Portable Intermittent Fault Detector™ (PIFD™)

[redacted]

F/A-18 EWIS

Nose Landing Gear & Flight Control System

Test Summary

Prepared and Submitted by:

Universal Synaptics Corporation

Nate Johnson, Vice President & CXO

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Introduction

Universal Synaptics (USC) delivered the Portable Intermittent Fault Detector™ (PIFD™) technology and Interface Test Adapters (ITA) to [redacted] at Royal Malaysia Air Force (RMAF) Butterworth Air Force Base from 7-11 February 2022. PIFD training was conducted during the same time period. PIFD testing, to include AutoMap™, Continuity, Shorts, and Intermittence tests, was performed on-site with [redacted], RMAF, and USC personnel to create finalized Test Program Set (TPS) maps for the Nose Landing Gear (NLG) and Flight Control System (FCS) Electrical Wiring Interconnection System (EWIS) subcomponents. Testing for continuity issues, shorts, and intermittent faults was also performed through on-job training on two F/A-18 aircraft.

[redacted] and RMAF EWIS troubleshooting team members have leveraged conventional troubleshooting tools such as ohmmeters or digital multimeters to detect hard faults in EWIS. This process of "pinning out" an EWIS harness entails manual point to point connection of the test lead to the desired test point and closing the loop on the other end of the harness with the other test lead. This can be a very time intensive process and often leads to No Fault Found (NFF) test results due to the manual error prone nature of the process, but also due to the lack of sensitivity of this type of test and its inability to detect and isolate intermittent or transient faults that only manifest under environmental stress such as temperature and vibration. The goal of this technology delivery was to provide and streamline EWIS troubleshooting for the RMAF F/A-18 aircraft through the deployment of automated technology, to include the detection and isolation of intermittent issues that are undetectable with traditional troubleshooting tools and standard troubleshooting processes.

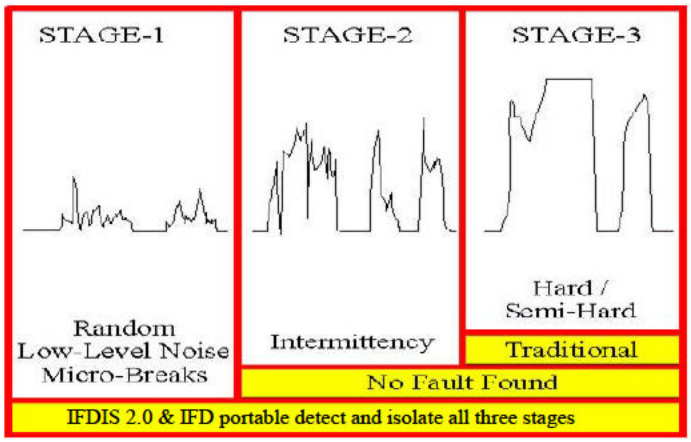
The RMAF F/A-18 weapon system experiences EWIS faults and intermittent issues. Past experiences of reported issues from RMAF pilots have led technicians to specific EWIS or components following recommended fault trees, only to test NFF and be approved for flight with no diagnosed issue(s). The [redacted] and RMAF team is capable of identifying hard faults leveraging handheld tools but has never had the technology to automate that process for speed and rapid testing nor the ability to detect and isolate intermittent faults that are the prime driver of NFF test results. These diagnostic processes are reactive in nature, meaning that faults are only identifiable after they become operationally evident. The delivery of PIFD technology allows [redacted] to better support the RMAF through prognostic testing and allows for root cause identification of intermittent issues that traditional tools and functional bench tests are incapable of detecting.

The implementation of the PIFD into the [redacted] and RMAF test process will reduce NFF test results, provide the ability to rapidly detect and isolate opens, shorts, and intermittent faults, and improve the readiness of the RMAF F/A-18 fleet. Significant reductions in sell-off / qualification test time will also be achievable as intermittent-free assets will easily pass go/no-go, pass/fail validation tests that are required prior to installing or an EWIS or component on the weapon system.

The on-job training and testing conducted during this project demonstrated the advanced prognostic and diagnostic capability of the only approved US DoD MIL-PRF-32516 tester. The PIFD's applicability to the NLG and FCS EWIS test procedures as well additional UUTs moving forward was also demonstrated. USC delivered a PIFD-512 with ITAs for the NLG and FCS subcomponents built with opposite gender mating connectors for those respective UUTs. Basic schematic data was provided by [redacted] and no Test Program Set (TPS) was developed prior to arrival, thus demonstrating the PIFD's AutoMap™ capability.

IFD Test Procedures

1. **AutoMap** – discovered the as-wired configuration of 11 different EWIS UUTs (1 NLG map, 14 FCS maps) across two F/A-18 aircraft – Tail #02, and Tail #08
    - UUTs were unable to be sent to USC as gold assets for baseline mapping. This necessitated a comparison of the AutoMap findings on Tail #02 and Tail #08 against the UUT schematics. The USC Technical Team was standing by to update the PIFD test database due to differences from the AutoMap findings and the provided schematics.
2. **Continuity** – tested for open circuits and measured resistance against established AutoMap baseline (open circuits / high resistance tests)
3. **Shorts** – provided shorts indication and shorts tracing
4. **Intermittence** – monitored all circuits simultaneously and continuously to detect and isolate all *Three Stages of an Intermittent Fault (Figure 1)*
5. **Fault Isolation** – detected intermittent faults through programmatic isolation



Stage 1 – random low-level nanosecond micro-breaks, likely not operationally evident yet, but on curve of degradation to become Stage 2

Stage 2 – intermittent failure evident to pilot in operation, reported to ground crew, passes ground test, and labeled No Problem Found (NPF). On curve of degradation to become Stage 3

Stage 3 – semi-hard or hard failures, Automatic Test Equipment (ATE) and troubleshooting tools, such as DMMs, designed to detect hard faults (open circuits or shorted circuits)

Figure 1 - Three Stages of an Intermittent Fault

Connecting the Interface Test Adapter (ITA)

The ITAs delivered for this project to test the F/A-18 NLG and FCS subcomponents each had five (5) sub-assemblies with NLG ITA having five (5) D-sub connectors *(Figure 2)*, marked J1-J5, and the FCS ITA having nine (9) D-sub connectors, marked JA-JH, and JJ. The D-sub connectors for NLG testing plug into the PIFD matching J1 to J1 through J5 to J5. The D-sub connectors for FCS sub-systems testing plug into the PIFD in accordance with *Figure 4 - FCS Test Configurations*.

