TA9210D+TS7441L

12.5 W CW 0.03 – 4.0 GHz GaN Power Transistor+
30 W CW 0.01-2.7 GHz GaN Broadband RF Switch

Application Note: TA9210D+TS7441L EVB K

Application Note

135 MHz~870 MHz

28 V, 50 mA

Rev-2.1

List of Contents

1. General Description

The TA9210D is a broadband GaN power transistor capable of delivering 12 W CW from 30 MHz to 2.7 GHz frequency band. The input and output can be matched for best power and efficiency for the desired band.

The TS7441L is a symmetrical reflective Single Pole Four Throws (SP4T) switch designed for broadband, high power switching applications. Its broadband behavior from 1 MHz to 2.7 GHz frequencies makes the TS7441L 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 TA9210D to be fine-tuned for each communication frequency band. In another word, it expands the fine-tuned frequency range (135 MHz ~ 870 MHz). The design can be applied in public safety or tactical radio system. TA9210D+TS7441L-EVB-K is tuned from 135 MHz to 870 MHz.

2. TA9210D+TS7441L-EVB-K Board Details

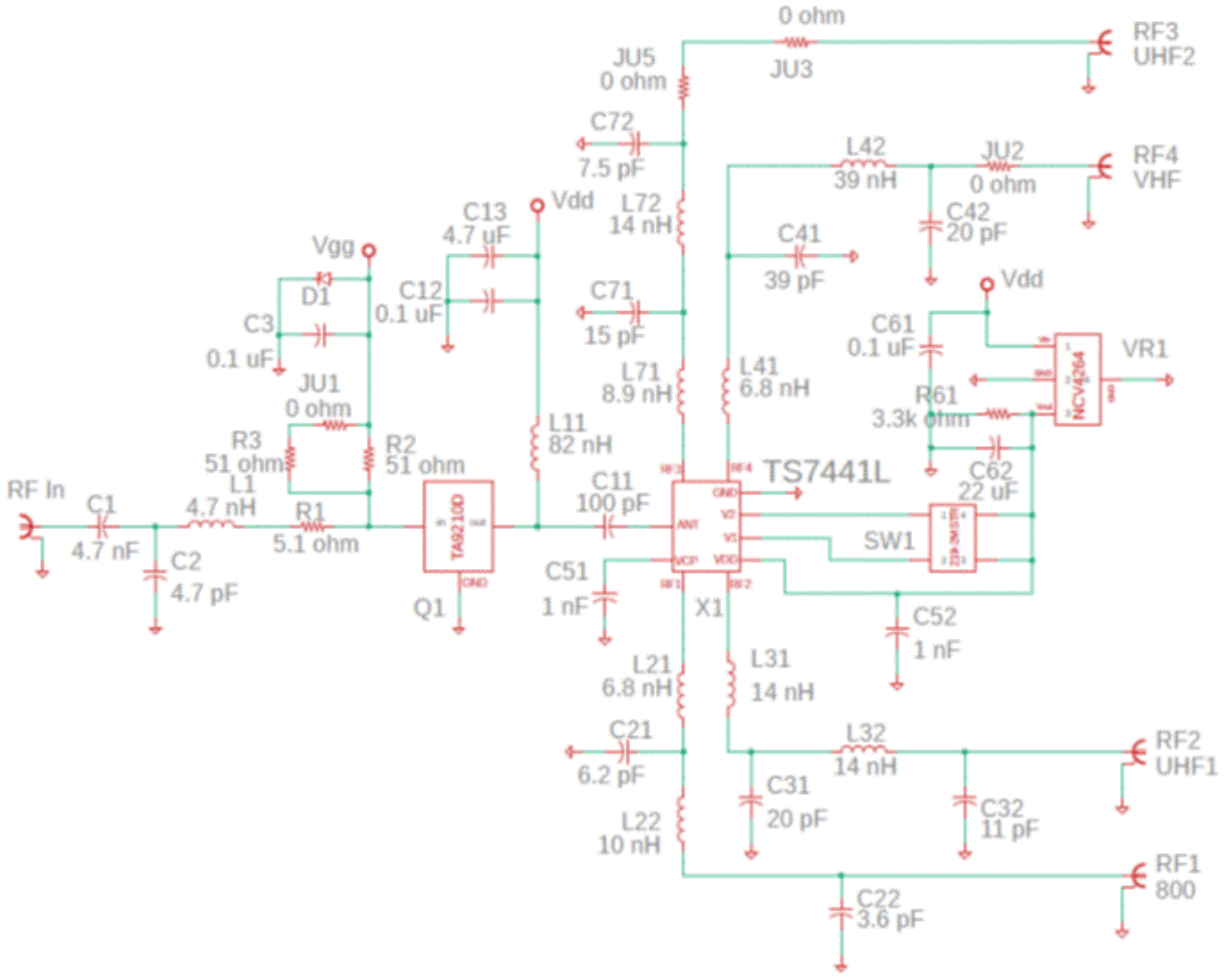

Figure 2.1 TA9210D+TS7441L-EVB-K 135 MHz ~ 870 MHz Schematic and EVB Layout

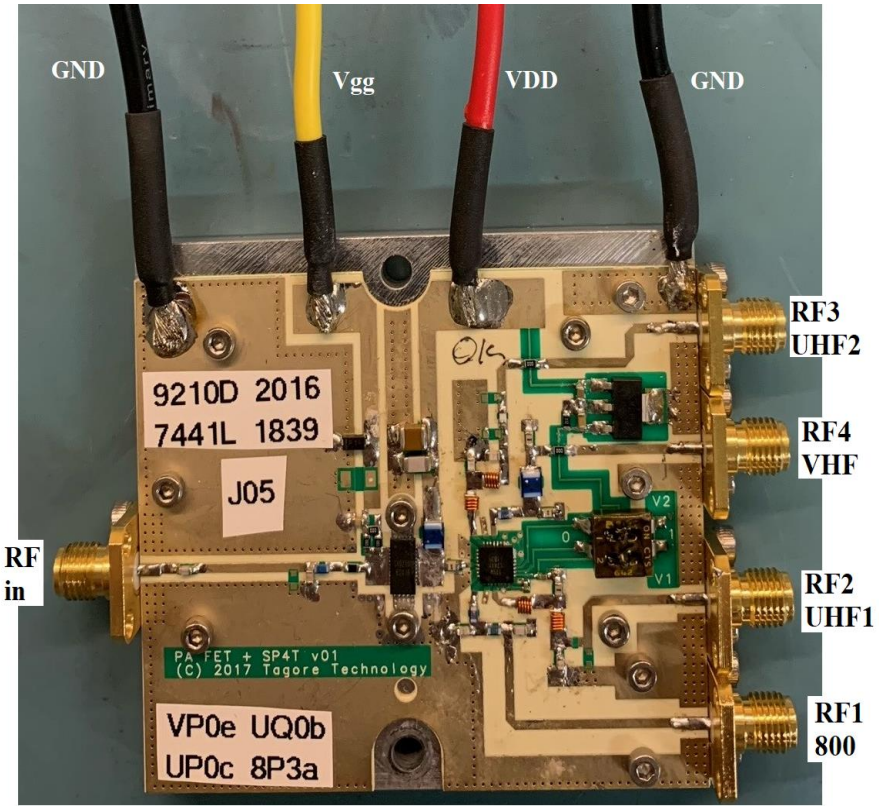

Figure 2.2 TA9210D+TS7441L-EVB-K 135 MHz ~ 870 MHz Schematic and Assembled Board

3. TA9210D+TS7441L-EVB-K Bill of Materials

Part Label	Part Description	Vendor Name	Vendor Part Number
C1	4.7 nF, 50 V, 0603	Murata	GRM1885C1H472JA01D
C2	4.7 pF, 250 V, 0603	AVX	600S4R7BT250XT
L1	4.7 nH, 0603	Coil craft	0603HP-4N7XG
R1	5.1 Ω, 0603, 1/4 W	Vishay	RCS06035R10FKEA
