DESIGN OF CONCURRENT DUAL BAND QPSK MODULATOR

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ABSTRACT

This paper proposes a new architecture of QPSK Modulator that enables concurrent transmission of two separate frequency bands 2.4/5.2 GHz in microstrip technology .This is required in order to realize a separate aggregation system . To demonstrate the effectiveness of this design, the results of a simulation in which QPSK signals were concurrently transmitted in two bands are presented. The rat race coupler and branch line coupler designed provide a very little phase deviation of 2° and 1.5 °. Schottky diode is used for switching purpose.

KEYWORDS: QPSK, Wilkinson Power Divider, Rat Race Coupler, Branch Line, Coupled Line

There is an increasing demand for additional services along with the traditional and standard wireless services. With the rapid increase in the use of mobile terminals for wireless communication, WLAN using ISM frequency bands of 2.4 GHz and 5.2 GHz .Each user's data is identified by a different pseudo-random code modulating the data using Quadrature Phase-shift Keying (QPSK). Several microwave digital communication links employ QPSK modulation as the preferred scheme for terrestrial [2] as well as satellite communications due to its ability to minimize Bit Error Rate (BER). Moreover a user wants to make the best use of the available wireless devices and expects the device to provide him with multiple services at the same time.

The original power divider developed by Wilkinson [1] consists of two quarter-wavelength lines and operates in a single band.For dual band operation of Wilkinson power divider [2-4],coupled line provide good power division with efficient isolation. A coupled line has advantages, such as compact structure and flexible to design..Rat race coupler have been developed [6-7]for multi band operation providing low loss.Also branch line couplers implementing with less phase distortion and good isolation[7-9].Compact and fast SPST switches [10-11] increases the overall output performance.

PROPOSED ARCHITECTURE

The proposed QPSK modulator consists of one dual band four Way Wilkinson power divider(which is a combination of three two way Wilkinson power divider two power divider connected at the output of one power divider)four broadband SPST switch, two dual band rat race coupler and one dual band branch line coupler. Four way Wilkinson power divider is used to split RF carrier signal into four equal phase equal amplitude signal. So signals coming out from dual band four ways Wilkinson power divider are in same phase and amplitude. After that four signals go through four broadband SPST switch. By proper biasing these switch either makes way for the signal or block the signals. Input digital data is provided by proper biasing of switch (when switch is on then it represents bit 1 and when it is off then it represent bit 0). Output of two switches goes to dual band rat race coupler. Here rat race coupler is used as 180° phase shifter. So the two rat race coupler modulates the carrier signal with one bit data, thus obtaining a BPSK modulation. Two BPSK signals are combined using a branch line coupler (acts like a quadrature combiner) which shifts the phase of one of the BPSK signal by 90°, hence achieving a QPSK signal at the output.

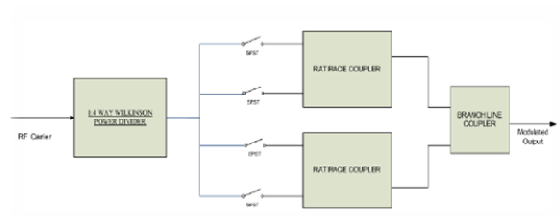

Figure 1: Block diagram of proposed QPSK Modulator

The modulator is designed using three basic microwave couplers the Wilkinson divider, branch line hybrid coupler and the Rat Race Coupler. The three structures are designed utilizing AD 450 laminate of thickness 0.508 mm with a permittivity of 4.5. The width of a 50 W line, for these specifications of the substrate, is 0.94mm. The Wilkinson and hybrid couplers, used in this modulator, are designed with the help of bends instead of curves since the bends demonstrate better response at higher frequencies.

LAYOUT AND SIMULATION RESULTS

The proposed dual band components are designed to operate in 2.4/5.2 GHz..The simulation is done in ADS (Advanced Design System) software and the scattering parameters are analyzed. The NH9320

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substrate which has 15µm thickness and a relative permittivity of 3.2 is used.

