AFE4960 用于临床可穿戴设备的双通道 ECG、呼吸和起搏脉冲检测模拟前端 (AFE)

1 特性

- 支持心电图和呼吸阻抗测量；可配置为 2 通道 ECG 或 1 通道 ECG + 1 通道呼吸
- 可用于符合 IEC 60601-2-47:2012/(R)2016 和 IEC 60601-2-27:2011(R)2016 的系统
- 作为 2 通道 ECG 运行时为 222 μA/通道
- 1 个通道上的集成起搏脉冲检测
- 支持 3 导联心电图，可通过并行操作两个或更多 AFE 扩展到 5 导联或更多
- ECG 信号链：
  - 高达 2.048 kHz 的单通道 ECG 采集
  - 高达 1.36 kHz/通道的 2 通道 ECG 采集
  - RLD 输出通过第三电极设置人体偏置
  - INA 增益在 2 至 12 的范围内可进行编程
  - >1 GΩ 输入阻抗，CMRR > 100 dB
  - 输入噪声（0.5 Hz 至 150 Hz）：INA 增益为 3 时为 13 μVpp；INA 增益为 12 时为 5 μVpp
  - 集成式 370 Hz 抗混叠低通滤波器
  - 持续导联开/关检测模式
  - 导联阻抗测量模式
- Bio-Z 信号链：
  - 在 30kHz 至 100kHz 的激励频率范围内测量生物阻抗
  - 正弦波激励或方波激励
  - 呼吸阻抗测量：2 kΩ 基线阻抗上的 45 mΩ-pp 噪声
- 双通道 ECG 通道：
  - Bio-Z 接收器，可配置为第 2 个 ECG 通道
- 外部时钟和内部振荡器模式
- 采样深度为 128 的 FIFO，24 位字
- SPI™，I²C 接口：可通过引脚进行选择
- 2.6mm × 2.6mm DSBGA 封装，0.4mm 间距
- 电源：Rx：1.7V - 1.9V，I_O：1.7V - 1.9V

2 应用

- 用于住院和门诊监测的无线贴片
- 用于心律失常检测的事件监视器
- 手持式 ECG 监护仪
- 便携式多导联 ECG
- 病人生命体征监控：动态心电图、事件、压力和远程医疗

3 说明

AFE4960 可配置为 2 通道 ECG 接收器或 1 通道 ECG 接收器和一个呼吸阻抗通道。AFE 信号链可以灵活地连接至最多 4 个电极。右腿驱动 (RLD) 放大器输出可用于设置人体偏置。AFE 具有用于导联开/关检测的直流引线偏置和用于测量引线阻抗的交流导联偏置。一个通道支持起搏器脉冲检测。

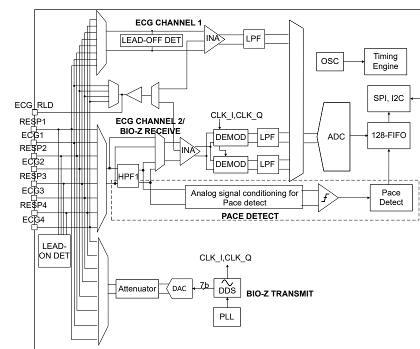
所有信号链输出都由单个 ADC 在明确定义的时隙中转换，并作为 24 位字存储在 128 样本 FIFO 中，可以使用 SPI 或 I²C 界面读出。

AFE4960 是一种完全集成的解决方案，可实现 3 导联 ECG 系统。两个 AFE 并行的同步操作可用于实现 5 导联 ECG。

器件信息

器件型号	封装(1)	封装尺寸（标称值）
AFE4960	DSBGA (YBG 36)	2.6 mm x 2.6 mm

(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。



方框图

本文档旨在为方便起见，提供有关 TI 产品中文版本的信息，以确认产品的概要。有关适用的官方英文版本的最新信息，请访问 www.ti.com，其内容始终优先。TI 不保证翻译的准确性和有效性。在实际设计之前，请务必参考最新版本的英文版本。
English Data Sheet: SBASAE1

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 Documentation Support

4.1.1 Related Documentation

For related documentation, see the following:

- AFE4960 EVM User's Guide, SBAU385
- Analog Front End for 3-Lead and 5-Lead ECG, SBAA536
- 5-Lead ECG Application Report, SBAA523

These documents are available upon request.

4.2 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。

4.3 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》。

4.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
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4.5 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.

4.6 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。

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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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)
AFE4960YBGR	Active	Production	DSBGA (YBG) | 36	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960
AFE4960YBGR.A	Active	Production	DSBGA (YBG) | 36	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960
AFE4960YBGT	Active	Production	DSBGA (YBG) | 36	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960
AFE4960YBGT.A	Active	Production	DSBGA (YBG) | 36	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960

(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.

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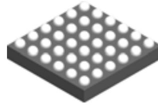
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.



