

AMPLIFIER FOR HIGH-GAIN TWO-WIRE MICROPHONES

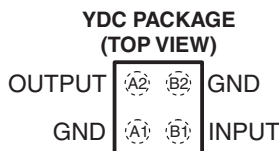
Check for Samples: [TLV1012](#)

FEATURES

- Supply Voltage: 2 V to 5 V
- Supply Current: <180 μ A
- Signal-to-Noise Ratio (A-Weighted): 60 dB
- Output Voltage Noise (A-Weighted): –89 dBV
- Total Harmonic Distortion: 0.013%
- Voltage Gain: 15.6 dB

APPLICATIONS

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



DESCRIPTION/ORDERING INFORMATION

The TLV1012 is an audio amplifier series for small-form-factor electret microphones. This two-wire amplifier is designed to replace JFET amplifiers currently in use. The TLV1012 is ideally suited for applications that require high signal integrity in the presence of ambient or RF noise, such as in cellular communications. The TLV1012 audio amplifier is specified for operation over a 2.2-V to 5-V supply voltage range with a fixed gain of 15.6 dB. The device offers excellent THD, gain accuracy, and temperature stability compared to JFET microphones.

The TLV1012 enables a two-pin electret microphone solution, which provides direct pin-to-pin compatibility with the existing JFET market.

The TLV1012 is offered in a space-saving four-terminal ultra-thin lead-free package (YDC) and is ideally suited for the form factor of miniature electret microphone packages. The TLV1012 is characterized for operation over a free-air temperature range of –40°C to 85°C.

ORDERING INFORMATION⁽¹⁾

T _A	A _V ⁽²⁾	PACKAGE ⁽³⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	15.6 dB	NanoStar™ WCSP (DSBGA) – YDC	Reel of 3000	TLV1012-15YDCR	Y38

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

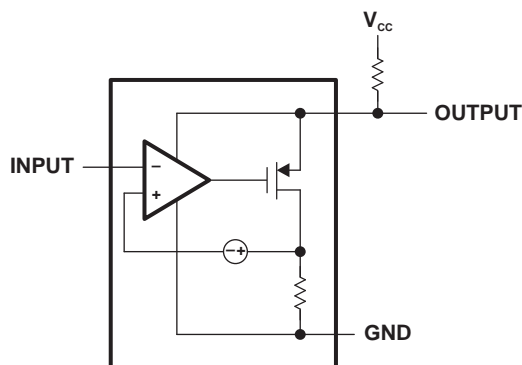
(2) Typical value measured at V_{DD} = 2.2 V, V_{IN} = 18 mV, R_L = 2.2 k Ω , C_L = 2.2 μ F

(3) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



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.

FUNCTIONAL BLOCK DIAGRAM

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

V_{CC}	Supply voltage	–0.3 V to 5.5 V
V_{IN}	Input voltage	–0.3 V to 0.3 V
θ_{JA}	Thermal impedance, junction to free air ⁽²⁾	230.47°C/W
T_A	Operating free-air temperature range	–40°C to 85°C
T_{stg}	Storage temperature range	–65°C to 150°C

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Package thermal impedance is calculated according to JESD 51-5.

RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
V_{CC}	Supply voltage	2	5	V
T_A	Operating free-air temperature	–40	85	°C

2.2-V ELECTRICAL CHARACTERISTICS

 $V_{CC} = 2.2$ V, $V_{IN} = 18$ mV, $R_L = 2.2$ k Ω and $C_L = 2.2$ μ F (unless otherwise noted)

