



1499 Poinsettia Ave., Suite 160
Vista, CA 92081

Validation Test Report

High Pressure High Temperature (HPHT)
Brushless DC (BLDC) Motor

DII15-60-201A

Rev	Date	Author	Reviewed by	App. by	Comments
A	2/1/17	J.Eral	H.Minor	A.Galvan	1 st release
B	2/14/17	J.Eral	H.Minor	A.Galvan	Addition of environmental test conditions to 5.3 section. Scope re-defined.

1. Introduction	- 3 -
2. Purpose	- 3 -
3. Results.....	- 3 -
4. Test Description	- 3 -
5. Test Program	- 3 -
5.1. Bench Test	- 3 -
5.1.1. Resistance Measurement	- 3 -
5.1.2. Inductance Measurement.....	- 4 -
5.1.3. BEMF Measurement.....	- 4 -
5.1.4. Insulation Resistance Test.....	- 5 -
5.1.5. Functional Test	- 5 -
5.2. Mechanical Durability Test	- 6 -
5.2.1. Vibration Test.....	- 6 -
5.2.2. Shock Test.....	- 6 -
5.3. Environmental Durability Test	- 7 -
6. Test Certification & Data	- 10 -
6.1. Bench Test	- 10 -
6.1.1. Bench Test Certification.....	- 10 -
6.1.2. Bench Test Equipment List	- 10 -
6.2. Mechanical Durability Test	- 11 -
6.2.1. Mechanical Durability Test Certification	- 11 -
6.3. Environmental Durability Test	- 11 -
6.3.1. Environmental Durability Test Certification.....	- 11 -
6.3.2. Environmental Durability Test Equipment List.....	- 12 -
7. Qualification Test Matrix.....	- 12 -

1. Introduction

This report summarizes the validation test procedure (ATP0163) and results for the BEI Kimco enhanced DII15-60-201A High Temperature High Pressure Hall Commutated BLDC designs.

2. Purpose

The purpose of the validation test protocol was to validate the BEI Kimco enhanced DII15-60-201A design under the specified temperature, pressure, vibration and shock conditions. The approved design will be released as P/N DII15-60-201A.

3. Results

- Initial Standard Performance Acceptance Test (10 units)
 - ✓ All units passed Initial Bench performance tests.
- Environmental Durability Test
 - ✓ All units passed Environmental Durability performance tests.
- Mechanical Durability Test
 - ✓ All units passed Mechanical Durability test.
- Final Standard Performance Acceptance Test
 - ✓ All units passed Final Bench performance tests.
- The HPHT motor has been validated to withstand all environmental conditions outlined in this test report and is therefore released for sale.

4. Test Description

The validation test protocol was conducted between **08/09/14** and **1/11/17**.

- Ten (10) test units of BEI Kimco DII15-60-201A were used for the validation test program.
- Section 5 of this report describes the test procedure followed in this evaluation program.
- Section 6 describes the test data for each test sequence.

5. Test program

5.1. Standard Acceptance Test

This test applies for Initial, Intermediary and Final Bench Test. Its purpose is to validate the motors before and after the other tests; Mechanical Durability and Environmental Durability.

5.1.1. Resistance Measurement

Resistance was measured with a Model 2750 Multimeter/Switch System and then results were recorded.



Figure 5.1.1

5.1.2. Inductance Measurement

Inductance was measured with a four-terminal sensing device @ 1000Hz and results were recorded on result summary form.



Figure 5.1.2

5.1.3. Back Electro Motive Force (BEMF) Constant Measurement/Calculation

Motor was back driven @ 1800 rpm by externally coupled AC motor. The measurement was performed using an oscilloscope. The proper phase sequencing was verified.

BEMF value data was recorded and BEMF constant calculated.

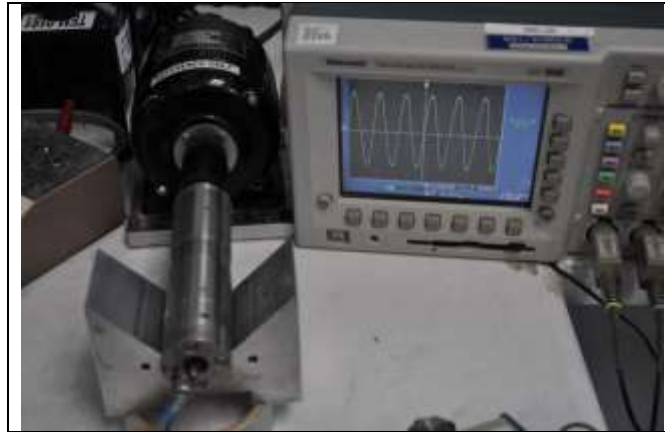


Figure 5.1.3

5.1.4. Insulation Resistance Test

Pass/fail test data was recorded.

