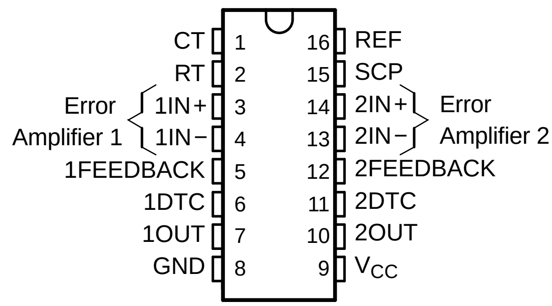
FEATURES

- **Controlled Baseline**
  - **– One Assembly/Test Site, One Fabrication Site**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree** (1)
- **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.

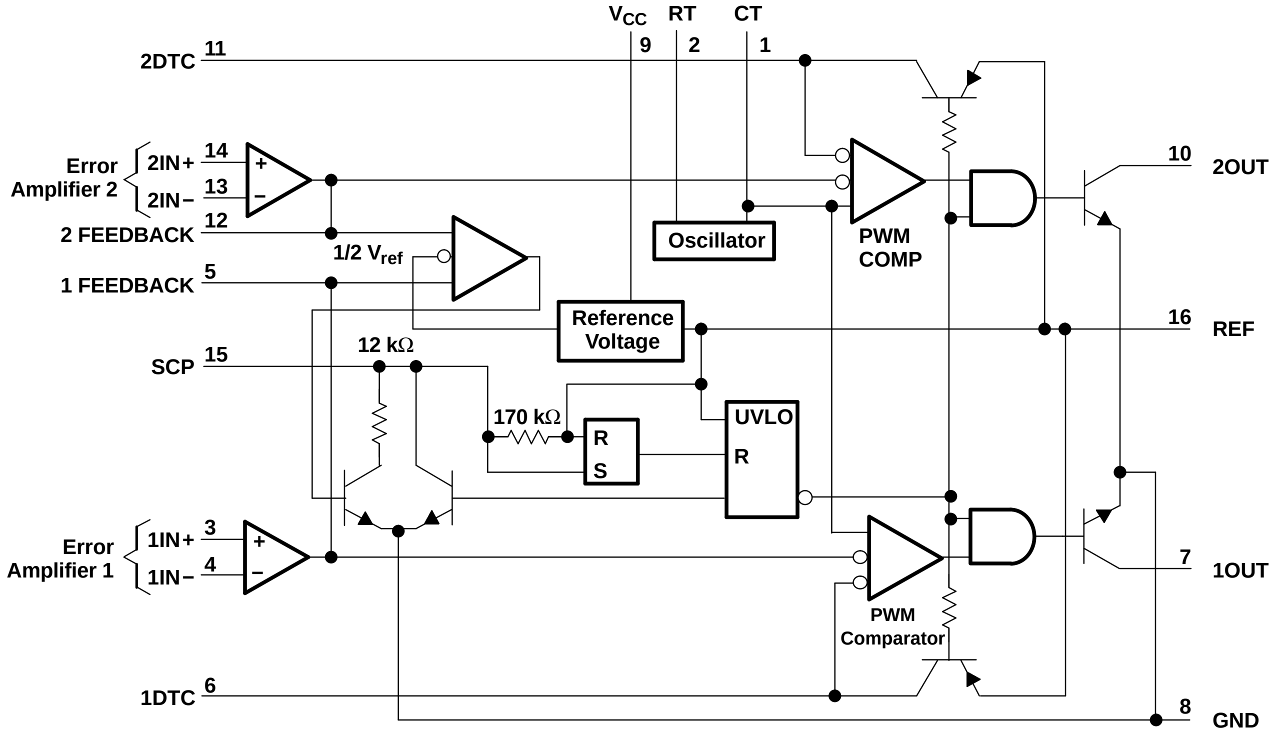
The TL1451A-EP is characterized for operation from –55°C to 125°C.

ORDERING INFORMATION

T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–55°C to 125°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.

FUNCTIONAL BLOCK DIAGRAM



COMPONENT COUNT

Resistors	65
Capacitors	8
Transistors	105
JFETs	18

Absolute Maximum Ratings(1)

over operating free-air temperature range

			MIN	MAX	UNIT
V_{CC}	Supply voltage			51	V
V_I	Amplifier input voltage			20	V
V_O	Collector output voltage			51	V
I_O	Collector output current			21	mA
	Continuous power total dissipation		See Dissipation Rating Table		
T_A	Operating free-air temperature range	M suffix	–55	125	°C
T_{stg}	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	$T_A \le 25°C$ 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

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	µA
R_F	Feedback resistor		100		kΩ
C_T	Timing capacitor		150	15000	pF
R_T	Timing resistor		5.1	100	kΩ
	Oscillator frequency		1	500	kHz
T_A	Operating free-air temperature	M suffix	–55	125	°C

Reference Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
Output voltage (pin 16)	I_O = 1 mA	T_A = 25°C	2.4	2.5	2.6	V
		T_A = MIN and 125°C	2.35	2.46	2.65	
Output voltage change with temperature				–0.63%	±4%(2)	
Input voltage regulation	V_{CC} = 3.6 V to 40 V	T_A = 25°C		2	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	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

(1) All typical values are at T_A = 25°C, unless otherwise indicated.
(2) These parameters are not production tested.

Undervoltage Lockout Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Upper threshold voltage (V_{CC})	T_A = 25°C		2.72		V
	T_A = 125°C		1.7		
	T_A = MIN		3.15		
Lower threshold voltage (V_{CC})	T_A = 25°C		2.6		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	1.5			V
	T_A = 125°C	0.95			
	T_A = MIN	1.5			

(1) All typical values are at T_A = 25°C, unless otherwise indicated.

Short-Circuit Protection Control Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Input threshold voltage (SCP)	T_A = 25°C	650	700	750	mV
	T_A = 125°C	400	478	650	
	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

(1) All typical values are at T_A = 25°C, unless otherwise indicated.

Oscillator Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
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%(2)	

(1) All typical values are at T_A = 25°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 V, f = 200 kHz (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
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	2.3			V
	T_A = 125°C	2.22	2.32		
	T_A = MIN	2.28	2.4		
Input threshold voltage at f = 10 kHz (DTC)	Zero duty cycle		2.05	2.25(2)	V
	Maximum duty cycle	1.2(2)	1.45		

(1) All typical values are at T_A = 25°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 V, f = 200 kHz (unless otherwise noted)

PARAMETER	TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
Input offset voltage	V_O (FEEDBACK) = 1.25 V	T_A = 25°C			±7	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		

(1) All typical values are at T_A = 25°C, unless otherwise indicated.

Output Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Collector off-state current	V_O = 50 V			10	μA
Output saturation voltage	T_A = 25°C		1.2	2	V
	T_A = 125°C		1.6	2.4	
	T_A = MIN		1.36	2.2	
Short-circuit output current	V_O = 6 V		90		mA

(1) All typical values are at T_A = 25°C, unless otherwise indicated.

PWM Comparator Section Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Input threshold voltage at f = 10 kHz (FEEDBACK)	Zero duty cycle		2.05	2.25(2)	V
	Maximum duty cycle	1.2(2)	1.45		

(1) All typical values are at T_A = 25°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 V, f = 200 kHz (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP(1)	MAX	UNIT
Standby supply current	Off-state		1.3	1.8	mA
Average supply current	R_T = 10 kΩ		1.7	2.4	mA

(1) All typical values are at T_A = 25°C, unless otherwise indicated.

