

21 February 1996

Saint Switch Test Report TR-1024  
Rev A, 17 April 1996

## Preliminary Report: RL2-M111 Random Vibration Test Results

### Objective:

The objective of the test is to evaluate REALLOCK<sub>TM</sub> locking washer RL2-M111, Revision A, performance in a random vibration environment. The vibration spectrum used is SP-1000: Limit Switch Random Vibration, Fighter Aircraft Applications. The objective is to complete a minimum three hours per axis without any mechanical failures.

### Results/Conclusions:

Four samples were evaluated and completed 40 hours random vibration in each of the X, Y, and Z axis. The samples were visually checked for damage, particularly fatigue damage in the tabs, at the end of the test. No visual cracks or anomalies were observed.

Based upon these results, REALLOCK<sub>TM</sub> RL2-M111, Revision A, exhibits satisfactory performance to the random vibrations specified in SP-1000. Additional samples need to be run to verify these results.

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**Referenced Documentation:**

Saint Switch Test Specification SP-1000: Random Vibration: Fighter Aircraft  
Applications  
Design Drawing, RL2-M111, Rev A

**Objective:**

The objective of the test is to evaluate REALLOCK<sub>TM</sub> locking washer RL2-M111 performance in a random vibration environment. The vibration spectrum used is SP-1000: Limit Switch Random Vibration, Fighter Aircraft Applications. The vibration spectrum is given in the following table:

<b>Break Point ID</b>	<b>Frequency (Hz)</b>	<b>Power Density (g<sup>2</sup>/Hz)</b>
1	15	0.063
2	53	0.063
3	100	3.79
4	300	3.49
5	400	0.40
6	550	0.15
7	700	0.39
8	900	0.39
9	1060	0.24
10	2000	0.24

The objective is to complete a minimum three hours per axis without any mechanical failures

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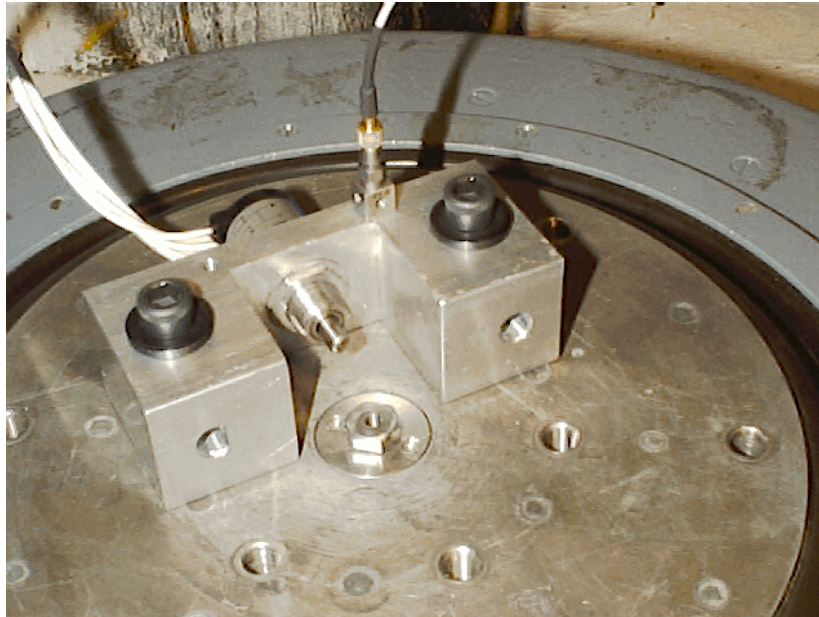
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i.e., fatigue fractures.

**Procedure:**

The REALLOCK<sub>TM</sub> lock washers were installed on the nut side of the fixture used to mount a limit switch with a 5/8 inch diameter bushing. A typical installation is shown in the photograph in Figure 1. The REALLOCK<sub>TM</sub> lock washer, which is mounted between the nut and fixture, is designed to prevent the nut from turning relative to the shaft upon which it is mounted.