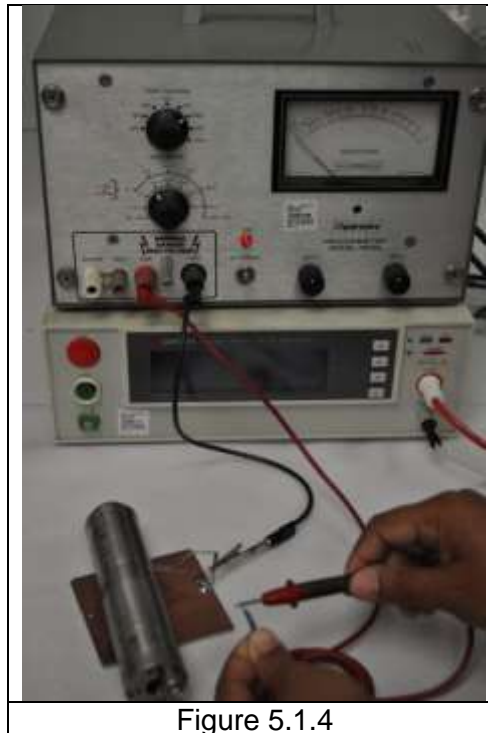


Figure 5.1.4

5.1.5. Functional Test

The device under test was driven open loop. The motor should rotate properly in both directions.

Speed and no load current data were recorded.



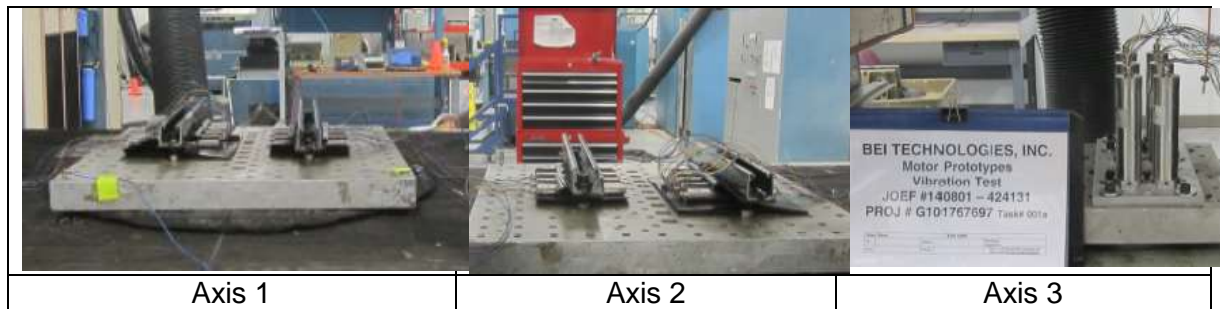
Figure 5.1.5

5.2. Mechanical Durability Test

5.2.1. Vibration Test

10 motors were tested to meet a reliability of 90% and a confidence of 50%.

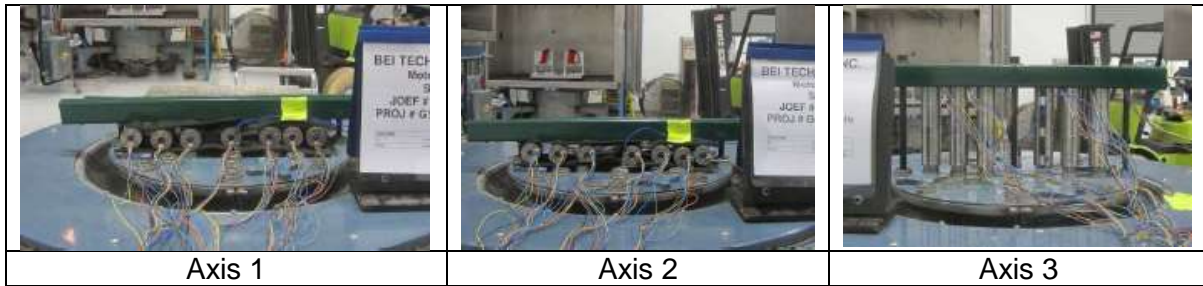
Frequency Range	30-500Hz
Amplitude	25 g rms
Number of Axes	3
Duration	3h/ Axis
Total Duration	9h



5.2.2. Shock Test

10 motors were tested to meet a reliability of 90% and a confidence of 50%.

