

AFE5832 32-Channel Ultrasound AFE With 35-mW/Channel Power, 2.1 nV/ $\sqrt{\text{Hz}}$ Noise, 12-Bit, 40-MSPS or 10-Bit, 50-MSPS Output, Passive CW Mixer and LVDS Interface

1 Features

- 32-Channel, AFE for Ultrasound Applications:
 - Input Attenuator, LNA, LPF, ADC, and CW Mixer
 - Digital Time Gain Compensation (DTGC)
 - Total Gain Range: 12 dB to 51 dB
 - Linear Input Range: 800 mV_{PP}
- Input Attenuator With DTGC:
 - 8-dB to 0-dB Attenuation With 0.125-dB Step
 - Supports Matched Impedance for:
 - 50- Ω to 800- Ω Source Impedance
- Low-Noise Amplifier (LNA) With DTGC:
 - 20-dB to 51-dB Gain With 0.125-dB Step
 - Low Input Current Noise: 1.2 pA/ $\sqrt{\text{Hz}}$
- 3rd-Order, Linear-Phase, Low-Pass Filter (LPF):
 - 5 MHz, 7.5 MHz, 10 MHz, and 12.5 MHz
- 16 ADCs Converting at 12-Bit, 80 MSPS or 10-bit, 100 MSPS:
 - Each ADC Converts Two Sets of Inputs at Half Rate
 - 12-Bit ADC: 72-dBFS SNR
 - 10-Bit ADC: 61-dBFS SNR
- Optimized for Noise and Power:
 - 35 mW/Ch at 2.1 nV/ $\sqrt{\text{Hz}}$, 40 MSPS
 - 42 mW/Ch at 1.4 nV/ $\sqrt{\text{Hz}}$, 40 MSPS
 - 52 mW/Ch at 1.3 nV/ $\sqrt{\text{Hz}}$, 40 MSPS
 - 60 mW/Ch in CW Mode
- Excellent Device-to-Device Gain Matching:
 - ± 0.5 dB (Typical)

- Low Harmonic Distortion: -55 dBc
- Fast and Consistent Overload Recovery
- Continuous Wave (CW) Path With:
 - Low Close-In Phase Noise of -151 dBc/Hz at 1-kHz Frequency Offset Off 2.5-MHz Carrier
 - Phase Resolution: $\lambda / 16$
 - Supports 16X CW Clock
 - 12-dB Suppression on Third and Fifth Harmonics
- LVDS Interface With a Speed Up to 1 Gbps
- Small Package: 15-mm \times 15-mm NFBGA-289

2 Applications

- Medical Ultrasound Imaging
- Nondestructive Evaluation Equipment
- Sonar Imaging Equipment
- Multichannel, High-Speed Data Acquisition

3 Description

The AFE5832 device is a highly-integrated, analog front-end solution specifically designed for ultrasound systems where high performance, low power, and small size are required.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
AFE5832	NFBGA (289)	15.00 mm \times 15.00 mm

(1) For all available packages, see the package option addendum at the end of the datasheet.

