TP0310K – 27dBm (0.5W) CW, 0.1 – 3.8 GHz Power Low Noise Amplifier

1.0 Features

- Small signal gain @ 1850MHz:16.5dB
- OP1dB @ 1850MHz: 27.5dBm
- NF:1.0dB
- OIP3 @1850MHz: 39dBm
- 5V Typical operation
- Operating frequency: 0.1GHz to 3.8GHz

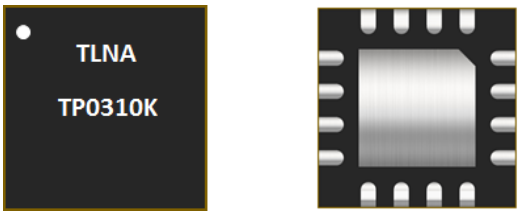

Figure 1.1 Device Image
(16 Pin 3×3×0.8mm QFN Package)

2.0 Applications

- 4G/5G Infrastructure Radios
- Small Cells and Cellular Repeaters
- L, S band Phase Array Radar
- Mil/Comms Radios
- SDARS

RoHS/REACH/Halogen Free Compliance

3.0 Description

The TP0310K is a power Low Noise Amplifier (LNA) providing high gain and linearity. With a simple input and output match, this LNA can be tuned for different frequency bands targeting low noise, high power and high linearity.

The TP0310K is packaged in a compact, low-cost Dual Flat No Lead (QFN) 3x3x0.8mm, 16 pin plastic package.

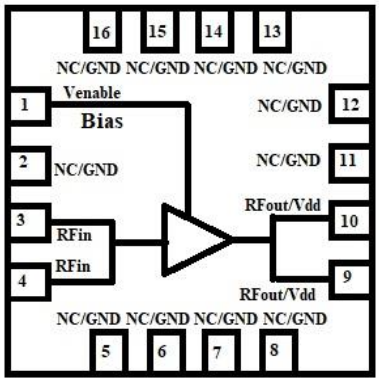

Figure 3.1 Function Block Diagram
(Top View)

4.0 Ordering Information

Table 4.1 Ordering Information

Base Part Number	Package Type	Form	Qty	Reel Diameter	Reel Width	Orderable Part Number
TP0310K	16Pin 3×3×0.8mm DFN	Tape and Reel	5000	13” (330mm)	18mm	TP0310KMTRPBF
Tuned Evaluation Board, 1700 - 2000MHz						TP0310K-EVB-A
Tuned Evaluation Board, 2300 - 2700MHz						TP0310K-EVB-B
Tuned Evaluation Board, 3300 - 3800MHz						TP0310K-EVB-C
Tuned Evaluation Board, 130 - 950MHz						TP0310K-EVB-D

5.0 Pin Description

Table 5.1 Pin Definition

Pin Number	Pin Name	Description
2,5-8, 11-16	NC	No internal connection, can be connected to ground
1	Venable	Venable along with series resistor, sets the Idq. Venable <0.2V disables the device
3,4	RF_{IN}	RF Input. DC blocking cap required
9,10	RF_{OUT}/V_{dd}	RF Output. Vdd 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 heatsinking required.

6.0 Absolute Maximum Ratings

Table 6.1 Absolute Maximum Ratings @T_A=+25°C Unless Otherwise Specified

Parameter	Symbol	Value	Unit
Electrical Ratings			
Supply voltage, Venable	V_{dd}	+6	V
Drain current	I_{DQ}	150	mA
RF input power CW	RF_{IN}	23	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	$R_{\theta JC}$	10	°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}		+5.0		V
Venable Voltage	V_{enable}		+5.0		V
Drain Bias Current	$I_{DQ,}$ Set by external resistor		140		mA
Venable Bias Current	I_{bias}		3.5	4	mA
Operating Temperature Range		-40	+25	+105	°C

8.0 RF Electrical Specifications for 1700 - 2000MHz, 2300 - 2700MHz,3300 – 3800MHz EVB and 130 – 950MHz EVB

Table 8.1 1700 – 2000MHz EVB @T_A=+25°C Unless Otherwise Specified; Venable = High

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across Band		16-17		dB
Noise Figure	Across Band		1.0		dB
EVB Noise Figure	Across Band		1.05		dB
Input Return Loss	Across Band		11-14		dB
Output Return Loss	Across Band		10-13		dB
OP1dB	Across Band		27-27.5		dBm
OIP3	Across Band, 8dBm per tone, Tone Spacing 2MHz		39		dBm
Switching Rise Time	10/90% of the RF value		4		nsec
Switching Fall Time	10/90% of the RF value		1000		nsec

Table 8.2 2300 – 2700MHz EVB @T_A=+25°C Unless Otherwise Specified; Venable = High

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	2500MHz	13	14		dB
Noise Figure	2500MHz		1.1		dB
EVB Noise Figure	2500MHz		1.2		dB
Input Return Loss	2500MHz		16		dB
Output Return Loss	2500MHz		18		dB
OP1dB	2500MHz	25.5	27		dBm
OIP3	2500MHz, 8dBm per tone, Tone Spacing 2MHz	35	37		dBm
Switching Rise Time	10/90% of the RF value		4		nsec
Switching Fall Time	10/90% of the RF value		1000		nsec

Table 8.3 3300 – 3800MHz EVB @T_A=+25°C Unless Otherwise Specified; Venable = High

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across Band		11-11.5		dB
Noise Figure	Across Band		0.85-1.15		dB
EVB Noise Figure	Across Band		1-1.3		dB
Input Return Loss	Across Band		7-11		dB
Output Return Loss	Across Band		17-24		dB
OP1dB	Across Band		27.5		dBm
OIP3	Across Band, 8dBm per tone, Tone Spacing 2MHz		41-42		dBm
Switching Rise Time	10/90% of the RF value		4		nsec
Switching Fall Time	10/90% of the RF value		1000		nsec

Table 8.4 130 – 950MHz EVB @T_A=+25°C Unless Otherwise Specified; Venable = High

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across Band		27.6-21		dB
Noise Figure	Across Band		1.5-2.4		dB
EVB Noise Figure	Across Band		1.6-2.5		dB
Input Return Loss	Across Band		6-25		dB
Output Return Loss	Across Band		7-17		dB
OP1dB	Across Band		24.7-27		dBm
OIP3	Across Band, 8dBm per tone, Tone Spacing 2MHz		34-37		dBm

