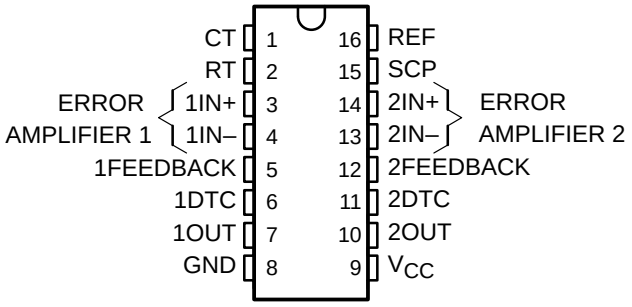
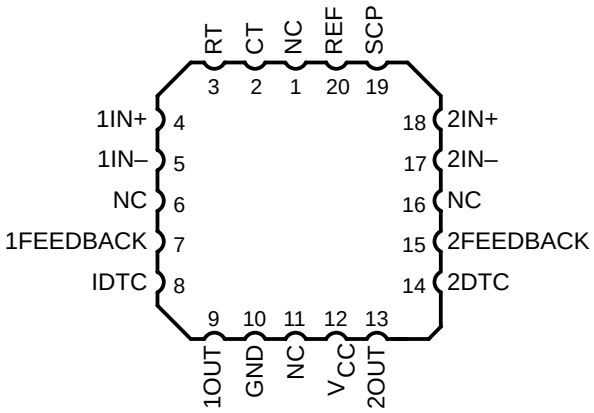
SLVS024E – FEBRUARY 1983 – REVISED NOVEMBER 1999

- **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)



FK PACKAGE
(TOP VIEW)



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	TL1451ACD	TL1451ACDB	TL1451ACN	TL1451ACNS	TL1451ACPW	—	—
–40°C to 125°C	TL1451AQD	—	—	—	—	—	—
–55°C to 125°C	—	—	—	—	—	TL1451AMFK	TL1451AMJ

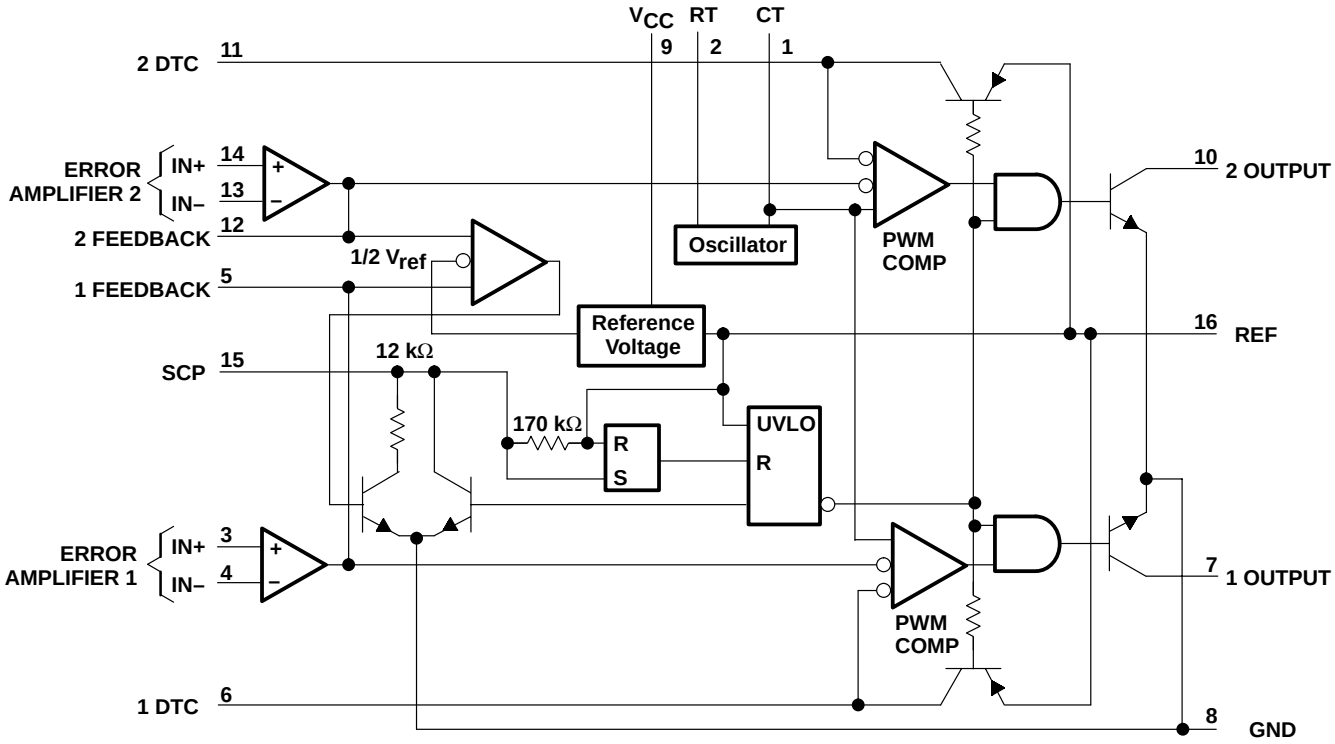
† The DB and PW packages are only available left-end taped and reeled (add LE suffix, i.e., TL1451ACPWLE).

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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 1999, Texas Instruments Incorporated
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

functional block diagram



COMPONENT COUNT

Resistors	65
Capacitors	8
Transistors	105
JFETs	18

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	$T_A \le 25°C$ 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
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.

dead-time control section

PARAMETER	TEST CONDITIONS	TL1451AC			UNIT
		MIN	TYP†	MAX	
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			UNIT
		MIN	TYP†	MAX	
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			UNIT
		MIN	TYP†	MAX	
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			UNIT
		MIN	TYP†	MAX	
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			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.

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.

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

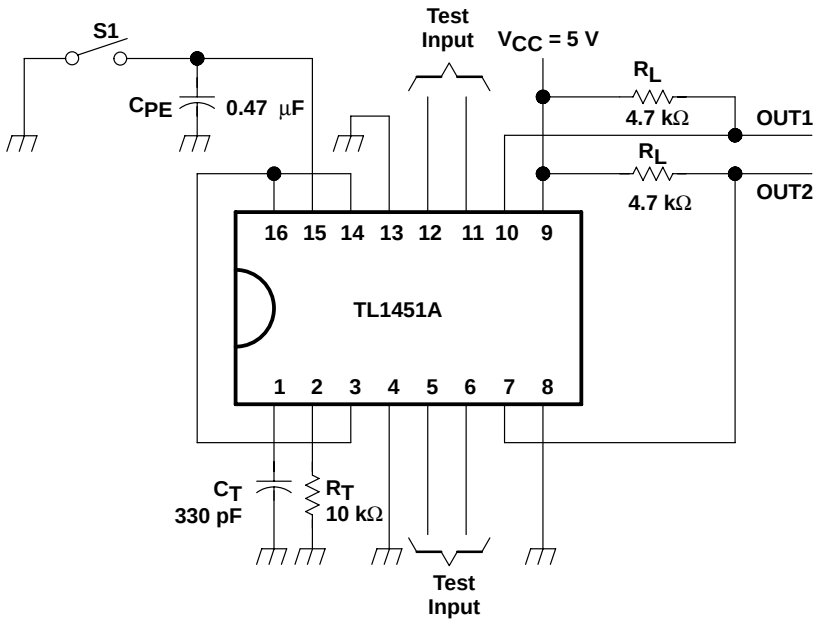
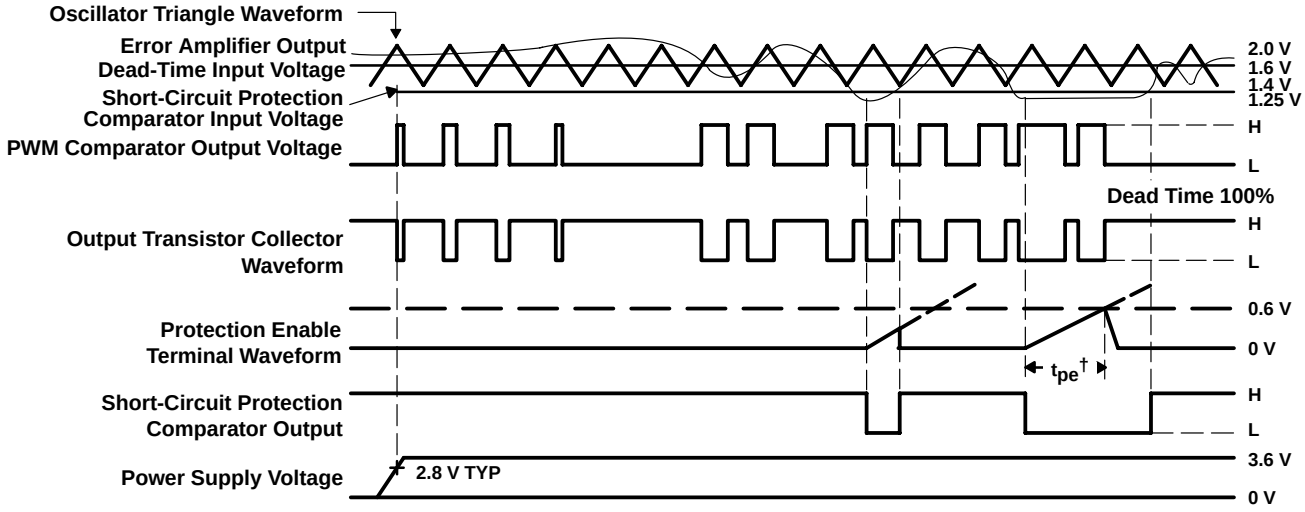