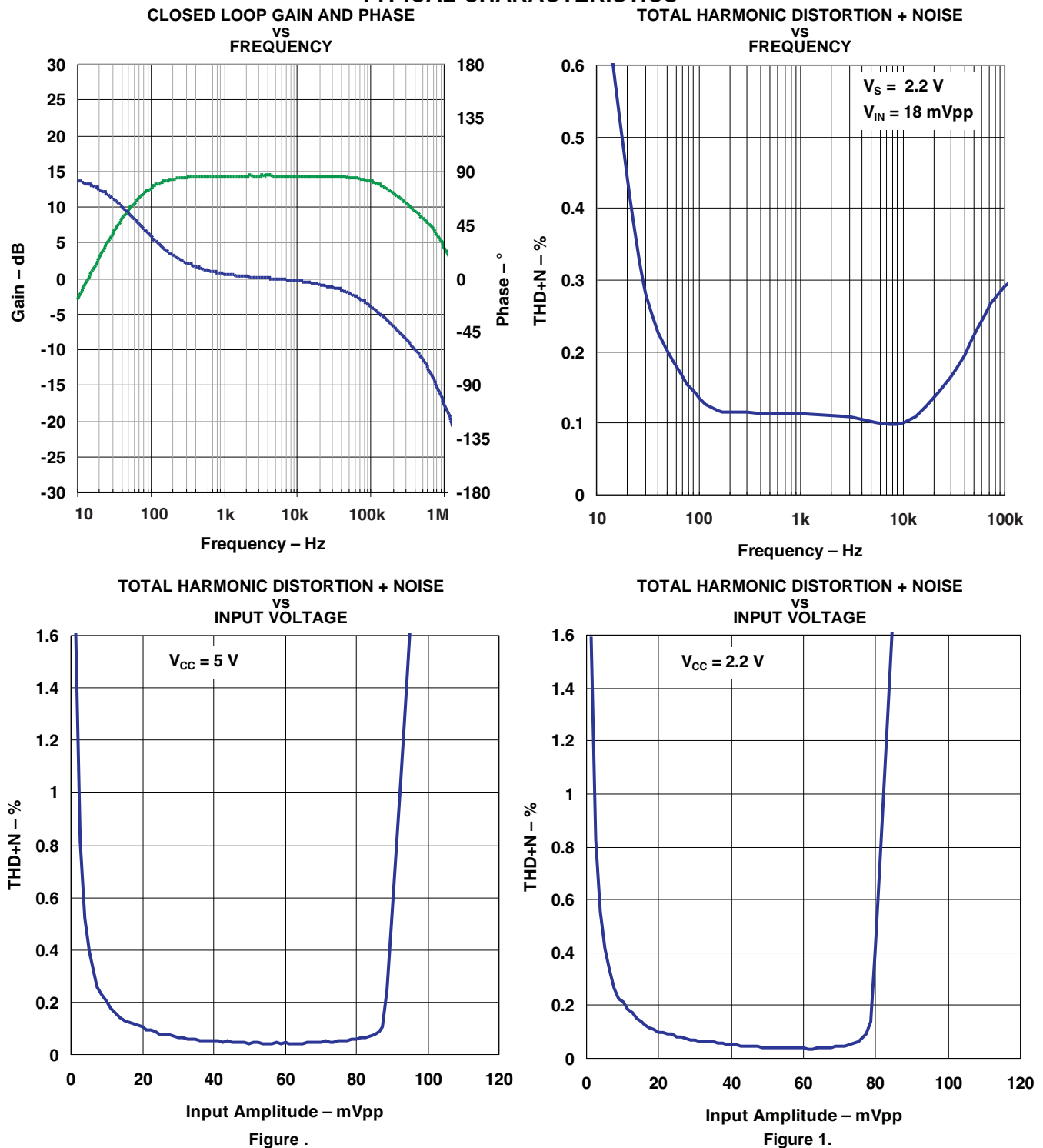
PARAMETER	TEST CONDITIONS	T_J	MIN	TYP	MAX	UNIT
I_{CC}	$V_{IN} = GND$	25°C		150	240	μ A
		Full range			280	
SNR	Signal-to-noise ratio	$f = 1$ kHz, $V_{IN} = 18$ mV _{PP} , A-weighted		60		dB
V_{IN}	Maximum input signal	$f = 1$ kHz, THD+N < 1%		100		mV _{PP}
V_{OUT}	Output voltage	25°C	1.70	1.87	1.94	V
		Full range	1.63		2.00	
f_{LOW}	Lower –3-dB roll-off frequency	$R_{SOURCE} = 50$ Ω		65		Hz
f_{HIGH}	Upper –3-dB roll-off frequency	$R_{SOURCE} = 50$ Ω		95		kHz
V_N	Output noise	A-weighted		–89		dBV
THD	Total harmonic distortion	$f = 1$ kHz, $V_{IN} = 18$ mV _{PP}		0.013		%
C_{IN}	Input capacitance	25°C		2		pF
Z_{IN}	Input impedance	25°C		>1000		G Ω
A_V	Gain	25°C	14.0	15.6	16.9	dB
		Full range	13.1		17.5	