9.0 Typical Characteristics

9.1 2300 - 2700MHz tuned EVB (Vdd=5V, I_{DQ}=140mA), -40°C, 25°C, 85°C, 105 °C, Narrowband

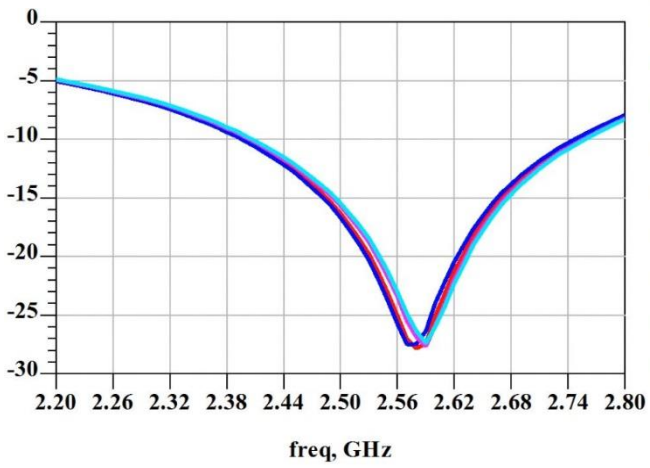

Figure 9.1 S11 (IRL) vs Freq

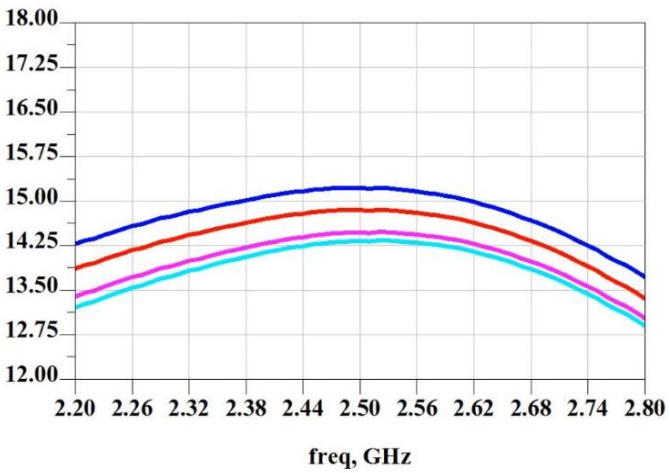

Figure 9.2 S21 (Gain) vs Freq

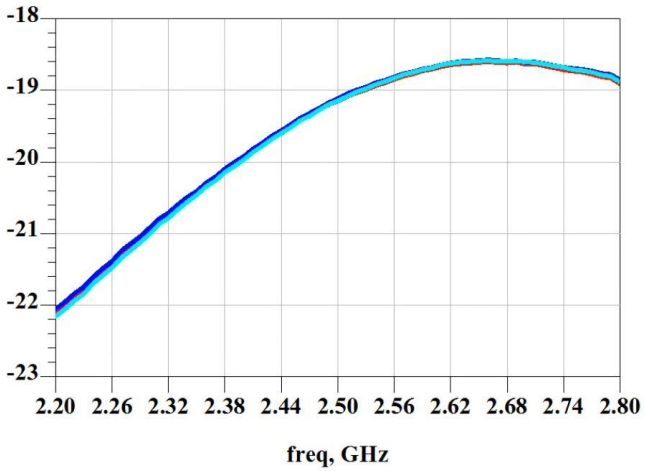

Figure 9.3 S12 (Rev Iso) vs Freq

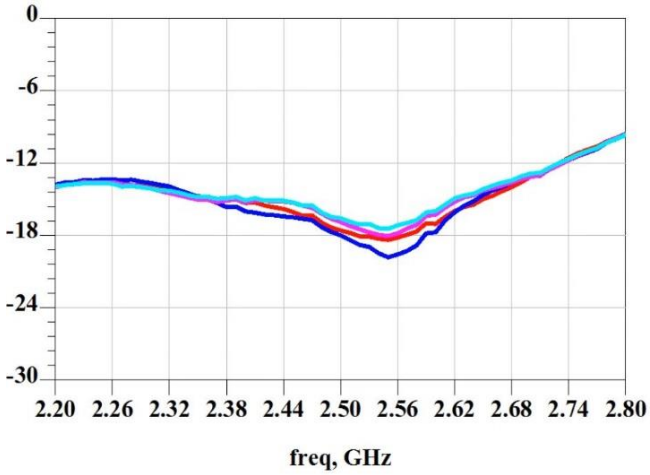

Figure 9.4 S22 (ORL) vs Freq

9.2 2300 - 2700MHz tuned EVB (Vdd=5V, I_{DQ}=140mA), -40ºC, 25ºC, 85ºC, 105ºC

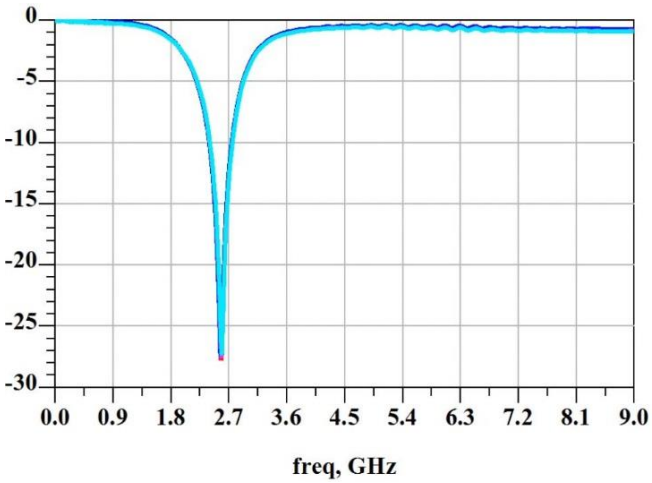

Figure 9.5 S11 (IRL) vs Freq

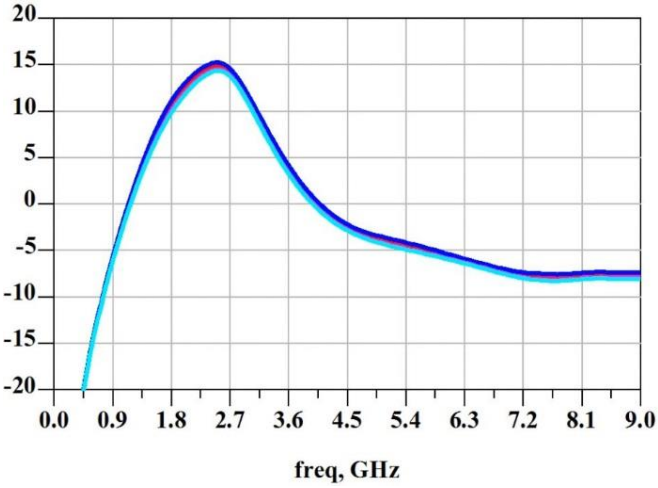