R2, R3	51 Ω, 0603, 1/4 W	Vishay	RCS060351R0FKEA
C3	0.1 uF, 10 V, 0603	AVX	0603ZC104K4T2A
D1	7.5 V Zener	On-Semiconductor	MMSZ5236BT1G
Q1	12.5 W GaN Transistor	Tagore Tech	TA9210D
X1	SP4T Switch	Tagore Tech	TS7441L
C51, C52	1 nF, 100 V, 0402	Murata	GCM155R72A102KA37D
L11	82 nH, 1008	Coil craft	1008HQ82XJ
C11	100 pF, 250 V, 0603	AVX	600S101JT250XT
C12	0.1 uF, 50 V, 1206	Murata	GRM31C5C1H104JA01L
C13	4.7 uF, 100 V, 1210	Murata	GCM32DC72A475KE02L
JU5*	0 Ω, 0603	Vishay	CRCW06030000Z0EA
JU1, JU2, JU3	0 Ω, 0603	Vishay	CRCW06030000Z0EA
L21, L41	6.8 nH, 0603	Coil craft	0603HC-6N8XJ
C21	6.2 pF, 250 V 0603	AVX	600S6R2CT250XT
L22	10 nH, 0603	Coil craft	0603HC-10NXG
C22	3.6 pF, 250 V, 0603	AVX	600S3R6BT250XT
L31, L32, L72	14 nH, 0807	Coil craft	0807SQ-14NG
C31, C42	20 pF, 250 V, 0603	AVX	600S200GT250XT
C32	11 pF, 250 V, 0603	AVX	600S110GT250XT
C41	39 pF, 250 V, 0603	AVX	600S390JT250XT
L42	39 nH, 1008	Coil craft	1008HQ-39XG
L71	8.9 nH, 0806	Coil craft	0806SQ-8N9GL
C71	15 pF, 250 V, 0603	AVX	600S150GT250XT
C72	7.5 pF, 250 V, 0603	AVX	600S7R5JT250XT
SW1	DPST DIP Switch	CTS Electronic	219-2MSTR
VR1	3.3 V Regulator	On-Semiconductor	NCV4264-2CST33T3G
R61	3.3 kΩ, 0603	Vishay	CRCW06033K30JNEB
C61	0.1 uF, 100 V, 0603	Murata	GCM188R72A104KA64D
C62	22uF, 6.3 V, 0603	Murata	GRM188R60J226MEA0D
* JU5 is placed upside down on PC board to minimize stray inductance.			

Table 3.1 TA9210D+TS7441L-EVB-K BOM

4. TA9210D+TS7441L-EVB-K Biasing & Operating Condition

4.1. Setup switch for desired output port.

