Bendix

Aerospace Systems Division

Array E S-Band Compatibility Test Results Analysis	ATM-1093
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Abstract

This report documents an investigation of the MSFN/ALSEP S-Band Compatibility Test Results and provides a rationale and recommendation relative to the test validity and relative to Command Decoder Circuit Modifications made subsequent to the test performance.

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1.0 INTRODUCTION

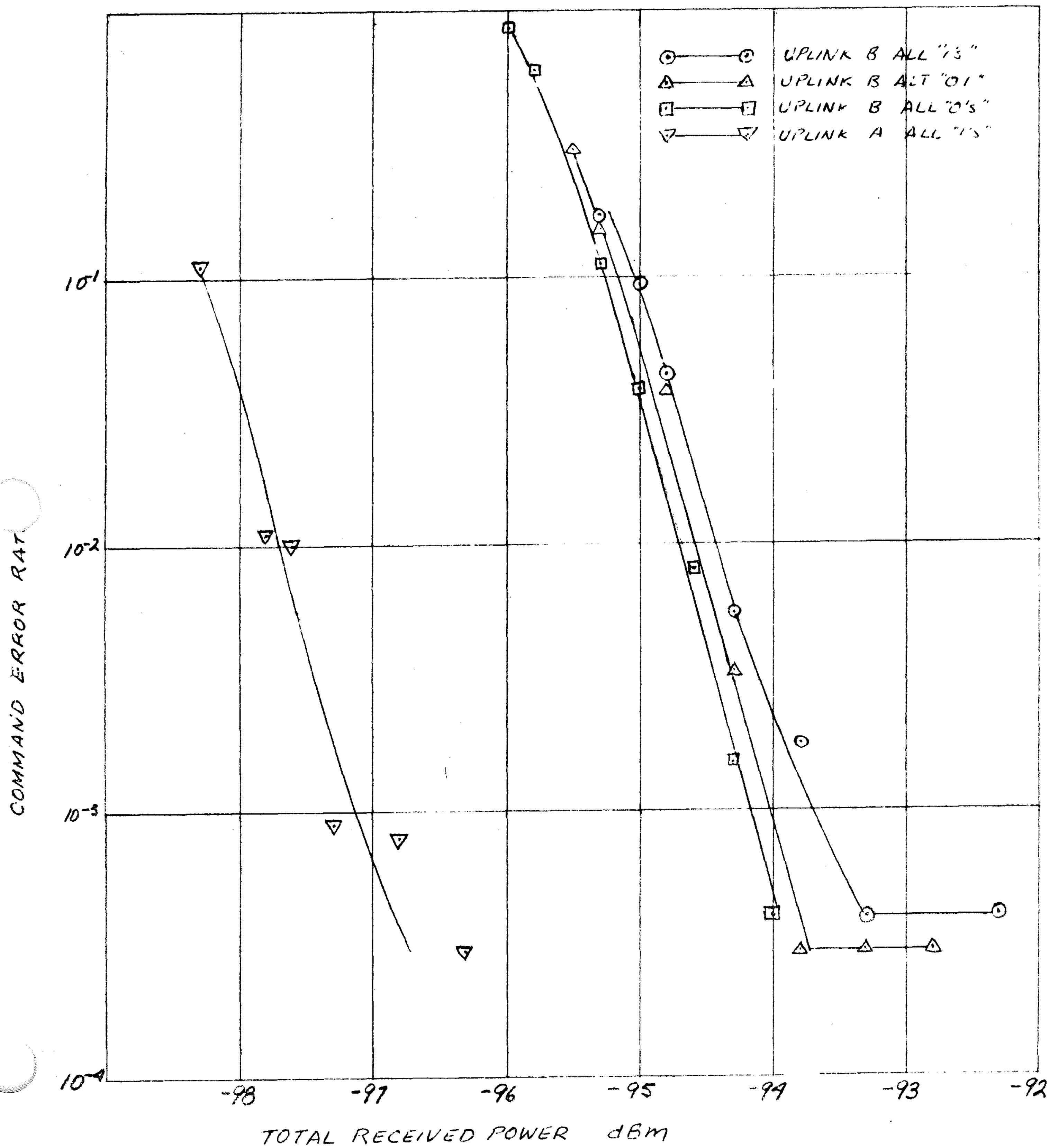
MSFN/ALSEP Compatibility and Performance Tests were run on the Array E Design Verification Model (DVM) Central Station during January 1972 at MSC. The results of these tests were as predicted except for the fact that the uplink command execution count was either 3 or 4 less than the commands transmitted count when no uplink bit errors were detected. Since this test, circuit changes have been made to improve operation and remove potential single point failures in the ALSEP uplink. Both the anomalous test results and the effect of the circuit changes have been evaluated to determine if there is a need to repeat the compatibility tests. The conclusion reached from resulting analysis and test is that further compatibility tests of ALSEP uplink are not required. Note that downlink test results were as predicted and that there have been no changes in the downlink circuitry. Therefore, there is definitely no need for further downlink compatibility tests.

2.0 DISCUSSION OF S-BAND COMPATIBILITY TEST RESULTS

Figure 1, curves of command error rate as a function of total received power, was plotted from the MSFN/ALSEP compatibility test data. First it should be noted that the system does meet the specification limit of one command error in 10^3 at the minimum predicted signal level of -92 dBm. The second point of interest is the fact that as the received power was increased to a level where the measured bit error rate went to zero, the results still indicated that three (or four) out of 10,000 commands were not executed. In fact the curves of Figure 1 indicate that a further increase in received power would not result in a reduction in command errors.

