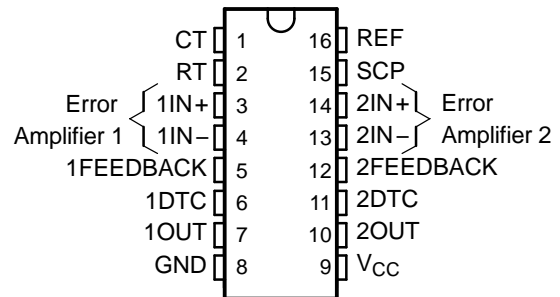


## FEATURES

- **Controlled Baseline**
  - One Assembly/Test Site, One Fabrication Site
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree <sup>(1)</sup>**
- **Complete Pulse-Width Modulation (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**

(1) Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

**D PACKAGE  
(TOP VIEW)**



## DESCRIPTION/ORDERING INFORMATION

The TL1451A-EP 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-EP 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 TL1451A-EP is characterized for operation from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

### ORDERING INFORMATION

$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$	SOIC – D	Tape and reel	TL1451AMDREP	TL1451EPG4

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

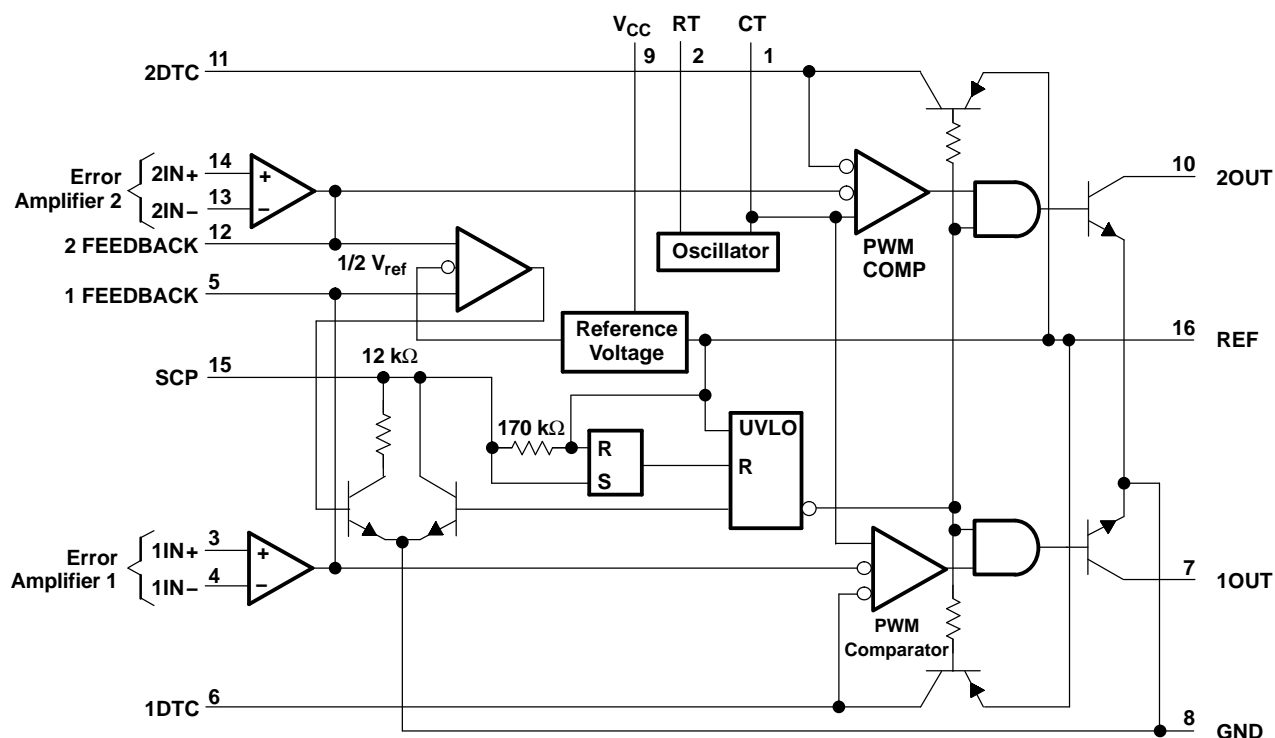


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the 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.

## FUNCTIONAL BLOCK DIAGRAM



## COMPONENT COUNT

Resistors	65
Capacitors	8
Transistors	105
JFETs	18

## Absolute Maximum Ratings<sup>(1)</sup>

over operating free-air temperature range

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage		51		V
V <sub>I</sub>	Amplifier input voltage		20		V
V <sub>O</sub>	Collector output voltage		51		V
I <sub>O</sub>	Collector output current		21		mA
Continuous power total dissipation			See Dissipation Rating Table		
T <sub>A</sub>	Operating free-air temperature range	M suffix	−55	125	°C
T <sub>stg</sub>	Storage temperature range		−65	150	°C
	Lead temperature	1,6 mm (1/16 in) from case for 10 s	260		°C

- (1) 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 Ratings

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	1088 mW	8.7 mW/ $^\circ\text{C}$	696 mW	566 mW	218 mW

### Recommended Operating Conditions

		MIN	MAX	UNIT
$V_{CC}$	Supply voltage	3.6	50	V
$V_I$	Amplifier input voltage	1.05	1.45	V
$V_O$	Collector output voltage		50	V
$I_O$	Collector output current		20	mA
	Current into feedback terminal		45	$\mu\text{A}$
$R_F$	Feedback resistor	100		$\text{k}\Omega$
$C_T$	Timing capacitor	150	15000	pF
$R_T$	Timing resistor	5.1	100	$\text{k}\Omega$
	Oscillator frequency	1	500	kHz
$T_A$	Operating free-air temperature			
		M suffix	–55	125
				$^\circ\text{C}$

### Reference Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS		MIN	TYP <sup>(1)</sup>	MAX	UNIT
Output voltage (pin 16)	$I_O = 1\text{ mA}$	$T_A = 25^\circ\text{C}$	2.4	2.5	2.6	V
		$T_A = \text{MIN and } 125^\circ\text{C}$	2.35	2.46	2.65	
Output voltage change with temperature			–0.63%	$\pm 4\%$ <sup>(2)</sup>		
Input voltage regulation	$V_{CC} = 3.6\text{ V to } 40\text{ V}$	$T_A = 25^\circ\text{C}$		2	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	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

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

(2) These parameters are not production tested.

# TL1451A-EP

## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS614–DECEMBER 2005

### Undervoltage Lockout Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
Upper threshold voltage ( $V_{CC}$ )	$T_A = 25^\circ\text{C}$		2.72		V
	$T_A = 125^\circ\text{C}$		1.7		
	$T_A = \text{MIN}$		3.15		
Lower threshold voltage ( $V_{CC}$ )	$T_A = 25^\circ\text{C}$		2.6		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 ( $V_{CC}$ )	$T_A = 25^\circ\text{C}$	1.5			V
	$T_A = 125^\circ\text{C}$	0.95			
	$T_A = \text{MIN}$	1.5			

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

### Short-Circuit Protection Control Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
Input threshold voltage (SCP)	$T_A = 25^\circ\text{C}$	650	700	750	mV
	$T_A = 125^\circ\text{C}$	400	478	650	
	$T_A = \text{MIN}$	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

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

### Oscillator Section Electrical Characteristics

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

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

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

(2) These parameters are not production tested.

## Dead-Time Control Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
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)	$T_A = 25^\circ\text{C}$	2.3			V
	$T_A = 125^\circ\text{C}$	2.22	2.32		
	$T_A = \text{MIN}$	2.28	2.4		
Input threshold voltage at $f = 10\text{ kHz}$ (DTC)	Zero duty cycle		2.05	2.25 <sup>(2)</sup>	V
	Maximum duty cycle	1.2 <sup>(2)</sup>	1.45		

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

(2) These parameters are not production tested.

