

TLV2432, TLV2432A, TLV2434, TLV2434A Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SLOS168F – NOVEMBER 1996 – REVISED MARCH 2001

- Output Swing Includes Both Supply Rails
- Extended Common-Mode Input Voltage Range . . . 0 V to 4.5 V (Min) with 5-V Single Supply
- No Phase Inversion
- Low Noise . . . 18 nV/√Hz Typ at f = 1 kHz
- Low Input Offset Voltage
950 μV Max at T_A = 25°C (TLV243xA)
- Low Input Bias Current . . . 1 pA Typ
- Very Low Supply Current . . . 125 μA Per Channel Max
- 600-Ω Output Drive
- Macromodel Included
- Available in Q-Temp Automotive
HighRel Automotive Applications
Configuration Control / Print Support
Qualification to Automotive Standards

description

The TLV243x and TLV243xA are low-voltage operational amplifier from Texas Instruments. The common-mode input voltage range for each device is extended over the typical CMOS amplifiers making them suitable for a wide range of applications. In addition, these devices do not phase invert when the common-mode input is driven to the supply rails. This satisfies most design requirements without paying a premium for rail-to-rail input performance. They also exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. This family is fully characterized at 3-V and 5-V supplies and is optimized for low-voltage operation. The TLV243x only requires 100 μA (typ) of supply current per channel, making it ideal for battery-powered applications. The TLV243x also has increased output drive over previous rail-to-rail operational amplifiers and can drive 600-Ω loads for telecom applications.

The other members in the TLV243x family are the high-power, TLV244x, and micro-power, TLV2422, versions.

The TLV243x, exhibiting high input impedance and low noise, is excellent for small-signal conditioning for high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels and low-voltage operation, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single- or split-supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). For precision applications, the TLV243xA is available and has a maximum input offset voltage of 950 μV.

If the design requires single operational amplifiers, see the TI TLV2211/21/31. This is a family of rail-to-rail output operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.

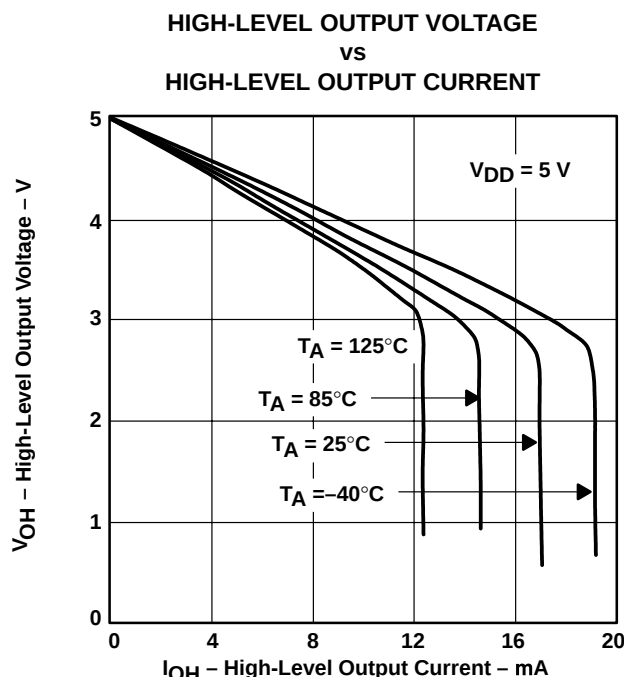


Figure 1



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.

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**TEXAS
INSTRUMENTS**

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TLV2432 and TLV2432A AVAILABLE OPTIONS

T _A	V _{IO} max AT 25°C	PACKAGED DEVICES				
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	TSSOP (PW)	CERAMIC FLAT PACK (U)
0°C to 70°C	2.5 mV	TLV2432CD	—	—	TLV2432CPW	—
–40°C to 85°C	950 µV 2.5 mV	TLV2432AID TLV2432ID	— —	— —	TLV2432AIPW —	— —
–40°C to 125°C	950 µV 2.5 mV	TLV2432AQD TLV2432QD	— —	— —	— —	— —
–55°C to 125°C	950 µV 2.5 mV	— —	TLV2432AMFK TLV2432MFK	TLV2432AMJG TLV2432MJG	— —	TLV2432AMU TLV2432MU

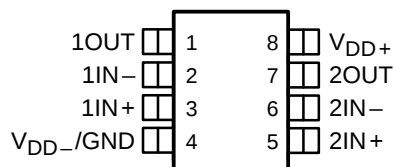
The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2432CDR). The PW package is available only left-end taped and reeled.

TLV2434 AVAILABLE OPTIONS

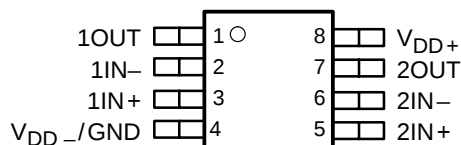
T _A	V _{IO} max AT 25°C	PACKAGED DEVICES	
		SMALL OUTLINE (D)	TSSOP (PW)
0°C to 70°C	2.5 mV	TLV2434CD	TLV2434CPW
–40°C to 125°C	950 µV 2.5 mV	TLV2434AID TLV2434ID	TLV2434AIPW TLV2434IPW

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLV2434CDR). The PW package is available only left-end taped and reeled.

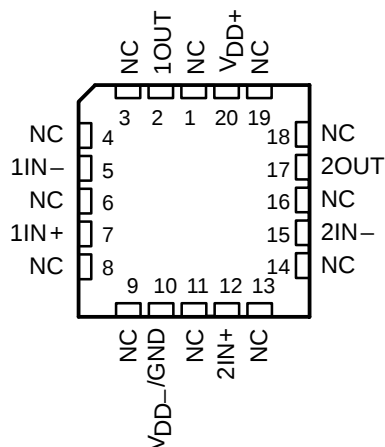
**TLV2432
D OR JG PACKAGE
(TOP VIEW)**



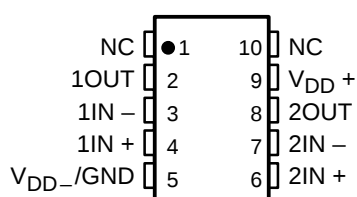
**TLV2432
PW PACKAGE
(TOP VIEW)**



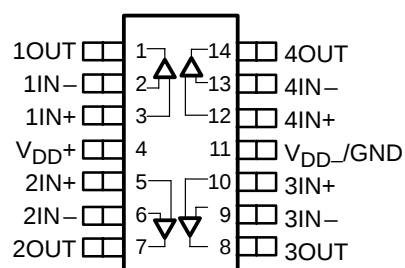
**TLV2432
FK PACKAGE
(TOP VIEW)**



**TLV2432
U PACKAGE
(TOP VIEW)**



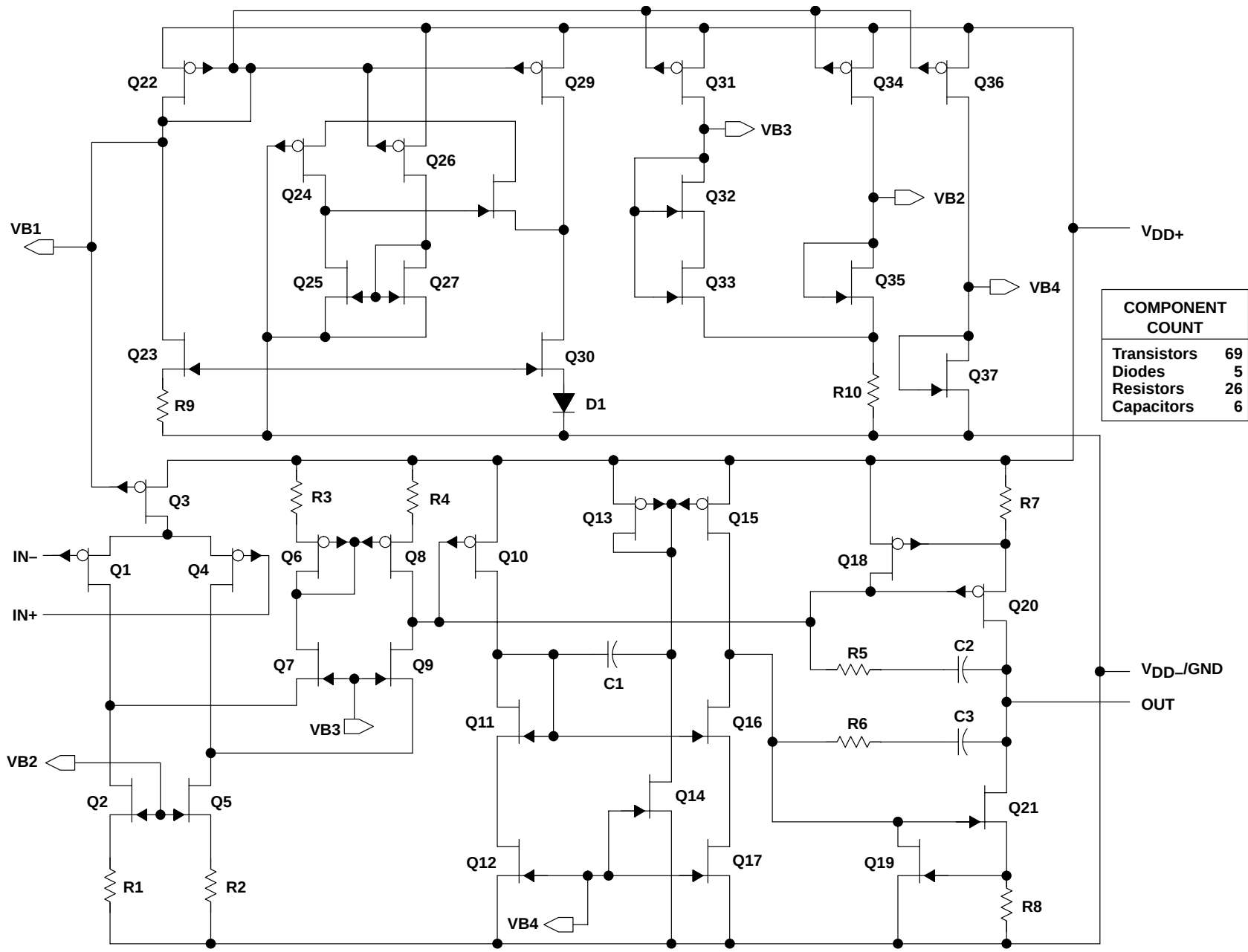
**TLV2434
D OR PW PACKAGE
(TOP VIEW)**



NC – No internal connection

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equivalent schematic (each amplifier)



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

Supply voltage, V_{DD} (see Note 1)	12 V
Differential input voltage, V_{ID} (see Note 2)	$\pm V_{DD}$
Input voltage, V_I (any input, see Note 1): C and I suffix	-0.3 V to V_{DD}
Input current, I_I (each input)	± 5 mA
Output current, I_O	± 50 mA
Total current into V_{DD+}	± 50 mA
Total current out of V_{DD-}	± 50 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A : C suffix	0°C to 70°C
I suffix (dual)	-40°C to 85°C
I suffix (quad)	-40°C to 125°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.

- NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{DD+} and V_{DD-} .
2. Differential voltages are at $IN+$ with respect to $IN-$. Excessive current flows if input is brought below $V_{DD-} - 0.3$ V.
3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D (8)	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
D (14)	1022 mW	7.6 mW/°C	900 mW	777 mW	450 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
PW (8)	525 mW	4.2 mW/°C	336 mW	273 mW	105 mW
PW (14)	720 mW	5.6 mW/°C	634 mW	547 mW	317 mW
U	675 mW	5.4 mW/°C	432 mW	350 mW	135 mW

recommended operating conditions

	C SUFFIX		I SUFFIX		Q SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, V_{DD}	2.7	10	2.7	10	2.7	10	2.7	10	V
Input voltage range, V_I	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V_{DD-}	$V_{DD+} - 0.8$	V
Common-mode input voltage, V_{IC}	V_{DD-}	$V_{DD+} - 1.3$	V_{DD-}	$V_{DD+} - 1.3$	V_{DD-}	$V_{DD+} - 1.3$	V_{DD-}	$V_{DD+} - 1.3$	V
Operating free-air temperature, T_A	0	70	-40	125	-40	125	-55	125	°C



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electrical characteristics at specified free-air temperature, $V_{DD} = 3\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A [†]	TLV243x			UNIT
					MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±1.5 V, R _S = 50 Ω	TLV243xC, TLV243xI	25°C	300 2000		μV	
				Full range	2500			
			TLV243xAI	25°C	300 950			
				Full range	1500			
α _{VIO}	Temperature coefficient of input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±1.5 V, R _S = 50 Ω		25°C to 70°C	2		μV/°C	
Input offset voltage long-term drift (see Note 4)				25°C	0.003		μV/mo	
I _{IO}	Input offset current			25°C	0.5 60		pA	
				Full range	150			
I _{IB}	Input bias current			25°C	1 60		pA	
				Full range	150			
V _{ICR}	Common-mode input voltage range	V _{IO} ≤ 5 mV, R _S = 50 Ω		25°C	0 to 2.5 -0.25 to 2.75		V	
				Full range	0 to 2.2			
V _{OH}	High-level output voltage	I _{OH} = −100 μA		25°C	2.98		V	
		I _{OH} = −3 mA		25°C	2.5			
				Full range	2.25			
V _{OL}	Low-level output voltage	V _{IC} = 1.5 V, I _{OL} = 100 μA		25°C	0.02		V	
		V _{IC} = 1.5 V, I _{OL} = 3 mA		25°C	0.83			
				Full range	1			
A _{VD}	Large-signal differential voltage amplification	V _{IC} = 2.5 V, V _O = 1 V to 2 V	R _L = 2 kΩ [‡]	25°C	1.5 2.5		V/mV	
				Full range	1			
			R _L = 1 MΩ [‡]	25°C	750			
r _{i(d)}	Differential input resistance			25°C	1000		GΩ	
r _{i(c)}	Common-mode input resistance			25°C	1000		GΩ	
c _{i(c)}	Common-mode input capacitance	f = 10 kHz		25°C	8		pF	
z _o	Closed-loop output impedance	f = 100 kHz, A _V = 10		25°C	130		Ω	
CMRR	Common-mode rejection ratio	V _{IC} = 0 to 2.5 V, V _O = 1.5 V, R _S = 50 Ω		25°C	70	83	dB	
				Full range	70			
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD} /ΔV _{IO})	V _{DD} = 2.7 V to 8 V, V _{IC} = V _{DD} /2, No load		25°C	80	95	dB	
				Full range	80			
I _{DD}	Supply current (per channel)	V _O = 1.5 V, No load		25°C	98	125	μA	
				Full range	125			

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is -40°C to 85°C. Full range for the quad I suffix is -40°C to 125°C.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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operating characteristics at specified free-air temperature, $V_{DD} = 3\text{ V}$

PARAMETER		TEST CONDITIONS		T _A [†]	TLV243x			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	V _O = 1 V to 2 V, C _L = 100 pF [‡]		R _L = 2 kΩ [‡]	25°C	0.15	0.25	V/μs
					Full range	0.1		
V _n	Equivalent input noise voltage	f = 10 Hz		25°C	120		nV/√Hz	
		f = 1 kHz		25°C	22			
V _{N(PP)}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	2.7		μV	
		f = 0.1 Hz to 10 Hz		25°C	4			
I _n	Equivalent input noise current			25°C	0.6		fA/√Hz	
THD + N	Total harmonic distortion plus noise	V _O = 0.5 V to 2.5 V, f = 1 kHz, R _L = 2 kΩ [‡]	A _V = 1	25°C	0.065%			
			A _V = 10		0.5%			
Gain-bandwidth product		f = 10 kHz, C _L = 100 pF [‡]	R _L = 2 kΩ [‡]	25°C	0.5		MHz	
B _{OM}	Maximum output-swing bandwidth	V _{O(PP)} = 1 V, R _L = 2 kΩ [‡]	A _V = 1, C _L = 100 pF [‡]	25°C	220		kHz	
t _s	Settling time	A _V = −1, Step = 0.5 V to 2.5 V, R _L = 2 kΩ [‡] , C _L = 100 pF [‡]	To 0.1%	25°C	6.4		μs	
			To 0.01%		14.1			
φ _m	Phase margin at unity gain	R _L = 2 kΩ [‡] , C _L = 100 pF [‡]		25°C	62°			
Gain margin				25°C	11		dB	

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is –40°C to 85°C. Full range for the quad I suffix is –40°C to 125°C.