D: Max = 2.59 mm, Min = 2.53 mm
E: Max = 2.59 mm, Min = 2.53 mm

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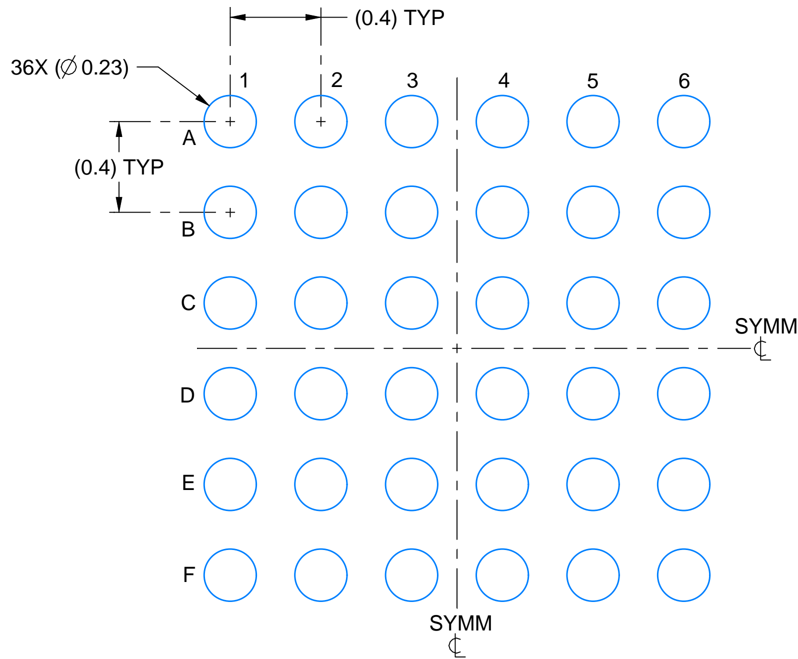
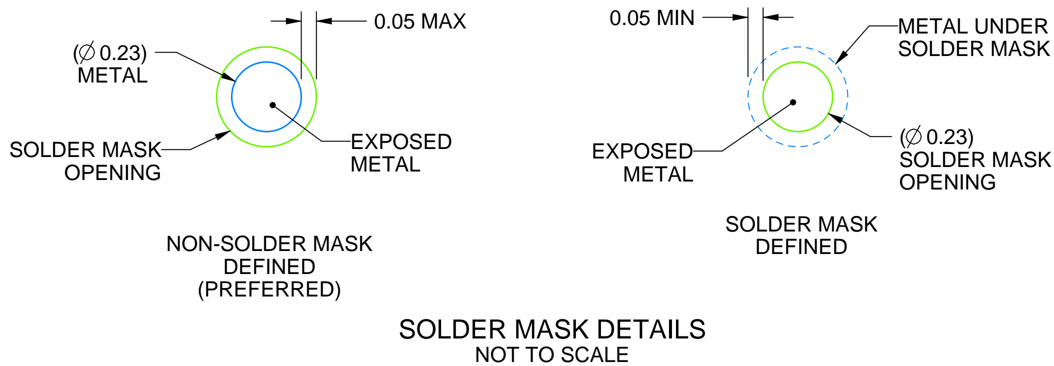
NOTES:

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.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 30X



NON-SOLDER MASK
DEFINED
(PREFERRED)

SOLDER MASK
DEFINED

SOLDER MASK DETAILS
NOT TO SCALE

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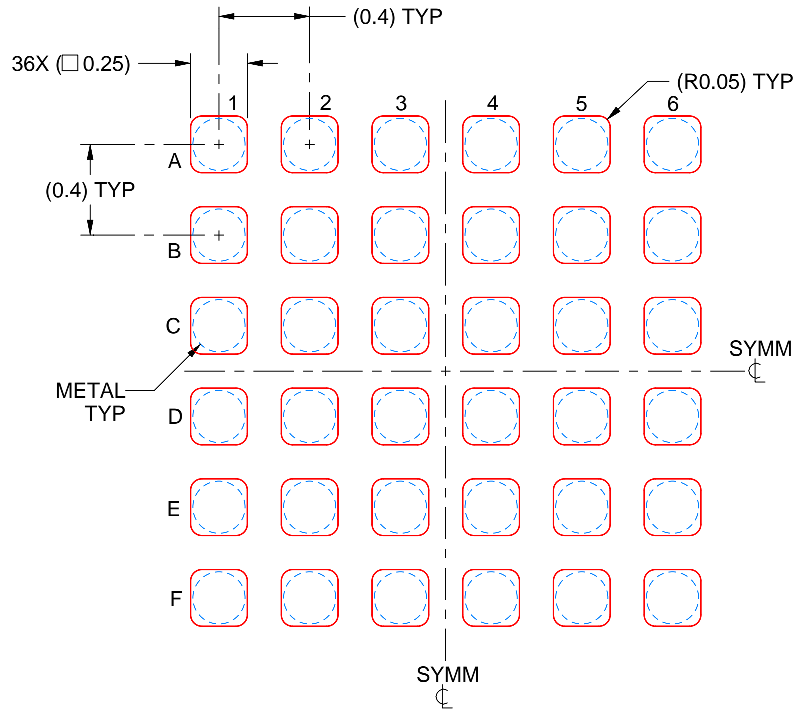
NOTES: (continued)

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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