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ELECTRONIC ENGINEERING

Design and Construction of Microcontroller Based Remote Keyless Entry System

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Abstract— **This research project focuses on the microcontroller based remote control technology. The integration of electronic functions into the door will continue to increase in the future. The trend is towards plug- and –play modules for discrete door functions with communication. The master could be the central body electronic control unit (ECU) or the window lift module, additional functions can be added easily slave connections. The two main objectives are to unlock a set of vehicle doors when the user approaches the vehicle and to lock the vehicle after the user leaves by remote keyless entry. The system is also designed to control the window's position and back mirror folding.**

In a remote keyless entry (RKE) system, a vehicle is unlocked and locked from a distance about ten to fifteen feet by a radio code sent from a remote control to a receiver in the vehicle. The remote control key includes a transmitter for transmitting a signal to remotely control locking and unlocking of a door. Radio frequency (RF) and Infra-red communications can provide additional vehicle functionality. Assembly programming language is applied to control AT89S51 controller for these functions. In this system, infra-red sensor is used and power MOSFET is applied for motor diver. This research work can be used for real application.

Keywords— assembly programming language, infra-red, remote keyless entry, radio frequency

I. INTRODUCTION

The Autonomous Vehicle Locking System is designed to improve vehicle security and accessibility. The intent of this project is to implement an autonomous vehicle door locking system that will unlock the vehicle doors when the vehicle owner approaches their automobile and to lock the doors when the vehicle needs to be secured. Mirror position and power window is also needed to control to improve security system. Thus the window's position can be controlled by controlling the motor. There are two main portions that are transmission and receiving portion for remote keyless entry system. Communication between the owner and the vehicle was established using wireless technology. In transmission portion, push button switch is used for input. This is for lock to satisfy the requirements of many end use applications such as weaving and knitting. and unlock, power window and mirror position for vehicle. When one switch that is programmed for locking is pressed, microcontroller sent corresponding signal to transmit from IR LED. Then, this signal is captured from IR sensor of receiving portion. Transmit frequency from transmission portion and receiving frequency is adjusted that is 38kHz according to RC5 coding. Capturing signal is sent to microcontroller passing through the wave shaping block. This block performs to get sharp wave for controller. Microcontroller sent corresponding signal to drive motor.

II. METHODOLOGY

This system approaches the microcontroller based Infra-red technology. Programming language used for this research is assembly programming language. Microcontroller based infra-red remote control is used in research. Modulation method used in research is bi-phase modulation. The software programming is based on RC-5 protocol. The RC-5 protocol uses bi-phase modulation of the IR carrier transmits a total of 14 bits. The block diagram for microcontroller based infra-red remote control system is shown in Fig. 1 and 2.

A. *Software Implementation for Microcontroller Based Remote Keyless Entry System*

Assembly programming language is used in this paper. This software is based on RC-5 protocol. One message has only total 14 bits. Two bits for ACK, one is for flip and five for address bit that is used for separating one vehicle from another. Next six bits are used for command.

B. *RC-5 Based IR Modulation*

With modulation the IR light source blinks in a particular frequency. The IR receiver will be tuned to that frequency, so it can ignore everything else. The protocol uses bi-phase modulation (or so-called Manchester coding) of a 36 kHz IR carrier frequency. All its are of equal length of 1.778ms in this protocol, with half of the bit time filled with a burst of the 36 kHz carrier and the other half being idle. A logical zero is represented by a burst in the first half of the bit time.

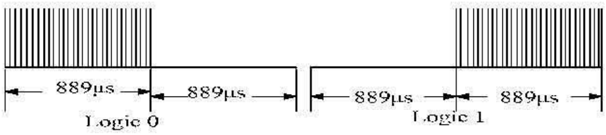

Fig. 1 Illustration of Modulation

A logical one is represented by a burst in the second half of the bit time. The pulse/pause ratio of the 36 kHz carrier frequency is 1/3 or ¼ which reduces power consumption. [13]

C. Receiving Portion Implementation

Main program loop support all initializing of I/O ports such as input, output. For receiving portion main loop, the AT89S51 controller must be initialized. The messages from transmission are waiting in interrupt loop. When the system is ready to start, it checks command bit for lock on off. If the system is lock on, it calls the lock on routine. If the system is lock off, it calls the lock off routine. Then, it checks for power window. If the system is power window up, it calls the power window up routine. If the system is power window down, it calls the power window down. Next, it checks for back mirror and it calls the concerned routine. Finally, it checks stop all mode and if the system exist in stop all routine, it calls stop all routine.

