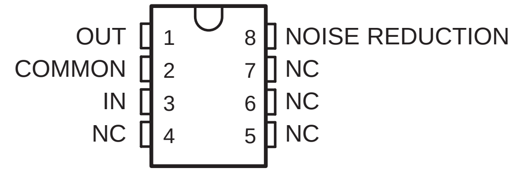
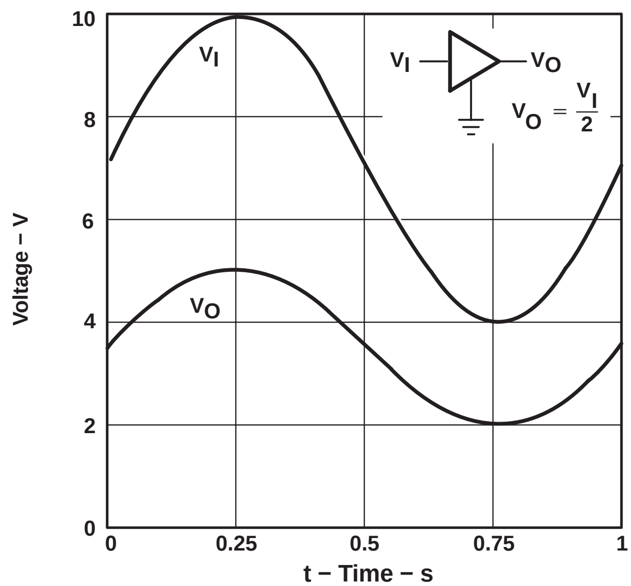
- **Qualified for Automotive Applications**
- **1/2 $V_I$ Virtual Ground for Analog Systems**
- **Micropower Operation . . . 170 µA Typ, $V_I$ = 5 V**
- **Wide $V_I$ Range . . . 4 V to 40 V**
- **High Output-Current Capability**
  - **Source . . . 20 mA Typ**
  - **Sink . . . 20 mA Typ**
- **Excellent Output Regulation**
  - **−102 µV Typ at $I_O$ = 0 to −10 mA**
  - **+49 µV Typ at $I_O$ = 0 to +10 mA**
- **Low-Impedance Output . . . 0.0075 Ω Typ**
- **Noise Reduction Pin**

**D PACKAGE**
**(TOP VIEW)**




NC − No internal connection

**INPUT/OUTPUT TRANSFER CHARACTERISTICS**




## description

In signal-conditioning applications utilizing a single power source, a reference voltage equal to one-half the supply voltage is required for termination of all analog signal grounds. Texas Instruments presents a precision virtual ground whose output voltage is always equal to one-half the input voltage, the TLE2426 *rail splitter*.

The unique combination of a high-performance, micropower operational amplifier and a precision-trimmed divider on a single silicon chip results in a precise $V_O/V_I$ ratio of 0.5 while sinking and sourcing current. The TLE2426 provides a low-impedance output with 20 mA of sink and source capability while drawing less than 280 µA of supply current over the full input range of 4 V to 40 V. A designer need not pay the price in terms of board space for a conventional signal ground consisting of resistors, capacitors, operational amplifiers, and voltage references. For increased performance, the 8-pin package provides a noise-reduction pin. With the addition of an external capacitor ($C_{NR}$), peak-to-peak noise is reduced while line ripple rejection is improved.

Initial output tolerance for a single 5-V or 12-V system is better than 1% over the full 40-V input range. Ripple rejection exceeds 12 bits of accuracy. Whether the application is for a data acquisition front end, analog signal termination, or simply a precision voltage reference, the TLE2426 eliminates a major source of system error.

**ORDERING INFORMATION**[†]

| $T_A$ | PACKAGE[‡] | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| −40°C to 125°C | SOIC (D) | Tape and Reel | TLE2426QDRQ1 | 2426Q1 |

[†] For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at http://www.ti.com.
[‡] Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.

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

Continuous input voltage, $V_I$ .......... 40 V
Continuous filter trap voltage .......... 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, $T_A$: Q suffix .......... −40°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

† 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 | $T_A \leq 25°C$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25°C$ | $T_A = 70°C$ POWER RATING | $T_A = 85°C$ POWER RATING | $T_A = 125°C$ POWER RATING |
|---|---|---|---|---|---|
| D | 1102 mV | 10.3 mW/°C | 638.5 mW | 484 mW | 72.1 mW |

## recommended operating conditions

| | MIN | MAX | UNIT |
|---|---|---|---|
| Input voltage, $V_I$ | 4 | 40 | V |
| Operating free-air temperature, $T_A$ | −40 | 125 | °C |

