

适用于可穿戴设备光学心率监测和生物检测且具有 FIFO 的 AFE4405 超小型集成式 AFE

1 特性

- 发送器：
 - 支持共阳极 LED 配置
 - 动态范围：100dB
 - 8 位可编程 LED 电流最高达 50mA（可扩展至 100mA）
 - 可编程 LED 接通时间
 - 同时支持 3 个 LED，适用于优化型血氧饱和度 (SpO₂) 测量、心率监测 (HRM) 或多波长 HRM
- 接收器：
 - 支持两路时分复用光电二极管输入
 - 以 24 位二进制补码格式表示光电二极管的电流输入
 - TIA 输入端的独立直流偏移减法 DAC ($\pm 15.75\mu\text{A}$ 范围)，用于每个 LED 和环境
 - ADC 输出端的数字环境减法
 - 互阻抗增益：10k Ω 至 2M Ω
 - 动态范围：100dB
 - 动态节能模式，可使接收器电流降至 200 μA
- 脉冲频率：5SPS 至 1000SPS
- 灵活的脉冲排序和定时控制
- 灵活的时钟选项：
 - 外部时钟：4MHz 至 60MHz 输入时钟
 - 内部时钟：4MHz 振荡器
- 采样深度为 240 的 FIFO：
 - 可针对各相编程设定分区
- I²C、SPI 接口：可通过引脚进行选择
- 工作温度范围：-20°C 至 +70°C
- 2.6mm x 2.1mm DSBGA 封装，0.4mm 间距
- 电源：Rx：2V 至 3.6V；Tx：3V 至 5.25V；IO：1.8V 至 3.6V

2 应用

- 光学心率监测 (HRM)（可穿戴设备和可听设备）
- 心率变异分析 (HRV)
- 血氧饱和度 (SpO₂) 测量
- 最大耗氧量 (VO₂ Max)
- 卡路里消耗

3 说明

AFE4405 是一款面向光学生物检测应用的模拟前端 (AFE)，例如心率监测 (HRM) 和血氧饱和度 (SpO₂) 测量。该器件支持三个开关发光二极管 (LED) 和最多两个光电二极管。光电二极管的电流通过互阻抗放大器 (TIA) 转换为电压，并使用模数转换器 (ADC) 进行数字化。ADC 编码可存储到深度可编程的 234 采样先入先出 (FIFO) 存储块。FIFO 深度可进行适当分区，以满足某些相位必须存储的需求。FIFO 的内容可使用 I²C 或 SPI 接口读出。这款 AFE 还配有带 8 位电流控制的全集成 LED 驱动器。该器件具有宽动态范围的发送和接收电路，有助于感测超小信号电平。

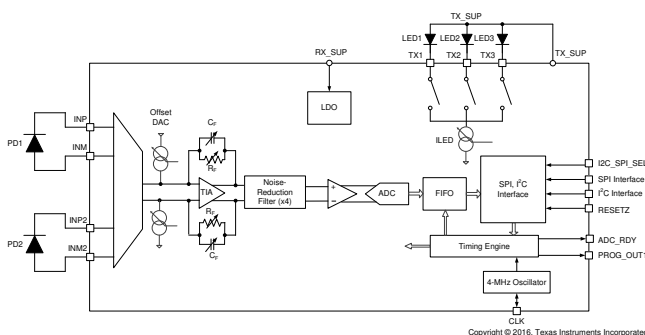
如需完整数据表或其他设计资源，请点击：[请求 AFE4405](#)

器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
AFE4405	DSBGA (30)	2.60mm x 2.10mm

(1) 如需了解所有可用封装，请参阅产品说明书末尾的可订购产品附录。

简化方框图



4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Revision B (May 2016) to Revision C	Page
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- 更改了机械封装图像 5
-

Changes from Revision A (May 2016) to Revision B	Page
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- 已添加 请求完整数据表的链接 1
-

Changes from Original (April 2016) to Revision A	Page
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- 已发布至生产 1
-

5 器件和文档支持

5.1 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的 [通知我](#) 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。

5.2 社区资源

The following links connect to TI community resources. Linked contents are 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](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

5.3 商标

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5.4 静电放电警告



ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

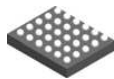
5.5 Glossary

SLYZ022 — *TI Glossary*.

