TL0374J LNA Evaluation Board, 4400 – 5000 MHz, 5 V, 55 mA

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 2.0×2.0 mm^2 8-lead Dual Flat No-lead (DFN) plastic package.

TL0374J-EVB-F is an evaluation board tuned for the 4400 – 5000 MHz band at 5 V, 55 mA. This band is outside the specified operating frequency range of the TL0374J (0.03 – 3.0 GHz); the board is given as a reference design. This application note gives the schematic, bill of materials, biasing sequence and test set-up of the board, and its measured S-parameters, noise figure, gain compression and third-order intercept point.

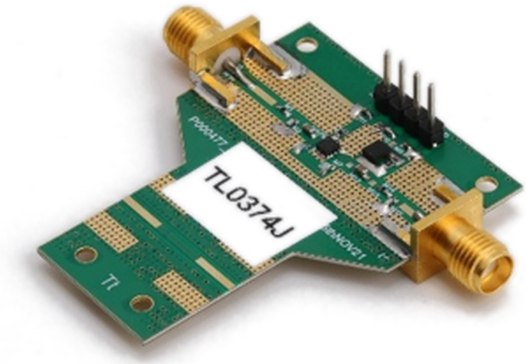

Figure 1: TL0374J evaluation board. The photo shows the resistive-feedback layout (EVB C, D1 and D2); TL0374J-EVB-F uses the layout of Figure 4.

Evaluation Board Highlights

- Frequency range 4400 MHz to 5000 MHz
- $V_{DD} = V_{enable} = 5$ V, $I_{DQ} = 55$ mA
- Gain: 13.0 – 14.2 dB
- Noise figure (SMA to SMA): 0.8 – 0.9 dB
- OP_{1dB}: 15.8 – 18.2 dBm
- OIP3: 32.0 – 35.0 dBm (0 dBm per tone, 1 MHz spacing)
- Input return loss (S_{11}): -24.3 to -12.7 dB
- Reference design outside the specified operating frequency range of the TL0374J (0.03 – 3.0 GHz)

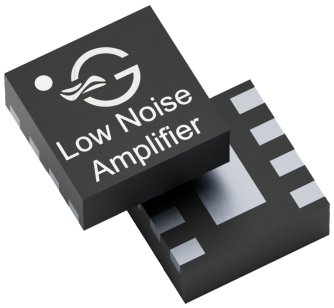

Figure 2: TL0374J in 2.0 x 2.0 mm^2 DFN 8-pin package.

RoHS

RoHS10/REACH/Halogen free

Related Documents

TL0374J datasheet: electrical specifications, package information and all evaluation boards.

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

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Ordering Information

Table 1: Ordering information

Part Number	Description	Notes
TL0374J-EVB-F	Evaluation board	Tuned, 4400 – 5000 MHz, 5 V, 55 mA, reference design outside the specified range
TL0374J	8 Pin 2.0x2.0x0.75 mm^3 DFN	Core part number

TL0374J-EVB-F Board Details

The board uses 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. The input is matched with M2 and M3, the output with the series resistor R15, M11 and M12; the drain is fed through M6 and M7, decoupled by M8 and M9. R15 (5 Ω) sits in an extra series position cut into the output RF line between M10 and M11. The series resistor M4 on the V_{enable} pin sets I_{DQ}. The board is built on the TL0375J evaluation board PCB (Rev B), assembled with the TL0374J. Component positions that are not assembled are shown dashed grey in the schematic and marked DNP (Do Not Populate) in the bill of materials.

