AFE44S30 Ultra-Small, Integrated AFE With FIFO for Multi-Sensor Wearable, Optical Heart-Rate Monitoring and Bio-Sensing

1 Features

- Supports signal acquisition of up to 24 phases
- Flexible allocation of 8 LED, 4 PD in each phase
- Simultaneous signal acquisition from different sensors at different data rates
- Accurate, continuous heart-rate monitoring:
  - System SNR up to 108-dB at 16 μA PD current
  - Low Current for Continuous Operation on a Wearable Device with a Typical Value: 15 μA for an LED, 20 μA for the Receiver
- Transmitter:
  - Supports common anode LED configuration
  - 8-Bit programmable LED current with range adjustable from 25 mA to 250 mA
  - Mode to fire two LEDs in parallel with independent per-phase current control
  - Programmable LED on-time per-phase
  - Simultaneous support of 8 LEDs for SpO_2, HRM, or multi-wavelength HRM
- Receiver:
  - Supports 4 Time-Multiplexed Photodiode Inputs
  - 2 parallel receivers (two sets of TIA/filter)
  - Individual Ambient Offset Subtraction DAC at each TIA Input with 8-bit per-phase control and range adjustable up to 255-μA
  - Individual LED Offset Subtraction DAC at each TIA input with 5-bit per-phase control and 15.5-μA range
  - Close to 100 dB ambient rejection up to 10 Hz
  - Noise filtering with programmable bandwidth
  - Transimpedance Gain: 3.7 kΩ to 1 MΩ
- Supports external clock and internal oscillator modes
- Option to acquire data synchronized with a system master clock
- Automatic cancellation of DC from ambient, LED
- FIFO with 128-sample depth
- SPI interface
- 2.6-mm × 2.1-mm DSBGA, 0.4-mm pitch
- Supplies: Rx: 1.7 V-1.9 V (LDO bypass); 1.9 V-3.6 V (LDO enabled), Tx: 3 V-5.5 V, IO: 1.7-3.6 V

2 Applications

- Optical heart-rate monitoring (HRM) for wearables, hearables
- Heart-rate variability (HRV)
- Pulse oximetry (SpO_2) measurements

3 Description

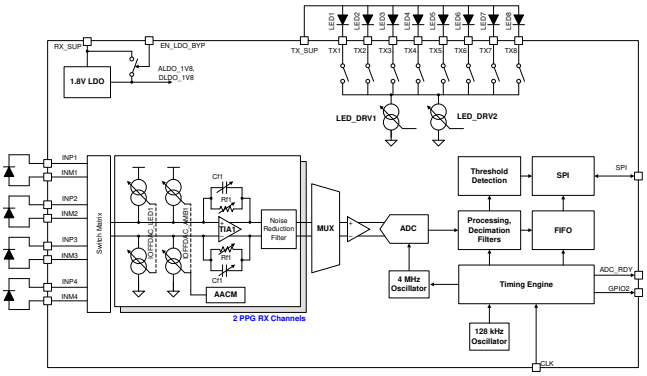
The AFE44S30 is an analog front-end for optical bio-sensing applications, such as heart-rate monitoring (HRM) and saturation of peripheral capillary oxygen (SpO_2). The device supports up to eight switching light-emitting diodes (LEDs) and up to four photodiodes. Up to 24 signal phases can be defined and the signal can be acquired from each phase in a synchronized manner. The current from the photodiode is converted into voltage by the transimpedance amplifier (TIA) and digitized using an analog-to-digital converter (ADC). The ADC code can be stored in a 128-sample First in, First out (FIFO) block. The FIFO can be read out using a SPI interface. The AFE also has a fully-integrated LED driver with an 8-bit current control. The device has a high dynamic range transmit-and-receive circuitry that helps with the sensing of very small signal levels.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
AFE44S30	DSBGA (30)	2.60 mm × 2.10 mm

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

Simplified Schematic



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

4 Device and Documentation Support

4.1 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.

4.2 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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4.3 Trademarks

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4.4 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.

4.5 Glossary

SLYZ022 — *TI Glossary*.

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

5 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.

