



## Very Low Noise, High-Speed, 12V CMOS Operational Amplifier

### FEATURES

- **BANDWIDTH:** 20MHz
- **SLEW RATE:** 30V/ $\mu$ s
- **FAST 16-BIT SETTling TIME**
- **LOW NOISE:** 6nV/ $\sqrt{\text{Hz}}$  (typ) at 100kHz
- **EXCELLENT CMRR, PSRR, and  $A_{OL}$**
- **RAIL-TO-RAIL OUTPUT**
- **CM RANGE INCLUDES GND**
- **THD+N:** 0.0003% (typ) at 1kHz
- **QUIESCENT CURRENT:** 5.5mA/ch (max)
- **SUPPLY VOLTAGE:** 4V to 12V
- **SHUTDOWN MODE (OPAx726):** 6 $\mu$ A/ch

### APPLICATIONS

- OPTICAL NETWORKING
- TRANSIMPEDANCE AMPLIFIERS
- INTEGRATORS
- ACTIVE FILTERS
- A/D CONVERTER BUFFERS
- I/V CONVERTER FOR DACs
- PORTABLE AUDIO
- PROCESS CONTROL
- TEST EQUIPMENT

### OPA725 RELATED PRODUCTS

| FEATURES                                                                      | PRODUCT |
|-------------------------------------------------------------------------------|---------|
| 10MHz, 16V, 16V/ $\mu$ s, 8.5nV/ $\sqrt{\text{Hz}}$ at 1kHz                   | TLC080  |
| 8MHz, 36V, FET Input, 20V/ $\mu$ s, 8.5nV/ $\sqrt{\text{Hz}}$ at 1kHz         | OPA132  |
| 100MHz, 5.5V, Precision Transimpedance Amplifier                              | OPA380  |
| 500MHz, $\pm$ 5V, FET Input, 290V/ $\mu$ s, 7nV/ $\sqrt{\text{Hz}}$ at 100kHz | OPA656  |
| 7MHz, 12V, RRIO, 10V/ $\mu$ s, 30nV/ $\sqrt{\text{Hz}}$ at 10kHz              | OPA743  |
| 16-Bit, 250kSPS, 4-Channel, Parallel Output ADC                               | ADS8342 |

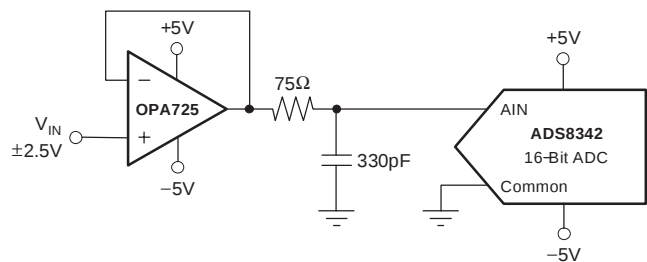
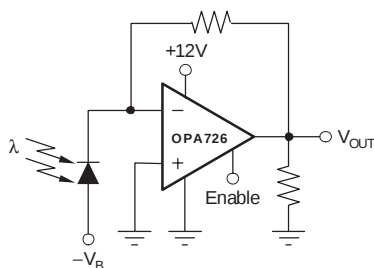
### DESCRIPTION

The OPA725 and OPA726 series op amps use a state-of-the-art 12V analog CMOS process, and combine outstanding ac performance with low bias current and excellent CMRR, PSRR, and  $A_{OL}$ . The 20MHz Gain-Bandwidth (GBW) Product is achieved by using a proprietary and patent-pending output stage design. These characteristics allow excellent 16-bit settling times for driving 16-bit Analog-to-Digital converters (ADCs).

Excellent ac characteristics, such as 20MHz GBW, 30V/ $\mu$ s slew rate and 0.0003% THD+N make the OPA725 and OPA726 well-suited for communication, high-end audio, and active filter applications. With a bias current of less than 200pA, they are well-suited for use as transimpedance (I/V-conversion) amplifiers for monitoring optical power in ONET applications.

The OPA725 and OPA726 op amps can be used in single-supply applications from 4V up to 12V, or dual-supply from  $\pm$ 2V to  $\pm$ 6V. The output swings to within 150mV of the rails, maximizing dynamic range. The shutdown versions (OPAx726) reduce the quiescent current to less than 6 $\mu$ A and feature a reference pin for easy shutdown operation with standard CMOS logic in dual-supply applications.

The OPA725 (single) is available in SOT23-5 and SO-8 packages, and the OPA2725 (dual) is available in MSOP-8 and SO-8 packages. The OPA726 (single with shutdown) is available in MSOP-8 and SO-8. The OPA2726 (dual with shutdown) is available in MSOP-10. All versions are specified for operation from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .



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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## ORDERING INFORMATION

| PRODUCT             | PACKAGE-LEAD | PACKAGE DESIGNATOR(1) | SPECIFIED TEMPERATURE RANGE | PACKAGE MARKING | ORDERING NUMBER | TRANSPORT MEDIA, QUANTITY |
|---------------------|--------------|-----------------------|-----------------------------|-----------------|-----------------|---------------------------|
| <b>Non-Shutdown</b> |              |                       |                             |                 |                 |                           |
| OPA725              | SOT23-5      | DBV                   | –40°C to +125°C             | OALI            | OPA725AIDBVT    | Tape and Reel, 250        |
| "                   | "            | "                     | "                           | "               | OPA725AIDBVR    | Tape and Reel, 3000       |
| OPA725              | SO-8         | D                     | –40°C to +125°C             | OPA725A         | OPA725AID       | Rails, 100                |
| "                   | "            | "                     | "                           | "               | OPA725AIDR      | Tape and Reel, 2500       |
| OPA2725             | SO-8         | D                     | –40°C to +125°C             | OPA2725A        | OPA2725AID      | Rails, 100                |
| "                   | "            | "                     | "                           | "               | OPA2725AIDR     | Tape and Reel, 2500       |
| OPA2725             | MSOP-8       | DGK                   | –40°C to +125°C             | BGM             | OPA2725AIDGKT   | Tape and Reel, 250        |
| "                   | "            | "                     | "                           | "               | OPA2725AIDGKR   | Tape and Reel, 2500       |
| <b>Shutdown</b>     |              |                       |                             |                 |                 |                           |
| OPA726              | SO-8         | D                     | –40°C to +125°C             | OPA726A         | OPA726AID       | Rails, 100                |
| "                   | "            | "                     | "                           | "               | OPA726AIDR      | Tape and Reel, 2500       |
| OPA726              | MSOP-8       | DGK                   | –40°C to +125°C             | BHC             | OPA726AIDGKT    | Tape and Reel, 250        |
| "                   | "            | "                     | "                           | "               | OPA726AIDGKR    | Tape and Reel, 2500       |
| OPA2726             | MSOP-10      | DGS                   | –40°C to +125°C             | BHB             | OPA2726AIDGST   | Tape and Reel, 250        |
| "                   | "            | "                     | "                           | "               | OPA2726AIDGSR   | Tape and Reel, 2500       |

(1) For the most current package and ordering information, see the Package Option Addendum located at the end of this datasheet.



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## ABSOLUTE MAXIMUM RATINGS(1)

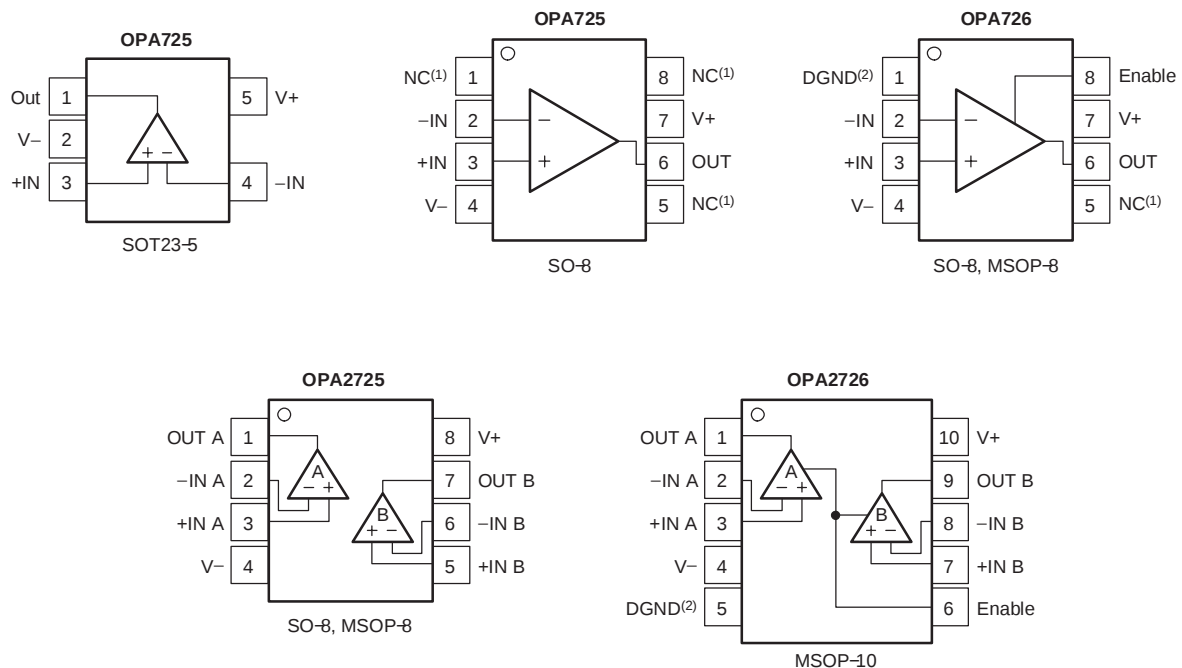
|                                    |                      |
|------------------------------------|----------------------|
| Supply Voltage                     | +13.2V               |
| Signal Input Terminals, Voltage(2) | –0.5V to (V+) + 0.5V |
| Current(2)                         | ±10mA                |
| Output Short Circuit(3)            | Continuous           |
| Operating Temperature              | –55°C to +125°C      |
| Storage Temperature                | –55°C to +150°C      |
| Junction Temperature               | +150°C               |
| Lead Temperature (soldering, 10s)  | +300°C               |
| ESD Rating (Human Body Model)      | 1000 V               |

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not supported.

(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.

(3) Short-circuit to ground, one amplifier per package.

## PIN CONFIGURATIONS



(1) NC denotes no internal connection.

(2) DGND = reference voltage for Enable Reference pin. Voltage on this pin will be the voltage to which the Enable Reference pin is referenced.

**ELECTRICAL CHARACTERISTICS:  $V_S = +4V$  to  $+12V$  or  $V_S = \pm 2V$  to  $\pm 6V$**

**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ .

At  $T_A = +25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.

