

5MHz, Low-Noise, Single, Dual, Quad CMOS Operational Amplifiers

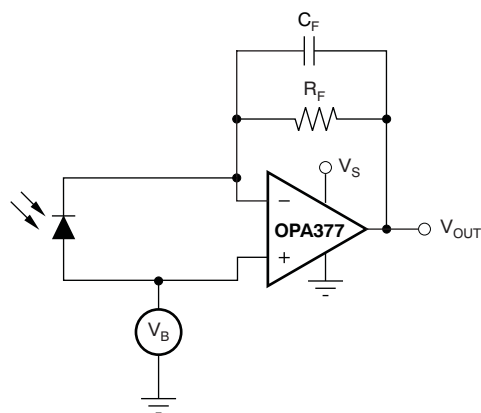
Check for Samples: [OPA377](#), [OPA2377](#), [OPA4377](#)

FEATURES

- **GAIN BANDWIDTH PRODUCT: 5.5MHz**
- **LOW NOISE: 7.5nV/√Hz at 1kHz**
- **OFFSET VOLTAGE: 1mV (max)**
- **INPUT BIAS CURRENT: 0.2pA**
- **RAIL-TO-RAIL OUTPUT**
- **UNITY-GAIN STABLE**
- **EMI INPUT FILTERING**
- **QUIESCENT CURRENT: 0.76mA/ch**
- **SUPPLY VOLTAGE: 2.2V to 5.5V**
- **SMALL PACKAGES:
SC70, SOT23, and MSOP**

APPLICATIONS

- **PHOTODIODE PREAMP**
- **PIEZOELECTRIC SENSOR PREAMP**
- **SENSOR SIGNAL CONDITIONING**
- **AUDIO EQUIPMENT**
- **ACTIVE FILTERS**



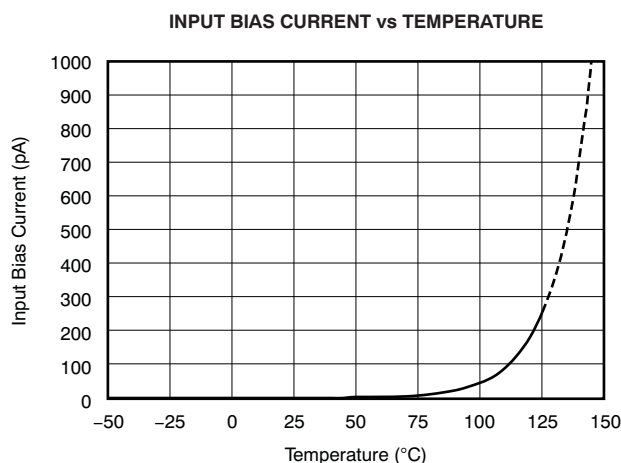
Photodiode Preamplifier

DESCRIPTION

The OPA377 family of operational amplifiers are wide-bandwidth CMOS amplifiers that provide very low noise, low input bias current, and low offset voltage while operating on a low quiescent current of 0.76mA (typ).

The OPA377 op amps are optimized for low-voltage, single-supply applications. The exceptional combination of ac and dc performance make them ideal for a wide range of applications, including small signal conditioning, audio, and active filters. In addition, these parts have a wide supply range with excellent PSRR, making them attractive for applications that run directly from batteries without regulation.

The OPA377 is available in the SC70-5, SOT23-5, and SO-8 packages. The dual OPA2377 is offered in the SO-8 and MSOP-8, and the quad OPA4377 in the TSSOP-14 packages. All versions are specified for operation from -40°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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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 RATING⁽¹⁾

Over operating free-air temperature range, unless otherwise noted.

| | | OPA377, OPA2377, OPA4377 | UNIT |
|-------------------------------------|------------------------|------------------------------|------|
| Supply Voltage | $V_S = (V+) - (V-)$ | +7 | V |
| Signal Input Terminals | Voltage ⁽²⁾ | $(V-) - 0.5$ to $(V+) + 0.5$ | V |
| | Current ⁽²⁾ | ±10 | mA |
| Output Short-Circuit ⁽³⁾ | | Continuous | |
| Operating Temperature | T_A | –40 to +150 | °C |
| Storage Temperature | T_A | –65 to +150 | °C |
| Junction Temperature | T_J | +150 | °C |
| ESD Rating | Human Body Model | 4000 | V |
| | Charged Device Model | 1000 | V |
| | Machine Model | 200 | 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.

PACKAGE INFORMATION⁽¹⁾

| PRODUCT | PACKAGE-LEAD | PACKAGE DESIGNATOR | PACKAGE MARKING |
|---------|--------------|--------------------|-----------------|
| OPA377 | SC70-5 | DCK | OP377A |
| | SOT23-5 | DBV | OP377A |
| | SO-8 | D | OP377A |
| OPA2377 | SO-8 | D | O2377A |
| | MSOP-8 | DGK | OTAQ |
| OPA4377 | TSSOP-14 | PW | O4377A |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or visit the device product folder at www.ti.com.

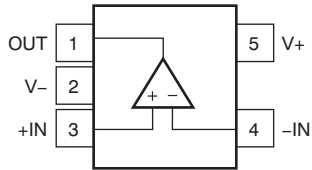
ELECTRICAL CHARACTERISTICS: $V_S = +2.2V$ to $+5.5V$
Boldface limits apply over the specified temperature range: $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$.

