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Microhard MHX2420 Orbital Performance Evaluation Using RT Logic T400CS

Oriol Tintore Gazulla, NASA Ames Research Center

Mark Lombardi, RT Logic



RT LOGIC
A **KRATOS** Company



Overview

- **Experimental Setup**
 - RT Logic
 - Microhard MHX2420
 - Hardware Setup
 - Software Setup
 - Communication simulation
 - Static, dynamic and STK tests
- **Microhard optimization**
 - Microhard and RT Logic settings
 - Microhard optimized settings
 - Test results
 - Future testing and Conclusion



Experimental Setup

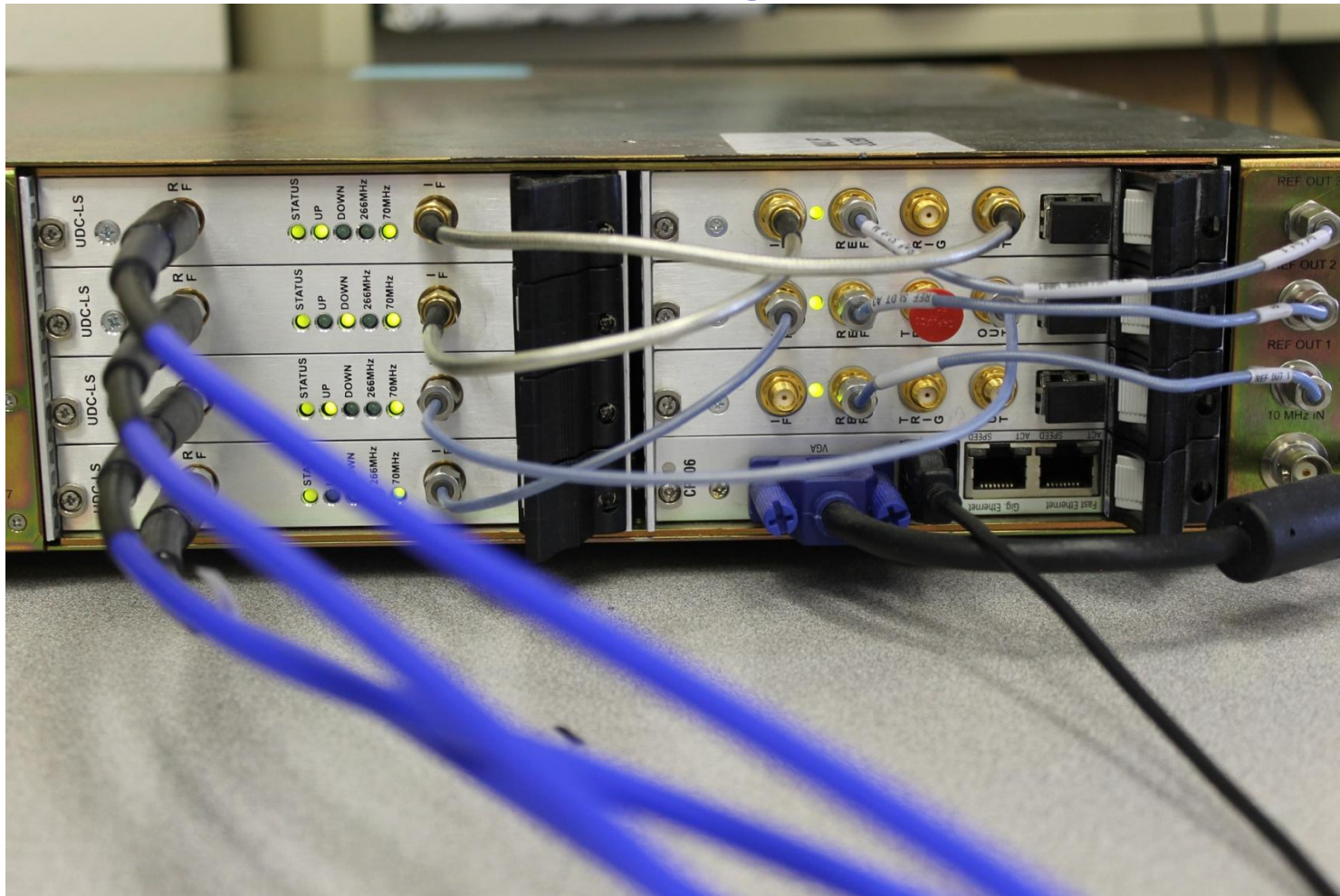




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RT Logic





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Microhard MHX2420

MHX2420		Specifications	
			
Frequency	2.4000 - 2.4835 GHz	Core Voltage	4.0VDC to 5.5VDC, 7VDC to 30VDC (see -HV option)
Spreading Method	Frequency Hopping	I/O Voltage (user selectable)	3.3VDC to 5.5VDC; RS232/485/422 levels (See -HV option)
Band Segments	Selectable via Freq. Restriction	Antenna Connector	MCX
Error Detection	32 bits of CRC, ARQ	Environmental	-40°F - +185°F (-40°C - +85°C) 5-95% humidity, noncondensing
Encryption	Optional (Canada & USA only. NOT AVAILABLE for export, see -AES option)	Weight	Approx. 2oz. (55 grams)
Range	30+ miles (50+ km) (dependant on link rate and line of sight)	Dimensions	Approx. 3.5" x 2.1" x .7" (89mm x 53.4mm x 17.8mm)
Output Power	100mW to 1W (30dBm)	Approvals	FCC Part 15.247 IC RSS210
Sensitivity	-108dBm @ 115.2kbps link rate (Also see option -SL)	Order Options	
System Gain	142dB (w/rubber duck antennas)	-HV	HV Option - High input voltage (12V to 30V) with RS232/485/422 Drivers
Serial Interface	RS232/RS485/RS422 TTL Driver Level (see -HV option)	-FT	Standard FAST Mode 115kbps - 230.4kbps
Serial Baud Rate	300bps to 230.4kbps	-FT1	Extended FAST mode 115kbps - 345.6kbps
Link Rate	19.2 kbps - 230.4kbps (See Order Options)	-SL	Extended sensitivity / SLOW Mode 19.2kbps - 230.4kbps
Operating Modes	Point-to-Point, Point-to-Multipoint, Store & Forward Repeater, Peer-to-Peer, TDMA, Multimaster	-C1D2	Class 1 Div 2 (for use in hazardous environments)
Signals Interface	RxD1, TxD1, RTS, CTS, DCD, DSR, DTR, RxD2, TxD2, RSSI LEDs, Tx/Rx LEDs, Reset, Config, Wake-up, RSmode	-AES	128-AES Encryption (Canada & USA only. NOT AVAILABLE for export)
Diagnostics	Battery Voltage, Temperature, RSSI, and remote diagnostics		
Rejection	Excellent strong signal interference & rejection characteristics		



