A

Project Report

On

"ACCIDENTAL SWITCH ON/OFF PROTECTION USING DELAY "

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Submitted to

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

Faculty of Technology & Engineering, CHARUSAT

ChanduBhai S. Patel Institute of Technology

at Changa, Dist. Anand – 388421

November 2019

CERTIFICATE

This is to certify that the report entitled **"ACCIDENTAL SWITCH ON/OFF PROTECTION USING DELAY"** is a bonafide work carried out by Kushang Darbar under the guidance and supervision of **Prof. Vishal Tank** & **Prof. Riki Patel** for the subject **Mini Project-I (EC244)** of 3rd Semester of Bachelor of Technology in Electronics & Communication at Faculty of Technology & Engineering (C.S.P.I.T.) – CHARUSAT, Gujarat.

To the best of my knowledge and belief, this work embodies the work of candidate himself, has duly been completed, and fulfils the requirement of the ordinance relating to the Subject specified for 3rd semester of the University and is up to the standard in respect of content, presentation and language for being referred to the examiner.

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ABSTRACT:

The project is Accidental switch on/off protection using delay using NE555 timer and a decade counter CD4017B. The timer IC generates the clock pulse through capacitor used respectively.the decade counter, through the output pin of timer IC connected to the clock pin of decade counter, countes the pulse.Accordingly the delay is obtained and the visual feedback given at decade counter is for reference of the user whether the circuit is turned on/off.The purpose of the project is to protect the appliance of the user from accidental switch on/off and the sudden voltage difference created due to that.

Acknowledgement:

I take this opportunity to express my profound gratitude and deep regards to my guide Prof. Vishal Tank & Prof. Riki Patel and coordinator of Electronics and Communication department of CSPIT, Dr Trushit Upadhyaya, for their exemplary guidance, monitoring and constant encouragement throughout the course of this project. The blessing, help and guidance given by them time to time shall carry me a long way in the journey of life on which I am about to embark.

I also take this opportunity to express a deep sense of gratitude to Mentor Vishal Tank for his cordial support, valuable information and guidance, which helped me in completing this task through various stages.

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ABBREVATIONS:

- IC - Integrated Circuit
- PCB - Printed Circuit Board
- DC - Direct current

CHAPTER 1: INTRODUCTION TO PROJECT

- This project "Accidental switch on/off protection using delay" is designed using two different ICs and the other components like transistors, LEDs, relay, resistors, etc.
- In this design, delay is produced and the visual feedback given through LEDs, using the two ICs and other components.
- Thus, the user gets notified that the circuit is switched on or off.

1.1: PROBLEM

The problems faced by the user using appliance are:

- Many of the times when the user uses the appliance, it may happen that the switch of the appliance is pressed by mistake, so to avoid any internal damage to the appliance this design is used.
- The accidental pressing of the on/off switch due to human error may cause the failure of the system it is connected to, or cause unnecessary delay to a part of the parent circuit.
- This could, in turn, cost money and time to reset/reboot the system.

1.2: SOLUTION

The solution to the problems faced:

- The circuit presented in this requires you to keep the on/off switch pressed for a certain duration to make sure that the action is actually intended and not accidental.