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

6 机械、封装和可订购信息

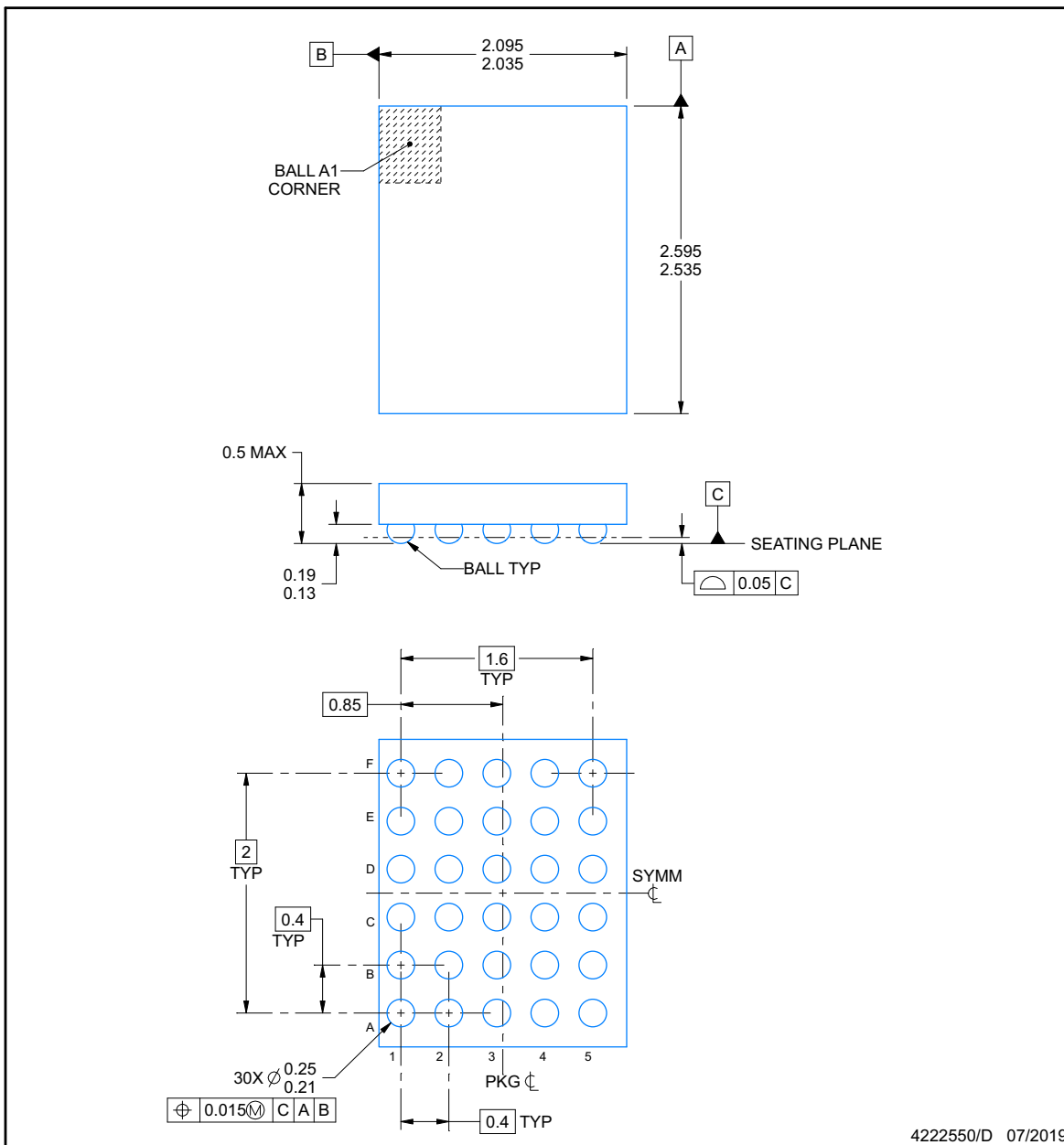
以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。



YZ0030-C01

PACKAGE OUTLINE
DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



NOTES:

