# AFSC5G23E39

## Airfast Power Amplifier Module

Rev. 0 — November 2022

Data Sheet: Technical Data

The AFSC5G23E39 is a fully integrated Doherty power amplifier module designed for wireless infrastructure applications that demand high performance in the smallest footprint. Ideal for applications in massive MIMO systems, outdoor small cells and low power remote radio heads. The field–proven LDMOS power amplifiers are designed for TDD and FDD LTE systems.

**2300–2400 MHz**

- Typical LTE Performance: $P_{out}$ = 8 W Avg., $V_{DD}$ = 28 Vdc, 1 × 20 MHz LTE, Input Signal PAR = 8 dB @ 0.01% Probability on CCDF. (1)

| Carrier Center Frequency | Gain (dB) | ACPR (dBc) | PAE (%) |
|---|---|---|---|
| 2310 MHz | 30.4 | –30.4 | 43.2 |
| 2350 MHz | 30.5 | –30.7 | 42.9 |
| 2390 MHz | 30.6 | –30.7 | 42.4 |

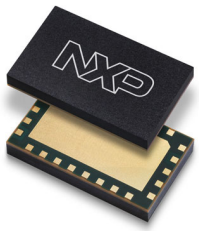
1. All data measured with device soldered in NXP reference circuit.

**Features**

- Frequency: 2300–2400 MHz
- Advanced high performance in–package Doherty
- Fully matched (50 ohm input/output, DC blocked)
- Designed for low complexity analog or digital linearization systems

