TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

- **Complete 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**
- **Available in Q-Temp Automotive HighRel Automotive Applications Configuration Control / Print Support Qualification to Automotive Standards**

D, DB, N, NS, PW, OR J PACKAGE
(TOP VIEW)

```
           CT [ 1      16 ] REF
           RT [ 2      15 ] SCP
ERROR     1IN+[ 3      14 ] 2IN+   ERROR
AMPLIFIER 1 1IN−[ 4    13 ] 2IN−   AMPLIFIER 2
    1FEEDBACK [ 5      12 ] 2FEEDBACK
         1DTC [ 6      11 ] 2DTC
         1OUT [ 7      10 ] 2OUT
          GND [ 8       9 ] V_CC
```

FK PACKAGE
(TOP VIEW)

```
              RT  CT  NC  REF SCP
               3   2   1   20  19
    1IN+   4                      18   2IN+
    1IN−   5                      17   2IN−
     NC    6                      16   NC
1FEEDBACK  7                      15   2FEEDBACK
    1DTC   8                      14   2DTC
               9   10  11  12  13
             1OUT GND  NC V_CC 2OUT
```
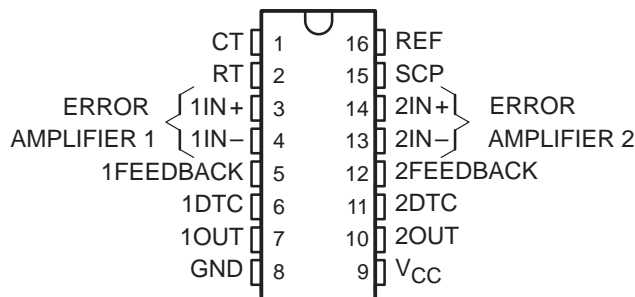
description

The TL1451A 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 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.
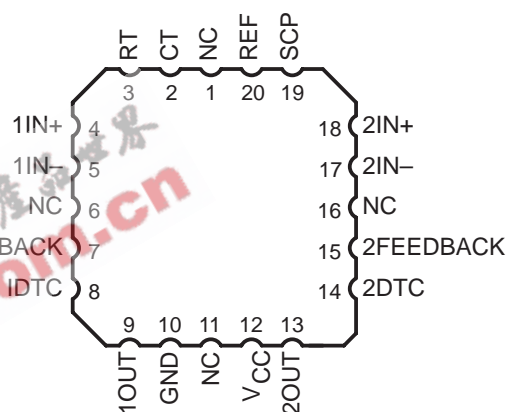
The uncommitted output transistors provide common-emitter output capability for each controller. The internal amplifiers exhibit a common-mode voltage range from 1.04 V to 1.45 V. The dead-time control (DTC) comparator has no offset unless externally altered and can provide 0% to 100% dead time. The 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 TL1451AC is characterized for operation from −20°C to 85°C. The TL1451AQ is characterized for operation from −40°C to 125°C. The TL1451AM is characterized for operation from −55°C to 125°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES						
	SMALL OUTLINE (D)	SMALL OUTLINE (DB)†	PLASTIC DIP (N)	SMALL OUTLINE (NS)	TSSOP (PW)†	CHIP CARRIER (FK)	CERAMIC DIP (J)
−20°C to 85°C	—	TL1451ACDB	TL1451ACN	TL1451ACNS	TL1451ACPW	—	—
−40°C to 125°C	TL1451AQD	—	—	—	—	—	—
−55°C to 125°C	—	—	—	—	—	TL1451AMFK	TL1451AMJ

† The DB and PW packages are only available left-end taped and reeled (add LE suffix, i.e., TL1451ACPWLE).

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.

TEXAS INSTRUMENTS

POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

functional block diagram
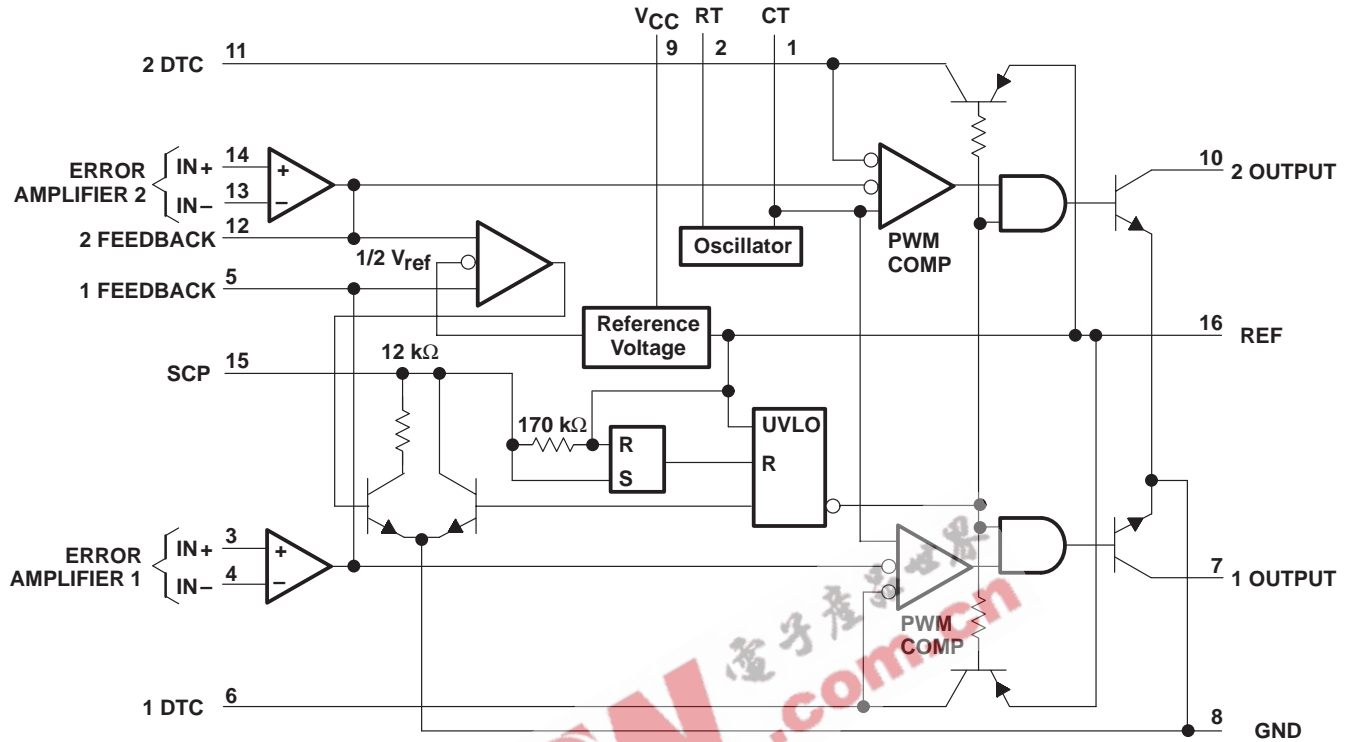
COMPONENT COUNT	
Resistors	65
Capacitors	8
Transistors	105
JFETs	18

TEXAS
INSTRUMENTS
POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

absolute maximum ratings over operating free-air temperature range†

Supply voltage, V_{CC}	51 V
Amplifier input voltage, V_I	20 V
Collector output voltage, V_O	51 V
Collector output current, I_O	21 mA
Continuous power total dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A C suffix	−20°C to 85°C
Q suffix	−40°C to 125°C
M suffix	−55°C to 125°C
Storage temperature range, T_{stg}	−65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

† 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 RATING TABLE

PACKAGE	$T_A \leq 25°C$ 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
DB	775 mW	6.2 mW/°C	496 mW	403 mW	—
N	1000 mW	8.0 mW/°C	640 mW	520 mW	—
NS	500 mW	4.0 mW/°C	320 mW	260 mW	—
PW	838 mW	6.7 mW/°C	536 mW	436 mW	168 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V_{CC}		3.6	50	V
Amplifier input voltage, V_I		1.05	1.45	V
Collector output voltage, V_O			50	V
Collector output current, I_O			20	mA
Current into feedback terminal			45	µA
Feedback resistor, R_F		100		kΩ
Timing capacitor, C_T		150	15000	pF
Timing resistor, R_T		5.1	100	kΩ
Oscillator frequency		1	500	kHz
Operating free-air temperature, T_A	C suffix	−20	85	°C
	Q suffix	−40	125	
	M suffix	−55	125	

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

reference section

PARAMETER	TEST CONDITIONS	TL1451AC			UNIT
		MIN	TYP†	MAX	
Output voltage (pin 16)	I_O = 1 mA	2.4	2.5	2.6	V
Output voltage change with temperature	T_A = −20°C to 25°C		−0.1%	±1%	
	T_A = 25°C to 85°C		−0.2%	±1%	
Input voltage regulation	V_{CC} = 3.6 V to 40 V		2	12.5	mV
Output voltage regulation	I_O = 0.1 mA to 1 mA		1	7.5	mV
Short-circuit output current	V_O = 0	3	10	30	mA

† All typical values are at T_A = 25°C.

undervoltage lockout section

PARAMETER	TEST CONDITIONS	TL1451AC			UNIT
		MIN	TYP†	MAX	
Upper threshold voltage (V_{CC})	$I_{O(ref)}$ = 0.1 mA, T_A = 25°C		2.72		V
Lower threshold voltage (V_{CC})			2.6		V
Hysteresis (V_{CC})		80	120		mV
Reset threshold voltage (V_{CC})		1.5	1.9		V

† All typical values are at T_A = 25°C.

short-circuit protection control section

PARAMETER	TEST CONDITIONS	TL1451AC			UNIT
		MIN	TYP†	MAX	
Input threshold voltage (SCP)	T_A = 25°C	0.65	0.7	0.75	V
Standby voltage (SCP)	No pullup	140	185	230	mV
Latched input voltage (SCP)	No pullup		60	120	mV
Input (source) current	V_I = 0.7 V, T_A = 25°C	−10	−15	−20	μA
Comparator threshold voltage (FEEDBACK)			1.18		V

† All typical values are at T_A = 25°C.

oscillator section

PARAMETER	TEST CONDITIONS	TL1451C			UNIT
		MIN	TYP†	MAX	
Frequency	C_T = 330 pF, R_T = 10 kΩ		200		kHz
Standard deviation of frequency	C_T = 330 pF, R_T = 10 kΩ		10%		
Frequency change with voltage	V_{CC} = 3.6 V to 40 V		1%		
Frequency change with temperature	T_A = −20°C to 25°C		−0.4%	±2%	
	T_A = 25°C to 85°C		−0.2%	±2%	

† All typical values are at T_A = 25°C.

TEXAS
INSTRUMENTS
POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

dead-time control section

PARAMETER	TEST CONDITIONS	TL1451AC MIN	TL1451AC TYP†	TL1451AC MAX	UNIT
Input bias current (DTC)				1	µA
Latch mode (source) current (DTC)	T_A = 25°C	−80	−145		µA
Latched input voltage (DTC)	I_O = 40 µA	2.3			V
Input threshold voltage at f = 10 kHz (DTC)	Zero duty cycle		2.05	2.25	V
	Maximum duty cycle	1.2	1.45		

† All typical values are at T_A = 25°C.

error-amplifier section

PARAMETER	TEST CONDITIONS	TL1451AC MIN	TL1451AC TYP†	TL1451AC MAX	UNIT
Input offset voltage	V_O (FEEDBACK) = 1.25 V			±6	mV
Input offset current	V_O (FEEDBACK) = 1.25 V			±100	nA
Input bias current	V_O (FEEDBACK) = 1.25 V		160	500	nA
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	70	80		dB
Unity-gain bandwidth			1.5		MHz
Common-mode rejection ratio		60	80		dB
Positive output voltage swing		V_{ref}−0.1			V
Negative output voltage swing				1	V
Output (sink) current (FEEDBACK)	V_{ID} = −0.1 V, V_O = 1.25 V	0.5	1.6		mA
Output (source) current (FEEDBACK)	V_{ID} = 0.1 V, V_O = 1.25 V	−45	−70		µA

† All typical values are at T_A = 25°C.

output section

PARAMETER	TEST CONDITIONS	TL1451AC MIN	TL1451AC TYP†	TL1451AC MAX	UNIT
Collector off-state current	V_O = 50 V			10	µA
Output saturation voltage	I_O = 10 mA		1.2	2	V
Short-circuit output current	V_O = 6 V		90		mA

† All typical values are at T_A = 25°C.

pwm comparator section

PARAMETER	TEST CONDITIONS	TL1451AC MIN	TL1451AC TYP†	TL1451AC MAX	UNIT
Input threshold voltage at f = 10 kHz (FEEDBACK)	Zero duty cycle		2.05	2.25	V
	Maximum duty cycle	1.2	1.45		

† All typical values are at T_A = 25°C.

total device

PARAMETER	TEST CONDITIONS	TL1451AC MIN	TL1451AC TYP†	TL1451AC MAX	UNIT
Standby supply current	Off-state		1.3	1.8	mA
Average supply current	R_T = 10 kΩ		1.7	2.4	mA

† All typical values are at T_A = 25°C.

