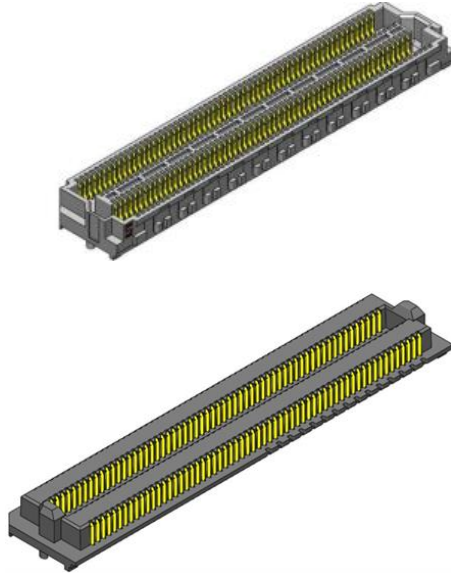




Project Number: Design Qualification Test Report	Tracking Code: CR-935801_Report_Rev_2
Requested by: Jacob Harris	Date: 12/1/2023
Part #: APF6-060-03.5-L-4-0-A-TR/APM6-060-01.5-L-4-0-A-TR	
Part description: APF6/APM6	Tech: Peter Chen
Test Start: 3/9/2023	Test Completed: 4/6/2023



DESIGN QUALIFICATION TEST REPORT

APF6/ APM6

APF6-060-03.5-L-4-0-A-TR/APM6-060-01.5-L-4-0-A-TR

Tracking Code: CR-935801_Report_Rev_2	Part #: APF6-060-03.5-L-4-0-A-TR/APM6-060-01.5-L-4-0-A-TR
Part description: APF6/ APM6	

REVISION HISTORY

DATA	REV.NUM.	DESCRIPTION	ENG
10/9/2023	1	Initial test	PC
11/20/2023	2	Updated the part numbers	PC

Tracking Code: CR-935801_Report_Rev_2	Part #: APF6-060-03.5-L-4-0-A-TR/APM6-060-01.5-L-4-0-A-TR
Part description: APF6/ APM6	

CERTIFICATION

All instruments and measuring equipment were calibrated to National Institute for Standards and Technology (NIST) traceable standards according to ISO 10012-1 and ANSI/NCSL 2540-1, as applicable.

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SCOPE

To perform the following tests: Design Qualification test. Please see test plan.

APPLICABLE DOCUMENTS

Standards: EIA Publication 364

TEST SAMPLES AND PREPARATION

- 1) All materials were manufactured in accordance with the applicable product specification.
- 2) All test samples were identified and encoded to maintain traceability throughout the test sequences.
- 3) After soldering, the parts to be used for LLCr testing were cleaned according to CO-SC-WI-3029.
- 4) Either an automated cleaning procedure or an ultrasonic cleaning procedure may be used.
- 5) The automated procedure is used with aqueous compatible soldering materials.
- 6) Parts not intended for testing LLCr is visually inspected and cleaned if necessary.
- 7) Any additional preparation will be noted in the individual test sequences.
- 8) Solder Information: Lead Free
- 9) Samtec Test PCBs used: PCB-112850-TST.

FLOWCHARTS

Mating/Unmating/Durability

Group 1

APF6-060-03.5-L-04-0-A-TR

APM6-060-01.5-L-04-0-A-TR

8 Assemblies

Step	Description
1.	Contact Gaps
2.	LLCR ⁽²⁾
3.	Mating/Unmating Force ⁽³⁾
4.	Cycles Quantity = 25 Cycles
5.	Mating/Unmating Force ⁽³⁾
6.	Contact Gaps
7.	LLCR ⁽²⁾ Max Delta = 15 mOhm
8.	Thermal Shock ⁽⁴⁾
9.	LLCR ⁽²⁾ Max Delta = 15 mOhm
10.	Humidity ⁽¹⁾
11.	LLCR ⁽²⁾ Max Delta = 15 mOhm
12.	Mating/Unmating Force ⁽³⁾