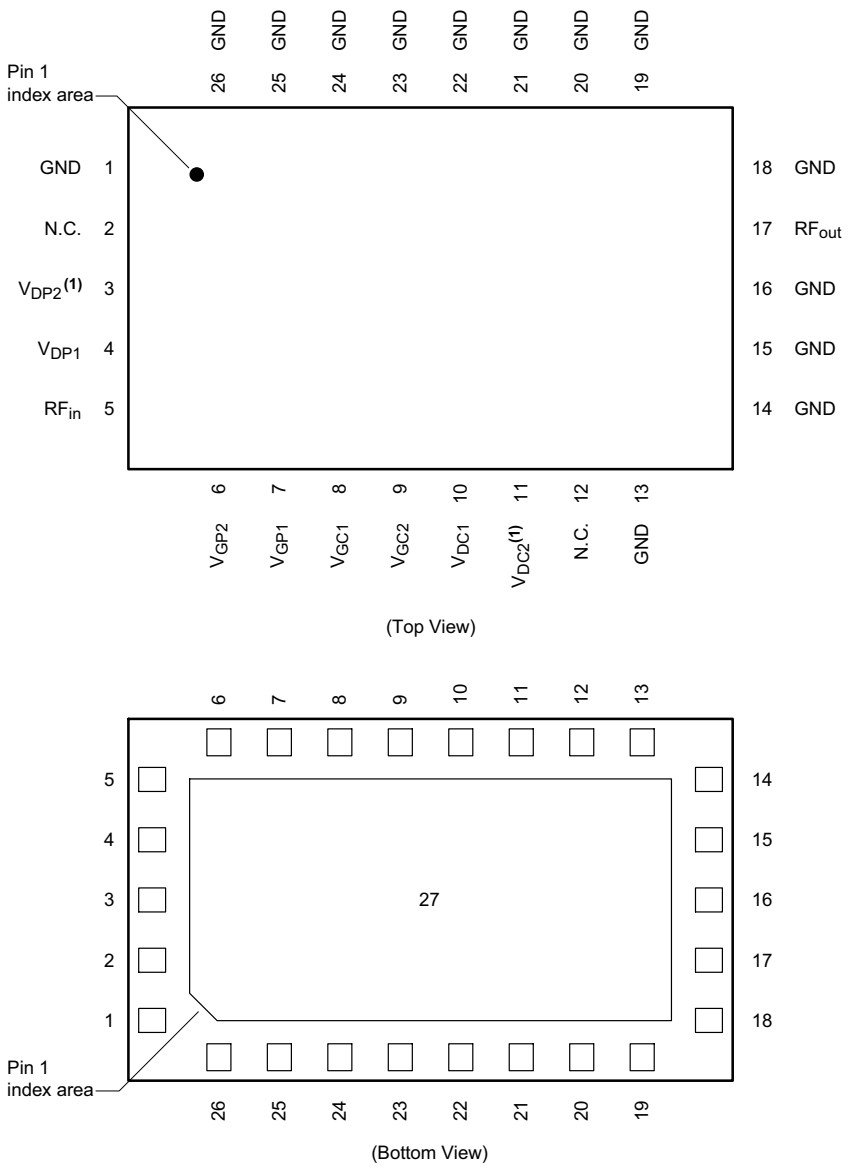
**AFSC5G23E39**

**2300–2400 MHz, 30 dB, 8 W Avg. AIRFAST POWER AMPLIFIER MODULE**



**10 mm × 6 mm Module**

NXP reserves the right to change the detail specifications as may be required to permit improvements in the design of its products.




Note: Exposed backside of the package is DC and RF ground.

**Figure 1. Pin Connections**

1. $V_{DP2}$ and $V_{DC2}$ are DC coupled internal to the package and must be powered by a single DC power supply.

**Table 1. Functional Pin Description**

| Pin Number | Pin Function | Pin Description |
|---|---|---|
| 1, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 | GND | Ground |
| 2, 12 | N.C. | No Connection |
| 3 | $V_{DP2}$ | Peaking Drain Supply, Stage 2 |
| 4 | $V_{DP1}$ | Peaking Drain Supply, Stage 1 |
| 5 | $RF_{in}$ | RF Input |
| 6 | $V_{GP2}$ | Peaking Gate Supply, Stage 2 |
| 7 | $V_{GP1}$ | Peaking Gate Supply, Stage 1 |
| 8 | $V_{GC1}$ | Carrier Gate Supply, Stage 1 |
| 9 | $V_{GC2}$ | Carrier Gate Supply, Stage 2 |
| 10 | $V_{DC1}$ | Carrier Drain Supply, Stage 1 |
| 11 | $V_{DC2}$ | Carrier Drain Supply, Stage 2 |
| 17 | $RF_{out}$ | RF Output |

**Table 2. Maximum Ratings**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Gate−Bias Voltage Range | $V_G$ | −0.5 to +10 | Vdc |
| Operating Voltage Range | $V_{DD}$ | 24 to 30 | Vdc |
| Storage Temperature Range | $T_{stg}$ | −65 to +150 | °C |
| Case Operating Temperature | $T_C$ | 125 | °C |
| Peak Input Power<br>(2350 MHz, Pulsed CW, 10 μsec(on), 10% Duty Cycle) | $P_{in}$ | 25 | dBm |

**Table 3. Lifetime**

| Characteristic | Symbol | Value | Unit |
|---|---|---|---|
| Mean Time to Failure<br>Case Temperature 125°C, 8 W Avg., 30 Vdc | MTTF | > 10 | Years |

**Table 4. ESD Protection Characteristics**

| Test Methodology | Class |
|---|---|
| Human Body Model (per JS−001−2017) | 1B |
| Charge Device Model (per JS−002−2014) | C2a |

**Table 5. Moisture Sensitivity Level**

| Test Methodology | Rating | Package Peak Temperature | Unit |
|---|---|---|---|
| Per JESD22−A113, IPC/JEDEC J−STD−020 | 3 | 260 | °C |

