PRODUCT ADVISORY NOTICE

KEEPING YOU INFORMED OF PRODUCT CHANGES

To: **All Customers, Sales Representatives and Distributors**

Date: December 23, 2019

Subject: **62A/V Die Cast Bushing Retooling**

This Product Advisory Notice is to alert you that Grayhill is retooling the die cast zinc bushing used on the 62A/V part numbers listed below. ***Please forward this notification to the appropriate person(s) in your organization.***

Description of Change
The die cast zinc bushing used in the 62A/V part numbers below is being retooled at an alternate supplier for supply chain risk mitigation reasons. This new tool has been qualified and approved for use in production units. Please see the qualification report SP02-2578.

Reason for Change
This die cast bushing has been retooled at a second source to mitigate supply chain risk potential issues.

Effective Date
December 23, 2019

Action Required
No action is required by the customer at this time. This is a notification of the configuration change on the part numbers below. Please contact your Grayhill, Inc. Customer Service Representative for further information.

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Part Numbers Affected

62A01-01-020C	62A11-02-035C	62A18-01-020C	62A22-02-200C	62AY22181	62V22-01-040S
62A01-01-020S	62A11-02-035CH	62A18-01-020S	62A22-02-240C	62AY22182	62V22-01-050C
62A01-01-020SH	62A11-02-035S	62A18-01-035C	62A22-02-250CH	62AY22185	62V22-01-060C
62A01-01-030S	62A11-02-040C	62A18-01-040CH	62A22-02-250S	62AY22186	62V22-01-060CH
62A01-01-040C	62A11-02-040CH	62A18-01-040SH	62A22-02-P	62AY22187	62V22-01-060S
62A01-01-040S	62A11-02-040S	62A18-01-P	62A30-01-020C	62AY22189	62V22-01-P
62A01-01-050CH	62A11-02-040SH	62A18-02-020C	62A30-01-070CH	62AY22190	62V22-02-020C
62A01-01-050S	62A11-02-050C	62A18-02-020S	62A30-01-080S	62AY22191	62V22-02-020CH
62A01-01-060C	62A11-02-050CH	62A18-02-030CH	62A30-01-120SH	62AY22192	62V22-02-020S
62A01-01-060S	62A11-02-050S	62A18-02-030S	62A30-01-P	62AY22196	62V22-02-025CH
62A01-01-060SH	62A11-02-050SH	62A18-02-040C	62A30-02-020C	62AY22197	62V22-02-030C
62A01-01-070CH	62A11-02-055C	62A18-02-040CH	62A30-02-020S	62AY22199	62V22-02-030CH
62A01-01-120S	62A11-02-060C	62A18-02-040SH	62A30-02-035CH	62AY30002	62V22-02-030SH
62A01-01-200S	62A11-02-060CH	62A18-02-050S	62A30-02-040C	62AY30003	62V22-02-040C
62A01-01-240SH	62A11-02-060S	62A18-02-060C	62A30-02-040CH	62AY30004	62V22-02-040CH
62A01-01-P	62A11-02-060SH	62A18-02-060S	62A30-02-040S	62V01-01-020S	62V22-02-050C
62A01-02-020C	62A11-02-070C	62A18-02-120S	62A30-02-040SH	62V01-01-025CH	62V22-02-050CH
62A01-02-020S	62A11-02-080C	62A18-02-150S	62A30-02-050C	62V01-01-050C	62V22-02-050S
62A01-02-030C	62A11-02-080CH	62A18-02-P	62A30-02-060C	62V01-01-080C	62V22-02-060C
62A01-02-030S	62A11-02-080S	62A22-01-020C	62A30-02-P	62V01-01-200SH	62V22-02-060CH
62A01-02-040CH	62A11-02-080SH	62A22-01-020CH	62AY01004	62V01-01-P	62V22-02-060S
62A01-02-040S	62A11-02-085S	62A22-01-020S	62AY01006	62V01-02-040C	62V22-02-160C
62A01-02-040SH	62A11-02-090C	62A22-01-020SH	62AY11097	62V01-02-040CH	62V22-02-P
62A01-02-050C	62A11-02-090SH	62A22-01-025C	62AY11153	62V01-02-060C	62V30-02-020C
62A01-02-050CH	62A11-02-100C	62A22-01-030CH	62AY11154	62V01-02-060SH	62V30-02-020S
62A01-02-250S	62A11-02-100CH	62A22-01-030S	62AY11155	62V01-02-P	62V30-02-030C
62A01-02-P	62A11-02-100S	62A22-01-035C	62AY11156	62V02-01-P	62V30-02-030S
62A02-01-020C	62A11-02-100SH	62A22-01-035CH	62AY11158	62V02-02-P	62V30-02-040C
62A02-01-020S	62A11-02-110C	62A22-01-040C	62AY11159	62V03-02-030S	62V30-02-080C
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62A02-01-040C	62A11-02-120C	62A22-01-040S	62AY11162	62V08-02-040C	62VY02002
62A02-01-040S	62A11-02-120CH	62A22-01-050C	62AY11165	62V11-01-020C	62VY11011
62A02-01-240SH	62A11-02-120S	62A22-01-050CH	62AY11166	62V11-01-020S	62VY11014
62A02-01-P	62A11-02-120SH	62A22-01-050S	62AY11167	62V11-01-030CH	62VY11018
62A02-02-060CH	62A11-02-130S	62A22-01-060C	62AY11168	62V11-01-040C	62VY11021
62A02-02-080C	62A11-02-140CH	62A22-01-060CH	62AY11172	62V11-01-050SH	62VY11022
62A02-02-P	62A11-02-150S	62A22-01-060S	62AY11173	62V11-01-060C	62VY11024
62A03-01-035C	62A11-02-160C	62A22-01-080S	62AY11174	62V11-01-060S	62VY11027
62A03-01-P	62A11-02-160CH	62A22-01-090CH	62AY11176	62V11-01-080SH	62VY11029
62A03-02-P	62A11-02-160S	62A22-01-090S	62AY11178	62V11-01-100C	62VY11030
62A05-01-070CH	62A11-02-180S	62A22-01-100C	62AY11179	62V11-01-110C	62VY11031