‡ Referenced to 2.5 V

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electrical characteristics at specified free-air temperature, $V_{DD} = 3\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A [†]	TLV243xQ, TLV243xM			UNIT
					MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±1.5 V, R _S = 50 Ω	TLV243xQ, TLV243xM	25°C	300	2000	μV	
				Full range	2500			
			TLV243xAQ, TLV243xAM	25°C	300	950		
				Full range	2000			
α _{VIO}	Temperature coefficient of input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±1.5 V, R _S = 50 Ω		25°C to 70°C	2		μV/°C	
Input offset voltage long-term drift (see Note 4)				25°C	0.003		μV/mo	
I _{IO}	Input offset current			25°C	0.5	60	pA	
				Full range	150			
I _{IB}	Input bias current			25°C	1	60	pA	
				Full range	300			
V _{ICR}	Common-mode input voltage range	V _{IO} ≤ 5 mV, R _S = 50 Ω	25°C	0 to 2.5 −0.25 to 2.75		V		
			Full range	0 to 2.2				
V _{OH}	High-level output voltage	I _{OH} = −100 μA	25°C	2.98		V		
		I _{OH} = −3 mA	25°C	2.5				
			Full range	2.25				
V _{OL}	Low-level output voltage	V _{IC} = 1.5 V, I _{OL} = 100 μA	25°C	0.02		V		
		V _{IC} = 1.5 V, I _{OL} = 3 mA	25°C	0.83				
			Full range	1				
A _{VD}	Large-signal differential voltage amplification	V _{IC} = 2.5 V, V _O = 1 V to 2 V	R _L = 2 kΩ [‡]	25°C	1.5	2.5	V/mV	
				Full range	0.5			
			R _L = 1 MΩ [‡]	25°C	750			
r _{i(d)}	Differential input resistance			25°C	1000		GΩ	
r _{i(c)}	Common-mode input resistance			25°C	1000		GΩ	
c _{i(c)}	Common-mode input capacitance	f = 10 kHz		25°C	8		pF	
z _o	Closed-loop output impedance	f = 100 kHz, A _V = 10		25°C	130		Ω	
CMRR	Common-mode rejection ratio	V _{IC} = 0 to 2.5 V, V _O = 1.5 V, R _S = 50 Ω	25°C	70	83	dB		
			Full range	70				
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD} /ΔV _{IO})	V _{DD} = 2.7 V to 8 V, V _{IC} = V _{DD} /2, No load	25°C	80	95	dB		
			Full range	80				
I _{DD}	Supply current	V _O = 1.5 V, No load	25°C	195	250	μA		
			Full range	260				

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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operating characteristics at specified free-air temperature, $V_{DD} = 3\text{ V}$

PARAMETER	TEST CONDITIONS	$T_A^\dagger$	TLV243xQ, TLV243xM, TLV243xAQ, TLV243xAM			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 1\text{ V to }2\text{ V},$ $C_L = 100\text{ pF}^\ddagger$ $R_L = 2\text{ k}\Omega^\ddagger$	25°C Full range	0.15 0.1	0.25		V/ μ s
V_n Equivalent input noise voltage	$f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C 25°C		120 22		nV/ $\sqrt{\text{Hz}}$
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$ $f = 0.1\text{ Hz to }10\text{ Hz}$	25°C 25°C		2.7 4		μ V
I_n Equivalent input noise current		25°C		0.6		fA/ $\sqrt{\text{Hz}}$
THD + N Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V},$ $f = 1\text{ kHz},$ $R_L = 2\text{ k}\Omega^\ddagger$ $A_V = 1$ $A_V = 10$	25°C		0.065% 0.5%		
Gain-bandwidth product	$f = 10\text{ kHz},$ $C_L = 100\text{ pF}^\ddagger$ $R_L = 2\text{ k}\Omega^\ddagger$	25°C		0.5		MHz
BOM Maximum output-swing bandwidth	$V_{O(PP)} = 1\text{ V},$ $R_L = 2\text{ k}\Omega^\ddagger$ $A_V = 1,$ $C_L = 100\text{ pF}^\ddagger$	25°C		220		kHz
t_s Settling time	$A_V = -1,$ Step = 0.5 V to 2.5 V, $R_L = 2\text{ k}\Omega^\ddagger$ $C_L = 100\text{ pF}^\ddagger$ $T_o = 0.1\%$ $T_o = 0.01\%$	25°C		6.4 14.1		μ s
ϕ_m Phase margin at unity gain	$R_L = 2\text{ k}\Omega^\ddagger$ $C_L = 100\text{ pF}^\ddagger$	25°C		62°		
Gain margin		25°C		11		dB

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 2.5 V

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electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A [†]	TLV243x			UNIT
					MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±2.5 V, R _S = 50 Ω	TLV243x	25°C	300	2000	μV	
				Full range	2500			
			TLV243xA	25°C	300	950		
				Full range	1500			
α _{VIO}	Temperature coefficient of input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±2.5 V, R _S = 50 Ω		25°C to 70°C	2		μV/°C	
Input offset voltage long-term drift (see Note 4)				25°C	0.003		μV/mo	
I _{IO}	Input offset current			25°C	0.5	60	pA	
				Full range	150			
I _{IB}	Input bias current			25°C	1	60	pA	
				Full range	150			
V _{ICR}	Common-mode input voltage range	V _{IO} ≤ 5 mV, R _S = 50 Ω	25°C	0 to 4.5 −0.25 to 4.75		V		
			Full range	0 to 4.2				
V _{OH}	High-level output voltage	I _{OH} = −100 μA		25°C	4.97		V	
		I _{OH} = −5 mA		25°C	4	4.35		
				Full range	4			
V _{OL}	Low-level output voltage	V _{IC} = 2.5 V, I _{OL} = 100 μA		25°C	0.01		V	
		V _{IC} = 2.5 V, I _{OL} = 5 mA		25°C	0.8			
				Full range	1.25			
A _{VD}	Large-signal differential voltage amplification	V _{IC} = 2.5 V, V _O = 1 V to 4 V	R _L = 2 kΩ [‡]	25°C	2.5	3.8	V/mV	
				Full range	1.5			
			R _L = 1 MΩ [‡]	25°C	950			
r _{i(d)}	Differential input resistance			25°C	1000		GΩ	
r _{i(c)}	Common-mode input resistance			25°C	1000		GΩ	
c _{i(c)}	Common-mode input capacitance	f = 10 kHz		25°C	8		pF	
z _o	Closed-loop output impedance	f = 100 kHz, A _V = 10		25°C	130		Ω	
CMRR	Common-mode rejection ratio	V _{IC} = 0 to 4.5 V, V _O = 2.5 V, R _S = 50 Ω		25°C	70	90	dB	
				Full range	70			
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD} /ΔV _{IO})	V _{DD} = 4.4 V to 8 V, V _{IC} = V _{DD} /2, No load		25°C	80	95	dB	
				Full range	80			
I _{DD}	Supply current (per channel)	V _O = 2.5 V, No load		25°C	100	125	μA	
				Full range	125			

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is -40°C to 85°C. Full range for the quad I suffix is -40°C to 125°C.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

PARAMETER		TEST CONDITIONS		T _A [†]	TLV243x			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	V _O = 1.5 V to 3.5 V, R _L = 2 kΩ [‡] , C _L = 100 pF [‡]		25°C	0.15	0.25	V/μs	
				Full range	0.1			
V _n	Equivalent input noise voltage	f = 10 Hz		25°C	100		nV/√Hz	
		f = 1 kHz		25°C	18			
V _{N(PP)}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1.9		μV	
		f = 0.1 Hz to 10 Hz		25°C	2.8			
I _n	Equivalent input noise current			25°C	0.6		fA/√Hz	
THD + N	Total harmonic distortion plus noise	V _O = 1.5 V to 3.5 V, f = 1 kHz, R _L = 2 kΩ [‡]	A _V = 1	25°C	0.045%			
			A _V = 10		0.4%			
Gain-bandwidth product		f = 10 kHz, C _L = 100 pF [‡]		25°C	0.55		MHz	
B _{OM}	Maximum output-swing bandwidth	V _{O(PP)} = 2 V, R _L = 2 kΩ [‡] ,		25°C	100		kHz	
t _s	Settling time	A _V = −1, Step = 1.5 V to 3.5 V, R _L = 2 kΩ [‡] , C _L = 100 pF [‡]	To 0.1%	25°C	6.4		μs	
			To 0.01%		13.1			
φ _m	Phase margin at unity gain	R _L = 2 kΩ [‡] , C _L = 100 pF [‡]		25°C	66°			
	Gain margin			25°C	11		dB	

† Full range for the C suffix is 0°C to 70°C. Full range for the dual I suffix is –40°C to 85°C. Full range for the quad I suffix is –40°C to 125°C.

‡ Referenced to 2.5 V

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electrical characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A [†]	TLV243xQ, TLV243xM			UNIT
					MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±2.5 V, R _S = 50 Ω	TLV2453x	25°C	300	2000	μV	
				Full range	2500			
			TLV2453xA	25°C	300	950		
				Full range	2000			
α _{VIO}	Temperature coefficient of input offset voltage	V _{IC} = 0, V _O = 0, V _{DD} ± = ±2.5 V, R _S = 50 Ω		25°C to 70°C	2		μV/°C	
	Input offset voltage long-term drift (see Note 4)			25°C	0.003		μV/mo	
I _{IO}	Input offset current			25°C	0.5	60	pA	
				Full range	150			
I _{IB}	Input bias current			25°C	1	60	pA	
				Full range	300			
V _{ICR}	Common-mode input voltage range	V _{IO} ≤ 5 mV, R _S = 50 Ω		25°C	0 to 4.5	−0.25 to 4.75	V	
				Full range	0 to 4.2			
V _{OH}	High-level output voltage	I _{OH} = −100 μA I _{OH} = −5 mA		25°C	4.97		V	
				25°C	4	4.35		
				Full range	4			
V _{OL}	Low-level output voltage	V _{IC} = 2.5 V, V _{IC} = 2.5 V,	I _{OL} = 100 μA I _{OL} = 5 mA	25°C	0.01		V	
				25°C	0.8			
				Full range	1.25			
A _{VD}	Large-signal differential voltage amplification	V _{IC} = 2.5 V, V _O = 1 V to 4 V	R _L = 2 kΩ [‡]	25°C	2.5	3.8	V/mV	
				Full range	0.5			
			R _L = 1 MΩ [‡]	25°C	950			
r _{i(d)}	Differential input resistance			25°C	1000		GΩ	
r _{i(c)}	Common-mode input resistance			25°C	1000		GΩ	
c _{i(c)}	Common-mode input capacitance	f = 10 kHz		25°C	8		pF	
z _o	Closed-loop output impedance	f = 100 kHz, A _V = 10		25°C	130		Ω	
CMRR	Common-mode rejection ratio	V _{IC} = 0 to 4.5 V, V _O = 2.5 V, R _S = 50 Ω		25°C	70	90	dB	
				Full range	70			
k _{SVR}	Supply-voltage rejection ratio (ΔV _{DD} /ΔV _{IO})	V _{DD} = 4.4 V to 8 V, V _{IC} = V _{DD} /2, No load		25°C	80	95	dB	
				Full range	80			
I _{DD}	Supply current	V _O = 2.5 V, No load		25°C	200	250	μA	
				Full range	270			

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 2.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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operating characteristics at specified free-air temperature, $V_{DD} = 5\text{ V}$

PARAMETER		TEST CONDITIONS		T _A [†]	TLV243xQ, TLV243xM, TLV243xAQ, TLV243xAM			UNIT
					MIN	TYP	MAX	
SR	Slew rate at unity gain	V _O = 1.5 V to 3.5 V, R _L = 2 kΩ [‡] , C _L = 100 pF [‡]		25°C	0.15	0.25	V/μs	
				Full range	0.1			
V _n	Equivalent input noise voltage	f = 10 Hz		25°C	100		nV/√Hz	
		f = 1 kHz		25°C	18			
V _{N(PP)}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C	1.9		μV	
		f = 0.1 Hz to 10 Hz		25°C	2.8			
I _n	Equivalent input noise current			25°C	0.6		fA/√Hz	
THD + N	Total harmonic distortion plus noise	V _O = 1.5 V to 3.5 V, f = 1 kHz, R _L = 2 kΩ [‡]	A _V = 1	25°C	0.045%			
			A _V = 10		0.4%			
Gain-bandwidth product		f = 10 kHz, R _L = 2 kΩ [‡] , C _L = 100 pF [‡]		25°C	0.55		MHz	
B _{OM}	Maximum output-swing bandwidth	V _{O(PP)} = 2 V, R _L = 2 kΩ [‡] ,		A _V = 1, C _L = 100 pF [‡]	25°C	100		kHz
t _s	Settling time	A _V = −1, Step = 1.5 V to 3.5 V, R _L = 2 kΩ [‡] , C _L = 100 pF [‡]	To 0.1%	25°C	6.4		μs	
			To 0.01%		13.1			
φ _m	Phase margin at unity gain	R _L = 2 kΩ [‡] , C _L = 100 pF [‡]		25°C	66°			
Gain margin				25°C	11		dB	

† Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

‡ Referenced to 2.5 V

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TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLV2432
INPUT OFFSET VOLTAGE

