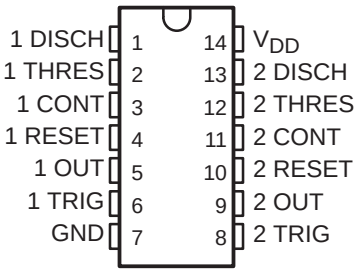
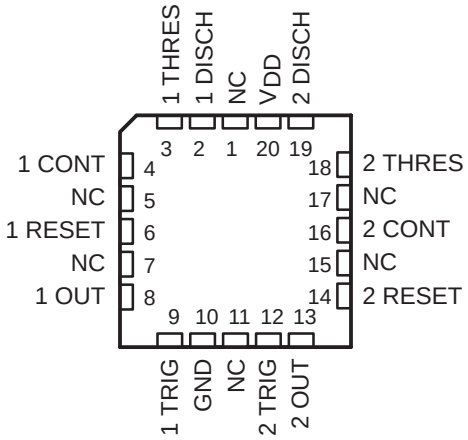
- **Very Low Power Consumption . . . 2 mW Typ at $V_{DD}$ = 5 V**
- **Capable of Operation in Astable Mode**
- **CMOS Output Capable of Swinging Rail to Rail**
- **High Output-Current Capability**
  **Sink 100 mA Typ**
  **Source 10 mA Typ**
- **Output Fully Compatible With CMOS, TTL, and MOS**
- **Low Supply Current Reduces Spikes During Output Transitions**
- **Single-Supply Operation From 2 V to 15 V**
- **Functionally interchangeable With the NE556; Has Same Pinout**

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




**FK PACKAGE**
**(TOP VIEW)**




NC–No internal connection

## 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.

LinCMOS is a trademark of Texas Instruments Incorporated.

**AVAILABLE OPTIONS**

| $T_A$ RANGE | $V_{DD}$ RANGE | PACKAGE | | | | CHIP FORM (Y) |
|---|---|---|---|---|---|---|
| | | SMALL OUTLINE (D) | CHIP CARRIER (FK) | CERAMIC DIP (J) | PLASTIC DIP (N) | |
| O°C to 70°C | 2 V to 18 V | TLC556CD | | | TLC556CN | TLC556Y |
| –4O°C to 85°C | 3 V to 18 V | TLC556lD | | | TLC556IN | |
| –55°C to 125°C | 5 V to 18 V | TLC556MD | TLC556MFK | TLC556MJ | TLC556MN | |

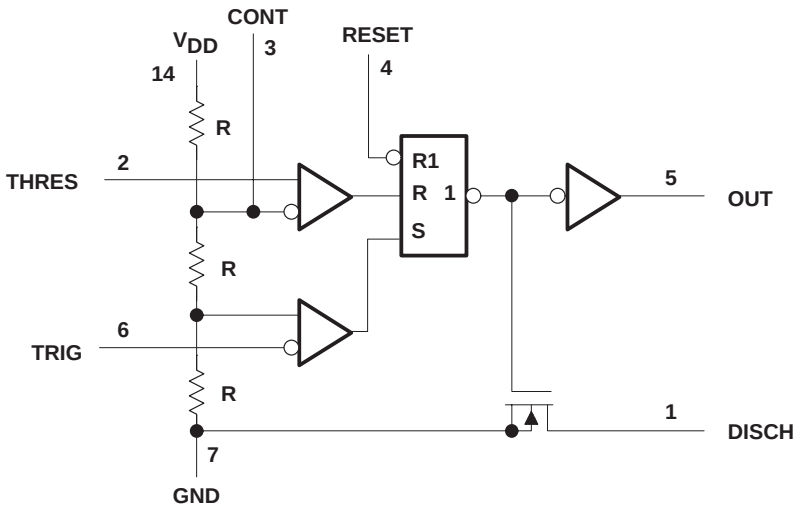
The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLC556CDR).

**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)



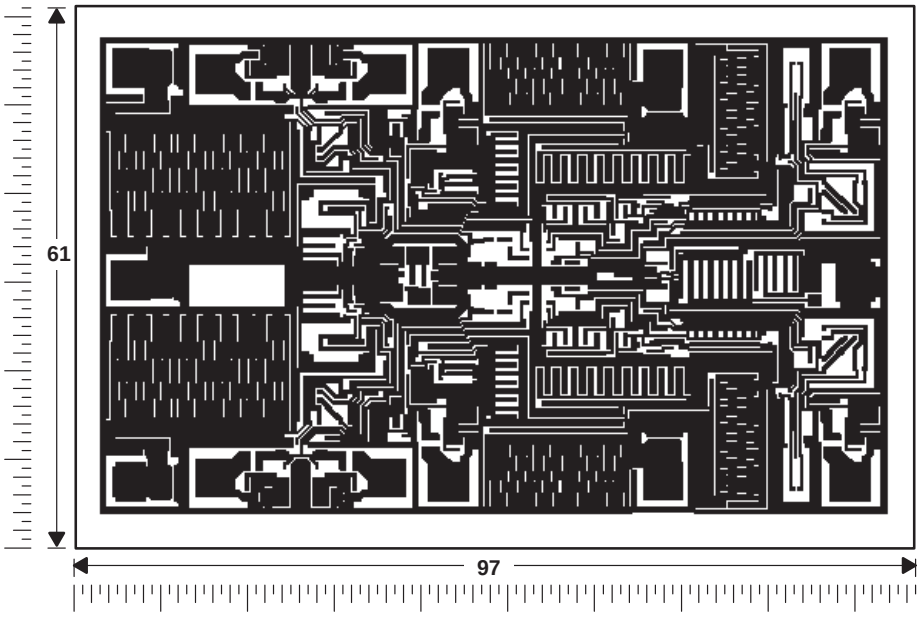

RESET can override TRIG and THRES.
TRIG can override THRES.

