Tagore Technology Inc

Application Note
High Power Switch solution for low charge-pump spur noise requirement

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Introduction

Tagore Technology has portfolio of high-power RF GaN Switches. Switch contain GaN die and CMOS controller die. Tagore GaN switches are designed with integrated controller. The GaN device requires negative voltage to properly control switch devices. The negative voltage is generated internally within controller using charge pump circuit. The charge pump circuit inherently generates switching spur at the switching frequency and harmonics of switching frequencies. This switching spurs are greatly reduced by external bypass capacitor connected on VCP pin of the IC as shown in figure 1. Recommended value for bypass capacitor is 1nF with voltage rating of 50V. Typical spur performance at lower frequency of operation (below 300MHz) is between -110dBm to -130dBm with resolution bandwidth of 10KHz. Figure 2 shows low frequency noise performance measured at all four RF ports for TS8441L; 30W 4T RF switch. The plot also shows noise level when “Thru” is connected instead of RF Switch to show measurement noise floor. The spur level above 300MHz of operating frequency should be below -135dBm which is sufficient for most of the applications. However, for applications operating at VHF and UHF band and if RF switch falls in the receive path of the system, this spur performance is not sufficient. They need to be below -134dBm, thermal noise floor for 10KHz channel bandwidth. Tagore switches with internal charge pump option doesn’t meet this noise requirement as shown in figure 2. This application note provide simple solution for those applications where noise needs to be below -135dBm (10KHz RBW) for frequency of operation below 300MHz

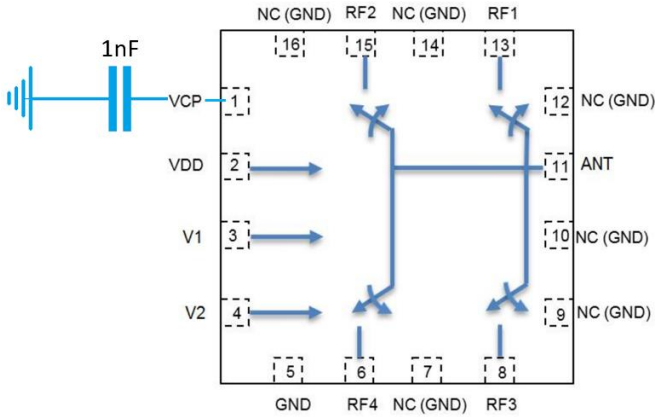

Figure 1: TS8441L Pinout

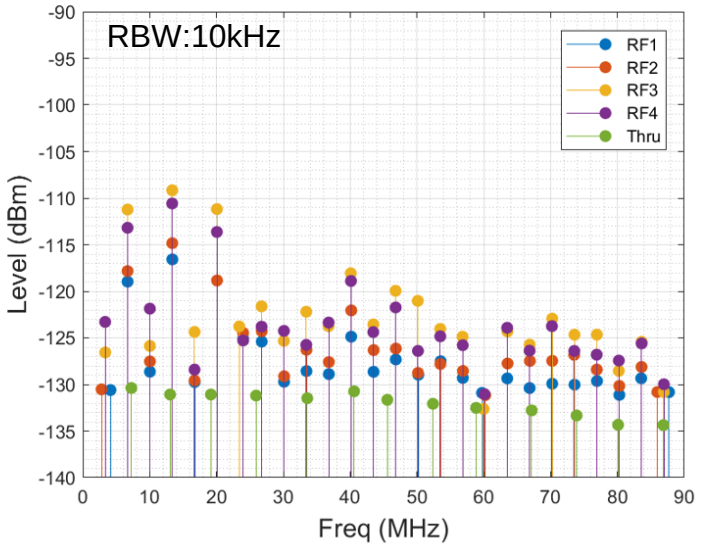

Figure 2: Noise performance for TS8441L

Solution

For application where low noise performance is required, Tagore has portfolio of switches designed with external charge pump voltage option. These switches require external negative voltage. This negative voltage can easily be fed from any Tagore RF switch product with internal charge pump as shown in figure 3. Tagore RF switches with internal charge pump circuit are designed to source required current for the switch with external charge pump option. It is recommended that each switch has its own bypass capacitor close to respective switches. In many instances there are multiple RF switches in system. In such instances the VCP voltage can be fed from switches which doesn't require very low noise performance (e.g., switches which fall in transmit path) to switch which require low noise performance (e.g., switches which fall in VHF & UHF Receive path). With this configuration the switch with external charge-pump option will have ultra low noise performance (<-134dBm) required to meet receiver sensitivity.