D. Transmission Portion Implementation

Firstly, initialized process is started. The AT89S51 controller must be initialized. After I/O port is set up, it checks switch. If the system exists in switchl, it calls the switch 1 routine. If the system exists in switch 2, it calls the switch 2 routine. If the system exists in switch 3, it calls the switch 3 routine and so on. If the system calls the switch 1 routine, it calls the ACK routine firstly. Secondly, it calls the flip routine. It calls the ADDR routine thirdly. Finally, it calls the CMD routine.

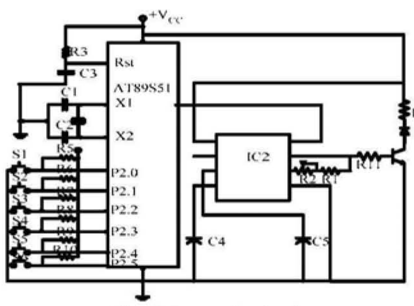

Fig. 2 Transmit circuit

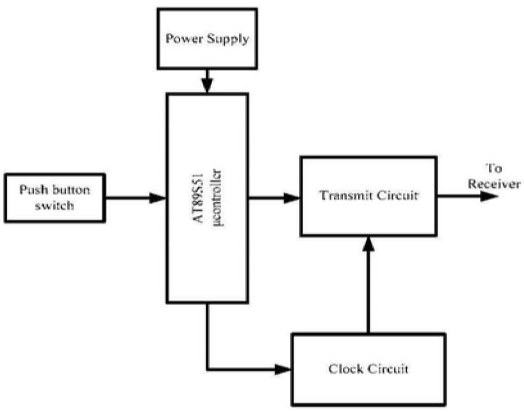

Fig. 3 Block Diagram for Transmission Circuit

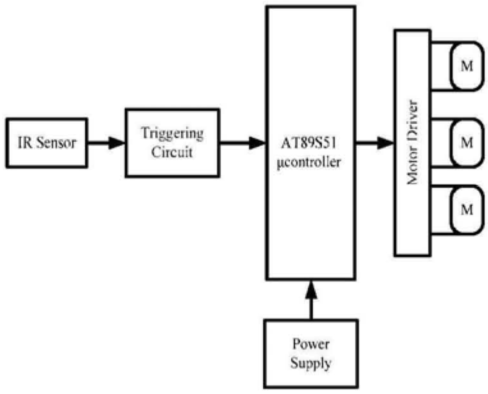

Fig. 4 Block Diagram for Receiving Circuit

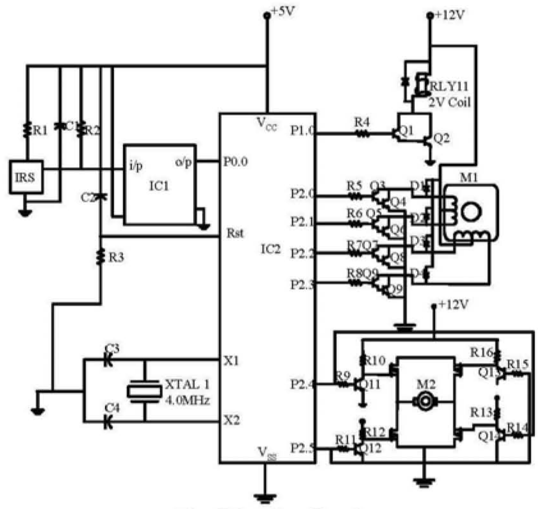

Fig. 5 Receive Circuit

III. Design Consideration

Remote keyless entry system is based on mainly two categories such as radio frequency and infra-red communication. In this system, Infra-red communication is used. It performs three main functions in this constructed system. There are lock/unlock, power window and back mirror folding. Setting up the hardware is mainly consisted of two AT89S51 controllers.

A. Relay Driver Circuit

The power for relay coil on state is 12 volts DC. In driver circuit, Q1 and Q2 is cascaded collector to collector that is intended to get high DC gain and current. In this case, Q1 and Q2 are chosen C1384 and D882 general purpose transistor respectively.