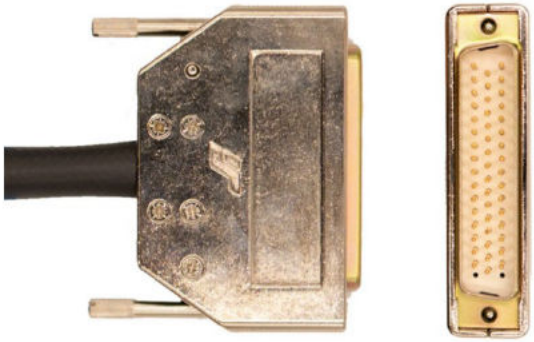


Figure 2 - 50 pin D-Sub

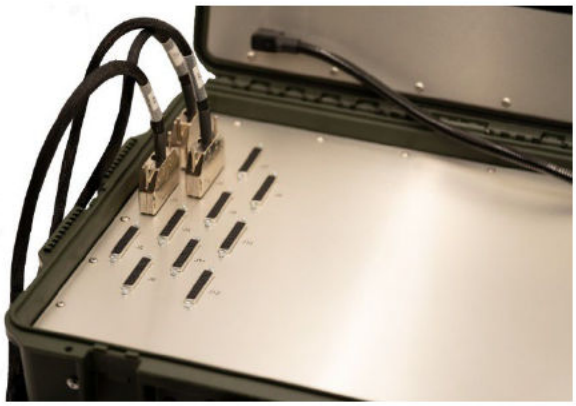


Figure 3 - D-Sub connected to PIFD

IFD Jack	L Aileron	L Rudder	L Leading EF	R Aileron	R Rudder	R Leading EF	L Stabilator 1
J1	JA	JA	JA	JA	JA	JA	JA
J2	JB	JB	JB	JB	JB	JB	JB
J3	JC	JC	JC	JC	JC	JC	JC
J4	JD	JD	JD	JD	JD	JD	JD
J5	JE	JE	JE	JE	JE	JE	JE
J6	-	-	-	-	-	-	-
J7	JF	JF	JF	JF	JF	JF	JF
J8	-	-	JG	-	-	JG	JG
J9	-	-	JH	-	-	JH	-
J10	-	-	JJ	-	-	JJ	-
IFD Jack	**L Stabilator 2**	**R Stabilator 1**	**R Stabilator 2**	**L Trailing EF 1**	**L Trailing EF 2**	**R Trailing EF 1**	**R Trailing EF 2**
J1	JA	JA	JA	JA	JA	JA	JA
J2	JB	JB	JB	JB	JB	JB	JB
J3	JC	JC	JC	JC	JC	JC	JC
J4	JD	JD	JD	JD	JD	JD	JD
J5	JE	JE	JE	JE	JE	JE	JE
J6	-	-	-	-	-	-	-
J7	JF	JF	JF	JF	JK	JF	JK
J8	JG	JG	JG	JG	JG	JG	JG

Figure 4 – FCS Test Configurations

The NLG ITA has 22 cannon connectors, each labeled to match the opposite gender mating connector of the UTT. These connectors are as follows:

- 52P-F058B
- 52P-F058E
- 52P-D092C
- 52P-D026A
- 12J-G060
- 12P-G005
- 12P-J029
- 52J-C051
- 84P-G035A
- 84P-G035B
- 12J-G061
- 34P-G003
- 7P-G026
- 10P-F015
- 52J-G040
- 52P-C057G
- 12P-E004A
- 52P-C057F
- 12P-H008
- 52P-H084
- 52P-K303A
- 76P-H009A

The FCS ITA has 15 cannon connectors, each labeled to match the opposite gender mating connector of the UUT in accordance with the desired subcomponent test, as outlined in *Figure 5 - FCS Connector Configurations*.

ITA Conn.	L Aileron	L Rudder	L Leading EF	R Aileron	R Rudder	R Leading EF	L Stabilator 1
P1	84P-F001B	84P-F001B	84P-F001B	84P-F002B	84P-F002B	84P-F002B	84P-F001B
P2	84P-F002H	84P-F002H	84P-F002H	84P-F001H	84P-F001H	84P-F001H	84P-F001H
P3	84P-F001A	84P-F001A	84P-F001A	84P-F002A	84P-F002A	84P-F002A	84P-F001A
P4	84P-F002J	84P-F002J	84P-F002J	84P-F001J	84P-F001J	84P-F001J	84P-F001J
P5	84P-U019B	84P-S017B	84P-U027A	84P-V020B	84P-T018B	84P-V028A	84P-S015A
P6	84P-U019A	84P-S017A	-	84P-V020A	84P-T018A	84P-M021B	-
P7	-	-	84P-U027B	-	-	84P-V028B	84P-S015B
P8	-	-	84P-M110B	-	-	-	-
P9	-	-	84P-M110A	-	-	-	-
P10	-	-		-	-	84P-M021A	-
P11	-	-	84P-M029A	-	-	-	-
P12	-	-	-	-	-	84P-M029C	-
P13	-	-	84P-M029D	-	-	-	-
P14	-	-	-	-	-	84P-M029B	-

