TEXAS INSTRUMENTS
AFE4960P
SBASAL5 – MAY 2022

AFE4960 Two-Channel ECG, Respiration and Pace Pulse Detection Analog Front End (AFE) for Clinical Wearables

1 Features

- Supports ECG and respiration impedance measurement; configurable as 2-channel ECG or 1-channel ECG + 1-channel respiration
- Can be used in IEC 60601-2-47:2012/(R)2016 and IEC 60601-2-27:2011(R)2016 compliant systems
- 222 µA/channel while operating as 2-channel ECG
- Integrated Pace pulse detection on 1 channel
- Supports a 3-lead ECG, extendable to 5 leads or higher by operating two or more AFEs in parallel
- PPG signal chain for SpO2, Heart rate and PTT
- ECG signal chain:
  - Single channel ECG acquisition up to 2.048 kHz
  - 2 channel ECG acquisition up to 1.36 kHz/ channel
  - RLD output to set body bias through third electrode
  - Programmable INA gain from approximately 2 to 12
  - >1 GΩ input impedance, CMRR > 100 dB
  - Input noise (0.5-150 Hz): 13 µVpp at INA gain of 3; 5 µVpp at INA gain of 12
  - Integrated 370 Hz anti-aliasing low pass filter
  - Mode for continuous lead on/off detection
  - Mode for lead impedance measurement
- Bio-Z signal chain:
  - Measurement of Bio-impedance over excitation frequency from 30 kHz to 100 kHz
  - Sine wave or square wave excitation
  - Respiration impedance measurement: 45 mΩ-pp noise on a baseline impedance of 2 kΩ
- Dual channel ECG channel:
  - Bio-Z receiver configurable as a 2nd ECG channel
- PPG Signal Chain
  - Supports acquisition of up to 24 PPG signals
  - Flexible allocation of 4 LED, 4 PD in each phase
  - 8-Bit LED Current control up to 250 mA
  - Low noise current DAC at input to cancel DC
  - Trans-impedance Gain: 3.7 kΩ to 1 MΩ
  - Filter to reduce sensor's optical noise bandwidth
- External clock and internal oscillator modes
- FIFO with 128-sample Depth, 24-bit word
- SPI™, I²C interfaces: Selectable by pin
- 2.6-mm × 2.6-mm DSBGA, 0.4-mm Pitch
- Supplies: Rx:1.7-1.9 V, I_O:1.7-1.9 V, Tx: 3.0-5.5 V

2 Applications

- Wireless patches for in-patient and out-patient monitoring
- Event monitors for arrhythmia detection
- Hand-held ECG monitor
- Portable multi-lead ECG
- Patient vital sign monitoring: holter, event, stress and telemedicine
- SpO2 & Heart rate, and PTT-based blood pressure through synchronized ECG, PPG

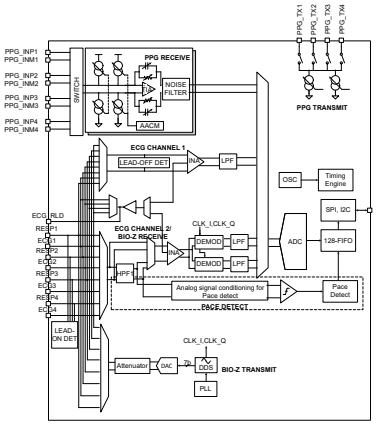
3 Description

The AFE4960P supports synchronized signal acquisition of ECG, PPG and bio-impedance signals. A PPG signal chain comprises of a current driver for LEDs and a receiver that senses the signal from PDs. The AFE can be configured as either a 2-channel ECG receiver or as a 1-channel ECG receiver and a Respiration impedance channel. The AFE signal chains can interface in a flexible manner to up to 4 electrodes. The AFE has AC and DC Lead biasing and lead on/off detection. Pacemaker pulse detection is supported on one channel. All the signal chain outputs are converted by a single ADC in well-defined time slots and stored as 24-bit words in a 128-sample FIFO which can be read out using a SPI or an I²C interface. The AFE4960P can be used to realize a 3-lead ECG system along with SpO2.

Device Information

PART NUMBER	PACKAGE(1)	BODY SIZE (NOM)
AFE4960P	DSBGA (YBG 36)	2.6 mm x 2.6 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.



Block Diagram

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
May 2022	*	Initial Release

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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 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

5.3 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is 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.

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 Glossary

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

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.

