TL0375J: 2.0 – 5.0 GHz Ultra Low Noise Amplifier

1.0 Features

- Small signal gain @ 3600MHz: 17.5dB
- NF @ 3600MHz: 0.4dB
- P1dB @ 3600MHz: 19.5dBm
- 5V Typical operating voltage
- Operating frequency: 2.0 to 5.0GHz

Figure 1.1 Device Image
(8 Pin 2×2×0.75mm QFN Package)

2.0 Applications

- 4G/5G Infrastructure Radios
- Small Cells and Cellular Repeaters
- Phase Array Radar
- SDARS

RoHS/REACH/Halogen Free Compliance

3.0 Description

The TL0375J is a high frequency version of TL0374J which is a broadband, ultra-low Noise Amplifier (LNA). With a simple input and output match, this LNA can be tuned for different frequency bands targeting LTE (small cells and infrastructure), radar and any other applications requiring low noise, high gain, and linearity.

The TL0375J is packaged in a compact, low cost Dual Flat No Lead (DFN) 2x2x0.75mm, 8 pin plastic package.

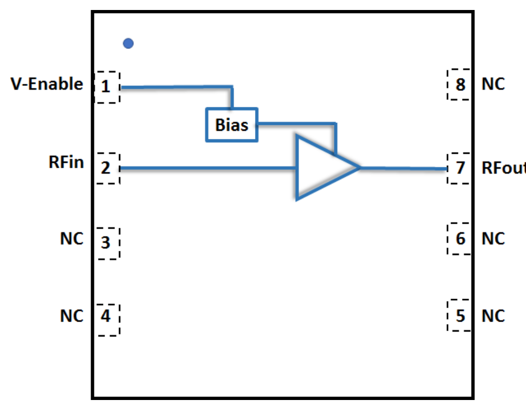


Figure 3.1 Function Block Diagram
(Top View)

4.0 Ordering Information

Table 4.1 Ordering Information

Base Part Number	Package Type	Form	Qty	Reel Diameter	Reel Width	Orderable Part Number
TL0375J	8 Pin 2×2×0.75mm DFN	Tape and Reel	3000	13" (330mm)	18mm	TL0375JMTRPBF
Tuned Evaluation Board, 3300 - 3800MHz						TL0375J-EVB-A
Tuned Evaluation Board, 3700 - 4200MHz						TL0375J-EVB-B
Tuned Evaluation Board, 4400 - 5000MHz						TL0375J-EVB-C

5.0 Pin Description

Table 5.1 Pin Definition

Pin Number	Pin Name	Description
3-6, 8	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
2	RF_{IN}	RF Input. DC blocking cap required
7	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 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}	+6	V
Drain current	I_{DQ}	70	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	$R_{\theta JC}$	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}		+5.0		V
Venable Voltage	V_{enable}		+5.0		V
Drain Bias Current	$I_{DQ,}$ Set by external resistor	45	60		mA
Venable Bias Current	I_{bias}		3.0		mA
Operating Temperature Range		-40	+25	+105	°C

8.0 RF Electrical Specifications for 3300 – 3800MHz, 3700 - 4200MHz and 4400-5000MHz EVB

Table 8.1 3300 – 3800MHz EVB @T_A=+25°C Unless Otherwise Specified; Venable = High

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	3600MHz	16.5	17.5		dB
Noise Figure	3600MHz		0.4	0.5	dB
EVB Noise Figure	3600MHz		0.5	0.6	dB
Input Return Loss	3600MHz		14		dB
Output Return Loss	3600MHz		10		dB
OP1dB	3600MHz		19.5		dBm
OIP3	3600MHz, 0dBm per tone, Tone Spacing 1MHz	30	33		dBm
Switching Rise Time	10/90% of the RF value		300		nsec
Switching Fall Time	10/90% of the RF value		350		nsec

Table 8.2 3700 – 4200MHz EVB @T_A=+25°C Unless Otherwise Specified; Venable = High

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across Band		15.5-16.5		dB
Noise Figure	Across Band		0.5-0.6		dB
EVB Noise Figure	Across Band		0.6-0.7		dB
Input Return Loss	Across Band		8-12		dB
Output Return Loss	Across Band		8-12		dB
OP1dB	Across Band		19-20.5		dBm
OIP3	Across Band, 0dBm per tone, Tone Spacing 1MHz		33-34		dBm
Switching Rise Time	10/90% of the RF value		300		nsec
Switching Fall Time	10/90% of the RF value		350		nsec

Table 8.3 4400 – 5000MHz EVB @T_A=+25°C Unless Otherwise Specified; Venable = High

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across Band		16		dB
Noise Figure	Across Band		0.55-0.65		dB
EVB Noise Figure	Across Band		0.7-0.8		dB
Input Return Loss	Across Band		10.4-12.4		dB
Output Return Loss	Across Band		7.5-9		dB
OP1dB	Across Band		18-20		dBm
OIP3	Across Band, 0dBm per tone, Tone Spacing 1MHz		33-36		dBm
Switching Rise Time	10/90% of the RF value		300		nsec
Switching Fall Time	10/90% of the RF value		350		nsec

