LMV1031-20 Amplifier for Internal 3-Wire Analog Microphones and External Preamplifier

Check for Samples: LMV1031

FEATURES

- **(Typical LMV1031-20, 2V Supply; Unless Otherwise Noted)**
- **Signal to Noise Ratio 62 dB**
- **Output Voltage Noise (A-Weighted) −86 dBV**
- **Low Supply Current 72 μA**
- **Supply Voltage 2V to 5V**
- **Input Impedance >100 MΩ**
- **Max Input Signal 108 mV_{PP}**
- **Output Voltage 1.09V**
- **Temperature Range −40°C to 85°C**
- **Large Dome 4-Bump DSBGA Package with Improved Adhesion Technology**

APPLICATIONS

- **Mobile Communications - Bluetooth**
- **Accessory Microphone Products**
- **Cellular Phones**
- **PDAs**

DESCRIPTION

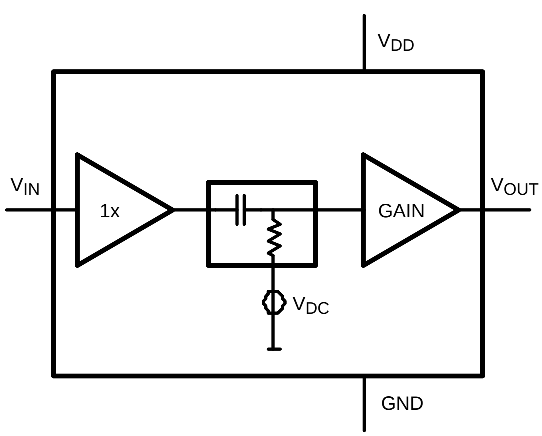
The LMV1031 audio amplifier is an ideal replacement for the JFET preamplifier that is currently used in the electret microphones. The LMV1031 is optimized for applications that require extended battery life, such as Bluetooth communication links. The supply current for the LMV1031 is only 72 μA. This is a dramatic reduction from that required for a JFET equipped microphone. The LMV1031, with its separate output and supply pins, offers a higher PSRR and eliminates the need for additional external components.

The LMV1031 is ensured to operate from 2V to 5V supply voltage over the full temperature range, has a fixed voltage gain of 20 dB and enhanced SNR performance. The LMV1031 is optimized for an output biasing of 1.09V.

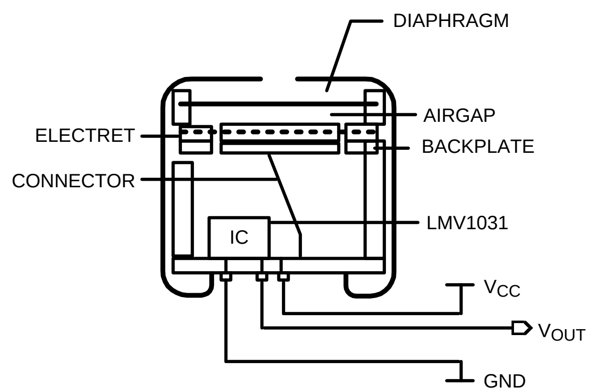
The LMV1031 has less than 200Ω of output impedance over the full audio bandwidth. The gain response of the LMV1031 is flat within the audio band and is stable over the temperature range.

The LMV1031 is available in a large dome 4-bump ultra thin DSBGA package that can easily fit on the PCB inside the miniature microphone metal can (package). This package is designed for microphone PCBs requiring 1 kg adhesion criteria.

Block Diagram



Electret Microphone



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.

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings (1) (2)

ESD Tolerance (3)	Human Body Model	2500V
	Machine Model	250V
Supply Voltage V_{DD} - GND		5.5V
Storage Temperature Range		−65°C to 150°C
Junction Temperature (4)		150°C max
Mounting Temperature	Infrared or Convection (20 sec.)	235°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not ensured. For specified specifications and the test conditions, see the Electrical Characteristics.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
(3) The human body model (HBM) is 1.5 kΩ in series with 100 pF. The machine model is 0Ω in series with 200 pF.
(4) The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA} and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly onto a PC board.

Operating Ratings (1)

Supply Voltage	2V to 5V
Temperature Range	−40°C to +85°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not ensured. For specified specifications and the test conditions, see the Electrical Characteristics.