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

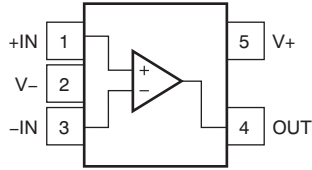
| PARAMETERS | | CONDITIONS | OPA377, OPA2377, OPA4377 | | | UNIT |
|-------------------------------------|---------------|---|---|-------------|--------------|------------------------------|
| | | | MIN | TYP | MAX | |
| OFFSET VOLTAGE | | | | | | |
| Input Offset Voltage | V_{OS} | $V_S = +5V$ | | 0.25 | 1 | mV |
| vs Temperature | dV_{OS}/dT | -40°C to $+125^\circ\text{C}$ | | 0.32 | 2 | $\mu\text{V}/^\circ\text{C}$ |
| vs Power Supply | PSRR | $V_S = +2.2V$ to $+5.5V$, $V_{CM} < (V+) - 1.3V$ | | 5 | 28 | $\mu\text{V}/V$ |
| Over Temperature | | $V_S = +2.2V$ to $+5.5V$, $V_{CM} < (V+) - 1.3V$ | | 5 | | $\mu\text{V}/V$ |
| Channel Separation, dc (dual, quad) | | | | 0.5 | | $\mu\text{V}/V$ |
| INPUT BIAS CURRENT | | | | | | |
| Input Bias Current | I_B | | | ± 0.2 | ± 10 | pA |
| Over Temperature | | | See Typical Characteristics | | | pA |
| Input Offset Current | I_{OS} | | | ± 0.2 | ± 10 | pA |
| NOISE | | | | | | |
| Input Voltage Noise, | e_n | $f = 0.1\text{Hz}$ to 10Hz | | 0.8 | | μV_{PP} |
| Input Voltage Noise Density | e_n | $f = 1\text{kHz}$ | | 7.5 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| Input Current Noise | i_n | $f = 1\text{kHz}$ | | 2 | | $\text{fA}/\sqrt{\text{Hz}}$ |
| INPUT VOLTAGE RANGE | | | | | | |
| Common-Mode Voltage Range | V_{CM} | | $(V-) - 0.1$ | | $(V+) + 0.1$ | V |
| Common-Mode Rejection Ratio | CMRR | $(V-) < V_{CM} < (V+) - 1.3V$ | 70 | 90 | | dB |
| INPUT CAPACITANCE | | | | | | |
| Differential | | | | 6.5 | | pF |
| Common-Mode | | | | 13 | | pF |
| OPEN-LOOP GAIN | | | | | | |
| Open-Loop Voltage Gain | A_{OL} | $50\text{mV} < V_O < (V+) - 50\text{mV}$, $R_L = 10\text{k}\Omega$ | 112 | 134 | | dB |
| | | $100\text{mV} < V_O < (V+) - 100\text{mV}$, $R_L = 2\text{k}\Omega$ | | 126 | | dB |
| FREQUENCY RESPONSE | | | | | | |
| | | $V_S = 5.5V$ | | | | |
| Gain-Bandwidth Product | GBW | | | 5.5 | | MHz |
| Slew Rate | SR | $G = +1$ | | 2 | | $V/\mu\text{s}$ |
| Settling Time 0.1% | t_s | 2V Step, $G = +1$ | | 1.6 | | μs |
| Settling Time 0.01% | t_s | 2V Step, $G = +1$ | | 2 | | μs |
| Overload Recovery Time | | $V_{IN} \times \text{Gain} > V_S$ | | 0.33 | | μs |
| THD + Noise | THD+N | $V_O = 1V_{RMS}$, $G = +1$, $f = 1\text{kHz}$, $R_L = 10\text{k}\Omega$ | | 0.00027 | | % |
| OUTPUT | | | | | | |
| Voltage Output Swing from Rail | | $R_L = 10\text{k}\Omega$ | | 10 | 20 | mV |
| Over Temperature | | $R_L = 10\text{k}\Omega$ | | | 40 | mV |
| Short-Circuit Current | I_{SC} | | | +30/-50 | | mA |
| Capacitive Load Drive | C_{LOAD} | | See Typical Characteristics | | | |
| Open-Loop Output Impedance | R_O | | | 150 | | Ω |
| POWER SUPPLY | | | | | | |
| Specified Voltage Range | V_S | | 2.2 | | 5.5 | V |
| Quiescent Current per amplifier | I_Q | $I_O = 0$, $V_S = +5.5V$ | | 0.76 | 1.05 | mA |
| Over Temperature | | | | | 1.2 | mA |
| TEMPERATURE RANGE | | | | | | |
| Specified Range | | | -40 | | +125 | $^\circ\text{C}$ |
| Thermal Resistance | θ_{JA} | | | | | $^\circ\text{C}/W$ |
| SC70-5 | | | | 250 | | $^\circ\text{C}/W$ |
| SOT23-5 | | | | 200 | | $^\circ\text{C}/W$ |
| MSOP-8, SO-8, TSSOP-14 | | | | 150 | | $^\circ\text{C}/W$ |

PIN CONFIGURATIONS

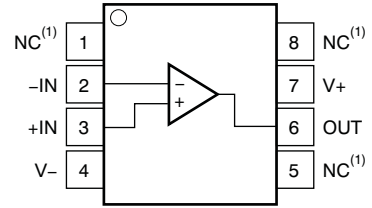
**OPA377
 SOT23-5
 (TOP VIEW)**



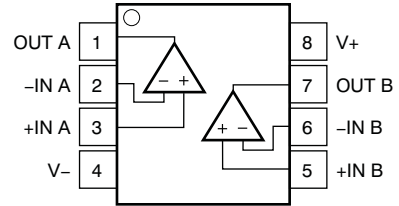
**OPA377
 SC70-5
 (TOP VIEW)**



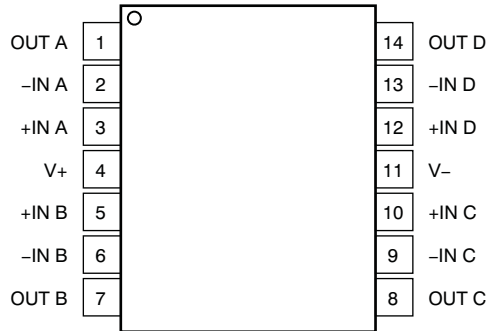
**OPA377
 SO-8
 (TOP VIEW)**



**OPA2377
 SO-8, MSOP-8
 (TOP VIEW)**



**OPA4377
 TSSOP-14
 (TOP VIEW)**



(1) NC denotes no internal connection.

(2) Connect thermal die to V-.

TYPICAL CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{CM} = V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.

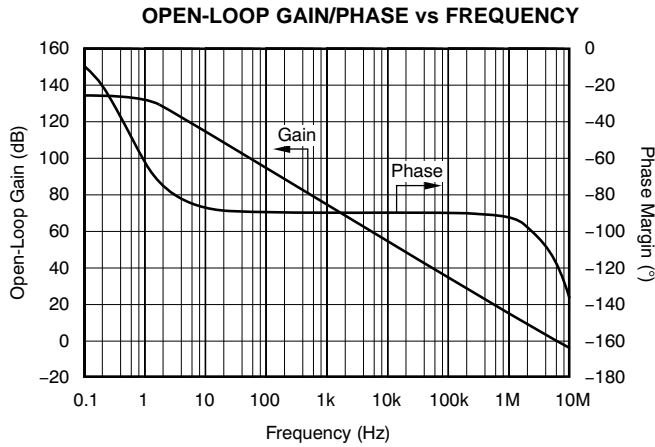


Figure 1.

