Bendix

Aerospace Systems Division

R. Miley

Reliability Overvoltage Tests of Fairchild Integrated Operational Amplifier Circuits

NO.	REV. NO.
ATM 801	
PAGE 1 OF 9	
DATE 10/10/68	

The purpose of this report is to document the results of special tests performed by Bendix Aerospace Division on randomly selected samples of Fairchild μA702 and μA709 integrated operational amplifier circuits to determine if damage can occur to these products due to over-voltage conditions like those experienced by the ALSEP Flight 2 equipments.

Six(6) devices of each type were electrically tested initially and after being exposed to over-voltage conditions which duplicate and exceed the conditions experienced by the Flight 2 equipment.

No degradation in either device type was experienced even after higher over-voltage values and longer time durations than those of Flight 2 conditions were applied. It is concluded that the μA702 and μA709 products in the Flight 2 experiments remain flight worthy due to the tolerance of the devices to voltage stress conditions as demonstrated herein.

This investigation was performed to ascertain the flight worthiness of μA702 (SL7274) and μA709 (SL7275) products now in the Flight 2 Command Decoder (S/N 5) and Power Distribution Unit (S/N 7).

Prepared by: Kermit D. Andreasen
K. D. Andreasen

Reviewed by: J. Mansour
J. Mansour

Approved by: R. C. Lonhas for
S. J. Ellison

CONTENTS

1.0 Objective

The investigation of Fairchild linear integrated circuit devices μA702 (SL7274) and μA709 (SL7275) was undertaken to determine if specific over-voltage conditions could result in damage or performance changes.

The over-voltage values represent the same conditions previously reported in ATM-800 and experienced by devices in the Command Decorder (S/N), PDU (S/N 7) of Flight 2 equipment during Central Station Power Dissipation Test. Longer application durations and higher voltage conditions were also evaluated to determine if a destruction threshold was approached.

2.0 Summary of Results and Conclusions

2.1 Results

Six(6) random samples of each device type were withdrawn from bonded stores for this investigation.

Four(4) special test fixtures were fabricated to provide the capability of displaying the Transfer Function Characteristics and Common Mode Input Offset Voltage Characteristics for the two device types. A polariod camera was used to record the displays for each individual device. Mr. Fred Brown of Fairchild informed that these two characteristics would indicate if degradation had occurred.

The devices were exposed to the following conditions:

Device	Voltage	Duration
μA702	*V+ = +19.5Vdc *V− = −9.75Vdc	8 minutes
	V+ = +20.5Vdc V− = −10.75Vdc	4 minutes
μA709	*V+ = +19.5Vdc *V− = −20.0Vdc	8 minutes
	V+ = +20.5Vdc V− = −21.0Vdc	4 minutes

*The voltages experienced by the Flight 2 equipments for a duration of one(1) minute.

Mr. Brown had indicated that the Fairchild Reliability Specialists did not expect that degradation should occur. Bendix overload evaluation tests confirmed the Fairchild predictions.

No performance changes of either device type were noted in either of the two overload test conditions after the full twelve(12) minute exposure.

2.2 Conclusions

It is concluded that no degradation would occur due to the over-voltage condition experienced by the Flight 2 equipments and that this investigation has demonstrated that the μA702 and μA709 products in that equipment remain flight worthy.

The Flight 2 equipment utilizing the μA702 and μA709 products has shown no change in performance due to the brief over-voltage exposure which supports the conclusion that no degradation has occurred.

2.3 Recommendations

Continue the use of existing μA702 and μA709 products in the Flight 2 equipments.

