

LMV1015 Analog Series: Built-in Gain IC's for High Sensitivity 2-Wire Microphones

Check for Samples: [LMV1015](#)

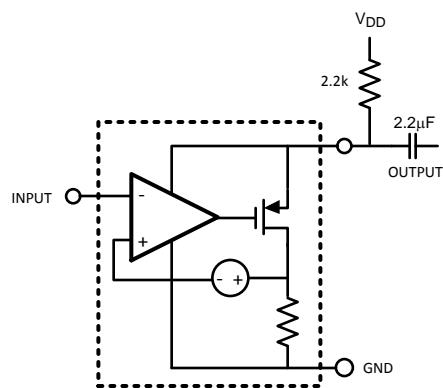
FEATURES

- (Typical LMV1015-15, 2.2V supply, $R_L = 2.2\text{ k}\Omega$, $C = 2.2\text{ }\mu\text{F}$, $V_{IN} = 18\text{ mV}_{PP}$, unless otherwise specified)
- **Supply Voltage: 2V - 5V**
- **Supply Current: <180 μA**
- **Signal to Noise Ratio (A-Weighted): 60 dB**
- **Output Voltage Noise (A-Weighted): -89 dBV**
- **Total Harmonic Distortion 0.09%**
- **Voltage Gain**
 - LMV1015-15: 15.6 dB
 - LMV1015-25: 23.8 dB
- **Temperature Range: -40°C to 85°C**
- **Large Dome 4-Bump DSBGA Package with Improved Adhesion Technology.**

APPLICATIONS

- **Cellular Phones**
- **Headsets**
- **Mobile Communications**
- **Automotive Accessories**
- **PDAs**
- **Accessory Microphone Products**

Schematic Diagram



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.

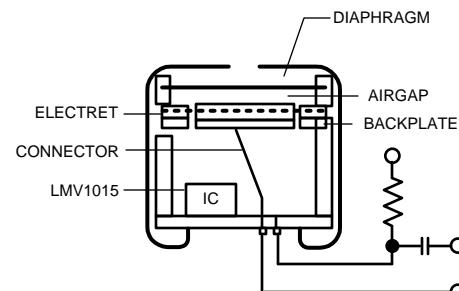
DESCRIPTION

The LMV1015 is an audio amplifier series for small form factor electret microphones. This 2-wire portfolio is designed to replace the JFET amplifier. The LMV1015 series is ideally suited for applications requiring high signal integrity in the presence of ambient or RF noise, such as in cellular communications. The LMV1015 audio amplifiers are ensured to operate over a 2.2V to 5.0V supply voltage range with fixed gains of 15.6 dB and 23.8 dB. The devices offer excellent THD, gain accuracy and temperature stability as compared to a JFET microphone.

The LMV1015 series enables a two-pin electret microphone solution, which provides direct pin-to-pin compatibility with the existing older JFET market.

Texas Instruments' built-in gain families are offered in extremely thin space saving 4-bump DSBGA packages (0.3 mm maximum). The LMV1015XR is designed for 1.0 mm ECM canisters and thicker. These extremely miniature packages have the Large Dome Bump (LDB) technology. This DSBGA technology is designed for microphone PCBs requiring 1 kg adhesion criteria.

Built-In Gain 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.

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Absolute Maximum Ratings⁽¹⁾

ESD Tolerance ⁽²⁾	Human Body Model	2500V
	Machine Model	250V
Supply Voltage	V _{DD} - GND	5.5V
Storage Temperature Range		-65°C to 150°C
Junction Temperature ⁽³⁾		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 ensured specifications and the test conditions, see the Electrical Characteristics.
- (2) Human Body Model (HBM) is 1.5 kΩ in series with 100 pF.
- (3) 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)/θ_{JA}. All numbers apply for packages soldered directly into a PC board.

Operating Ratings⁽¹⁾

Supply Voltage	2V to 5V
Operating Temperature Range	-40°C to 85°C
Thermal Resistance (θ _{JA})	368°C/W

- (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 ensured specifications and the test conditions, see the Electrical Characteristics.

2.2V Electrical Characteristics⁽¹⁾

Unless otherwise specified, all limits ensured for T_J = 25°C, V_{DD} = 2.2V, V_{IN} = 18 mV_{PP}, R_L = 2.2 kΩ and C = 2.2 μF.

Boldface limits apply at the temperature extremes.

