

Ground Link Characterization Utilizing Bit Error Rate with Noise Introduced

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Overview

Introduction

Equipment Setup

Procedure

Results

Future Work



Frequency Restrictions

**440
BAND**

*420-430 MHz not available along Canadian Corridor



IARU restricts Amateur UHF satellite communication to the 435MHz - 438Mhz range

This narrow frequency band restricts the bandwidth a mission can have

Restricted bandwidth limits data rates

Mission	Frequency (MHz)	Bandwidth (KHz)	Data Rate (Bits/sec)
Vermont Lunar	437.305	12	9600
KySat-2	437.405	12	9600
GOMX-1	437.250	5	4800
SwissCube	437.505	4	1200
CP5	437.405	4	1200

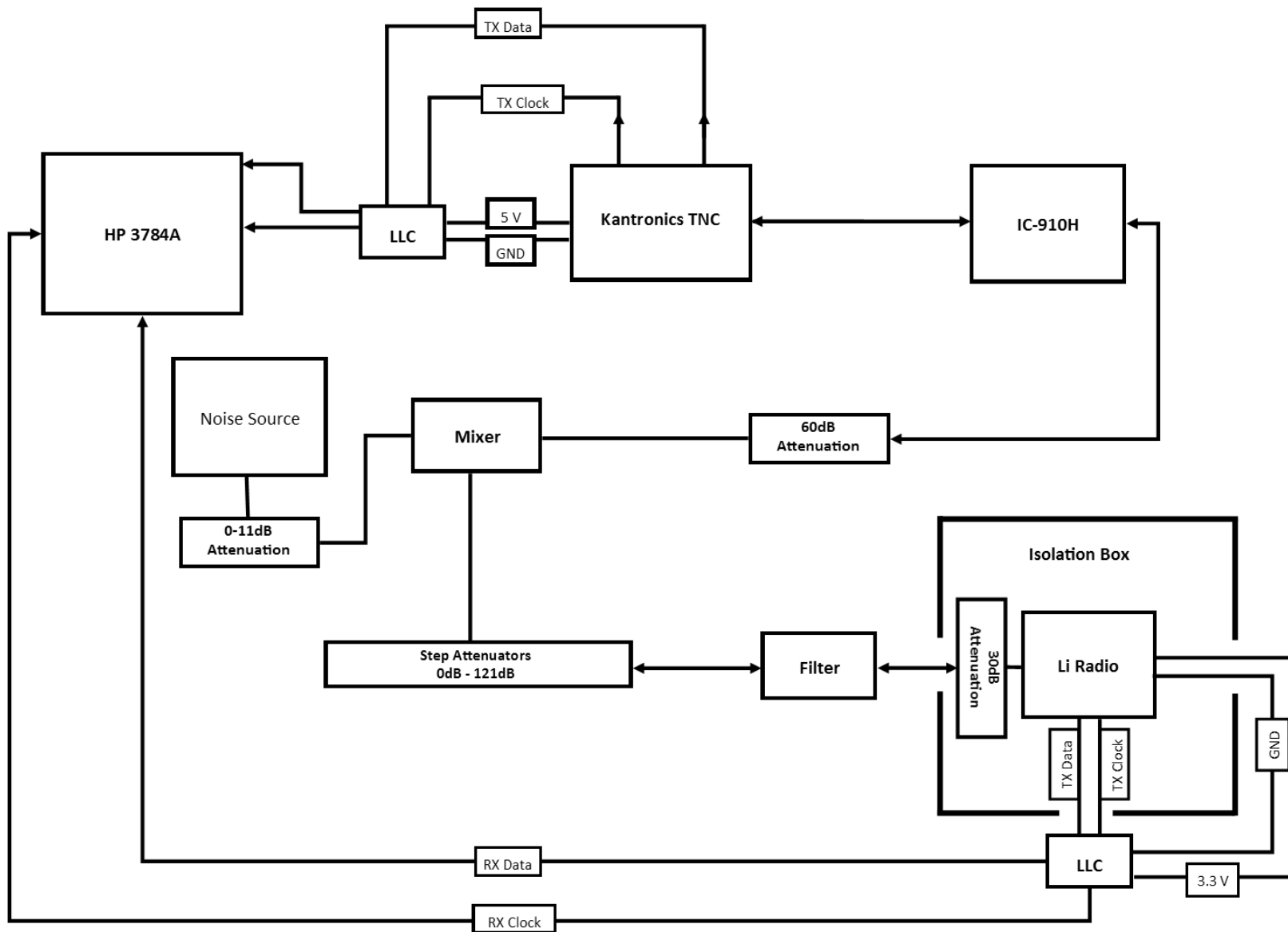


Link Budgets

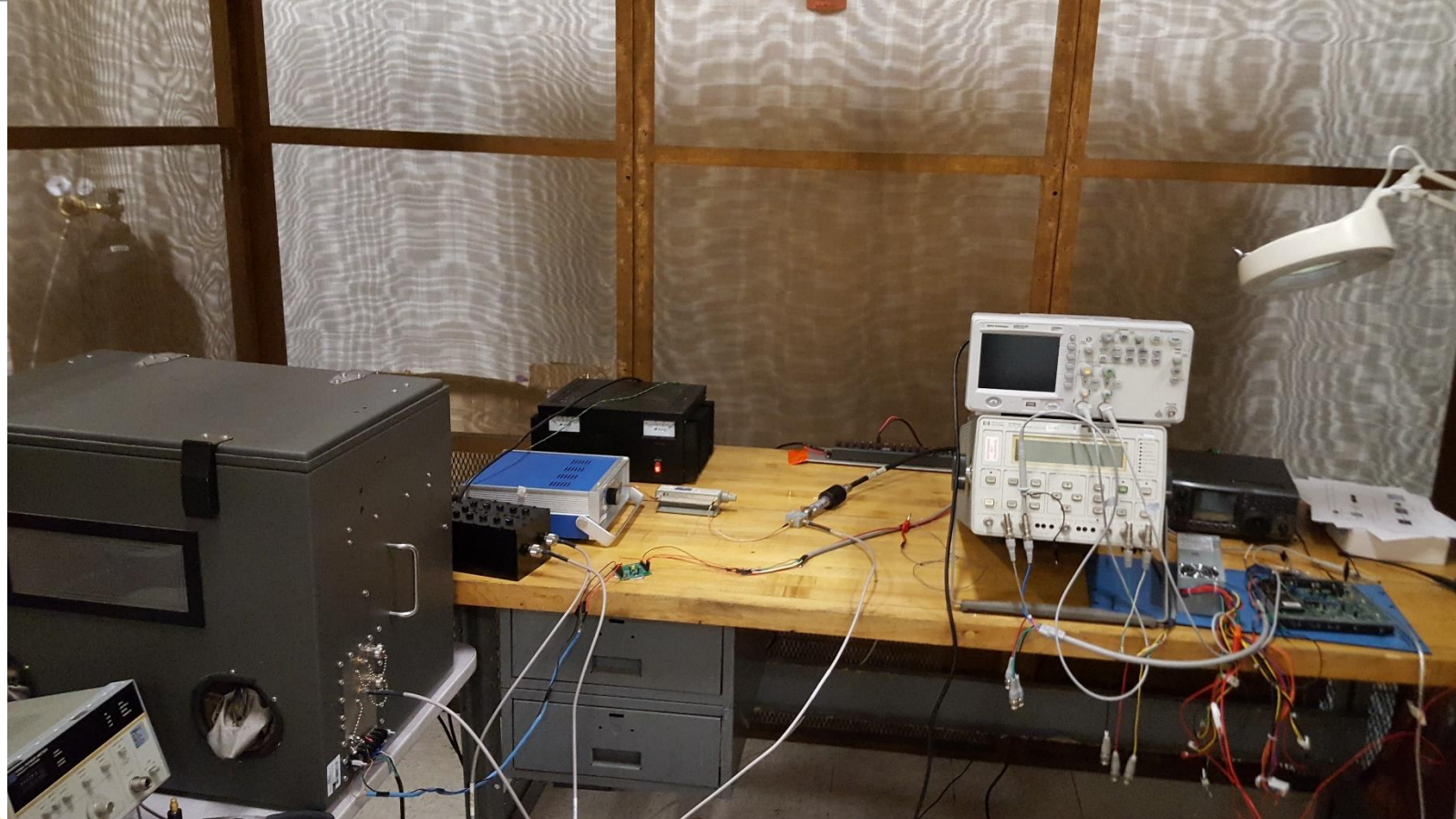
Uplink Link Budget		
UHF Frequency	MHz	437.485
Wavelength	m	0.69
Transmit Power	W	50
Propagation Range	Km	2294
Free Space Loss	dB	-152.48
S/C Antenna Gain	dB	0.00
GS Antenna Gain	dB	15.00
Noise Power	W	2.43E-16
Power Received	W	8.93E-13
S/N	dB	35.66
Demodulation Margin	dB	10.00
Cross-Polarization Loss	dB	3.00
S/N Margin	dB	22.66