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

| PARAMETER | TEST CONDITIONS | | $T_A$† | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Output voltage | $V_I$ = 4 V | | 25°C | 1.98 | 2 | 2.02 | V |
| | $V_I$ = 5 V | | | 2.48 | 2.5 | 2.52 | |
| | $V_I$ = 40 V | | | 19.8 | 20 | 20.2 | |
| | $V_I$ = 5 V | | Full range | 2.465 | | 2.535 | |
| Temperature coefficient of output voltage | | | Full range | | 25 | | ppm/°C |
| Supply current | No load | $V_I$ = 5 V | 25°C | | 170 | 300 | μA |
| | | $V_I$ = 4 to 40 V | Full range | | | 400 | |
| Output voltage regulation (sourcing current)‡ | $I_O$ = 0 to −10 mA | | 25°C | | −0.102 | ±0.7 | mV |
| | | | Full range | | | ±10 | |
| | $I_O$ = 0 to −20 mA | | 25°C | | −0.121 | ±1.4 | |
| Output voltage regulation (sinking current)‡ | $I_O$ = 0 to 10 mA | | 25°C | | 0.049 | ±0.5 | mV |
| | $I_O$ = 0 to 8 mA | | Full range | | | ±10 | |
| | $I_O$ = 0 to 20 mA | | 25°C | | 0.175 | ±1.4 | |
| Output impedance‡ | | | 25°C | | 7.5 | 22.5 | mΩ |
| Noise-reduction impedance | | | 25°C | | 110 | | kΩ |
| Short-circuit current | Sinking current, | $V_O$ = 5 V | 25°C | | 26 | | mA |
| | Sourcing current, | $V_O$ = 0 | | | −47 | | |
| Output noise voltage, rms | f = 10 Hz to 10 kHz | $C_{NR}$ = 0 | 25°C | | 120 | | μV |
| | | $C_{NR}$ = 1 μF | | | 30 | | |
| Output voltage current step response | $V_O$ to 0.1%, $I_O$ = ±10 mA | $C_L$ = 0 | 25°C | | 290 | | μs |
| | | $C_L$ = 100 pF | | | 275 | | |
| | $V_O$ to 0.01%, $I_O$ = ±10 mA | $C_L$ = 0 | 25°C | | 400 | | |
| | | $C_L$ = 100 pF | | | 390 | | |
| Step response | $V_I$ = 0 to 5 V, $V_O$ to 0.1% | $C_L$ = 100 pF | 25°C | | 20 | | μs |
| | $V_I$ = 0 to 5 V, $V_O$ to 0.01% | | | | 120 | | |

† Full range is −40°C to 125°C.
‡ The listed values are not production tested.

## electrical characteristics at specified free-air temperature, $V_I$ = 12 V, $I_O$ = 0 (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | | $T_A$† | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Output voltage | $V_I$ = 4 V | | 25°C | 1.98 | 2 | 2.02 | V |
| | $V_I$ = 12 V | | | 5.95 | 6 | 6.05 | |
| | $V_I$ = 40 V | | | 19.8 | 20 | 20.2 | |
| | $V_I$ = 12 V | | Full range | 5.925 | | 6.075 | |
| Temperature coefficient of output voltage | | | Full range | | 35 | | ppm/°C |
| Supply current | No load | $V_I$ = 12 V | 25°C | | 195 | 300 | μA |
| | | $V_I$ = 4 to 40 V | Full range | | | 400 | |
| Output voltage regulation (sourcing current)‡ | $I_O$ = 0 to −10 mA | | 25°C | | −1.48 | ±10 | mV |
| | | | Full range | | | ±10 | |
| | $I_O$ = 0 to −20 mA | | 25°C | | −3.9 | ±10 | |
| Output voltage regulation (sinking current)‡ | $I_O$ = 0 to 10 mA | | 25°C | | 2.27 | ±10 | mV |
| | $I_O$ = 0 to 8 mA | | Full range | | | ±10 | |
| | $I_O$ = 0 to 20 mA | | 25°C | | 4.3 | ±10 | |
| Output impedance‡ | | | 25°C | | 7.5 | 22.5 | mΩ |
| Noise-reduction impedance | | | 25°C | | 110 | | kΩ |
| Short-circuit current | Sinking current, | $V_O$ = 12 V | 25°C | | 31 | | mA |
| | Sourcing current, | $V_O$ = 0 | | | −70 | | |
| Output noise voltage, rms | f = 10 Hz to 10 kHz | $C_{NR}$ = 0 | 25°C | | 120 | | μV |
| | | $C_{NR}$ = 1 μF | | | 30 | | |
| Output voltage current step response | $V_O$ to 0.1%, $I_O$ = ±10 mA | $C_L$ = 0 | 25°C | | 290 | | μs |
| | | $C_L$ = 100 pF | | | 275 | | |
| | $V_O$ to 0.01%, $I_O$ = ±10 mA | $C_L$ = 0 | 25°C | | 400 | | |
| | | $C_L$ = 100 pF | | | 390 | | |
| Step response | $V_I$ = 0 to 12 V, $V_O$ to 0.1% | $C_L$ = 100 pF | 25°C | | 12 | | μs |
| | $V_I$ = 0 to 12 V, $V_O$ to 0.01% | | | | 120 | | |

† Full range is −40°C to 125°C.
‡ The listed values are not production tested.

## TYPICAL CHARACTERISTICS

### Table Of Graphs

| | | FIGURE |
|---|---|---|
| Output voltage | Distribution | 1, 2 |
| Output voltage change | vs Free-air temperature | 3 |
| Output voltage error | vs Input voltage | 4 |
| Input bias current | vs Input voltage | 5 |
| | vs Free-air temperature | 6 |
| Output voltage regulation | vs Output current | 7 |
| Output impedance | vs Frequency | 8 |
| Short-circuit output current | vs Input voltage | 9, 10 |
| | vs Free-air temperature | 11, 12 |
| Ripple rejection | vs Frequency | 13 |
| Spectral noise voltage density | vs Frequency | 14 |
| Output voltage response to output current step | vs Time | 15 |
| Output voltage power-up response | vs Time | 16 |
| Output current | vs Load capacitance | 17 |

