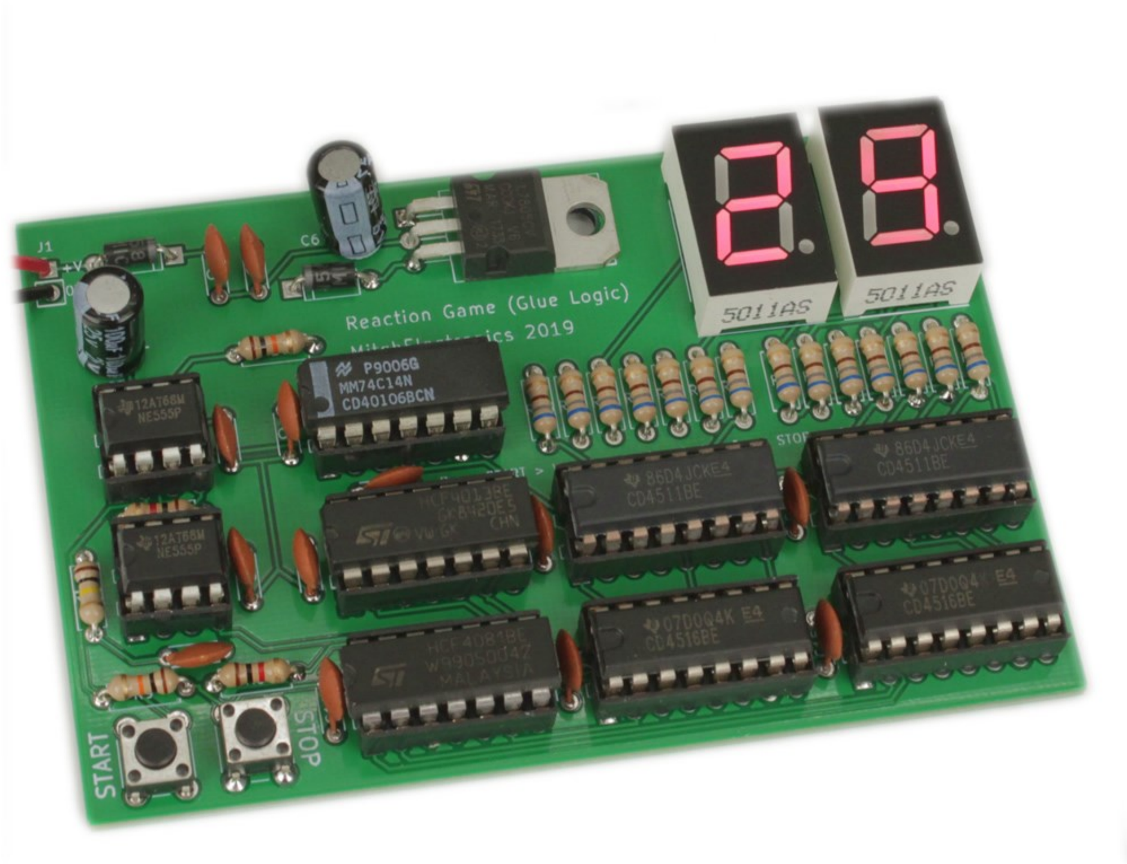
Reaction Game Kit

MitchElectronics 2019



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