TL594

Precision Switchmode Pulse Width Modulation Control Circuit

The TL594 is a fixed frequency, pulse width modulation control circuit designed primarily for Switchmode power supply control.

Features

- Complete Pulse Width Modulation Control Circuitry
- On−Chip Oscillator with Master or Slave Operation
- On−Chip Error Amplifiers
- On−Chip 5.0 V Reference, 1.5% Accuracy
- Adjustable Deadtime Control
- Uncommitted Output Transistors Rated to 500 mA Source or Sink
- Output Control for Push−Pull or Single−Ended Operation
- Undervoltage Lockout
- Pb−Free Packages are Available*

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	42	V
Collector Output Voltage	V_{C1}, V_{C2}	42	V
Collector Output Current (Each Transistor) (Note 1)	I_{C1}, I_{C2}	500	mA
Amplifier Input Voltage Range	V_{IR}	−0.3 to +42	V
Power Dissipation @ $T_A \leq 45°C$	P_D	1000	mW
Thermal Resistance Junction−to−Ambient (PDIP) Junction−to−Air (TSSOP) Junction−to−Ambient (SOIC)	$R_{\theta JA}$	80 140 135	°C/W
Operating Junction Temperature	T_J	125	°C
Storage Temperature Range	T_{stg}	−55 to +125	°C
Operating Ambient Temperature Range TL594CD, CN, CDTB	T_A	−40 to 85	°C
Derating Ambient Temperature	T_A	45	°C

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.
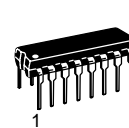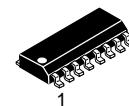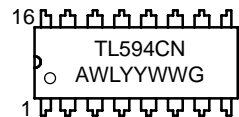1. Maximum thermal limits must be observed.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ON Semiconductor®

http://onsemi.com

PIN CONNECTIONS

Noninv Input	1
Inv Input	2
Compen/PWN Comp Input	3
Deadtime Control	4
C_T	5
R_T	6
Ground	7
C1	8

(Top View)

TL594
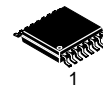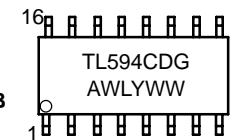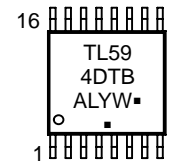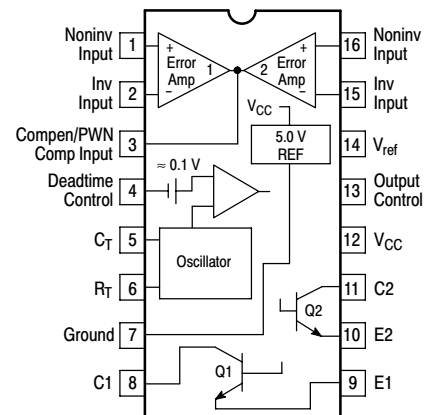
RECOMMENDED OPERATING CONDITIONS

Characteristics	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{CC}	7.0	15	40	V
Collector Output Voltage	V_{C1}, V_{C2}	–	30	40	V
Collector Output Current (Each transistor)	I_{C1}, I_{C2}	–	–	200	mA
Amplified Input Voltage	V_{in}	0.3	–	V_{CC} – 2.0	V
Current Into Feedback Terminal	I_{fb}	–	–	0.3	mA
Reference Output Current	I_{ref}	–	–	10	mA
Timing Resistor	R_T	1.8	30	500	kΩ
Timing Capacitor	C_T	0.0047	0.001	10	μF
Oscillator Frequency	f_{osc}	1.0	40	300	kHz
PWM Input Voltage (Pins 3, 4, 13)	–	0.3	–	5.3	V

ELECTRICAL CHARACTERISTICS (V_{CC} = 15 V, C_T = 0.01 μF, R_T = 12 kΩ, unless otherwise noted.)

For typical values T_A = 25°C, for min/max values T_A is the operating ambient temperature range that applies, unless otherwise noted.

Characteristics	Symbol	Min	Typ	Max	Unit
REFERENCE SECTION					
Reference Voltage (I_O = 1.0 mA, T_A = 25°C) (I_O = 1.0 mA)	V_{ref}	 4.925 4.9	 5.0 –	 5.075 5.1	V
Line Regulation (V_{CC} = 7.0 V to 40 V)	Reg_{line}	–	2.0	25	mV
Load Regulation (I_O = 1.0 mA to 10 mA)	Reg_{load}	–	2.0	15	mV
Short Circuit Output Current (V_{ref} = 0 V)	I_{SC}	15	40	75	mA
OUTPUT SECTION					
Collector Off–State Current (V_{CC} = 40 V, V_{CE} = 40 V)	$I_{C(off)}$	–	2.0	100	μA
Emitter Off–State Current (V_{CC} = 40 V, V_C = 40 V, V_E = 0 V)	$I_{E(off)}$	–	–	–100	μA
Collector–Emitter Saturation Voltage (Note 1) Common–Emitter (V_E = 0 V, I_C = 200 mA) Emitter–Follower (V_C = 15 V, I_E = –200 mA)	 $V_{SAT(C)}$ $V_{SAT(E)}$	 – –	 1.1 1.5	 1.3 2.5	V
Output Control Pin Current Low State (V_{OC} ≤ 0.4 V) High State (V_{OC} = V_{ref})	 I_{OCL} I_{OCH}	 – –	 0.1 2.0	 – 20	μA
Output Voltage Rise Time Common–Emitter (See Figure 13) Emitter–Follower (See Figure 14)	t_r	 – –	 100 100	 200 200	ns
Output Voltage Fall Time Common–Emitter (See Figure 13) Emitter–Follower (See Figure 14)	t_f	 – –	 40 40	 100 100	ns
ERROR AMPLIFIER SECTION					
Input Offset Voltage ($V_{O (Pin 3)}$ = 2.5 V)	V_{IO}	–	2.0	10	mV
Input Offset Current ($V_{O (Pin 3)}$ = 2.5 V)	I_{IO}	–	5.0	250	nA
Input Bias Current ($V_{O (Pin 3)}$ = 2.5 V)	I_{IB}	–	–0.1	–1.0	μA
Input Common Mode Voltage Range (V_{CC} = 40 V, T_A = 25°C)	V_{ICR}	0 to V_{CC}–2.0			V
Inverting Input Voltage Range	$V_{IR(INV)}$	–0.3 to V_{CC}–2.0			V
Open Loop Voltage Gain (ΔV_O = 3.0 V, V_O = 0.5 V to 3.5 V, R_L = 2.0 kΩ)	A_{VOL}	70	95	–	dB
Unity–Gain Crossover Frequency (V_O = 0.5 V to 3.5 V, R_L = 2.0 kΩ)	f_C	–	700	–	kHz
Phase Margin at Unity–Gain (V_O = 0.5 V to 3.5 V, R_L = 2.0 kΩ)	φm	–	65	–	deg.
Common Mode Rejection Ratio (V_{CC} = 40 V)	CMRR	65	90	–	dB
Power Supply Rejection Ratio (ΔV_{CC} = 33 V, V_O = 2.5 V, R_L = 2.0 kΩ)	PSRR	–	100	–	dB
Output Sink Current ($V_{O (Pin 3)}$ = 0.7 V)	I_O–	0.3	0.7	–	mA
Output Source Current ($V_{O (Pin 3)}$ = 3.5 V)	I_O+	–2.0	–4.0	–	mA

1. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

ELECTRICAL CHARACTERISTICS (V_{CC} = 15 V, C_T = 0.01 μF, R_T = 12 kΩ, unless otherwise noted.)

