SIRC BASED ON DELAY/OFF DELAY RELAY SWITCHING

A Project report submitted in partial fulfillment
of the requirements for the degree of B. Tech in Electrical Engineering

by

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CERTIFICATE

To whom it may concern

This is to certify that the project work entitled **SIRC BASED ON DELAY OF F DELAY RELAY SWITCHING** is the bonafide work carried out by **Souvik Chatterjee (11701614052), Aneek Barman (11701614007)** and **Md. Wahid Rahaman (11701614027)**, the students of B.Tech in the Department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2016-17, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

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ACKNOWLEDGEMENT

It is our great fortune that we have got opportunity to carry out this project work under the supervision of **Mr. Budhaditya Bisw as** in the Department of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (**MAKAUT**), West Bengal, India. We express our sincere thanks and deepest sense of gratitude to our guide for his constant support, unparalleled guidance and limitless encouragement.

We would also like to convey our gratitude to all the faculty members and staffs of the Department of Electrical Engineering, RCCIIT for their whole hearted cooperation to make this work turn into reality.

We are very thankful to our Department and to the authority of RCCIIT for providing all kinds of infrastructural facility towards the research work.

Thanks to the fellow members of our group for working as a team.

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To

The Head of the Department
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Respected Sir,

In accordance with the requirements of the degree of Bachelor of Technology in the Department of Electrical Engineering, RCC Institute of Information Technology, We present the following thesis entitled "**SIRC BASED ON DELA Y/OFF DELAY REL AY SWITCHING**". This work was performed under the valuable guidance of Mr. Budhadtiya Biswas, Assistant Professor in the Dept. of Electrical Engineering.

We declare that the thesis submitted is our own, expected as acknowledge in the test and reference and has not been previously submitted for a degree in any other Institution.

Yours Sincerely,

SOUVIK CHATTERJEE (11701614052)

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Contents

List of Figures

List of Tables

ABBREVIATIONS AND ACRONYMS

SIRC – SONY Infrared Remote Controller
***IC* -** Integrated Circuit
PCB – Printed Circuit Board
µC – Micro Controller
***BJT* -** Bi-polar Junction Transistor
***SPDT* -** Single Pole Double Throw
***NO* -** Normally Open
***NC* -** Normally Closed
COM – Common
LCD – Liquid Crystal Display
***LED* -** Light Emitting Diode
POT – Potentiometer
SMPS – Switch Mode Power Supply
IR – Infrared
ISM – Industrial, scientific and medical
***TDR* –** Time Delay Relay

ABSTRACT

Time Delay is defined as the controlled period between the functioning of two events. A Time Delay relay is a combination of an electromechanical output relay and a control circuit. The control circuit is comprised of solid state components and timing circuits that control operation of the relay and timing range. Typical time delay functions include On-delay, Repeat cycle (starting off), Interval, Off-Delay, Re-triggerable One Shot, Repeat cycle (starting on), Pulse Generator, One Shot, On/Off Delay, and Memory Latch. Time delay relays have a broad choice of timing ranges from less than one second to many days. There are many choices of timing adjustments from calibrated external knobs, DIP switches, thumbwheel switches, or recessed potentiometer. The output contacts on the electromechanical output relay are direct wired to the output terminals. The contact load ratings are specified for each specific type of time delay relay.

In this project we want to develop a ON/OFF delay relay using a microcontroller. The time of the relay are adjusted through a Sony IR remote using SIRC protocol. The time is adjusted from 00 sec to 99 sec according to the user requirement. The parameters are also shown in a LCD screen. After receiving all the parameter from the user the controller control the relay driver a successively the relay controls the load connected to its output.

CHAPTER 1

(Introduction)

1.1 INTRODUCTION

Time delay relays (TDRs) can provide simple, reliable, and economical control when a definite-purpose solution is required. Providing time-delayed switching to start a motor, control a load, or affect a process, TDRs are typically used in industrial applications. Additionally, they play an important role for targeted logic needs, such as in a small panel or in sub panels. They have a variety of features and operating characteristics, such as compactness, economy, simplicity, and ease-of-use.

Automatic control of home appliances is highly demand now a day .In this work, we have designed, constructed a circuit which will preciously control the time of a TRD using SONY IR remote protocol. The system works satisfactorily and it is also considered to be a cost effective system.

ON DELAY RELAY

When the input voltage **U** is applied, timing delay **t** begins. Relay contacts **R** change state after time delay is complete. Contacts **R** return to their shelf state when input voltage U is removed. Trigger switch is not used in this function.

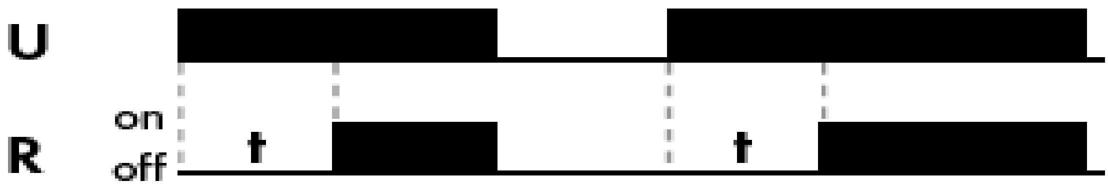


Figure 1: ON delay relay timing diagram

OFF DELAY RELAY

Input voltage **U** must be applied continuously. When trigger switch **S** is closed, relay contacts **R** change state. When trigger switch **S** is opened, delay **t** begins. When delay **t** is complete, contacts **R** return to their shelf state. If trigger switch **S** is closed before time delay **t** is complete, then time is reset. When trigger switch **S** is opened, the delay begins again, and relay contacts **R** remain in their energized state. If input voltage **U** is removed, relay contacts **R** return to their shelf state.

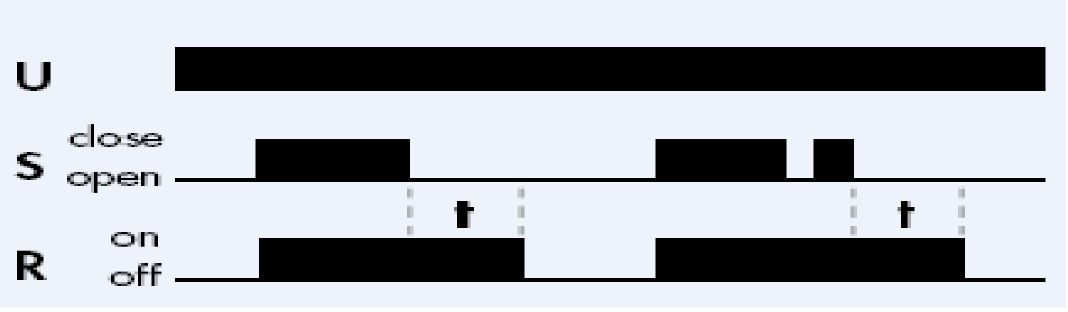


Figure 2: OFF delay relay timing diagram

1.2 SIRC Protocol

SIRC stands for **S**ONY **I**NF**R**ARED **C**ONTROLLER. SONY uses 12-bit SIRC protocol. The code starts with a header of 2.4ms followed by 7-bit command and 5-bit device address in which least significant bits (LSB) are transmitted first. Then the commands are repeated every 45ms for as long as the key on the remote control is held down. The address and commands exist of logical ones and zeros. A space of 600 µs or 1T and a pulse of 1200 µs or 2T form logical one. A logical zero is formed by a space of 600 µs and a pulse of 600 µs as shown in Fig. 1.

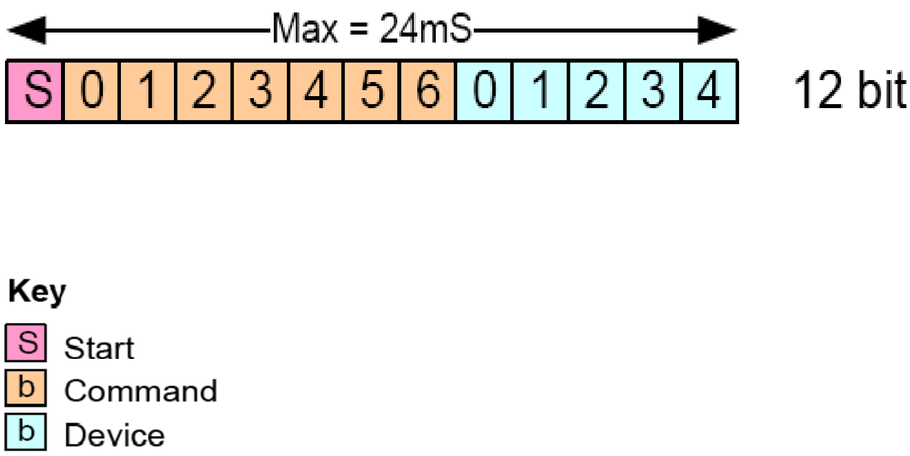
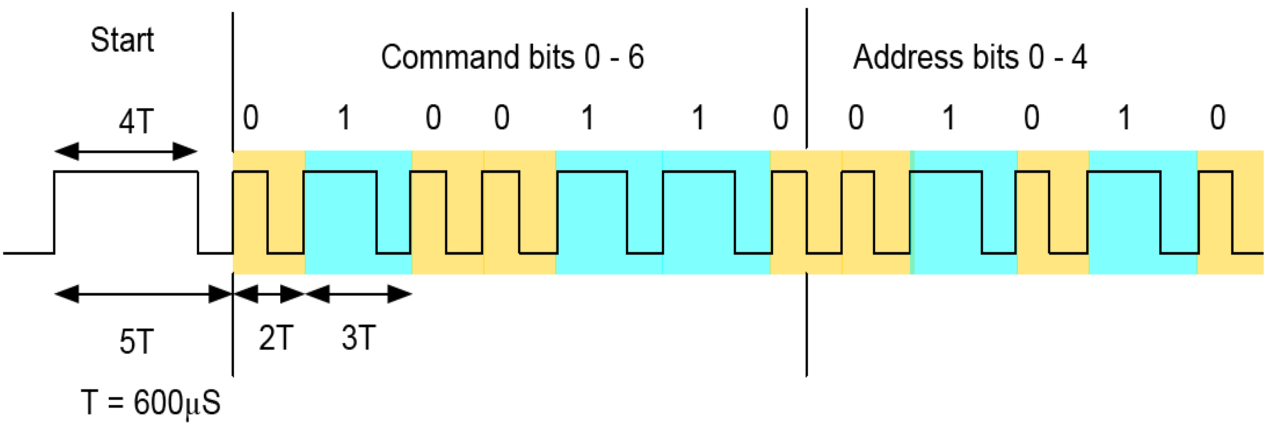


Figure 3: SIRC 12 bit pattern

1.3 SIRC data pattern

SIRC 12 bit pattern is shown in the fig. 2. It always starts with a 3ms burst then 7 bits for the command and 5 bit for the address of the remote device as shown in Fig. 4.



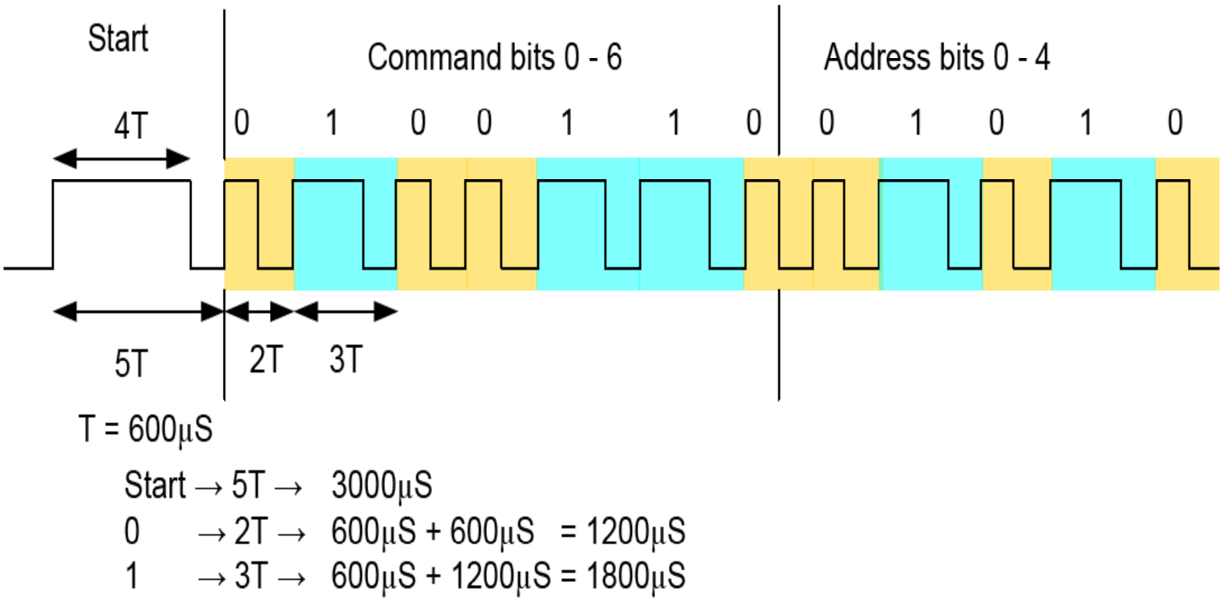
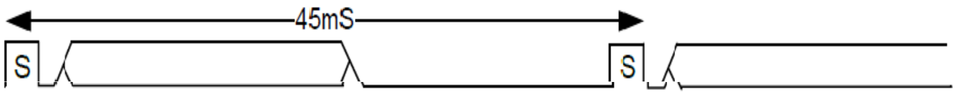


Figure 4: SIRC protocol data and command bit pattern

1.4 SIRC wave form repeat rate

Frames are repeated at an interval of 45mS
Sony remotes tested all appear to repeat each frame a minimum of 3 times



The output from the TSOP4838 IR receiver IC is active low so we need to invert the level seen on the I/O input pin when receiving data.

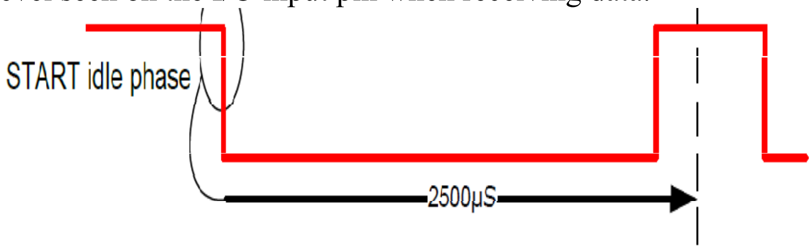


Figure 5: SIRC protocol detection initialization

- Wait for falling edge of start mark pulse
- Once falling edge detected start 2500µS timer.
- If another falling edge seen before the timeout, abort.
- Else start data bit receive phase

1.5 DATA BIT receive phase

Data is transmitted LSB first so it is assembled LSB to MSB. Since it is sentas a 7 bit command, followed by 5 bit device id, the code must split the 12 received bits into two groups of 7 and 5 bits.

- Wait for falling edge:

• If edge detected start 900µS timer
• If no edge within 1200µS abort receive

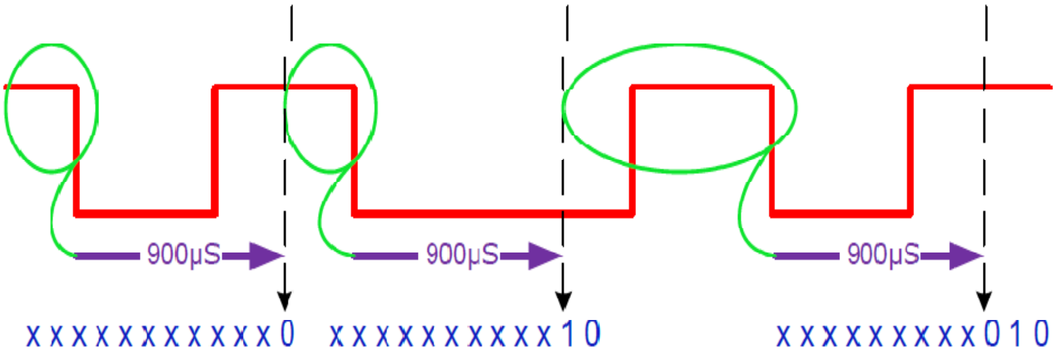


Figure 6: SIRC protocol detection principle

Wait for 900µS then sample input.
If falling edge detected before time out abort receive

The data bit receive code loops until all 12 bits have been received. Because SIRC also supports 15 and 20 bit transmission, after 12 bits have received, the code 'listens' for more falling edges over a 10mS period. And falling edges seen during this hold down period will cause the receiver code to abort since it indicates either 15/20 bit SIRC or spurious reception.

1.6 SIRC device address

The addresses of different SONY devices are tabulated below. The SIRC remote will generate the command bit with the address bit. Command bit may be same for a particular switch of the remote control device but the address bit is different for different gadgets made by SONY.

Table 1: SIRC address for different devices

ADDRESS	DEVICE
1	TV
2	VCR 1
3	VCR 2
6	LASER DISK
12	SURROUND SOUND
16	CASSETTE DECK/TUNER
17	CD PLAYER
18	EQUALIZER

1.7 Overview and benefits of the project

Remote Control Technology's line of dependable, durable wireless remote switching systems can and will make money for you and your business. Wireless remote control benefits include:

No legal issues
Obtaining access to or traversing properties with hard lines is extremely difficult.

No copper wire to steal
As the price of copper increases, so does the possibility that your wire will be stolen. Using a wireless remote system means no wire for thieves to steal.

Extended range
Unlike much of the equipment on the market, Remote Control Technology's wireless remote equipment has long-range communication capabilities — up to 5 miles.

Eliminate the need for wire and conduit
Wire and conduit are expensive and high maintenance. Typical wear-and-tear, digging, rodent damage, theft, etc., are all examples of problems that can damage wire. RCT's wireless remote systems put an end to these drawbacks of wired technology.

Higher profits
Wireless remote switching systems eliminate the costly, labor-intensive process of trenching and laying wire. As a result, the contractor can enjoy an increased profitability of 200 percent or more in this facet of the job.

No FCC licensing required
RCT equipment does not require FCC licensing, whereas much of the other equipment on the market does. This is a significant benefit, as the FCC licensing process alone may take up to 8 weeks.

Less maintenance and servicing
In many states a contractor is obligated by law to maintain pumping systems for up to a year after its installation. RCT switching systems eliminate a majority of these maintenance and servicing issues by automating the job. Fewer service calls mean higher profits.

Reliability and compatibility
All of the components that a contractor puts into a project must interface with one another and have the utmost reliability. RCT wireless remote equipment has proven to be highly compatible with standard equipment used in most industries, as well as offering unparalleled reliability in use with programmable logic controllers (PLCs), various switches and relays, etc.

1.8 Organisation of thesis

The thesis is organised into five chapters including the chapter of introduction. Each chapter is different from the other and is described along with the necessary theory required to comprehend it.

Chapter 2 deals with the literature reviews. From this chapter we can see before our project who else works on this topic and how our project is different and advance from those projects.

Chapter 3 deals with the theory required to do the project. The basic of operation of SIRC protocol detection using microcontroller are described there.

Chapter 4 deals with the hardware modelling of the projects. The main features, photographs, step by step operation of the prototype, component listing and the hardware interfacing of the required components are described here.

Chapter 5 describes the operation of the prototype circuit. A flow chart is presented on the actions which describes the principle of SIRC protocol detection. Once the protocol is detected by the controller we can use the remote to send signals to the controller easily.

Chapter 6 concludes the work performed so far. The possible limitations in proceeding research towards this work are discussed. The future work that can be done in improving the current scenario is mentioned. The future potential along the lines of this work is also discussed.

Chapter 7 References are listed in this chapter

Appendix A, B & C Hardware description, software coding and datasheets are listed here.

CHAPTER 2

(Literature Review)

The system proposed in [1] describes the Implementation of Infrared remote control system for home appliances by using **SPDT** Relay, IR LED, Step down transformer, Timer **NE555 IC** and 5V Regulator. In this research paper, a circuit is designed to turn o n /off any home appliance by using the TV/DVD remote controller.

