FEATURES

- **HIGH SPEED:** 7MHz, 10V/µs
- **RAIL-TO-RAIL INPUT AND OUTPUT**
- **WIDE SUPPLY RANGE:**
  - Single Supply: 3.5V to 12V
  - Dual Supplies: ±1.75V to ±6V
- **LOW QUIESCENT CURRENT:** 1.1mA
- **FULL-SCALE CMRR:** 84dB
- **MicroSIZE PACKAGES:**
  - SOT23-5, MSOP-8, TSSOP-14
- **LOW INPUT BIAS CURRENT:** 1pA

APPLICATIONS

- **LCD GAMMA CORRECTION**
- **AUTOMOTIVE APPLICATIONS:**
  - Audio, Sensor Applications, Security Systems
- **PORTABLE EQUIPMENT**
- **ACTIVE FILTERS**
- **TRANSUCER AMPLIFIER**
- **TEST EQUIPMENT**
- **DATA ACQUISITION**

DESCRIPTION

The OPA743 series utilizes a state-of-the-art 12V analog CMOS process and offers outstanding AC performance, such as 7MHz GBW, 10V/µs slew rate and 0.0008% THD+N. Optimized for single supply operation up to 12V, the input common-mode range extends beyond the power supply rails and the output swings to within 100mV of the rails. The low quiescent current of 1.1mA makes it well suited for use in battery operated equipment.

The OPA743 series’ ability to drive high output currents together with 12V operation makes it particularly useful for use as gamma correction reference buffer in LCD panels. For ease of use the OPA743 op-amp family is fully specified and tested over the supply range of ±1.75V to ±6V. Single, dual and quad versions are available.

The single versions (OPA743) are available in the MicroSIZE SOT23-5 and in the standard SO-8 surface-mount, as well as DIP-8 packages. Dual versions (OPA2743) are available versions in the MSOP-8, SO-8, and DIP-8 packages. The quad versions (OPA4743) are available in the TSSOP-14 and SO-14 packages. All are specified for operation from –40°C to +85°C.
ABSOLUTE MAXIMUM RATINGS(1)

Supply Voltage, V+ to V− ................................. 13.2V
Signal Input Terminals, Voltage(2)............. (V−) –0.3V to (V+) +0.3V
Current(2) ..................................................................... 10mA
Output Short-Circuit(3) ....................................................................................... Continuous
Operating Temperature ..................................–55°C to +125°C
Storage Temperature ........................................–65°C to +150°C
Junction Temperature ........................................... +150°C
Lead Temperature (soldering, 10s) ..................+300°C

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. (2) Input terminals are diode-clamped to the power supply rails. Input signals that can swing more than 0.3V beyond the supply rails should be current-limited to 10mA or less. (3) Short-circuit to ground, one amplifier per package.

ELECTROSTATIC DISCHARGE SENSITIVITY

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.

PACKAGE/ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PRODUCT</th>
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<th>PACKAGE DRAWING NUMBER</th>
<th>PACKAGE MARKING</th>
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<th>TRANSPORT MEDIA</th>
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<td>OPA743NA/250</td>
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<tr>
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<td>OPA743PA</td>
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<td>SO-8</td>
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Quad

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<td>OPA4743EA/250</td>
<td>Tape and Reel</td>
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<tr>
<td>OPA4743UA</td>
<td>SO-14</td>
<td>235</td>
<td>OPA4743UA</td>
<td>OPA4743UA/2K5</td>
<td>Tape and Reel</td>
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NOTE: (1) Models with a slash (/) are available only in Tape and Reel in the quantities indicated (e.g., /3K indicates 3000 devices per reel). Ordering 3000 pieces of “OPA743NA/3K” will get a single 3000-piece Tape and Reel.
**ELECTRICAL CHARACTERISTICS: $V_S = 3.5V$ to $12V$**