| PARAMETER                                                      | CONDITIONS                                                                       | OPA725, OPA726, OPA725S, OPA726S |                             |               | UNIT                         |
|----------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------------------|-----------------------------|---------------|------------------------------|
|                                                                |                                                                                  | MIN                              | TYP                         | MAX           |                              |
| <b>OFFSET VOLTAGE</b>                                          |                                                                                  |                                  |                             |               |                              |
| Input Offset Voltage $V_{OS}$                                  | $V_S = \pm 6V, V_{CM} = 0V$                                                      |                                  | 1.2                         | 3             | mV                           |
| OPA725, OPA726                                                 | $V_S = \pm 6V, V_{CM} = 0V$                                                      |                                  | 1.5                         | 5             | mV                           |
| OPA725S, OPA726S                                               |                                                                                  |                                  | <b>4</b>                    |               | $\mu\text{V}/^\circ\text{C}$ |
| Drift $dV_{OS}/dT$                                             |                                                                                  |                                  | 30                          | 100           | $\mu\text{V}/V$              |
| vs Power Supply PSRR                                           | $V_S = \pm 2V$ to $\pm 6V, V_{CM} = V_-$                                         |                                  |                             | <b>150</b>    | $\mu\text{V}/V$              |
| <b>Over Temperature</b>                                        | $V_S = \pm 2V$ to $\pm 6V, V_{CM} = V_-$                                         |                                  |                             |               | $\mu\text{V}/V$              |
| Channel Separation, DC                                         |                                                                                  |                                  | 1                           |               | $\mu\text{V}/V$              |
| <b>INPUT BIAS CURRENT</b>                                      |                                                                                  |                                  |                             |               |                              |
| Input Bias Current $I_B$                                       |                                                                                  |                                  | 30                          | 200           | pA                           |
| <b>Over Temperature</b>                                        |                                                                                  |                                  | See Typical Characteristics |               |                              |
| Input Offset Current $I_{OS}$                                  |                                                                                  |                                  | 10                          | 50            | pA                           |
| <b>NOISE</b>                                                   |                                                                                  |                                  |                             |               |                              |
| Input Voltage Noise, $f = 0.1\text{Hz}$ to $10\text{Hz}$ $e_n$ | $V_S = \pm 6V, V_{CM} = 0V$                                                      |                                  | 10                          |               | $\mu\text{V}_{PP}$           |
| Input Voltage Noise Density, $f = 10\text{kHz}$ $e_n$          | $V_S = \pm 6V, V_{CM} = 0V$                                                      |                                  | 10                          |               | $\text{nV}/\sqrt{\text{Hz}}$ |
| Input Voltage Noise Density, $f = 100\text{kHz}$ $e_n$         | $V_S = \pm 6V, V_{CM} = 0V$                                                      |                                  | 6                           |               | $\text{nV}/\sqrt{\text{Hz}}$ |
| Input Current Noise Density, $f = 1\text{kHz}$ $i_n$           | $V_S = \pm 6V, V_{CM} = 0V$                                                      |                                  | 2.5                         |               | $\text{fA}/\sqrt{\text{Hz}}$ |
| <b>INPUT VOLTAGE RANGE</b>                                     |                                                                                  |                                  |                             |               |                              |
| Common-Mode Voltage Range $V_{CM}$                             |                                                                                  | ( $V_-$ )                        |                             | ( $V_+$ ) – 2 | V                            |
| Common-Mode Rejection Ratio CMRR                               | $(V_-) \leq V_{CM} \leq (V_+) - 2V$                                              | 88                               | 94                          |               | dB                           |
| <b>Over Temperature</b>                                        | <b><math>(V_-) \leq V_{CM} \leq (V_+) - 2V</math></b>                            | <b>84</b>                        |                             |               | <b>dB</b>                    |
|                                                                | $(V_-) \leq V_{CM} \leq (V_+) - 3V$                                              | 94                               | 100                         |               | dB                           |
| <b>Over Temperature</b>                                        | <b><math>(V_-) \leq V_{CM} \leq (V_+) - 3V</math></b>                            | <b>84</b>                        |                             |               | <b>dB</b>                    |
| <b>INPUT IMPEDANCE</b>                                         |                                                                                  |                                  |                             |               |                              |
| Differential                                                   |                                                                                  |                                  | $10^{11}    5$              |               | $\Omega    \text{pF}$        |
| Common-Mode                                                    |                                                                                  |                                  | $10^{11}    4$              |               | $\Omega    \text{pF}$        |
| <b>OPEN-LOOP GAIN</b>                                          |                                                                                  |                                  |                             |               |                              |
| Open-Loop Voltage Gain $A_{OL}$                                |                                                                                  |                                  |                             |               |                              |
| OPA725, OPA726                                                 | $R_L = 100\text{k}\Omega, 0.15V < V_O < (V_+) - 0.15V$                           | 110                              | 120                         |               | dB                           |
| <b>Over Temperature</b>                                        | <b><math>R_L = 100\text{k}\Omega, 0.15V &lt; V_O &lt; (V_+) - 0.15V</math></b>   | <b>100</b>                       |                             |               | <b>dB</b>                    |
| OPA725S, OPA726S                                               | $R_L = 100\text{k}\Omega, 0.175V < V_O < (V_+) - 0.175V$                         | 110                              | 120                         |               | dB                           |
| <b>Over Temperature</b>                                        | <b><math>R_L = 100\text{k}\Omega, 0.175V &lt; V_O &lt; (V_+) - 0.175V</math></b> | <b>100</b>                       |                             |               | <b>dB</b>                    |
| OPA725, OPA726                                                 | $R_L = 1\text{k}\Omega, 0.25V < V_O < (V_+) - 0.25V$                             | 106                              | 116                         |               | dB                           |
| <b>Over Temperature</b>                                        | <b><math>R_L = 1\text{k}\Omega, 0.25V &lt; V_O &lt; (V_+) - 0.25V</math></b>     | <b>96</b>                        |                             |               | <b>dB</b>                    |
| OPA725S, OPA726S                                               | $R_L = 2\text{k}\Omega, 0.25V < V_O < (V_+) - 0.25V$                             | 106                              | 116                         |               | dB                           |
| <b>Over Temperature</b>                                        | <b><math>R_L = 2\text{k}\Omega, 0.25V &lt; V_O &lt; (V_+) - 0.25V</math></b>     | <b>96</b>                        |                             |               | <b>dB</b>                    |
| <b>FREQUENCY RESPONSE</b>                                      |                                                                                  |                                  |                             |               |                              |
|                                                                | $C_L = 20\text{pF}$                                                              |                                  |                             |               |                              |
| Gain-Bandwidth Product GBW                                     |                                                                                  |                                  | 20                          |               | MHz                          |
| Slew Rate SR                                                   | $G = +1$                                                                         |                                  | 30                          |               | V/ $\mu\text{s}$             |
| Settling Time, 0.1% $t_S$                                      | $V_S = \pm 6V, 5V \text{ Step}, G = +1$                                          |                                  | 350                         |               | ns                           |
| 0.01%                                                          | $V_S = \pm 6V, 5V \text{ Step}, G = +1$                                          |                                  | 450                         |               | ns                           |
| Overload Recovery Time                                         | $V_{IN} \cdot \text{Gain} > V_S$                                                 |                                  | 50                          |               | ns                           |
| Total Harmonic Distortion + Noise THD+N                        | $V_S = \pm 6V, V_{OUT} = 2V_{RMS}, R_L = 600\Omega, G = +1, f = 1\text{kHz}$     |                                  | 0.0003                      |               | %                            |

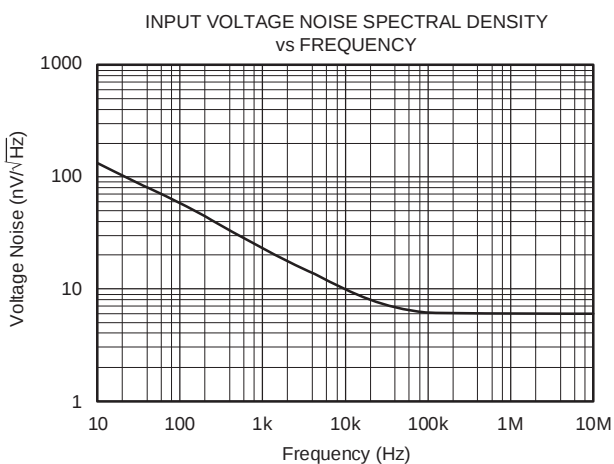
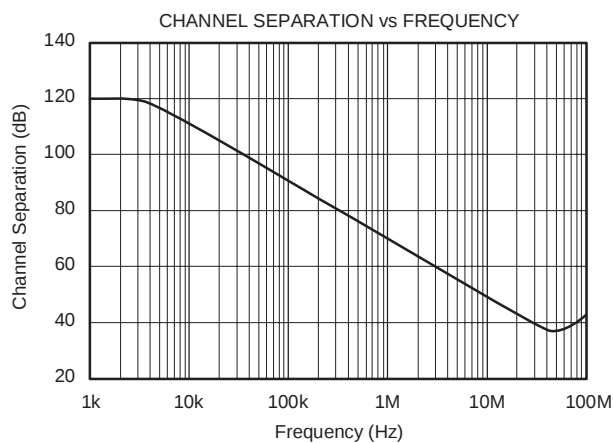
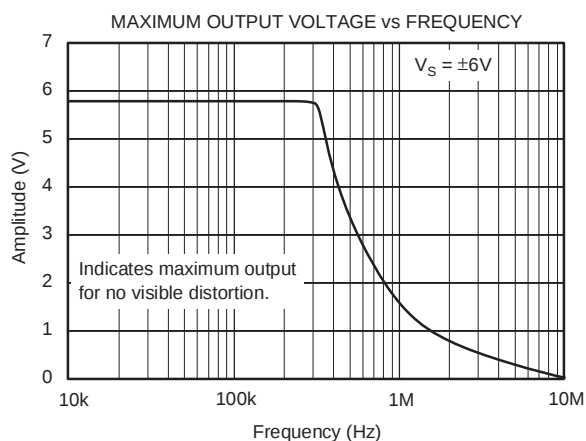
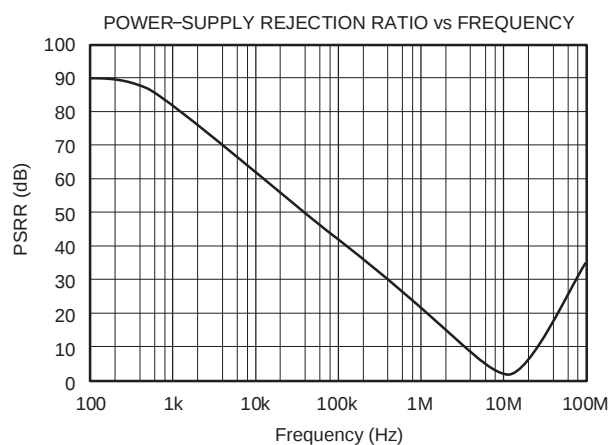
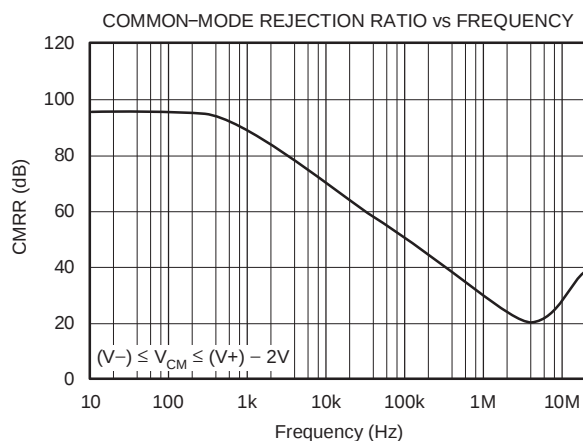
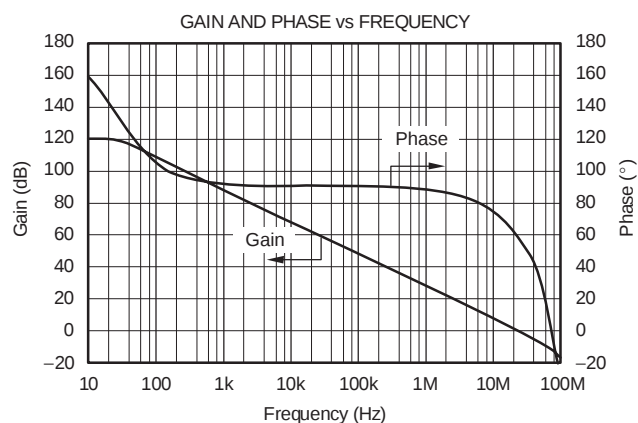
**ELECTRICAL CHARACTERISTICS:  $V_S = +4V$  to  $+12V$  or  $V_S = \pm 2V$  to  $\pm 6V$  (continued)**
**Boldface** limits apply over the specified temperature range,  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ .

