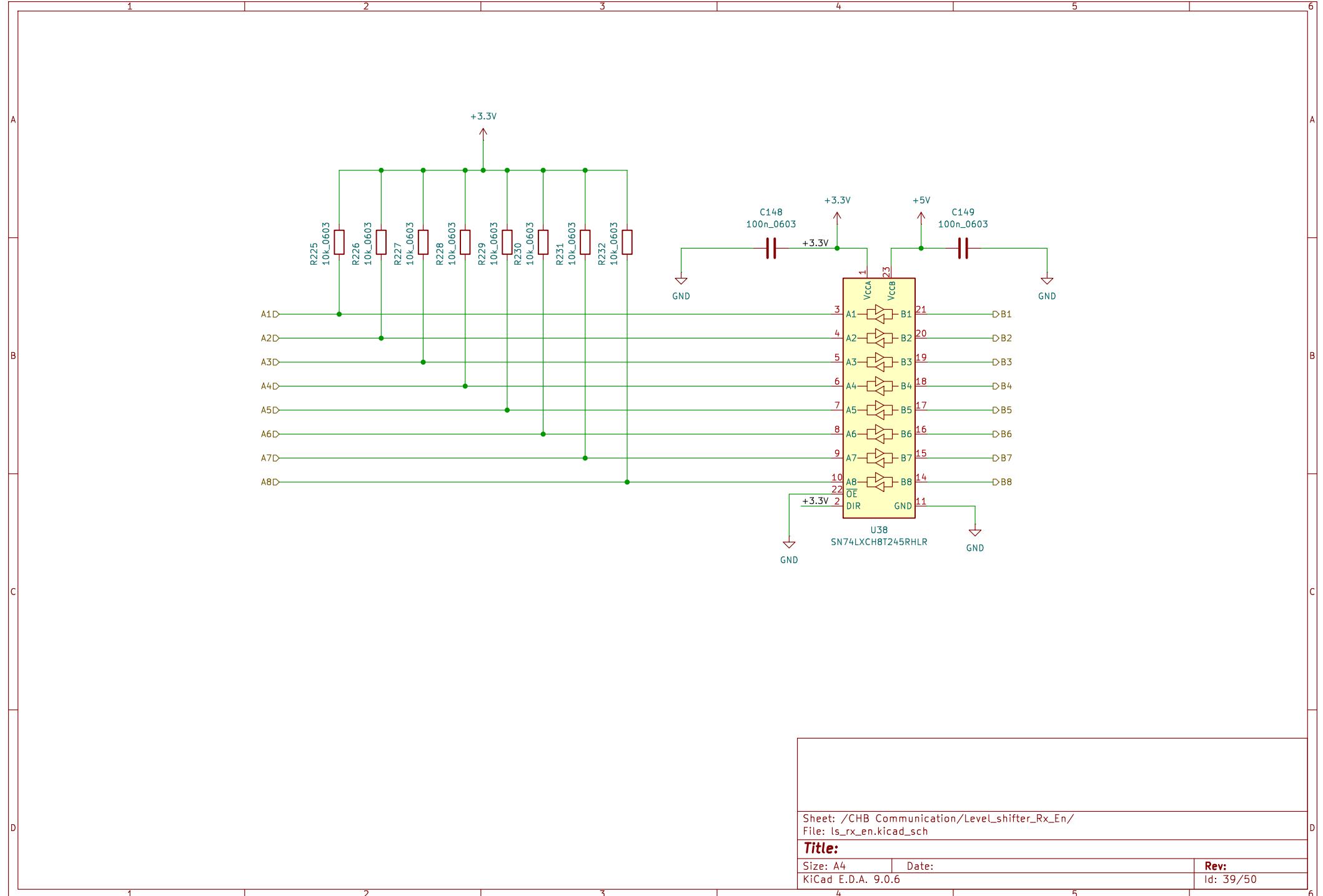


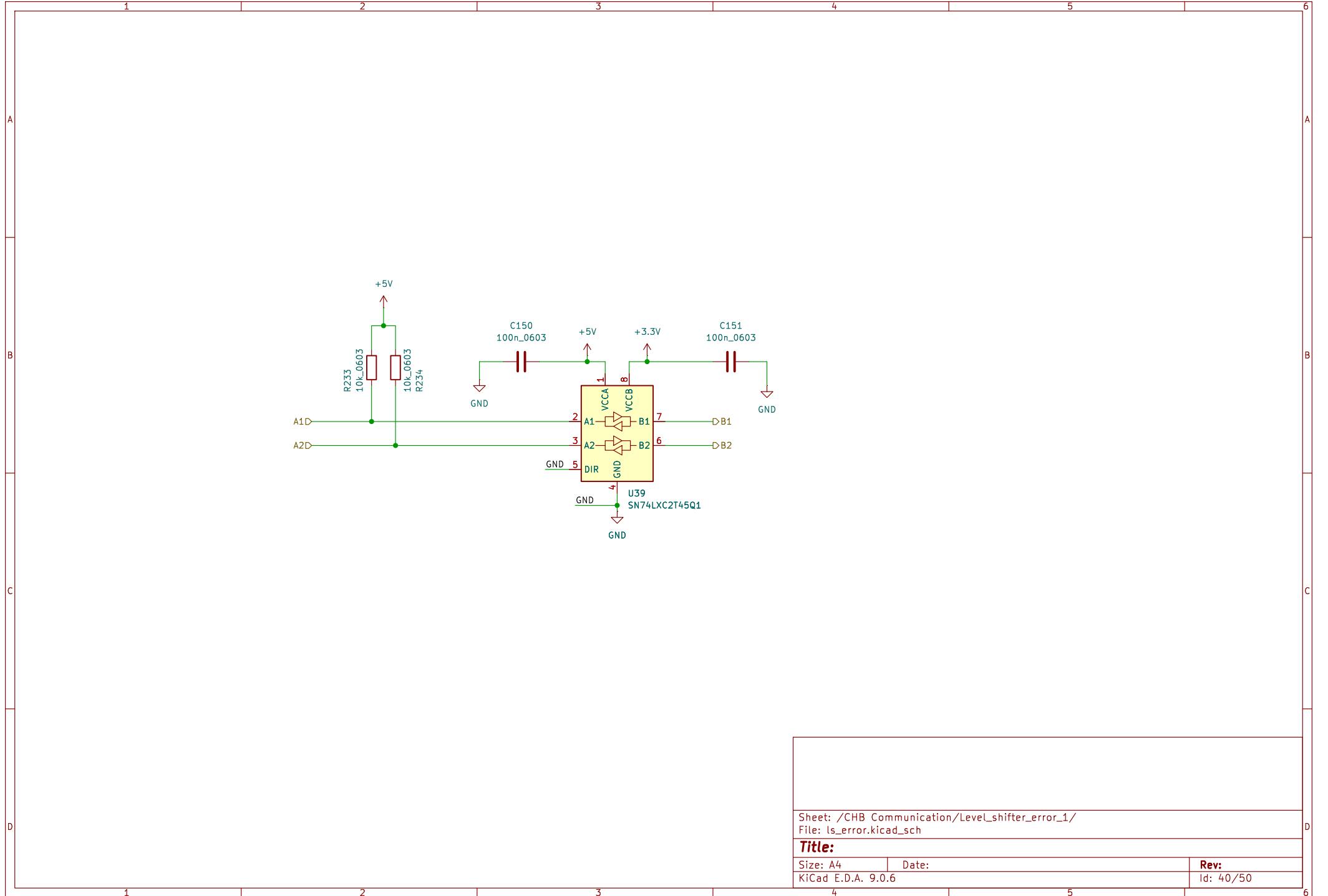
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File: ls\_error.kicad\_sch

