Take advantage of current-feedback amps for high-frequency gain

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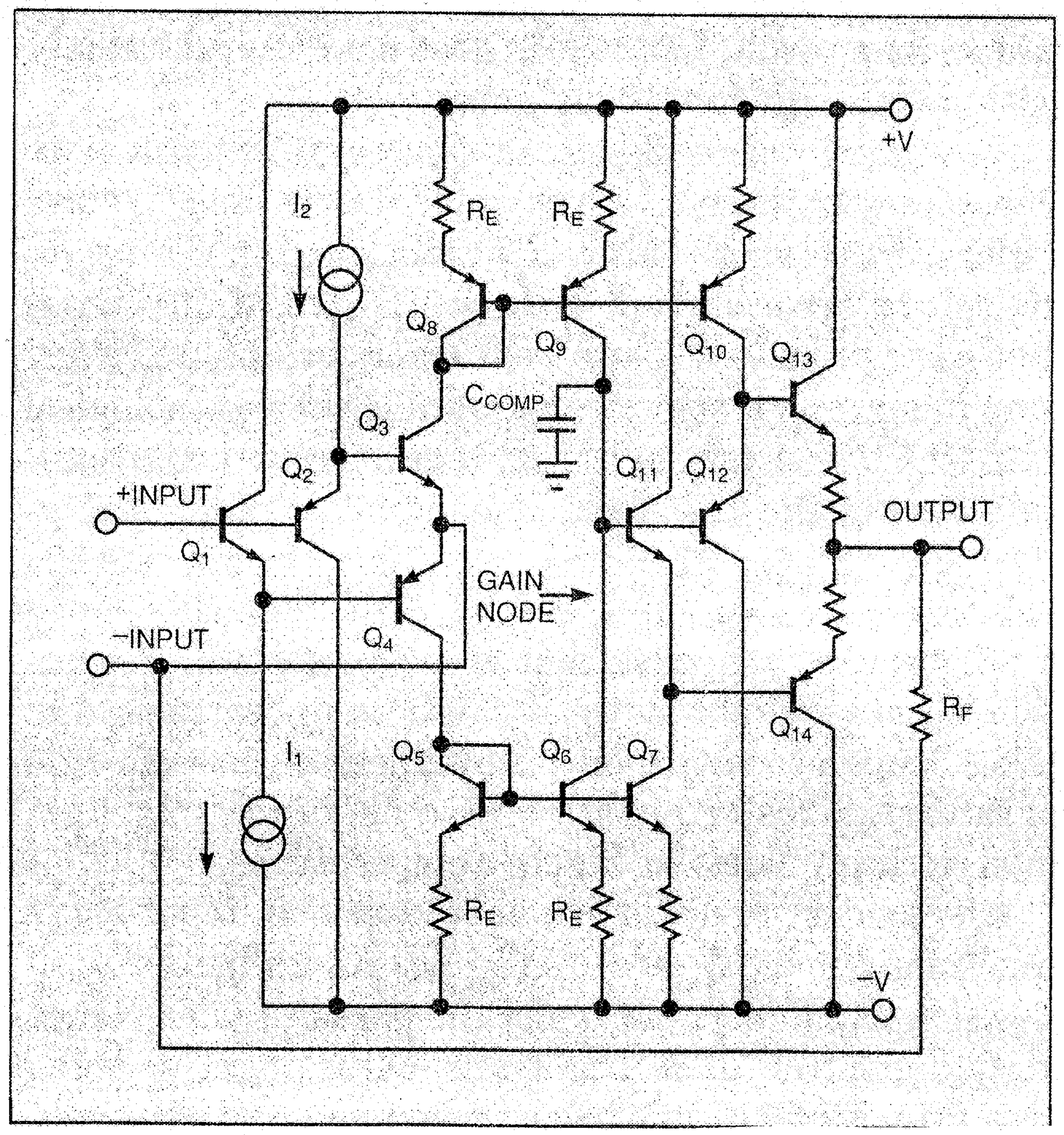
Current-feedback amplifiers have virtues unavailable in the traditional voltage-feedback design. To take full advantage of these virtues, you'll need to know the strengths and weaknesses of current-feedback amplifiers and techniques for coping with amplifier problems.

Current-feedback amplifiers develop high-frequency gain in a manner that is fundamentally different from that of voltage-feedback amplifiers. These amplifiers are not just input stages, but full-fledged amplifier circuits that have some outstanding characteristics: very high slew rates, −3-dB bandwidths almost constant with increasing circuit gain, and low high-frequency distortion. Almost all commercial current-feedback amplifiers offer these benefits, but many exhibit such seldom publicized limitations as slew distortion, thermal settling errors, and so-so gain accuracy.

Fig 1 illustrates the simplest current-feedback-amplifier circuit. Transistors Q_1 through Q_4 form a complementary buffer, so the −INPUT terminal is actually an output—a buffered replica of the voltage at the +INPUT. Q_3 and Q_4 idle at a quiescent current proportional to the geometric mean of i_1 and i_2 and a scale factor dependent on the relative sizes of Q_1 through Q_4. When the feedback loop is at null, no error current flows to the −INPUT, and Q_3 and Q_4 draw equal collector currents (ignoring base-current errors). Q_8 and Q_9 mirror Q_3's collector current and transfer the value to the gain node. Q_5 and Q_6 mirror Q_4's collector current and use the current to balance the Q_8-Q_9 current mirror at the gain node. Transistors Q_{11} through Q_{14} provide buffering between the gain node and the output terminal.

To understand the behavior of the circuit, assume that the +INPUT and output terminals are resting at 0V. If you apply a 1V positive step to the +INPUT, the Q_1-through-Q_4 input buffer quickly replicates the step at the −INPUT terminal. Because the output terminal has not had time to react, the step voltage is impressed across feedback resistor R_F. Assuming a value of 1 kΩ for R_F (typical in most cases), the 1V step causes a 1-mA transient current to flow through R_F. This current flow increases Q_3's current by 500 μA and decreases Q_4's current by 500 μA. If both current mirrors have a gain of 1, Q_9's collector current will increase by 500 μA, and Q_6's collector current will decrease by 500 μA. The 1-mA transient-error current through R_F arrives at the amplifier's gain node and slews the node positive at a rate determined by the R_F-C_{COMP} time constant. The amp's output follows the gain node, moving in a positive direction until the circuit reaches equilibrium. At this point, almost no current flows through R_F and currents to the gain node balance.



CURRENT-FEEDBACK AMPLIFIERS