Bendix
Aerospace Systems Division

NO.	REV. NO.
ATM 853	

ALSEP Command Decoder
S/N 3 Reliability Evaluation

PAGE 1 OF 5

DATE 1-28-70

File

The purpose of this ATM is to document the results of the reliability evaluation of a Command Decoder that was subjected to erroneous voltage conditions.

The objective of the evaluation was to determine if the decoder was degraded and to assess its flight worthiness.

CONCLUSION

Based on the reliability evaluation and special tests performed during the evaluation, it is concluded that the erroneous voltage application did not degrade the Command Decoder and that the Command Decoder is considered flight worthy.

Prepared by: J. Stewart
J. J. Stewart

Approved by:
S. J. Ellison, Manager
ALSEP Reliability

SCOPE

This ATM details the reliability evaluation of Command Decoder S/N 3. The Command Decoder was subjected to erroneous voltages when the test set power was turned on while the test set connector was reversed. The purpose of this evaluation is to determine if the decoder was degraded as a result of the erroneous voltage application.

HISTORY

The Command Decoder failed paragraph 6.3.5 of Test Procedure 2334301 (In Process Ambient Functional Test Procedure) on October 10, 1969, when the -6 volt meter showed 135 milliamperes. Maximum current should have been 42 milliamperes. Subsequent investigation showed the decoder had failed because the test set connector was connected to the decoder backwards; i.e., pin one (1) from the test set was connected to pin 244 of the decoder. The connection was backwards because some unknown person had disassembled the test set connector and reassembled it with the keyway 180 degrees out of phase.

The connector discrepancy was corrected and the decoder was successfully tested.

Although the decoder successfully passed functional tests, it was suspected of being subjected to electrical stresses beyond design limits because power was turned on for approximately 15 seconds while the connector was installed backwards.

As a result of the suspected stresses, the only way to assure that the decoder was not damaged by the erroneous connection was to perform a pin-by-pin circuit analysis and determine the exact stresses that were applied to each component.

ANALYSIS

The pin-to-pin analysis showed most of the erroneous pin connections to be either connections to spare pins or connections of passive circuits to other passive circuits. (The circuits are passive only when no signal is applied, and no signals were applied while the connector was connected backwards. The only testing done while the connector was backwards was to turn the power on.) The only pairs of interchanged pins that could have caused a problem were 4 and 241, 35 and 210, 39 and 206, 72 and 173, and 77 and 168.

Analysis of the circuitry involving these pins showed that +5 volts was applied to the signal return ground and -6 volts was applied to the input of Fairchild flatpack logic units. This meant that the units were subjected to reverse polarity when power was turned on while the connectors were reversed.

Fairchild was contacted via telecon to obtain information concerning the degrading effects of applying reverse voltage to the logic units. Fairchild then tested identical logic units to conditions representing the worst case conditions that the units inside the decoder would have been subjected to while power was turned on with the connectors reversed. The units were functionally tested after being subjected to these stresses. They showed no signs of immediate degradation. Fairchild stated that although the units showed no signs of immediate degradation, no guarantees or predictions could be made on the long term reliability of stressed units.

In an effort to further establish reliability integrity of the command decoder, additional analyses and tests were conducted at BxA. The analysis showed that the +5 volts applied to the signal return ground was applied to all of the several hundred units at the same time through parallel circuits. This meant that only a very small amount of current could have gone through each device during the time power was turned on with the connector reversed (less than 0.3 milliampere at regulated power supply current and less than 3 milliamperes at full power supply capability). The power would have been dissipated through isolation junction regions that are large compared to normal transistor junctions in the circuits and which are capable of dissipating power in excess of power dissipated during normal circuit operation. The flat-pack units are rated at 250 milliwatts continual power dissipation. The most power each unit could possibly have dissipated as a result of the erroneous voltage application of +5 volts would be 15 milliwatts. This factor eliminated the +5 volts as a cause for degrading the reliability of the decoder.

The analysis showed the -6 volts was applied to only 3 logic units within the decoder. The voltage was applied to pin 5 of a 9041 gate, pin 13 of a 9040 flip-flop, and pin 6 of another 9040 flip-flop.

A special reliability test plan and test set-up was prepared at BxA to evaluate the degrading effects of the -6 volts being applied to the three logic units within the decoder. Several Fairchild 9040 and 9041 flat-pack logic units were made available for testing.

The 9041 gates were tested by applying -6 volts to pin 5 (input) and measuring the current flowing through the unit. The current was found to be 25 milliamperes which was only a small part of the total 135 milliamperes that was observed at the time the decoder was subjected to erroneous voltage conditions. The 9041 units functioned normally after being subjected to the erroneous voltage.

A 9040 flip-flop unit was tested by applying -6 volts to pin 13 (input) and measuring the current flowing through the unit. The current was found to be 15 milliamperes which was only a small part of the total 135 milliamperes that was observed at the time the decoder was subjected to erroneous voltage conditions.

The application of -6 volts to pin 5 of 9041 units and pin 13 of 9040 units showed that these two units in the decoder only drew a small amount of the total current (135 mA) seen during the time the decoder was subjected to erroneous voltage.

Another 9040 flip-flop unit was tested by applying -6 volts to pin 6 (output) and measuring the current flowing through the unit. The current was found to be 100 milliamperes. This showed that the 9040 flip-flop unit in the decoder, that had the -6 volts applied to pin 6, drew most of the current observed at the time the decoder was subjected to erroneous voltage.

Since the previous testing had shown that the 9040 flip-flop with the -6 volts applied to pin 6 had drawn most of the current observed at the time of erroneous voltage application, the remaining tests were made on 9040 units.

Because the -6 volts was applied to pin 6 (an output pin looking into a low impedance circuit) and the +5 volts was applied to the signal return, the entire output region of the flip-flop was subjected to reverse bias conditions. Since pin 6 drew most of the current resulting from the erroneous voltage application, the output region would be the most severely stressed and would be the area that degradation, if any, would occur. Degradation in the output region would be detected by a change in output breakdown voltage.

The initial output breakdown voltage was measured on two 9040 units and was found to be 7.0 volts at 50 micro-amperes current. One of the units was then subjected to the stress of -6 volts being applied to pin 6 with 131 milliamperes current flow for 15 seconds. The output breakdown voltage was again measured at 50 micro-amperes and found to be 7.0 volts. The stress test was repeated for 15 seconds, 30 seconds, and 60 seconds. After each stress test the output breakdown voltage was measured at 50 micro-amperes and found to be 7.0 volts.

The other flip-flop unit was then subjected to the stress of -6 volts being applied to pin 6 with 135 milliamperes current flow for durations of 15, 45, and 300 seconds. After each stress the output breakdown voltage was measured at 50 micro-amperes and found to be 7.0 volts.

When the command decoder was subjected to the erroneous voltage because of the reversed connector, the voltage was only applied for about 15 seconds to logic units within the decoder. During the special reliability tests identical flat-pack flip-flop logic units were stressed to the same voltage and current conditions for periods up to 300 seconds. The units showed no signs of degradation after being stressed.

CONCLUSION

Based on the results of the special reliability tests, it is concluded that the Command Decoder S/N 3 was not degraded by the erroneous voltage application.