Figure 9.6 S21 (Gain) vs Freq

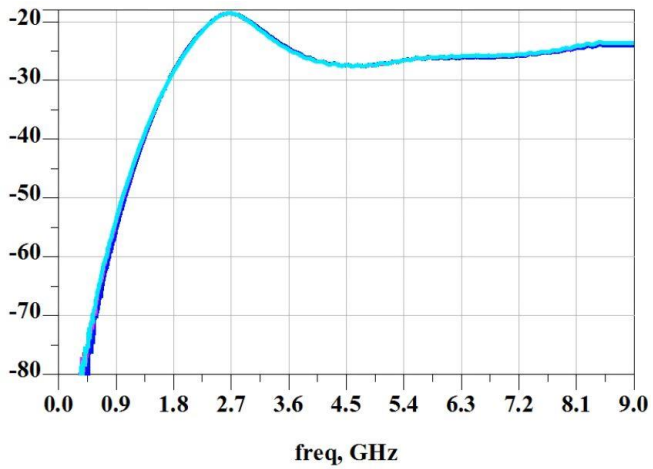

Figure 9.7 S12 (Rev Iso) vs Freq

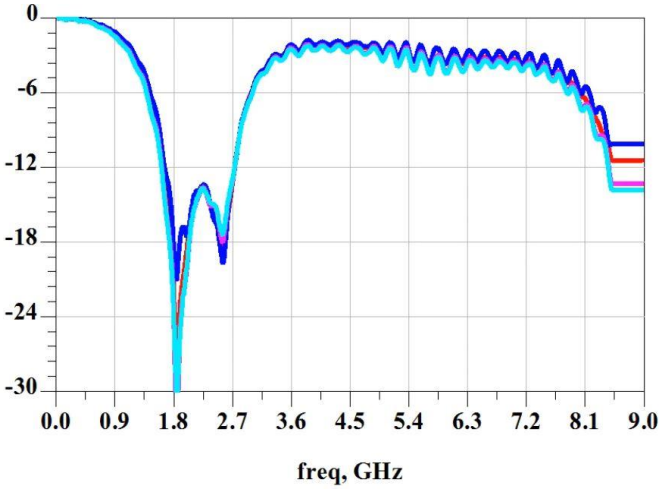

Figure 9.8 S22 (ORL) vs Freq

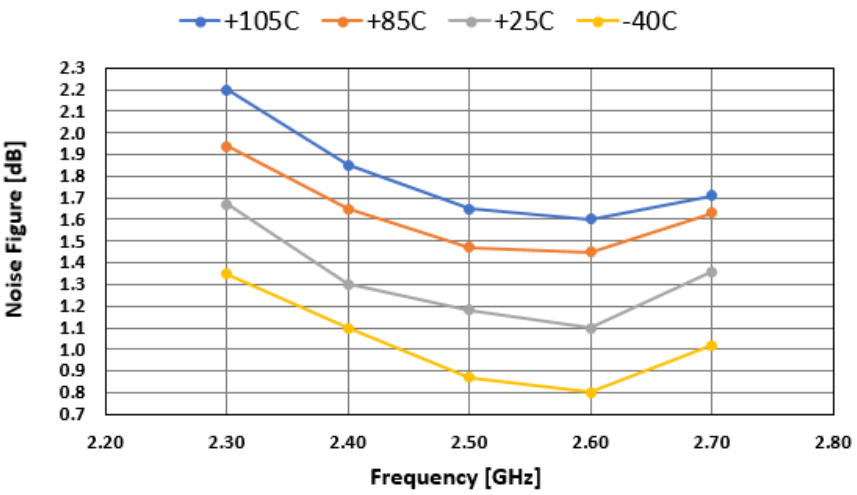

Figure 9.9 Noise Figure (EVB) vs Freq

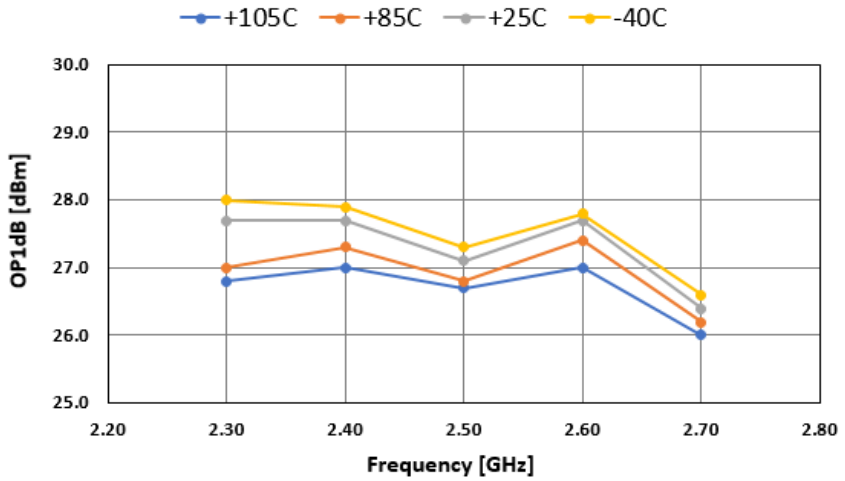

Figure 9.10 Output P1dB vs Freq

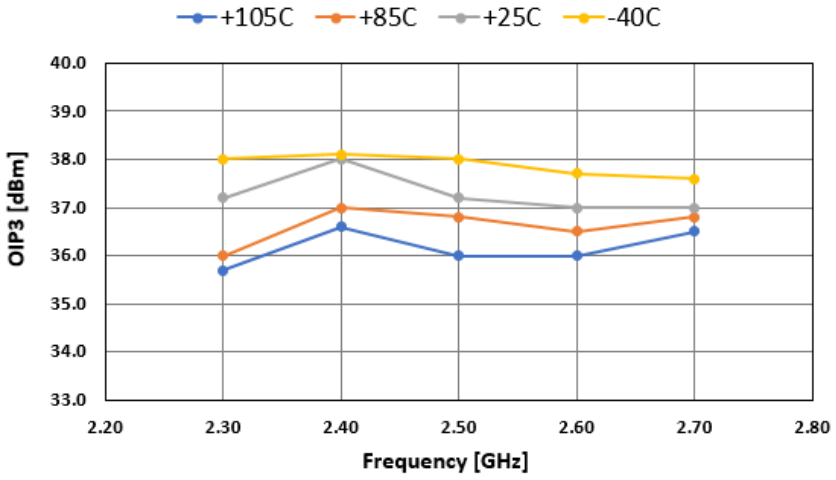

Figure 9.11 Output IP3 vs Freq

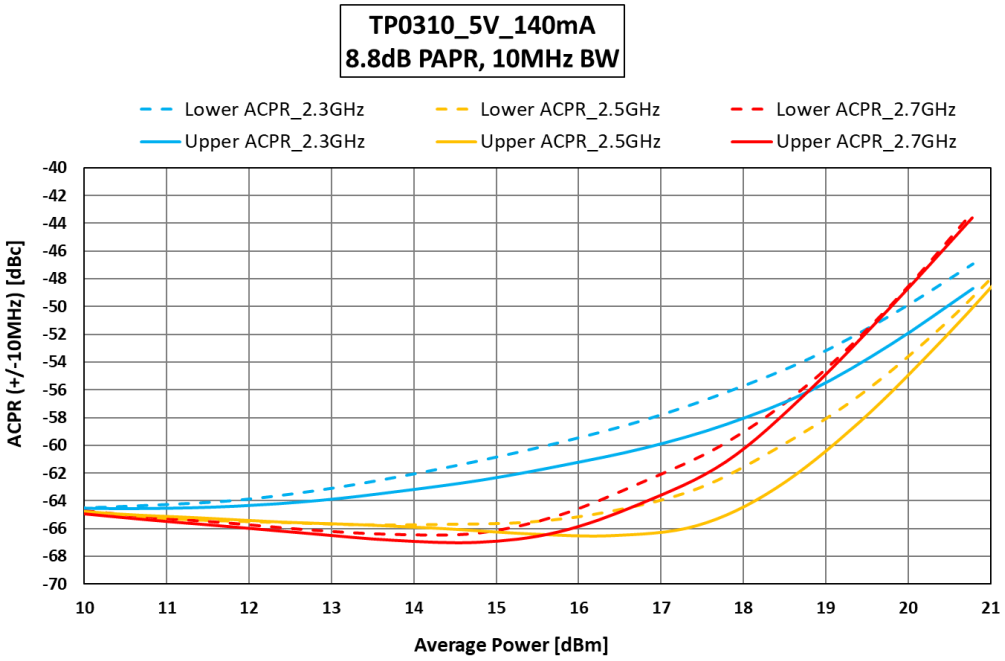

Figure 9.12 ACPR vs Average Power

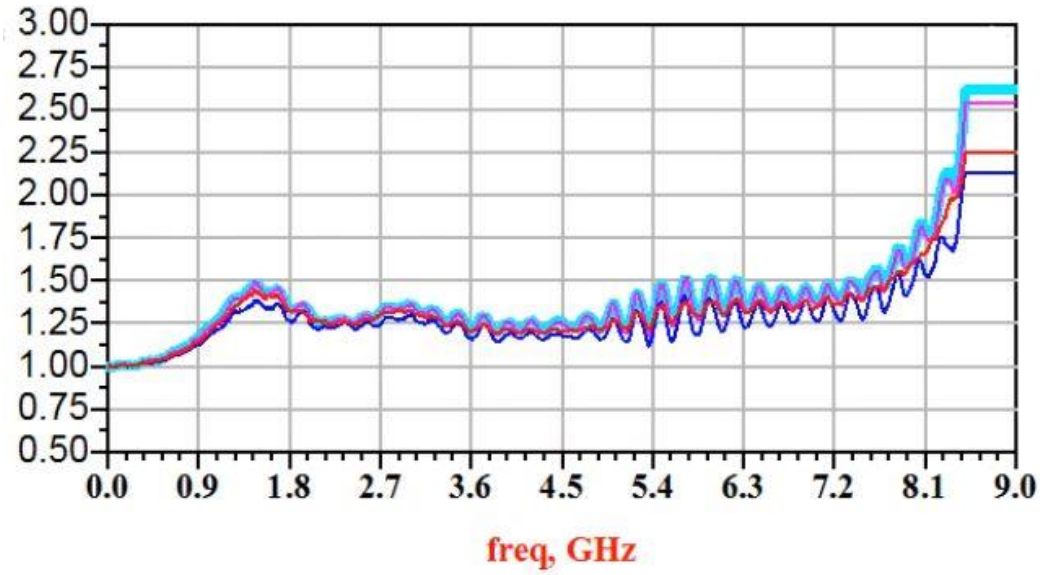

Figure 9.13 Mu1 vs Freq

10.0 Evaluation Boards

