# TA9210D+TS7441L

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

**Application Note: TA9210D+TS7441L EVB K**

Application Note

135MHz~870MHz

28V 50mA

Rev-1.1

## List of Contents

## 1. General Description

The TA9210D is a broadband GaN power transistor capable of delivering 12W CW from 30MHz to 2.7GHz 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 1MHz to 2.7GHz 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 (135MHz ~ 870MHz). The design can be applied in public safety or tactical radio system. TA9210D+TS7441L-EVB-K is tuned from 135MHz to 870MHz.

## 2. TA9210D+TS7441L-EVB-K Board Details

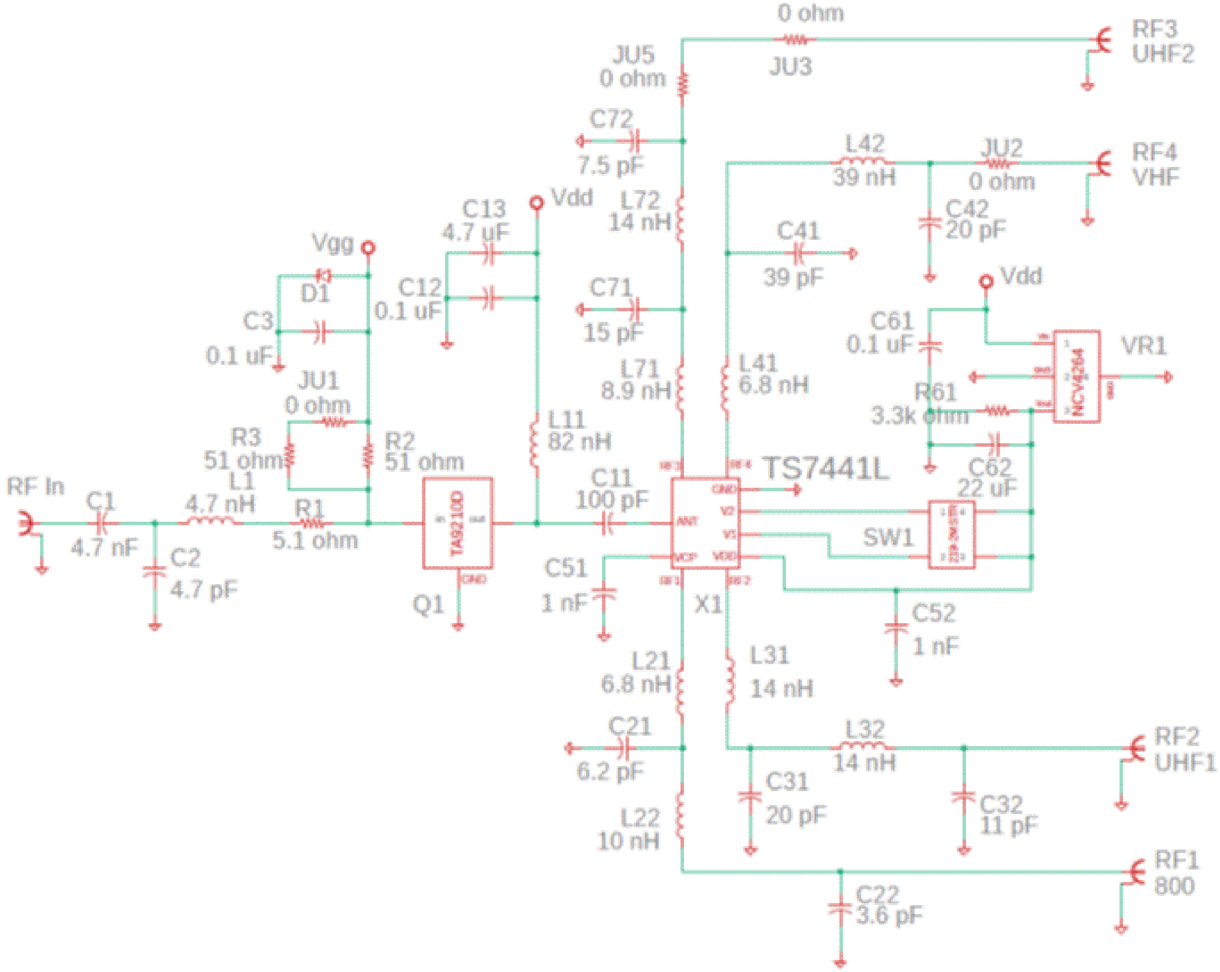


**Figure 2.1 TA9210D+TS7441L-EVB-K 135MHz ~ 870MHz Schematic and EVB Layout**

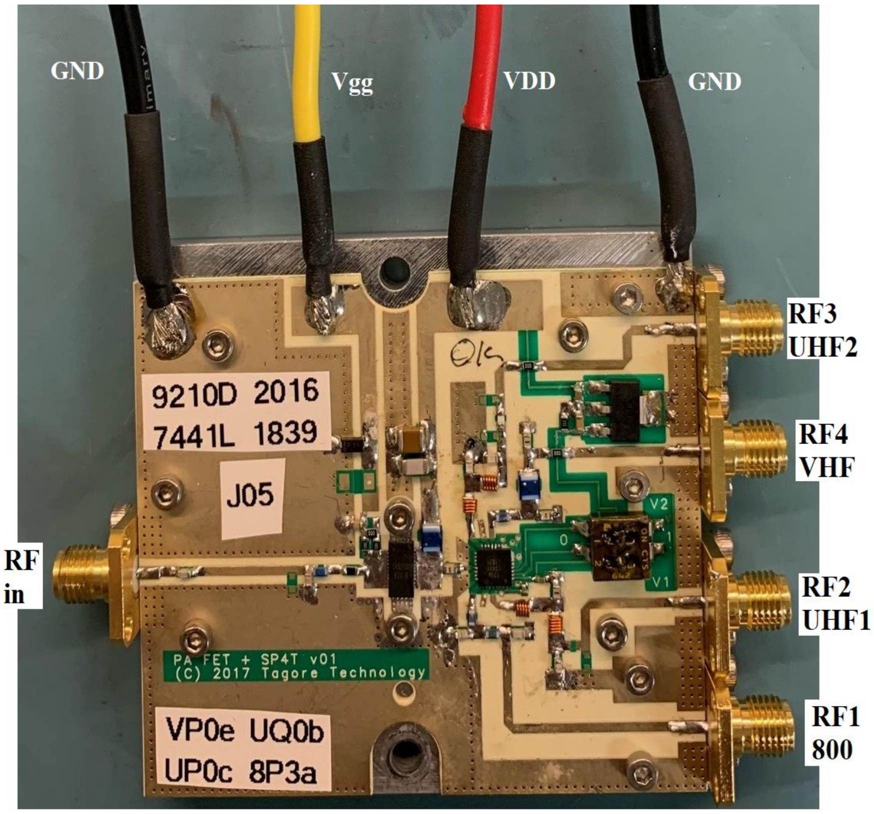


**Figure 2.2 TA9210D+TS7441L-EVB-K 135MHz ~ 870MHz Schematic and Assembled Board**

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

| Part Label | Part Description | Vendor Name | Vendor Part Number |
|---|---|---|---|
| C1 | 4.7nF 50V 0603 | Murata | GRM1885C1H472JA01D |
| C2 | 4.7pF 250V 0603 | AVX | 600S4R7BT250XT |
| L1 | 4.7nH 0603 | Coil craft | 0603HP-4N7XG |
