DALHOUSIE SPACE SYSTEMS LAB

Low Orbit Reconnaissance & Imaging Satellite (LORIS)MISSION

LORIS Post-Launch Comms Testing – Microhard p400 & nL400

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Reviewed By: _____

Revision	Revision Date	Revised by	Revision Description
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Background

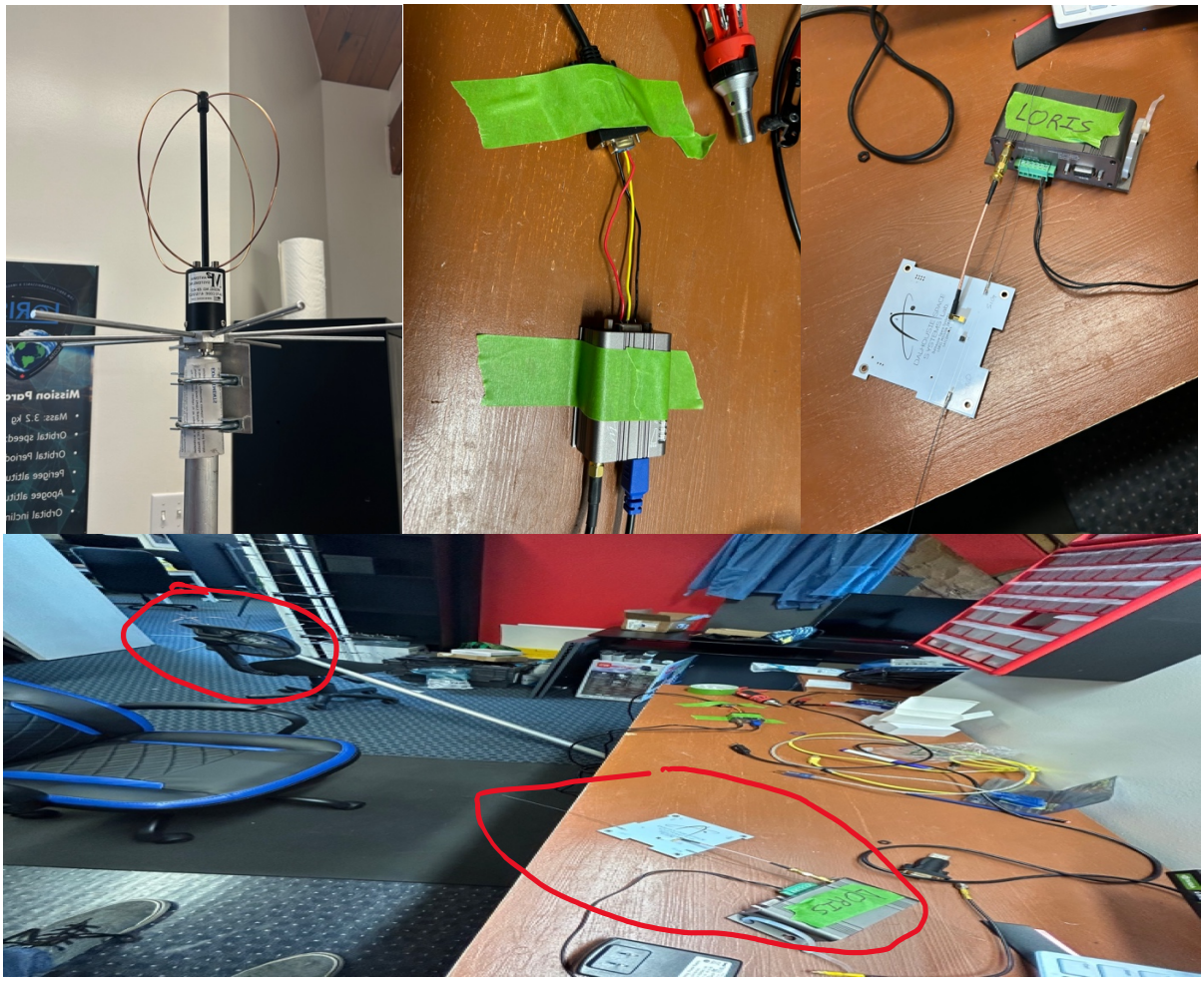
Since the design & implementation of the LORIS Comms subsystem, the manufacturer of the proprietary transponder Microhard have stopped producing and supporting the nL400.