The system proposed in [2] and [3] describes the designing of a circuit that controls the home appliances via any remote controlled device using **ATMEL 89C52** microcontroller. The system can also be made password included through this tool.

The system in [4] proposes the designing of a Remote controlled switch board to control different home appliances using 8 bit microcontroller ,IR transmitter , IR receiver , Relay driver and Relays and the program to control the switch board is written in C language.

The system in [5] and [6] proposes the designing of Wireless Infrared Remote Controller for multiple home appliances using **SAMSUNG S3F80PB** 8-Bit Microcontroller. In this system a single IR remote control is developed for controlling several home appliances like Television, Home theatre and Air Conditioner.

The system proposed in [7] is describes the designing of a circuit that controls the home appliances via any remote controlled device using **ATMEL 89C52** microcontroller. The device is able to control a load of high power rating from remote area.

The system described in [8] proposes the Design of PIC-Based IR Remote Control Moving Robot using **PIC16F873A** microcontroller. This system also describes an electronic speed control designed to drive two DC motors from 6V battery pack to b e controlled by a commercial universal infrared remote control hand set.

CHAPTER 3

(Theory)

3.1 The Basics of Time Delay Relays

Time delay relays (TDRs) can provide simple, reliable, and economical control. Adjusting the delay time is often as simple as turning a knob. Providing time-delayed switching to start a motor, control a load, or affect a process, TDRs are typically used in industrial applications and OEM equipment. Additionally, they play an important role for targeted logic needs, such as in a small panel or in sub-panels. They have a variety of features and operating characteristics, such as compactness, economy, simplicity, and ease-of-use.

Figure 7: Timer delay relay

In a standard control relay, contacts close immediately when voltage is applied to the coil, and open immediately when voltage is removed. In a variety of applications, it’s desirable to have the operation of the contacts delayed following application or removal of voltage. A TDR solves the problem handily. However, some TDRs postpone closing of the contacts after voltage is applied while others close the contacts — and then reopen them after a delay.

TDRs are available as plug-in devices, much like plug-in control relays. However, they are also available in a range of other forms, including base-mounted devices and direct IEC DIN-mounted controls. For instance, a TDR can be fixed on a motor starter. In this application, energizing the motor starter causes the timing function to begin; contacts within the device operate when timing is complete. Electronic, starter-mounted TDRs are also available. Some TDRs have solid-state outputs instead of relay outputs.

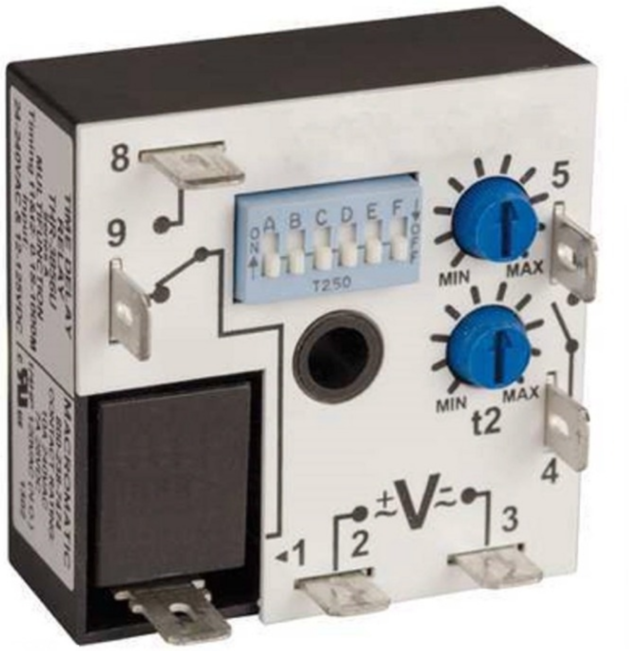


Figure 8: Digital time delay relay

Traditionally, TDRs were available only as single-function, single-time-range devices. These devices are still available and are typically used in applications where the timing needs to be locked in. Today, many TDRs are also available with multiple timing ranges and functions. Costing little more than single-function devices, these TDRs also have wide control voltage ranges. In addition, newer multifunction IEC-style timers allow for reduced inventories. Let's take a closer look at a few of the more common types of TDRs.

3.2 On-delay timers

With an on-delay timer, timing begins when voltage is applied. When the time has expired, the contacts close — and remain closed until voltage is removed from the coil. If voltage is removed before time-out, the time delay resets.

3.3 Off-delay timers

When using an off-delay timer, nothing happens when voltage is applied. Closing the control input (SW) causes the contacts to transfer (Fig 9). Opening the control input causes timing to begin, and the contacts remain closed. On time-out, the contacts transfer. Closing the control input prior to time-out causes timing to reset. Removing voltage prior to time-out resets the timing and opens the contacts. In addition, true off-delay timers provide this functionality (keeping contacts closed) after input voltage is lost. They have capacitors to keep contacts closed even if the timer loses power.

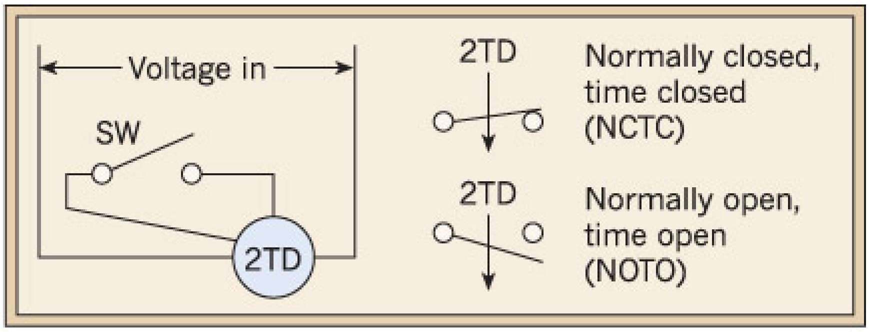


Figure 9: OFF delay relay timer

There are special contact symbols for the on-delay and off-delay timers. In fact, they are the only TDRs for which special contact symbols have been assigned. Other types of TDRs simply use the same contact symbols as those for relays. Often, a note is made near the relay symbol to denote the operating condition. The state of relay contacts is always shown with voltage removed.

3.4 Additional Types of Timers

Beyond the few types of timers already mentioned in this article, additional types are available, such as:

Interval-on-operate — when voltage is applied to the coil, contacts transfer, and timing begins. At the end of the timing interval, the contacts transfer. Power must be removed and reapplied to restart.

Flasher — when voltage is applied, the contacts energize and de-energize alternately. Timing action is halted by removing voltage from the coil. On and off cycle times are the same lengths.

Repeat cycle — Operation is similar to the flasher, but the timing cycles are independently adjustable.

3.5 Single-shot timers

A single-shot TDR has voltage and control inputs similar to the off-delay TDR. Nothing happens when voltage is applied. On closure of the control input, the contacts transfer and timing begins. While timing, the control input can be left open, closed, or opened and closed; in each case, timing continues, and the contacts remain closed. Only at time-out will the contacts transfer. The TDR is reset at this time, ready for another cycle. The only means to interrupt the operation is to remove voltage.

3.6 Real-world applications

Let's put our basic TDR knowledge to practical use. In the three examples below, learn how you can use TDRs effectively to manage processes in various manufacturing facilities.

Crusher and conveyor line — Figure 10 illustrates a simple circuit for a crusher and its feeder conveyor. The circuit is meant purely to illustrate the operation of the TDRs discussed in this article; additional circuitry is required to complete a functioning crusher circuit. Furthermore, familiar voltages are referenced throughout to lend an air of familiarity to the circuitry.

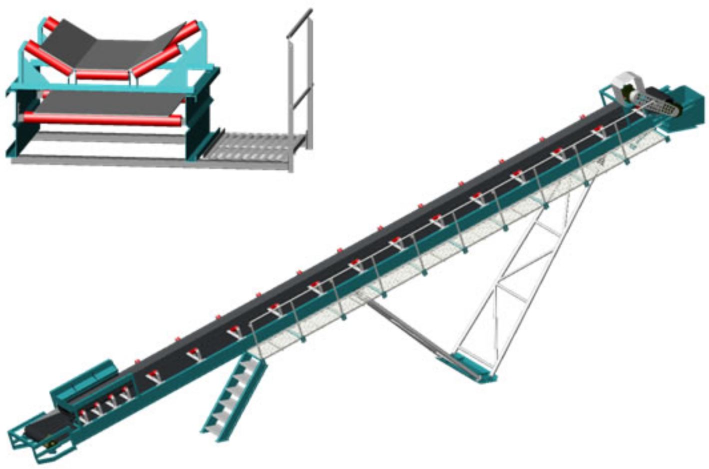


Figure 10: Crusher and conveyor line

The following sequence of events takes place to start the crusher:

- When the start button (line 1) is depressed, relay CR closes.
- CR's contact on line 2 seals in across the start button. Simultaneously, CR's contact on line 3 closes, causing 1TD to begin timing.

- CR’s contact on line 4 closes, causing the warning horn (line 5) to sound through 1TD’s NCTO contact.
- The CR contacts on line 6 closes, causing 2TD to energize its NOTO contact on line 8.
- When 1TD times out after 10 sec, its NCTO contact on line 5 opens, silencing the warning horn.
- Simultaneously, 1TD’s NOTC contact on line 8 closes, energizing 2M, starting the crusher, and causing 3TD to begin timing; 2M’s contact on line 9 seals in across 1TD on line 8.
- When 3TD times out after 10 sec, the feeder conveyor starter, 1M, energizes. 3TD serves to delay starting of the feeder conveyor until the crusher is operating at full speed.

It’s important to note that 3TD does not have a coil but is pneumatic and mounted on top of 2M. 3TD’s timing begins when 2M energizes.

Two methods for stopping are available: normal (labeled cleanout stop) and emergency stop. To stop the crusher under normal circumstances, the button labeled “cleanout stop” is depressed; relay CR de-energizes, causing its seal-in contact on line 2 to open. Additionally, CR’s contacts open simultaneously on all the other lines. The conveyor starter 1M (line 4) de-energizes and stops the feeder conveyor. On line 3, 1TD de-energizes, opening 1TD NOTC on line 8; because 2M is sealed in across 1TD NOTC, 2M stays energized. Timer 2TD allows the crusher to run until all material is out to prevent clogging the crusher — 60 sec in this example. When 2TD times out, its NOTO contact on line 8 opens, de-energizing 2M and stopping the crusher. Note that 3TD’s NOTC contact (line 4) will also stop the feeder conveyor if the crusher starter’s overload relay de-energizes 2M to prevent overfilling of the crusher.

While the cleanout stop is used to assure that the crusher is cleared of material during normal operation, the emergency stop is for real emergencies — when personnel are in danger or a malfunction occurs. The emergency stop button is a large, palm-operated device (hence, the special symbol), shown as a latching button. When depressed, it opens, stopping all motors immediately, and remains latched in the open position. To restart the system, the emergency stop button must first be pulled out and the start button depressed.

Window manufacturing process — At times, it’s imperative to have a momentary input trigger in an operation. For example, a paint drying line for windows uses infrared heaters to dry the paint. Because the material flow is irregular and energy conservation is important, the owner wants the heaters to remain off between windows. A method is required to trigger the heaters to remain on as long as a window is in the oven. For this example, assume the windows are of equal lengths but of varying widths. Because lengths are the same, a uniform drying time can be selected for all windows.

A single-shot TDR can be used in this manufacturing process nicely. A photo sensor is positioned to detect the leading edge of the window. When the photo sensor's output contact closes (line 4), it triggers timer TD. TD's output contact closes (line 6), causing the infrared heater's contactor to close. Time delay TD also begins its timing cycle. Although other parts of the window, such as the minting strips separating panes, may retrigger TD, the output contacts remain closed and TD continues to time. Only when TD has timed out does its output contact open. After time-out, the single-shot is ready to be retriggered for the next cycle. The M contacts are interlocked with TD to prevent overheating the window should M trip-out due to an overload.

Belt conveyors and bucket elevators — Many bucket elevators have buckets attached to a wide rubber belt, lift grain, and other materials vertically — depositing it onto other conveyors. Drive motors for conveyors are located on the head pulley (to pull the belt). Conveyor drives consist of a motor coupled to a gear reducer, which drives the head pulley. Should the head pulley slip, because the conveyor belt is not tensioned properly, the head pulley will slip and burn through the belt. In this event, the best case scenario is that the belt may break and spill the contents, requiring an outage — or worse, the belt and its contents may erupt in flames.

A watchdog timer can serve to prevent such a calamity. An inductive (metal-sensing) proximity sensor detects a metal protrusion (like a key) on the tail pulley. As long as the pulley is rotating, the watchdog timer resets (retriggers) and allows the starter to run. When the conveyor's main belt goes slack, the tail pulley fails to rotate, the proximity switch fails to retrigger the timer, and the watchdog timer times out, stopping the conveyor motor.

A watchdog timer in conjunction with a conveyor starter is illustrated in Fig. 11. Again, note that additional circuitry may be required in an operational system. The start button (line 1) is depressed and held until the conveyor reaches sufficient velocity to allow TD's contact on line 2 to close and seal across the start button; the contact is normally open and times open (NOTO). Should the tail pulley fail to rotate, TD will time out, causing the starter to de-energize, stopping the conveyor before damage occurs. In practice, TD's time delay is set for a few seconds.

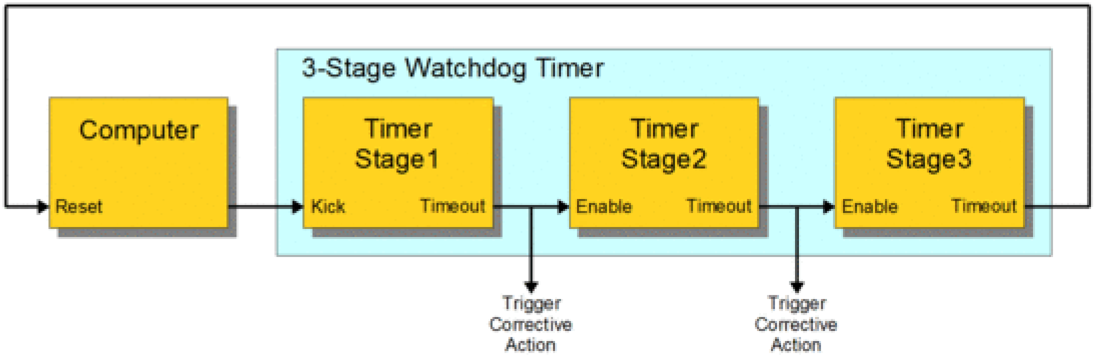


Figure 11: Watch dog timers

The examples demonstrated above are simply meant to provide an introduction into the myriad of uses for TDRs. Actual applications for TDRs are quite expansive.

3.7 Time delay relay- function, types and category

Time delay relay makes a delay to initiate a process after getting a signal. There are pneumatic, thermal & solid state time delay relay. Time delay relay is one the important auxiliary relay that ensures the sequence of operation executes properly.

Several different designs of delay timers, which use different operating principles, have evolved over the years. Much depends on their accuracy and persistent, as this devices are used to synergize a complete process. Naturally one task have to wait while other is doing a thing, and take over the task ahead and pass on and then again wait. Thus time delay relay has its own importance in industrial application.

3.8 Types of time delay relay according to material and process

The pneumatic time-delay relay

This relay works as follows: When the relay is activated, a small spring-loaded bellows is squeezed closed, causing the air to escape through a check valve. The bellows then is allowed to slowly expand (the air being admitted through a small hole). When the bellows reaches its normal size again, the contacts close. These relays are available with a fixed or an adjustable delay.

A thermal time-delay relay

This relay uses a temperature-sensitive bimetallic strip. When the relay is energized, a small resistance heater warms the bimetallic strip. As the strip heats, it bends and eventually closes the contacts. The flasher unit in a car, which controls the flashing directional signals, works on this principle.

Solid-state time-delay relays

These relays are used in most new systems that require delay relays. The knob is for setting the delay. These units are based on the delay involved when (1) charging a capacitor or (2) counting high-speed clock pulses with a digital counter: the higher the count, the longer the delay.

Category of time delay relay according to initial condition:

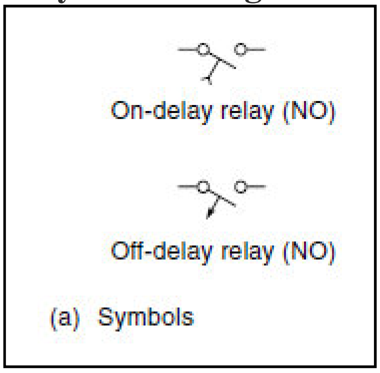


Figure 12: symbols of time delay relay

Time delay relays are categorized as being either on-delay or off-delay,

On delay relay:

On delay relay: A 5-s on-delay relay with NO contacts will wait 5 s (after being energized) before closing its contacts. When the relay is de-energized, the contacts will open immediately.

3.9 Application of On-delay relay

An application of the **on-delay** function is a security system that delays activation for a period of time after being turned on, to allow the turn off the false alarm if there are any.

Off delay relay

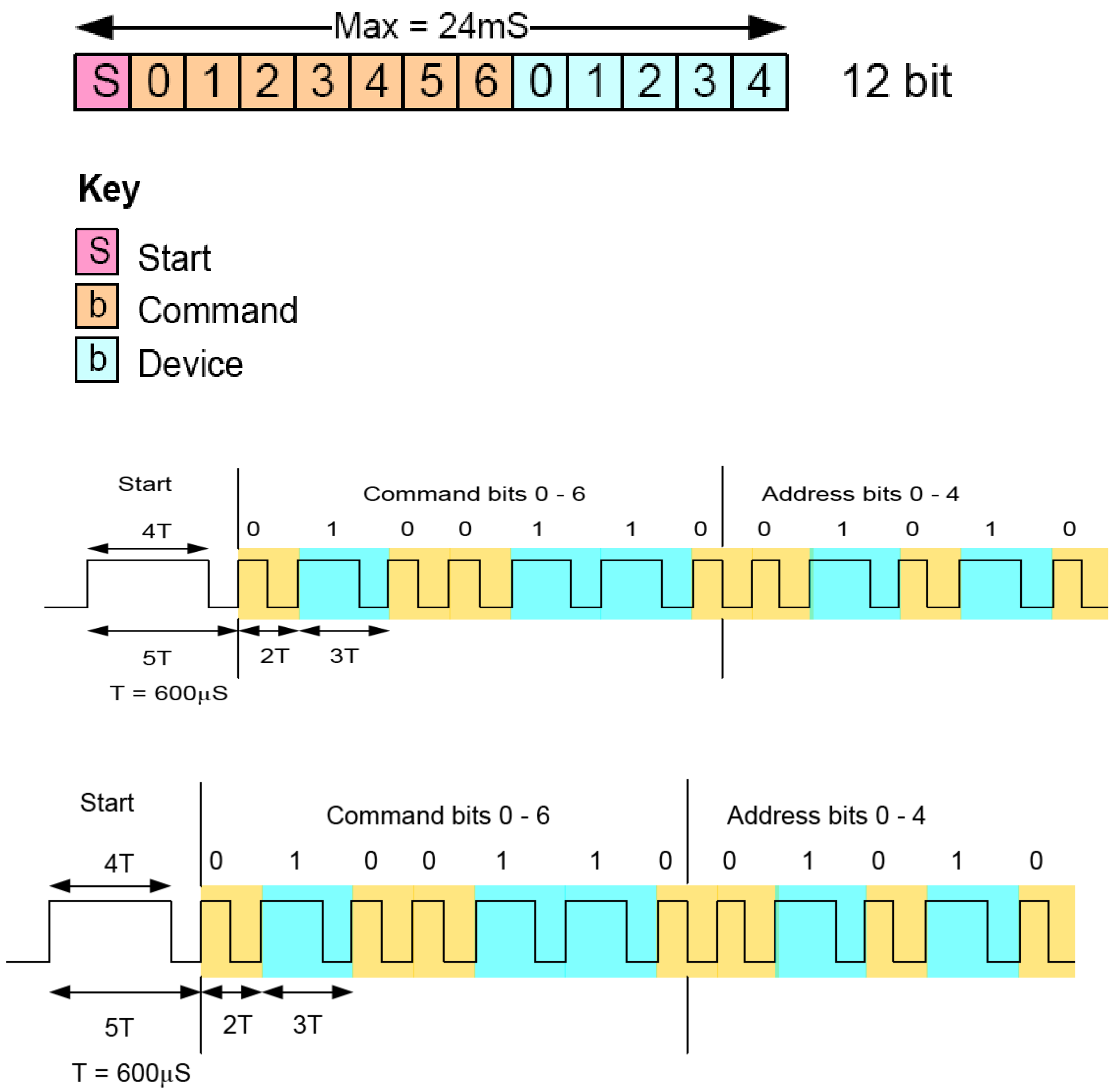
Off delay relay: The off-delay relay provides a time delay when the coil is de-energized. For example, a 5-s off-delay relay with NO contacts would close its contacts immediately when energized; when it is de-energized, however, the contacts would remain closed for 5 more seconds before opening.