| R1 | 5.1 ohm 0603 1/4 W | Vishay | RCS06035R10FKEA |
| R2, R3 | 51 ohm 0603 1/4 W | Vishay | RCS060351R0FKEA |
| C3 | 0.1uF 10V 0603 | AVX | 0603ZC104K4T2A |
| D1 | 7.5V Zener | On-Semiconductor | MMSZ5236BT1G |
| Q1 | PA device | Tagore Technology | TA9210D |
| X1 | SP4T Switch | Tagore Technology | TS7441L |
| C51, C52 | 1nF 100V 0402 | Murata | GCM155R72A102KA37D |
| L11 | 82nH 1008 | Coil craft | 1008HQ82XJ |
| C11 | 100pF 250V 0603 | AVX | 600S101JT250XT |
| C12 | 0.1uF 50V 1206 | Murata | GRM31C5C1H104JA01L |
| C13 | 4.7uF 100V 1210 | Murata | GCM32DC72A475KE02L |
| JU5* | 0 ohm 0603 | Vishay | CRCW06030000Z0EA |
| JU1, JU2, JU3 | 0 ohm 0603 | Vishay | CRCW06030000Z0EA |
| L21, L41 | 6.8 nH 0603 | Coil craft | 0603HC-6N8XJ |
| C21 | 6.2pF 250V 0603 | AVX | 600S6R2CT250XT |
| L22 | 10nH 0603 | Coil craft | 0603HC-10NXG |
| C22 | 3.6pF 250V 0603 | AVX | 600S3R6BT250XT |
| L31, L32, L72 | 14nH 0807 | Coil craft | 0807SQ-14NG |
| C31, C42 | 20pF 250V 0603 | AVX | 600S200GT250XT |
| C32 | 11pF 250V 0603 | AVX | 600S110GT250XT |
| C41 | 39pF 250V 0603 | AVX | 600S390JT250XT |
| L42 | 39nH 1008 | Coil craft | 1008HQ-39XG |
