GD SDR Automatic Gain Control Characterization Testing

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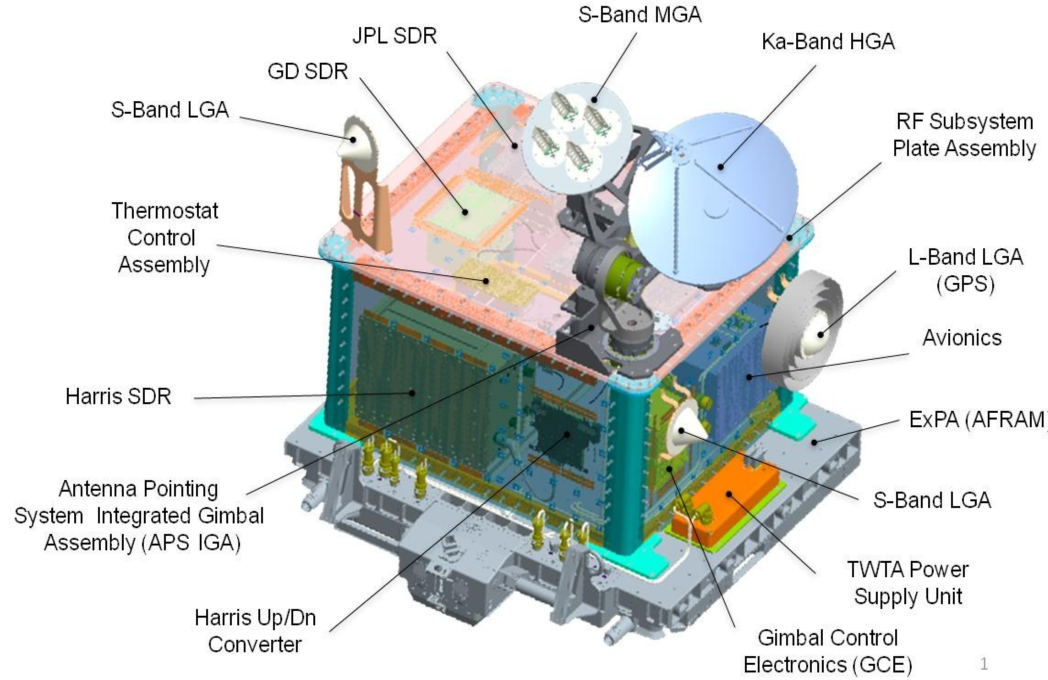
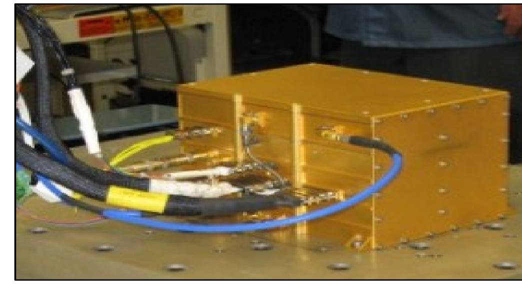
SCaN Testbed Flight System Overview

- 2 S-band SDRs
- 1 Ka-band SDR
- Ka-band TWTA
- S-band switch network
- Antennas
  - 2 - low gain S-band antennas
  - 1 - L-band GPS antenna
  - Medium gain S-band and Ka-band antenna on antenna pointing subsystem.
- Antenna pointing system
- Flight Computer/Avionics



- Launched on Japanese HTV-3 on July 20, 2012
- Installed on ISS August 7, 2012
- Checkout and Commissioning is in progress

SCaN Testbed GD SDR Description



- TDRSS S-band Transponder
  - 8 Forward link receive waveform configurations
  - 30 Return link transmit waveform configurations
- 1 Xilinx Virtex II QPro FPGA, 3 M gate
- ColdFire microprocessor with VxWorks RTOS running the Space Telecommunications Radio System (STRS) Architecture
- CRAM (Chalcogenide RAM) Memory (4 Mb)
- Analog (10 MHz filter bandwidth) and Digital (6 MHz filter bandwidth) automatic gain controls (AGCs)

