AFE4432 适用于光学生物传感应用的超小型集成式 AFE

1 特性

- 支持多达 12 个相位集的信号采集
- 支持多达 4 个 LED 和 3 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：接收器为 12 µA
  - 在 0.5Hz - 10Hz 频带内的峰值系统 SNR 为 115dB，可实现高精度 SpO2 测量
- 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
  - 可编程每相位 LED 导通时间
  - 同时支持 4 个 LED，适用于 SpO2、多波长 HRM
- 接收器：
  - 支持 3 路时分多路复用 PD 输入
  - 2 个并行接收器（2 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 µA
  - 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 µA
  - 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 kΩ 至 1 MΩ
- 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 160 的 FIFO
- SPI™ 接口/I2C 接口
- 1.9mm × 1.8mm DSBGA 封装，0.35mm 间距
- 电源：接收：1.7V - 1.9V，发射：3V - 5.5V

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

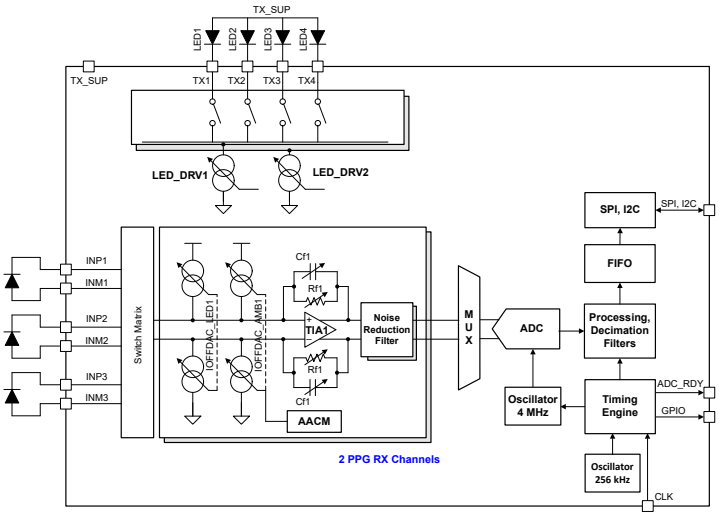
3 说明

AFE4432 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 4 个开关发光二极管 (LED) 和三个光电二极管 (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 12 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，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 160 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）
AFE4432	DSBGA (25)	1.80mm x 1.92mm

(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 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.

4.1 接收文档更新通知

要接收文档更新通知，请导航至 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。

4.2 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》。

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 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。

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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5.1 Package Option Addendum

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)
AFE4432YCHR	ACTIVE	DSBGA	YCH	25	3000	Green (RoHS & no Sn/Br)	SNAGCU	Level-1-260C-UNLIM	-20 to 85	AFE4432
AFE4432YCHT	ACTIVE	DSBGA	YCH	25	250	Green (RoHS & no Sn/Br)	SNAGCU	Level-1-260C-UNLIM	-20 to 85	AFE4432

(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.
PRE_PROD Unannounced device, not in production, not available for mass market, nor on the web, samples not available.
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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material).

(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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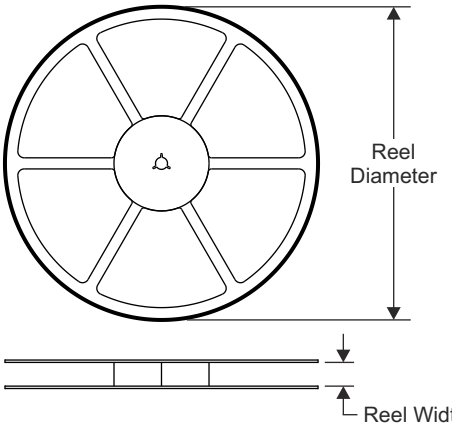
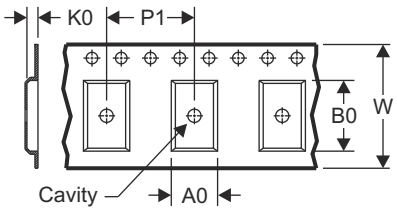
5.2 Tape and Reel Information

REEL DIMENSIONS

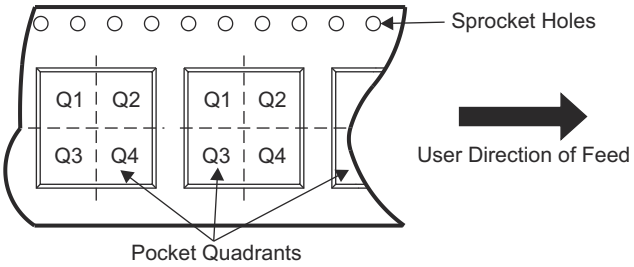


TAPE DIMENSIONS



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



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
AFE4432YCHR	DSBGA	YCH	25	3000	128.0	9.2	1.92	2.02	0.48	4.0	12.0	Q1
AFE4432YCHT	DSBGA	YCH	25	250	128.0	9.2	1.92	2.02	0.48	4.0	12.0	Q1