A compatible and more modern model was suggested by the manufacturer to be used instead known as the p400. Besides a set of characteristic differences between the two, the p400 supports a much broader range of settings and operational modes.

Objective

To explore the compatibility and interoperation between the nL400 and the p400, including operational limits, data corruption, signal strength, frequency shift tolerance, bandwidth tolerance, and antenna specific effects.

Methods



The omnidirectional M2 Antenna Systems EB-432 was connected to the p400 as a mock ‘ground station’ whilst a redo of the dipole antenna onboard LORIS was connected to the enclosure version of the nL400 (labelled ‘LORIS’ in the pictures).

The same laptop was connected to both the serial connection of the p400 and nL400 simultaneously. The devices were interfaced using the ‘screen’ terminal application @ 9600 baud rate (screen is a similar program to PuTTY).[1]

Although the omnidirectional antenna is slightly directional (higher gain in the overhead direction), it is assumed that its orientation should not matter at such proximity (~3m).

Transmission tests were conducted at varying send and receive frequencies and occupied bandwidths as outlined in the results. A positive result was validated when transmitted keystrokes appeared intact on the other terminal. A partial result was validated when characters would appear to transmit at least partially even if infrequently. A negative result was validated when no transfer took place.

(Results found on next page).

[1] It is unknown to the operator whether software and/or hardware flow control was enabled. It is assumed that neither were enabled.

Results

Test 1: Frequency Shift Tolerance. BW=12.5kHz

Test 1: Frequency Shift Tolerance. BW=12.5kHz			
Tx Freq. on P400 (MHz)	**Received on NL400?**	**Rx Freq. on P400 (MHz)**	**Tx from NL400 Received?**
437.156	NO	437.156	NO
437.157	NO	437.157	YES
437.158	NO	437.158	YES
437.159	NO	437.159	YES
437.16	YES	437.16	YES
437.161	YES	437.161	YES
437.162	YES	437.162	YES
437.163	YES	437.163	YES
437.164	YES	437.164	YES
437.165	YES	437.165	YES
437.166	YES	437.166	YES
437.167	YES	437.167	YES
437.168	YES	437.168	YES
437.169	YES	437.169	YES
437.17	YES	437.17	YES
437.171	PARTIAL	437.171	YES
437.172	NO	437.172	YES
437.173	NO	437.173	YES
437.174	NO	437.174	YES
437.175	NO	437.175	NO

In this configuration, the p400 was connected to the mock LORIS dipole antenna and the nL400 was connected to the omni. Bandwidth settings were kept at 12.5kHz for both devices and RX/TX frequencies on the p400 were iteratively changed. Transmission was tested both ways at every frequency in the table.

Test 2: Frequency Shift Tolerance. BW=12.5kHz

Test 2: Frequency Shift Tolerance. BW=12.5kHz			
Tx Freq. on P400 (MHz)	**Received on NL400?**	**Rx Freq. on P400 (MHz)**	**Tx from NL400 Received?**
437.156	NO	437.156	NO
437.157	NO	437.157	YES
437.158	NO	437.158	YES
437.159	NO	437.159	YES
437.16	PARTIAL	437.16	YES
437.161	YES	437.161	YES
437.162	YES	437.162	YES
437.163	YES	437.163	YES
437.164	YES	437.164	YES
437.165	YES	437.165	YES
437.166	YES	437.166	YES
437.167	YES	437.167	YES
437.168	YES	437.168	YES
437.169	YES	437.169	YES
437.17	YES	437.17	YES
437.171	NO	437.171	YES
437.172	NO	437.172	YES
437.173	NO	437.173	YES
437.174	NO	437.174	YES
437.175	NO	437.175	NO

In this configuration, the p400 was connected to the omni and the nL400 was connected to the LORIS mock dipole antenna (opposite to *Test 1*). Bandwidth was maintained on both devices in the same fashion as in *Test 1*. Frequency was tested in an identical fashion as *Test 1*.