Set DIP Switch V1 and V2 positions as follows to select RF output port V1, V2, 0, and 1 position are marked on the PC Board

Output Port	V1	V2	RF Frequency
RF1	Off (0, Left)	Off (0, Left)	760 – 870 MHz
RF2	On (1, Right)	Off (0, Left)	380 – 450 MHz
RF4	On (1, Right)	On (1, Right)	135 - 175 MHz
RF3	Off (0, Left)	On (1, Right)	450- 520MHz

Table 4.1 TA9210D+TS7441L-EVB-K DIP Switch logic operation

4.2. PA Turn on sequence

4.2.1 Connect selected output port to 50 Ω load.
4.2.2 Apply -5.5 V to Vgg terminal.
4.2.3 Connect power supply to Vdd terminal.
4.2.4 Start at 0.00 volts, then SLOWLY increase to **+ 28 V or +32 V.**
4.2.5 Monitor Vdd supply current (Id), stop increasing Vdd if Id exceeds 20 mA.
4.2.6 SLOWLY raise Vgg (toward 0 volts) until Id = **30 mA** (Vgg should be between **-2.5 V to -3.2 V**)
4.2.7 Apply RF drive to RF input port.

4.3 PA Turn off sequence.

4.3.1 Remove RF drive from RF input port.
4.3.2 Decrease Vdd to zero volts.
4.3.3 Return Vgg to -5.5 V setting.

5. TA9210D+TS7441L-EVB-K Board Measurement Summary

Frequency (MHz)	Psat (dBm)	DE% @Psat	Second Harmonic [dBc]	Third Harmonic [dBc]	IRL [dB]	Drain Current [A]
135-175	40.3-40.4	62-67	-18 to -30	-37 to -70	-12.0	0.60 A @ 40 dBm
380-450	38.8-40.0	66-70	-35 to -51	-55 to -75	-10 to -11.5	0.55 A @ 40 dBm
450-520	40.5-40.8	62-63	- 32 to -41	-47 to -65	-10.0	0.70 A @ 40.5dBm
760-870	39.0-40.0	48-53	-43 to -60	-55 to -68	-20 to -24	0.70 A @ 40dBm

Table 5.1 TA9210D+TS7441L-EVB-K 28 V, 30 mA Electrical Characteristics Summary

6. TA9210D+TS7441L-EVB-K Test Results

All the tests are carried out at room temperature.

