AFE4462 Ultra-Small, Integrated AFE for Optical Bio-Sensing

1 Features

- Supports signal acquisition of up to 16 phase sets
- Supports up to 16 LEDs, 4 PDs
- Flexible allocation of LEDs, PDs in each phase
- Simultaneous signal acquisition from different sensors at different data rates
- Accurate, continuous PPG monitoring:
  - Low current for continuous heart-rate monitoring on a wearable device with a typical value: 15 µA for an LED, 15 µA for the receiver
  - Peak system SNR of 115 dB
- Transmitter:
  - 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 16 LEDs for SpO2, Multi-Wavelength HRM, and Spectroscopy
- Receiver:
  - Supports 4 Time-Multiplexed PD Inputs
  - 2 parallel receivers (4 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 9-bit per-phase control and 64-µA range
  - Digital ambient subtraction at ADC output
  - Noise filtering with programmable bandwidth
  - Transimpedance gain: 3.7 kΩ to 1 MΩ
- Supports external clock or internal oscillator
- Option to acquire data synchronized with a system clock
- Automatic cancellation of DC from Ambient, LED
- FIFO with 256-sample depth
- SPI™ interface/ I2C interface
- 2.6-mm × 2.6-mm DSBGA, 0.4-mm Pitch
- Supplies: Rx:1.7 - 1.9 V (LDO Bypass); 1.9 - 3.6 V (LDO Enabled), Tx: 3-5.5 V, IO: 1.7-RX_SUP

2 Applications

- Optical Heart-Rate Monitoring (HRM) for wearables, hearables
- Heart-Rate Variability (HRV)
- Pulse Oximetry (SpO2) measurements
- Optical Spectroscopy

3 Description

The AFE4462 is an analog front-end for optical bio-sensing applications, such as heart-rate monitoring (HRM) and saturation of peripheral capillary oxygen (SpO2). The device supports up to 16 switching light-emitting diodes (LEDs) and up to four photodiodes (PDs). The AFE has two LED drivers each with 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. Up to 16 signal phase sets can be defined, each phase set comprising a combination of LED and Ambient phases. Low noise offset DACs at the receiver inputs can be automatically controlled to cancel DC from Ambient and LED light. The current from each of the 4 PDs in each phase is converted into voltage by TIAs, filtered, and then digitized using a common ADC. The ADC code can be stored in a 256-sample FIFO block. The FIFO can be read out using a SPI or I^2C interface.

Device Information

PART NUMBER	PACKAGE(1)	BODY SIZE (NOM)
AFE4462	DSBGA (36)	2.60 mm × 2.60 mm

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

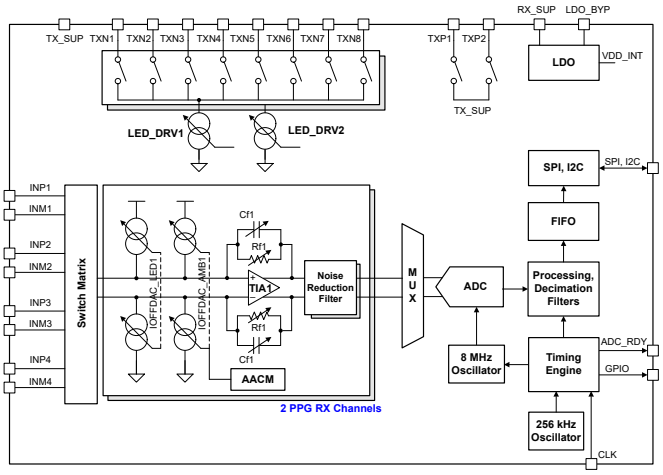


Table of Contents

4 Revision History

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

DATE	REVISION	NOTES
December 2024	*	Initial Release

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.

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)
AFE4462YBGR	Active	Production	DSBGA (YBG) | 36	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-20 to 85	AFE4462
AFE4462YBGR.A	Active	Production	DSBGA (YBG) | 36	3000 | LARGE T&R	Yes	SAC396	Level-1-260C-UNLIM	-20 to 85	AFE4462

(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.

