

DTMF BASED HOME AUTOMATION SYSTEM USING MICROCONTROLLER WITH PORTABLE POWER SUPPLY

***Mrs. Ashwini Sawant, **Mr. Sanjay Mirchandani,**

*****Santoshi Saravanan, ****Shreeparna Sarkar**

**Assistant Professor, Electronics and Telecommunication,
Vivekanand Education Society Institute of Technology
Chembur, Mumbai, India*

***Assistant Professor, Electronics and Telecommunication,
Vivekanand Education Society Institute of Technology
Chembur, Mumbai, India*

****B.E. Student, Electronics and Telecommunication,
Vivekanand Education Society Institute of Technology
Chembur, Mumbai, India*

*****B.E. Student, Electronics and Telecommunication,
Vivekanand Education Society Institute of Technology
Chembur, Mumbai, India*

ABSTRACT

Traditional electronic home appliances are controlled using switches. Technological advancements have resulted in more simple and user-friendly developments. This resulted in massive growth in cellular mobile communication technology with mobile phones from a device used for wireless communications to a portable terminal used for networking. Such integrated mobiles introduce a wide variety of applications to explore. This paper introduces a method for using the DTMF tone which is generated by the mobile phone buttons to control the electronic appliances at home. It is possible to control a particular system and acquire information about it from anywhere.

Keywords: DTMF, transmitter, receiver, mobile networks, portable, automation

INTRODUCTION

Many methods available for controlling remote devices require special hardware devices and software which reduces their ease of use. The use of wireless technologies like Bluetooth, GPRS, ZigBee require use of dedicated hardware thereby making their implementation time consuming and costly. This paper makes use of DTMF principle along with prevailing mobile handsets at the receiver end. [3]

This system can even be used in places where human access is difficult thus ensuring safe explorations of the place without any issues. It can be used in domestic systems as well as in corporations and laboratories research effective monitoring system. Mobile communication networks work time independently which makes it suitable for any working conditions. Mobile phones used in this system can be any model but the only requirement is that it should be in

working condition within the coverage area of the service provider. Users can control the appliances at home by sending DTMF tone to the other mobile terminal at home. [2]

This paper also presents the design and working of a variable output power supply from AC power supply which is used to give input to the home automation system. The main advantage of this power supply circuit is that it provides almost 2 to 3 time higher current than the normal power supply circuits. [4]

BLOCK DIAGRAM DESCRIPTION

1. Variable power supply

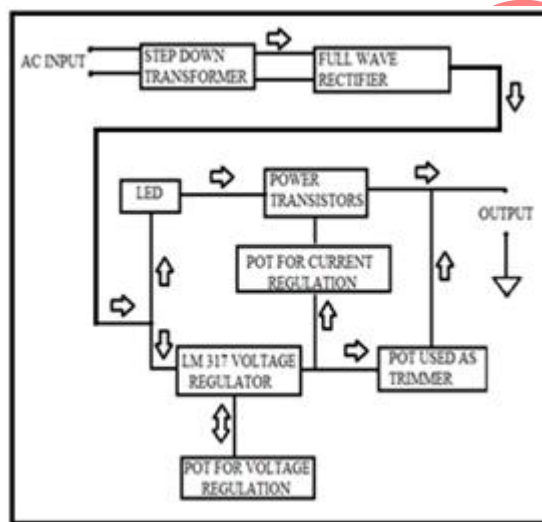


Figure 1. Block diagram of variable power supply

The above figure shows block diagram of the power supply system. The input to the system is from AC mains which is 230V, 50Hz. This input is converted to lower amplitude AC voltage using step down transformer. The output of the transformer is then given to a rectifier circuit which converts the alternating current into direct current. This voltage and current obtained is fed to power transistors and voltage regulator. Output from them is then regulated using different potentiometers and variable voltage and current values are obtained.

