

- **Very Low Power Consumption . . . 2 mW**  
Typ at  $V_{DD} = 5\text{ V}$
- **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 NE556; Has Same Pinout**

## description

The TLC556 series are monolithic timing circuits fabricated using the TI LinCMOS™ process, which provides full compatibility with CMOS, TTL, and MOS logic and operates at frequencies up to 2 MHz. Accurate time delays and oscillations are possible with smaller, less-expensive timing capacitors than the NE556 because of the high input impedance. Power consumption is low across the full range of power supply voltages.

Like the NE556, the TLC556 has a trigger level approximately one-third of the supply voltage and a threshold level approximately two-thirds of the supply voltage. These levels can be altered by use of the control voltage terminal. When the trigger input falls below the trigger level, the flip-flop is set and the output goes high. If the trigger input is above the trigger level and the threshold input is above the threshold level, the flip-flop is reset and the output is low. The reset input can override all other inputs and can be used to initiate a new timing cycle. If the reset input 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 and ground.

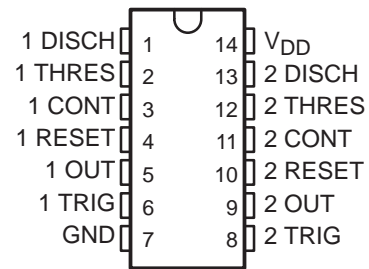
While the CMOS output is capable of sinking over 100 mA and sourcing over 10 mA, the TLC556 exhibits greatly reduced supply-current spikes during output transitions. This minimizes the need for the large decoupling capacitors required by the NE556.

These devices have internal electrostatic-discharge (ESD) protection circuits that prevent catastrophic failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015. However, care should be exercised in handling these devices, as exposure to ESD may result in degradation of the device parametric performance.

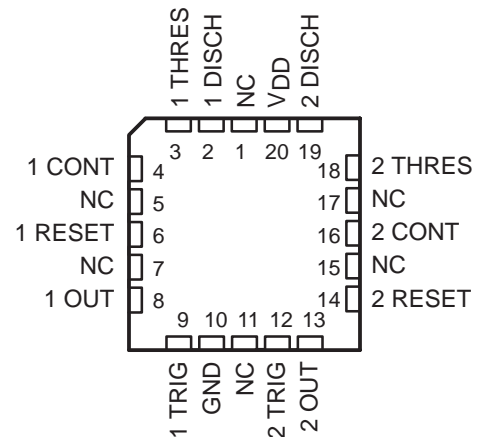
All unused inputs should be tied to an appropriate logic level to prevent false triggering.

The TLC556C is characterized for operation from 0°C to 70°C. The TLC556I is characterized for operation from -40°C to 85°C. The TLC556M is characterized for operation over the full military temperature range of -55°C to 125°C.

**D, J, OR N PACKAGE  
(TOP VIEW)**



**FK PACKAGE  
(TOP VIEW)**



NC—No internal connection

LinCMOS is a trademark of Texas Instruments Incorporated.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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# TLC556, TLC556Y DUAL LinCMOS™ TIMERS

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## AVAILABLE OPTIONS

T <sub>A</sub> RANGE	V <sub>DD</sub> RANGE	PACKAGE				CHIP FORM (Y)
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	
0°C to 70°C	2 V to 18 V	TLC556CD			TLC556CN	TLC556Y
-40°C to 85°C	3 V to 18 V	TLC556ID			TLC556IN	
-55°C to 125°C	5 V to 18 V	TLC556MD	TLC556MFK	TLC556MJ	TLC556MN	

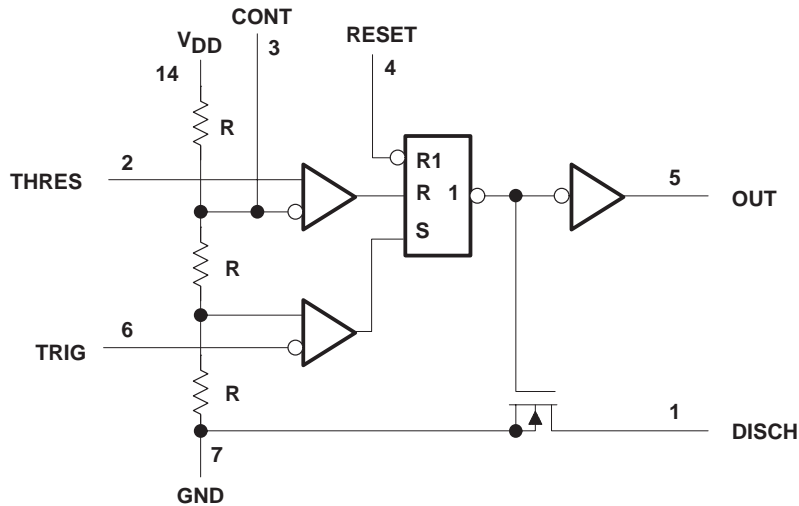
The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLC556CDR).