10.1 1700 - 2000MHz EVB A

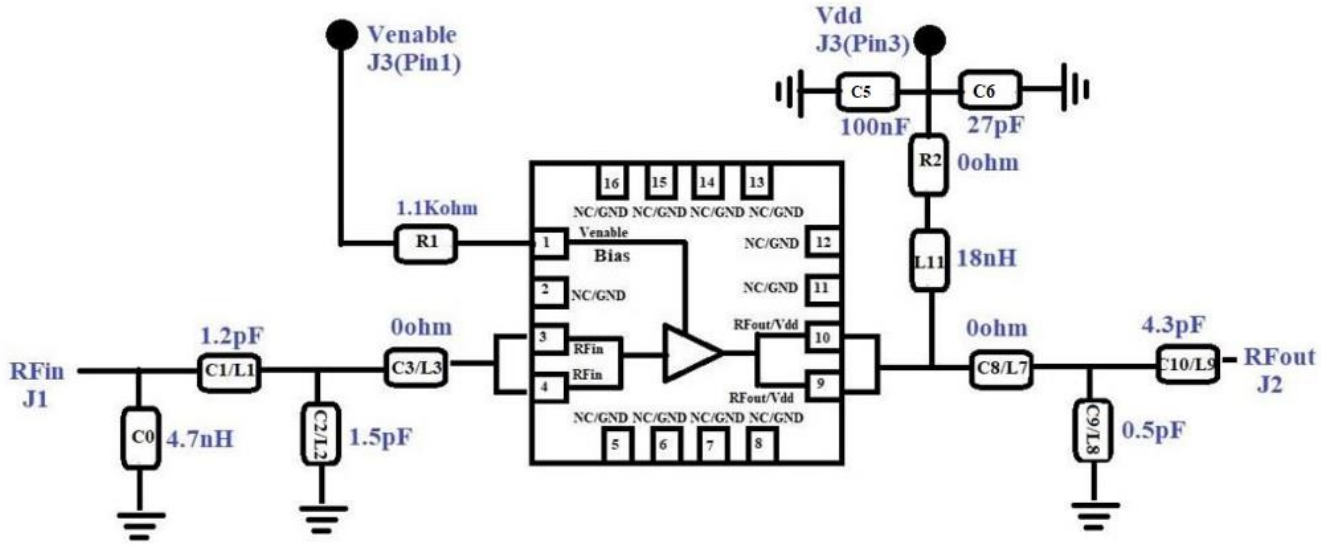

Figure 10.1 Schematic of the 1700 - 2000MHz EVB A

Table 10.1 BOM of the 1700 - 2000MHz EVB A

Component ID	Value	Manufacturer	Recommended Part Number
C0	4.7nH	Coil craft	0402HP-4N7XGRW
C1	1.2pF	Murata	GJM1555C1H1R2BB01
C2	1.5pF	Murata	GJM1555C1H1R5BB01
R1	1.1K	Panasonic	ERJ-2RKF1101X
C9	0.5pF	Murata	GJM1555C1HR50BB01
C10/L9	4.3pF	Murata	GJM1555C1H4R3BB01
C3/L3, C8/L7, R2	0 ohm	Panasonic	ERJ-2GE0R00X
L11	18nH	Coil craft	0402HP-18NXGRW
C5	100nF	TDK	C1005X7R1H104K050BE
C6	27pF	AVX	04025A270JAT4A
PCB	Rogers RO4350B, 20 mils, 1 oz copper		