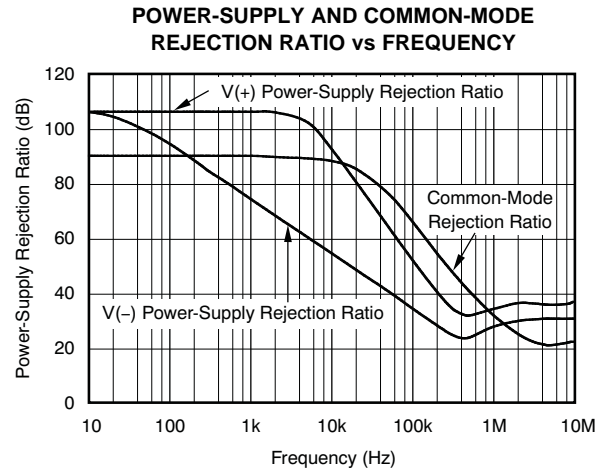


Figure 2.

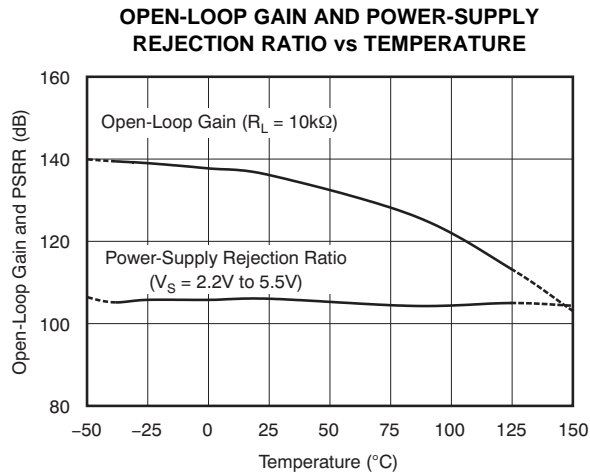


Figure 3.

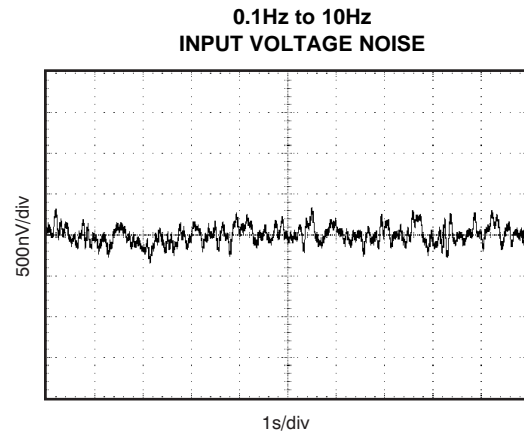


Figure 4.

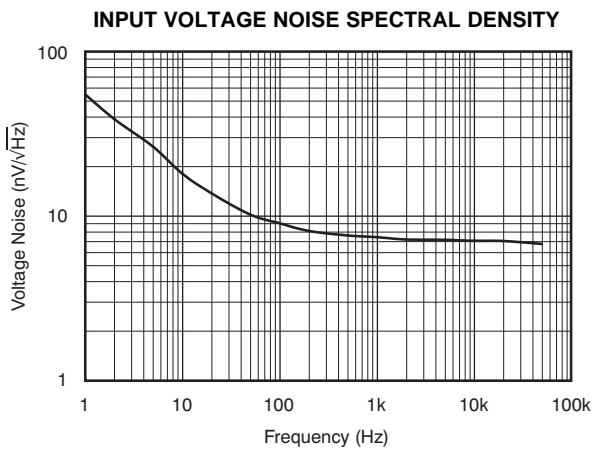


Figure 5.

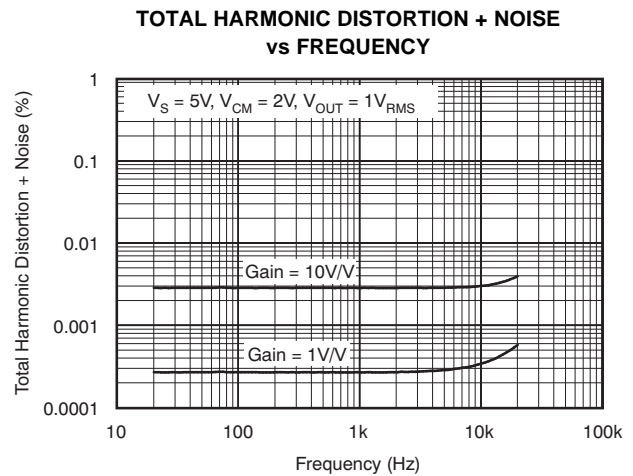


Figure 6.

TYPICAL CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{CM} = V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.

COMMON-MODE REJECTION RATIO vs TEMPERATURE

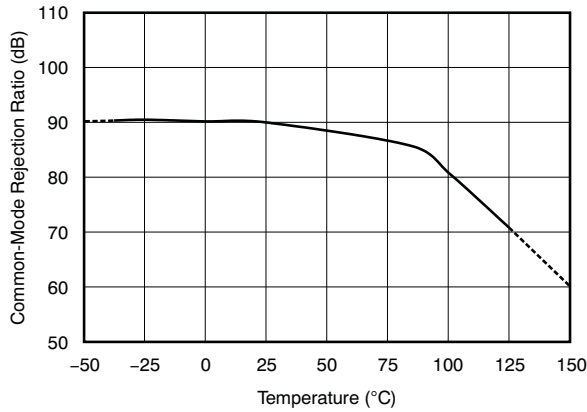


Figure 7.

QUIESCENT CURRENT vs TEMPERATURE

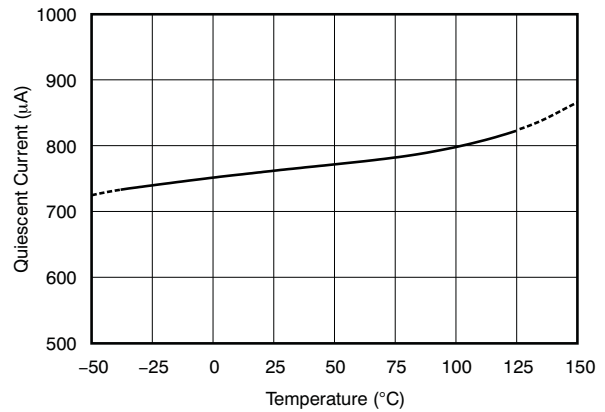


Figure 8.

