Test Project document
TP16_41_BR_EN

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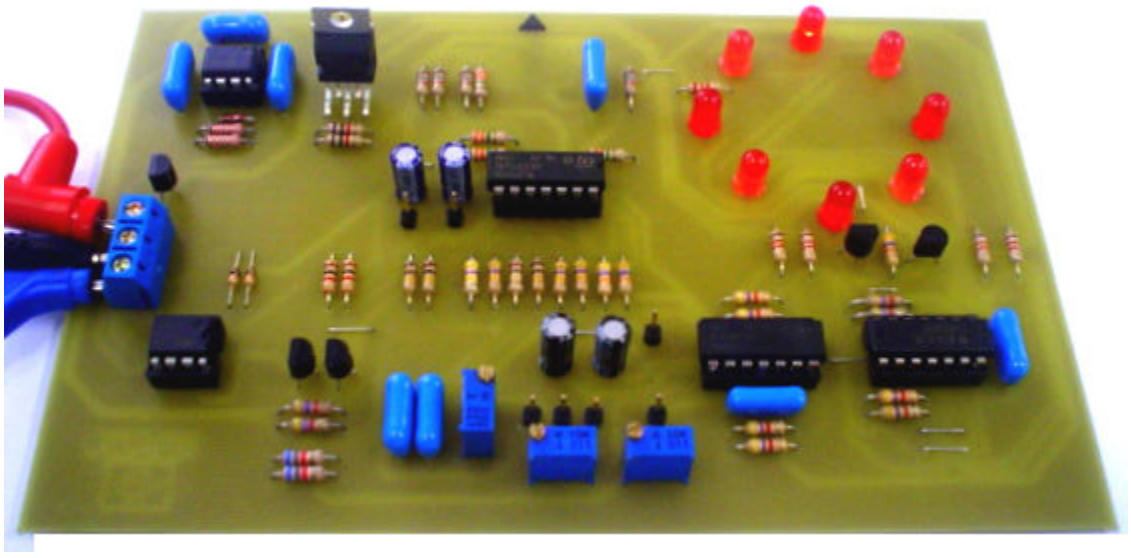
Hardware Design



PROJECT DESCRIPTION AND TASKS

This product is a electronic compass. It consists in an integrated circuit KMZ52, which is sensible to the magnetic field of the Earth.

You have to design the project following the instructions below.

1. Complete the circuits #A, #B and #C.

2. Design the print circuit board (PCB)

3. Complete design and

   - **Submit the following PCB Gerber files to the experts usb sticks.**

     *.GBL Bottom Layer

     *.GKO KeepOutLayer (Dimension)

     *.txt NC Drill File

   - **Submit the following files as *.pdf Data**

     All schematics

     PCB Top Layer (scale 1:1)

     PCB Bottom Layer (scale 1:1)

     Component Placement Side (scale 1:1)

4. Assembly the manufactured PCB and then connect with the power supply.

INSTRUCTIONS

Development of the circuits #A, #B, #C: the timeout is **2 hours**.

PCB development: the timeout is **2 hours**.

Building and testing of the Hardware: the timeout is **2 hours**.