Application of off-delay relay:

An application of the **off-delay** function is car lights that remain on for a period of time after being turned off (to provide light for the occupants as they are leaving the vehicle). Figure shows the symbols used for time-delay relays.

3.10 SIRC PROTOCOL

SIRC stands for **S**ONY **I**NF**R**ARED **C**ONTROLLER. SONY uses 12-bit SIRC protocol. The code starts with a header of 2.4ms followed by 7-bit command and 5-bit device address in which least significant bits (LSB) are transmitted first. Then the commands are repeated every 45ms for as long as the key on the remote control is held down. The address and commands exist of logical ones and zeros. A space of 600 µs or 1T and a pulse of 1200 µs or 2T form logical one. A logical zero is formed by a space of 600 µs and a pulse of 600 µs as shown in Fig. 13.



Start → 5T → 3000µS
0 → 2T → 600µS + 600µS = 1200µS
1 → 3T → 600µS + 1200µS = 1800µS

Figure 13: SIRC bit pattern

3.11 SIRC Command address

The commend address for different button of a SONY remote are tabulated in table 2

Table 2: SIRC commands for different button of a SONY TV remote

Command	Function
0	Digit key 0
1	Digit key 1
2	Digit key 2
3	Digit key 3
4	Digit key 4
5	Digit key 5
6	Digit key 6
7	Digit key 7
8	Digit key 8
9	Digit key 9
16	Channel +
17	Channel -
18	Volume +
19	Volume -
20	Mute
21	Power
22	Reset
23	Audio Mode
24	Contrast +
25	Contrast -
26	Colour +
27	Colour -
30	Brightness +
31	Brightness -
38	Balance Left
39	Balance Right
47	Standby

CHAPTER 4

(Hardware Modeling)

4.1 Main features of the prototype

The features of the developed prototype are:

- LCD display (showing the condition of the load status and the status of the circuit)
- 1 independent load can be controlled (ON/OFF control)
- On board relay driver incorporated
- Can be connected with any SONY TV remote controller
- 5 Volt operation (both control board and ON & OFF relay)
- LED indication for ON OFF relay (green LED for ON Delay, red LED for OFF Delay relay)
- After completion of time display on LCD showing the operation of ON/OFF relay
- Cost effective (Rs 400/- approx)

4.2 Overview of the Project

The working process of our project is shown below in figure 14. It receives signals from a SONY remote and decode it using microcontroller. Then according to the code it either switch on the ON delay relay or the OFF delay relay.

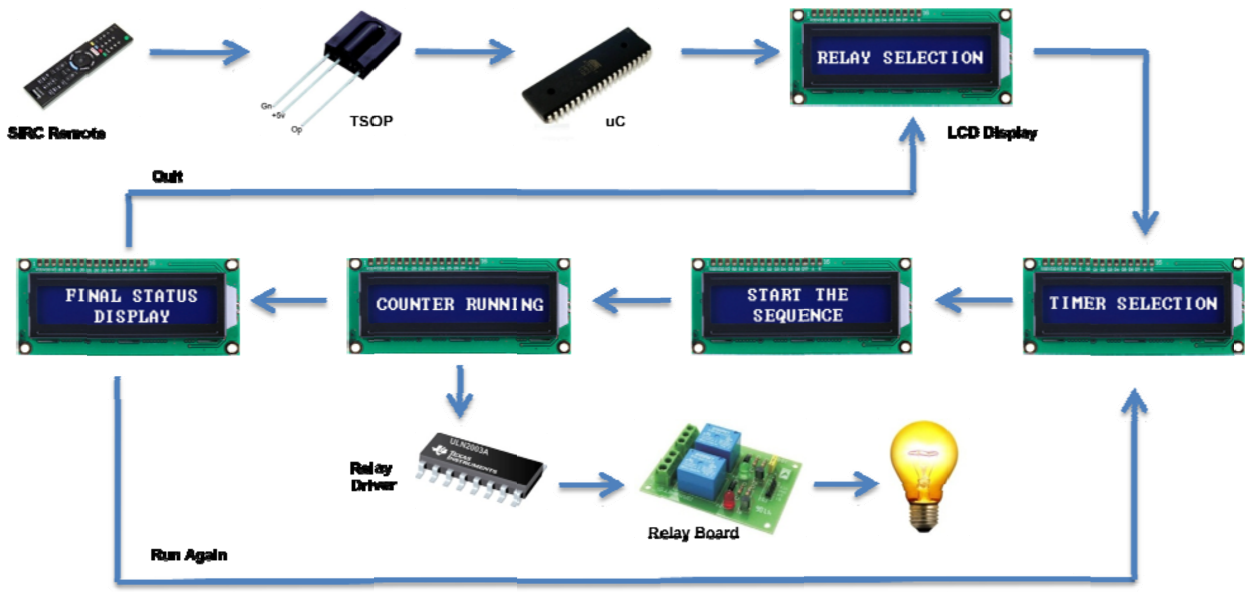
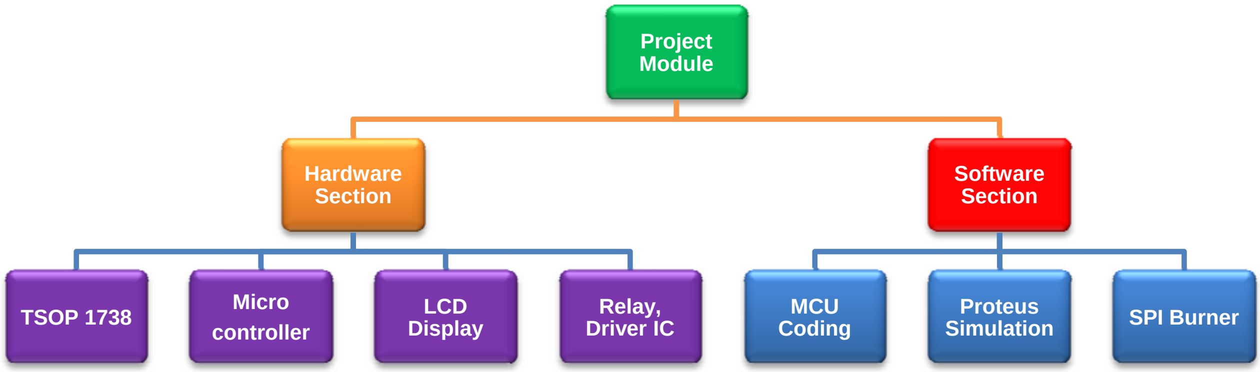


Figure 14: flow diagram of the project

4.3 Project layout



4.4 Photographs of the prototype

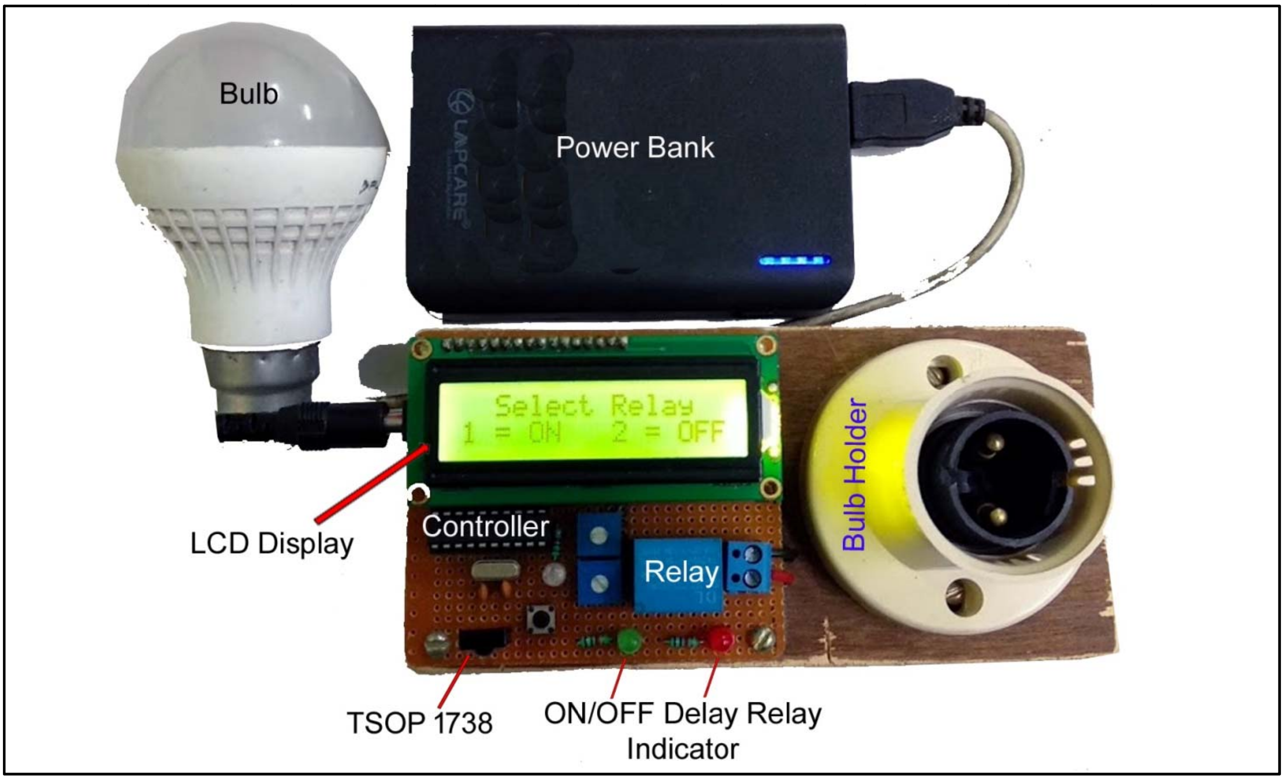
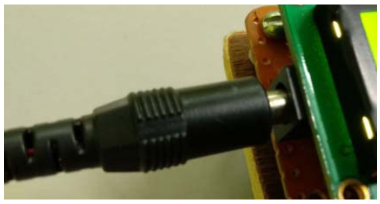


Figure 15: Main Controller and Relay board

4.5 Step by step operation of the prototype

1. Connect the dc power jack to the prototype board (5V DC).



2. LCD will display some initial message.

3. Select the required time delay relay (1 for ON LOAD and 2 for OFF LOAD) using the SONY remote.

4. After selecting the required relay LED indication will be there in the prototype (Green LED for ON LOAD relay and Red LED for OFF LOAD relay).

5. Set the required time for the relay (00 to 99 second range) using the numeric button of the remote control.

6. Initialize the delay count (by pressing OK button in the relay).

7. After every operation the circuit will ask for repeat run or relay selection (1 for repeat run and 2 for relay selection).

4.6 Components required

Table 3: Component listing

Sl. No.	Component	Qtn
1.	TSOP 1738	1
2.	AT89c51 µC	1
3.	11.0592 MHz Crystal	1
4.	33 pf Capacitor	2
5.	0.1µF Capacitor	2
6.	10µF Capacitor	2
7.	ULN 2003 A IC	1
8.	Static Relay (5 volt)	1
9.	16x2 LCD Module	1
10.	3 mm LED (Red/Green)	9
11.	General blank PCB	1
12.	330 Ω Resistance	9
13.	16 pin IC base	1
14.	40 pin IC base	1
15.	Single strand wire	3m
16.	Wire nipper	1
17.	Wire striper	1
18.	Soldering Iron	1
19.	Soldering material	1
20.	De-soldering pump	1
21.	Female pin header	1
22.	Male pin header	1
23.	10K POT	1
24.	Bulb & Holder	1

4.7 Cost estimation of the prototype

Table 4: Cost estimation of the project

Sl. No.	Component	Qtn	Price (Rs)
1.	TSOP 1738	1	20
2.	AT89c51 µC	1	45
3.	11.0592 MHz Crystal	1	10
4.	33 pf Capacitor	2	2
5.	10µF Capacitor	1	4
6.	ULN 2003 A IC	1	20
7.	Static Relay (5 volt)	1	20
8.	16x2 LCD Module Blue	1	130
9.	3 mm LED (Red/Green)	2	5
10.	General blank PCB	1	30
11.	330 Ω Resistance	3	5
12.	IC base	2	10
13.	Bulb & Holder	1	30
14.	Single strand wire	3m	30
15.	Male/Female pin header	2	20
16.	10K POT	1	10
Total	**400/- (approx)**		

4.8 Hardware connection

4.8.1 Relay Driver interfacing with microcontroller

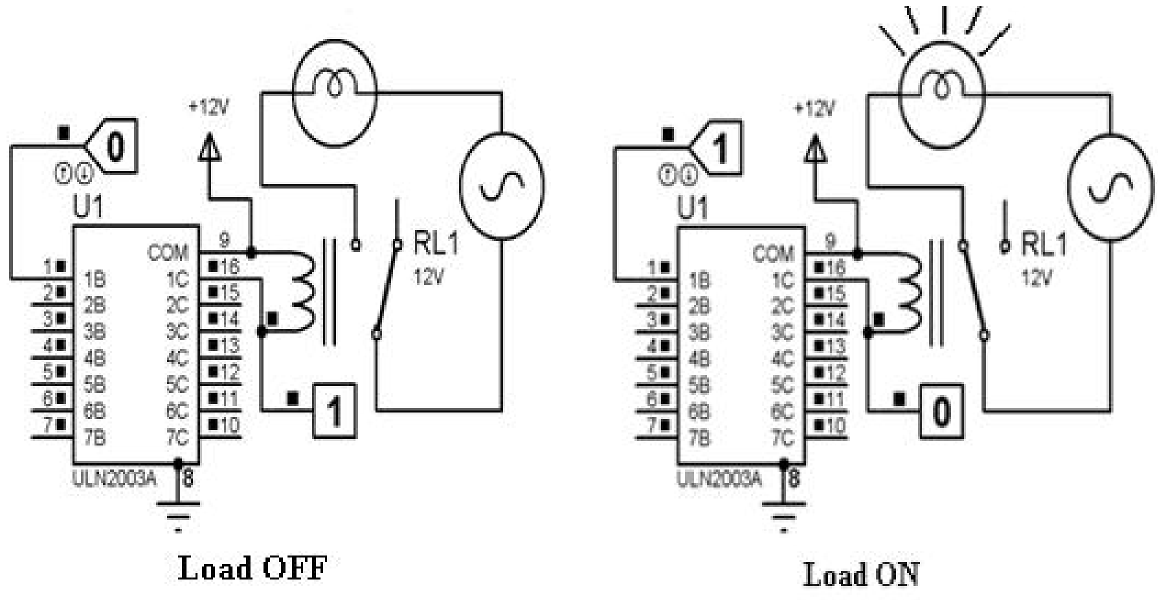


Figure 16: ULN2003A interfacing with microcontroller

The ULN2003A is a active high relay driver. 7 relays are controlled by this relay driver. Pin 1-7 are for controlling the relay which are connected to pin 10-16. For a ‘0’ from microcontroller the corresponding relay is turned off and a ‘1’ from microcontroller is turned on the relay.

4.8.2 TSOP 1738 interfacing with microcontroller

This section describes how to interface an Infrared Receiver (TSOP 1738) to the microcontroller AT89S51/52 through a SONY TV Remote control. The data pin of TSOP 1738 can be directly connected to the microcontroller as the voltage level of the data pin is limited to 5V.

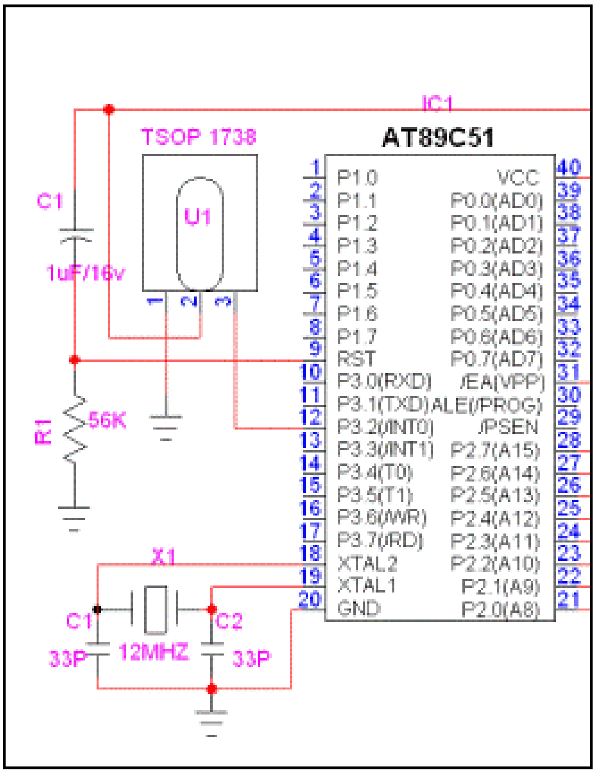


Figure 17: TSOP 1738 interfacing with microcontroller

CHAPTER 5

(Logic & Operation)

5.1 INTRODUCTION

After assembling the system, what remains is to observe its operation and efficiency of the system. The total system is divided in several sub systems, like

- TSOP interfacing
- Relay with driver
- LCD section

The operation of the whole circuit is depending on every sections performance.

5.2 Flow Diagram

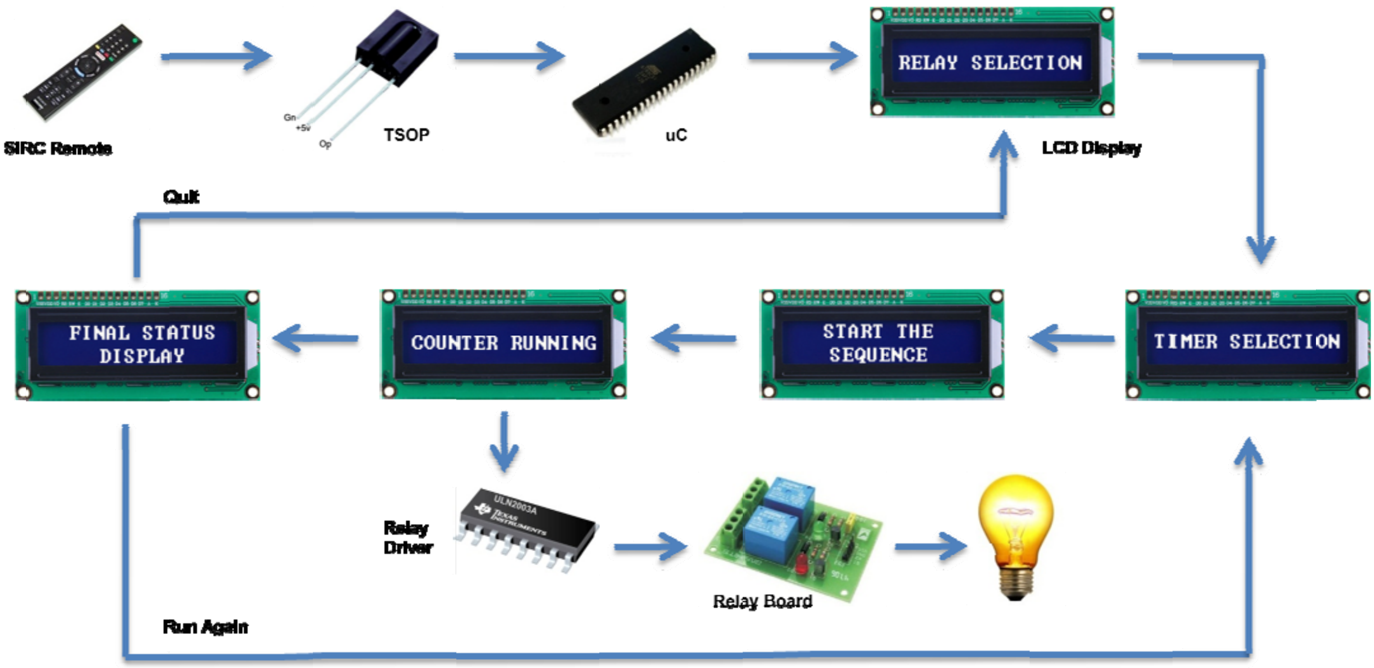


Figure 18: flow diagram of the prototype

5.3 Principle & Operations

TSOP is an Infrared receiver. It works on a carrier frequency of 38 kHz. The SIRC have a particular pattern as shown in figure 19. When the button of a SONY remote is pressed the signal is received by TSOP as produce the exactly same pattern to its data pin. The data pic is directly connected to the microcontroller pin. Using programming the command and address bit hidden inside the SIRC protocol is decoded and store inside the microcontroller. Depending on the button pressed from the remote the microcontroller switched on the ON delay relay or the OFF delay relay according the user requirement. Here user can set the time for any relay from 00 second (instantaneously) to 99 seconds. This prototype is very perfect counter. It can switch on or off the relay exactly after the time set by the user. After every operation it will ask the user for repeat run or selecting the relay (ON/OFF). This is a cost effective multipurpose prototype used in different domestic application where delayed switching are required.

