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DESIGNING DIGITAL COMBINATION KEYS ON SAFES

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ABSTRACT

A digital combination lock is a key that works electronically and only people who know the code can open it and close it. By doing several combinations consisting of 4 digits, namely by pressing the numbers 0 to 9 on the keypad keys. The digital combination lock on the safe consists of a krndali encoder, decoder, comperator, timer and shif register, also consists of a dc motor that serves to open and pop the safe door. The results of the trials that the safe door conducted when closing and opening it can be set using a potentiote with a lap time of between 1 to 5 seconds.

INTRODUCTION

Digital engineering is one of the fields of electronics that is widely known by the public. Nowadays, almost all human life has been filled with various goods that use digital techniques for their operation (Fitzgerald et al., 2013). The use of this technique has a superiority that can provide many conveniences for wearing or the human being himself who uses it.

With technology, human intervention in carrying out a job can be slightly reduced (Landsbergis, 2019). As for one of the benefits of digital techniques, the use for a security system, this system often occurs in the storage and theft of valuables that are stored in any place or less permanently (Filkins et al., 2016). With this system, it can prevent these valuables from irresponsible hands for these items. For more details, the following will be explained about the functions of the parts of the digital combination key series in the safe.

The development of digital techniques mentioned above led to the emergence of the idea of researching other benefits of one of the existing security systems (Grieves & Vickers, 2016). On this occasion, the author tried to develop a safety device in another form replacing analog systems in safes and with digital systems. This combination key series will later have data both binary and decimal, but what is read is only decimal numbers, these data are from pressing the keypad keys.

Then the existing data were stored by the register simultaneously with different numbers according to the manipulation of the keystrokes from 0 to 9, after which the data stored or displayed on the display will be preset by the switch on the switch for each diplay. The occurrence of this preset is essentially what will remove the comperator from comparing the existing data, after being compared with the same output from the compensator will activate the timer and this timer will control the rotation of the motor both in the rotation state to open or close the door along with the work of the relay and indicator lights.

An encoder is a network of combinations of gates that convert a decimal (non-binary) number into a binary number (Yu et al., 2014). A decimal number of binary numbers on this encoder has 16 inputs on the saccharine for a 4-bit state, but the switch that is functioned is only 10 switches i.e. (0 to 9) becausethis frame n only displays the data output decimal on the number 9 foruk the last data on the seven segments, an encoder has the number of inputs, but only one in the high state 1 (active) at the time of pressing the button dan a code N. The resulting depends on which input or switch is stimulated or pressed.

The encoder in this circuit has a 4 bit output from 0 to a value of 9. 1 4 bit code in this circuit will generate a word of BCD (Decimal Code Binaries) data for the output codes, for more details the output input process on an encoder based on this table. As for the Driver Encoder, it is in the image below:

MASUKAN										KELUARAN			
Y2X1	Y2Xo	Y1X3	Y1X2	Y1X1	Y1Xo	YoX3	YoX2	YoX1	YoXo				
9	8	7	6	5	4	3	2	1	0	D	C	B	A
0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	1
0	0	0	0	0	0	0	1	0	0	0	0	1	0
0	0	0	0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	0	1	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0	0	0	0	1	0	1
0	0	0	1	0	0	0	0	0	0	0	1	1	0
0	0	1	0	0	0	0	0	0	0	0	1	1	1
0	1	0	0	0	0	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0	0	1	0	0	1

Table 1. Truth to Input Output on Encoder Driver (Keypad)

The working principle of the encoder driver circuit is that this circuit will work if when the Vcc is connected or painted so that by pressing one of the buttons from (0-9) it will conduct current to the diode, so that the connected diode will be short-circuited or the diode will be induced with an induction voltage of 0.6 v and the other diode is not induced this is due to the absence of voltage that induces it and will produce a low active output of "0", The induced diode will produce an active output high "1", so it will incite the output at, D=0, C=0, B=0, A=1 this corresponds to the input in the truth table, this output applies to the press on the key 1. This will continue if keystrokes are performed either randomly or not from all ten buttons.

