

# 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

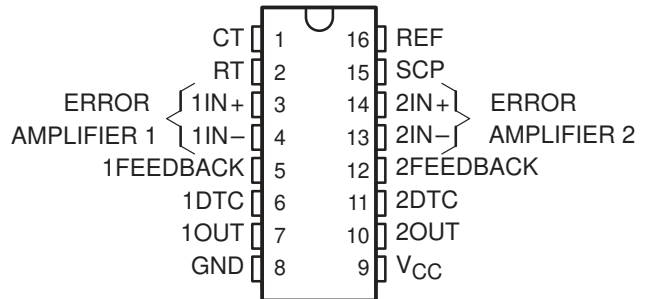
### description

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.

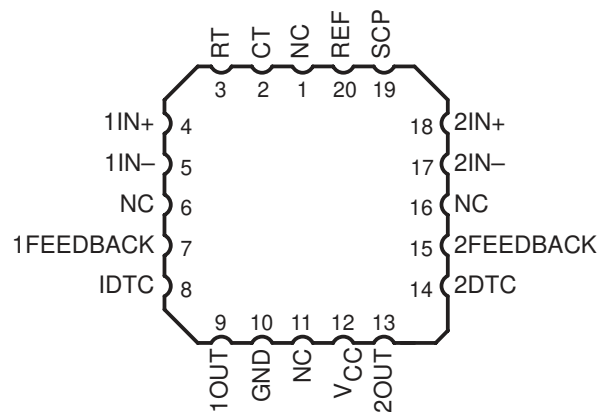
The uncommitted output transistors provide common-emitter output capability for each controller. The internal amplifiers exhibit a common-mode voltage range from 1.04 V to 1.45 V. The dead-time control (DTC) comparator has no offset unless externally altered and can provide 0% to 100% dead time. The 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  $125^{\circ}\text{C}$ .

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



FK PACKAGE  
(TOP VIEW)



### 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 $85^{\circ}\text{C}$  | —                 | 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).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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.



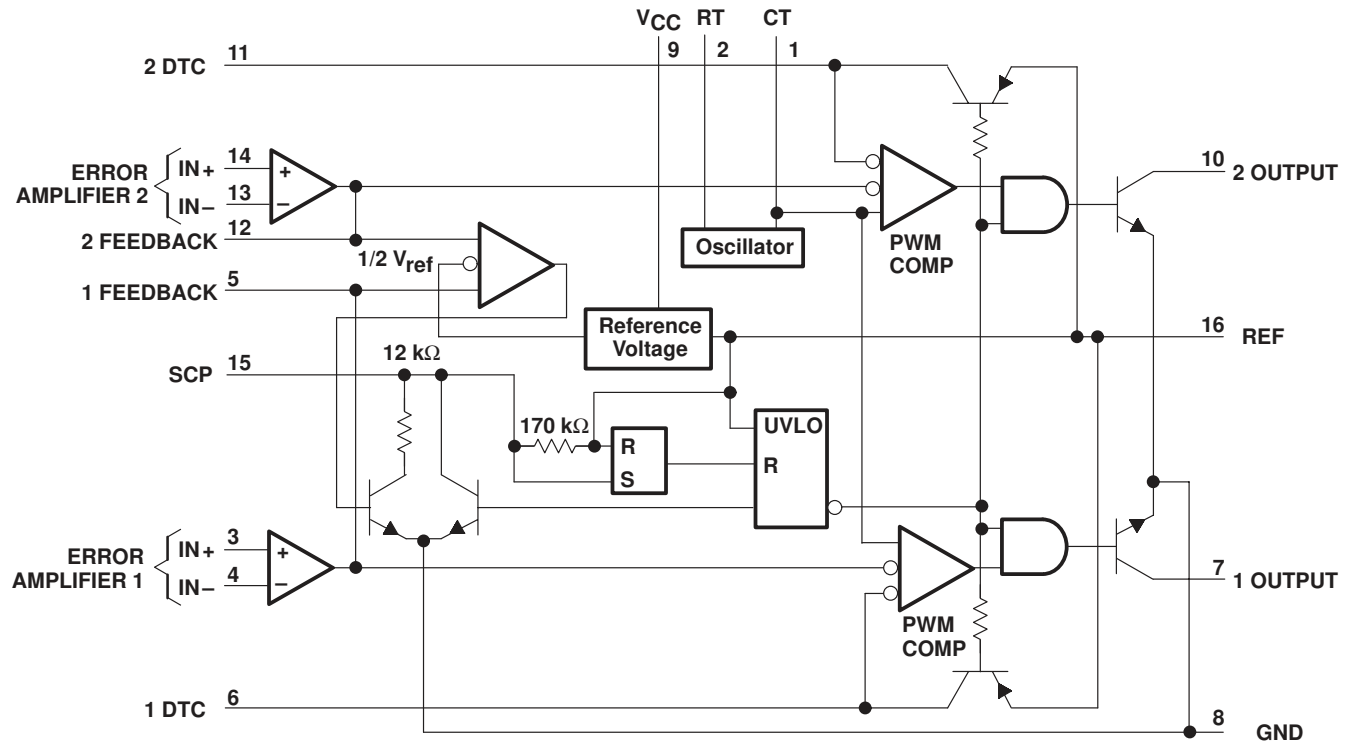
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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## functional block diagram



### COMPONENT COUNT

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

# TL1451A

## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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### 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                     |
|  | Q suffix                     |
|  | M suffix                     |
| Storage temperature range, $T_{stg}$                         | –20°C to 85°C                |
|  | –40°C to 125°C               |
|  | –55°C to 125°C               |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | –65°C to 150°C               |
|  | 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 | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING FACTOR<br>ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 85^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>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    | $\mu\text{A}$    |
| Feedback resistor, $R_F$              | 100      |       | $\text{k}\Omega$ |
| Timing capacitor, $C_T$               | 150      | 15000 | pF               |
| Timing resistor, $R_T$                | 5.1      | 100   | $\text{k}\Omega$ |
| Oscillator frequency                  | 1        | 500   | kHz              |
| Operating free-air temperature, $T_A$ | C suffix | –20   | 85               |
|                                       | Q suffix | –40   | 125              |
|                                       | M suffix | –55   | 125              |
|                                       |          |       | °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                                 | 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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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   | $C_T = 330 \text{ pF}$ ,<br>$R_T = 10 \text{ k}\Omega$ |                           | 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.



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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 | 2.0 | V    |
|                              | $T_A = 125^\circ\text{C}$ |                    | 1.60 | 2.4 |      |
|                              | $T_A = \text{MIN}$        |                    | 1.36 | 2.2 |      |
| 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 | *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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## 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

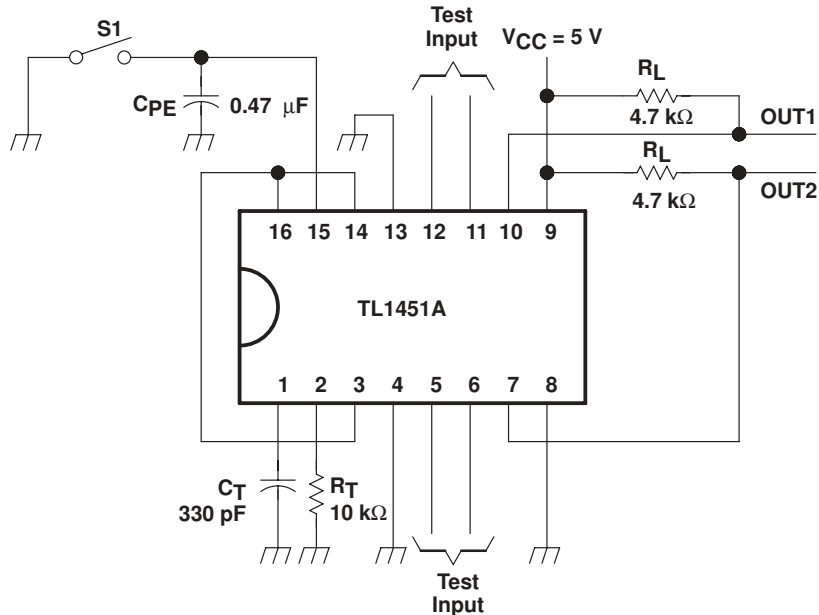
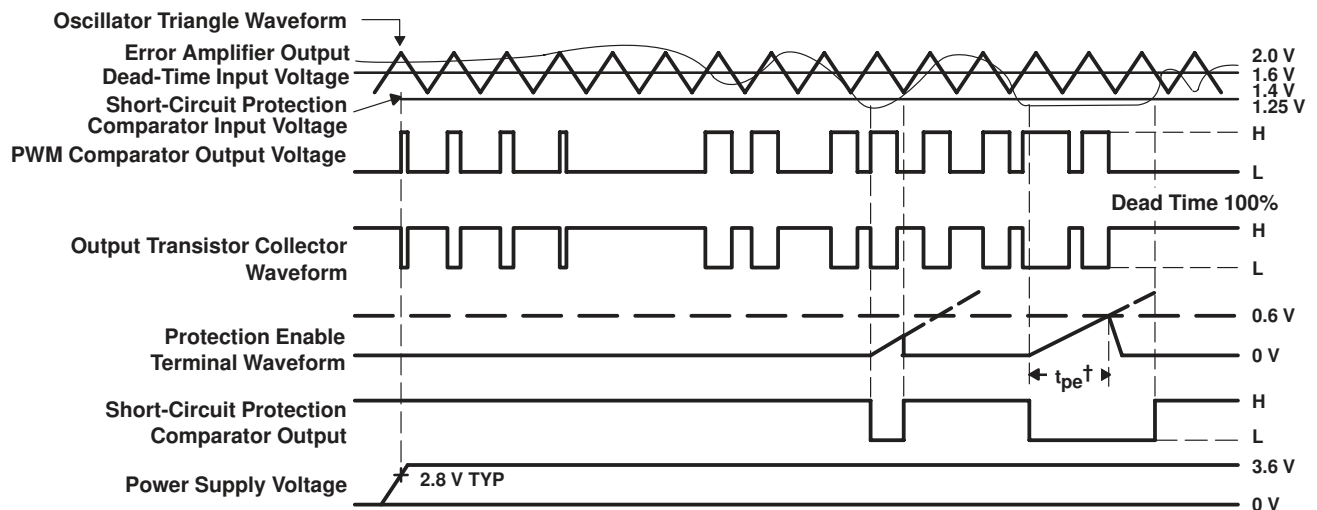


