TA9310E + 2xTS8441L

20 W CW 0.5 – 4.0 GHz GaN Power Transistor+
30 W CW GaN Broadband RF Switch SP4T

Application Note: TA9310E + TS8441L EVB I

Application Note

30 MHz~520 MHz

28 V, 50 mA

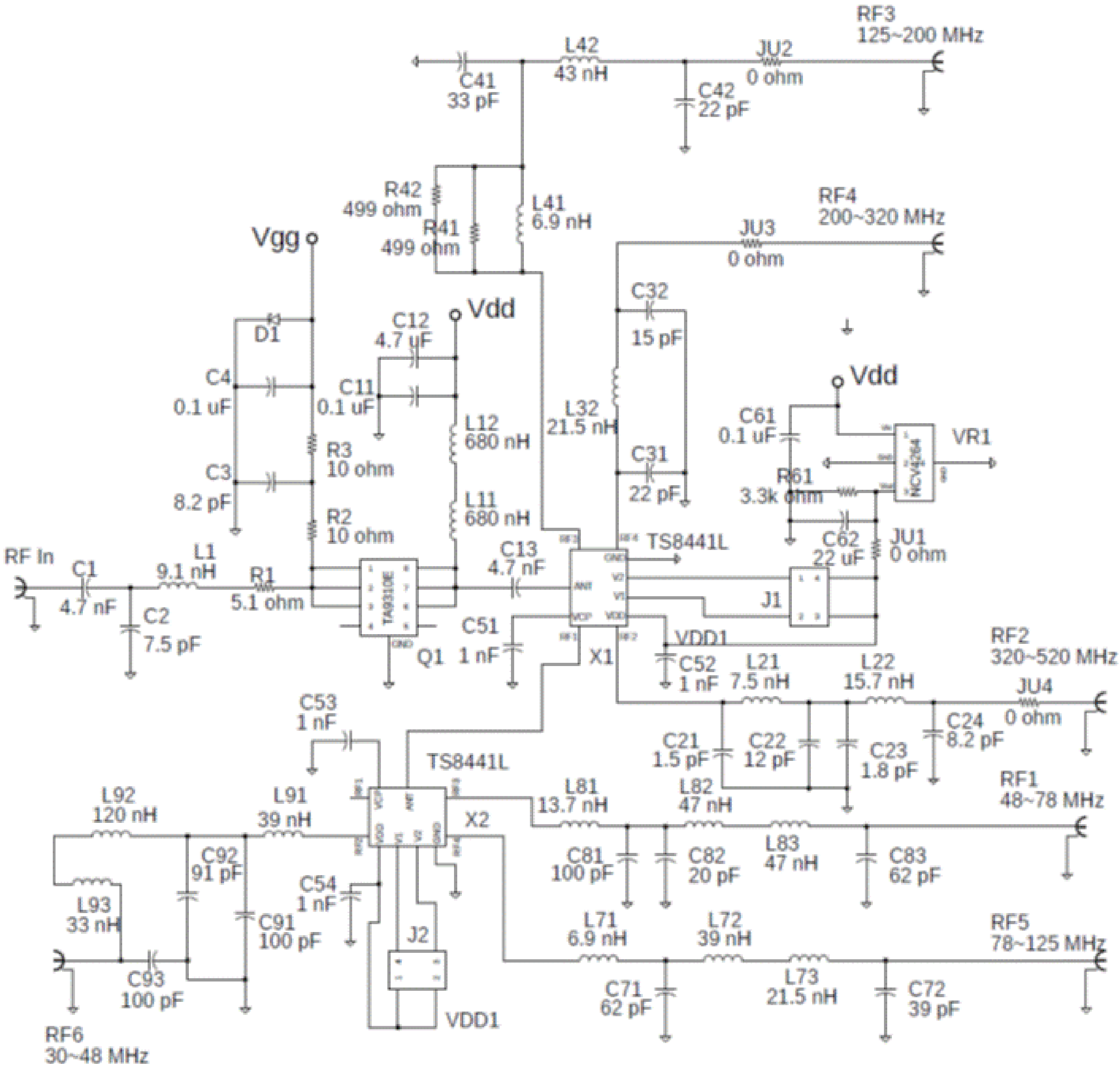
Rev-2.1

List of Contents

1. General Description

The TA9310E is a broadband GaN power transistor capable of delivering 20 W CW from 500 MHz to 4.0 GHz frequency band. The input and output can be matched for best power and efficiency for the desired band.
The TS8441L is a symmetrical reflective Single Pole Four Throws (SP4T) switch designed for broadband, high power switching applications. Its broadband behavior from 30 MHz to 4.0 GHz frequencies makes the TS8441L an excellent switch for all the applications requiring low insertion loss, high isolation, and high linearity within a small package size.
This combined design makes TA9310 to be fine-tuned for each communication frequency band. In another word, it expands the fine-tuned frequency range (30 MHz ~ 520 MHz). The design can be applied in public safety or tactical radio system.