## 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 (each timer)

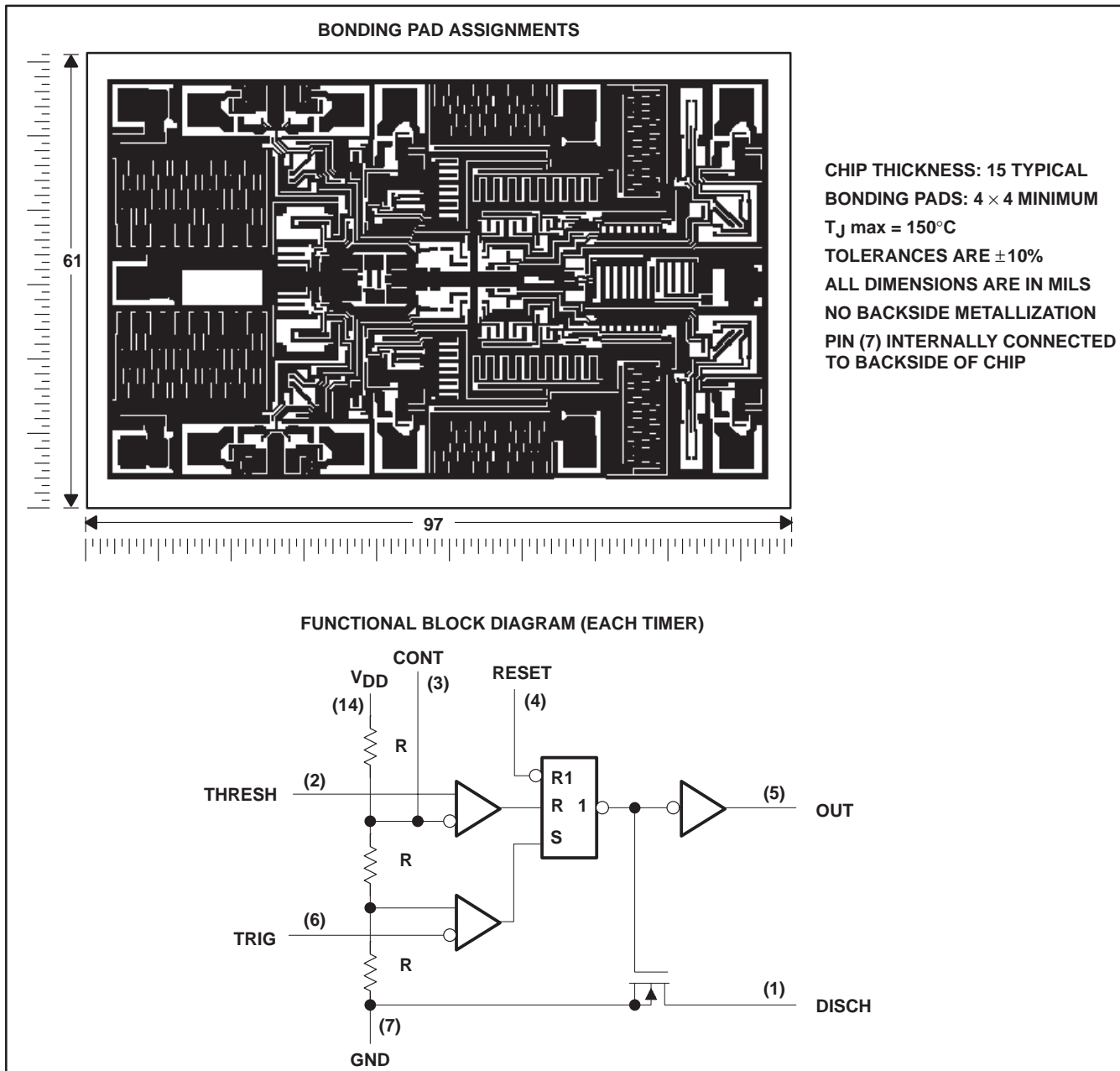


RESET can override TRIG and THRES.  
TRIG can override THRES.

Pin numbers shown are for the D, J, or N packages.

**TLC556Y chip information**

These chips, properly assembled, display characteristics similar to the TLC556 (see electrical table). 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.



# TLC556, TLC556Y DUAL LinCMOS™ TIMERS

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

	TLC556C	TLC556I	TLC556M	UNIT
Supply voltage, $V_{DD}$ (see Note 1)	18	18	18	V
Input voltage range, $V_I$	-0.3 to $V_{DD}$	-0.3 to $V_{DD}$	-0.3 to $V_{DD}$	V
Sink current, discharge or output	150	150	150	mA
Source current, output	15	15	15	mA
Continuous total power dissipation	See Dissipation Rating Table			
Operating free-air temperature range	0 to 70	-40 to 85	-55 to 125	°C
Storage temperature range	-65 to 150	-65 to 150	-65 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	J package		300	
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	D or N package	260	260	