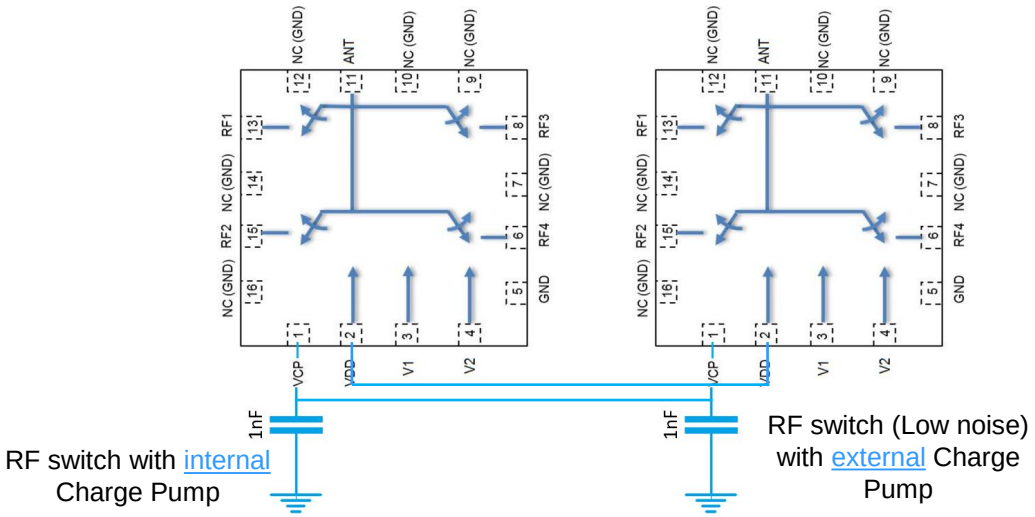

Figure 3: Low noise solution (Allowed)

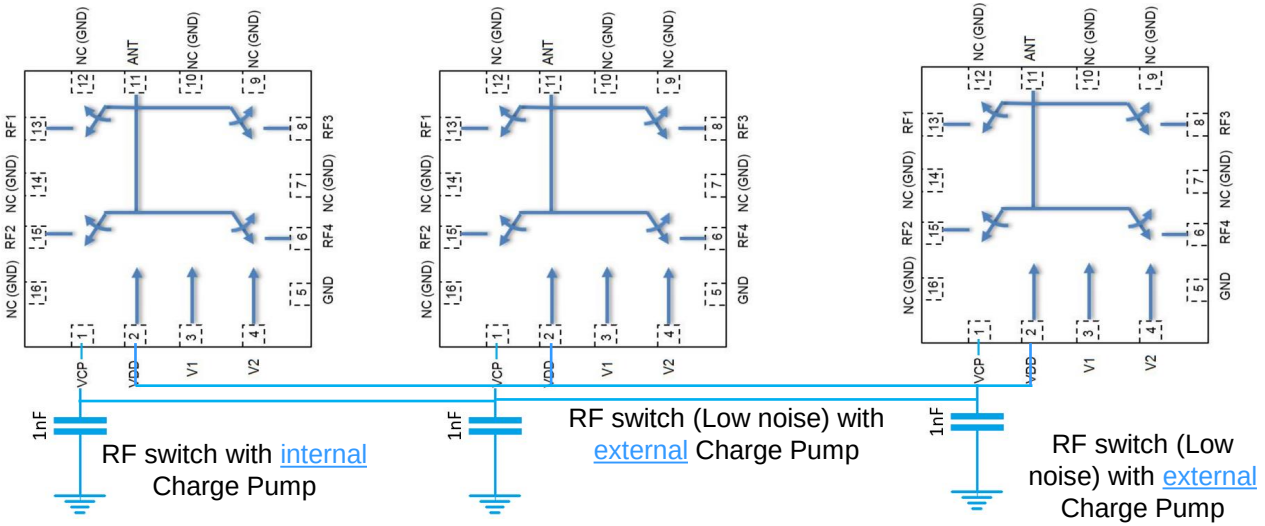

Figure 4: Low noise solution (Not allowed)

Important Note: Tagore RF switch with internal charge pump can be connected to only one with external charge pump switch. If there are more than one switch with external charge pump in system than the second one should be connected to different Tagore switch with internal charge pump option. For example, solution shown in figure 3 is allowed. The solution shown in figure 4 is not allowed. Also, it is must that both switches(internal charge pump option and external charge pump option) are powered by same regulator. Both switches should have bypass capacitor of 1nF or higher and they should be closer to respective switch.