At  $T_A = +25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.

| PARAMETER                             |               | CONDITIONS                                                                         | OPA725, OPA726, OPA2725, OPA2726 |             |                            | UNIT               |
|---------------------------------------|---------------|------------------------------------------------------------------------------------|----------------------------------|-------------|----------------------------|--------------------|
|                                       |               |                                                                                    | MIN                              | TYP         | MAX                        |                    |
| OUTPUT                                |               |                                                                                    |                                  |             |                            |                    |
| Voltage Output Swing from Rail        |               | $R_L = 100\text{k}\Omega$ , $A_{OL} > 110\text{dB}$                                |                                  | 100         | 150                        | mV                 |
| OPA725, OPA726                        |               | <b><math>R_L = 100\text{k}\Omega</math>, <math>A_{OL} &gt; 100\text{dB}</math></b> |                                  |             | <b>150</b>                 | <b>mV</b>          |
| Over Temperature                      |               | $R_L = 100\text{k}\Omega$ , $A_{OL} > 110\text{dB}$                                |                                  | 125         | 175                        | mV                 |
| OPA2725, OPA2726                      |               | <b><math>R_L = 100\text{k}\Omega</math>, <math>A_{OL} &gt; 100\text{dB}</math></b> |                                  |             | <b>175</b>                 | <b>mV</b>          |
| Over Temperature                      |               | $R_L = 1\text{k}\Omega$ , $A_{OL} > 106\text{dB}$                                  |                                  | 200         | 250                        | mV                 |
| OPA725, OPA726                        |               | <b><math>R_L = 1\text{k}\Omega</math>, <math>A_{OL} &gt; 96\text{dB}</math></b>    |                                  |             | <b>250</b>                 | <b>mV</b>          |
| Over Temperature                      |               | $R_L = 2\text{k}\Omega$ , $A_{OL} > 106\text{dB}$                                  |                                  | 200         | 250                        | mV                 |
| OPA2725, OPA2726                      |               | <b><math>R_L = 2\text{k}\Omega</math>, <math>A_{OL} &gt; 96\text{dB}</math></b>    |                                  |             | <b>250</b>                 | <b>mV</b>          |
| Over Temperature                      |               | $ V_S - V_{OUT}  < 1\text{V}$                                                      |                                  | 40          |                            | mA                 |
| Output Current                        | $I_{OUT}$     |                                                                                    |                                  | $\pm 55$    |                            | mA                 |
| Short-Circuit Current                 | $I_{SC}$      |                                                                                    | See Typical Characteristics      |             |                            |                    |
| Capacitive Load Drive                 | $C_{LOAD}$    |                                                                                    |                                  | 40          |                            | $\Omega$           |
| Open-Loop Output Impedance            |               | $f = 1\text{MHz}$ , $I_O = 0$                                                      |                                  |             |                            |                    |
| ENABLE/SHUTDOWN (OPAx726)             |               |                                                                                    |                                  |             |                            |                    |
| $t_{OFF}$                             |               |                                                                                    |                                  | 5           |                            | $\mu\text{s}$      |
| $t_{ON}$                              |               |                                                                                    |                                  | 30          |                            | $\mu\text{s}$      |
| Enable Reference (DGND) Voltage Range | $V_{DGND}$    |                                                                                    | $V^-$                            |             | $(V^+) - 2$                | V                  |
| $V_L$ (shutdown)                      |               |                                                                                    |                                  |             | $< V_{DGND} + 0.8\text{V}$ | V                  |
| $V_H$ (amplifier is active)           |               |                                                                                    | $> V_{DGND} + 2\text{V}$         |             |                            | V                  |
| Input Disable Current                 |               | Ref Pin = Enable Pin = $V^-$                                                       |                                  | 5           |                            | $\mu\text{A}$      |
| $I_{QSD}$ (per amplifier)             |               |                                                                                    |                                  | 6           | 15                         | $\mu\text{A}$      |
| POWER SUPPLY                          |               |                                                                                    |                                  |             |                            |                    |
| Specified Voltage Range               | $V_S$         |                                                                                    | 4                                |             | 12                         | V                  |
| Operating Voltage Range               | $V_S$         |                                                                                    |                                  | 3.5 to 13.2 |                            | V                  |
| Quiescent Current (per amplifier)     | $I_Q$         | $I_O = 0$                                                                          |                                  | 4.3         | 5.5                        | mA                 |
| Over Temperature                      |               |                                                                                    |                                  |             | <b>6</b>                   | <b>mA</b>          |
| TEMPERATURE RANGE                     |               |                                                                                    |                                  |             |                            |                    |
| Specified Range                       |               |                                                                                    | $-40$                            |             | 125                        | $^\circ\text{C}$   |
| Operating Range                       |               |                                                                                    | $-55$                            |             | 125                        | $^\circ\text{C}$   |
| Storage Range                         |               |                                                                                    | $-55$                            |             | 150                        | $^\circ\text{C}$   |
| Thermal Resistance                    | $\theta_{JA}$ |                                                                                    |                                  |             |                            |                    |
| SOT23-5                               |               |                                                                                    |                                  | 200         |                            | $^\circ\text{C/W}$ |
| MSOP-8, MSOP-10, SO-8                 |               |                                                                                    |                                  | 150         |                            | $^\circ\text{C/W}$ |

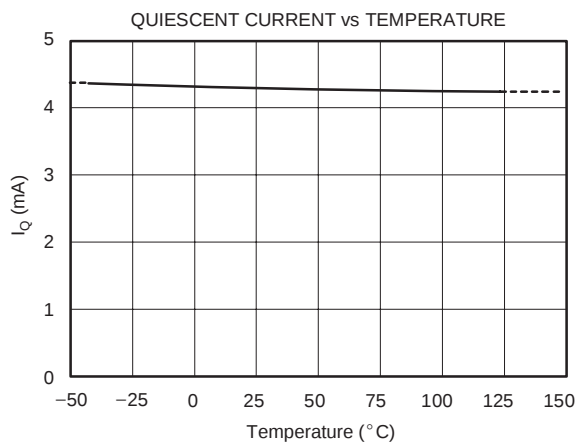
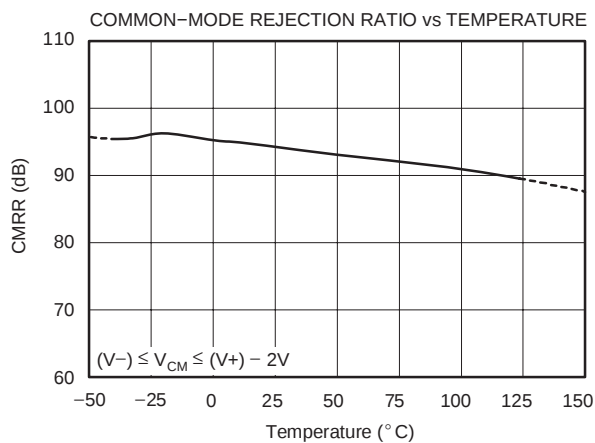
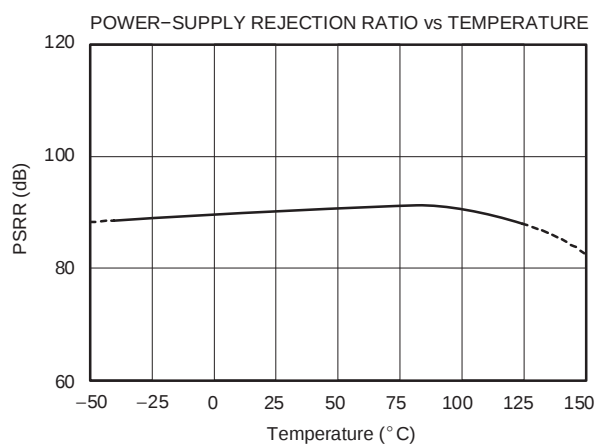
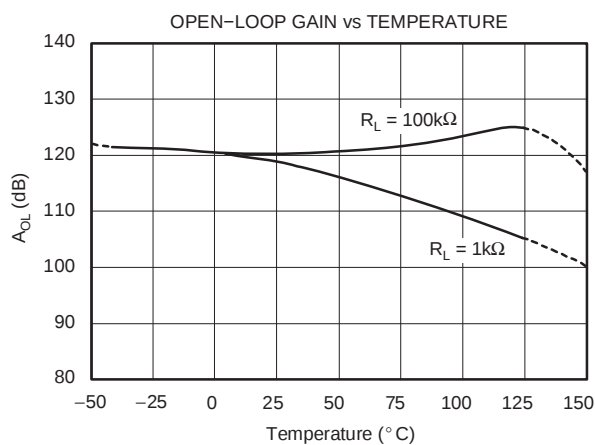
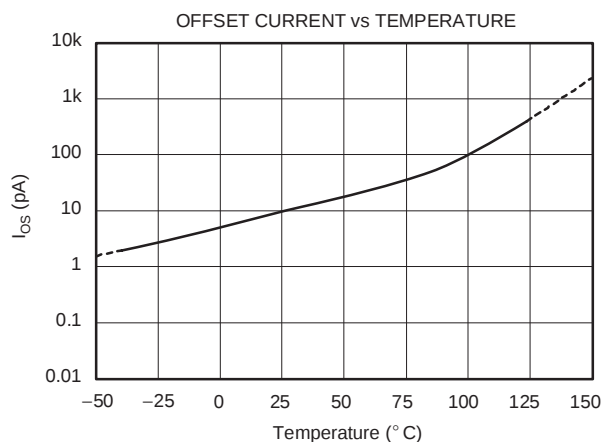
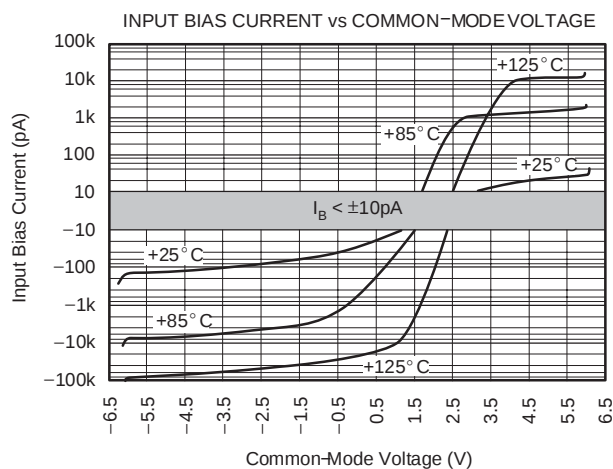
## TYPICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 6\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.



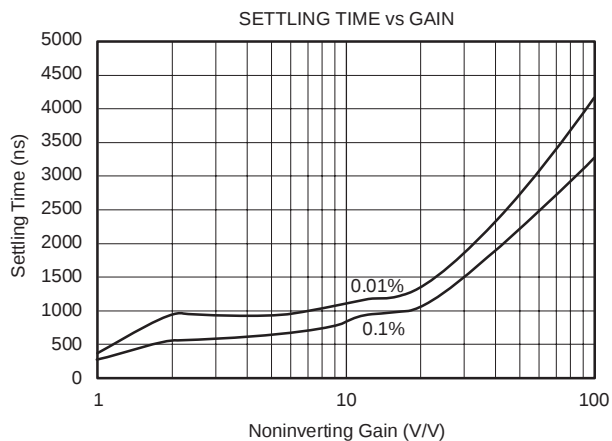
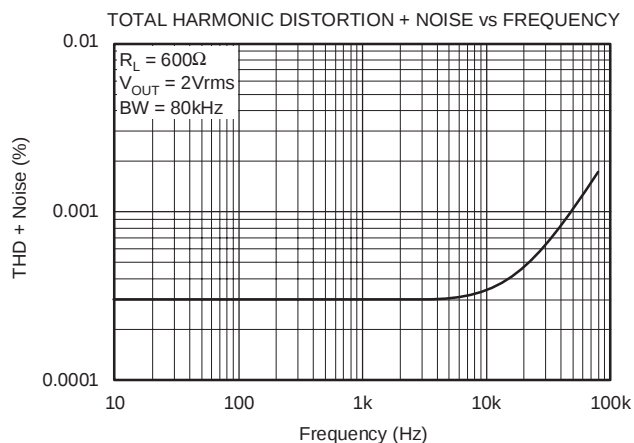
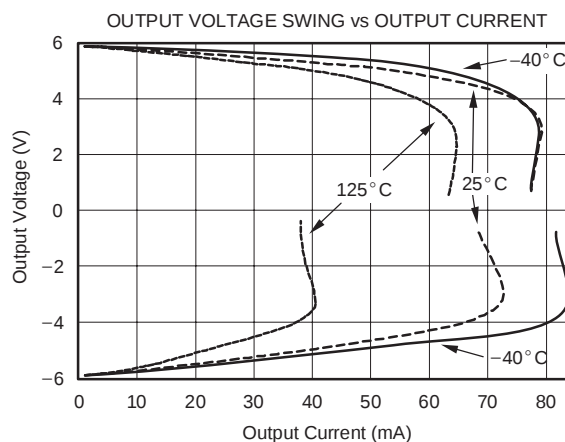
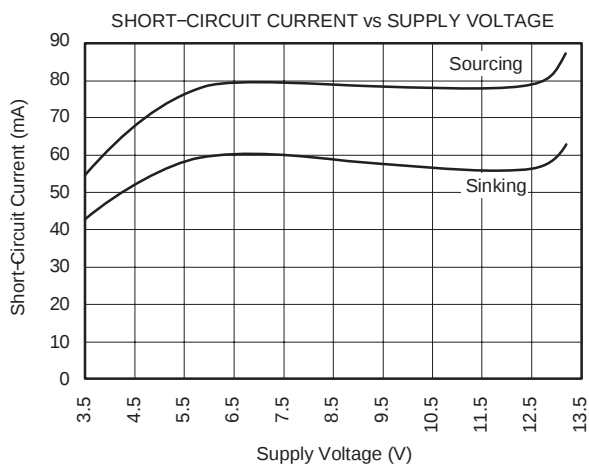
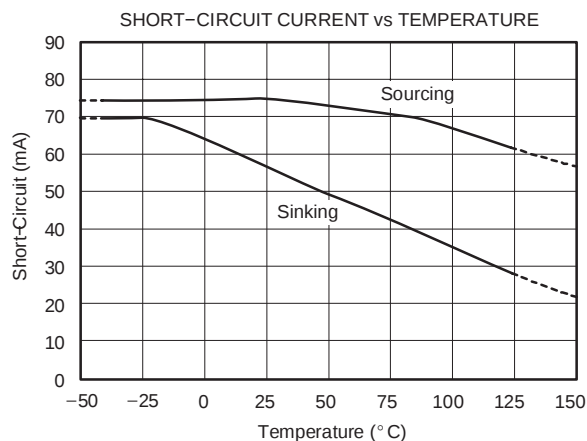
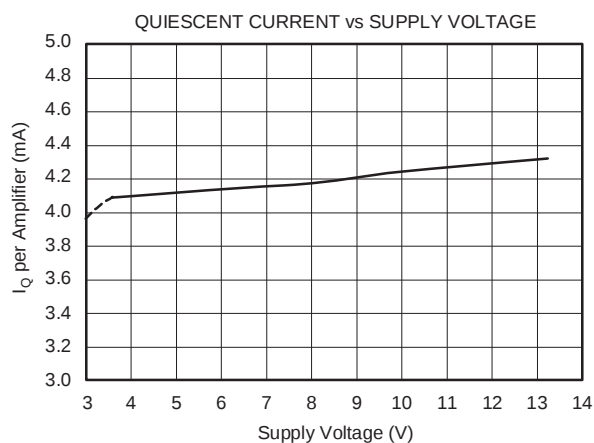
## TYPICAL CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 6\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.



