



## TL1451

## LINEAR INTEGRATED CIRCUIT

### DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

#### DESCRIPTION

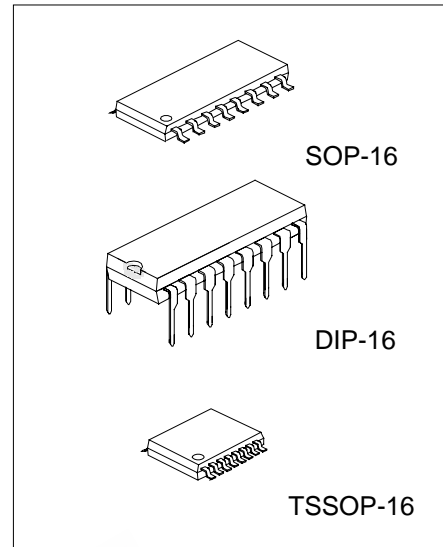
The UTC **TL1451** incorporates on a single monolithic chip all the functions required in the construction of two pulse-width-modulation (PWM) control circuits. Designed primarily for power supply control, the UTC **TL1451** contains an on-chip 2.5V regulator, two error amplifiers, an adjustable oscillator, two dead-time comparators, undervoltage lockout circuitry, and dual common –emitter output transistor circuits.

#### FEATURES

- \*Complete PWM power control circuitry
- \*Completely synchronized operation
- \*Internal undervoltage lockout protection
- \*Wide supply voltage range
- \*Internal Short-Circuit protection
- \*Oscillator frequency 500kHz max
- \*Variable dead time provides control over total range
- \*Internal regulator provides a stable 2.5V reference supply

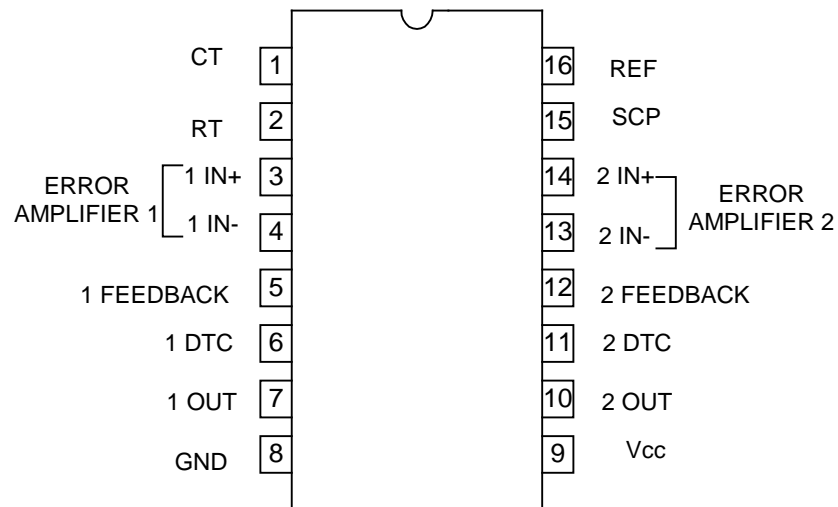
#### ORDERING INFORMATION

Order Number		Package	Packing
Normal	Lead free plating		
TL1451-S16-R	TL1451L-S16-R	SOP-16	Tape Reel
TL1451-S16-T	TL1451L-S16-T	SOP-16	Tube
TL1451-P16-R	TL1451L-P16-R	TSSOP-16	Tape Reel
TL1451-P16-T	TL1451L-P16-T	TSSOP-16	Tube
TL1451-D16-T	TL1451L-D16-T	DIP-16	Tube

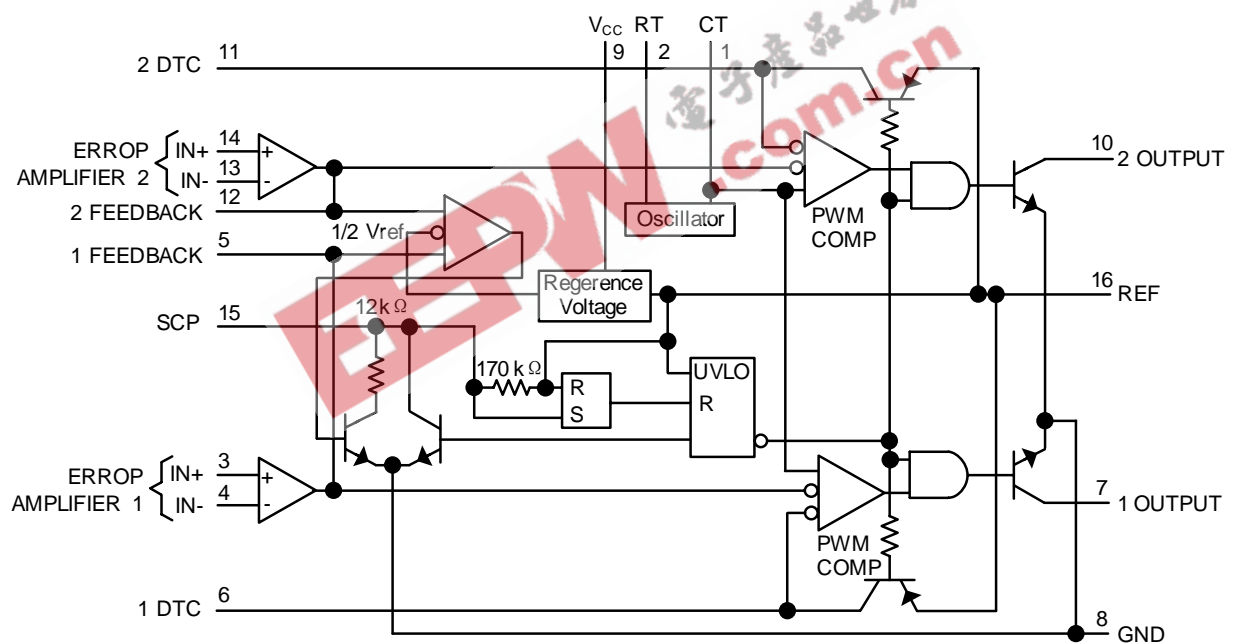


\*Pb-free plating product number: TL1451L

### PIN CONFIGURATION



### BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS ( $T_a=25^\circ\text{C}$ , unless otherwise specified)

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	$V_{CC}$	51	V
Amplifier Input Voltage	$V_{IN}$	20	V
Collector Output Voltage	$V_{OUT}$	51	V
Collector Output Current	$I_{OUT}$	21	mA
Power Dissipation	DIP-16	1000	mW
	SOP-16	500	
	TSSOP-16	700	
Junction Temperature	$T_J$	+125	$^\circ\text{C}$
Operating Temperature	$T_{OPR}$	-20 ~ +85	$^\circ\text{C}$
Storage Temperature	$T_{STG}$	-40 ~ +150	$^\circ\text{C}$

Note 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

2. The device is guaranteed to meet performance specification within 0 ~ +70 operating temperature range and assured by design from -20 ~ +85 .

