PSK (Phase Shift Keying Modulation)

PSK is a digital modulation technique defined as the process of shifting the phase of the carrier signal between two levels, depending on whether 1 or 0 is to be transmitted.
Let the two carriers be defined as

$$v_{c1} = V_c \cos\omega_c t$$

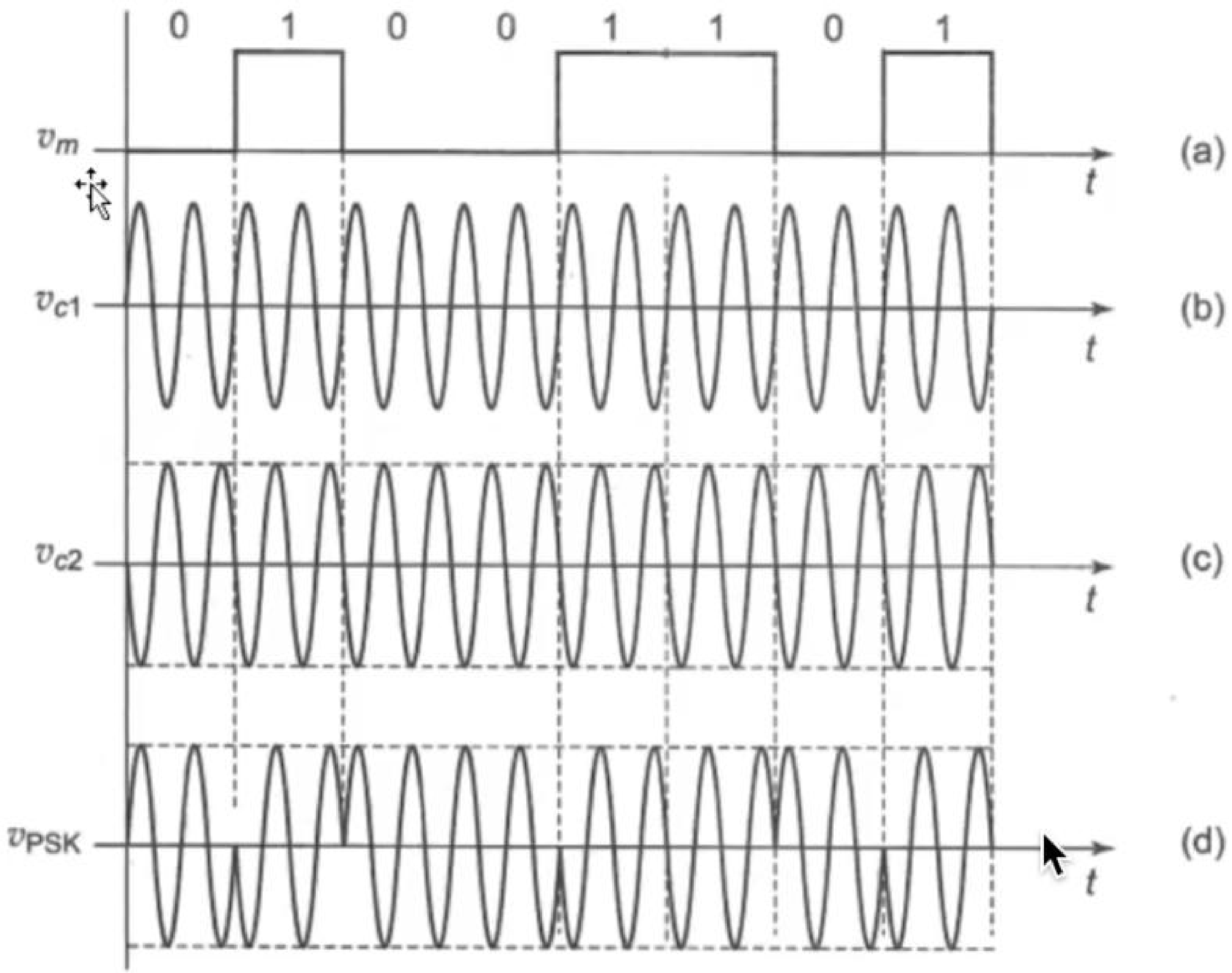
$$v_{c2} = -V_c \cos\omega_c t$$

The corresponding PSK signal is defined as

$$v_{PSK} = V_m V_c \cos \omega_c t \qquad \text{when symbol is 1}$$
$$= -V_m V_c \cos\omega_c t \qquad \text{when sumbol is 0}$$

