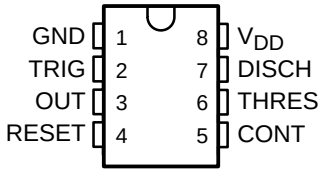
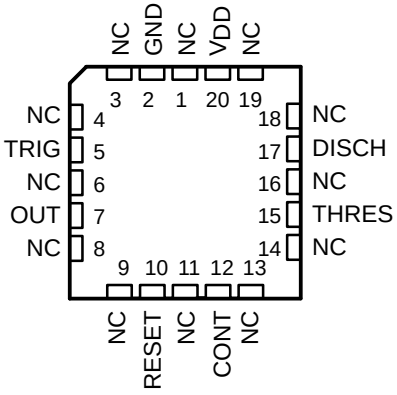
- **Very Low Power Consumption**
  1 mW Typ at V_{DD} = 5 V
- **Capable of Operation in Astable Mode**
- **CMOS Output Capable of Swinging Rail to Rail**
- **High Output-Current Capability**
  Sink 100 mA Typ
  Source 10 mA Typ
- **Output Fully Compatible With CMOS, TTL, and MOS**
- **Low Supply Current Reduces Spikes During Output Transitions**
- **Single-Supply Operation From 2 V to 15 V**
- **Functionally Interchangeable With the NE555; Has Same Pinout**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883C, Method 3015.2**

D, DB, JG, P, OR PW PACKAGE
(TOP VIEW)



FK PACKAGE
(TOP VIEW)



NC – No internal connection

description

The TLC555 is a monolithic timing circuit fabricated using the TI LinCMOS™ process. The timer is fully compatible with CMOS, TTL, and MOS logic and operates at frequencies up to 2 MHz. Because of its high input impedance, this device uses smaller timing capacitors than those used by the NE555. As a result, more accurate time delays and oscillations are possible. Power consumption is low across the full range of power supply voltage.

Like the NE555, the TLC555 has a trigger level equal to approximately one-third of the supply voltage and a threshold level equal to approximately two-thirds of the supply voltage. These levels can be altered by use of the control voltage terminal (CONT). When the trigger input (TRIG) falls below the trigger level, the flip-flop is set and the output goes high. If TRIG is above the trigger level and the threshold input (THRES) is above the threshold level, the flip-flop is reset and the output is low. The reset input (RESET) can override all other inputs and can be used to initiate a new timing cycle. If RESET is low, the flip-flop is reset and the output is low. Whenever the output is low, a low-impedance path is provided between the discharge terminal (DISCH) and GND. All unused inputs should be tied to an appropriate logic level to prevent false triggering.

While the CMOS output is capable of sinking over 100 mA and sourcing over 10 mA, the TLC555 exhibits greatly reduced supply-current spikes during output transitions. This minimizes the need for the large decoupling capacitors required by the NE555.

The TLC555C is characterized for operation from 0°C to 70°C. The TLC555I is characterized for operation from – 40°C to 85°C. The TLC555M is characterized for operation over the full military temperature range of – 55°C to 125°C.

This device contains circuits to protect its inputs and outputs against damage due to high static voltages or electrostatic fields. These circuits have been qualified to protect this device against electrostatic discharges (ESD) of up to 2 kV according to MIL-STD-883C, Method 3015; however, it is advised that precautions be taken to avoid application of any voltage higher than maximum-rated voltages to these high-impedance circuits. During storage or handling, the device leads should be shorted together or the device should be placed in conductive foam. In a circuit, unused inputs should always be connected to an appropriated logic voltage level, preferably either supply voltage or ground. Specific guidelines for handling devices of this type are contained in the publication *Guidelines for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices and Assemblies* available from Texas Instruments.