CHAPTER 2: PROJECTION DESCRIPTION

2.1: BLOCK DIAGRAM

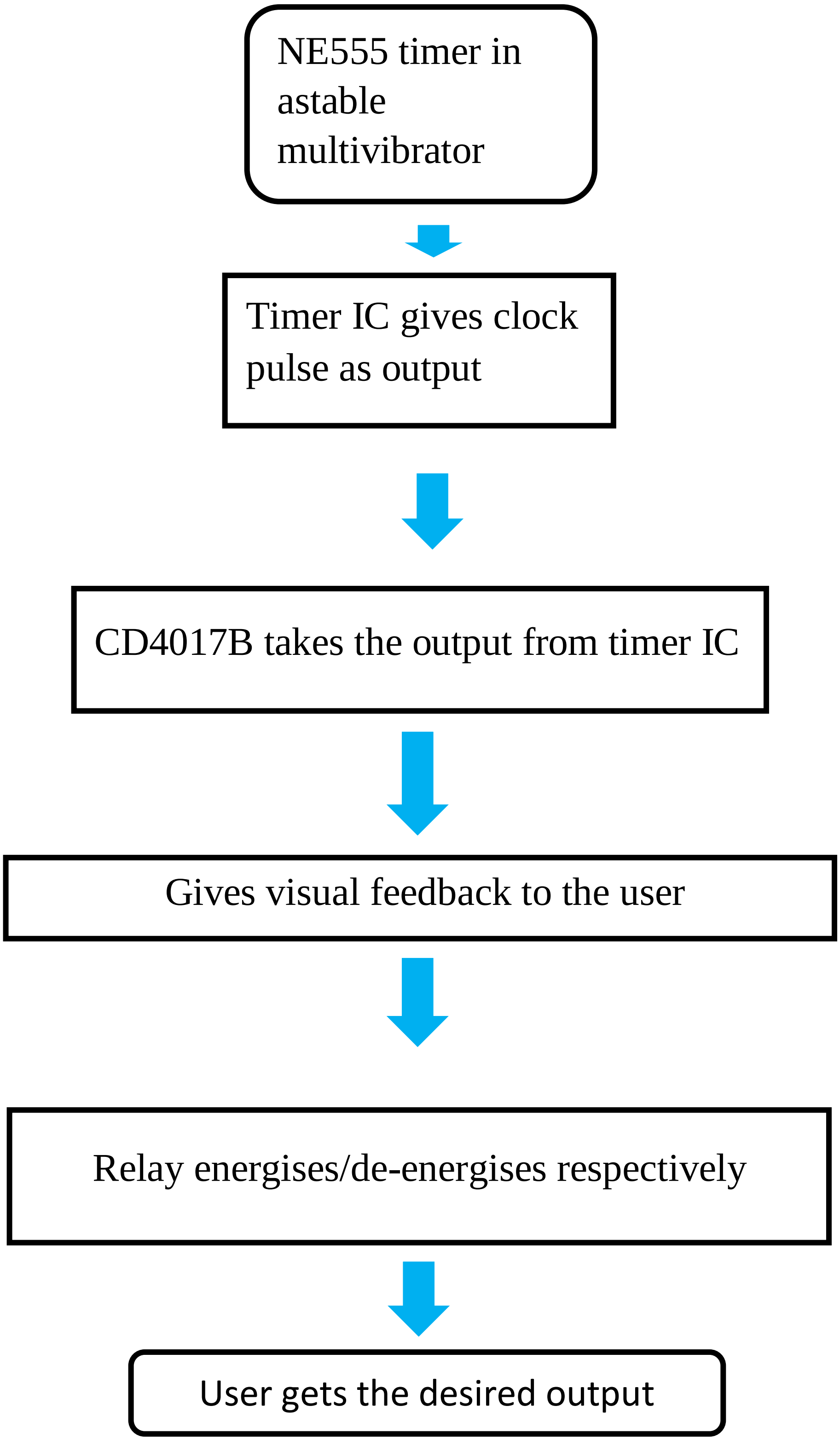


Figure 1:Block diagram

2.2: CIRCUIT DIAGRAM

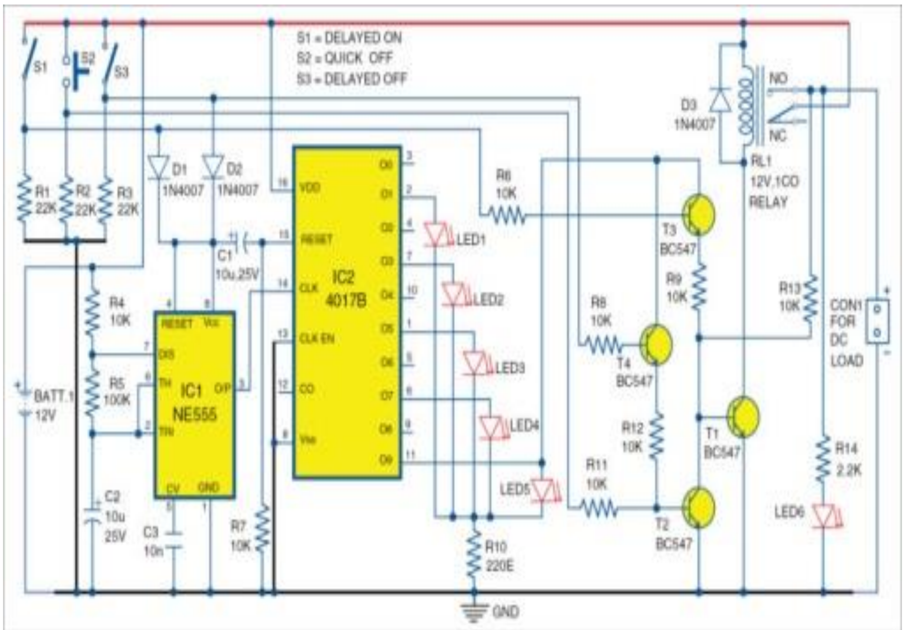


Figure 2: Circuit diagram

WORKING

- The circuit employs 555 timer IC, wired in astable-multivibrator mode, which serves as the clock source.
- Decade counter IC CD4017 provides visual feedback on how long you should keep pressing the on/off switch to achieve the desired action.
- 12V DC load can be connected to relay output, which is controlled through switches S1 through S3.
- Delay timing of IC1 is decided by timing components, namely, resistors R4 and R5, and capacitor C2.
- LED1 through LED5 provide visual delay indication.
- On closing delay-on switch S1, transistor T3 conducts.
- IC1 starts oscillating, IC2 starts counting and LED1 through LED5 glow one after another and when IC2 counts to Q9 (at pin 11), its output turns on T1, relay RL1 energises.

CHAPTER 3: COMPONENTS AND ITS DETAILS

3.1: COMPONENTS LIST

Sr. No.	Component Name	Quantity	Specification
1	Bread board	3	-
2	General purpose board	1	-
3	NE555 timer (IC1)	1	-
4	Decade counter CD4017B (IC2)	1	-
5	LED	6	Maximum voltage 2v
6	npn transistors BC547	4	-
7	Battery	1	12 V
8	22k Ω	3	Tolerance 5%
9	10k Ω	7	Tolerance 5%
10	2.2k Ω	1	Tolerance 5%
11	100k Ω	1	Tolerance 5%
12	220E Ω	1	Tolerance 5%
13	Pushbutton switch	2	-
14	Toggle switch	1	-
15	Diode 1N4007	3	-
16	Relay	1	12 V
17	Wires	-	-
18	Capacitor	2 1	10uF,25 V 10n

3.2: DETAILS OF COMPONENTS

- **Breadboard**

➢ A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes are connected horizontally and split in the middle while the remaining holes are connected vertically.

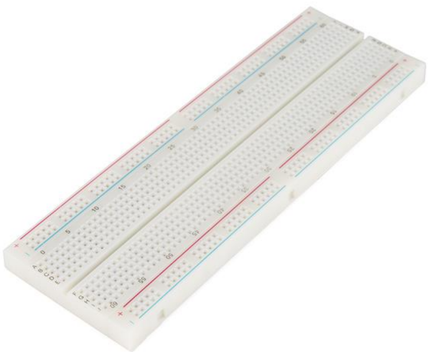


Figure 3: Breadboard

- **General purpose board**

➢ As its name suggests, **general purpose PCB's** are widely used to embed circuits randomly for running of hardware. Its layer is coated with copper and allows proper soldering without any short circuit. **General purpose board**, connections are not built so connections are to be created.

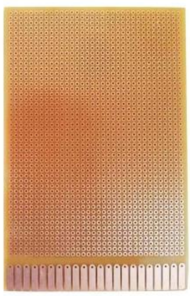


Figure 4: General purpose board

- **NE555 timer(IC1)**

The 555 timer IC is an integrated circuit(chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element.The standard 555 package includes 25 transistors, 2 diodes and 15 resistors on a silicon chip installed in an 8-pin dual in-line package (DIP-8).

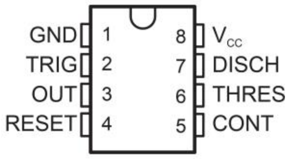


Figure 5:NE555 **Figure 6:NE555 Pin diagram**

- **CD4017B(IC2)**

CD4017B are 4-stage Johnson counters having 8 decoded outputs. Inputs include a CLOCK, a RESET, and a CLOCK INHIBIT signal. Schmitt trigger action in the CLOCK input circuit provides pulse shaping that allows unlimited clock input pulse rise and fall times.