**Title:**

Size: A4 Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 35/50



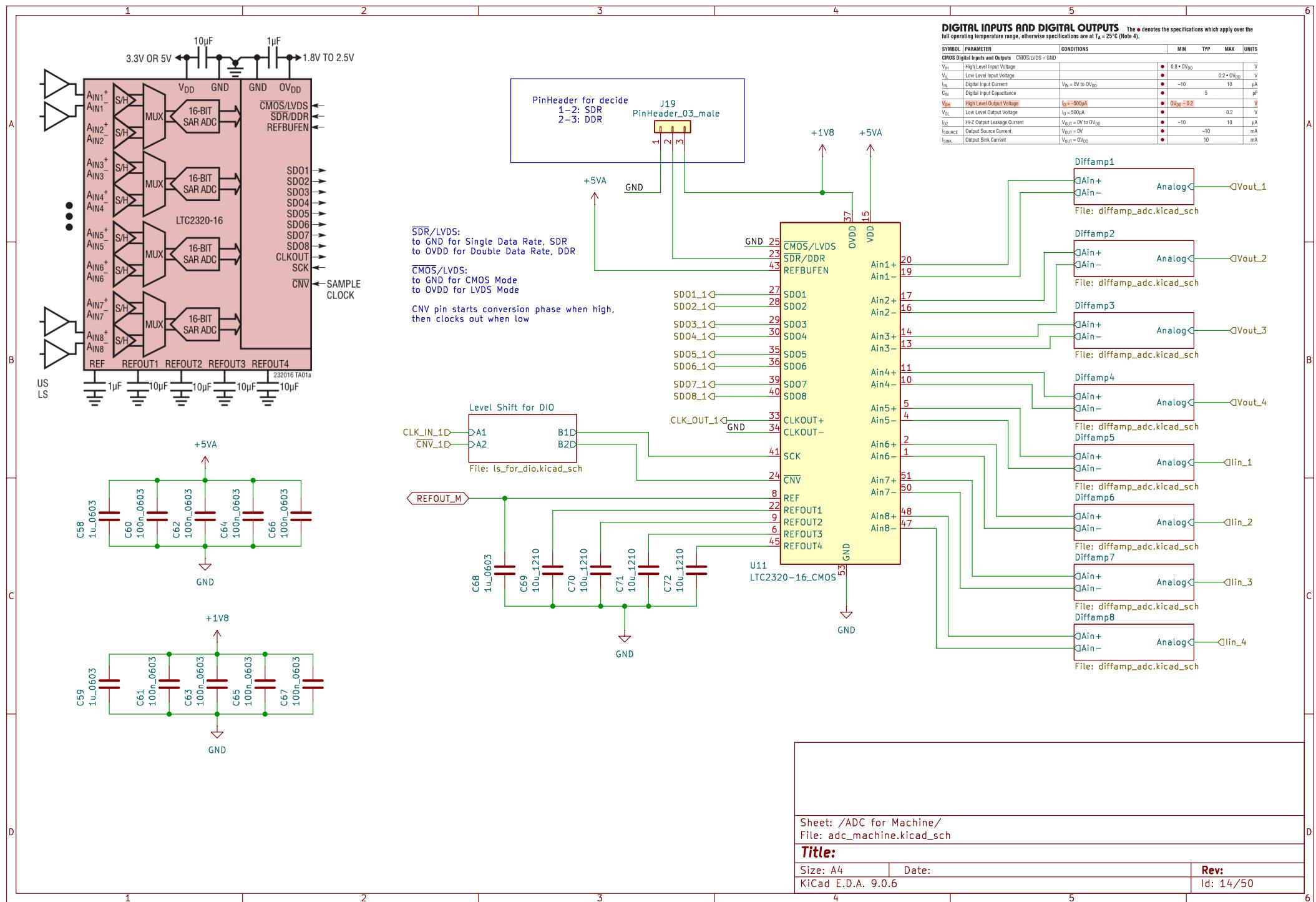


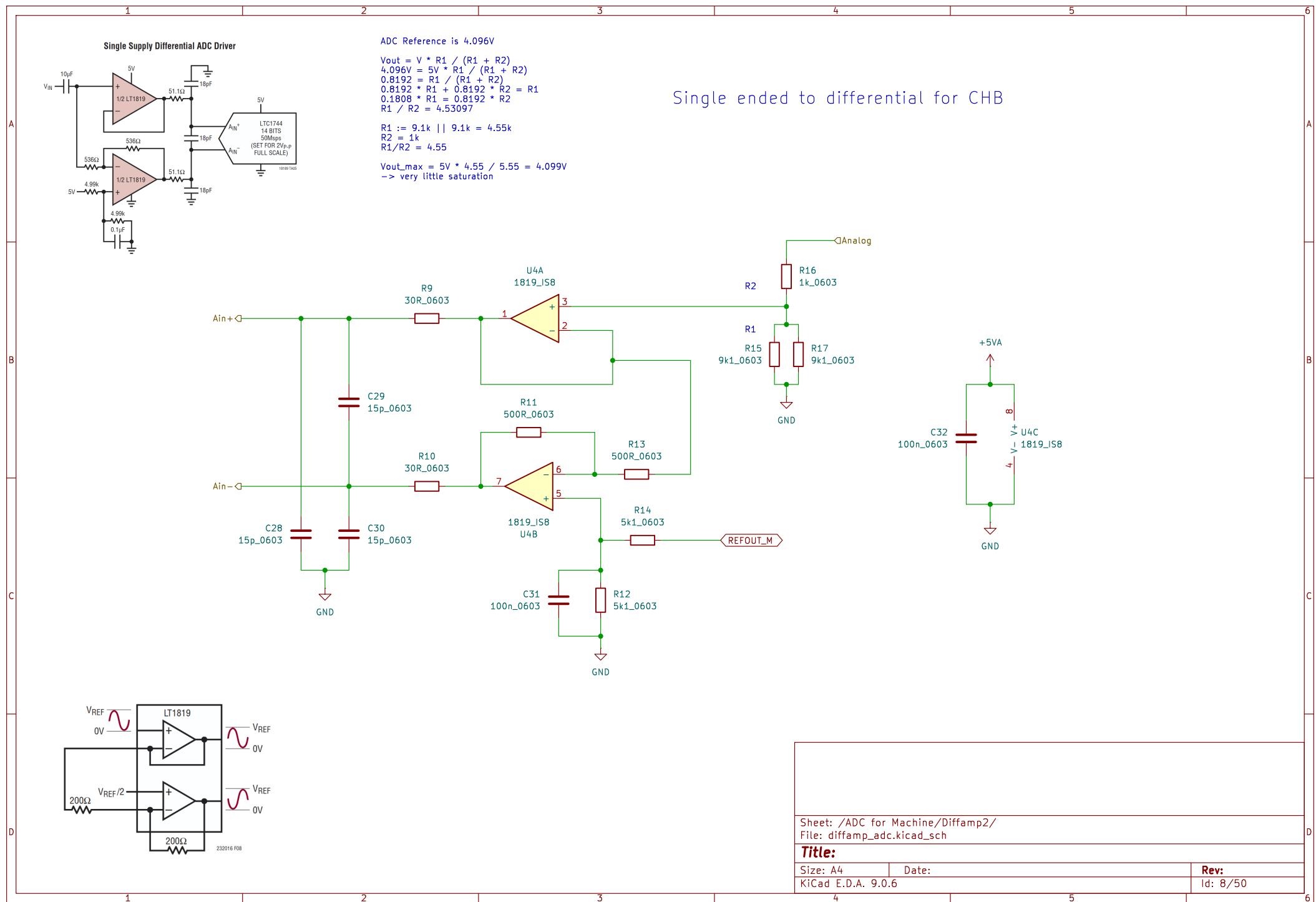