PARAMETER MEASUREMENT INFORMATION

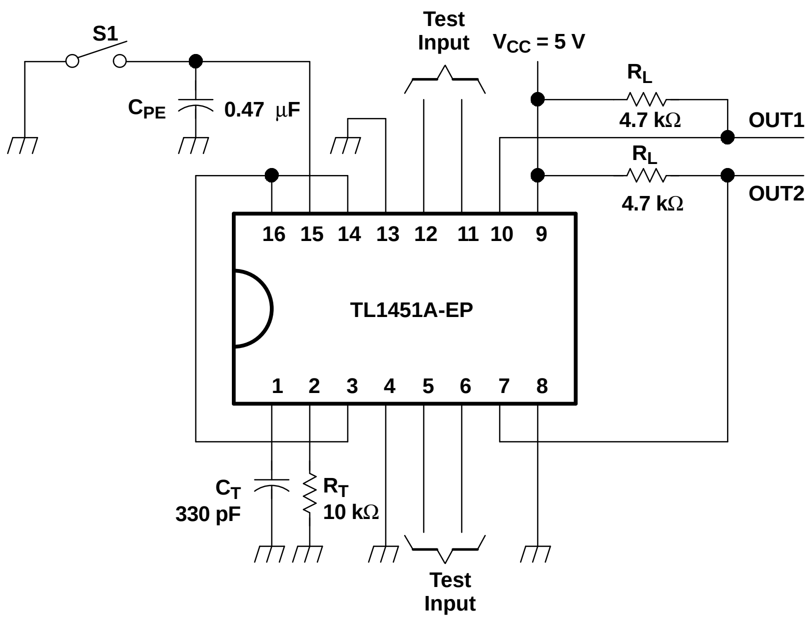
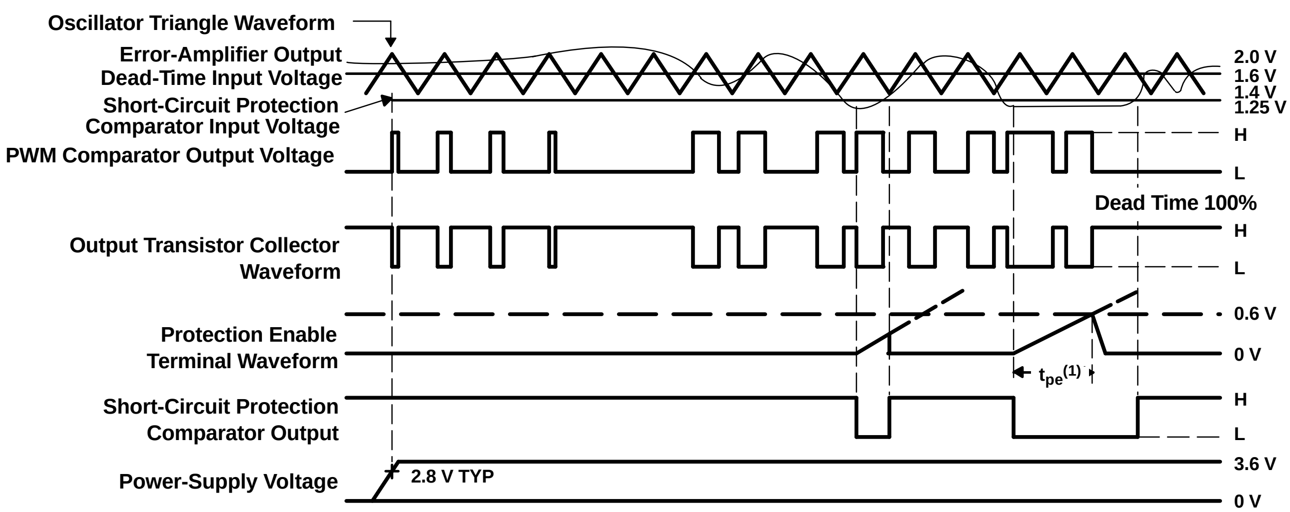


Figure 1. Test Circuit



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

Figure 2. TL1451A-EP Timing

TYPICAL CHARACTERISTICS

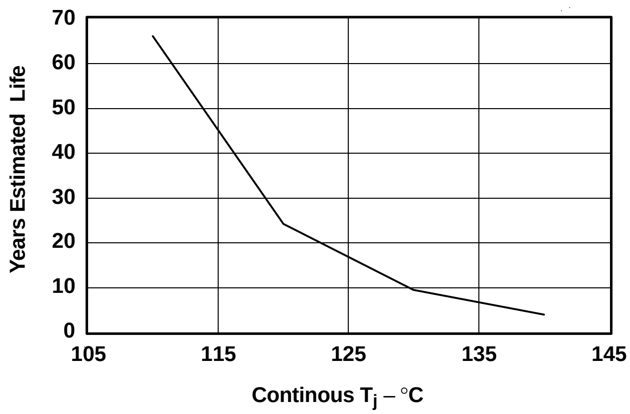


Figure 3. Estimated Deviced Life at Elevated Temperatures for Wirebond Voiding Fail Mode

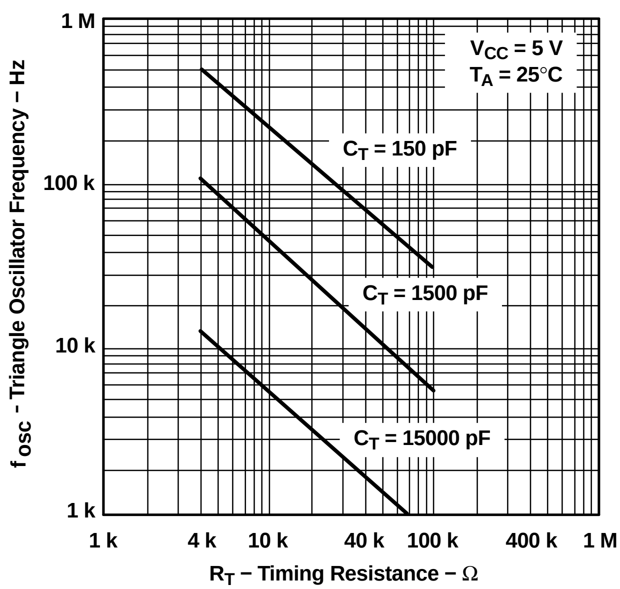


Figure 4. Triangle Oscillator Frequency vs Timing Resistance

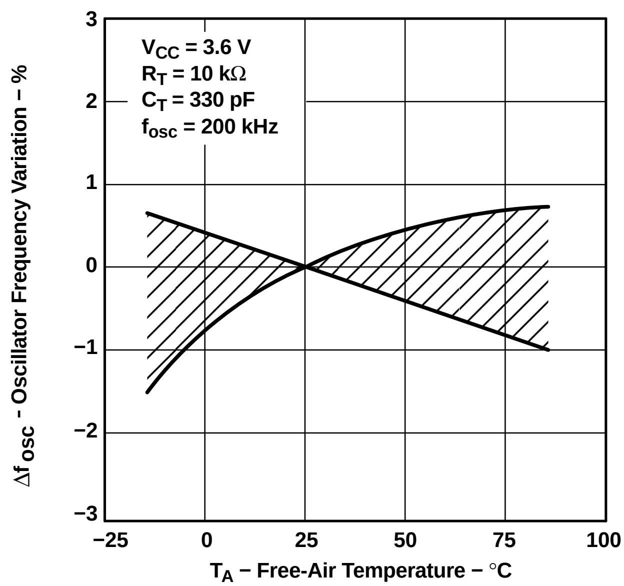


Figure 5. Oscillator Frequency Variation vs Free-Air Temperature

TYPICAL CHARACTERISTICS (continued)

