Quality is a true
reflection of character.

Webinar:

Design Considerations for

Field Ready Manpack & Flyaway Terminals

**KORE
COMPOSITES**

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KORE COMPOSITES REFLECTIVITY | RIGIDITY | RMS

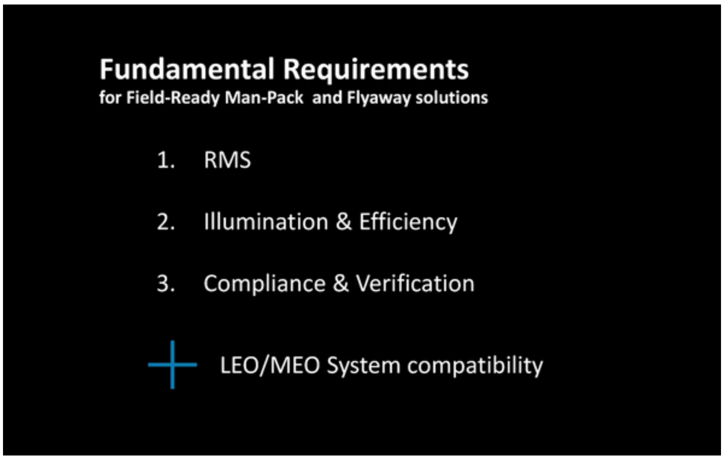
Via Satellite

Webinar Overview

Design Considerations for Field Ready Manpack and Flyaway Terminals presentation educated participants about ways to ensure they are obtaining the highest quality antennas and how those products should be measured and tested. Information shared includes how reflectors, feeds, and other components must be developed, inspected, and tested during product manufacturing and prior to delivery to ensure federal compliance and that all possibilities for field readiness conditions are met.

Micro-Ant, LLC., and its subsidiary companies – Kore Composites and Kore Precision Manufacturing – recognized the growing requirement in the satellite industry for Manpack and Flyaway terminals that are 100% compliant. So, they took on the challenge and met the need for quality product design and development. Over time, they proved to be leading the industry through well-designed, rigorously tested, and 100% compliant products.

Along with spearheading new product development, Micro-Ant has been in critical to programs to replace antennas in noncompliant and discontinued terminals. Drawing from these project experiences, Micro-Ant presented three fundamental requirements for excellence in man-pack satcoms terminals:



- RMS
- Illumination & Efficiency
- Compliance Verification

RMS: a fundamental requirement of the reflector

The fundamental requirement for high-performing segmented reflectors is RMS – which is a measurement of the surface errors of the reflector surface. The relationship between surface error on a reflector surface and the antenna performance is well defined: increases in surface error exponentially reduce the gain. But in a segmented reflector, which is typically made from carbon composite material, there are many challenges to maintaining a low RMS.

The three main challenges with achieving target RMS are:

1. Rigidly maintaining the specified parabolic shape despite the reflector being assembled from multiple pieces. Kore Composites had created a process that controls and verifies that each segment reassembles into the complete parabolic shape exactly as it was originally designed.

2. Environmental conditions pose the second challenge. Ensuring the reflector stays rigid in its parabolic shape under wind and/or movement, despite the individual components being easy to assemble and disassemble from each other, must be considered during design and assembly. Kore Composites utilizes materials and a design structure that are rigid and hold precisely at key points of contact.

3. And finally, measuring the surface accuracy of the reflector can only really be done on a truly reflective surface. A surface made of copper or silver is not truly reflective. Fundamentally, surface accuracy can only be measured mechanically, and the only surface error that matters is that of the conductive surface of the reflector. Kore Composites uses proprietary techniques to enable verification of the reflective surface.

