

1. LABWORX ASSEMBLY MANUAL

This is an accompanying document to LabWorX 1: Mastering the I2C bus.

Some of you have requested the bill of material to be available in an easy to use format and you will find this in this document. Some errata's that have popped up in the BOM and PCB labelling have been corrected as well.

Every section contains the schematic, the assembly plan as well as a parts list. Parts lists are given for Digikey order codes.

NOTE : When using other suppliers be careful when selecting the integrated circuits. In the BOM only the GENERIC part number is given. Depending on the manufacturer there may be letters behind this part number that specify a particular package. Double-check that you have the right code when ordering. Only the Digikey order code gives you the exact component.

None of the components, apart from some integrated circuits, are critical in these designs. As long as they physically match the footprint you will be ok. Capacitor types may be substituted from X7R to any other type. Resistor tolerances are 5% and ¼ watt or less. Integrated circuits are manufacturer independent, and may be sourced from any manufacturer, apart from those where there is only one supplier. There is one exception though, which is the 74HC245 or 74HCT245. Only Fairchild and Texas instruments have that particular package. Many other manufacturers make the same part but the physical package is LARGER and will NOT FIT the board.

Regards

The Author

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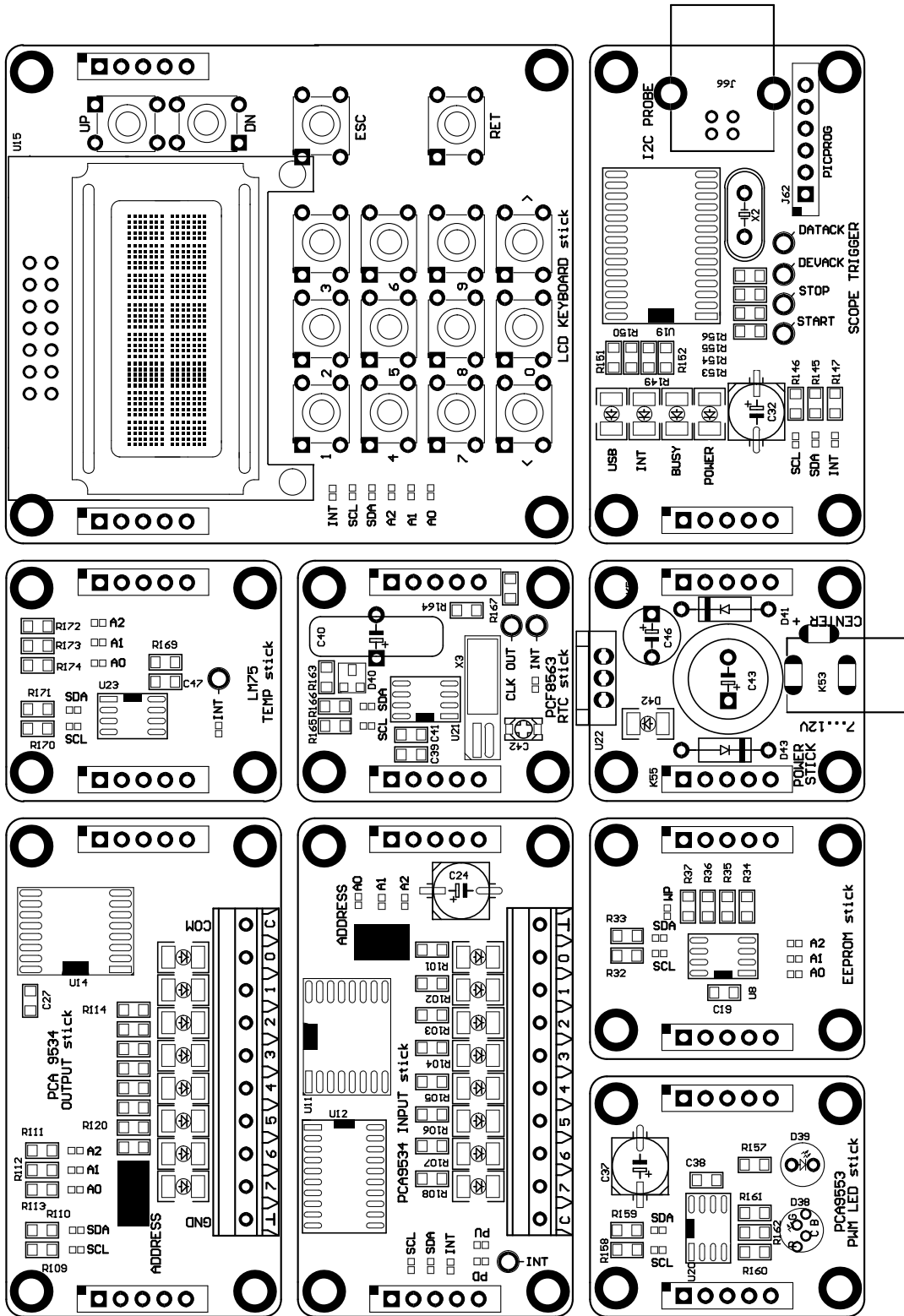
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3. OVERVIEW OF THE BOARDS

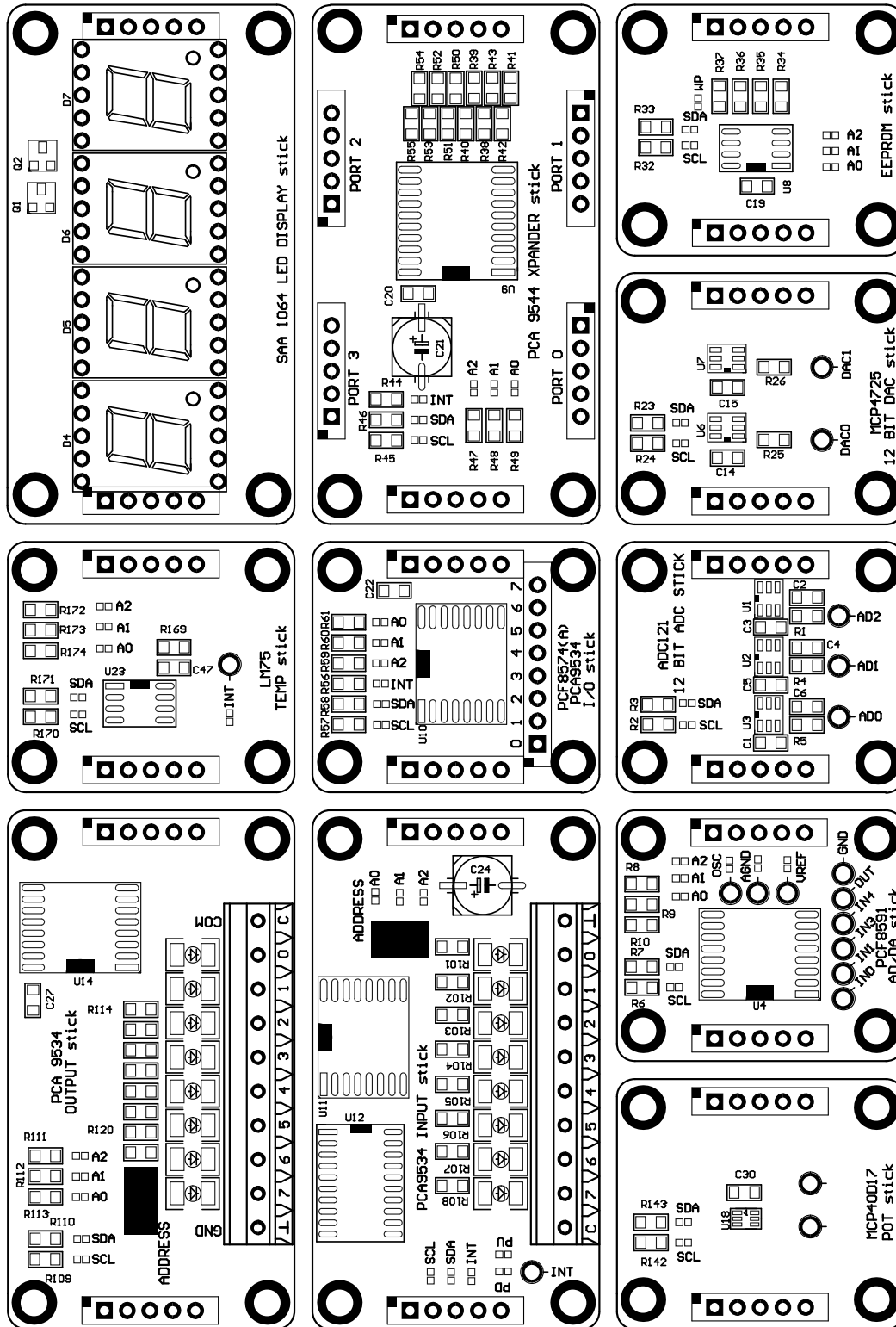
These are the boards available and the individual sticks they hold.

Stick Number	Description	Collection
1- 1	I2C Probe	Board 1
1- 2	I2C Stick Power supply	Board 1
1- 3	24xxx EEprom stick	Board 1 & 2
1- 4	PCA9553 PWM LED controller	Board 1
1- 5	PCA9554 LCD / Keyboard module	Board 1
1- 6	LM75 Thermometer module	Board 1 & 2
1- 7	PCF8563 Real time clock with backup	Board 1
1- 8	PCA9554 High current 8-bit output	Board 1 & 2
1- 9	PCA9554 / PCF8574 Protected 8-bit input	Board 1 & 2
1- 10	MCP4725 Dual channel D/A Converter	Board 2
1- 11	ADC121 Three channel A/D Converter	Board 2
1- 12	PCF8591 A/D D/A converter	Board 2
1- 13	MCP40D17 Potentiometer	Board 2
1- 14	PCA9544 I2C Expander	Board 2
1- 15	PCF8574 / PCF8574A / PCA95xx Universal 8-bit I/O stick	Board 2
1- 16	SAA1064 4 Digit LED display (7 Segment)	Board 2