## Error-Amplifier Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
Input offset voltage	$V_O (\text{FEEDBACK}) = 1.25\text{ V}$	$T_A = 25^\circ\text{C}$		$\pm 7$	mV
		$T_A = 125^\circ\text{C}$		$\pm 10$	
		$T_A = \text{MIN}$		$\pm 12$	
Input offset current	$V_O (\text{FEEDBACK}) = 1.25\text{ V}$	$T_A = 25^\circ\text{C}$		$\pm 100$	nA
		$T_A = 125^\circ\text{C}$		$\pm 100$	
		$T_A = \text{MIN}$		$\pm 200$	
Input bias current	$V_O (\text{FEEDBACK}) = 1.25\text{ V}$	$T_A = 25^\circ\text{C}$	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 to 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	$\mu\text{A}$
		$T_A = 125^\circ\text{C}$	–25	–50	
		$T_A = \text{MIN}$	–15	–70	

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

## Output Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
Collector off-state current	$V_O = 50\text{ V}$			10	$\mu\text{A}$
Output saturation voltage	$T_A = 25^\circ\text{C}$		1.2	2	V
	$T_A = 125^\circ\text{C}$		1.6	2.4	
	$T_A = \text{MIN}$		1.36	2.2	
Short-circuit output current	$V_O = 6\text{ V}$		90		mA

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

## PWM Comparator Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
Input threshold voltage at $f = 10\text{ kHz}$ (FEEDBACK)	Zero duty cycle		2.05	2.25 <sup>(2)</sup>	V
	Maximum duty cycle	1.2 <sup>(2)</sup>	1.45		

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

(2) These parameters are not production tested.

## Total Device Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
Standby supply current	Off-state		1.3	1.8	mA
Average supply current	$R_T = 10\text{ k}\Omega$		1.7	2.4	mA

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

## PARAMETER MEASUREMENT INFORMATION

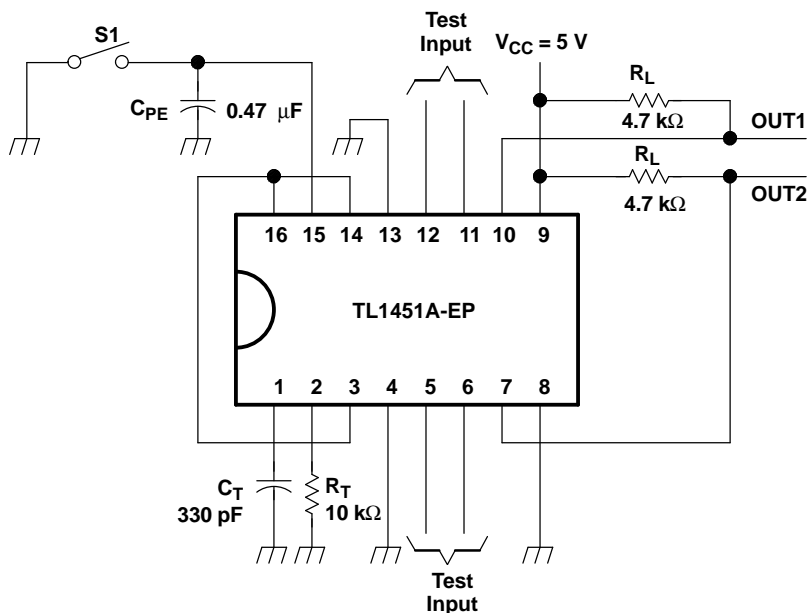
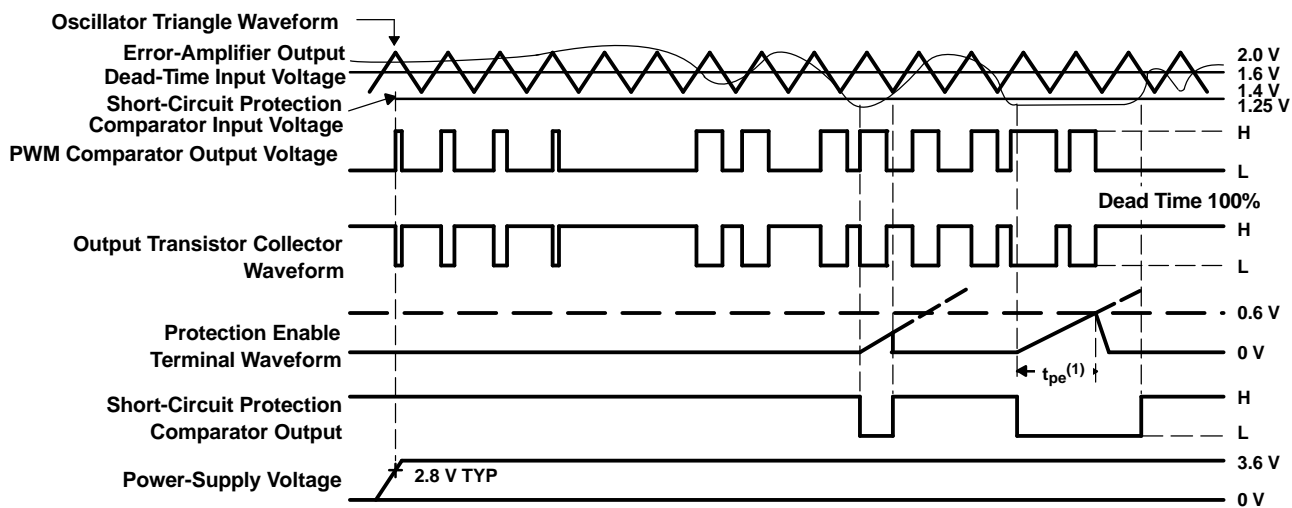


Figure 1. Test Circuit



(1) Protection enable time,  $t_{pe} = (0.051 \times 10^6 \times C_{pe})$  in seconds

Figure 2. TL1451A-EP Timing

## TYPICAL CHARACTERISTICS

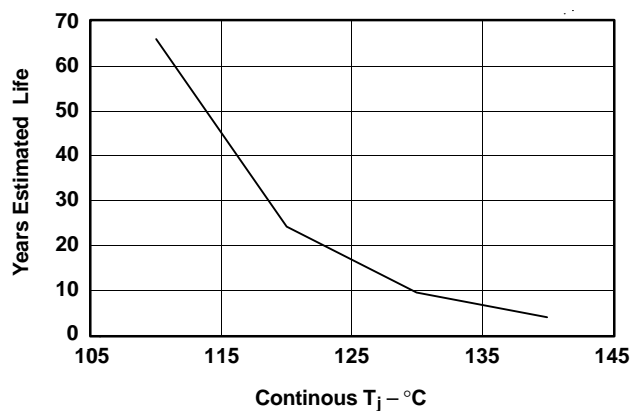


Figure 3. Estimated Device Life at Elevated Temperatures for Wirebond Voiding Fail Mode

