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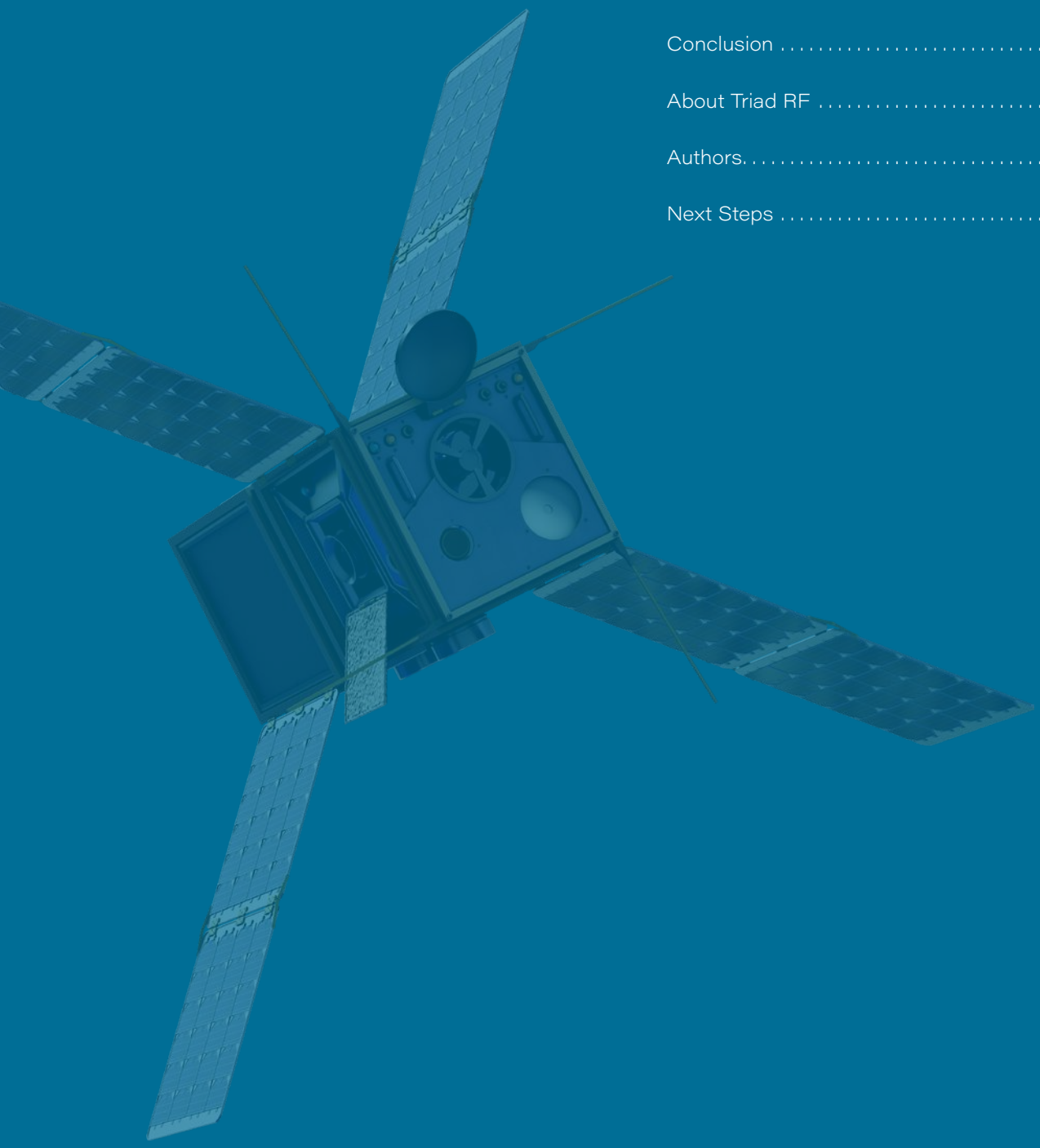
TECH BRIEF

Automated Radio Testing Made Easy: Triad RF Systems' Latest Capabilities



INTRODUCTION

Triad's new T006 Attenuation Rack and Automated Radio Test Suite significantly refine high-power radio validation, granting end-users comprehensive, data-driven insights to support enhanced connectivity. By combining robust hardware with advanced automation, Triad sets a new benchmark in testing efficiency to help customers meet operational demands with greater confidence and minimized risk.

