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## AN AM/TV/FM STEREO RADIO IC INCLUDING IF FILTERS FOR A DTS

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### ABSTRACT

*A single-chip AM/TV/FM stereo radio IC including IF ( Intermediate Frequency ) filters for a DTS (Digital Tuning System) has been developed. The IF filter center frequency is controlled by the new equivalent resistor circuits.*

### INTRODUCTION

Recently, at FM/AM radio, analog tuning system is replaced by digital tuning system (local oscillator frequency controlled system by PLL frequency synthesis ). But a prior radio IC " including IF filter can not be used for a DTS because IF filter center frequency varies. In order to compensate the frequency error , an equivalent resistor circuit is realized in this new IC.

#### A problem of a prior system

To include IF filters in a radio IC, these IF filters should consist of active RC (resistor and capacitor) filter, which the FM IF is 150kHz, and the AM IF is 45kHz . The problem of such IF filter is a error of center frequency caused by process-related variations. Therefore a prior radio IC including IF filters is used only for an analog tuning radio because the IF error can be neglected.

An another problem is an incorrect tuning phenomena at a conventional DTS , caused by insufficient AM filter selectivity.

#### A new equivalent resistor circuit

In order to reduce the error of IF center frequency, a new equivalent resistor circuit shown in Fig. 1 is used. The AM IF filter in this new IC consists of biquad BPF (Band Pass Filter) shown in Fig. 2 . To control this filter center frequency when a value of resistor varies, resistor R1 and R3 are realized by the equivalent resistor circuits .

Shown in Fig. 1, Input signal of the circuit is  $V_{in}$  and the output current is  $I_{out}$ . An equivalent

resistor,  $R_{eq}$  ( $V_{in}/I_{out}$ ), is controlled by the frequency control voltage  $\Delta V$ .

Consequently the characteristics of AM IF filter, which consists of three second-order biquad filters, are shown in Fig. 4 . And the filter is low-noise, low-distortion circuit adequate for a radio IF filter.

#### AM radio precise scanning

One of the convenient future of a digital tuning radio is scanning ( tuning in a station automatically ) . For precise AM radio scanning, not only received signal strength , but also the frequency must be detected. In this new IC an AM IF signal frequency can be detected by FM detector circuit block, which center frequency is adjusted to the AM IF center frequency at AM receiving mode, shown in Fig. 3. It can be achieved because AM IF (45kHz) is similar to FM IF (150kHz) . Shown in Fig. 4, when a received signal frequency is an adjacent channel, tuning current doesn't occur. Therefore precise scanning can be achieved.

### CONCLUSION

Shown in Fig. 3, this IC has all functions for TV/AM/FM stereo radio from antenna input to detector output and FM stereo decoder. Even though the value of resistors varies, the IF center frequency can be fixed using equivalent resistor circuits . Consequently, a radio IC including IF filters can be used for a digital tuning system, and peripheral components and production costs are reduced.

" "Advanced Low Voltage Single Chip Radio IC", IEEE Trans. Consumer Electronics, vol. CE-38, pp. 465-475, August 1992.

