AC characteristics of 741 Op-Amp

Typical low cost, general purpose op-amps exhibit a gain bandwidth product of a few megahertz. Specialty and high speed op-amps can achieve gain bandwidth products of hundreds of megahertz. For very high-frequency circuits, a completely different form of op-amp called the current-feedback operational amplifier is often used.

The op-amp gain calculated at DC does not apply at higher frequencies. To a first approximation, the gain of a typical op-amp is inversely proportional to frequency. This means that an op-amp is characterized by its gain-bandwidth product. For example, an op-amp with a gain bandwidth product of 1 MHz would have a gain of 5 at 200 kHz, and a gain of 1 at 1 MHz. This low-pass characteristic is introduced deliberately, because it tends to stabilize the circuit by introducing a dominant pole. This is known as frequency compensation.

All amplifiers have a finite bandwidth. This creates several problems for op amps. First, associated with the bandwidth limitation is a phase difference between the input signal and the amplifier output that can lead to oscillation in some feedback circuits. The internal frequency compensation used in some op amps to increase the gain or phase margin intentionally reduces the bandwidth even further to maintain output stability when using a wide variety of feedback networks. Second, reduced bandwidth results in lower amounts of feedback at higher frequencies, producing higher distortion, noise, and output impedance and also reduced output phase linearity as the frequency increases.

FREQUENCY DEPENDENT PROPERTIES

Introduction

DC operational amplifiers will operate successfully at audio, ultrasonic, and radio frequencies with some predictable variation from DC operation. Circuits designed to operate at DC are also affected by the AC response since random noise and varying DC levels contain AC components. The AC response characteristics of the operational amplifier are very important considerations in circuit design.

Open Loop Gain and the Bode Plot:

Bode plot is conveniently used to represent the frequency response curve of operational amplifier . The absolute value of voltage gain is plotted in dB

$$dB = 20 \log \frac{E_O}{E_I}$$

so that a gain of 10 is 20 dB, a gain of 100 is 40 dB, etc.) versus the orthodox decade logarithmic frequency scale. The Bode plot of a typical operational amplifier's open loop gain is shown in figure along with a convenient linear approximation to the actual curve.

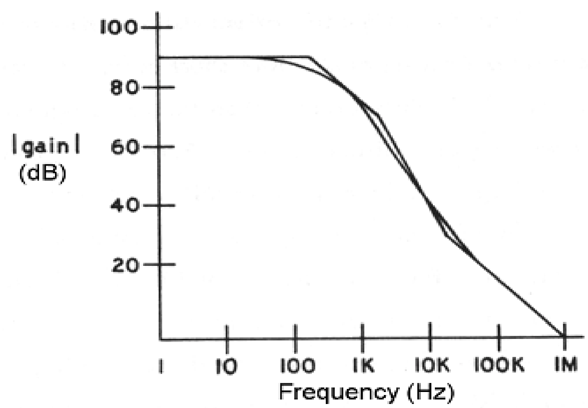

Figure 1.7

Bode Plot:

The shape of the Bode plot shown in figure is characteristic of all compensated voltage feedback operational amplifiers. It is so characteristic, in fact, that any open loop Bode plot may be approximated rapidly from only two bits of information about the particular operational amplifier:

1) DC open loop gain

2) The unity-gain crossover frequency (open loop bandwidth).

For example: An operational amplifier has DC open loop gain of 108 dB and open loop bandwidth of 1 MHz. From these two values, we can sketch the Bode plot as indicated in figure.

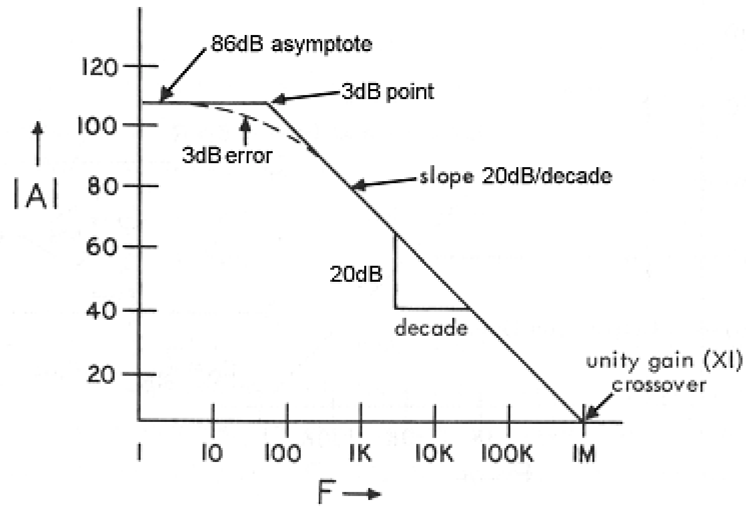

Figure 1.8