Parameter	Test Conditions		Min ⁽²⁾	Typ ⁽³⁾	Max ⁽²⁾	Units
I _{DD}	Supply Current	V _{IN} = GND	LMV1015-15		180	300
			LMV1015-25		141	325 250 300
SNR	Signal to Noise Ratio	f = 1 kHz, V _{IN} = 18 mV _{PP} , A-Weighted	LMV1015-15		60	
			LMV1015-25		61	
V _{IN}	Max Input Signal	f = 1 kHz and THD+N < 1%	LMV1015-15		100	
			LMV1015-25		28	
V _{OUT}	Output Voltage	V _{IN} = GND	LMV1015-15	1.54 1.48	1.81	1.94
			LMV1015-25	1.65 1.49	1.90	2.00 2.02 2.18
f _{LOW}	Lower -3dB Roll Off Frequency	R _{SOURCE} = 50Ω			65	
f _{HIGH}	Upper -3dB Roll Off Frequency	R _{SOURCE} = 50Ω			95	
e _n	Output Noise	A-Weighted	LMV1015-15		-89	
			LMV1015-25		-82	
THD	Total Harmonic Distortion	f = 1 kHz, V _{IN} = 18 mV _{PP}	LMV1015-15		0.09	
			LMV1015-25		0.15	
C _{IN}	Input Capacitance				2	
Z _{IN}	Input Impedance				>1000	
A _V	Gain	f = 1 kHz, R _{SOURCE} = 50Ω	LMV1015-15	14.0 13.1	15.6	16.9 17.5
			LMV1015-25	22.5 21.4	23.8	25.0 25.7

- (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 specification 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.

5V Electrical Characteristics⁽¹⁾

Unless otherwise specified, all limits ensured for $T_J = 25^\circ\text{C}$, $V_{DD} = 5\text{V}$, $V_{IN} = 18\text{ mV}_{PP}$, $R_L = 2.2\text{ k}\Omega$ and $C = 2.2\text{ }\mu\text{F}$. **Boldface** limits apply at the temperature extremes.

Parameter		Test Conditions		Min ⁽²⁾	Typ ⁽³⁾	Max ⁽²⁾	Units
I_{DD}	Supply Current	$V_{IN} = \text{GND}$	LMV1015-15		200	300 325	μA
			LMV1015-25		160	250 300	
SNR	Signal to Noise Ratio	$f = 1\text{ kHz}$, $V_{IN} = 18\text{ mV}_{PP}$, A-Weighted	LMV1015-15		60		dB
			LMV1015-25		61		
V_{IN}	Max Input Signal	$f = 1\text{ kHz}$ and $\text{THD+N} < 1\%$	LMV1015-15		100		mV_{PP}
			LMV1015-25		28		
V_{OUT}	Output Voltage	$V_{IN} = \text{GND}$	LMV1015-15	4.34 4.28	4.56	4.74 4.80	V
			LMV1015-25	4.45 4.39	4.65	4.83 4.86	
f_{LOW}	Lower -3dB Roll Off Frequency	$R_{SOURCE} = 50\Omega$			67		Hz
f_{HIGH}	Upper -3dB Roll Off Frequency	$R_{SOURCE} = 50\Omega$			150		kHz
e_n	Output Noise	A-Weighted	LMV1015-15		-89		dBV
			LMV1015-25		-82		
THD	Total Harmonic Distortion	$f = 1\text{ kHz}$, $V_{IN} = 18\text{ mV}_{PP}$	LMV1015-15		0.13		$\%$
			LMV1015-25		0.21		
C_{IN}	Input Capacitance				2		pF
Z_{IN}	Input Impedance				>1000		$\text{G}\Omega$
A_V	Gain	$f = 1\text{ kHz}$, $R_{SOURCE} = 50\Omega$	LMV1015-15	14.0 13.1	15.6	16.9 17.5	dB
			LMV1015-25	22.5 21.2	23.9	25.1 25.9	

(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 specification 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.

Connection Diagram

Top View

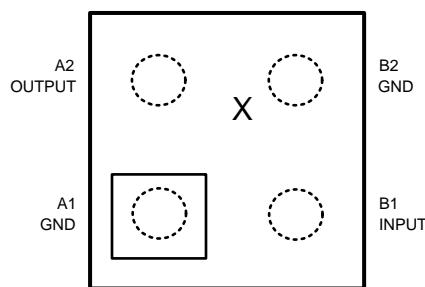


Figure 1. Large Dome 4-Bump DSBGA Package

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.