■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Supply Voltage	$V_{CC}$	3.6		50	V
Amplifier Input Voltage	$V_{IN}$	1.05		1.45	V
Collector Output Voltage	$V_{OUT}$			50	V
Collector Output Current(each Transistor)	$I_{OUT}$			20	mA
Current into Feedback Terminal	$I_{FB}$			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	$F_{OSC}$	1		500	kHz
Operating Temperature	$T_{OPR}$	-20		85	$^\circ\text{C}$

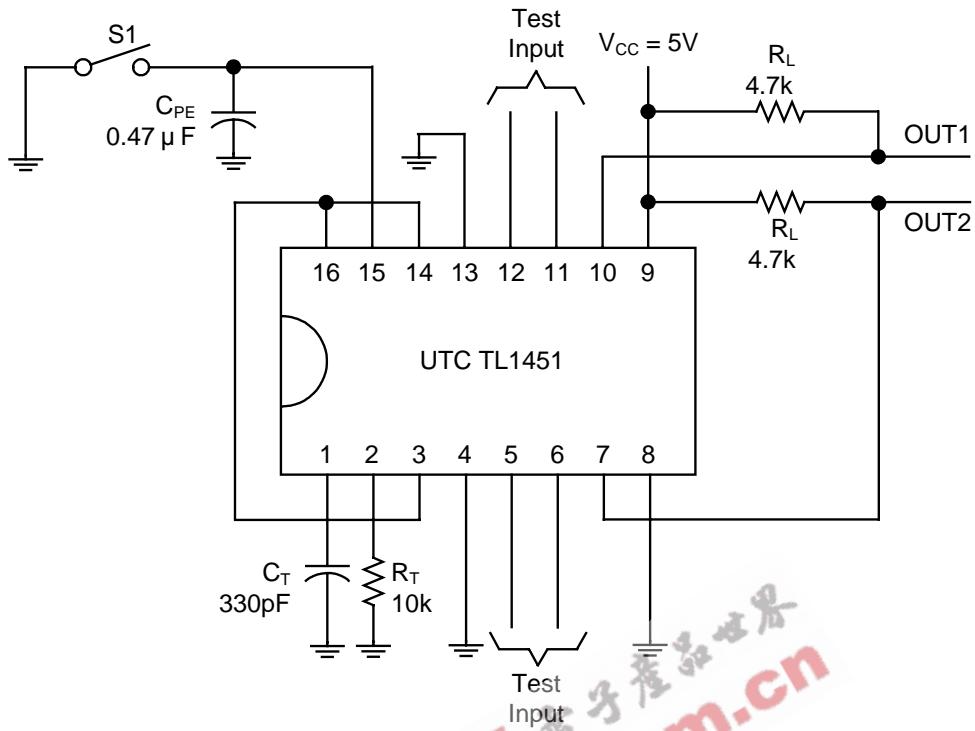
■ ELECTRICAL CHARACTERISTICS ( $V_{CC}=6\text{V}$ ,  $f=200\text{kHz}$ ,  $T_a=25^\circ\text{C}$ , unless otherwise specified.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT		
<b>Reference Section</b>								
Output Voltage	$V_{OUT}$	$I_{OUT}=1\text{mA}$	2.4	2.5	2.6	V		
Output Voltage Change with Temperature		$T_a = -20^\circ\text{C} \sim 25^\circ\text{C}$		-0.1	$\pm 1$	%		
		$T_a = 25^\circ\text{C} \sim 85^\circ\text{C}$		-0.2	$\pm 1$			
Input Voltage Regulation	$V_{IN}$	$V_{CC}=3.6\text{V} \sim 40\text{V}$		2	12.5	mV		
Output Voltage Regulation	$V_{OUT}$	$I_{OUT}=0.1\text{mA} \sim 1\text{mA}$		1	7.5	mV		
Short-Circuit Output Current	$I_{OUT}$	$V_{OUT}=0$	3	10	30	mA		
<b>Undervoltage Lockout Section</b>								
Threshold Voltage ( $V_{CC}$ )	Upper	$V_{THR}$	$I_{OUT(REF)}=0.1\text{mA}$		2.72		V	
	Lower				2.6		V	
Hysteresis ( $V_{CC}$ )		$V_{HYS}$			80	120		mV
Reset Threshold voltage ( $V_{CC}$ )					1.5	1.9		V
<b>Short-Circuit Protection Control Section</b>								
Input Threshold Voltage(SCP)	$V_{IN(THR)}$		0.65	0.7	0.75	V		
Standby Voltage(SCP)	$V_{STN-BY}$	No pullup	140	185	230	mV		
Latched Input Voltage (SCP)	$V_{IN(LAT)}$	No pullup		60	120	mV		
Input (source) Current	$I_{IN(source)}$	$V_{IN}=0.7\text{V}$	-10	-15	-20	$\mu\text{A}$		
Comparator Threshold Voltage (FEEDBACK)	$V_{THR}$			1.18		V		