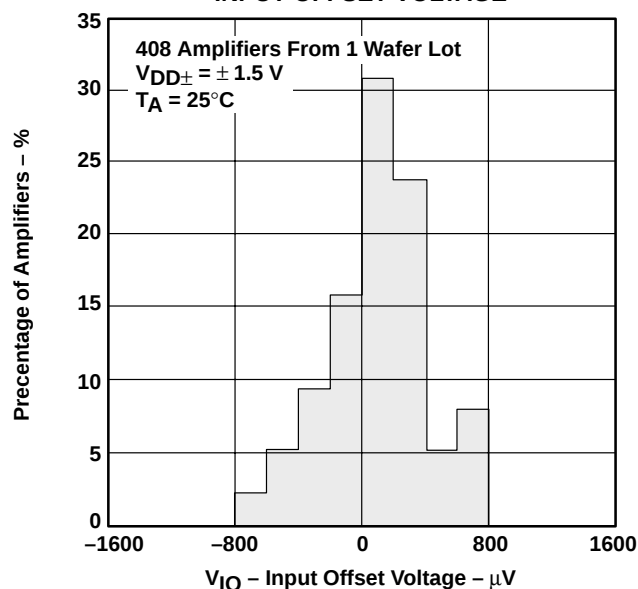


Figure 2

DISTRIBUTION OF TLV2432
INPUT OFFSET VOLTAGE

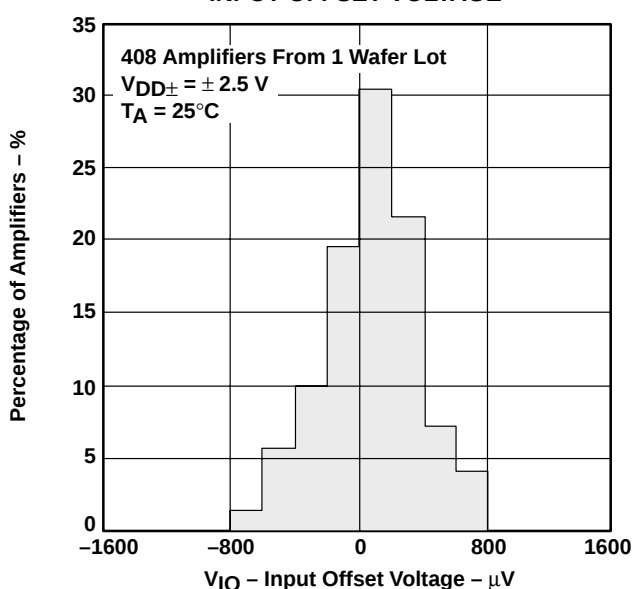


Figure 3

INPUT OFFSET VOLTAGE
VS
COMMON-MODE INPUT VOLTAGE

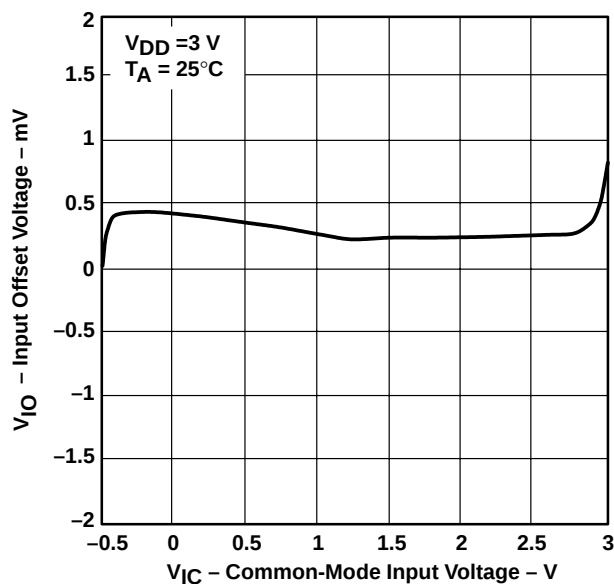


Figure 4

INPUT OFFSET VOLTAGE
VS
COMMON-MODE INPUT VOLTAGE

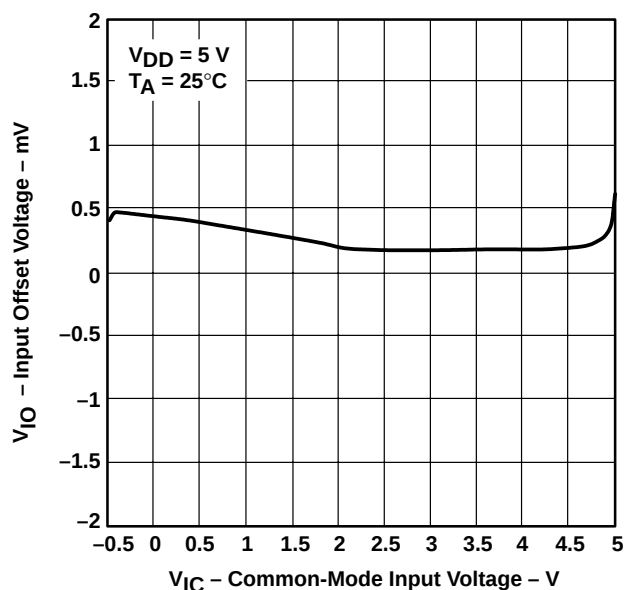


Figure 5

TYPICAL CHARACTERISTICS

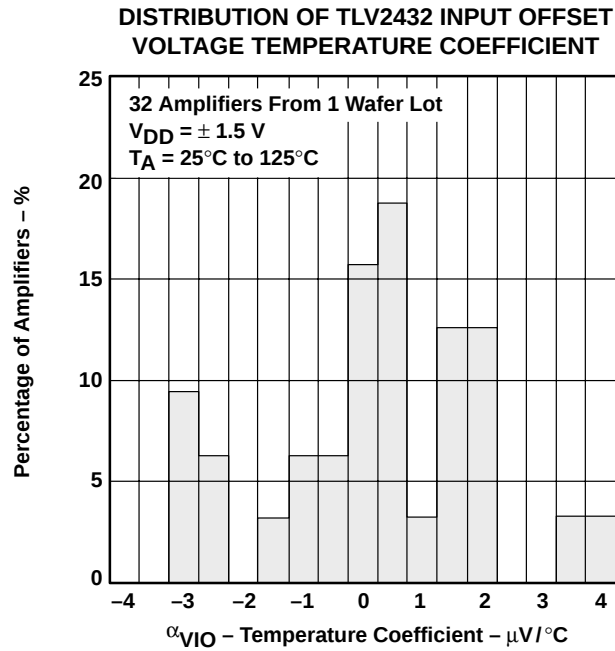


Figure 6

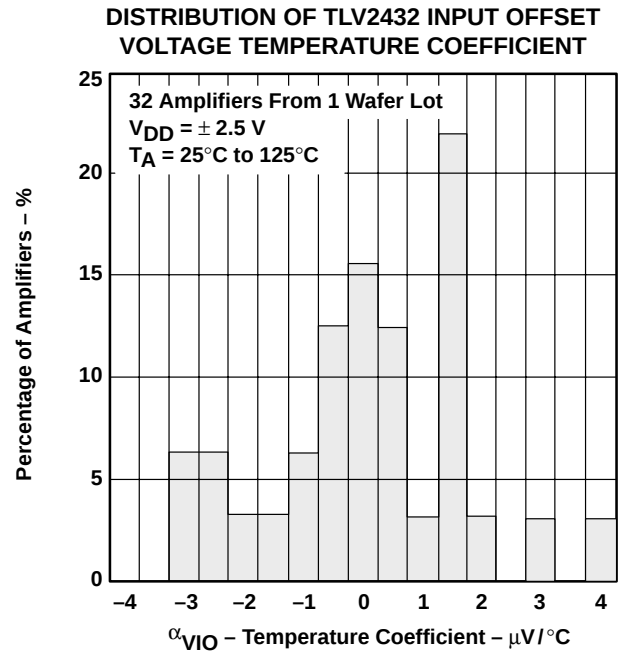


Figure 7

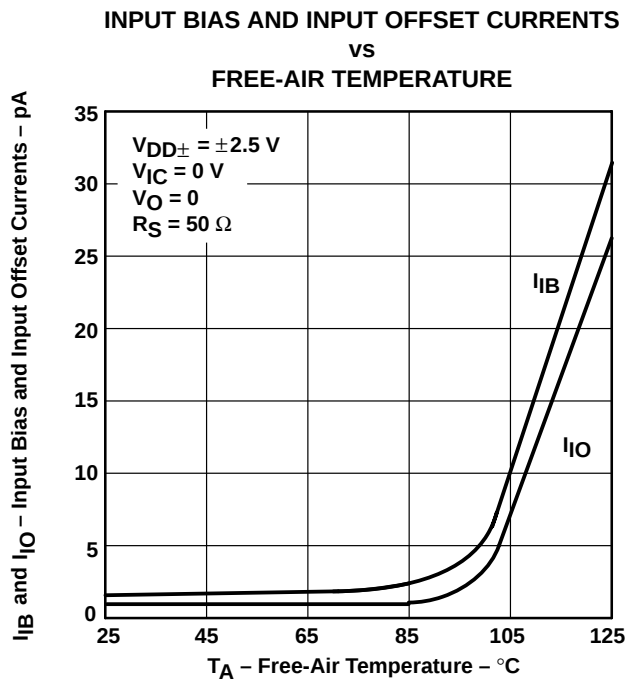


Figure 8

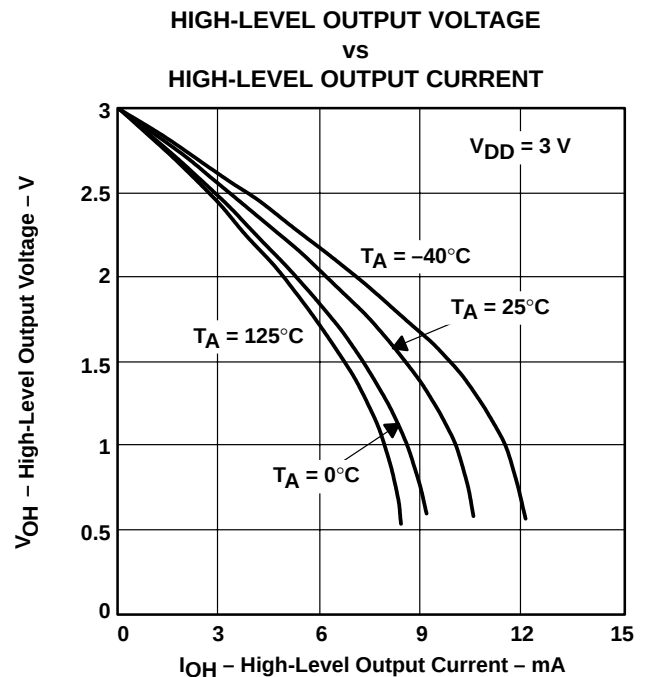


Figure 9

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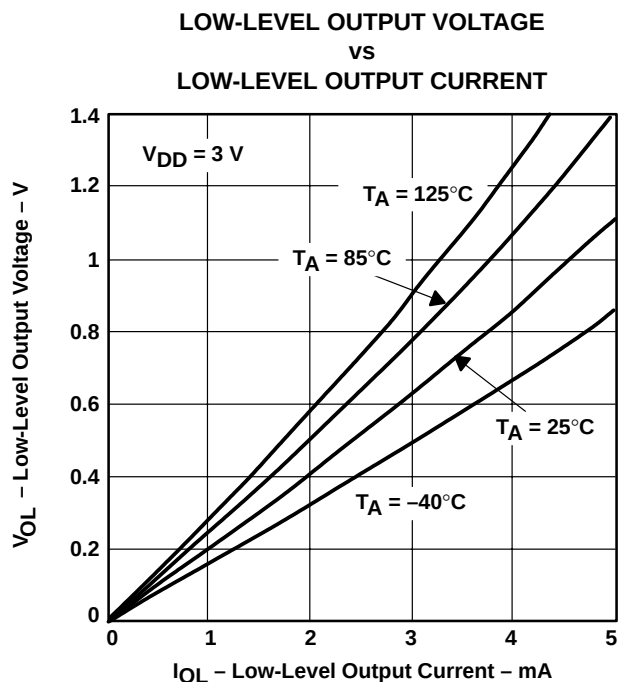


Figure 10

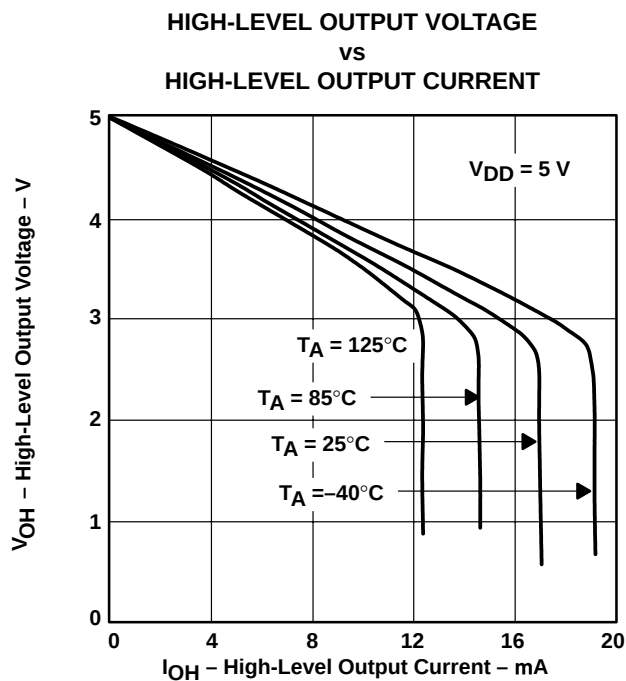


Figure 11

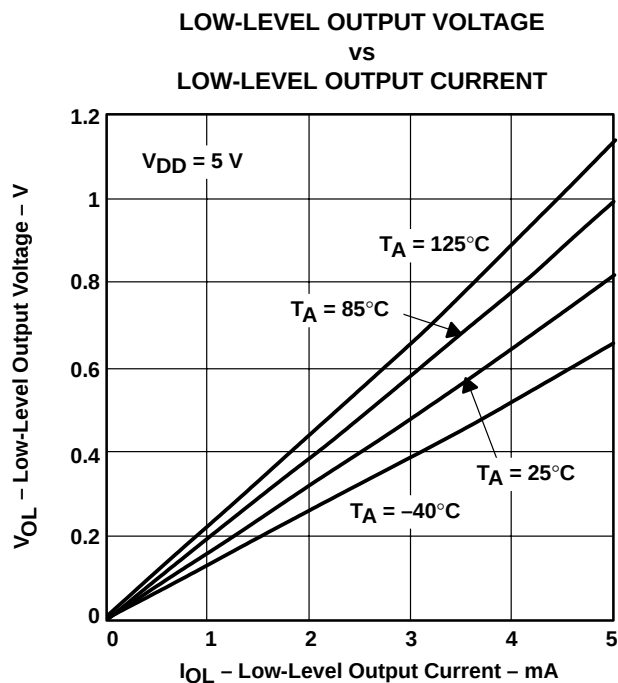


Figure 12

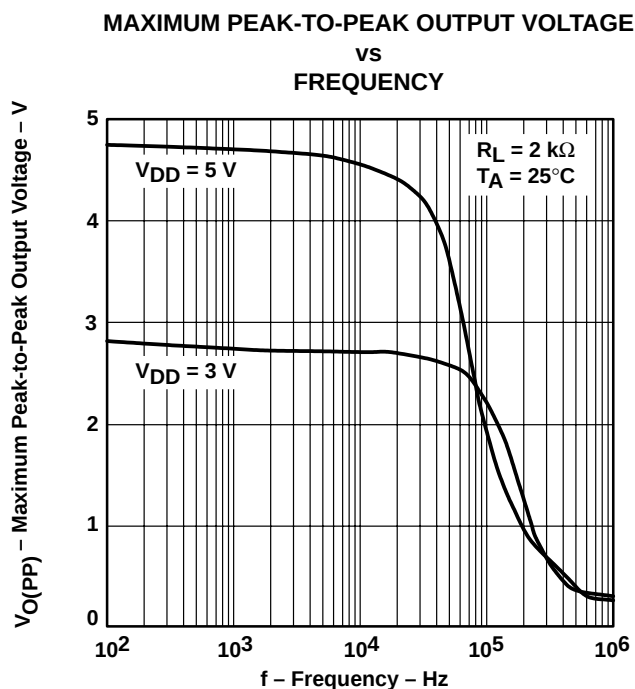


Figure 13

TYPICAL CHARACTERISTICS

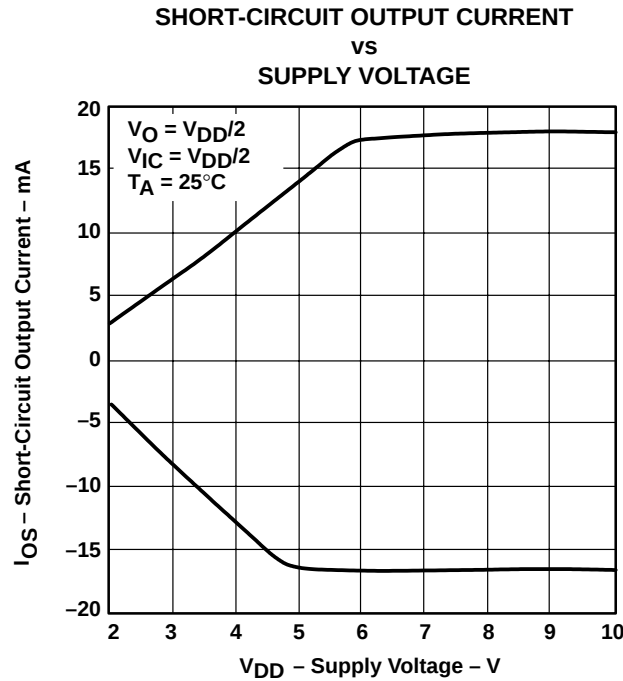


Figure 14

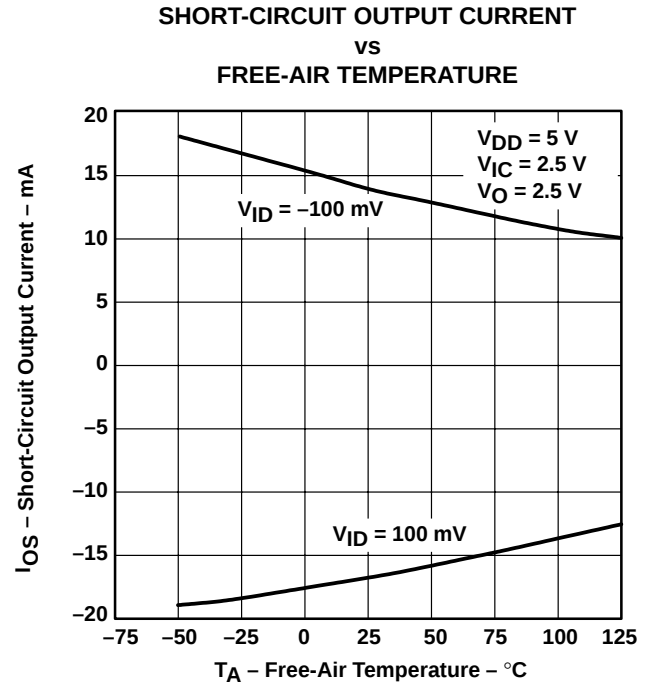


Figure 15

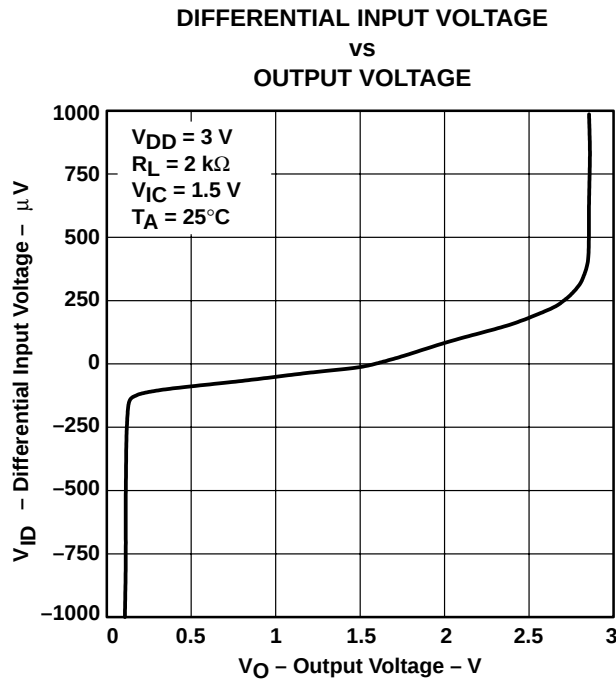


Figure 16

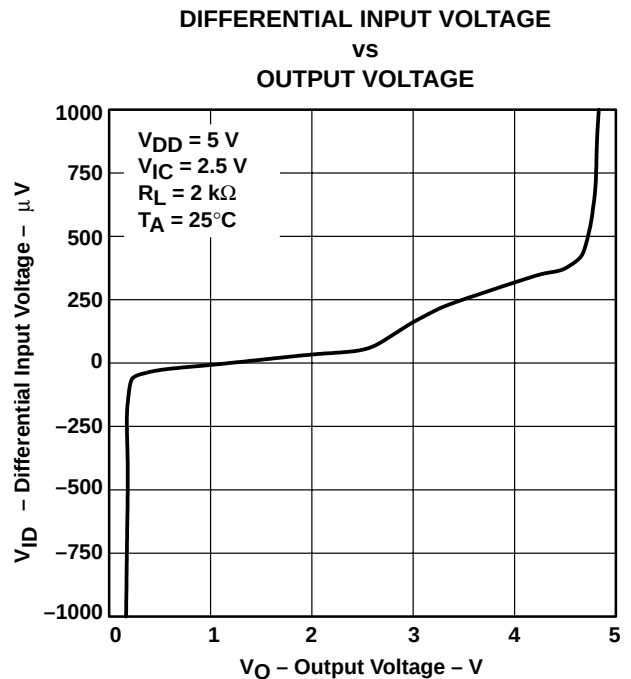


Figure 17

TLV2432, TLV2432A, TLV2434, TLV2434A
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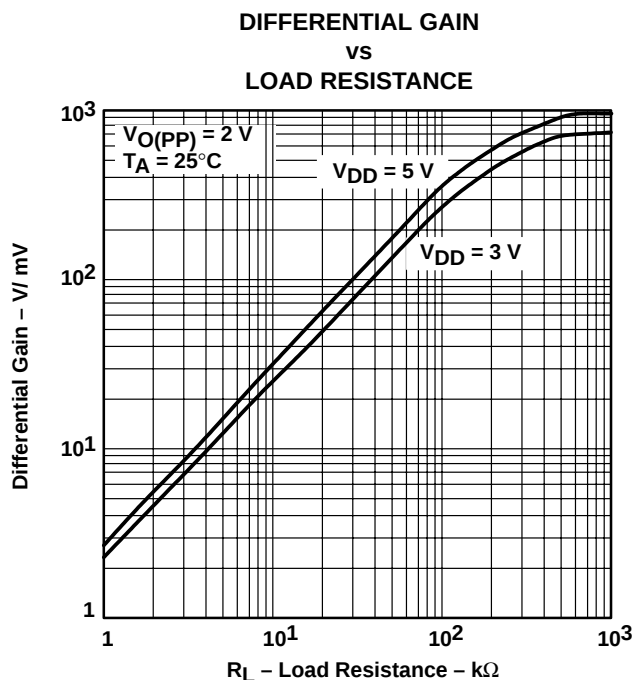


