

Who received this brief?



Digital Recovery Sequencer

(UDRI)

Materials & Manufacturing Directorate

3 Aug 2020

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AFRL Received the following:

Incident Digital Recovery Sequencer (DRS)

- Manufacturer: Teledyne Defense Electronics
- Part Number: 10002109-503
- Serial Number: 2538
- Received printed wiring board (PWB) and cabling. Enclosure not received; PWB mounted to test fixture.
- Serial flash memory chips (3) were removed/replaced
- Parallel flash memory chip removed/replaced (Channel 2)
- X-Y Accelerometer chip removed/replaced (Channel 1)



Photo of exemplar DRS, not incident DRS S/N 2538.

Parallel Flash Memory Chip

- Removed from Incident DRS
- Channel 2
- U73
- Atmel AT49F1614

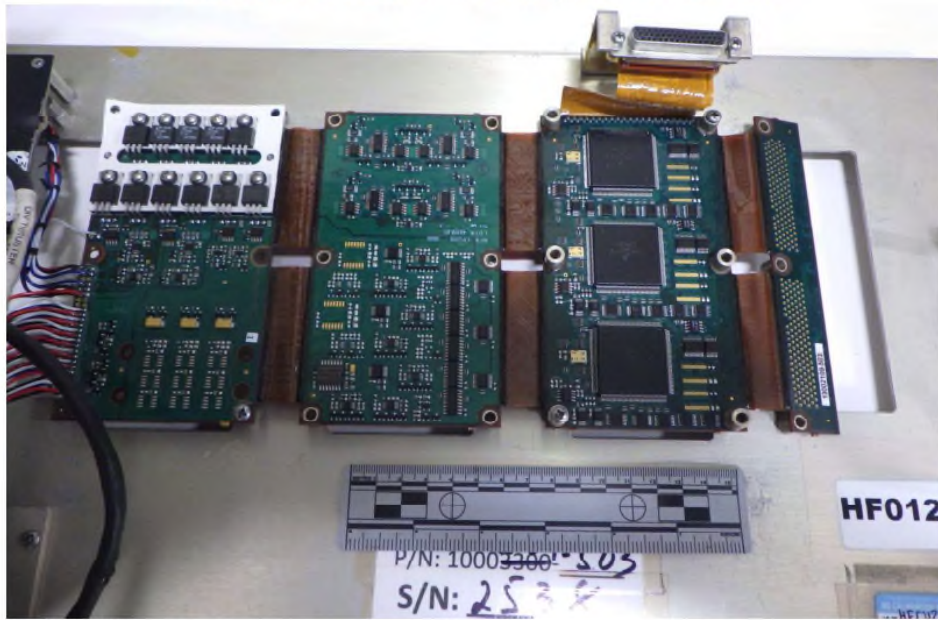
Likely removed by
Teledyne during SIB



Two-Axis Accelerometer

- Removed from Incident DRS
- U41
- Analog Devices ADXL250AQC

Incident PWB from DRS, As-Received



Visual inspection of PWB was performed using stereo optical microscope:

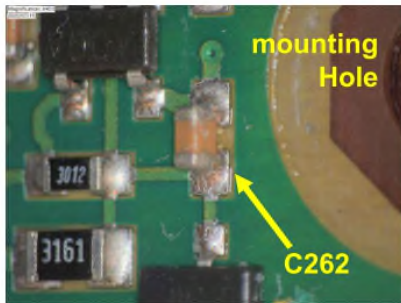
- Overall workmanship was considered good.
- PWB and components were generally clean.
- Solder junctions were well formed. No cracks observed.
- Conformal coating was somewhat uneven, but coverage appeared adequate.
- No evidence of delamination, corrosion, tin whiskers, dendrites, arcing, or thermal damage.

Anomalies noted during visual inspection of PWB:

- Five surface mount devices (SMDs) did not have conformal coating, and had evidence they were recently replaced:
 - Serial flash memory chips U58, U76, and U94
 - Parallel flash memory chip U73
 - Dual axis accelerometer U41
- SMD capacitor C262 was partially dislodged from solder pads.

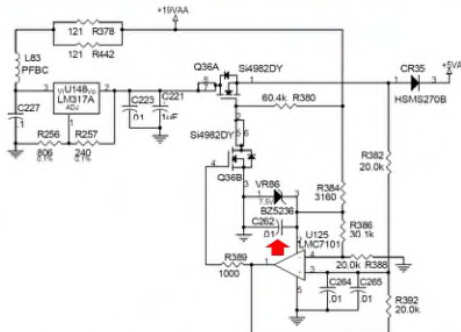
- Some components were suspected of being counterfeit. More analysis is needed.