1. Complete the hardware design project using materials and documents given.

Block Diagram

PCB Design

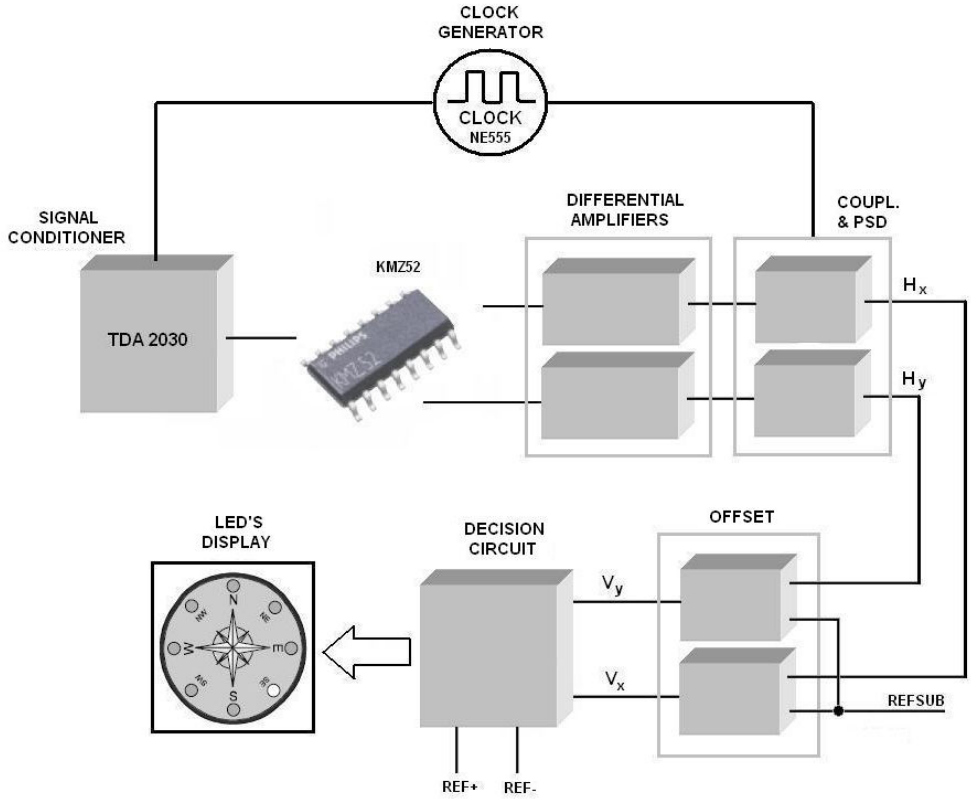
Description of operation

Hardware design sheet

Part list

Datasheets of the components

2. Block Diagram



COUPL. & PSD (Coupling and phase sensitive detector)

3. PCB Design

- Please design a one Layer PCB with Bottom Layer and components on the Top Side, except the SMD sensor should be on the Bottom Side.

- Please integrate normal measurement pins to connect your PCB with your power supply of +/-12V and GND.

- Please integrate measurement pins and for the following Signals and put the Labels next to them and write the names on it:

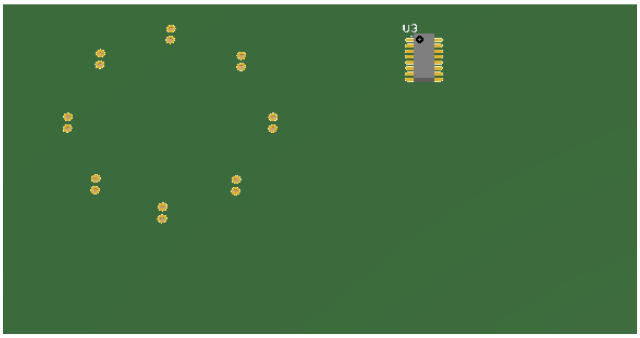
  - ✓ Output Sinal NE555 (TP1)
  - ✓ V_{SENSY} Signal (TP2)
  - ✓ V_{SENSX} Signal (TP3)
  - ✓ Vx Signal (TP4)
  - ✓ Vy Signal (TP5)
  - ✓ REFSUB Signal (TP6)
  - ✓ REF+ Signal (TP7)
  - ✓ REF- Signal (TP8)

Place the LEDs and the KMZ52 in the same orientation (Position don't care) like in the PCB shown below.

The diameter of the circumference of the LEDs is 40 mm (centre to centre of LEDs!!).

Put labels of the LED Functions in Altium PCB to the LEDS
(Labels: N, E , S , W , NW , NE , SE , SW)

PCB Top Side



PCB Bottom Side

4. Description of the compass operation

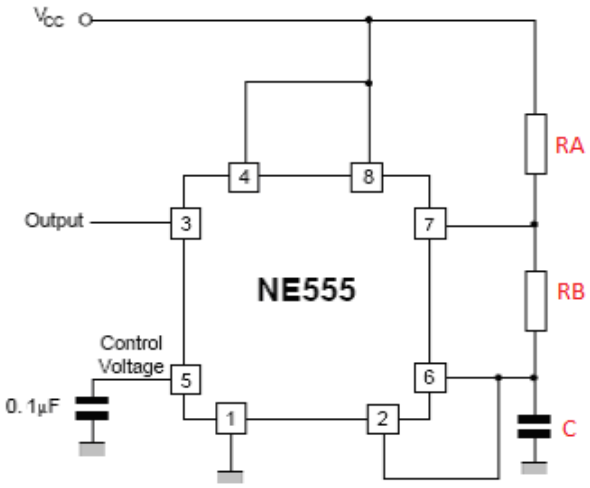
Clock generator with the NE555

You have to design a clock generator with the following characteristics:

- T = 776 us, t_H = 388 us, t_L = 388 us
- V_{CC} = 5V

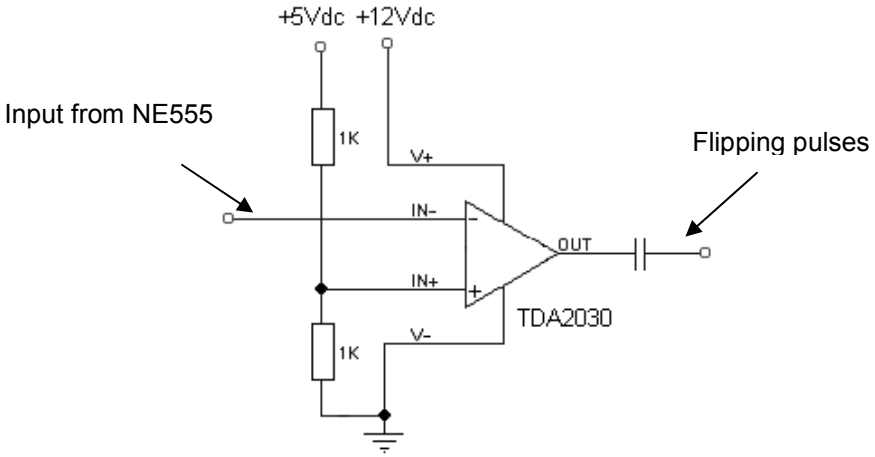
Calculate the values of R_A, R_B and C and describe the values on page 9.

Draw the clock generator circuit on page 9.



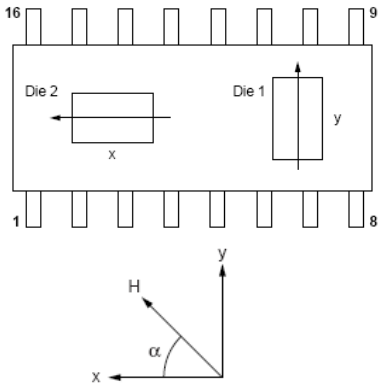
Signal conditioner

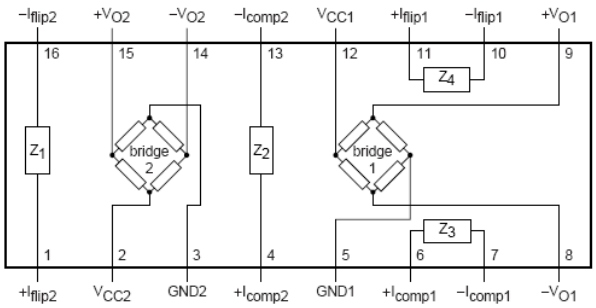
Its function is generate the current pulses to the sensor flipping coil from the square wave generate by the NE555.



KMZ52 sensor

It has internally 2 resistors bridges that work like magnetic sensors. When it is properly supplied it results in a 2 differential voltages output (the order of μV): one is proportional to the cosine and the other is proportional to the sine of the orientation angle of the IC on the Earth's axis.



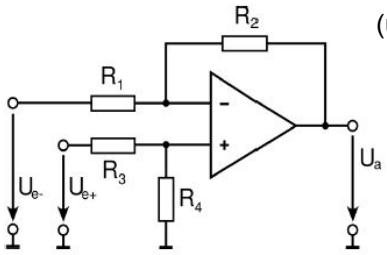


Differential Amplifiers

Design two subtractors circuits (#B1 e #B2) with OP using the IC TL074.

Characteristics: Av = 1833

(use the TL074)



Calculate the values of R_1, R_2, R_3 and R_4 and describe the results on page 9.

Draw the circuits on page 10.

