



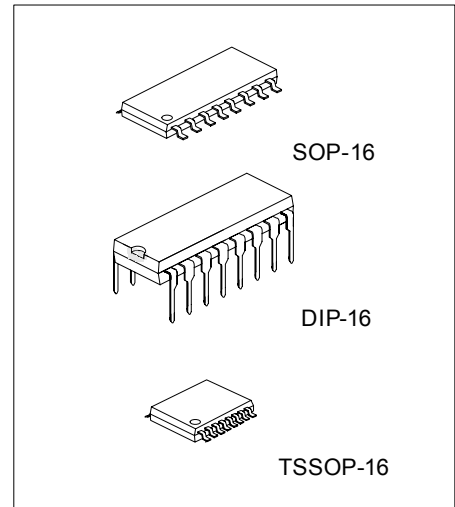
## TL594

## LINEAR INTEGRATED CIRCUIT

### PULSE-WIDTH-MODULATION CONTROL CIRCUIT

#### DESCRIPTION

The UTC **TL594** incorporates all the functions required for a pulse-width-modulation (PWM) control circuit. It is pin compatible with TL494 with upgrade performance.



\*Pb-free plating product number: TL594L

#### FEATURES

- \* Outputs for 200-mA Sink or Source Current
- \* Output is Single-Ended or Push-Pull Operation Selectable suppression circuit
- \* Internal Circuitry Prohibits Double Pulse at Either Output
- \* Variable Dead Time
- \* Internal Reference Supply Deliever 5V within 1% tolerance
- \* Undervoltage Lockout for Low-V<sub>CC</sub> Conditions

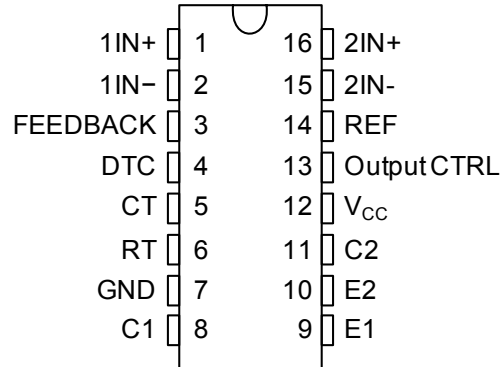
#### ORDERING INFORMATION

Order Number		Package	Packing
Normal	Lead Free Plating		
TL594-D16-T	TL594L-D16-T	DIP-16	Tube
TL594-P16-R	TL594L-P16-R	TSSOP-16	Tape Reel
TL594-P16-T	TL594L-P16-T	TSSOP-16	Tube
TL594-S16-R	TL594L-S16-R	SOP-16	Tape Reel
TL594-S16-T	TL594L-S16-T	SOP-16	Tube

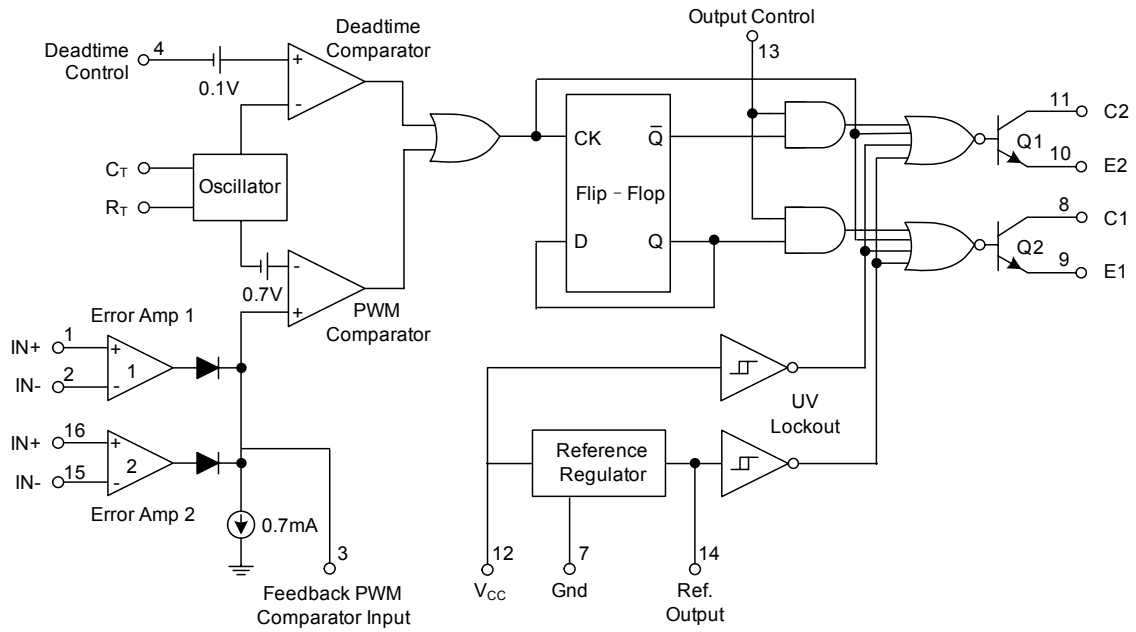
<p>TL594L-D16-T</p> <p>(1)Packing Type (2)Package Type (3)Lead Plating</p>	<p>(1) R: Tape Reel, T: Tube (2) D16: DIP-16, S16: SOP-16, P16: TSSOP-16 (3) L: Lead Free Plating, Blank: Pb/Sn</p>
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### ■ PIN CONFIGURATION