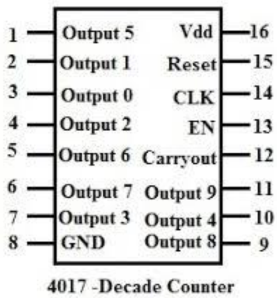


Figure 7: CD4017B **Figure 8:CD4017B Pin diagram**

- ## Transistor BC547

BC547 is an NPN bi-polar junction **transistor**.

Figure 9:Transistor(BC547)

- ## Diode(1N4007)

1N4007 is a PN junction rectifier **diode**. These types of **diodes** allow only the flow of electrical current in one direction only. So, it can be **used** for the conversion of AC power to DC.

Figure 10:Diode(1N4007)

- ## LED

Figure 11:LED

- ## Relay

Relays are switches that open and close circuits electromechanically or electronically. **Relays** control one electrical circuit by opening and closing contacts in another circuit.

Figure 12:Relay

CHAPTER 4: IMPLEMENTATION

4.1(a): Hardware Implementation on Breadboard

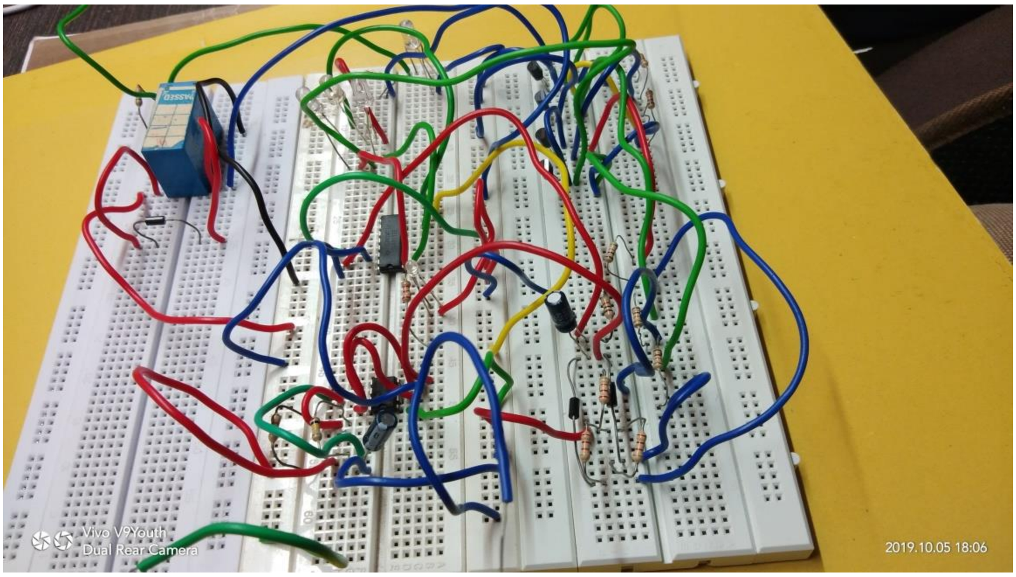


Figure 13:Breadboard circuit

(b) Hardware Implementation on GENERAL PURPOSE PCB

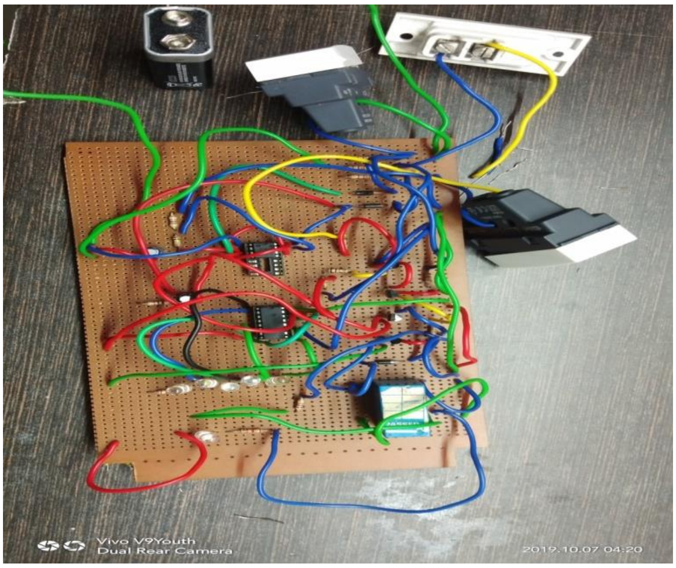


Figure 14:General Purpose PCB circuit

4.2(a):CIRCUIT IMPLEMENTATION ON PROTEUS SOFTWARE

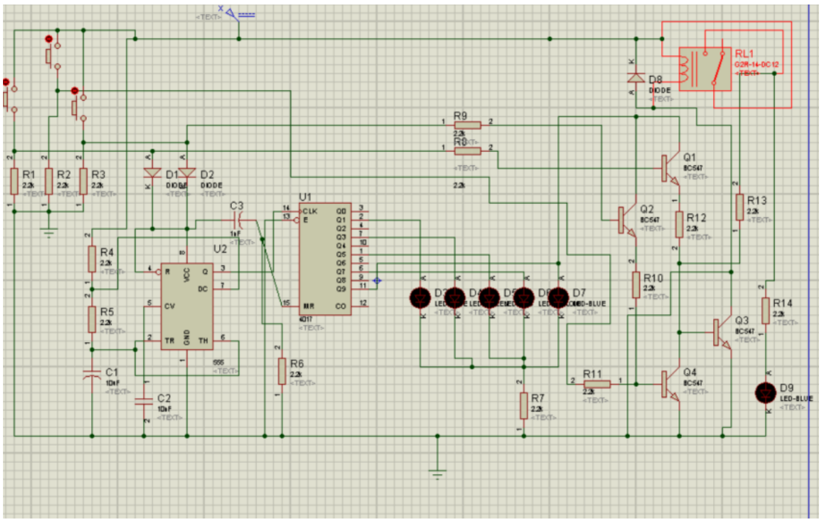


Figure 15:Proteus Software circuit

(b)ARES PCB DESIGN

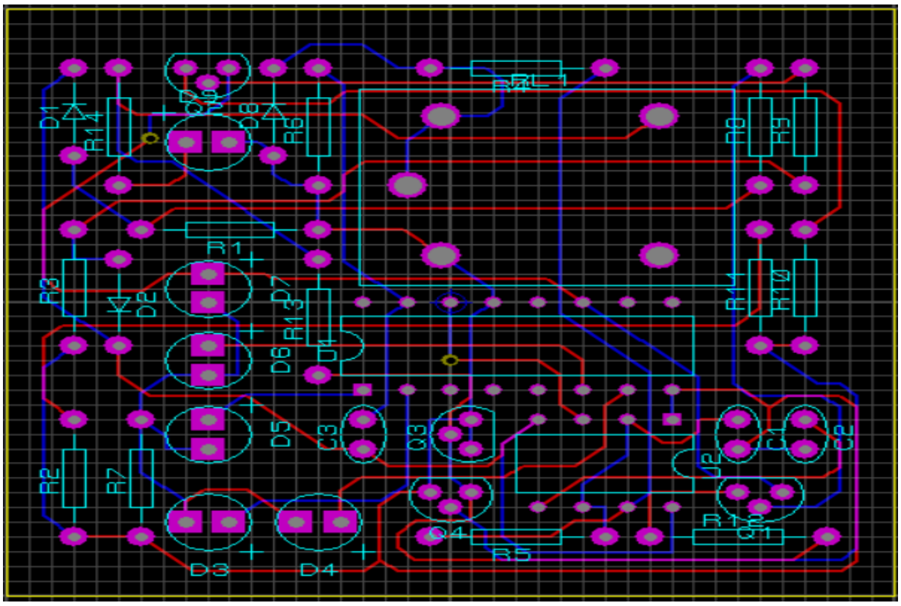


Figure 16:ARES PCB design

(c) 3 – D VIEW OF PCB

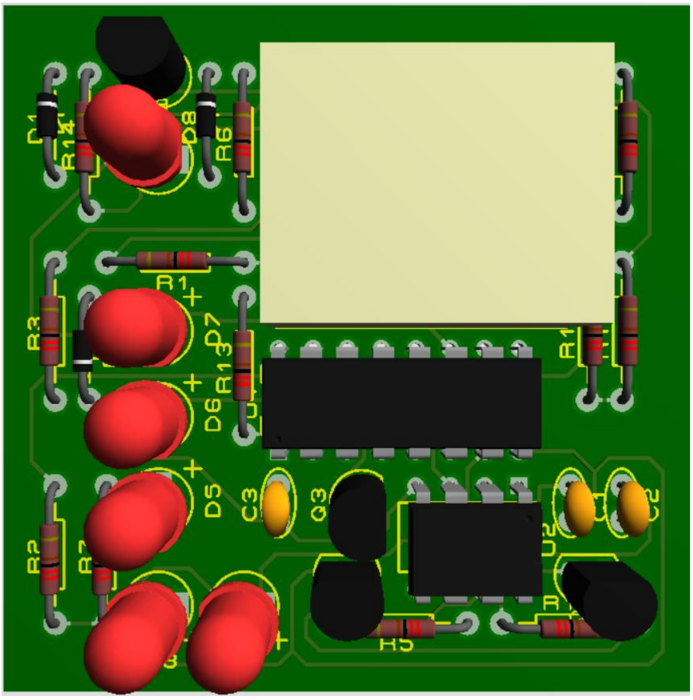


Figure 17:3-D view of PCB

CHAPTER 5: APPLICATIONS

5.1: APPLICATIONS

- Used to protect the home appliances from voltage fluctuations by connecting a power guard in the circuit.
- Even in the industries and other commercial purpose, this is used.
- In the industries and commercial purposes,the supply given in the circuit is AC and it may contain the changes in the circuit respectively.
- For example, the circuit will consist of the Triac. Time delay Circuit using Triac and 555 Timer is very useful when we want to activate or switch on, appliances or devices that works on alternating current (AC), after a preset time.
- The timer triggers a TRIAC that works as a solid state relay and can control a load of up to 4 amps, when connected to 110 VAC.
- The output of the timer 555 (pin 3) which is connected to the gate (G) of the TRIAC through the resistor, powers on the load.