Simplified Block Diagram

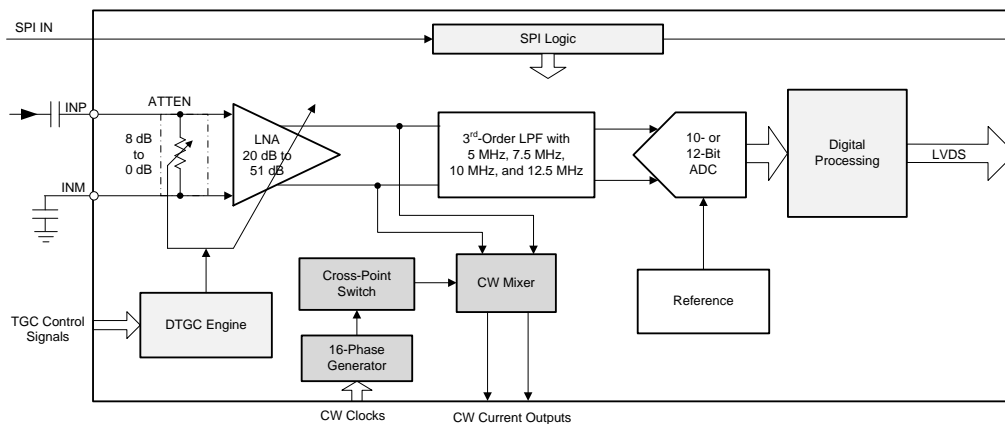


Table of Contents

1 Features	1	6.2 Receiving Notification of Documentation Updates	4
2 Applications	1	6.3 Community Resources.....	4
3 Description	1	6.4 Trademarks	4
4 Revision History	2	6.5 Electrostatic Discharge Caution	4
5 Description (continued)	3	6.6 Glossary	4
6 Device and Documentation Support	4	7 Mechanical, Packaging, and Orderable Information	5
6.1 Documentation Support	4	7.1 Tray Information	6

4 Revision History

Changes from Original (August 2017) to Revision A	Page
• Changed <i>Power</i> and <i>Noise</i> values in the Title	1
• Added values for Ultra low-power mode in <i>Features</i> section	1

5 Description (continued)

The AFE5832 is an integrated analog front-end (AFE) optimized for medical ultrasound application. The device is realized through a multichip module (MCM) with three dies: two voltage-controlled amplifier (VCA) dies and one analog-to-digital converter (ADC) die. Each VCA die has 16 channels and the ADC die converts all of the 32 channels.

Each channel in the VCA die is configured in either of two modes: time gain compensation (TGC) mode or continuous wave (CW) mode. In TGC mode, each channel includes an input attenuator (ATTEN), a low-noise amplifier (LNA) with variable-gain, and a third-order, low-pass filter (LPF). The attenuator supports an attenuation range of 8 dB to 0 dB, and the LNA supports gain ranges from 20 dB to 51 dB. The LPF cutoff frequency can be configured at 5 MHz, 7.5 MHz, 10 MHz, or 12.5 MHz to support ultrasound applications with different frequencies. In CW mode, each channel includes an LNA with a fixed gain of 18 dB, and a low-power passive mixer with 16 selectable phase delays. Different phase delays can be applied to each analog input signal to perform an on-chip beamforming operation. A harmonic filter in the CW mixer suppresses the third and fifth harmonic to enhance the sensitivity of the CW Doppler measurement.

The ADC die has 16 physical ADCs. Each ADC converts two sets of outputs – one from each VCA die. The ADC is configured to operate with a resolution of 12 bits or 10 bits. The ADC resolution can be traded off with conversion rate, and operates at maximum speeds of 80 MSPS and 100 MSPS at 12-bit and 10-bit resolution, respectively. The ADC is designed to scale its power with sampling rate. The output interface of the ADC comes out through a low-voltage differential signaling (LVDS) which can easily interface with low-cost field-programmable gate arrays (FPGAs).

The AFE5832 also allows various power and noise combinations to be selected for optimizing system performance. Therefore, this device is a suitable ultrasound AFE solution for systems with strict battery-life requirements.

6 Device and Documentation Support

6.1 Documentation Support

6.1.1 Related Documentation

For related documentation see the following:

- [AFE5818 16-Channel, Ultrasound, Analog Front-End with 140-mW/Channel Power, 0.75-nV/√Hz Noise, 14-Bit, 65-MSPS or 12-Bit, 80-MSPS ADC, and Passive CW Mixer](#)
- [ADS8413 16-BIT, 2-MSPS, LVDS SERIAL INTERFACE, SAR ANALOG-TO-DIGITAL CONVERTER](#)
- [ADS8472 16-BIT, 1-MSPS, PSEUDO-BIPOLAR, FULLY DIFFERENTIAL INPUT, MICROPOWER SAMPLING ANALOG-TO-DIGITAL CONVERTER WITH PARALLEL INTERFACE, REFERENCE](#)
- [CDCE72010 Ten Output High Performance Clock Synchronizer, Jitter Cleaner, and Clock Distributor](#)
- [CDCM7005 3.3-V High Performance Clock Synchronizer and Jitter Cleaner](#)
- [ISO724x High-Speed, Quad-Channel Digital Isolators](#)
- [LMK0480x Low-Noise Clock Jitter Cleaner with Dual Loop PLLs](#)
- [OPA1632 High-Performance, Fully-Differential Audio Operational Amplifier](#)
- [OPA2x11 1.1-nv/√Hz Noise, Low Power, Precision Operational Amplifier](#)
- [SN74AUP1T04 LOW POWER, 1.8/2.5/3.3-V INPUT, 3.3-V CMOS OUTPUT, SINGLE INVERTER GATE](#)
- [THS413x High-Speed, Low-Noise, Fully-Differential I/O Amplifiers](#)
- [MicroStar BGA Packaging Reference Guide](#)