2. Home automation system

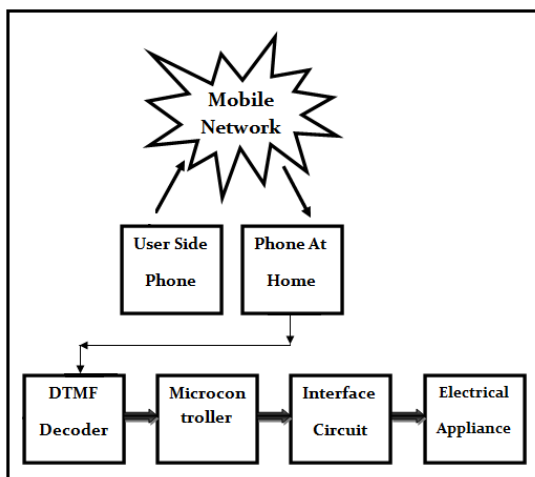


Figure 2. Block diagram of DTMF based home automation system

Figure shows the block diagram of the home automation system. User side phone will send DTMF signals to the phone at home via mobile network. The received signal is then given to DTMF decoder which decodes the information using a decoder table. The decoder sends the information to the microcontroller which decides which device needs to be controlled and sends corresponding signal to the device using an interface circuit. To activate the cell phone at home, a call is placed and as the call is answered, the user will enter a two digit password according to the device specific table to turn ON or turn OFF a device. [2]

		High Group			
		1209	1336	1477	1633 Hz
Low Group	697 Hz	1	2	3	A
	770 Hz	4	5	6	B
	852 Hz	7	8	9	C
	941 Hz	*	0	#	D

Figure 3. Frequencies generated on pressing different keys

When the user presses a button on his mobile, both row and column of the above matrix produces DTMF tones which are unique for each key. Two waves, one low frequency and one high frequency are associated with each key and a resulting frequency is produced by mixing of the two tones. This frequency signal is sent to the receiver end over a communication channel to a decoder.

