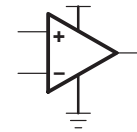


# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

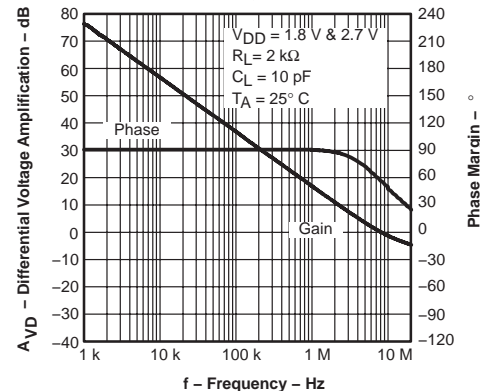
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- Supply Voltage Range . . . 1.8 V to 3.6 V
- Rail-to-Rail Input/Output
- High Bandwidth . . . 8 MHz
- High Slew Rate . . . 4.8 V/ $\mu$ s
- $V_{ICR}$  Exceeds Rails . . .  $-0.2$  V to  $V_{DD} + 0.2$
- Supply Current . . . 650  $\mu$ A/Channel
- Input Noise Voltage . . . 9 nV/ $\sqrt{\text{Hz}}$  at 10 kHz
- Specified Temperature Range:  
0°C to 70°C . . . Commercial Grade  
-40°C to 125°C . . . Industrial Grade
- Ultrasmall Packaging
- Universal Operational Amplifier EVM

## Operational Amplifier



## DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE VS FREQUENCY



## description

The TLV278x single supply operational amplifiers provide rail-to-rail input and output capability. The TLV278x takes the minimum operating supply voltage down to 1.8 V over the extended industrial temperature range ( $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ) while adding the rail-to-rail output swing feature. The TLV278x also provides 8 MHz bandwidth from only 650  $\mu$ A of supply current. The maximum recommended supply voltage is 3.6 V, which allows the devices to be operated from ( $\pm 1.8$  V supplies down to  $\pm 0.9$  V) two rechargeable cells.

The combination of wide bandwidth, low noise, and low distortion makes it ideal for high speed and high resolution data converter applications.

All members are available in PDIP, SOIC, and the newer, smaller SOT-23 (singles), MSOP (duals), and TSSOP (quads).

FAMILY PACKAGE TABLE

DEVICE	$V_{DD}$ [V]	$V_{IO}$ [ $\mu$ V]	$I_{DD}/\text{ch}$ [ $\mu$ A]	$I_{IB}$ [pA]	GBW [MHz]	SLEW RATE [V/ $\mu$ s]	$V_n$ , 1 kHz [nV/ $\sqrt{\text{Hz}}$ ]	$I_O$ [mA]	SHUTDOWN	RAIL-TO-RAIL
TLV278x(A)	1.8–3.6	250	650	2.5	8	5	18	10	Y	I/O
TLV276x(A)	1.8–3.6	550	20	3	0.5	0.23	95	5	Y	I/O
TLV246x(A)	2.7–6	150	550	1300	6.4	1.6	11	25	Y	I/O
TLV247x(A)	2.7–6	250	600	2.5	2.8	1.5	15	20	Y	I/O
TLV244x(A)	2.7–10	300	750	1	1.81	1.4	16	2	—	O
TLV277x(A)	2.5–5.5	360	1000	2	5.1	10.5	17	6	Y	O



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.

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# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## TLV2780 and TLV2781 AVAILABLE OPTIONS(1)

T <sub>A</sub>	V <sub>IOmax</sub> AT 25°C	PACKAGED DEVICES			
		SMALL OUTLINE (D)†	SOT-23		PLASTIC DIP (P)
			(DBV)‡	SYMBOL	
0°C to 70°C	3000 μV	TLV2780CD	TLV2780CDBV	VASC	—
		TLV2781CD	TLV2781CDBV	VATC	—
-40°C to 125°C	3000 μV	TLV2780ID	TLV2780IDBV	VASI	TLV2780IP
	2000 μV	TLV2781ID	TLV2781IDBV	VATI	TLV2781IP
		TLV2780AID	—	—	—
		TLV2781AID	—	—	—

† This package is available taped and reeled. To order this packaging option, add an **R** suffix to the part number (e.g., TLV2780CDR).

‡ This package is only available taped and reeled. For standard quantities (3,000 pieces per reel), add an **R** suffix (i.e., TLV2780CDBVR). For smaller quantities (250 pieces per mini-reel), add a **T** suffix to the part number (e.g., TLV2780CDBVT).

## TLV2782 and TLV2783 AVAILABLE OPTIONS(1)

T <sub>A</sub>	V <sub>IOmax</sub> AT 25°C	PACKAGED DEVICES						
		SMALL OUTLINE† (D)	MSOP				PLASTIC DIP (N)	PLASTIC DIP (P)
			(DGK)†	SYMBOL	(DGS)†	SYMBOL		
0°C to 70°C	3000 μV	TLV2782CD	TLV2782CDGK	xxTIADL	—	—	—	—
		TLV2783CD	—	—	TLV2783CDGS	xxTIADN	—	—
-40°C to 125°C	3000 μV	TLV2782ID	TLV2782IDGK	xxTIADM	—	—	—	TLV2782IP
	2000 μV	TLV2783ID	—	—	TLV2783IDGS	xxTIADO	TLV2783IN	—
		TLV2782AID	—	—	—	—	—	—
		TLV2783AID	—	—	—	—	—	—

† This package is available taped and reeled. To order this packaging option, add an **R** suffix to the part number (e.g., TLV2782CDR).

## TLV2784 and TLV2785 AVAILABLE OPTIONS(1)

T <sub>A</sub>	V <sub>IOmax</sub> AT 25°C	PACKAGED DEVICES		
		SMALL OUTLINE (D)	PLASTIC DIP (N)	TSSOP† (PW)
0°C to 70°C	3000 μV	TLV2784CD	—	TLV2784CPW
		TLV2785CD	—	TLV2785CPW
-40°C to 125°C	3000 μV	TLV2784ID	TLV2784IN	TLV2784IPW
	2000 μV	TLV2785ID	TLV2785IN	TLV2785IPW
		TLV2784AID	—	TLV2784AIPW
		TLV2785AID	—	TLV2785AIPW

† This package is available taped and reeled. To order this packaging option, add an **R** suffix to the part number (e.g., TLV2784CDR).

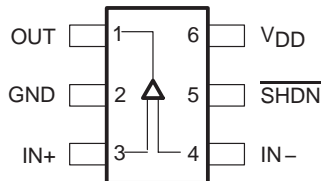
- For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).

# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

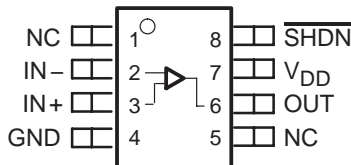
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## TLV278x PACKAGE PINOUTS

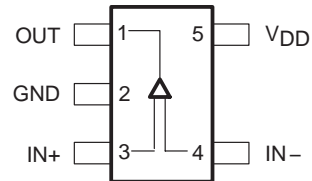
**TLV2780**  
DBV PACKAGE  
(TOP VIEW)



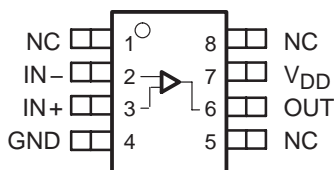
**TLV2780**  
D OR P PACKAGE  
(TOP VIEW)



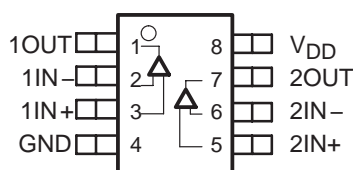
**TLV2781**  
DBV PACKAGE  
(TOP VIEW)



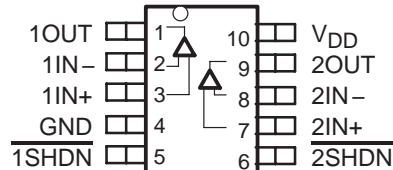
**TLV2781**  
D OR P PACKAGE  
(TOP VIEW)



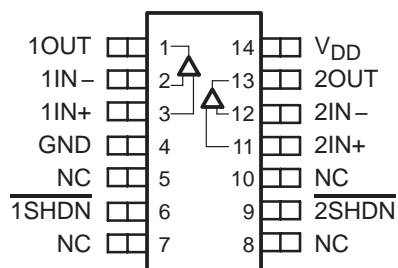
**TLV2782**  
D, DGK, OR P PACKAGE  
(TOP VIEW)



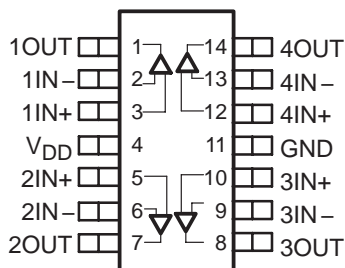
**TLV2783**  
DGS PACKAGE  
(TOP VIEW)



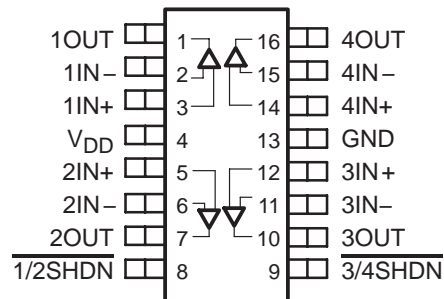
**TLV2783**  
D OR N PACKAGE  
(TOP VIEW)



**TLV2784**  
D, N, OR PW PACKAGE  
(TOP VIEW)



**TLV2785**  
D, N, OR PW PACKAGE  
(TOP VIEW)



NC – No internal connection

# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{DD}$ (see Note 1)	4 V
Differential input voltage, $V_{ID}$	$\pm V_{DD}$
Input current, $I_I$ (any input)	$\pm 10$ mA
Output current, $I_O$	$\pm 10$ mA
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : C-suffix	0°C to 70°C
I-suffix	-40°C to 125°C
Maximum junction temperature, $T_J$	150°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.

NOTE 1: All voltage values, except differential voltages, are with respect to GND.

DISSIPATION RATING TABLE

PACKAGE	$\theta_{JC}$ (°C/W)	$\theta_{JA}$ (°C/W)	$T_A \leq 25^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D (8)	38.3	176	710 mW	142 mW
D (14)	26.9	122.3	1022 mW	204.4 mW
D (16)	25.7	114.7	1090 mW	218 mW
DBV (5)	55	324.1	385 mW	77.1 mW
DBV (6)	55	294.3	425 mW	85 mW
DGK (8)	54.2	259.9	481 mW	96.2 mW
DGS (10)	54.1	257.7	485 mW	97 mW
N (14, 16)	32	78	1600 mW	320.5 mW
P (8)	41	104	1200 mW	240.4 mW
PW (14)	29.3	173.6	720 mW	144 mW
PW (16)	28.7	161.4	774 mW	154.9 mW

## recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, $V_{DD}$	Single supply	1.8	3.6	V
	Split supply	$\pm 0.9$	$\pm 1.8$	
Common-mode input voltage range, $V_{ICR}$		-0.2	$V_{DD}+0.2$	V
Operating free-air temperature, $T_A$	C-suffix	0	70	°C
	I-suffix	-40	125	
Shutdown on/off voltage level‡	$V_{IH}$	$V_{DD} < 2.7$ V	$0.75V_{DD}$	V
		$V_{DD} = 2.7$ to 3.6 V	2	
	$V_{IL}$		0.6	

‡ Relative to GND.