Downlink Link Budget		
UHF Frequency	MHz	437.485
Wavelength	m	0.69
Transmit Power	W	1.41
Propagation Range	Km	2294
Free Space Loss	dB	-152.48
S/C Antenna Gain	dB	0.00
GS Antenna Gain	dB	15.00
Noise Power	W	5.96E-17
Power Received	W	2.52E-14
S/N	dB	26.26
Demodulation Margin	dB	10.00
Cross-Polarization Loss	dB	3.00
S/N Margin	dB	13.26





Setup



Radios

Ground Station radio: ICOM IC-910H

CXBN-2's radio: Astrodev Lithium-1

The Li-1 was placed in an RF isolation box to protect it from outside RF interference

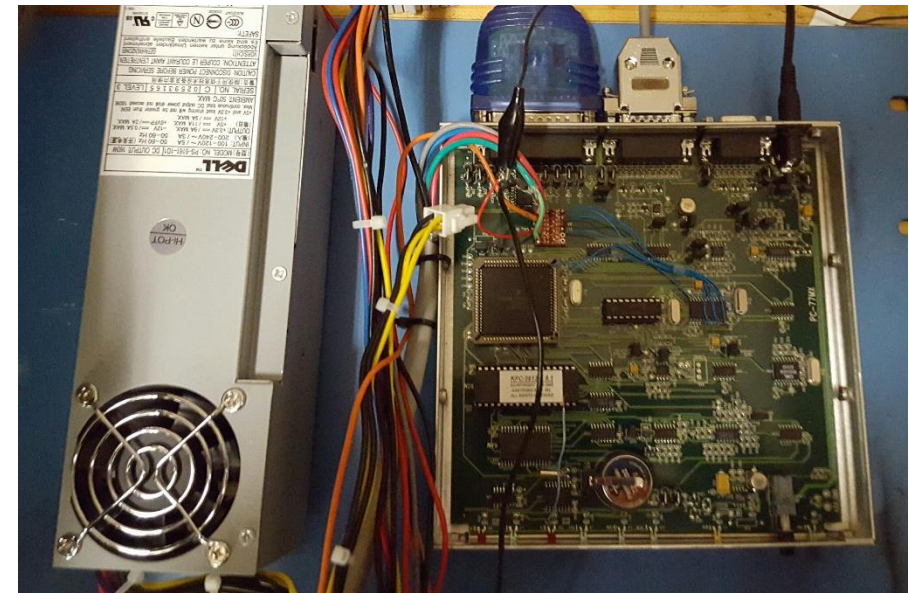


Terminal Node Controller (TNC)

