

适用于可穿戴设备、连续光学心率监测和生物传感且具有 FIFO 功能的 AFE4410 超小型集成式 AFE

1 特性

- 精确、连续的心率监测：
 - 高达 100dB 的动态范围可实现精确心率监测
 - 用于在可穿戴设备上持续运行的低电流，其典型值为：
 - 对于 LED 为 30 μ A，对于接收器为 25 μ A
- 发送器：
 - 4 个采用共阳极配置的 LED
 - 高达 200mA 的 8 位可编程 LED 电流
 - 支持同时点亮两个 LED 的模式
 - 可编程 LED 导通时间
 - 同时支持 3 个 LED，适用于优化型 SpO₂ 测量、HRM 或多波长 HRM
 - 平均电流为 30 μ A，可满足典型的心率监测情形：
 - 20mA 设置、60 μ s 脉冲持续时间、25Hz 采样率
- 接收器：
 - 支持 3 路时分多路复用 PD 输入
 - 以 24 位二进制补码格式表示 PD 的电流输入
 - TIA 输入端的独立直流失调消减 DAC（范围高达 $\pm 127\mu$ A），用于每个 LED 和环境光相位
 - ADC 输出端的数字环境减法
 - 跨阻增益：10k Ω 至 2M Ω
 - 具有带宽可配的噪声滤波器
 - 接收器在约 1 μ A/Hz 的采样率（例如 25 μ A/25Hz）下运行
 - 硬件断电模式：约 0 μ A 电流
- 灵活的脉冲排序和时序控制
- 通过外部时钟或者内部振荡器作为参考时钟
- 采样深度为 128 的 FIFO：
 - 可针对各阶段编程设定分区
- 可通过引脚来选择 I²C、SPI 接口
- 工作温度范围：-20°C 至 +70°C
- 2.6mm × 2.1mm、0.4mm 间距 DSBGA 封装
- 电源：
 - Tx: 3V 至 5.25V
 - Rx: 1.8V 至 1.9V（LDO 旁路），2.0V 至 3.6V（LDO 使能）
 - IO: 1.7V 至 Rx_SUP

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)

3 说明

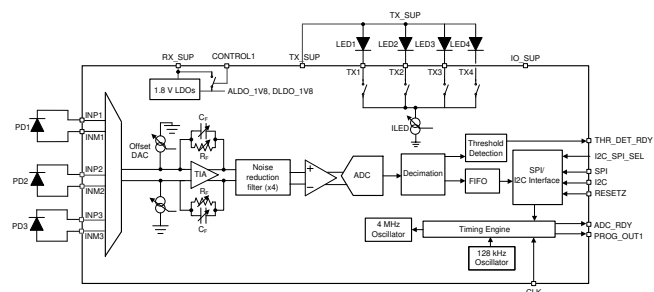
AFE4410 是一款模拟前端，适用于光学生物传感应用，比如心率监测 (HRM)。该器件最多支持四个可切换发光二极管 (LED) 和三个光电二极管 (PD)。光电二极管的电流通过跨阻放大器 (TIA) 转换为电压，并由模数转换器 (ADC) 进行数字化处理。ADC 编码可存储到深度可编程的 128 采样先入先出块 (FIFO) 中。您可以使用 I²C 接口或串行外设接口 (SPI) 读取 FIFO。该 AFE 还带有 8 位电流控制的完全集成式 LED 驱动器。该器件具有高动态范围的收发电路，可提供高达 100dB 的动态范围，从而精确地感应心率。该 AFE 通过以超低功耗 (ULP) 模式（通过使用 ENABLE_ULP 寄存器位进行设置）运行来实现极低的电流电平。

器件信息⁽¹⁾

器件型号	封装	封装尺寸（标称值）
AFE4410	DSBGA (30)	2.6mm × 2.10mm

(1) 如需了解所有可用封装，请参阅数据表末尾的封装选项附录。

简化方框图



4 修订历史记录

Changes from Revision A (May 2017) to Revision B	Page
• 更改了机械封装 图像	5
Changes from Original (May 2017) to Revision A	Page
• 已更改 将范围从 $\pm 126\mu\text{A}$ 更改为 $\pm 127\mu\text{A}$	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。