For typical values T_A = 25°C, for min/max values T_A is the operating ambient temperature range that applies, unless otherwise noted.

Characteristics	Symbol	Min	Typ	Max	Unit
PWM COMPARATOR SECTION (Test Circuit Figure 11)					
Input Threshold Voltage (Zero Duty Cycle)	V_{TH}	–	3.6	4.5	V
Input Sink Current ($V_{Pin\ 3}$ = 0.7 V)	I_{I-}	0.3	0.7	–	mA
DEADTIME CONTROL SECTION (Test Circuit Figure 11)					
Input Bias Current (Pin 4) ($V_{Pin\ 4}$ = 0 V to 5.25 V)	$I_{IB\ (DT)}$	–	−2.0	−10	μA
Maximum Duty Cycle, Each Output, Push–Pull Mode ($V_{Pin\ 4}$ = 0 V, C_T = 0.01 μF, R_T = 12 kΩ) ($V_{Pin\ 4}$ = 0 V, C_T = 0.001 μF, R_T = 30 kΩ)	DC_{max}	45 –	48 45	50 –	%
Input Threshold Voltage (Pin 4) (Zero Duty Cycle) (Maximum Duty Cycle)	V_{TH}	– 0	2.8 –	3.3 –	V
OSCILLATOR SECTION					
Frequency (C_T = 0.001 μF, R_T = 30 kΩ) (C_T = 0.01 μF, R_T = 12 kΩ, T_A = 25°C) (C_T = 0.01 μF, R_T = 12 kΩ, T_A = T_{low} to T_{high})	f_{osc}	– 9.2 9.0	40 10 –	– 10.8 12	kHz
Standard Deviation of Frequency* (C_T = 0.001 μF, R_T = 30 kΩ)	σf_{osc}	–	1.5	–	%
Frequency Change with Voltage (V_{CC} = 7.0 V to 40 V, T_A = 25°C)	$\Delta f_{osc}\ (\Delta V)$	–	0.2	1.0	%
Frequency Change with Temperature (ΔT_A = T_{low} to T_{high}, C_T = 0.01 μF, R_T = 12 kΩ)	$\Delta f_{osc}\ (\Delta T)$	–	4.0	–	%
UNDERVOLTAGE LOCKOUT SECTION					
Turn–On Threshold (V_{CC} Increasing, I_{ref} = 1.0 mA) T_A = 25°C T_A = T_{low} to T_{high}	V_{th}	4.0 3.5	5.2 –	6.0 6.5	V
Hysteresis TL594C,I TL594M	V_H	100 50	150 150	300 300	mV
TOTAL DEVICE					
Standby Supply Current (Pin 6 at V_{ref}, All other inputs and outputs open) (V_{CC} = 15 V) (V_{CC} = 40 V)	I_{CC}	– –	8.0 8.0	15 18	mA
Average Supply Current ($V_{Pin\ 4}$ = 2.0 V, C_T = 0.01 μF, R_T = 12 kΩ, V_{CC} = 15 V, See Figure 11)		–	11	–	mA

*Standard deviation is a measure of the statistical distribution about the mean as derived from the formula, $\sigma = \sqrt{\dfrac{\sum\limits_{n=1}^{N}(X_n - \overline{X})^2}{N - 1}}$

TL594
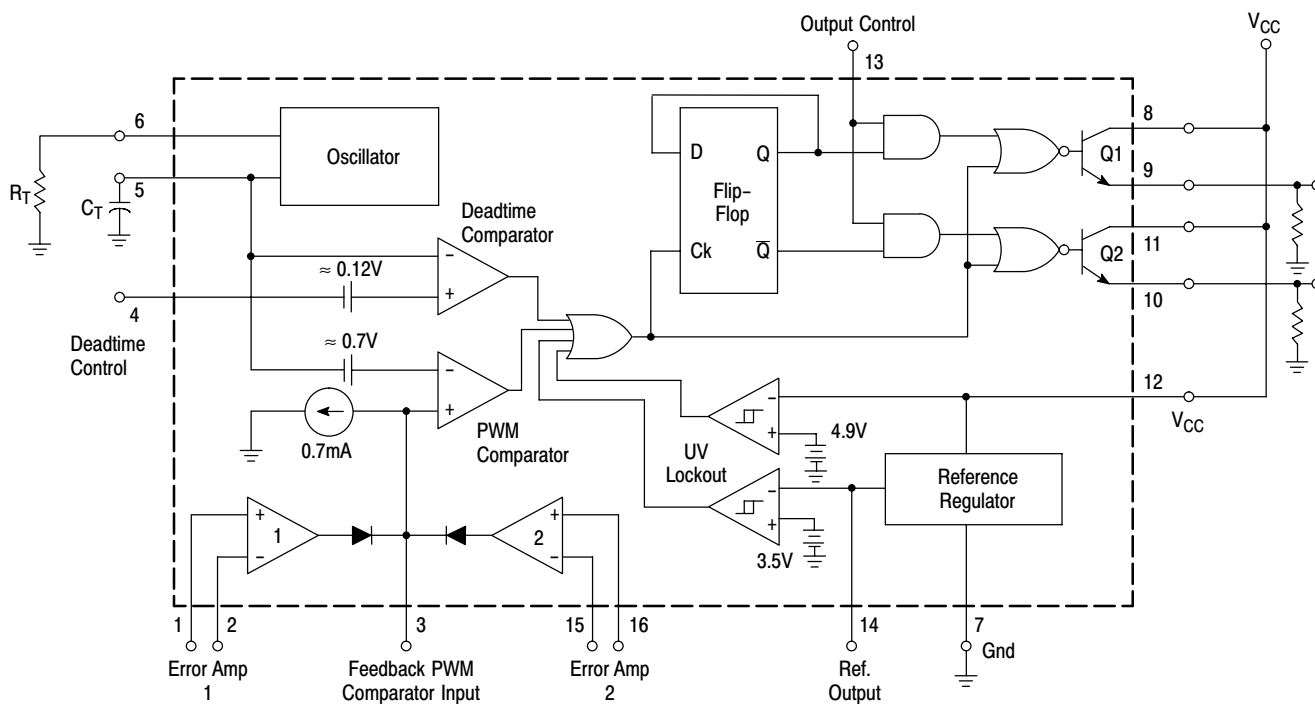
This device contains 46 active transistors.