ITA Conn.	L Stabilator 2	R Stabilator 1	R Stabilator 2	L Trailing EF 1	L Trailing EF 2	R Trailing EF 1	R Trailing EF 2
P1	84P-F002B	84P-F001B	84P-F002B	84P-F001B	84P-F002B	84P-F001B	84P-F002B
P2	84P-F002H	84P-F001H	84P-F002H	84P-F001H	84P-F002H	84P-F001H	84P-F002H
P3	84P-F002A	84P-F001A	84P-F002A	84P-F001A	84P-F002A	84P-F001A	84P-F002A
P4	84P-F002J	84P-F001J	84P-F002J	84P-F001J	84P-F002J	84P-F001J	84P-F002J
P5	-	84P-T016A	-	-	-	-	-
P6	84P-S015C	-	84P-T016C	84P-U013B	-	84P-V014B	-
P7	-	84P-T016B	-	84P-U013A	-	84P-V014A	-
P8	84P-S015D	-	84P-T016D	-	84P-U013C	-	84P-V014C
P15	-	-	-	-	84P-U013D	-	84P-V014D

Figure 5 – FCS Connector Configurations

Test Plan and Procedures

1. AutoMap™

   AutoMap™ was performed as follows to discover the as-wired configuration of the NLG and the FCS subcomponents. This was completed on Tail #02 and Tail #08 and the USC and [redacted] teams reviewed results and verified against available schematics.

   1. Login as Advanced Technician
   2. Select the appropriate map from the group
   3. Run Automap
   4. Log out of Advanced Technician

2. Conventional Tests

   Continuity and shorts tests were performed while UUTs were in a static state to evaluate the UUTs. Operators and technicians were unable to repair any hard opens or shorts, pending RMAF Over and Above repair approval. Conventional tests were performed as follows.

   1. Select appropriate map with the highest Rev or final version from Map Group
   2. Input Serial Number of the UUT and press Enter
   3. Press Start button to run Continuity and Shorts testing.
   4. Address any open or shorted circuits, as per local process.

3. Intermittence Testing

   Starts automatically if no open or shorted circuits are present in the UUT and differs from the scanning tests above as this test constantly monitors all electrical paths simultaneously and continuously. Testing period is technician determined to allow for environmental and/or vibrational profile or manual manipulation of the UUT. Intermittent events, displayed in real time with precision, will show in RED on the Fault Isolation Graphic as highlighted in *Figure 6*.

4. Fault Isolation

   Performed Fault Isolation to begin to visually identify root cause(s) of the intermittent fault(s).

5. Reports

   Detected and Isolated faults discovered during PIFD testing will be compiled and exported to the “Reports” folder on the PIFD Desktop.

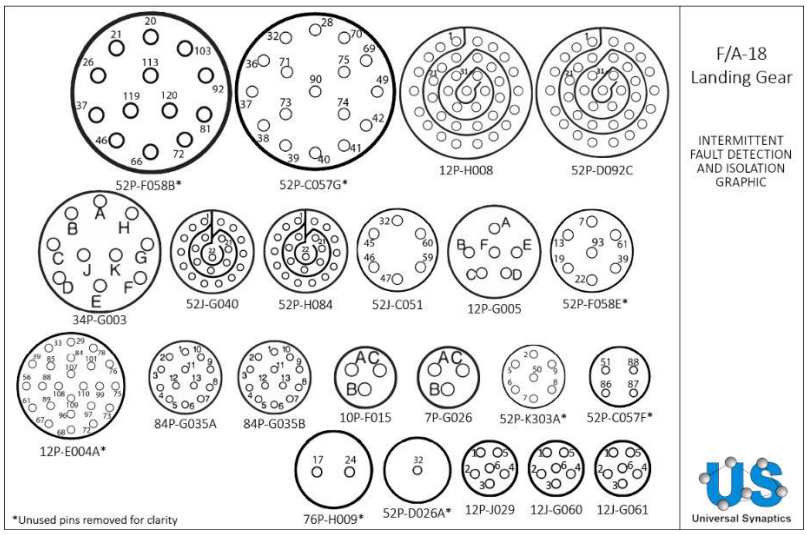


Figure 6 - NLG Fault Isolation Graphic

Results

1. PIFD AutoMap executed on NLG and FCS EWIS UUTs – as-wired configuration of all UUTs discovered, on average, in less than five (5) minutes
2. PIFD Continuity testing conducted – see *Table 1* for specific UUT test results
3. PIFD Shorts testing conducted – see *Table 1* for specific UUT test results
4. PIFD Intermittence testing conducted – see *Table 1* for specific UUT test results
5. PIFD Fault Isolation – some intermittent faults were taken to root cause visually and will be highlighted below. The majority of intermittent issues were not taken to root cause due to required RMAF approval for repairs. These faults were annotated and tagged appropriately to allow the [redacted] / RMAF team to repair later and are highlighted in *Table 1*.