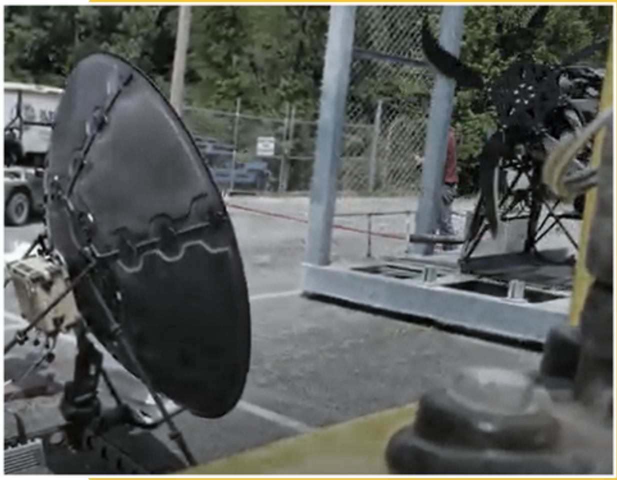
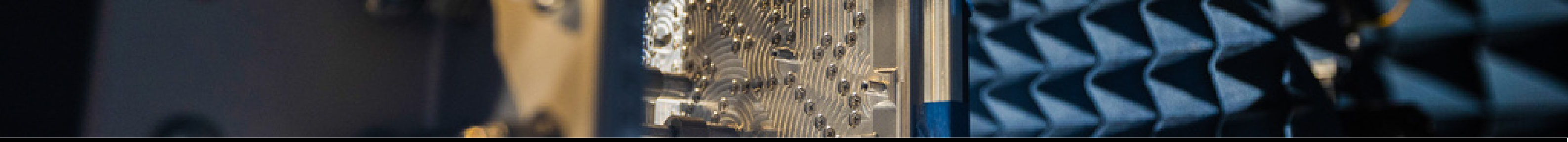


Figure 1: 1.3 m Kore Composites reflector wind load testing



The fundamental requirement of the feed and sub reflector is illuminating the reflector efficiently while meeting gain and sidelobe requirements.

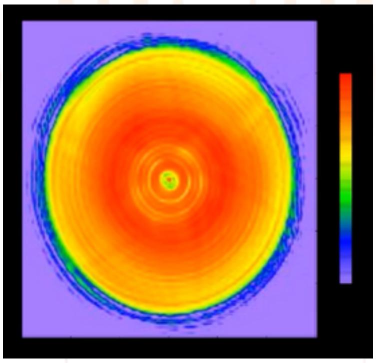
Illumination and Efficiency

For Illumination and efficiency, Micro-Ant also exceeds the expectations of regulatory compliance with proper sub-reflector testing. This is done through the review of Gain and X-Pol Symmetry and X-Pol tests to assess the mechanical symmetry of the design. Without proper X-Pol, there can be issues residing in the actual parts and pieces of the overall system itself, not visible. Visual inspections do play a part when examining how components fit together. They cannot be forced or have any gaps that would compromise the antenna's accuracy.

Compliance verification requires that the sub-reflectors are proper, with symmetrical illumination of the reflector and efficiency of the components. Micro-Ant recommends that gain and cross-pol are measured on all systems because these tests provide vital verification of the compliance of the system.

Asymmetries could either indicate degradation in manufacturing or process through time. Proper measurements ensure that each component is interchangeable and that the overall product will sustain accurate functionality, even in windy conditions and other vibration scenarios, free from interruption.

Ultimately, to use parabolic systems for LEO or MEO tracking, two terminals need to operate simultaneously. The first terminal will be tracking the setting satellite while the second is positioning for the next best satellite to connect to. This is what is called the "make before break" capability. Nonetheless, standard 2-axis positioners used for auto-acquiring on GEO networks will not be adequate to track and reposition.



From the materials chosen to the fundamentals of physics, taken together, Kore Composites reflectors and Micro-Ants designs lead the industry in high-performing, manpack, and flyaway terminal custom antenna creations. Where many companies cannot rise to the challenge, they do. Quality of materials and mechanics, testing for compliance ensures the end user receives a product that will perform needed expectations with full dependability and ease of operation.

Q/A | Specifications and Achieving Compliance

Can you tell us about a few of the lessons you have learned when replacing 3rd party terminals?

1. Recognize that the challenge is with the terminal provider, the terminal provider's customer, and the satellite operator.
2. The replacement needs to look and operate very similarly to the previous terminal. This will include size, weight pack-out, and ease of use.
3. The replacement terminal must have the same mechanical integration as the replacement antenna.
4. The satellite operator will need to have the same (or better) performance as the replacement antenna. With ARSTRAT, this will have to be demonstrated as virtually the same. Inadequate performance is unacceptable, but significantly better performance will also be a problem due to spectrum allocation. Pay careful attention to the details of the initial certification and understand clearly what needs to be tested for the replacement.
5. Make all submissions to satellite operators clear and unambiguous.

What are the regulatory standards for manpack terminals and antenna?

