

# TL1451A

## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

- Complete PWM Power Control Circuitry
- Completely Synchronized Operation
- Internal Undervoltage Lockout Protection
- Wide Supply Voltage Range
- Internal Short-Circuit Protection
- Oscillator Frequency . . . 500 kHz Max
- Variable Dead Time Provides Control Over Total Range
- Internal Regulator Provides a Stable 2.5-V Reference Supply
- Available in Q-Temp Automotive HighRel Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards

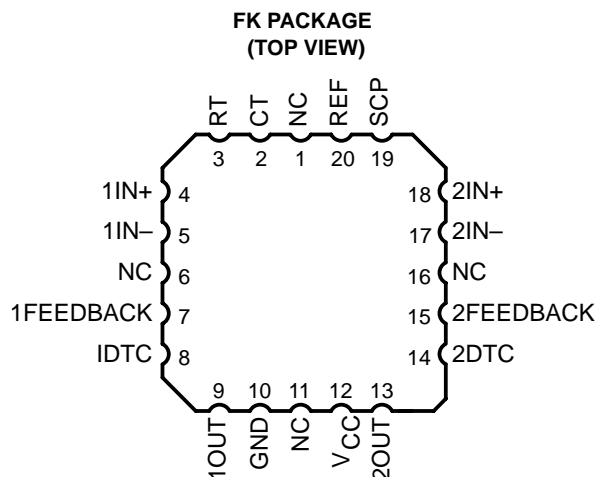
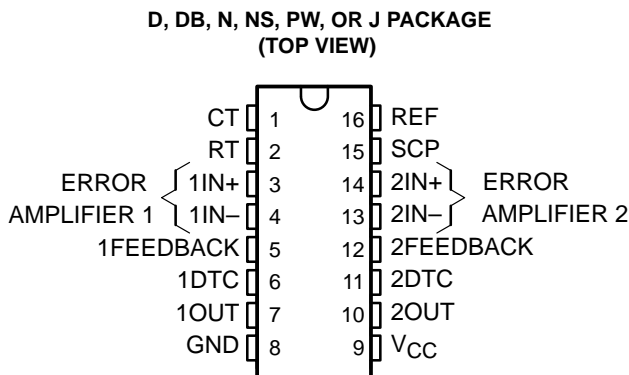
### description

The TL1451A incorporates on a single monolithic chip all the functions required in the construction of two pulse-width-modulation (PWM) control circuits. Designed primarily for power-supply control, the TL1451A contains an on-chip 2.5-V regulator, two error amplifiers, an adjustable oscillator, two dead-time comparators, undervoltage lockout circuitry, and dual common-emitter output transistor circuits.

The uncommitted output transistors provide common-emitter output capability for each

controller. The internal amplifiers exhibit a common-mode voltage range from 1.04 V to 1.45 V. The dead-time control (DTC) comparator has no offset unless externally altered and can provide 0% to 100% dead time. The on-chip oscillator can be operated by terminating RT and CT. During low  $V_{CC}$  conditions, the undervoltage lockout control circuit feature locks the outputs off until the internal circuitry is operational.

The TL1451AC is characterized for operation from  $-20^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The TL1451AQ is characterized for operation from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The TL1451AM is characterized for operation from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .



### AVAILABLE OPTIONS

| T <sub>A</sub>                                 | PACKAGED DEVICES  |                                 |                 |                    |                         |                   |                 |
|--|-------------------|---------------------------------|-----------------|--------------------|-------------------------|-------------------|-----------------|
|  | SMALL OUTLINE (D) | SMALL OUTLINE (DB) <sup>†</sup> | PLASTIC DIP (N) | SMALL OUTLINE (NS) | TSSOP (PW) <sup>†</sup> | CHIP CARRIER (FK) | CERAMIC DIP (J) |
| $-20^{\circ}\text{C}$ to $85^{\circ}\text{C}$  | TL1451ACD         | TL1451ACDB                      | TL1451ACN       | TL1451ACNS         | TL1451ACPW              | —                 | —               |
| $-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | TL1451AQD         | —                               | —               | —                  | —                       | —                 | —               |
| $-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | —                 | —                               | —               | —                  | —                       | TL1451AMFK        | TL1451AMJ       |

<sup>†</sup> The DB and PW packages are only available left-end taped and reeled (add LE suffix, i.e., TL1451ACPWLE).



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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.

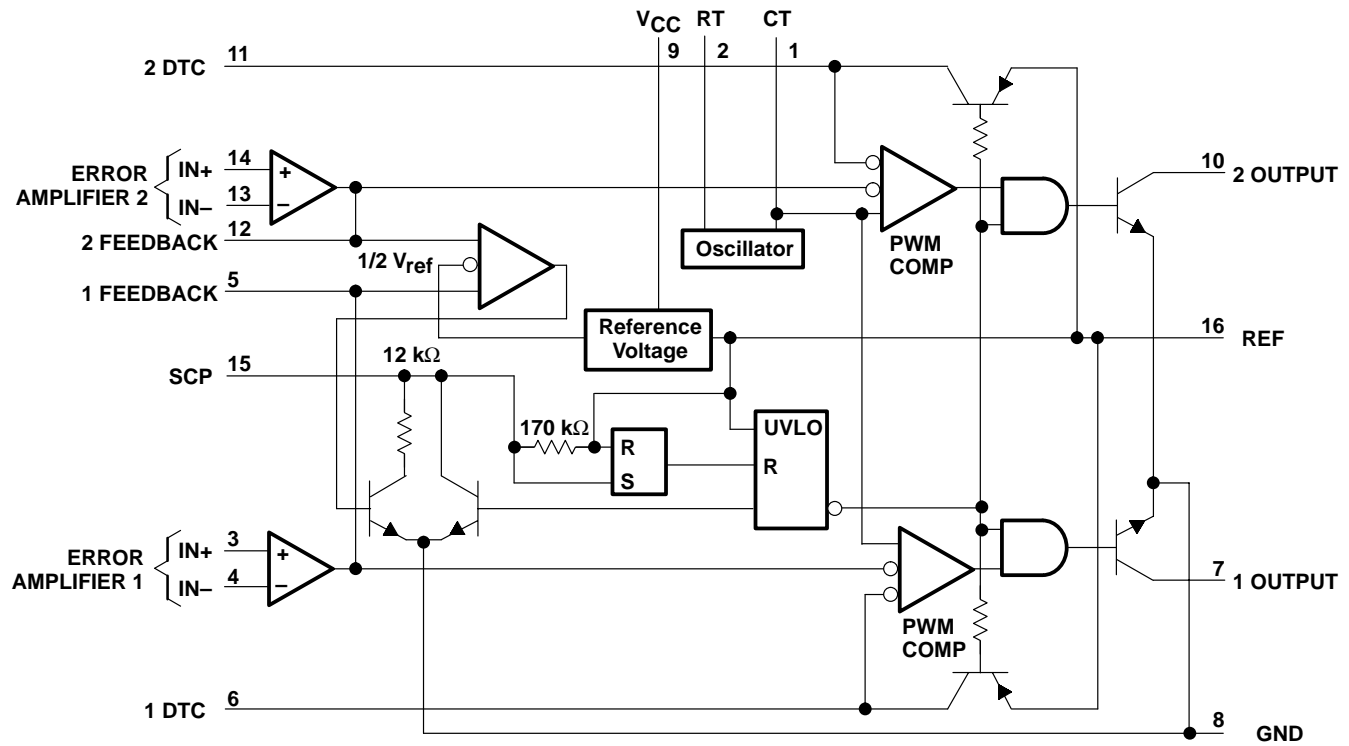
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# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## functional block diagram



### COMPONENT COUNT

|             |     |
|-------------|-----|
| Resistors   | 65  |
| Capacitors  | 8   |
| Transistors | 105 |
| JFETs       | 18  |



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## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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electrical characteristics over recommended operating free-air temperature range,  $V_{CC} = 6\text{ V}$ ,  $f = 200\text{ kHz}$  (unless otherwise noted)

### reference section

| PARAMETER                              | TEST CONDITIONS                                 | TL1451AC |       |           | UNIT |
|--|---|----------|-------|-----------|------|
|  |   | MIN      | TYP†  | MAX       |      |
| Output voltage (pin 16)                | $I_O = 1\text{ mA}$                             | 2.4      | 2.5   | 2.6       | V    |
| Output voltage change with temperature | $T_A = -20^\circ\text{C}$ to $25^\circ\text{C}$ |          | -0.1% | $\pm 1\%$ |      |
|  | $T_A = 25^\circ\text{C}$ to $85^\circ\text{C}$  |          | -0.2% | $\pm 1\%$ |      |
| Input voltage regulation               | $V_{CC} = 3.6\text{ V}$ to $40\text{ V}$        |          | 2     | 12.5      | mV   |
| Output voltage regulation              | $I_O = 0.1\text{ mA}$ to $1\text{ mA}$          |          | 1     | 7.5       | mV   |
| Short-circuit output current           | $V_O = 0$                                       | 3        | 10    | 30        | mA   |

† All typical values are at  $T_A = 25^\circ\text{C}$ .

### undervoltage lockout section

| PARAMETER                            | TEST CONDITIONS  | TL1451AC |      |     | UNIT |
|--------------------------------------|--|----------|------|-----|------|
|                                      |  | MIN      | TYP† | MAX |      |
| Upper threshold voltage ( $V_{CC}$ ) | $I_{O(\text{ref})} = 0.1\text{ mA}$ , $T_A = 25^\circ\text{C}$ |          | 2.72 |     | V    |
| Lower threshold voltage ( $V_{CC}$ ) |  |          | 2.6  |     | V    |
| Hysteresis ( $V_{CC}$ )              |  | 80       | 120  |     | mV   |
| Reset threshold voltage ( $V_{CC}$ ) |  | 1.5      | 1.9  |     | V    |

† All typical values are at  $T_A = 25^\circ\text{C}$ .

### short-circuit protection control section

| PARAMETER                               | TEST CONDITIONS                                 | TL1451AC |      |      | UNIT          |
|---|---|----------|------|------|---------------|
|   |   | MIN      | TYP† | MAX  |               |
| Input threshold voltage (SCP)           | $T_A = 25^\circ\text{C}$                        | 0.65     | 0.7  | 0.75 | V             |
| Standby voltage (SCP)                   | No pullup                                       | 140      | 185  | 230  | mV            |
| Latched input voltage (SCP)             | No pullup                                       |          | 60   | 120  | mV            |
| Input (source) current                  | $V_I = 0.7\text{ V}$ , $T_A = 25^\circ\text{C}$ | -10      | -15  | -20  | $\mu\text{A}$ |
| Comparator threshold voltage (FEEDBACK) |   |          | 1.18 |      | V             |

† All typical values are at  $T_A = 25^\circ\text{C}$ .

### oscillator section

| PARAMETER                         | TEST CONDITIONS                                   | TL1451C |       |           | UNIT |
|-----------------------------------|---|---------|-------|-----------|------|
|                                   |   | MIN     | TYP†  | MAX       |      |
| Frequency                         | $C_T = 330\text{ pF}$ , $R_T = 10\text{ k}\Omega$ |         | 200   |           | kHz  |
| Standard deviation of frequency   | $C_T = 330\text{ pF}$ , $R_T = 10\text{ k}\Omega$ |         | 10%   |           |      |
| Frequency change with voltage     | $V_{CC} = 3.6\text{ V}$ to $40\text{ V}$          |         | 1%    |           |      |
| Frequency change with temperature | $T_A = -20^\circ\text{C}$ to $25^\circ\text{C}$   |         | -0.4% | $\pm 2\%$ |      |
|                                   | $T_A = 25^\circ\text{C}$ to $85^\circ\text{C}$    |         | -0.2% | $\pm 2\%$ |      |

† All typical values are at  $T_A = 25^\circ\text{C}$ .

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## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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### dead-time control section

| PARAMETER                                   | TEST CONDITIONS        | TL1451AC |      |      | UNIT |
|---|------------------------|----------|------|------|------|
|   |                        | MIN      | TYP† | MAX  |      |
| Input bias current (DTC)                    |                        |          |      | 1    | μA   |
| Latch mode (source) current (DTC)           | T <sub>A</sub> = 25°C  | -80      | -145 |      | μA   |
| Latched input voltage (DTC)                 | I <sub>O</sub> = 40 μA | 2.3      |      |      | V    |
| Input threshold voltage at f = 10 kHz (DTC) | Zero duty cycle        |          | 2.05 | 2.25 | V    |
|   | Maximum duty cycle     | 1.2      | 1.45 |      |      |

† All typical values are at T<sub>A</sub> = 25°C.

### error-amplifier section

| PARAMETER                          | TEST CONDITIONS                                   | TL1451AC           |      |                       | UNIT |
|------------------------------------|---|--------------------|------|-----------------------|------|
|                                    |   | MIN                | TYP† | MAX                   |      |
| Input offset voltage               | V <sub>O</sub> (FEEDBACK) = 1.25 V                |                    |      | ±6                    | mV   |
| Input offset current               | V <sub>O</sub> (FEEDBACK) = 1.25 V                |                    |      | ±100                  | nA   |
| Input bias current                 | V <sub>O</sub> (FEEDBACK) = 1.25 V                |                    | 160  | 500                   | nA   |
| Common-mode input voltage range    | V <sub>CC</sub> = 3.6 V to 40 V                   | 1.05<br>to<br>1.45 |      |                       | V    |
| Open-loop voltage amplification    | R <sub>F</sub> = 200 kΩ                           | 70                 | 80   |                       | dB   |
| Unity-gain bandwidth               |   |                    | 1.5  |                       | MHz  |
| Common-mode rejection ratio        |   | 60                 | 80   |                       | dB   |
| Positive output voltage swing      |   |                    |      | V <sub>ref</sub> -0.1 | V    |
| Negative output voltage swing      |   |                    |      | 1                     | V    |
| Output (sink) current (FEEDBACK)   | V <sub>ID</sub> = -0.1 V, V <sub>O</sub> = 1.25 V | 0.5                | 1.6  |                       | mA   |
| Output (source) current (FEEDBACK) | V <sub>ID</sub> = 0.1 V, V <sub>O</sub> = 1.25 V  | -45                | -70  |                       | μA   |

† All typical values are at T<sub>A</sub> = 25°C.

### output section

| PARAMETER                    | TEST CONDITIONS        | TL1451AC |      |     | UNIT |
|------------------------------|------------------------|----------|------|-----|------|
|                              |                        | MIN      | TYP† | MAX |      |
| Collector off-state current  | V <sub>O</sub> = 50 V  |          |      | 10  | μA   |
| Output saturation voltage    | I <sub>O</sub> = 10 mA |          | 1.2  | 2   | V    |
| Short-circuit output current | V <sub>O</sub> = 6 V   |          | 90   |     | mA   |

† All typical values are at T<sub>A</sub> = 25°C.

