0.03 – 3.0 GHz GaAs Ultra Low Noise Amplifier

Features

- Operating frequency 0.03 GHz to 3.0 GHz
- Small signal gain @ 1800 MHz: 21.5 dB
- Noise figure @ 1800 MHz: 0.35 dB
- OP_{1dB} @ 1800 MHz: 18.5 dBm
- OIP3 @ 1800 MHz: 35 dBm
- 5 V typical operating voltage
- Bias current adjustable with one external resistor

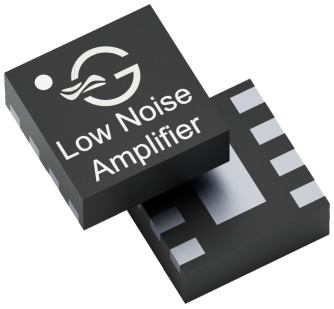

Figure 1: TL0374J in 2.0 x 2.0 mm^2 DFN 8-pin package, top and bottom view.

Applications

- 4G/5G infrastructure radios
- Small cells and cellular repeaters
- Phased array radar
- SDARS

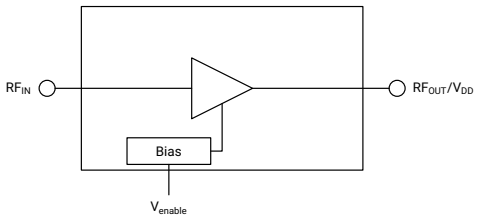

Figure 2: TL0374J functional block diagram [top view]

General Description

The TL0374J is a broadband, ultra-low noise amplifier (LNA) providing high gain and linearity. With a simple input and output match, the LNA can be tuned for different frequency bands targeting LTE (small cells and infrastructure) and any other applications requiring low noise, high gain, and linearity. For frequency bands above 3 GHz, the TagoreTech TL0375J can be considered.

The TL0374J is housed in a compact, low-cost $2.0 \times 2.0\,mm^2$ 8-lead Dual Flat No-lead (DFN) plastic package.

RoHS

RoHS10/REACH/Halogen free

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Ordering information

Table 1: Ordering Information

Device Part Number	Package Type	Notes
TL0374J	8 Pin 2.0x2.0x0.75 mm^3 DFN	Core part number
TL0374JMTRPBF[1]	330 mm reel, 5 000 pcs	Full reel
TL0374J-EVB-A	Evaluation Board	Tuned, 1800 – 2100 MHz
TL0374J-EVB-B	Evaluation Board	Tuned, 2500 – 2700 MHz
TL0374J-EVB-C	Evaluation Board	Tuned, 30 – 1000 MHz
TL0374J-EVB-D1	Evaluation Board	Tuned, 30 – 2600 MHz, 3.3 V, 30 mA
TL0374J-EVB-D2	Evaluation Board	Tuned, 30 – 2600 MHz, 5 V, 55 mA
TL0374J-EVB-E	Evaluation Board	Tuned, 1000 – 2000 MHz
TL0374J-EVB-F	Evaluation Board	Tuned, 4400 – 5000 MHz

[1] MTRPBF - M: Manufacturing, TR: Tape and Reel, and PBF: lead free.

Table 2: Tape and Reel Information

Form	Quantity	Reel Diameter	Reel Width
Tape and Reel	5 000	13” (330mm)	18mm

Evaluation boards and application notes

Each evaluation board is supported by its own application note with schematic, bill of materials, bias procedure and measured performance. Please click the blue links.

All evaluation boards use a Rogers RO4350B, 20 mil, 1 oz copper PCB with SMA connectors on RF_{IN} and RF_{OUT} and a header for V_{enable}, V_{DD} and ground. Two board layouts are used: a matching-ladder layout (EVB A, B, E and F) and a broadband resistive-feedback layout (EVB C, D1 and D2), in which M5 and M6 feed back from RF_{OUT} to RF_{IN}. Component positions that are not assembled on a given board are shown dashed grey in the schematics and marked DNP (Do Not Populate) in the bills of materials. The DC-feed and bias parts (V_{enable} resistor M4 and the drain feed to V_{DD}) set the operating point, see Figure 18.

Table 3: TL0374J evaluation boards and application notes

Evaluation board	Frequency range	Bias	Application note
TL0374J-EVB-A	1800 – 2100 MHz	5 V, 60 mA	TL0374J_EVB_A.pdf
TL0374J-EVB-B	2500 – 2700 MHz	5 V, 60 mA	TL0374J_EVB_B.pdf
TL0374J-EVB-C	30 – 1000 MHz	3.3 V, 30 mA	TL0374J_EVB_C.pdf
TL0374J-EVB-D1	30 – 2600 MHz	3.3 V, 30 mA	TL0374J_EVB_D1.pdf
TL0374J-EVB-D2	30 – 2600 MHz	5 V, 55 mA	TL0374J_EVB_D2.pdf
TL0374J-EVB-E	1000 – 2000 MHz	3.3 V, 50 mA	TL0374J_EVB_E.pdf
TL0374J-EVB-F[1]	4400 – 5000 MHz	5 V, 55 mA	TL0374J_EVB_F.pdf

[1] Reference design outside the specified operating frequency range of 0.03 – 3.0 GHz.

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Pin Assignment

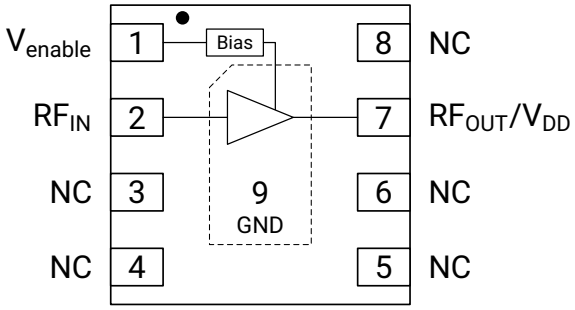

Figure 3: TL0374J pin assignment [top view]

Table 4: Pin Definition

Pin Number	Pin Name	Description
1	V_{enable}	Enable input. V_{enable} together with the series resistor sets I_{DQ}. $V_{enable} < 0.2\,V$ disables the device.
2	RF_{IN}	RF input. A DC blocking capacitor is required.
3, 4, 5, 6, 8	NC	No internal connection, can be connected to ground.
7	RF_{OUT}/V_{DD}	RF output. V_{DD} is supplied through an external choke inductor.
9 (paddle)[1]	GND	DC and RF ground, also provides the thermal path. Multiple vias are recommended.

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

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Absolute Maximum Ratings

Table 5: Absolute Maximum Ratings $T_A = +25$°C unless otherwise specified[1].

Parameter	Symbol	Value	Unit
Electrical Ratings			
Supply voltage, V_{DD} and V_{enable}	V_{DD}	+6	V
Drain current	I_{DQ}	70	mA
RF input power, CW	RF_{IN}	23	dBm
Storage Temperature Range	T_{st}	−55 – 150	°C
Operating Temperature Range	T_{op}	−40 – 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_{solder}	+260	°C
ESD Ratings			
Human Body Model (HBM)	Level 1B	500 – $<$1000	V
Charged Device Model (CDM)	Level C	$\geq$1000	V
Moisture Rating			
Moisture Sensitivity Level[2]	MSL	1	

[1] Maximum ratings are absolute ratings. Exposure to absolute maximum rating conditions for extended periods may affect device reliability and can cause permanent damage to the device. Exceeding one or a combination of the absolute maximum ratings may cause permanent and irreversible damage to the device and/or to surrounding circuit. Functional operation of the device is not implied in any conditions above those indicated in the Electrical Specifications section.

[2] Tagore recommends to store parts in moisture barrier bag to preserve solderability.

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Recommended DC Operating Conditions

Table 6: Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Unit
Drain voltage	V_{DD}		+5.0		V
Enable voltage	V_{enable}		+5.0		V
Drain bias current, set by external resistor[1]	I_{DQ}	45	60		mA
Enable bias current	I_{bias}		3.0		mA
Operating temperature range	T_{op}	-40	+25	+105	°C

[1] V_{enable} together with the series resistor on the V_{enable} pin sets I_{DQ}, see Figure 18. $V_{enable} < 0.2$ V disables the device.

Table 7: Switching Time

Parameter	Test Condition	Typical	Unit
Switching rise time	10/90% of the RF value	300	ns
Switching fall time	10/90% of the RF value	350	ns

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RF Electrical Specifications

The values below are typical ranges across the band of each tuned evaluation board. Noise figure is given both de-embedded to the device reference plane and as measured on the evaluation board (EVB noise figure, including connector and PCB losses).

Table 8: EVB A, 1800 – 2100 MHz: $V_{enable} = 5$ V, $I_{DD} = 60$ mA, $V_{DD} = 5$ V, $T_A = +25$°C unless otherwise specified.

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across the band		20 – 22		dB
Noise figure	Across the band		0.3 – 0.4		dB
EVB noise figure	Across the band		0.4 – 0.5		dB
Input return loss	Across the band		-27 to -17		dB
Output return loss	Across the band		-10 to -9		dB
OP_{1dB}	Across the band		18.3 – 19.5		dBm
OIP3	Across the band, 0 dBm per tone, tone spacing 1 MHz		35 – 37.3		dBm

Table 9: EVB B, 2500 – 2700 MHz: $V_{enable} = 5$ V, $I_{DD} = 60$ mA, $V_{DD} = 5$ V, $T_A = +25$°C unless otherwise specified.

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across the band		18.5 – 19.2		dB
Noise figure	Across the band		0.3 – 0.4		dB
EVB noise figure	Across the band		0.4 – 0.5		dB
Input return loss	Across the band		-33 to -27		dB
Output return loss	Across the band		-9.3 to -9		dB
OP_{1dB}	Across the band		18.4 – 19.6		dBm
OIP3	Across the band, 0 dBm per tone, tone spacing 1 MHz		41 – 43		dBm

Table 10: EVB C, 30 – 1000 MHz: $V_{enable} = 3.3$ V, $I_{DD} = 30$ mA, $V_{DD} = 3.3$ V, $T_A = +25$°C unless otherwise specified.

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across the band		21.3 – 25.6		dB
Noise figure	Across the band		0.5 – 0.6		dB
EVB noise figure	Across the band		0.5 – 0.7		dB
Input return loss	Across the band		-26 to -12.5		dB
Output return loss	Across the band		-19.3 to -7.4		dB
OP_{1dB}	Across the band		14.6 – 15.2		dBm
OIP3	Across the band, 0 dBm per tone, tone spacing 1 MHz		27.5 – 29.3		dBm

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Table 11: EVB D1, 30 – 2600 MHz: $V_{enable} = 3.3$ V, $I_{DD} = 30$ mA, $V_{DD} = 3.3$ V, $T_A = +25$°C unless otherwise specified.

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across the band		13 – 20.3		dB
Noise figure	Across the band		0.4 – 0.6		dB
EVB noise figure	Across the band		0.4 – 0.7		dB
Input return loss	Across the band		-16 to -8.3		dB
Output return loss	Across the band		-19.3 to -7.4		dB
OP_{1dB}	Across the band		12.1 – 14.7		dBm
OIP3	Across the band, 0 dBm per tone, tone spacing 1 MHz		22.6 – 29.1		dBm

Table 12: EVB D2, 30 – 2600 MHz: $V_{enable} = 5$ V, $I_{DD} = 55$ mA, $V_{DD} = 5$ V, $T_A = +25$°C unless otherwise specified.

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across the band		13.5 – 21.9		dB
Noise figure	Across the band		0.5 – 0.7		dB
EVB noise figure	Across the band		0.5 – 0.8		dB
Input return loss	Across the band		-23.5 to -8.9		dB
Output return loss	Across the band		-19.6 to -6.4		dB
OP_{1dB}	Across the band		13.8 – 17.8		dBm
OIP3	Across the band, 0 dBm per tone, tone spacing 1 MHz		27.2 – 33.0		dBm

Table 13: EVB E, 1000 – 2000 MHz: $V_{enable} = 3.3$ V, $I_{DD} = 50$ mA, $V_{DD} = 3.3$ V, $T_A = +25$°C unless otherwise specified.

Parameter	Test Condition	Minimum	Typical	Maximum	Unit
Gain	Across the band		18.5 – 23.6		dB
Noise figure	Across the band		0.4 – 0.5		dB
EVB noise figure	Across the band		0.5 – 0.6		dB
Input return loss	Across the band		-21.5 to -5.1		dB
Output return loss	Across the band		-6.7 to -5.2		dB
OP_{1dB}	Across the band		15.8 – 16.8		dBm
OIP3	Across the band, 0 dBm per tone, tone spacing 1 MHz		30.7 – 33.4		dBm

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Evaluation Boards

EVB A, 1800 – 2100 MHz

Measured performance of this board is given in Table 8. Bias: 5 V, 60 mA.
Application note: TL0374J-EVB-A application note.

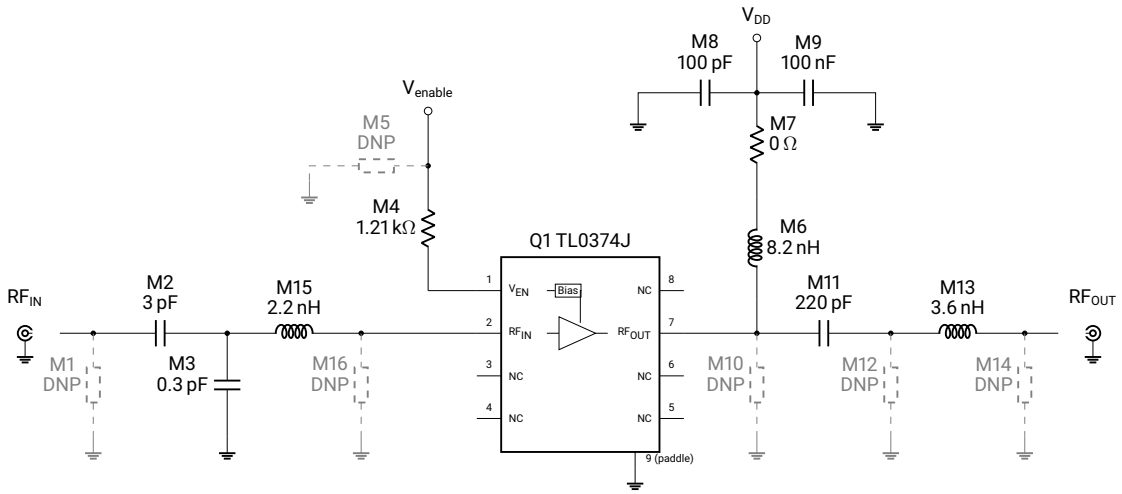

Figure 4: Schematic of TL0374J-EVB-A, 1800 – 2100 MHz. Dashed grey positions are not assembled (DNP).

Table 14: Bill of materials, TL0374J-EVB-A

Component ID	Value	Manufacturer	Recommended part number
M2	3.0 pF	Murata	GJM1555C1H3R0BB01
M3	0.3 pF	Murata	GJM1555C1HR30BB01
M15	2.2 nH	Coilcraft / Würth Elektronik	0402HP-2N2XJE / 744765022A
M4	1.21 kΩ	Panasonic	ERJ-2RKF1211X
M8	100 pF	AVX	04025A101JAT4A
M9	100 nF	TDK	C1005X7R1H104K050BE
M7	0 Ω	Panasonic	ERJ-2GE0R00X
M6	8.2 nH	Coilcraft / Würth Elektronik	0402HP-8N2XGE / 744765082GA
M11	220 pF	Kemet	C0402C221K5GACAUTO
M13	3.6 nH	Coilcraft / Würth Elektronik	0402HP-3N6XGE / 744765036A
M1, M5, M10, M12, M14, M16	DNP		
Q1	GaAs LNA	TagoreTech	TL0374J
PCB	Rogers RO4350B, 20 mil, 1 oz copper		

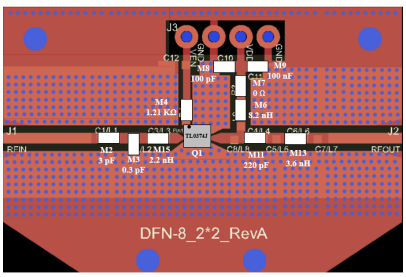

Figure 5: Layout of TL0374J-EVB-A.

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EVB B, 2500 – 2700 MHz

Measured performance of this board is given in Table 9. Bias: 5 V, 60 mA.
Application note: TL0374J-EVB-B application note.

