ERP - Distributed Fence Monitor

A Embry-Riddle Aeronautical University project.

FULL DOCUMENT

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1 Terminology used in the document

Applicable Documents	Applicable documents are those specification, standards, criteria etc. used to define the requirement
EQF	Environmental Qualification Form
Equipment	The term “equipment” includes the Units and all of the components necessary (as determined by the equipment manufacturer) for the equipment to properly perform its intended function(s).
Estimated stabilization time	Is the time required by the unit to change (in his biggest inertia part) the temperature from Maximum Storage Temperature to Minimum Storage Temperature after a long storage at high temperature.
EUT	Equipment Under Test
Reference Documents	Reference Documents are those documents included for information purpose; they provide insight into the operation, characteristics and interfaces, as well as relevant background information
Sample	Is a part of an Unit
Sample Group	Is a set of samples, composed by two or more samples
TBD	To Be Defined
Unit	Is the element to be qualified
Unit Group	Is a set of units, composed by two or more units
UUT	Unit Under Test, is the unit (or Sample, or Unit Group or Sample Group) that is subjected to tests

2 Project overview

2.1 Project description

Our capstone team, ERP - Distributed Fence Monitor, is designing and building a module that attaches to a fence and, when it detects vibrations, sends an alert and the appropriate response can be taken.

2.2 Environments for project

The product will be used in the following environments:

- Other/Unknown;

2.3 Aircraft Type

- Unknown

2.4 Number of tests

The total number of test described in this document is: 1

2.5 Number of UUT

This project has 1 UUT distributed as follows:

Units
1

3 Document Info

This Document was compiled by:

- https://app.do160.org Software rev. 1.6.0 of 2022/Jun/27
- Customer data of 2023/Apr/07

Ref.	Name	Type	Last Changes	Rev	Description
§ 2	ERP - Distributed Fence Monitor	Project	2023/Apr/07	1.2	
§ 4.1	Erp_Distributed_Fence_Monitor_Node_1_2023-04-07	Unit	2023/Apr/07	1.0	
§ 5.1	RTCA DO 357:2014 User Guide Supplement To Do-160G	Reference Document	2023/Apr/07	1.0	
§ 5.2	Standard DO160	Applicable Document	2023/Apr/07	1.0	
§ 6.1	Power_Supply_Setup01	Setup	2023/Apr/07	1.2	
§ 7.1	Board_Test_01	Functional Test	2023/Apr/07	1.3	
§ 7.2	Case_Test_01	Functional Test	2023/Apr/07	1.2	
§ 7.3	Case_Test_02	Functional Test	2023/Apr/07	1.1	
§ 7.4	Board_Test_03	Functional Test	2023/Apr/07	1.2	
§ 7.5	Battery_Test_01	Functional Test	2023/Apr/07	1.2	
§ 7.6	Battery_Test_02	Functional Test	2023/Apr/07	1.1	
§ 7.7	Board_Test_02	Functional Test	2023/Apr/07	1.0	
§ 12	Test interruption for environmental test methods	Page	2023/Apr/07	1.0	
§ 13	System of Units and Numeric Convention Used in this Document	Page	2023/Apr/07	1.0	
§ 17.1	Temperature Variation (Sec.5 - Temperature Variation 001)	Test	2023/Apr/07	1.1	

4 Units

4.1 Erp_Distributed_Fence_Monitor_Node_1_2023-04-07

Part number: Node_1

4.1.1 Weight

Unit	Weight
Kilograms	0.4
Pounds	0.88

4.1.2 Sizes

Unit	Width	Height	Depth
Millimeters	101.6	177.8	76.2
Inches	4	7	3

4.1.3 Input powers

Name	Max Current [A]	Special Requirements
Other voltage	128mA	

4.1.4 Details

Function Performed: The node will be placed in the thermal chamber and cycle through different power levels and temperatures. It will be expected to operate normally under the varying conditions.