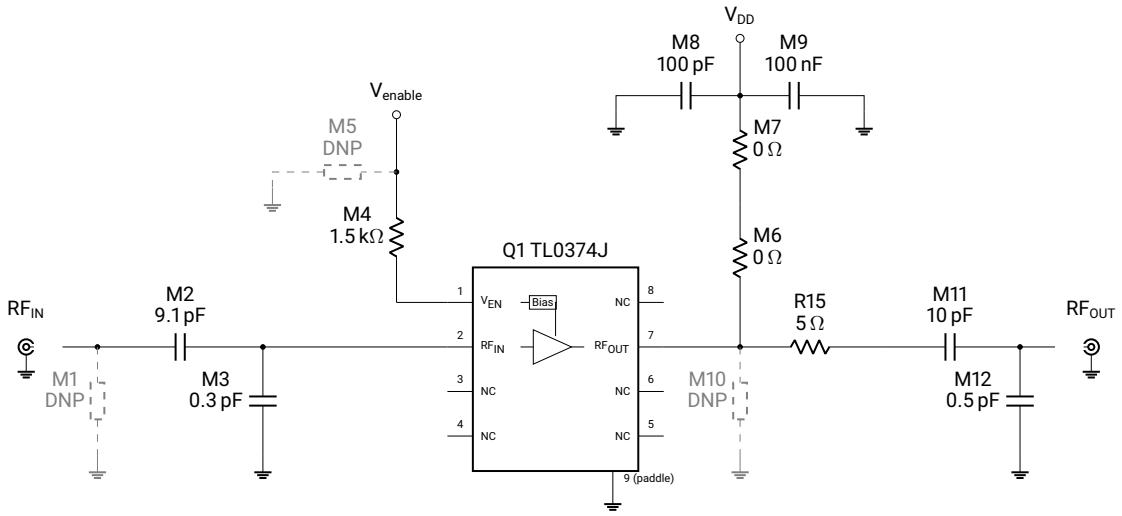
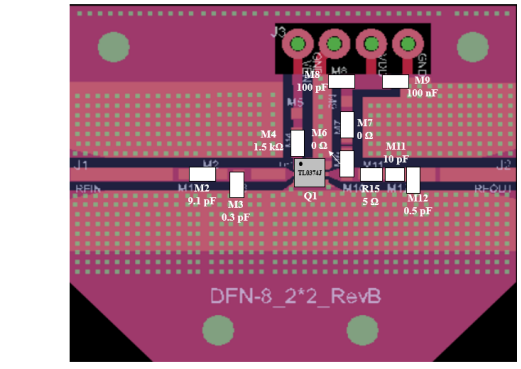


Figure 3: Schematic of TL0374J-EVB-F, 4400 – 5000 MHz. Dashed grey positions are not assembled (DNP).



R15 is the extra series cut that we made at output side RF line between M10 and M11 to accommodate 5 Ω resistor.
Please note that we have used TL0375 EVB REV B for this application and device used is TL0374.

Figure 4: Layout of TL0374J-EVB-F.

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TL0374J-EVB-F Bill of Materials

Table 2: 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.

TL0374J-EVB-F 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 V_{DD} or 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 3: TL0374J-EVB-F 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 V_{enable} to +5 V.	2. Turn V_{DD} off.
3. Set V_{DD} to +5 V and check that the quiescent current is $I_{DQ} \approx 55$ mA.	3. Turn V_{enable} off.
4. Apply the RF power.	4. Disconnect the ground last.

I_{DQ} is set by V_{enable} and the series resistor M4; a quiescent current clearly different from 55 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. $V_{enable} < 0.2$ V disables the device. When V_{enable} and V_{DD} are supplied from the same 5 V source, as in the test set-up of Figure 5, 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.

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Test Set-up

The TL0374J-EVB-F is shipped fully assembled and tested. Figure 5 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 V_{enable} and V_{DD} test points to the output of a 5 V supply capable of sourcing approximately 55 mA.
3. Connect a calibrated network analyzer to the RF_{IN} and RF_{OUT} SMA connectors. Sweep the frequency from 10 MHz to 8.5 GHz with a source power of -25 dBm.

The TL0374J-EVB-F is expected to show a gain of about 14 dB at 4.4 GHz; see Table 4 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.