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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)
AFE4960PYBGR	Active	Production	DSBGA (YBG) | 36	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960P
AFE4960PYBGR.A	Active	Production	DSBGA (YBG) | 36	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960P
AFE4960PYBGT	Active	Production	DSBGA (YBG) | 36	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960P
AFE4960PYBGT.A	Active	Production	DSBGA (YBG) | 36	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	AFE4960P

(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.

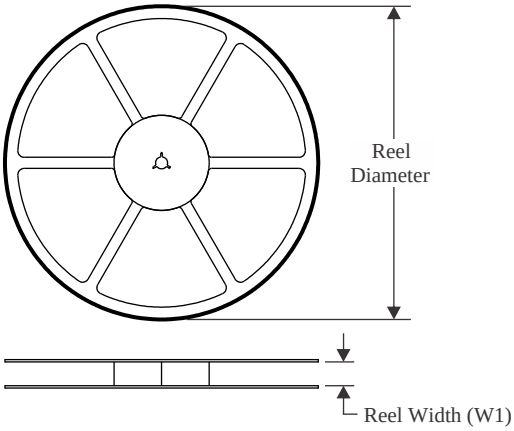
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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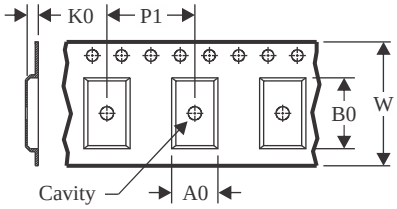
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

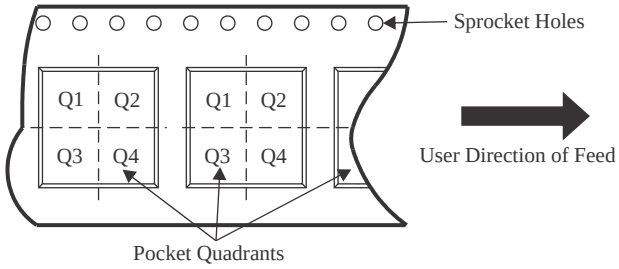


TAPE DIMENSIONS



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

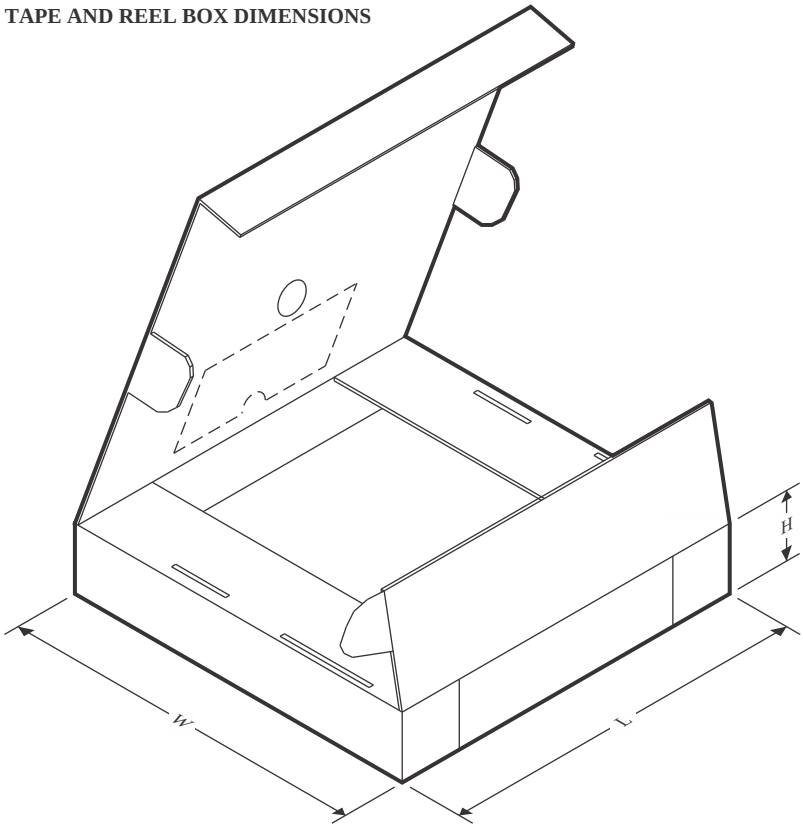
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
AFE4960PYBGR	DSBGA	YBG	36	3000	330.0	12.4	2.73	2.73	0.67	8.0	12.0	Q1
AFE4960PYBGT	DSBGA	YBG	36	250	330.0	12.4	2.73	2.73	0.67	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