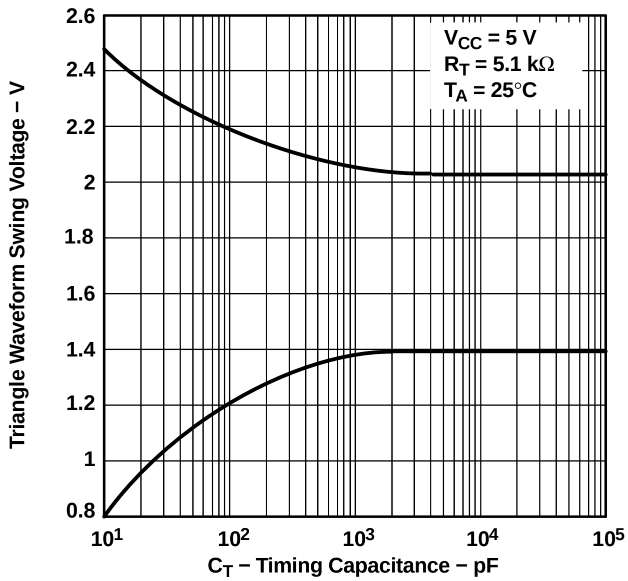


Figure 6. Trangle Waveform Swing Voltage vs Timing Capacitance

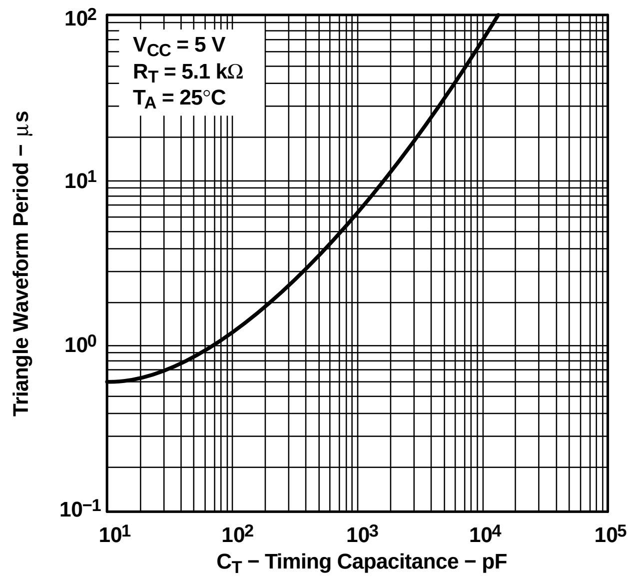


Figure 7. Triangle Waveform Period vs Timing Capacitance

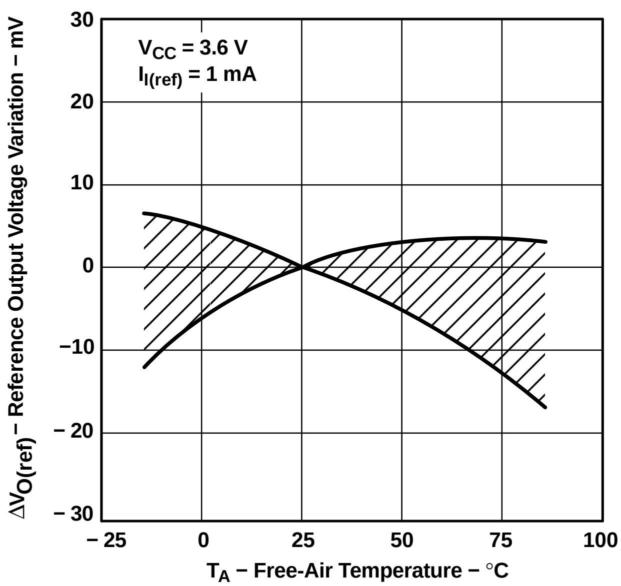


Figure 8. Reference Output Voltage Variation vs Free-Air Temperature

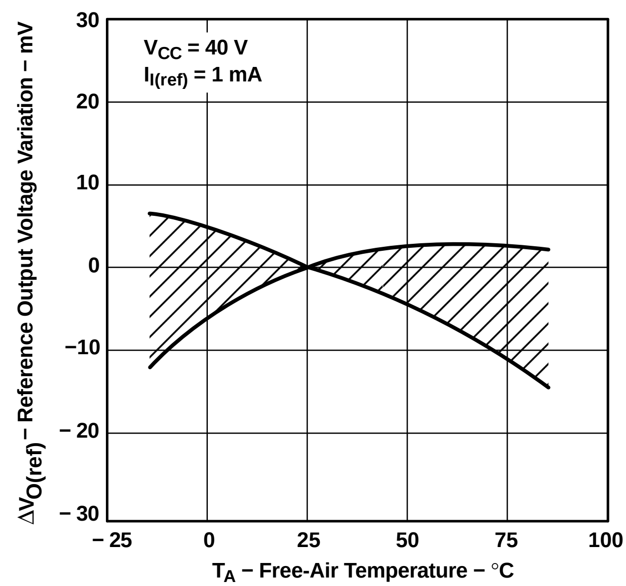


Figure 9. Reference Output Voltage Variation vs Free-Air Temperature

TYPICAL CHARACTERISTICS (continued)

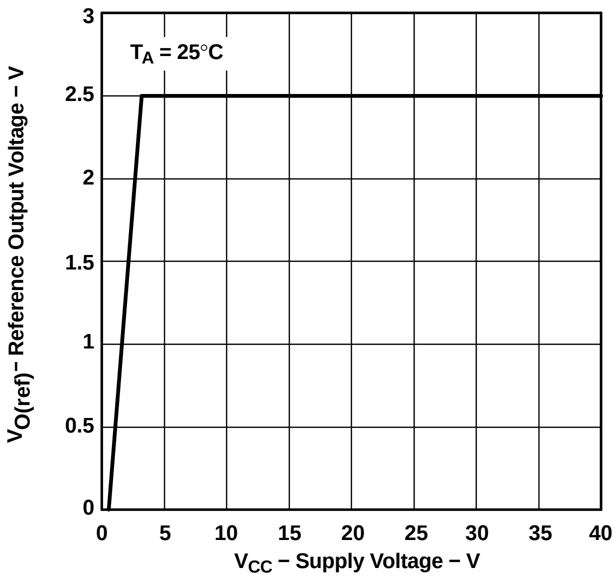


Figure 10. Reference Output Voltage vs Supply Voltage

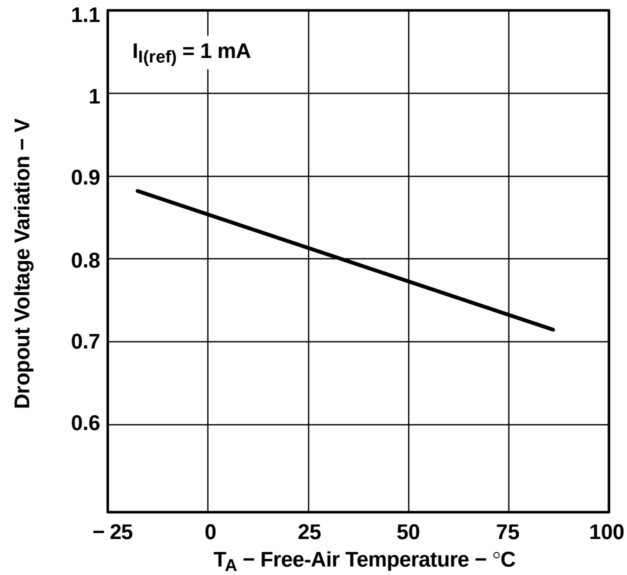


Figure 11. Dropout Voltage Variation vs Free-air Temperature

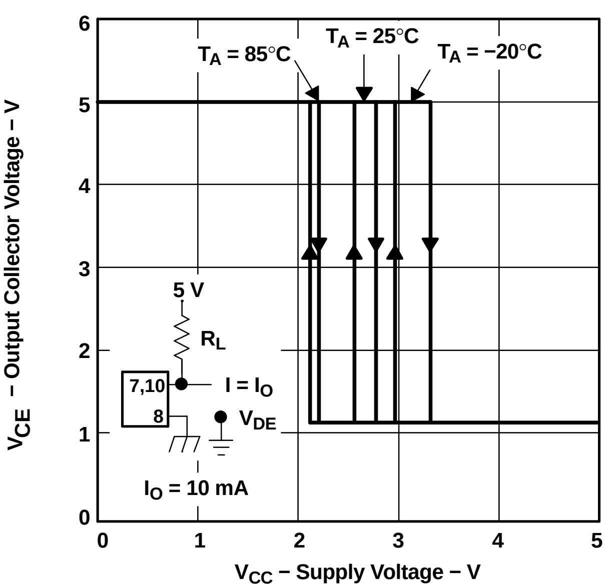


Figure 12. Undervoltage Lockout Hysteresis Characteristics

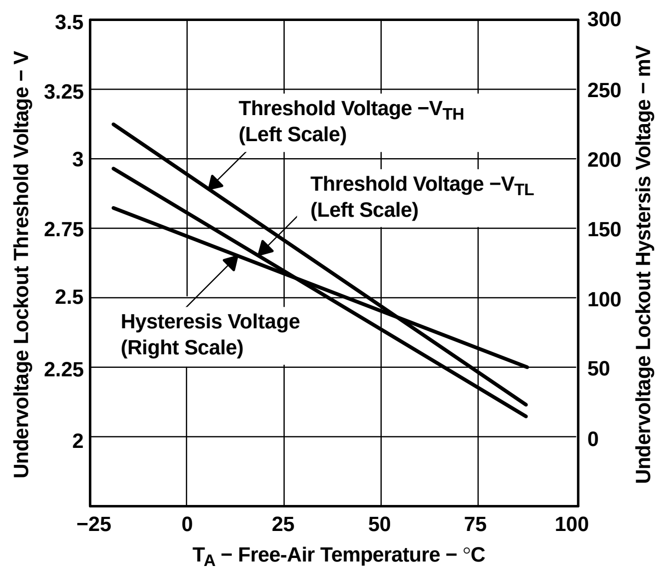


Figure 13. Undervoltage Lockout Characteristics

TYPICAL CHARACTERISTICS (continued)

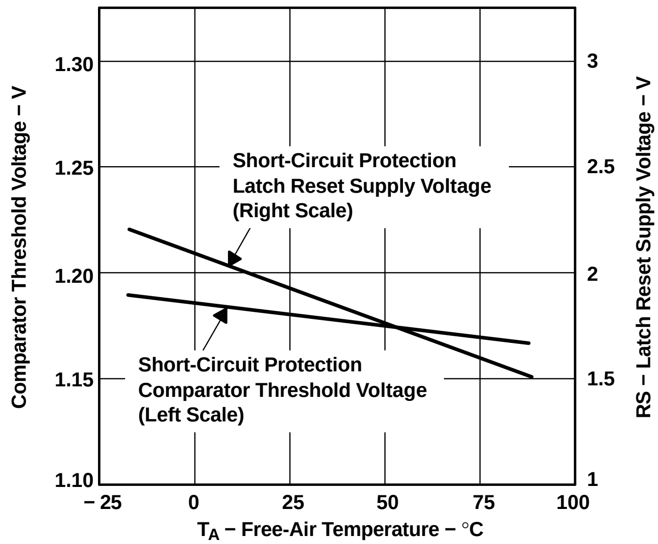
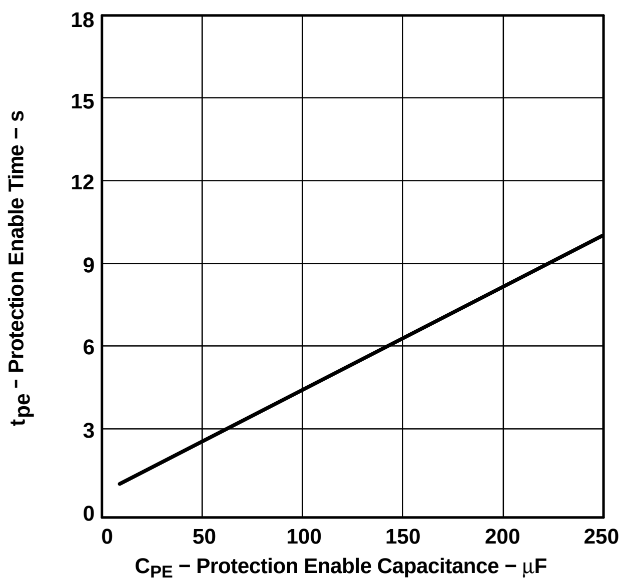


