# TL0301H: 4.9 – 6.0 GHz High Gain Ultra Low Noise Amplifier

## 1.0 Features

- Small signal gain @ 5.5 GHz: 17.8 dB
- EVB NF @ 5.5 GHz: 1 dB
- IP1dB @ 5.5 GHz: -4.5 dBm
- 3.3 V Typical operating voltage
- Operating frequency: 4.9 to 6.0 GHz


**Figure 1.1 Device Image**
(6 Pin 1.5 × 1.5 × 0.8 mm DFN Package)

## 2.0 Applications

- IEEE 802.11 b/g/a/n/ac Wi-Fi, WLAN
- Small Cells and Cellular Repeaters
- 4G Infrastructure Radios
- Phase Array Radar

**RoHS/REACH/Halogen Free Compliance**

## 3.0 Description

The TL0301H is a High Gain, Ultra-low Noise Amplifier (LNA) providing high gain and linearity. Over the above-mentioned frequency band, this device exhibits excellent noise figure of 1.0 dB (SMA-SMA) with outstanding gain flatness.

The LNA is operated with a typical bias condition of 3.3 V and 15 mA. TL0301H is internally matched to 50 Ω at the input and output ports.

The TL0301H is packaged in a compact, low-cost DFN 1.5x1.5x0.8mm, 6 pin plastic package.

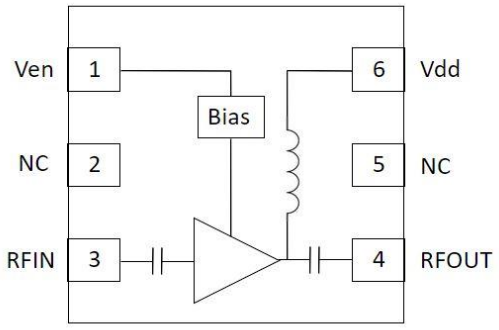


**Figure 3.1 Function Block Diagram**
(Top View)

## 4.0 Ordering Information

**Table 4.1 Ordering Information**

| Base Part Number | Package Type | Form | Qty | Reel Diameter | Reel Width | Orderable Part Number |
|---|---|---|---|---|---|---|
| TL0301H | 6 Pin 1.5 × 1.5 × 0.8mm DFN | Tape and Reel | 5000 | 13” (330 mm) | 18 mm | TL0301HMTRPBF |
| Tuned Evaluation Board, 5.125-5.925GHz | | | | | | TL0301H-EVB-A |

## 5.0 Pin Description

**Table 5.1 Pin Definition**

| Pin Number | Pin Name | Description |
|---|---|---|
| 1 | Ven | Venable along with series resistor sets the Idq. Venable <0.2V disables the device |
| 2 | NC | No internal connection, can be connected to ground |
| 3 | RFIN | RF Input. DC blocking cap required |
| 4 | RFOUT | RF Output |
| 5 | NC | No internal connection, can be connected to ground |
| 6 | $V_{dd}$ | Supply Voltage for the LNA, supplied through an external choke inductor |
| Package Base | Paddle/Slug | DC and RF Ground. Also provides thermal relief. Multiple vias are recommended |

Note: [1] The backside ground slug of the device must be grounded directly to the ground plane through multiple vias to ensure proper operation. Adequate heat sinking required.

## 6.0 Absolute Maximum Rating

**Table 6.1 Absolute Maximum Rating** @$T_A$=+25°C Unless Otherwise Specified

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| **Electrical Ratings** | | | |
| Supply voltage, Venable | $V_{dd,}$ Ven | +6 | V |
| Drain current | $I_{DQ}$ | 25 | mA |
| RF input power CW | RFIN | 15 | dBm |
| Storage Temperature Range | $T_{st}$ | -55 to +150 | °C |
| Operating Temperature Range | $T_{op}$ | -40 to +105 | °C |
| Maximum Junction Temperature | $T_J$ | 170 | °C |
| **Thermal Ratings** | | | |
| Thermal Resistance (junction-to-case) – Bottom side | $R_{\theta JC}$ | 15.0 | °C/W |
| Soldering Temperature | $T_{SOLD}$ | 260 | °C |
| **ESD Ratings** | | | |
| Human Body Model (HBM) | Level 1B | 500 to <1000 | V |
| Charged Device Model (CDM) | Level C | ≥1000 | V |
| **Moisture Rating** | | | |
| Moisture Sensitivity Level | MSL | 1 | - |

**Attention:** Maximum ratings are absolute ratings. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Exceeding one or a combination of the absolute maximum ratings may cause permanent and irreversible damage to the device and/or to surrounding circuit.