DIP-16/SOP-16/TSSOP-16 PACKAGE  
(TOP VIEW)



## FUNCTIONAL BLOCK DIAGRAM



### ■ ABSOLUTE MAXIMUM RATINGS

(over operating free-air temperature range (unless otherwise noted)<sup>Note1</sup>)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	$V_{CC}$	41	V
Amplifier input voltage		$V_{CC} + 0.3$	V
Collector output voltage		41	V
Collector output current		250	mA
Operating Junction Temperature	$T_J$	+150	°C
Operating Free-Air Temperature	$T_A$	-40 ~ +85	°C
Storage Temperature	$T_{STG}$	-40 ~ 150	°C

Note 1. Stresses beyond “absolute maximum ratings” may cause permanent damage to the device. For reliability, considerations use 80% or below for application is recommended.

### ■ THERMAL DATA

PARAMETER	SYMBOL	RATINGS	UNIT
Package thermal impedance (see Notes 2 and 3)	DIP package	67	°C/W
	SOP package	64	
	TSSOP package	108	

Note 1. Maximum power dissipation is a function of  $T_J(\max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.

2. The package thermal impedance is calculated in accordance with JESD 51-7.

### ■ RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply voltage	$V_{CC}$	7	40	V
Amplifier input voltage	$V_I$	-0.3	$V_{CC}-2$	V
Collector output voltage	$V_O$		40	V
Collector output current (each transistor)			200	mA
Current into feedback terminal			0.3	mA
Timing capacitor	$C_T$	0.47	10000	nF
Timing resistor	$R_T$	1.8	500	kΩ
Oscillator frequency	$f_{OSC}$	1	300	KHz
Operating free-air temperature	$T_A$	-40	85	°C

### ■ FUNCTION TABLE

INPUT	OUTPUT FUNCTION
Output CTRL	
$V_I = 0$	Single-ended or parallel output
$V_I = V_{REF}$	Normal push-pull operation

## ■ ELECTRICAL CHARACTERISTICS

(Testing conditions is set at  $V_{CC}=15V$ ,  $25^{\circ}C$  unless otherwise specified)

### reference section

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage (REF)	$V_{REF}$	$I_{OUT} = 1mA$ , $T_a = 25^{\circ}C$	4.95	5	5.05	V
Input regulation	$V_{IN}$	$V_{CC} = 7V \sim 40V$ , $T_a = 25^{\circ}C$		2	25	mV
Output regulation	$V_{OUT}$	$I_{OUT} = 1 \sim 10mA$ , $T_a = 25^{\circ}C$		14	35	mV
Output-voltage change with temperature		$\Delta T_A = MIN \sim MAX$		2	10	mV/V
Short-circuit output current (Note1)		$V_{REF} = 0$	10	35	50	mA