http://www.microhardcorp.com/detail-images/detail_MHX920-2420_HV_bottom.jpg

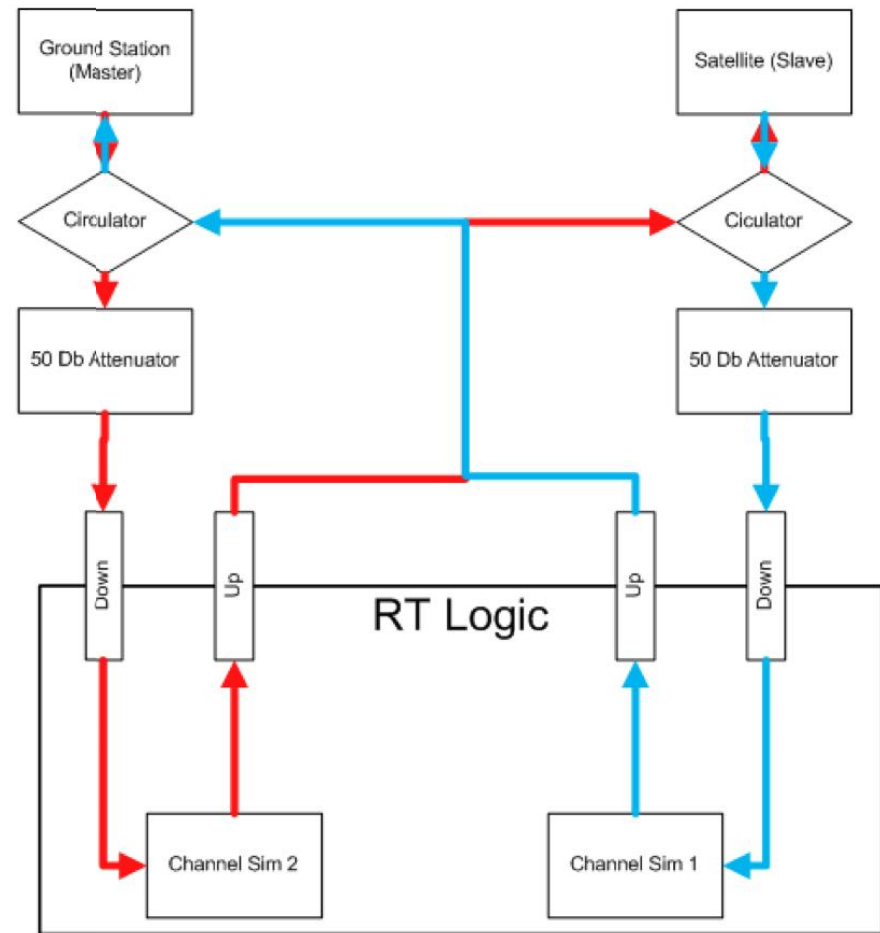


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Hardware Setup

1. Satellite sends file
2. Signal attenuated
3. Signal digitalized
4. RT Logic simulation
5. Output signal converted back to analog
6. File reaches the Ground Station





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Software Setup

1. Initial Microhard settings: baseline settings for both radios
2. 2 computers using Tera Term as configuration terminal and Zmodem as the file transfer protocol
3. File sent: 640kB JPEG picture

Ground Station Baseline Settings

Setting	Value	Setting	Value
Operating Mode	S101=0	Wireless Link Rate	S103=1
Serial Baud Rate	S102=1	Network Address	S104=5400
Output Power(dBm)	S108=25	Data Format	S110=1
Packet Retransmissions	S113=5	Average RSSI(dBm)	S123=-50
Character Timeout	S116=10	Destination Address	S140=1
Protocol Type	S217=0	Address Tag	S153=0
Sleep mode	S143=0	Sniff Search Sleep	S169=60
Wake time, sec	S145=10	Ch Access Mode	S244=0
Sync Mode	S150=0	M hop alloc timeout	S251=10
Hop Interval	S109=9	Packet Max Size	S112=255
Repeat Interval	S115=3	Roaming	S118=1
Network Type	S133=1	Serial Channel Mode	S142=0
Sniff timeout, hops	S237=10	Sleep time, sec	S144=60
LEDs brightness, %	S149=100	Fast Sync Timeout,hops	S151=100
FEC Mode	S158=0	Sniff Search Wake	S170=30
Sync timeout	S248=512		