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

### DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	950 mW	7.6 mW/°C	608 mW	494 mW	N/A
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
N	1150 mW	9.2 mW/°C	736 mW	598 mW	N/A

## recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, $V_{DD}$		2	15	V
Operating free-air temperature range, $T_A$	TLC556C	0	70	°C
	TLC556I	-40	85	
	TLC556M	-55	125	



electrical characteristics at specified free-air temperature,  $V_{DD} = 2\text{ V}$  for TLC556C,  $V_{DD} = 3\text{ V}$  for TLC556I

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC556C			TLC556I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IT}$ Input threshold voltage		25°C	0.95	1.33	1.65	1.6	2	2.4	V
		Full range	0.85		1.75	1.5		2.5	
Threshold current		25°C		10			10		pA
		MAX		75			150		
$V_{(trigger)}$ 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	
$I_{(trigger)}$ Trigger current		25°C		10			10		pA
		MAX		75			150		
$V_{(reset)}$ Reset voltage		25°C	0.4	1.1	1.5	0.4	1.1	1.5	V
		Full range	0.3		1.8	0.3		1.8	
$I_{(reset)}$ 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 on-state voltage	$I_{OL} = 1\text{ mA}$	25°C		0.04	0.2		0.03	0.2	V
		Full range			0.25			0.375	
Discharge switch off-state current		25°C		0.1			0.1		nA
		MAX		0.5			120		
$V_{OH}$ High-level output voltage	$I_{OH} = -300\text{ }\mu\text{A}$	25°C	1.5	1.9		1.5	1.9		V
		Full range	1.5			2.5			
$V_{OL}$ Low-level output voltage	$I_{OL} = 1\text{ mA}$	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		130	500		130	500	$\mu\text{A}$
		Full range			800			1000	

† Full range is 0°C to 70°C for TLC556C and –40°C to 85°C for TLC556I.

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

# TLC556, TLC556Y DUAL LinCMOS™ TIMERS

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

PARAMETER	TEST CONDITIONS	$T_A$ †	TLC556C			TLC556I			TLC556M			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IT}$ Input 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	
Threshold current		25°C	10			10			10			pA
		MAX	75			150			5000			
$V_{(trigger)}$ 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	
$I_{(trigger)}$ Trigger current		25°C	10			10			10			pA
		MAX	75			150			5000			
$V_{(reset)}$ 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	
$I_{(reset)}$ 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	$I_{OL} = 10\text{ mA}$	25°C	0.15 0.5			0.15 0.5			0.15 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			2			120			
$V_{OH}$ High-level output voltage	$I_{OH} = -1\text{ mA}$	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	$I_{OL} = 8\text{ mA}$	25°C	0.21 0.4			0.21 0.4			0.21 0.4			V
		Full range	0.5			0.5			0.6			
	$I_{OL} = 5\text{ mA}$	25°C	0.13 0.3			0.13 0.3			0.13 0.3			
		Full range	0.4			0.4			0.45			
	$I_{OL} = 3.2\text{ mA}$	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	340 700			340 700			340 700			$\mu\text{A}$
		Full range	1000			1200			1400			

† Full range is 0°C to 70°C for TLC556C, -40°C to 85°C for TLC556I, and -55°C to 125°C for TLC556M.

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,  $V_{DD} = 15\text{ V}$

PARAMETER		TEST CONDITIONS	$T_A^\dagger$	TLC556C			TLC556I			TLC556M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IT}$	Input 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	
	Threshold current		25°C		10			10			10	pA	
			MAX		75			150			5000		
$V_{(trigger)}$	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	
$I_{(trigger)}$	Trigger current		25°C		10			10			10	pA	
			MAX		75			150			5000		
$V_{(reset)}$	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	
$I_{(reset)}$	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	$I_{OL} = 100\text{ mA}$	25°C		0.8	1.7		0.8	1.7		0.8	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			2			120		
$V_{OH}$	High-level output voltage	$I_{OH} = -10\text{ mA}$	25°C	12.5	14.2		12.5	14.2		12.5	14.2	V	
			Full range	12.5			12.5			12.5			
		$I_{OH} = -5\text{ mA}$	25°C	13.5	14.6		13.5	14.6		13.5	14.6		
			Full range	13.5			13.5			13.5			
		$I_{OH} = -1\text{ mA}$	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	$I_{OL} = 100\text{ mA}$	25°C		1.28	3.2		1.28	3.2		1.28	3.2	V
			Full range			3.6			3.7			3.8	
		$I_{OL} = 50\text{ mA}$	25°C		0.63	1		0.63	1		0.63	1	
			Full range			1.3			1.4			1.5	
		$I_{OL} = 10\text{ mA}$	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		0.72	1.2		0.72	1.2		0.72	1.2	mA
			Full range			1.6			1.8			2	

† Full range is 0°C to 70°C for TLC556C, -40°C to 85°C for TLC556I, and -55°C to 125°C for TLC556M.