### amplifier section (see Figure 1)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input offset voltage, error amplifier	$V_{I(OFF)}$	FEEDBACK = 2.5V		2	10	mV
Input offset current	$I_{I(OFF)}$	FEEDBACK = 2.5V		25	250	nA
Input bias current	$I_{I(BIAS)}$	FEEDBACK = 2.5V		0.2	1	$\mu A$
Common-mode input voltage range, error amplifier		$V_{CC}=7V \sim 40V$	0.3 to $V_{CC}-2$			V
Open-loop voltage amplification, error amplifier		$\Delta V_{OUT}=3V$ , $R_L = 2k\Omega$ , $V_{OUT} = 0.5V \sim 3.5V$	70	95		dB
Unity-gain bandwidth	$B_W$	$V_{OUT} = 0.5V \sim 3.5V$ , $R_L = 2k\Omega$		800		kHz
Common-mode rejection ratio, error amplifier		$V_{CC} = 40V$ , $T_A = 25^{\circ}C$	65	80		dB
Output sink current, FEEDBACK	$I_{O(SINK)}$	$V_{ID} = -15mV \sim -5V$ , FEEDBACK = 0.5V	0.3	0.7		mA
Output source current, FEEDBACK	$I_{O(SOURCE)}$	$V_{ID} = 15mV \sim 5V$ , FEEDBACK = 3.5V	-2			mA

### oscillator section, $C_T = 0.01\mu F$ , $R_T = 12k\Omega$ (see Figure 2)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Frequency	F			10		kHz
Standard deviation of frequency <sup>(Note1)</sup>		All values of $V_{CC}$ , $C_T$ , $R_T$ , and $T_A$ constant		100		Hz/kHz
Frequency change with voltage		$V_{CC} = 7V \sim 40V$ , $T_A = 25^{\circ}C$		1		Hz/kHz
Frequency change with temperature		$\Delta T_A = MIN \sim MAX$			50	Hz/kHz

Note 1. Standard deviation is a measure of the statistical distribution about the mean, as derived from the formula:

$$\sigma = \sqrt{\frac{\sum_{n=1}^N (x_n - \bar{x})^2}{N - 1}}$$

### dead-time control section (see Figure 2)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input bias current	$I_{I(BIAS)}$	$V_I = 0 \sim 5.25V$		-2	-10	$\mu A$
Maximum duty cycle, each output		DTC = 0V	0.45			
Input threshold voltage	$V_{I(THD)}$	Zero duty cycle		3	3.3	V
		Maximum duty cycle	0			

## ■ ELECTRICAL CHARACTERISTICS(Cont.)

### output section

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Collector off-state current	$I_{C(OFF)}$	$V_C = 40V, V_E = 0V, V_{CC} = 40V$		2	100	$\mu A$
		DTC and Output CTRL = 0V, $V_C = 15V, V_E = 0V, V_{CC} = 1 \sim 3V$		4	200	
Emitter off-state current	$I_{E(OFF)}$	$V_{CC} = V_C = 40V, V_E = 0$			-100	$\mu A$
Collector-emitter saturation voltage	Common emitter	$V_{CE}$		1.1	1.3	V
	Emitter follower			1.5	2.5	
Output control input current		$V_I = V_{REF}$			3.5	mA

### pwm comparator section (see Figure 2)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input threshold voltage, FEEDBACK	$V_{I(THD)}$	Zero duty cycle		4	4.5	V
Input sink current, FEEDBACK	$I_{I(SINK)}$	FEEDBACK = 0.5V	0.3	0.7		mA

