

- 2.5-V Virtual Ground for 5-V/GND Analog Systems
- High Output-Current Capability
Sink or Source . . . 20 mA Typ
- Micropower Operation . . . 170 μ A Typ
- Excellent Regulation Characteristics
 - Output Regulation
–45 μ V Typ at $I_O = 0$ to –10 mA
+15 μ V Typ at $I_O = 0$ to +10 mA
 - Input Regulation = 1.5 μ V/V Typ
- Low-Impedance Output . . . 0.0075 Ω Typ
- Macromodel Included

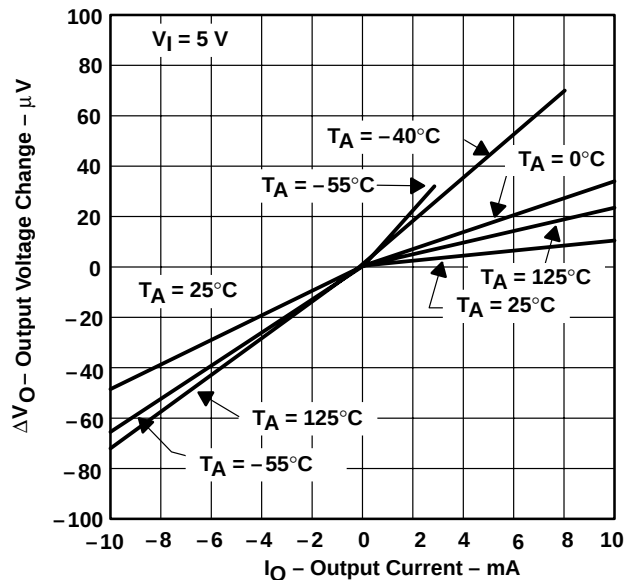
description

In signal-conditioning applications using a single power source, a reference voltage is required for termination of all signal grounds. To accomplish this, engineers have typically used solutions consisting of resistors, capacitors, operational amplifiers, and voltage references. Texas Instruments has eliminated all of those components with one easy-to-use 3-terminal device. That device is the TLE2425 precision virtual ground.

Use of the TLE2425 over other typical circuit solutions gives the designer increased dynamic signal range, improved signal-to-noise ratio, lower distortion, improved signal accuracy, and easier interfacing to ADCs and DACs. These benefits are the result of combining a precision micropower voltage reference and a high-performance precision operational amplifier in a single silicon chip. It is the precision and performance of these two circuit functions together that yield such dramatic system-level performance.

The TLE2425 improves input regulation as well as output regulation and, in addition, reduces output impedance and power dissipation in a majority of virtual-ground-generation circuits. Both input regulation and load regulation exceed 12 bits of accuracy on a single 5-V system. Signal-conditioning front ends of data acquisition systems that push 12 bits and beyond can use the TLE2425 to eliminate a major source of system error.

OUTPUT REGULATION



AVAILABLE OPTIONS

T_A	SMALL OUTLINE (D)	PLASTIC TO-226AA (LP)
0°C to 70°C	TLE2425CD	TLE2425CD
–40°C to 85°C	TLE2425ID	TLE2425ID
–55°C to 125°C	TLE2425MD	—

† The D package is available taped and reeled. Add R suffix to the device type (e.g., TLE2425CDR).



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.

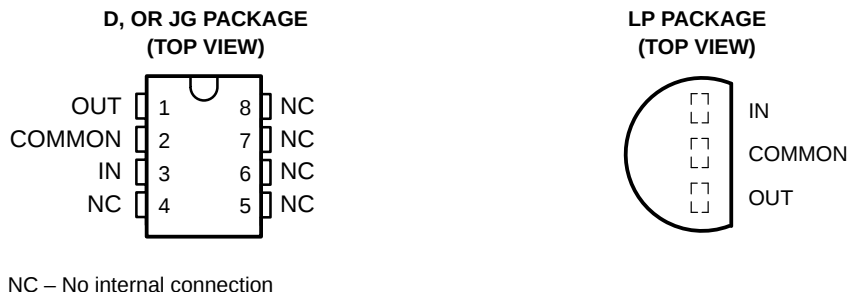
**TEXAS
INSTRUMENTS**

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TLE2425 PRECISION VIRTUAL GROUND

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

Continuous input voltage, V_I	40 V
Output current, I_O	±80 mA
Duration of short-circuit current at (or below) 25°C (see Note 1)	unlimited
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 85°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: D package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG or LP package	300°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: 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	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
LP	775 mW	6.2 mW/°C	496 mW	403 mW	155 mW

recommended operating conditions

	C-SUFFIX		I-SUFFIX		M-SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Input voltage, V_I	4	40	4	40	4	40	V
Operating free-air temperature, T_A	0	70	–40	85	–55	125	°C



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electrical characteristics at specified free-air temperature, $V_I = 5\text{ V}$, $I_O = 0$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		T _A [†]	TLE2425C			UNIT
				MIN	TYP	MAX	
Output voltage			25°C	2.48	2.5	2.52	V
			Full range	2.47		2.53	
Temperature coefficient of output voltage			25°C	20			ppm/°C
Bias current	I _O = 0	25°C	170			250	μA
		Full range	250				
Input voltage regulation	V _I = 4.5 V to 5.5 V	25°C	1.5			20	μV
		Full range	25				
	V _I = 4 V to 40 V	25°C	1.5			20	μV/V
		Full range	25				
Ripple rejection	f = 120 Hz,	ΔV _{I(PP)} = 1 V	25°C	80			dB
Output voltage regulation (source current) [‡]	I _O = 0 to −10 mA		25°C	−160	−45	160	μV
			Full range	−250		250	
	I _O = 0 to −20 mA		25°C	−450	−150	450	
Output voltage regulation (sink current) [‡]	I _O = 0 to 10 mA		25°C	−160	15	160	μV
			Full range	−250		250	
	I _O = 0 to 20 mA		25°C	−235	65	235	
Long-term drift of output voltage	Δt = 1000 h,	Noncumulative	25°C	15			ppm
Output impedance			25°C	7.5	22.5		mΩ
Short-circuit output current (sink current)	V _O = 5 V		25°C	30	55		mA
Short-circuit output current (source current)	V _O = 0			−30	−50		
Output noise voltage, rms	f = 10 Hz to 10 kHz		25°C	100			μV
Output voltage response to output current step	V _O to 0.1%, I _O = ±10 mA	C _L = 0	25°C	110			μs
		C _L = 100 pF		115			
	V _O to 0.01%, I _O = ±10 mA	C _L = 0		180			
		C _L = 100 pF		180			
Output voltage response to input voltage step	V _I = 4.5 to 5.5 V, V _O to 0.1%		25°C	12			μs
	V _I = 4.5 to 5.5 V, V _O to 0.01%			30			
Output voltage turn-on response	V _I = 0 to 5 V, V _O to 0.1%		25°C	125			μs
	V _I = 0 to 5 V, V _O to 0.01%			210			

[†] Full range is 0°C to 70°C.