This gate also referred to as a gate or gate OR will produce a low output what when all inputs are low. Conversely what if all or one of the inputs is high then the OR gate will produce a high output. For more details about the inputs and outputs and symbols of the OR gate will be shown by the truth table along with the figure below.

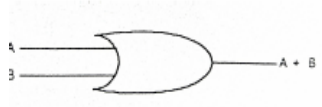

Figure 1. OR Gateway

Masukan		Keluaran
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

Table 2. OR Truth Table

Nor gate is also referred to as a combination of NOT and OR, a NOR output is the opposite of an OR output with the addition of a small circle mark at the end as shown in the figure.

Figure 2. Gate NOT OR (NOR)

Masukan		Keluaran
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Table 3. Truth Table NOT OR (NOR)

And gate is also called AND gate which if and gate has two or more input signals, if one of the inputs is low value then the output will be low but if all inputs are high value then the output will also be of high value. To find out the picture of the AND gate, it will be shown by the following figure.

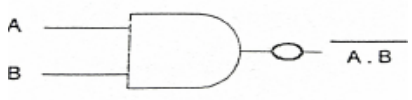

Figure 3. AND Gate

Masukan		Keluaran
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Table 4. Gate AND Truth Table

NAND gate is a combination of NOT and AND, or an AND function whose output is all reversed, nand gate will produce a low output if all inputs are high as shown below.

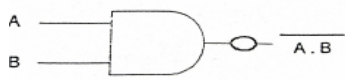

Figure 4. NAND Gateway

Masukan		Keluaran
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

Table 5. Gate AND Truth Table

Shif Register

The register is a 1-bit reminder (Memory) with n-flip-flop, so that the data can be stored as many words as n- bits. To allow data in a word to be read into the register in series, the output of the I flip-flop is connected to the entry of the next register Shif register is a special register that can receive one bit of data on each unit of time by serial input and will release the data in parallel or synchronously.

The bits of data in this register are shifted to the ground and can also be shifted to the left after getting the clock, this data will shift simultaneously from one register to the next, as for the number of data transmissions as much as 1 bit by1 bit every time there is a pulse clock that comes, this is useful for providing the next bit. So that this shif register can receive and output data serially and output in parallel by using logic 0 and logic 1. The series of 4 bit shif registers are as follows:

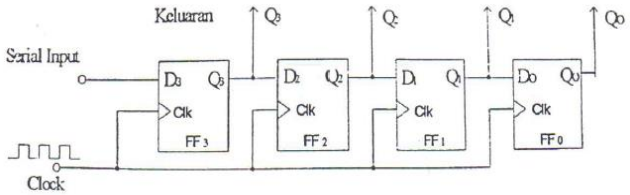

Figure 5. 4 Bit Sliding Register Circuit

This circuit consists of 1 serial bit and 4 bits of data that are displaced in parallel, so that in this path it is called SIPO (Serial Input Parallel Output), Clock which serves to shift data on the registers that are captured 4 aims to make the incoming data transfer can be moved simultaneously. The table pembacaan of the sliding rgister at the time of obtaining the clock and the time diagram to express the bits of data that are shifted are as follows:

Clock	Input Bit Data	Q_3	Q_2	Q_1	Q_0
0	0	0	0	0	0
1	1	1	0	0	0
2	0	0	1	0	0
3	0	0	0	1	0
4	1	1	0	0	1

Table 6. Sliding Register Reader After Clock

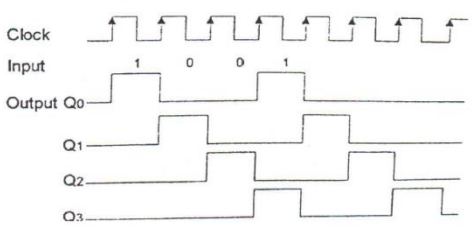

Figure 6. Time Key Pulse Diagram **(**Q= 1000)

By appearing = 0, it will make Q change with the presence of a second positive clock coming and make the saved word become Q = 0100.