Figure 18

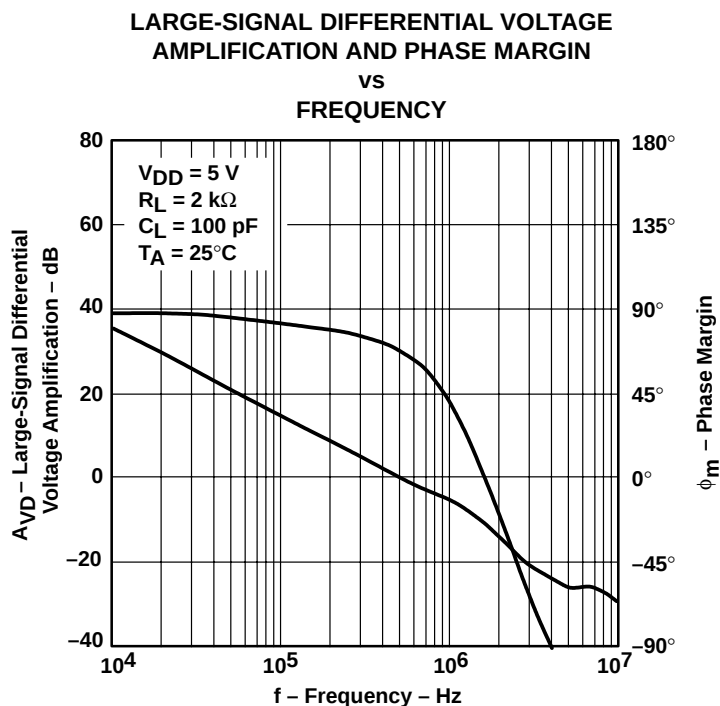


Figure 19

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN

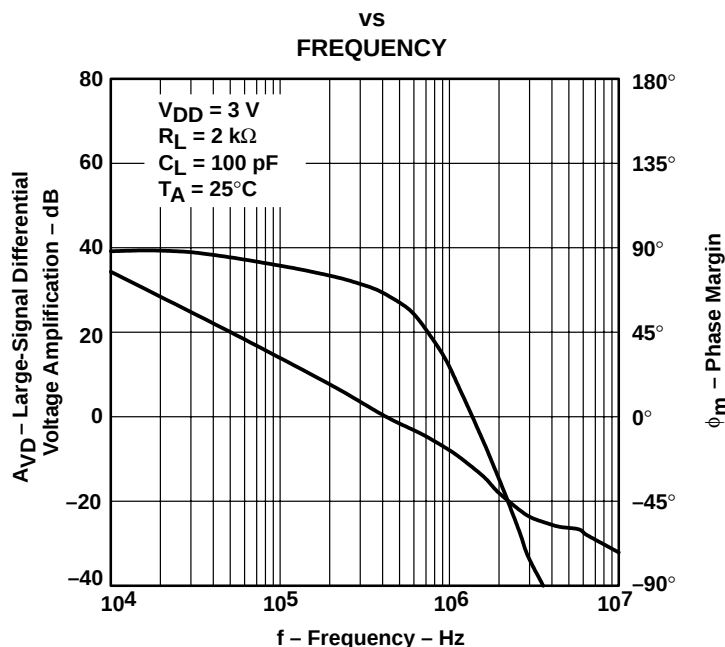


Figure 20

DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

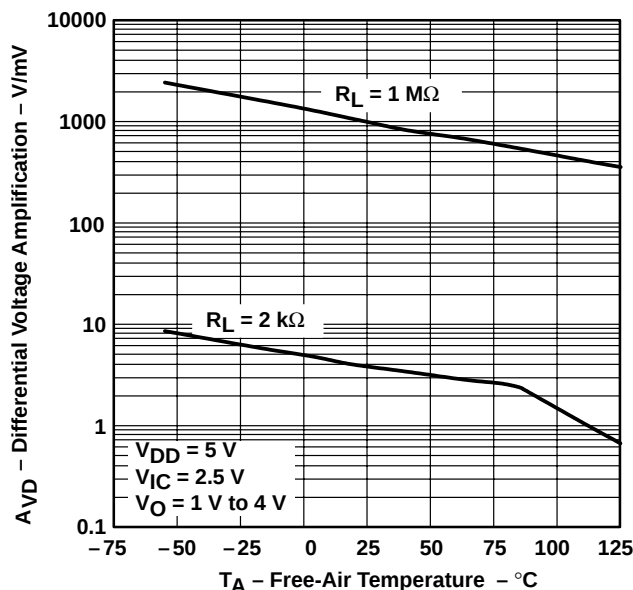


Figure 21

DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

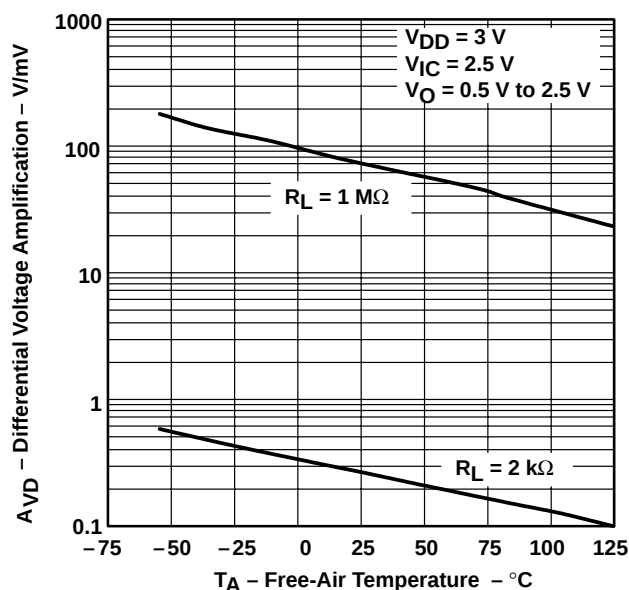


Figure 22

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OUTPUT IMPEDANCE
VS
FREQUENCY

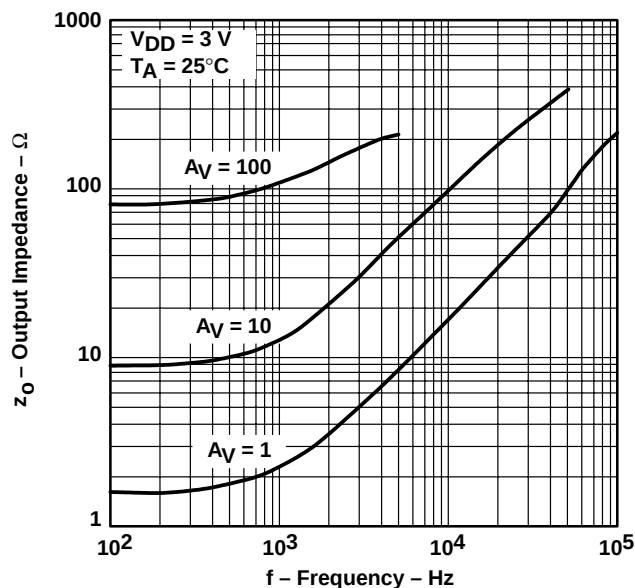


Figure 23

OUTPUT IMPEDANCE
VS
FREQUENCY

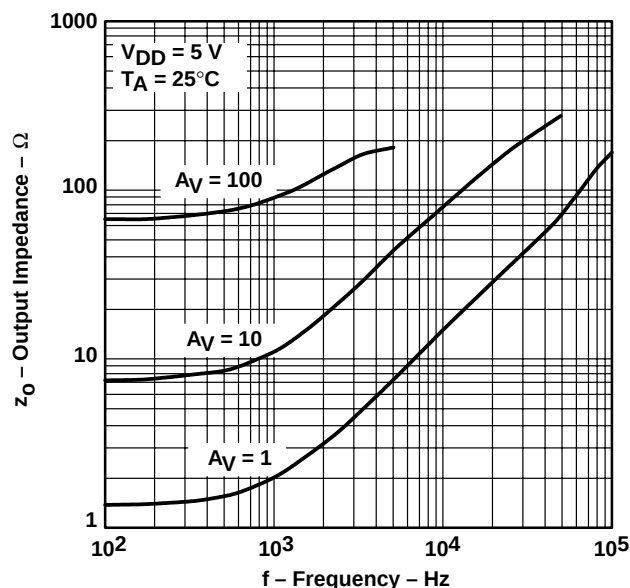


Figure 24

COMMON-MODE REJECTION RATIO
VS
FREQUENCY

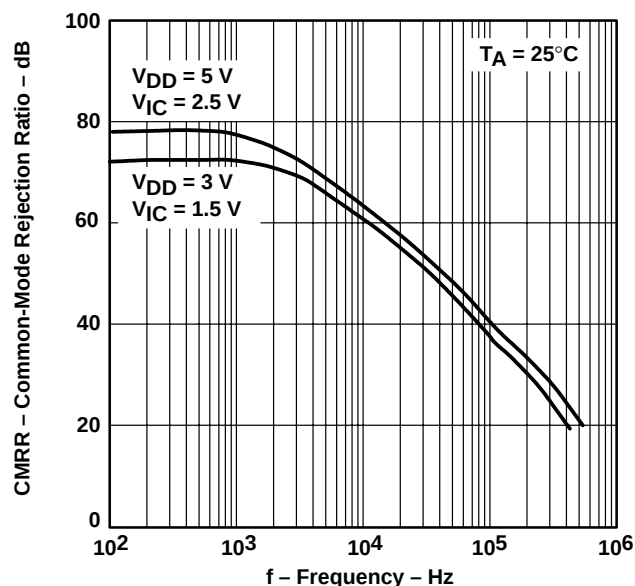


Figure 25

COMMON-MODE REJECTION RATIO
VS
FREE-AIR TEMPERATURE

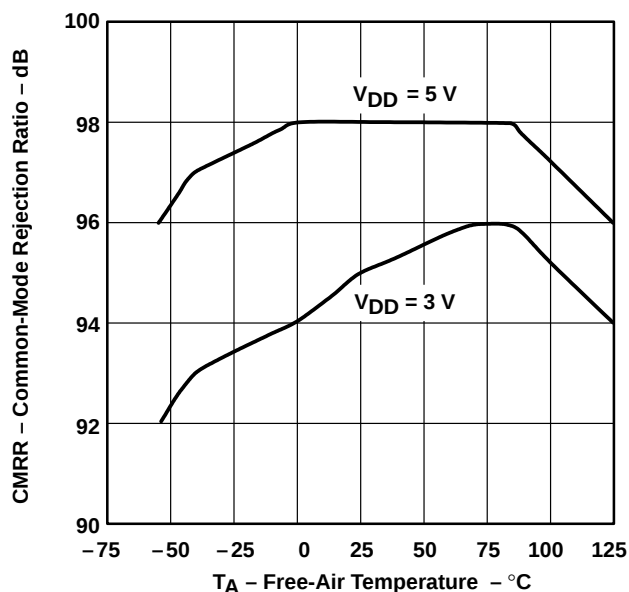


Figure 26

TYPICAL CHARACTERISTICS

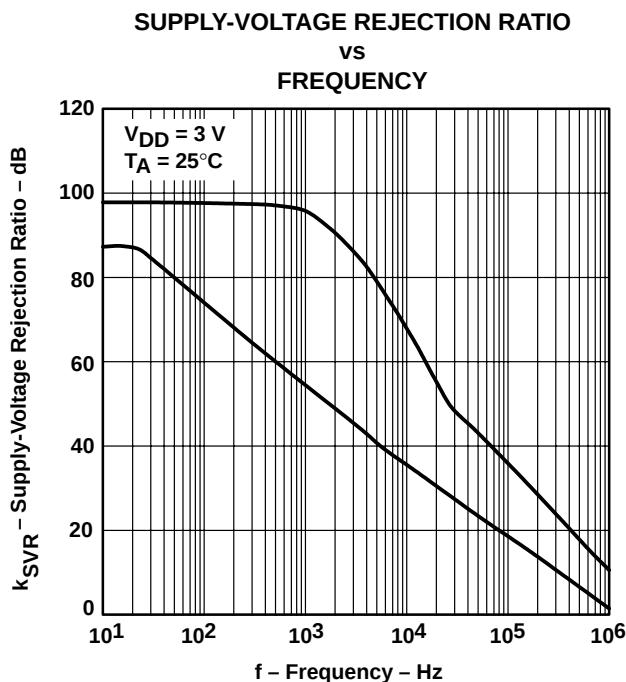


Figure 27

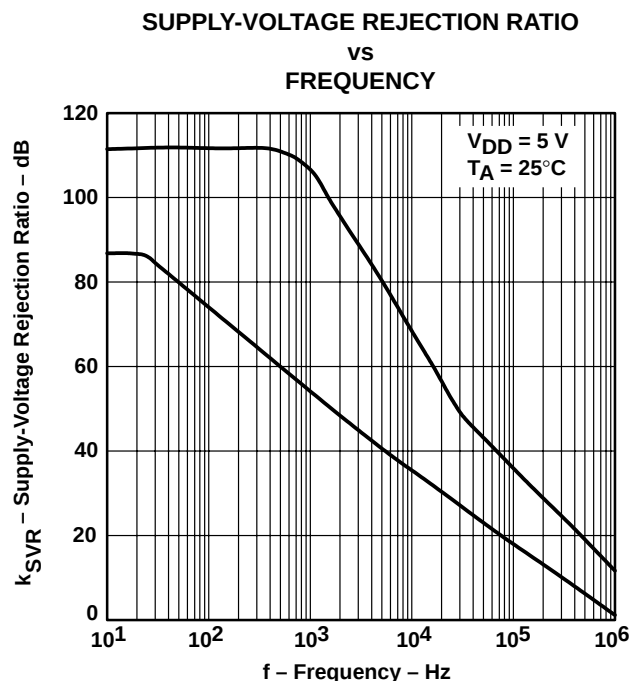


Figure 28

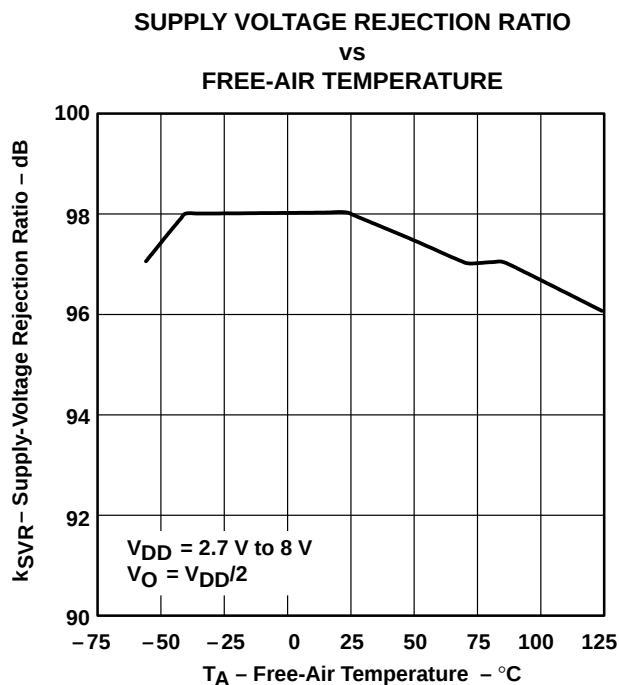


Figure 29

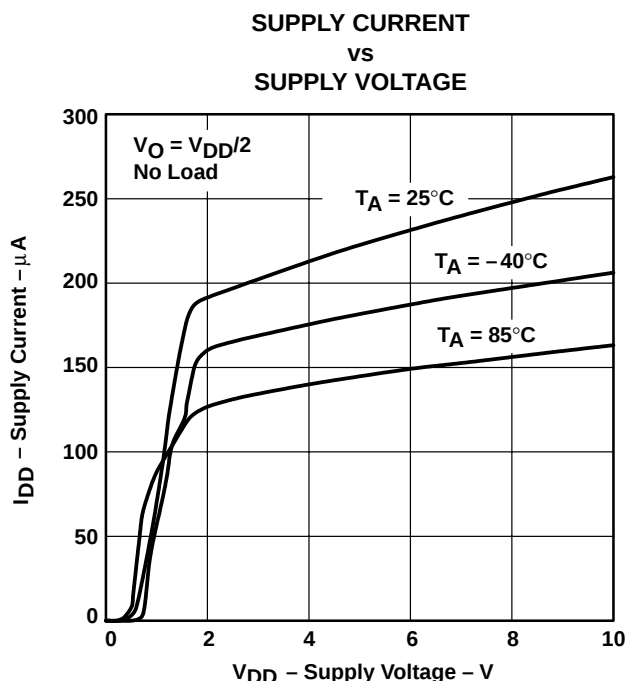


Figure 30

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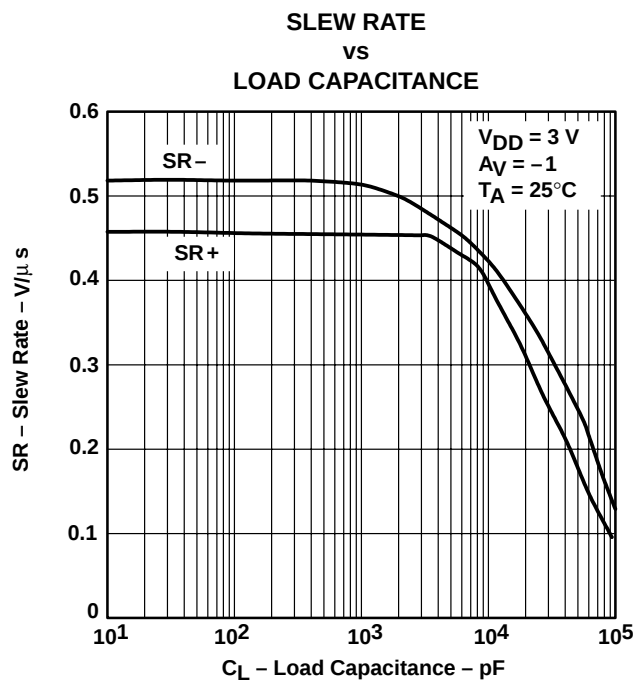