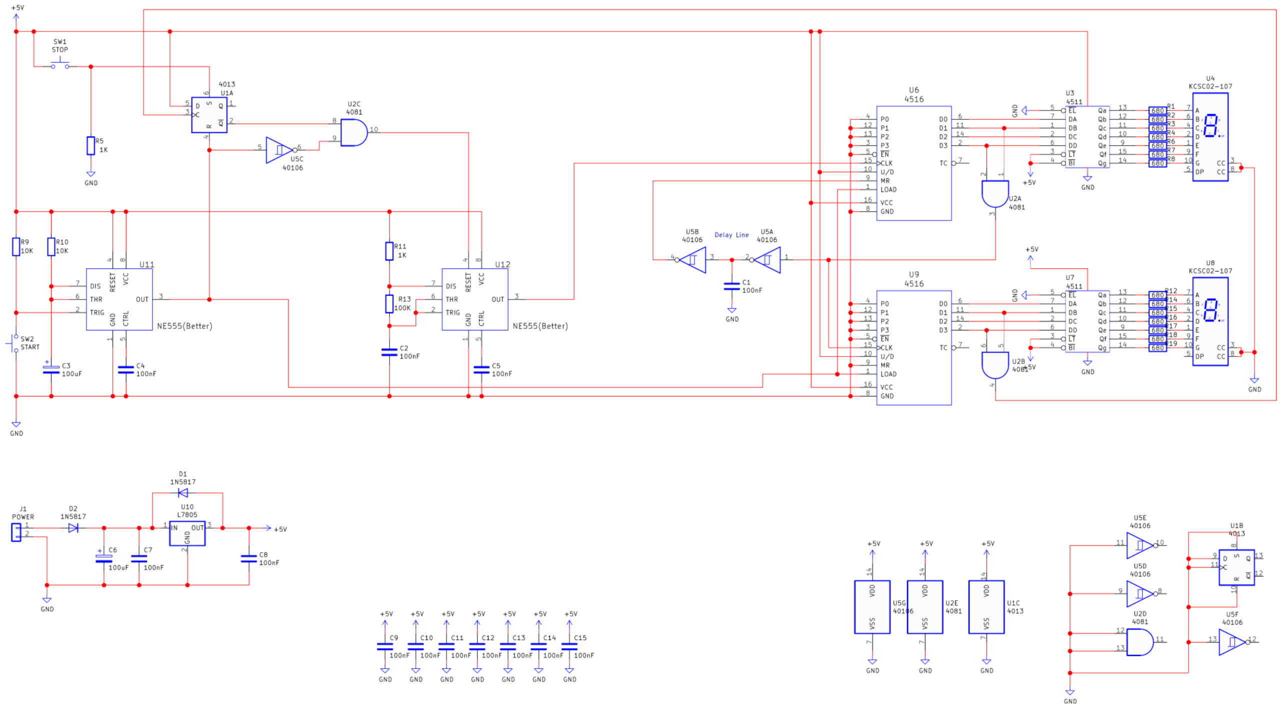
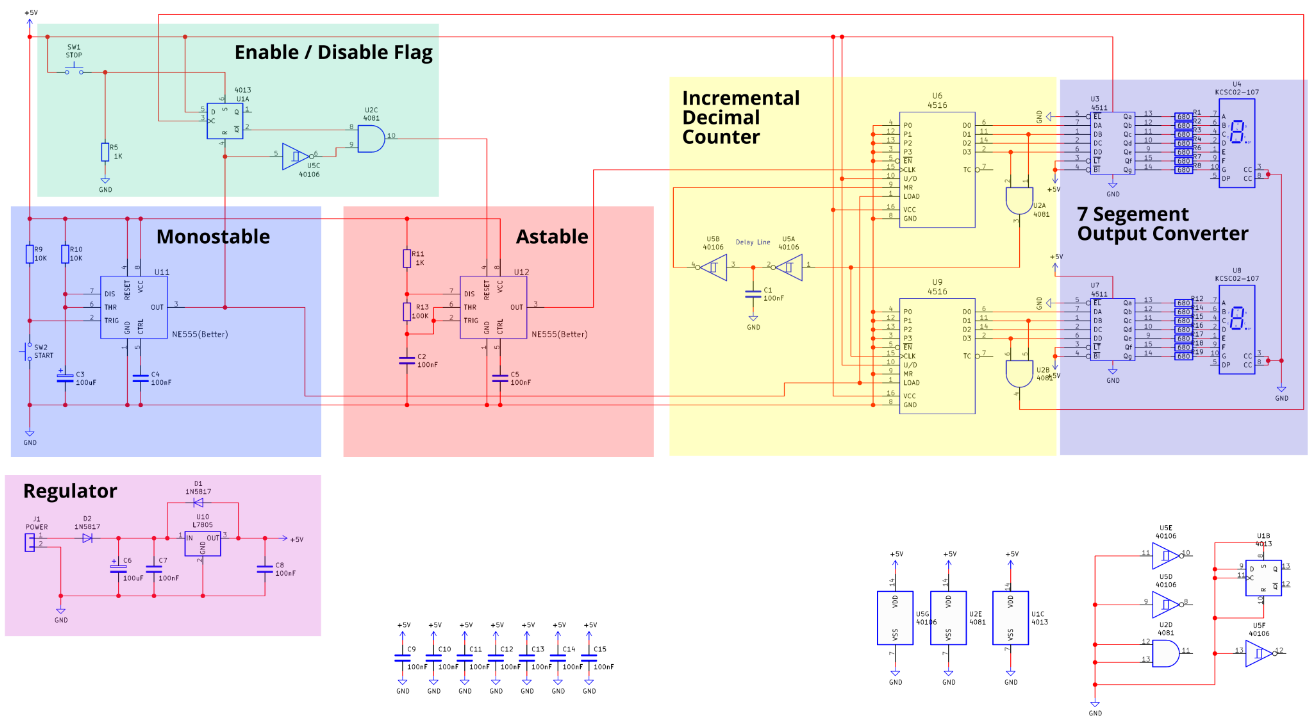




