AFE5818 16-Channel, Ultrasound, Analog Front-End with 140mW/Channel Power, 0.75nV/√Hz Noise, 14-Bit, 65-MSPS or 12-Bit, 80 MSPS ADC, and Passive CW Mixer

1 Features

- 16-channel, complete analog front-end:
  - LNA, VCAT, PGA, LPF, ADC, and CW mixer
- LNA with programmable gain:
  - Gain: 24dB, 18dB, and 12dB
  - Linear input range: $0.25V_{PP}$, $0.5V_{PP}$, and $1V_{PP}$
  - Input-referred noise: 0.63nV/√Hz, 0.7nV/√Hz, and 0.9nV/√Hz
  - Programmable active termination
- Voltage-controlled attenuator (VCAT): 40dB
- Programmable gain amplifier (PGA): 24dB and 30dB
- Total signal chain gain: 54dB (maximum)
- 3rd-order, linear-phase LPF:
  - 10MHz, 15MHz, 20MHz, 30MHz, 35MHz, and 50MHz
- Analog-to-digital converter (ADC):
  - 14-bit ADC: 75dBFS SNR at 65 MSPS
  - 12-bit ADC: 72dBFS SNR at 80 MSPS
- LVDS interface maximum speed of 1Gbps
- Noise and power optimizations (full-channel):
  - 140mW/Ch at 0.75nV/√Hz, 65 MSPS
  - 91.5mW/Ch at 1.1nV/√Hz, 40 MSPS
  - 80mW/Ch at CW mode
- Excellent device-to-device gain matching:
  - ±0.5dB (typical) and ±1.1dB (maximum)
- Low harmonic distortion
- Fast and consistent overload recovery
- Passive mixer for CWD:
  - Low close-in phase noise: –156dBc/Hz at 1kHz off 2.5MHz carrier
  - Phase resolution: λ / 16
  - Supports 16X, 8X, 4X, and 1X CW clocks
  - 12dB suppression on 3rd and 5th harmonics
  - CWD high-pass filter rejects undesired low-frequency signals < 1kHz
- Small package: 15mm × 15mm NFBGA-289

2 Applications

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

3 Description

The AFE5818 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 AFE5818 is a suitable ultrasound AFE solution for high-end and portable systems

Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
AFE5818	ZBV (NFBGA, 289)	15mm × 15mm

(1) For all available packages, see Section 6.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.

The AFE5818 has a total of 16 channels, with each channel consisting of a voltage-controlled amplifier (VCA), a simultaneous sampling 14-bit and 12-bit analog-to-digital converter (ADC), and a continuous wave (CW) mixer. The VCA includes a low-noise amplifier (LNA), a voltage-controlled attenuator (VCAT), a programmable gain amplifier (PGA), and a low-pass filter (LPF). LNA gain is programmable and supports 250mV$_{PP}$ to 1V$_{PP}$ input signals and programmable active termination. The ultra-low noise VCAT provides an attenuation control range of 40dB and improves overall low-gain SNR, which benefits harmonic and near-field imaging. The PGA provides gain options of 24dB and 30dB. In front of the ADC, an LPF can be configured at 10MHz, 15MHz, 20MHz, 30MHz, 35MHz, or 50MHz to support ultrasound applications with different frequencies.

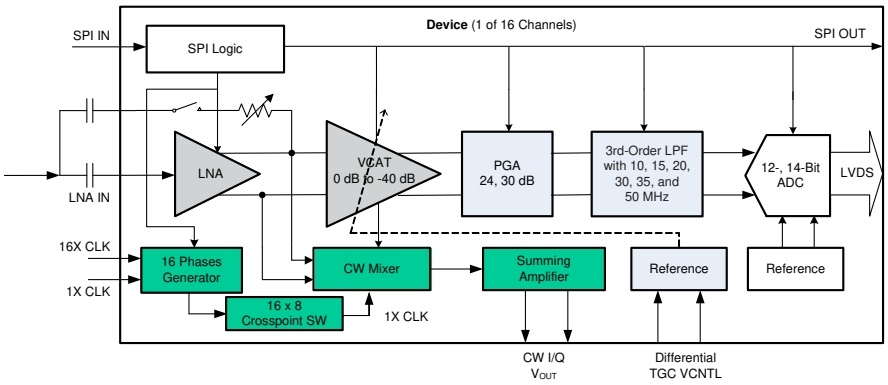
The AFE5818 also integrates a low-power passive mixer and a low-noise summing amplifier to create an on-chip CWD beamformer. 16 selectable phase delays can be applied to each analog input signal. Furthermore, a unique third- and fifth-order harmonic suppression filter is implemented to enhance CW sensitivity

The high-performance, 14-bit ADC achieves 75dBFS 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 AFE5818 also allows various power and noise combinations to be selected to optimize system performance. Therefore, the AFE5818 is a suitable ultrasound AFE solution for both high-end and portable systems.