3.1. BOARD 1 OVERVIEW

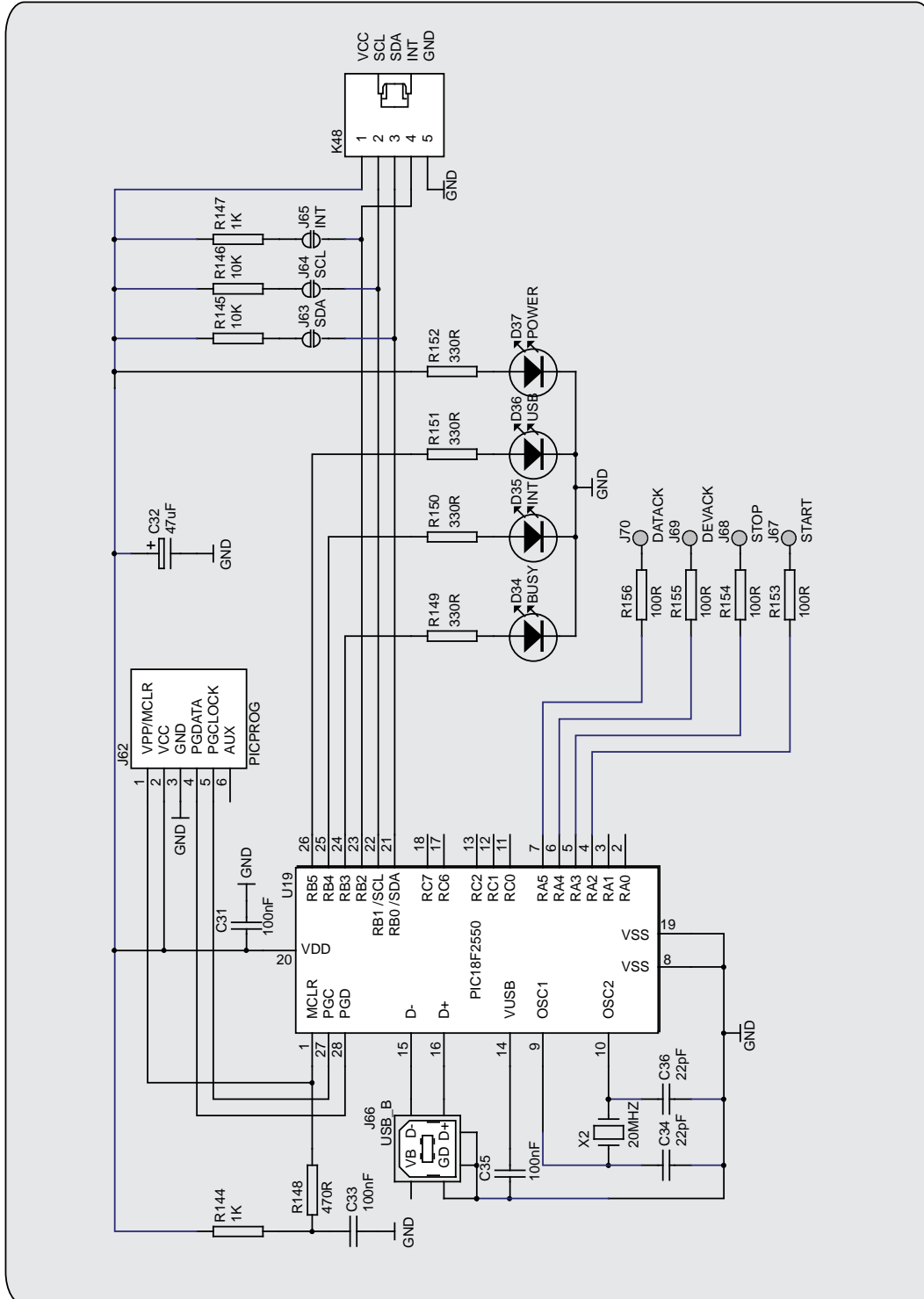


3.2. BOARD 2 OVERVIEW

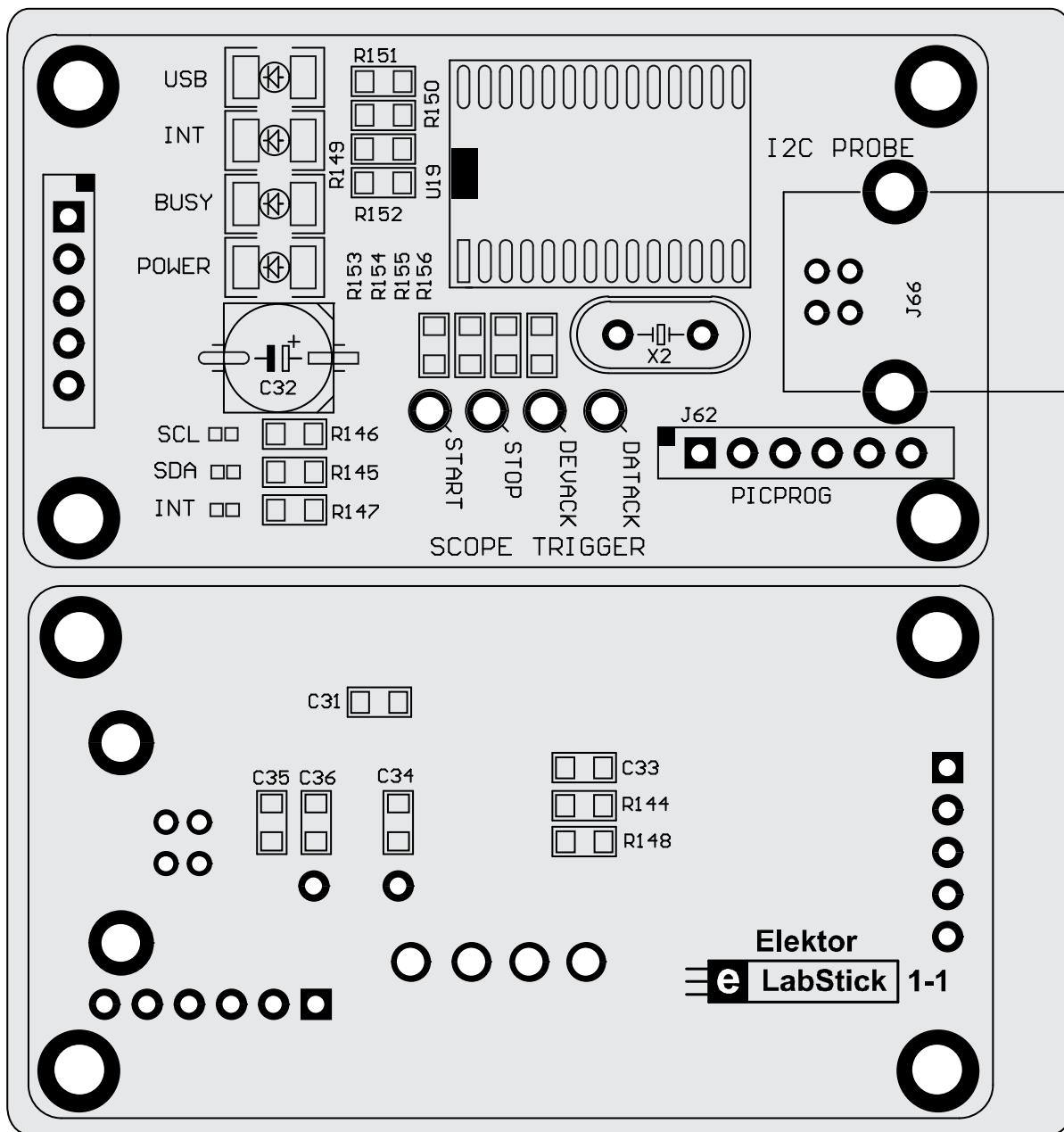


4. LABSTICK 1-1: I2C PROBE

4.1. SCHEMATIC



4.2. ASSEMBLY DRAWING

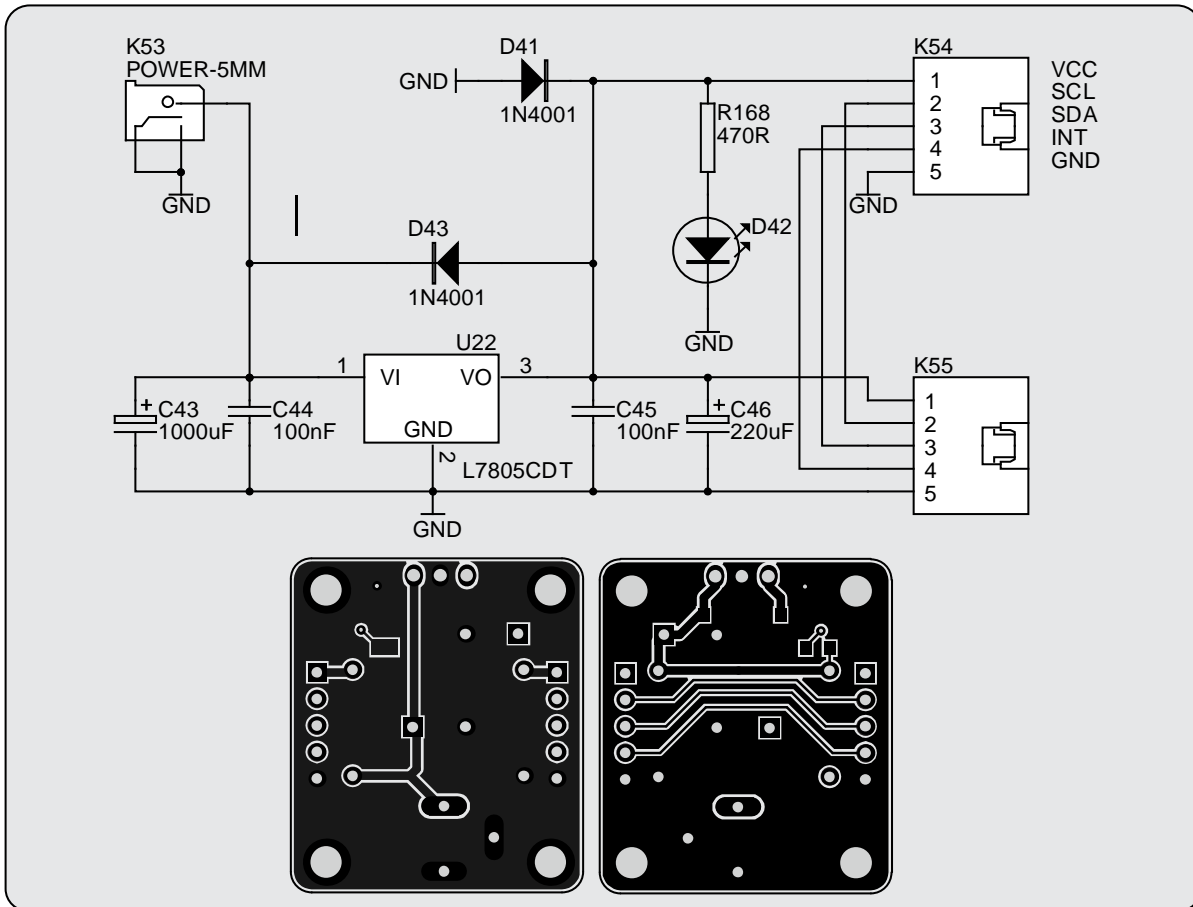


4.3. BILL OF MATERIALS

	Description	Digikey Order Code
R153, R154, R155, R156	100 Ohm SMD 0805	RMCF0805JT100RCT-ND
R149, R150, R151, R152	330 Ohm SMD 0805	RMCF0805JT330RCT-ND
R148	470 Ohm SMD 0805	RMCF0805JT470RCT-ND
R144	1K Ohm SMD 0805	RMCF0805JT1K00CT-ND
R145, R146, R147	10K Ohm SMD 0805	RMCF0805JT10K0CT-ND
C34, C35	22pF 50V NPO ceramic capacitor SMD 0805	399-1113-1-ND
C31, C33, C35	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
C32	47uF 16V Electrolytic capacitor	PCE4000CT-ND
D34, D35, D36, D37	LED PLCC-2 (TOPLED) colour of choice	475-2562-1-ND
X2	20 MHz Crystal RJ49/U package	XC1926-ND
U19	PIC18F2550 with I2CPROBE.BIN loaded	PIC18F2550-I/SO-ND
K48, J62	100 mils (2.54mm) pins. Strip 6 pins.	WM6436-ND
J66	USB connector Right Angle B Type	A98573-ND

5. LABSTICK 1-2: UNIVERSAL POWER SUPPLY

5.1. SCHEMATIC



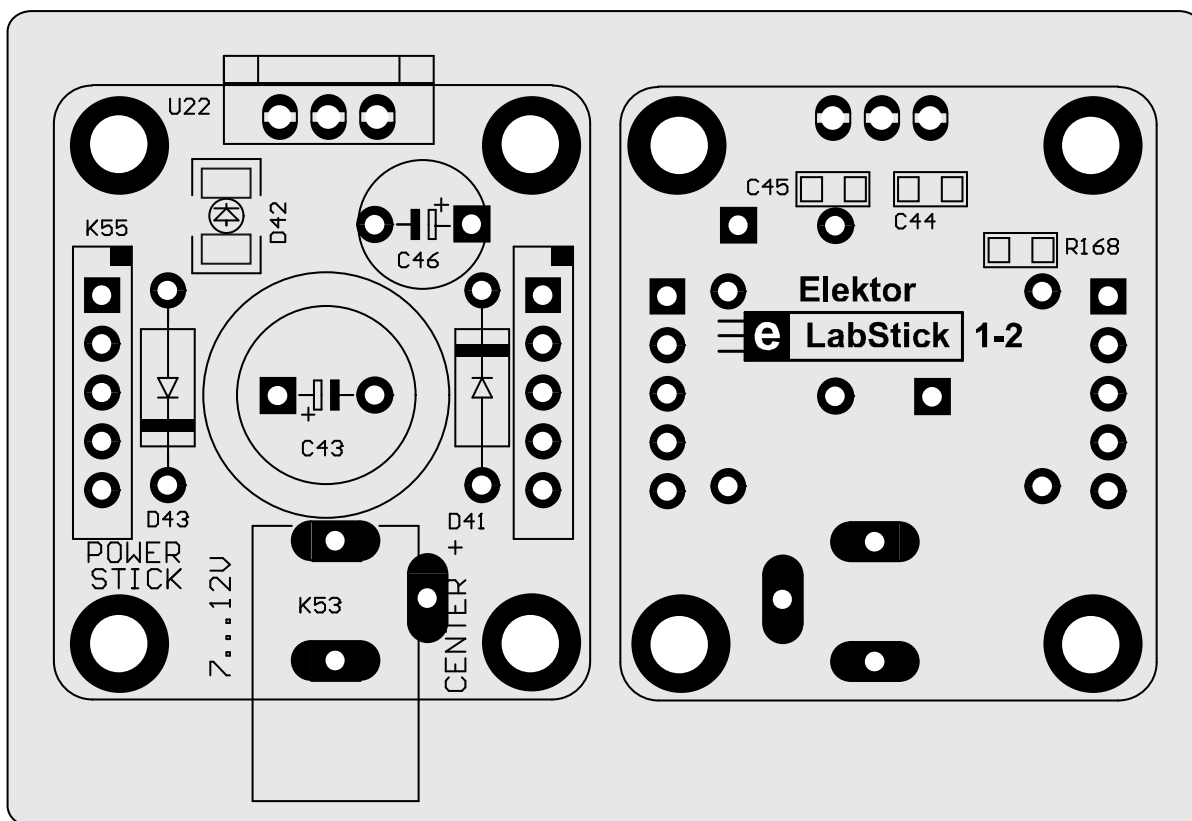
5.2. SELECTING THE OUTPUT VOLTAGE

This table shows the parts to be changed depending on the desired output voltage of the regulator

Output voltage	Installed regulator (U22)	LED resistor (R168)
3.3 volts	78033	180 ohm
5 volts	7805	330 ohm
9 volts	7809	680 ohm
12 volts	7812	1 K ohm

For application in the I2C board only the 5 VOLT configuration is allowed !

5.3. ASSEMBLY DRAWING

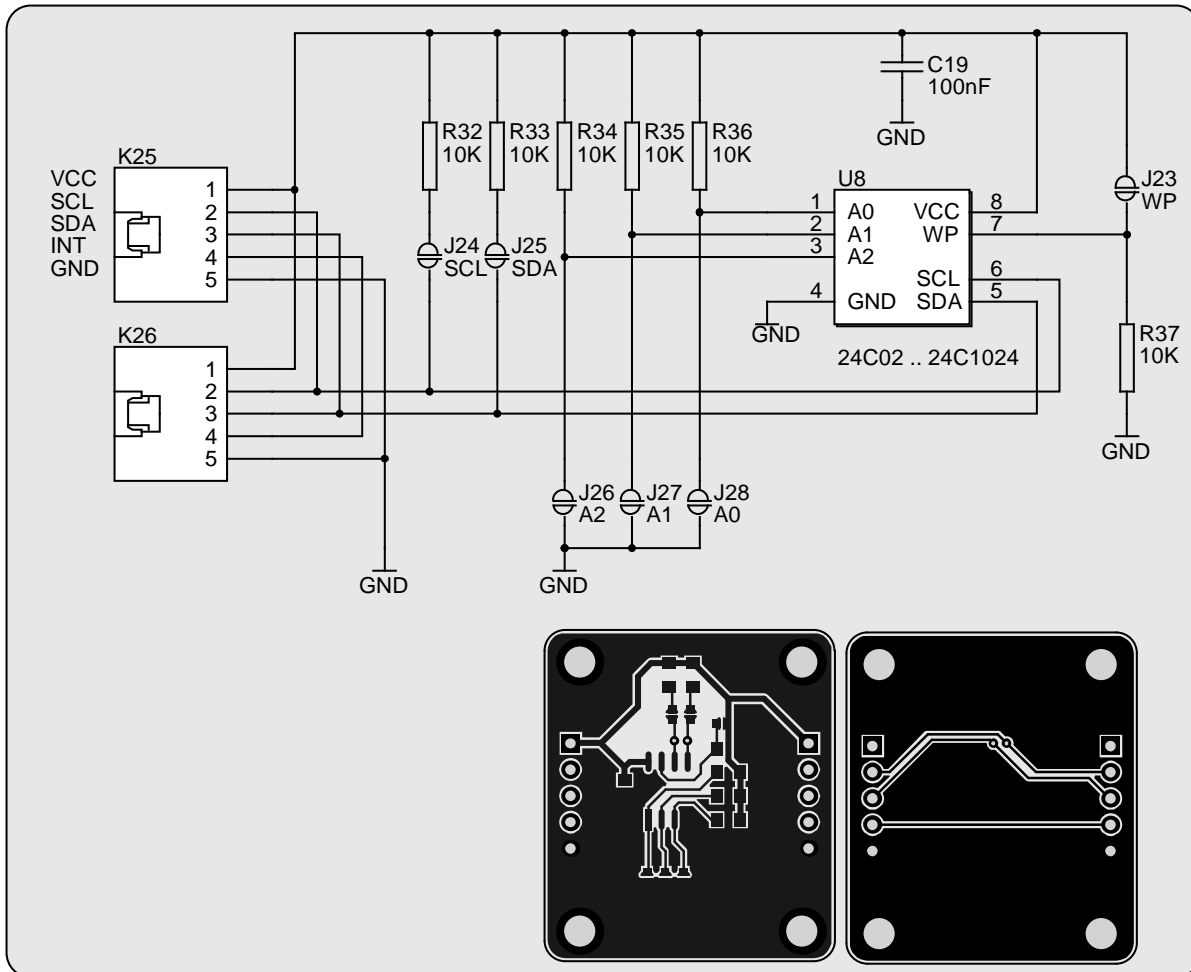


5.4. BILL OF MATERIALS

	Description	Digikey Order Code
C43	1000uF 25v radial electrolytic 12mm body	P13121-ND
C46	220uF 16v radial electrolytic 7mm body	P5139-ND
C44, C45	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
D42	Led yellow SMD PLCC-2 (TOPLED)	475-2562-1-ND
D41, D43	1N400x	1N4007FSCT-ND
U22	7805	497-1441-5-ND
R168	330 Ohm 0805	RMCF0805JT330RCT-ND
K53	DC power jack 3.5mm PCB mount	CP-057B-ND
K54, K55	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

6. LABSTICK 1-3: 24XXX EEPROM

6.1. SCHEMATIC

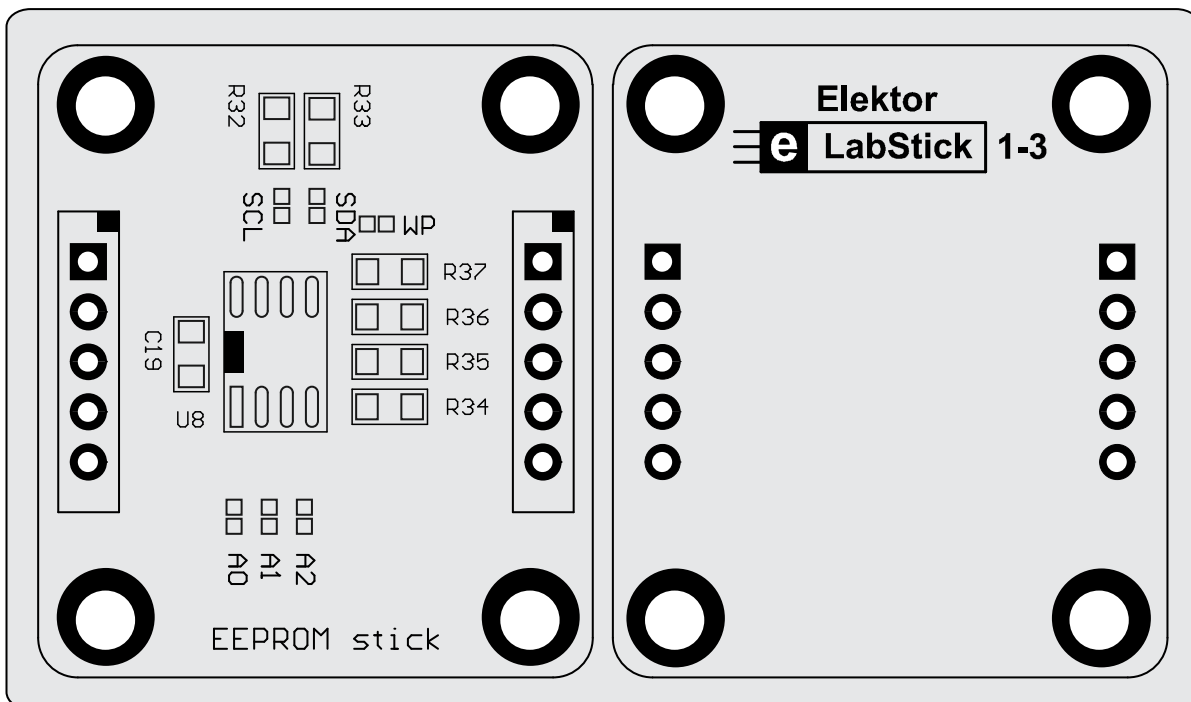


6.2. DEVICES

The table below gives an overview of the most commonly used devices. All these devices will fit the board.