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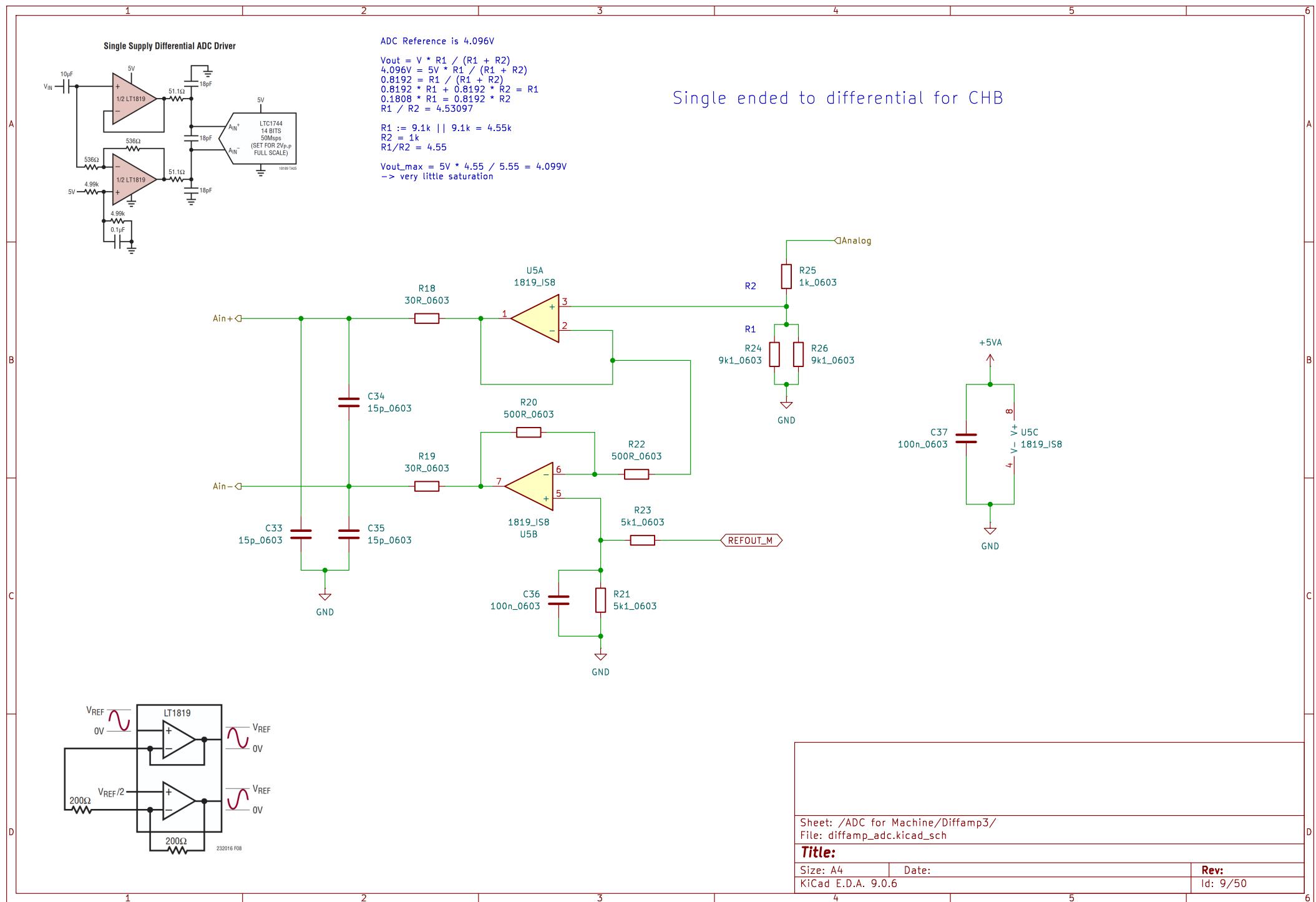
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