- The 555 timer and its associated elements operate with 10 DC volts. This voltage is obtained using a transformerless voltage source implemented with a zener diode, a resistor, an electrolytic capacitor and a rectifier diode.
- The main application of the project is, it is used to protect the electronic device from being damaged due to unintentional switch on/off.

CONCLUSION:

1. First, implementing the circuit in the software is important. Here the software used is PROTEUS and ARES.
2. Drawing the circuit in the Schematic and then Simulating, implementing the circuit on the breadboard gives the idea that whether the connections are properly connected and desired output is getting or not.
3. When the PROTEUS circuit is working properly, then implement the ARES PCB design.
4. Some packages were not available in ARES, so I learnt to download them.
5. The 3-D view of circuit gives basic idea of implementing circuit on Breadboard and General-Purpose PCB.
6. After checking the circuit connections on the breadboard, implemented the circuit on general purpose board and learnt to solder the components used in the circuit.
7. Learnt, how to read datasheet of ICs, Transistors, etc.

REFERENCES:

1) https://electronicsforu.com/electronics-projects/accidental-switch-on-switch-off-protection-using-delay
2) https://electronicsforu.com/resources/learn-electronics/555-timer-working-specifications
3) https://www.elprocus.com/ic-4017-pin-configuration-application/
4) Electronics for You – vol. 1

DATASHEETS OF COMPONENTS

- **Datasheet for NE555 IC**

DESCRIPTION

The 555 monolithic timing circuit is a highly stable controller capable of producing accurate time delays, or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA.

FEATURES

- Turn-off time less than 2 µs
- Max. operating frequency greater than 500 kHz
- Timing from microseconds to hours
- Operates in both astable and monostable modes
- High output current
- Adjustable duty cycle
- TTL compatible
- Temperature stability of 0.005% per °C