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

# TLC556, TLC556Y DUAL LinCMOS™ TIMERS

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## electrical characteristics, $V_{DD} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IT}$	Input threshold voltage		2.8	3.3	3.8	V
	Threshold current			10		pA
$V_{(trigger)}$	Trigger voltage		1.36	1.66	1.96	V
$I_{(trigger)}$	Trigger current			10		pA
$V_{(reset)}$	Reset voltage		0.4	1.1	1.5	V
$I_{(reset)}$	Reset current			10		pA
	Discharge switch on-state voltage	$I_{OL} = 10\text{ mA}$		0.15	0.5	V
	Discharge switch off-state current			0.1		nA
$V_{OH}$	High-level output voltage	$I_{OH} = -1\text{ mA}$	4.1	4.8		V
$V_{OL}$	Low-level output voltage	$I_{OL} = 8\text{ mA}$		0.21	0.4	V
		$I_{OL} = 5\text{ mA}$		0.13	0.3	
		$I_{OL} = 2.1\text{ mA}$		0.08	0.3	
$I_{DD}$	Supply current	See Note 2		3.40	700	$\mu\text{A}$

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

## operating characteristics, $V_{DD} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	Initial error of timing interval †	$V_{DD} = 5\text{ V to }15\text{ V}$ , $R_A = R_B = 1\text{ k}\Omega\text{ to }100\text{ k}\Omega$		1%	3%	
	Supply voltage sensitivity of timing interval	$C_T = 0.1\text{ }\mu\text{F}$ , See Note 3		0.1	0.5	%/V
$t_r$	Output pulse rise time	$R_L = 10\text{ M}\Omega$ , $C_L = 10\text{ pF}$		20	75	ns
$t_f$	Output pulse fall time			15	60	
$f_{max}$	Maximum frequency in astable mode	$R_A = 470\text{ }\Omega$ , $C_T = 200\text{ pF}$ , $R_B = 200\text{ }\Omega$ , 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 3.





TYPICAL CHARACTERISTICS

DISCHARGE SWITCH ON-STATE RESISTANCE  
vs  
FREE-AIR TEMPERATURE

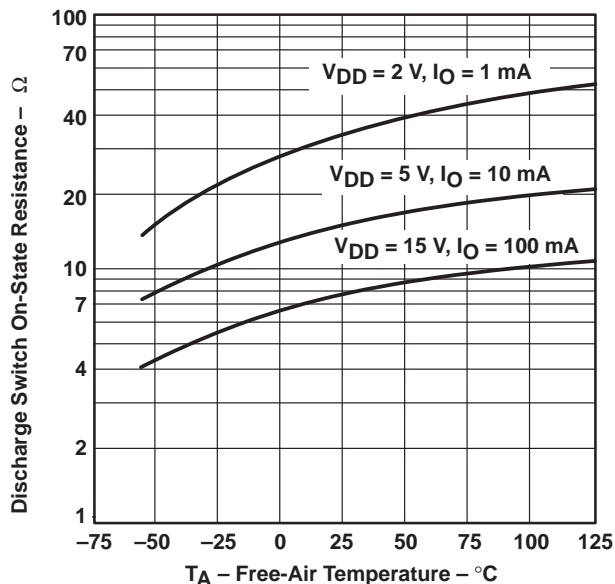
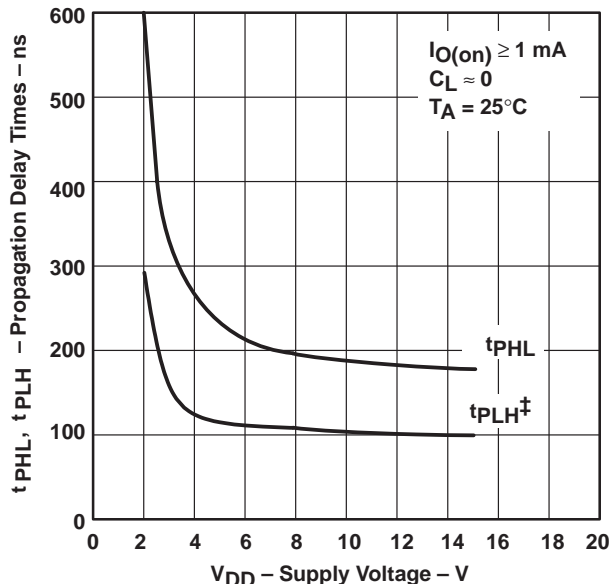