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

reference section

PARAMETER	TEST CONDITIONS		TL1451AQ, TL1451AM			UNIT
			MIN	TYP†	MAX	
Output voltage (pin 16)	I_O = 1 mA	T_A = 25°C	2.40	2.50	2.60	V
		T_A = MIN and 125°C	2.35	2.46	2.65	
Output voltage change with temperature				−0.63%	*±4%	
Input voltage regulation	V_{CC} = 3.6 V to 40 V	T_A = 25°C		2.0	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		1.0	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

*These parameters are not production tested.
† All typical values are at T_A = 25°C unless otherwise indicated.

undervoltage lockout section

PARAMETER	TEST CONDITIONS		TL1451AQ, TL1451AM			UNIT
			MIN	TYP†	MAX	
Upper threshold voltage (V_{CC})		T_A = 25°C		2.72		V
		T_A = 125°C		1.70		
		T_A = MIN		3.15		
Lower threshold voltage (V_{CC})		T_A = 25°C		2.60		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	1.50			V
		T_A = 125°C	0.95			
		T_A = MIN	1.50			

† All typical values are at T_A = 25°C unless otherwise indicated.

short-circuit protection control section

PARAMETER	TEST CONDITIONS	TL1451AQ, TL1451AM			UNIT
		MIN	TYP†	MAX	
Input threshold voltage (SCP)	$T_A = 25°C$	650	700	750	mV
	$T_A = 125°C$	400	478	550	
	$T_A = MIN$	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

† All typical values are at $T_A = 25°C$ unless otherwise indicated.

oscillator section

PARAMETER	TEST CONDITIONS		TL1451AQ, TL1451AM			UNIT
			MIN	TYP†	MAX	
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%	

*These parameters are not production tested.
† All typical values are at $T_A = 25°C$ unless otherwise indicated.

dead-time control section

PARAMETER	TEST CONDITIONS	TL1451AQ, TL1451AM			UNIT
		MIN	TYP†	MAX	
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)	$T_A = 25°C$	2.30			V
	$T_A = 125°C$	2.22	2.32		
	$T_A = MIN$	2.28	2.40		
Input threshold voltage at f = 10 kHz (DTC)	Zero duty cycle		2.05	*2.25	V
	Maximum duty cycle	*1.20	1.45		

*These parameters are not production tested.
† All typical values are at $T_A = 25°C$ unless otherwise indicated.

TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

error-amplifier section

PARAMETER	TEST CONDITIONS		TL1451AQ, TL1451AM			UNIT
			MIN	TYP†	MAX	
Input offset voltage	V_O (FEEDBACK) = 1.25 V	T_A = 25°C			±6	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		

† All typical values are at T_A = 25°C unless otherwise indicated.

output section

PARAMETER	TEST CONDITIONS	TL1451AQ, TL1451AM			UNIT
		MIN	TYP†	MAX	
Collector off-state current	V_O = 50 V			10	µA
Output saturation voltage	T_A = 25°C		1.20	2.0	V
	T_A = 125°C		1.60	2.4	
	T_A = MIN		1.36	2.2	
Short-circuit output current	V_O = 6 V		90		mA

† All typical values are at T_A = 25°C unless otherwise indicated.

pwm comparator section

PARAMETER	TEST CONDITIONS	TL1451AQ, TL1451AM			UNIT
		MIN	TYP†	MAX	
Input threshold voltage at f = 10 kHz (FEEDBACK)	Zero duty cycle		2.05	*2.25	V
	Maximum duty cycle	*1.20	1.45		

*These parameters are not production tested.
† All typical values are at T_A = 25°C unless otherwise indicated.

total device

PARAMETER	TEST CONDITIONS	TL1451AQ, TL1451AM			UNIT
		MIN	TYP†	MAX	
Standby supply current	Off-state		1.3	1.8	mA
Average supply current	R_T = 10 kΩ		1.7	2.4	mA

† All typical values are at T_A = 25°C unless otherwise indicated.

PARAMETER MEASUREMENT INFORMATION
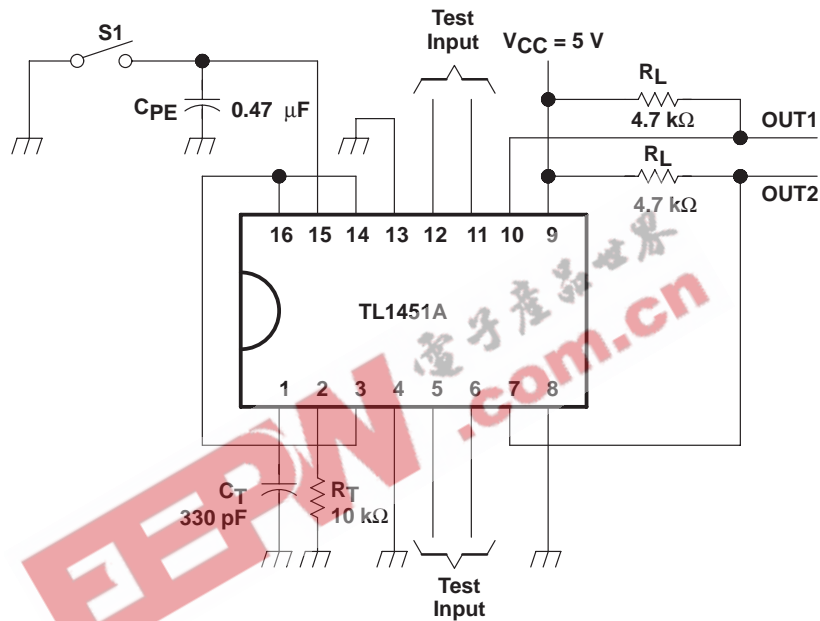
Figure 1. Test Circuit
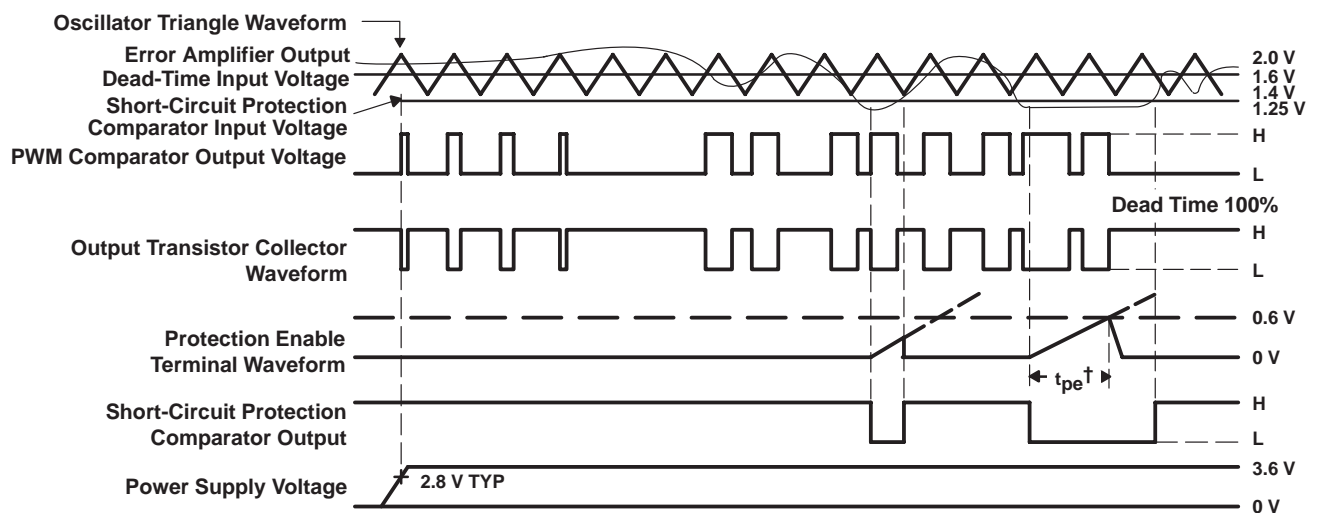
† Protection Enable Time, t_{pe} = (0.051 x 10^6 x C_{pe}) in seconds

Figure 2. TL1451A Timing Diagram

TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

TYPICAL CHARACTERISTICS

TRIANGLE OSCILLATOR FREQUENCY
vs
TIMING RESISTANCE

Figure 3

OSCILLATOR FREQUENCY VARIATION
vs
FREE-AIR TEMPERATURE

Figure 4

TRIANGLE WAVEFORM SWING VOLTAGE
vs
TIMING CAPACITANCE

Figure 5

TRIANGLE WAVEFORM PERIOD
vs
TIMING CAPACITANCE

Figure 6

10

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
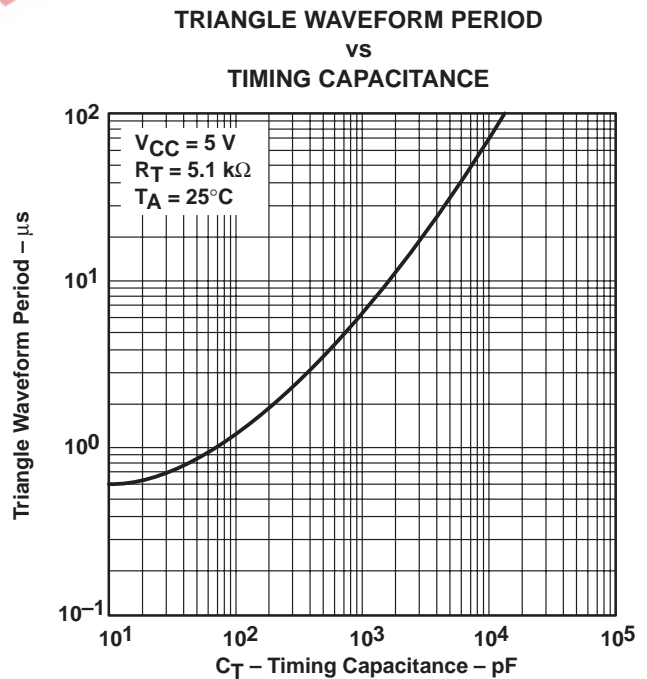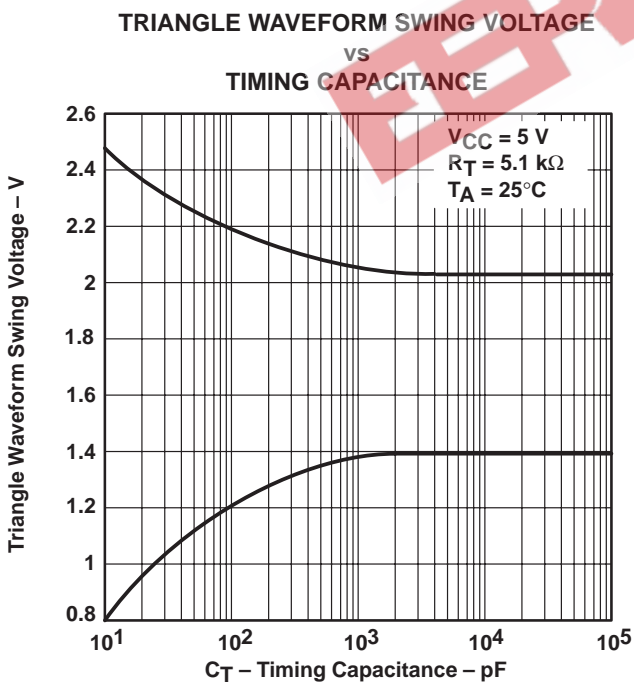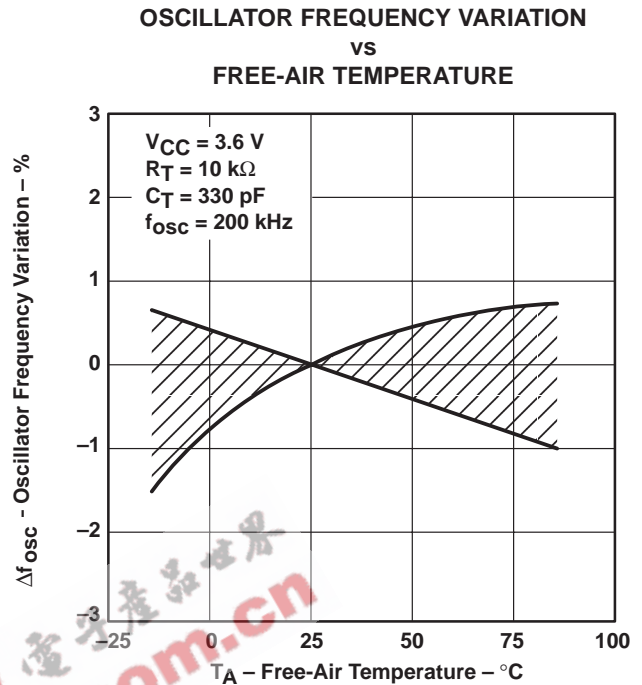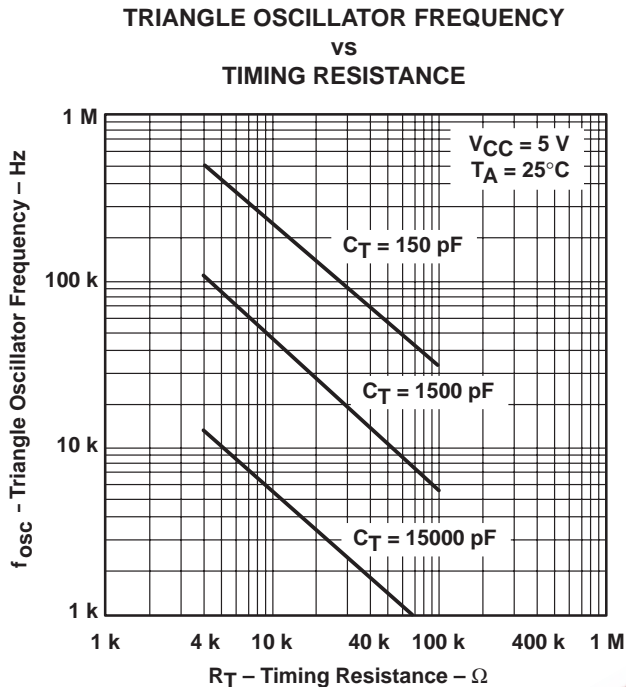
TYPICAL CHARACTERISTICS