After the third positive clock comes with Dmas = 0 then it will make the word stored in the flip flop 3 will be Q = 0010 and with the input of the fourth data = 1, it will make the data after the arrival of the clock, the fourth positive will be Q = 1001.

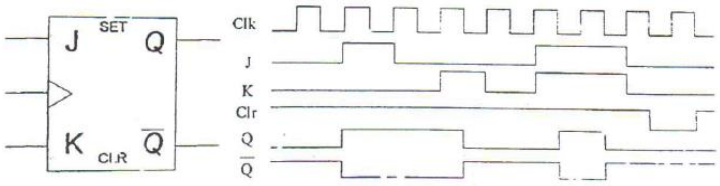

Figure 7. Truth Table Flip Flop J-K Enumerator

J	K	Q	Kegiatan
0	0	Status Terakhir	Tertahan
0	1	0	Riset
1	0	1	Set
1	1	Status Terakhir	Toggle

Table 7. Symbol Flip Flop JK (b) Pulse Isyar

METHOD

The writing method taken by the author here is a way of collecting data based on electronic theories related to the tools made. Based on the data sheet of the components used, namely Intergrated (IC), testing the tool to analyze the performance of the tool. The combination key series

on this safe consists of several parts including Encoder Driver, Shift Register, Decoder Driver Display, Comparator, Pengaktif Key, Timmer and Mechanical Circuit Control.

RESULT AND DISCUSSION

Digital Combination Key Block on Safe

Based on the block diagram, the combination key series consists of several parts as shownbelow. Whose function and how each block works will be explained as a chapter:

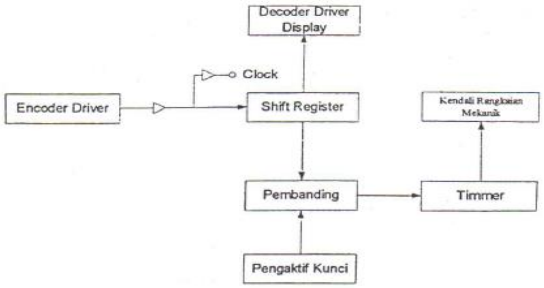

Figure 8. The Mechanical Combination Key Diagram Block

Input on YX (N= 0.1....9) which describes a button to –n, if YoXo is at n= 1, then the button on n will be pressed. In the event that in the process an encoder is nothing more than a button that is activated simultaneously, then each row of all inputs will be at state 0 and the active button will be at state 1. Based on the table above, A = 1, if YoXo = 1, then YoX_3=1, Y_1X_1=1, Y_1X_3=1and Y_2X_1 = 1. Hence, according to the Boole notation equation it is as follows for A, B, C, and D:

$A = YoXo + YoX_3 + Y_1X_1 + Y_1X_3 + Y_2X_1$

$B = YoX_2 + YoX_3 + Y_1X_2 + Y_1X_3$

$C = Y_1X_0 + Y_1X_1 + Y_1X_2 + Y_1X_3$

$D = YoX_2 + Y_2X_1$

There is also the Encoder Driver Series in the following picture:

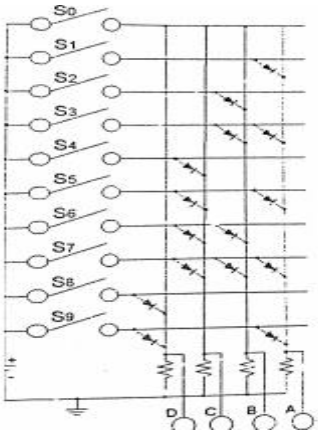

Figure 9. 4 Bit Encoder Circuit

Encoder Driver

This section is formed by the driver button (Key Pad) and an IC 74MC922. The part will work if the key pad (9 keys) is pressed, when the button is in the open state, then the data is at a high to low state, after the button is pressed the clock is at low to high and when the button is released the clock at its original state, namely at the transition of high to low. Under the simulation example of inputting data on the button for the first display driver decoder until this data will shift to the limit after getting the clock, among others, as below:

Key 1 : Input 1 will output 0001 for D C B A

Key 3 : Input 3 will produce output 0011 for D C B A

Key 5 : Input 5 will output 0101 for D C B A

Key 4 : Input 4 will produce output 0100 for D C B A

By pressing the T key, the encoder will output BCD data, namely at A = 1, B = 0, C = 0, D = 0. This data is as input data on the first register and this data will move to the output of the first register and input on the second register (D = Q). Likewise, henceforth and will be described in the shift register block section, where a simulation example of several combinations of data at the time of pressing the keys for input and output is as follows:

SAKLAR		DATA PADA DISPLAY				BCD
Dip Switch		2 4 2 0	6 5 4 1	5 4 3 1	2 1 4 3	
S 1	1	0	1	1	1	1
	2	0	0	0	1	2
	3	0	0	0	0	4
	4	0	0	0	0	8
S 2	1	0	0	1	0	1
	2	1	0	1	0	2
	3	0	1	0	1	4
	4	0	0	0	0	8
S 3	1	0	1	0	1	1
	2	0	0	0	0	2
	3	1	1	1	0	4
	4	0	0	0	0	8
S 4	1	0	0	1	0	1
	2	1	1	0	1	2
	3	0	1	1	0	4
	4	0	0	0	0	8

Table 8. Input on Keypad (Key)

For example, if we press in the order of 4231, while on the display panel it is still read with the sequence of the numbers 0087, then when the button 1 (Yo, X_1 = 0001) pressed the display panel will read 1008, then if the 3 button (Yo, X_3 = 0011) is pressed, then the display panel will be read 3100, while on button 2 (Yo, X_2 = 0010) pressed will make the display panel 2310 and the last button pressed, namely button 4 (Y_1, X_0 = 0100), then it will make the display panel read 4231.

A decoder is a combinational series that converts binary numbers in its input and into logic 1 and 0 at the output or in other words from binary to decimal. This decoder has a series of gerbang logic and in each decoder requires additional input where the input is always at a high state of "1." This input used, namely the LT (Lamp Test), can also serve to add enlightenment to the LED seven segments. Thus, this Decoder is a series that can absorb the information that comes and is useful for the encoded signal. The image of the decoder series is as follows:

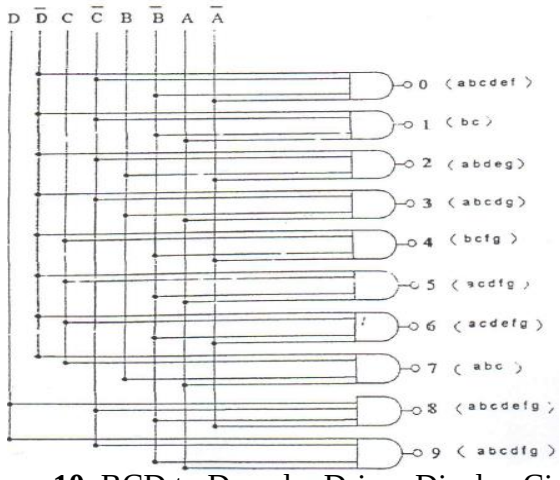

Figure 10. BCD to Decoder Driver Display Circuit

Decoder Driver Display

This section is formed by IC 74LS47 and Led Seven Segments, this section will work if it gets input data from the registers that have been stored or research, then the BCD data is converted into decimal form by the display driver decoder. The data in display = 5431 and the stored data is registered which is 0101 0100 0011 0001.