## 7.0 Recommended DC Operating Conditions

**Table 7.1 Recommended Operating Conditions**

| Parameter | Symbol | Minimum | Typical | Maximum | Unit |
|---|---|---|---|---|---|
| Drain Voltage | $V_{DD}$ | | +3.3 | | V |
| Venable Voltage | Ven | | +3.3 | | V |
| Drain Bias Current | $I_{DQ,}$ Set by external resistor | | 15.0 | | mA |
| Venable Bias Current | $I_{bias}$ | | 2.0 | | mA |
| Operating Temperature Range | | -40 | +25 | +105 | ℃ |

## 8.0 RF Electrical Specifications for 5.1-5.925 GHz EVB

**Table 8.1 5.1-5.925 GHz EVB** @$T_A$=+25℃ Unless Otherwise Specified; **Ven= Vdd=3.3 V, Idd=15 mA**

| Parameter | Test Condition | Minimum | Typical | Maximum | Unit |
|---|---|---|---|---|---|
| Gain | Across the band | | 16-18 | | dB |
| Noise Figure | Across the band | | 0.8-1.1 | | dB |
| EVB Noise Figure | Across the band | | 0.9-1.2 | | dB |
| Input Return Loss | Across the band | | 9-10 | | dB |
| Output Return Loss | Across the band | | 5-7 | | dB |
| IP1dB | Across the band | | -3 to -5 | | dBm |
| IIP3 | Across the band, 0dBm per tone, Tone Spacing 1MHz | | 0-1.1 | | dBm |