Satellite Baseline Settings

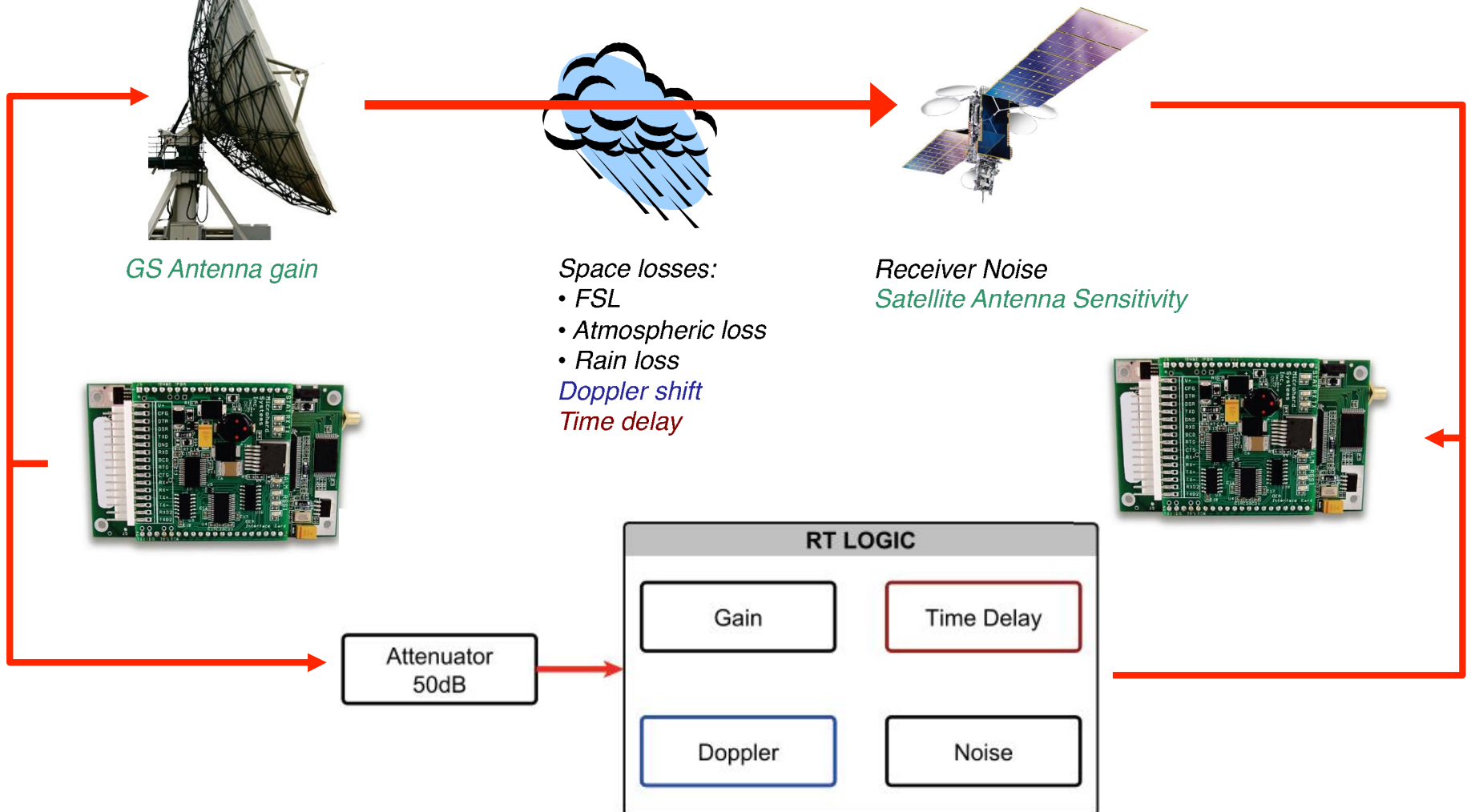
Setting	Value	Setting	Value
Operating Mode	S101=2	Wireless Link Rate	S103=1
Serial Baud Rate	S102=1	Network Address	S104=5400
Output Power(dBm)	S108=2	Data Format	S110=1
Packet Retransmissions	S113=5	Average RSSI(dBm)	S123=-50
Character Timeout	S116=10	Destination Address	S140=1
Protocol Type	S217=0	Address Tag	S153=0
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Communication simulation





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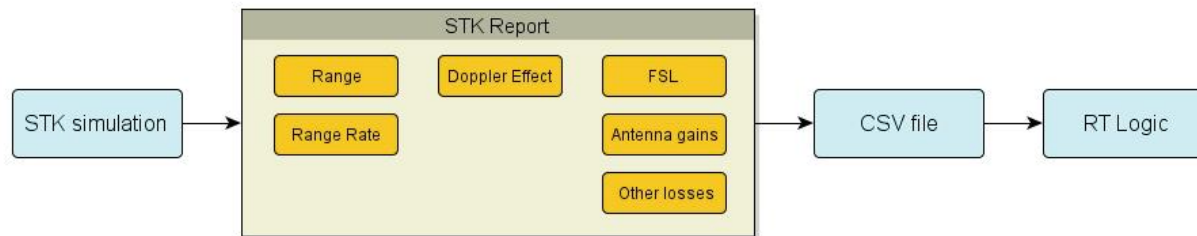
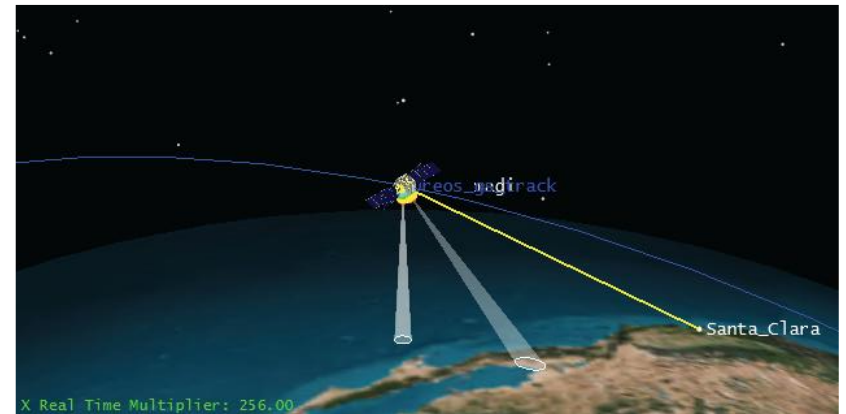
Static and dynamic test