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AVAILABLE OPTIONS

PACKAGED DEVICES								CHIP FORM (Y)
T_A	V_{DD} RANGE	SMALL OUTLINE (D)	SSOP (DB)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP (PW)	
0°C to 70°C	2 V to 15 V	TLC555CD	TLC555CDBLE	—	—	TLC555CP	TLC555CPWLE	TLC555Y
– 40°C to 85°C	3 V to 15 V	TLC555ID	—	—	—	TLC555IP	—	
– 55°C to 125°C	5 V to 15 V	TLC555MD	—	TLC555MFK	TLC555MJG	TLC555MP	—	

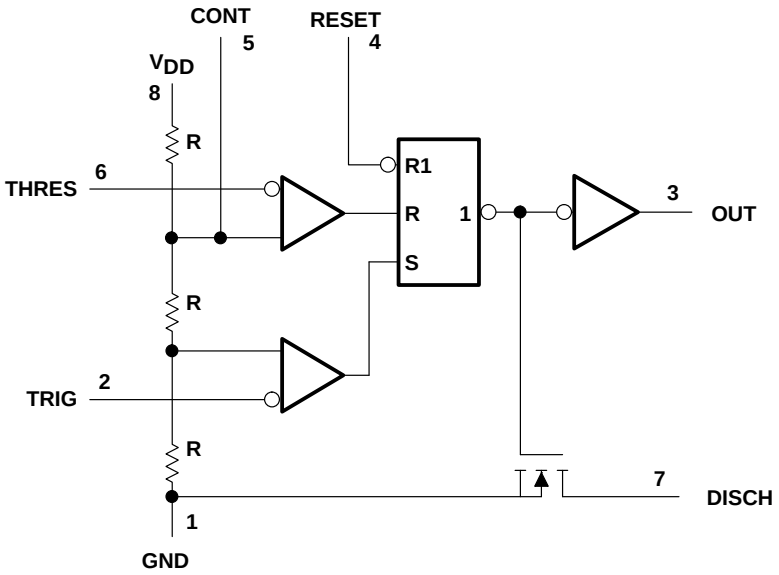
The D package is available taped and reeled. Add the R suffix to device type (e.g., TLC555CDR). The DB and PW packages are only available left-end taped and reeled (indicated by the LE suffix on the device type; e.g., TLC555CDBLE). Chips are tested at 25°C.

FUNCTION TABLE

RESET VOLTAGE†	TRIGGER VOLTAGE†	THRESHOLD VOLTAGE†	OUTPUT	DISCHARGE SWITCH
<MIN	Irrelevant	Irrelevant	L	On
>MAX	<MIN	Irrelevant	H	Off
>MAX	>MAX	>MAX	L	On
>MAX	>MAX	<MIN	As previously established	

