Packaged Piezoelectric Fan Qualification and Reliability Testing

Updated on April 15th, 2015

Testing Summary

TEST	STATUS	PASS/FAIL	EXPECTED COMPLETION DATE	Notes
Initial HALT (9 Samples)	COMPLETED	PASS		No failures, 1000 thermal cycles (-40 to 125 ºC)
HTOL & LTOL	COMPLETED	PASS		No failures at high or low temp limits of chamber
Voltage Step Test	COMPLETED	PASS		No failures, tested to 100% over voltage
HALT	COMPLETED	PASS		No fan failures
Mixed Flowing Gas	NOT COMPLETED		May/June 2015	Outside Testing Service
Humidity HALT (Unbiased)	NOT COMPLETED		May/June 2015	Outside Testing Service
Humidity HALT (Biased)	COMPLETED	PASS		No Failures, 1000 hours at 85/85
IR Thermal	COMPLETED	PASS		No hot spots of concern discovered
Cold Start	COMPLETED	PASS		No failures
High Temperature Storage	COMPLETED	PASS		No failures
Dust Ingress	COMPLETED	PASS		No failures, also tested new Midé standard product design
Salt Spray/Fog	NOT COMPLETED		May/June 2015	Outside Testing Service
IP68	COMPLETED	PASS		No Failures, fully submersed 3m depth

Initial HALT

Status –COMPLETED, Passed

9 samples tested, no failures

Test ran from October 2013 to February 2014

- 1000 thermal cycles ranging from -40 to 125 ^{o}C
- Fans fully operational during the entire test
- Fans driven at max operating voltage of 140 V_{RMS}
- Each fan actuated 687 million times (68 Hz natural frequency)

Baseline HTOL and LTOL

Status - COMPLETED, Passed

48 samples tested, no failures

- 24 for HTOL and 24 for LTOL

All 24 HTOL samples survived up to 180 C (limit of the test chamber)

- Fans all turned a brown color, operated over maximum operating temperature of FR4 (140 C)

All 24 LTOL survived to -70 C (limit of the test chamber)

Voltage Step Test

Status – COMPLETED, PASSED

5 Samples tested, no failures

Fans driven up to 280 V_{RMS} AC

- 100% over normal operating voltage of 140 V_{RMS}
- Testing performed while fans soaking at temperature of 100 ^{o}C
- Testing performed over 6 days as drive voltage was slowly increased

HALT Temperature Cycling

Status – COMPLETED, PASSED

Being run simultaneously by customer

Tested 30 samples, no fan failures

- Did witness several solder joint failures
- No noticeable degradation in fan performance

Mixed Flow Gas Testing

Status – NOT COMPLETED, Expected May/June 2015

Humidity HALT (Unbiased)

Status – NOT COMPLETE, Expected May/June 2015

Humidity HALT (Biased)

Status – COMPLETED, PASSED

No failures, some discoloration of the beams

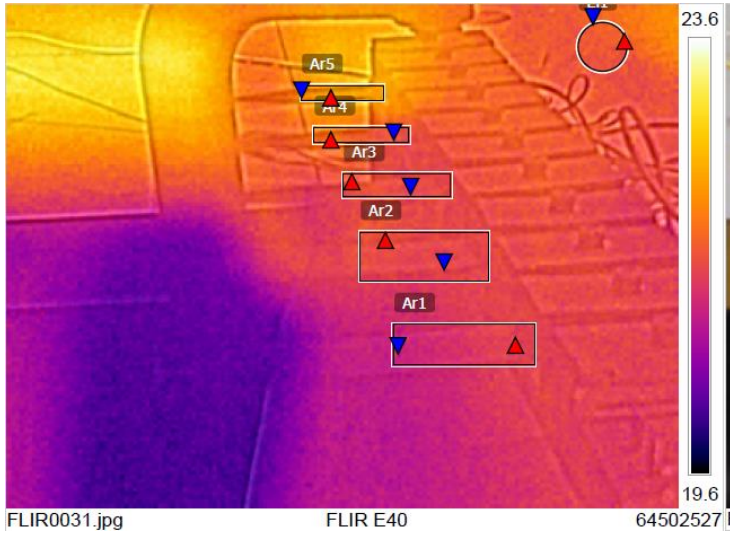
IR Thermal Test

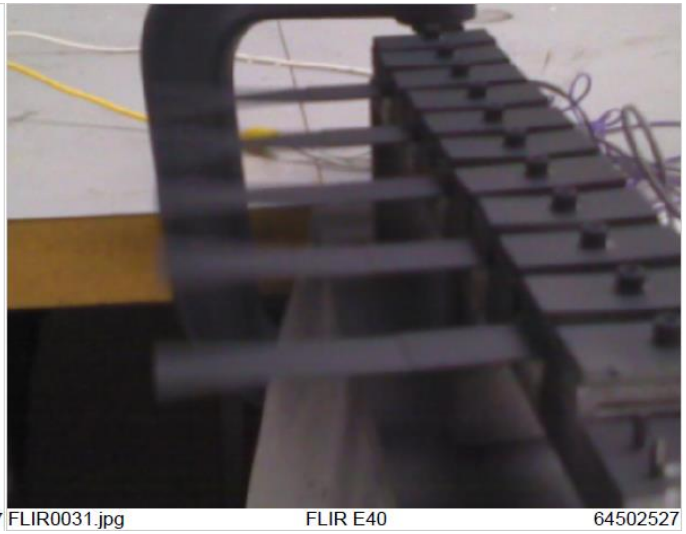
Status –COMPLETED, PASSED

5 Samples driven at max voltage of 140 V_{RMS} for 80 minutes

- No visible hot spots

Measurements		°C
Ar1	Max	21.6
	Min	20.9
	Average	21.3
Ar2	Max	21.8
	Min	21.3
	Average	21.5
Ar3	Max	21.8
	Min	21.3
	Average	21.6
Ar4	Max	22.1
	Min	21.4
	Average	21.8
Ar5	Max	22.5
	Min	22.1
	Average	22.3
El1	Max	22.0
	Min	21.4
	Average	21.7





Cold Start Testing

Status – COMPLETED, PASSED

5 samples tested, no failures

Fan's soaked at -40 ºC for 14 hours

- Hard start up at maximum drive voltage of 140 V_{RMS}

High Temperature Storage Test

Status – COMPLETED, PASSED

25 Samples soaked at 140 C for 1000 hours, non-operating state

No fan failures as measured by capacitance

Fans turned brown due to equaling the maximum operating temperature of the FR4 (140 C)

Not part of the test plan, but cycle testing will be performed on these fans to ensure they still operate

Dust Ingress Testing

Status – COMPLETED, PASSED

Tested both custom blade and Midé standard product blade

No loss in performance

Salt Spray/Fog Testing

Status – NOT COMPLETED, Expected May/June 2015

IP68

Worked with customer and decided to do a more rigorous IP test

- Original plan IP67, easier for us to run IP68
- IP68 is 3m submersion for 72 hours
- All samples passed test