TL0374J LNA Evaluation Board, 30 – 2600 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 $\times$ 2.0 mm^2 8-lead Dual Flat No-lead (DFN) plastic package.

TL0374J-EVB-D2 is an evaluation board tuned for the 30 – 2600 MHz band at 5 V, 55 mA. 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.

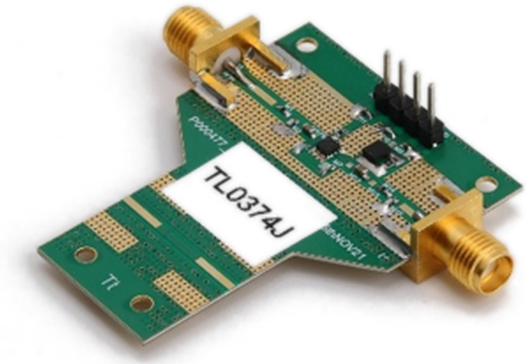

Figure 1: TL0374J evaluation board with the resistive-feedback layout used on TL0374J-EVB-D2.

Evaluation Board Highlights

- Frequency range 30 MHz to 2600 MHz
- $V_{DD} = V_{enable} = 5$ V, $I_{DQ} = 55$ mA
- Gain: 13.5 – 21.9 dB
- Noise figure (de-embedded): 0.7 – 0.9 dB
- OP_{1dB}: 13.8 – 17.8 dBm
- OIP3: 27.2 – 32.8 dBm (0 dBm per tone, 1 MHz spacing)
- Input return loss (S_{11}): -23.5 to -8.9 dB

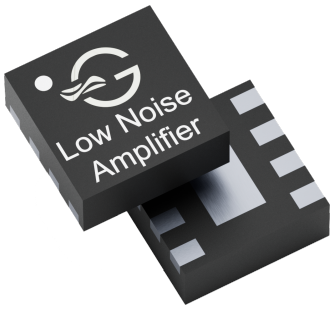

Figure 2: TL0374J in 2.0 x 2.0 mm^2 DFN 8-pin package.

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.

RoHS

RoHS10/REACH/Halogen free

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Ordering Information

Table 1: Ordering information

Part Number	Description	Notes
TL0374J-EVB-D2	Evaluation board	Tuned, 30 – 2600 MHz, 5 V, 55 mA
TL0374J	8 Pin 2.0x2.0x0.75 mm^3 DFN	Core part number

TL0374J-EVB-D2 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 board uses resistive feedback: M5 with the DC-blocking capacitor M6, connected from RF_{OUT} to RF_{IN}, flattens the gain and gives a broadband input and output match. M3 and M12 are the input and output DC blocks, M2 and M15 small shunt capacitors that trim the input and output match. The drain is fed through M8, an inductor in parallel with a resistor that damps the choke resonance, and decoupled by M9 and M10. The series resistor M4 on the V_{enable} pin sets I_{DQ}, M11 decouples V_{enable} (see the TL0374J datasheet for the bias resistor curve). Component positions that are not assembled are shown dashed grey in the schematic and marked DNP (Do Not Populate) in the bill of materials.