Figure 1. Representative Block Diagram

Figure 2. Timing Diagram

TL594

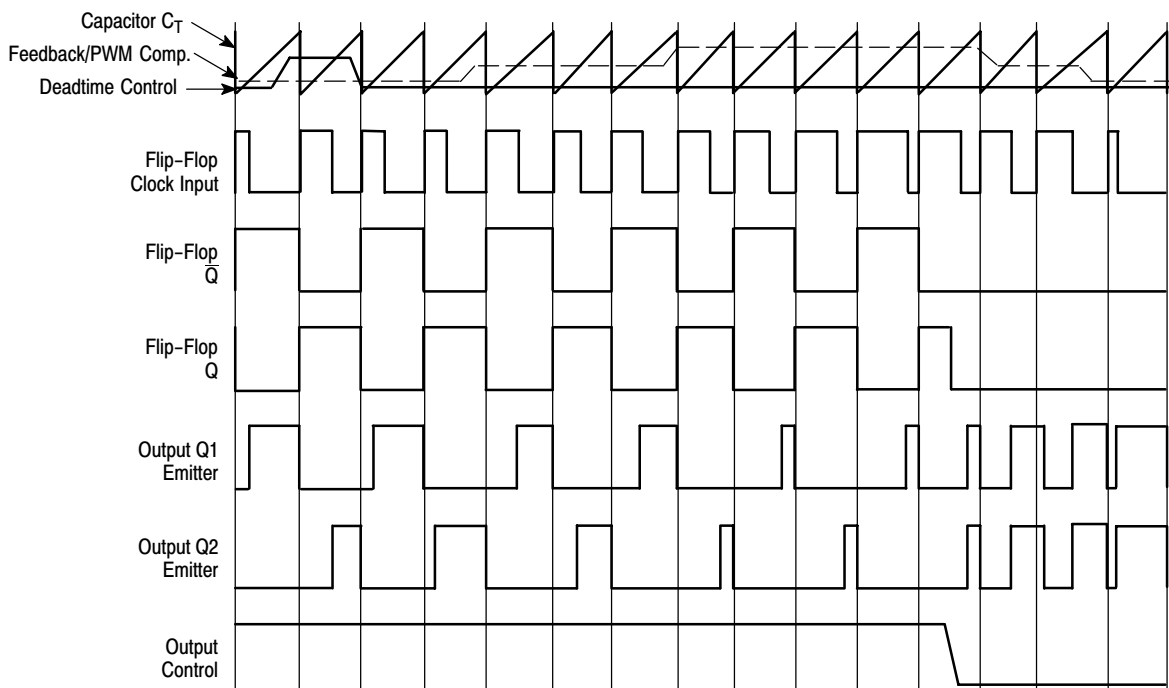## APPLICATIONS INFORMATION

Description

The TL594 is a fixed–frequency pulse width modulation control circuit, incorporating the primary building blocks required for the control of a switching power supply. (See Figure 1) An internal–linear sawtooth oscillator is frequency–programmable by two external components, R_T and C_T. The approximate oscillator frequency is determined by:

$$f_{osc} \approx \frac{1.1}{R_T \bullet C_T}$$

For more information refer to Figure 3.

Output pulse width modulation is accomplished by comparison of the positive sawtooth waveform across capacitor C_T to either of two control signals. The NOR gates, which drive output transistors Q1 and Q2, are enabled only when the flip–flop clock–input line is in its low state. This happens only during that portion of time when the sawtooth voltage is greater than the control signals. Therefore, an increase in control–signal amplitude causes a corresponding linear decrease of output pulse width. (Refer to the Timing Diagram shown in Figure 2.)

The control signals are external inputs that can be fed into the deadtime control, the error amplifier inputs, or the feedback input. The deadtime control comparator has an effective 120 mV input offset which limits the minimum output deadtime to approximately the first 4% of the sawtooth–cycle time. This would result in a maximum duty cycle on a given output of 96% with the output control grounded, and 48% with it connected to the reference line. Additional deadtime may be imposed on the output by setting the deadtime–control input to a fixed voltage, ranging between 0 V to 3.3 V.

The pulse width modulator comparator provides a means for the error amplifiers to adjust the output pulse width from the maximum percent on–time, established by the deadtime control input, down to zero, as the voltage at the feedback pin varies from 0.5 V to 3.5 V. Both error amplifiers have a common–mode input range from –0.3 V to (V_{CC} – 2 V), and may be used to sense power–supply output voltage and current. The error–amplifier outputs are active high and are ORed together at the noninverting input of the pulse–width modulator comparator. With this configuration, the amplifier that demands minimum output on time, dominates control of the loop.

Functional Table

Input/Output Controls	Output Function	$\frac{f_{out}}{f_{osc}} =$
Grounded	Single–ended PWM @ Q1 and Q2	1.0
@ V_{ref}	Push–pull Operation	0.5

When capacitor C_T is discharged, a positive pulse is generated on the output of the deadtime comparator, which clocks the pulse–steering flip–flop and inhibits the output transistors, Q1 and Q2. With the output–control connected to the reference line, the pulse–steering flip–flop directs the modulated pulses to each of the two output transistors alternately for push–pull operation. The output frequency is equal to half that of the oscillator. Output drive can also be taken from Q1 or Q2, when single–ended operation with a maximum on–time of less than 50% is required. This is desirable when the output transformer has a ringback winding with a catch diode used for snubbing. When higher output–drive currents are required for single–ended operation, Q1 and Q2 may be connected in parallel, and the output–mode pin must be tied to ground to disable the flip–flop. The output frequency will now be equal to that of the oscillator.

The TL594 has an internal 5.0 V reference capable of sourcing up to 10 mA of load current for external bias circuits. The reference has an internal accuracy of ±1.5% with a typical thermal drift of less than 50 mV over an operating temperature range of 0° to 70°C.

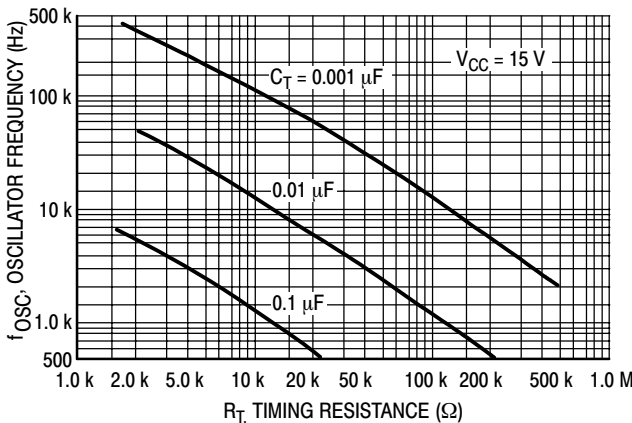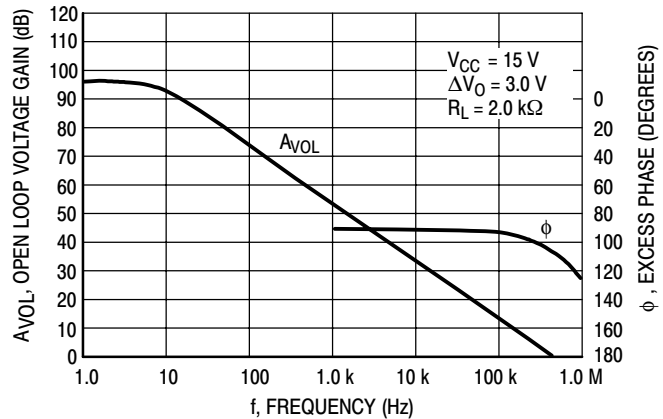**Figure 3. Oscillator Frequency versus Timing Resistance**