If Counterfeit, then components cannot have met contract specifications
What did the additional analysis determine? (results are not in investigations)

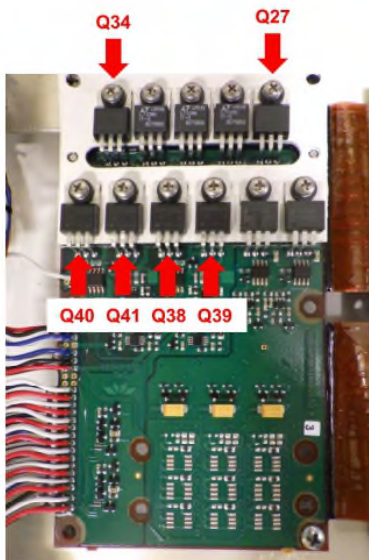


Capacitor C262

- 0.01 μF ceramic SMD capacitor.
- Function: bypass/decoupling capacitor for op amp U125's 7.5 V power supply terminals.
- Partially dislodged from solder pads.
- Each capacitor terminal is making electrical contact with its respective pad.
- Direct, localized impact the most likely cause. (No other components had a similar failure.) Hypothesis: since C262 is adjacent to mounting hole, it was damaged during installation or removal of PWB by accidental direct contact with mounting hardware.



Power MOSFETs – Suspect Counterfeit Components

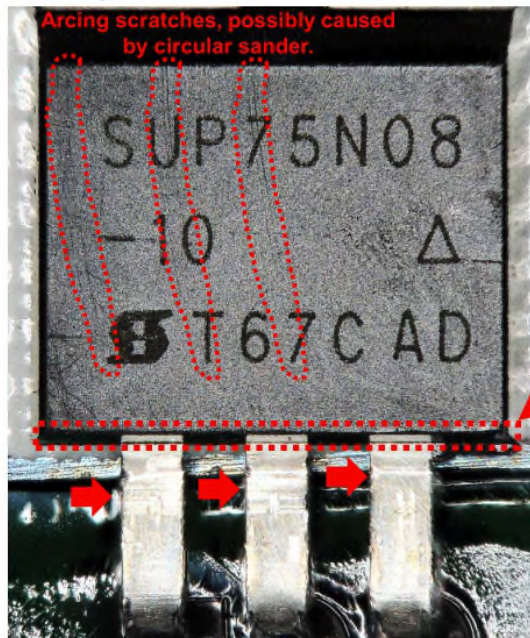


- Siliconix SUB75N08-10.
- TO-220 package.
- Quantity = 6.
- No conformal coating.
- **Obsolete.**
- Function: series element switches used in 19 V regulator circuits and BUSA/B (power supplies for firing EEDs).
- **Suspected of being counterfeit. More analysis needed.**

Example: Power MOSFET Q27

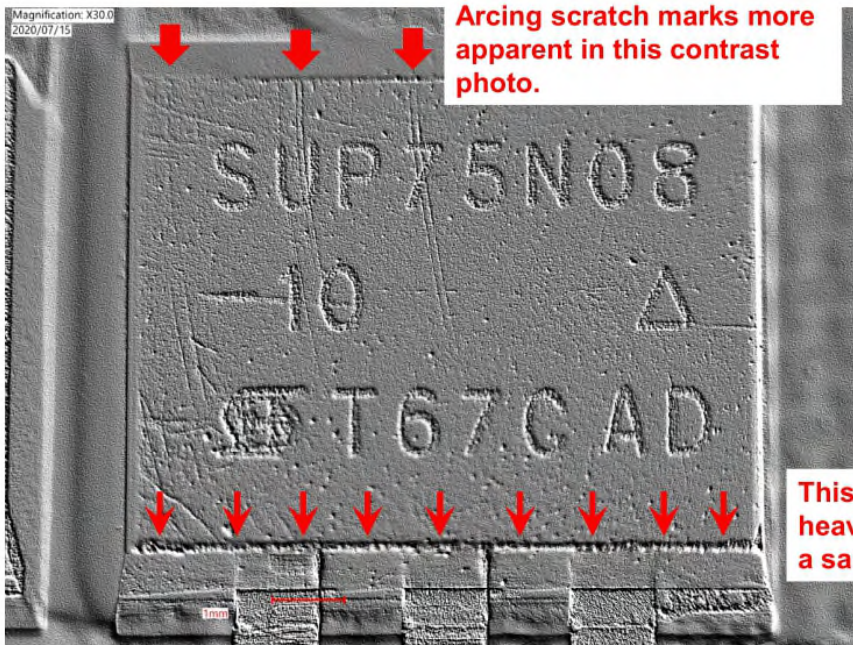
Font and Style of markings match those of genuine components

Top of leads have deep horizontal grooves, possibly caused by a clamp. Other TO-220 devices on PWB do not exhibit these grooves.



This corner (and only this corner) is heavily gouged, possibly caused by a sander.