- Regulatory standards vary by mission/location and chosen satellite service, but there are commonalities we see across most manpack terminals. For most applications, switchable polarization is needed on X and Ka frequencies and accurate skew control on Ku frequencies.
- We often see two or three different pattern mask requirements needed because the intended systems are meant to operate across multiple satellite operators. For example, compliance with both WGS and Inmarsat GX is a commonly combined requirement, though very difficult to meet. Mechanically, these systems usually need to withstand at least 30mph winds for operations and up to 50mph gusts. We're seeing increasing requirements for cooler temperature storage.

Q/A | Specifications and Achieving Compliance

How do you verify that your petals are interchangeable?

- We start by designing our system and the process by which it is made and assembled. Our testing includes the development of a prototype for mechanical testing, such as thermals, vibration, and wind testing. Then we verify both the RMS and the radiation pattern over multiple reflectors assembled "as manufactured" and then at random for each new design.
- In the volume manufacturing stage, all independent components, and then each final product as a whole, are inspected and tested. Units are retested periodically per quality standards.

For producing a segmented reflector, is there a significant difference in cost between a spherical curvature vs. a parabolic curvature?

- Whether the surface is true parabolic, parabolic ring focus, spherical, or optically shaped generally does not have an impact on manufacturing costs, but there are several factors that do:
  - Reflector optics (center fed, offset, prime focus, etc.)
  - Overall aperture size (60cm, 80cm, 100cm, etc.)
  - Reflector contour (focal length/diameter or F/D)
  - Design complexity (segmented, tool-free assembly, custom interface, timed assembly/disassembly, etc.)

What are the common causes of poor cross-pol?

- Asymmetries in the design and/or manufacturing of the antenna aperture will create higher order modes resulting in poor cross-pol.
- This is one reason that both inspection and component testing is important to long-term compliant products: small gradual changes can creep into tooling and machining precision to deteriorate the product.
- 100% functional testing is the best way to maintain product quality and reliability over time.

Q/A | Specifications and Achieving Compliance

How to realize a low-cross polar performance in a single offset reflector across a transmit band?

- The key is to maintain physical symmetry and suppress high-order modes.

Why is testing every system on satellite not enough?

1. Only testing the full system on satellite is not enough for verification for two main reasons.
2. This test does not provide any information about your side lobes and cross-pol. If your system is not compliant with requirements and causes interference, the satellite test will not show it.
3. If your components are underperforming, isolating the reasons from a satellite test will be difficult. More detailed testing is required at the level of the individual component of the faulty terminal and for historical data from the components in other terminals to establish a true root cause.

Have you tested how the antenna performs after multiple uses?

1. We start out by designing all materials and components to be durable and able to withstand difficult environments.
2. Components that get cycled, such as latches, underwent testing to validate that the expected cyclical use over many years would not impact the rigidity of the reflectors. Finally, we tested completed reflectors, both new and fielded units, for wind-load testing and other demonstrations.
3. Our earliest products have been in the field since 2015. Our customer has kept us updated on feedback from the end users and has returned to do more developments with us on various sizes and frequencies.

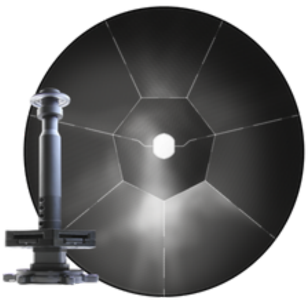
Q/A | New Technologies and Future Developments

Has Micro-Ant fielded wideband Ka-band antenna feed to customers who require communication with LEO & MEO satellites (BW = 3.5GHz in both Tx & Rx)?

- Micro-Ant has been the first antenna company to field fully compliant Ka-Band antennas that cover the full 17.7-31GHz frequencies. We recently completed the development of a Ka-Band feed system for a 2.4m terminal. It is being used in testing the new SES O3B mPower satellites by the satellite operator.

What are the positioning, navigation, and timing (PNT) specifications of the tracking system? More specifically, what are the pointing accuracy and jitter specs? Who makes the gimbal?

- The positioner, gimbal, and software are designed and manufactured by NextMove Technologies.
- Regarding the PNT: the typical pointing error of the NextMove MPT is around 0.02 degrees between the Delta commanded vs. actual during a track. Jitter can vary based on the time input selected. We have a standard GPS, Differential GPS, and Network time. Our timing is accurate to within 20ns.