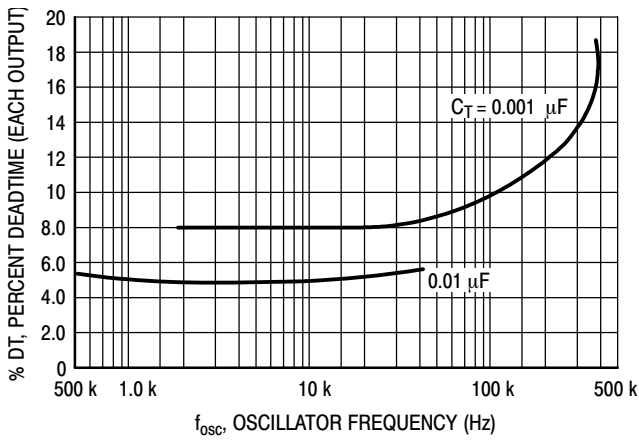**Figure 4. Open Loop Voltage Gain and Phase versus Frequency**

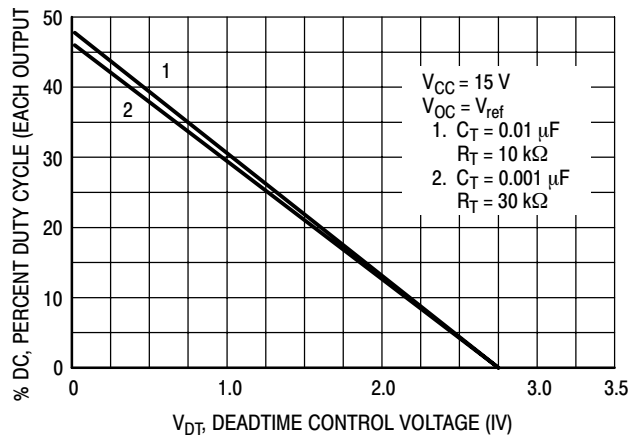**Figure 5. Percent Deadtime versus Oscillator Frequency**

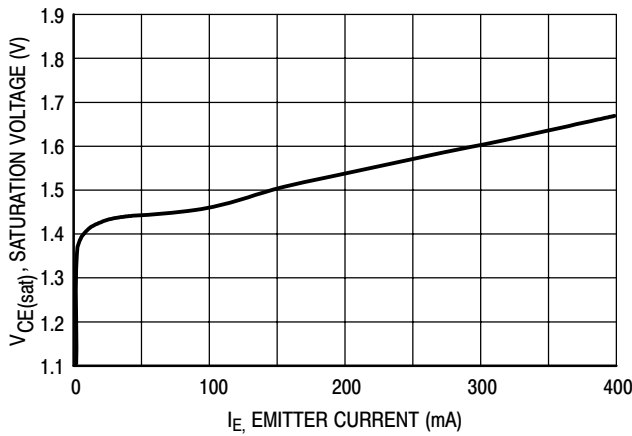**Figure 6. Percent Duty Cycle versus Deadtime Control Voltage**

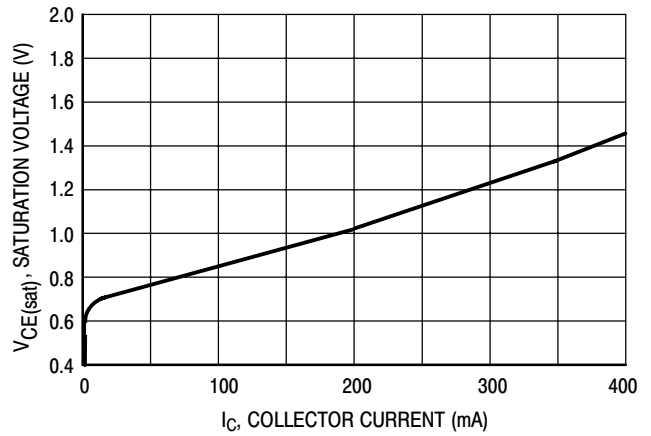**Figure 7. Emitter−Follower Configuration Output Saturation Voltage versus Emitter Current**

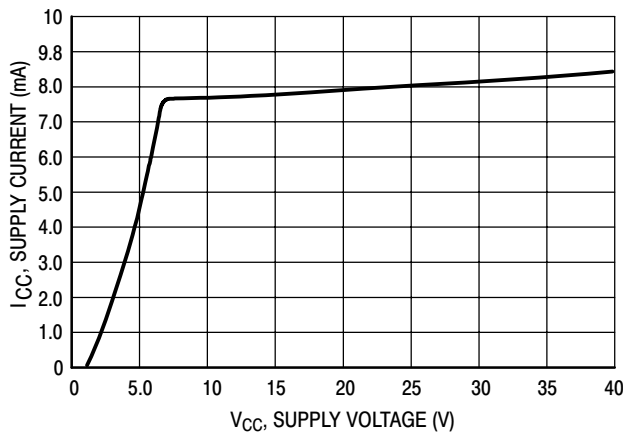**Figure 8. Common−Emitter Configuration Output Saturation Voltage versus Collector Current**
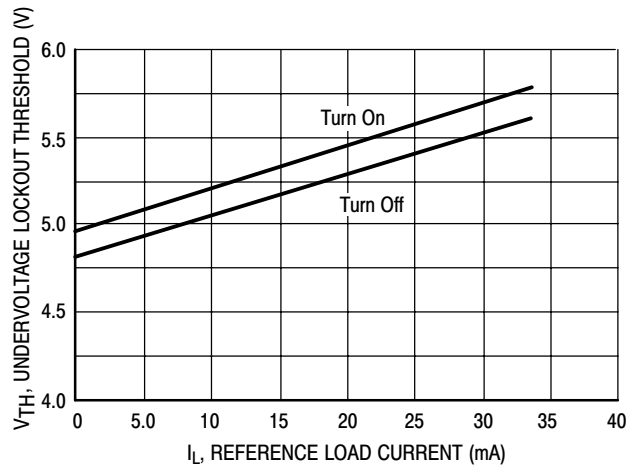

Figure 9. Standby Supply Current versus Supply Voltage

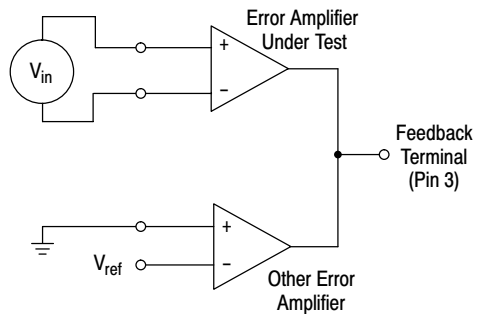**Figure 10. Undervoltage Lockout Thresholds versus Reference Load Current**

