We present a dual-carrier vital sign detection scheme based on phase-locked loop to automatically reduce the noise introduced by residual phase noise and transmission paths. Two phase-locked microwave signals at 5.76 and 5.68 GHz are adopted to suppress noise and extract the vital sign, respectively. When the feedback beat signal is locked to the highly stable low-noise reference, the residual phase noise and path noise of the corresponding 5.76-GHz wave are reduced, providing low-noise circumstances for the 5.68-GHz carrier, which has the same path. Additionally, the 5.68-GHz carrier is phase modulated by the vital sign, thus its demodulation leads to a vital sign of low noise level and high spectral purity. The experimental results show that our system based on discrete components introduces no extra noise, has a 12-dB improvement in the signal to noise ratio at the 10-Hz frequency offset, and can effectively measure both respiration and heartbeat signals in four physical orientations at a distance of 50 cm. In addition, by suppressing the residual phase noise and path noise, the detection distance of the weak heartbeat signal from the front of the human subject is extended to at least 250 cm, which is more than double the distance of a system without the noise suppression scheme.