Typical Performance Characteristics

Unless otherwise specified, $V_S = 2.2V$, $R_L = 2.2\text{ k}\Omega$, $C = 2.2\text{ }\mu\text{F}$, single supply, $T_A = 25^\circ\text{C}$

Supply Current vs. Supply Voltage (LMV1015-15)

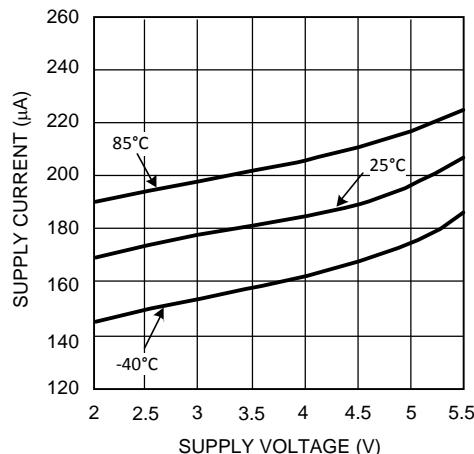


Figure 2.

Supply Current vs. Supply Voltage (LMV1015-25)

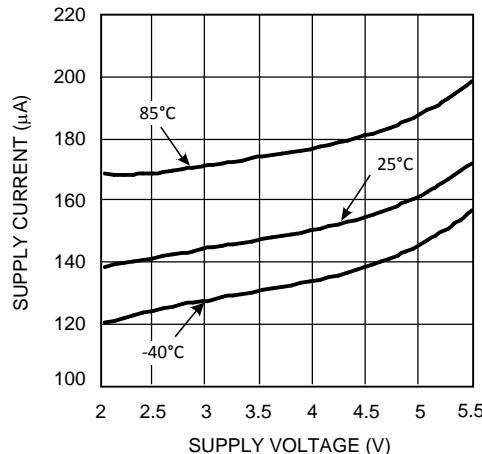


Figure 3.

Gain and Phase vs. Frequency (LMV1015-15)

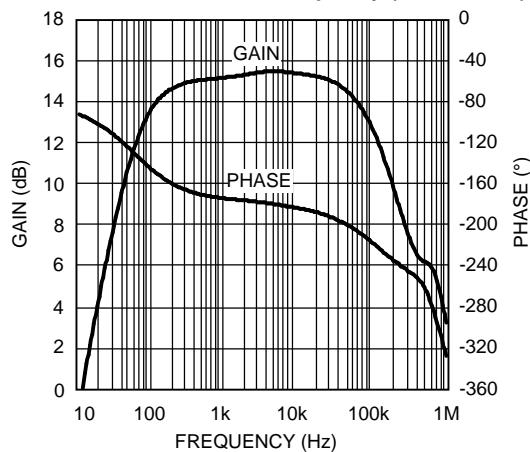


Figure 4.

Gain and Phase vs. Frequency (LMV1015-25)

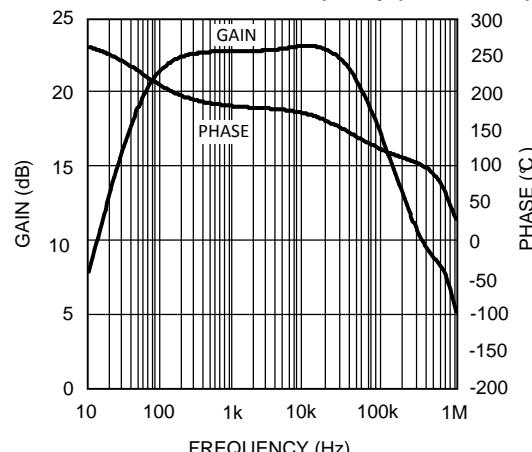


Figure 5.

Total Harmonic Distortion vs. Frequency (LMV1015-15)

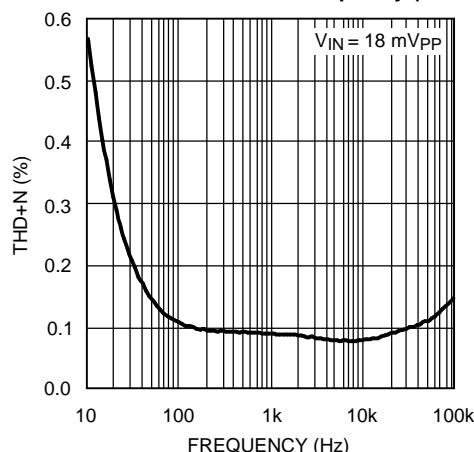


Figure 6.