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62A05-01-P
62A05-02-030SH
62A05-02-060S
62A05-02-P
62A08-01-030S
62A08-02-030S
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62VY22011
62VY22012
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62VY22017
62VY22018
62VY22019
62VY22021
62VY22022
62VY22023
62VY30003

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62A11-01-150S	62A15-02-050S	62A22-02-085C	62AY22154	62V15-02-080C
62A11-01-180S	62A15-02-060C	62A22-02-090C	62AY22155	62V15-02-080CH
62A11-01-240S	62A15-02-060S	62A22-02-100C	62AY22157	62V15-02-080S
62A11-01-250C	62A15-02-070SH	62A22-02-100CH	62AY22160	62V15-02-180C
62A11-01-250S	62A15-02-080C	62A22-02-100S	62AY22162	62V15-02-P
62A11-01-P	62A15-02-080S	62A22-02-100SH	62AY22163	62V18-02-020C
62A11-02-020C	62A15-02-080SH	62A22-02-120C	62AY22165	62V18-02-040C
62A11-02-020CH	62A15-02-090C	62A22-02-130C	62AY22167	62V18-02-080CH
62A11-02-020S	62A15-02-090S	62A22-02-135C	62AY22170	62V18-02-100SH
62A11-02-020SH	62A15-02-100C	62A22-02-140C	62AY22171	62V18-02-P
62A11-02-025CH	62A15-02-100CH	62A22-02-150S	62AY22173	62V22-01-020C
62A11-02-030C	62A15-02-120C	62A22-02-155S	62AY22174	62V22-01-020S
62A11-02-030CH	62A15-02-120CH	62A22-02-160C	62AY22176	62V22-01-030C
62A11-02-030S	62A15-02-120S	62A22-02-160S	62AY22178	62V22-01-040C
62A11-02-030SH	62A15-02-P	62A22-02-180SH	62AY22180	62V22-01-040CH

Grayhill INC.
Intuitive Human Interface Solutions

Device Under Test:
621402-3

Environmental Test:
Humidity; Operational Temp; Storage Temp; Thermal Shock

Physical Test:
Mechanical Shock; Mechanical Vibration; Push Button Life; Rotational Life; Shaft Push Out;

Test Report Number:	**SP02-2578**
Test Start Date:	**12/04/2018**
Test Completion Date:	**2/15/2019**
Test Facility:	**Grayhill, Inc.**
Test Requested By:	**Jason Kifer**
Test Performed By:	**Jake Tilton / Laboratory Technician II** **Neringa Noreika / Quality Technician**
Report Written By:	**Jake Tilton / Laboratory Technician II** **Neringa Noreika / Quality Technician**
Report Approved By:	**Nick Walls** **Quality Lab Manager**

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REVISION HISTORY

Revision	Date	Written By	Description
A	3/06/2018	Jake Tilton, Neringa Noreika	Original

SUMMARY

1.1. PURPOSE

Qualification testing of new 62A bushing (621402-3) from Inventix.