**Table 6. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Typ | Range | Unit |
|---|---|---|---|---|
| **Carrier Stage 1 — On Characteristics** | | | | |
| Gate Threshold Voltage (1) ($V_{DS}$ = 10 Vdc, $I_D$ = 2.4 μAdc) | $V_{GS(th)}$ | 1.2 | ±0.4 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 Vdc, $I_{DQ1A}$ = 26 mAdc) | $V_{GS(Q)}$ | 2.0 | ±0.4 | Vdc |
| Fixture Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_{DQ1A}$ = 26 mAdc, Measured in Functional Test) | $V_{GG(Q)}$ | 5.3 | ±1.4 | Vdc |
| **Carrier Stage 2 — On Characteristics** | | | | |
| Gate Threshold Voltage (1) ($V_{DS}$ = 10 Vdc, $I_D$ = 19 μAdc) | $V_{GS(th)}$ | 1.2 | ±0.4 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 Vdc, $I_{DQ2A}$ = 116 mAdc) | $V_{GS(Q)}$ | 1.9 | ±0.4 | Vdc |
| Fixture Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_{DQ2A}$ = 116 mAdc, Measured in Functional Test) | $V_{GG(Q)}$ | 3.6 | ±1.2 | Vdc |
| **Peaking Stage 1 — On Characteristics (1)** | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 4.4 μAdc) | $V_{GS(th)}$ | 1.2 | ±0.4 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 Vdc, $I_{DQ1A}$ = 0.7 mAdc) | $V_{GS(Q)}$ | 1.6 | ±0.4 | Vdc |
| Fixture Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_{DQ1A}$ = 0.7 mAdc, Measured in Functional Test) | $V_{GG(Q)}$ | 1.6 | ±0.4 | Vdc |
| **Peaking Stage 2 — On Characteristics (1)** | | | | |
| Gate Threshold Voltage ($V_{DS}$ = 10 Vdc, $I_D$ = 41 μAdc) | $V_{GS(th)}$ | 1.2 | ±0.4 | Vdc |
| Gate Quiescent Voltage ($V_{DS}$ = 28 Vdc, $I_{DQ2A}$ = 2.5 mAdc) | $V_{GS(Q)}$ | 1.5 | ±0.4 | Vdc |
| Fixture Gate Quiescent Voltage ($V_{DD}$ = 28 Vdc, $I_{DQ2A}$ = 2.5 mAdc, Measured in Functional Test) | $V_{GG(Q)}$ | 1.5 | ±0.4 | Vdc |

1. Each side of device measured separately.

(continued)

**Table 6. Electrical Characteristics** ($T_A$ = 25°C unless otherwise noted) **(continued)**

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **Functional Tests — 2300 MHz** (1) (In NXP Doherty Production ATE (2) Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ1A}$ = 26 mA, $I_{DQ2A}$ = 116 mA, $V_{GS1B}$ = ($V_t$ + 0.02) Vdc, $V_{GS2B}$ = ($V_t$ – 0.13) Vdc, $P_{out}$ = 8 W Avg., 1–tone CW, f = 2300 MHz. | | | | | |
| Gain | G | 28.0 | 29.8 | — | dB |
| Drain Efficiency | $\eta_D$ | 37.6 | 43.6 | — | % |
| $P_{out}$ @ 3 dB Compression Point | P3dB | 46.3 | 47.3 | — | dBm |
| **Functional Tests — 2400 MHz** (1) (In NXP Doherty Production ATE (2) Test Fixture, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ1A}$ = 26 mA, $I_{DQ2A}$ = 116 mA, $V_{GS1B}$ = ($V_t$ + 0.02) Vdc, $V_{GS2B}$ = ($V_t$ – 0.13) Vdc, $P_{out}$ = 8 W Avg., 1–tone CW, f = 2400 MHz. | | | | | |
| Gain | G | 28.0 | 29.9 | — | dB |
| Drain Efficiency | $\eta_D$ | 36.7 | 42.7 | — | % |
| $P_{out}$ @ 3 dB Compression Point | P3dB | 46.6 | 47.6 | — | dBm |
| **Wideband Ruggedness** (3) (In NXP Doherty Power Amplifier Module Reference Circuit, 50 ohm system) $I_{DQ1A}$ = 26 mA, $I_{DQ2A}$ = 116 mA, $V_{GSP1}$ = 1.6 Vdc, $V_{GSP2}$ = 1.5 Vdc, f = 2350 MHz, Additive White Gaussian Noise (AWGN) with 10 dB PAR | | | | | |
| ISBW of 400 MHz at 30 Vdc, 3 dB Input Overdrive from 8 W Avg. Modulated Output Power | No Device Degradation | | | | |
| **Typical Performance** (3) (In NXP Doherty Power Amplifier Module Reference Circuit, 50 ohm system) $V_{DD}$ = 28 Vdc, $I_{DQ1A}$ = 26 mA, $I_{DQ2A}$ = 116 mA, $V_{GSP1}$ = 1.6 Vdc, $V_{GSP2}$ = 1.5 Vdc, $P_{out}$ = 8 W Avg., 2350 MHz | | | | | |
| VBW Resonance Point, 2–tone, 1 MHz Tone Spacing (IMD Third Order Intermodulation Inflection Point) | $VBW_{res}$ | — | 280 | — | MHz |
| Quiescent Current Accuracy over Temperature (4) with 2.2 kΩ Gate Feed Resistors (–40 to 105°C) Stage 1 | $\Delta I_{QT}$ | — | 14.5 | — | % |
| with 2.2 kΩ Gate Feed Resistors (–40 to 105°C) Stage 2 | | — | 6.2 | — | |
| **1–carrier 20 MHz LTE, 8 dB Input Signal PAR** | | | | | |
| Gain | G | — | 30.5 | — | dB |
| Power Added Efficiency | PAE | — | 42.9 | — | % |
| Adjacent Channel Power Ratio | ACPR | — | –30.7 | — | dBc |
| Adjacent Channel Power Ratio | ALT1 | — | –40.8 | — | dBc |
| Adjacent Channel Power Ratio | ALT2 | — | –49.7 | — | dBc |
| Gain Flatness (5) | $G_F$ | — | 0.2 | — | dB |
| **Fast CW, 27 ms Sweep** | | | | | |
| $P_{out}$ @ 3 dB Compression Point | P3dB | — | 47.2 | — | dBm |
| AM/PM @ P3dB | Φ | — | –7 | — | ° |
| Gain Variation @ Avg. Power over Temperature (–40°C to +105°C) | ΔG | — | 0.028 | — | dB/°C |
| P3dB Variation over Temperature (–40°C to +105°C) | P3dB | — | 0.004 | — | dB/°C |