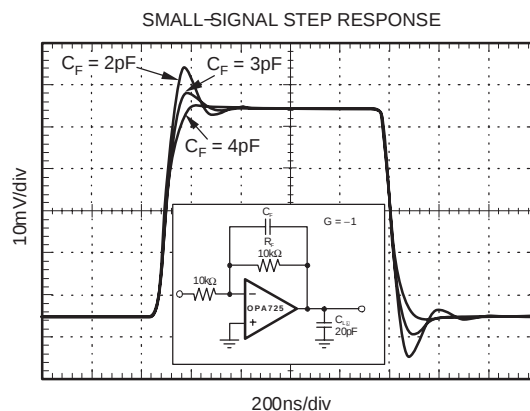
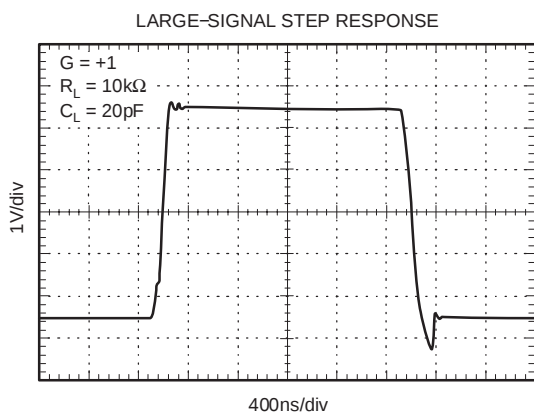
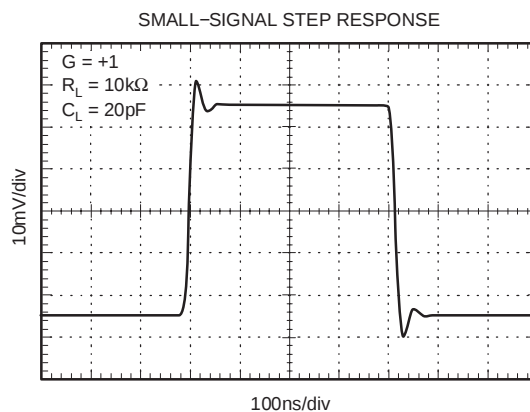
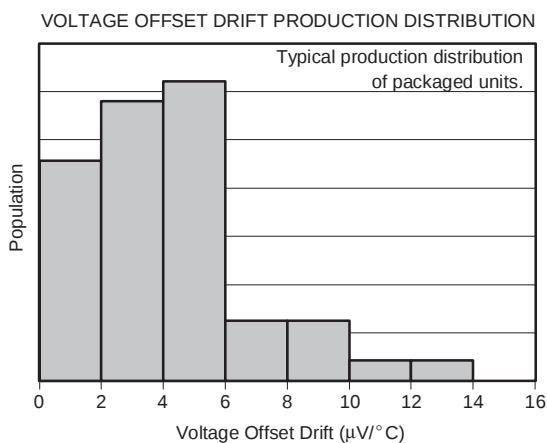
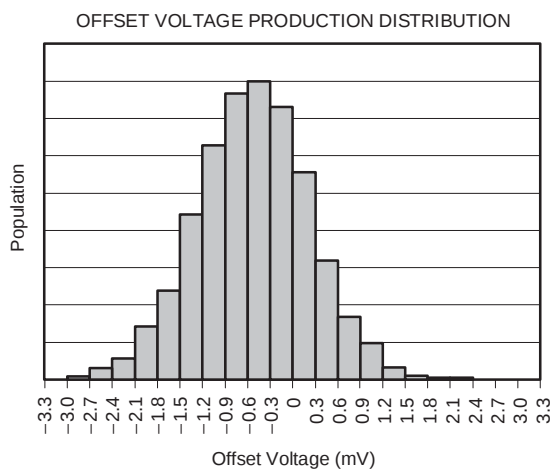
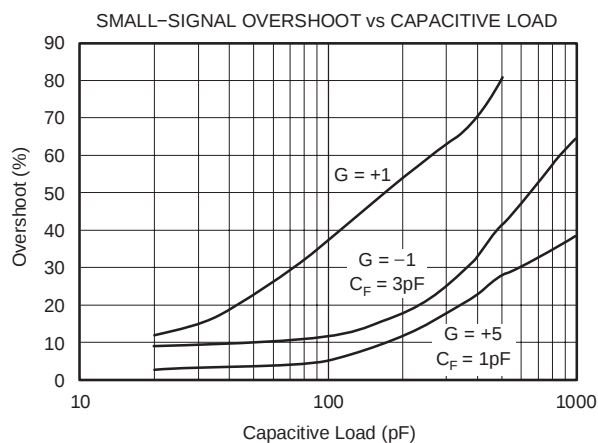
## TYPICAL CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 6\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.



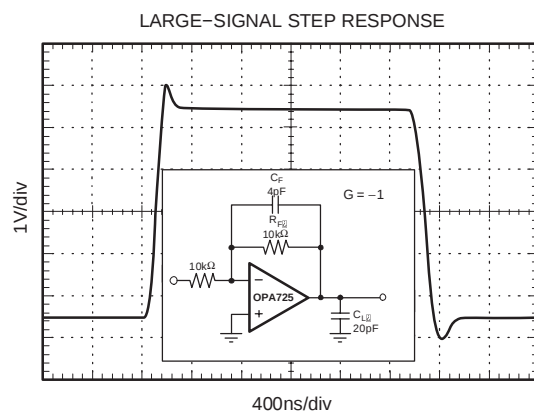
## TYPICAL CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 6\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.



## TYPICAL CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 6\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.



## APPLICATIONS INFORMATION

OPA725 and OPA726 series 20MHz CMOS op amps have a fast slew rate, low noise, and excellent PSRR, CMRR, and  $A_{OL}$ . These op amps can operate on typically 4.3mA quiescent current from a single (or split) supply in the range of 4V to 12V ( $\pm 2V$  to  $\pm 6V$ ), making them highly versatile and easy to use. They are stable in a unity-gain configuration.

Power-supply pins should be bypassed with 1nF ceramic capacitors in parallel with 1 $\mu$ F tantalum capacitors.

### OPERATING VOLTAGE

OPA725 series op amps are specified from 4V to 12V supplies over a temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . They will operate well in  $\pm 5V$  or  $+5V$  to  $+12V$  power-supply systems. Parameters that vary significantly with operating voltage or temperature are shown in the Typical Characteristics.

### ENABLE/SHUTDOWN

OPA725 series op amps require approximately 4.3mA quiescent current. The enable/shutdown feature of the OPA726 allows the op amp to be shut off to reduce this current to approximately 6 $\mu$ A.

The enable/shutdown input is referenced to the Enable Reference Pin, DGND (see Pin Configurations). This pin can be connected to logic ground in dual-supply op amp configurations to avoid level-shifting the enable logic signal, as shown in Figure 1.

The Enable Reference Pin voltage,  $V_{DGND}$ , must not exceed  $(V+) - 2V$ . It may be set as low as  $V-$ . The amplifier is enabled when the Enable Pin voltage is greater than  $V_{DGND} + 2V$ . The amplifier is disabled (shutdown) if the Enable Pin voltage is less than  $V_{DGND} + 0.8V$ . The Enable Pin is connected to internal pull-up circuitry and will enable the device if left unconnected.

### COMMON-MODE VOLTAGE RANGE

The input common-mode voltage range of the OPA725 and OPA726 series extends from  $V-$  to  $(V+) - 2V$ .

Common-mode rejection is excellent throughout the input voltage range from  $V-$  to  $(V+) - 3V$ . CMRR decreases somewhat as the common-mode voltage extends to  $(V+) - 2V$ , but remains very good and is tested throughout this range. See the Electrical Characteristics table for details.

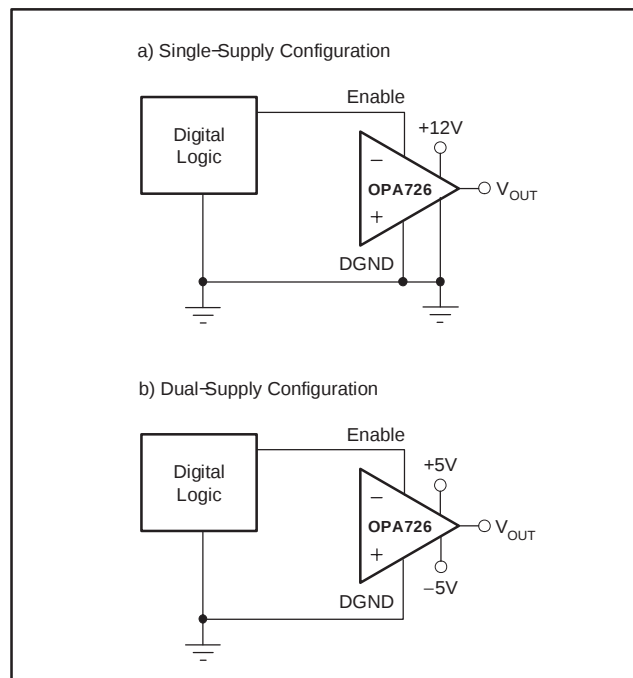


Figure 1. Enable Reference Pin Connection for Single- and Dual-Supply Configurations

### INPUT OVER-VOLTAGE PROTECTION

Device inputs are protected by ESD diodes that will conduct if the input voltages exceed the power supplies by more than approximately 300mV. Momentary voltages greater than 300mV beyond the power supply can be tolerated if the current is limited to 10mA. This is easily accomplished with an input resistor in series with the op amp, as shown in Figure 2. The OPA725 series features no phase inversion when the inputs extend beyond supplies, if the input is current limited.

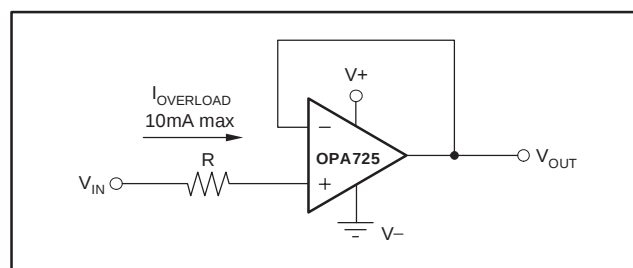


Figure 2. Input Current Protection for Voltages Exceeding the Supply Voltage

## RAIL-TO-RAIL OUTPUT

A class AB output stage with common-source transistors is used to achieve rail-to-rail output. This output stage is capable of driving heavy loads connected to any point between  $V_+$  and  $V_-$ . For light resistive loads ( $> 100\text{k}\Omega$ ), the output voltage can swing to 150mV (175mV for dual) from the supply rail, while still maintaining excellent linearity ( $A_{OL} > 110\text{dB}$ ). With  $1\text{k}\Omega$  ( $2\text{k}\Omega$  for dual) resistive loads, the output is specified to swing to within 250mV from the supply rails with excellent linearity (see the Typical Characteristics curve *Output Voltage Swing vs Output Current*).

