

## PWM Control Circuit

(compatible to TL494)

### Description

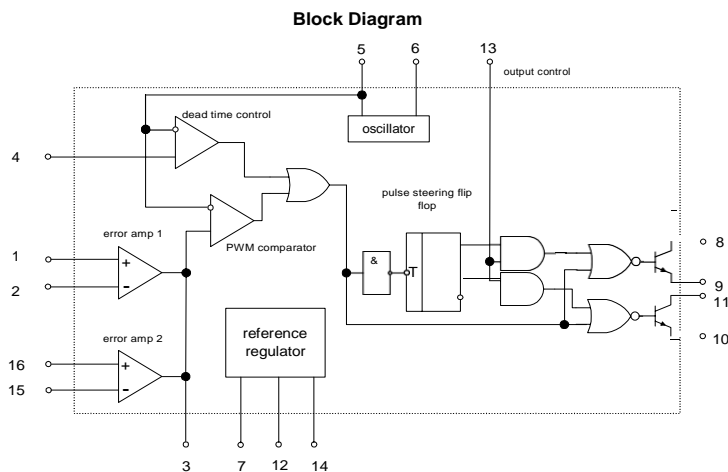
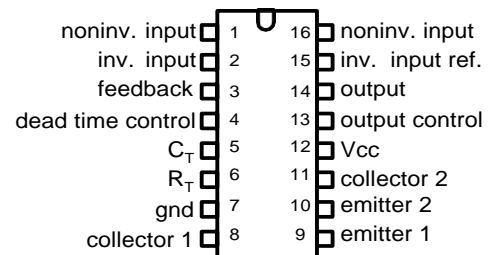
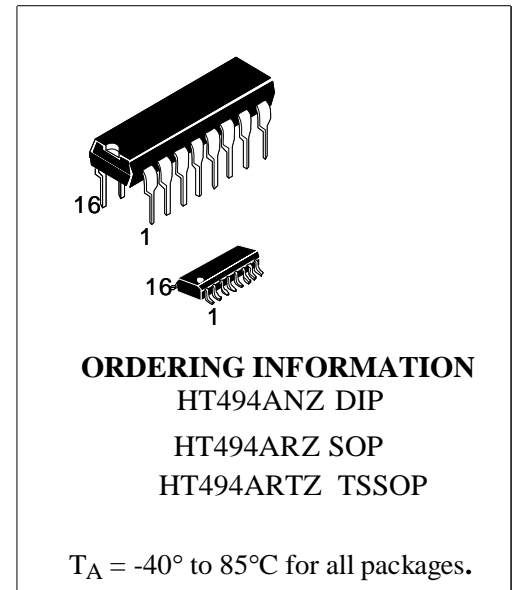
The HT494A incorporates on a single monolithic chip all the function required in the development of a pulse - width modulation control circuits. Designed primarily for power supply control , the HT494A contains an on-chip 5 volt regulator, two error amplifiers, adjustable oscillator, dead time control comparator, pulse-steering flip-flop, and output control circuitry. The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Push-pull or single-ended output operation may be selected through the output-control function. The architecture of the HT494A prohibits the possibility of either output being pulsed twice during push-pull operation.

### Features

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for 200 mA Sink or Source
- Output Control Selects Single-Ended or Push-Pull Operation
- Internal Circuitry Prohibits Double Pulse at Either Output
- Internal Regulator Provides a Stable 5V Reference Supply
- Variable Dead-Time Provides Control Over Whole Range

### Function Table

| Output Control | Output Function                 |
|----------------|---------------------------------|
| Grounded       | Single-ended or Parallel Output |
| At $V_{ref}$   | Normal Push-Pull Operation      |



Standard deviation is derived from the formula

$$\sigma = \sqrt{\frac{\sum_{n=1}^N (X_n - \bar{X})^2}{N - 1}}$$

**RECOMMENDED OPERATION CONDITIONS**

| PARAMETER                                  | MIN  | MAX                | UNIT |
|--|------|--------------------|------|
| Supply Voltage                             | 7    | 40                 | V    |
| Amplifier Input Voltage                    | -0.3 | V <sub>CC</sub> -2 | V    |
| Collector Output Voltage                   |      | 40                 | V    |
| Collector Output Current (Each Transistor) |      | 200                | mA   |
| Current Into Feedback Terminal             |      | 0.3                | mA   |
| Timing Capacitor                           | 0.47 | 10000              | nF   |
| Timing Resistor                            | 1.8  | 500                | kΩ   |
| Oscillator Frequency                       | 1    | 300                | kHz  |
| Operating Free-Air Temperature             | -20  | 85                 | °C   |