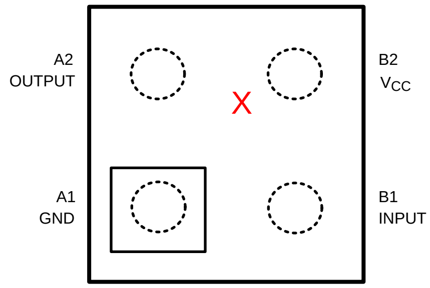
2V and 5V Electrical Characteristics (1)

Unless otherwise specified, all limits are specified for T_J = 25°C and V_{DD} = 2V and 5V. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (2)	Typ (3)	Max (2)	Units
I_{DD}	Supply Current	V_{IN} = GND		72	90 **100**	μA
SNR	Signal to Noise Ratio	f = 1 kHz, V_{IN} = 18 mV_{PP}		62		dB
THD	Total Harmonic Distortion	f = 1 kHz, V_{IN} = 18 mV_{PP}		0.18		%
e_n	Output Noise	A-Weighted		−86		dBV
A_V	Gain	f = 1 kHz, V_{IN} = 18 mV_{PP}	19.18 **19.00**	20.1	20.90 **21.00**	dB
f_{LOW}	Lower −3 dB Roll Off Frequency	R_{SOURCE} = 50Ω, V_{IN} = 18 mV_{PP}		72		Hz
f_{HIGH}	Upper −3 dB Roll Off Frequency	R_{SOURCE} = 50Ω, V_{IN} = 18 mV_{PP}		52		kHz
V_{IN}	Max Input Signal	f = 1 kHz and THD+N < 1%		108		mV_{PP}
Z_{IN}	Input Impedance			>100		MΩ
C_{IN}	Input Capacitance			2		pF
V_{OUT}	Output Voltage	V_{IN} = GND	890 **875**	1090	1310 **1325**	mV
R_O	Output Impedance	f = 1 kHz		<200		Ω
PSRR	Power Supply Rejection Ratio	2V < V_{DD} < 5V		56		dB

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device such that $T_J = T_A$. No ensuring of parametric performance is indicated in the electrical tables under conditions of internal self-heating where $T_J > T_A$.
(2) All limits are specified by design or statistical analysis.
(3) Typical values represent the most likely parametric norm at the time of characterization.

Connection Diagram



Note:
- Pin numbers are referenced to package marking text orientation.
- The actual physical placement of the package marking will vary slightly from part to part. The package will designate the date code and will vary considerably. Package marking does not correlate to device type in any way.

Figure 1. 4-Bump Ultra Thin DSBGA
Top View

Typical Performance Characteristics

Unless otherwise specified, V_S = 2V, single supply, T_A = 25°C

Supply Current vs. Supply Voltage

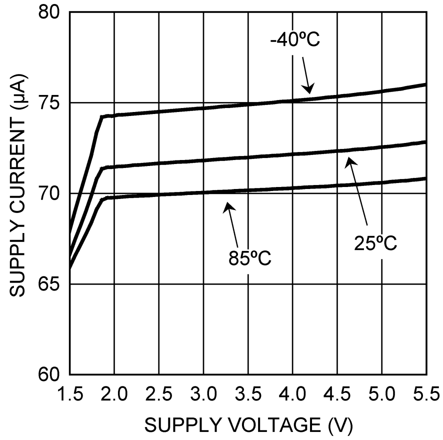


Figure 2.

Output Voltage vs. Supply Voltage

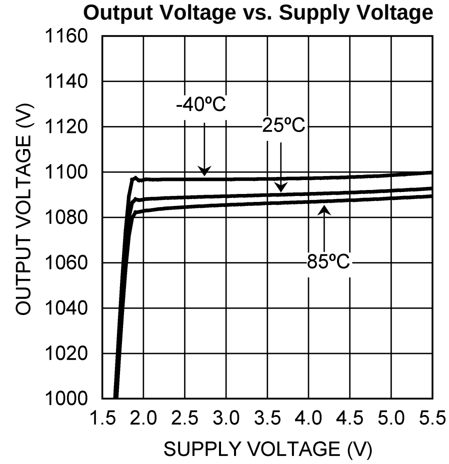


Figure 3.