Power MOSFET Q27 cont.



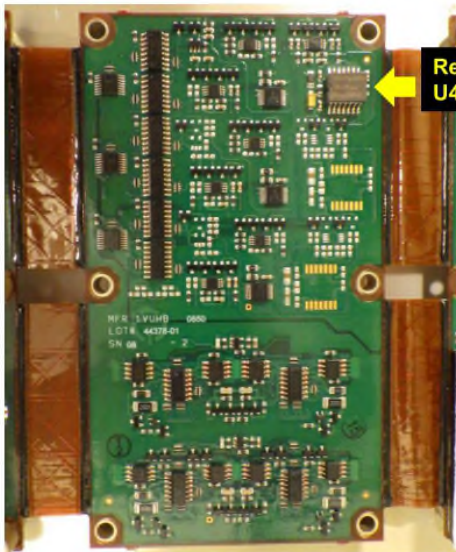
Arcing scratch marks more apparent in this contrast photo.

Better photos and analysis can be performed after components are removed from PWB.

This corner (and only this corner) is heavily gouged, possibly caused by a sander.

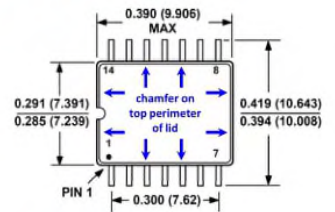
Important components

Dual Axis Accelerometers – Suspect Counterfeit Components



Replacement U41

- Analog Devices ADXL250AQC.
- 14 lead Cerpac package.
- Quantity of one on PWB (U41).
- Obsolete.
- AFRL is performing analysis on two ADXL250AQC (U41) chips:

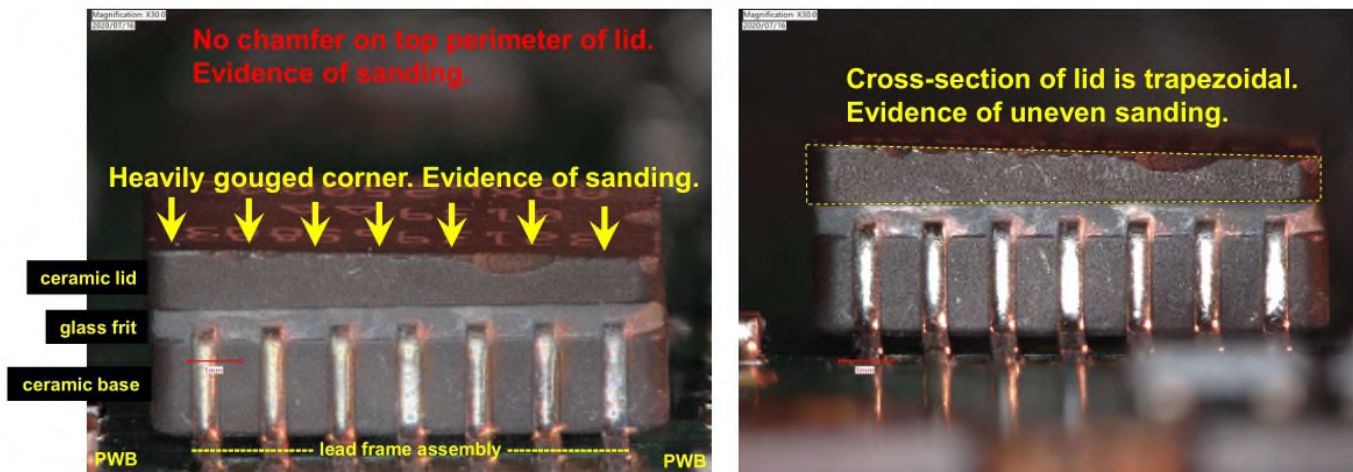


1. Original ADXL250AQC chip mounted on PWB during incident. Removed from PWB by Teledyne after incident. AFRL will refer to this chip as Incident U41.
2. After removal of Incident U41 from PWB, Teledyne installed a replacement on PWB. AFRL will refer to this chip as Replacement U41.