5-V ELECTRICAL CHARACTERISTICS

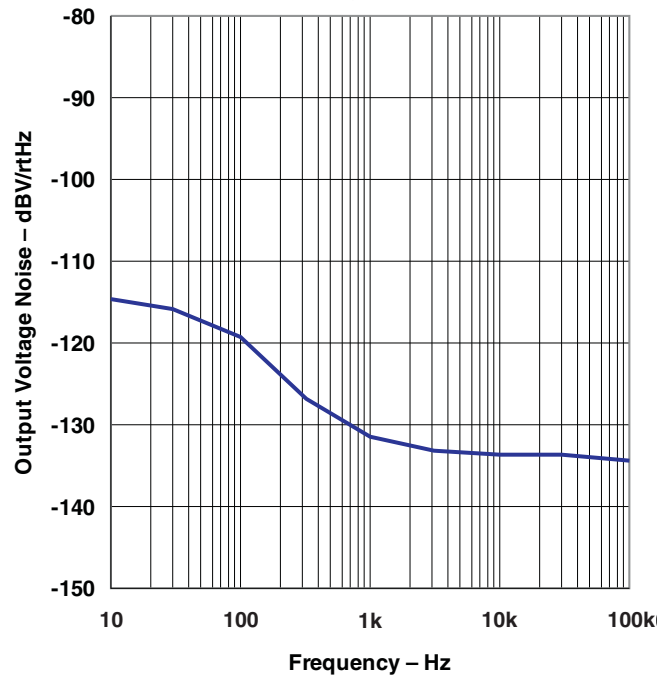
 $V_{CC} = 5\text{ V}$, $V_{IN} = 18\text{ mV}$, $R_L = 2.2\text{ k}\Omega$ and $C_L = 2.2\text{ }\mu\text{F}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_J	MIN	TYP	MAX	UNIT
I_{CC}	Supply current	$V_{IN} = \text{GND}$	25°C		160	300	μA
			Full range			325	
SNR	Signal-to-noise ratio	$f = 1\text{ kHz}$, $V_{IN} = 18\text{ mV}_{PP}$, A-weighted	25°C		60		dB
V_{IN}	Maximum input signal	$f = 1\text{ kHz}$, $\text{THD+N} < 1\%$	25°C		100		mV_{PP}
V_{OUT}	Output voltage	$V_{IN} = \text{GND}$	25°C	4.34	4.56	4.74	V
			Full range	4.28		4.80	
f_{LOW}	Lower –3-dB roll-off frequency	$R_{SOURCE} = 50\text{ }\Omega$	25°C		67		Hz
f_{HIGH}	Upper –3-dB roll-off frequency	$R_{SOURCE} = 50\text{ }\Omega$	25°C		150		kHz
V_N	Output noise	A-weighted	25°C		–89		dBV
THD	Total harmonic distortion	$f = 1\text{ kHz}$, $V_{IN} = 18\text{ mV}_{PP}$	25°C		0.013		%
C_{IN}	Input capacitance		25°C		2		pF
Z_{IN}	Input impedance		25°C		>1000		$\text{G}\Omega$
A_V	Gain	$f = 1\text{ kHz}$, $R_{SOURCE} = 50\text{ }\Omega$	25°C	14.0	15.6	16.9	dB
			Full range	13.1		17.5	

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS (continued)
OUTPUT VOLTAGE NOISE
VS
FREQUENCY



APPLICATION INFORMATION

High Gain

The TLV1012 provides outstanding gain compared to JFET amplifiers 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 TLV1012 is offered in the space-saving YDC package, which fits perfectly into the metal can of a microphone. This allows the TLV1012 to be placed on the PCB inside the microphone.

