IMPORTANCE OF HIGH OPEN-LOOP GAIN

The ideal operational amplifier would have an infinite voltage gain when no feedback resistor was present, but since this is unattainable in practice, the effect of a finite open-loop gain on amplifier accuracy must be examined.

In Fig. 3.8, selected values of open-loop gain $-A$ are plotted against closed-loop gains $-G$, and percentage amplifier error. Closed-loop gains are normally restricted to 0·1–50 as this caters for almost all operational conditions, and it is seldom required to extend these limits. A different set of circumstances apply when the op-amp is used for integration, and these will be considered in detail later.

Very high $-A$ gains bring attendant drift and stability problems, and this in turn demands a larger number of components and more complicated circuitry to keep drift and stability within acceptable limits. At the opposite extreme, very simple amplifier circuits can be built to yield $-A$ gains in the region of 100–1,000, but when $-G$ approaches 50 the errors of such amplifiers would be near 10 per cent. Thus, if a low value for $-A$ was chosen, for the sake of simplicity, the range of available closed-loop gains would have to be restricted if the error was not to exceed one or two per cent, and this would place severe limitations on the operational flexibility of the amplifier.

It was assumed that PEAC operators would not wish to employ plug-in computing components with a selection tolerance better than, say, ± 1 per cent. Therefore, the error contributed by the amplifier will preferably be less than external component errors, but not so small as to call for ridiculous extremes of circuit sophistication. The thickened curve of Fig. 3.8, corresponding to $-A = 5{,}000$, shows that the maximum error contribution of UNIT "A" amplifiers is 1 per cent or less for $-G$ gains of less than 50.

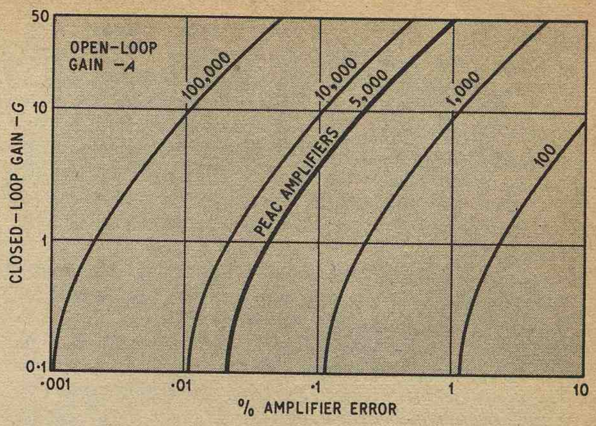

Fig. 3.8. Open-loop gain plotted against closed-loop gains and percentage amplifier error

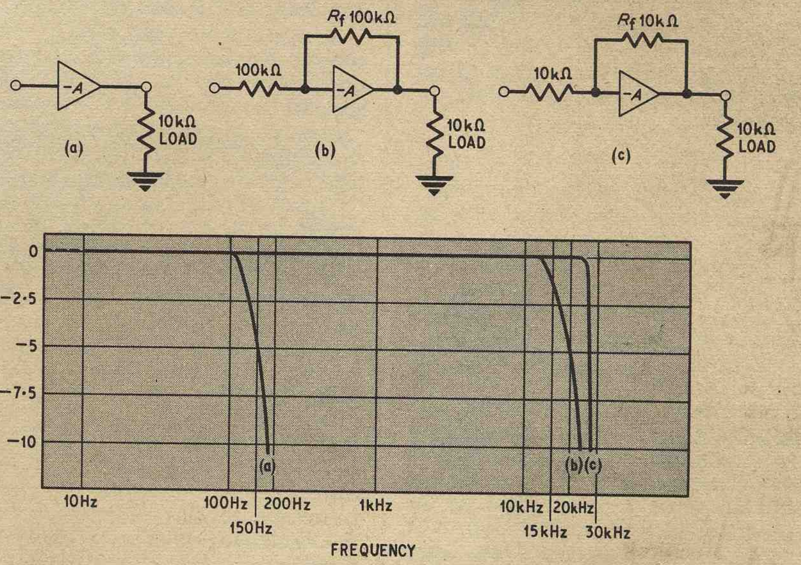

Fig. 3.9. Amplifier frequency response

TABLE 3.1

UNIT "A" OPERATIONAL AMPLIFIER. TYPICAL PERFORMANCE

Supply voltage $\pm$12·5V $\pm$0·5%

Open-loop voltage gain 5,000 d.c.—100Hz. 200 at 10kHz

Maximum output voltage $\pm$10V for loads >2kΩ; $\pm$5V for loads >300Ω

Input impedance 40kΩ approx.

Input current 0·005μA for 1V out

Closed-loop frequency response 0–10kHz within 1% when R_f = 100kΩ

Equivalent input drift $\pm$0·5mV per hour

Input offset voltage and current almost zero when amplifier correctly balanced

R.M.S. noise, referred to input with input open circuit 200μV

Normal maximum range of plug-in components

R_{in} 2–100kΩ

R_f 10–100kΩ

C_f 1–0·01μF

Stability unconditional with all normal problem layouts

BANDWIDTH AND STABILITY

A direct coupled amplifier of the Fig. 3.7 type will display an almost constant phase change of exactly 180 degrees over a range of frequencies from d.c. to