Test 3: Frequency Shift Tolerance. BWp400=25kHz, BWnL400=12.5kHz

Test 3: Frequency Shift Tolerance. BWp400=25kHz, BWnL400=12.5kHz			
Tx Freq. on P400 (MHz)	**Received on NL400?**	**Rx Freq. on P400 (MHz)**	**Tx from NL400 Received?**
437.156	NO	437.156	PARTIAL
437.157	NO	437.157	NO
437.158	NO	437.158	NO
437.159	PARTIAL	437.159	NO
437.16	YES	437.16	NO
437.161	YES	437.161	NO
437.162	YES	437.162	PARTIAL
437.163	YES	437.163	NO
437.164	YES	437.164	NO
437.165	YES	437.165	NO
437.166	YES	437.166	NO
437.167	YES	437.167	NO
437.168	YES	437.168	NO
437.169	YES	437.169	PARTIAL
437.17	YES	437.17	NO
437.171	YES	437.171	NO
437.172	PARTIAL	437.172	NO
437.173	NO	437.173	NO
437.174	NO	437.174	NO
437.175	NO	437.175	PARTIAL

In this configuration, the p400 was connected to the omni and the nL400 was connected to the mock LORIS dipole (same as *Test 2*). The bandwidth on the p400 was set to 25kHz and the nL400 was kept at 12.5kHz. Frequency was tested in an identical fashion to *Test 1*.

Test 4: Frequency Shift Tolerance. BWp400=12.5kHz, BWnL400=25kHz

Test 4: Frequency Shift Tolerance. BWp400=12.5kHz, BWnL400=25kHz			
Tx Freq. on P400 (MHz)	**Received on NL400?**	**Rx Freq. on P400 (MHz)**	**Tx from NL400 Received?**
437.156	NO	437.156	NO
437.157	NO	437.157	NO
437.158	NO	437.158	NO
437.159	NO	437.159	NO
437.16	YES	437.16	NO
437.161	YES	437.161	NO
437.162	YES	437.162	NO
437.163	YES	437.163	NO
437.164	YES	437.164	NO
437.165	YES	437.165	NO
437.166	YES	437.166	NO
437.167	YES	437.167	NO
437.168	YES	437.168	NO
437.169	YES	437.169	NO
437.17	YES	437.17	NO
437.171	NO	437.171	NO
437.172	NO	437.172	NO
437.173	NO	437.173	NO
437.174	NO	437.174	NO
437.175	NO	437.175	NO

In this configuration, the p400 was connected to the omni and the nL400 was connected to the mock LORIS dipole. The bandwidth on the p400 was reverted to 12.5kHz and the nL400 was set to 25kHz. Frequency was tested in an identical fashion to *Test 1.*

Discussion

It appears that, in case of differing bandwidth values (12.5kHz vs 25kHz) on either device result in a disruption of 2-way communication. Interestingly, this asymmetry only affects the p400's ability to receive transmission from the nL400 and not the other way around. This effect is independent of bandwidth setting (i.e.: the p400 was unable to receive a transmission whether it was 12.5kHz or 25kHz).

Next, assuming matching bandwidth values on both devices (12.5kHz), there is another asymmetry in the frequency shift tolerance between both devices. It appears that the p400 tolerates a wider operational receive frequency range than the nL400, which is in line with expectations regarding the p400's superior flexibility.

A bandwidth mismatch between a p400-powered ground station and LORIS would enable LORIS to receive data on the uplink within a limited frequency tolerance, but not the other way around. It is unknown whether this effect is an accurate reflection of using 2 nL400s in the same mismatched configuration.

Recap

1. Bandwidth mismatch between p400 & nL400 disrupts 2-way communication,
2. The p400 is superior in terms of frequency shift tolerance (i.e.: a wider frequency range),
3. It is unknown whether 2 nL400s would behave the same way in case of bandwidth mismatch.