

SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Near-Earth and Interplanetary Communications (2)

Author: Mr. zhugang wang

National Space Science Center (NSSC), Chinese Academy of Sciences, China, wangzg@nssc.ac.cn

A CREATIVE ARCHITECTURE FOR MASS-SENSITIVE TRANSPONDER

Abstract

This article describes a much simplified, Digital and analog mixed architecture that support general S-band transponder operation. The mass is reduced to under 1.4kg (including TCXO), and the dimension is about 170*70*100mm. The power consumption is less than 11W measured in the side of 28V input with 1W SSPA transmitter output.

The mass cut down is benefit mainly from the progress of digital design techniques and the improvement of the FPGA technologies. The designer implements the IF command and tracking demodulation by a 3 million system gates FPGA. Furthermore, the device is employed with tri-mode-redundancy. The algorithm of the main carrier tracking is based on phase lock loop, the command demodulation is based on Costas loop for sub carrier tracking and DTTL loop for bit synchronization. The carrier acquisition threshold is under -128dBm with PM/BPSK demodulation losses 1dB. The dynamic range is -128dBm to -55dBm.

The second technique that decreases the complexity is the structure of RF front-side. We use a small size saturation amplifier replacing the AGC amplifier, the saturation amplifier depresses the mostly of the signal dynamic and DSP deal with the dynamic left. We select a low power A/D converter with working frequency under 3Msps in under-sampling mode; however, the IF Frequency is about 9.3MHz that can diminish the order of RF front-side down converter and the difficulties of analog band pass filter design.

For the standard of the USB transmitter is only support modulation type: BPSK/PM, so we build a RF-IF close loop transmitter architecture that eliminate the components used in up converter architecture, the saved mixers and band pass filters extremely reduce the amount and the volume of PCB. Moreover, we creatively put the coherent forwarding signal generator and the Frequency-Phase Detector together in FPGA. The digital phase noise or jitter is wonderfully filtered by a well-designed analog low pass loop filter. To conclude, there is not any DAC or RF-filter in transponder's transmitter loop. The other advantage is that we can adjust the modulation index easily by digital parameter.

The transponder developed by NSSC has passed flight verification.