Dual Band 4-way Power Divider

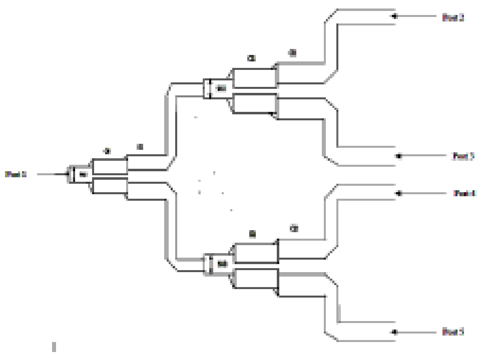

Figure 2: Layout of 1:4 dual band Wilkinson power divider

Table 1: Specification of the coupled line in 1:4 way

Characteristic Impedance(Z)	Length(L) mm	Width(W) mm	Spacing(S) mm
(Cl1) 58.8048 Ω	12.1662	2.43217	0.477336
(Cl2) 50.2752 Ω	11.2138	3.24632	0.51926
50 Ω	10	3.6441	-

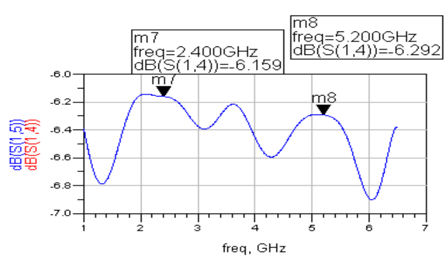

Figure 3: Power in dB (port 2 and port 3) and (port 4 and port 5)

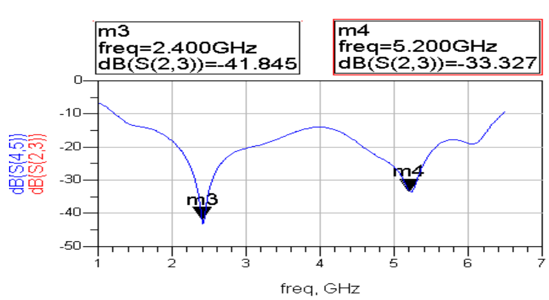

Figure 4: Isolation at two frequencies

Dual band Rat Race Coupler

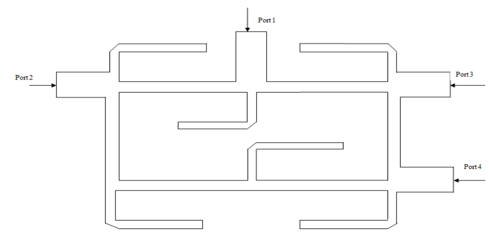

Figure 5: Layout of dual band rat race coupler

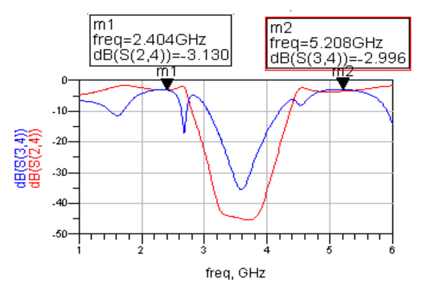

Figure 6: Power in dB from port 4 to port 2 and port 3

Table 2: Specification of microstrip used in rat race coupler

Characteristic Impedance(Z)	Length(L)	Width(W)
84.47006 Ω	12.7336 mm	1.38789 mm
50 Ω	10 mm	3.6441 mm

Insertion loss is nearly -3dB and phase difference is 178.994° at lower frequency and 182.688° which is close to 180°.

Dual band Branch Line Coupler

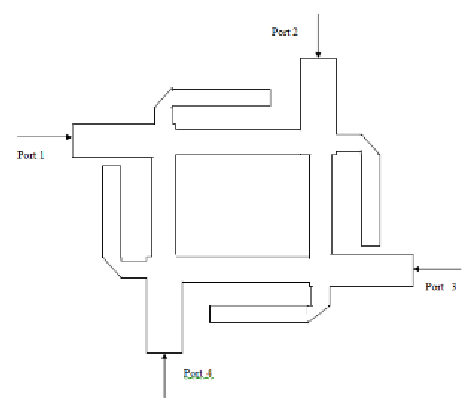

Figure 7: Layout of dual band BLC

Table 3: Specification for microstrip in branch line coupler

Characteristic Impedance(Z)	Length(L)	Width(W)
42.22865207 Ω	13.51343 mm	4.717050 mm
59.7293523 Ω	13.494425 mm	2.715860 mm
50 Ω	10 mm	3.6441 mm