Enable / Disable Flag
Monostable
Astable
Incremental Decimal Counter
7 Segement Output Converter
Regulator

SCHEMATIC EXPLANATION

The Reaction Tester is a circuit that times your reaction and displays the result on a seven segment display. While it would be very easy to design a single chip solution with the use of a microcontroller this kit demonstrates how glue logic can be used to create complex systems with discrete parts and no processors.

The Reaction Tester is split up into the following sub-circuits

- Monostable circuit (U11)
- Astable circuit (U12)
- Enable / Disable flag (U1A, U2C, U5C)
- Incremental decimal counter (U6, U9, U5B, U5A, U2A, U2B)
- 7-segment display converter (U3, U7)
- Input power regulation (U10)

The following sub-circuits will not be explained as they are covered in other kits

- 555 Astable—https://www.mitchelectronics.co.uk/product/555-astable-kit/
- 555 Monostable—https://www.mitchelectronics.co.uk/product/5v-source/
- Power Regulator—https://www.mitchelectronics.co.uk/product/5v-source/

In the reset state the Enable / Disable flip-flop is in its on state where Q is 1 and /Q is 0. Since the output of the monostable is 0 the reset pin on the flip-flop is also 0 and therefore U5C flips this (being an inverter) to a 1. The result is that U2Cs output is 0 and this feeds into the 555 astable U12 which prevents it from oscillating. Since the output of the 555 astable is connected to the counter circuit the counter therefore does not count during reset.

When the user wants to time their reaction they start by pressing the switch SW2. This initiates the 555 monostable which causes its output to go to 1. The output of the monostable is connected to the reset pin on the Enable / Disable flag which causes the flip-flop to reset to Q = 0 and /Q = 1. However, since the output of the monostable is 1 the output of U2C is still off as this input is inverted by U5C. But when the output of the monostable goes to 1 it causes the two 4516 counters to reset because all of the data inputs to the 4516 counters are connected to 0V and the 555 monostable output is connected to the parallel load pin on the counters.

Eventually the output of the monostable returns back to 0 and this causes the 555 astable oscillator to start oscillating. This oscillation is fed into the first 4516 counter (U6) which causes the counter U6 to begin increasing in value. This counter represents the number of units in the count. The 4516 are binary counters which is not helpful when trying to display numbers between 0 and 9 so the first counter (U6) has an AND gate connected to bits D1 and D3. When the counter counts to 10 (binary 1010), the output of the AND gate goes high which causes the second counter (U9) to increase in value by 1. At the same time, the output of the AND gate is also connected to a delay line which resets the counter to return back to 0.

Counter			Counter Value	Increments ->	
U6	8	9	0	1	2
U9	1	1	2	2	2

SCHEMATIC EXPLANATION

The delay line is made up of two NOT gates and a capacitor and has a VERY specific function; to induce a delay in a logic signal. One of the problems that can occur here is that the counter U6 can reset itself faster than the next counter (U9) can increment. In other words, when U6 increments to the value 10 it would immediately turn on the output of U2A which feeds back into the reset pin of U6 which would set the counter value to 0 and then turn off U2A. All of this could happen faster than the time U9 needs to read the output of U2A to increment. To get around this, a simple delay line is included which creates a small delay so that the output of U6 stays at 10 long enough for the next counter to increment before resetting itself.

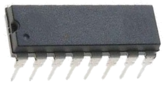
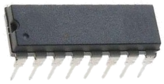
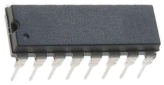
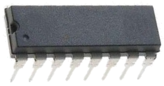
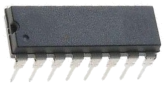
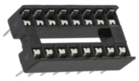
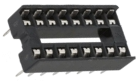
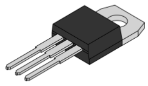
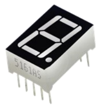
The last counter, U9, counts tens and also has an AND gate connected to D1 and D3. However, instead of using this output to reset the counters it instead triggers the Enable / Disable flag to prevent further counting. Each counter has its output connected to a 4511 decoder chip which converts binary coded decimal numbers into a 7-segment pattern.