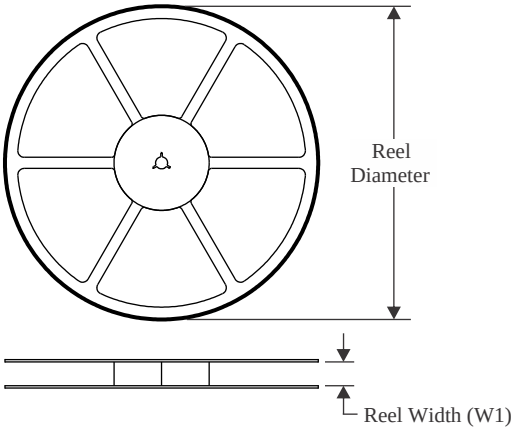
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will 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.

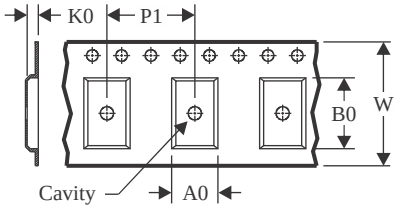
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

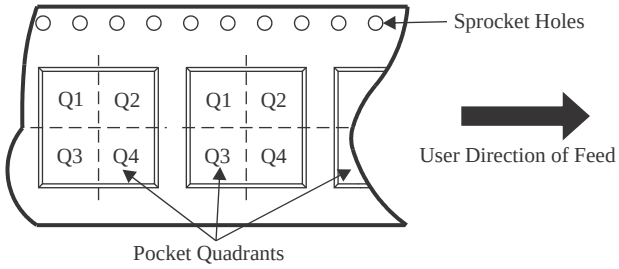


TAPE DIMENSIONS



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

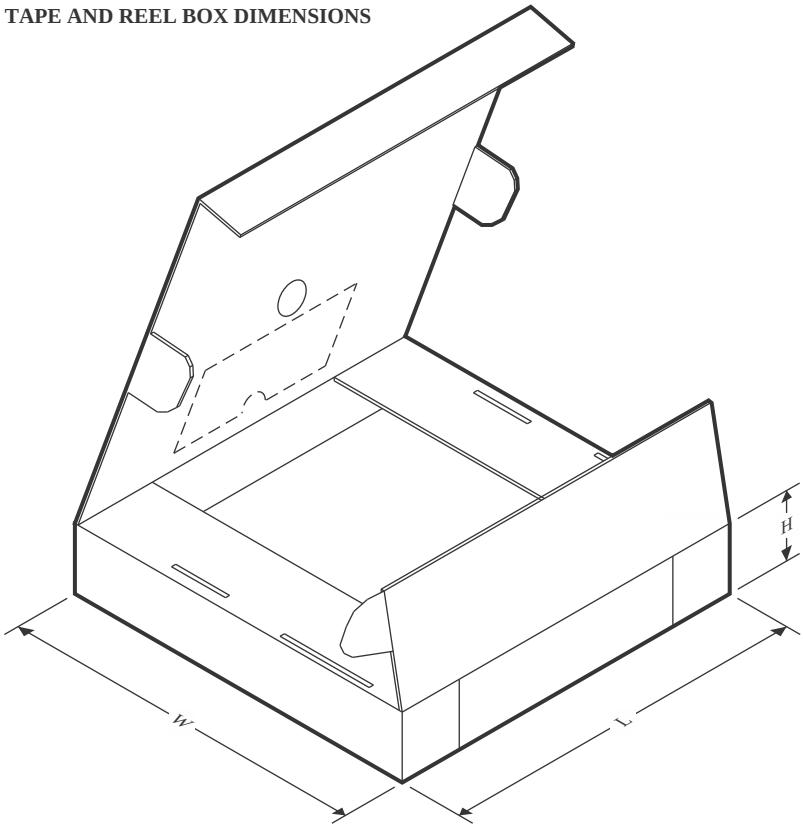
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
AFE4462YBGR	DSBGA	YBG	36	3000	330.0	12.4	2.73	2.73	0.67	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