REFERENCE OUTPUT VOLTAGE VARIATION
vs
FREE-AIR TEMPERATURE
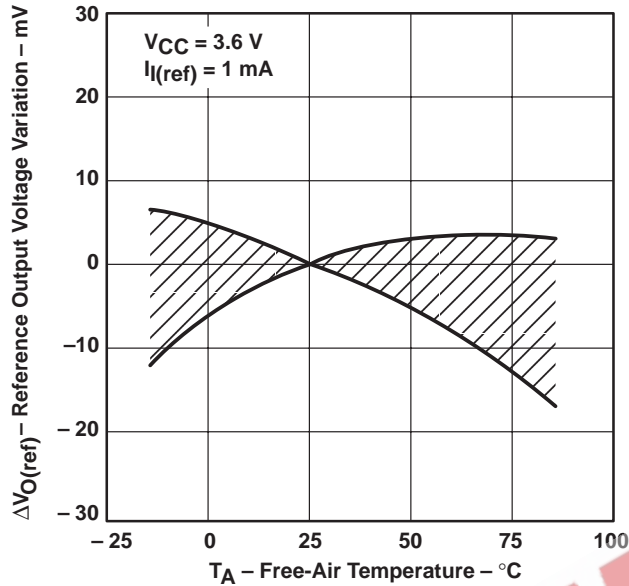
Figure 7

REFERENCE OUTPUT VOLTAGE VARIATION
vs
FREE-AIR TEMPERATURE
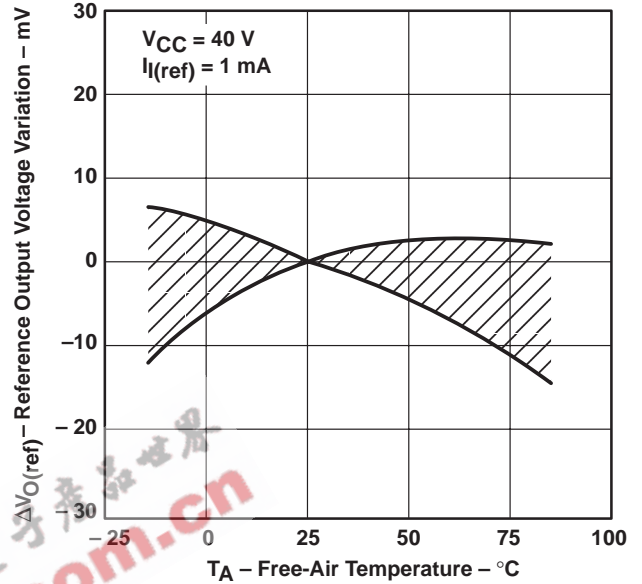
Figure 8

REFERENCE OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE
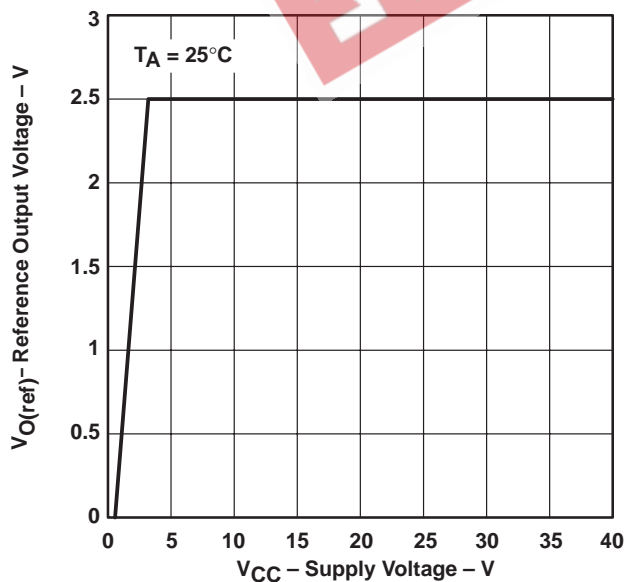
Figure 9

DROPOUT VOLTAGE VARIATION
vs
FREE-TEMPERATURE
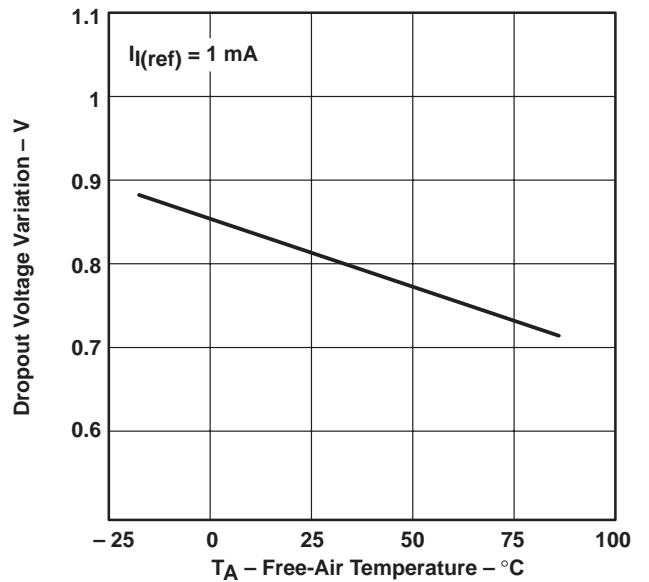
Figure 10

TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

TYPICAL CHARACTERISTICS

UNDERVOLTAGE LOCKOUT HYSTERESIS CHARACTERISTICS

Figure 11
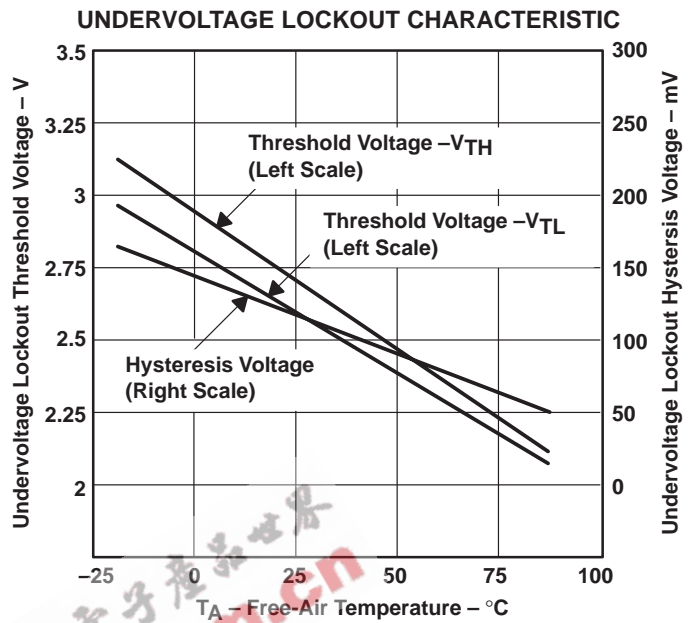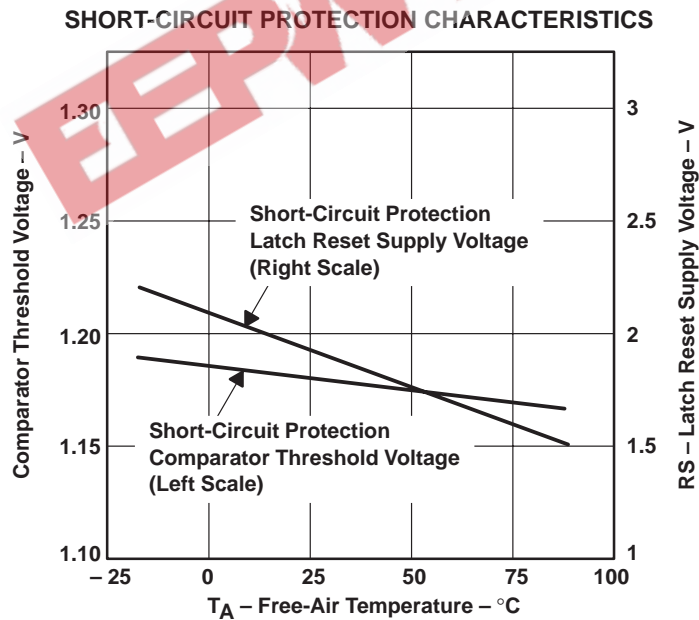
UNDERVOLTAGE LOCKOUT CHARACTERISTIC