Waveform Number	Center Frequency	Data Rate (kbps)	Forward Error Correction
1	SA	18	Coded
2	SA	18	Uncoded
3	SA	72	Coded
4	SA	72	Uncoded
5	MA	18	Coded
6	MA	18	Uncoded
7	MA	72	Coded
8	MA	72	Uncoded

Test Objective and Plan

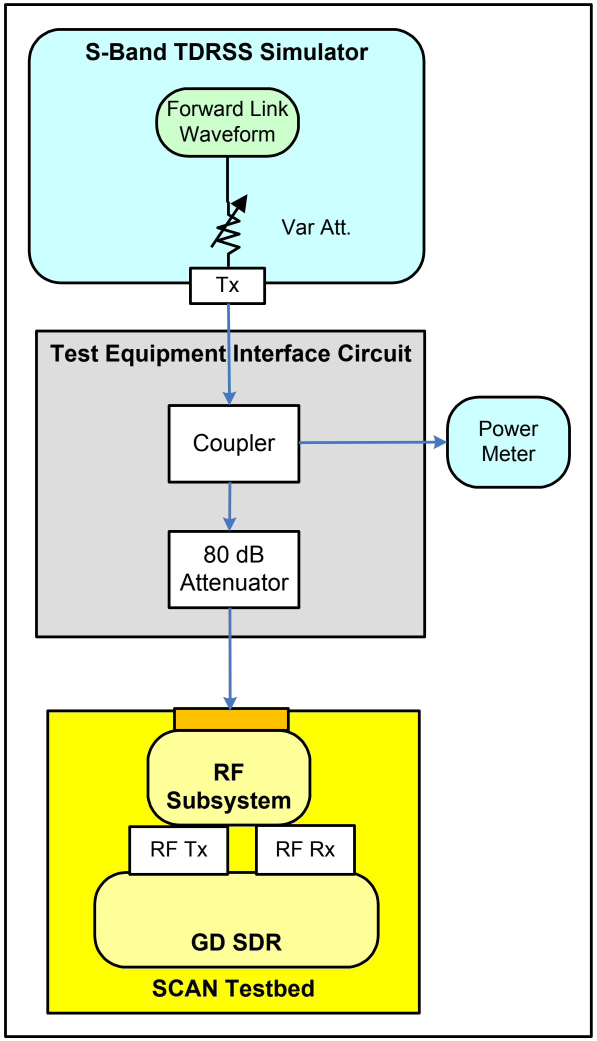
- Characterize the relationship between:
  - SDR input power
  - SDR baseplate temperature
  - Waveform configuration
  - The digital and analog AGC values
- Temperature range:
  - -15 to +45 °C
- SDR input power range:
  - -90 to -130 dBm


SCaN Testbed during TVAC testing, March 2011

- Results will be used to estimate SDR input power in future testing
- Testing phases included:
  - GD verification testing
  - GRC thermal vacuum (TVAC) testing
  - GRC verification testing

GRC Test Setup

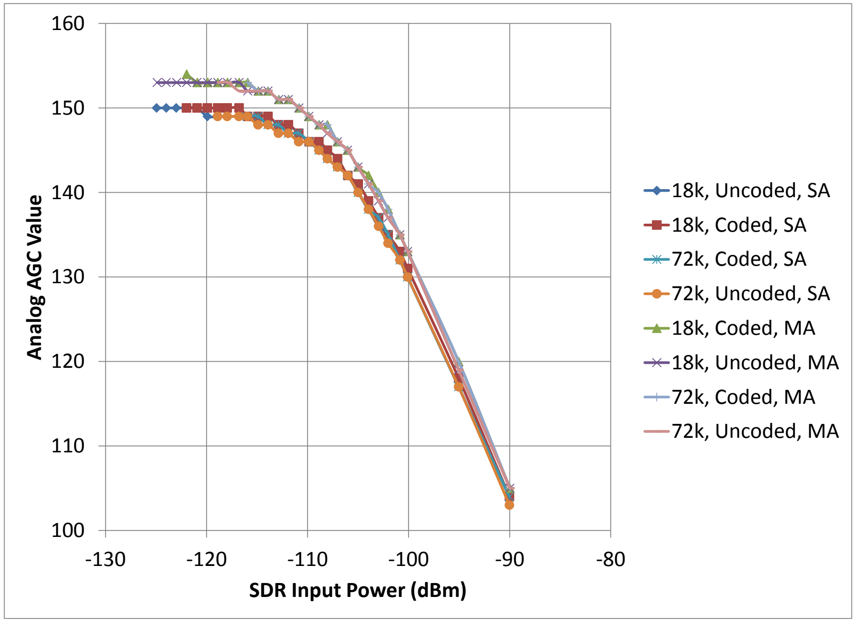
- S-Band TDRSS Simulator (TSIM) was used to emulate the forward link waveform
- TSIM was connected to the SCaN Testbed using a test equipment interface circuit and RF cable
- SDR input power was measured from a coupled port in the interface circuit using a power meter
- The RF subsystem inside the SCaN Testbed was used to connect an antenna port to the GD SDR
- During TVAC, the RF cable and SCaN Testbed were located in the vacuum chamber



