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Ultra-Wideband Antennas for Ultra-Wideband Communication and Sensing Systems

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Abstract : Ultra-wideband (UWB) time-domain impulse communication and radar systems use ultra-short duration pulses in the sub-nanosecond regime, instead of continuous sinusoidal waves, to transmit information. The pulse directly generates a very wide-band instantaneous signal with various duty cycles depending on specific usages. In UWB systems, the total transmitted power is spread over an extremely wide range of frequencies; the power spectral density is extremely low. This effectively results in extremely small interference to other radio signals while maintains excellent immunity to interference from these signals. UWB devices can therefore work within frequencies already allocated for other radio services, thus helping to maximize this dwindling resource. Therefore, impulse UWB technique is attractive for realizing high-data-rate, short-range communications, ground penetrating radar (GPR), and military radar with relatively low emission power levels. UWB antennas are the key element dictating the transmitted and received pulse shape and amplitude in both time and frequency domain. They should have good impulse response with minimal distortion. To facilitate integration with transmitters and receivers employing microwave integrated circuits, UWB antennas enabling direct integration are preferred. We present the development of two UWB antennas operating from 3.1 to 10.6 GHz and 0.3-6 GHz for UWB systems that provide direct integration with microwave integrated circuits. The operation of these antennas is based on the principle of wave propagation on a non-uniform transmission line. Time-domain EM simulation is conducted to optimize the antenna structures to minimize reflections occurring at the open-end transition. Calculated and measured results of these UWB antennas are presented in both frequency and time domains. The antennas have good time-domain responses. They can transmit and receive pulses effectively with minimum distortion, little ringing, and small reflection, clearly demonstrating the signal fidelity of the antennas in reproducing the waveform of UWB signals which is critical for UWB sensors and communication systems. Good performance together with seamless microwave integrated-circuit integration makes these antennas good candidates not only for UWB applications but also for integration with printed-circuit UWB transmitters and receivers.

Keywords : antennas, ultra-wideband, UWB, UWB communication systems, UWB radar systems
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