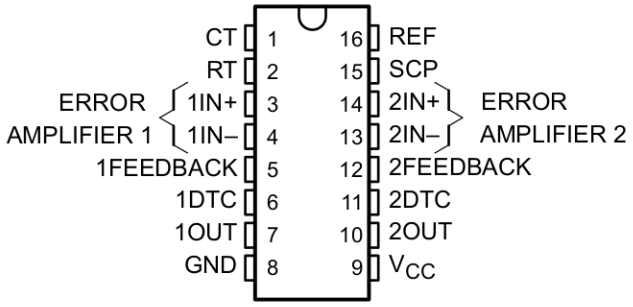
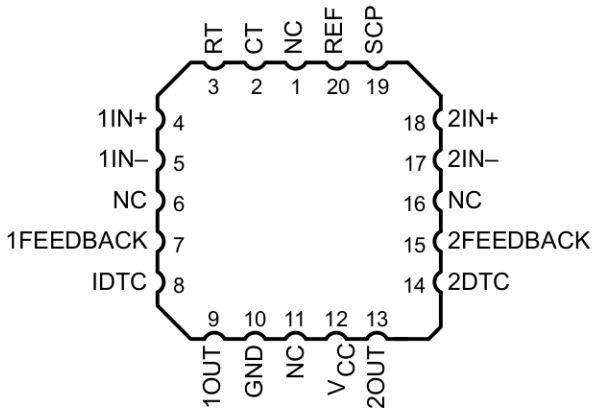
SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

- **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**

**D, DB, N, NS, PW, OR J PACKAGE**
**(TOP VIEW)**




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




## 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.

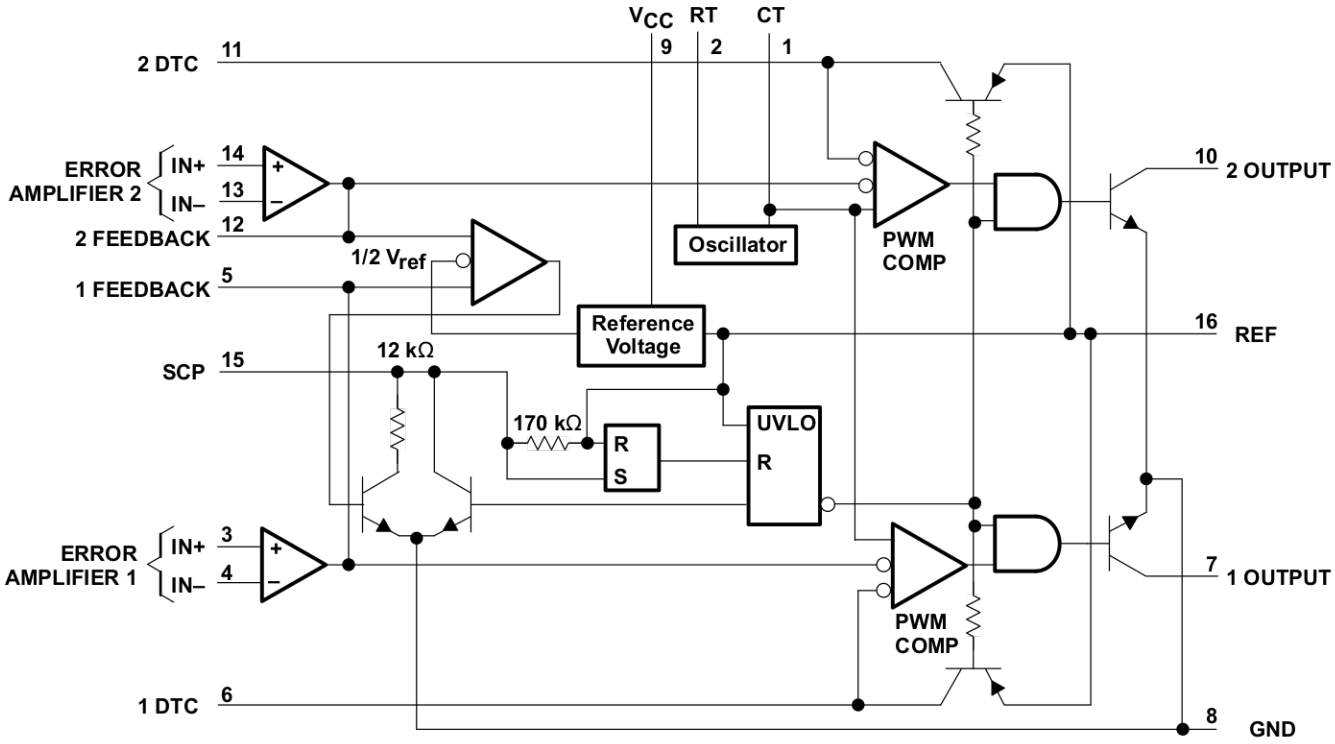
The TL1451AC is characterized for operation from –20°C to 85°C. The TL1451AQ is characterized for operation from –40°C to 125°C. The TL1451AM is characterized for operation from –55°C to 125°C.

**AVAILABLE OPTIONS**

| $T_A$ | PACKAGED DEVICES | | | | | | |
|---|---|---|---|---|---|---|---|
| | SMALL OUTLINE (D) | SMALL OUTLINE (DB)† | PLASTIC DIP (N) | SMALL OUTLINE (NS) | TSSOP (PW)† | CHIP CARRIER (FK) | CERAMIC DIP (J) |
| –20°C to 85°C | TL1451ACD | TL1451ACDB | TL1451ACN | TL1451ACNS | TL1451ACPW | — | — |
| –40°C to 125°C | TL1451AQD | — | — | — | — | — | — |
| –55°C to 125°C | — | — | — | — | — | TL1451AMFK | TL1451AMJ |

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

## functional block diagram




**COMPONENT COUNT**

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

## absolute maximum ratings over operating free-air temperature range†

Supply voltage, $V_{CC}$ . . . . . 51 V
Amplifier input voltage, $V_I$ . . . . . 20 V
Collector output voltage, $V_O$ . . . . . 51 V
Collector output current, $I_O$ . . . . . 21 mA
Continuous power total dissipation . . . . . See Dissipation Rating Table
Operating free-air temperature range, $T_A$ C suffix . . . . . –20°C to 85°C
Q suffix . . . . . –40°C to 125°C
M suffix . . . . . –55°C to 125°C
Storage temperature range, $T_{stg}$ . . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

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

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \leq 25°C$ 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 | 1088 mW | 8.7 mW/°C | 696 mW | 566 mW | 218 mW |
| DB | 775 mW | 6.2 mW/°C | 496 mW | 403 mW | — |
| N | 1000 mW | 8.0 mW/°C | 640 mW | 520 mW | — |
| NS | 500 mW | 4.0 mW/°C | 320 mW | 260 mW | — |
| PW | 838 mW | 6.7 mW/°C | 536 mW | 436 mW | 168 mW |
| 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 |

## recommended operating conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Supply voltage, $V_{CC}$ | | 3.6 | 50 | V |
| Amplifier input voltage, $V_I$ | | 1.05 | 1.45 | V |
| Collector output voltage, $V_O$ | | | 50 | V |
| Collector output current, $I_O$ | | | 20 | mA |
| Current into feedback terminal | | | 45 | μA |
| Feedback resistor, $R_F$ | | 100 | | kΩ |
| Timing capacitor, $C_T$ | | 150 | 15000 | pF |
| Timing resistor, $R_T$ | | 5.1 | 100 | kΩ |
| Oscillator frequency | | 1 | 500 | kHz |
| Operating free-air temperature, $T_A$ | C suffix | –20 | 85 | °C |
| | Q suffix | –40 | 125 | |
| | M suffix | –55 | 125 | |

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

### reference section

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

† All typical values are at $T_A$ = 25°C.

### undervoltage lockout section

| PARAMETER | TEST CONDITIONS | TL1451AC | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP† | MAX | |
| Upper threshold voltage ($V_{CC}$) | $I_{O(ref)}$ = 0.1 mA, $T_A$ = 25°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°C.

### short-circuit protection control section

| PARAMETER | TEST CONDITIONS | TL1451AC | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP† | MAX | |
| Input threshold voltage (SCP) | $T_A$ = 25°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 V, $T_A$ = 25°C | –10 | –15 | –20 | µA |
| Comparator threshold voltage (FEEDBACK) | | | 1.18 | | V |

† All typical values are at $T_A$ = 25°C.

### oscillator section

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

† All typical values are at $T_A$ = 25°C.

### dead-time control section

| PARAMETER | TEST CONDITIONS | TL1451AC | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP† | MAX | |
| Input bias current (DTC) | | | | 1 | µA |
| Latch mode (source) current (DTC) | $T_A$ = 25°C | –80 | –145 | | µA |
| Latched input voltage (DTC) | $I_O$ = 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 $T_A$ = 25°C.

### error-amplifier section

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

† All typical values are at $T_A$ = 25°C.

### output section

| PARAMETER | TEST CONDITIONS | TL1451AC | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP† | MAX | |
| Collector off-state current | $V_O$ = 50 V | | | 10 | µA |
| Output saturation voltage | $I_O$ = 10 mA | | 1.2 | 2 | V |
| Short-circuit output current | $V_O$ = 6 V | | 90 | | mA |

† All typical values are at $T_A$ = 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 $T_A$ = 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 | $R_T$ = 10 kΩ | | 1.7 | 2.4 | mA |

† All typical values are at $T_A$ = 25°C.

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

### reference section

| PARAMETER | TEST CONDITIONS | | TL1451AQ, TL1451AM | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP† | MAX | |
| Output voltage (pin 16) | $I_O$ = 1 mA | $T_A$ = 25°C | 2.40 | 2.50 | 2.60 | V |
| | | $T_A$ = MIN and 125°C | 2.35 | 2.46 | 2.65 | |
| Output voltage change with temperature | | | | –0.63% | *±4% | |
| Input voltage regulation | $V_{CC}$ = 3.6 V to 40 V | $T_A$ = 25°C | | 2.0 | 12.5 | mV |
| | | $T_A$ = 125°C | | 0.7 | 15 | |
| | | $T_A$ = MIN | | 0.3 | 30 | |
| Output voltage regulation | $I_O$ = 0.1 mA to 1 mA | $T_A$ = 25°C | | 1.0 | 7.5 | mV |
| | | $T_A$ = 125°C | | 0.3 | 14 | |
| | | $T_A$ = 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°C unless otherwise indicated.

### undervoltage lockout section

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

† All typical values are at $T_A$ = 25°C unless otherwise indicated.

### short-circuit protection control section

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

† All typical values are at $T_A$ = 25°C unless otherwise indicated.

### oscillator section

| PARAMETER | TEST CONDITIONS | | TL1451AQ, TL1451AM | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP† | MAX | |
| Frequency | $C_T$ = 330 pF, $R_T$ = 10 kΩ | $T_A$ = 25°C | | 200 | | kHz |
| | | $T_A$ = 125°C | | 195 | | |
| | | $T_A$ = MIN | | 193 | | |
| Standard deviation of frequency | $C_T$ = 330 pF, | $R_T$ = 10 kΩ | | 2% | | |
| Frequency change with voltage | $V_{CC}$ = 3.6 V to 40 V | $T_A$ = 25°C | | 1% | | |
| | | $T_A$ = 125°C | | 1% | | |
| | | $T_A$ = MIN | | 3% | | |
| Frequency change with temperature | | | | 1.37% | *±10% | |

*These parameters are not production tested.
† All typical values are at $T_A$ = 25°C unless otherwise indicated.

### dead-time control section

| PARAMETER | TEST CONDITIONS | TL1451AQ, TL1451AM | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP† | MAX | |
| Input bias current (DTC) | $T_A$ = 25°C | | | 1 | μA |
| | $T_A$ = MIN and 125°C | | | 3 | |
| Latch mode (source) current (DTC) | | –80 | –145 | | μA |
| Latched input voltage (DTC) | $T_A$ = 25°C | 2.30 | | | V |
| | $T_A$ = 125°C | 2.22 | 2.32 | | |
| | $T_A$ = MIN | 2.28 | 2.40 | | |
| Input threshold voltage at f = 10 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°C unless otherwise indicated.

### error-amplifier section

| PARAMETER | TEST CONDITIONS | | TL1451AQ, TL1451AM | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP† | MAX | |
| Input offset voltage | $V_O$ (FEEDBACK) = 1.25 V | $T_A$ = 25°C | | | ±6 | mV |
| | | $T_A$ = 125°C | | | ±10 | |
| | | $T_A$ = MIN | | | ±12 | |
| Input offset current | $V_O$ (FEEDBACK) = 1.25 V | $T_A$ = 25°C | | | ±100 | nA |
| | | $T_A$ = 125°C | | | ±100 | |
| | | $T_A$ = MIN | | | ±200 | |
| Input bias current | $V_O$ (FEEDBACK) = 1.25 V | $T_A$ = 25°C | | 160 | 500 | nA |
| | | $T_A$ = 125°C | | 100 | 500 | |
| | | $T_A$ = MIN | | 142 | 700 | |
| Common-mode input voltage range | $V_{CC}$ = 3.6 V to 40 V | | 1.05 to 1.45 | | | V |
| Open-loop voltage amplification | $R_F$ = 200 kΩ | $T_A$ = 25°C | 70 | 80 | | dB |
| | | $T_A$ = 125°C | 70 | 80 | | |
| | | $T_A$ = 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 V, $V_O$ = 1.25 V | $T_A$ = 25°C | 0.5 | 1.6 | | mA |
| | | $T_A$ = 125°C | 0.4 | 1.8 | | |
| | | $T_A$ = MIN | 0.3 | 1.7 | | |
| Output (source) current (FEEDBACK) | $V_{ID}$ = 0.1 V, $V_O$ = 1.25 V | $T_A$ = 25°C | –45 | –70 | | µA |
| | | $T_A$ = 125°C | –25 | –50 | | |
| | | $T_A$ = MIN | –15 | –70 | | |

† All typical values are at $T_A$ = 25°C unless otherwise indicated.

### output section

| PARAMETER | TEST CONDITIONS | TL1451AQ, TL1451AM | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP† | MAX | |
| Collector off-state current | $V_O$ = 50 V | | | 10 | µA |
| Output saturation voltage | $T_A$ = 25°C | | 1.20 | 2.0 | V |
| | $T_A$ = 125°C | | 1.60 | 2.4 | |
| | $T_A$ = MIN | | 1.36 | 2.2 | |
| Short-circuit output current | $V_O$ = 6 V | | 90 | | mA |

† All typical values are at $T_A$ = 25°C unless otherwise indicated.