## TYPICAL CHARACTERISTICS†

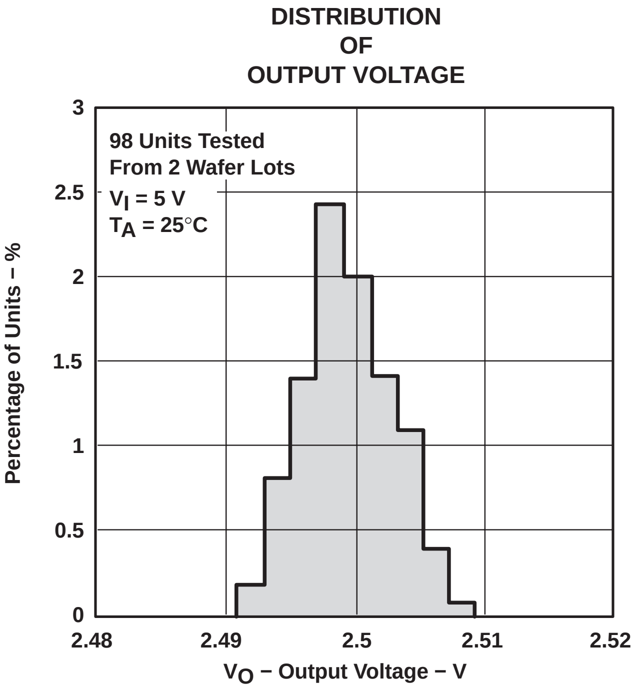



**Figure 1**

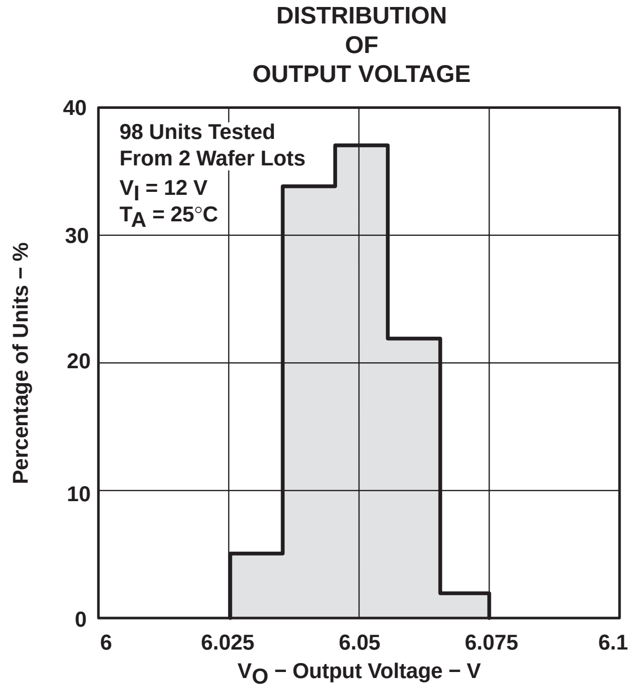



**Figure 2**

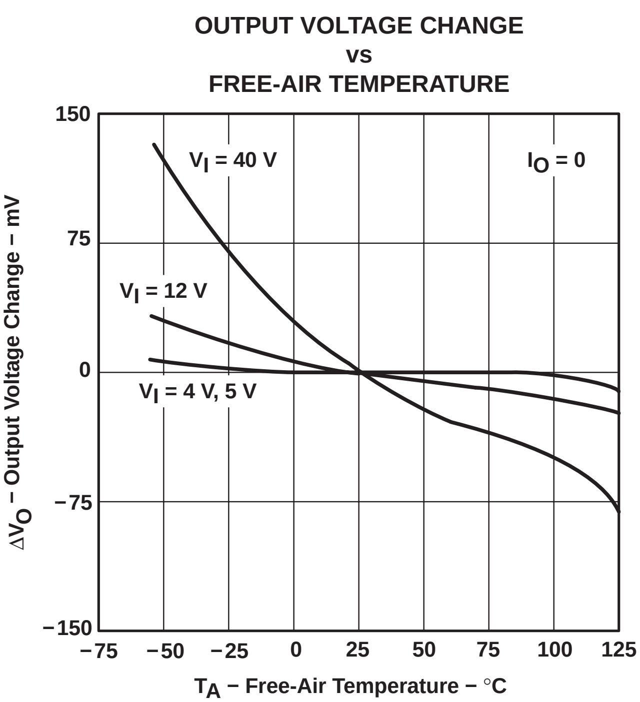



**Figure 3**

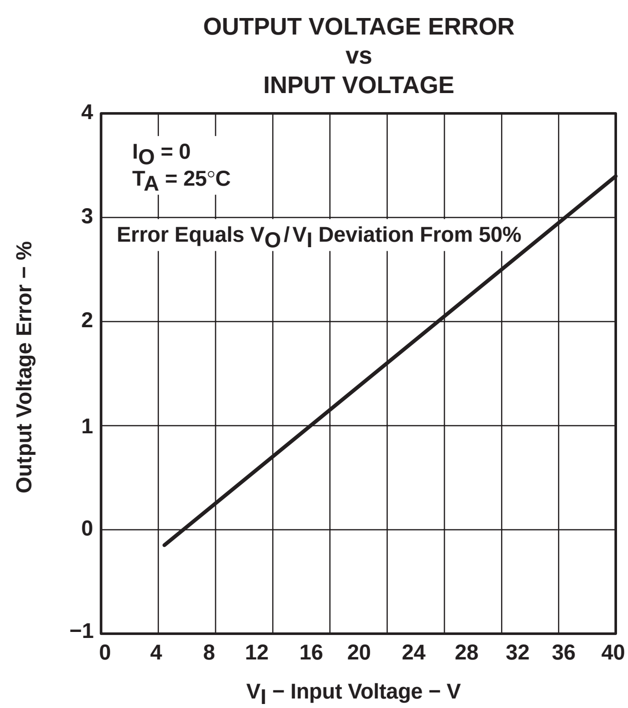



**Figure 4**

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

## TYPICAL CHARACTERISTICS†

INPUT BIAS CURRENT
vs
INPUT VOLTAGE

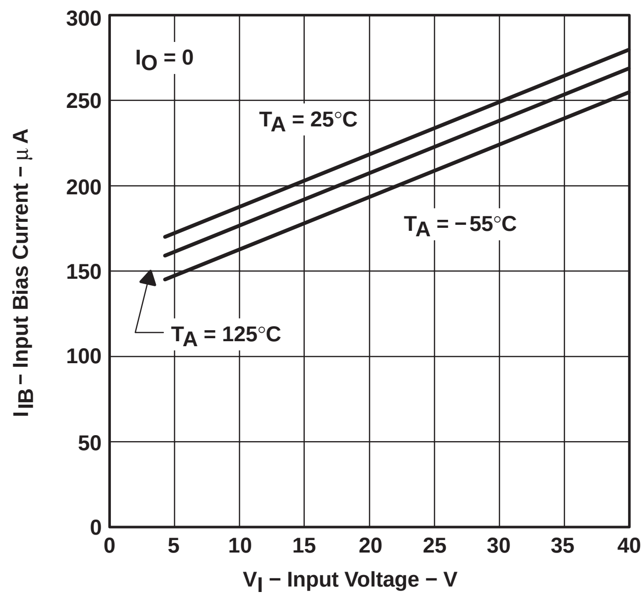



Figure 5

INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE

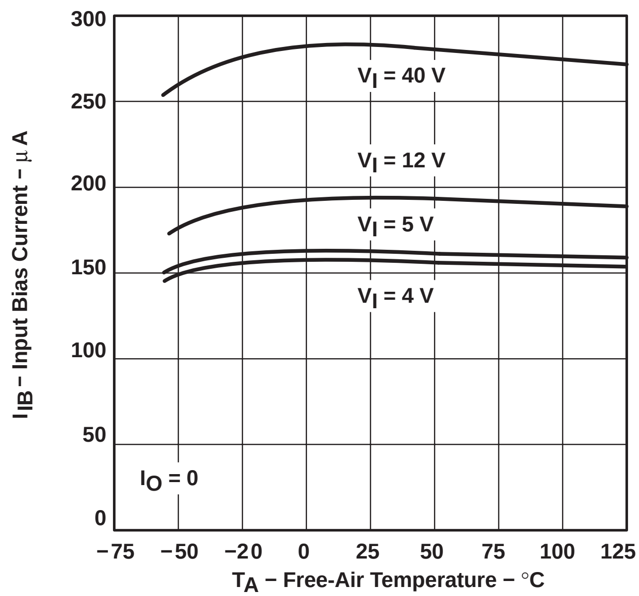



Figure 6

OUTPUT VOLTAGE REGULATION
vs
OUTPUT CURRENT

