



# AFE58JD16 16-Channel Ultrasound AFE with 90-mW/Channel Power, 1-nV/ $\sqrt{\text{Hz}}$ Noise, 14-Bit, 65-MSPS or 12-Bit, 80-MSPS ADC and Passive CW Mixer

## 1 Features

- 16-Channel, AFE for Ultrasound Applications:
  - Input Attenuator, LNA, LPF, ADC, and CW Mixer
  - Digital Time Gain Compensation (DTGC)
  - Total Gain Range: 6 dB to 45 dB
  - Linear Input Range: 1 V<sub>PP</sub>
- 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:
  - 14-dB to 45-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):
  - 10 MHz, 15 MHz, 20 MHz, and 25 MHz
- Analog-to-Digital Converter (ADC):
  - 14-Bit ADC: 75-dBFS SNR at 65 MSPS
  - 12-Bit ADC: 72-dBFS SNR at 80 MSPS
- LVDS Interface with a Maximum Speed Up to 1 GBPS
- Optimized for Noise and Power:
  - 90 mW/Ch at 1 nV/ $\sqrt{\text{Hz}}$ , 65 MSPS
  - 55 mW/Ch at 1.45 nV/ $\sqrt{\text{Hz}}$ , 40 MSPS
  - 59 mW/Ch in CW Mode
- Excellent Device-to-Device Gain Matching:
  - $\pm 0.5$  dB (Typical)
- Low Harmonic Distortion: –60-dBc Level
- Fast and Consistent Overload Recovery
- Continuous Wave (CW) Path with:
  - Low Close-In Phase Noise of –148 dBc/Hz at 1-kHz frequency
  - Phase Resolution:  $\lambda / 16$
  - Supports 16X, 8X, 4X, and 1X CW Clocks
- Digital Features:
  - Digital I/Q Demodulator after ADC:
    - Fractional Decimation Filter M = 1 to 63 with 0.25X Increment Step
    - Data Throughput Reduction After Decimation
    - On-Chip RAM with 32 Preset Profiles
- 5-Gbps JESD Interface:
  - JESD204B Subclass 0, 1, and 2
  - 2, 4, or 8 Channels per JESD Lane
- Small Package: 15-mm × 15-mm NFBGA-289

## 2 Applications

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

## 3 Description

The AFE58JD16 is a highly-integrated, analog front-end (AFE) solution specifically designed for ultrasound systems where high performance, low power, and small size are required.

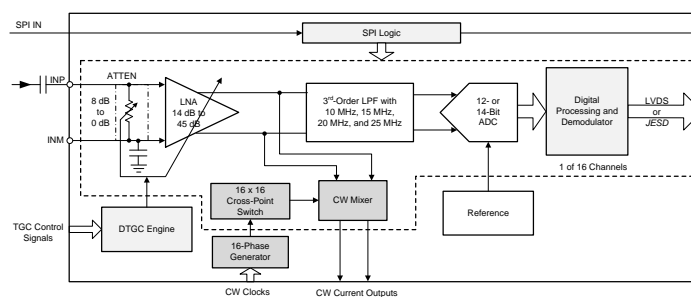
To request a full datasheet or other design resources: [request AFE58JD16](#)

### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
AFE58JD16	nFBGA (289)	15.00 mm × 15.00 mm

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

### Simplified Block Diagram



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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from Original (August 2015) to Revision A</b>	<b>Page</b>
• Added link to request full data sheet .....	<b>1</b>

## 5 Description (continued)

The AFE58JD16 is an integrated analog front-end (AFE) optimized for medical ultrasound application. The AFE58JD16 is a multichip module (MCM) device with two dies: VCA and ADC\_CONV. Each die has total of 16 channels.

Each channel in the VCA die can be configured in two modes: time gain compensation (TGC) mode and 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 14 dB to 45 dB. The LPF cutoff frequency can be configured at 10 MHz, 15 MHz, 20 MHz, or 25 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. CW mode supports three clock modes: 16X, 8X, and 4X.

Each channel of the ADC\_CONV die has a high-performance analog-to-digital converter (ADC) with a programmable resolution of 14 bits or 12 bits. The ADC achieves 75-dBFS signal-to-noise ratio (SNR) in 14-bit mode, and 72-dBFS SNR in 12-bit mode. This ADC provides excellent SNR at low-channel gain. The devices operate at maximum speeds of 65 MSPS and 80 MSPS, providing 14-bit and 12-bit output, respectively. The ADC is designed to scale power with sampling rate. The output interface of the ADC is a low-voltage differential signaling (LVDS) or JESD interface that can easily interface with low-cost field-programmable gate arrays (FPGAs).

The AFE58JD16 includes an optional digital demodulator and JESD204B data packing blocks after the 12- or 14-bit ADC. The digital in-phase and quadrature (I/Q) demodulator with programmable fractional decimation filters accelerates computationally-intensive algorithms at low power. The device also supports an optional JESD204B interface that runs up to 5 Gbps and further reduces the circuit-board routing challenges in high-channel count systems.

The AFE58JD16 also allows various power and noise combinations to be selected for optimizing system performance. Therefore, these devices are suitable ultrasound AFE solutions for systems with strict battery-life requirements. The AFE58JD16 is available in a 15-mm × 15-mm NFBGA-289 package (ZAV package, S-PBGA-N289) and is specified for operation from –40°C to +85°C. The device pinout is also similar to the [AFE5818](#) family.