Estimated stabilization time: 4 minutes

Operating Altitude: 1034 m (3392 ft) (89.52 kPa)

4.1.5 Safety Risks

This chapter contain the list of risk specific for this Unit.

- High Temperatures;

5 Reference and applicable documents

5.1 Reference Documents

Reference Documents are those documents included for information purpose; they provide insight into the operation, characteristics and interfaces, as well as relevant background information.

Identification	Release	Date	Description
RTCA DO 357:2014 User Guide Supplement To Do-160G	G	2014-12-16	The purpose of this document is to provide users of DO-160G additional background information for the associated test procedures and requirements in DO-160G.

5.2 Applicable Documents

Applicable documents are those specification, standards, criteria etc. used to define the requirement.

Identification	Release	Date	Description
Standard DO160	G	2010-12-08	Standard

6 Setups

This chapter describes the setup used to perform functional test.

6.1 Power_Supply_Setup01 - Power_Supply

6.1.1 Description

1) Set u the power supply in the thermal test room.
2)Set the power supply to cycle between 3.3V and 4.1V
3)
4)

6.1.2 Instruments used for this setup

Instrument	Detail
Power Supply	

7 Functional Tests

This chapter describes the functional/operative tests to be performed during testing.

7.1 Board_Test_01 - Board_Test_01

7.1.1 Test Description

1. Visually inspect the board for any imperfections.
2. Run the (power test) on the board and record the results.
3. Put the board into the chamber.
4. Attach the thermocouple to (specified points on the board).

7.1.2 Pass Conditions

- Board does not exceed (required temp);

7.1.3 Safety Risks

The Test indicated in this document can be dangerous for person, or can spread risk. In this chapter a list of risk for all test described in this document are listed.

- Destroying the product;

7.2 Case_Test_01 - Case_Test_01

7.2.1 Test Description

1. Visually inspect the case for any imperfections, and note them.
2. Put the case into the thermal chamber.

7.2.2 Pass Conditions

- Case is not compromised;

7.3 Case_Test_02 - Case_Test_02

7.3.1 Test Description

1. Remove the case from the thermal chamber.
2. Visually inspect the case to check for any imperfections not noted before.

7.3.2 Pass Conditions

- No new imperfections;

7.3.3 Operator

This functional test requires an operator, so it normally cannot be carried on during the night or during weekend.

7.4 Board_Test_03 - Board_Test_03

7.4.1 Test Description

1. Visually inspect the board for any imperfections not noted before.
2. Run the (power test) and record the results.
3. Verify the data is the same as the previous test.

7.4.2 Pass Conditions

- No new imperfections;
- Board power is not effected;

7.5 Battery_Test_01 - Battery_Test_01

7.5.1 Test Description

1. Measure the voltage of the battery.
2. Put the battery in the thermal chamber.

7.5.2 Pass Conditions

- Battery voltage macthes;

7.6 Battery_Test_02 - Battery_Test_02

7.6.1 Test Description

1. Remove the battery from the thermal chamber.
2. Measure the voltage of the battery.
3. Verify it matches the previous measurement.

7.6.2 Pass Conditions

- Battery voltages match;

7.7 Board_Test_02 - Board_Test_02

7.7.1 Test Description

1. Run the (power test) to go through the different transmission levels.

7.7.2 Pass Conditions

- Board cycles through power levels;

8 Correlation Between Functional Tests and Setups

Setup	Power_Supply_Setup01
Functional Test	
Board_Test_01	
Case_Test_01	
Case_Test_02	
Board_Test_03	
Battery_Test_01	
Battery_Test_02	
Board_Test_02	

9 Testing Laboratory Summary

This chapter provides information on where each test indicated in this document will be performed.

9.1 Unit Erp_Distributed_Fence_Monitor_Node_1_2023-04-07

Test (Identification)	Ref	Laboratory
Sec.5 Temperature Variation (Sec.5 - Temperature Variation 001)	17.1	Not Defined

10 List of test document used in this document

This chapter contain a cross reference between each test and used documentation.