[‡] The listed values are not production tested.

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electrical characteristics at specified free-air temperature, $V_I = 5\text{ V}$, $I_O = 0$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		T _A [†]	TLE2425I			UNIT	
				MIN	TYP	MAX		
Output voltage			25°C	2.48	2.5	2.52	V	
			Full range	2.47		2.53		
Temperature coefficient of output voltage			25°C	20			ppm/°C	
Bias current	I _O = 0	25°C	170			250	μA	
		Full range	250					
Input voltage regulation	V _I = 4.5 V to 5.5 V	25°C	1.5			20	μV	
		Full range	75					
	V _I = 4 V to 40 V	25°C	1.5			20	μV/V	
		Full range	75					
Ripple rejection	f = 120 Hz,	ΔV _{I(PP)} = 1 V	25°C	80			dB	
Output voltage regulation (source current) [‡]	I _O = 0 to −10 mA		25°C	−160	−45	160	μV	
			Full range	−250		250		
	I _O = 0 to −20 mA		25°C	−450	−150	450		
Output voltage regulation (sink current) [‡]	I _O = 0 to 8 mA		25°C	−160	15	160	μV	
			Full range	−250		250		
	I _O = 0 to 20 mA		25°C	−235	65	235		
Long-term drift of output voltage	Δt = 1000 h,	Noncumulative	25°C	15			ppm	
Output impedance			25°C	7.5			22.5	mΩ
Short-circuit output current (sink current)	V _O = 5 V		25°C	30	55		mA	
Short-circuit output current (source current)	V _O = 0			−30	−50			
Output noise voltage, rms	f = 10 Hz to 10 kHz		25°C	100			μV	
Output voltage response to output current step	V _O to 0.1%, I _O = ±10 mA	C _L = 0	25°C	110			μs	
		C _L = 100 pF		115				
	V _O to 0.01%, I _O = ±10 mA	C _L = 0		180				
		C _L = 100 pF		180				
Output voltage response to input voltage step	V _I = 4.5 to 5.5 V, V _O to 0.1%		25°C	12			μs	
	V _I = 4.5 to 5.5 V, V _O to 0.01%			30				
Output voltage turn-on response	V _I = 0 to 5 V, V _O to 0.1%		25°C	125			μs	
	V _I = 0 to 5 V, V _O to 0.01%			210				

† Full range is -40°C to 85°C.

‡ The listed values are not production tested.



electrical characteristics at specified free-air temperature, $V_I = 5\text{ V}$, $I_O = 0$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		T _A [†]	TLE2425M			UNIT
				MIN	TYP	MAX	
Output voltage			25°C	2.48	2.5	2.52	V
			Full range	2.47		2.53	
Temperature coefficient of output voltage			25°C	20			ppm/°C
Bias current	I _O = 0		25°C	170	250	μA	
		Full range	250				
Input voltage regulation	V _I = 4.5 V to 5.5 V		25°C	1.5	20	μV	
		Full range	100				
	V _I = 4.5 V to 40 V		25°C	1.5	20	μV/V	
		Full range	100				
Ripple rejection	f = 120 Hz,	ΔV _{I(PP)} = 1 V	25°C	80			dB
Output voltage regulation (source current) [‡]	I _O = 0 to −10 mA		25°C	−160	−45	160	μV
			Full range	−250		250	
	I _O = 0 to −20 mA		25°C	−450	−150	450	
Output voltage regulation (sink current) [‡]	I _O = 0 to 3 mA		25°C	−160	15	160	μV
			Full range	−250		250	
	I _O = 0 to 20 mA		25°C	−235	65	235	
Long-term drift of output voltage	Δt = 1000 h,	Noncumulative	25°C	15			ppm
Output impedance			25°C	7.5	22.5		mΩ
Short-circuit output current (sink current)	V _O = 5 V		25°C	30	55		mA
Short-circuit output current (source current)	V _O = 0			−30	−50		
Output noise voltage, rms	f = 10 Hz to 10 kHz		25°C	100			μV
Output voltage response to output current step	V _O to 0.1%, I _O = ±10 mA	C _L = 0	25°C	110			μs
		C _L = 100 pF		115			
	V _O to 0.01%, I _O = ±10 mA	C _L = 0		180			
		C _L = 100 pF		180			
Output voltage response to input voltage step	V _I = 4.5 to 5.5 V, V _O to 0.1%		25°C	12			μs
	V _I = 4.5 to 5.5 V, V _O to 0.01%			30			
Output voltage turn-on response	V _I = 0 to 5 V, V _O to 0.1%		25°C	125			μs
	V _I = 0 to 5 V, V _O to 0.01%			210			

[†] Full range is -55°C to 125°C.

[‡] The listed values are not production tested.