Figure 1

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

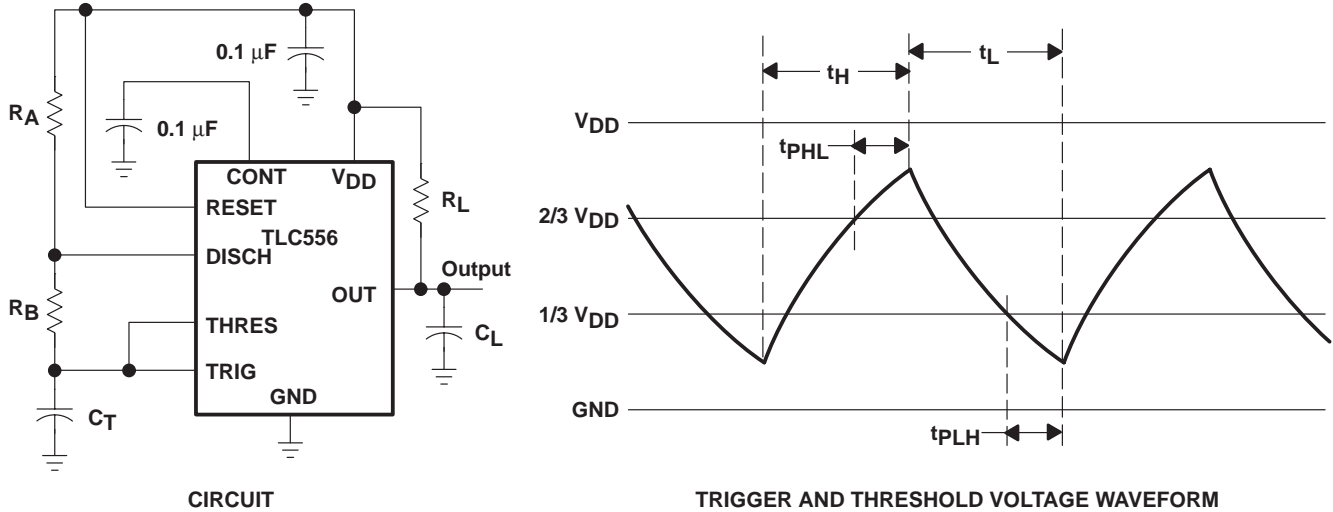


Figure 3. Astable Operation

Connecting the trigger input to the threshold input, 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 threshold voltage level (approximately  $0.67 V_{DD}$ ) and then discharges through  $R_B$  only to the value of the trigger voltage level (approximately  $0.33 V_{DD}$ ). The output is high during the charging cycle ( $t_H$ ) and low during the discharge cycle ( $t_L$ ). The duty cycle is controlled by the values of  $R_A$ , and  $R_B$ , and  $C_T$ , as shown in the equations below.

$$t_H \approx C_T (R_A + R_B) \ln 2 \quad (\ln 2 = 0.693)$$

$$t_L \approx C_T R_B \ln 2$$

$$\text{Period} = t_H + t_L \approx C_T (R_A + 2R_B) \ln 2$$

$$\text{Output driver duty cycle} = \frac{t_L}{t_H + t_L} \approx 1 - \frac{R_B}{R_A + 2R_B}$$

$$\text{Output waveform duty cycle} = \frac{t_H}{t_H + t_L} \approx \frac{R_B}{R_A + 2R_B}$$

The  $0.1\text{-}\mu\text{F}$  capacitor at CONT in Figure 3 decreases the period by about 10%.

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

The equations below provide better agreement with measured values.

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

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

### APPLICATION INFORMATION

The preceding 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  $\ln 2$  at low frequencies and  $\ln 3$  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%  $\frac{t_H}{t_H + t_L}$  will require that  $\frac{t_H}{t_L} < 1$  and possibly  $R_A \leq r_{on}$ . These conditions can be difficult to obtain.

In monostable applications, the trip point of the trigger input 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- $\mu$ A bias provides good results.