	Test	§17.1
	DO160 G Section	5
Document	Section	
Standard DO160	5	X
RTCA DO 357:2014 User Guide Supplement To Do-160G	5	X

11 Safety Risk for test described in this document

The Test indicated in this document can be dangerous for person, or can spride risk. In this chapter a list of risk for each test is described.

Test	§17.1
DO160 G Section	5
Risk	
Danger of very low temperatures	X
Danger of High Temperature	X
From Functional Test Board_Test_01 - Board_Test_01: Destroying the product	X

12 Test interruption for environmental test methods

The following procedures shall be followed when a test is interrupted. Explain test interruptions in the test report, and any deviation from the following information.

1. ***In-tolerance interruptions***
   Interruption periods during which the prescribed test tolelrances (e.g. power interruptions that do not affect chamber temperature) do not constitute a test interruption. Therefore, do not modify the test duration if exposure to proper test levels was maintained during the ancillary interruption.
2. ***Out-of-tolerance interruptions***
   - ***Undertest***
     If test tolerances have been exceed resulting in an under test condition, the test may be resumed from the point at which tolerances were exceed following reestablishment of prescribed conditions (except as noted in the individual methods), and extended to insure that the prescribed test cycle is achieved by the test laboratory.
   - ***Overtest***
     If the overtest was occurred, the test will be stopped during the test according to customer's chosen, and will be conducted an a functional checks according to § 7. if the functional checks results are compliant with the § 7, re start the test, otherwise the test will be performed with a new test article.

     If any damage is a direct result of the over test conditions and will not affect other EUT characteristics, or if the EUT can be repaired, the test may be resumed and extended as in the under test condition.

     If an item failure occurs during the remainder of the test, the test result shall be considered invalid.

     For the ambient measurement into electromagnetics environments, the ambient electromagnetic level measured with the EUT de-energized and all auxiliary equipment turned on shall be at least 6 dB below the allowable specified limits when the tests are performed in a shielded enclosure.
3. ***Other environmental test methods set out in the document***
   Each of these methods contains guidance for handling out-of-tolerance-test interruption. Any such interruption must be carefully analysed. If the decision is made to continue testing from the point interruption, to restart the last successfully completed test cycle, or to restart the entire test with the same EUT, and a failure occurs, it is essential to consider the possibility effect of the interruption or of the extended length of the test

13 System of Units and Numeric Convention Used in this Document

Numbers where defined using a dot: (For example 1/3= 0.333333333)

Thousands where defined with space. (For example 1 000 000)

The following units where used

- **s** - Seconds
- **m** - Meters
- **kg** - Kilograms
- **Pa** - Pascal
- **F** - Farad
- **C** - Coloumb
- **A** - Ampere
- **V** - Volt
- **J** - Joule
- **N** - Newton
- **H** - Henry
- **T** - Tesla
- **w** - Weber
- **W** - Watt
- **Ohm** - Ohm
- **K** - Kelvin
- **Hz** - Hertz

Factor Scale

- Kilo **(k)** = 1000
- Mega **(M)** = 1 000 000
- Giga **(G)** = 1 000 000 000
- micro **(u)** = 0.000 001
- nano **(n)** = 0.000 000 001
- pico **(p)** = 0.000 000 000 001

DATES FORMAT **YYYY-MM-DD**

14 Environmental Qualification Form

14.1 EQF for Erp_Distributed_Fence_Monitor_Node_1_2023-04-07

NOMENCLATURE	Erp_Distributed_Fence_Monitor_Node_1_2023-04-07
TYPE/MODEL/PART NO	Node_1
TSO NUMBER	_____
MANUFACTURER'S SPECIFICATION AND/OR OTHER APPLICABLE SPECIFICATION	_____ _____ _____ _____
MANUFACTURER	Embry-Riddle Aeronautical University
ADDRESS	_____
REVISION & CHANGE NUMBER OF DO-160	DO 160 G
DATE TESTED	_____