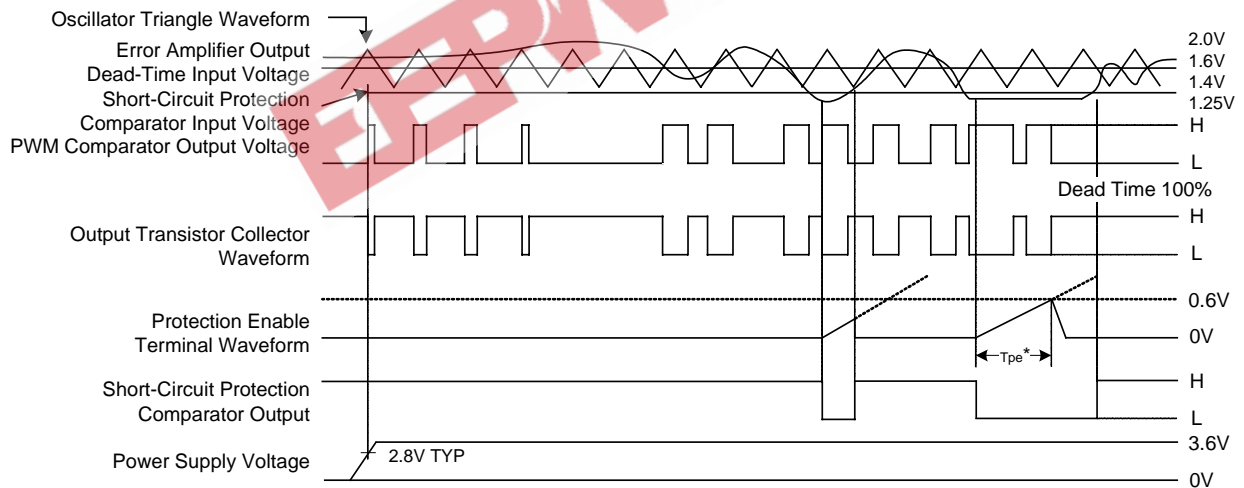
### ■ ELECTRICAL CHARACTERISTICS(Cont.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Oscillator Section</b>						
Frequency	F	$C_T=330\text{pF}$ , $R_T=10\text{k}\Omega$		200		kHz
Standard deviation of frequency		$C_T=330\text{pF}$ , $R_T=10\text{k}\Omega$		10%		
Frequency Change with Voltage		$V_{CC}=3.6\text{V} \sim 40\text{V}$		1%		
Frequency Change with Temperature		$T_A=-20^\circ\text{C} \sim 25^\circ\text{C}$		-0.4	$\pm 2$	%
		$T_A=25^\circ\text{C} \sim 85^\circ\text{C}$		-0.2	$\pm 2$	
<b>Dead-Time Control Section</b>						
Input bias Current (DTC)	$I_{IN(BIAS)}$				1	$\mu\text{A}$
Latch mode (source) Current (DTC)			-80	-145		$\mu\text{A}$
Latched Input Voltage (DTC)	$V_{IN}$	$I_{OUT}=40\mu\text{A}$	2.3			V
Input threshold Voltage at $f=10\text{kHz}$ (DTC)	$V_{IN(THR)}$	Zero duty cycle		2.05	2.25	V
		Maximum duty cycle	1.2	1.45		
<b>Error-Amplifier Section</b>						
Input Offset Voltage	$V_{IN(OFF)}$	$V_{OUT}(\text{FEEDBACK})=1.25\text{V}$			$\pm 6$	mV
Input Offset Current	$I_{IN(OFF)}$	$V_{OUT}(\text{FEEDBACK})=1.25\text{V}$			$\pm 100$	nA
Input Bias current	$I_{IN(BIAS)}$	$V_{OUT}(\text{FEEDBACK})=1.25\text{V}$		160	500	nA
Common-Mode Input Voltage Range	$V_{IN(CM)}$	$V_{CC}=3.6\text{V} \sim 40\text{V}$	1.05~ 1.45			V
Open-loop Voltage Amplification		$R_F=200\text{k}\Omega$	70	80		dB
Unity-gain Bandwidth	$B_G$			1.5		MHz
Common-mode Rejection Ratio	RR		60	80		dB
Positive Output Voltage Swing	$V_{OUT}$		$V_{ref}-0.1$			V
Negative Output Voltage Swing	$V_{OUT}$				1	V
Output (sink) Current (FEEDBACK)	$I_{OUT(SIN)}$	$V_{ID}=-0.1\text{V}$ , $V_{OUT}=1.25\text{V}$	0.5	1.6		mA
Output (source) Current (FEEDBACK)	$I_{OUT(SOU)}$	$V_{ID}=0.1\text{V}$ , $V_{OUT}=1.25\text{V}$	-45	-70		$\mu\text{A}$
<b>Output Section</b>						
Collector off-state Current	$I_{OFF}$	$V_{OUT}=50\text{V}$			10	$\mu\text{A}$
Output Saturation Voltage	$V_{OUT(SAT)}$	$I_{OUT}=10\text{mA}$		1.2	2	V
Short-Circuit Output Current	$I_{OUT(SHT)}$	$V_{OUT}=6\text{V}$		90		mA
<b>PWM Comparator Section</b>						
Input Threshold Voltage at $f=10\text{kHz}$ (FEEDBACK)	$V_{I(THR)}$	Zero duty cycle		2.05	2.25	V
		Maximum duty cycle	1.2	1.45		
<b>TOTAL DEVICE</b>						
Standby Supply Current	$I_{STN-BY}$	Off-state		1.3	1.8	mA
Average Supply Current		$R_T=10\text{k}\Omega$		1.7	2.4	mA