Table 1 - Test Results

Test #	Date	UUT	A/C Tail	AutoMap™	Continuity	Shorts	Intermittence	Notes
1	9 Feb 22	NLG	02	Complete	Pass	Pass	Intermittent Free	- Appendix 1 Full Test Report
2	9 Feb 22	FCS - Right Aileron	02	Complete	Pass	Pass	- TP303 V020A-SH 50 events - TP91 F001H-078 2 events	- Appendix 2 Full Test Report
3	9 Feb 22	FCS - Right Rudder	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
4	9 Feb 22	FCS - Right Stabilator 1	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
5	9 Feb 22	FCS - Right Stabilator 2	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
6	9 Feb 22	FCS - Right Trailing Edge Flap 1	02	Complete	Pass	Pass	- *TP3 84P-F001B 1 event	- *Recommend monitoring TP3 (1 event) with non-replicable intermittent common with Stage 1 faults and will degrade to Stage 2 - Appendix 3 Int. Report - Appendix 4 Full Test Report
7	9 Feb 22	FCS - Right Trailing Edge Flap 2	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
8	9 Feb 22	FCS - Left Trailing Edge Flap 2	02	Complete	Pass	Pass	- TP257 U013D-01 15 events - TP206 F002J-067 1 event - TP258 U013D-02 7 events - TP89 F002H-076 3 events - TP91 F002H-078 11 events - TP82 F002H-064 3 events - TP259 U013D-03 9 events	- Appendix 5 Full Test Report
9	9 Feb 22	FCS - Left Stabilator 2	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
10	9 Feb 22	FCS - Left Stabilator 1	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
11	9 Feb 22	FCS - Left Trailing Edge Flap 1	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
12	9 Feb 22	FCS - Left Aileron	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
13	9 Feb 22	FCS - Left Rudder	02	Complete	Pass	Pass	Intermittent Free	- Same as Appendix 1
14	9 Feb 22	FCS - Right Leading Edge Flap	02	Complete	Pass	Pass	- TP327 V028B-SH 50 events - TP313 V028B-09 3 events - TP91 F001H-078 4 events	- Appendix 6 Full Test Report

15	9 Feb 22	FCS - Left Leading Edge Flap	02	Complete	*Fail → Pass	Pass	- TP351 M110B-SH 50 events - TP91 F002H-078 13 events - TP265 U027A-09 1 event - TP329 M110B-01 6 events - TP146 F001A-050 2 events	- *TP351 - 25 M110B-SH – F001B-053 → Disconnect → Reconnect → Pass - Manifested in Intermittence Test – perfect example of No Fault Found / "Swaptronics" / Mx practices to pass selloff requirements - Appendix 7 Full Test Report
16	10 Feb 22	NLG	08	Map from 9 Feb A/C #02	Pass	Pass	- TP193 12P-H008-11 34 events - TP97 84P-G035A-10 49 events	- Appendix 8 Full Test Report
17	10 Feb 22	FCS - Right Aileron	08	Map from 9 Feb A/C #02	Pass	Pass	- TP271 V020B-15 50 events - TP285 V020A-05 34 events - TP303 V020A-SH 3 events	- Appendix 9 Full Test Report
18	10 Feb 22	FCS - Right Rudder	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
19	10 Feb 22	FCS - Right Leading Edge Flap	08	Map from 9 Feb A/C #02	Fail	*Fail	- TP263 V028A-07 8 events - TP91 F001H-078 3 events - TP257 V028A-01 1 event - TP279 V028A-SH 4 events - TP432	- *Connector 84P-V028B had been removed for outer wing removal – wires were taped together causing shorting conditions - Fault indications due to connector removal, etc. - Appendix 10 Full Test Report
20	10 Feb 22	FCS - Left Leading Edge Flap	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
21	10 Feb 22	FCS - Left Rudder	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
22	10 Feb 22	FCS - Left Aileron	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
23	10 Feb 22	FCS - Left Stabilator 1	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
24	10 Feb 22	FCS - Right Stabilator 1	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
25	10 Feb 22	FCS - Left Trailing Edge Flap 1	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
26	10 Feb 22	FCS - Right Trailing Edge Flap 1	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
27	10 Feb 22	FCS - Left Stabilator 2	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
28	10 Feb 22	FCS - Right Stabilator 2	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
29	10 Feb 22	FCS - Right Trailing Edge Flap 2	08	Map from 9 Feb A/C #02	Pass	Pass	Intermittent Free	- Same as Appendix 1
30	10 Feb 22	FCS - Left Trailing Edge Flap	08	Map from 9 Feb A/C #02	Pass	Pass	- TP259 U013D-03 1 event - TP258 U013D-02 2 events	- Appendix 11 Full Test Report & Fault Isolation photos taking faults to root cause
31	11 Feb 22	NLG	02	*Finalized Map from 9 Feb A/C #02 & 10 Feb #08	Fail	Fail	Intermittent Free	- *Based on AutoMap of A/C #02 and A/C #08 overlay plus comparison and adjustment to schematics - Multiple open and shorted circuits - Appendix 12 Full Test Report

Lessons Learned

- The PIFD-512 and manufactured ITAs for NLG and FCS sub-systems provided adequate coverage of needed circuit connections to test according to the planned test procedures. The team discussed future expansion of PIFD testing to other EWIS and components. It was recommended that a simple ITA test and manufacturing approach be followed by trying to focus on smaller harness runs and not a combination of different cable harness being built into one ITA test capability. While this in not always feasible, based on different EWIS branching out to components or parts of the aircraft, it is highly recommended to simplify a test for ease of manufacturing, setup, test procedure, and root cause failure analysis.
- USC can continue to provide ITA manufacturing capability to [redacted] or USC can quote cost of training [redacted] in setting up this manufacturing process and capability as an IFD ITA Manufacturing Certified Facility – see www.usynaptics.com/ita.
- The test team utilized a simple handheld vibration tool to allow the intermittent issues to manifest as this failure mode only wreaks havoc on EWIS and systems with environmental stimulus. The vibration tool leveraged was a Theragun mini.
- The combined team from [redacted] / RMAF / USC built quick rapport and worked efficiently to conduct on-job training and prepare [redacted] for continued use of the PIFD testing the NLG and the FCS subcomponents on the F/A-18 platform for RMAF. Use of the PIFD across additional F/A-18 EWIS and smaller components is feasible and the [redacted] team is well-equipped and prepared to improve readiness on the Hornet fleet.
- The [redacted] PIFD test team can easily expand use of the technology to other platforms, such as the C-130, helicopters, and any others, leveraging AutoMap once ITAs are manufactured to connect the PIFD to the desired UUT.
- [redacted] will save numerous man hours by leveraging Continuity and Shorts hard fault testing provided by the PIFD. Previous process entails point-to-point use of an ohmmeter or digital multimeter. The PIFD greatly simplifies these Stage 3 tests and removes the potential for human error.
- Initial testing on Day 1 on Aircraft Tail #02 experienced a delay in testing due to the PIFD experiencing significant noise in the hangar. Noise or chaos to the neural network can be caused by weather, different testers running in an adjacent room, and numerous other factors. After discussing the experience with the USC technical team that evening, the first course of action to resolution was to unhook the earth ground to the aircraft in the bay of the hangar where testing was conducted. This disconnect removed the noise and the tester functioned without issue, thus indicating an issue with the earth ground in that bay. The PIFD is a sensitive diagnostic instrument and has uncovered earth ground issues in hangar bays for the US Air Force and US Navy. It is recommended that this earth ground be tested according to local procedure. The other earth was connected with no issues to testing, indicating a good earth ground. This procedure was followed on Aircraft Tail #08 the next day and that earth ground also caused chaos to the tester, indicating that it should be verified as well. USC has annotated these findings and is making considerations for addressing this issue via technical support guidance and/or visual indication on the test screen.
- In Table 1 – Test Results, Test #15 is highlighted and was conducted on the FCS - Left Leading Edge Flap on Tail #02. AutoMap was completed and then test commenced. Continuity immediately showed three (3) issues – one (1) circuit was now open (TP 351 - 25, M110B-SH – F001B-053) varying from the baseline AutoMap of 26.95ohms as discovered minutes before to Open or 9.9e+37 - see *Figure 7 - Left Leading Edge Flap Continuity Results #1.* The other two (2) issues simply were outside of the established default +/- 2ohm tolerance.