2. TA9310E+TS8441L EVB-I Board Details



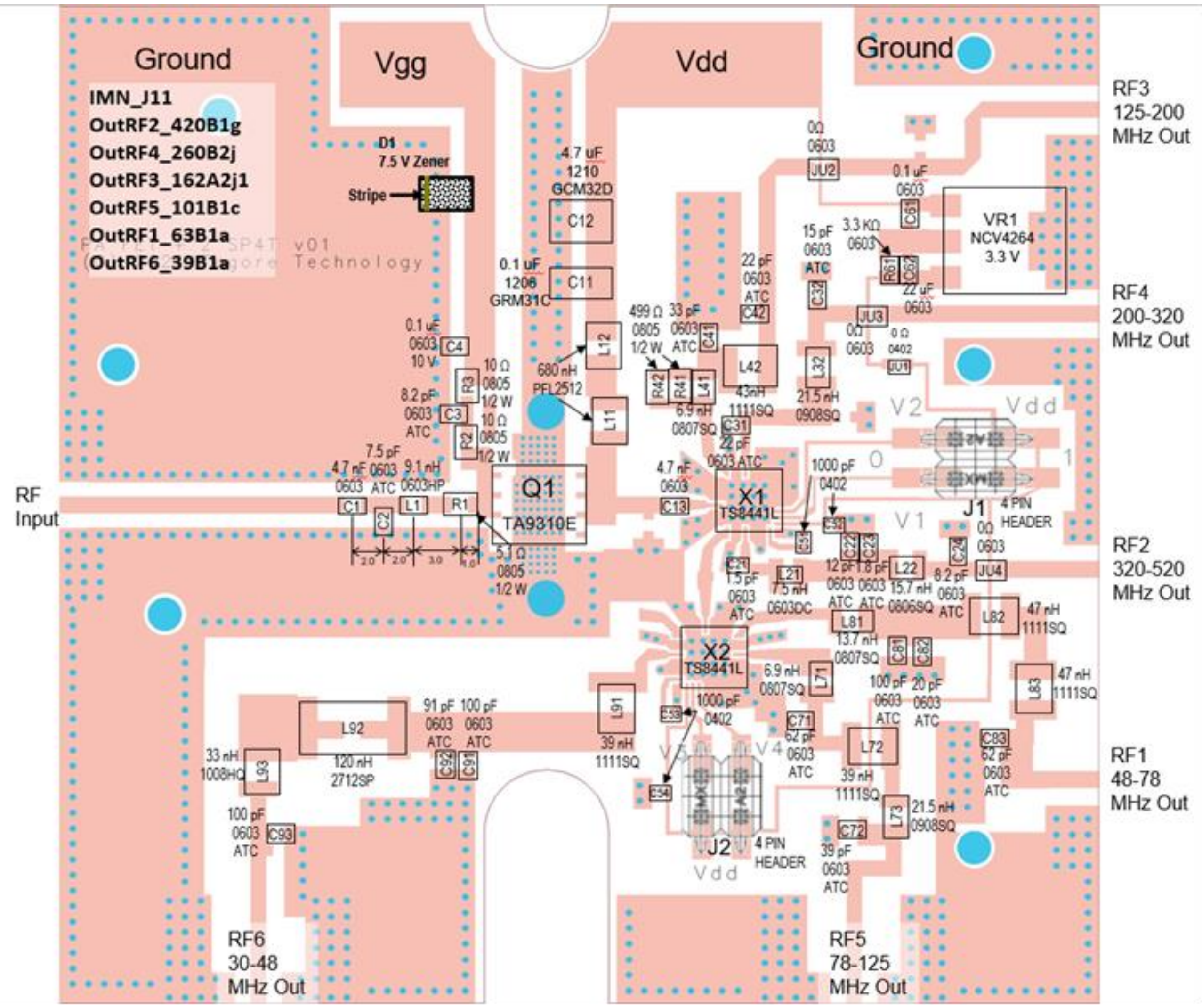


Figure 2.1 TA9310E + TS8441L EVB-I 30 MHz ~ 520 MHz Schematic and EVB Layout

3. TA9310E+TS8441L EVB-I Bill of Material

Part Label	Part Description	Vendor Name	Vendor Part Number
C1, C13	4.7 nF 5% 50 V 0603	Murata	GRM1885C1H472JA01D
C2	7.5 pF 5% 250 V 0603	AVX	600S7R5JT250XT
L1	9.1 nH 5% 0603	Coil craft	0603HP-9N1XJ
R1	5.1 Ω 5% 0805 1/2 W	Panasonic	ERJ-6DQJ5R1V
R2, R3	10 Ω 5% 0805 1/2 W	Panasonic	ERJ-P06J100V
C3	8.2 ±0.25 pF 250 V 0603	AVX	600S8R2JT250XT
C4	0.1 µF 20% 10 V 0603	AVX	0603ZC104K4T2A
D1	7.5 V Zener	On-Semiconductor	MMSZ5236BT1G
Q1	20 W GaN transistor	Tagore Tech	TA9310D
X1, X2	SP4T Switch	Tagore Tech	TS8441L
C51, C52, C53, C54	1 nF 20% 100 V 0402	Murata	GCM155R72A102KA37D
VR1	3.3 V Regulator	On-Semiconductor	NCV4264-2CST33T3G
R61	3.3 KΩ 5% 0603	Vishay	CRCW06033K30JNEB
C61	0.1 µF 10% 100 V 0603	Murata	GCM188R72A104KA64D
C62	22 µF 20% 6.3 V 0603	Murata	GRM188R60J226ME0D
JU1	0 Ω 0402	Vishay	CRCW04020000Z0E
J1, J2	4 Pin Header	Molex	15-91-2040
L11, L12	680 nH 20% 1008	Coil craft	PFL2512-681ME
C11	0.1 µF 5% 50 V 1206	Murata	GRM31C5C1H104JA01L
