

AFE4460 光学生物检测用超小型集成式 AFE

1 特性

- 支持多达 16 个相位集的信号采集
- 支持多达 32 个 LED 和 4 个 PD
- 在每个相位内均可实现灵活的 LED 和 PD 分配
- 从不同的传感器以不同的数据速率同时采集信号
- 精确、连续的 PPG 监测：
 - 可穿戴设备连续监测心率的低电流，其典型值为：LED 为 $15\ \mu\text{A}$ ，接收器为 $15\ \mu\text{A}$
 - 系统峰值 SNR 为 115dB
- 发送器：
 - 8 位可编程 LED 电流，可调范围为 25mA 至 250mA
 - 可点亮两个并联 LED 且具有独立的每相位电流控制功能的模式
 - 每相位可编程 LED 导通时间
 - 同时支持 32 个 LED，适用于 SpO₂、多波长 HRM 和光谱分析
- 接收器：
 - 支持 4 路时分多路复用 PD 输入
 - 4 个并行接收器（4 组 TIA/滤波器）
 - 各 TIA 输入端都具有独立环境失调电压消减 DAC，各相控制均为 8 位，可调范围高达 $255\ \mu\text{A}$
 - 每个 TIA 输入端具有单独的 LED 失调电压消减 DAC，各相控制均为 9 位，范围为 $64\ \mu\text{A}$
 - ADC 输出端的数字环境消减
 - 具有可编程带宽的噪声滤波器
 - 跨阻增益： $3.7\ \text{k}\Omega$ 至 $1\ \text{M}\Omega$
- 支持外部时钟或内部振荡器
- 可选择以与系统时钟同步的方式获取数据
- 自动消除环境、LED 直流
- 采样深度为 256 的 FIFO
- SPI™ 接口/I2C 接口
- 2.6mm × 2.6mm DSBGA 封装，0.4mm 间距
- 电源：Rx：1.7V 至 1.9V（LDO 旁路）；1.9V 至 3.6V（启用 LDO），Tx：3-5.5V，IO：1.7-
RX_SUP

2 应用

- 用于可穿戴设备和耳戴式设备的光学心率监测 (HRM)
- 心率变异性 (HRV) 分析
- 血氧饱和度 (SpO₂) 测量
- 光谱分析

3 说明

AFE4460 是一款面向诸如心率监测 (HRM) 和周围毛细血管氧饱和度 (SpO₂) 测量等光学生物传感应用的模拟前端。该器件支持多达 32 个可切换发光二极管 (LED) 和四个光电二极管 (PD)。AFE 配有两个带 8 位电流控制的 LED 驱动器。该器件具有宽动态范围的发送和接收电路，有助于检测超小信号电平。可定义多达 16 个信号相位集，每个相位集都包含 LED 和环境相位的组合。接收器输入端的低噪声失调 DAC 可自动控制，从而消除环境光和 LED 光产生的直流。在各相位中，4 个 PD 所产生的电流先经 TIA 转换为电压，再滤波，然后使用通用 ADC 进行数字化。ADC 代码可存储在 256 样本的 FIFO 块中。可使用 SPI 或 I²C 接口读取 FIFO。

器件信息

器件型号	封装 ⁽¹⁾	封装尺寸 (标称值)
AFE4460	DSBGA (36)	2.60mm × 2.60mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

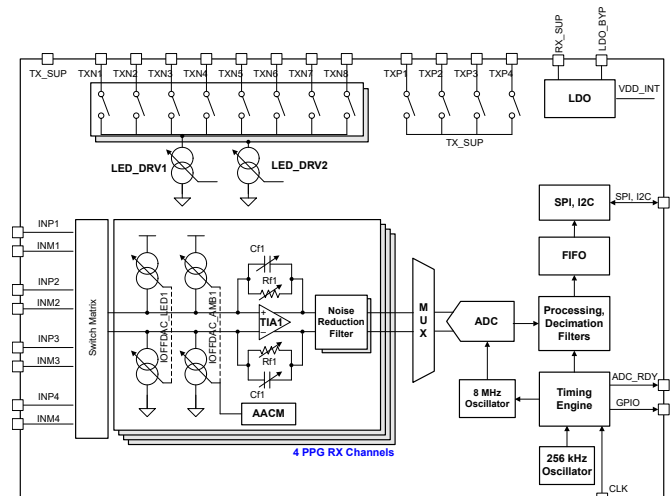


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4 Revision History

注：以前版本的页码可能与当前版本的页码不同

DATE	REVISION	NOTES
June 2022	*	Initial Release

5 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

5.1 Documentation Support

5.1.1 Related Documentation

5.2 接收文档更新通知

要接收文档更新通知，请导航至 [ti.com](https://www.ti.com) 上的器件产品文件夹。点击 [订阅更新](#) 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

5.3 支持资源

[TI E2E™ 支持论坛](#) 是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 [《使用条款》](#)。

5.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.

