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Design and Implementation of a GSM Activated Automobile Demobilizer with Identification Capability

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Abstract. The incidence of car theft in Nigeria has grown to nearly epidemic proportion. On daily basis, the numbers of stolen cars reported over the media are on the increase. Alarms and other deterrents are not enough. There is actually little one can do to prevent a car from being stolen. However, with a Global System for Mobile communication (GSM) activated automobile demobilizer with identification capability one can virtually take control of the virtually impossible incidence and hence increase the possibility of car recovery. This paper is aimed at implementing a security device capable of safeguarding cars from theft as well as provides picture and audio information of the culprits in an attempt to steal the car. To realize this work, use was made of a GSM phone

Introduction

Cars security in Nigeria has deteriorated over the past years, with high crimes rate of occurrence between November and January yearly. There is little we can do to prevent a car from being stolen. However, with enhanced security systems, the situation can be control. Hence in this paper we present a GSM activated automobile demobilizer with identification capability. The device is capable of providing and storing the audio and picture images of the culprits (intruders) for identification and possible prosecution evolved, thus reducing car theft [1]. The device can be controlled with a GSM handset, and can conveniently deactivate the car. This equipment is hidden within the vehicle.

Literature Review

The GSM car security system allows authorized users to gain control over the safety of their car. It is a hybrid system which combines different features to realize car security. This high-technology vehicle security and monitoring system is a state-of-the-art device which gives car owners complete control of their cars. Some GSM security systems combines the GSM mobile communication, MGPS locating technology and MICROCHIP rolling code technology, multi-code mating and microcomputer technology [2]. Some combines GSM and GPS technology to track and demobilize the owners car from anywhere in the world [3], GSM car alarm and demobilizer [4]. However, in this paper we present a security system which combines GSM technology to track and demobilize the owner's car within the GSM service areas, as well as identification capability.

Prior to the development of digital electronics, car engine demobilizers use analogue timers which work until the preset time is reached. With the advent of digital electronics, electronic counters like NE555 timers, JK-Flip flop, binary and decade counters [5] are now in use. The use of these electronic components with low noise, and relatively small size compared to the analogue timers, made it difficult to be detected in the car system.

In this work, we used a GSM handset as a control unit to deactivate the security device as well as provide and stores the picture image and audio information of the culprits in case the car was stolen at gun point.

Methodology/Design Consideration

The design and implementation of the GSM activated automobile demobilizer with identification capability is achieved with both discrete components and integrated circuits (ICs). The entire circuitry is designed around a Sony Ericsson K600i Camera Phone that is MMS compatible. It consists of three parts: Power Supply Unit, Signal Processing Unit, and the Latch Shutdown Circuitry

Design Analysis

The design analysis was carried out in stages [6 – 11].

Fig. 1 shows the charging circuit

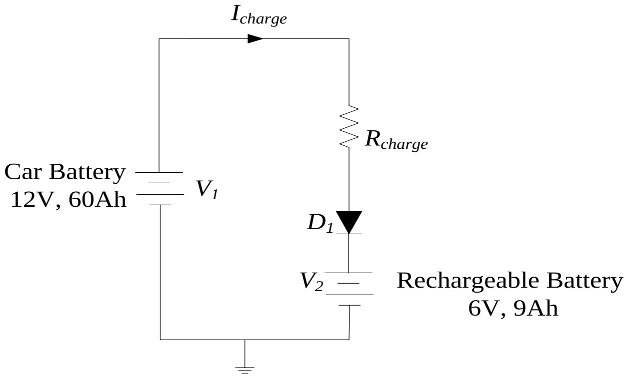

Fig. 1: The charging circuit

The charging resistance, R_{charge} is given as; [12]

$$R_{charge} = R_1 = \frac{V_1 - V_F}{I_{charge}} \qquad (1)$$

and

$$I_{charge} = 0.1 I_{max} \qquad (2)$$

I_{max} is the maximum current capacity of rechargeable battery, V_F is the forward voltage drop of diode D_1, and V_1 is the voltage of car battery.