QUIESCENT AND SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE

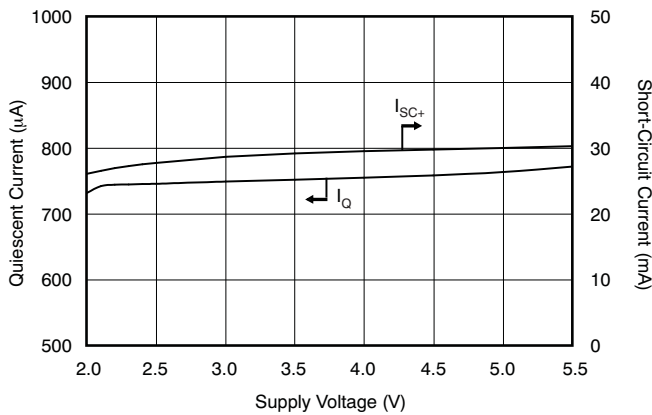


Figure 9.

SHORT-CIRCUIT CURRENT vs TEMPERATURE

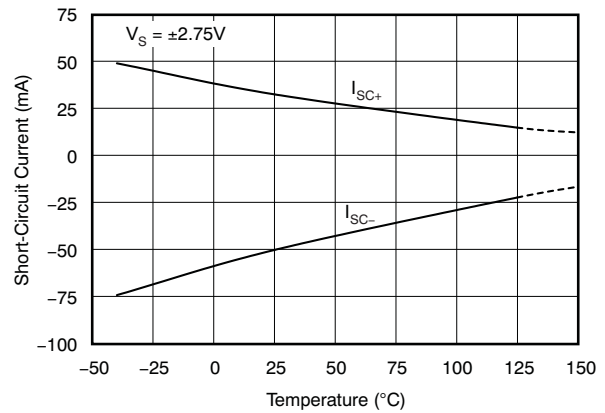


Figure 10.

INPUT BIAS CURRENT vs TEMPERATURE

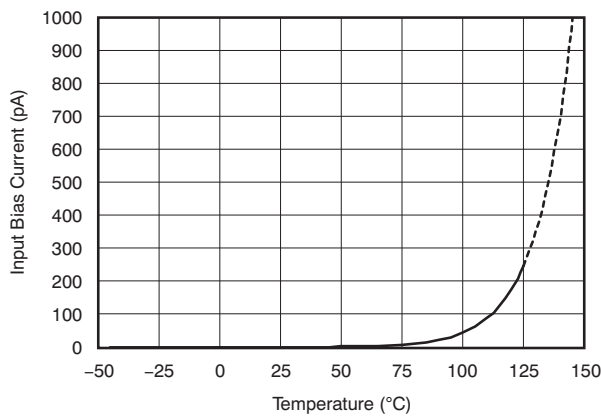


Figure 11.

OUTPUT VOLTAGE vs OUTPUT CURRENT

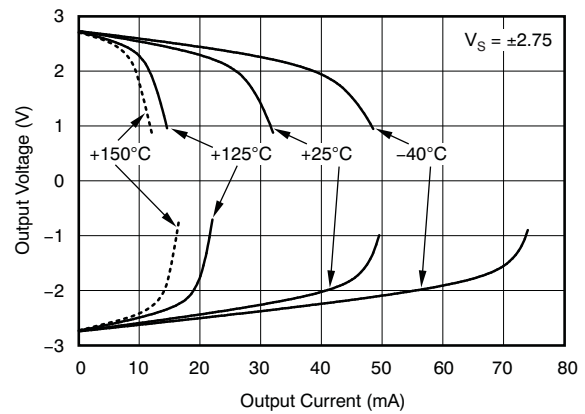


Figure 12.

TYPICAL CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{CM} = V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.

OFFSET VOLTAGE PRODUCTION DISTRIBUTION

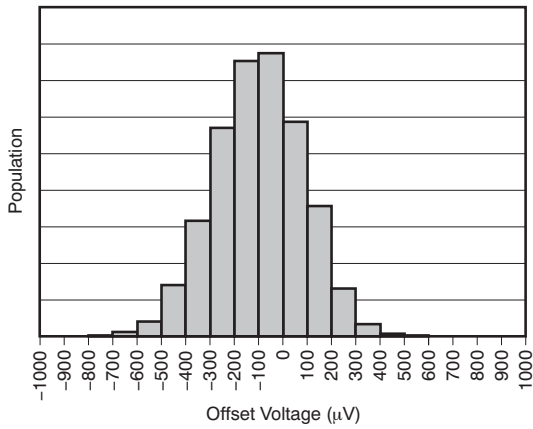


Figure 13.

MAXIMUM OUTPUT VOLTAGE vs FREQUENCY

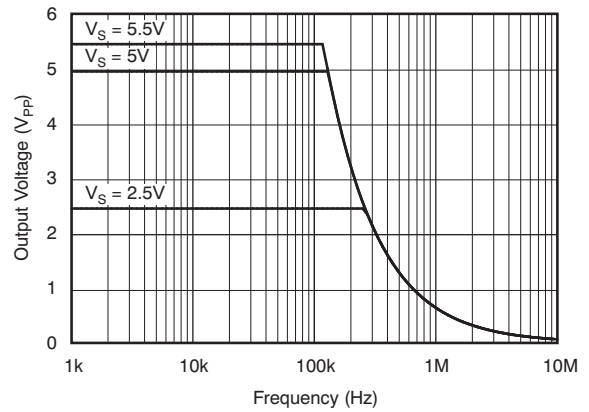


Figure 14.

SMALL-SIGNAL OVERSHOOT vs LOAD CAPACITANCE

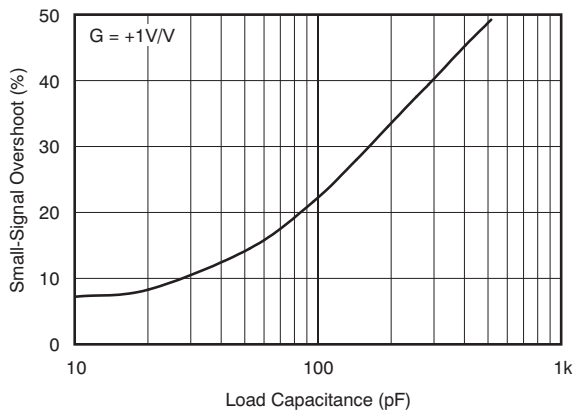


Figure 15.

SMALL-SIGNAL PULSE RESPONSE

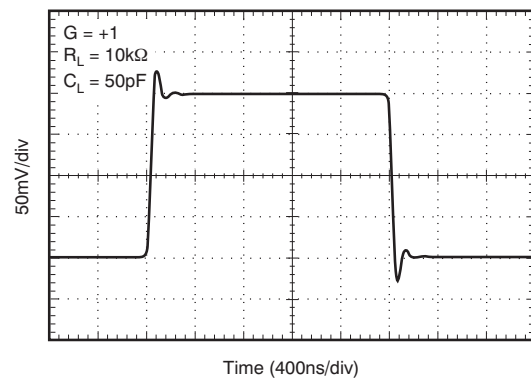


Figure 16.