| L71 | 8.9 nH 0806 | Coil craft | 0806SQ-8N9GL |
| C71 | 15pF 250V 0603 | AVX | 600S150GT250XT |
| C72 | 7.5pF 250V 0603 | AVX | 600S7R5JT250XT |
| SW1 | DPST DIP Switch | CTS Electronic | 219-2MSTR |
| VR1 | 3.3V Regulator | On-Semiconductor | NCV4264-2CST33T3G |
| R61 | 3.3k ohm 0603 | Vishay | CRCW06033K30JNEB |
| C61 | 0.1uF 100V 0603 | Murata | GCM188R72A104KA64D |
| C62 | 22uF 6.3V 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 - 870MHz |
| RF2 | On (1, Right) | Off (0, Left) | 380 - 450MHz |
| RF4 | On (1, Right) | On (1, Right) | 135 - 175MHz |
| 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 **+ 28V or +32V.**
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 -3.2V**)
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 | 0.6A@40dBm |
| 380-450 | 38.8-40 | 66-70 | -35 to -51 | -55 to -75 | -10 to -11.5 | 0.55A@40dBm |
| 450-520 | 40.5-40.8 | 62-63 | - 32 to -41 | -47 to -65 | -10 | 0.7A@40.5dBm |
| 760-870 | 39-40 | 48-53 | -43 to -60 | -55 to -68 | -20 to -24 | 0.7A@40dBm |

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

# 6. TA9210D+TS7441L-EVB-K Test Results

All the tests are carried out at room temperature.