Figure 1. Test Circuit



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

Figure 2. TL1451A Timing Diagram

TYPICAL CHARACTERISTICS

TRIANGLE OSCILLATOR FREQUENCY vs TIMING RESISTANCE

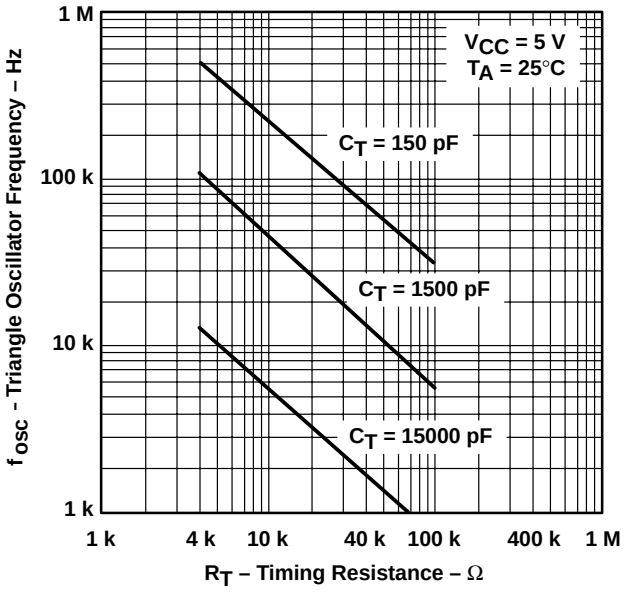


Figure 3

OSCILLATOR FREQUENCY VARIATION vs FREE-AIR TEMPERATURE

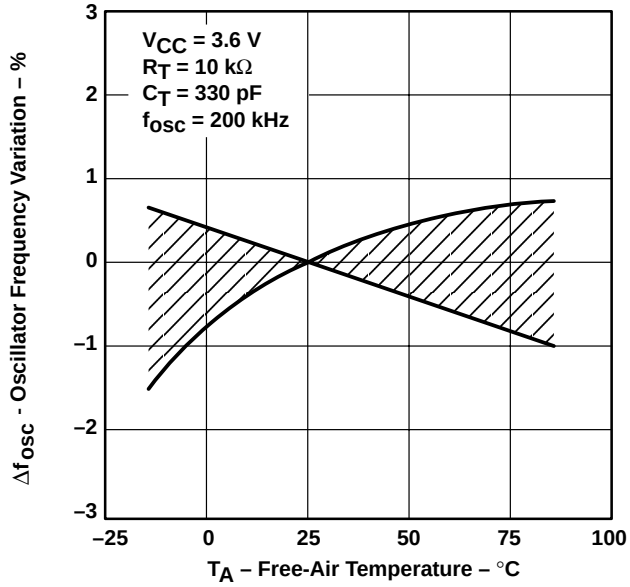


Figure 4

TRIANGLE WAVEFORM SWING VOLTAGE vs TIMING CAPACITANCE

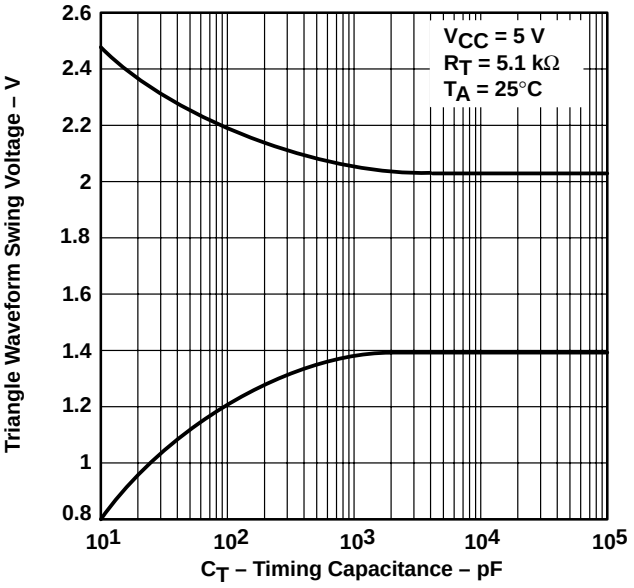


Figure 5

TRIANGLE WAVEFORM PERIOD vs TIMING CAPACITANCE

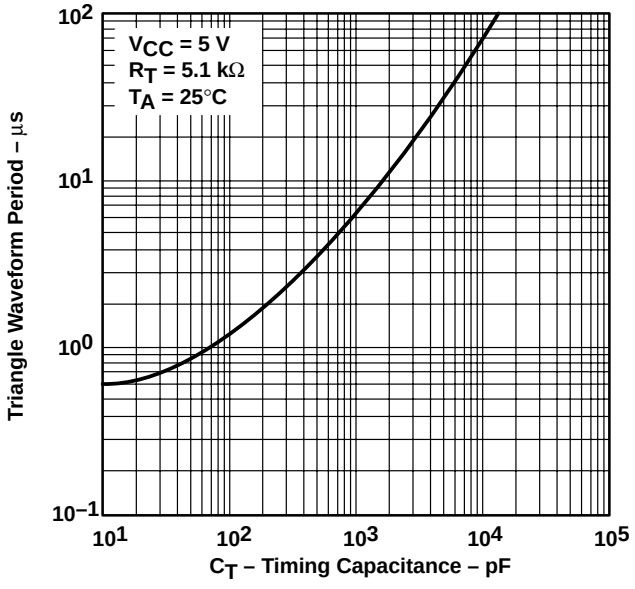


Figure 6

TYPICAL CHARACTERISTICS

REFERENCE OUTPUT VOLTAGE VARIATION vs FREE-AIR TEMPERATURE

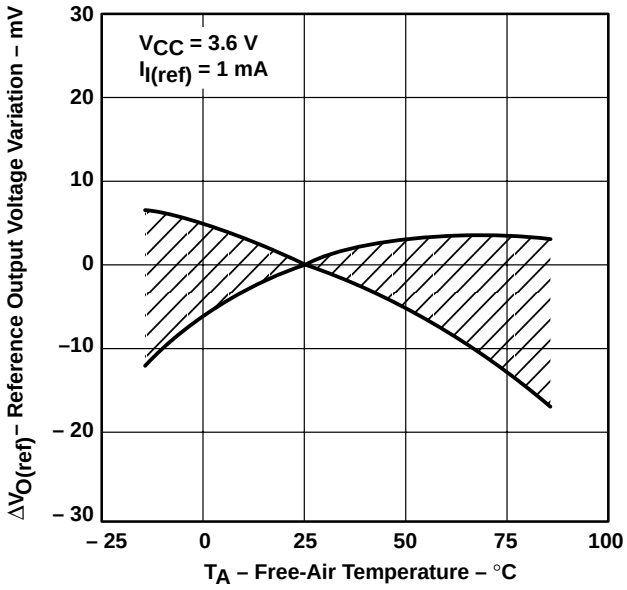


Figure 7

REFERENCE OUTPUT VOLTAGE VARIATION vs FREE-AIR TEMPERATURE

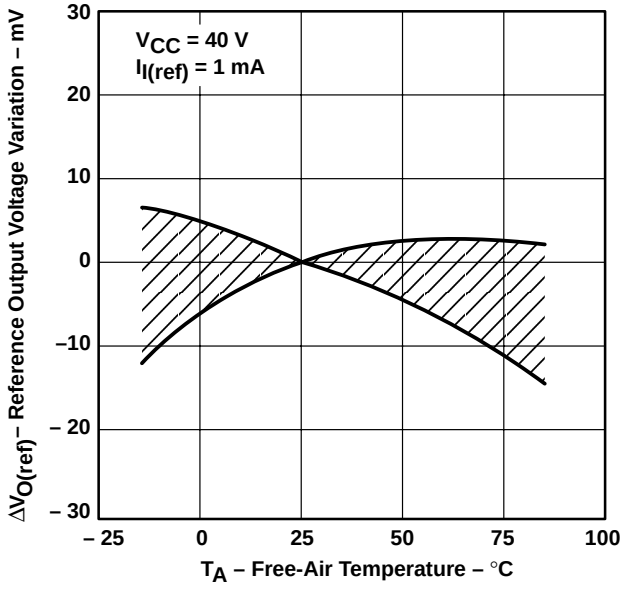


Figure 8

REFERENCE OUTPUT VOLTAGE vs SUPPLY VOLTAGE

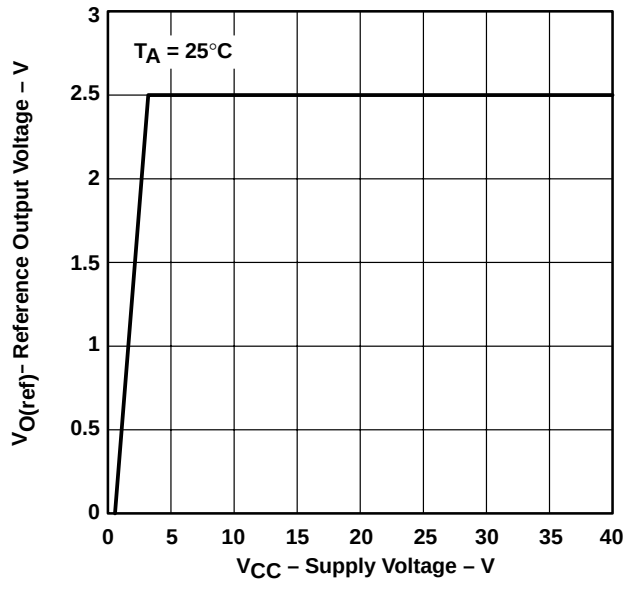


Figure 9

DROPOUT VOLTAGE VARIATION vs FREE-TEMPERATURE

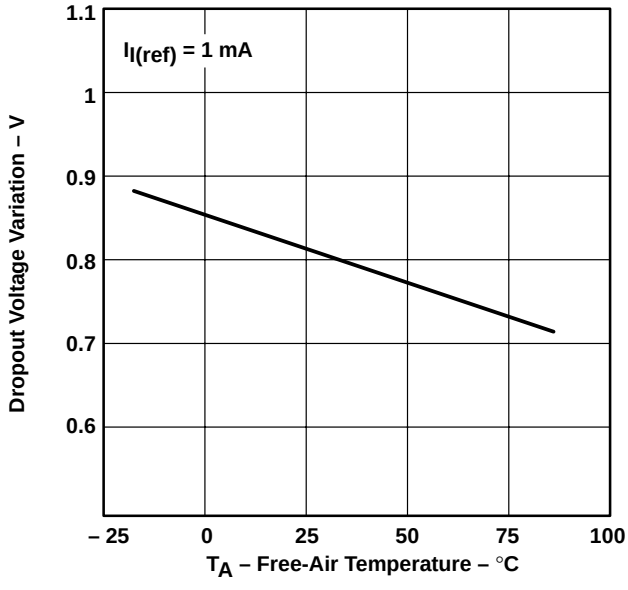


Figure 10

TYPICAL CHARACTERISTICS

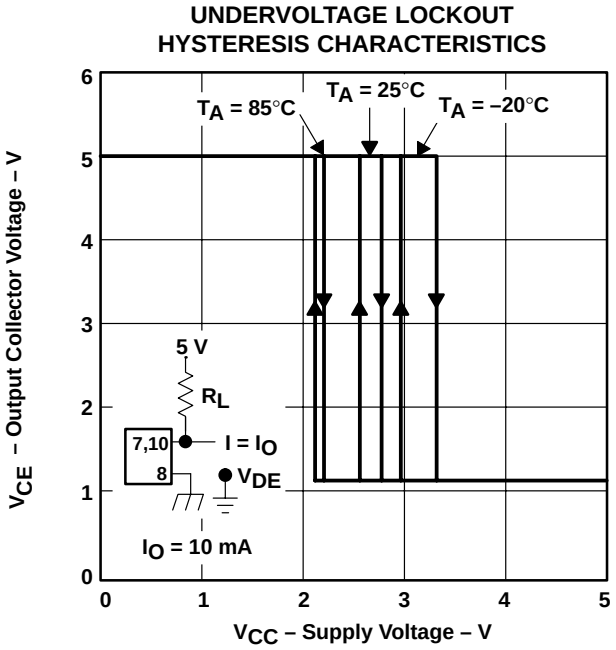


Figure 11

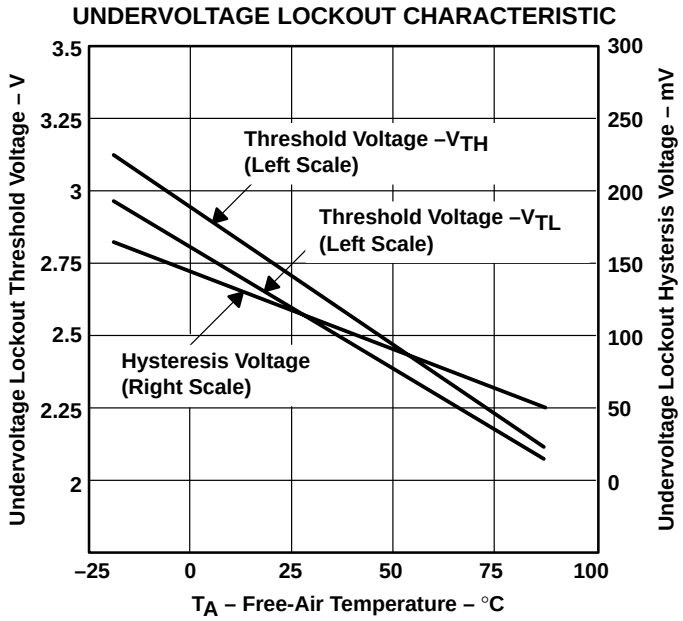


Figure 12

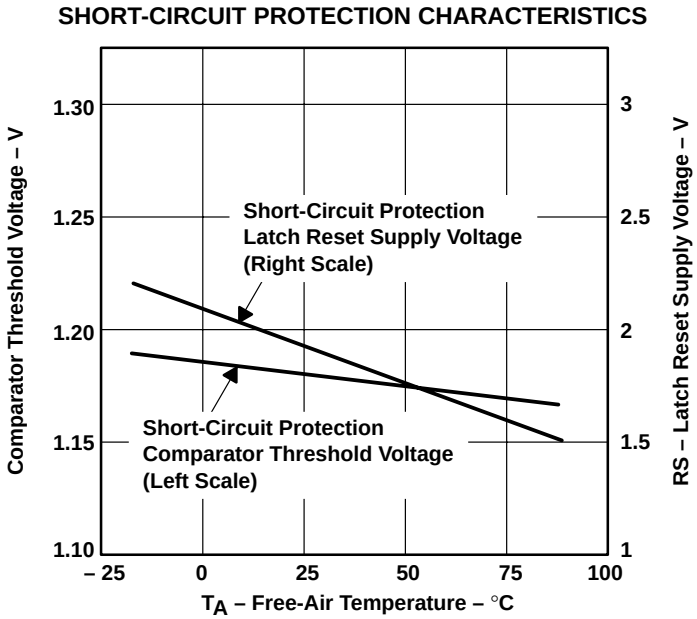
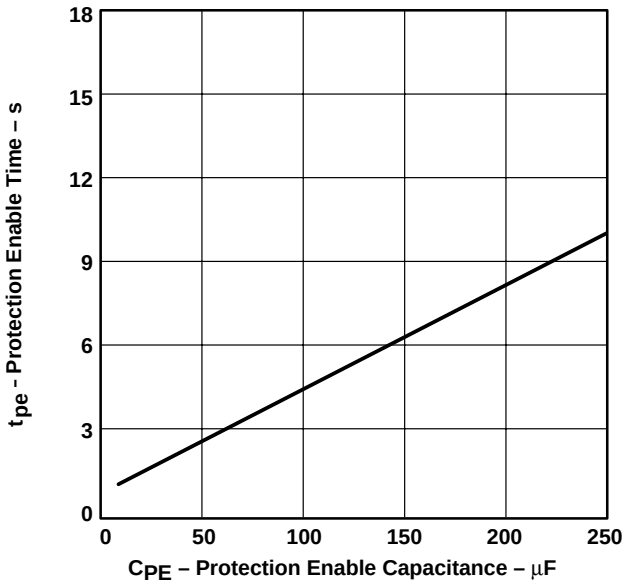