LARGE-SIGNAL PULSE RESPONSE

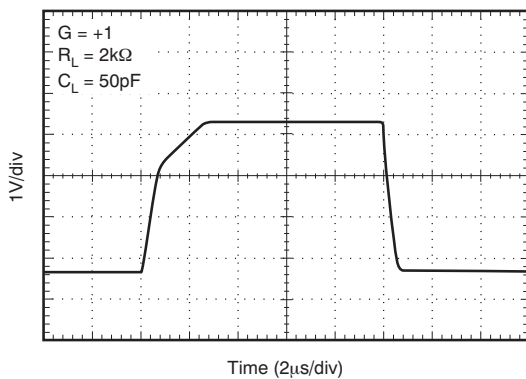


Figure 17.

SETTLING TIME vs CLOSED-LOOP GAIN

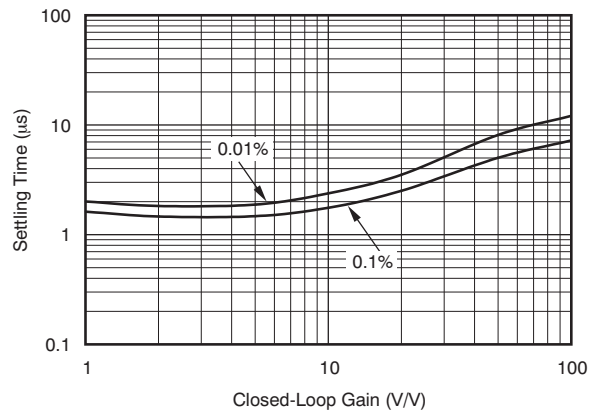


Figure 18.

TYPICAL CHARACTERISTICS (continued)

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $R_L = 10\text{k}\Omega$ connected to $V_S/2$, $V_{CM} = V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.

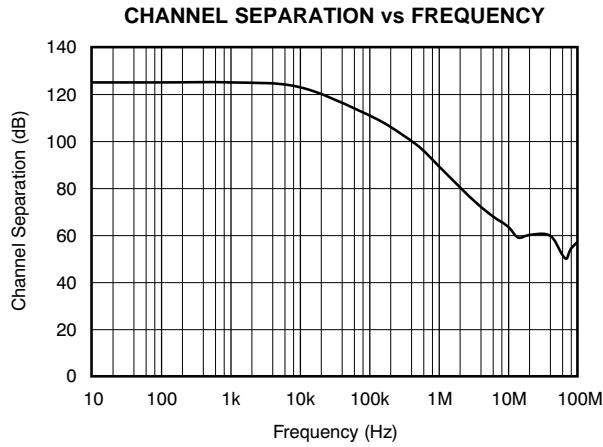


Figure 19.

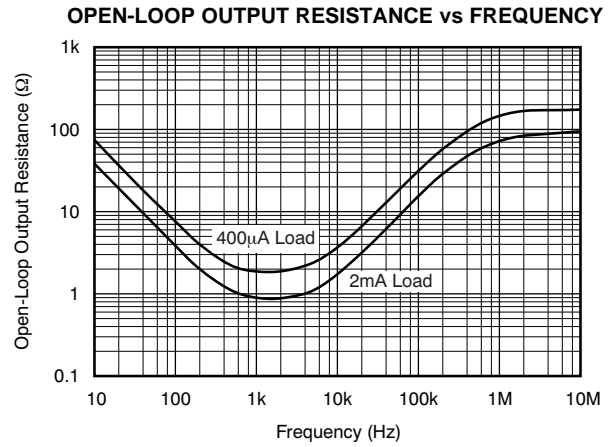


Figure 20.

APPLICATION INFORMATION

OPERATING CHARACTERISTICS

The OPA377 family of amplifiers has parameters that are fully specified from 2.2V to 5.5V ($\pm 1.1V$ to $\pm 2.75V$). Many of the specifications apply from -40°C to $+125^{\circ}\text{C}$. Parameters that can exhibit significant variance with regard to operating voltage or temperature are presented in the [Typical Characteristics](#).

GENERAL LAYOUT GUIDELINES

For best operational performance of the device, good printed circuit board (PCB) layout practices are required. Low-loss, $0.1\mu\text{F}$ bypass capacitors must be connected between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from $V+$ to ground is applicable to single-supply applications.

BASIC AMPLIFIER CONFIGURATIONS

The OPA377 family is unity-gain stable. It does not exhibit output phase inversion when the input is overdriven. A typical single-supply connection is shown in [Figure 21](#). The OPA377 is configured as a basic inverting amplifier with a gain of $-10V/V$. This single-supply connection has an output centered on the common-mode voltage, V_{CM} . For the circuit shown, this voltage is 2.5V, but may be any value within the common-mode input voltage range.

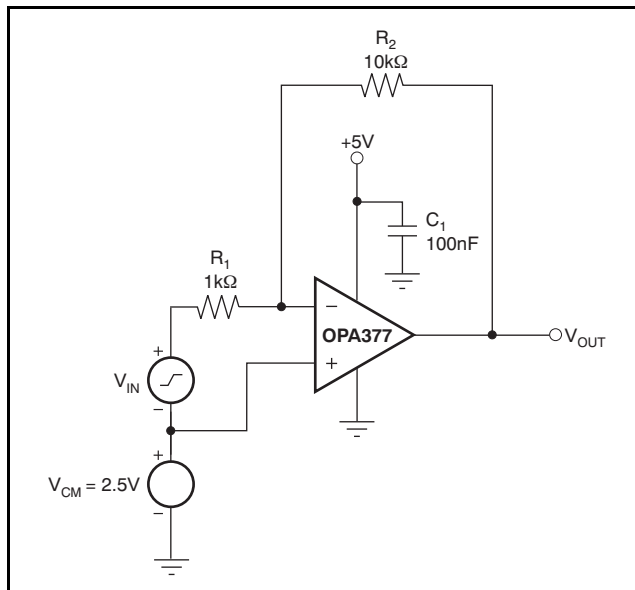


Figure 21. Basic Single-Supply Connection

COMMON-MODE VOLTAGE RANGE

The input common-mode voltage range of the OPA377 series extends 100mV beyond the supply rails. The offset voltage of the amplifier is low, from approximately $(V-)$ to $(V+) - 1V$, as shown in [Figure 22](#). The offset voltage increases as common-mode voltage exceeds $(V+) - 1V$. Common-mode rejection is specified from $(V-)$ to $(V+) - 1.3V$.

