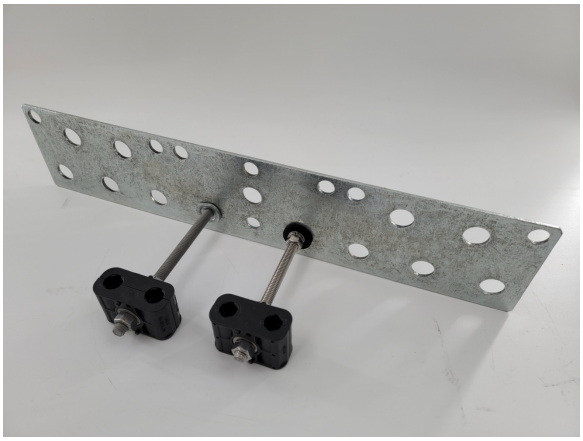
Low PIM Solutions: Threaded Rod Adapters and Insulators

Introduction

ConcealFab offers many low PIM solutions for supporting and organizing cables at basestation sites, typically employing the use of plastic or metal hybrid snap-ins and coax cable blocks. In some locations, due to extreme weather events, it may be necessary to use cable blocks instead of snap-ins to ensure stronger cable support. Many low PIM adapter solutions, using threaded rods, have been developed for securing these cable blocks to a variety of support-member profiles. However, the question arose—how can we adapt cable blocks to ConcealFab's high-cable-count snap-in mounting system using threaded rod hardware? From a PIM perspective, this presents a challenge—whether galvanized or stainless steel threaded rods are used. ConcealFab has developed low-PIM solutions for adapting threaded rods to the snap-in holes of cable support bars: the threaded rod adapter and insulator.



Cable blocks adapted to snap-in holes of cable support bar via galvanized threaded rod adapter (left assembly) and stainless-steel threaded rod insulator (right assembly).

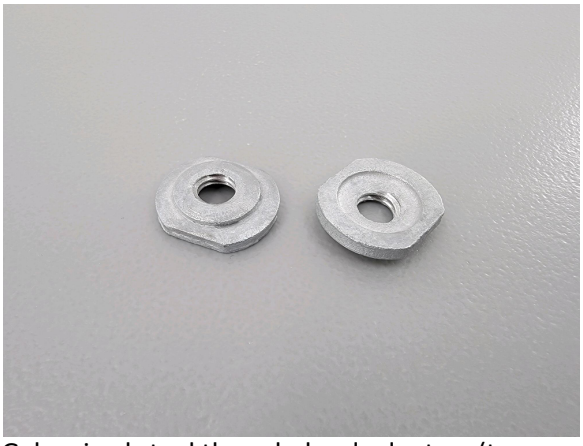
PIM Issues: Adapting Threaded Rods to Cable Support Bars

There are two major non-linear conditions known to be responsible for PIM interference found in high-risk PIM zones. Namely, poor metal-on-metal contact and galvanic corrosion. These two conditions should be kept in mind when designing hardware configurations to be low PIM. Poor metal-on-metal contact can result if the hardware, for example, is merely hand-tightened. If the hardware has been hot-dip galvanized, but not properly post-processed, then flakes or burrs may be present, potentially leading to PIM interference. PIM may also result due to the inherent design of the assembly, even if by applying appropriate torque during installation, proper contact pressure is still not achieved.

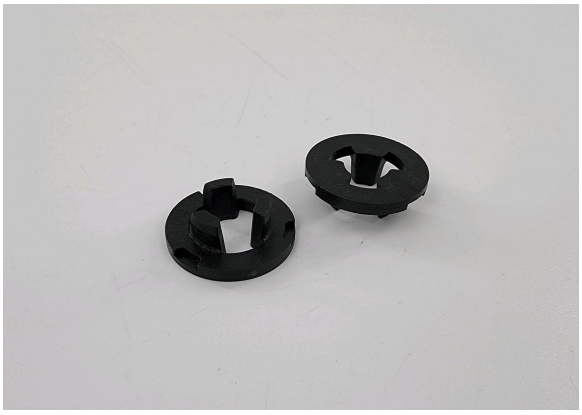
The other condition mentioned is galvanic corrosion. When two different metals far apart on the galvanic series chart (e.g. stainless steel and galvanized steel) are in contact with one another, corrosion products will be produced over time leading to PIM when exposed to RF energy. If two different metals must be assembled together, then insulation can be applied as the PIM-mitigation strategy. Both galvanic corrosion and loose metal-metal contact were considered during the design of the threaded rod adapters and insulators.