(1) Humidity = EIA-364-31

Test Condition = B (240 Hours)

Test Method = III (+25°C to +65°C @ 90% RH to 98% RH)

Test Exceptions: ambient pre-condition and delete steps 7a and 7b

(2) LLCR = EIA-364-23

Open Circuit Voltage = 20 mV Max

Test Current = 100 mA Max

(3) Mating/Unmating Force = EIA-364-13

(4) Thermal Shock = EIA-364-32

Exposure Time at Temperature Extremes = 1/2 Hour

Method A, Test Condition = I (-55°C to +85°C)

Test Duration = A-3 (100 Cycles)

FLOWCHARTS Continued**Mechanical Shock/Random Vibration/LLCR**Group 1

APF6-060-03.5-L-04-0-A-TR

APM6-060-01.5-L-04-0-A-TR

8 Assemblies

Step Description

1. LLCR ⁽¹⁾
2. Mechanical Shock ⁽²⁾
3. Random Vibration ⁽³⁾
4. LLCR ⁽¹⁾
Max Delta = 15 mOhm

(1) LLCR = EIA-364-23

Open Circuit Voltage = 20 mV Max

Test Current = 100 mA Max

(2) Mechanical Shock = EIA-364-27

Test Condition = C (100 G Peak, 6 milliseconds, Half Sine)

Number of Shocks = 3 Per Direction, Per Axis, 18 Total

(3) Random Vibration = EIA-364-28

Condition = VB (7.56 gRMS Average, 2 Hours/Axis)

Mechanical Shock/Random Vibration/Event DetectionGroup 1

APF6-060-03.5-L-04-0-A-TR

APM6-060-01.5-L-04-0-A-TR

60 Points

Step Description

1. Nanosecond Event Detection
(Mechanical Shock) ⁽¹⁾
2. Nanosecond Event Detection
(Random Vibration) ⁽²⁾

(1) Nanosecond Event Detection (Mechanical Shock)

Use EIA-364-87 for Nanosecond Event Detection:

Test Condition = F (50 nanoseconds at 10 ohms)

Use EIA-364-27 for Mechanical Shock:

Test Condition = C (100 G Peak, 6 milliseconds, Half Sine)

Number of Shocks = 3 Per Direction, Per Axis, 18 Total

(2) Nanosecond Event Detection (Random Vibration)

Use EIA-364-87 for Nanosecond Event Detection:

Test Condition = F (50 nanoseconds at 10 ohms)

Use EIA-364-28 for Random Vibration:

Condition = VB (7.56 gRMS Average, 2 Hours/Axis)

ATTRIBUTE DEFINITIONS

The following is a brief, simplified description of attributes.

THERMAL SHOCK:

- 1) EIA-364-32, *Thermal Shock (Temperature Cycling) Test Procedure for Electrical Connectors*.
- 2) Test Condition I: -55°C to +85°C
- 3) Test Time: ½ hour dwell at each temperature extreme
- 4) Number of Cycles: 100
- 5) All test samples are pre-conditioned at ambient.
- 6) All test samples are exposed to environmental stressing in the mated condition.

HUMIDITY:

- 1) Reference document: EIA-364-31, *Humidity Test Procedure for Electrical Connectors*.
- 2) Test Condition B, 240 Hours.
- 3) Method III, +25° C to + 65° C, 90% to 98% Relative Humidity excluding sub-cycles 7a and 7b.
- 4) All samples are pre-conditioned at ambient.
- 5) All test samples are exposed to environmental stressing in the mated condition.