Figure 1. Test Circuit



† 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

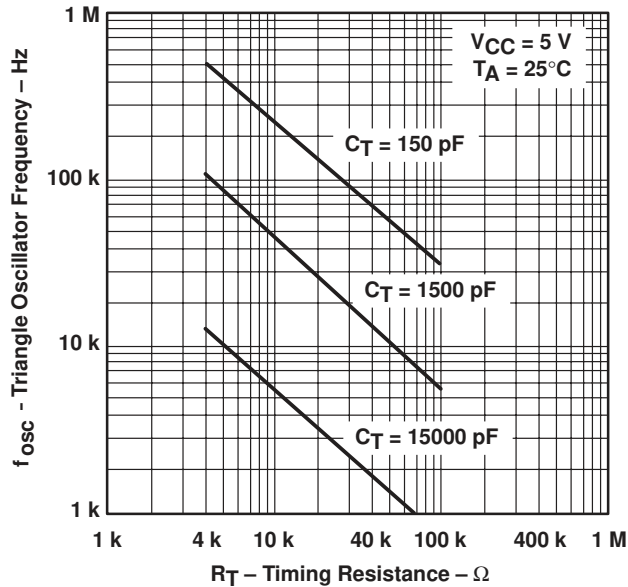


Figure 3

OSCILLATOR FREQUENCY VARIATION  
vs  
FREE-AIR TEMPERATURE

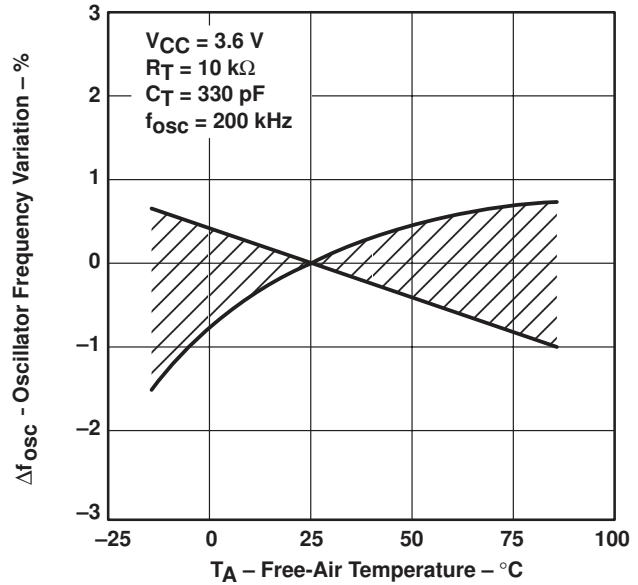


Figure 4

TRIANGLE WAVEFORM SWING VOLTAGE  
vs  
TIMING CAPACITANCE

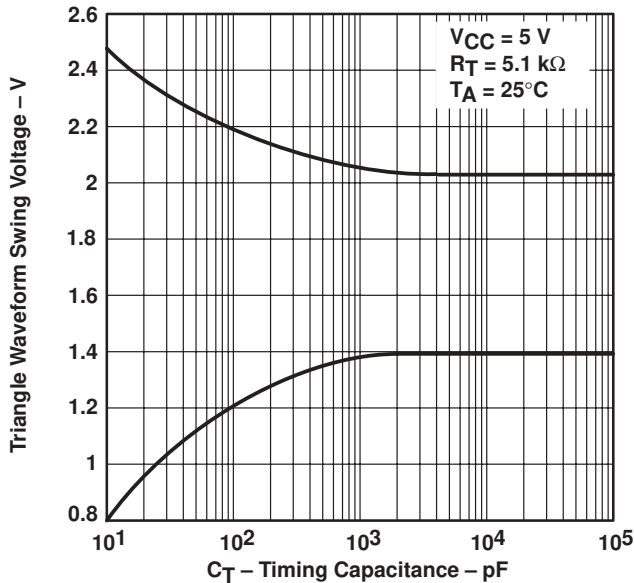


Figure 5

TRIANGLE WAVEFORM PERIOD  
vs  
TIMING CAPACITANCE

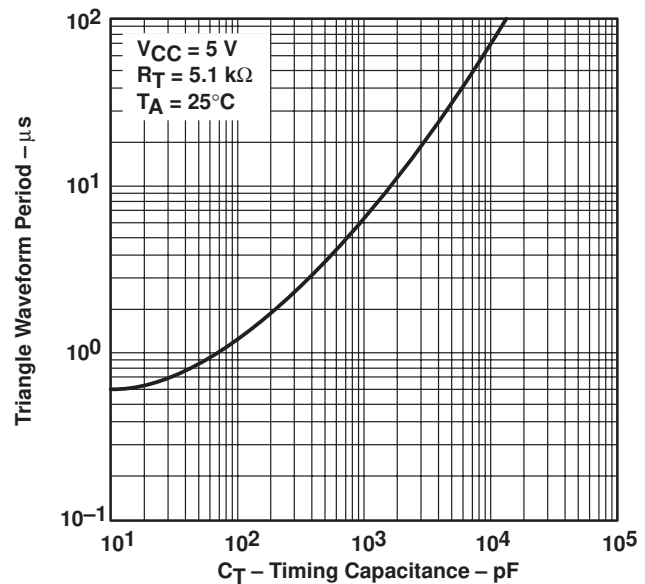


Figure 6



TYPICAL CHARACTERISTICS

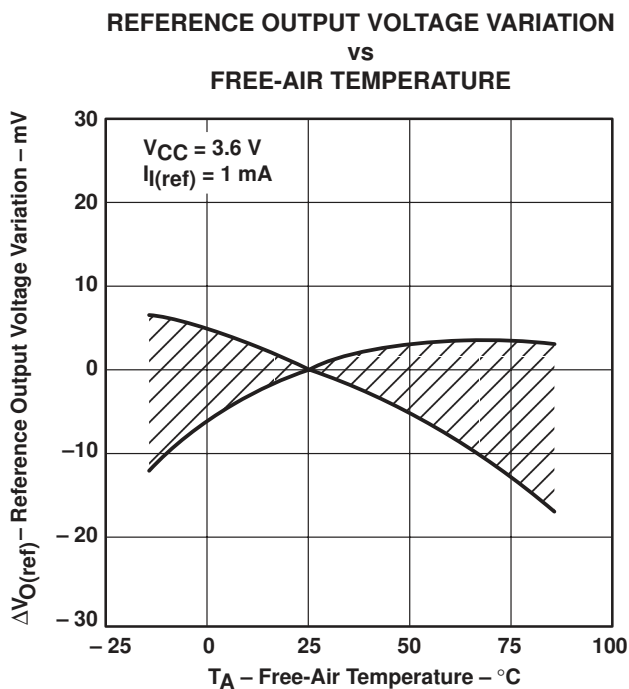


Figure 7

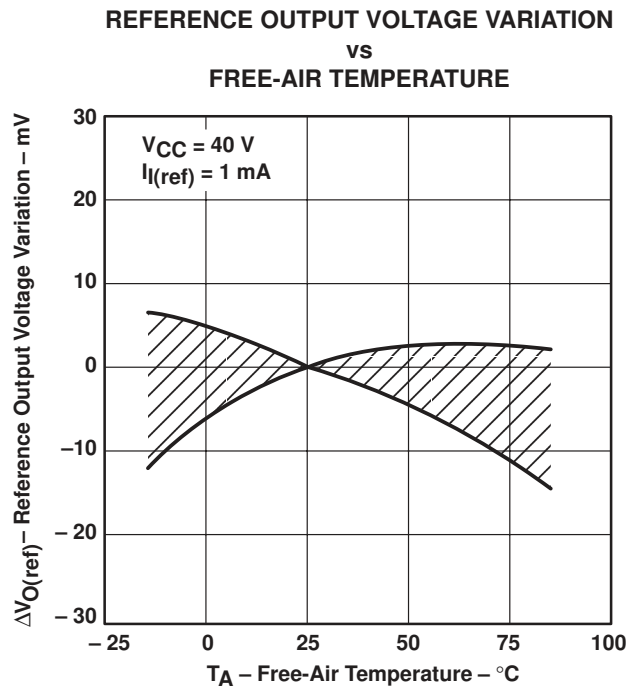


Figure 8

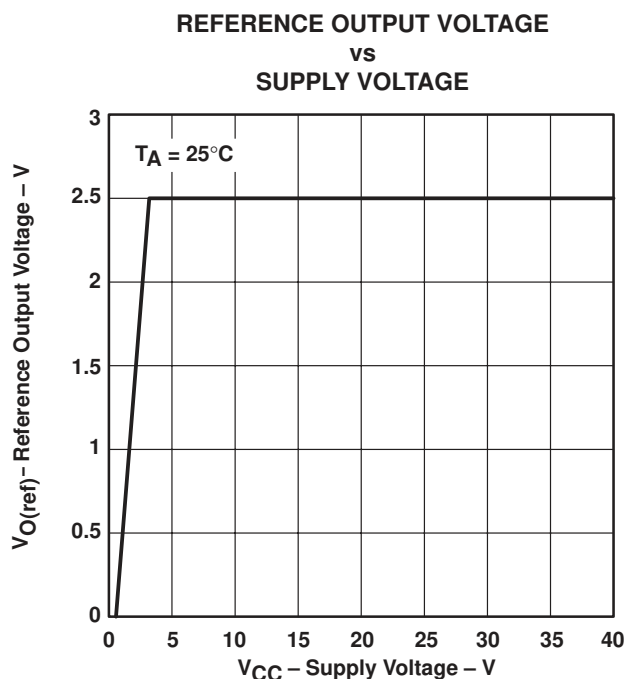


Figure 9

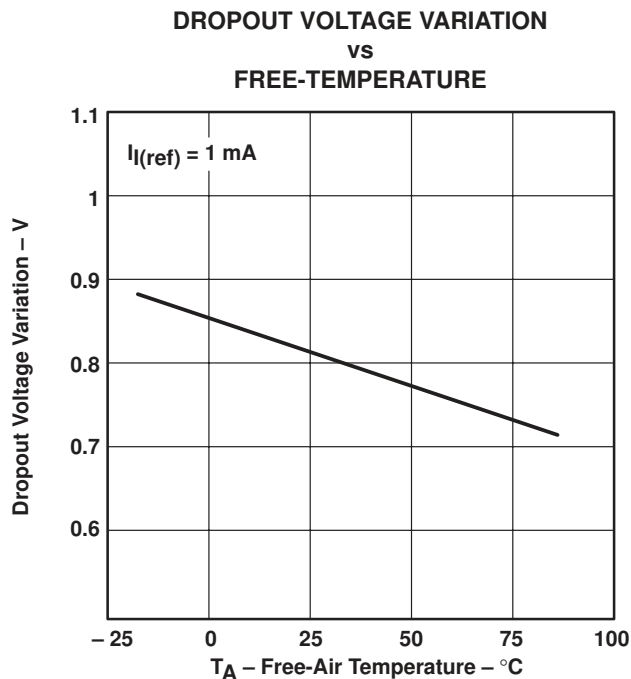


Figure 10

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## TYPICAL CHARACTERISTICS

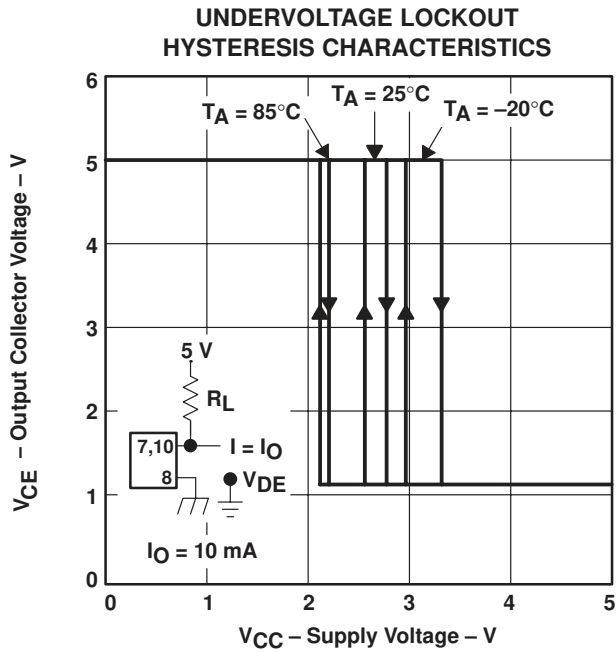