Figure 11. Error–Amplifier Characteristics
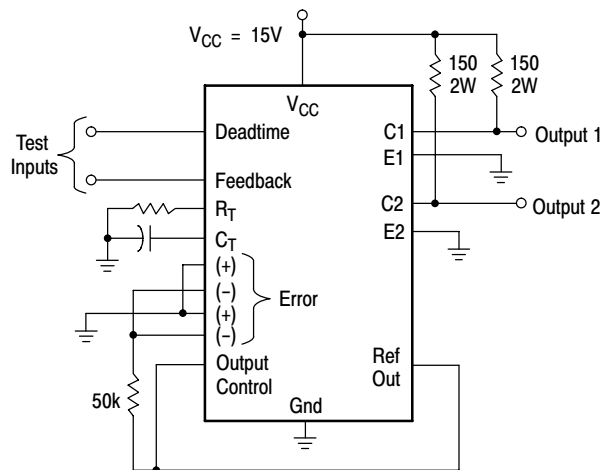
Figure 12. Deadtime and Feedback Control Circuit
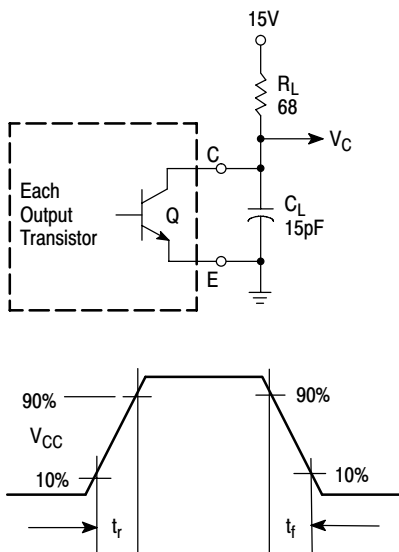
**Figure 13. Common–Emitter Configuration
Test Circuit and Waveform**
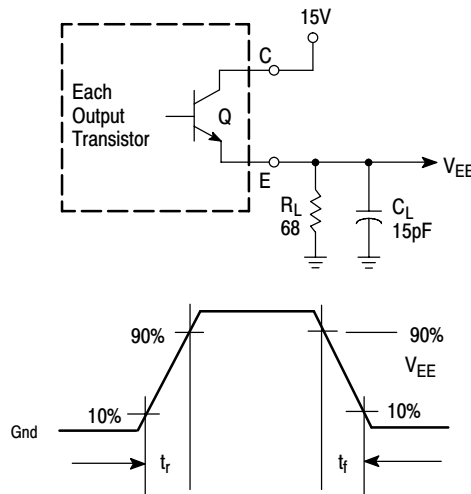
**Figure 14. Emitter–Follower Configuration
Test Circuit and Waveform**
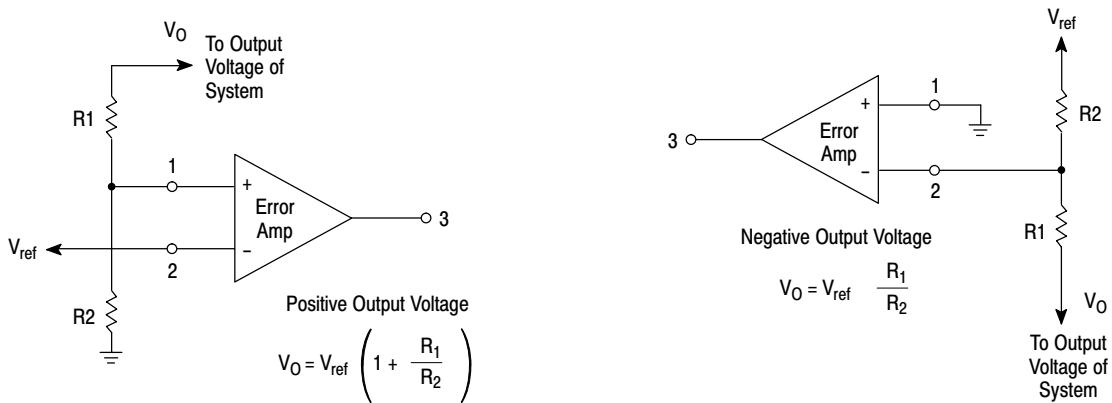
Figure 15. Error–Amplifier Sensing Techniques

For the positive output voltage circuit:

Positive Output Voltage

$$V_O = V_{ref} \left(1 + \frac{R_1}{R_2} \right)$$

For the negative output voltage circuit:

Negative Output Voltage

$$V_O = V_{ref} \quad \frac{R_1}{R_2}$$

Max. % on Time, each output $\approx 45 - \left(\dfrac{80}{1 + \dfrac{R1}{R2}} \right)$
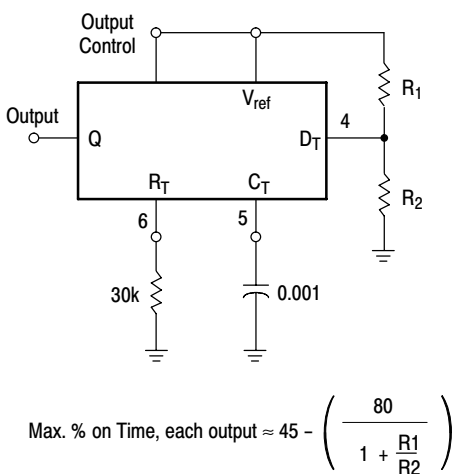
Figure 16. Deadtime Control Circuit
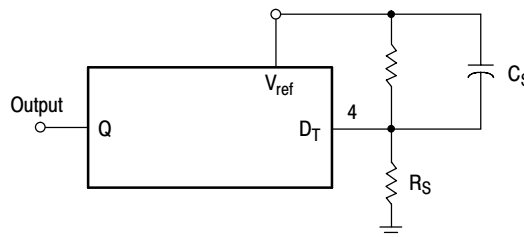
Figure 17. Soft–Start Circuit
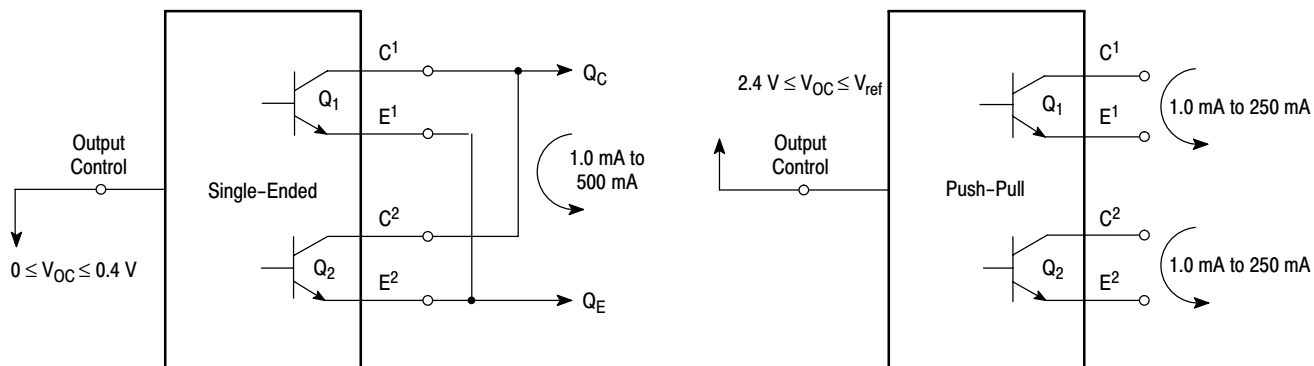
Figure 18. Output Connections for Single–Ended and Push–Pull Configurations
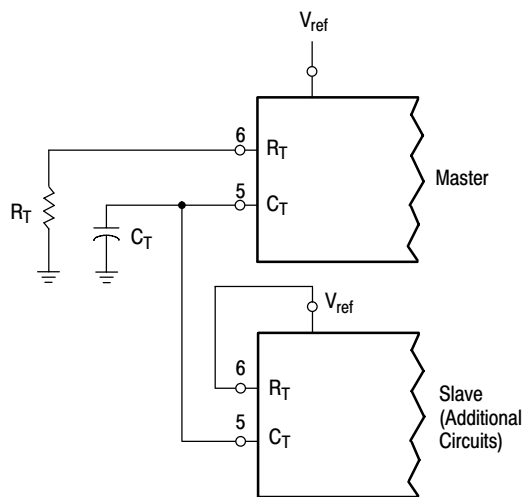
Figure 19. Slaving Two or More Control Circuits
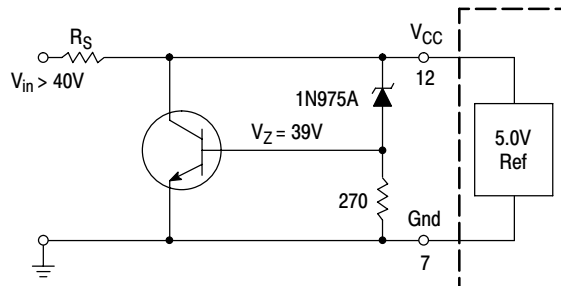
Figure 20. Operation with V_{in} > 40 V Using External Zener