## 6 Device and Documentation Support

### 6.1 Documentation Support

#### 6.1.1 Related Documentation

AFE5818 Data Sheet, [SBAS687](#)

ADS8413 Data Sheet, [SLAS490](#)

ADS8472 Data Sheet, [SLAS514](#)

CDCE72010 Data Sheet, [SCAS858](#)

CDCM7005 Data Sheet, [SCAS793](#)

ISO7240 Data Sheet, [SLLS868](#)

LMK04803 Data Sheet, [SNAS489](#)

OPA1632 Data Sheet, [SBOS286](#)

OPA2211 Data Sheet, [SBOS377](#)

SN74AUP1T04 Data Sheet, [SCES800](#)

THS4130 Data Sheet, [SLOS318](#)

*MicroStar BGA Packaging Reference Guide*, [SSYZ015](#)

[WEBENCH® Filter Designer](#)

### 6.2 Trademarks

All trademarks are the property of their respective owners.

### 6.3 Electrostatic Discharge Caution



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.

### 6.4 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.

## 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)
<a href="#">AFE58JD16ZAV</a>	Active	Production	NFBGA (ZAV)   289	126   JEDEC TRAY (5+1)	Yes	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE58JD16
AFE58JD16ZAV.A	Active	Production	NFBGA (ZAV)   289	126   JEDEC TRAY (5+1)	Yes	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE58JD16
AFE58JD16ZAV.B	Active	Production	NFBGA (ZAV)   289	126   JEDEC TRAY (5+1)	-	Call TI	Call TI	-40 to 85	

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

<sup>(2)</sup> **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.

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

<sup>(4)</sup> **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.

<sup>(5)</sup> **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.

<sup>(6)</sup> **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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## TRAY



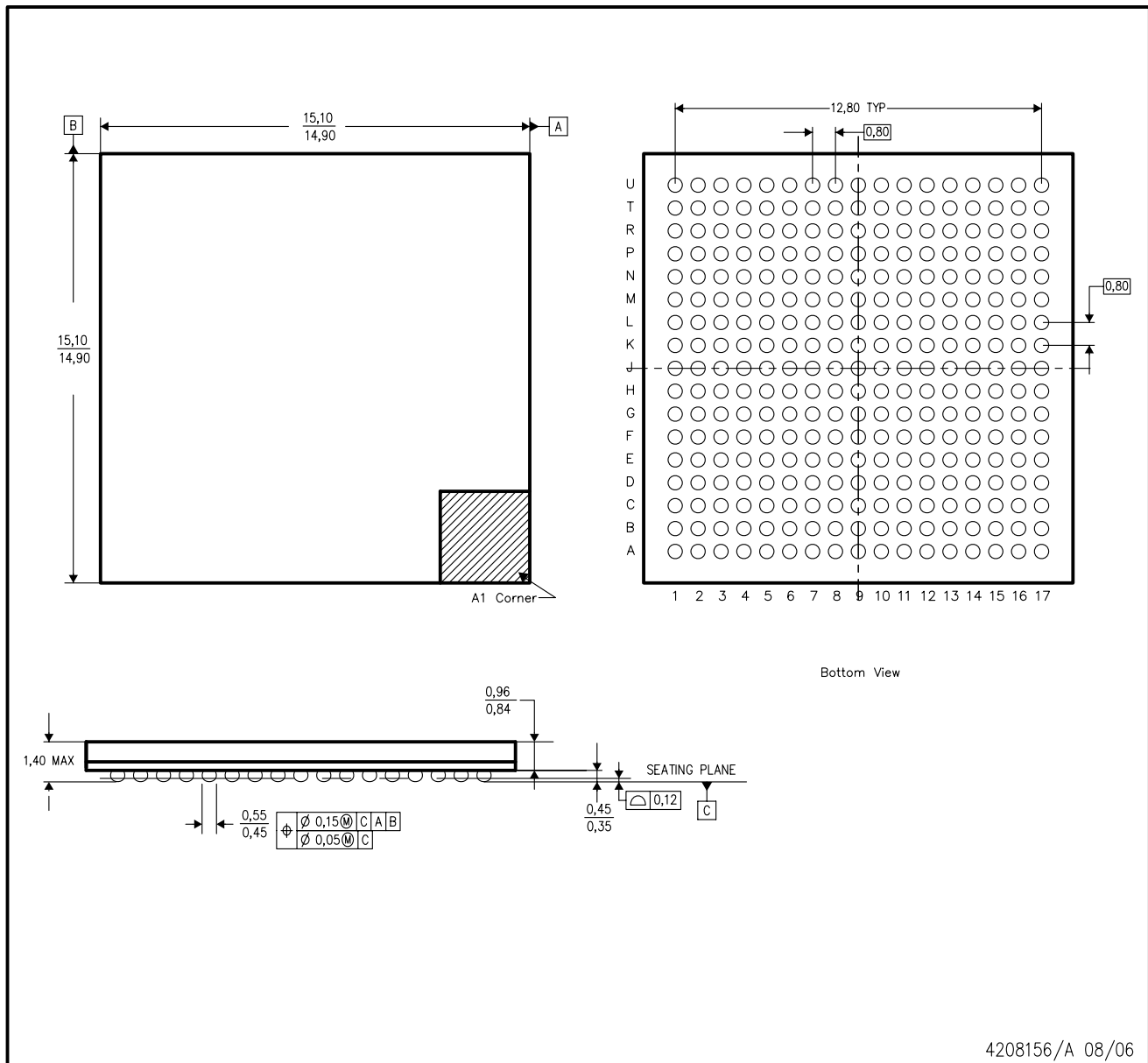
Chamfer on Tray corner indicates Pin 1 orientation of packed units.

\*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)
AFE58JD16ZAV	ZAV	NFBGA	289	126	7 X 18	150	315	135.9	7620	17.2	11.3	16.35
AFE58JD16ZAV.A	ZAV	NFBGA	289	126	7 X 18	150	315	135.9	7620	17.2	11.3	16.35

## ZAV (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 lead-free solder ball design.

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