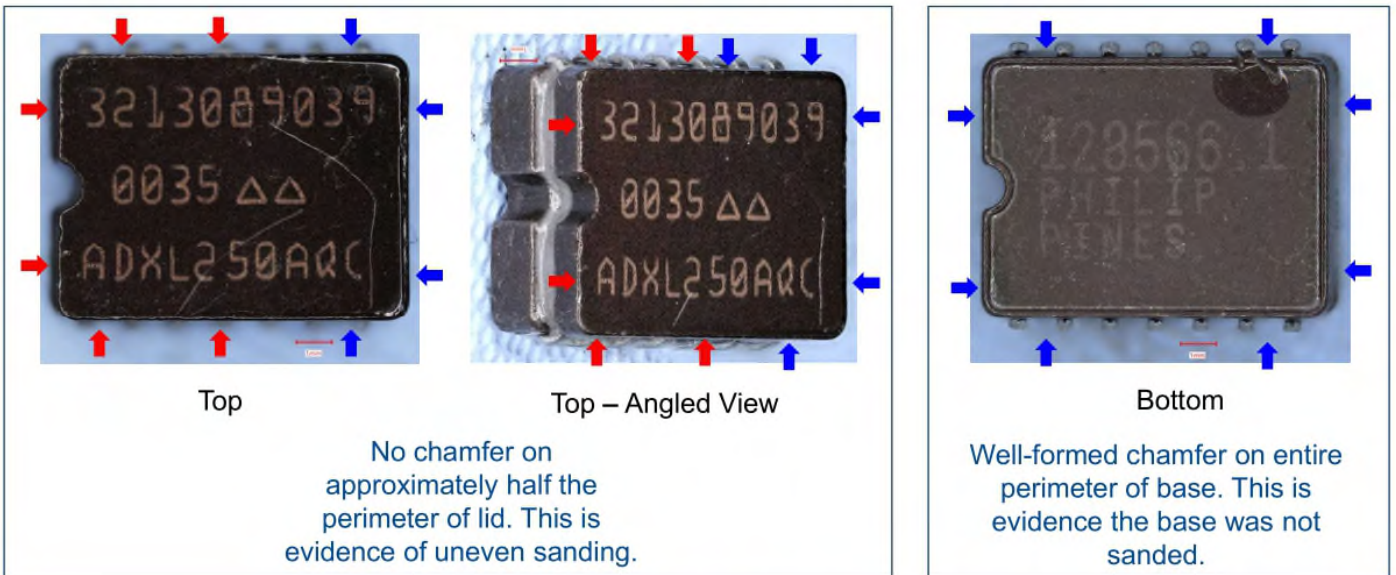
- Both Incident U41 and Replacement U41 are suspected of being counterfeit. More analysis needed.

even the replacement chip is suspected of being counterfeit

Replacement U41 – Suspect Counterfeit Component



Incident U41 – Suspect Counterfeit Component



↑ = chamfer ↑ = no chamfer

Incident U73 – Suspect Counterfeit Component



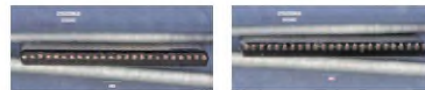
Parallel Flash
Channel 2



Possible "blacktopping" on top side of chip
(conformal coating partially removed. Presumably during
attempted desoldering process)

Laser markings on bottom side of chip

Note: Leads unfortunately were cut to facilitate chip removal from DRS



BIG. According to AFRL's forensics analysis, these suspected counterfeit serial flash cards are the 2 channels that failed in the mishap DRS. Channel 1 worked, 2 & 3 failed.

AFRL

Incident U76 & U94 – Suspect Counterfeit Components



Potential "blacktopping" (yellow arrow) on top side of chip. Normal chip surface (red arrow)

Incident
Serial Flash




Suspect "ghost markings" on top side of chip brought out by application of deionized water. Conformal coating is not present.

Suspect Counterfeit Components

General Comments:

- The parts in the previous slides are strictly considered suspect as this time. Destructive analysis on these components, and analysis of components on other DRS boards, would be required to provide higher level of confidence in whether or not they are counterfeit.
- Thus far, AFRL has not seen evidence that any of the suspect counterfeit components were causal in the failure of the ACES-II ejection system.
- Presence of counterfeit parts in DRS would not necessarily result in operational failure of ACES-II ejection system.
- Counterfeit components in DoD inventory has been an ongoing problem over the past few decades. Often the manufacturer/supplier is not aware the components are counterfeit. The DoD is aware of this problem and is working to eliminate these components from supply chains.

Recommended Remaining Tasks for AFRL Analysis

- Procure exemplar DRS units for more detailed examination (may include destructive analysis)
 - Two DRS units being shipped from Toledo ANG
 - Examine for suspect counterfeit parts 
 - Remove suspect counterfeit parts for closer examination
 - Perform simulated ejection to load Serial Flash with data
 - Desolder Serial and Parallel Flash to recover simulated ejection data along with flight/test code
 - Raw binary (hexadecimal) data files
- Download of Incident Channel 2 Parallel Flash Memory Contents (U73)
 - Die extraction & replacement (may be other alternatives as well)
 - Attempt to recover Parallel flash data using reader tool (flight and test code)
 - Verify whether device will power and if any flight/test code recoverable
 - Compare any recovered data to Toledo Parallel flash

SIB Direction Needed on Disposition of Incident DRS Unit

- AFRL is currently in possession of incident DRS unit. Teledyne is requesting return of DRS unit for additional test & evaluation

Who has it now?