Figure 11

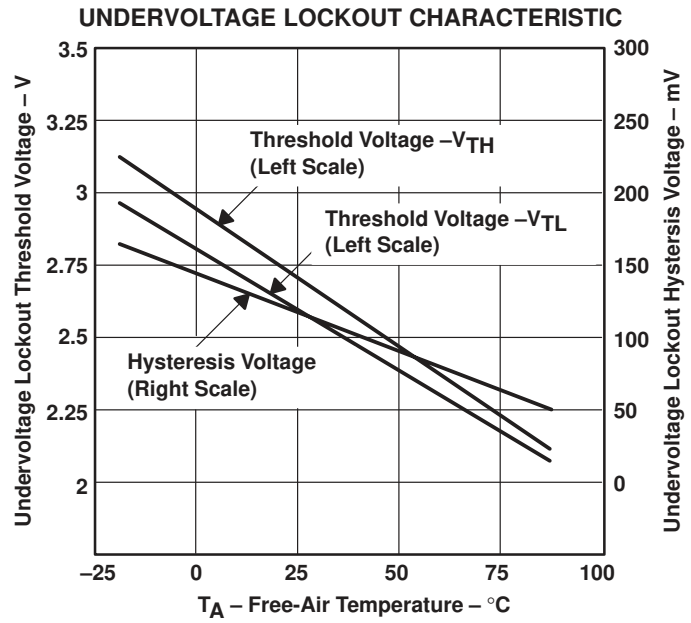


Figure 12

## SHORT-CIRCUIT PROTECTION CHARACTERISTICS

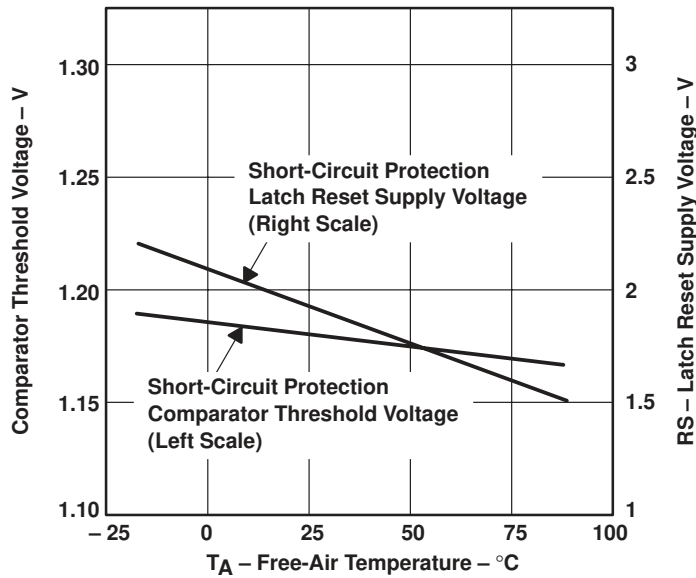


Figure 13

TYPICAL CHARACTERISTICS

PROTECTION ENABLE TIME  
 VS  
 PROTECTION ENABLE CAPACITANCE

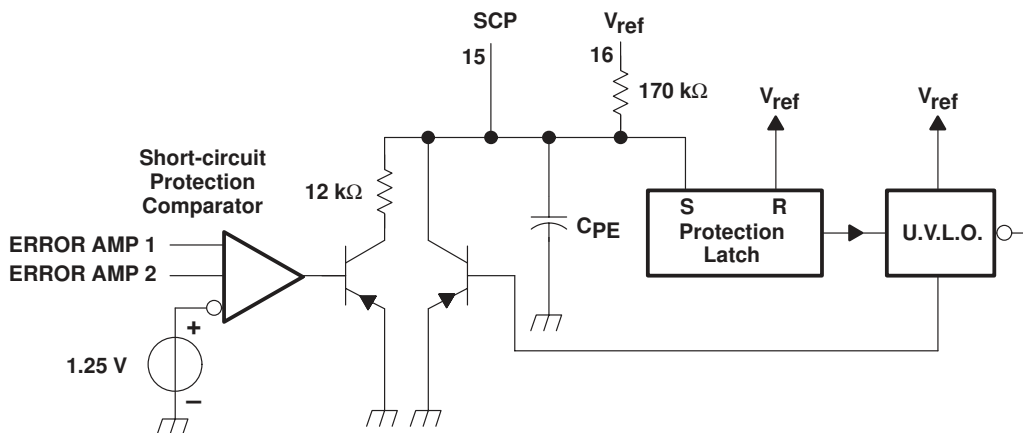
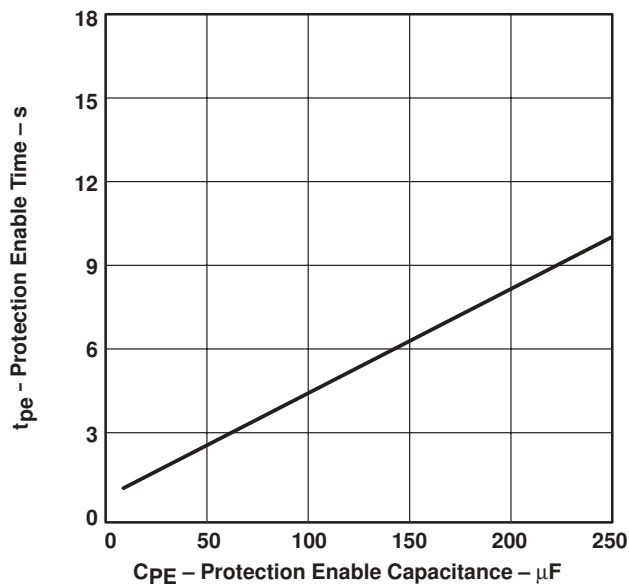


Figure 14

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## TYPICAL CHARACTERISTICS

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

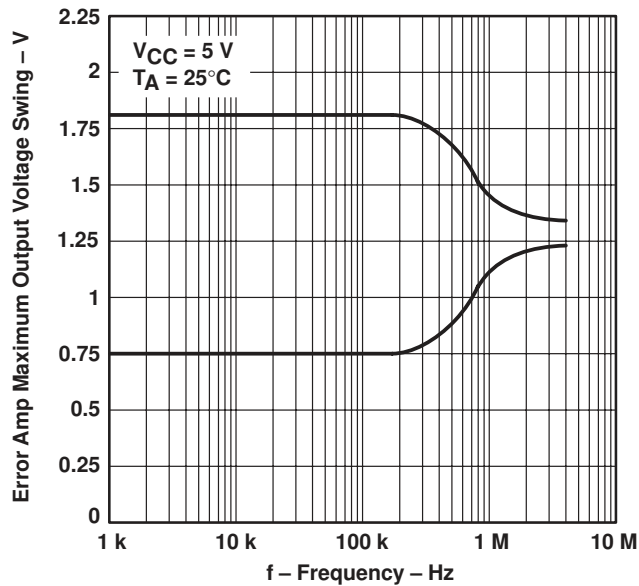


Figure 15

**OPEN-LOOP VOLTAGE AMPLIFICATION  
vs  
FREQUENCY**

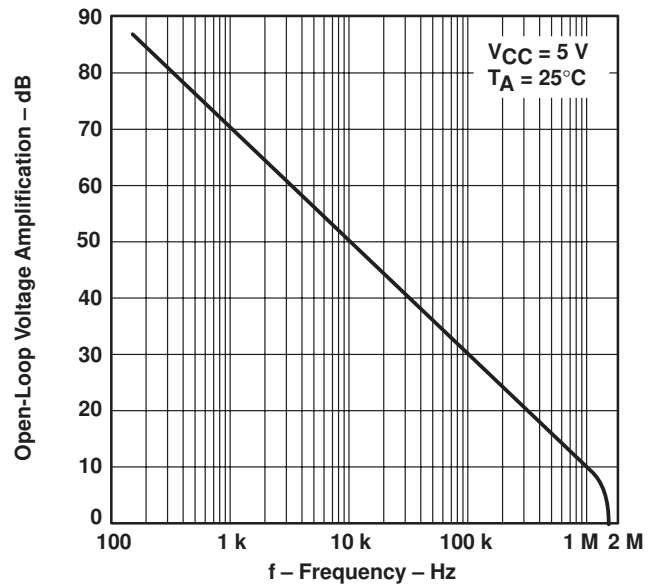


Figure 16

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

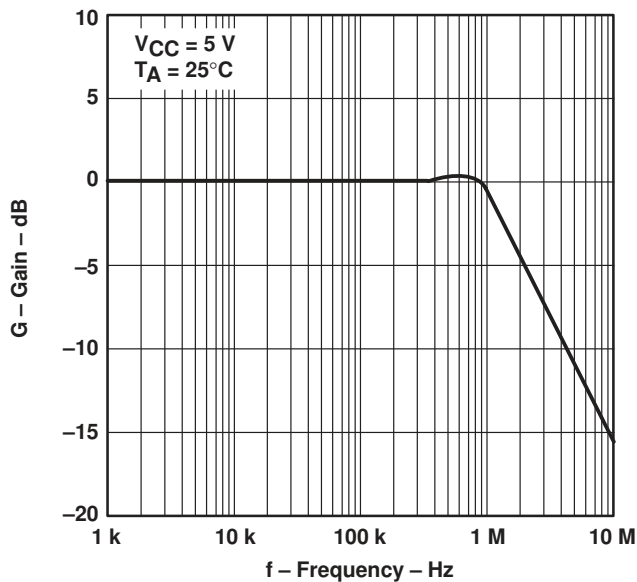
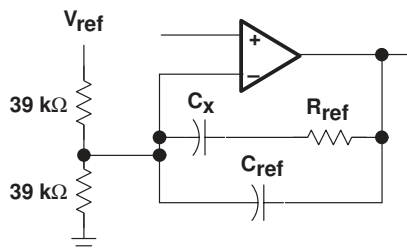
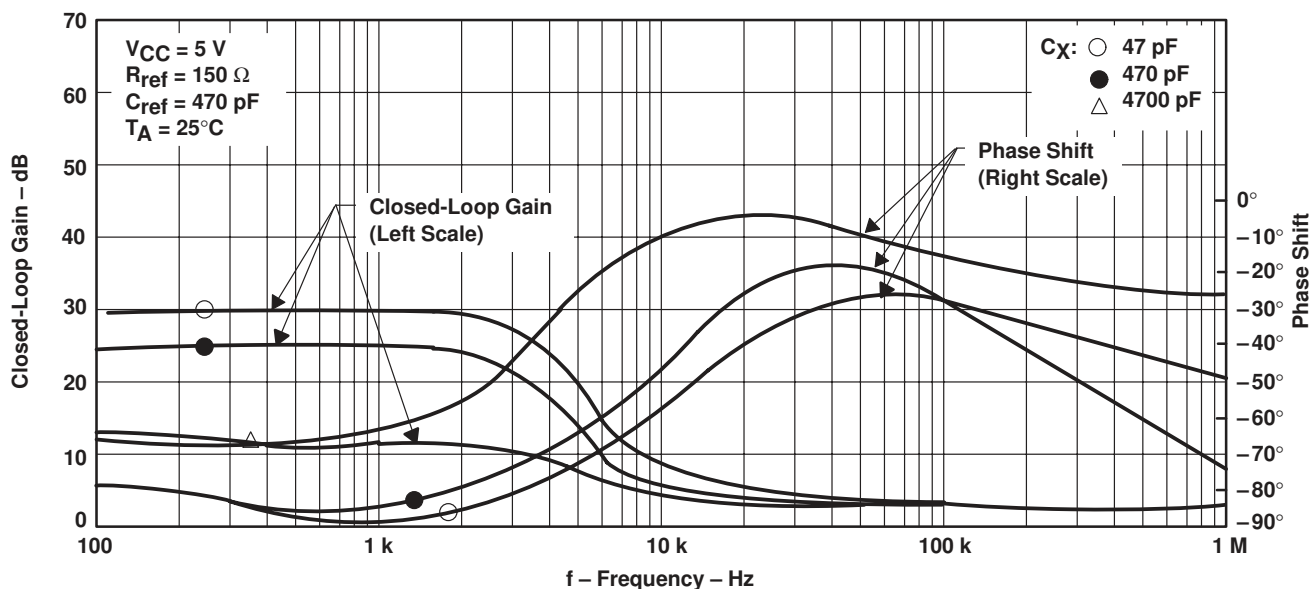