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

## TLC556Y chip information

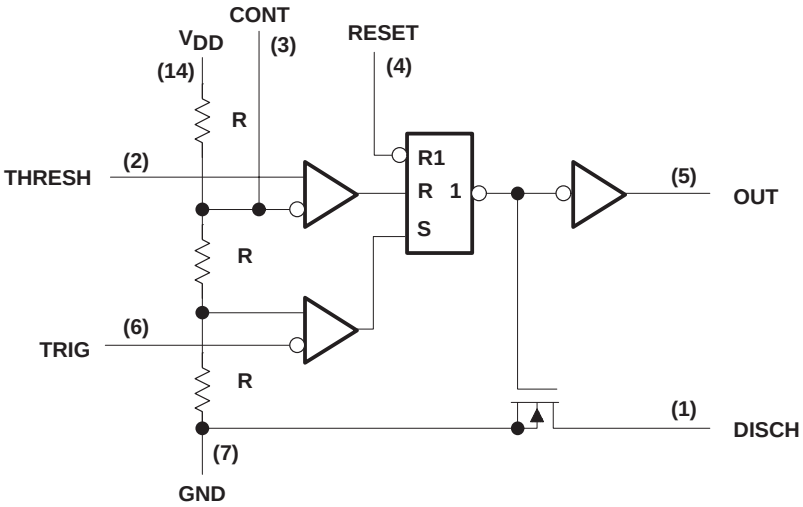
These chips, properly assembled, display characteristics similar to the TLC556 (see electrical table). Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

**BONDING PAD ASSIGNMENTS**




**CHIP THICKNESS: 15 TYPICAL**
**BONDING PADS: 4 × 4 MINIMUM**
**$T_J$ max = 150°C**
**TOLERANCES ARE ±10%**
**ALL DIMENSIONS ARE IN MILS**
**NO BACKSIDE METALLIZATION**
**PIN (7) INTERNALLY CONNECTED TO BACKSIDE OF CHIP**

**FUNCTIONAL BLOCK DIAGRAM (EACH TIMER)**



## 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 | $T_A \le 25°C$ 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 | 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 V for TLC556C, $V_{DD}$ = 3 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 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 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 | | 130 | 500 | | 130 | 500 | μA |
| | | | 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.

## electrical characteristics at specified free-air temperature, $V_{DD}$ = 5 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 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 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 | | 340 | 700 | | 340 | 700 | | 340 | 700 | µA |
| | | | 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 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 | 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 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 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 | | 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.

## electrical characteristics, $V_{DD}$ = 5 V, $T_A$ = 25°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 mA | | 0.15 | 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 | |
| | | $I_{OL}$ = 2.1 mA | | 0.08 | 0.3 | |
| $I_{DD}$ | Supply current | See Note 2 | | 3.40 | 700 | µA |

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 | | 1% | 3% | |
| | Supply voltage sensitivity of timing interval | $C_T$ = 0.1 µF, | See Note 3 | | 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, $C_T$ = 200 pF, | $R_B$ = 200 Ω, 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**

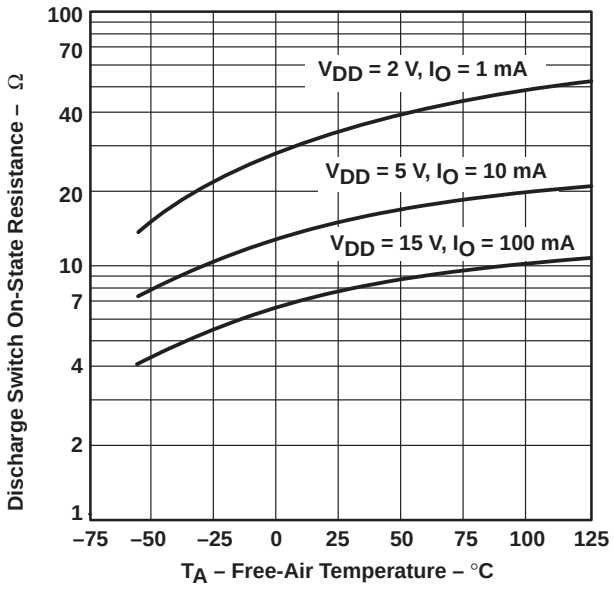
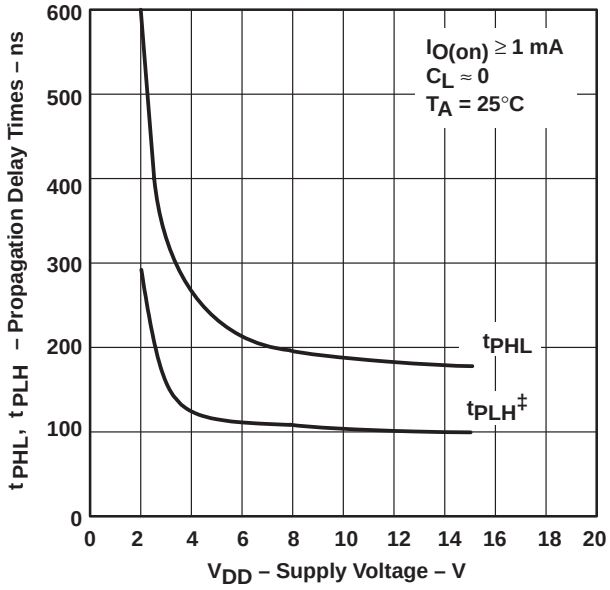



**Figure 1**

**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

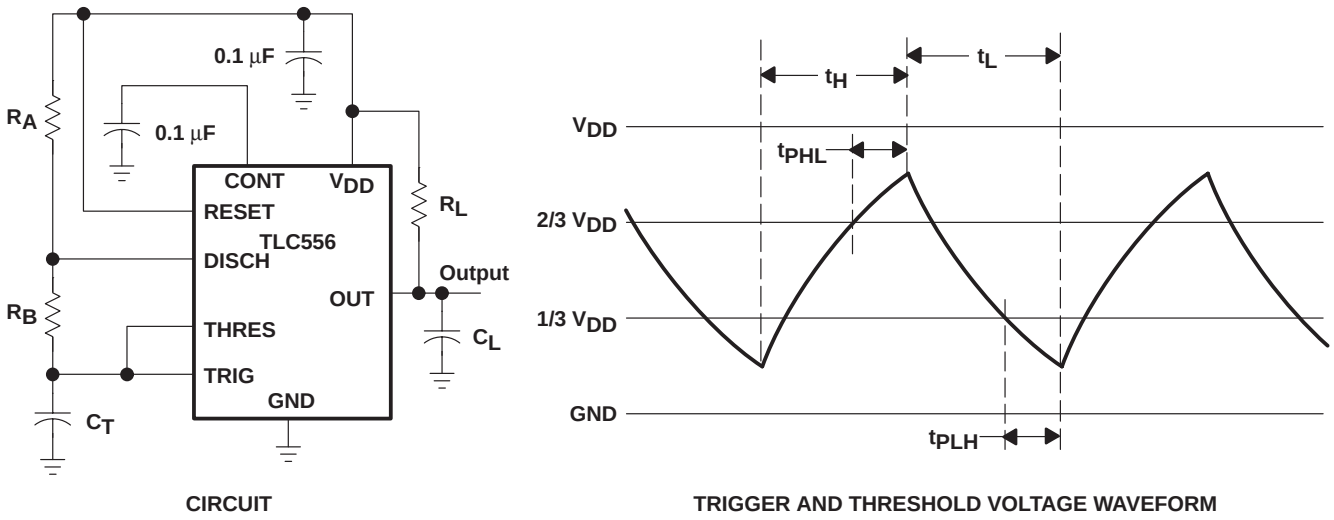



**Figure 3. Astable Operation**

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-μF 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