DEVICE	SIZE	BASE ADDRESS	NOTES
PCA8581	128 * 8	1 0 1 0 A2 A1 A0	J63 MUST BE CLOSED
PCF8582	256 * 8	1 0 1 0 A2 A1 A0	J63 MUST BE CLOSED
PCF8594	512 * 8	1 0 1 0 A2 A1 P0	PAGED DEVICE, CLOSE J63
PCF8598	1024 * 8	1 0 1 0 A2 P1 P0	PAGED DEVICE, CLOSE J63
PCF85116	2048 * 8	1 0 1 0 P2 P1 P1	PAGED DEVICES
PCF85102	256 * 8	1 0 1 0 A2 A1 A0	NO WRITE PROTECT
PCF85103	256 * 8	0 0 1 0 A2 A1 A0	
24C01	128 * 8	1 0 1 0 A2 A1 A0	
24C02	256 * 8	1 0 1 0 A2 A1 A0	
24C04	512 * 8	1 0 1 0 A2 A1 P0	PAGED DEVICE
24C08	1024 * 8	1 0 1 0 A2 P1 P0	PAGED DEVICE
24C16	2048 * 8	1 0 1 0 P2 P1 P0	PAGED DEVICE
24C32	4096 * 8	1 0 1 0 A2 A1 A0	
24C64	8192 * 8	1 0 1 0 A2 A1 A0	
24C128	16384 * 8	1 0 1 0 A2 A1 A0	
24C256	32768 * 8	1 0 1 0 A2 A1 A0	
24C512	65536 * 8	1 0 1 0 A2 A1 A0	
24C1024	131072 * 8	1 0 1 0 A2 A1 P0	PAGED DEVICE

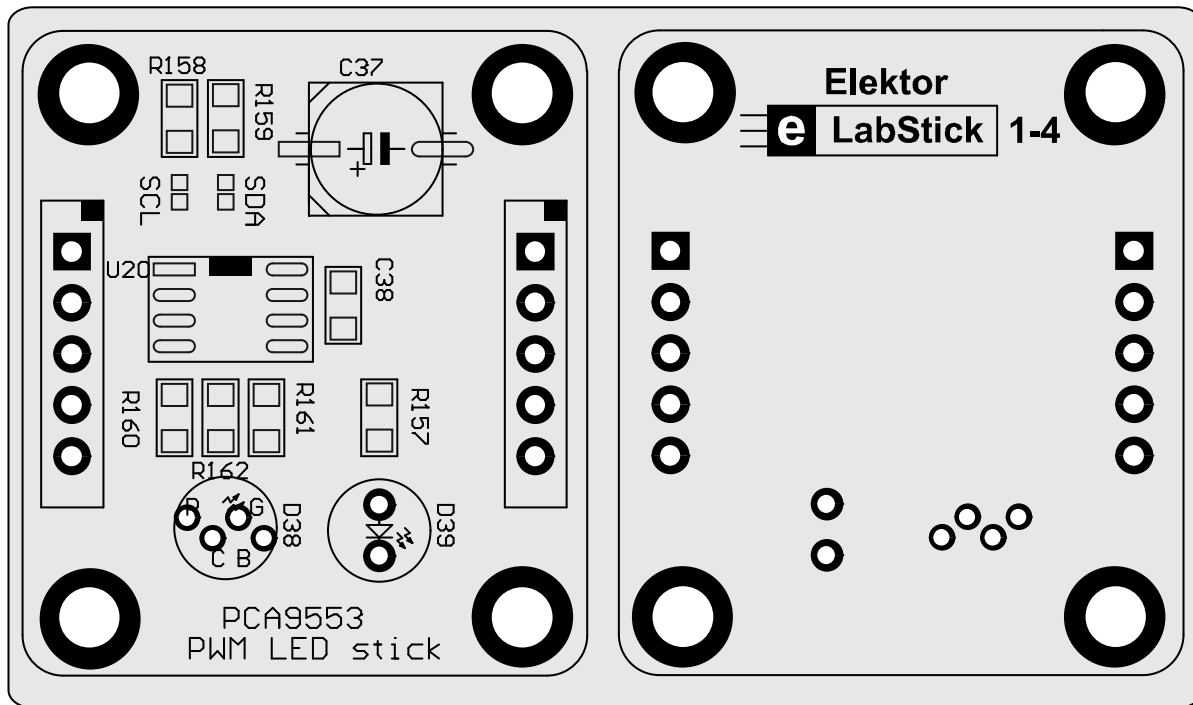
6.3. ASSEMBLY DRAWING



6.4. BILL OF MATERIALS

	Description	Digikey Order Code
R32, R33, R34, R35, R36, R37	10K ohm SMD 0805	RMCF0805JT10K0CT-ND
C19	100nF 25V X7R ceramic capacitor SMD 0805	PCC1812CT-ND
U8	2401 ... 24512 / PCF 8581, PCF8582 I2C EEPROM	
	M24C01-WMN6TP	497-8631-1-ND
	M24C02-WMN6TP	497-8552-1-ND
	M24C04-WMN6TP	497-5671-1-ND
	M24C08-WMN6TP	497-8554-1-ND
	M24C16-RMN6TP	497-8640-1-ND
	M24C32-WMN6TP	497-5027-1-ND
	M24C64-WMN6TP	497-8650-1-ND
	CAT24C128WI-GT3	CAT24C128WI-GT3CT-ND
	CAT24C256WI-G	CAT24C256WI-G-ND
	CAT24C512WI-GT3	CAT24C512WI-GT3OSCT-ND
K25, K26	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

7.2. ASSEMBLY DRAWING

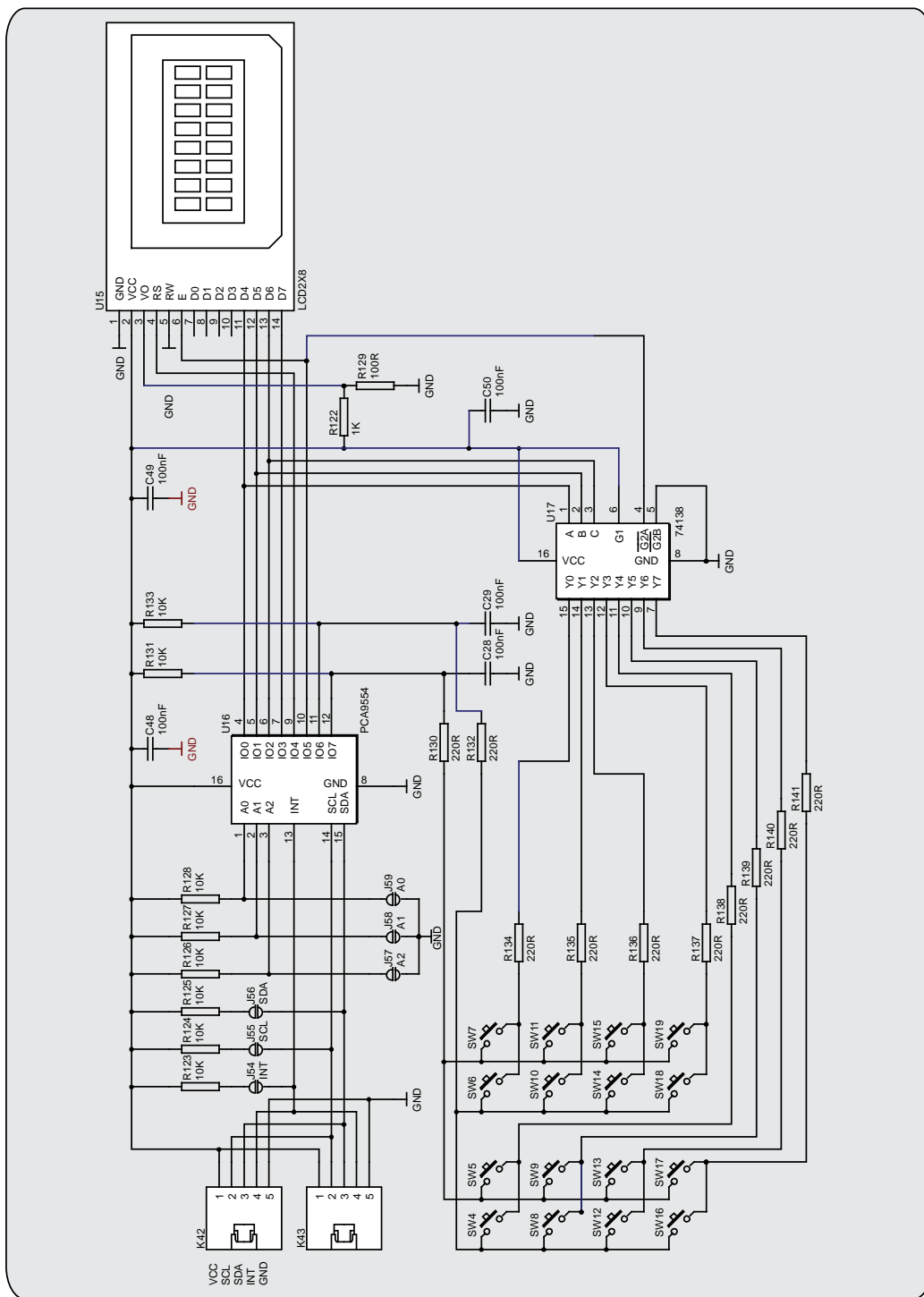


7.3. BILL OF MATERIALS

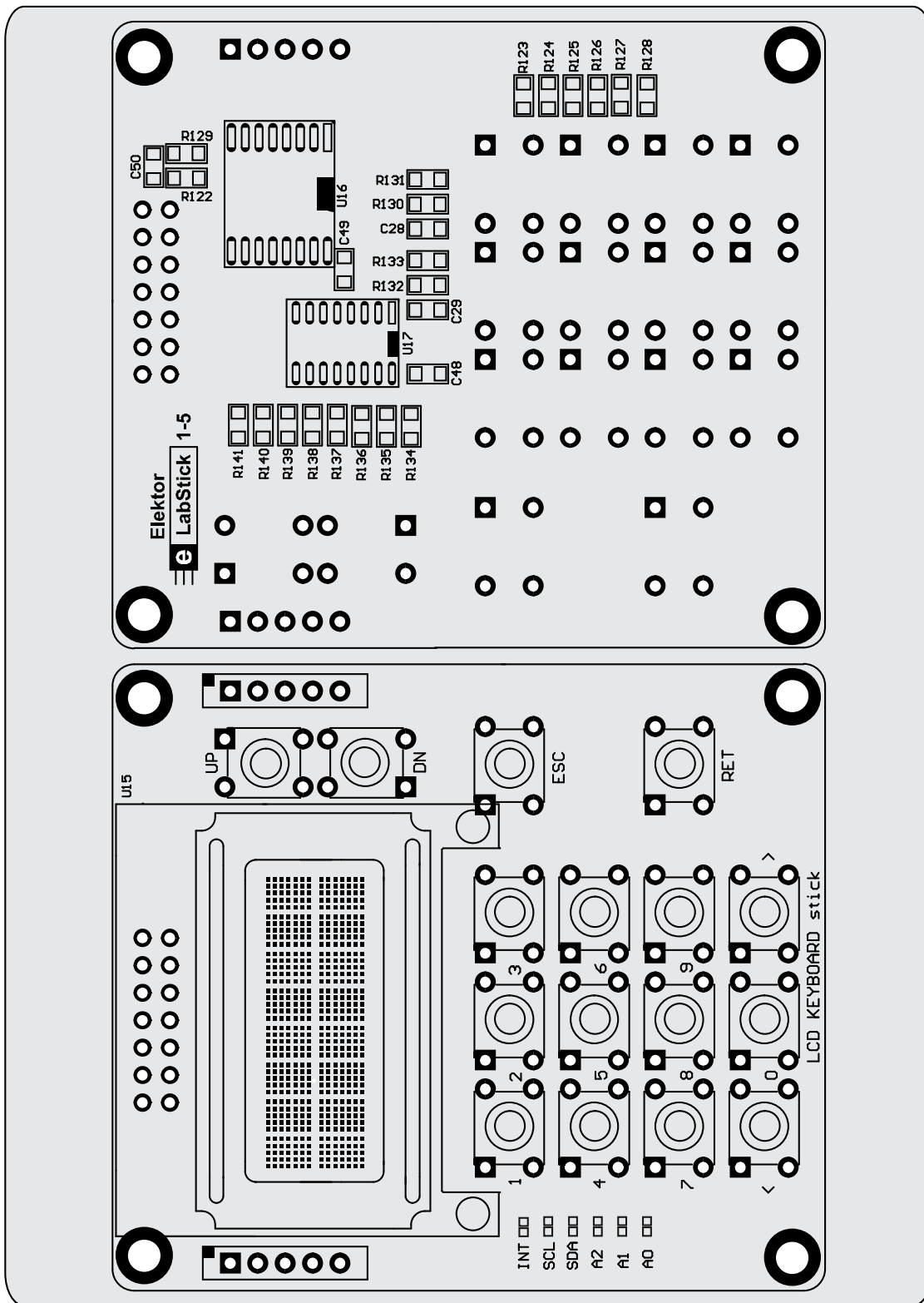
	Description	Digikey Order Code
R158, R159	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
R157, R160, R161, R162	150 Ohm SMD 0805	RMCF0805JT150RCT-ND
C38	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
C37	47uF 16V SMD	PCE4000CT-ND
U20	PCA9533 or PCA9553	568-3372-5-ND 568-3391-5-ND
D39	LED WHITE 5MM	1080-1004-ND
D38	LED RGB 5MM Common ANODE	
K49, K50	100 mils (2.54mm) pins. Strip 5 pins.	WM6436-ND