Figure 12

SHORT-CIRCUIT PROTECTION CHARACTERISTICS

Figure 13

TEXAS
INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

TYPICAL CHARACTERISTICS

PROTECTION ENABLE TIME
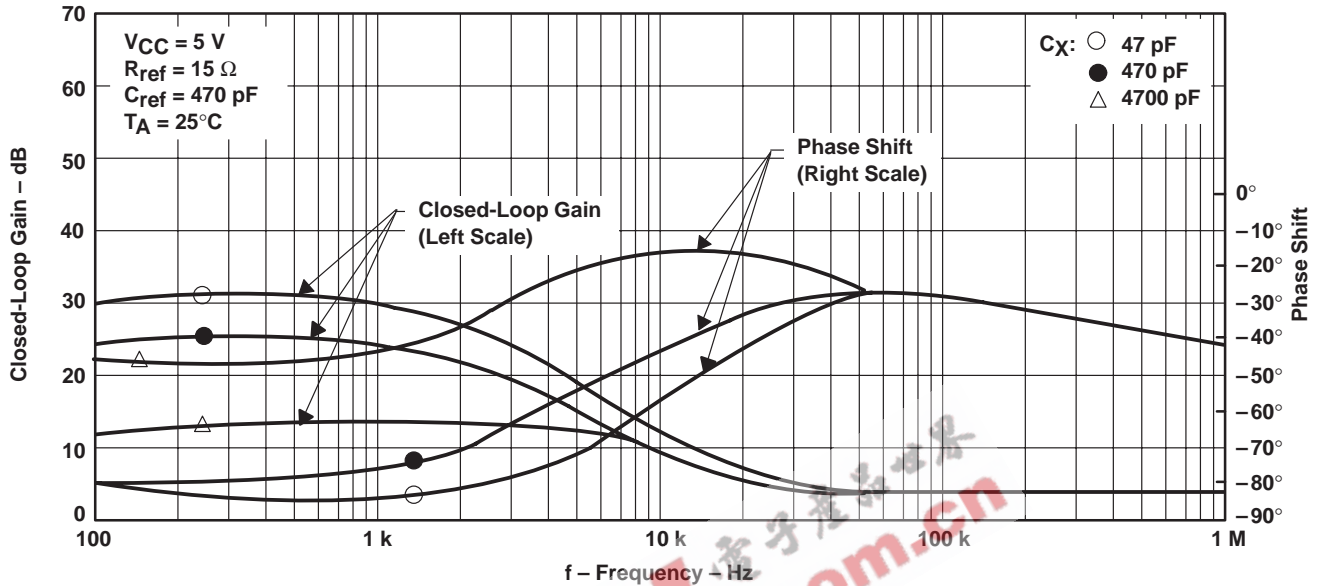**vs**
PROTECTION ENABLE CAPACITANCE
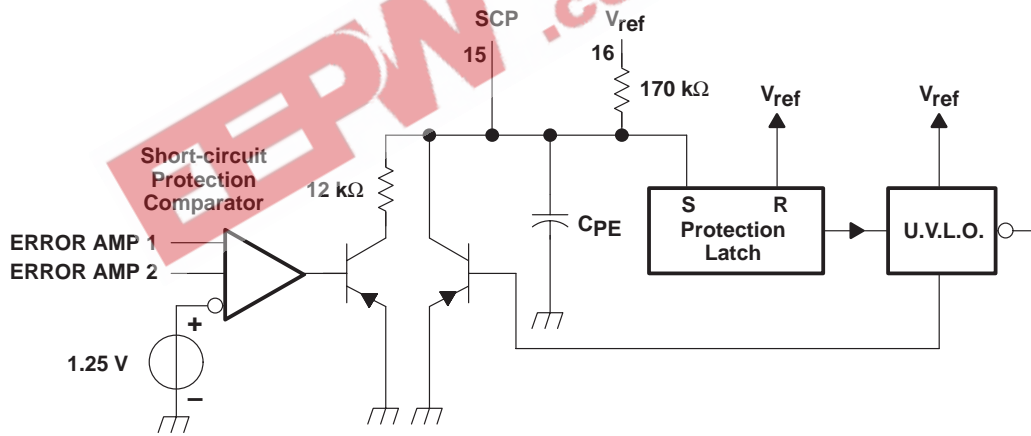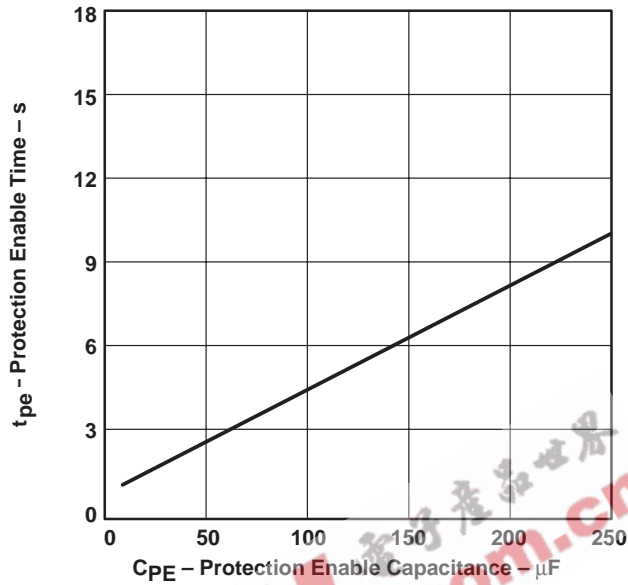
Figure 14

TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

TYPICAL CHARACTERISTICS

ERROR AMP MAXIMUM OUTPUT VOLTAGE SWING
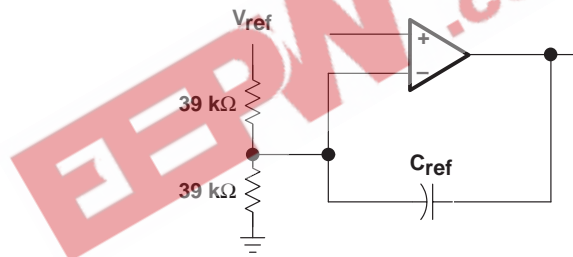**vs**
FREQUENCY

V_{CC} = 5 V
T_A = 25°C
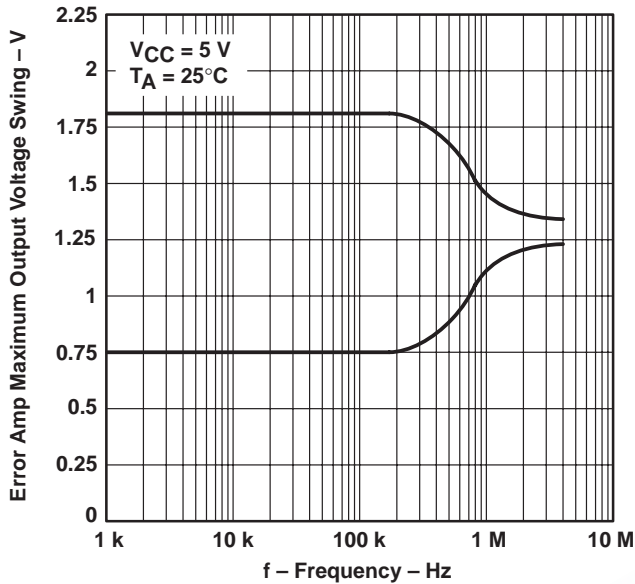
Figure 15

OPEN-LOOP VOLTAGE AMPLIFICATION
vs
FREQUENCY

V_{CC} = 5 V
T_A = 25°C
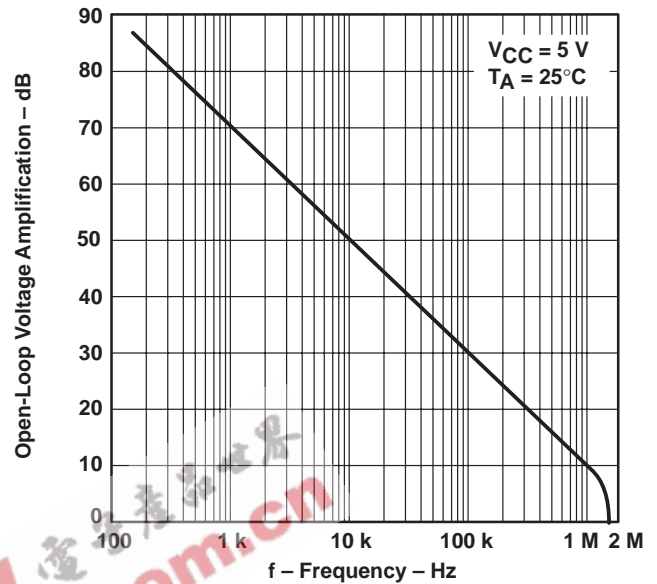
Figure 16

GAIN (AMPLIFIER IN
UNITY-GAIN CONFIGURATION)
vs
FREQUENCY

V_{CC} = 5 V
T_A = 25°C
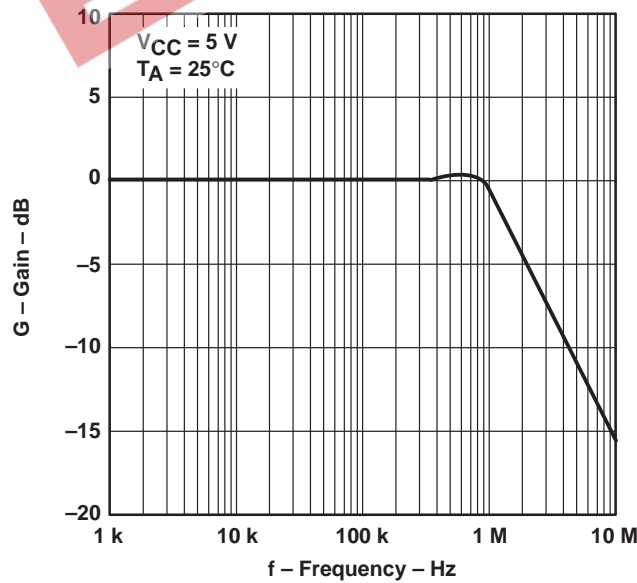
Figure 17

TYPICAL CHARACTERISTICS
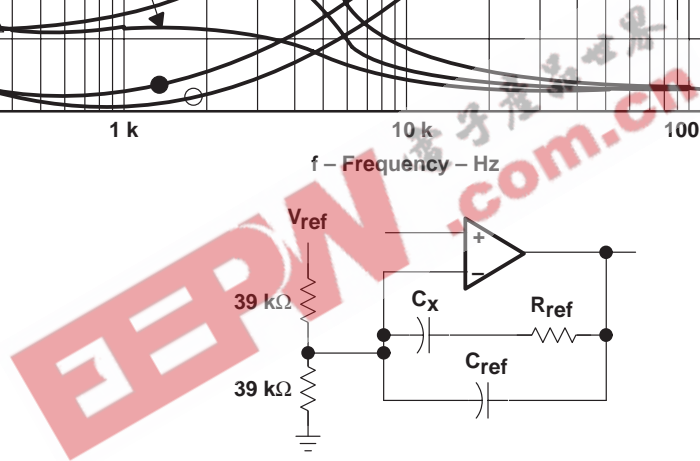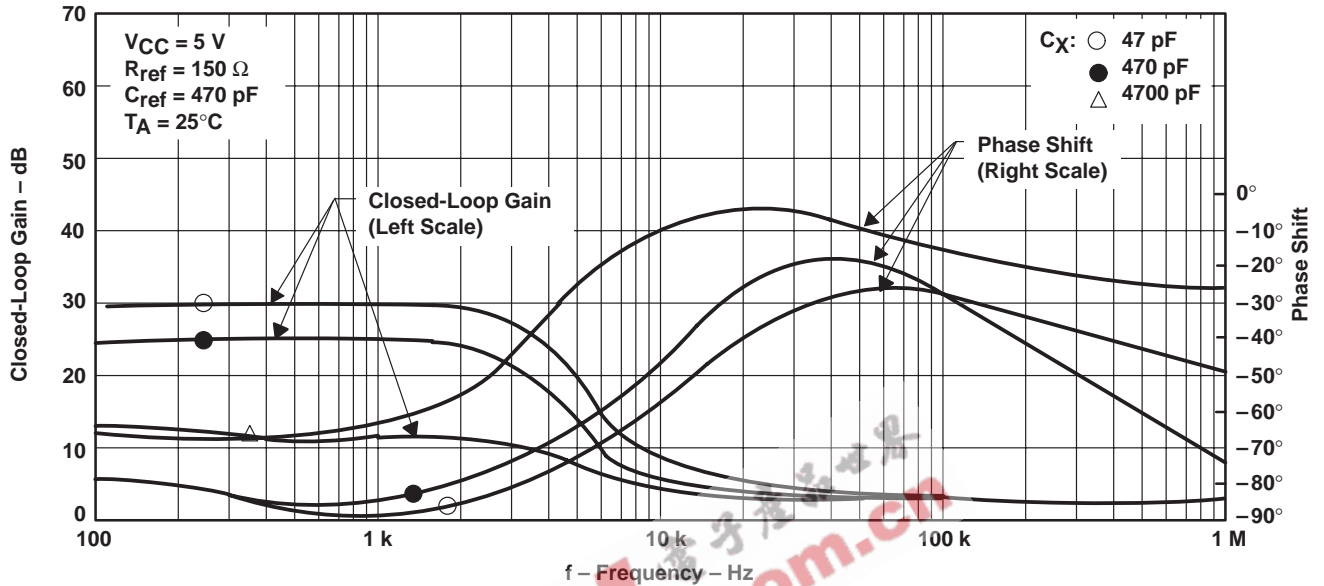
**CLOSED-LOOP GAIN AND PHASE SHIFT
vs
FREQUENCY**