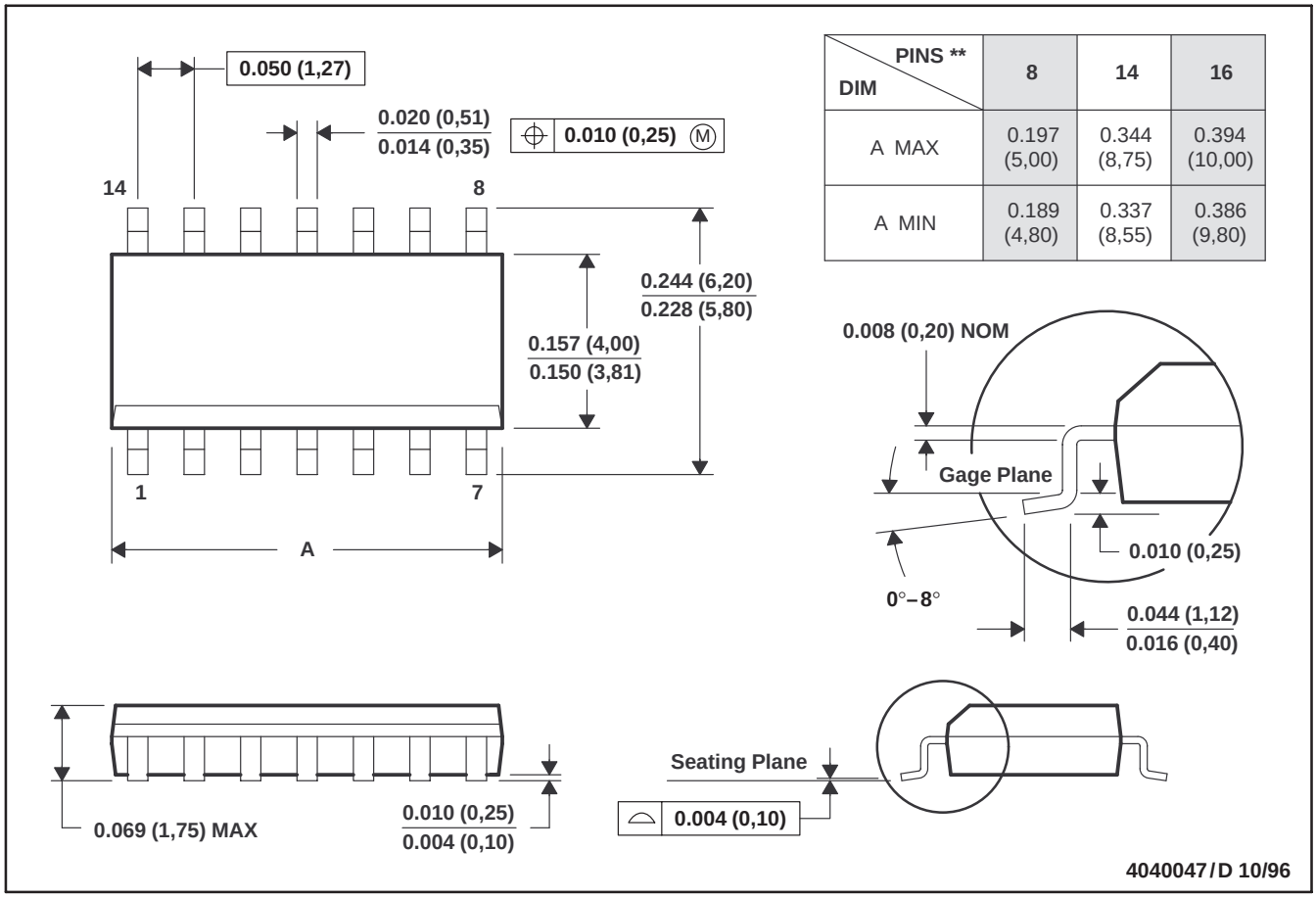
The preceding equations and those given earlier are similar in that a time constant is multiplied by the logarithm of a number or function. The limit values of the logarithmic terms must be between In 2 at low frequencies and In 3 at extremely high frequencies. For a duty cycle close to 50%, an appropriate constant for the logarithmic terms can be substituted with good results. Duty cycles less than 50% $\frac{t_H}{t_H + t_L}$ 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-μA bias provides good results.

## MECHANICAL INFORMATION

**D (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**14 PIN SHOWN**



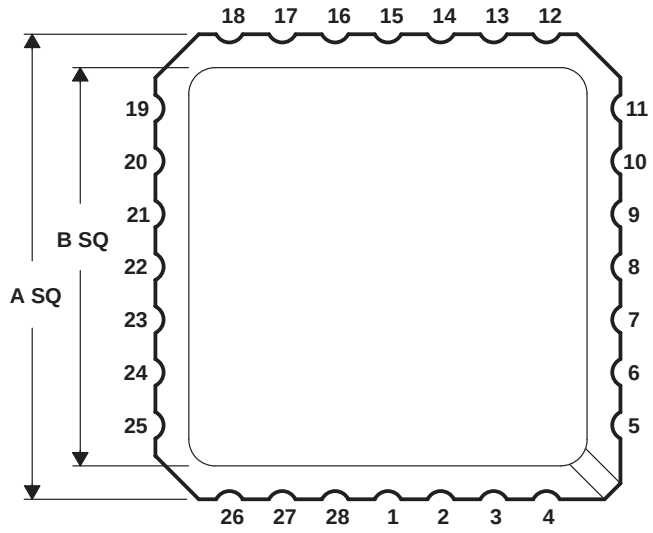

| DIM \ PINS ** | 8 | 14 | 16 |
|---|---|---|---|
| A MAX | 0.197 (5,00) | 0.344 (8,75) | 0.394 (10,00) |
| A MIN | 0.189 (4,80) | 0.337 (8,55) | 0.386 (9,80) |