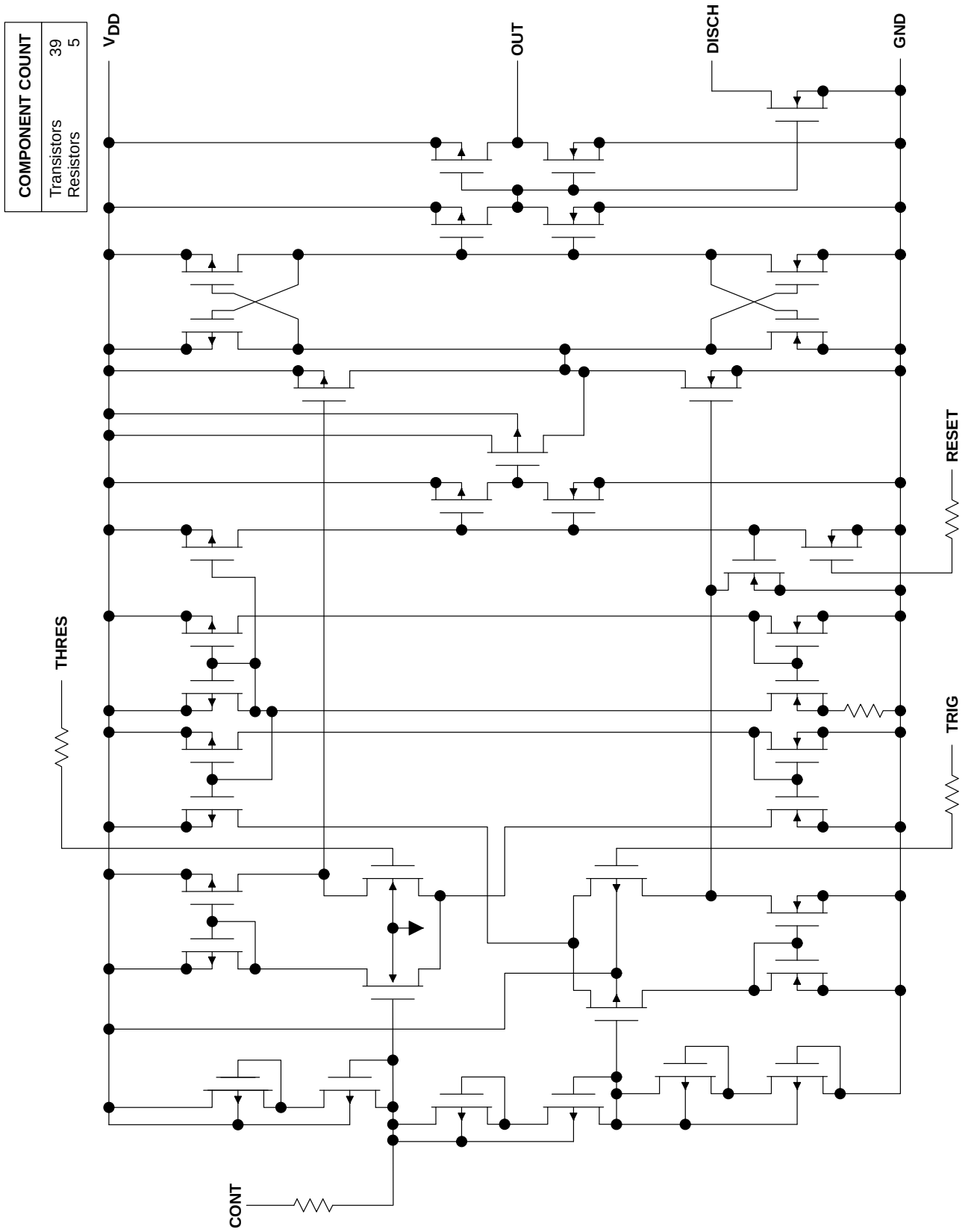
† For conditions shown as MIN or MAX, use the appropriate value specified under electrical characteristics.

functional block diagram



Pin numbers are for all packages except the FK package.
RESET can override TRIG, which can override THRES.

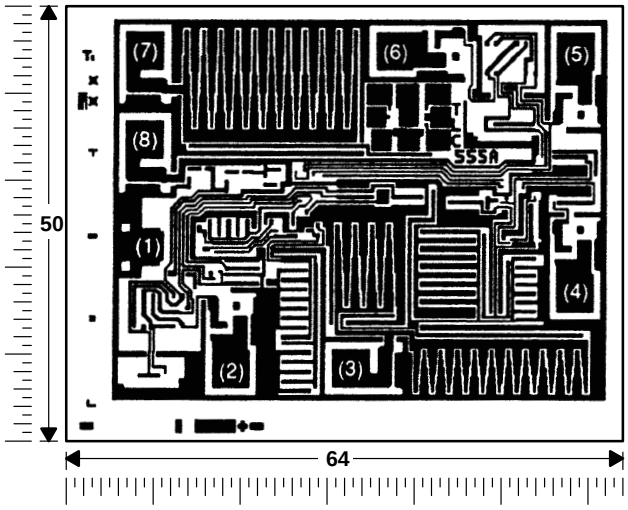
equivalent schematic (each channel)