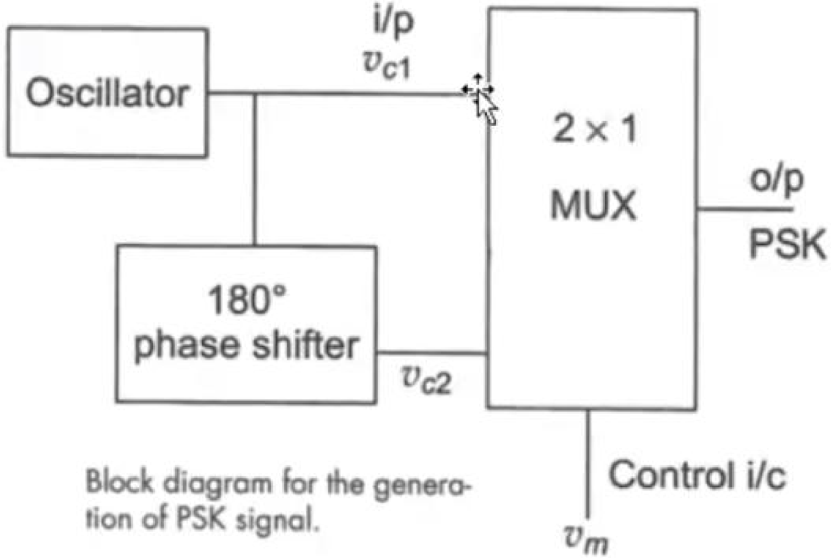
Figure shows the time domain representation of the generation of PSK signal. The digital message, i.e., binary sequence can be represented as a message signal as shown in Fig. *a*. Two carrier signals of opposite phases generated from an oscillator and an inverter (180° phase shifter) are as shown in Figs. *b* and *c*. When the binary symbol is 1, the PSK signal will have the original carrier signal

PSK Signals



Time domain representation of generation of PSK signal: (a) message, (b) carrier with 0° phase shift, (c) carrier with 180° phase shift, and (d) PSK signal.