Test Circuit

Figure 18

TYPICAL CHARACTERISTICS

CLOSED-LOOP GAIN AND PHASE SHIFT
vs
FREQUENCY
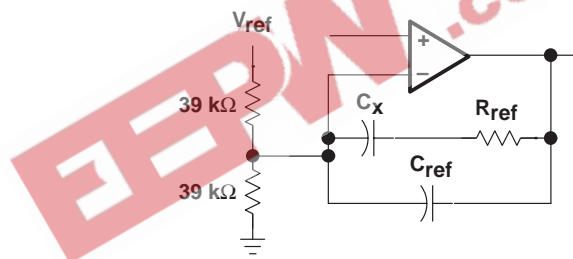
Test Circuit

Figure 19

Texas
INSTRUMENTS
POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

TYPICAL CHARACTERISTICS

CLOSED-LOOP GAIN AND PHASE SHIFT
vs
FREQUENCY
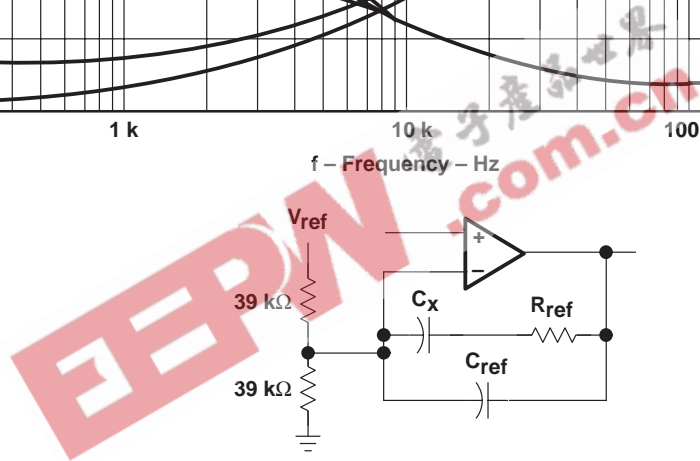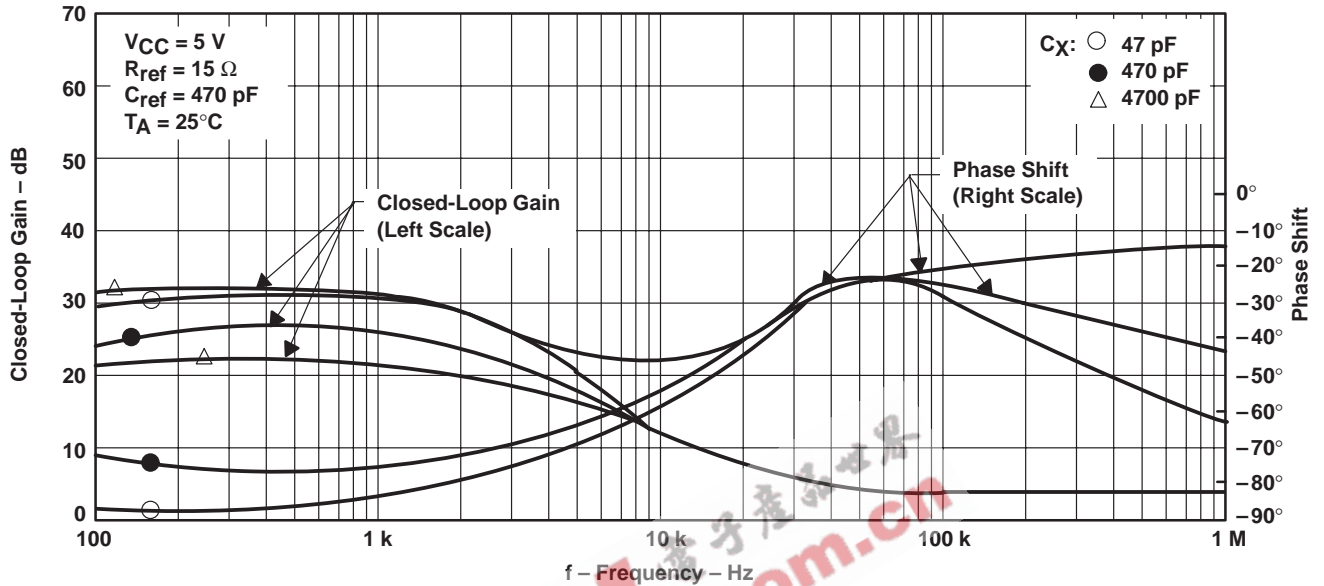
Test Circuit

Figure 20

TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

TYPICAL CHARACTERISTICS

CLOSED-LOOP GAIN AND PHASE SHIFT
vs
FREQUENCY
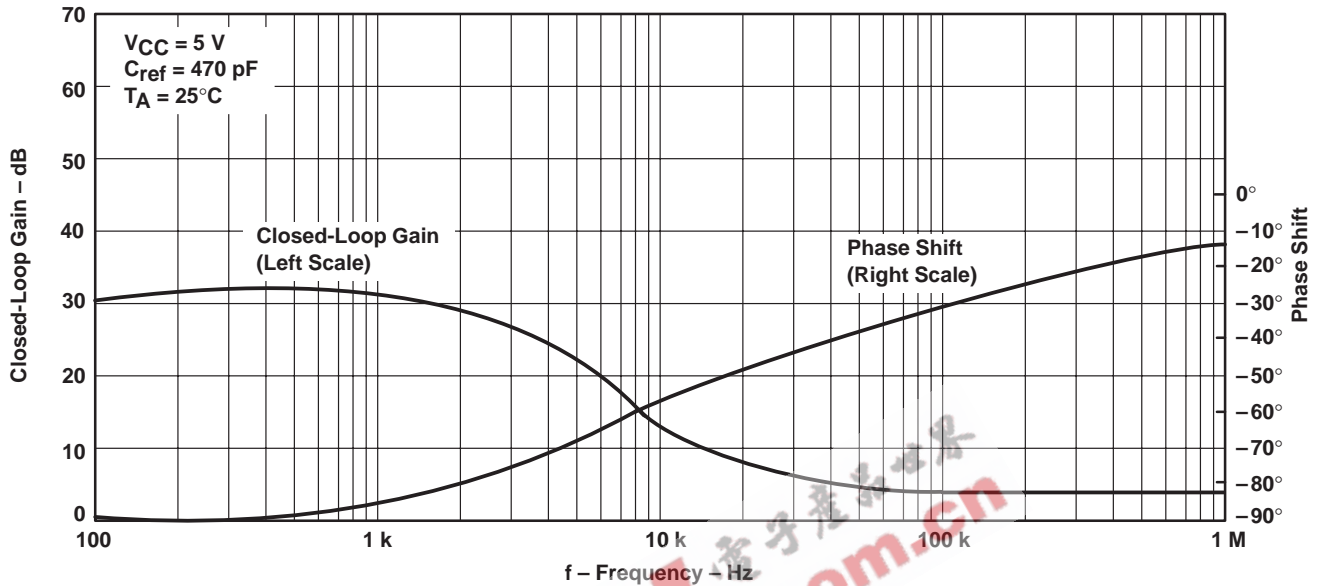
Test Circuit

Figure 21

TYPICAL CHARACTERISTICS
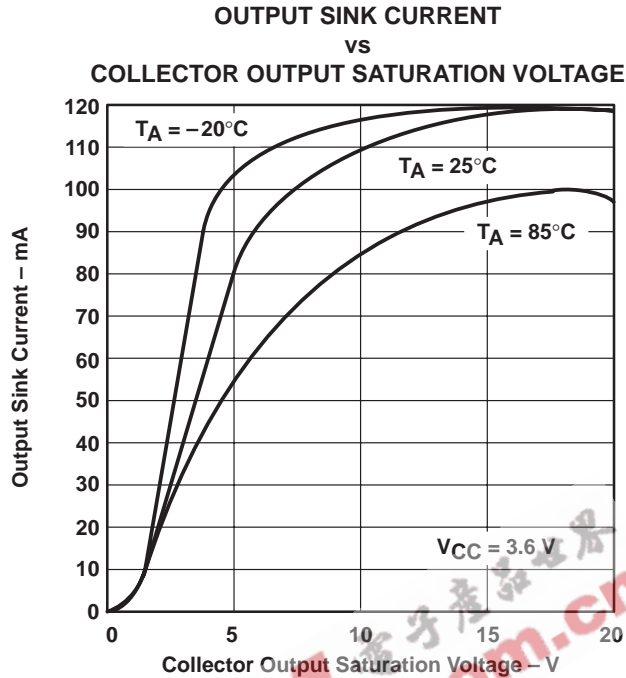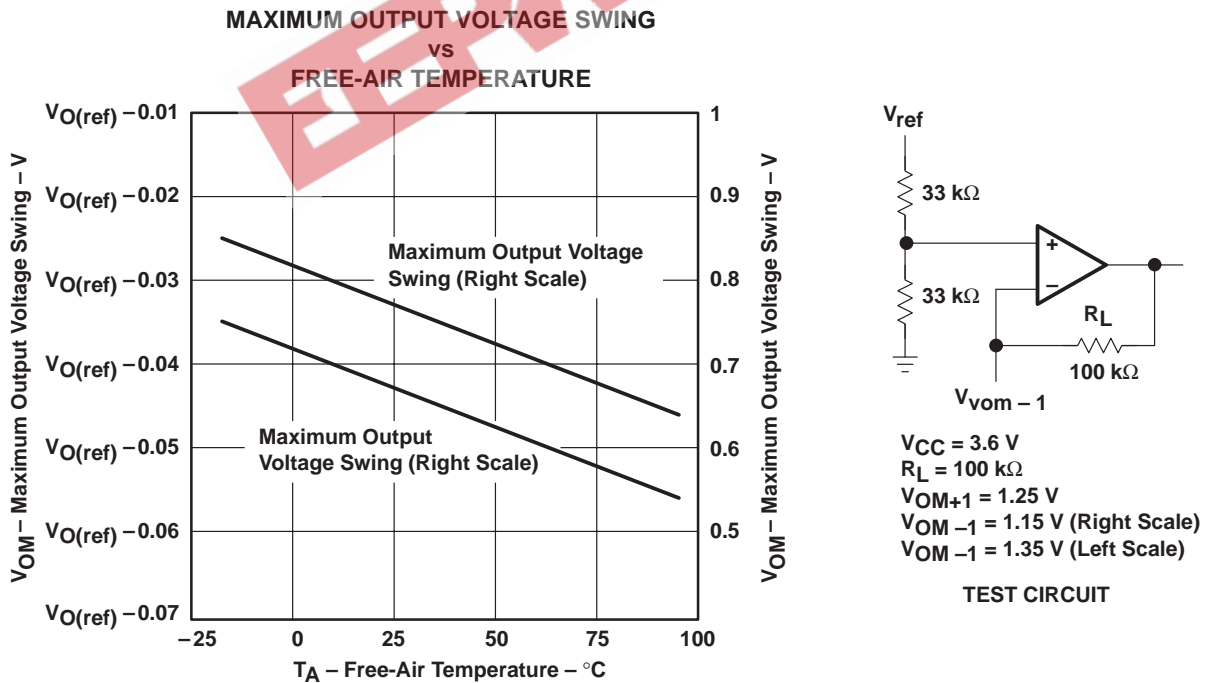
OUTPUT SINK CURRENT
vs
COLLECTOR OUTPUT SATURATION VOLTAGE

Figure 22

MAXIMUM OUTPUT VOLTAGE SWING
vs
FREE-AIR TEMPERATURE

TEST CIRCUIT

V_{CC} = 3.6 V
R_L = 100 kΩ
V_{OM+1} = 1.25 V
V_{OM-1} = 1.15 V (Right Scale)
V_{OM-1} = 1.35 V (Left Scale)