1.2. REQUIREMENTS & METHODS

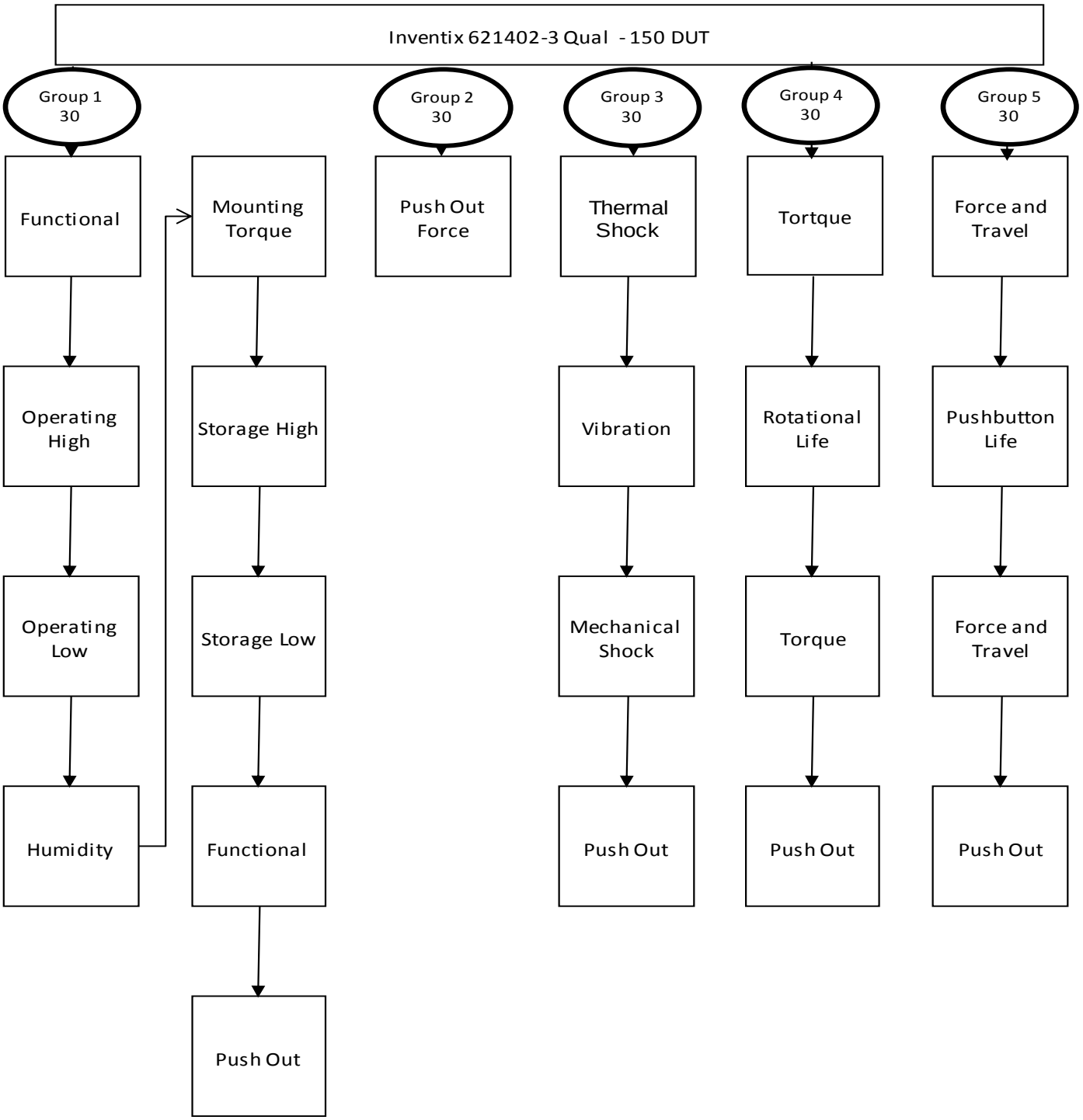
Tests to be performed per tests specified in the LREQ, per the 62 series qualification plan.

1.3. TEST SUMMARY

Table 1 – Test Summary

Test Description	Basic Standard	Test Results	Test Date	Test Location
Humidity	MIL-STD-202, Method 103B	PASS	1/03/2019- 1/07/2019	Grayhill, Inc.
Mechanical Shock	MIL-STD-202 Method 213	PASS	12/14/18	Grayhill, Inc.
Mechanical Vibration	(MIL-STD-202, Method 204, Test Condition B)	PASS	12/11/2018- 12/12/2018	Grayhill, Inc.
Operational Temp High	IEC 68-2-2, Method Aa	PASS	12/04/2018- 12/08/2018	Grayhill, Inc.
Operational Temp Low	IEC 68-2-2, Method Aa	PASS	12/08/2018- 12/13/2018	Grayhill, Inc.
Push Button Life	62 Series Optical Encoders DV Test Plan	PASS	2/07/2019- 2/18/2019	Grayhill, Inc.
Rotational Life	62 Series Optical Encoder Plan	PASS	12/04/2018- 1/03/2018	Grayhill, Inc.
Shaft Push Out	62 Series Optical Encoders DV Test Plan	PASS	12/04/18	Grayhill, Inc.
Shaft Push Out to Failure	62 Series Optical Encoders DV Test Plan	PASS	2/18/2019	Grayhill, Inc.
Storage Temp High	IEC 68-2-2, Method Ab	PASS	12/13/2018- 12/17/2018	Grayhill, Inc.
Storage Temp Low	IEC 68-2-2, Method Ab	PASS	12/18/2018- 12/22/2018	Grayhill, Inc.
Thermal Shock	MIL-STD-810F, Method 503.4, Procedure I	PASS	12/08/2018	Grayhill, Inc.