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

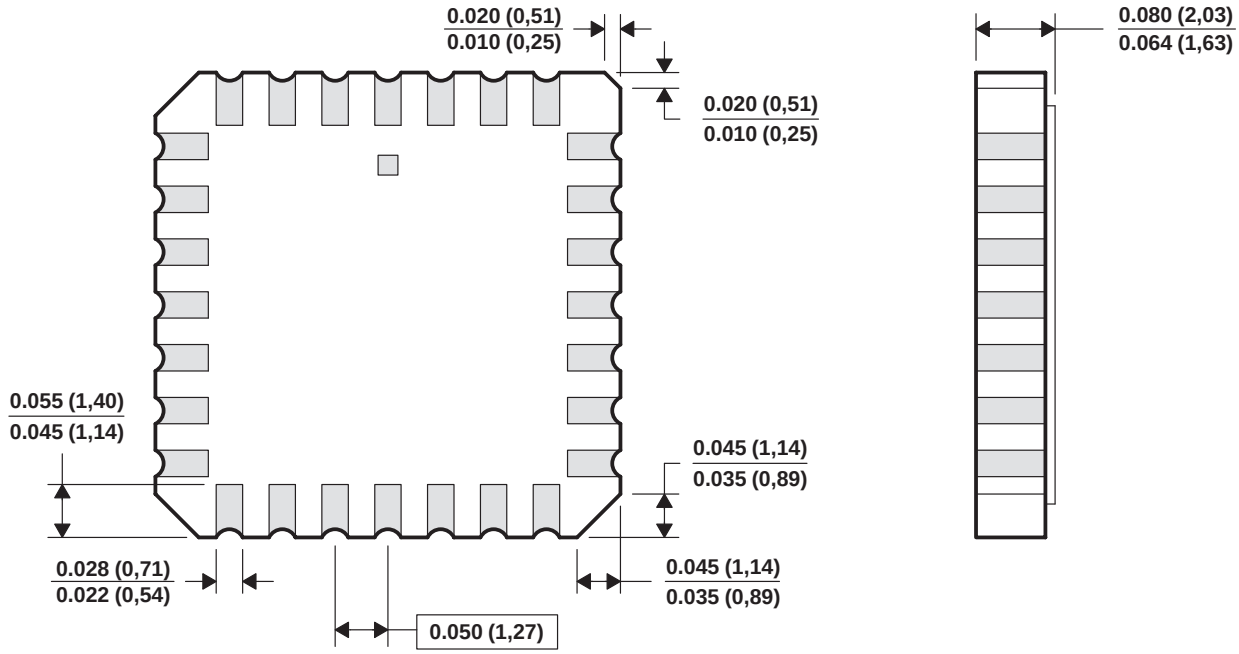
## MECHANICAL INFORMATION

**FK (S-CQCC-N**)** **LEADLESS CERAMIC CHIP CARRIER**

**28 TERMINAL SHOWN**




| NO. OF TERMINALS ** | A | | B | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| 20 | 0.342 (8,69) | 0.358 (9,09) | 0.307 (7,80) | 0.358 (9,09) |
| 28 | 0.442 (11,23) | 0.458 (11,63) | 0.406 (10,31) | 0.458 (11,63) |
| 44 | 0.640 (16,26) | 0.660 (16,76) | 0.495 (12,58) | 0.560 (14,22) |
| 52 | 0.739 (18,78) | 0.761 (19,32) | 0.495 (12,58) | 0.560 (14,22) |
| 68 | 0.938 (23,83) | 0.962 (24,43) | 0.850 (21,6) | 0.858 (21,8) |
| 84 | 1.141 (28,99) | 1.165 (29,59) | 1.047 (26,6) | 1.063 (27,0) |



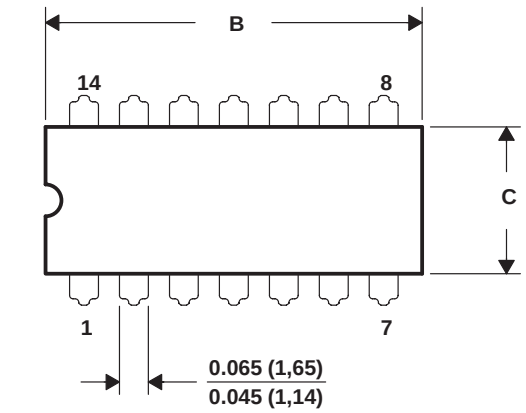

4040140/D 10/96

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

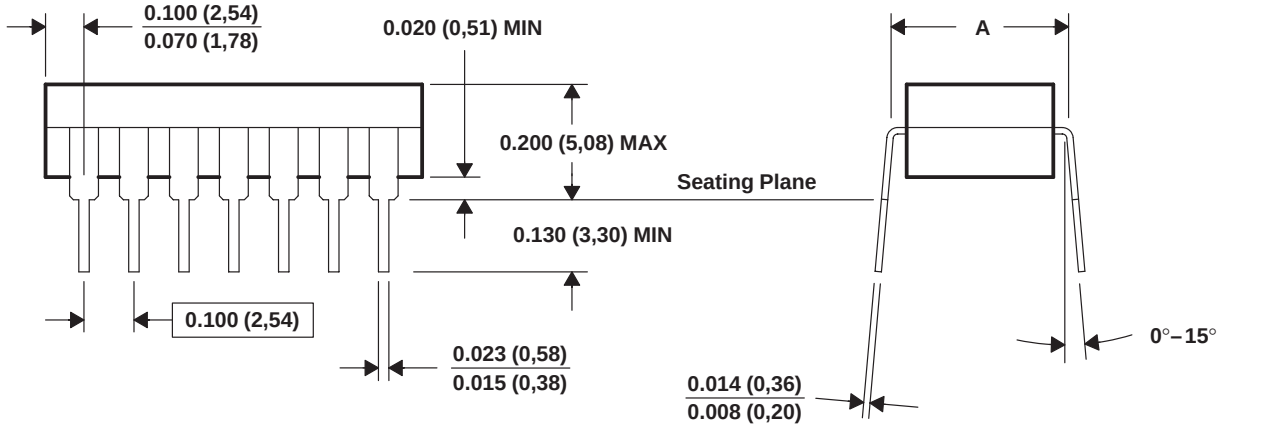
## MECHANICAL INFORMATION

**J (R-GDIP-T**)** **CERAMIC DUAL-IN-LINE PACKAGE**

**14 PIN SHOWN**




| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.310 (7,87) | 0.310 (7,87) | 0.310 (7,87) | 0.310 (7,87) |
| A MIN | 0.290 (7,37) | 0.290 (7,37) | 0.290 (7,37) | 0.290 (7,37) |
| B MAX | 0.785 (19,94) | 0.785 (19,94) | 0.910 (23,10) | 0.975 (24,77) |
| B MIN | 0.755 (19,18) | 0.755 (19,18) | — | 0.930 (23,62) |
| C MAX | 0.280 (7,11) | 0.300 (7,62) | 0.300 (7,62) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.245 (6,22) | 0.245 (6,22) |




