







AFE5818 SBASB10 - MARCH 2024

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

1 Features

TEXAS

INSTRUMENTS

- 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: $0.63 \text{ nV}/\sqrt{\text{Hz}}$, $0.7 \text{ nV}/\sqrt{\text{Hz}}$, and $0.9 \text{ nV}/\sqrt{\text{Hz}}$ 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/\(\sqrt{Hz}\), 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 lowfrequency 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 timegain-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

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

For all available packages, see Section 6. (1)

The package size (length × width) is a nominal value and (2) 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



Table of Contents

1 Features1
2 Applications1
3 Description 1
4 Device Comparison
5 Device and Documentation Support4
5.1 Receiving Notification of Documentation Updates4

6	Mechanical, Packaging, and Orderable Information	4
	5.5 Glossary	4
	5.4 Electrostatic Discharge Caution	4
	5.3 Trademarks	4
	5.2 Support Resources	4

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/ $\sqrt{\rm Hz}$ 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/ \sqrt{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, $0.75nV/\sqrt{Hz},14$ and 12 Bits, 65 MSPS, 158mW/ch	NFBGA (135)	15mm × 9mm
AFE5808A	8-Channel Ultrasound AFE with Passive CW Mixer, 0.75nV/ $\sqrt{\text{Hz}},$ 14 and 12 Bits, 65 MSPS, 158mW/ch	NFBGA (135)	15mm × 9mm
AFE5807	8-Channel Ultrasound AFE with Passive CW Mixer, 1.05nV/ $\sqrt{\text{Hz}},$ 12 Bits, 80 MSPS, 117mW/ch	NFBGA (135)	15mm × 9mm
AFE5803	8-Channel Ultrasound AFE, 0.75nV/ $\sqrt{\text{Hz}}$, 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/ $\!\sqrt{\text{Hz}},$ 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/ $\sqrt{\text{Hz}},$ 99mW/ch	HTQFP (80)	14mm × 14mm
VCA8500	8-Channel, Ultra-Low-Power VGA with Low-Noise Pre-Amp, 0.8nV/ $\sqrt{\text{Hz}}$, 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.

Linked content is 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.

5.3 Trademarks

TI E2E[™] is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

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 part number	Status	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/	MSL rating/	Op temp (°C)	Part marking
	(1)	(2)			(3)	Ball material	Peak reflow		(6)
						(4)	(5)		
AFE5818ZBV	Active	Production	NFBGA (ZBV) 289	126 JEDEC	Yes	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE5818
				TRAY (5+1)					
AFE5818ZBV.A	Active	Production	NFBGA (ZBV) 289	126 JEDEC	Yes	SNAGCU	Level-3-260C-168 HR	-40 to 85	AFE5818
				TRAY (5+1)					
AFE5818ZBV.B	Active	Production	NFBGA (ZBV) 289	126 JEDEC	-	Call TI	Call TI	-40 to 85	
			. , , ,	TRAY (5+1)					

⁽¹⁾ **Status:** For more details on status, see our product life cycle.

⁽²⁾ 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.

⁽³⁾ RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

⁽⁴⁾ 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.

⁽⁵⁾ 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.

⁽⁶⁾ 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.

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.

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 © 2025, Texas Instruments Incorporated