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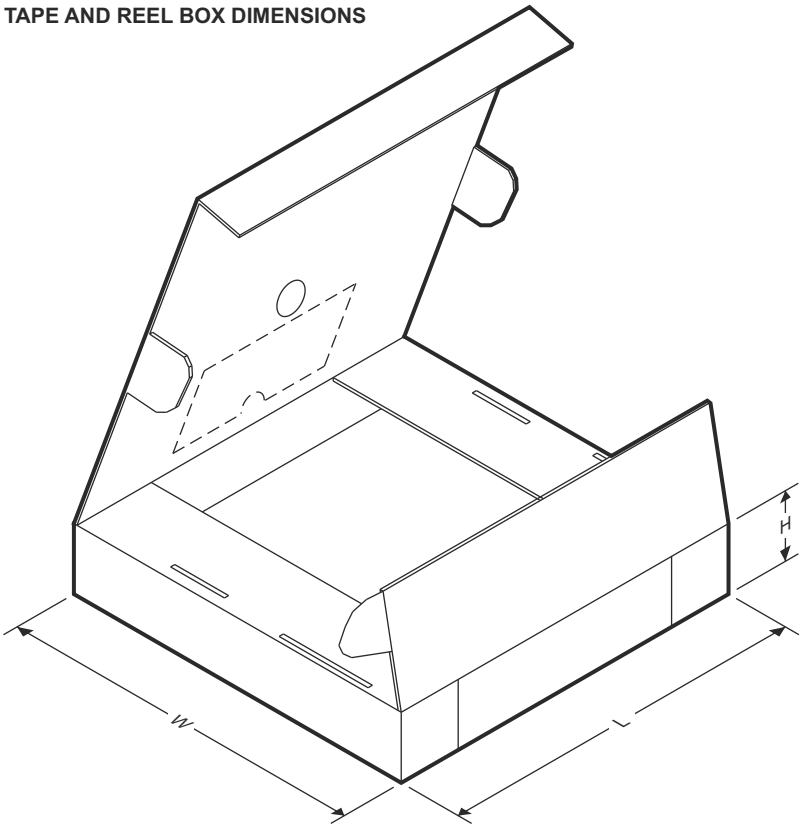
TAPE AND REEL BOX DIMENSIONS



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
AFE4432YCHR	DSBGA	YCH	25	3000	345.0	365.0	55.0
AFE4432YCHT	DSBGA	YCH	25	250	345.0	365.0	55.0

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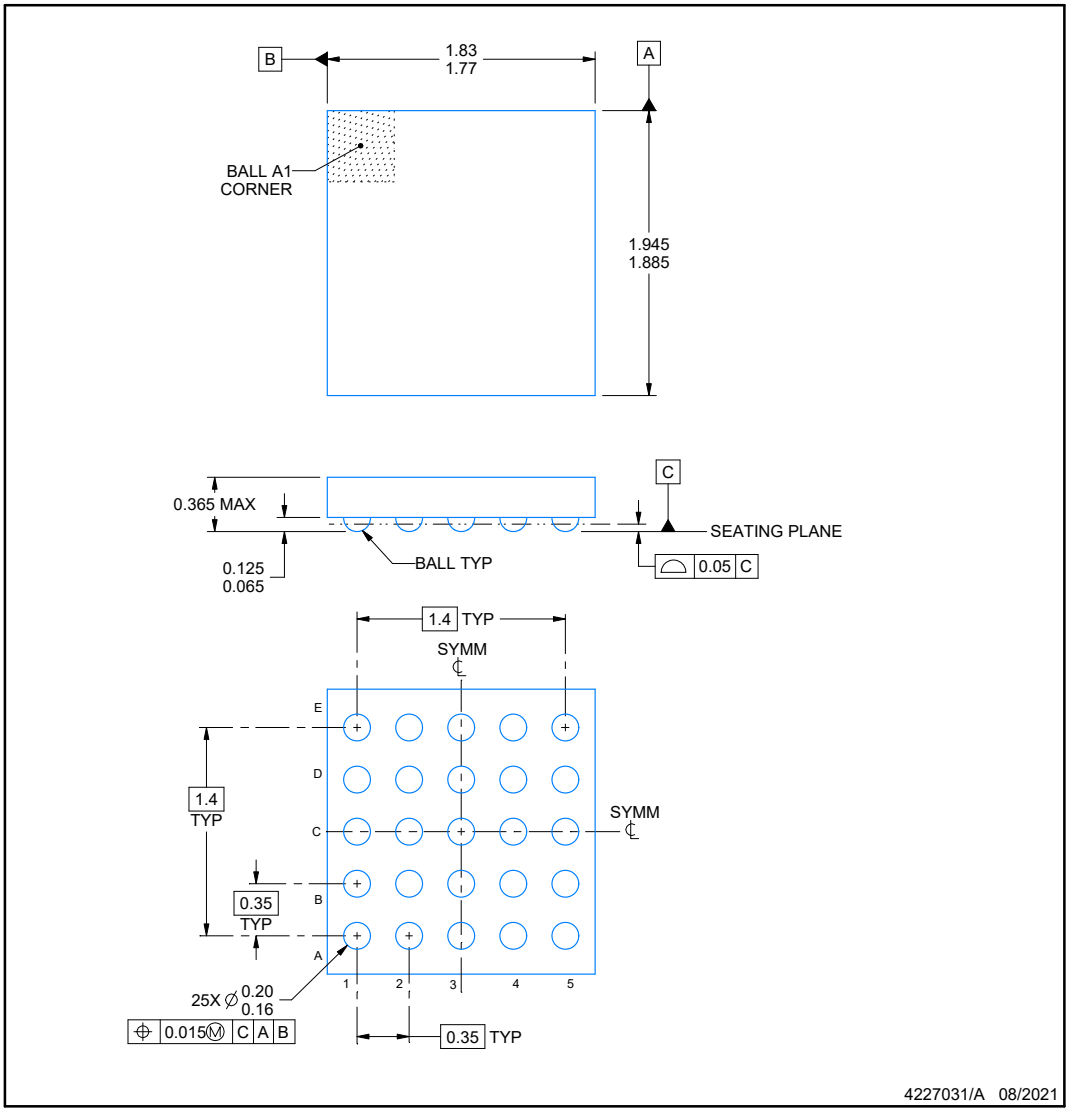
5.3 Mechanical Data

