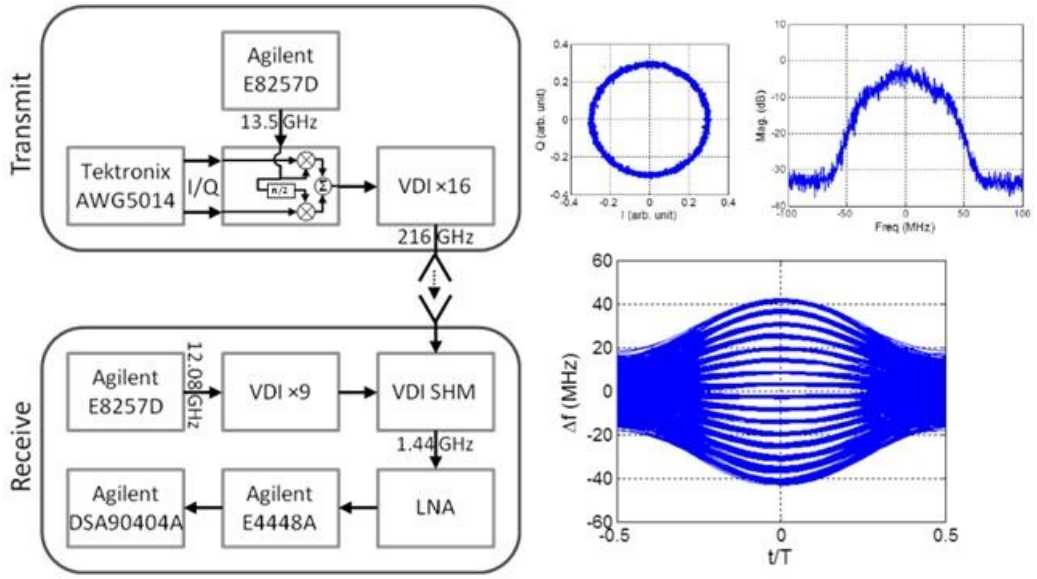
Kilometer-range communications link in the 220 GHz atmospheric window using continuous phase modulation

Charles R. Dietlein* and Joe X. Qiu
U.S. Army Research Laboratory, Adelphi, MD, 20783

We have explored and demonstrated a digital communications link operating in the 220 GHz atmospheric window, utilizing multi-level continuous phase modulation (CPM), capable of kilometer-distance links at sea level in a standard US atmosphere. The transmitter architecture consists of direct I/Q modulation on a Ku-band (13.5 GHz) carrier, followed by diode frequency multiplication (×16) to 216 GHz. The receiver architecture consists of a sub-harmonic mixer (SHM) driven by an X-band (12.08 GHz) LO that is multiplied by ×9; the resulting IF at 1.44 GHz is analyzed with a spectrum analyzer or digital oscilloscope that runs appropriate demodulation software. The constant-envelope architecture enables minimal distortion at the full saturated power of the transmitter, with no output power backoff, resulting in high spectral and power efficiency. This technique is ideal for the millimeter-wave/terahertz frequency range (100-1000 GHz) where transmit power is limited. Our transmitter produces, at the horn antenna flange, approximately 3 mW, measured in both CW and CPM operation. We have characterized the system in the lab at short range (1 m), indoors at moderate ranges (100 m), and will shortly demonstrate it outdoors at a range of 1 kilometer. In these measurements we introduce additional attenuation into the link to explore the bit error rate, and vary the number of CPM levels. Additionally, we have incorporated a G-band LNA before the SHM to extend the link distance. The presentation will describe our system architecture in detail, discuss system-level communications aspects above 100 GHz, and include descriptions of our experiments and their results.



(left) Block diagram of the 216 GHz communications link. (right) Signal envelope, PSD, and eye diagram of the CPM waveform after downconversion from 216 GHz.