### pwm comparator section

| PARAMETER  | TEST CONDITIONS    | TL1451AC |      |      | UNIT |
|--|--------------------|----------|------|------|------|
|  |                    | MIN      | TYP† | MAX  |      |
| Input threshold voltage at f = 10 kHz (FEEDBACK) | Zero duty cycle    |          | 2.05 | 2.25 | V    |
|  | Maximum duty cycle | 1.2      | 1.45 |      |      |

† All typical values are at T<sub>A</sub> = 25°C.

### total device

| PARAMETER              | TEST CONDITIONS        | TL1451AC |      |     | UNIT |
|------------------------|------------------------|----------|------|-----|------|
|                        |                        | MIN      | TYP† | MAX |      |
| Standby supply current | Off-state              |          | 1.3  | 1.8 | mA   |
| Average supply current | R <sub>T</sub> = 10 kΩ |          | 1.7  | 2.4 | mA   |

† All typical values are at T<sub>A</sub> = 25°C.

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## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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electrical characteristics over recommended operating free-air temperature range,  $V_{CC} = 6\text{ V}$ ,  $f = 200\text{ kHz}$  (unless otherwise noted)

### reference section

| PARAMETER                              | TEST CONDITIONS                         |   | TL1451AQ, TL1451AM |      |      | UNIT |
|--|---|---|--------------------|------|------|------|
|  |   |   | MIN                | TYP† | MAX  |      |
| Output voltage (pin 16)                | $I_O = 1\text{ mA}$                     | $T_A = 25^\circ\text{C}$                  | 2.40               | 2.50 | 2.60 | V    |
|  |   | $T_A = \text{MIN and } 125^\circ\text{C}$ | 2.35               | 2.46 | 2.65 |      |
| Output voltage change with temperature |   |   | -0.63%             |      | *±4% |      |
| Input voltage regulation               | $V_{CC} = 3.6\text{ V to } 40\text{ V}$ | $T_A = 25^\circ\text{C}$                  |                    | 2.0  | 12.5 | mV   |
|  |   | $T_A = 125^\circ\text{C}$                 |                    | 0.7  | 15   |      |
|  |   | $T_A = \text{MIN}$                        |                    | 0.3  | 30   |      |
| Output voltage regulation              | $I_O = 0.1\text{ mA to } 1\text{ mA}$   | $T_A = 25^\circ\text{C}$                  |                    | 1.0  | 7.5  | mV   |
|  |   | $T_A = 125^\circ\text{C}$                 |                    | 0.3  | 14   |      |
|  |   | $T_A = \text{MIN}$                        |                    | 0.3  | 20   |      |
| Short-circuit output current           | $V_O = 0$                               |   | 3                  | 10   | 30   | mA   |

\*These parameters are not production tested.

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

### undervoltage lockout section

| PARAMETER                            | TEST CONDITIONS |                           | TL1451AQ, TL1451AM |      |     | UNIT |
|--------------------------------------|-----------------|---------------------------|--------------------|------|-----|------|
|                                      |                 |                           | MIN                | TYP† | MAX |      |
| Upper threshold voltage ( $V_{CC}$ ) |                 | $T_A = 25^\circ\text{C}$  |                    | 2.72 |     | V    |
|                                      |                 | $T_A = 125^\circ\text{C}$ |                    | 1.70 |     |      |
|                                      |                 | $T_A = \text{MIN}$        |                    | 3.15 |     |      |
| Lower threshold voltage ( $V_{CC}$ ) |                 | $T_A = 25^\circ\text{C}$  |                    | 2.60 |     | V    |
|                                      |                 | $T_A = 125^\circ\text{C}$ |                    | 1.65 |     |      |
|                                      |                 | $T_A = \text{MIN}$        |                    | 3.09 |     |      |
| Hysteresis ( $V_{CC}$ )              |                 | $T_A = 25^\circ\text{C}$  | 80                 | 120  |     | mV   |
|                                      |                 | $T_A = 125^\circ\text{C}$ | 10                 | 50   |     |      |
|                                      |                 | $T_A = \text{MIN}$        | 10                 | 60   |     |      |
| Reset threshold voltage ( $V_{CC}$ ) |                 | $T_A = 25^\circ\text{C}$  |                    | 1.50 |     | V    |
|                                      |                 | $T_A = 125^\circ\text{C}$ |                    | 0.95 |     |      |
|                                      |                 | $T_A = \text{MIN}$        |                    | 1.50 |     |      |

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

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## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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### short-circuit protection control section

| PARAMETER                               | TEST CONDITIONS           | TL1451AQ, TL1451AM |      |     | UNIT       |
|---|---------------------------|--------------------|------|-----|------------|
|   |                           | MIN                | TYP† | MAX |            |
| Input threshold voltage (SCP)           | $T_A = 25^\circ\text{C}$  | 650                | 700  | 750 | mV         |
|   | $T_A = 125^\circ\text{C}$ | 400                | 478  | 550 |            |
|   | $T_A = \text{MIN}$        | 800                | 880  | 950 |            |
| Standby voltage (SCP)                   |                           | 140                | 185  | 230 | mV         |
| Latched input voltage (SCP)             | $T_A = 25^\circ\text{C}$  |                    | 60   | 120 | mV         |
|   | $T_A = 125^\circ\text{C}$ |                    | 70   | 120 |            |
|   | $T_A = \text{MIN}$        |                    | 60   | 120 |            |
| Equivalent timing resistance            |                           |                    | 170  |     | k $\Omega$ |
| Comparator threshold voltage (FEEDBACK) |                           |                    | 1.18 |     | V          |

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

### oscillator section

| PARAMETER                         | TEST CONDITIONS  | TL1451AQ, TL1451AM        |       |            | UNIT |
|-----------------------------------|--|---------------------------|-------|------------|------|
|                                   |  | MIN                       | TYP†  | MAX        |      |
| Frequency                         | $C_T = 330 \text{ pF}$ ,<br>$R_T = 10 \text{ k}\Omega$ | $T_A = 25^\circ\text{C}$  | 200   |            | kHz  |
|                                   |  | $T_A = 125^\circ\text{C}$ | 195   |            |      |
|                                   |  | $T_A = \text{MIN}$        | 193   |            |      |
| Standard deviation of frequency   | $C_T = 330 \text{ pF}$ , $R_T = 10 \text{ k}\Omega$    |                           | 2%    |            |      |
| Frequency change with voltage     | $V_{CC} = 3.6 \text{ V to } 40 \text{ V}$              | $T_A = 25^\circ\text{C}$  | 1%    |            |      |
|                                   |  | $T_A = 125^\circ\text{C}$ | 1%    |            |      |
|                                   |  | $T_A = \text{MIN}$        | 3%    |            |      |
| Frequency change with temperature |  |                           | 1.37% | $\pm 10\%$ |      |

\*These parameters are not production tested.

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

### dead-time control section

| PARAMETER   | TEST CONDITIONS                           | TL1451AQ, TL1451AM |      |       | UNIT          |
|---|---|--------------------|------|-------|---------------|
|   |   | MIN                | TYP† | MAX   |               |
| Input bias current (DTC)                              | $T_A = 25^\circ\text{C}$                  |                    |      | 1     | $\mu\text{A}$ |
|   | $T_A = \text{MIN and } 125^\circ\text{C}$ |                    |      | 3     |               |
| Latch mode (source) current (DTC)                     |   | -80                | -145 |       | $\mu\text{A}$ |
| Latched input voltage (DTC)                           | $T_A = 25^\circ\text{C}$                  | 2.30               |      | V     |               |
|   | $T_A = 125^\circ\text{C}$                 | 2.22               | 2.32 |       |               |
|   | $T_A = \text{MIN}$                        | 2.28               | 2.40 |       |               |
| Input threshold voltage at $f = 10 \text{ kHz}$ (DTC) | Zero duty cycle                           |                    | 2.05 | *2.25 | V             |
|   | Maximum duty cycle                        | *1.20              | 1.45 |       |               |

\*These parameters are not production tested.

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

# TL1451A

## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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### error-amplifier section

| PARAMETER                          | TEST CONDITIONS                                 | TL1451AQ, TL1451AM        |      |     | UNIT |
|------------------------------------|---|---------------------------|------|-----|------|
|                                    |   | MIN                       | TYP† | MAX |      |
| Input offset voltage               | $V_O$ (FEEDBACK) = 1.25 V                       | $T_A = 25^\circ\text{C}$  | ±6   |     | mV   |
|                                    |   | $T_A = 125^\circ\text{C}$ | ±10  |     |      |
|                                    |   | $T_A = \text{MIN}$        | ±12  |     |      |
| Input offset current               | $V_O$ (FEEDBACK) = 1.25 V                       | $T_A = 25^\circ\text{C}$  | ±100 |     | nA   |
|                                    |   | $T_A = 125^\circ\text{C}$ | ±100 |     |      |
|                                    |   | $T_A = \text{MIN}$        | ±200 |     |      |
| Input bias current                 | $V_O$ (FEEDBACK) = 1.25 V                       | $T_A = 25^\circ\text{C}$  | 160  | 500 | nA   |
|                                    |   | $T_A = 125^\circ\text{C}$ | 100  | 500 |      |
|                                    |   | $T_A = \text{MIN}$        | 142  | 700 |      |
| Common-mode input voltage range    | $V_{CC} = 3.6 \text{ V to } 40 \text{ V}$       | 1.05<br>to<br>1.45        |      |     | V    |
| Open-loop voltage amplification    | $R_F = 200 \text{ k}\Omega$                     | $T_A = 25^\circ\text{C}$  | 70   | 80  | dB   |
|                                    |   | $T_A = 125^\circ\text{C}$ | 70   | 80  |      |
|                                    |   | $T_A = \text{MIN}$        | 64   | 80  |      |
| Unity-gain bandwidth               |   | 1.5                       |      | MHz |      |
| Common-mode rejection ratio        |   | 60                        | 80   | dB  |      |
| Positive output voltage swing      |   | 2                         |      | V   |      |
| Negative output voltage swing      |   | 1                         |      | V   |      |
| Output (sink) current (FEEDBACK)   | $V_{ID} = -0.1 \text{ V}, V_O = 1.25 \text{ V}$ | $T_A = 25^\circ\text{C}$  | 0.5  | 1.6 | mA   |
|                                    |   | $T_A = 125^\circ\text{C}$ | 0.4  | 1.8 |      |
|                                    |   | $T_A = \text{MIN}$        | 0.3  | 1.7 |      |
| Output (source) current (FEEDBACK) | $V_{ID} = 0.1 \text{ V}, V_O = 1.25 \text{ V}$  | $T_A = 25^\circ\text{C}$  | -45  | -70 | μA   |
|                                    |   | $T_A = 125^\circ\text{C}$ | -25  | -50 |      |
|                                    |   | $T_A = \text{MIN}$        | -15  | -70 |      |

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

### output section

| PARAMETER                    | TEST CONDITIONS           | TL1451AQ, TL1451AM |      |      | UNIT |
|------------------------------|---------------------------|--------------------|------|------|------|
|                              |                           | MIN                | TYP† | MAX  |      |
| Collector off-state current  | $V_O = 50 \text{ V}$      |                    |      | 10   | μA   |
| Output saturation voltage    | $T_A = 25^\circ\text{C}$  |                    |      | 1.20 | V    |
|                              | $T_A = 125^\circ\text{C}$ |                    |      | 1.60 |      |
|                              | $T_A = \text{MIN}$        |                    |      | 1.36 |      |
| Short-circuit output current | $V_O = 6 \text{ V}$       |                    |      | 90   | mA   |

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

### pwm comparator section

| PARAMETER  | TEST CONDITIONS    | TL1451AQ, TL1451AM |      |       | UNIT |
|--|--------------------|--------------------|------|-------|------|
|  |                    | MIN                | TYP† | MAX   |      |
| Input threshold voltage at $f = 10 \text{ kHz}$ (FEEDBACK) | Zero duty cycle    |                    |      | 2.05  | V    |
|  | Maximum duty cycle | *1.20              | 1.45 | *2.25 |      |

\*These parameters are not production tested.

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.



# TL1451A

## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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### total device

| PARAMETER              | TEST CONDITIONS           | TL1451AQ, TL1451AM |      |     | UNIT |
|------------------------|---------------------------|--------------------|------|-----|------|
|                        |                           | MIN                | TYP† | MAX |      |
| Standby supply current | Off-state                 |                    | 1.3  | 1.8 | mA   |
| Average supply current | $R_T = 10\text{ k}\Omega$ |                    | 1.7  | 2.4 | mA   |

† All typical values are at  $T_A = 25^\circ\text{C}$  unless otherwise indicated.