MECHANICAL SHOCK (Specified Pulse):

- 1) Reference document: EIA-364-27, *Mechanical Shock Test Procedure for Electrical Connectors*
- 2) Test Condition G
- 3) Peak Value: 100 G
- 4) Duration: 6 Milliseconds
- 5) Wave Form: Half Sine
- 6) Velocity: 12.3 ft/s
- 7) Number of Shocks: 3 Shocks / Direction, 3 Axis (18 Total)

VIBRATION:

- 1) Reference document: EIA-364-28, *Vibration Test Procedure for Electrical Connectors*
- 2) Test Condition V, Letter B
- 3) Power Spectral Density: 0.04 G² / Hz
- 4) G 'RMS': 7.56
- 5) Frequency: 50 to 2000 Hz
- 6) Duration: 2.0 Hours per axis (3 axis total)

NANOSECOND-EVENT DETECTION:

- 1) Reference document: EIA-364-87, *Nanosecond-Event Detection for Electrical Connectors*
- 2) Prior to test, the samples were characterized to assure the low nanosecond event being monitored will trigger the detector.
- 3) After characterization it was determined the test samples could be monitored for 50 nanosecond events

MATING/UNMATING:

- 1) Reference document: EIA-364-13, *Mating and Unmating Forces Test Procedure for Electrical Connectors*.
- 2) The full insertion position was to within 0.003" to 0.004" of the plug bottoming out in the receptacle to prevent damage to the system under test.
- 3) One of the mating parts is secured to a floating X-Y table to prevent damage during cycling.

ATTRIBUTE DEFINITIONS Continued

The following is a brief, simplified description of attributes

LLCR:

- 1) EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 2) A computer program, *LLCR 221.exe*, ensures repeatability for data acquisition.
- 3) The following guidelines are used to categorize the changes in LLCR as a result from stressing
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms:-----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms: -----Unstable
 - f. $>+1000$ mOhms:-----Open Failure

RESULTS

Mating – Unmating Forces

Mating/Unmating Durability Group

- **Initial**
 - **Mating**
 - **Min** -----10.54 lbs
 - **Max** -----12.03 lbs
 - **Unmating**
 - **Min** -----5.07 lbs
 - **Max** -----6.32 lbs
- **After 25 Cycles**
 - **Mating**
 - **Min** -----10.62 lbs
 - **Max** -----13.20 lbs
 - **Unmating**
 - **Min** -----6.05 lbs
 - **Max** -----6.80 lbs
- **After Humidity**
 - **Mating**
 - **Min** -----6.82 lbs
 - **Max** -----8.18 lbs
 - **Unmating**
 - **Min** -----3.14 lbs
 - **Max** -----3.75 lbs

RESULTS Continued

LLCR Durability (480 LLCR test points)

- Initial ----- 21.96 mOhms Max
- Durability, 25 Cycles
 - <= +5.0 mOhms ----- 480 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 0 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure
- Thermal
 - <= +5.0 mOhms ----- 480 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 0 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure
- Humidity
 - <= +5.0 mOhms ----- 468 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 12 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure

LLCR Shock & Vibration (480 LLCR test points)

- Initial ----- 24.13 mOhms Max
- Shock & Vibration
 - <= +5.0 mOhms ----- 478 Points ----- Stable
 - +5.1 to +10.0 mOhms ----- 2 Points ----- Minor
 - +10.1 to +15.0 mOhms ----- 0 Points ----- Acceptable
 - +15.1 to +50.0 mOhms ----- 0 Points ----- Marginal
 - +50.1 to +1000 mOhms ----- 0 Points ----- Unstable
 - >+1000 mOhms ----- 0 Points ----- Open Failure

Mechanical Shock & Random Vibration:

- Shock
 - No Damage ----- Pass
 - 50 Nanoseconds ----- Pass
- Vibration
 - No Damage ----- Pass
 - 50 Nanoseconds ----- Pass

DATA SUMMARIES

MATING/UNMATING:

Mating/Unmating Durability Group

	Initial				25 Cycles			
	Mating		Unmating		Mating		Unmating	
	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)	Newtons	Force (Lbs)
Minimum	46.88	10.54	22.55	5.07	47.24	10.62	26.91	6.05
Maximum	53.51	12.03	28.11	6.32	58.71	13.20	30.25	6.80
Average	49.46	11.12	26.06	5.86	55.38	12.45	28.88	6.49
St Dev	2.04	0.46	1.77	0.40	3.54	0.80	1.35	0.30
Count	8	8	8	8	8	8	8	8

	After Humidity			
	Mating		Unmating	
	Newtons	Force (Lbs)	Newtons	Force (Lbs)
Minimum	30.34	6.82	13.97	3.14
Maximum	36.38	8.18	16.68	3.75
Average	34.11	7.67	15.58	3.50
St Dev	2.08	0.47	0.97	0.22
Count	8	8	8	8

DATA SUMMARIES Continued

LLCR Durability:

- 1) A total of 480 points were measured.
- 2) EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 3) A computer program, *LLCR 221.exe*, ensures repeatability for data acquisition.
- 4) The following guidelines are used to categorize the changes in LLCR as a result from stressing.
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms: -----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms: -----Unstable
 - f. $>+1000$ mOhms: -----Open Failure

LLCR Measurement Summaries by Pin Type				
Date	5/25/2023	6/8/2023	6/13/2023	6/23/2023
Room Temp (Deg C)	22	22	22	22
Rel Humidity (%)	39	46	41	55
Technician	Richard Ison	Richard Ison	Richard Ison	Richard Ison
mOhm values	Actual	Delta	Delta	Delta
	Initial	Cycles	Therm Shck	Humidity
Pin Type: Signal 1				
Average	18.07	0.72	0.83	1.22
St. Dev.	1.62	0.66	0.72	1.43
Min	15.23	0	0	0
Max	21.96	4.84	3.82	9.83
Summary Count	480	480	480	480
Total Count	480	480	480	480

LLCR Delta Count by Category						
	Stable	Minor	Acceptable	Marginal	Unstable	Open
mOhms	≤ 5	$>5 \text{ \& } \leq 10$	$>10 \text{ \& } \leq 15$	$>15 \text{ \& } \leq 50$	$>50 \text{ \& } \leq 1000$	>1000
Cycles	480	0	0	0	0	0
Therm Shck	480	0	0	0	0	0
Humidity	468	12	0	0	0	0

DATA SUMMARIES Continued

LLCR Shock &Vibration:

- 1). A total of 480 points were measured.
- 2). EIA-364-23, *Low Level Contact Resistance Test Procedure for Electrical Connectors and Sockets*.
- 3). The following guidelines are used to categorize the changes in LLCR as a result from stressing.
 - a. $\leq +5.0$ mOhms: -----Stable
 - b. $+5.1$ to $+10.0$ mOhms: -----Minor
 - c. $+10.1$ to $+15.0$ mOhms: -----Acceptable
 - d. $+15.1$ to $+50.0$ mOhms: -----Marginal
 - e. $+50.1$ to $+1000$ mOhms -----Unstable
 - f. $>+1000$ mOhms: -----Open Failure

LLCR Measurement Summaries by Pin Type			
Date	5/25/2023	6/1/2023	
Room Temp (Deg C)	22	22	
Rel Humidity (%)	40	51	
Technician	Richard Ison	Richard Ison	
mOhm values	Actual	Delta	
	Initial	Shock-Vib	
Pin Type: Signal 1			
Average	18.89	0.55	
St. Dev.	1.7	0.7	
Min	15.51	0	
Max	24.13	6.7	
Summary Count	480	480	
Total Count	480	480	

LLCR Delta Count by Category						
	Stable	Minor	Acceptable	Marginal	Unstable	Open
mOhms	≤ 5	$>5 \text{ \& } \leq 10$	$>10 \text{ \& } \leq 15$	$>15 \text{ \& } \leq 50$	$>50 \text{ \& } \leq 1000$	>1000
Shock-Vib	478	2	0	0	0	0