OVERVIEW

Validating mission-critical systems requires a deep understanding of the environments in which they operate. Defense and aerospace platforms rely on dependable, long-distance connectivity under variable and often harsh conditions. These factors demand uncompromising quality control throughout the design and manufacturing process. This is especially true for the THPR product line, given its critical role in extending range and maintaining strong data throughput. Consequently, Triad has improved rigorous testing standards to ensure that each unit can withstand the demands of real-world missions.

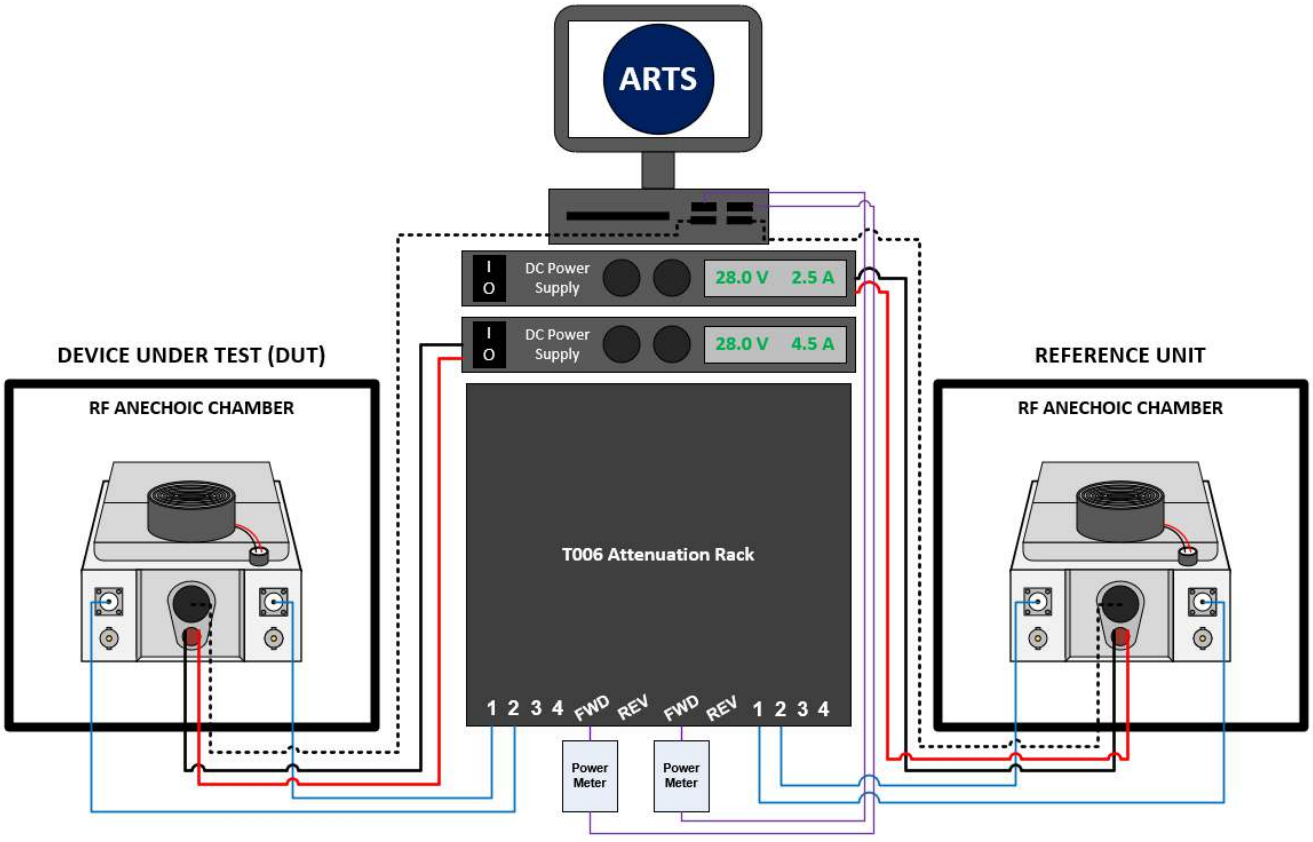
Beyond the meticulous production testing performed on every outgoing unit, newly designed THPR models undergo a comprehensive characterization process to replicate field conditions and facilitate seamless end-user integration. This combination of routine production testing and specialized characterization guarantees robust performance under even the most demanding circumstances. By proactively identifying potential vulnerabilities in the lab, Triad significantly reduces the risk of failures during deployment, underscoring its dedication to delivering dependable, high-performance RF solutions for mission-critical applications.