CIRCUIT DIAGRAM AND WORKING

1.1 Variable power supply part 1

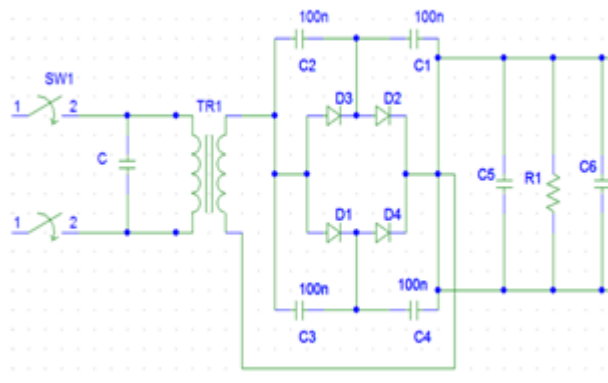


Figure 4. Circuit diagram of variable power supply part1

Bridge Diodes= D1= D2= D3= D4= MR750

C1= C2= C3= C4= 100nF, C5= 47nF, C6= 4700μF/50V, R1= 2.2kΩ (2.5 Watt),

1.2. Variable power supply part 2

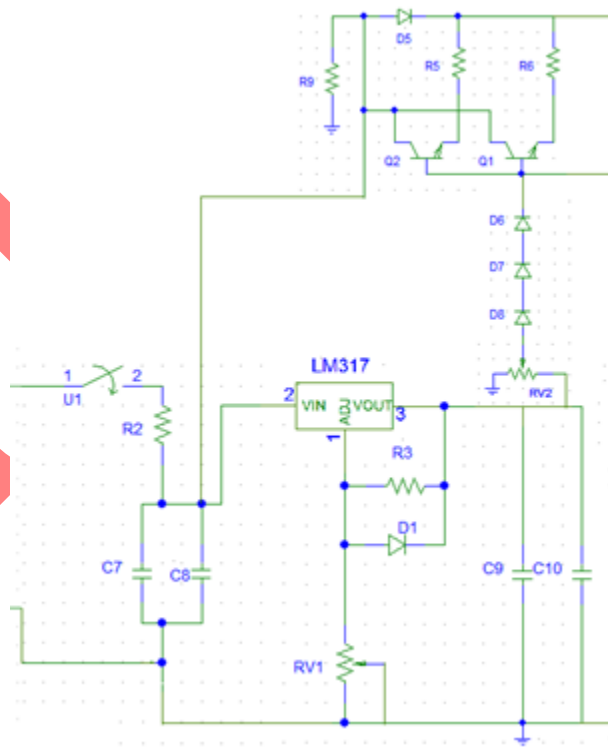


Figure 5. Circuit diagram of variable power supply part2

R2=47 Ω (0.5 watt), C7=10 μ F/50v, C8=100nF, R3=240 Ω , D1=1n4148, C9=10 μ F/50V, C10=100nF, D5= D6= D7= D8= IN4001, Q1= Q2= 2N3055, R3= R4= 0.1 Ω (10 watt), R9=8.2k Ω , Pot RV1=5k Ω , Pot RV2=47 ohm or 220 ohm, 1 watt

1.3. Variable power supply part 3

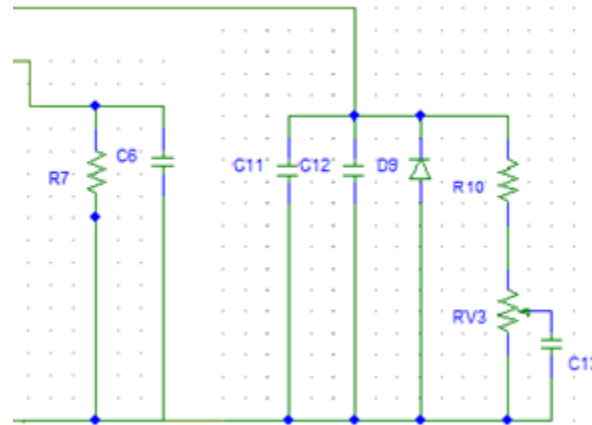


Figure 6. Circuit diagram of variable power supply part3

R7=6.8k Ω , C6=47nF, C11=330 μ F/50V, C12=47nF, D9=1N5401, R10=10k Ω , C13=1 μ F/16V, Pot RV3=10k trimmer

Atmega used for home automation circuit is powered using the above portable power supply which makes the entire system more cost efficient and portable.

WORKING OF THE PORTABLE POWER SUPPLY:

Input of the power supply is AC supply from the mains. This input is passed through a 230 V, 5 Amp transformer which steps down the voltage to 28 V. The output of the transformer is passed through a rectifier circuit consisting of diodes D1, D2, D3 and D4. The rectified output is passed through a parallel combination of capacitors and resistor. When switch U1 is closed current flows through the input terminal VIN of voltage regulator LM317. RV1 which is connected to the ADJ terminal of LM317 is used to vary the output voltage between 0V and 28V. Q1 and Q2 are power transistors which are used for current amplification. The minimum output voltage of LM317 voltage regulator 1.2V. In order to get 0V at the output we are using 3 diodes D6, D7 and D8. RV2 is used to set the maximum output current available.

2. Home automation interface

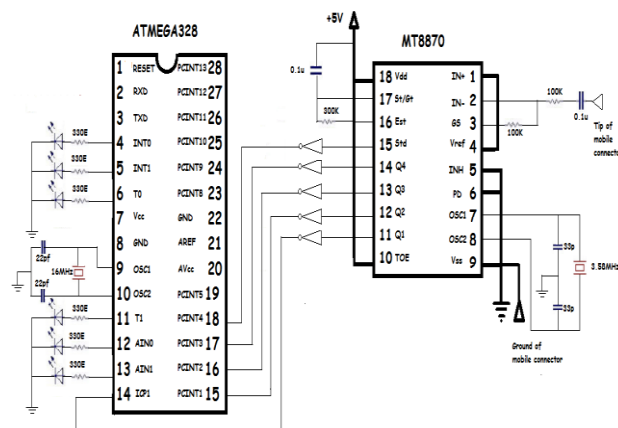


Figure 7. Interfaces of the home automation system

WORKING OF THE HOME AUTOMATION SYSTEM:

The MT8870 is a DTMF decoder which is being used in this circuit. The decoder uses a digital counting technique to detect and decode the DTMF tones into a 4 bit long codeword.