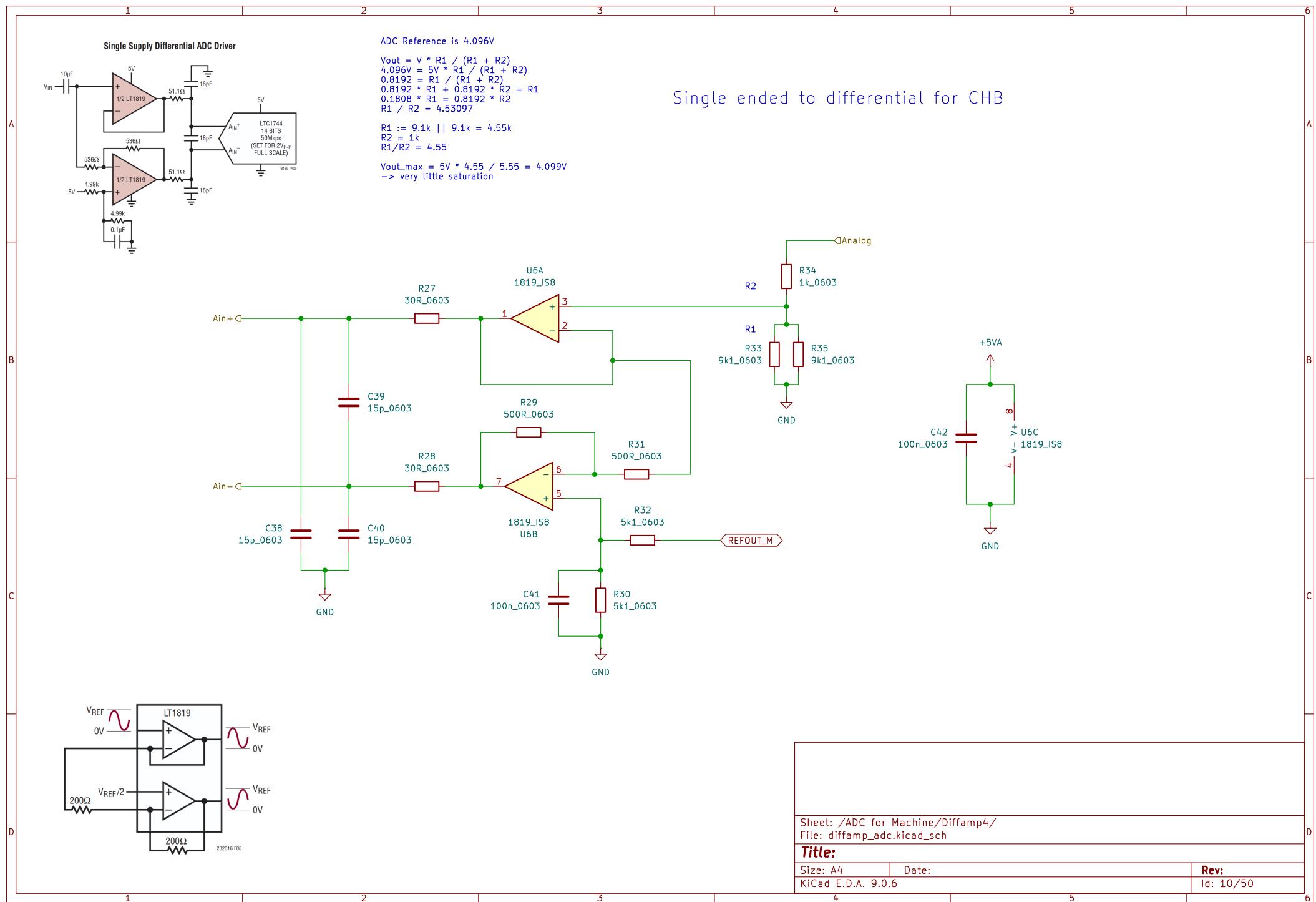
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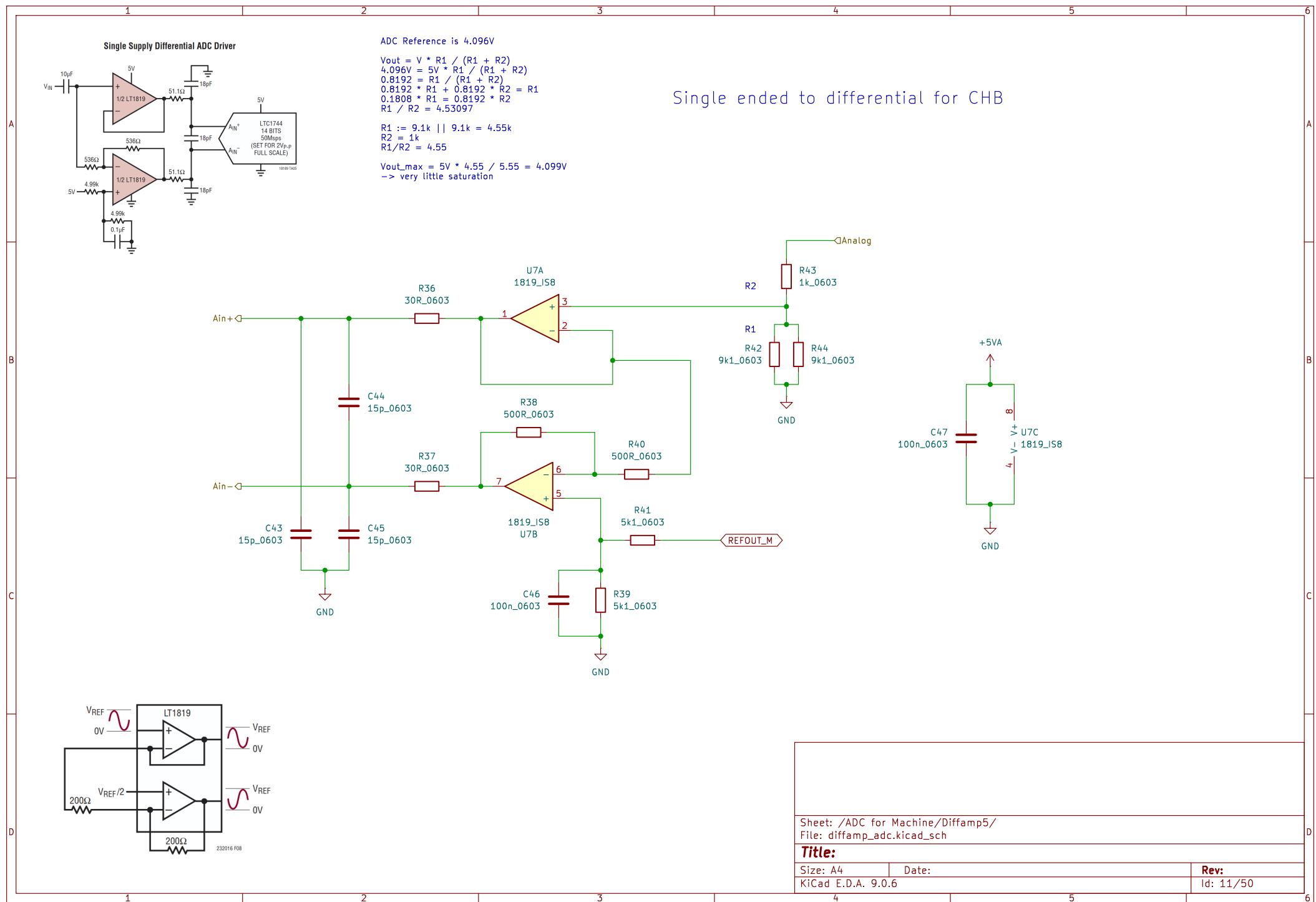
**Rev:**  
Id: 40/50

