TRIAD RF SYSTEMS

TEST REPORT

Test Report

THPR1006

S-Band High Power Radio System

Using Microhard pMDDL2450

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INTRODUCTION

Microhard Corporation is among the leading radio manufacturers of choice for Unmanned System Data Links where high performance and low SWaP is essential. These radios are capable of UDP throughputs of up to of 24 Mbps, which can easily support data-intensive tasks including HD video feeds along with telemetry.

You can easily achieve acceptable throughput over short (<10 km) hops with the default 1-Watt output power-per-channel that the pMDDL2450 delivers. However, when you need to close a longer link or when the radios are not operating to their maximum throughput over a target distance, increasing the link's RF power is a quick and viable method for closing the gap.

A common way of doing this is to connect a bi-directional amplifier (BDA) in line with each of the radio's output ports and its respective antenna. The resulting increase in RF output power can be crucial as it allows adequate margin to:

- Overcome free-space path loss over distance
- Ensure the signal arrives at the receiver (RX) with sufficient signal-to-noise (SNR) to meet the minimum signal quality required for successful reception and demodulation
- Present a signal level that rises above electromagnetic interference (EMI) that may originate from either co-located systems in the vehicle, or from man-made RF noise present in the area of operations.

However, simply connecting a BDA to your existing radio system can also bring along challenges and variables that can cause performance or stability issues due to many varying factors. The Triad THPR takes away all of these factors, and is easy to integrate into your existing ISR platform.

This Test Report describes to readers the advantages and simplicity of using a Triad RF Systems THPR1006 in an ISR link, and demonstrates the increase in RF link distance and performance as compared to a stand-alone Microhard pMDDL2450 Radio.

This report will lay out a repeatable test method for recording data link performance and will compare the data from both the THPR1006 and pMDDL2450 to illustrate their performance.

TEST SETUP

Ideally, we would conduct all ISR data link testing and characterization in a real-world over-the-air test. Unfortunately however, it is nearly impossible to maintain an ideal and repeatable over-the-air test due to the number of factors that can significantly affect signal quality and the ensuing results.

We use a proper test setup to eliminate these factors, all of which can have a negative effect on the results. Common factors that affect operation include: weather, antenna variations, surrounding structures, and interference from nearby WiFi devices, cell phones, and more.

To rule out all of these variables, Triad RF Systems employs the use of a custom built fading simulator to increase the attenuation between the radio systems in an accurate and repeatable fashion. Doing so simulates the radio systems moving further apart by mimicking the Free Space Path Loss that is experienced in ISR Data Links as the link distance changes.

Shown above: Triad Fading Simulator

This setup also uses RF shielded enclosures not only to isolate the radio systems from one another, but also to insulate them completely from any unwanted external EMI or RF signals.

TEST PROCEDURE

To characterize each radio and High Power Radio System, need to use a repeatable test method. The following is an outline of how each device is tested, along with how these test results are compared to one another.

Data Rate Test

We connect one radio to each side of the Triad fading simulator using the desired number of antenna ports based on the radio being tested (e.g. SISO, 1x1, 2x2, 3x3, 4x4 MIMO). We then set the fading simulator to a specific attenuation value to represent a static amount of free space path loss (typically 100 dB).

We then run a UDP throughput test using iPerf and record the data rate in the test procedure as the baseline data rate. We also record numerous other data fields, such as: Signal to Noise Ratio (SNR), Received Signal Strength (RSSI), Output power, and Modulation.

We take the above measurements using several different frequencies and power levels across the radio's operational range. This characterization is essential to the design of future THPR Systems.

Data Link Distance Test

In the Data Link Distance Test, the configuration is the same as above; however, the Triad fading simulator does most of the work.

We then run an UDP throughput test using iPerf, and record the data rate along with the SNR RSSI, Power, and Modulation scheme,

Next, we slowly increase the attenuation in 0.5 dB steps, which simulatse the radios moving further apart from one another. During each of these 0.5 dB steps, we measure and record all of the above criteria. This test continues until the radios are no longer able to communicate, whether from poor SNR, or low RSSI due to the increased attenuation.