135-175 MHz- VHF Band

6.1. Gain & DE vs Pout and IRL & Drain current Vs Pout@ 28 V and 32 V, 30 mA.

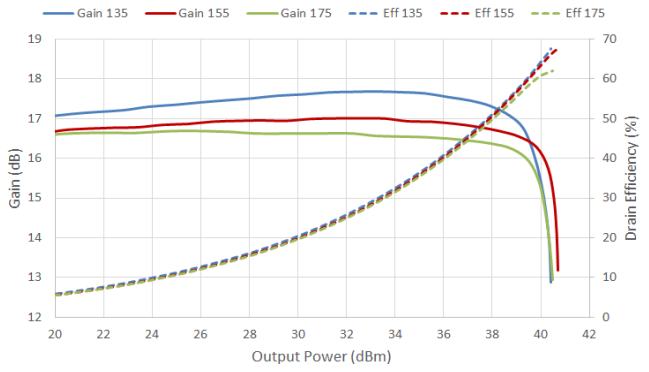

Figure 6.1.1 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

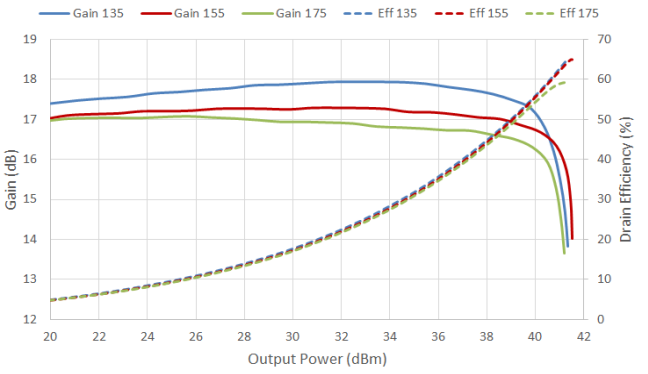

Figure 6.1.2 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V IDQ=30 mA

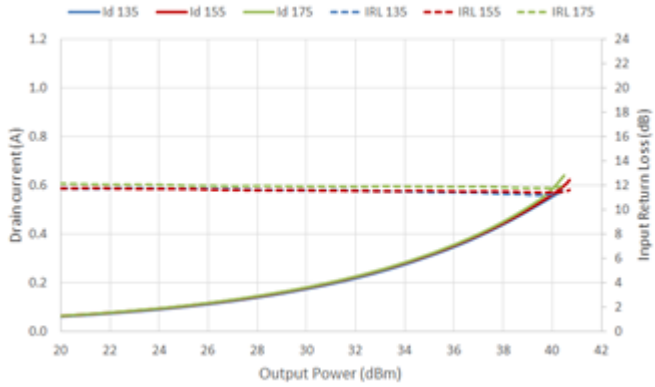

Figure 6.1.3 Drain Current and IRL v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

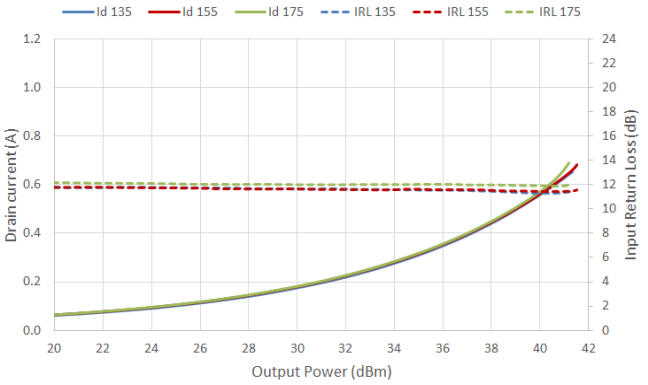

Figure 6.1.4 Drain Current and IRL v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