**ABSOLUTE MAXIMUM RATINGS**

|   |                       |
|---|-----------------------|
| Supply Voltage                                  | 41V                   |
| Amplifier Input Voltage                         | V <sub>CC</sub> +0.3V |
| Collector Output Voltage                        | 41V                   |
| Continuous Total Dissipation at (or below) 25°C | 1000mW                |
| Operating Free-Air Temperature Range            | -20 to 85°C           |
| Storage Temperature Range                       | -65 to 150°C          |
| Collector Output Current                        | 250mA                 |

**Electrical Characteristics (Temperature -20...85°C, V<sub>CC</sub>=15V, f=10kHz)**
**REFERENCE SECTION**

| PARAMETER                              | TEST CONDITIONS                                  | MIN  | MAX  | UNIT |
|--|--|------|------|------|
| Output voltage (V <sub>ref</sub> )     | I <sub>o</sub> =1mA                              | 4.75 | 5.25 | V    |
| Input regulation                       | V <sub>CC</sub> =7V to 40V, T <sub>a</sub> =25°C |      | 25   | mV   |
| Output regulation                      | I <sub>o</sub> =1 to 10mA, T <sub>a</sub> =25°C  |      | 15   | mV   |
| Output voltage change with temperature | T <sub>a</sub> =-20 °C to 85 °C                  |      | 1    | %    |
| Short circuit output current           | V <sub>ref</sub>                                 |      | 60   | mV   |

**DEAD TIME CONTROL SECTION**

| PARAMETER                        | TEST CONDITIONS             | MIN | MAX | UNIT |
|----------------------------------|-----------------------------|-----|-----|------|
| Input bias current (pin 4)       | V <sub>i</sub> =0V to 5.25V |     | -10 | μA   |
| Maximum duty cycle (each output) | V <sub>i(pin 4)</sub> =0V   | 45  |     | %    |
| Input threshold voltage (pin 4)  | zero duty cycle             |     | 3.3 | V    |
|                                  | maximum duty cycle          | 0   |     | V    |

**ERROR AMPLIFIERS SECTION**

| PARAMETER                       | TEST CONDITIONS  |      | MIN                | MAX | UNIT |
|---------------------------------|--|------|--------------------|-----|------|
| Input offset voltage            | V <sub>o(pin 3)</sub> =2.5                                 |      |                    | 10  | mV   |
| Input offset current            | V <sub>o(pin 3)</sub> =2.5                                 |      |                    | 250 | nA   |
| Input bias current              | V <sub>o(pin 3)</sub> =2.5                                 |      |                    | 1   | μA   |
| Common mode input voltage range | V <sub>CC</sub> =7 to 40V                                  | LOW  | -0.3               |     | V    |
|                                 |  | HIGH | V <sub>CC</sub> -2 |     | V    |
| Open loop voltage amplification | ΔV <sub>o</sub> =3V, V <sub>o</sub> =0.5 to 3.5V           |      | 70                 |     | dB   |
| Unity-gain bandwidth            |  |      | 100                |     | kHz  |
| Common mode rejection ratio     | V <sub>CC</sub> =40V, T <sub>a</sub> =25°C                 |      | 65                 |     | dB   |
| Output sink current (pin 3)     | V <sub>ID</sub> =-15mV to -5V, V <sub>o(pin 3)</sub> =0.7V |      | 0.3                |     | mA   |
| Output source current (pin 3)   | V <sub>ID</sub> =15mV to 5V, V <sub>o(pin 3)</sub> =3.5V   |      | -2                 |     | mA   |

**DISSIPATION RATING TABLE**

| PACKAGE | T <sub>A</sub> = 25°C<br>POWER<br>RATING | OPERATING<br>FACTOR | DERATE ABOVE T <sub>A</sub> | T <sub>A</sub> =70°C<br>POWER RATING | T <sub>A</sub> =85°C<br>POWER RATING |
|---------|--|---------------------|-----------------------------|--------------------------------------|--------------------------------------|
| D       | 900 mW                                   | 7.6 mW/°C           | 25°C                        | 608 mw                               | 494 mW                               |
| N       | 1000 mW                                  | 9.2 mW/°C           | 41°C                        | 736 mW                               | 598 mW                               |