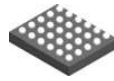
5.5 Glossary

[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。

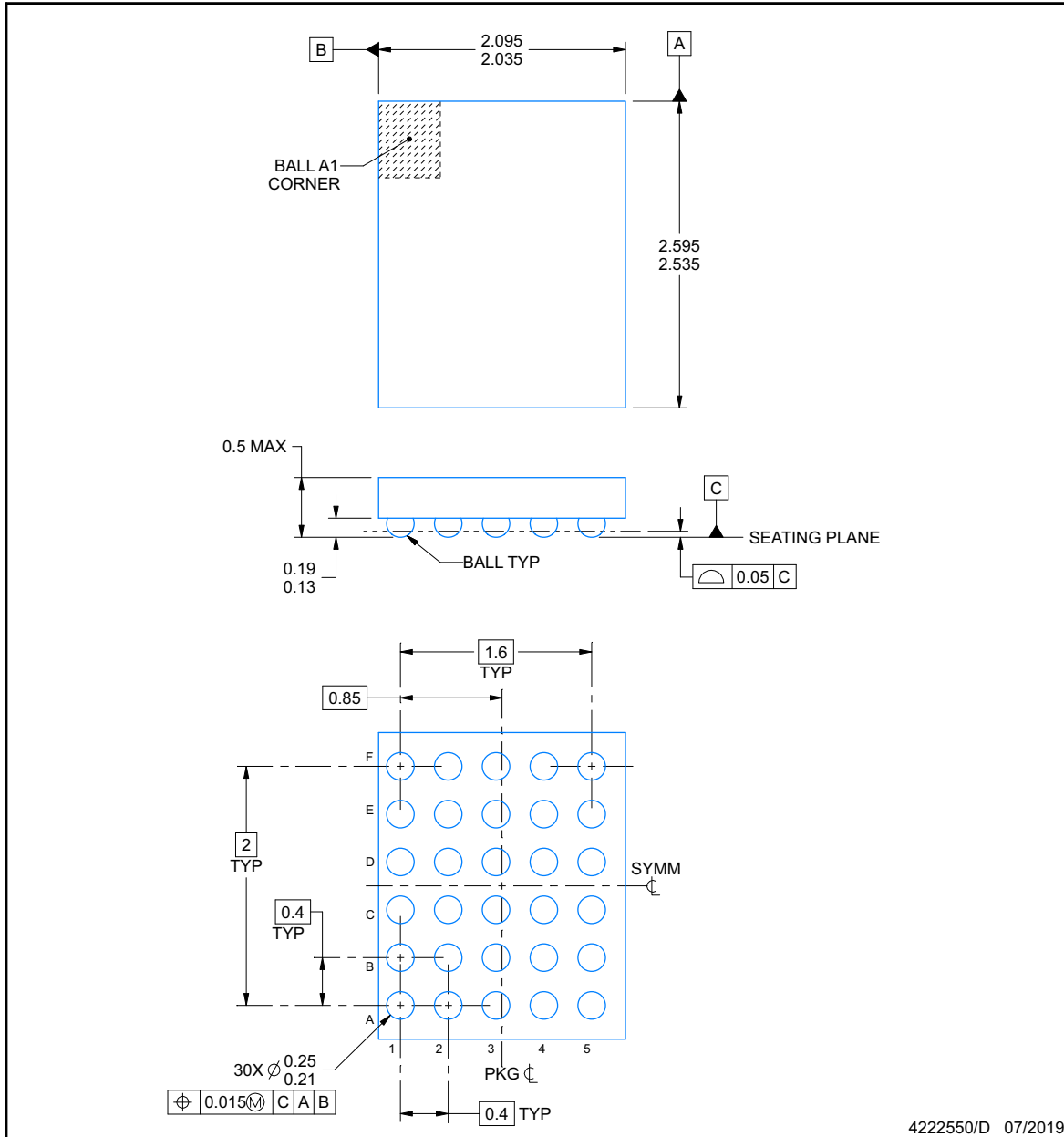


YZ0030-C01

PACKAGE OUTLINE

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



NOTES:

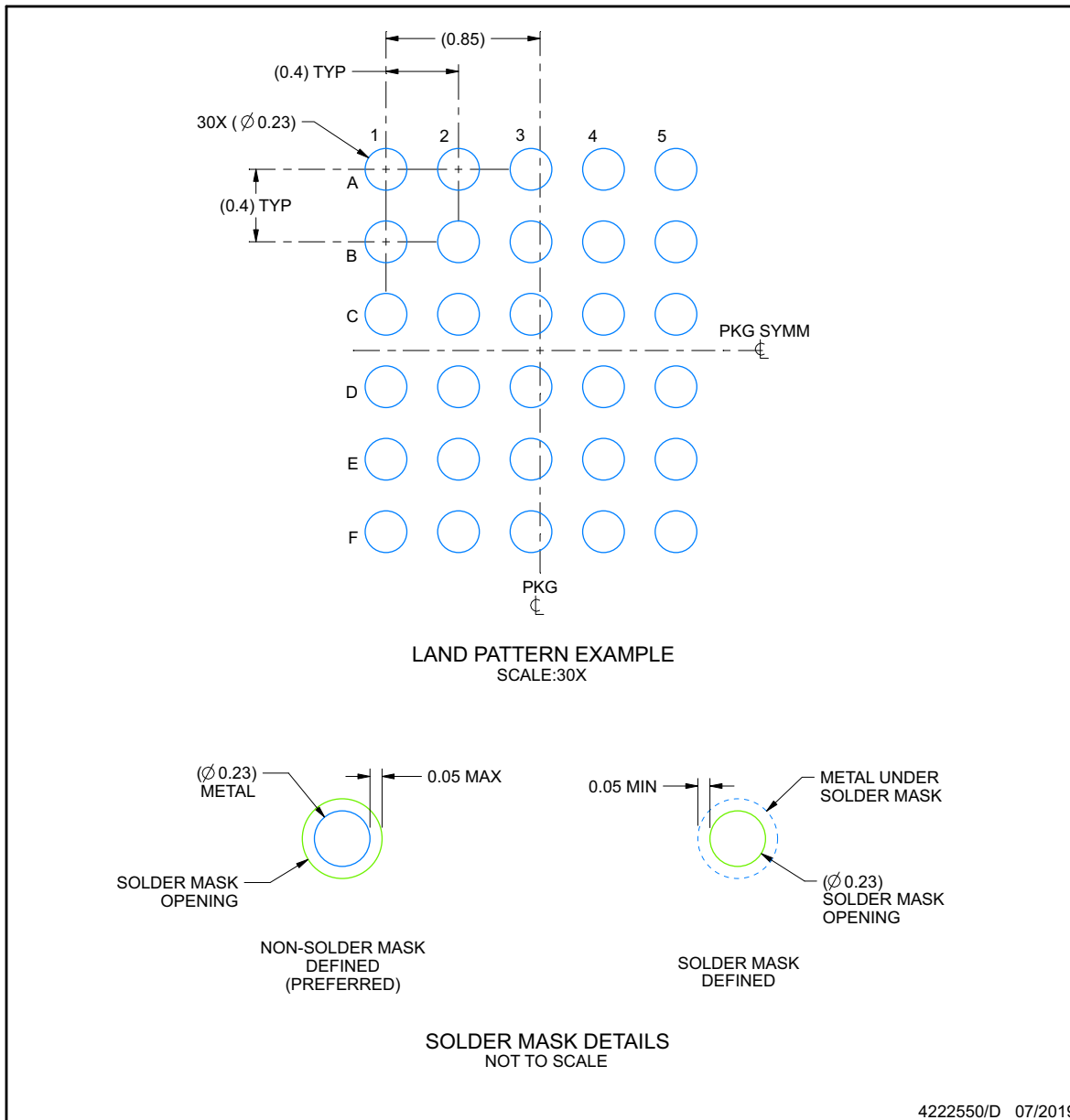
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

YZ0030-C01

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



NOTES: (continued)

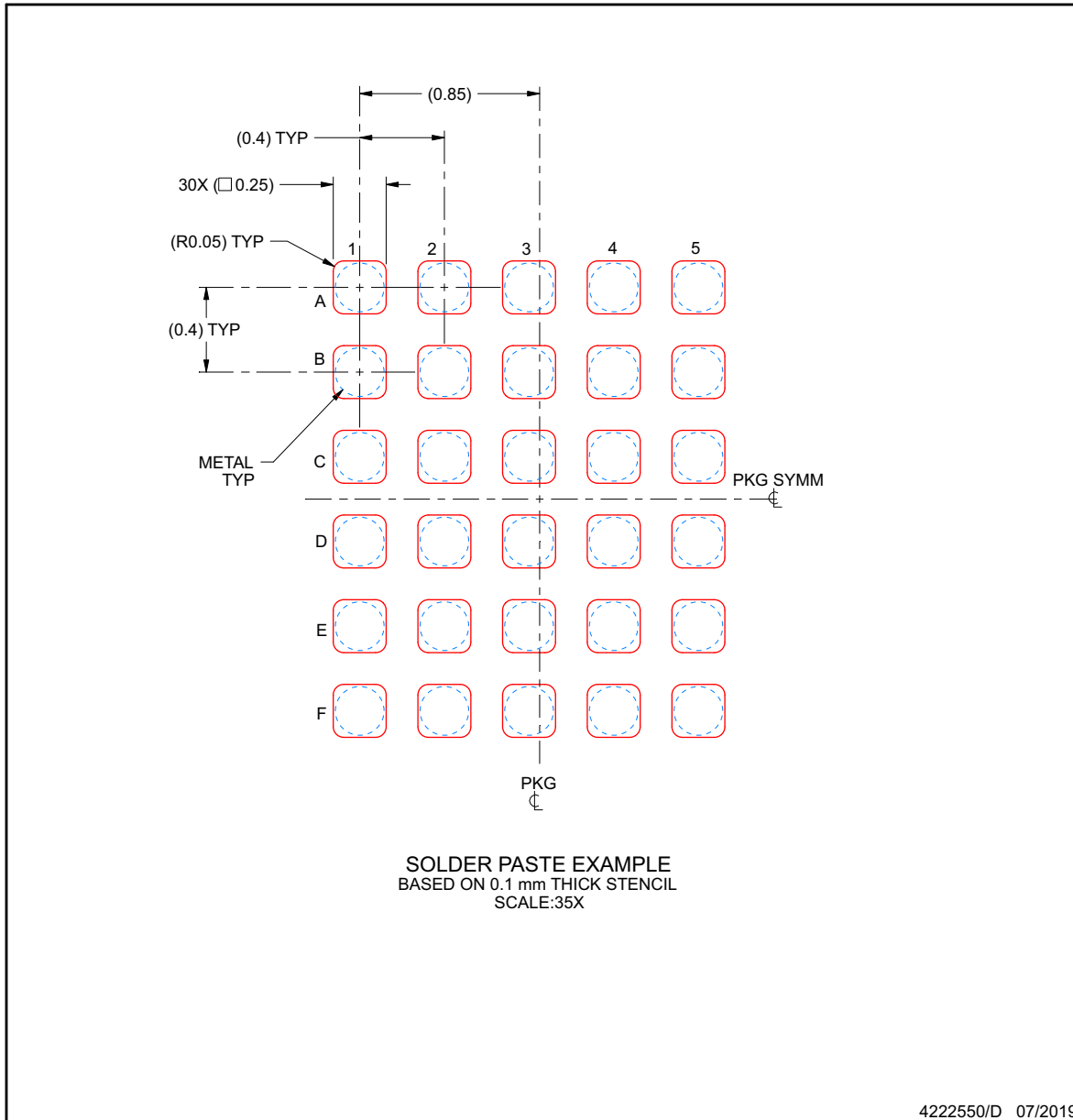
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