8. LABSTICK 1-5: LCD / KEYBOARD USER INTERFACE

8.1. SCHEMATIC



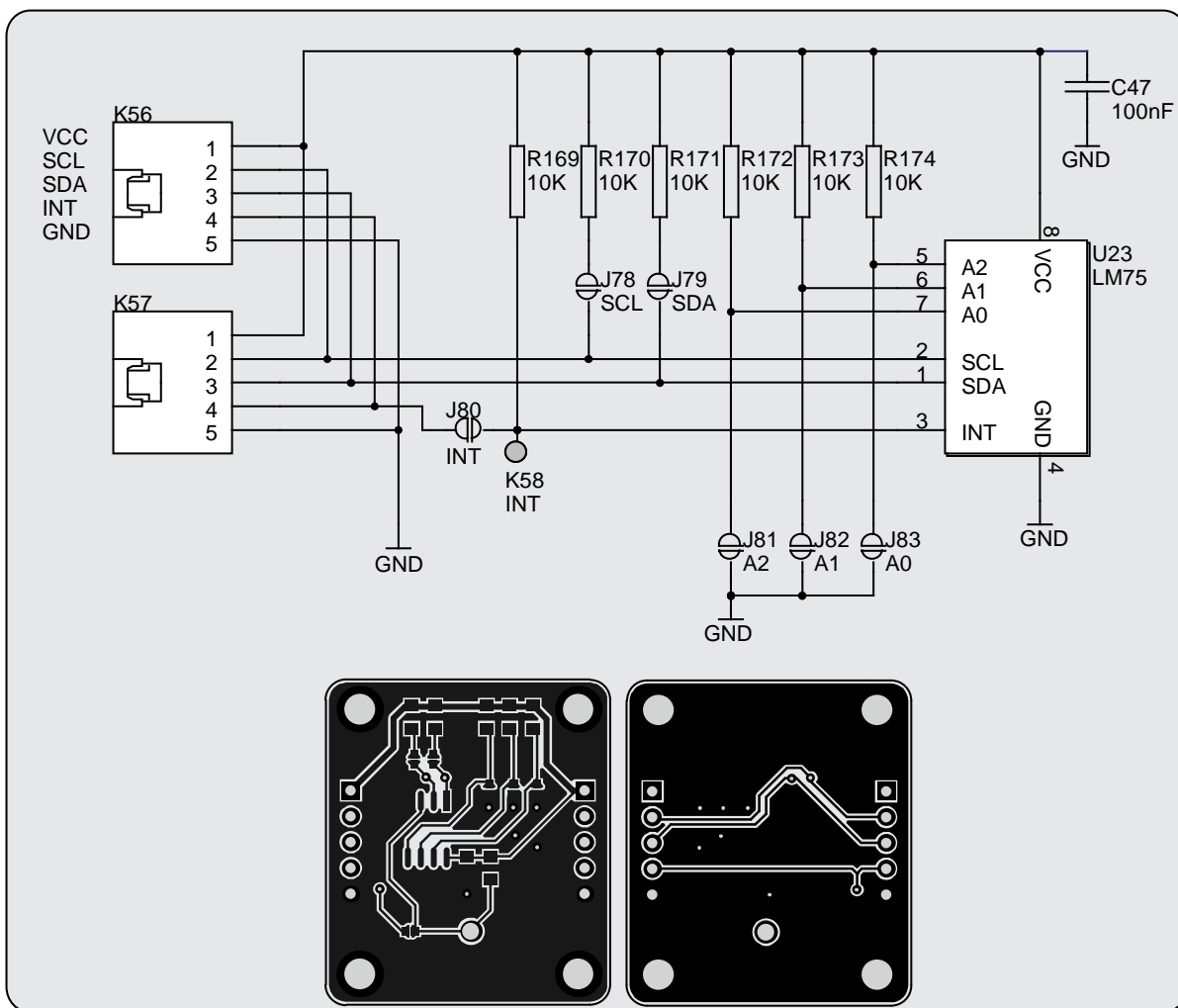
8.2. ASSEMBLY DRAWING



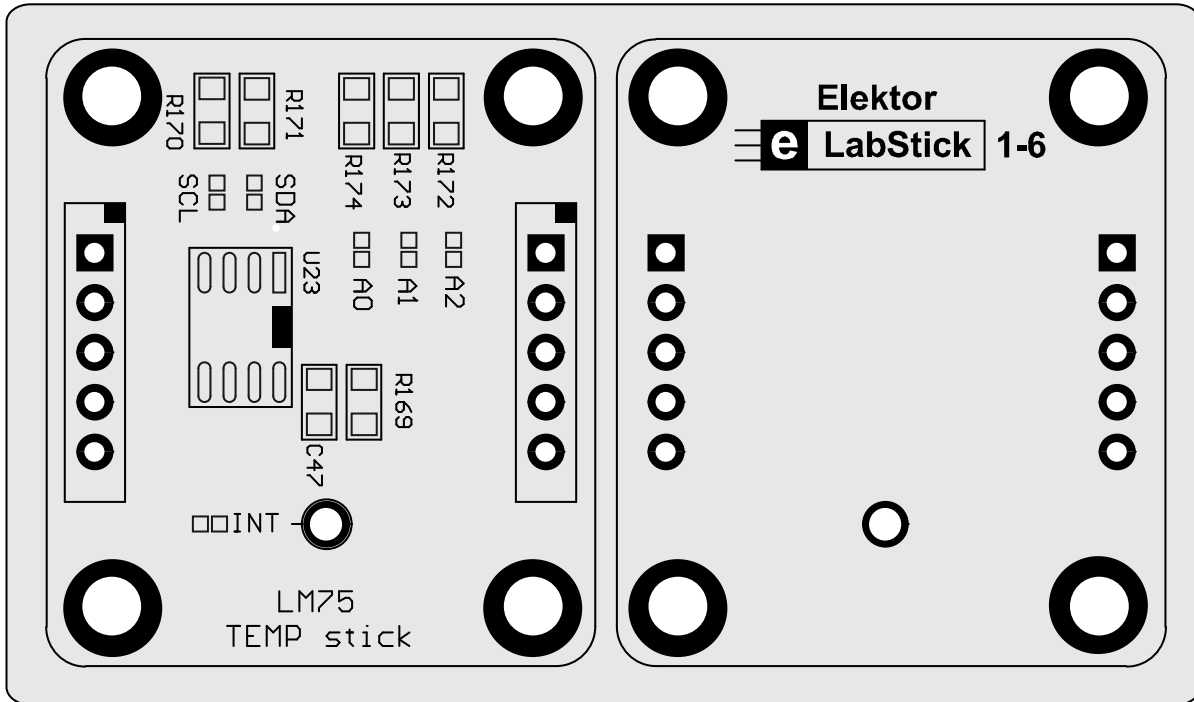
8.3. BILL OF MATERIALS

	Description	Digikey Order Code
R123, R124, R125, R126, R127, R128, R131, R133	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
R130, R132, R134, R135, R136, R137, R138, R139, R140, R141	220 Ohm SMD 0805	RMCF0805JT220RCT-ND
R122	1K Ohm SMD 0805	RMCF0805JT1K00CT-ND
R129	100 Ohm SMD 0805	RMCF0805JT100RCT-ND
C48, C49, C50, C28, C29	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
U16	PCA9554 or PCF8574	568-1053-5-ND 568-1076-5-ND
U17	74HCT138 SO-16 PACKAGE	568-1512-1-ND
SW4 ... SW19	6x6 MM pushbutton.	SW405-ND
	Cap for above buttons	
	Orange	SW845-ND
	Blue	SW250-ND
	Yellow	SW249-ND
	Red	SW252-ND
	White	SW251-ND
	Green	SW450-ND
	Black	SW451-ND
K42, K43	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

9. LABSTICK 1-6: LM75 (A) TEMPERATURE SENSOR



9.1. ASSEMBLY DRAWING



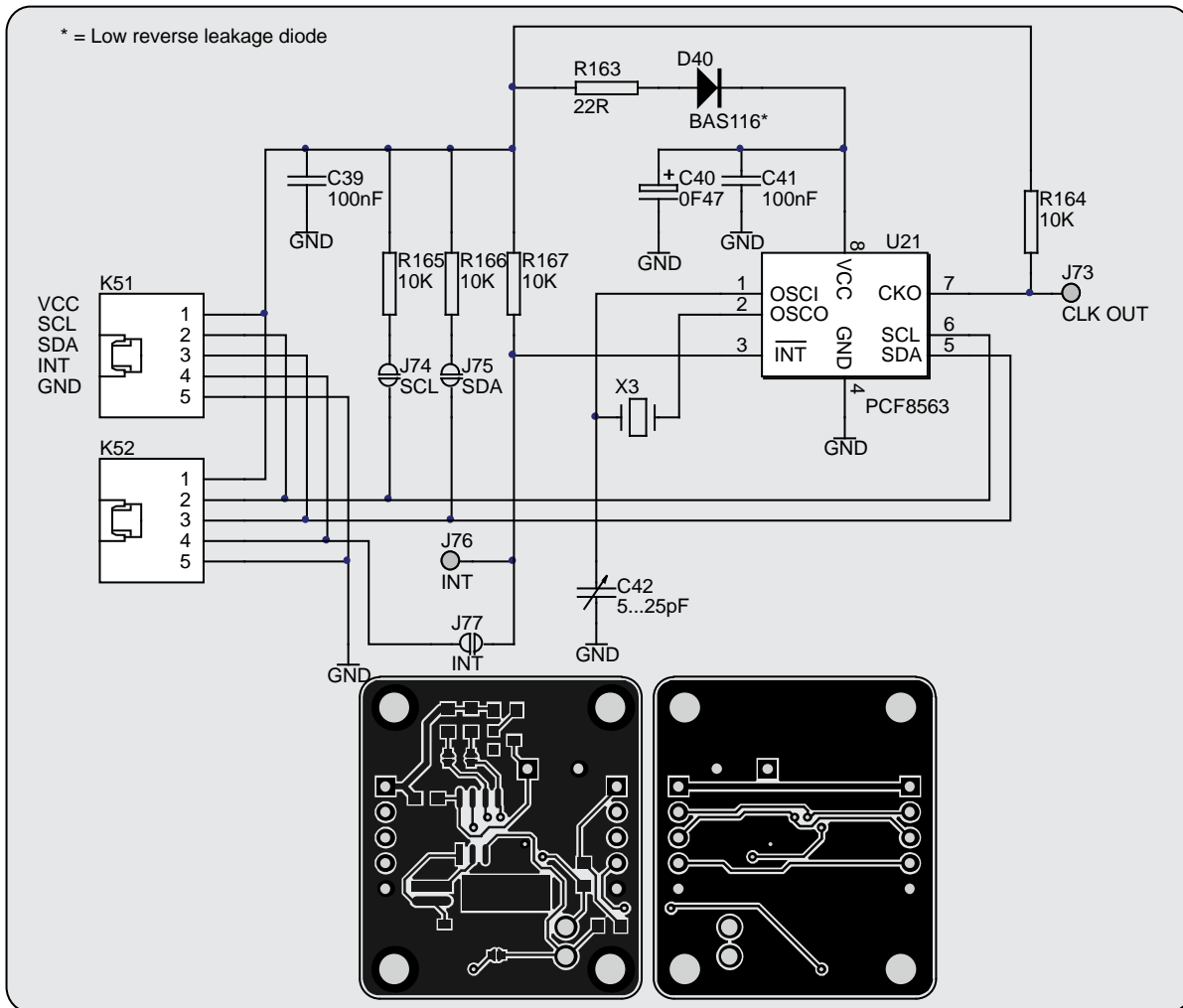
9.2. BILL OF MATERIALS

	Description	Digikey Order Code
R169, R170, R171, R17, R174	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
C47	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
U23	LM75 in SO-8 package	LM75AD,118-ND
K56, K57	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

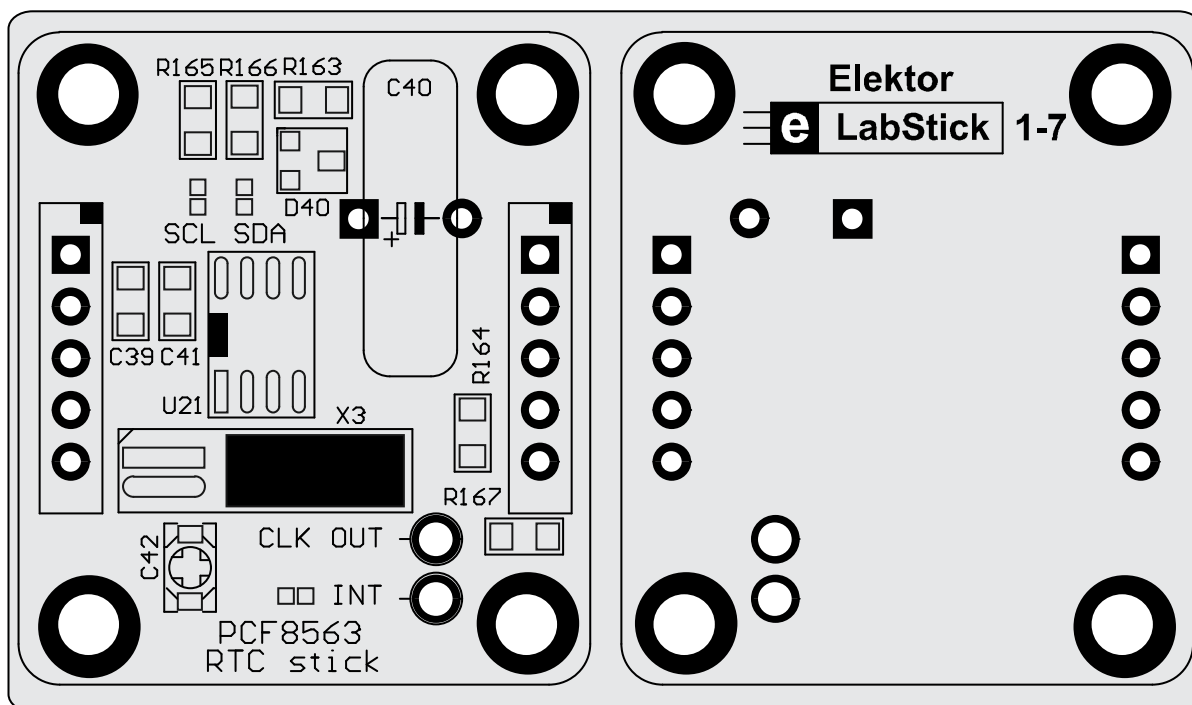
9.3. ERRATA

The text A2 and A0 for the address selection on the PCB is reversed. The correct order is A2 A1 A0.