FLOW CHART


Inventix 621402-3 Qual - 150 DUT
Group 1 30
Group 2 30
Group 3 30
Group 4 30
Group 5 30
Functional
Operating High
Operating Low
Humidity
Mounting Torque
Storage High
Storage Low
Functional
Push Out
Push Out Force
Thermal Shock
Vibration
Mechanical Shock
Push Out
Tortque
Rotational Life
Torque
Push Out
Force and Travel
Pushbutton Life
Force and Travel
Push Out

2.0 HUMIDITY (MIL-STD-202, METHOD 103B)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Humidity	MIL-STD-202, Method 103B	621402-3	1-30	Grayhill Inc.	1/03/2019- 1/07/2019
				Results:	PASS

2.1. PURPOSE

This test is performed to evaluate the properties of materials used as they are influenced by the absorption and diffusion of moisture and moisture vapors.

This is an accelerated environmental test, accomplished by the continuous exposure of the DUT to high relative humidity at an elevated temperature.

2.2. TEST SETUP DETAILS

1. Visual Inspection of the DUT is to be performed before and after testing.
2. Perform the Functional Test.
3. Place the DUT in the chamber.
4. The DUT shall be conditioned at a temperature of 40 +5ºC / -0ºC and 90% humidity for a period of 24 hours.
5. Power up the chamber and let it stabilize at the specified temperatures and humidity.
6. When the set duration is complete, return the DUT to ambient conditions.
7. Perform the Functional Test after exposure.

Table 2 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-1012	Temperature and Humidity Chamber	SM-16-3200	Thermotron	8/2019
GT-554	Power Supply	GPS 4251	GW Instek	Verified with GT-539
GT-539	Multimeter	77	Fluke	8/2019

Table 3 –Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Hours	96
Operational Mode		Powered
Maximum Temperature	°C	40 +5 / -0
Humidity Level	%RH	90 – 95
Mating Connector Attached		Yes
Mounting Torque Test	Y/N	Yes