**135-175MHz- VHF Band**

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

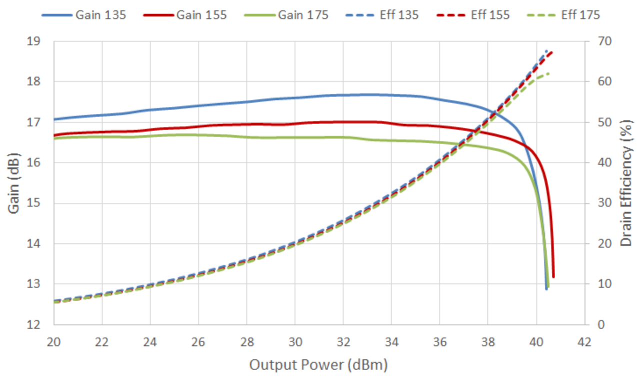


**Figure 6.1.1 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

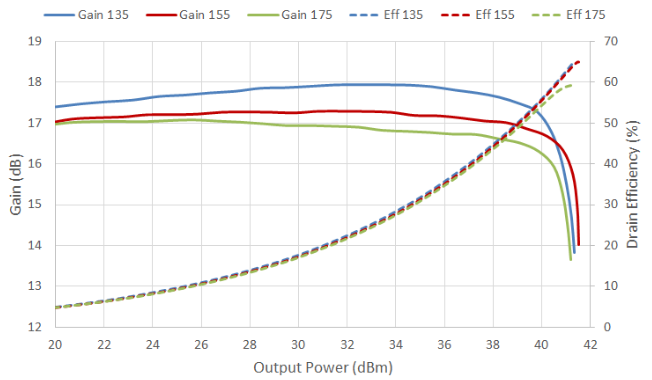


**Figure 6.1.2 Gain, DE v/s Pout of TA9210D+TS7441L-EVB-K, VD=32V IDQ=30mA**

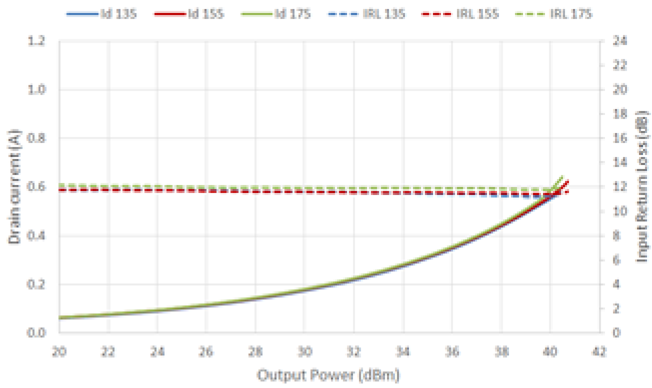


**Figure 6.1.3 Drain Current and IRL v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

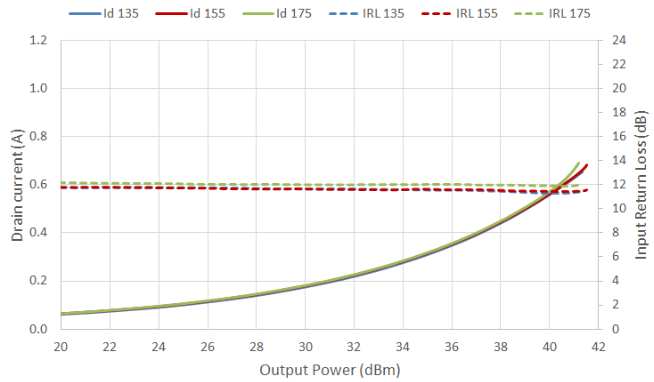


**Figure 6.1.4 Drain Current and IRL v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

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

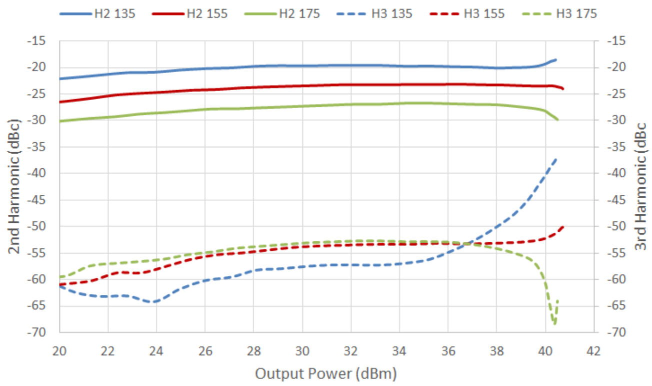


**Figure 6.2.1 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

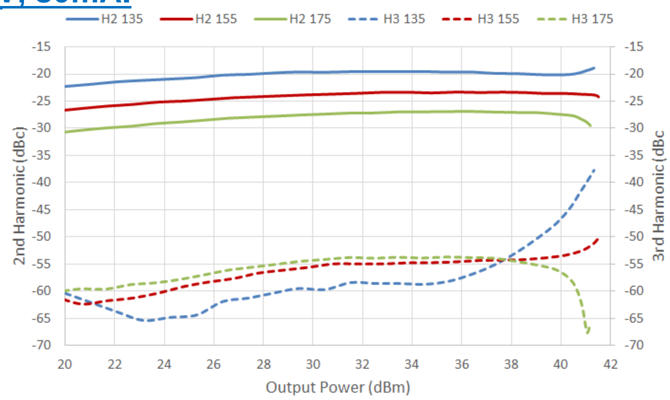