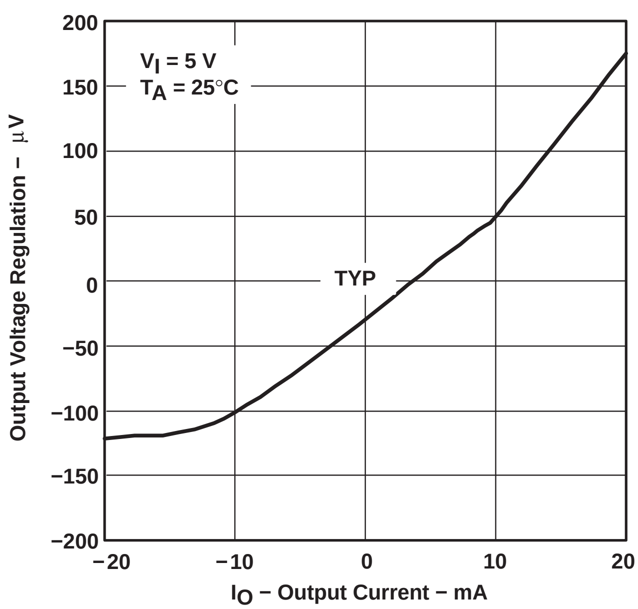



Figure 7

OUTPUT IMPEDANCE
vs
FREQUENCY

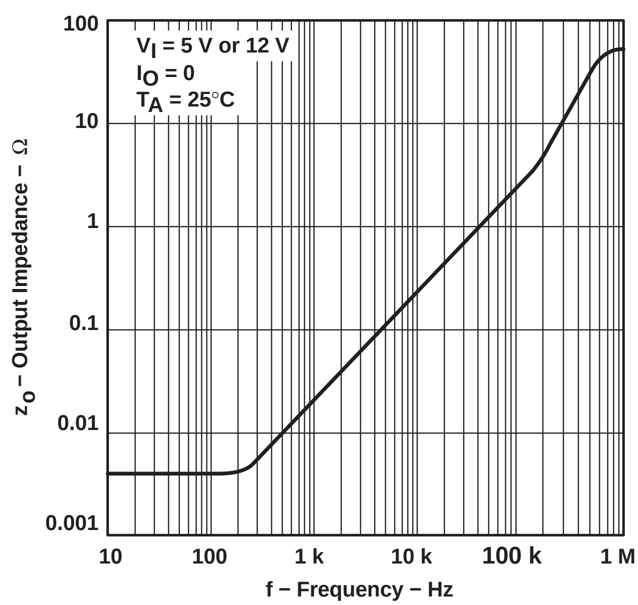



Figure 8

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

## TYPICAL CHARACTERISTICS†

**SHORT-CIRCUIT OUTPUT CURRENT vs INPUT VOLTAGE**

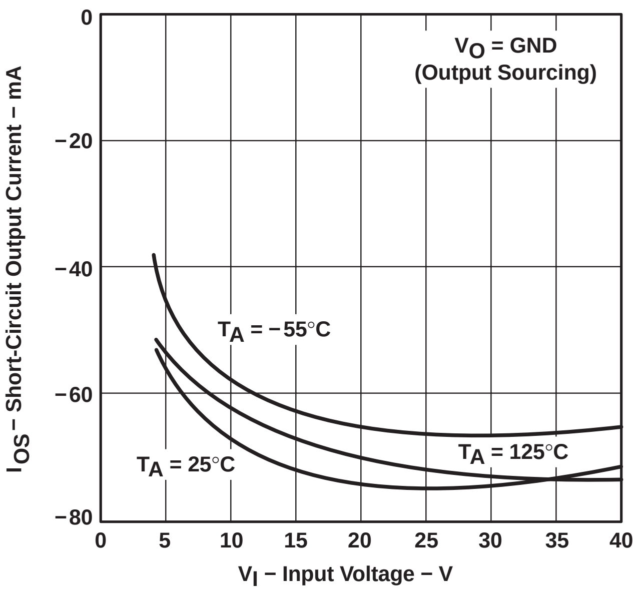



**Figure 9**

**SHORT-CIRCUIT OUTPUT CURRENT vs INPUT VOLTAGE**

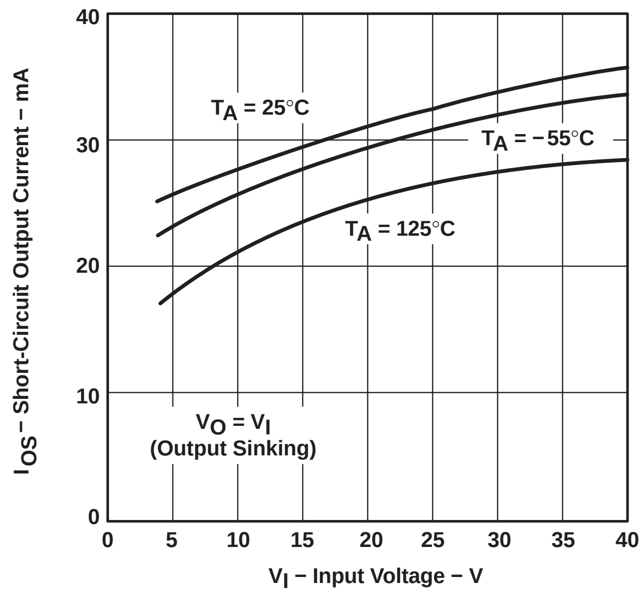



**Figure 10**

**SHORT-CIRCUIT OUTPUT CURRENT vs FREE-AIR TEMPERATURE**

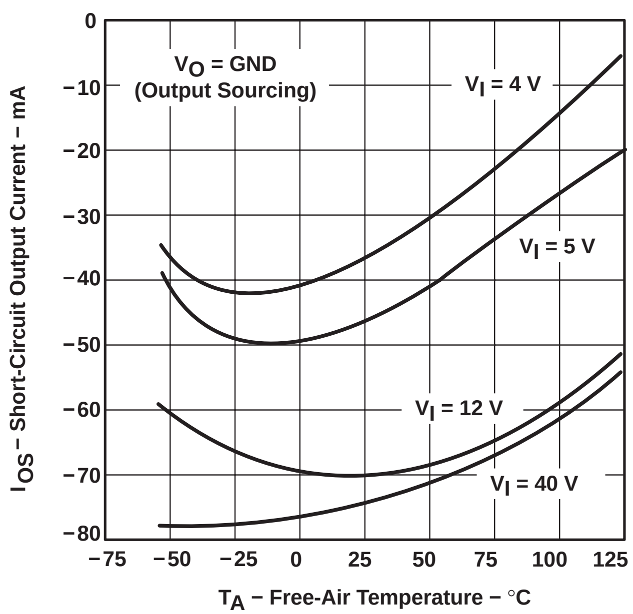



