

AFE5816 16-Channel, Ultrasound, AFE with 90-mW/Channel Power, 0.95-nV/ $\sqrt{\text{Hz}}$ Noise, 14-Bit, 65-MSPS or 12-Bit, 80-MSPS ADC and Passive CW Mixer

1 Features

- 16-Channel, Complete Analog Front-End (AFE):
 - Input Attenuator, LNA, LPF, ADC, and CW Mixer
 - Digital TGC Range (DTGC): 6 dB to 45 dB
 - Linear Input Range: 1 V_{PP}
- Input Attenuator:
 - Digital Time Gain Compensation (DTGC)
 - Attenuation Range: 8 dB to 0 dB
 - Attenuation step: 0.125 dB
 - Supports Different Source Resistance:
 - 50 Ω to 800 Ω
- Low-Noise Amplifier (LNA):
 - Digital TGC (DTGC)
 - Gain Range: 14-dB to 45-dB Gain
 - Gain Step: 0.125 dB
 - Low Input Current Noise: 1.2 pA/ $\sqrt{\text{Hz}}$
- 3rd-Order, Linear-Phase LPF:
 - 10 MHz, 15 MHz, 20 MHz, and 25 MHz
- Analog-to-Digital Converter (ADC):
 - 14-Bit ADC: 75-dBFS SNR at 50 MSPS
 - 12-Bit ADC: 72-dBFS SNR at 65 MSPS
- Output Interface Supports:
 - LVDS Interface Maximum Speed of 1 Gbps
- Noise and Power Optimizations (Full-Chain):
 - 90 mW/Ch at 0.95 nV/ $\sqrt{\text{Hz}}$, 65 MSPS
 - 55 mW/Ch at 1.3 nV/ $\sqrt{\text{Hz}}$, 40 MSPS
 - 59 mW/Ch at CW Mode
- Excellent Device-to-Device Gain Matching:
 - ± 0.5 dB (typical) and ± 1 dB (max)
- Low Harmonic Distortion

- Fast and Consistent Overload Recovery
- Passive Mixer for Continuous Wave Doppler (CWD):
 - Low Close-In Phase Noise:
 - 148 dBc/Hz at 1 kHz Off 2.5-MHz Carrier
 - Phase Resolution: 1/16 λ
 - Supports 16x, 8x, 4x, and 1x CW Clocks
 - 12-dB Suppression on 3rd and 5th Harmonics
- Small Package: 15-mm x 15-mm NFBGA-289

2 Applications

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

3 Description

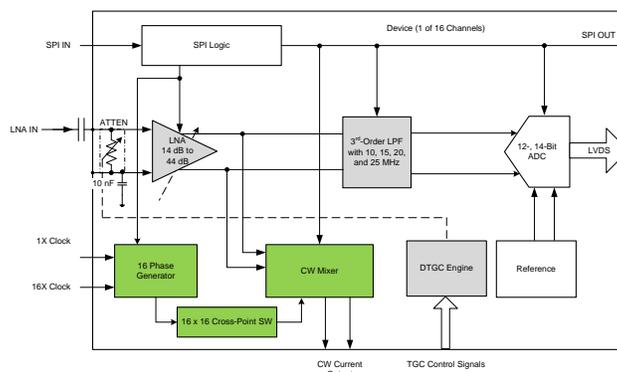
The AFE5816 is a highly-integrated, analog front-end (AFE) solution specifically designed for ultrasound systems where high-performance and small size are required. The device integrates a complete time-gain-control (TGC) imaging path and a continuous wave Doppler (CWD) path. The device also allows various power and noise combinations to be selected to optimize system performance. Therefore, the AFE5816 is a suitable ultrasound AFE solution for high-end and portable systems.

Device Information⁽¹⁾

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|-------------|-------------|---------------------|
| AFE5816 | NFBGA (289) | 15.00 mm x 15.00 mm |

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

Simplified Block Diagram



4 Description (continued)

The device has a total of 16 channels, with each channel consisting of a voltage-controlled amplifier (VCA) channels, a simultaneous sampling 14-bit and 12-bit analog-to-digital converter (ADC), and a continuous wave (CW) mixer. The VCA includes an attenuator (ATTEN), a variable gain low-noise amplifier (LNA), and a third order low-pass filter (LPF). The attenuator supports attenuation range of 8 dB to 0 dB and LNA supports gain ranges from 14 dB to 45 dB. Low-pass filter's (LPF) cut off frequency can be configured at 10 MHz, 15 MHz, 20 MHz, or 25 MHz to support ultrasound applications with different frequencies.

