A waveguide loop coupled to two external line waveguides via a 50/50 beam splitter forms a Sagnac interferometer. We consider the situation where a cascade four-level emitter is coupled to the loop of a Sagnac interferometer and a single photon is input through one end of the line waveguides. Since the incoming photon is always in a superposition of the clockwise and counterclockwise modes of the loop, the two frequency-down conversions with the clockwise and counterclockwise modes are coherence and ensure that the frequency-down conversion with three-photon emission definitely happens. We investigate the correlations of the emitted three photons in frequency and spatial domains. We find that the three photons can have the strong frequency correlation under the single-, two- and three-photon resonant conditions. We also find that the three wavepackets of photons can well overlap and correlate in real space. It means that our scheme may can be used to generate three-photon bound states in a one-dimensional real space.