**Table 7. Ordering Information**

| Device | Tape and Reel Information | Package |
|---|---|---|
| AFSC5G23E39T2 | T2 Suffix = 2,000 Units, 24 mm Tape Width, 13–inch Reel | 10 mm × 6 mm Module |

1. Part input and output matched to 50 ohms.
2. ATE is a socketed test environment.
3. All data measured in fixture with device soldered in NXP reference circuit.
4. Refer to AN1977, *Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family*, and to AN1987, *Quiescent Current Control for the RF Integrated Circuit Device Family*. Go to http://www.nxp.com/RF and search for AN1977 or AN1987.
5. Gain flatness = Max(G($f_{Low}$ to $f_{High}$)) – Min(G($f_{Low}$ to $f_{High}$))

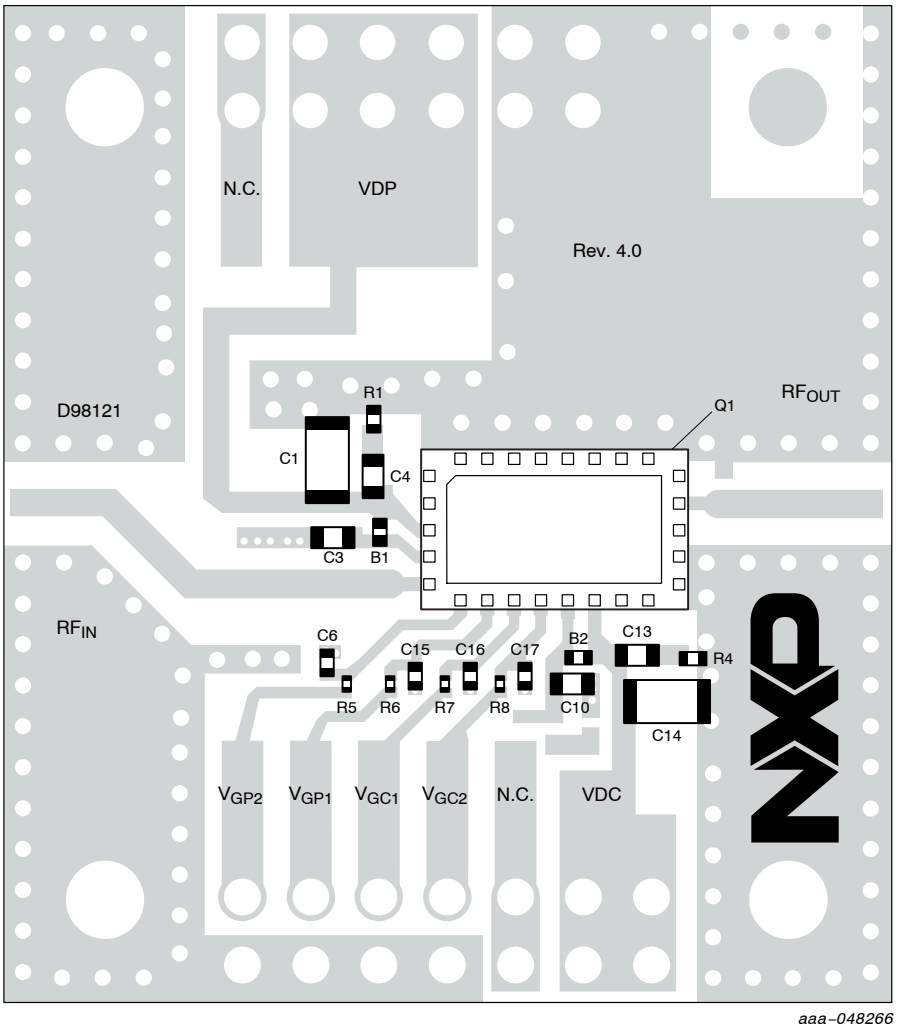



**Figure 2. AFSC5G23E39 Reference Circuit Component Layout**

**Table 8. AFSC5G23E39 Reference Circuit Component Designations and Values**

| Part | Description | Part Number | Manufacturer |
