

# Serrodyne amplifier generates wideband linear ramp

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Producing an extremely linear 200-V ramp or peak-to-peak sine wave over a frequency range of 50 kilohertz, this circuit is ideally suited for modulating the helix of a traveling-wave tube (serrodyning) or generating large voltages for circuit synchronizers. Because of the inherent symmetry of the circuit design, it can produce both positive-going and negative-going ramp waveforms.

In addition to the advantages previously mentioned, the circuit offers:

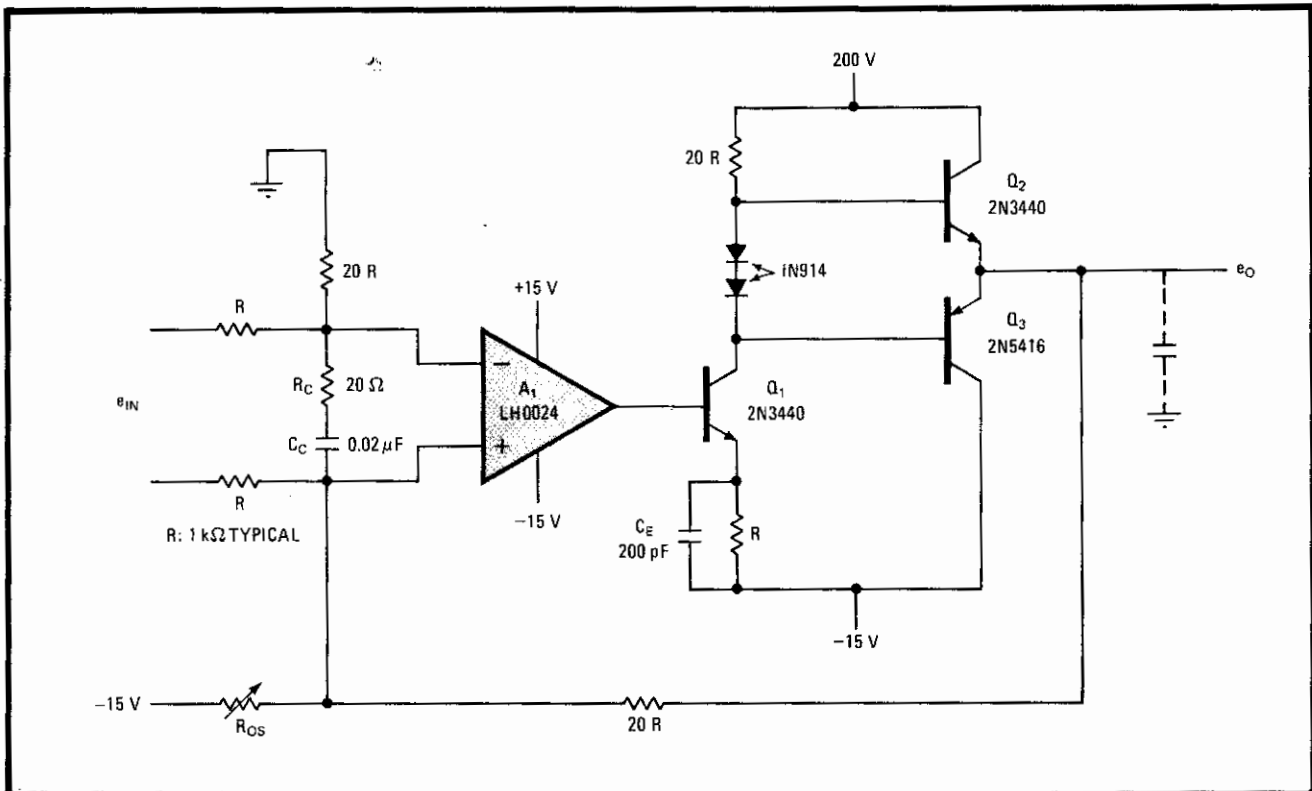
- Low gain error through either input.

- Fast response for both ramp polarities—the output's flyback-settling time is 1 microsecond.
- Wide dc-offset capabilities.

To achieve this performance, an operational amplifier with a high slew rate and broadband response is used in a simple feedback arrangement.

The low-level ramp or sine wave signal is applied to either input of  $A_1$ . Note that the polarity of the ramp at the output is reversed if the input signal is applied to the opposite port of  $A_1$ . The broadband characteristics of  $A_1$  provide sufficient output, even at a closed-loop gain of 20. This is the minimum loop gain required to obtain the linearity, precision, and dynamic range that were initially specified for this application.

After inversion and further amplification by  $Q_1$ , the signal passes through complementary-transistor pair  $Q_2$ - $Q_3$  to the output. Because  $Q_1$  is designed for a closed-loop gain of 20, it is only necessary to swing 10 volts at the output of  $A_1$ , well within the operational



**Well-behaved.** Feedback circuit provides high-voltage ramp or sinewave to capacitive loads exceeding 200 picofarads. Broadband op amp having high slew rate contributes to excellent linearity of waveforms over 50 kilohertz range. Flyback settling time is 1  $\mu$ s.