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TYPICAL CHARACTERISTICS

Table Of Graphs

		FIGURE
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Output voltage hysteresis	vs Free-air temperature	3
Input bias current	vs Input voltage	4
	vs Free-air temperature	5
Input voltage regulation		6
Ripple rejection	vs Frequency	7
Output voltage regulation		8
Output impedance	vs Frequency	9
Short-circuit output current	vs Free-air temperature	10
Spectral noise voltage density	vs Frequency	11
Wide-band noise voltage	vs Frequency	12
Output voltage change with current step	vs Time	13
Output voltage change with voltage step	vs Time	14
Output voltage power-up response	vs Time	15
Output current	vs Load capacitance	16



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TYPICAL CHARACTERISTICS†

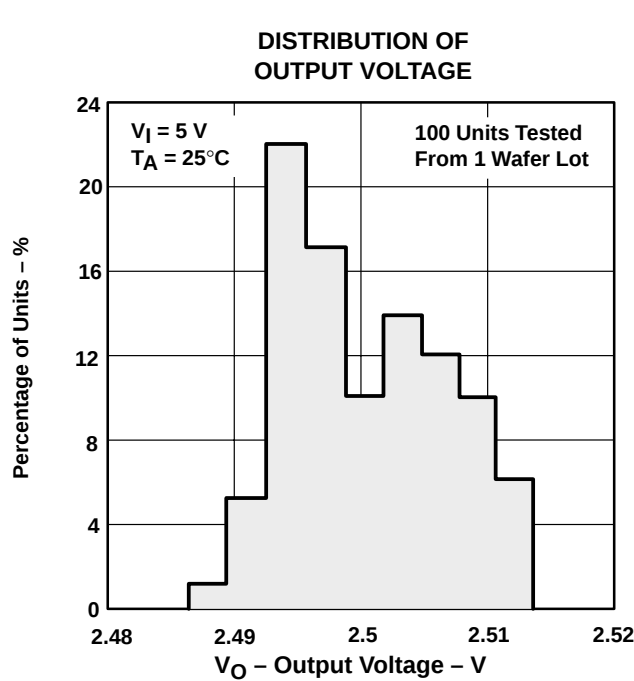


Figure 1

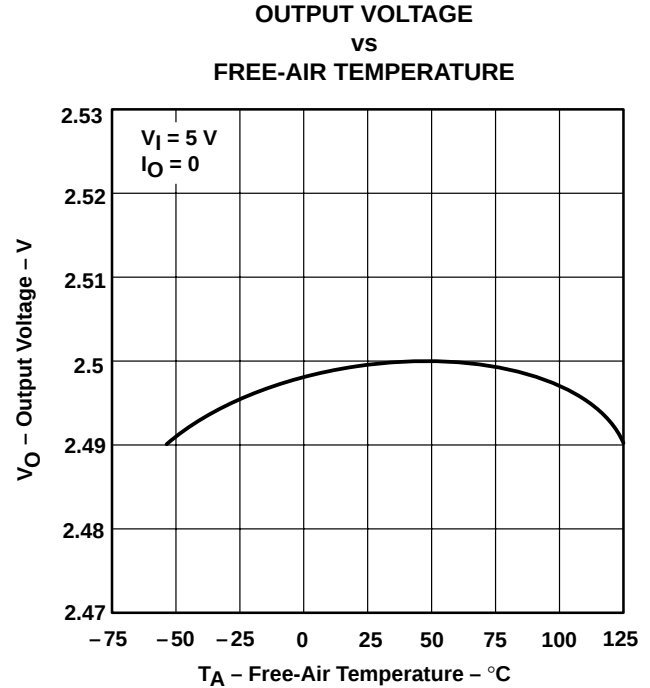


Figure 2

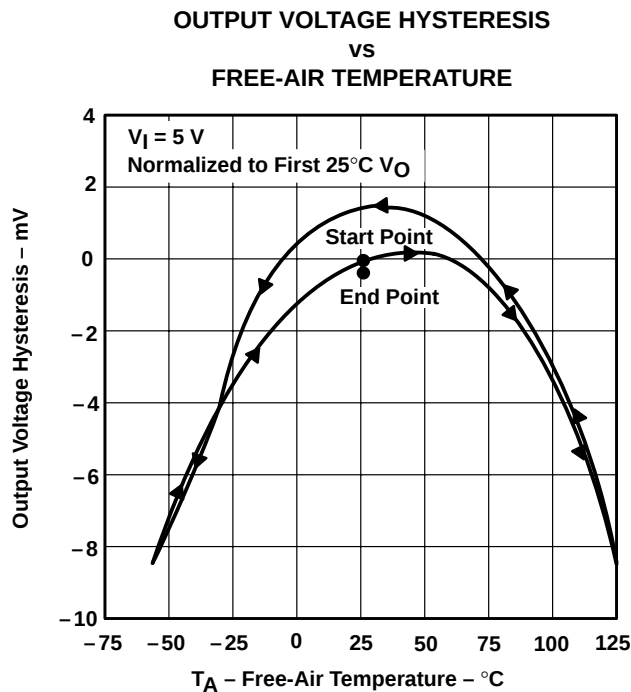


Figure 3

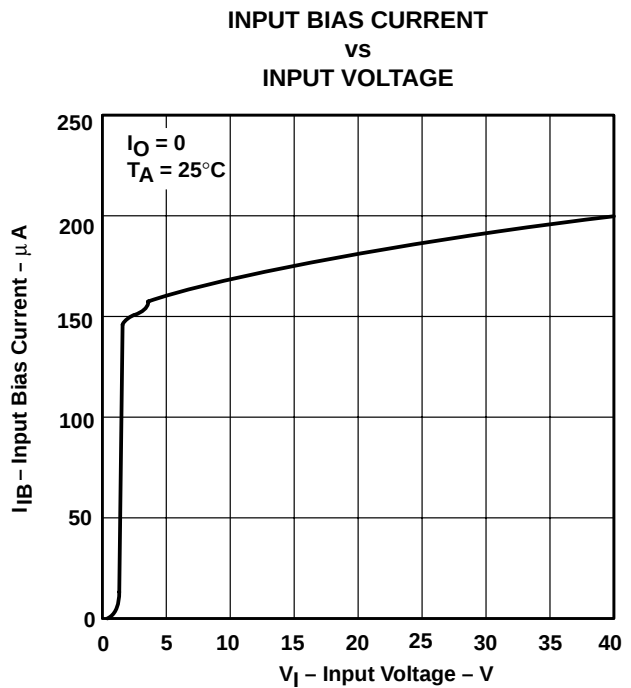


Figure 4

† Data at high and low temperatures are applicable within rated operating free-air temperature ranges of the various devices.

