Power supply design is perhaps the most challenging aspect of the entire process of controlling noise and radiation in high-speed DSP design. This is largely because of the complexity of the dynamic load switching conditions. These include the DSP going into or out of low power modes, excessive in-rush current due to bus contention and charging decoupling capacitors, large voltage droop due to inadequate decoupling and layout, oscillations that overload the linear regulator output, and high current switching noise generated by switching voltage regulators. A clean and stable power supply design is required for all DSP systems to guarantee system stability. This chapter outlines the importance of proper power supply design and the methods to minimize unwanted noise.

4.1 POWER SUPPLY ARCHITECTURES

The two types of power supplies commonly being used in DSP systems are linear and switching power supplies. The linear power supply is the best architecture for low noise designs such as analog audio, video and data converter circuits. The disadvantages of this architecture are its power efficiency and dissipation. As shown in Figure 4.1, the linear power supply consists of two main stages, input/output transistor and error amplifier. The input DC voltage here has to be higher than the output voltage and the minimum input voltage varies depending on the component selected. So,
it is very important for designers to review the power supply’s specifications and set input and output voltage levels appropriately.

The circuit in Figure 4.1 works as follows:

- The transistor T1 operates in a linear region where the emitter current, $I_e$, (output current) is controlled by the base current, $I_b$, and the gain of the transistor, $\beta$.

\[
I_e = I_c + I_b \quad (4.1)
\]
\[
I_c = I_b \beta \quad (4.2)
\]

Substitute Eq. (4.2) into Eq. (4.1)

\[
I_e = I_b \beta + I_b \quad (4.3)
\]

- If the output voltage drops due to higher current load, the error amplifier configured as a negative feedback circuit compares the Regulated Output divided by the resistors $R_1$ and $R_2$ to the Reference Voltage and drives higher base current $I_b$ to maintain regulation. As shown in Eq. (4.3), the output current $I_e$ is increased with the increase in the base current $I_b$.

- If the output voltage increases do to lighter current load, the error amplifier sees more negative voltage at the input and lowers the base current. This leads to lower output current and again the system maintains regulation.

![Figure 4.1. Linear Power Supply Architecture](image_url)