## CAPACITIVE LOAD AND STABILITY

Capacitive load drive is dependent upon gain and the overshoot requirements of the application. Increasing the gain enhances the ability of the amplifier to drive greater capacitive loads (see the Typical Characteristics curve *Small-Signal Overshoot vs Capacitive Load*).

One method of improving capacitive load drive in the unity-gain configuration is to insert a  $10\Omega$  to  $20\Omega$  resistor inside the feedback loop, as shown in Figure 3. This reduces ringing with large capacitive loads while maintaining DC accuracy.

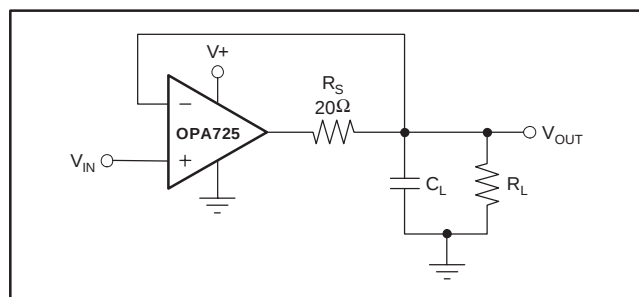


Figure 3. Series Resistor in Unity-Gain Buffer Configuration Improves Capacitive Load Drive

## DRIVING FAST 16-BIT ADCs

The OPA725 series is optimized for driving fast 16-bit ADCs such as the ADS8342. The OPA725 op amps buffer the converter input capacitance and resulting charge injection, while providing signal gain. Figure 4 shows the OPA725 in a single-ended method of interfacing to the ADS8342 16-bit, 250kSPS, 4-channel ADC with an input range of  $\pm 2.5\text{V}$ . The OPA725 has demonstrated excellent settling time to the 16-bit level within the 600ns acquisition time of the ADS8342. The RC filter, shown in Figure 4, has been carefully tuned for best noise and settling performance. It may need to be adjusted for different op amp configurations. Please refer to the ADS8342 data sheet (available for download at [www.ti.com](http://www.ti.com)) for additional information on this product.

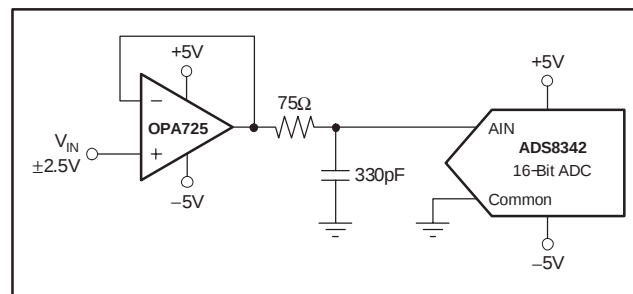


Figure 4. OPA725 Driving an ADC

## TRANSIMPEDANCE AMPLIFIER

Wide bandwidth, low input bias current, and low input voltage and current noise make the OPA725 an ideal wideband photodiode transimpedance amplifier. Low-voltage noise is important because photodiode capacitance causes the effective noise gain of the circuit to increase at high frequency.

The key elements to a transimpedance design, as shown in Figure 5, are the expected diode capacitance ( $C_D$ ), which should include the parasitic input common-mode and differential-mode input capacitance ( $4\text{pF} + 5\text{pF}$  for the OPA725); the desired transimpedance gain ( $R_F$ ); and the GBW for the OPA725 (20MHz). With these three variables set, the feedback capacitor value ( $C_F$ ) can be set to control the frequency response.  $C_F$  includes the stray capacitance of  $R_F$ , which is  $0.2\text{pF}$  for a typical surface-mount resistor.

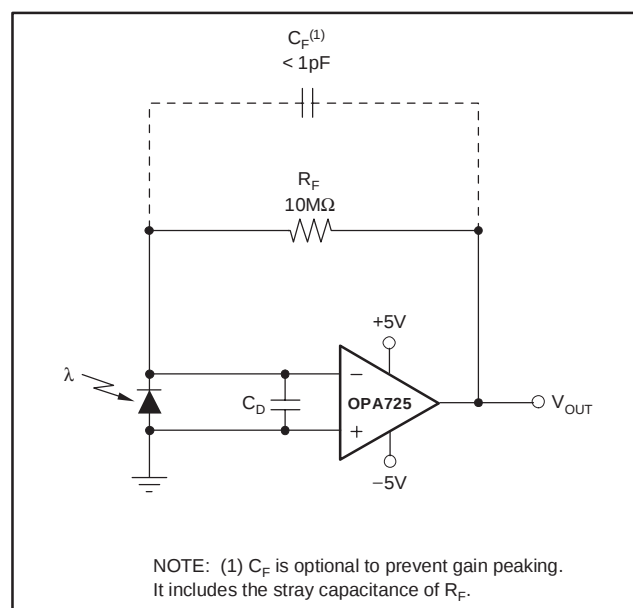


Figure 5. Dual-Supply Transimpedance Amplifier

To achieve a maximally-flat, 2nd-order Butterworth frequency response, the feedback pole should be set to:

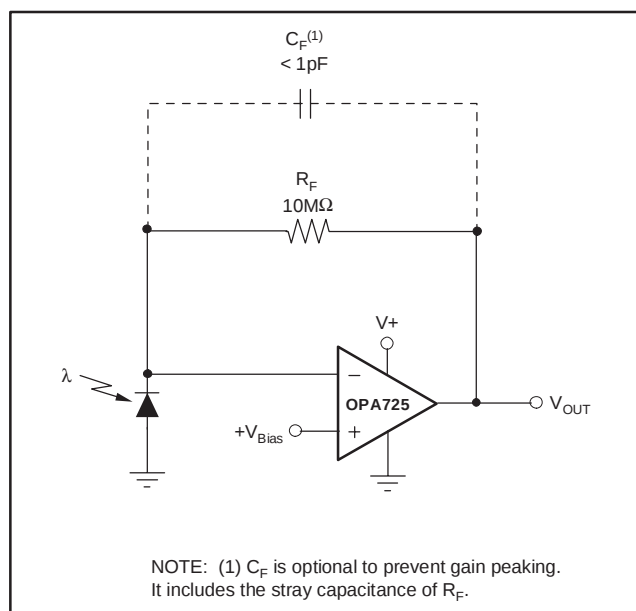
$$\frac{1}{2\pi R_F C_F} = \sqrt{\frac{GBW}{4\pi R_F C_D}} \quad (1)$$

Bandwidth is calculated by:

$$f_{-3dB} = \sqrt{\frac{GBW}{2\pi R_F C_D}} \text{ Hz} \quad (2)$$

For even higher transimpedance bandwidth, the high-speed CMOS OPA354 (100MHz GBW), OPA300 (180 MHz GBW), OPA355 (200MHz GBW), or OPA656, OPA657 (400MHz GBW) may be used.

For single-supply applications, the +IN input can be biased with a positive dc voltage to allow the output to reach true zero when the photodiode is not exposed to any light, and respond without the added delay that results from coming out of the negative rail. (Refer to Figure 6.) This bias voltage also appears across the photodiode, providing a reverse bias for faster operation.



**Figure 6. Single-Supply Transimpedance Amplifier**

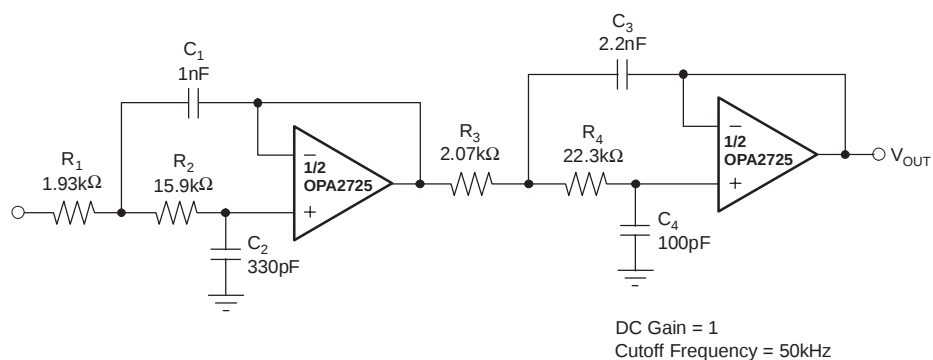
For additional information, refer to Application Bulletin SBOA055, *Compensate Transimpedance Amplifiers Intuitively*, available for download at [www.ti.com](http://www.ti.com).

## OPTIMIZING THE TRANSIMPEDANCE CIRCUIT

To achieve the best performance, components should be selected according to the following guidelines:

1. For lowest noise, select  $R_F$  to create the total required gain. Using a lower value for  $R_F$  and adding gain after the transimpedance amplifier generally produces poorer noise performance. The noise produced by  $R_F$  increases with the square-root of  $R_F$ , whereas the signal increases linearly. Therefore, signal-to-noise ratio is improved when all the required gain is placed in the transimpedance stage.
2. Minimize photodiode capacitance and stray capacitance at the summing junction (inverting input). This capacitance causes the voltage noise of the op amp to be amplified (increasing amplification at high frequency). Using a low-noise voltage source to reverse-bias a photodiode can significantly reduce its capacitance. Smaller photodiodes have lower capacitance. Use optics to concentrate light on a small photodiode.
3. Noise increases with increased bandwidth. Limit the circuit bandwidth to only that required. Use a capacitor across the  $R_F$  to limit bandwidth, even if not required for stability.
4. Circuit board leakage can degrade the performance of an otherwise well-designed amplifier. Clean the circuit board carefully. A circuit board guard trace that encircles the summing junction and is driven at the same voltage can help control leakage.

For additional information, refer to the Application Bulletins *Noise Analysis of FET Transimpedance Amplifiers* (SBOA060), and *Noise Analysis for High-Speed Op Amps* (SBOA066), available for download at the TI web site.



NOTE: FilterPro is a low-pass filter design program available for download at no cost from TI's web site ([www.ti.com](http://www.ti.com)). The program can be used to determine component values for other cutoff frequencies or filter types.

**Figure 7. Four-Pole Butterworth Sallen-Key Low-Pass Filter**

**PACKAGING INFORMATION**

| Orderable part number         | Status<br>(1) | Material type<br>(2) | Package   Pins   | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|-------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">OPA2725AID</a>    | Active        | Production           | SOIC (D)   8     | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>2725A        |
| OPA2725AID.B                  | Active        | Production           | SOIC (D)   8     | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>2725A        |
| OPA2725AIDG4                  | Active        | Production           | SOIC (D)   8     | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>2725A        |
| <a href="#">OPA2725AIDGKR</a> | Active        | Production           | VSSOP (DGK)   8  | 2500   LARGE T&R      | Yes         | Call TI   Nipdauag                   | Level-2-260C-1 YEAR               | -40 to 125   | BGM                 |
| OPA2725AIDGKR.B               | Active        | Production           | VSSOP (DGK)   8  | 2500   LARGE T&R      | Yes         | Call TI                              | Level-2-260C-1 YEAR               | -40 to 125   | BGM                 |
| <a href="#">OPA2725AIDGKT</a> | Active        | Production           | VSSOP (DGK)   8  | 250   SMALL T&R       | Yes         | Call TI   Nipdauag                   | Level-2-260C-1 YEAR               | -40 to 125   | BGM                 |
| OPA2725AIDGKT.B               | Active        | Production           | VSSOP (DGK)   8  | 250   SMALL T&R       | Yes         | Call TI                              | Level-2-260C-1 YEAR               | -40 to 125   | BGM                 |
| <a href="#">OPA2725AIDR</a>   | Active        | Production           | SOIC (D)   8     | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>2725A        |
| OPA2725AIDR.B                 | Active        | Production           | SOIC (D)   8     | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>2725A        |
| <a href="#">OPA2726AIDGST</a> | Active        | Production           | VSSOP (DGS)   10 | 250   SMALL T&R       | Yes         | Call TI   Nipdauag                   | Level-2-260C-1 YEAR               | -40 to 125   | BHB                 |
| OPA2726AIDGST.B               | Active        | Production           | VSSOP (DGS)   10 | 250   SMALL T&R       | Yes         | Call TI                              | Level-2-260C-1 YEAR               | -40 to 125   | BHB                 |
| OPA2726AIDGSTG4               | Active        | Production           | VSSOP (DGS)   10 | 250   SMALL T&R       | Yes         | Call TI                              | Level-2-260C-1 YEAR               | -40 to 125   | BHB                 |
| <a href="#">OPA725AID</a>     | Active        | Production           | SOIC (D)   8     | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>725A         |
| OPA725AID.B                   | Active        | Production           | SOIC (D)   8     | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>725A         |
| <a href="#">OPA725AIDBVR</a>  | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OALI                |
| OPA725AIDBVR.B                | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OALI                |
| OPA725AIDBVRG4                | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OALI                |
| <a href="#">OPA725AIDBVT</a>  | Active        | Production           | SOT-23 (DBV)   5 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OALI                |
| OPA725AIDBVT.B                | Active        | Production           | SOT-23 (DBV)   5 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OALI                |
| <a href="#">OPA725AIDR</a>    | Active        | Production           | SOIC (D)   8     | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>725A         |
| OPA725AIDR.B                  | Active        | Production           | SOIC (D)   8     | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>725A         |
| <a href="#">OPA726AID</a>     | Active        | Production           | SOIC (D)   8     | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>726A         |