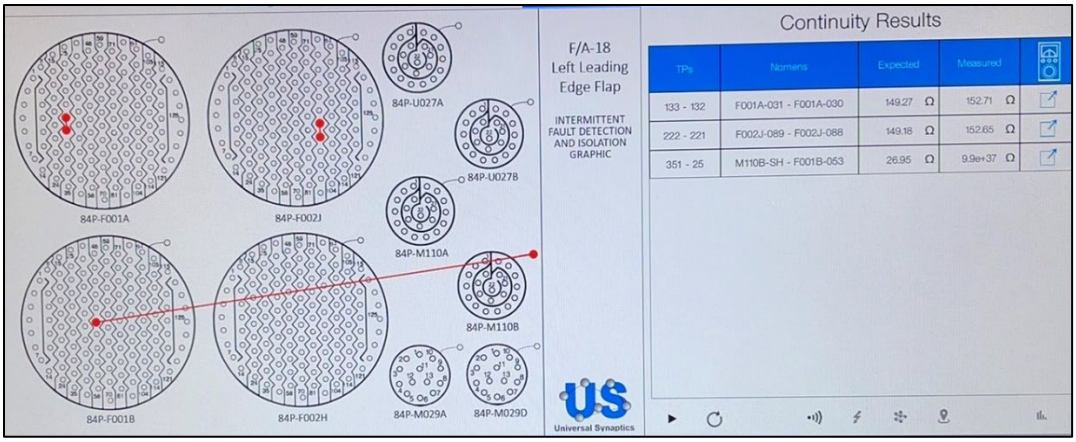


Figure 7 - Left Leading Edge Flap Continuity Results #1

The [redacted] / RMAF / USC test team discussed why this could possibly be happening. From our training sessions, the group recalled the "curve of degradation" as outlined in *Figure 1* above. A hard broke, open circuit does not instantaneously become such. It progresses from a low-level micro-break (Stage 1) intermittent issue, likely not yet causing an operational failure, into a true intermittent issue (Stage 2) failing in operation of the weapon system, that is testing as NFF and is undetectable by traditional processes of troubleshooting and deployed tools, such as ohmmeters or digital multimeters. This then degrades further with usage / wear and tear into a true hard faults or open circuit (Stage 3). Recommended course of action was to re-seat the UUT connectors and re-run Continuity test. These results are outlined in *Figure 8 - Left Leading Edge Flap Continuity Results #2*.

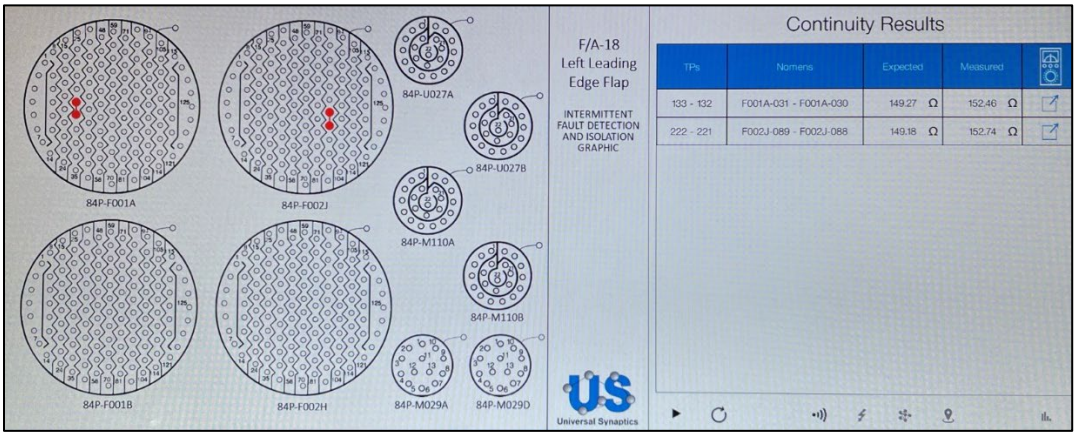


Figure 8 - Left Leading Edge Flap Continuity Results #2

The differences from Figure 7 to Figure 8 highlight an intermittent issue that, with stimulus such as disconnect/re-connect of connectors and/or movement of the UUT harness, is degrading and electrically behaving intermittently between a Stage 2 intermittent issue and Stage 3 semi-hard / hard fault. This is a great example of intermittent behavior and highlights why NFF is such a large cost driver and readiness degrader. Continuity testers were not built to detect and isolate intermittent issues that manifest in flight or on the ground with environmental stimulus. Figure 9 - Left Leading Edge Flap Intermittence Results highlights the differences between a Continuity test and the Intermittence test. It shows the power of the continuous and simultaneously monitoring of IFD technology. TP 351, M110B-SH quickly limited out at 50 intermittent events. IFD

technology also pinpointed other intermittent issues on indicated TPs that traditional testing methods were incapable of finding.

