500 MHz. We believe this to be the first experimental correlation of noise with linewidth broadening in DBR lasers.

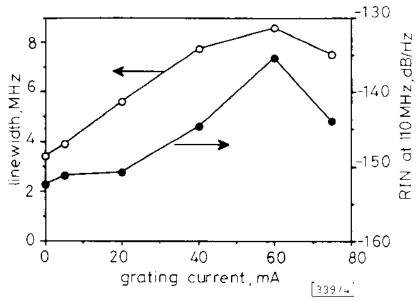

Fig. 4 *Correlation of linewidth and RIN with grating current*
I_a adjusted for constant power of 9 mW
110 MHz

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H. SUNDARESAN
N. C. FLETCHER
British Telecom Research Laboratories
Martlesham Heath
Ipswich IP5 7RE, United Kingdom

8th October 1990

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CASCADABLE CURRENT-MODE SINGLE CCII BIQUADS

Indexing term: Active filters

A new configuration for the realisation of current-mode single-CCII-biquad (SCB) filters with high output impedance is presented. It can synthesise lowpass, bandpass, highpass, notch, and allpass filtering functions with a single CCII connected to five passive RC one-port elements. The quality factor, Q, and the central frequency, ω_0, of the proposed SCBs are insensitive to the current tracking error of the CCII. These SCBs have the advantages of low passive sensitivities and independently adjustable ω_0 or Q.

Introduction: The applications and advantages in the synthesis of various active filter transfer functions using second-generation current conveyors (CCIIs) have received considerable attention.[1,2] Recently, current-mode allpass networks using a single current conveyor were proposed.[3,4] These current-mode networks can be easily cascaded because of high output impedance. However, no universal active-filter networks which use a single current conveyor to realise any type of filtering characteristics with high output impedance have been reported.

In this letter, a new configuration, which can synthesise current-mode lowpass, highpass, bandpass, notch and allpass filters with high output impedance, is presented.

Circuit description: Consider the circuit configuration shown in Fig. 1. Routine circuit analysis shows that the configuration has the following current transfer function:

$$\frac{I_0}{I_1} = \pm \frac{y_3(y_2 y_1 - y_4 y_5)}{y_1 y_5(y_2 + y_3 + y_4) + y_1 y_2(y_3 + y_4) + y_2 y_4 y_5} \tag{1}$$

The positive and negative signs in eqn. 1 correspond to the use of CCII+ and CCII−, respectively. As an example, in

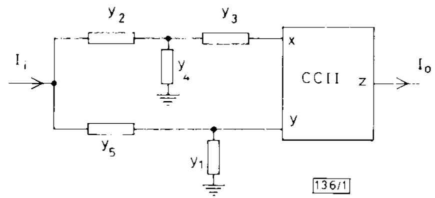

Fig. 1 *General configuration for current-mode single-CCII-biquad with high output impedance*

eqn. 1, if $y_1 = 1/R_1$, $y_2 = \infty$ (short circuit), $y_3 = 1/R_3$, $y_4 = sC_4$, and $y_5 = sC_5$, this results in the following lowpass current transfer function:

$$\frac{I_0}{I_1} = \frac{1}{s^2 R_1 R_3 C_4 C_5 + sR_3(C_4 + C_5) + 1} \tag{2}$$

where

$$\omega_0 = \left(\frac{1}{R_1 R_3 C_4 C_5}\right)^{1/2} \tag{3}$$

and

$$\omega_0/Q = \frac{C_4 + C_5}{R_1 C_4 C_5} \tag{4}$$

Note that ω_0 can be adjusted independently of ω_0/Q by changing the value of R_3. Sensitivity analysis of this lowpass filter shows that

$$S^{\omega_0}_{R_1} = S^{\omega_0}_{R_3} = S^{\omega_0}_{C_4} = S^{\omega_0}_{C_5} = S^{Q}_{R_3} = -S^{Q}_{R_1} = -1/2$$

$$S^{Q}_{C_4} = -S^{Q}_{C_5} = \frac{1}{2}\frac{C_5 - C_4}{C_4 + C_5}$$

If we choose $y_1 = sC_1$, $y_2 = \infty$ (short circuit), $y_3 = sC_3$, $y_4 = 1/R_4$, and $y_5 = 1/R_5$, a highpass SCB can be realised. Its characteristics can be expressed as

$$\omega_0 = \left(\frac{1}{R_4 R_5 C_1 C_3}\right)^{1/2} \tag{5}$$

and

$$\omega_0/Q = \frac{R_4 + R_5}{C_3 R_4 R_5} \tag{6}$$

Also, note that ω_0 can be adjusted independently of ω_0/Q by changing the value of C_1. Sensitivity analysis of this highpass filter yields

$$S^{\omega_0}_{R_4} = S^{\omega_0}_{R_5} = S^{\omega_0}_{C_1} = S^{\omega_0}_{C_3} = S^{Q}_{C_1} = -S^{Q}_{C_3} = -1/2$$

$$S^{Q}_{R_4} = -S^{Q}_{R_5} = \frac{1}{2}\frac{R_5 - R_4}{R_4 + R_5}$$

The third example is a bandpass filter with $y_1 = 1/R_1$, $y_2 = sC_2$, $y_3 = 1/R_3$, $y_4 = sC_4$, and $y_5 = \infty$ (short circuit). Its current transfer function can be described as

$$\omega_0 = \left(\frac{1}{R_1 R_3 C_2 C_4}\right)^{1/2} \tag{7}$$

and

$$\omega_0/Q = \frac{C_2 + C_4}{R_1 C_2 C_4} \tag{8}$$

Again, note that ω_0 can be adjusted independently of ω_0/Q by changing the value of R_3. Sensitivity analysis of this bandpass filter gives