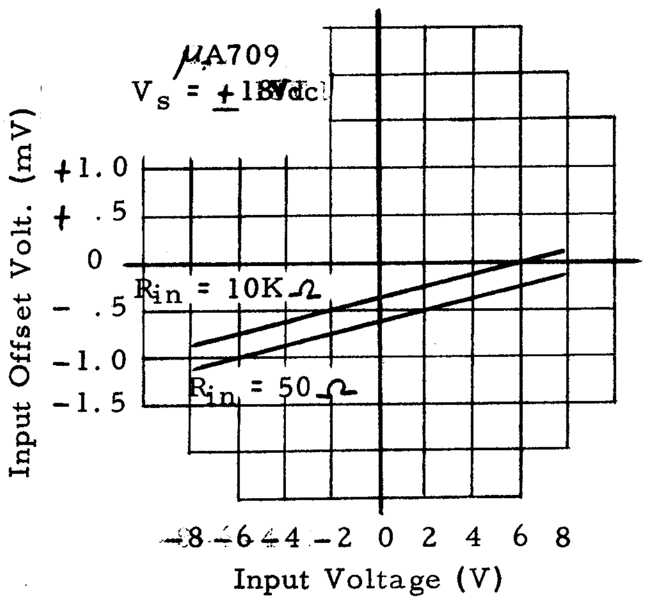
3.0 Detailed Test Description

During the planning of the special overload tests, Mr. Fred Brown of Fairchild was contacted and he indicated that degradation resulting from over-voltage would cause noticeable changes in amplifier gain and input offset voltage values.

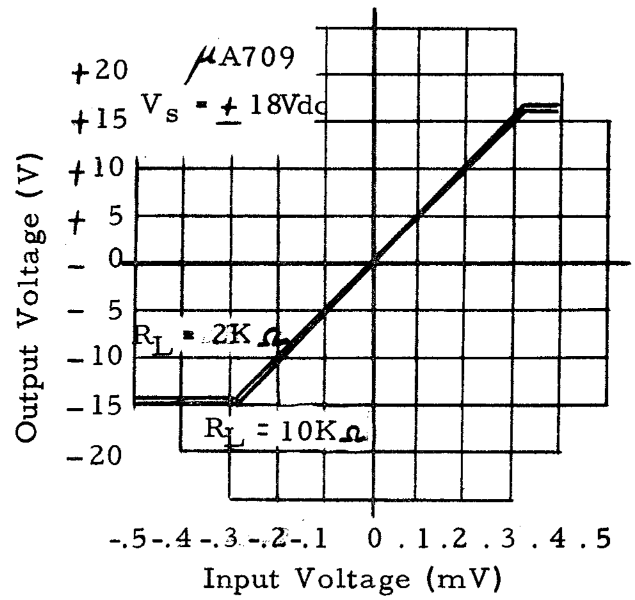
Test fixtures were fabricated using the test circuit information obtained from Fairchild. Schematics of these circuits are shown in Figures 1, 2, 3 and 4. The circuits allowed for the display of the entire Transfer Function and the entire Common Mode Input Offset Voltage Characteristic for the maximum input voltage condition. Following are typical traces recorded using the mentioned circuits.