Gain vs. Supply Voltage

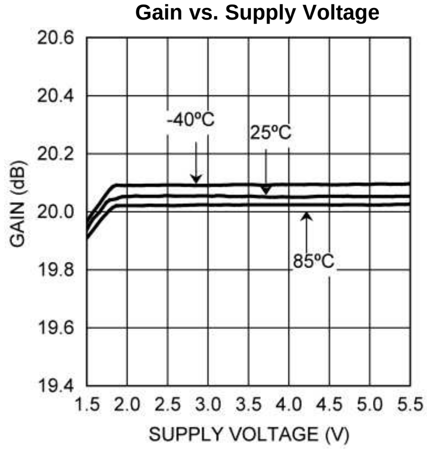


Figure 4.

Closed Loop Gain and Phase vs. Frequency

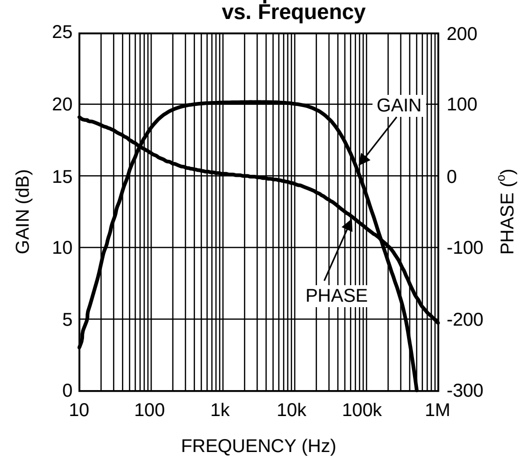


Figure 5.

Power Supply Rejection Ratio vs. Frequency

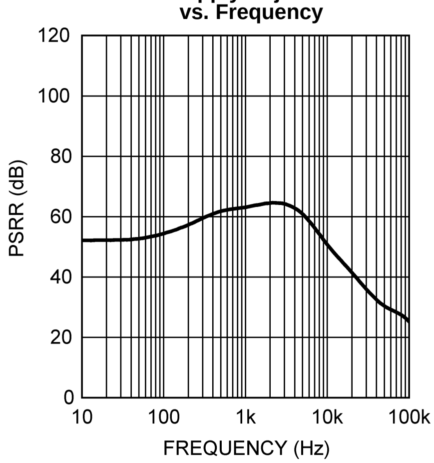


Figure 6.

Total Harmonic Distortion vs. Frequency

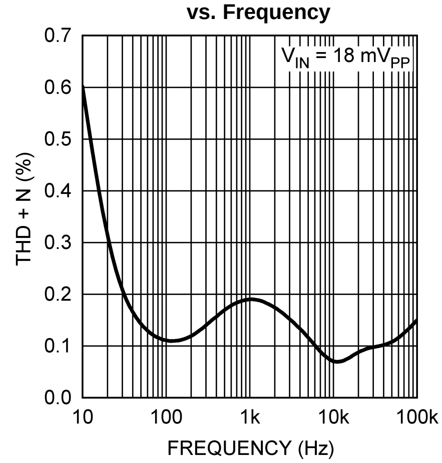


Figure 7.

Typical Performance Characteristics (continued)

Unless otherwise specified, V_S = 2V, single supply, T_A = 25°C

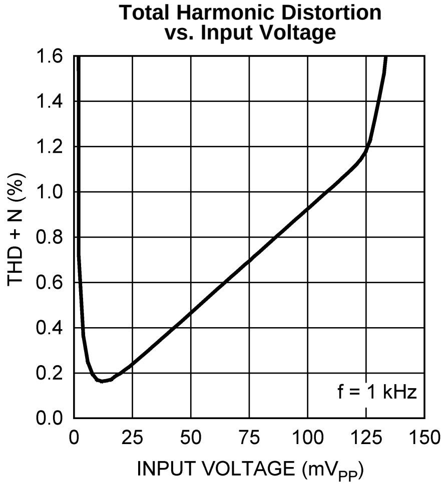


Figure 8.