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electrical characteristics at specified free-air temperature,  $V_{DD} = 1.8\text{ V}, 2.7\text{ V}$  (unless otherwise noted)

**dc performance**

PARAMETER	TEST CONDITIONS		$T_A$ †	MIN	TYP	MAX	UNIT
$V_{IO}$ Input offset voltage	$V_O = V_{DD}/2,$ $R_L = 2\text{ k}\Omega,$ $R_S = 50\ \Omega$	TLV278x	25°C	250	3000		$\mu\text{V}$
			Full range		4500		
		TLV278xA	25°C	250	2000		
			Full range		3000		
$\alpha_{VIO}$ Temperature coefficient of input offset voltage				8		$\mu\text{V}/^\circ\text{C}$	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }V_{DD},$ $R_S = 50\ \Omega$	$V_{DD} = 1.8\text{ V}$	25°C	50	76		dB
			Full range		50		
		$V_{DD} = 2.7\text{ V}/3.6\text{ V}$	25°C	55	80		
			Full range		50		
	$V_{IC} = 1.2\text{ V to }V_{DD},$ $R_S = 50\ \Omega$	$V_{DD} = 2.7\text{ V}/3.6\text{ V}$	25°C	70	100		
			Full range		70		
$A_{VD}$ Large-signal differential voltage amplification	$R_L = 2\text{ k}\Omega,$ $V_{O(PP)} = 1\text{ V}$	$V_{DD} = 1.8\text{ V}$	25°C	200	600		V/mV
			Full range		50		
		$V_{DD} = 2.7\text{ V}/3.6\text{ V}$	25°C	200	1000		
			Full range		70		

† Full range is 0°C to 70°C for the C-suffix and -40°C to 125°C for the I-suffix. If not specified, full range is -40°C to 125°C.

**input characteristics**

PARAMETER	TEST CONDITIONS	$T_A$ †	MIN	TYP	MAX	UNIT
$I_{IO}$ Input offset current	$V_O = V_{DD}/2,$ $R_L = 2\text{ k}\Omega,$ $R_S = 50\ \Omega$	25°C		2.5	15	$\text{pA}$
		TLV278xC	Full range		100	
		TLV278xI	Full range		300	
$I_{IB}$ Input bias current	$V_O = V_{DD}/2,$ $R_L = 2\text{ k}\Omega,$ $R_S = 50\ \Omega$	25°C		2.5	15	$\text{pA}$
		TLV278xC	Full range		100	
		TLV278xI	Full range		300	
$r_{i(d)}$ Differential input resistance		25°C		1000		$\text{G}\Omega$
$C_{i(c)}$ Common-mode input capacitance	$f = 1\text{ kHz}$	25°C		19		$\text{pF}$

† Full range is 0°C to 70°C for the C-suffix and -40°C to 125°C for the I-suffix. If not specified, full range is -40°C to 125°C.

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electrical characteristics at specified free-air temperature,  $V_{DD} = 1.8\text{ V}, 2.7\text{ V}$  (unless otherwise noted) (continued)

**output characteristics**

PARAMETER	TEST CONDITIONS		$T_A$ †	MIN	TYP	MAX	UNIT	
$V_{OH}$ High-level output voltage	$I_{OH} = -1\text{ mA}$	$V_{DD} = 1.8\text{ V}$	25°C	1.7	1.77		V	
			Full range	1.63				
		$V_{DD} = 2.7\text{ V}$	25°C	2.6	2.68			
			Full range	2.6				
		$V_{DD} = 3.6\text{ V}$	25°C		3.58			
			$I_{OH} = -5\text{ mA}$	$V_{DD} = 1.8\text{ V}$	25°C	1.5		1.55
	Full range				1.46			
	$V_{DD} = 2.7\text{ V}$	$V_{DD} = 2.7\text{ V}$	25°C	2.5	2.55			
			Full range	2.45				
$V_{DD} = 3.6\text{ V}$		25°C		3.55				
$V_{OL}$ Low-level output voltage	$I_{OL} = 1\text{ mA}$		25°C			70	mV	
			Full range			80		
	$I_{OL} = 5\text{ mA}$	$V_{DD} = 1.8\text{ V}$	25°C		180	240		
			Full range			290		
		$V_{DD} = 2.7\text{ V}$	25°C		120	170		
			Full range			200		
$I_O$ Output current	$V_{DD} = 1.8\text{ V},$ $V_O = 0.5\text{ V from}$	Positive rail	25°C			10	mA	
		Negative rail				15		
	$V_{DD} = 2.7\text{ V},$ $V_O = 0.5\text{ V from}$	Positive rail				17		
		Negative rail				23		
$I_{OS}$ Short-circuit output current	Sourcing	$V_{DD} = 1.8\text{ V}$	25°C			13	mA	
		$V_{DD} = 2.7\text{ V}$				35		
	Sinking	$V_{DD} = 1.8\text{ V}$				21		
		$V_{DD} = 2.7\text{ V}$				45		

† Full range is 0°C to 70°C for the C-suffix and -40°C to 125°C for the I-suffix. If not specified, full range is -40°C to 125°C.

**power supply**

PARAMETER	TEST CONDITIONS		$T_A$ †	MIN	TYP	MAX	UNIT
$I_{DD}$ Supply current (per channel)	$V_O = V_{DD}/2,$	$\overline{\text{SHDN}} = V_{DD}$	25°C		650	770	$\mu\text{A}$
			Full range			820	
$k_{SVR}$ Supply voltage rejection ratio ( $\Delta V_{DD} / \Delta V_{IO}$ )	$V_{DD} = 1.8\text{ V to } 2.7\text{ V},$ $V_{IC} = V_{DD}/2$	No load,	25°C		60	75	dB
			Full range			58	
	$V_{DD} = 2.7\text{ V to } 3.6\text{ V},$ $V_{IC} = V_{DD}/2$	No load,	25°C		75	90	
			Full range			70	
	$V_{DD} = 1.8\text{ V to } 3.6\text{ V},$ $V_{IC} = V_{DD}/2$	No load,	25°C		65	80	
			Full range			60	

† Full range is 0°C to 70°C for the C-suffix and -40°C to 125°C for the I-suffix. If not specified, full range is -40°C to 125°C.

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electrical characteristics at specified free-air temperature,  $V_{DD} = 1.8 \text{ V}, 2.7 \text{ V}$  (unless otherwise noted) (continued)

**dynamic performance**

PARAMETER		TEST CONDITIONS		$T_A^\dagger$	MIN	TYP	MAX	UNIT
UGBW	Unity gain bandwidth	$R_L = 2 \text{ k}\Omega$ ,	$C_L = 25 \text{ pF}$	25°C		8		MHz
SR+	Positive slew rate at unity gain	$V_{O(PP)} = 1 \text{ V}$ , $R_L = 2 \text{ k}\Omega$ , $C_L = 50 \text{ pF}$	$V_{DD} = 1.8 \text{ V}$	25°C	3.3	4.3	V/ $\mu$ s	
				Full range	3.1			
			$V_{DD} = 2.7 \text{ V}$	25°C	3.8	4.8		
				Full range	3.5			
			$V_{DD} = 3.6 \text{ V}$	25°C	4	5		
				Full range	3.6			
SR-	Negative slew rate at unity gain	$V_{O(PP)} = 1 \text{ V}$ , $R_L = 2 \text{ k}\Omega$ , $C_L = 50 \text{ pF}$	$V_{DD} = 1.8 \text{ V}$	25°C	2.1	2.8		
				Full range	1.89			
			$V_{DD} = 2.7 \text{ V}$	25°C	2.2	2.8		
				Full range	1.97			
			$V_{DD} = 3.6 \text{ V}$	25°C	3.5	4.2		
				Full range	3.4			
$\phi_m$	Phase margin	$R_L = 2 \text{ k}\Omega$ ,	$C_L = 25 \text{ pF}$	25°C	58°			
	Gain margin				8		dB	
$t_s$	Settling time	$V_{DD} = 1.8 \text{ V}$ , $V_{(STEP)PP} = 1 \text{ V}$ , $A_V = -1$ , $C_L = 10 \text{ pF}$ , $R_L = 2 \text{ k}\Omega$	0.1%	25°C	1.7		$\mu$ s	
			0.01%		2.8			
		$V_{DD} = 2.7 \text{ V}$ , $V_{(STEP)PP} = 1 \text{ V}$ , $A_V = -1$ , $C_L = 10 \text{ pF}$ , $R_L = 2 \text{ k}\Omega$	0.1%		1.7			
			0.01%		2.4			

$^\dagger$  Full range is 0°C to 70°C for the C-suffix and -40°C to 125°C for the I-suffix. If not specified, full range is -40°C to 125°C.

**noise/distortion performance**

PARAMETER		TEST CONDITIONS		$T_A$	MIN	TYP	MAX	UNIT
THD + N	Total harmonic distortion plus noise	$V_{O(PP)} = V_{DD}/2$ , $R_L = 2 \text{ k}\Omega$ , $f = 10 \text{ kHz}$	$A_V = 1$	25°C	0.055%			
			$A_V = 10$		0.08%			
			$A_V = 100$		0.45%			
$V_n$	Equivalent input noise voltage	$f = 1 \text{ kHz}$			18		nV/ $\sqrt{\text{Hz}}$	
		$f = 10 \text{ kHz}$			9			
$I_n$	Equivalent input noise current	$f = 1 \text{ kHz}$			0.9		fA/ $\sqrt{\text{Hz}}$	

**shutdown characteristics**

PARAMETER		TEST CONDITIONS	$T_A^\dagger$	MIN	TYP	MAX	UNIT
$I_{DD(SHDN)}$	Supply current, per channel in shutdown mode (TLV2780, TLV2783, TLV2785)	$\overline{\text{SHDN}} = 0 \text{ V}$	25°C	900	1400	1700	nA
			Full range				
$t_{(on)}$	Amplifier turnon time $^\ddagger$	$R_L = 2 \text{ k}\Omega$	25°C	800			ns
$t_{(off)}$	Amplifier turnoff time $^\ddagger$	$R_L = 2 \text{ k}\Omega$		200			

$^\dagger$  Full range is 0°C to 70°C for the C-suffix and -40°C to 125°C for the I-suffix. If not specified, full range is -40°C to 125°C.

$^\ddagger$  Disable time and enable time are defined as the interval between application of the logic signal to  $\overline{\text{SHDN}}$  and the point at which the supply current has reached half its final value.

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**TYPICAL CHARACTERISTICS**

**Table of Graphs**

			<b>FIGURE</b>
$V_{IO}$	Input offset voltage	vs Common-mode input voltage	1, 2
CMRR	Common-mode rejection ratio	vs Frequency	3
$V_{OH}$	High-level output voltage	vs High-level output current	4, 6
$V_{OL}$	Low-level output voltage	vs Low-level output current	5, 7
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	8
$Z_o$	Output impedance	vs Frequency	9
$I_{DD}$	Supply current	vs Supply voltage	10
$I_{DD}$	Supply current	vs Free-air temperature	11
PSRR	Power supply rejection ratio	vs Frequency	12
$A_{VD}$	Differential voltage amplification & phase	vs Frequency	13
	Gain-bandwidth product	vs Free-air temperature	14
SR	Slew rate	vs Supply voltage	15
		vs Free-air temperature	16, 17
$\phi_m$	Phase margin	vs Load capacitance	18
$V_n$	Equivalent input noise voltage	vs Frequency	19
	Voltage-follower large-signal pulse response	vs Time	20
	Voltage-follower small-signal pulse response	vs Time	21
	Inverting large-signal pulse response	vs Time	22
	Inverting small-signal pulse response	vs Time	23
	Crosstalk	vs Frequency	24
	Shutdown forward & reverse isolation	vs Frequency	25
$I_{DD(SHDN)}$	Shutdown supply current	vs Free-air temperature	26
$I_{DD(SHDN)}$	Shutdown supply current	vs Supply voltage	27
$I_{DD(SHDN)}$	Shutdown supply current/output voltage	vs Time	28



# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## TYPICAL CHARACTERISTICS

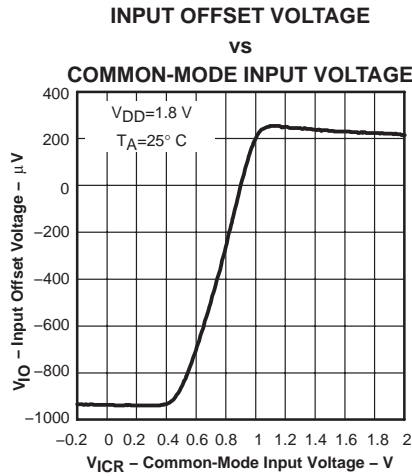


Figure 1

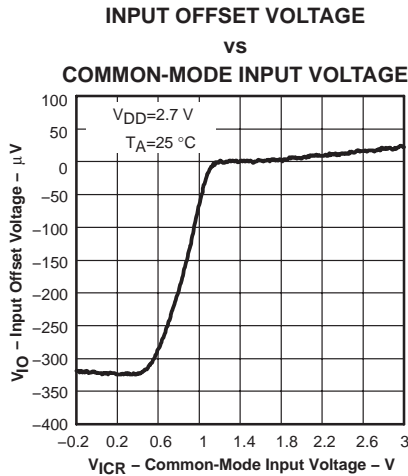


Figure 2

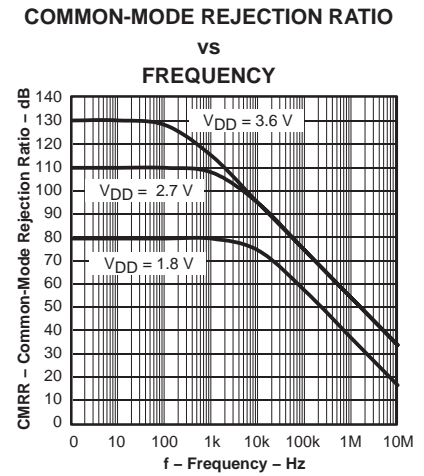


Figure 3

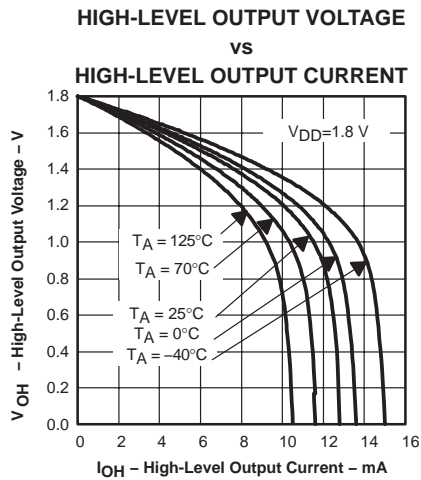


Figure 4

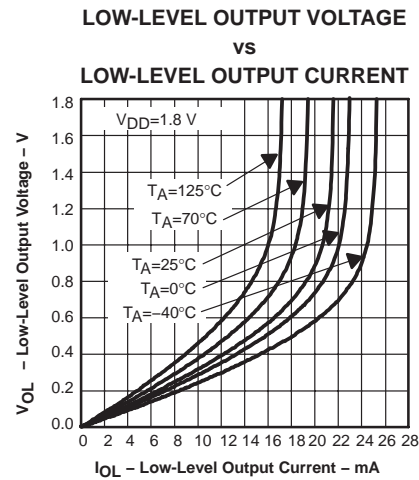


Figure 5

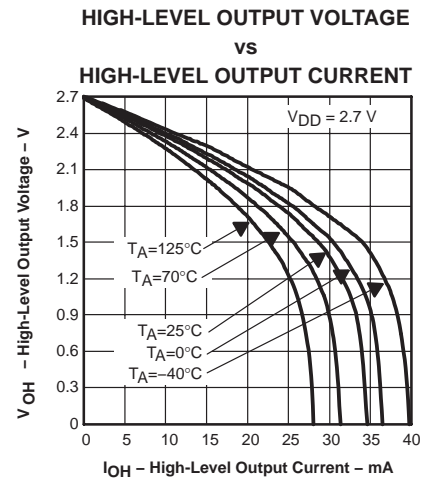


Figure 6

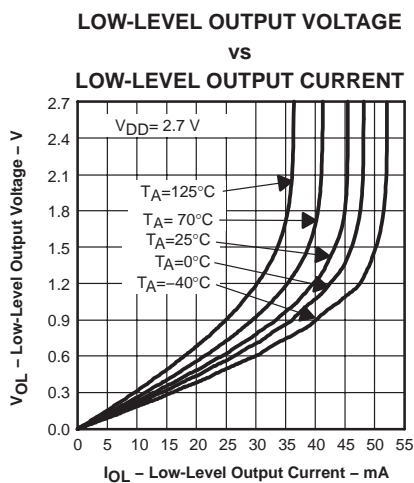


Figure 7

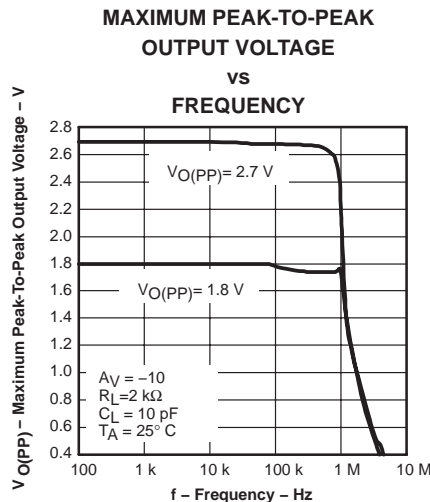


Figure 8

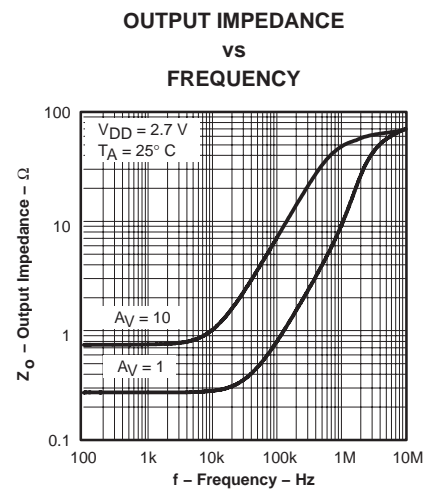


Figure 9

# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## TYPICAL CHARACTERISTICS

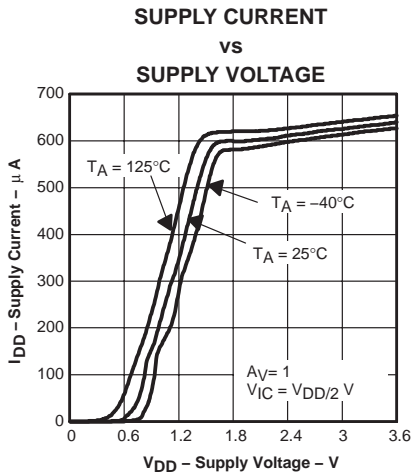


Figure 10

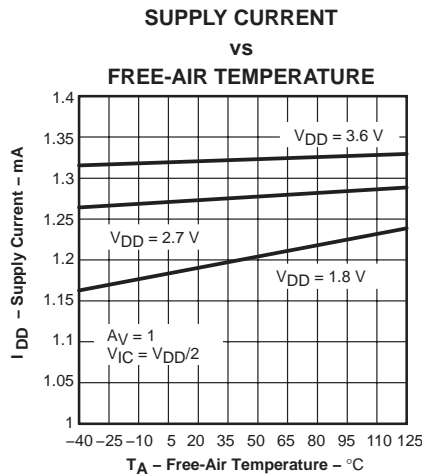


Figure 11

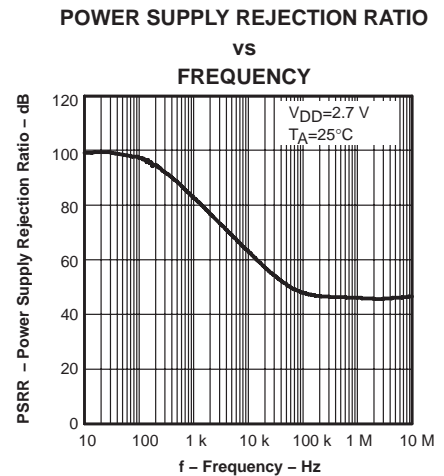


Figure 12

### DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE

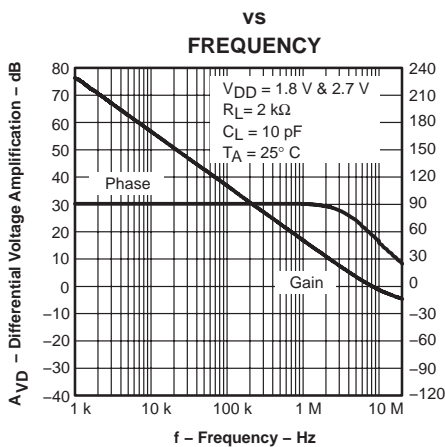


Figure 13

### GAIN-BANDWIDTH PRODUCT

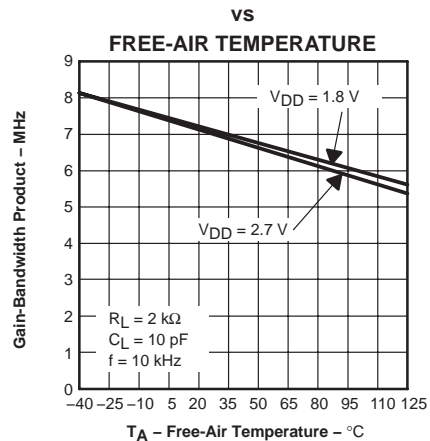


Figure 14

### SLEW RATE

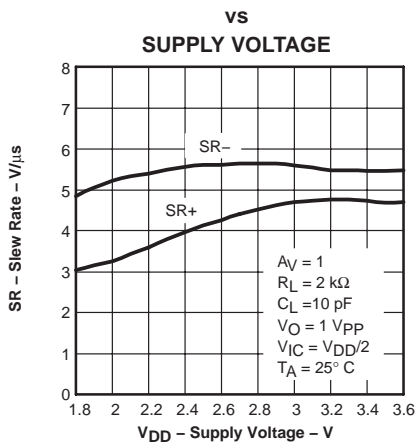


Figure 15

### SLEW RATE

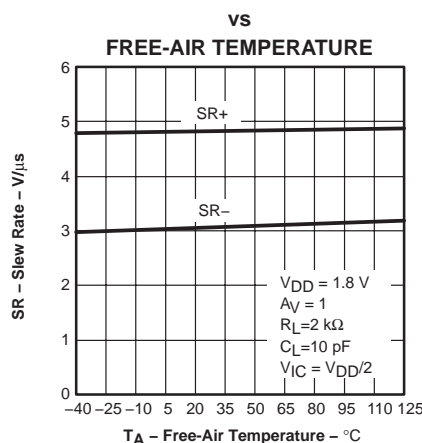


Figure 16

### SLEW RATE

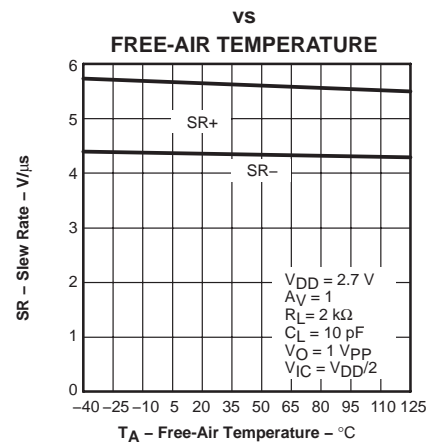


Figure 17

# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## TYPICAL CHARACTERISTICS

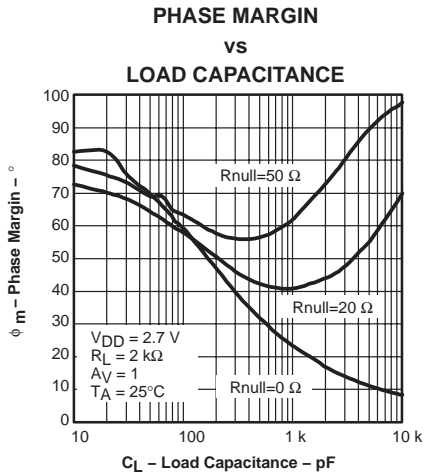


Figure 18

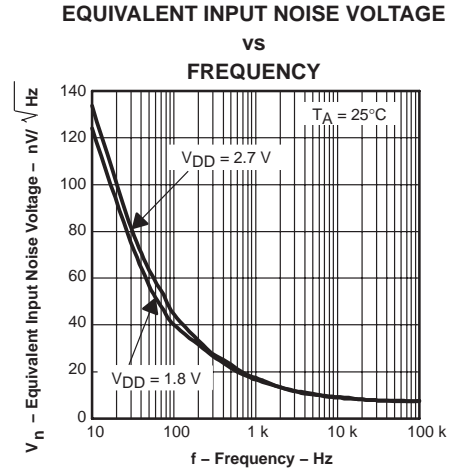


Figure 19

### VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

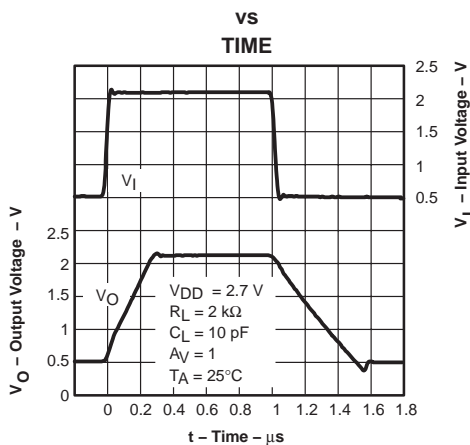


Figure 20

### VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

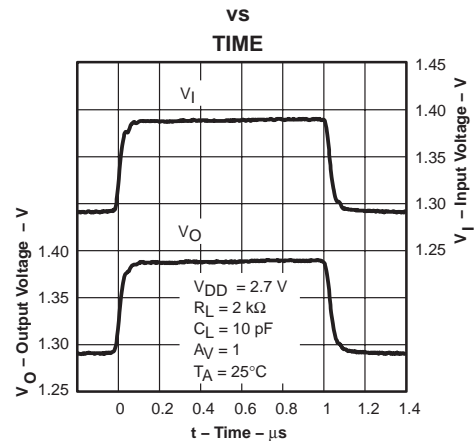


Figure 21

### INVERTING LARGE-SIGNAL PULSE RESPONSE

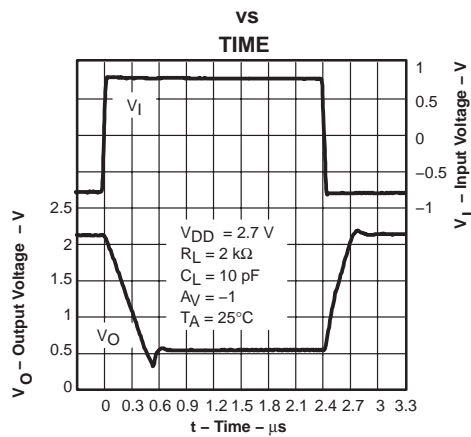


Figure 22

### INVERTING SMALL-SIGNAL PULSE RESPONSE

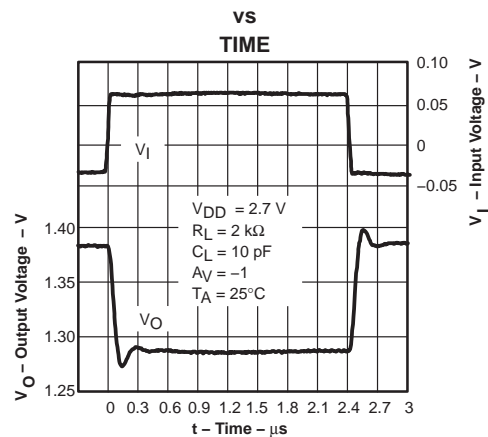
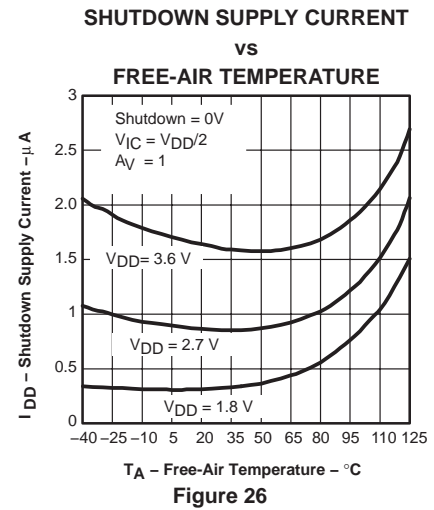