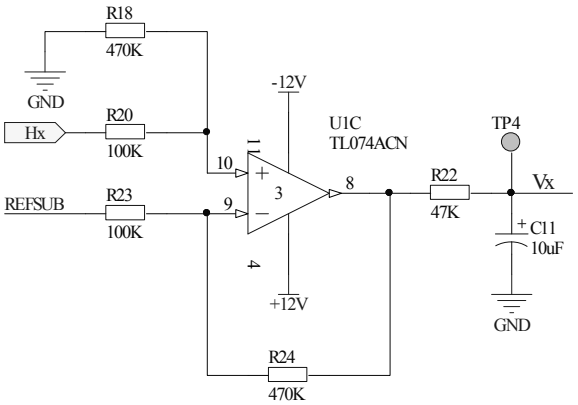
$$U_a = U_{a1} + U_{a2} = \frac{R_4}{R_3 + R_4} \cdot \frac{R_1 + R_2}{R_1} \cdot U_{e+} - \frac{R_2}{R_1} \cdot U_{e-}$$

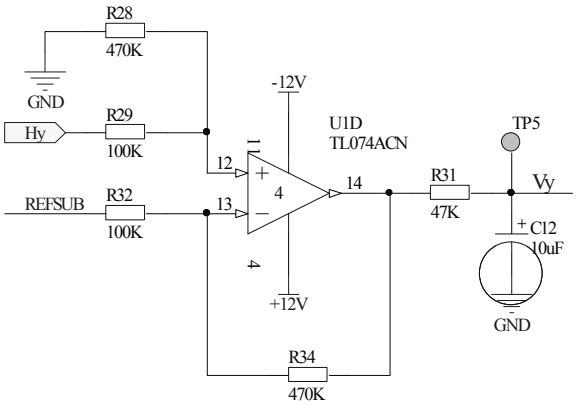
Coupling and phase sensitive detector circuits

This circuit has a decoupling capacitor, a pullup resistor to maintain the DC level of the Vref sensor signal, a signal synchronizer (with a common clock with the sensor clock) and a lowpass filter.

OFFSET circuits

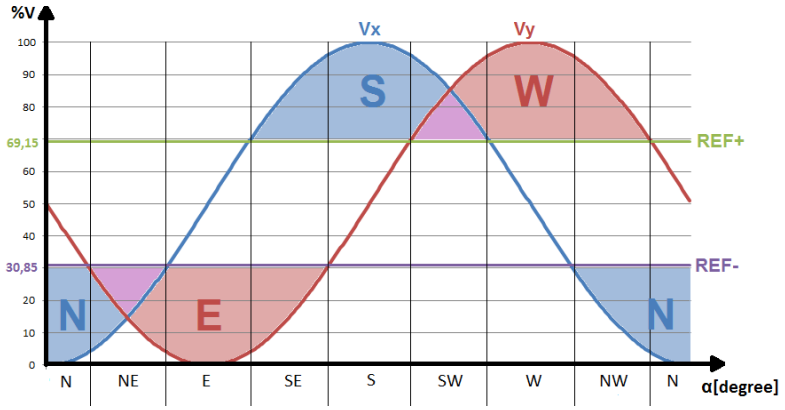
Consisting of a subtractor circuit and a lowpass filter.





Decision circuit

The output signals Vx e Vy are showed in the waveform below for a complete rotation in the clockwise direction of the compass, considering REFSUB calibrated and the IC in Bottom View. By comparing the signals generated with thresholds REF+ and REF- the logical signals N, S, E, W, NE, NW, SE, SW can be derived.



Complete the unfinished section of the circuit on page 11.

Components:

- IC: 14001 qty: 1 (4 gates)
- LED's: red 5mm qty: 4
- Resistors: 4k7 [kΩ] qty: 4
  2k2 [kΩ] qty: 1

5. After you have finished the manufacturing, check the following functions.

5.1 Adjust REFSUB to eliminate the DC signal in Vx and Vy (approximately 2V). The signals Vx and Vy with REFSUB calibrated go approximately from zero to 5,5V.

5.2 Measure the maximum and minimum values of Vx and Vy and use waveform available in the task to calculate the voltage value to REF+ and REF-.