Total Harmonic Distortion vs. Frequency (LMV1015-25)

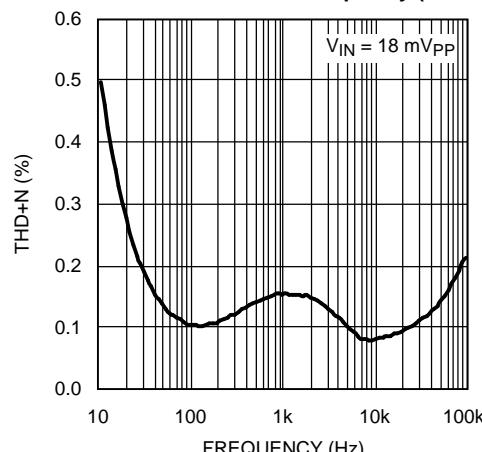


Figure 7.

Typical Performance Characteristics (continued)

Unless otherwise specified, $V_S = 2.2V$, $R_L = 2.2\text{ k}\Omega$, $C = 2.2\text{ }\mu\text{F}$, single supply, $T_A = 25^\circ\text{C}$

Total Harmonic Distortion vs. Input Voltage (LMV1015-15)

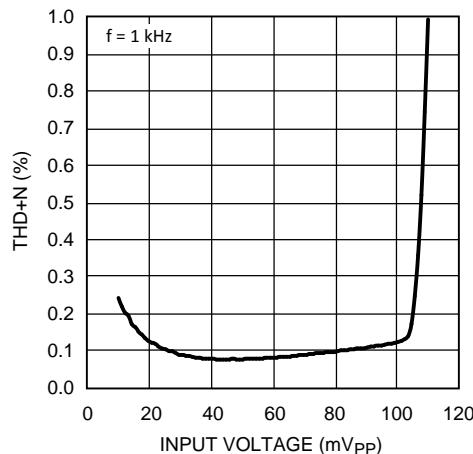


Figure 8.

Total Harmonic Distortion vs. Input Voltage (LMV1015-25)

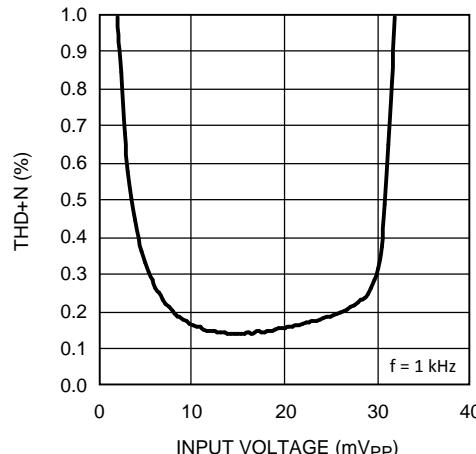


Figure 9.

Output Noise vs. Frequency (LMV1015-15)

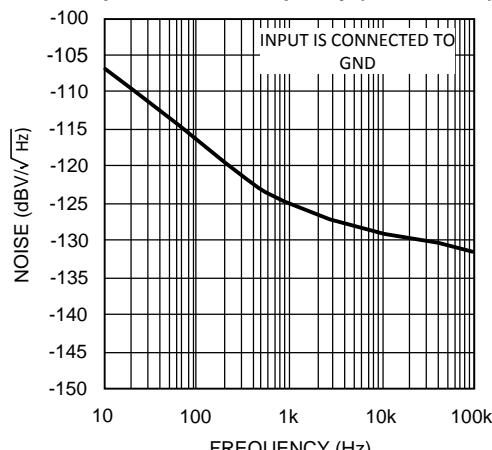


Figure 10.