Figure 14. Short-Circuit Protection Characteristics



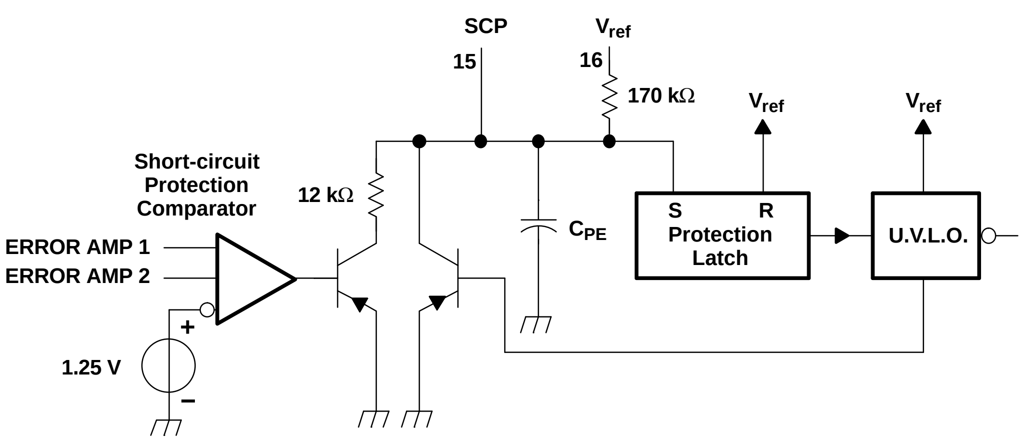


Figure 15. Protection Enable Time vs Protection Enable Capacitance

TYPICAL CHARACTERISTICS (continued)

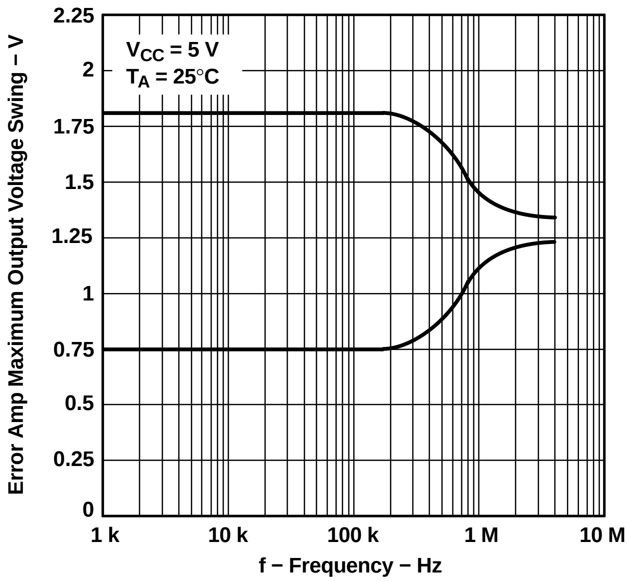


Figure 16. Error Amplifier Maximum Output Voltage Swing vs Frequency

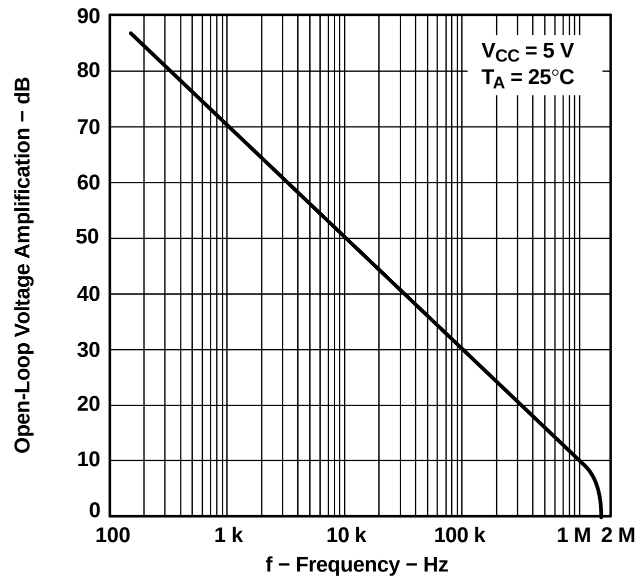


Figure 17. Open-Loop Voltage Amplification vs Frequency

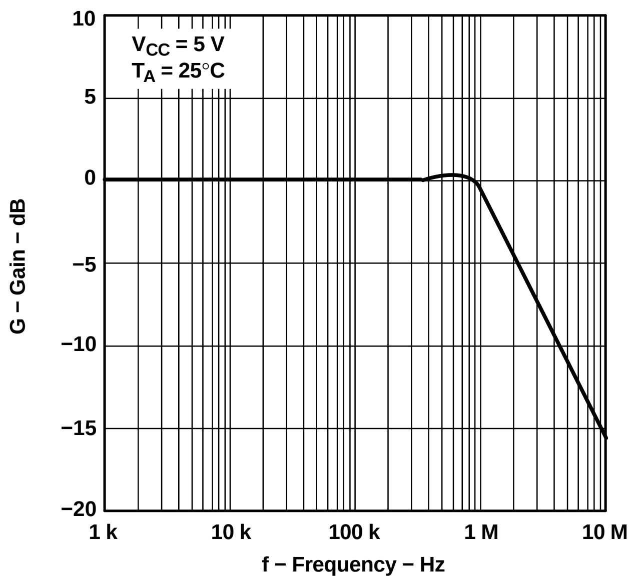


Figure 18. Gain
(Amplifier in Unity-Gain Configuration vs Frequency)

TYPICAL CHARACTERISTICS (continued)

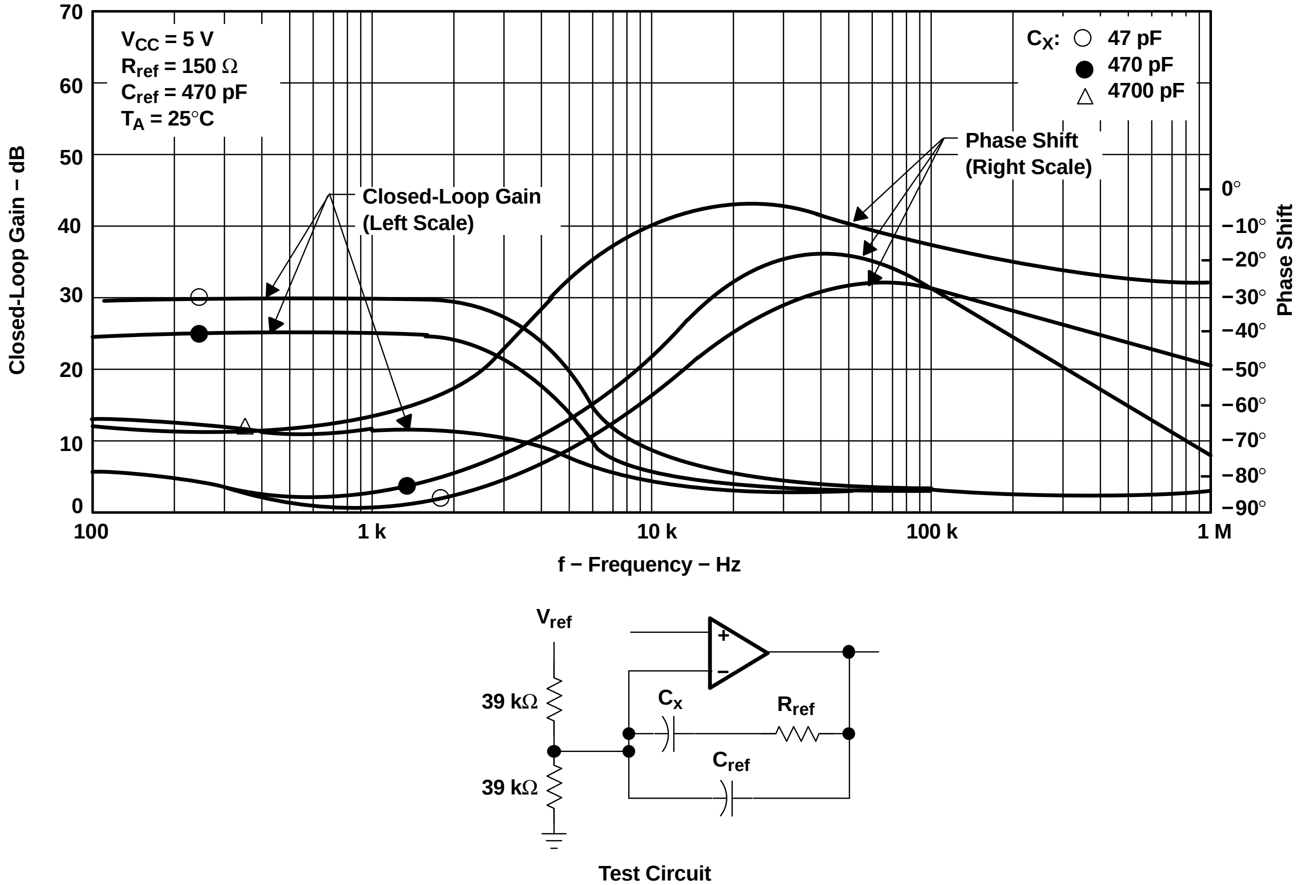


Figure 19. Closed-Loop Gain and Phase Shift vs Frequency

TYPICAL CHARACTERISTICS (continued)