The power dissipated, $P_{Rcharge}$ by the choke resistor is

$$P_{Rcharge} = I^2 R_{charge} \qquad (3)$$

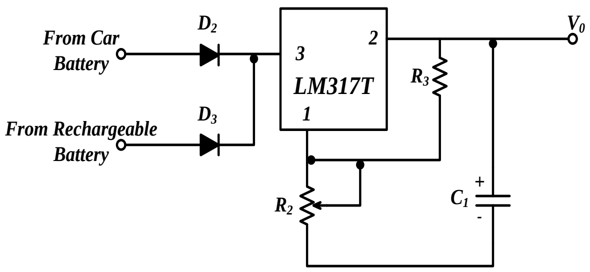

Fig. 2: Schematics a constant 3.9 volts supply using LM317T

The parameters can be calculated as; [13]

$$R_2 = R_3\left(\frac{V_{out}}{V_{ref}} - 1\right) \qquad (4)$$

V_{ref} is 1.25 volts while standard values of R_1 range from 220 Ω - 240 Ω. V_{out} is designed to be 3.9 volts.

The oscillatory frequency, f_{osc} of CMOS Relaxation RC Oscillator Circuit is expressed as

$$f_{osc} = \frac{1}{R_4 C_2} \tag{5}$$

The timing resistor R_4 and capacitor C_2 were chosen

The induced voltage across the inductor of the forward DC-DC converter is given as [14,15];

$$V_L = L I_L f \tag{6}$$

Where *L* is the inductance of coil, *f* is the oscillatory frequency and I_L is the induced current.

The cut-off frequency, f_c of the low-pass filter formed by C_3 and D_4 is given as [16];

$$f_C = \frac{1}{2\pi R_f C_3} \tag{7}$$

Where R_f is the specified forward resistance of D_4 (=400 Ω)

The input current I_{B3} of the Darlington Transistor is expressed as [12];

$$I_{B3} = \frac{I_{E4}}{(h_{fe4}+1)(h_{fe3}+1)} \tag{8}$$

KTC9014 current gain, h_{fe3} is 200 (given) and D882 current gain, h_{fe4} is 12 and I_{E4} is the required charging current, designed to be 500mA [12].

$$R_{E3} = \frac{(V_Z - V_{BE3})}{I_{B3}} \tag{9}$$

The bit number, *N* of binary counters is given as [17];

$$N = 2^n \tag{10}$$

Where *n* is the number of stage and it is specified to be 14 for CD4020. The input period of the interrupt charger is [17];

$$T_{in} = \frac{T_{out}}{2^{14}} \tag{11}$$

T_{out} is chosen to be 3600 seconds.
For *RC DC* circuits, the timing constant is given as [12];

$$T = RC \tag{12}$$

and

$$R_8 = \frac{T_{in}}{C_5} \tag{13}$$

C_5 was chosen.

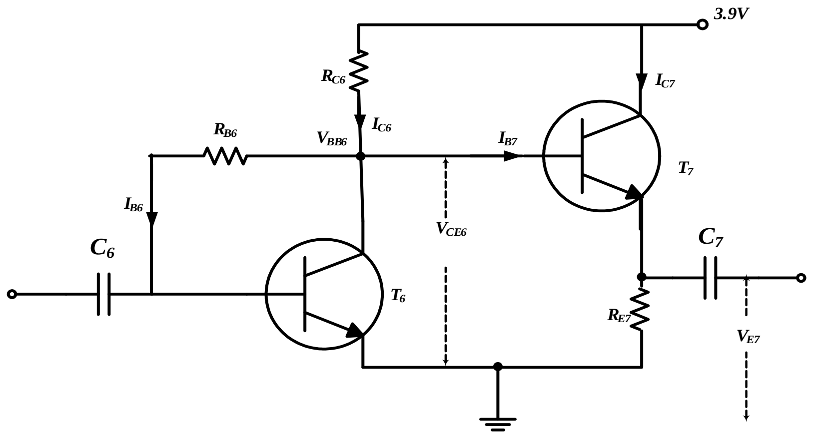

Fig. 3: Common Collector Fixed Base Bias Buffered with an Emitter Follower.

From Fig. 3, the emitter follower was biased such that

$$V_{E7} = \frac{1}{2} V_{CC} \quad (14)$$

$$R_{E7} = \frac{V_{E7}}{I_{E7}} = \frac{V_{CC}}{2I_{E7}} \quad (15)$$

$$I_{E7} = I_{C7} + I_{B7}$$

$$I_{E7} = I_{B7}(h_{fe7} + 1) \quad (16)$$

$$I_{B7} = \frac{I_{E7}}{(h_{fe7} + 1)} \quad (17)$$

$$V_{CE6} = V_{E7} + V_{BE7}$$

$$V_{BB6} = V_{CE6} - V_{BE6} \quad (18)$$

$$R_{C6} = \frac{(V_{CC} - V_{CE6})}{I_{C6}} \quad (19)$$

$$I_{B6} = \frac{I_{C6}}{h_{fe6}} \quad (20)$$

$$R_{B6} = \frac{V_{BB6}}{I_{B6}} \quad (21)$$

$C_6 = C_7 = 0.01\mu\text{F(chosen)}$

The gain, G of the amplifier in Fig. 4 is given by Ebers-Moll Equation as; [16]