2.3. TEST SETUP PHOTOS

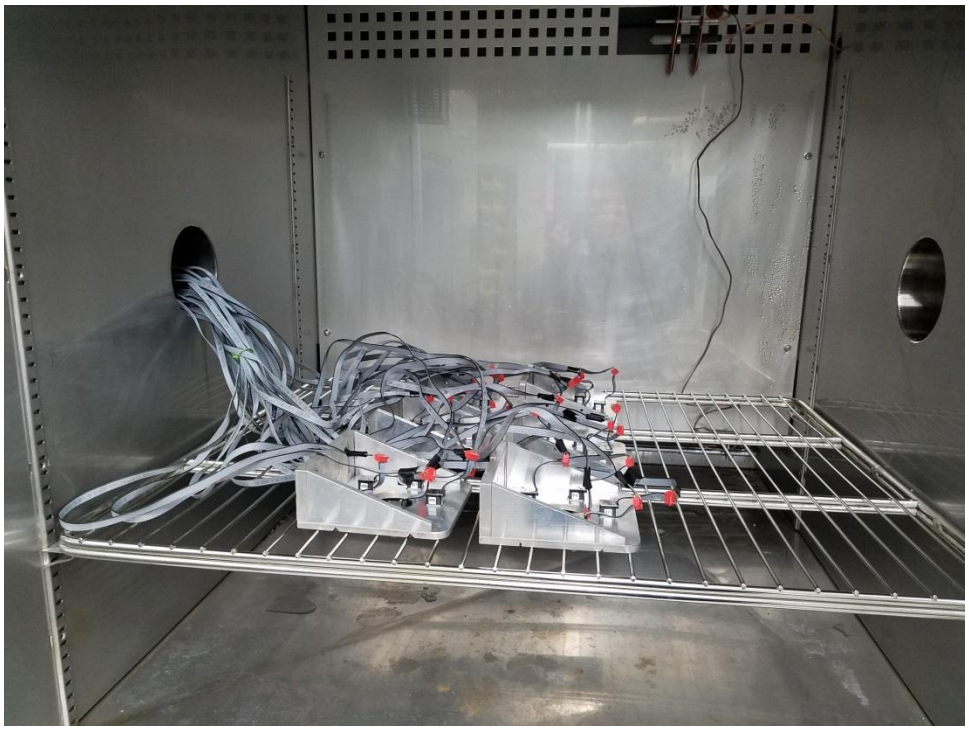


Figure 1 – Humidity Setup

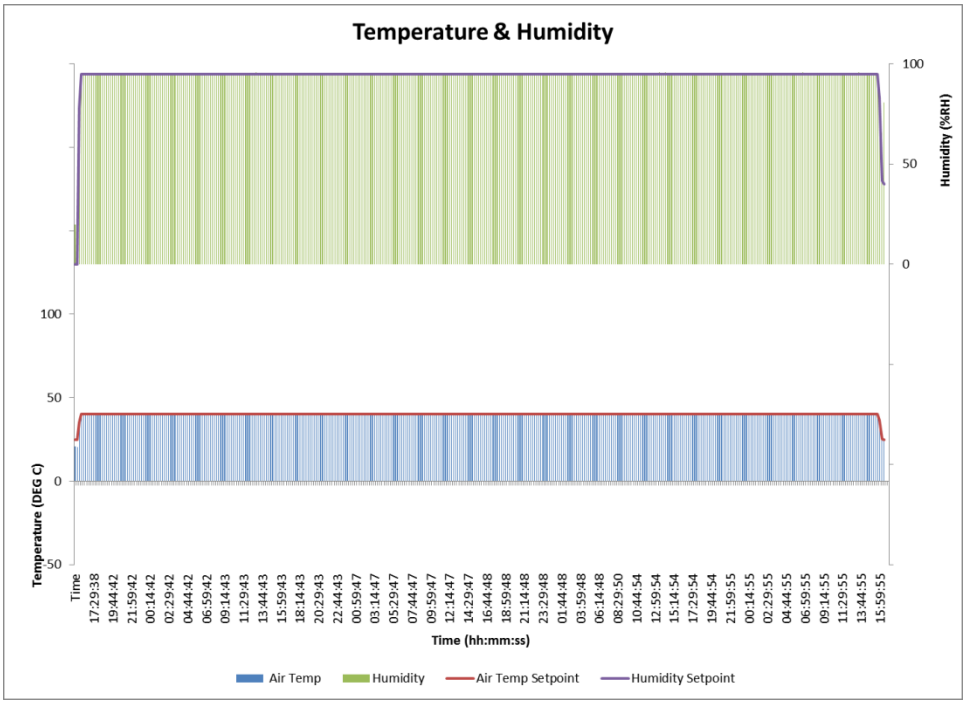


Figure 2 – Humidity Profile

2.4. ACCEPTANCE CRITERIA

The DUT must pass the Visual Check and Functional Check. DUT must pass mounting torque test after.

2.5. TEST RESULTS

All DUT passed a functional test after Humidity

Table 4 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
1-30	Humidity	MIL-STD-202, Method 103B	PASS	Grayhill Inc.	1/03/2019- 1/07/2019

3.0 MECHANICAL SHOCK (MIL-STD-202 METHOD 213)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Mechanical Shock	MIL-STD-202 Method 213	62A11-02-020C	31-60	Grayhill Inc.	12/14/18
				Results:	PASS

3.1. PURPOSE

The purpose of this test is to validate the manufacturing process in its ability to produce a product capable of withstanding the effects of shipping, handling, installation, and operational shock. The potential product issue modes and effects detected in this test are:

- Housing cracks
- Product/component breakage
- Inadvertent activation

Table 5– Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-534	Accelerometer	M-350A04	PCB Piezotronics	2/2019
GT-141	Mechanical Shock Table	M-RAD 1616(100)PA-MP	MRAD	Calibration at use (verified by controller's software & Accelerometer GT-534)

Table 6**– Mechanical Shock Condition C**

Test 1 – Condition C	Units	Parameters
Quantity		30
Operational Mode		Powered
Temperature	°C	Ambient
Pulse Type		Half Sine
Acceleration	G	100
Pulse duration	'msec.	6
Direction		3 in each of +/-X, +/-Y, +/-Z (18 shocks total)
Mating Connector Attached	Y/N	Yes

Table 7 **– Mechanical Shock Condition I**

Test 2 - Condition I	Units	Parameters
Quantity		30
Operational Mode		Powered
Temperature	°C	Ambient
Pulse Type		Sawtooth
Acceleration	G	100
Pulse duration	'msec.	6
Direction		3 in each of +/-X, +/-Y, +/-Z (18 shocks total)
Mating Connector Attached	Y/N	Yes