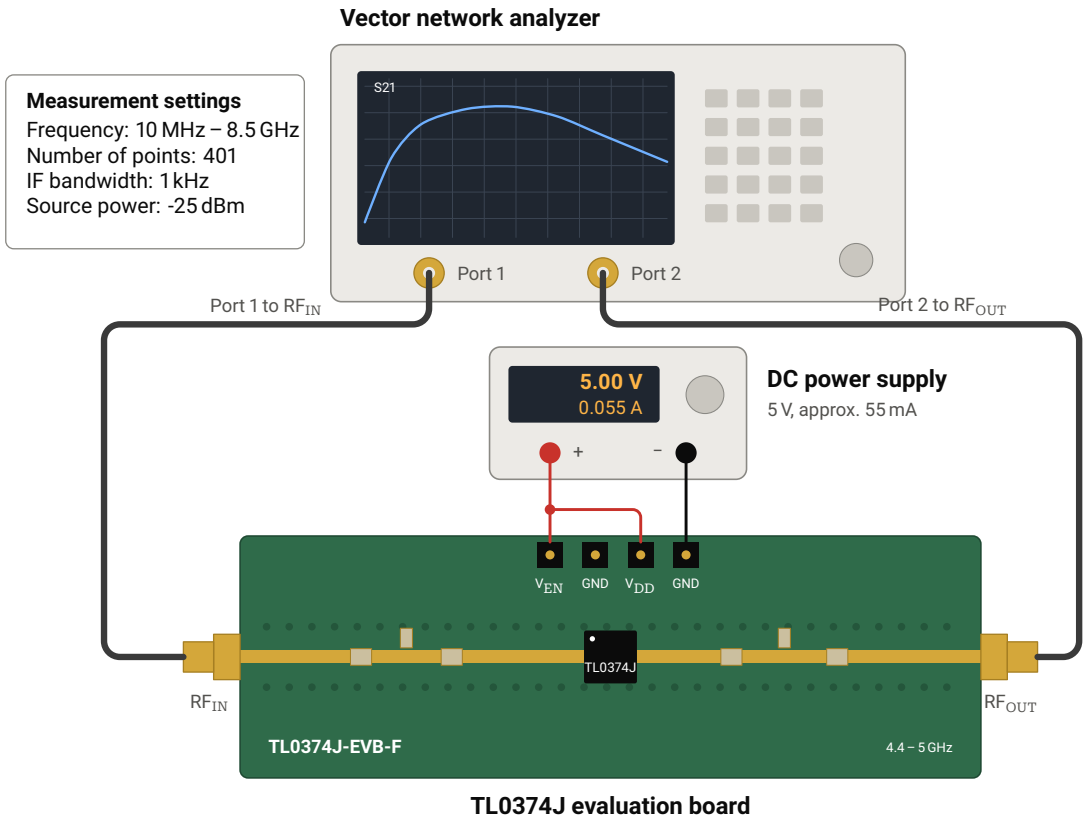

Figure 5: Test set-up for S-parameter measurements.

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TL0374J-EVB-F Measurement Summary

All measurements are carried out at room temperature, $V_{DD} = V_{enable} = 5$ V, with the reference planes at the SMA connectors.

Table 4: TL0374J-EVB-F electrical characteristics summary, $T_A = +25$°C

Frequency [MHz]	Noise figure[1] [dB]	Gain [dB]	OP_{1dB} [dBm]	OIP3[2] [dBm]	S_{11} [dB]	S_{22} [dB]	μ
4400	0.8	14.2	16.8	35.0	-12.7	-11.6	1.5
4600	0.9	14.0	18.2	32.0	-14.0	-18.5	1.9
4800	0.8	13.7	15.8	33.8	-17.3	-23.3	1.9
5000	0.9	13.0	15.8	35.0	-24.3	-12.3	1.6

[1] SMA to SMA, including connector and PCB losses.
[2] Two tones, 1 MHz spacing, 0 dBm output power per tone.