| Orderable part number        | Status<br>(1) | Material type<br>(2) | Package   Pins  | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|------------------------------|---------------|----------------------|-----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| OPA726AID.B                  | Active        | Production           | SOIC (D)   8    | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>726A         |
| OPA726AIDG4                  | Active        | Production           | SOIC (D)   8    | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>726A         |
| OPA726AIDG4.B                | Active        | Production           | SOIC (D)   8    | 75   TUBE             | Yes         | NIPDAU                               | Level-2-260C-1 YEAR               | -40 to 125   | OPA<br>726A         |
| <a href="#">OPA726AIDGKT</a> | Active        | Production           | VSSOP (DGK)   8 | 250   SMALL T&R       | Yes         | Call TI   Nipdauag                   | Level-2-260C-1 YEAR               | -40 to 125   | BHC                 |
| OPA726AIDGKT.B               | Active        | Production           | VSSOP (DGK)   8 | 250   SMALL T&R       | Yes         | Call TI                              | Level-2-260C-1 YEAR               | -40 to 125   | BHC                 |
| OPA726AIDGKTG4               | Active        | Production           | VSSOP (DGK)   8 | 250   SMALL T&R       | Yes         | Call TI                              | Level-2-260C-1 YEAR               | -40 to 125   | BHC                 |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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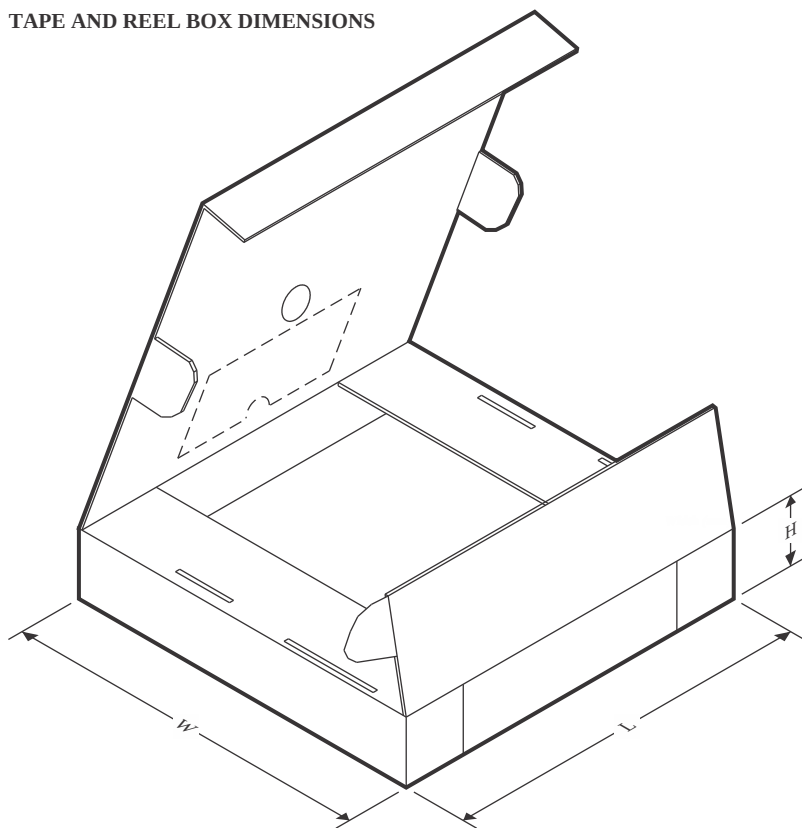
## TAPE AND REEL INFORMATION



\*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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| OPA2725AIDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| OPA725AIDBVR | SOT-23       | DBV             | 5    | 3000 | 178.0              | 9.0                | 3.3     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| OPA725AIDBVT | SOT-23       | DBV             | 5    | 250  | 178.0              | 9.0                | 3.3     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| OPA725AIDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

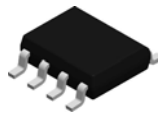
| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| OPA2725AIDR  | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |
| OPA725AIDBVR | SOT-23       | DBV             | 5    | 3000 | 180.0       | 180.0      | 18.0        |
| OPA725AIDBVT | SOT-23       | DBV             | 5    | 250  | 180.0       | 180.0      | 18.0        |
| OPA725AIDR   | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |

## TUBE



\*All dimensions are nominal

| Device        | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|---------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| OPA2725AID    | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA2725AID.B  | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA2725AIDG4  | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA725AID     | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA725AID.B   | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA726AID     | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA726AID.B   | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA726AIDG4   | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |
| OPA726AIDG4.B | D            | SOIC         | 8    | 75  | 506.6  | 8      | 3940   | 4.32   |

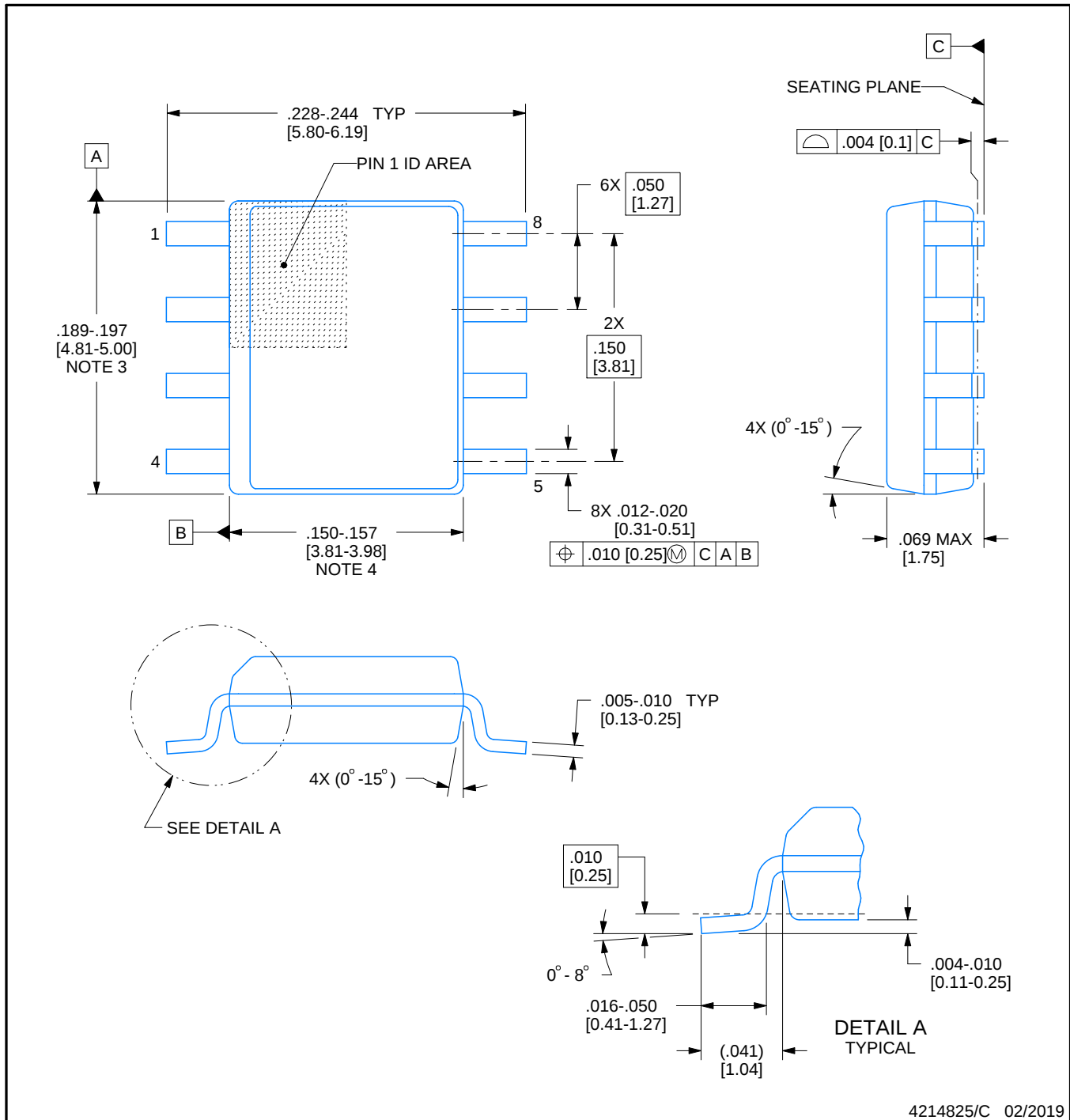


**D0008A**

# PACKAGE OUTLINE

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

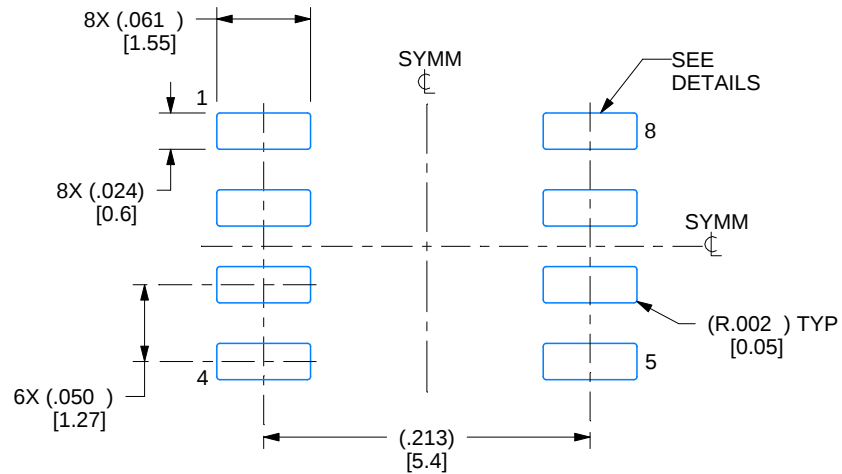
## NOTES:

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.