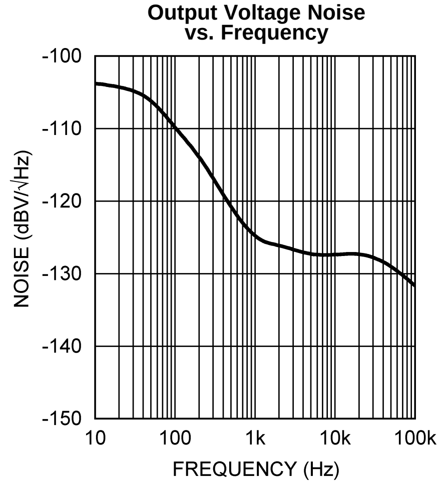


Figure 9.

APPLICATION SECTION

LOW CURRENT

The LMV1031 has a low supply current which allows for a longer battery life. The low supply current of 72 µA makes this amplifier optimal for microphone applications which need to be always on.

BUILT-IN GAIN

The LMV1031 is offered in the space saving small DSBGA package which fits perfectly into the metal can of a microphone. This allows the LMV1031 to be placed on the PCB inside the microphone.

The bottom side of the PCB has the pins that connect the supply voltage to the amplifier and make the output available. The input of the amplifier is connected to the microphone via the PCB.

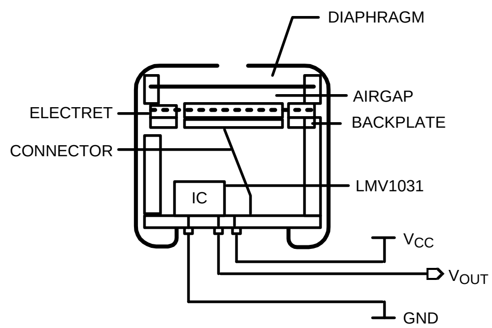


Figure 10. Built-in Gain

EXTERNAL PREAMPLIFIER APPLICATION

The LMV1031 can also be used outside of an ECM as a space saving external preamplifier. In this application, the LMV1031 follows a phantom biased JFET microphone in the circuit. This is shown in Figure 11. The input of the LMV1031 is connected to the microphone via a 2.2 µF capacitor. The advantages of this circuit over one with only a JFET microphone are the additional gain and the high pass filter supplied by the LMV1031. The high pass filter makes the output signal more robust and less sensitive to low frequency disturbances. In this configuration the LMV1031 should be placed as close as possible to the microphone.

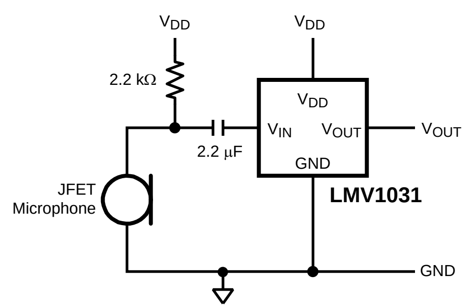


Figure 11. LMV1031 as external preamplifier

A-WEIGHTED FILTER

The human ear has a frequency range from 20 Hz to about 20 kHz. Within this range the sensitivity of the human ear is not equal for each frequency. To approach the hearing response weighting filters are introduced. One of those filters is the A-weighted filter.

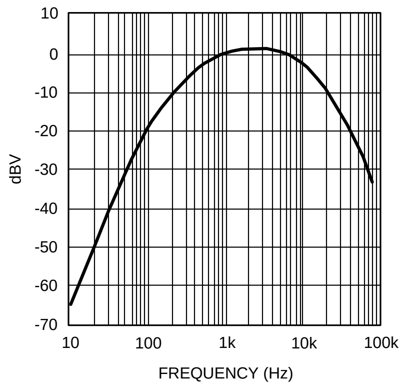


Figure 12. A-Weighted Filter

The A-weighted filter is commonly used in signal-to-noise ratio measurements, where sound is compared to device noise. It improves the correlation of the measured data to the signal-to-noise ratio perceived by the human ear.

OUTPUT CURRENT

The LMV1031 is designed for driving high ohmic loads with several milli amperes of output current. Figure 13 shows the gain performance of the LMV1031 versus the sinking and sourcing current. The gain remains constant within the shown output current range. This sets the operating range of the LMV1031 with respect to the output current.