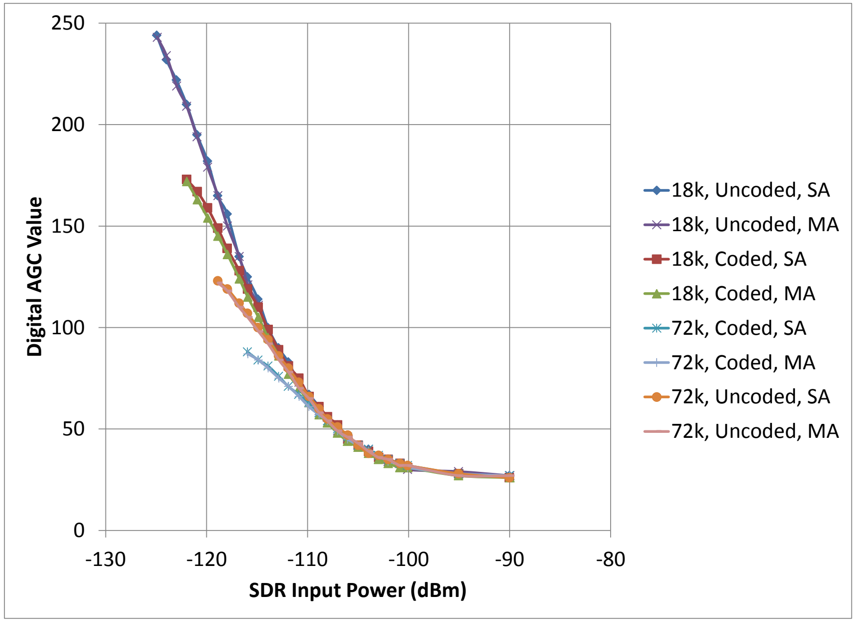
GRC Test Setup

AGC Characterization Results at Ambient Temperature

Analog AGC at 26 °C



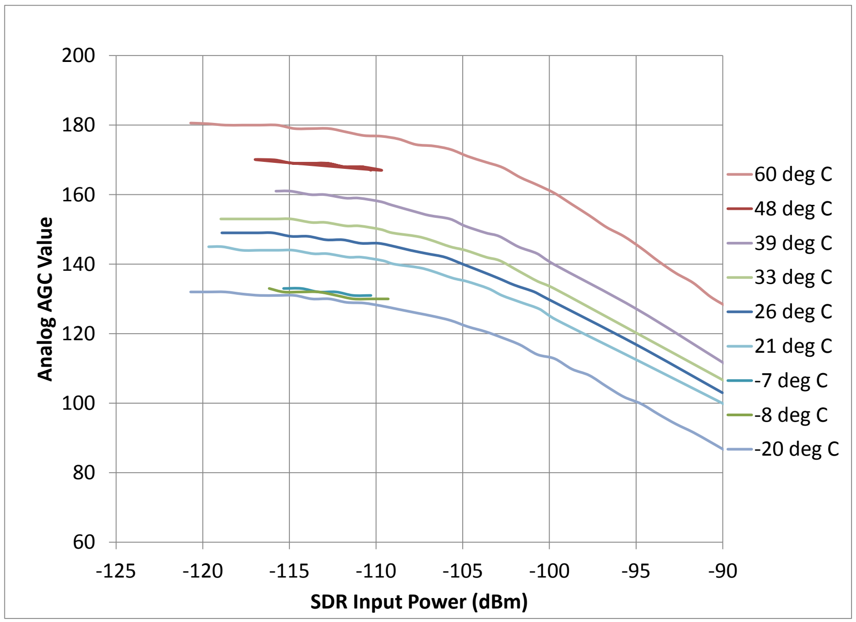
Digital AGC at 26 °C



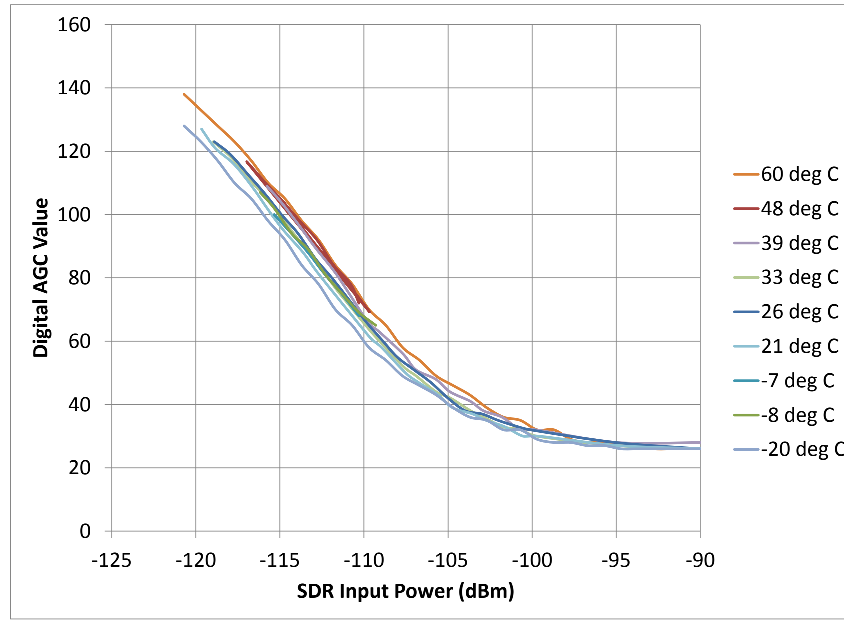
- Analog AGC varies with center frequency (MA/SA)
- Digital AGC varies with symbol rate (coding + data rate)