APPLICATIONS

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation

PIN CONFIGURATION

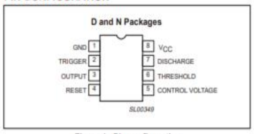


Figure 1. Pin configuration

BLOCK DIAGRAM

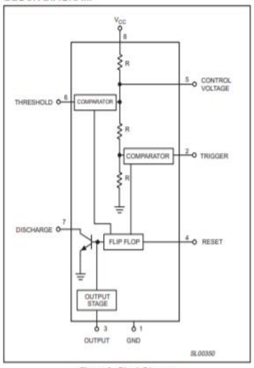


Figure 2. Block Diagram

EQUIVALENT SCHEMATIC

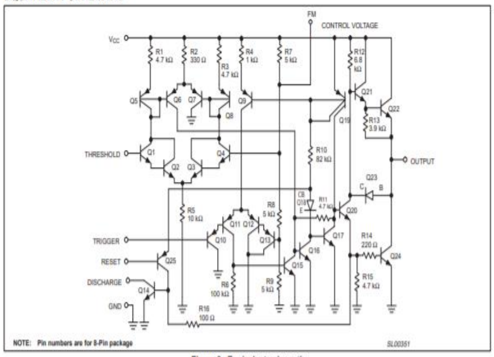


Figure 3. Equivalent schematic

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
8-Pin Plastic Small Outline (SO) Package	0 to +70 °C	NE555D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	0 to +70 °C	NE555N	SOT97-1
8-Pin Plastic Small Outline (SO) Package	–40 °C to +85 °C	SA555D	SOT96-1
8-Pin Plastic Dual In-Line Package (DIP)	–40 °C to +85 °C	SA555N	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	–55 °C to +125 °C	SE555CN	SOT97-1
8-Pin Plastic Dual In-Line Package (DIP)	–55 °C to +125 °C	SE555N	SOT97-1

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V_{CC}	Supply voltage SE555 NE555, SE555C, SA555	 +18 +16	 V V
P_D	Maximum allowable power dissipation[1]	600	mW
T_{amb}	Operating ambient temperature range NE555 SA555 SE555, SE555C	 0 to +70 –40 to +85 –55 to +125	 °C °C °C
T_{stg}	Storage temperature range	–65 to +150	°C
T_{SOLD}	Lead soldering temperature (10 sec max)	+230	°C

NOTE:

1. The junction temperature must be kept below 125 °C for the D package and below 150°C for the N package. At ambient temperatures above 25 °C, where this limit would be derated by the following factors:
   D package 160 °C/W
   N package 100 °C/W

DC AND AC ELECTRICAL CHARACTERISTICS

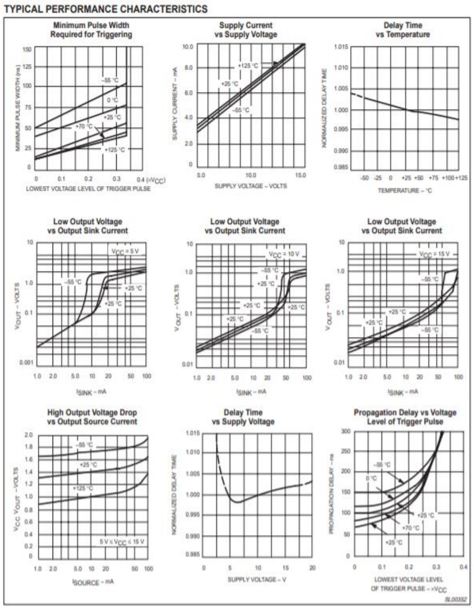
T_{amb} = 25 °C, V_{CC} = +5 V to +15 V unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE555 Min	SE555 Typ	SE555 Max	NE555/SA555/SE555C Min	NE555/SA555/SE555C Typ	NE555/SA555/SE555C Max	UNIT
V_{CC}	Supply voltage		4.5		18	4.5		16	V
I_{CC}	Supply current (low state)[1]	V_{CC} = 5 V, $R_L = \infty$ V_{CC} = 15 V, $R_L = \infty$		3 10	5 12		3 10	6 15	mA mA
 t_M $\Delta t_M/\Delta T$ $\Delta t_M/\Delta V_S$	Timing error (monostable) Initial accuracy[2] Drift with temperature Drift with supply voltage	R_A = 2 kΩ to 100 kΩ C=0.1 µF		 0.5 30 0.05	 2.0 100 0.2		 1.0 50 0.1	 3.0 150 0.5	 % ppm/°C %/V
 t_A $\Delta t_A/\Delta T$ $\Delta t_A/\Delta V_S$	Timing error (astable) Initial accuracy[2] Drift with temperature Drift with supply voltage	R_A, R_B = 1 kΩ to 100 kΩ C = 0.1 µF V_{CC} = 15 V		 4 0.15	 6 500 0.6		 5 0.3	 13 500 1	 % ppm/°C %/V
V_C	Control voltage level	V_{CC} = 15 V V_{CC} = 5 V	9.6 2.9	10.0 3.33	10.4 3.8	9.0 2.6	10.0 3.33	11.0 4.0	V V
V_{TH}	Threshold voltage	V_{CC} = 15 V V_{CC} = 5 V	9.4 2.7	10.0 3.33	10.6 4.0	8.8 2.4	10.0 3.33	11.2 4.2	V V
I_{TH}	Threshold current[3]			0.1	0.25		0.1	0.25	µA
V_{TRIG}	Trigger voltage	V_{CC} = 15 V V_{CC} = 5 V	4.8 1.45	5.0 1.67	5.2 1.9	4.5 1.1	5.0 1.67	5.6 2.2	V V
I_{TRIG}	Trigger current	V_{TRIG} = 0 V		0.5	0.9		0.5	2.0	µA
V_{RESET}	Reset voltage[4]	V_{CC} = 15 V, V_{TH} = 10.5 V	0.3		1.0	0.3		1.0	V
I_{RESET}	Reset current Reset current	V_{RESET} = 0.4 V V_{RESET} = 0 V		0.1 0.4	0.4 1.0		0.1 0.4	0.4 1.5	mA mA
V_{OL}	LOW-level output voltage	V_{CC} = 15 V I_{SINK} = 10 mA I_{SINK} = 50 mA I_{SINK} = 100 mA I_{SINK} = 200 mA		 0.1 0.4 2.0 2.5	 0.15 0.5 2.2		 0.1 0.4 2.0 2.5	 0.25 0.75 2.5	 V V V V
		V_{CC} = 5 V I_{SINK} = 8 mA I_{SINK} = 5 mA		 0.1 0.05	 0.25 0.2		 0.3 0.25	 0.4 0.35	 V V
V_{OH}	HIGH-level output voltage	V_{CC} = 15 V I_{SOURCE} = 200 mA I_{SOURCE} = 100 mA	 13.0	 12.5 13.3		 12.75	 12.5 13.3		 V V
		V_{CC} = 5 V I_{SOURCE} = 100 mA	 3.0	 3.3		 2.75	 3.3		 V
t_{OFF}	Turn-off time[5]	V_{RESET} = V_{CC}		0.5	2.0		0.5	2.0	µs
t_R	Rise time of output			100	200		100	300	ns
t_F	Fall time of output			100	200		100	300	ns
	Discharge leakage current			20	100		20	100	nA

NOTES:

1. Supply current when output high typically 1 mA less.
2. Tested at V_{CC} = 5 V and V_{CC} = 15 V.
3. This will determine the max value of R_A+R_B, for 15 V operation, the max total R = 10 MΩ, and for 5 V operation, the max. total R = 3.4 MΩ.
4. Specified with trigger input HIGH.
5. Time measured from a positive-going input pulse from 0 to $0.8 \times V_{CC}$ into the threshold to the drop from HIGH to LOW of the output. Trigger is tied to threshold.