Output Noise vs. Frequency (LMV1015-25)

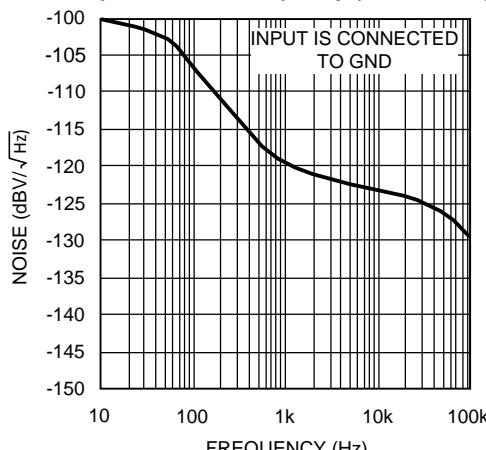


Figure 11.

APPLICATION SECTION

HIGH GAIN

The LMV1015 series provides outstanding gain versus the JFET and still maintains the same ease of implementation, with improved gain, linearity and temperature stability. A high gain eliminates the need for extra external components.

BUILT IN GAIN

The LMV1015 is offered in 0.3 mm height space saving small 4-pin DSBGA packages in order to fit inside the different size ECM canisters of a microphone. The LMV1015 is placed on the PCB inside the microphone using Large Dome Bump technology (LDB).

The bottom side of the PCB usually shows a bull's eye pattern where the outer ring, which is shorted to the metal can, should be connected to the ground. The center dot on the PCB is connected to the V_{DD} through a resistor. This phantom biasing allows both supply voltage and output signal on one connection.

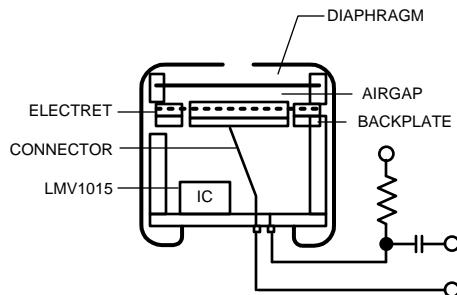


Figure 12. Built in Gain

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.

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

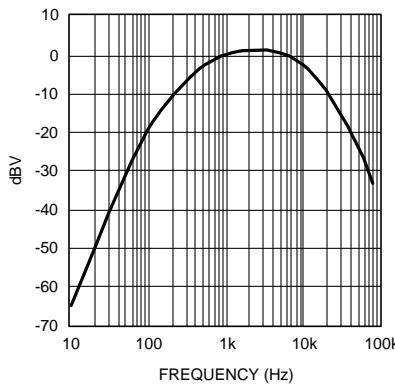


Figure 13. A-Weighted Filter

MEASURING NOISE AND SNR

The overall noise of the LMV1015 is measured within the frequency band from 10 Hz to 22 kHz using an A-weighted filter. The input of the LMV1015 is connected to ground with a 5 pF capacitor, as in [Figure 14](#). Special precautions in the internal structure of the LMV1015 have been taken to reduce the noise on the output.

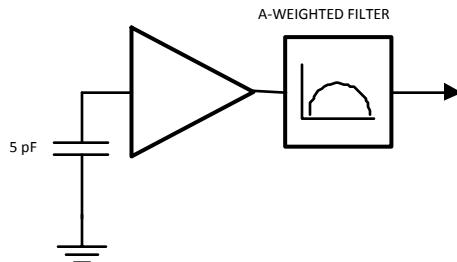


Figure 14. Noise Measurement Setup

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 SPL. No input capacitor is connected for the measurement.

SOUND PRESSURE LEVEL

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

$$\text{Sound pressure level (dB)} = 20 \log \frac{P_m}{P_0}$$

Where,

P_m is the measured sound pressure

P_0 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 referred to 1 Pascal (Pa).

The conversion is given by:

$$\text{dBPa} = \text{dB SPL} + 20 \log 20 \mu\text{Pa}$$

$$\text{dBPa} = \text{dB SPL} - 94 \text{ dB}$$

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.

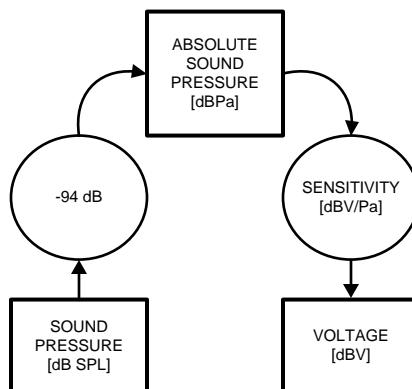


Figure 15. dB SPL to dBV Conversion

Example: Busy traffic is 70 dB SPL.

$$V_{\text{OUT}} = 70 - 94 - 44 = -68 \text{ dBV. This is equivalent to } 1.13 \text{ mV}_{\text{PP}}$$

Since the LMV1015-15 has a gain of 6 (15.6 dB) over the JFET, the output voltage of the microphone is 6.78 mV_{PP}. By implementing the LMV1015-15, the sensitivity of the microphone is -28.4 dBV/Pa (-44 + 15.6).