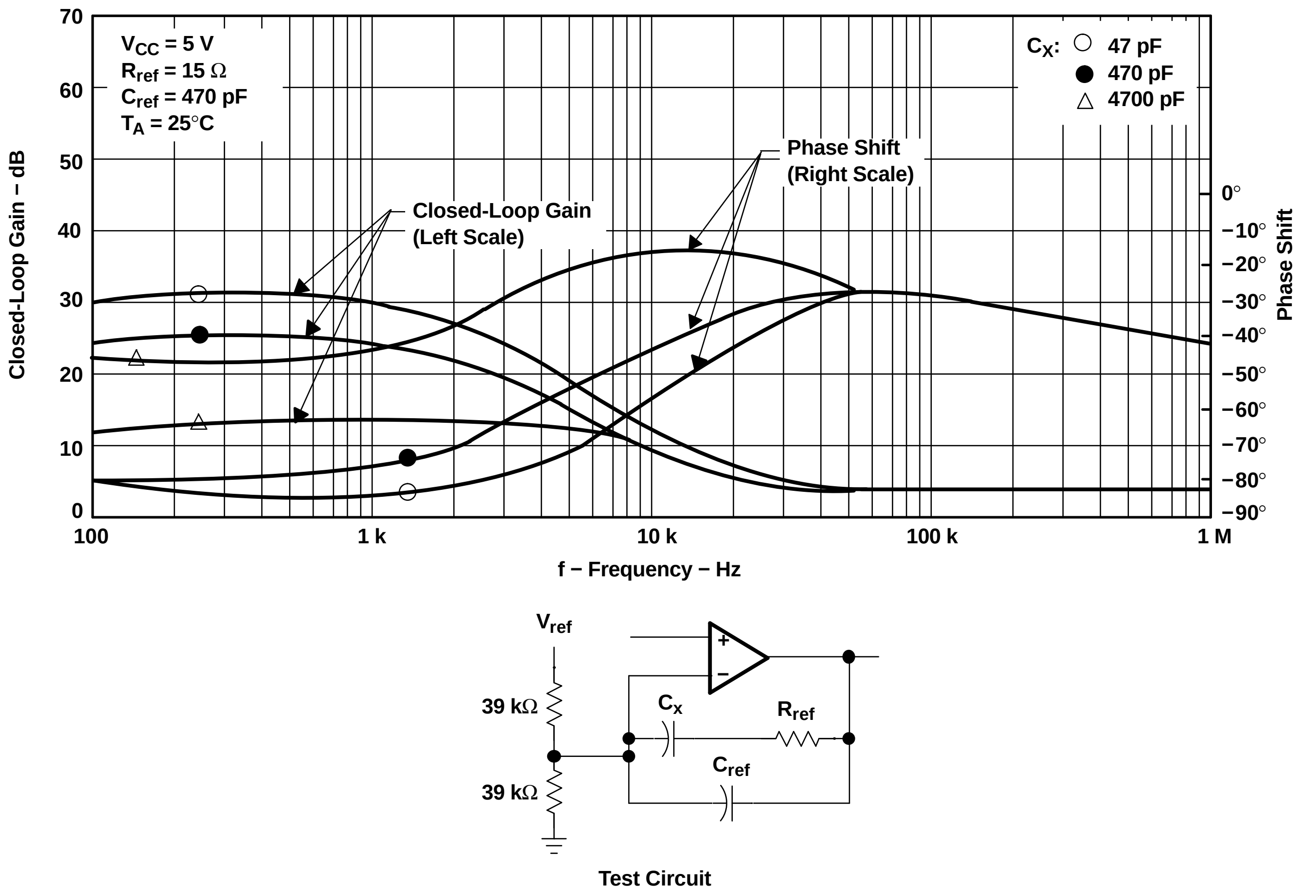
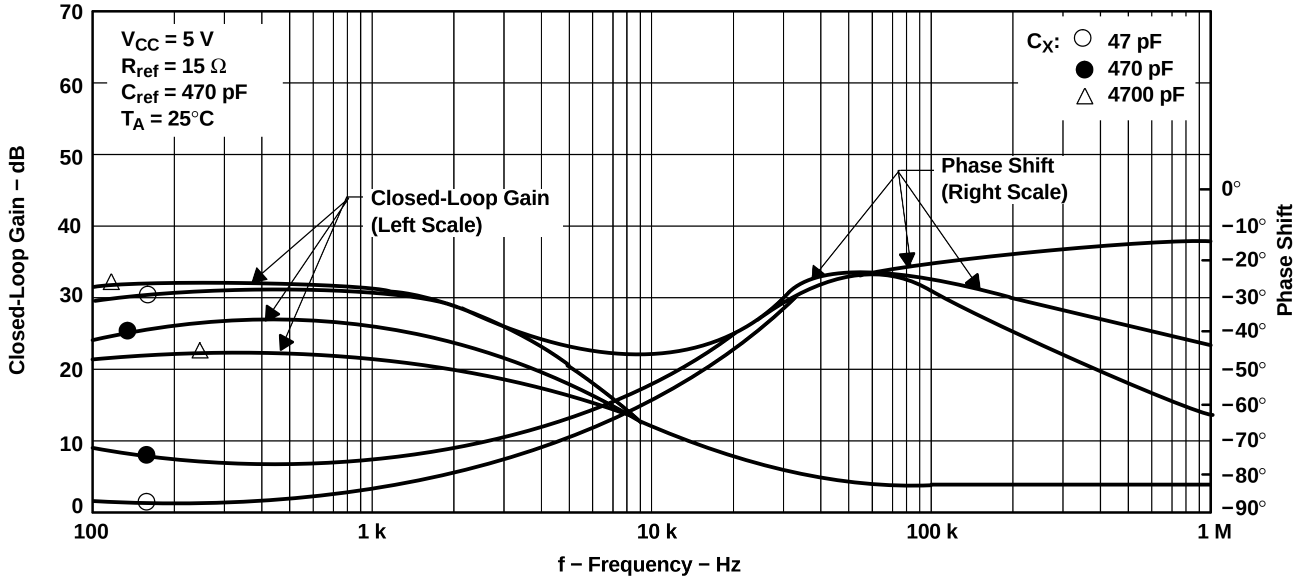


Figure 20. Closed-Loop Gain and Phase Shift vs Freqency

TYPICAL CHARACTERISTICS (continued)



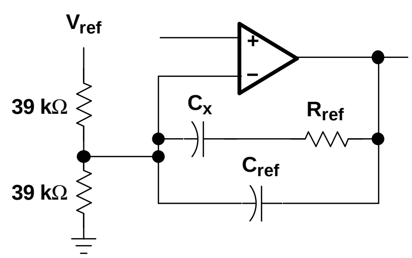


Figure 21. Closed-Loop Gain and Phase Shift vs Frequency

TYPICAL CHARACTERISTICS (continued)