According to datasheet of Q1, the electrical characteristic are shown as follow:

V_{CE} at IC=50mA and I_B=5mA is 0.14V.

$V_{BE(sat)}$of Q1=0.8V

$V_{CE(sat)}$of Q1=0.14V

According to datasheet of Q2,

$V_{CE(sat)}$ at IC=500mA, I_B=50mA is 0.2V.

$V_{BE(sat)}$ at I_B=50mA, I_C=500mA is 0.85V

h_{FE} of Q1=10(I_C=10I_B)
h_{FE} of Q2=10(I_C=10I_B)
To drive the 12V, 500mA relay coil,
Irelay= I_{CQ}=500mA

$$I_{BQ}=\frac{I_{CQ}}{h_{FEQ1}h_{FEQ2}}$$

$$=\frac{500\times10^{-3}}{10\times10}=5\text{mA}$$

$$R_4=\frac{V_B-(V_{BE(sat)Q1}+V_{BE(sat)Q2})}{I_{BQ}}$$

$$=\frac{5-(0.8+0.85)}{5\times10^{-3}}=670\Omega$$

Neglect the voltage drop of $V_{CE(sat)}$= 0.2V

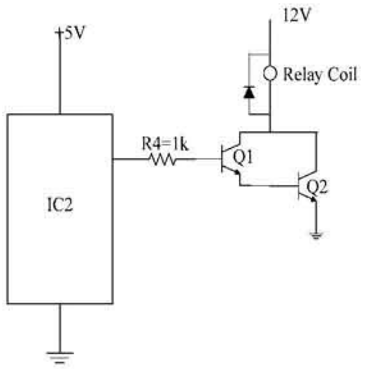

Fig. 6 Relay Coil Circuit

B. Stepper Motor Driver Circuit

Driver for stepper motor is implemented by two transistors Q3 C828 and Q4 D882. These two transistors are cascaded collector to collector by Darlington connection to get high gain. In this case, full-step mode is used and step angle is $1.8°$ per step.

Stepper Motor Specification V=12V/phase
I= 750mA/phase

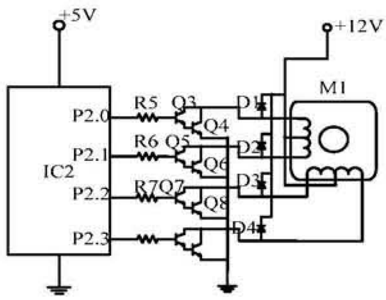

Fig. 7 Driver Circuit for Stepper Motor

According to the C828 and D882 datasheet, h_{FE} is chosen by base and collector saturation voltage vs collector-current-curve.

h_{FE} of Q3 =60
h_{FE} of Q4 =30

To drive the 1A, stepper motor, the collector of I_{CQ} is 1A. Therefore, I_{CQ}=1A

$$I_{BQ}=\frac{I_{CQ}}{\text{hFEQ3}}=\frac{1}{60\times30}$$

=0.56mA

To limit the base current, the current limiting resistor R_5 must be calculated.

$$R_5=\frac{V_{CC}-[V_{BE(sat)}{}_{Q3}+V_{BE(sat)}{}_{Q4}}{I_{BQ}}$$

$$=\frac{5-[o.8+1.5]}{0.56\times10^{-3}}=4821\Omega$$

R_5=4.8k Ω

In this case, R_5=R_6=R_7= R_8=4.7k Ω is chosen.

C. DC Motor Control Circuit

This motor is used for power window. H-Bridge motor driver is used for DC motor. In this case, Q11, Q12, Q13 and Q14 is chosen C945 transistor and MOSFET is chosen IRFZ44.

DC Motor Specification: V=12V/phase
I =2A/phase
Revolution per minute = 470rpm

IRFZ44 can operate with VDSS of maximum 55 volts and ID with 49A.