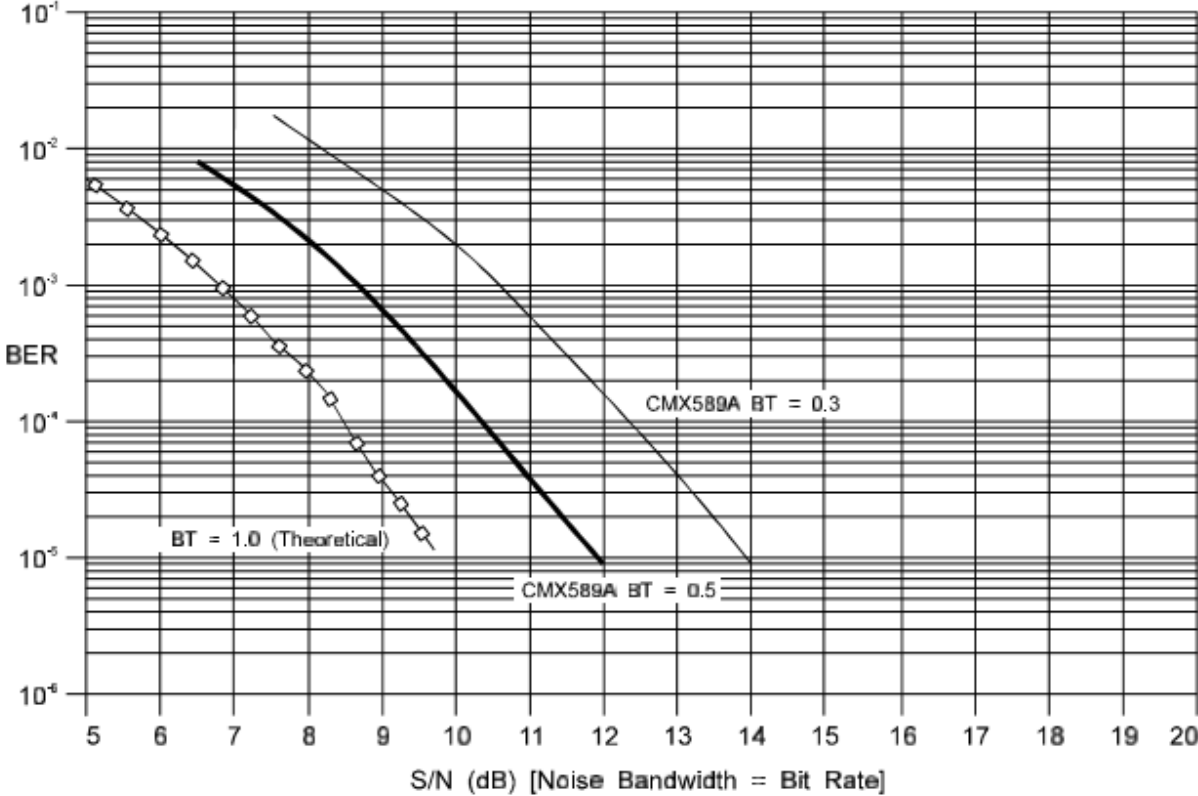
Ground Station uses a Kantronics 9612+

Modified the Kantronics to transmit continuously

A level converter was used to increase the current off the modem



Modem Performance



Digital Transmission Analyzer

Requires a continuous stream

Needs 5V to read the signal

Compares the clock and data lines of the Kantronics and the Li-1 to calculate the BER