AGC Characterization Results over Temperature

Analog AGC



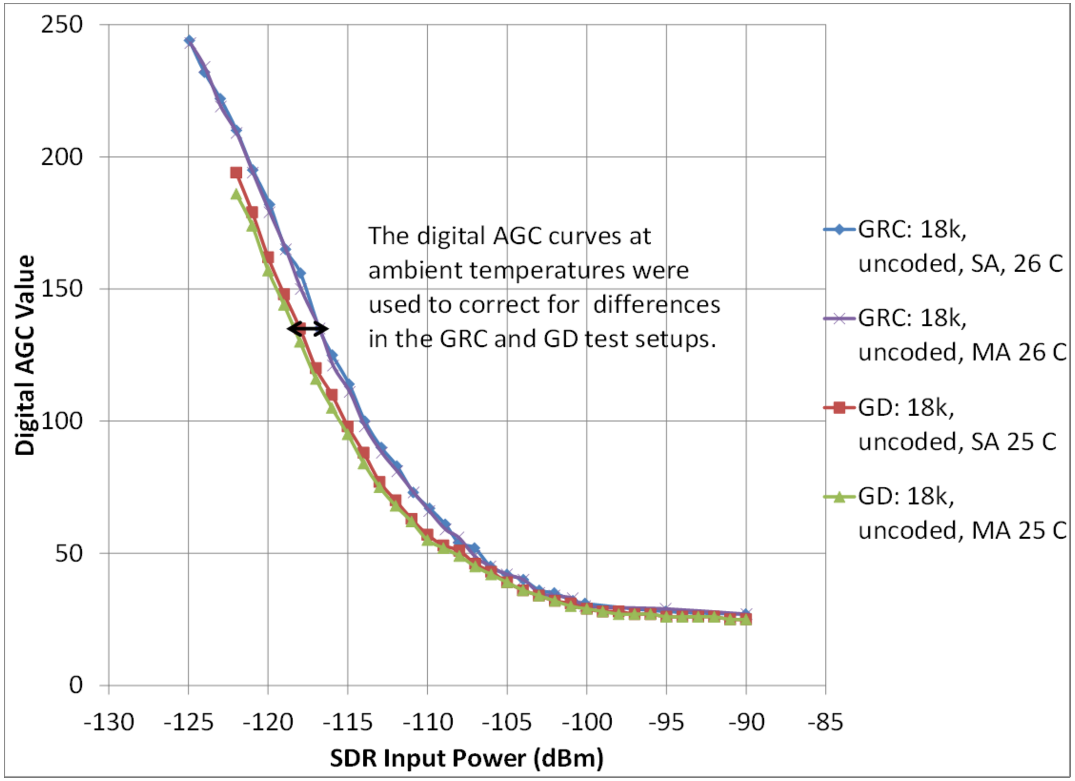
Digital AGC



- Both analog and digital AGCs vary over temperature. The analog AGC variation is more significant.

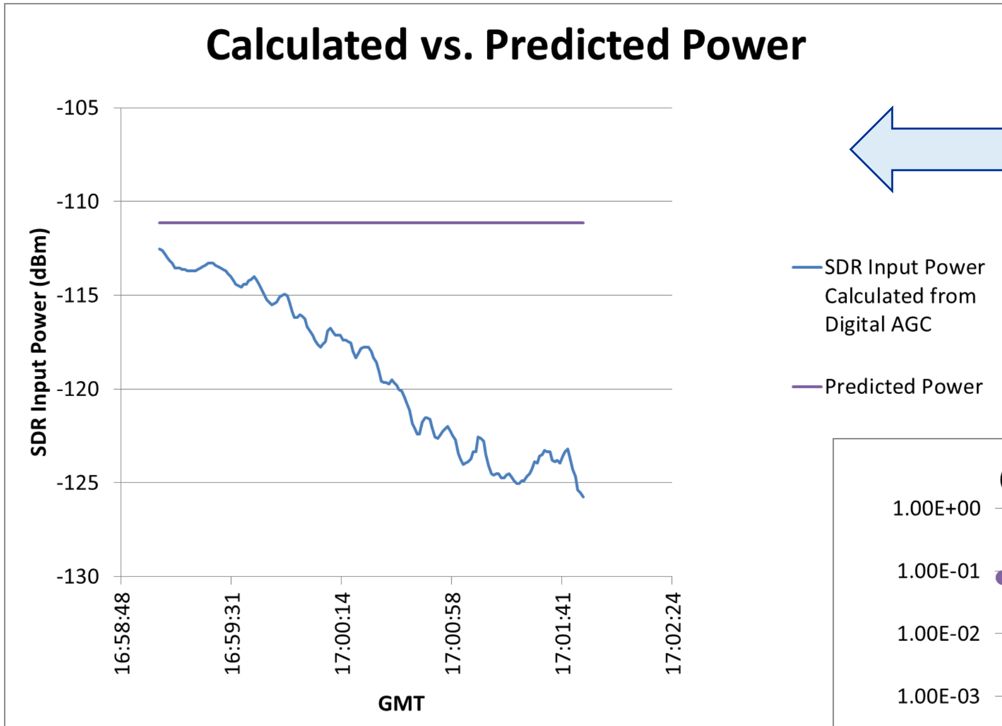
Sources of Error in Data Collection

- Differences in the GD and GRC test setup (+/-.5 dB)
- Compensation method for the cable loss over temperature during thermal vacuum testing (+/-.5 dB)