3.2. TEST SETUP

Figure 3 - Mechanical Shock Set-up

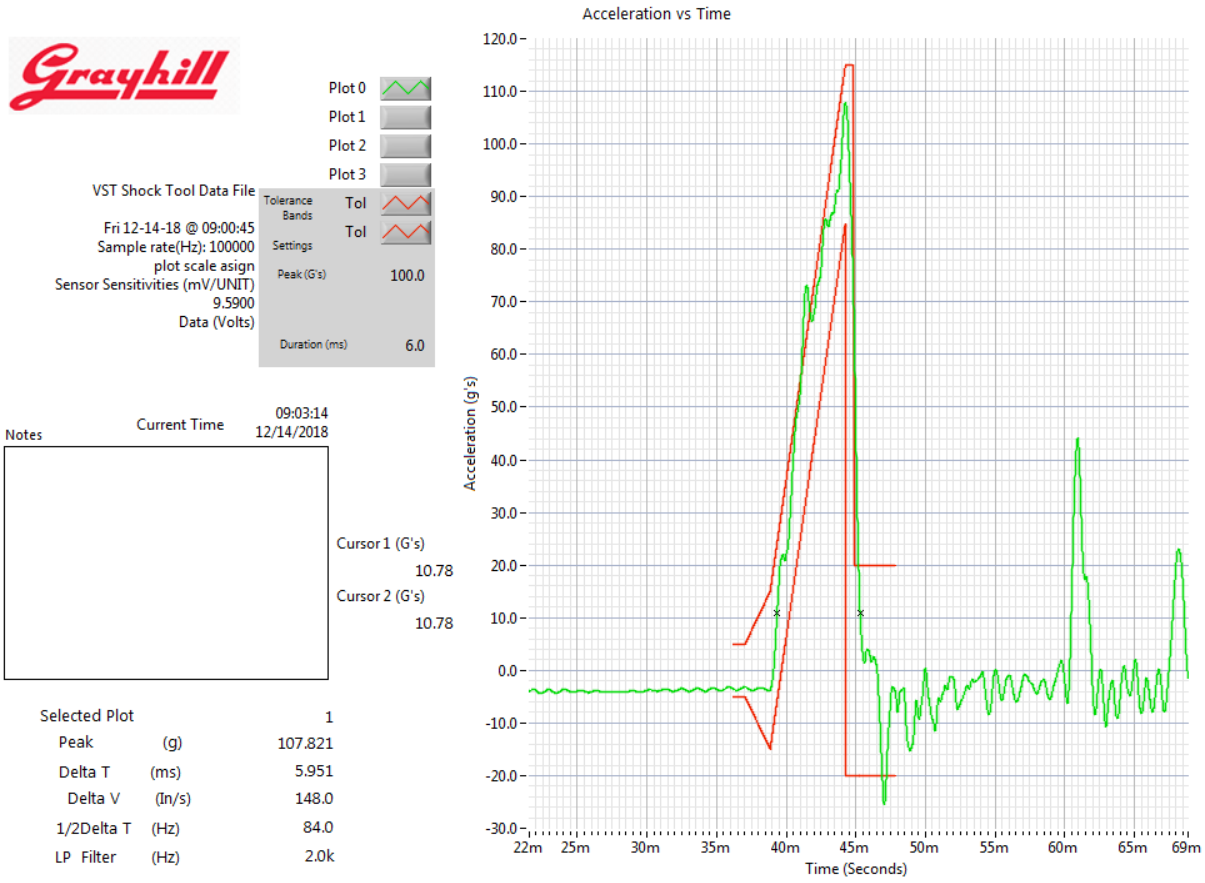


Figure 4 - Mechanical Shock Sawtooth Profile

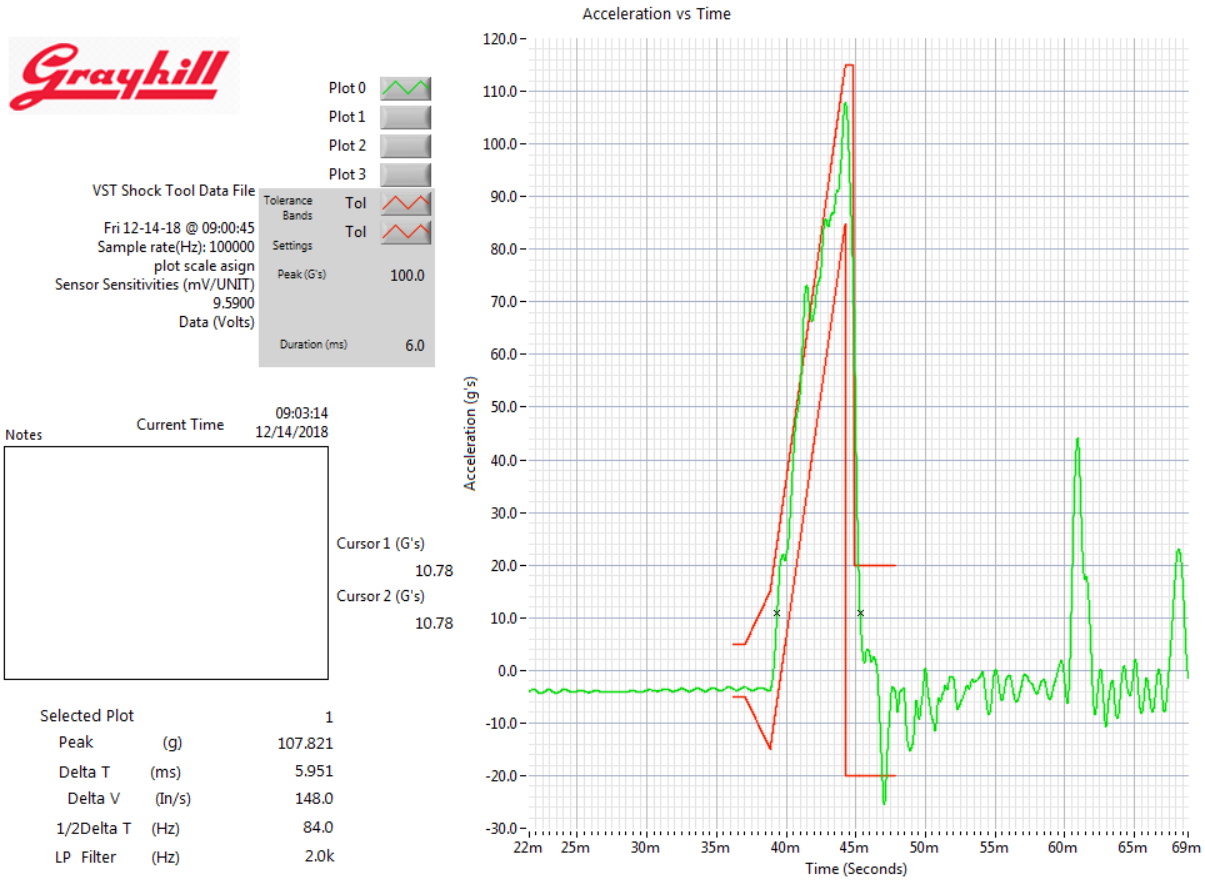


Figure 5 Mechanical Shock Half Sine Profile

Pass/Fail (Acceptance Criteria)

DUT must have no disassembly of parts. The DUT must be functionally tested and operate as intended after test.