Figure 13

TYPICAL CHARACTERISTICS

PROTECTION ENABLE TIME
vs
PROTECTION ENABLE CAPACITANCE



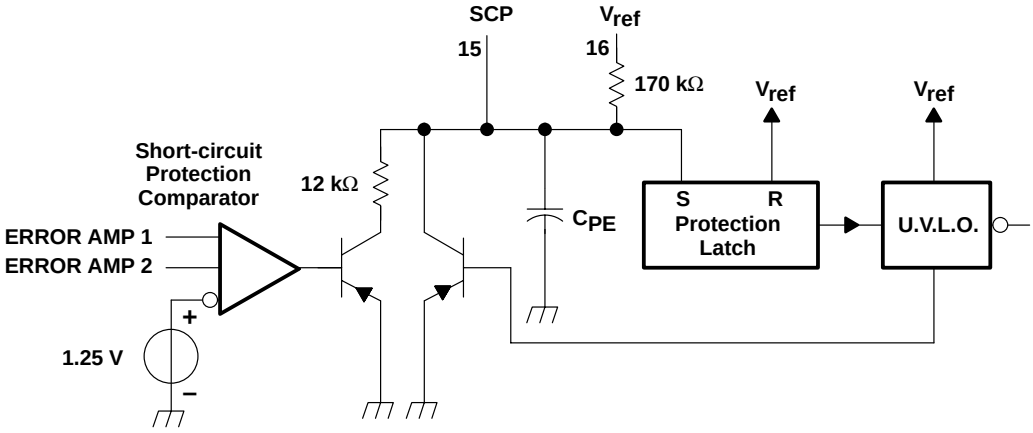


Figure 14

TYPICAL CHARACTERISTICS

ERROR AMP MAXIMUM OUTPUT VOLTAGE SWING vs FREQUENCY

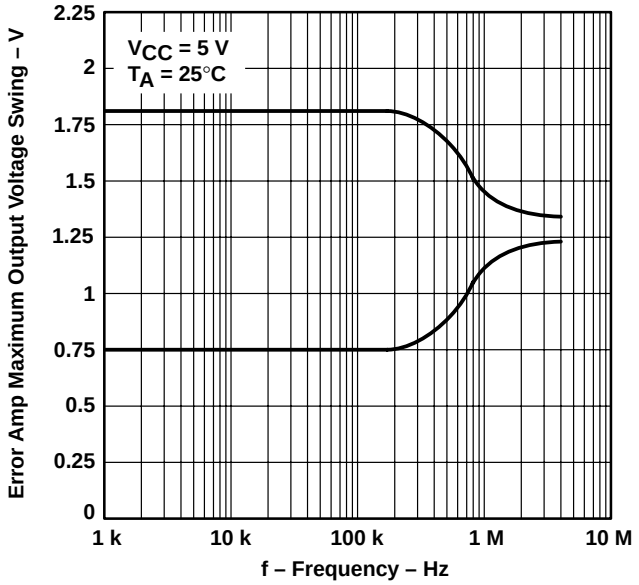


Figure 15

OPEN-LOOP VOLTAGE AMPLIFICATION vs FREQUENCY

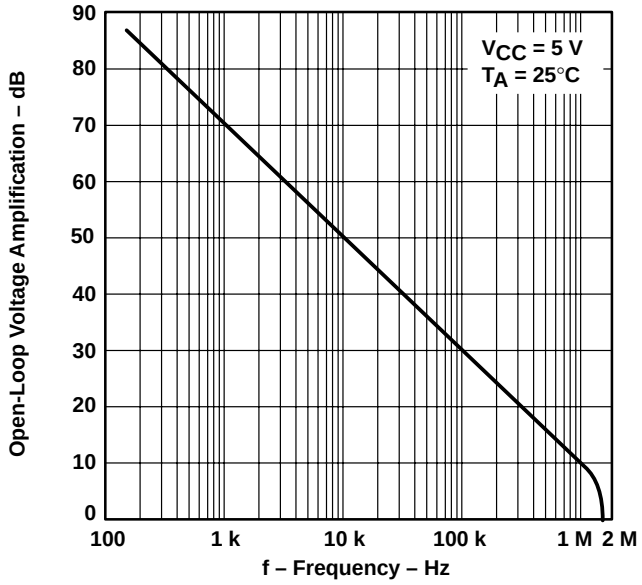


Figure 16

GAIN (AMPLIFIER IN UNITY-GAIN CONFIGURATION) vs FREQUENCY

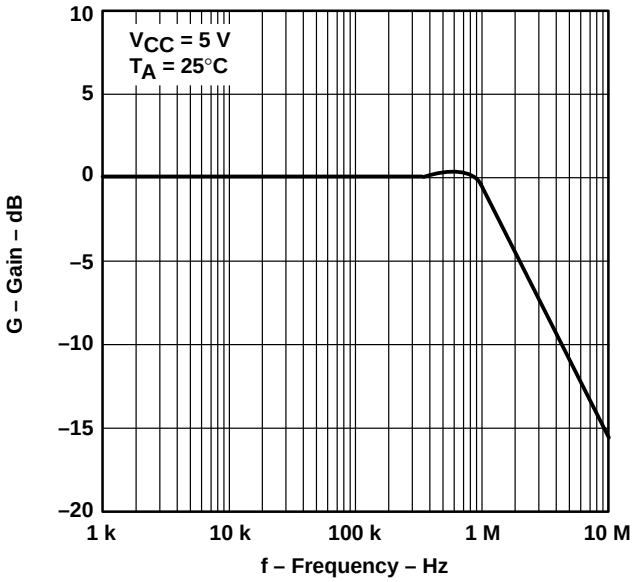
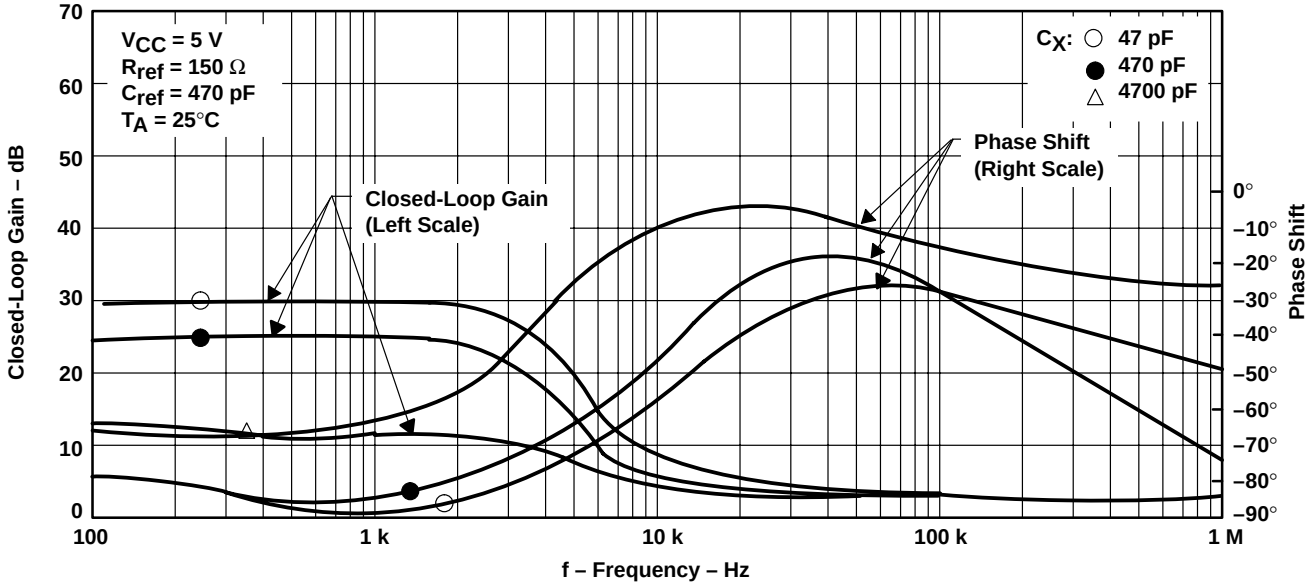
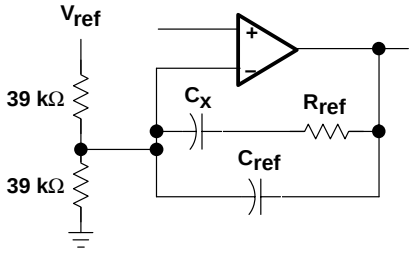