Measured Performance

Noise performance was measured by feeding VCP voltage for TS84410L (external VCP option) from TS7225FK (Internal VCP option) as shown in figure 5. Both switches has it's 1nf bypass capacitor. Figure 6 shows the noise performance of TS84410L. Figure shows that all spurs are below noise floor of the measurement system. Figure 7 shows the close-in spectrum plot with improved measurement dynamic range. It is shown at frequencies which are typically worst-case in terms of noise performance for switches with internal charge pump option(Figure 2). Figure shows that all three worst-case spurs are below thermal noise floor.

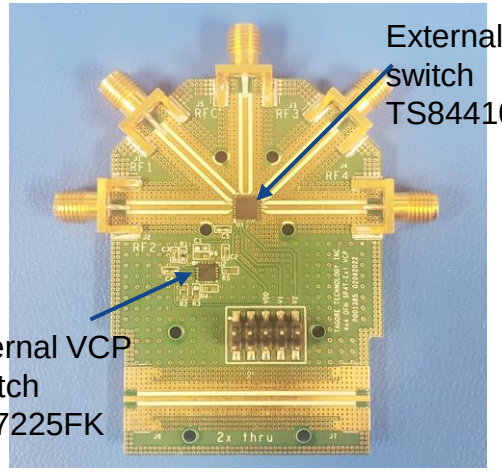

Figure 5: Validation EVB

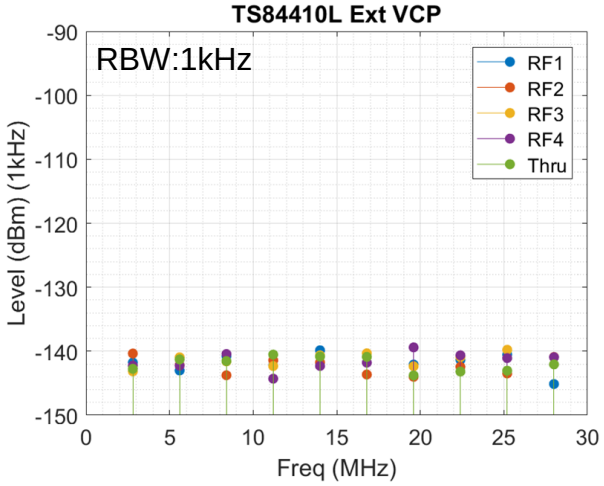

Figure 6: Noise performance of TS84410L(Ext CP option)