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5.5 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.

5.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

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
AFE4460YBGR	ACTIVE	DSBGA	YBG	36	3000	RoHS & Green	SAC396	Level-1-260C-UNLIM	-40 to 85	AFE4460	Samples
AFE4460YBGT	ACTIVE	DSBGA	YBG	36	250	RoHS & Green	SAC396	Level-1-260C-UNLIM	-40 to 85	AFE4460	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.

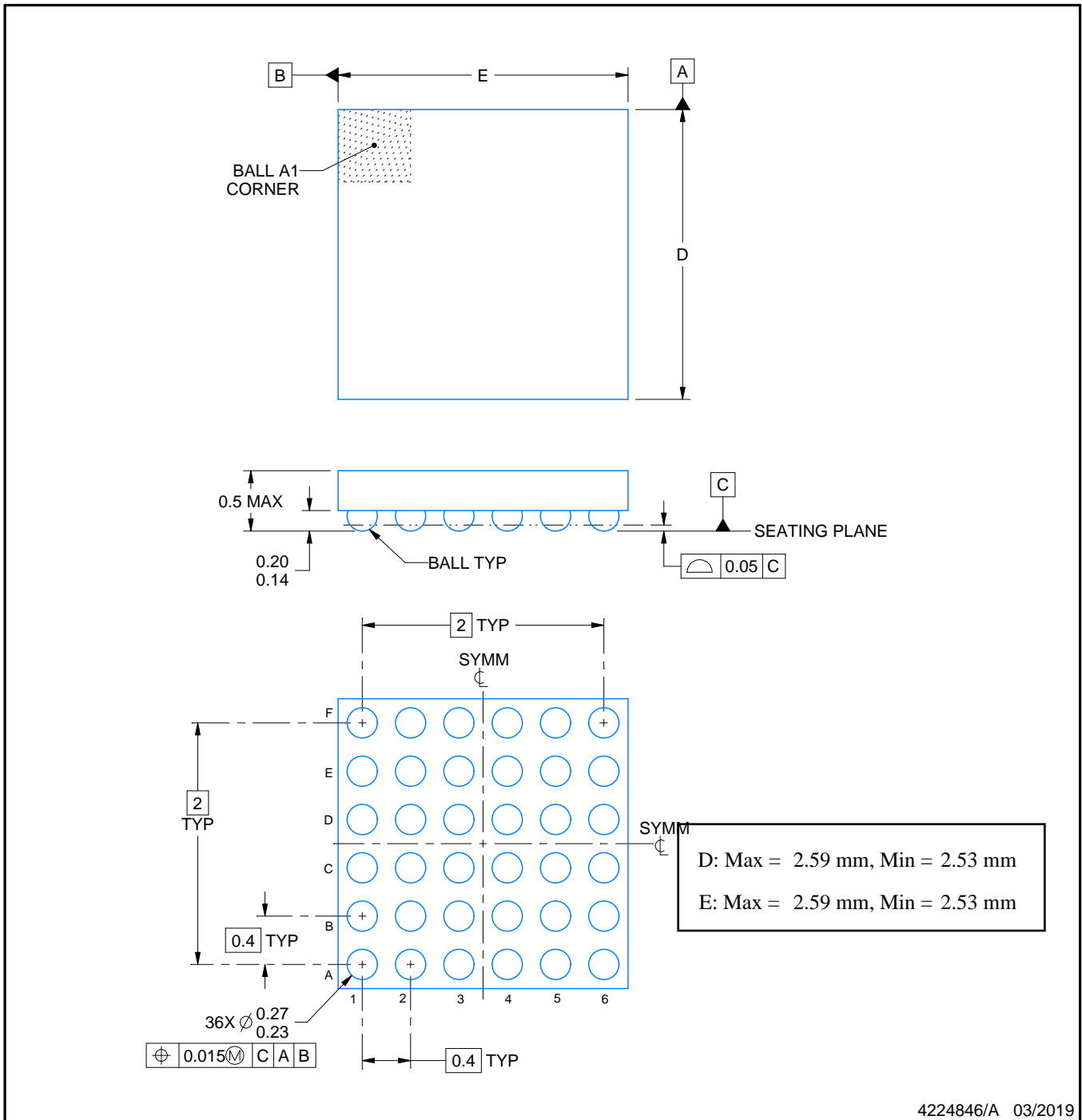
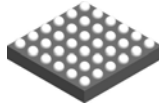
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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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NOTES:

