Response to AI_04-03, AI_04-09, and AI_04-04 (Questions Regarding DSN Ranging Capabilities)

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I. Introduction

Action item AI_04-03 was assigned to JPL at the May 2004 RF&Modulation WG meeting to determine the lowest chopping frequency used by the DSN in relation to Rec. 2.5.4B. In addition, AI_04-09 was assigned to find if any number can be accepted for the carrier-to-chip rate ratio for the DSN. AI_04-04 was assigned to align the differing PN ranging spectra from DSMS document 810-005 and ESA simulations. Since the response to the three action items were short, they are all addressed in this input paper.

II. Response to AI_04-03

This action item originated from a review at the last meeting of Rec. 2.5.4B, which recommends that the ranging channel baseband response should be uniform within +/-0.5 dB between 3 kHz to 1.1 MHz. It was observed at the time that lower end of the frequency range might be unnecessarily restrictive particularly if chopping was used. Thus the question arose as to what the lowest chopping frequency used by the DSN was.

According to the DSMS Document 810-005, the lowest chopping frequency used by the DSN is 16 kHz. However, frequency chopping can be disabled in which case no ranging components are chopped until 1 kHz and the remaining lower frequency components are reached. The lowest ranging code component is 0.983 Hz. In general though, there is little advantage to be gained in not chopping the lowest frequencies and also the possible disadvantage of interference from the ranging tones to telemetry.

Given these facts, the lower end of the filter frequency range in the recommendation can be increased to 16 kHz.

III. Response to AI_04-09

This action item was to determine if any number can be accepted for the carrier to chip rate ratio for the DSN.

According to the DSMS Document 810-005, the X-band uplink ranging clock frequency is coherently related to the uplink carrier by the following relationship:

$$f_{RC} = \left(\frac{221}{749}\right) \times \frac{1}{128 \cdot 2^k} f_x$$

where f_x is the X-band uplink frequency carrier, and $1 \leq k \leq 10$. So the carrier-to-chip rate ratio is fixed for a given k. A similar formula exists for a S-band carrier.

On the downlink, the PN ranging can be done in either coherent or non-coherent mode. In non-coherent mode, the downlink range clock is not coherent with the downlink carrier. In this case, the carrier-to-chip rate ratio will vary.

IV. Response to AI_04-04

This action item was to the resolve the differing PN ranging spectra seen in DSMS document 810-005 and in ESA's simulation. A quick check of 810-005 revealed that the spectra there was generated sinewave ranging. ESA confirmed that their simulations used a 1 MHz squarewave . This accounts for the difference seen in the spectra.