### pwm comparator section

| PARAMETER | TEST CONDITIONS | TL1451AQ, TL1451AM | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP† | MAX | |
| Input threshold voltage at f = 10 kHz (FEEDBACK) | 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°C unless otherwise indicated.

**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 kΩ | | 1.7 | 2.4 | mA |

† All typical values are at $T_A$ = 25°C unless otherwise indicated.

## PARAMETER MEASUREMENT INFORMATION

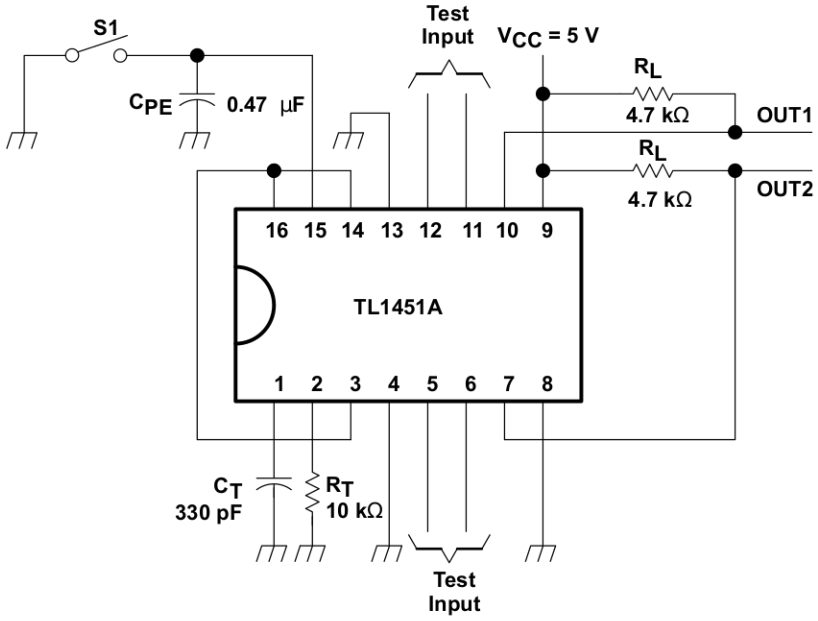
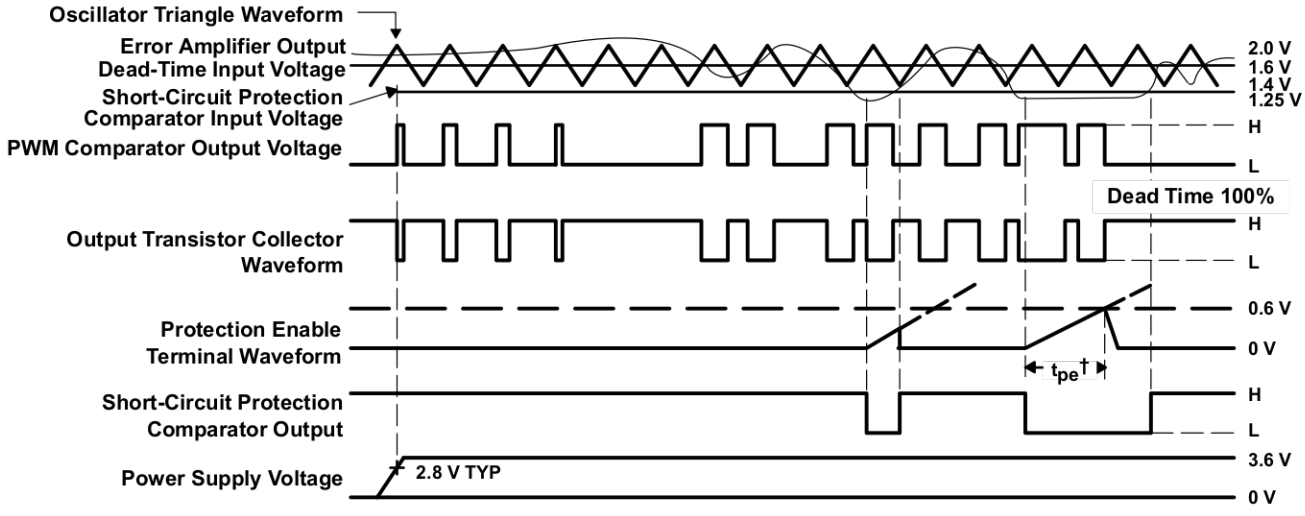