The AFE5818 is available in a 15mm × 15mm NFBGA-289 package (ZBV package, S-PBGA-N289) and are specified for operation from –40°C to 85°C. The devices are also pin-to-pin compatible with the AFE5816 device family.



Simplified Block Diagram

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4 Device Comparison

Table 4-1. Device Comparison

DEVICE	DESCRIPTION	PACKAGE	BODY SIZE (NOM)
AFE5818	16-Channel, Ultrasound, Analog Front-End (AFE) with 124-mW/Channel, 0.75nV/√Hz Noise, 14-Bit, 65-MSPS or 12-Bit, 80-MSPS ADC and Passive CW Mixer	NFBGA (289)	15mm × 15mm
AFE5812	Fully Integrated, 8-channel Ultrasound AFE with Passive CW Mixer, and Digital I/Q Demodulator, 0.75nV/√Hz, 14 and 12 Bits, 65 MSPS, 180mW/ch	NFBGA (135)	15mm × 9mm
AFE5809	8-Channel Ultrasound AFE with Passive CW Mixer, and Digital I/Q Demodulator, 0.75nV/√Hz, 14 and 12 Bits, 65 MSPS, 158mW/ch	NFBGA (135)	15mm × 9mm
AFE5808A	8-Channel Ultrasound AFE with Passive CW Mixer, 0.75nV/√Hz, 14 and 12 Bits, 65 MSPS, 158mW/ch	NFBGA (135)	15mm × 9mm
AFE5807	8-Channel Ultrasound AFE with Passive CW Mixer, 1.05nV/√Hz, 12 Bits, 80 MSPS, 117mW/ch	NFBGA (135)	15mm × 9mm
AFE5803	8-Channel Ultrasound AFE, 0.75nV/√Hz, 14 and 12 Bits, 65 MSPS, 158mW/ch	NFBGA (135)	15mm × 9mm
AFE5805	8-Channel Ultrasound AFE, 0.85nV/√Hz, 12 Bits, 50 MSPS, 122mW/ch	NFBGA (135)	15mm × 9mm
AFE5804	8-Channel Ultrasound AFE, 1.23nV/√Hz, 12 Bits, 50 MSPS, 101mW/ch	NFBGA (135)	15mm × 9mm
AFE5801	8-Channel Variable-Gain Amplifier (VGA) with Octal High-Speed ADC, 5.5nV/√Hz, 12 Bits, 65 MSPS, 65mW/ch	VQFN (64)	9mm × 9mm
AFE5851	16-Channel VGA with High-Speed ADC, 5.5nV/√Hz, 12 Bits, 32.5 MSPS, 39mW/ch	VQFN (64)	9mm × 9mm
VCA5807	8-Channel Voltage-Controlled Amplifier for Ultrasound with Passive CW Mixer, 0.75nV/√Hz, 99mW/ch	HTQFP (80)	14mm × 14mm
VCA8500	8-Channel, Ultra-Low-Power VGA with Low-Noise Pre-Amp, 0.8nV/√Hz, 65mW/ch	VQFN (64)	9mm × 9mm
ADS5294	Octal-Channel, 14-Bit, 80-MSPS ADC, 75dBFS SNR, 77mW/ch	HTQFP (80)	14mm × 14mm
ADS5292	Octal-Channel, 12-Bit, 80-MSPS ADC, 70dBFS SNR, 66mW/ch	HTQFP (80)	14mm × 14mm
ADS5295	Octal-Channel, 12-Bit, 100-MSPS ADC, 70.6dBFS SNR, 80mW/ch	HTQFP (80)	14mm × 14mm
ADS5296A	10-Bit, 200-MSPS, 4-Channel, 61dBFS SNR, 150mW/ch and 12-bBit, 80-MSPS, 8-Channel, 70dBFS SNR, 65mW/ch ADC	VQFN (64)	9mm × 9mm

5 Device and Documentation Support

5.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* 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.

5.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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5.4 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.

5.5 Glossary

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

6 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 finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
AFE5818ZBV	ACTIVE	NFBGA	ZBV	289	126	RoHS & Green	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE5818	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.

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