4040083/C 08/96

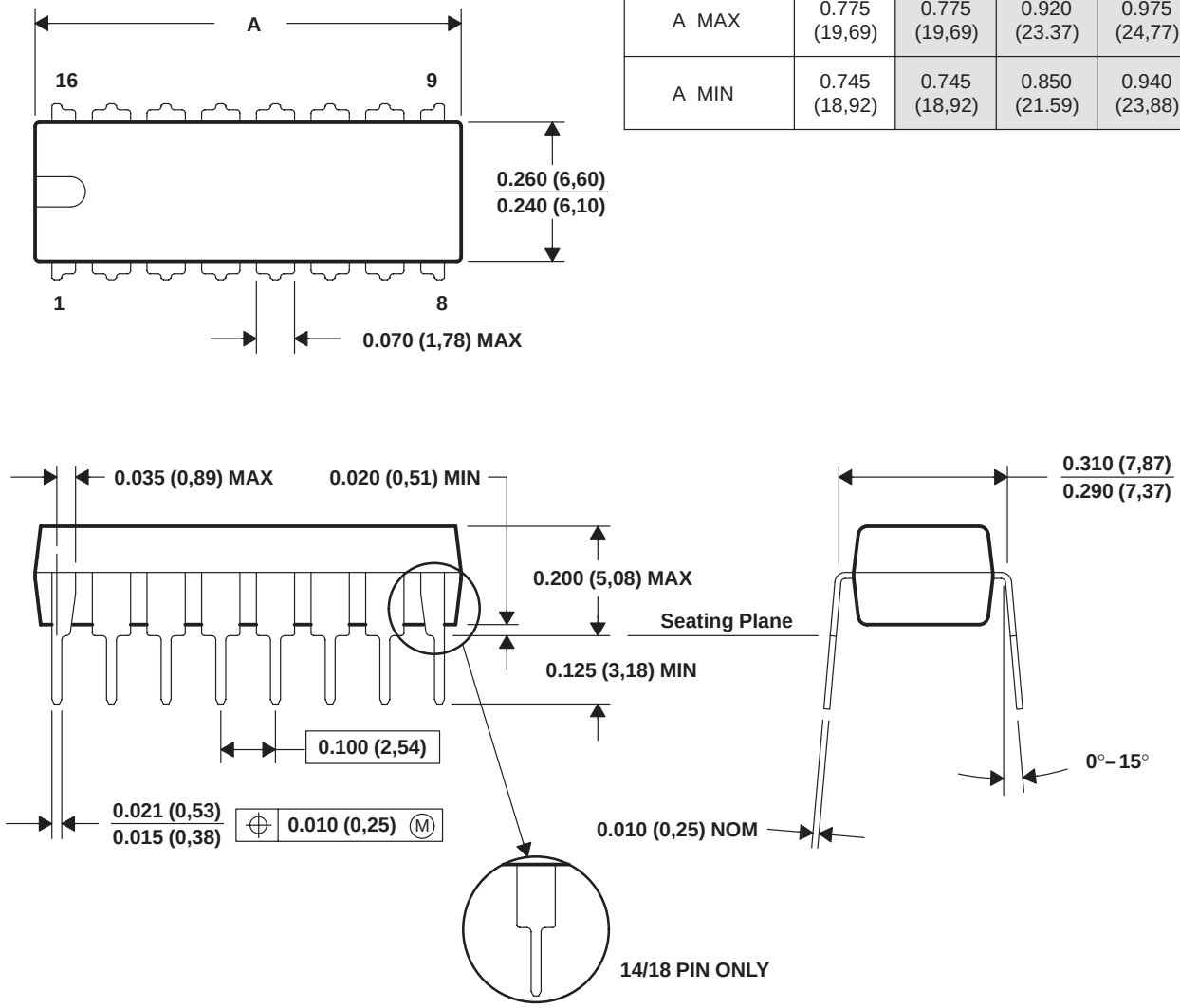
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. 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**

| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23.37) | 0.975 (24,77) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21.59) | 0.940 (23,88) |




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 then MS-001.)

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) |
|---|---|---|---|---|---|---|---|---|
| 5962-89503022A | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| 5962-8950302CA | ACTIVE | CDIP | J | 14 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| TLC556CD | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556CDG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556CDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556CDRG4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556CN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC556CNE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC556ID | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556IDG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556IDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556IDRG4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556IN | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC556INE4 | ACTIVE | PDIP | N | 14 | 25 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC556MD | ACTIVE | SOIC | D | 14 | 50 | TBD | CU NIPDAU | Level-1-220C-UNLIM |
| TLC556MDG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556MDR | ACTIVE | SOIC | D | 14 | 2500 | TBD | CU NIPDAU | Level-1-220C-UNLIM |
| TLC556MDRG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLC556MFKB | ACTIVE | LCCC | FK | 20 | 1 | TBD | POST-PLATE | N / A for Pkg Type |
| TLC556MJ | ACTIVE | CDIP | J | 14 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| TLC556MJB | ACTIVE | CDIP | J | 14 | 1 | TBD | A42 SNPB | N / A for Pkg Type |
| TLC556MN | OBSOLETE | PDIP | N | 14 | | TBD | Call TI | Call TI |

(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered

at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

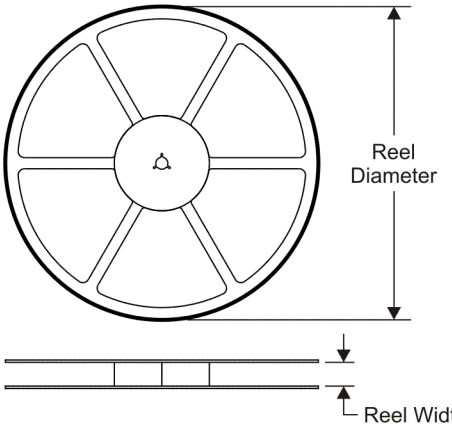
**(3)** MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