### PARAMETER MEASUREMENT INFORMATION

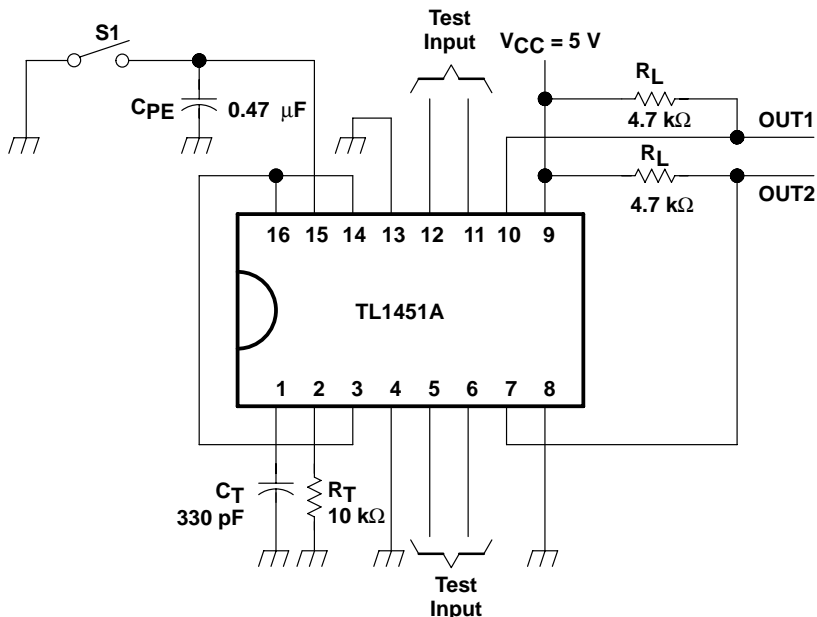
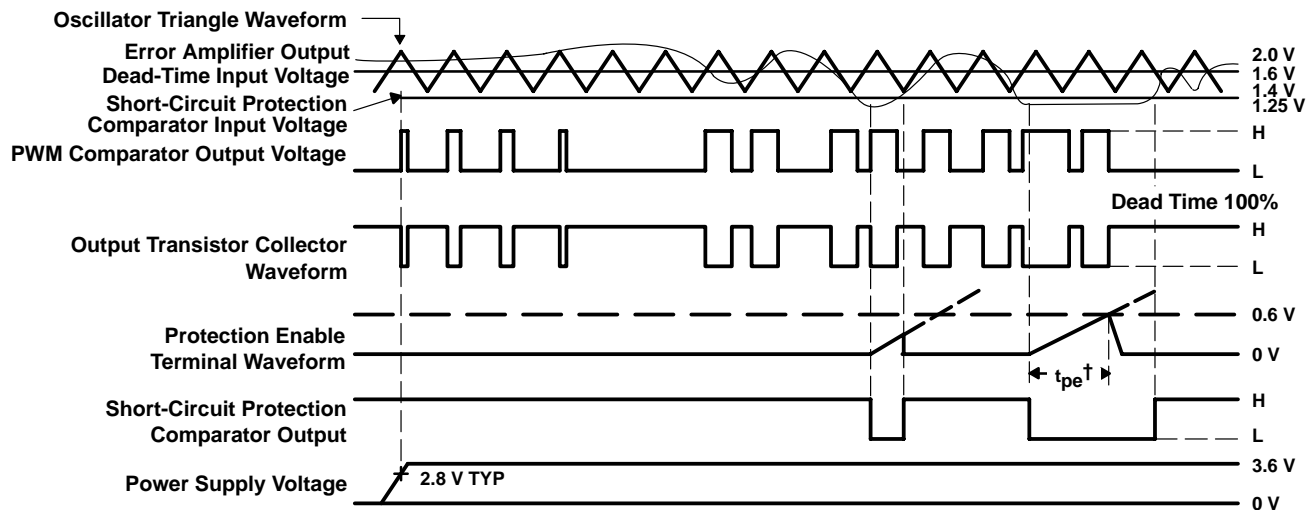


Figure 1. Test Circuit



† Protection Enable Time,  $t_{pe} = (0.051 \times 10^6 \times C_{pe})$  in seconds

Figure 2. TL1451A Timing Diagram

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## TYPICAL CHARACTERISTICS

TRIANGLE OSCILLATOR FREQUENCY  
vs  
TIMING RESISTANCE

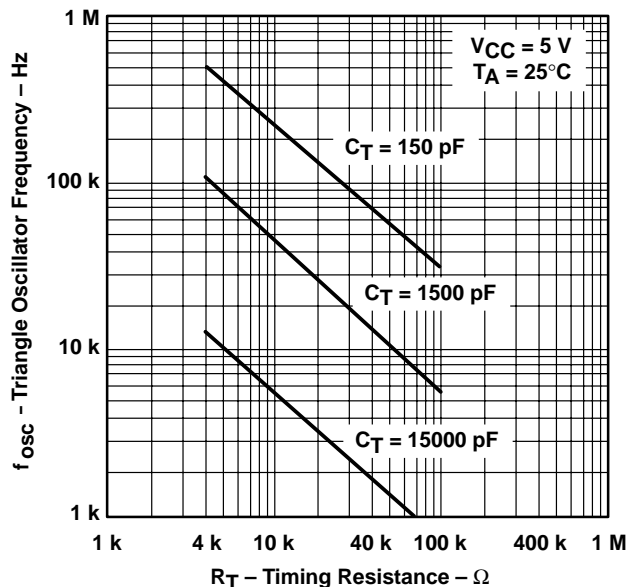


Figure 3

OSCILLATOR FREQUENCY VARIATION  
vs  
FREE-AIR TEMPERATURE

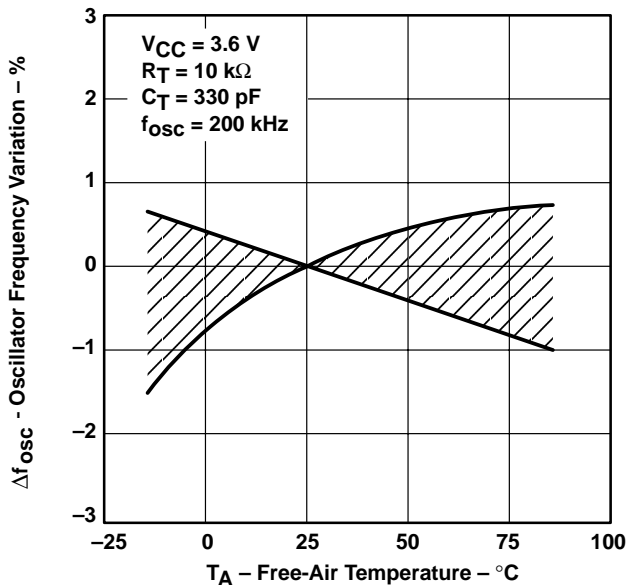


Figure 4

TRIANGLE WAVEFORM SWING VOLTAGE  
vs  
TIMING CAPACITANCE

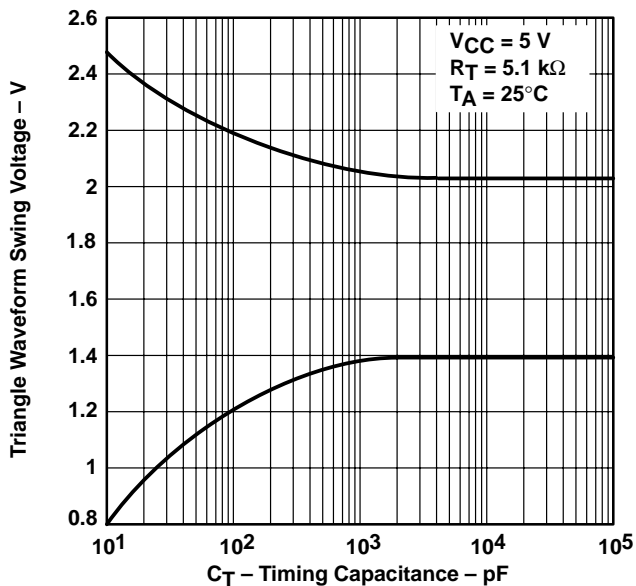


Figure 5

TRIANGLE WAVEFORM PERIOD  
vs  
TIMING CAPACITANCE

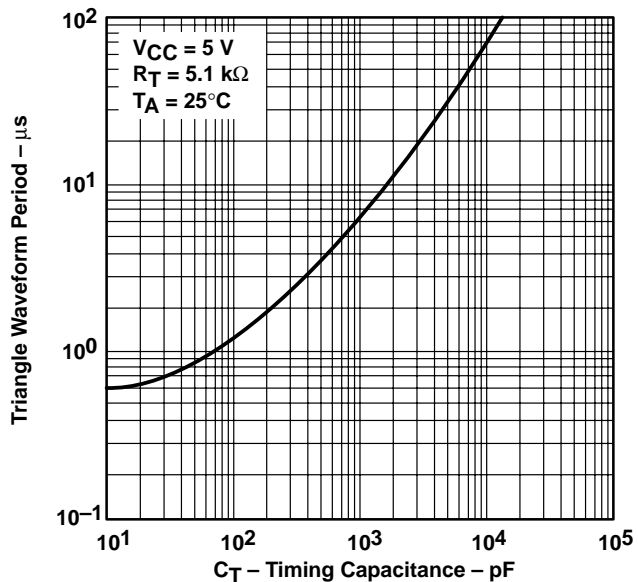
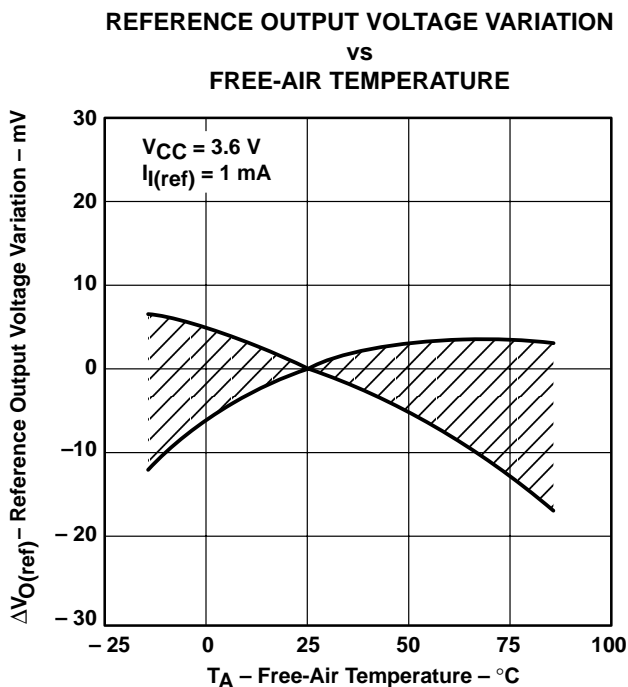
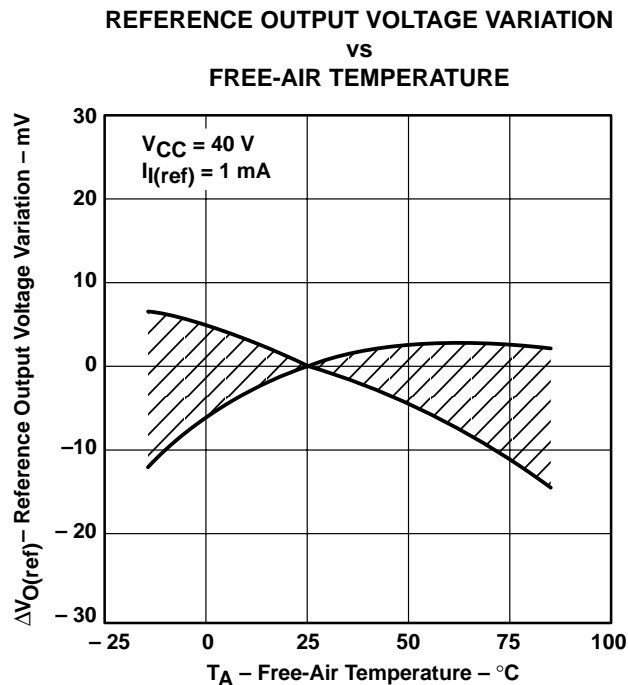