By taking this proactive and data-driven approach to testing, Triad ultimately offers a more efficient, reliable experience for its customers. Detailed test results and real-world performance profiles allow customers to make fewer assumptions about how a system will behave once deployed. The result is faster, more informed support whenever technical questions arise, as well as smoother integration processes that minimize downtime and complexity for end-users. Consequently, Triad's commitment to thorough, front-end testing benefits customers long after deployment by enabling more reliable, mission-ready systems and reducing the challenges often associated with field success.

TEST SETUP

Central to characterization testing is establishing an RF datalink between the device under test (DUT) and a reference radio using Triad's new T006 Attenuation Rack. Building upon the capabilities of the previous T005 model, the T006 delivers substantially improved isolation between channels. In the T005, high-power datalinks occasionally persisted even when the variable attenuator reached its maximum setting due to cross-channel signal leakage. This meant it could not fully simulate THPR performance at maximum link distances, which compromised simulation accuracy. The enhanced isolation of the T006 eliminates this limitation, enabling more precise fading and more realistic simulations of extended-range datalinks. This advancement contributes to Triad's ongoing commitment to performance and reliability, demonstrating our company's continuous investment in innovation to meet the evolving needs of operationally essential RF systems.

In tandem with the T006 Rack, Triad's Applications and Software Engineering teams have developed a fully automated characterization test known as the Automated Radio Test Suite (ARTS). Previously, each datapoint was manually measured, recorded, and formatted, requiring significant time for a single test to be completed. Under Triad's Lean Six Sigma initiative, ARTS now produces detailed, actionable data for every THPR, eliminating the need for hundreds of engineering hours formerly spent on manual testing.



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ARTS can evaluate every THPR in Triad's product lineup, along with a variety of radio and bidirectional amplifier (BDA) configurations. It is capable of testing SISO (Single-Input Single-Output) radios, as well as 2x2 and 4x4 MIMO (Multiple-Input Multiple-Output) systems. It has already proven successful with industry-leading software-defined radios (SDRs) including Domo Tactical Communications, Silvus Technologies, and Doodle Labs. This capability ensures balanced output power and SNR ratios across channels, further positioning Triad as a trusted partner for advanced RF testing and validation.