We then repeat all of the above tests using the Triad THPR version of the same radio, so that we can compare the results.

DATA RATE TEST

Below is an excerpt of the Data Rate test performed on the stand-alone pMDDL2450 and THPR1006, detailing the output power capability while maintaining a UDP Throughput Data Rate of 24 Mbps. All tests are performed through an attenuation of 100 dB.

Microhard pMDDL2450

Average Burst Power	Signal to Noise Ratio	Data Rate
28.1 dBm	25	24 Mbps

Triad THPR1006

Average Burst Power	Signal to Noise Ratio	Data Rate
42.6 dBm	39	24 Mbps

The above data indicates that the **THPR1006** is capable of an output power of 42.6 dBm, a **2800% increase** over the stand-alone radio, while still maintaining a UDP throughput of 24 Mbps.

In some instances, output power and link distance may take precedence over data rate (i.e. Telemetry or Autopilot). In this case, the **THPR1006** can offer even more output power than the previous test, which will result in an increase in link margin, at the slight cost of data rate.

Average Burst Power	Signal to Noise Ratio	Data Rate
45.4 dBm	45	10 Mbps

As is evident from the high power test data above, the THPR1006 is able to produce an output power of 45.4 dBm while still being able to maintain a throughput of 10 Mbps. That is **5300%** higher than the standalone pMDDL2450 radio.

DATA LINK TEST

Below is an excerpt of the Data Link Distance Test performed on the stand-alone pMDDL2450, detailing the point at which the radio is no longer able to overcome the signal conditions created by the fading simulator. In this case, insufficient link quality is defined by a UDP throughput of less than 5 Mbps.

NOTE: All tests assume 0dBi of antenna gain.

Microhard pMDDL2450

Link Distance (km)	SNR (dB)	Power (Pk)	Power (avg)	Data Rate
6.40	11	34.2	27.6	5.8 Mbps
7.25	9	34.1	27.6	5.5 Mbps
8.14		Insufficient Link Quality		

As is evident in the test data above, the stand-alone pMDDL2450 radio is unable to maintain a useful data link beyond a link distance of 7.25 kilometers.

Triad THPR1006

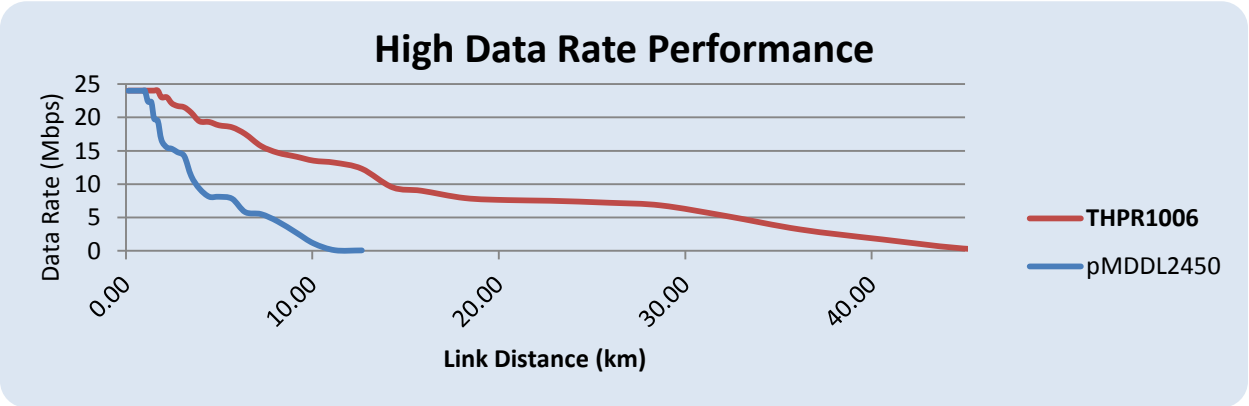
Link Distance (km)	SNR (dB)	Power (Pk)	Power (avg)	Data Rate
69.14	13	47.5	45.2	6.8 Mbps
32.22	12	47.5	45.1	5.4 Mbps
36.17		Insufficient Link Quality		

