TABLE I

Input Frequency in Hz	Percent error in symmetry for multiplication by a factor of:			
	2	3	4	5
300	2%	3%	15%	20%
400	1.5%	2.5%	13%	16%
600	0%	0%	7%	10%
800	0%	0%	0%	0%
1000	1%	3%	5%	10%
1100	2%	6%	9%	15%

Fig. 3. Photograph showing the input/output wave for multiplication by a factor of 3 for input frequency of 800 Hz.

multiplication over a wide range of frequency and multiplication factor, they seldom justify the high costs [5] involved in such sophisticated techniques. The cost can be reduced by performing the required operation in an analog circuit.

In many applications a number of gating pulses are required to be generated between two successive pulses. It is also desirable to have precise symmetry in the pulses generated so that strobing at the proper instant is possible. The present scheme describes a low cost method to effect pulse frequency multiplication over a wide range of frequencies.

The basic scheme is shown in Fig. 1(a). The input square wave is integrated, and the output of the integrator varies from 0 to V volts, for example. The peak detector, therefore, produces at its output the peak level V which is then divided into n threshold levels, where n is the desired multiplying factor. The integrator output is also connected to all the comparators whose other inputs are set from the threshold values. The comparators, therefore, produce output level changes, which occur in a precise sequence, when the integrator input crosses the threshold. A typical sequence waveform for multiplication by factor of 3 is shown in Fig. 1(b). These comparator outputs are then added and subtracted in proper sequence in a summer, with the outputs of the odd numbered comparators connected to the positive inputs and the even numbered outputs to the negative inputs. The output of this summer is a bidirectional pulse train whose levels are made unidirectional by passing the negative levelled pulses through an inverter. The detailed circuit diagram is shown in Fig. 2.

The circuit works over a wide frequency range because the threshold levels are derived from the peak level of the integrator output, which means that the levels adapt themselves to changing input frequencies. The symmetry of the output is therefore automatically maintained over a range of frequencies once it is set for a particular frequency. Any particular scheme works with two extreme values of frequency determined on the lower side by the integrator time constant, the supply voltage of the integrator and the maximum differential input voltage of the comparators used and on the higher side by the comparator sensitivity and the value of n.

The results as obtained from the experimental circuit for various multiplying factors are shown in Table 1. The percent error in symmetry was observed at various frequencies and tabulated. It is seen that for the same percent error, the range of frequency is lower for high values of n. The range so decreases for higher values of n because of the lower threshold steps due to higher n–particularly in the high frequency end where the range limitation appears more stringent. The photograph showing the input/output wave for multiplication by a factor of 3 is shown in Fig. 3.

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New Active-Gyrator Circuit Using a Single Current Conveyor

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Abstract—A new canonic active RC circuit for realizing an ideal grounded inductor using a single second generation current conveyor as the active building block is described. The circuit may be considered as a novel active-gyrator circuit realized using only a single current conveyor.

I. Introduction

Several methods are available for the simulation of an ideal grounded inductor using the second generation current conveyor (CC II) as the active building block [1]–[4]. The first method is to use an ideal passive gyrator terminated by a capacitor at one of its two ports. The passive-gyrator realization requires two opposite polarity current conveyors [1]. The inductance realized in this case is directly proportional to the terminating capacitor and the realization is canonic. The second method is to use LC mutators of the converter type. In this case the inductor circuit requires three capacitors and three conveyors [2], [3]. The inductance simulated by this method is inversely proportional to the terminating capacitor. The third method is to use LR mutators of either the converter or the inverter type. Here again two or three current conveyors are needed for the LR mutator realization [2], [4].

The purpose of this letter is to introduce a novel active-gyrator circuit realized using only four resistors and a single CC II. The circuit is used to realize an ideal grounded inductance. Tuning the circuit to realize a lossy inductor in the form of a series RL or a parallel RL is possible.

II. The New Circuit

Fig. 1 represents the new-active gyrator circuit with the nongrounded port terminated by a capacitor C. The circuit uses a single positive polarity CC II which is defined by the following instantaneous port relations [1]:

$$i_b = 0, v_a = v_b, i_c = i_a. \tag{1}$$

It is more useful to analyze the network in terms of the simulated grounded inductance. By direct analysis, the input impedance Z_{in} to the circuit is given by:

$$Z_{in} = \frac{sa_1 + b_1}{sa_2 + b_2} \tag{2}$$

Manuscript received May 25, 1978.
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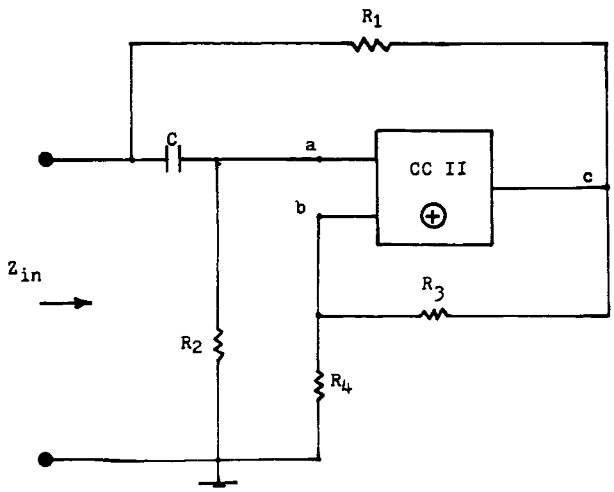

Fig. 1.