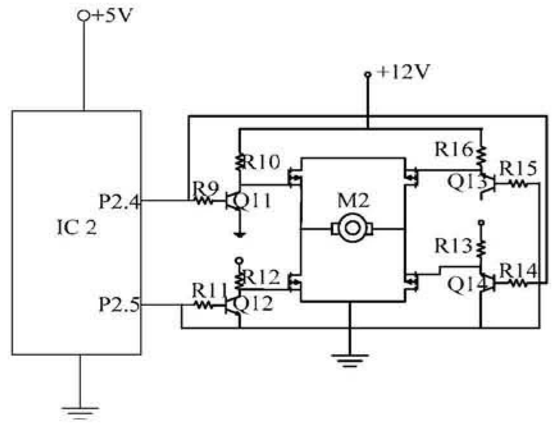

Fig. 8 H-Bridge Motor Driver

According to the datasheet of transistor Q11, 2SC945, the electrical characteristics are shown as follow:

$V_{CE(sat)}$=0.2V
$h_{FE(min)}$=70

Choose: I_C=10mA

$$R_C=\frac{12-0.2}{10\times10^{-3}}$$

= 1180Ω

In this case, R_C is 1kΩ.

Base current= $I_{B(min)} = \frac{I_C}{h_{FE(min)}}$

$$= \frac{10 \times 10^{-3}}{70} = 0.14\text{mA}$$

Output signal of controller is 5V.

$$R_{B(max)} = \frac{V_{BB} - V_{BE(on)}}{I_{B(min)}}$$

$$= \frac{5-1}{0.14 \times 10^{-3}}$$

$$= 28.59\text{k}\Omega$$

So the base resistance of Q11 must be 28.59kΩ as maximum and any resistor under this value can be chosen resistance of Q_{11}. In this case, R_B is chosen 4.7kΩ.

IV. PROGRAMMING ALGORITHMS OF AT89S51 CONTROLLER

Before programming the AT89S51, the address, data and control signals should be set up according to the flash programming mode table. To program the AT89S51, take the following steps:

(i) Input the desired memory location on the address lines.
(ii) Input the appropriate data byte on the data lines.
(iii) Activate the correct combination of control signals.
(iv) Raise $\overline{EA}$ /VPP to 12V.
(v) Pulse ALE/ $\overline{PROG}$ once to program a byte in the flash array or the lock bits

The byte write cycle is self-timed and typically takes no more than 50μs. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.[3]

A. Delay Calculation

To calculate the delay time, 4MHz crystal is used this project. Then, Example of 105ms delay calculation is following,

```
delay 105:
        mov             var2,#69
        mov             var1,#19
TT13:   djnz var1, TT13
        djnz var2, TT13
```