### ■ TEST CIRCUIT



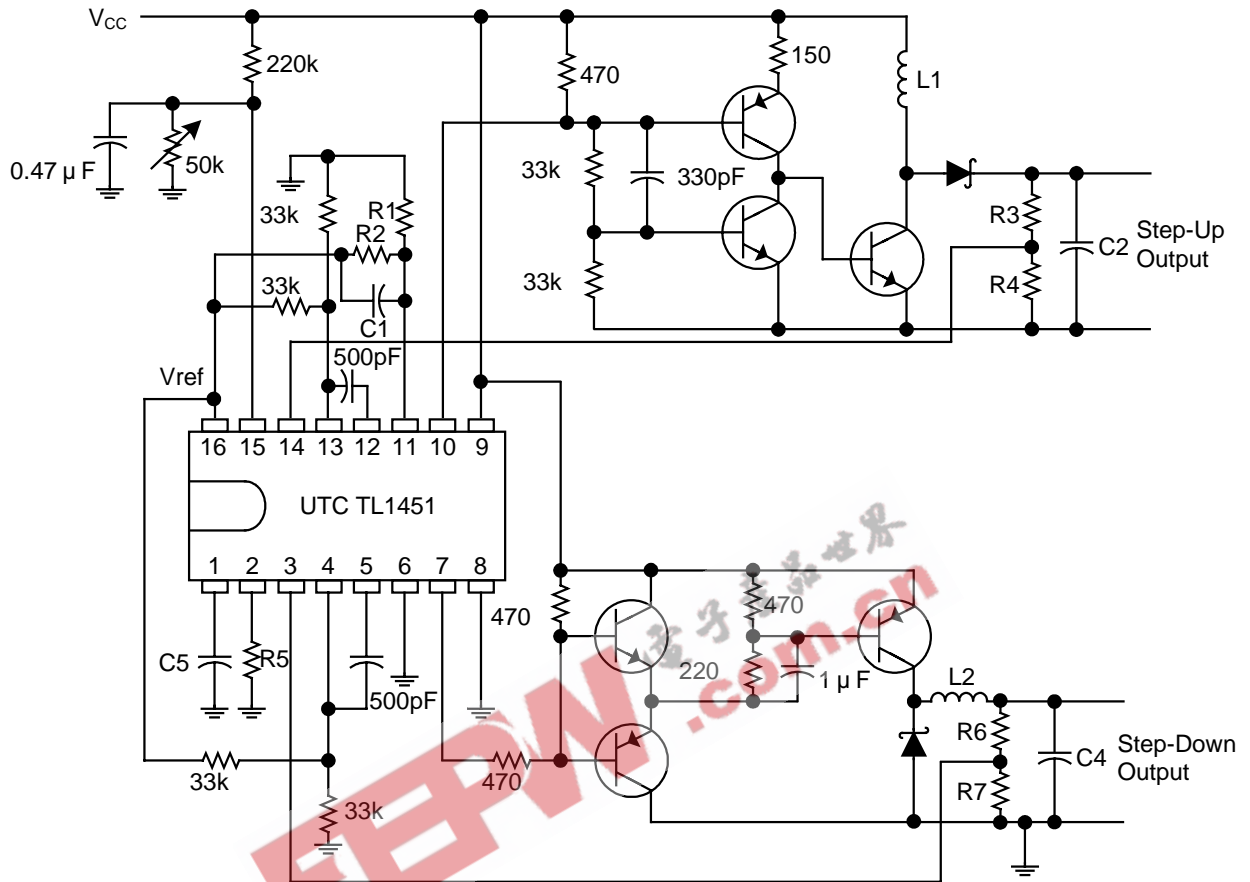
### ■ TIMING DIAGRAM



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

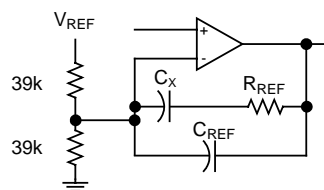
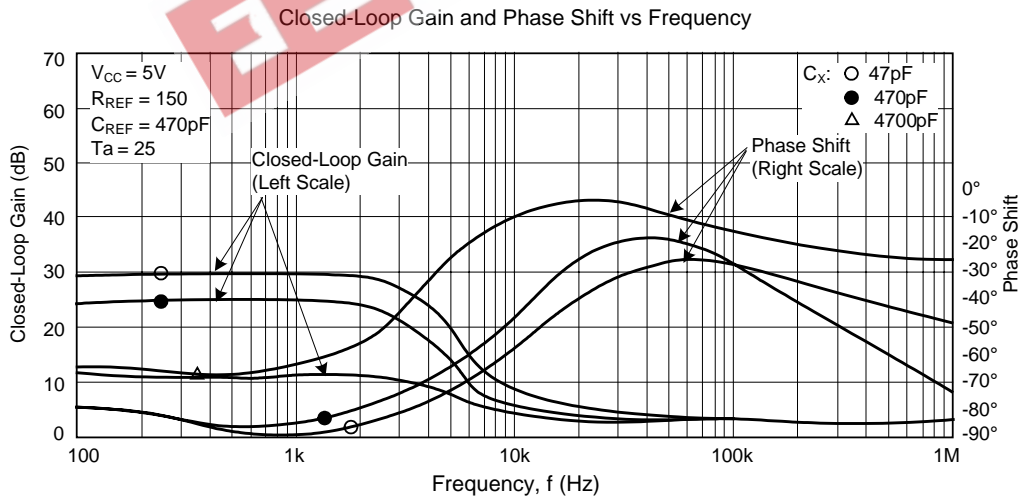
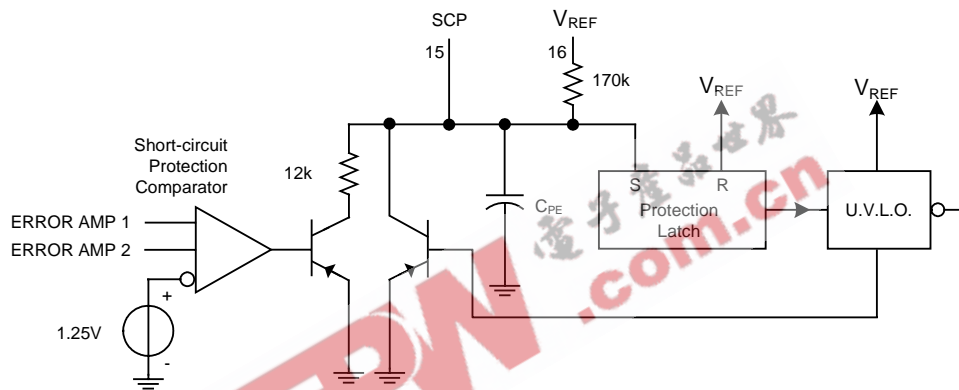
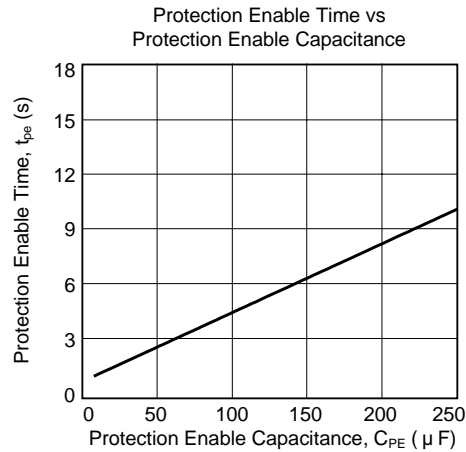
### APPLICATION INFORMATION

#### HIGH-SPEED DUAL SWITCHING REGULATOR



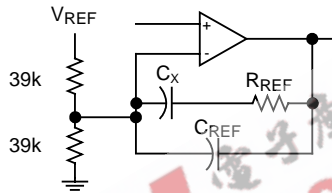
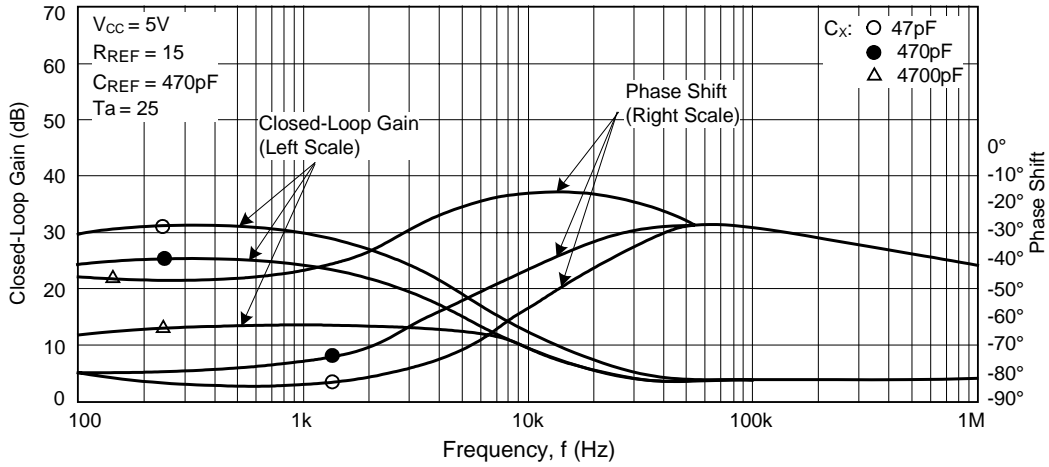
NOTE A: Values for R1 through R7, C1 through C4, and L1 and L2 depend upon individual application.