Figure 17

TYPICAL CHARACTERISTICS

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



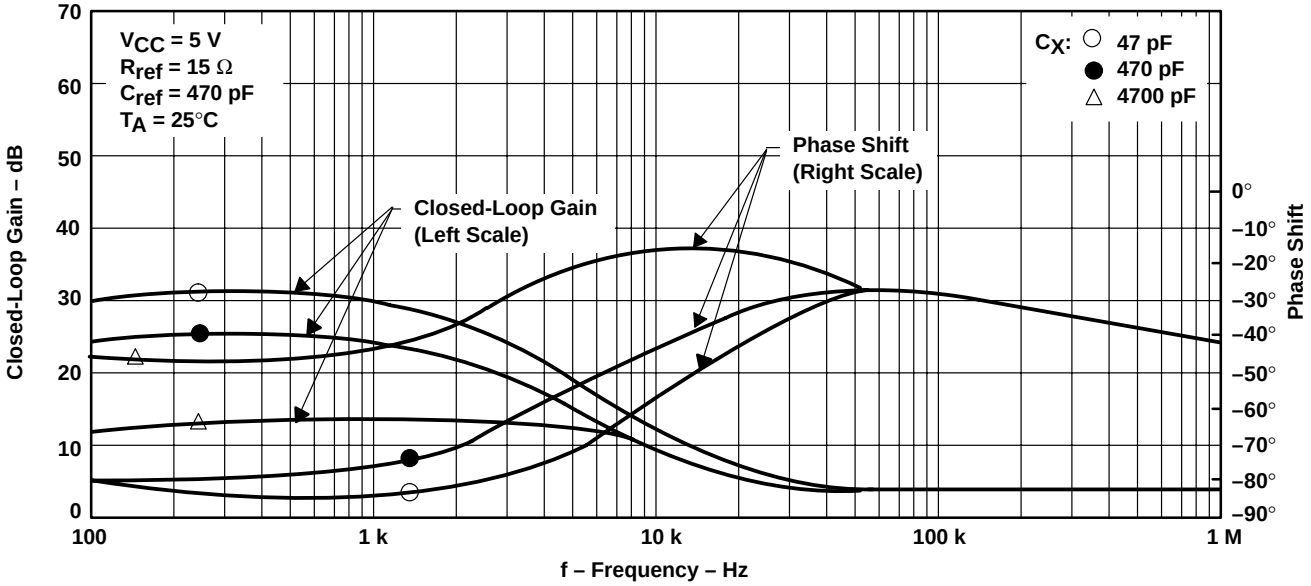


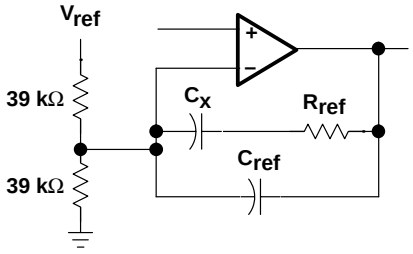
Test Circuit

Figure 18

TYPICAL CHARACTERISTICS

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



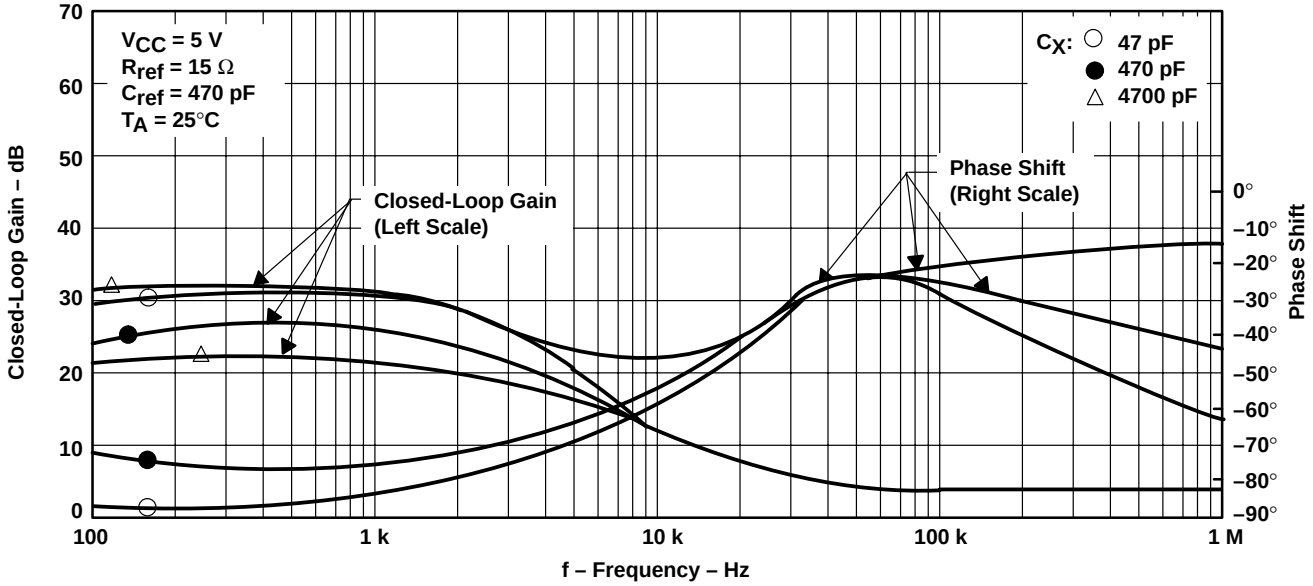


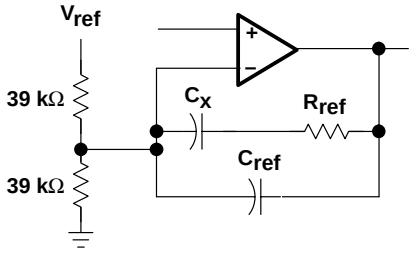
Test Circuit

Figure 19

TYPICAL CHARACTERISTICS

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

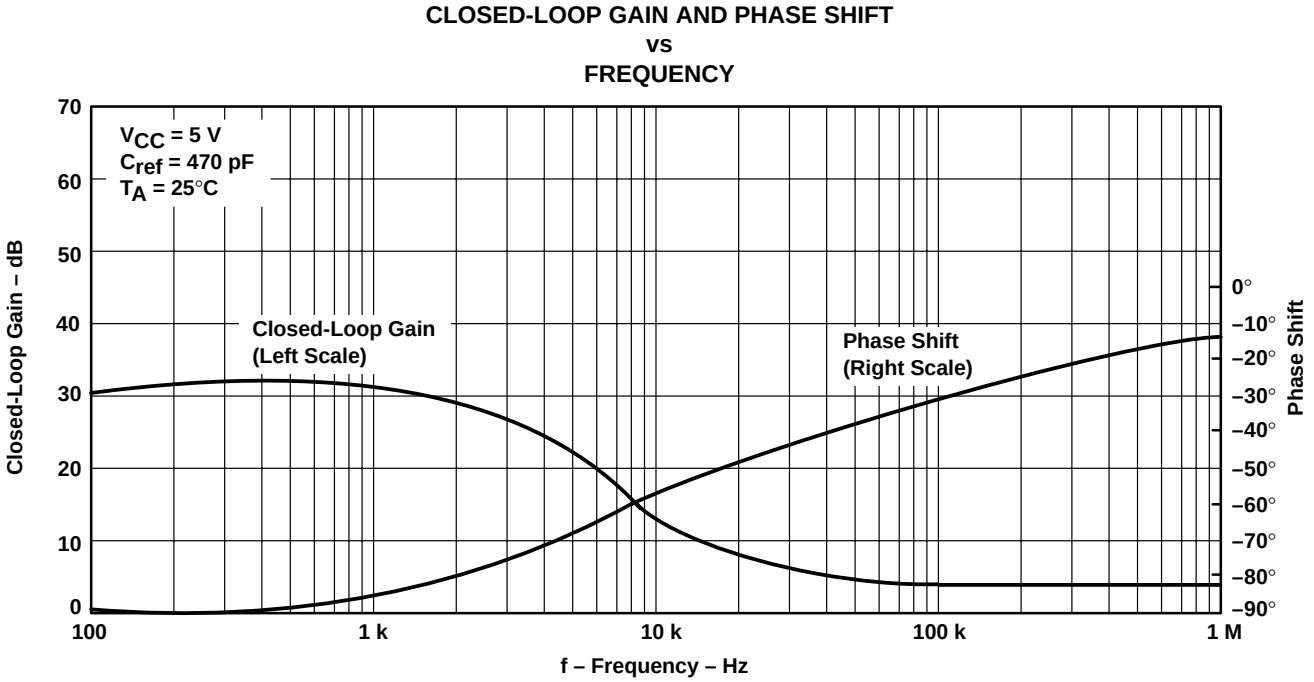


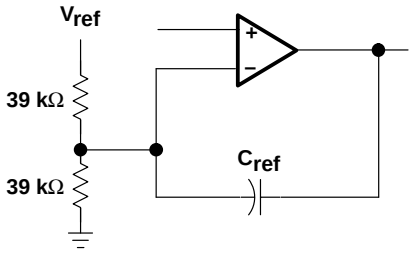


Test Circuit

Figure 20

TYPICAL CHARACTERISTICS





Test Circuit

Figure 21

TYPICAL CHARACTERISTICS

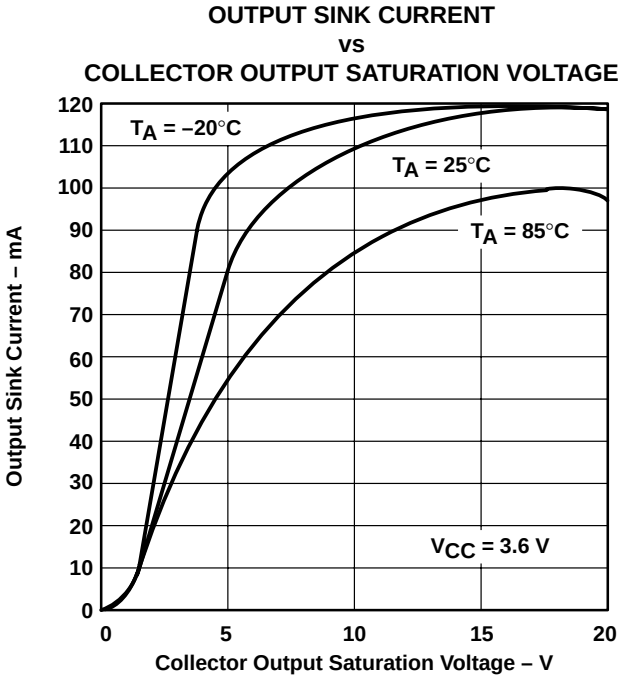
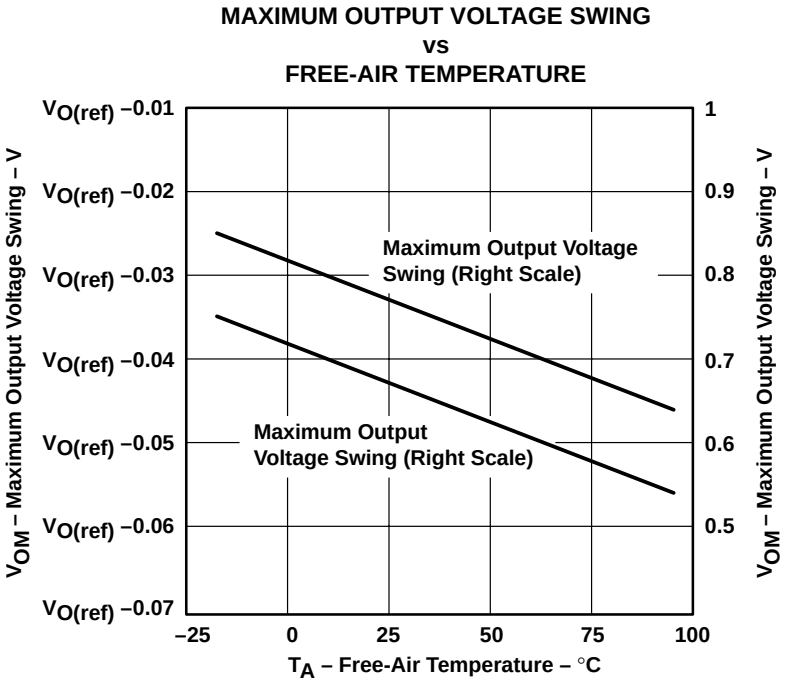
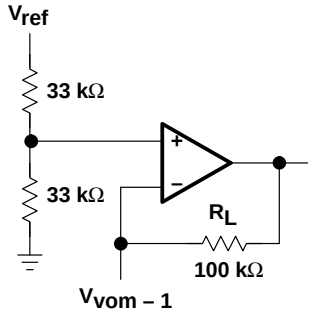


Figure 22





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)