# TLC556, TLC556Y DUAL LinCMOS™ TIMERS

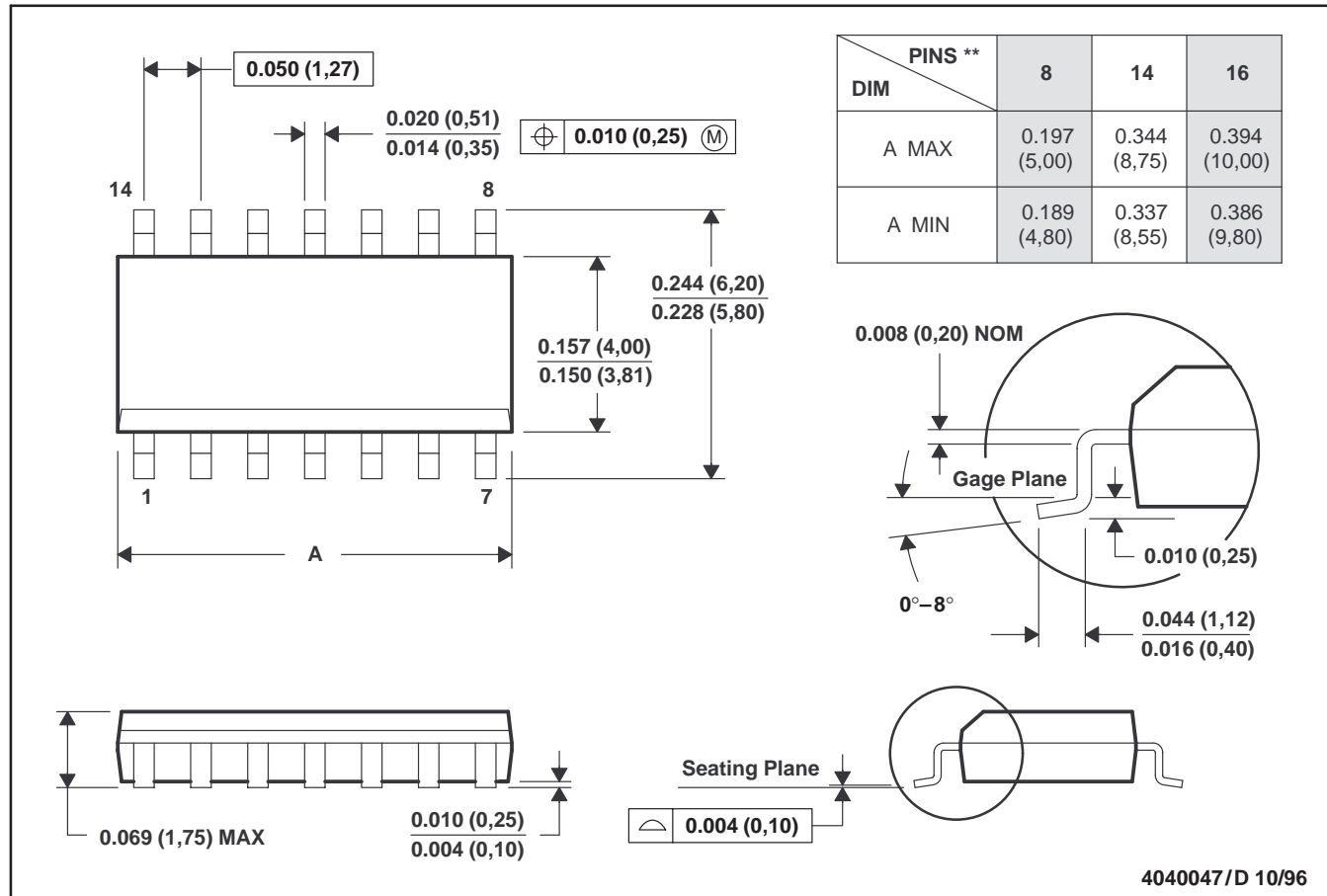
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## MECHANICAL INFORMATION

D (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



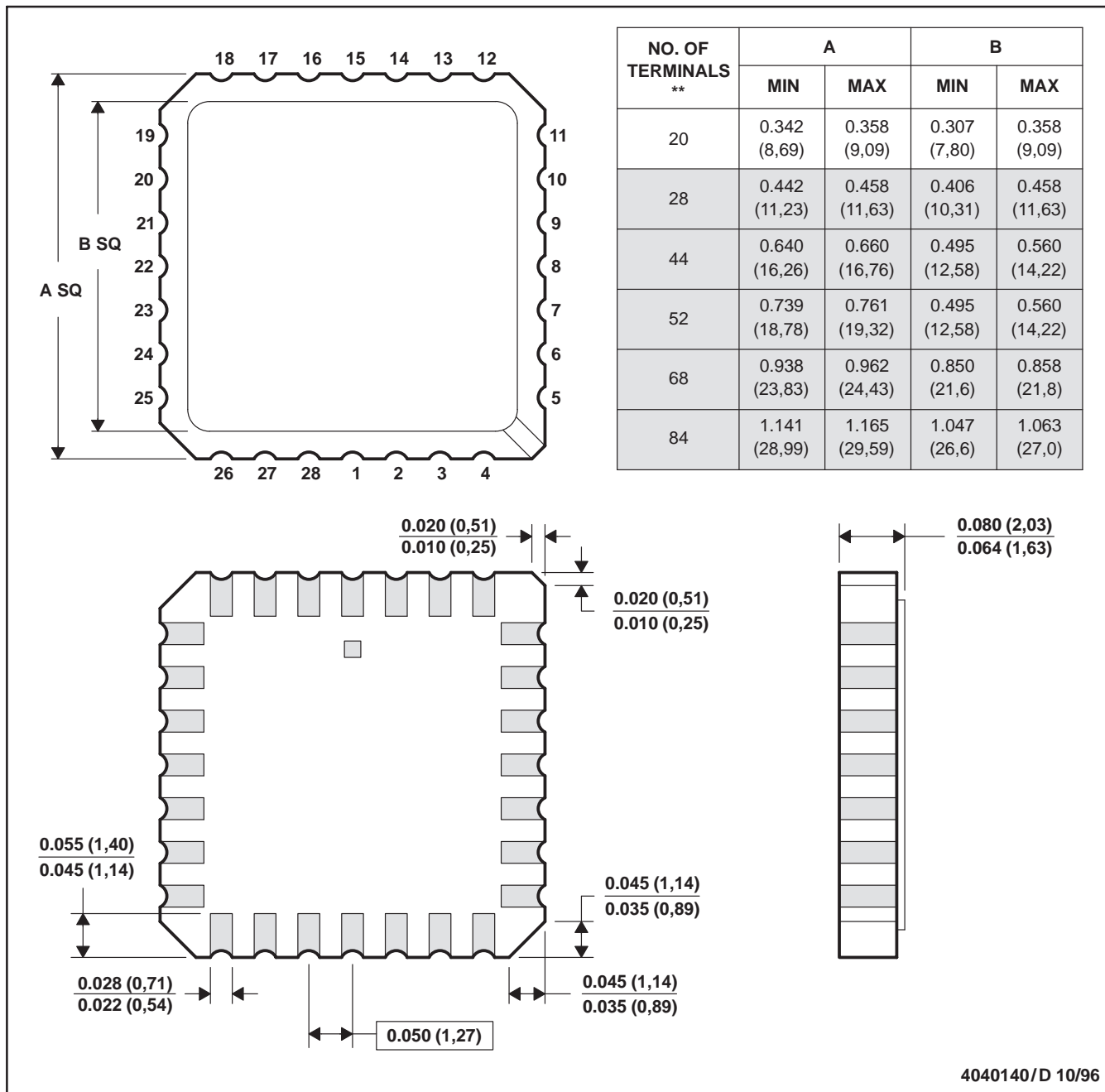
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012