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_{CC} through a resistor. This phantom biasing allows both supply voltage and output signal on one connection.

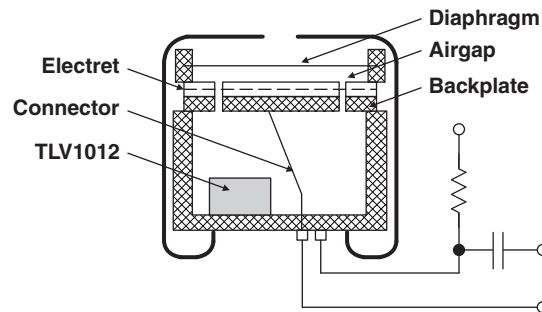


Figure 2. Built-In Gain

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. It improves the correlation of the measured data to the signal-to-noise ratio perceived by the human ear.

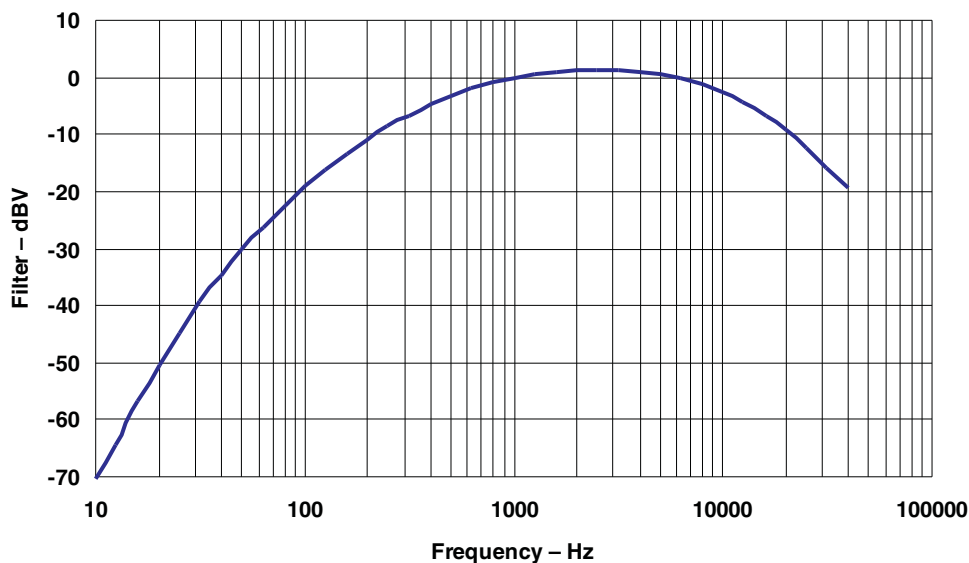


Figure 3. A-Weighted Filter

Measuring Noise and SNR

The overall noise of the TLV1012 is measured within the frequency band from 10 Hz to 22 kHz using an A-weighted filter. The input of the TLV1012 is connected to ground with a 5-pF capacitor.

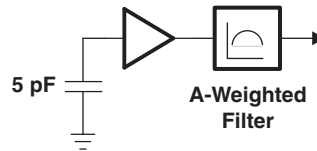


Figure 4. Noise Measurement

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 dBSPL. No input capacitor is connected.

Sound Pressure Level

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

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

Where P_m is the measured sound pressure, and P_0 is the threshold of hearing (20 μ Pa).

To calculate the resulting output voltage of the microphone for a given sound pressure level, the sound pressure in dBSPL needs to be converted to the absolute sound pressure in dBP_a. This is the sound pressure level in decibels, which is referred to as 1 Pascal (Pa).

The conversion is given by:

$$\text{dBP}_a = \text{dBSPL} + 20 \log 20 \mu\text{Pa}$$

$$\text{dBP}_a = \text{dBSPL} - 94 \text{ dB}$$

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.