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.

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
AFE4410YZR	ACTIVE	DSBGA	YZ	30	3000	RoHS & Green	SAC396 SNAGCU	Level-1-260C-UNLIM	0 to 0	AFE4410	Samples
AFE4410YZT	ACTIVE	DSBGA	YZ	30	250	RoHS & Green	SAC396 SNAGCU	Level-1-260C-UNLIM	-20 to 70	AFE4410	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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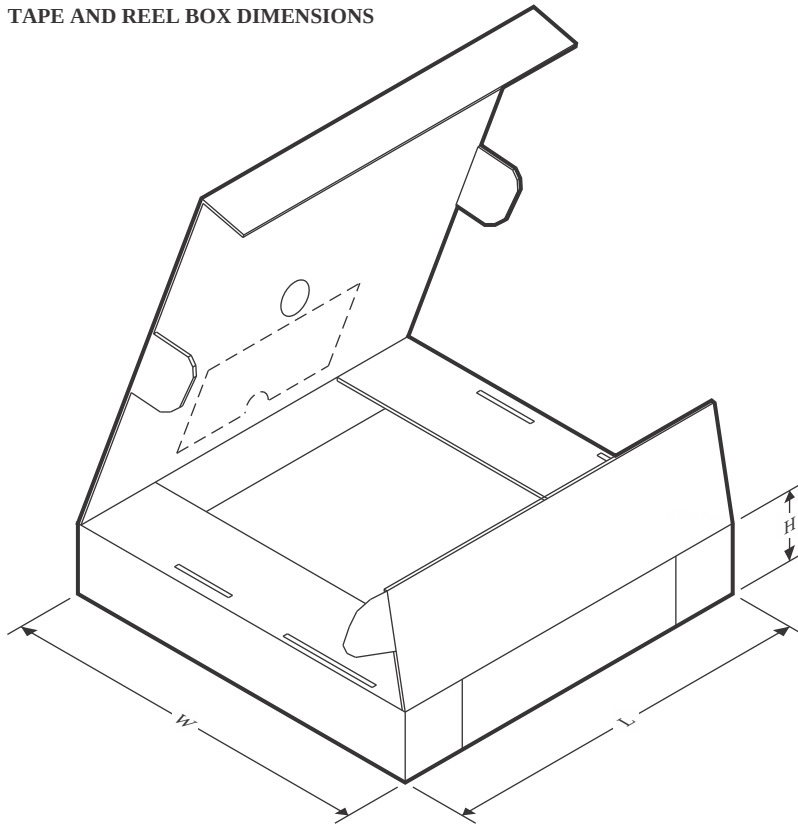
TAPE AND REEL INFORMATION



*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
AFE4410YZR	DSBGA	YZ	30	3000	180.0	8.4	2.16	2.66	0.6	4.0	8.0	Q1
AFE4410YZT	DSBGA	YZ	30	250	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)
AFE4410YZR	DSBGA	YZ	30	3000	182.0	182.0	20.0
AFE4410YZT	DSBGA	YZ	30	250	182.0	182.0	20.0

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