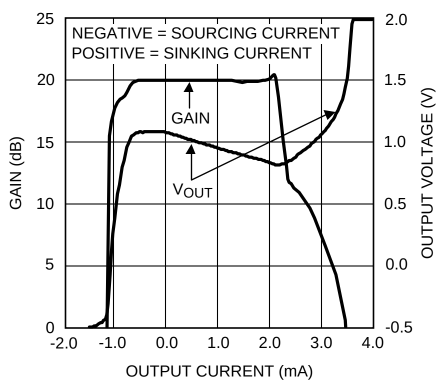


Figure 13. Performance vs. Output Current

MEASURING NOISE AND SNR

The overall noise of the LMV1031 is measured within the frequency band from 10 Hz to 22 kHz using an A-weighted filter. The input of the LMV1031 is connected to ground with a 5 pF capacitor.

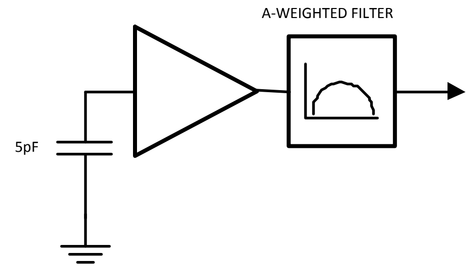


Figure 14. Noise Measurement Setup

The signal-to-noise ratio (SNR) is measured with a 1 kHz input signal of 18 mV_{PP} using an A-weighted filter. This represents a sound pressure level of 94 dB with a standard ECM sensitivity. No input capacitor is connected.

SOUND PRESSURE LEVEL

The volume of sound applied to a microphone is commonly stated as the pressure level with respect to the threshold of hearing of the human ear. This sound pressure level (SPL) in decibels is defined by:

Sound pressure level (dB) = 20 log P_m/P_O

where

- P_m is the measured sound pressure
- P_O is the threshold of hearing (20 µPa)

In order to be able to calculate the resulting output voltage of the microphone for a given SPL, the sound pressure in dB SPL needs to be converted to the absolute sound pressure in dBPa. This is the sound pressure level in decibels which is referred to 1 Pascal (Pa).

The conversion is given by:

dBPa = dB SPL + 20*log 20 µPa

dBPa = dB SPL - 94 dB

Translation from absolute sound pressure level to a voltage is specified by the sensitivity of the microphone. A conventional microphone has a sensitivity of −44 dBV/Pa.

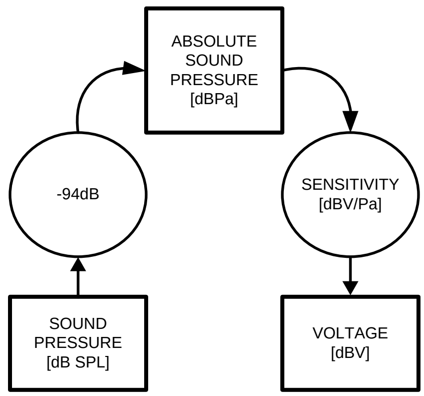


Figure 15. dB SPL to dBV Conversion

Example: Busy traffic is 70 dB

V_{OUT} = 70 −94 −44 = −68 dBV

This is equivalent to 1.13 mV_{PP}

Since the LMV1031-20 has a gain of 10 times (20 dB) over the JFET, the output voltage of the microphone is 11.3 mV_{PP}. By replacing the JFET with the LMV1031-20, the sensitivity of the microphone is −24 dBV/Pa (−44 + 20).

LOW FREQUENCY CUT-OFF FILTER

The LMV1031 has a low cut-off filter on the output of the microphone, to reduce low frequency noises, such as wind and vibration. This also helps to reduce the proximity effect in directional microphones. This effect occurs when the sound source is very close to the microphone. The lower frequencies are amplified which gives a bass sound. This amplification can cause an overload, which results in a distortion of the signal.

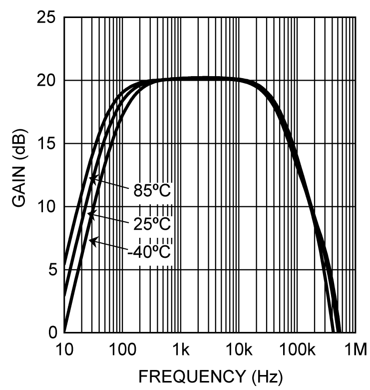


Figure 16. Gain vs. Frequency

The LMV1031 is optimized to be used in audio band applications. As shown in Figure 16, the LMV1031 provides a flat gain response within the audio band and offers excellent temperature stability.