**Figure 1. Test Circuit**




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

**Figure 2. TL1451A Timing Diagram**

## TYPICAL CHARACTERISTICS

**TRIANGLE OSCILLATOR FREQUENCY vs TIMING RESISTANCE**

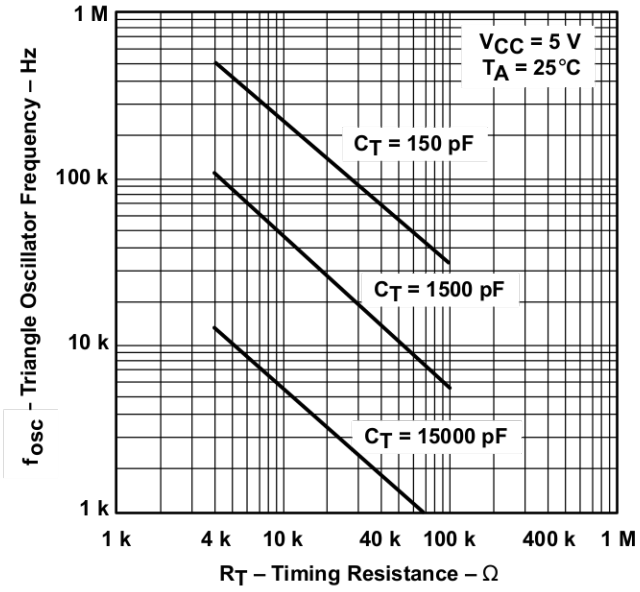



Figure 3

**OSCILLATOR FREQUENCY VARIATION vs FREE-AIR TEMPERATURE**

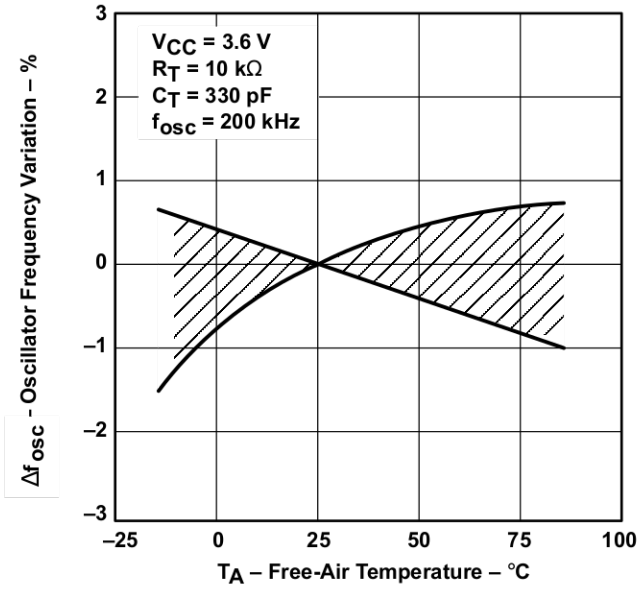



Figure 4

**TRIANGLE WAVEFORM SWING VOLTAGE vs TIMING CAPACITANCE**

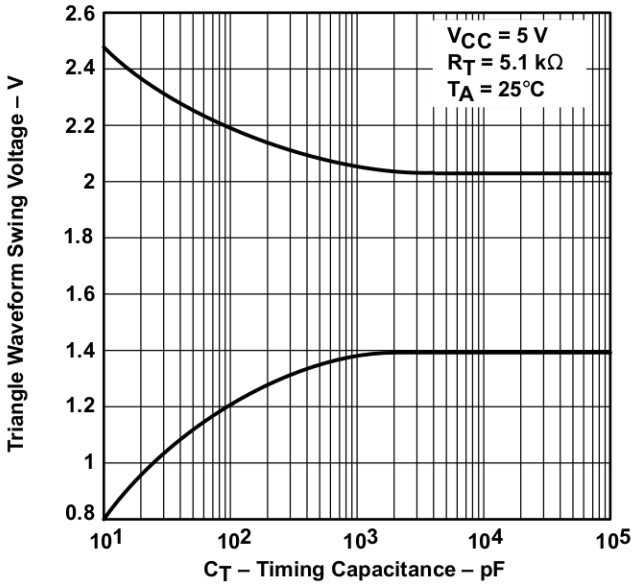



Figure 5

**TRIANGLE WAVEFORM PERIOD vs TIMING CAPACITANCE**

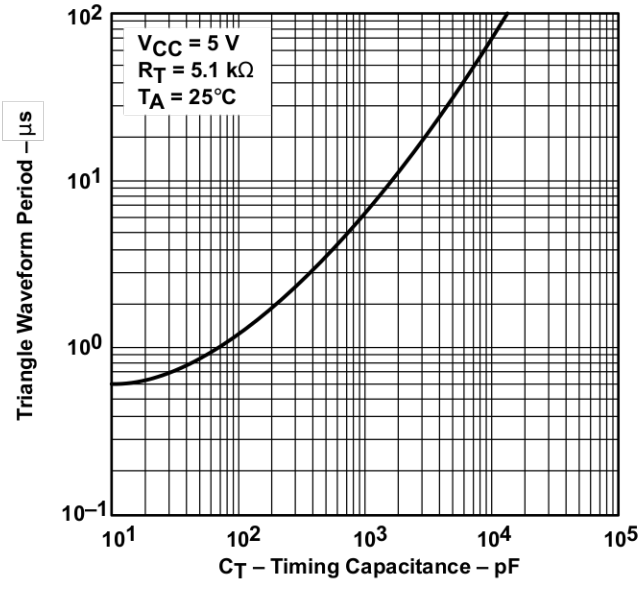



Figure 6

## TYPICAL CHARACTERISTICS

REFERENCE OUTPUT VOLTAGE VARIATION
vs
FREE-AIR TEMPERATURE

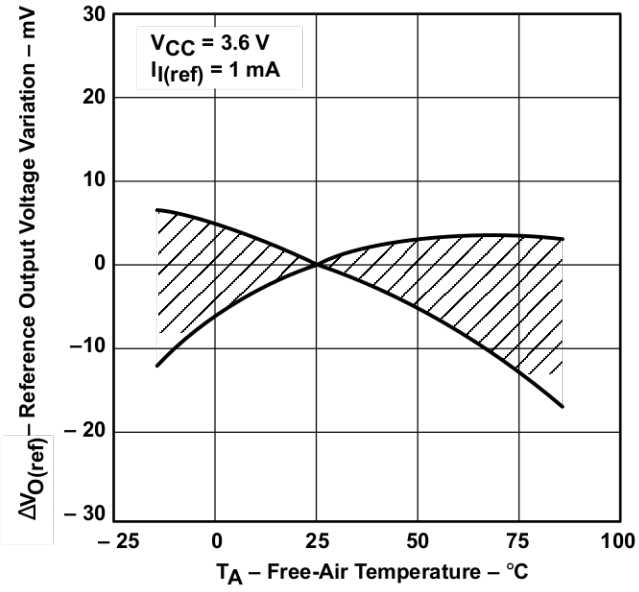



Figure 7

REFERENCE OUTPUT VOLTAGE VARIATION
vs
FREE-AIR TEMPERATURE

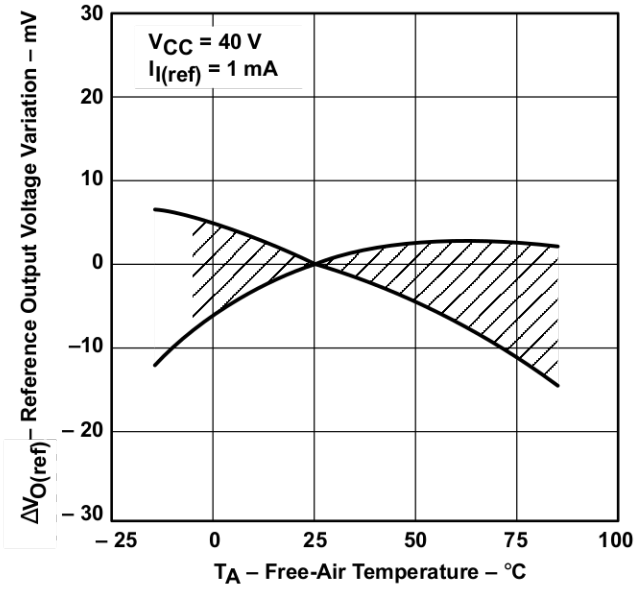



Figure 8

REFERENCE OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

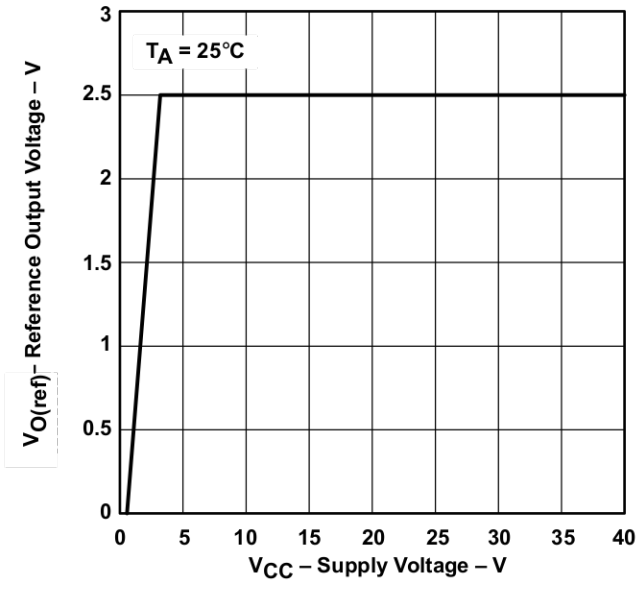



Figure 9

DROPOUT VOLTAGE VARIATION
vs
FREE-TEMPERATURE

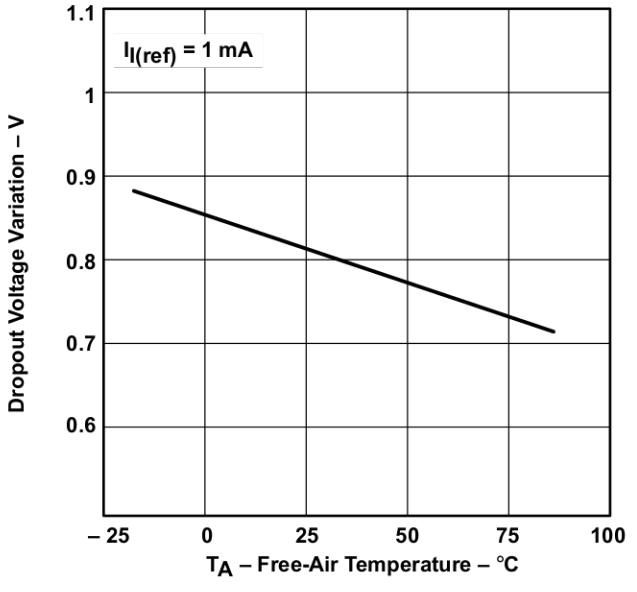



Figure 10

## TYPICAL CHARACTERISTICS

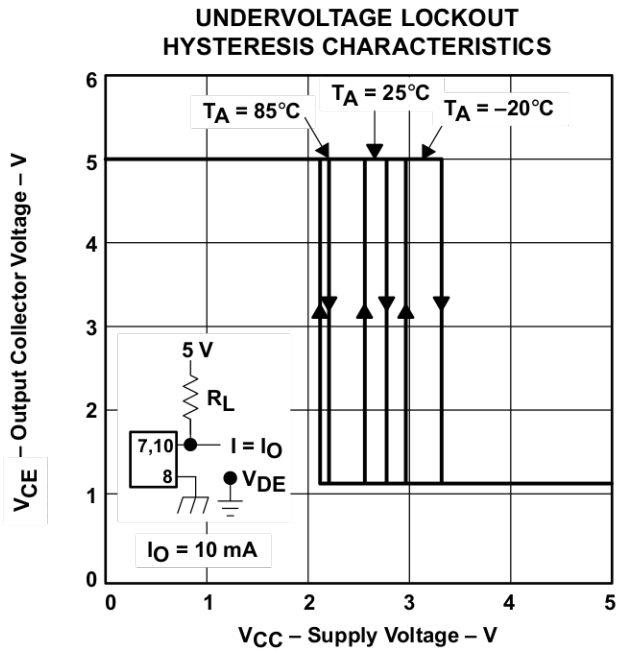



Figure 11

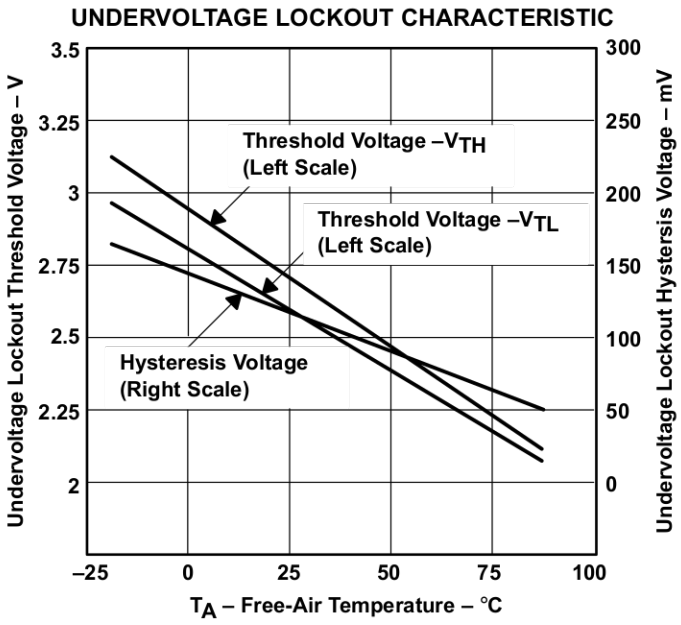



Figure 12

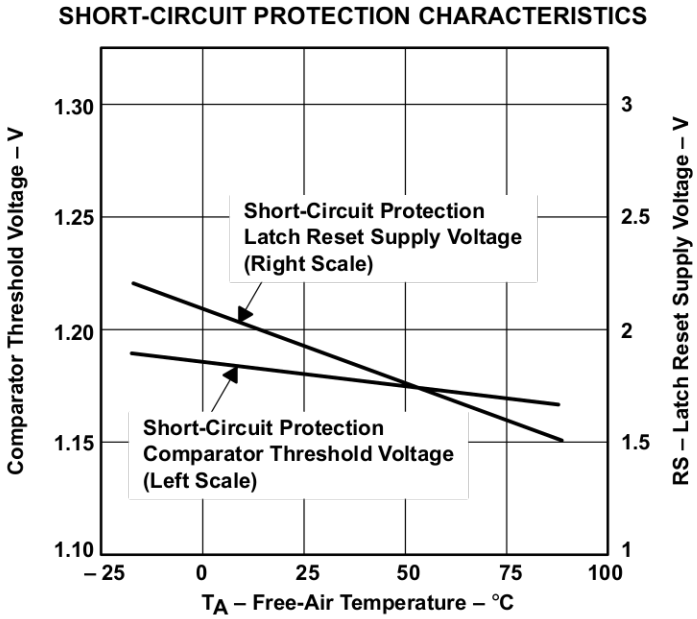



Figure 13

## TYPICAL CHARACTERISTICS

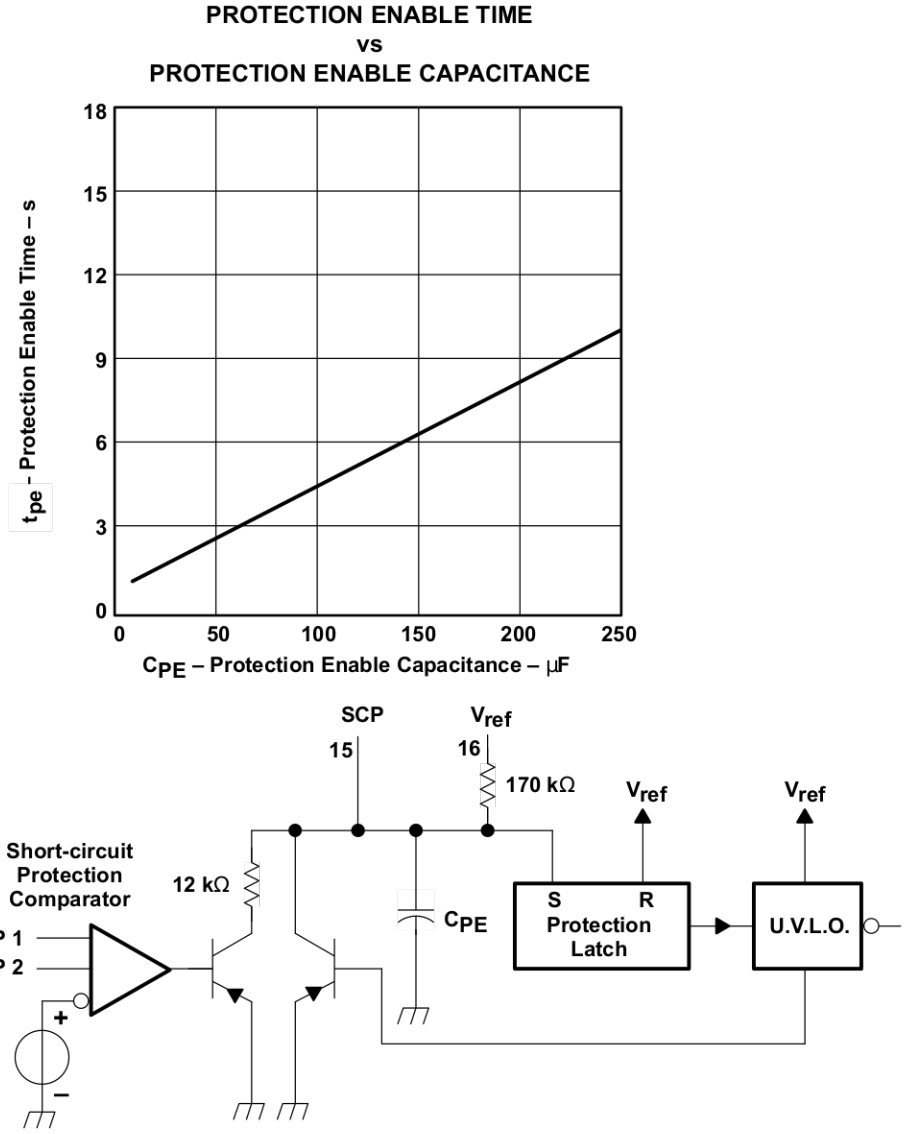



Figure 14

## TYPICAL CHARACTERISTICS

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

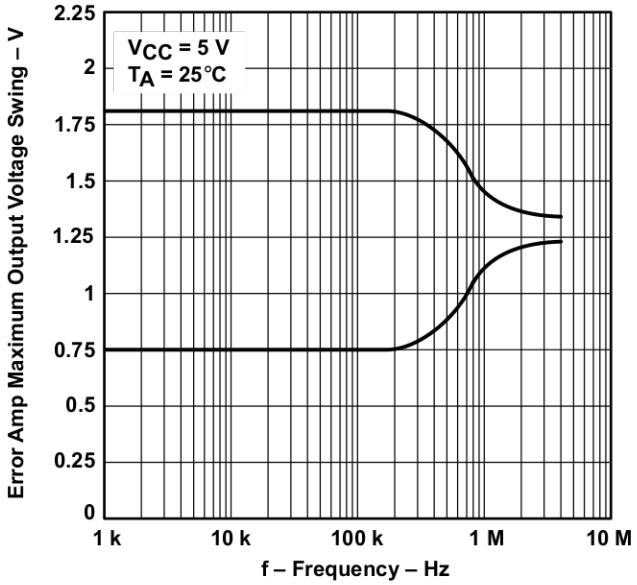



Figure 15

**OPEN-LOOP VOLTAGE AMPLIFICATION vs FREQUENCY**

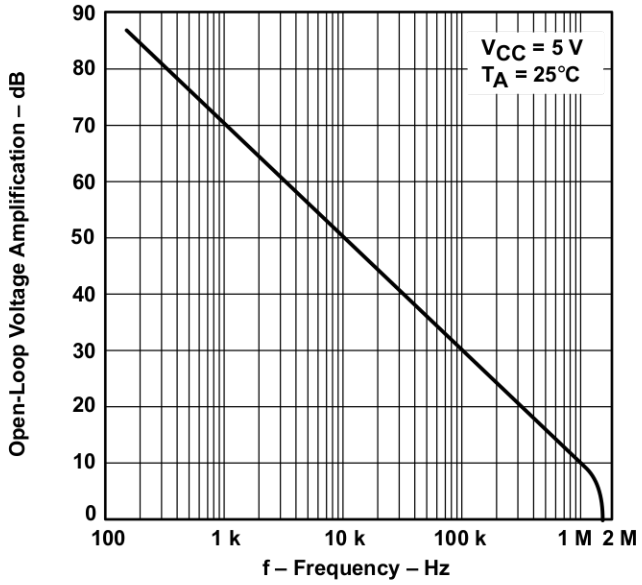



Figure 16

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

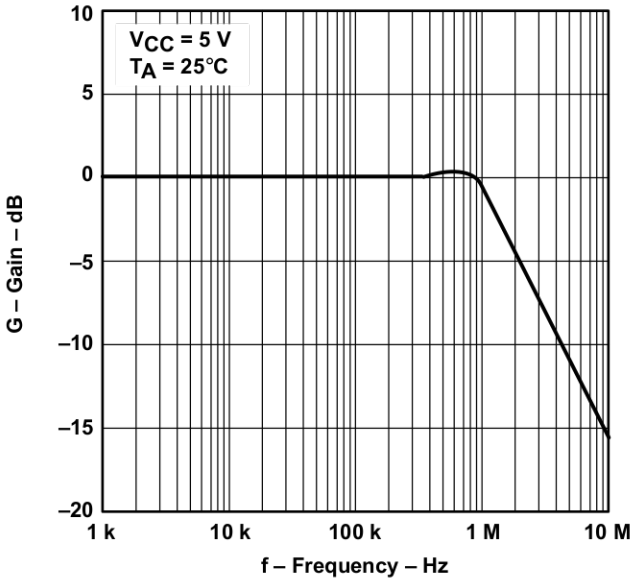
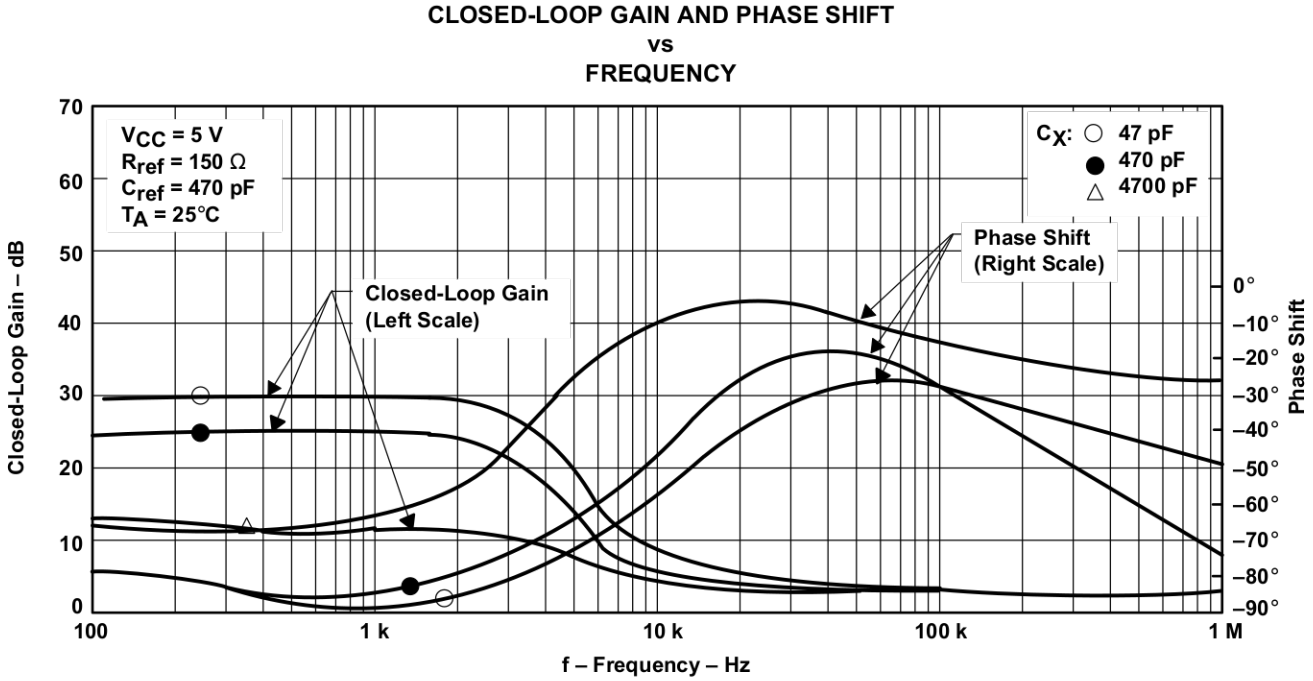
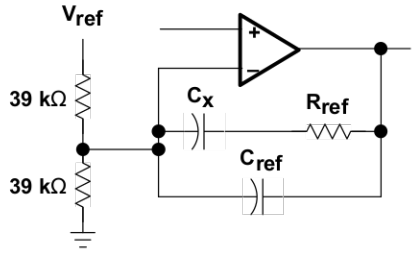