6.2. H2dBc and H3dBc vs Pout@ 28V and 32V, 30mA.

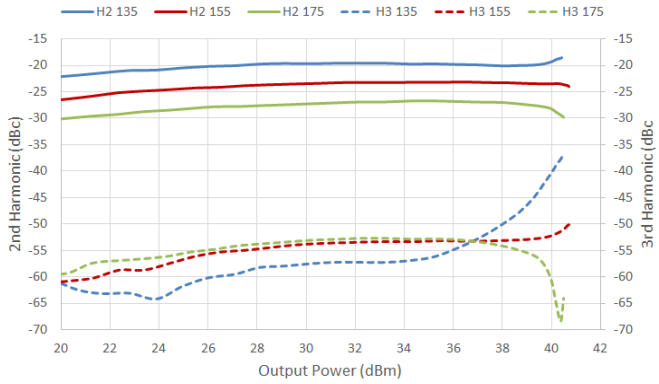

Figure 6.2.1 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

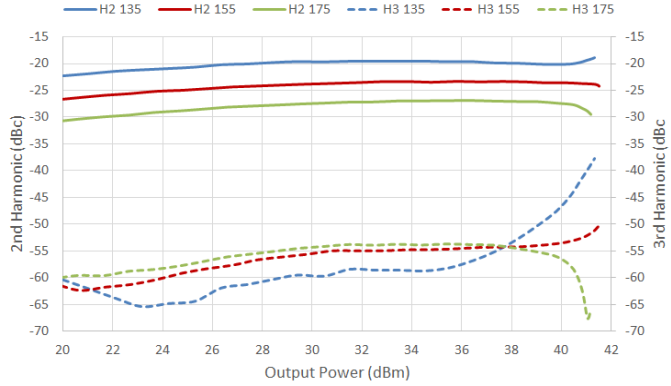

Figure 6.2.2 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

380-450 MHz- UHF1 Band

6.3. Gain & DE vs Pout and IRL & Drain current Vs Pout@ 28 V and 32 V, 30 mA.

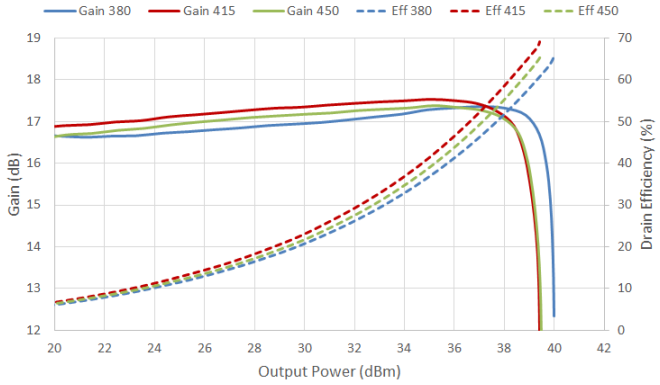

Figure 6.3.1 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

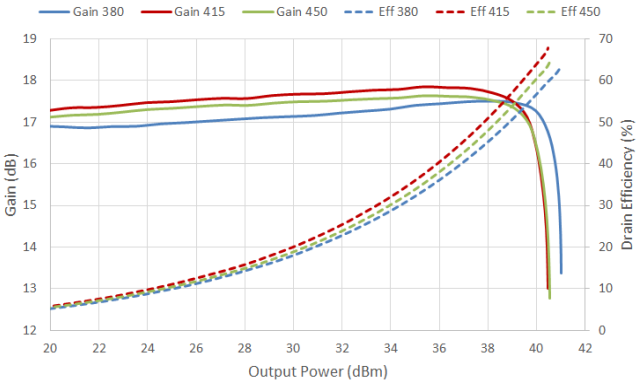

Figure 6.3.2 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

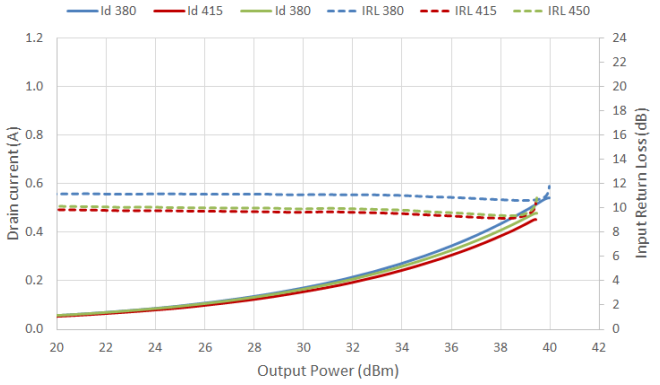

Figure 6.3.3 Drain Current and IRL v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

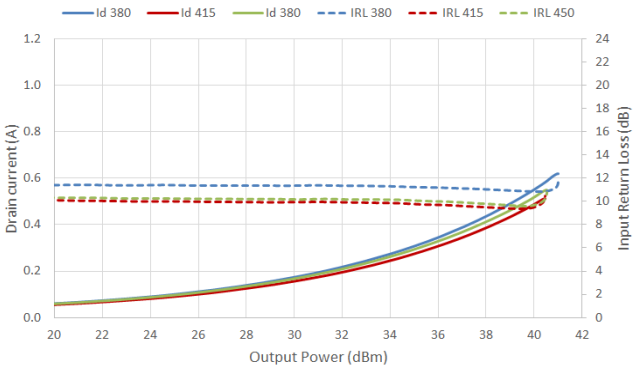

Figure 6.3.4 Drain Current and IRL v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