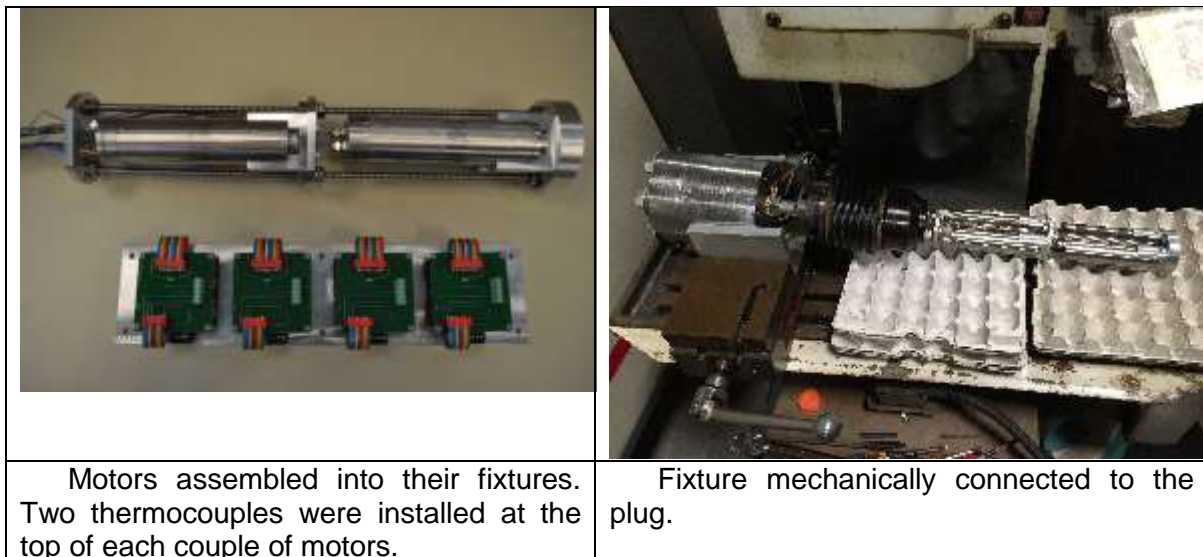
Pulse Amplitude	1000g (~9810m/s ²)
Pulse Duration	0.5 ms
Number of Axes	3
Number of Pulses/Axis	2
Total Pulses	6



5.3. Environmental Durability Test

10 motors were tested to meet a reliability of 90% and a confidence of 50%.

Pressure	30,000 psi
Temperature	205 °C
Total Duration	600h min

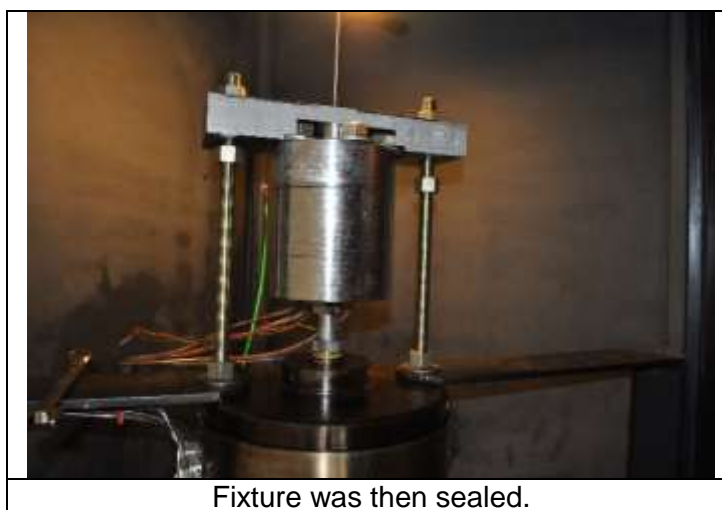


Motors assembled into their fixtures. Two thermocouples were installed at the top of each couple of motors.