## 9.0 Typical Characteristics

### 9.1 5.125 – 5.925 GHz tuned EVB (Vdd=3.3 V, $I_{DQ}$=15 mA) @$T_A$=+25°C


Figure 9.1 S21(Gain) vs Freq

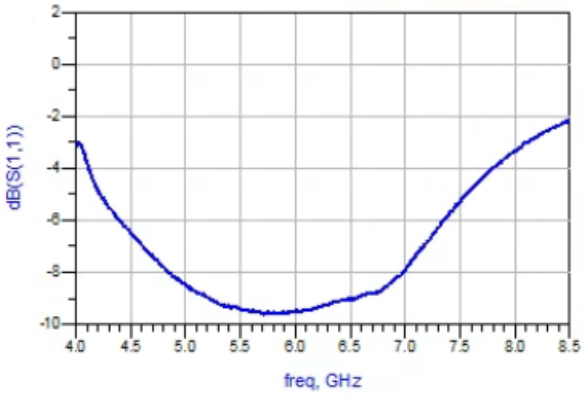


Figure 9.2 S11 (IRL)vs Freq

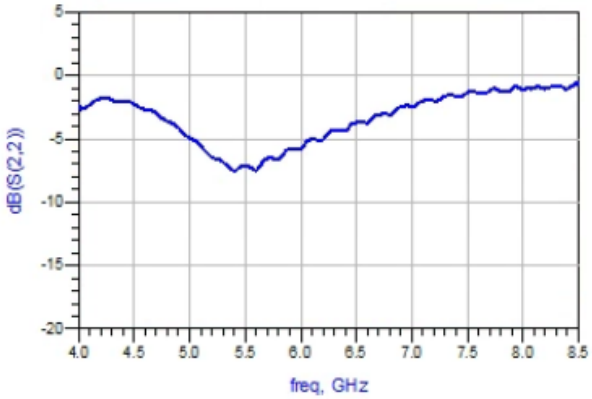


Figure 9.3 S22 (ORL) vs Freq

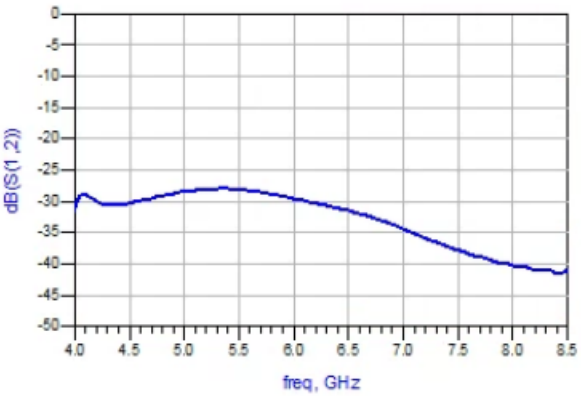


Figure 9.4 S12(Reverse Isolation) vs Freq

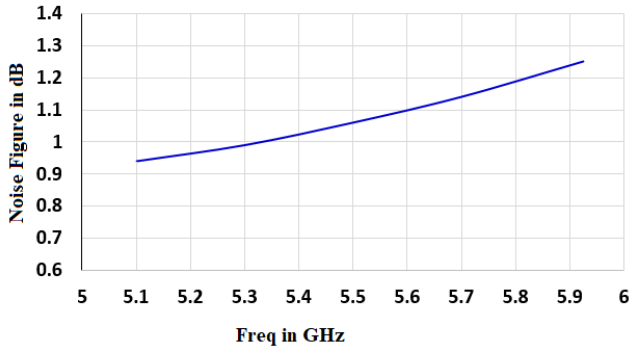


Figure 9.5 EVB Noise Figure vs Freq

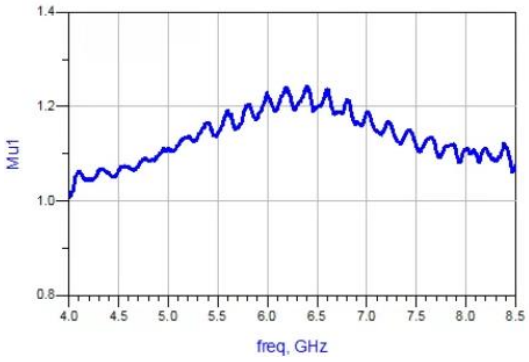


Figure 9.6 Stability (Mu1) vs Freq