Static test

- Objective: gain insight of the effects of both the Microhard and the RT Logic settings on the quality and data throughput of the link
- Static gain, time delay, receiver noise and Doppler effects

Dynamic test

- Objective: simulate an entire orbital pass for a given satellite
- Possibility of attitude simulation
- Dynamic gain, time delay, receiver noise and Doppler effects
- Start and stop communication conditions



STK test

- STK Plug-in

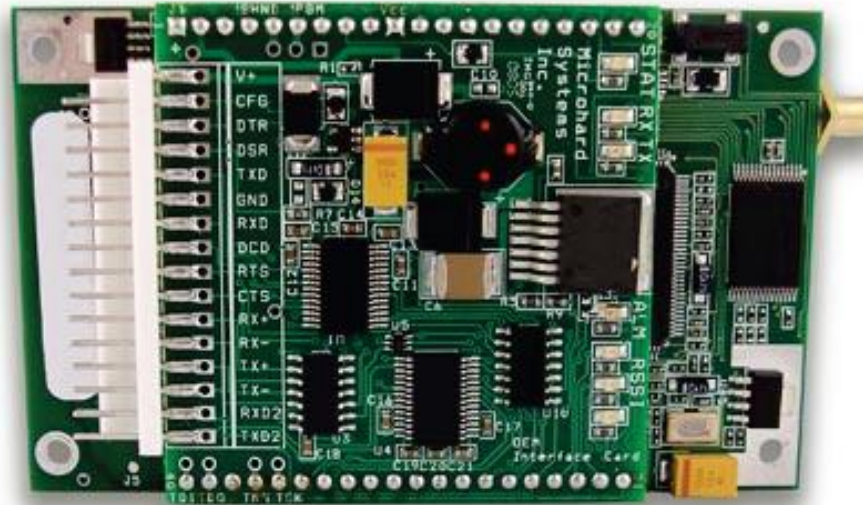
T400CS Target	Name	Range (km)	Range Rate...	Path Delay (ms)	Azimuth °	Elevation °	Total Loss (dB)	Comm Link	Doppler (Hz)	Gain (dB)	Delay (ms)	AWGN (dBm/Hz)	Recv Noise (dBm/Hz)	Freq (Hz)
☒ /T400/DG4000ChannelSim1	T400CS-Oreos_gs_track_downlink	1,497.563	-4.742	4.996	-41.0	31.7	-163.6	None	0	-63.6	0.003	-168.0	-168.0	0.0
☒ /T400/DG4000ChannelSim2	T400CS-Oreos_mag_downlink	1,497.563	-4.742	4.996	16.9	57.4	-163.6	None	38,200	-8.6	4.996	-138.0	-150.0	0.0
☒ /T400/DG4000ChannelSim2	T400CS-Oreos_nadir_downlink	1,497.563	-4.742	4.996	-41.0	31.7	-163.6	None	38,279	-7.2	4.996	-150.0	-150.0	0.0



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Microhard optimization



http://www.microhardcorp.com/detail-images/detail_MHX920-2420_HV_bottom.jpg



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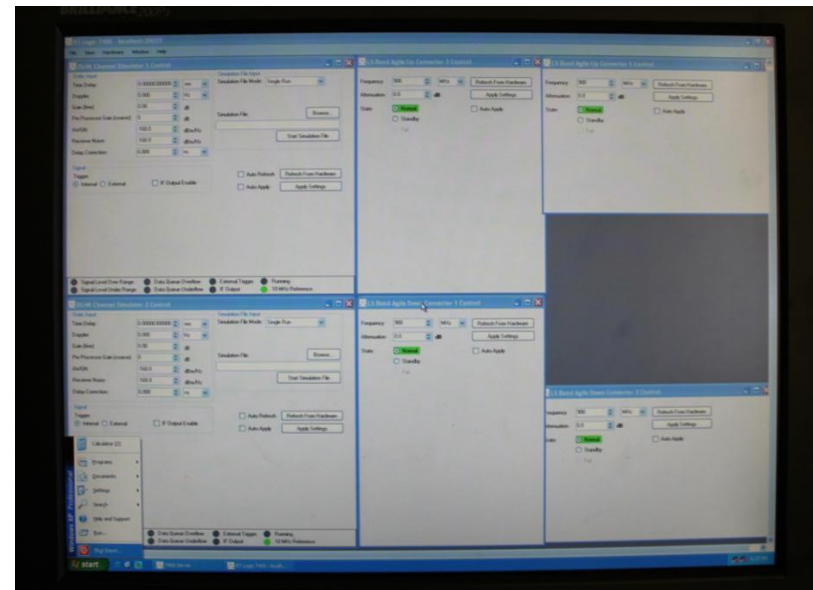
Microhard and RT Logic Settings