10. LABSTICK 1-7: PCF8563 REALTIME CLOCK



10.1. ASSEMBLY DRAWING

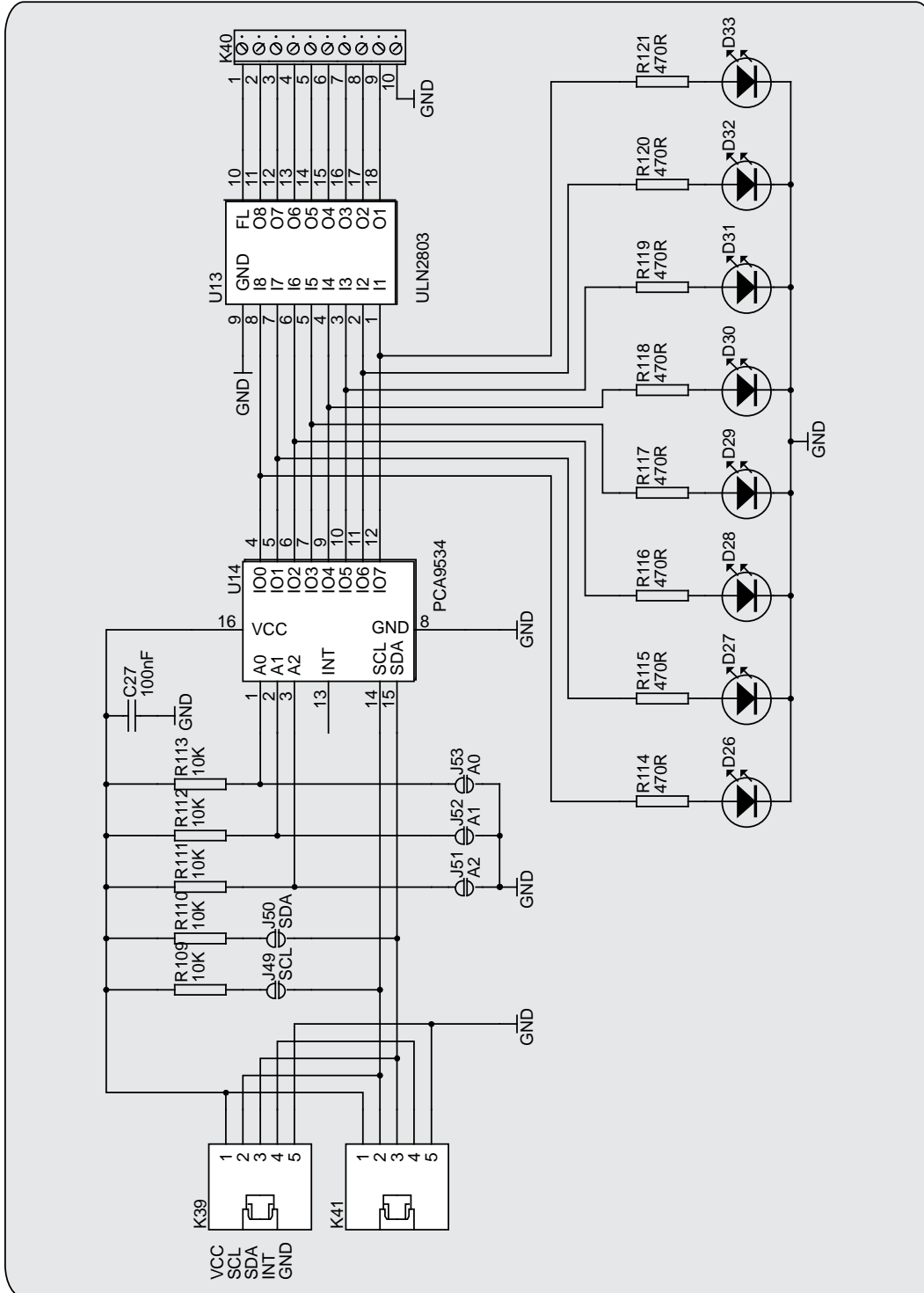


10.2. BILL OF MATERIALS

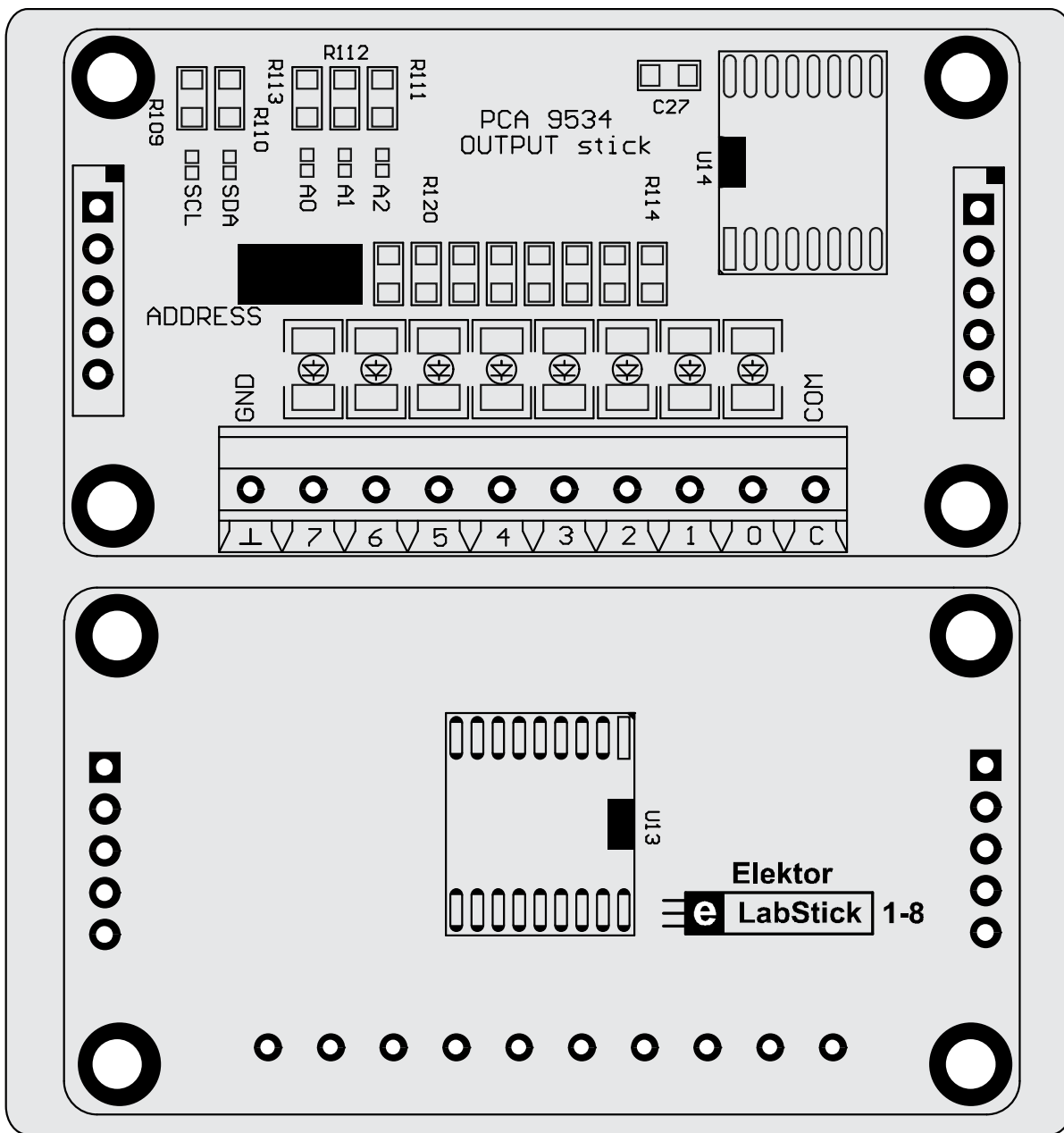
	Description	Digikey Order Code
R165, R166, R164, R167	10K ohm SMD 0805	RMCF0805JT10K0CT-ND
R163	22 ohm SMD 0805	RMCF0805JT22R0CT-ND
C40	0.47F 5.5V vertical supercap	P6974-ND
C39, C41	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
C42	22pF trim capacitor SMD	490-2004-1-ND
D40	BAS116 Schottky diode SOT23	BAS116-FDICT-ND
U21	PCF8563	568-6650-1-ND
K51, K52	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND
X3	32.768 KHz watch crystal	535-9032-ND

11. LABSTICK 1-8: 8-BIT PROTECTED OUTPUT

11.1. SCHEMATIC



11.2. ASSEMBLY

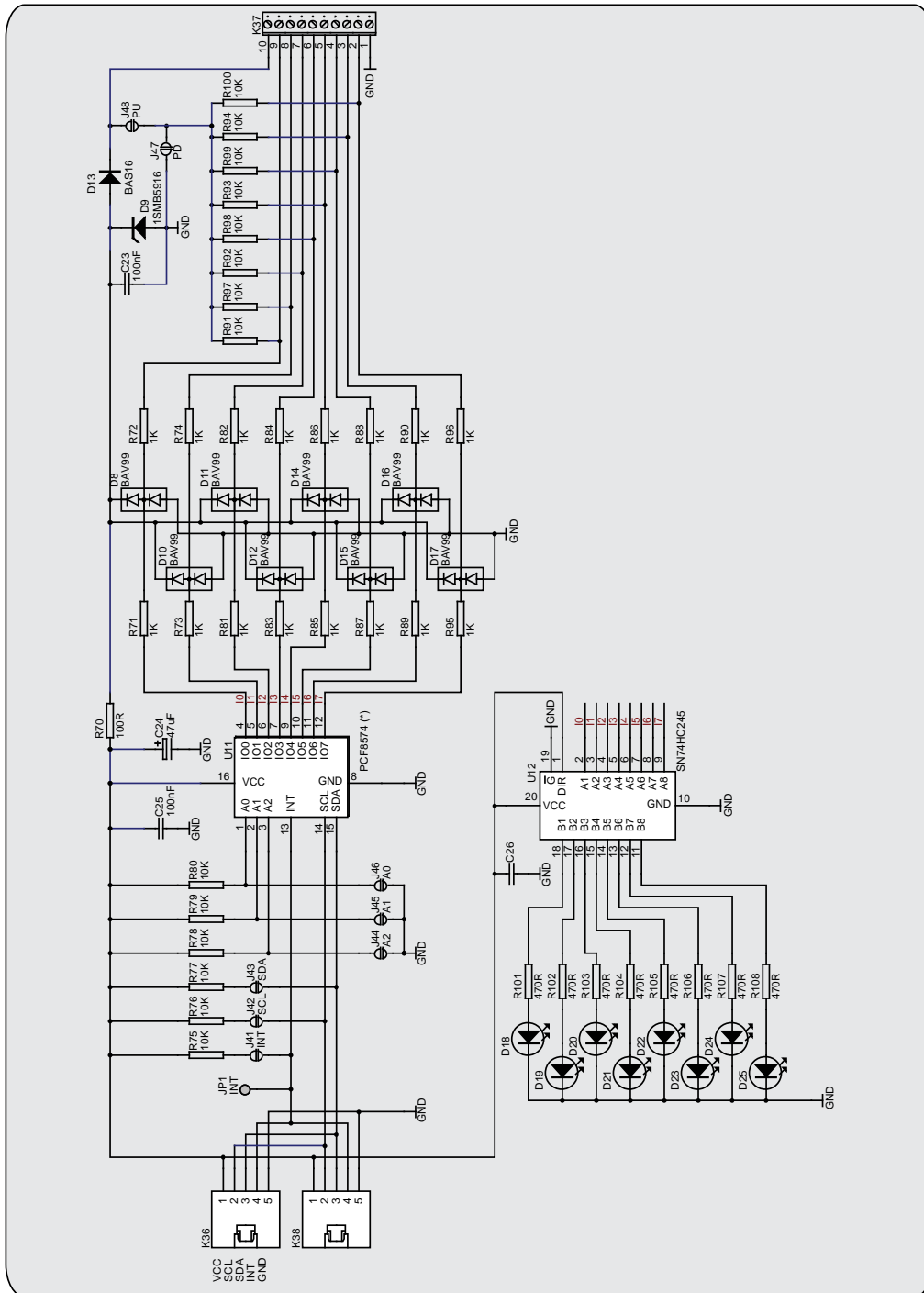


11.3. BILL OF MATERIALS

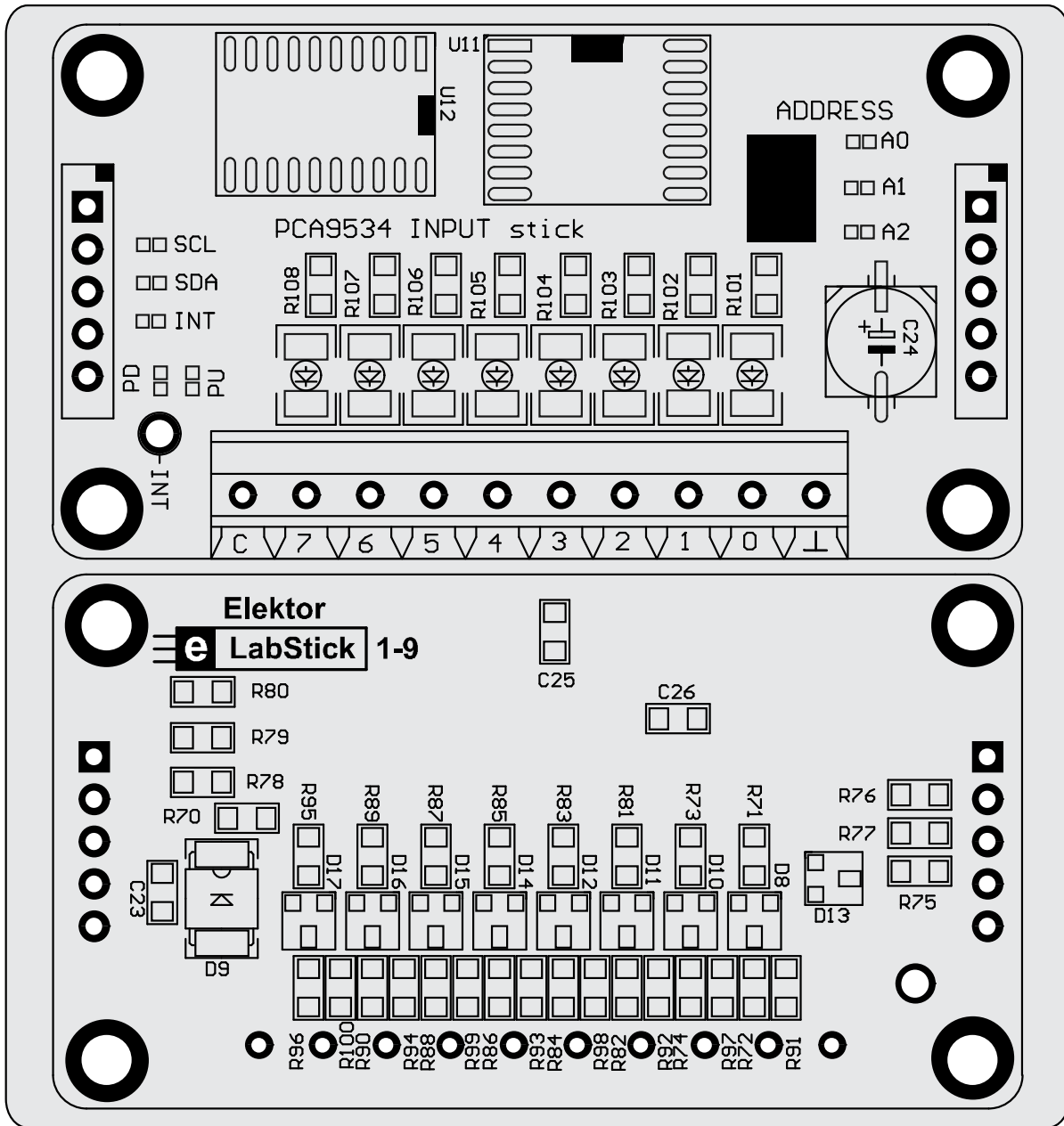
	Description	Digikey Order Code
R109, R110, R111, R112, R113	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
R114, R115, R116, R117, R118, R119, R120, R121	470 Ohm SMD 0805	RMCF0805JT470RCT-ND
C27	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
D26, D27, D28, D29, D30, D31, D32, D33	LED, Colour of choice PLCC-2 PACKAGE (TOPLED)	475-2562-1-ND
U14	PCA9534	568-1833-1-ND
U13	ULN2803	296-15777-1-ND
K39, K41	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND
K40	TERMINAL BLOCK	609-3926-ND