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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
AFE44S30YZR	ACTIVE	DSBGA	YZ	30	3000	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	-40 to 85	AFE44S30	Samples
AFE44S30YZT	ACTIVE	DSBGA	YZ	30	250	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	-40 to 85	AFE44S30	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.

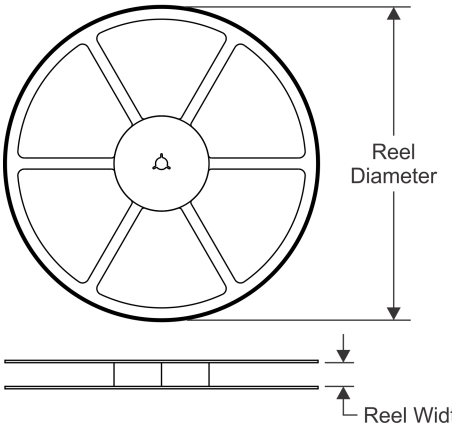
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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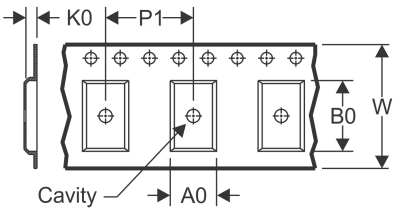
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TAPE AND REEL INFORMATION

REEL DIMENSIONS

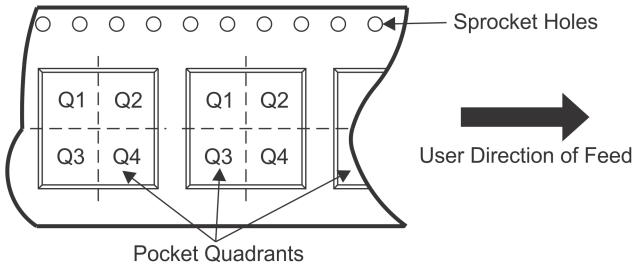


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

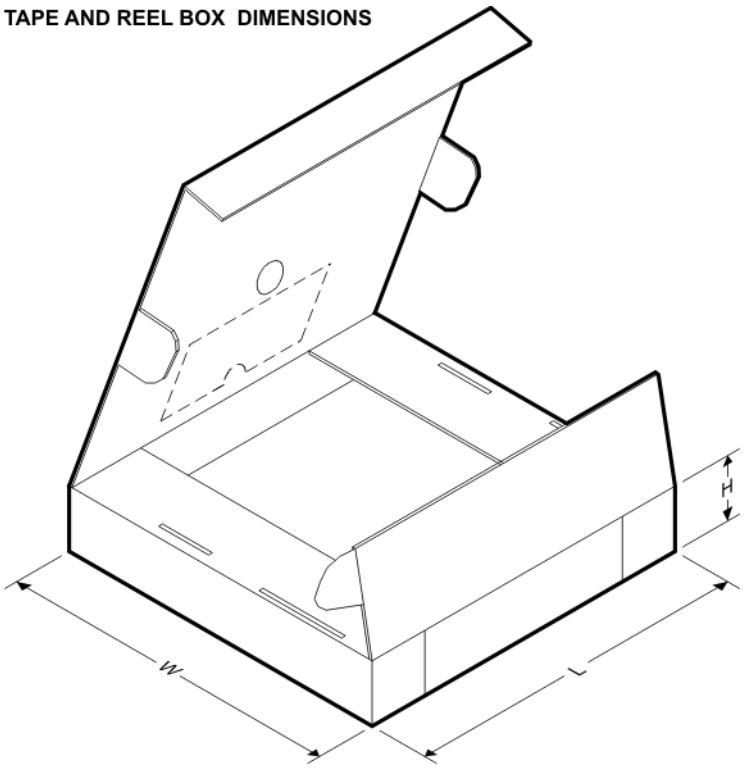
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
AFE44S30YZR	DSBGA	YZ	30	3000	330.0	12.4	2.3	2.68	0.65	8.0	12.0	Q1
AFE44S30YZT	DSBGA	YZ	30	250	330.0	12.4	2.3	2.68	0.65	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
AFE44S30YZR	DSBGA	YZ	30	3000	345.0	365.0	55.0
AFE44S30YZT	DSBGA	YZ	30	250	345.0	365.0	55.0

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