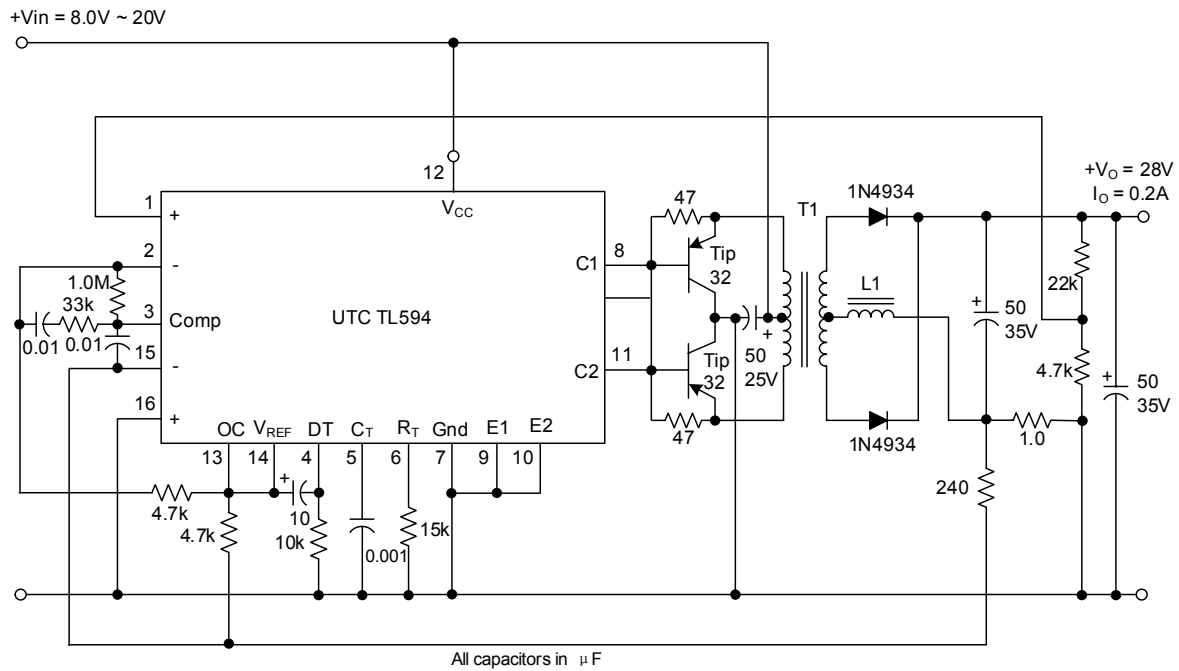
### undervoltage lockout section (see Figure 2)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
Threshold voltage	$V_{THD}$	$T_A = 25^\circ C$			6	V	
		$\Delta T_A = MIN \sim MAX$	3.5		6.9		
Hysteresis	$V_{HYS}$		100			mV	
Standby supply current	$I_{ST-BY}$	$R_T$ at $V_{REF}$ All other inputs and outputs open	$V_{CC} = 15V$		9	15	mA
			$V_{CC} = 40V$		11	18	
Average supply current		DTC = 2V, See Figure 2		12.4		mA	

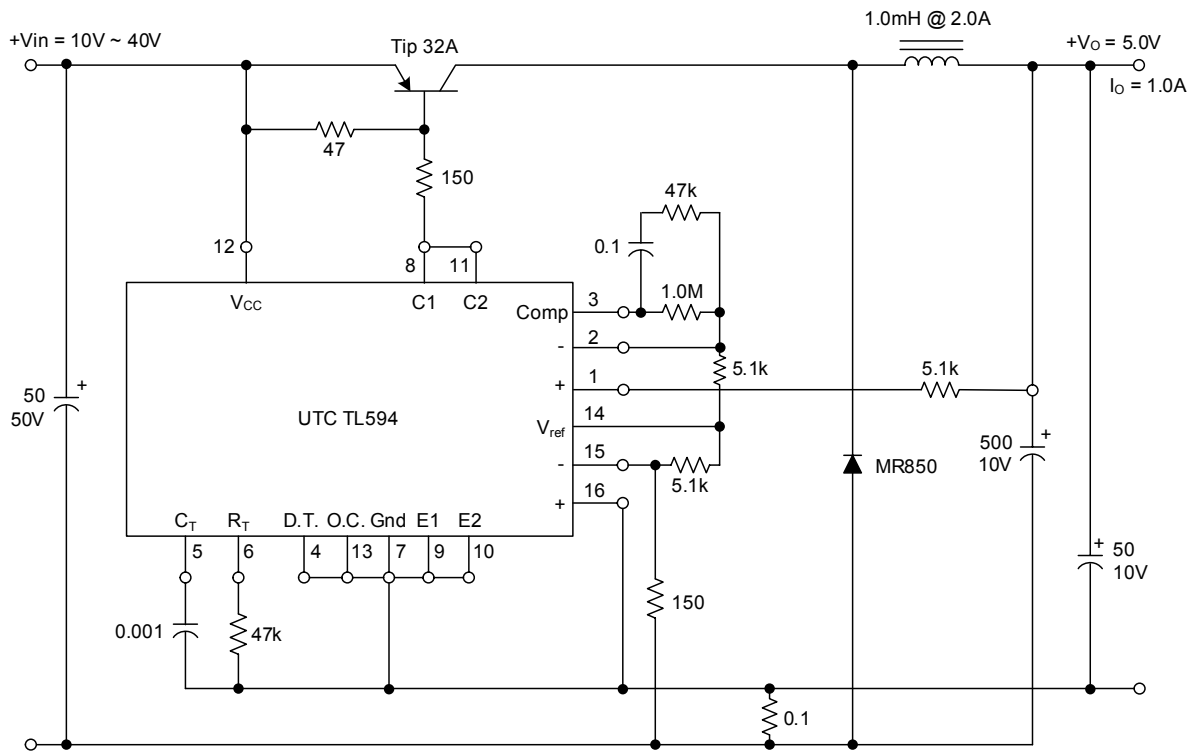
### switching characteristics, $T_A = 25^\circ C$