Figure 23

TYPICAL CHARACTERISTICS

OUTPUT TRANSISTOR ON DUTY CYCLE
vs
DEAD-TIME INPUT VOLTAGE

V_{CC} = 3.6 V
R_T = 10kΩ
C_T = 330 pF
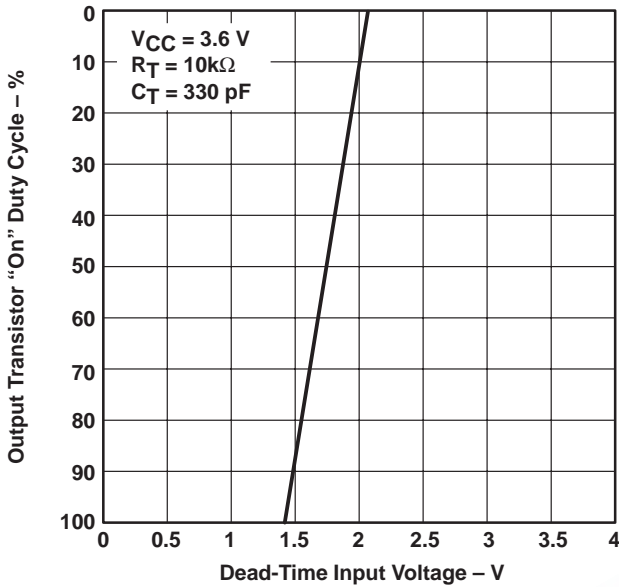
Figure 24

STANDBY CURRENT
vs
SUPPLY VOLTAGE

T_A = 25°C
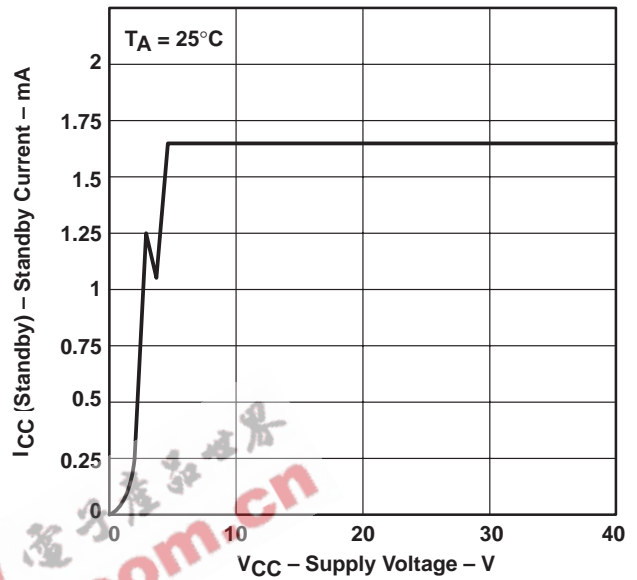
Figure 25

STANDBY CURRENT
vs
FREE-AIR TEMPERATURE

Average Supply Current
V_{CC} = 6 V, R_T = 10 kΩ,
C_T = 330 pF

Stand-By Current, V_{CC} = 40 V, No Load

Stand-By Current, V_{CC} = 3.6 V, No Load
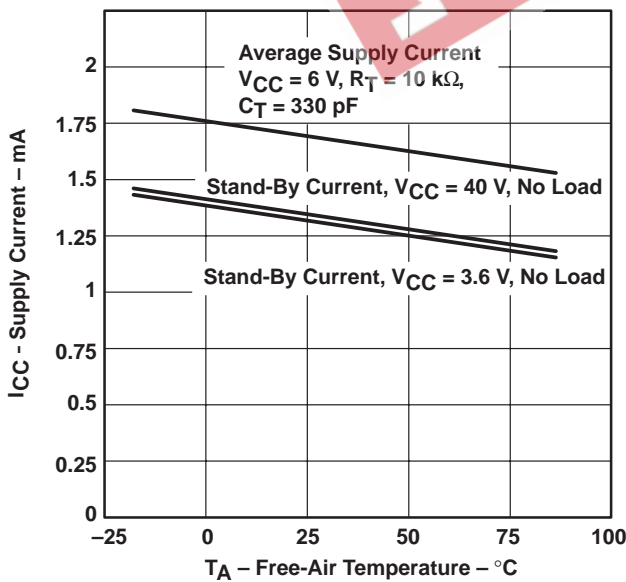
Figure 26

MAXIMUM CONTINUOUS POWER DISSIPATION
vs
FREE-AIR TEMPERATURE
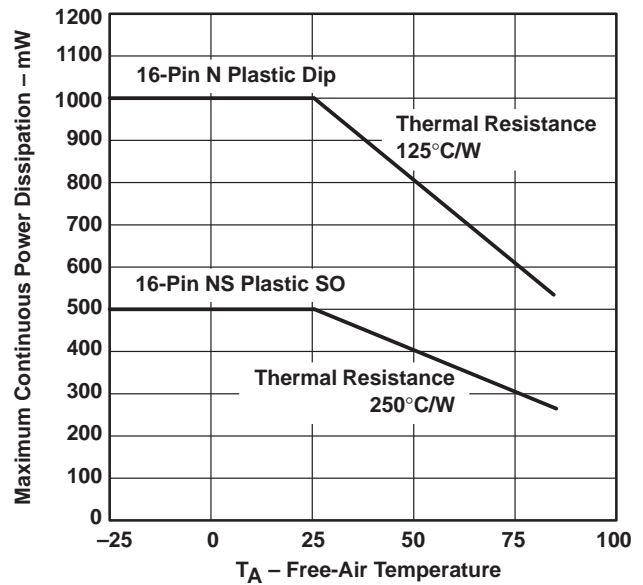
16-Pin N Plastic Dip

Thermal Resistance
125°C/W

16-Pin NS Plastic SO

Thermal Resistance
250°C/W

Figure 27

TEXAS
INSTRUMENTS

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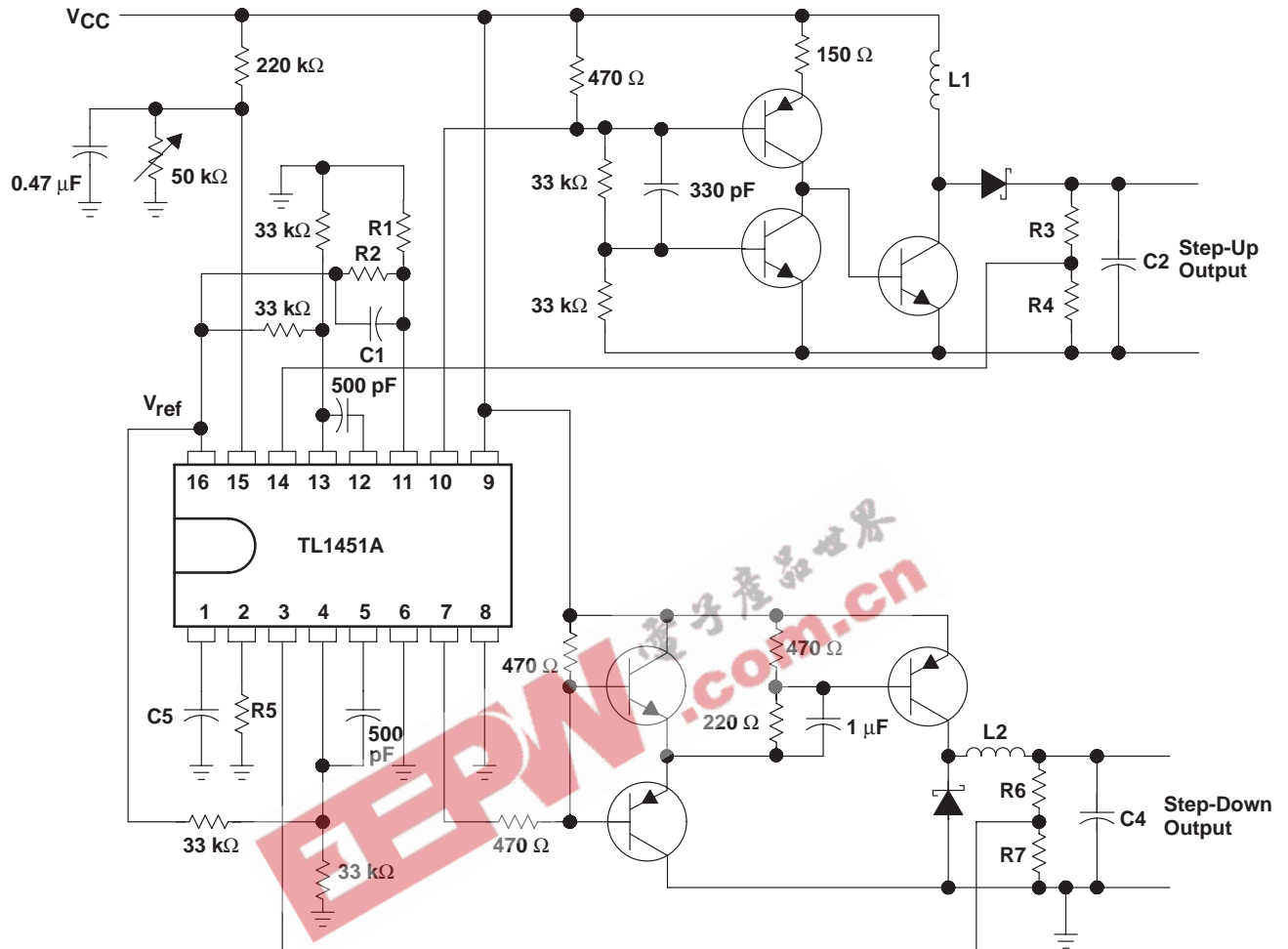
NOTE A: Values for R1 through R7, C1 through C4, and L1 and L2 depend upon individual application.

Figure 28. High-Speed Dual Switching Regulator
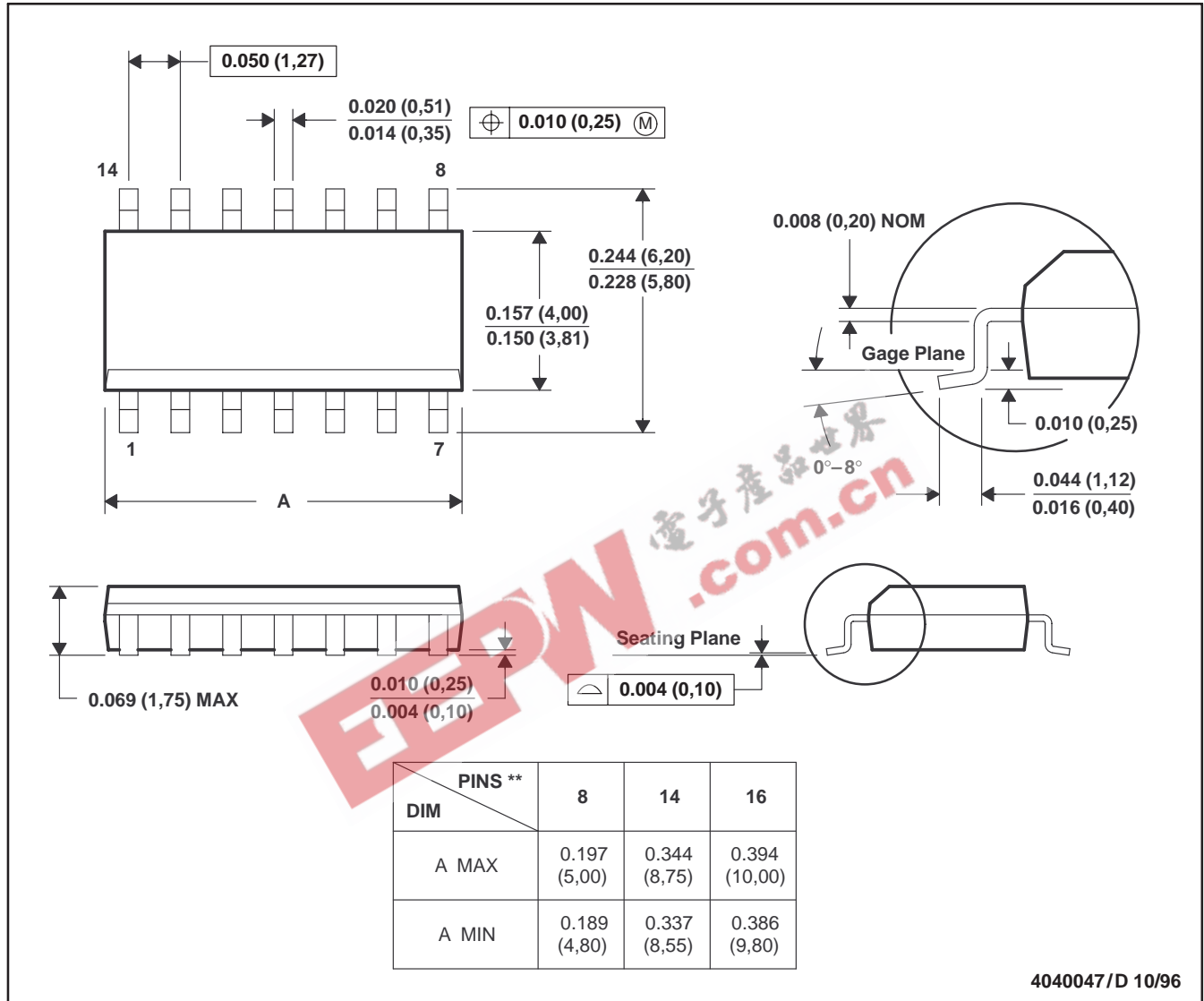
TL1451A
DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