|---|---|---|---|
| B1, B2 | 30 Ω Ferrite Bead | BLM15PD300SN1 | Murata |
| C1, C14 | 10 μF Chip Capacitor | CL31A106KBHNNNE | Samsung |
| C3, C4, C10, C13 | 1 μF Chip Capacitor | 06035D105KAT2A | AVX |
| C6, C15, C16, C17 | 0.1 μF Chip Capacitor | GRM155R61H104KE14 | Murata |
| Q1 | Power Amplifier Module | AFSC5G23E39 | NXP |
| R1, R4 | 5.1 Ω, 1/10 W Chip Resistor | ERJ-2GEJ5R1X | Panasonic |
| R5, R6, R7, R8 | 2.2 kΩ, 1/20 W Chip Resistor | ERJ-1GNJ222C | Panasonic |
| PCB | Rogers RO4350B, 0.020″, $\varepsilon_r$ = 3.66 | D98121 | MTL |

Note: Component numbers C2, C5, C7, C8, C9, C11, C12, R2 and R3 are intentionally omitted.


**Figure 3. Product Marking**

# Package Information

H–PLGA–27 I/O
10 X 6 X 1.365 PKG, 1 PITCH

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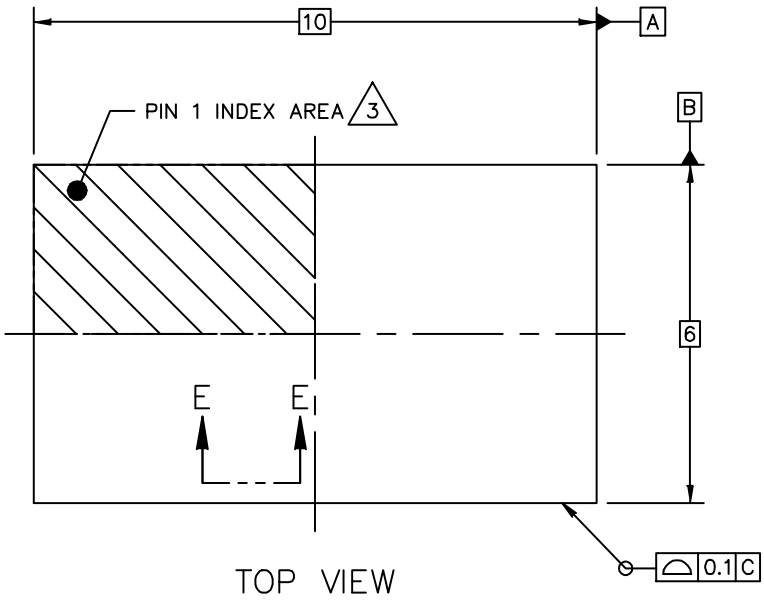
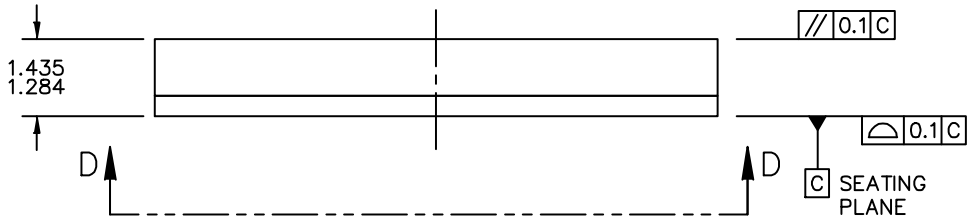