TEST CIRCUIT

Figure 23

TYPICAL CHARACTERISTICS

OUTPUT TRANSISTOR ON DUTY CYCLE vs DEAD-TIME INPUT VOLTAGE

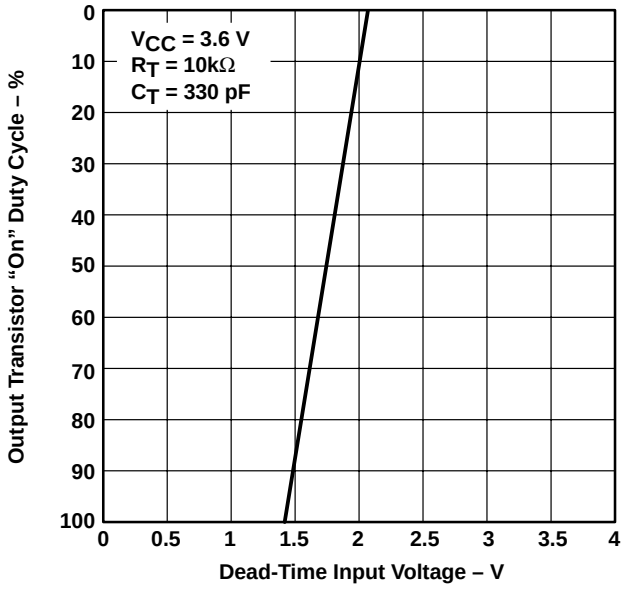


Figure 24

STANDBY CURRENT vs SUPPLY VOLTAGE

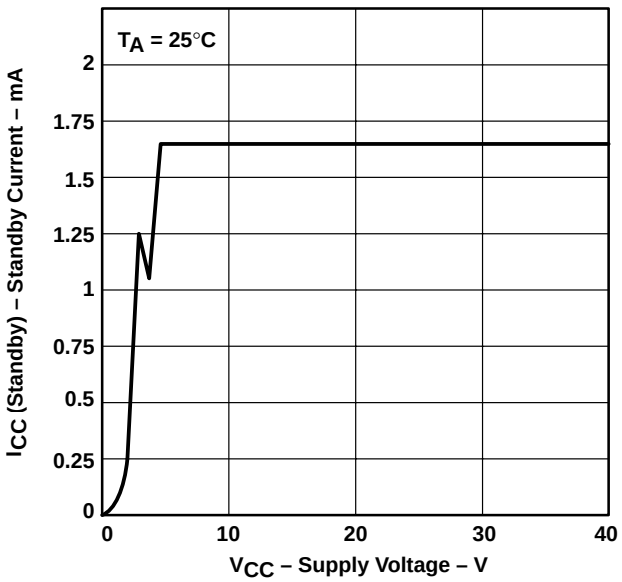


Figure 25

STANDBY CURRENT vs FREE-AIR TEMPERATURE

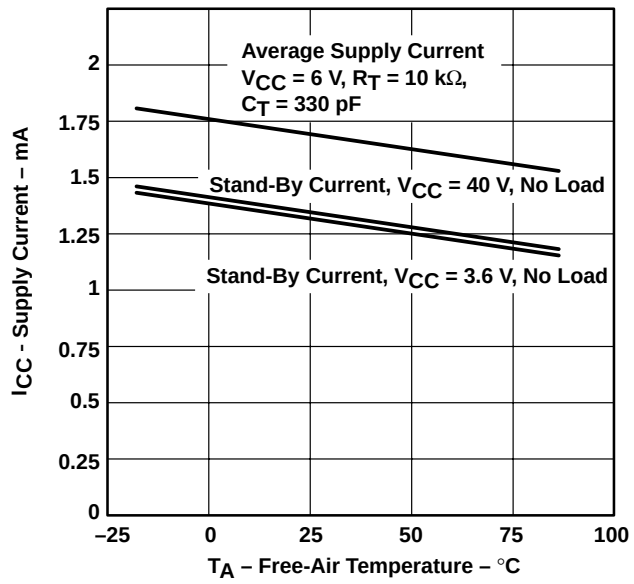


Figure 26

MAXIMUM CONTINUOUS POWER DISSIPATION vs FREE-AIR TEMPERATURE

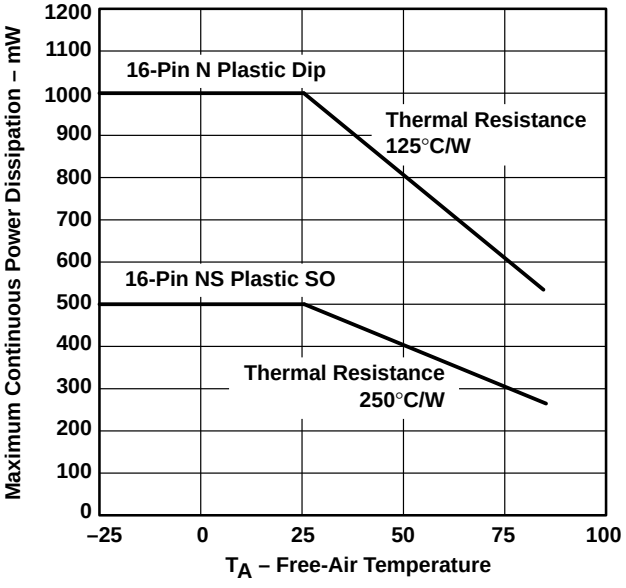
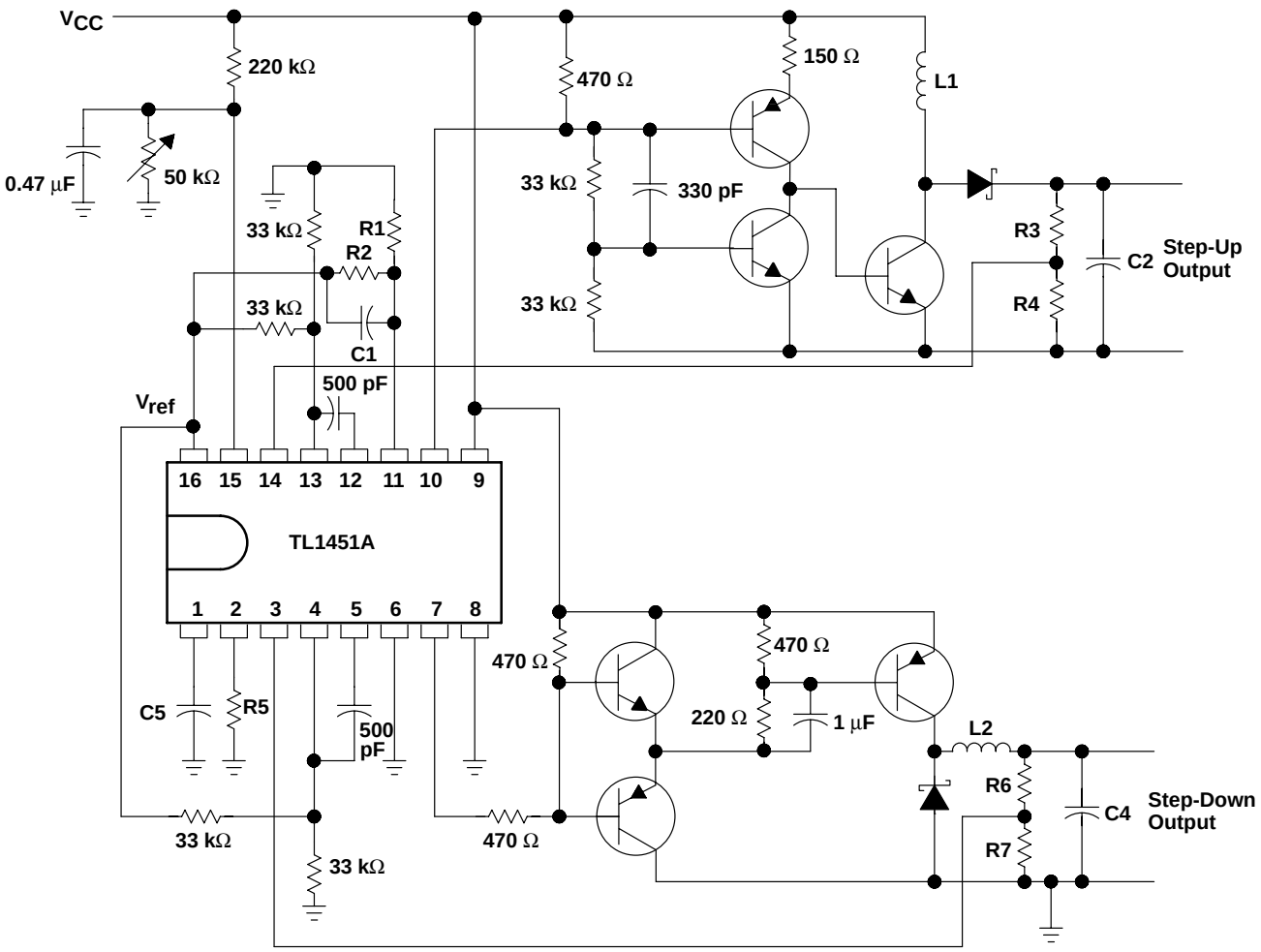


Figure 27

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

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TL1451ACD	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	TL1451AC	Samples
TL1451ACDBR	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	T1451A	Samples
TL1451ACDBRG4	ACTIVE	SSOP	DB	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	T1451A	Samples
TL1451ACDR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	TL1451AC	Samples
TL1451ACN	ACTIVE	PDIP	N	16	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-20 to 85	TL1451ACN	Samples
TL1451ACNS	ACTIVE	SO	NS	16	50	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 0	TL1451A	Samples
TL1451ACNSR	ACTIVE	SO	NS	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	TL1451A	Samples
TL1451ACPW	ACTIVE	TSSOP	PW	16	90	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	T1451A	Samples
TL1451ACPWR	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	T1451A	Samples
TL1451ACPWRG4	ACTIVE	TSSOP	PW	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	T1451A	Samples
TL1451AQD	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TL1451AQ	Samples
TL1451AQDR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TL1451AQ	Samples
TL1451CN	ACTIVE	PDIP	N	16	25	RoHS & Green	NIPDAU	N / A for Pkg Type	-20 to 85	TL1451CN	Samples
TL1451CNS	ACTIVE	SO	NS	16	50	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	TL1451	Samples
TL1451CNSR	ACTIVE	SO	NS	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	TL1451	Samples
TL1451INSR	ACTIVE	SO	NS	16	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-20 to 85	TL1451I	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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 finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material 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 :

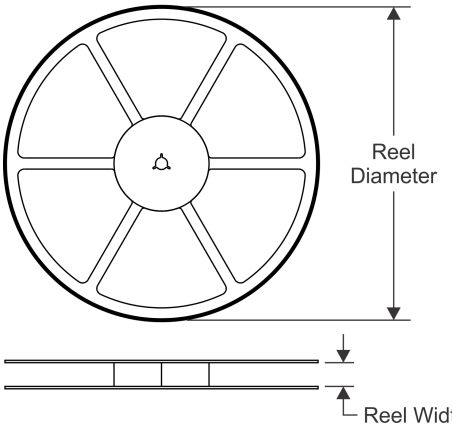
- Automotive : TL1451A-Q1
- Enhanced Product : TL1451A-EP

NOTE: Qualified Version Definitions:

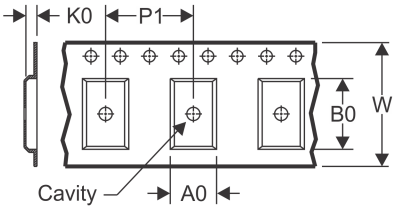
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

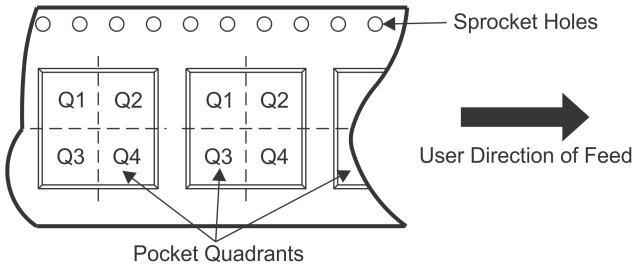


TAPE DIMENSIONS



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

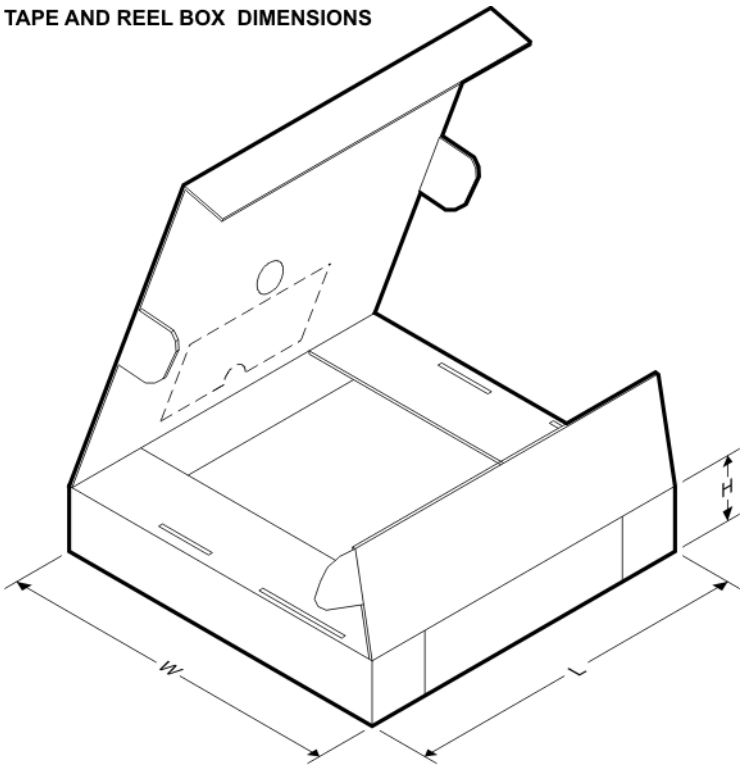
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TL1451ACDBR	SSOP	DB	16	2000	330.0	16.4	8.35	6.6	2.5	12.0	16.0	Q1
TL1451ACDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TL1451ACNSR	SO	NS	16	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1
TL1451ACPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TL1451AQDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TL1451CNSR	SO	NS	16	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1
TL1451INSR	SO	NS	16	2000	330.0	16.4	8.1	10.4	2.5	12.0	16.0	Q1