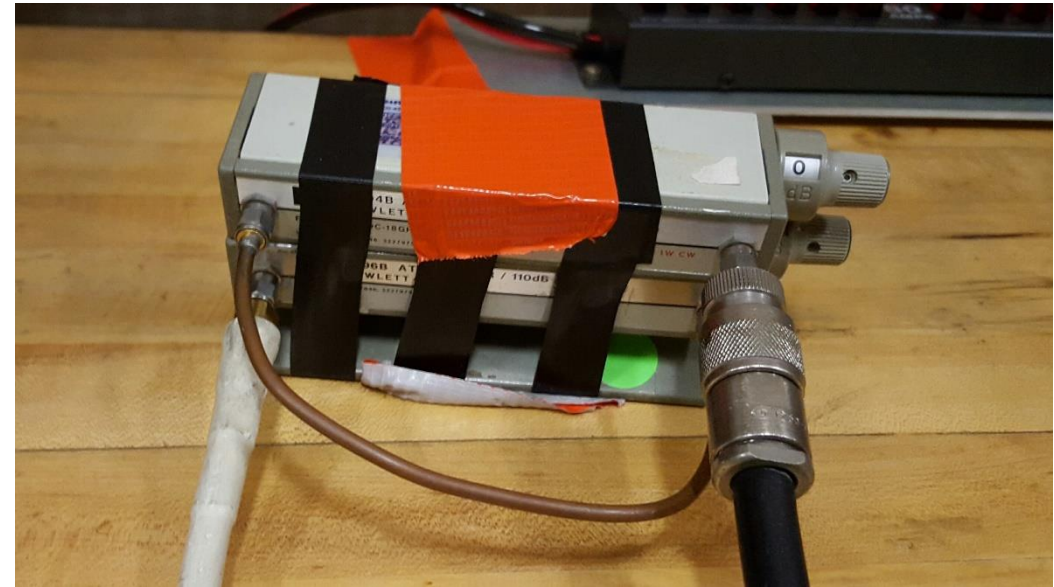


Step Attenuators

Used to simulate the free space as the satellite travels over head

Consists of two banks

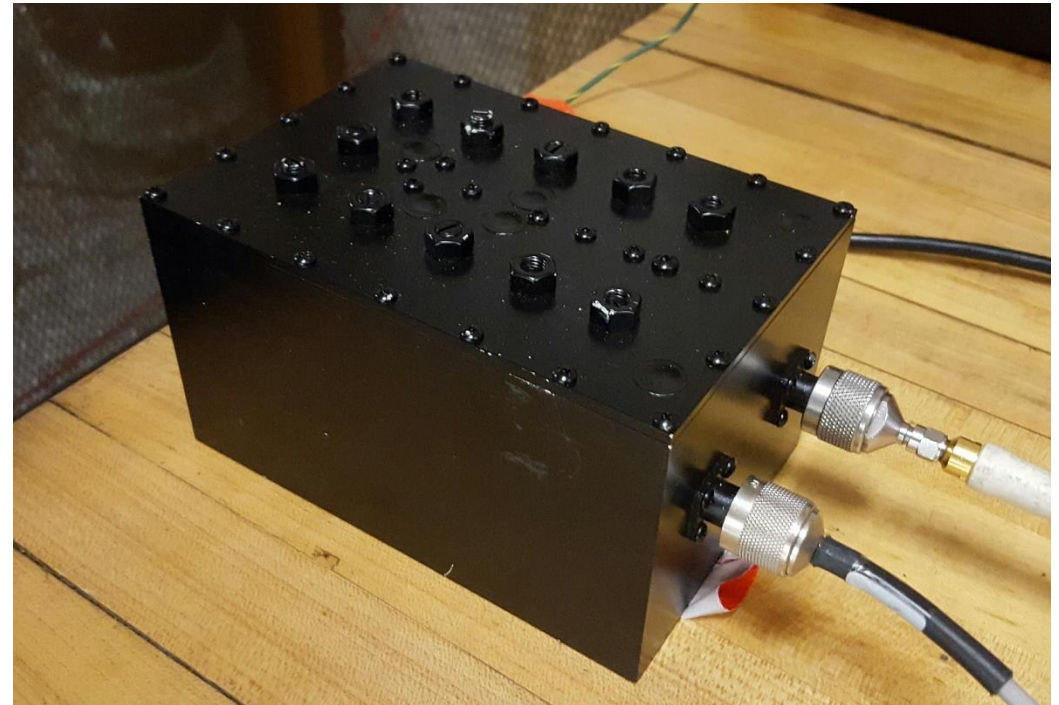
- 0 – 110dB in steps of 10dB
- 0 – 11dB in steps of 1dB