C12	4.7 µF 10% 100 V 1210	Murata	GCM32DC72A475KE02L
C21	1.5 ±0.1 pF 250 V 0603	ATC	600S1R5BT250XT
L21	7.5 nH 2% 0603	Coil craft	0603DC-7N5XG
C22	12 pF 2% 250 V 0603	ATC	600S120GT250XT
C23	1.8 ±0.1 pF 250 V 0603	ATC	600S1R8BT250XT
L22	15.7 nH 2% 0806	Coil craft	0806SQ-16NG
C24	8.2 ±0.25 pF 250V 0603	ATC	600S8R2JT250XT
JU2, JU3, JU4	0 Ω 0603	Vishay	CRCW06030000Z0E
C31, C42	22 pF 2% 250 V 0603	ATC	600S220GT250XT
L32, L73	21.5 nH 2% 0806	Coil craft	0806SQ-22NG
C32	15 pF 2% 250 V 0603	ATC	600S150GT250XT
L41, L71	6.9 nH 2% 0807	Coil craft	0807SQ-6N9G
R41, R42	499 Ω 1% 0805 1/2 W	Panasonic	ERJ-P06F4990V
C41	33 pF 2% 250 V 0603	ATC	600S330GT250XT
L42	43 nH 2% 1111	Coil craft	1111SQ-43NG
C71, C83	62 pF 2% 250 V 0603	ATC	600S620GT250XT
L72, L91	39 nH 2% 1111	Coil craft	1111SQ-39NG
C72	39 pF 2% 250 V 0603	ATC	600S390GT250XT
L81	13.7 nH 2% 0807	Coil craft	0807SQ-14NG
C81, C91, C93	100 pF 2% 250 V 0603	ATC	600S101GT250XT
C82	20 pF 2% 250 V 0603	ATC	600S200GT250XT
L82, L83	47 nH 2% 1111	Coil craft	1111SQ-47NG
C92	91 pF 2% 250 V 0603	ATC	600S910GT250XT
L92	120 nH 2% 2712	Coil craft	2712SP-121G4E
L93	33 nH 2% 1008	Coil craft	1008HQ-33NXG