**Boldface limits apply over the specified temperature range, $T_A = -40^\circ C$ to $+85^\circ C$**

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITION</th>
<th>OPA743NA, UA, PA</th>
<th>OPA2743EA, UA, PA</th>
<th>OPA4743EA, UA</th>
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<td>Input Offset Voltage</td>
<td>$V_{OS}$</td>
<td>$V_S = \pm 5V$, $V_{CM} = 0V$</td>
<td>$\pm 1.5$</td>
<td>$\pm 7$</td>
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<tr>
<td>Drift</td>
<td>$dV_{OS}/dT$</td>
<td>$V_S = \pm 1.75V$ to $\pm 6V$, $V_{CM} = -0.25$</td>
<td>$\pm 10$</td>
<td>$100$</td>
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<td>vs Power Supply</td>
<td>PSRR</td>
<td>$V_S = \pm 1.75V$ to $\pm 6V$, $V_{CM} = -0.25$</td>
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<td>Over Temperature</td>
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<td>Channel Separation, dc</td>
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<td>INPUT VOLTAGE RANGE</td>
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<tr>
<td>Common-Mode Voltage Range</td>
<td>$V_{CM}$</td>
<td>$(V-) - 0.1V$</td>
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<td>84</td>
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<td>Common-Mode Rejection Ratio</td>
<td>$CMRR$</td>
<td>$(V+) + 0.1V$</td>
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<td>over Temperature</td>
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<td>INPUT BIAS CURRENT</td>
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<tr>
<td>Input Bias Current</td>
<td>$I_B$</td>
<td>$V_S = \pm 6V$, $V_{CM} = 0V$</td>
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<tr>
<td>Input Offset Current</td>
<td>$I_{OS}$</td>
<td>$V_S = \pm 6V$, $V_{CM} = 0V$</td>
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<td>$\pm 10$</td>
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<td>INPUT IMPEDANCE</td>
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<td>$10^7 \parallel 4 \Omega \parallel pF$</td>
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<td>NOISE</td>
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<td>Input Voltage Noise, $f = 0.1Hz$ to $10Hz$</td>
<td>$e_k$</td>
<td>$V_S = \pm 6V$, $V_{CM} = 0V$</td>
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<tr>
<td>Input Voltage Noise Density, $f = 10kHz$</td>
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<td>$V_S = \pm 6V$, $V_{CM} = 0V$</td>
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<td>Current Noise Density, $f = 1kHz$</td>
<td>$I_n$</td>
<td>$V_S = \pm 6V$, $V_{CM} &lt; 0V$</td>
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<td>OPEN-LOOP GAIN</td>
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<td>Open-Loop Voltage Gain</td>
<td>$A_{OL}$</td>
<td>$R_L = 100k\Omega$, $(V-) + 0.1V &lt; V_O &lt; (V+) - 0.1V$</td>
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<td>120</td>
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<tr>
<td>over Temperature</td>
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<td>$R_L = 10k\Omega$, $(V-) + 0.125V &lt; V_O &lt; (V+) - 0.125V$</td>
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<td>$R_L = 1k\Omega$, $(V-) + 0.325V &lt; V_O &lt; (V+) - 0.325V$</td>
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<td>$R_L = 1k\Omega$, $(V-) + 0.450V &lt; V_O &lt; (V+) - 0.450V$</td>
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<td>OUTPUT</td>
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<td>Voltage Output Swing from</td>
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<td>$R_L = 100k\Omega$, $A_{OL} &gt; 106\Omega$</td>
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<td>Rail</td>
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<td>$R_L = 10k\Omega$, $A_{OL} &gt; 100\Omega$</td>
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<td>$R_L = 1k\Omega$, $A_{OL} &gt; 86\Omega$</td>
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<td>450</td>
<td>mV</td>
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<td>Output Current</td>
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<td>$V_{OUT} = 1V$</td>
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<td>Short-Circuit Current</td>
<td>$I_{SC}$</td>
<td>$V_S = \pm 6V$, $V_{CM} = 0V$</td>
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<td>Capacitive Load Drive</td>
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<tr>
<td>Gain-Bandwidth Product</td>
<td>$GBW$</td>
<td>$G = +1$</td>
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<td>Slew Rate</td>
<td>$SR$</td>
<td>$V_S = \pm 6V$, $G = +1$</td>
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<tr>
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<td>$t_s$</td>
<td>$V_S = \pm 6V$, $5V$ Step, $G = +1$</td>
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<td>0.01%</td>
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<td>$V_S = \pm 6V$, $5V$ Step, $G = +1$</td>
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<td>$V_{IN} \cdot Gain = V_S$</td>
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<td>Total Harmonic Distortion + Noise</td>
<td>$THD+N$</td>
<td>$V_S = \pm 6V$, $V_O = 1Vrms$, $G = +1$, $f = 6kHz$</td>
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<td>POWER SUPPLY</td>
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<tr>
<td>Specified Voltage Range, Single Supply</td>
<td>$V_S$</td>
<td>$\pm 1.75$</td>
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<td>Specified Voltage Range, Dual Supplies</td>
<td>$V_S$</td>
<td>$\pm 6V$</td>
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<td>V</td>
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<td>Quiescent Current (per amplifier)</td>
<td>$I_Q$</td>
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<td>over Temperature</td>
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<td>$\theta_J$</td>
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<td>TSSOP-14 Surface-Mount</td>
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<td>SO-8 Surface Mount</td>
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<td>DIP-8</td>
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</table>
TYPICAL CHARACTERISTICS

At $T_A = +25^\circ C$, $V_S = \pm 6V$, and $R_L = 10\, \Omega$, unless otherwise noted.