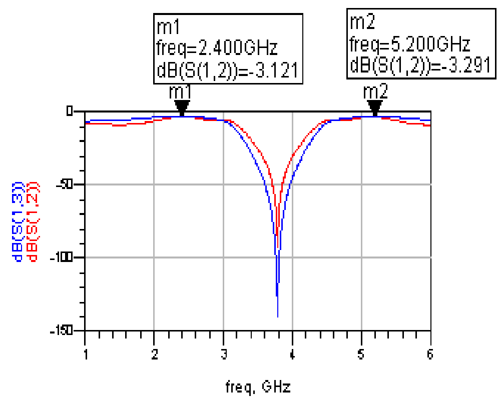

Figure 8: Power in dB at port 2 and port 3 from port1

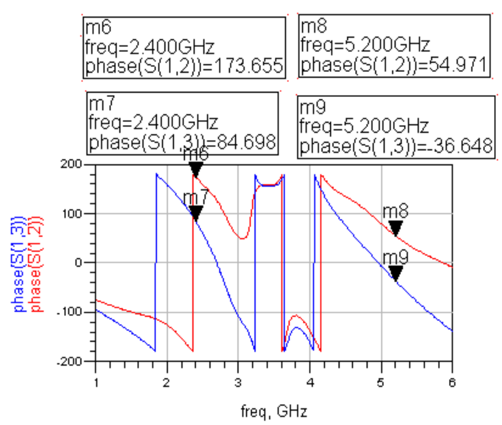

Figure 9: Phase at port 2 and port 3

Phase difference is 88.957° at lower frequency and 91.619° which is ≅90° at both frequencies

Design of the Switch

In proposed QPSK modulator 4 SPST switch are used. Schottky diode (HSMS286-K) is used.

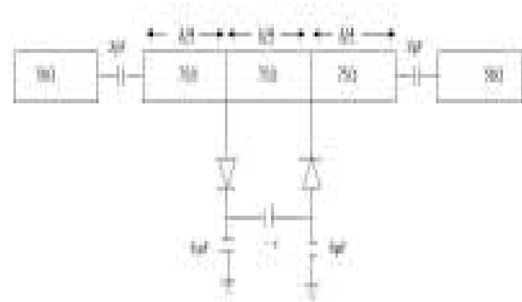

Figure 10: Layout design of SPST Switch

Table 4: Microstrip line used in SPST switch

Characteristic Impedance(Z)	Length(L)	Width(W)
75 Ω	5.250304 mm	0.904985mm
50 Ω	10 mm	3.6441 mm

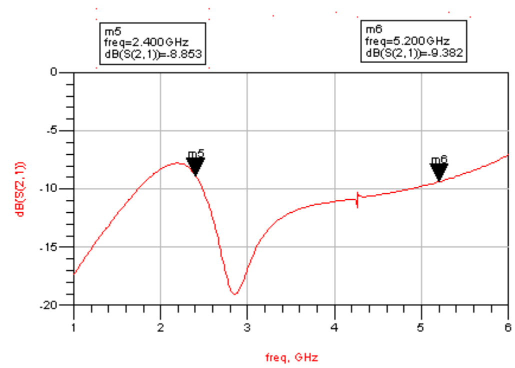

Figure 11: Isolation loss of the switch at the two frequencies

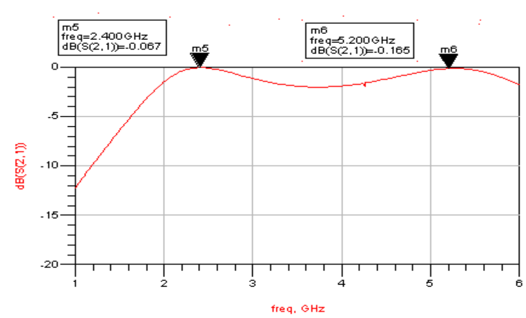

Figure 12: Insertion loss of switch at two frequencies

CONCLUSION

Rigorous design for concurrent dual band QPSK modulator for 2.4/5.2 GHz has been presented. Concurrency would not only greatly reduce the circuit complexity and size but also solve the problem of power dissipation that arises while using multiple circuits for a multi-band modulator. A 4 way power divider is used to divide the power in equal phase and amplitude. For biasing simplification shunt switches (two series connected diode) are used.

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