Table 3.1 TA9310E + TS8441L EVB-I BOM

4. TA9310E + TS8441L EVB-I Assembled Board Picture

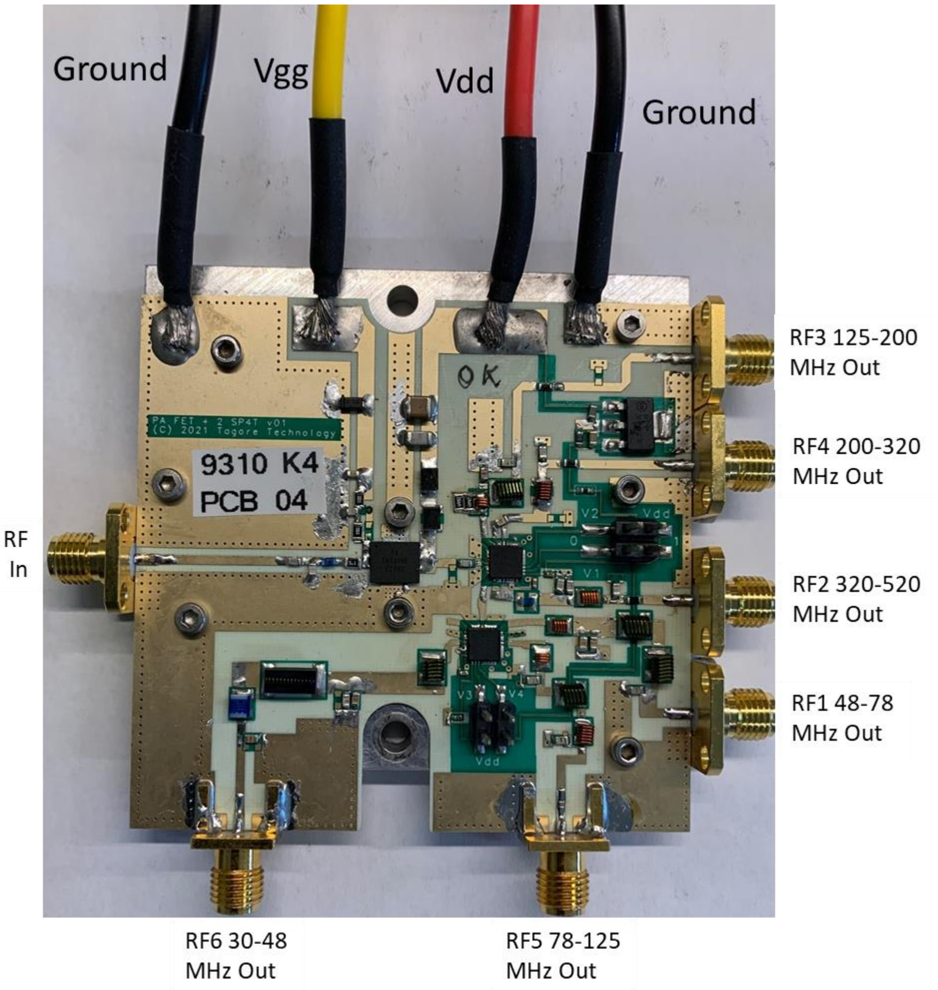


Figure 4.1 TA9310E + TS8441L EVB-I Assembled Board Picture

5. TA9310E +TS8441L EVB-I RF Output & Frequency Band Selection

RF output / frequency selection is done by either placing jumper plugs across certain pins of J1 and J2 or applying voltages to these pins. The board as supplied is setup to use jumpers, since it has an on-board 3.3 V regulator to provide the switch bias voltage (Vdd). An external switch matrix could also be used in place of the jumper plugs.

To use an external supply for switch bias and band selection, it is first necessary to remove JU1, shown in the yellow box on Figure 5.1. Switch bias must be in the range of 2.7 – 5.0 V and is applied to the outermost pin's pf J1 and J2 (i.e., the pins closest to the board edge). Band selection is then made by selectively applying switch bias voltage to selected pins marked V1…V4 in Figure 5.1.

The jumper / voltage settings for each band are shown in Table 5.1.