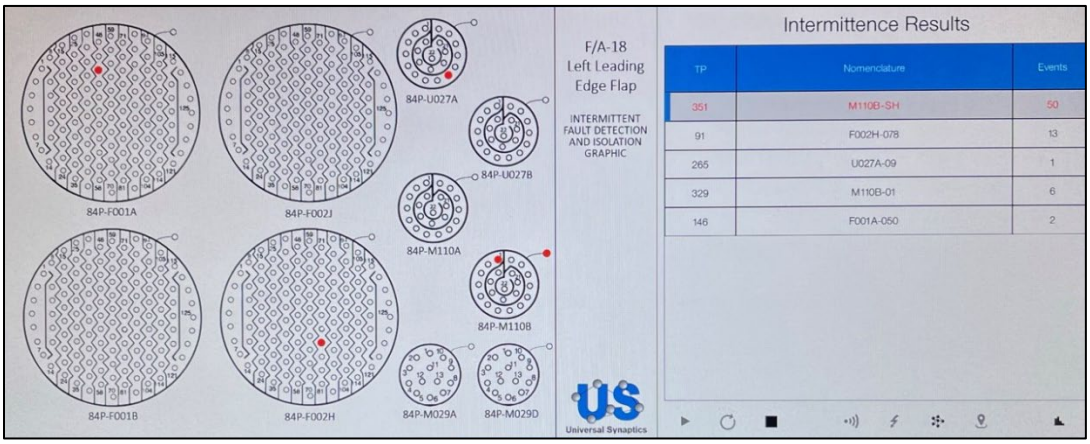


Figure 9 - Left Leading Edge Flap Intermittence Results

- Connectors 84P-U027A and 84P-U027B on the Left Leading Edge Flap had been removed entirely for outer wing removal on Aircraft Tail #08; exposed wires were taped together. Finalized map includes all schematic connections as if outer wing were installed.
- Connectors 84P-U028A and 84P-U028B on the Right Leading Edge Flap had been removed entirely for outer wing removal on Aircraft Tail #08; exposed wires were taped together. PIFD highlighted several shorted conditions during Shorts testing. Finalized map includes all schematic connections as if outer wing were installed.
- Database map comparison had been conducted by USC overnight on 9 Feb by USC and updated maps had been freshly updated and re-installed prior to testing on 10 Feb. First test of the day was conducted on the Right Aileron of Aircraft Tail #08. USC had renamed AutoMap configurations with an * special character. This prevented test reports from automatically saving due to the overarching Windows OS requirements. USC will ensure naming requirements are adhered to in the future to prevent report autosave issues.

Recommendations

- Utilize PIFD within [redacted] to simplify continuity and shorts testing while decreasing test time.
- Implement PIFD to enable repair actions for current NFF issues within the [redacted] / RMAF procedures to detect and isolate intermittent issues that are currently going undetected by traditional deployed testing capabilities.
- Leverage PIFD as a Quality Assurance (QA) tool to validate cables and components before sell-off / validation testing.
- Verify completed repairs of EWIS cables and components as accurate and intermittent-free prior to releasing assets as ready for install on an aircraft.
- Deploy PIFD test sets to enable quick and comprehensive test outcomes, improve EWIS and component failure rates, increase overall efficiency of current test capability, and most importantly improve F/A-18 readiness for the RMAF.
- Introduce PIFD test technology to other areas of use in the [redacted] portfolio. PIFD test technology is easily adaptable to production, manufacturing, quality assurance, and other repair procedures.

Summary

PIFD versatility and capabilities were highlighted during this delivery and training project, underscoring the technology's abilities to build TPS maps automatically, detect and isolate intermittent faults, reduce maintenance time associated with the intermittence failure mode, remediate NFF test results, quality assure repair actions, and enhance overall depth of testing and efficiency.

IFD technology has proven to increase components and wiring system reliability. With continued use of the PIFD by [redacted] reliability of the RMAF F/A-18 weapon system will increase by ensuring that open, shorted, and intermittent circuits are rapidly identified to allow for quick repair. This will have a major impact on the unnecessary wasted funds attributed intermittent issues that drive NFF test results.

Universal Synaptics

Appendix 1

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-09-2022

Map Group: F/A-18 Landing Gear
Map: Landing Gear Rev 4

UUT S/N: M45-02

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
Passed		

End of Report

Universal Synaptics

Appendix 2

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-09-2022

Map Group: F/A-18 FCS Right Aileron
Map: Right Aileron Rev 3

UUT S/N: M45-02

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
303	V020A-SH	50
91	F001H-078	2

End of Report

Universal Synaptics

Appendix 3

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-09-2022

Map Group: F/A-18 FCS Right Trailing Edge Flap 1
Map: Right Trailing Edge Flap 1 Rev 2

UUT S/N: M45-02

Intermittence

TP	Nomenclature	Events
1	F001B-003	1

End of Report

Universal Synaptics

Appendix 4

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-09-2022

Map Group: F/A-18 FCS Right Trailing Edge Flap 1
Map: Right Trailing Edge Flap 1 Rev 2