Filter

Passband Cavity Filter covers 420 – 450MHz

Serves as the antenna in the simulation



Noise Source

Broadband noise generator

Built in attenuator



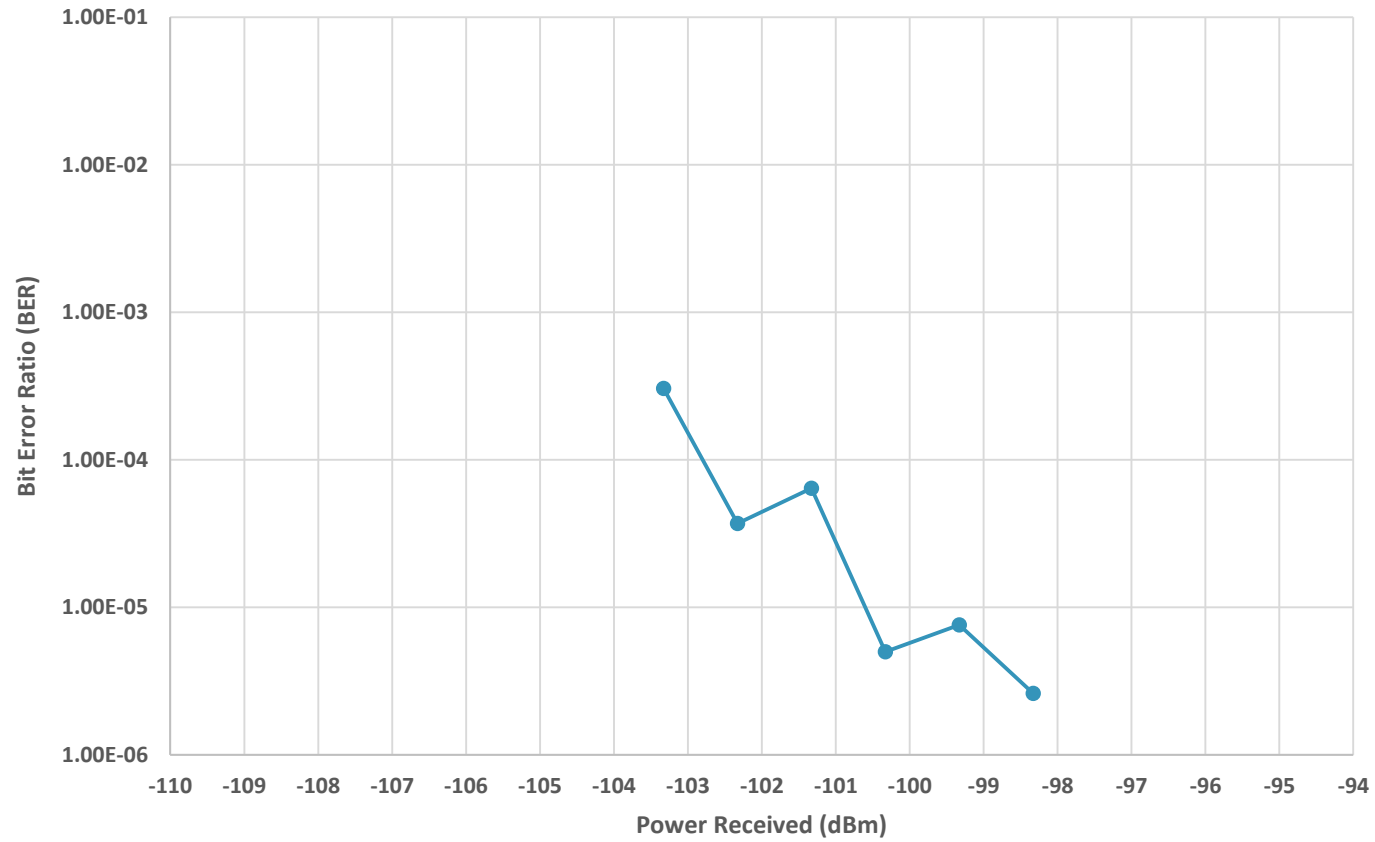
Without Noise

Step Attenuator Value (dB)	Power Received (dB)	Bit Error Ratio (BER)
-80	-98.33	2.60E-06
-81	-99.33	7.60E-06
-82	-100.33	5.00E-06
-83	-101.33	6.40E-05
-84	-102.33	3.70E-05
-85	-103.33	3.04E-04