**Figure 11**

**SHORT-CIRCUIT OUTPUT CURRENT vs FREE-AIR TEMPERATURE**

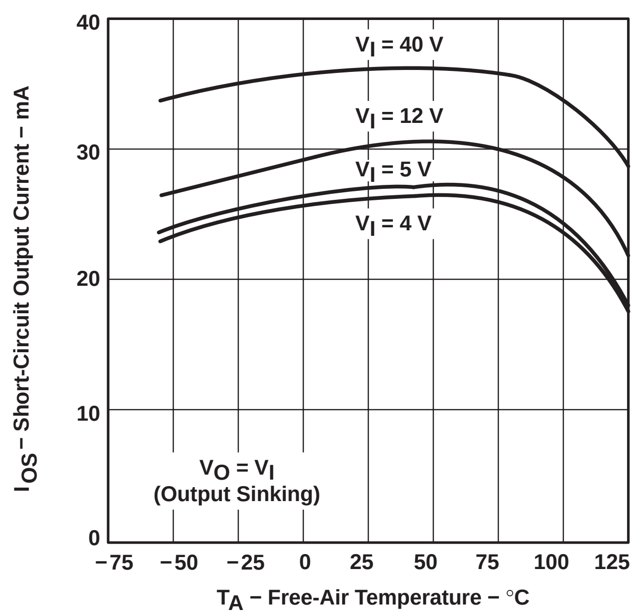



**Figure 12**

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

## TYPICAL CHARACTERISTICS

RIPPLE REJECTION
vs
FREQUENCY

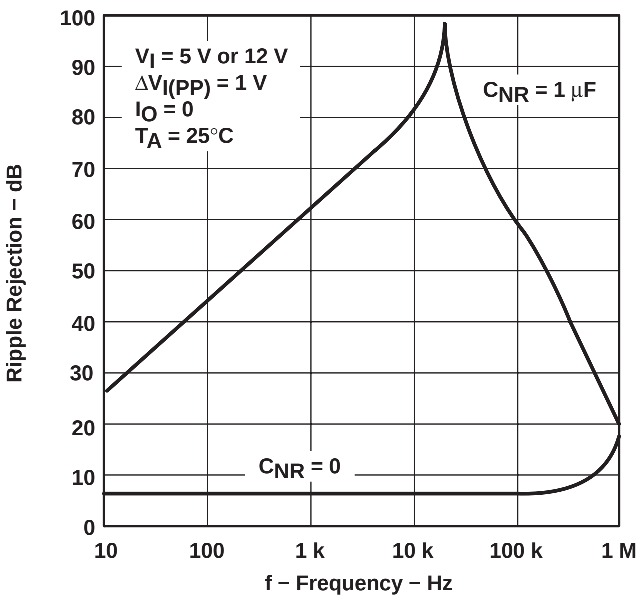



Figure 13

SPECTRAL NOISE VOLTAGE DENSITY
vs
FREQUENCY

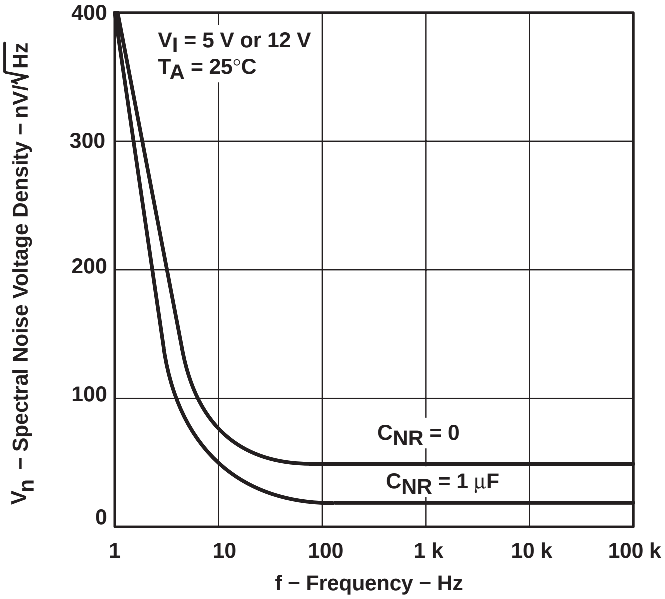



Figure 14

OUTPUT VOLTAGE RESPONSE
TO OUTPUT CURRENT STEP

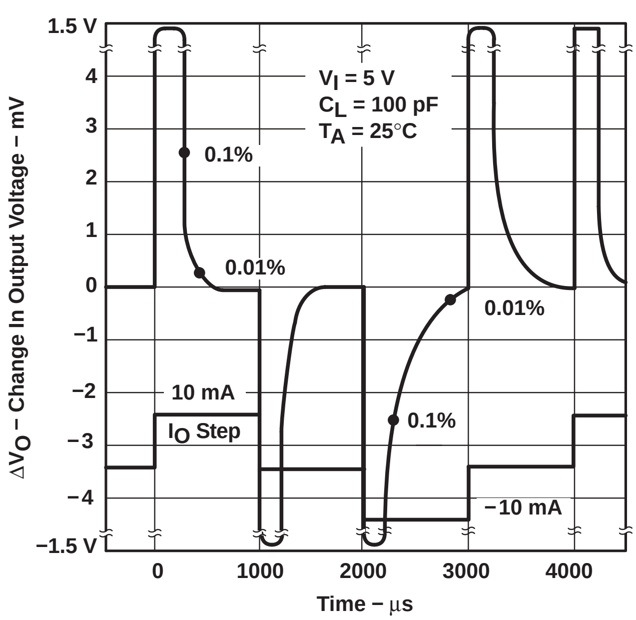



Figure 15

OUTPUT VOLTAGE POWER-UP RESPONSE

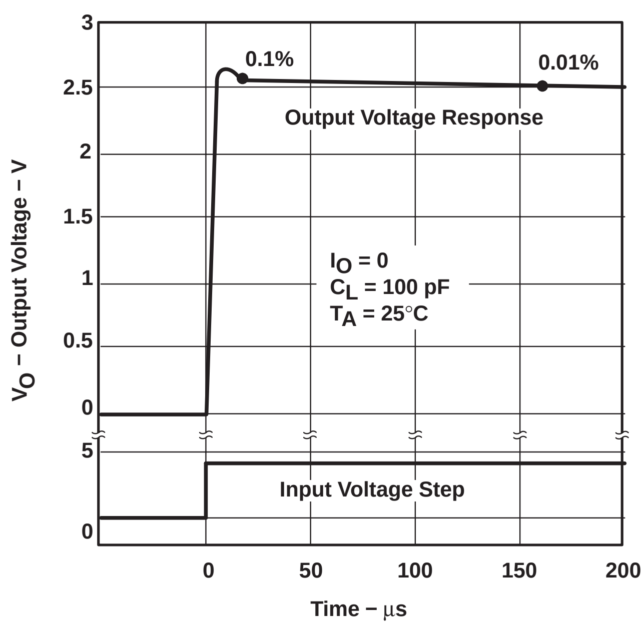



Figure 16