$$G = \frac{R_L}{R_E} \quad (22)$$

Where R_L is the load resistance (=R_{C6}) and R_E is the total emitter resistance

$$R_E = R_e + r_e \quad (23)$$

Where R_e is the external resistance and r_e is the internal intrinsic resistance. Thus

$$G = \frac{R_L}{(R_E + r_e)} \quad (24)$$

Since emitter for T_6 is grounded, $R_e = 0$ thus Eq. 24 becomes

$$G = \frac{R_{C6}}{r_e} \tag{25}$$

$$G = \frac{V_{out}}{V_{in}} \tag{26}$$

$$V_{out} = GV_{in} \tag{27}$$

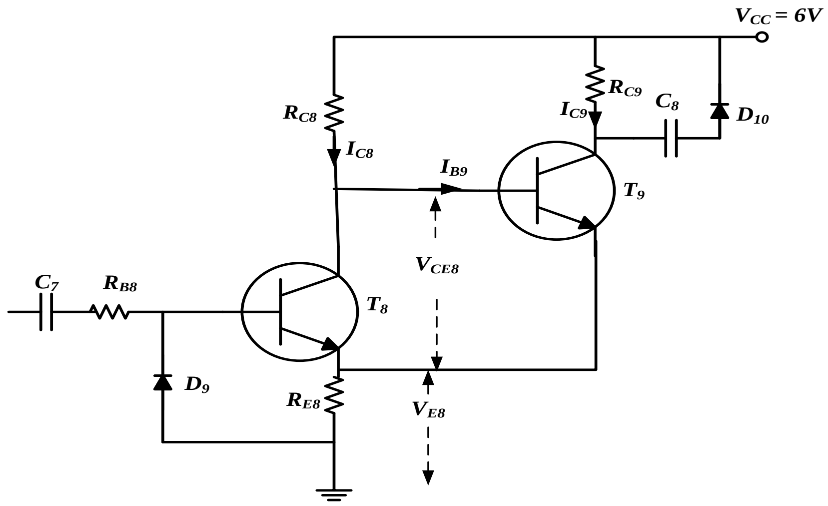

Fig. 4: Transistor Schmitt Trigger.

From Fig. 4, the design of the input (turn-on) voltage is such that

$$V_{in} \succ 0.6V \tag{28}$$

$$V_{E8} = \frac{1}{4}V_{CC} \tag{29}$$

$$V_{CE8} = \frac{1}{2}V_{CC} \tag{30}$$

$$R_{C8} = \frac{V_{C8}}{I_{C8}} = \frac{(V_{CC} - V_{CE8})}{I_{C8}} \tag{31}$$

$$I_{E8} = I_{C8} + I_{B8}$$

since Ic >> I_B

$$I_{E8} \approx I_{C8} \tag{32}$$

$$R_{E8} = \frac{V_{E8}}{I_{E8}}$$

Similarly for T_9

$$R_{C9} = \frac{(V_{CC} - V_{CE9})}{I_{C9}} \tag{33}$$

$$I_{E9} \approx I_{C9} \tag{34}$$

The output period of two cascaded decade counters is given as; [17]

$$T_{out} = 100T_{in} \tag{35}$$

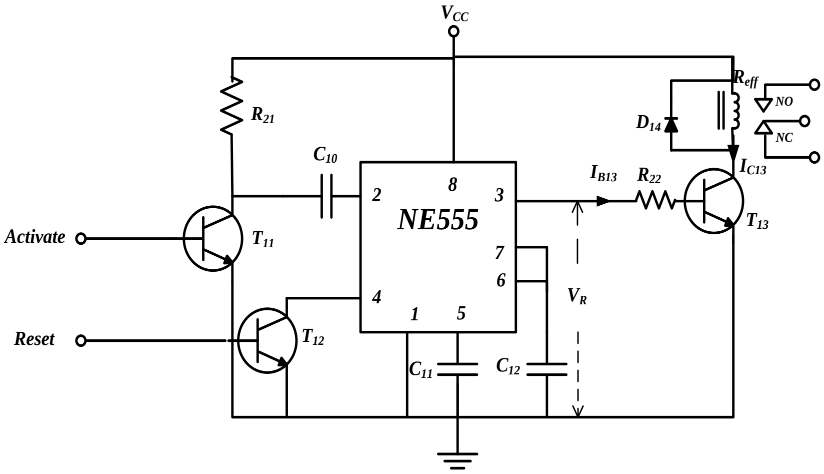

Fig. 5: Latch Circuit used to drive a Transistor Relay Driver.