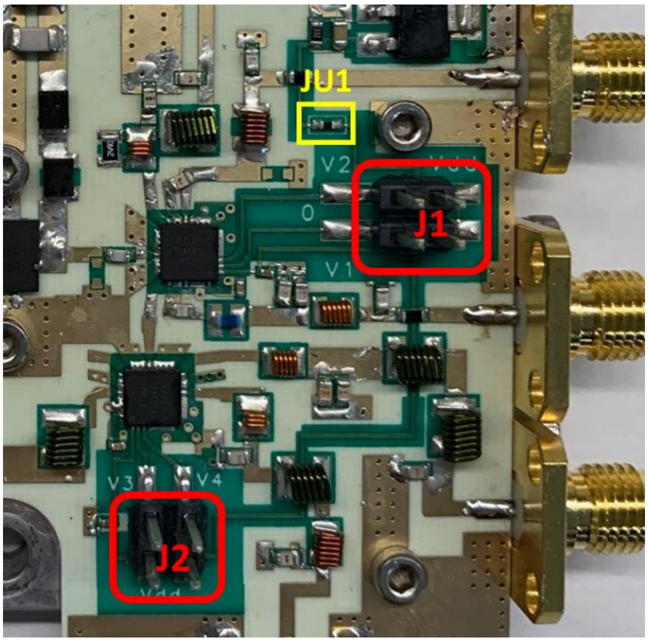


Figure 5.1 TA9310E + TS8441L EVB-I Assembled board Picture.

		Pin Voltages				Jumper Settings			
Freq. MHz	Port	V1	V2	V3	V4	V1	V2	V3	V4
320-520	RF2	3.3 V	0 V	0 V	0 V	Short	Open	Open	Open
200-320	RF4	3.3 V	3.3 V	0 V	0 V	Short	Short	Open	Open
125-200	RF3	0 V	3.3 V	0 V	0 V	Open	Short	Open	Open
78-125	RF5	0 V	0 V	3.3 V	3.3 V	Open	Open	Short	Short
48-78	RF1	0 V	0 V	0 V	3.3 V	Open	Open	Open	Short
30-48	RF6	0 V	0 V	3.3 V	0 V	Open	Open	Short	Open

Table 5.1. Band Selection Table

6. TA9310E + TS8441L EVB-I Biasing Sequence

Turn ON Device	Turn OFF Device
1. Connect selected output port to 50 Ω load. 2. Apply -5.5 V to Vgg terminal. 3. Connect power supply to Vdd terminal. 4. Start at 0.00 volts, then SLOWLY increase to **+ 28 V.** 5. Monitor Vdd supply current (Id), stop increasing Vdd if Id exceeds 20 mA. 6. SLOWLY raise Vgg (toward zero volts) until Id = **50 mA** (Vgg should be between **-2.5 V to -3.2V**) 7. Apply RF drive to RF input port.	1. Remove RF drive from RF input port. 2. Decrease Vdd to zero volts. 3. Return Vgg to -5.5 V setting.

Table 6.1 TA9310E + TS8441L EVB-I Bias and Sequencing

7. TA9310E + TS8441L EVB-I Board Measurement Summary

Frequency (MHz)	Psat (dBm)	PAE% @Psat	Second Harmonic[dBc]	Third Harmonic[dBc]
30-48	42-42.2	62-65	-15 to -30	-35 to -65
48-78	42-42.5	58-65	-15 to -30	-35 to -65
78-125	42.0	60-70	-15 to -30	-36 to -65
125-200	42-42.1	65-75	-15 to -28	-36 to -55
200-320	42.2-42.7	55-66	-15 to -30	-33 to -65
320-520	42.2-43	59-68	-15 to -30	-32 to -65

Table 7.1 TA9310E + TS8441L EVB-I 32 V. 100 mA Electrical Characteristics Summary

8. TA9310E + TS8441L EVB-I Test Results

8.1. Gain & PAE vs Pout, IRL &Pdiss Vs Pout and H2-H3 dBc Vs Pout@ 28 V, 50 mA.

30-48 MHz Band

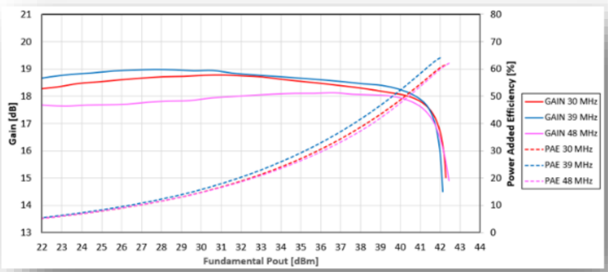


Figure 8.1.1 Gain, PAE v/s Pout Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=30 mA