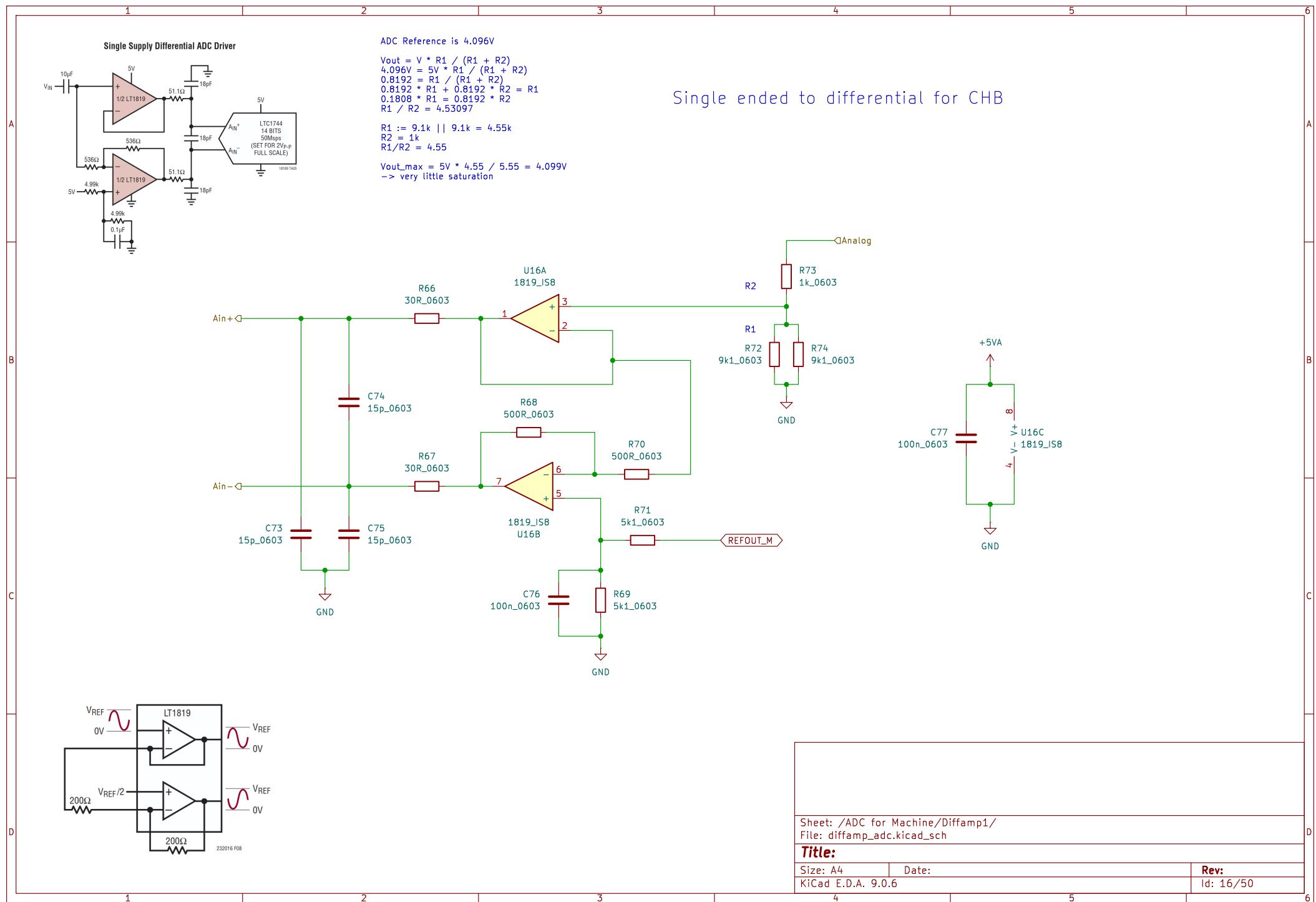


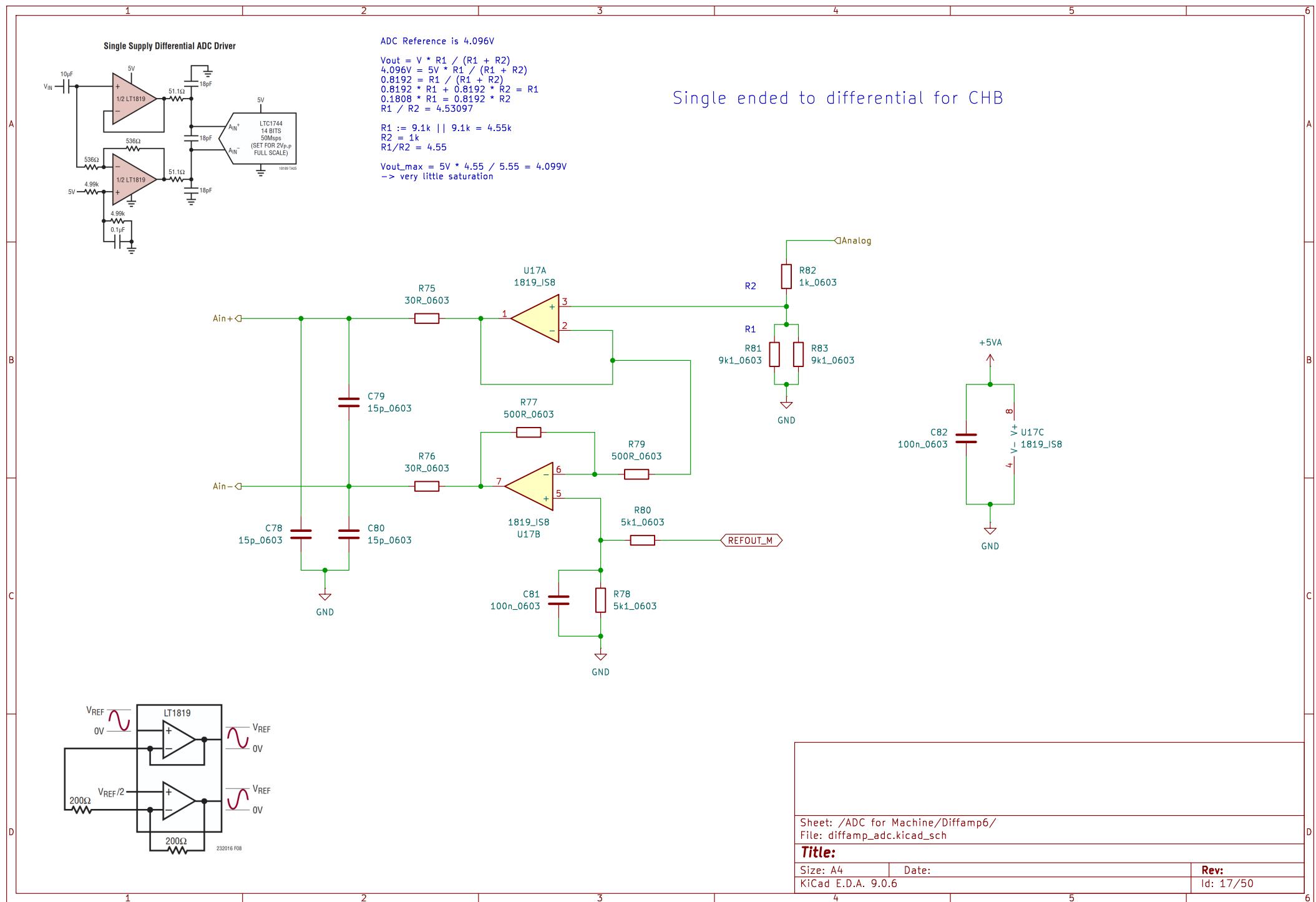


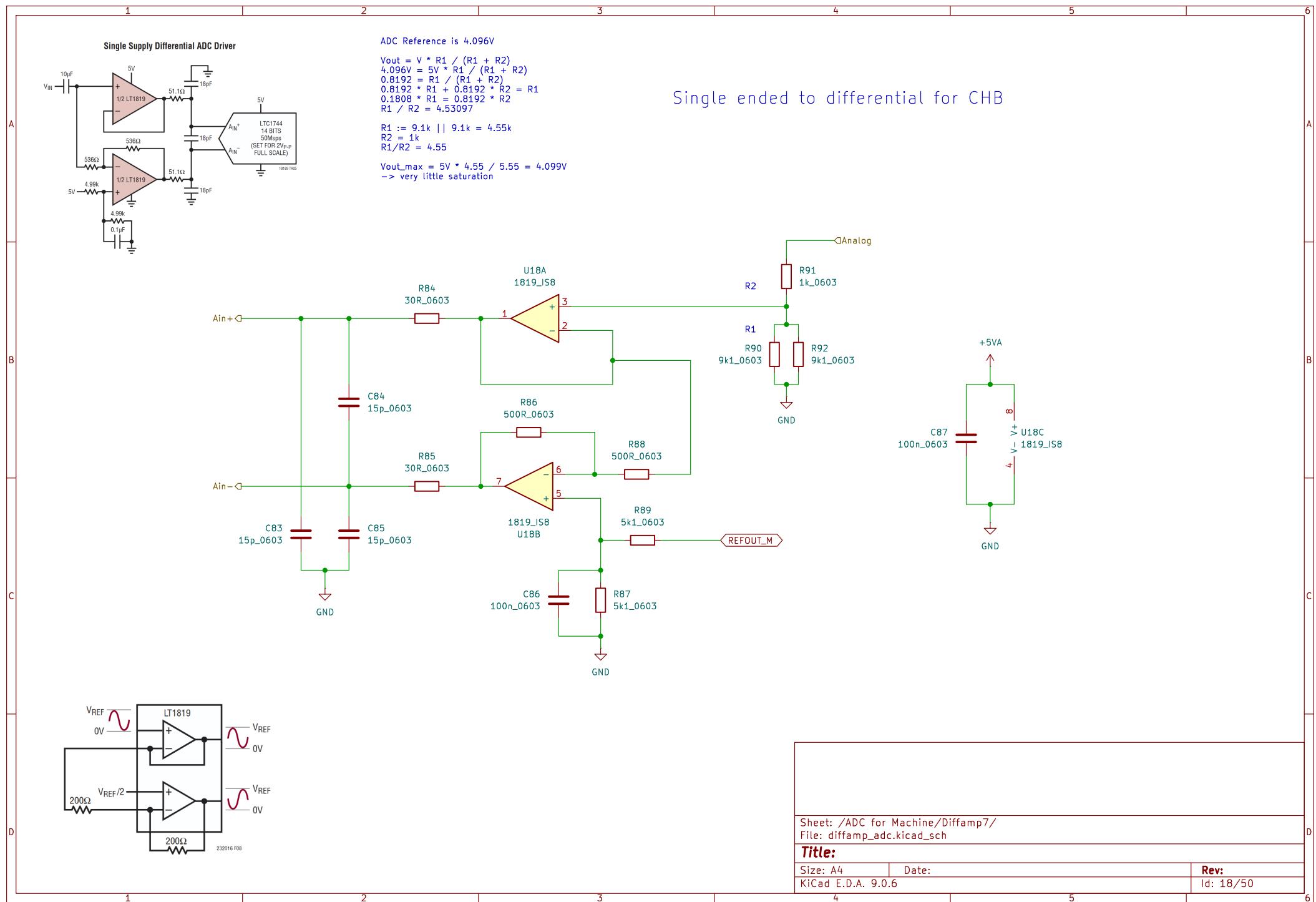