The trigger (ON) voltage is [5];

$$V_{th} = \frac{1}{3} V_{cc} \tag{36}$$

$R_{21} = R_{25} = 10K\Omega$ (Chosen)

$R_{24} = 1K\Omega$ (Chosen)

The relay effective resistance is given as [12];

$$R_{eff} = \frac{R_{rly} R_{rly}}{R_{rly} + R_{rly}} = \frac{R_{rly}}{2} \tag{37}$$

Using h - parameters [14]

$$I_B = \frac{I_C}{h_{fe}} \tag{38}$$

$C_{10} = C_{11} = C_{12} = C_{13} = C_{14} = C_{15} = 0.01\mu F$ (Chosen)

Operational Principles of the GSM Activated Automobile Demobilizer with Identification Capability

The power supply unit, which consists of the charging circuit, the conditioned voltage supply and the one hour interrupt GSM charger is designed to charge the GSM phone battery as well as the rechargeable (backup) battery. The GSM phone battery powers the demobilizer in case the car battery is disconnected. The diode OR-Gate is designed such that the car battery having a higher potential of 12 volts, supplies current to the LM317T voltage regulator which in turn supplies a constant 3.9 volts to the demobilizer system. The clock oscillation section is designed around the MM74HC14 Hex Inverting Schmitt Trigger and it runs from the 3.9 volts. The MM74HC14 Hex Inverting Schmitt Trigger sends clock signals to CD4020 and CD4017.

When the Sony Ericsson K600i camera phone positioned within the signal processing unit receives the audio signal (ring tone) from the caller's phone through the earpiece, it is connected to the input of the common collector fixed base bias small signal amplifier with emitter follower. This amplifier amplifies the incoming signal and its output is sent to the transistor Schmitt Trigger, which converts the sine wave (audio signal) into a square wave. The output of the square wave is used to clock the first decade counter; *CD4017*, with odd outputs connected to an *LED* via *IN4001* signal diodes. The *LED* flashes as the sine wave signal flows through it. The outputs of this counter through IN4001 are used to trigger the master latch circuit. This is shown in Fig. 6. The master latch circuit designed around an *NE555* timer and two KTC 9014 Transistors activates a transistor relay driver circuit. This relay when activated supplies +6 volts to the dialing network. The dialing network consists of cascaded Johnson Counters: CD4017 (2) and CD4017 (3), a Schmitt Trigger RC Oscillator, a transistor relay switch, two transistors relay circuits driven by monostable circuits and the Sony Ericsson K600i Camera Phone. The cascaded counter is fed by the Schmitt Trigger RC Oscillator, which generates 1.2 seconds clocked signal.

From the time the dialing network is activated, the cascaded counter initializes its counting sequence and after 24 seconds, output "1" of CD4017 (2) through IN4001 and a transistor relay switch activates the snap button on the GSM phone keypad while output "2" and output "3" via IN4001 signal diodes feed a transistor relay switch driven by a monostable circuit. This helps to process the picture information of the intruder and send same to the owner's phone whose SIM number has previously been stored in the demobilizer's contact. The owner's phone must be MMS compatible and must be activated by the GSM service provider to enable access. Output "4" of CD4017 acts as a delay, while output "5" is used to activate another monostable circuit. This circuit drives a transistor relay switch which in turn is used to clear the screen of the K600i Camera Phone. Output "6" also acts as a delay while at 94 seconds, output "7" is used to dial the caller so that when he accepts the call, he will be able to listen to the audio conversation of the occupants in the car as well as what is going on in the surrounding environment in order to determine the location of the car and be equipped with vital information. Output "8" also acts as a delay while at 120 seconds, output "9" is used to enable CD4017 (3). Output "1" of this counter designed at 240 seconds from the initial counting sequence (start time) through IN4001 activates the shutdown latch circuit. This in turn forward biases transistor, T_{10} (KTC9014). With T_{10} *ON*, I_{C10} flows, thus reverse biasing T_{11}. This turns *OFF* the relay connected to the ignition coil thereby switching *OFF* the car. This action is indicated by the switching *OFF* of the LED connected between the relay terminal and ground. At the same time the output signal from output "1" of CD4017 (3) is used to reset the master latch circuit thereby switching *OFF* power supply from the dialing network.