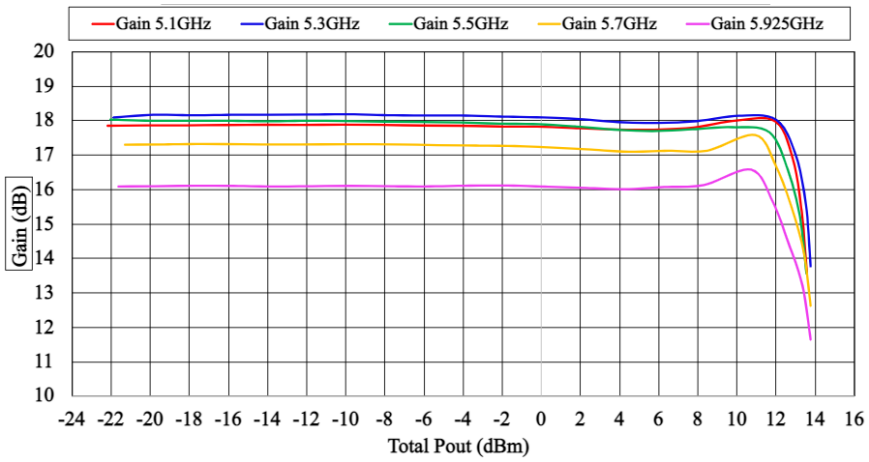


**Figure 9.7 Output P1dB vs Pout for all Freq**

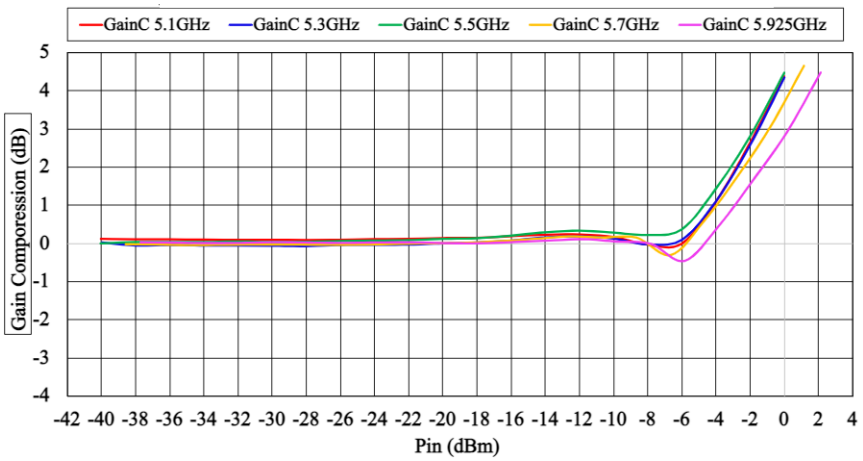


**Figure 9.8 Gain compression Vs Pin for all Freq**

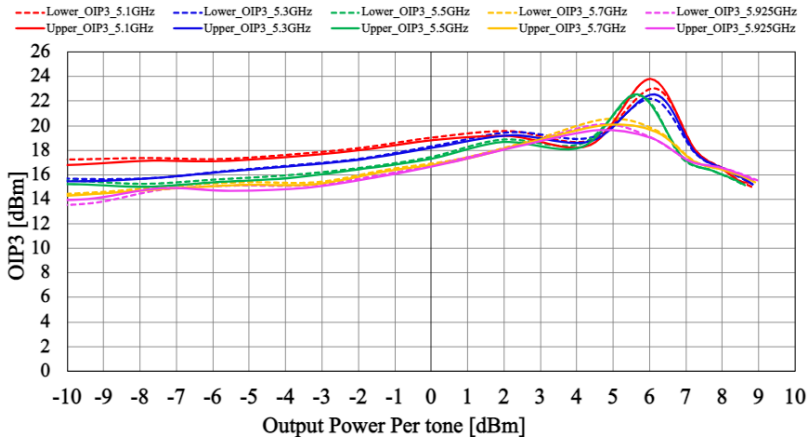


**Figure 9.9 OIP3 vs Pout per tone for all Freq**

## 10.0 Evaluation Boards

### 10.1 5.1-5.925 GHz EVB (Vdd=3.3 V, $I_{DQ}$=15 mA)

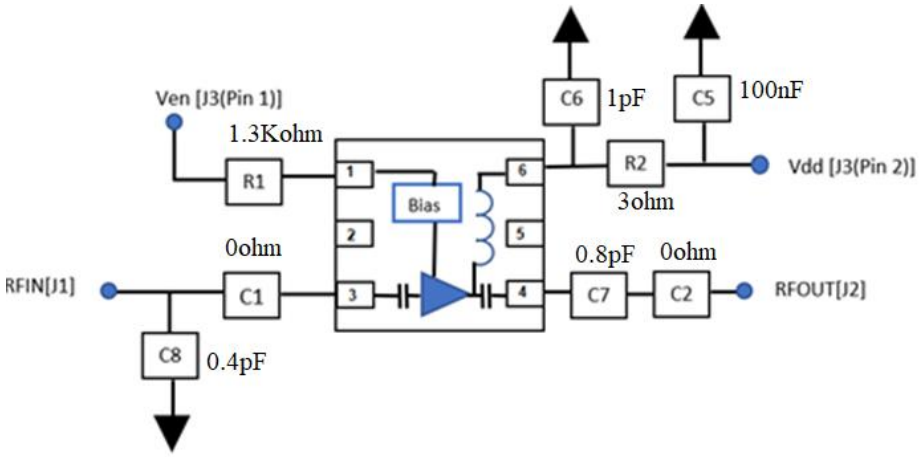


**Figure 10.1 Schematic of the 5.1-5.925 GHz EVB**

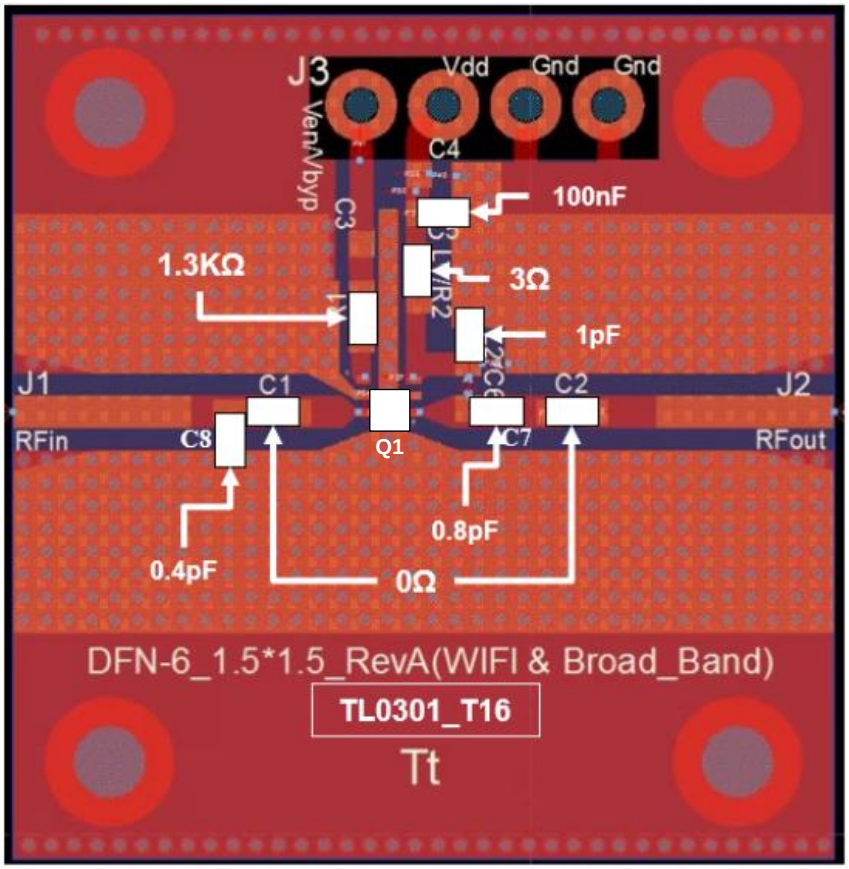


**Figure 10.2 Board Layout of the 5.1-5.925 GHz EVB**

**Table 10.1 BOM of the 5.1-5.925 GHz EVB**

| Component ID | Value | Manufacturer | Recommended Part Number |
|---|---|---|---|
| C1, C2 | 0 Ω | Panasonic | ERJ-2GE0R00X |
| R1 | 1.3 KΩ | Panasonic | ERJ-2RKF1301X |
| R2 | 3 Ω | Vishay | CRCW06033R00FKEAHP |
| C5 | 100 nF | TDK | C1005X7R1H104K050BE |
| C6 | 1 pF | Murata | GJM1555C1H1R0BB01D |
| C7 | 0.8 pF | Murata | GJM1555C1HR80BB01D |
| C8 | 0.4 pF | Murata | GJM1555C1HR40BB01D |
| Q1 | LNA | Tagore Tech | TL0301H |
| PCB | Rogers RO4350B, 20 mils, 1 oz Copper | | |