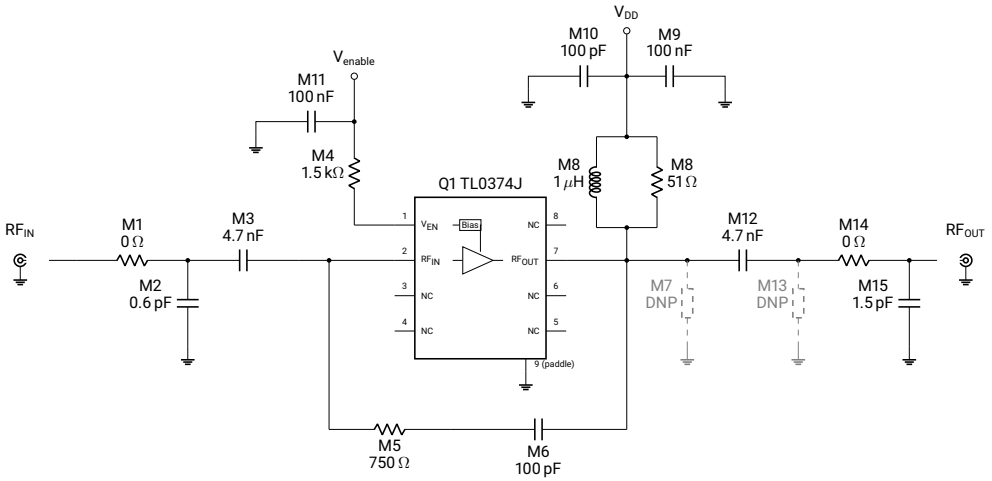

Figure 3: Schematic of TL0374J-EVB-D2, 30 – 2600 MHz. Dashed grey positions are not assembled (DNP).

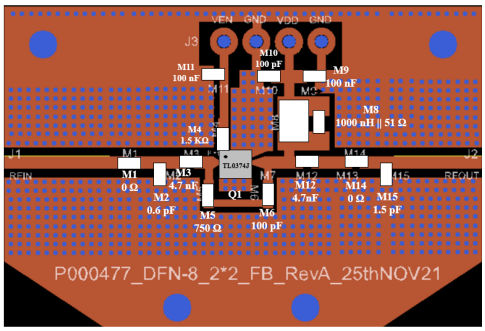

Figure 4: Layout of TL0374J-EVB-D2.

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TL0374J-EVB-D2 Bill of Materials

Table 2: 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		

TL0374J-EVB-D2 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-D2 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-D2 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 3 GHz with a source power of -25 dBm.

The TL0374J-EVB-D2 is expected to show a gain of about 22 dB at 100 MHz; 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.