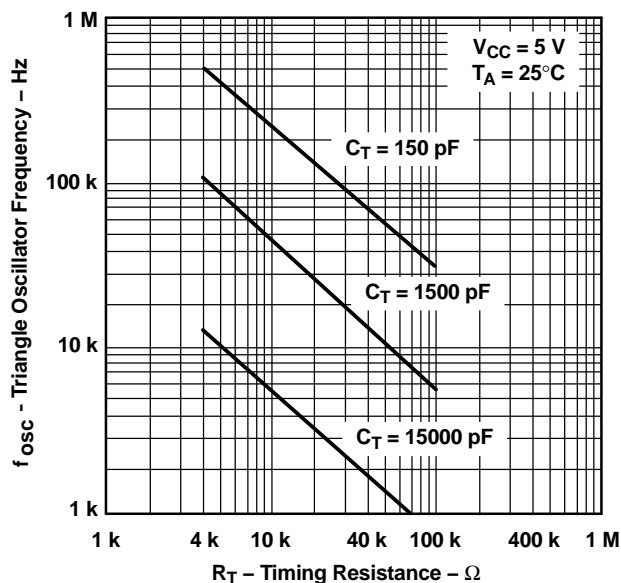


Figure 4. Triangle Oscillator Frequency vs Timing Resistance

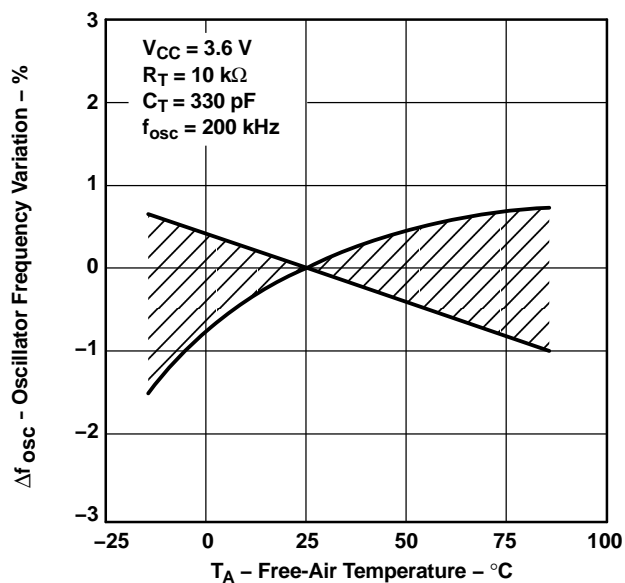


Figure 5. Oscillator Frequency Variation vs Free-Air Temperature



# TYPICAL CHARACTERISTICS (continued)

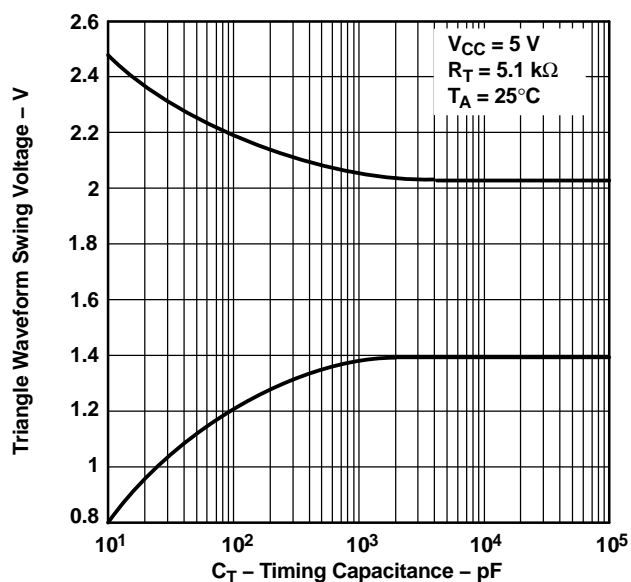


Figure 6. Triangle Waveform Swing Voltage vs Timing Capacitance

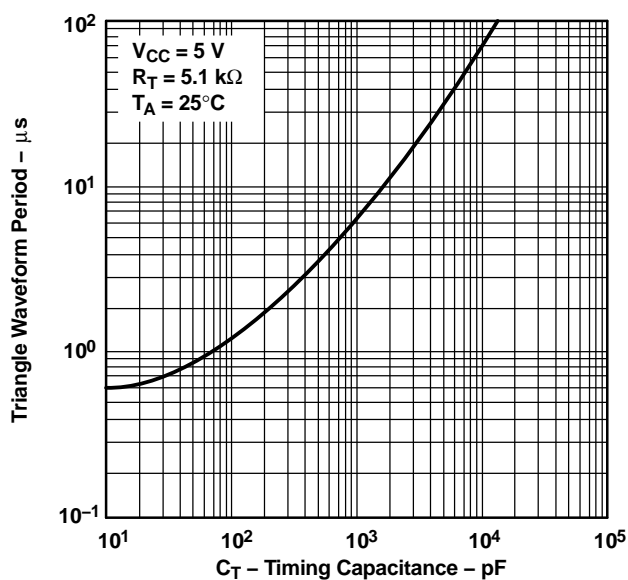


Figure 7. Triangle Waveform Period vs Timing Capacitance

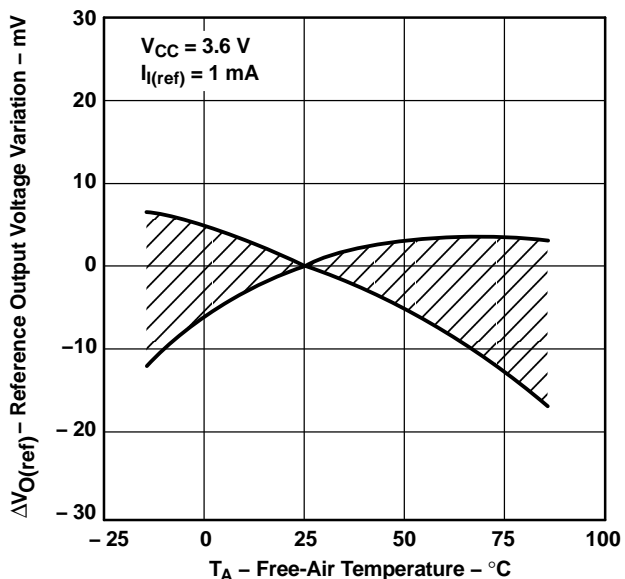


Figure 8. Reference Output Voltage Variation vs Free-Air Temperature

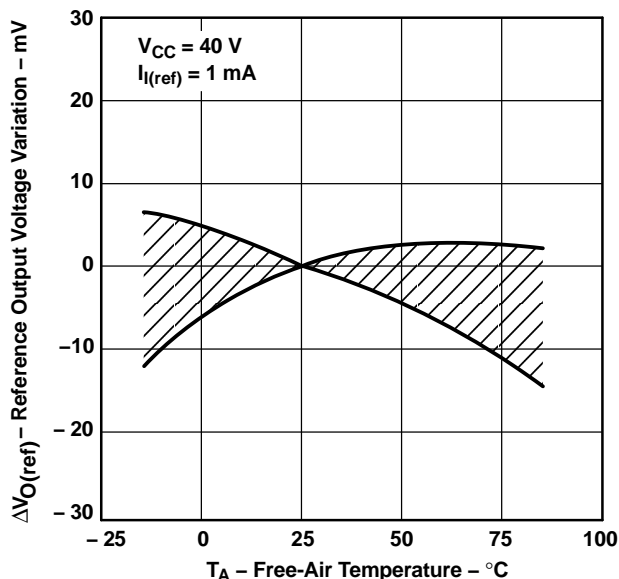


Figure 9. Reference Output Voltage Variation vs Free-Air Temperature