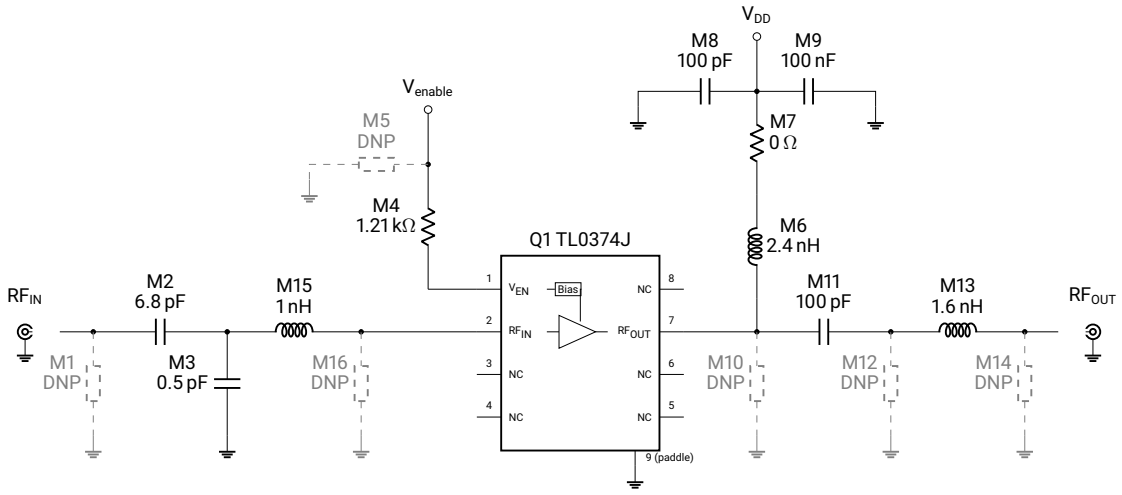

Figure 6: Schematic of TL0374J-EVB-B, 2500 – 2700 MHz. Dashed grey positions are not assembled (DNP).

Table 15: Bill of materials, TL0374J-EVB-B

Component ID	Value	Manufacturer	Recommended part number
M2	6.8 pF	Murata	GJM1555C1H6R8BB01
M3	0.5 pF	Murata	GJM1555C1HR50BB01
M15	1.0 nH	Coilcraft	0402HP-1N0XJE
M4	1.21 kΩ	Panasonic	ERJ-2RKF1211X
M8	100 pF	AVX	04025A101JAT4A
M9	100 nF	TDK	C1005X7R1H104K050BE
M7	0 Ω	Panasonic	ERJ-2GE0R00X
M6	2.4 nH	Coilcraft	0402HP-2N4XGE
M11	100 pF	AVX	04025A101JAT4A
M13	1.6 nH	Coilcraft	0603HC-1N6XGLW
M1, M5, M10, M12, M14, M16	DNP		
Q1	GaAs LNA	TagoreTech	TL0374J
PCB	Rogers RO4350B, 20 mil, 1 oz copper		

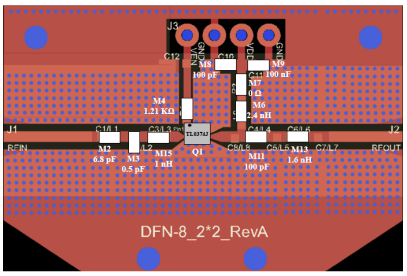

Figure 7: Layout of TL0374J-EVB-B.

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EVB C, 30 – 1000 MHz

Measured performance of this board is given in Table 10. Bias: 3.3 V, 30 mA.
Application note: TL0374J-EVB-C application note.

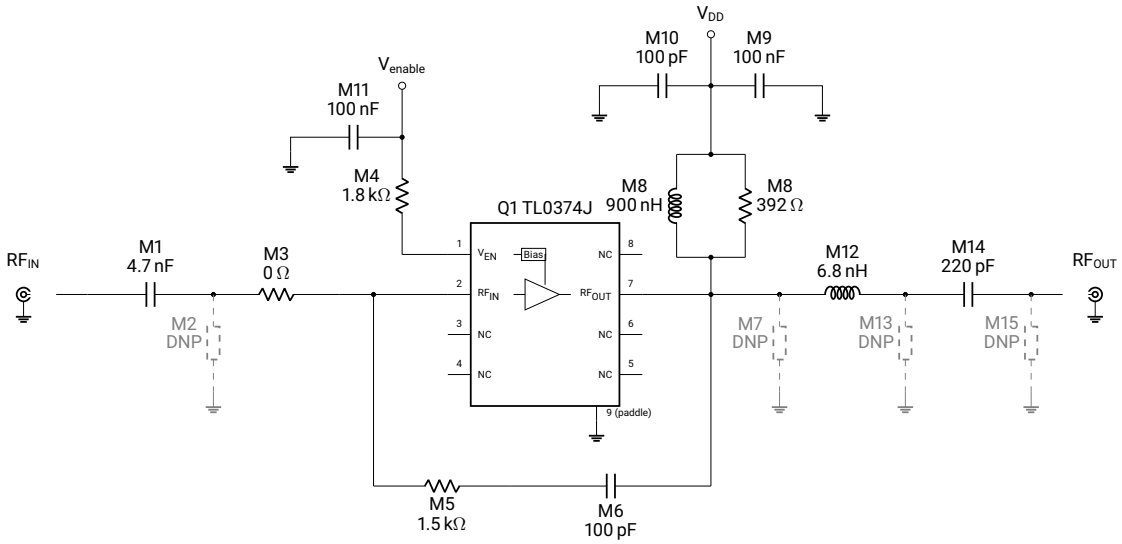

Figure 8: Schematic of TL0374J-EVB-C, 30 – 1000 MHz. Dashed grey positions are not assembled (DNP).

Table 16: Bill of materials, TL0374J-EVB-C

Component ID	Value	Manufacturer	Recommended part number
M1	4.7 nF, 50 V	Murata	GRM1885C1H472JA01D
M3	0 Ω	Panasonic	ERJ-2GE0R00X
M4	1.8 kΩ	Panasonic	ERJ-2RKF1801X
M5	1.5 kΩ	Panasonic	ERJ-2RKF1501X
M6, M10	100 pF	AVX	04025A101JAT4A
M8 (L)	900 nH	Coilcraft	1008AF-901XJLC
M8 (R)	392 Ω	Panasonic	ERJ-UP3F3920V
M9, M11	100 nF	TDK	C1005X7R1H104K050BE
M12	6.8 nH	Coilcraft	0402HP-6N8XJRW
M14	220 pF	Kemet	C0402C221K5GACAUTO
M2, M7, M13, M15	DNP		
Q1	GaAs LNA	TagoreTech	TL0374J
PCB	Rogers RO4350B, 20 mil, 1 oz copper		

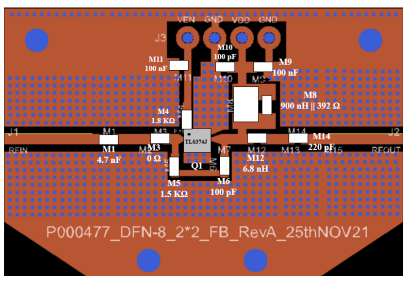

Figure 9: Layout of TL0374J-EVB-C.

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EVB D1, 30 – 2600 MHz

Measured performance of this board is given in Table 11. Bias: 3.3 V, 30 mA.
Application note: TL0374J-EVB-D1 application note.

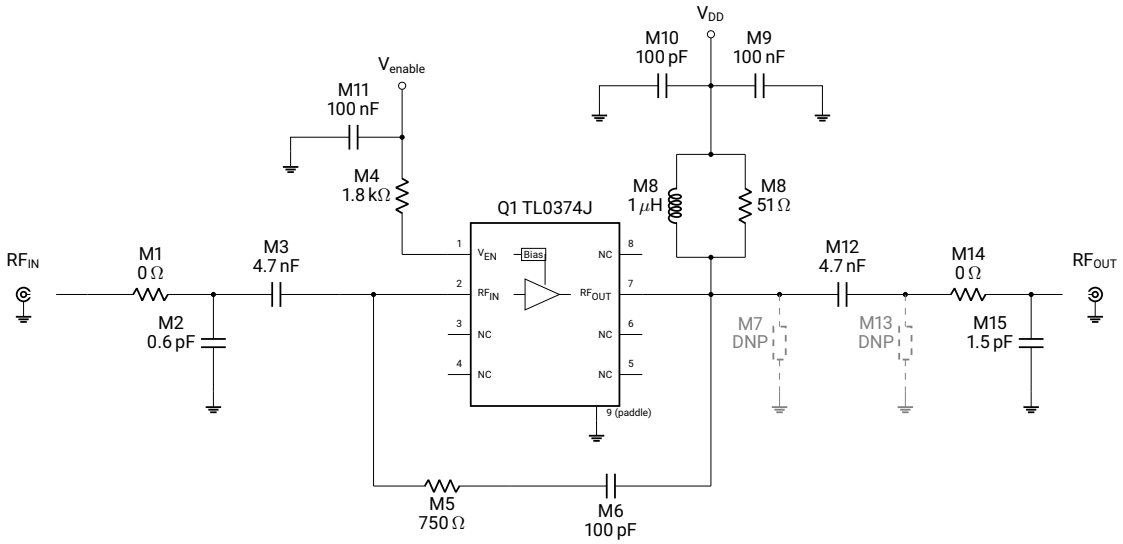

Figure 10: Schematic of TL0374J-EVB-D1, 30 – 2600 MHz. Dashed grey positions are not assembled (DNP).

Table 17: Bill of materials, TL0374J-EVB-D1

Component ID	Value	Manufacturer	Recommended part number
M1, M14	0 Ω	Panasonic	ERJ-2GE0R00X
M2	0.6 pF	Murata	GJM1555C1HR60BB01D
M3, M12	4.7 nF, 50 V	Murata	GRM1885C1H472JA01D
M4	1.8 kΩ	Panasonic	ERJ-2RKF1801X
M5	750 Ω	KOA Speer	RK73H1ERTTP7500F
M6, M10	100 pF	AVX	04025A101JAT4A
M8 (L)	1 μH	Coilcraft	PFL2512-102MEC
M8 (R)	51 Ω	ROHM Semiconductor	ESR03EZPJ510
M9, M11	100 nF	TDK	C1005X7R1H104K050BE
M15	1.5 pF	Murata	GJM1555C1H1R5BB01J
M7, M13	DNP		
Q1	GaAs LNA	TagoreTech	TL0374J
PCB	Rogers RO4350B, 20 mil, 1 oz copper		

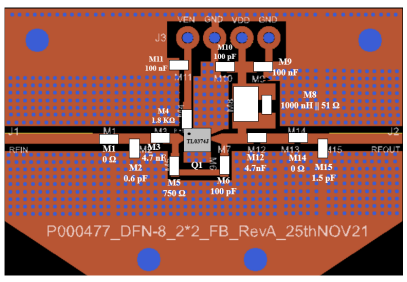

Figure 11: Layout of TL0374J-EVB-D1.

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EVB D2, 30 – 2600 MHz

Measured performance of this board is given in Table 12. Bias: 5 V, 55 mA.
Application note: TL0374J-EVB-D2 application note.

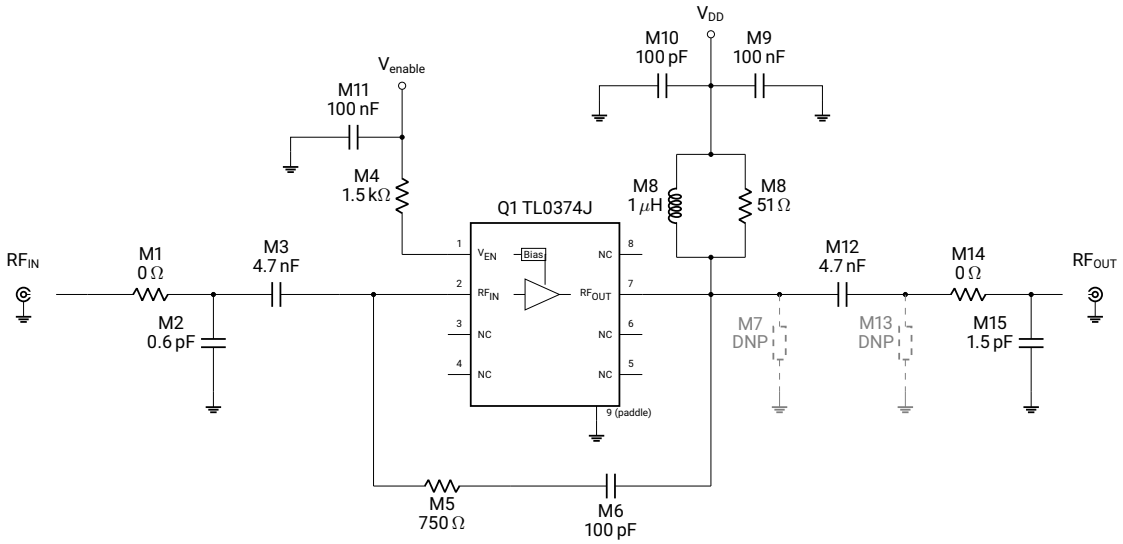

Figure 12: Schematic of TL0374J-EVB-D2, 30 – 2600 MHz. Dashed grey positions are not assembled (DNP).

Table 18: Bill of materials, TL0374J-EVB-D2

Component ID	Value	Manufacturer	Recommended part number
M1, M14	0 Ω	Panasonic	ERJ-2GE0R00X
M2	0.6 pF	Murata	GJM1555C1HR60BB01D
M3, M12	4.7 nF, 50 V	Murata	GRM1885C1H472JA01D
M4	1.5 kΩ	Panasonic	ERJ-2RKF1501X
M5	750 Ω	KOA Speer	RK73H1ERTTP7500F
M6, M10	100 pF	AVX	04025A101JAT4A
M8 (L)	1 μH	Coilcraft	PFL2512-102MEC
M8 (R)	51 Ω	ROHM Semiconductor	ESR03EZPJ510
M9, M11	100 nF	TDK	C1005X7R1H104K050BE
M15	1.5 pF	Murata	GJM1555C1H1R5BB01J
M7, M13	DNP		
Q1	GaAs LNA	TagoreTech	TL0374J
PCB	Rogers RO4350B, 20 mil, 1 oz copper		

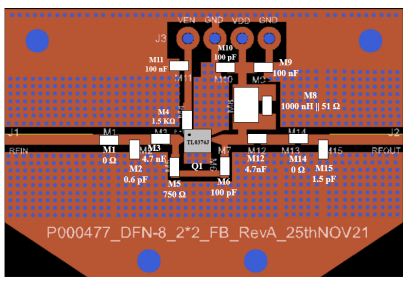

Figure 13: Layout of TL0374J-EVB-D2.

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EVB E, 1000 – 2000 MHz

Measured performance of this board is given in Table 13. Bias: 3.3 V, 50 mA.
Application note: TL0374J-EVB-E application note.

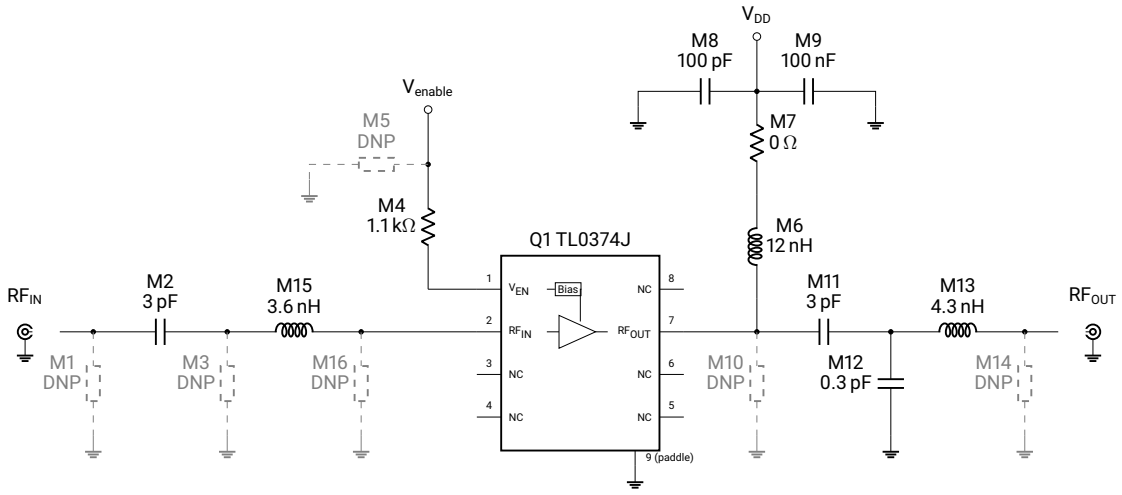

Figure 14: Schematic of TL0374J-EVB-E, 1000 – 2000 MHz. Dashed grey positions are not assembled (DNP).