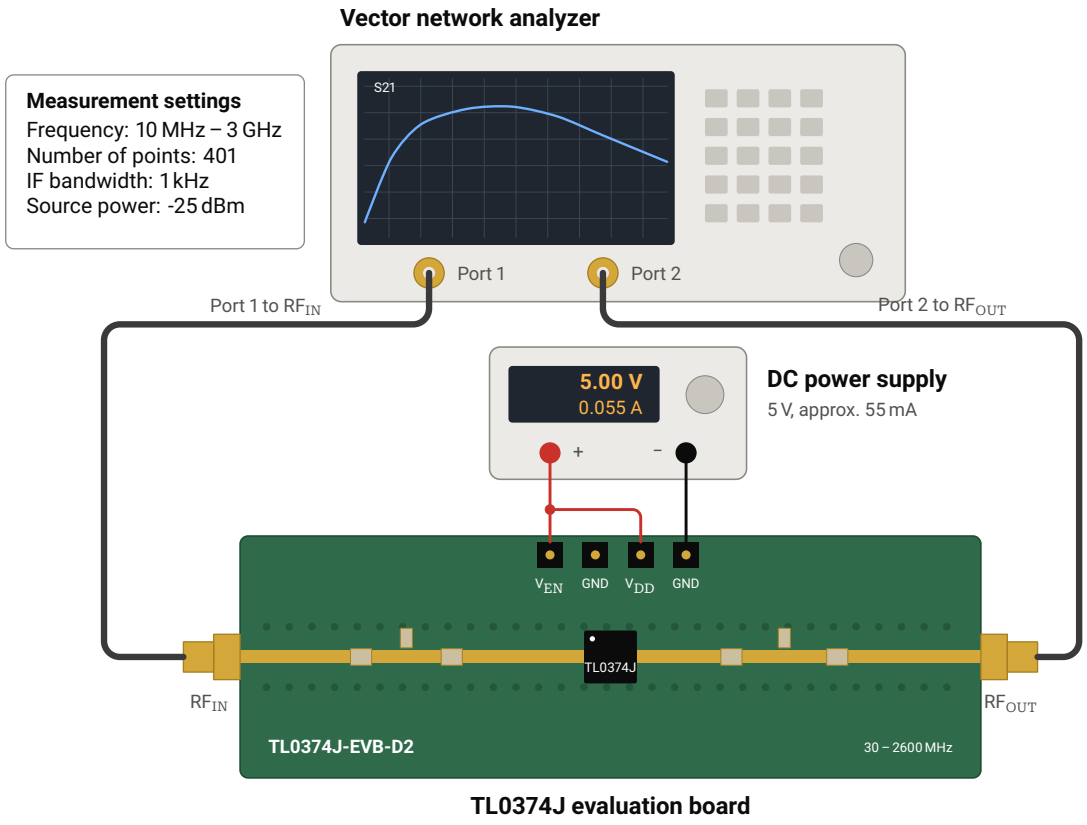

Figure 5: Test set-up for S-parameter measurements.

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TL0374J-EVB-D2 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-D2 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
30	0.9	21.9	13.8	28.6	-17.5	-6.4	1.1
100	0.7	21.9	14.6	27.2	-23.5	-6.8	1.1
250	0.7	21.5	14.8	28.4	-22.0	-7.8	1.2
500	0.7	20.4	14.3	28.4	-16.6	-11.9	1.4
1000	0.7	17.1	14.4	28.5	-11.2	-17.4	2.4
1500	0.8	14.9	15.6	29.9	-8.9	-9.3	1.9
2000	0.9	13.5	16.5	31.3	-8.9	-7.9	1.7
2600	0.9	14.0	17.8	32.8	-16.1	-19.6	2.0

[1] De-embedded: the losses of the input connector and trace are removed.
[2] Two tones, 1 MHz spacing, 0 dBm output power per tone.

The S-parameters are shown from 30 MHz to 3 GHz; the shaded area marks the 30 – 2600 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 de-embedded to the device pins. 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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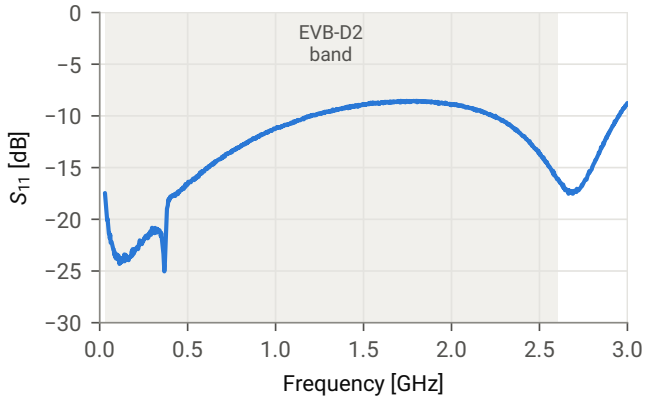
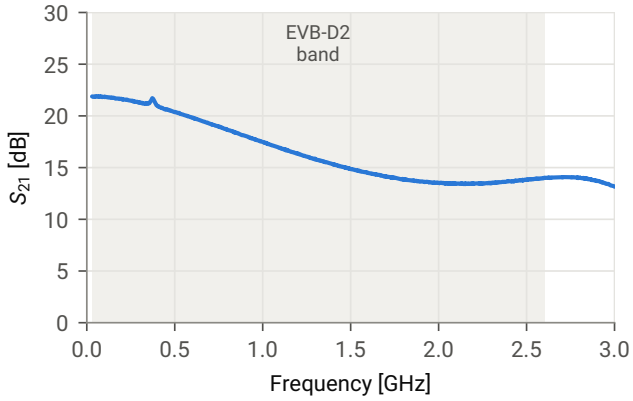
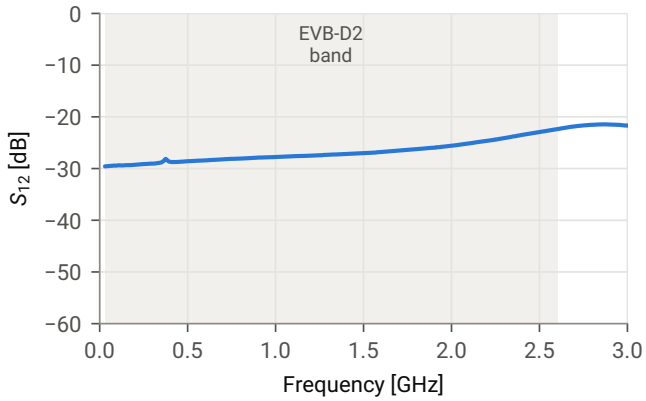
TL0374J-EVB-D2 Measurement Results