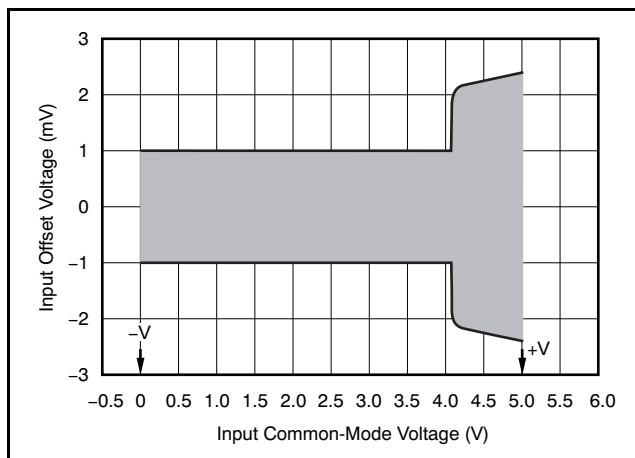


Figure 22. Offset and Common-Mode Voltage

INPUT AND ESD PROTECTION

The OPA377 family incorporates internal electrostatic discharge (ESD) protection circuits on all pins. In the case of input and output pins, this protection primarily consists of current steering diodes connected between the input and power-supply pins. These ESD protection diodes also provide in-circuit, input overdrive protection, as long as the current is limited to 10mA as stated in the [Absolute Maximum Ratings](#). [Figure 23](#) shows how a series input resistor may be added to the driven input to limit the input current. The added resistor contributes thermal noise at the amplifier input and its value should be kept to a minimum in noise-sensitive applications.

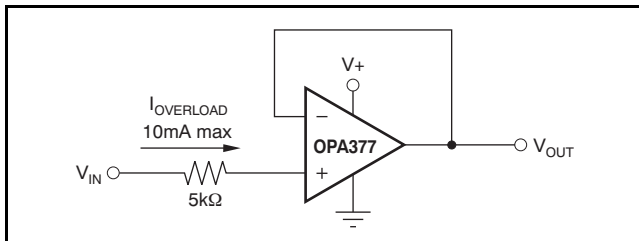


Figure 23. Input Current Protection

EMI SUSCEPTIBILITY AND INPUT FILTERING

Operational amplifiers vary in susceptibility to electromagnetic interference (EMI). If conducted EMI enters the operational amplifier, the dc offset observed at the amplifier output may shift from the nominal value while the EMI is present. This shift is a result of signal rectification associated with the internal semiconductor junctions. While all amplifier pin functions can be affected by EMI, the input pins are likely to be the most susceptible. The OPA377 operational amplifier family incorporates an internal input low-pass filter that reduces the amplifier response to EMI. Both common-mode and differential mode filtering are provided by the input filter. The filter is designed for a cutoff frequency of approximately 75MHz (–3dB), with a roll-off of 20dB per decade.

CAPACITIVE LOAD AND STABILITY

The OPA377 series of amplifiers may be used in applications where driving a capacitive load is required. As with all op amps, there may be specific instances where the OPAx377 can become unstable, leading to oscillation. The particular op amp circuit configuration, layout, gain, and output loading are some of the factors to consider when establishing whether an amplifier will be stable in operation. An op amp in the unity-gain (+1V/V) buffer configuration and driving a capacitive load exhibits a greater tendency to be unstable than an amplifier operated at a higher noise gain. The capacitive load, in conjunction with the op amp output resistance, creates a pole within the feedback loop that degrades the phase margin. The degradation of the phase margin increases as the capacitive loading increases.

The OPAx377 in a unity-gain configuration can directly drive up to 250pF pure capacitive load. Increasing the gain enhances the ability of the amplifier to drive greater capacitive loads; see the typical characteristic plot, [Small-Signal Overshoot vs Capacitive Load](#). In unity-gain configurations, capacitive load drive can be improved by inserting a small (10Ω to 20Ω) resistor, R_S , in series with the output, as shown in [Figure 24](#). This resistor significantly reduces ringing while maintaining dc performance for purely capacitive loads. However, if there is a resistive load in parallel with the capacitive load, a voltage divider is created, introducing a gain error at the output and slightly reducing the output swing. The error introduced is proportional to the ratio R_S/R_L , and is generally negligible at low output current levels.

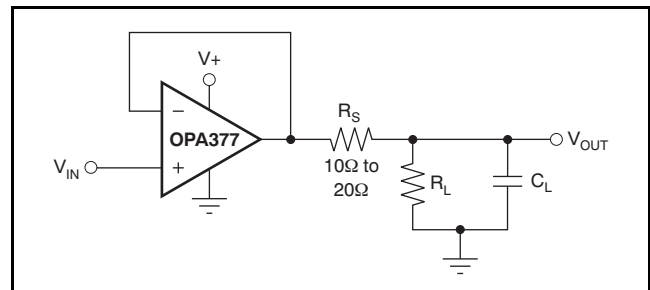


Figure 24. Improving Capacitive Load Drive

ACTIVE FILTERING

The OPA377 series is well-suited for filter applications requiring a wide bandwidth, fast slew rate, low-noise, single-supply operational amplifier. Figure 25 shows a 50kHz, 2nd-order, low-pass filter. The components have been selected to provide a maximally-flat Butterworth response. Beyond the cutoff frequency, roll-off is -40dB/dec . The Butterworth response is ideal for applications requiring predictable gain characteristics such as the anti-aliasing filter used ahead of an analog-to-digital converter (ADC).

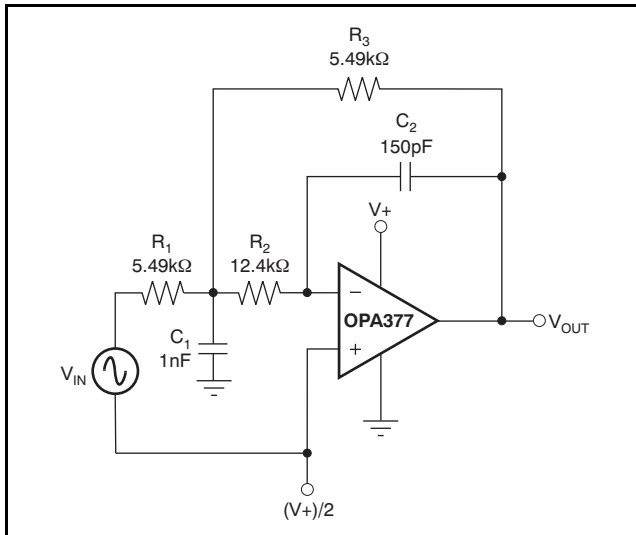
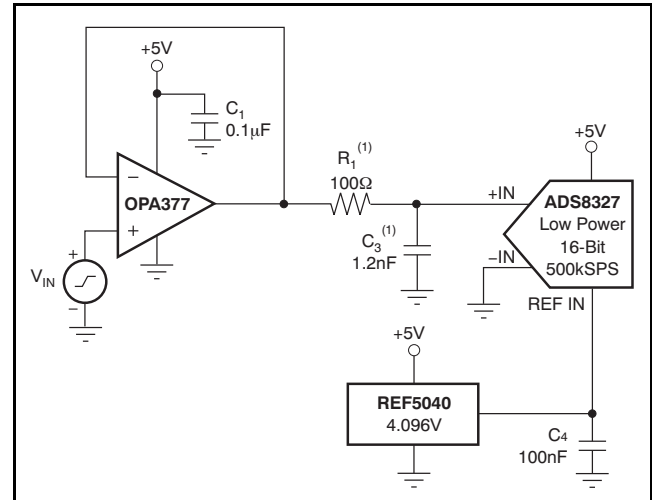