5.3 Adjust the thresholds REF+ and REF-.

6. Answers:

6-1. Design of #A:

Clock generator with NE555

R_A =_____ [kohm]	R_B = _____ kohm]	C = _____ [nF]

Schematic: Clock generator

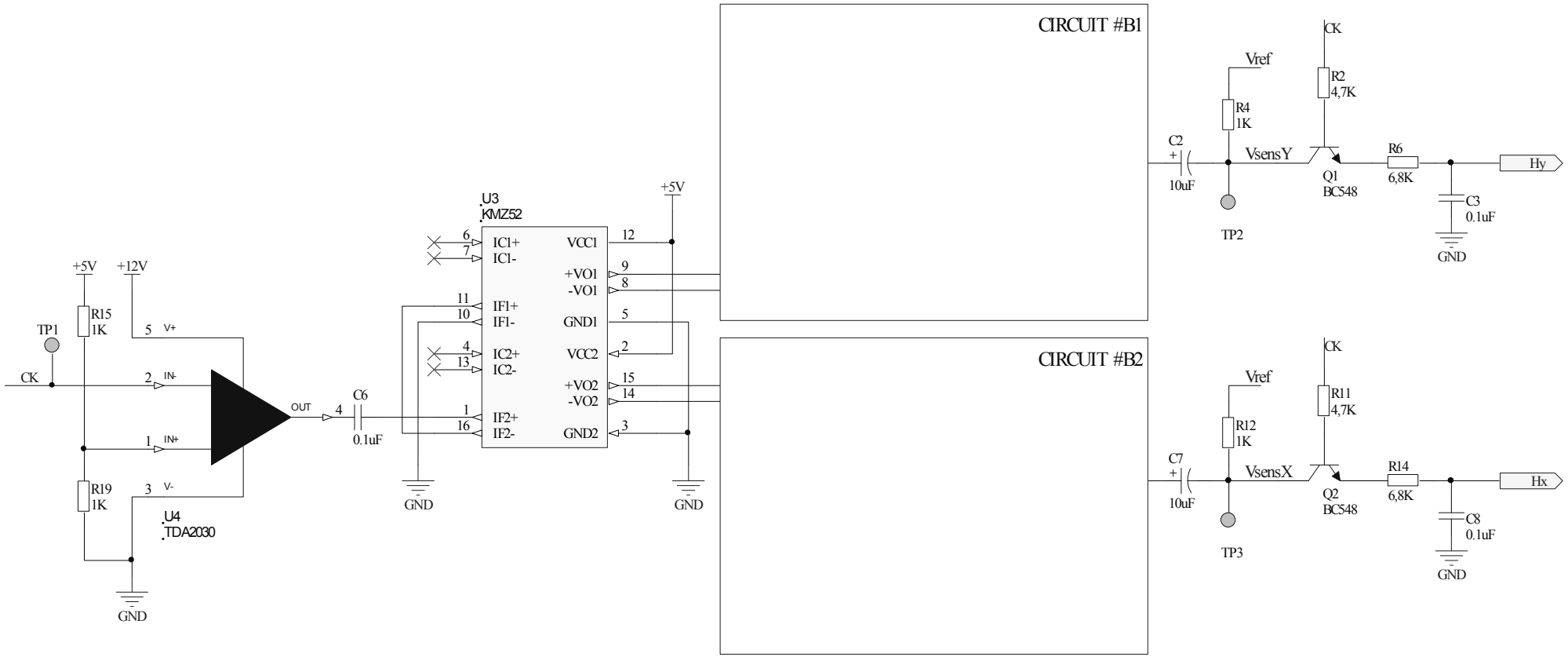
6-2. Design of #B

Subtractors:

R1 =_____ [kohm]	R2 = _____ kohm]	R3 = _____ kohm]	R4 = _____ kohm]