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TYPICAL CHARACTERISTICS†

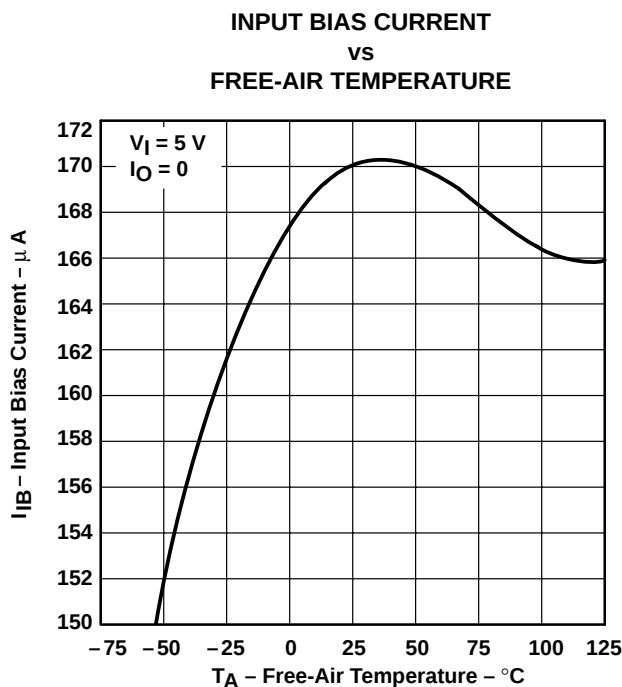


Figure 5

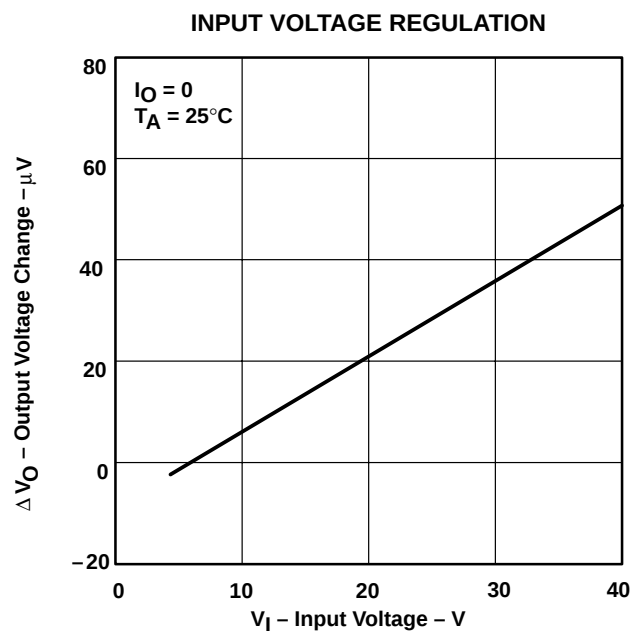


Figure 6

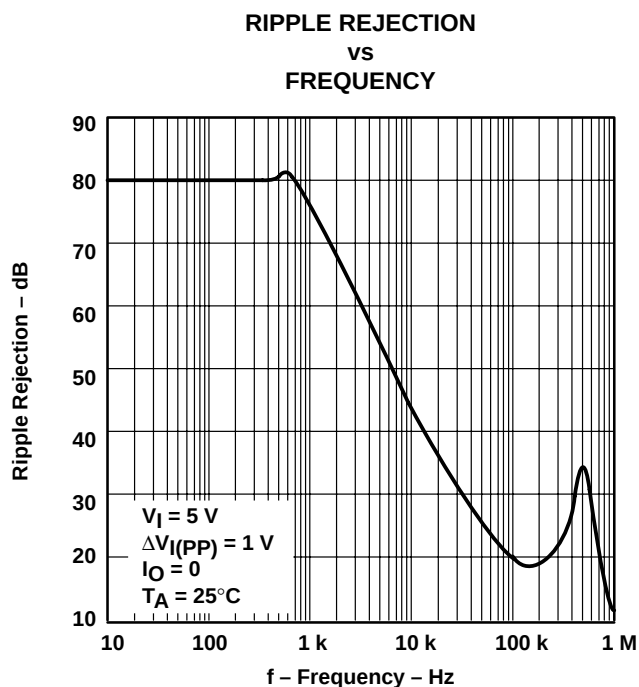


Figure 7

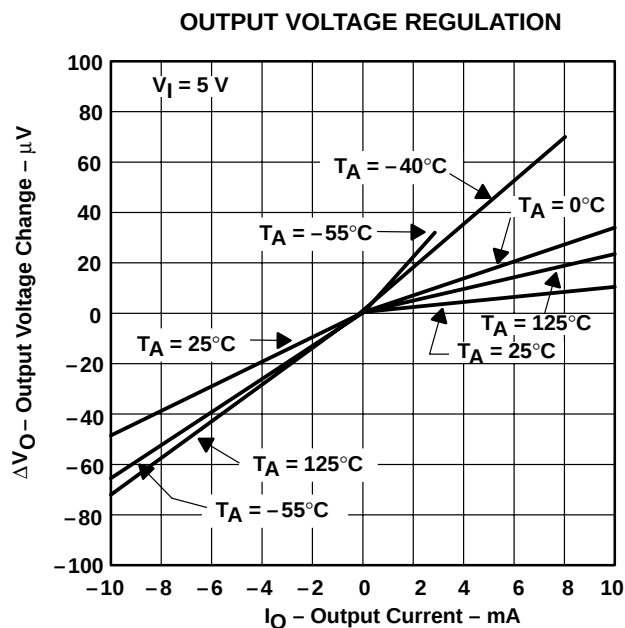


Figure 8

† Data at high and low temperatures are applicable within rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