**PWM COMPARATOR SECTION**

| PARAMETER                       | TEST CONDITIONS           | MIN | MAX | UNIT |
|---------------------------------|---------------------------|-----|-----|------|
| Input threshold voltage (pin 3) | zero duty cycle           |     | 4.5 | V    |
| Input sink current (pin 3)      | $V_{o(\text{pin}3)}=0.7V$ | 0.3 |     | mA   |

**SWITCHING CHARACTERISTICS**

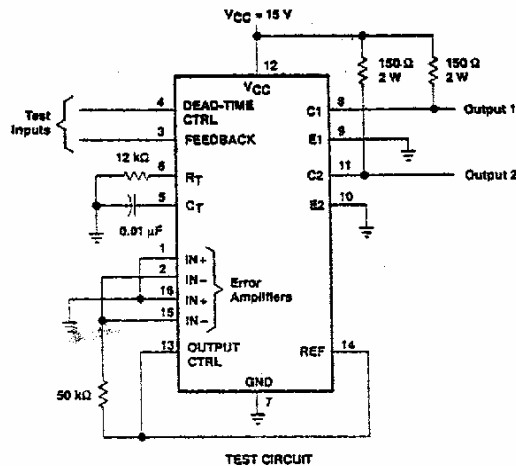
| PARAMETER                | TEST CONDITIONS  | MIN | MAX | UNIT |
|--------------------------|------------------|-----|-----|------|
| Output voltage rise time | Common emitter   |     | 200 | ns   |
| Output voltage fall time | configuration    |     | 100 | ns   |
| Output voltage rise time | Emitter-follower |     | 200 | ns   |
| Output voltage fall time | configuration    |     | 100 | ns   |

**OUTPUT SECTION**

| PARAMETER                    | TEST CONDITIONS           | MIN | MAX  | UNIT    |
|------------------------------|---------------------------|-----|------|---------|
| Collector off-state current  | $V_{CE}=40V, V_{CC}=40V$  |     | 100  | $\mu A$ |
| Emitter off-state current    | $V_{CC}=V_C=40V, V_E=40V$ |     | -100 | $\mu A$ |
| Collector - Emitter          | Common emitter            |     | 1.3  | V       |
| saturation voltage           | Emitter-follower          |     | 2.5  | V       |
| Output control input current | $V_i=V_{ref}$             |     | 3.5  | mA      |

**OSCILLATOR SECTION**

| PARAMETER                         | TEST CONDITIONS                                    | MIN | MAX | UNIT |
|-----------------------------------|--|-----|-----|------|
| Frequency                         | $C_T=0.01\mu F, R_T=12k\Omega$                     |     | 30  | kHz  |
| Standard deviation of frequency   | All Values of $V_{CC}, C_T, R_T, T_a$ are constant |     | 30  | %    |
| Frequency change with voltage     | $V_{CC}=7V$ to $40V, T_a=25^\circ C$               |     | 10  | %    |
| Frequency change with temperature | $C_T=0.01\mu F, R_T=12k\Omega,$                    |     | 2   |      |

