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ENVIRONMENTAL TEST OF THE EQM PAYLOAD SYSTEM FOR THE COMMUNICATIONS AND BROADCASTING SATELLITE

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ABSTRACT

ETRI has developed the EQM (Engineering Qualification model) payload system for the communications and broadcasting satellite (CBS) with Korean local companies. This paper describes a series of environmental tests such as vibration, thermal/thermal vacuum, and EMC tests. All the development processes including the design, implementation, integration and workmanship were verified and evaluated by these tests. The results of the functional tests and the compliance to the requirements are also presented. The technologies and heritage obtained from this development will be applied to the development of the payload system for the Korean communication satellite in the near future.

Keywords: environmental test, thermal vacuum, vibration, EMI/EMC

1. INTRODUCTION

ETRI has developed the Ku band and Ka band payload systems for the communications and broadcasting satellite to provide the satellite services in Korea and to acquire the related core technologies, such as design, manufacturing, system integration, test, and equipment development. Each of the payload system consists of the transponder and the antenna subsystem. The overall environmental test procedures and test results for CBS EQM payload system have been introduced.

2. ENVIRONMENTAL TESTS OF TRANSPONDER

2.1 Overview

The transponder subsystem is composed of 3 active 100 MHz bandwidth channels and one redundant channel for Ku band and 3 active 36 MHz bandwidth channels and one redundant channel for Ka band.

2.2 RF Performance Test

The end-to-end RF performance tests conducted before and after the environmental tests exposure to measure RF main parameters of transponder subsystem and to demonstrate the compliance

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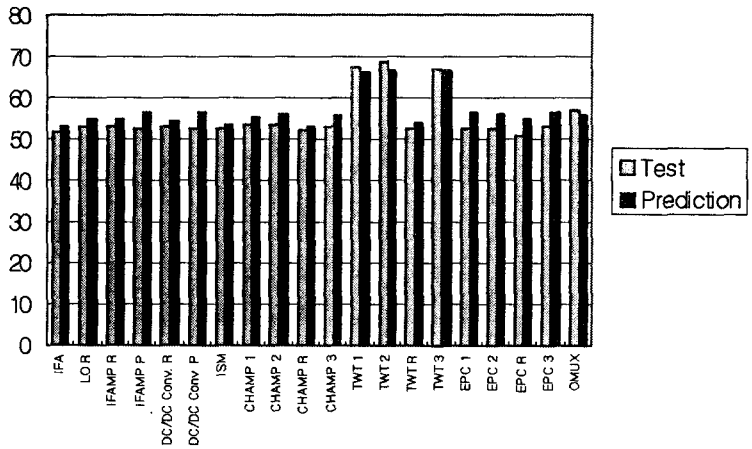


Figure 1. Comparison of the measured & predicted temperature.

with performance requirements under the ambient and in-orbit conditions. The RF performance test results at initial, post-vibration, thermal cycling and final test comply with the specifications.

2.3 Environmental Test

As the initial performance test is completed, the environmental test is conducted to verify the system workmanship, performance and design margin.

The random vibration test and thermal cycling test are performed at transponder level according to the system environmental test requirements. A low level vibration survey is conducted to determine the natural frequency of the system and proper notching criteria. As a total, 30 accelerometers are attached on the equipment and panel to measure the dynamic response and to control the shaker system (Seo et al. 2003). The minimum natural frequency of Ka band transponder is 33.75 Hz which is compliant to the requirement.

The thermal cycling test is also performed to verify the thermal design margin and the workmanship of the integrated system. During the 5 thermal cycles, the transponder RF performances at hot plateau and cold plateau are also measured to evaluate the performance variation under the thermal cycling conditions. 40 thermocouples are attached on the equipment and panel to measure the temperature and to control the thermal chamber. The comparison of the measured and predicted temperature is represented in Figure 1.

3. ENVIRONMENTAL TESTS OF ANTENNA

3.1 Antenna Near Field Range Test

The antenna range test is conducted before and after the environmental tests exposure to measure radiation performance, such as patterns, polarization, gain, cross-polarization, side-lobes etc. in the Near Field Range (NFR) facility.