MECHANICAL DATA

D (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN

PINS ** DIM	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047 / D 10/96

NOTES: A.   All linear dimensions are in inches (millimeters).
　　　　　B.   This drawing is subject to change without notice.
　　　　　C.   Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
　　　　　D.   Falls within JEDEC MS-012

MECHANICAL DATA

DB (R-PDSO-G**)   **PLASTIC SMALL-OUTLINE PACKAGE**

28 PINS SHOWN
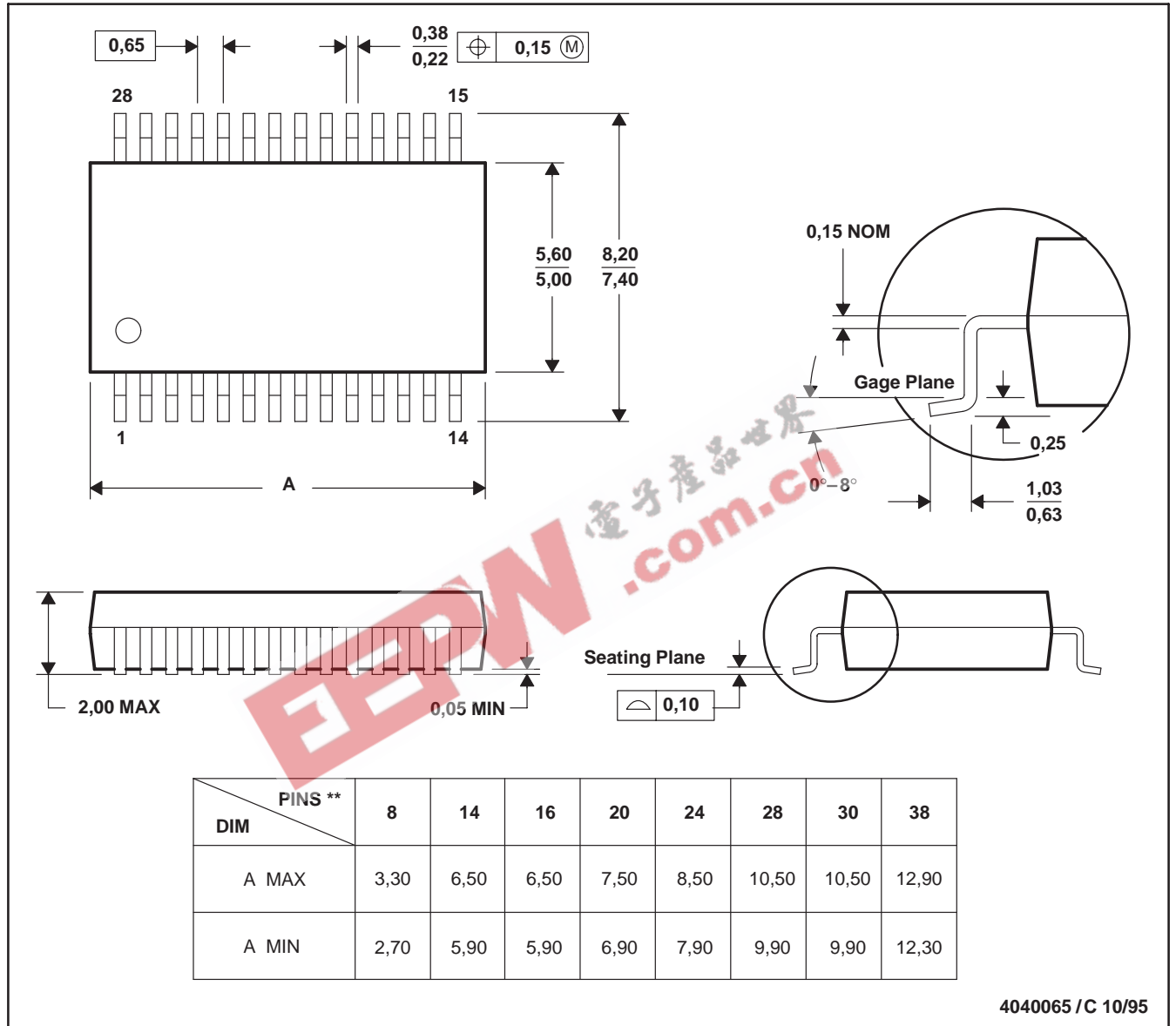
DIM PINS **	8	14	16	20	24	28	30	38
A MAX	3,30	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	2,70	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 / C 10/95

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-150

TEXAS
INSTRUMENTS

POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

23

MECHANICAL DATA

FK (S-CQCC-N)**   **LEADLESS CERAMIC CHIP CARRIER**

28 TERMINALS SHOWN
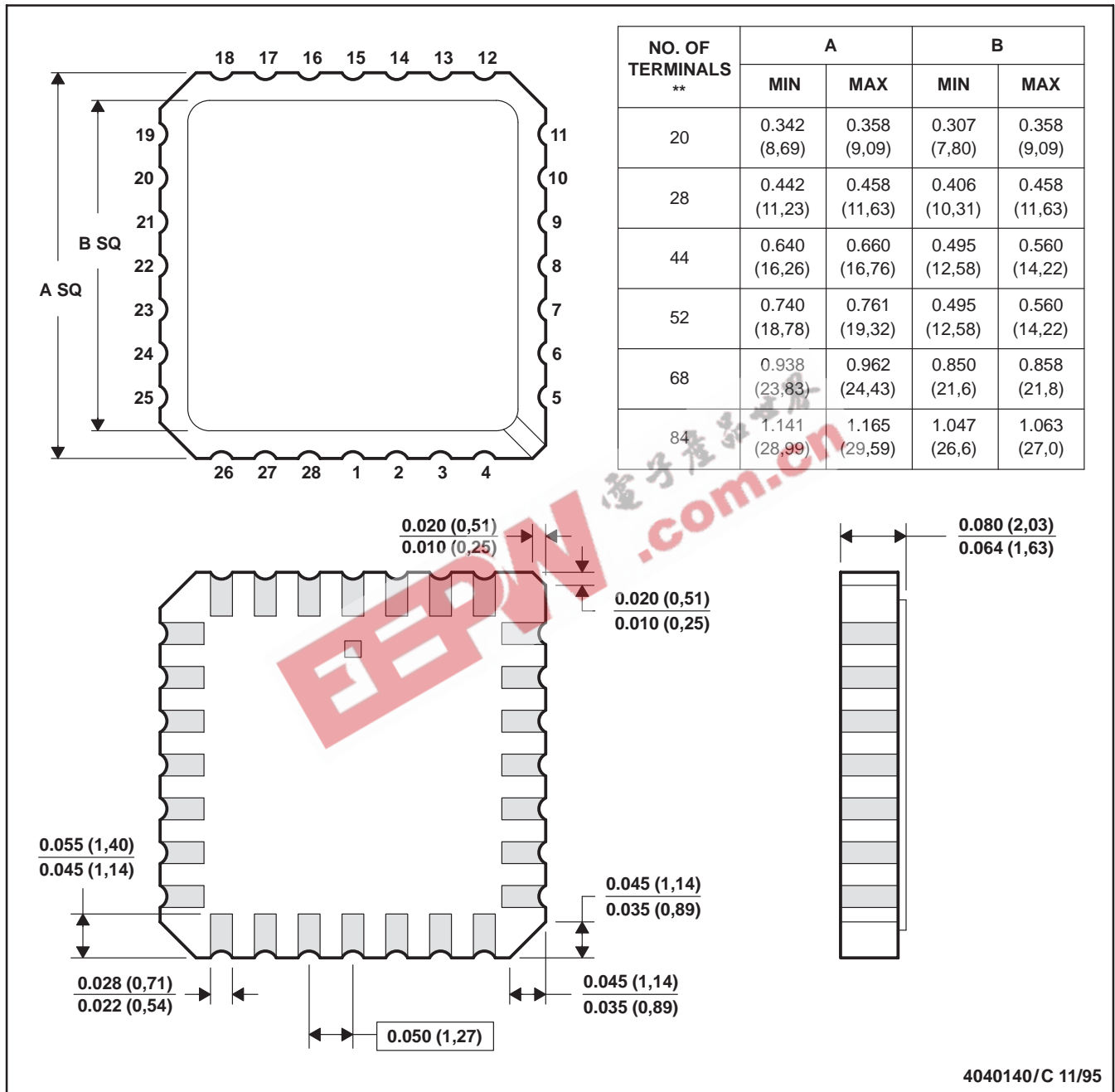
NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)

4040140/C 11/95

NOTES: A. All linear dimensions are in inches (millimeters).
            B. This drawing is subject to change without notice.
            C. This package can be hermetically sealed with a metal lid.
            D. The terminals are gold-plated.
            E. Falls within JEDEC MS-004

TEXAS
INSTRUMENTS

POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

MECHANICAL DATA

J (R-GDIP-T**)   **CERAMIC DUAL-IN-LINE**

14 LEADS SHOWN
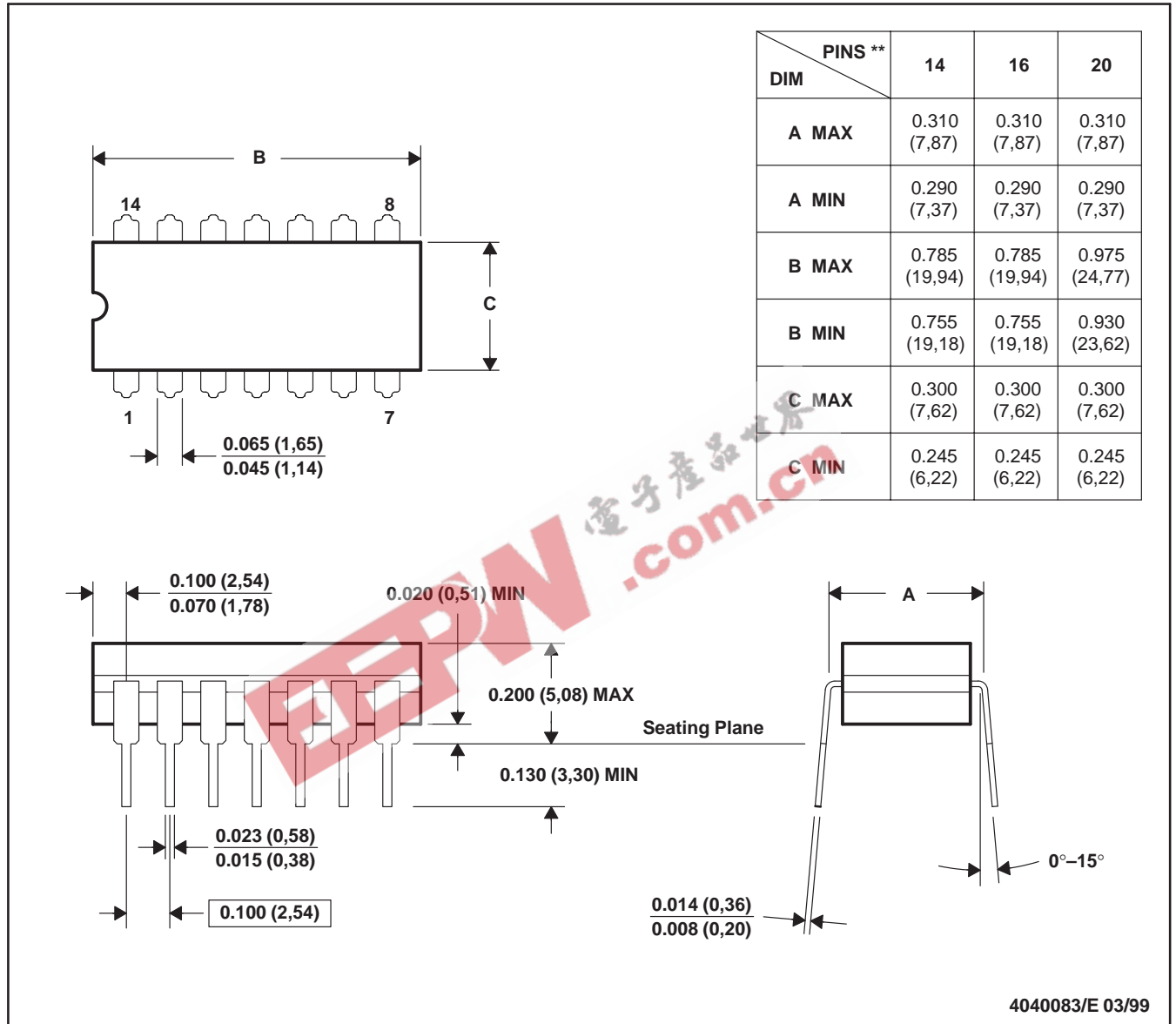
DIM \ PINS **	14	16	20
A MAX	0.310 (7,87)	0.310 (7,87)	0.310 (7,87)
A MIN	0.290 (7,37)	0.290 (7,37)	0.290 (7,37)
B MAX	0.785 (19,94)	0.785 (19,94)	0.975 (24,77)
B MIN	0.755 (19,18)	0.755 (19,18)	0.930 (23,62)
C MAX	0.300 (7,62)	0.300 (7,62)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.245 (6,22)