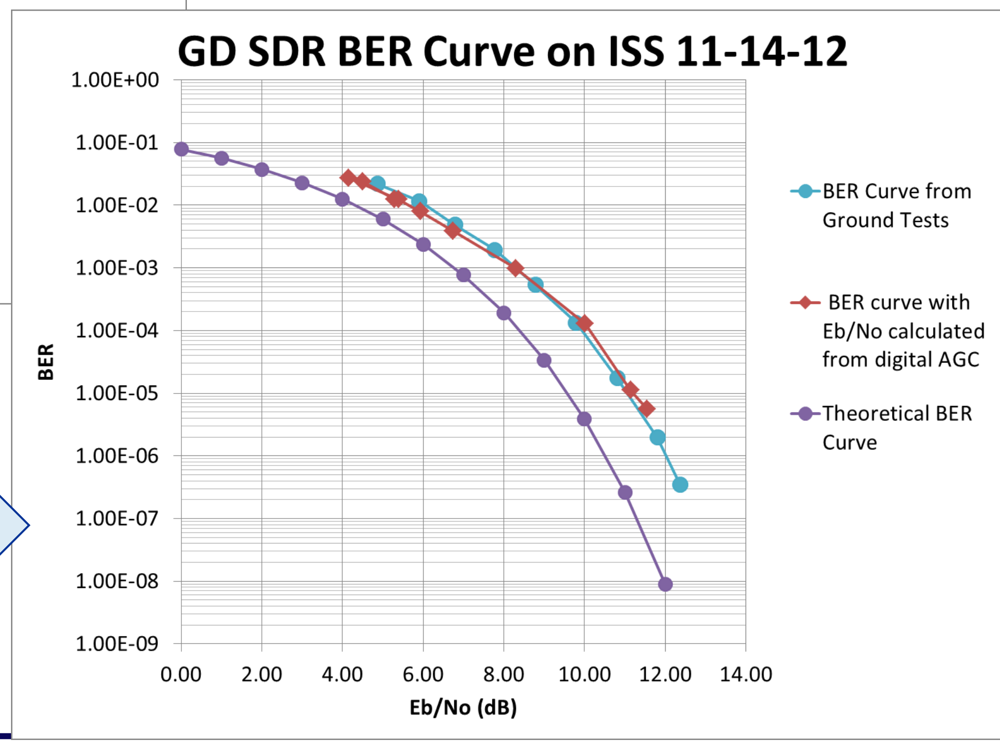
- Data interpolated for waveforms with incomplete data sets (+/- 1 dB)
- System loss measurement error (+/-.3 dB)