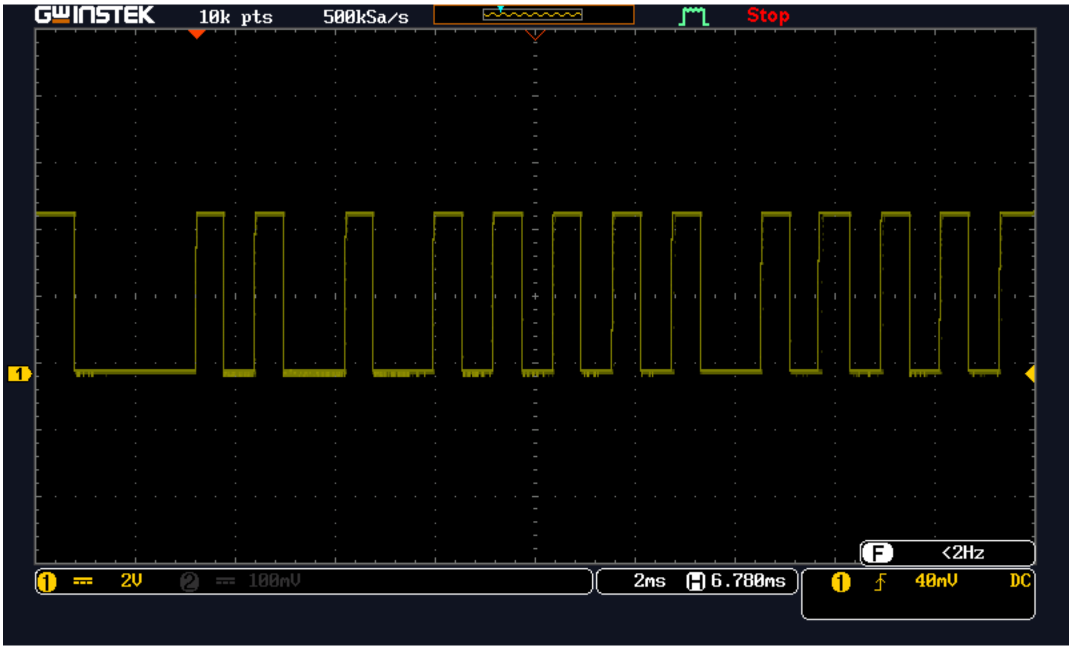


Figure 19: actual photograph of the SIRC signals from DSO

5.4 Advantages of the project

- Very accurate time count
- Cost effective
- Relay driver included
- 250V, 7A load may be connected at the output
- Remote operation
- LCD display for massages
- LED indication for ON/OFF relay

5.5 Disadvantages

- Limited range (10 – 20 meter) as it uses IR remote
- Large electrical load cannot be handled by the circuit (250V, 7A max)
- Timer count is limited to 0 to 99 second only (can be overcome through modified code)

5.6 Photographs of the prototype

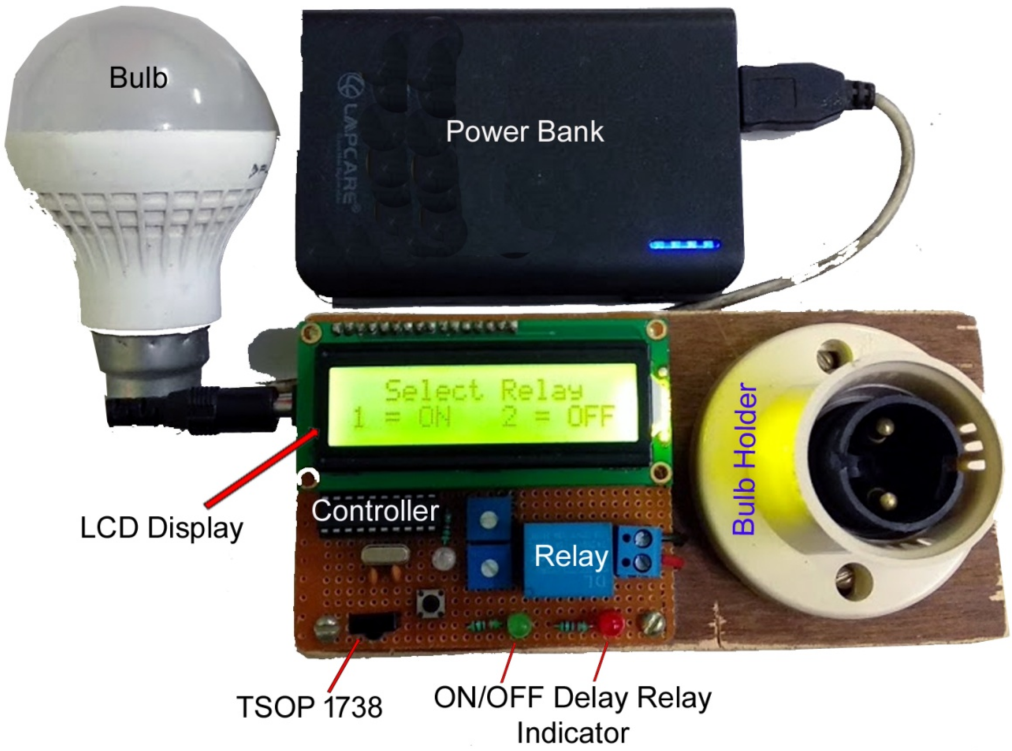


Figure 20: complete photograph of the prototype

Chapter 6

(Conclusion & Future Scope)

6.1 CONCLUSION

Here we are developed a 'SIRC based ON Delay OFF Delay Relay' switching circuit. So in this project we developed an ON/OFF Delay Relay using microcontroller 89c2051. The time of the Relay is adjusted using SONY IR Remote using SIRC protocol and the time is adjusted from 0 seconds to 99 seconds according to the user requirements. The parameters are shown in a LCD screen. After receiving all the parameters from the user the controller control the relay driver and successively the relay controls the load connected to its output. Therefore, in this project the hardware model basically consists of Microcontroller (89c2051), TSOP 1738(IR receiver), Relay Driver Circuit, LCD Screen, Relay, Bulb (Used as load). The system works satisfactorily and it is also considered to be a cost effective system.

6.2 RESULTS

The experimental model was made according to the circuit diagram and the results were as expected. When the IR Pulse is given using the SONY IR Remote, the TSOP 1738 module receives the IR pulse and transmits it to the Microcontroller after decoding the Pulse. Then it is displayed in the LCD screen and according to the user inputs the working f the circuit for ON/OFF Relay operation starts.

6.3 FUTURE SCOPE

Automatic control of Home Appliances is in highly demand nowadays. So, in this work we have designed and constructed a circuit which will precisely control the time of a TRD using a SONY IR Remote Protocol. As the range of the IR remote is limited to a certain distance so our future work will be install a IoT device to control the relay globally. Also the time delay of the relay is limited to 0 second to 99 second. By modifying the code we will make the time delay higher as required by the user.

Chapter 7

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Appendix A

(Hardware description)

Transformer less AC to DC power supply cir cuit using dropping capacitor

Production of low voltage DC power supply from AC power is the most important problem faced by many electronics developers and hobbyists. The straight forward technique is the use of a step down transformer to reduce the 230 V or 110V AC to a preferred level of low voltage AC. But *SMPS* power supply comes with the most appropriate method to create a low cost power supply by avoiding the use of bulky transformer. This circuit is so simple and it uses a voltage dropping capacitor in series with the phase line. Transformer less power supply is also called as capacitor power supply. It can generate 5V, 6V, 12V 150mA from 230V or 110V AC by using appropriate zener diodes.

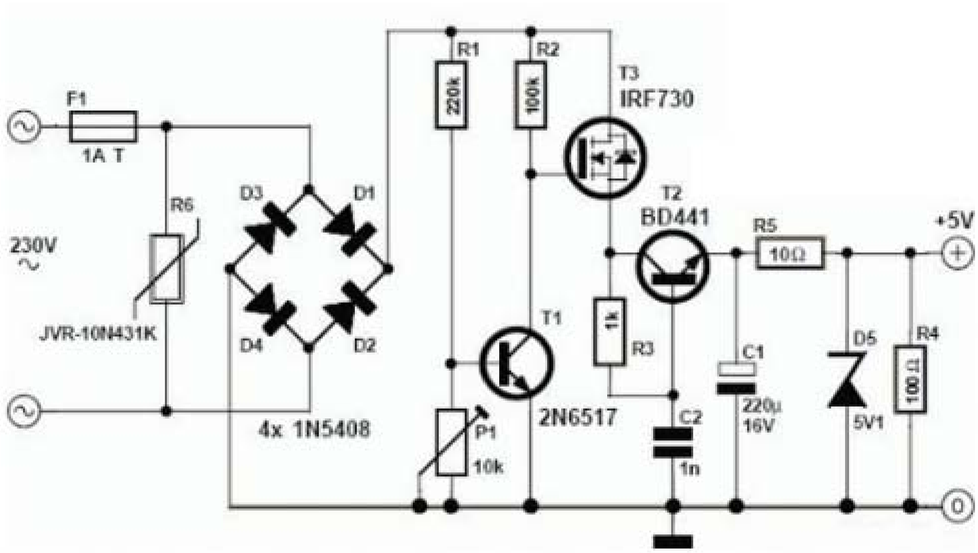


Figure 21: Transformer less SMPS 5 volt power supply

Working of Transformer less capacitor power supply

- This transformer less power supply circuit is also named as capacitor power supply since it uses a special type of AC capacitor in series with the main power line.
- A common capacitor will not do the work because the mains spikes will generate holes in the dielectric and the capacitor will be cracked by passing of current from the mains through the capacitor.
- X rated capacitor suitable for the use in AC mains is vital for reducing AC voltage.
- A X rated dropping capacitor is intended for 250V, 400V, 600V AC. Higher voltage versions are also obtainable. The dropping capacitor is non polarized so that it can be connected any way in the circuit.
- The 470kΩ resistor is a bleeder resistor that removes the stored current from the capacitor when the circuit is unplugged. It avoids the possibility of electric shock.
- Reduced AC voltage is rectified by bridge rectifier circuit. We have already discussed about bridge rectifiers. Then the ripples are removed by the 1000µF capacitor.

- This circuit provides 24 volts at 160 mA current at the output. This 24 volt DC can be regulated to necessary output voltage using an appropriate 1 watt or above zener diode.

- Here we are using 6.2V zener. You can use any type of zener diode in order to get the required output voltage.

AT 89c51 Microcontroller

AT89C51 is an 8-bit microcontroller and belongs to Atmel's 8051 family. **ATMEL 89C51** has 4KB of Flash programmable and erasable read only memory (PEROM) and 128 bytes of RAM. It can be erased and program to a maximum of 1000 times.

In 40 pin AT89C51, there are four ports designated as P_1, P_2, P_3 and P_0. All these ports are 8-bit bi-directional ports, *i.e.*, they can be used as both input and output ports. Except P_0 which needs external pull-ups, rest of the ports have internal pull-ups. When 1s are written to these port pins, they are pulled high by the internal pull-ups and can be used as inputs. These ports are also bit addressable and so their bits can also be accessed individually.

Port P_0 and P_2 are also used to provide low byte and high byte addresses, respectively, when connected to an external memory. Port 3 has multiplexed pins for special functions like serial communication, hardware interrupts, timer inputs and read/write operation from external memory. AT89C51 has an inbuilt UART for serial communication. It can be programmed to operate at different baud rates. Including two timers & hardware interrupts, it has a total of six interrupts.

PIN Diagram:

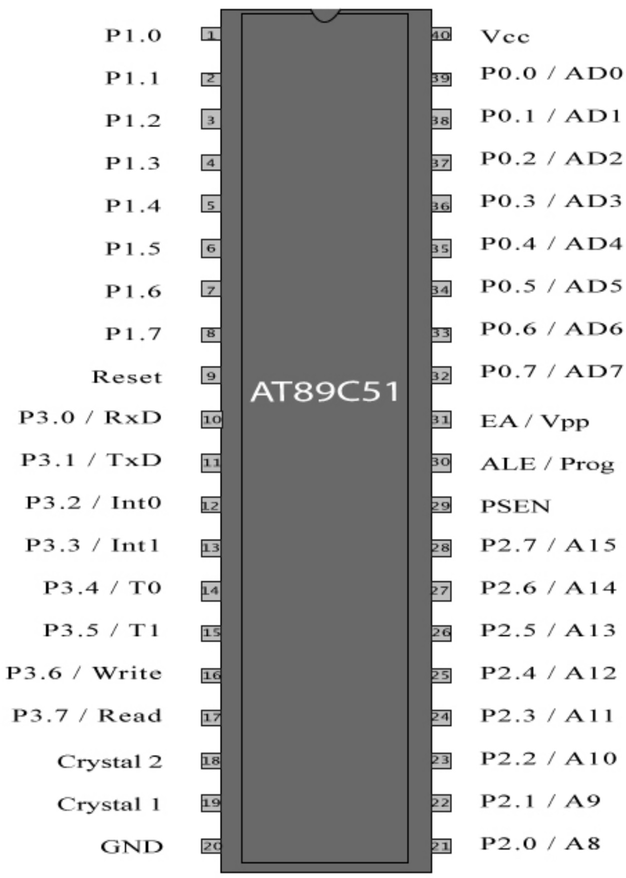


Figure 22: 89c51 Microcontroller Pin Diagram

PIN Description:

Pin No	Function			Name
1	8 bit input/output port (P_1) pins			P_1.0
2				P_1.1
3				P_1.2
4				P_1.3
5				P_1.4
6				P_1.5
7				P_1.6
8				P_1.7
9	Reset pin; Active high			Reset
10	Input (receiver) for serial communication	RxD	8 bit input/output port (P_3) pins	P_3.0
11	Output (transmitter) for serial communication	TxD		P_3.1
12	External interrupt 1	Int0		P_3.2
13	External interrupt 2	Int1		P_3.3
14	Timer1 external input	T_0		P_3.4
15	Timer2 external input	T_1		P_3.5
16	Write to external data memory	Write		P_3.6
17	Read from external data memory	Read		P_3.7
18	Quartz crystal oscillator (up to 24 MHz)			Crystal 2
19				Crystal 1
20	Ground (0V)			Ground
21	8 bit input/output port (P_2) pins / High-order address bits when interfacing with external memory			P_2.0/ A_8
22				P_2.1/ A_9
23				P_2.2/ A_{10}
24				P_2.3/ A_{11}
25				P_2.4/ A_{12}
26				P_2.5/ A_{13}
27				P_2.6/ A_{14}
28				P_2.7/ A_{15}
29	Program store enable; Read from external program memory			PSEN
30	Address Latch Enable			ALE
	Program pulse input during Flash programming			Prog
31	External Access Enable; Vcc for internal program executions			EA
	Programming enable voltage; 12V (during Flash programming)			Vpp
32	8 bit input/output port (P_0) pins Low-order address bits when interfacing with external memory			P_0.7/ AD_7
33				P_0.6/ AD_6
34				P_0.5/ AD_5
35				P_0.4/ AD_4
36				P_0.3/ AD_3
37				P_0.2/ AD_2
38				P_0.1/ AD_1
39				P_0.0/ AD_0
40	Supply voltage; 5V (up to 6.6V)			Vcc

Table 5: Pin Description of 89c51 microcontroller

16x2 LCD Module:

- 16 character 2 lines display
- 4 bit and 8 bit data transfer mode
- display alpha numeric display
- backlight compatible
- contrast adjustment
- backlight intensity adjustment
- 5 volt operation
- compatible to almost every microcontroller

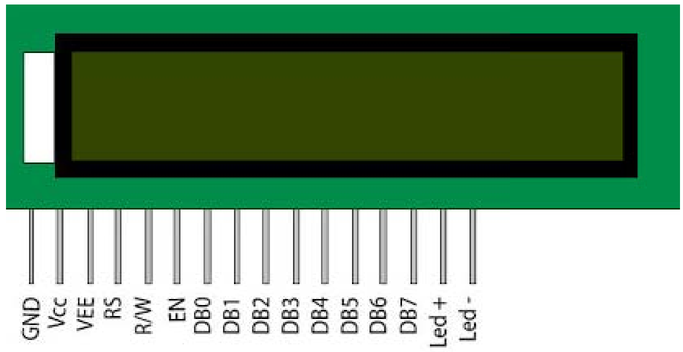


Figure 23: 16X2 LCD Module

LCD Pin outs

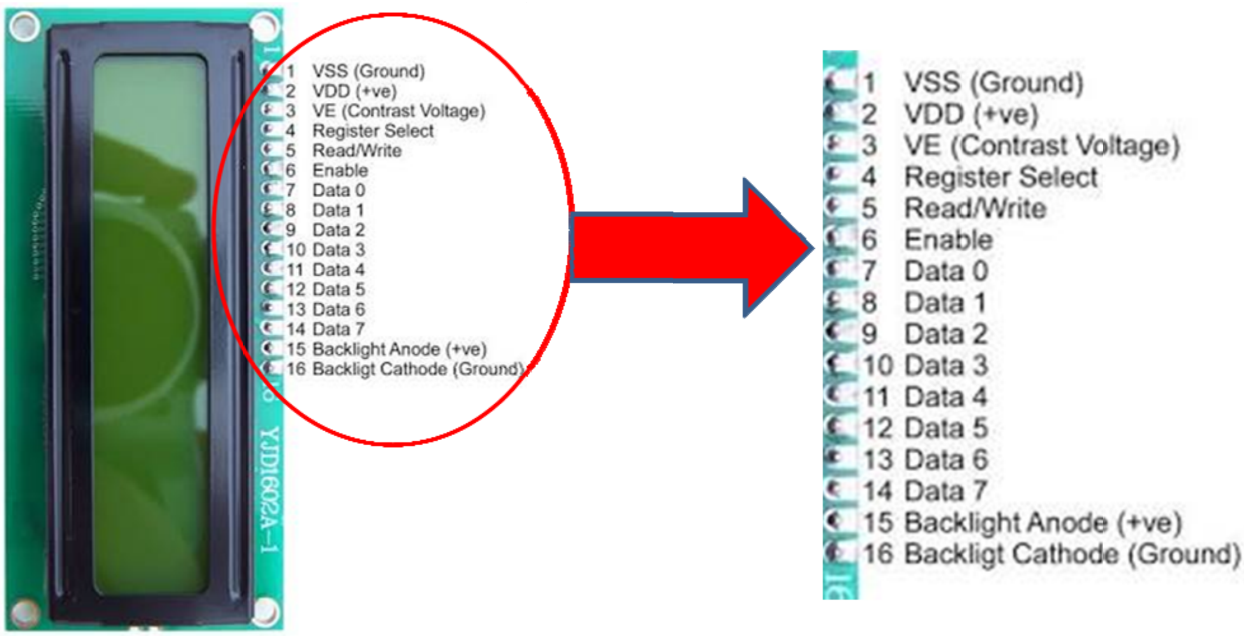


Figure 24: LCD Pin Diagram

Relay Driver

- The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays.
- It consists of seven NPN Darlington pairs that features high-voltage outputs with common-cathode clamp diode for switching inductive loads.
- The collector-current rating of a single Darlington pair is 500mA.
- The ULN functions as an inverter.
- If the logic at input 1B is high then the output at its corresponding pin 1C will be low.