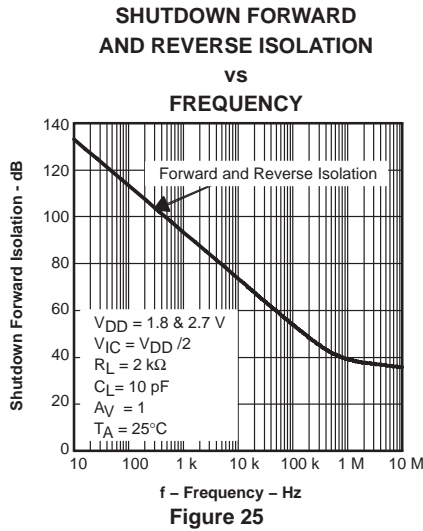
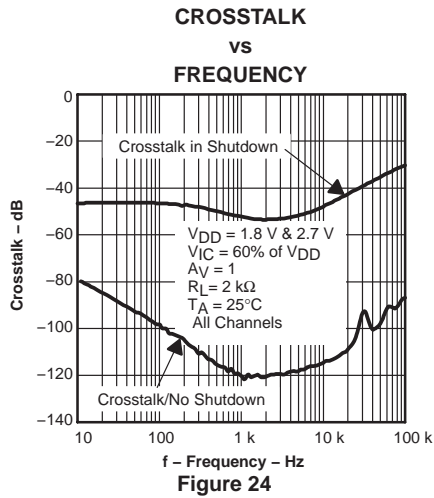


Figure 23

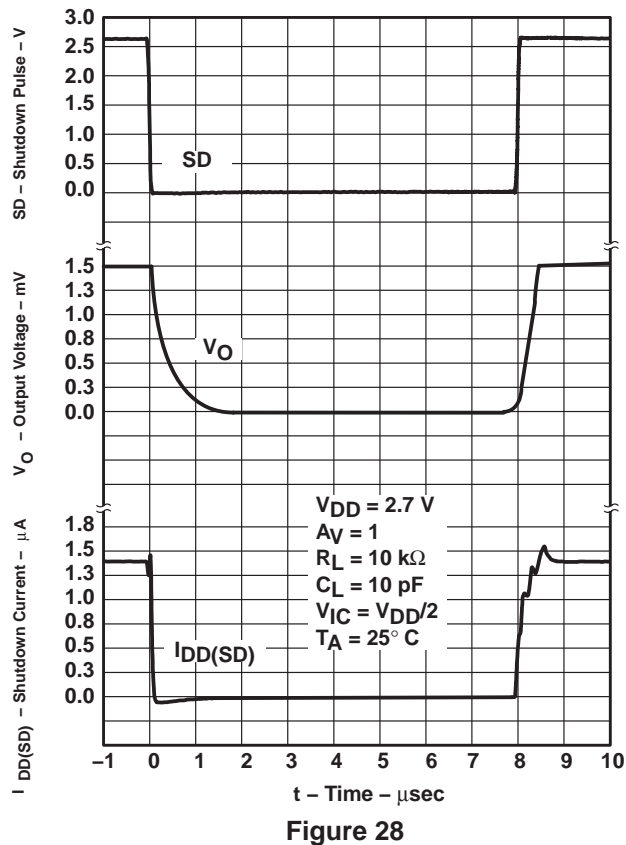
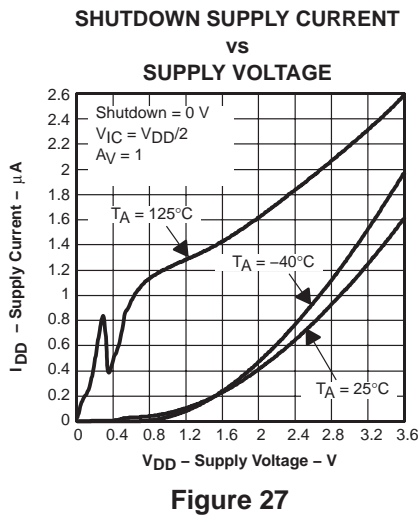
# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## TYPICAL CHARACTERISTICS



## SHUTDOWN SUPPLY CURRENT / OUTPUT VOLTAGE vs TIME



PARAMETER MEASUREMENT INFORMATION

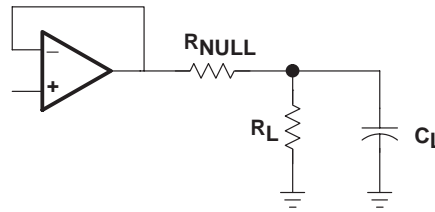


Figure 29

APPLICATION INFORMATION

driving a capacitive load

When the amplifier is configured in this manner, capacitive loading directly on the output will decrease the device's phase margin leading to high frequency ringing or oscillations. Therefore, for capacitive loads of greater than 10 pF, it is recommended that a resistor be placed in series ( $R_{NULL}$ ) with the output of the amplifier, as shown in Figure 30.

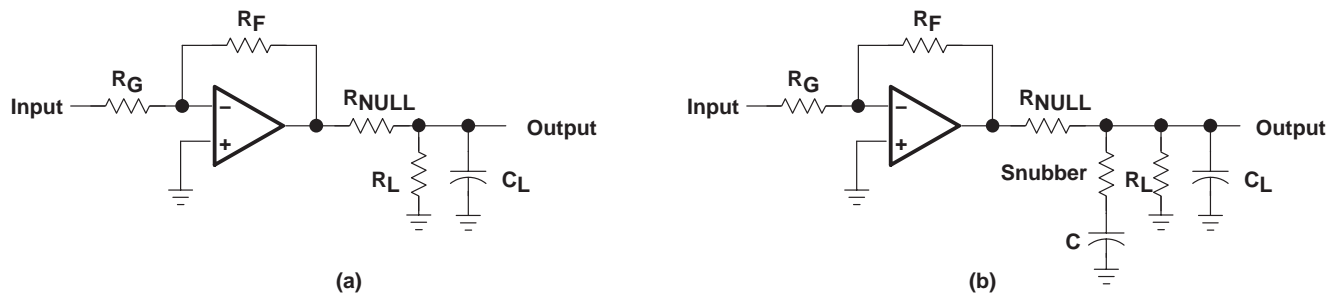


Figure 30. Driving a Capacitive Load

offset voltage

The output offset voltage, ( $V_{OO}$ ) is the sum of the input offset voltage ( $V_{IO}$ ) and both input bias currents ( $I_{IB}$ ) times the corresponding gains. The following schematic and formula can be used to calculate the output offset voltage:

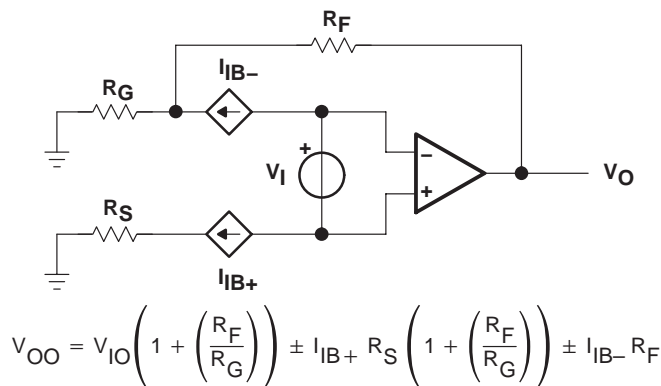


Figure 31. Output Offset Voltage Model

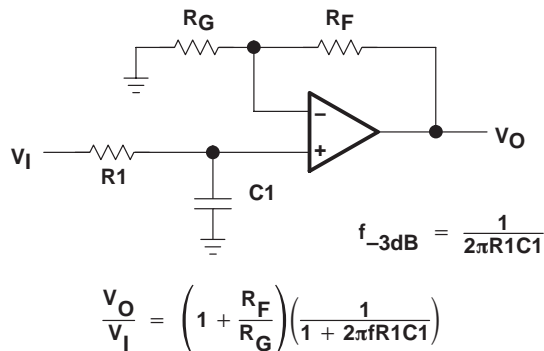
**TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA**  
**FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

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**APPLICATION INFORMATION**

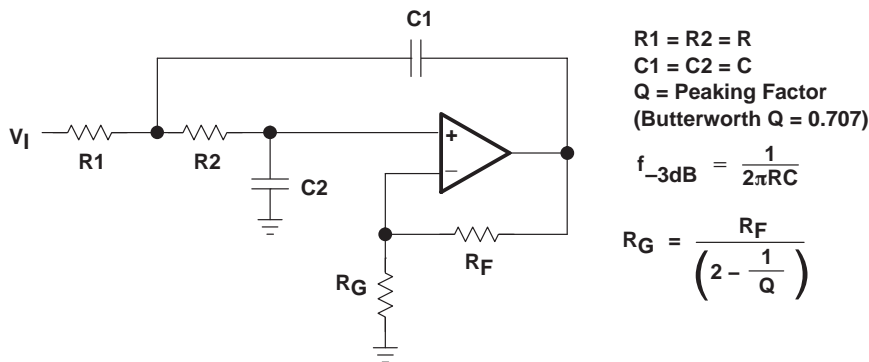
**general configurations**

When receiving low-level signals, limiting the bandwidth of the incoming signals into the system is often required. The simplest way to accomplish this is to place an RC filter at the noninverting terminal of the amplifier (see Figure 32).