## 11.0 Device Package Information

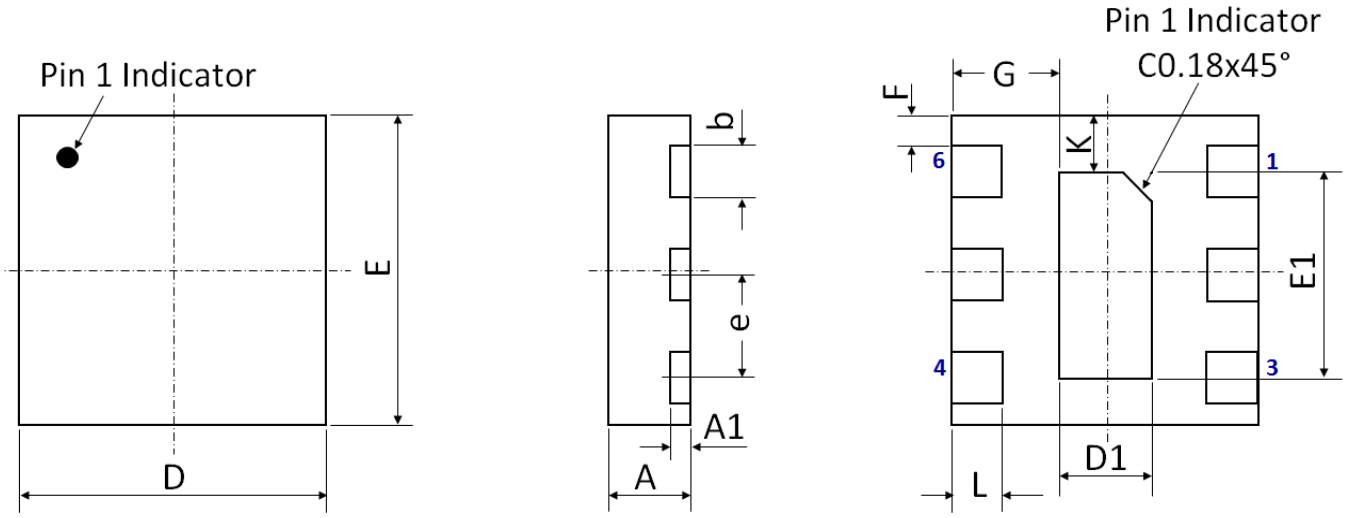


**Figure 11.1 Device Package Drawing**
(All dimensions are in mm)

**Table 11.1 Device Package Dimensions**

| **Dimension** (mm) | **Value** (mm) | **Tolerance**(mm) | **Dimension** (mm) | **Value** (mm) | **Tolerance**(mm) |
|---|---|---|---|---|---|
| A | 0.55 | ±0.05 | E | 1.50 BSC | ±0.05 |
| A1 | 0.15 | ±0.02 | E1 | 1.00 | ±0.05 |
| b | 0.25 | ±0.02 | F | 0.15 | ±0.02 |
| D | 1.50 BSC | ±0.05 | G | 0.525 | ±0.05 |
| D1 | 0.45 | ±0.02 | L | 0.25 | ±0.05 |
| e | 0.50 BSC | ±0.05 | K | 0.28 | ±0.02 |

**Note:** Lead finish: Pure Sn without underlayer; Thickness: 7.5 µm ~ 20 µm (Typical 10 µm ~ 12 µm)

**Attention:** Please refer to application notes *TN-001* and *TN-002* at http://www.tagoretech.com for PCB and soldering related guidelines.

## 12.0 PCB Land Design

**Guidelines:**
[1] 4-layer PCB is recommended
[2] Via diameter is recommended to be 0.3mm for better thermal performance
[3] Thermal vias shall be placed on the center pad and should be filled/plugged with solder or copper
[4] The maximum via number for the center pad is 1(X)×2(Y)=2

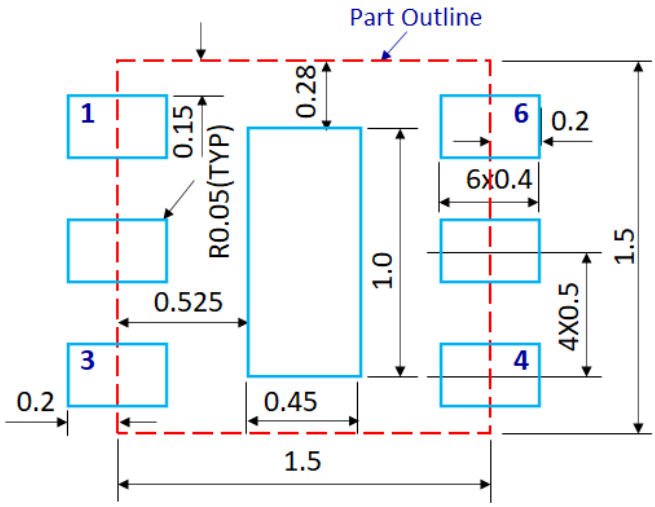


**Figure 12.1 PCB Land Pattern**
(Dimensions are in mm)


Non-Solder Mask Defined (Preferred)