9.0 Typical Characteristics

9.1 3300 - 3800MHz tuned EVB (Vdd=5V, I_{DQ}=60mA),-40ºC,25ºC,85ºC,105 ºC, Narrowband

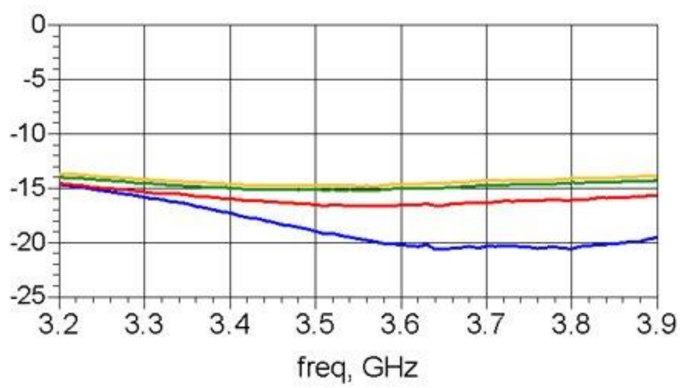


Figure 9.1 S11 (IRL) vs Freq

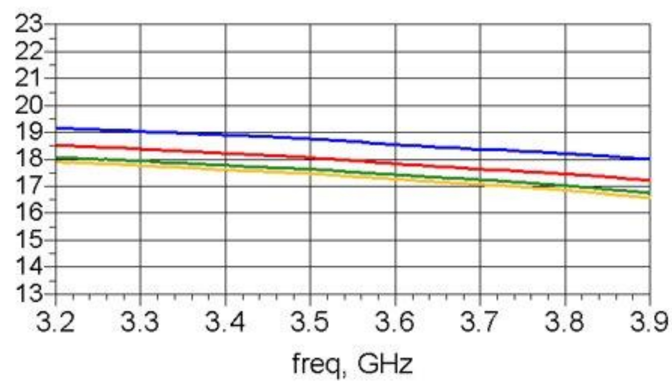


Figure 9.2 S21 (Gain) vs Freq

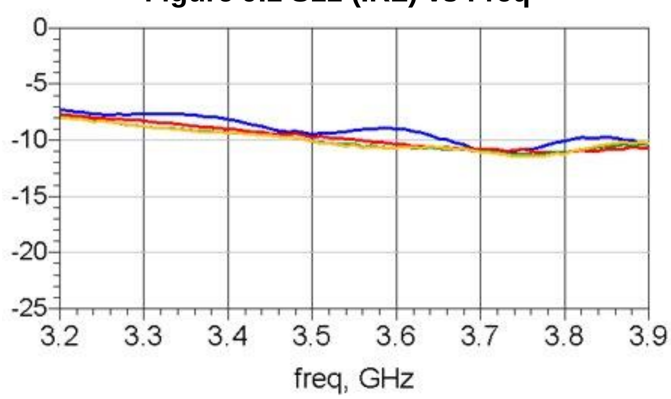


Figure 9.3 S12 (Rev Iso) vs Freq

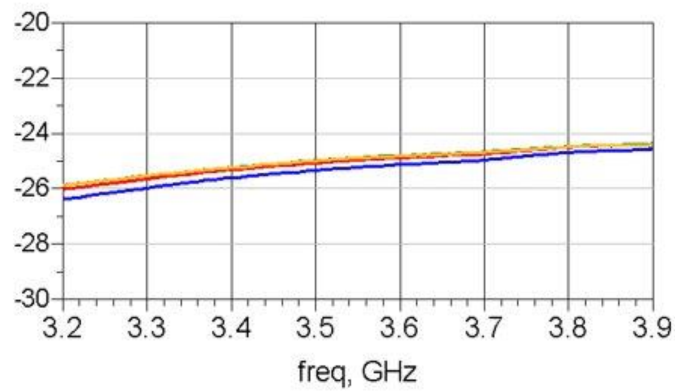


Figure 9.4 S22 (ORL) vs Freq

9.2 3300 - 3800MHz tuned EVB (Vdd=5V, I_{DQ}=60mA), -40ºC,25ºC,85ºC,105 ºC, Broadband