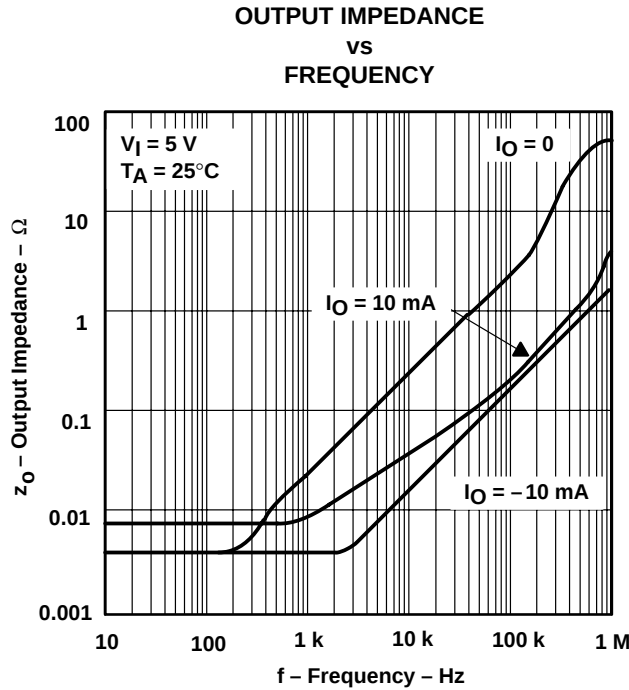


Figure 9

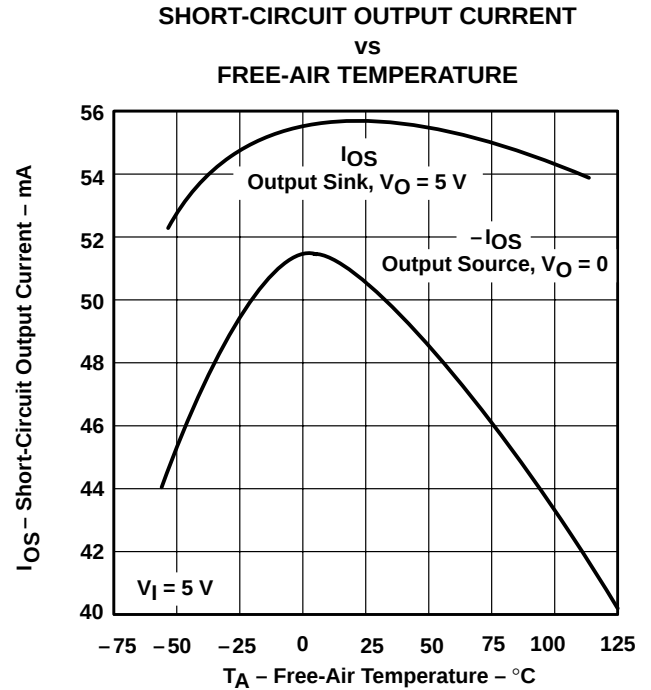


Figure 10

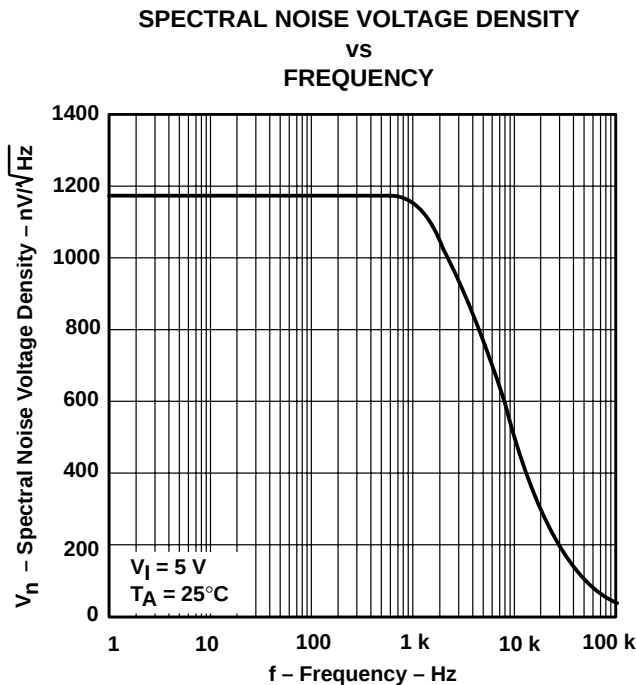


Figure 11

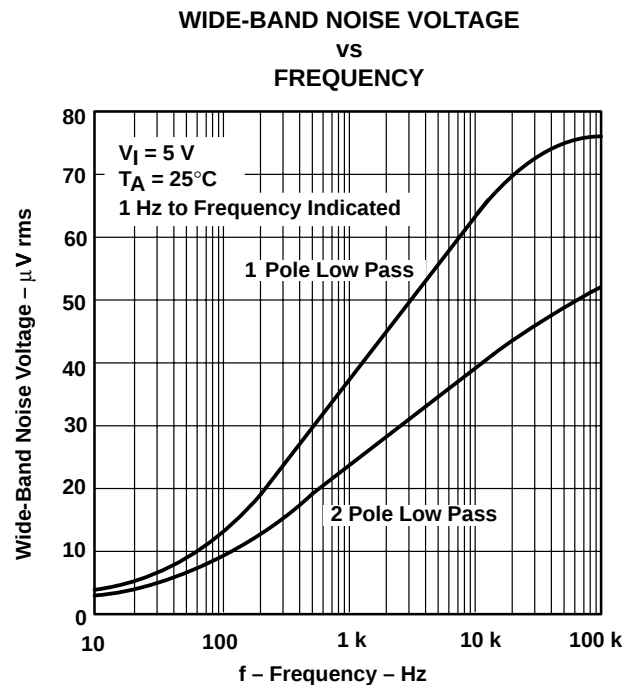


Figure 12

TYPICAL CHARACTERISTICS

**OUTPUT VOLTAGE RESPONSE
TO OUTPUT CURRENT STEP**

VS
TIME

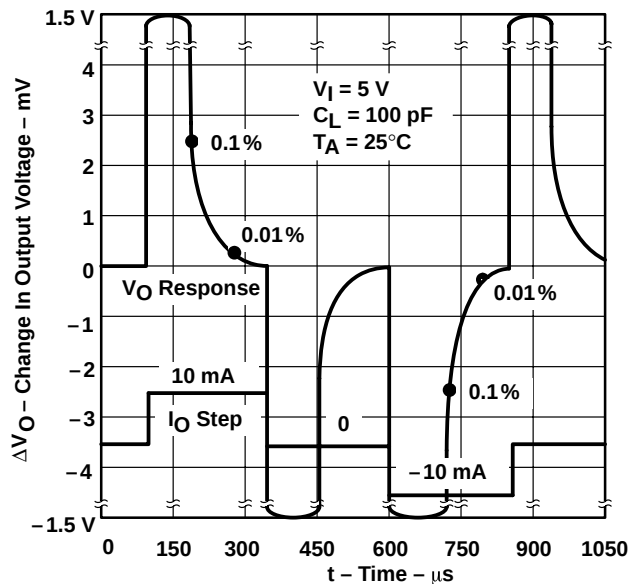


Figure 13

**OUTPUT VOLTAGE RESPONSE
TO INPUT VOLTAGE STEP**

VS
TIME

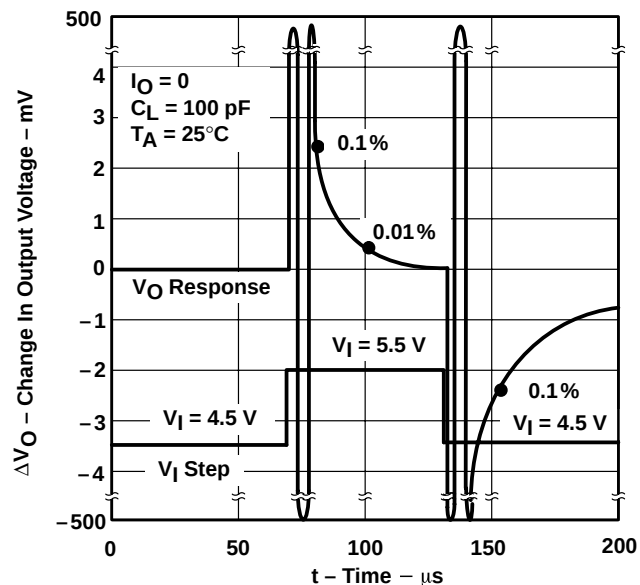


Figure 14

OUTPUT VOLTAGE POWER-UP RESPONSE

VS
TIME

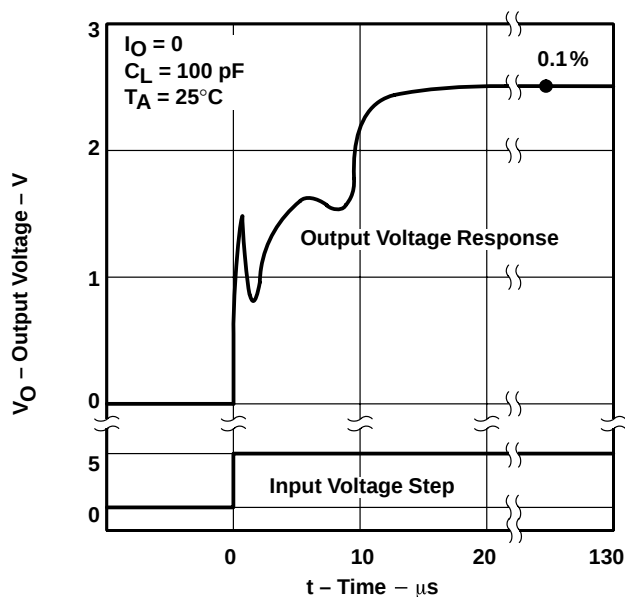


Figure 15

**STABILITY RANGE
OUTPUT CURRENT**

VS
LOAD CAPACITANCE

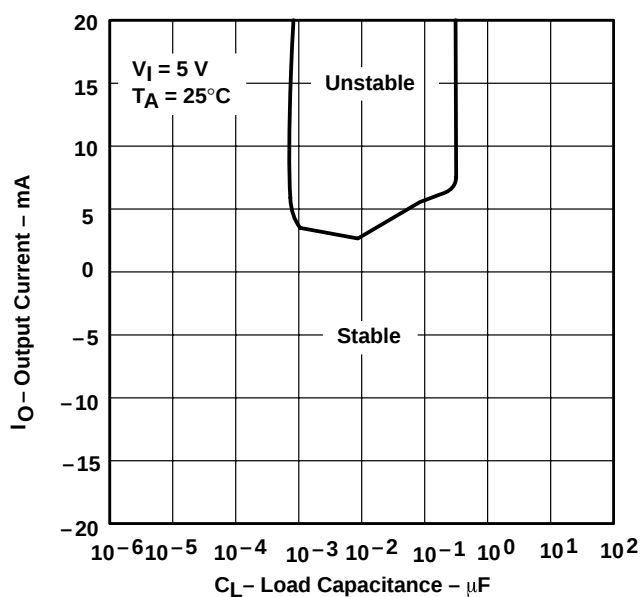


Figure 16

macromodel information

```
* TLE2425 OPERATIONAL AMPLIFIER "MACROMODEL" SUBCIRCUIT
* CREATED USING PARTS RELEASE 4.03 ON 08/21/90 AT 13:51
* REV (N/A) SUPPLY VOLTAGE: 5 V
* CONNECTIONS: INPUT
*               | COMMON
*               | | OUTPUT
*               | | |
.SUBCKT TLE2425 3 4 5
*
```

```
* OPAMP SECTION