Table 8 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
31-60	Mechanical Shock	MIL-STD-202 Method 213	PASS	Grayhill Inc.	12/04/2018- 12/08/2018

4.0 OPERATING HIGH TEMPERATURE (IEC 68-2-2, METHOD AA)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Operating High Temperature	IEC 68-2-2, Method Aa	621402-3	1-30	Grayhill Inc.	12/04/2018-12/08/2018
				Results:	PASS

4.1. PURPOSE

This test is performed to verify that the DUT can withstand the effects of extreme high temperatures. Typical environmental effects of this test are changes in physical properties and/or dimensions of materials resulting in:

- Binding due to contraction of dissimilar materials
- Permanent setting of resinous materials such as plastics and rubbers
- Cracking or crazing of organic materials

4.2. TEST SETUP DETAILS

1. Visual check.
2. Perform the Functional Test.
3. Power up the chamber and stabilize at the specified temperature in the Test Conditions Table.
4. Expose the DUT for the specified duration in Test Conditions Table.
5. When the test is complete return the DUT to ambient conditions
6. Perform the Visual Check after exposure.
7. Perform the Functional Test after exposure.

Table 9 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-1012	Temperature and Humidity Chamber	SM-16-3200	Thermotron	8/2019
GT-554	Power Supply	GPS 4251	GW Instek	Verified with GT-539
GT-539	Multimeter	77	Fluke	8/2019

Table 10 –Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Hours	96
Operational Mode		Powered
Functional Check Frequency	Daily	Minimum Once
Maximum Temperature	°C	85*
Mating Connector Attached		Yes

4.3. TEST SETUP PHOTOS

Figure 6 – Operating High Setup

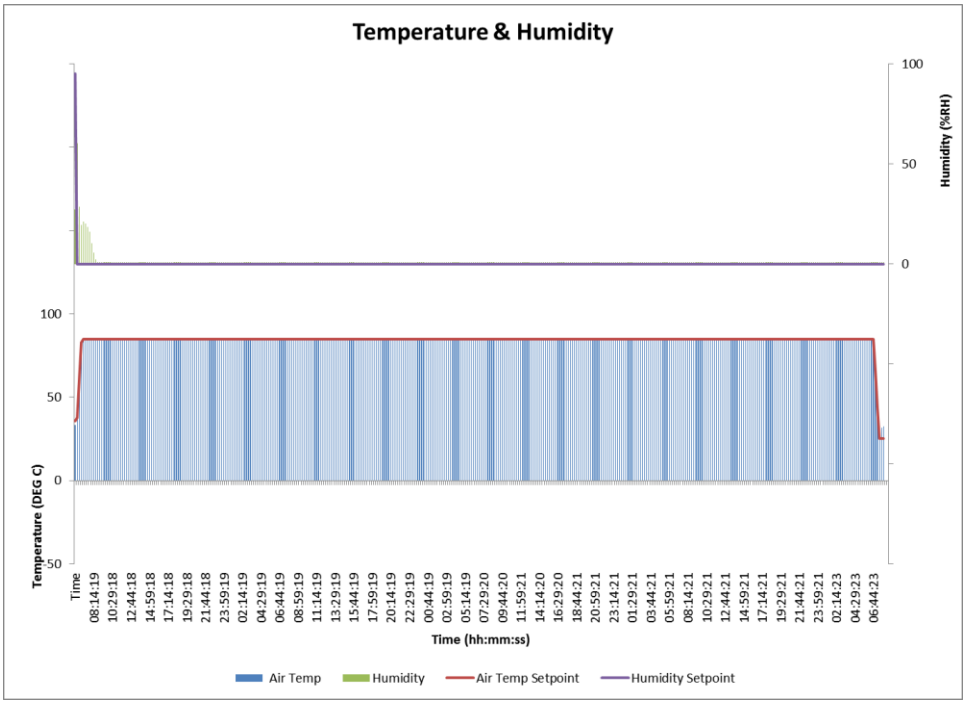


Figure 7 – Operating High Profile

4.4. ACCEPTANCE CRITERIA

The DUT must be functionally tested and operate as intended after test.

4.5. TEST RESULTS

All DUT were fully functional after the Operating High test.

Table 11 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
1-30	Operating High Temperature	IEC 68-2-2, Method Aa	PASS	Grayhill Inc.	12/04/2018- 12/08/2018

5.0 OPERATING LOW (IEC 68-2-2, METHOD AA)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Operating Low	IEC 68-2-2, Method Aa	621402-3	1-30	Grayhill Inc.	12/08/2018-12/13/2018
				Results:	PASS

5.1. PURPOSE

This test simulates the exposure of the DUT to low temperatures with electrical operation, e.g. the use of the system/components at very low ambient temperature. Failure mode is electrical malfunction caused by low temperature.