10.2 2300 - 2700MHz EVB B

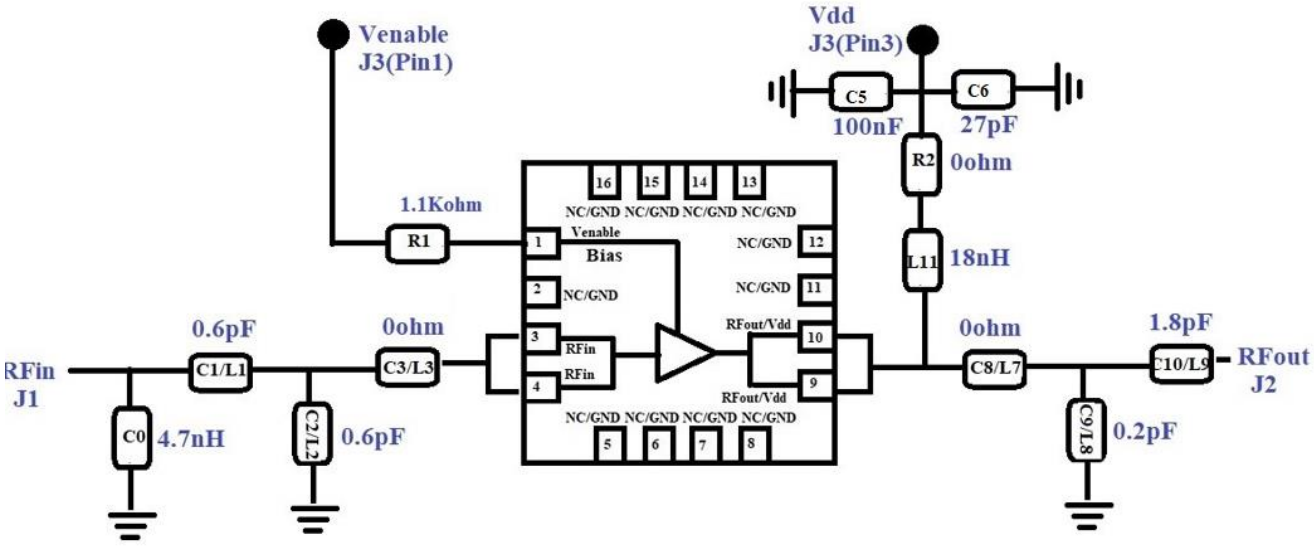

Figure 10.2 Schematic of the 2300 - 2700MHz EVB B

Table 10.2 BOM for 2300 - 2700MHz EVB B

Component ID	Value	Manufacturer	Recommended Part Number
C0	4.7nH	Coil craft	0402HP-4N7XGRW
C1, C2	0.6pF	Murata	GJM1555C1HR60BB01
C3/L3, C8/L7, R2	0 ohm	Panasonic	ERJ-2GE0R00X
R1	1.1K	Panasonic	ERJ-2RKF1101X
C9	0.2pF	Murata	GJM1555C1HR20BB01
C10/L9	1.8pF	Murata	GJM1555C1H1R8BB01
L11	18nH	Coil craft	0402HP-18NXGRW
C5	100nF	ATC	600S1R0CT250XT
C6	27pF	AVX	04025A270JAT4A
PCB	Rogers RO4350B, 20 mils, 1 oz copper		