6.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

6.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

6.4 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

6.5 Electrostatic Discharge Caution



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.

6.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

7 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

Tray Information (continued)

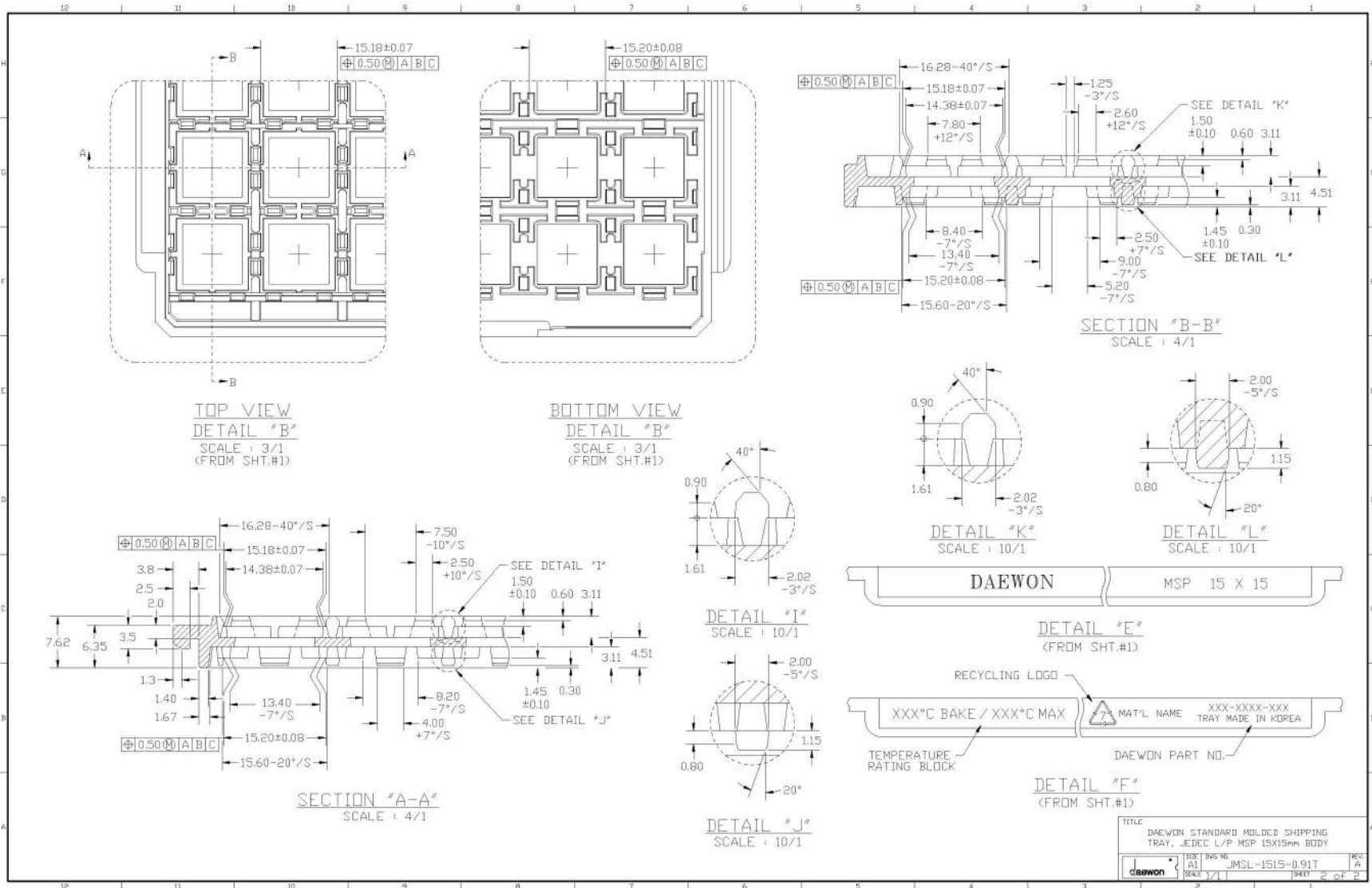


Figure 2. Tray Diagram, Section 2

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
AFE5832ZBV	ACTIVE	NFBGA	ZBV	289	126	RoHS & Green	SNAGCU	Level-3-260C-168 HR	0 to 85	AFE5832	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.

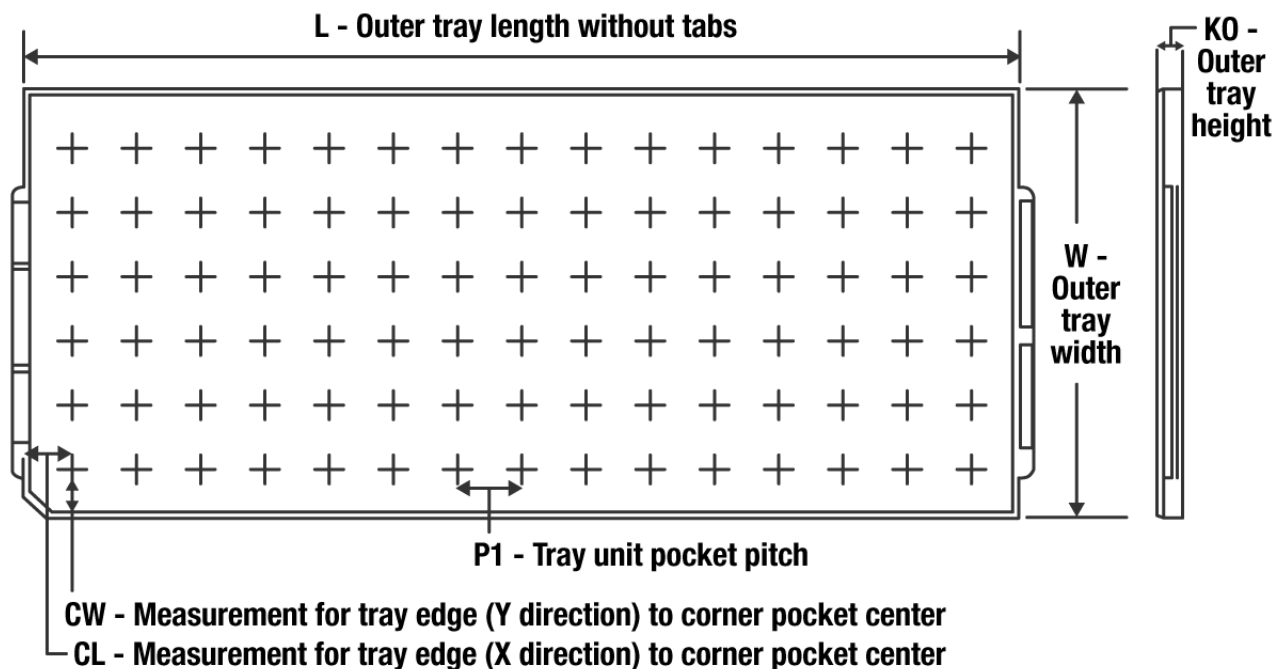
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

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.

