An oscillator is what you get when you try to build an amplifier. This is a popular definition of an oscillator. There is some truth in this statement. Surely, it takes a good amplifier circuit to create an oscillator. It also takes a good resonator to build a harmonic oscillator. On-chip passive components have evolved considerably the last few years. Flip-chip techniques have enabled high Q on-board resonators.

Meanwhile supply voltage of communications equipment is decreasing whereas phase noise requirements are becoming more and more severe. The design of an oscillator for telecommunication applications still constitutes a major challenge for the electronic designer. This chapter proposes a well-structured way to oscillator design by giving both theoretical considerations and practical oscillator implementation examples.

12.1 INTRODUCTION

An oscillator is an active electrical circuit that can generate periodic waveforms out of constants [1]. This short definition is illustrated in Figure 12.1.

DC energy from the power supply is transformed into the time varying oscillator output signal

\[ A(t) = \hat{A} \Psi (\omega_0 t + \theta) \]  

(12.1)

classified by the following parameters

- Waveform \( \Psi \)
- Amplitude \( \hat{A} \)
- Frequency \( \omega_0 \)
In an ideal oscillator circuit, the oscillation frequency \( \omega_0 \) depends only on the constants and not on the active part. In a practical oscillator circuit, the active part does have an influence on the oscillation frequency. Part of the frequency determining constants may be constituted by the active circuit’s parasitic capacitances.

The oscillator can be more precisely characterized by its frequency accuracy and both long and short-term stability. Especially the short-term frequency fluctuations, often referred to as phase noise, have become a driving factor for the oscillator circuits used in today’s communication equipment. Low noise oscillators use frequency selective devices or resonators to determine the oscillation frequency.

12.2 THE HARMONIC OSCILLATOR

The harmonic oscillator uses a timing reference, a passive circuit whose transfer function \( H \) has at least two poles, to provide the constants that determine the oscillator frequency. Figure 12.2 shows the oscillator’s mathematical model.