The Solution: Threaded Rod Adapters and Insulators

ConcealFab has developed low PIM solutions for adapting threaded rods with cable blocks to the holes of cable support bars, originally intended for snap-in style cable hangers. The galvanized threaded rod adapter was designed to secure 3/8" galvanized threaded rods to cable support bars with 3/4" diameter snap-in mounting holes. The adapter ensures solid metal-on-metal contact when torqued to the proper specification (10 ft-lbs, ConcealFab tool 900053). The size of the adapter also accounts for potential galvanization build-up in the snap-in holes.



Galvanized steel threaded rod adapters (two shown).



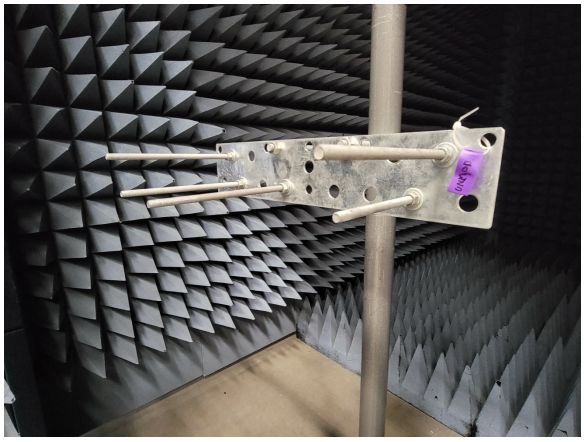
Threaded rod insulator (consists of two halves).

In addition, the threaded rod *insulator* was designed for situations in which a 3/8" stainless steel threaded rod (or rod consisting of some other dissimilar metal) must be applied to a galvanized steel bar with snap-in holes. Each insulator consists of two halves, with each halve consisting of three protruding features. When the insulator halves are inserted on each side of the mounting hole, they help align the two halves and safeguard against metal-to-metal interaction between the threaded hardware and the hole. The hardware is torqued to 10 ft-lbs.

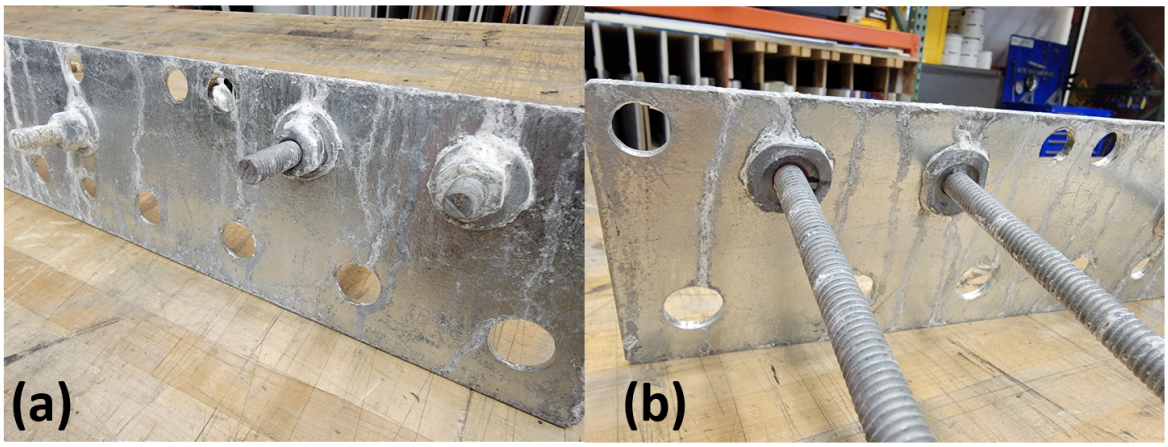
Radiated PIM Testing and Salt Spray Endurance

Radiated PIM testing was performed to IEC specification 62037-8 on the full assemblies incorporating the plastic insulators and galvanized steel adapters. Both assemblies were shown to be low PIM when subjected to a dynamic stimulus, generating peak IM3 power of less than -100 dBm. Radiated PIM test reports for both the insulators and adapters are provided on the ConcealFab website.