Figure 6

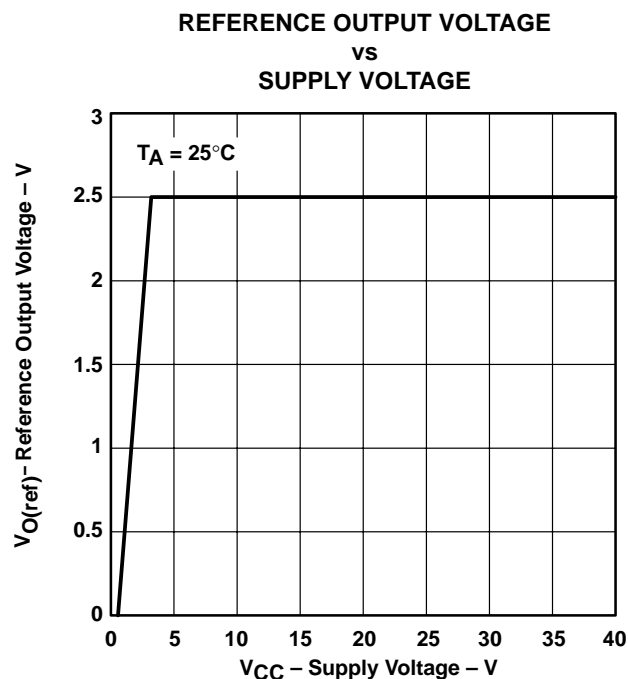
**TYPICAL CHARACTERISTICS**



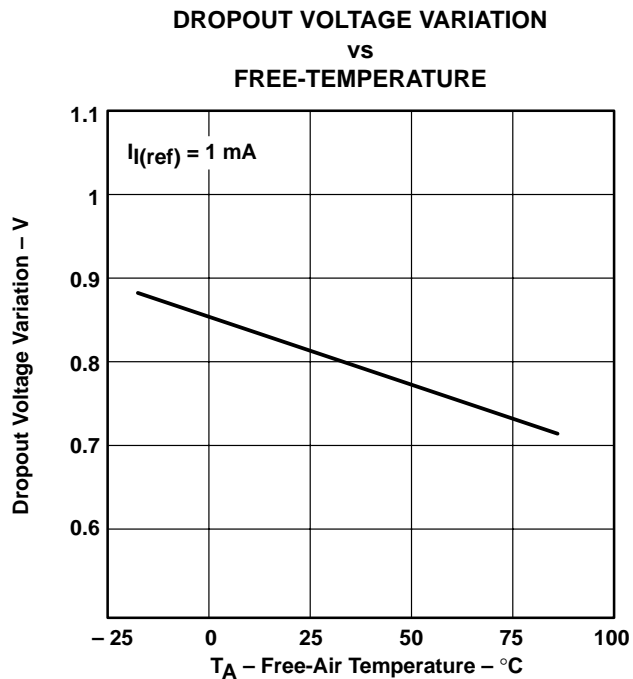
**Figure 7**



**Figure 8**



**Figure 9**



**Figure 10**

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## TYPICAL CHARACTERISTICS

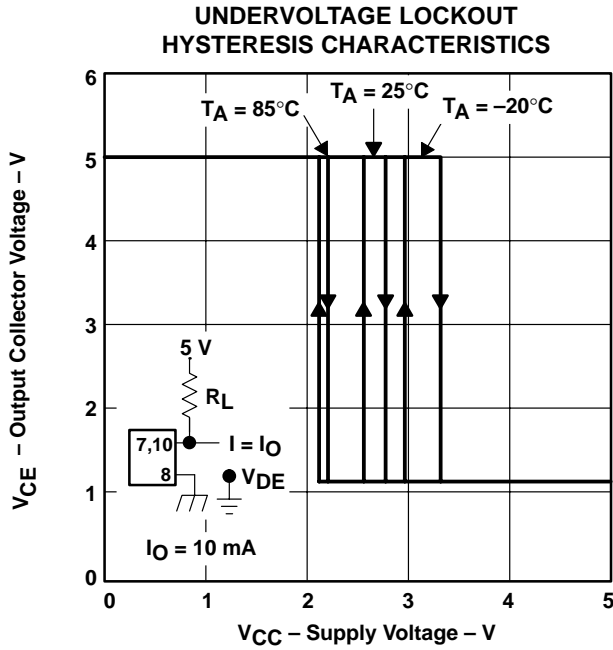


Figure 11

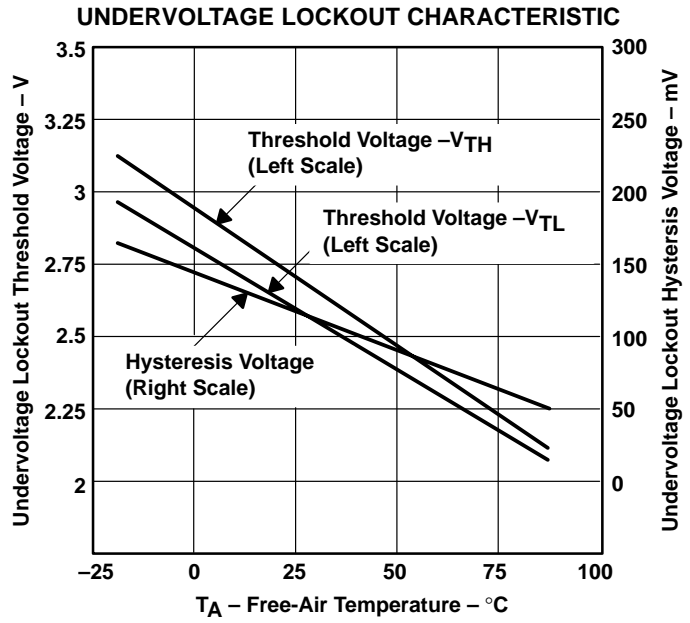


Figure 12

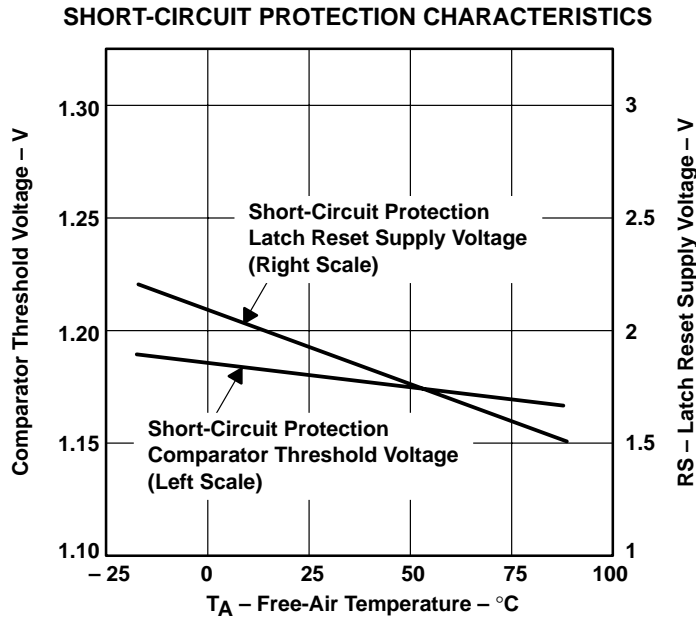
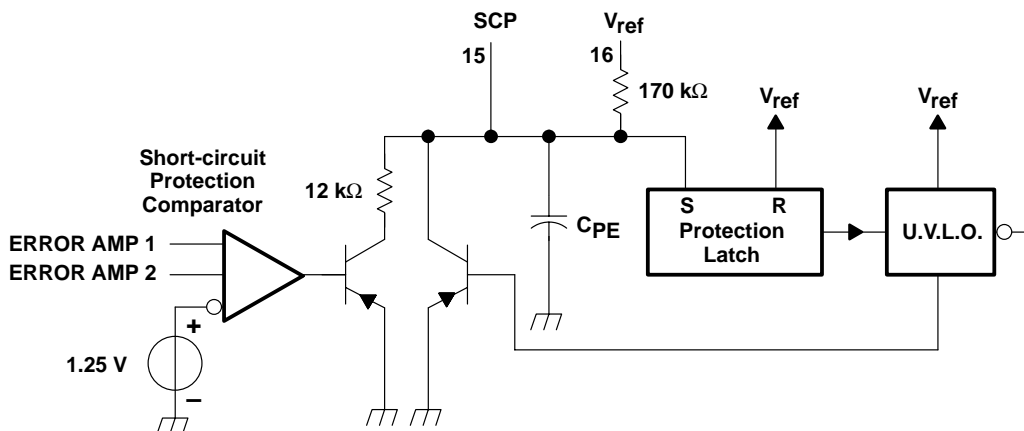
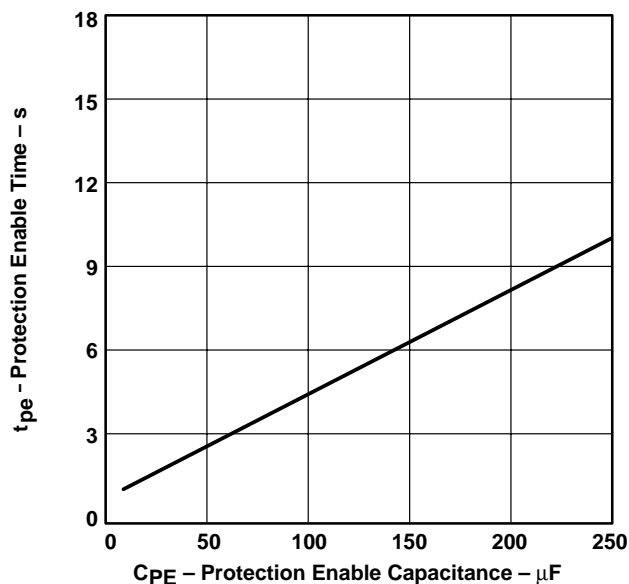


Figure 13

**TYPICAL CHARACTERISTICS**

**PROTECTION ENABLE TIME  
vs  
PROTECTION ENABLE CAPACITANCE**



**Figure 14**

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## TYPICAL CHARACTERISTICS

**ERROR AMP MAXIMUM OUTPUT VOLTAGE SWING  
vs  
FREQUENCY**

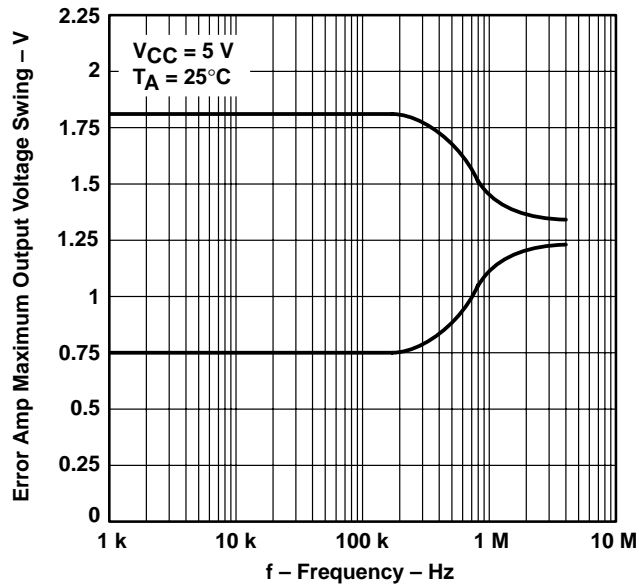


Figure 15

**OPEN-LOOP VOLTAGE AMPLIFICATION  
vs  
FREQUENCY**

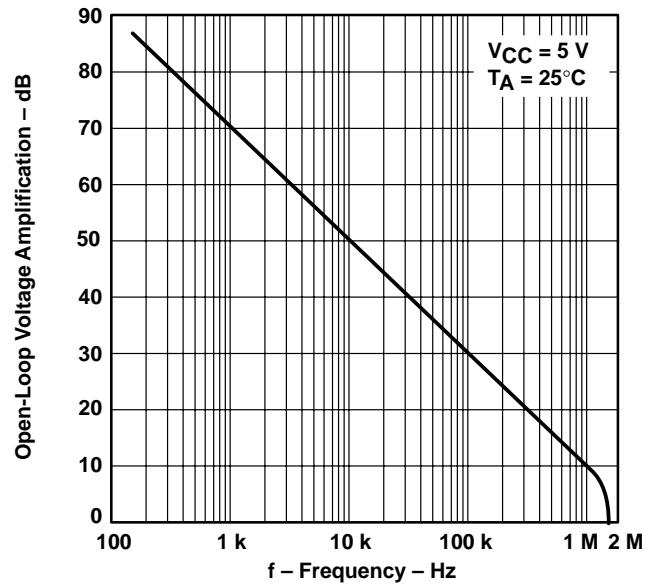


Figure 16

**GAIN (AMPLIFIER IN  
UNITY-GAIN CONFIGURATION)  
vs  
FREQUENCY**

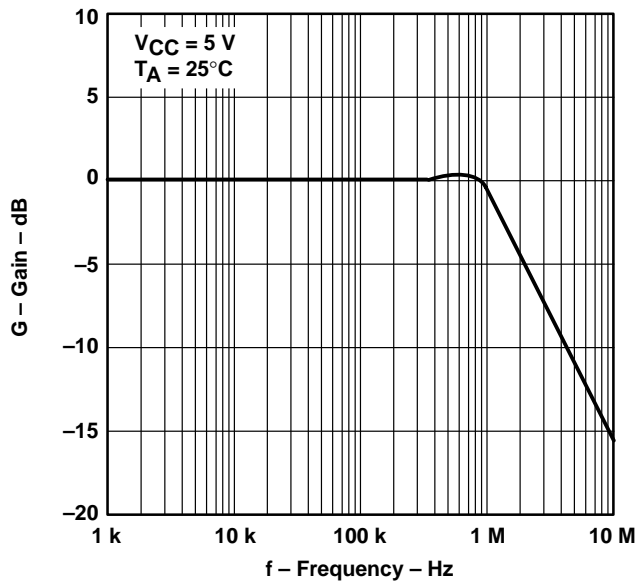
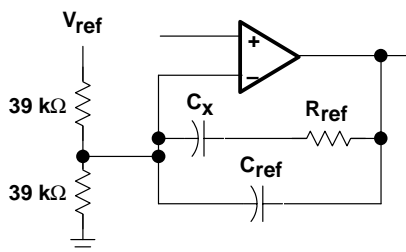
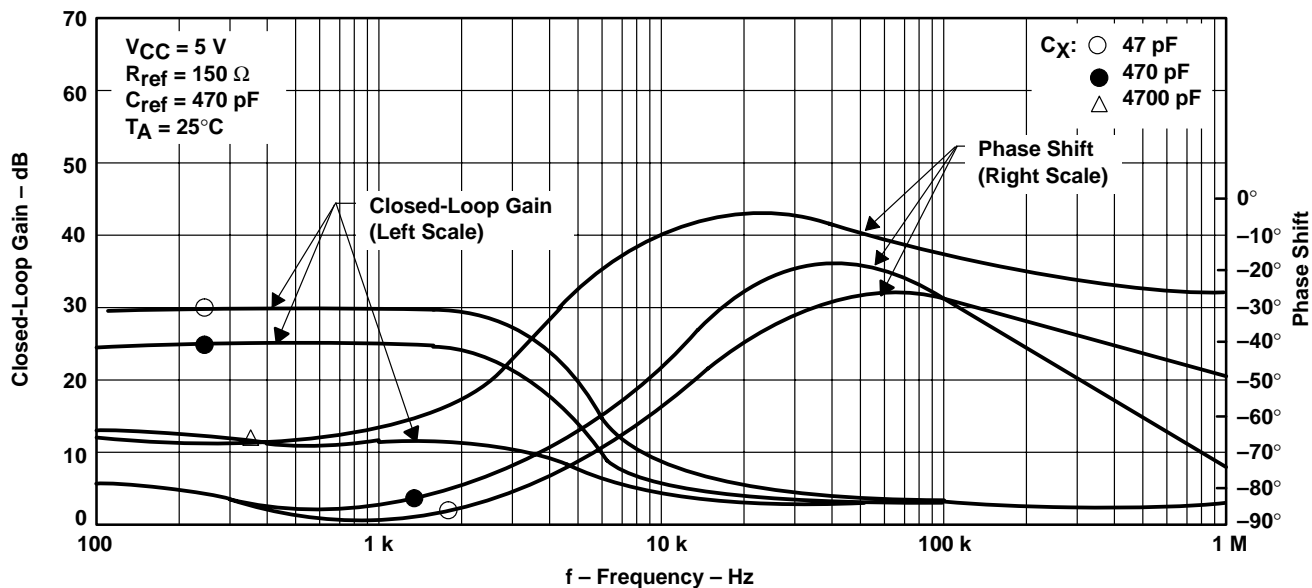


Figure 17

## TYPICAL CHARACTERISTICS

### CLOSED-LOOP GAIN AND PHASE SHIFT VS FREQUENCY



Test Circuit

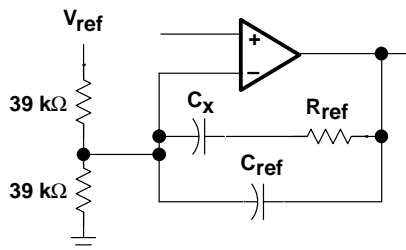
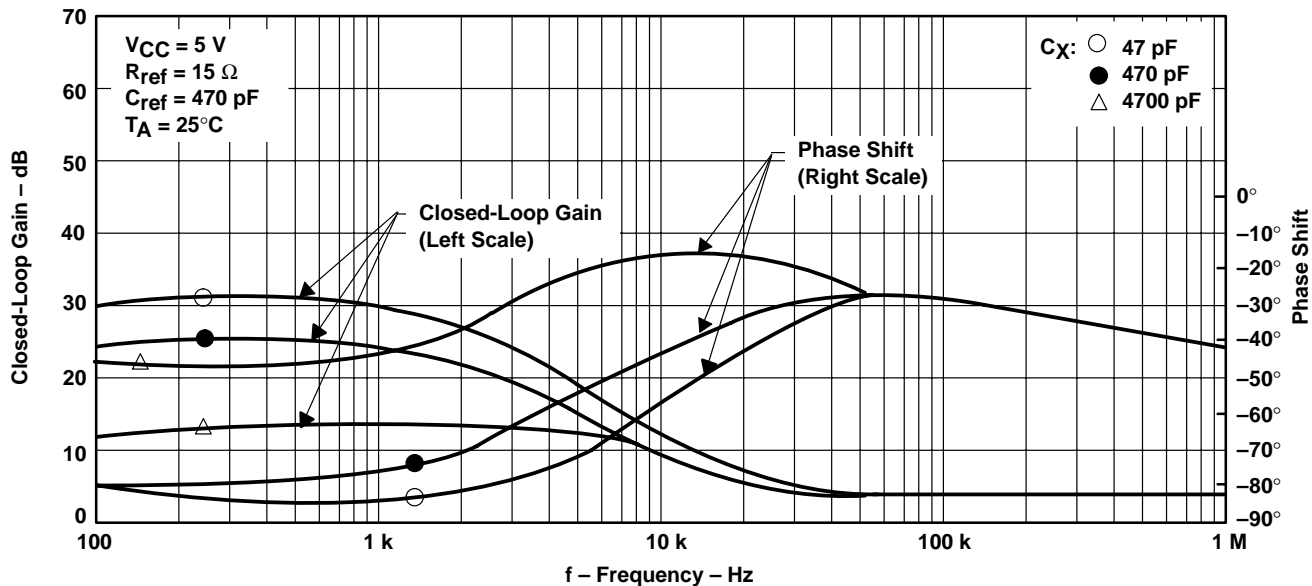
Figure 18