C1      11 12 21.66E-12
C2      6 7 30.00E-12
C3     87 0 10.64E-9
CPSR   85 86 15.9E-9
DCM+   81 82 DX
DCM-   83 81 DX
DC      5 53 DX
DE     54 5 DX
DLN    92 90 DX
DLP    90 91 DX
DP      4 3 DX
ECMR   84 99 (2,99) 1
EGND   99 0 POLY(2) (3,0) (4,0) 0 .5 .5
EPSR   85 0 POLY(1) (3,4) -16.22E-6 3.24E-6
ENSE   89 2 POLY(1) (88,0) 120E-6 1
FB      7 99 POLY(6) VB VC VE VLP VLN VPSR 0 74.8E6 -10E6 10E6 10E6
+ -10E6 74E6
GA      6 0 11 12 320.4E-6
GCM     0 6 10 99 1.013E-9
GPSR   85 86 (85,86) 100E-6
GRC1    4 11 (4,11) 3.204E-4
GRC2    4 12 (4,12) 3.204E-4
GRE1   13 10 (13,10) 1.038E-3
GRE2   14 10 (14,10) 1.038E-3
HLIM   90 0 VLIM 1K
HCMR   80 1 POLY(2) VCM+ VCM- 0 1E2 1E2
IRP     3 4 146E-6
IEE     3 10 DC 24.05E-6
IIO     2 0 .2E-9
I1     88 0 1E-21
Q1     11 89 13 QX
Q2     12 80 14 QX
R2      6 9 100.0E3
RCM     84 81 1K
REE     10 99 8.316E6
RN1     87 0 2.55E8
RN2     87 88 11.67E3
```



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macromodel information (continued)

