A photonic multi-channel terahertz (THz) wireless transmission system in the 350-475 GHz band is experimentally demonstrated. The employment of six THz carriers modulated with 10 Gbaud Nyquist quadrature phase-shift keying baseband signal per carrier results in an overall capacity of up to 120 Gb/s. The THz carriers with high-frequency stability and low phase noise are generated based on photonic photomixing of 25-GHz spaced six optical tones and a single optical local oscillator derived from a same optical frequency comb in an ultrabroadband uni-travelling carrier photodiode. The bit-error-rate performance below the hard decision forward error correction threshold of $3.8 \times 10^{-3}$ for all the channels is successfully achieved after wireless delivery. Furthermore, we also investigate the influence of the harmonic spurs in a THz receiver on the performance of transmission system, and the experimental results suggest more than 30 dB spur suppression ratio in downconverted intermediate frequency signals for obtaining less than 1 dB interference.