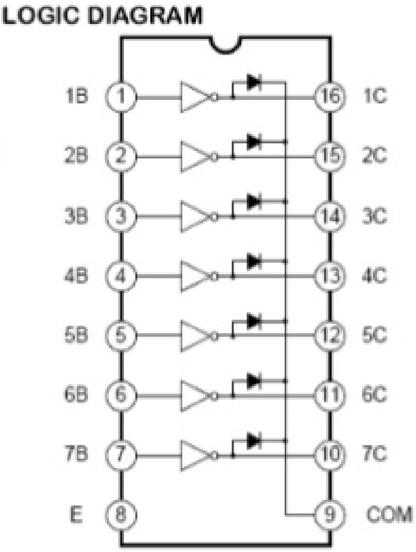


Figure 25: ULN2003A Internal Block Diagram

Resistor

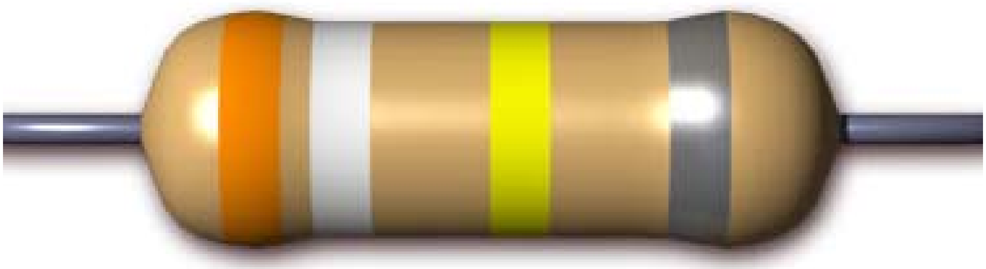


Figure 26: Resistor

Resistance is the opposition of a material to the current. It is measured in Ohms Ω. All conductors represent a certain amount of resistance, since no conductor is 100% efficient. To control the electron flow (current) in a predictable manner, we use resistors. Electronic circuits use calibrated lumped resistance to control the flow of current. Broadly speaking, resistor can be divided into two groups viz. fixed & adjustable (variable) resistors. In fixed resistors, the value is fixed & cannot be varied. In variable resistors, the resistance value can be varied by an adjuster knob. It can be divided into (a) Carbon composition (b) Wire wound (c) Special type. The most common type of resistors used in our projects is carbon type. The resistance value is normally indicated by color bands. Each resistance has four colors, one of the band on either side will be gold or silver, this is called fourth band and indicates the tolerance, others three band will give the value of resistance (see table). For example if a resistor has the following marking on it say red, violet, gold. Comparing these colored rings with the color code, its value is 27000 ohms or 27 kilo ohms and its tolerance is ±5%. Resistor comes in various sizes (Power rating).The bigger the size, the more power rating of 1/4 watts. The four color rings on its body tells us the value of resistor value.

Color Code of the resistor

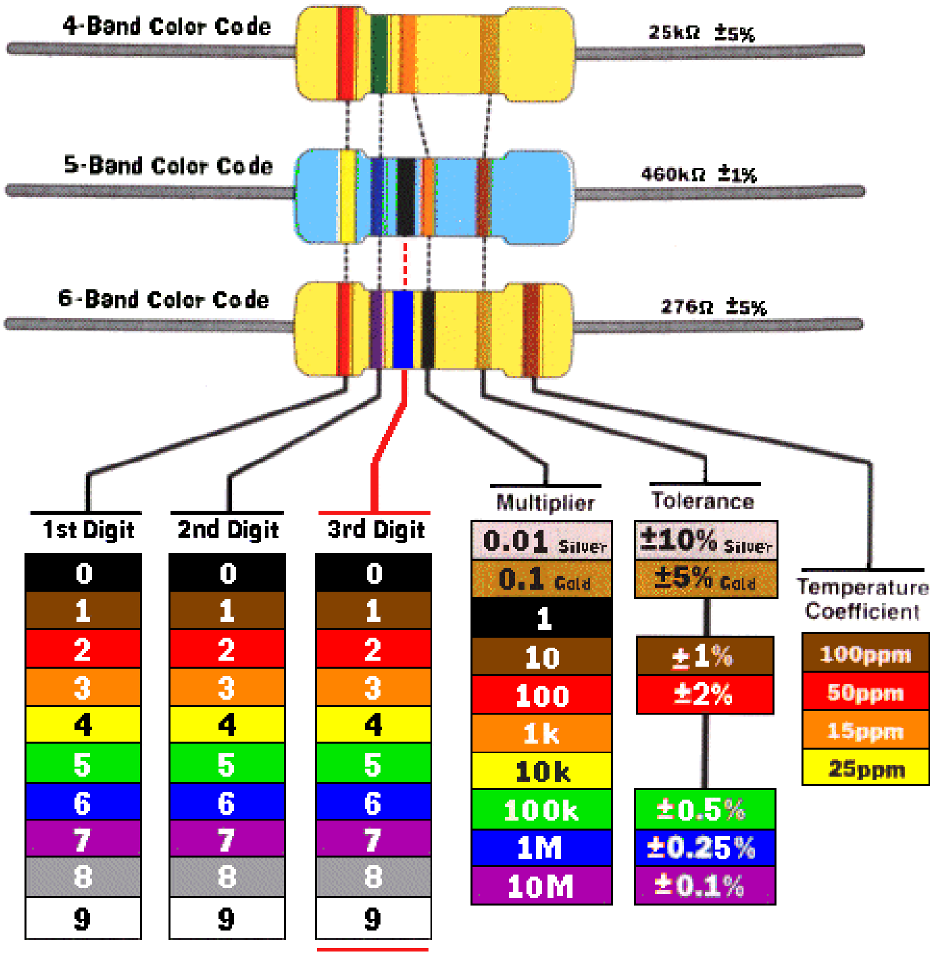


Figure 27: Color Code for resistance

RELAY

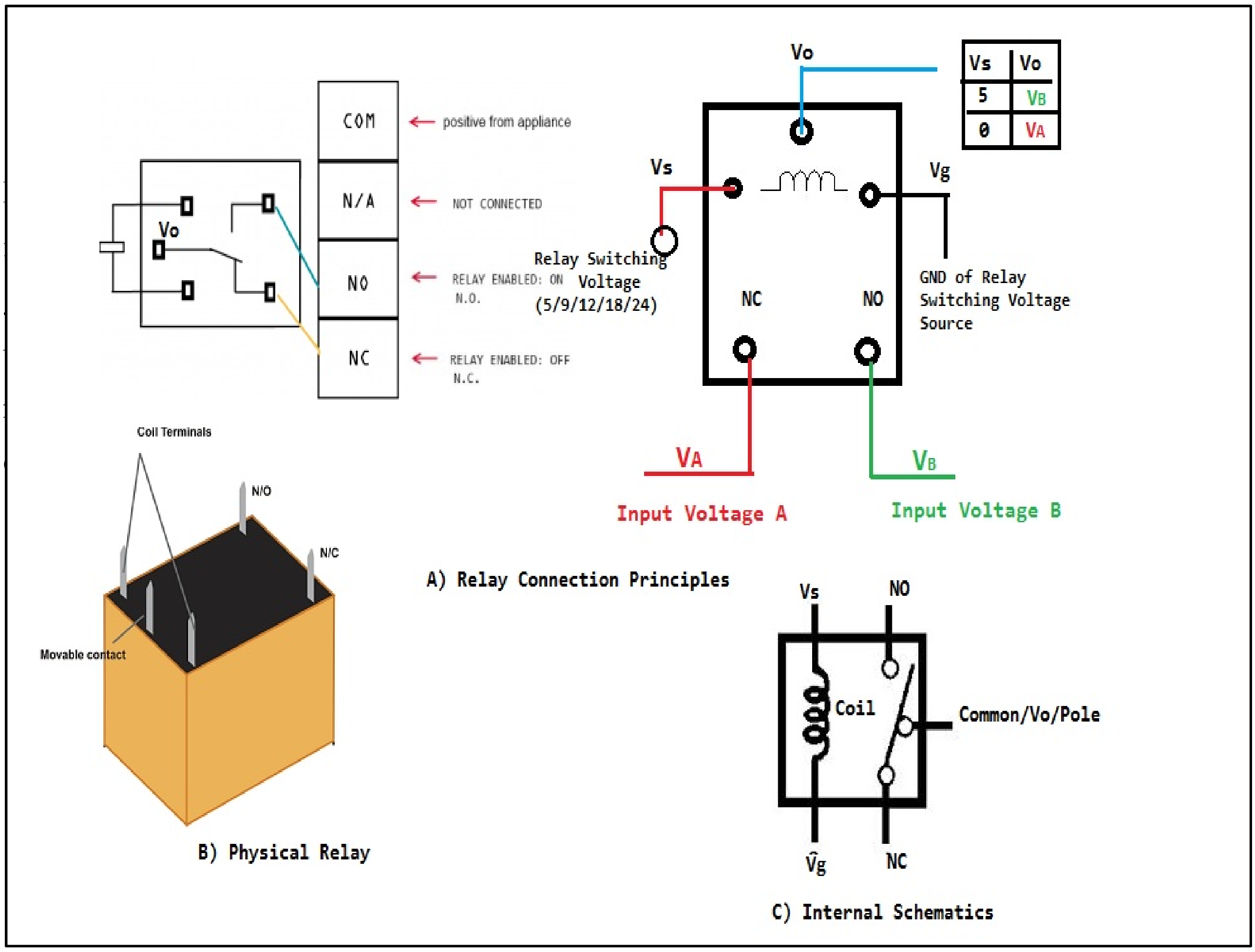


Figure 28: 6 volt Cube Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches.

The relay's switch connections are usually labeled COM (POLE), NC and NO:

COM/POLE= Common, NC and NO always connect to this, it is the moving part of the switch.

NC = Normally Closed, COM/POLE is connected to this when the relay coil is not magnetized.

NO = Normally Open, COM/POLE is connected to this when the relay coil is MAGNETIZED and vice versa.

Capacitors

It is an electronic component whose function is to accumulate charges and then release it.

To understand the concept of capacitance, consider a pair of metal plates which all are placed near to each other without touching. If a battery is connected to these plates the positive pole to one and the negative pole to the other, electrons from the

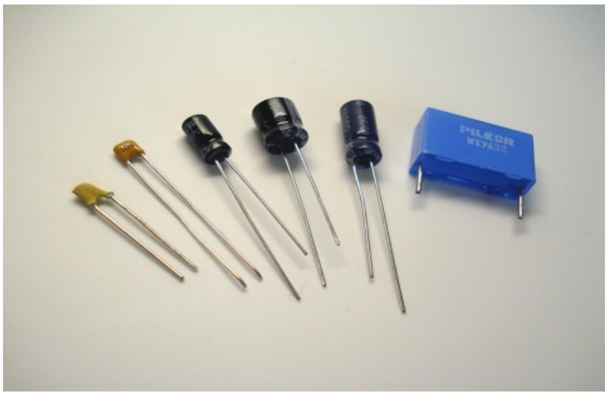


Figure 29: Types of capacitors

battery will be attracted from the plate connected to the positive terminal of the battery. If the battery is then disconnected, one plate will be left with an excess of electrons, the other with a shortage, and a potential or voltage difference will exists between them. These plates will be acting as capacitors. Capacitors are of two types: - (1) **fixed type** like ceramic, polyester, electrolytic capacitors - these names refer to the material they are made of aluminum foil. (2) **Variable type** like gang condenser in radio or trimmer. In fixed type capacitors, it has two leads and its value is written over its body and variable type has three leads. Unit of measurement of a capacitor is farad denoted by the symbol F. It is a very big unit of capacitance. Small unit capacitor are pico-farad denoted by pf (1pf=1/1000,000,000,000 f) Above all, in case of electrolytic capacitors, it's two terminal are marked as (-) and (+).

Crystal Oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is commonly used to keep track of time, as in quartz wristwatches, to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.

Figure 30: Crystal Oscillator

Quartz crystals are manufactured for frequencies from a few tens of kilohertz to hundreds of megahertz. More than two billion crystals are manufactured annually. Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cell phones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscopes.

Piezo buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep.

Figure 31: Piezo Buzzer

Blank PCB

A **printed circuit board** (**PCB**) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. PCBs can be *single sided* (one copper layer), *double sided* (two copper layers) or *multi-layer* (outer and inner layers). Multi-layer PCBs allow for much higher component density. Conductors on different layers are connected with plated-through holes called vias. Advanced PCBs may contain components - capacitors, resistors or active devices - embedded in the substrate.

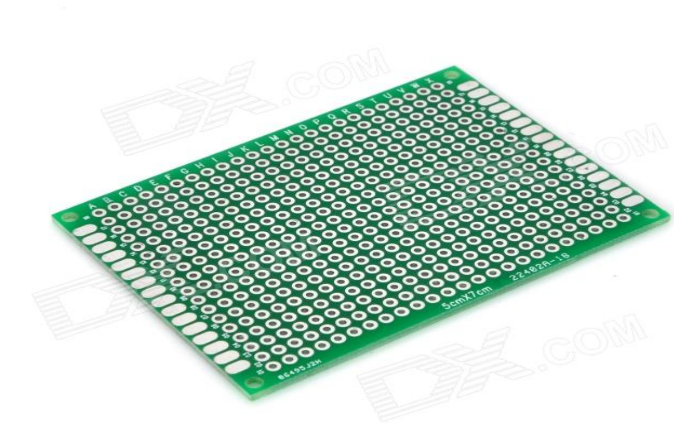


Figure 32: Blank glass epoxy PCB Board

FR-4 glass epoxy is the primary insulating substrate upon which the vast majority of rigid PCBs are produced. A thin layer of copper foil is laminated to one or both sides of an FR-4 panel. Circuitry interconnections are etched into copper layers to produce printed circuit boards. Complex circuits are produced in multiple layers.

Printed circuit boards are used in all but the simplest electronic products. Alternatives to PCBs include wire wrap and point-to-point construction. PCBs require the additional design effort to lay out the circuit, but manufacturing and assembly can be automated. Manufacturing circuits with PCBs is cheaper and faster than with other wiring methods as components are mounted and wired with one single part. Furthermore, operator wiring errors are eliminated.

Appendix B

(Software coding)