TEST OUTLINE

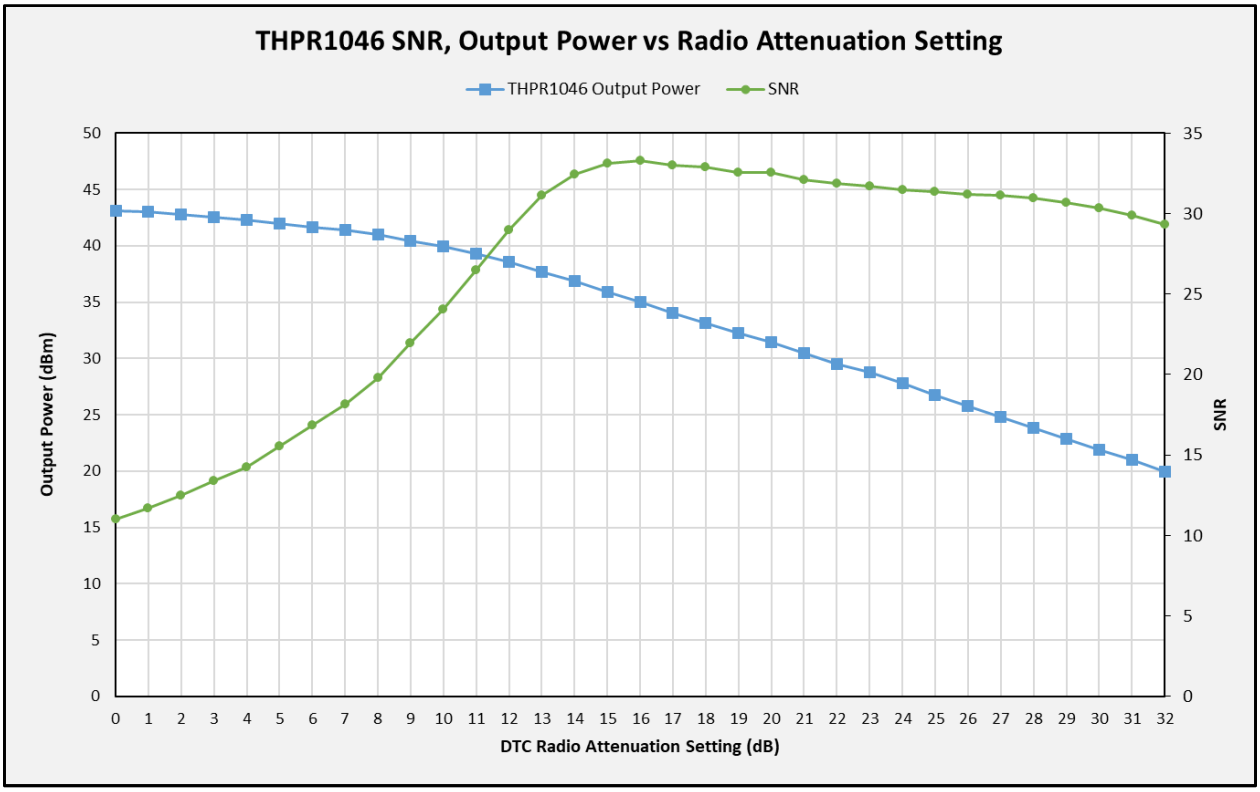
Output Power Test

The Output Power Test is one of three primary evaluations in Triad's comprehensive test suite, alongside the Datalink Fading Test and Data Rate Throughput Test. It is conducted across all available SDR channel bandwidths at the lowest, center, and highest frequencies within the THPR's operating range to capture a complete performance profile.

To begin, the DUT is set to its lowest possible output power while operating through the T006 Attenuation Rack which is configured to its baseline of 90 dB attenuation. Once a stable UDP datalink is established between the DUT and reference radio, the DUT's output power is increased in 1 dB increments. At each

Note:

In this example, DTC Radio Attenuation Setting (dB) is used in place of Output Power Setting (dB) for the THPR1046. The two are synonymous as lowering SDR attenuation increases THPR output power.



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increment, key performance parameters (e.g., output power level and any associated error metrics) are logged. This process continues until the DUT reaches its maximum attainable power.