The S-parameters are shown from 30 MHz to 8.5 GHz; the shaded area marks the 4400 – 5000 MHz band. The Smith charts show S_{11} and S_{22} normalised to 50 Ω, with the band as a thick line. The stability factors μ (load) and μ' (source) are calculated from the S-parameters; $\mu > 1$ indicates unconditional stability. The noise figure is measured SMA to SMA. Gain and gain compression are measured with a single tone, the output third-order intercept point with two tones 1 MHz apart.

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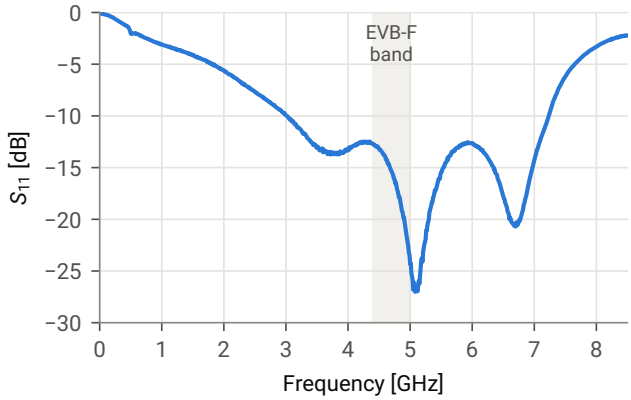
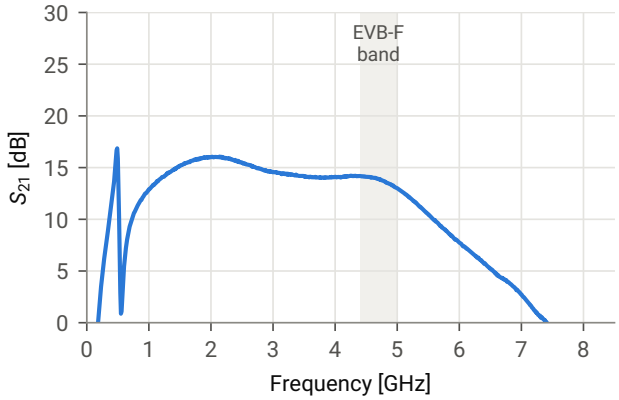
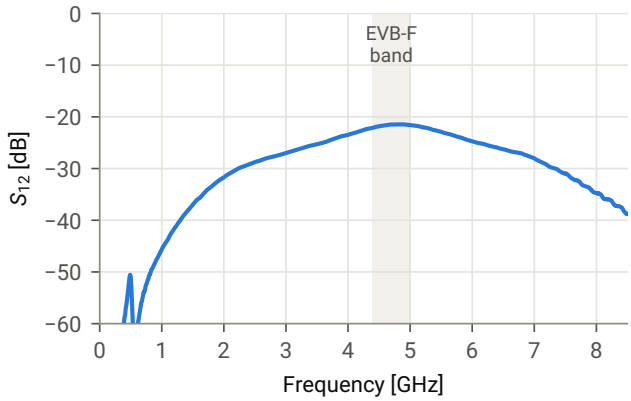
TL0374J-EVB-F Measurement Results



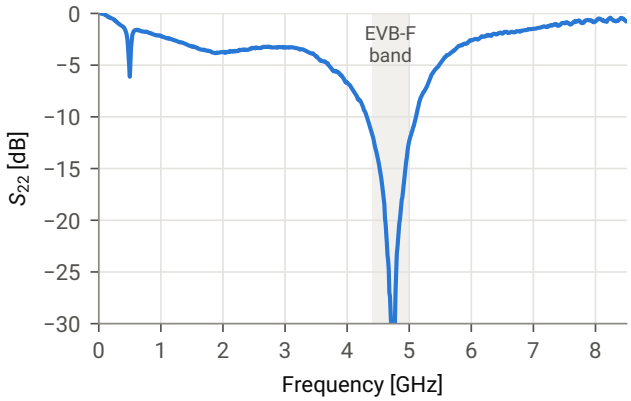
(a) S_{11} (input return loss) vs. frequency.