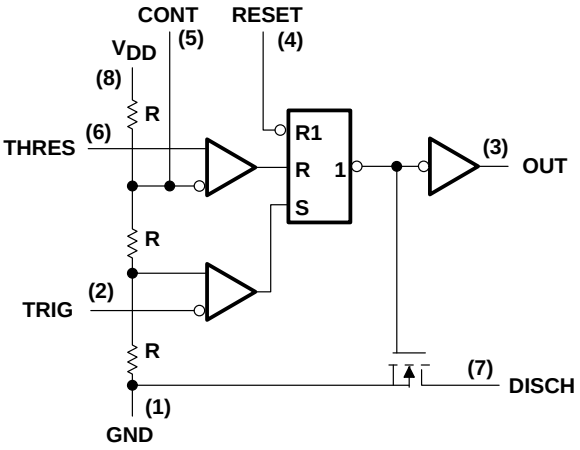


chip information

This chip, when properly assembled, displays characteristics similar to the TLC555. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





RESET can override TRIG, which can override THRES.

CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ± 10%.

ALL DIMENSIONS ARE IN MILS.

PIN (1) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{DD} (see Note 1) . . . . . 18 V
Input voltage range, V_I (any input) . . . . . −0.3 to V_{DD}
Sink current, discharge or output . . . . . 150 mA
Source current, output, I_O . . . . . 15 mA
Continuous total power dissipation . . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: C-suffix . . . . . 0°C to 70°C
I-suffix . . . . . −40°C to 85°C
M-suffix . . . . . −55°C to 125°C
Storage temperature range . . . . . −65°C to 150°C
Case temperature for 60 seconds: FK package . . . . . 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package . . . . . 300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, DB, P, or PW package . . . . . 260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to network GND.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
DB or PW	525 mW	4.2 mW/°C	336 mW	273 mW	105 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V_{DD}		2	15	V
Operating free-air temperature range, T_A	TLC555C	0	70	°C
	TLC555I	−40	85	
	TLC555M	−55	125	

electrical characteristics at specified free-air temperature, V_{DD} = 2 V for TLC555C, V_{DD} = 3 V for TLC555I

PARAMETER		TEST CONDITIONS	T_A†	TLC555C			TLC555I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IT}	Threshold voltage		25°C	0.95	1.33	1.65	1.6		2.4	V
			Full range	0.85		1.75	1.5		2.5	
I_{IT}	Threshold current		25°C		10			10		pA
			MAX		75			150		
$V_{I(TRIG)}$	Trigger voltage		25°C	0.4	0.67	0.95	0.71	1	1.29	V
			Full range	0.3		1.05	0.61		1.39	
$I_{I(TRIG)}$	Trigger current		25°C		10			10		pA
			MAX		75			150		
$V_{I(RESET)}$	Reset voltage		25°C	0.4	1.1	1.5	0.4	1.1	1.5	V
			Full range	0.3		2	0.3		1.8	
$I_{I(RESET)}$	Reset current		25°C		10			10		pA
			MAX		75			150		
	Control voltage (open circuit) as a percentage of supply voltage		MAX		66.7%			66.7%		
	Discharge switch on1–stage voltage	I_{OL} = 1 mA	25°C		0.03	0.2		0.03	0.2	V
			Full range			0.25			0.375	
	Discharge switch off-stage current		25°C		0.1			0.1		nA
			MAX		0.5			120		
V_{OH}	High-level output voltage	I_{OH} = –300 µA	25°C	1.5	1.9		1.5	1.9		V
			Full range	1.5			2.5			
V_{OL}	Low-level output voltage	I_{OL} = 1 mA	25°C		0.07	0.3		0.07	0.3	V
			Full range			0.35			0.4	
I_{DD}	Supply current	See Note 2	25°C			250			250	µA
			Full range			400			500	

† Full range is 0°C to 70°C for the TLC555C and – 40°C to 85°C for the TLC555I. For conditions shown as MAX, use the appropriate value specified in the recommended operating conditions table.