10.3 3300 - 3800MHz EVB C

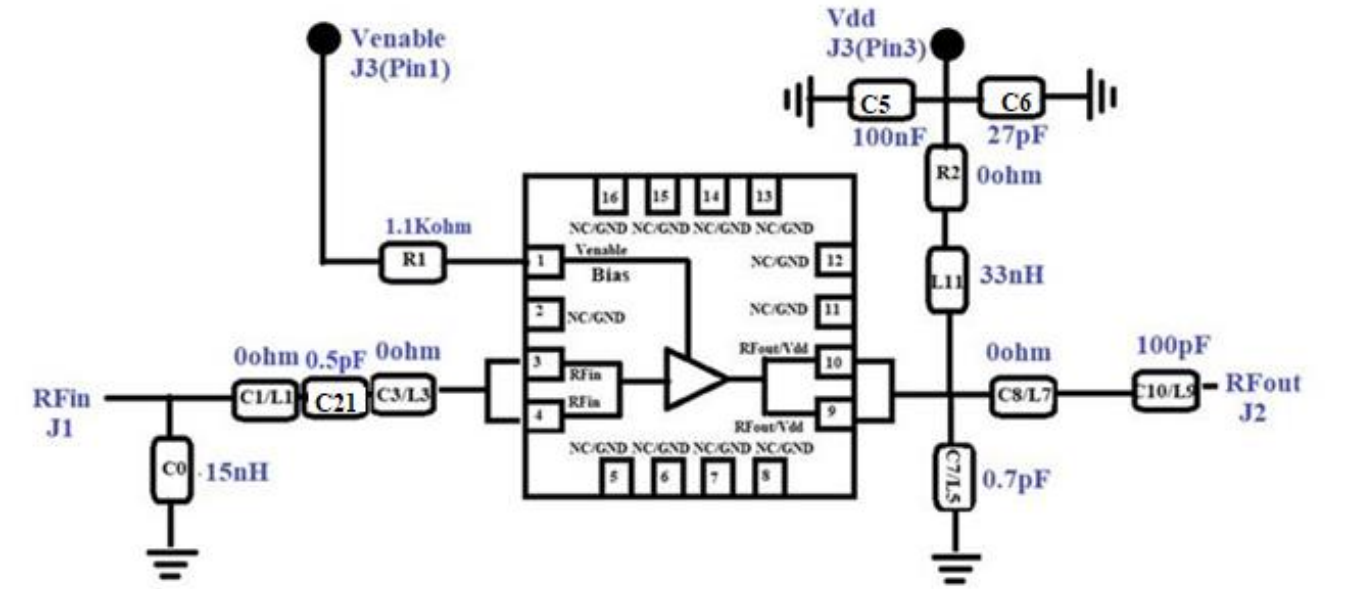

Figure 10.3 Schematic of the 3300 - 3800MHz EVB C

Table 10.3 BOM of the 3300 - 3800MHz EVB C

Component ID	Value	Manufacturer	Recommended Part Number
C0	15nH	Coil craft	0402HP-15NXGRW
C21	0.5pF	Murata	GJM1555C1HR50BB01
R1	1.1K	Panasonic	ERJ-2RKF1101X
C7	0.7pF	Murata	GJM1555C1HR70BB01
C1/L1, C3/L3, C8/L7, R2	0 ohm	Panasonic	ERJ-2GE0R00X
C10/L9	100pF	AVX	04025A101JAT4A
L11	33nH	Coil craft	0402HP-33NXGRW
C5	100nF	ATC	600S1R0CT250XT
C6	27pF	AVX	04025A270JAT4A
PCB	Rogers RO4350B, 20 mils, 1 oz copper		

Note: A external series cut has been made between C1/L1 and C2/L2 in the EVB board to incorporate an extra series capacitance 0.5pF (named as C21) at the input side match.