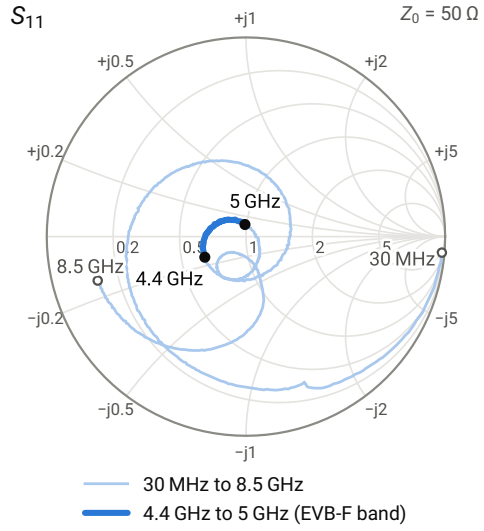
(b) S_{21} (gain) vs. frequency.



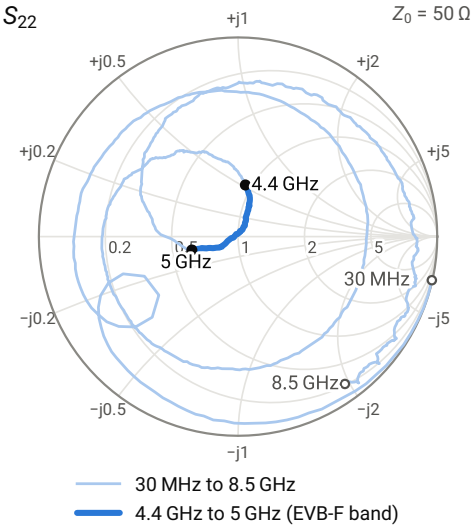
(c) S_{12} (reverse isolation) vs. frequency.



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



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



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

Figure 6: TL0374J-EVB-F S-parameters, 30 MHz to 8.5 GHz, $+25$°C, 5 V, 55 mA. Shaded and thick line: 4400 – 5000 MHz band.

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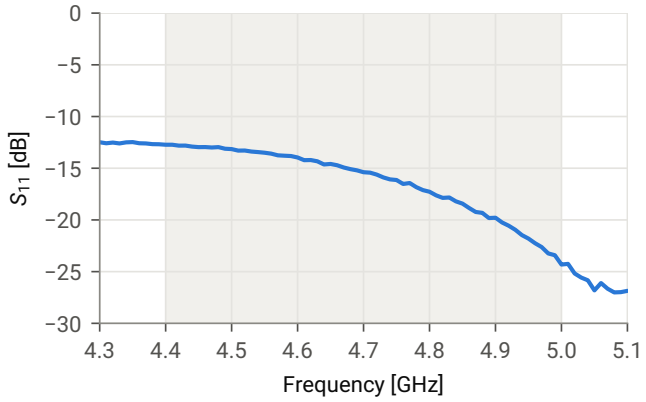
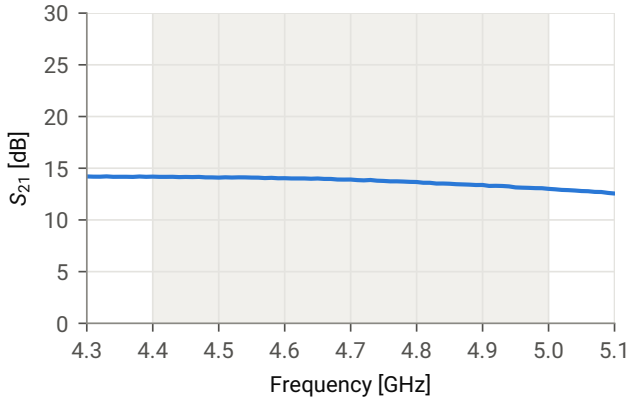
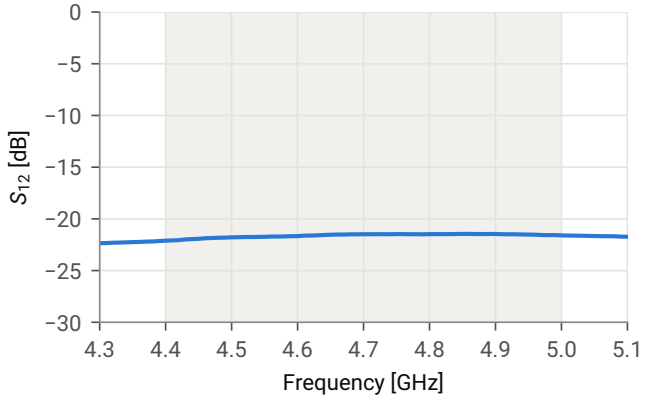
S-parameters, 4400 – 5000 MHz band