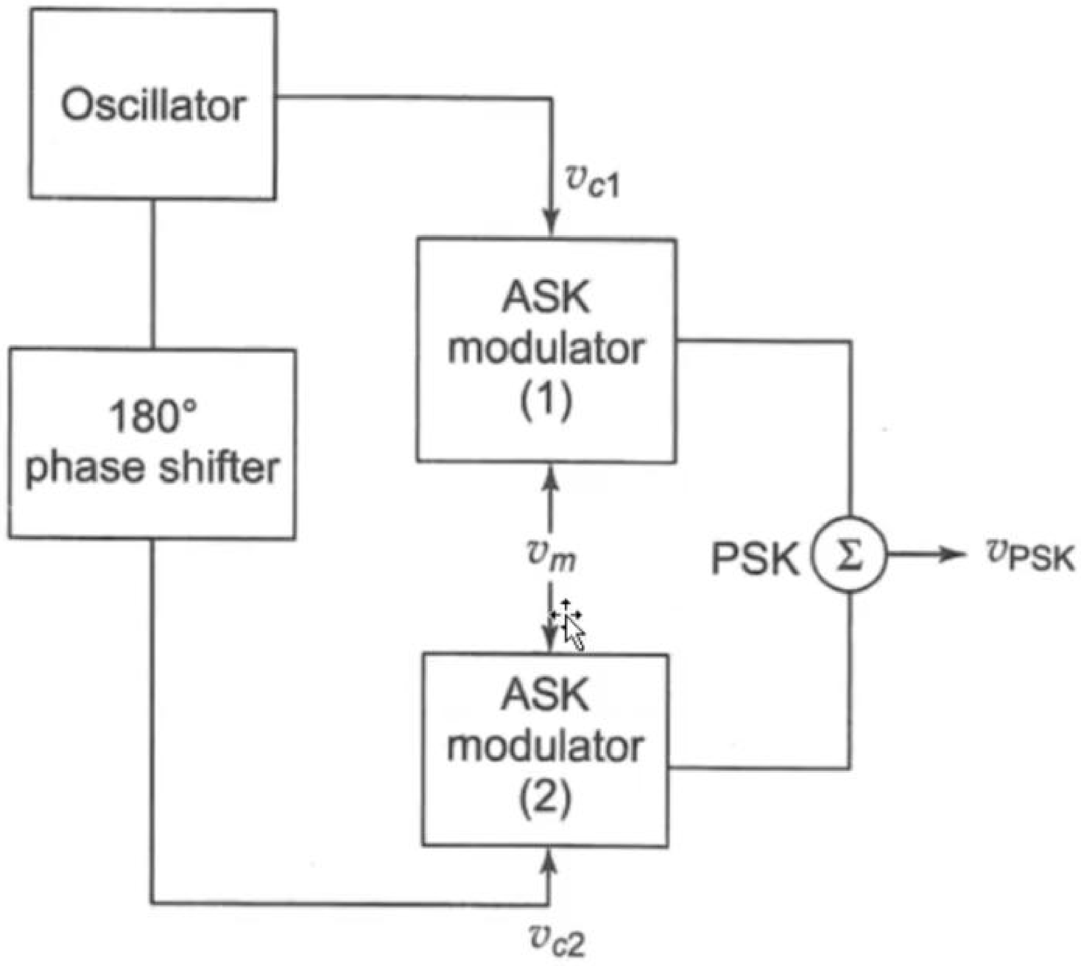
PSK Generator



Block diagram for the generation of PSK signal.

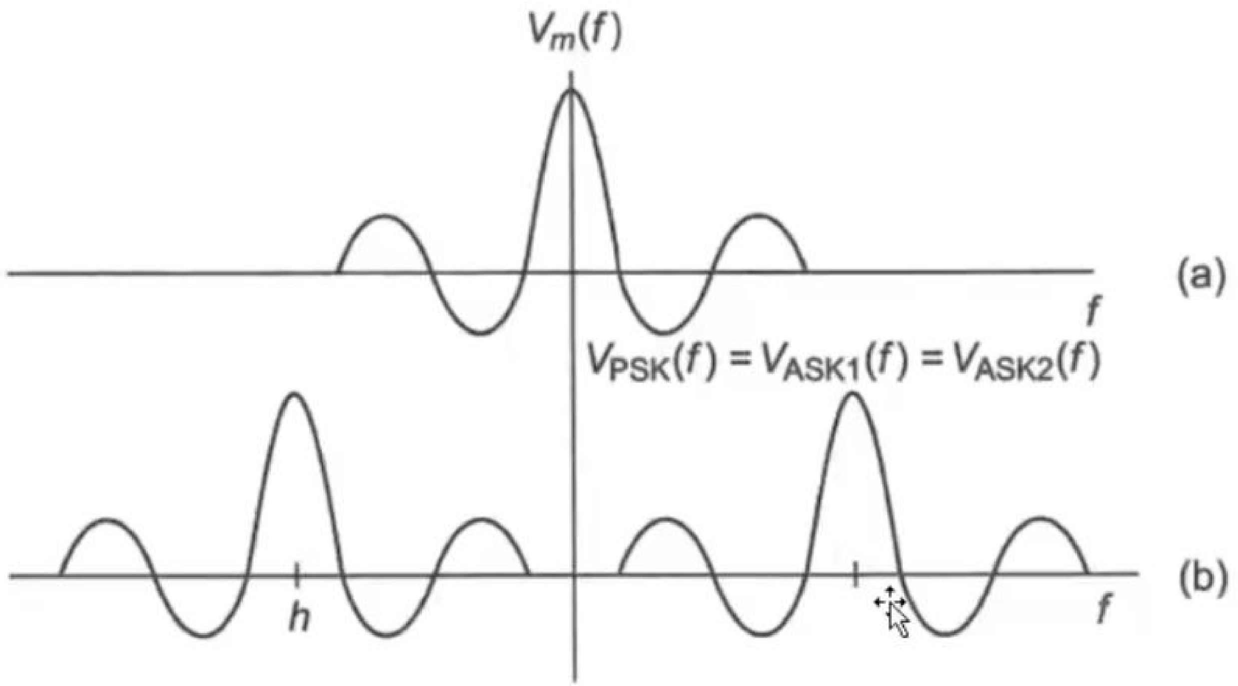
PSK signal will have the 180° phase shifted carrier signal when the binary symbol is 0. This can be achieved by using a suitable combinational logic circuit like 2 × 1 multiplexer as described in the case of FSK. Thus the output of the multiplexer shifts between the two distinct phase values, namely, 0° and 180°. Hence the name phase shift keying. Based on this discussion a block diagram for the generation of PSK signal can be written as given in Fig.