3.2 Environmental Test

The antenna subsystem should survive and meet all performance requirements after the environmental tests. The sine vibration test is conducted in x, y and z-axes at the qualification level. 30 accelerometers are attached on the antenna structure to measure the dynamic response and to control

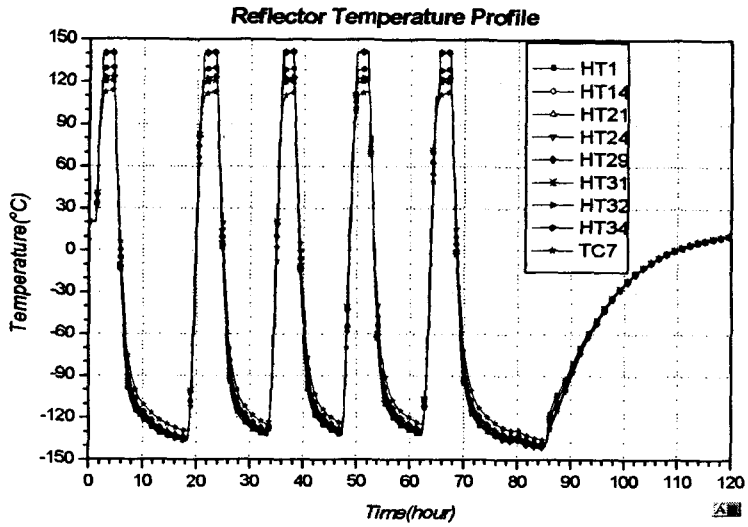
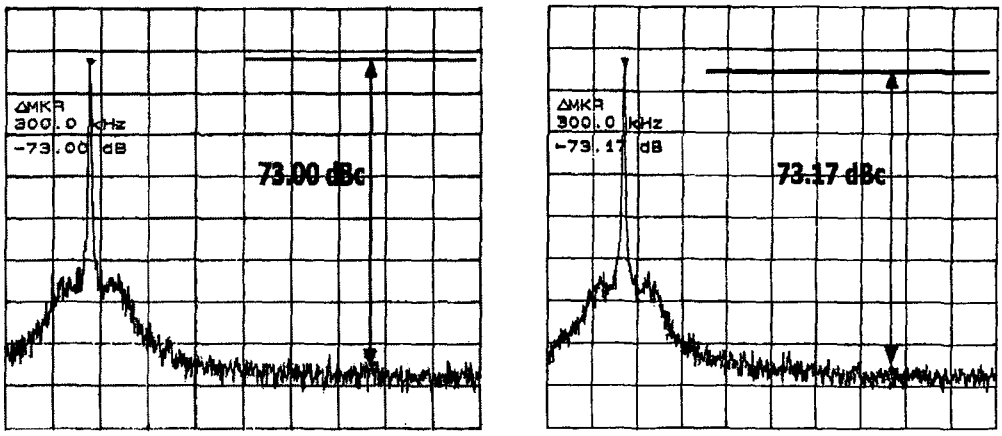


Figure 2. Temperature profile of Antenna.



(a) No External Field

(b) External Field Injection

Figure 3. Comparison of Spurious Response.

the shaker system. The post vibration survey test and the tap check show that there is no structural degradation.

The thermal vacuum test is also performed to verify the thermal design margin, the workmanship & survivability of integrated antenna under utmost temperature conditions and to detect out-gassing from the antenna material. The number of cycles is 5 and the temperature range of antenna is from 150C to +110C. During the cycles, the chamber wall temperature is varied from 180C to +120C. 35 thermocouples are attached on the antenna to measure the temperature and to control the thermal

vacuum chamber. The temperature profile of Ku band antenna is shown in Figure 2 (Choi et al. 2002).

4. EMC TEST OF PAYLOAD

The aim of EMC (Electromagnetic Compatibility) test is to verify that the payload system has no effect on the other system and is not affected by the external field. The emission level from the payload system is measured and the variation of performance by the noise injection is measured to inspect the susceptibility of the payload system. Figure 3 shows that characteristics of the Ka band transponder are not affected by the external field injection. The EMC test results show that the electromagnetic interference has no serious effect on the overall payload system performance and the test parameters are comply with EMI/EMC requirements.

5. CONCLUSIONS

The overall Test processes of the CBS payload system has been introduced. The environment test results indicate that the transponder and antenna subsystem have enough design margins under severe environmental test conditions. The EMC test results show that the electromagnetic interference has no serious effect on the overall payload system performance and the test parameters are comply with EMI/EMC requirements. The auto-compatibility test results show that transponder chains operate correctly in a self-radiated environment.

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