After the car has been demobilized, the caller still has access to the audio information within the car for as long as the demobilizer's SIM is recharged. The entire circuit can be reset first by pressing the hidden reset button to reset the shutdown latch circuit and then switching *OFF* and then *ON* the power supply switch. This helps to deactivate the CD4017 (1). However when the power supply is switched *ON*, the CD4017 (1) can not be activated without the external 900MHz GSM signal. This is because the two $0.01\mu F$ capacitors C_6 and C_7 help to block the DC voltage between the GSM phone and the Transistor Schmitt Trigger thus keeping it *OFF*.

Results and Discussion

Apart from realizing the objective of this work, we tested for the performance of the system based on its parameter as against their theoretical and designed specifications as shown in Table 1. The measured system parameters obtained as compared to the designed parameters were satisfactory. The developed system performed satisfactorily.

Table 1: Test Results

S/N	Parameters	Theoretical Values	Designed Values	Measured Values
1.	Charging Current, I_{charge}	450mA	380mA	350mA
2.	Charging Voltage, V_{charge}	12V	11.6V	11.6V
3.	Output Voltage to LM317T, V_{out}	Adjustable	3.9V	3.9V
4.	Input Voltage to LM317T, V_{in}	12V	11.7V	11.7V
5.	Output frequency from Schmitt Trigger Oscillator	0 – 16MHz	20KHz (adjustable)	20KHz (adjustable)
6.	Minimum Current to charge phone	300mA	400mA	350mA
7.	Maximum Current to charge phone	550mA	500mA	480mA
8.	Minimum Voltage to charge phone	4.2V	5V	5V
9.	Maximum Voltage to charge phone	6V	6V	6V
10.	Forward biased V_{BE} of Audio Pre-Amp	0.6V – 0.7V	0.6V	0.65V
11.	Base voltage of KTC9014	2.55V	1.95V	2.45V

Conclusion

In this paper, we have been able to design and implement a GSM activated automobile demobilizer with identification capability, which provides a mechanism that can conveniently secure automobile cars from theft, and in case of theft can transmit the audio signal and picture image of the occupants of the car to the owners phone and shutdown the car in four (4) minutes to enable the owner recover it. The owner can identify and if possible arrests the culprits through the stored information (photographs and audio conversations) in the GSM handset.

References

[1] Information on http://www.premium-mobile.com/content/2-billion-gsm-users-worldwide/, (2007)
[2] Information on http://www.zuden.com, ‘ Zuden Security Intruder Burglar Alarm Co. Ltd, China, (2008).
[3] Information on www.allafrica.com, 26/11/2007.
[4] Eeo, Car tracking system, Nairalan.htm, November 28, 2008.
[5] M. B. Harvard: Learn how to Connect the 555 Timer, perform 17 Experiments, Cambridge University Press, (1995).
[6] A.K. Theraja and B. L. Theraja, “A Textbook of Electrical Technology”, 22nd Edition, S. Chand and Co., New Delhi, (1995).
[7] P. Horowitz, and W. Hill: The Art of Electronics, Cambridge University Press, Low Price Edition, (2002).
[8] P. Rudy and G. Severns: Modern DC-DC Switchmode Power Conversion Circuits, Van Nostrand Reinhold, (1985).
[9] S. K. Andre, R. Richard and O. S. Nathan; Dynamic Analysis of Switch-Mode DC-DC Converters, Van Nostrand Reinhold, (1991).
[10] V. O Akpaida, O.Omorogiuwa and M. S. Okundamiya; Principles of Electronic Devices and Circuits, Stemic Publications, Benin City, (2005).
[11] J. R. Nowicki and L. J. Adams: Digital Circuits, Prentice-Hall International, (1993).
[12] F. Sergio: Design with Operational Amplifier and Analog Integrated Circuits, McGraw Hill Series, International Edition, (1988).
[13] P. C. Juan: The Greatest Communication Inventions, IET Communications Engineer, Vol. 5, Issue 1, UK, (March 2007) p. 19
[14] L. Yim-Shu: Computer-Aided Analysis and Design of Switch-Mode Power Supplies, Marcel Dekker, (1993).
[15] C. C. George: High Frequency Switching Power Supplies - Theory and Designs, McGraw-Hill, New York, (1989).
[16] C. E. Strangio: Digital Electronic Fundamental Concept and Application, McGraw Hill, (1983).
[17] W. E. Robert and M. Dragan: Fundamentals of Power Electronics, Kluwer Academic Publishers, (2001)
[18] A. K. Yusufu: Cellular Wireless Communications: Evolution and Impact Assessment, Journal of Engineering Science and Application (JESA), Vol. 3, No. 2, Ekpoma, (Dec. 2002), p. 31