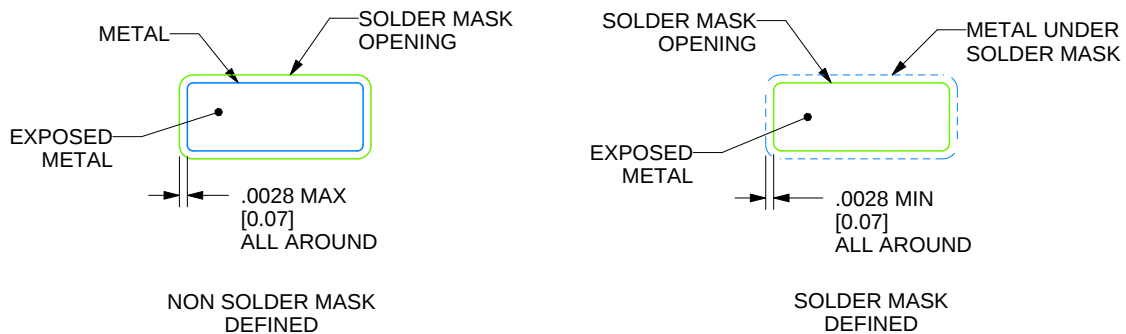
**D0008A**

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



## SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

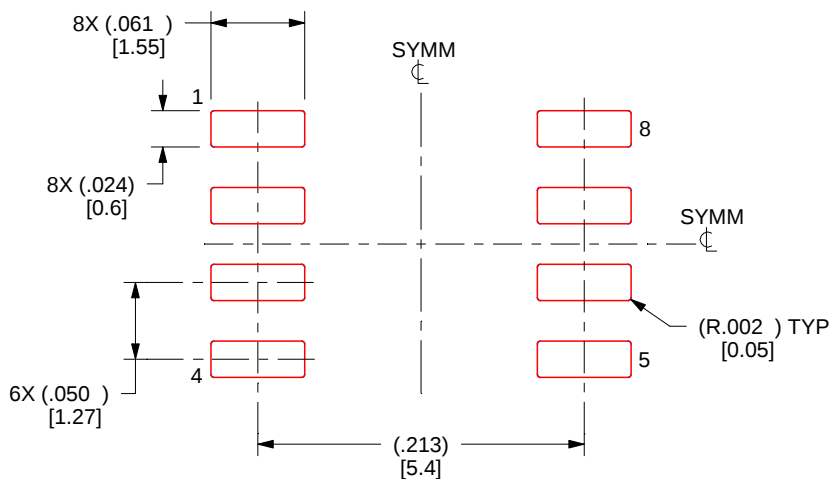
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



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

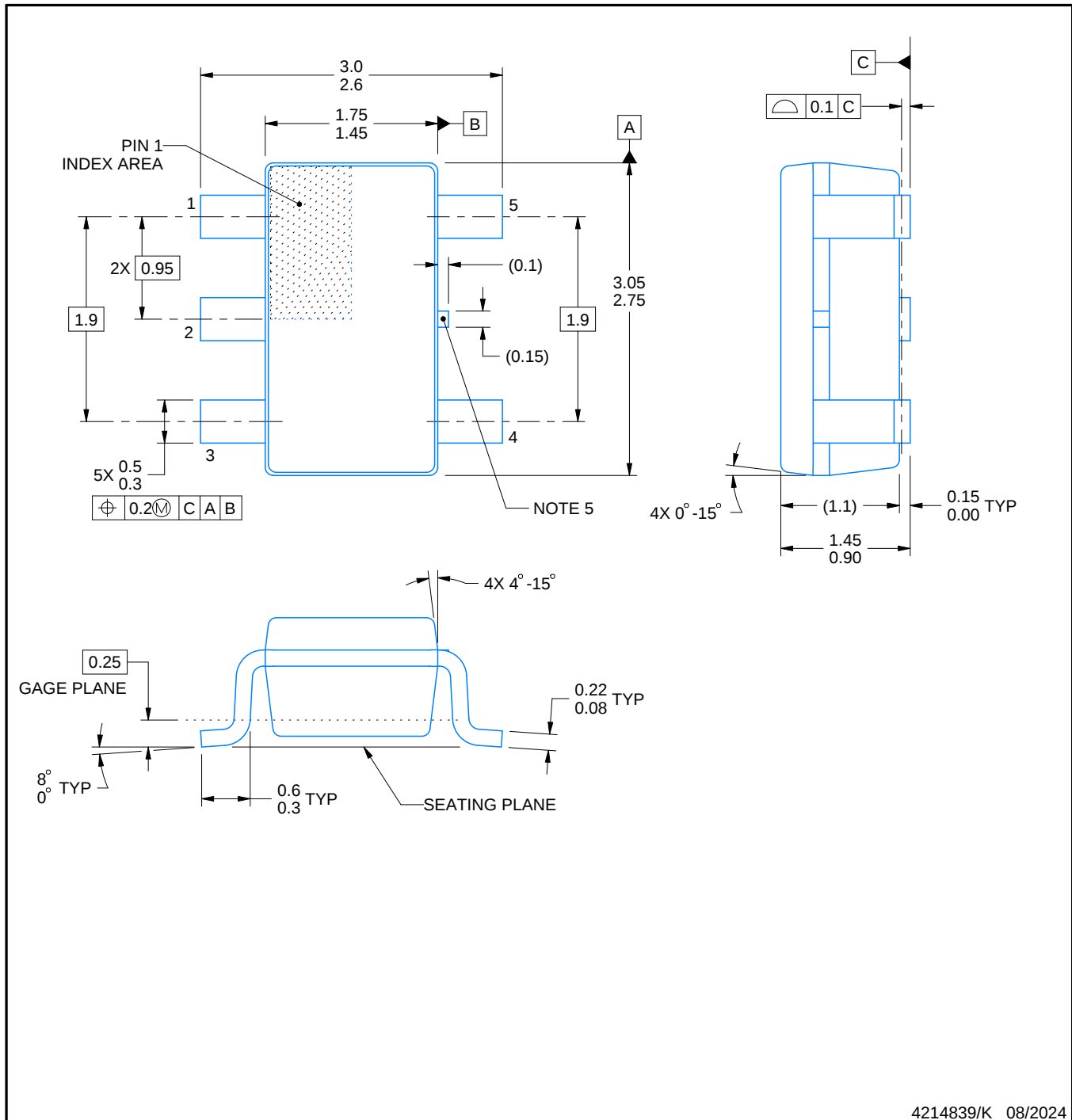
4214825/C 02/2019

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.

**DBV0005A****PACKAGE OUTLINE****SOT-23 - 1.45 mm max height**

SMALL OUTLINE TRANSISTOR



4214839/K 08/2024

**NOTES:**

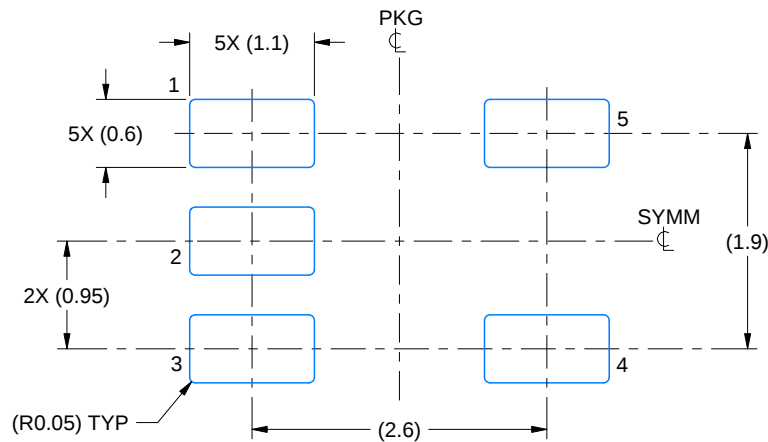
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.

# EXAMPLE BOARD LAYOUT

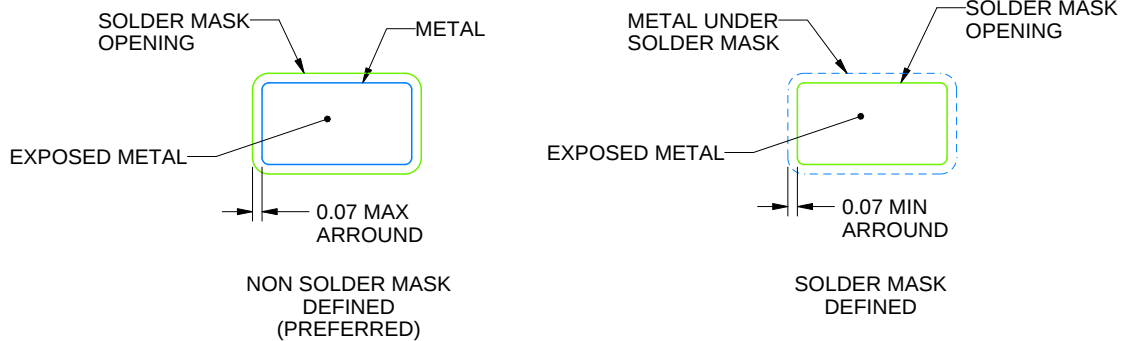
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214839/K 08/2024

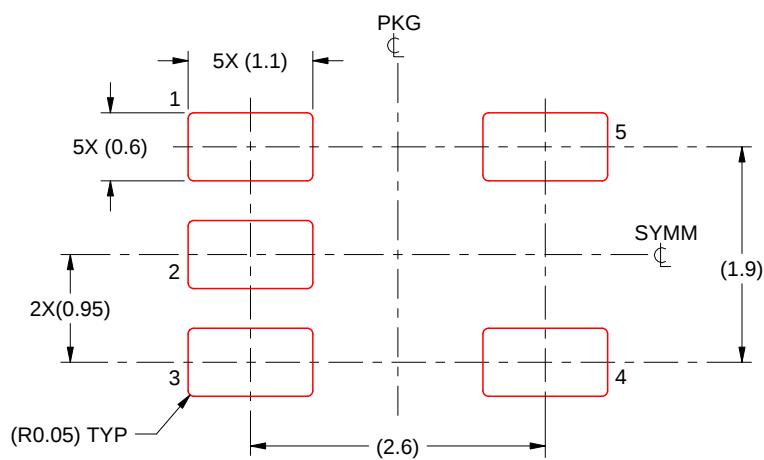
NOTES: (continued)

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

**DBV0005A**

**SOT-23 - 1.45 mm max height**

## SMALL OUTLINE TRANSISTOR



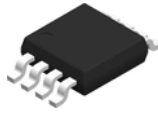
SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4214839/K 08/2024

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.

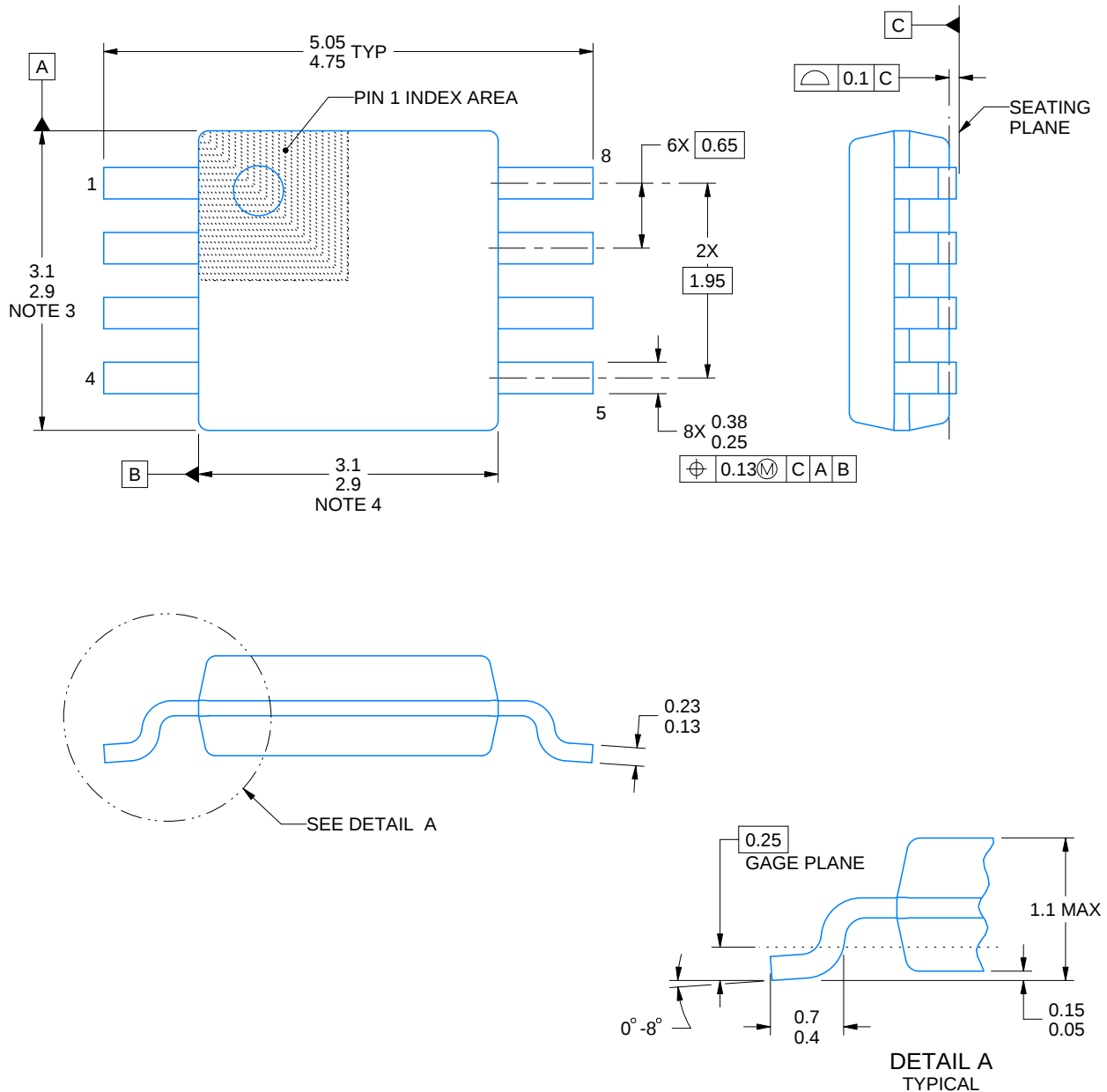
DGK0008A



# PACKAGE OUTLINE

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



4214862/A 04/2023

## NOTES:

PowerPAD is a trademark of Texas Instruments.