**PARAMETER MEASUREMENT INFORMATION**


TEST CIRCUIT

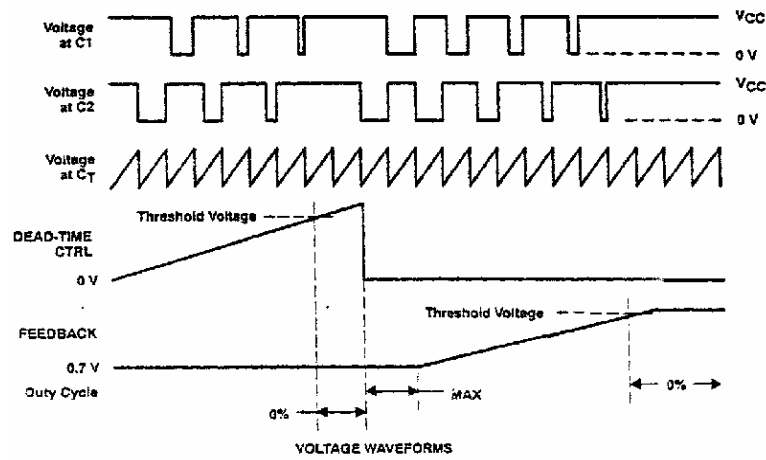


Figure 1. Operational Test Circuit and Waveforms

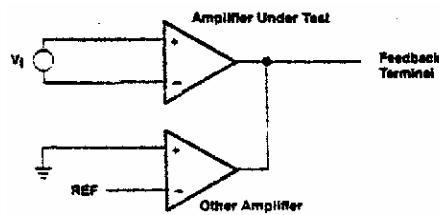


Figure 2. Amplifier Characteristics

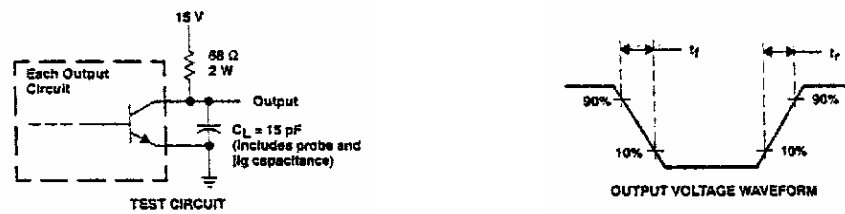


Figure 3. Common-Emitter Configuration

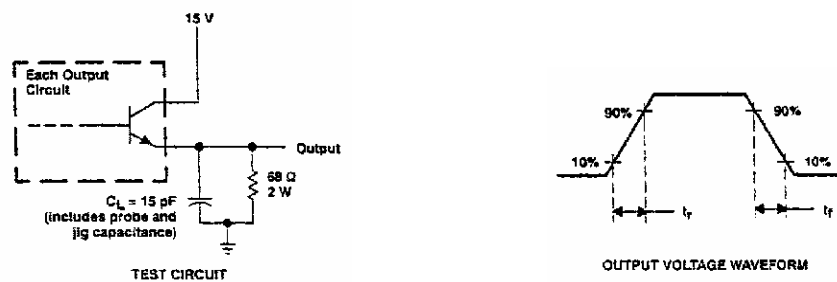