10.4 130 - 950MHz EVB D

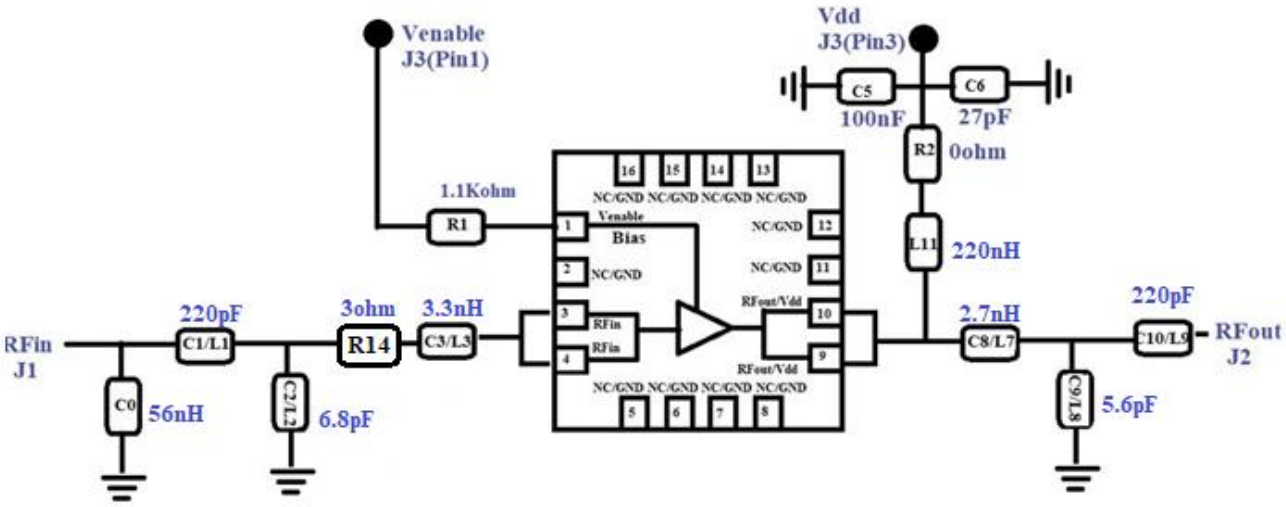

Figure 10.4 Schematic of the 130 - 950MHz EVB D

Table 10.4 BOM of the 130 - 950MHz EVB D

Component ID	Value	Manufacturer	Recommended Part Number
C0	56nH	Coil craft	0402HPH-56NXGLU
C1, C10	220pF	Murata	GRM0335C1H221FA01D
C2	6.8pF	Murata	GJM1555C1H6R8BB01D
R14	3ohm	Panasonic	ERJ-U02F3R00X
C3/L3	3.3nH	Coil craft	0402HP-3N3XGLU
R1	1.1KOhm	Panasonic	ERJ-2RKF1101X
C5	100nF	TDK	C1005X7R1H104K050BE
C6	27pF	Murata	GJM1555C1H270JB01D
L11	220nH	Coil craft	0402HPH-R22XGLU
C8/L8	2.7nH	Coil craft	0402HP-2N7XGLU
C7	5.6pF	Murata	GJM1555C1H5R6BB01D
PCB	Rogers RO4350B, 20 mils, 1 oz copper		

Note: A external series cut has been made between C3/L3 and C2/L2 in the EVB board to incorporate an extra series resistance 3ohm (named as R14) at the input side match.

11.0 Device Package Information

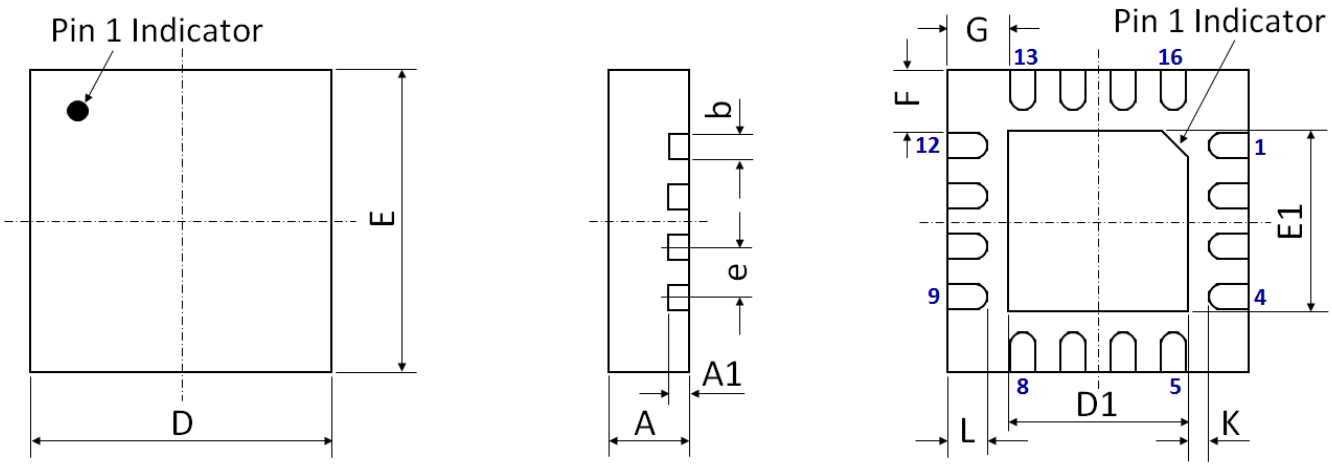

Figure 11.1 Device Package Drawing
(All dimensions are in mm)

Table 11.1 Device Package Dimensions

Dimension (mm)	**Value** (mm)	**Tolerance** (mm)	**Dimension** (mm)	**Value** (mm)	**Tolerance** (mm)
A	0.80	±0.05	E	3.00 BSC	±0.05
A1	0.203	±0.02	E1	1.70	±0.05
b	0.25	+0.05/-0.07	F	0.625	±0.05
D	3.00 BSC	±0.05	G	0.625	±0.05
D1	1.70	±0.05	L	0.25	±0.05
e	0.50 BSC	±0.05	K	0.40	±0.05

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

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] 2-layer PCB is recommended
[2] Via diameter is recommended to be 0.3mm to prevent solder wicking inside the vias
[3] Thermal vias shall only 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 3(X)×3(Y)=9

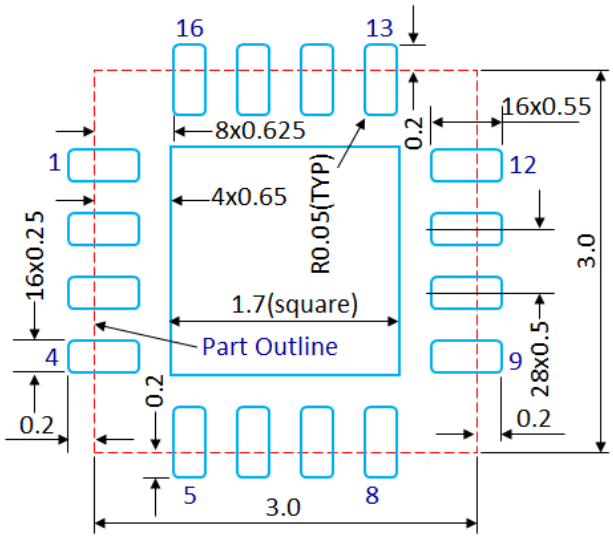

Figure 12.1 PCB Land Pattern
(Dimensions are in mm)

Non-Solder Mask Defined
(Preferred)

Solder Mask Defined

Figure 12.2 Solder Mask Pattern
(Dimensions are in mm)

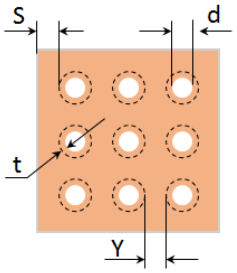

Figure 12.3 Thermal Via Pattern
(Recommended Values: S≥0.15mm; Y≥0.20mm; d=0.3mm; Plating Thickness t=25μm or 50μm)

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.