6.4. H2dBc and H3dBc vs Pout@ 28 V and 32 V, 30 mA.

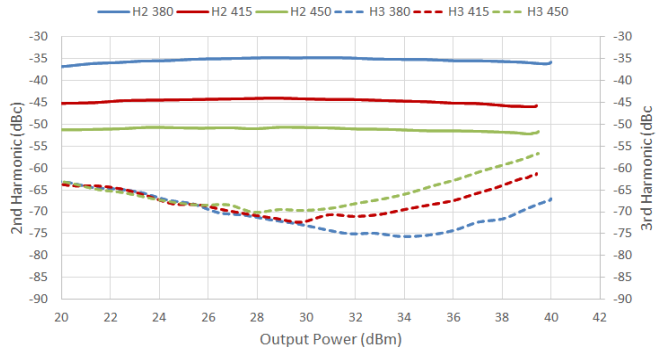

Figure 6.4.1 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

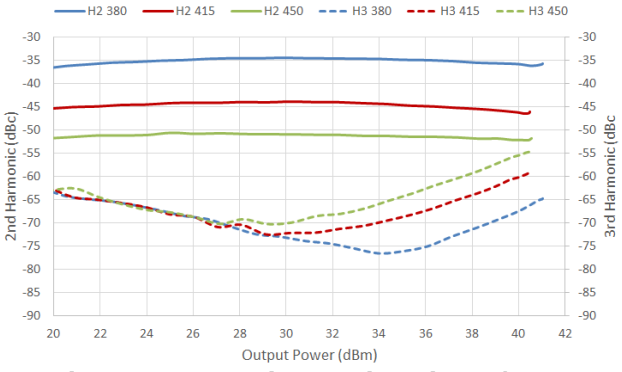

Figure 6.4.2 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

450-520 MHz- UHF2 Band

6.5. Gain & DE vs Pout and IRL & Drain current Vs Pout@ 28 V and 32 V, 30 mA.

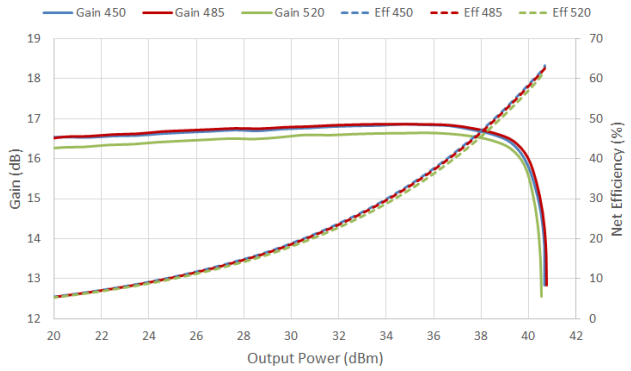

Figure 6.5.1 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

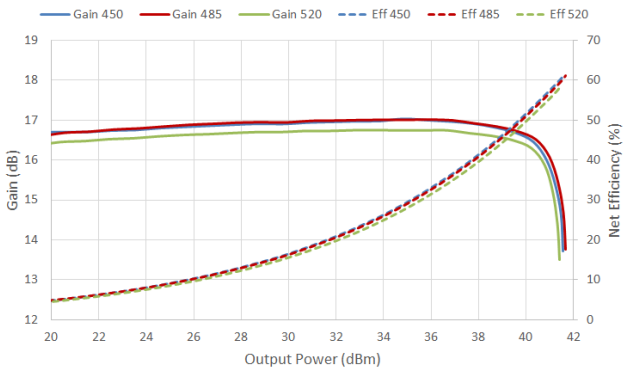

Figure 6.5.2 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

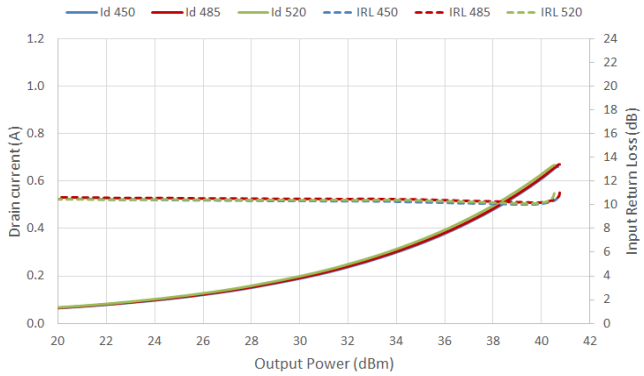

Figure 6.5.3 Drain Current and IRL v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

