FAM 19.1

A NEW RADIO RECEIVER SYSTEM FOR PERSONAL COMMUNICATIONS

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ABSTRACT

An extremely small and high-reliability receiver for personal communications is described. This technology incorporates direct conversion into an integrated circuit in such a way that the need for discrete filters is avoided. The resulting design is particularly suitable for use in wireless devices such as cordless phones.

INTRODUCTION

Developments of a wide-array of devices have brought us small and lightweight personal communication equipments. However, it was plain enhancement in discrete component integration brought about by advances made in device-mount technology and certainly not a new revolutionary technological step.

By using a new system that combines the concept of the direct conversion and a second IF functional circuit that features a carrier leak suppression mechanism, the inclusion into the IC design approach of a circuit that functions as discrete IF filter and the know-how in traditional IC-discrete filter interface has been realized.

THE CONFIGURATION OF THE NEW RADIO RECEIVER SYSTEM

Fig.1 shows the block diagram of the receiver using the new system. The AGC circuit assures that the received signal will not exceed the dynamic range of the mixers and the active LPFs. It is fabricated as an active filter in the monolithic IC and an indispensable part of a discrete filter-less system.

The received signal will be converted into a baseband frequency by the first mixer. This baseband signal passes through a LPF and then converted again by the second mixer to a frequency that can be used for demodulation. In the

