Analysis of Passive Intermodulation Products over Spectral Bands

Ekta Dogra
Space Applications Centre, ISRO, Ahmedabad, 380058, e-mail: ektadogra@sac.isro.gov.in

Passive intermodulation (PIM) products are generated when multiple RF signals pass through the non-linear passive components/subsystems. PIM poses a serious concern for both space based links as well as terrestrial links. The effect of these unwanted intermodulation products is ultimately reflected in the throughput/capacity of the system. PIM products increase the noise level at the receiver, reducing the C/N of the uplink signal. Typically, overall system link is governed by the user; whether forward link or return link. C/N is low in user uplinked return link, as user terminals have lower power level. PIM products generated at the transmitter and coupled in-band at receiver increases the noise level and decreases the already low C/N at user uplinked return link. This affects the throughput of the system.

In comparison to higher frequency bands, gain is low at lower bands along with poor user uplink. This leads to typically lower C/N at lower frequencies. So effect of in-band PIM product at receiver; is higher at lower frequency bands; due to already low C/N. Moreover, at higher frequency bands, wide bandwidth is available and higher modulation schemes are feasible. Higher modulation leads to increase in spectral efficiency and ultimately provides higher throughput at higher spectral bands. Spectral efficiency at lower frequency bands is poor due to lower modulation schemes available for the links to sustain. Measurement metrics of a system is its throughput. Ultimately the throughput decreases at lower bands due to already lower C/N which causes lower order modulation schemes selection, that in turns lower spectral efficiency. Assumption is constant bandwidth over the spectral bands and constant carrier & noise power. PIM is depicted as interference which enhances the received noise level.

Figure 1 shows PIM level against system throughput. For a constant carrier and noise levels, C/N+I decreases as PIM become significant i.e. when delta between PIM & noise level decreases. This relates to throughput in a way that, for a constant system bandwidth, and changing PIM interference, most spectrally efficient modulation scheme is selected for each PIM value. Thus, when PIM interference becomes significant, less spectrally efficient modcod is selected to sustain the link, which leads to reduction in throughput.

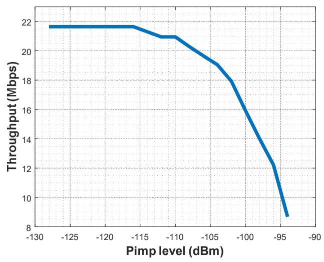

Figure 1. PIM against Throughput

Table 1. PIMP (dBc) over spectral bands

Bands	Transmit Receive Antennas	
	Different	Same
UHF-band	-162	-192
S-band	-147	-187
C-band	-145	-175
Ku-band	-145	-175

Table 1 presents typical PIM level requirement (w.r.t transmit carrier) over spectral band, for same as well as different transmit and receive antennas. For higher bands, PIMP requirement become less stringent. Also, PIMP levels are relatively lower for different transmit and receive antennas, due to high isolation. Effect of PIM can only be avoided by selecting PIMP free receive frequency bands. Moreover, effect can be reduced, by making use of perfectly clean surfaces, avoiding dissimilar materials & by maintaining maximum isolation between transmit and receive antennas, if possible.

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