TOP VIEW

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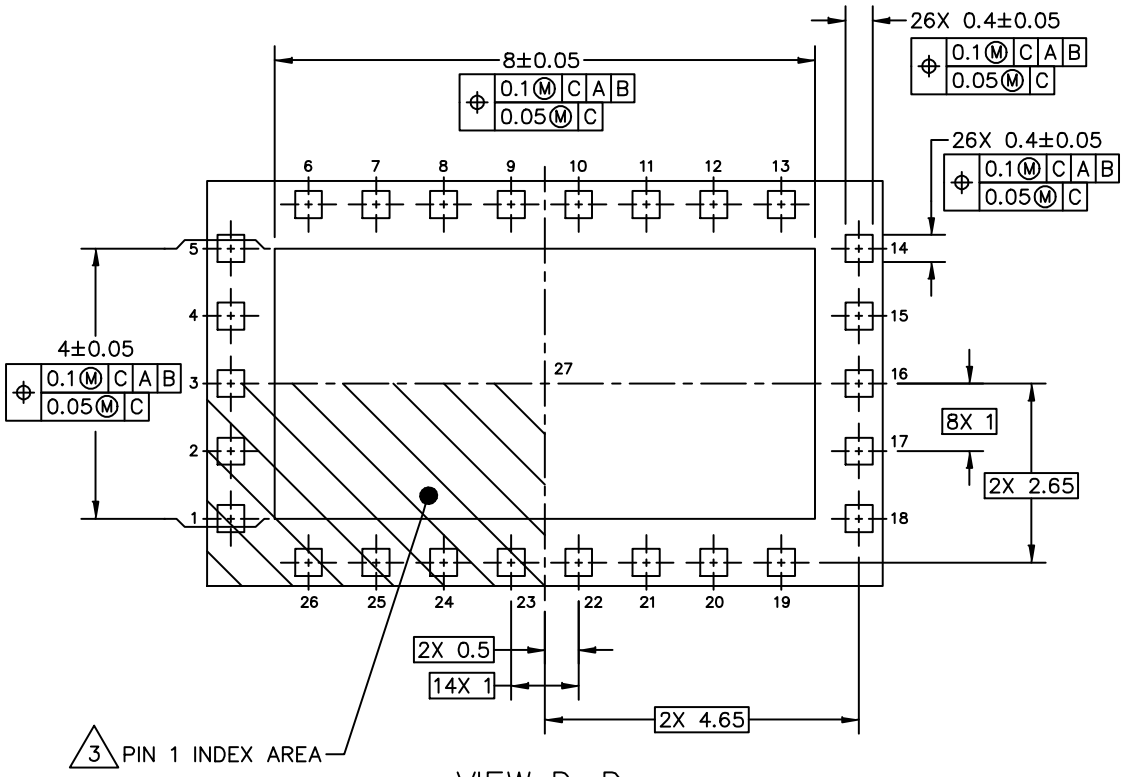
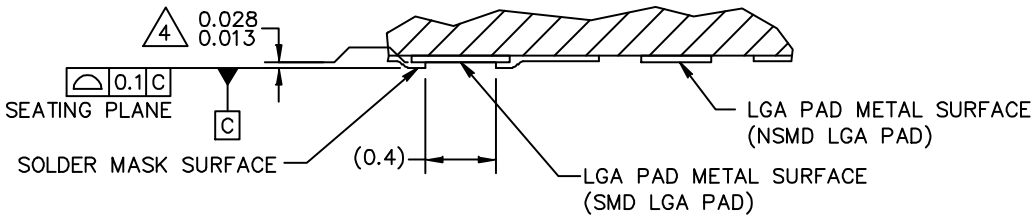
|---|---|---|---|---|

H-PLGA-27 I/O
10 X 6 X 1.365 PKG, 1 PITCH

SOT1831-2




VIEW D-D
(BOTTOM VIEW)