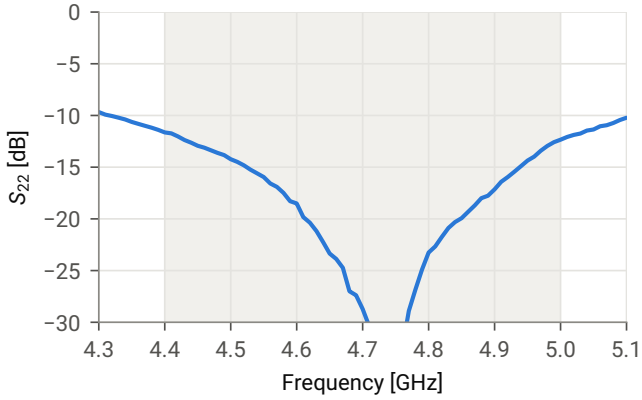
(a) S_{11} (input return loss) vs. frequency.



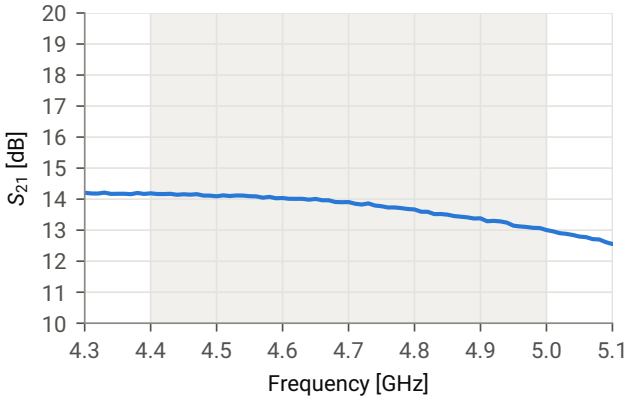
(b) S_{21} (gain) vs. frequency.



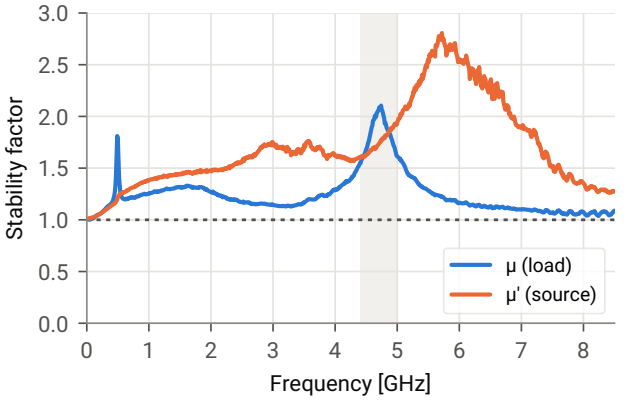
(c) S_{12} (reverse isolation) vs. frequency.