Figure 17

TYPICAL CHARACTERISTICS

CLOSED-LOOP GAIN AND PHASE SHIFT  
 VS  
 FREQUENCY



Test Circuit

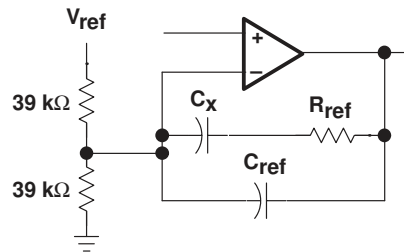
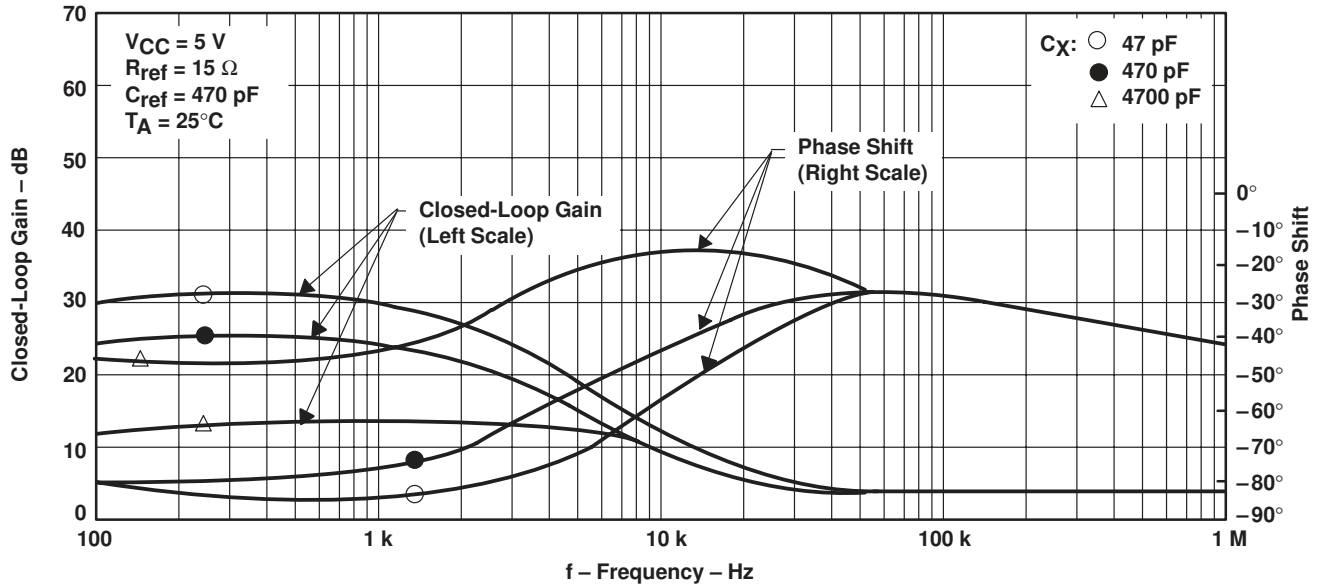
Figure 18

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## TYPICAL CHARACTERISTICS

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



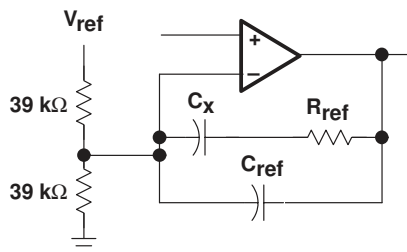
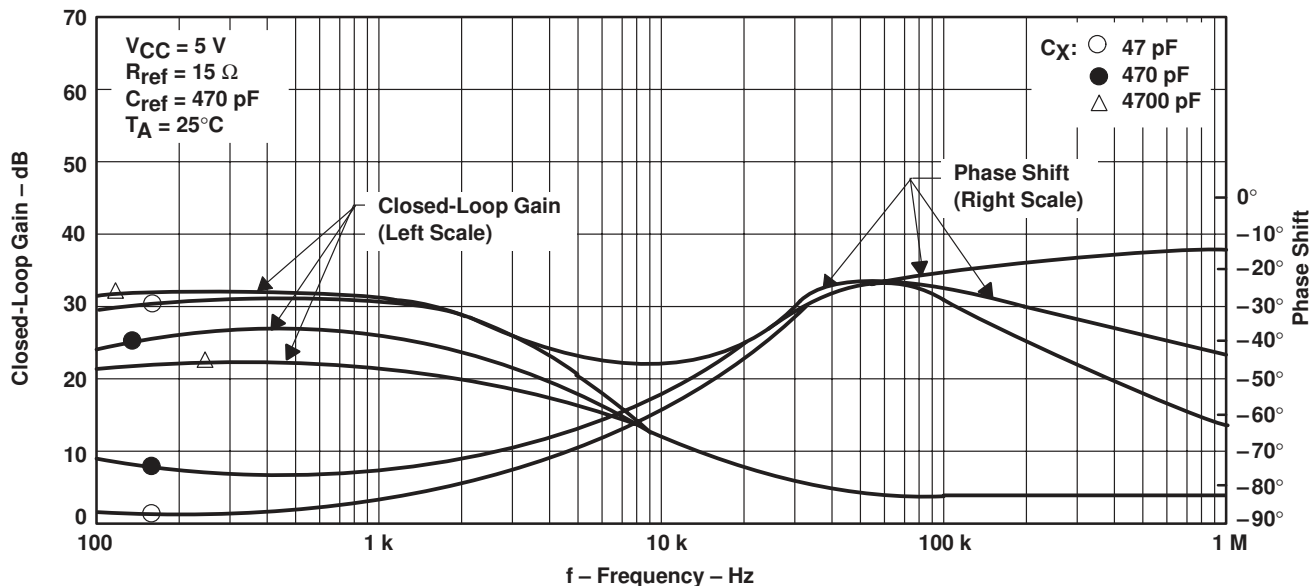
Test Circuit

Figure 19



TYPICAL CHARACTERISTICS

CLOSED-LOOP GAIN AND PHASE SHIFT  
 VS  
 FREQUENCY



Test Circuit

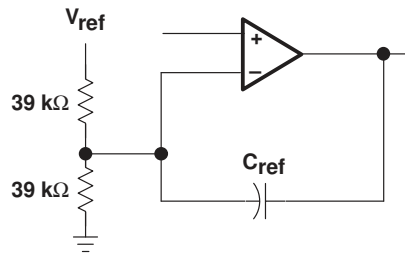
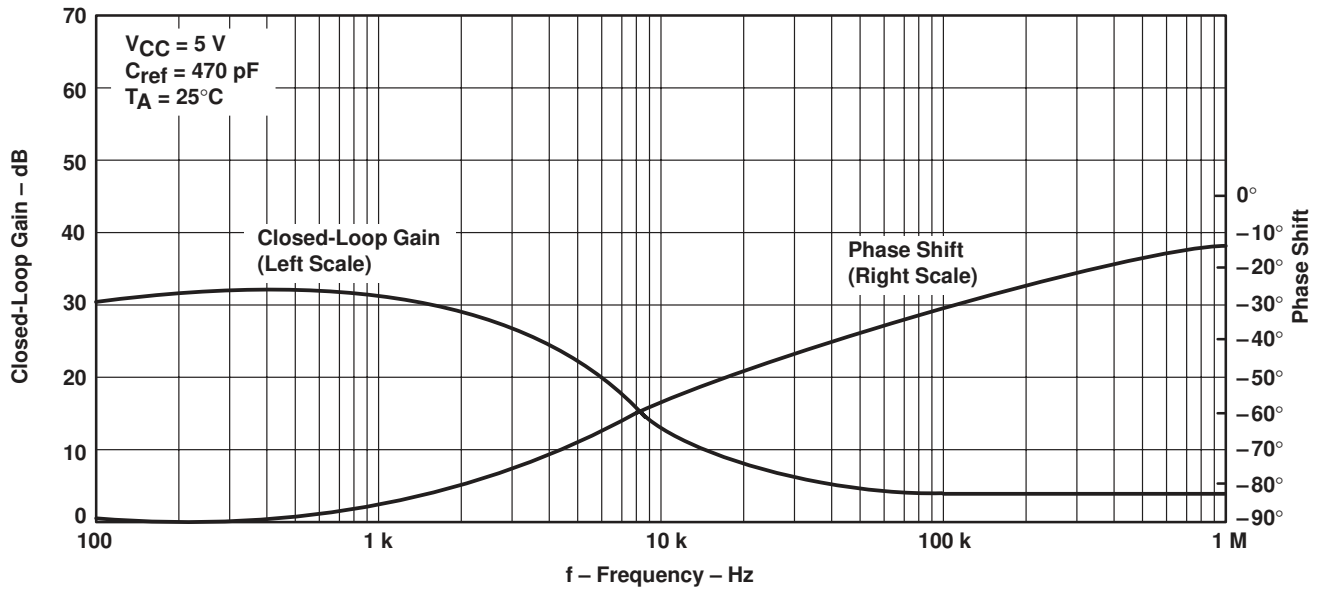
Figure 20