## ■ TYPICAL CHARACTERISTICS

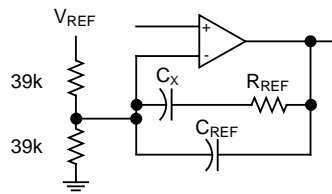
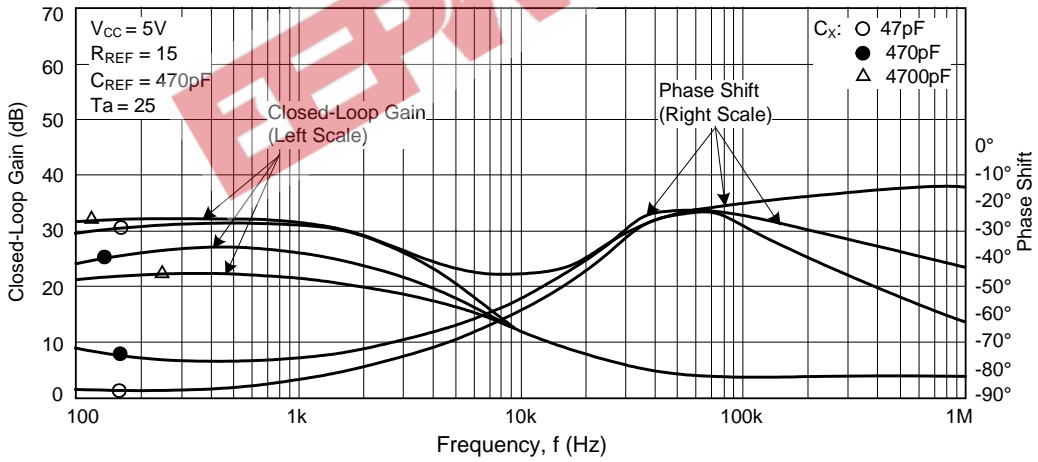


■ TYPICAL CHARACTERISTICS(cont.)

Closed-Loop Gain and Phase Shift vs Frequency



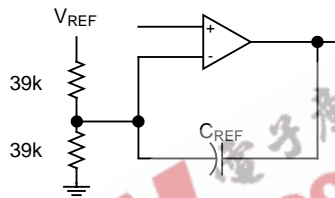
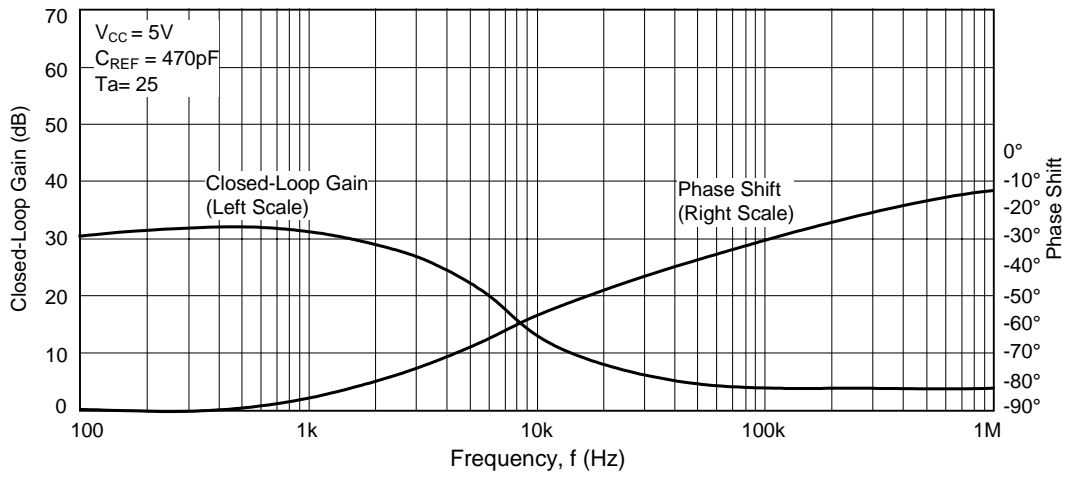
Closed-Loop Gain and Phase Shift vs Frequency





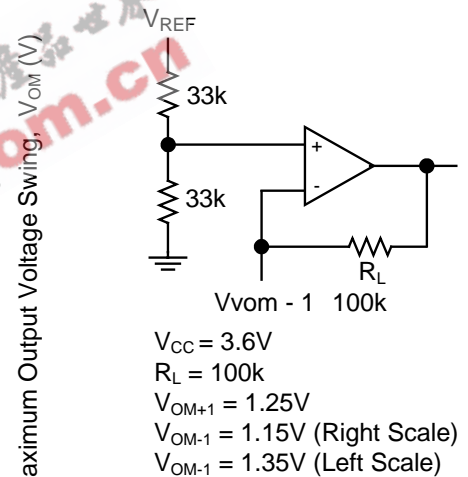
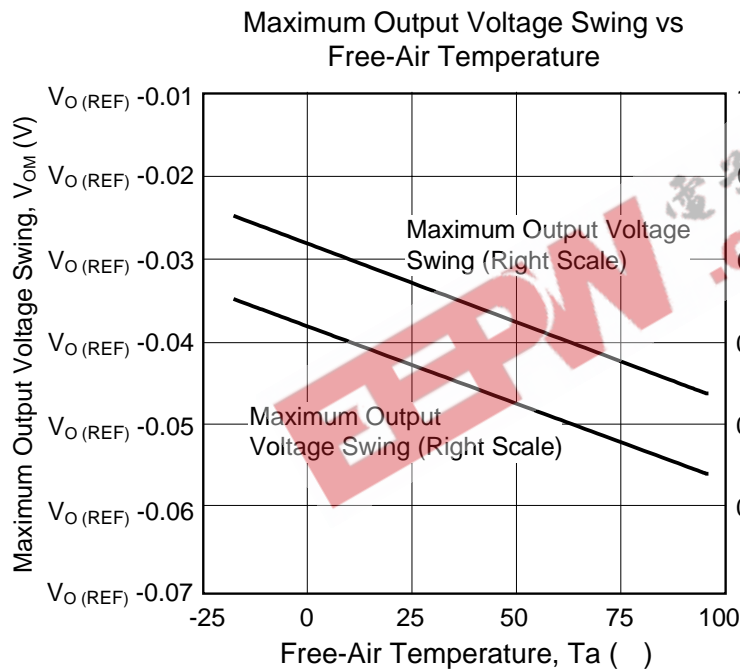
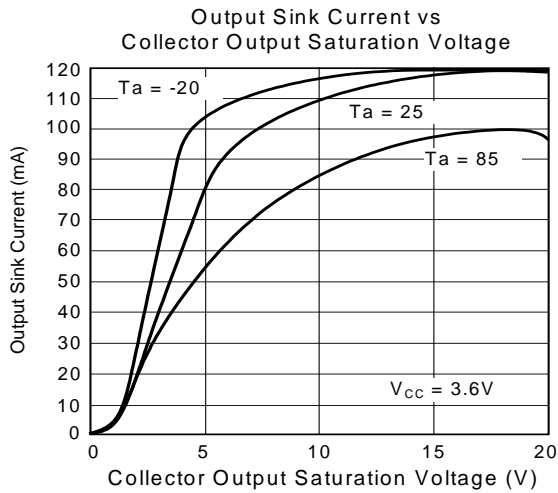
■ TYPICAL CHARACTERISTICS(Cont.)