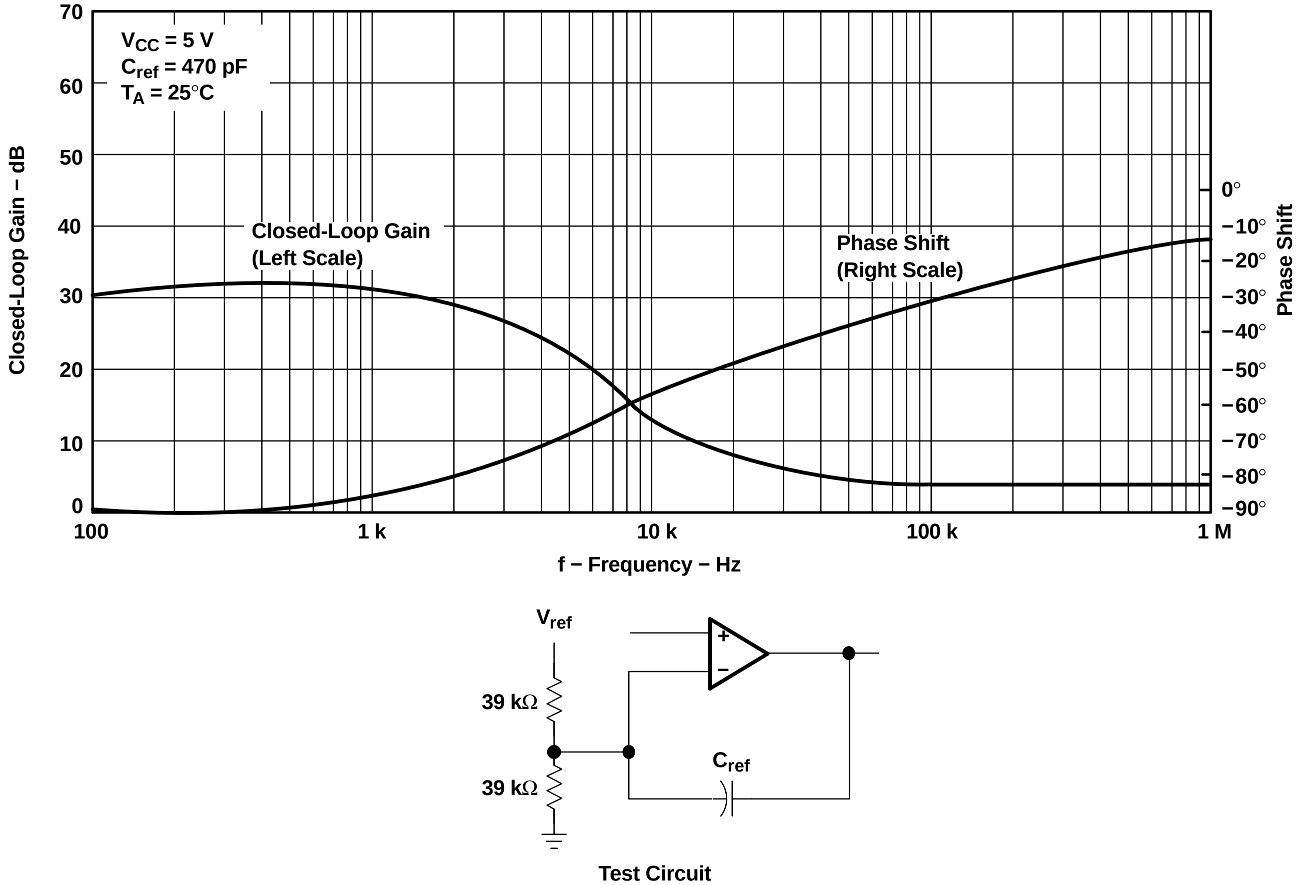


Figure 22. Closed-Loop Gain and Phase Shift vs Frequency

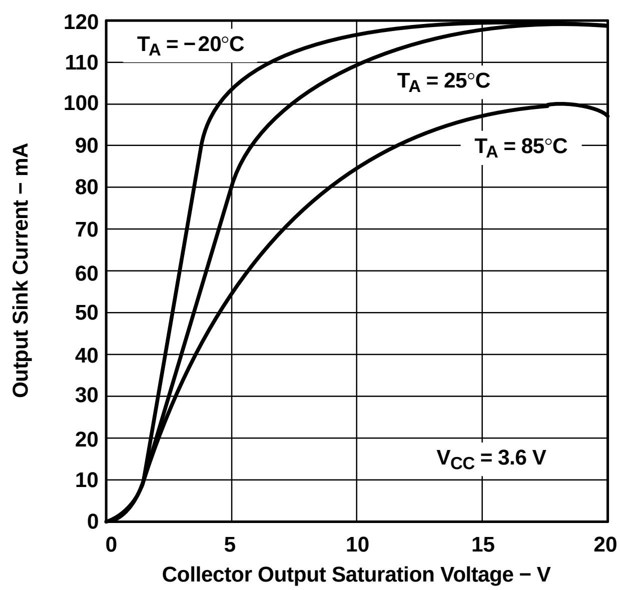


Figure 23. Output Sink Current vs Collector Output Saturation Voltage

TYPICAL CHARACTERISTICS (continued)

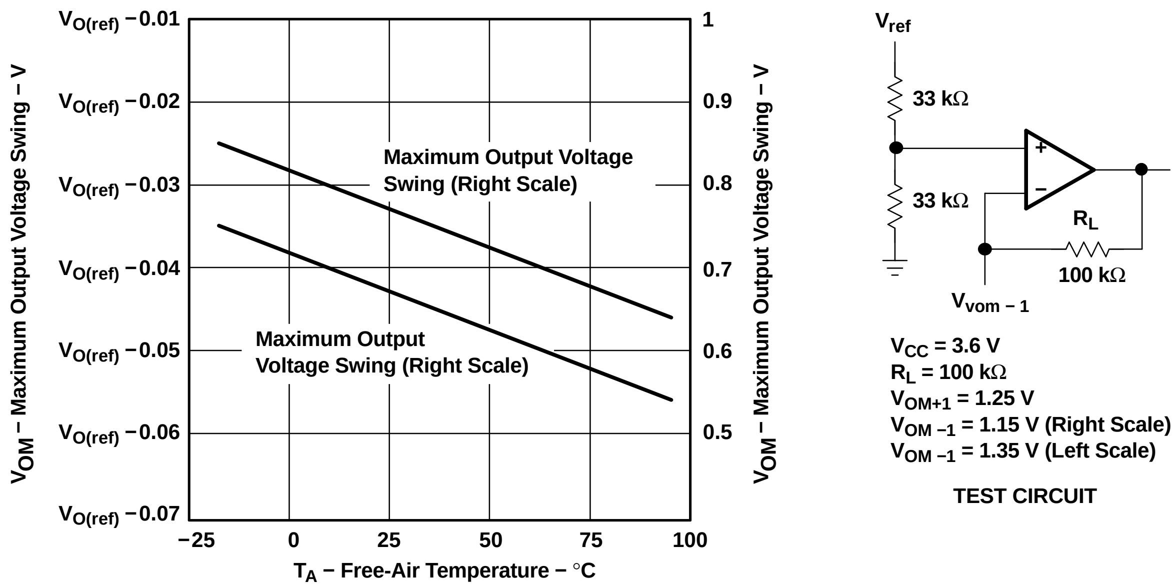


Figure 24. Maximum Output Voltage Swing vs Free-Air Temperature

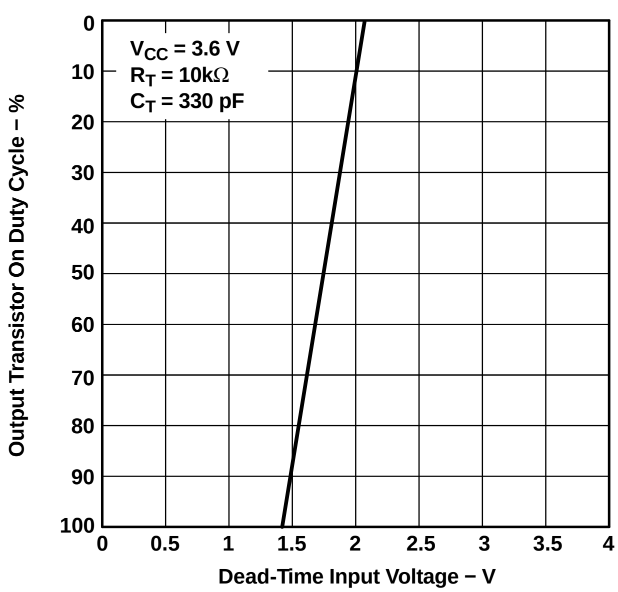


Figure 25. Output Transistor On Duty Cycle vs Dead-Time Input Voltage

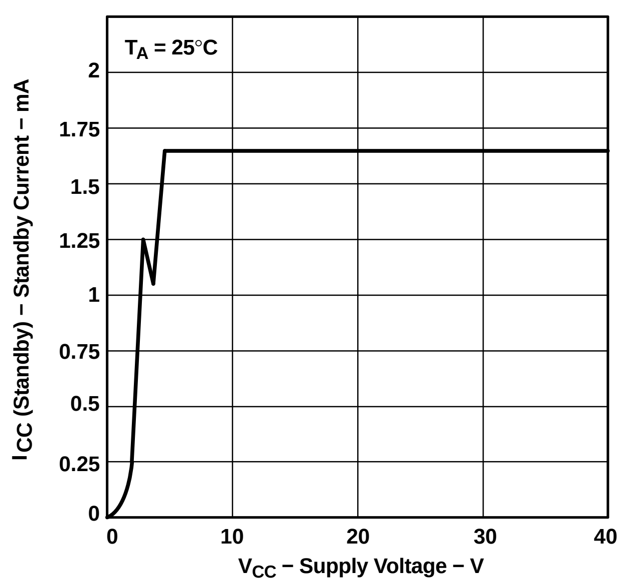


Figure 26. Standby Current vs Supply Voltage

TYPICAL CHARACTERISTICS (continued)