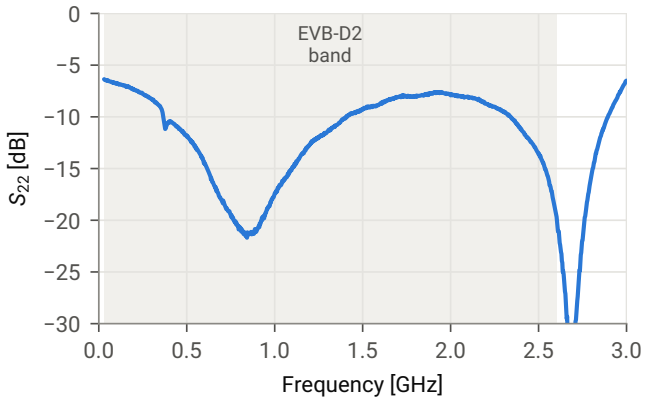
(a) S_{11} (input return loss) vs. frequency.



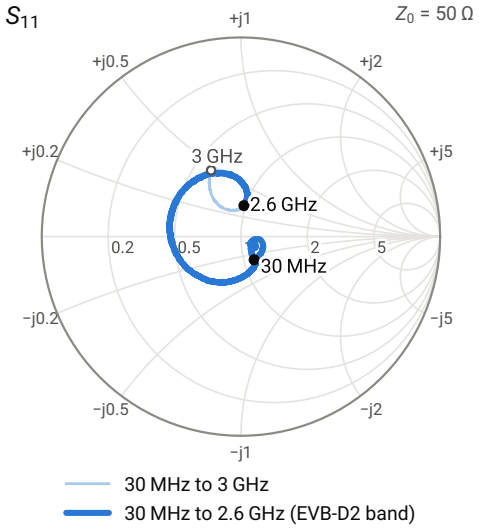
(b) S_{21} (gain) vs. frequency.



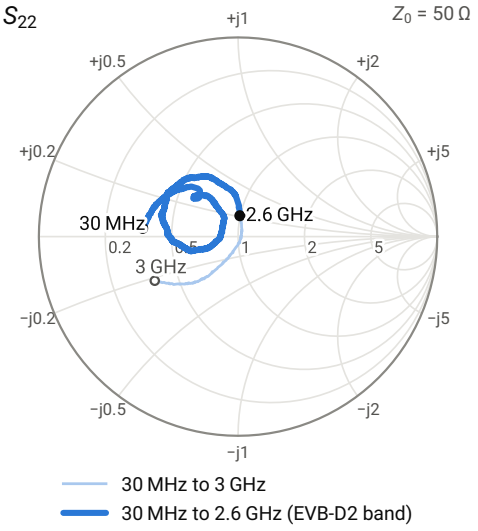
(c) S_{12} (reverse isolation) vs. frequency.