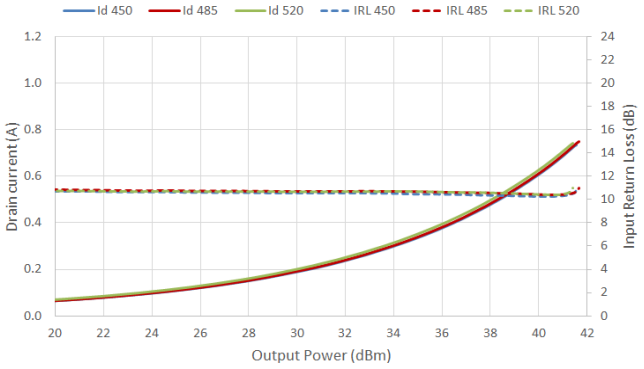

Figure 6.5.4 Drain Current and IRL v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

6.6. H2dBc and H3dBc vs Pout@ 28V and 32V, 30mA.

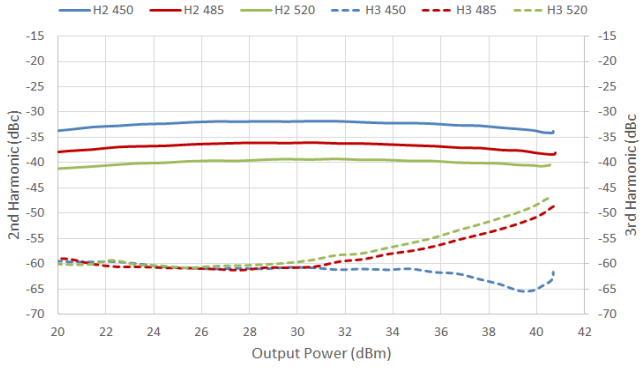

Figure 6.6.1 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

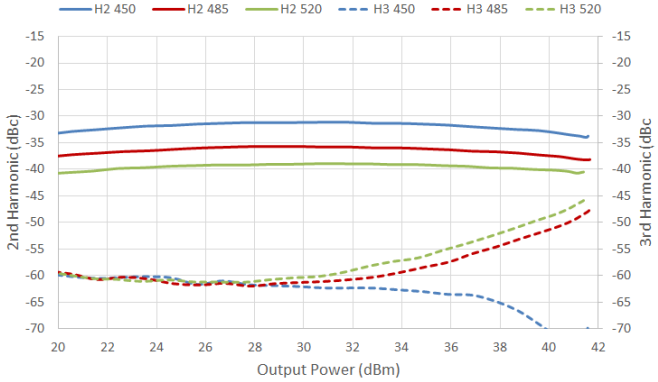

Figure 6.6.2 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

760-870 MHz- 800 MHz Band

6.7. Gain & DE vs Pout and IRL & Drain current Vs Pout@ 28 V and 32 V, 30 mA.

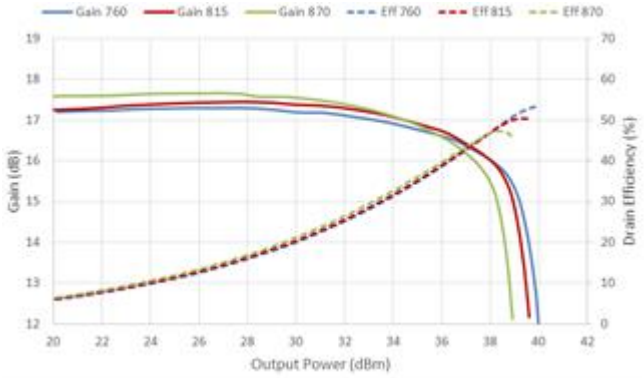

Figure 6.7.1 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

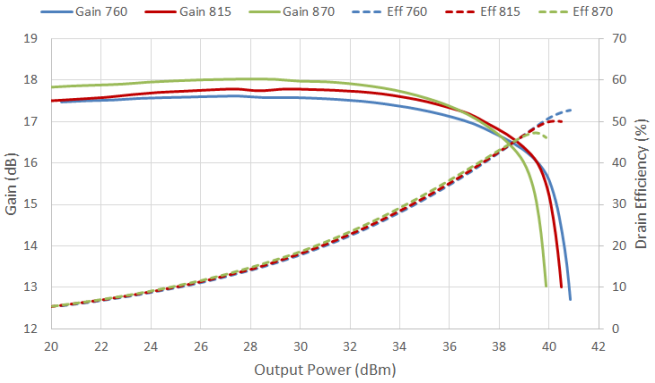