12. LABSTICK 1-9: 8-BIT PROTECTED INPUT

12.1. SCHEMATIC



12.2. ASSEMBLY DRAWING

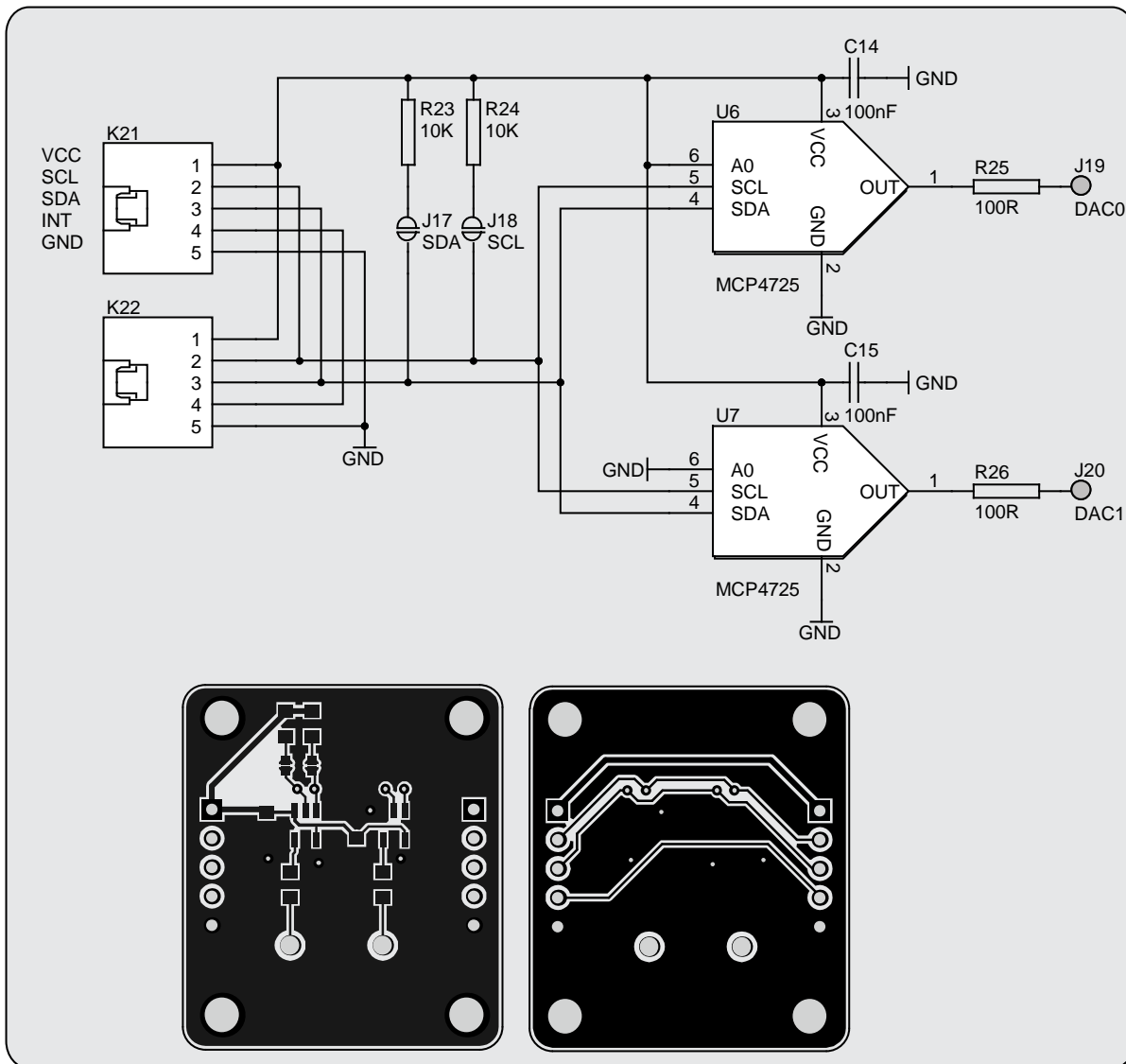


12.3. BILL OF MATERIALS

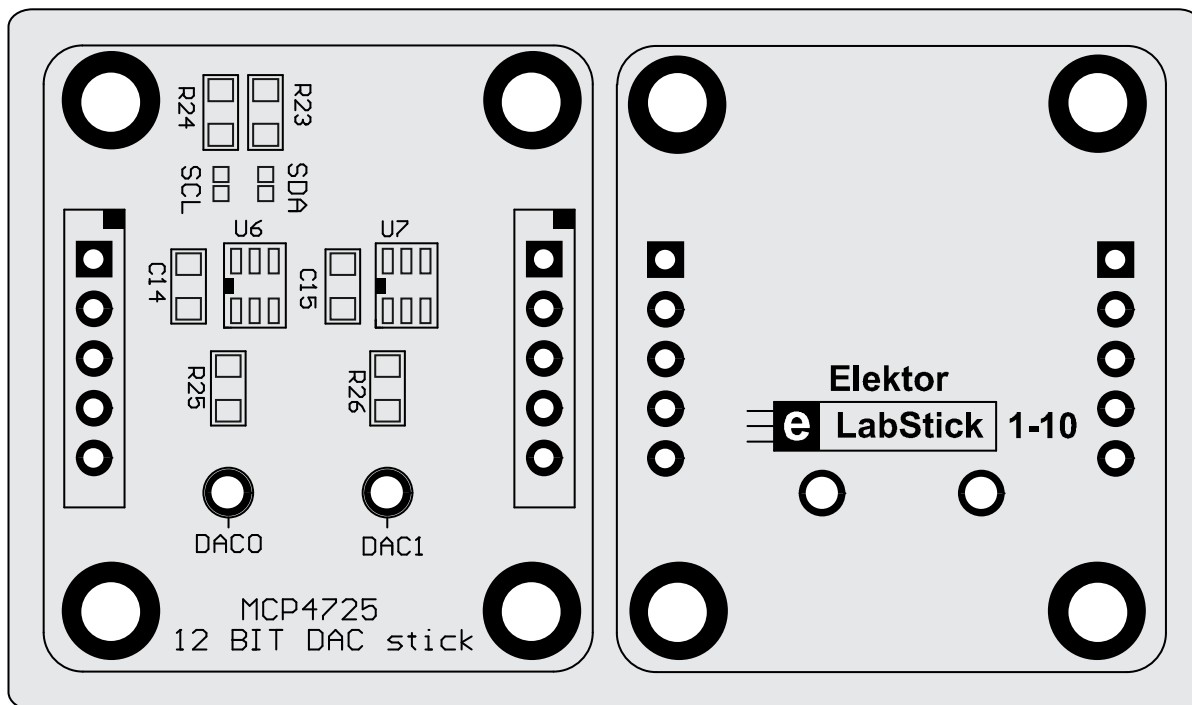
	Description	Digikey Order Code
R71, R72, R73, R74, R81, R82, R93, R84, R85, R86, R87, R88, R89, R90, R95, R96	1K Ohm SMD 0805	RMCF0805JT1K00CT-ND
R75, R76, R77, R78, R79, R80, R91, R92, R93, R94, R97, R98, R99, R100	10K Ohm SMD 0805	RMCF0805JT10K0CT-ND
R101, R102, R103, R104, R105, R106, R107, R108	470 Ohm SMD 0805	RMCF0805JT470RCT-ND
R70	100 Ohm SMD 0805	RMCF0805JT100RCT-ND
C23, C25, C26	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
C24	47uF 16V Electrolytic	PCE4000CT-ND
D9	Zener diode 4.3V SMB package	1SMB5916BT3GOSCT-ND
D8, D10, D11, D12, D14, D15, D16, D17	BAV99 DUAL DIODE SOT-23	568-1624-1-ND
D13	MMBD4148 in SOT23	MMBD4148-FDICT-ND
D18, D19, D20, D21, D22, D23, D24, D25	LED PLCC 2 (TOPLD) PACKAGE. Colour to your liking Red, Green Orange Yellow Blue can be used if the board runs on 5 volts.	475-1180-1-ND 475-2679-1-ND 475-2745-1-ND 475-2562-1-ND 475-1387-1-ND
U11	PCF8574 or pin compatible I/O expander PCF8574A	568-1076-5-ND 568-1074-1-ND
U12	74HC245 or 74HCT245 in SO20 narrow package (5.3mm) Made by Texas Instruments, ON semi and Fairchild.	MM74HC245ASJ-ND MM74HCT245SJ-ND
K36, K38	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND
K54	TERMINAL BLOCK	609-3926-ND

13. LABSTICK 1-10: MCP4725 D/A CONVERTERS

13.1. SCHEMATIC



13.2. ASSEMBLY DRAWING

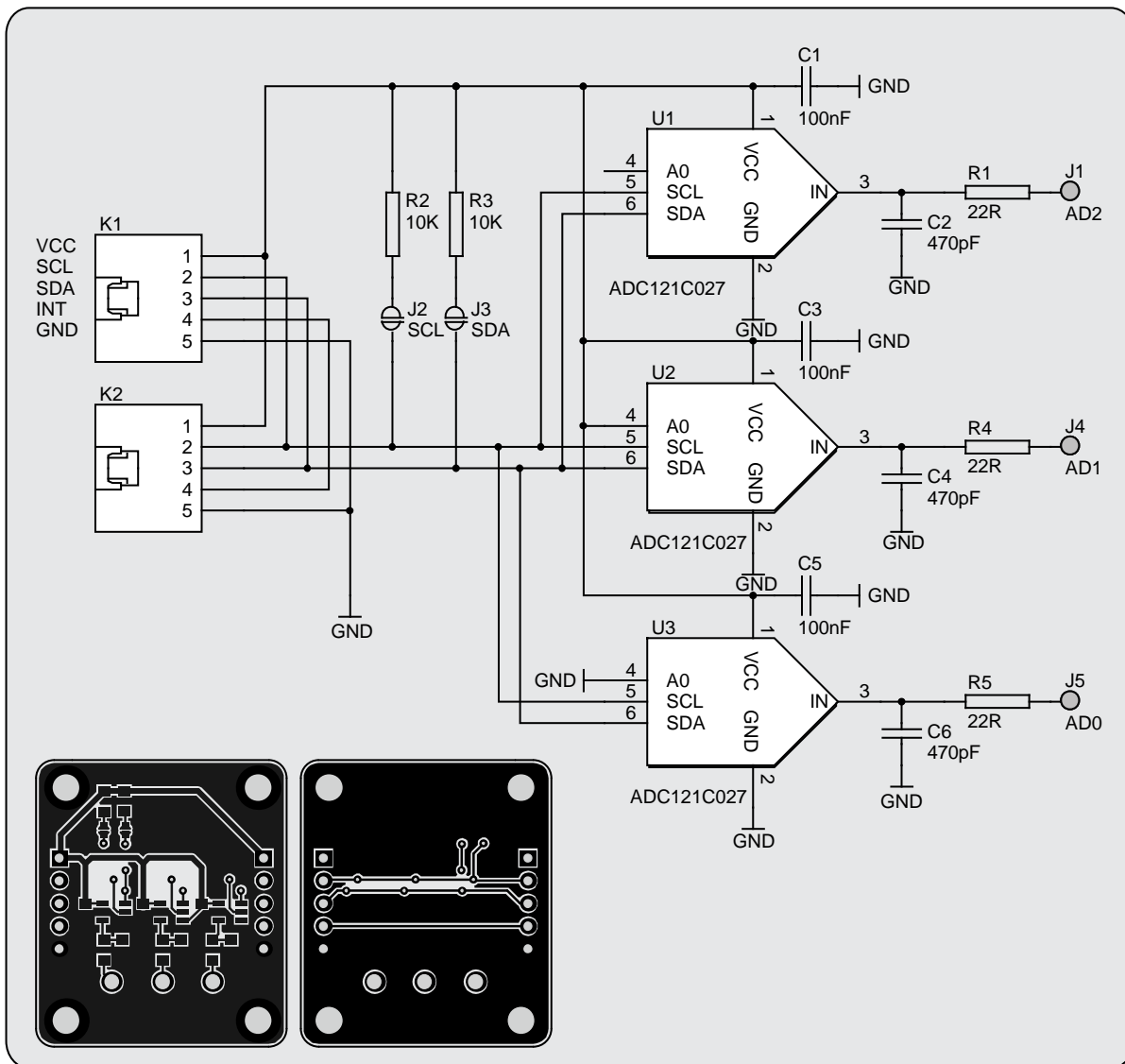


13.3. BILL OF MATERIALS

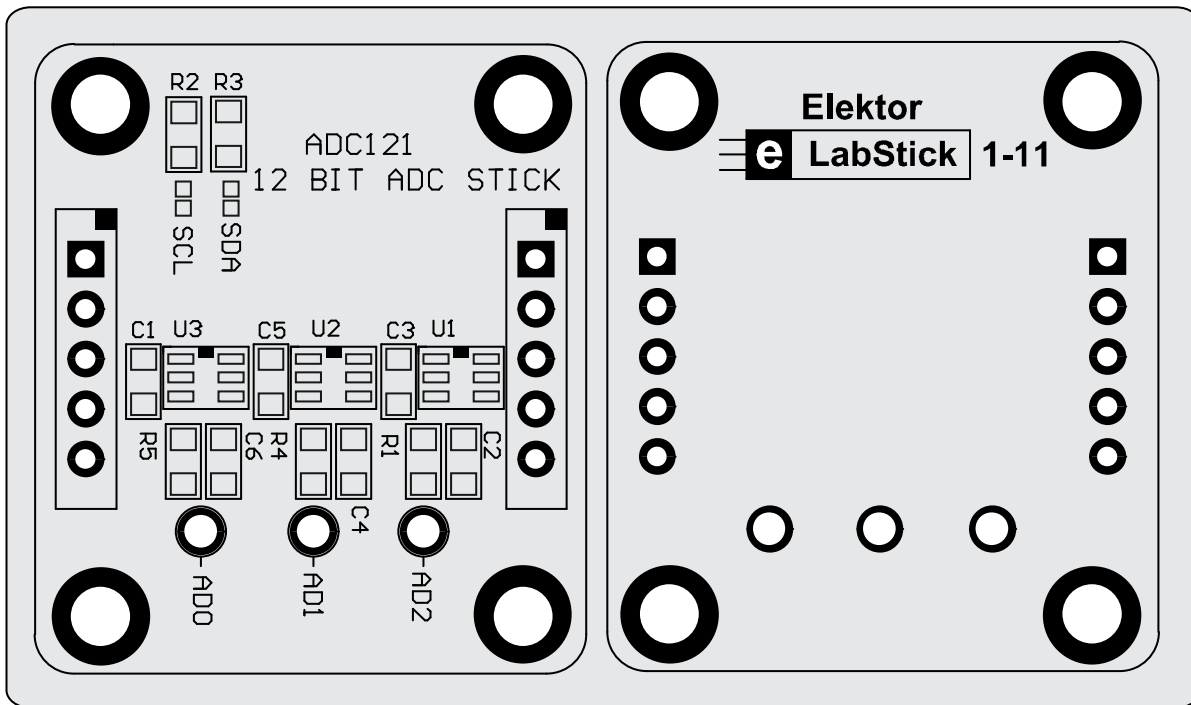
	Description	Digikey Order Code
R23, R24	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
R25, R26	100 Ohm SMD 0805	RMCF0805JT100RCT-ND
C14, C15	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
U6, U7	MCP4725 SOT23-6 PACKAGE Depending on the address you want	MCP4725A0T-E/CHCT-ND MCP4725A1T-E/CHCT-ND MCP4725A2T-E/CHCT-ND MCP4725A3T-E/CHCT-ND
K21, K22	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

14. LABSTICK 1-11: ADC081 / ADC101 / ADC121 A/D CONVERTERS

14.1. SCHEMATIC



14.2. ASSEMBLY DRAWING

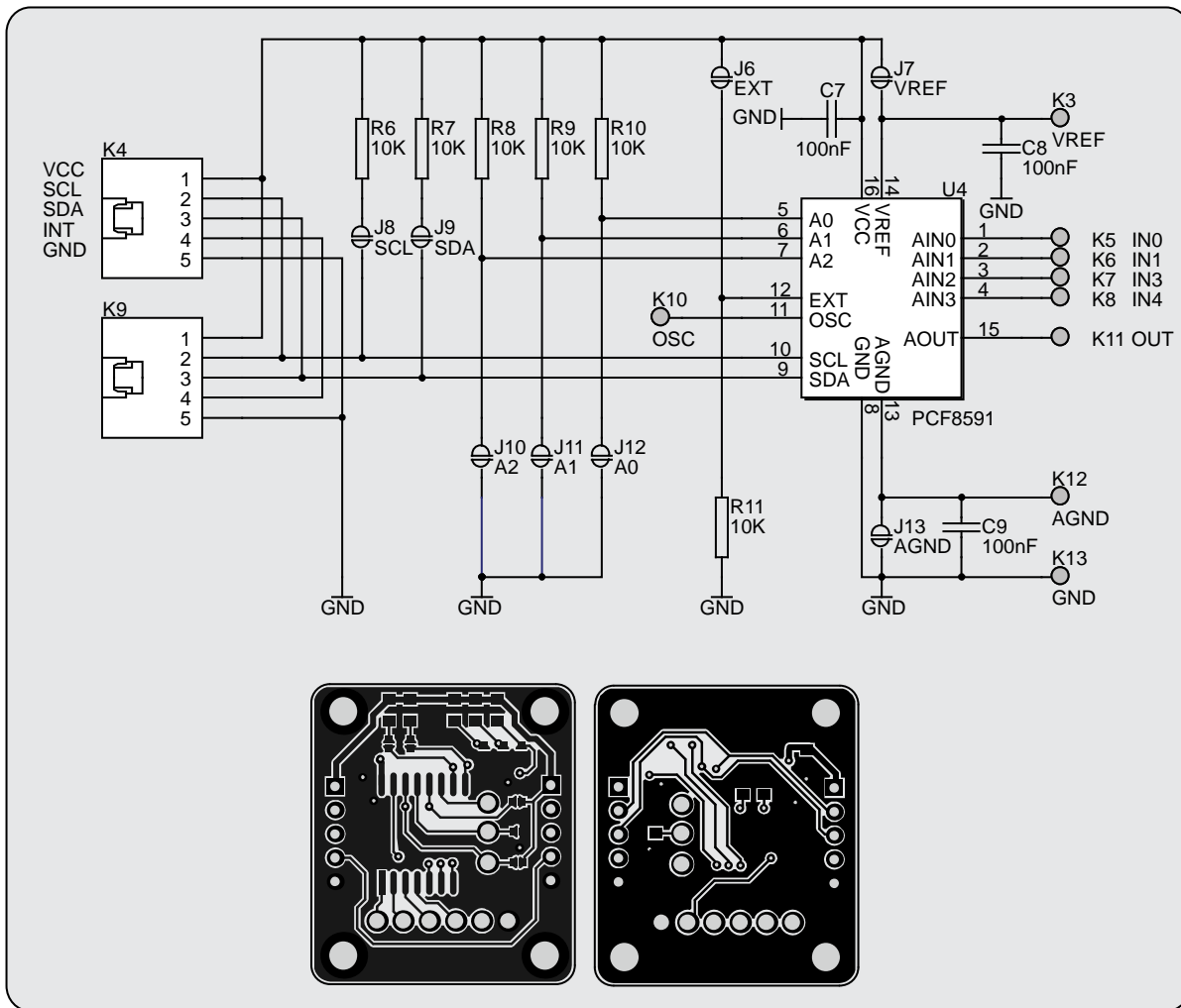


14.3. BILL OF MATERIALS

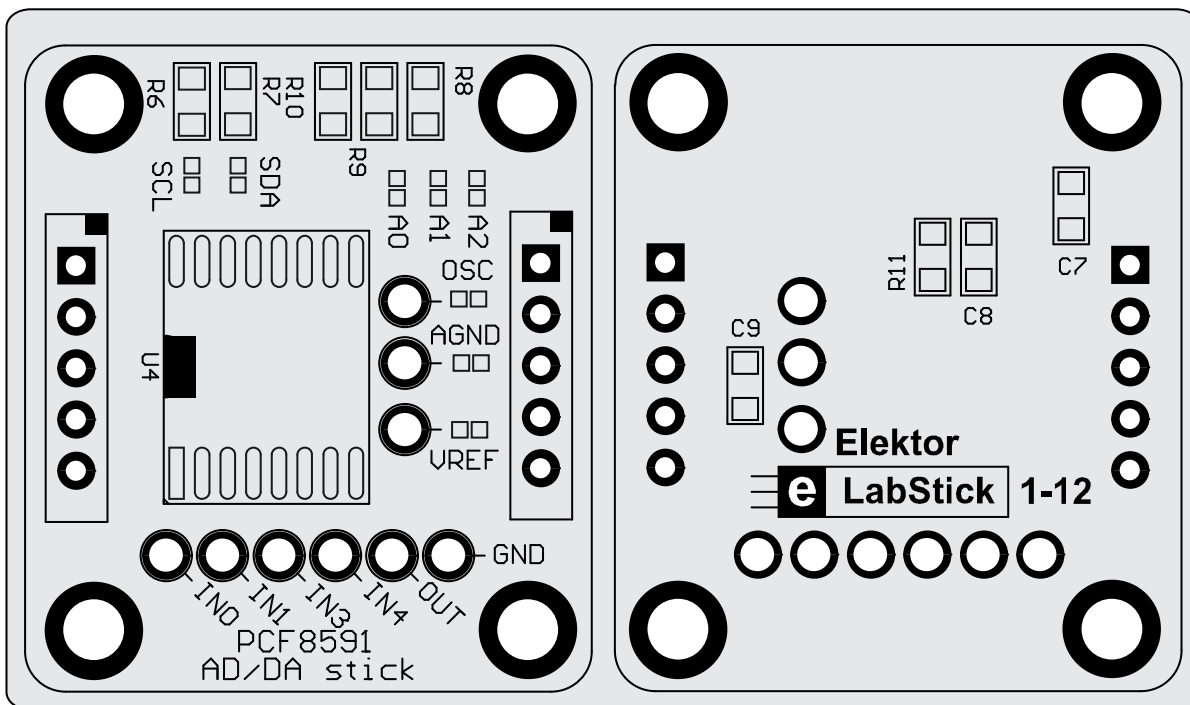
	Description	Digikey Order Code
R2, R3	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
R1, R4, R5	22 Ohm SMD 0805	RMCF0805JT22R0CT-ND
C1, C3, C5	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
C2, C4, C6	470pF 50V COG / NP0 SMD 0805	445-4134-1-ND
U1, U2, U3	ADC121C027 SOT23-6 PACKAGE 12 BIT ADC101C027 SOT23-6 PACKAGE 10 BIT ADC081C027 SOT23-6 PACKAGE 8 BIT	ADC121C027CIMKCT-ND ADC101C027CIMKCT-ND ADC081C027CIMKCT-ND
K1, K2	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