PROGRAM CODE:

```
;               ON DELAY / OFF DELAY RELAY Using SIRC
;--------------------------------------------------------------------------------
ORG 00H
MOV P3, #01H                ;P3.0 as input pin (SIRC Connected)
SETB P3.1                   ;P3.1 Relay Pin (Active Low-initially OFF)
SETB P3.2                   ;ON Delay LED (Active low)
SETB P3.3                   ;OFF Delay LED (Active low)
SETB P3.5                   ;Flip Bit
;--------------------------------------------------------------------------------
; LCD module is connected at Port 1 (data), Controls are connected at port P3.7 (RS)
; P3.5 (RW) and P3.4 (E)
;--------------------------------------------------------------------------------
;--------------------------------------------------------------------------------
;                       INITIAL MESSAGE SECTION
;--------------------------------------------------------------------------------
MOV A,#38H      ;Use 2 lines and 5x7 matrix
ACALL CMND
MOV A,#0CH      ;LCD ON, cursor blinking OFF
ACALL CMND
MOV A,#30H      ;Clear screen
ACALL CMND
MOV A,#06H      ;Increment cursor (Input Mode)
ACALL CMND
MOV A,#3CH      ;Activate second line
ACALL CMND
MOV A,#01H                  ;Clear screen
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA   ;'ON / OFF DELAY' display
H_1:        CLR A
MOVC A, @A+DPTR
JZ b_1
ACALL DISP
INC DPTR
SJMP H_1
b_1:
MOV A,#0C5H                 ;Jump to second line, position 5
ACALL CMND
MOV DPTR, #MYDATA1 ;'RELAY' display
H_2:        CLR A
MOVC A, @A+DPTR
JZ b_2
ACALL DISP
INC DPTR
SJMP H_2
b_2:        ACALL DELAY1S           ;display for 1 sec
MOV A,#01H                  ;Clear screen
ACALL CMND
MOV A,#81H                  ;Cursor line one , position 2
ACALL CMND
MOV DPTR, #MYDATA2 ;'Using 89c2051' display
H_3:        CLR A
MOVC A, @A+DPTR
JZ b_3
ACALL DISP
INC DPTR
SJMP H_3
b_3:
```

```
MOV A,#0C0H            ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA3 ;'Micro Controller' display
H_4:    CLR A
MOVC A, @A+DPTR
JZ b_4
ACALL DISP
INC DPTR
SJMP H_4
b_4:    ACALL DELAY1S
MOV A,#01H    ;Clear screen
ACALL CMND
MOV A,#81H             ;Cursor line one , position 2
ACALL CMND
MOV DPTR, #MYDATA19         ;'Controlled by' display
H_25:   CLR A
MOVC A, @A+DPTR
JZ b_26
ACALL DISP
INC DPTR
SJMP H_25
b_26:
MOV A,#0C1H            ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA20         ;'SIRC PROTOCOL' display
H_26:   CLR A
MOVC A, @A+DPTR
JZ b_27
ACALL DISP
INC DPTR
SJMP H_26
b_27:   ACALL DELAY1S
MOV A,#01H    ;Clear screen
ACALL CMND
MOV A,#82H             ;Cursor line one , position 3
ACALL CMND
MOV DPTR, #MYDATA21         ;'Developed by' display
H_27:   CLR A
MOVC A, @A+DPTR
JZ b_28
ACALL DISP
INC DPTR
SJMP H_27
b_28:
MOV A,#0C3H            ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA22         ;'Budhaditya' display
H_28:   CLR A
MOVC A, @A+DPTR
JZ b_29
ACALL DISP
INC DPTR
SJMP H_28
b_29:   ACALL DELAY1S
START:
MOV A,#01H    ;Clear screen
ACALL CMND
MOV A, #82H
ACALL CMND
MOV DPTR, #MYDATA4 ;'Select Relay' display
H_5:    CLR A
MOVC A, @A+DPTR
JZ b_5
ACALL DISP
INC DPTR
```

```
SJMP H_5
b_5:
MOV A,#0C0H                    ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA5 ;'1 = ON   2 = OFF' display
H_6:     CLR A
MOVC A, @A+DPTR
JZ b_6
ACALL DISP
INC DPTR
SJMP H_6
;--------------------------------------------------------------------------------
;            RELAY TYPE SELECTION
;--------------------------------------------------------------------------------
b_6:     ACALL SIRC
MOV A, R6            ;take the address
CJNE A, #00H, temp1
LJMP ONDELAY         ;if '1(00)' pressed goto ONDELAY program
temp1:   CJNE A, #01H, b_9
LJMP OFFDELAY                  ;if '2(01)' pressed goto OFFDELAY program
b_9:
MOV A,#01H     ;Clear screen
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA8 ;'Please Select' display
H_9:     CLR A
MOVC A, @A+DPTR
JZ b_10
ACALL DISP
INC DPTR
SJMP H_9
b_10:
MOV A,#0C1H          ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA9 ;'either 1 or 2' display
H_10:    CLR A
MOVC A, @A+DPTR
JZ b_11
ACALL DISP
INC DPTR
SJMP H_10
B_11:    ACALL DELAY1S
SJMP START
;--------------------------------------------------------------------------------
;            ON DELAY SECTION
;--------------------------------------------------------------------------------
ONDELAY:
CLR P3.2       ;Status LED ON
MOV A,#01H           ;Clear screen
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA10            ;'ON DELAY RELAY' display
H_11:    CLR A
MOVC A, @A+DPTR
JZ b_12
ACALL DISP
INC DPTR
SJMP H_11
b_12:
MOV A,#0C1H          ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA11            ;'Set time(S)=' display
H_12:    CLR A
```

```
MOVC A, @A+DPTR
JZ b_33
ACALL DISP
INC DPTR
SJMP H_12
B_33:
MOV A,#0CDH             ;Jump to second line, position 1
ACALL CMND
MOV A,#0FH              ;Display ON Cursor Blinking ON
ACALL CMND
;------------------------------------------------------------------------------------
;                       TIMER SET SECTION
;------------------------------------------------------------------------------------
B_13:   ACALL SIRC      ;for the first digit (MSB)
MOV A, R6       ; following three lines is for only the number pressed on remote
ANL A, #0F0H
CJNE A, #00H, B_13      ;upto this
MOV A, R6
CJNE A, #09H, CHECK
MOV R5, #00H    ;store the value in R5
MOV A,#0CDH             ;Jump to second line, position 1
ACALL CMND
MOV A, #30H     ;Display 0(30 in HEX)
ACALL DISP
SJMP CHECK8
CHECK:
MOV A,#0CDH             ;Jump to second line, position 1
ACALL CMND
MOV A, R6
ADD A, #31H     ;convert it to ASCII (also add 1 for remote 1=0, 2=1 etc)
ACALL DISP
MOV A, R6
ADD A, #01H
MOV R5, A
CHECK8:
MOV A,#0CEH             ;Jump to second line, position 1
ACALL CMND
MOV A,#0FH              ;Jump to second line, position 1
ACALL CMND
ACALL DELAY500MS
ACALL SIRC              ;for the second digit (LSB)
MOV A, R6       ; following three lines is for only the number pressed on remote
ANL A, #0F0H
CJNE A, #00H, Check8    ;upto this
MOV A, R6
CJNE A, #09, CHECK1
MOV A, R5
SWAP A
MOV R5, A       ;store the value in R5
MOV R4, A       ;R4 temporary stores the timer value
MOV A,#0CEH             ;Jump to second line, position 1
ACALL CMND
MOV A, #30H     ;Display 0(30 in HEX)
ACALL DISP
SJMP CHECK9
CHECK1:
MOV A,#0CEH             ;Jump to second line, position 1
ACALL CMND
MOV A, R6
ADD A, #31H     ;convert it to ASCII (also add 1 for remote 1=0, 2=1 etc)
ACALL DISP
MOV A, R6
ADD A, #01H
SWAP A
ADD A, R5
```

```
SWAP A
MOV R5, A         ;R5 fially stores the timer value (00 to 99 second)
MOV R4, A         ;R4 temporary stores the timer value
CHECK9:
ACALL DELAY1S                    ;wait for 1 second before fault initialization
;------------------------------------------------------------------------------------
; ON DELAY Fault Initialization
;------------------------------------------------------------------------------------
MOV A,#01H      ;Clear screen
ACALL CMND
MOV A,#0CH      ;LCD ON, cursor blinking OFF
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA12           ;'Plz Initialize' display
H_13:     CLR A
MOVC A, @A+DPTR
JZ b_14
ACALL DISP
INC DPTR
SJMP H_13
b_14:
MOV A,#0C1H                ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA13           ;'The FAULT (OK)' display
H_14:     CLR A
MOVC A, @A+DPTR
JZ b_15
ACALL DISP
INC DPTR
SJMP H_14
B_15:     ACALL SIRC
MOV A, R6
CJNE A, #65H, B_14         ;65H is the data for (ok)
;------------------ Timer ON (ON DELAY) -------------------------------------------
MOV A,#01H      ;Clear screen
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA6 ;'ON DELAY TIMER' display
H_7:      CLR A
MOVC A, @A+DPTR
JZ b_7
ACALL DISP
INC DPTR
SJMP H_7
b_7:
MOV A,#0C1H                ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA7 ;'Remaining    S' display
H_8:      CLR A
MOVC A, @A+DPTR
JZ b_8
ACALL DISP
INC DPTR
SJMP H_8
B_8:
MOV A,#0CBH                ;Jump to second line, position 11
ACALL CMND
MOV A, R5
CJNE A, #00H, CHECK2
LJMP ONLOAD
CHECK2:
ANL A, #0FH
CJNE A, #0FH, P_1
```

```
MOV A, R5
ANL A, #0F0H
ADD A,#09H
MOV R5, A
ANL A, #0F0H
ADD A, #03H
SWAP A
ACALL DISP
MOV A, R5
ANL A, #0FH
ADD A, #30H
ACALL DISP
ACALL DELAY1S
DEC R5
SJMP B_8
P_1:
MOV A, R5
ANL A, #0F0H
ADD A, #03H
SWAP A
ACALL DISP
MOV A, R5
ANL A, #0FH
ADD A, #30H
ACALL DISP
ACALL DELAY1S
DEC R5
SJMP B_8
ONLOAD:
CLR P3.1                    ;ON the relay (Active low)
MOV A,#01H                  ;Clear screen
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA14               ;'Relay ON after' display
H_15:     CLR A
MOVC A, @A+DPTR
JZ b_16
ACALL DISP
INC DPTR
SJMP H_15
b_16:
MOV A,#0C3H                 ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA15               ;'S Agn-1,Ret-2' display
H_16:     CLR A
MOVC A, @A+DPTR
JZ b_17
ACALL DISP
INC DPTR
SJMP H_16
B_17:     MOV A,#0C0H             ;Jump to second line, position 0
ACALL CMND
MOV A, R4
ANL A, #0F0H
SWAP A
ADD A, #30H
ACALL DISP
MOV A, R4
ANL A, #0FH
ADD A, #30H
ACALL DISP
Temp2:
ACALL SIRC
MOV A, R6
```

```
CJNE A, #00H, CHECK3
SETB P3.1
LJMP ONDELAY
CHECK3: CJNE A, #01H, temp2
SETB P3.1
SETB P3.2
LJMP START
;-----------------------------------------------------------------------------------
;           OFF DELAY SECTION
;-----------------------------------------------------------------------------------
OFFDELAY:
CLR P3.3          ;Status LED ON (P1.3 OFF DELAY RELAY LED)
MOV A,#01H                ;Clear screen
ACALL CMND
MOV A, #80H
ACALL CMND
MOV DPTR, #MYDATA16           ;'OFF DELAY RELAY' display
H_17:     CLR A
MOVC A, @A+DPTR
JZ b_18
ACALL DISP
INC DPTR
SJMP H_17
b_18:
MOV A,#0C1H               ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA11           ;'Set time(S)= ' display
H_18:     CLR A
MOVC A, @A+DPTR
JZ b_39
ACALL DISP
INC DPTR
SJMP H_18
B_39:
MOV A,#0CDH               ;Jump to second line, position 1
ACALL CMND
MOV A,#0FH                ;Jump to second line, position 1
ACALL CMND
;-----------------------------------------------------------------------------------
;                     TIMER SET SECTION
;-----------------------------------------------------------------------------------
B_19:     ACALL SIRC      ;for the first digit (MSB)
MOV A, R6         ; following three lines is for only the number pressed on remote
ANL A, #0F0H
CJNE A, #00H, B_19        ;upto this
MOV A, R6
CJNE A, #09H, CHECK4
MOV R5, #00H     ;store the value in R5
MOV A,#0CDH               ;Jump to second line, position 1
ACALL CMND
MOV A, #30H      ;Display 0(30 in HEX)
ACALL DISP
SJMP CHECK10
CHECK4:
MOV A,#0CDH               ;Jump to second line, position 1
ACALL CMND
MOV A, R6
ADD A, #31H      ;convert it to ASCII (also add 1 for remote 1=0, 2=1 etc)
ACALL DISP
MOV A, R6
ADD A, #01H
MOV R5, A
CHECK10:
MOV A,#0CEH               ;Jump to second line, position 1
ACALL CMND
```

```
MOV A,#0FH                  ;Jump to second line, position 1
ACALL CMND
ACALL DELAY500MS
ACALL SIRC                  ;for the second digit (LSB)
MOV A, R6         ; following three lines is for only the number pressed on remote
ANL A, #0F0H
CJNE A, #00H, CHECK10 ;upto this
MOV A, R6
CJNE A, #09, CHECK5
MOV A, R5
SWAP A
MOV R5, A         ;store the value in R5
MOV R4, A         ;R4 temporary stores the timer value
MOV A,#0CEH                 ;Jump to second line, position 1
ACALL CMND
MOV A, #30H       ;Display 0(30 in HEX)
ACALL DISP
SJMP CHECK11
CHECK5:
MOV A,#0CEH                 ;Jump to second line, position 1
ACALL CMND
MOV A, R6
ADD A, #31H       ;convert it to ASCII (also add 1 for remote 1=0, 2=1 etc)
ACALL DISP
MOV A, R6
ADD A, #01H
SWAP A
ADD A, R5
SWAP A
MOV R5, A         ;R5 fially stores the timer value (00 to 99 second)
MOV R4, A         ;R4 temporary stores the timer value
CHECK11:
ACALL DELAY1S                         ;wait for 1 second before fault initialization
;------------------------------------------------------------------------------------------
; OFF DELAY Fault Initialization
;------------------------------------------------------------------------------------------
MOV A,#01H        ;Clear screen
ACALL CMND
MOV A,#0CH        ;LCD ON, cursor blinking OFF
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA12             ;'Plz Initialize' display
H_19:   CLR A
MOVC A, @A+DPTR
JZ b_20
ACALL DISP
INC DPTR
SJMP H_19
b_20:
MOV A,#0C1H                 ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA13             ;'The FAULT (OK)' display
H_20:   CLR A
MOVC A, @A+DPTR
JZ b_21
ACALL DISP
INC DPTR
SJMP H_20
B_21:   ACALL SIRC
MOV A, R6
CJNE A, #65H, B_21          ;65H is the data for (ok)
;------------------ Timer ON (OFF DELAY) --------------------------------------------
CLR P3.1;Relay ON (OFF DELAY RELAY)
MOV A,#01H        ;Clear screen
```

```
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA17             ;'OFF DELAY TIMER' display
H_21:    CLR A
MOVC A, @A+DPTR
JZ b_22
ACALL DISP
INC DPTR
SJMP H_21
b_22:
MOV A,#0C1H             ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA7 ;'Remaining    S' display
H_22:    CLR A
MOVC A, @A+DPTR
JZ b_23
ACALL DISP
INC DPTR
SJMP H_22
B_23:
MOV A,#0CBH             ;Jump to second line, position 11
ACALL CMND
MOV A, R5
CJNE A, #00H, CHECK6
LJMP OFFLOAD
CHECK6:
ANL A, #0FH
CJNE A, #0FH, P_2
MOV A, R5
ANL A, #0F0H
ADD A,#09H
MOV R5, A
ANL A, #0F0H
ADD A, #03H
SWAP A
ACALL DISP
MOV A, R5
ANL A, #0FH
ADD A, #30H
ACALL DISP
ACALL DELAY1S
DEC R5
SJMP B_23
P_2:
MOV A, R5
ANL A, #0F0H
ADD A, #03H
SWAP A
ACALL DISP
MOV A, R5
ANL A, #0FH
ADD A, #30H
ACALL DISP
ACALL DELAY1S
DEC R5
SJMP B_23
OFFLOAD:
SETB P3.1               ;OFF the relay (Active low-OFF DELAY)
MOV A,#01H              ;Clear screen
ACALL CMND
MOV A, #81H
ACALL CMND
MOV DPTR, #MYDATA18             ;'Relay OFF after' display
H_23:    CLR A
```

```
MOVC A, @A+DPTR
JZ b_24
ACALL DISP
INC DPTR
SJMP H_23
b_24:
MOV A,#0C3H                 ;Jump to second line, position 1
ACALL CMND
MOV DPTR, #MYDATA15            ;'S Agn-1,Ret-2' display
H_24:     CLR A
MOVC A, @A+DPTR
JZ b_25
ACALL DISP
INC DPTR
SJMP H_24
B_25:     MOV A,#0C0H               ;Jump to second line, position 0
ACALL CMND
MOV A, R4
ANL A, #0F0H
SWAP A
ADD A, #30H
ACALL DISP
MOV A, R4
ANL A, #0FH
ADD A, #30H
ACALL DISP
Temp3:
ACALL SIRC
MOV A, R6
CJNE A, #00H, CHECK7
LJMP OFFDELAY
CHECK7: CJNE A, #01H, temp3
SETB P3.3
LJMP START
;------------------------------------------------------------------------------------------
; SIRC reading section (P0.3)
;------------------------------------------------------------------------------------------
SIRC:
SETB P3.5                   ;flip bit (LED ON)
jb P3.0, $          ;Wait for Start Pulse (active high otherwise)
CLR P3.5
ACALL DELAY2500US   ;if the start pulse detected wait for 2500 us
jb p3.0, $          ;wait for negative edge
CLR A                       ;clear the accumulator
MOV R3, #07                 ;Set the count (address is 7 bit length)
ADDR:
ACALL DELAY900US
MOV C, P3.0                 ;read the 1st bit (LSB)
RRC A                       ;rotate RIGHT with carry. C->A.7
JNB P3.0, $                 ; wait for positive edge
JB p3.0, $                  ; wait for negative edge
DJNZ R3, ADDR
RR A                        ;last rotation withput carry
CPL A                       ;take the complement, as TSOP1738 gives active low output
ANL A, #7FH                 ;ignore the MSB (A.7)
MOV R6, A                   ;Address will store at R6
CLR A
MOV R3,#04
Device:
ACALL DELAY900US
MOV C, P3.0
RRC A
JNB P3.0, $
JB P3.0, $
DJNZ R3, DEVICE
```

```
ACALL DELAY900US
MOV C, P3.0
RRC A
RR A
RR A
RR A
CPL A
ANL A, #1FH
CALL DELAY10000US
CJNE A, #01H, SIRC          ; if command are not match with 01, run the loop again
MOV R7, A                   ;Command will store at R7 (valid command 01)
SETB P3.5                   ;flip bit (LED OFF)
RET
;-----------------------------------------------------------------------------------------
MYDATA:                     DB 'ON / OFF DELAY', 0
MYDATA1:        DB 'RELAY', 0
MYDATA2:        DB 'Using 89c2051', 0
MYDATA3:        DB 'Micro Controller', 0
MYDATA4:        DB 'Select Relay', 0
MYDATA5:        DB '1 = ON   2 = OFF', 0
MYDATA6:        DB 'ON DELAY TIMER', 0
MYDATA7:        DB 'Remaining    S', 0
MYDATA8:        DB 'Please Select', 0
MYDATA9:        DB 'either 1 or 2', 0
MYDATA10:       DB 'ON DELAY RELAY', 0
MYDATA11:       DB 'Set Time(S)= ', 0
MYDATA12:       DB 'Plz Initialize', 0
MYDATA13:       DB 'The FAULT (OK)', 0
MYDATA14:       DB 'Relay ON after', 0
MYDATA15:       DB 'S Agn-1,Ret-2', 0
MYDATA16:       DB 'OFF DELAY RELAY', 0
MYDATA17:       DB 'OFF DELAY TIMER', 0
MYDATA18:       DB 'Relay OFF After', 0
MYDATA19:       DB 'Controlled by', 0
MYDATA20:       DB 'SIRC PROTOCOL', 0
MYDATA21:       DB 'Developed by', 0
MYDATA22:       DB 'BUDHADITYA', 0
;------------------------------------------------------
CMND:
MOV P1,A
CLR P3.7; RS
SETB P3.4       ; E
ACALL DELY
CLR P3.4; E
RET
;------------------------------------------------------
DISP:
MOV P1,A
SETB P3.7       ; RS
SETB P3.4       ; E
ACALL DELY
CLR P3.4; E
RET
;------------------------------------------------------
DELY:
MOV R1, #02H
LOOP:
MOV     TMOD, #01H      ; Counter 1, Mode 0
MOV TL0, #78H  ; EC78 provides 5 ms Delay (12 MHz)
MOV TH0, #0ECH
SETB TR0
JNB TF0, $
CLR TR0
CLR TF0
DJNZ R1, LOOP
```

```
RET
;-----------------------------------------------------
DELAY1S:                          ; for display the content for 1 sec
MOV R1, #0EH
LOOP2:
MOV     TMOD, #01H      ; Counter 1, Mode 0
MOV TL0, #9BH  ; 089B provides 950 ms Delay (12 MHz)
MOV TH0, #08H
SETB TR0
JNB TF0, $
CLR TR0
CLR TF0
DEC R1
MOV A, R1
JNZ LOOP2
RET
;------------------------------------------------------
DELAY2500us:                      ; for display the content for 2480 usec
MOV R1, #01H
LOOP3:
MOV     TMOD, #01H      ; Counter 1, Mode 0
MOV TL0, #50H  ; F650 provides 2480 us Delay (12 MHz)
MOV TH0, #0F6H
SETB TR0
JNB TF0, $
CLR TR0
CLR TF0
DJNZ R1, LOOP3

RET
;-------------------------------------------------------------------------------------------
DELAY900us:                       ; for display the content for 890 usec
MOV R1, #01H
LOOP4:
MOV     TMOD, #01H      ; Counter 1, Mode 0
MOV TL0, #86H  ; FC86 provides 890 us Delay (12 MHz)
MOV TH0, #0FCH
SETB TR0
JNB TF0, $
CLR TR0
CLR TF0
DJNZ R1, LOOP4

RET
;-------------------------------------------------------------------------------------------
DELAY10000us:                     ; for display the content for 10000 usec
MOV R1, #01H
LOOP5:
MOV     TMOD, #01H      ; Counter 1, Mode 0
MOV TL0, #0F0H; D8F0 provides 10000 us Delay (12 Mhz)
MOV TH0, #0D8H
SETB TR0
JNB TF0, $
CLR TR0
CLR TF0
DJNZ R1, LOOP5

RET
;-------------------------------------------------------------------------------------------
DELAY500ms:               ; delay between the two switch pressed in remote
MOV R1, #08H
LOOP_5:
MOV     TMOD, #01H      ; Counter 1, Mode 0
MOV TL0, #00H  ; FCCC provides 10000 us Delay (CHECK)
MOV TH0, #1FH
```

```
SETB TR0
JNB TF0, $
CLR TR0
CLR TF0
DJNZ R1, LOOP_5

RET
;-------------------------------------------------------------------------------------------
END
```

Appendix C

(Data sheets)

Features

- **Compatible with MCS-51™ Products**
- **2K Bytes of Reprogrammable Flash Memory**
  - **– Endurance: 1,000 Write/Erase Cycles**
- **2.7V to 6V Operating Range**
- **Fully Static Operation: 0 Hz to 24 MHz**
- **Two-level Program Memory Lock**
- **128 x 8-bit Internal RAM**
- **15 Programmable I/O Lines**
- **Two 16-bit Timer/Counters**
- **Six Interrupt Sources**
- **Programmable Serial UART Channel**
- **Direct LED Drive Outputs**
- **On-chip Analog Comparator**
- **Low-power Idle and Power-down Modes**

8-bit Microcontroller with 2K Bytes Flash

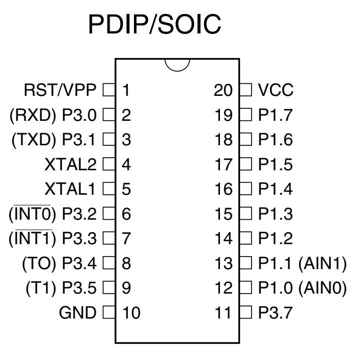
AT89C2051

Description

The AT89C2051 is a low-voltage, high-performance CMOS 8-bit microcomputer with 2K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C2051 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