Closed-Loop Gain and Phase Shift vs Frequency

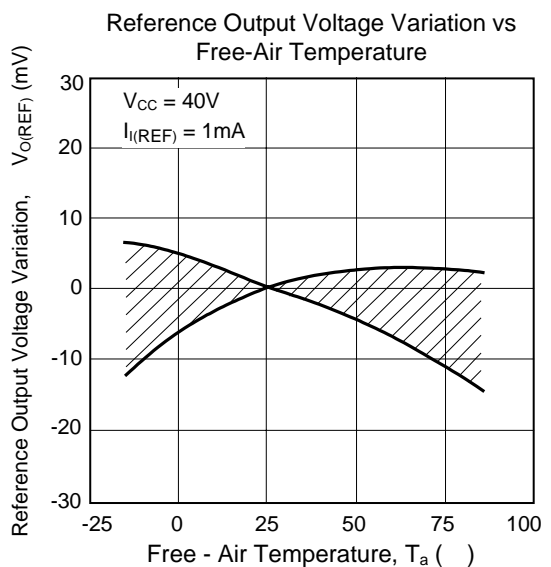
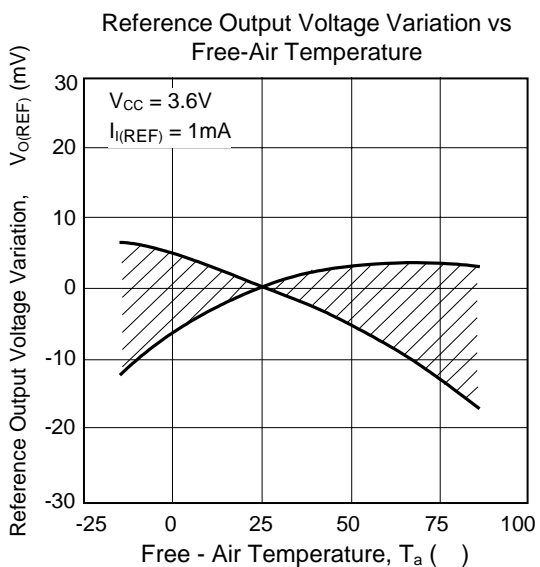
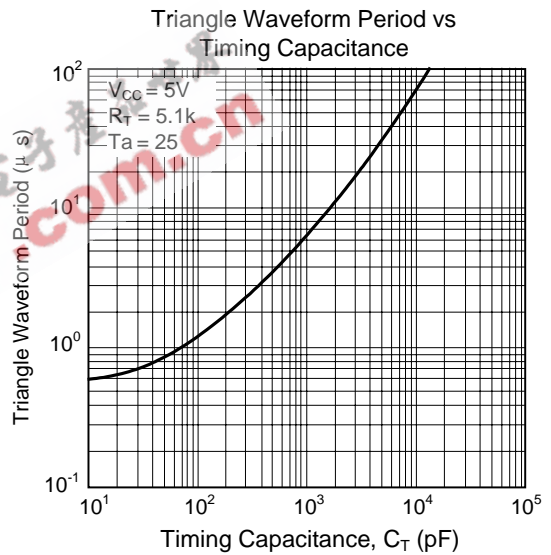
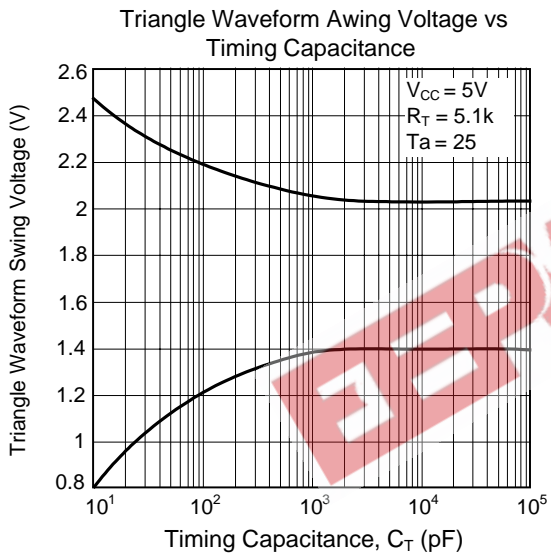
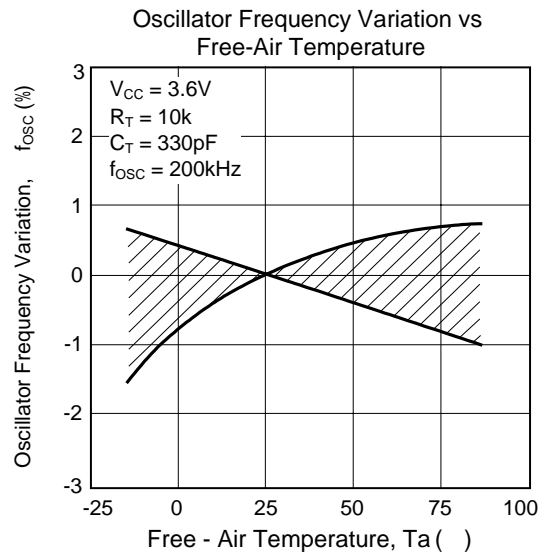
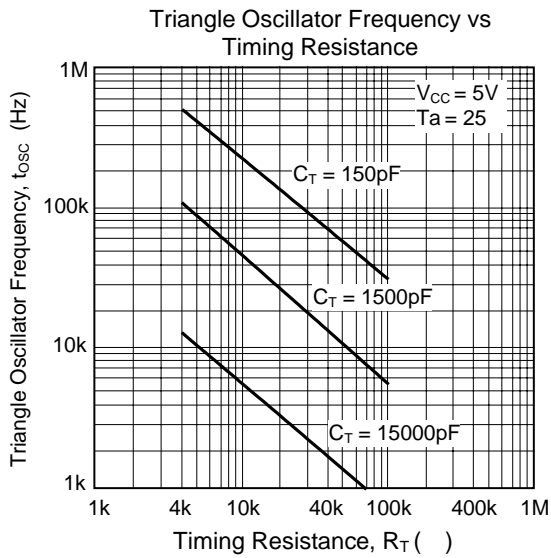