LOW FREQUENCY CUT OFF FILTER

To reduce noise on the output of the microphone a low frequency cut off filter has been implemented. This filter reduces the effect of wind and handling noise.

It's also helpful 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.

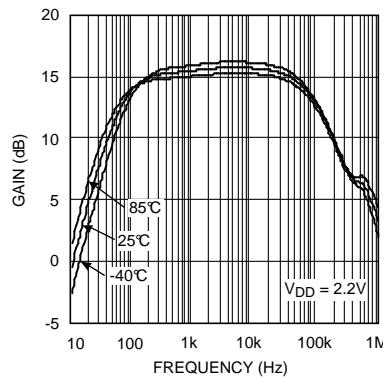


Figure 16. LMV1015-15 Gain vs. Frequency Over Temperature

The LMV1015 is optimized to be used in audio band applications. By using the LMV1015, the gain response is flat within the audio band and has linearity and temperature stability [Figure 16](#).

NOISE

Noise pick-up by a microphone in cell phones is a well-known problem. A conventional JFET circuit is sensitive for noise pick-up because of its high output impedance, which is usually around 2.2 kΩ.

RF noise is amongst other caused by non-linear behavior. The non-linear behavior of the amplifier at high frequencies, well above the usable bandwidth of the device, causes AM-demodulation of high frequency signals. The AM modulation contained in such signals folds back into the audio band, thereby disturbing the intended microphone signal. The GSM signal of a cell phone is such an AM-modulated signal. The modulation frequency of 216 Hz and its harmonics can be observed in the audio band. This kind of noise is called bumblebee noise.

RF noise caused by a GSM signal can be reduced by connecting two external capacitors to ground, see [Figure 17](#). One capacitor reduces the noise caused by the 900 MHz carrier and the other reduces the noise caused by 1800/1900 MHz.

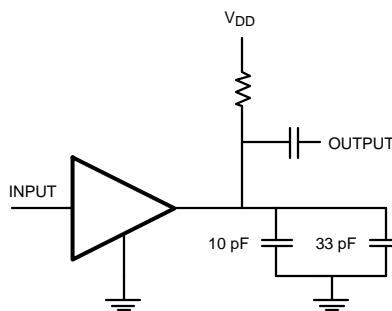


Figure 17. RF Noise Reduction

REVISION HISTORY

Changes from Revision A (April 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format	8

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LMV1015UR-25/NOPB	Active	Production	DSBGA (YPD) 4	250 SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-	
LMV1015UR-25/NOPB.A	Active	Production	DSBGA (YPD) 4	250 SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	See LMV1015UR-25/ NOPB	

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

⁽²⁾ **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.

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

⁽⁴⁾ **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.

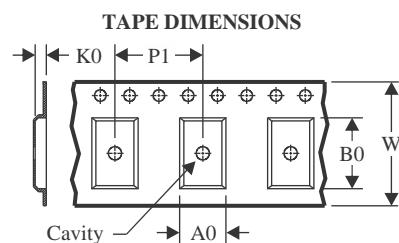
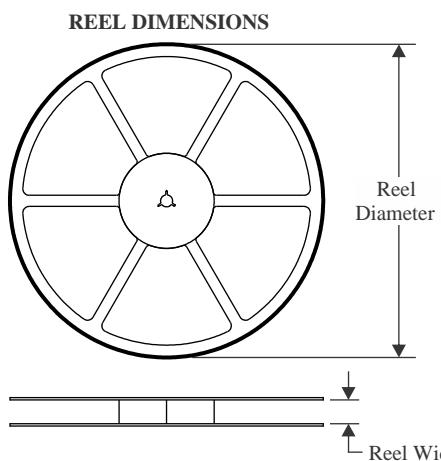
⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will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

⁽⁶⁾ **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.