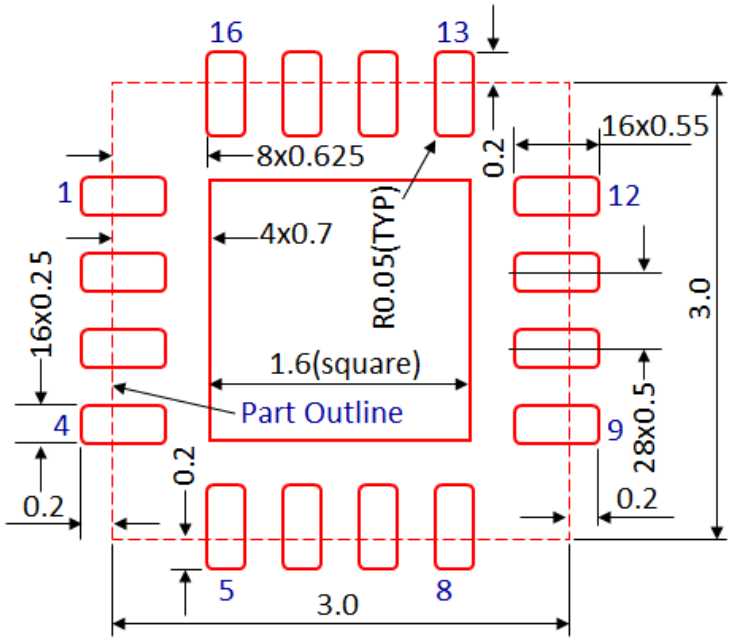

Figure 13.1 Stencil Openings
(Dimensions are in mm)

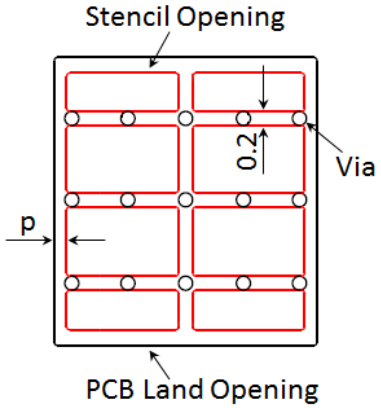

Figure 13.2 Stencil Openings Shall not Cover Via Areas If Possible
(Dimensions are in mm)

14.0 Tape and Reel Information

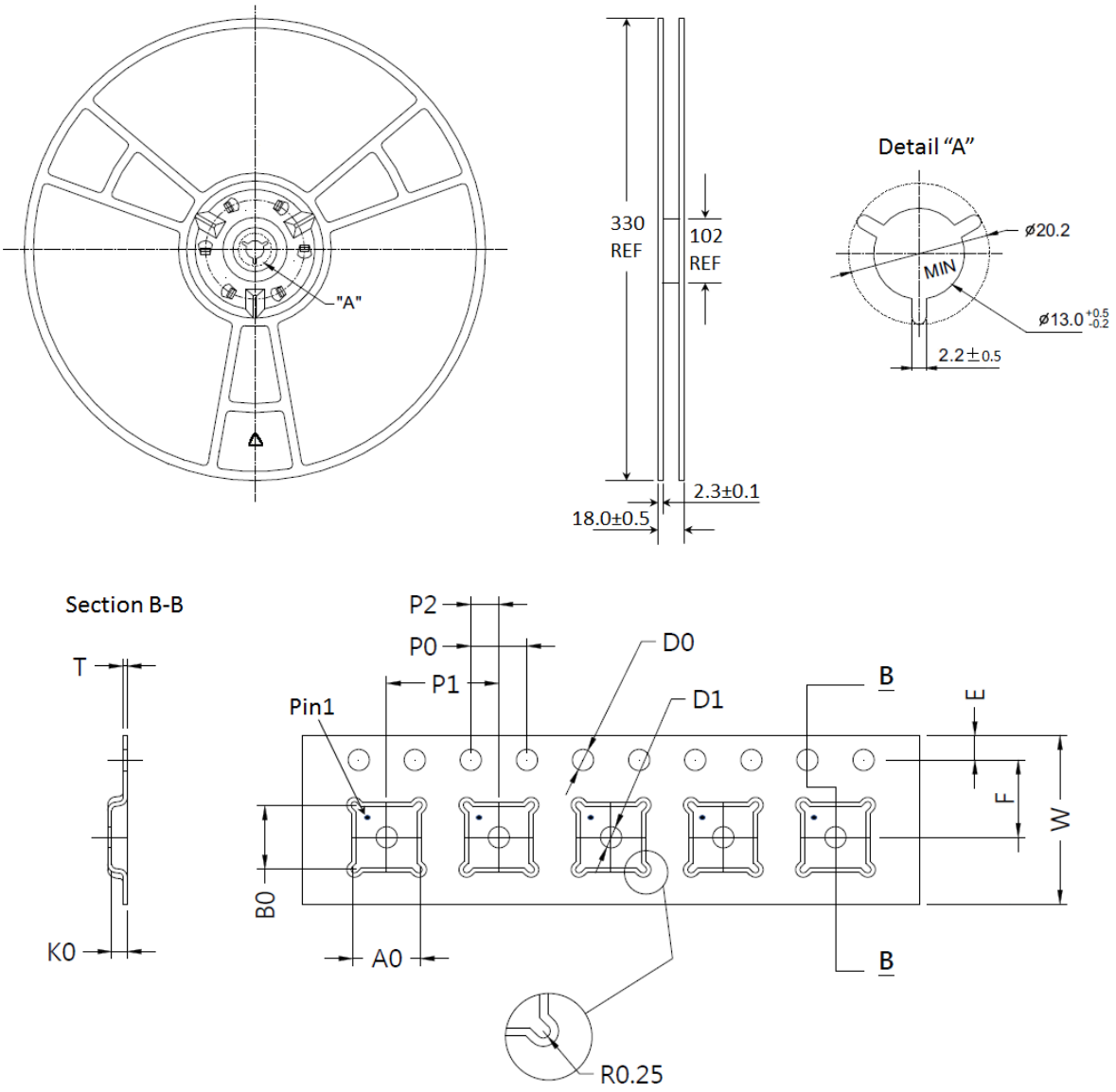

Figure 14.1 Tape and Reel Drawing

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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