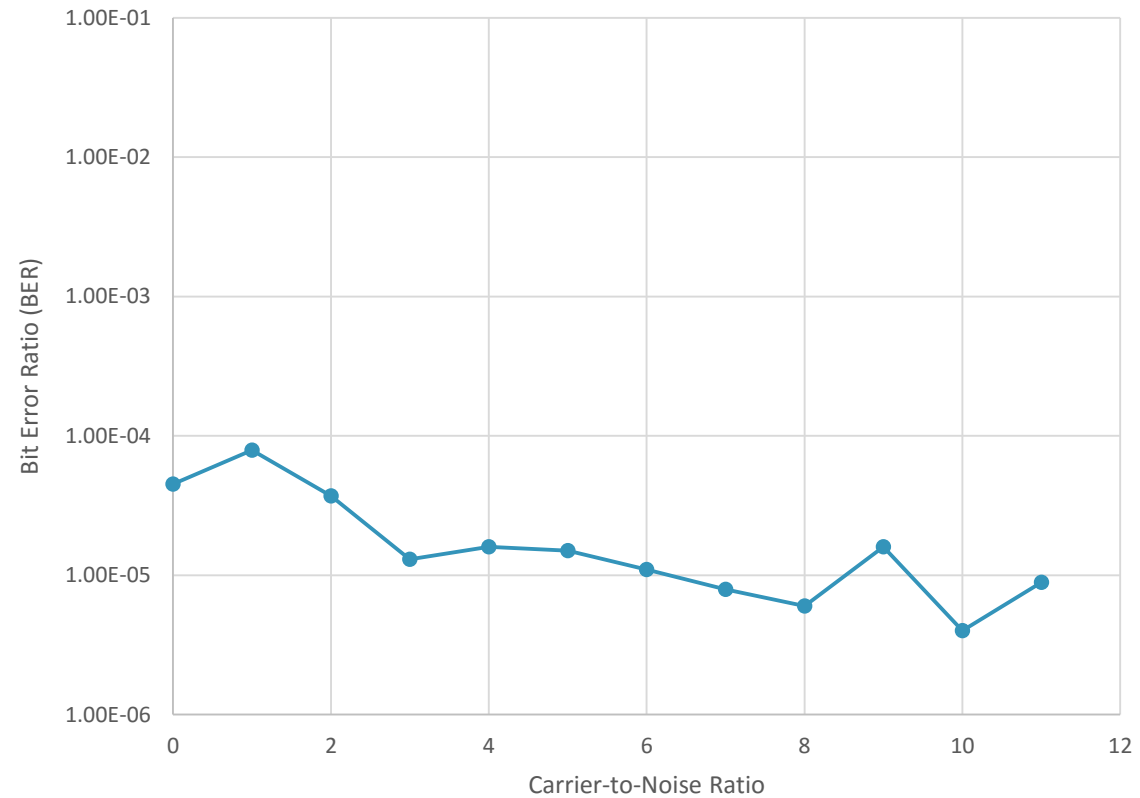
Loss in Box	-29.67dB
Filter Loss	-0.61dB
Loss from Step Attenuators at 0dB	-0.51dB
Radio Output	12.46dBm
Total Line Loss	-18.33dB



Without Noise



With Noise



Noise (dB)	BER
11	8.90E-06
10	4.00E-06
9	1.60E-05
8	6.00E-06
7	7.90E-06
6	1.10E-05
5	1.50E-05
4	1.60E-05
3	1.30E-05
2	3.70E-05
1	7.90E-05
0	4.50E-05



Future Work

Refine Noise injection

Setup refinement

Test out other TNCs



Questions?