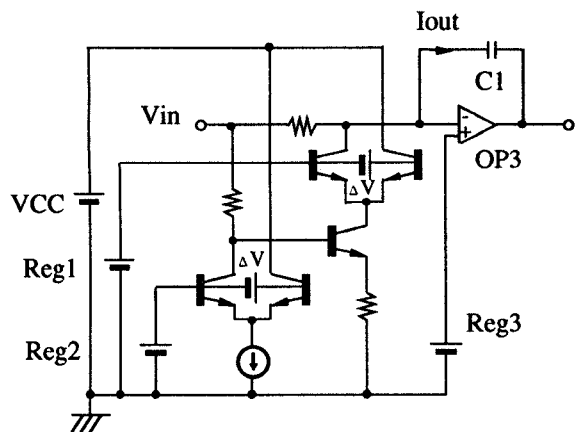


Fig. 1 An equivalent resistor circuit

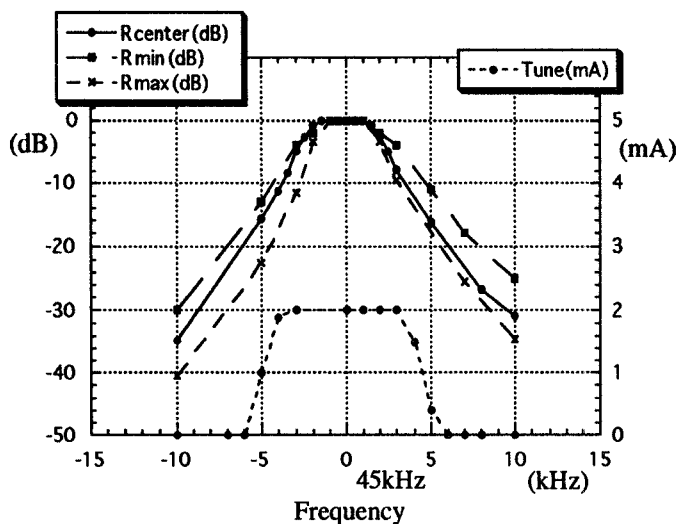


Fig. 4 A characteristic of AM IF filter

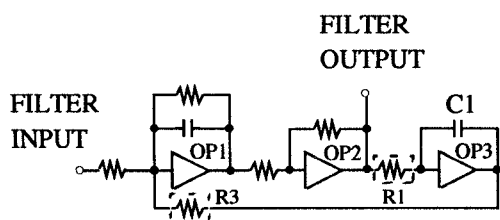


Fig. 2 A second order biquad BPF

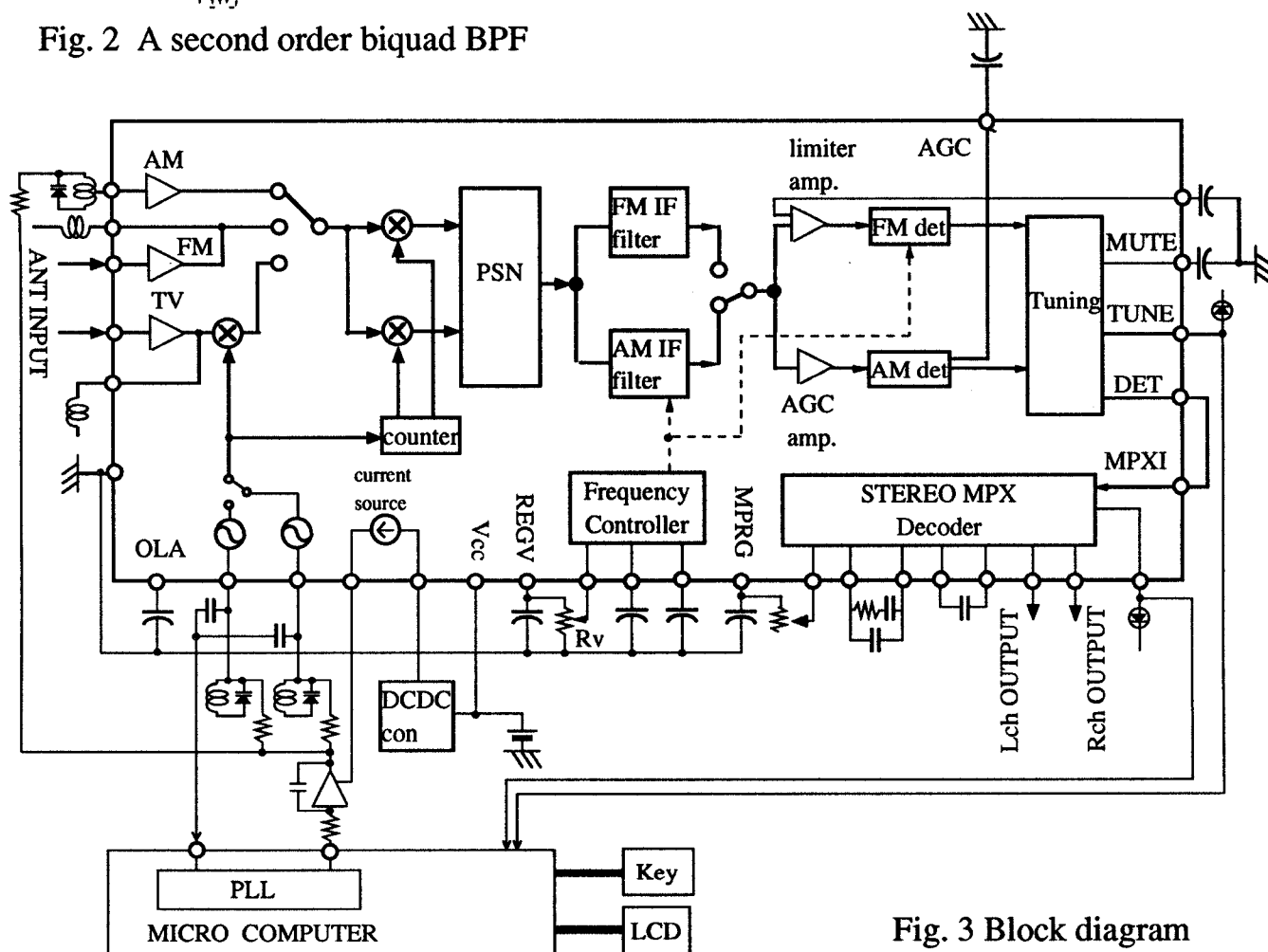


Fig. 3 Block diagram