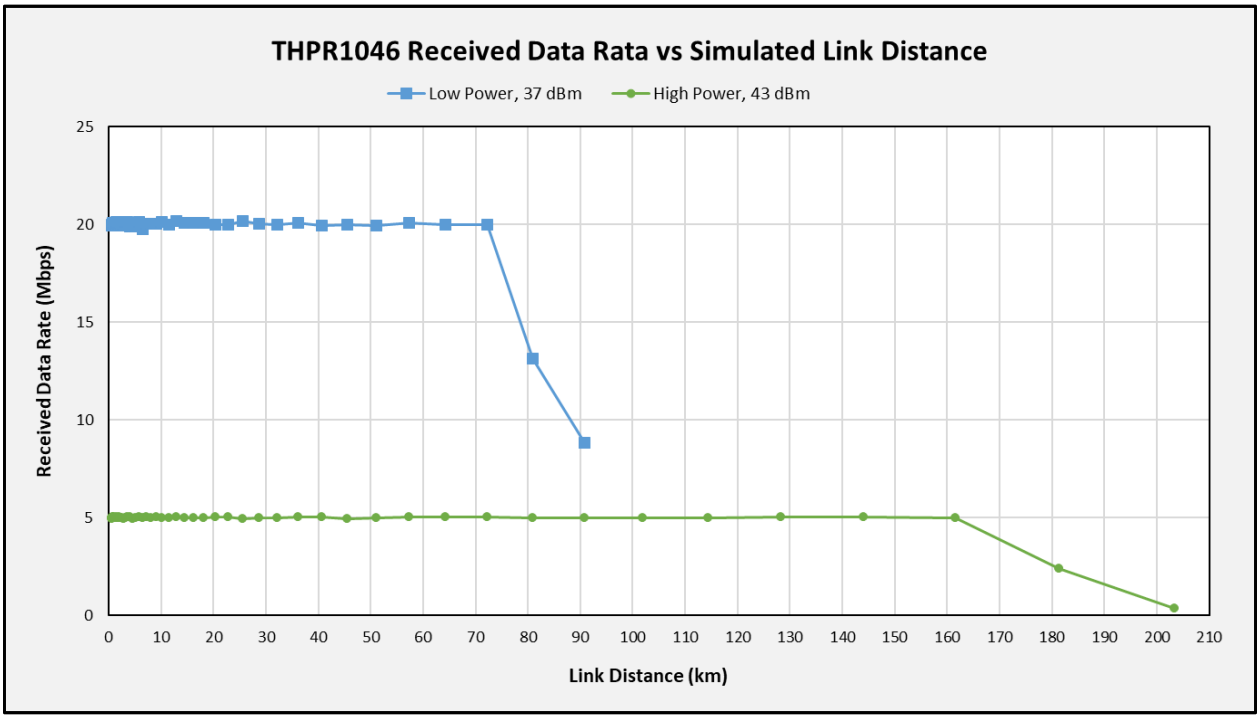
By systematically sweeping the DUT's power range in fine increments, engineers gain a detailed understanding of how the THPR behaves at various output power levels. This data informs both production-quality benchmarks and the eventual real-world deployment of Triad's High Power Radios, ensuring that end users can reliably achieve the power levels needed for extended-range operations.

Datalink Fading Test

The Datalink Fading Test evaluates how effectively the THPR can maintain a reliable datalink as signal conditions deteriorate. By methodically increasing attenuation within the T006 Attenuation Rack, this test simulates real-world range limitations and environmental factors, particularly those encountered in line-of-sight (LOS) conditions.

$$FSPL = 20\log_{10}(d) + 20\log_{10}(f) + 20\log_{10}\left(\frac{4\pi}{c}\right) - G_t - G_r$$

First, a stable UDP datalink is established between the DUT and a reference radio at a known power level. Utilizing the T006 Rack's built-in variable attenuator, Triad engineers then introduce incremental attenuation in 1 dB steps, observing how the datalink responds to progressively lower signal strength. The process continues until the datalink fails or reaches a performance threshold deemed unacceptably



low, such as excessive packet loss or significant drop in throughput.