TRAY


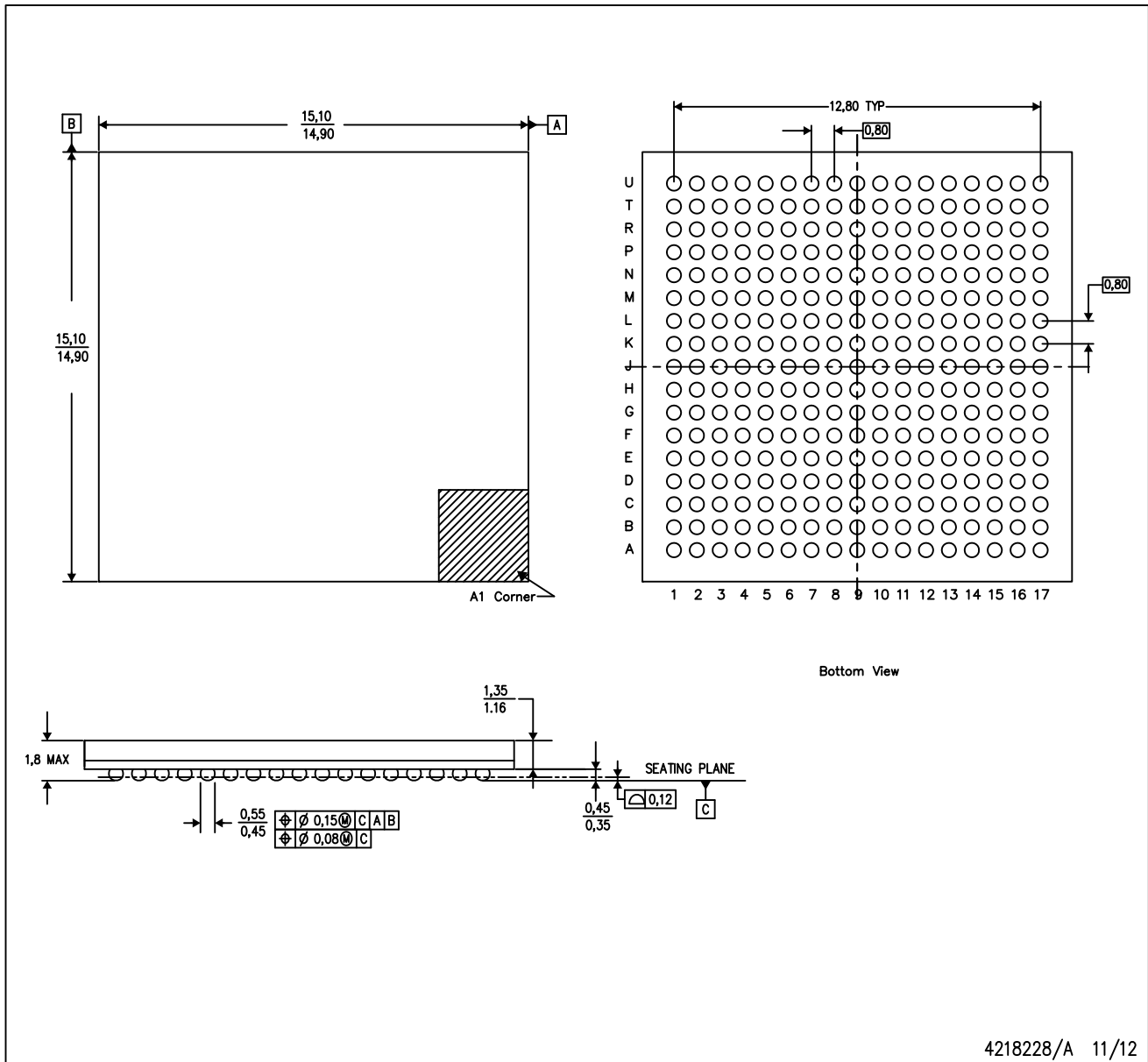
Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
AFE5832ZBV	ZBV	NFBGA	289	126	7 X 18	150	315	135.9	7620	17.2	11.3	16.35

ZBV (S-PBGA-N289)

PLASTIC BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. This is a Pb-free solder ball design.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2022, Texas Instruments Incorporated