PSK Equivalent



Equivalent representation of PSK in terms of two ASK systems.

PSK Spectrum



Spectra at various stages in the generation of PSK signal. Spectrum of (a) message, and (b) first ASK, second ASK and FSK modulators.

PSK Demodulation

Demodulation of PSK Signal The demodulation of PSK can also be understood easiliy by considering the ASK view of PSK. However, the message can only be demodulated by coherent detection. This can be appreciated from the non-coherent detection of FSK signal which was made possible due to the frequency selective operation of the filters present in the upper and lower channels. In PSK, the two ASK signals are separated in phase values, not in frequency.

The block diagram for the coherent detection of PSK may drawn as given in Fig. The incoming PSK signal is multiplied with the carrier signal with phase shift 0° in the upper channel and carrier signal with phase shift 180° in the lower channel. The output of the multiplier in the upper channel will be low frequency message and ASK signal at twice ω_c during the intervals when the PSK is due to the carrier with phase shift 0°.

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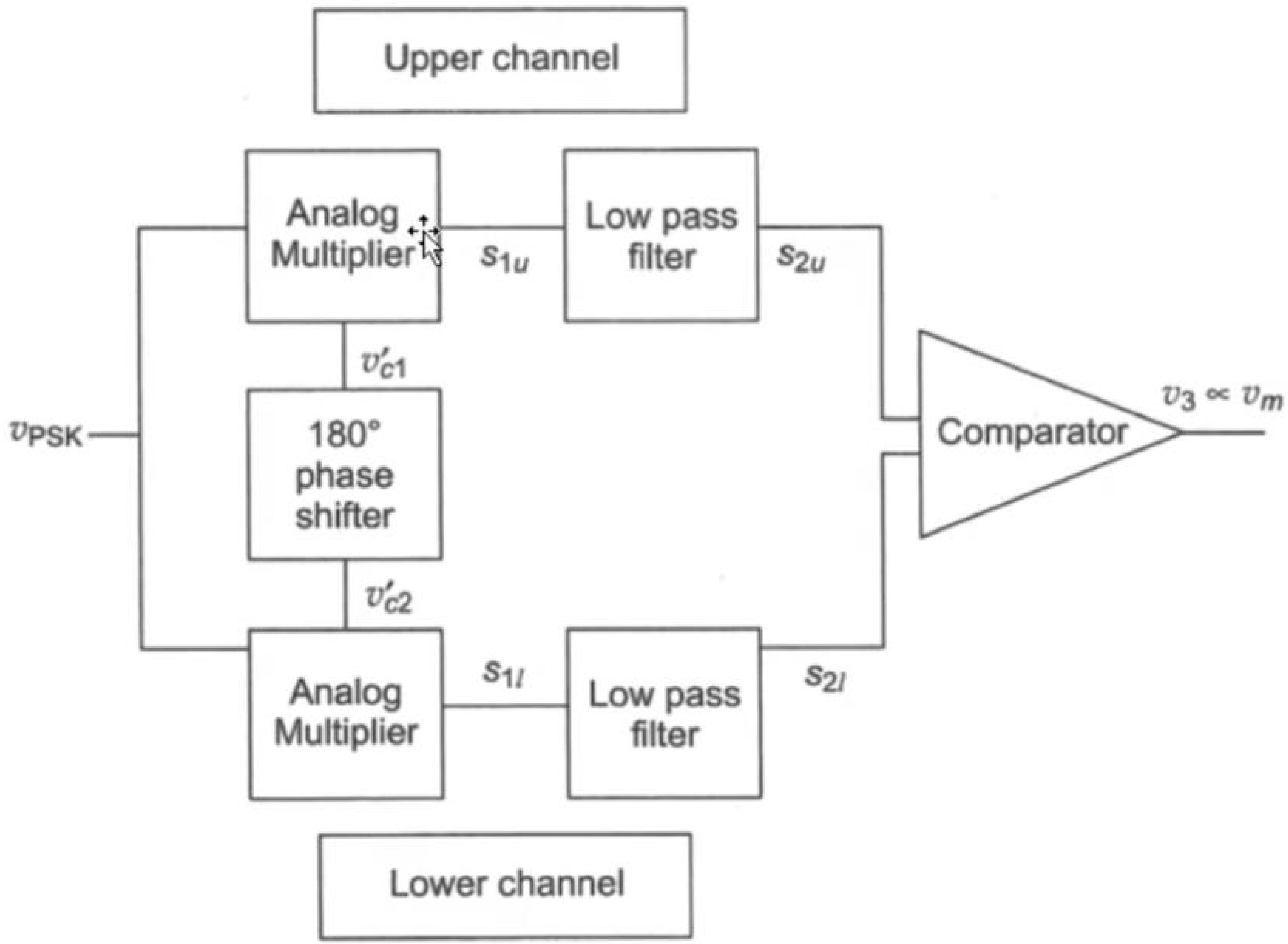
PSK Coherent Detection