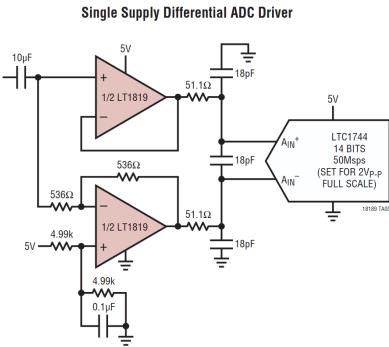




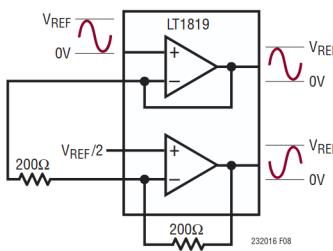
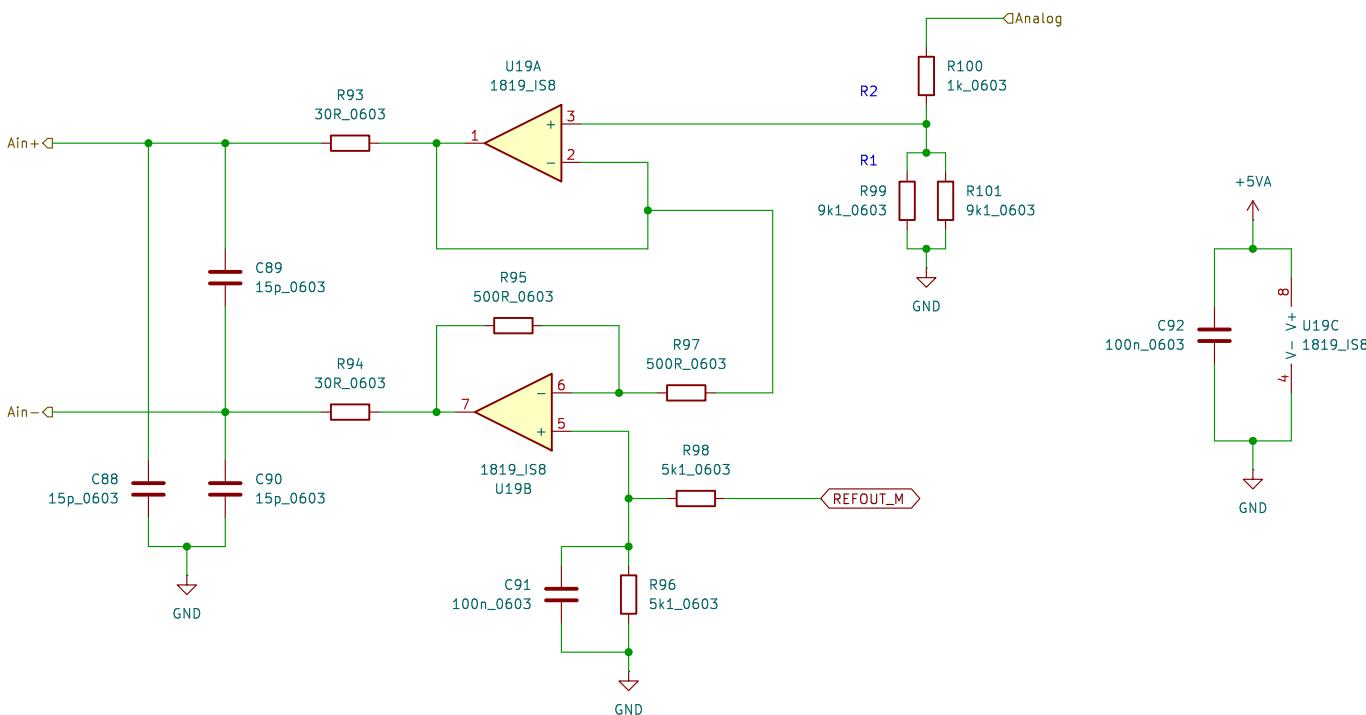