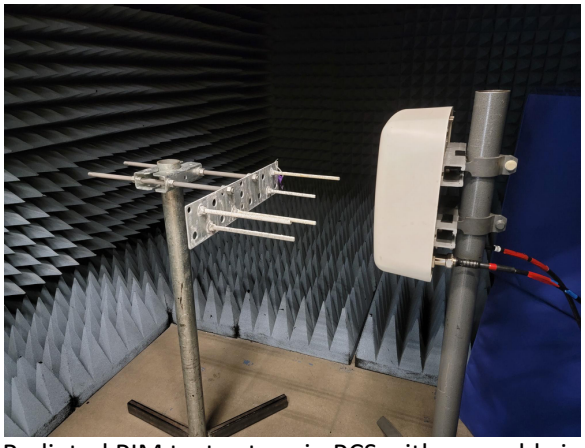
In addition to the standard PIM-testing required for qualifying low-PIM product, ConcealFab has also performed salt-fog testing (done to specification ASTM B117) to simulate the impact of outdoor exposure on PIM performance of the galvanized adapters. It is known that galvanized steel assemblies, while considered robust for the outdoor environment, can eventually corrode over time leading to intermodulation products when exposed to RF energy. To address this concern, a fully mounted cable support bar assembly with five galvanized threaded rod adapters and threaded rods kits were exposed to salt-spray for 168 hours and PIM-tested before and after. Before salt spray, the assembly passed radiated PIM-testing in both 1900 (PCS) and 700-band (data not shown).



BEFORE SALT FOG: Mounted cable support bar with galvanized threaded rod adapters



AFTER SALT FOG: close-up photos of (a) the front side, and (b) back side of the cable support bar.



Radiated PIM test set-up in PCS with assembly in front-facing orientation (after salt-fog).

After salt-spray exposure, the assembly was gently rinsed, dried, and re-mounted to the support stand and PIM-tested again to IEC 62037-8. Under dynamic stimulus, the peak IM3 generated from the assembly was less than -100 dBm at all tested transmitted signal polarizations and product orientations—a passing result.

Post Salt-Fog: Radiated PIM Test Results

700-band Radiated PIM Testing

Test Point*	Polarization	Peak PIM (dBm)	Result
700 RESIDUAL	-45	-124.6	**PASS**
700 FRONT	-45	-129	**PASS**
700 LEFT	-45	-124	**PASS**
700 BACK	-45	-126.1	**PASS**
700 RIGHT	-45	-127.4	**PASS**
700 RESIDUAL	+45	-115.5	**PASS**
700 FRONT	+45	-118.2	**PASS**
700 LEFT	+45	-115.9	**PASS**
700 BACK	+45	-116.4	**PASS**
700 RIGHT	+45	-116.9	**PASS**

* Product was tested in four orientations. Residual PIM was tested with the product removed from the test-chamber.

1900-band (PCS) Radiated PIM Testing

Test Point	Polarization	Peak PIM (dBm)	Result
1900 RESIDUAL	-45	-113.2	**PASS**
1900 FRONT	-45	-112.8	**PASS**
1900 LEFT	-45	-112.8	**PASS**
1900 BACK	-45	-114.4	**PASS**
1900 RIGHT	-45	-116.9	**PASS**
1900 RESIDUAL	+45	-119.5	**PASS**
1900 FRONT	+45	-112.7	**PASS**
1900 LEFT	+45	-115.8	**PASS**
1900 BACK	+45	-118.6	**PASS**
1900 RIGHT	+45	-117.1	**PASS**

Conclusion

ConcealFab's 13-position and 22-Position Cable Support Bar kits provide an effective method for organizing large numbers of cables at cell sites, typically employing the use of plastic and metal hybrid snap-ins. Because of the increasing demand for coax cable blocks (vs. snap-ins) in high-wind regions, ConcealFab created a low-PIM solution for adapting cable blocks to the cable support bar kits. In the case for all-galvanized hardware, the 901295-10 Galvanized PIM Shield Threaded Rod Adapter was developed to mount cable blocks to the snap-in holes of bars using galvanized threaded rod hardware. If installed at the correct torque, the assembly has been confirmed to be low-PIM after exposure to a salt-spray environment. The 901191-xx PIM Shield Threaded Rod Insulator has also been developed specifically for mounting cable blocks to galvanized bar kits with *stainless steel* threaded rod hardware. Due to the insulation provided, any 3/8" threaded rods may be adapted to bar kits with this insulator.