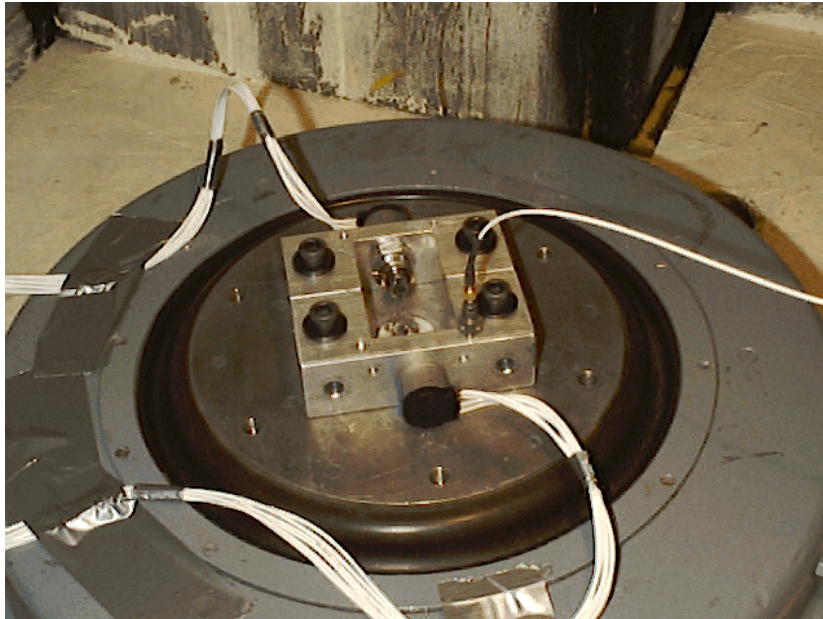


**Figure 1: Typical REALLOCK<sub>TM</sub> Instalation**

The fixture containing the REALLOCK<sub>TM</sub> and switch is mounted on the pad of the vibration test machine. The installation is shown in the photograph in Figure 2.

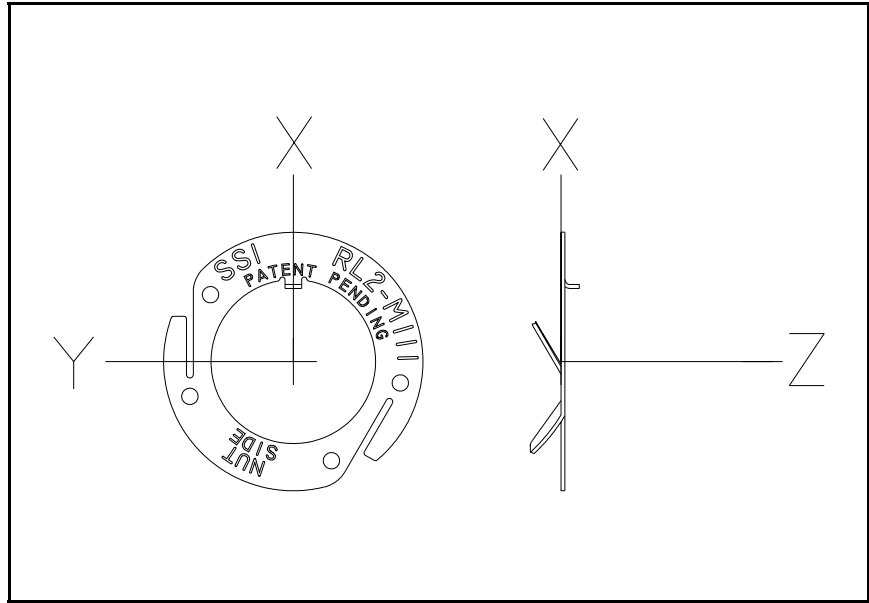
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**Figure 2: Vibration Test Setup**

Figure 3 below shows the axis alignment used for vibration testing. The selection of these axes puts two mutually perpendicular side loads on the tabs and internal key. Vertical loads to the tabs occurs during Z axis testing. Testing proceeds in the order of the X-axis, the Y-axis, and Z-axis . The length of testing along each axis was 40 hours which coincided with the switch that was the primary test specimen. The nuts which mount the switches to the fixture require loosening once during the 120 hour duration of the test.



**Figure 3: Test Axes**

**Equipment Used:**

- UniMode C10E Vibration Test Machine
- Umholz Dickey Power Amplifier
- LDS DVC 4000 Vibration Controller
- Mounting Test Fixture for 5/8 Diameter Mounting Thread Switches

**Results and Discussion:**

Two REALLOCK<sub>TM</sub> washers RL2-M111 were tested in conjunction with random vibration tests on series ML limit switches. As a result, the duration of the tests on each axis were greater than the three hour target listed in the objectives. Test duration for the limit switches is forty hours per axis.

The lock washers were removed at the completion of the test for detailed inspection. The washers function was normal during removal, i.e., the tabs had to be depressed to permit the nut

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to be rotated. The key prevented the washer from rotating with respect to the bushing of the switch.

A detailed inspection of the lockwasher after removal revealed no damage beyond normal wear that occurs during nut installation and removal. There were no failures in the lobe or key ways where regions of highest stress are expected and which are subject to the most cold working during the forming process.

**Conclusions/Recommendations:**

The results of this test indicate that the present REALLOCK<sub>TM</sub> design is adequate to meet the random vibration requirements of SP-1000.

Additional tests need to be run on this vibration spectrum as well as others to validate the results indicated herein.