Table 19: Bill of materials, TL0374J-EVB-E

Component ID	Value	Manufacturer	Recommended part number
M2, M11	3.0 pF	Murata	GJM1555C1H3R0BB01
M12	0.3 pF	Murata	GJM1555C1HR30BB01
M8	100 pF	AVX	04025A101JAT4A
M9	100 nF	TDK	C1005X7R1H104K050BE
M7	0 Ω	Panasonic	ERJ-2GE0R00X
M6	12 nH	Coilcraft	0402HP-12NXE
M15	3.6 nH	Coilcraft / Würth Elektronik	0402HP-3N6XGE / 744916036
M4[1]	1.1 kΩ	Panasonic	ERJ-2RKF1101X
M13	4.3 nH	Coilcraft	0402HP-4N3XGE
M1, M3, M5, M10, M14, M16	DNP		
Q1	GaAs LNA	TagoreTech	TL0374J
PCB	Rogers RO4350B, 20 mil, 1 oz copper		

[1] The Word/app-note BOM lists this resistor as M14; the schematic shows it at the V_{enable} position M4, M14 is not placed.

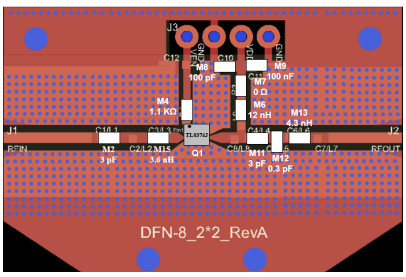

Figure 15: Layout of TL0374J-EVB-E.

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EVB F, 4400 – 5000 MHz

TL0374J-EVB-F is tuned for 4400 – 5000 MHz, which is outside the specified operating frequency range of the TL0374J (0.03 – 3.0 GHz). The board is given as a reference design; the performance is described in the EVB-F application note. Bias: 5 V, 55 mA.
Application note: TL0374J-EVB-F application note.

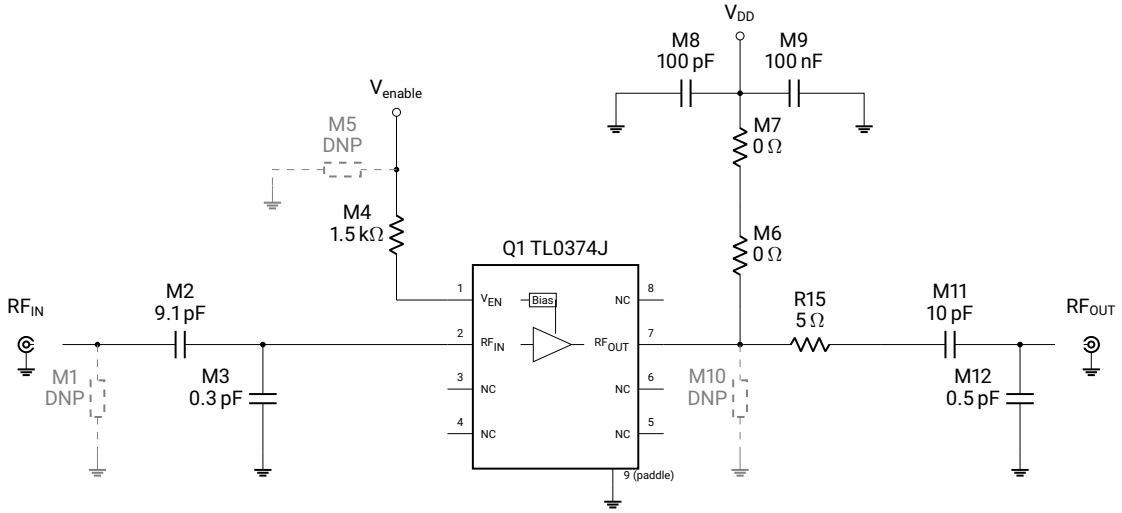

Figure 16: Schematic of TL0374J-EVB-F, 4400 – 5000 MHz. Dashed grey positions are not assembled (DNP).

Table 20: Bill of materials, TL0374J-EVB-F

Component ID	Value	Manufacturer	Recommended part number
M2	9.1 pF	Murata	GJM1555C1H3R0BB01[1]
M3	0.3 pF	Murata	GJM1555C1HR30BB01
M4	1.5 kΩ	Panasonic	ERJ-2RKF1501X
M6, M7	0 Ω	Panasonic	ERJ-2GE0R00X
M8[2]	100 pF	AVX	04025A101JAT4A
M9[2]	100 nF	TDK	C1005X7R1H104K050BE
M11	10 pF	Murata	GJM1555C1H100JB01
M12	0.5 pF	Murata	GJM1555C1HR50BB01
R15[3]	5 Ω	KOA Speer	RK73H1ETTP4R99F
M1, M5, M10	DNP		
Q1	GaAs LNA	TagoreTech	TL0374J
PCB	Rogers RO4350B, 20 mil, 1 oz copper		

[1] Part number GJM1555C1H3R0BB01 is a 3.0 pF capacitor; the part number for 9.1 pF is to be confirmed.
[2] Assignment according to the schematic (M8 100 pF, M9 100 nF); the earlier BOM listed them the other way round.
[3] Extra series position cut into the output RF line between M10 and M11 for a 5 Ω (4.99 Ω) resistor.

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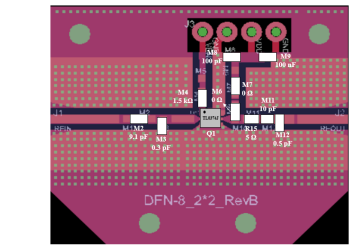

Figure 17: Layout of TL0374J-EVB-F.

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Typical characteristics

The S-parameters below are measured Touchstone data of the evaluation boards at $T_A = +25$°C, at the bias of each board given in the figure captions. The reference planes are at the SMA connectors, so connector and PCB losses are included. The shaded area and the thick line in the Smith charts mark the band the board is tuned for. For each board the wideband plots and the Smith charts of S_{11} and S_{22} (normalised to 50 Ω) are shown first, followed by the tuned band on an expanded frequency scale. The wideband plots start at the specified lower frequency limit of 30 MHz and end at the upper end of the measured data. The broadband boards EVB D1 and D2 cover almost the whole measured range, so their gain and stability plots are shown together on one page instead of a separate narrowband page. The gain on the expanded scale uses a 10 dB window (1 dB/div) placed around the gain of each board.

Stability factors

The stability factors μ (load) and μ' (source) shown for each board are calculated from the S-parameters:

$$\mu = \frac{1 - |S_{11}|^2}{|S_{22} - \Delta S_{11}^*| + |S_{12}S_{21}|}, \qquad \mu' = \frac{1 - |S_{22}|^2}{|S_{11} - \Delta S_{22}^*| + |S_{12}S_{21}|}, \qquad \Delta = S_{11}S_{22} - S_{12}S_{21}.$$

$\mu > 1$ (or $\mu' > 1$) is the necessary and sufficient condition for unconditional stability; the value is the distance from the centre of the Smith chart to the nearest unstable load (source) impedance.

Bias resistor

The drain current is set by V_{enable} and the series resistor on the V_{enable} pin (M4 on the evaluation boards).

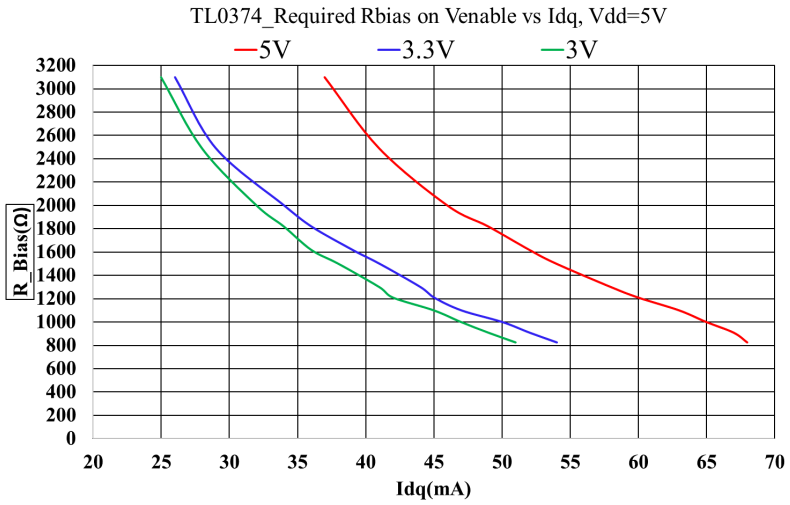

Figure 18: Bias resistor on V_{enable} vs. I_{DQ}.

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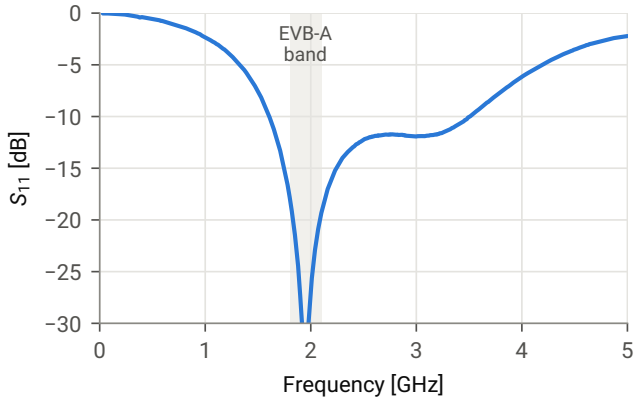
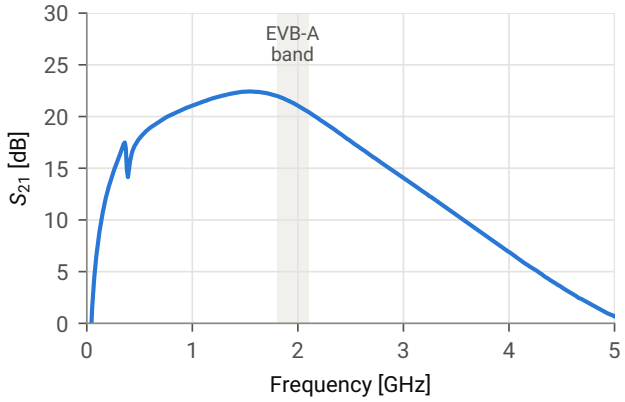
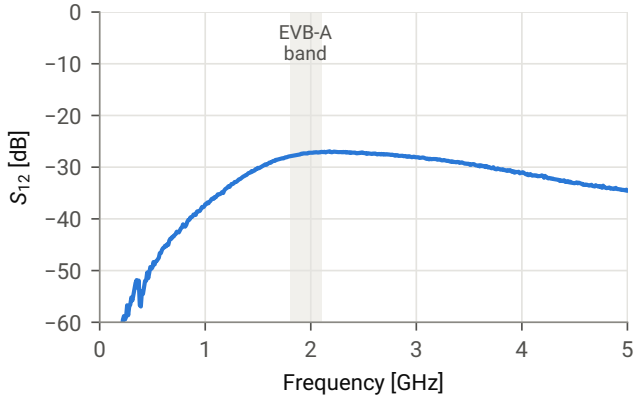
EVB A, wideband S-parameters and Smith charts



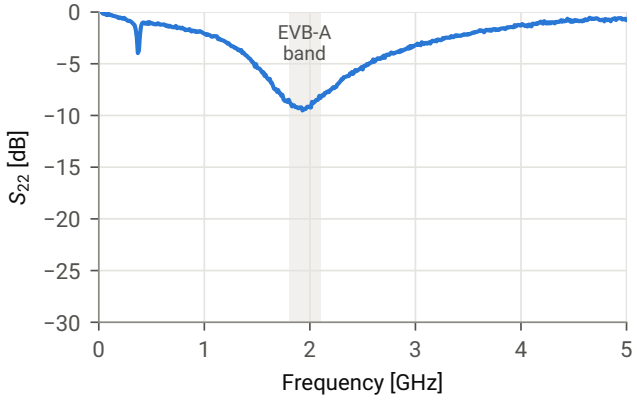
(a) S_{11} (input return loss) vs. frequency.



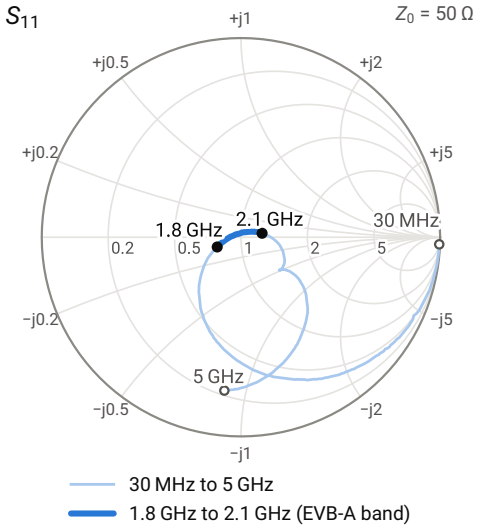
(b) S_{21} (gain) vs. frequency.



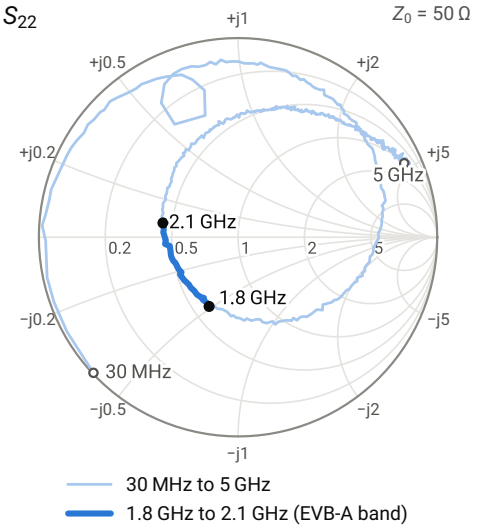
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{11} Smith chart, input impedance.



(f) S_{22} Smith chart, output impedance.

Figure 19: TL0374J-EVB-A S-parameters, 30 MHz to 5 GHz, $+25$°C, 5 V, 60 mA. Shaded and thick line: 1800 – 2100 MHz tuned band.

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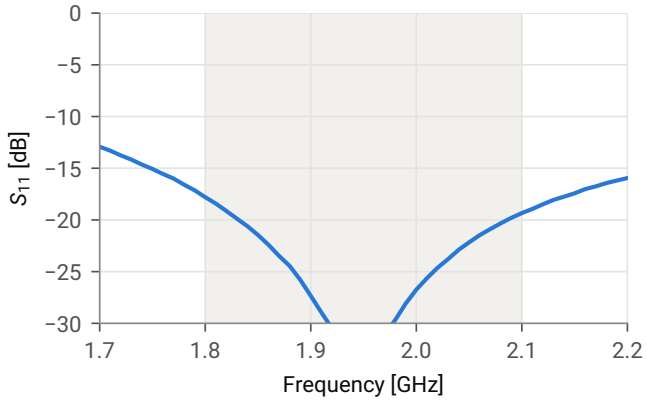
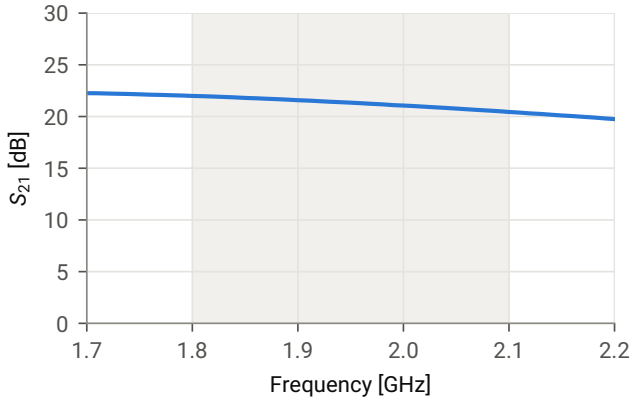
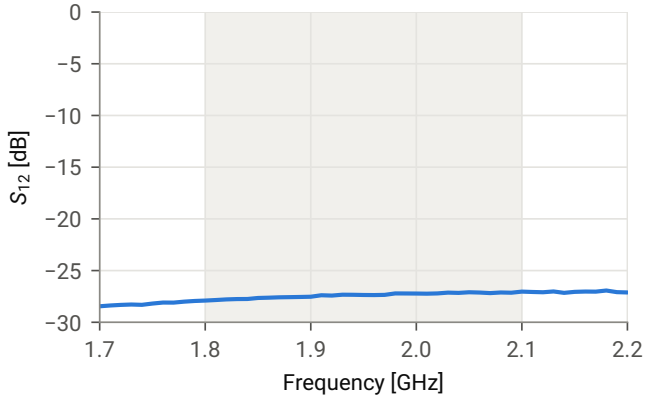
EVB A, narrowband S-parameters



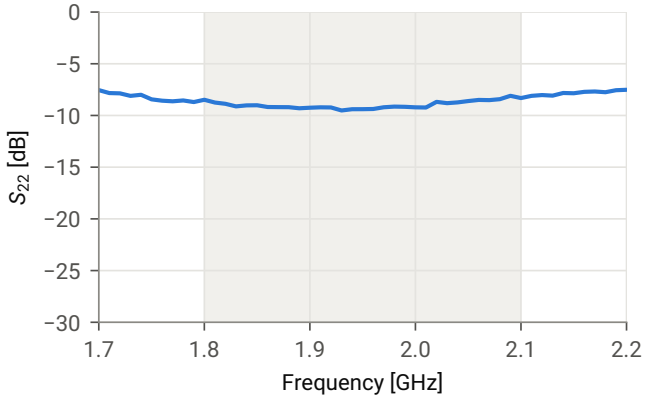
(a) S_{11} (input return loss) vs. frequency.



