Electronics Letters

AN INTERNATIONAL PUBLICATION

CONTENTS

11th JULY 1974 Vol. 10 No. 14

pages 269-288

THE INSTITUTION OF ELECTRICAL ENGINEERS

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 nth-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.[1-3] 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[4] for driving-point admittance functions with dependent sources and 2-terminal RC networks only.

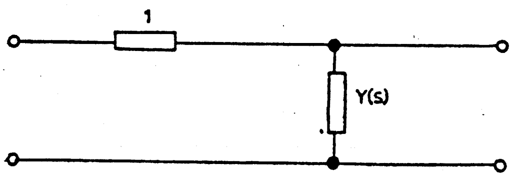

Fig. 1 *Simple network configuration*

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

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

where

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

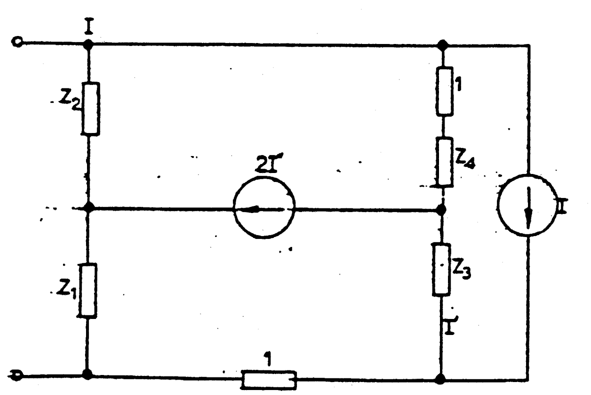

Fig. 2 *Realisation of Y(s) by Sandberg's configuration*

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

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

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

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

And by RC–RC decomposition, we have

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

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

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.

Acknowledgment: The author wishes to thank Prof. M. K. Sarioglu and Prof. Y. Tokad for their helpful discussions.

S. CAN

12th June 1974

Technical University of Istanbul
Engineering & Architecture Faculty
Electrical Engineering Department
Beşiktaş, Istanbul, Turkey

References

1 KUH, E. S.: 'Transfer function synthesis of active RC networks', *IRE Trans.*, 1960, CT-7, Suppl., pp. 3–7
2 HOROWITZ, I. M.: 'Synthesis of active RC transfer functions'. PIB Microwave Research Institute Research Report R-507-56, PIB-437, 1956
3 HAKIM, S. S.: 'RC active filters using an amplifier as the active element', *Proc. IEE*, 1965, 112, (5), pp. 901–912
4 SANDBERG, I. W.: 'Active RC networks'. PIB Microwave Research Institute Research Report R-662-58, PIB-590, 1958

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,[1] 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).

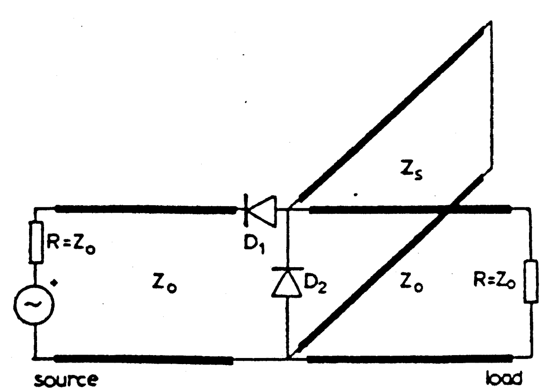

Fig. 1 *Circuit diagram of frequency divider*