DESIGN AND SIMULATION OF MICROSTRIP 16-PSK MODULATOR FOR WIRELESS COMMUNICATION APPLICATIONS

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ABSTRACT

In this paper, we present a new topology of 16-phase shift keying modulator at the frequency 2.4GHz that allows achieving a very high accuracy with very low power consumption. In this various PSK modulation schemes are presented which is designed for the wireless communication systems using MIC (microwave integrated circuit) techniques. This modulator is fabricated using microstrip lines on ADS (Advance design system) software. The 16-PSK modulator consist of QPSK modulator, Branch line coupler, rat race coupler, power combiner, 8-PSK and switches designed at the S-band that allows to achieve a very high accuracy in phase. The configuration of the proposed modulator is of parallel type. The passive components are very easy to fabricate, occupy the reasonable area and provide satisfactory performance. It provides high isolation between the carrier input port and output port and the phase error is less than 1º. Amplitude and phase variation are very less and can be extended to the millimeter - wave band.

I. INTRODUCTION

There have been always demandsfor high quality, high data rate and high spectral efficiency in communication systems. Moving to higher modulation techniques, the number of discrete signals allows, increases the amount of information per symbols, although greater energy is required to maintain the same distance between signal vectors. Due to the above facts, the number of researchers [1-4] gives their great attention to it. The reduction of weight and cost due to quasi absence tuning is the key feature of PSK modulator. Moreover, it provides good reproducibility and high reliability. These modulation schemes permits the high amount of information to be carried within the same bandwidth with little additional complexity. There are two types of modulators, which are categorized on the basis of fabrication techniques, namely balanced modulator and path-length modulator. In the balanced type modulator the path length is same, so no variation in signal is present and hence no circulator is required. The path length modulators are divided into two, reflection type modulator and transmission type modulator. The Transmission- type modulators use two microstrip lines with different lengths. The reflection type modulators have been constructed by MIC 3-dB branch line hybrid coupler.

II. DESIGN CONSIDERATION AND DISCUSSION OF RESULTS

The microwave integrated circuit modulator has been simulated for use in digital and wireless communication which requires some additional features and circuitries. A general block diagram of various PSK modulators is shown in Figure 1.The substrate used for the modulators is FR-4 and the thickness of the substrate is (*h*) =0.08mm, conductor thickness (*t*) =0.035mm, dielectric constant (ε)=4.4 and tangent loss=0.001.

PSK Modulator: Various Digital keying modulators are designed with reference to RF section. BPSK is achieved through the help of 180º hybrid (Rat- race) followed by a switch. It is a four port network with 180° phase shift between the two output ports. The signal applied to port1 will be eventually split into two in phase components at ports 2 and 3, and port4 be isolated. If the input is applied to port 4, it will be equally split into two components with a 180° phase difference at ports 2 and 3, and port 1 will isolated. When operated as a as a combiner, with input signals applied at ports 2 and 3, the sum of the inputs will forms be at port 1, while the difference will be formed at port 4. Hence, port 1 and 4 are referred to as the sum and difference ports respectively. Table I shows the designing parameter of the Rat Race coupler. Length and width of the stubs are calculated by using line calculator of ADS software.

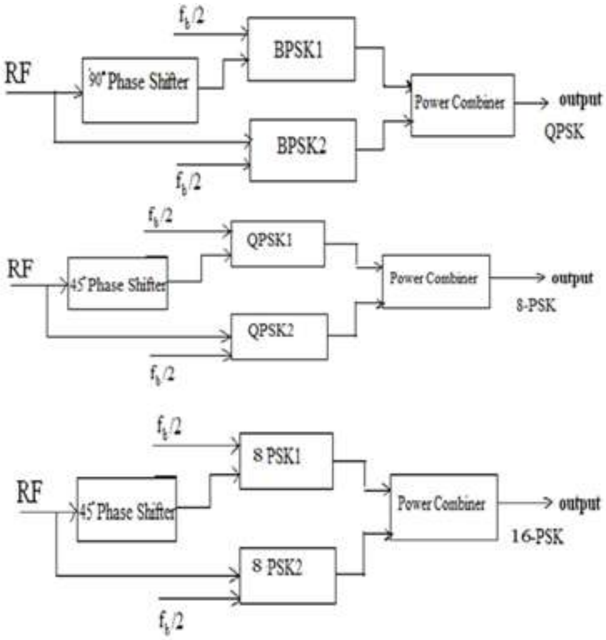

Fig. 1 Block diagram of 16-PSK modulator

TABLE I: Rat Race Coupler Designing Parameters

$\sqrt{2}\ z_0$ = 70.7106ω	$z_0/2$ =35. 35ω	z_0 = 50ω
βl = 90°	βl = 270°	βl =90°
w= 0.76635mm	*w* = 0.76635mm	*w* = 1.4897mm
l = 17.7077mm	*l* = 53.1232 mm	*l* = 17.1900mm
r =16.9179mm	*r* = 16.918mm	-
angle=60°	angle = 180°	-

2.1 Binary phase Shift Keying: The Binary Phase shift keying designed by the Rat Race and a switch. Binary Phase shift keying has two states, state 1 and state 2.The phase difference between two outputs state 1and state 2 of BPSK is 180°.The schematic and simulation results are shown in Table II. This table shows the phase difference of 180º at 2.4GHz of frequency.