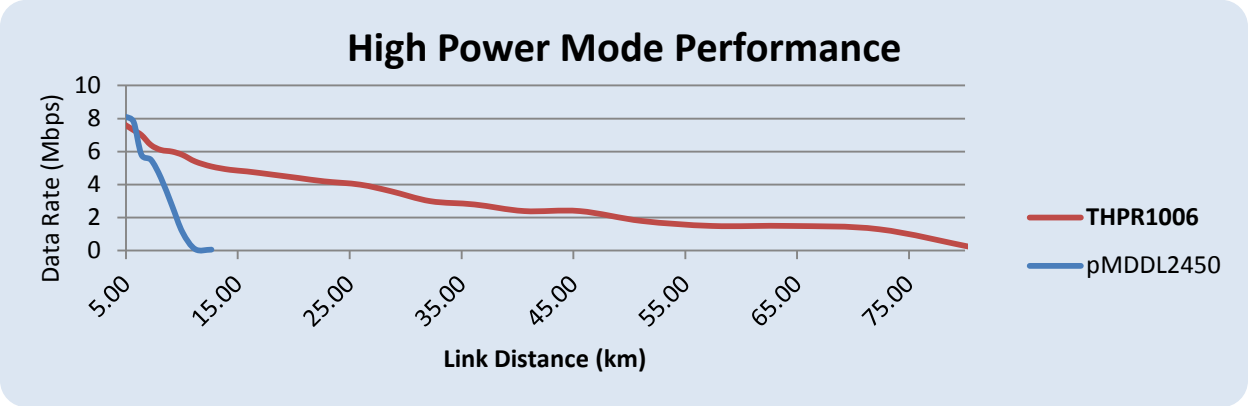
As seen in the above data, the THPR1006 is able to maintain a successful data link up to a simulated link distance in excess of **32 kilometers**. This represents a more than **450% increase** in the usable data link distance versus a standalone pMDDL2450 radio.

TEST DATA COMPARISON

Now that these Data Link Distance tests are complete, the results can be graphed and compared in order to properly show a visual representation of the performance difference between the THPR1006 and a stand-alone pMDDL2450.

The graphs below compare the Data Link Distance Test results of the THPR1006 and pMDDL2450 in both High Data Rate mode, and High Power mode, where link distance is a priority over data rate.





It is also important to consider that the above test data does not factor in antenna gain, and that every additional 6 dB of link margin results in twice the available link distance. Commonly used antennas typically range anywhere from 3 dBi to 26 dBi, depending on their design. This can cause a difference in link margins differing by **up to a factor of 10**, simply by making changes to the antennas.

Due to these large differences, 0 dBi of gain is assumed to show the delta between THPR1006 and pMDDL2450 data link performance. In many use cases, directional and/or tracking antennas are combined with the THPR1006, and can easily achieve link distances in excess of **200 kilometers**.

CONCLUSION

This Test Report demonstrates that the THPR1006 can increase the link distance margin by roughly **450%** over a stand-alone pMDDL2450. Additionally, the THPR1006 can increase the available UDP throughput while operating within the typical range of a stand-alone pMDDL2450. This is especially beneficial in mission critical ISR scenarios where:

- Extra node-to-node link distance is required and the internal radio module does not have the linear RF power capability to close the link.
- The wireless link is functioning properly between nodes, but a higher data rate than is required.

The results of this Test Report show that the THPR1006 is a superior choice for long distance ISR Data Links, as well as Data Links in which a higher data rate is required within the typical range of a stand-alone pMDDL2450.

Though these performance gains can largely be attributed to the increase in RF output power that the THPR1006 offers, integrating all components properly and meticulously is also crucial to a successful high-power data link. The THPR1006 takes all of these and packages them into one simple and easy to integrate module. This saves weeks or months of potential troubleshooting and ensures optimal performance, which is crucial for a successful mission launch, whose timelines and results are critical.

For more information and to request a quote visit: Triad RF Radio Systems