A Low-Noise Variable Gain Control

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The EL2082 current-mode variable gain control IC can be connected in a way to minimize circuit noise. In the usual forward configuration, the circuit has an 80nV/√Hz input noise which is constant with respect to gain adjustment. The circuit to be shown has an effective input noise which reduces as adjusted gain is increased. The circuit is useful in AGC or leveling functions where a relatively constant output amplitude is required for a range of inputs.

Figure 1 shows the schematic of the configuration. The EL2082 provides an output current equal to V_{GAIN}/1V times the input current. The output impedance of the EL2082 is in the megohm range and the input impedance is about 90Ω, and the part behaves as a current conveyor with adjustable gain. In essence, the EL2082 causes R_{FV} to behave as a variable feedback resistor, and in parallel with R_{FF} controls the gain of the circuit.

With V_{GAIN} = 0, the circuit gain is $-R_{FF}/R_{IN}$, and the noise of the EL2082 is gained to zero. In this mode, the circuit gain is maximum and input noise is determined by the op-amp alone. With V_{GAIN} = 1V, the circuit gain is $-(R_{FF}/R_{FV})/R_{IN}$, and EL2082 noise mixes with op-amp noise.

For the maximum value of V_{GAIN} = 2V, the EL2082 dominates the feedback signal and gain is minimum while output noise is increased.

The op-amp must be a current-feedback type for the circuit to work. The CMF amplifier's low-input impedance prevents capacitance at the -input from causing a feedback pole and drastically limiting potential bandwidth. On the other hand, since the time delay of the EL2082 is inside the R_{FV} feedback loop, R_{FV} is a rather high value and must be adjusted to prevent excessive peaking or oscillation when V_{GAIN} = 2V. R_{FF} is set to control the maximum gain when V_{GAIN} = 0. For the values shown, the output can swing ±2V for 0.25% distortion, and the maximum swing is ±4V.

The input noise is successfully reduced by the circuit when small inputs require higher gain, as shown in Figure 2. The constancy of bandwidth and peaking and gain range are the tradeoffs. Here is a table of measured values:

V_{GAIN}	A_V	BW, -3dB	PEAKING	INPUT NOISE
0	9.03	11MHz	None	8.7nV/√Hz
0.5V	5.41	26MHz	None	19nV/√Hz
1.0V	3.91	58MHz	None	33nV/√Hz
1.5V	3.11	75MHz	2.2dB	42nV/√Hz
2.0V	2.62	80MHz	5.5dB	57nV/√Hz

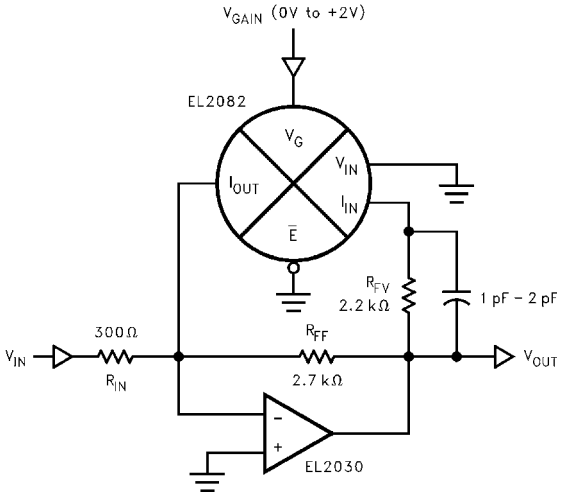

FIGURE 1.

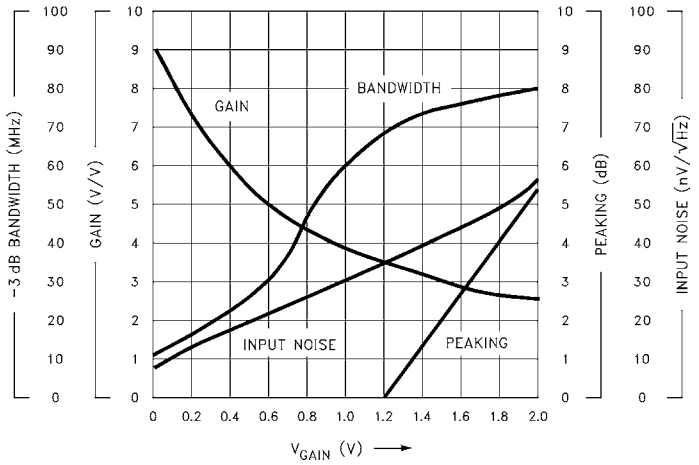

FIGURE 2.