Microhard adjusted settings:

- Serial baud rate
- Wireless link rate
- FEC
- Hop interval
- Maximum packet size

RT Logic adjusted settings:

- Receiver noise
- Doppler shift
- Gain
- Time delay
- AWGN





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Microhard optimized settings

Setting	Baseline value	Optimized value
Serial Baud rate	115200bps	115200bps
Wireless link rate	115200bps	115200bps
Hop Interval	20ms	150ms
Maximum packet size	255bytes	255bytes
FEC	None	Reed-Solomon

Setting	Value	Setting	Value
Operating Mode	S101=0	Wireless Link Rate	S103=1
Serial Baud Rate	S102=1	Network Address	S104=5400
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Sync Mode	S150=0	M hop alloc timeout	S251=10
Hop Interval	S109=19	Packet Max Size	S112=255
Repeat Interval	S115=3	Roaming	S118=1
Network Type	S133=1	Serial Channel Mode	S142=0
Sniff timeout, hops	S237=10	Sleep time, sec	S144=60
LEDs brightness, %	S149=100	Fast Sync Timeout,hops	S151=100
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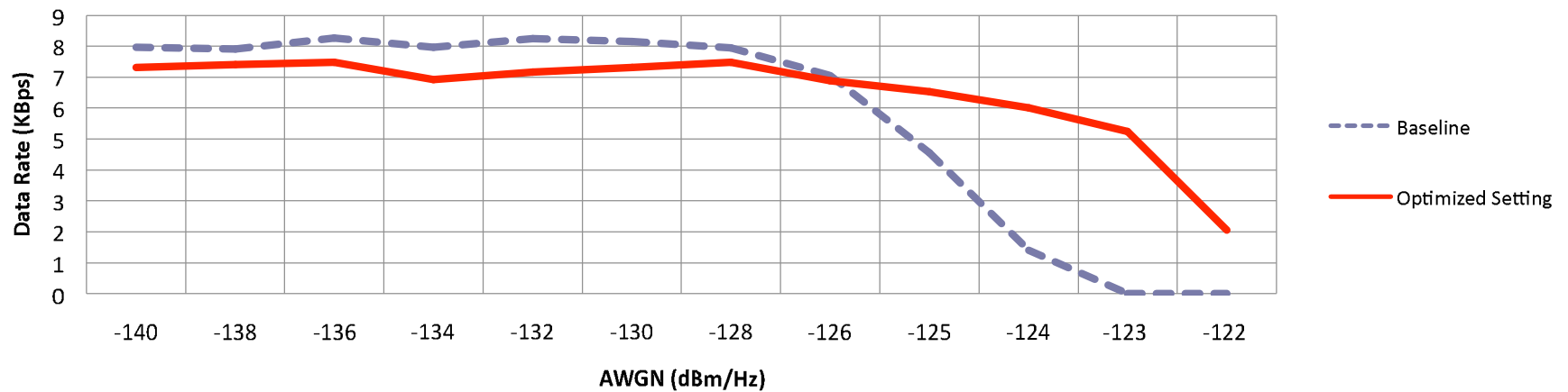