15. LABSTICK 1-12 PCF8591 COMBINED A/D AND D/A CONVERTER

15.1. SCHEMATIC



15.2. ASSEMBLY

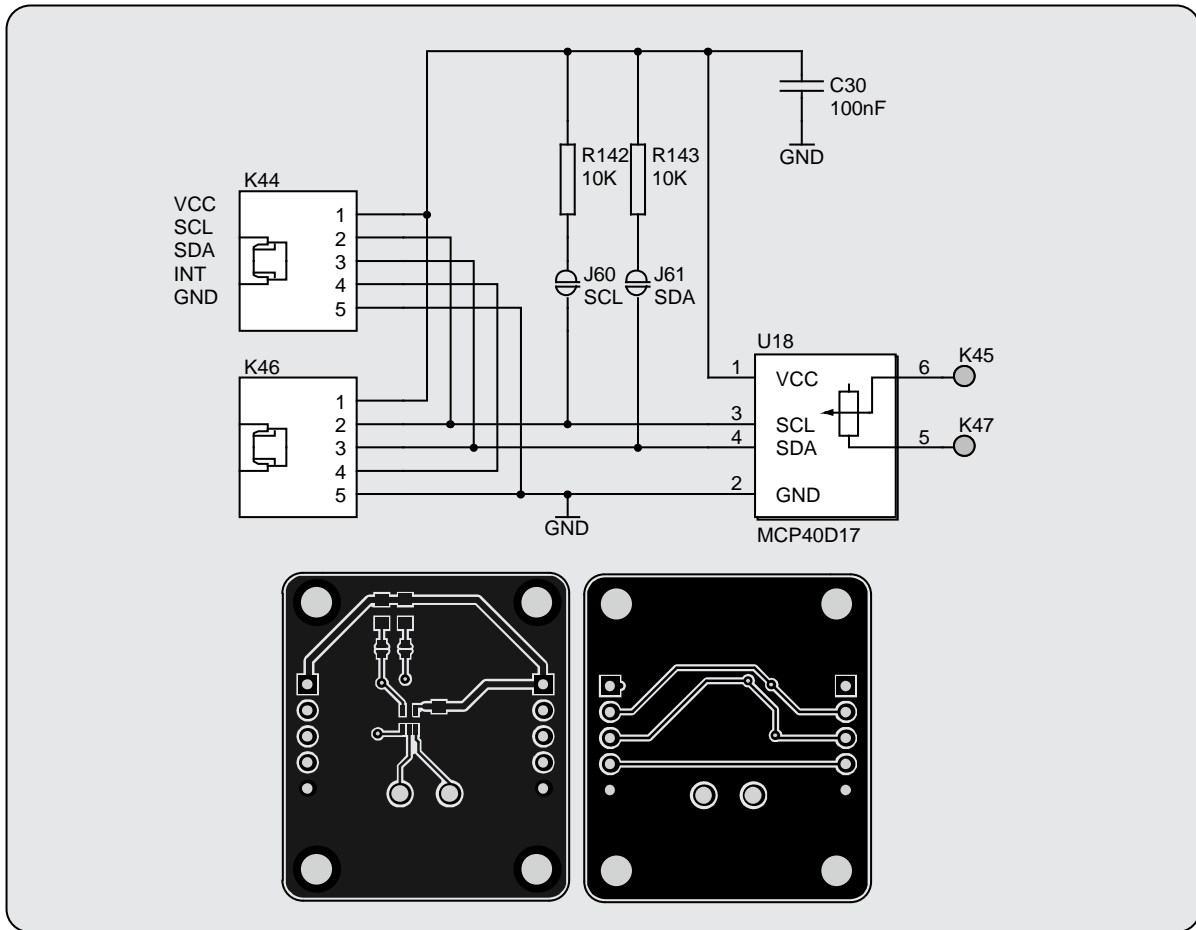


15.3. BILL OF MATERIALS

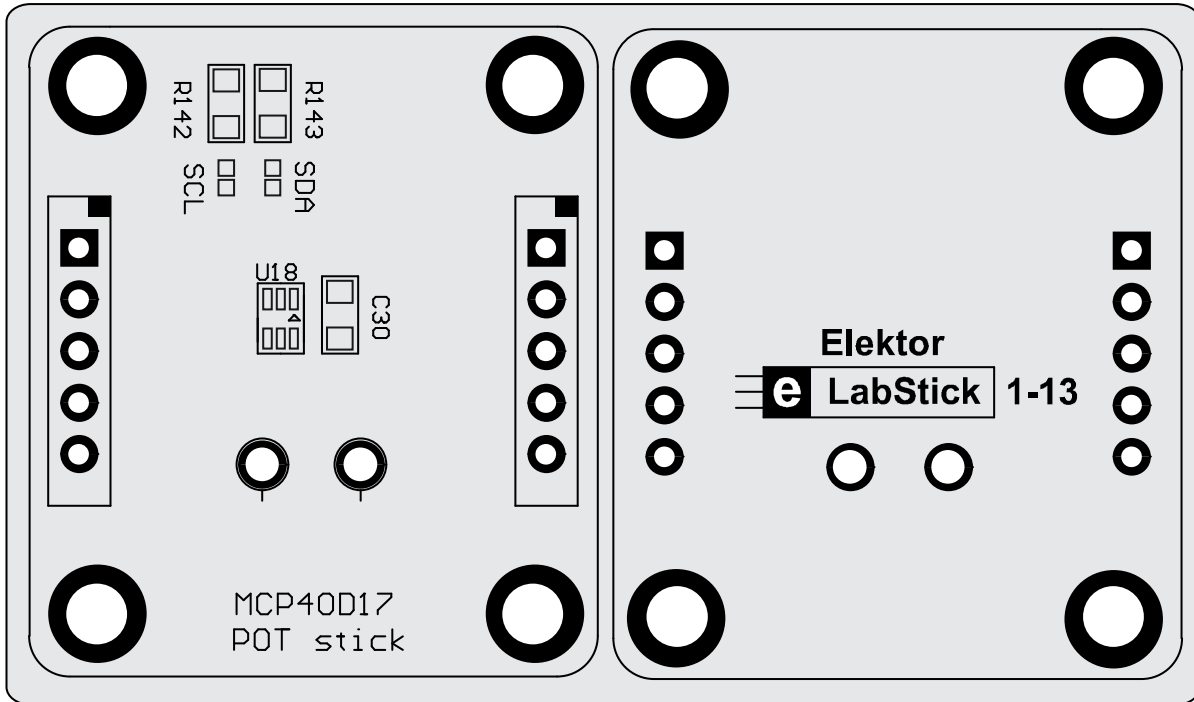
	Description	Digikey Order Code
R6, R7, R8, R9, R10, R11	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
C7, C8, C9	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
U4	PCF8591	568-1088-1-ND
K4, K9	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

16. LABSTICK 1-13: POTENTIOMETER

16.1. SCHEMATIC



16.2. ASSEMBLY DRAWING

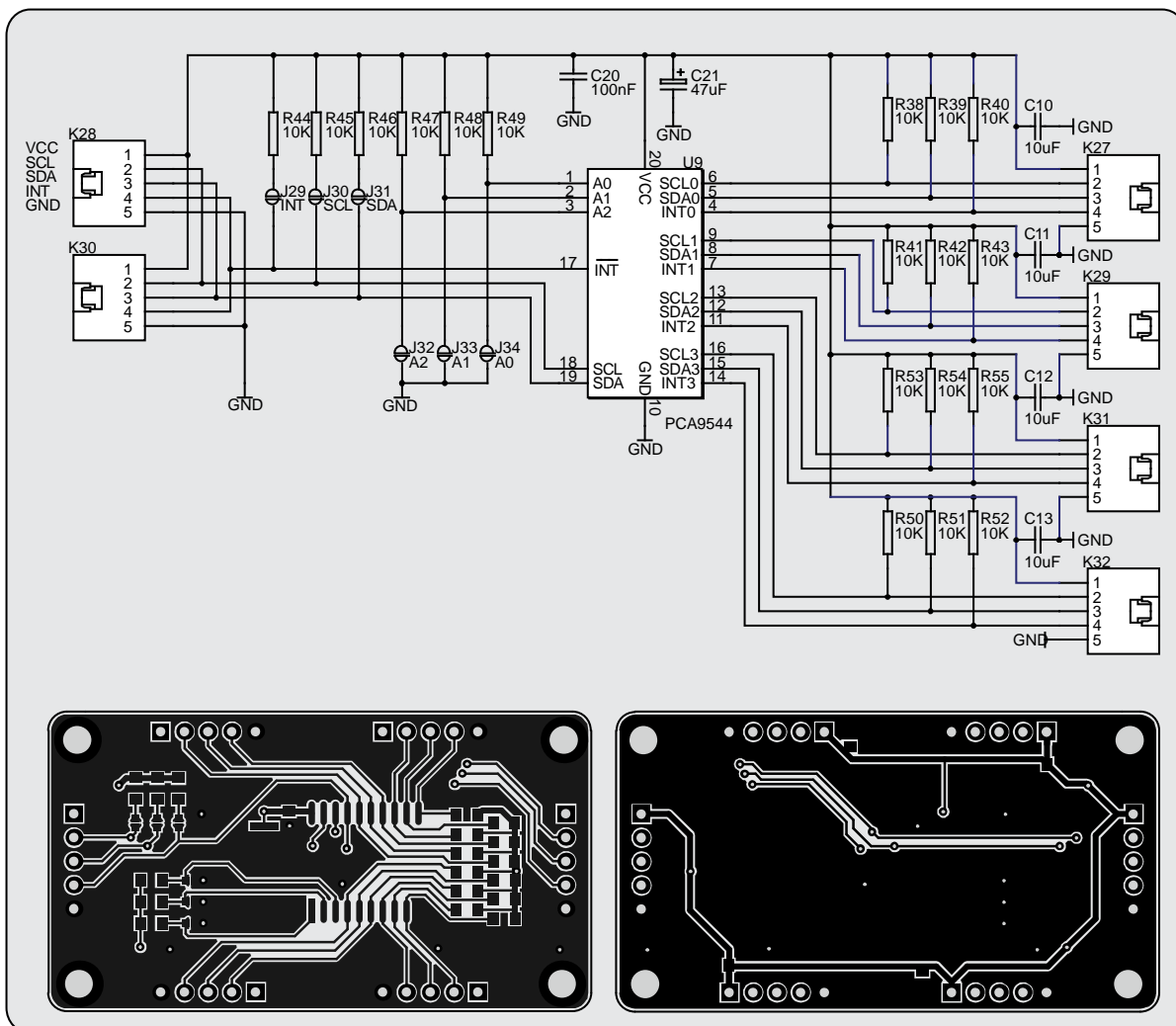


16.3. BILL OF MATERIALS

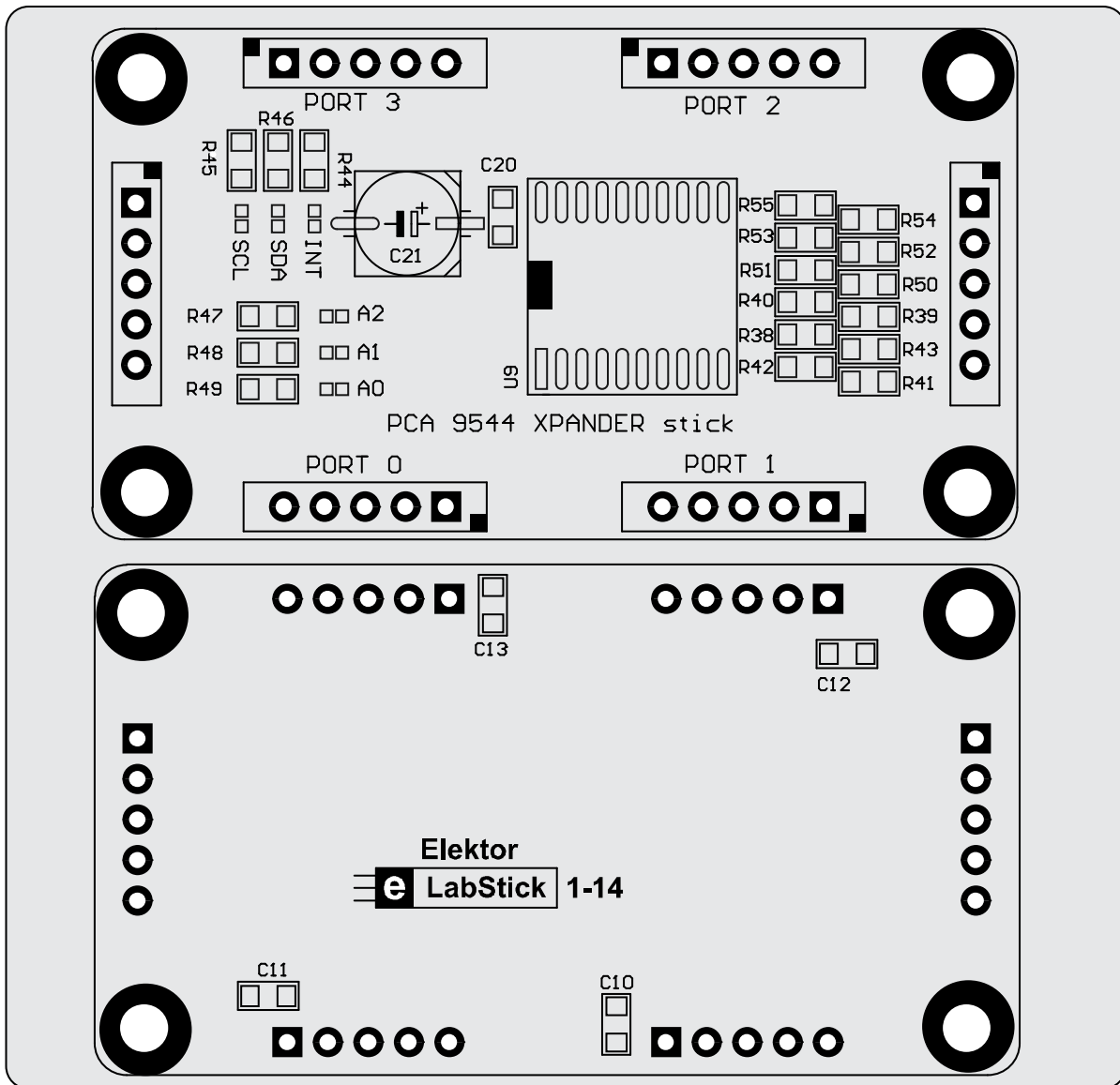
	Description	Digikey Order Code
R142, R143	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
C30	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
U18	MCP4017 in SC 70 package MCP4018 in SC 70 package MCP4019 in SC 70 package MCP40D17 in SC 70 package MCP40D18 in SC 70 package MCP40D19 in SC 70 package	MCP4017T-103E/LTCT-ND MCP4018T-103E/LTCT-ND MCP4019T-103E/LTCT-ND MCP40D17T-103E/LTCT-ND MCP40D18T-103E/LTCT-ND MCP40D19T-103E/LTCT-ND
K44, K46	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