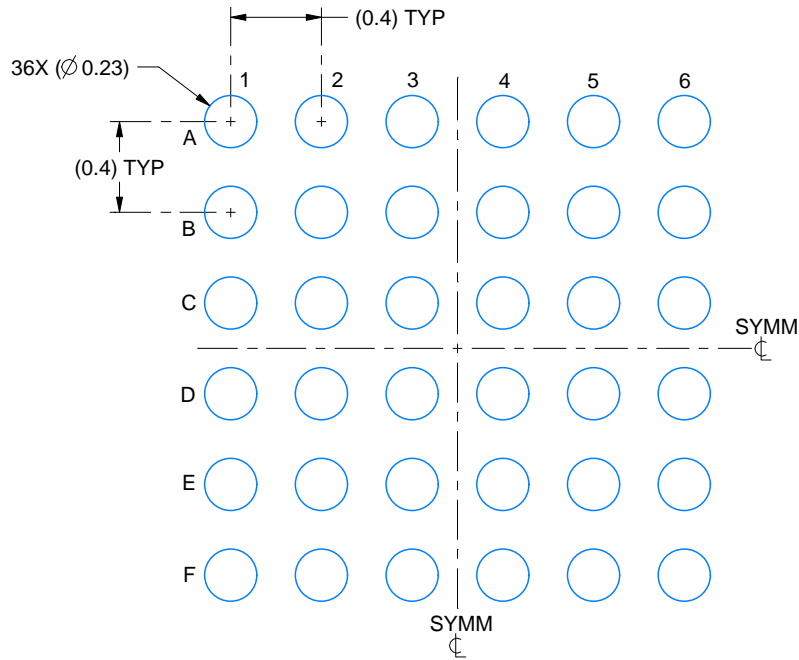
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

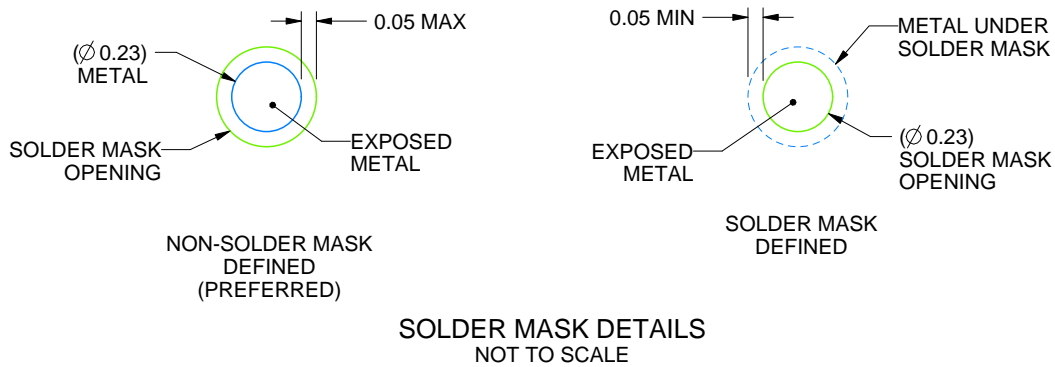
YBG0036

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

4224846/A 03/2019

NOTES: (continued)

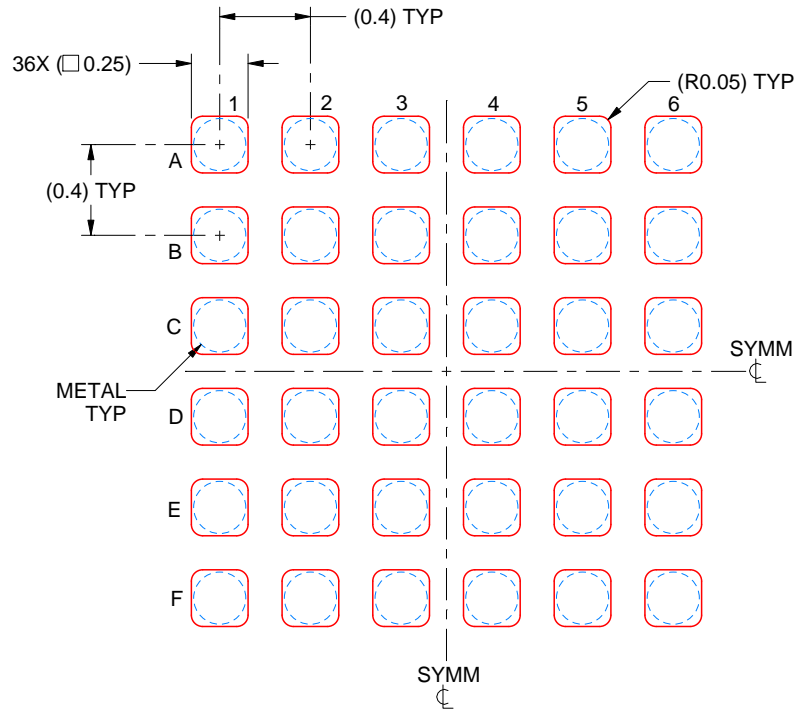
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YBG0036

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



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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