Figure 31

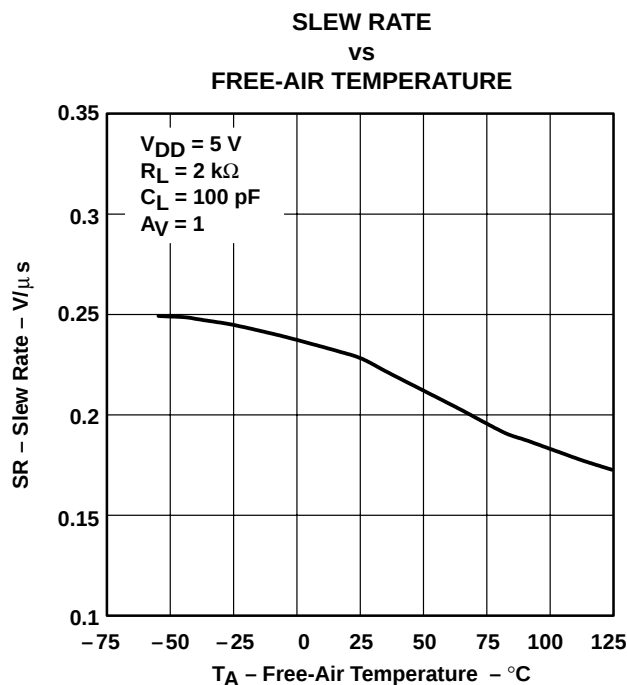


Figure 32

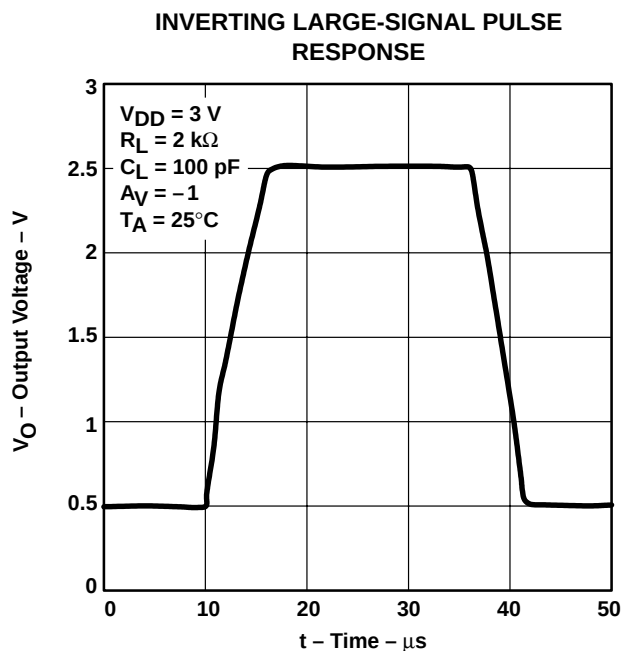


Figure 33

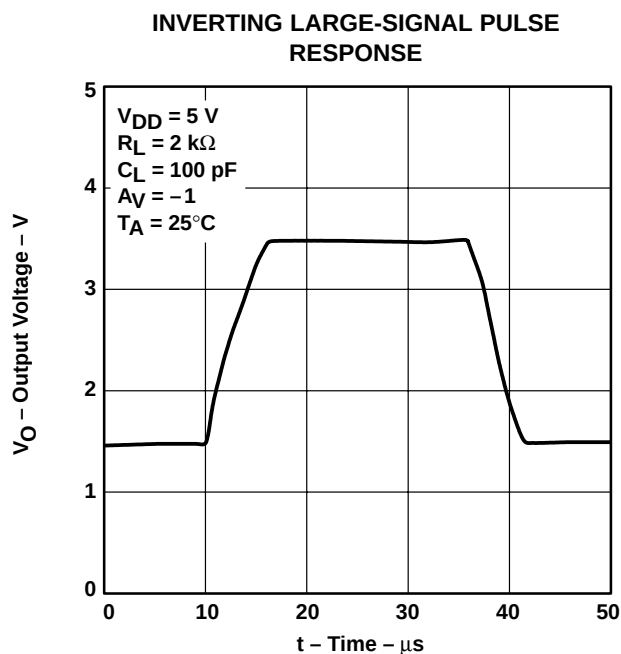


Figure 34

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE

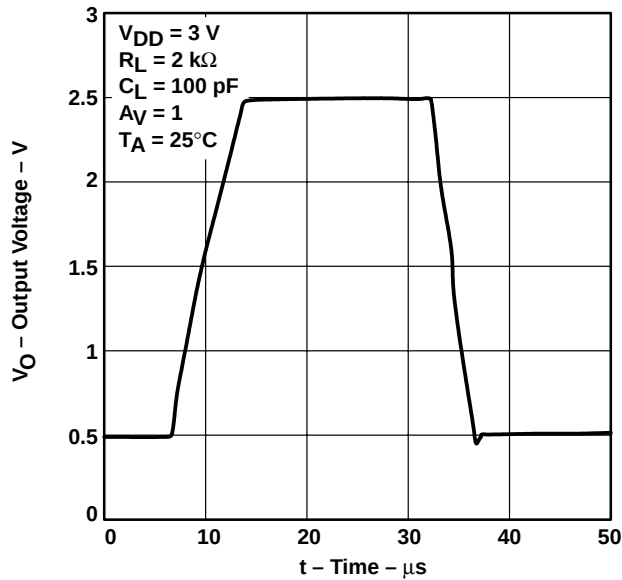


Figure 35

VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE

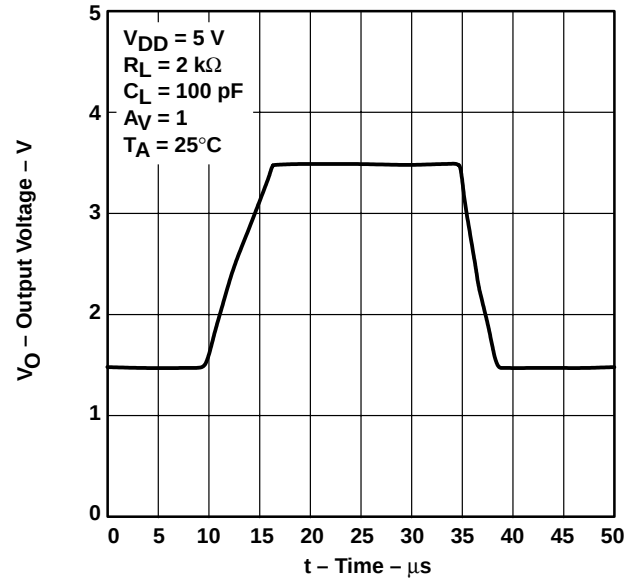


Figure 36

INVERTING SMALL-SIGNAL PULSE
RESPONSE

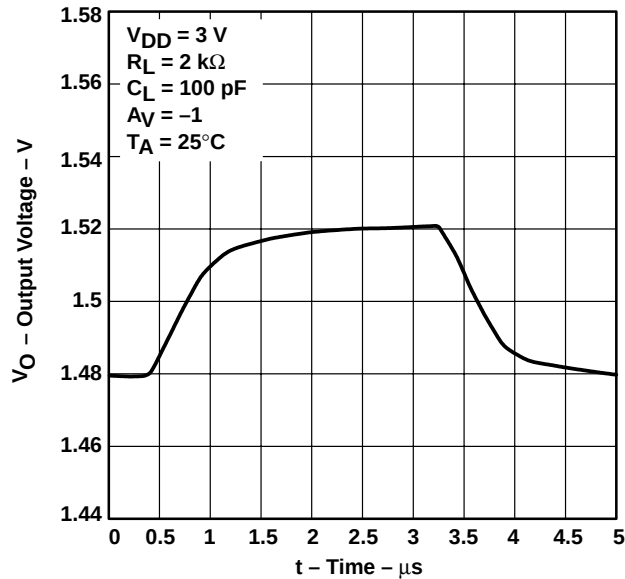


Figure 37

INVERTING SMALL-SIGNAL PULSE
RESPONSE

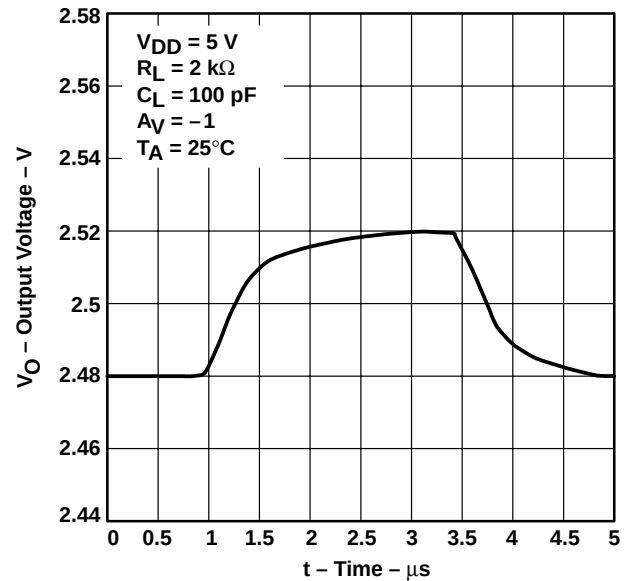


Figure 38

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VOLTAGE-FOLLOWER SMALL-SIGNAL
PULSE RESPONSE

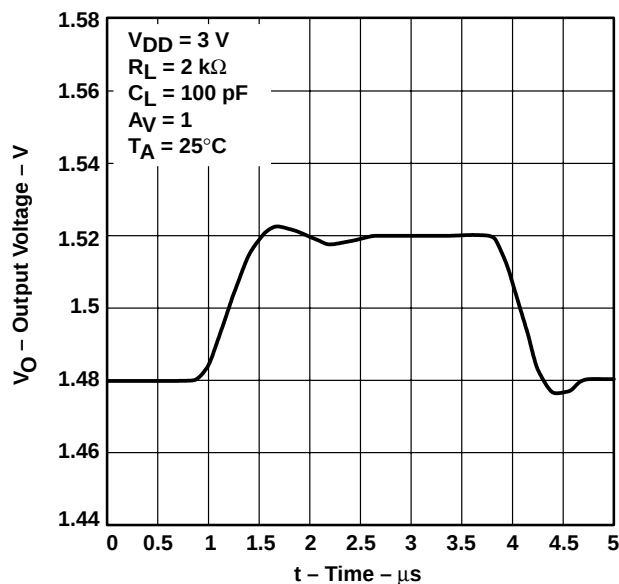


Figure 39

VOLTAGE-FOLLOWER SMALL-SIGNAL
PULSE RESPONSE

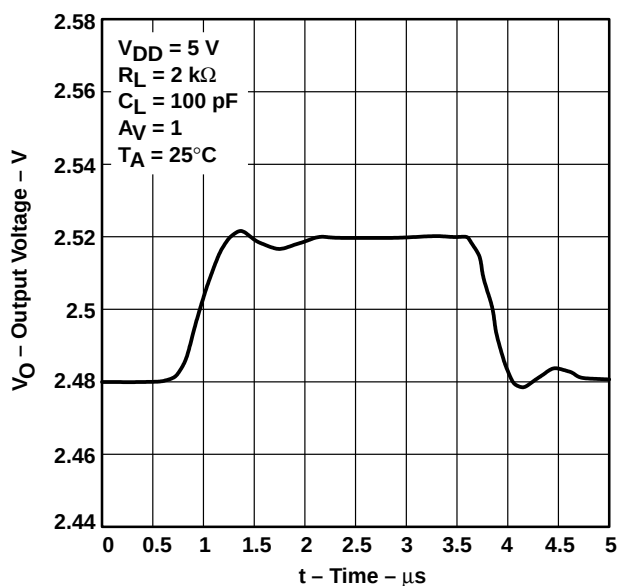


Figure 40

EQUIVALENT INPUT NOISE VOLTAGE
VS
FREQUENCY

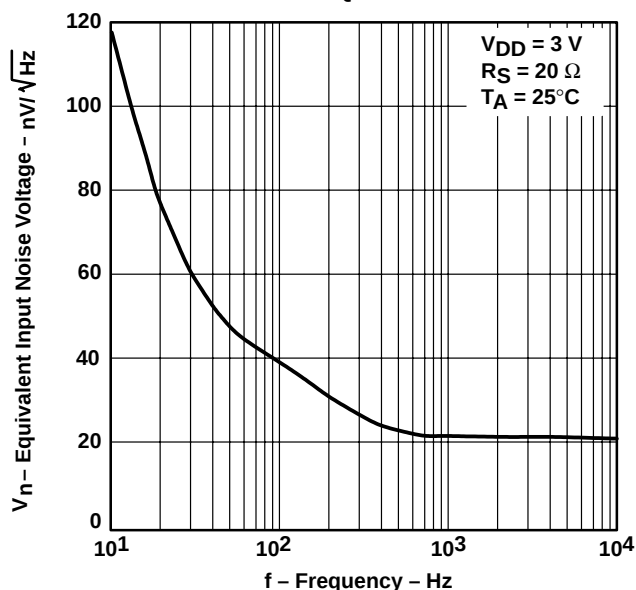


Figure 41

EQUIVALENT INPUT NOISE VOLTAGE
VS
FREQUENCY

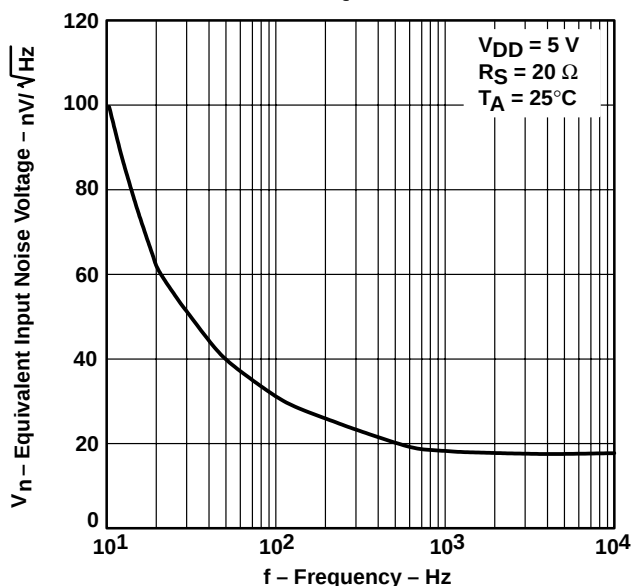


Figure 42

TYPICAL CHARACTERISTICS

NOISE VOLTAGE OVER A 10-SECOND PERIOD

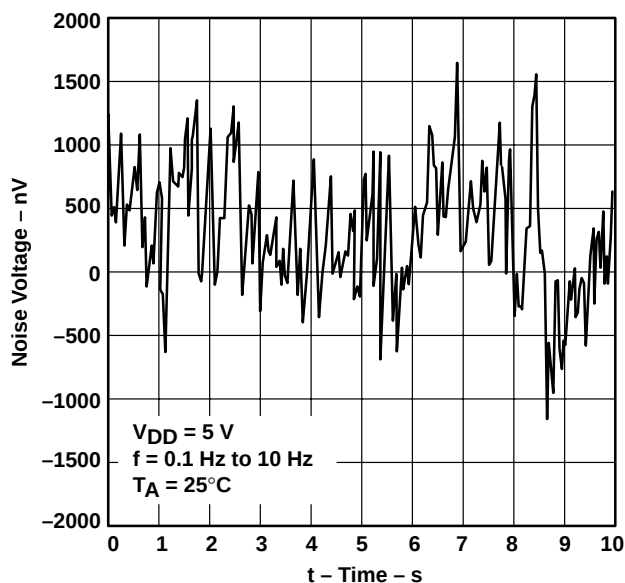


Figure 43

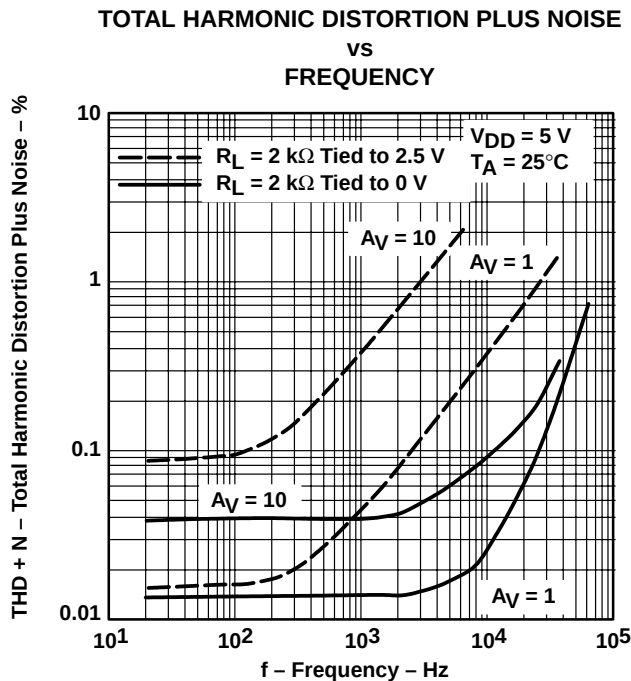


Figure 44

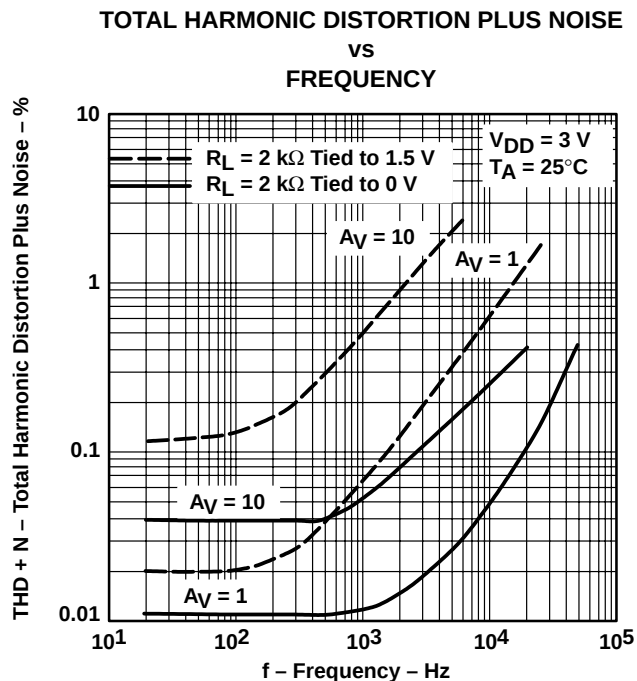


Figure 45