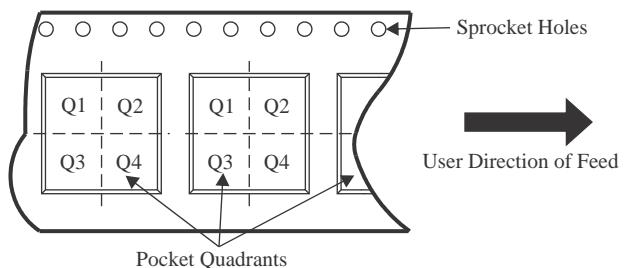
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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.

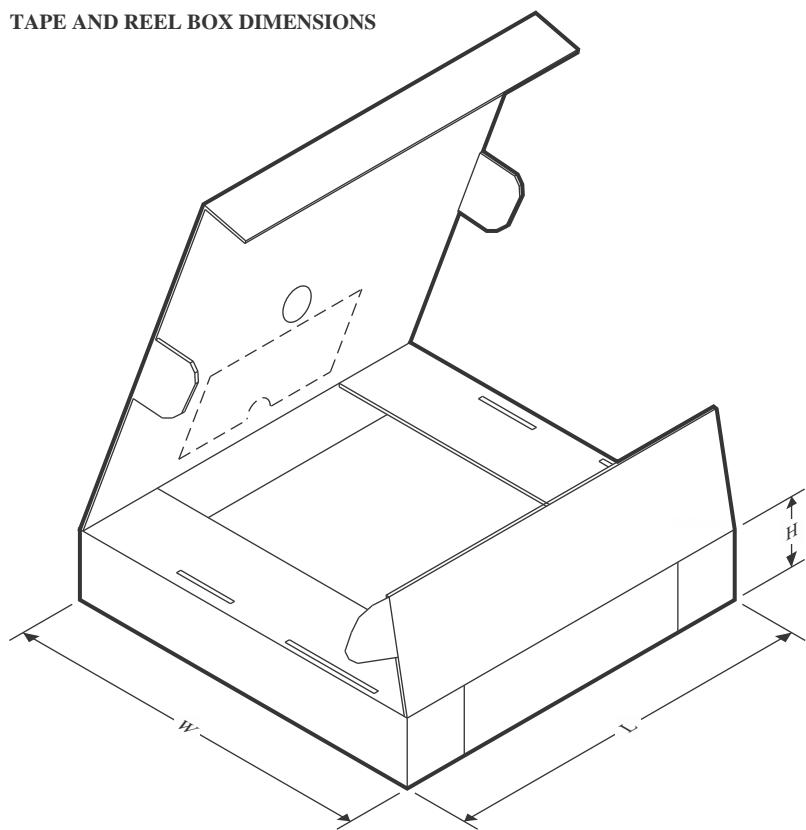
TAPE AND REEL INFORMATION


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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


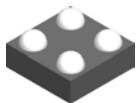
*All dimensions are nominal

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
LMV1015UR-25/NOPB	DSBGA	YPD	4	250	178.0	8.4	1.02	1.09	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)
LMV1015UR-25/NOPB	DSBGA	YPD	4	250	208.0	191.0	35.0

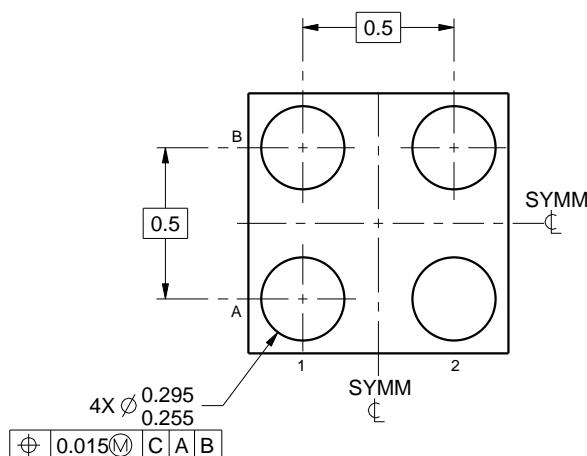
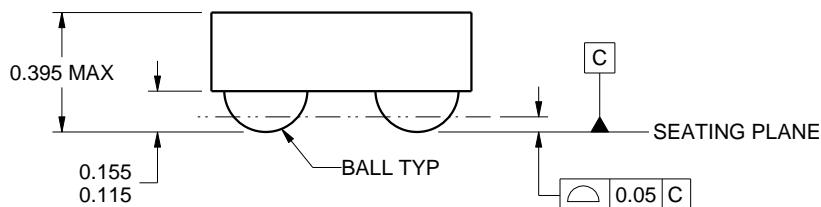
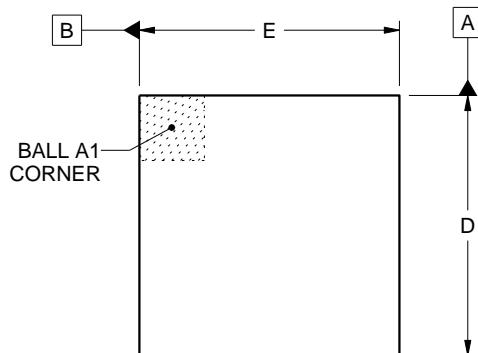