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### ■ TYPICAL CHARACTERISTICS(Cont.)

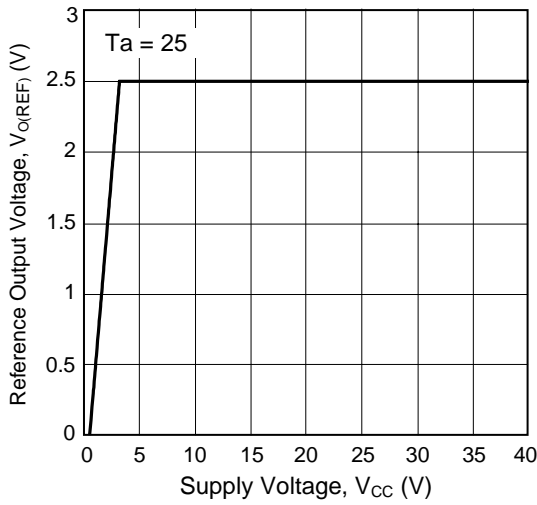


■ TYPICAL CHARACTERISTICS

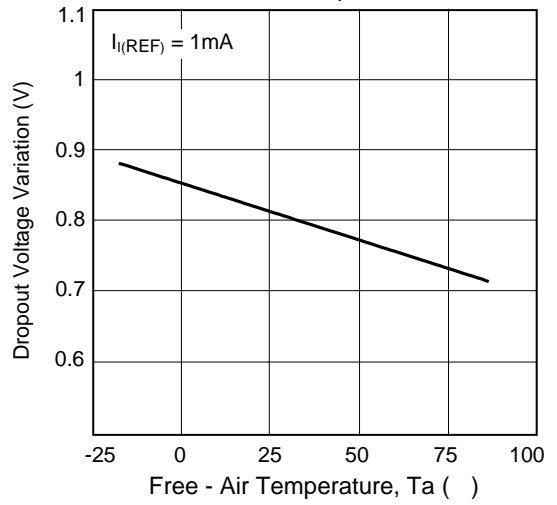


■ TYPICAL CHARACTERISTICS(Cont.)

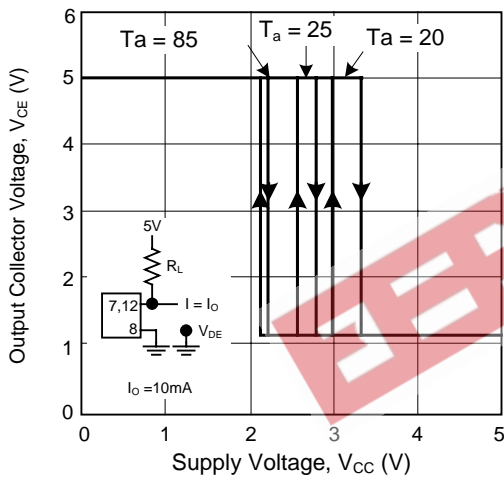
Reference Output Voltage vs Supply Voltage



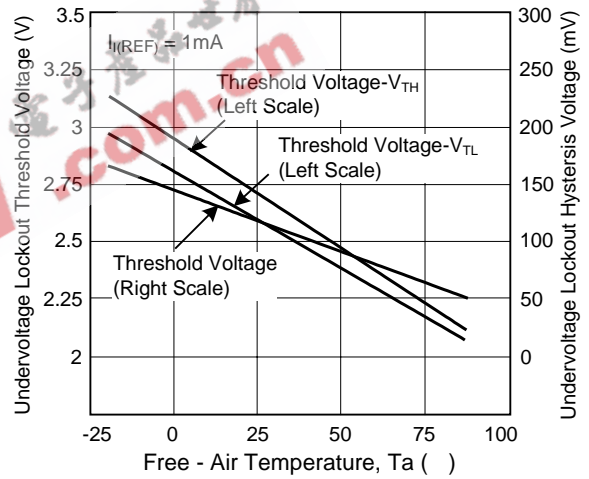
Dropout Voltage Variation vs Free-Air Temperature



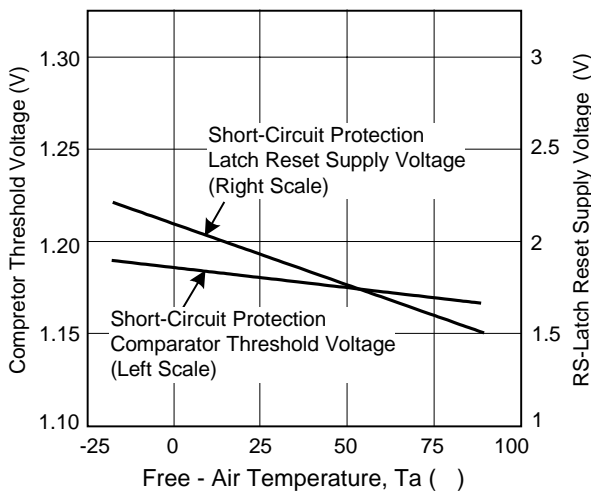
Undervoltage Lockout Hysteresis Characteristics