SDR Input Power Estimation using Digital AGC

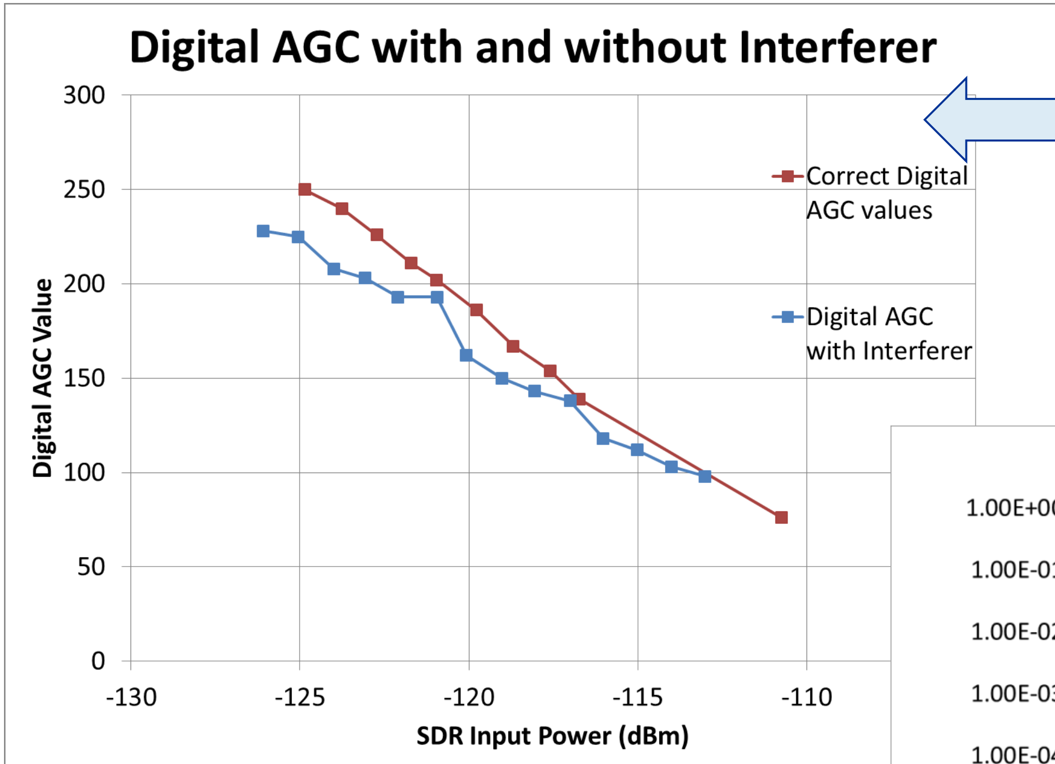


- The Digital AGC characterization data was used estimate the SDR input power during operations on ISS (note: predicted power is TBD)

- The Eb/No was calculated from the SDR input power and used to create a BER curve

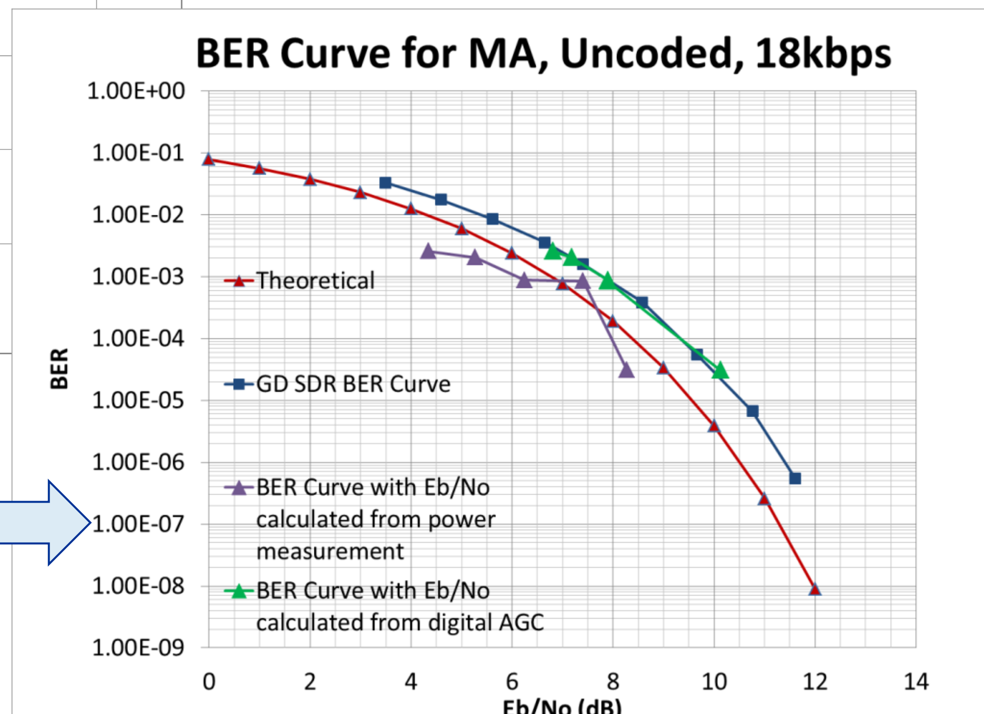


Estimation of Interferer Signal Strength using Digital AGC



- Digital AGC shows received power is higher than expected due to an interferer

- The purple curve was plotted with the Eb/No calculated from a measured power.
- The green curve was plotted with the Eb/No calculated from the digital AGC



Recommendations and Forward Work

Recommendations

- Plan test phases and design a test setup that can be kept constant throughout each phase
- Balance SDR reconfigurable parameters with project test time

Forward Work

- 3 SDR input power estimation algorithms have been developed
- Characterize the SDR input power algorithms during on-orbit operations on ISS
- Utilize the engineering model (EM) characterization data to create SDR input power estimators for the EM

Questions?

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