General Requirements on Logic Circuits

A computer consists of many logic circuits. These may be connected in many ways, but in principle their organisation is as shown in figure 4.1.

During a clock pulse, data is transferred from one register to another. Between the registers the signals are processed by logic circuits. The registers typically consist of a number of bistable flip-flop circuits. Control signals inform the logic

![Diagram of computer circuit]

Figure 4.1 Schematic view of computer circuit. Register B feeds its information back to influence the input signals. This gives a closed feedback loop.
circuits how the signals are to be processed. Often the control signals are determined by data from the different registers. Consequently we obtain a closed feedback loop as shown in figure 4.1. This loop should not oscillate and to prevent this either the phase shift of the loop should be less than $180^\circ$ or the small-signal gain in a quiescent operating point should be less than unity for each stage. In high speed digital circuits the latter is the more practical, and a first necessary requirement is set that the \textit{small-signal gain be less than unity} (see figure 4.2).

A further necessary requirement is that the signals out for logical '1' and '0' should be \textit{well defined} as otherwise when there are several stages in series a '1' may deteriorate successively to '0'. These requirements will be considered in more detail later.

Besides those necessary we have also several desirable features. One of these is that the circuits should have \textit{low power} consumption. This preference is underlined by the fact that a medium size computer may contain more than ten thousand gates. High power consumption means high operating temperature and this is normally not allowed to exceed about $60^\circ$ C for reasons of reliability.

For easy combination of many logic circuits the \textit{fan-out of each circuit should be large}. This means that it should be possible to connect many inputs to each output without overloading.

Further it is desirable that the \textit{logical circuit should be fast}. This is both to provide a high information rate and to allow several logic stages to respond in one cycle.

Finally inductive or capacitive pick up of unwanted signals should not disturb the logic. This means that \textit{the noise margin of a logic circuit should be large} as explained in more detail later. To summarise:

\textbf{Necessary requirements}

- Gain at the quiescent operating points less than unity
- Well defined output voltages