This test is performed in two main use cases:

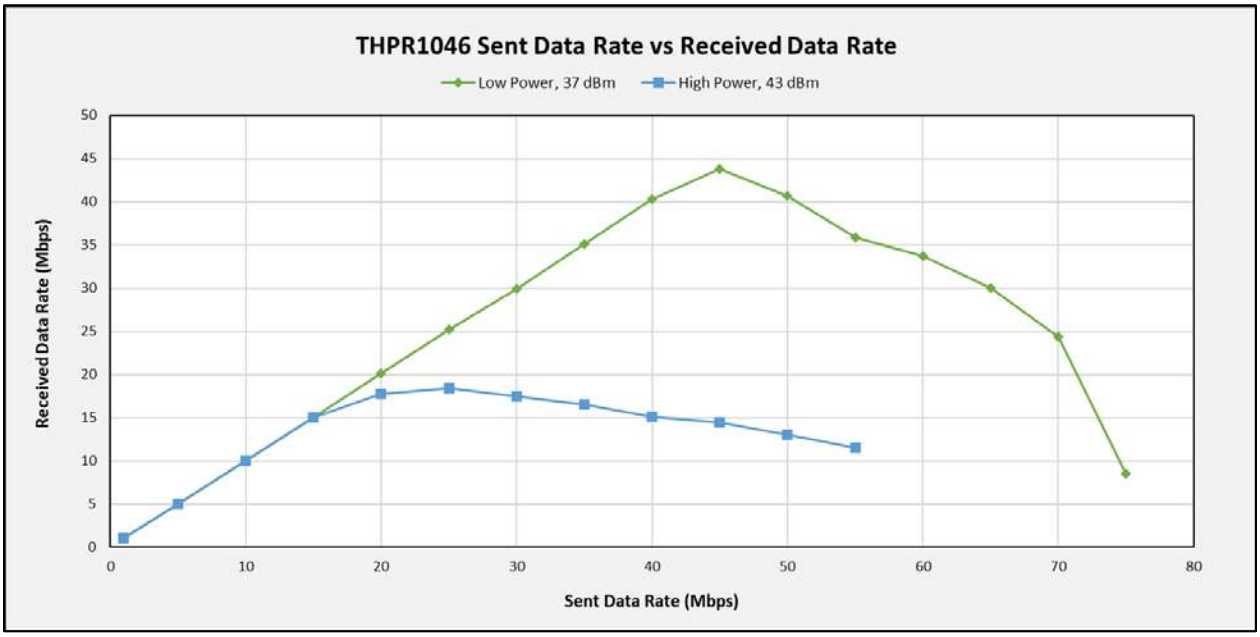
1. High Power, Low Data Rate: Typically set at 5 Mbps TX, with the DUT operating at its maximum power output.

2. Low Power, High Data Rate: Typically set at 20 Mbps TX, with the DUT backed off by 6 dB from maximum output power.

Running the Fading Test at multiple channel bandwidths, as well as at the lowest, center, and highest frequencies in the THPR's range, yields a comprehensive understanding of how each system's performance varies across different operational setups. The resulting data, correlated to Free-Space Path Loss (FSPL) assumptions, clarifies the maximum distance at which the datalink remains stable under representative conditions. This information underpins Triad's ISR datalink budgeting recommendations and has been validated within a 3 dB margin of accuracy in real-world flight tests, confirming the superior range-extending capability of Triad's amplification solutions.

Data Rate Throughput Test

The Data Rate Throughput Test measures the maximum throughput achievable between the DUT and a reference radio before the datalink experiences unacceptable degradation. To begin, the UDP datastream is incrementally increased in steps of 5 Mbps while monitoring throughput received by the reference radio. Once the received data rate drops to 25% or less of the transmitted data rate, the channel is considered saturated. At this point, delayed performance and significant packet retransmissions indicate that the maximum practical data rate has been exceeded.