# TYPICAL CHARACTERISTICS (continued)

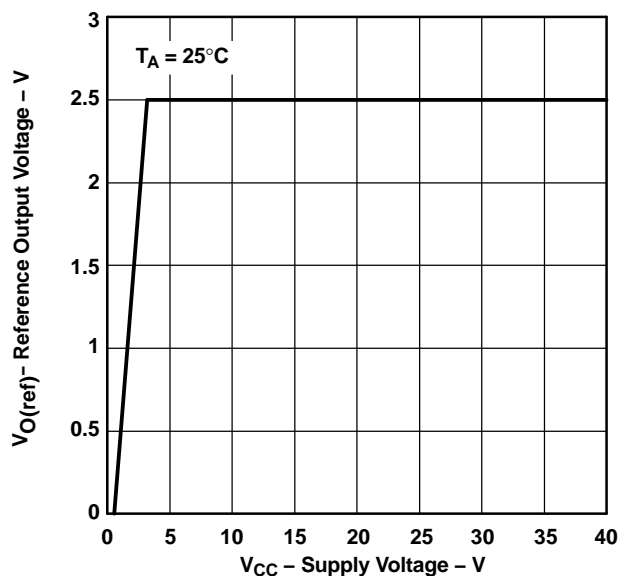


Figure 10. Reference Output Voltage vs Supply Voltage

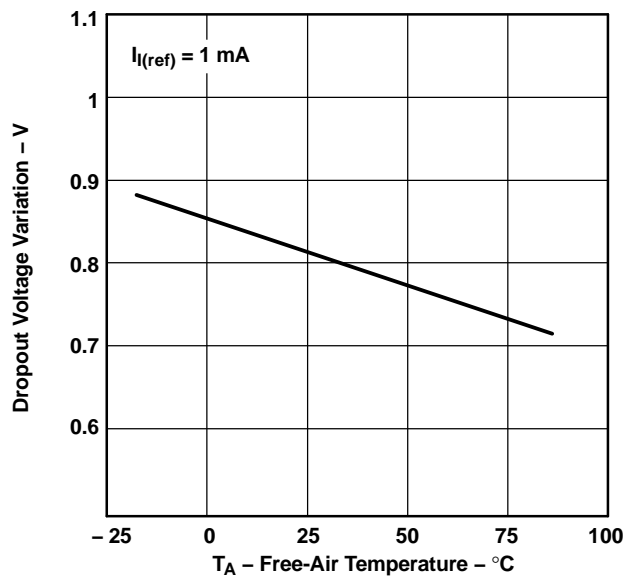


Figure 11. Dropout Voltage Variation vs Free-air Temperature

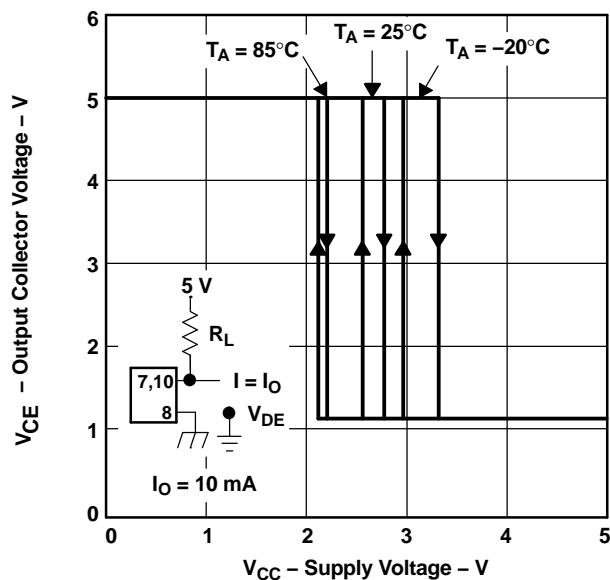


Figure 12. Undervoltage Lockout Hysteresis Characteristics

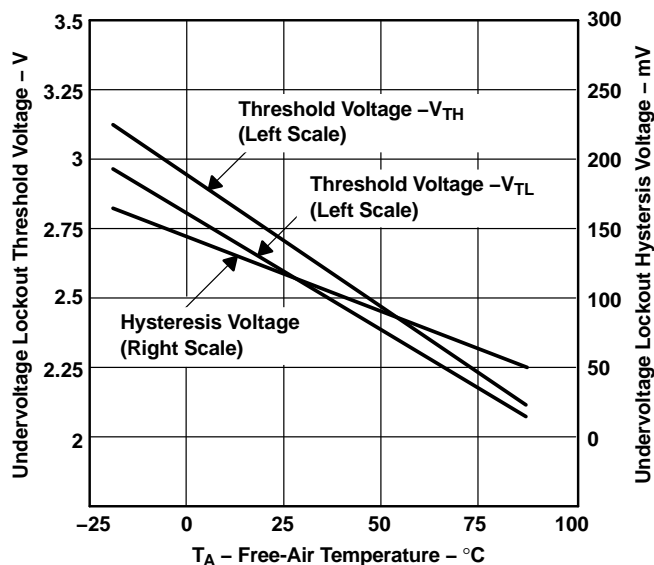


Figure 13. Undervoltage Lockout Characteristics

### TYPICAL CHARACTERISTICS (continued)

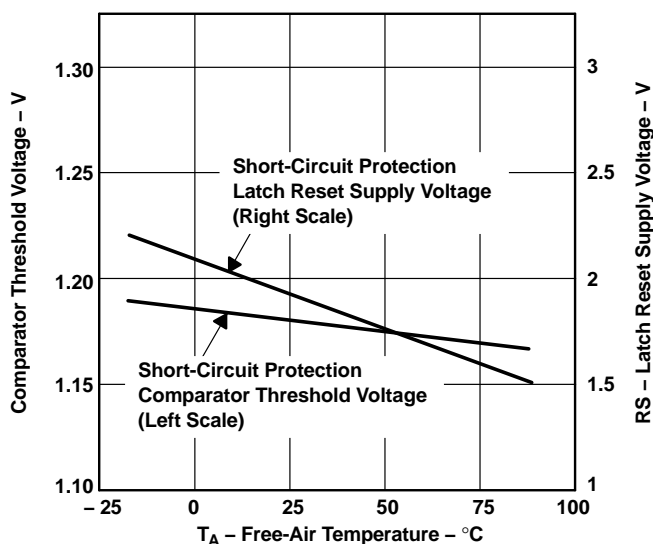


Figure 14. Short-Circuit Protection Characteristics

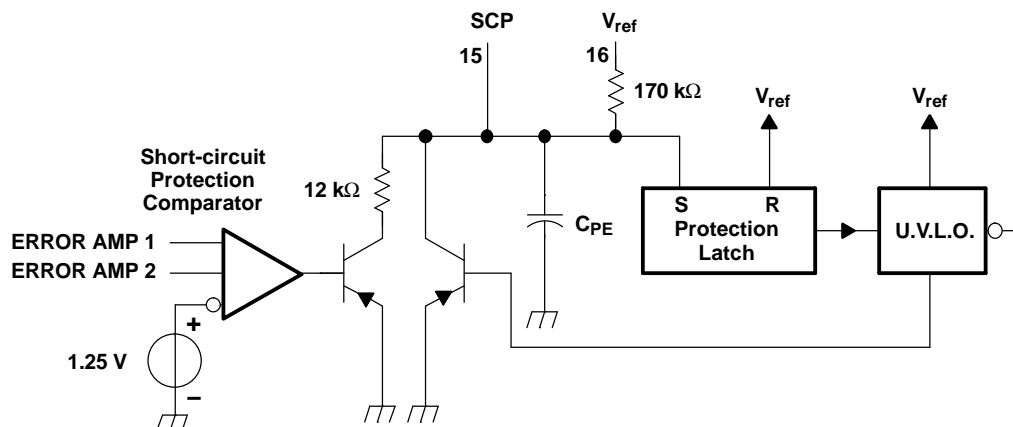
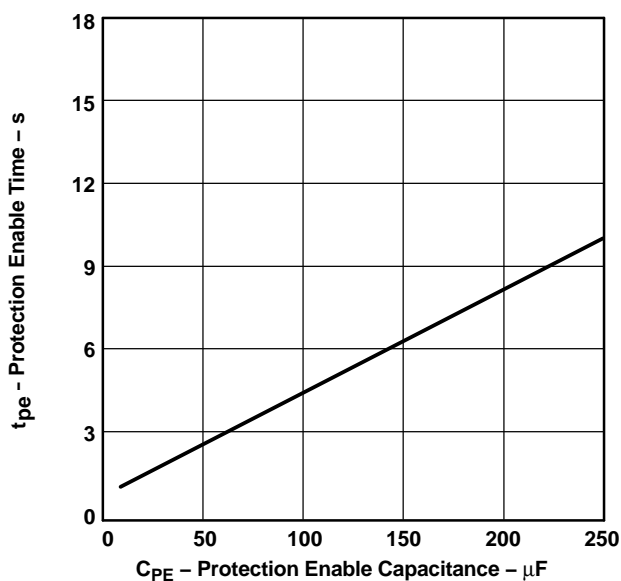