ADVANTAGE OF THREE PINS

When implemented in an Electret Condenser Microphone (ECM) the LMV1031 adds the advantages of a three pin configuration. The third pin provides a low supply current, higher PSRR, and eliminates the need for additional external components.

It is well known that cell phone microphones are sensitive to noise pick-up. A conventional JFET circuit is sensitive to noise pick-up because of its high output impedance, which is usually around 2.2 kΩ. The LMV1031 is less sensitive to noise pick-up because it provides separate output and supply pins. Using separate pins greatly reduces the output impedance.

REVISION HISTORY

Changes from Revision A (May 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format	9

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMV1031UR-20/NOPB	ACTIVE	DSBGA	YPD	4	250	RoHS & Green	SNAGCU	Level-1-260C-UNLIM			Samples
LMV1031URX-20/NOPB	ACTIVE	DSBGA	YPD	4	3000	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-40 to 85		Samples

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

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

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

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

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

(6) Lead finish/Ball material - Orderable Devices 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.

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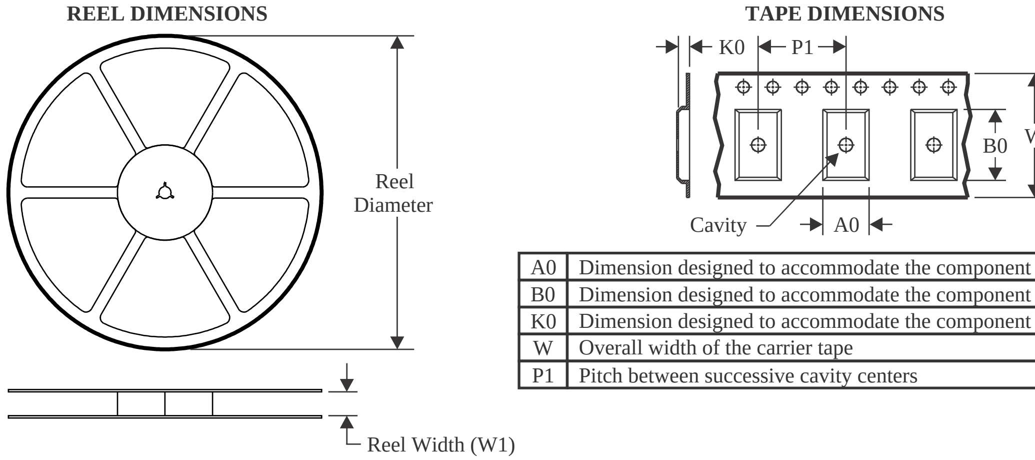
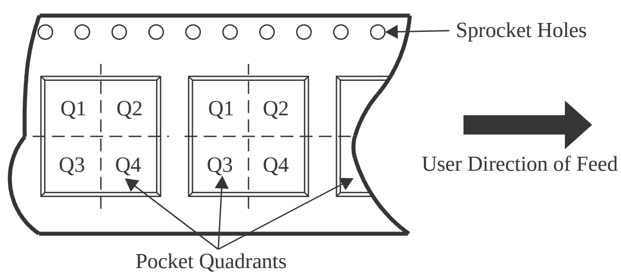
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION



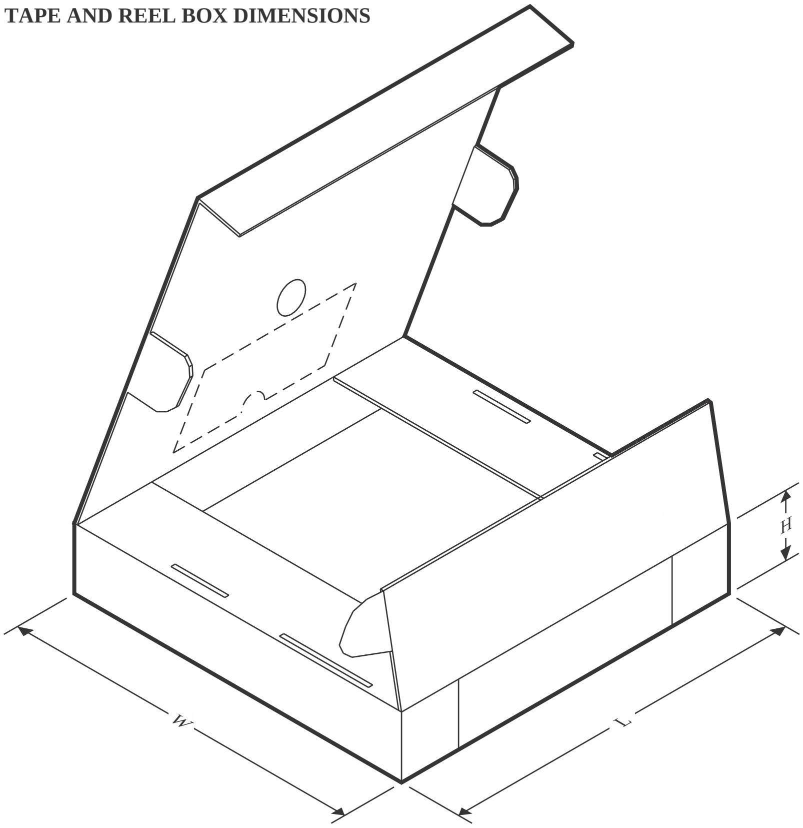
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers



*All dimensions are nominal

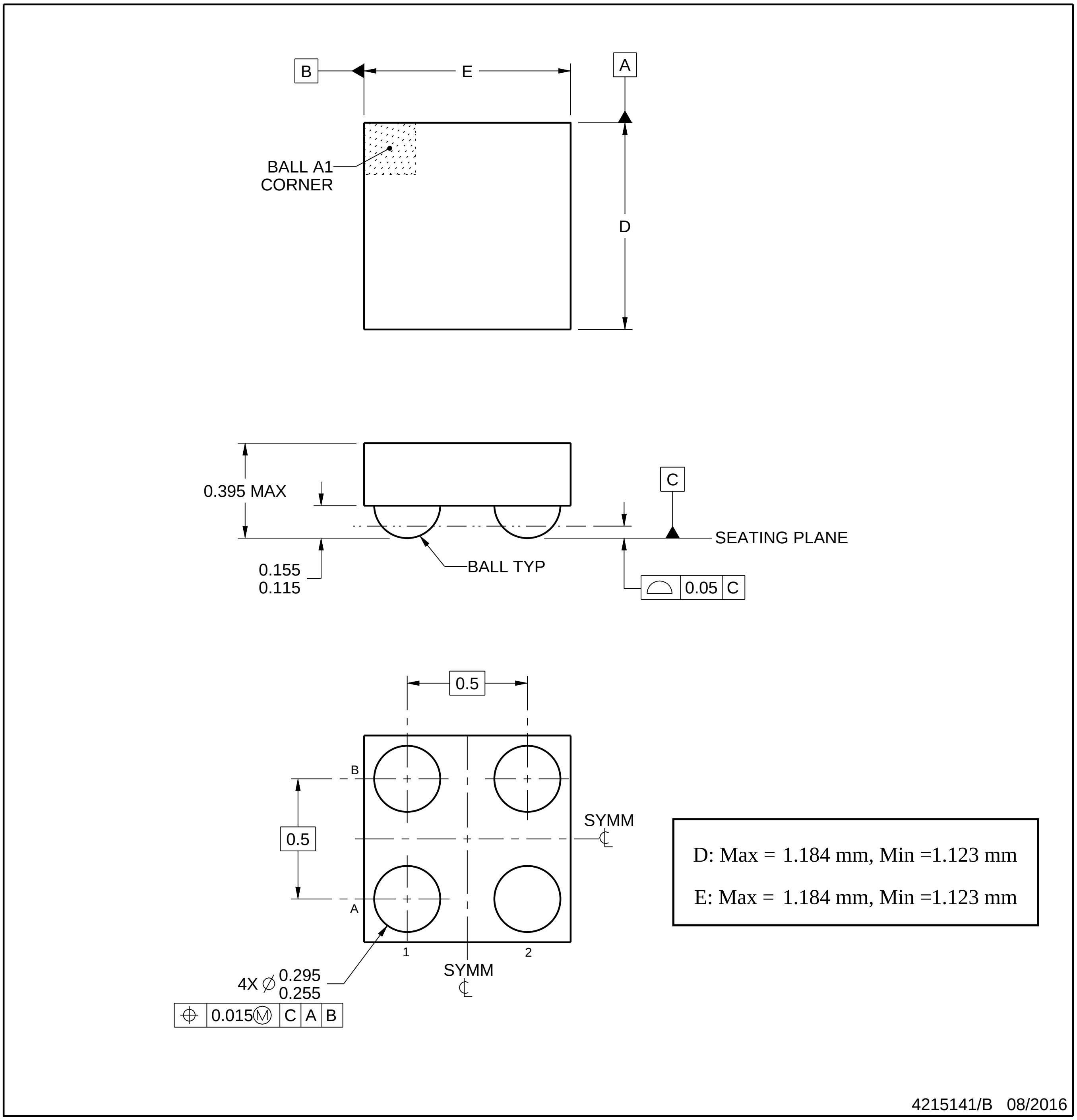
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LMV1031UR-20/NOPB	DSBGA	YPD	4	250	178.0	8.4	1.22	1.22	0.56	4.0	8.0	Q1
LMV1031URX-20/NOPB	DSBGA	YPD	4	3000	178.0	8.4	1.22	1.22	0.56	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