## TYPICAL CHARACTERISTICS

**STABILITY RANGE**
**OUTPUT CURRENT**
**vs**
**LOAD CAPACITANCE**

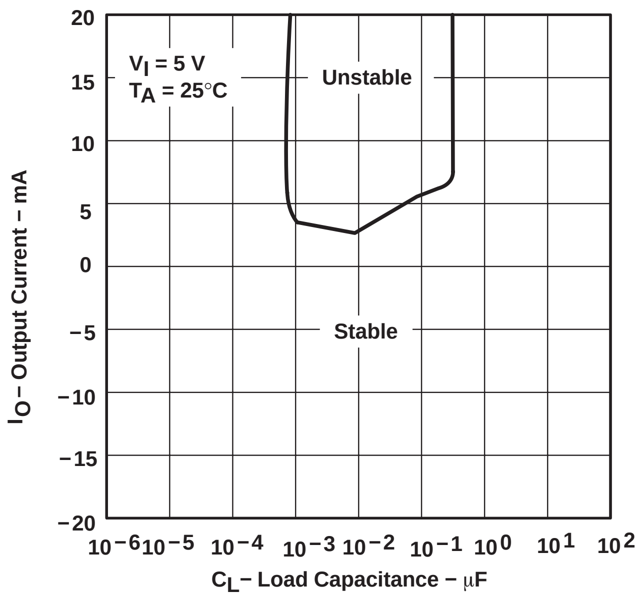



**Figure 17**

## MACROMODEL INFORMATION

```
*   TLE2426 OPERATIONAL AMPLIFIER "MACROMODEL" SUBCIRCUIT
*   CREATED USING PARTS RELEASE 4.03 0N 08/21/90 AT 13:51
*   REV (N/A)     SUPPLY VOLTAGE: 5 V
*   CONNECTIONS:      FILTER
                      |   INPUT
*                     |   |   COMMON
*                     |   |   |   OUTPUT
*                     |   |   |   |
.SUBCKT TLE2426       1   3   4   5
```

```
   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
   DLP    90  91  DX