Block diagram of coherent detection of PSK signal.

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It will be 180° phase shifted versions during intervals when the PSK is due to the carrier of phase shift 180°. Thus the output of the low pass filter in the upper channel will contain baseband message during intervals belonging to 0° phase shift and its 180 phase shifted version during the intervals belonging to the phase shift of 180°. Exactly opposite happens in the lower channel. The outputs of the two channels are further passed onto a comparator. The ouput of the comparator will be high when upper channel output is greater than the lower channel and low when lower channel output is greater than the upper channel. In this way the baseband message is retreived from the PSK signal

Let the synchronous carriers at the receiver be given by

$$v'_{c1} = V'_c \cos\omega_c t$$

$$v'_{c2} = -V'_c \cos\omega_c t$$

The output of the multiplier in the upper channel during the interval having 0° phase shift is given by

$$s_{1u} = v_{PSK}\, v'_{c1} = \frac{V_m V_c V'_c}{2}(1 + \cos 2\omega_c t)$$

The output of the multiplier in the upper channel during the interval having 180° phase shift is given by

$$s_{1u} = -\frac{V_m V_c V'_c}{2}(1 + \cos 2\omega_c t)$$

The output of the low pass filter in the upper channel during the interval having 0° phase shift is given by

$$s_{2u} = \frac{V_m V_c V'_c}{2}$$

The output of the low pass filter in the upper channel during the interval having 180° phase shift is given by

$$s_{2u} = -\frac{V_m V_c V'_c}{2}$$

Click to add title

Thus the filter output in the upper channel is

$$s_{2u} \propto v_m$$

during the interval having 0° phase shift and

$$s_{2u} \propto -v_m$$

during the interval having 180° phase shift.
The exact opposite phenomenon happens in the lower channel. As a result, the filter output in the lower channel is

$$s_{2l} \propto v_m$$

during the interval having 0° phase shift and

$$s_{2l} \propto -v_m$$

during the interval having 180° phase shift.
Therefore the output of the compartor is given by

$$s_3 \propto v_m$$

Hence the recovery of baseband message is carried out.