

# Electronics Letters

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# SYNTHESIS OF TRANSFER FUNCTIONS BY DEPENDENT SOURCES

*Indexing terms: Active networks, Linear network synthesis, Transfer functions*

A new procedure is given for the synthesis of  $n$ th-order voltage transfer functions by two dependent current sources as active elements. In the letter, by using a simple voltage-divider circuit configuration, the problem of the synthesis of transfer functions has been transformed to the synthesis of driving-point admittance functions.

**Introduction:** Most of the transfer-function synthesis procedures using dependent sources require the use of 3-terminal or 2-port RC networks.<sup>1-3</sup> Since the synthesis of RC networks having more than 2-terminals is laborious and time consuming, to avoid the use of multiterminal RC networks in the synthesis of transfer functions the simple network of Fig. 1 is proposed, which basically reduces the problem to the realisation procedure of Sandberg<sup>4</sup> for driving-point admittance functions with dependent sources and 2-terminal RC networks only.

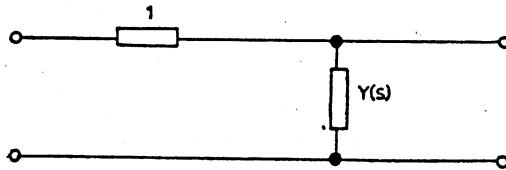


Fig. 1 Simple network configuration

**Realisation:** The voltage-ratio transfer function for the network in Fig. 1 is

$$T(s) = \frac{N(s)}{D(s)} = \frac{V_2}{V_1} = \frac{1}{1+Y} \quad (1)$$

where

$$Y = \frac{D(s)-N(s)}{N(s)} \quad (2)$$

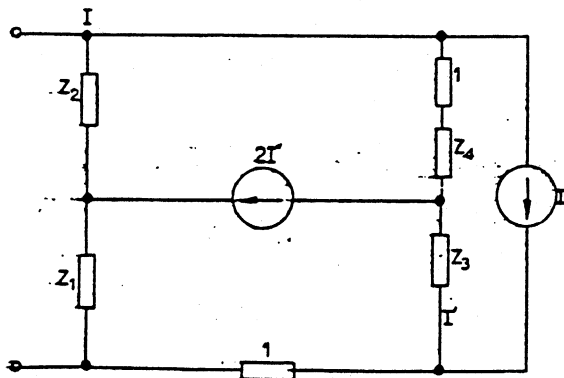


Fig. 2 Realisation of  $Y(s)$  by Sandberg's configuration

The procedure given by Sandberg for the synthesis of eqn. 2 yields the network in Fig. 2. Since

$$Y = 1 + \frac{Z_3 - Z_4}{Z_1 - Z_2} \quad (3)$$

where  $Z_1, Z_2, Z_3$  and  $Z_4$  are RC impedance functions, from eqns. 2 and 3 we can write

$$\frac{Z_3 - Z_4}{Z_1 - Z_2} = \frac{D(s) - 2N(s)}{N(s)} \quad (4)$$

And by RC-RC decomposition, we have

$$Z_3 - Z_4 = \frac{D(s) - 2N(s)}{A(s)} \quad (5)$$

$$Z_1 - Z_2 = \frac{N(s)}{A(s)} \quad (6)$$

where  $A(s)$  is an arbitrary polynomial. The following example explains this procedure:

**Example:** Given

$$T(s) = \frac{N(s)}{D(s)} = \frac{s^3 + 2s^2 + 2s + 1}{s^3 + 2s^2 + s + 1}$$

Since  $N(s)$  contains the factor  $(s+1)$ , in choosing  $A(s)$  we include this factor and write  $A(s) = (s+1)(s+2)(s+3)$ . From eqns. 5 and 6, we have

$$Z_3 - Z_4 = \frac{-(s^3 + 2s^2 + 3s + 1)}{(s+1)(s+2)(s+3)} = \frac{1/2}{s+1} + \frac{17/2}{s+3} - \frac{5}{s+2} - 1$$

$$Z_1 - Z_2 = \frac{s_2 + s + 1}{(s+2)(s+3)} = 1 + \frac{3}{s+2} - \frac{7}{s+3}$$

and the expressions for  $Z_1, Z_2, Z_3$  and  $Z_4$  are determined, all of which are realisable as 2-terminal RC networks.

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## NOVEL WIDEBAND FREQUENCY DIVIDER EMPLOYING TWO STEP-RECOVERY DIODES

*Indexing term: Frequency dividers*

A new type of wideband frequency-divider circuit employing two step-recovery diodes is described. Results of two experimental divide-by-2 circuits, which are capable of operating over the input frequency ranges of 160-320 MHz and 880-1800 MHz, are described.

In a recent letter,<sup>1</sup> a pulse-generator circuit consisting of two step-recovery diodes has been introduced by the author. In this letter, it will be shown that the addition of a short-circuited transmission line in parallel with the shunt diode converts the pulse generator into a wideband frequency divider (Fig. 1).

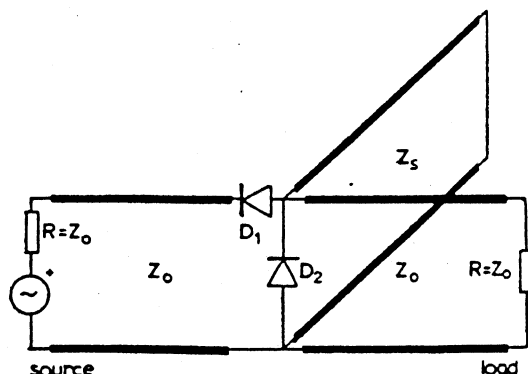


Fig. 1 Circuit diagram of frequency divider