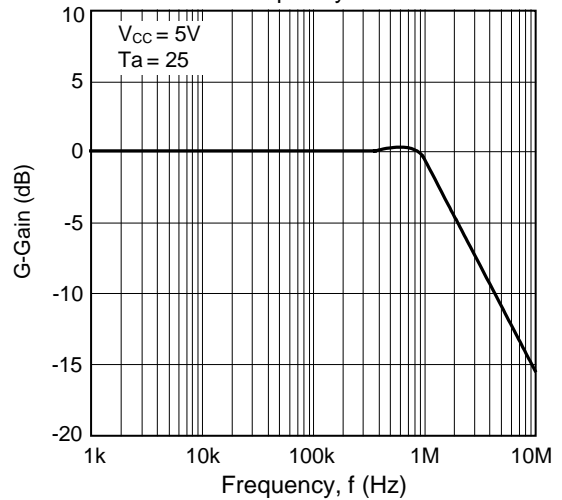
Undervoltage Lockout Characteristics



Short-Circuit Protection Characteristics

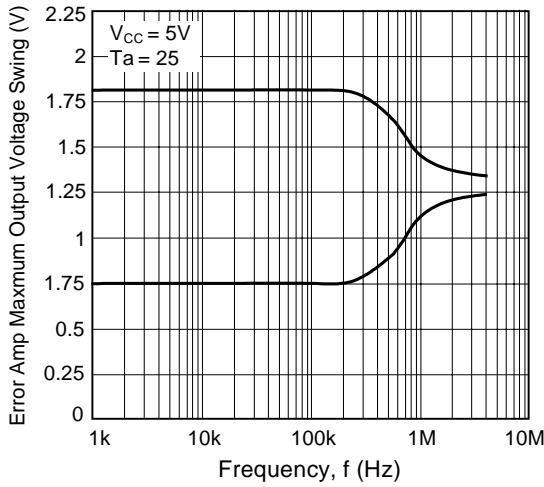


Gain (Amplifier In Unity-Gain Configuration) vs Frequency

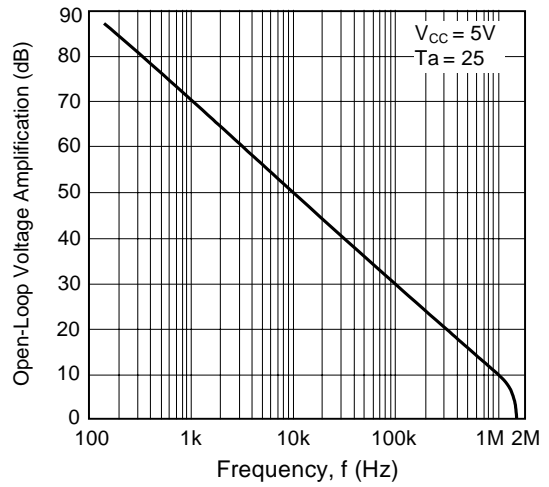


## TYPICAL CHARACTERISTICS(Cont.)

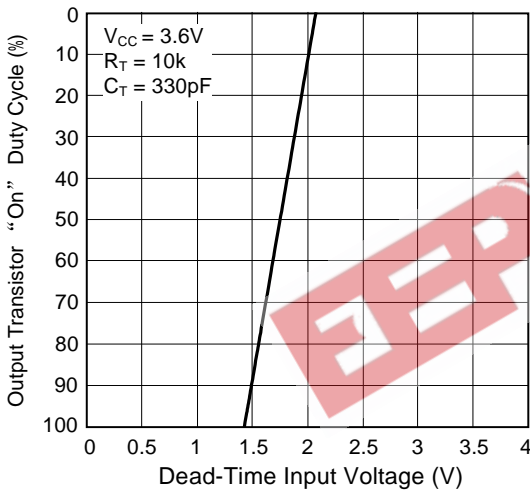
Error Amp Maximum Output Voltage Swing vs Frequency



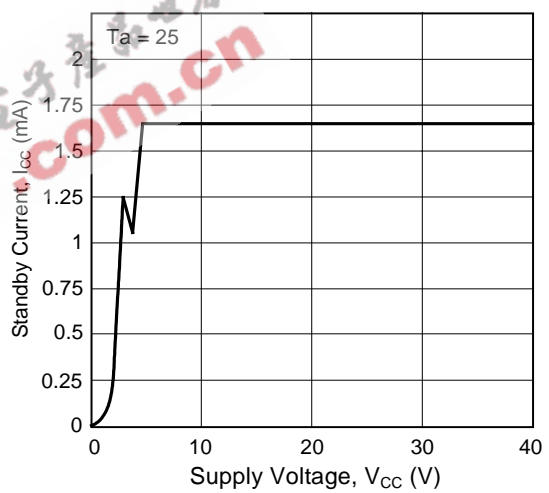
Open-Loop Voltage Amplification vs Frequency



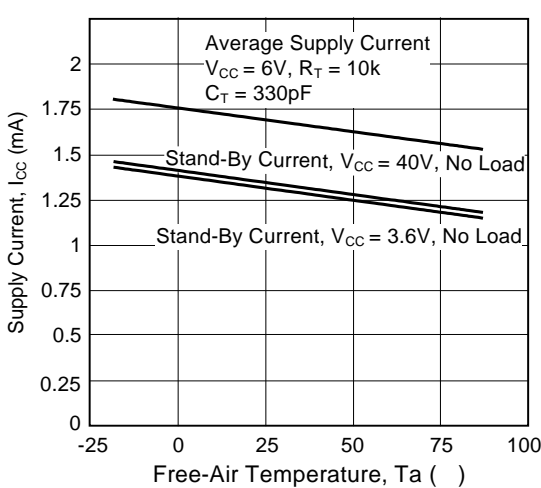
Output Transistor on Duty Cycle vs Dead-Time Input Voltage



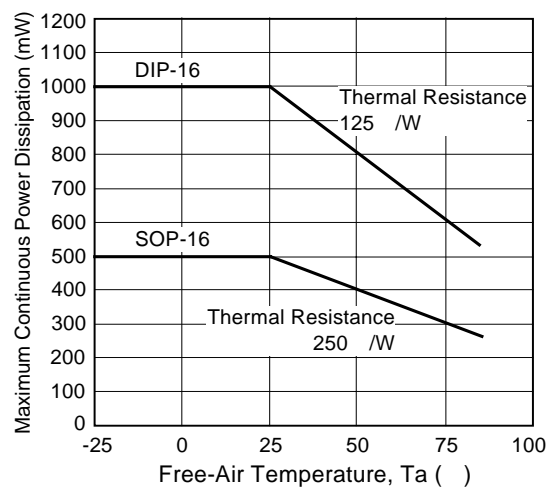
Standby Current vs Supply Voltage



Standby Current vs Free-Air Temperature



Maximum Continuous Power Dissipation vs Free-Air Temperature



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