Chapter 1

INTRODUCTION

1.1 General Description

Modulation, which is the method of processing the signal for efficient transmission over a medium between the transmitter and receiver, has been first found many decades ago. Most of the present sophisticated communication systems are the outcome of the development of various modulation systems of the past. Among the earliest contributors to the advancement of the communication systems, E.H. Armstrong is highly noted for his considerable contributions on the theory of modulation[1].

Basically the modulation can be classified into two kinds, namely analog and digital. In an analog modulation either of the amplitude, frequency and phase of a specified sine wave, referred as carrier, is varied in accordance with the information to be transmitted. The carrier frequency for such a modulation is usually at much higher frequency than that of the signal in order to ensure that the separation of the signal from the carrier is achieved without much difficulties at the receiving end. The modulation where only amplitude of the carrier is varied is called amplitude modulation (AM), whereas the modulation with frequency variation while the amplitude is kept constant is called frequency modulation (FM), and the one with phase

variation only is called phase modulation (PM).

In digital modulation, usually binary system, it is the switching of one of the three parameters, namely amplitude, frequency and phase, between any digital state but usually between either of two possible values. When the amplitude switches between zero (OFF-state) and some predetermined amplitude level (ON-state) it is called ON-OFF keyed (OOK), also amplitude-shift-keyed (ASK) system. If the phase of a carrier switches by π radians or 180°, it is then phase-shift-keyed (PSK) system. Similarly if the carrier switches between two predetermined frequencies, it is frequency-shift-keyed system (FSK).

With the advent of advanced digital processing techniques and the availability of sophisticated computers to handle various data, designing digital circuits which was once a difficult job has now been found relatively quite simple. In addition to that the easy application of integrated circuits and the minimization of the noise and interference effects by using various recently found delicate coding systems of digital signals have made great contribution to the now widely growing digital communication systems[2]. Among the digital systems of information transmission, PSK system has been one of the most efficient techniques for trading bandwidth for signal-to-noise ratio (SNR)[3]. The PSK system is also the most promising system in which considerable noise immunity is achieved along with the insensitivity to carriers switching or level variations. Compared with AM and FM systems, with the same error-rate, the PSK system operates with a carrier-to-noise

ratio of 1 to 3 db less than an FM system and 5 to 7 db less than an AM system[4]. A research on a new type of PSK modulator is being carried out and this thesis is based on its results.

1.2 Kinds of PSK Systems

In general there are two types of PSK systems. The first one is synchronous or coherent PSK (CPSK) system in which synchronous or coherent detection at the receiver is achieved by recovering the carrier from the received signal itself. The second one is the differential PSK (DPSK) system in which the demodulation is the differential detection type which uses the preceding signal as a reference in deciding on the present signal. As the input and output of a multiphase data system are usually binary data, the number of phase conditions is always equal to an integral power of two. For example, each interval of four phase or 4-level PSK carries two bits of information and that of 8-level carries three bits. Both the DPSK and CPSK have excellent system performance in presence of noise.

1.3 PSK Utilization

The PSK system with four possible phase-shifts was first developed around the late fifties. Since then extensive studies have been made on the topic. The differential PSK (DPSK) has now been recognized as the most effective among the various signaling formats[5]. Such systems are

widely deployed in many of modern sophisticated data communication systems like Dataphone[6], Kathryn[7], Kineplex[8], space communication - telemetry systems of Pioneer IV and V systems[2] etc. The reason for such a wide use of PSK in modern communication systems is its high speed transmission capability with low error-rate and the optimum bandwidth of PSK. The CPSK is also suitable for operation with amplifiers that operate most efficiently in a nonlinear region. Such amplifiers are traveling-wave-tube (TWT), Varacter-up-converters and tunnel or IMPATT diodes[9].

1.4 State-of-the-art in Armstrong and PSK Circuitry

In the year 1936 the first balanced modulator for amplitude modulation was found by Armstrong[1]. This basic Armstrong modulator has later been developed to a phase modulator. In such a basic Armstrong phase modulator a baseband signal is modulated in a double-sideband suppressed carrier amplitude modulator (DSB-SC AM) with a low index of modulation to have linear operation. Another carrier, 90° out of phase with the first one, is added to the DSB-SC AM output. The residual amplitude variation is clamped by means of a limiter which then yields an output of low index phase modulated signal[10-14].

The original Armstrong technique is suitable to large baseband bandwidths particularly high-speed pulse sequences for PSK pulse-code-modulation (PCM) systems. Since the modulator uses a temperature-stabi-

lized quartz crystal oscillator its carrier frequency is stable with respect to ambient effects. The circuits for operations like limiting, mixing and multiplication to realize the modulator are practically realizable[15]. But the condition for its reasonably linear operation is the low modulation index[16]. Besides that, this type of modulator has the disadvantage of inherent phase instability. Such an Armstrong configuration has been studied for various analog signals and for a four-level PSK digital signal[15].

The phase instability of the original Armstrong modulator[4] has been overcome with the development of a new PSK modulator that employs two Armstrong-type DSB-SC AM modulators in a balanced configuration[16]. In such new PSK modulator the modulating signal is fed along with each of two inphase carriers to the two modulators. Some inphase carrier is later added to the quadrature carrier at the output of the double-sideband suppressed-carrier modulators. The sums of the two adders are multiplied, the product is then passed through a limiter to obtain the PSK signal[17]. By adopting this technique the experimental research is carried out to get the PSK signal.