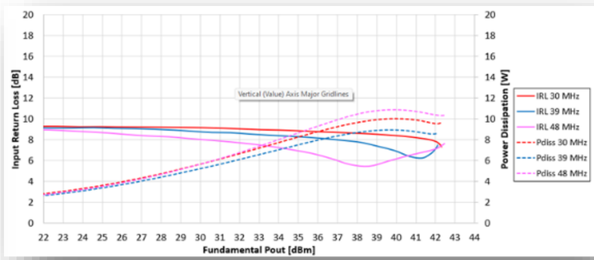


Figure 8.1.2 IRL and Pdiss v/s Pout Of TA9310E + TS8441L EVB-I, VD=32 V, IDQ=30 mA

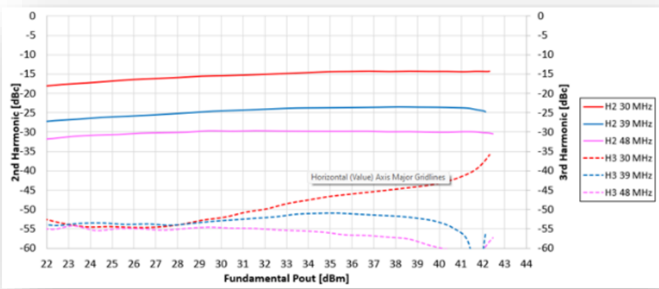
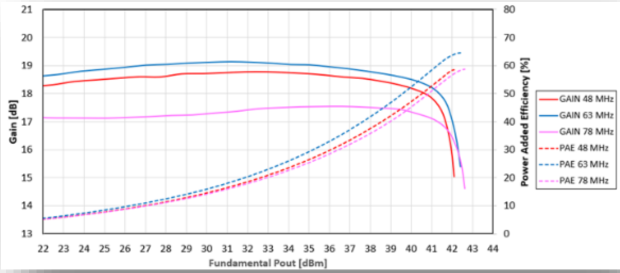


Figure 8.1.3 H2dBc and H3dBc v/s Pout Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=30 mA

48-78 MHz Band



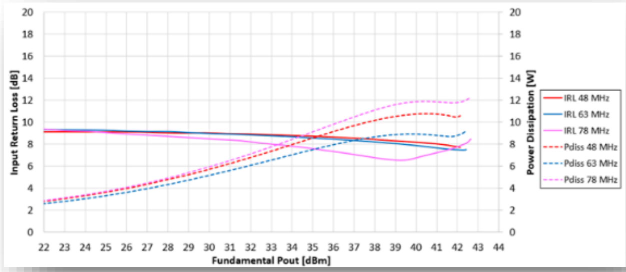


Figure 8.1.4 Gain, PAE v/s Pout Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=30 mA

Figure 8.1.5 IRL and Pdiss v/s Pout Of TA9310E + TS8441L EVB-I, VD=32 V, IDQ=30 mA

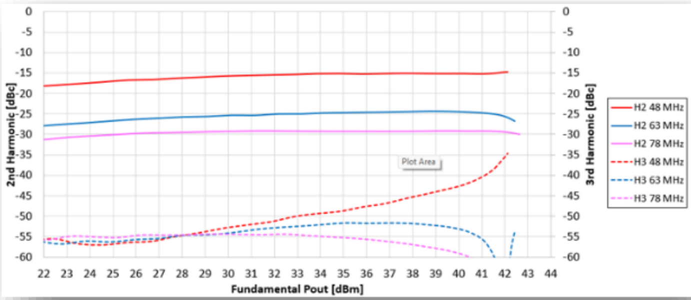
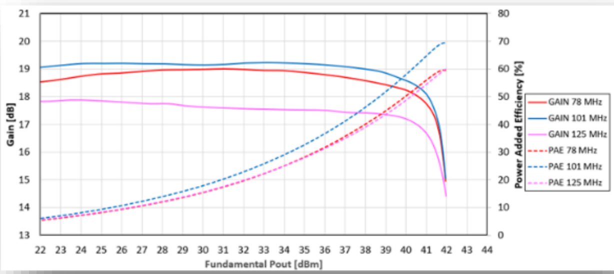


