Voltage-controlled integrator sets filter's bandwidth

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Because it uses operational transconductance amplifiers as electrically tuned integrators for selecting a state-variable filter's center frequency and bandwidth virtually independently of one another, this circuit is ideal for use in music and speech synthesizers that require individual voltage-controlled setting of these parameters.

As shown, input signals to be processed are applied to transconductance amplifier A_1, whose bias current is derived from voltage-to-current driver A_5Q_5. The bias current, in turn, is set by control voltage V_ω, which ultimately determines the filter's center frequency. In general, $I_{bias} = V_\omega/2R_{11}$.

Placing the capacitor C_ω across the output of the operational transconductance amplifiers A_1 and A_2 converts the two-stage network into a noninverting integrator, the transfer function becoming $V_o(s)/V_i(s) = k/s$, where k is the 3080's transconductance factor k'/C, and transconductance k' as given in its data sheets is $k' = 19.2\ I_{bias}$. Substituting for I_{bias}, $V_o(s)/V_i(s) = 19.2\ V_\omega/sRC_\omega$.

Placing integrator A_3 in the feedback loop of A_1 and A_2 equips the basic filter with the capability to control bandwidth. As seen from inspection of the circuit:

$$V_x(s) = R_1 \| R_2 \| R_3 \| R_4 \left[\frac{V_i(s)}{R_1} + \frac{V_y(s)}{R_3} + \frac{V_{LP}(s)}{R_4}\right]$$

where the low-pass function is given by:

$$V_{LP}(s) = -(k_2/s)^2 V_x(s) R_6/(R_5 + R_6)$$

and where $V_y(s) = -k_1V_x(s)/s$. Constants k_1 and k_2 are given by:

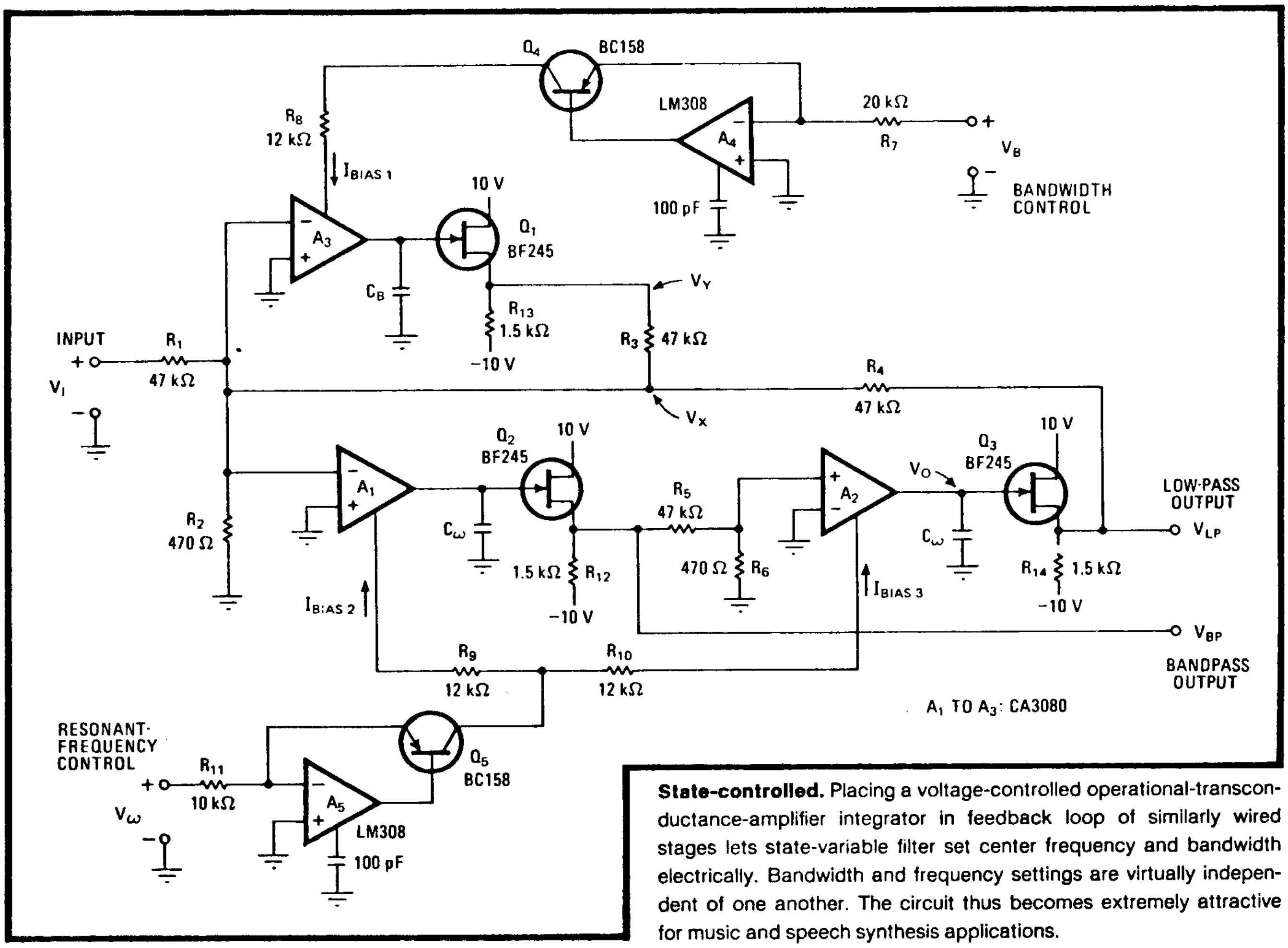
$$k_1 = 19.2\ V_B/R_7C_B$$

$$k_2 = 19.2\ V_\omega/2R_{11}C_\omega$$

and the bandpass function, $V_{BP}(s)$, equals $-k_2V_x(s)/s$.

Assuming $R_1 = R_3 = R_4 = R_5 = R'$ and $R_2 = R_6 = R''$, with $R''/R' = a << 1$, it follows that $R_1\|R_2\|R_3\|R_4 = R_2$. Substituting the appropriate quantities back into all the above equations, it is seen that:

$$V_{LP}(s)/V_i(s) = -1/[(s/\omega_o)^2 + (B/\omega_o)(s/\omega_o) + 1]$$



State-controlled. Placing a voltage-controlled operational-transconductance-amplifier integrator in feedback loop of similarly wired stages lets state-variable filter set center frequency and bandwidth electrically. Bandwidth and frequency settings are virtually independent of one another. The circuit thus becomes extremely attractive for music and speech synthesis applications.

$V_{BP}(s)/V_i(s) = -(s/\omega_o) / [(s/\omega_o)^2 + (B/\omega_o)(s/\omega_o) + 1]$

Where the resonant frequency and the bandwidth are given by: ω_o (rad/s) $= a k_2 = 19{,}2\ a V_\omega / 2 R_{11} C_\omega$

B (rad/s $= a k_1 = 19{,}2\ a V_B / R_7 C_B$

Parameter a should be near 0,01 to ensure the best compromi

ω 300 pF ?