TABLE II: BPSK Modulator Results

s.no	Bit	Frequency (GHz)	measure phase(deg)	equivalent phase(deg)	Error(deg)
1	0	2.4	-92.649	-90	0
2	1	2.4	88.021	+90	0.670

2.2 8-PSK Modulator: 90º phase difference between the output ports. The power combiner PC1 and PC2 combine the power obtain from their respective BPSK. The configuration of the 8-PSK modulator consists of two parallel connected QPSK modulators with a switch and a power combiner and 45º phase shifter. The amplitude and phase error for 8-PSK directly depends on the accuracy in amplitude and phase of phase shifter and elementary modulator. Here we have designed Branch line coupler for 45° phase difference between the through and coupled arms. The branch line coupler (BLC1) provides 45º phase difference between the two outputs at port3 and port4. The BLC2 and BLC3 provide

The eight phase states of 8-PSK modulator are shown in table III. The table III shows the results between the phase and frequency. The phase error is less than 1º. The phase error also includes that of the power combiner the branch line coupler, therefore the phase error of the 8-PSK modulator is greater than the QPSK modulator. Table III shows the eight states of phase with measured + reference phase and error. The reference phase is 5.4220.

TABLE III: 8-psk Modulator Results

s.no	Bit	Freq(GHz)	measure phase(deg)	equivalent Phase(deg)	Error(deg)
1	000	2.4	-5.422	0	0
2	001	2.4	40.495	45	0.917
3	100	2.4	85.278	90	0.7
4	101	2.4	131.140	135	1.662
5	110	2.4	175.374	180	0.796
6	111	2.4	138.711	-135	1.711
7	010	2.4	-95.316	-90	0.106
8	011	2.4	-49.453	-45	0.969

2.3 16-PSK Modulator: It is an M array encoding technique where M=16 therefore 16 different output phases possible. Four bits are sent at a time. Minimum bandwidth and baud equals to ¼ of the bit rate i.e. $f_b/4$. Angular separation between adjacent output phases is 22.5º. Phase shifts during transmission and still retains its integrity.

M-PSK is a method of modulating a carrier with a unique symbol. Each symbol consists of two or more bits. The number of unique data states is defined as M = 2", where *n* represents the number of bits which comprise the symbol. A 16-PSK scheme would utilize a symbol containing four data bits to shift the phase of a carrier, 16 distinct amounts. In 16PSK modulation, the alphabets $\{1, e^{\frac{j2\pi}{M}}, e^{\frac{j4\pi}{M}}, \dots\dots, e^{\frac{j2\pi(M-1)}{M}}\}$ is used, where M=16.

TABLE IV:Designing Parameters for 16-PSK

$\sqrt{2}\, Z_0 = 70.7106\Omega$	$\sqrt{2}\, Z_0 = 70.7106\Omega$	$Z_0 = 50\Omega$
βl = 90°	βl = 270°	βl = 90°
W = 0.76635mm	W = 0.76635mm	W = 1.4897mm
L = 17.7077mm	L = 53.1232 mm	L = 17.1900mm
R =16.9179mm	R = 16.918mm	-
Angle=60°	Angle=180°	-

By using above parameters 16-PSK modulator is designed on Agilent ADS software, and results are shown in table below. Table IV shows the phase difference of 22.5º at 2.4GHz. This shows that we have successfully designed the microstrip 16-PSK modulator.

TABLE V: 16-PSK Results at 2.4GHz

s. n	bit	measure phase (degree)	measure phase+reference phase(deg)	Error (deg)
1	0 0 0 0	-5.588	0	0
2	0 0 0 1	61.916	67.504	0.004
3	0 0 1 0	39.440	45.028	.028
4	0 0 1 1	106.944	112.532	.032
5	0 1 0 0	85.179	90.767	.767
6	0 1 0 1	152.670	158.258	.758
7	0 1 1 0	130.146	135.734	.734
8	0 1 1 1	-162.362	-156.774	.726
9	1 0 0 0	-95.487	-89.899	.101
10	1 0 0 1	-27.997	-22.408	.092
11	1 0 1 0	-50.520	-44.932	.068
12	1 0 1 1	16.971	+22.599	.099
13	1 1 0 0	175.215	180.803	.803
14	1 1 0 1	-117.281	-111.693	.807
15	1 1 1 0	-139.758	-134.17	.83
16	1 1 1 1	-72.253	-66.665	.835

III. CONCLUSION

The experimental result of the various PSK modulation scheme in S-band demonstrate the good performance for the wireless communication bands and larger applications such as Wi-Fi and Wi-MAX with least phase error of 1º. These PSK modulators transmit high power with less error in phase so the modulator can be extended for higher band of frequency.

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