B

14   8

C

1   7

0.065 (1,65)
0.045 (1,14)

0.100 (2,54)
0.070 (1,78)

0.020 (0,51) MIN

0.200 (5,08) MAX

Seating Plane

0.130 (3,30) MIN

0.023 (0,58)
0.015 (0,38)

0.100 (2,54)

A

0°–15°

0.014 (0,36)
0.008 (0,20)

4040083/E 03/99

NOTES: A. All linear dimensions are in inches (millimeters).
    B. This drawing is subject to change without notice.
    C. This package is hermetically sealed with a ceramic lid using glass frit.
    D. Index point is provided on cap for terminal identification.
    E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, and GDIP1-T20

TL1451A
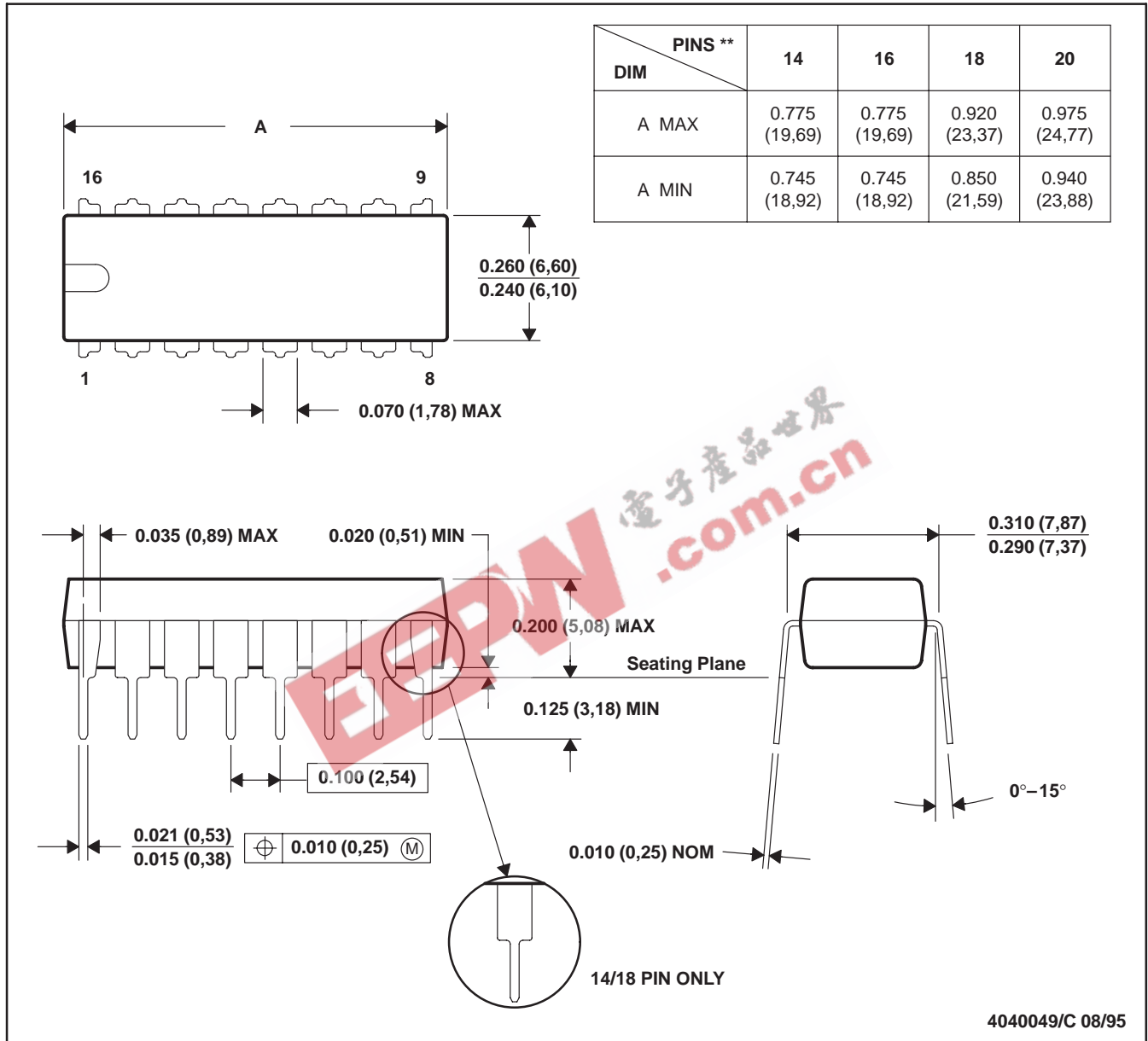## DUAL PULSE-WIDTH-MODULATION CONTROL CIRCUITS

SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

MECHANICAL DATA

N (R-PDIP-T**)   **PLASTIC DUAL-IN-LINE PACKAGE**

16 PINS SHOWN

PINS ** DIM	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)

A

16   9

0.260 (6,60)
0.240 (6,10)

1   8

0.070 (1,78) MAX

0.035 (0,89) MAX   0.020 (0,51) MIN

0.310 (7,87)
0.290 (7,37)

0.200 (5,08) MAX

Seating Plane

0.125 (3,18) MIN

0.100 (2,54)

0.021 (0,53)
0.015 (0,38)   ⊕ 0.010 (0,25) Ⓜ

0.010 (0,25) NOM

0°–15°

14/18 PIN ONLY

4040049/C 08/95

NOTES: A. All linear dimensions are in inches (millimeters).
        B. This drawing is subject to change without notice.
        C. Falls within JEDEC MS-001 (20-pin package is shorter than MS-001).

MECHANICAL DATA

NS (R-PDSO-G)**   **PLASTIC SMALL-OUTLINE PACKAGE**
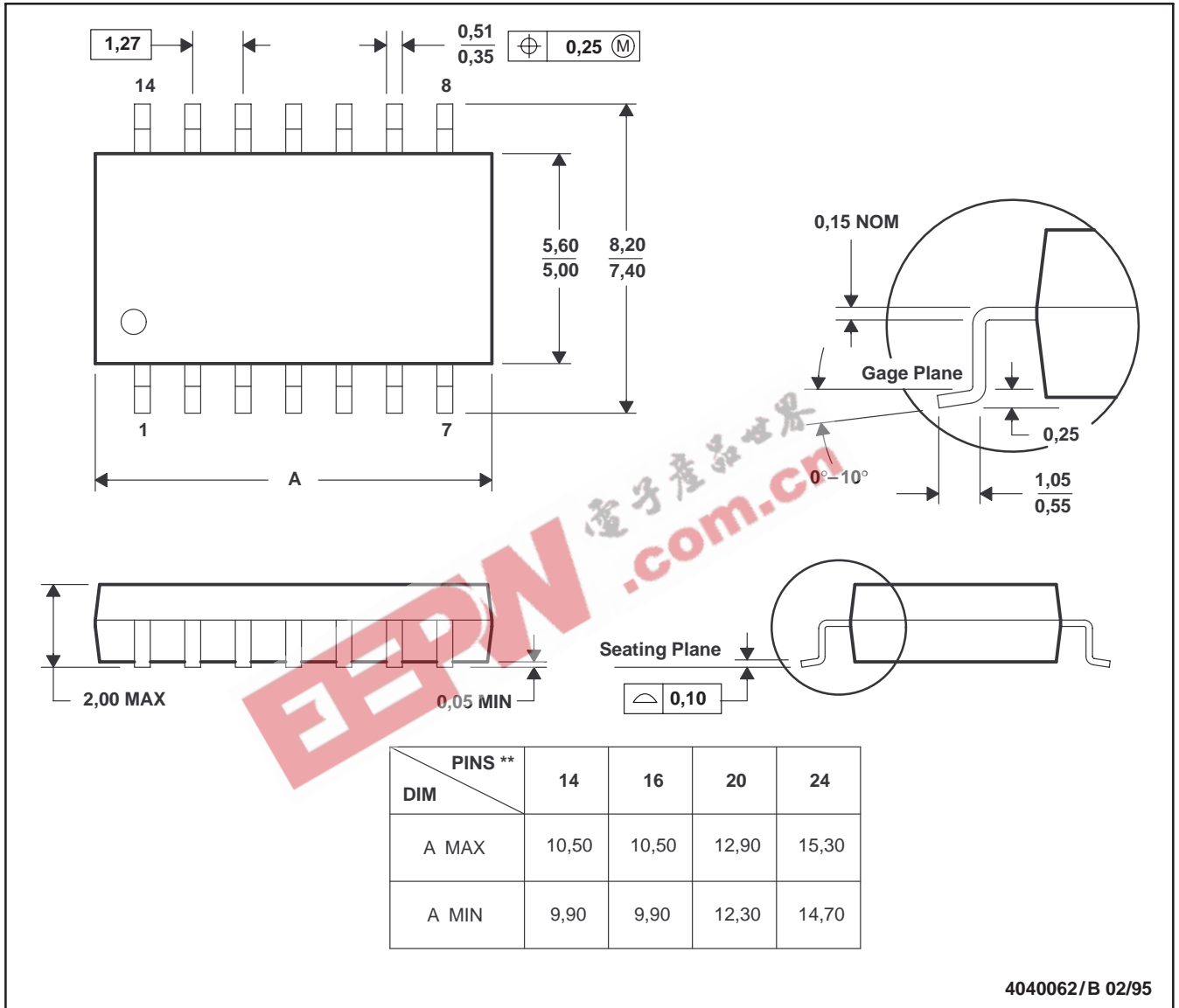
14 PINS SHOWN

1,27   0,51 / 0,35   ⊕ 0,25 Ⓜ

14   8

5,60 / 5,00   8,20 / 7,40

1   7

A

0,15 NOM

Gage Plane

0,25

0°–10°

1,05 / 0,55

2,00 MAX   0,05 MIN   Seating Plane   ⌓ 0,10

PINS ** / DIM	14	16	20	24
A MAX	10,50	10,50	12,90	15,30
A MIN	9,90	9,90	12,30	14,70

4040062/B 02/95

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

MECHANICAL DATA

PW (R-PDSO-G****)**   **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN

PINS ** DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
        B. This drawing is subject to change without notice.
        C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
        D. Falls within JEDEC MO-153