Single ended to differential for CHB

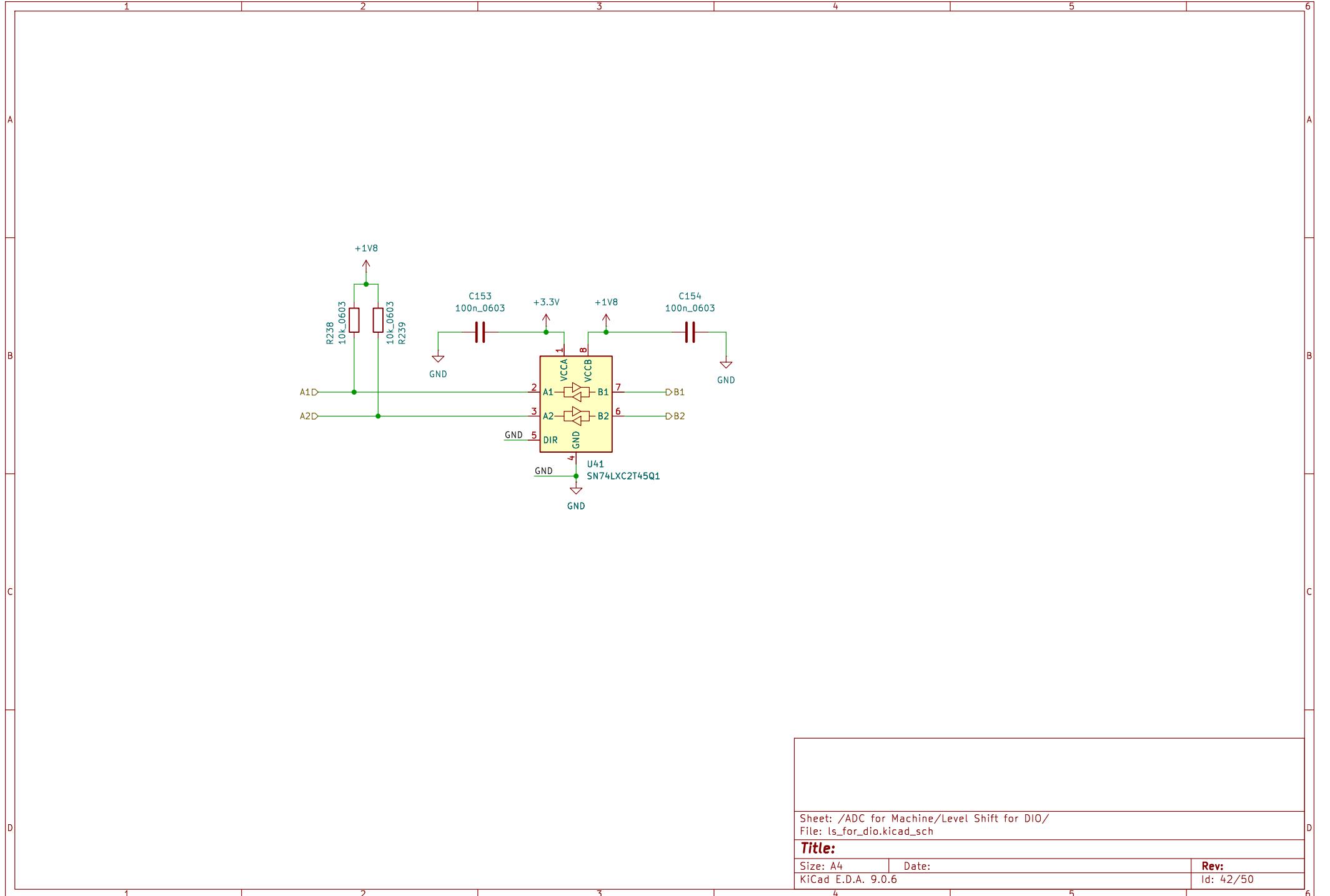


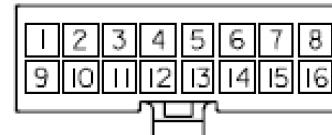
Sheet: /ADC for Machine/Diffamp8/  
File: diffamp\_adc.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 19/50



**Molex® Mini-Fit Jr.™**

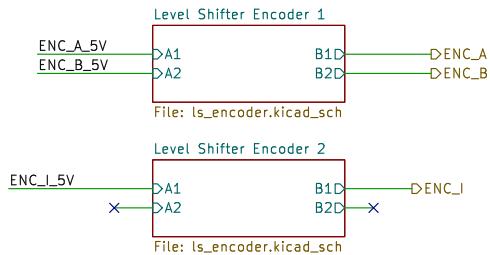
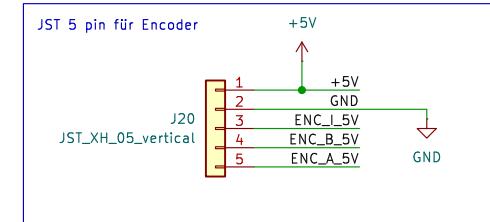
(Wire Entry View)

Mating Housing P/N: 39-01-2161  
 Mating (Male) Contact P/N: 39-00-0049 (24 AWG) 39-00-0082 (16 AWG)  
 Crimp Tool P/N: 11-01-0198

Pin	Color	Signal	Pin	Color	Signal
1	DRAIN x3	P DRAIN	9	16AWG BLK	PHASE R
2	N/A	N/A	10	16AWG RED	PHASE S
3	GRN	COMM S-T	11	16AWG WHT	PHASE T
4	GRN/WHT	COMM R-S	12	RED	+5VDC IN
5	GRY/WHT	COMM T-R	13	BRN	ENC I
6	DRAIN x1	E DRAIN	14	ORN	ENC B
7	BLK	GND	15	BLU	ENC A
8*	BLU/WHT	ENC A~	16*	ORN/WHT	ENC B~

\* Although all terminals in the connector are populated, this signal complement is available only in motor models configured with a differential encoder

(The encoder is not Differential)