Figure 6.7.2 Gain, DE v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

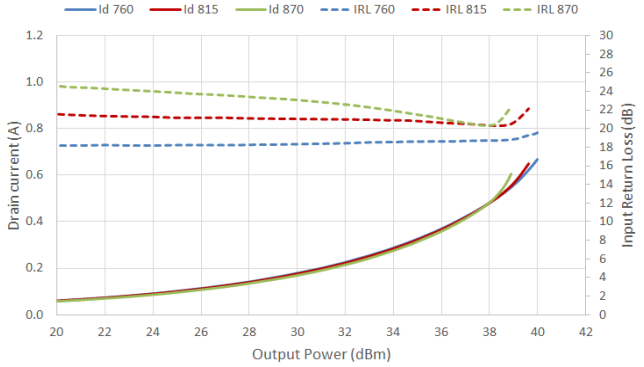

Figure 6.7.3 Drain Current and IRL v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

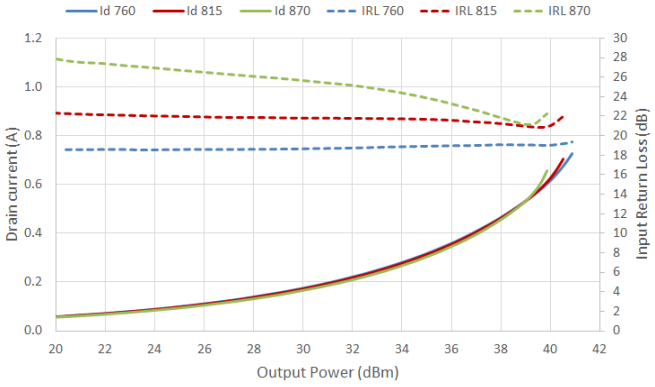

Figure 6.7.4 Drain Current and IRL v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

6.8. H2dBc and H3dBc vs Pout@ 28 V and 32 V, 30 mA.

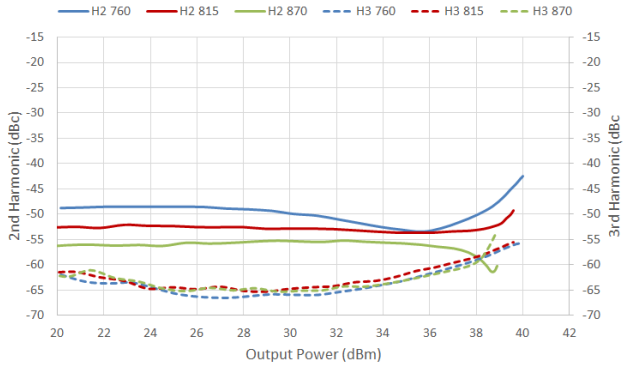

Figure 6.8.1 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=28 V, IDQ=30 mA

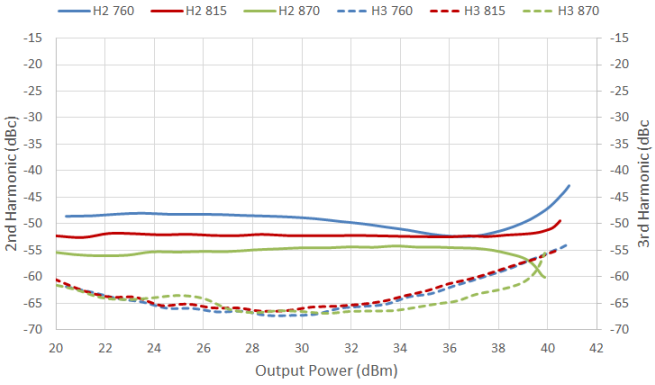

Figure 6.8.2 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=32 V, IDQ=30 mA

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