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output-voltage rise time	$T_R$	Common-emitter configuration (see Figure 3)		100	200	ns
Output-voltage fall time	$T_F$				30	100
Output-voltage rise time	$T_R$	Emitter-follower configuration (see Figure 4)		200	400	ns
Output-voltage fall time	$T_F$				45	100

## TYPICAL APPLICATIONS INFORMATION

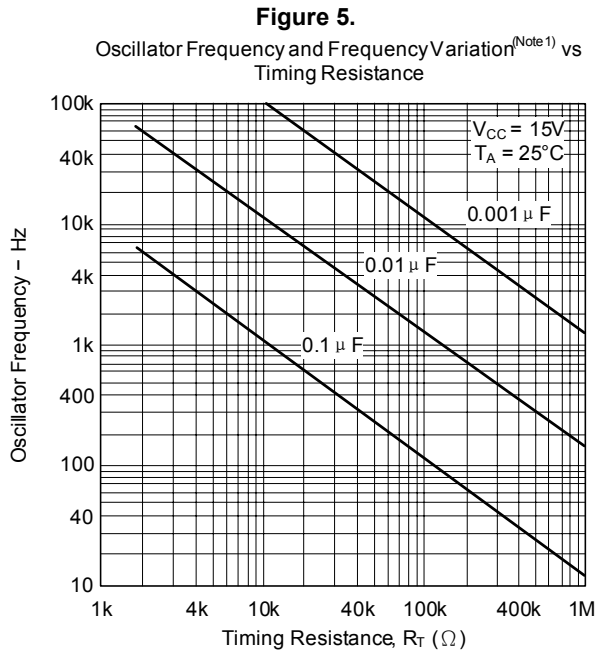


Push-Pull Operation

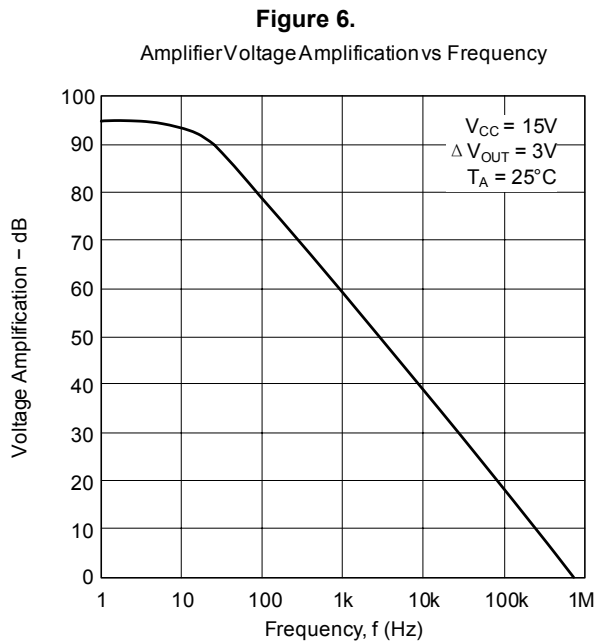


Single-Ended Operation

■ TYPICAL CHARACTERISTICS



Note 1. Frequency variation ( $\Delta f$ ) is the change in oscillator frequency that occurs over the full temperature range.



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