UUT S/N: M45-02

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
Passed		

End of Report

Universal Synaptics

Appendix 5

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-09-2022

Map Group: F/A-18 FCS Left Trailing Edge Flap 2
Map: Left Trailing Edge Flap 2 Rev 2

UUT S/N: M45-02

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
257	U013D-01	15
206	F002J-067	1
258	U013D-02	7
89	F002H-076	3
91	F002H-078	11
82	F002H-064	3
259	U013D-03	9

End of Report

Appendix 6

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-09-2022

Map Group: F/A-18 FCS Right Leading Edge Flap
Map: Right Leading Edge Flap Rev 2

UUT S/N: M45-02

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
327	V028B-SH	50
313	V028B-09	3
91	F001H-078	4

End of Report

Universal Synaptics

Appendix 7

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-09-2022

Map Group: F/A-18 FCS Left Leading Edge Flap
Map: Left Leading Edge Flap Rev 3

UUT S/N: M45-02

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
351	M110B-SH	50
91	F002H-078	13
265	U027A-09	1
329	M110B-01	6
146	F001A-050	2

End of Report

Universal Synaptics

Appendix 8

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-10-2022

Map Group: F/A-18 Landing Gear
Map: Landing Gear Rev 4

UUT S/N: M45-08

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
193	12P-H008-11	34
97	84P-G035A-10	49

End of Report

Universal Synaptics

Appendix 9

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-10-2022

Map Group: F/A-18 FCS Right Aileron
Map: Right Aileron Rev 2

UUT S/N: M45-08

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Intermittence

TP	Nomenclature	Events
271	V020B-15	50
285	V020A-05	34
303	V020A-SH	3

End of Report

Universal Synaptics

Appendix 10

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-10-2022

Map Group: F/A-18 FCS Right Leading Edge Flap
Map: Right Leading Edge Flap Rev 2

UUT S/N: M45-08

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
259 - 64	V028A-03 - F001H-017	20.599	9.9e+37	2 / 2
260 - 66	V028A-04 - F001H-019	20.2114	9.9e+37	2 / 2
261 - 65	V028A-05 - F001H-018	20.1945	9.9e+37	2 / 2
262 - 25	V028A-06 - F002B-053	18.7192	9.9e+37	2 / 2
265 - 25	V028A-09 - F002B-053	18.7387	9.9e+37	2 / 2
305 - 258	V028B-01 - V028A-02	18.7666	9.9e+37	2 / 2
307 - 55	V028B-03 - F002B-125	20.3436	9.9e+37	2 / 2
308 - 54	V028B-04 - F002B-124	20.5241	9.9e+37	2 / 2
309 - 56	V028B-05 - F002B-126	20.2132	9.9e+37	2 / 2
310 - 25	V028B-06 - F002B-053	18.6225	9.9e+37	2 / 2
311 - 138	V028B-07 - F002A-038	20.3358	9.9e+37	2 / 2
312 - 139	V028B-08 - F002A-039	20.4002	9.9e+37	2 / 2
313 - 25	V028B-09 - F002B-053	18.5527	9.9e+37	2 / 2
327 - 25	V028B-SH - F002B-053	19.9767	9.9e+37	2 / 2

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
25 - 64	F002B-053 - F001H-017	9.9e+37	20.1881	1e+37 / 1e+37
25 - 65	F002B-053 - F001H-018	9.9e+37	19.7565	1e+37 / 1e+37
25 - 66	F002B-053 - F001H-019	9.9e+37	19.6297	1e+37 / 1e+37
25 - 214	F002B-053 - F001J-081	9.9e+37	20.1774	1e+37 / 1e+37
25 - 223	F002B-053 - F001J-093	9.9e+37	20.2085	1e+37 / 1e+37
64 - 65	F001H-017 - F001H-018	9.9e+37	20.8781	1e+37 / 1e+37
64 - 66	F001H-017 - F001H-019	9.9e+37	20.8821	1e+37 / 1e+37
64 - 214	F001H-017 - F001J-081	9.9e+37	21.6412	1e+37 / 1e+37
64 - 223	F001H-017 - F001J-093	9.9e+37	21.6954	1e+37 / 1e+37
65 - 66	F001H-018 - F001H-019	9.9e+37	21.0371	1e+37 / 1e+37
65 - 214	F001H-018 - F001J-081	9.9e+37	21.3276	1e+37 / 1e+37
65 - 223	F001H-018 - F001J-093	9.9e+37	21.384	1e+37 / 1e+37
66 - 214	F001H-019 - F001J-081	9.9e+37	21.2692	1e+37 / 1e+37
66 - 223	F001H-019 - F001J-093	9.9e+37	21.2781	1e+37 / 1e+37
214 - 223	F001J-081 - F001J-093	9.9e+37	21.3441	1e+37 / 1e+37

Intermittence

TP	Nomenclature	Events
263	V028A-07	8
91	F001H-078	3
257	V028A-01	1
279	V028A-SH	4
432	P13-10	1

End of Report

Universal Synaptics

Appendix 11

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-10-2022

Map Group: F/A-18 FCS Left Trailing Edge Flap 2
Map: Left Trailing Edge Flap 2 Rev 3