Figure 17

## TYPICAL CHARACTERISTICS

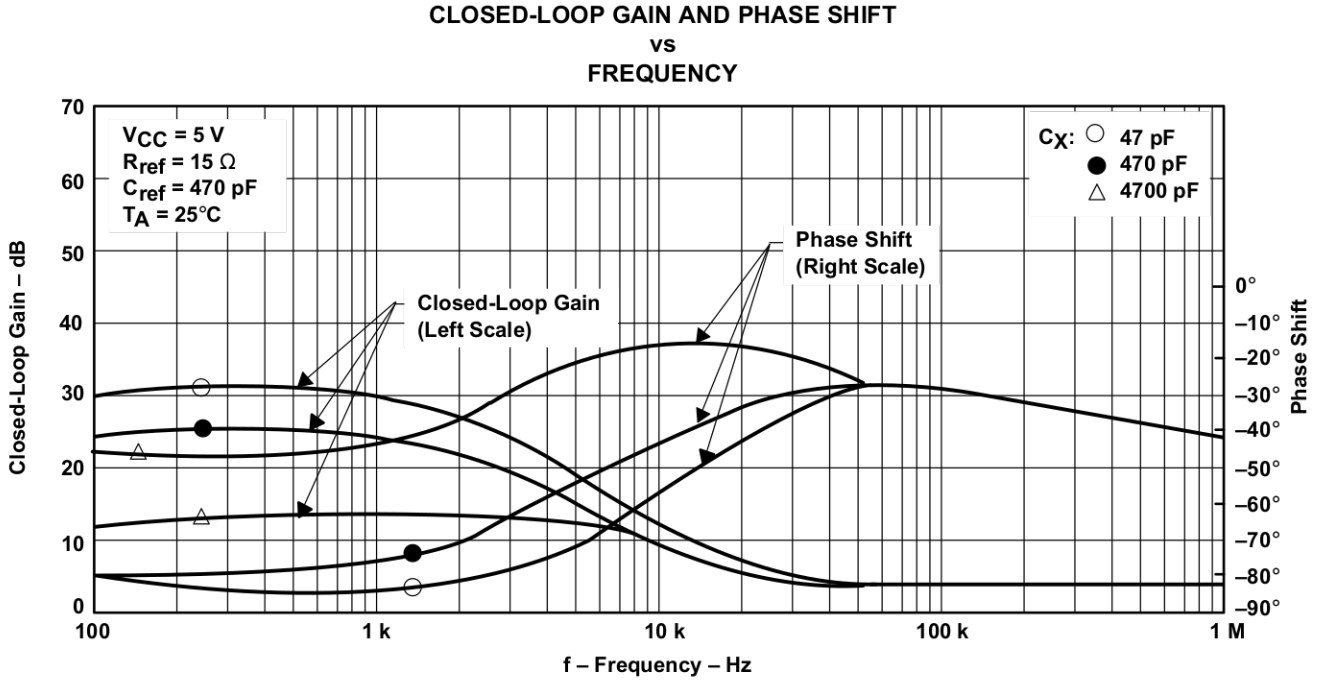


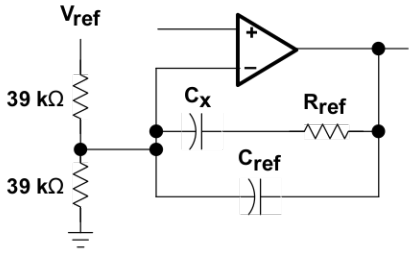




Test Circuit

**Figure 18**

## TYPICAL CHARACTERISTICS

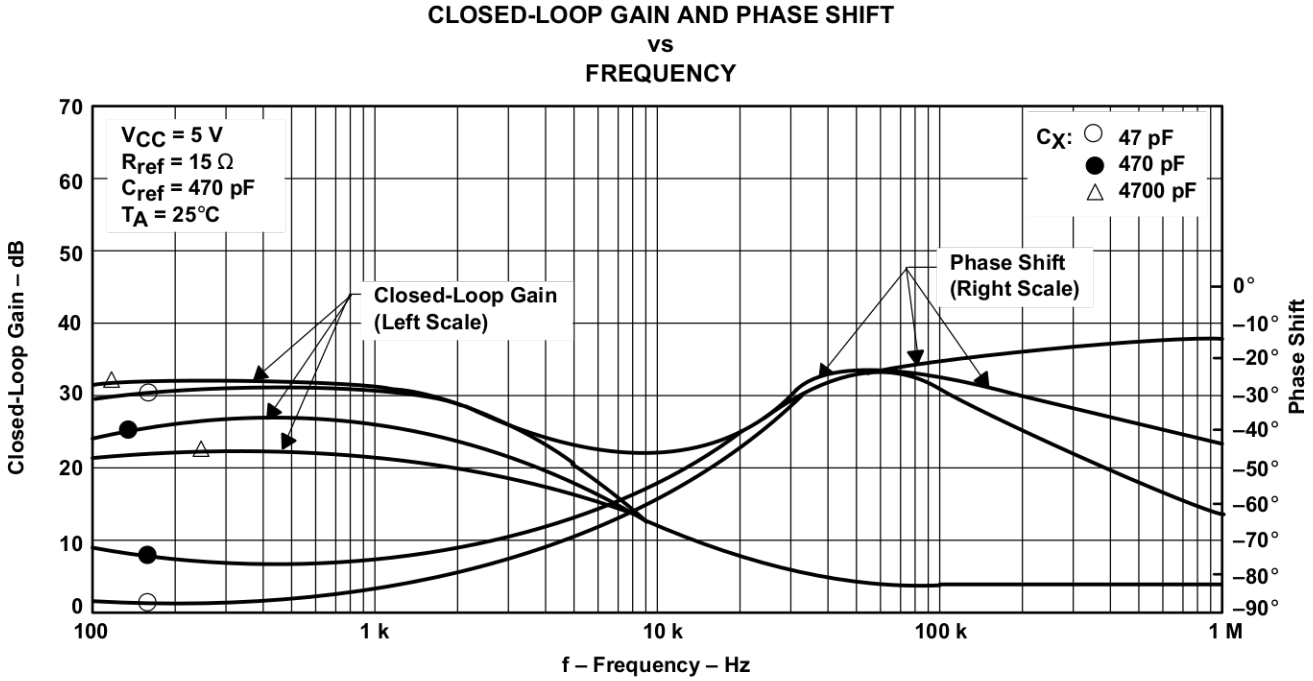


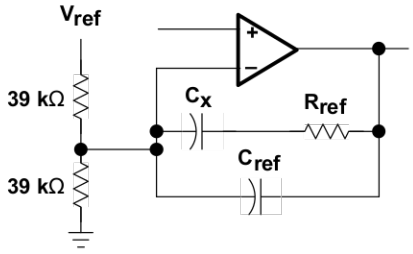




Test Circuit

**Figure 19**

## TYPICAL CHARACTERISTICS

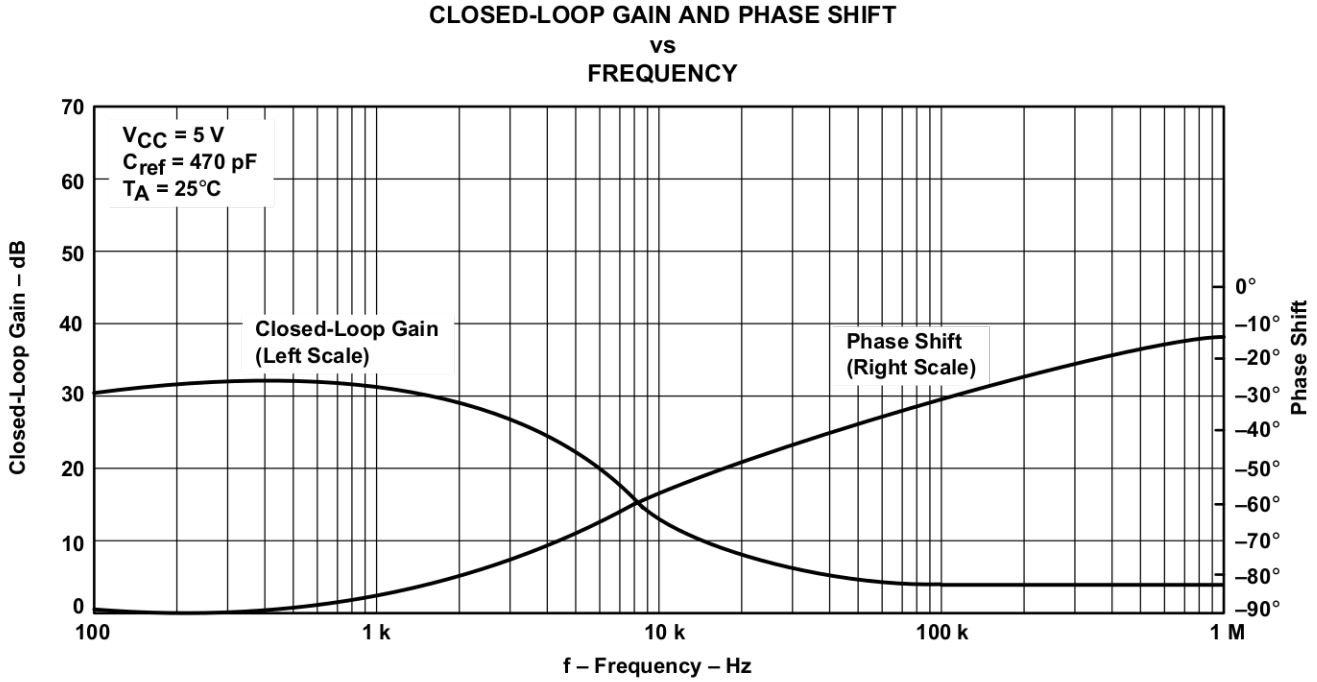


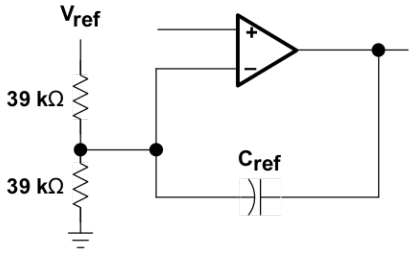




Test Circuit

**Figure 20**

## TYPICAL CHARACTERISTICS




Test Circuit

**Figure 21**

## TYPICAL CHARACTERISTICS

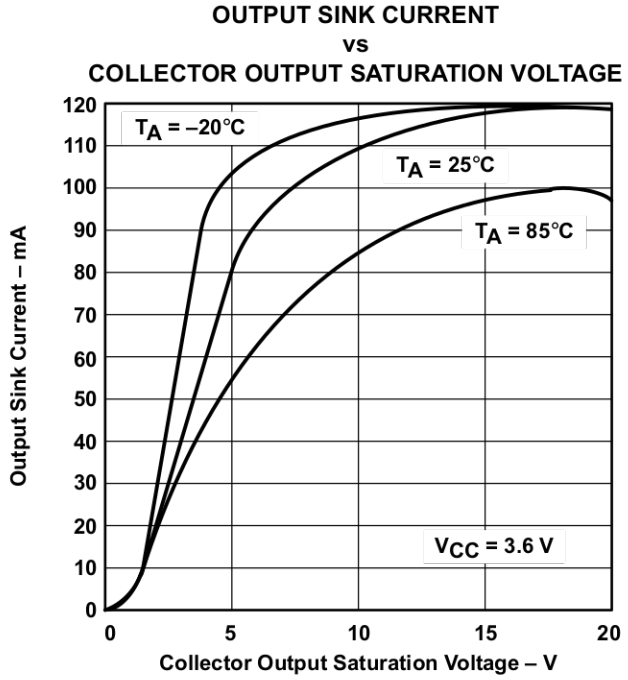
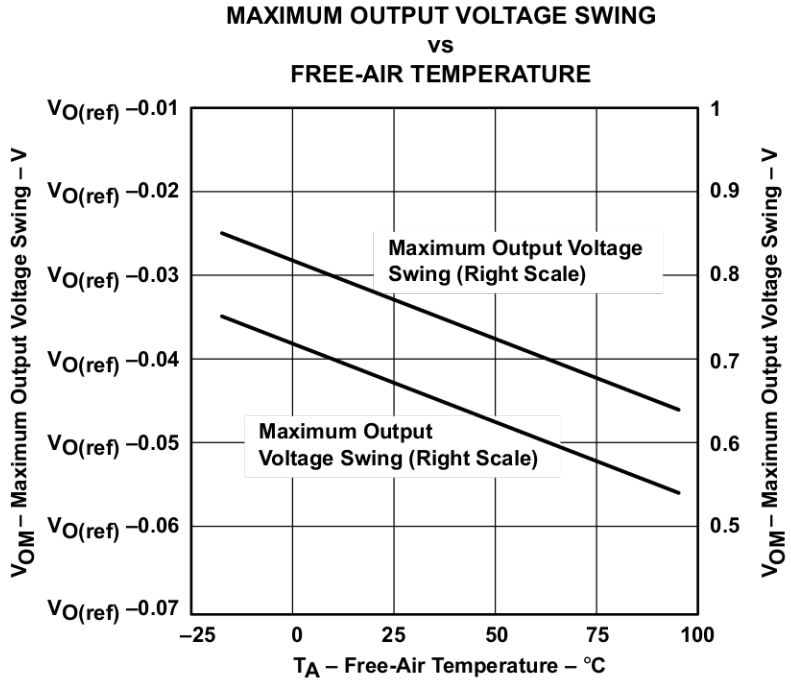
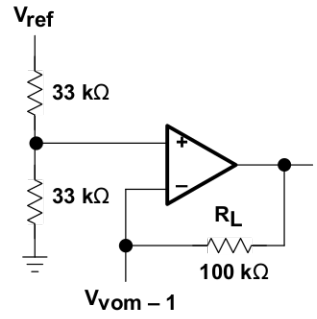