ATmega 328 microcontroller manufactured by ATMEL is a high performance 8 bit, low power microcontroller. It is compatible with the industry-standard 80C51 instruction set and pin-outs.

The input consists of a mobile phone and a 3.5 mm audio jack. For the decoder section MT8870 IC is used.

When any key of the mobile phone is pressed, the corresponding DTMF tone is transferred to the input of DTMF decoder via the audio jack which is connected to pin 2 of the decoder. Pins 11-14 give the 4 bit codeword output and pin 15 is the Std pin.

However, we are not directly giving the output of the decoder to the microcontroller. Instead, the output is initially given to a NOT gate and then given to the microcontroller. This is done as the output of the DTMF decoder is not very stable and does not provide accurate results. Hence, we are using SN74LS04 HEX Inverter after the decoder. The output of the NOT Gate is provided to the pins 14-19 of Atmega 328.

The microcontroller (here, ATmega 328) is programmed to switch on or off the devices connected to its output pins 4,5,6,11,12,13.

Initially, for testing, LEDs were connected to the output pins. Later, the microcontroller output was fed to a transistor relay driver circuit and finally, was used to control 230V lamps.

TRANSISTOR RELAY DRIVER CIRCUIT:

Relays are electromechanical devices. They use an electromagnet to operate a pair of movable contacts from an open position to a closed position. The relay can be used as electrically operated

switches. The transistor relay driver circuit is required after the microcontroller as the output voltage is only 5 V and a bulb, tubelight or fan work at 230 V supply.

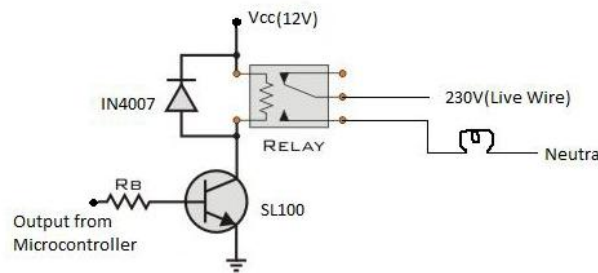


Figure 8. Transistor relay driver circuit

The relay is connected between the positive power supply and collector of transistor. The IN4007 diode is included in the circuit to eliminate back emf when the relay switches off and provides protection.

FLOWCHART

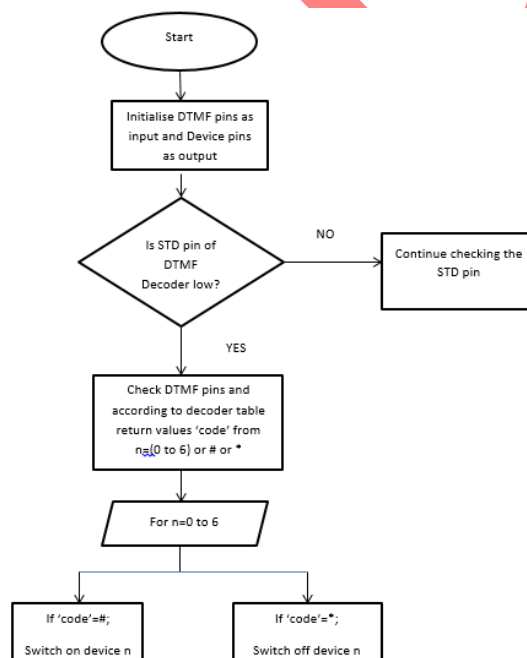


Figure 9. Flowchart of the microcontroller program

We select the DTMF pins as input and device pins as output by programming the microcontroller. Depending on the state of the STD pin, the microcontroller switches on or off the devices.