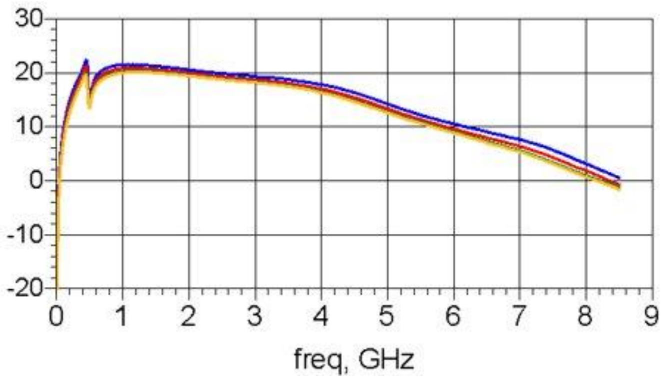


Figure 9.5 S11 (IRL) vs Freq

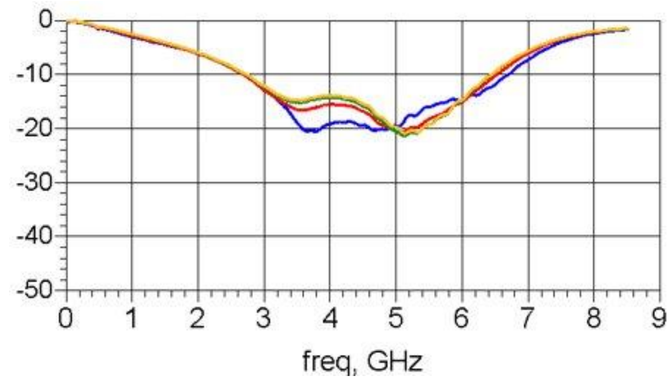


Figure 9.6 S21 (Gain) vs Freq

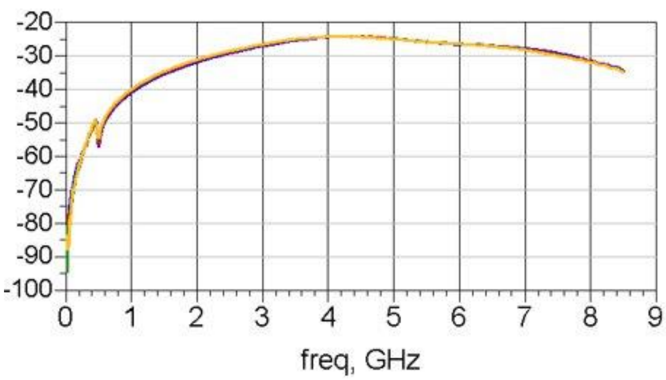


Figure 9.7 S12 (Rev Iso) vs Freq

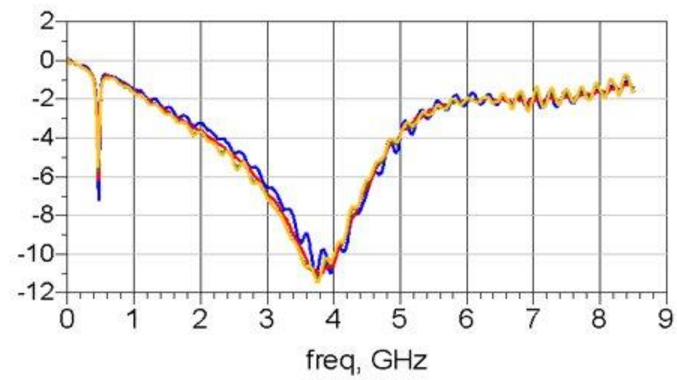


Figure 9.8 S22 (ORL) vs Freq

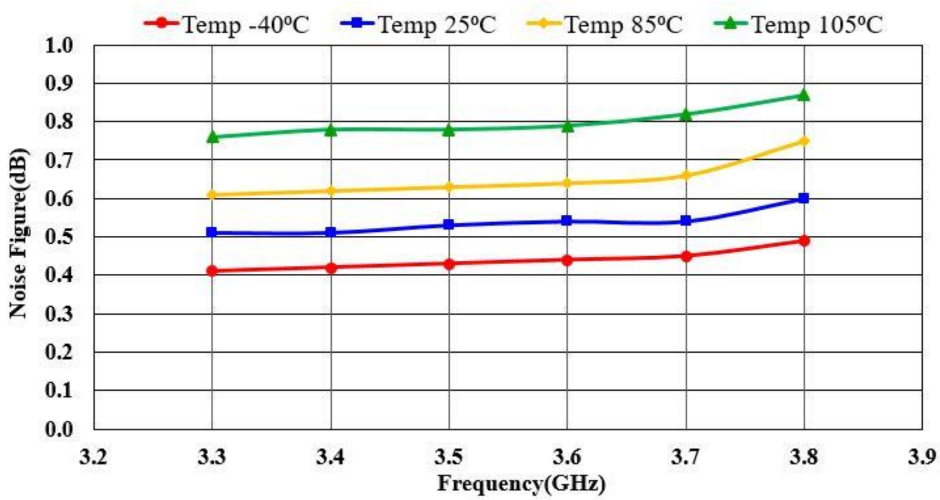


Figure 9.9 Noise Figure (EVB) vs Freq

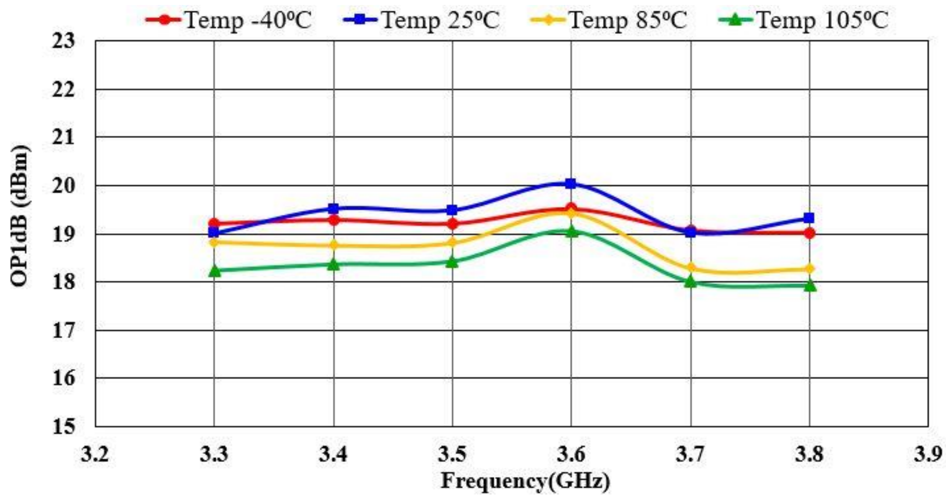


Figure 9.10 Output P1dB vs Freq

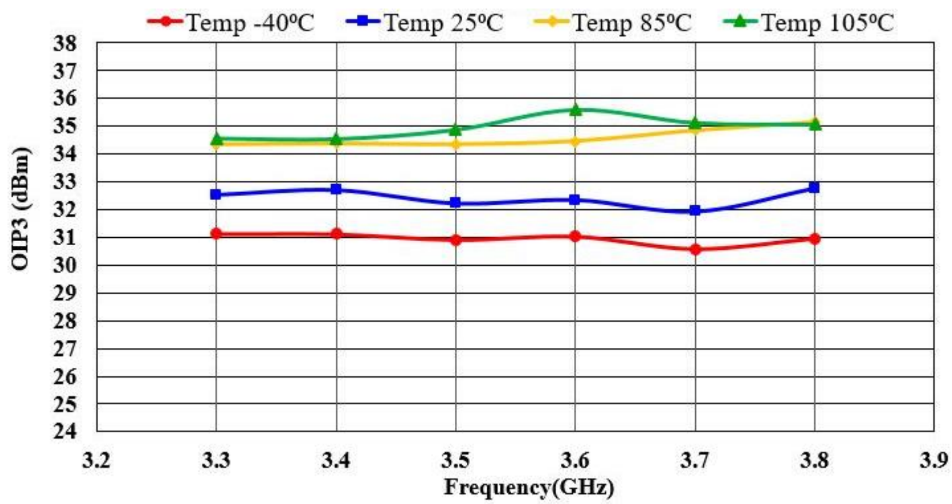


Figure 9.11 Output IP3 vs Freq

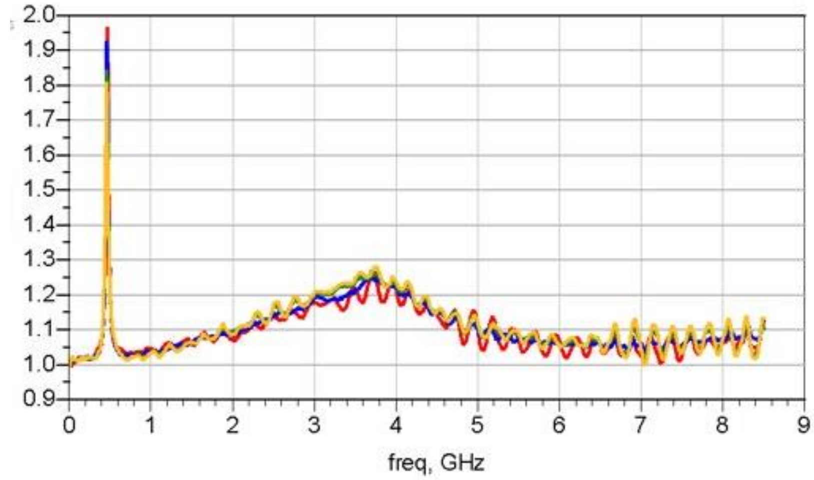