Figure 22




$V_{CC}$ = 3.6 V
$R_L$ = 100 kΩ
$V_{OM+1}$ = 1.25 V
$V_{OM\ –1}$ = 1.15 V (Right Scale)
$V_{OM\ –1}$ = 1.35 V (Left Scale)

TEST CIRCUIT

Figure 23

## TYPICAL CHARACTERISTICS

OUTPUT TRANSISTOR ON DUTY CYCLE
vs
DEAD-TIME INPUT VOLTAGE

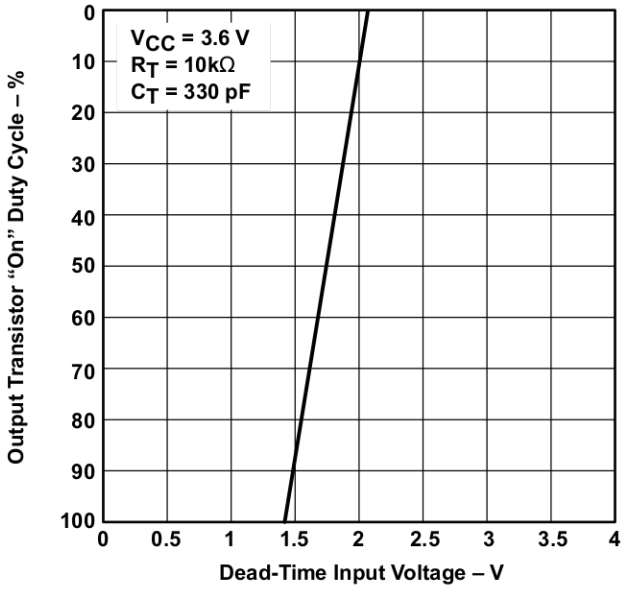



Figure 24

STANDBY CURRENT
vs
SUPPLY VOLTAGE

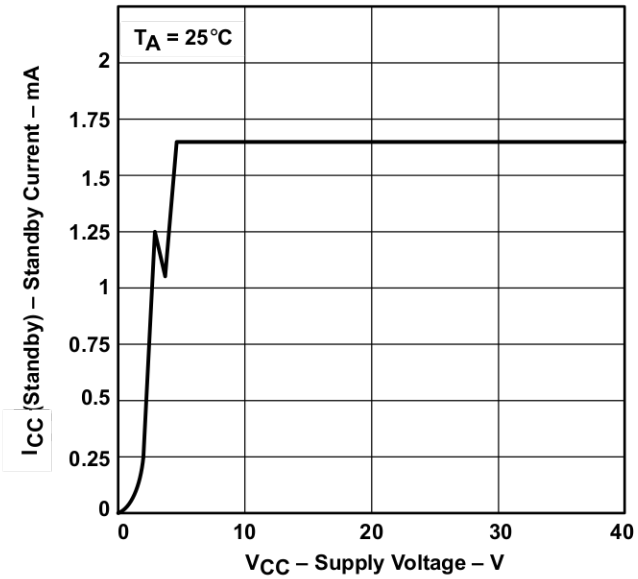



Figure 25

STANDBY CURRENT
vs
FREE-AIR TEMPERATURE

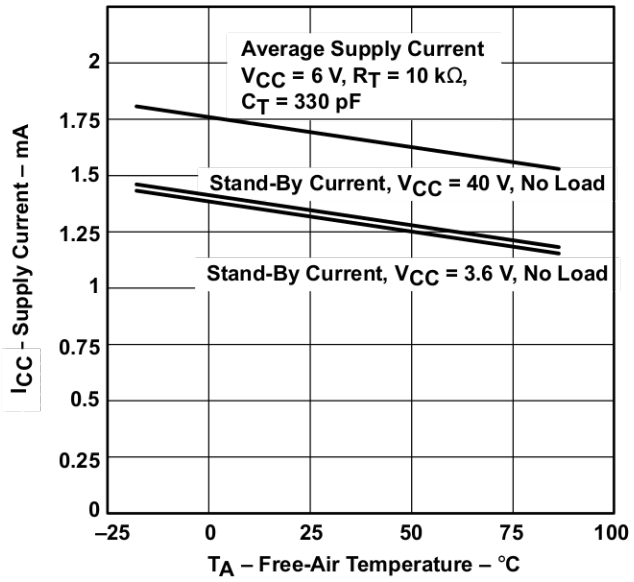



Figure 26

MAXIMUM CONTINUOUS POWER DISSIPATION
vs
FREE-AIR TEMPERATURE

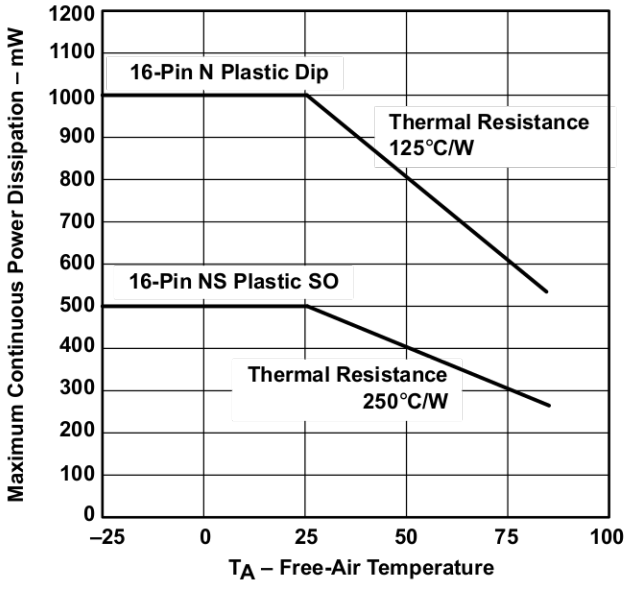
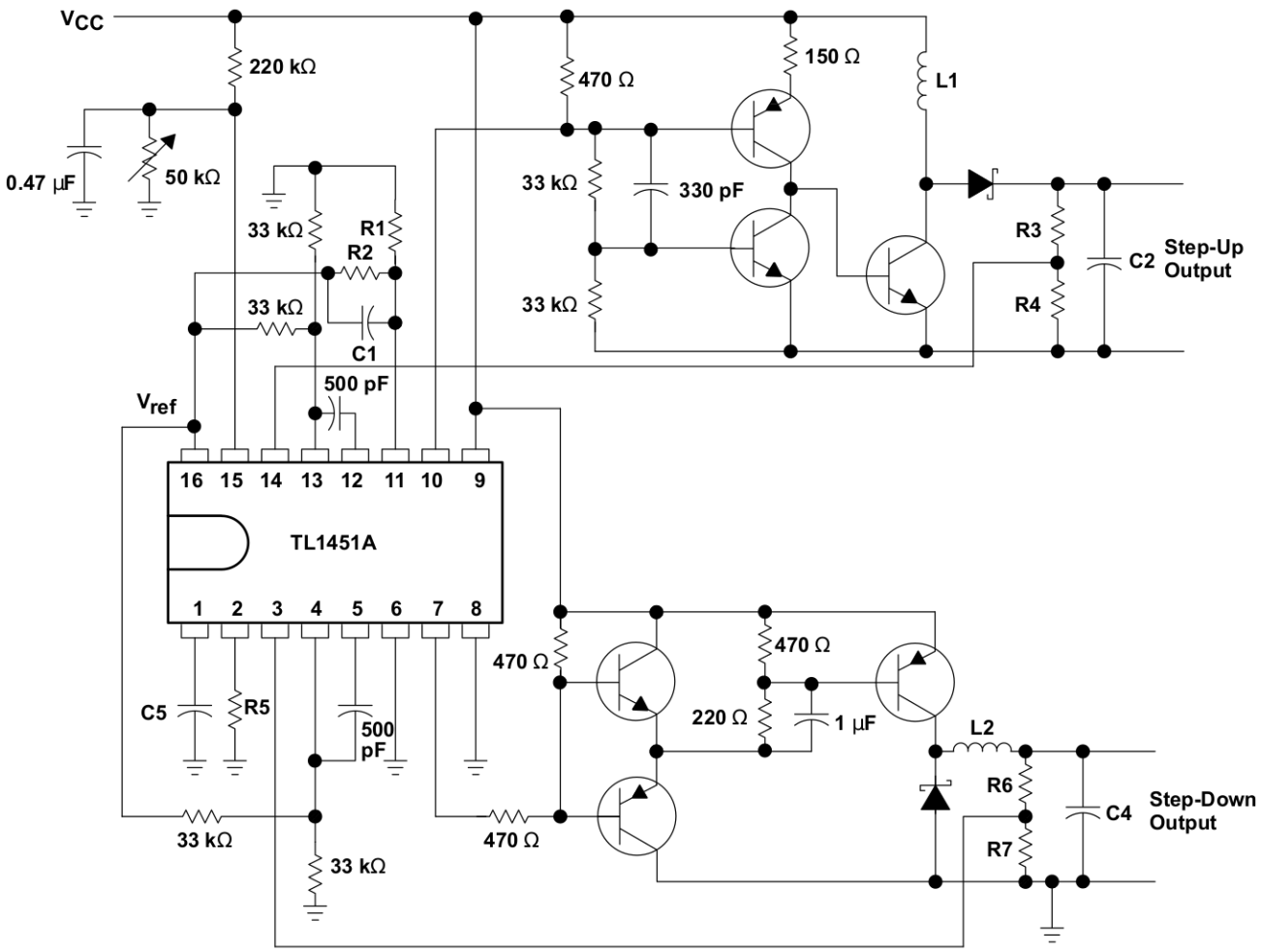



Figure 27

## APPLICATION INFORMATION




NOTE A: Values for R1 through R7, C1 through C4, and L1 and L2 depend upon individual application.

**Figure 28. High-Speed Dual Switching Regulator**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TL1451ACD | ACTIVE | SOIC | D | 16 | 40 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | TL1451AC | Samples |
| TL1451ACDBR | ACTIVE | SSOP | DB | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | T1451A | Samples |
| TL1451ACDR | ACTIVE | SOIC | D | 16 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | TL1451AC | Samples |
| TL1451ACN | ACTIVE | PDIP | N | 16 | 25 | RoHS & Green | NIPDAU | N / A for Pkg Type | -20 to 85 | TL1451ACN | Samples |
| TL1451ACNS | ACTIVE | SO | NS | 16 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | 0 to 0 | TL1451A | Samples |
| TL1451ACNSR | ACTIVE | SO | NS | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | TL1451A | Samples |
| TL1451ACPW | ACTIVE | TSSOP | PW | 16 | 90 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | T1451A | Samples |
| TL1451ACPWR | ACTIVE | TSSOP | PW | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | T1451A | Samples |
| TL1451ACPWRG4 | ACTIVE | TSSOP | PW | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | T1451A | Samples |
| TL1451AQD | ACTIVE | SOIC | D | 16 | 40 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TL1451AQ | Samples |
| TL1451AQDR | ACTIVE | SOIC | D | 16 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | TL1451AQ | Samples |
| TL1451CN | ACTIVE | PDIP | N | 16 | 25 | RoHS & Green | NIPDAU | N / A for Pkg Type | -20 to 85 | TL1451CN | Samples |
| TL1451CNS | ACTIVE | SO | NS | 16 | 50 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | TL1451 | Samples |
| TL1451CNSR | ACTIVE | SO | NS | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | TL1451 | Samples |
| TL1451INSR | ACTIVE | SO | NS | 16 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -20 to 85 | TL1451I | Samples |

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.



**OTHER QUALIFIED VERSIONS OF TL1451A :**

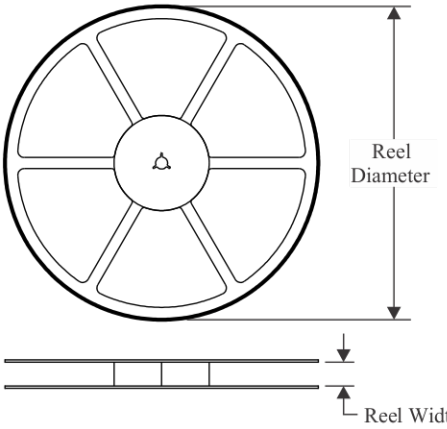
- Automotive : TL1451A-Q1
- Enhanced Product : TL1451A-EP

NOTE: Qualified Version Definitions:

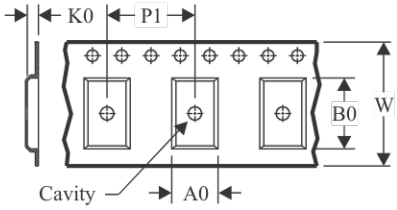
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

## TAPE AND REEL INFORMATION

REEL DIMENSIONS

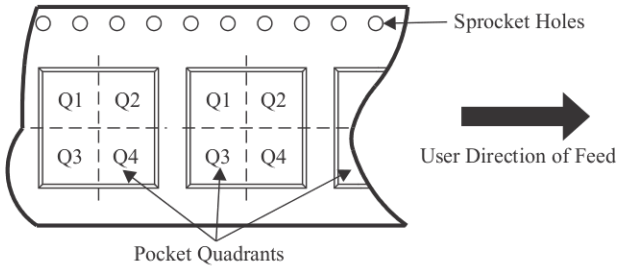



TAPE DIMENSIONS




| | |
|---|---|
| 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 |

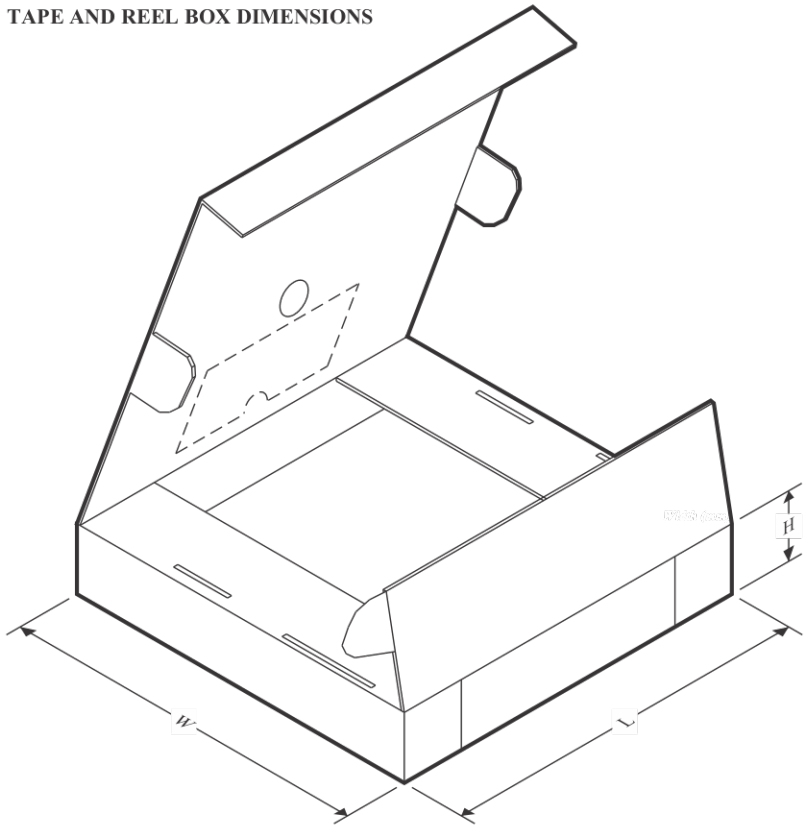
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | SO | NS | 16 | 2000 | 330.0 | 16.4 | 8.1 | 10.4 | 2.5 | 12.0 | 16.0 | 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 | SO | NS | 16 | 2000 | 330.0 | 16.4 | 8.1 | 10.4 | 2.5 | 12.0 | 16.0 | Q1 |
| TL1451INSR | SO | NS | 16 | 2000 | 330.0 | 16.4 | 8.1 | 10.4 | 2.5 | 12.0 | 16.0 | Q1 |