**Figure 32. Single-Pole Low-Pass Filter**

If even more attenuation is needed, a multiple pole filter is required. The Sallen-Key filter can be used for this task. For best results, the amplifier should have a bandwidth that is 8 to 10 times the filter frequency bandwidth. Failure to do this can result in phase shift of the amplifier.



**Figure 33. 2-Pole Low-Pass Sallen-Key Filter**

---

## APPLICATION INFORMATION

### circuit layout considerations

To achieve the levels of high performance of the TLV278x, follow proper printed-circuit board design techniques. A general set of guidelines is given in the following.

- Ground planes – It is highly recommended that a ground plane be used on the board to provide all components with a low inductive ground connection. However, in the areas of the amplifier inputs and output, the ground plane can be removed to minimize the stray capacitance.
- Proper power supply decoupling – Use a 6.8- $\mu$ F tantalum capacitor in parallel with a 0.1- $\mu$ F ceramic capacitor on each supply terminal. It may be possible to share the tantalum among several amplifiers depending on the application, but a 0.1- $\mu$ F ceramic capacitor should always be used on the supply terminal of every amplifier. In addition, the 0.1- $\mu$ F capacitor should be placed as close as possible to the supply terminal. As this distance increases, the inductance in the connecting trace makes the capacitor less effective. The designer should strive for distances of less than 0.1 inches between the device power terminals and the ceramic capacitors.
- Sockets – Sockets can be used but are not recommended. The additional lead inductance in the socket pins will often lead to stability problems. Surface-mount packages soldered directly to the printed-circuit board is the best implementation.
- Short trace runs/compact part placements – Optimum high performance is achieved when stray series inductance has been minimized. To realize this, the circuit layout should be made as compact as possible, thereby minimizing the length of all trace runs. Particular attention should be paid to the inverting input of the amplifier. Its length should be kept as short as possible. This will help to minimize stray capacitance at the input of the amplifier.
- Surface-mount passive components – Using surface-mount passive components is recommended for high performance amplifier circuits for several reasons. First, because of the extremely low lead inductance of surface-mount components, the problem with stray series inductance is greatly reduced. Second, the small size of surface-mount components naturally leads to a more compact layout, thereby minimizing both stray inductance and capacitance. If leaded components are used, it is recommended that the lead lengths be kept as short as possible.

### shutdown function

Three members of the TLV278x family (TLV2780/3/5) have a shutdown terminal for conserving battery life in portable applications. When the shutdown terminal is tied low, the supply current is reduced to 900 nA/channel, the amplifier is disabled, and the outputs are placed in a high impedance mode. To enable the amplifier, the shutdown terminal can either be left floating or pulled high. When the shutdown terminal is left floating, care should be taken to ensure that parasitic leakage current at the shutdown terminal does not inadvertently place the operational amplifier into shutdown.

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**FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

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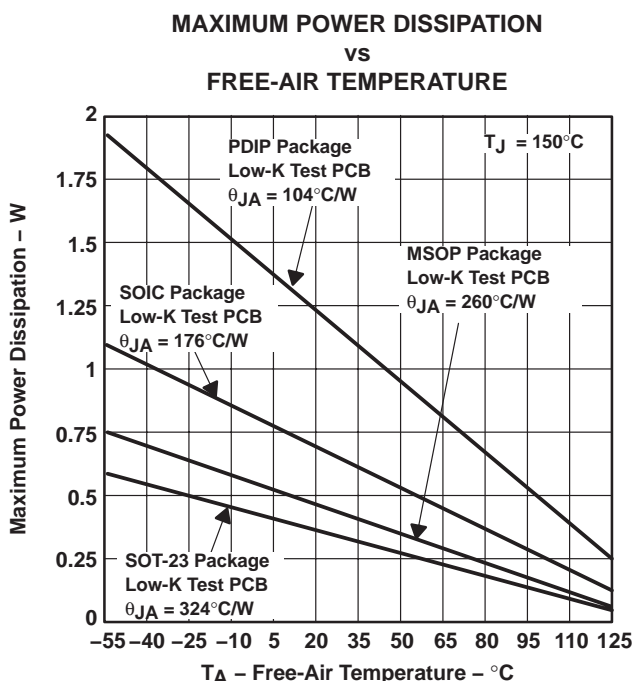
**general power dissipation considerations**

For a given  $\theta_{JA}$ , the maximum power dissipation is shown in Figure 34 and is calculated by the following formula:

$$P_D = \left( \frac{T_{MAX} - T_A}{\theta_{JA}} \right)$$

Where:

- $P_D$  = Maximum power dissipation of TLV278x IC (watts)
- $T_{MAX}$  = Absolute maximum junction temperature (150°C)
- $T_A$  = Free-ambient air temperature (°C)
- $\theta_{JA}$  =  $\theta_{JC} + \theta_{CA}$
- $\theta_{JC}$  = Thermal coefficient from junction to case
- $\theta_{CA}$  = Thermal coefficient from case to ambient air (°C/W)



NOTE A: Results are with no air flow and using JEDEC Standard Low-K test PCB.

**Figure 34. Maximum Power Dissipation vs Free-Air Temperature**



# TLV2780, TLV2781, TLV2782, TLV2783, TLV2784, TLV2785, TLV278xA FAMILY OF 1.8 V HIGH-SPEED RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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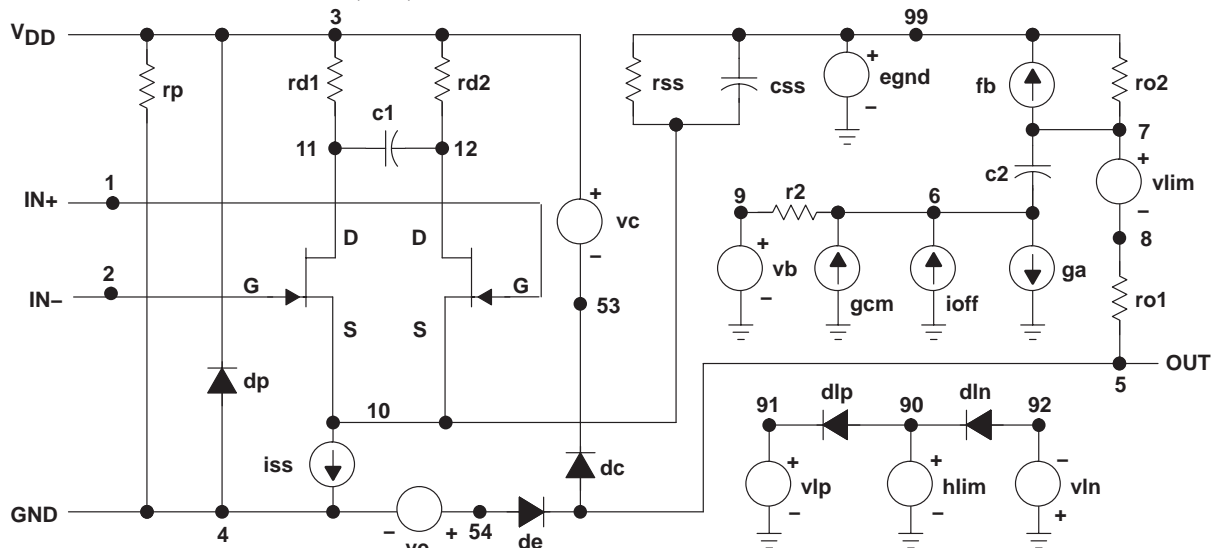
## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using Microsim *Parts*™ Release 9.1, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 2) and subcircuit in Figure 35 are generated using TLV278x typical electrical and operating characteristics at  $T_A = 25^\circ\text{C}$ . Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 2: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers," *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).



\* TLV2782\_HVDD operational amplifier "macromodel" subcircuit  
 \* created using Model Editor release 9.1 on 03/3/00 at 9:47  
 \* Model Editor is an OrCAD product.

```
* connections: non-inverting input
*                |
*                | inverting input
*                |
*                | positive power supply
*                | negative power supply
*                |
*                | output
*                |
.subckt TLV2782_HVDD 1 2 3 4 5
```

```
c1      11    12    49.58E-15
c2      6     7     10.200E-12
css     10   99    1.0000E-30
dc      5    53    dy
de     54    5     dy
dlp    90    91    dx
dln    92    90    dx
dp      4     3     dx
egnd   99    0     poly(2) (3,0) (4,0) 0 .5
fb      7     99    poly(5) vb vc ve vlp vln 0
                      41.096E6 -1E3 1E3 41E6
                      -41E6
```

```
ga      6     0     11 12 544.75E-6
gcm     0     6     10 99 1.1538E-9
iss     10    4     dc 56.957E-6
hlim    90    0     vlim 1K
j1      11    2     10 jx1
J2      12    1     10 jx2
r2      6     9     100.00E3
rd1     3     11    1.8357E3
rd2     3     12    1.8357E3
ro1     8     5     10
ro2     7     99    10
rp      3     4     2.1845E3
rss     10   99    3.5114E6
vb      9     0     dc 0
vc      3     53    dc .81911
ve     54    4     dc .81911
vlim    7     8     dc 0
vlp     91    0     dc 45.400
vln     0     92    dc 45.400
.model  dx     D(Is=800.00E-18)
.model  dy     D(Is=800.00E-18 Rs=1m Cjo=10p)
.model  jx1    NJF(Is=500.00E-15 Beta=5.2102E-3 Vto=-1)
.model  jx2    NJF(Is=500.00E-15 Beta=5.2102E-3 Vto=-1)
.ends
```

**Figure 35. Boyle Macromodel and Subcircuit**

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**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLV2780CDBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780CDBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780CDBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780CDBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780IDBVR	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780IDBVRG4	ACTIVE	SOT-23	DBV	6	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780IDBVT	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780IDBVTG4	ACTIVE	SOT-23	DBV	6	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2780IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781CDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781CDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781CDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781CDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781IDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781IDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2781IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782AID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLV2782AIDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782AIDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782AIDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CDGK	ACTIVE	MSOP	DGK	8	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CDGKG4	ACTIVE	MSOP	DGK	8	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CDGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CDGKRG4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782CDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782ID	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IDGK	ACTIVE	MSOP	DGK	8	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IDGKG4	ACTIVE	MSOP	DGK	8	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IDGKR	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IDGKRG4	ACTIVE	MSOP	DGK	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2782IP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2782IPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2783AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783CDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783CDGSR	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLV2783CDGSRG4	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783CDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783IDGS	ACTIVE	MSOP	DGS	10	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783IDGSG4	ACTIVE	MSOP	DGS	10	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783IDGSR	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783IDGSRG4	ACTIVE	MSOP	DGS	10	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2783IN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2783INE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2784AID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784AIDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784CPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784CPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784CPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784CPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784IDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784IPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784IPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2784IPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785AID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TLV2785AIDG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785CPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785CPWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785CPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785CPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785ID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785IDG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785IDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785IDRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785IN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2785INE4	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLV2785IPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2785IPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