**Figure 6.2.2 H2dBc and H3dBc v/s Pout of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

## 380-450MHz- UHF1 Band

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

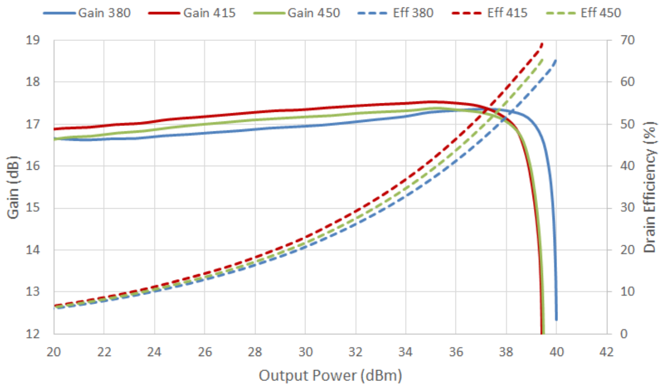


**Figure 6.3.1 Gain, DE v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

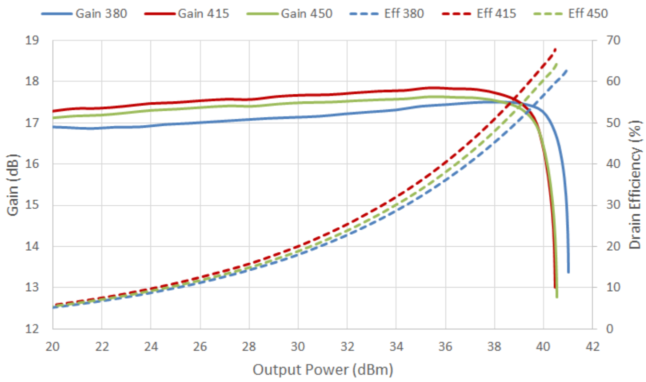


**Figure 6.3.2 Gain, DE v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

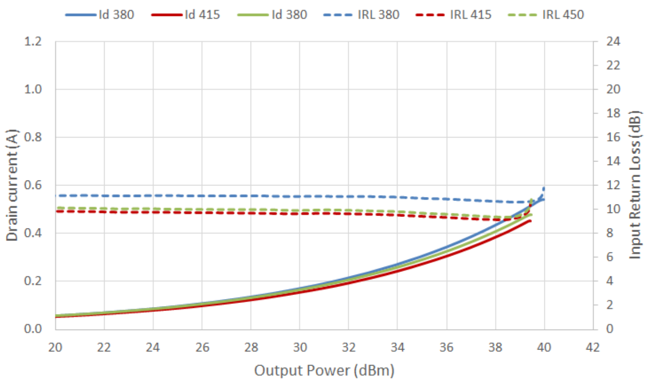


**Figure 6.3.3 Drain Current and IRL v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

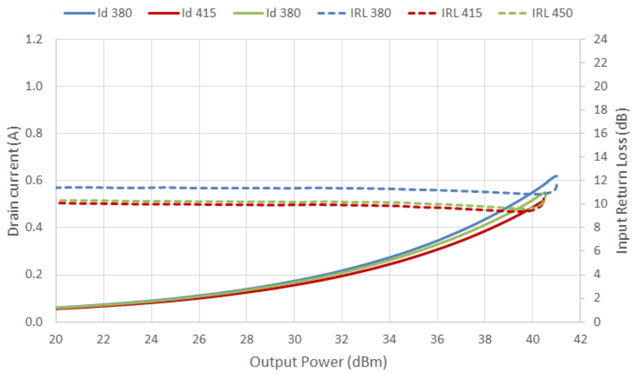


**Figure 6.3.4 Drain Current and IRL v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

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