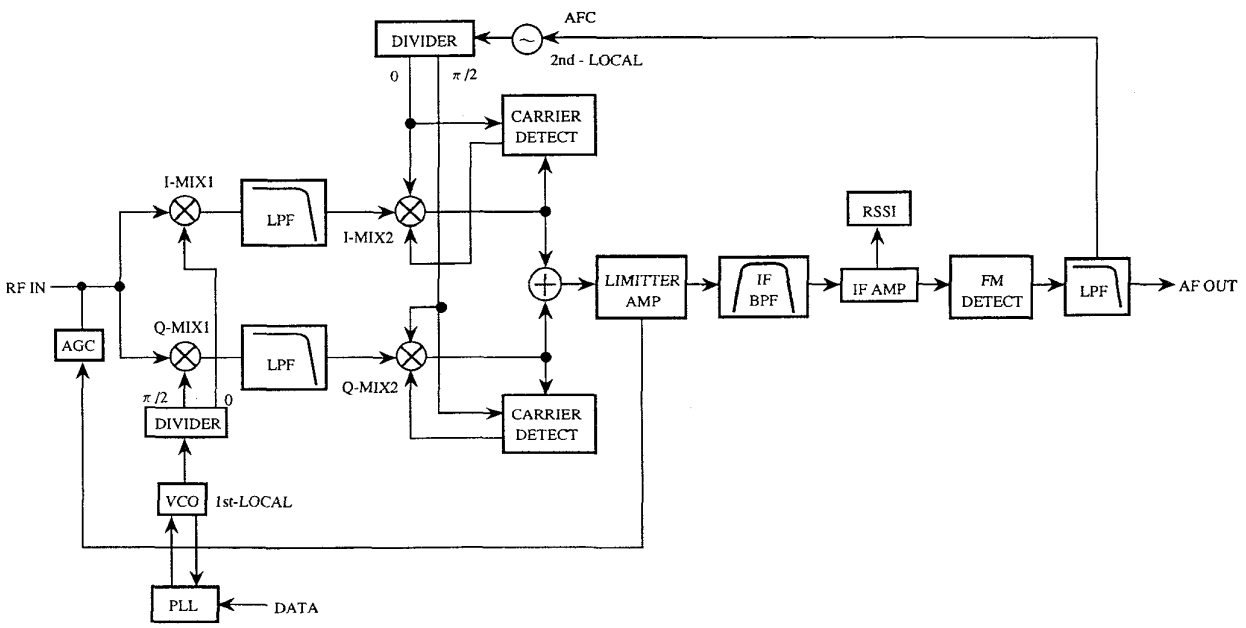

Fig1. A New Radio Receiver System for Personal Communications

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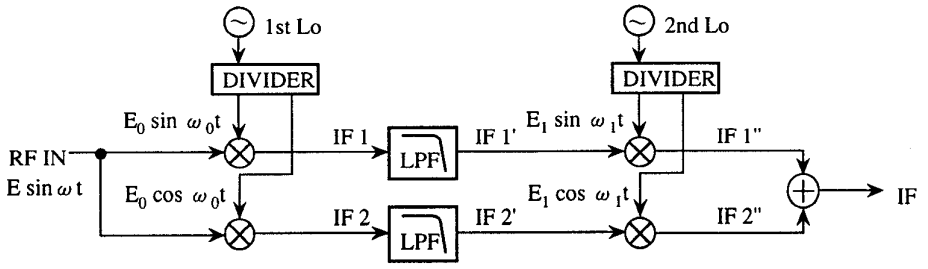

Fig2. New Image Frepuency Signal Cancelling System

following stages, the image frequency signal will be canceled and the resultant second IF frequency selectively amplified and in the end demodulated.

THE DIRECT CONVERSION FOR THE OFF-CHIP FILTER-LESS SYSTEM

Because the IF filter is included in the integrated circuit, in this system, the received signal is mixed with a carrier of equal frequency generated by the PLL. The output is a so-called zero IF and the received signal converted to baseband frequency. After passing through the LPF, it will be remodulated with the carrier from the second local oscillator (around 55~65kHz) .

To suppress the image frequency, the received signal is fed into two subsystems. In the first and second mixers, the signal will be mixed with a carrier, and finally by adding them together an image frequency signal suppression of more than 40 dB can be achieved.

In Fig.2, mixing the received signal Esin ω t and the first local oscillator signal E0 sin ω 0t results to IF1 and IF2.

$$IF\,1 = \frac{E \cdot E_0}{2}\left\{-\cos(\omega+\omega_0)t + \cos(\omega-\omega_0)t\right\}$$

$$IF\,2 = \frac{E \cdot E_0}{2}\left\{\sin(\omega+\omega_0)t + \cos(\omega-\omega_0)t\right\}$$

IF1 and IF2 passes through LPFs and becomes IF1' and IF2'.

$$IF\,1' = \frac{E \cdot E_0}{2}\cos(\omega-\omega_0)t$$

$$IF\,2' = \frac{E \cdot E_0}{2}\sin(\omega-\omega_0)t$$

Again, mixing IF1' and IF2' with a second local oscillator signal E_1 sin w_1t results to IF1" and IF2".

$$IF\,1'' = \frac{E \cdot E_0 \cdot E_1}{4}\left\{\sin(\omega-\omega_0+\omega_1)t + \sin(-\omega+\omega_0+\omega_1)t\right\}$$

$$IF\,2'' = \frac{E \cdot E_0 \cdot E_1}{4}\left\{\sin(\omega-\omega_0+\omega_1)t + \sin(\omega-\omega_0-\omega_1)t\right\}$$

Finally, adding IF1" and IF2" gives us IF

$$IF = \frac{E \cdot E_0 \cdot E_1}{2}\left\{\sin(\omega-\omega_0+\omega_1)t\right\}$$

When $\omega=\omega_0$,

$$IF = \frac{E \cdot E_0 \cdot E_1}{2}(\sin\omega_1 t)$$

Thus, the image frequency signal has been cancelled.

THE CARRIER LEAK DETECTOR AND THE ADJUSTMENT-FREE SYSTEM

The carrier leak detector is the most important circuit in this new system. How much is the carrier leak suppressed from the modulator will determine the degree of degradation to the IF characteristic. By mixing the carrier leak and carrier, it develops a DC level that is used as feedback to the input bias circuit. The carrier leak can be suppressed up to more than 60 dB.

The IF BPF, double pulse count discriminator, and second oscillator are designed to have the same time constant so that even though there is deviation in the absolute value of devices related to fabrication or temperature characteristics, the whole circuit in the closed system will perform accordingly to this change and a stable characteristic can be guaranteed.

CONCLUSION

By effectively implementing the concept of direct conversion and characteristics of semiconductor devices, and furthermore, by introducing new circuit, what has been traditionally needed discrete filters have been fabricated into the IC and a new revolutionary technology in receiver for personal communications like the cordless phone has been brought out.