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

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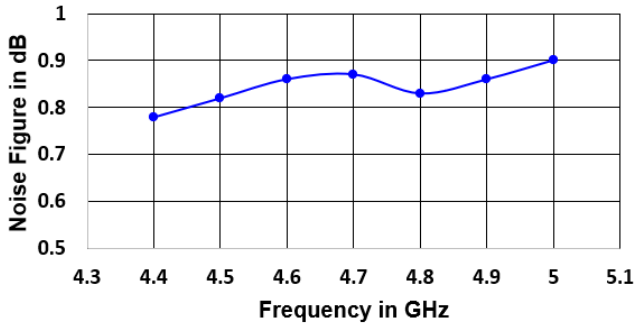
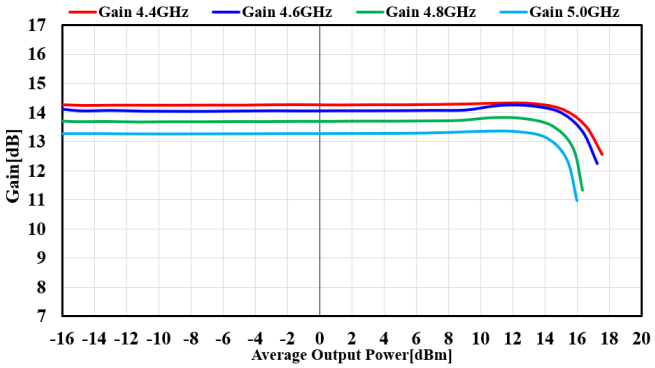
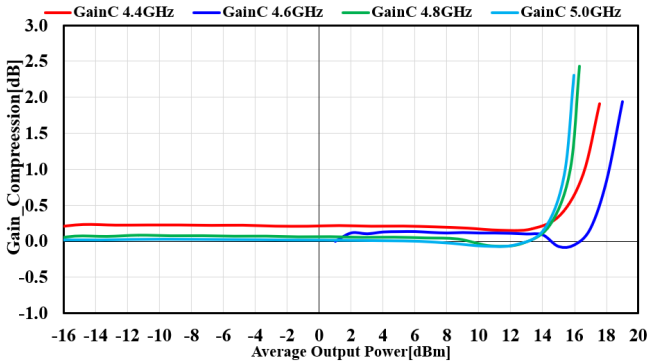
Noise figure and large-signal performance



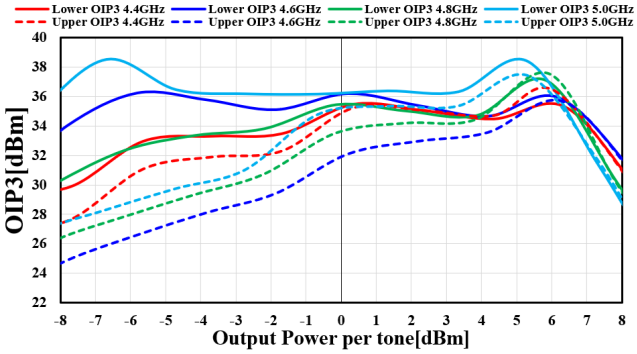
(a) Noise figure, SMA to SMA. The trace loss is 0.1 – 0.15 dB, so the de-embedded noise figure is 0.7 – 0.8 dB.



(b) Gain vs. output power.



(c) Gain compression vs. output power.



(d) OIP3 vs. output power per tone, 1 MHz tone spacing.

Figure 8: TL0374J-EVB-F noise figure and large-signal performance, $+25$°C, 5 V, 55 mA.

Changelog

Table 5: Changelog

Date	Revision	Notes
07/30/2024	2.1	Application note in the previous format.
09/27/2026	3.0	Application note converted to the common TagoreTech document template: schematic redrawn with not-assembled positions marked DNP, biasing sequence and test set-up added, S-parameters with Smith charts and stability factors redrawn as vector graphics from the measured Touchstone data, bill of materials aligned with the schematic (M8, M9, M11), links to the TL0374J datasheet and application notes TN-001/TN-002, QR code link to the latest version.

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