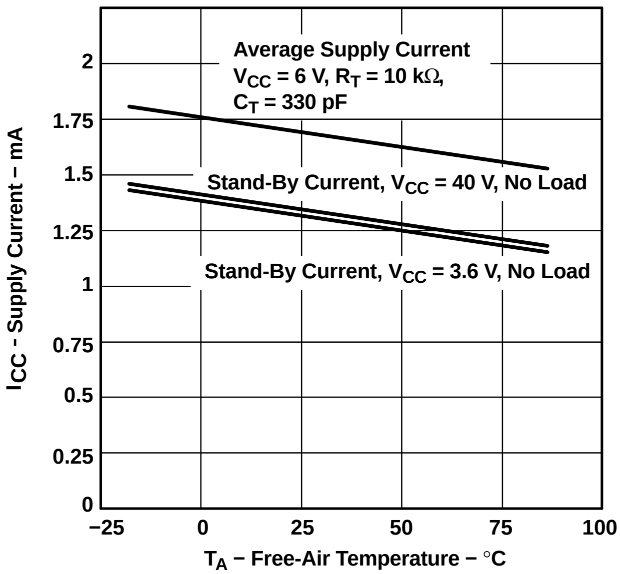


Figure 27. Sandby Current vs Free-Air Temperature

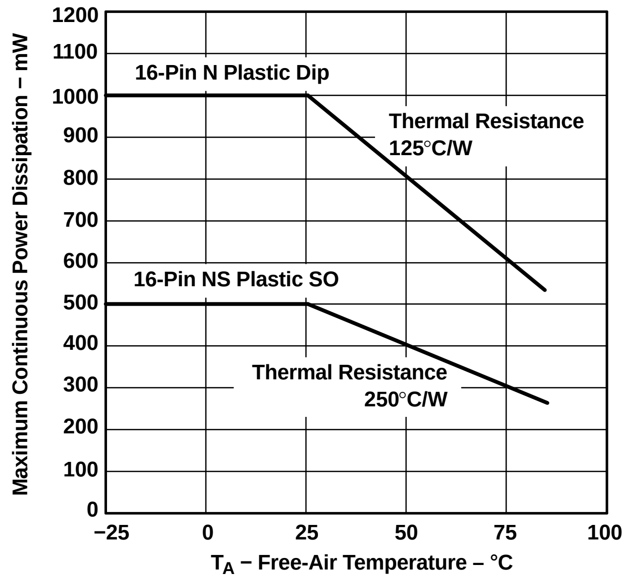


Figure 28. Maximum Continuous Power Dissipation vs Free-Air Temperature

APPLICATION INFORMATION

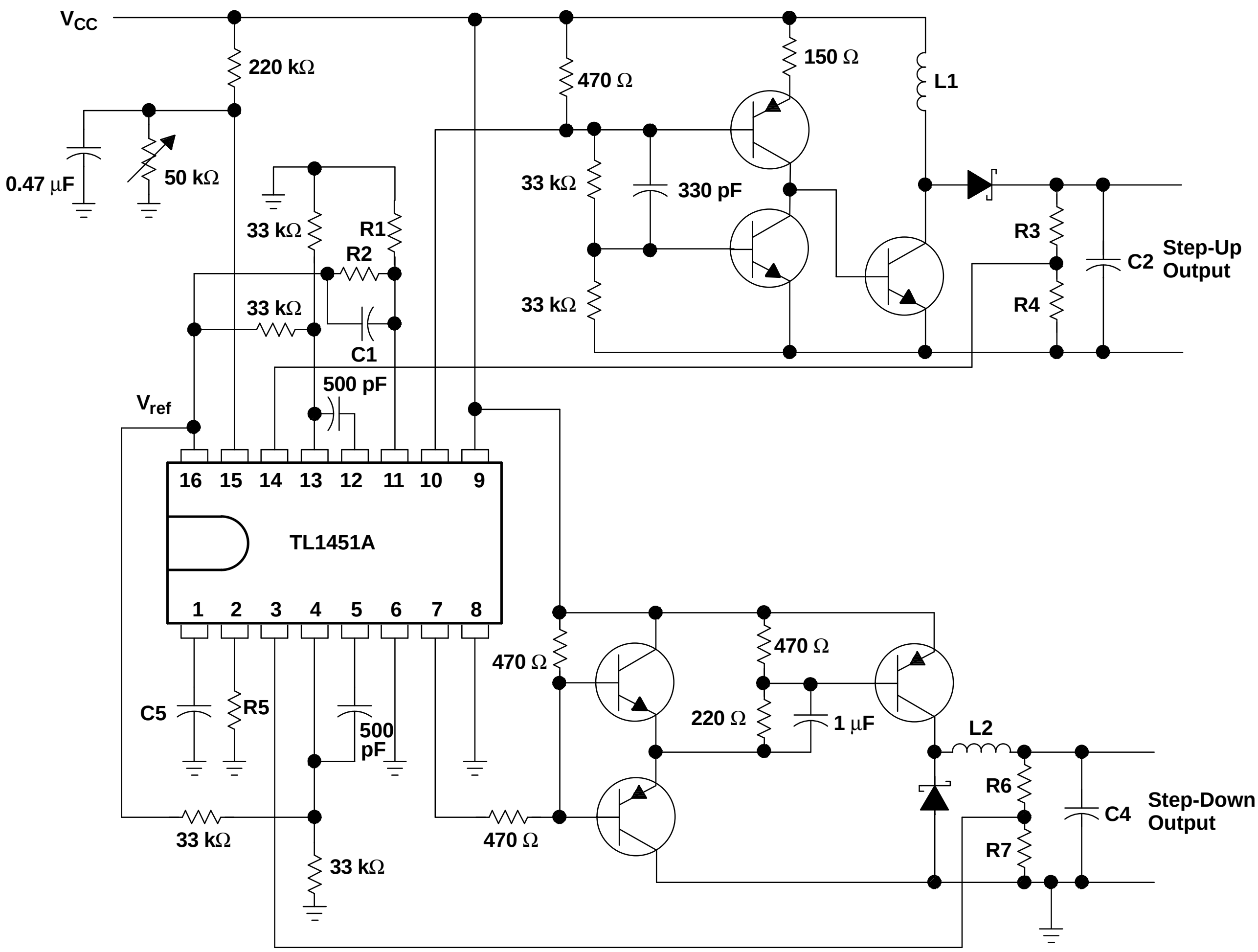


Figure 29. High-Speed Dual Switching Regulator

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL1451AMDREP	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	TL1451EP	Samples
V62/06611-01XE	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-55 to 125	TL1451EP	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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

OTHER QUALIFIED VERSIONS OF TL1451A-EP :

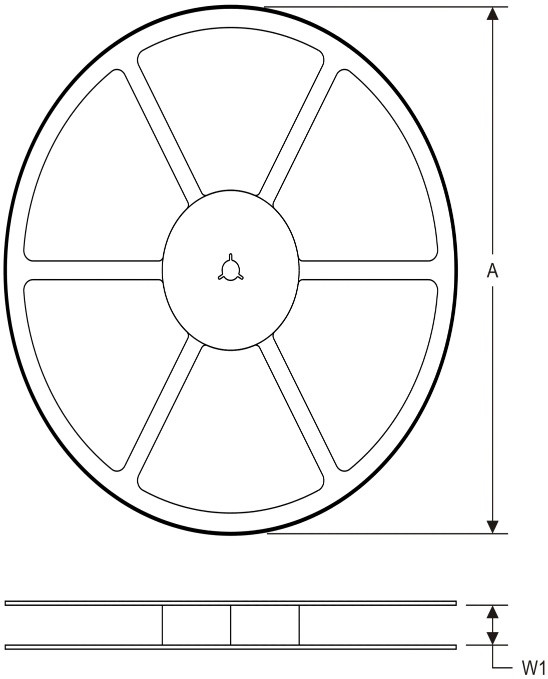
- Catalog: TL1451A
- Automotive: TL1451A-Q1
- Military: TL1451AM

NOTE: Qualified Version Definitions:

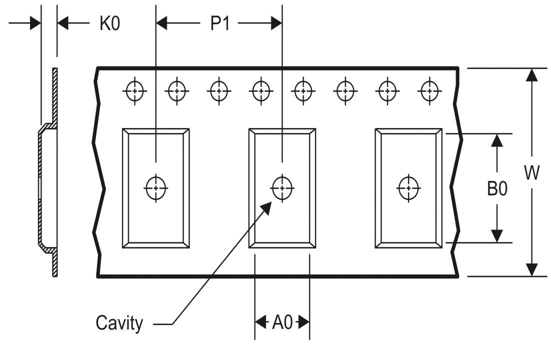
- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Military - QML certified for Military and Defense Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



