High speed time-domain balanced homodyne detector

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A time-domain balanced homodyne detector (BHD) is invaluable for the direct measurement of electric field quadratures of pulsed quantum light fields. Such detector play an important role in quantum communication and quantum tomography. We have designed and built a fiber-based high-speed time-domain BHD, which can measure the electric field quadratures of pulsed optical quantum states with a pulse width of 3 ns and repetition rate of 40 MHz. The correlation coefficient between the adjacent output pulses of the detector proves its ability for identification of individual optical pulses. The detector exhibits a common mode suppression of 80 dB and a signal-to-noise ratio above 11 dB at a local oscillator (LO) power of 8×10^7 photons per pulse. The measured noise variance for vacuum field input shows a linear dependence on the LO power, which is in consistent with the prediction of the shot-noise. We also evaluate the Allan variance of the peak value of the detector output pulses, the results shows that the drift of the detector baseline is negligible for the measurement time of 2 seconds.

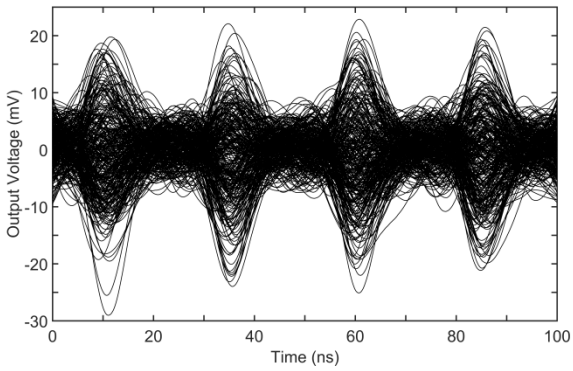

Fig. 1 Time traces of the homodyne detector output at a repetition rate of 40 MHz (The LO power is 8×10^7 photons per pulse).

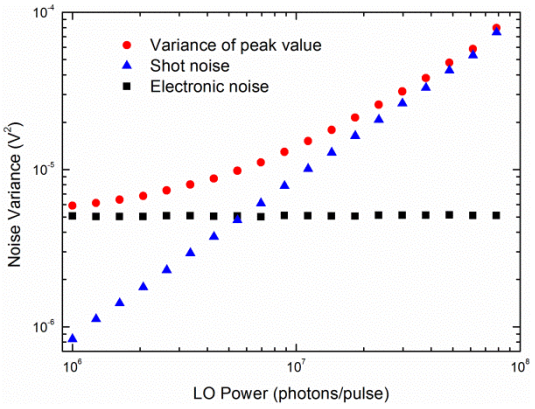

Fig. 2 The output peak value variance of the detector versus the LO power for vacuum field input.