Figure 9.12 Mu1 vs Freq

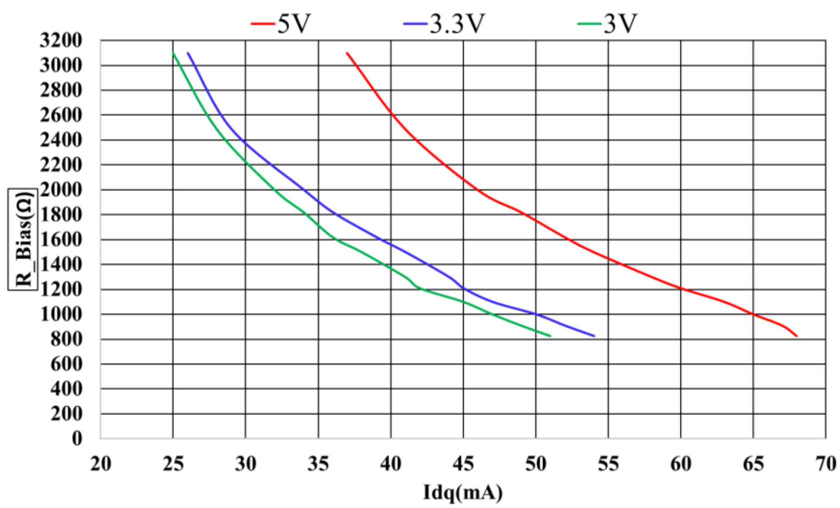


Figure 9.13 Rbias on Venable vs Idq

10.0 Evaluation Boards

10.1 3300 - 3800MHz EVB

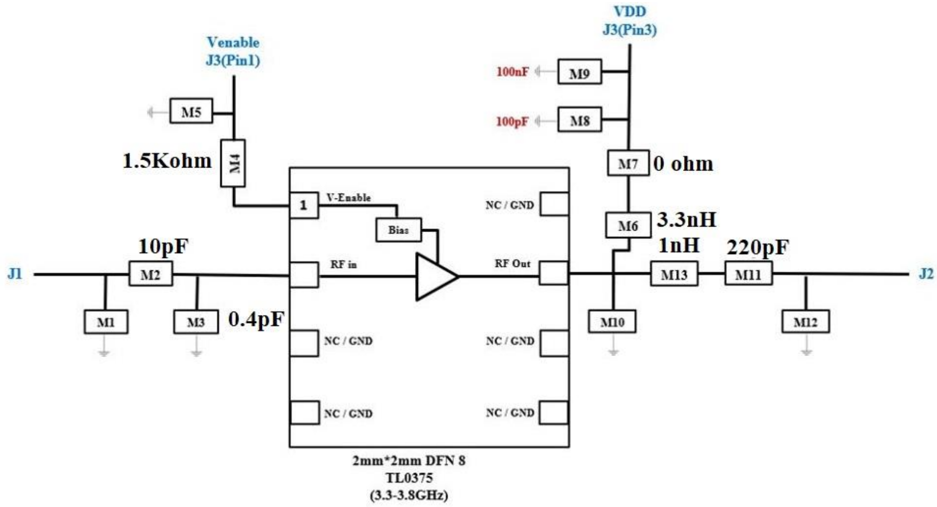


Figure 10.1 Schematic of the 3300-3800MHz EVB

Table 10.1 BOM of the 3300-3800MHz EVB

Component ID	Value	Manufacturer	Recommended Part Number
M2	10pF	Murata	GJM1555C1H100JB01
M3	0.4pF	Murata	GJM1555C1HR40BB01
M6	3.3nH	Coilcraft	0402HP-3N3XGE
M4	1.5KΩ	Panasonic	ERJ-2RKF1501X
M8	100pF	AVX	04025A101JAT4A
M9	100nF	TDK	C1005X7R1H104K050BE
M7	0Ω	Panasonic	ERJ-2GE0R00X
M11	220pF	Kemet	C0402C221K5GACAUTO