MECHANICAL INFORMATION

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a metal lid.  
 D. The terminals are gold plated.  
 E. Falls within JEDEC MS-004

# TLC556, TLC556Y DUAL LinCMOS™ TIMERS

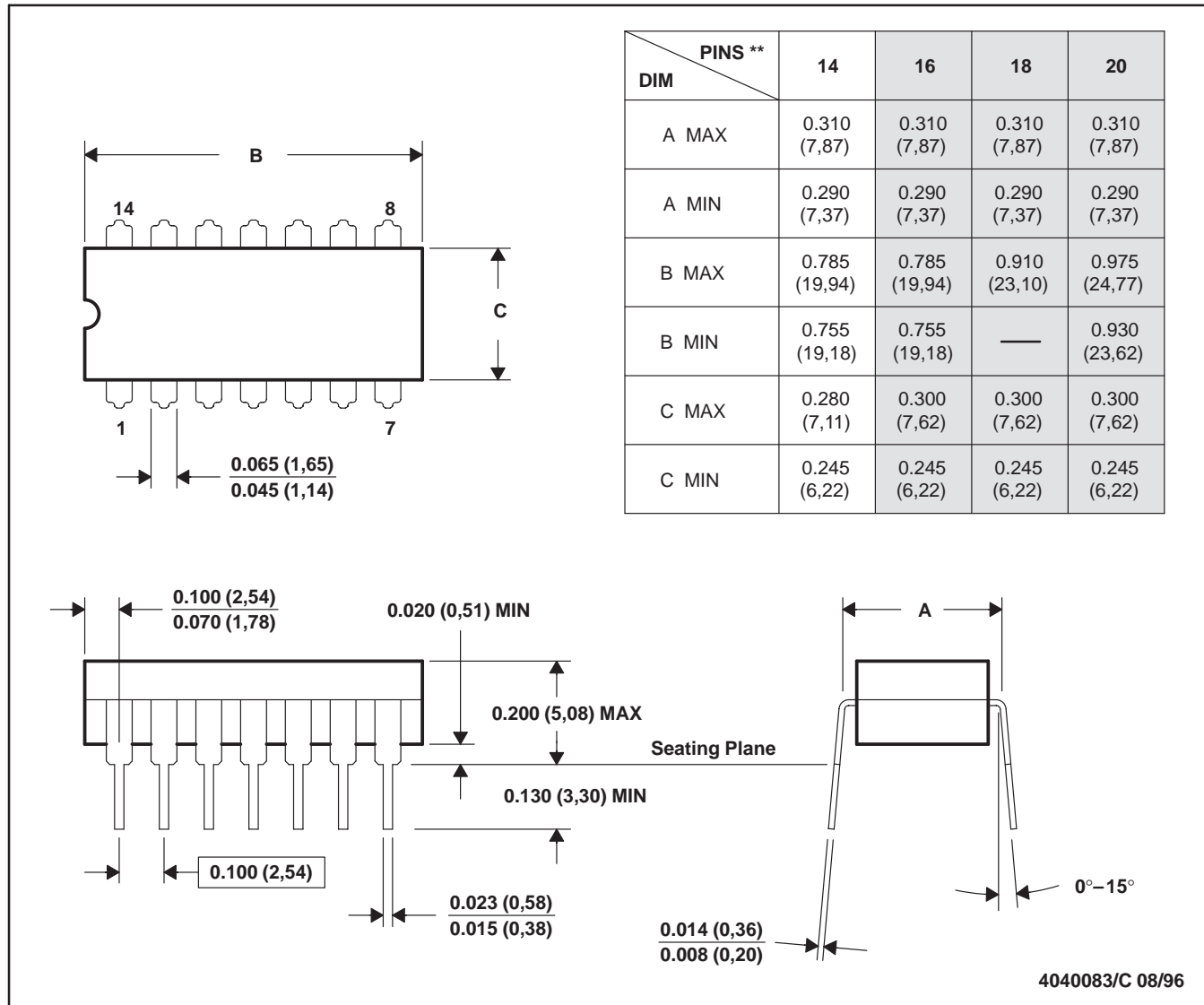
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## MECHANICAL INFORMATION