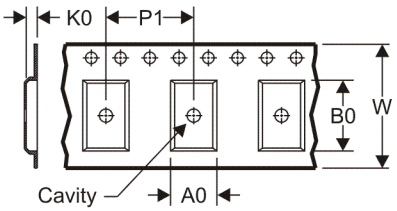
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

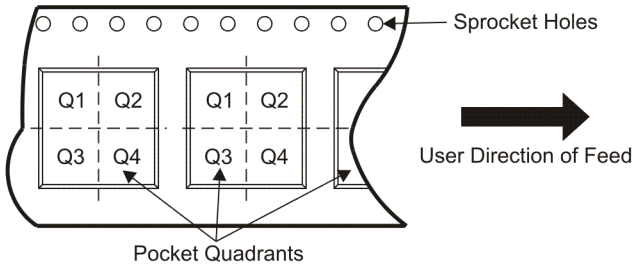



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

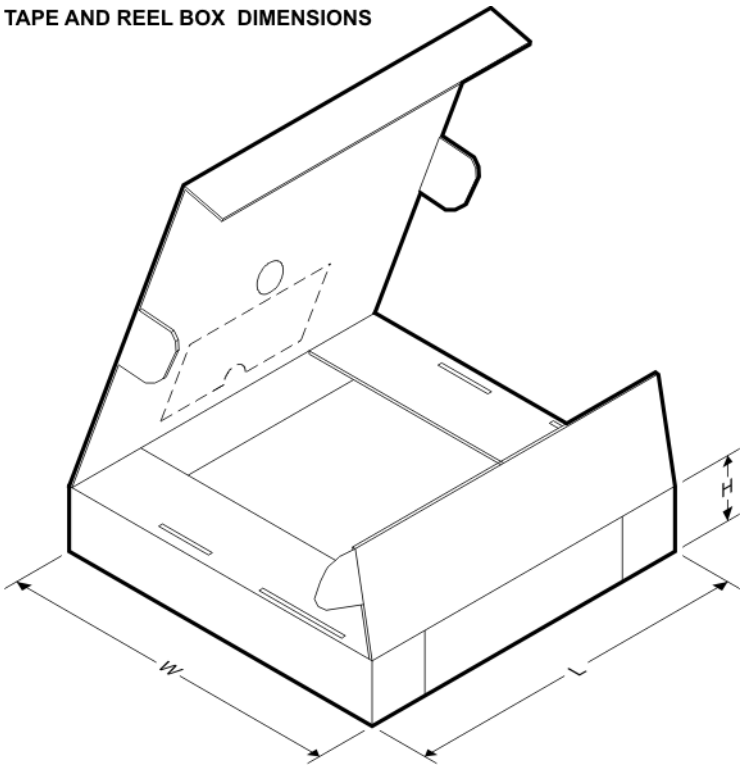
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TLC556CDR | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| TLC556IDR | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



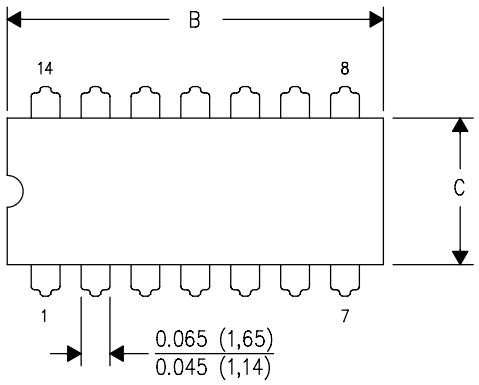

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TLC556CDR | SOIC | D | 14 | 2500 | 346.0 | 346.0 | 33.0 |
| TLC556IDR | SOIC | D | 14 | 2500 | 346.0 | 346.0 | 33.0 |

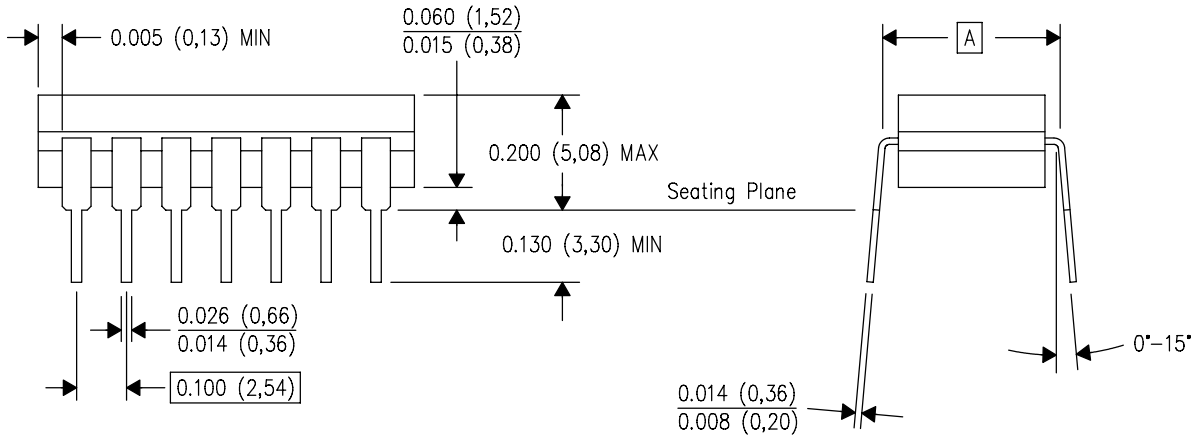
J (R–GDIP–T**)

14 LEADS SHOWN

# CERAMIC DUAL IN–LINE PACKAGE




| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC | 0.300 (7,62) BSC |
| B MAX | 0.785 (19,94) | .840 (21,34) | 0.960 (24,38) | 1.060 (26,92) |
| B MIN | — | — | — | — |
| C MAX | 0.300 (7,62) | 0.300 (7,62) | 0.310 (7,87) | 0.300 (7,62) |
| C MIN | 0.245 (6,22) | 0.245 (6,22) | 0.220 (5,59) | 0.245 (6,22) |