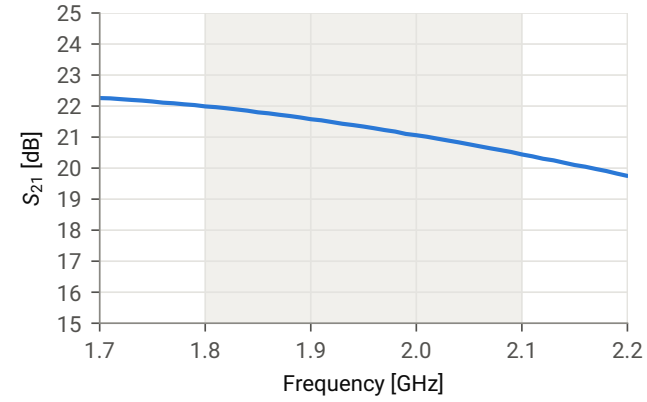
(b) S_{21} (gain) vs. frequency.



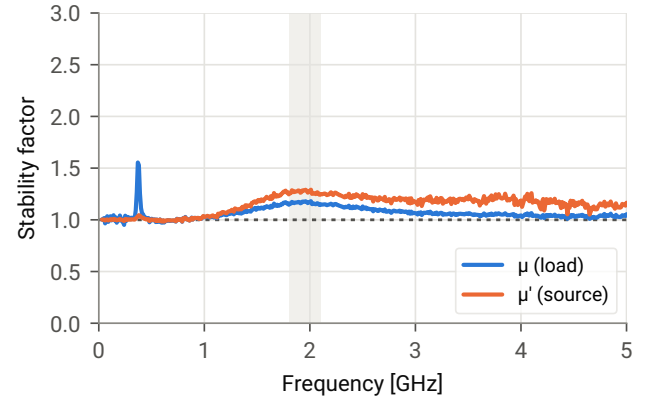
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{21} (gain) vs. frequency, expanded scale.



(f) Stability factors μ and μ' vs. frequency, 30 MHz to 5 GHz.

Figure 20: TL0374J-EVB-A S-parameters, 1800 – 2100 MHz band, $+25$°C, 5 V, 60 mA.

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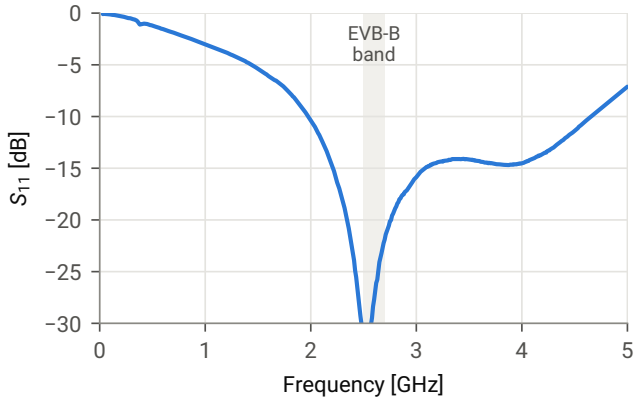
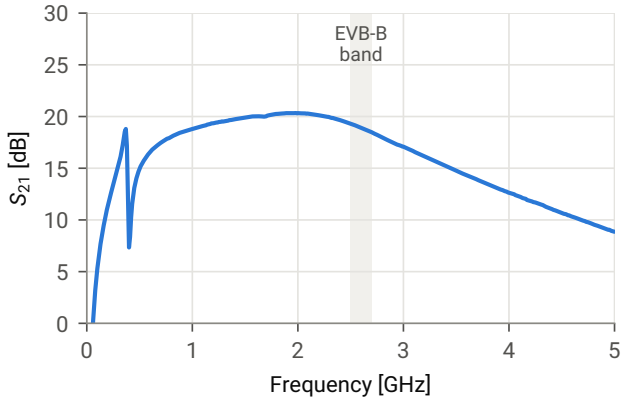
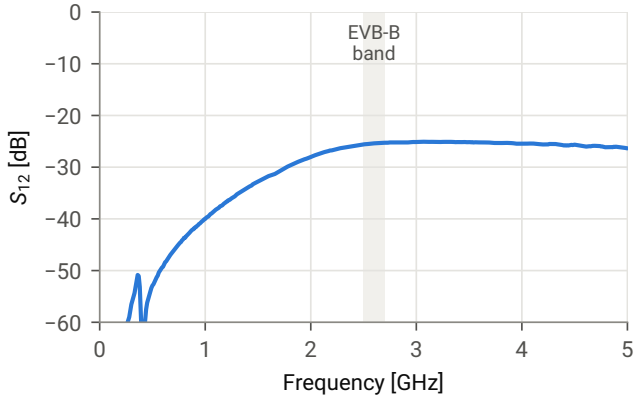
EVB B, wideband S-parameters and Smith charts



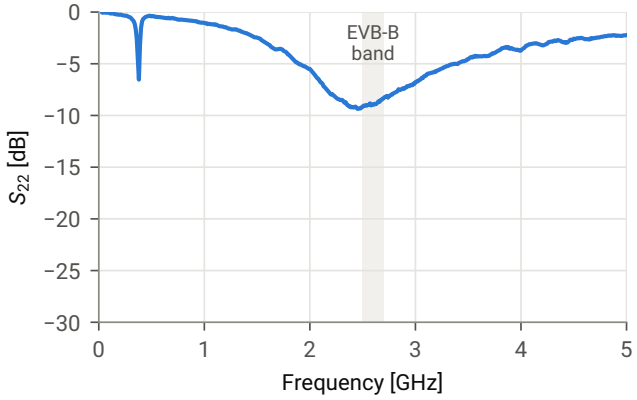
(a) S_{11} (input return loss) vs. frequency.



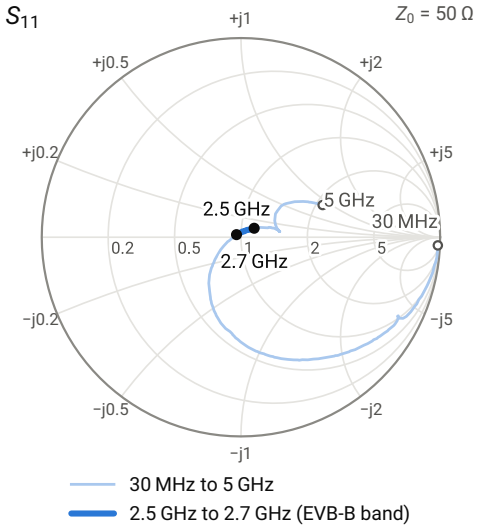
(b) S_{21} (gain) vs. frequency.



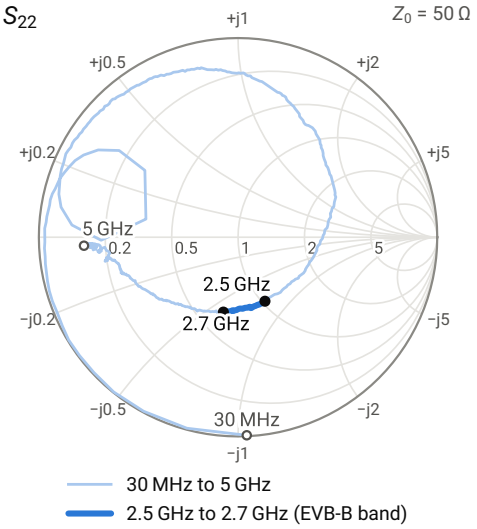
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{11} Smith chart, input impedance.



(f) S_{22} Smith chart, output impedance.

Figure 21: TL0374J-EVB-B S-parameters, 30 MHz to 5 GHz, $+25$°C, 5 V, 60 mA. Shaded and thick line: 2500 – 2700 MHz tuned band.

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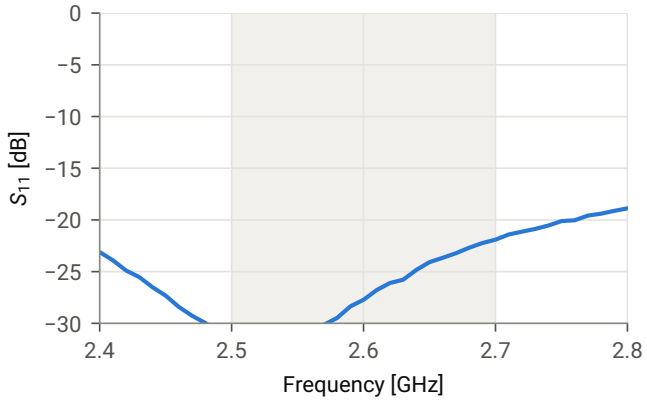
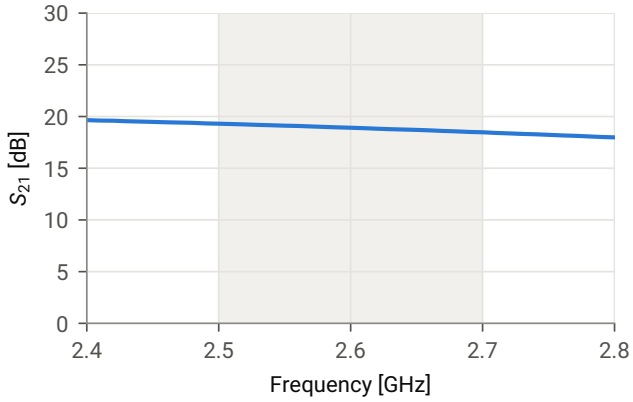
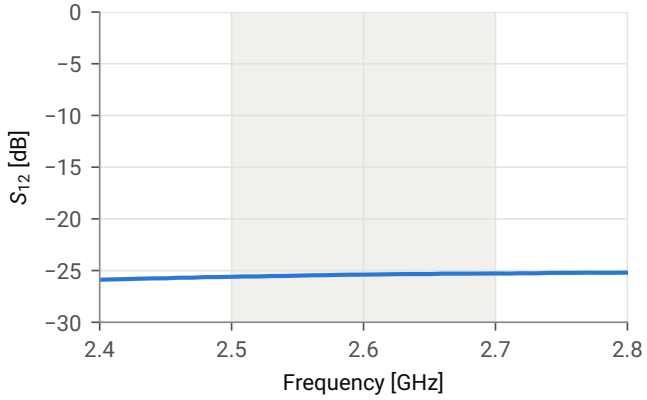
EVB B, narrowband S-parameters



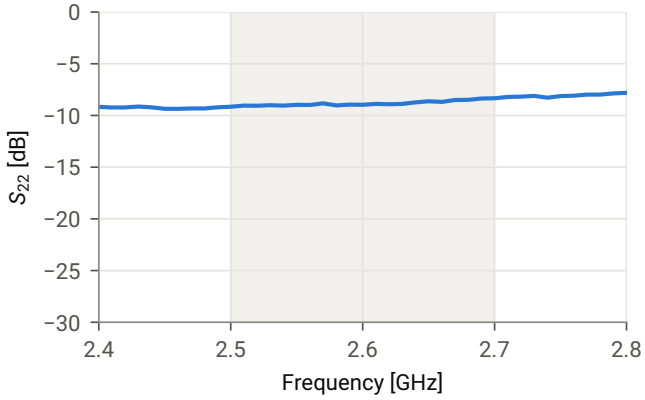
(a) S_{11} (input return loss) vs. frequency.



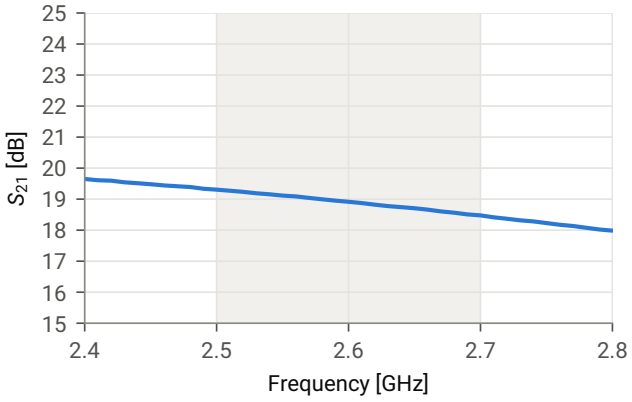
(b) S_{21} (gain) vs. frequency.



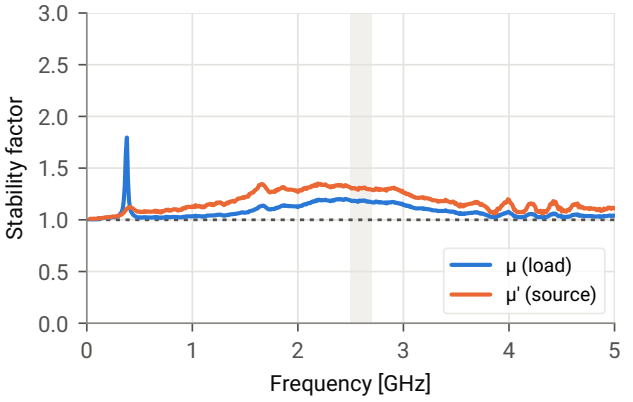
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{21} (gain) vs. frequency, expanded scale.



(f) Stability factors μ and μ' vs. frequency, 30 MHz to 5 GHz.

Figure 22: TL0374J-EVB-B S-parameters, 2500 – 2700 MHz band, $+25$°C, 5 V, 60 mA.

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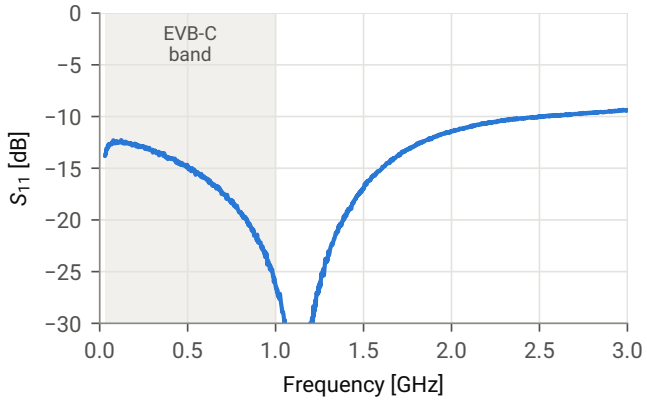
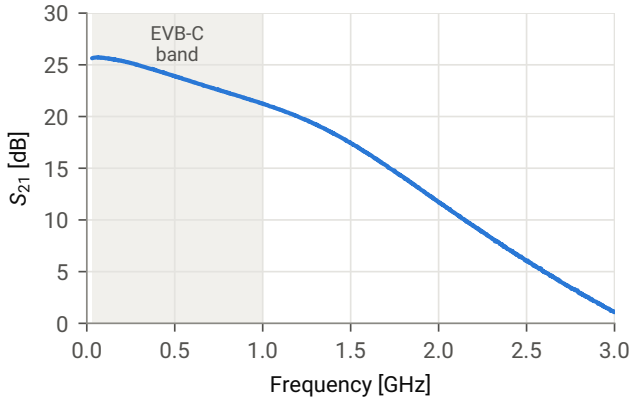
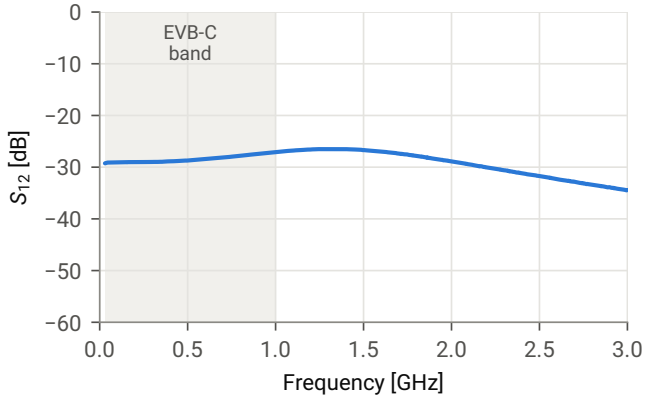
EVB C, wideband S-parameters and Smith charts



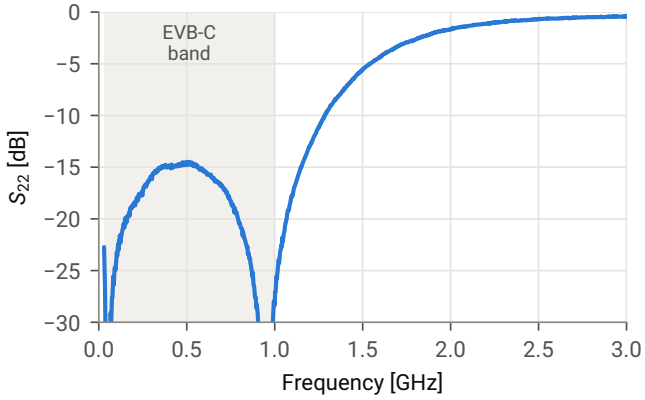
(a) S_{11} (input return loss) vs. frequency.