M13	1nH	Coilcraft	0402HP-1N0XJE
PCB	Rogers RO4350B, 20 mils, 1 oz copper		

10.2 3700 - 4200MHz EVB

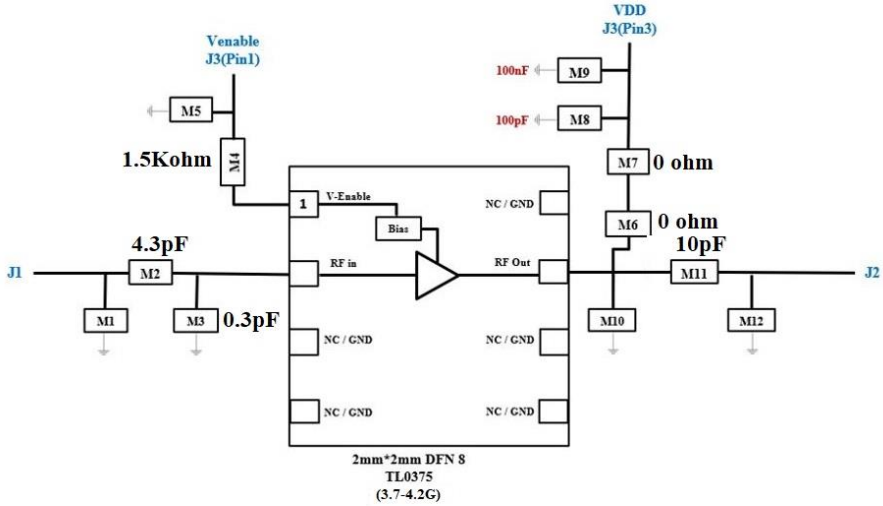


Figure 10.2 Schematic of the 3700-4200MHz EVB

Table 10.2 BOM for 3700 - 4200MHz EVB

Component ID	Value	Manufacturer	Recommended Part Number
M2	4.3pF	Murata	GJM1555C1H4R3BB01
M3	0.3pF	Murata	GJM1555C1HR30BB01
M4	1.5KΩ	Panasonic	ERJ-2RKF1501X
M8	100pF	AVX	04025A101JAT4A
M9	100nF	TDK	C1005X7R1H104K050BE
M7	0Ω	Panasonic	ERJ-2GE0R00X
M6	0Ω	Panasonic	ERJ-2GE0R00X
M11	10pF	AVX	04025A100JAT4A
PCB	Rogers RO4350B, 20 mils, 1 oz copper		