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## TYPICAL CHARACTERISTICS

### CLOSED-LOOP GAIN AND PHASE SHIFT vs FREQUENCY



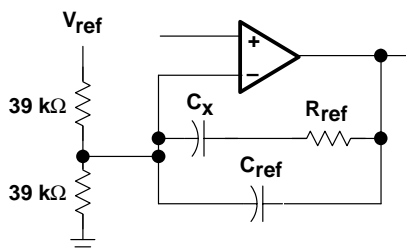
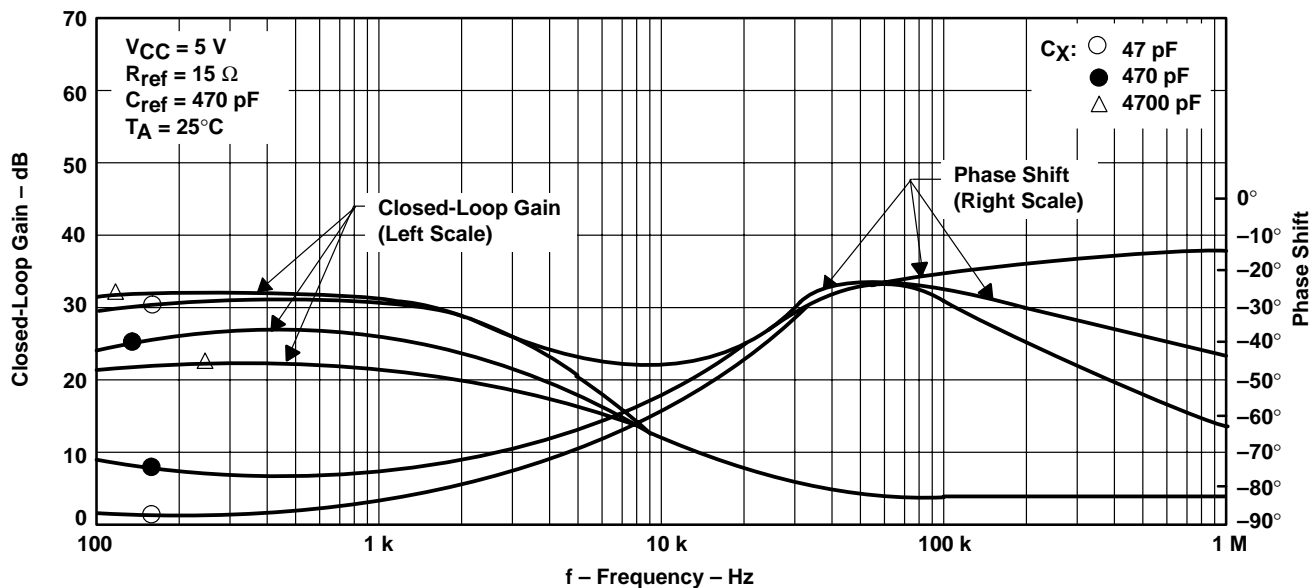
Test Circuit

Figure 19



## TYPICAL CHARACTERISTICS

### CLOSED-LOOP GAIN AND PHASE SHIFT VS FREQUENCY



Test Circuit

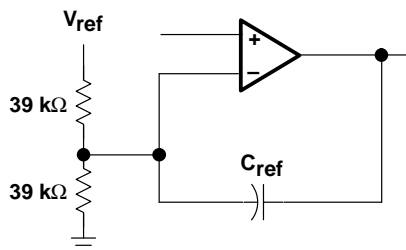
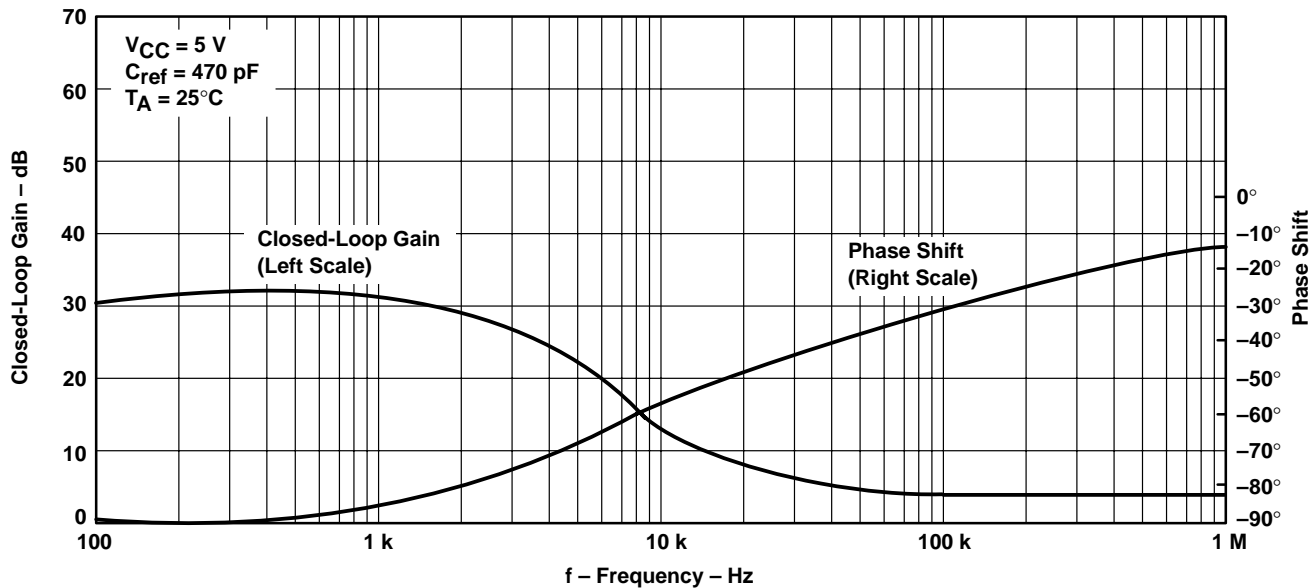
Figure 20

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## TYPICAL CHARACTERISTICS

### CLOSED-LOOP GAIN AND PHASE SHIFT vs FREQUENCY



Test Circuit

Figure 21

**TYPICAL CHARACTERISTICS**

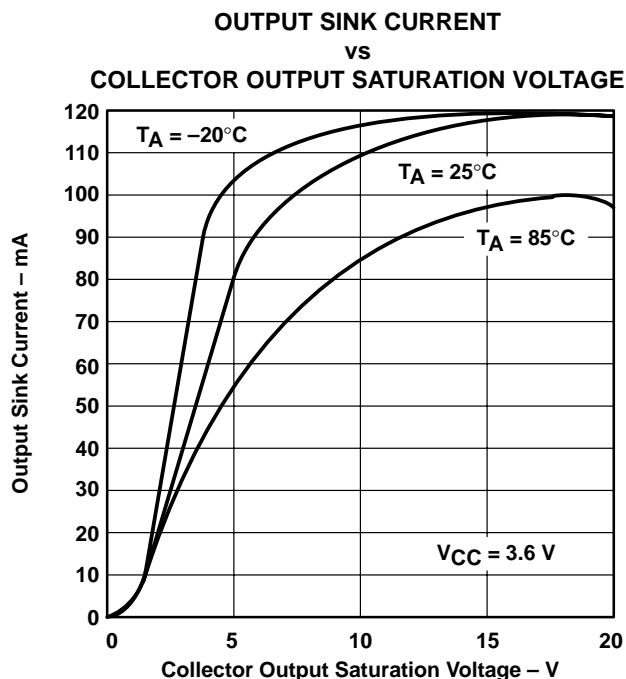
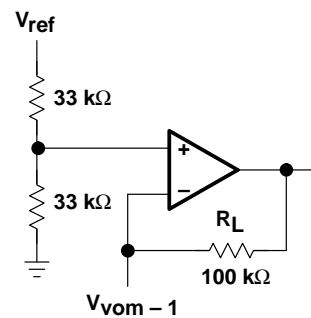
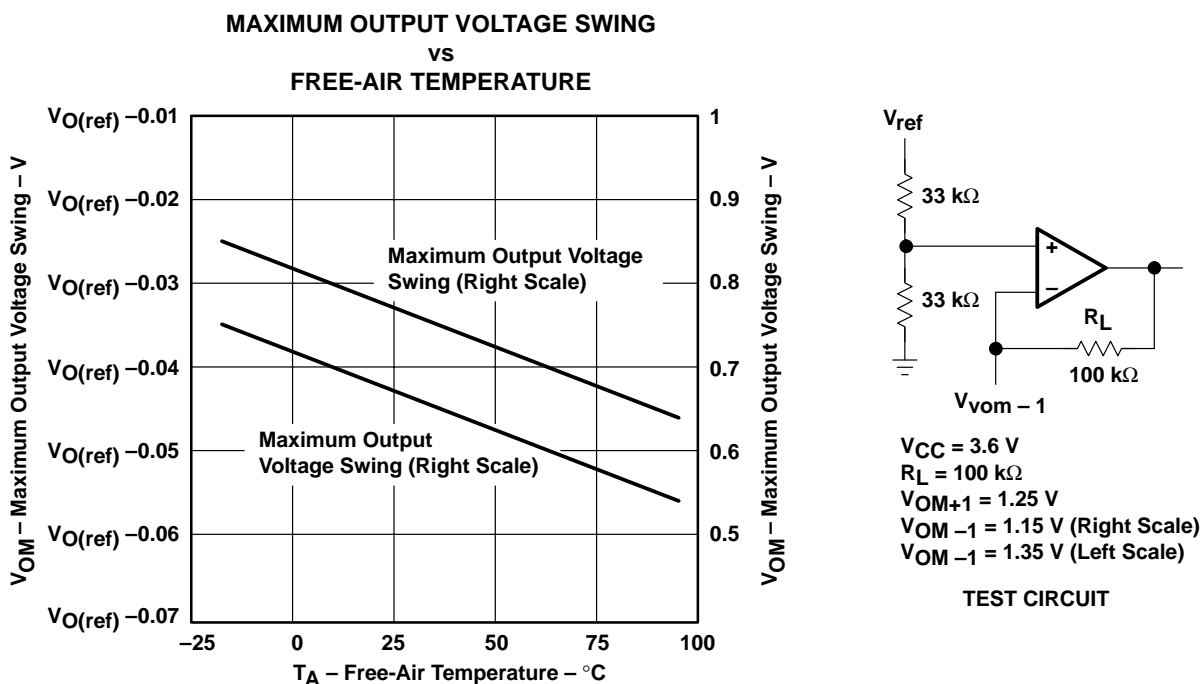


Figure 22



$V_{CC} = 3.6\text{ V}$   
 $R_L = 100\text{ k}\Omega$   
 $V_{\text{OM}+1} = 1.25\text{ V}$   
 $V_{\text{OM} - 1} = 1.15\text{ V}$  (Right Scale)  
 $V_{\text{OM} - 1} = 1.35\text{ V}$  (Left Scale)