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10 X 6 X 1.365 PKG, 1 PITCH

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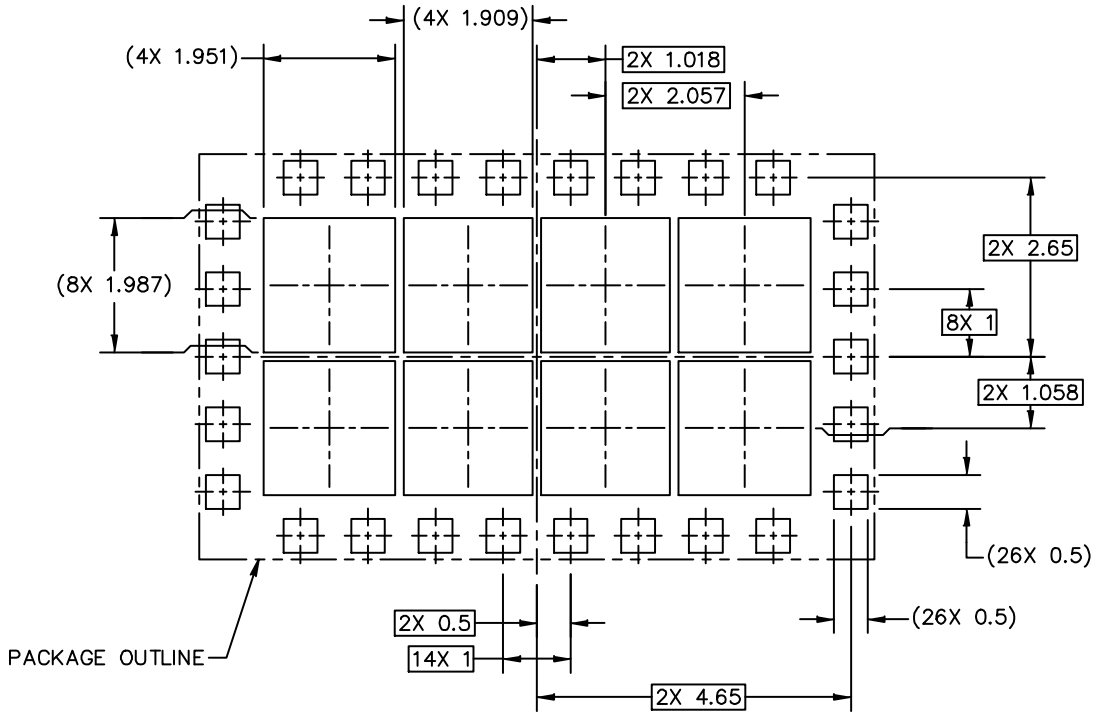


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10 X 6 X 1.365 PKG, 1 PITCH

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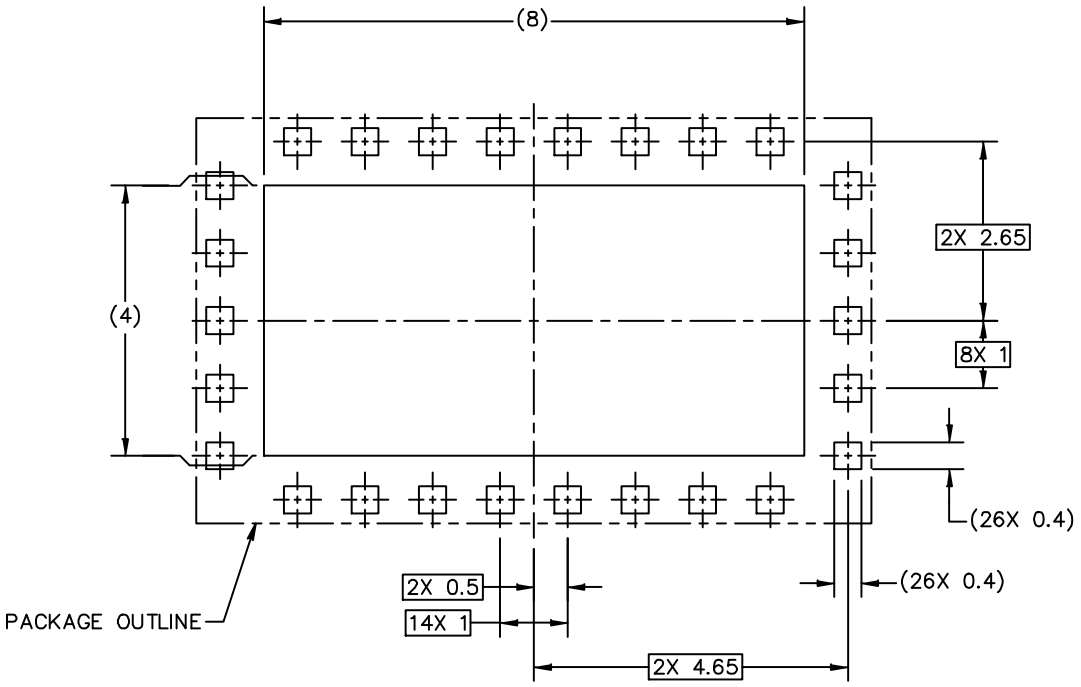