TYPICAL PERFORMANCE CHARACTERISTICS



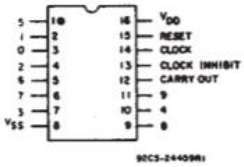
- # Datasheet for CD4017B

RECOMMENDED OPERATING CONDITIONS

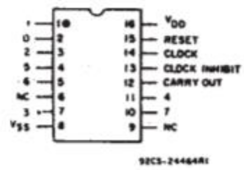
For maximum reliability, nominal operating conditions should be selected so that operation is always within the following ranges:

CHARACTERISTICS	V_{DD} (V)	LIMITS Min.	LIMITS Max.	UNITS
Supply-Voltage Range (For T_A = Full Package-Temperature Range)		3	18	V
Clock Input Frequency, f_{CL}	5 10 15	– – –	2.5 5 5.5	MHz
Clock Pulse Width, t_W	5 10 15	200 90 60	– – –	ns
Clock Rise & Fall Time, t_{rCL}, t_{fCL}	5 10 15	UNLIMITED*		
Clock Inhibit Setup Time, t_s	5 10 15	230 100 70	– – –	ns
Reset Pulse Width, t_{RW}	5 10 15	260 110 60	– – –	ns
Reset Removal Time, t_{rem}	5 10 15	400 280 150	– – –	ns

*Only if Pin 14 is used as the clock input. If Pin 13 is used as the clock input and Pin 14 is tied high (for advancing count on negative transition of the clock), rise and fall time should be ≤ 15 μs.

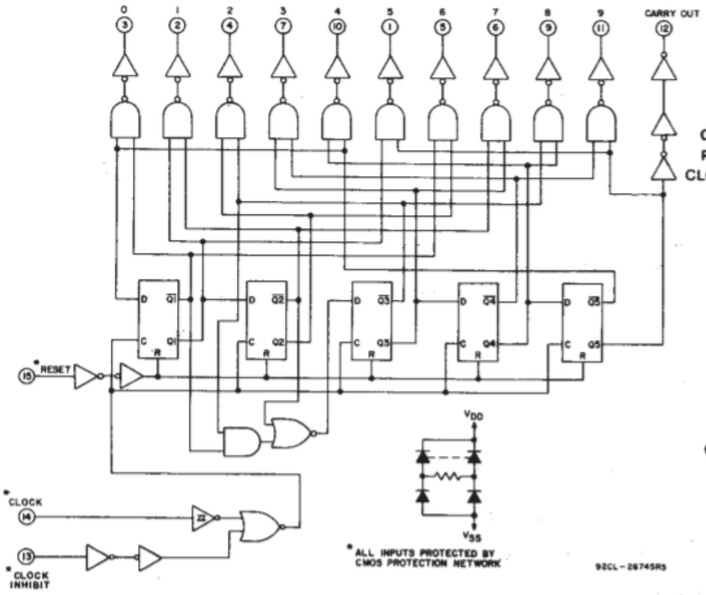


TOP VIEW
CD4017B
TERMINAL DIAGRAM



TOP VIEW
NC - no connection
CD4022B
TERMINAL DIAGRAM

CD4017B, CD4022B Types



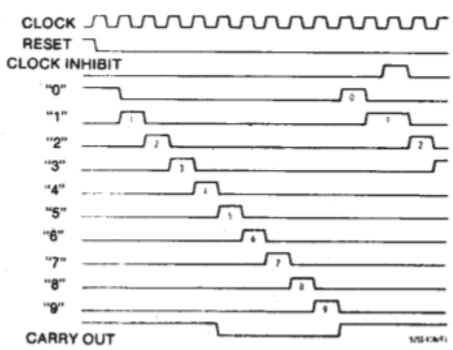
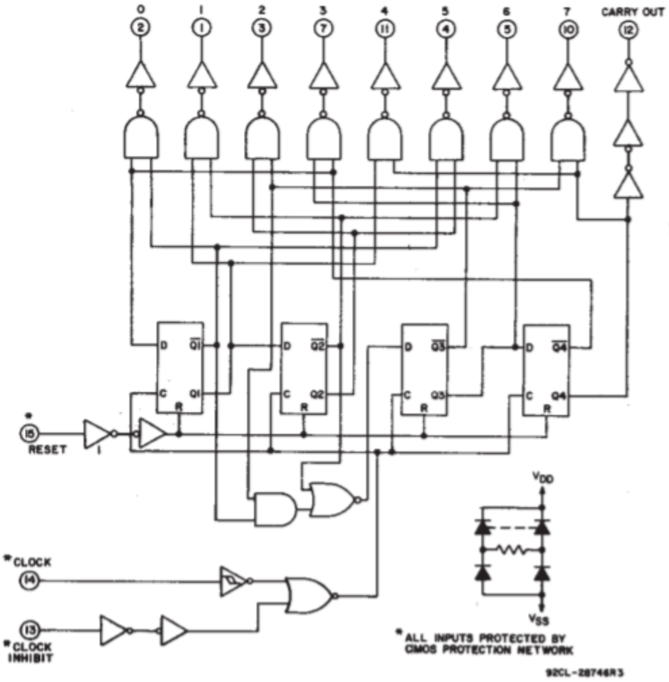


Fig. 2 – Timing diagram for CD4017B.



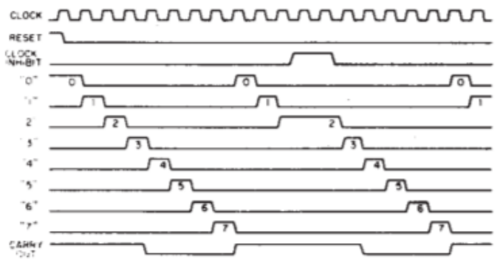


Fig. 4 – Timing diagram for CD4022B.