TEST CIRCUIT

Figure 23

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## TYPICAL CHARACTERISTICS

OUTPUT TRANSISTOR ON DUTY CYCLE  
vs  
DEAD-TIME INPUT VOLTAGE

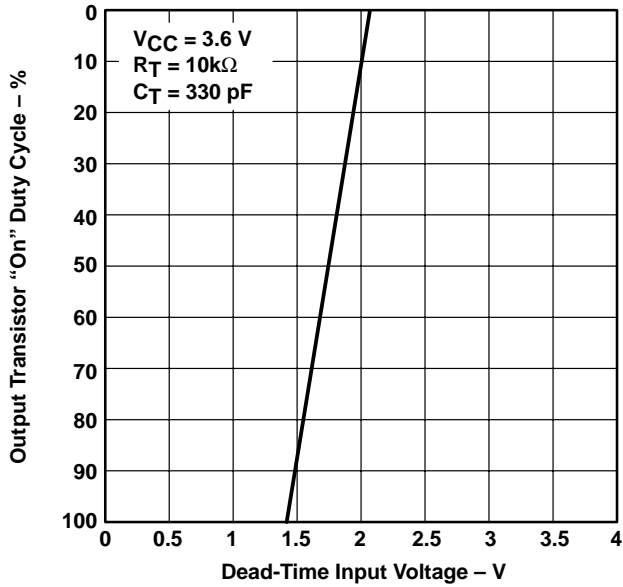


Figure 24

STANDBY CURRENT  
vs  
SUPPLY VOLTAGE

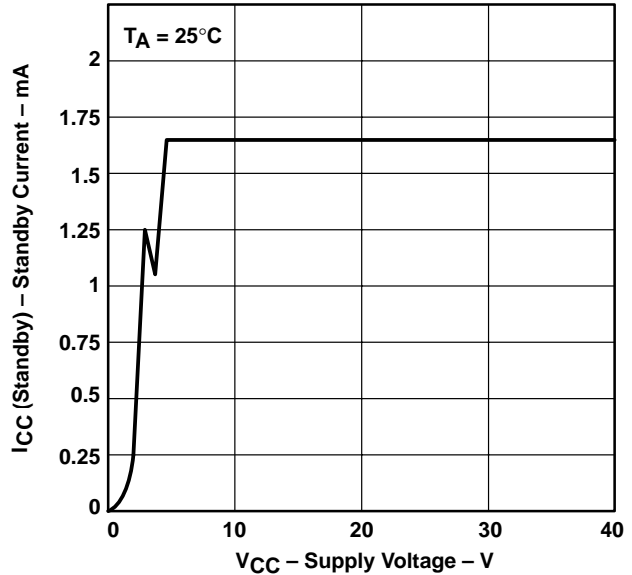


Figure 25

STANDBY CURRENT  
vs  
FREE-AIR TEMPERATURE

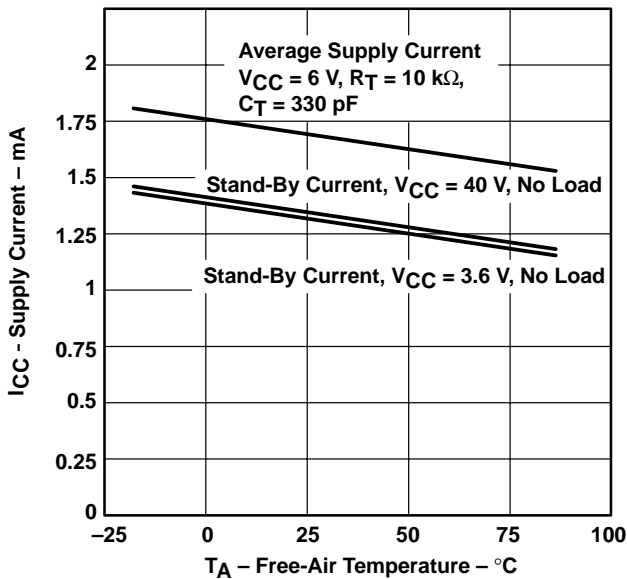


Figure 26

MAXIMUM CONTINUOUS POWER DISSIPATION  
vs  
FREE-AIR TEMPERATURE

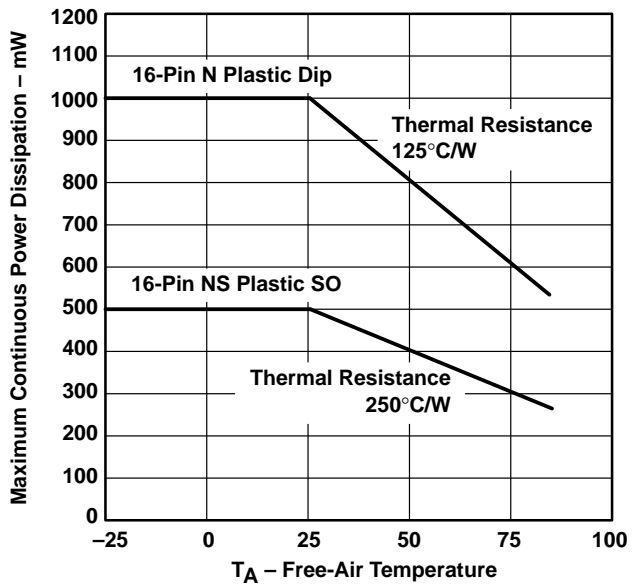


Figure 27



**PACKAGING INFORMATION**

| Orderable part number         | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">TL1451ACD</a>     | Active        | Production           | SOIC (D)   16   | 40   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | TL1451AC            |
| <a href="#">TL1451ACDBR</a>   | Active        | Production           | SSOP (DB)   16  | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | T1451A              |
| <a href="#">TL1451ACDR</a>    | Active        | Production           | SOIC (D)   16   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | TL1451AC            |
| <a href="#">TL1451ACN</a>     | Active        | Production           | PDIP (N)   16   | 25   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -20 to 85    | TL1451ACN           |
| <a href="#">TL1451ACNS</a>    | Active        | Production           | SOP (NS)   16   | 50   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | 0 to 0       | TL1451A             |
| <a href="#">TL1451ACNSR</a>   | Active        | Production           | SOP (NS)   16   | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | TL1451A             |
| <a href="#">TL1451ACPW</a>    | Active        | Production           | TSSOP (PW)   16 | 90   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | T1451A              |
| <a href="#">TL1451ACPWR</a>   | Active        | Production           | TSSOP (PW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | T1451A              |
| <a href="#">TL1451ACPWRG4</a> | Active        | Production           | TSSOP (PW)   16 | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | T1451A              |
| <a href="#">TL1451AQD</a>     | Active        | Production           | SOIC (D)   16   | 40   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | TL1451AQ            |
| <a href="#">TL1451AQDR</a>    | Active        | Production           | SOIC (D)   16   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | TL1451AQ            |
| <a href="#">TL1451CN</a>      | Active        | Production           | PDIP (N)   16   | 25   TUBE             | Yes         | NIPDAU                               | N/A for Pkg Type                  | -20 to 85    | TL1451CN            |
| <a href="#">TL1451CNS</a>     | Active        | Production           | SOP (NS)   16   | 50   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | TL1451              |
| <a href="#">TL1451CNSR</a>    | Active        | Production           | SOP (NS)   16   | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | TL1451              |
| <a href="#">TL1451INSR</a>    | Active        | Production           | SOP (NS)   16   | 2000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -20 to 85    | TL1451I             |

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**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.

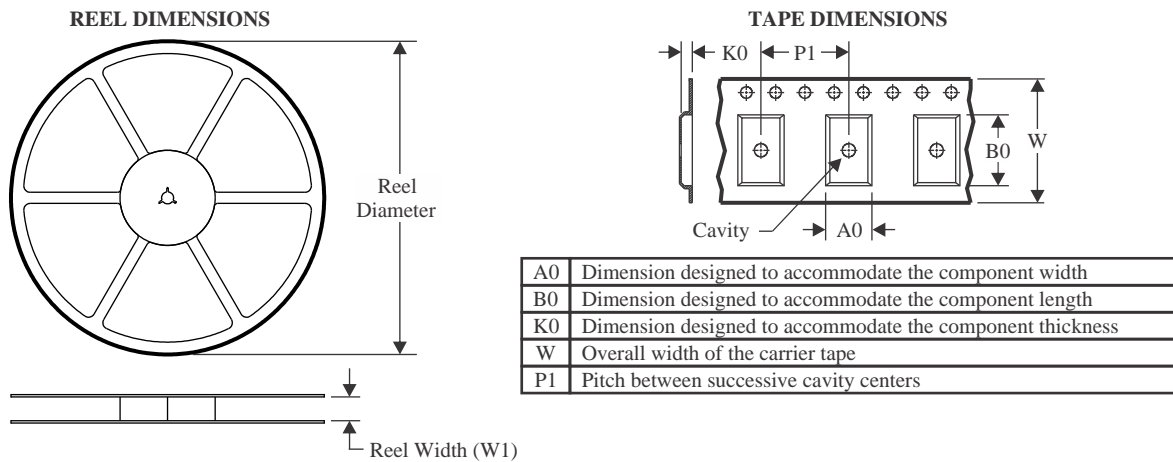
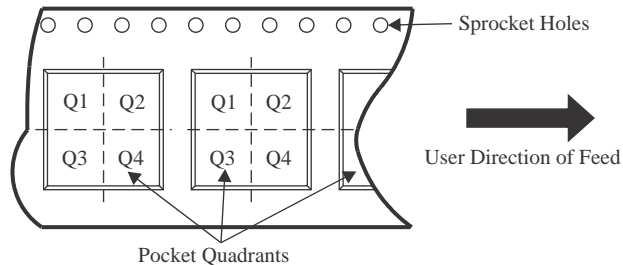
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TL1451A :**

- Automotive : [TL1451A-Q1](#)
- Enhanced Product : [TL1451A-EP](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

**TAPE AND REEL INFORMATION**

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


\*All dimensions are nominal

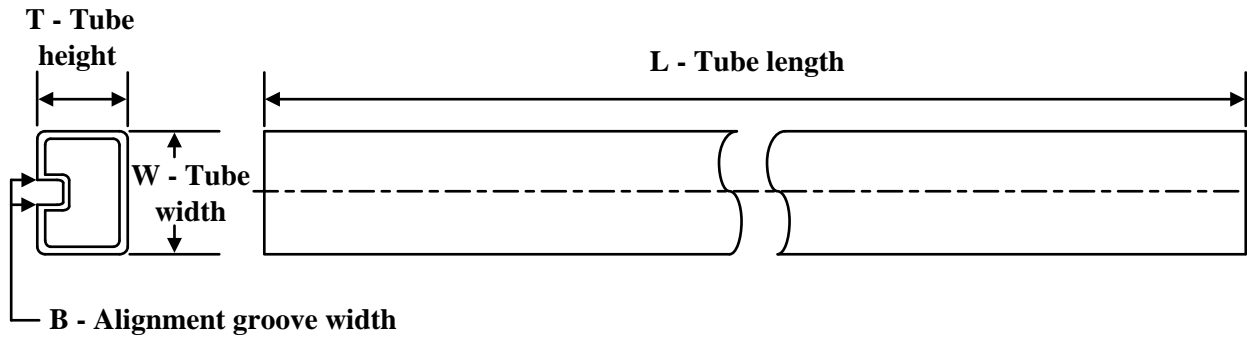
| Device      | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TL1451ACDBR | SSOP         | DB              | 16   | 2000 | 330.0              | 16.4               | 8.35    | 6.6     | 2.5     | 12.0    | 16.0   | Q1            |
| TL1451ACDR  | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |
| TL1451ACNSR | SOP          | NS              | 16   | 2000 | 330.0              | 16.4               | 8.45    | 10.55   | 2.5     | 12.0    | 16.2   | Q1            |
| TL1451ACPWR | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TL1451AQDR  | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |
| TL1451CNSR  | SOP          | NS              | 16   | 2000 | 330.0              | 16.4               | 8.1     | 10.4    | 2.5     | 12.0    | 16.0   | Q1            |
| TL1451INSR  | SOP          | NS              | 16   | 2000 | 330.0              | 16.4               | 8.1     | 10.4    | 2.5     | 12.0    | 16.0   | Q1            |



**TAPE AND REEL BOX DIMENSIONS**

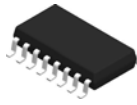

\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TL1451ACDBR | SSOP         | DB              | 16   | 2000 | 356.0       | 356.0      | 35.0        |
| TL1451ACDR  | SOIC         | D               | 16   | 2500 | 353.0       | 353.0      | 32.0        |
| TL1451ACNSR | SOP          | NS              | 16   | 2000 | 356.0       | 356.0      | 35.0        |
| TL1451ACPWR | TSSOP        | PW              | 16   | 2000 | 356.0       | 356.0      | 35.0        |
| TL1451AQDR  | SOIC         | D               | 16   | 2500 | 350.0       | 350.0      | 43.0        |
| TL1451CNSR  | SOP          | NS              | 16   | 2000 | 356.0       | 356.0      | 35.0        |
| TL1451INSR  | SOP          | NS              | 16   | 2000 | 356.0       | 356.0      | 35.0        |

**TUBE**


\*All dimensions are nominal

| Device     | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TL1451ACD  | D            | SOIC         | 16   | 40  | 505.46 | 6.76   | 3810   | 4      |
| TL1451ACD  | D            | SOIC         | 16   | 40  | 507    | 8      | 3940   | 4.32   |
| TL1451ACN  | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| TL1451ACNS | NS           | SOP          | 16   | 50  | 530    | 10.5   | 4000   | 4.1    |
| TL1451ACPW | PW           | TSSOP        | 16   | 90  | 530    | 10.2   | 3600   | 3.5    |
| TL1451AQD  | D            | SOIC         | 16   | 40  | 505.46 | 6.76   | 3810   | 4      |
| TL1451CN   | N            | PDIP         | 16   | 25  | 506    | 13.97  | 11230  | 4.32   |
| TL1451CNS  | NS           | SOP          | 16   | 50  | 530    | 10.5   | 4000   | 4.1    |