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or to TRIG.

electrical characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS	T_A†	TLC555C			TLC555I			TLC555M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IT}	Threshold voltage		25°C	2.8	3.3	3.8	2.8	3.3	3.8	2.8	3.3	3.8	V
			Full range	2.7		3.9	2.7		3.9	2.7		3.9	
I_{IT}	Threshold current		25°C		10			10			10		pA
			MAX		75			150			5000		
$V_{I(TRIG)}$	Trigger voltage		25°C	1.36	1.66	1.96	1.36	1.66	1.96	1.36	1.66	1.96	V
			Full range	1.26		2.06	1.26		2.06	1.26		2.06	
$I_{I(TRIG)}$	Trigger current		25°C		10			10			10		pA
			MAX		75			150			5000		
$V_{I(RESET)}$	Reset voltage		25°C	0.4	1.1	1.5	0.4	1.1	1.5	0.4	1.1	1.5	V
			Full range	0.3		1.8	0.3		1.8	0.3		1.8	
$I_{I(RESET)}$	Reset current		25°C		10			10			10		pA
			MAX		75			150			5000		
	Control voltage (open circuit) as a percentage of supply voltage		MAX		66.7%			66.7%			66.7%		
	Discharge switch on-state voltage	I_{OL} = 10 mA	25°C		0.14	0.5		0.14	0.5		0.14	0.5	V
			Full range			0.6			0.6			0.6	
	Discharge switch off-state current		25°C		0.1			0.1			0.1		nA
			MAX		0.5			120			120		
V_{OH}	High-level output voltage	I_{OH} = – 1 mA	25°C	4.1	4.8		4.1	4.8		4.1	4.8		V
			Full range	4.1			4.1			4.1			
V_{OL}	Low-level output voltage	I_{OL} = 8 mA	25°C		0.21	0.4		0.21	0.4		0.21	0.4	V
			Full range			0.5			0.5			0.6	
		I_{OL} = 5 mA	25°C		0.13	0.3		0.13	0.3		0.13	0.3	
			Full range			0.4			0.4			0.45	
		I_{OL} = 3.2 mA	25°C		0.08	0.3		0.08	0.3		0.08	0.3	
			Full range			0.35			0.35			0.4	
I_{DD}	Supply current	See Note 2	25°C		170	350		170	350		170	350	µA
			Full range			500			600			700	

† Full range is 0°C to 70°C the for TLC555C, – 40°C to 85°C for the TLC555I, and – 55°C to 125°C for the TLC555M. For conditions shown as MAX, use the appropriate value specified in the recommended operating conditions table.

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or TRIG.