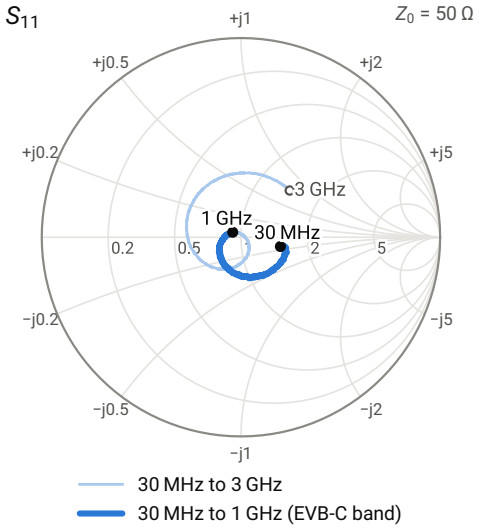
(b) S_{21} (gain) vs. frequency.



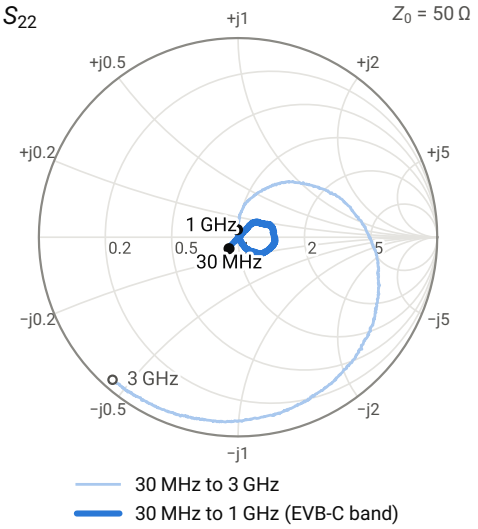
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{11} Smith chart, input impedance.



(f) S_{22} Smith chart, output impedance.

Figure 23: TL0374J-EVB-C S-parameters, 30 MHz to 3 GHz, $+25$°C, 3.3 V, 30 mA. Shaded and thick line: 30 – 1000 MHz tuned band.

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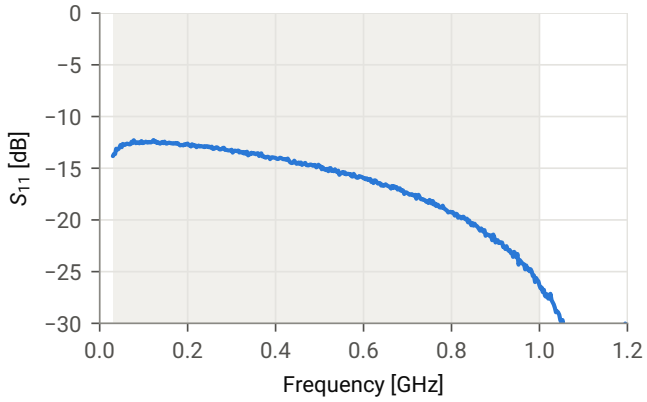
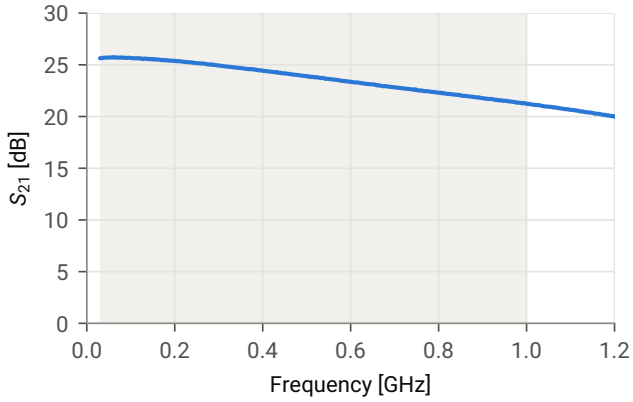
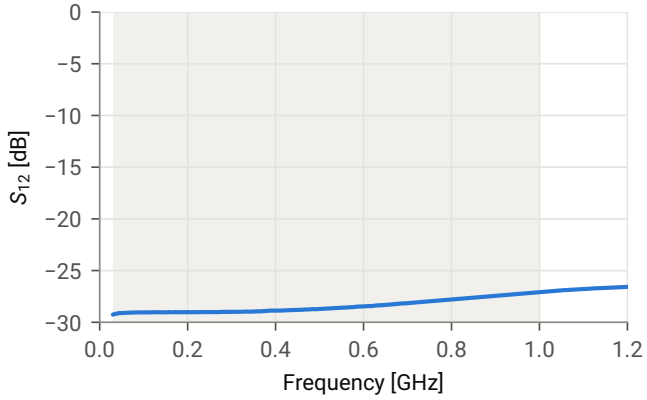
EVB C, narrowband S-parameters



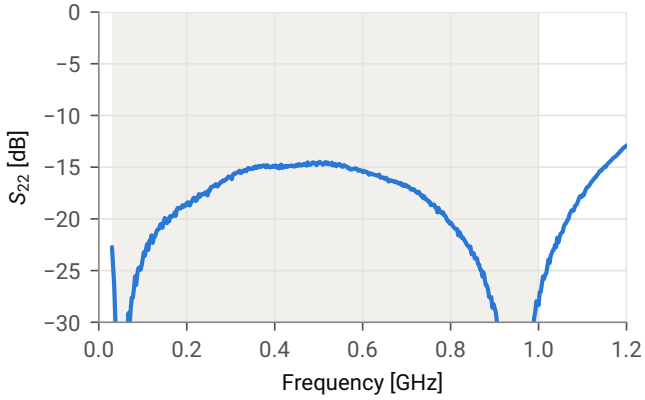
(a) S_{11} (input return loss) vs. frequency.



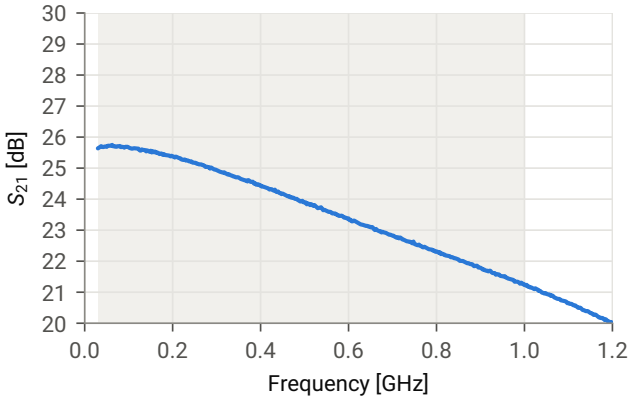
(b) S_{21} (gain) vs. frequency.



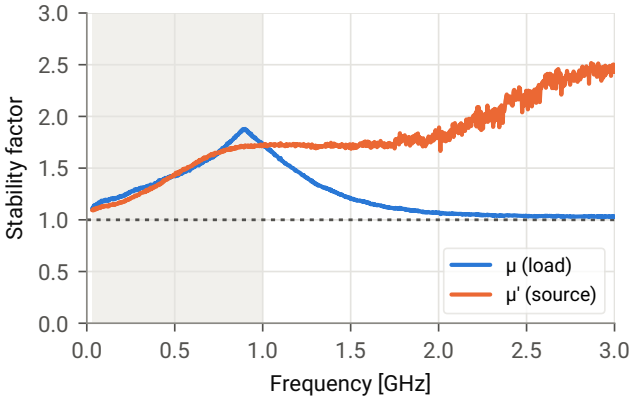
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{21} (gain) vs. frequency, expanded scale.



(f) Stability factors μ and μ' vs. frequency, 30 MHz to 3 GHz.

Figure 24: TL0374J-EVB-C S-parameters, 30 – 1000 MHz band, $+25$°C, 3.3 V, 30 mA.

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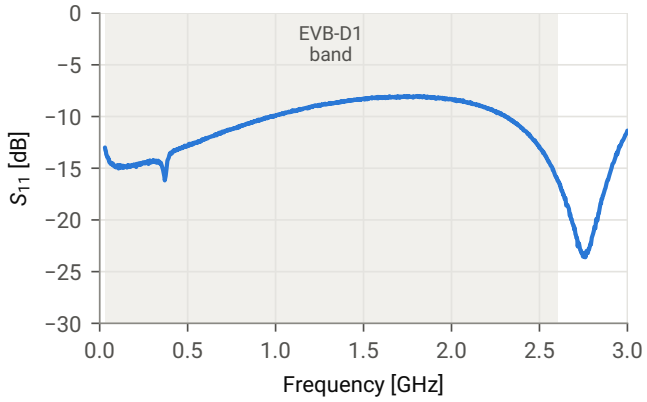
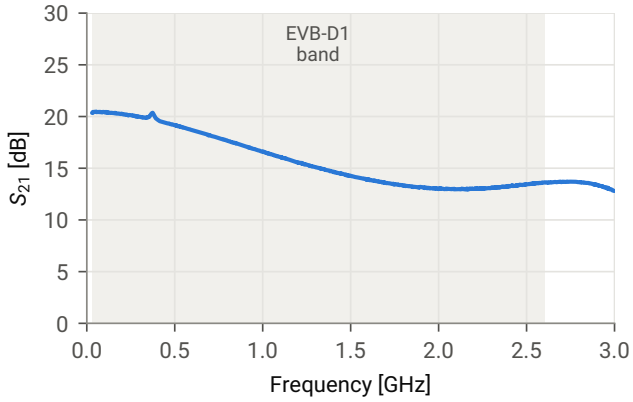
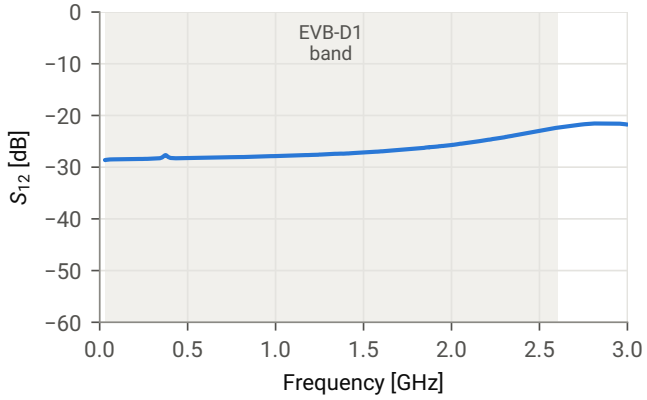
EVB D1, wideband S-parameters and Smith charts



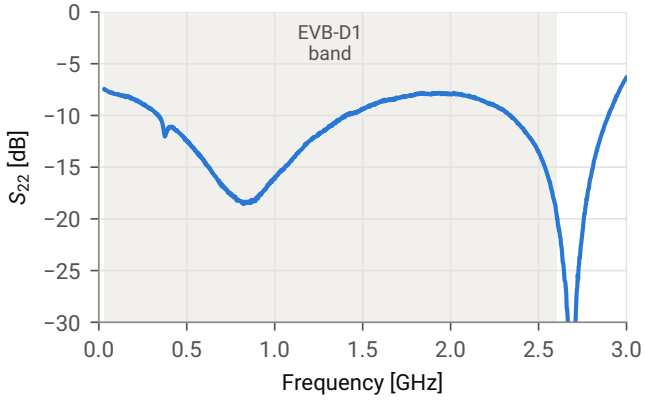
(a) S_{11} (input return loss) vs. frequency.



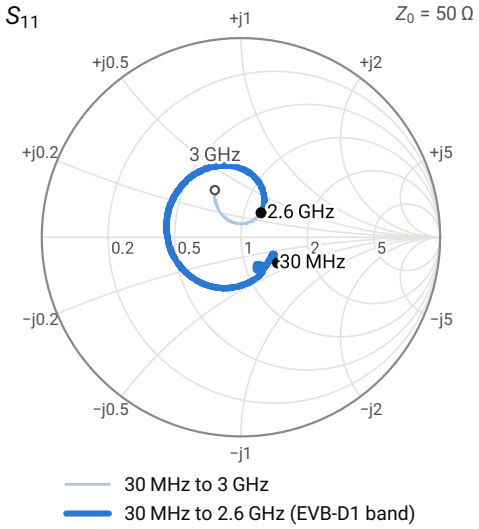
(b) S_{21} (gain) vs. frequency.



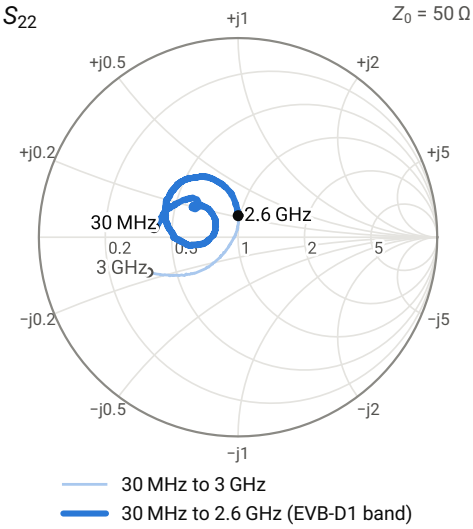
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{11} Smith chart, input impedance.



(f) S_{22} Smith chart, output impedance.

Figure 25: TL0374J-EVB-D1 S-parameters, 30 MHz to 3 GHz, $+25$°C, 3.3 V, 30 mA. Shaded and thick line: 30 – 2600 MHz tuned band.

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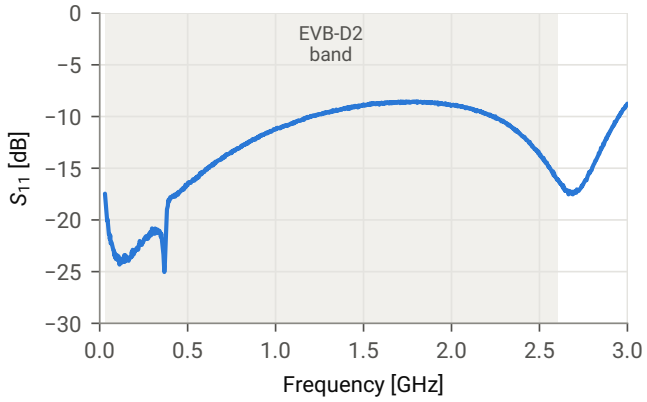
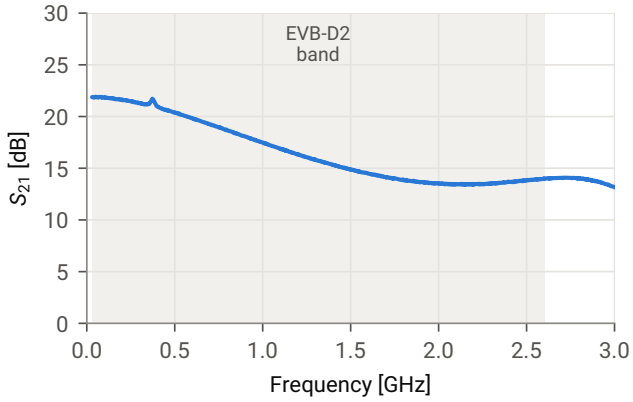
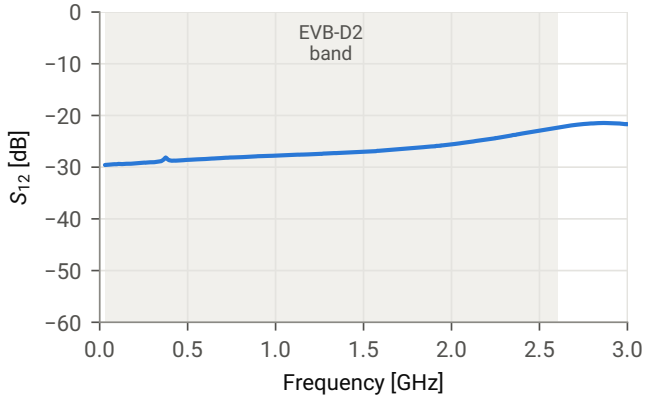
EVB D2, wideband S-parameters and Smith charts



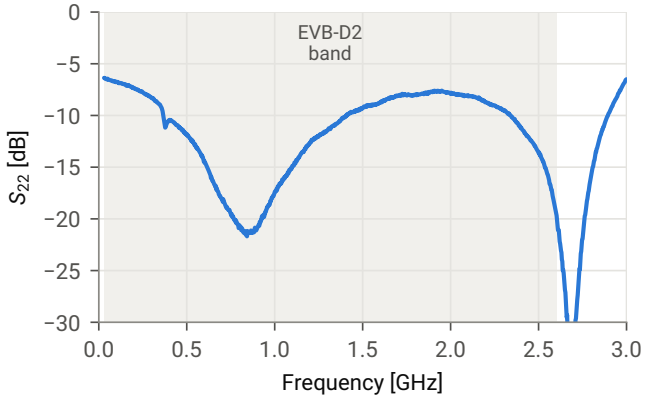
(a) S_{11} (input return loss) vs. frequency.