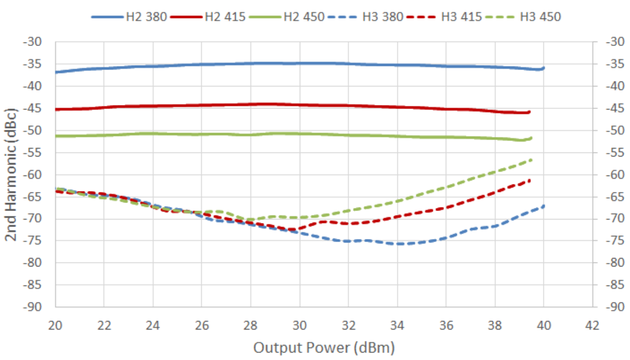


**Figure 6.4.1 H2dBc and H3dBc v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

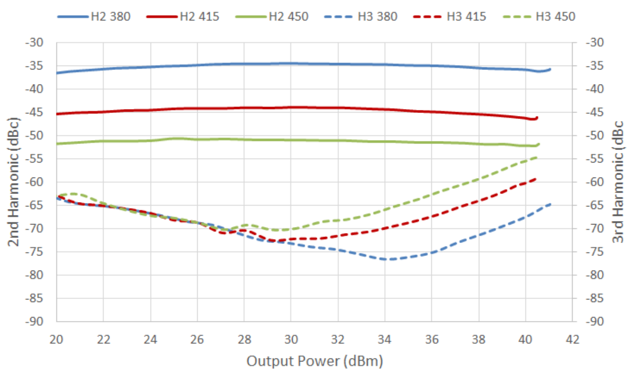


**Figure 6.4.2 H2dBc and H3dBc v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

# 450-520MHz- UHF2 Band

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

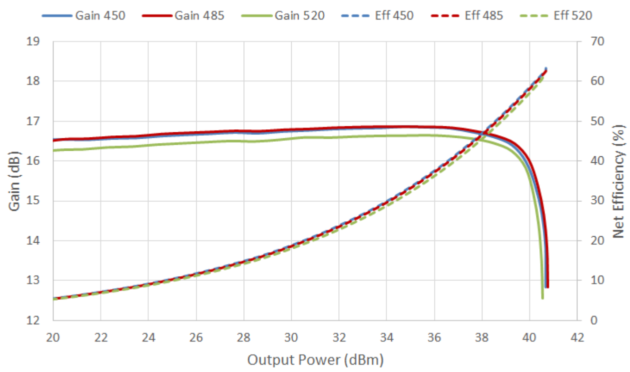


**Figure 6.5.1 Gain, DE v/s Pout**
**Of TA9210D+TS7441L-EVB-K, VD=28V,**
**IDQ=30mA**

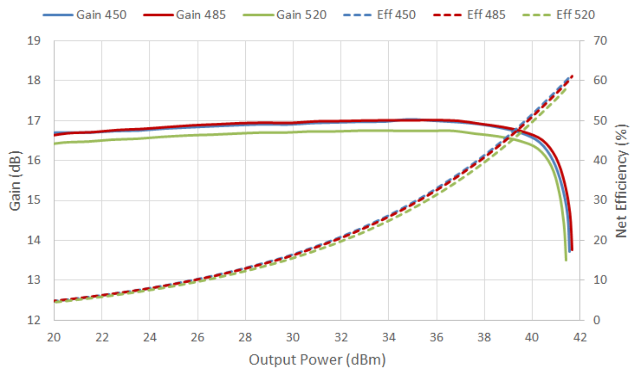


**Figure 6.5.2 Gain, DE v/s Pout**
**Of TA9210D+TS7441L-EVB-K, VD=32V,**
**IDQ=30mA**

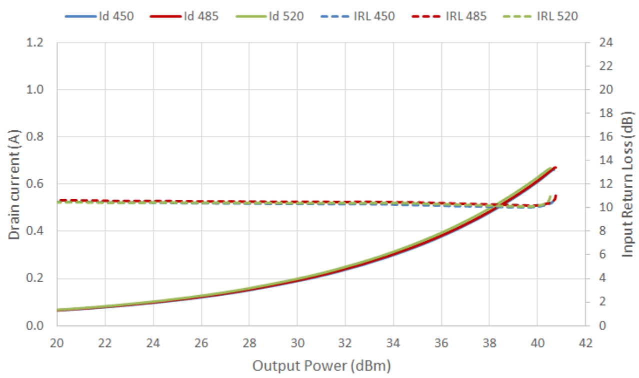