RESULT

Output voltage	Resistance of the potentiometer
0.0 V	2.8 K-ohm
5.0 V	2 K-ohm
10.0V	1.5 K-ohm
15.0V	0.9 K-ohm
20.0 V	450 ohm
21.0 V	270 ohm
22.0 V	1 ohm

Table I. Varying output voltage with change in resistance of the power supply circuit

Output current	Resistance of the potentiometer RV2
0 A	1 K-ohm
0.05 A	700 ohm
0.1 A	350 ohm
0.15 A	125 ohm
0.22 A	1.75 ohm

Table II. Varying output current with change in resistance of the power supply circuit

The above two tables provide the output values of voltage and current while varying the corresponding potentiometers in the variable power supply circuit. Accordingly, the atmega of the home automation system can be powered by using a particular value of voltage.

DTMF DECODER TABLE:

Button	Low DTMF frequency (Hz)	High DTMF frequency (Hz)	Binary coded output			
			a ₄	a ₃	a ₂	a ₁
1	697	1209	0	0	0	1
2	697	1336	0	0	1	0
3	697	1477	0	0	1	1
4	770	1209	0	1	0	0
5	770	1336	0	1	0	1
6	770	1477	0	1	1	0
7	852	1209	0	1	1	1
8	852	1336	1	0	0	0
9	852	1477	1	0	0	1
0	941	1336	1	0	1	0
*	941	1209	1	0	1	1
#	941	1477	1	1	0	0

Table III. DTMF decoder table

As it can be seen from the decoder table, for every number, a unique row and column frequency is generated and correspondingly a 4 bit binary codeword is generated.

Sr. No.	Key pressed	output
1	0#	All devices switched on
2	0*	All device switched off
3	n#	Device n (any no between 1-6) is switched on
4	n*	Device n (any no between 1-6) is switched off

Table IV. Key assignment to different devices for performing ON/OFF operations

The ATmega 328 microcontroller had been programmed such that * indicated switching off devices whereas # indicated switching on devices. Six devices had been connected to the output ports of the microcontroller. So, keys 1 to 6 represented the six devices and 0 represented all the devices combined. As it can be observed, different combinations of mobile keys resulted in a variety of operations.

APPLICATIONS

1. Used for saving electricity at home where people often forget to switch OFF their electronic appliances.
2. DTMF tones are used at IVR systems, call centers and security systems.
3. Used in terrestrial stations for switching ON or OFF of remote transmitters.
4. It is used in telephone switching centers for detection of dialed numbers.
5. Can be used in continuous monitoring of system of wireless robots. [1][2]

ADVANTAGES

1. There is minimal delay in the system.
2. There is no distance limitation because of the use of mobile network.
3. Cost effective and low power consumption.
4. Any number of devices can be connected for the user to access.
5. Any kind of telephone set or mobile device can be used.

DISADVANTAGES

1. Security issues may arise since any unauthorized person can access the devices at home.
2. Absence of feedback will result in uncertainty of whether the task is performed or not on pressing the corresponding key.

CONCLUSION

This paper presents the working of a home automation system which is based on the DTMF tone generated by pressing the phone keys. When the user at any place pushes a key of his mobile phone, then a corresponding DTMF tone is generated which is transmitted to the mobile phone at home. The decoder table is referred while decoding the DTMF tone received at the receiver depending upon its frequency and corresponding device is either switched ON or Off depending on the command given by the user. The system is portable since it is accompanied by a variable power supply. Also this method uses mobile communication networks for signal transmission and reception thereby enabling the user to have a continuous control of the system in place of his actual presence.