10.3 4400-5000MHz EVB

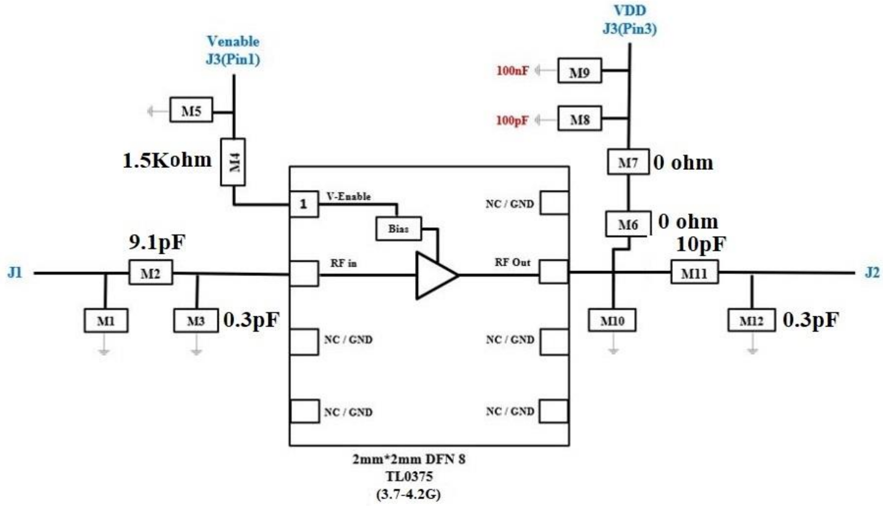


Figure 10.3 Schematic of the 4400-5000MHz EVB

Table 10.3 BOM for 4400-5000MHz EVB

Component ID	Value	Manufacturer	Recommended Part Number
M2	9.1pF	Murata	GJM1555C1H9R1BB01
M4	1.5KΩ	Panasonic	ERJ-2RKF1501X
M3	0.3pF	Murata	GJM1555C1HR30BB01
M8	100pF	AVX	04025A101JAT4A
M9	100nF	TDK	C1005X7R1H104K050BE
M7	0Ω	Panasonic	ERJ-2GE0R00X
M6	0Ω	Panasonic	ERJ-2GE0R00X
M11	10pF	AVX	04025A100JAT4A
M12	0.3pF	Murata	GJM1555C1HR30BB01
PCB	Rogers RO4350B, 20 mils, 1 oz copper		

11.0 Device Package Information

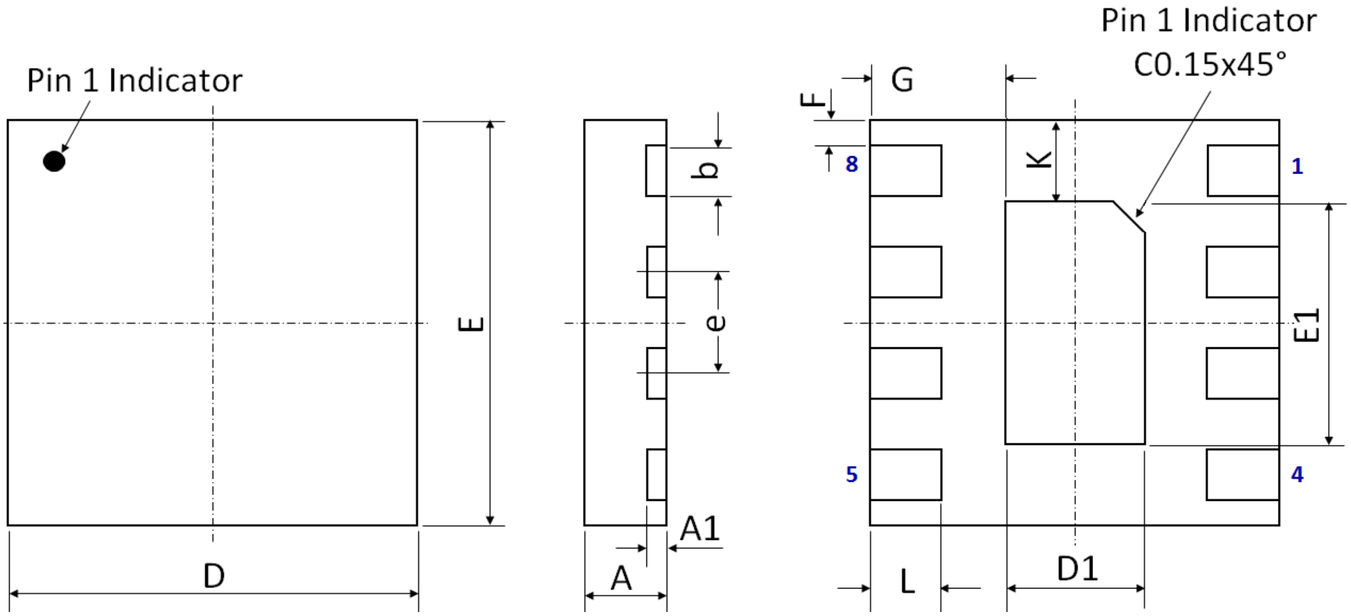


Figure 11.1 Device Package Drawing
(All dimensions are in mm)