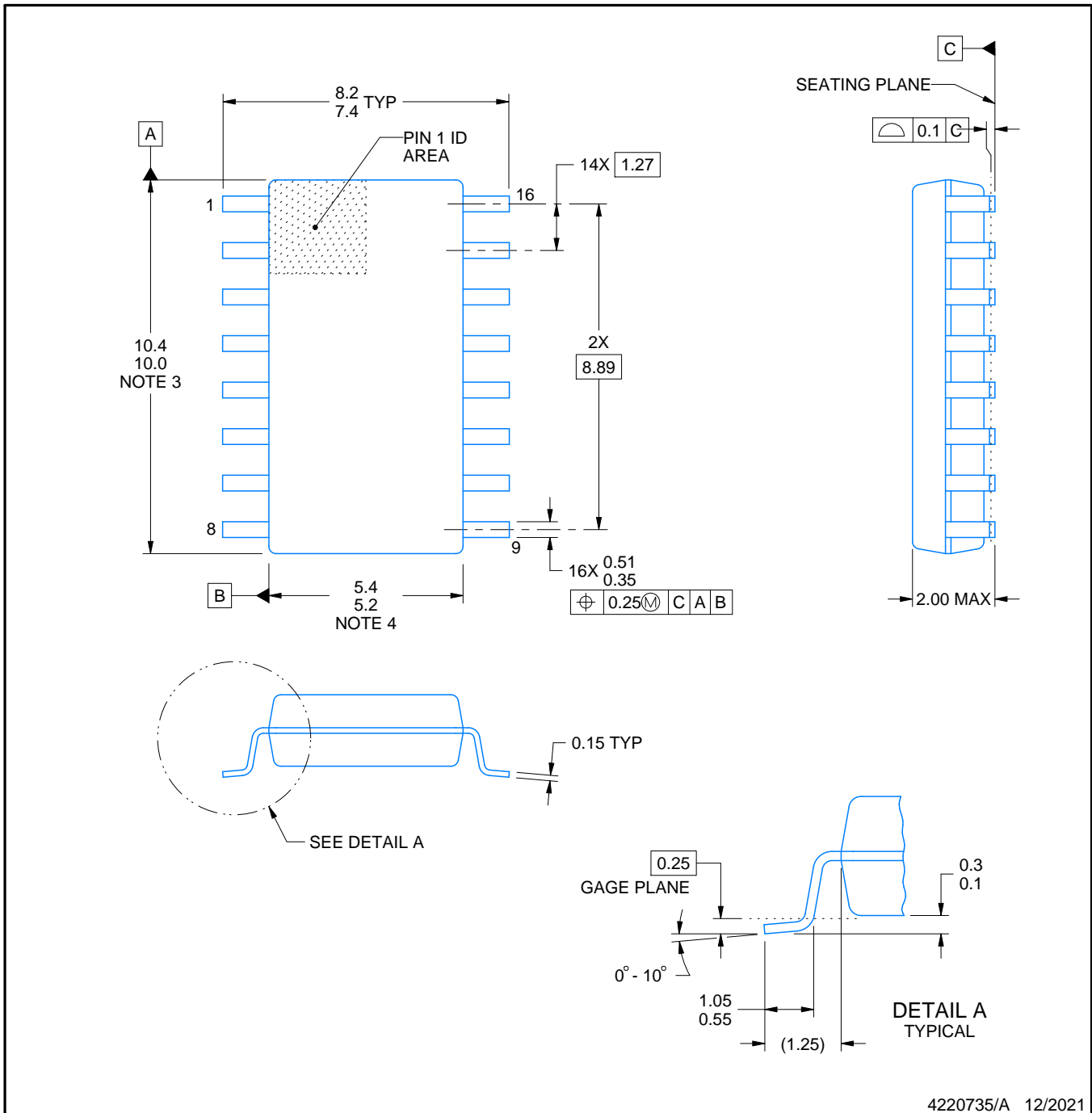


# PACKAGE OUTLINE

## NS0016A

### SOP - 2.00 mm max height

SOP



4220735/A 12/2021

#### NOTES:

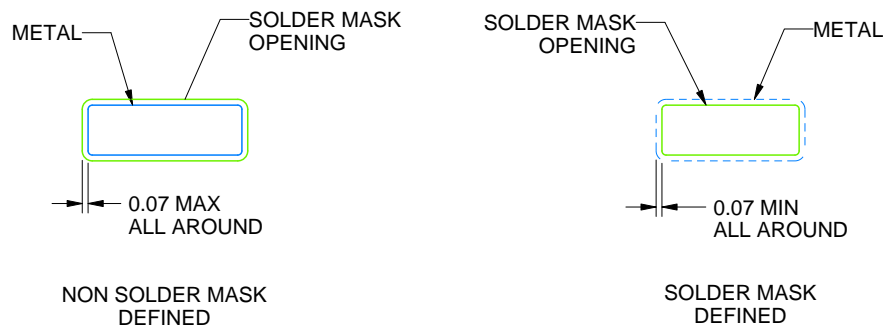
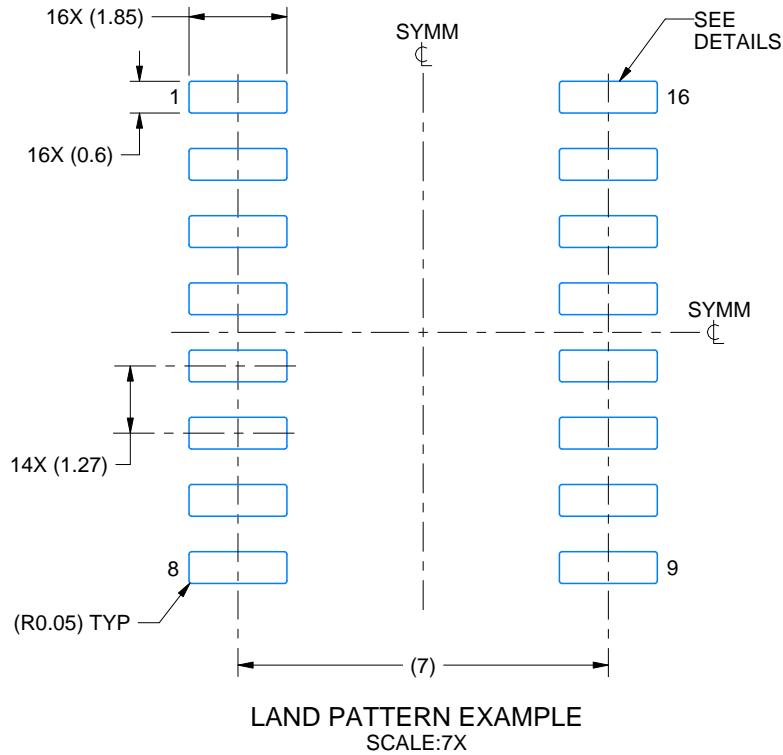
1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.

# EXAMPLE BOARD LAYOUT

NS0016A

SOP - 2.00 mm max height

SOP



4220735/A 12/2021

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

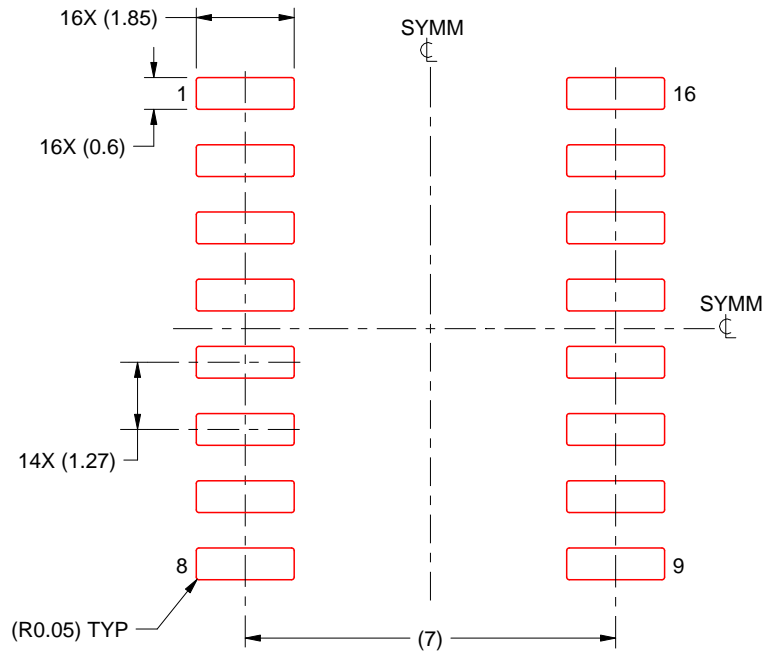
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

NS0016A

SOP - 2.00 mm max height

SOP



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:7X

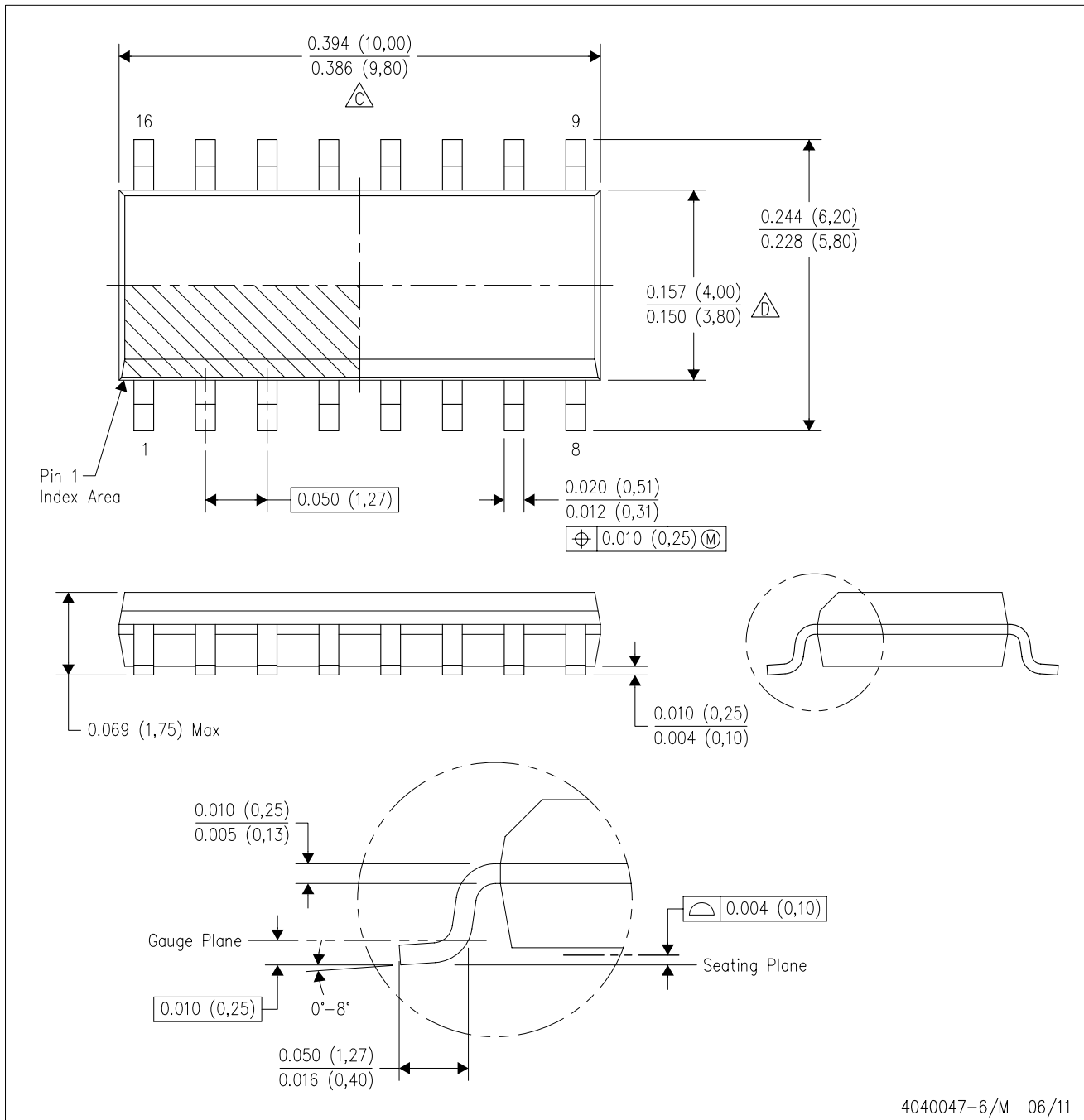
4220735/A 12/2021

NOTES: (continued)

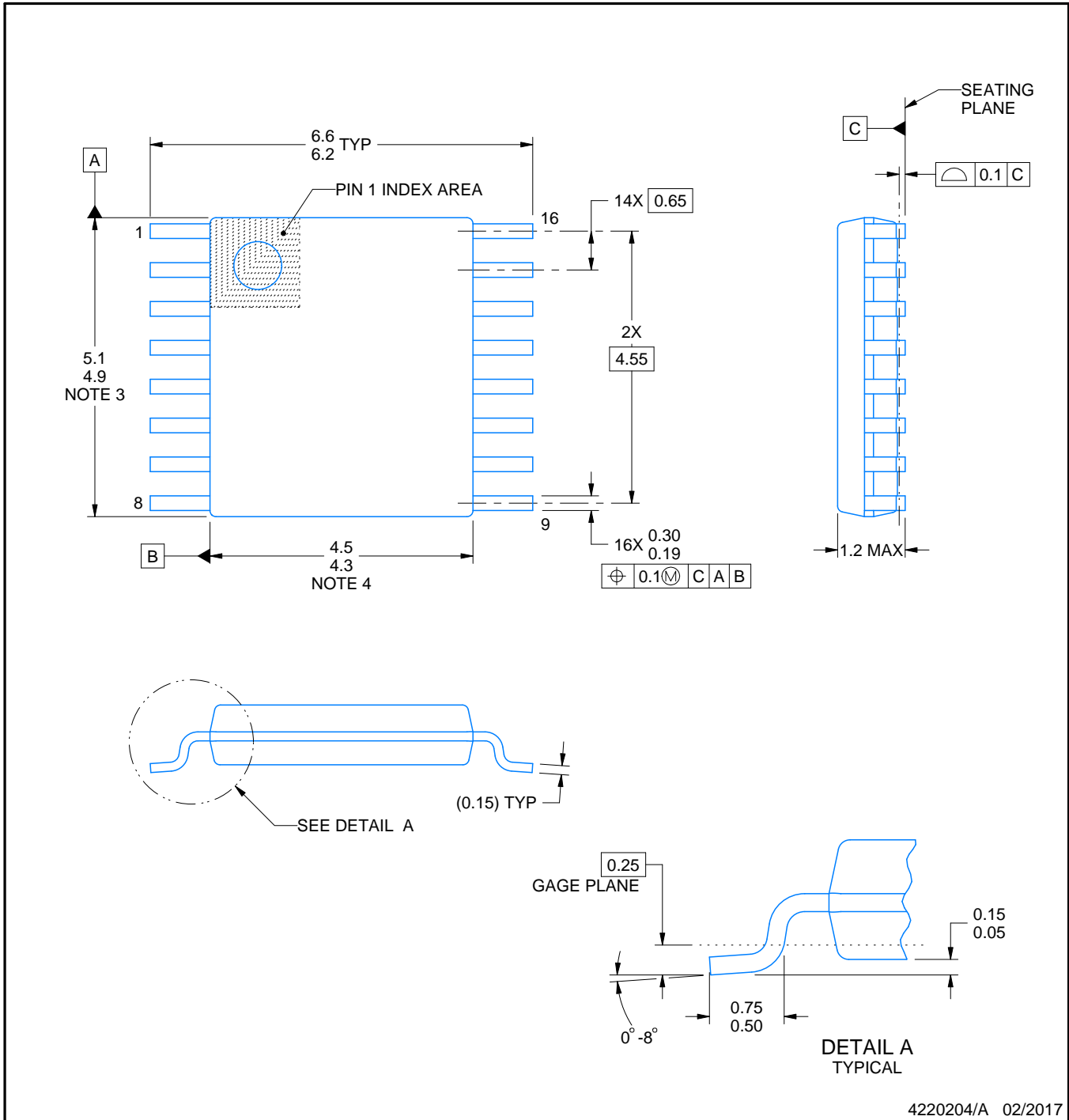
7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- 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 0.006 (0,15) each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AC.



