The Method of Multiplying the Frequency of the Phase-Shift Keying Signals

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Abstract – **The new method of multiplying the frequency of the phase-shift keying signals, that allows to multiply the frequency of PSK signals without using mixers and additional sources of reference, heterodyning or intermediate frequency, while the phase attributes stay unchanged is given.**

Keywords – **PSK signals, frequency pulling, frequency multiplying.**

I. Introduction

The development of radio access and mobile networks has resulted in using frequency synthesizers (FS) almost in all telecommunication devices. But the presence of power amplifier in the transmission channel causes the reverse leakage of a part of the power of transmitting signal that affects the voltage-controlled oscillator (VCO) and results in VCO frequency pulling. This effect causes errors both in FS and radio frequency (RF) block.

The universal method of VCO frequency pulling effect reducing consists in frequency separation of VCO FS and transmitting power signals by using frequency multiplier after VCO. Such structures are widely used in RF blocks of DECT and Bluetooth devices.

II. Main Part

All of the widely used frequency multipliers (FM) can save only the law of the variation of amplitude and frequency of the signal. And the fact that the most robust type of modulation is PSK has led to the appearance of the actual scientific problem that consists in development of the frequency multiplying methods by engineering the new method of multiplying the frequency of the phase-shift keying signals, that allows to multiply the frequency of PSK signals without using mixers and additional sources of reference, heterodyning or intermediate frequency, while the phase attributes stay unchanged [1].

The basis of the development model of frequency multiplying was formed by the trigonometric identity:

$$\sin(a \pm b) = \sin(a)\cdot\cos(b) \pm \cos(a)\cdot\sin(b). \qquad (1)$$

In case of three times frequency multiplying:

$$\sin(3wt + j(t)) = \sin(2wt + (wt + j(t))) =$$
$$= \sin(2wt)\cdot\cos(wt + j(t)) + \cos(2wt)\cdot\sin(wt + j(t)). \qquad (2)$$

Using Eq.(2) as the algorithm of output signals forming gives a chance to synthesize the device block diagram shown in Fig.1, where “*x2*” is a two times FM [1], “*PS*” is a π/2 phase shifter, ⊗ is a signals multiplier and Σ is a signals combiner.

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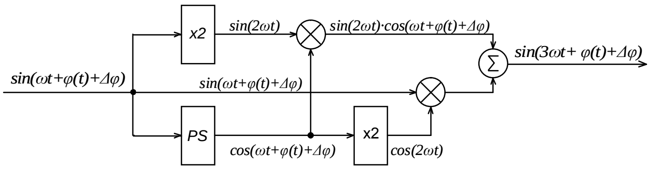

Fig.1 Block diagram of three times frequency multiplier

In Fig.2 timing diagram of input and output signals for device given in Fig.1 is shown.

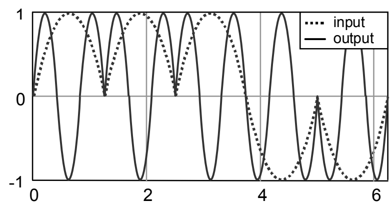

Fig.2 Timing diagram of input and output signals

It should be noted that according to Eq.(1) can be synthesized FM with any multiplication factor:

$$\sin((n-1)w\,t)\cdot\cos(w\,t + j\,(t)) + \cos((n-1)w\,t)\cdot\sin(w\,t + j\,(t)) =$$
$$= \sin(nw\,t + j\,(t) + \Delta j\,). \qquad (3)$$

The advantage of the proposed method consists in ability to multiply the frequency of PSK signals without using any additional sources of reference, heterodyning or intermediate frequency or mixers and not to change the phase attributes in the output signal; therefore the proposing device has only one input and one output node.

III. Conclusion

In this paper the new method of multiplying the frequency of PSK signals, that allows to multiply the frequency of PSK signals without using mixers and additional sources of reference, heterodyning or intermediate frequency, while the phase attributes stay unchanged is given and a variant of the scheme of three times frequency multiplier is offered.

References

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