Figure 15. Protection Enable Time vs Protection Enable Capacitance

# TYPICAL CHARACTERISTICS (continued)

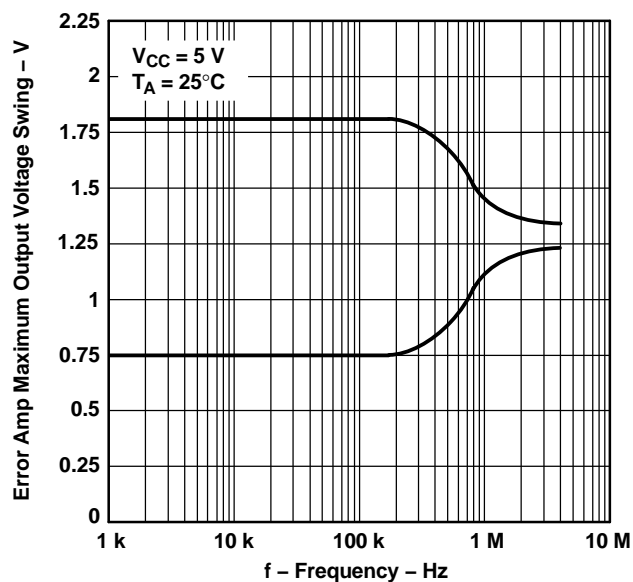


Figure 16. Error Amplifier Maximum Output Voltage Swing vs Frequency

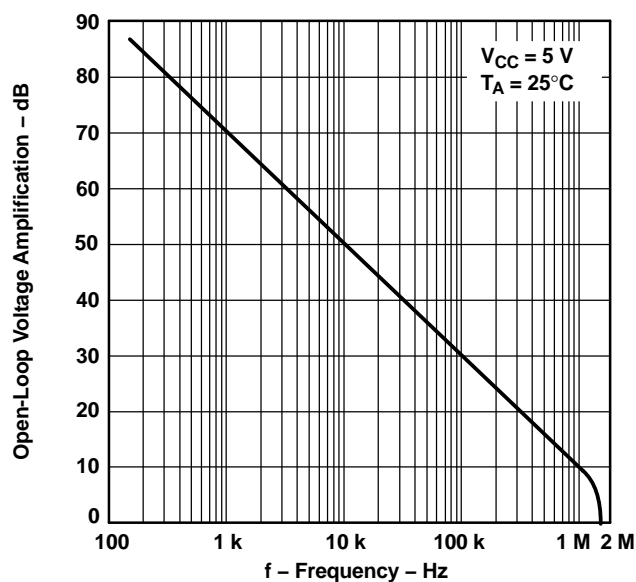


Figure 17. Open-Loop Voltage Amplification vs Frequency

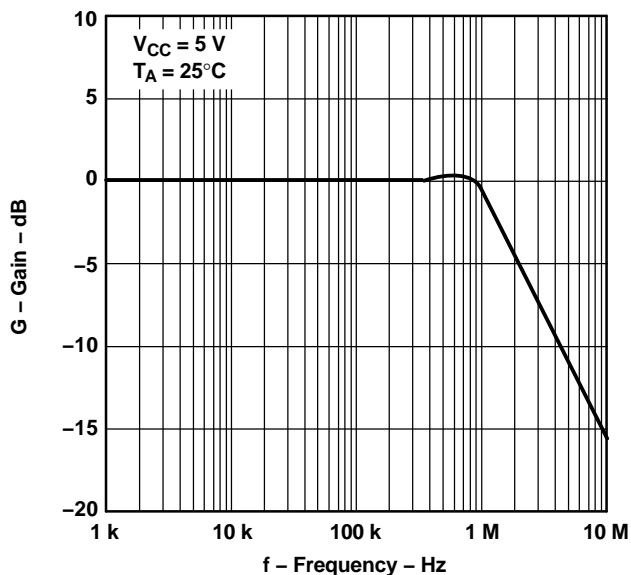


Figure 18. Gain  
(Amplifier in Unity-Gain Configuration vs Frequency)

TYPICAL CHARACTERISTICS (continued)

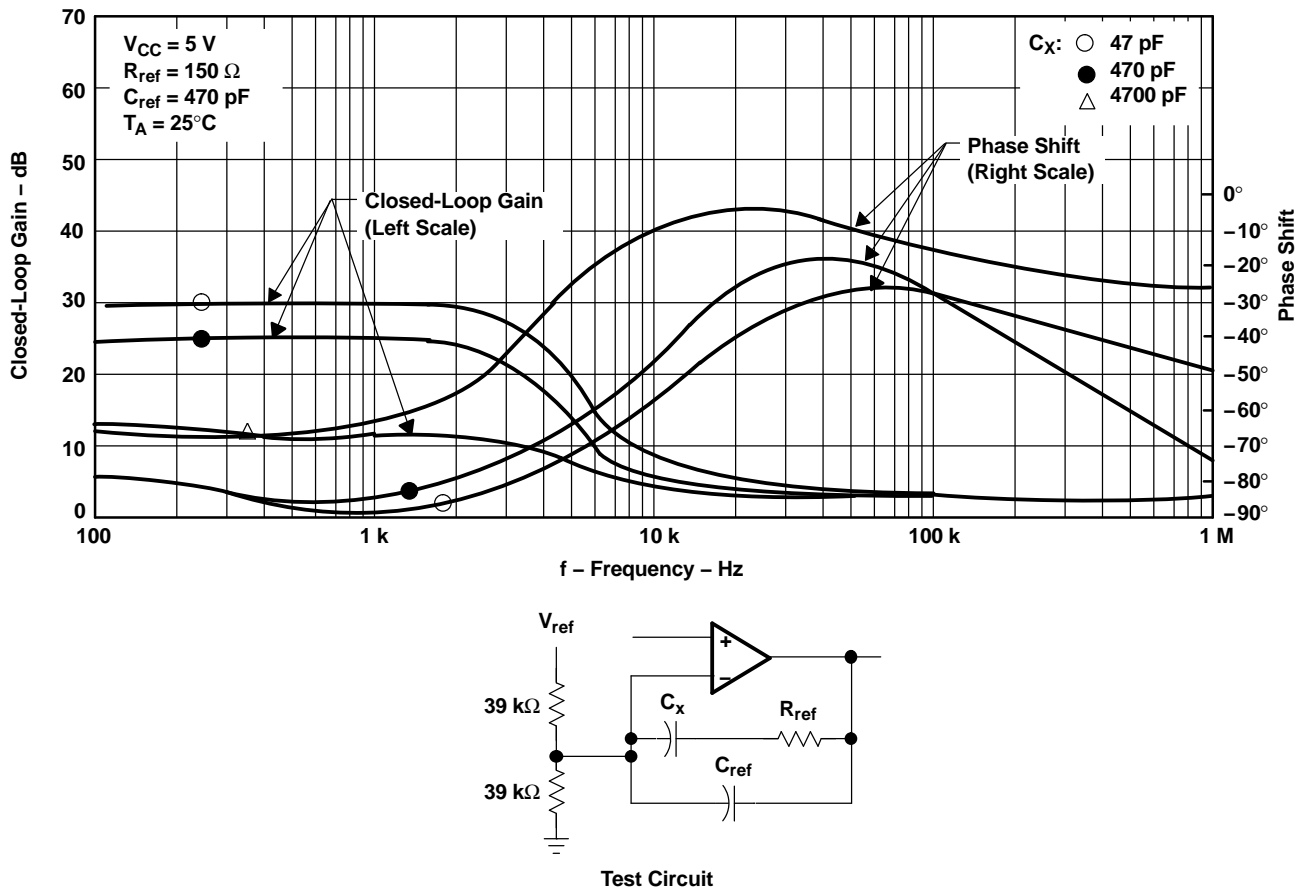


Figure 19. Closed-Loop Gain and Phase Shift vs Frequency

TYPICAL CHARACTERISTICS (continued)