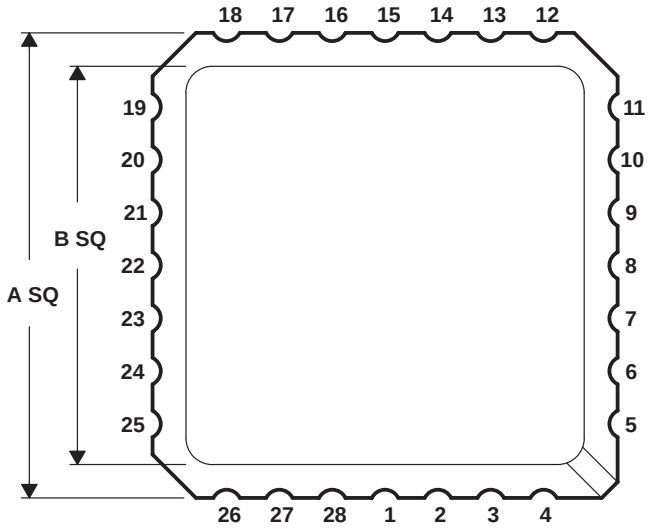



4040083/F 03/03

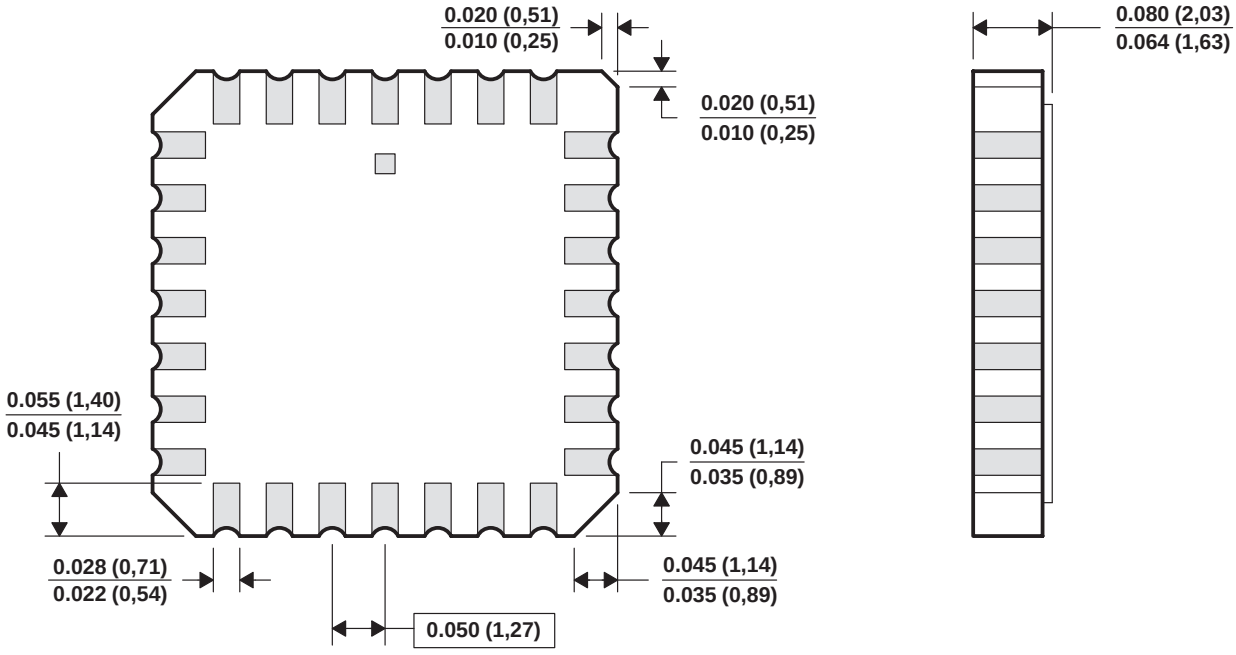
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package is hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls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