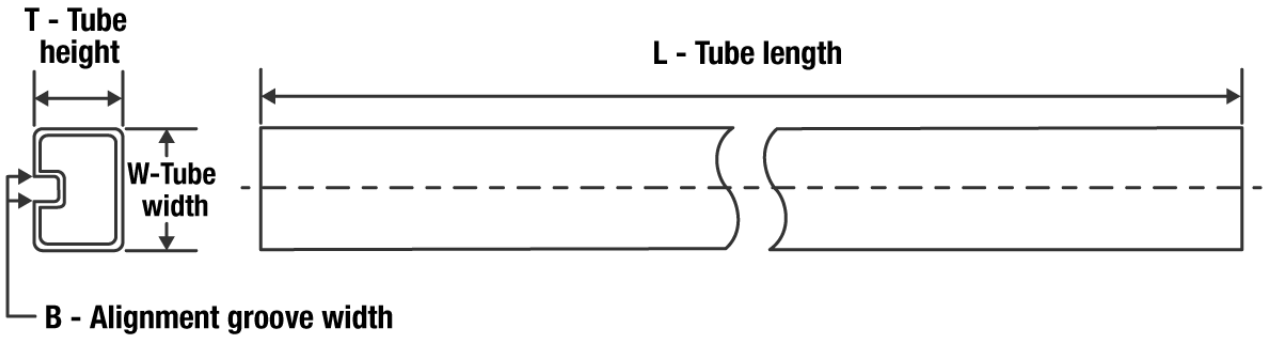
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

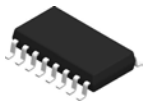
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TL1451ACDBR	SSOP	DB	16	2000	853.0	449.0	35.0
TL1451ACDR	SOIC	D	16	2500	340.5	336.1	32.0
TL1451ACNSR	SO	NS	16	2000	853.0	449.0	35.0
TL1451ACPWR	TSSOP	PW	16	2000	853.0	449.0	35.0
TL1451AQDR	SOIC	D	16	2500	350.0	350.0	43.0
TL1451CNSR	SO	NS	16	2000	853.0	449.0	35.0
TL1451INSR	SO	NS	16	2000	853.0	449.0	35.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
TL1451ACD	D	SOIC	16	40	507	8	3940	4.32
TL1451ACD	D	SOIC	16	40	505.46	6.76	3810	4
TL1451ACN	N	PDIP	16	25	506	13.97	11230	4.32
TL1451ACNS	NS	SOP	16	50	530	10.5	4000	4.1
TL1451ACPW	PW	TSSOP	16	90	530	10.2	3600	3.5
TL1451AQD	D	SOIC	16	40	505.46	6.76	3810	4
TL1451CN	N	PDIP	16	25	506	13.97	11230	4.32
TL1451CNS	NS	SOP	16	50	530	10.5	4000	4.1

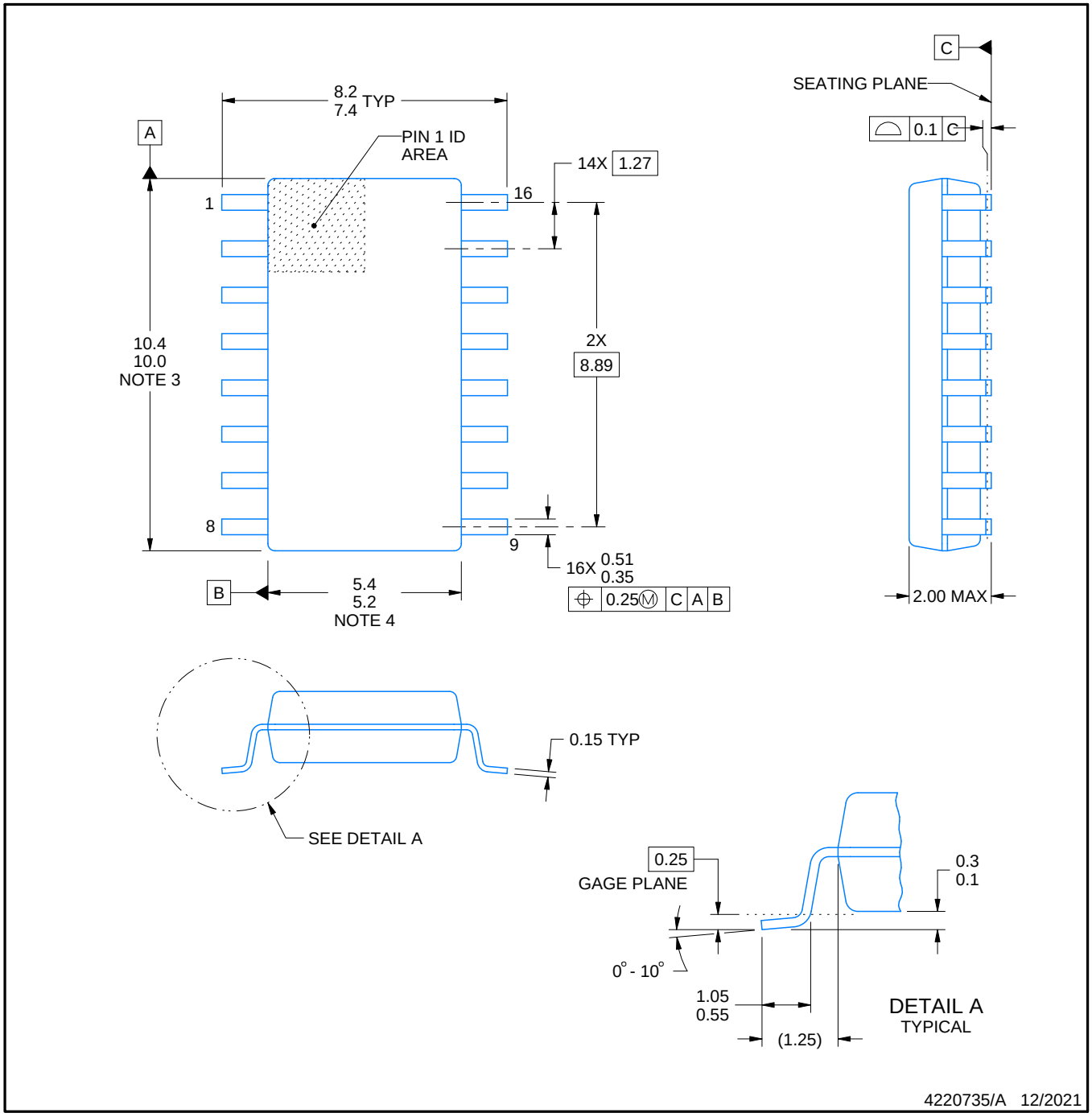


PACKAGE OUTLINE

NS0016A

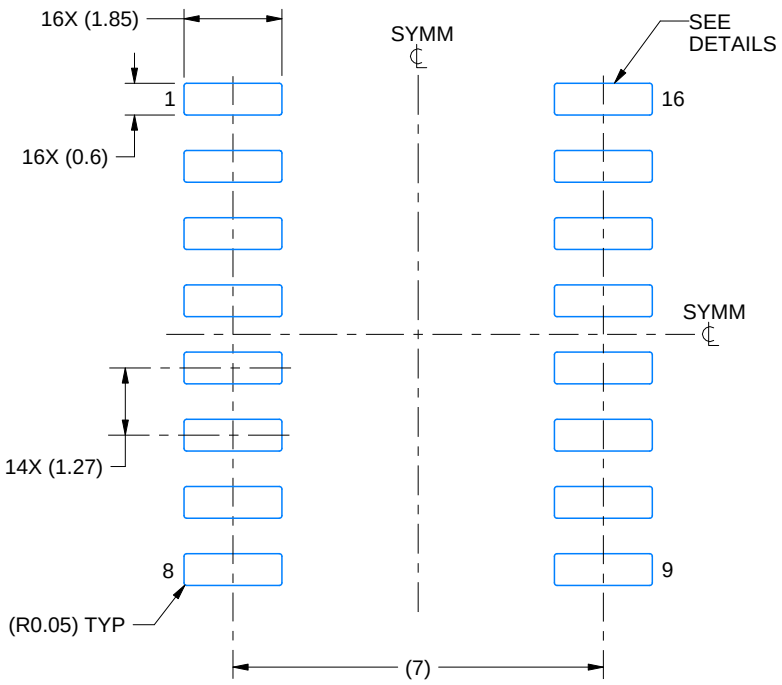
SOP - 2.00 mm max height

SOP

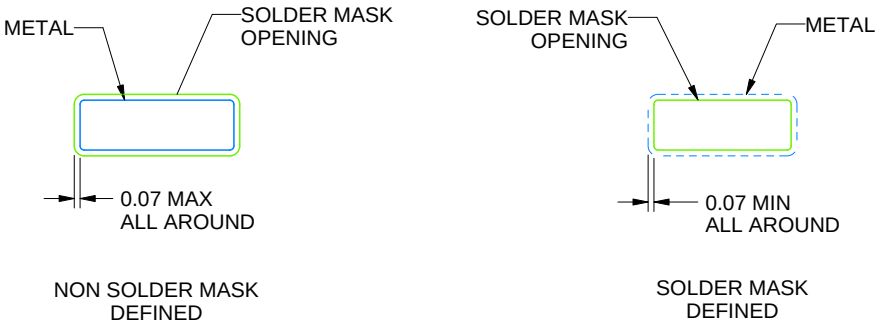


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm, per side.