Gain (dB) vs Frequency

Phase (°) vs Frequency

CMRR vs Frequency

PSRR vs Frequency

Maximum Amplitude vs Frequency

Channel Separation vs Frequency

Input Current and Voltage Spectral Noise vs Frequency
At $T_A = +25^\circ C$, $V_S = \pm 5V$, and $R_L = 10k\Omega$, unless otherwise noted.

**TYPICAL CHARACTERISTICS** (Cont.)

**INPUT BIAS CURRENT ($I_B$) vs COMMON-MODE VOLTAGE ($V_{CM}$) TEMPERATURE = 25°C**

**INPUT BIAS CURRENT ($I_B$) vs COMMON-MODE VOLTAGE ($V_{CM}$) TEMPERATURE = 85°C**

**INPUT BIAS ($I_B$) AND OFFSET ($I_{OS}$) CURRENT vs TEMPERATURE**

**OPEN-LOOP GAIN vs TEMPERATURE**

**PSRR vs TEMPERATURE**

**CMRR vs TEMPERATURE**
TYPICAL CHARACTERISTICS (Cont.)

At \(T_A = +25^\circ C\), \(V_S = \pm 6V\), and \(R_L = 10k\Omega\), unless otherwise noted.
TYPICAL CHARACTERISTICS (Cont.)

At $T_A = +25^\circ C$, $V_S = \pm 6V$, and $R_L = 10k\Omega$, unless otherwise noted.

**SETTLING TIME vs GAIN**

- $V_{OUT} = 5Vp-p$
- 0.01% settling time
- 0.1% settling time

**OVERSHOOT (%) vs CAPACITANCE**

- Noninverting Gain (V/V)
- Gain values: $G = -1$, $G = +1$, $G = +5$

**V_{OS} PRODUCTION DISTRIBUTION**

- Frequency (%)
- Voltage Offset (mV)

**V_{OS} DRIFT PRODUCTION DISTRIBUTION**

- Frequency (%)
- Voltage Offset Drift ($\mu V/^\circ C$)

**SMALL SIGNAL STEP RESPONSE**

- $G = +1V/V$, $R_L = 10k\Omega$, $C_L = 15pF$
- $10mV/div$
- $100ns/div$

- $G = -1V/V$, $R_F = 100k\Omega$, $C_F = 1pF$, $R_L = 10k\Omega$, $C_L = 15pF$
- $10mV/div$
- $1\mu s/div$

NOTE: $C_F$ is used to optimize settling time.
TYPICAL CHARACTERISTICS (Cont.)

At $T_A = +25^\circ C$, $V_S = \pm 6V$, and $R_L = 10k\Omega$, unless otherwise noted.

LARGE SIGNAL STEP RESPONSE
($G = +1V/V$, $R_L = 10k\Omega$, $C_L = 15pF$)

LARGE SIGNAL STEP RESPONSE
($G = -1V/V$, $R_L = 10k\Omega$, $C_L = 15pF$)
APPLICATIONS INFORMATION

OPA743 series op amps can operate on 1.1mA quiescent current from a single (or split) supply in the range of 3.5V to 12V (±1.75V to ±6V), making them highly versatile and easy to use. The OPA743 is unity-gain stable and offers 7MHz bandwidth and 10V/µs slew rate.

Rail-to-rail input and output swing helps maintain dynamic range, especially in low supply applications. Figure 1 shows the input and output waveforms for the OPA743 in unity-gain configuration. On a ±6V supply with a 100kΩ load connected to V_S/2. The output is tested to swing within 100mV to the rail.

Power-supply pins should be bypassed with 1000pF ceramic capacitors in parallel with 1µF tantalum capacitors.

FIGURE 1. Rail-to-Rail Input and Output.

OPERATING VOLTAGE

OPA743 series op amps are fully specified and guaranteed from 3.5V to 12V over a temperature range of –40ºC to +85ºC. Parameters that vary significantly with operating voltages or temperature are shown in the Typical Characteristics.