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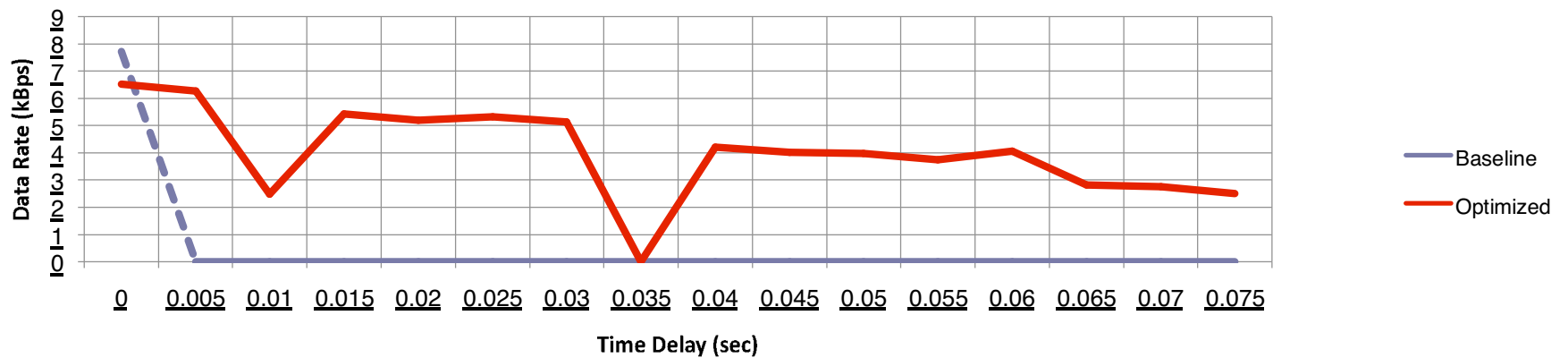