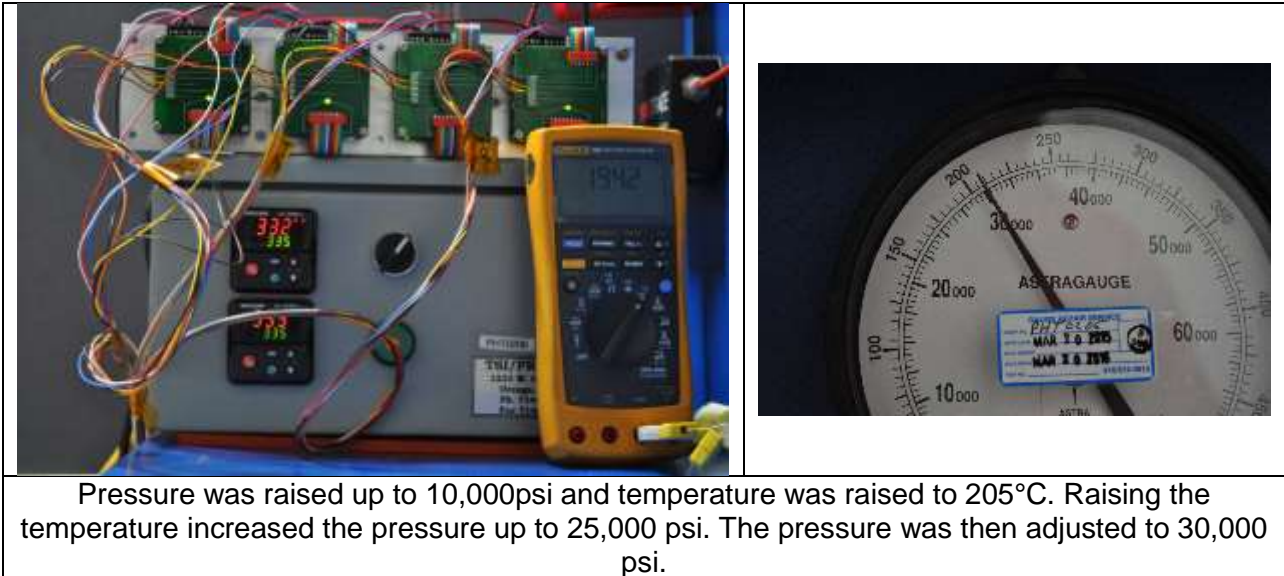
Fixture mechanically connected to the plug.



The fixture and plug were placed inside the vessel prefilled with oil. The connections to the controllers were then made.



Fixture was then sealed.



Pressure was raised up to 10,000psi and temperature was raised to 205°C. Raising the temperature increased the pressure up to 25,000 psi. The pressure was then adjusted to 30,000 psi.

Motors were powered during 100% of the life test duration, 660 hours restarting every 24 hours. A blinking LED indicated normal activity per motor. Activity was verified once per day.

The fixture was able to operate a maximum of 4 motors simultaneously. The test was divided in two groups (8 motors total)

6. Test Certification & Data

6.1. Standard Acceptance “Bench” Test

6.1.1. Bench Test Certification

Test Procedure No: ATP0142

No. of units tested: 10 Units

Test start date: 08/09/14

Test finish date: 08/09/14

Test operator: Dom Deguia

Remarks:

- All units passed initial bench performance tests.

6.1.2. Bench Test Equipment List

Test Name: 5.1 Bench Test

Procedure: ATP0142

Operator: Dom Deguia

Manufacturer	Model#	Description	Asset#	Last CAL	Next CAL
Keithley	2750	Resistance Meter	23207-07	02/19/14	02/05/15
QuadTech	1715LCR	Inductance Meter	23207-08	02/19/14	02/05/15
Hipotronics	HM3A	Insulation Resistance	23207-09	02/19/14	02/05/15
Tektronix	TDS3054B	Oscilloscope	23213-10	02/20/14	02/05/15
BEI Kimco	TFM0088	Controller	22620-24	NA	NA

6.2. Mechanical Durability Test

6.2.1. Mechanical Durability Test Certification

Test Procedure No: N/A, non-proprietary

No. of units tested: 10 Units

Test start date: 01/28/16

Test finish date: 01/29/16

Test operator: Elite Test

Remarks:

- All units passed mechanical durability tests.

6.2.1.1. *Vibration Test*

See 1600962-01 Vibration Test

6.2.1.2. *Shock Test*

See 1600962-01 Shock Test

6.3. Environmental Durability Test

6.3.1. Environmental Durability Test Certification

Test Procedure No: N/A, non-proprietary

No. of units tested: 10 Units

Test start date: 10/15/16

Test finish date: 11/17/16

Test operator: PHT

Remarks:

- All units passed environmental durability tests.

6.3.2. Environmental Durability Test Equipment List

Manufacturer	Model#	Description	Asset#	Last CAL	Next CAL
Astragauge	ASTR6	Pressure gauge	NA	03/20/15	03/20/16
Omega	5TC-TT-K-30-36	Thermocouple	NA	NA	NA
FLUKE	189	DMM		07/17/15	07/17/16
Ingenia	PLUTO-STD	Controller	NA	NA	NA
HIP	NA	Pressure Vessel	NA	NA	NA

7. Qualification Test Matrix