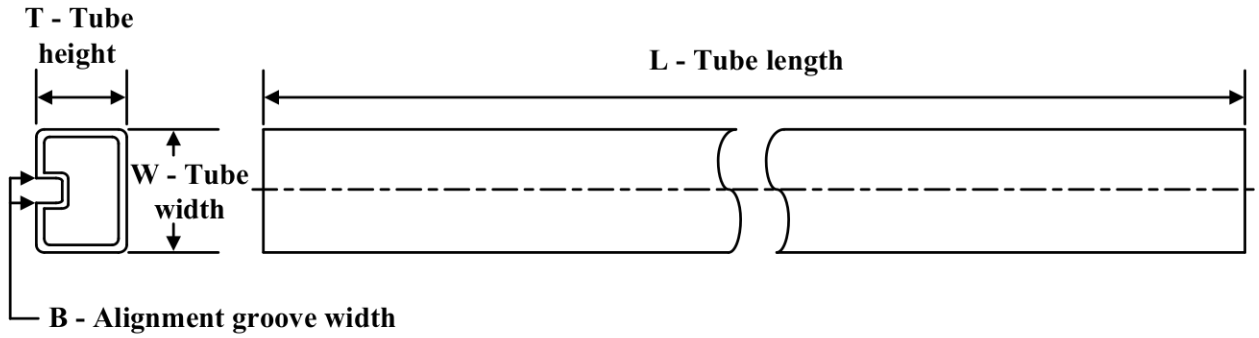
TAPE AND REEL BOX DIMENSIONS




*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 | 340.5 | 336.1 | 32.0 |
| TL1451ACNSR | SO | 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 | SO | NS | 16 | 2000 | 356.0 | 356.0 | 35.0 |
| TL1451INSR | SO | NS | 16 | 2000 | 356.0 | 356.0 | 35.0 |

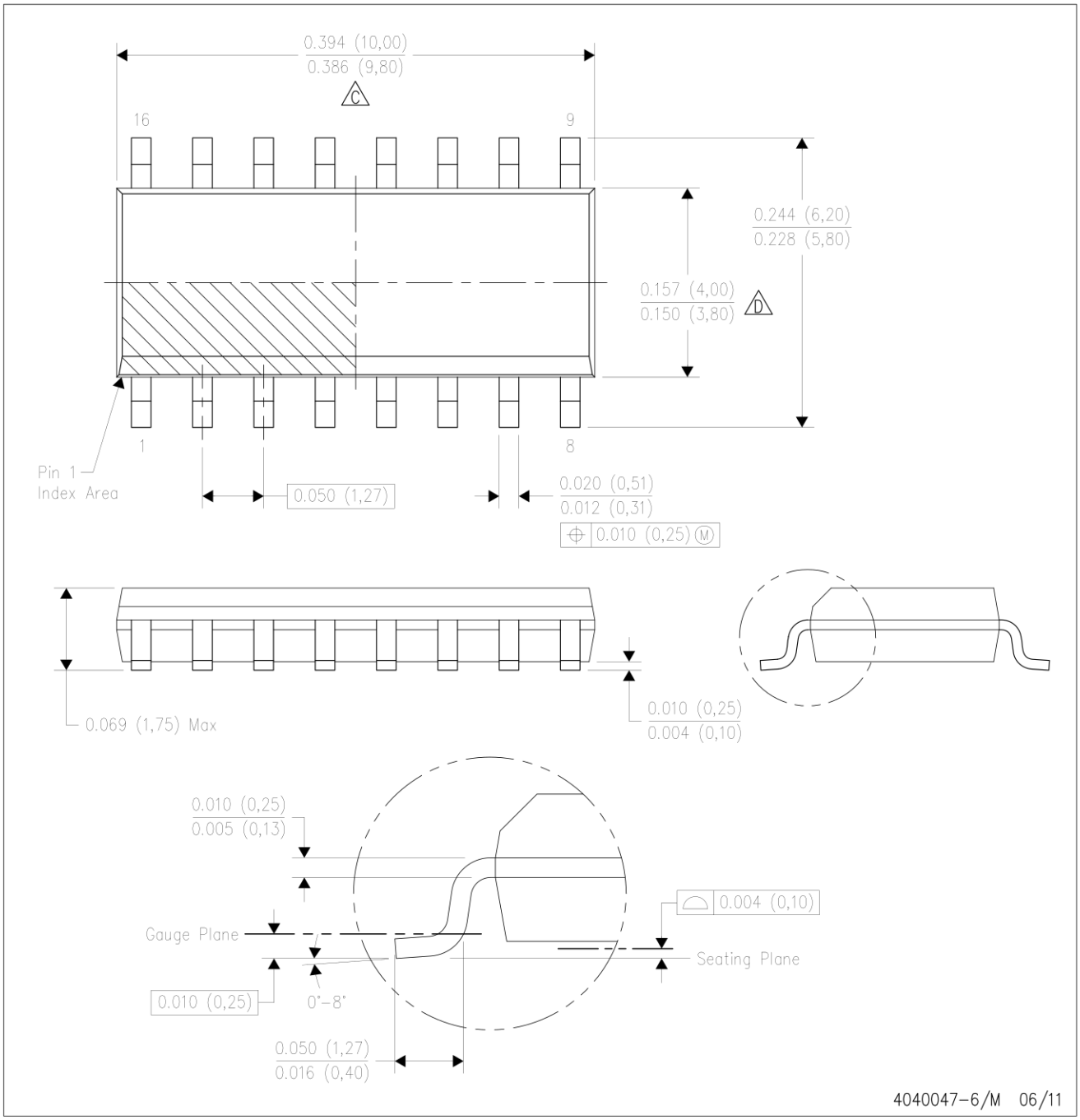
## TUBE




*All dimensions are nominal

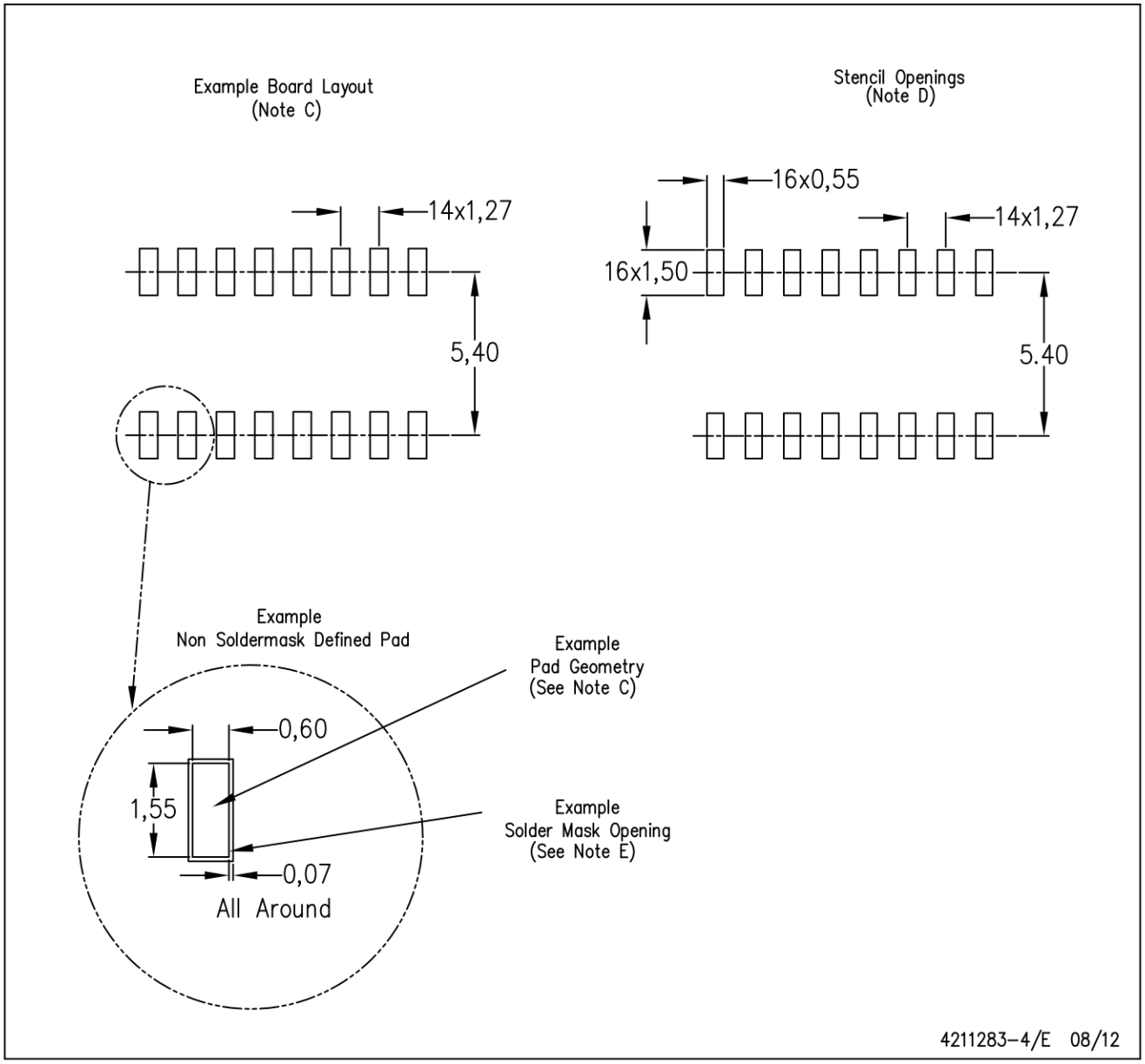
| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (µm) | B (mm) |
|---|---|---|---|---|---|---|---|---|
| TL1451ACD | D | SOIC | 16 | 40 | 505.46 | 6.76 | 3810 | 4 |
| TL1451ACD | D | SOIC | 16 | 40 | 507 | 8 | 3940 | 4.32 |
| TL1451ACN | N | PDIP | 16 | 25 | 506 | 13.97 | 11230 | 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 |

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.

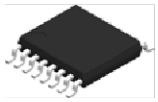
D (R–PDSO–G16) PLASTIC SMALL OUTLINE




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525 for other stencil recommendations.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