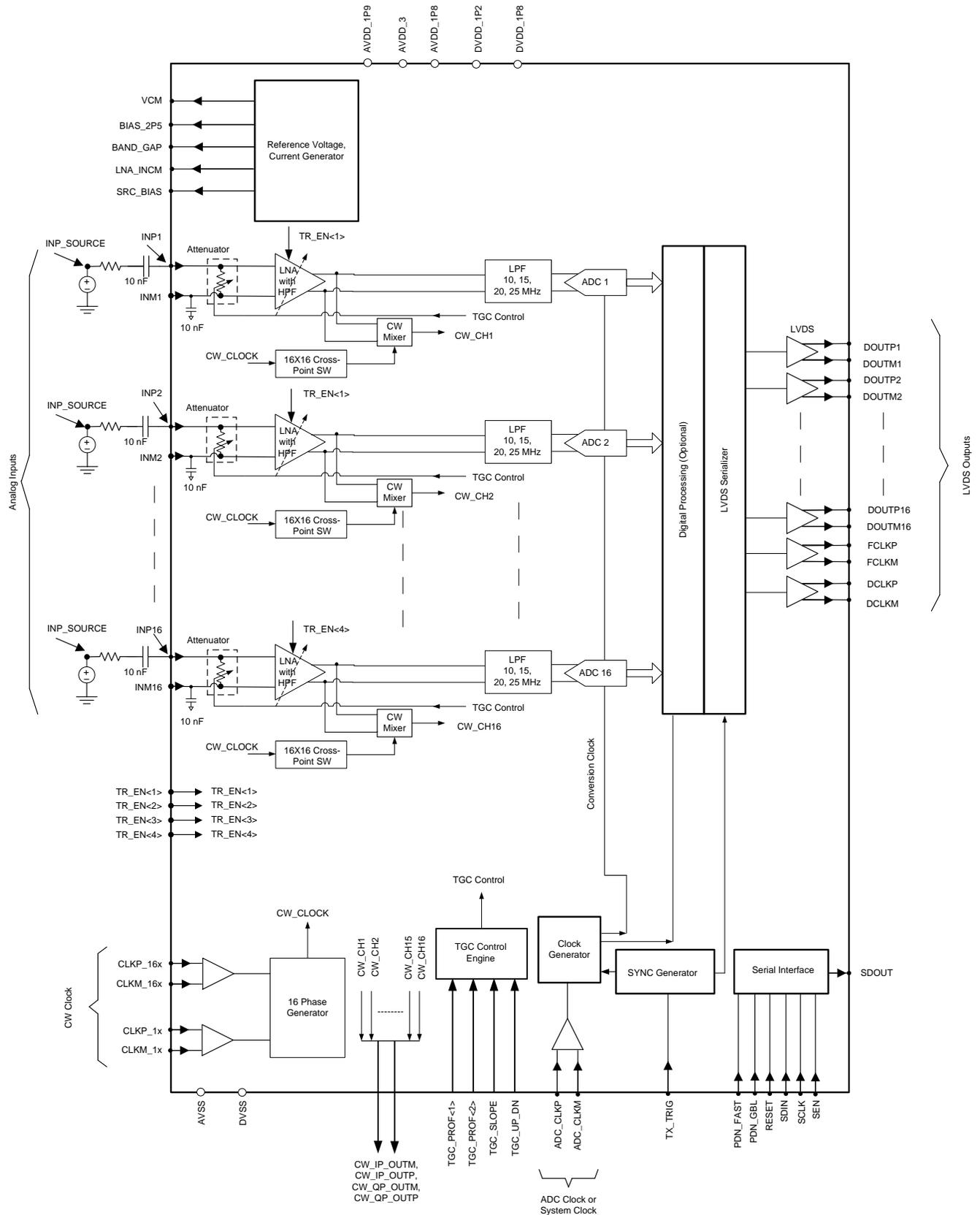
The high-performance, 14-bit ADC achieves 75-dBFS SNR. This ADC ensures excellent SNR at low-chain gain. The device can operate at maximum speeds of 65 MSPS and 80 MSPS, providing a 14-bit and a 12-bit output, respectively.

The ADC low-voltage differential signaling (LVDS) outputs enable a flexible system integration that is desirable for miniaturized systems.

The device also integrates a low-power passive mixer to create an on-chip CWD beamformer. 16 selectable phase delays can be applied to each analog input signal. Furthermore, a unique third- and fifth-order harmonic suppression filter is implemented to enhance CW sensitivity.

The device 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 is also pin-to-pin compatible with the AFE58JD18 and AFE5818 families.