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FIGURES AND TABLES

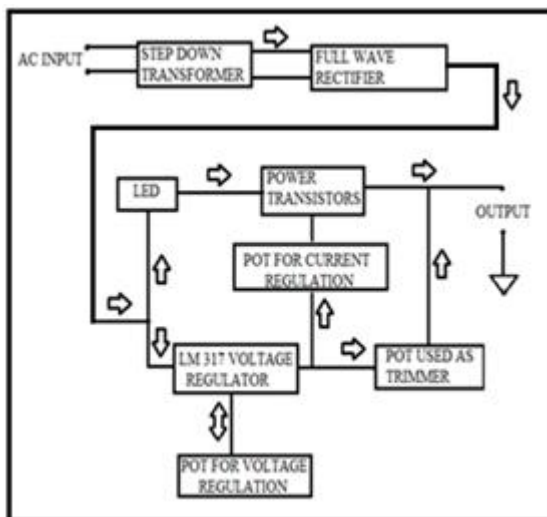


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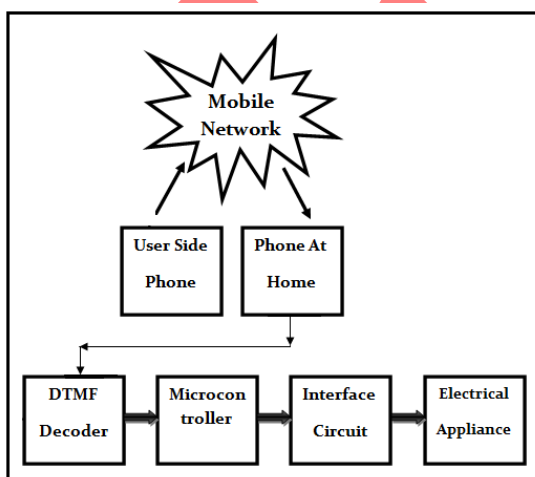


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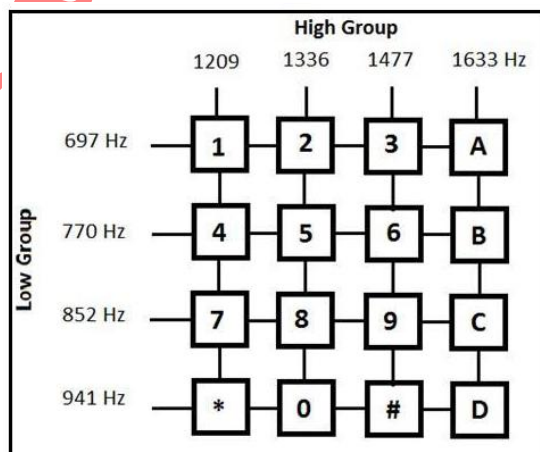


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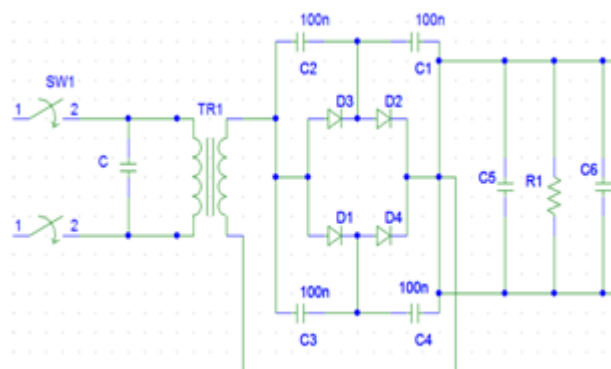