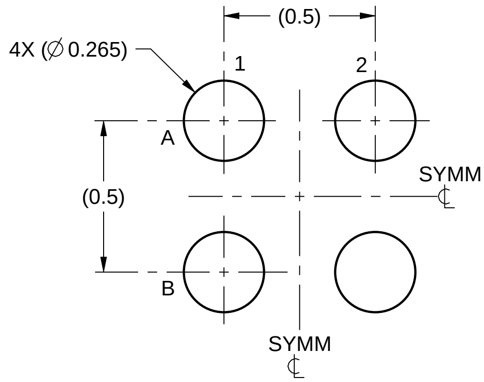
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV1031UR-20/NOPB	DSBGA	YPD	4	250	208.0	191.0	35.0
LMV1031URX-20/NOPB	DSBGA	YPD	4	3000	208.0	191.0	35.0

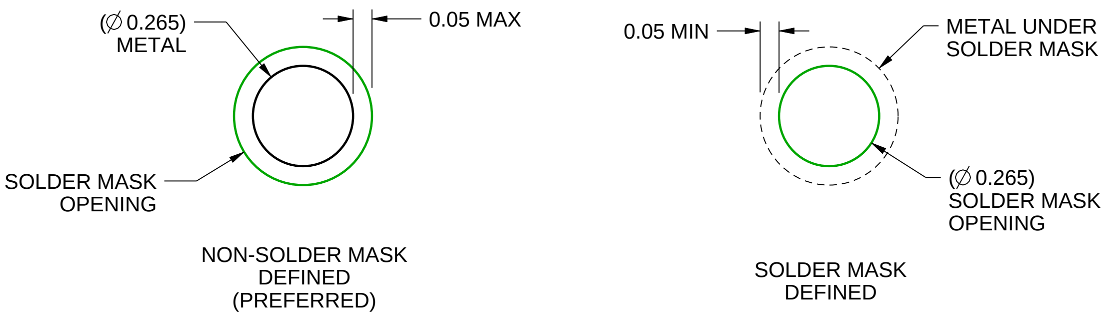


NOTES:

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.



LAND PATTERN EXAMPLE
SCALE:40X



SOLDER MASK DETAILS
NOT TO SCALE

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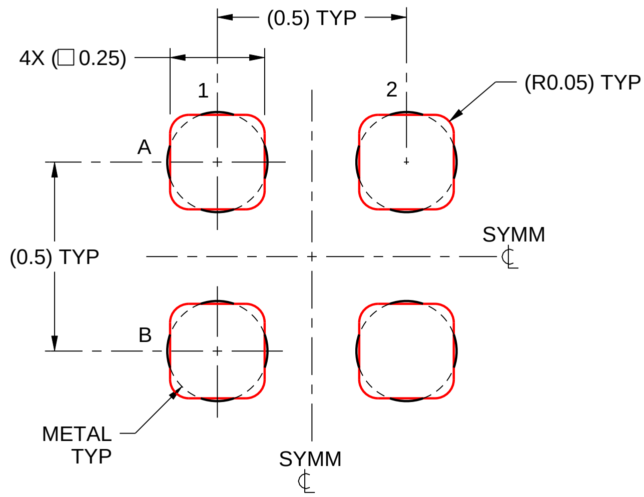
NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE:50X

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NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.