Passive intermodulation (PIM) often limits the performance of communication systems with analog and digitally modulated signals and especially of systems supporting multiple carriers. Since the origins of the apparently multiple physical sources of nonlinearity causing PIM are not fully understood, the behavioral models are frequently used to describe the process of PIM generation. In this paper, a polynomial model of memoryless nonlinearity is deduced from PIM measurements of a microstrip line with distributed nonlinearity with two-tone CW signals. The analytical model of nonlinearity is incorporated in Keysight Technology's ADS simulator to evaluate the metrics of signal fidelity in the receive band for analog and digitally modulated signals. PIM-induced distortion and cross-band interference with modulated signals are compared with those with two-tone CW signals. It is shown that conventional metrics can be applied to quantify the effect of distributed nonlinearities on signal fidelity. It is found that the two-tone CW test provides a worst-case estimate of cross-band interference for two-carrier modulated signals, whereas, with a three-carrier signal, PIM interference in the receive band is noticeably overestimated. The simulated constellation diagrams for QPSK signals demonstrate that PIM interference exhibits the distinctive signatures of correlated distortion and this indicates that there are opportunities for mitigating PIM interference and that PIM interference cannot be treated as noise. One of the interesting results is that PIM distortion on a transmission line results in asymmetrical regrowth of output PIM interference for modulated signals.