Conditions	Sections	Description of tests conducted (Category)
DO160G - Temperature and Altitude	Sec.4	Not performed/Applicable
Temperature Variation	**Sec.5**	A
DO160G - Humidity	Sec.6	Not performed/Applicable
DO160G - Operational Shocks and Crash Safety	Sec.7	Not performed/Applicable
DO160G - Vibration	Sec.8	Not performed/Applicable
DO160G - Explosive Atmosphere	Sec.9	Not performed/Applicable
DO160G - Waterproofness	Sec.10	Not performed/Applicable
DO160G - Fluids Susceptibility	Sec.11	Not performed/Applicable
DO160G - Sand and Dust	Sec.12	Not performed/Applicable
DO160G - Fungus Resistance	Sec.13	Not performed/Applicable
DO160G - Salt Fog	Sec.14	Not performed/Applicable
DO160G - Magnetic Effect	Sec.15	Not performed/Applicable
DO160G - Power Input	Sec.16	Not performed/Applicable
DO160G - Voltage Spike	Sec.17	Not performed/Applicable
DO160G - Audio Frequency Conducted Susceptibility - Power Inputs	Sec.18	Not performed/Applicable
DO160G - Induced Signal Susceptibility	Sec.19	Not performed/Applicable
DO160G - Radio Frequency Susceptibility (Radiated and Conducted)	Sec.20	Not performed/Applicable
DO160G - Emission of Radio Frequency Energy (Radiated and Conducted)	Sec.21	Not performed/Applicable
DO160G - Lightning Induced Transient Susceptibility	Sec.22	Not performed/Applicable
DO160G - Lightning Direct Effects	Sec.23	Not performed/Applicable

Conditions	Sections	Description of tests conducted (Category)
DO160G - Icing	Sec.24	Not performed/Applicable
DO160G - Electrostatic Discharge (ESD)	Sec.25	Not performed/Applicable
DO160G - Fire and Flammability	Sec.26	Not performed/Applicable

15 Section Category Cross Reference

This chapter contain information on the environment selected for each test.

15.1 Environments for Erp_Distributed_Fence_Monitor_Node_1_2023-04-07

Test	Sections	Description of Environment described in the section
Temperature Variation (Sec.5 - Temperature Variation 001)	**Sec.5**	**Category: A -** For equipment external to the aircraft or internal to the aircraft: 10 degrees Celsius minimum per minute.

16 Test Sequence

16.1 Test Sequence for unit "Node_1 Erp_Distributed_Fence_Monitor_Node_1_2023-04-07"

16.1.1 Execute in this order

Test Name	Section
Temperature Variation Sec.5 - Temperature Variation 001	Sec.5

17 Test requirement for unit Node_1
Erp_Distributed_Fence_Monitor_Node_1_2023-04-07

17.1 DO 160 G - Sec.5 - Temperature Variation - "Sec.5 - Temperature Variation 001"

Standard:	DO160 G
Section:	5
Title:	Temperature Variation
Category:	A

17.1.1 Purpose of the test

This test determines performance characteristics of the equipment during temperature variations between high and low operating temperature extremes.

Note: The test is not intended to verify the behavior of the equipment in wet or icing conditions. In conducting this test, the test chamber may incorporate the capability of controlling or altering humidity to the extent that condensation is minimized or does not occur.