J (R-GDIP-T\*\*)

CERAMIC DUAL-IN-LINE PACKAGE

14 PIN SHOWN



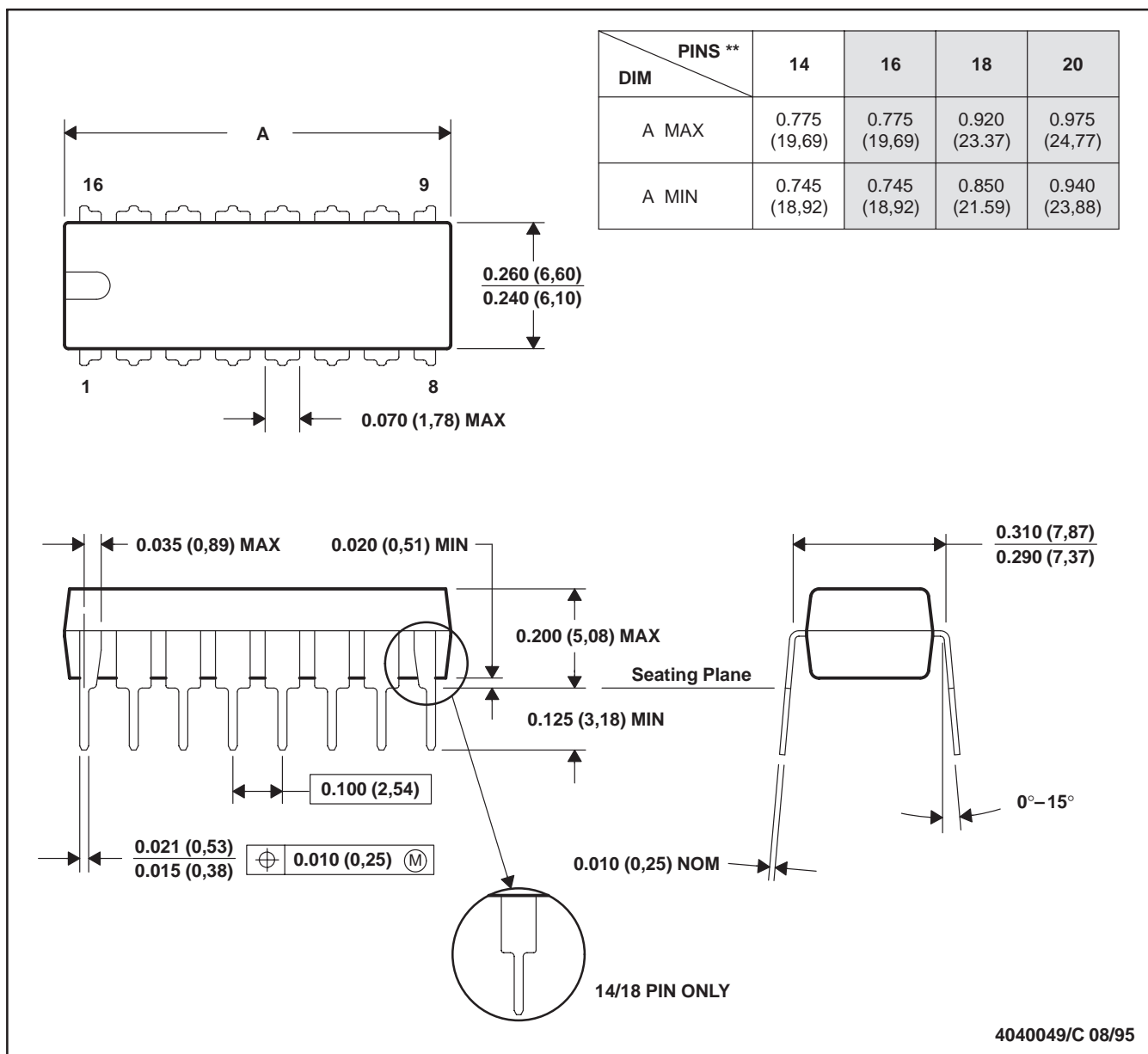
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.  
 E. Falls within MIL-STD-1835 GDIP1-T14, GDIP1-T16, GDIP1-T18, and GDIP1-T20

MECHANICAL INFORMATION

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001 (20 pin package is shorter than MS-001.)

## IMPORTANT NOTICE

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