UUT S/N: M45-08

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

Shorts

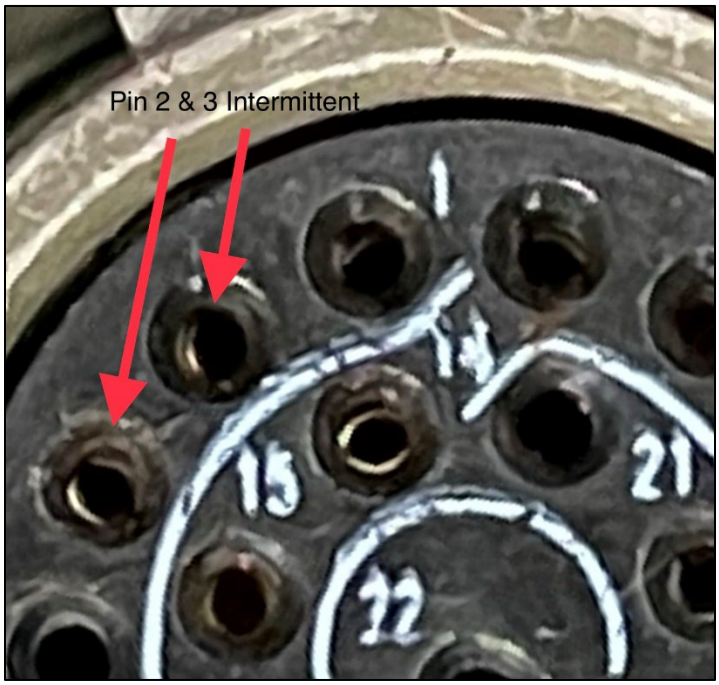
TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
Passed				

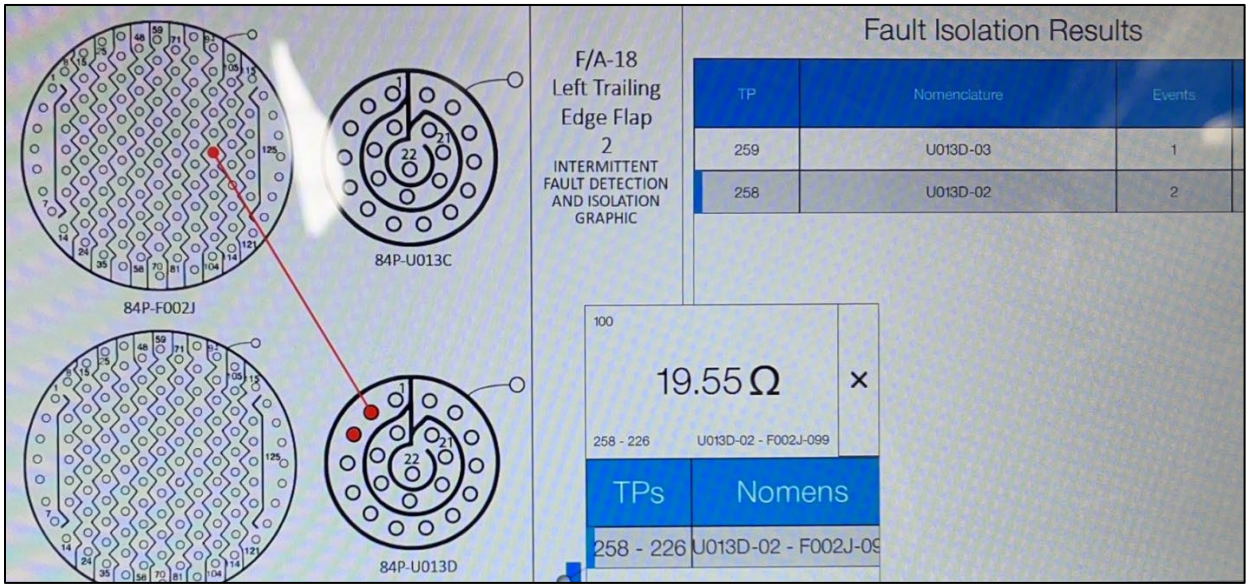
Intermittence

TP	Nomenclature	Events
259	U013D-03	1
258	U013D-02	2

End of Report

Intermittent issues on connector U013D, test points 258 and 259 were detected. Pin 2 experienced two intermittent events while Pin 3 experienced one intermittent event. These faults were visually taken to root cause during Fault Isolation immediately after detection and isolation in Intermittence mode. It appears that the pin receptables are bent to varying degrees causing intermittency when vibration was applied. This entire connector was worn and damaged yet passed all standard, conventional hard fault static tests. Other pin receptacles appear damaged yet were not behaving intermittently. It is recommended that these faults be put under magnification for further analysis before repair.





Universal Synaptics

Appendix 12

Universal Synaptics
Intermittent Fault Detection (IFD) Test Equipment

Date: 02-11-2022

Map Group: F/A-18 Landing Gear
Map: Landing Gear Final

UUT S/N: M45-02

Continuity

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
74 - 31	12P-G005-B - 52P-F058E-93	17.33	9.9e+37	5 / 2
75 - 5	12P-G005-C - 52P-F058B-46	17.33	9.9e+37	5 / 2
76 - 5	12P-G005-D - 52P-F058B-46	17.33	9.9e+37	5 / 2
104 - 5	12J-G061-03 - 52P-F058B-46	17.33	9.9e+37	5 / 2
107 - 5	12J-G061-06 - 52P-F058B-46	17.33	9.9e+37	5 / 2
117 - 5	7P-G026-B - 52P-F058B-46	17.33	9.9e+37	5 / 2
156 - 106	12P-E004A-78 - 12J-G061-05	17.33	9.9e+37	5 / 2
160 - 105	12P-E004A-89 - 12J-G061-04	17.33	9.9e+37	5 / 2
205 - 73	12P-H008-24 - 12P-G005-A	17.33	9.9e+37	5 / 2
228 - 193	76P-H009A-24 - 12P-H008-11	17.33	9.9e+37	5 / 2

Shorts

TPs	Nomenclatures	Expected	Measured	Tol +/- ohms
3 - 4	52P-F058B-26 - 52P-F058B-37	9.9e+37	598.529	1e+37 / 1e+37
5 - 206	52P-F058B-46 - 12P-H008-25	9.9e+37	21.9363	1e+37 / 1e+37
29 - 206	52P-F058E-39 - 12P-H008-25	9.9e+37	891.115	1e+37 / 1e+37

Intermittence

TP	Nomenclature	Events
Passed		

End of Report