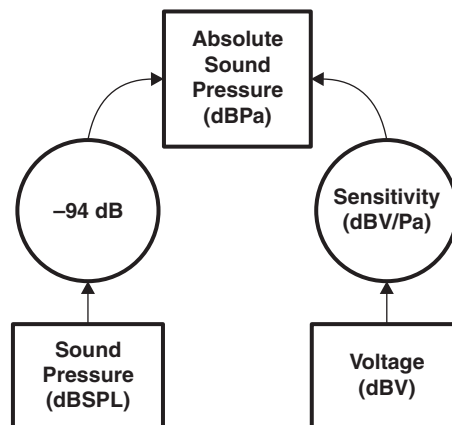


Figure 5. dB SPL to dBV Conversion

For example, busy traffic is 70 dBSPL:

$$V_{OUT} = 70 - 94 - 44 = -68 \text{ dBV}$$

This is equivalent to 1.13 mV_{PP}.

Because the TLV1012-15 has a gain of 6 (15.6 dB) over the JFET, the output voltage of the microphone is 6.78 mV_{PP}. By replacing the JFET with the TLV1012-15, 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-cut filter is implemented in the TLV1012. This filter reduces the effect of wind and handling noise.

It is 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.

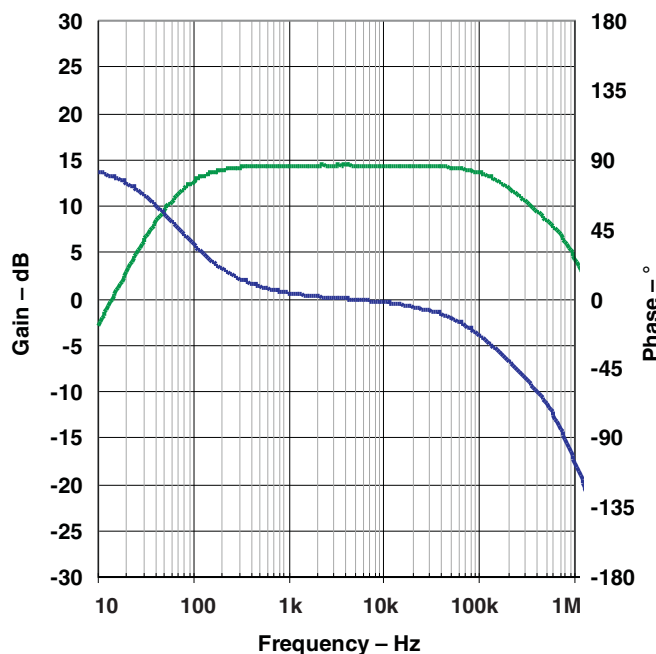


Figure 6. Gain and Phase vs Frequency

The TLV1012 is optimized to be used in audio-band applications. The TLV1012 provides a flat gain response within the audio band and offers linearity and excellent temperature stability.

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 k Ω .

RF noise is among other noises caused by nonlinear behavior. The nonlinear 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 7](#)). One capacitor reduces the noise caused by the 900-MHz carrier, and the other reduces the noise caused by 1800/1900 MHz.

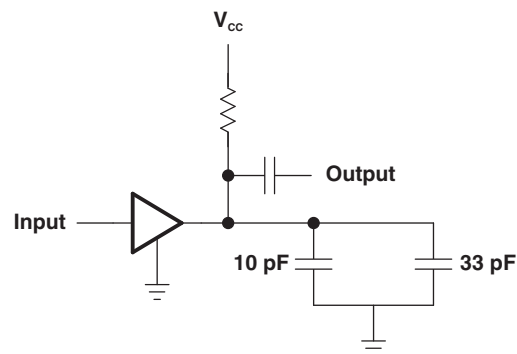


Figure 7. RF Noise Reduction

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
TLV1012-15YDCR	OBSOLETE	DSBGA	YDC	4		TBD	Call TI	Call TI	-40 to 85	Y3 8	

(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) 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.