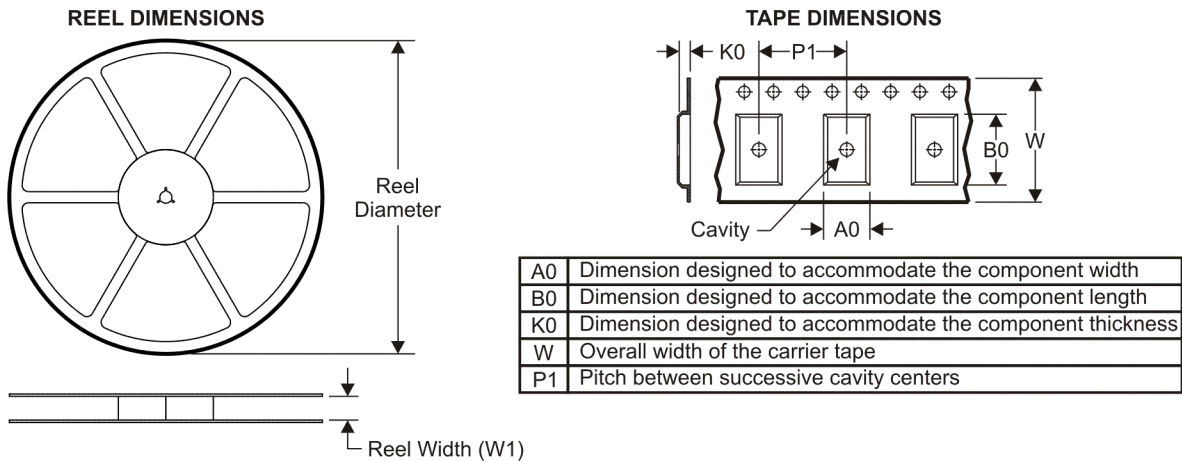
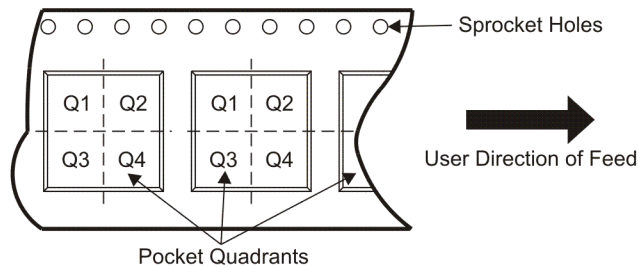
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**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.

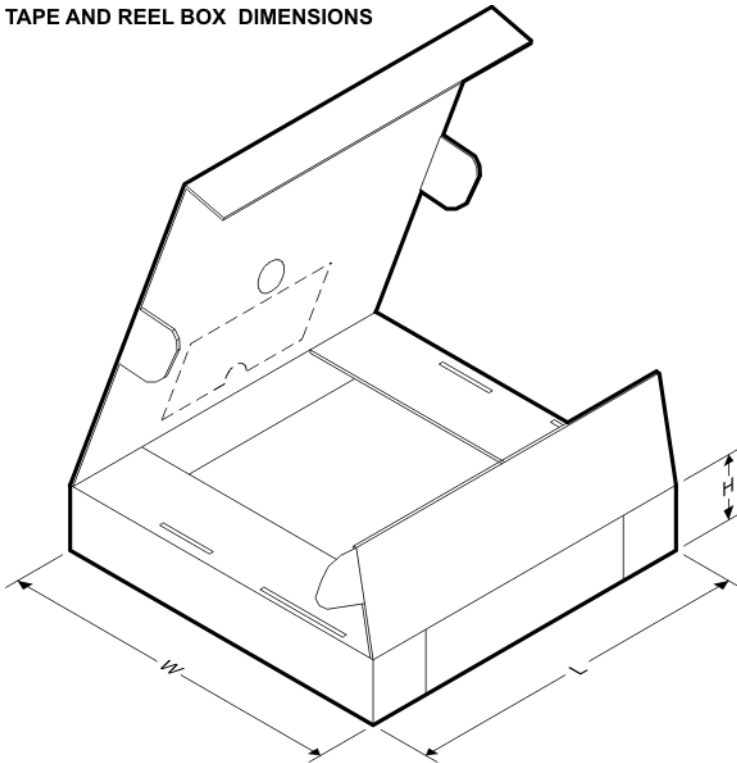
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**TAPE AND REEL INFORMATION**

**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
TLV2780CDBVR	SOT-23	DBV	6	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2780CDBVT	SOT-23	DBV	6	250	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2780IDBVR	SOT-23	DBV	6	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2780IDBVT	SOT-23	DBV	6	250	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2780IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV2781CDBVR	SOT-23	DBV	5	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2781CDBVT	SOT-23	DBV	5	250	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2781IDBVR	SOT-23	DBV	5	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2781IDBVT	SOT-23	DBV	5	250	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2781IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV2782AIDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV2782CDGKR	MSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TLV2782CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV2782IDGKR	MSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TLV2782IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV2783CDGSR	MSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TLV2783CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLV2783IDGSR	MSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1

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
TLV2784CPWR	TSSOP	PW	14	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
TLV2784IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLV2784IPWR	TSSOP	PW	14	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
TLV2785CPWR	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1
TLV2785IDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TLV2785IPWR	TSSOP	PW	16	2000	330.0	12.4	7.0	5.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV2780CDBVR	SOT-23	DBV	6	3000	182.0	182.0	20.0
TLV2780CDBVT	SOT-23	DBV	6	250	182.0	182.0	20.0
TLV2780IDBVR	SOT-23	DBV	6	3000	182.0	182.0	20.0
TLV2780IDBVT	SOT-23	DBV	6	250	182.0	182.0	20.0
TLV2780IDR	SOIC	D	8	2500	346.0	346.0	29.0
TLV2781CDBVR	SOT-23	DBV	5	3000	182.0	182.0	20.0
TLV2781CDBVT	SOT-23	DBV	5	250	182.0	182.0	20.0
TLV2781IDBVR	SOT-23	DBV	5	3000	182.0	182.0	20.0
TLV2781IDBVT	SOT-23	DBV	5	250	182.0	182.0	20.0
TLV2781IDR	SOIC	D	8	2500	346.0	346.0	29.0
TLV2782AIDR	SOIC	D	8	2500	346.0	346.0	29.0



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV2782CDGKR	MSOP	DGK	8	2500	358.0	335.0	35.0
TLV2782CDR	SOIC	D	8	2500	346.0	346.0	29.0
TLV2782IDGKR	MSOP	DGK	8	2500	358.0	335.0	35.0
TLV2782IDR	SOIC	D	8	2500	346.0	346.0	29.0
TLV2783CDGSR	MSOP	DGS	10	2500	358.0	335.0	35.0
TLV2783CDR	SOIC	D	14	2500	346.0	346.0	33.0
TLV2783IDGSR	MSOP	DGS	10	2500	358.0	335.0	35.0
TLV2784CPWR	TSSOP	PW	14	2000	346.0	346.0	29.0
TLV2784IDR	SOIC	D	14	2500	346.0	346.0	33.0
TLV2784IPWR	TSSOP	PW	14	2000	346.0	346.0	29.0
TLV2785CPWR	TSSOP	PW	16	2000	346.0	346.0	29.0
TLV2785IDR	SOIC	D	16	2500	346.0	346.0	33.0
TLV2785IPWR	TSSOP	PW	16	2000	346.0	346.0	29.0

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- 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. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-178 Variation AA.

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



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

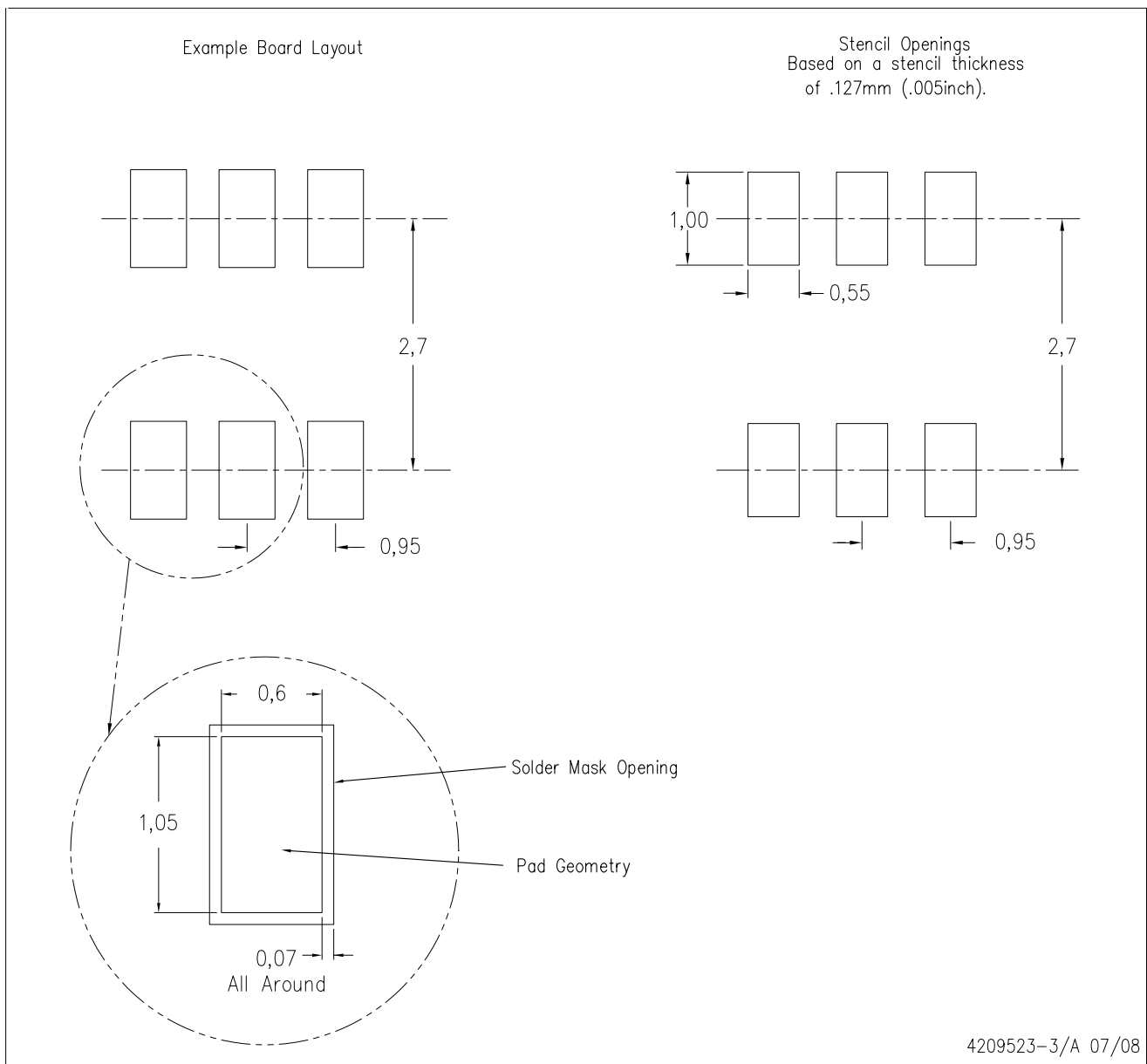
DBV (R-PDSO-G6)