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS AT INDICATED TEMPERATURES (°C)							UNITS
								+25			
	V_O (V)	V_{IN} (V)	V_{DD} (V)	−55	−40	+85	+125	Min.	Typ.	Max.	
Quiescent Device Current, I_{DD} Max.	–	0,5	5	5	5	150	150	–	0.04	5	μA
	–	0,10	10	10	10	300	300	–	0.04	10	
	–	0,15	15	20	20	600	600	–	0.04	20	
	–	0,20	20	100	100	3000	3000	–	0.08	100	
Output Low (Sink) Current I_{OL} Min.	0.4	0,5	5	0.64	0.61	0.42	0.36	0.51	1	–	mA
	0.5	0,10	10	1.6	1.5	1.1	0.9	1.3	2.6	–	
	1.5	0,15	15	4.2	4	2.8	2.4	3.4	6.8	–	
Output High (Source) Current, I_{OH} Min.	4.6	0,5	5	−0.64	−0.61	−0.42	−0.36	−0.51	−1	–	
	2.5	0,5	5	−2	−1.8	−1.3	−1.15	−1.6	−3.2	–	
	9.5	0,10	10	−1.6	−1.5	−1.1	−0.9	−1.3	−2.6	–	
	13.5	0,15	15	−4.2	−4	−2.8	−2.4	−3.4	−6.8	–	
Output Voltage: Low-Level, V_{OL} Max.		0,5	5	0.05				–	0	0.05	V
		0,10	10	0.05				–	0	0.05	
	-	0,15	15	0.05				–	0	0.05	
Output Voltage: High-Level, V_{OH} Min.	-	0,5	5	4.95				4.95	5	–	
		0,10	10	9.95				9.95	10	–	
	–	0,15	15	14.95				14.95	15	–	
Input Low Voltage V_{IL} Max.	0.5,4.5	–	5	1.5				–	–	1.5	V
	1,9	–	10	3				–	–	3	
	1.5,13.5	–	15	4				–	–	4	
Input High Voltage, V_{IH} Min.	0.5,4.5	–	5	3.5				3.5	–	–	
	1,9	–	10	7				7	–	–	
	1.5,13.5	–	15	11				11	–	–	
Input Current I_{IN} Max.	–	0,18	18	±0.1	±0.1	±1	±1	–	$\pm 10^{-5}$	±0.1	μA

DYNAMIC ELECTRICAL CHARACTERISTICS

At T_A = 25°C, Input t_r, t_f = 20 ns, C_L = 50 pF, R_L = 200 kΩ

CHARACTERISTIC	CONDITIONS V_{DD} (V)	LIMITS Min.	Typ.	Max.	UNITS
CLOCKED OPERATION					
Propagation Delay Time, t_{PHL}, t_{PLH} Decode Out	5	–	325	650	ns
	10	–	135	270	ns
	15	–	85	170	ns
Carry Out	5	–	300	600	ns
	10	–	125	250	ns
	15	–	80	160	ns
Transition Time, t_{THL}, t_{TLH} Carry Out or Decode Out Line	5	–	100	200	ns
	10	–	50	100	ns
	15	–	40	80	ns
Maximum Clock Input Frequency, f_{CL}*	5	2.5	5	–	MHz
	10	5	10	–	MHz
	15	5.5	11	–	MHz
Minimum Clock Pulse Width, t_W	5	–	100	200	ns
	10	–	45	90	ns
	15	–	30	60	ns
Clock Rise or Fall Time, t_rCL, t_fCL	5, 10, 15	UNLIMITED			
Minimum Clock Inhibit to Clock Setup Time, t_s	5	–	115	230	ns
	10	–	50	100	ns
	15	–	35	70	ns
Input Capacitance, C_{IN}	Any Input	–	5	–	pF
RESET OPERATION					
Propagation Delay Time, t_{PHL}, t_{PLH} Carry Out or Decode Out Lines	5	–	265	530	ns
	10	–	115	230	ns
	15	–	85	170	ns
Minimum Reset Pulse Width, t_W	5	–	130	260	ns
	10	–	55	110	ns
	15	–	30	60	ns
Minimum Reset Removal Time	5	–	200	400	ns
	10	–	140	280	ns
	15	–	75	150	ns

• Datasheet for Transistor BC547

General description

NPN general-purpose transistors in small plastic packages.

Table 1. Product overview

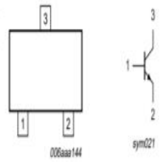
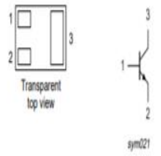
Type number[1]	Package			PNP complement
	NXP	JEITA	JEDEC	
BC847	SOT23	-	TO-236AB	BC857
BC847A				BC857A
BC847B				BC857B
BC847B/DG				-
BC847C				BC857C
BC847W	SOT323	SC-70	-	BC857W
BC847AW				BC857AW
BC847BW				BC857BW
BC847BW/DG				-
BC847CW				BC857CW
BC847T	SOT416	SC-75	-	BC857T
BC847AT				BC857AT
BC847AT/DG				-
BC847BT				BC857BT
BC847CT				BC857CT
BC847AM	SOT883	SC-101	-	BC857AM
BC847BM				BC857BM
BC847CM				BC857CM
BC547[2]	SOT54	SC-43A	TO-92	BC557[2]
BC547B[2]				BC557B[2]
BC547C[2]				BC557C[2]

[1] /DG: halogen-free

[2] Also available in SOT54A and SOT54 variant packages (see Section 2).

Pinning information

Table 3. Pinning

Pin	Description	Simplified outline	Graphic symbol
SOT23, SOT323, SOT416			
1	base		
2	emitter		
3	collector		
SOT883			
1	base		
2	emitter		
3	collector		

Limiting values

Table 6. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CBO}	collector-base voltage	open emitter		-	50	V
V_{CEO}	collector-emitter voltage	open base		-	45	V
V_{EBO}	emitter-base voltage	open collector		-	6	V
I_C	collector current			-	100	mA
I_{CM}	peak collector current	single pulse; $t_p \leq 1$ ms		-	200	mA
I_{BM}	peak base current	single pulse; $t_p \leq 1$ ms		-	100	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C				
	SOT23		[1]	-	250	mW
	SOT323		[1]	-	200	mW
	SOT416		[1]	-	150	mW
	SOT883		[2][3]	-	250	mW
	SOT54		[1]	-	500	mW
T_j	junction temperature			-	150	°C
T_{amb}	ambient temperature			−65	+150	°C
T_{stg}	storage temperature			−65	+150	°C

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

[2] Reflow soldering is the only recommended soldering method.