17.1.2 Reference Documents

Identification	Release
RTCA DO 357:2014 User Guide Supplement To Do-160G	G

17.1.3 Applicable Documents

Identification	Release
Standard DO160	G

17.1.4 Test Procedure

1) Setup the unit as per [Power_Supply_Setup01 - Power_Supply (§ 6.1)];
2) Perform test as per [Board_Test_01 - Board_Test_01 (§ 7.1)];
3) Perform test as per [Case_Test_01 - Case_Test_01 (§ 7.2)];
4) Perform test as per [Battery_Test_01 - Battery_Test_01 (§ 7.5)];
5) Install the EUT in the climatic chamber
6) Install the UUT in chamber 2 as for [Board_Test_02 - Board_Test_02] [**ONLY** at cycle (**1**)]
7) Start at standard ambient temperature (**22 °C | 54 °F**)
8) Decrease the temperature in the chamber towards the operating low temperature level (**0 °C | 32 °F**) at the applicable rates of 10 degrees Celsius minimum per minute)
9) Stabilize the equipment in the operating mode at this operating low temperature level of (**0 °C | 32 °F**) for a time of 4 minutes
10) Increase the temperature in the chamber towards the operating high temperature level (**50 °C | 82 °F**) at the applicable rates of 10 degrees Celsius minimum per minute)
11) Stabilize the equipment in the operating mode at this operating high temperature level of (**50 °C | 82 °F**) for a time of 4 minutes
12) Switch off the UUT
13) Maintain the equipment in a non-operating state for 2 minutes

14) Turn the equipment on
15) Lower the temperature in the chamber towards the operating low temperature level (**0 °C | 32 °F**) at the applicable rates of 10 degrees Celsius minimum per minute)
16) Stabilize the equipment in the operating mode at this operating low temperature level of (**0 °C | 32 °F**) for a time of 4 minutes
17) Perform test [Board_Test_02 - Board_Test_02] [**ONLY** at cycle (**1**)]
18) Turn off the equipment
19) Wait 30 minutes
20) Switch on the UUT as per [Board_Test_02 - Board_Test_02] [**ONLY** at cycle (**1**)]
21) Change the temperature of the chamber towards the ambient temperature (**22 °C | 54 °F**) at the applicable rates of 10 degrees Celsius minimum per minute)
22) Stabilize the chamber and the equipment at ambient temperature
23) Repeat steps **7)..22)** for another time (**Total** of 2 cycles)
24) Perform test as per [Board_Test_03 - Board_Test_03 (§ 7.4)];
25) Perform test as per [Case_Test_02 - Case_Test_02 (§ 7.3)];
26) Perform test as per [Battery_Test_02 - Battery_Test_02 (§ 7.6)];

17.1.5 Test Duration

Estimated test duration: 2 Days 2 Hours

17.1.6 Test Interruption

Continue with testing

17.1.7 Instruments

- From SETUP "Power_Supply_Setup01 - Power_Supply [§ 6.1]": Power Supply;
- Thermal CHamber;

17.1.8 Safety Risks

- Danger of very low temperatures;
- Danger of High Temperature;
- From Functional Test Board_Test_01 - Board_Test_01: Destroying the product;
- From Functional Test "Board_Test_01 - Board_Test_01 [§ 7.1]": Destroying the product;

17.1.9 Pass conditions

- [Before TEST] - from (Board_Test_01 - Board_Test_01 [§ 7.1]): Board does not exceed (required temp);
- [Before TEST] - from (Case_Test_01 - Case_Test_01 [§ 7.2]): Case is not compromised;
- [Before TEST] - from (Battery_Test_01 - Battery_Test_01 [§ 7.5]): Battery voltage macthes;
- [During TEST] - from (Board_Test_02 - Board_Test_02 [§ 7.7]): Board cycles through power levels;
- [After TEST] - from (Board_Test_03 - Board_Test_03 [§ 7.4]): No new imperfections;
- [After TEST] - from (Board_Test_03 - Board_Test_03 [§ 7.4]): Board power is not effected;
- [After TEST] - from (Case_Test_02 - Case_Test_02 [§ 7.3]): No new imperfections;
- [After TEST] - from (Battery_Test_02 - Battery_Test_02 [§ 7.6]): Battery voltages match;