When will you be offering Flat ESA Manpack antennas?

- Micro-Ant is the prime supplier of manually positioned Ka and Ku flat panel antennas in the USA. We also supply low-profile, LEO tracking ESA antennas in L-Band and in X-Band that have the full make-before-break capability with a low-profile design. We do not currently offer a "flat aperture" ESA design.

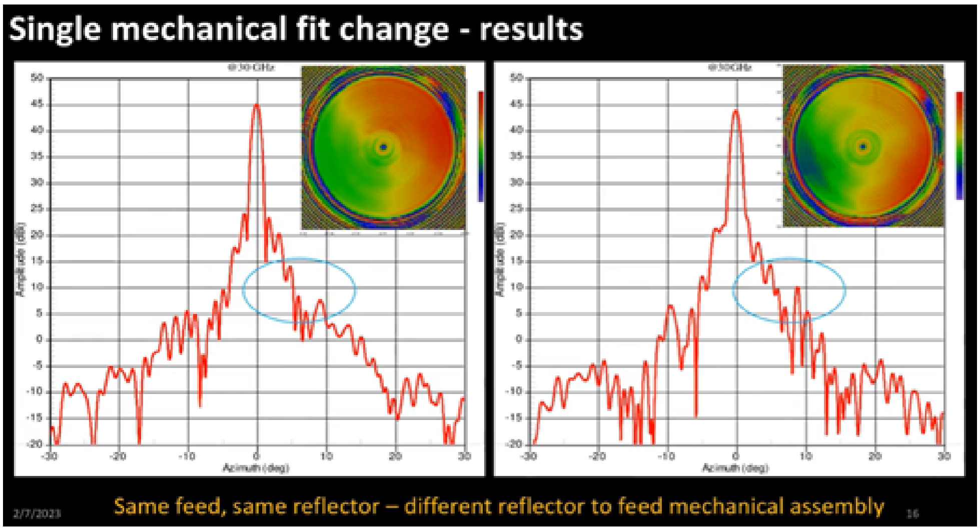
Q/A | Kore Composite Reflector Technology Specs

What surface accuracy specification do you design for EHF?

- We don't. Our reflector is used mostly from above 2 GHz.

The antenna gain on the left side is better than the right one, correct?

- This question, regarding slide 16, compares two gain patterns for systems that had identical feed and reflectors but different fitments between the feed and reflector. The left diagram is the originally designed system and had a main-beam gain of 45dB. The alternative system in the right-side graph included an alteration our customer was proposing. The measured results showed a 1.5dB reduction in gain (43.5dB) and sidelobes at 10 degrees, which were a potential concern for a sidelobe mask.



Does Kore embed metal screens and/or materials into composite material to produce high efficiency?

No, Kore Composites use a proprietary carbon fiber laminate stack-up that has been electrically qualified within our anechoic chambers to exhibit negligible reflectivity dispersion up to 40GHz.

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is a true reflection of character.

Micro-Ant

Founded in 2001, Micro-Ant designs, develops and manufactures custom antennas for land, maritime and aerospace applications operating within the Microwave Frequency Spectrum, including UHF, L, S, C, X, Ku, and Ka-bands. Micro-Ant develops intellectual property for various uses including 2-way SATCOM, COTM, low profile aircraft antennas, SDARS, DVB, and GPS. Products include phased arrays, patches, parabolic and flat-panel antennas, and low-profile active antennas. Micro-Ant is an ISO 9001 and AS 9100 Certified company.

Kore Composites

Kore Composites was launched to develop custom segmented reflector solutions for Micro-Ant customers alongside parabolic and offset reflectors which been manufactured since 2014. Kore Veritas series reflectors were launched in 2022 to make high quality segmented antennas available to customers globally, and, in commonly used sizes. Kore Composites Reflectors are proudly manufactured in the United States.

Kore Precision Manufacturing

Kore Precision Manufacturing uses cutting-edge machines to manufacture high precision RF products in volumes of 10 to 10,000. The KPM team is trained in RF principles and works closely with Micro-Ant engineering and production to bring new antenna technologies into reality.

Automation in tool selection, robotics, and automated measurement support competitive delivery schedules even on the most complex components such as Ka band polarizers. KPM is based in the United States and specializes in machining for microwave applications.

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NOTES

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