LAND PATTERN EXAMPLE
SCALE:7X



NON SOLDER MASK
DEFINED

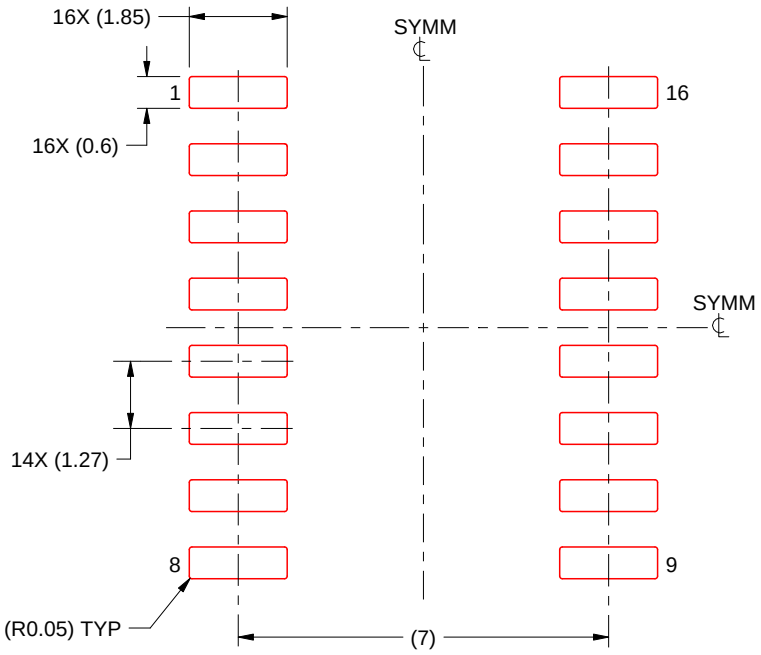
SOLDER MASK
DEFINED

SOLDER MASK DETAILS

4220735/A 12/2021

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



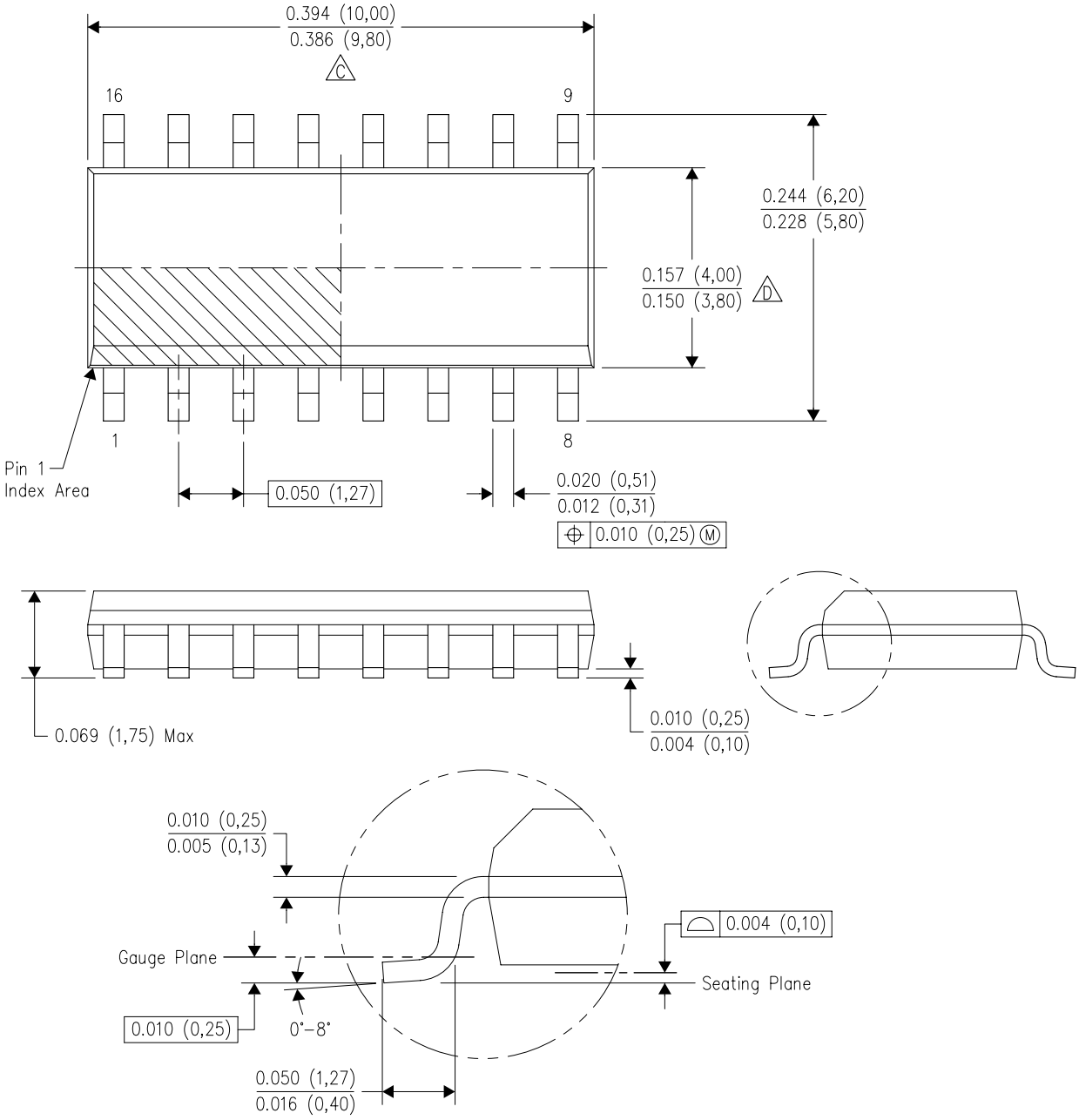
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:7X

4220735/A 12/2021

NOTES: (continued)

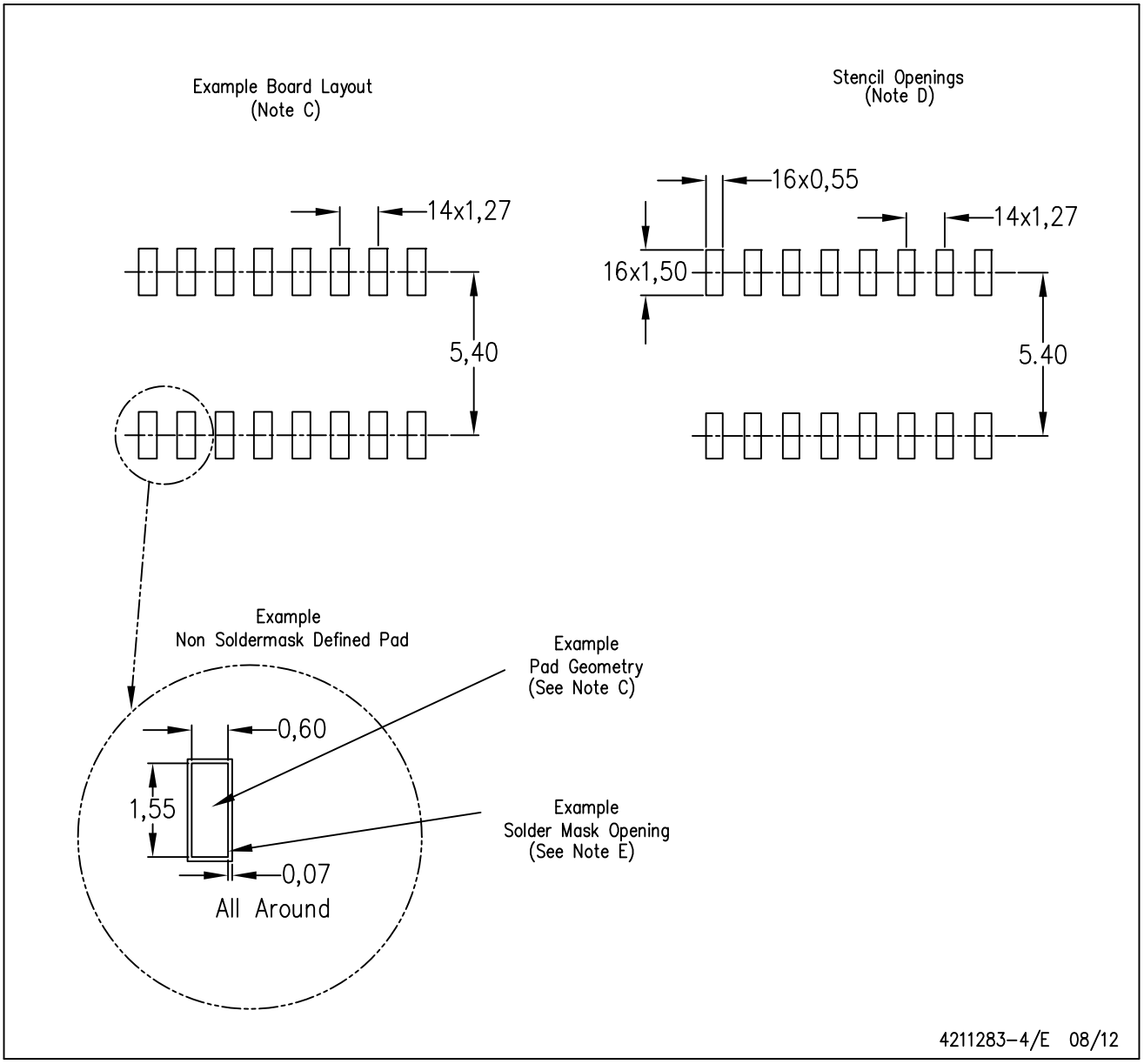
7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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



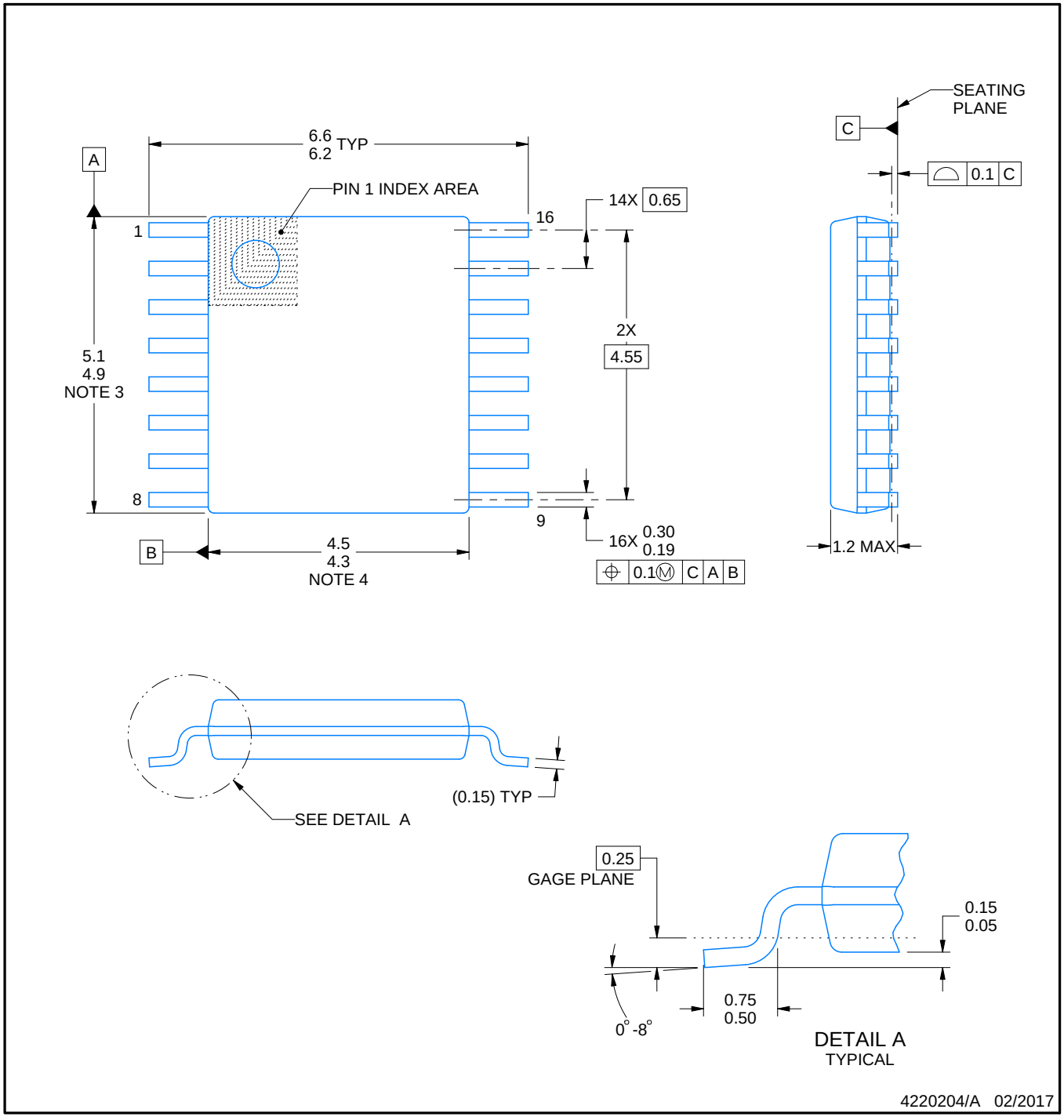
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

PACKAGE OUTLINE

PW0016A

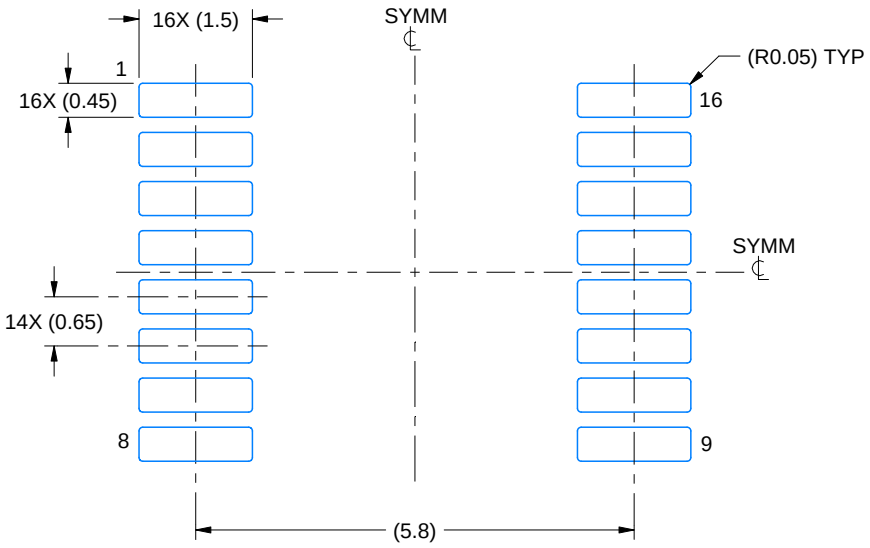
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