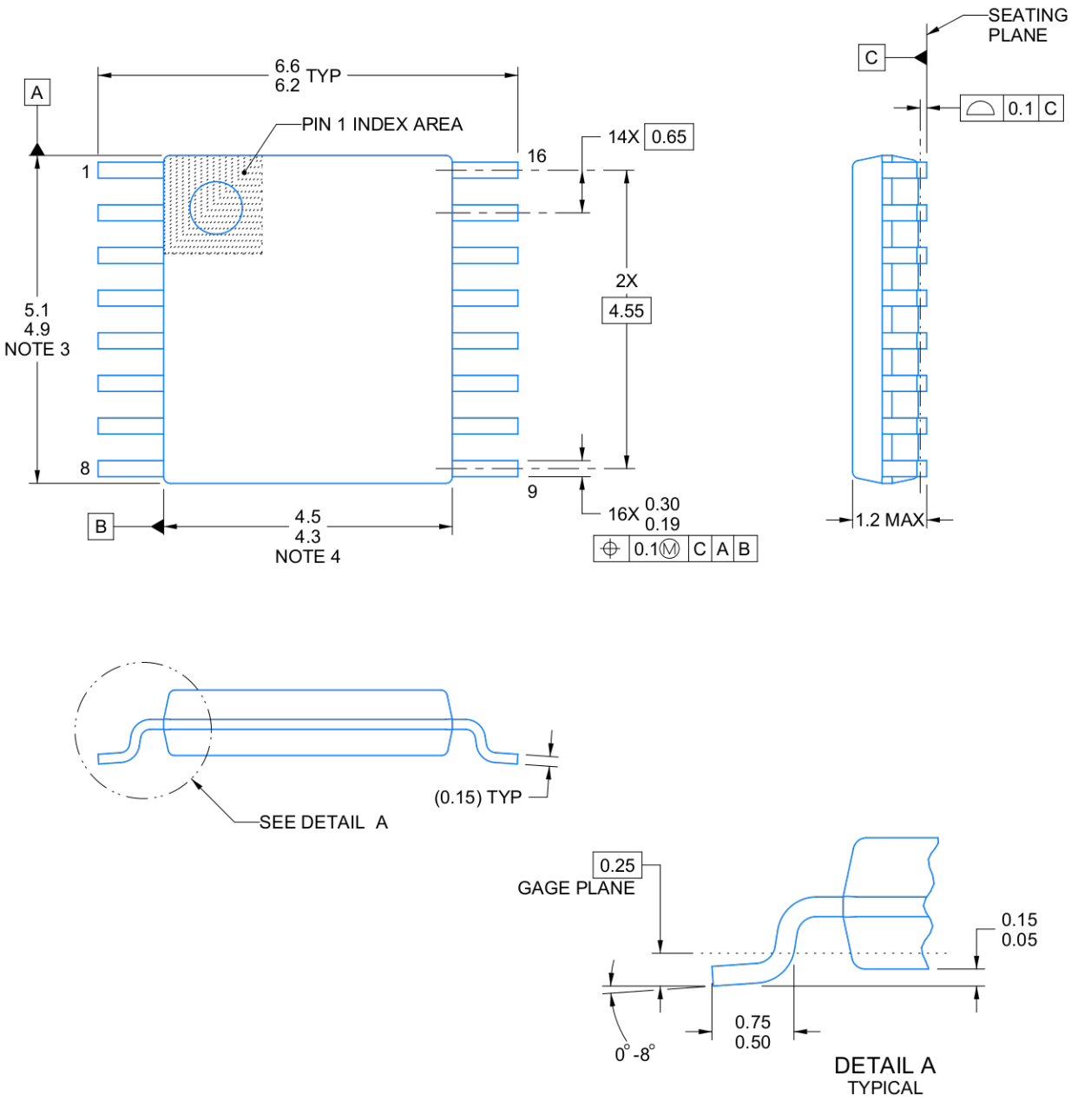
# PACKAGE OUTLINE

## PW0016A



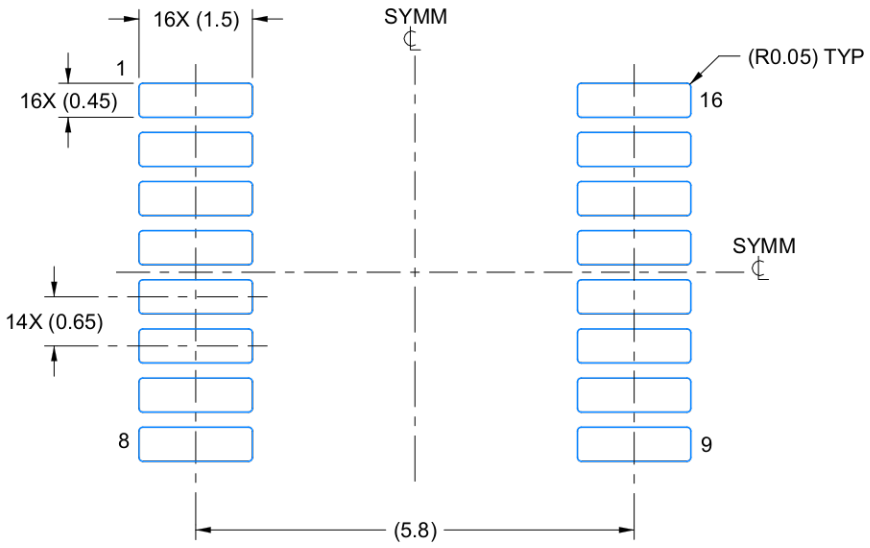
## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE




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.



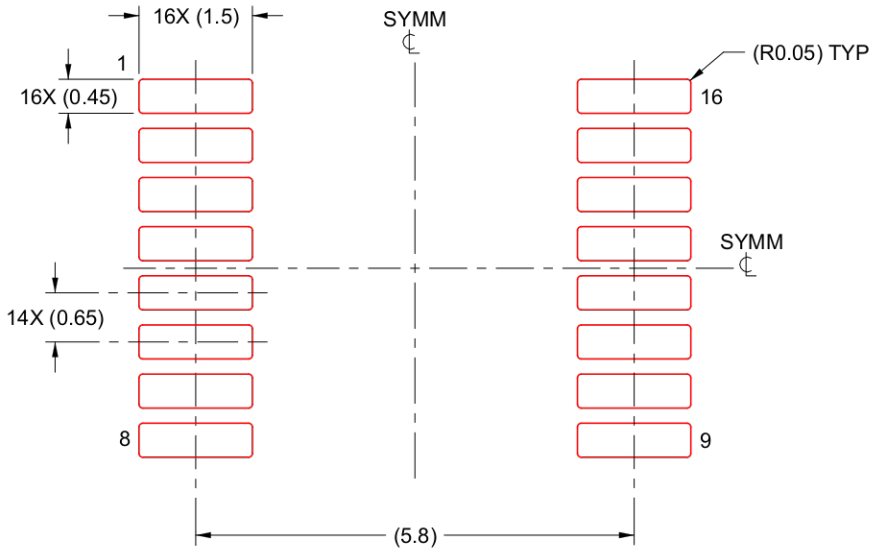

LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X


SOLDER MASK DETAILS

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.




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

4220204/A 02/2017

NOTES: (continued)

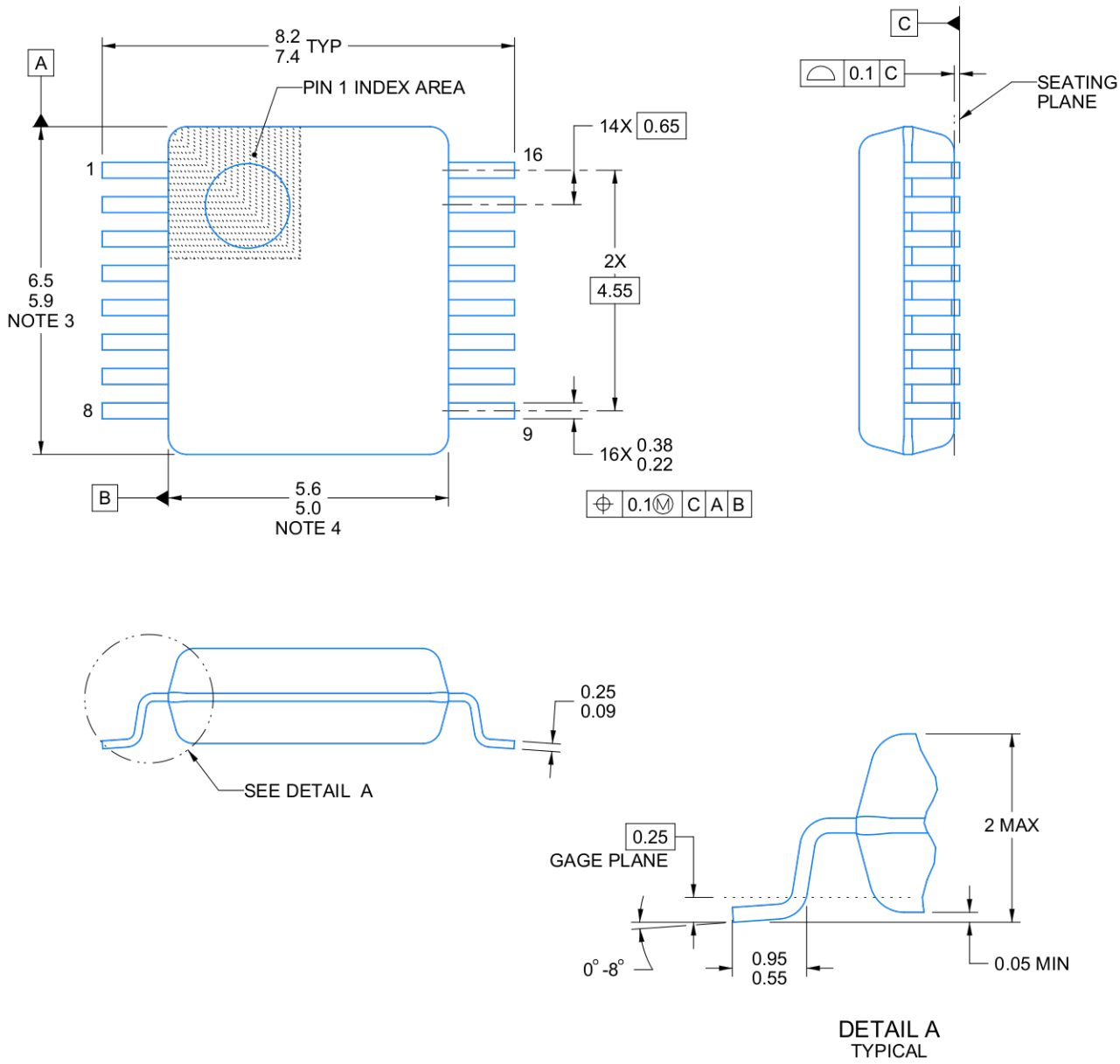
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

# PACKAGE OUTLINE

## DB0016A

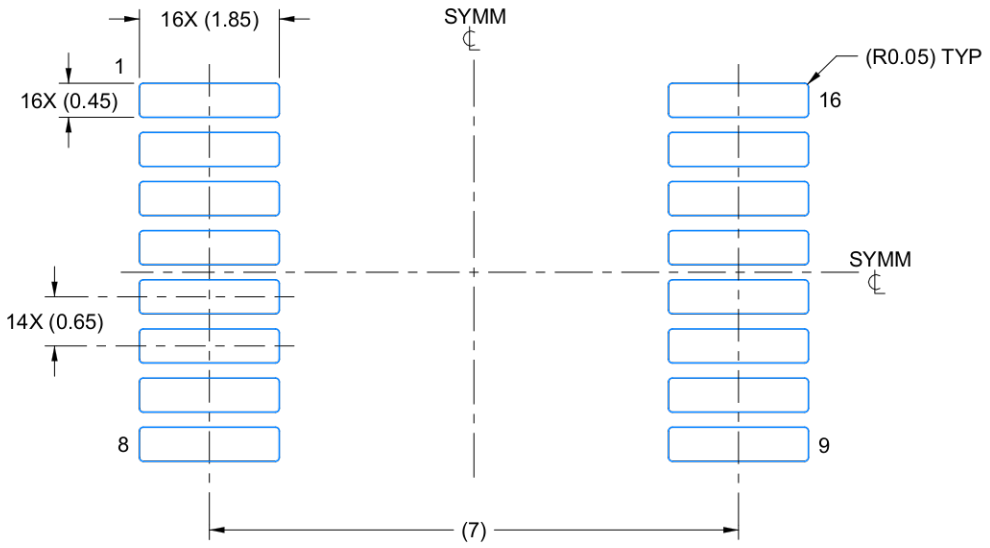
## SSOP - 2 mm max height

SMALL OUTLINE PACKAGE

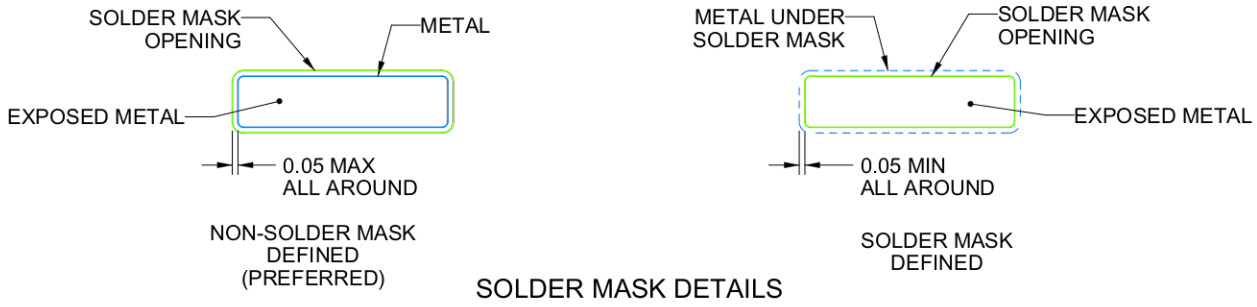



NOTES:

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. Reference JEDEC registration MO-150.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

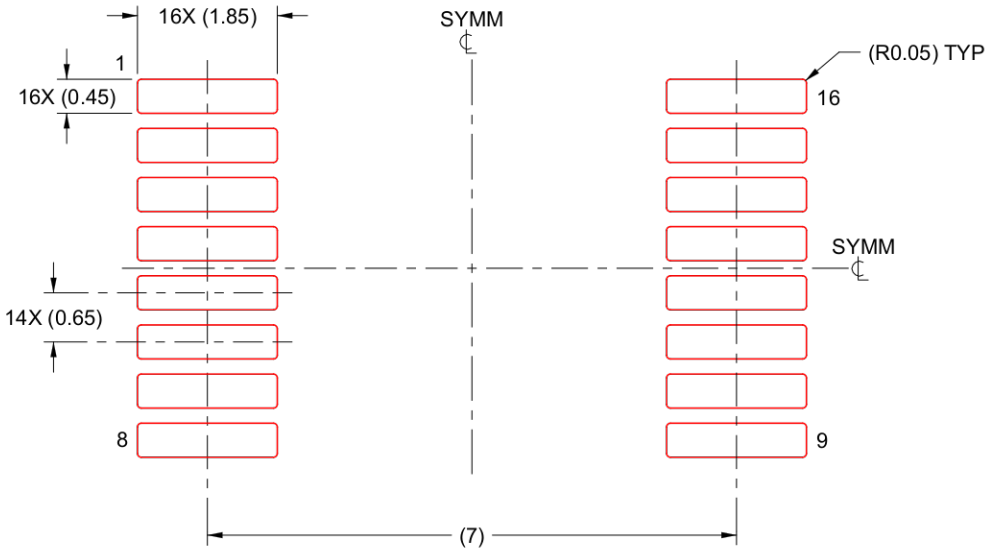



SOLDER MASK DETAILS

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.