Solder Mask Defined

**Figure 12.2 Solder Mask Pattern**
(Dimensions are in mm)

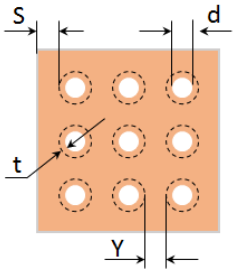


**Figure 12.3 Thermal Via Pattern**
(Recommended Values: S≥0.15 mm; Y≥0.20 mm; d=0.3 mm; Plating Thickness t=25 µm or 50 µm)

## 13.0 PCB Stencil Design

**Guidelines:**

[1] Laser-cut, stainless steel stencil is recommended with electro-polished trapezoidal walls to improve the paste release.

[2] Stencil thickness is recommended to be 125µm.

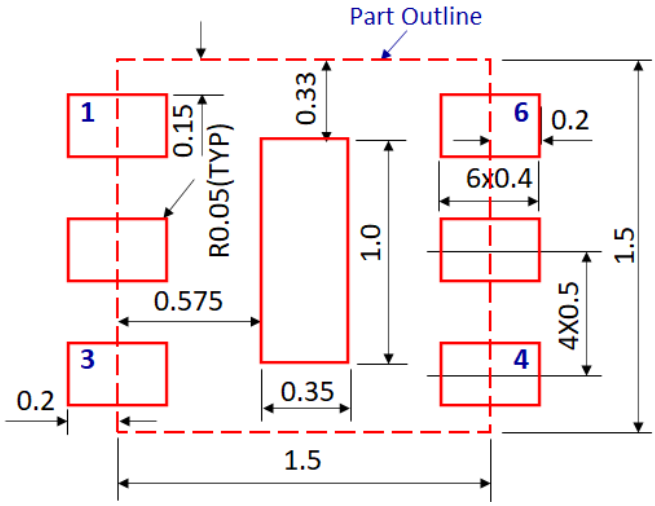


**Figure 13.1 Stencil Openings**
(Dimensions are in mm)

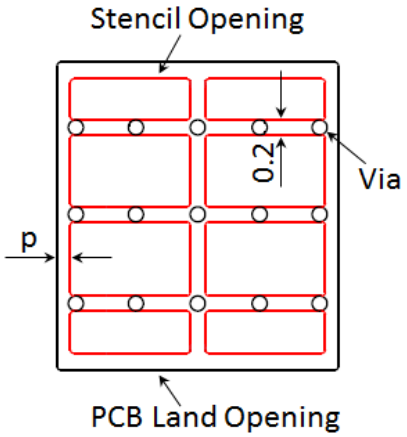


**Figure 13.2 Stencil Openings Shall not Cover Via Areas If Possible**
(Dimensions are in mm)