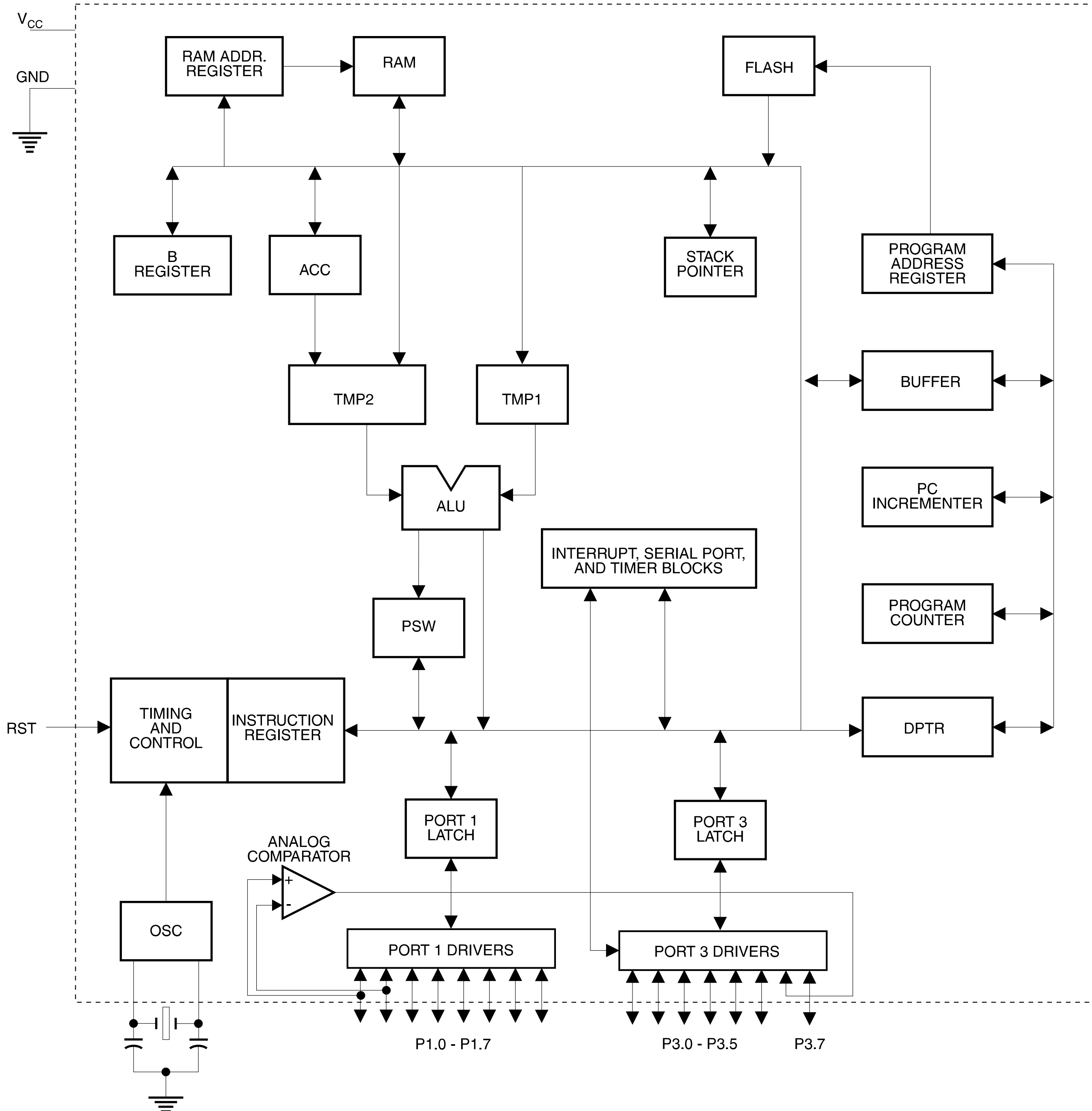
The AT89C2051 provides the following standard features: 2K bytes of Flash, 128 bytes of RAM, 15 I/O lines, two 16-bit timer/counters, a five vector two-level interrupt architecture, a full duplex serial port, a precision analog comparator, on-chip oscillator and clock circuitry. In addition, the AT89C2051 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The power-down mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

Pin Configuration



Rev. 0368E–02/00

Block Diagram



Pin Description

VCC

Supply voltage.

GND

Ground.

Port 1

Port 1 is an 8-bit bi-irectional I/O port. Port pins P1.2 to P1.7 provide internal pullups. P1.0 and P1.1 require external pullups. P1.0 and P1.1 also serve as the positive input (AIN0) and the negative input (AIN1), respectively, of the on-chip precision analog comparator. The Port 1 output buffers can sink 20 mA and can drive LED displays directly. When 1s are written to Port 1 pins, they can be used as inputs. When pins P1.2 to P1.7 are used as inputs and are externally pulled low, they will source current (I_{IL}) because of the internal pullups.

Port 1 also receives code data during Flash programming and verification.

Port 3

Port 3 pins P3.0 to P3.5, P3.7 are seven bi-irectional I/O pins with internal pullups. P3.6 is hard-wired as an input to the output of the on-chip comparator and is not accessible as a general purpose I/O pin. The Port 3 output buffers can sink 20 mA. When 1s are written to Port 3 pins they are pulled high by the internal pullups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (I_{IL}) because of the pullups.

Port 3 also serves the functions of various special features of the AT89C2051 as listed below:

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{\text{INT0}}$ (external interrupt 0)
P3.3	$\overline{\text{INT1}}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)

Port 3 also receives some control signals for Flash programming and verification.

RST

Reset input. All I/O pins are reset to 1s as soon as RST goes high. Holding the RST pin high for two machine cycles while the oscillator is running resets the device.

Each machine cycle takes 12 oscillator or clock cycles.

XTAL1

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

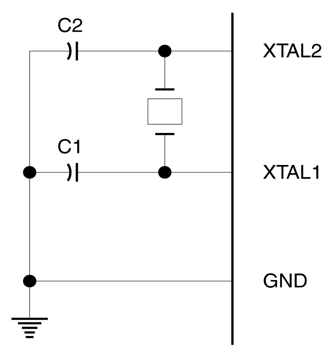
XTAL2

Output from the inverting oscillator amplifier.

Oscillator Characteristics

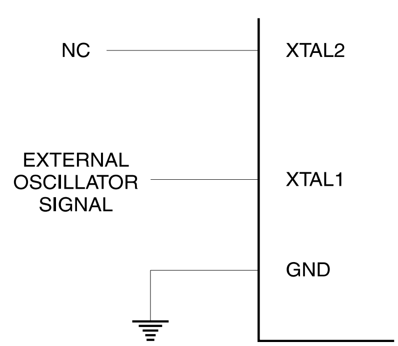
XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator, as shown in Figure 1. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven as shown in Figure 2. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

Figure 1. Oscillator Connections



Note: C1, C2 = 30 pF ± 10 pF for Crystals
= 40 pF ± 10 pF for Ceramic Resonators

Figure 2. External Clock Drive Configuration



Special Function Registers

A map of the on-chip memory area called the Special Function Register (SFR) space is shown in the table below.

Note that not all of the addresses are occupied, and unoccupied addresses may not be implemented on the chip. Read accesses to these addresses will in general return random data, and write accesses will have an indeterminate effect.

User software should not write 1s to these unlisted locations, since they may be used in future products to invoke new features. In that case, the reset or inactive values of the new bits will always be 0.

Table 1. AT89C2051 SFR Map and Reset Values

0F8H									0FFH
0F0H	B 00000000								0F7H
0E8H									0EFH
0E0H	ACC 00000000								0E7H
0D8H									0DFH
0D0H	PSW 00000000								0D7H
0C8H									0CFH
0C0H									0C7H
0B8H	IP XXX00000								0BFH
0B0H	P3 11111111								0B7H
0A8H	IE 0XX00000								0AFH
0A0H									0A7H
98H	SCON 00000000	SBUF XXXXXXXX							9FH
90H	P1 11111111								97H
88H	TCON 00000000	TMOD 00000000	TL0 00000000	TL1 00000000	TH0 00000000	TH1 00000000			8FH
80H		SP 00000111	DPL 00000000	DPH 00000000				PCON 0XXX0000	87H

Restrictions on Certain Instructions

The AT89C2051 and is an economical and cost-effective member of Atmel's growing family of microcontrollers. It contains 2K bytes of flash program memory. It is fully compatible with the MCS-51 architecture, and can be programmed using the MCS-51 instruction set. However, there are a few considerations one must keep in mind when utilizing certain instructions to program this device.

All the instructions related to jumping or branching should be restricted such that the destination address falls within the physical program memory space of the device, which is 2K for the AT89C2051. This should be the responsibility of the software programmer. For example, LJMP 7E0H would be a valid instruction for the AT89C2051 (with 2K of memory), whereas LJMP 900H would not.

1. Branching instructions:

LCALL, LJMP, ACALL, AJMP, SJMP, JMP @A+DPTR

These unconditional branching instructions will execute correctly as long as the programmer keeps in mind that the destination branching address must fall within the physical boundaries of the program memory size (locations 00H to 7FFH for the 89C2051). Violating the physical space limits may cause unknown program behavior.

CJNE [...], DJNZ [...], JB, JNB, JC, JNC, JBC, JZ, JNZ With these conditional branching instructions the same rule above applies. Again, violating the memory boundaries may cause erratic execution.

For applications involving interrupts the normal interrupt service routine address locations of the 80C51 family architecture have been preserved.

2. MOVX-related instructions, Data Memory:

The AT89C2051 contains 128 bytes of internal data memory. Thus, in the AT89C2051 the stack depth is limited to 128 bytes, the amount of available RAM. External DATA memory access is not supported in this device, nor is external PROGRAM memory execution. Therefore, no MOVX [...] instructions should be included in the program.

A typical 80C51 assembler will still assemble instructions, even if they are written in violation of the restrictions mentioned above. It is the responsibility of the controller user to know the physical features and limitations of the device being used and adjust the instructions used correspondingly.

Program Memory Lock Bits

On the chip are two lock bits which can be left unprogrammed (U) or can be programmed (P) to obtain the additional features listed in the table below:

Lock Bit Protection Modes[1]

Program Lock Bits			
	LB1	LB2	Protection Type
1	U	U	No program lock features.
2	P	U	Further programming of the Flash is disabled.
3	P	P	Same as mode 2, also verify is disabled.

Note: 1. The Lock Bits can only be erased with the Chip Erase operation.

Idle Mode

In idle mode, the CPU puts itself to sleep while all the on-chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset.

P1.0 and P1.1 should be set to “0” if no external pullups are used, or set to “1” if external pullups are used.

It should be noted that when idle is terminated by a hardware reset, the device normally resumes program execution, from where it left off, up to two machine cycles before the internal reset algorithm takes control. On-chip hardware inhibits access to internal RAM in this event, but access to the port pins is not inhibited. To eliminate the possibility of an unexpected write to a port pin when Idle is terminated by reset, the instruction following the one that invokes Idle should not be one that writes to a port pin or to external memory.

Power-down Mode

In the power down mode the oscillator is stopped, and the instruction that invokes power down is the last instruction executed. The on-chip RAM and Special Function Registers retain their values until the power down mode is terminated. The only exit from power down is a hardware reset. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before V_{CC} is restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize.

P1.0 and P1.1 should be set to “0” if no external pullups are used, or set to “1” if external pullups are used.

Programming The Flash

The AT89C2051 is shipped with the 2K bytes of on-chip PEROM code memory array in the erased state (i.e., contents = FFH) and ready to be programmed. The code memory array is programmed one byte at a time. *Once the array is programmed, to re-program any non-blank byte, the entire memory array needs to be erased electrically.*

Internal Address Counter: The AT89C2051 contains an internal PEROM address counter which is always reset to 000H on the rising edge of RST and is advanced by applying a positive going pulse to pin XTAL1.

Programming Algorithm: To program the AT89C2051, the following sequence is recommended.

1. Power-up sequence:
   Apply power between V_{CC} and GND pins
   Set RST and XTAL1 to GND
2. Set pin RST to "H"
   Set pin P3.2 to "H"
3. Apply the appropriate combination of "H" or "L" logic levels to pins P3.3, P3.4, P3.5, P3.7 to select one of the programming operations shown in the PEROM Programming Modes table.

To Program and Verify the Array:

4. Apply data for Code byte at location 000H to P1.0 to P1.7.
5. Raise RST to 12V to enable programming.
6. Pulse P3.2 once to program a byte in the PEROM array or the lock bits. The byte-write cycle is self-timed and typically takes 1.2 ms.
7. To verify the programmed data, lower RST from 12V to logic "H" level and set pins P3.3 to P3.7 to the appropiate levels. Output data can be read at the port P1 pins.
8. To program a byte at the next address location, pulse XTAL1 pin once to advance the internal address counter. Apply new data to the port P1 pins.
9. Repeat steps 5 through 8, changing data and advancing the address counter for the entire 2K bytes array or until the end of the object file is reached.
10. Power-off sequence:
    set XTAL1 to "L"
    set RST to "L"
    Turn V_{CC} power off

$\overline{\text{Data}}$ Polling: The AT89C2051 features $\overline{\text{Data}}$ Polling to indicate the end of a write cycle. During a write cycle, an attempted read of the last byte written will result in the complement of the written data on P1.7. Once the write cycle has been completed, true data is valid on all outputs, and the next cycle may begin. $\overline{\text{Data}}$ Polling may begin any time after a write cycle has been initiated.

Ready/$\overline{\text{Busy}}$: The Progress of byte programming can also be monitored by the RDY/$\overline{\text{BSY}}$ output signal. Pin P3.1 is pulled low after P3.2 goes High during programming to indicate BUSY. P3.1 is pulled High again when programming is done to indicate READY.

Program Verify: If lock bits LB1 and LB2 have not been programmed code data can be read back via the data lines for verification:

1. Reset the internal address counter to 000H by bringing RST from "L" to "H".
2. Apply the appropriate control signals for Read Code data and read the output data at the port P1 pins.
3. Pulse pin XTAL1 once to advance the internal address counter.
4. Read the next code data byte at the port P1 pins.
5. Repeat steps 3 and 4 until the entire array is read.

The lock bits cannot be verified directly. Verification of the lock bits is achieved by observing that their features are enabled.

Chip Erase: The entire PEROM array (2K bytes) and the two Lock Bits are erased electrically by using the proper combination of control signals and by holding P3.2 low for 10 ms. The code array is written with all "1"s in the Chip Erase operation and must be executed before any non-blank memory byte can be re-programmed.

Reading the Signature Bytes: The signature bytes are read by the same procedure as a normal verification of locations 000H, 001H, and 002H, except that P3.5 and P3.7 must be pulled to a logic low. The values returned are as follows.

(000H) = 1EH indicates manufactured by Atmel
(001H) = 21H indicates 89C2051

Programming Interface

Every code byte in the Flash array can be written and the entire array can be erased by using the appropriate combination of control signals. The write operation cycle is self-timed and once initiated, will automatically time itself to completion.

All major programming vendors offer worldwide support for the Atmel microcontroller series. Please contact your local programming vendor for the appropriate software revision.

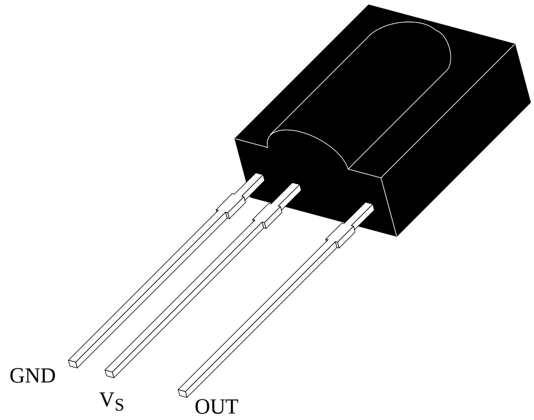
Photo Modules for PCM Remote Control Systems

Available types for different carrier frequencies

Type	fo	Type	fo
TSOP1730	30 kHz	TSOP1733	33 kHz
TSOP1736	36 kHz	TSOP1737	36.7 kHz
TSOP1738	38 kHz	TSOP1740	40 kHz
TSOP1756	56 kHz		

Description

The TSOP17.. – series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter.
The demodulated output signal can directly be decoded by a microprocessor. TSOP17.. is the standard IR remote control receiver series, supporting all major transmission codes.

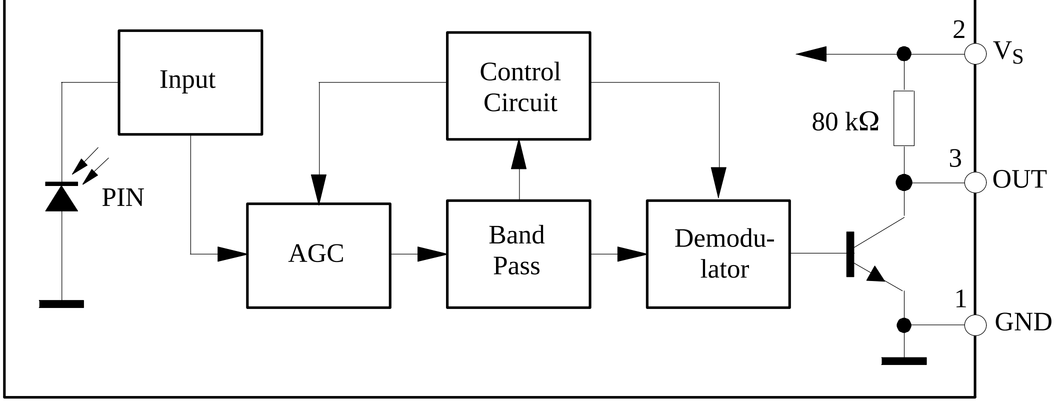


94 8691

Features

- Photo detector and preamplifier in one package
- Internal filter for PCM frequency
- Improved shielding against electrical field disturbance
- TTL and CMOS compatibility
- Output active low
- Low power consumption
- High immunity against ambient light
- Continuous data transmission possible (up to 2400 bps)
- Suitable burst length ≥10 cycles/burst

Block Diagram



94 8136

Absolute Maximum Ratings

T_{amb} = 25°C

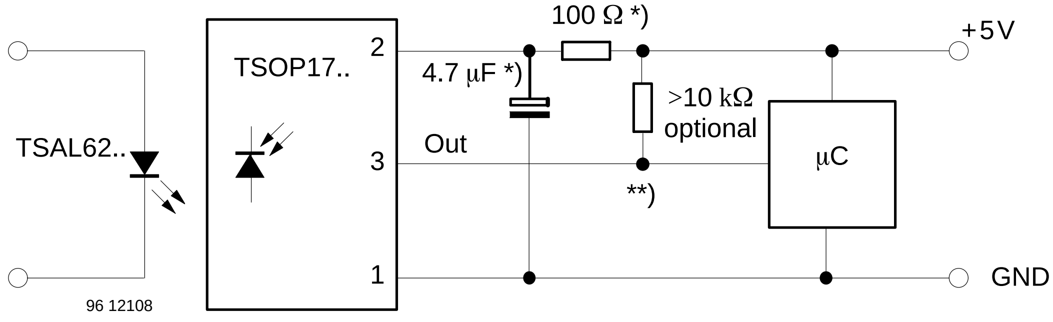
Parameter	Test Conditions	Symbol	Value	Unit
Supply Voltage	(Pin 2)	V_S	–0.3...6.0	V
Supply Current	(Pin 2)	I_S	5	mA
Output Voltage	(Pin 3)	V_O	–0.3...6.0	V
Output Current	(Pin 3)	I_O	5	mA
Junction Temperature		T_j	100	°C
Storage Temperature Range		T_{stg}	–25...+85	°C
Operating Temperature Range		T_{amb}	–25...+85	°C
Power Consumption	(T_{amb} ≦ 85 °C)	P_{tot}	50	mW
Soldering Temperature	t ≦ 10 s, 1 mm from case	T_{sd}	260	°C

Basic Characteristics

T_{amb} = 25°C

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
Supply Current (Pin 2)	V_S = 5 V, E_v = 0	I_{SD}	0.4	0.6	1.5	mA
	V_S = 5 V, E_v = 40 klx, sunlight	I_{SH}		1.0		mA
Supply Voltage (Pin 2)		V_S	4.5		5.5	V
Transmission Distance	E_v = 0, test signal see fig.7, IR diode TSAL6200, I_F = 400 mA	d		35		m
Output Voltage Low (Pin 3)	I_{OSL} = 0.5 mA, E_e = 0.7 mW/m^2, f = f_o, t_p/T = 0.4	V_{OSL}			250	mV
Irradiance (30 – 40 kHz)	Pulse width tolerance: $t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$, test signal (see fig.7)	$E_{e\,min}$		0.35	0.5	mW/m^2
Irradiance (56 kHz)	Pulse width tolerance: $t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$, test signal (see fig.7)	$E_{e\,min}$		0.4	0.6	mW/m^2
Irradiance	$t_{pi} - 5/f_o < t_{po} < t_{pi} + 6/f_o$	$E_{e\,max}$	30			W/m^2
Directivity	Angle of half transmission distance	$\varphi_{1/2}$		±45		deg

Application Circuit



*) recommended to suppress power supply disturbances

**) The output voltage should not be hold continuously at a voltage below 3.3V by the external circuit.

Suitable Data Format

The circuit of the TSOP17.. is designed in that way that unexpected output pulses due to noise or disturbance signals are avoided. A bandpassfilter, an integrator stage and an automatic gain control are used to suppress such disturbances.
The distinguishing mark between data signal and disturbance signal are carrier frequency, burst length and duty cycle.