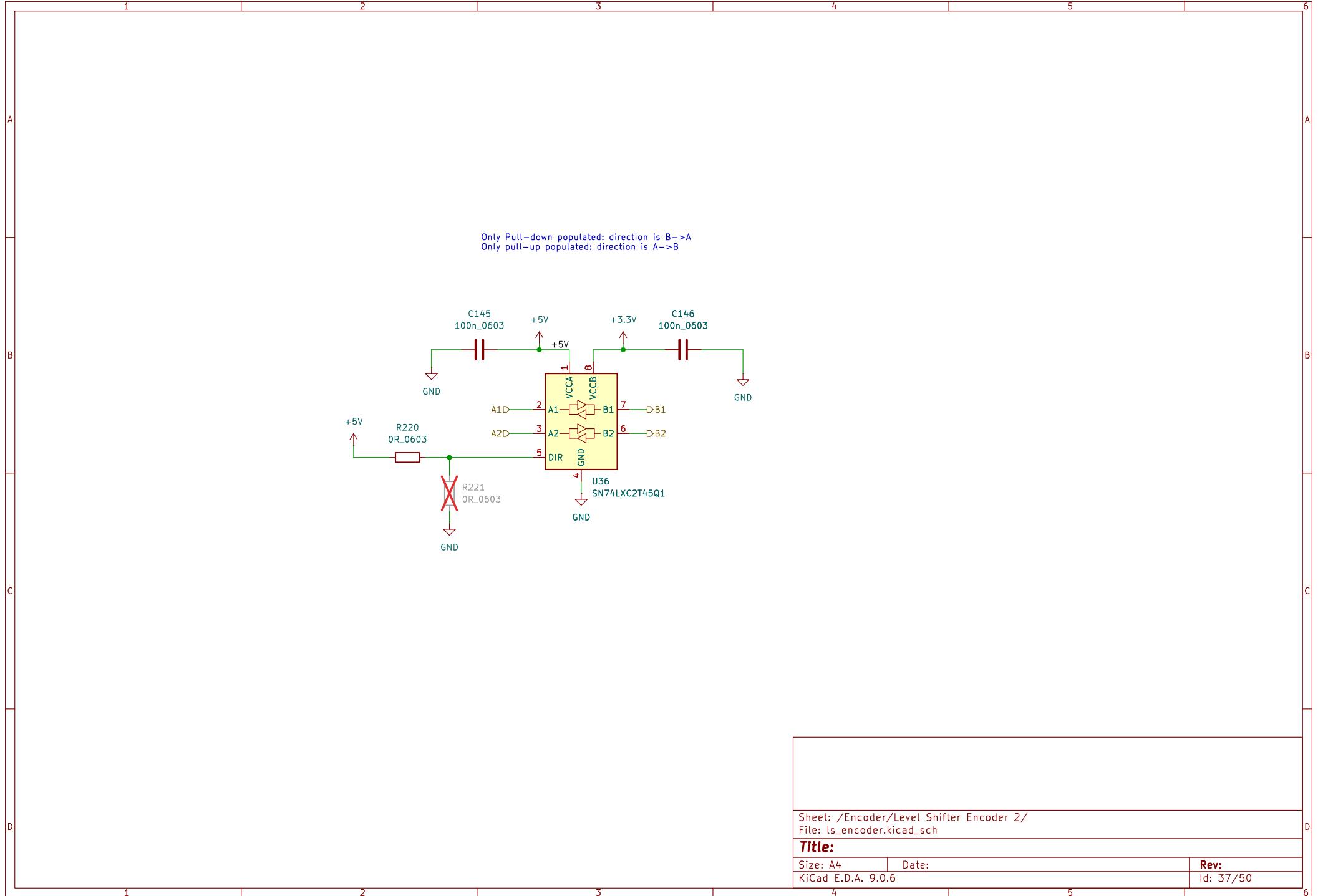


Sheet: /Encoder/  
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**Title:**

Size: A4 Date:  
 KiCad E.D.A. 9.0.6

Rev:  
 Id: 15/50

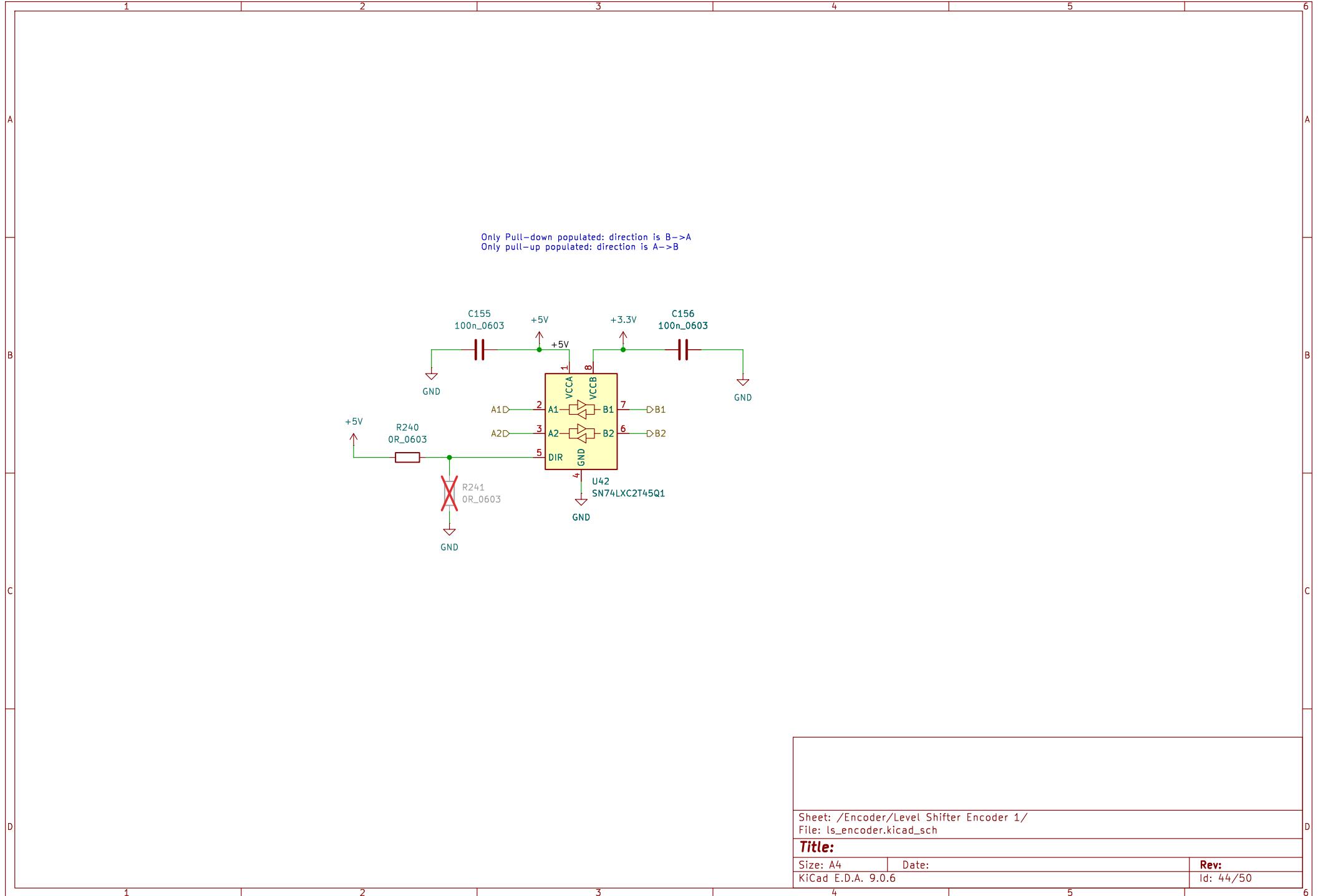


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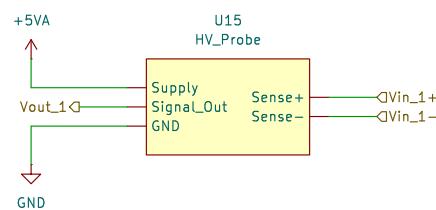
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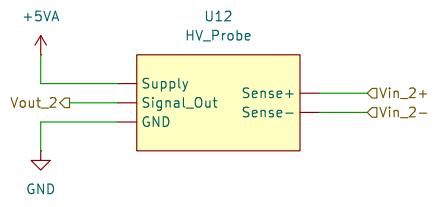
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Id: 37/50



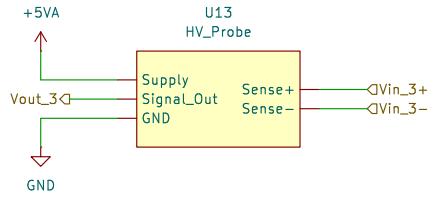
A



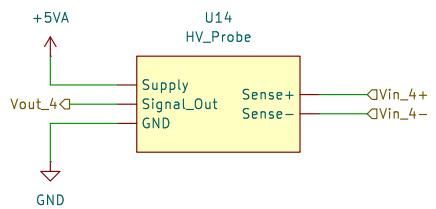
B



C



D



Sheet: /Voltage Measure/  
File: voltage\_meas.kicad\_sch

**Title:**

Size: A4 | Date:  
KiCad E.D.A. 9.0.6

**Rev:**  
Id: 15/50