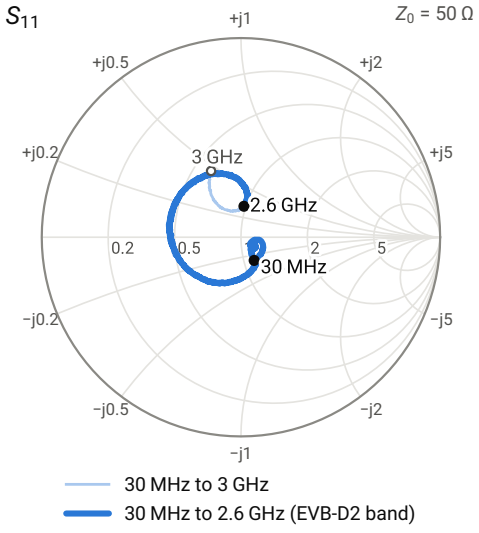
(b) S_{21} (gain) vs. frequency.



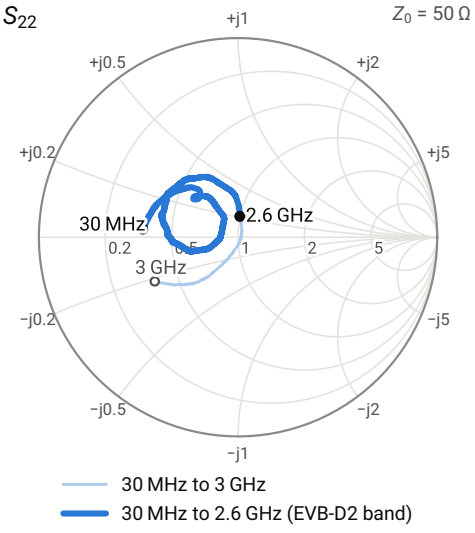
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{11} Smith chart, input impedance.



(f) S_{22} Smith chart, output impedance.

Figure 26: TL0374J-EVB-D2 S-parameters, 30 MHz to 3 GHz, $+25$°C, 5 V, 55 mA. Shaded and thick line: 30 – 2600 MHz tuned band.

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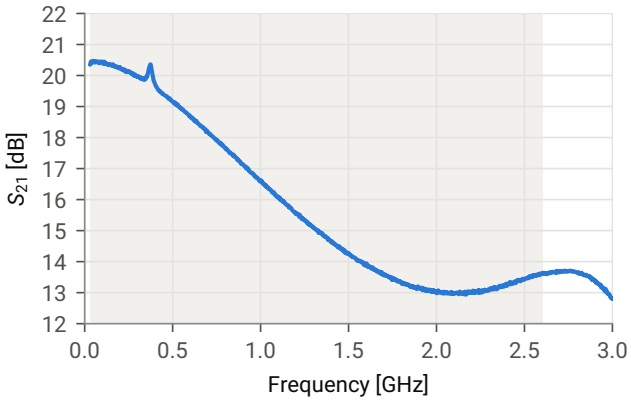
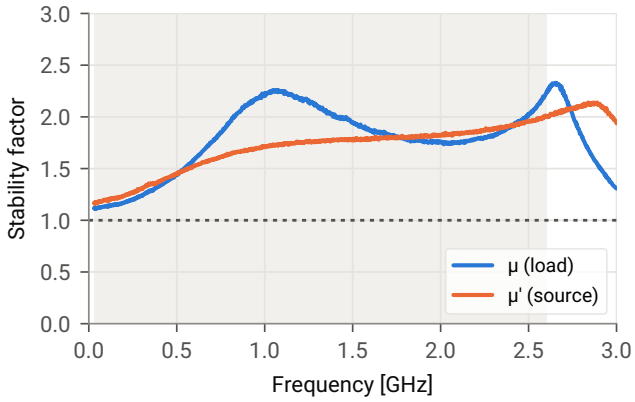
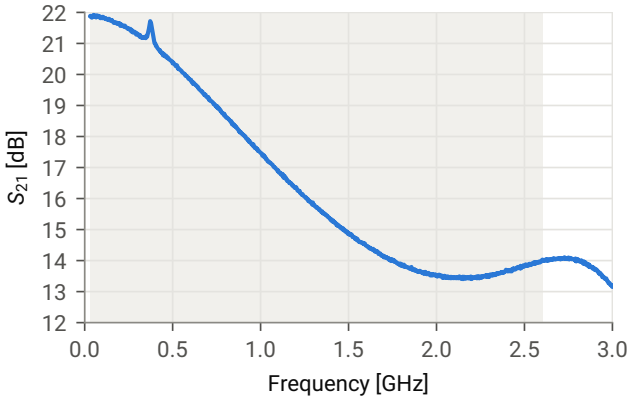
EVB D1 and D2, gain and stability



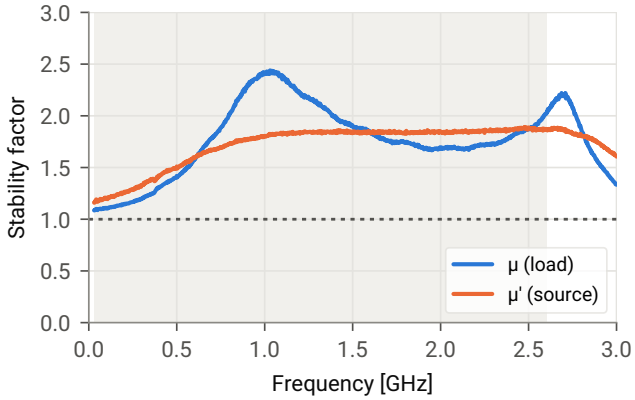
(a) EVB D1: S_{21} (gain) vs. frequency, expanded scale.



(b) EVB D1: stability factors μ and μ' vs. frequency.



(c) EVB D2: S_{21} (gain) vs. frequency, expanded scale.



(d) EVB D2: stability factors μ and μ' vs. frequency.

Figure 27: TL0374J-EVB-D1 (3.3 V, 30 mA) and TL0374J-EVB-D2 (5 V, 55 mA) gain on an expanded scale and stability factors, $+25$°C, 30 – 2600 MHz tuned band.

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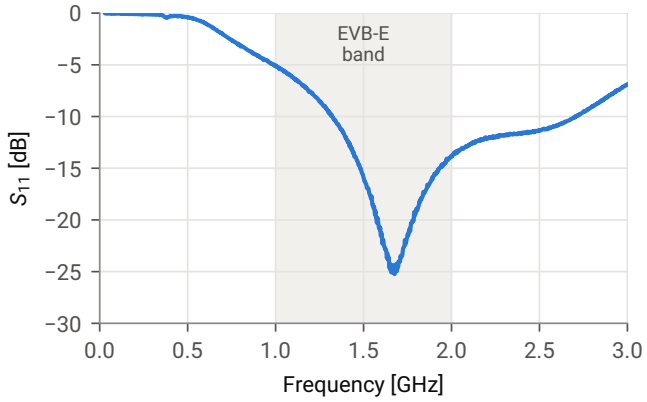
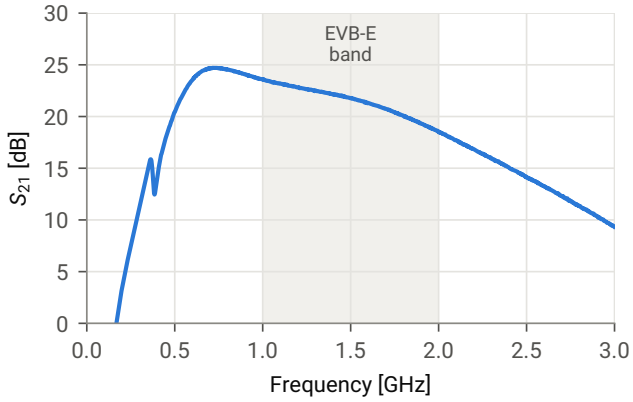
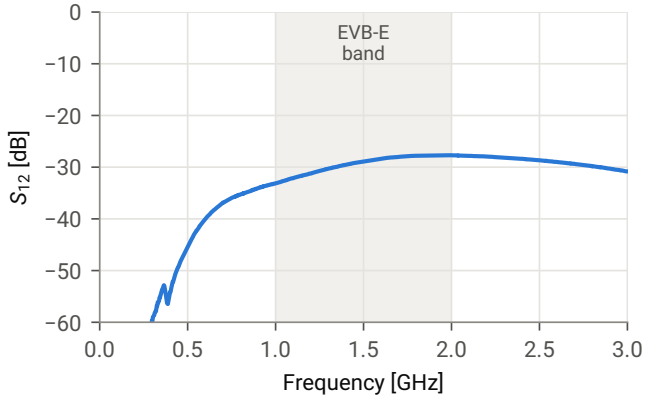
EVB E, wideband S-parameters and Smith charts



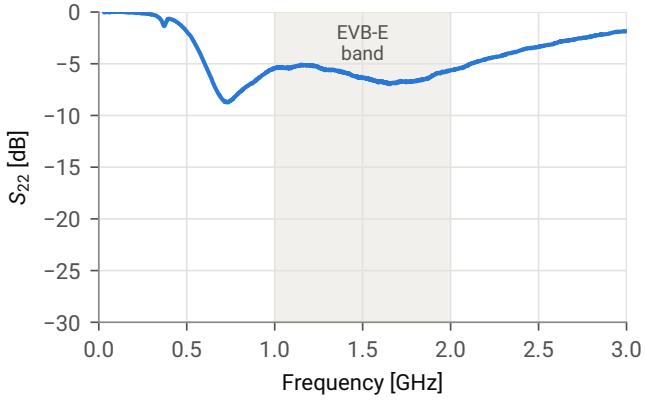
(a) S_{11} (input return loss) vs. frequency.



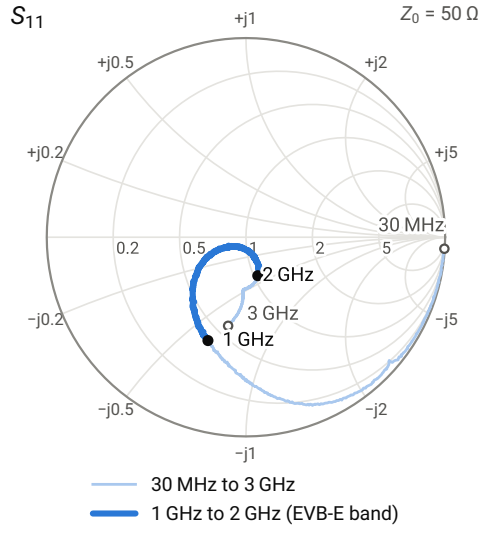
(b) S_{21} (gain) vs. frequency.



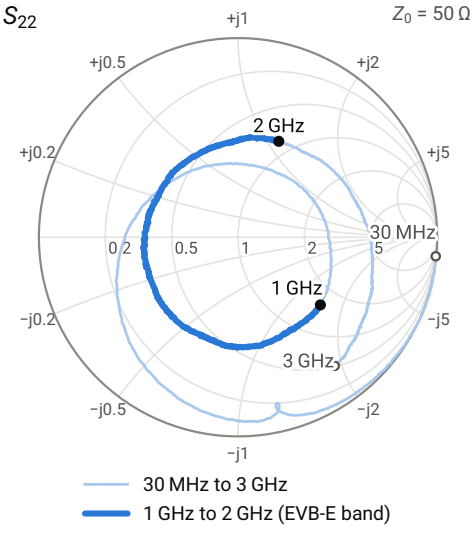
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{11} Smith chart, input impedance.



(f) S_{22} Smith chart, output impedance.

Figure 28: TL0374J-EVB-E S-parameters, 30 MHz to 3 GHz, $+25$°C, 3.3 V, 50 mA. Shaded and thick line: 1000 – 2000 MHz tuned band.

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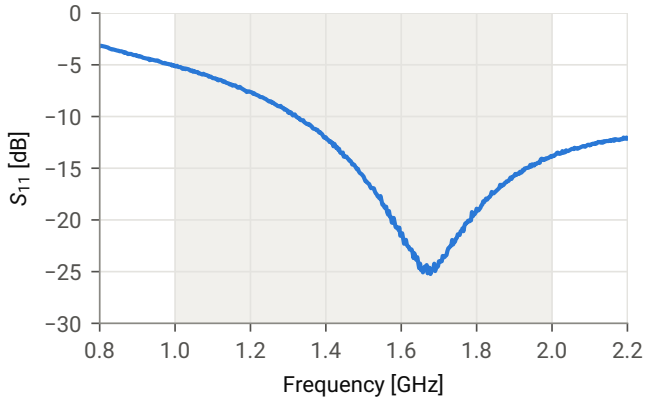
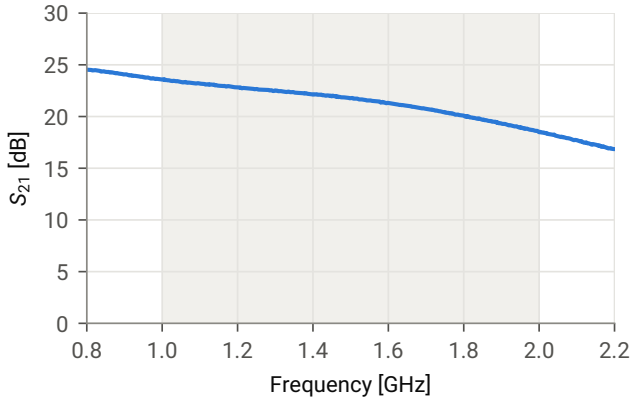
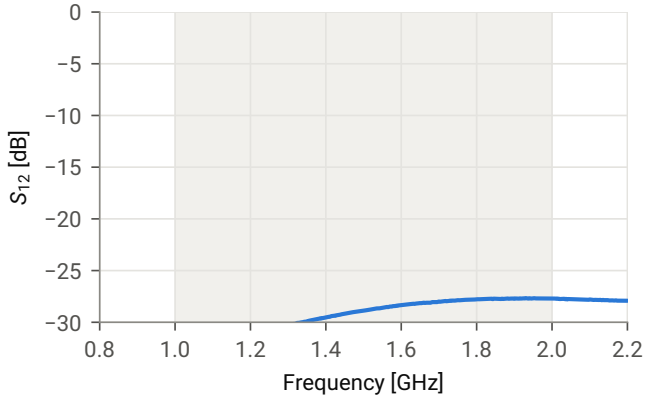
EVB E, narrowband S-parameters



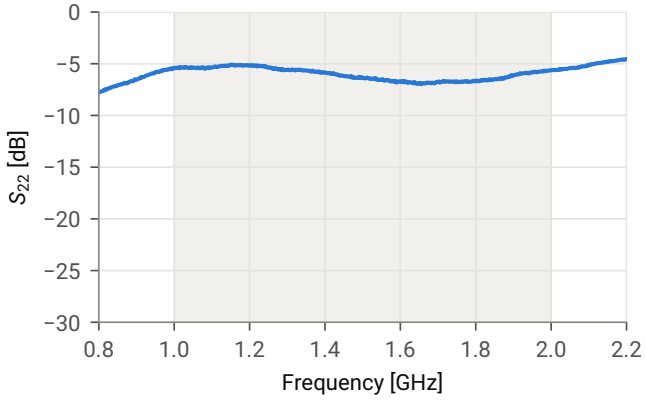
(a) S_{11} (input return loss) vs. frequency.