PLASTIC SMALL-OUTLINE PACKAGE



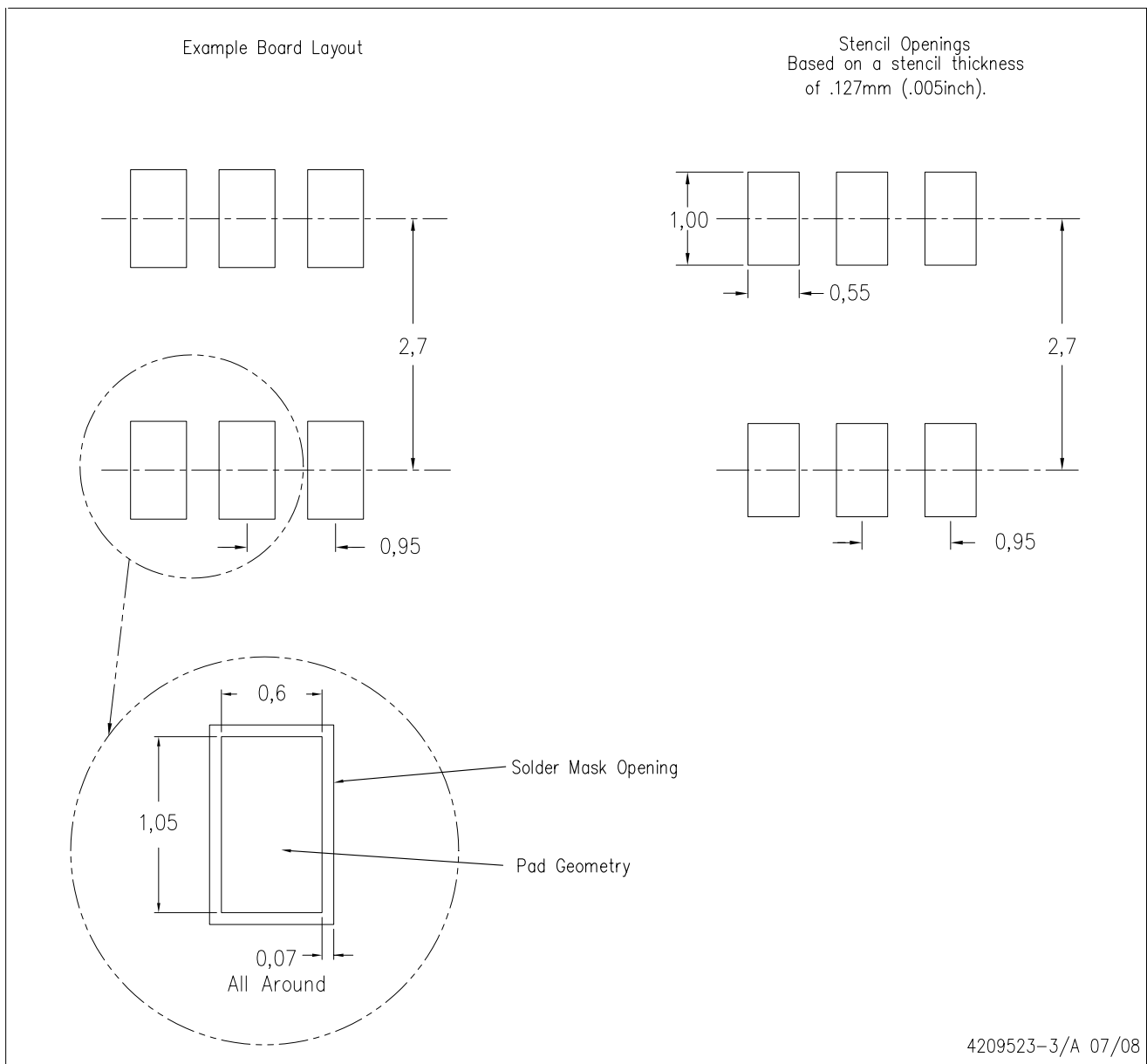
- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
- $\triangle$  Falls within JEDEC MO-178 Variation AB, except minimum lead width.

DBV (R-PDSO-G6)



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

DBV (R-PDSO-G6)



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

DGK (S-PDSO-G8)

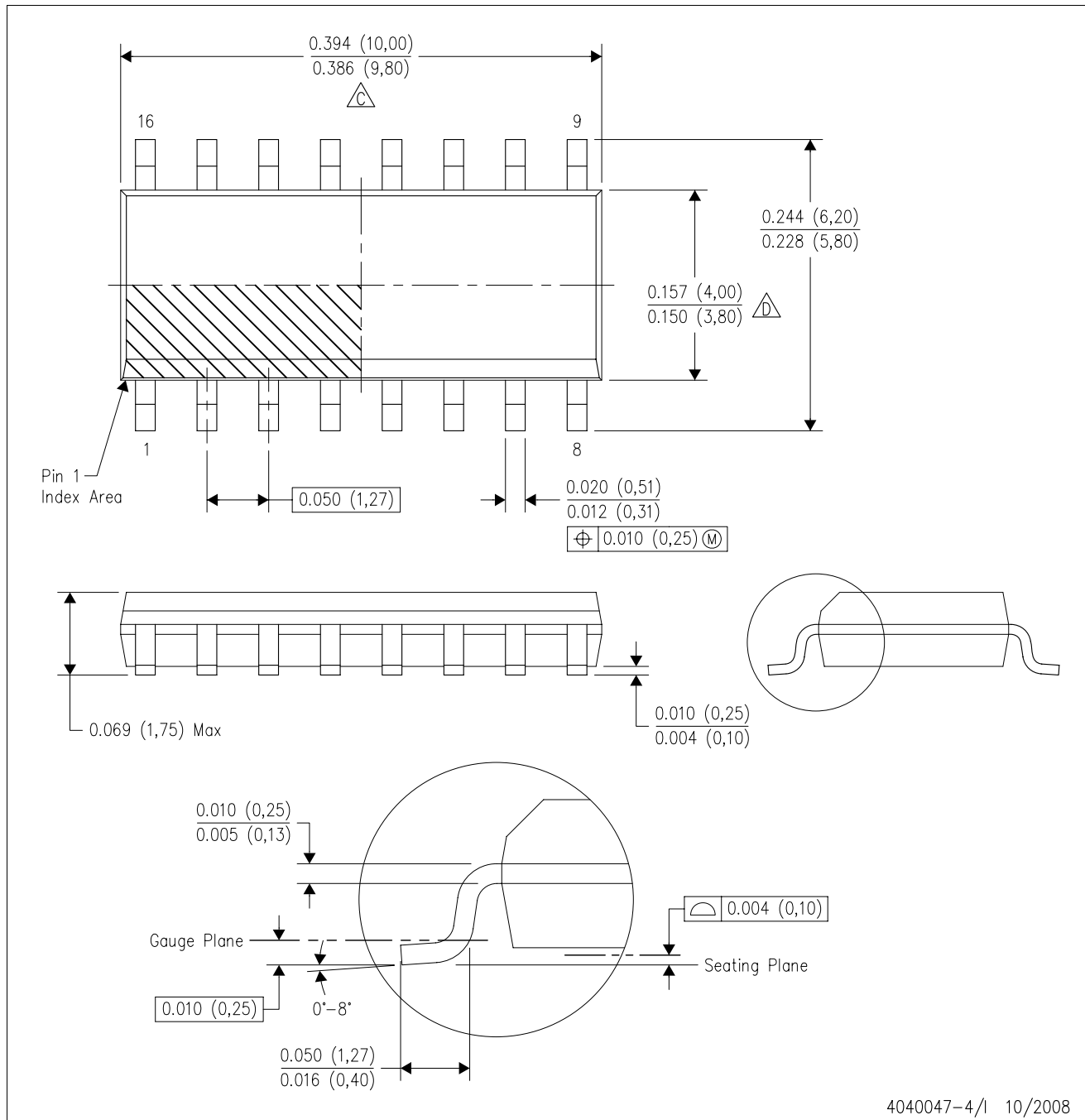
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
  - Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
  - Falls within JEDEC MO-187 variation AA, except interlead flash.

D (R-PDSO-G16)

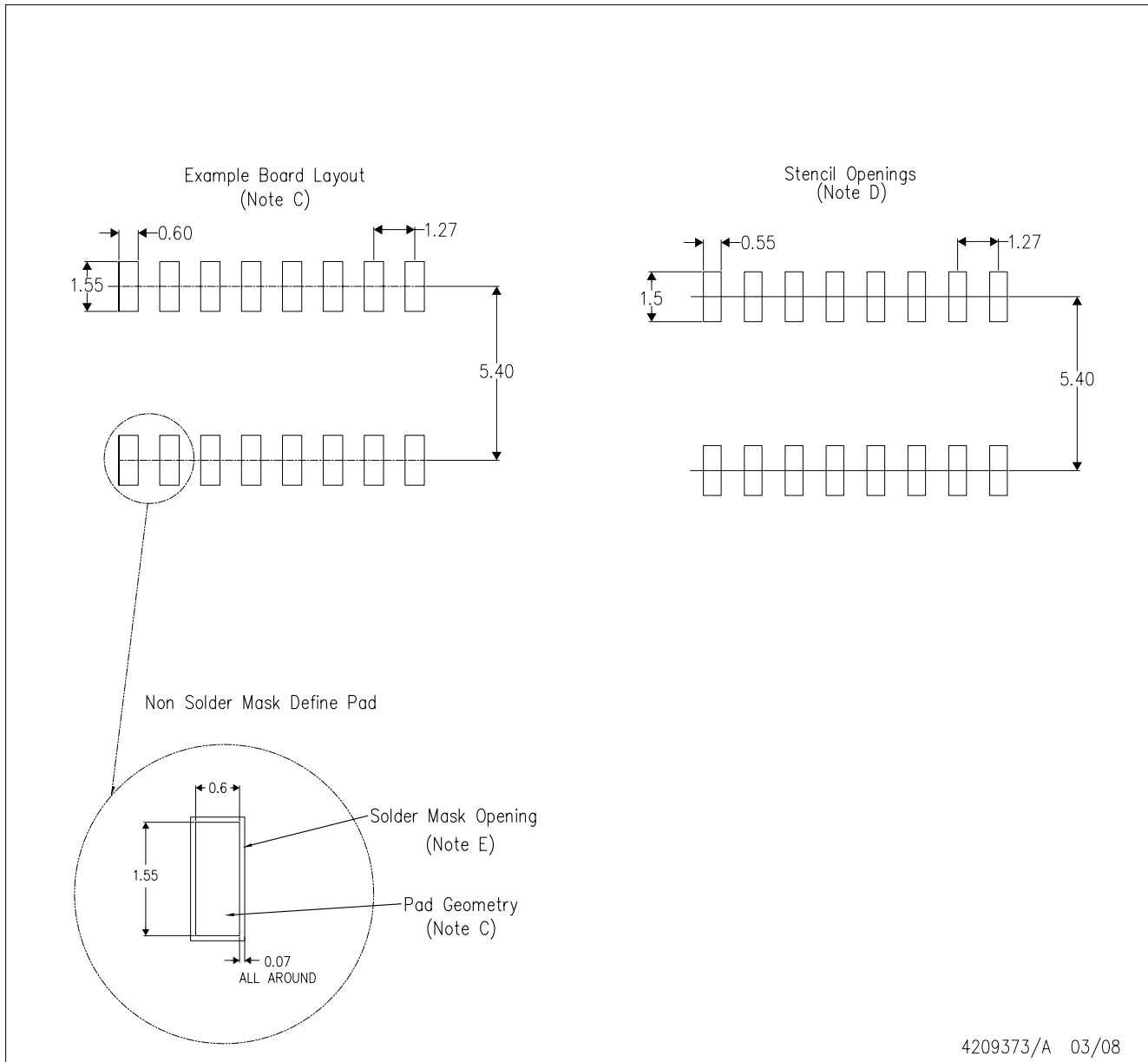
PLASTIC SMALL-OUTLINE PACKAGE



- 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 .006 (0,15) per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AC.