Answer

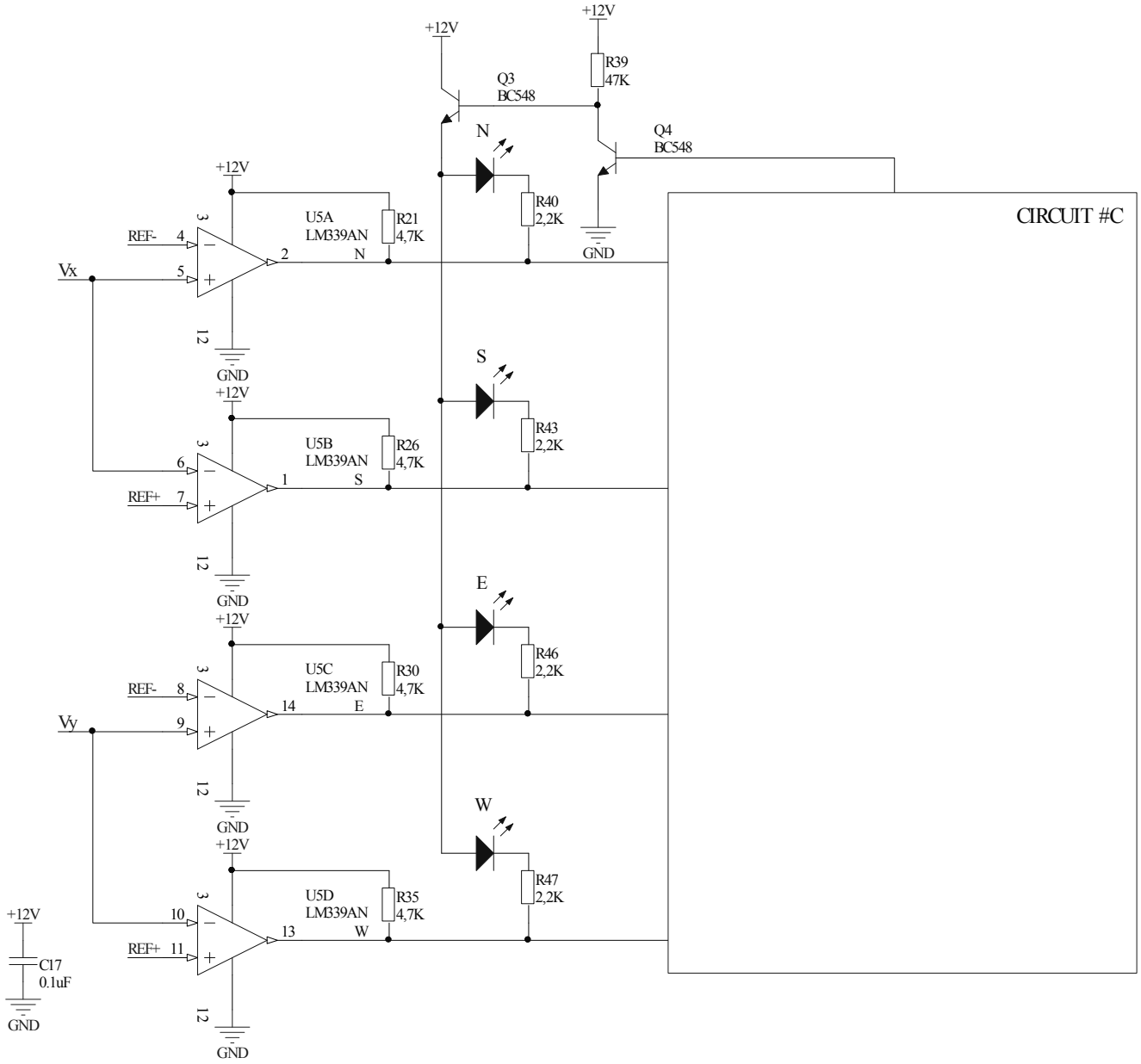
Complete the schematic diagram



6-3. Design of #C

Answer

Complete the schematic diagram



7. Part list:

Parts name	Parts value	Quantity	Reference number
Capacitor polyester	100 nF	8	
Capacitor for electric	10 uF 50V	4	
Diode for switching	1N4148	1	
LED	Red 5 mm	8	
Terminal Block	BR-500C, 3P	1	
NPN Transistor	BC548	4	
Resistor	1k 1/3W	4	
Resistor	1k8 1/3W	4	
Resistor	2k2 1/3W	5	
Resistor	4k7 1/3W	10	
Resistor	5k6 1/3W	2	
Resistor	6k8 1/3W	2	
Resistor	10k 1/3W	2	
Resistor	47k 1/3W	3	
Resistor	100k 1/3W	4	
Resistor	470k 1/3W	4	
Resistor	3M3 1/3W	4	
Variable Resistor	5k	1	
Variable Resistor	100k	2	
Test point	-	8	
Quad Operational Amplifier	TL074ACN	1	
Timer	NE555N	1	
Magnetic sensor	KMZ52	1	
Hi-Fi Audio Amplifier	TDA2030	1	
Quad Comparator	LM339AN	1	
Positive Voltage Regulator	L78L05	1	
Dual Operational Amplifier	TL072ACJG	1	
Quad 2-Input NOR Gate	MC14001BCL	1	
IC Socket	RIC-DIP-8	2	
IC Socket	RIC-DIP-14	3	