**FK (S-CQCC-N**)** **LEADLESS CERAMIC CHIP CARRIER**

**28 TERMINAL SHOWN**



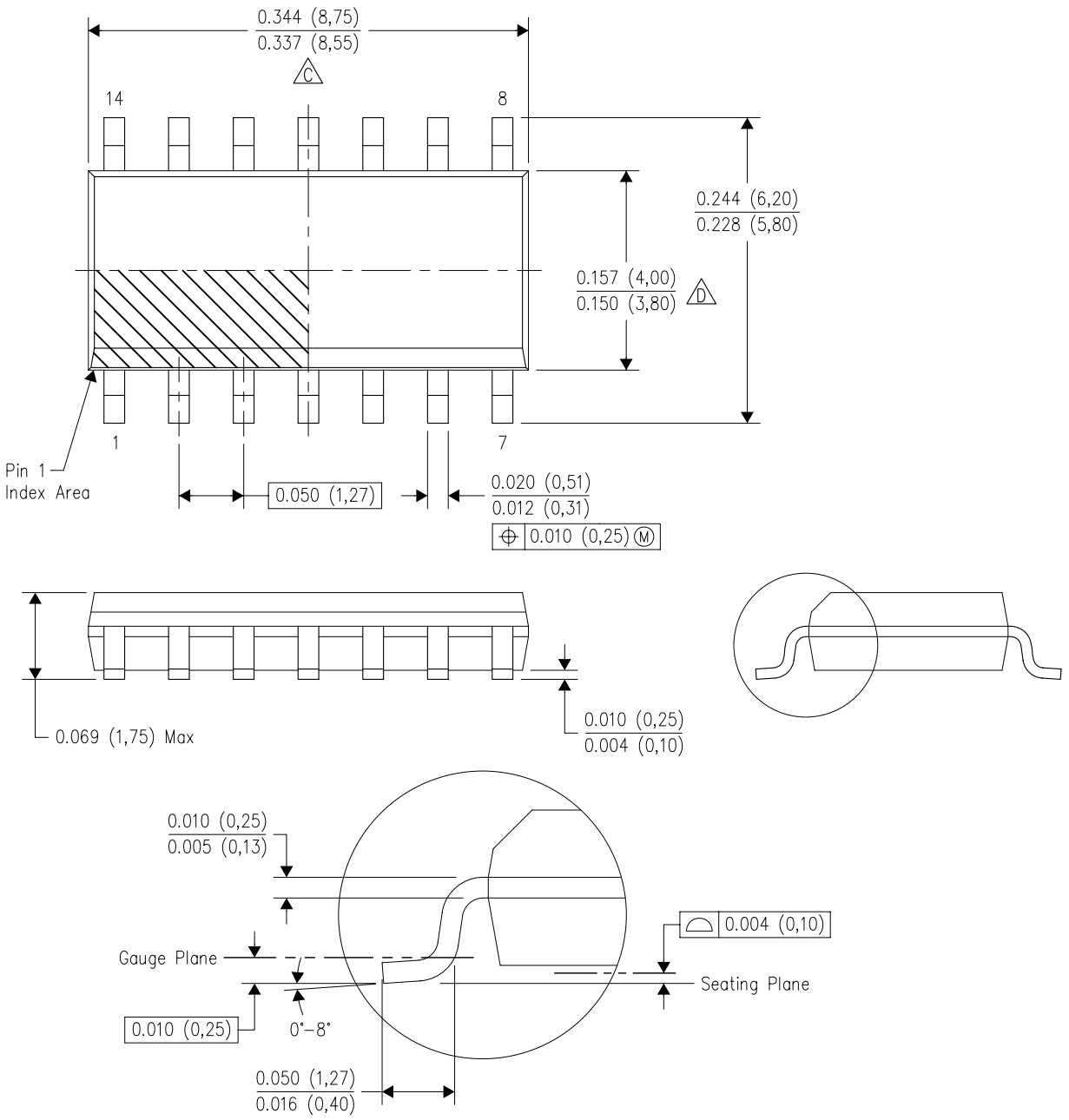

| NO. OF TERMINALS ** | A | | B | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| 20 | 0.342 (8,69) | 0.358 (9,09) | 0.307 (7,80) | 0.358 (9,09) |
| 28 | 0.442 (11,23) | 0.458 (11,63) | 0.406 (10,31) | 0.458 (11,63) |
| 44 | 0.640 (16,26) | 0.660 (16,76) | 0.495 (12,58) | 0.560 (14,22) |
| 52 | 0.739 (18,78) | 0.761 (19,32) | 0.495 (12,58) | 0.560 (14,22) |
| 68 | 0.938 (23,83) | 0.962 (24,43) | 0.850 (21,6) | 0.858 (21,8) |
| 84 | 1.141 (28,99) | 1.165 (29,59) | 1.047 (26,6) | 1.063 (27,0) |




**4040140/D 10/96**

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

D (R–PDSO–G14) PLASTIC SMALL–OUTLINE PACKAGE

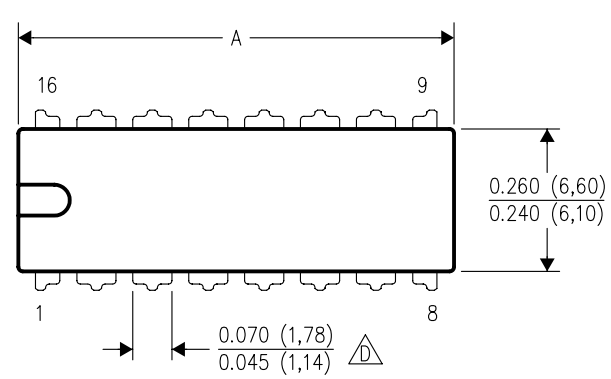



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
E. Reference JEDEC MS–012 variation AB.

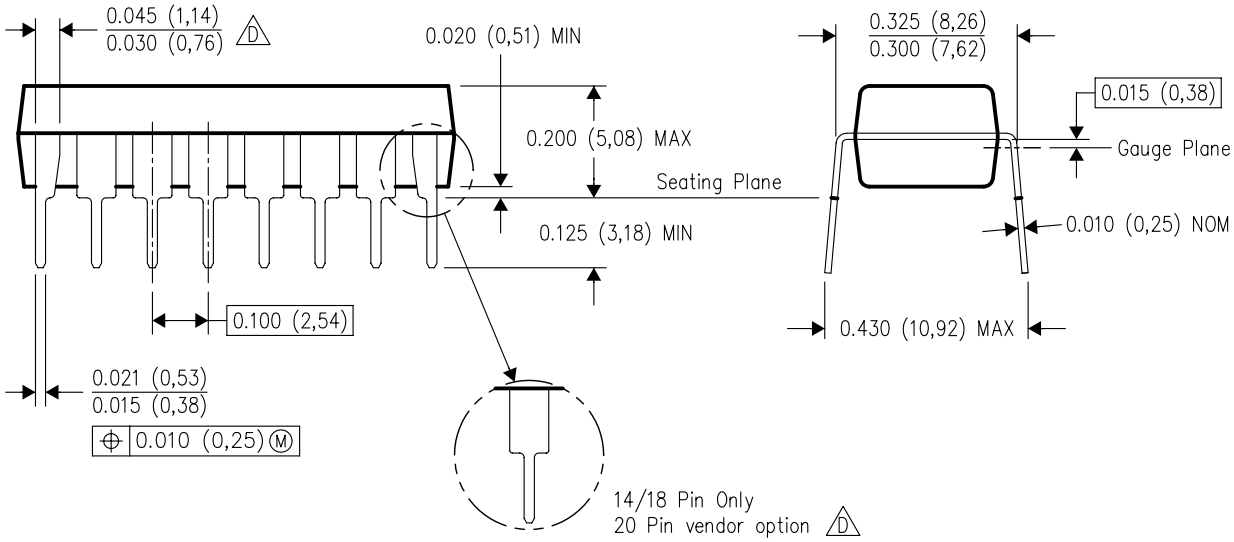
## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN




| DIM \ PINS ** | 14 | 16 | 18 | 20 |
|---|---|---|---|---|
| A MAX | 0.775 (19,69) | 0.775 (19,69) | 0.920 (23,37) | 1.060 (26,92) |
| A MIN | 0.745 (18,92) | 0.745 (18,92) | 0.850 (21,59) | 0.940 (23,88) |
| MS–001 VARIATION (C) | AA | BB | AC | AD |




4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

| **Products** | | **Applications** | |
|---|---|---|---|
| Amplifiers | amplifier.ti.com | Audio | www.ti.com/audio |
| Data Converters | dataconverter.ti.com | Automotive | www.ti.com/automotive |
| DSP | dsp.ti.com | Broadband | www.ti.com/broadband |
| Clocks and Timers | www.ti.com/clocks | Digital Control | www.ti.com/digitalcontrol |
| Interface | interface.ti.com | Medical | www.ti.com/medical |
| Logic | logic.ti.com | Military | www.ti.com/military |
| Power Mgmt | power.ti.com | Optical Networking | www.ti.com/opticalnetwork |
| Microcontrollers | microcontroller.ti.com | Security | www.ti.com/security |
| RFID | www.ti-rfid.com | Telephony | www.ti.com/telephony |
| RF/IF and ZigBee® Solutions | www.ti.com/lprf | Video & Imaging | www.ti.com/video |
| | | Wireless | www.ti.com/wireless |

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265