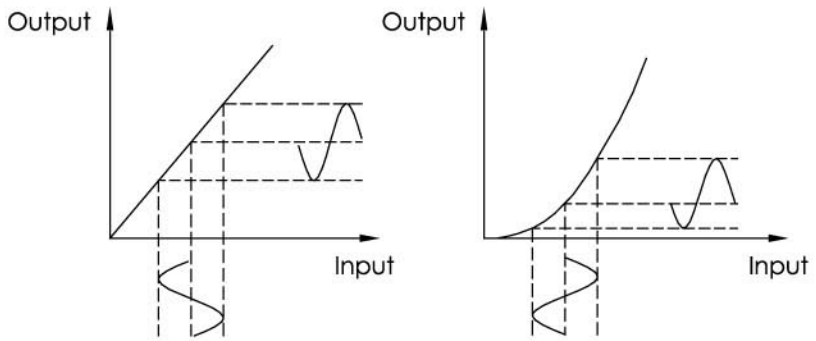
PIM in Connector

Introduction

PIM is the abbreviation of passive intermodulation distortion which, nowadays, is a critical parameter in wireless community due to it's debilitating effect on performance of telecommunication system. PIM, unwanted signal, is generated whenever two or more frequencies mix together in a non-linear device such as connector or cable assembly.

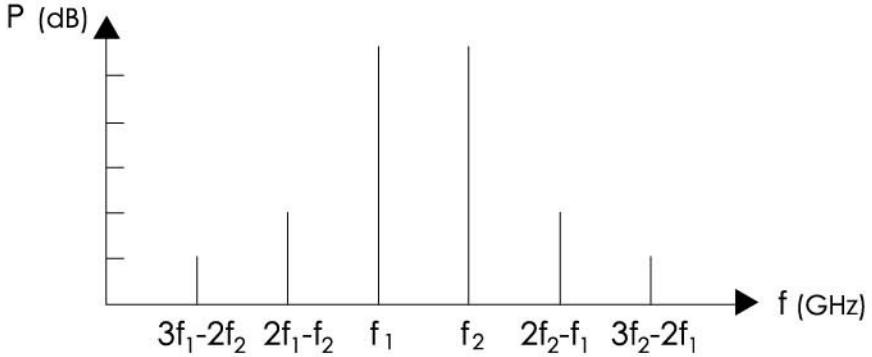


linear response **non-linear response**

Because the non-linearity have a imperfect diode response, the waveform of output is obviously distorted, whereas the one of linearity is proportional to input. When the distorted signal is converted to frequency domain, it consists of the desired fundamental carriers and a series of related harmonics named intermodulation products. The products are mathematically related to the original frequencies:

$$f_{PIM}=mf1\pm nf_2$$

The sum of m and n is called product order, the 3rd product is the primary concern because it is the highest level in all products.



Potential causes

Any minor deviation from original design or the manufacturing process such as raw material, assembly, packaging, transportation can raise the unwanted PIM. The potential causes are most likely as below:

- contaminated plating
- insufficient plating thickness
- corrosion
- dissimilar metals in direct contact
- ferrous metals use in signal path
- too many contact junctions
- low contact pressure
- less than 360 degree contact
- poor surface roughness
- debris and dust within connector
- convoluted signal path
- crimp cable termination

And it is must noted that PIM can be time dependent because of RF heating effort, which will vary the conjunctions inside the assembly. In such cases, depending on the design and assembly condition of the device, the PIM can either increase or even decrease over time. Well designed and properly made components should not vary with time.

PIM definition

PIM is normally specified in terms of dBm or dBc. dBm is a measure of power relative to 1 milliwatt. Zero dBm is 1 milliwatt into a 50 ohm load. dBc is a measure of dB below a specified carrier level. Because the PIM changes when the two carrier powers vary, the input power must be stated when specifying PIM. 20 watts, or 43 dBm is a typical input power level specified for testing passive devices, in this case, if the requirement for PIM is –120 dBm, it also can be explained the specification -163 dBc.

General Information

PIM improvement

several factors must be evaluated when considering a low PIM design such as contact design, connector mating interface, connector internal junctions, cable attachment, materials and plating.

Interface contact must be designed to provide high contact pressures at the point of desired current flow. A imperfect contact will generate a voltage barrier where the microscopic arcing may take place resulting in a nonlinear voltage to current ratio.

One-piece center contact or body is preferred in PIM sensitive connector. The less there are the internal junctions in connector, the more possibility the excellent PIM would be. In addition, press-fit configurations can lead to problems.

The plating must be free from contaminants, thick enough and with excellent adhesion to base material. Silver has been the preferred plating material as it features the lowest resistivity thereby minimizing interface contact resistances.

Ferromagnetic materials such as nickel or steel must be eliminated from the current path due to their non-linear characteristics. Brass and copper alloys are generally accepted as linear materials. Tests have shown that nickel plate under gold on the center contact will typically result in a 40 to 50 dB increase in PIM. Stainless Steel in the body will usually give a 10-20 dB increase in PIM.

Surface finish is paramount. The signal propagates within a "skin" if this skin is too rough, the signal will repeatedly transit through metal and surface oxide layers, thereby creating the same effect as a poor panel contact.

Crimps, by nature, can only give multiple point contact rather than 360-degree contact and also cause a variability in the position of electrical contact during dynamic testing. IM products will therefore be greater. It has been found that soldered center contacts and clamp/solder outer contacts give the best static and dynamic IM performance.

Extreme care must be taken to ensure no metal particles or chips of any kind from the assembly process end up inside the assembly. This relates to both assembly of the connector, trimming of the cable and soldering operations. Excess flux will attract other contaminants. Pieces of copper jacket or braid will compromise the performance and cause intermittent operation.