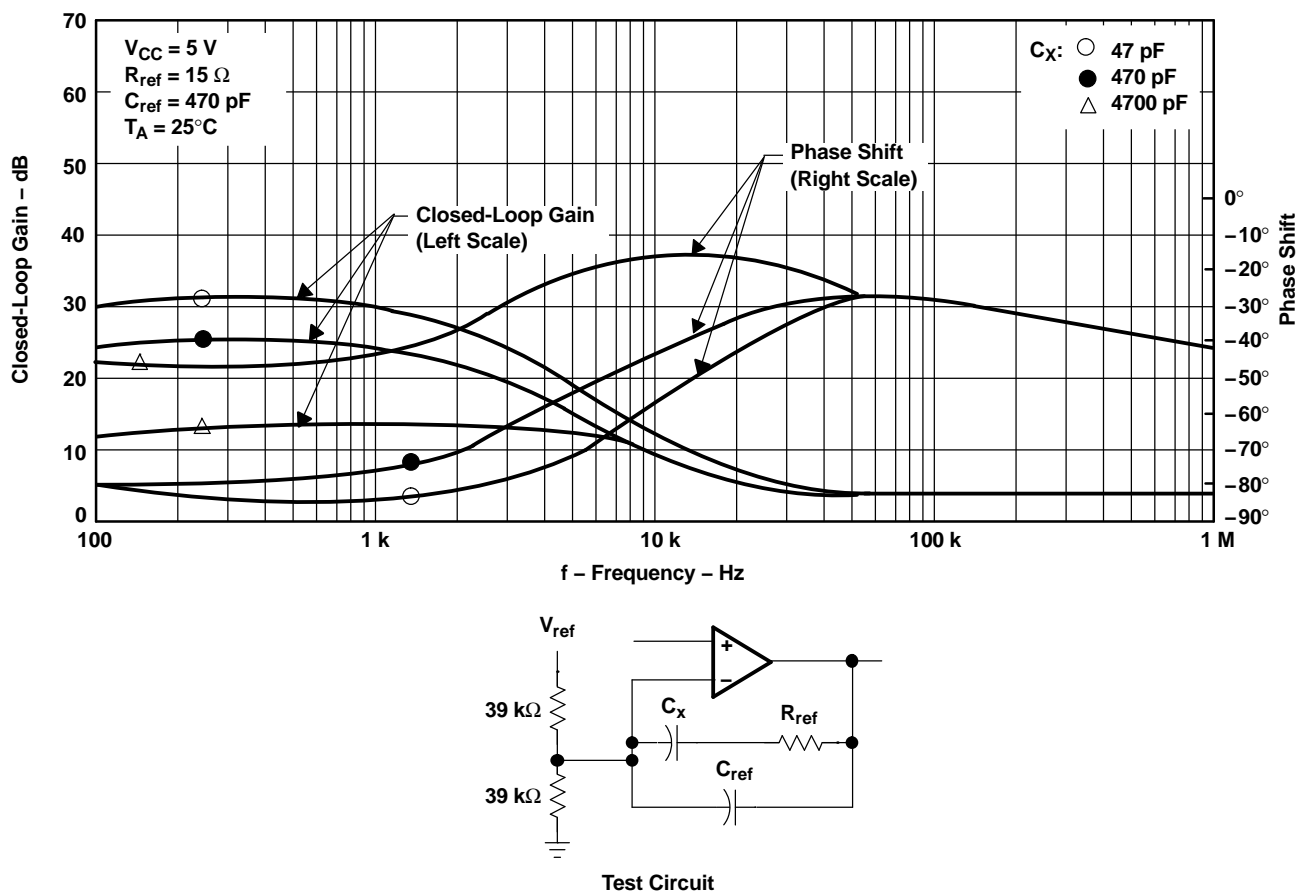


Figure 20. Closed-Loop Gain and Phase Shift vs Frequency

TYPICAL CHARACTERISTICS (continued)

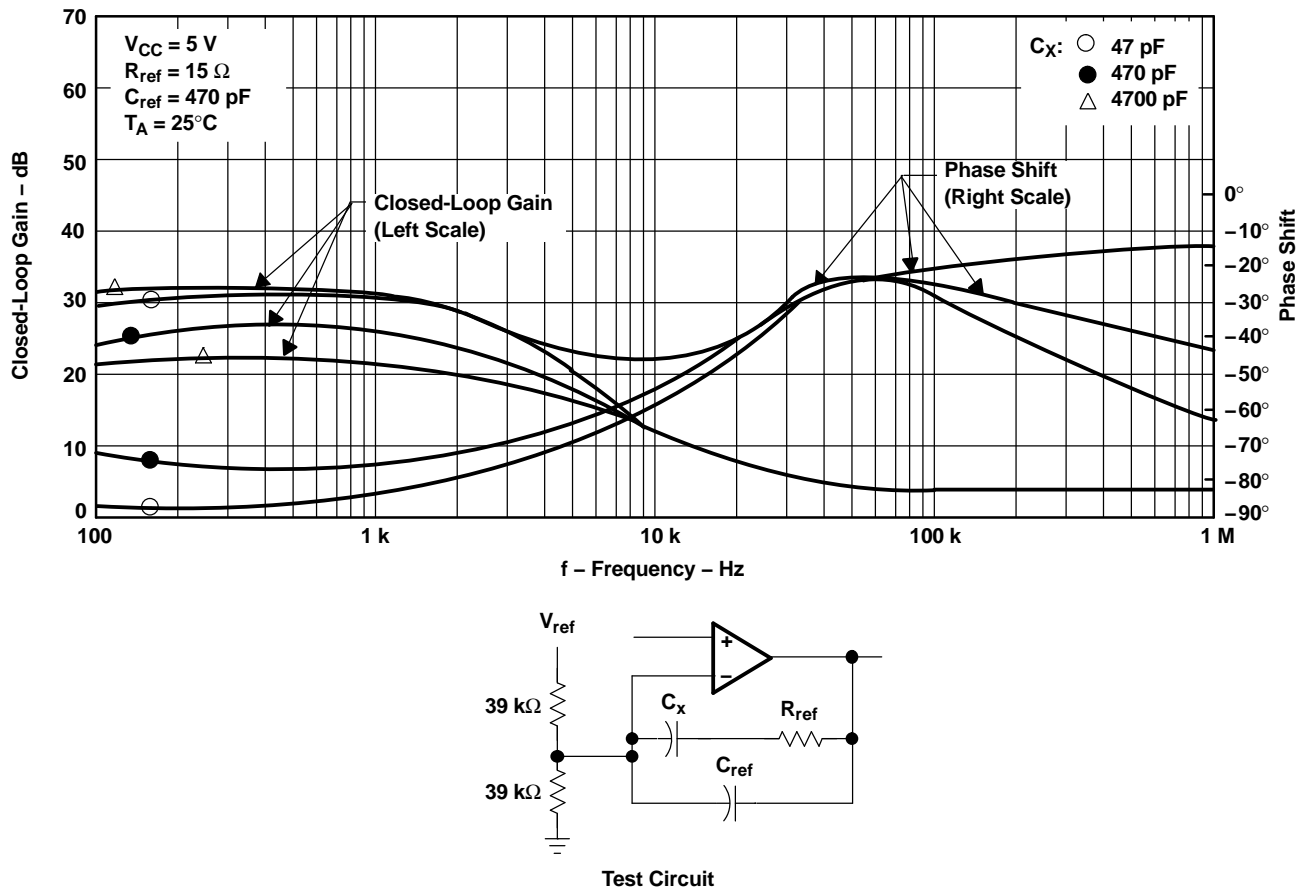


Figure 21. Closed-Loop Gain and Phase Shift vs Frequency

TYPICAL CHARACTERISTICS (continued)