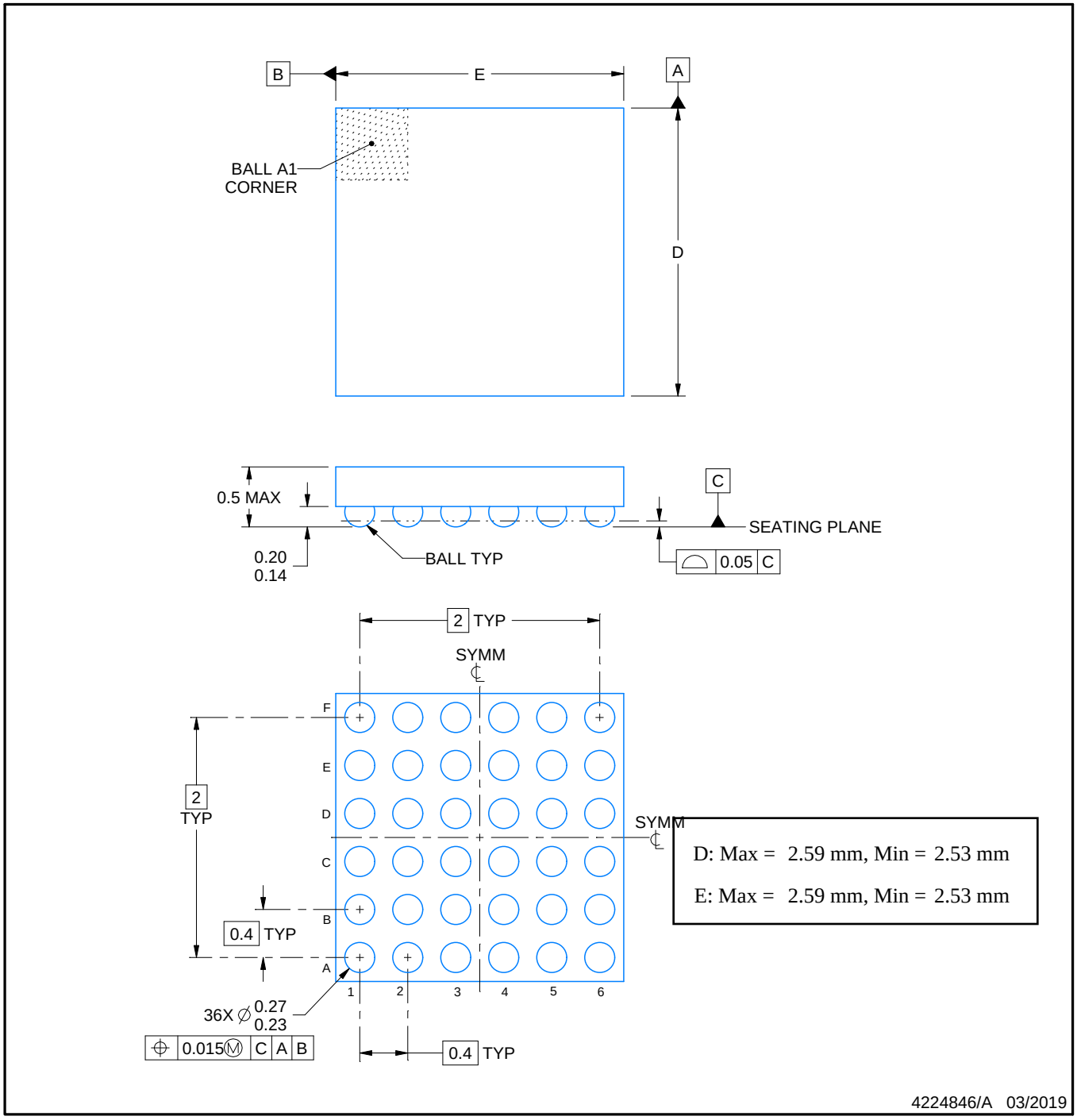
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
AFE4462YBGR	DSBGA	YBG	36	3000	345.0	365.0	55.0

YBG0036

PACKAGE OUTLINE

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



NOTES:

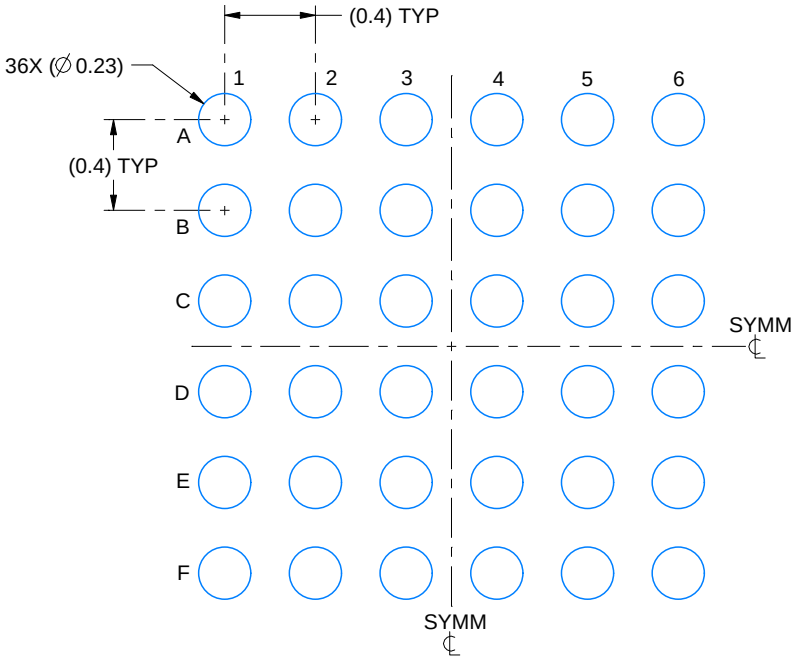
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

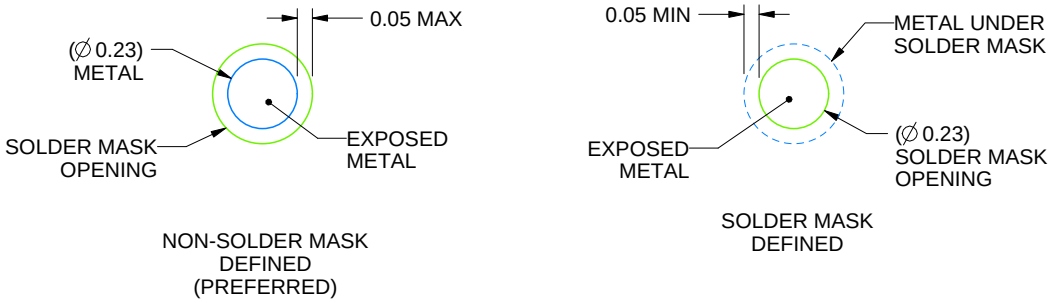
YBG0036

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 30X



SOLDER MASK DETAILS
NOT TO SCALE

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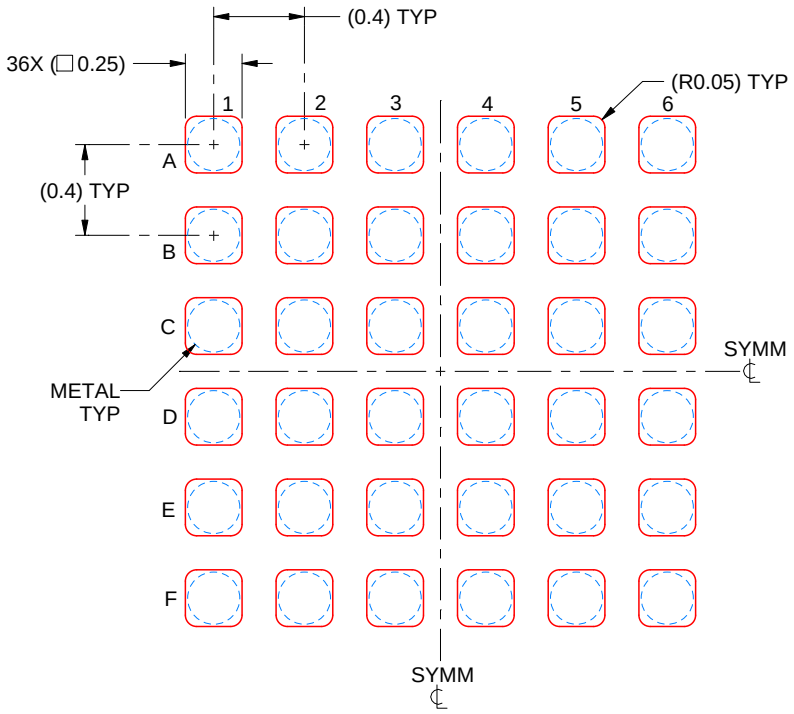
NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
   See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL
SCALE: 30X

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NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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