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

4220763/A 05/2022

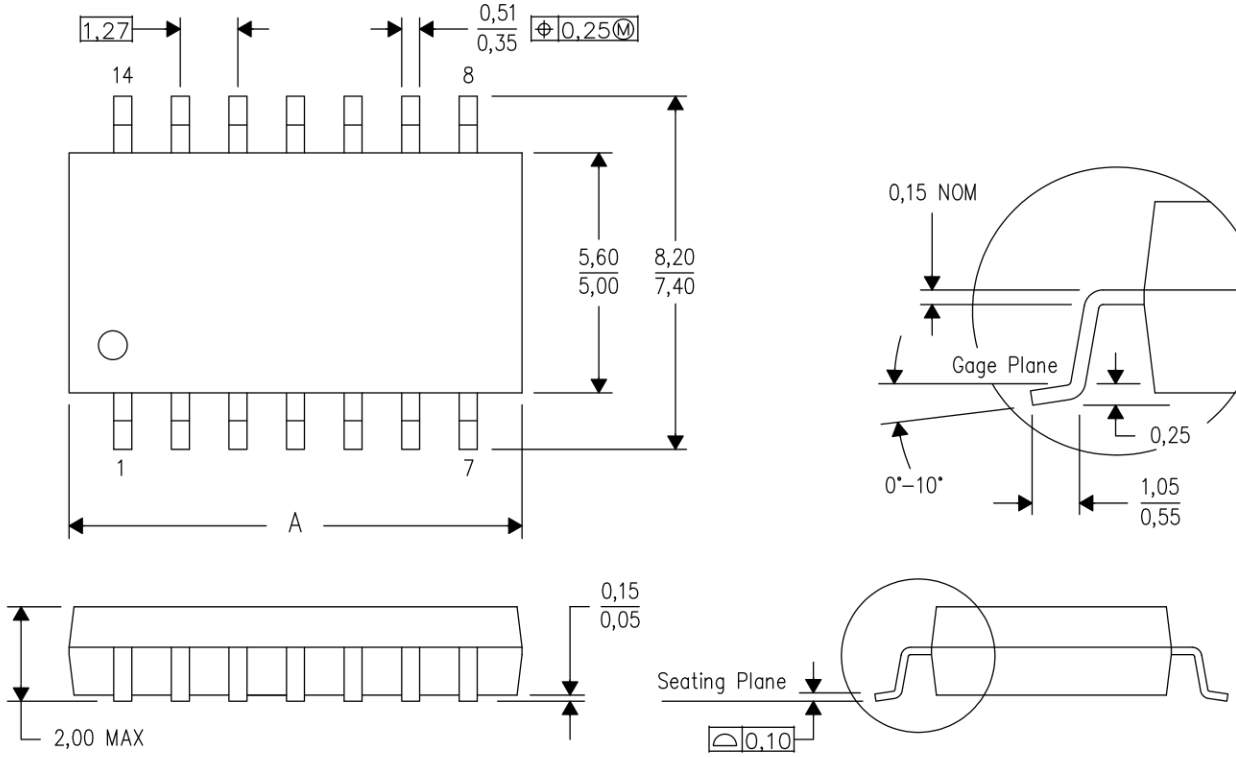
NOTES: (continued)

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.

## MECHANICAL DATA

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

**14-PINS SHOWN**




| DIM \ PINS ** | 14 | 16 | 20 | 24 |
|---|---|---|---|---|
| A MAX | 10,50 | 10,50 | 12,90 | 15,30 |
| A MIN | 9,90 | 9,90 | 12,30 | 14,70 |

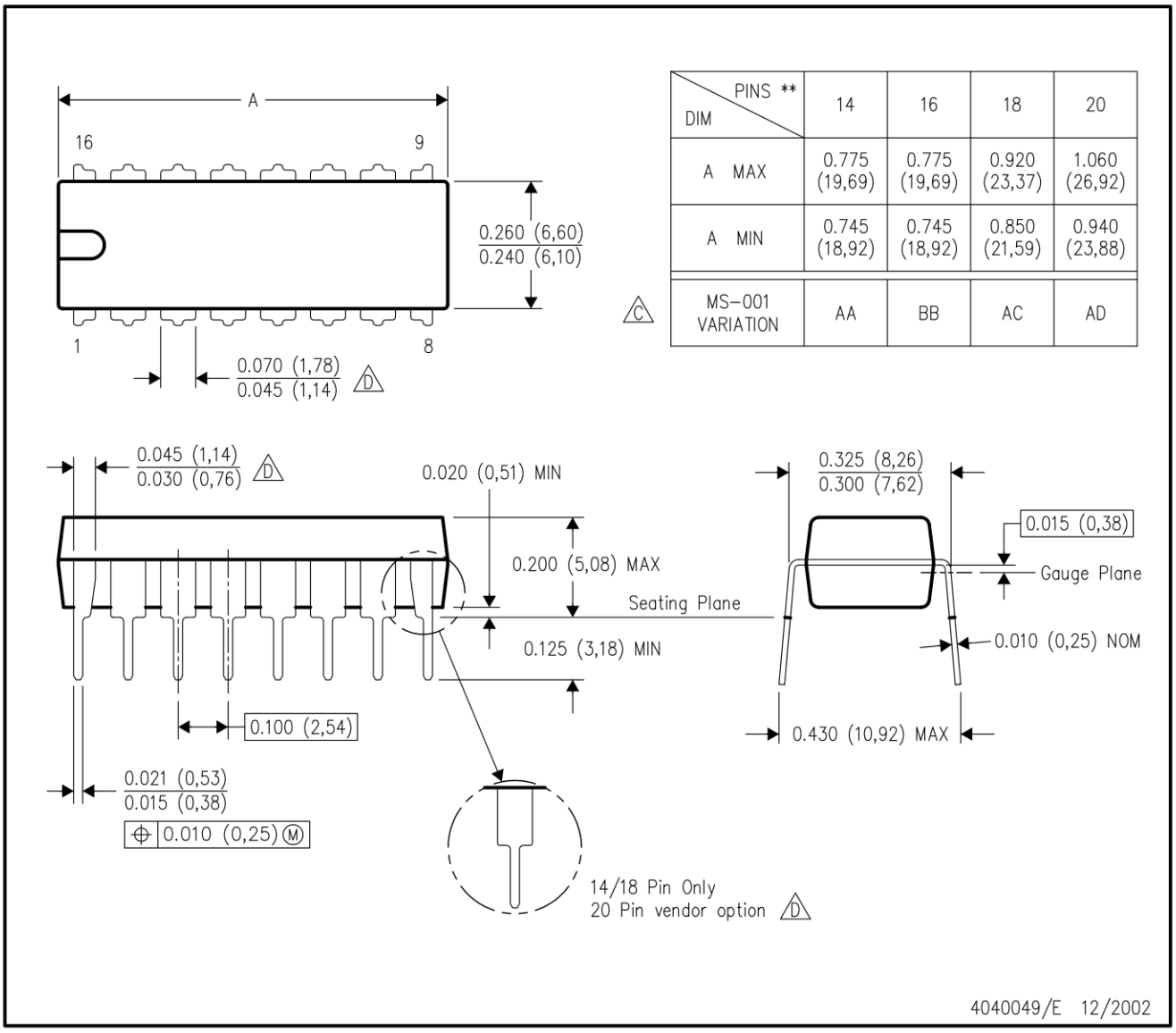
4040062/C 03/03

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.

## N (R–PDIP–T**)

## PLASTIC DUAL–IN–LINE PACKAGE

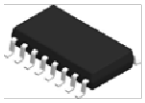
16 PINS SHOWN




| 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 | 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.

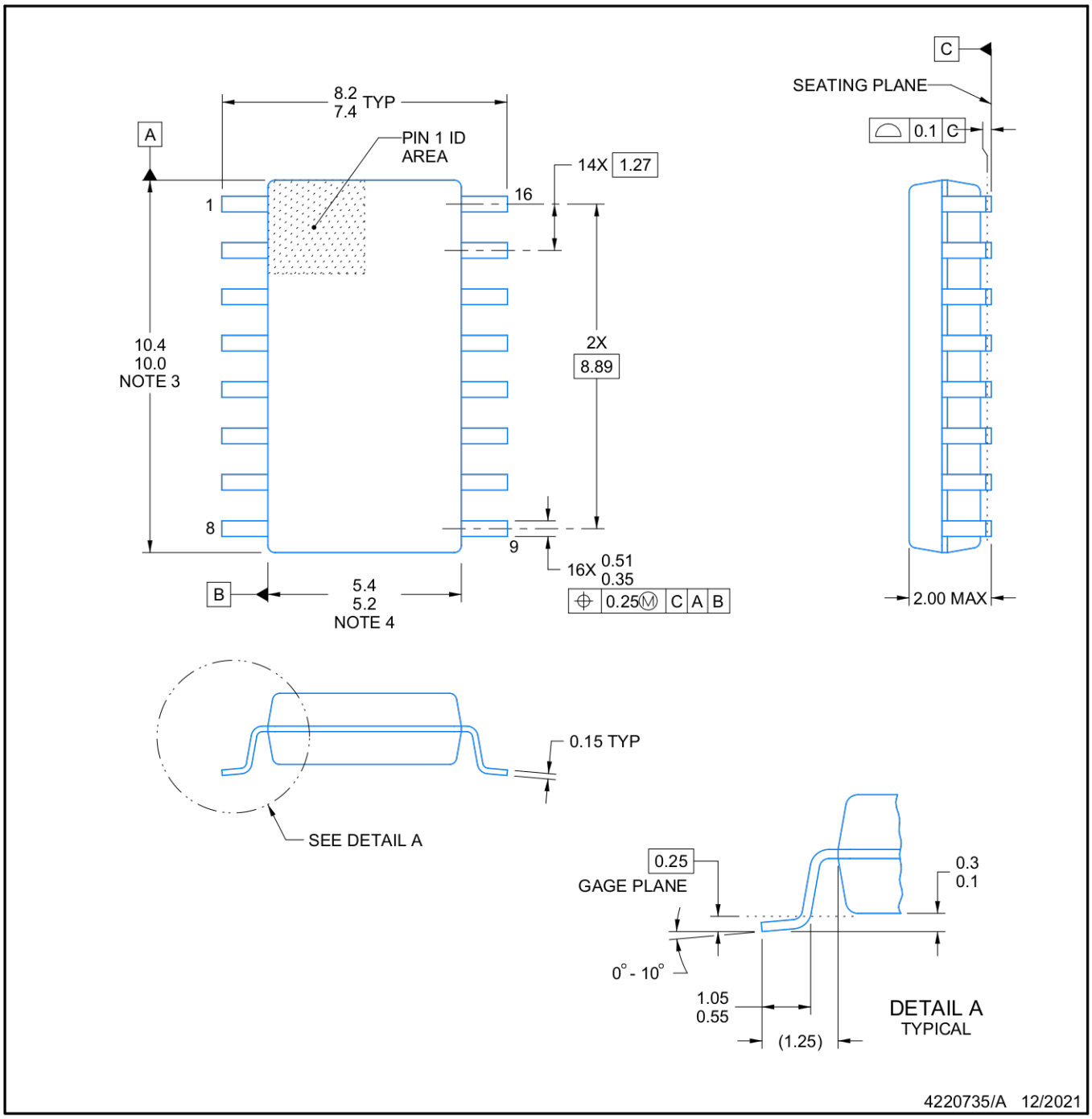


# PACKAGE OUTLINE

## NS0016A

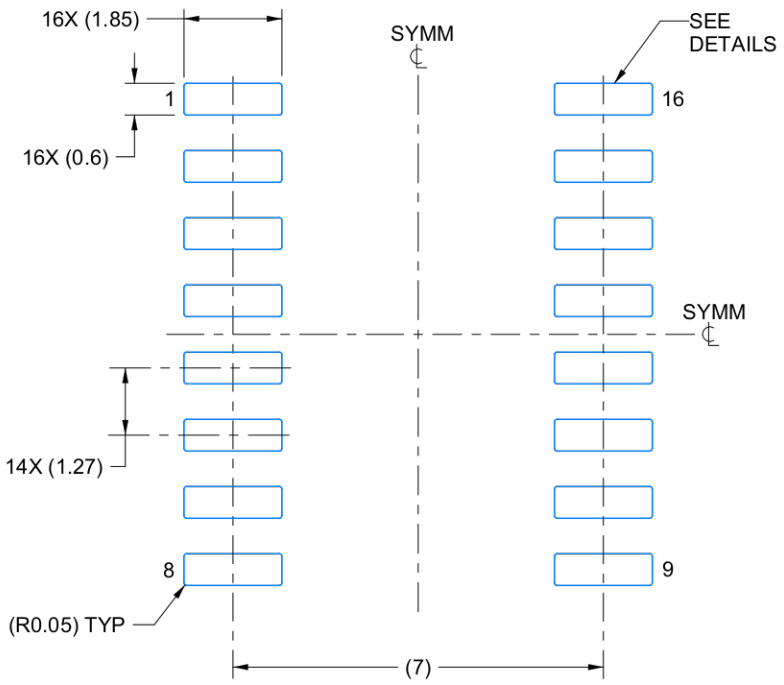
## SOP - 2.00 mm max height

SOP

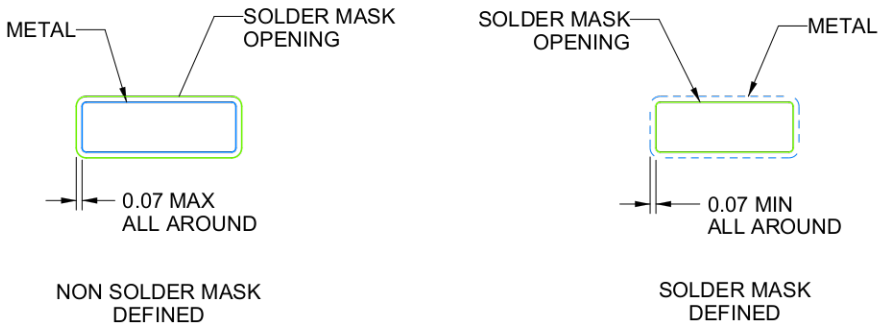



NOTES:

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.




LAND PATTERN EXAMPLE
SCALE:7X

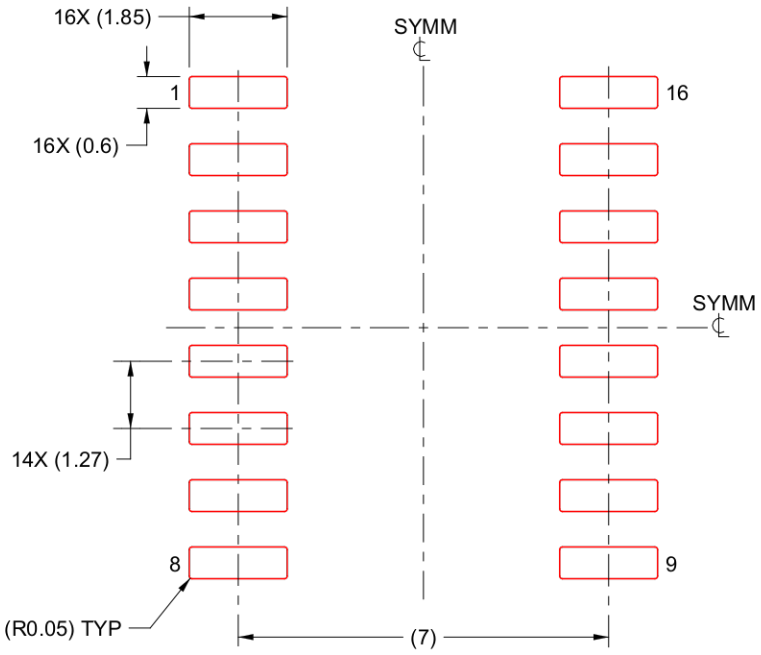



SOLDER MASK DETAILS

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.




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.

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