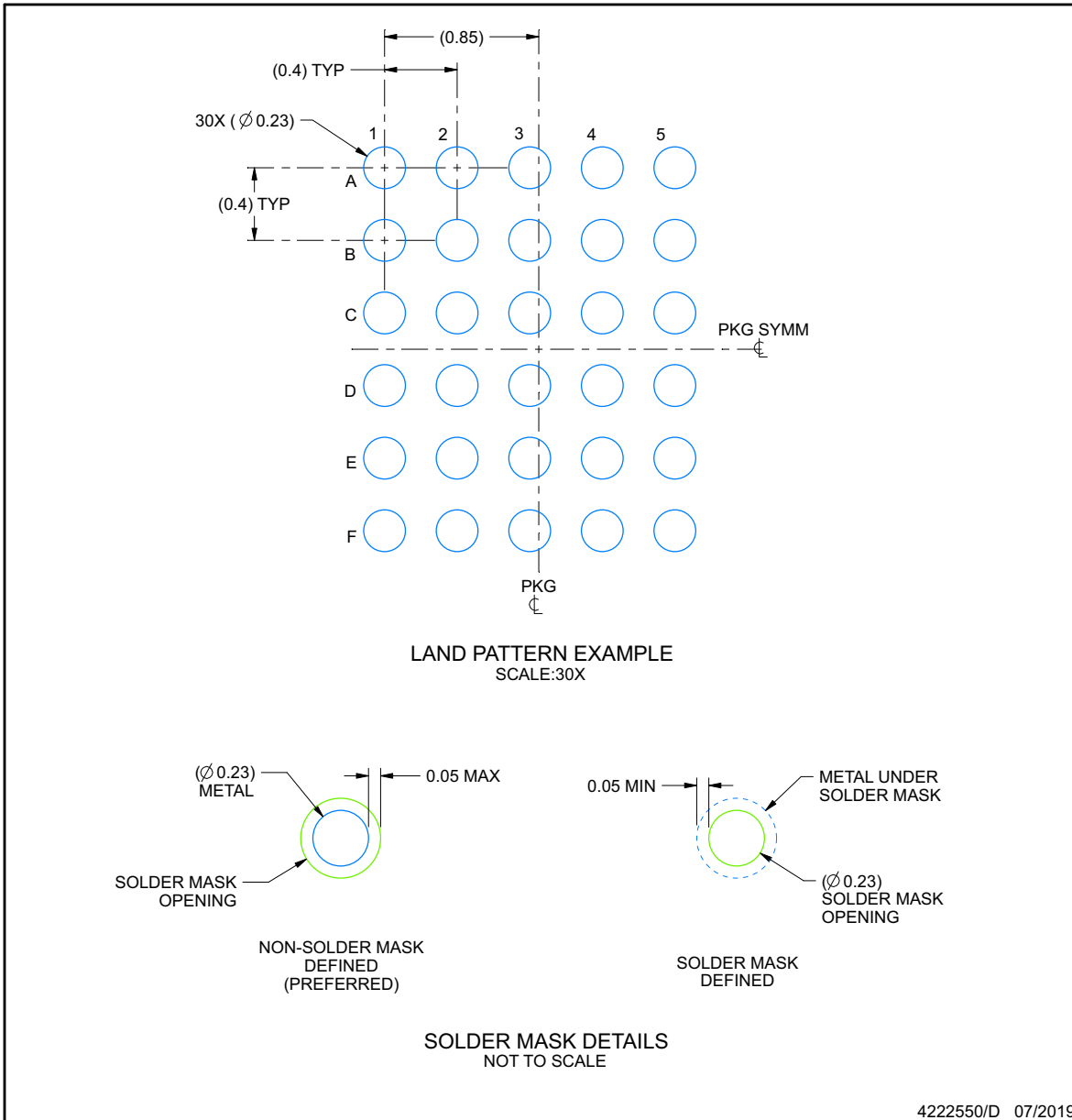
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

YZ0030-C01

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



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NOTES: (continued)