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## TYPICAL CHARACTERISTICS

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



Test Circuit

Figure 21

TYPICAL CHARACTERISTICS

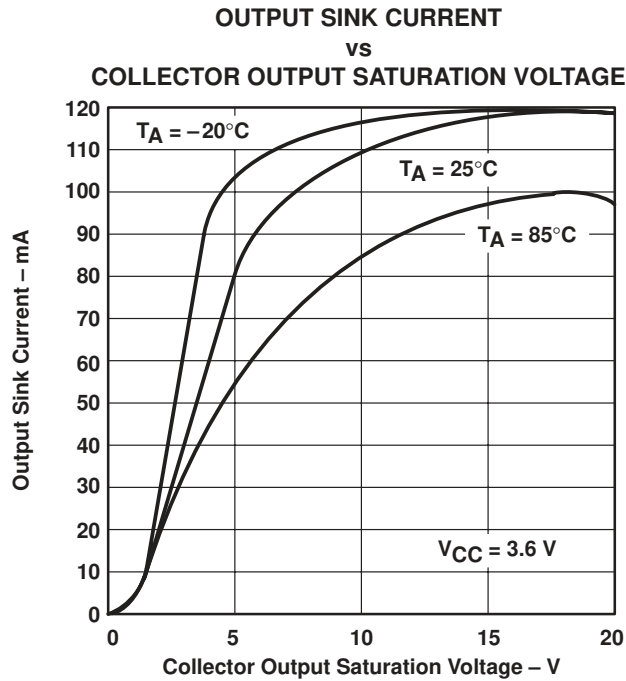


Figure 22

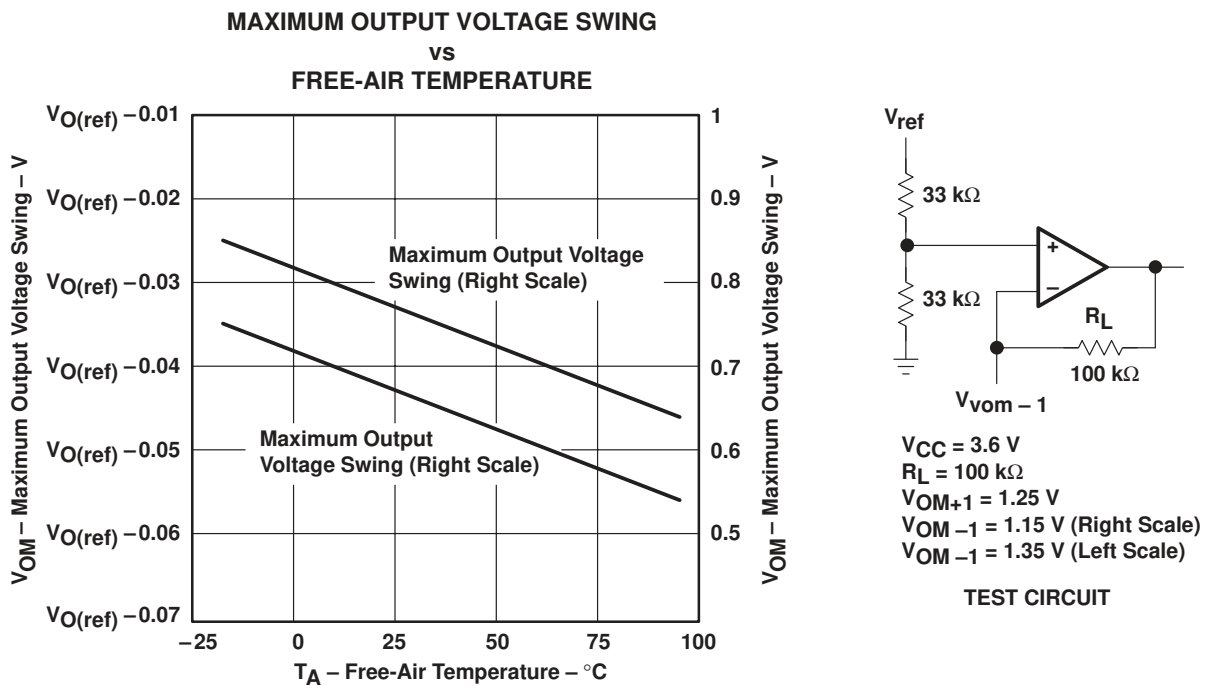


Figure 23

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

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## TYPICAL CHARACTERISTICS

OUTPUT TRANSISTOR ON DUTY CYCLE  
vs  
DEAD-TIME INPUT VOLTAGE

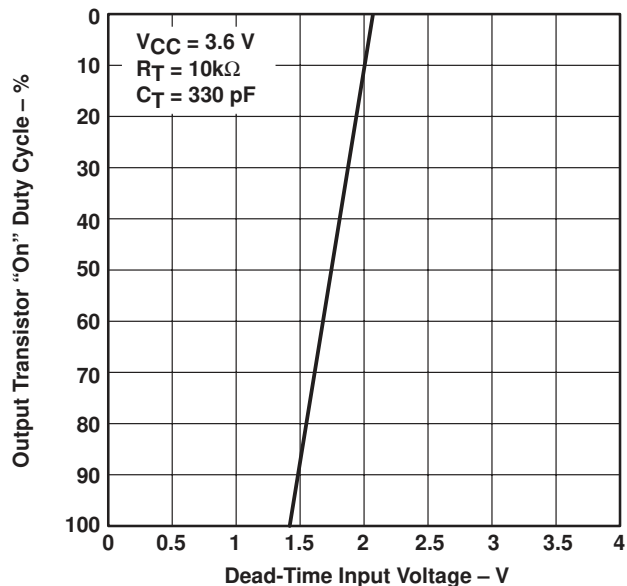


Figure 24

STANDBY CURRENT  
vs  
SUPPLY VOLTAGE

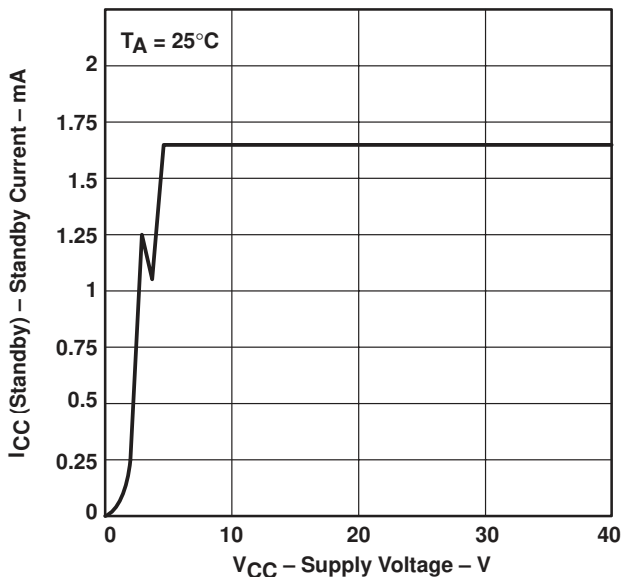


Figure 25

STANDBY CURRENT  
vs  
FREE-AIR TEMPERATURE

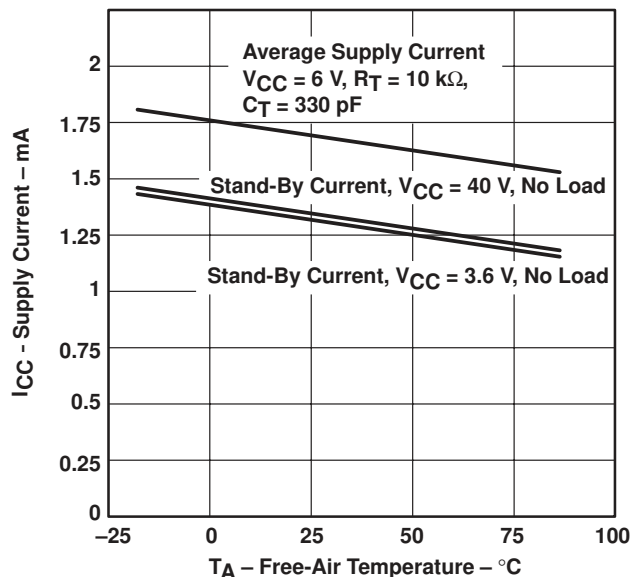


Figure 26

MAXIMUM CONTINUOUS POWER DISSIPATION  
vs  
FREE-AIR TEMPERATURE

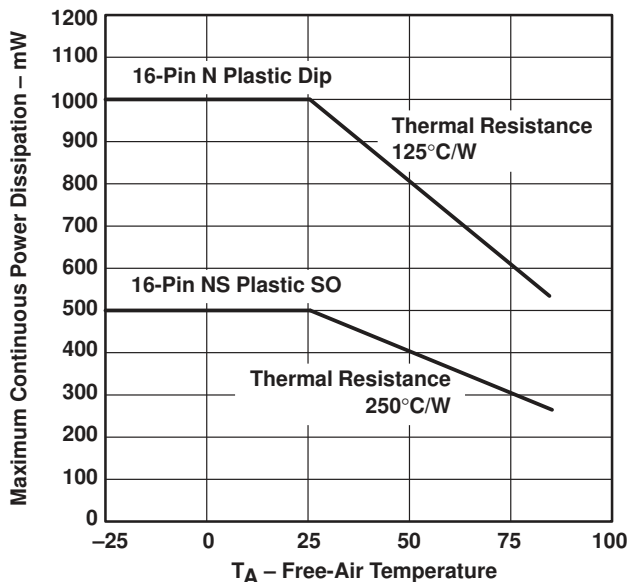
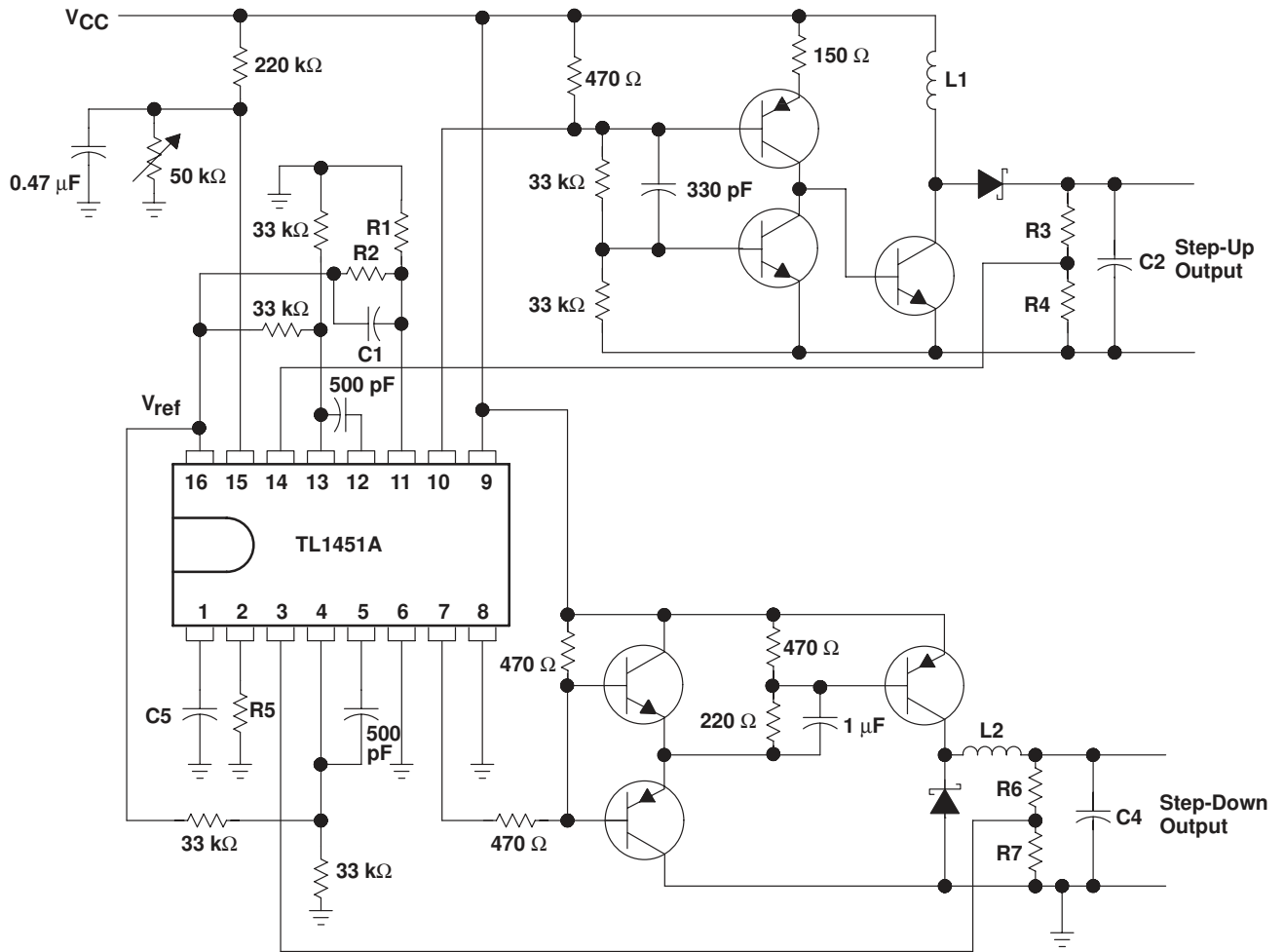