Instruction execution time for movR,#data=12

Instruction execution time for djnz Rn, rel=24

(250n x(12+12)+250n x (18 x24) +250n x(255 x 68 x 24) =105ms

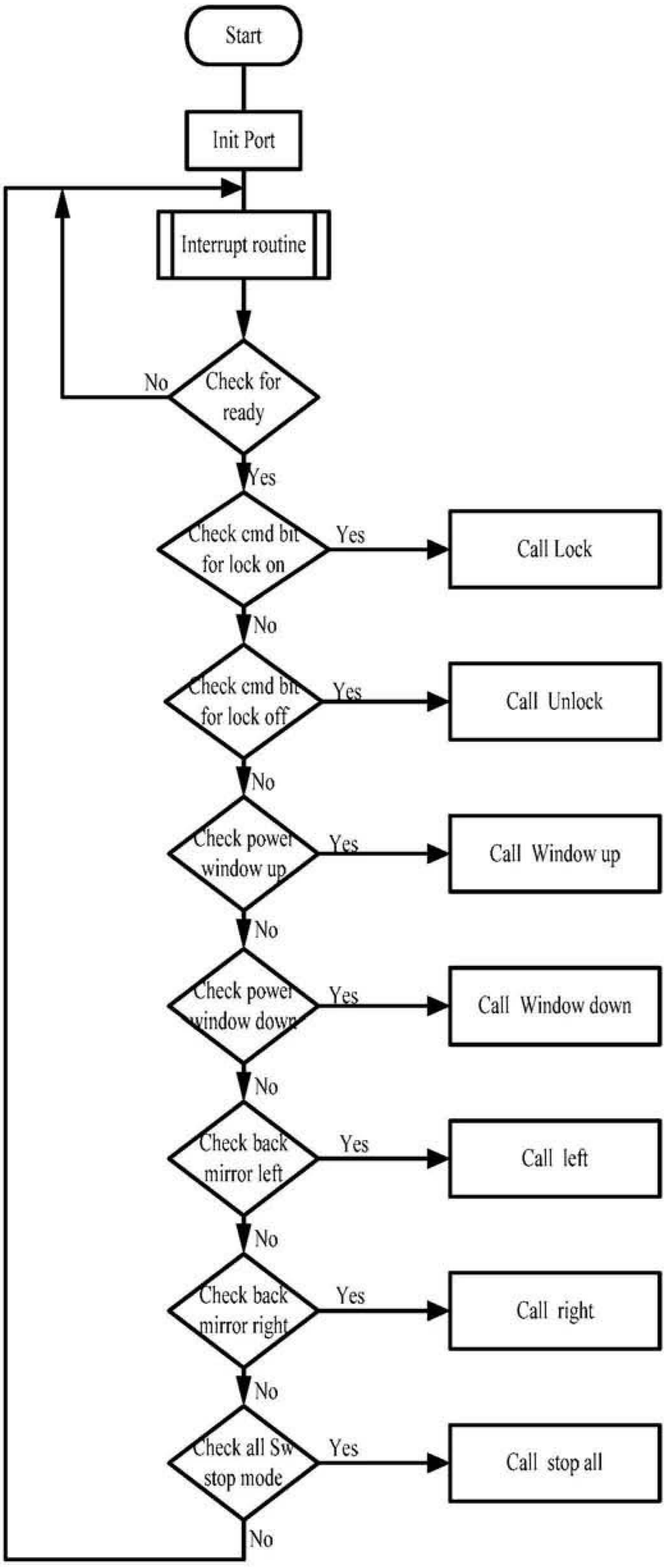

Fig. 9 Flowchart for Receiving potion Main Loop

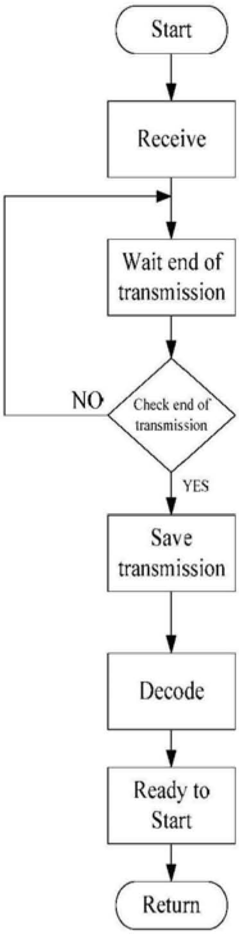

Fig. 10 Interrupt Routine

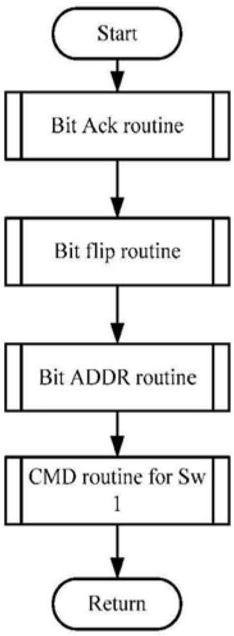

Fig. 11 Subroutine for transmission switch

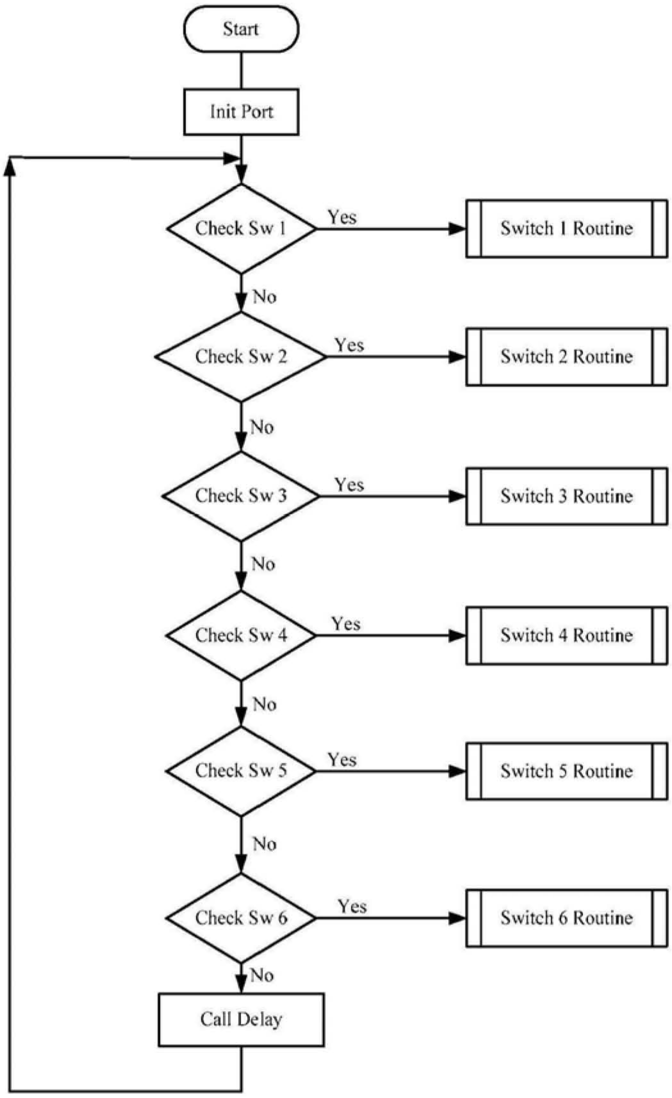

Fig. 5 Flow Chart for Transmitting Portion

V. TEST RESULT

The system is programmed for two signals. The connection can achieved with the spanning angle of $\pm 45°$ from line of sight. As the next step, the system is set up with motor driver for DC motor using the IRFZ44. The motor can be well derived for turning left and right via the remote control. In this case, it is used the small DC motor. As the final hardware implementation, the system is set up with the completely circuit on project board. After the achievement of well function of receiving potion, the transmission portion of the system is implemented and tested. At this final stage of test, after the modification of the system repeatedly, the well accessed between the transmitting and receiving portions are achieved. The power window motor, the lock/unlock relay coil and back mirror driving motor are well droved by giving the command through the implemented transmitting and receiving portions.

TABLE 1
RESULTS FOR THE SYSTEM

No	Distance between transmitter and Receiver	Result
1	1m loss	Well connect
2	1m, 10 degree los	Well connect
3	1m, 45 degree los	Well connect
4	1m, 90 degree los	Well connect
5	1m, 135 degree los	Not Well connect
6	1m, 180 degree los	Entirely disconnect
7	2m los	Well connect
8	2m, 45 degree los	Well connect
9	2m, 90 degree los	Well connect
10	2m, 180 degree los	Entirely disconnect
11	3m los	Well connect
12	3m, 45 degree los	Well connect
13	3m, 90 degree los	Slightly not Well connect
14	3m, 180 degree los	Entirely disconnect