Figure 8.1.6 H2dBc and H3dBc v/s Pout Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=30 mA

78-125 MHz Band



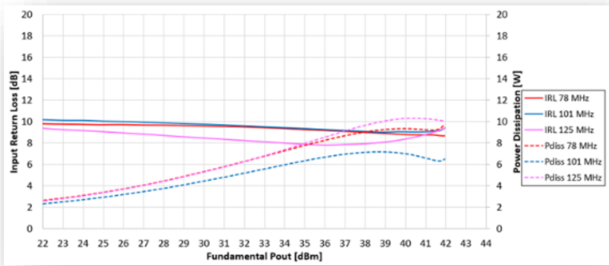


Figure 8.1.7 Gain, PAE v/s Pout Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=30 mA

Figure 8.1.8 IRL and Pdiss v/s Pout Of TA9310E + TS8441L EVB-I, VD=32 V, IDQ=30 mA

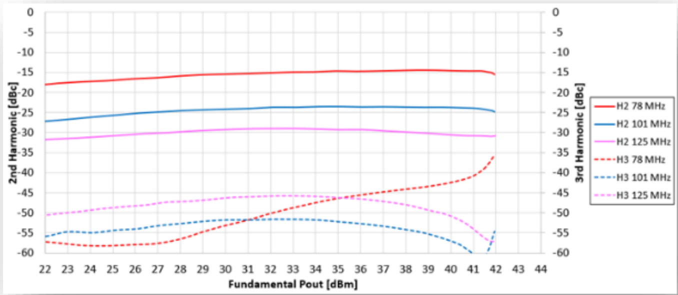
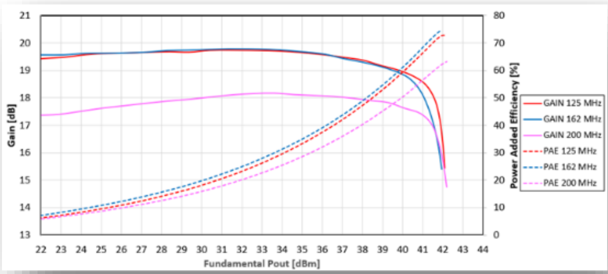


Figure 8.1.9 H2dBc and H3dBc v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=30 mA

125-200 MHz Band



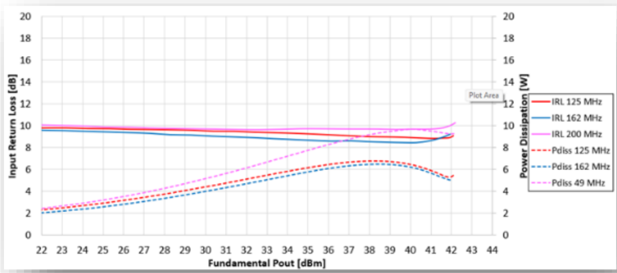


Figure 8.1.10 Gain, PAE v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

Figure 8.1.11 IRL and Pdiss v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

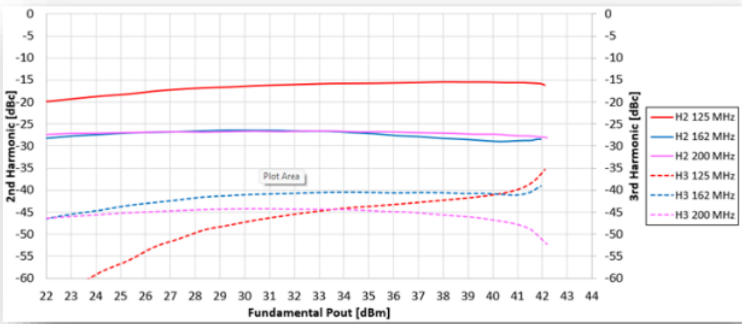


Figure 8.1.12 H2dBc and H3dBc v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