TLV2432, TLV2432A, TLV2434, TLV2434A

Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT

WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS

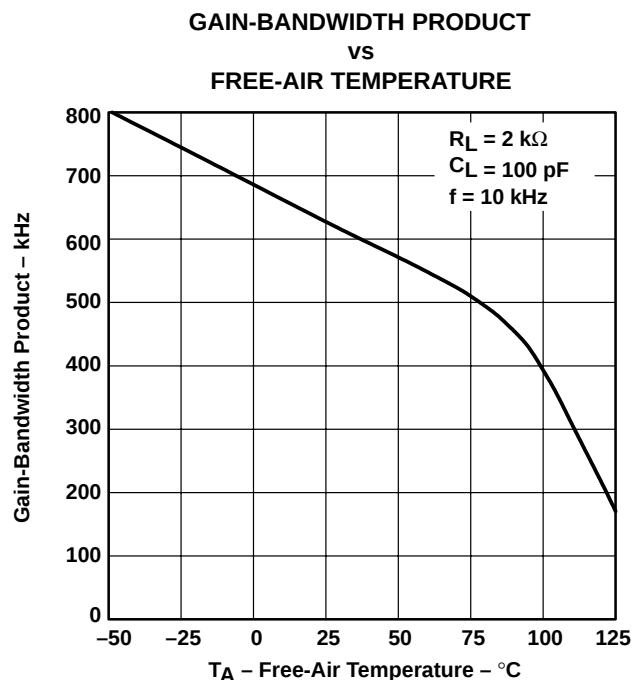


Figure 46

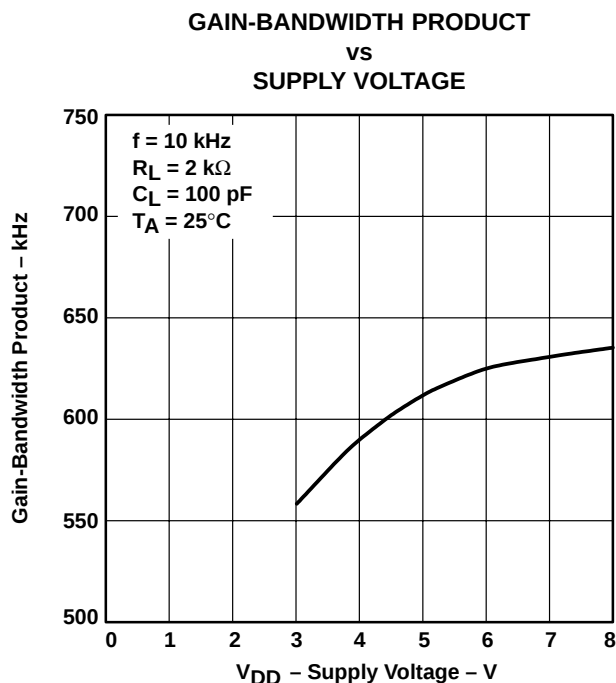


Figure 47

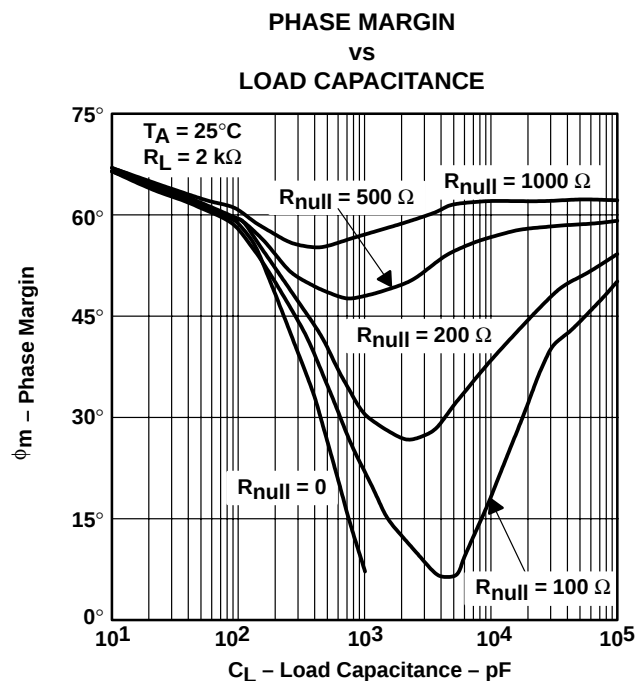


Figure 48

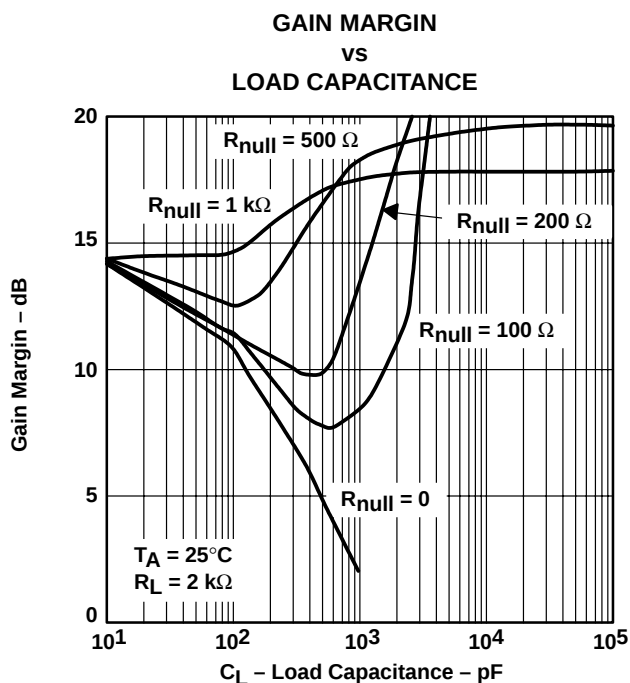


Figure 49

TYPICAL CHARACTERISTICS

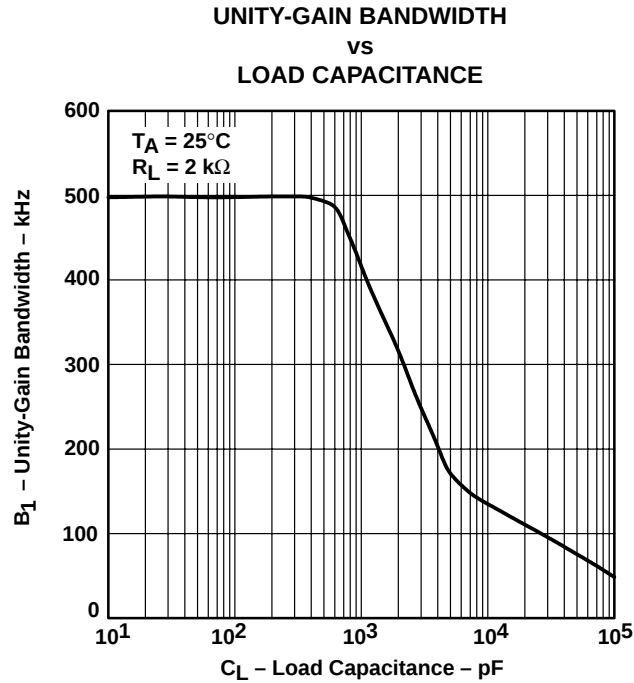


Figure 50

TLV2432, TLV2432A, TLV2434, TLV2434A

Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT

WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

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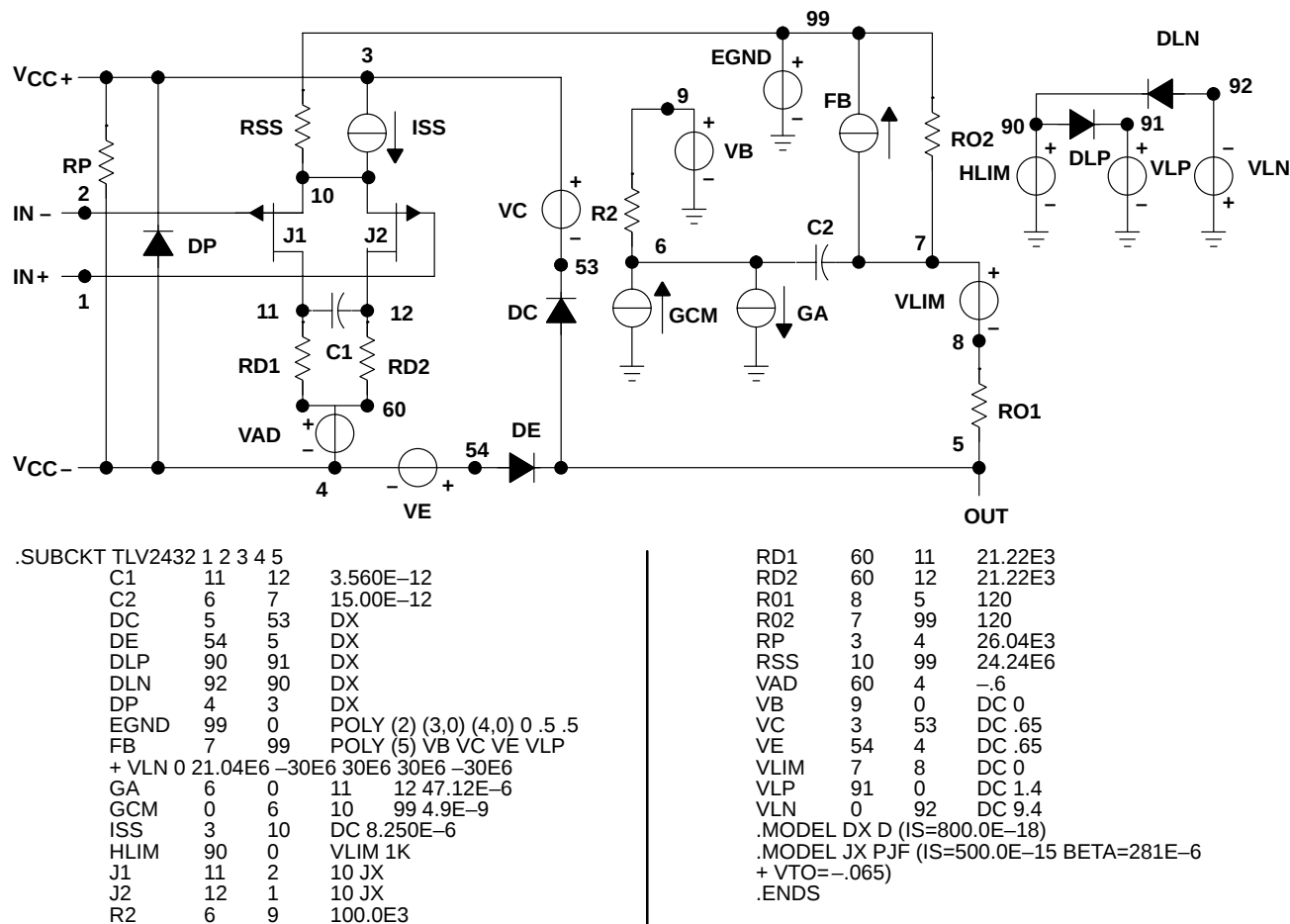
APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 51 are generated using the TLV243x 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 4: 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).



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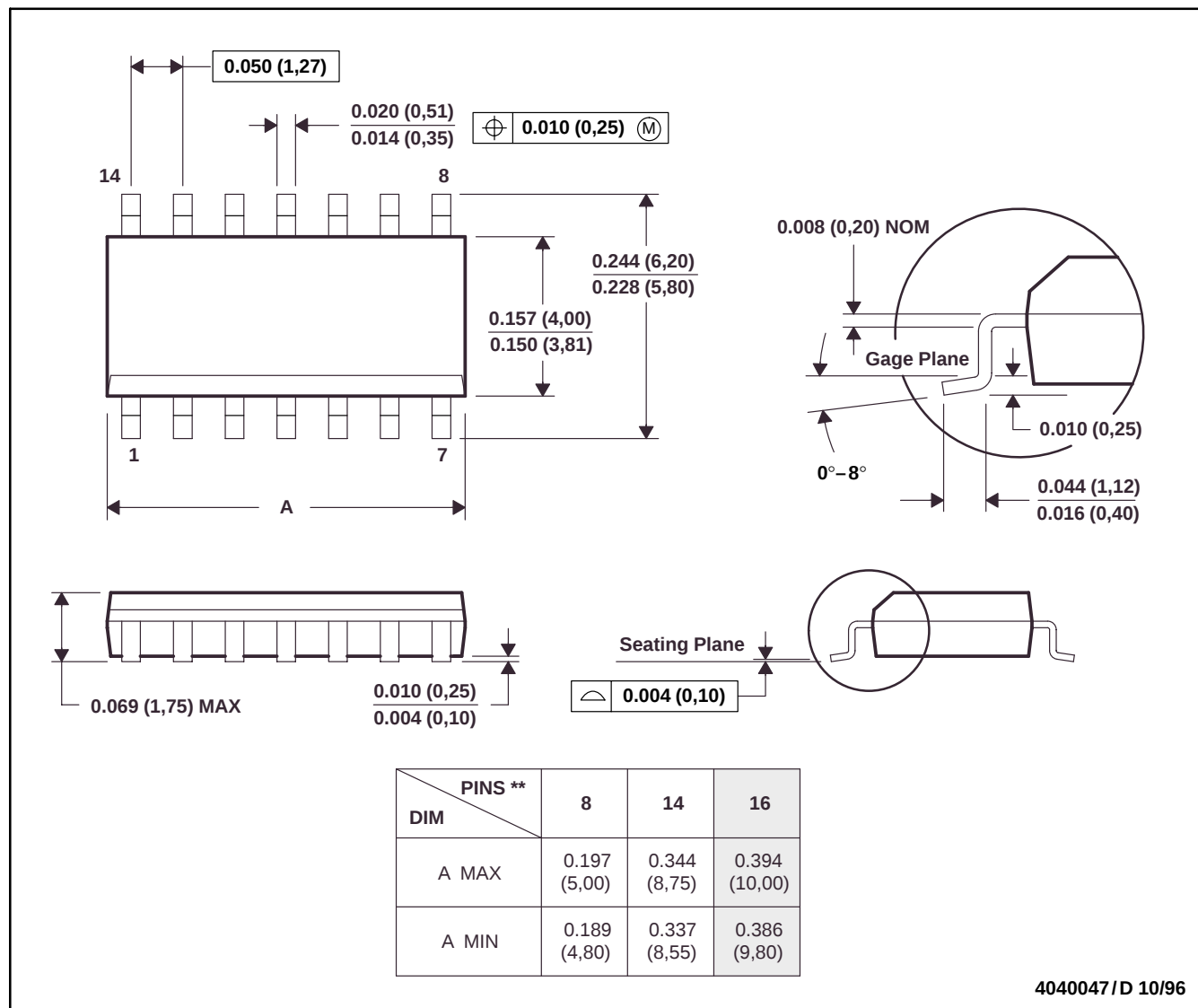
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MECHANICAL DATA

D (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



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

TLV2432, TLV2432A, TLV2434, TLV2434A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