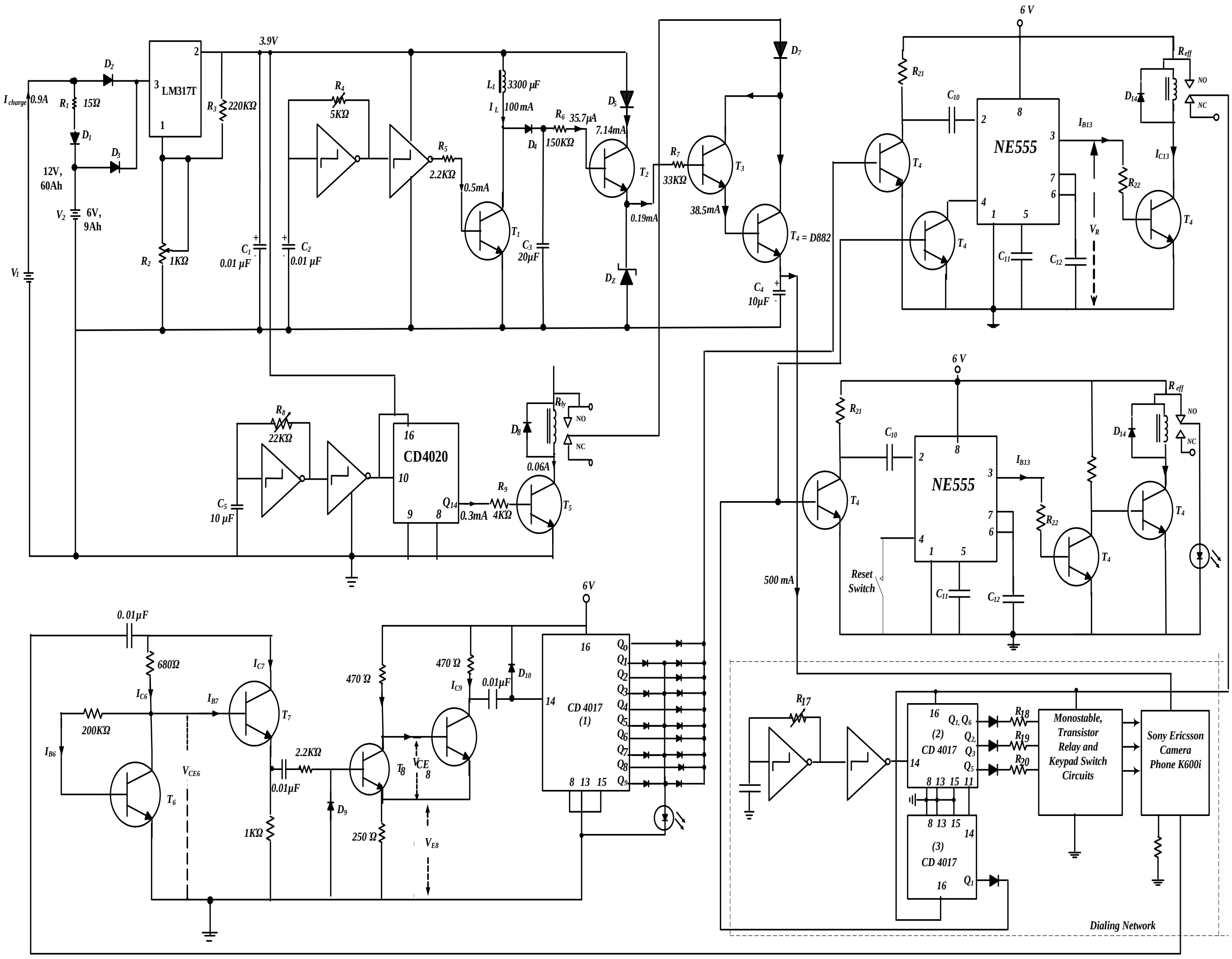

Fig. 6: Complete Circuit Diagram of GSM Activated Automobile Demobilizer with Identification Capability

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