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H-PLGA-27 I/O
10 X 6 X 1.365 PKG, 1 PITCH

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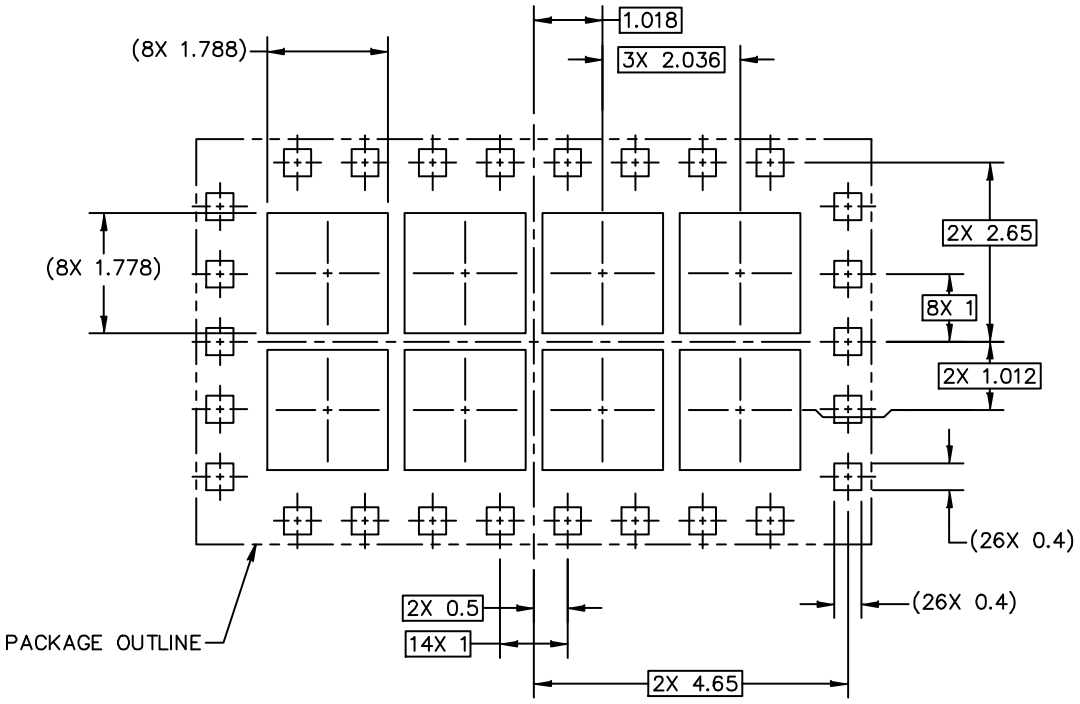


RECOMMENDED STENCIL THICKNESS 0.125

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H–PLGA–27 I/O
10 X 6 X 1.365 PKG, 1 PITCH

SOT1831–2

NOTES:

1. ALL DIMENSIONS IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994.
3. PIN 1 FEATURE SHAPE, SIZE AND LOCATION MAY VARY.
4. DIMENSION APPLIES TO ALL LEADS AND FLAG.
5. THE BOTTOM VIEW SHOWS THE SOLDERABLE AREA OF THE PADS. THE CENTER PAD (PIN 27) IS SOLDER MASK DEFINED. SOME PERIPHERAL PADS ARE SOLDER MASK DEFINED (SMD) AND OTHERS ARE NON–SOLDERMASK DEFINED (NSMD).

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# Product Documentation and Tools

Refer to the following resources to aid your design process.

**Application Notes**

- AN1977: Quiescent Current Thermal Tracking Circuit in the RF Integrated Circuit Family
- AN1987: Quiescent Current Control for the RF Integrated Circuit Device Family

**Development Tools**

- Printed Circuit Boards

# Failure Analysis

At this time, because of the physical characteristics of the part, failure analysis is limited to electrical signature analysis. In cases where NXP is contractually obligated to perform failure analysis (FA) services, full FA may be performed by third party vendors with moderate success. For updates contact your local NXP Sales Office.

# Revision History

The following table summarizes revisions to this document.

| Revision | Date | Description |
|---|---|---|
| 0 | Nov. 2022 | • Initial release of data sheet |

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