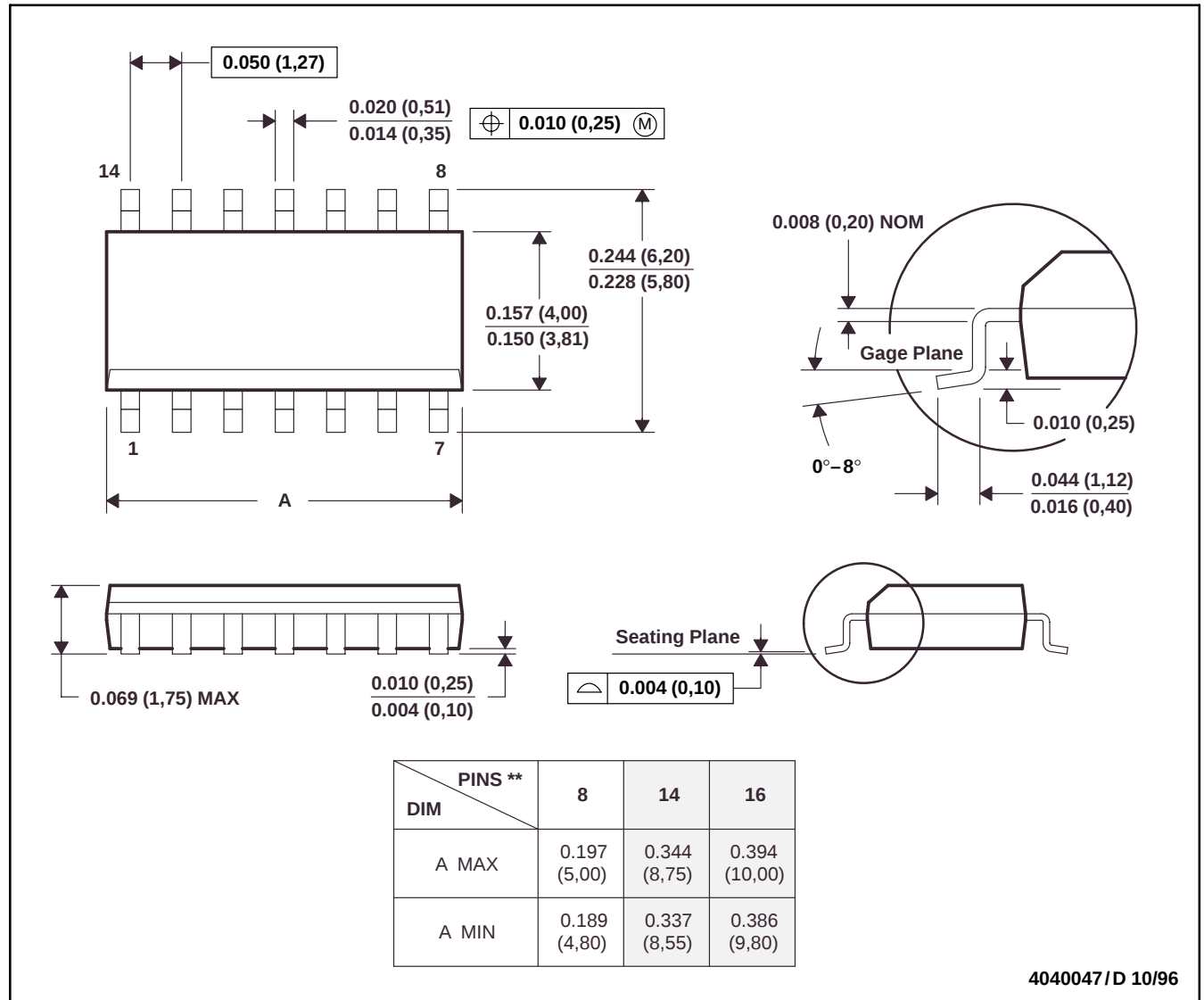
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R01      8  5  63
R02      7 99  62
VCM+    82 99  1.0
VCM-    83 99 -2.3
VB       9  0  DC  0
VC       3 53  DC  1.400
VE      54  4  DC  1.400
VLIM     7  8  DC  0
VLP     91  0  DC  30
VLN      0 92  DC  30
VPSR     0 86  DC  0
RFB       5  2  1K
RIN     30  1  1K
RCOM     34  4  .1
*REGULATOR SECTION
RG1     30  0  20MEG
RG2     30 31  .2
RG3     31 35  400K
RG4     35 34  411K
RG5     31 36  25MEG
HREG    31 32  POLY(2)   VPSET VNSET  0  1E2 1E2
VREG    32 33  DC  0V
EREG    33 34  POLY(1)   (36,34)  1.23 1
VADJ    36 34  1.27V
HPSET   37  0  VREG  1.030E3
VPSET   38  0  DC  20V
HNSET   39  0  VREG  6.11E5