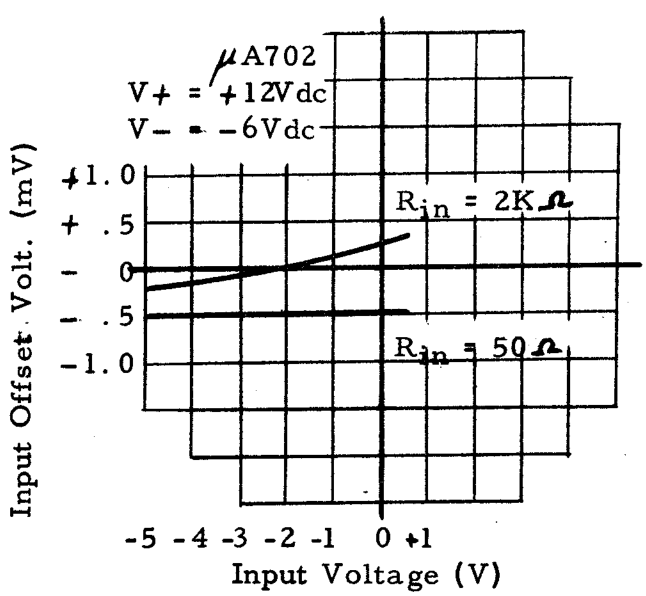
TYPICAL TRACES RECORDED

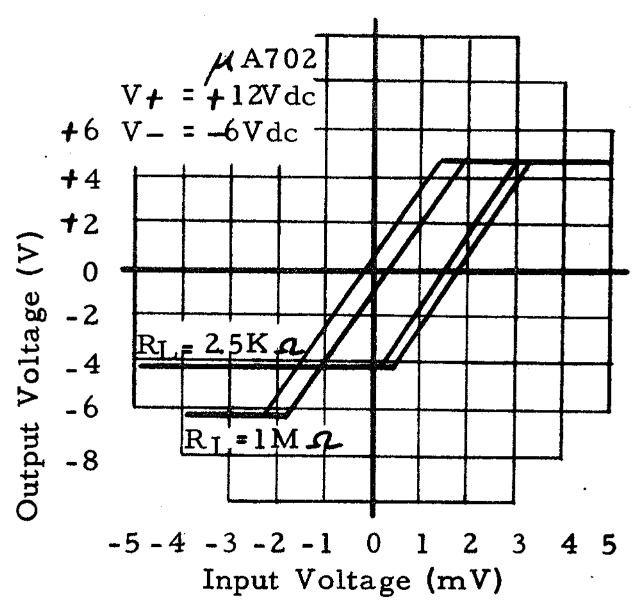
Common Mode
Input Offset Voltage



Transfer Function







Interpretation of the Common Mode Input Offset Voltage display is straight forward. The Input Offset Voltage can be read directly from the $R_{in} = 50\Omega$ display for every input voltage value. This display also demonstrates the Input Offset Current for all input voltage values. The voltage difference between the $R_{in} = 50\Omega$ and $R_{in} = 10K$ or 2K traces divided by the 10K (μA709) or 2K (μA702) resistance values results in this current.

For example, from the displays shown here:

$$\mu\text{A709 Input Offset Current @ } (V_{in} = 0 \text{ Volts}) = \frac{0.25 \times 10^{-3}\text{V}}{10\text{K}\Omega} = 25\text{nA}$$

$$\mu\text{A702 Input Offset Current @ } (V_{in} = 0 \text{ Volts}) = \frac{0.75 \times 10^{-3}\text{V}}{2\text{K}\Omega} = 375\text{nA}$$

The same calculation can be made for every input voltage condition.

The Transfer Function Characteristic yields various information. The Output Voltage Swing and Linearity can be observed directly from the display. The Open Loop Voltage Gain can be obtained by calculating the slope of the characteristics.

$$\text{Gain} = \frac{dV_{out}}{dV_{in}}$$

The over-voltage condition was applied to the devices while they were in the Transfer Function Test Circuit. Conditions applied were those shown in Figure 1 or Figure 3 except for the V+ and V− voltage levels.

The electrical tests performed as end-point tests consisted of the conditions shown in Figures 1, 2, 3 and 4.

No variation in Open Loop Voltage Gain or Input Offset Voltage was shown in either device type. The only noticeable variation observed in the investigation was a slight change in the input offset current in the μA702 product which cannot be considered critical since in all cases, it never exceed 50nA. The Fairchild specification allows a maximum change of 500nA. No variation was experienced in the μA709 devices.

The over-voltage condition experienced in the Flight 2 system applied stresses to the μA702 devices beyond the published maximum voltage conditions by a greater margin than it did the μA709 devices. Although Fairchild has published a maximum voltage value of 21Vdc between the V+ and V− terminals for the μA702, it is obvious that this is a conservative continuous operating rating which this investigation has demonstrated can be exceeded to at least the voltage values and time durations applied here without degrading the device performance. The published maximum rating for the μA709 is $V_S = \pm 18$Vdc. The V+ = +19.5Vdc and V− = −20.0Vdc over-voltage condition experienced in Flight 2 is only slightly greater than this continuous operation rating and would not be expected to be, and indeed was not, harmful to the device as demonstrated in this investigation.