Figure 25. Second-Order Butterworth 50kHz Low-Pass Filter

DRIVING AN ANALOG-TO-DIGITAL CONVERTER

The low noise and wide gain bandwidth of the OPA377 family make it an ideal driver for ADCs. Figure 26 illustrates the OPA377 driving an ADS8327, 16-bit, 250kSPS converter. The amplifier is connected as a unity-gain, noninverting buffer.



(1) Suggested value; may require adjustment based on specific application.

(2) Initial calibration recommended.

Figure 26. Driving an ADS8327⁽²⁾

REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision A (October 2010) to Revision B | Page |
|---|------|
| • Changed document status to production data | 1 |
| • Deleted cross-reference to note 2 and shading from DCK package in Package Information table | 2 |
| • Updated Figure 22 | 9 |

| Changes from Original (February 2010) to Revision A | Page |
|--|------|
| • Deleted DFN from list of packages in final <i>Features</i> bullet | 1 |
| • Deleted DFN package from <i>Description</i> section | 1 |
| • Updated <i>Input Bias Current vs Temperature</i> plot | 1 |
| • Deleted cross-reference to note 2 and shading from all packages except SC70-5 in Package Information table | 2 |
| • Deleted DFN-8 package from Package Information table | 2 |
| • Deleted Temperature Range, <i>DFN-8</i> parameter from Electrical Characteristics table | 3 |
| • Deleted DFN-8 pin configuration | 4 |
| • Updated Figure 11 | 6 |

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 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|----------------------------|----------------------|--------------|-------------------------|-------------------------|
| OPA2377AID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | O2377A | Samples |
| OPA2377AIDGKR | ACTIVE | VSSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU CU NIPDAUAG | Level-2-260C-1 YEAR | -40 to 125 | OTAQ | Samples |
| OPA2377AIDGKT | ACTIVE | VSSOP | DGK | 8 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU CU NIPDAUAG | Level-2-260C-1 YEAR | -40 to 125 | OTAQ | Samples |
| OPA2377AIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | O2377A | Samples |
| OPA377AID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OP377A | Samples |
| OPA377AIDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PAG | Samples |
| OPA377AIDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PAG | Samples |
| OPA377AIDCKR | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PAF | Samples |
| OPA377AIDCKT | ACTIVE | SC70 | DCK | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PAF | Samples |
| OPA377AIDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OP377A | Samples |
| OPA4377AIPW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OP4377A | Samples |
| OPA4377AIPWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | OP4377A | 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.

OBSELETE: TI has discontinued the production of the device.

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

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

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

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

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

⁽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.

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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| OPA2377AIDGKR | VSSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| OPA2377AIDGKT | VSSOP | DGK | 8 | 250 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| OPA2377AIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| OPA377AIDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| OPA377AIDBVT | SOT-23 | DBV | 5 | 250 | 179.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| OPA377AIDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| OPA377AIDCKT | SC70 | DCK | 5 | 250 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| OPA377AIDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| OPA4377AIPWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| OPA2377AIDGKR | VSSOP | DGK | 8 | 2500 | 366.0 | 364.0 | 50.0 |
| OPA2377AIDGKT | VSSOP | DGK | 8 | 250 | 366.0 | 364.0 | 50.0 |
| OPA2377AIDR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| OPA377AIDBVR | SOT-23 | DBV | 5 | 3000 | 223.0 | 270.0 | 35.0 |
| OPA377AIDBVR | SOT-23 | DBV | 5 | 3000 | 195.0 | 200.0 | 45.0 |
| OPA377AIDBVT | SOT-23 | DBV | 5 | 250 | 195.0 | 200.0 | 45.0 |
| OPA377AIDBVT | SOT-23 | DBV | 5 | 250 | 223.0 | 270.0 | 35.0 |
| OPA377AIDCKR | SC70 | DCK | 5 | 3000 | 195.0 | 200.0 | 45.0 |
| OPA377AIDCKT | SC70 | DCK | 5 | 250 | 195.0 | 200.0 | 45.0 |
| OPA377AIDR | SOIC | D | 8 | 2500 | 367.0 | 367.0 | 35.0 |
| OPA4377AIPWR | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |

DCK (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
 - D. Falls within JEDEC MO-203 variation AA.

DCK (R-PDSO-G5)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - D. Publication IPC-7351 is recommended for alternate designs.
 - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