Table 11.1 Device Package Dimensions

Dimension (mm)	**Value** (mm)	**Tolerance** (mm)	**Dimension** (mm)	**Value** (mm)	**Tolerance** (mm)
A	0.75	±0.05	E	2.00 BSC	±0.05
A1	0.203	±0.02	E1	1.20	±0.05
b	0.25	±0.02	F	0.125	±0.02
D	2.00 BSC	±0.05	G	0.66	±0.03
D1	0.68	±0.03	L	0.35	±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 1(X)×2(Y)=2

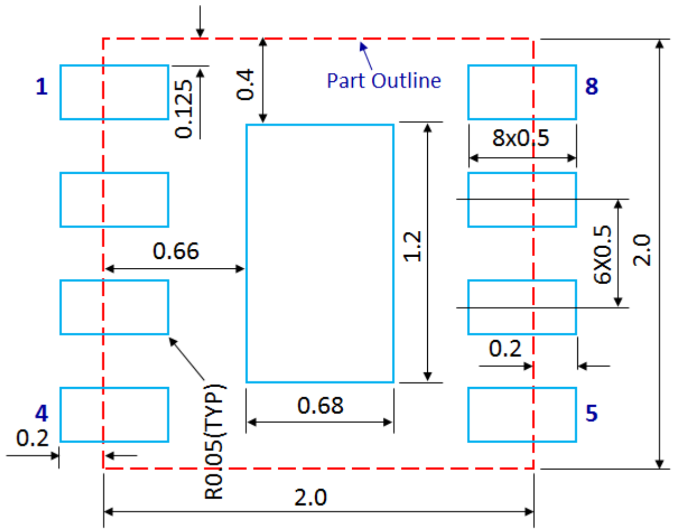


Figure 12.1 PCB Land Pattern
(Dimensions are in mm)

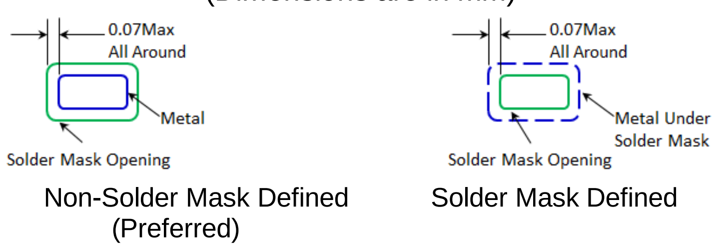


Figure 12.2 Solder Mask Pattern
(Dimensions are in mm)

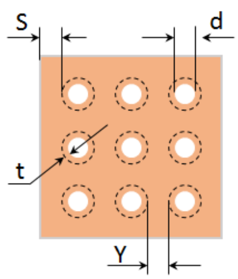


Figure 12.3 Thermal Via Pattern
(Recommended Values: S≥0.15mm; Y≥0.20mm; d=0.3mm; Plating Thickness t=25µm or 50µm)

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.

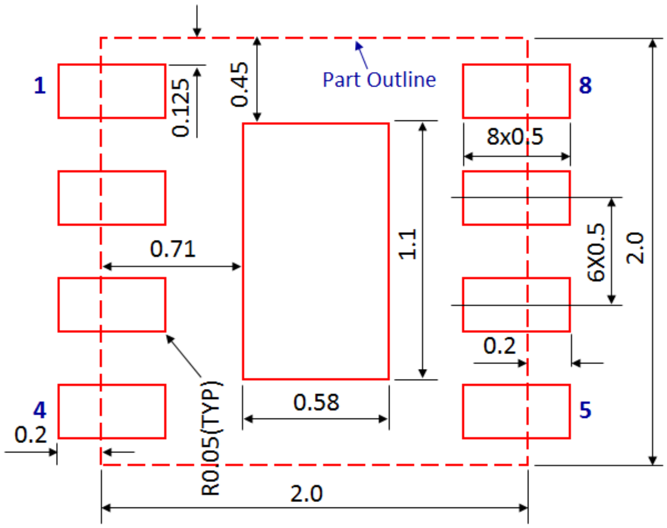


Figure 13.1 Stencil Openings
(Dimensions are in mm)

