Part II
Oscillator Designs for Temperature and Voltage Independence

As pointed out in Part I, the spread on active components due to mismatch, temperature, and other external parameters is large and difficult to control. These effects are even more dominant in deep-submicron CMOS processes. Passive devices, or at least their linearity and temperature dependency, are much more predictable and controllable, providing a better starting point for an oscillator with PVT-independence. In this part, six design cases to obtain a voltage- and/or temperature-independent time value are studied and implemented.

In Chap. 5, two RC oscillator designs are discussed. The first design starts from the principle that the frequency should only be determined by passive components (R, C, or L) and that the influence of active components on the oscillation frequency should be minimized. It will be shown that at low supply voltages this methodology becomes difficult or even impossible. Therefore, a second RC oscillator design is designed, using control circuitry to keep the transistor parameters as constant as possible.

In Chap. 6, a completely different approach is taken. Instead of using a low-Q RC tank, an LC tank is used. Due to the high Q factor of the bondwire inductor, the energy losses in the tank are extremely small. As a result, the impact of the amplifier can drastically be reduced. In order to keep the power consumption as low as possible, an alternative 'pulsed' driving technique was developed. This results in a highly temperature- and voltage-independent low-power oscillator.

The designs in Chap. 7 do not rely on the absolute accuracy of a free-running oscillator anymore. A low-quality oscillator is built and injection-locked to an external RF reference clock. Two designs are discussed: the first locks to the carrier frequency and the second locks to an AM-modulated clock signal. In both cases this results in an exact low-power clock reference. The second design can also be used as an ultra-low-power AM-PSK receiver.

The last chapter of this part, Chap. 8, uses an oscillator as a sensor interface. To obtain a temperature- and voltage-independent sensor value, a ratio of two time values is used rather than an absolute time value. Simulations show that the proposed interface topology scales properly towards deep-submicron CMOS technologies. This design was implemented in 40 nm CMOS.