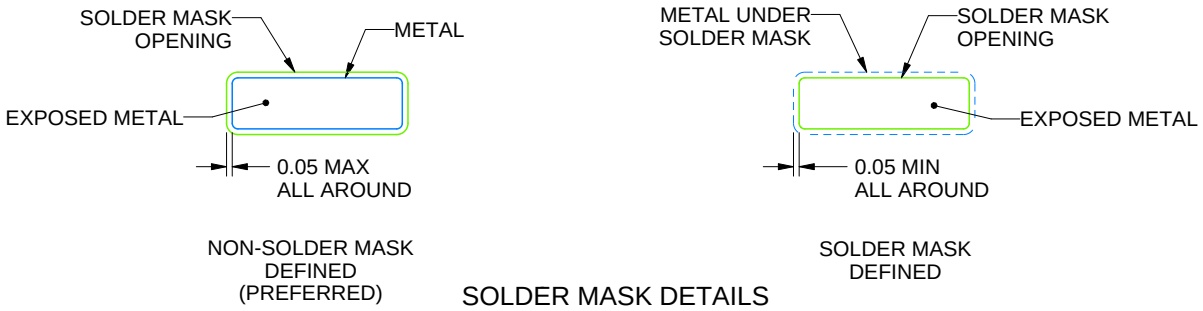


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

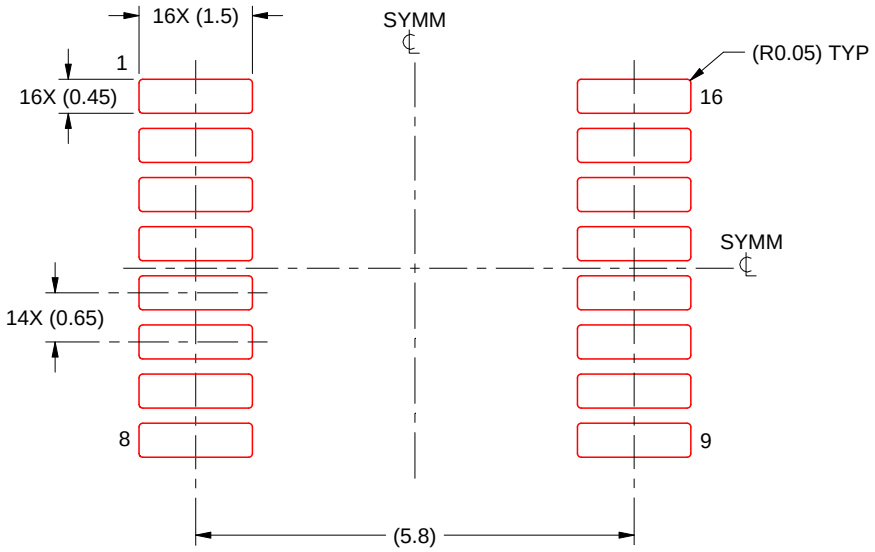


SOLDER MASK DETAILS

4220204/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220204/A 02/2017

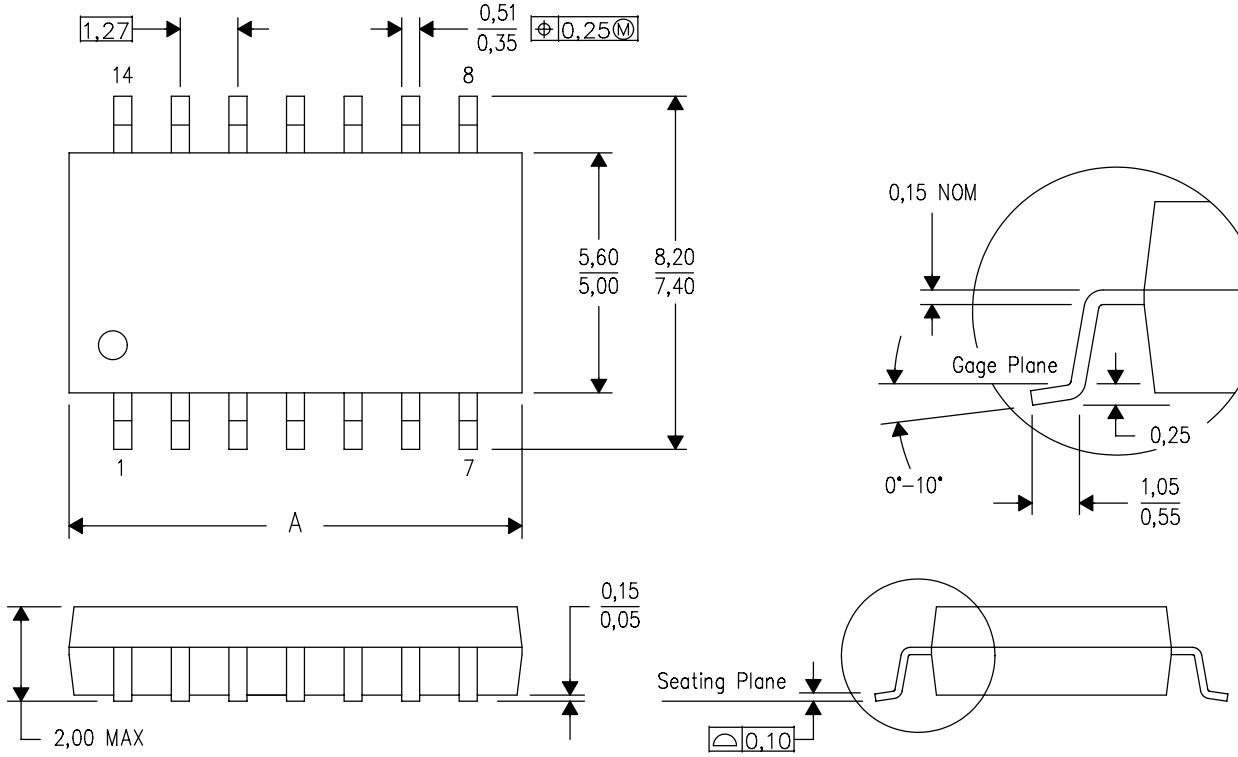
NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

MECHANICAL DATA

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

14-PINS SHOWN



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

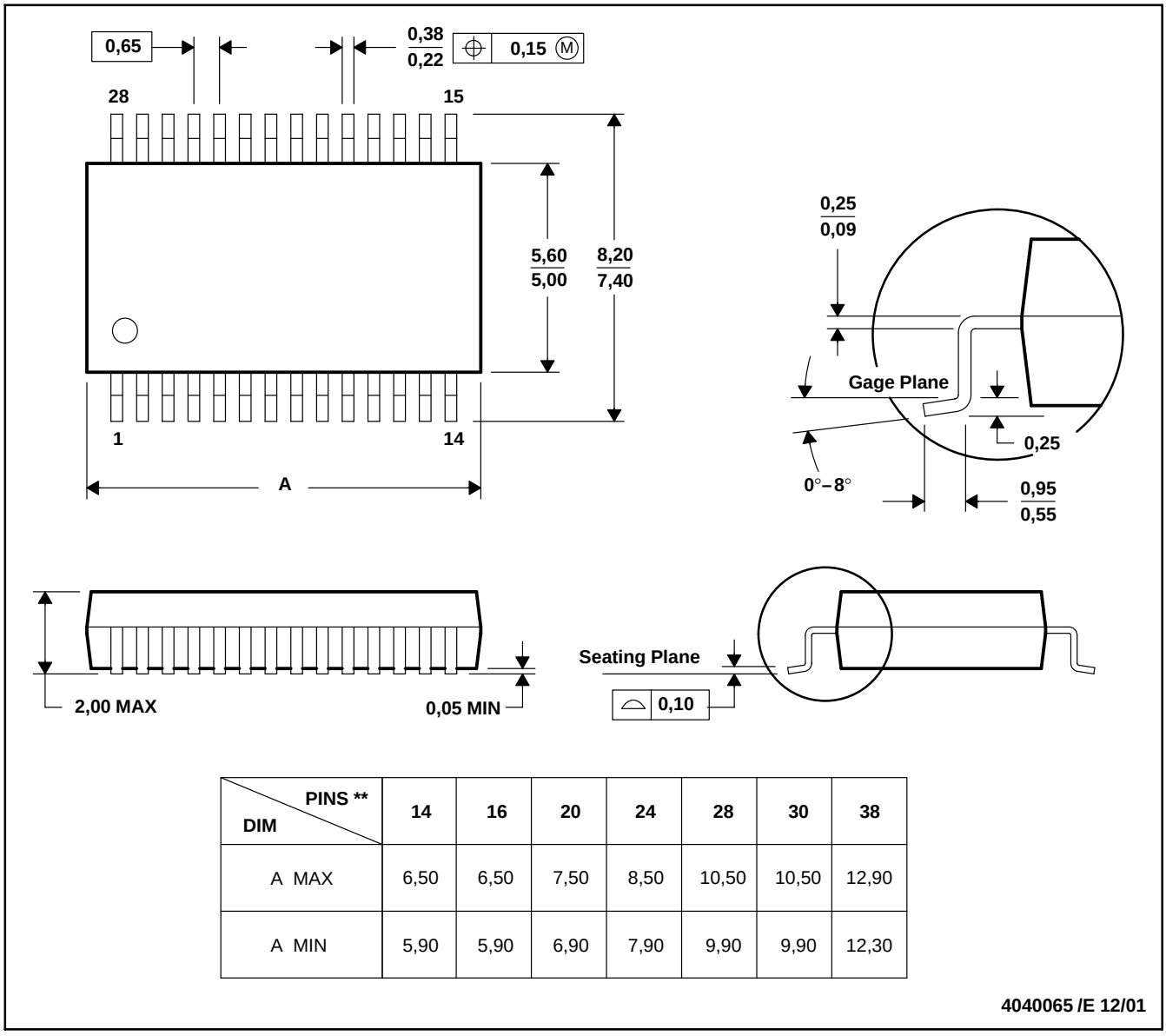
4040062/C 03/03

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.

MSSO002E – JANUARY 1995 – REVISED DECEMBER 2001

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

28 PINS SHOWN



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

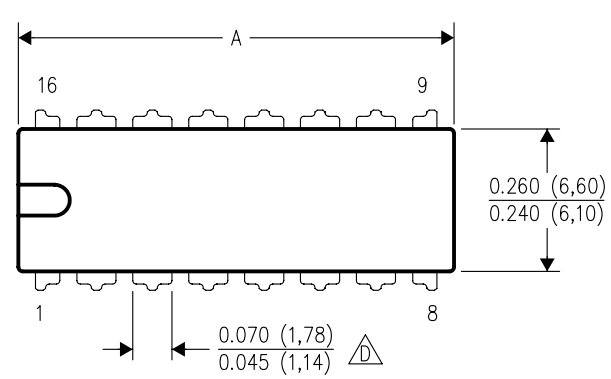
4040065 /E 12/01

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

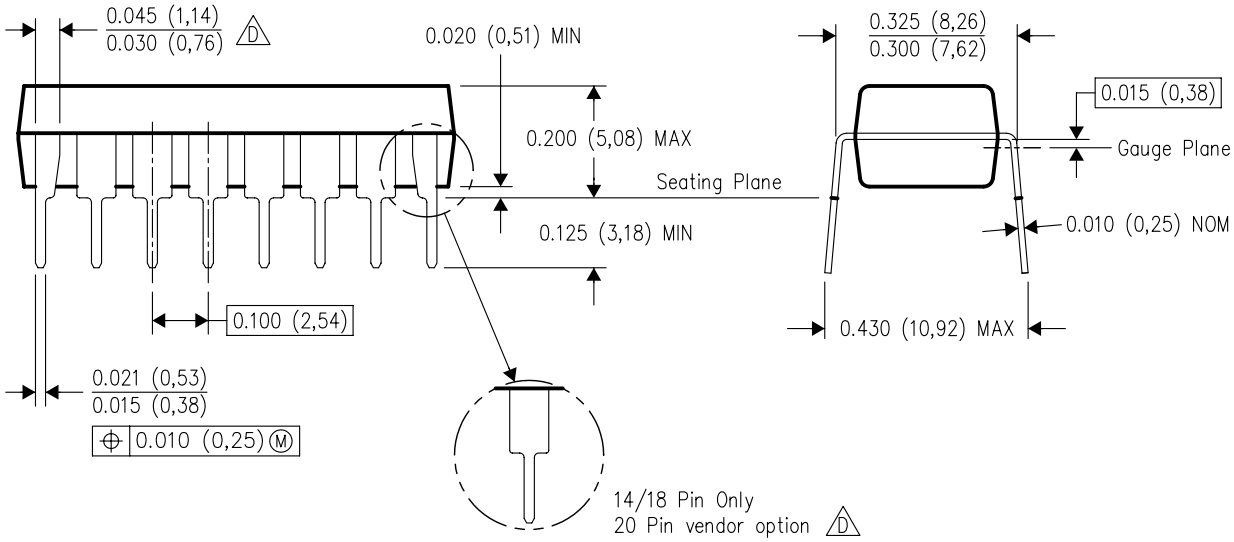
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2022, Texas Instruments Incorporated