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200-320 MHz Band

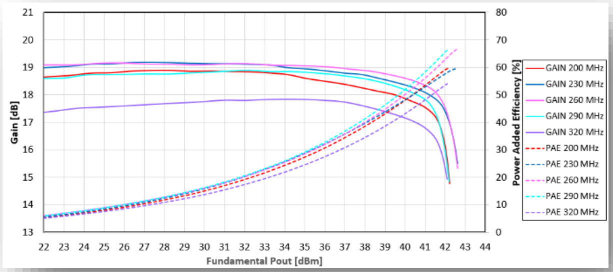

Figure 8.1.13 Gain, PAE v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

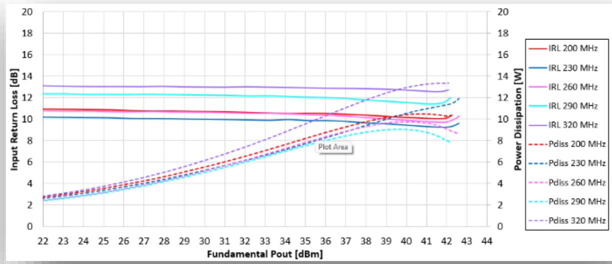

Figure 8.1.14 IRL and Pdiss v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

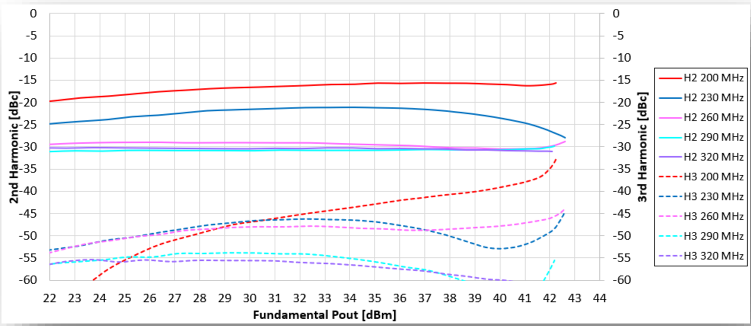

Figure 8.1.15 H2dBc and H3dBc v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

320-520 MHz Band

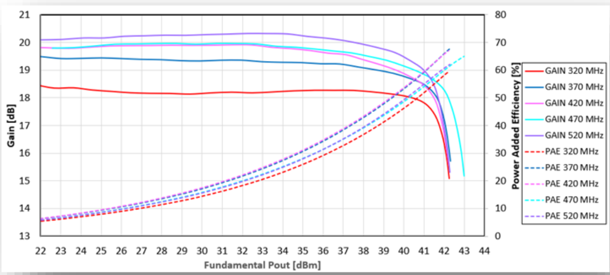

Figure 8.1.16 Gain, PAE v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

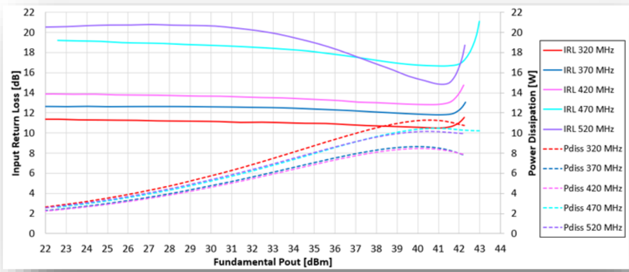

Figure 8.1.17 IRL and Pdiss v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

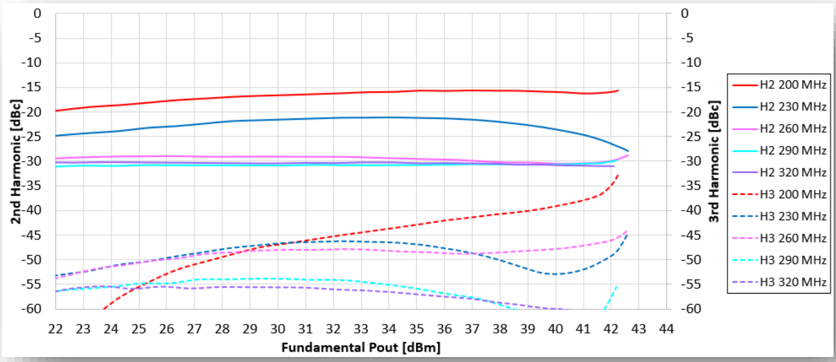

Figure 8.1.18 H2dBc and H3dBc v/s Pout
Of TA9310E + TS8441L EVB-I, VD=28 V, IDQ=50 mA

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