Figure 4. Circuit diagram of variable power supply part1

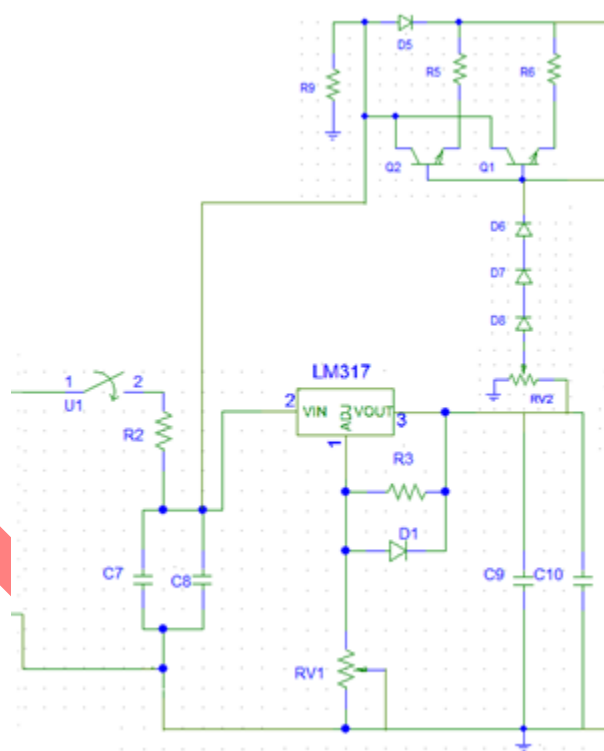


Figure 5. Circuit diagram of variable power supply part2

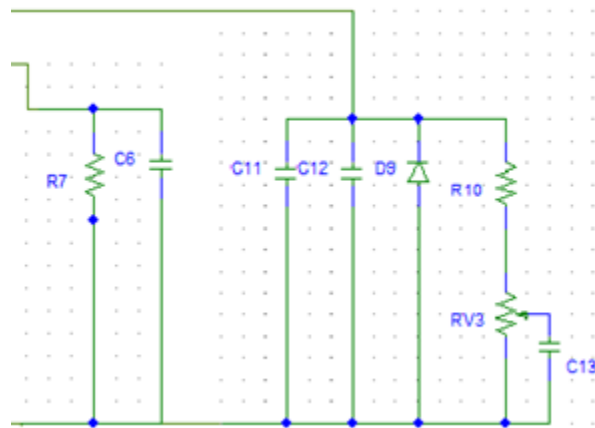


Figure 6. Circuit diagram of variable power supply part3

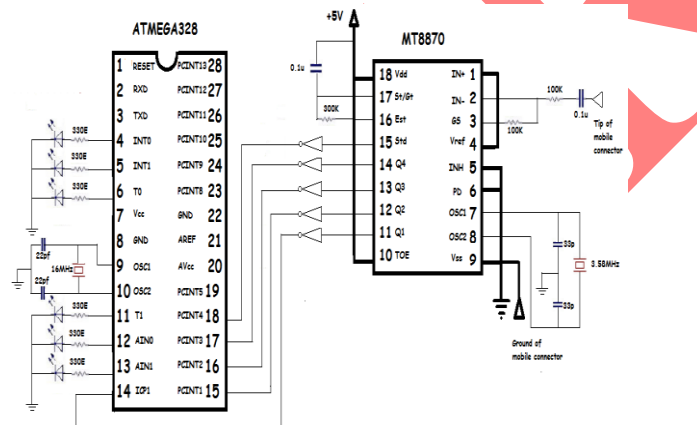


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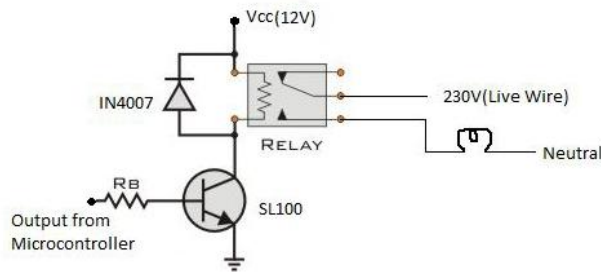


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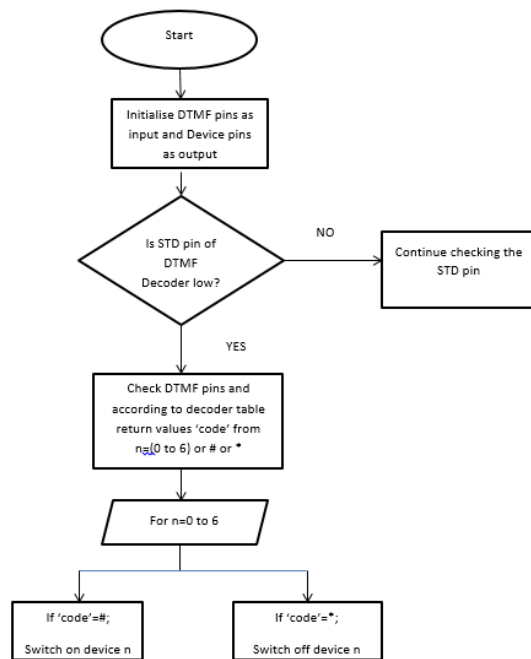


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9	852	1477	1	0	0	1
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