Figure 27

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

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

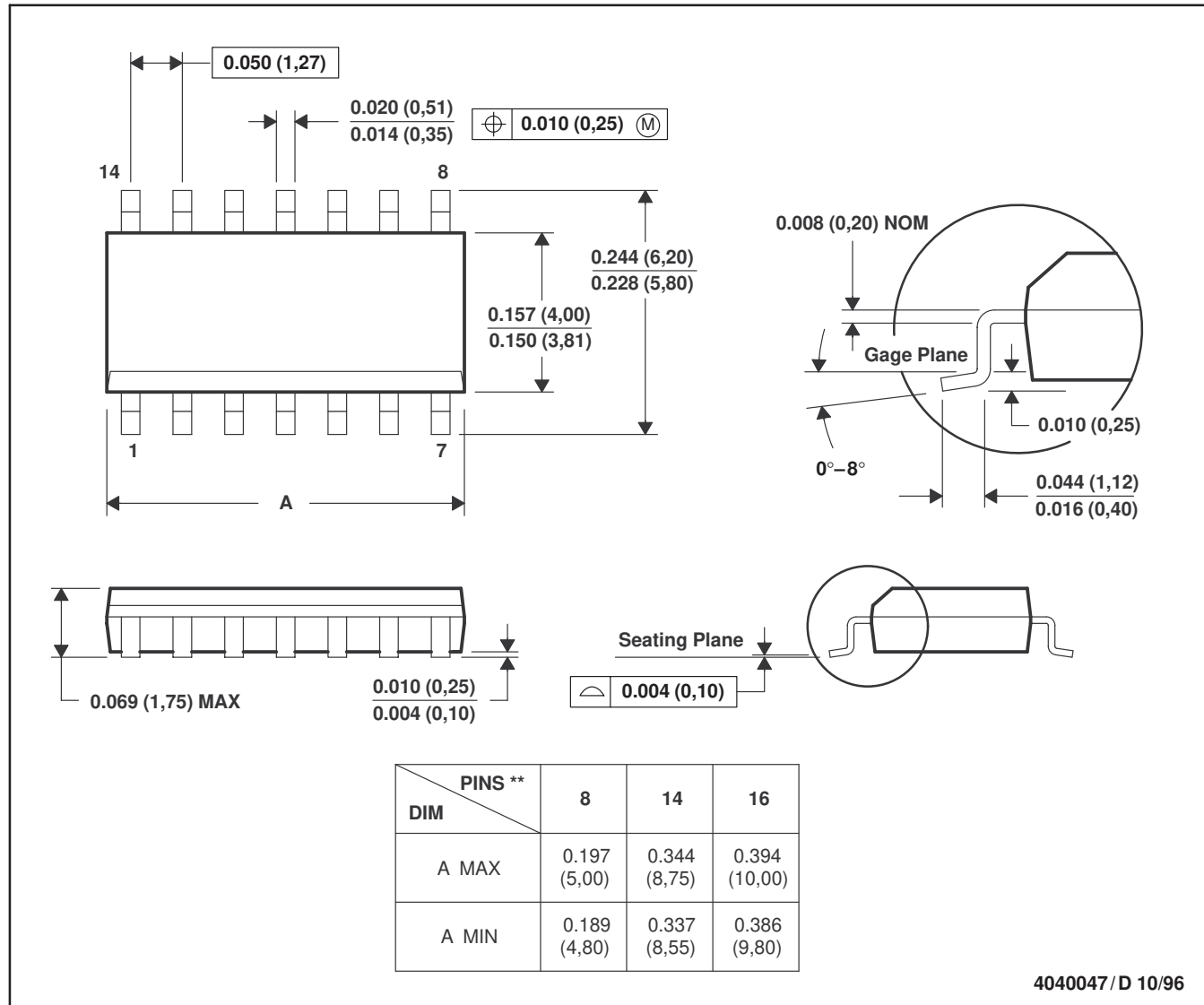
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## MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



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

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

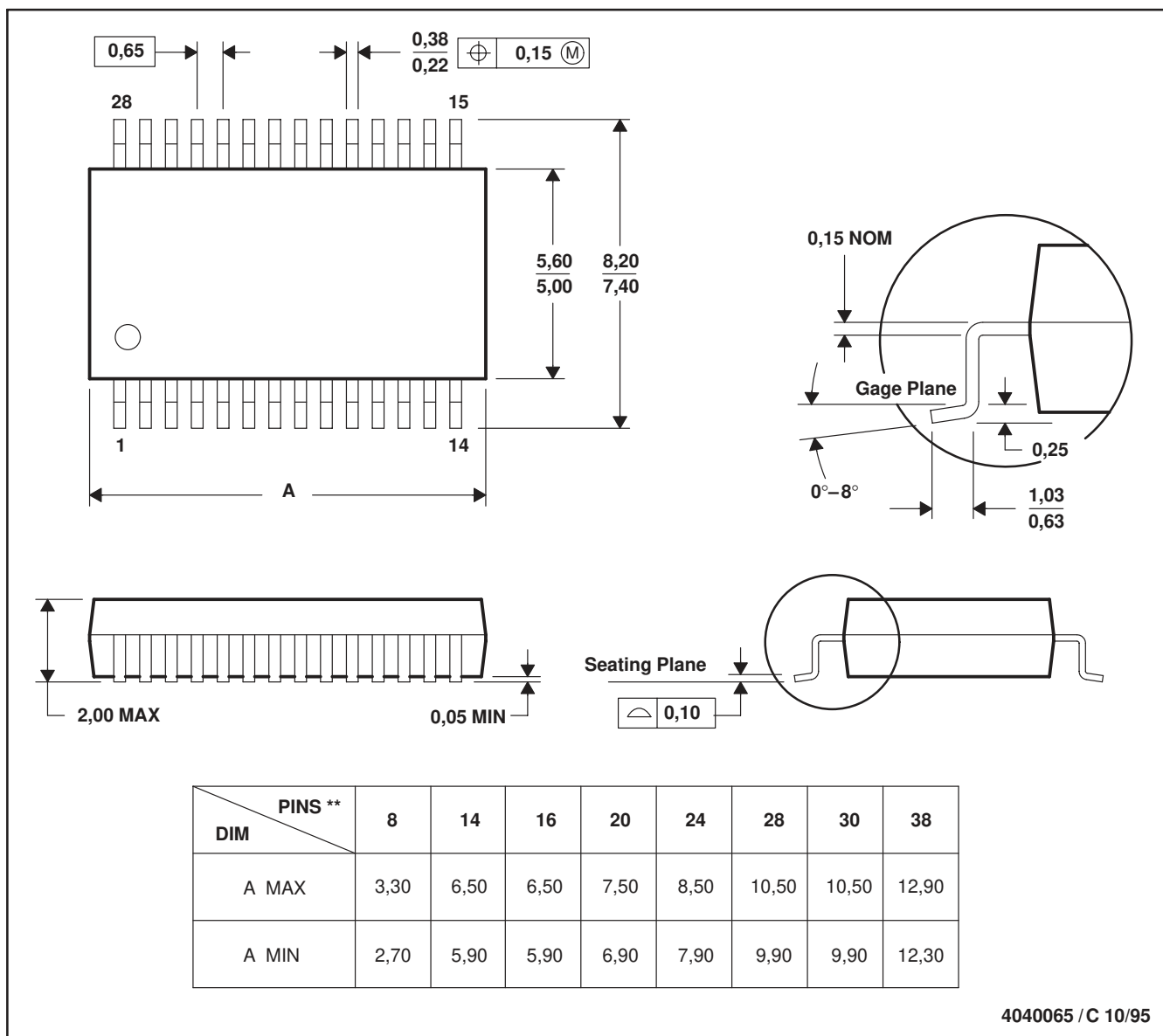
SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## MECHANICAL DATA

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

**PLASTIC SMALL-OUTLINE PACKAGE**

28 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.  
 D. Falls within JEDEC MO-150