**Figure 6.5.3 Drain Current and IRL v/s Pout**
**Of TA9210D+TS7441L-EVB-K, VD=28V,**
**IDQ=30mA**

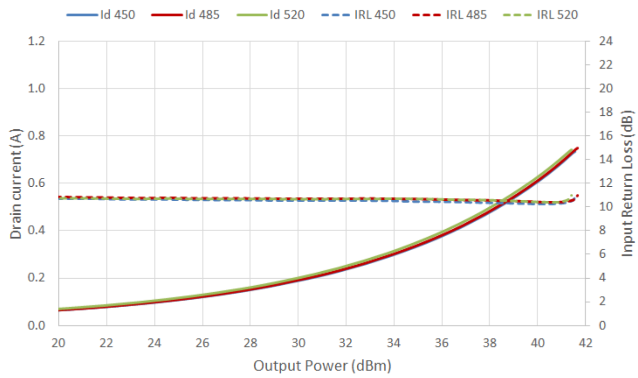


**Figure 6.5.4 Drain Current and IRL v/s Pout**
**Of TA9210D+TS7441L-EVB-K, VD=32V,**
**IDQ=30mA**

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

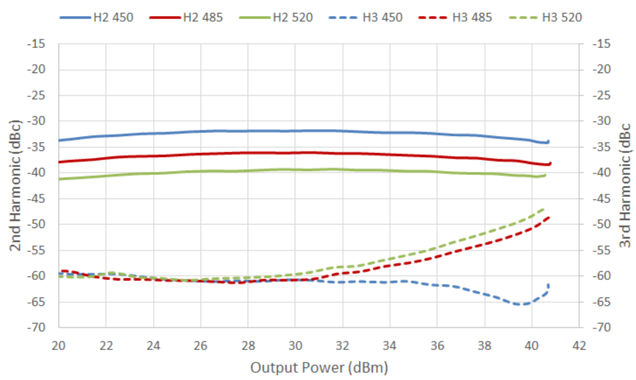


**Figure 6.6.1 H2dBc and H3dBc v/s Pout**
**Of TA9210D+TS7441L-EVB-K, VD=28V,**
**IDQ=30mA**

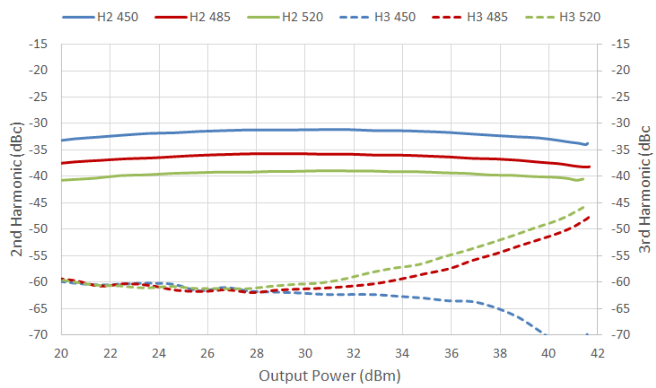


**Figure 6.6.2 H2dBc and H3dBc v/s Pout**
**Of TA9210D+TS7441L-EVB-K, VD=32V,**
**IDQ=30mA**

# 760-870MHz- 800MHz Band

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

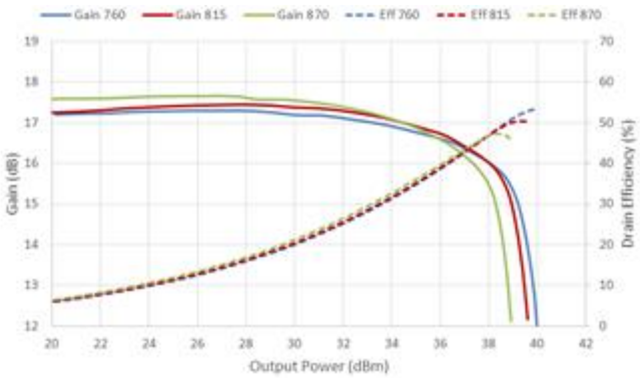


**Figure 6.7.1 Gain, DE v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

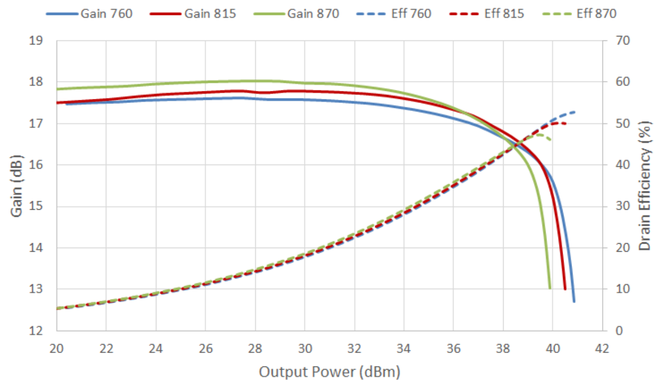