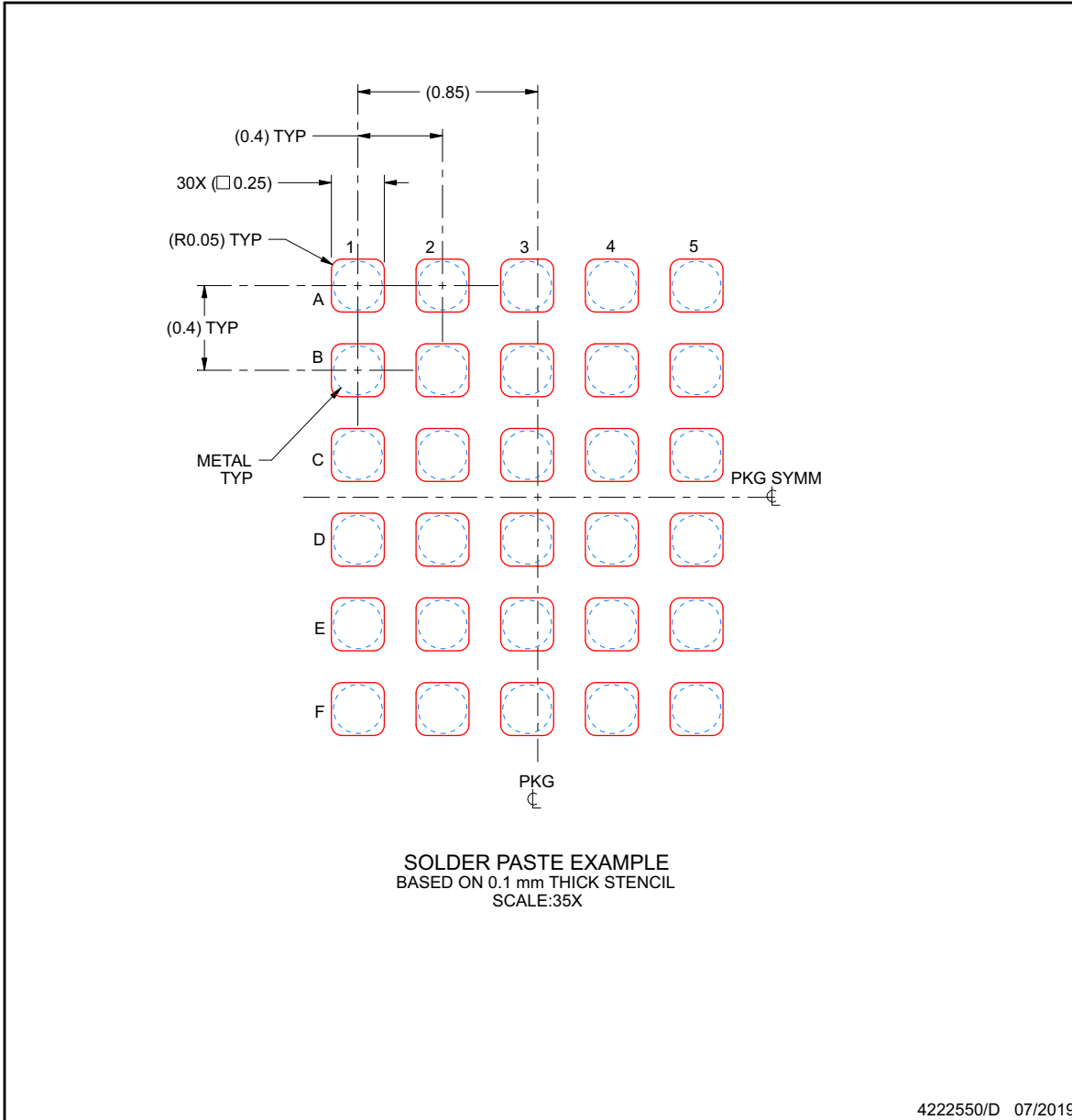
- 3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YZ0030-C01

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

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

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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
AFE4405YZR	ACTIVE	DSBGA	YZ	30	3000	RoHS & Green	SNAGCU	Level-1-260C-UNLIM	-20 to 70	AFE4405	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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TAPE AND REEL INFORMATION



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
AFE4405YZR	DSBGA	YZ	30	3000	180.0	8.4	2.16	2.66	0.6	4.0	8.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
AFE4405YZR	DSBGA	YZ	30	3000	210.0	185.0	35.0

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