D(R-PDSO-G16)

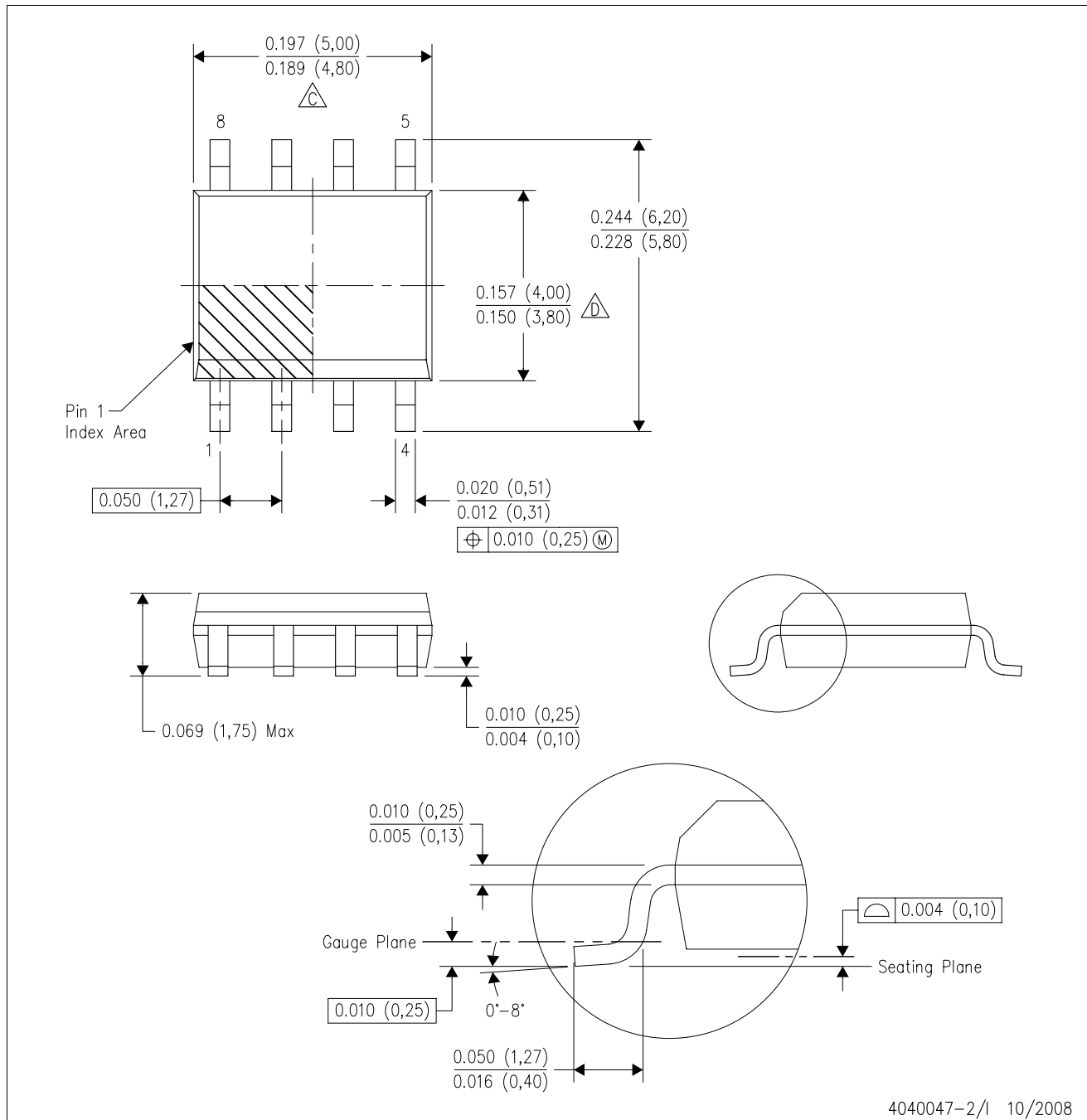


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- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Refer to IPC7351 for alternate board design.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

D (R-PDSO-G8)

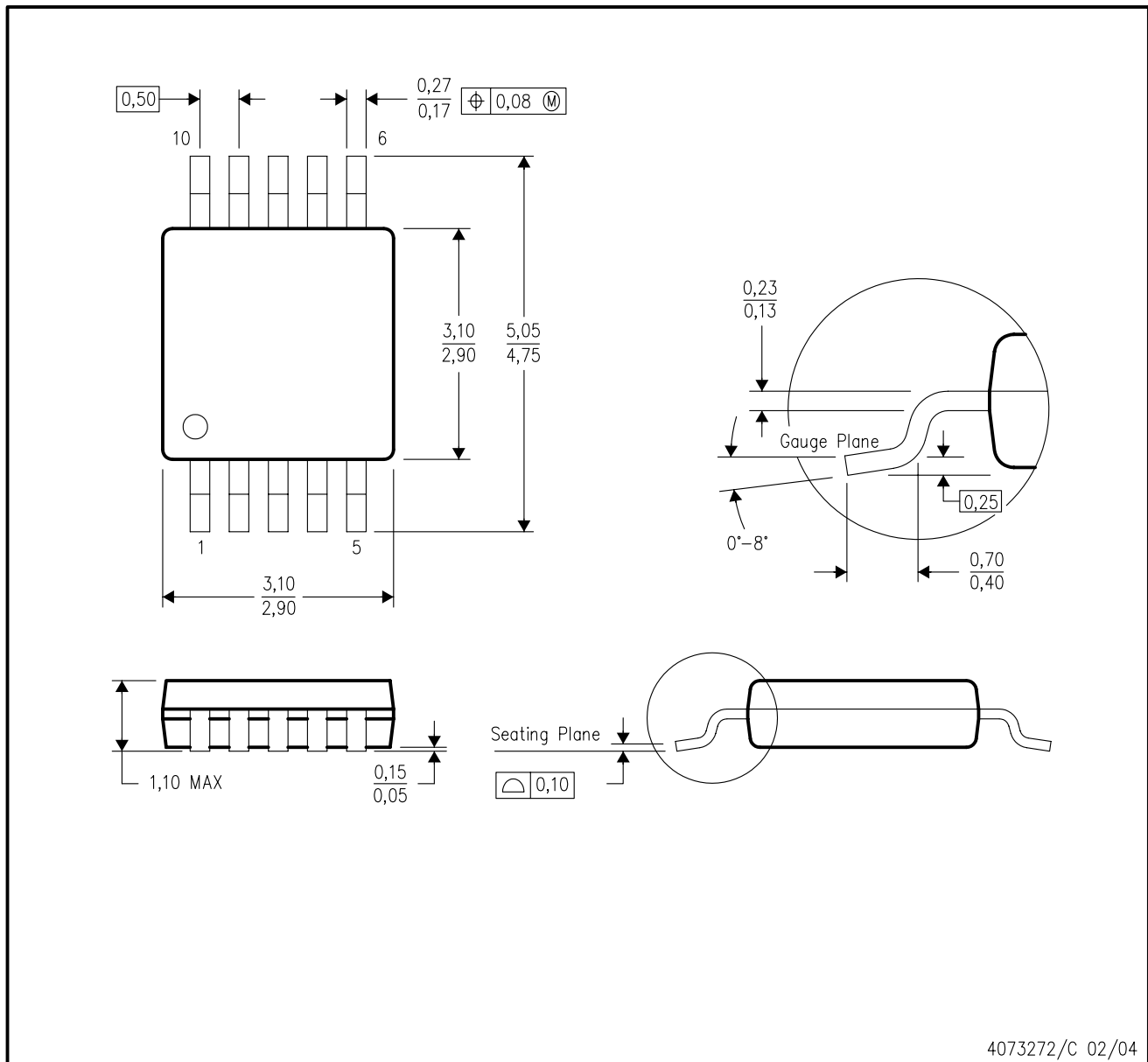
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AA.

DGS (S-PDSO-G10)

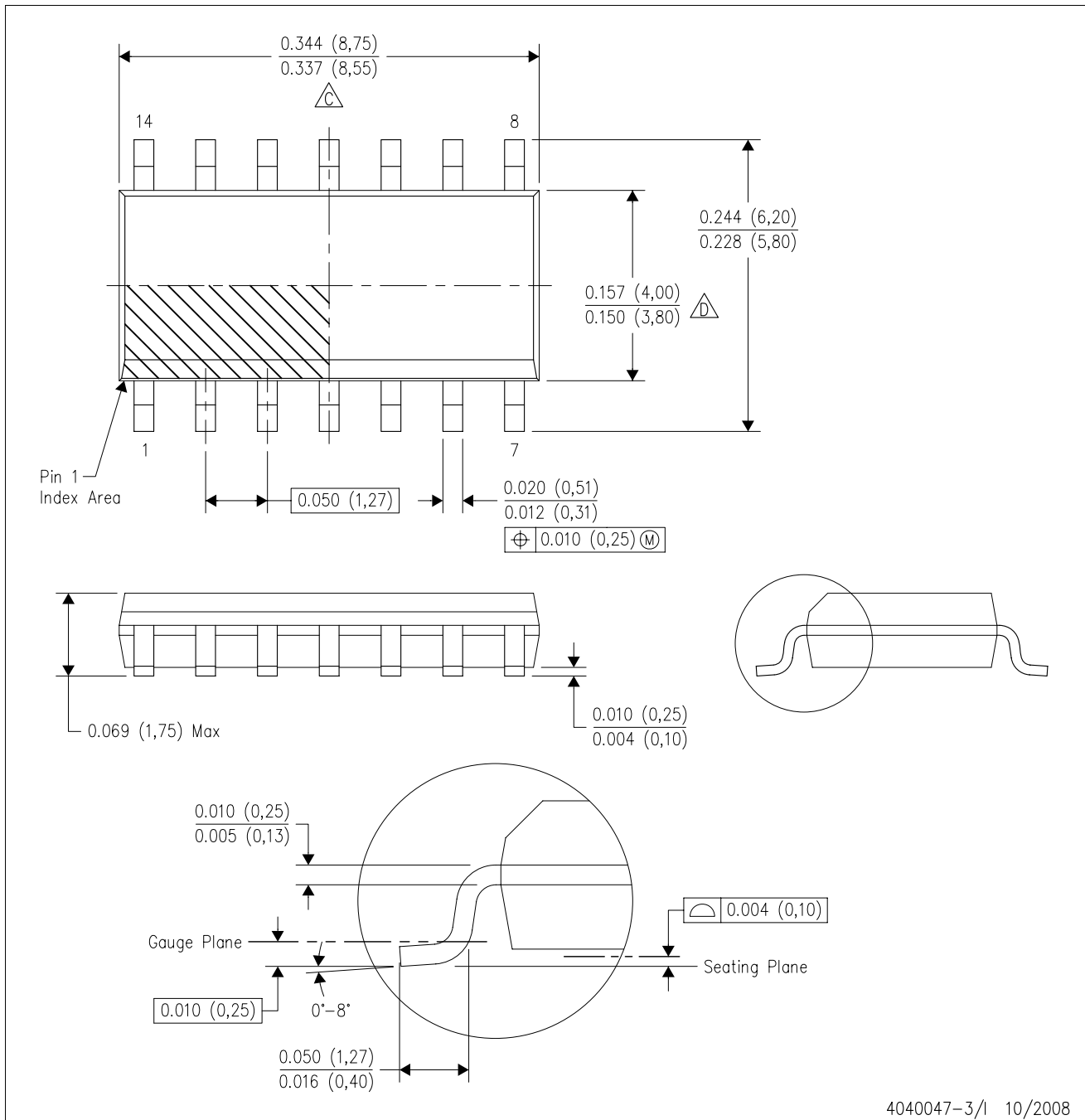
PLASTIC SMALL-OUTLINE PACKAGE



- 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.
  - D. Falls within JEDEC MO-187 variation BA.

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



- 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 .006 (0,15) per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
  - E. Reference JEDEC MS-012 variation AB.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



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

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