## 14.0 Tape and Reel Information

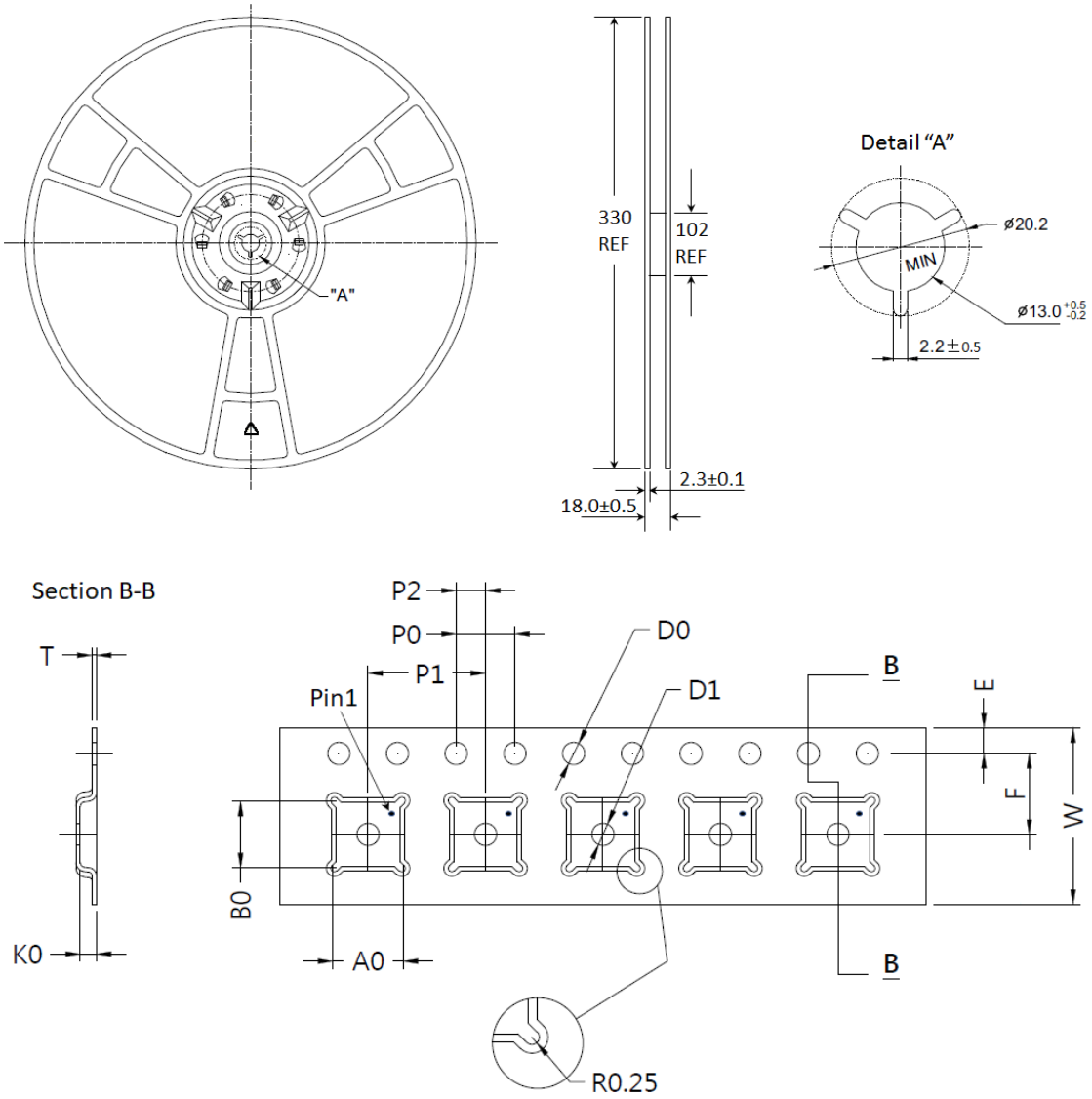


**Figure 14.1 Tape and Reel Drawing**

**Table 14.1 Tape and Reel Dimensions**

| **Dimension** (mm) | **Value** (mm) | **Tolerance**(mm) | **Dimension** (mm) | **Value** (mm) | **Tolerance**(mm) |
|---|---|---|---|---|---|
| A0 | 3.35 | ±0.10 | K0 | 1.10 | ±0.10 |
| B0 | 3.35 | ±0.10 | P0 | 4.00 | ±0.10 |
| D0 | 1.50 | +0.10/-0.00 | P1 | 8.00 | ±0.10 |
| D1 | 1.50 | +0.10/-0.00 | P2 | 2.00 | ±0.05 |
| E | 1.75 | ±0.10 | T | 0.30 | ±0.05 |
| F | 5.50 | ±0.05 | W | 12.00 | ±0.30 |

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