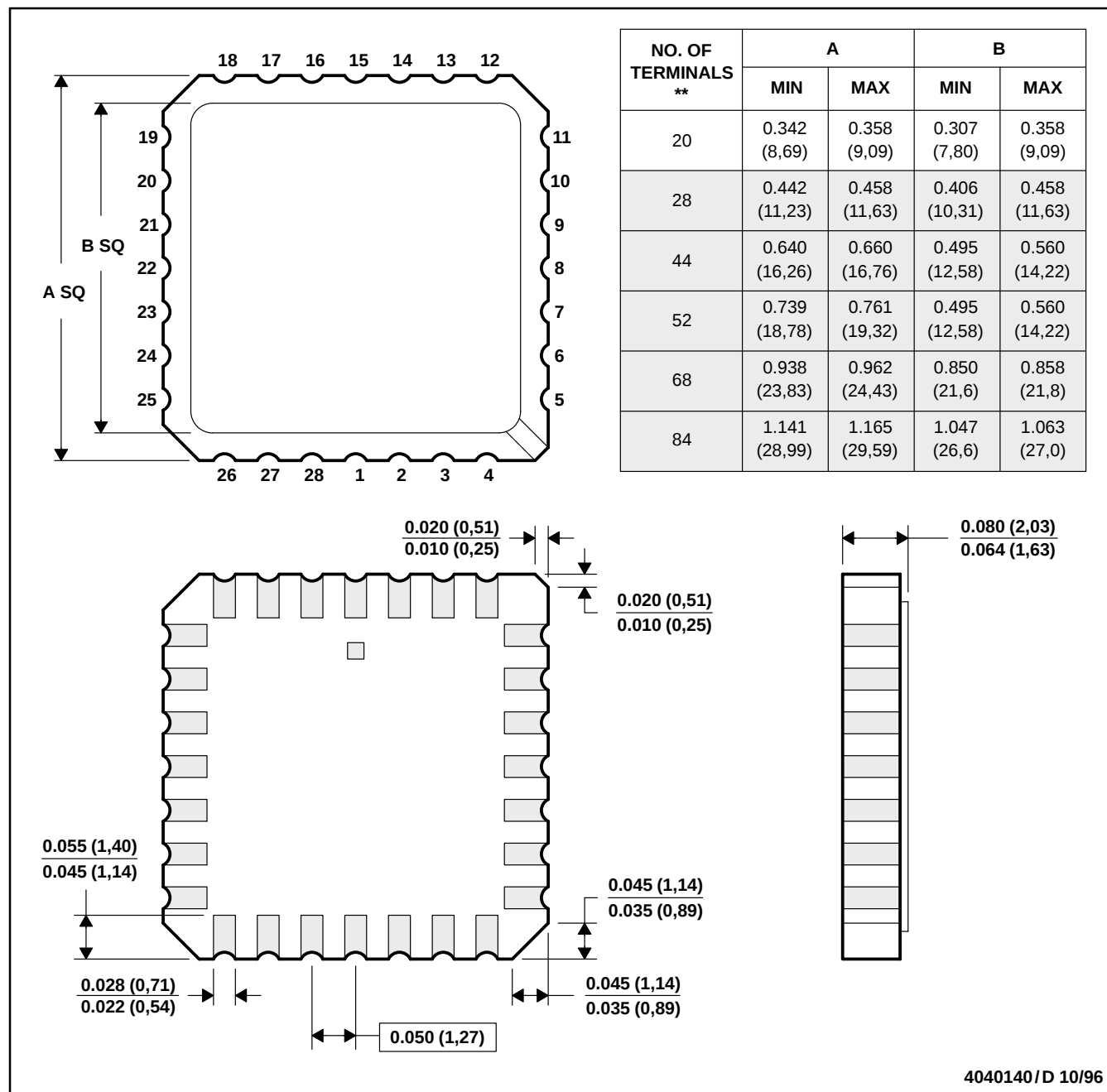
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MECHANICAL DATA

FK (S-CQCC-N)**

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



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

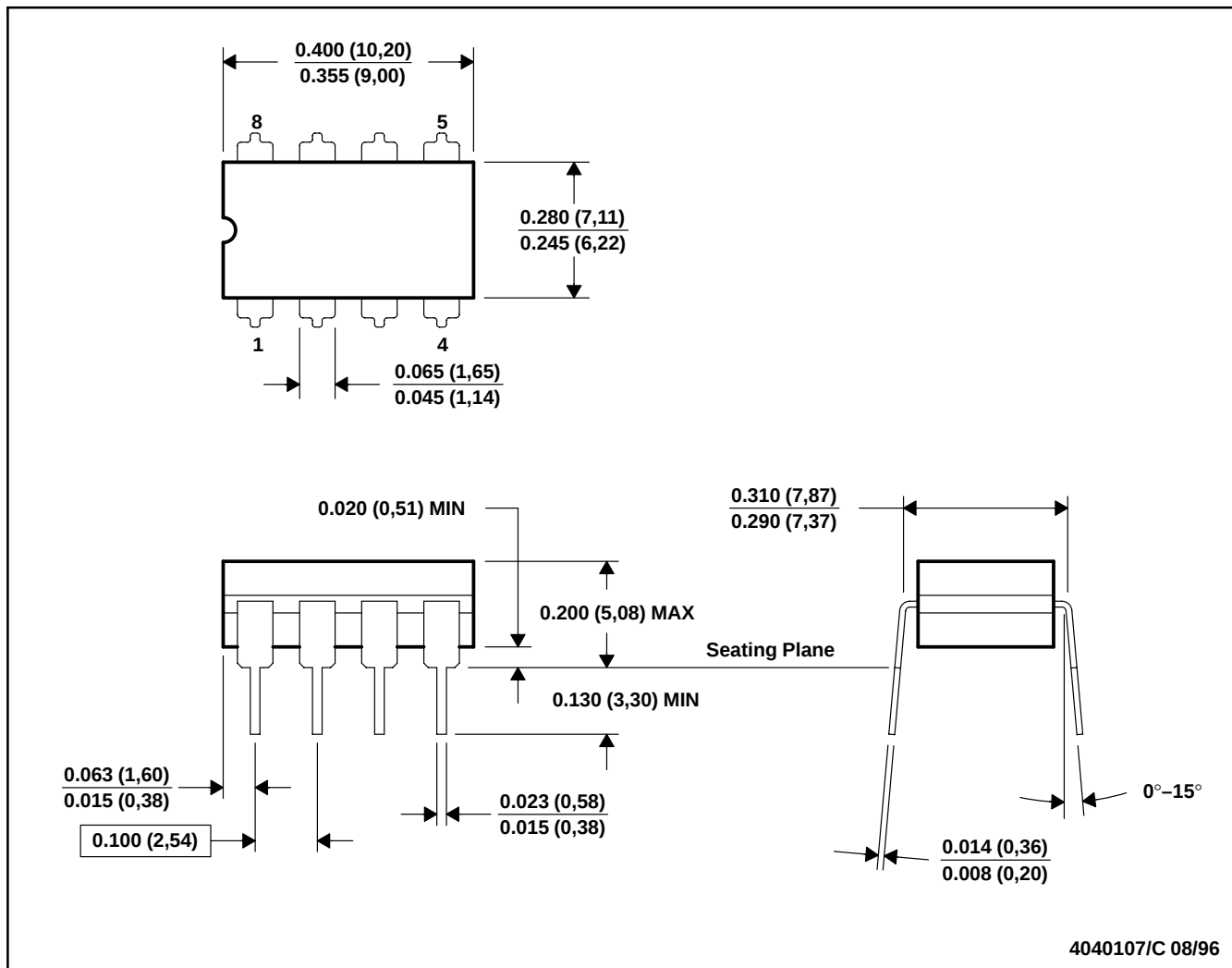
TLV2432, TLV2432A, TLV2434, TLV2434A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

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MECHANICAL DATA

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE PACKAGE



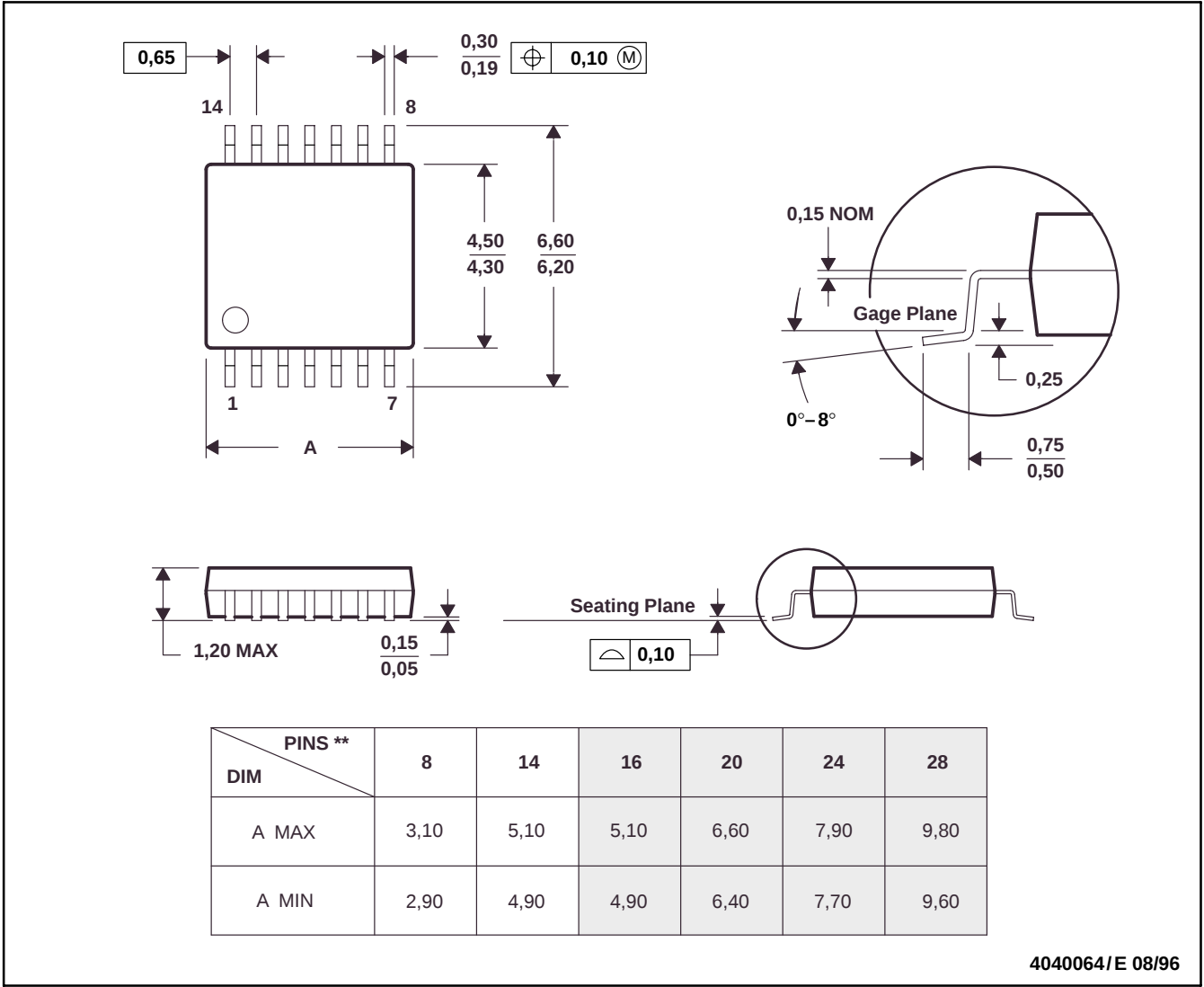
- NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification on press ceramic glass frit seal only.
E. Falls within MIL-STD-1835 GDIP1-T8

TLV2432, TLV2432A, TLV2434, TLV2434A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS
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MECHANICAL DATA

PW (R-PDSO-G)**
 14 PIN SHOWN

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 not to exceed 0,15.
 D. Falls within JEDEC MO-153

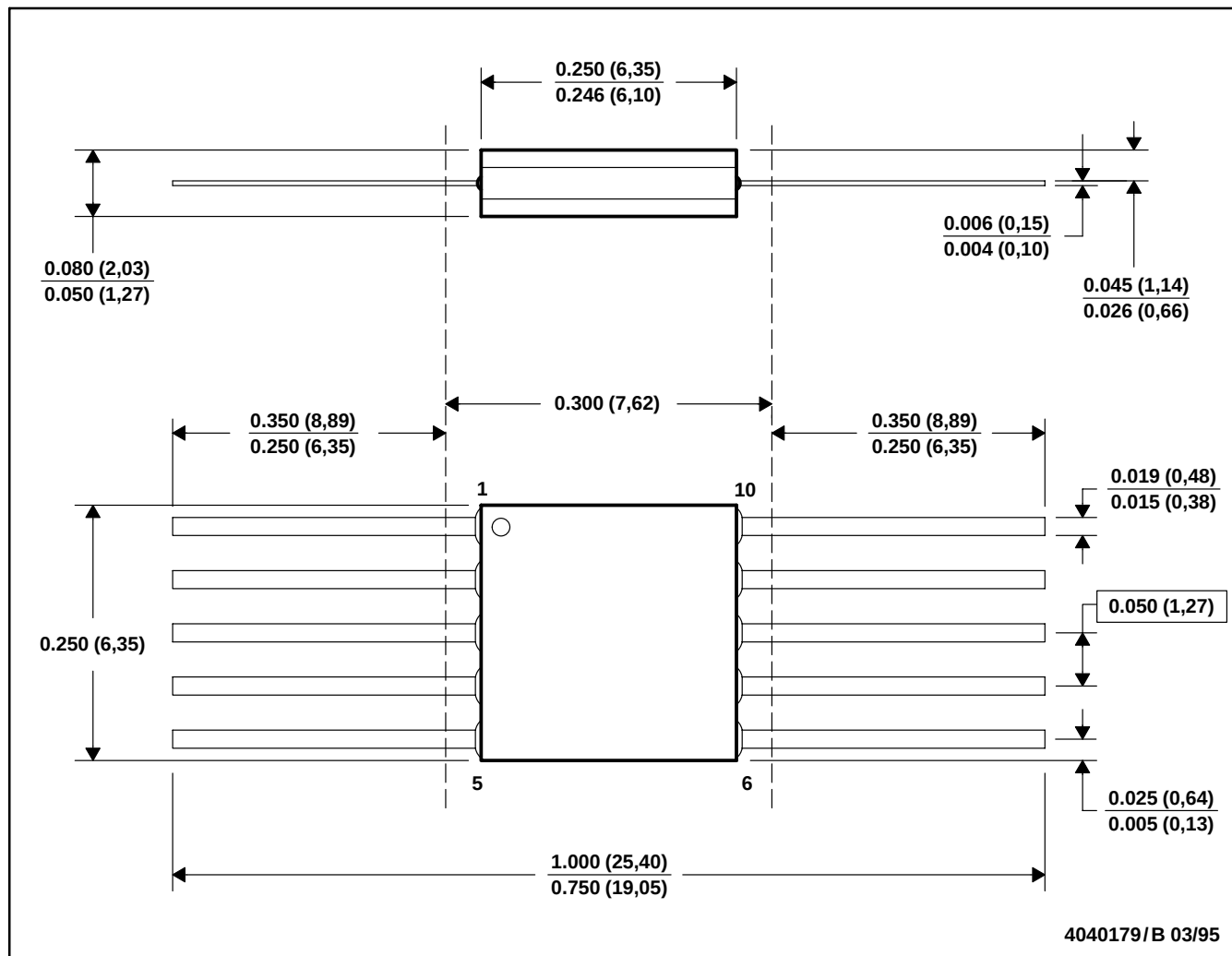
TLV2432, TLV2432A, TLV2434, TLV2434A
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

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MECHANICAL DATA

U (S-GDFP-F10)

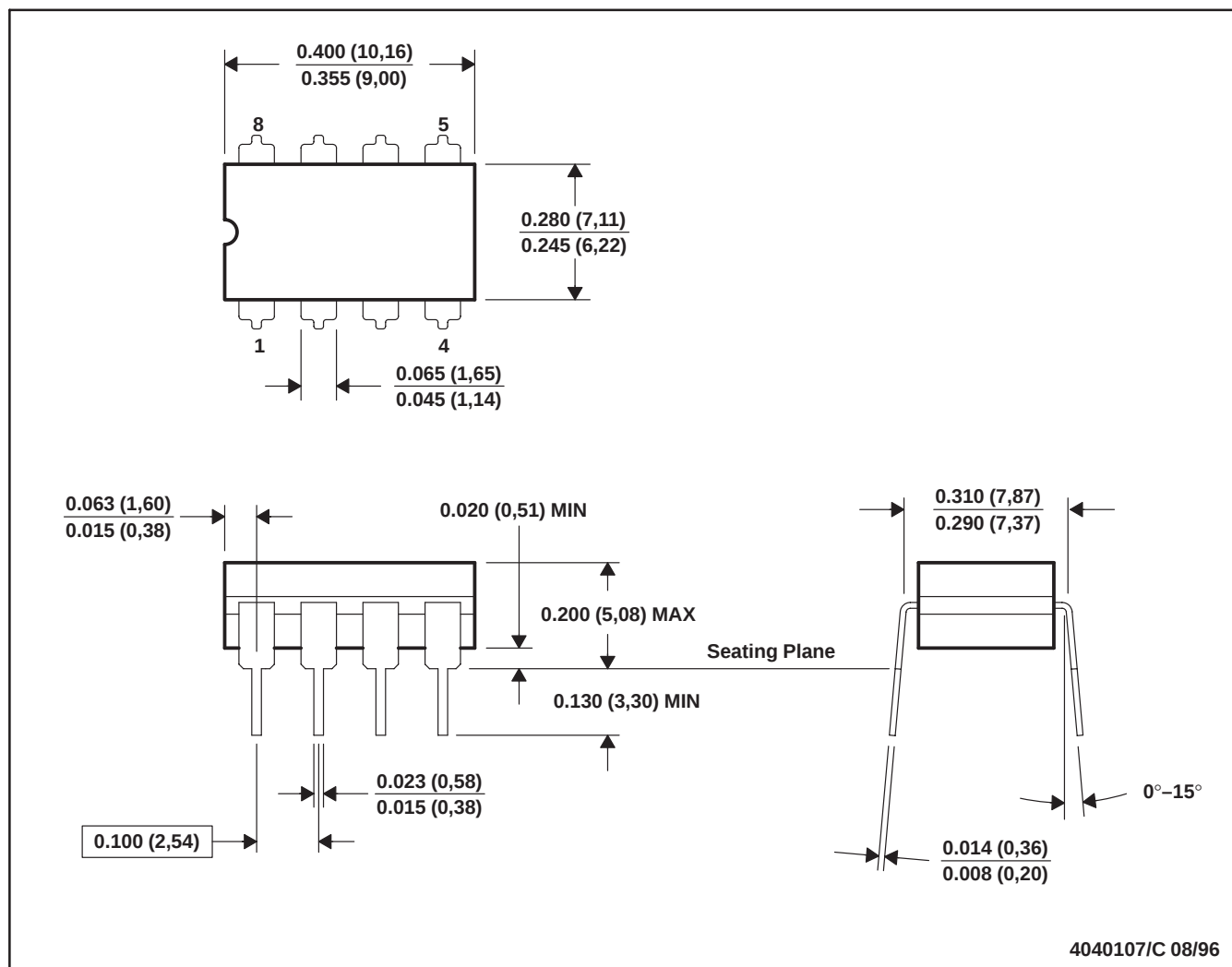
CERAMIC DUAL FLATPACK



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a ceramic lid using glass frit.
 - D. Index point is provided on cap for terminal identification only.
 - E. Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA

JG (R-GDIP-T8)

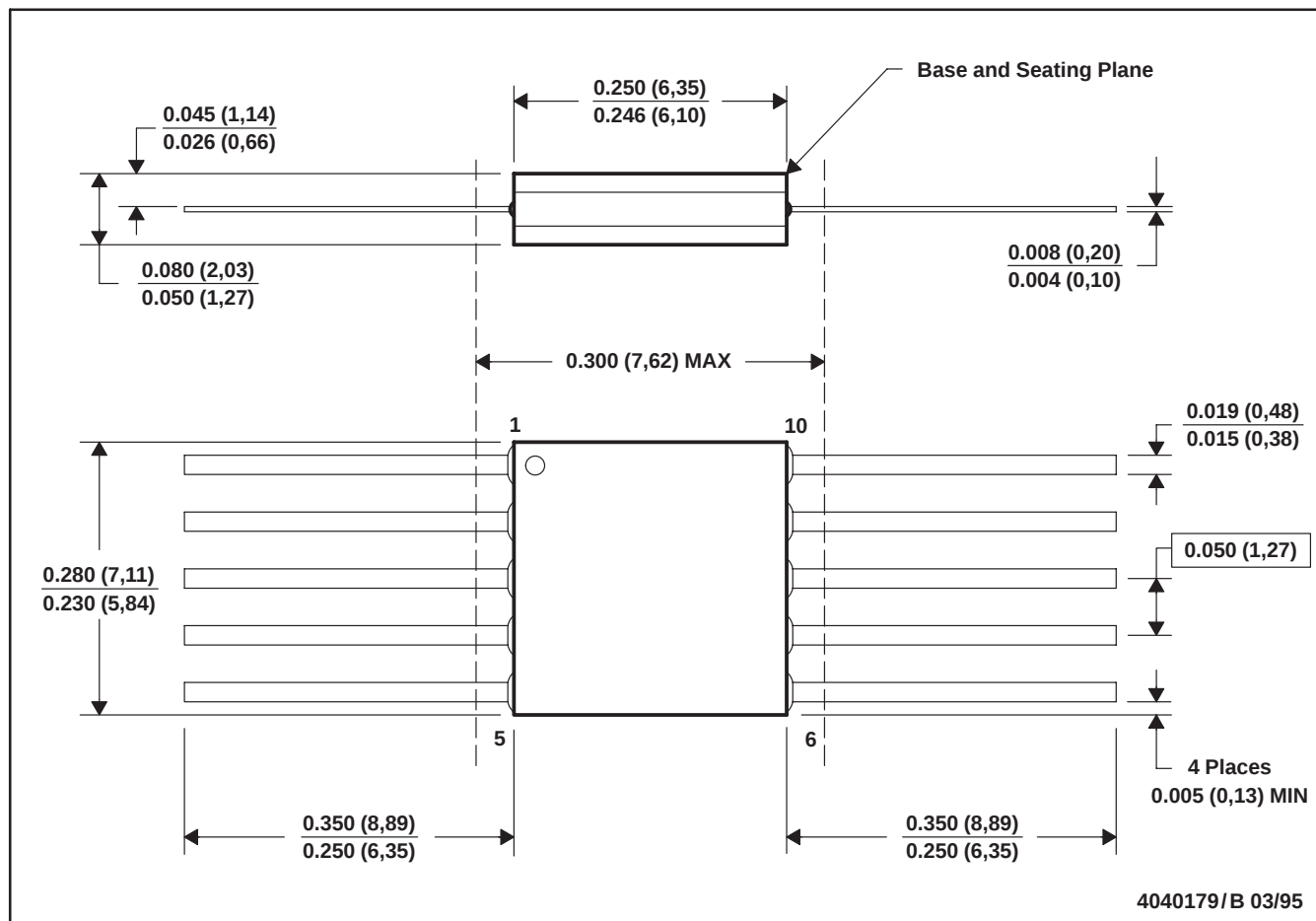
CERAMIC DUAL-IN-LINE



- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package can be hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification.
 - Falls within MIL STD 1835 GDIP1-T8

U (S-GDFP-F10)

CERAMIC DUAL FLATPACK

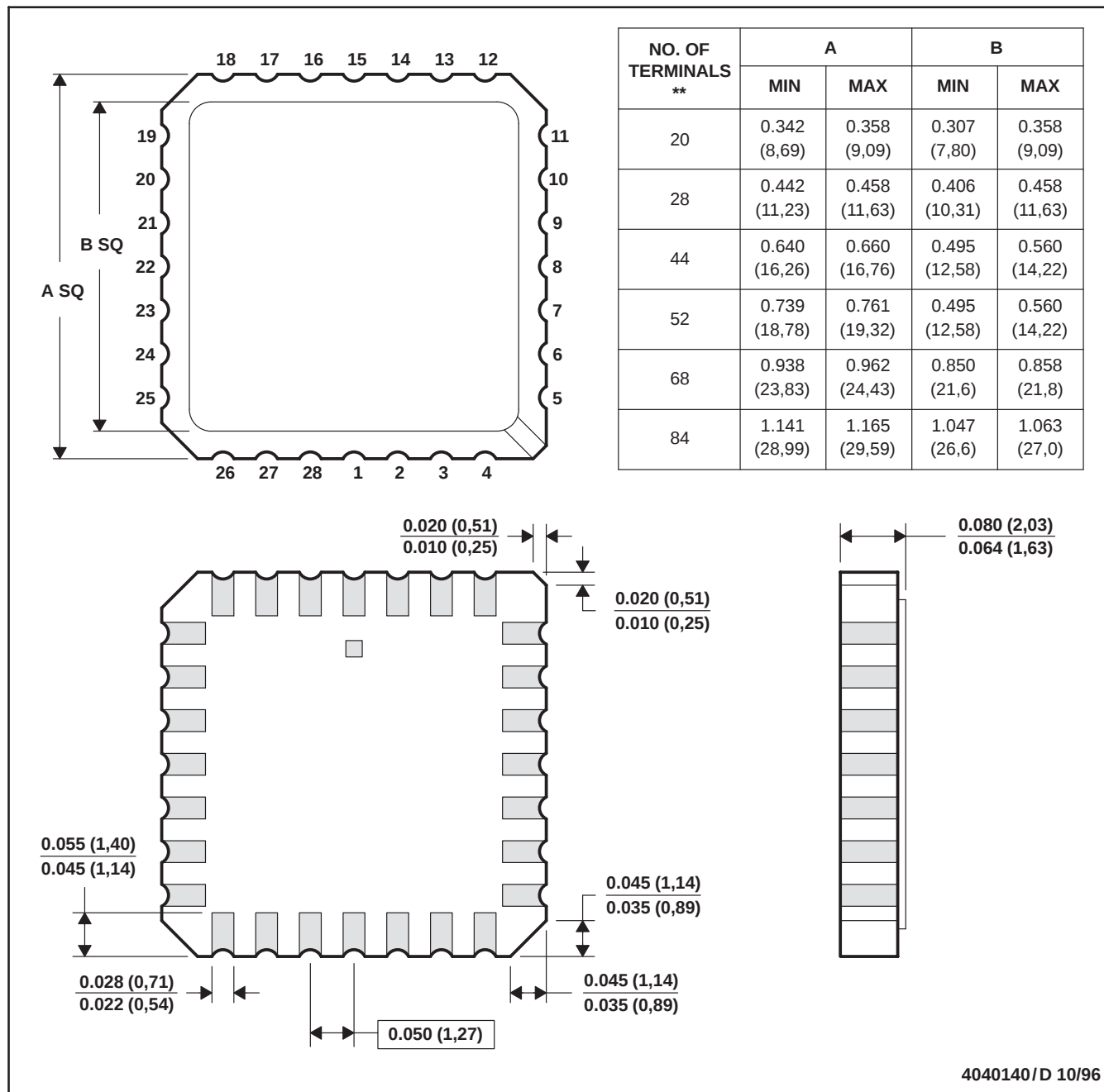


- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification only.
 E. Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA

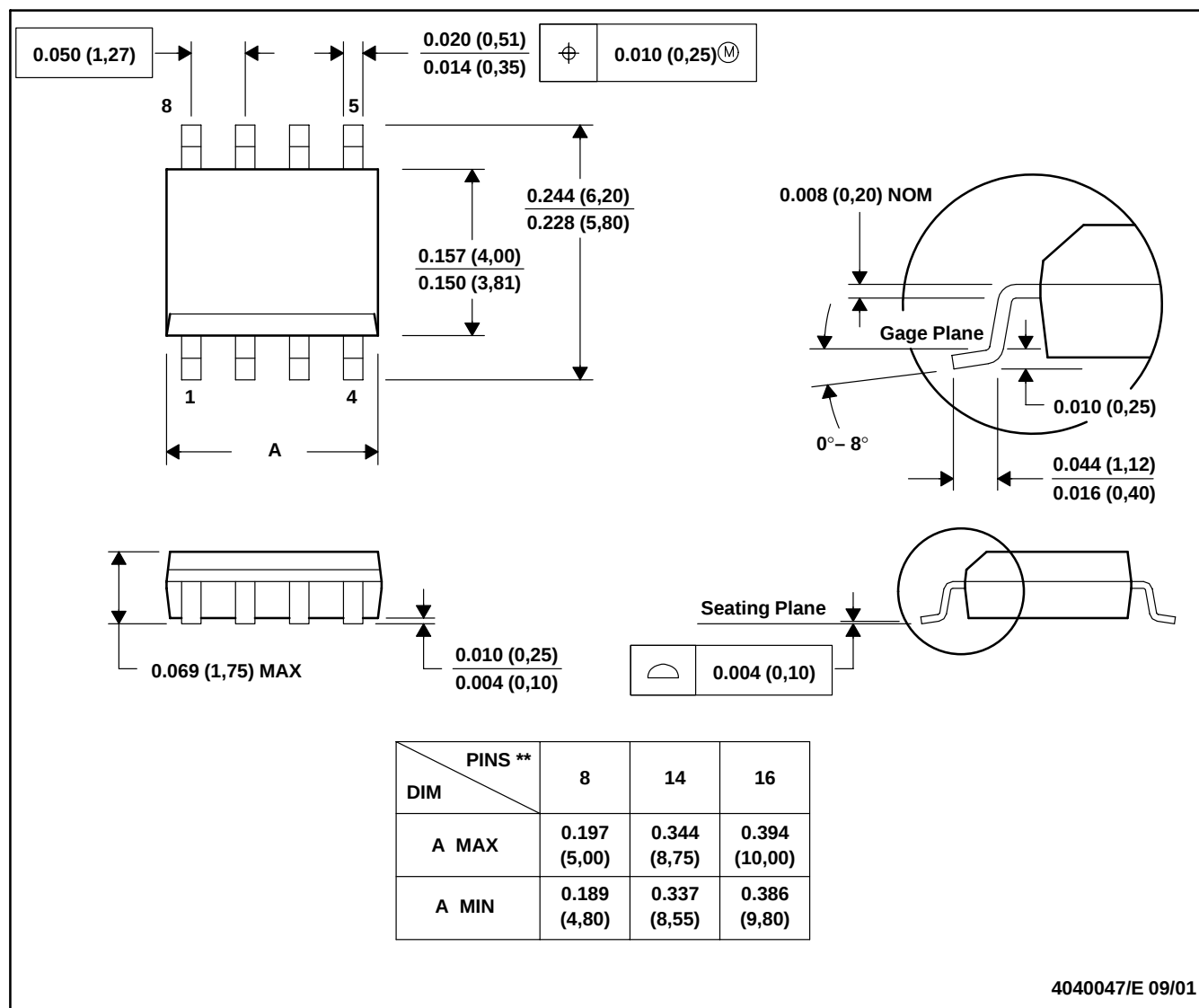
FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



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

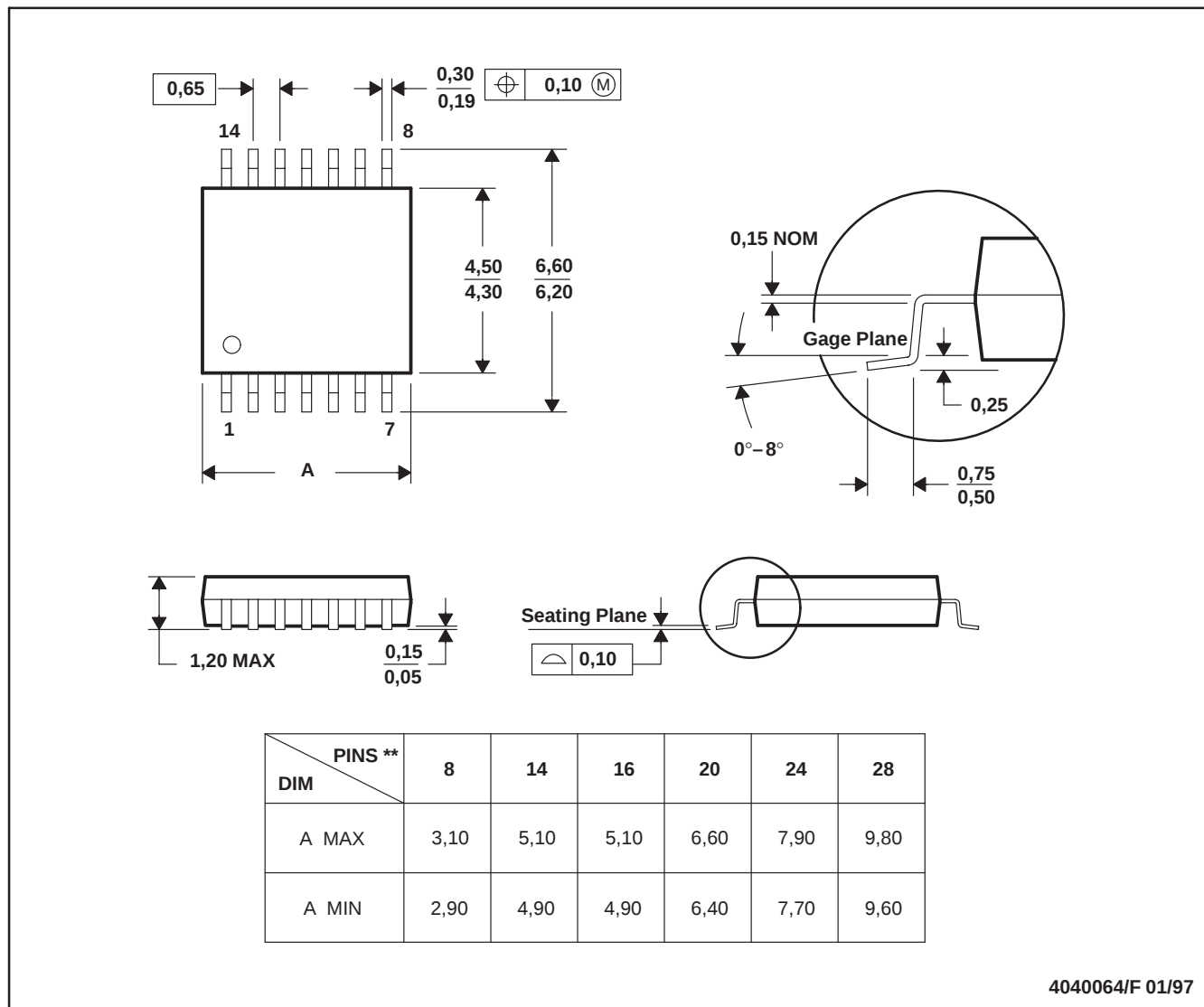
D (R-PDSO-G)****PLASTIC SMALL-OUTLINE PACKAGE****8 PINS SHOWN**

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

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- 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

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