5 Functional Block Diagram



PRODUCT PREVIEW

6 Device and Documentation Support

6.1 Trademarks

All trademarks are the property of their respective owners.

6.2 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.

6.3 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 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 |
|------------------|---------------|--------------|--------------------|------|----------------|-------------------|-------------------------|----------------------|--------------|-------------------------|---------|
| AFE5816ZAV | PREVIEW | NFBGA | ZAV | 289 | 126 | Pb-Free (RoHS) | SNAGCU | Level-3-260C-168 HR | -40 to 85 | AFE5816 | |

(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.

OBSELETE: 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.

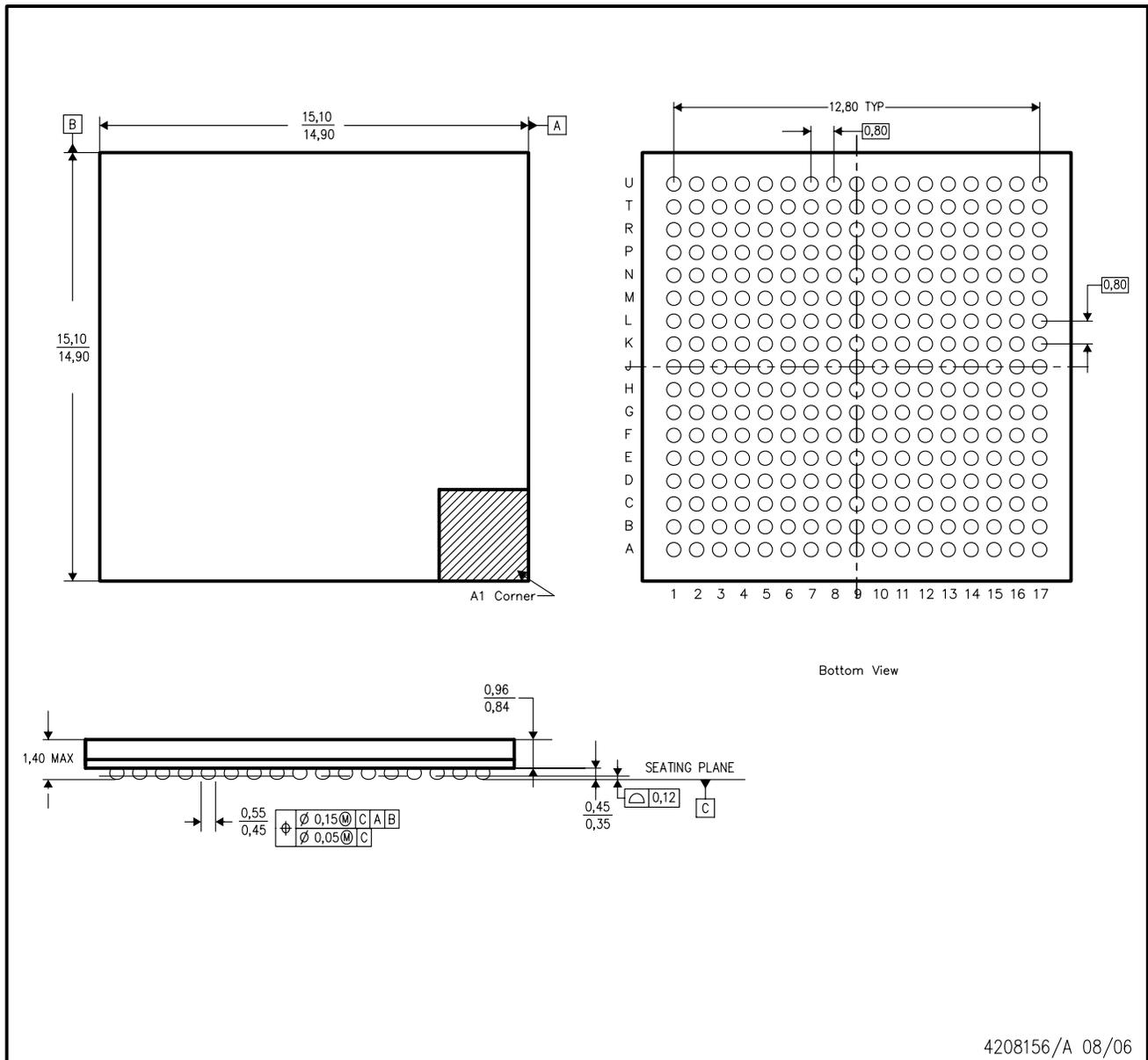
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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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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