15	4m los	Well connect

VI. DISCUSSION

In this research work, remote keyless entry receiving portion and remote control is constructed. For both portion AT89S51 microcontroller is used in this research work. The AT89S51 microcontroller was selected because of the easy capturing frequency to its transmission and having enough features needed for this project. The application software has been developed by using C programming, assembly and basic programming languages. The security can be controlled by remote control. In this research project, 74ls32IC is used for wave shaping to get sharp wave. DC motor is used for power window and power supply in motor is restricted to 12V because of low cost and low power. In this research project, motor driver for DC motor is applied H-Bridge circuit that has simple operation. Stepper motor is used for back mirror folding and switching sequence of the stepper motor used in this thesis is full-step mode. The motor is driven by Darlington connection transistors and this is local available. Relay coil is used for Lock/Unlock that is really used in vehicle security. These devices are controlled with AT89S51 outputs.

VII. CONCLUSION

In this research work, there is power window motor particularly. But it is expansive for testing. For complete design, calculation and implementation is finished and well tested. Also implemented transmitting and receiving portion can communicate each other for the application of power window, lock/unlock and back mirror functions.

VIII. RECOMMANDATION

There are some limitations for this project. The available DC motor is not practically in use. Really used motor is very expensive. But, both have same specifications. Some components are not easily available locally and some they are imported. The infra-red communication is applied in this research that is short length range because infra-red sensor is cheap.

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