   DLN    92  90  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
   RO1     8   5  63
   RO2     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
   RIN1    3   1  220K
   RIN2    1   4  220K
.MODEL DX  D(IS=800.OE-18)
.MODEL QX  PNP(IS=800.OE-18 BF=480)
.ENDS
```

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TLE2426QDRG4Q1 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2426Q1 | Samples |

(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

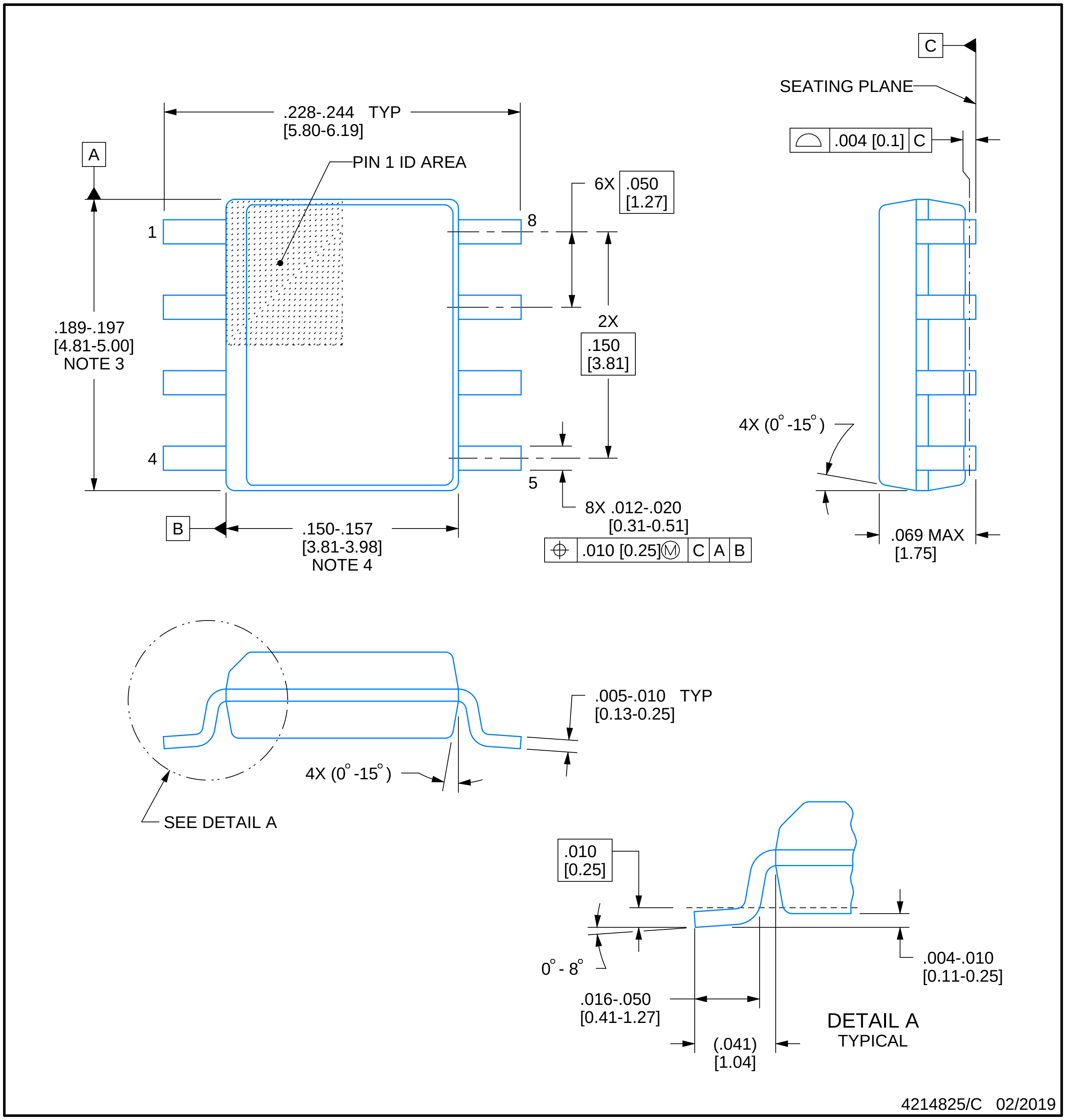
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TLE2426-Q1 :**