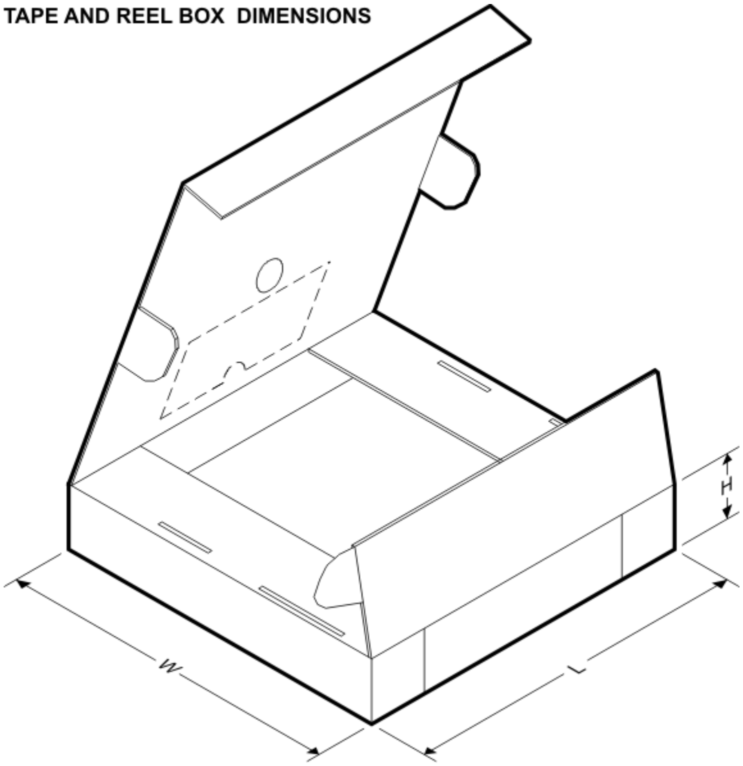
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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

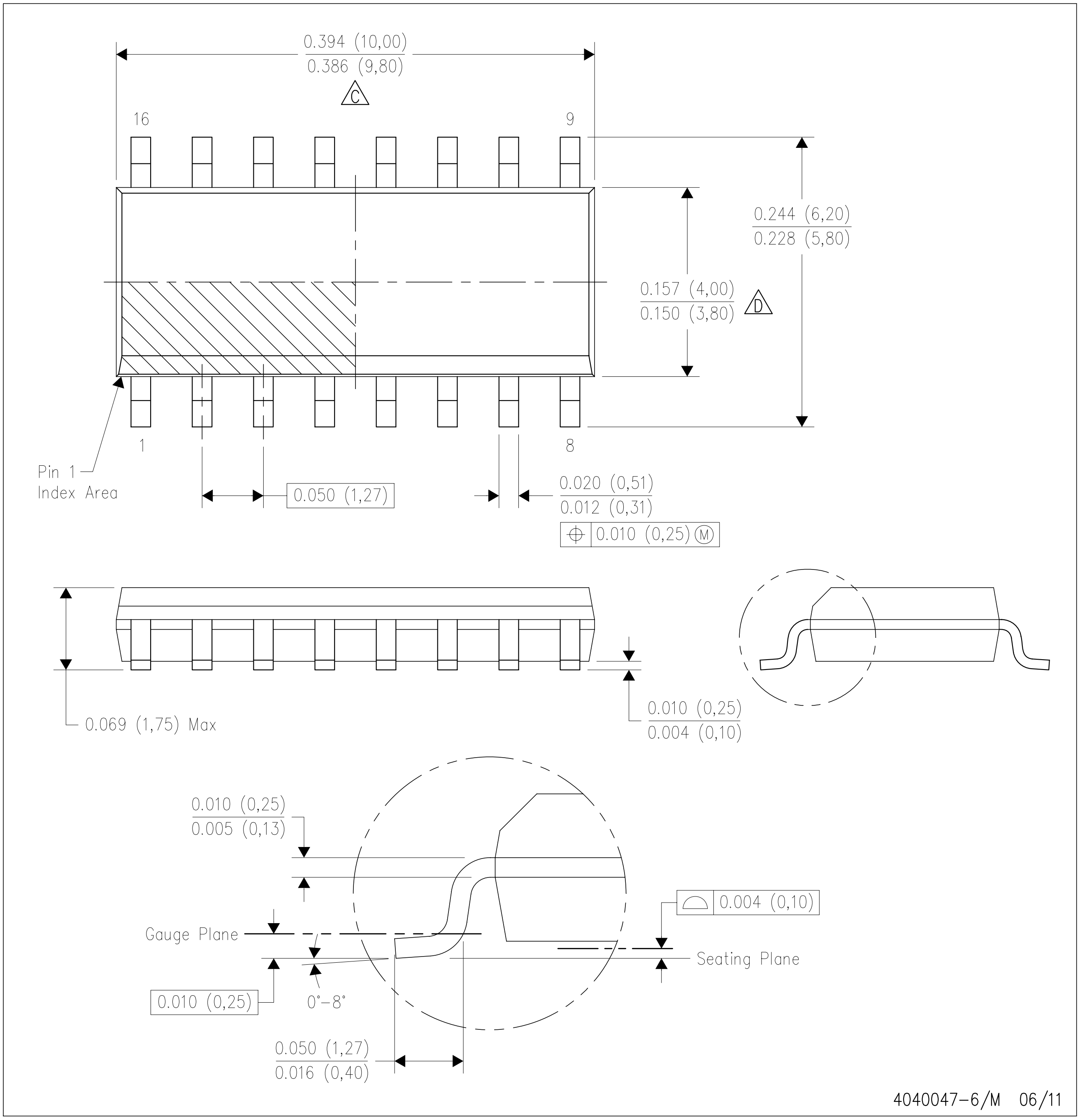
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

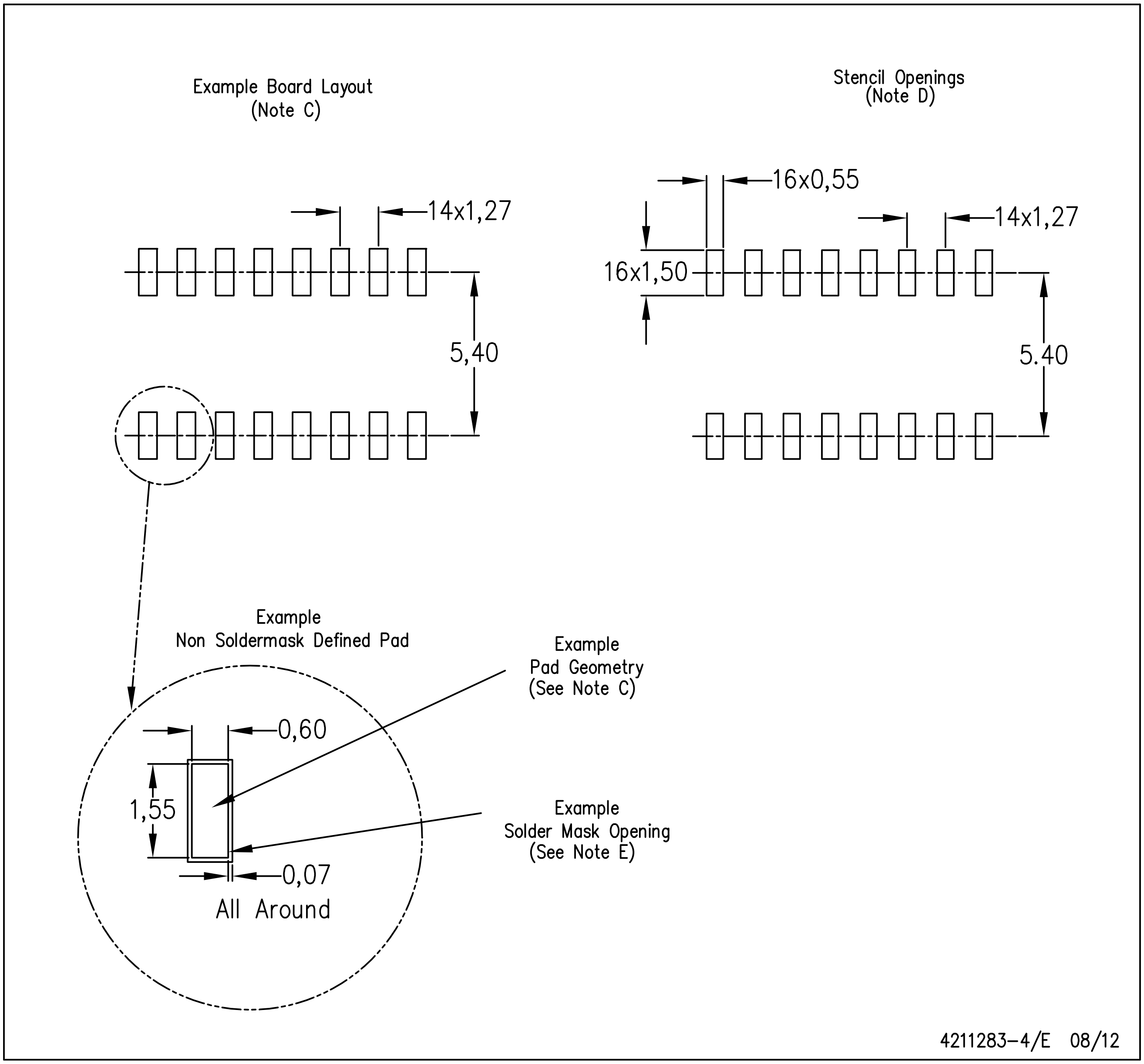
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL1451AMDREP	SOIC	D	16	2500	367.0	367.0	38.0

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.
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.