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INFLUENCE ANALYSIS OF DOPPLER AND COMPENSATION FOR THE RANGING PERFORMANCE OF TEST EQUIPMENT OF NON-COHERENT TT&C TRANSPONDERS

Abstract

For Spaceborne DSSS(direct sequence spread spectrum) TTC transponders, there are two main ranging methods: coherent and non-coherent. Coherent DSSS transponders measure ranges by receiving and retransmitting long pseudo-codes. In recent years, China has developed a non-coherent ranging system based on short pseudo-codes. Compared to coherent ranging system, non-coherent one has some advantages, such as: 1) Ranging and command signals are separate, thus ranging work can be done alone without command signal. 2)It is easier and more flexible for multi-channel ranging , because different channels' sampling information is merged into one downlink frame and transmitted.3) Pseudo-codes used for ranging are short instead of long codes, which is simpler to synchronize the codes. The processes of coherent and non-coherent ranging are different. The test equipment of Coherent transponders just needs to calculate the time difference (TD)between the sent uplink long-code initial phase and the received downlink long-code initial phase, and then subtract a fixed value which is called calibrated equipment time delay(CETD) to get the true bidirectional time delay. CETD is usually stable or changes slightly as the ambient temperature changes which can be calibrated. For non-coherent transponders, the test equipment calculates the time difference between the sent uplink short-code initial phase and the received downlink short-code initial phase with the assistance of frame header to eliminate the ambiguity, and then subtract CETD, besides, test equipment should subtract another random value called sampling time delay (STD).When testing transponders in a lab, fixed or sweeping code Doppler should be added to test the dynamic performance of ranging. For the test equipment of coherent transponders, the calculation procedure is not affected by the existence of Doppler, because TD and CETD are not sensitive to Doppler. But for the test equipment of non-coherent transponders, the calculation results vary as code Doppler varies, because STD is sensible to the Doppler. i.e. at the same sampling moment, STD varies as Doppler varies, which leads that the ranging result varies because TD and CETD keep the same. In this context, an appropriate compensation method needs to be introduced to eliminate the influence of Doppler, which is the main issue this paper will focus on after discussing the theory of non-coherent ranging. Besides, this paper simulates the method with Matlab and applies it to the test equipment of a satellite TTC transponder. The test result shows that this method is effective and can eliminate all the Doppler influence.