IEEE 802.15.4 standard is widely used in the field of low-power, low-cost and low-bit rate communications. In this paper, we analyze performance of an IEEE 802.15.4 network operating in 2450 MHz ISM (Industry, Science and Medicine) band in the presence of κ–μ fading, interference and additive white Gaussian noise. A novel analytical expression for the chip error probability evaluation of an IEEE 802.15.4 wireless channel has been derived. Its correctness is validated by Monte Carlo simulations. Capitalizing on the derived CEP expression, the symbol error probability and the packet error probability are also evaluated for various values of the κ–μ fading channel parameters and signal-to-interference-to-noise ratios.