All capacitors in μF
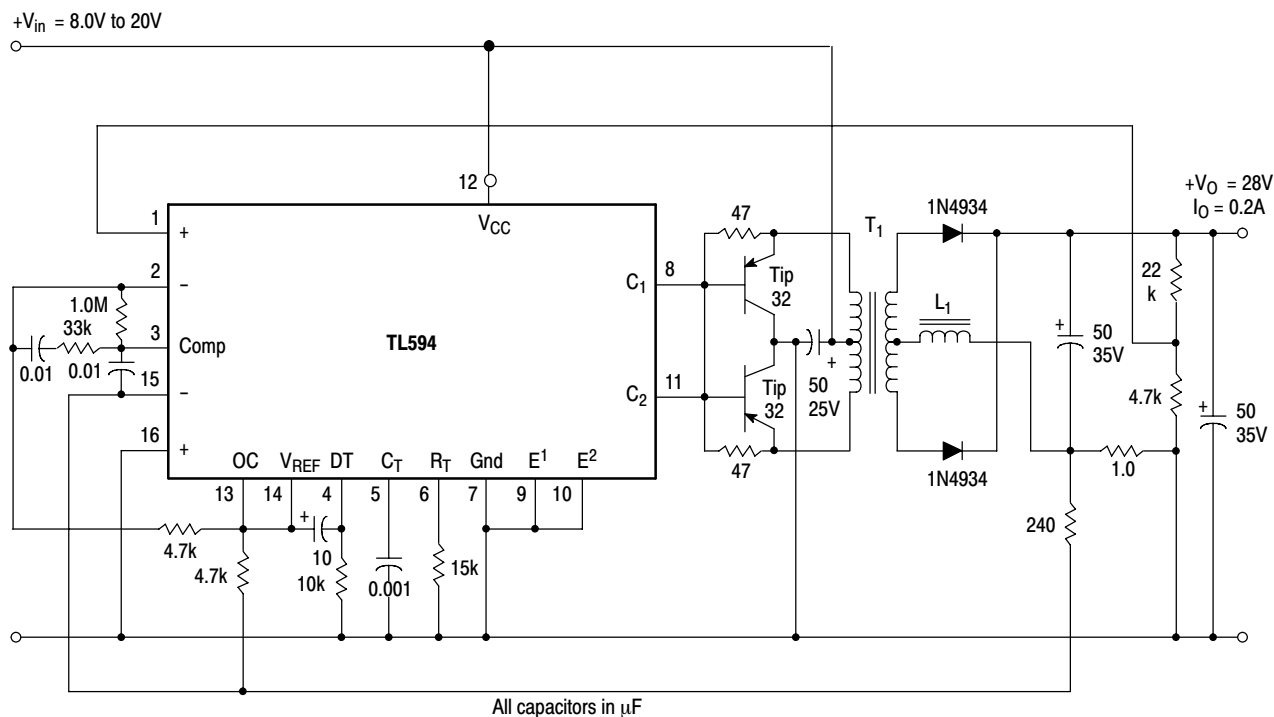
Figure 21. Pulse Width Modulated Push–Pull Converter

Test	Conditions	Results	
Line Regulation	V_{in} = 10 V to 40 V	14 mV 0.28%	L1 – 3.5 mH @ 0.3 A
Load Regulation	V_{in} = 28 V, I_O = 1.0 mA to 1.0 A	3.0 mV 0.06%	T1 – Primary: 20T C.T. #28 AWG
Output Ripple	V_{in} = 28 V, I_O = 1.0 A	65 mVpp P.A.R.D.	Secondary: 12OT C.T. #36 AWG
Short Circuit Current	V_{in} = 28 V, R_L = 0.1 Ω	1.6 A	Core: Ferroxcube 1408P–L00-3CB
Efficiency	V_{in} = 28 V, I_O = 1.0 A	71%	

+V_{in} = 10V to 40V

Tip 32A

1.0mH @ 2.0A

+V_O = 5.0V

I_O = 1.0A

47

150

47k

12

0.1

1.0M

8   11

V_{CC}

C_1 C_2

Comp   3

–   2

+   1

5.1k   5.1k

50
50V

TL594

V_{ref} 14

–   15

+   16

5.1k

MR850

500
10V

150

C_T R_T D.T.   O.C.   Gnd E_1 E_2

5   6   4   13   7   9   10

50
10V

0.001   47k

0.1
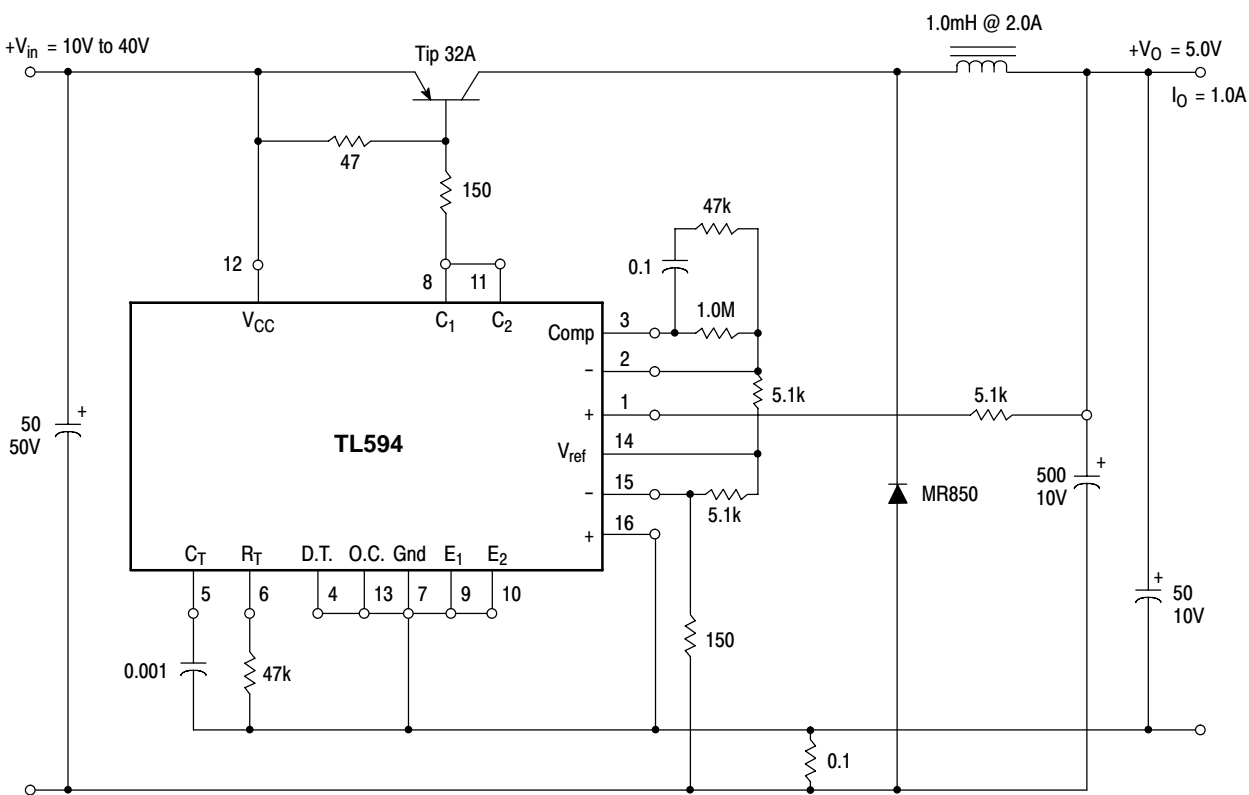
Figure 22. Pulse Width Modulated Step−Down Converter