Similar to the Fading Test, the Data Rate Test is typically repeated under two broad conditions:

1. High Power, Low Data Rate
2. Low Power, High Data Rate

While lower transmit power often supports higher data rates, Triad's real-world experience shows that most users rarely require more than 20 Mbps for field applications. However, for those who do need greater bandwidth while still aiming to extend communication range, the Data Rate Test offers invaluable insight. By pinpointing the threshold at which throughput declines, engineers and end users alike can determine the most effective operating configuration for their specific application—balancing power levels, data rates, and desired range.

CONCLUSION

As demonstrated by Triad's recent advancements in testing and characterization, we remain deeply committed to delivering robust, high-performance RF solutions for crucial end-user applications. By refining our T006 Attenuation Rack and automating our characterization procedures with ARTS, we have established a strong foundation for ensuring system reliability and extended range.

These improvements underscore Triad RF Systems' dedication to delivering industry-leading product data, streamlined workflows, and best-in-class system performance. With knowledgeable sales and engineering teams, we stand ready to support customers seeking extended datalinks that achieve ambitious distance and throughput goals. Our enhanced testing capabilities and detailed characterization data significantly reduce the integration complexity and deployment risk faced by end-users, enabling faster, more informed decision-making and accelerated operational readiness.

By continually investing in innovation and technical excellence, we empower our customers with systems capable of reliably performing in challenging and unpredictable environments. The ongoing enhancement of our power amplifiers, bidirectional amplifiers, and high-power radio systems directly translates into greater confidence and mission success for end-users. As Triad continues to grow, we will further strengthen our collaborative relationships with customers, ensuring our solutions consistently surpass rigorous field requirements and contribute meaningfully to their operational objectives.

About Triad RF

Founded in 2013, Triad RF Systems engineers high-performance RF and microwave amplifiers and subsystems that boost the range, reliability, and data throughput of today's most demanding communication platforms. With a focus on MIMO radio systems, high-data-rate UxV links, and satellite amplification solutions, Triad delivers compact, efficient, and rugged products trusted in defense, aerospace, and space-based applications worldwide.

Among Triad's most significant recent efforts is the High Power Radio (THPR) product line. Designed to optimize industry-leading radios for extended range and high throughput, THPR Amplified Radio Systems are the go-to choice when performance, range, and time-to-deployment are paramount. These integrated and optimized systems draw on extensive experience delivering robust, long-range wireless datalinks for defense and aerospace across sea, land, air, and space. To address issues such as power drift, the THPR series incorporates dedicated equalization circuitry, ensuring stable RF output power and signal-to-noise ratio (SNR) under variable operating conditions.

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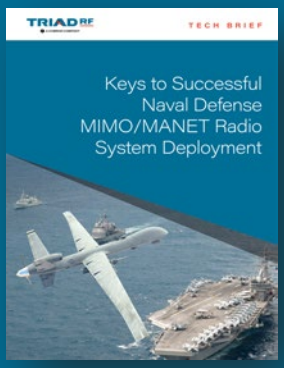

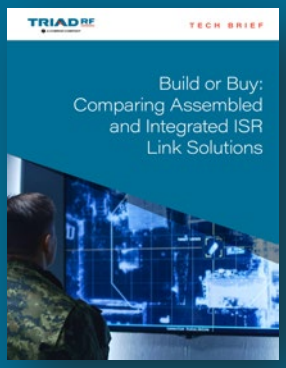

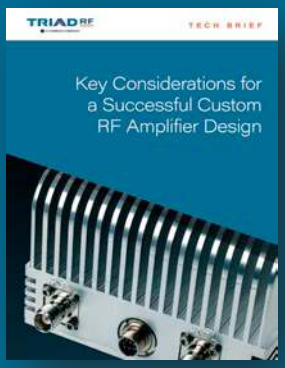

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