electrical characteristics at specified free-air temperature, V_{DD} = 15 V

PARAMETER		TEST CONDITIONS	T_A†	TLC555C			TLC555I			TLC555M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IT}	Threshold voltage		25°C	9.45	10	10.55	9.45	10	10.55	9.45	10	10.55	V
			Full range	9.35		10.65	9.35		10.65	9.35		10.65	
I_{IT}	Threshold current		25°C		10			10			10		pA
			MAX		75			150			5000		
$V_{I(TRIG)}$	Trigger voltage		25°C	4.65	5	5.35	4.65	5	5.35	4.65	5	5.35	V
			Full range	4.55		5.45	4.55		5.45	4.55		5.45	
$I_{I(TRIG)}$	Trigger current		25°C		10			10			10		pA
			MAX		75			150			5000		
$V_{I(RESET)}$	Reset voltage		25°C	0.4	1.1	1.5	0.4	1.1	1.5	0.4	1.1	1.5	V
			Full range	0.3		1.8	0.3		1.8	0.3		1.8	
$I_{I(RESET)}$	Reset current		25°C		10			10			10		pA
			MAX		75			150			5000		
	Control voltage (open circuit) as a percentage of supply voltage		MAX		66.7%			66.7%			66.7%		
	Discharge switch on-state voltage	I_{OL} = 100 mA	25°C		0.77	1.7		0.77	1.7		0.77	1.7	V
			Full range			1.8			1.8			1.8	
	Discharge switch off-state current		25°C		0.1			0.1			0.1		nA
			MAX		0.5			120			120		
V_{OH}	High-level output voltage	I_{OH} = – 10 mA	25°C	12.5	14.2		12.5	14.2		12.5	14.2		V
			Full range	12.5			12.5			12.5			
		I_{OH} = – 5 mA	25°C	13.5	14.6		13.5	14.6		13.5	14.6		
			Full range	13.5			13.5			13.5			
		I_{OH} = – 1 mA	25°C	14.2	14.9		14.2	14.9		14.2	14.9		
			Full range	14.2			14.2			14.2			
V_{OL}	Low-level output voltage	I_{OL} = 100 mA	25°C		1.28	3.2		1.28	3.2		1.28	3.2	V
			Full range			3.6			3.7			3.8	
		I_{OL} = 50 mA	25°C		0.63	1		0.63	1		0.63	1	
			Full range			1.3			1.4			1.5	
		I_{OL} = 10 mA	25°C		0.12	0.3		0.12	0.3		0.12	0.3	
			Full range			0.4			0.4			0.45	
I_{DD}	Supply current	See Note 2	25°C		360	600		360	600		360	600	µA
			Full range			800			900			1000	

† Full range is 0°C to 70°C for TLC555C, – 40°C to 85°C for TLC555I, and – 55°C to 125°C for TLC555M. For conditions shown as MAX, use the appropriate value specified in the recommended operating conditions table.

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or TRIG.

operating characteristics, V_{DD} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Initial error of timing interval‡	V_{DD} = 5 V to 15 V, R_A = R_B = 1 kΩ to 100 kΩ, C_T = 0.1 µF, See Note 3		1%	3%	
	Supply voltage sensistivity of timing interval			0.1	0.5	%/V
t_r	Output pulse rise time	R_L = 10 MΩ, C_L = 10 pF		20	75	ns
t_f	Output pulse fall time			15	60	
f_{max}	Maximum frequency in astable mode	R_A = 470 Ω, R_B = 200 Ω, C_T = 200 pF, See Note 3	1.2	2.1		MHz

‡ Timing interval error is defined as the difference between the measured value and the average value of a random sample from each process run.

NOTE 3: R_A, R_B, and C_T are as defined in Figure 1.

electrical characteristics at V_{DD} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IT}	Threshold voltage		2.8	3.3	3.8	V
I_{IT}	Threshold current			10		pA
$V_{I(TRIG)}$	Trigger voltage		1.36	1.66	1.96	V
$I_{I(TRIG)}$	Trigger current			10		pA
$V_{I(RESET)}$	Reset voltage		0.4	1.1	1.5	V
$I_{I(RESET)}$	Reset current			10		pA
	Control voltage (open circuit) as a percentage of supply voltage			66.7%		
	Discharge switch on-state voltage	I_{OL} = 10 mA		0.14	0.5	V
	Discharge switch off-state current			0.1		nA
V_{OH}	High-level output voltage	I_{OH} = – 1 mA	4.1	4.8		V
V_{OL}	Low-level output voltage	I_{OL} = 8 mA		0.21	0.4	V
		I_{OL} = 5 mA		0.13	0.3	
		I_{OL} = 3.2 mA		0.08	0.3	
I_{DD}	Supply current	See Note 2		170	350	µA

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or TRIG.