[3] Device mounted on an FR4 PCB with 60 μm copper strip line, standard footprint.

Table 8. Characteristics

T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{CBO}	collector-base cut-off current	V_{CB} = 30 V; I_E = 0 A		-	-	15	nA
		V_{CB} = 30 V; I_E = 0 A; T_j = 150 °C		-	-	5	μA
I_{EBO}	emitter-base cut-off current	V_{EB} = 5 V; I_C = 0 A		-	-	100	nA
h_{FE}	DC current gain						
	h_{FE} group A	V_{CE} = 5 V; I_C = 10 μA		-	90	-	
	h_{FE} group B	V_{CE} = 5 V; I_C = 10 μA		-	150	-	
	h_{FE} group C	V_{CE} = 5 V; I_C = 10 μA		-	270	-	
	DC current gain	V_{CE} = 5 V; I_C = 2 mA		110	-	800	
	h_{FE} group A	V_{CE} = 5 V; I_C = 2 mA		110	180	220	
	h_{FE} group B	V_{CE} = 5 V; I_C = 2 mA		200	290	450	
	h_{FE} group C	V_{CE} = 5 V; I_C = 2 mA		420	520	800	
V_{CEsat}	collector-emitter saturation voltage	I_C = 10 mA; I_B = 0.5 mA		-	90	200	mV
		I_C = 100 mA; I_B = 5 mA	[1]	-	200	400	mV
V_{BEsat}	base-emitter saturation voltage	I_C = 10 mA; I_B = 0.5 mA	[2]	-	700	-	mV
		I_C = 100 mA; I_B = 5 mA	[2]	-	900	-	mV
V_{BE}	base-emitter voltage	I_C = 2 mA; V_{CE} = 5 V	[2]	580	660	700	mV
		I_C = 10 mA; V_{CE} = 5 V		-	-	770	mV
C_c	collector capacitance	$I_E = i_e$ = 0 A; V_{CB} = 10 V; f = 1 MHz		-	-	1.5	pF
C_e	emitter capacitance	$I_C = i_c$ = 0 A; V_{EB} = 0.5 V; f = 1 MHz		-	11	-	pF
f_T	transition frequency	I_C = 10 mA; V_{CE} = 5 V; f = 100 MHz		100	-	-	MHz
NF	noise figure	I_C = 200 μA; V_{CE} = 5 V; R_S = 2 kΩ; f = 1 kHz; B = 200 Hz		-	2	10	dB

[1] Pulse test: $t_p \leq 300$ μs; $\delta \leq 0.02$.

[2] V_{BE} decreases by approximately 2 mV/K with increasing temperature.

• Datasheet for Diode 1N4007

FEATURES

- Low cost
- Low leakage
- Low forward voltage drop
- High current capacity
- Easily cleaned with freon, alcohol, chlorothene and similar solvents
- **RoHS COMPLIANT**

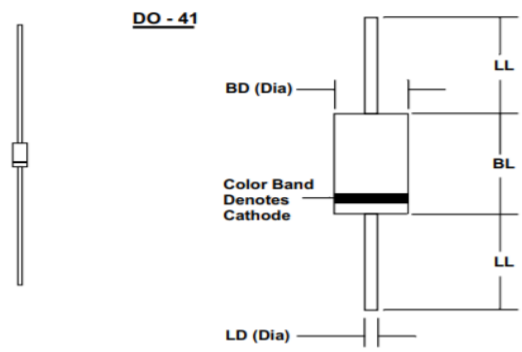
MECHANICAL DATA

- Case: JEDEC DO-41, molded epoxy (U/L Flammability Rating 94V-0)
- Terminals: Plated axial leads
- Soldering: Per MIL-STD 202 Method 208 guaranteed
- Polarity: Color band denotes cathode
- Mounting Position: Any
- Weight: 0.012 Ounces (0.34 Grams)

MECHANICAL SPECIFICATION

ACTUAL SIZE OF DO-41 PACKAGE

SERIES 1N4001 - 1N4007



Sym	Minimum		Maximum	
	In	mm	In	mm
BL	0.160	4.1	0.205	5.2
BD	0.103	2.6	0.107	2.7
LL	1.00	25.4		
LD	0.028	0.71	0.034	0.86

MAXIMUM RATINGS & ELECTRICAL CHARACTERISTICS

Ratings at 25 °C ambient temperature unless otherwise specified.
Single phase, half wave, 60Hz, resistive or inductive load.
For capacitive loads, derate current by 20%.

PARAMETER (TEST CONDITIONS)	SYMBOL	RATINGS							UNITS
Series Number		1N4001	1N4002	1N4003	1N4004	1N4005	1N4006	1N4007	
Maximum DC Blocking Voltage	V_{RM}	50	100	200	400	600	800	1000	VOLTS
Maximum RMS Voltage	V_{RMS}	35	70	140	280	420	560	700	
Maximum Peak Recurrent Reverse Voltage	V_{RRM}	50	100	200	400	600	800	1000	
Average Forward Rectified Current @ T_A = 75 °C (Lead length = 0.375 in. (9.5 mm))	I_O	1							AMPS
Peak Forward Surge Current (8.3 mSec single half sine wave superimposed on rated load)	I_{FSM}	50							
Maximum Forward Voltage at 1 Amp DC	V_{FM}	1							VOLTS
Maximum Full Cycle Reverse Current @ T_L = 75 °C (Note 1)	$I_{RM(AV)}$	30							μA
Maximum Average DC Reverse Current At Rated DC Blocking Voltage @ T_A = 25°C / @ T_A = 100°C	I_{RM}	5 / 50							
Typical Thermal Resistance, Junction to Ambient (Note 1)	$R_{\theta JA}$	30							°C/W
Typical Junction Capacitance (Note 2)	C_J	26							pF
Operating and Storage Temperature Range	T_J, T_{STG}	-65 to +175							°C

NOTES: (1) Lead length = 0.375 in. (9.5 mm)
(2) Measured at 1 MHz & applied reverse voltage of 4 volts