PACKAGE OUTLINE

YPD0004

DSBGA - 0.395 mm max height

DIE SIZE BALL GRID ARRAY



D: Max = 1.057 mm, Min = 0.996 mm
E: Max = 0.981 mm, Min = 0.92 mm

4215141/B 08/2016

NOTES:

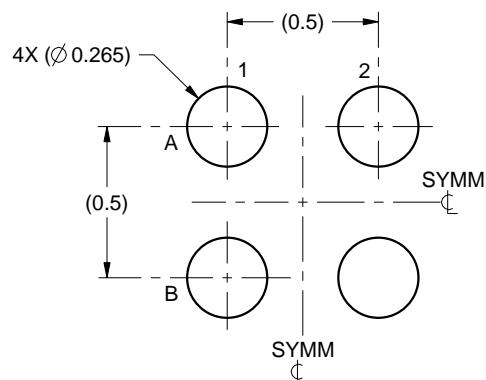
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

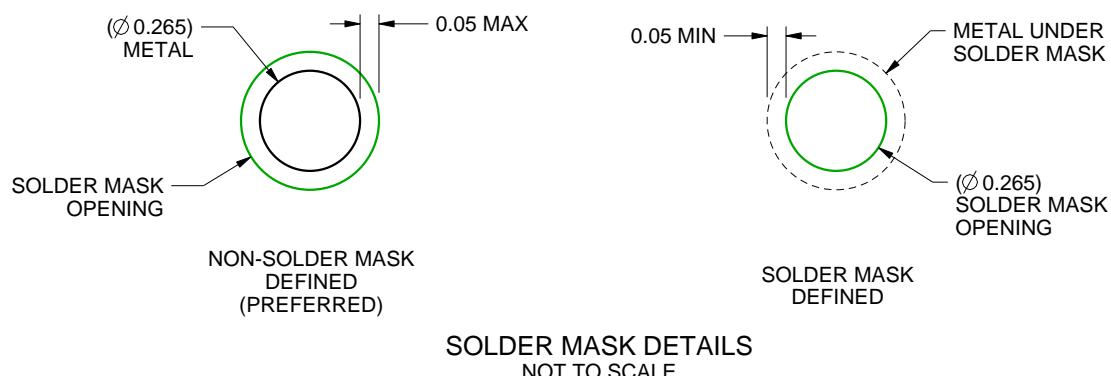
YPD0004

DSBGA - 0.395 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE
SCALE:40X



4215141/B 08/2016

NOTES: (continued)

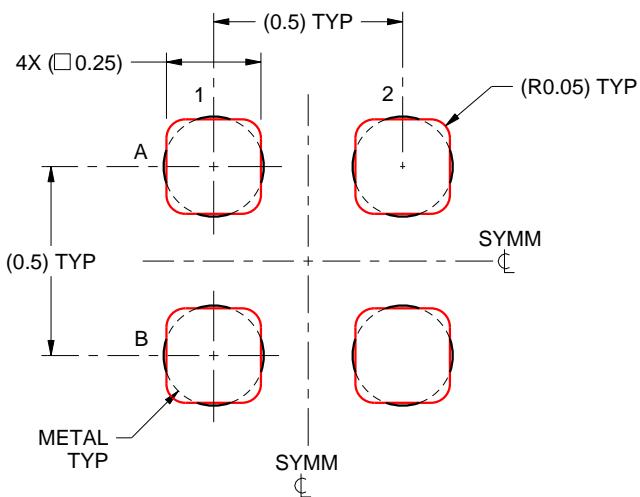
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YPD0004

DSBGA - 0.395 mm max height

DIE SIZE BALL GRID ARRAY



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

4215141/B 08/2016

NOTES: (continued)

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

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