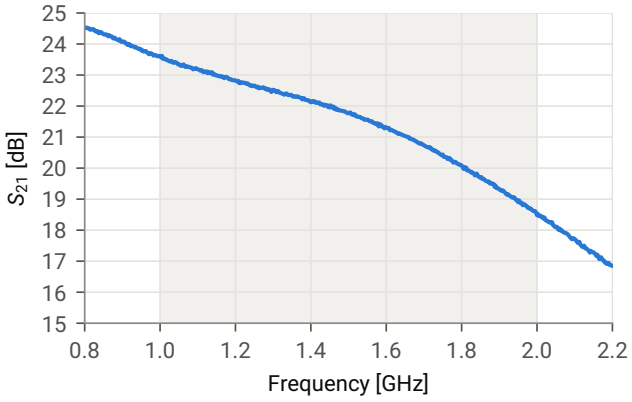
(b) S_{21} (gain) vs. frequency.



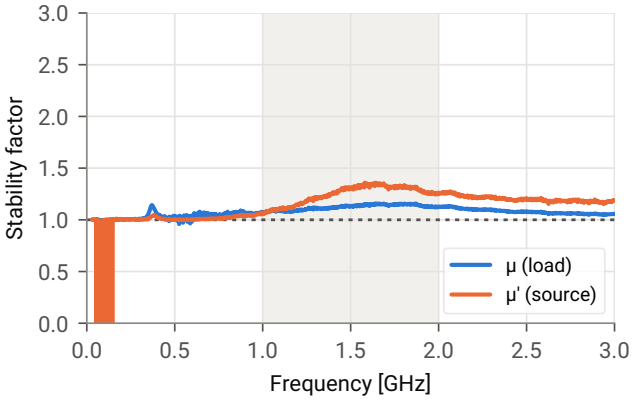
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{21} (gain) vs. frequency, expanded scale.



(f) Stability factors μ and μ' vs. frequency, 30 MHz to 3 GHz.

Figure 29: TL0374J-EVB-E S-parameters, 1000 – 2000 MHz band, $+25$°C, 3.3 V, 50 mA.

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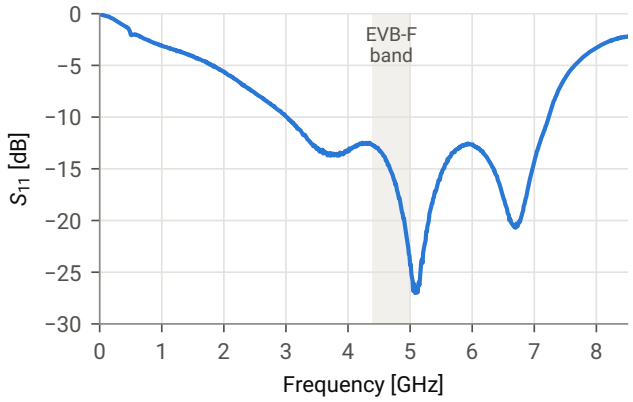
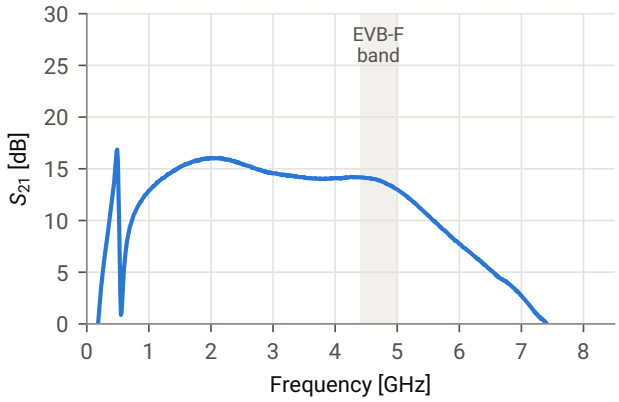
EVB F, wideband S-parameters and Smith charts

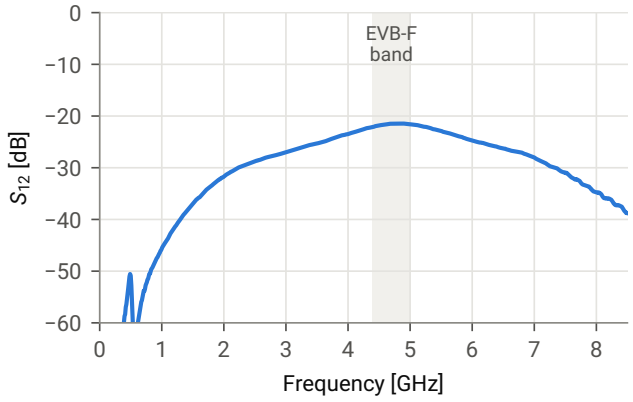
TL0374J-EVB-F is a reference design outside the specified operating frequency range of 0.03 – 3.0 GHz.



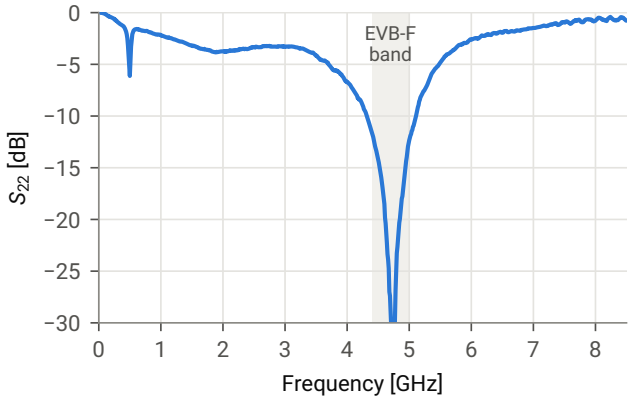
(a) S_{11} (input return loss) vs. frequency.



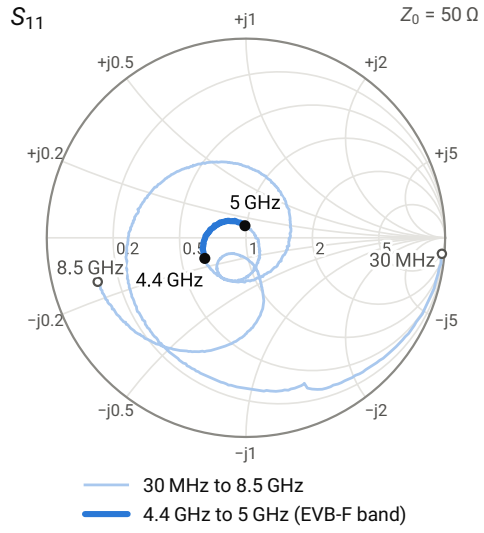
(b) S_{21} (gain) vs. frequency.



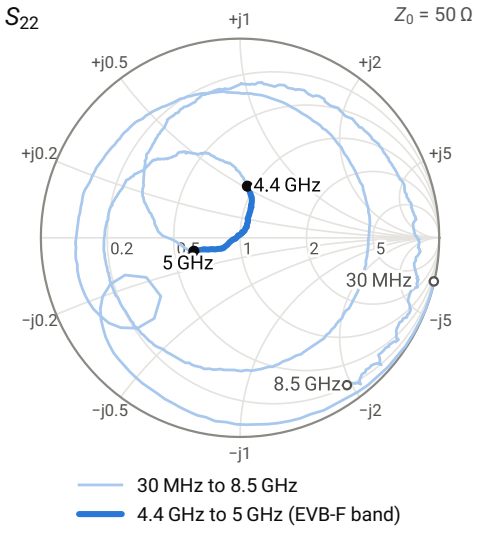
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{11} Smith chart, input impedance.



(f) S_{22} Smith chart, output impedance.

Figure 30: TL0374J-EVB-F S-parameters, 30 MHz to 8.5 GHz, $+25$°C, 5 V, 55 mA. Shaded and thick line: 4400 – 5000 MHz tuned band.

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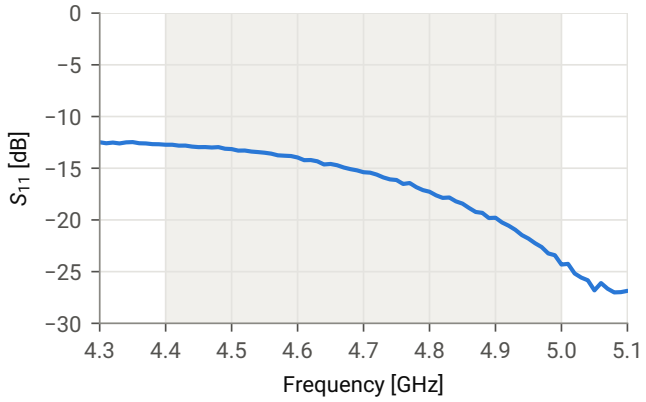
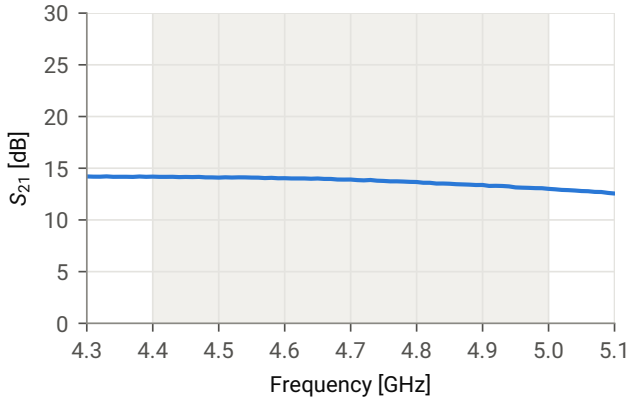
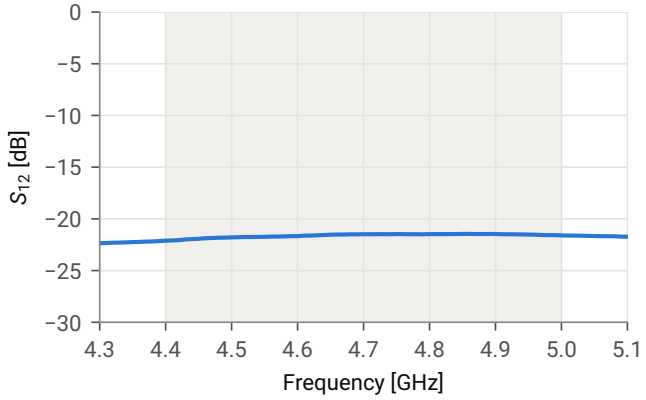
EVB F, narrowband S-parameters



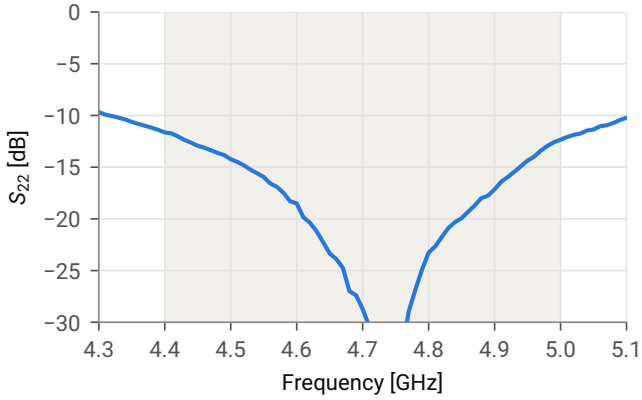
(a) S_{11} (input return loss) vs. frequency.



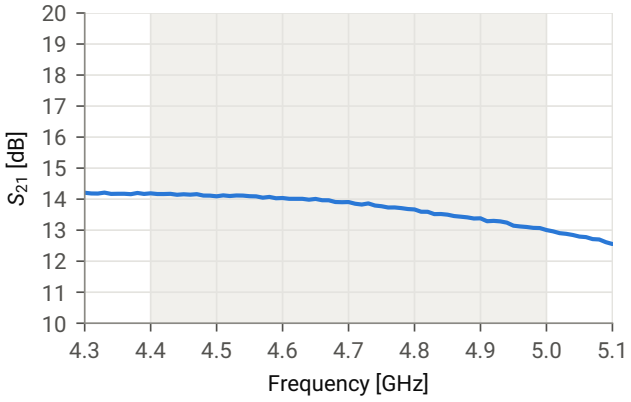
(b) S_{21} (gain) vs. frequency.



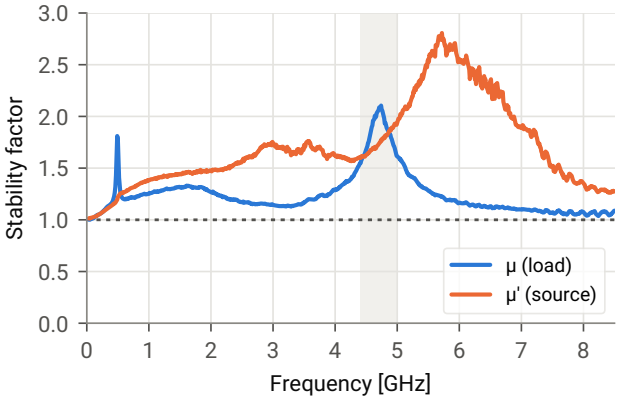
(c) S_{12} (reverse isolation) vs. frequency.



(d) S_{22} (output return loss) vs. frequency.



(e) S_{21} (gain) vs. frequency, expanded scale.



(f) Stability factors μ and μ' vs. frequency, 30 MHz to 8.5 GHz.

Figure 31: TL0374J-EVB-F S-parameters, 4400 – 5000 MHz band, $+25$°C, 5 V, 55 mA.

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Test Procedures

TL0374J-EVB-A Biasing Sequence

TagoreTech recommends following the biasing sequence below every time the evaluation board is powered up or down. Applying RF power to an amplifier that is not yet biased, removing the bias while RF power is still present, or letting a supply overshoot during switching can stress the input transistor and damage the device or reduce its long-term reliability. The sequence is part of the board's normal operating procedure, not an optional step.

Before switching on, set the current limit of the supply to about 70 mA, the absolute maximum drain current, and make sure that the supply does not overshoot $\mathrm{V_{DD}}$ or $\mathrm{V_{enable}}$ above the +6 V absolute maximum rating when it is switched on. The RF input power must stay below the absolute maximum of 23 dBm CW. The TL0374J is ESD sensitive (HBM class 1B); handle the board with ESD precautions and connect the ground before any other connection.

Table 21: TL0374J-EVB-A bias and sequencing

Turn on	Turn off
1. Connect the supply ground to the ground test point.	1. Turn the RF power off.
2. Set $\mathrm{V_{enable}}$ to +5 V.	2. Turn $\mathrm{V_{DD}}$ off.
3. Set $\mathrm{V_{DD}}$ to +5 V and check that the quiescent current is $\mathrm{I_{DQ}} \approx 60$ mA.	3. Turn $\mathrm{V_{enable}}$ off.
4. Apply the RF power.	4. Disconnect the ground last.

$\mathrm{I_{DQ}}$ is set by $\mathrm{V_{enable}}$ and the series resistor M4; a quiescent current clearly different from 60 mA indicates a wrong supply voltage, a wrong M4 value or an assembly problem, and the RF power should not be applied before the cause is found. $\mathrm{V_{enable}} < 0.2$ V disables the device. When $\mathrm{V_{enable}}$ and $\mathrm{V_{DD}}$ are supplied from the same 5 V source, as in the test set-up of Figure 33, they rise and fall together; the RF power must still be applied only after the supply has settled and removed before the supply is switched off.

S-parameter test set-up

The TL0374J-EVB-A is shipped fully assembled and tested; Figure 32 shows an evaluation board. Figure 33 shows the basic test set-up for evaluating the S-parameters (gain, input and output return loss, reverse isolation) with a vector network analyzer.

1. Connect the ground test point to the ground terminal of the power supply.
2. Connect the $\mathrm{V_{enable}}$ and $\mathrm{V_{DD}}$ test points to the output of a 5 V supply capable of sourcing approximately 60 mA.
3. Connect a calibrated network analyzer to the $\mathrm{RF_{IN}}$ and $\mathrm{RF_{OUT}}$ SMA connectors. Sweep the frequency from 1 GHz to 6 GHz with a source power of -25 dBm.

The TL0374J-EVB-A is expected to show a gain of 21.5 dB at 1.8 GHz; see Table 8 for the expected results.