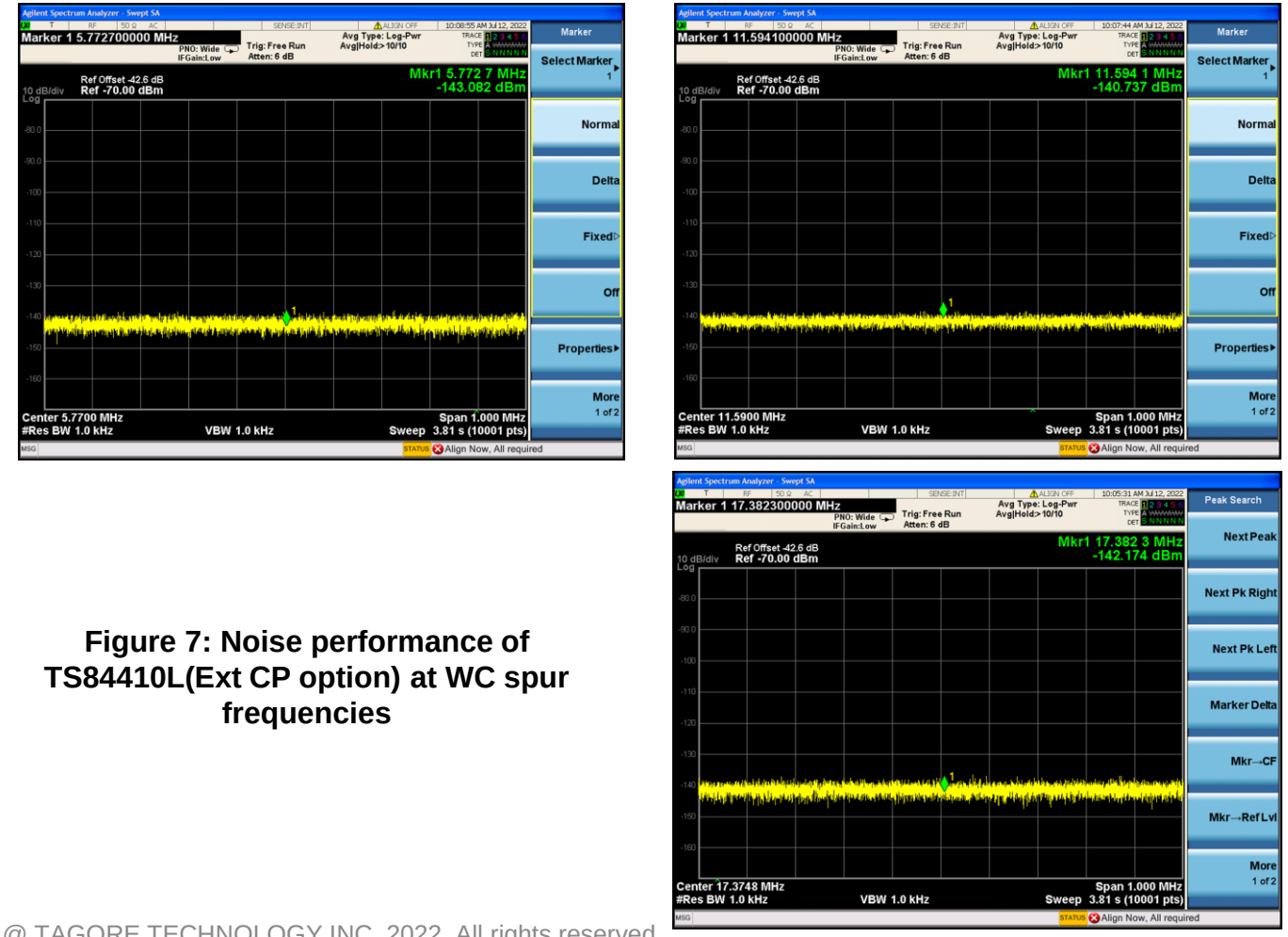

Figure 7: Noise performance of TS84410L(Ext CP option) at WC spur frequencies

Switch Portfolio with external CP option

Table below shows portfolio of switches offered by Tagore with external CP option which can be used along with switches with internal CP option to realize noise performance below thermal noise. This solution eliminate burden of generating negative voltage required for switches with external CP option. This solution doesn't add any additional hardware or cost where there are already multiple Tagore switches in system.

Tagore Technology Inc.- RF Switches

BYPASS RF SYMMETRIC SWITCHES – CHARGE PUMP DISABLED FOR VERY LOW - NOISE APPLICATIONS

Part Number	Spara	SPnT	Frequency	P0.1dB (CW)	Isolation 1/max GHz	IL 1/max GHz	H2/3(35 dBm)	Switching Time	Package	VDD, VCP Supply	Logic
					10W						
TS72250K	TS72250K.snp	2T	0.03 - 6 GHz	10W	40 / 15 dB	0.35 / 0.9 dB	81 dBc	0.7 us	3x3	2.6 - 5.5 V, -17 / -18 V	1.1 – VDD
TS72420K	TS72420K.snp	4T	0.03 - 3 GHz	10W	35 / 23 dB	0.4 / 0.8 dB	77 dBc	0.65 us	3x3	2.6 - 5.5 V, -17 / -18 V	1.1 – VDD
TS82420FK NEW!	TS82420FK.snp	4T	0.03 - 5 GHz	10W	40 / 18 dB	0.3 / 1.0 dB	-86 / -89 dBc	0.6 us	3x3	2.6 - 5.5 V, -18V	1.1 - VDD
					20W						
TS82250FK NEW!	TS82250FK.snp	2T	0.03 - 5 GHz	20W	46 / 22 dB	0.2 / 0.5 dB	-92 / -95 dBc	0.9 us	3x3	2.6 - 5.5 V, -18V	1.1 - VDD
					30W						
TS74230L	TS74230L.snp	2T	1 MHz - 3 GHz	30W	40 / 30 dB	0.4 / 0.6 dB	85 dBc	2.0 us	4x4	2.6 - 5.5 V, -17 / -18 V	1.1 – VDD
TS84410L NEW!	TS84410L.snp	4T	0.03 - 4 GHz	30W	37 / 20 dB	0.23 / 1.0 dB	-81 / -90 dBc	0.8 us	4x4	2.6 - 5.5 V, -18V	1.1 – VDD