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DESIGN OF X-BAND 8PSK MODULATOR USING ADS TOOL

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Abstract: -8-PSK (8 Phase Shift Keying) is one of the phase modulation algorithm.It uses eight symbols with constant carrier amplitude 45° shifts between them enabling three bits to be transmitted for each symbol. We can achieve bandwidth efficiency by representing each signal element to map more than one bit. In 8-PSK eight different phase angles are used to represent 3 bits. 8-PSK provides more data capacity.

Keywords: - 8-PSK modulator,hybrid, s-parameters, phase shifter.

1. Introduction

Phase-shift keying (PSK) is a digital modulation scheme that conveys data by changing (modulating) the phase of a reference signal (the carrier wave). The modulation is carried out by varying the sine and cosine inputs. It is used widely for wireless LANs, Bluetooth communication and RFID. All convey data by changing some aspect of a base signal the carrier wave (usually a sinusoid) in response to a data signal. In the case of PSK, to represent the data signal the phase is changed. The phase of the signal can be used in two fundamental ways.

By viewing the phase, itself as conveying the information, in which case the demodulator must have a reference signal to compare the received signal's phase against; or

By viewing the change in phase for conveying information i.e., differential schemes. A convenient method to represent PSK schemes is by using a constellation diagram. This shows the points in the complex plane where, in this context, the real and imaginary axes are termed the in-phase and quadrature axes respectively due to their 90° separation. PSK has the constellation points chosen such that, they are usually positioned with uniform angular spacing around a circle.

Two common examples are "binary phase-shift keying" (BPSK) which uses two phases and "quadrature phase-shift keying" (QPSK) which uses four phases, although any number of phases may be used. Since the data that is conveyed is mostly binary, the PSK scheme that is designed usually has a number of constellation points which is equal to power of 2.

Scattering parameters or S-parameters (the elements of a scattering matrix or S-matrix) describe the electrical behavior of linear electrical networks when undergoing various steady state stimuli by electrical signals.

2. 8-PSK modulator

The 8PSK modulator is realized as an augmentation of the existing two BPSK modulators at X band. The BPSK modulator is preceded with a 45° phase shifter and 90-degree hybrid coupler to obtain the 8 PSK phase states.

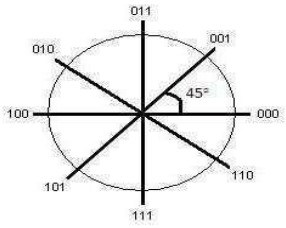


Figure 1: 8-PSK constellation diagram

The block diagram of the 8-PSK modulator is shown in Fig: RF input at X-band is fed to the 45º phase shifter which shifts the phase of the RF signal as per the logic state of the C bit. The output of the phase shifter and the I and Q data are fed to the BPSK modulator. The overall output is the 8-PSK modulated signal.

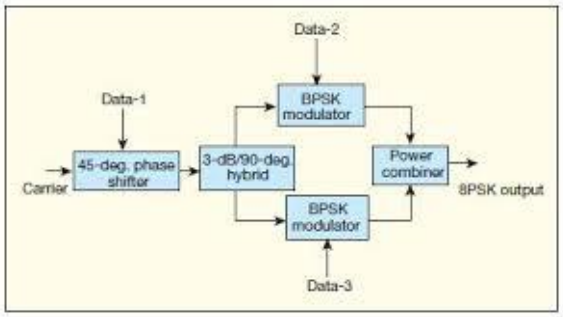
The 8PSK Modulator provides eight phases as shown in the table below.

Table:

I (bit)	Q (bit)	C (bit)	Phase Shift (degree)
0	0	0	0
0	0	1	45
0	1	0	90
0	1	1	135
1	0	0	180
1	0	1	225

1	1	0	270
1	1	1	315

Block diagram:

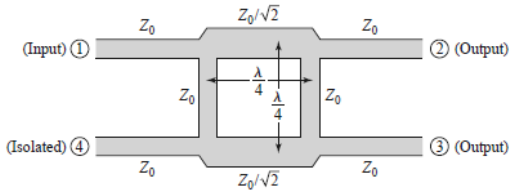


The above block diagram shows the system that is going to be designed.
It consists of the following, performing their own function: -
1) 45-Degree Phase Shifter.
2) 90-Degree Hybrid Coupler.
3) BPSK Modulators.
4) Wilkinson Power Divider.

1. 45 Degree Phase Shifter:

An X Band RF signal is given as input to 45-degree phase shifter where the signal is phase shifted by 45 degree depending on the data bit-1. The output of this 45-degree phase shifter is given to the 90-degree hybrid coupler.

2.90 Degree Hybrid Coupler:

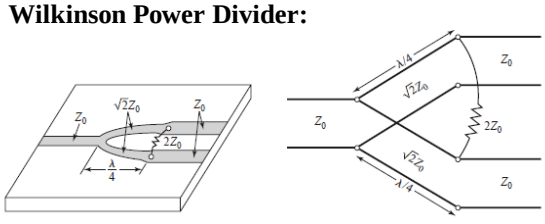


A 90-degree hybrid gives two outputs which are 90-degree out of phase with each other. When the coupling is designed to be 3 dB, it is called a hybrid coupler. These are often called quadrature couplers, couplers or branch-line couplers, edge couplers, overlay couplers and short-slot hybrid couplers. Here it is considered as branch-line coupler.