Additional test equipment is required for a comprehensive evaluation. For noise figure, use a noise figure analyzer or a spectrum analyzer with noise option, together with a low excess noise ratio (ENR) noise source. For the third-order intercept point, use two signal generators, a high-isolation power combiner and a spectrum analyzer. For power compression and power handling, use a signal generator and a two-channel power meter; make sure that the driver amplifier has sufficient output power and that couplers and attenuators have adequate power handling.

Measurements taken at the SMA connectors include the losses of the connectors and the PCB. The through line on the board, consisting of an RF input and an RF output line of equal length, should be measured to calibrate these effects.

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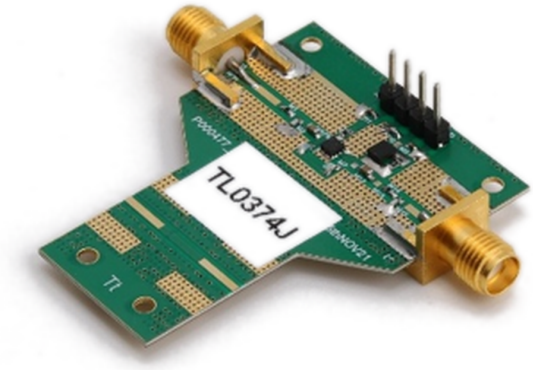

Figure 32: TL0374J evaluation board, broadband resistive-feedback layout (EVB C, D1 and D2).

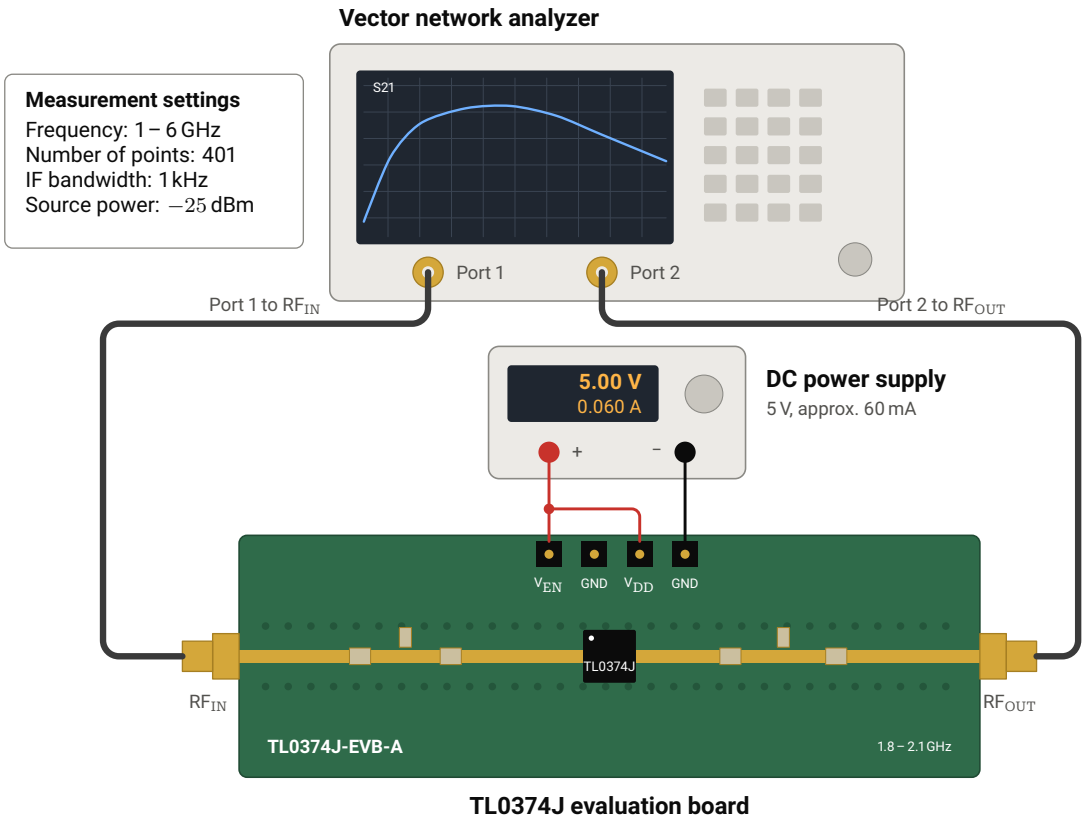

Figure 33: Test set-up for S-parameter measurements.

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Device Package information

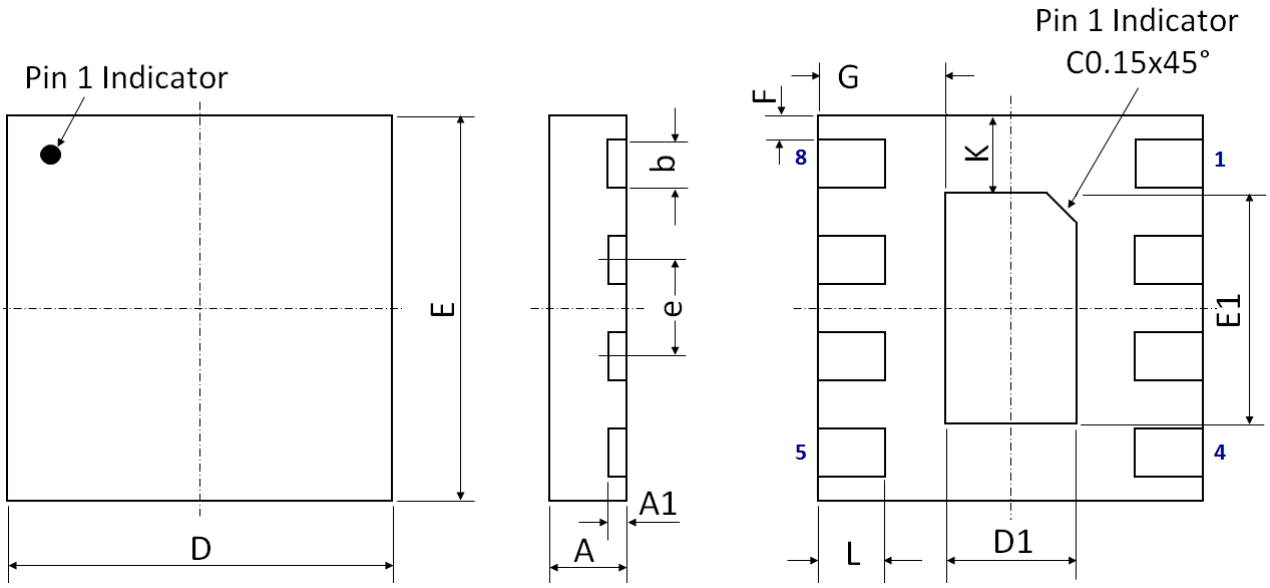

Figure 34: 8-pin DFN 2.0 x 2.0 x 0.75 mm^3 package drawing, dimensions in [mm].

Please refer to application notes TN-001 PCB Design guideline and TN-002 Solder Rework at TagoreTech web page for PCB and soldering guidelines.

Table 22: Device Package Dimensions

Dimension	Value [mm]	Tolerance [mm]	Dimension	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).

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PCB Land Design

Notes:

- 2-layer PCB is recommended.
- Via diameter is recommended to be 0.3mm to prevent solder wicking inside the vias.
- Thermal vias shall only be placed on the center pad and should be filled/plugged with solder or copper.
- The maximum via number for the center pad is 1(X)×2(Y)=2.

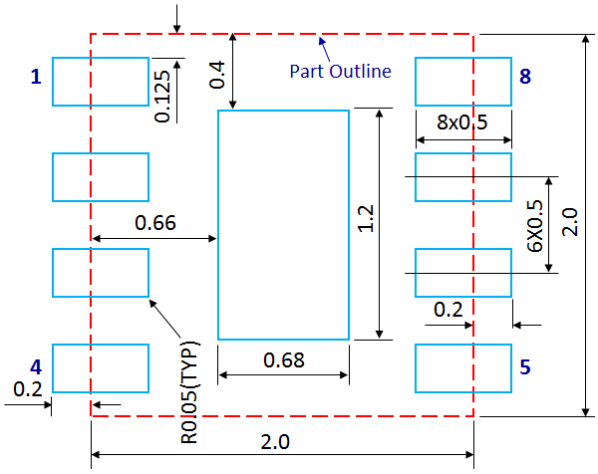

Figure 35: PCB land pattern, dimensions in [mm].



Figure 36: Solder mask pattern: non-solder mask defined (preferred, left) and solder mask defined (right), dimensions in [mm].

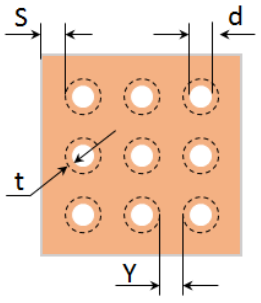

Figure 37: Thermal via pattern, recommended values: S≥0.15mm; Y≥0.20mm; d=0.3mm; plating thickness t=25μm or 50μm.

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PCB Stencil Design

Notes:

- Laser-cut, stainless steel stencil is recommended with electro-polished trapezoidal walls to improve the paste release.
- Stencil thickness is recommended to be 125μm.

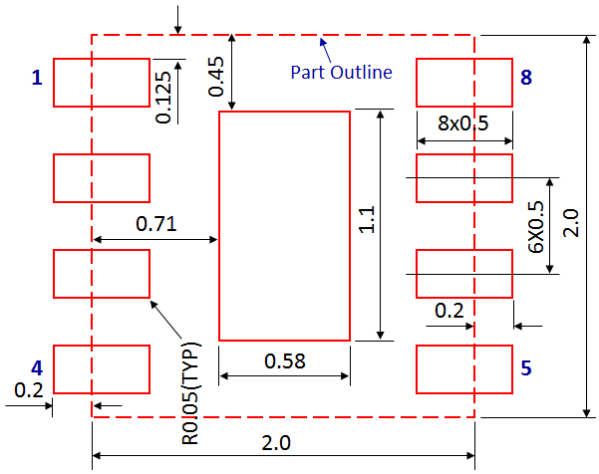

Figure 38: Stencil openings, dimensions in [mm].

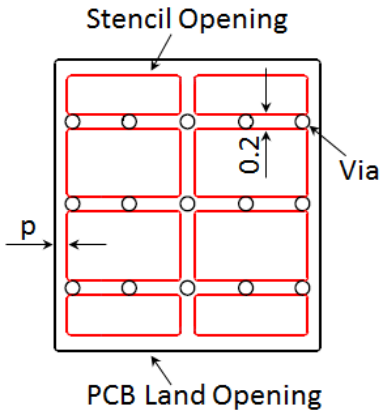

Figure 39: Stencil openings shall not cover via areas if possible, dimensions in [mm].

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Tape and Reel Information

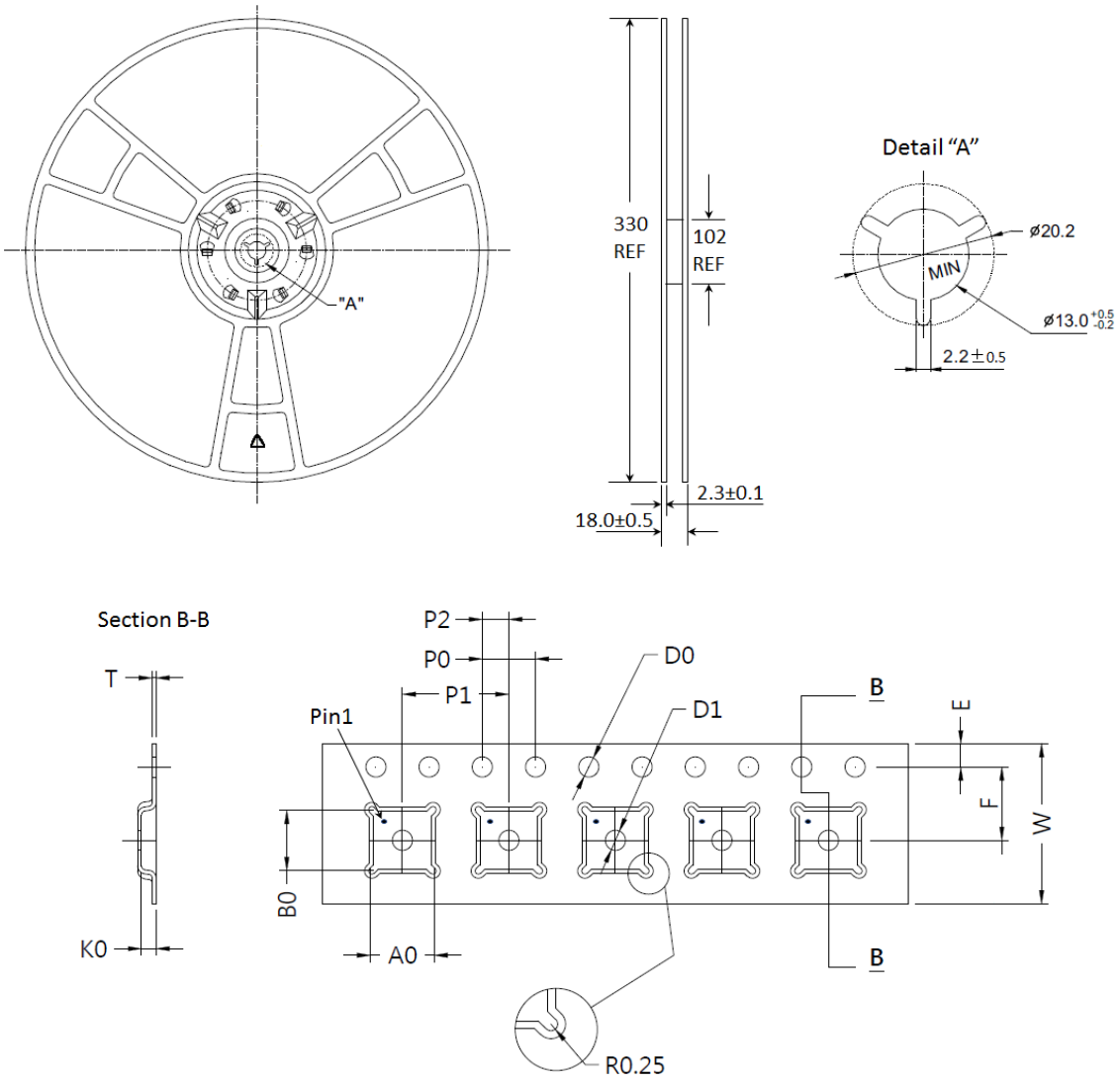

Figure 40: Tape and reel drawing.

Table 23: Tape and Reel Dimensions

Dimension	Value [mm]	Tolerance [mm]	Dimension	Value [mm]	Tolerance [mm]
A0	2.20	±0.05	K0	1.00	±0.10
B0	2.20	±0.05	P0	4.00	±0.10
D0	1.50	+0.10	P1	4.00	±0.10
D1	1.00	min.	P2	2.00	±0.05
E	1.75	±0.10	T	0.30	±0.05
F	3.50	±0.05	W	8.00	+0.30/-0.10

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Glossary

DFN	Dual Flat No-lead package
DNP	Do Not Populate: component position on the PCB that is not assembled
ENR	Excess noise ratio of a noise source
EVB	Evaluation board
IRL / ORL	Input / output return loss
LNA	Low noise amplifier
NF	Noise figure
OIP3	Output third-order intercept point
OP_{1dB}	Output power at 1 dB gain compression
μ, μ', μ_1	Single-parameter (Edwards–Sinsky) stability factors, load (μ, μ_1) and source (μ') side; $\mu > 1$ indicates unconditional stability
S_{ij}	S-parameters: S_{11} input match, S_{21} gain, S_{12} reverse isolation, S_{22} output match

Changelog

Table 24: Changelog

Date	Revision	Notes
11/29/2024	3.0	Datasheet in the previous format.
09/27/2026	4.00	Datasheet converted to the common TagoreTech document template: evaluation board schematics redrawn with not-assembled positions marked DNP, EVB bill of materials corrected to match the schematics (EVB E M4, EVB F M8/M9), table of evaluation boards with links to the application notes, links to application notes TN-001/TN-002, QR code link to the latest datasheet, return loss given in house sign convention. S-parameter plots redrawn as vector graphics from the Touchstone data, stability factors μ and μ' and Smith charts of S_{11} and S_{22} added, S-parameters of all evaluation boards A to F. S-parameter test set-up redrawn as vector graphics. TL0374J-EVB-F added to the ordering information, photo of the evaluation board and DigiKey link added.

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Application notes of all evaluation boards are linked in the table Evaluation boards and application notes.

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