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

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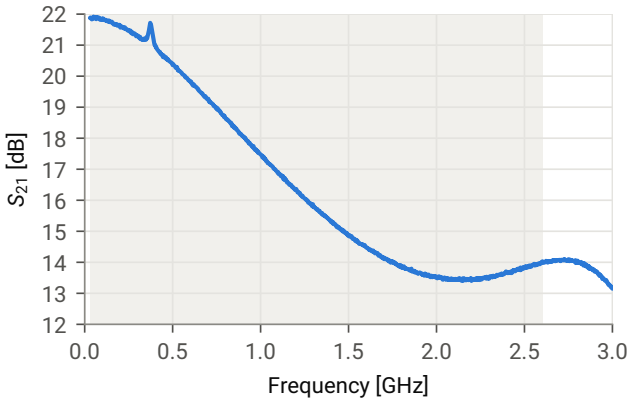
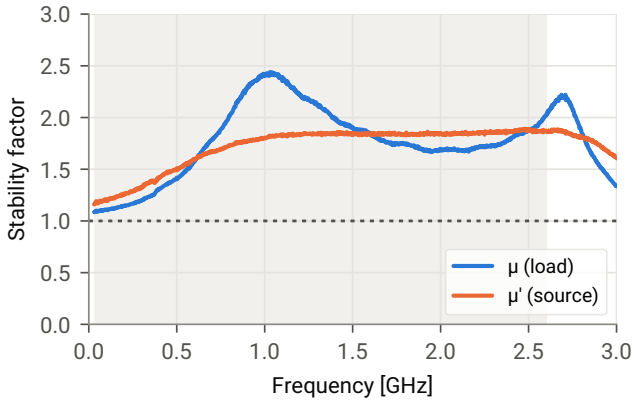
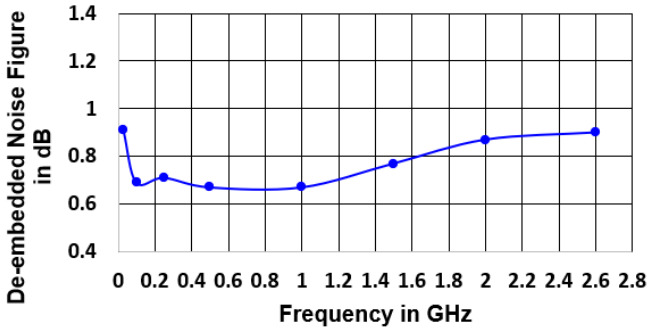
Gain, stability and noise figure



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



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



(c) De-embedded noise figure. The input trace loss is about 0.02 – 0.1 dB, so the SMA to SMA noise figure is 0.7 – 1.0 dB.

Figure 7: TL0374J-EVB-D2 gain on an expanded scale, stability factors and noise figure, $+25$°C, 5 V, 55 mA.

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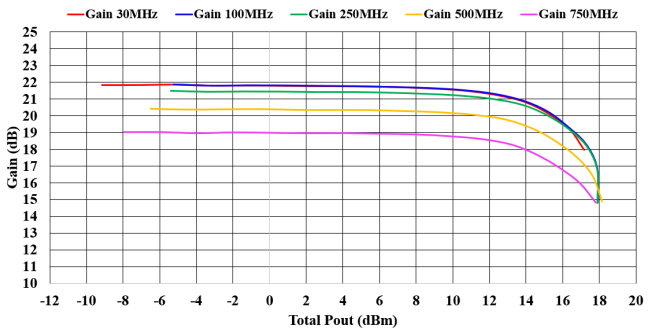
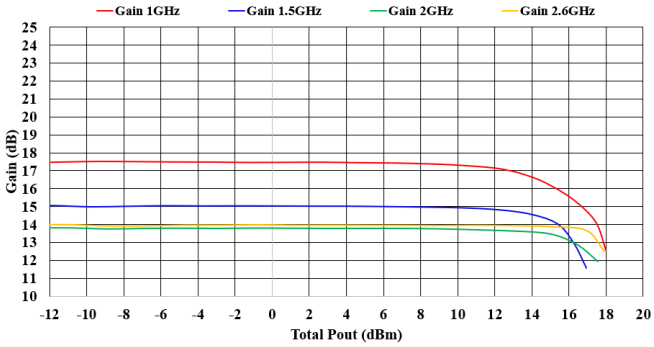
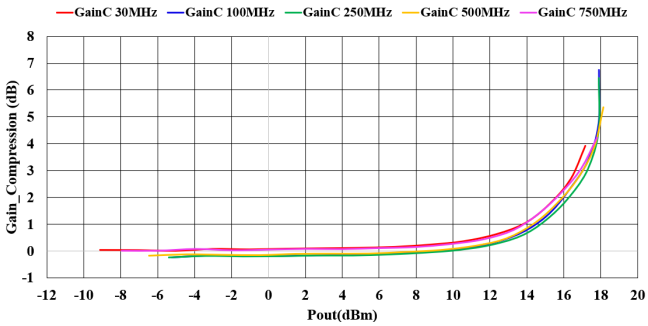
Large-signal performance