17. LABSTICK 1-14: PCA9544 I2C MULTIPLEXER

17.1. SCHEMATIC



17.2. ASSEMBLY DRAWING

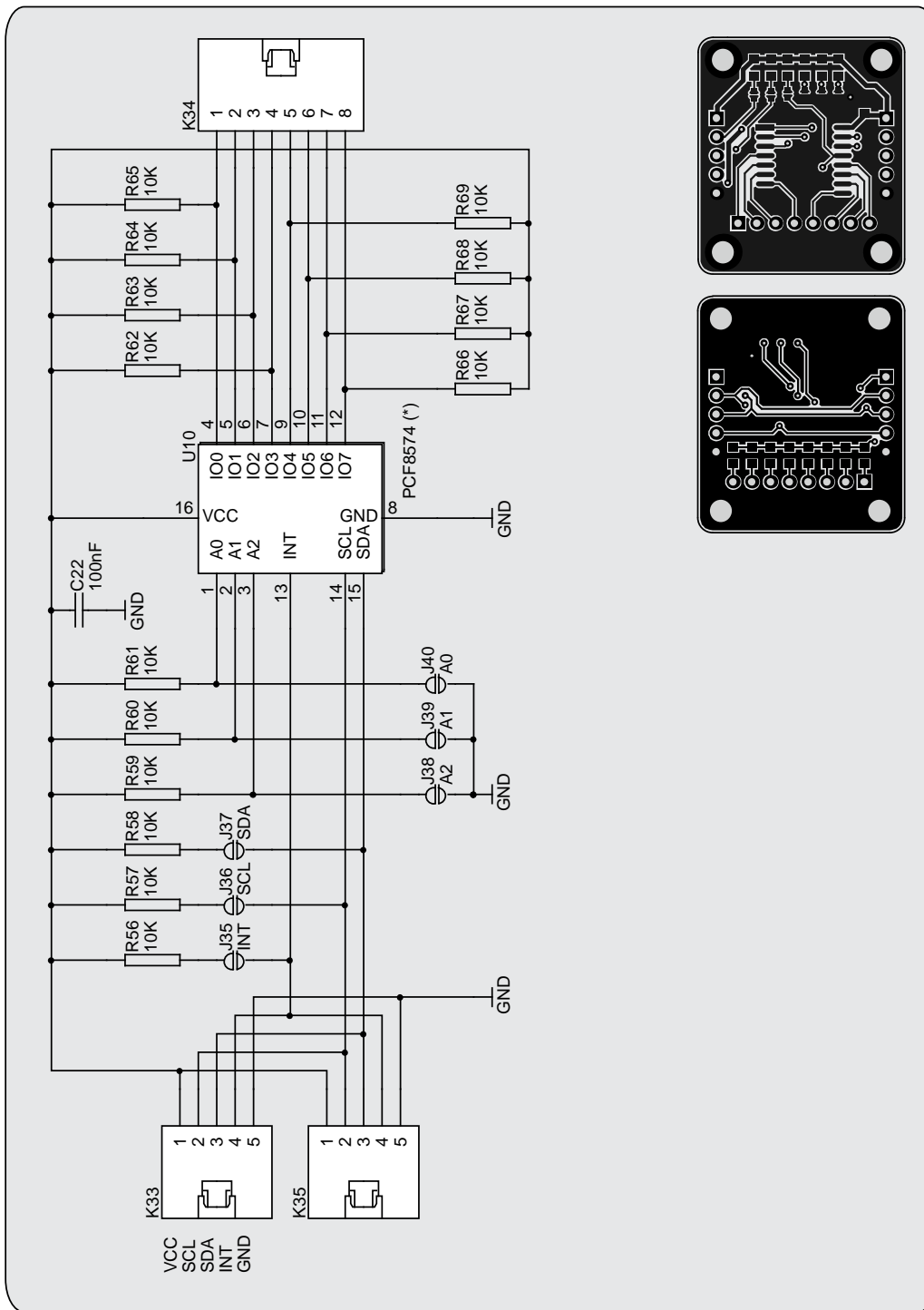


17.3. BILL OF MATERIALS

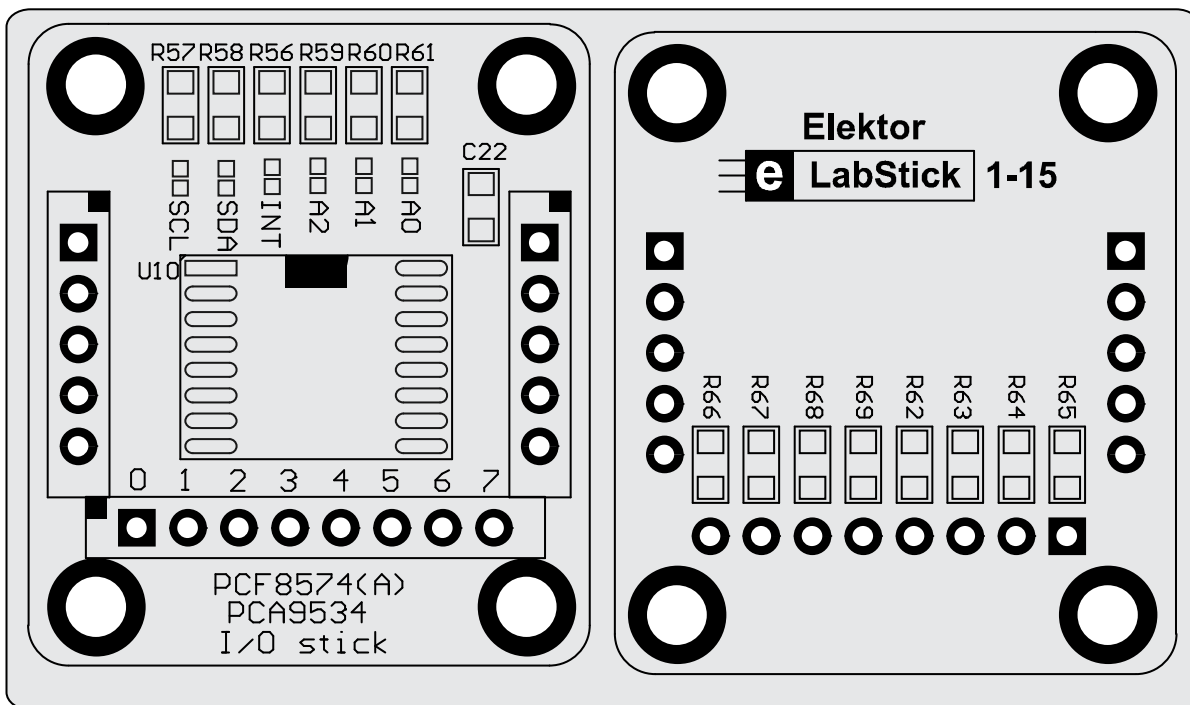
	Description	Digikey Order Code
R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55,	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
C20	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
C10, C11, C12, C13	10uF 10V X5R OR X7R SMD 0805	490-1709-1-ND
C21	47uF 16V	PCE4000CT-ND
U9	PCA9544	568-1860-1-ND
K27, K28, K29, K30, K31, K32	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

18. LABSTICK 1-15: PCF8574(A) / PCA9XXX UNIVERSAL I/O EXPANDER

18.1. SCHEMATIC



18.2. ASSEMBLY DRAWING



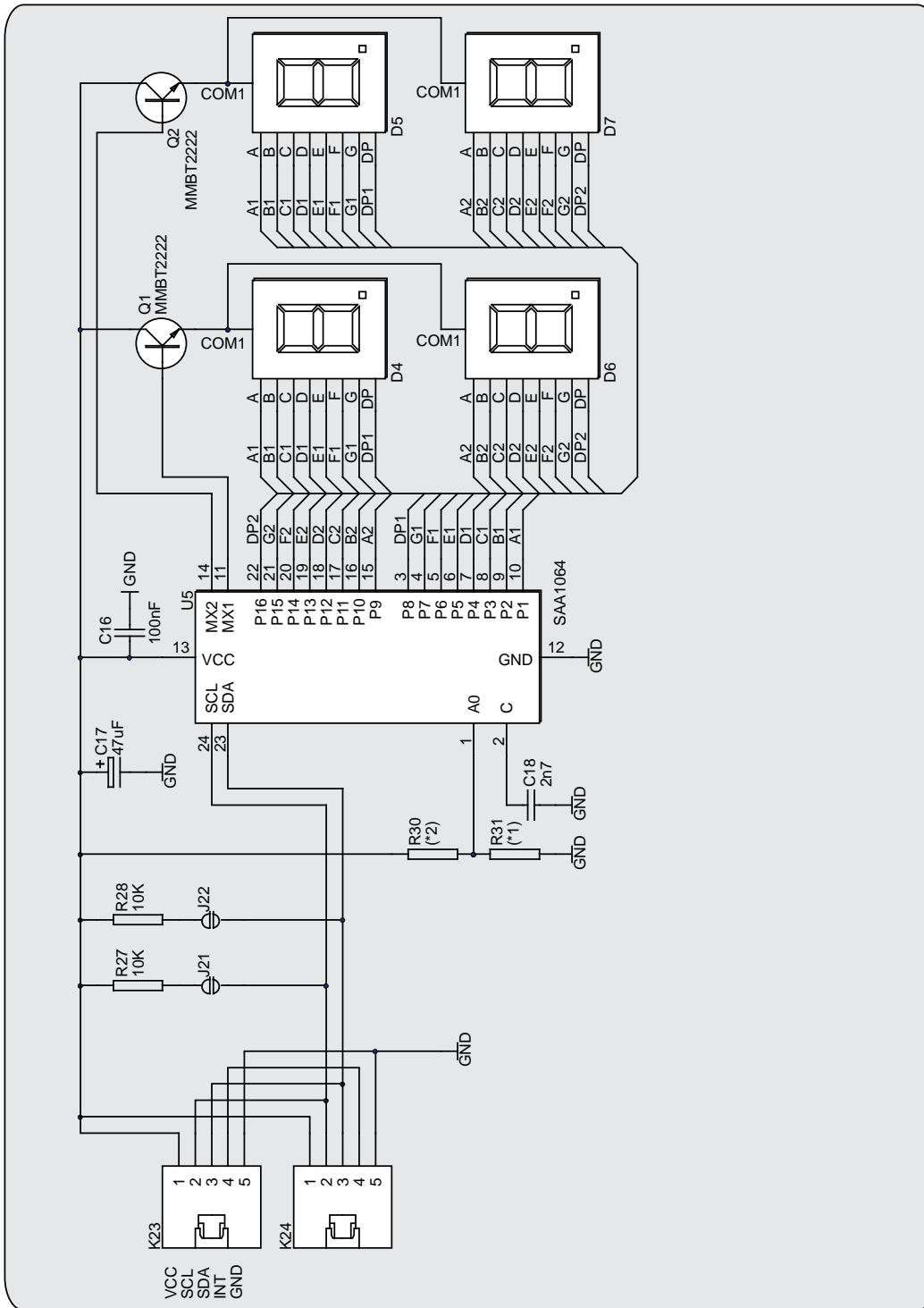
device	description	Base address
PCA9500	8-bit I/O PORT AND 2K EEPROM. Close INT jumper	0100xxx *1
PCA9534	PUSH / PULL output	0100xxx
PCA9538	Reset input instead of A2. Do not close A2 jumper onboard.	11100xx *2
PCA9554	Push / Pull output and pull up's.	0100xxx
PCA9554A	Push / Pull output and pull up's.	0111xxx
PCA9670	Fast mode + and reset. Close INT jumper (INT is replaced with reset)	0100xxx *3 *5
PCA9672	Fast mode +, reset and int. Do not close A2 onboard	01000xx *4
PCA9674	Fast mode +	0100xxx *5
PCA9674A	Fast mode +	0111xxx *5
PCF8574	Original port expander	0100xxx
PCF8574A	Original port expander alternate address	0111xxx
MAX7328	Enhanced 8574	0100xxx
MAX7329	Enhanced 8574A	0111xxx

18.3. BILL OF MATERIALS

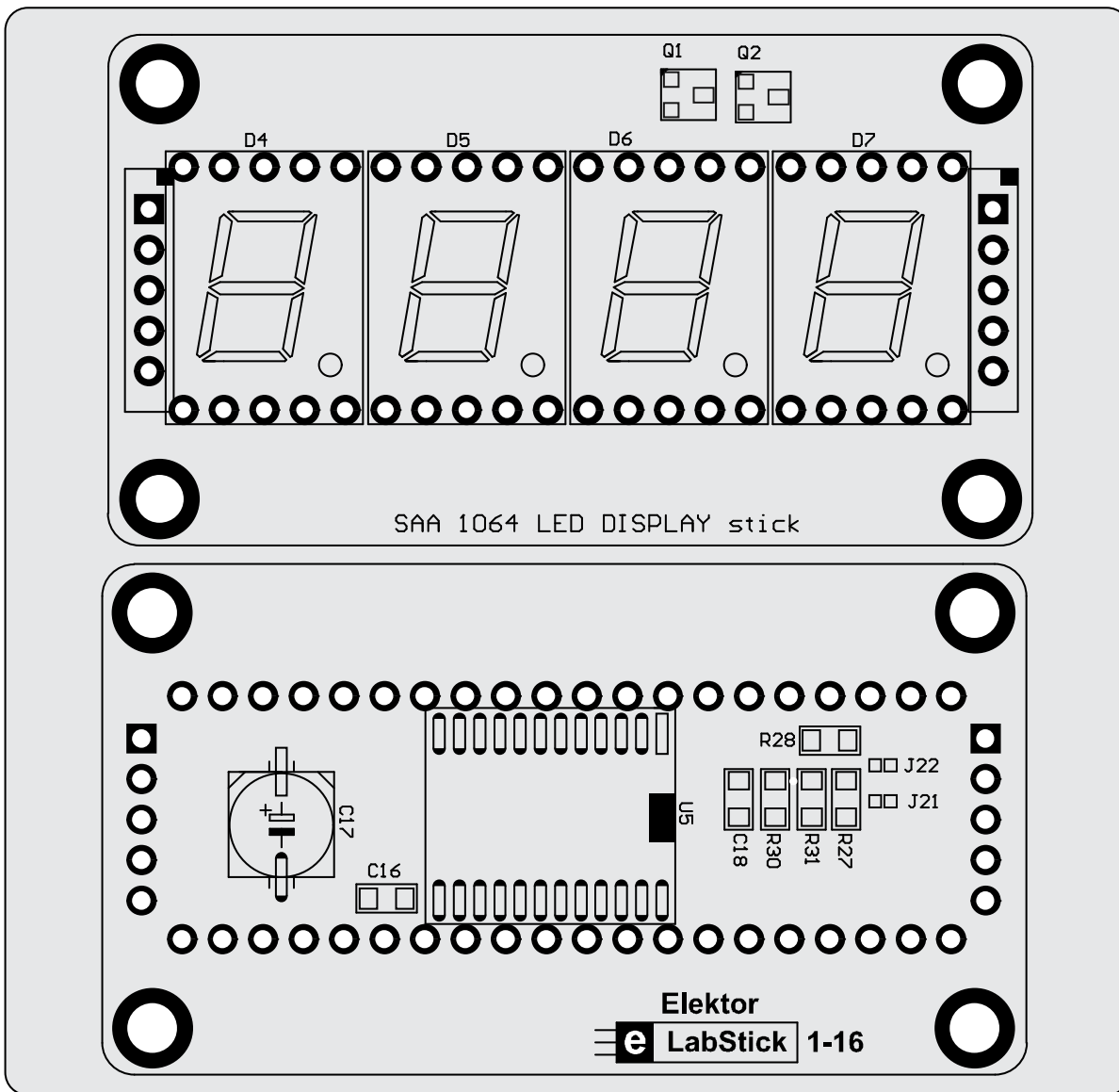
	Description	Digikey Order Code
R56, R57, R58, R59, R60, R61, R62, R63, R64, R65, R66, R67, R68, R69	10 K Ohm 0805 SMD	RMCF0805JT10K0CT-ND
C22	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
U10	PCF8574 PCF8574A / or similar in SO16 wide body.	568-1077-1-ND 568-1074-1-ND
K33, K35	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND

19. LABSTICK 1-16: SAA1064 7 SEGMENT DISPLAY

19.1. SCHEMATIC



19.2. ASSEMBLY DRAWING



19.3. BILL OF MATERIALS

R27, R28	10 K Ohm SMD 0805	RMCF0805JT10K0CT-ND
R30, R31	Depends on address. See description under address.	
C16	100nF 25V X7R ceramic capacitor SMD 0805	445-8183-1-ND
C17	47uF 16V SMD Electrolytic	PCE4000CT-ND
U5	SAA1064 in SMD	568-8258-1-ND
D4, D5, D6, D7	7 Segment Common ANODE display	160-1575-5-ND
Q1, Q2	MMBT2222 or BC847 PNP transistor in SOT-23	MMBT2222A-FDICT-ND
K23, K24	100 mils (2.54mm) pins. Strip of 5 pins.	WM6436-ND