4.0 Analysis of Results

The fact that no change was observed in the Transfer Function or the Common Mode Input Offset Voltage indicates that no degradation occurred during the over-voltage condition. Being very critical and considering the slight change observed in the Input Offset Current values in the μA702 product, the 50nA maximum change is well below the 500nA value allowed by Fairchild and that a current of this amplitude is well within the realm of normal leakage current values in integrated circuit products. It was noted that this current change reversed in some instances which would substantiate the consideration that this is normal leakage current as opposed to current caused by degradation due to power. Current due to power damage would not be reversible. Finally, no Input Offset Current change was observed after exposure to the exact over-voltage conditions experienced by the Flight 2 equipments.

The conclusion reached by the results of this investigation is that no degradation would occur due to an over-voltage condition as experienced by the Flight 2 equipments for the duration of one minute or even eight minutes. In fact, no degradation would occur due to slight higher over-voltage conditions for at least a duration of four minutes.

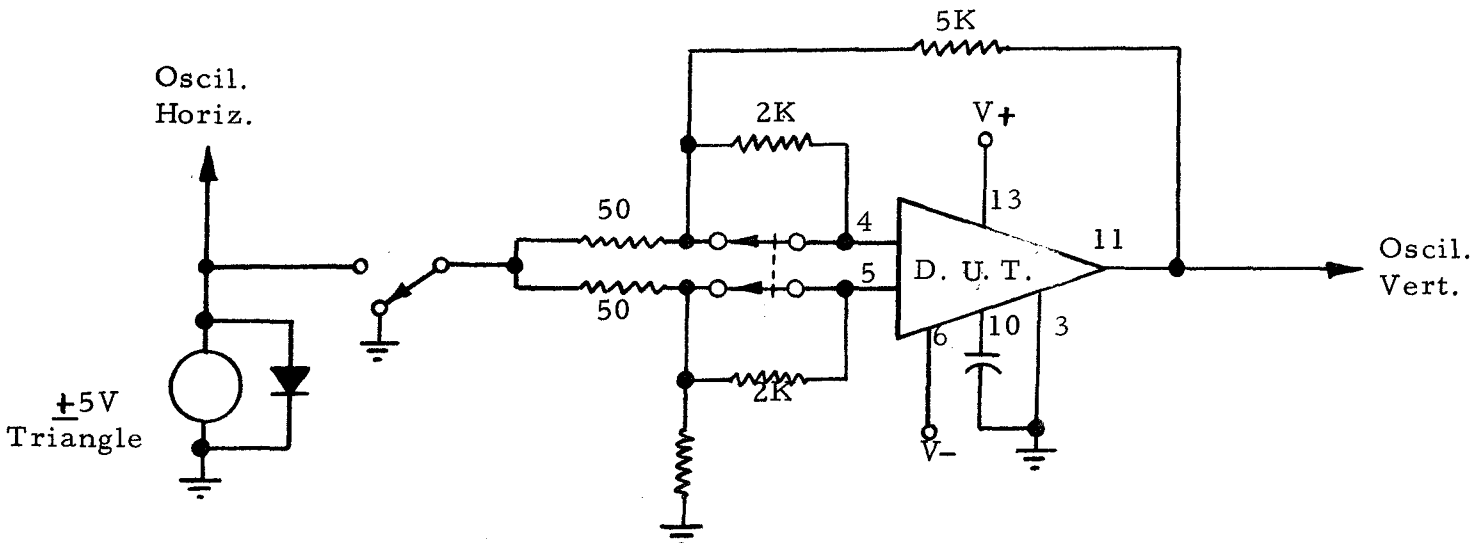


FIGURE 1 - μA702 Common Mode Input Offset Voltage Circuit

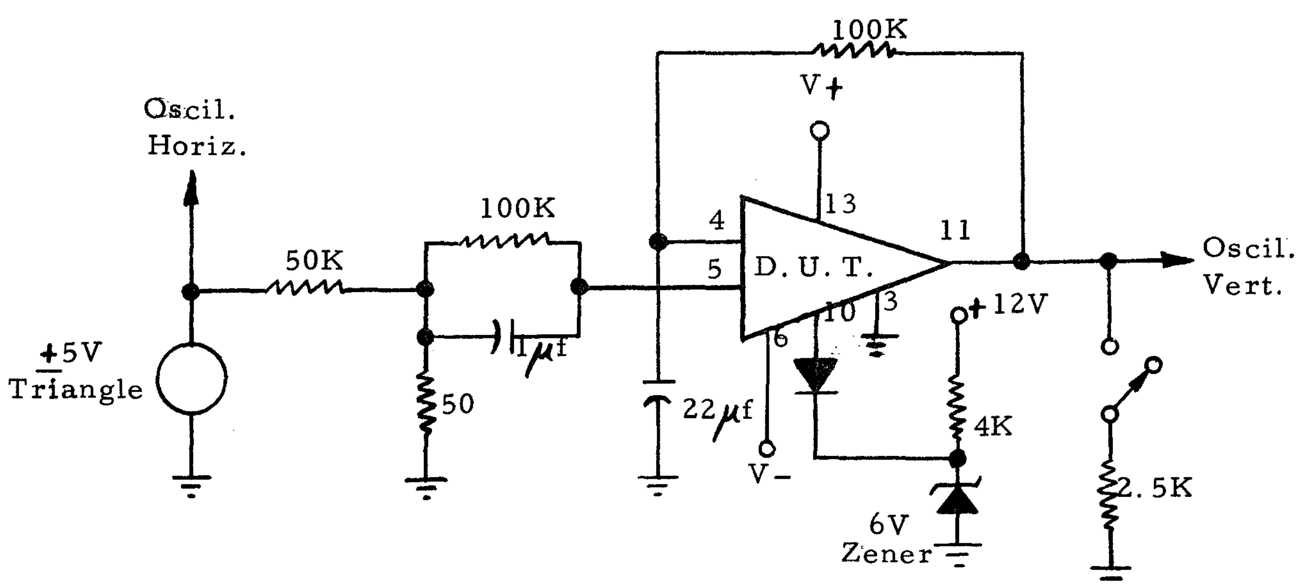


FIGURE 2 - μA702 Transfer Function Circuit

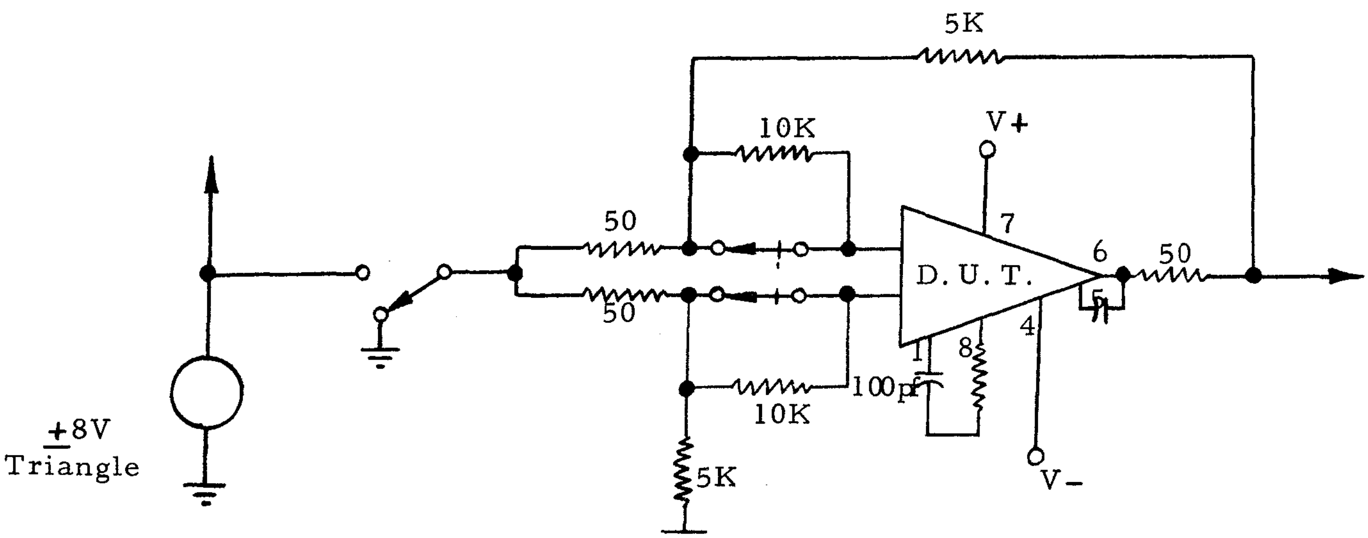


FIGURE 3 - μA709 Common Mode Input Offset Voltage Circuit

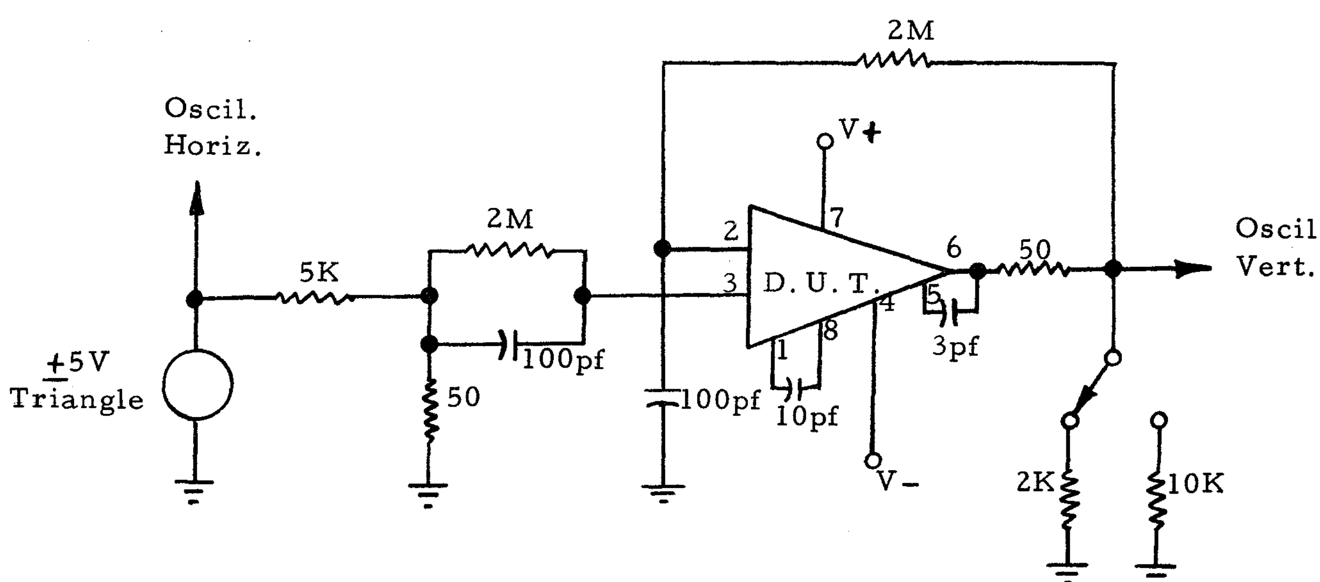


FIGURE 4 - μA709 Transfer Function Circuit