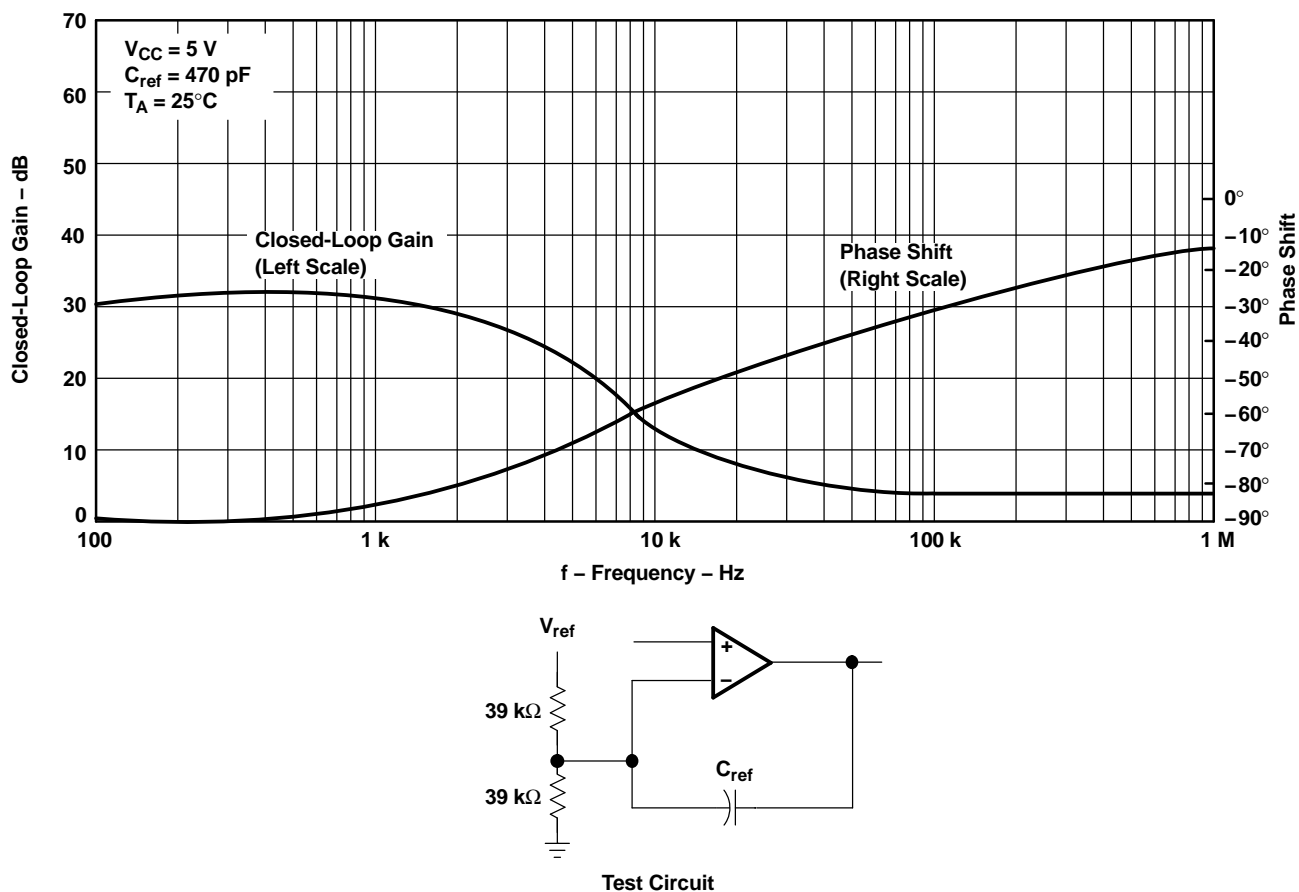


Figure 22. Closed-Loop Gain and Phase Shift vs Frequency

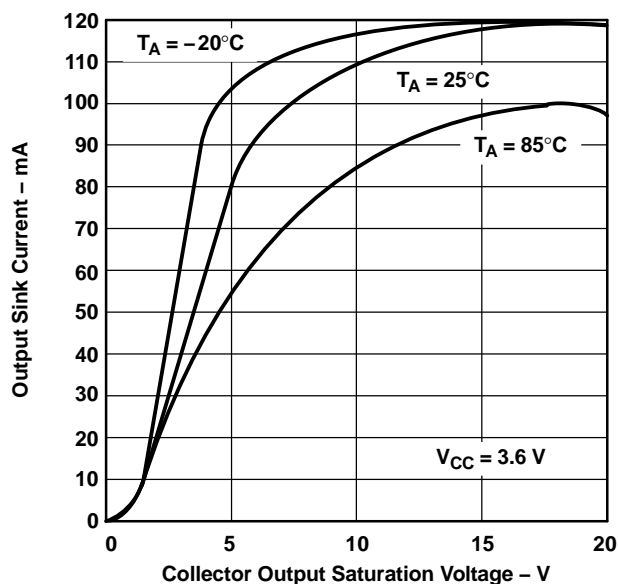


Figure 23. Output Sink Current vs Collector Output Saturation Voltage



# TYPICAL CHARACTERISTICS (continued)

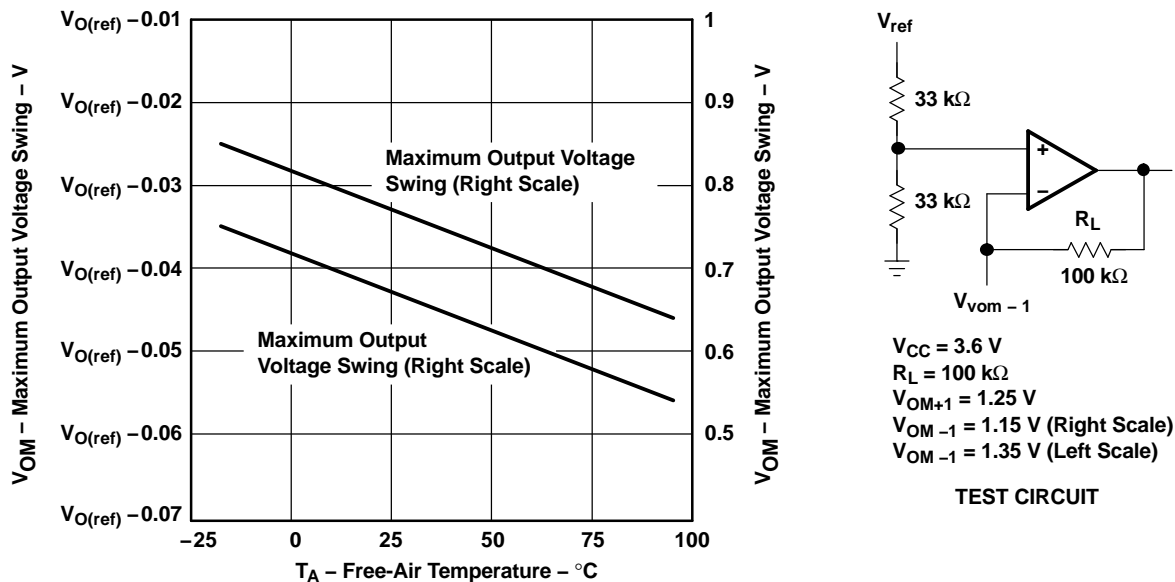


Figure 24. Maximum Output Voltage Swing vs Free-Air Temperature

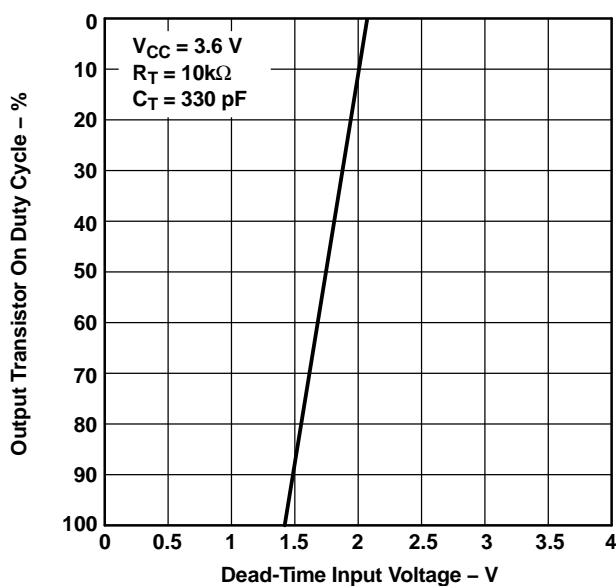


Figure 25. Output Transistor On Duty Cycle vs Dead-Time Input Voltage

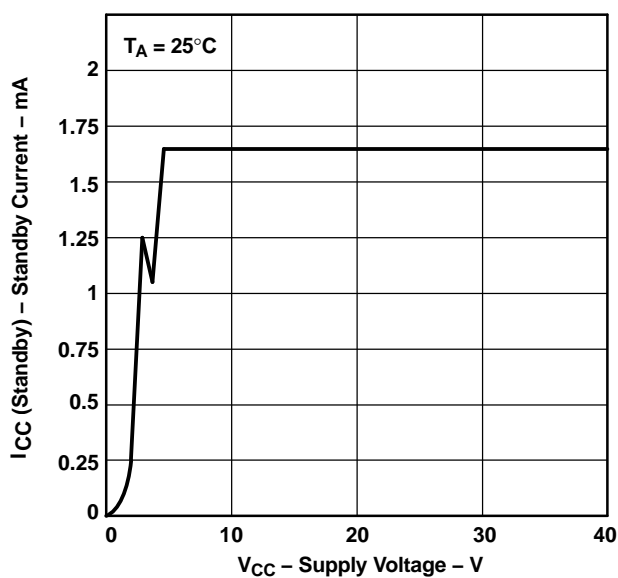


Figure 26. Standby Current vs Supply Voltage

# TYPICAL CHARACTERISTICS (continued)

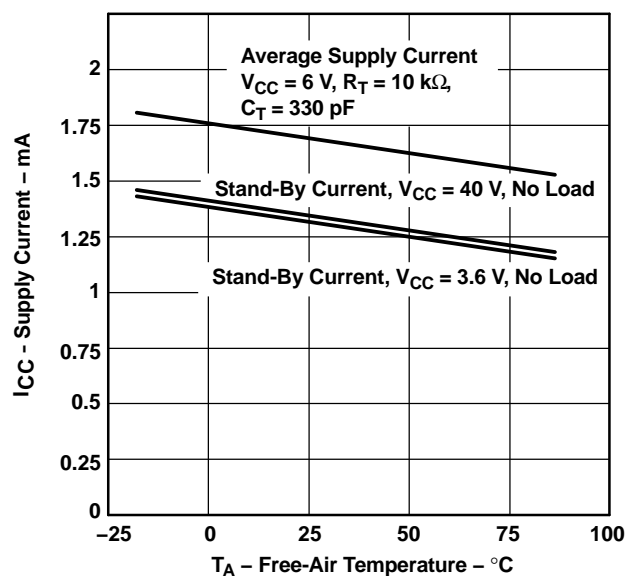


Figure 27. Standby Current vs Free-Air Temperature

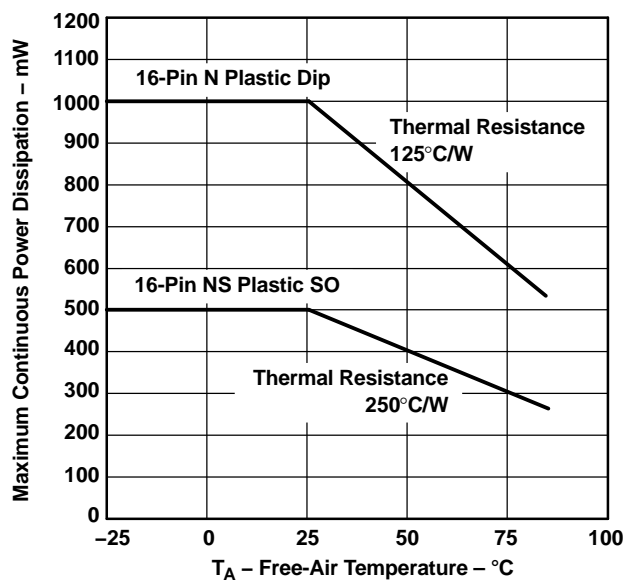


Figure 28. Maximum Continuous Power Dissipation vs Free-Air Temperature

# APPLICATION INFORMATION

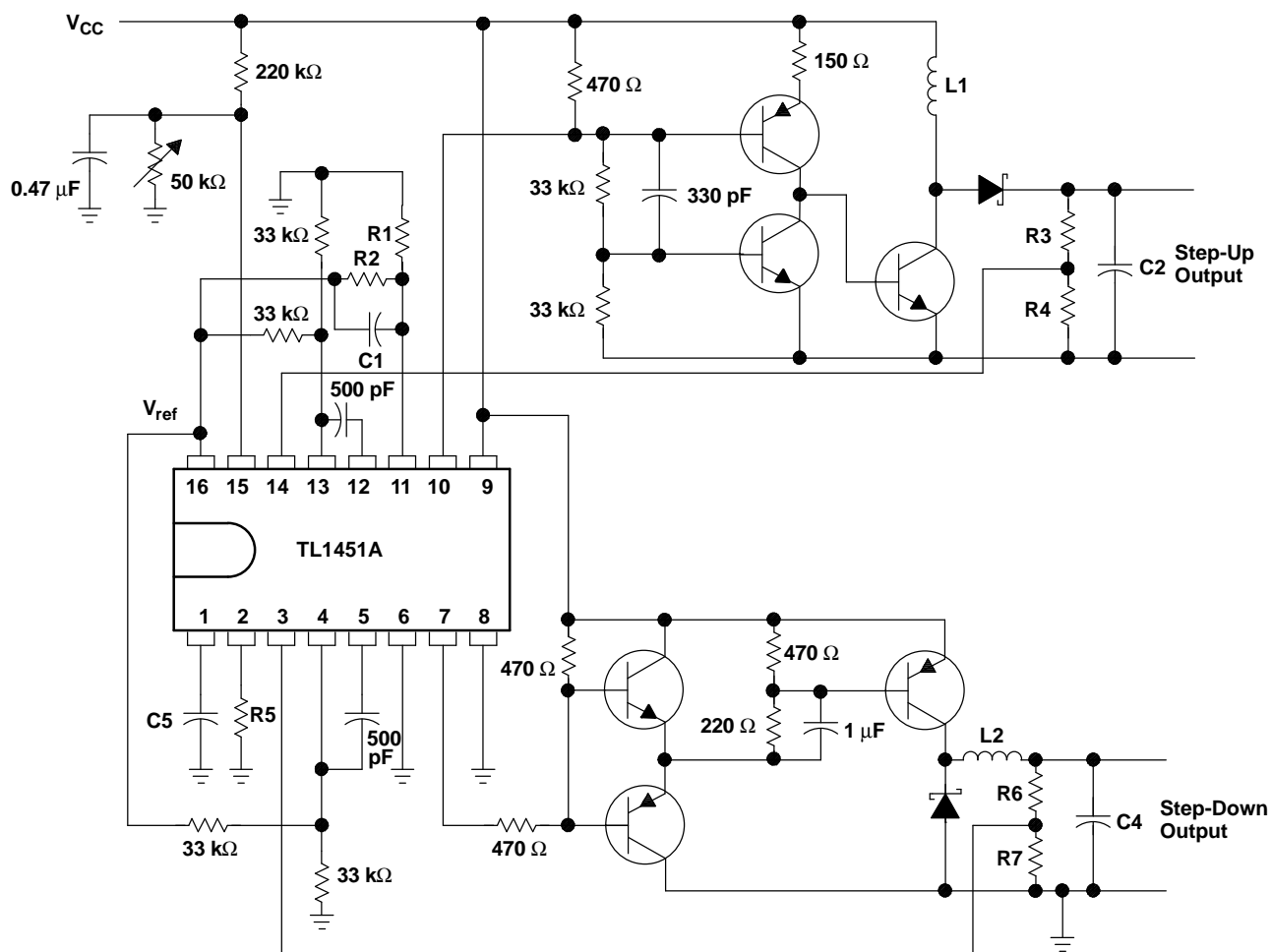


Figure 29. High-Speed Dual Switching Regulator

## 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
TL1451AMDREP	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	TL1451EP	<a href="#">Samples</a>
V62/06611-01XE	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	TL1451EP	<a href="#">Samples</a>

(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.

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**OTHER QUALIFIED VERSIONS OF TL1451A-EP :**

- Catalog: [TL1451A](#)
- Automotive: [TL1451A-Q1](#)

**NOTE:** Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

## TAPE AND REEL INFORMATION



\*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
TL1451AMDREP	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL1451AMDREP	SOIC	D	16	2500	350.0	350.0	43.0

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.
  - $\triangle C$  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.
  - $\triangle D$  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.



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