Test	Conditions	Results	
Line Regulation	V_{in} = 8.0 V to 40 V	3.0 mV	0.01%
Load Regulation	V_{in} = 12.6 V, I_O = 0.2 mA to 200 mA	5.0 mV	0.02%
Output Ripple	V_{in} = 12.6 V, I_O = 200 mA	40 mVpp	P.A.R.D.
Short Circuit Current	V_{in} = 12.6 V, R_L = 0.1 Ω	250 mA	
Efficiency	V_{in} = 12.6 V, I_O = 200 mA	72%	

ORDERING INFORMATION

Device	Operating Temperature Range	Package	Shipping[†]
TL594CD	−40 to 85°C	SOIC−16	48 Units/Rail
TL594CDG	−40 to 85°C	SOIC−16 (Pb−Free)	48 Units/Rail
TL594CDR2	−40 to 85°C	SOIC−16	2400 Tape & Reel
TL594CDR2G	−40 to 85°C	SOIC−16 (Pb−Free)	2400 Tape & Reel
TL594CN	−40 to 85°C	PDIP−16	25 Units/Rail
TL594CNG	−40 to 85°C	PDIP−16 (Pb−Free)	25 Units/Rail
TL594CDTBG*	−40 to 85°C	TSSOP−16*	96 Units/Rail
TL594CDTBR2G	−40 to 85°C	TSSOP−16*	2500 Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*This package is inherently Pb−Free.

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

ON Semiconductor®
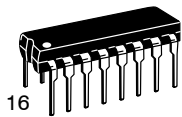
PDIP−16
CASE 648−08
ISSUE V

DATE 22 APR 2015

SCALE 1:1

TOP VIEW

END VIEW
WITH LEADS CONSTRAINED
NOTE 5

SIDE VIEW

⊕ | 0.010 Ⓜ | C A Ⓜ B Ⓜ

END VIEW
NOTE 6
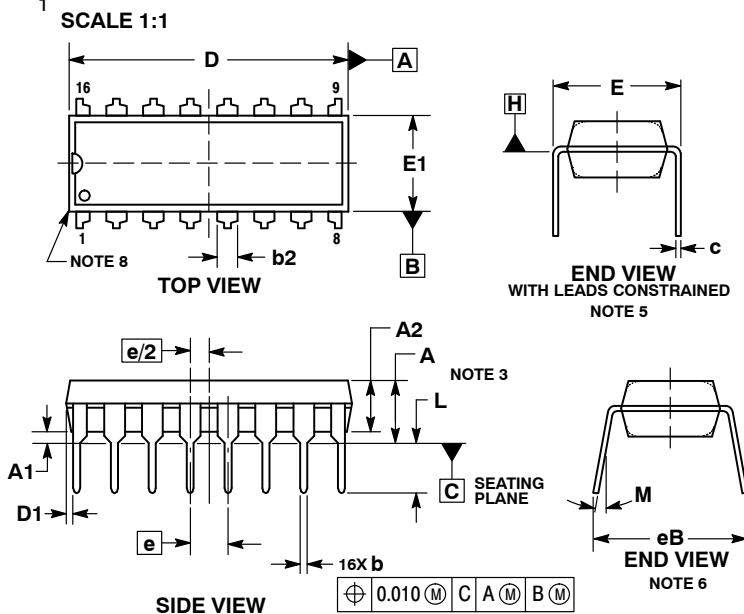
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACK-AGE SEATED IN JEDEC SEATING PLANE GAUGE GS−3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION eB IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	-----	0.210	---	5.33
A1	0.015	-----	0.38	---
A2	0.115	0.195	2.92	4.95
b	0.014	0.022	0.35	0.56
b2	0.060 TYP		1.52 TYP	
C	0.008	0.014	0.20	0.36
D	0.735	0.775	18.67	19.69
D1	0.005	-----	0.13	---
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
eB	-----	0.430	---	10.92
L	0.115	0.150	2.92	3.81
M	-----	10°	---	10°

**GENERIC
MARKING DIAGRAM***

XXXXXXXXXXX
XXXXXXXXXXX
AWLYYWWG
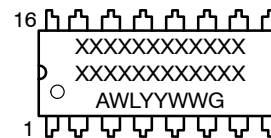
XXXXX = Specific Device Code
A   = Assembly Location
WL   = Wafer Lot
YY   = Year
WW   = Work Week
G   = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot " ▪", may or may not be present.

STYLE 1:		STYLE 2:	
PIN 1.	CATHODE	PIN 1.	COMMON DRAIN
2.	CATHODE	2.	COMMON DRAIN
3.	CATHODE	3.	COMMON DRAIN
4.	CATHODE	4.	COMMON DRAIN
5.	CATHODE	5.	COMMON DRAIN
6.	CATHODE	6.	COMMON DRAIN
7.	CATHODE	7.	COMMON DRAIN
8.	CATHODE	8.	COMMON DRAIN
9.	ANODE	9.	GATE
10.	ANODE	10.	SOURCE
11.	ANODE	11.	GATE
12.	ANODE	12.	SOURCE
13.	ANODE	13.	GATE
14.	ANODE	14.	SOURCE
15.	ANODE	15.	GATE
16.	ANODE	16.	SOURCE

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DESCRIPTION:	PDIP−16		PAGE 1 OF 1

SOIC−16
CASE 751B−05
ISSUE K

DATE 29 DEC 2006

SCALE 1:1

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0 °	7 °	0 °	7 °
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

⊕ 0.25 (0.010) Ⓜ T B Ⓢ A Ⓢ

STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. NO CONNECTION
5. EMITTER
6. BASE
7. COLLECTOR
8. COLLECTOR
9. BASE
10. EMITTER
11. NO CONNECTION
12. EMITTER
13. BASE
14. COLLECTOR
15. EMITTER
16. COLLECTOR

STYLE 2:
PIN 1. CATHODE
2. ANODE
3. NO CONNECTION
4. CATHODE
5. CATHODE
6. NO CONNECTION
7. ANODE
8. CATHODE
9. CATHODE
10. ANODE
11. NO CONNECTION
12. CATHODE
13. CATHODE
14. NO CONNECTION
15. ANODE
16. CATHODE

