

This paper presents a 60-GHz CMOS direct-conversion Doppler radar RF sensor with a clutter canceller for single-antenna noncontact human vital-signs detection. A high isolation quasi-circulator (QC) is designed to reduce the transmitting (Tx) power leakage (to the receiver). The clutter canceller performs cancellation for the Tx leakage power (from the QC) and the stationary background reflection clutter to enhance the detection sensitivity of weak vital signals. The integration of the 60-GHz RF sensor consists of the voltage-controlled oscillator, divided-by-2 frequency divider, power amplifier, QC, clutter canceller (consisting of variable-gain amplifier and 360° phase shifter), low-noise amplifier, in-phase/quadrature-phase sub-harmonic mixer, and three couplers. In the human vital-signs detection experimental measurement, at a distance of 75 cm, the detected heartbeat (1-1.3 Hz) and respiratory (0.35-0.45 Hz) signals can be clearly observed with a 60-GHz 17-dBi patch-array antenna. The RF sensor is fabricated in 90-nm CMOS technology with a chip size of 2 mm×2 mm and a consuming power of 217 mW.