The data signal should fullfill the following condition:

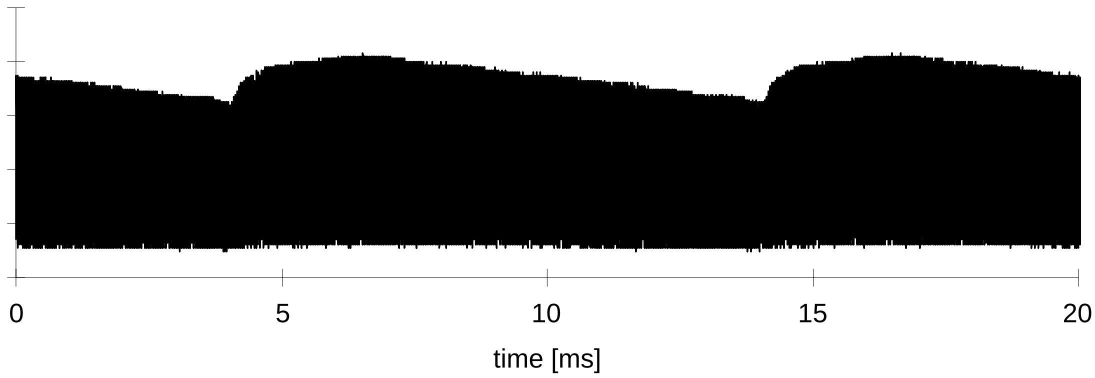
- Carrier frequency should be close to center frequency of the bandpass (e.g. 38kHz).
- Burst length should be 10 cycles/burst or longer.
- After each burst which is between 10 cycles and 70 cycles a gap time of at least 14 cycles is neccessary.
- For each burst which is longer than 1.8ms a corresponding gap time is necessary at some time in the data stream. This gap time should have at least same length as the burst.
- Up to 1400 short bursts per second can be received continuously.

Some examples for suitable data format are:
NEC Code, Toshiba Micom Format, Sharp Code, RC5 Code, RC6 Code, R–2000 Code, Sony Format (SIRCS).

When a disturbance signal is applied to the TSOP17.. it can still receive the data signal. However the sensitivity is reduced to that level that no unexpected pulses will occure.

Some examples for such disturbance signals which are suppressed by the TSOP17.. are:

- DC light (e.g. from tungsten bulb or sunlight)
- Continuous signal at 38kHz or at any other frequency
- Signals from fluorescent lamps with electronic ballast (an example of the signal modulation is in the figure below).



IR Signal from Fluorescent Lamp with low Modulation

Typical Characteristics (Tamb = 25°C unless otherwise specified)

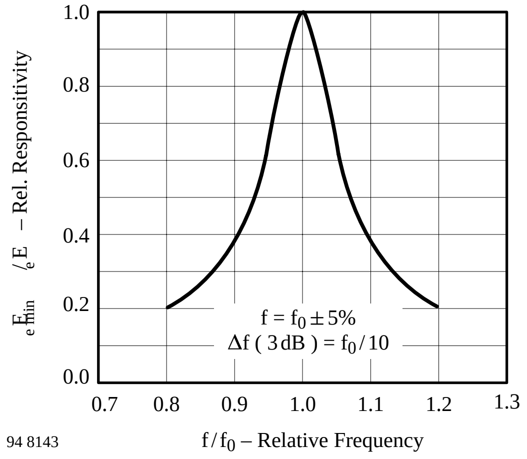


Figure 1. Frequency Dependence of Responsivity

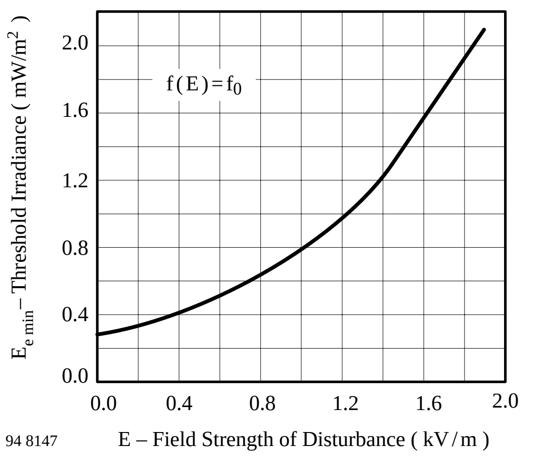


Figure 4. Sensitivity vs. Electric Field Disturbances

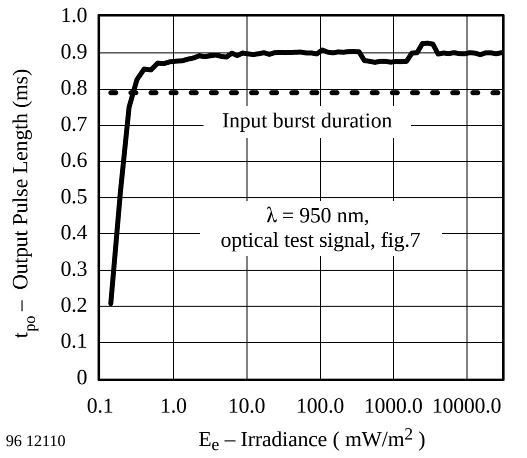


Figure 2. Sensitivity in Dark Ambient

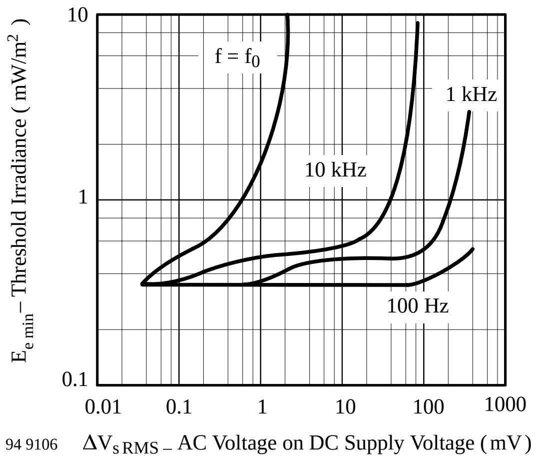


Figure 5. Sensitivity vs. Supply Voltage Disturbances

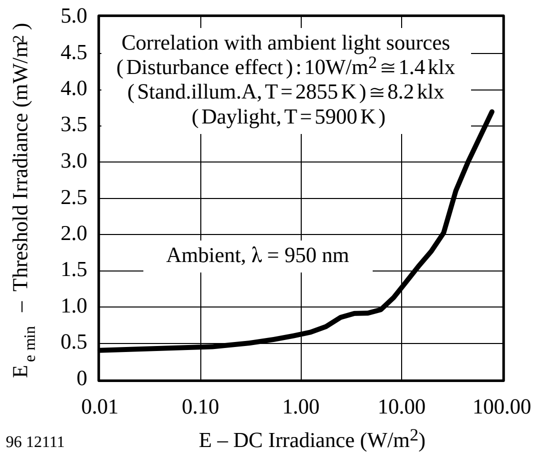


Figure 3. Sensitivity in Bright Ambient

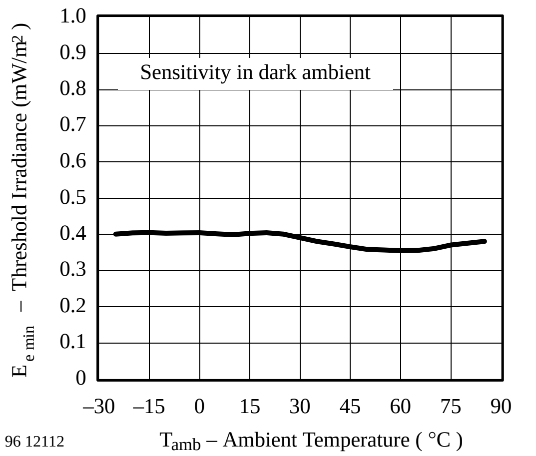


Figure 6. Sensitivity vs. Ambient Temperature

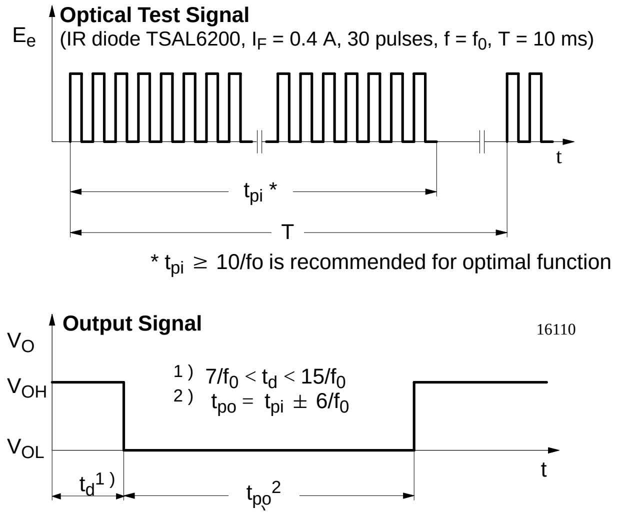


Figure 7. Output Function

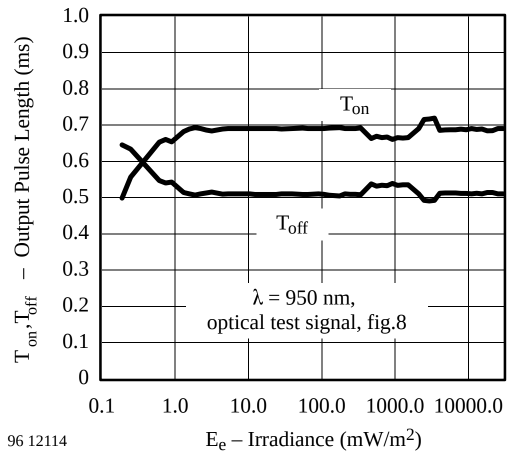


Figure 10. Output Pulse Diagram

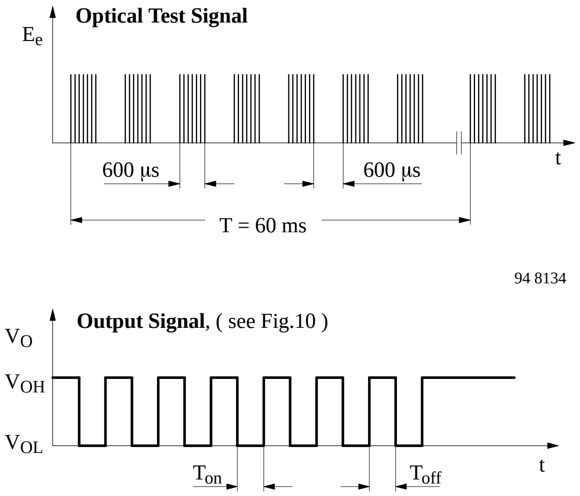


Figure 8. Output Function

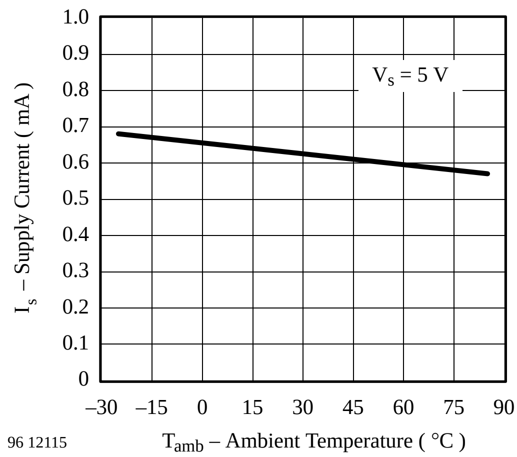


Figure 11. Supply Current vs. Ambient Temperature

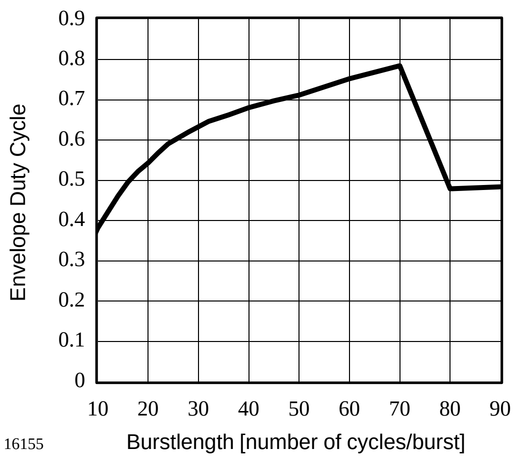


Figure 9. Max. Envelope Duty Cycle vs. Burstlength

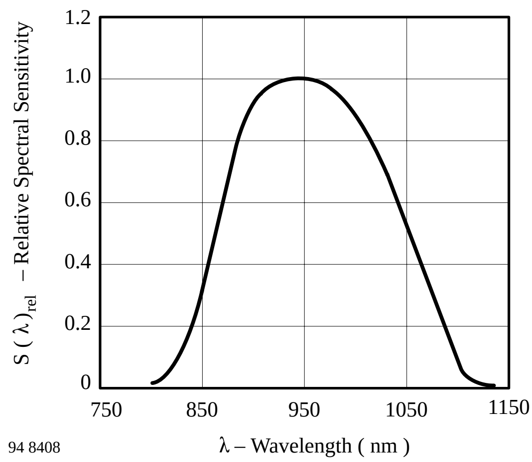


Figure 12. Relative Spectral Sensitivity vs. Wavelength

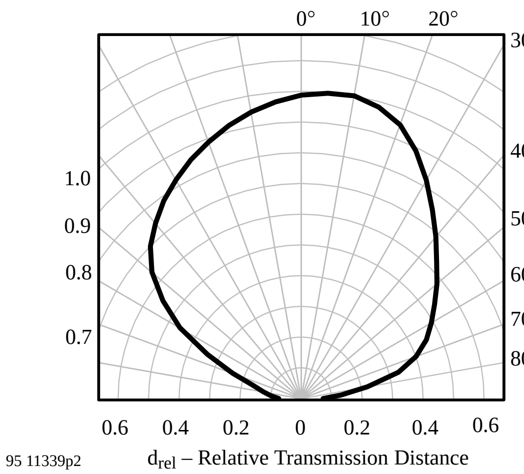


Figure 13. Vertical Directivity φ_y

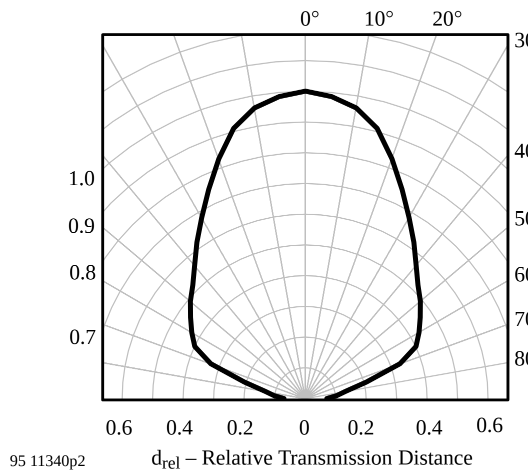
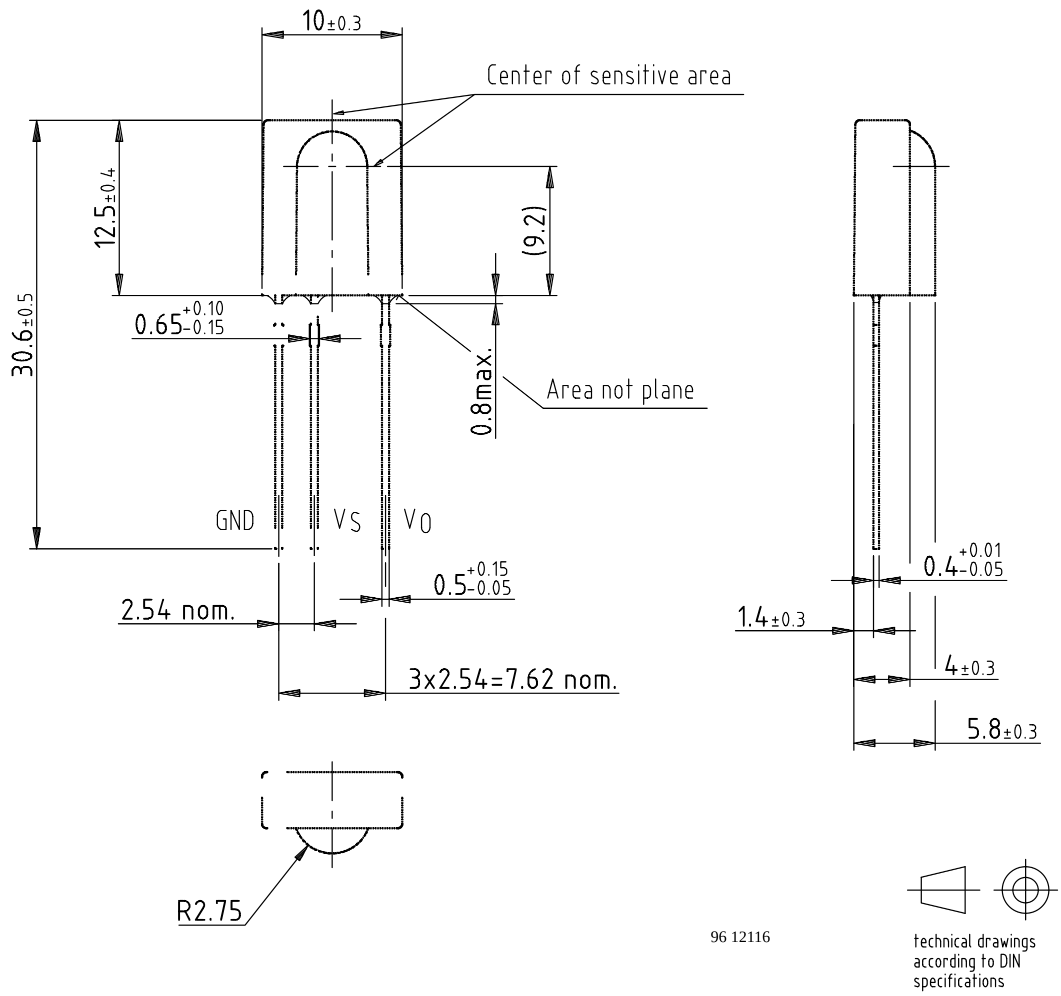


Figure 14. Horizontal Directivity φ_x

Dimensions in mm



Ozone Depleting Substances Policy Statement

It is the policy of **Vishay Semiconductor GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

Vishay Semiconductor GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

Vishay Semiconductor GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

We reserve the right to make changes to improve technical design and may do so without further notice.
Parameters can vary in different applications. All operating parameters must be validated for each customer application by the customer. Should the buyer use Vishay-Semiconductors products for any unintended or unauthorized application, the buyer shall indemnify Vishay-Semiconductors against all claims, costs, damages, and expenses, arising out of, directly or indirectly, any claim of personal damage, injury or death associated with such unintended or unauthorized use.

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