TYPICAL CHARACTERISTICS

DISCHARGE SWITCH ON-STATE RESISTANCE vs FREE-AIR TEMPERATURE

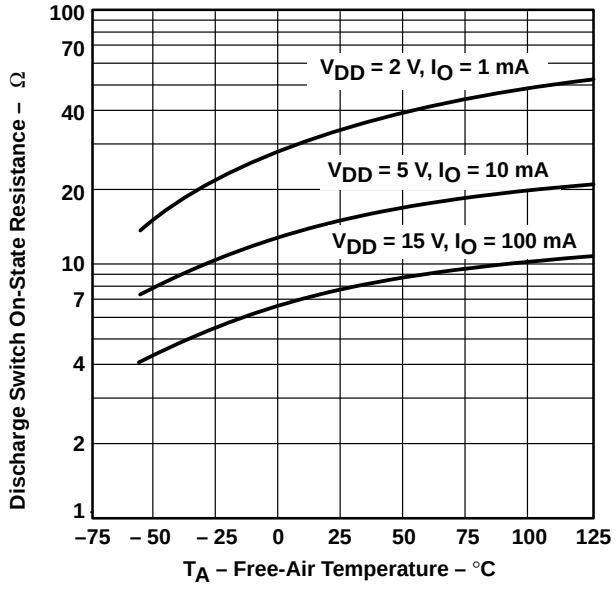
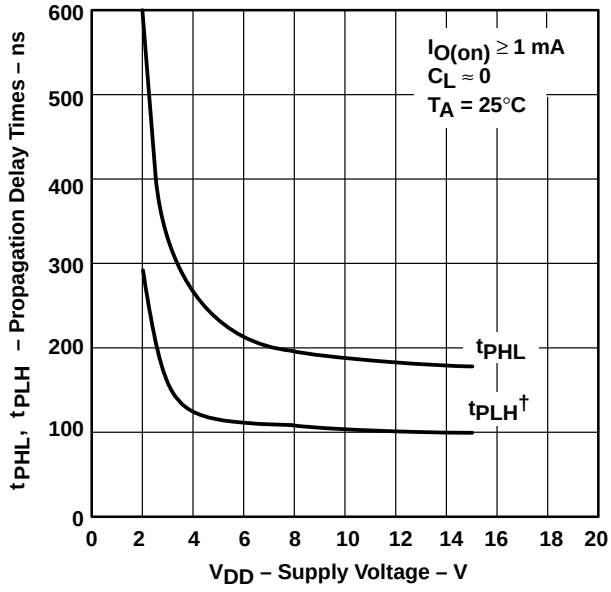


Figure 1

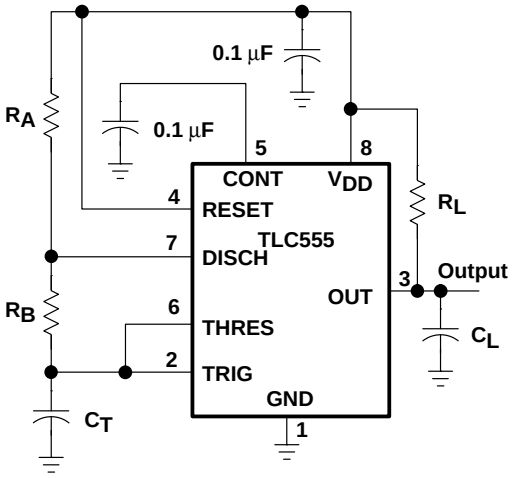
PROPAGATION DELAY TIMES TO DISCHARGE OUTPUT FROM TRIGGER AND THRESHOLD SHORTED TOGETHER vs SUPPLY VOLTAGE



† The effects of the load resistance on these values must be taken into account separately.

