Tech Bulletin EMW-001

Push Pin vs. Leaf Spring

"To Plunge and not to Plunge"

A brief description and comparison between Plunger Pin and Leaf Spring contacts used in traditional Land Mobile and Public Safety Vehicular Antennas.

Myth: *Plunger Pin Contacts provide better mechanical performance and reliability than traditional Leaf Spring designs.*

Fact: It is true that Plunger Pin Contacts can be designed to provide reliable mechanical and electrical performance. Manufacturer's plunger pin products vary widely in design, but the key performance criteria are limited and determined by the specific attention paid to the details in their respective designs. Other factors include the relative care the antenna-mount interface receives during multiple couplings and de-couplings. The key points to consider when selecting a plunger pin include:

i) Spring, Plunger and Retainer interface tolerances; critical to prevent pin hang-ups and sticking when exposed to inevitable moisture from car wash or o-ring loss or damage.

ii) Spring and plunger contact material choice (brass, stainless steel, phosphor bronze).

iii) Surface plating quality (none, silver, gold, etc…).

Plunger deficiencies are easily overcome by using a single leaf spring component made of phosphor bronze or beryllium alloy with an inherently high spring retention force for multiple "hang-up free" couplings. E/M Wave VHF and UHF antenna products, incorporate high grade phosphor bronze leaf spring contacts finished with silver plating for high conductivity, long life, and corrosion free performance.

Myth: *The larger the diameter of the Plunger Pin contact, the better the electrical connection and/or impedance match.*

Fact: The impedance match is optimized at the drive point for any quality antenna design, regardless of the plunger pin diameter. The NMO contact creates an additional impedance discontinuity in the feed system, and it is up to the antenna designer's expertise to specify and compensate accordingly.

Myth: *Plunger Pin contacts are the only contact that can be used for High Frequency (> 1 GHz) applications such as Dual Band Cellular (800/1900 MHz) and Wifi (2400 MHz) applications.*

Fact: Leaf Spring contacts can be used if the antenna is designed and matched to the specific mount. The limiting factor for any antenna's impedance match is determined by the quality of the mount impedance used to install the antenna. Typical NMO mounts are designed as "split-lead" right angle transitions between the 50Ω feed cable and the antenna drive point. The split-lead transition creates a low impedance discontinuity at higher frequencies and were not designed for the shorter operating wavelengths found in many of today's newly emerging antenna applications. The split-lead transition has minimal effect on traditional LMR designs operating below 1 GHz. Successful impedance matching with split-lead NMO's can be achieved for antennas operating at frequencies up to 2 GHz, provided the antenna is designed appropriately to compensate for the unwanted discontinuity. It is not recommended to use split-lead NMO mounts above 2 GHz, as the impedance mismatch becomes too great to overcome, causing high VSWR conditions. E/M Wave designs are optimized per specification. All users can be assured that E/M Wave products will perform optimally as specified when using the recommended quality NMO type mount.

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Myth: *Plunger Pin contacts offer superior performance vs. Leaf Spring designs when replacing Leaf Springs with plunger pins in traditional low band frequency LMR and Public Safety antennas.*

Fact: Traditional lower band antennas (30-500 MHz) were specifically designed for optimal impedance performance using the NMO and the Leaf Spring components. The inherent advantage of the traditional Leaf Spring design provides overall product simplicity with increased coupling/de-coupling reliability for taller profile antennas requiring total removal from the vehicle during automatic car wash or other servicing requirements. This high rate repetitive coupling/de-coupling, creates many opportunities for damaging the antenna o-ring seals, total loss of the o-ring or other means of inadvertent moisture ingress. Moisture is the greatest enemy to any antenna system and specifically targets vulnerably corrosive materials and interfaces. The plunger pin spring and its associated components are usually the first mechanical items subject to dirt build-up and salt or moisture corrosion, causing ultimate failure of the plunger pin action. This fact emphasizes the need for high grade materials, tolerances and plating for the plunger pin to provide reliable performance. However, the design simplicity of the constant tension leaf spring provides consistent, highly reliable RF contact, without susceptibility to dirt or moisture corrosion, making it the clear choice for traditional Land Mobile/Public Safety antennas.

A few characteristics to consider when choosing an antenna with either Plunger Pin or Leaf Spring contacts:

Plunger Pin (NMO)

- Multi-component Construction – RF Noise Generator
- Susceptible to Moisture/Corrosion
- High Cost and Complexity
- Requires 3 components (Spring, Retainer, Plunger)
- Self Adjusting - During install and operation
- Not Field Repairable, if corroded or hanging up
- Typical Z-Axis NMO Contact Range: 0-5mm
- Machine Brass and Stainless Steel Spring

Leaf Spring (NMO)

- Single Tempered Self Tensioned Leaf Spring – RF Noise Free
- Corrosion/Moisture Resistant
- Low Cost, Simple, Reliable Construction
- Requires 1 component (Leaf Spring)
- Self Adjusting - During install and operation
- Simple Field Adjustment possible, but rarely needed
- Typical Z-Axis NMO Contact Range: 0-6mm
- Tempered Phosphor Bronze used in Mil-Spec RF Connectors

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