4220204/A 02/2017

NOTES:

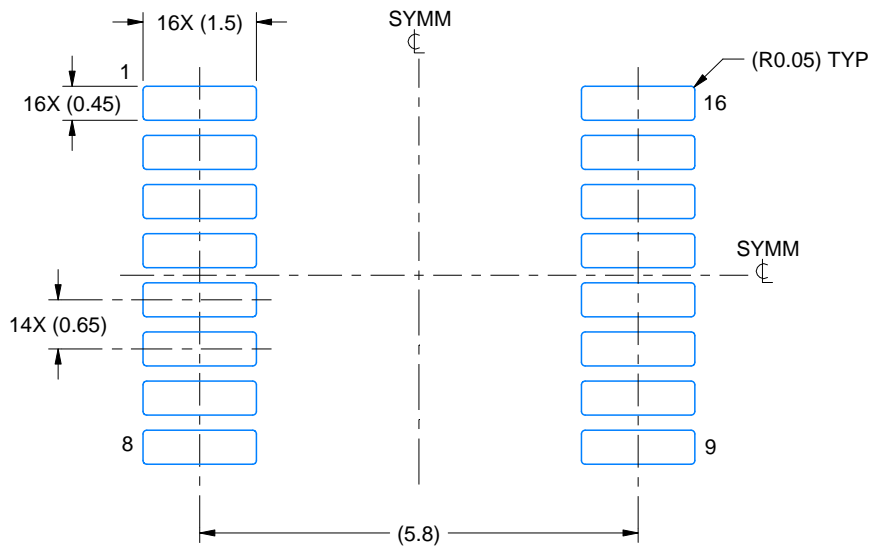
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

# EXAMPLE BOARD LAYOUT

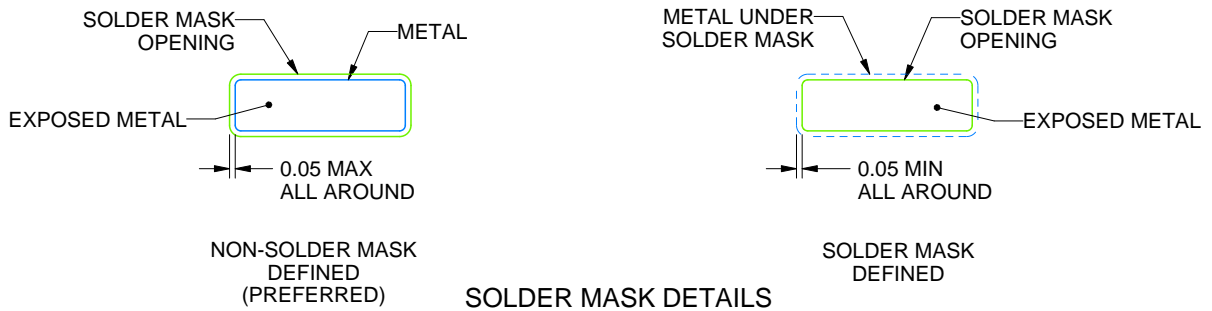
PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220204/A 02/2017

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

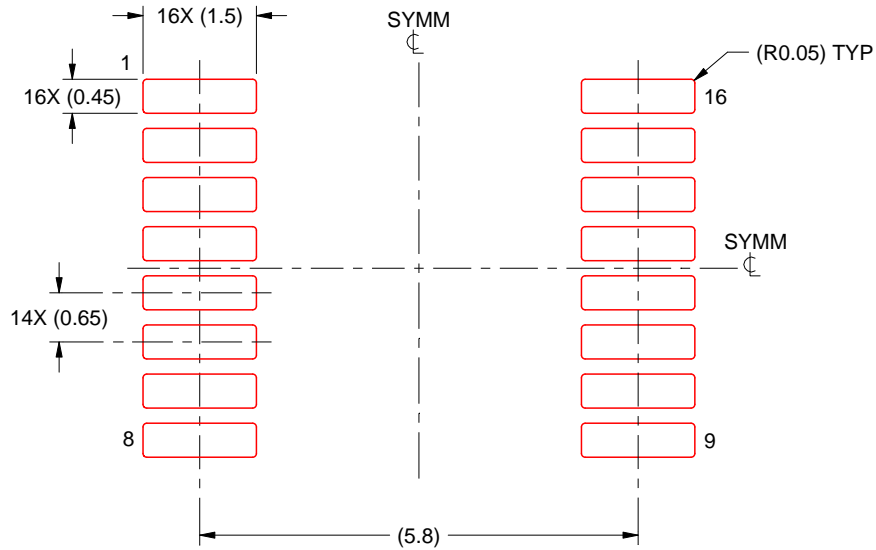


# EXAMPLE STENCIL DESIGN

PW0016A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE: 10X

4220204/A 02/2017

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

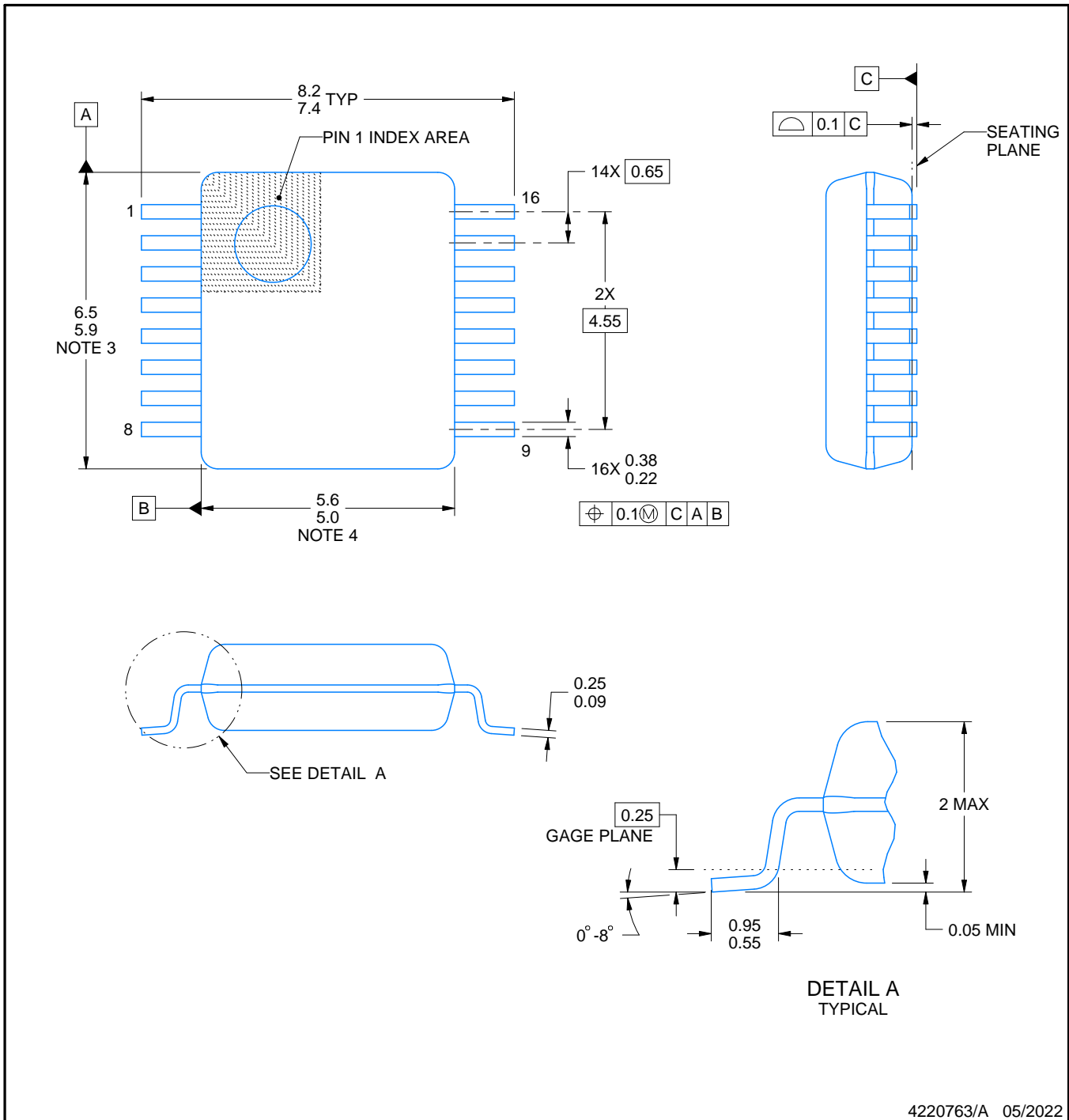
# DB0016A



# PACKAGE OUTLINE

## SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



4220763/A 05/2022

### NOTES:

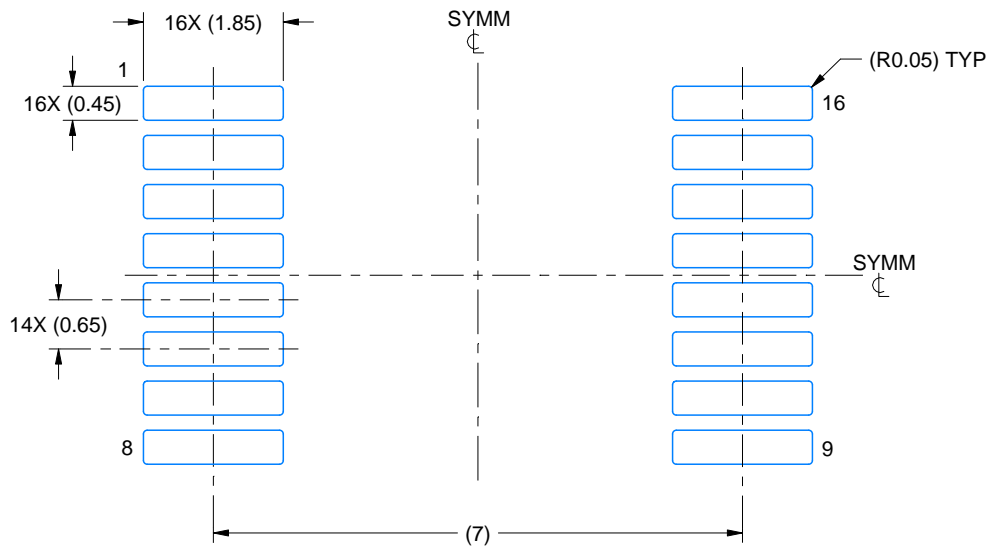
- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
- Reference JEDEC registration MO-150.

# EXAMPLE BOARD LAYOUT

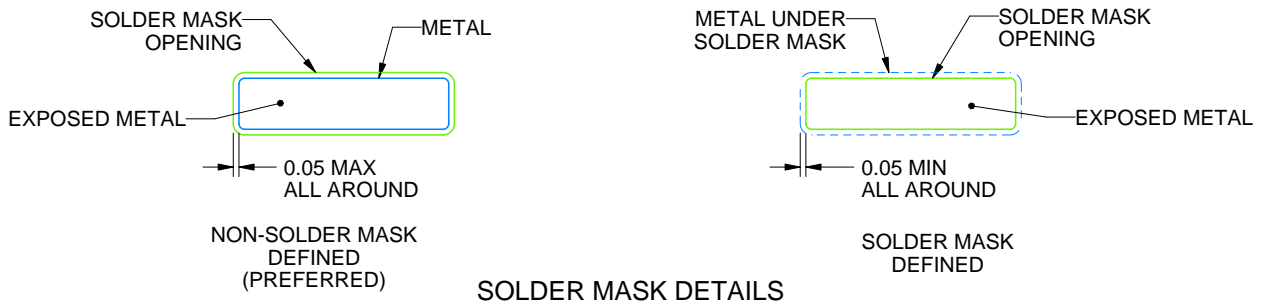
DB0016A

SSOP - 2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 10X



4220763/A 05/2022

NOTES: (continued)

- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

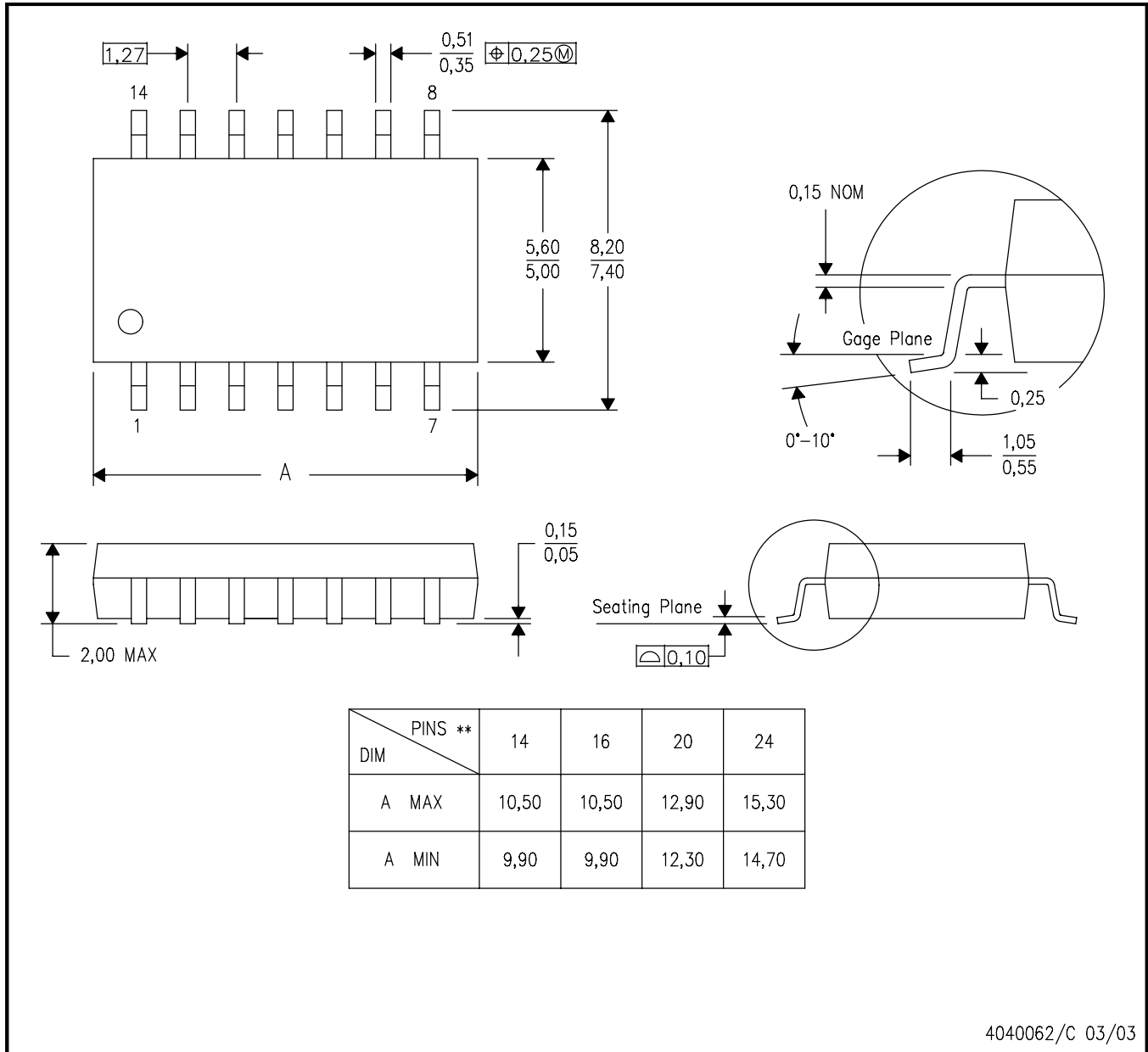


## MECHANICAL DATA

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

**PLASTIC SMALL-OUTLINE PACKAGE**

**14-PINS SHOWN**



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.



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