**Figure 6.7.2 Gain, DE v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

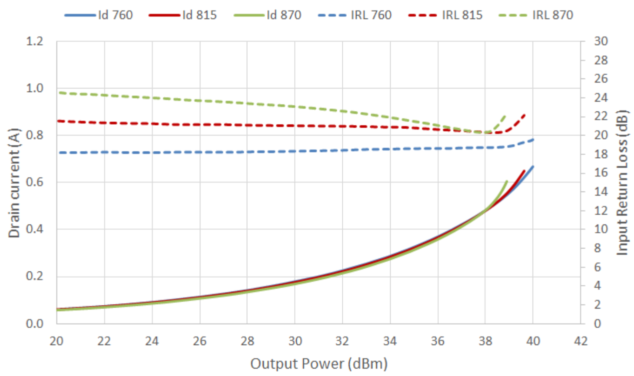


**Figure 6.7.3 Drain Current and IRL v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

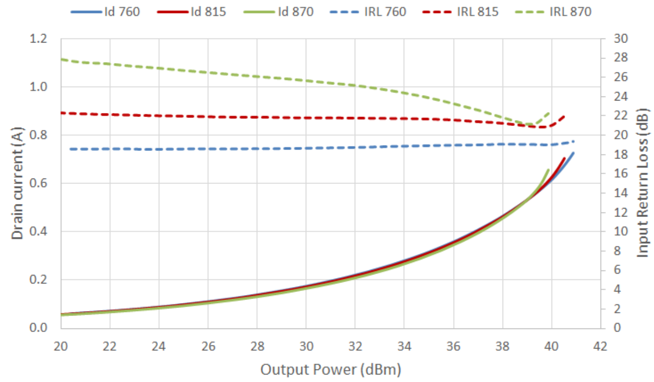


**Figure 6.7.4 Drain Current and IRL v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

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

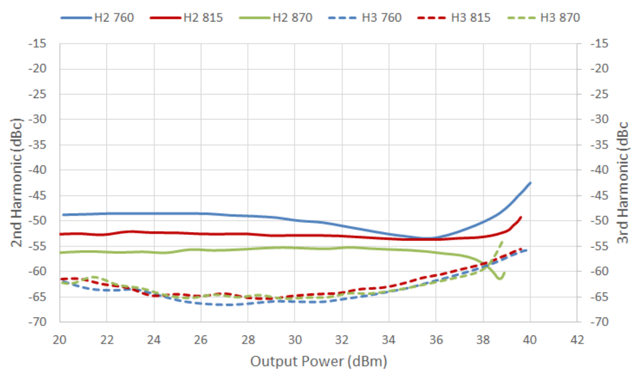


**Figure 6.8.1 H2dBc and H3dBc v/s Pout Of TA9210D+TS7441L-EVB-K, VD=28V, IDQ=30mA**

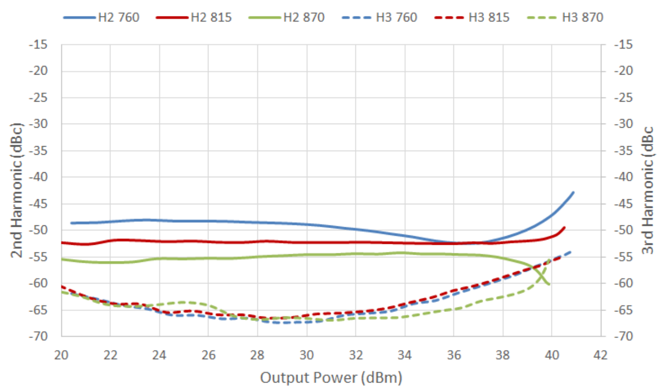


**Figure 6.8.2 H2dBc and H3dBc v/s Pout Of TA9210D+TS7441L-EVB-K, VD=32V, IDQ=30mA**

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