As further background, it was noted during these tests that there were three command errors for the case of no bit errors if 1000 or 10,000 commands were transmitted. This indicates that the command errors were not occurring randomly in the test sample but were systematic and most probably occurred at the beginning of the test run. With no further knowledge it is possible to suspect either the MSC test set up or the ALSEP uplink. However, thorough analysis of the Command Decoder circuitry by both Bendix and MSC personnel failed to uncover any mechanism for failure to execute a command when an error free bit stream is delivered to the command decoder. Furthermore, during DVM and Qual model testing, thousands of commands have been transmitted to Array E ALSEP with no indication of systematic rejection of commands. Finally,

COMMAND ERROR RATE
AS A FUNCTION OF TOTAL RECEIVED POWER



an independent uplink test was run at BxA using the Pre Flight Model Command Decoder (See AER 489). This model had been updated to final circuit configuration including all modifications to the control logic. The test was performed in conjunction with an ALSEP receiver (SN-13), similar to the compatibility test at MSC for a single received power level of -92 dBm. Approximately 9.75×10^3 commands were transmitted during this test with 100% command execution and no loss of CVW. Based on circuit analysis and these test results, it is the BxA opinion that the difference in the count between commands received and commands transmitted measured during the MSFN/ALSEP compatibility test, when no bit errors were detected, is due to the operation of the MSC test set up and not due to improper operation of the ALSEP Command Decoder.

3.0 IMPACT OF CHANGES IN COMMAND DECODER

Four changes have been made in Command Decoder since the MSFN/ALSEP Compatibility Tests were run. As background the rationale for each change along with a description of the change has been prepared and is presented here. The first two changes were the result of the study of single point failures due to chip contamination. This study was completed during the time the compatibility tests were being run. The continuation of the theoretical failure analysis, completed after the compatibility test, gave rise to thefinal two Command Decoder modifications. The changes and their rationale are:

(a) Remove experiment formatting command cross-strapping by abandoning Octal Command 011 and substituting Octal Command 003. This was simply a matter of using existing printed circuits to the maximum advantage. All command output circuits are similar and the particular octal numbers associated with different commands have no significance.

(b) Reverse the polarity of the "Experiment Formatting Required (EXFZN)" signal from the Command Decoder, so that a contamination short-to-ground will fail the system into the preferred mode.

(c) The Master Reset pulse following a CVW was terminated by the appropriate Address Recogniation pulse within the Command Decoder, rather than by the Data Processor clock, CWEZP.

The Master Reset is generated by the end of the Data Demand pulse, and in the original design it was terminated after approximately 0.5 millisecond by the next CWEZP pulse from the Data Processor. A failure of CWEZP at the cross-strapped interface or in the DDP would have left the system in a permanent reset condition, unable to respond correctly to further commands. Address Recognition is not cross-strapped, thereby removing the single paint failure. The main operational difference is that the Master Reset following a CVW is now maintained until the start of the next command message.

(d) The period of inhibition of the Threshold Reset was reduced to just the 21 millisecond period of the Execute pulse. Previously, Threshold Reset had been inhibited from the start of Execute until the end of the CVW transmission. Without the modification a failure of the Data Demand pulse in the Data Processor, or at the interface, could have left the Decoder locked in a no-reset condition, unable to respond to further commands. One undesirable but inevitable result of this modification is to give rise to the finite probability of losing a CVW following a large commanded power change at very high or very low reserve power levels.

The possible effects which each of these modifications could have had upon the results of the MSFN Compatibility Testhave been assessed, with the conclusion that they will result in no observable differences from the compatibility test already run.

Bit error rate and threshold loss rate are functions of the demodulator section of the Command Decoder only, and this section is not affected in any way by the modifications to the later decoding circuits. There are no feedback paths from the decoding and command output sections into the demodulator section.

Modification (a), substituting Command Octal 003 for Command Octal 011, may appear to have some importance, since 011 was the command which was used during the test, but in fact the complete interchangeability of commands and the initial arbitrary allocation of command numbers to functions makes this change of no significance to the test results.

Modification (b), changing the polarity of EXFZN, might have been significant if the test had been run using the Data Processor. Since the Data Processor was not used during the test, and since only Data Processor operation could be affected by this change, it is of no signifiance to the test results.

Modification (c), the substitution of Address Recognition, ADRAN, for CWEZP, could not affect the operation of the MSFN Compatibility Test, as run, since in that test the CVW reset loop was bypassed.

Modification (d), reduce the period of Threshold Reset inhibit, affects only the probability of reception of a CVW. Since the CVW mode was bypassed, this modification could not in any way affect the results of the MSFN Compatibility Test.

4.0 CONCLUSION

The results of investigation and tests performed on the Array E uplink system indicate that performance is in full compliance with the specification for command error rate requirements. Modifications to the command decoder control logic subsequent to S-Band Compatibility Tests have been shown to have no effect on the measurements performed during that test. Bendix recommends, consequently, that the results be accepted and that no further tests at MSC are required to verify compatibility of the Array E uplink system with the MSFN.