TABLE I

The realizable impedance function	Series RL	Parallel RL	Ideal L
Conditions on z_{in} coefficients	$a_2 = 0$	$b_1 = 0$	$a_2 = b_1 = 0$
Zero position	$-b_1/a_1$	origin	origin
Pole position	$-\infty$	$-b_2/a_2$	$-\infty$
Realizability conditions	$K < \frac{1}{2}$ $\frac{1}{R_2} = \frac{2}{R_1} \cdot \frac{R_3}{R_4} + \frac{1}{R_4}$	$K > \frac{1}{2}$ $\frac{1}{R_2} = \frac{1}{R_1}(1+\frac{R_3}{R_4}) + \frac{1}{R_4}$	$K = \frac{1}{2}$ $\frac{1}{R_2} = \frac{2}{R_1} + \frac{1}{R_4}$
Equivalent circuit parameters	$L = \frac{CKR_1^2}{2(1-K)}$ $R_s = R_1 \cdot \frac{1-2K}{2(1-K)}$	$L = CKR_1^2$ $R_p = \frac{KR_1}{2K-1}$	$L = \frac{1}{2} CR_1^2$

where

$$a_1 = CK \qquad b_1 = \frac{K}{R_2} - \frac{1}{R_1} - \frac{1}{R_3 + R_4}$$

$$a_2 = C\left[\frac{K}{R_2} - \frac{2(1-K)}{R_1} - \frac{1}{R_3 + R_4}\right]$$

$$b_2 = \frac{1}{R_1}\left[\frac{K}{R_2} - \frac{1}{R_3 + R_4}\right] \qquad K = \frac{R_4}{R_3 + R_4}. \tag{3}$$

The circuit is capable of realizing an ideal inductance or a lossy inductance in the form of a series RL or a parallel RL by simple circuit tuning. The results for these three cases are summarized in Table I.

It is noted that the parameter K is adjusted by tuning the grounded resistor R_4. The capacitor C controls the magnitude of L without affecting the realizability conditions. For the realization of an ideal inductor, two degrees of freedom are available, thus R_1 and R_3 may be taken arbitrarily. The design equations for the remaining circuit components are:

$$R_4 = R_3 \tag{4}$$

$$\frac{1}{R_2} = \frac{2}{R_1} + \frac{1}{R_4} \tag{5}$$

$$C = \frac{2L}{R_1^2}. \tag{6}$$

It is worth noting that this inductance circuit is generated and generalized from the oscillator circuit described recently by the author [5]. The simulated inductance may be employed in realizing tunable filters using element replacement techniques.

III. Conclusions

It is proved that an active-gyrator circuit is realizable with four resistors and a single CC II along similar steps to the Orchard-Willson active-gyrator which requires six resistors and a single operational amplifier [6].

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Comments on the Performance of Maximum Entropy Algorithms

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Abstract—**Two points recently brought up in this journal concerning the performance of maximum entropy spectral analysis are discussed. First, an additional recursive formula is presented which simplifies and reduces the computational load of the Burg algorithm. Second, attention is drawn to some recent results in the geophysics literature related to the proper selection of prediction filter length.**

The maximum entropy method developed by Burg [1], [2] has become increasingly used for spectral analysis of a large variety of data records in physics, geophysics, astronomy, and engineering. Algorithms have been developed by Andersen [3] for real data and Smylie *et al.* [4] for complex valued records. The principal mathematical characteristics have been explored, though unsolved problems still remain [5], [6]. This letter briefly comments upon two points of a more technical character which become important when maximum entropy estimation is carried out in practice, as recently brought up in this journal [7]–[9].

Burg [2] outlined an iteration scheme for estimation of the prediction filter coefficients $(a_{1m}, \cdots, a_{mm})$ for a given data record $(X_1, \cdots, X_N)$, here assumed for simplicity to be real. The reader is referred to Andersen [3] for details on the recursive technique. First we shall present an additional recursion formula which apparently has been overlooked in the literature, and which simplifies the Burg algorithm. It involves the denominator in the expression for evaluation of a_{mm}:

$$a_{mm} = \frac{2\sum_{n=1}^{N-m} b_{m-1\,n+1}\, b^1_{m-1\,n}}{\sum_{n=1}^{N-m} (b^2_{m-1\,n+1} + b^{1\,2}_{m-1\,n})} = \frac{2\sum_{n=1}^{N-m} b_{m-1\,n+1}\, b^1_{m-1\,n}}{\mathrm{den}\,(m)}. \tag{1}$$

Manuscript received March 23, 1978.
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