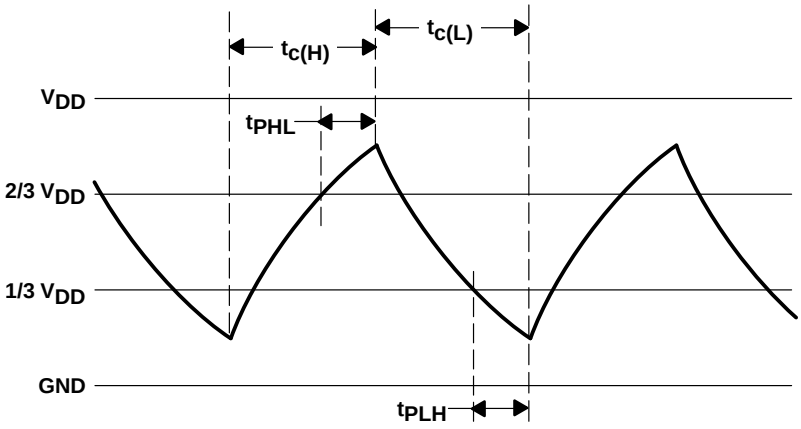
Figure 2

APPLICATION INFORMATION



Pin numbers shown are for all packages except the FK package.

CIRCUIT



TRIGGER AND THRESHOLD VOLTAGE WAVEFORM

Figure 3. Astable Operation

Connecting TRIG to THRES, as shown in Figure 3, causes the timer to run as a multivibrator. The capacitor C_T charges through R_A and R_B to the trigger voltage level (approximately 0.67 V_{DD}) and then discharges through R_B only to the value of the threshold voltage level (approximately 0.33 V_{DD}). The output is high during the charging cycle ($t_{c(H)}$) and low during the discharge cycle ($t_{c(L)}$). The duty cycle is controlled by the values of R_A, R_B, and C_T as shown in the equations below.

$$t_{c(H)} \approx C_T (R_A + R_B) \ln 2 \quad (\ln 2 = 0.693)$$

$$t_{c(L)} \approx C_T R_B \ln 2$$

$$\text{Period} = t_{c(H)} + t_{c(L)} \approx C_T (R_A + 2R_B) \ln 2$$

$$\text{Output driver duty cycle} = \frac{t_{c(L)}}{t_{c(H)} + t_{c(L)}} \approx 1 - \frac{R_B}{R_A + 2R_B}$$

$$\text{Output waveform duty cycle} = \frac{t_{c(H)}}{t_{c(H)} + t_{c(L)}} \approx \frac{R_B}{R_A + 2R_B}$$

The 0.1-μF capacitor at CONT in Figure 3 decreases the period by about 10%.

The formulas shown above do not allow for any propagation delay times from the TRIG and THRES inputs to DISCH. These delay times add directly to the period and create differences between calculated and actual values that increase with frequency. In addition, the internal on-state resistance r_{on} during discharge adds to R_B to provide another source of timing error in the calculation when R_B is very low or r_{on} is very high.

APPLICATION INFORMATION

The equations below provide better agreement with measured values.

$$t_{c(H)} = C_T (R_A + R_B) \ln \left[3 - \exp\left(\frac{-t_{PLH}}{C_T (R_B + r_{on})} \right) \right] + t_{PHL}$$

$$t_{c(L)} = C_T (R_B + r_{on}) \ln \left[3 - \exp\left(\frac{-t_{PHL}}{C_T (R_A + R_B)} \right) \right] + t_{PLH}$$

These equations and those given earlier are similar in that a time constant is multiplied by the logarithm of a number or function. The limit values of the logarithmic terms must be between In 2 at low frequencies and In 3 at extremely high frequencies. For a duty cycle close to 50%, an appropriate constant for the logarithmic terms can be substituted with good results. Duty cycles less than 50% $\frac{t_{c(H)}}{t_{c(H)} + t_{c(L)}}$ require that $\frac{t_{c(H)}}{t_{c(L)}} < 1$ and possibly $R_A \leq r_{on}$. These conditions can be difficult to obtain.

In monostable applications, the trip point on TRIG can be set by a voltage applied to CONT. An input voltage between 10% and 80% of the supply voltage from a resistor divider with at least 500-µA bias provides good results.

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