Test results

AWGN Test



Time Delay Test



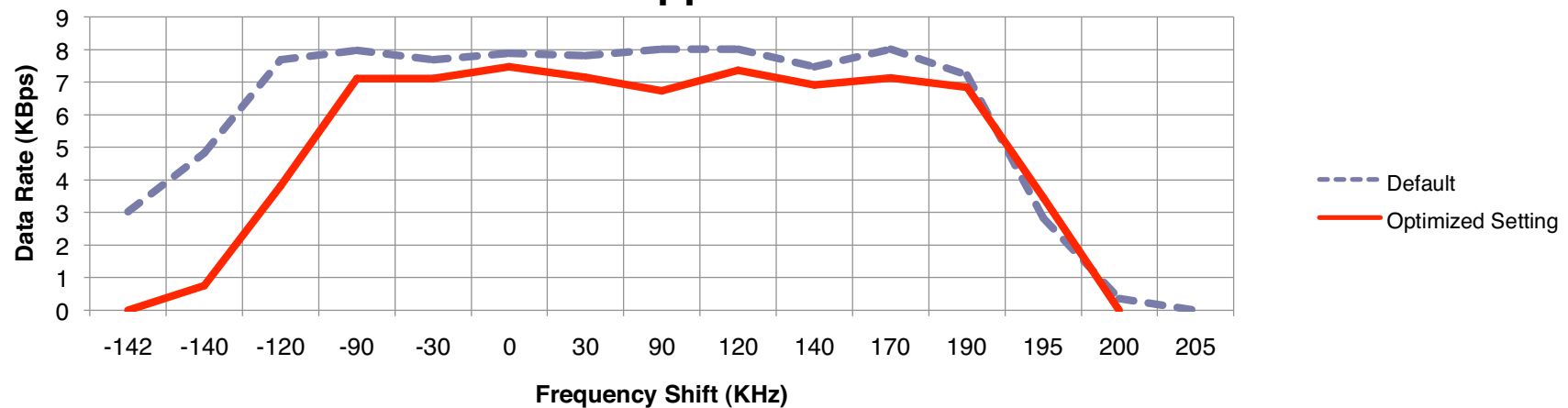


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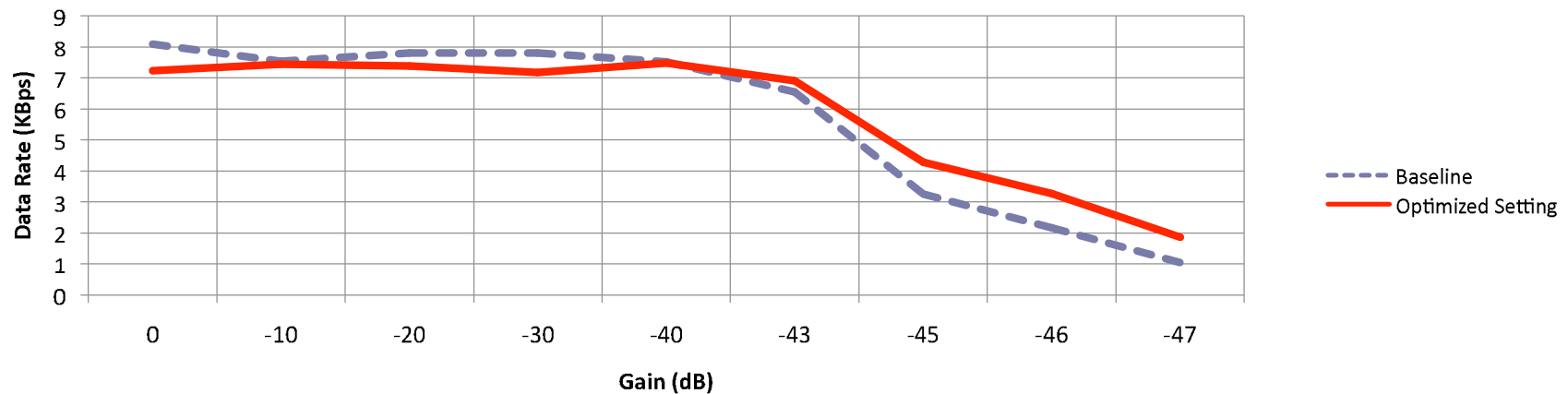


Test results

Doppler Effect Test



Gain Test



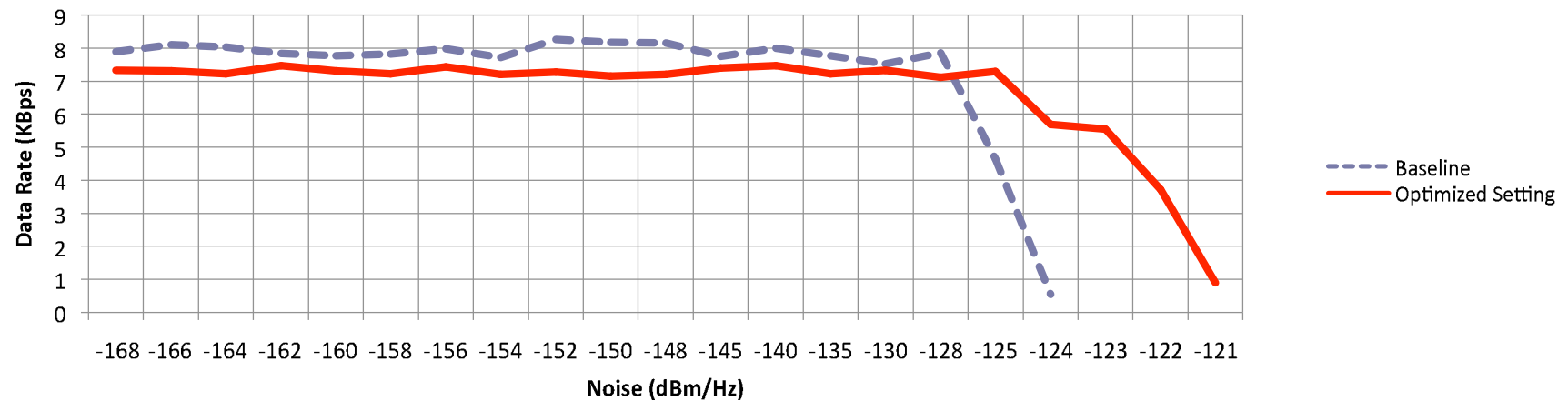


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Test results

Receiver Noise Test



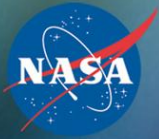


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Conclusions

- **RT Logic allows simulation of Ground Station – satellite communications**
 - Static tests have been successful
 - Dynamic tests have been performed for simple passes
 - Future dynamic tests are needed to simulate real orbit communications
 - **Satellite attitude changes antenna gain**
 - **Atmospheric and rain losses need to be added**
 - STK Plug-in will be the next step to improve the dynamic tests
 - **Possibility of running longer simulations**
 - **Simulation of different losses available in the STK Plug-in**
- **Microhard optimization**
 - Effect of Microhard settings on the data throughput have been understood
 - Optimized settings improve data throughput for LEO communications
 - **Longer hop intervals make transfer of larger packets more efficient (more time between hops in frequency)**
 - **Use of FEC (Reed-Solomon) reduces the number of retransmissions for long-range or noisy communications**



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Thank you!! Questions??

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