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

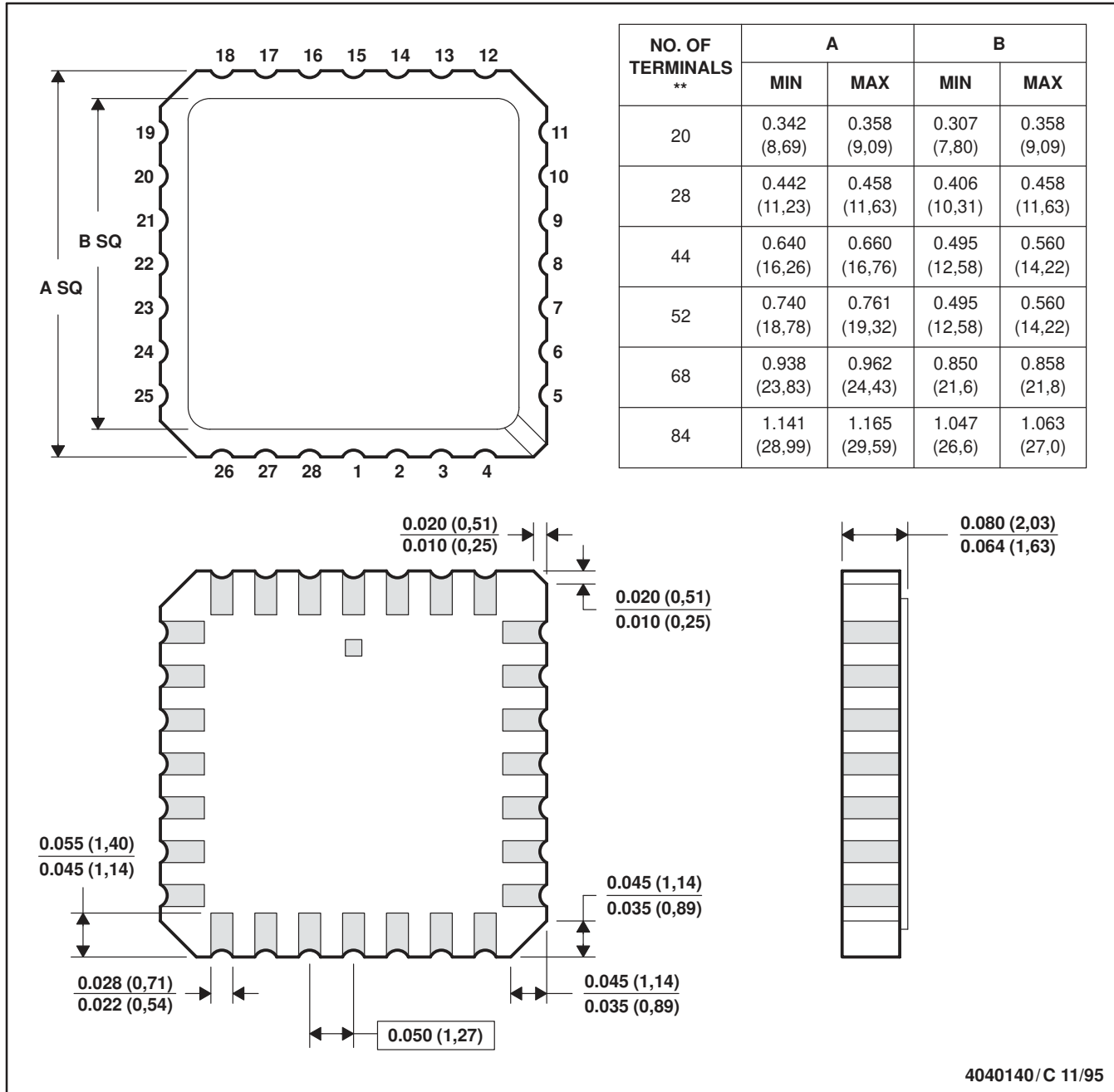
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## MECHANICAL DATA

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

LEADLESS CERAMIC CHIP CARRIER

28 TERMINALS SHOWN



4040140/C 11/95

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



# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

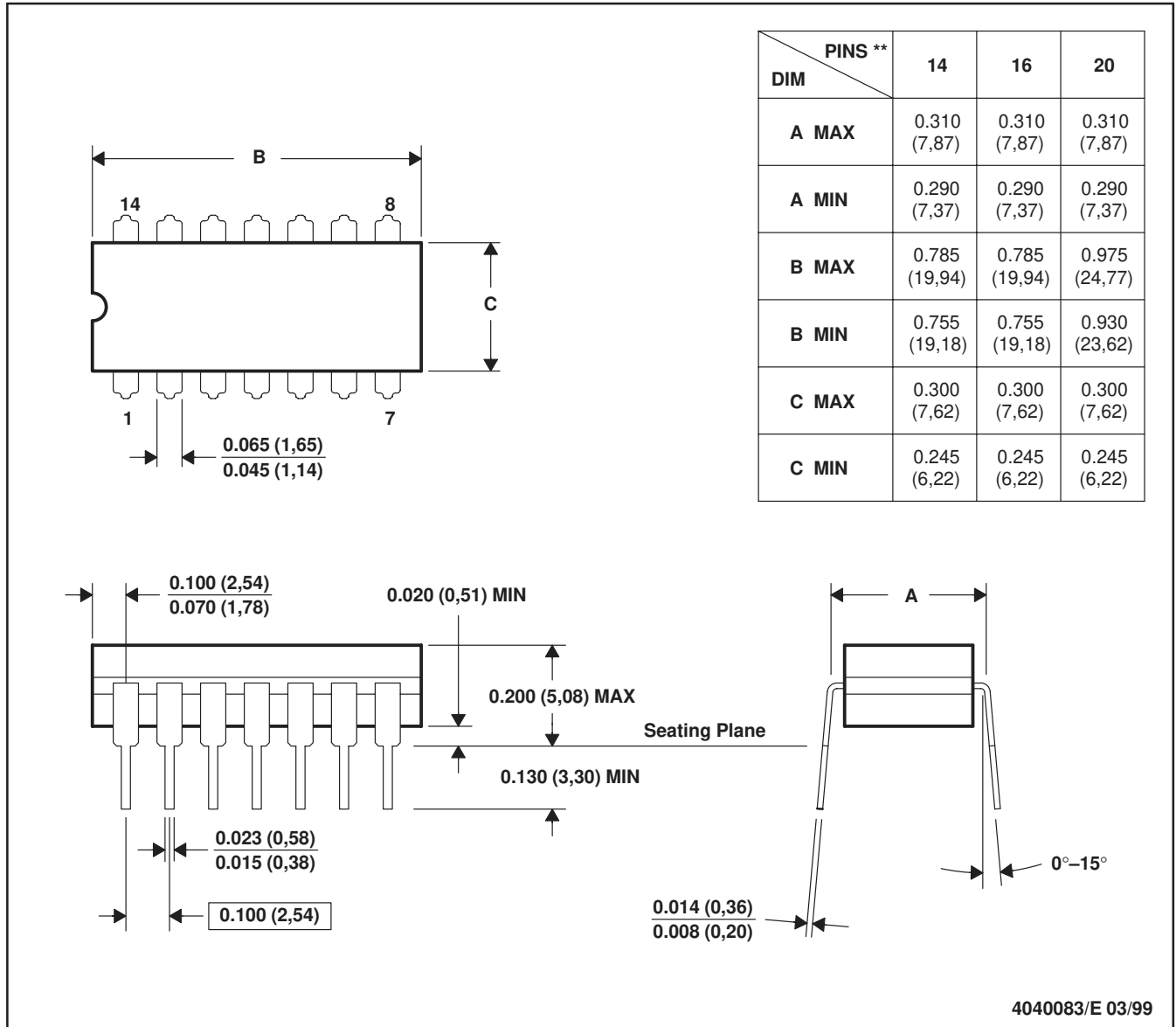
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## MECHANICAL DATA

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

**CERAMIC DUAL-IN-LINE**

14 LEADS SHOWN



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

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

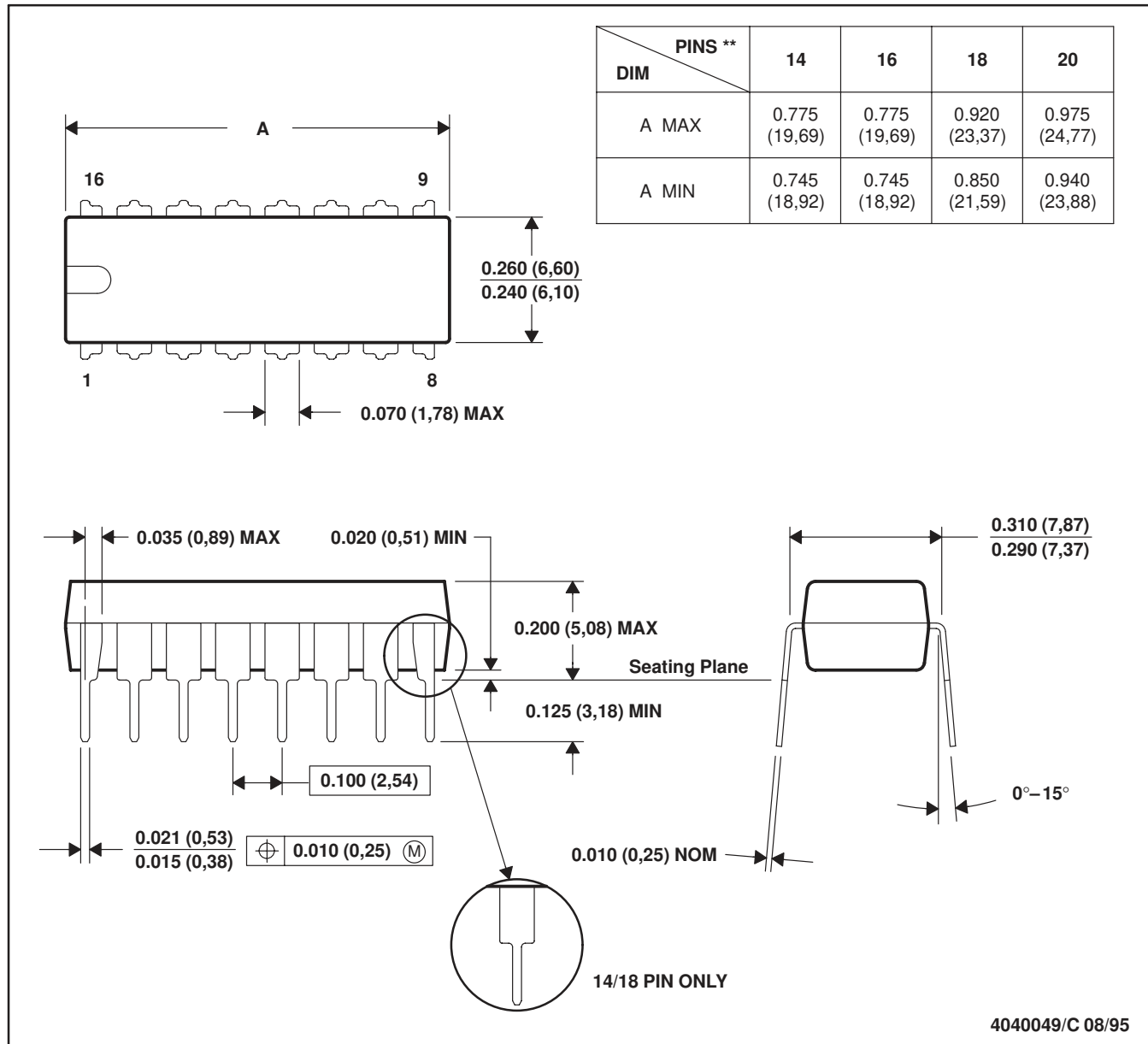
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## MECHANICAL DATA