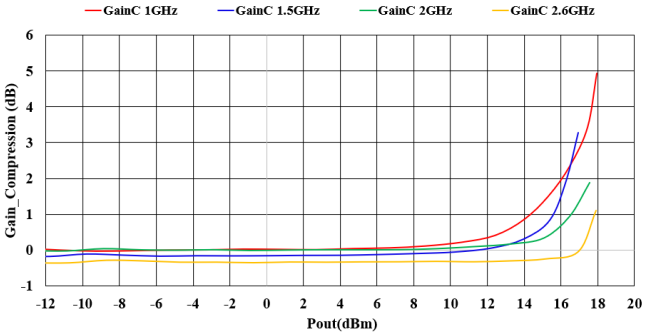
(a) Gain vs. output power, 30 – 750 MHz.



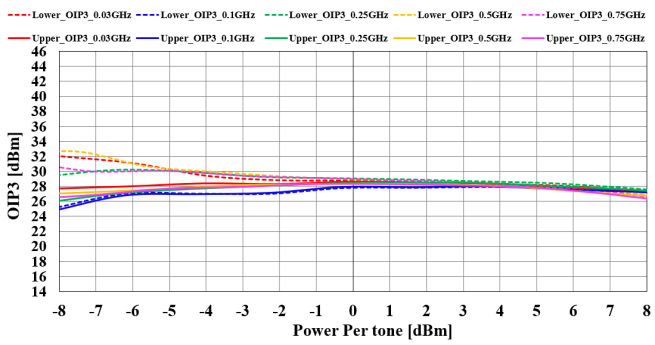
(b) Gain vs. output power, 1 – 2.6 GHz.



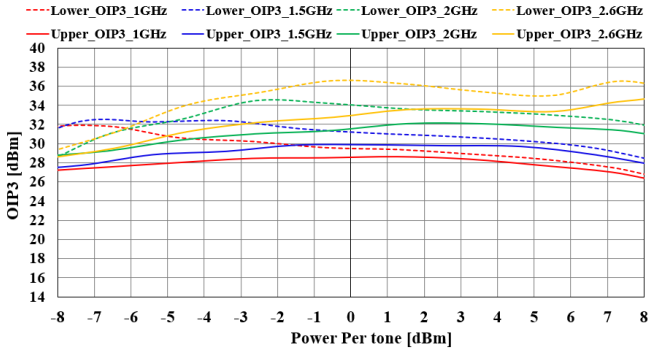
(c) Gain compression vs. output power, 30 – 750 MHz.



(d) Gain compression vs. output power, 1 – 2.6 GHz.



(e) OIP3 vs. output power per tone, 30 – 750 MHz.



(f) OIP3 vs. output power per tone, 1 – 2.6 GHz.

Figure 8: TL0374J-EVB-D2 large-signal performance, $+25$°C, 5 V, 55 mA. OIP3 with two tones 1 MHz apart.

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Changelog

Table 5: Changelog

Date	Revision	Notes
07/30/2024	2.3	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 re-drawn as vector graphics from the measured Touchstone data, links to the TL0374J datasheet and application notes TN-001/TN-002, QR code link to the latest version.

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