- Catalog: TLE2426
- Enhanced Product: TLE2426-EP

NOTE: Qualified Version Definitions:

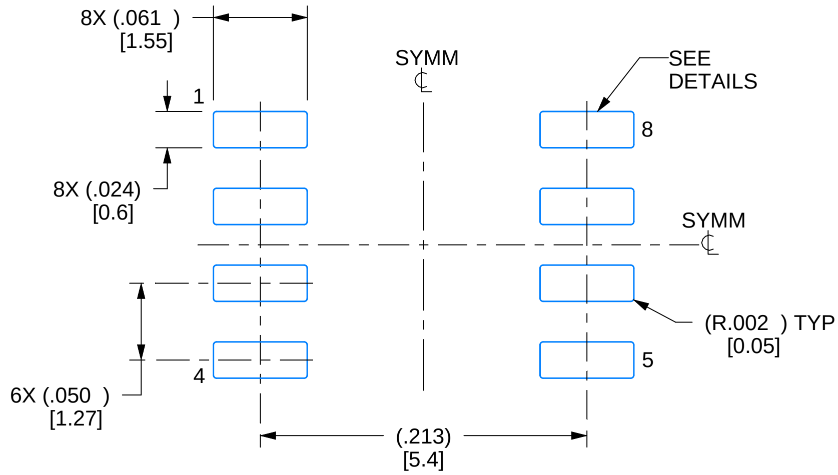
- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications



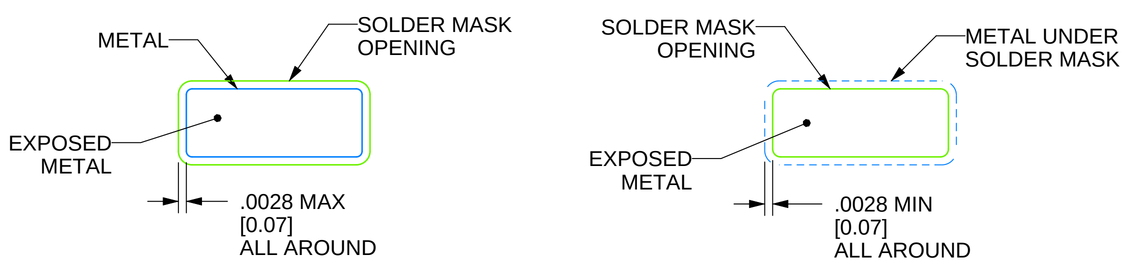

4214825/C 02/2019

NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X




NON SOLDER MASK DEFINED

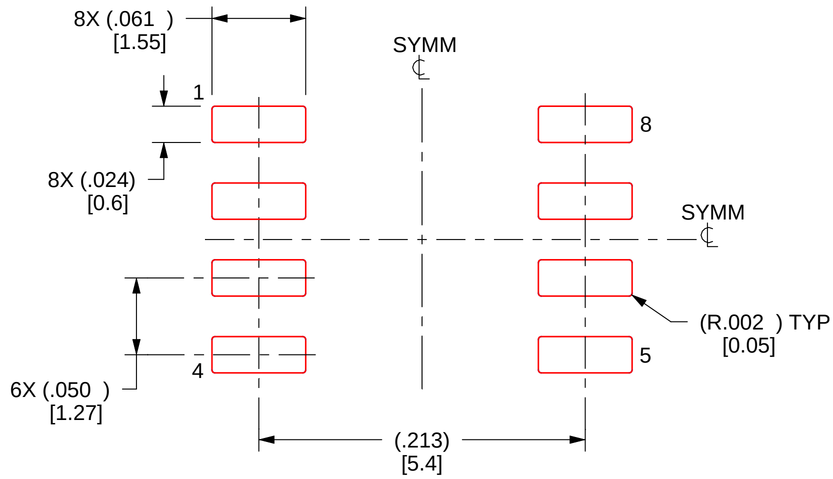
SOLDER MASK DEFINED

SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

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




SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

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