PACKAGE OUTLINE

YCH0025-C01 — **DSBGA - 0.365 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.

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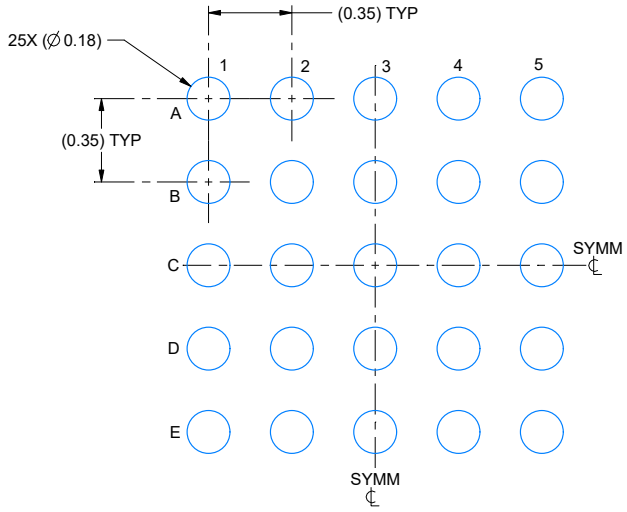
EXAMPLE BOARD LAYOUT

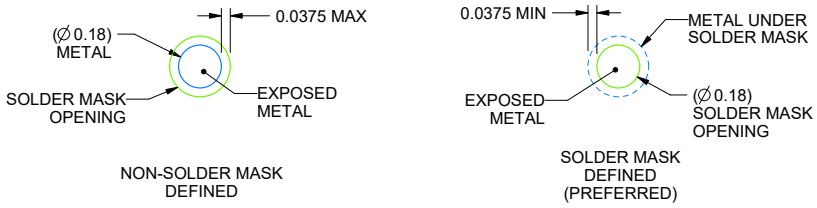
YCH0025-C01

DSBGA - 0.365 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 40X



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).

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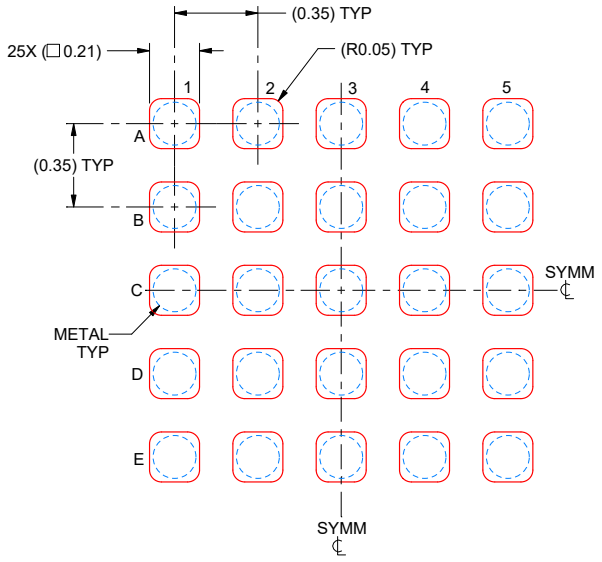
EXAMPLE STENCIL DESIGN

YCH0025-C01 **DSBGA - 0.365 mm max height**

DIE SIZE BALL GRID ARRAY



SOLDER PASTE EXAMPLE
BASED ON 0.075 mm THICK STENCIL
SCALE: 40X

4227031/A 08/2021

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
AFE4432YCHR	ACTIVE	DSBGA	YCH	25	3000	RoHS & Green	Call TI	Level-1-260C-UNLIM	-40 to 85	AFE4432	Samples
AFE4432YCHT	ACTIVE	DSBGA	YCH	25	250	RoHS & Green	Call TI	Level-1-260C-UNLIM	-40 to 85	AFE4432	Samples

(1) The marketing status values are defined as follows:
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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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