

NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division

Washington, D.C. 20594

June 15, 2021

Non-Volatile Memory (NVM) Device

Specialist's Factual Report

By Sean Payne

1. EVENT SUMMARY

Location: Edwards, CA
Date: March 5, 2021
Aircraft: Aermacchi Impala MB-326M
Registration: N155TP
Operator: Flight Research Inc
NTSB Number: WPR21LA123

2. GROUP

A group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following device:

Device Manufacturer/Model:	CompactFlash (CF) Card
Serial Number:	N/A

3.1. Device Description

A CompactFlash (CF) card is a flash memory (non-volatile memory) mass storage device often used in portable electronic devices.¹

3.2. Device Condition

Upon arrival at the Vehicle Recorder Laboratory, an examination revealed the unit had sustained light impact damage. The device is shown in figure 1, as received. The device's plastic outer casing showed signs of heavy use. The outer casing was carefully opened, and the card's internal board was revealed to be slightly bent (figure 2).

¹ Non-volatile memory is semiconductor memory that does not require external power for data retention.

The device was inspected, and no obvious defects were noted. The device was inserted into a forensic write blocker and was attempted to be read on a PC. The device did not mount as a drive on a PC, or within a Linux emulator.



Figure 1. Photo of CF card as received.



Figure 2. Photo of internal components.

The device consists of a 48 pin NVM memory component as well as a memory controller. The memory controller organizes the data on the 48-pin memory component in a logical manner and facilitates readout via a PC. The 48-pin memory component can be removed and read independently, however, to convert the data, the logic of the memory controller must be replicated. This can be accomplished with complex commercial software. As such, the device was sent to a third-party repair lab in California for an evaluation on May 3, 2021.

The third-party lab received the device and reported “electro-mechanical failure and resulting media damage.” The NTSB requested a return of the memory device.

The NTSB received the card from the third-party lab on May 15, 2021. The CF card was subsequently re-examined. The 48-pin memory component was removed and inspected under a digital stereoscope. Figure 3 is a stereoscopic microscopy photo of the device taken on June 2, 2021. The device exhibited a crack along the face of the device when oriented in a manner to exploit external lighting. The crack is annotated in figure 3.



Figure 3. Stereoscopic microscopy photo of 48-pin memory component exhibiting a crack. The crack is annotated.

Figure 4 is an alternate view of the same crack, with external lighting used in such a way to highlight the crack.

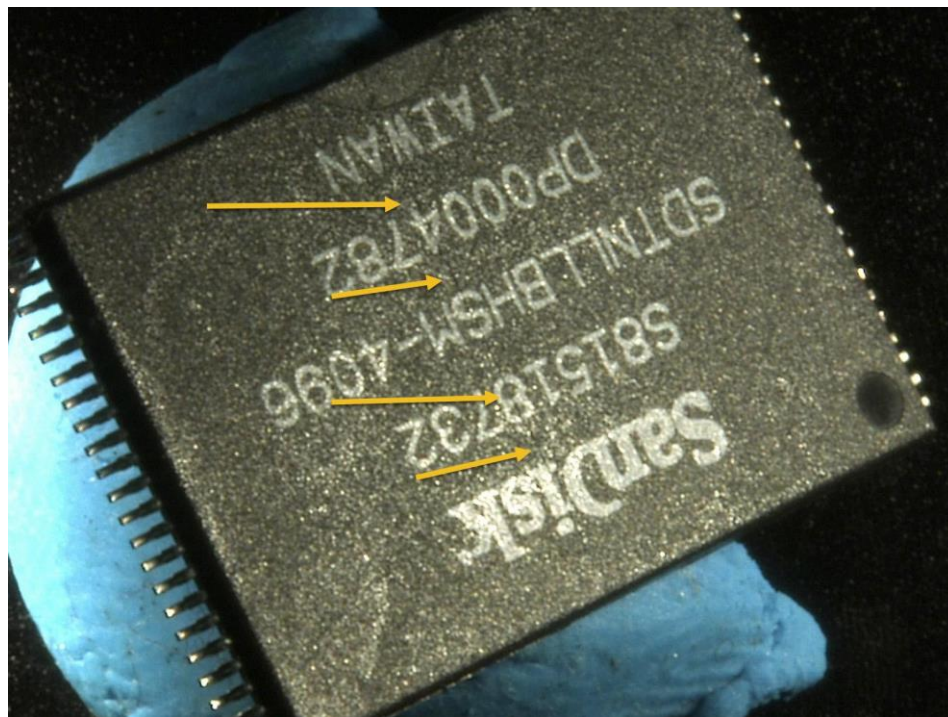


Figure 4. Alternate stereoscopic microscopy photo of 48-pin memory component exhibiting a crack. The crack is annotated.

Older photos of the device, prior to being sent to the third-party lab, were then re-evaluated for evidence of the crack prior to shipment. Figure 5 is a photo taken on April 25, 2021, prior to shipment and third-party evaluation. The figure is annotated to show evidence of the potentially cracked area, congruent with the location of the crack later discovered in figures 3 and 4, above.



Figure 5. Re-evaluation of initial stereoscopic microscopy taken on April 25, 2021 at the NTSB lab.

Cracks to an NVM component's external packaging often cause damage to the internal silicon die. If the internal silicon die is damaged, there are no known repair methods and results in a data loss situation. X-ray imagery of this type of damage are insufficient to image the damage, as the silicon die is too lightweight to image with an x-ray device. Instead of x-raying the device, a Confocal Scanning Acoustic Microscope (C-SAM) can be used to image the internal silicon die. A C-SAM evaluation of this component was not available for this investigation.

In lieu of a C-SAM evaluation, the 48-pin memory component was removed from the device and was attempted to be read with a specialized 48 pin reader designed specifically for this chip. Communication was unable to be established with the 48-pin memory component, the silicon die was assumed to be damaged, and no data was recovered.

3.3. Data Description

This device is capable of storing data in the NVM. In cases where silicon memory components exhibit cracking on the substrate die, there is no known method for data recovery. Therefore, no data pertinent to the event were recovered.