Figure 4. Emitter-Follower Configuration

**TYPICAL CHARACTERISTICS**  
**OSCILLATOR FREQUENCY AND FREQUENCY VARIATION**  
**VS**  
**TIMING RESISTANCE**

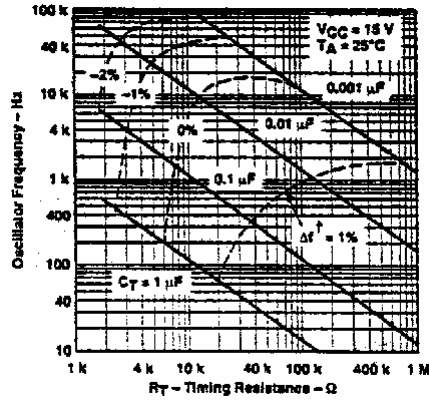


Figure 5

**AMPLIFIER VOLTAGE AMPLIFICATION vs FREQUENCY**

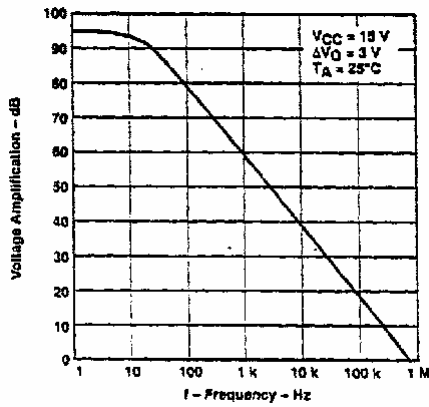
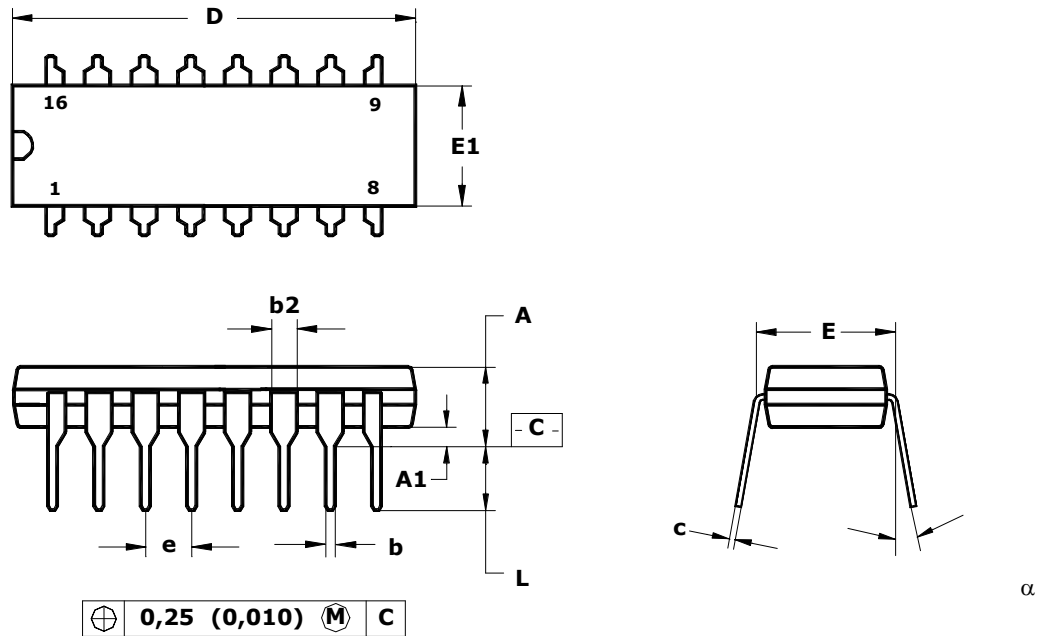
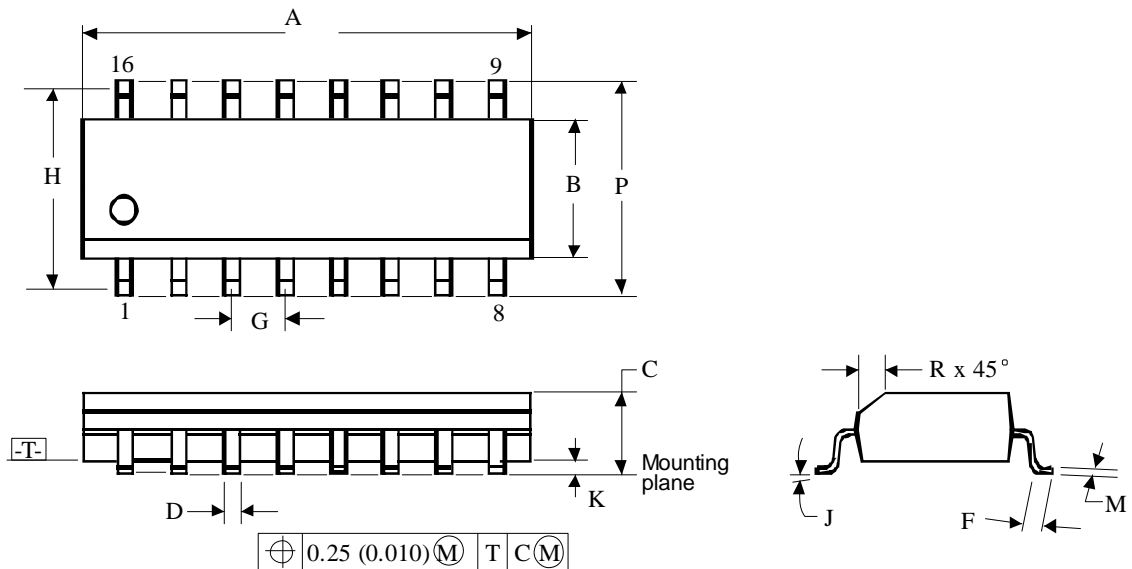


