RF Lightning Protectors and PIM- What you NEED to know

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The basic function of an RF Lightning/Surge Protection Device is to limit voltage and energy to the protected equipment by conducting surge current to the shield/ground during lightning events. One important factor in the selection process is whether the application requires RF only or if it requires DC voltage and current on the center conductor to power Tower Top Electronics.

Other factors that need to be considered in selecting lightning protectors for RF applications include:

- Insertion Loss
- Return Loss/VSWR
- Surge current handling capability
- Voltage and energy limiting capability
- Form factor
- Corrosion resistance
- Ruggedness/Durability

Different RF protection circuit topologies and PIM performance

In today's wireless architecture, another important issue is PIM. Passive Intermodulation distortion is generated when two or more RF signals pass through a non-linear junction. The below graphs provide visual illustration of this phenomenon. Fig. 1 shows the linear response of a proper contact, while Fig. 2 represents the behavior of a non-linear junction in the RF path.

Fig 1 and 2

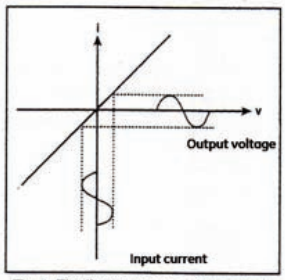

Fig. 1 The linear response of an ohmic contact.

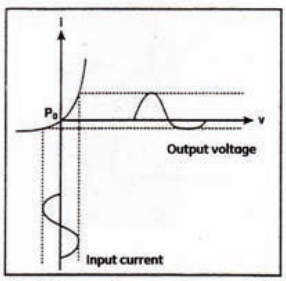

Fig. 2 The nonlinear response possible from contact resistance.

The primary causes for PIM generation are:

- Dissimilar metals (galvanic action)
- Poor surface quality (roughness)
- Low Contact Pressure (improper torque or solder)
- Poor Contact Cleanliness (residual chemical films)
- Use of Magnetic Materials
- Changes in Temperature and current density

In-line RF lightning protection devices contribute to PIM interference based on one or more of the above issues. For PIM sensitive applications, properly designed and tested lightning protectors should be selected and installed in accordance with required guidelines.

The below sweeps represent three different RF Lightning Protector designs tested for PIM with two +43dBm (20W) carriers applied to the surge side connector. All units were taken "out of the box" to provide an objective evaluation.

Fig 3

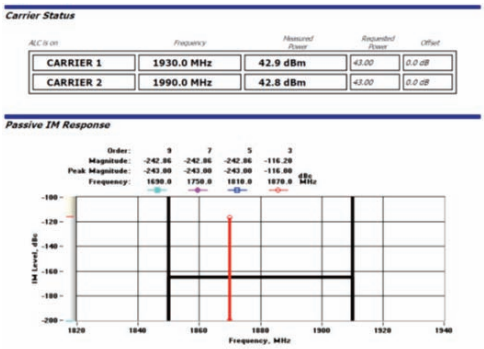

Figure 3 illustrates PIM performance of a basic Gas Tube Lightning protection device. While Gas Tube protection technology may be sufficient in some

applications, Gas Tube protectors are inherently "bad" for PIM. A typical protector, based on a single gas tube design, measures -110dBc at the above stated test parameters. This is not adequate for many wireless communications base station applications.

Fig 4

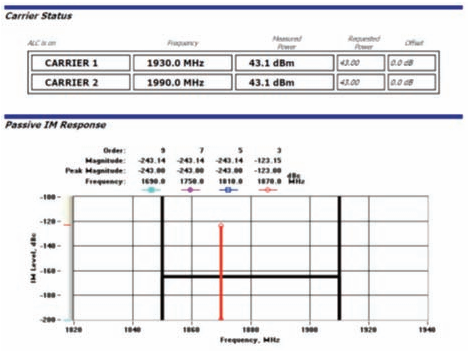

Figure 4 is the PIM performance of an "Ultra Low" PIM RF lightning protection product based on a high band pass filter design. This "ultra-low" PIM product is rated to <-155dBc on the manufacturer's data sheet, but testing showed that the measured value was -123-124dBc. This is a level that can potentially cause performance problems in a wireless base station.

Fig 5

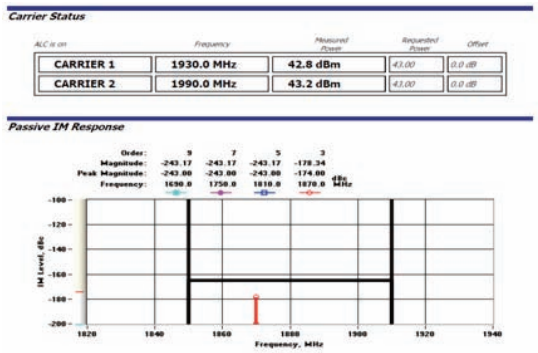

Figure 5. The Times Microwave Systems low PIM line of Lightning Protectors for PIM sensitive applications is a broadband design with center conductor DC blocking and inductive decoupling of the center conductor to the shield/ground. Several static and dynamic tests were performed on these units to ensure reliable data capture. *The measured PIM value for the LP-STR and LP-STRL series protectors is -174 dBc with a specified minimum value of -160 dBc.*

Conclusions:

Manufacturers of RF Lightning Protection Devices for PIM sensitive applications should factor into design, manufacturing process and final inspection and testing the following practices:

- Proper selection of RF protection circuit topology utilizing PIM "friendly" components.
- Materials and plating techniques ensuring minimum, if any, dissimilar galvanic junctions.
- Materials utilized in protector design and assembly should be free of any roughness
- Use of materials with Magnetic Properties should be avoided in protector design.
- Plating of internal components for RF protection circuit should be carefully controlled.
- Final inspection and testing must consist of PIM sweeps in both dynamic and rest conditions
- Every RF Lightning Protector for PIM sensitive application should be PIM certified.

In addition to the afore mentioned recommendations, ensuring "clean" installation of any in-line RF components, including a Lightning Protector, is critical to overall system performance. Proper connector torque, avoidance of dissimilar metals (galvanic junctions) as well as weatherization of components exposed to outside weather will yield stable long term performance for a wireless site. Site maintenance and periodic checks of RF system interconnecting cables and connectors is critical to eliminating PIM issues over the long run. At Times Microwave Systems, all the above practices are taken into account while designing and manufacturing products for PIM sensitive applications. PIM testing requires high quality PIM test components including test leads, adapters and loads which are also available from Times Microwave Systems.

Fig. 1 and 2 - reprinted with permission from Microwave Journal - May 1995 issue

Times-Protect® LP-STRL-D

SilverLine-LP™ (Low PIM)

Bogdan (Bogey) Klobassa with Times Microwave Systems supports the wireless industry in lightning protection, grounding, power quality and risk management. Bogey has contributed to the Motorola R-56 and multiple IEEE standards development.
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