However, if the user presses the stop button as the counter counts, the flip-flop U1A is set which turns off the oscillator. This results in the counters retaining their current value showing how fast the user was able to press the STOP button after having pressed the START button and the counter beginning its count.

To summarise

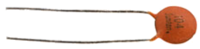
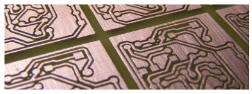
- The user presses START to initiate the monostable
- The monostable resets the counters
- The monostable starts the astable counter
- The counter beings to increment in value
- The user, at this point, can hit the STOP button to stop the count
- The counter will keep counting until it reaches 99 and then resets

Check that you have the following components

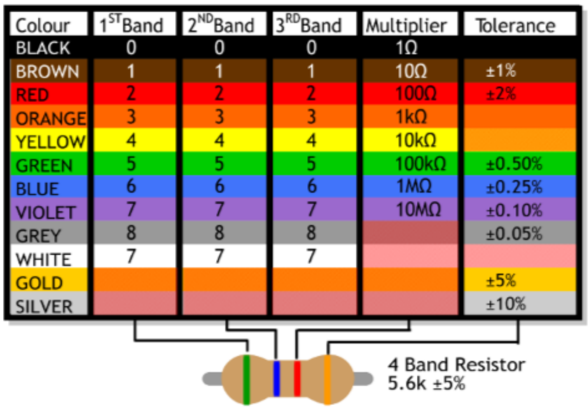
Component	Component Name	Quantity	Looks like
4516	U6, U9	2	
4511	U3, U7	2	
40106	U5	1	
4081	U2	1	
4013	U1	1	
NE555	U11, U12	2	
8 DIP Socket	U11, U12	2	
14 DIP Socket	U1, U2, U5	3	
16 DIP Socket	U3, U6, U7, U9	4	
7805 Regulator	U10	1	
7 Segment Display	U4, U8	2	
680R Resistor	R1 -> R8, R12, and R14 -> R19	14	
1K Resistor	R5, R11	2	
10K Resistor	R9, R10	2	
100K Resistor	R13	1	

CONSTRUCTION

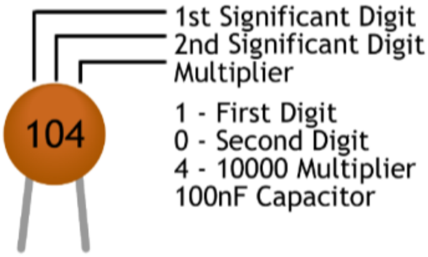
Check that you have the following components

Component	Component Name	Quantity	Looks like
100nF Capacitor	C1, C2, C4, C5, C7 -> C15	13	
100uF Capacitor	C3, C6	2	
1N5817	D1, D2	2	
Tactile Switch	SW1, SW2	2	
PP3 Connector	J1 (Power)	1	
PCB	-	1	

RESISTOR AND CAPACITOR IDENTIFICATION



Colour	1ST Band	2ND Band	3RD Band	Multiplier	Tolerance
BLACK	0	0	0	1Ω	
BROWN	1	1	1	10Ω	±1%
RED	2	2	2	100Ω	±2%
ORANGE	3	3	3	1kΩ	
YELLOW	4	4	4	10kΩ	
GREEN	5	5	5	100kΩ	±0.50%
BLUE	6	6	6	1MΩ	±0.25%
VIOLET	7	7	7	10MΩ	±0.10%
GREY	8	8	8		±0.05%
WHITE	7	7	7		
GOLD					±5%
SILVER					±10%



CONSTRUCTION

Download the electronics construction manual

To learn how to construct circuits on PCBs download the Electronics Construction Manual from Mitch-Electronics using the link below. This document shows you how to install all electronic components used in MitchElectronics kits. The list below shows the sections relevant to this kit so do not worry if you see component sections in the document that don't come with this kit!

www.mitchelectronics.co.uk/electronicsConstructionManual.pdf

Relevant sections in the electronics construction manual

Resistors

Capacitors

Diodes

Integrated Circuits

7 Segment Displays

Connectors / Wires

IMPORTANT INFORMATION

RoHS Compliant Kit (Lead free)

Low Voltage Kit

Caution! Soldering Required