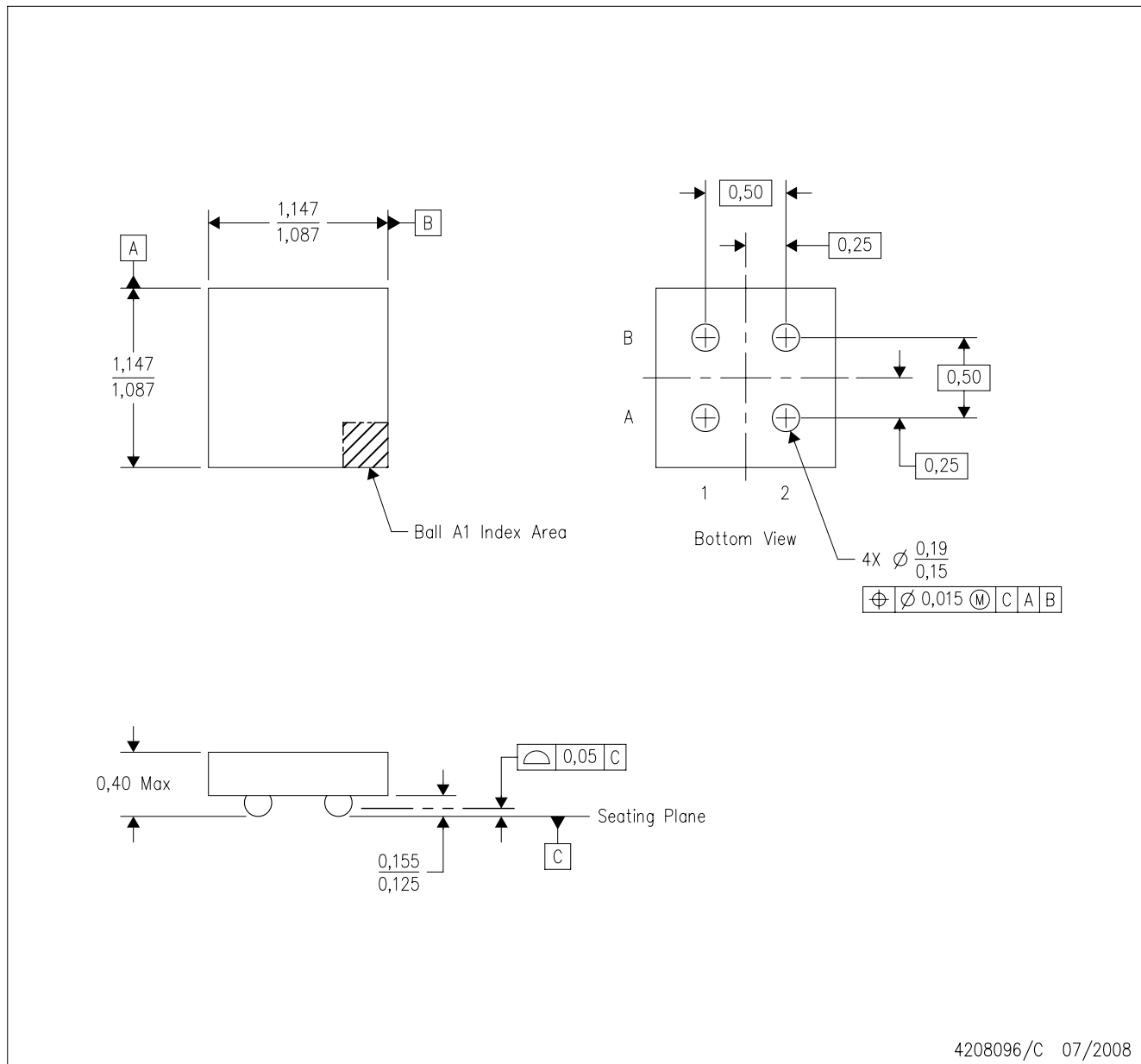
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

YDC (S-XBGA-N4)

DIE-SIZE BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. NanoFree™ package configuration.
 - D. This package contains lead-free solder balls.

NanoFree is a trademark of Texas Instruments.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com