GENERIC PACKAGE VIEW

DBV 5

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4073253/P

EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



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

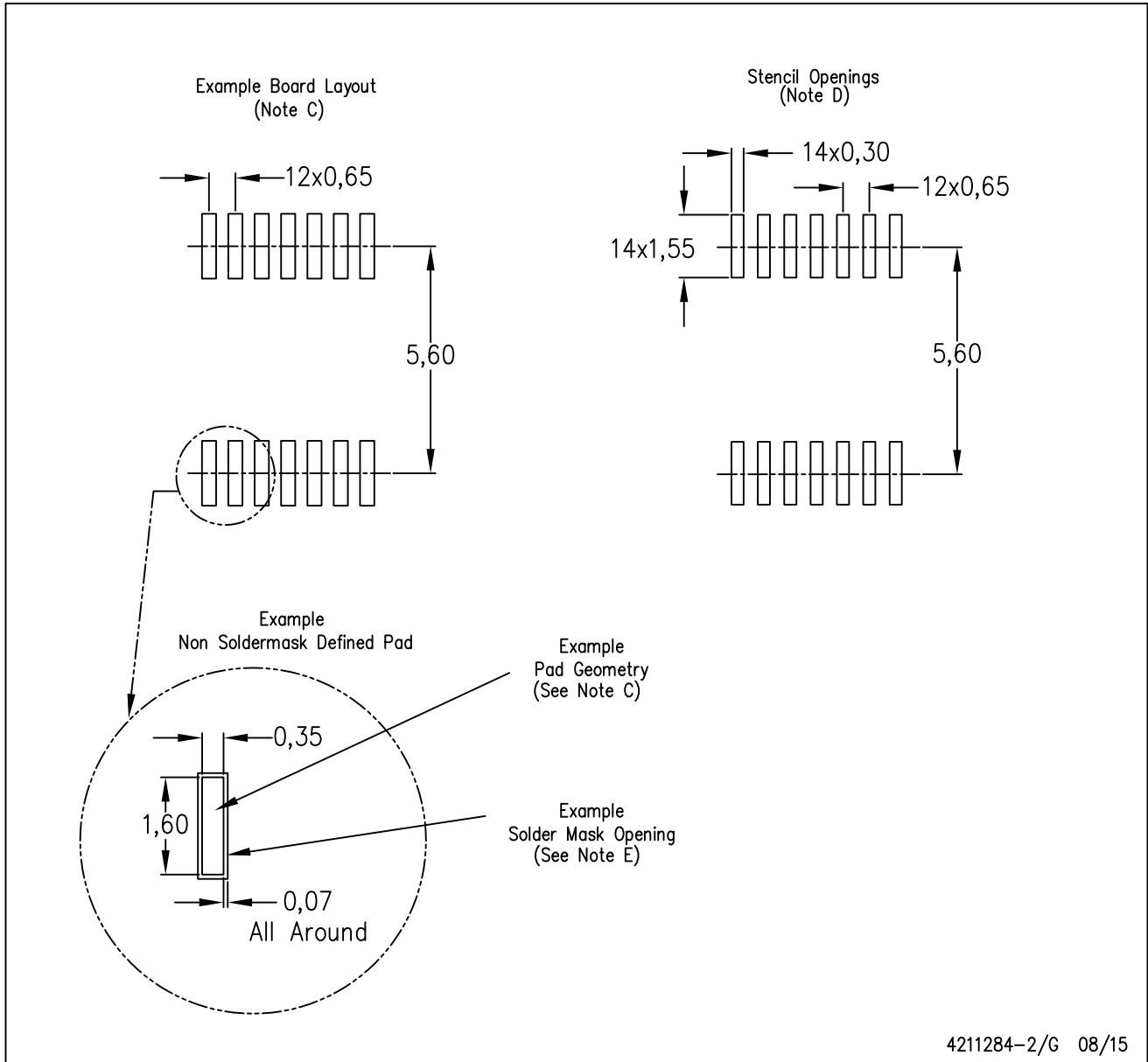
4214839/C 04/2017

NOTES: (continued)

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

PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 E. Reference JEDEC MS-012 variation AA.

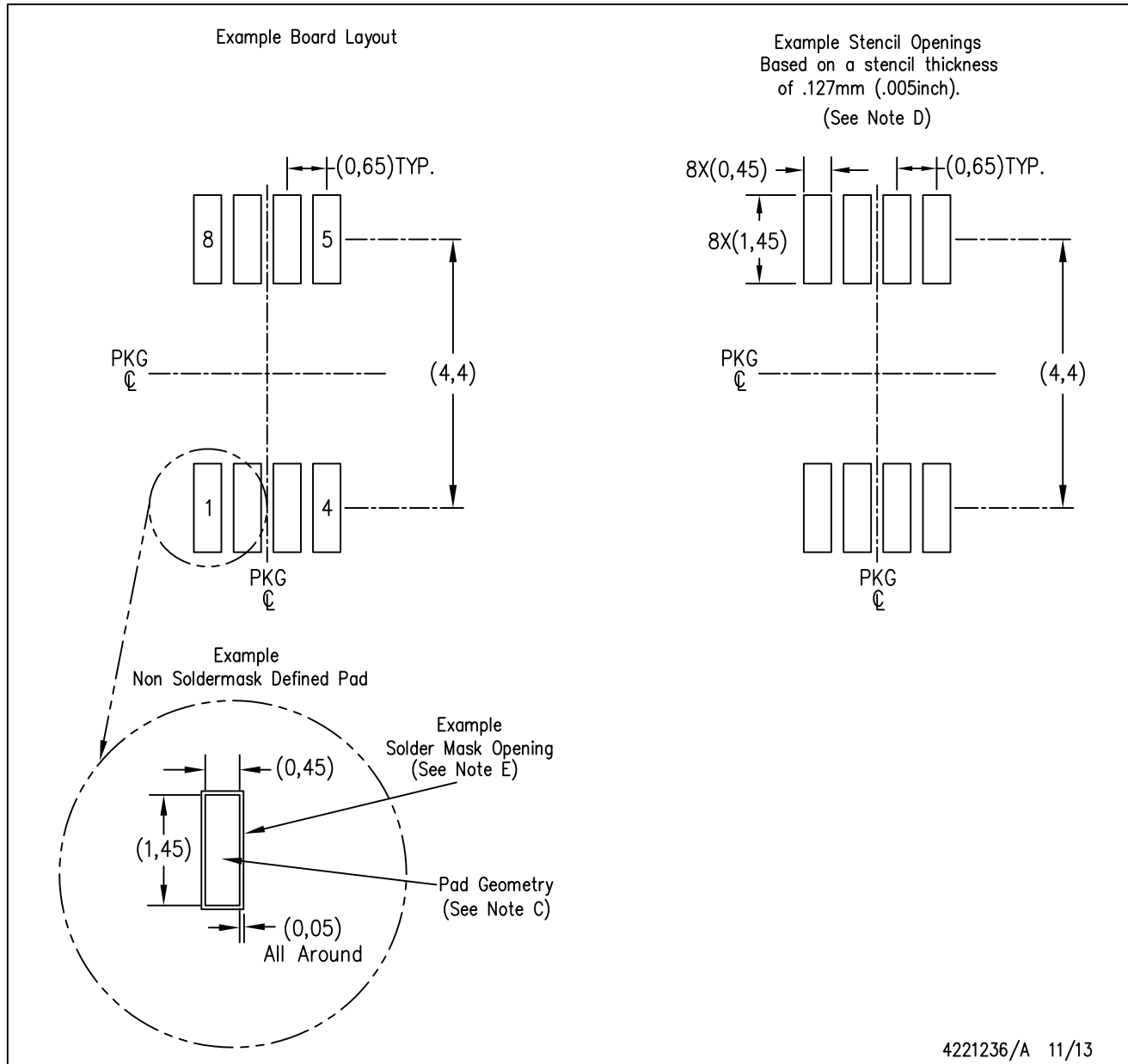
D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



4211283-2/E 08/12

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate designs.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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