Figure 6

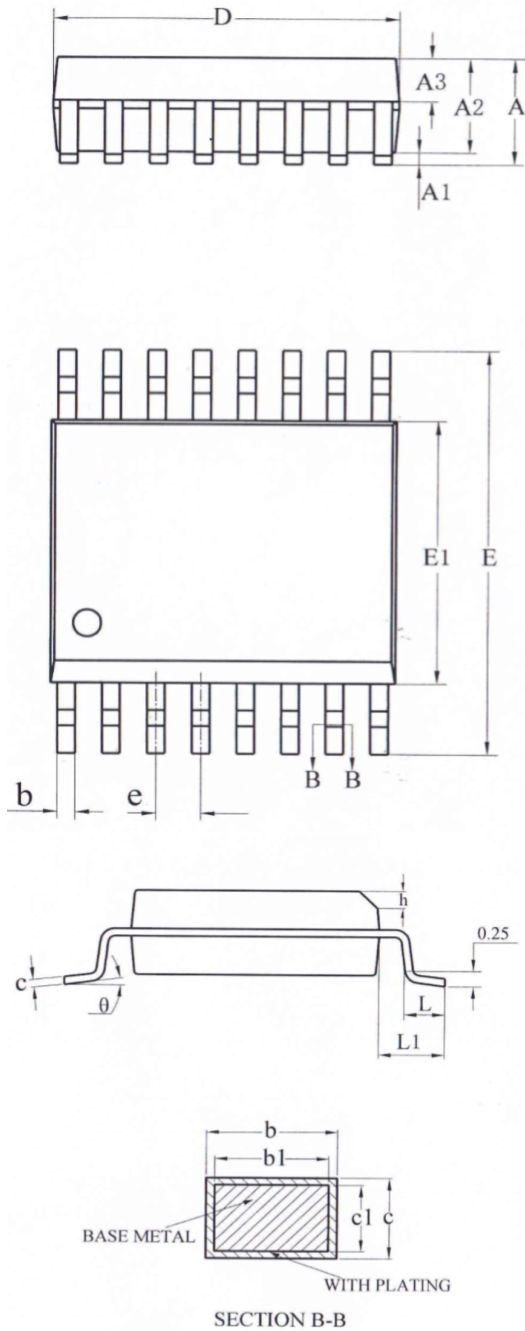
**Package Dimensions**  
**DIP16**


Note - Dimensions D, E1 do not include the fin value, which should not exceed 0.25 mm (0.010) per side.

|        | D     | E1    | A     | b     | b2    | e    | $\alpha$ | L     | E     | c     | A1    |
|--------|-------|-------|-------|-------|-------|------|----------|-------|-------|-------|-------|
| mm     |       |       |       |       |       |      |          |       |       |       |       |
| min    | 18.93 | 6.07  | —     | 0.36  | 1.14  | 2.54 | 0°       | 2.93  | 7.62  | 0.20  | 0.38  |
| max    | 19.43 | 7.11  | 5.33  | 0.56  | 1.78  |      | 15°      | 3.81  | 8.26  | 0.36  | —     |
| Inches |       |       |       |       |       |      |          |       |       |       |       |
| min    | 0.355 | 0.240 | —     | 0.014 | 0.045 | 0.1  | 0°       | 0.115 | 0.300 | 0.008 | 0.015 |
| max    | 0.400 | 0.280 | 0.210 | 0.022 | 0.070 |      | 15°      | 0.150 | 0.325 | 0.014 | —     |

**Package Dimensions**  
**SOP16**


|   |                             |                  |            |
|---|-----------------------------|------------------|------------|
| <b>Note:</b><br>1. Dimensional sizes A and B are preset without consideration of fin and the metal bulges.<br>2. Availability of the fin and the metal bulges for A – up to 0.15 mm (0.006) per side; for B – up to 0.25 mm (0.010) per side. | <b>Identifi-<br/>cation</b> | <b>Sizes, mm</b> |            |
|   |                             | <b>MIN</b>       | <b>MAX</b> |
|   | A                           | 9.80             | 10.0       |
|   | B                           | 3.80             | 4.00       |
|   | C                           | 1.35             | 1.75       |
|   | D                           | 0.33             | 0.51       |
|   | F                           | 0.40             | 1.27       |
|   | G                           | 1.27             |            |
|   | H                           | 5.72             |            |
|   | J                           | 0°               | 8°         |
|   | K                           | 0.10             | 0.25       |
|   | M                           | 0.19             | 0.25       |
|   | P                           | 5.80             | 6.20       |
| R   | 0.25                        | 0.50             |            |

**Package Dimensions**  
**TSSOP16**


| SYMBOL   | MILLIMETER |      |       |
|----------|------------|------|-------|
|          | MIN        | NOM  | MAX   |
| A        | —          | —    | 1.75  |
| A1       | 0.10       | —    | 0.225 |
| A2       | 1.30       | 1.40 | 1.50  |
| A3       | 0.55       | 0.60 | 0.65  |
| b        | 0.23       | —    | 0.31  |
| b1       | 0.22       | 0.25 | 0.28  |
| c        | 0.20       | —    | 0.24  |
| c1       | 0.19       | 0.20 | 0.21  |
| D        | 4.80       | 4.90 | 5.00  |
| E        | 5.80       | 6.00 | 6.20  |
| E1       | 3.80       | 3.90 | 4.00  |
| e        | 0.635BSC   |      |       |
| h        | 0.25       | —    | 0.50  |
| L        | 0.50       | 0.65 | 0.80  |
| L1       | 1.05REF    |      |       |
| $\theta$ | 0          | —    | 8°    |



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