$$S_{R_1}^{\omega_0} = S_{R_3}^{\omega_0} = S_{C_2}^{\omega_0} = S_{C_4}^{\omega_0} = S_{R_1}^{Q} = -S_{R_3}^{Q} = -1/2$$

$$S_{C_2}^{Q} = -S_{C_4}^{Q} = \frac{1}{2}\frac{C_4 - C_2}{C_2 + C_4}$$

As the fourth example, if $y_3 = \infty$, then eqn. 1 becomes

$$\frac{I_0}{I_1} = \frac{y_2 y_1 - y_4 y_5}{y_1 y_5 + y_1 y_2} \tag{9}$$

If $y_1 = sC_1 + 1/R_1$, $y_2 = sC_2 + 1/R_2$, $y_4 = sC_4$, and $y_5 = 1/R_5$, a notch filter can be realised with

$$\frac{C_1}{R_2} + \frac{C_2}{R_1} = \frac{C_4}{R_5} \tag{10}$$

Eqn. 9 can also synthesise the allpass filters proposed in Reference 4.

Considering a nonideal CCII, we can describe the currents and voltages of its ports as $I_z = \alpha_i I_x$ and $V_x = \alpha_v V_y$, where $\alpha_v = 1 - \varepsilon_v$, $\alpha_i = 1 - \varepsilon_i$ and ε_v ($|\varepsilon_v| \ll 1$), ε_i ($|\varepsilon_i| \ll 1$) denote the voltage and current tracking errors, respectively. A detailed analysis for the transfer function of this configuration gives the following expression:

$$\frac{I_0}{I_1} = \alpha_i \frac{y_3[y_1 y_2 - y_4 y_5 + (\alpha_v - 1) y_3 y_5]}{y_1 y_5 (y_2 + y_3 + y_4) + y_1 y_2 (y_3 + y_4) + y_2 y_5 [y_3 (1 - \alpha_v) + y_4]} \tag{11}$$

Note that the Q and ω_0 of the SCBs are insensitive to the current tracking error of the CCII.

Finally, the third example is simulated by using the proposed CMOS current conveyor[5] with $C_2 = C_4 = 10\,pF$, $R_1 = 500\,k\Omega$, and $R_3 = 50\,k\Omega$ as a numerical example. The result is given in Fig. 2, which agrees well with the theoretical analysis.

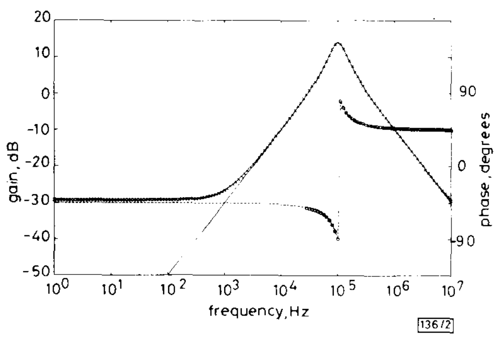

Fig. 2 *Simulation results of current-mode bandpass biquad*

——— gain (theoretical)
– – – – phase (theoretical)
× × × gain (simulated)
○○○ phase (simulated)

Conclusions: A new configuration for realising any type of current-mode second-order filtering transfer function with high output impedance is presented. By analysing these configurations of the SCBs employing four or six one-port passive RC elements, a versatile family of SCB filter sections suitable for systematic design is described. These networks are canonical in the number of passive components. The passive sensitivities of the SCBs are calculated to evaluate the performance of these circuits. The suitability of CCIIs as the active elements to obtain basic building blocks for the design of SCB filters is established.

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S.-I. LIU
H.-W. TSAO
J. WU

Department of Electrical Engineering
National Taiwan University
Taipei, Taiwan, ROC 10764

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EFFECTS OF ICE DEPOLARISATION ON Ka-BAND SATELLITE-EARTH PATH IN STRATUS RAINFALL EVENTS

Indexing terms: Satellite links, Radiowave propagation

In stratus rainfall events, the effects of ice depolarisation are evaluated using the CS-2 beacon signal and X-band radar observations. Although the ice effects described in terms of the deviation from theoretical rain depolarisation show a large variation according to the rain height, net ice depolarisations deduced above this height are relatively constant.

Introduction: A dual polarisation communication system is one of the promising techniques for frequency reuse of satellite communication links. In future, the demand for satellite channel capacity will increase in higher frequency bands such as the Ku (14/11 GHz) and Ka (30/20 GHz) bands. In these higher frequency bands, however, ice particles above the melting layer may make a considerable impact on slant path depolarisations even in a low attenuation range.[1–3] However, ice depolarisations are not so strongly related to meteorological data available on the ground such as rain fall rates. This makes it difficult to predict the ice depolarisations occurring above the rain height. The ice effects are usually described by additional values dependent on rain depolarisations and time percentages in long term statistics.[4]

In this study, we focus our attention on cross-polarisation discrimination (XPD) data obtained from the CS-2 beacon signal (19·45 GHz, circular, EL = 49·5°)[5] in 'stratus' rainfall events, where ice depolarisation is relatively prominent.[3] In each event, the ice effects are evaluated by the deviation of the observed XPD from theoretical rain depolarisations. The relationship between the ice effects and the rain height is then discussed, using the simultaneous X-band (9·41 GHz) radar observations. Furthermore, numerical calculations are performed to estimate average ice depolarisations above the rain height.

Observations: The 'stratus' rainfall event is characterised by a clear bright band (melting layer in radar observation), small rainfall rate (< 5 mm/h) or attenuation (< 10 dB), and considerably long duration (1–6 h). This type is generally associated with widespread rain clouds due to fronts. In the stratus events, however, large depolarisations of less than 25 dB are frequently observed as well as in the 'cumulus' rainfall events.[6]