VNSET   40  0  DC -20V
DSUB     4 34  DX
DPOS    37 38  DX
DNNEG   40 39  DX
.MODEL DX  D(IS=800.0E-18)
.MODEL QX  PNP(IS=800.0E-18 BF=480)
.ENDS
```

MECHANICAL INFORMATION

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

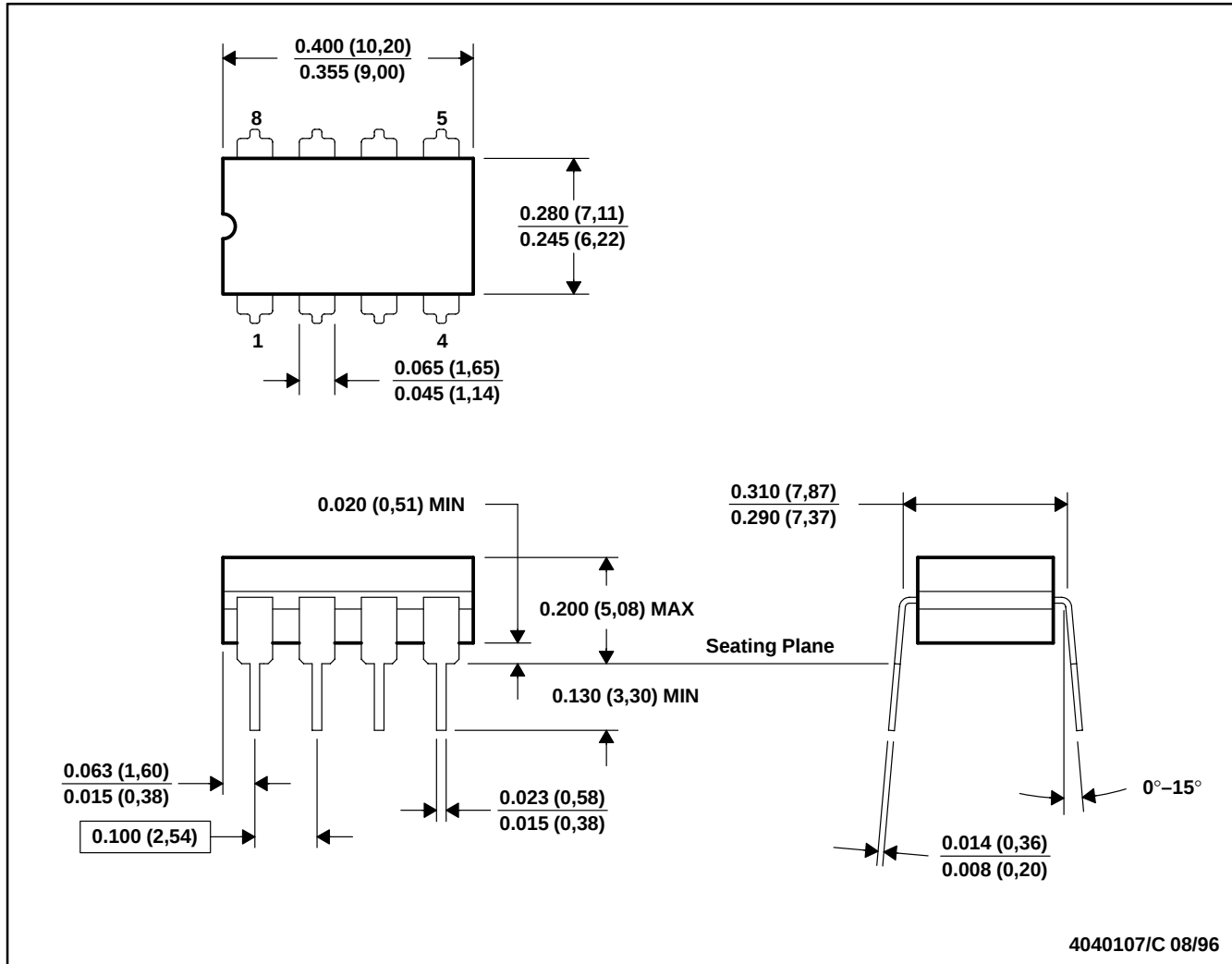
PRECISION VIRTUAL GROUND

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MECHANICAL INFORMATION

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE PACKAGE

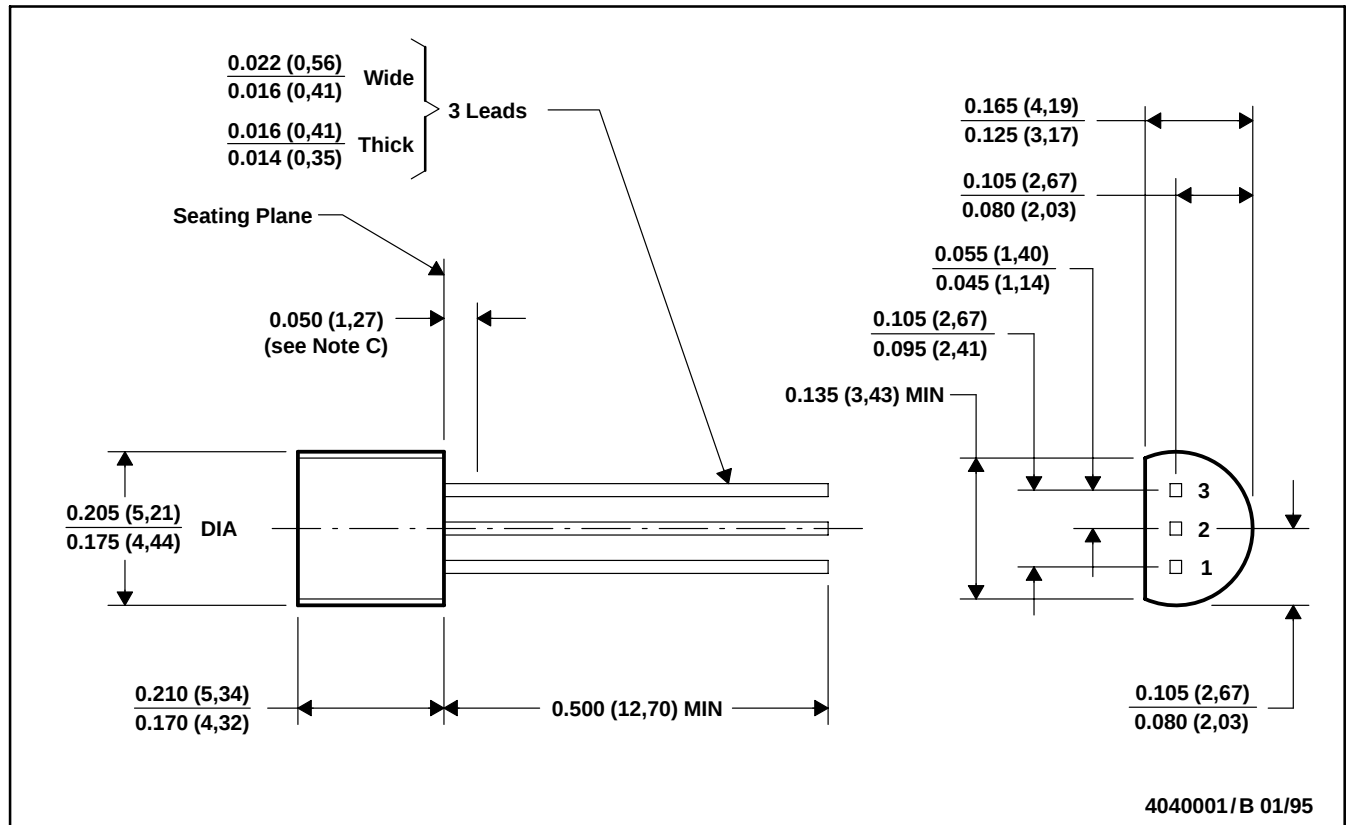


- NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.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

MECHANICAL INFORMATION

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



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