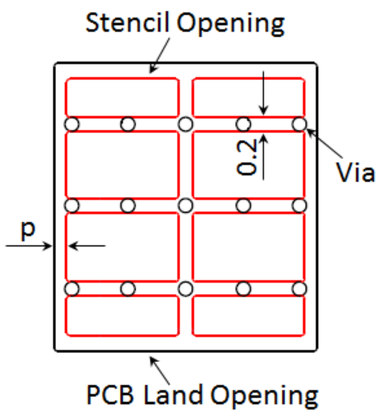
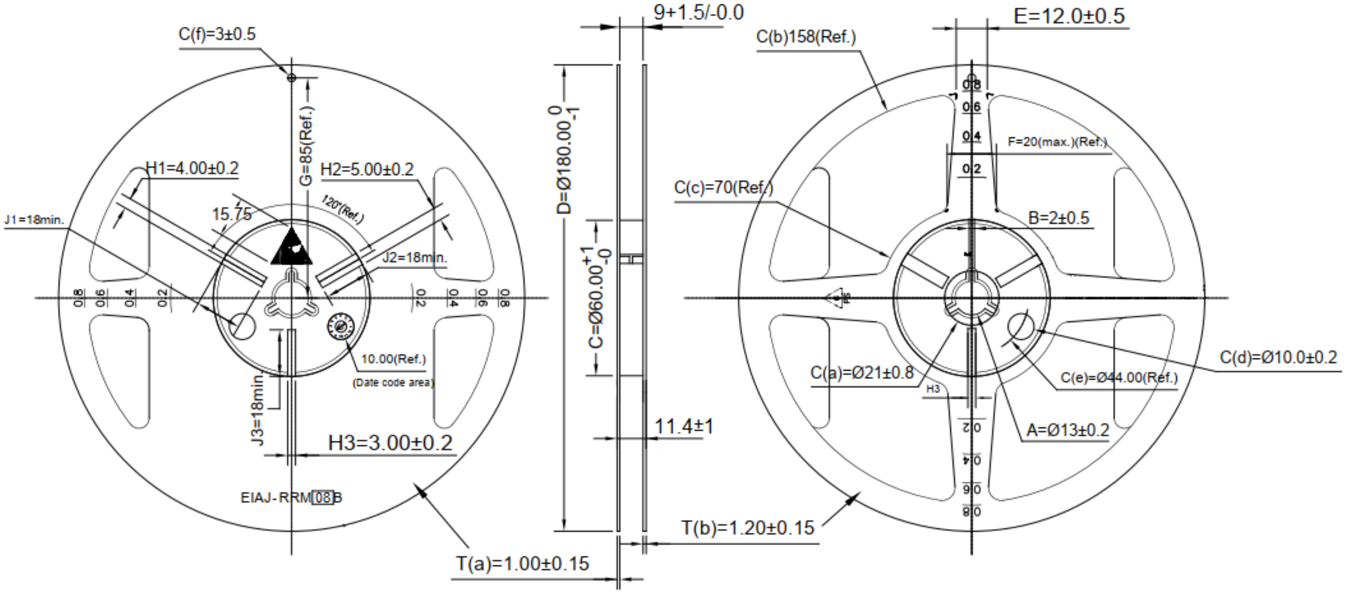


Figure 13.2 Stencil Openings Shall not Cover Via Areas If Possible
(Dimensions are in mm)

14.0 Tape and Reel Information



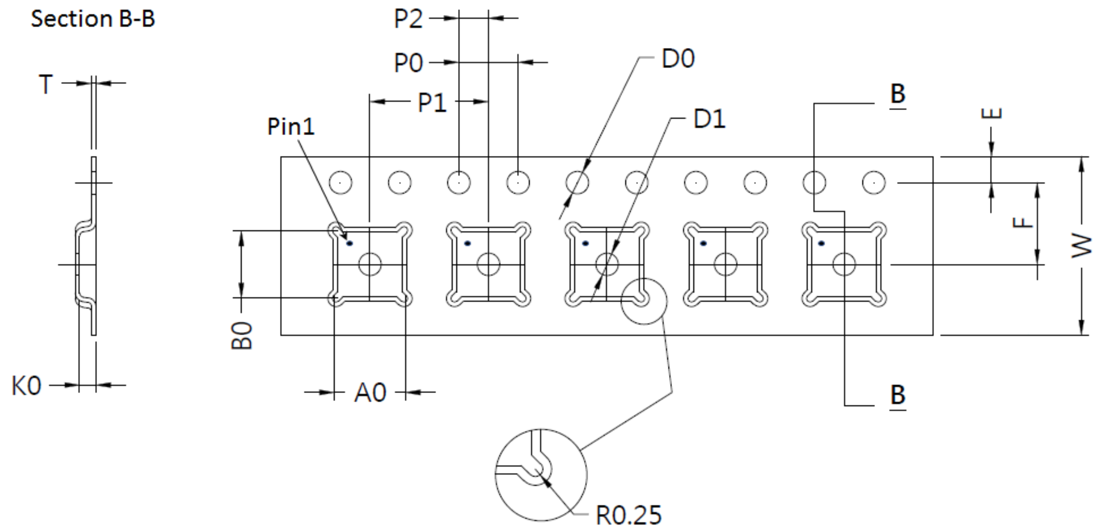


Figure 14.1 Tape and Reel Drawing

Table 14.1 Tape and Reel Dimensions

Dimension (mm)	**Value** (mm)	**Tolerance** (mm)	**Dimension** (mm)	**Value** (mm)	**Tolerance** (mm)
A0	2.35	±0.10	K0	1.10	±0.10
B0	2.35	±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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