Based on will calculate and will reason will be led seven segments (a, c, d, f, and g), while on data 4 = 0100 decoder will calculate and will turn on led seven segments (b,c,f, and g), then on the next one, namely data 3 = 0011 the decoder will calculate and turn on the led seven segments (a, b, c, d and g), the last data stored on the register i.e. 1 = 0001 decoder will calculate and will turn on the led seven segments (b and c). The examples of inputs and outputs on the display driver decoder are as follows:

Preset

This preset part is formed from the SPST DIP SWITCH switch. This section has 4 BCD switches. As for the example input on the preset as follows:

SAKLAR Dip Switch		DATA PADA DISPLAY 2420	6541	5431	2143	BCD
S1	1	0	1	1	1	1
	2	0	0	0	1	2
	3	0	0	0	0	4
	4	0	0	0	0	8
S2	1	0	0	1	0	1
	2	1	0	1	0	2
	3	0	1	0	1	4
	4	0	0	0	0	8
S3	1	0	1	0	1	1
	2	0	0	0	0	2
	3	1	0	1	0	4
	4	0	0	0	0	8
S4	1	0	0	1	0	1
	2	1	1	0	1	2
	3	0	1	1	0	4
	4	0	0	0	0	8

Table 9. Preset Examples (Combination Lock Activator)

In the example table above where switch 1 has afunction to enter thousands of data, then on switch 2 to enter hundreds of data. On switch 3 it serves to enter tens of data and switch 1 to enter unit data in the form of BCD cipher data (Binary Coded Decimal) 8 4 2 1. This switch is in the closed position, then it is at the low state of "0", while in the condition of the open switch it is in the High state of "1". The BCD data in this preset will work if the presets are the same as the data on the display, where the data in the preset and on the display will be compared by the compiler (A=B).

Testing Objectives

This step can also compare the results of the values from those that have been tested at the measuring point of each block of the circuit. Also, expect the values of the results of the measurements to match the values expected on carrying out the tracking tool.

This part of the circuit uses a supply voltage of 5 Volts, so by doing several measuring points, data is obtained on the following quantities:

No	Sumber Sinyal	Komponen	Berdasarkan Teori	Hasil Uji Coba
1	Catu Daya	IC 74MC922	5 V	4,72 V
2	Osilator	IC 74MC922	10 KHz	9,468 Hz

Table 10. Test Data for Frequency and Voltage Values

The form of the pulse signal produced on IC 74MC922 at the measuring point 1 (first) (pin 5 "oscillator") is as follows:

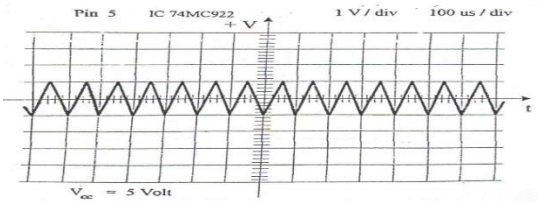

Figure 11. Shape of Signal Output Pin 5 on IC 74MC922

Then the signals generated between the first register and the next register will always be the same, which is an example of the signals tested are as follows:

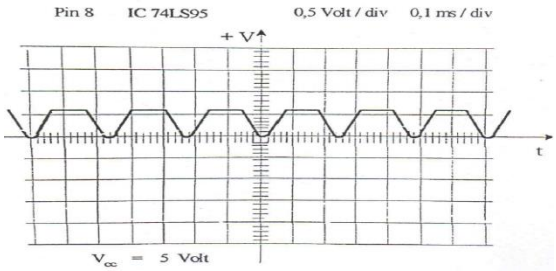

Figure 12. Shape of Signal Clock pin 8 on IC 74LS95

Measurements made using a digital multimeter mounted on pin 11 and pin 12, as for some examples of inputs and outputs and the characteristics of IC 7447 are as follows:

Masukan				Keluaran							7 Segment
D	C	B	A	a	B	C	d	e	F	g	Tampilan
0	0	0	0	0	0	0	0	0	0	1	0
0	0	0	1	1	0	0	1	1	1	1	1
0	0	1	0	0	0	1	0	0	1	0	2
0	0	1	1	0	0	0	0	1	1	0	3
0	1	0	0	1	0	0	1	1	0	0	4
0	1	0	1	0	1	0	0	1	0	0	5
0	1	1	0	0	1	0	0	0	0	0	6
0	1	1	1	0	0	0	1	1	1	1	7
1	0	0	0	0	0	0	0	0	0	0	8
1	0	0	1	0	0	0	0	1	0	0	9

Table 11. Output Input Table on the Display Driver Decorder

The examples of observations and tests carried out in the section are as follows:

Penekanan Tombol Data Desimal				Data BCD (Register) DCBA DCBA DCBA DCBA				Tampilan Display Seven Segment			
6	1	4	2	0110	0001	0100	0010				
5	0	3	7	0101	0000	0011	0111				
8	3	2	9	1000	0011	0010	1001				

Table 12. Examples of Multiple Combinations of Data Displayed by Display

The compensator is in the state of A= B, that way the timmer is active. The following are some examples of testscarried out on the key activator (preset) are as follows:

Data Tersimpan / Tampilan Display				Pengaktif Kunci Kombinasi (Preset)				Comparator Keluaran	Lampu Indikator
Reg. 1 A_3	Reg. 2 A_2	Reg. 3 A_1	Reg. 4 A_0	Dip.S. 1 B_3	Dip.S. 2 B_2	Dip.S. 3 B_1	Dip.S. 4 B_0		
0110	0001	0100	0010	0110	0001	0100	0010	A = B	Nyala
0101	0000	0011	0111	0101	1000	0011	0111	A < B	Mati
1000	0011	0010	1001	1000	0011	0010	1001	A = B	Nyala
0101	1000	0011	0111	0101	0000	0011	0111	A > B	Mati

Table 13. Multiple Activating Keys (Preset) Data Combinations

Timer Circuit

Measurements in this circuit are carried out on IC 555 which is atimer for motor rotation (opening and closing). The form of the wave signal on pin 2 of the trigger input is as follows:

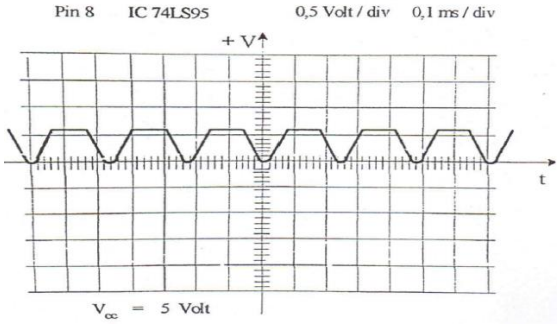

Figure 13. Form of Signal Input Trigger Pin 2 on IC 555

While the frequency values produced by OLE IC 555 in this circuit are as follows:
The form of the signal generated on pin 3 of IC 555 is as follows:

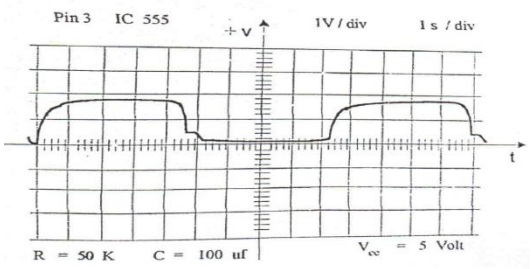

Figure 14. The Shape of the Signal Ouput Trigger Pin 3 on IC 555

CONCLUSION

As for the conclusion results that the author can conclude based on the results of this writing, by doing a few presses on the keypad key, it will activate the alternation of data or decimal numbers that tampil on the display (seven segments). So that by repeated pressings on the keypad keys, the display can display several combinations of data that appear on the seven-segment display, which is between 0000 and 9999 possible numbers that appear.

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