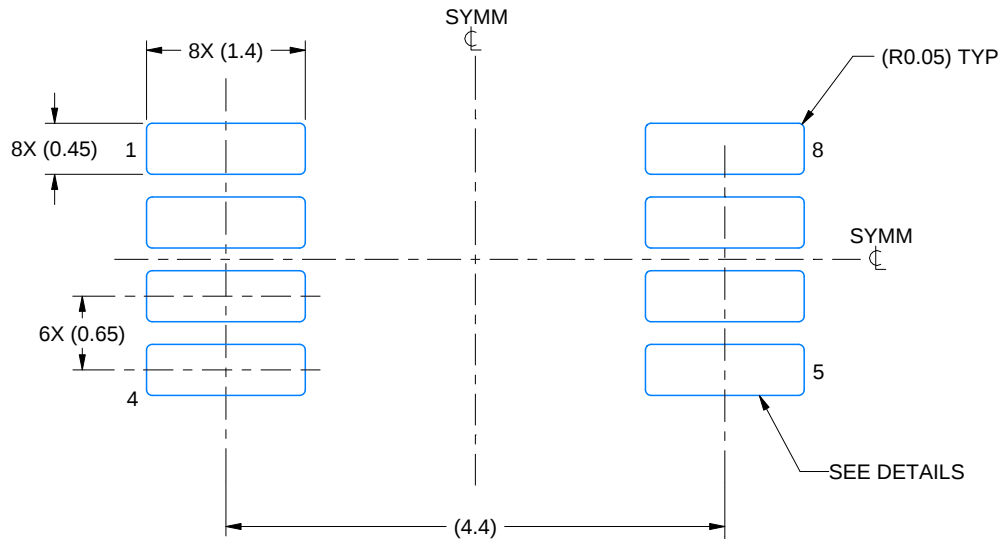
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.

# EXAMPLE BOARD LAYOUT

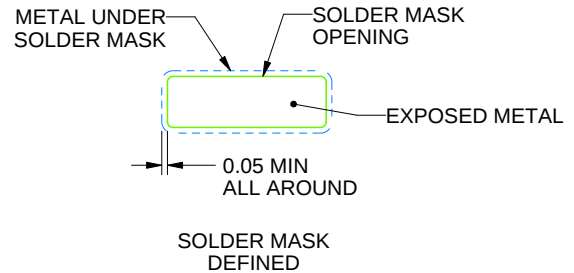
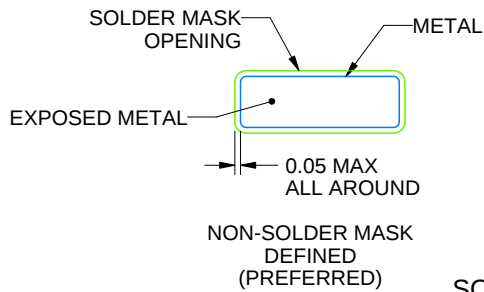
DGK0008A

<sup>TM</sup> VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 15X



SOLDER MASK DETAILS

4214862/A 04/2023

NOTES: (continued)

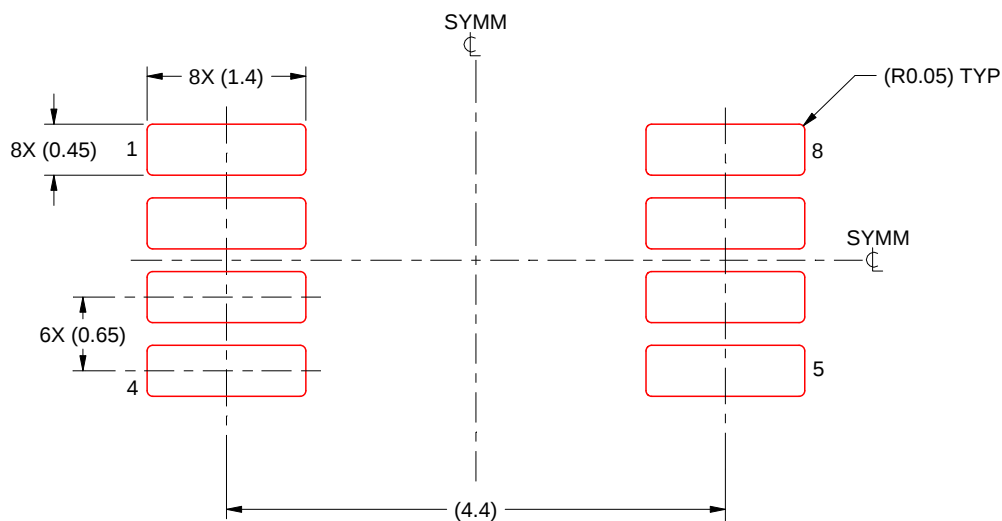
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.

## EXAMPLE STENCIL DESIGN

DGK0008A

<sup>TM</sup> VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE

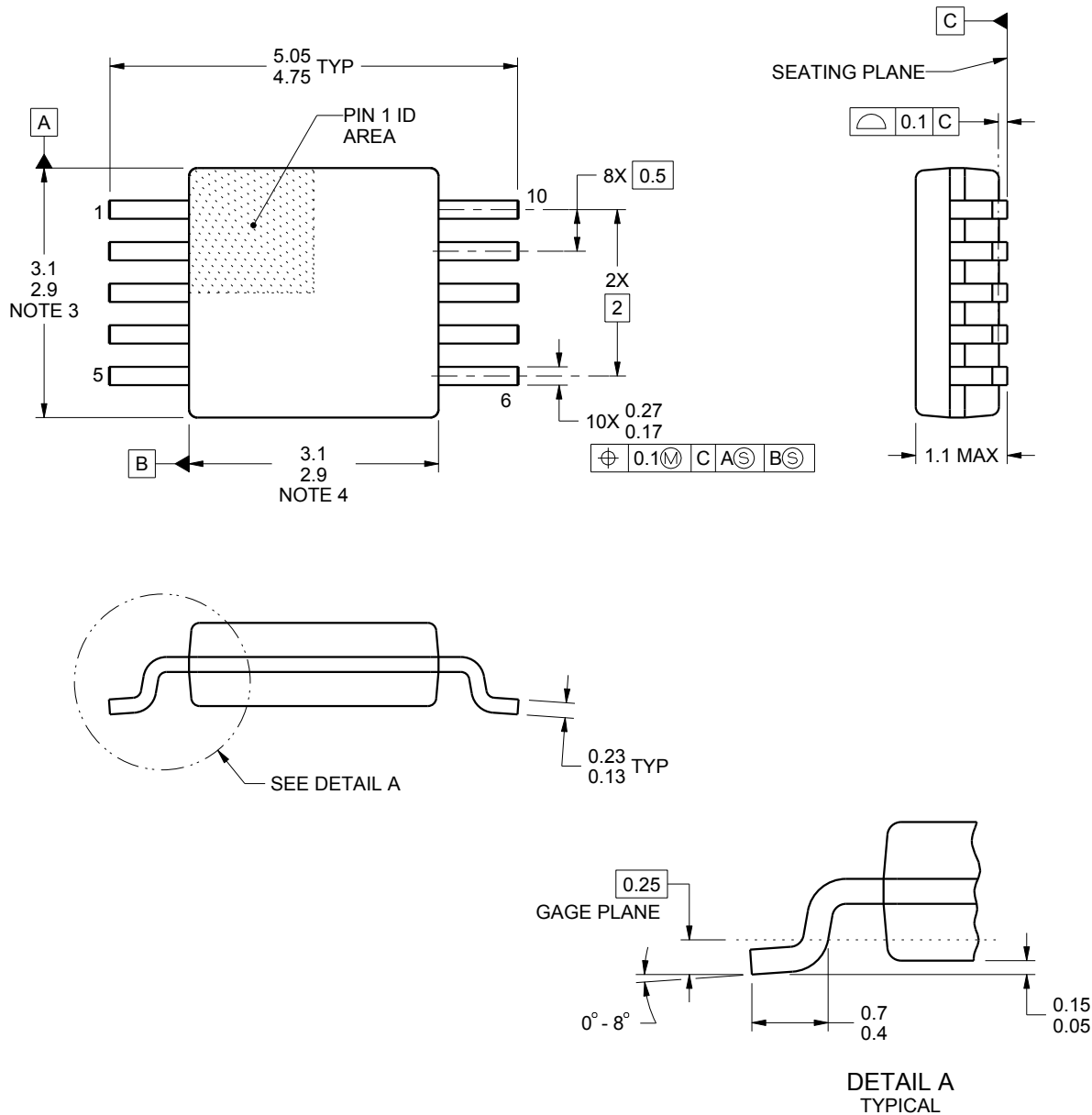


SOLDER PASTE EXAMPLE  
SCALE: 15X

4214862/A 04/2023

NOTES: (continued)

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



4221984/A 05/2015

**NOTES:**

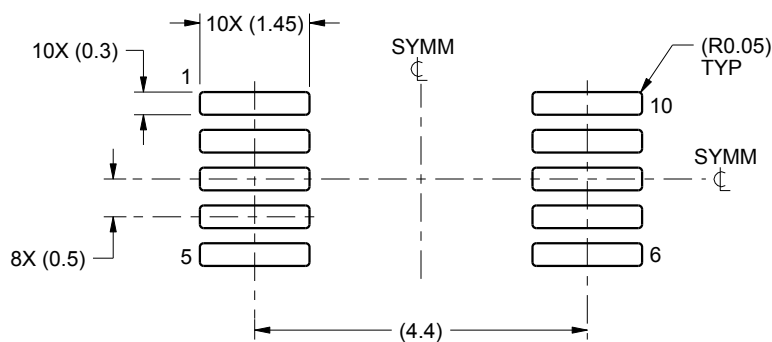
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187, variation BA.

# EXAMPLE BOARD LAYOUT

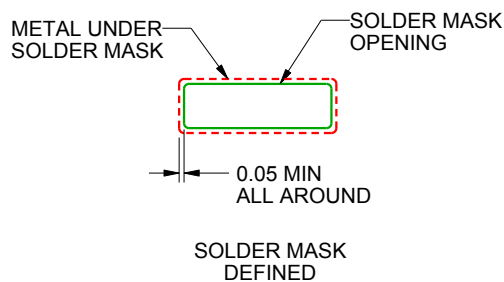
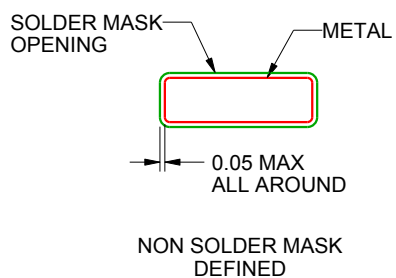
DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221984/A 05/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

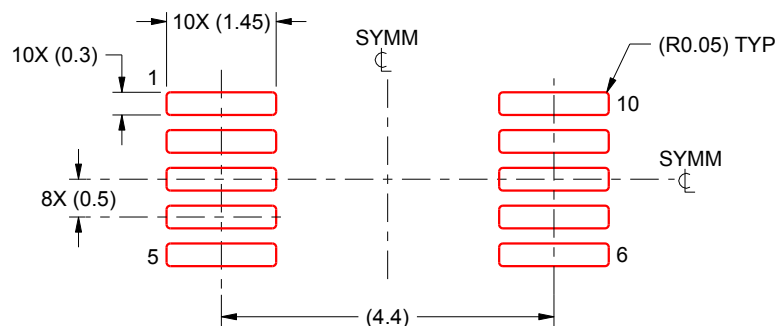
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



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

4221984/A 05/2015

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.

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