Nanosecond Event Detection:

Shock and Vibration Event Detection Summary	
Contacts tested	60
Test Condition	C, 100g's, 6ms, Half-Sine
Shock Events	0
Test Condition	V-B, 7.56 rms g
Vibration Events	0
Total Events	0

Tracking Code: CR-935801_Report_Rev_2	Part #: APF6-060-03.5-L-4-0-A-TR/APM6-060-01.5-L-4-0-A-TR
Part description: APF6/ APM6	

EQUIPMENT AND CALIBRATION SCHEDULES

Equipment #: HZ-TCT-01

Description: Normal force analyzer

Manufacturer: Mecmesin Multitester

Model: Mecmesin Multitester 2.5-i

Serial #: 08-1049-04

Accuracy: Last Cal: 4/26/2022, Next Cal: 4/25/2023

Equipment #: HZ-OV-01

Description: Oven

Manufacturer: Huida

Model: CS101-1E

Serial #: CS101-1E-B

Accuracy: Last Cal: 12/13/2022, Next Cal: 12/12/2023

Equipment #: HZ-THC-01

Description: Humidity transmitter

Manufacturer: Thermtron

Model: SM-8-8200

Serial #: 38846

Accuracy: Last Cal: 2/28/2023, Next Cal: 2/27/2024

Equipment #: HZ-TSC-01

Description: Vertical Thermal Shock Chamber

Manufacturer: Cincinnatti Sub Zero

Model: VTS-3-6-6-SC/AC

Serial #: 10-VT14994

Accuracy: See Manual

... Last Cal: 06/28/2022, Next Cal: 06/27/2023

Equipment #: HZ-HPM-01

Description: NA9636H

Manufacturer: Ainuo

Model: 6031A

Serial #: 089601091

Accuracy: Last Cal: 3/7/2023, Next Cal: 3/6/2024

Equipment #: HZ-MO-05

Description: Micro-ohmmeter

Manufacturer: Keithley

Model: 3706

Serial #: 1285188

Accuracy: Last Cal: 11/15/2022, Next Cal: 11/14/2023

Equipment #: HZ-MO-01

Description: Micro-ohmmeter

Manufacturer: Keithley

Model: 2700

Serial #: 1199807

Accuracy: Last Cal: 04/28/2023, Next Cal: 04/28/2024

Tracking Code: CR-935801_Report_Rev_2	Part #: APF6-060-03.5-L-4-0-A-TR/APM6-060-01.5-L-4-0-A-TR
Part description: APF6/ APM6	

EQUIPMENT AND CALIBRATION SCHEDULES Continued

Equipment #: HZ-PS-01
Description: Power Supply
Manufacturer: Agilent
Model: 6031A
Serial #: MY41000982
Accuracy: Last Cal: 04/28/2023, Next Cal: 04/28/2024

Equipment #: SVC-01
Description: Shock & Vibration Table
Manufacturer: Data Physics
Model: LE-DSA-10-20K
Serial #: 10037
Accuracy: See Manual
 ... Last Cal: 11/31/2022, Next Cal: 11/31/2023

Equipment #: ACLM-01
Description: Accelerometer
Manufacturer: PCB Piezotronics
Model: 352C03
Serial #: 115819
Accuracy: See Manual
 ... Last Cal: 07/09/2022, Next Cal: 07/09/2023

Equipment #: ED-03
Description: Event Detector
Manufacturer: Analysis Tech
Model: 32EHD
Serial #: 1100604
Accuracy: See Manual
 ... Last Cal: 06/04/2022, Next Cal: 06/04/2023

Equipment #: DG-MFG-01
Description: Mixed Flow Gas Chamber
Manufacturer: Yamasaki
Model: GH-180
Serial #: 715
Accuracy: Last Cal: 12/5/2022, Next Cal: 12/4/2023