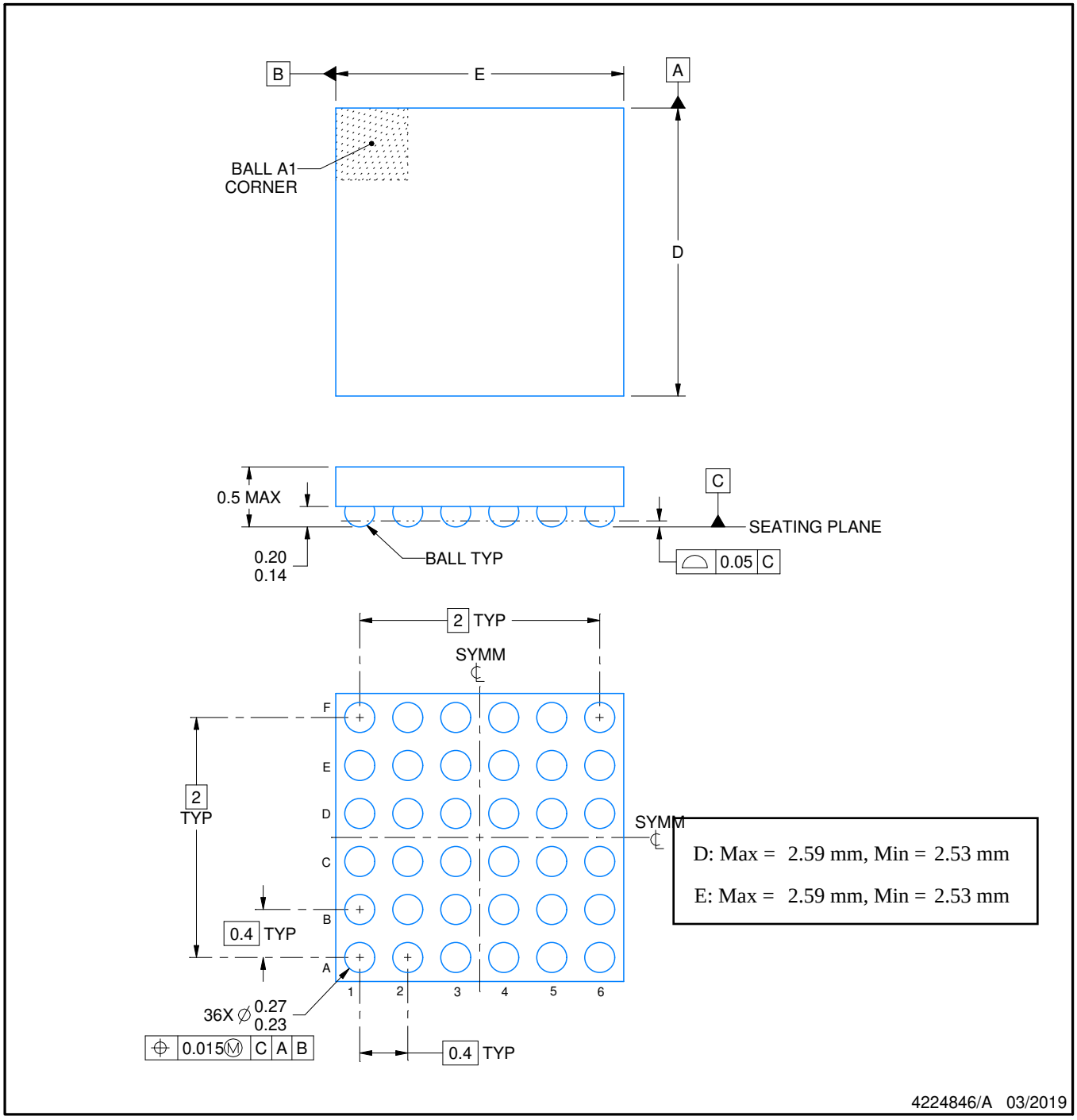
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
AFE4960PYBGR	DSBGA	YBG	36	3000	345.0	365.0	55.0
AFE4960PYBGT	DSBGA	YBG	36	250	345.0	365.0	55.0

YBG0036

PACKAGE OUTLINE

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



NOTES:

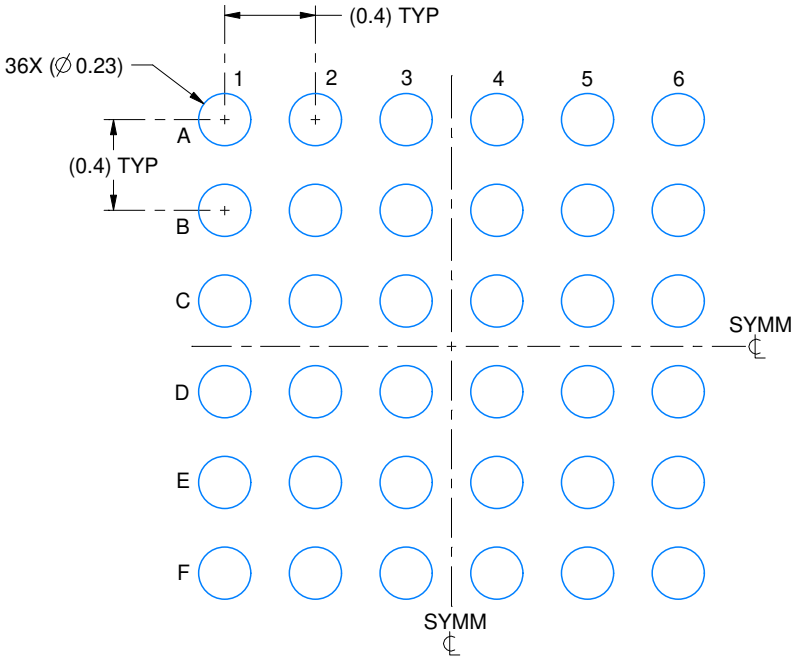
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

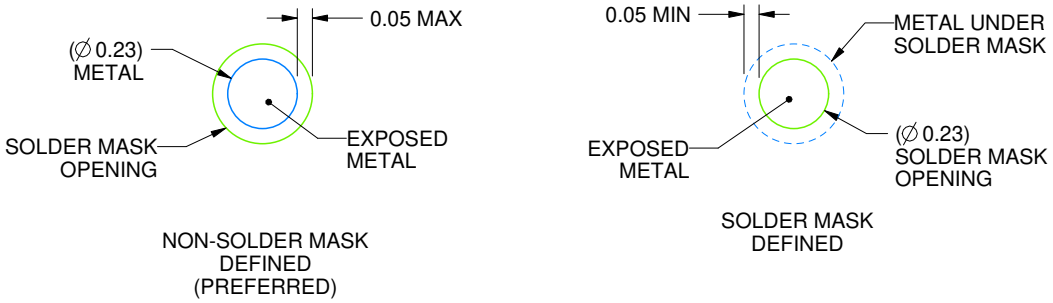
YBG0036

DSBGA - 0.5 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 30X

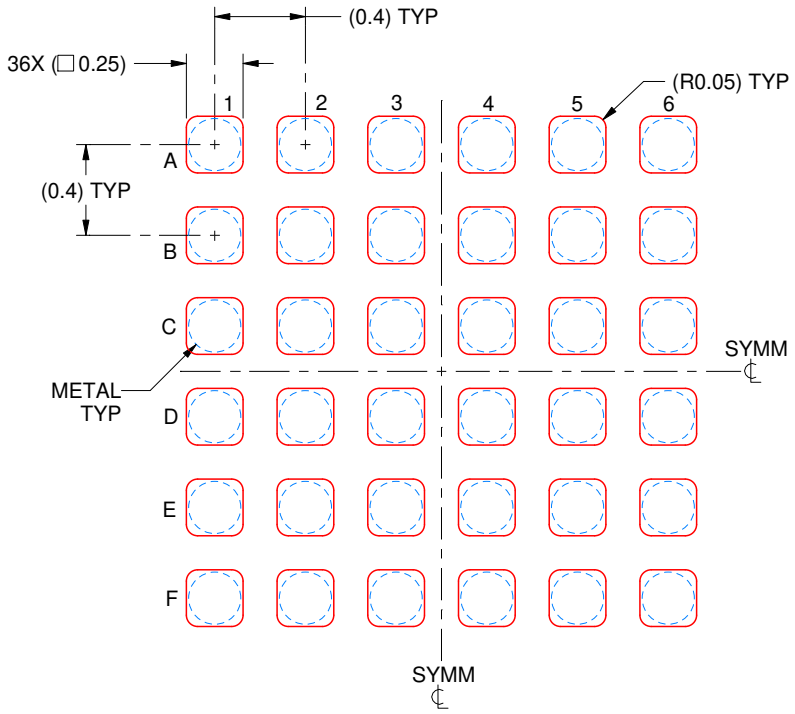


SOLDER MASK DETAILS
NOT TO SCALE

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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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