RAIL-TO-RAIL INPUT

The input common-mode voltage range of the OPA743 series extends 100mV beyond the supply rails at room temperature. This is achieved with a complementary input stage—an N-channel input differential pair in parallel with a P-channel differential pair. The N-channel pair is active for input voltages close to the positive rail, typically (V+) – 2.0V to 100mV above the positive supply, while the P-channel pair is on for inputs from 100mV below the negative supply to approximately (V+) – 1.5V. There is a small transition region, typically (V+) – 2.0V to (V+) – 1.5V, in which both pairs are on. This 500mV transition region can vary ±100mV with process variation. Thus, the transition region (both stages on) can range from (V+) – 2.1V to (V+) – 1.4V on the low end, up to (V+) – 1.9V to (V+) – 1.6V on the high end. Most rail-to-rail op amps on the market use this two input stage approach, and exhibit a transition region where CMRR, offset voltage, and THD may vary compared to operation outside this region.


FIGURE 3. OPA743—No Phase Inversion with Inputs Greater than the Power-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 1kΩ loads connected to any point between V+ and V−. For light resistive loads (> 100kΩ), the output voltage can swing to 100mV from the supply rail. With 1kΩ resistive loads, the output can swing to within 325mV from the supply rails while maintaining high open-loop gain (see the typical performance curve “Output Voltage Swing vs Output Current”).
CAPACITIVE LOAD AND STABILITY
The OPA743 series op amps can drive up to 1000pF pure capacitive load. Increasing the gain enhances the amplifier’s ability to drive greater capacitive loads (see the typical performance curve “Small Signal Overshoot vs Capacitive Load”).

One method of improving capacitive load drive in the unity-gain configuration is to insert a 10Ω to 20Ω resistor inside the feedback loop, as shown in Figure 4. This reduces ringing with large capacitive loads while maintaining DC accuracy.

REFERENCE BUFFER FOR LCD SOURCE DRIVERS
In modern high resolution TFT LCD displays, gamma correction must be performed to correct for nonlinearities in the glass transmission characteristics of the LCD panel. The typical LCD source driver for 64 Bits of Grayscale uses internal DAC to convert the 6-Bit data into analog voltages applied to the LCD. These DAC typically require external voltage references for proper operation. Normally these external reference voltages are generated using a simple resistive ladder, like the one shown in Figure 6.

Typical laptop or desktop LCD panels require 6 to 8 of the source driver circuits in parallel to drive all columns of the panel. Although the resistive load of one internal string DAC is only around 10kΩ, 6 to 8 in parallel represent a very substantial load. The power supply used for the LCD source drivers for laptops is typically in the order of 10V. To maximize the dynamic range of the DAC, rail-to-rail output performance is required for the upper and lower buffer. The OPA4743’s ability to operate on 12V supplies, to drive heavy resistive loads (as low as 1kΩ), and to swing to within 325mV of the supply rails, makes it very well suited as a buffer for the reference voltage inputs of LCD source drivers.

During conversion, the DAC’s internal switches create current glitches on the output of the reference buffer. The capacitor CL (typically 100nF) functions as a charge reservoir that provides/absorbs most of the glitch energy. The series resistor RS isolates the outputs of the OPA4743 from the heavy capacitive load and helps to improve settling time.

APPLICATION CIRCUITS
The OPA743 series op amps are optimized for driving medium-speed sampling data converters. The OPA743 op amps buffer the converter’s input capacitance and resulting charge injection while providing signal gain.

CAPACITIVE LOAD AND STABILITY
The OPA743 series op amps can drive up to 1000pF pure capacitive load. Increasing the gain enhances the amplifier’s ability to drive greater capacitive loads (see the typical performance curve “Small Signal Overshoot vs Capacitive Load”).

One method of improving capacitive load drive in the unity-gain configuration is to insert a 10Ω to 20Ω resistor inside the feedback loop, as shown in Figure 4. This reduces ringing with large capacitive loads while maintaining DC accuracy.

APPLICATION CIRCUITS
The OPA743 series op amps are optimized for driving medium-speed sampling data converters. The OPA743 op amps buffer the converter’s input capacitance and resulting charge injection while providing signal gain.
FIGURE 6. OPA743 Configured as a Reference Buffer for an LCD Display.

NOTE: The actual values of $R_S$ and $C_L$ are application specific and may not be needed.
## PACKAGING INFORMATION

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<tr>
<th>Orderable Device</th>
<th>Status</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan</th>
<th>Lead/Ball Finish</th>
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<th>Op Temp (°C)</th>
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(1) The marketing status values are defined as follows:
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(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**

**PACKAGE MATERIALS INFORMATION**

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*All dimensions are nominal.*
### TAPE AND REEL BOX DIMENSIONS

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*All dimensions are nominal*
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