3. BPSK Modulator:

Then the two signals are given to two BPSK modulators, to perform binary phase shift keying giving two states of the input. In Binary Phase Shift Keying (BPSK) only one sinusoidal wave is considered as basis function modulation. Modulation is achieved by varying the phase of the basis function depending on the message bits.

4. Wilkinson Power Divider:



Each BPSK modulator gives 4 phases of the signal. All these phases are combined in the Wilkinson power combiner to gives 8 phases/states of the input signal.

Related works - Deployed fiber optic networks demands for higher capacity. 8-phase-shift keying (8PSK) is one promising modulation format. 8-PSK constellation provides 3 bits /symbol, with a 50% increase in spectral efficiency than quaternary(Q)PSK.8PSK transmitter is designed for space applications.

3. Methodology

To design the above proposed system, electronic design software is used in which we perform various steps to get the desired results.
The steps followed are:-

1. Determining the necessary design and dimensions of the component of interest, manually.
2. Designing the schematic diagram of the component in the software using necessary microwave tools.
3. Completing the schematic by giving its dimensions.
4. Simulate the schematic diagram to generate a graph that gives different losses and shows the obtained output.
5. Generate a layout of the schematic.
6. To get the desired results, tuning and optimization is performed and then the layout is simulated to check for better results.
7. Co-simulation is performed to get the best results.

4. Tools and Techniques

The software used to design a 8PSK modulator is ADS (Advanced Design System).Advanced Design System is the world's leading electronic design automation software for RF, microwave, and high speed digital applications. In a easy-to-use and powerful interface, ADS instigates the most innovative and commercially successful technologies, such as X-parameters and 3D EM simulators, that are used by leading companies in the wireless communication & networking and also in aerospace & defense industries.

For WiMAX™, LTE, multi-gigabit per second data links, system-EM co-simulation in an integrated platform. Key Benefits-Complete, integrated set of fast, accurate and easy-to-use system, circuit & EM simulators enable first-pass design success in a complete desktop flow. ADS is supported by leading industry and foundry partners.

5. Application

Owing to PSK's simplicity, particularly when compared with its competitor quadrature amplitude modulation, it is widely used in existing technologies.

The wireless LAN standard, IEEE 802.11b-1999, uses a variety of different PSKs depending on the data rate required. Because of its simplicity, BPSK is appropriate for low-cost passive transmitters, and is used in RFID standards such as ISO/IEC 14443 which has been adopted for biometric

passports, credit cards such as American Express, ExpressPay, and many other applications.

Bluetooth 2 will use pi /4-DQPSK at its lower rate (2 Mbit/s) and 8-DPSK at its higher rate (3 Mbit/s) when the link between the two devices is sufficiently robust.

Both QPSK and 8PSK are widely used in satellite broadcasting. QPSK is still widely used in the streaming of SD satellite channels and some HD channels. High definition programming is delivered almost exclusively in 8PSK due to the higher bitrates of HD video and the high cost of satellite bandwidth. The DVB-S2 standard requires support for both QPSK and 8PSK.The chipsets used in new satellite set top boxes, such as Broadcom's 7000 series support 8PSK and are backward compatible with the older standard.
Historically, voice-band synchronous modems such as the Bell 201, 208, and 209 and the CCITT V.26, V.27, V.29, V.32, and V.34 used PSK.

6. Conclusion

During design of components of the 8PSK modulator like the 90-degree hybrid, Wilkinson power combiner and 45-degree phase shifter at the desired frequency of 8.75 GHz, the results obtained were consolidated in the table given below.

90-DEGREE HYBRID COUPLER

PARAMETE-RS	EXPECTED RESULTS	OBTAINED RESULTS	
		Schematic	Momentum
INSERTION LOSS	-3dB	-3.2dB	-3.008dB
RETURN LOSS	-20dB	-39.19dB	-42.44dB
PHASE DIFFERENCE	90°	-90.048°	-89.390◦

WILKINSON POWER COMBINER

PARAMETERS	EXPECTED RESULTS	OBTAINED RESULTS	
		Schematic	Co-Simulation
INSERTION LOSS	-3dB	-3.3dB	-3.74dB
RETURN LOSS	-20dB	-29.05dB	-17.43dB
ISOLATION LOSS	-20dB	-20.02dB	-18.45dB

45-DEGREE PHASE SHIFTER

PARAMETERS	EXPECTED RESULTS	OBTAINED RESULTS	
		Schematic	Co-Simulation
RETURN LOSS	-20dB	-13.52dB & -18.61dB	-15.65dB & -38.65dB
AMPLITUDE IMBALANCE	<0.5dB	0.355dB	0.274dB
PHASE IMBALANCE	45°	44.33°	45.121°

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