STYLE 3:
PIN 1. COLLECTOR, DYE #1
2. BASE, #1
3. EMITTER, #1
4. COLLECTOR, #1
5. COLLECTOR, #2
6. BASE, #2
7. EMITTER, #2
8. COLLECTOR, #2
9. COLLECTOR, #3
10. BASE, #3
11. EMITTER, #3
12. COLLECTOR, #3
13. COLLECTOR, #4
14. BASE, #4
15. EMITTER, #4
16. COLLECTOR, #4

STYLE 4:
PIN 1. COLLECTOR, DYE #1
2. COLLECTOR, #1
3. COLLECTOR, #2
4. COLLECTOR, #2
5. COLLECTOR, #3
6. COLLECTOR, #3
7. COLLECTOR, #4
8. COLLECTOR, #4
9. BASE, #4
10. EMITTER, #4
11. BASE, #3
12. EMITTER, #3
13. BASE, #2
14. EMITTER, #2
15. BASE, #1
16. EMITTER, #1

STYLE 5:
PIN 1. DRAIN, DYE #1
2. DRAIN, #1
3. DRAIN, #2
4. DRAIN, #2
5. DRAIN, #3
6. DRAIN, #3
7. DRAIN, #4
8. DRAIN, #4
9. GATE, #4
10. SOURCE, #4
11. GATE, #3
12. SOURCE, #3
13. GATE, #2
14. SOURCE, #2
15. GATE, #1
16. SOURCE, #1

STYLE 6:
PIN 1. CATHODE
2. CATHODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE
7. CATHODE
8. CATHODE
9. ANODE
10. ANODE
11. ANODE
12. ANODE
13. ANODE
14. ANODE
15. ANODE
16. ANODE

STYLE 7:
PIN 1. SOURCE N-CH
2. COMMON DRAIN (OUTPUT)
3. COMMON DRAIN (OUTPUT)
4. GATE P-CH
5. COMMON DRAIN (OUTPUT)
6. COMMON DRAIN (OUTPUT)
7. COMMON DRAIN (OUTPUT)
8. SOURCE P-CH
9. SOURCE P-CH
10. COMMON DRAIN (OUTPUT)
11. COMMON DRAIN (OUTPUT)
12. COMMON DRAIN (OUTPUT)
13. GATE N-CH
14. COMMON DRAIN (OUTPUT)
15. COMMON DRAIN (OUTPUT)
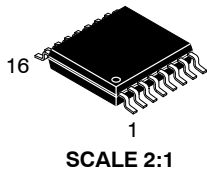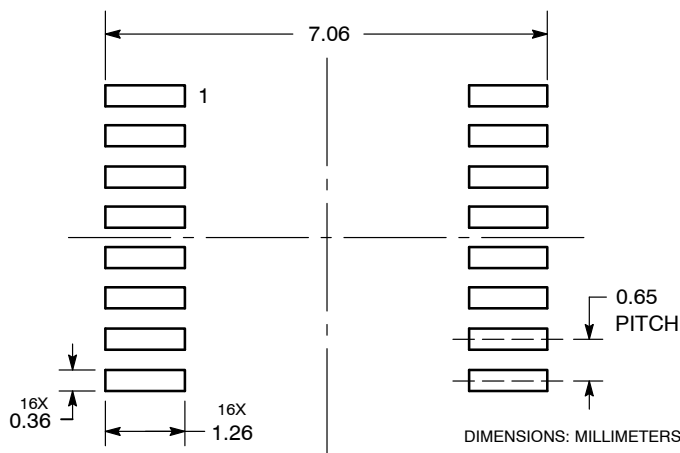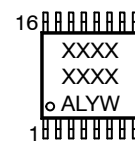16. SOURCE N-CH

SOLDERING FOOTPRINT

DIMENSIONS: MILLIMETERS

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DESCRIPTION:	**SOIC−16**		**PAGE 1 OF 1**

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

TSSOP−16
CASE 948F−01
ISSUE B

DATE 19 OCT 2006
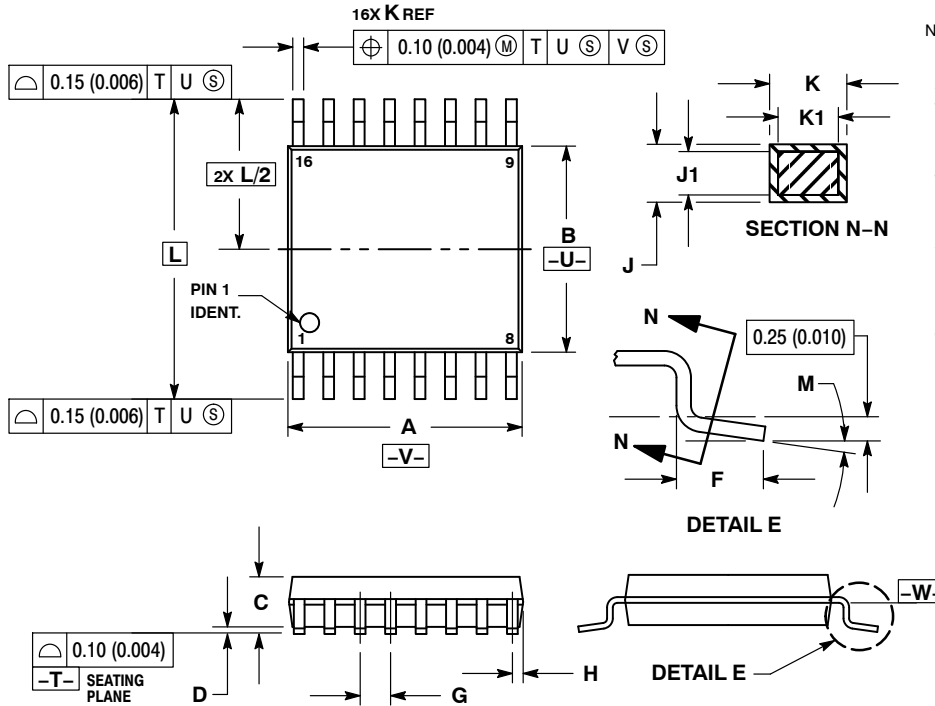
SCALE 2:1

16

1

16X **K** REF

⊕ | 0.10 (0.004) Ⓜ | T | U Ⓢ | V Ⓢ

◺ | 0.15 (0.006) | T | U Ⓢ

2X **L/2**

L

PIN 1
IDENT.

◺ | 0.15 (0.006) | T | U Ⓢ

16   9

8

−U−

B

A

−V−

16X **K** REF

K

K1

J1

J

SECTION N−N

N

0.25 (0.010)

M

N

F

DETAIL E

C

◺ | 0.10 (0.004)

−T− | SEATING
PLANE

D

G

H

DETAIL E

−W−

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE −W−.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	−−−	1.20	−−−	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.18	0.28	0.007	0.011
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0 °	8 °	0 °	8 °

SOLDERING FOOTPRINT

7.06

1

0.65
PITCH

16X
0.36

16X
1.26

DIMENSIONS: MILLIMETERS

GENERIC
MARKING DIAGRAM*

16

XXXX
XXXX
ALYW

1

XXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
G or ▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot " ▪ ", may or may not be present.

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DESCRIPTION:	TSSOP−16		PAGE 1 OF 1

PUBLICATION ORDERING INFORMATION

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