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

**PLASTIC DUAL-IN-LINE PACKAGE**

16 PINS SHOWN



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

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

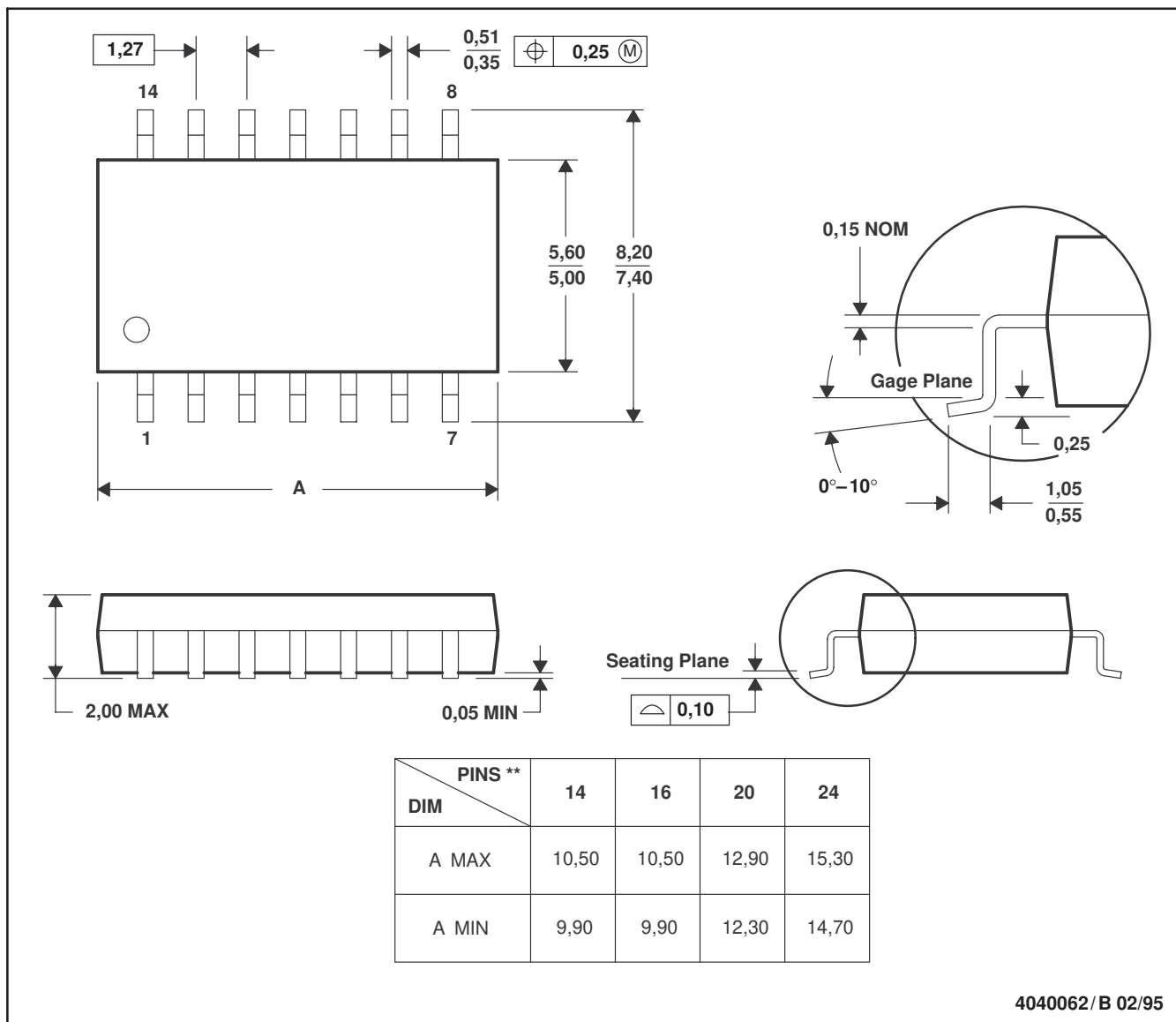
SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## 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.

# TL1451A DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

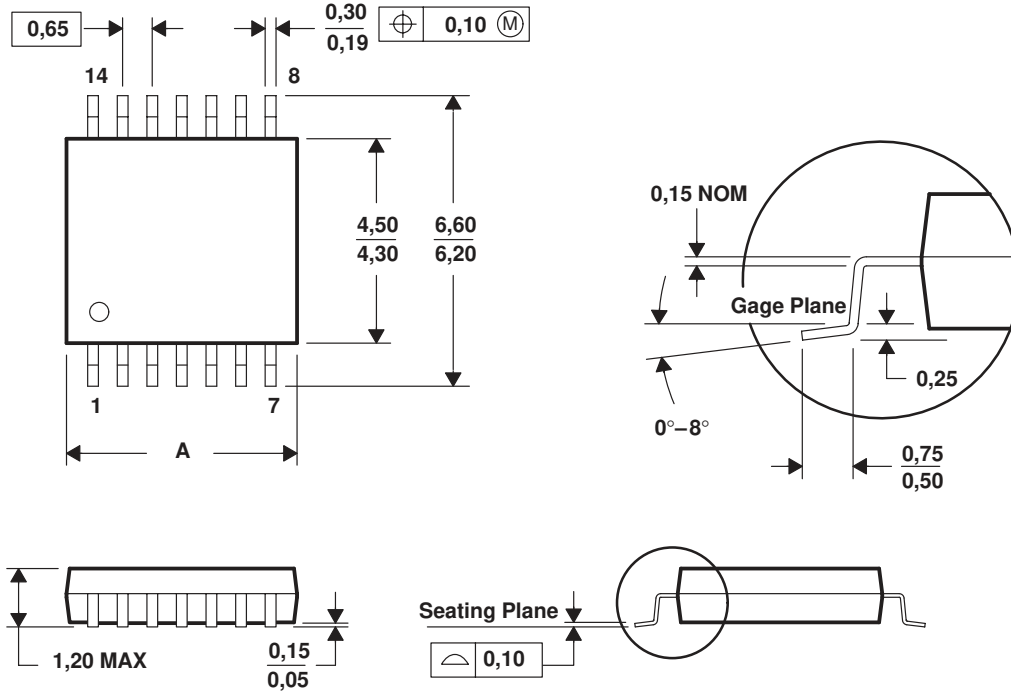
SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

## MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



| DIM \ PINS ** | 8    | 14   | 16   | 20   | 24   | 28   |
|---------------|------|------|------|------|------|------|
| A MAX         | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN         | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

4040064/F 01/97

- 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.  
 D. Falls within JEDEC MO-153

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## TL1451A, DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUIT

Device Status: Active

- > [Description](#)
- > [Features](#)
- > [Datasheets](#)
- > [Pricing/Samples/Availability](#)
- > [Application Notes](#)
- > [Development Tools](#)
- > [Applications](#)

| Parameter Name                   | TL1451A       |
|----------------------------------|---------------|
| Shutdown                         | No            |
| Pulse - by - Pulse Isense        | No            |
| Vsupply Operating Range (V)      | 3.6-50        |
| Output Type                      | Single Switch |
| Output Current (mA)              | 20            |
| Frequency (max) (kHz)            | 500           |
| Operating / Standby Current (mA) | 1.7/1.3       |
| Reference Voltage (V)            | 2.5           |
| Vref tol (%)                     | 4             |
| Duty Cycle (max) (%)             | 100           |
| Undervoltage Lockout             | Yes           |
| On-board Amplifiers              | 2             |
| Output Mode Fixed Push - Pull    | No            |
| Output Mode Single - Ended       | Yes           |
| Programmable Outputs             | No            |
| Dead Time Control                | Yes           |

### 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.

## Features

- 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

To view the following documents, [Acrobat Reader 3.x](#) is required.

To download a document to your hard drive, right-click on the link and choose 'Save'.

## Datasheets

Full datasheet in Acrobat PDF: [slvs024e.pdf](#) (425 KB)

Full datasheet in Zipped PostScript: [slvs024e.psz](#) (387 KB)

## Pricing/Samples/Availability

| <a href="#">Orderable Device</a> | <a href="#">Package</a> | <a href="#">Pins</a> | <a href="#">Temp (°C)</a> | <a href="#">Status</a> | <a href="#">Price/unit USD (100-999)</a> | <a href="#">Pack Qty</a> | <a href="#">DSCC Number</a> | <a href="#">Availability / Samples</a> |
|----------------------------------|-------------------------|----------------------|---------------------------|------------------------|--|--------------------------|-----------------------------|--|
| 5962-9958401Q2A                  | <a href="#">FK</a>      | 20                   | -55 TO 125                | ACTIVE                 | 7.00                                     | 1                        |                             | <a href="#">Check stock or order</a>   |
| 5962-9958401QEA                  | <a href="#">J</a>       | 16                   | -55 TO 125                | ACTIVE                 | 5.59                                     | 1                        |                             | <a href="#">Check stock or order</a>   |
| TL1451ACDBLE                     | <a href="#">DB</a>      | 16                   |                           | OBSOLETE               |  |                          |                             |  |
| TL1451ACDBR                      | <a href="#">DB</a>      | 16                   |                           | ACTIVE                 | 0.97                                     | 2000                     |                             | <a href="#">Check stock or order</a>   |
| TL1451ACN                        | <a href="#">N</a>       | 16                   |                           | ACTIVE                 | 1.12                                     | 25                       |                             | <a href="#">Check stock or order</a>   |
| TL1451ACNSLE                     | <a href="#">NS</a>      | 16                   |                           | ACTIVE                 | 1.12                                     | 2000                     |                             | <a href="#">Check stock or order</a>   |
| TL1451ACNSR                      | <a href="#">NS</a>      | 16                   |                           | ACTIVE                 | 0.97                                     | 2000                     |                             | <a href="#">Check stock or order</a>   |
| TL1451ACPWLE                     | <a href="#">PW</a>      | 16                   |                           | OBSOLETE               |  |                          |                             |  |

|             |                    |    |            |        |      |      |                 |                                      |
|-------------|--------------------|----|------------|--------|------|------|-----------------|--------------------------------------|
| TL1451ACPWR | <a href="#">PW</a> | 16 |            | ACTIVE | 0.97 | 2000 |                 | <a href="#">Check stock or order</a> |
| TL1451AMFKB | <a href="#">FK</a> | 20 | -55 TO 125 | ACTIVE | 7.00 | 1    | 5962-9958401Q2A | <a href="#">Check stock or order</a> |
| TL1451AMJ   |                    | 16 | -55 TO 125 | ACTIVE | 4.75 | 1    |                 | <a href="#">Check stock or order</a> |
| TL1451AMJB  | <a href="#">J</a>  | 16 | -55 TO 125 | ACTIVE | 5.59 | 1    | 5962-9958401QEA | <a href="#">Check stock or order</a> |
| TL1451AQD   |                    | 16 | -40 TO 125 | ACTIVE | 0.83 | 40   |                 | <a href="#">Check stock or order</a> |
| TL1451AQDR  |                    | 16 | -40 TO 125 | ACTIVE | 0.81 | 2500 |                 | <a href="#">Check stock or order</a> |

## Application Reports

- [ANALOG APPLICATIONS JOURNAL, FEBRUARY 2000 \(SLYT012A\)](#)
- [ANALOG APPLICATIONS JOURNAL, NOVEMBER 1999 \(SLYT010A\)](#)
- [ELECTROSTATIC DISCHARGE APPLICATION NOTE \(SSYA008\)](#)
- [THERMAL CHARACTERISTICS OF LINEAR AND LOGIC PACKAGES USING JEDEC PCB DESIGNS \(SZZA017A\)](#)
- [UNDERSTANDING BOOST POWER STAGES IN SWITCHMODE POWER SUPPLIES \(SLVA061\)](#)
- [UNDERSTANDING BUCK POWER STAGES IN SWITCHMODE POWER SUPPLIES \(SLVA057\)](#)
- [UNDERSTANDING BUCK-BOOST POWER STAGES IN SWITCHMODE POWER SUPPLIES \(SLVA059\)](#)

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