5.2. TEST SETUP DETAILS

1. Visual Inspection of the DUT is to be performed before and after testing.
2. Perform the Functional Test.
3. Place the DUT in the chamber.
4. Power up the chamber and let it stabilize at the specified temperatures.
5. Set DUT in normal operating mode.
6. Power up DUT by attaching its cable to test interface hardware.
7. Monitor DUT during test.
8. Check DUT for operational function a minimum of once per day.
9. When the set duration is complete, return the DUT to ambient conditions.
10. Perform the Functional Test after exposure.

Table 12 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-1012	Temperature and Humidity Chamber	SM-16-3200	Thermotron	8/2019
GT-554	Power Supply	GPS 4251	GW Instek	Verified with GT-539
GT-539	Multimeter	77	Fluke	8/2019

Table 13 –Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Hours	96
Operational Mode		Powered
Functional Check Frequency	Daily	Minimum Once
Minimum Temperature	°C	-40
Mating Connector Attached		Yes

5.3. TEST SETUP PHOTOS

Figure 8 – Operating Low Setup

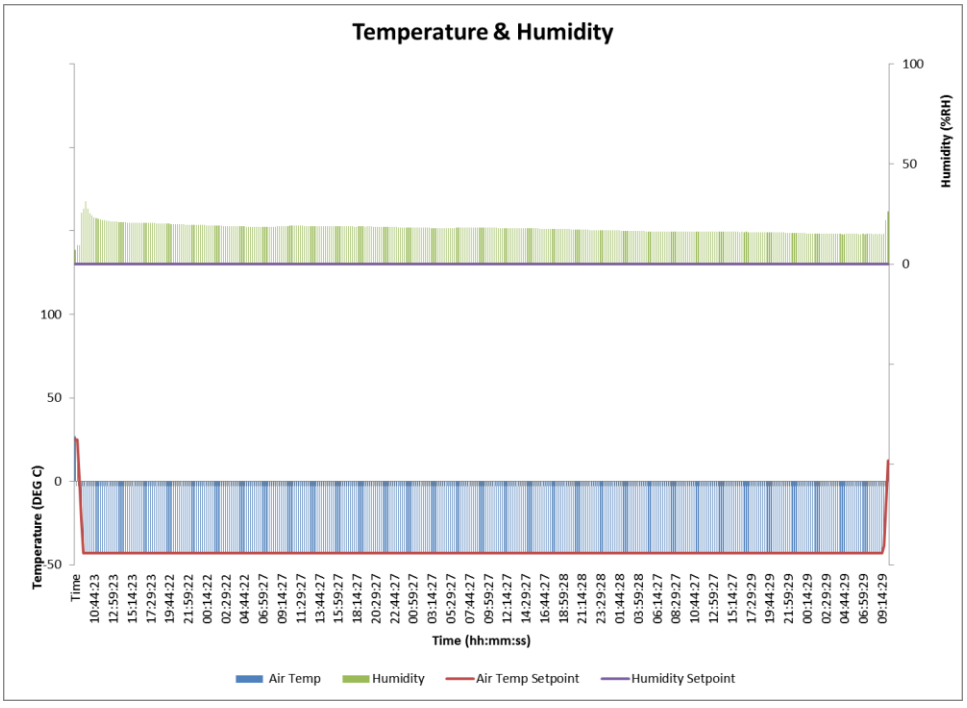


Figure 9 – Operating Low Profile

5.4. ACCEPTANCE CRITERIA

The DUT must be functionally tested and operate as intended after test.

5.5. TEST RESULTS

All DUT were fully functional after the Operating Low test.

Table 14 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
621402-3	Operating Low	IEC 68-2-2, Method Aa	PASS	Grayhill Inc.	12/08/2018-12/13/2018

6.0 PUSH BUTTON LIFE TEST (62 Series Optical Encoders DV Test Plan)

	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Push Button Life	62 Series Optical Encoders DV Test Plan	621402-3	71-90	Grayhill Inc.	2/07/2019-2/18/2019
				Results:	PASS

6.1. PURPOSE

The purpose for this test is to determine the effects of subjecting the mechanical and electronic components to repeated pushbutton actuations a number of actuations approximating the specified pushbutton life of the encoder.

6.2. PROCEDURE

1. Visual Inspection of DUT is to be performed before and after testing.
2. Measure and record initial actuation force of DUT.
3. Mount DUT on test fixture.
4. Set pushbutton tester to actuate DUT per Test Conditions table below.
5. Power up DUT by attaching its cable to a power supply.
6. Remove DUT from tester and measure actuation force, and travel of pushbutton at 1 million actuations.

Table 15- Push Button Life Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Cycles	1 Million
Actuation Rate	APM	60
Operational Mode		Powered
Temperature	°C	Ambient
Mating Connector Attached		YES

6.3. TEST SETUP PHOTO

Figure 10- Push Button Setup

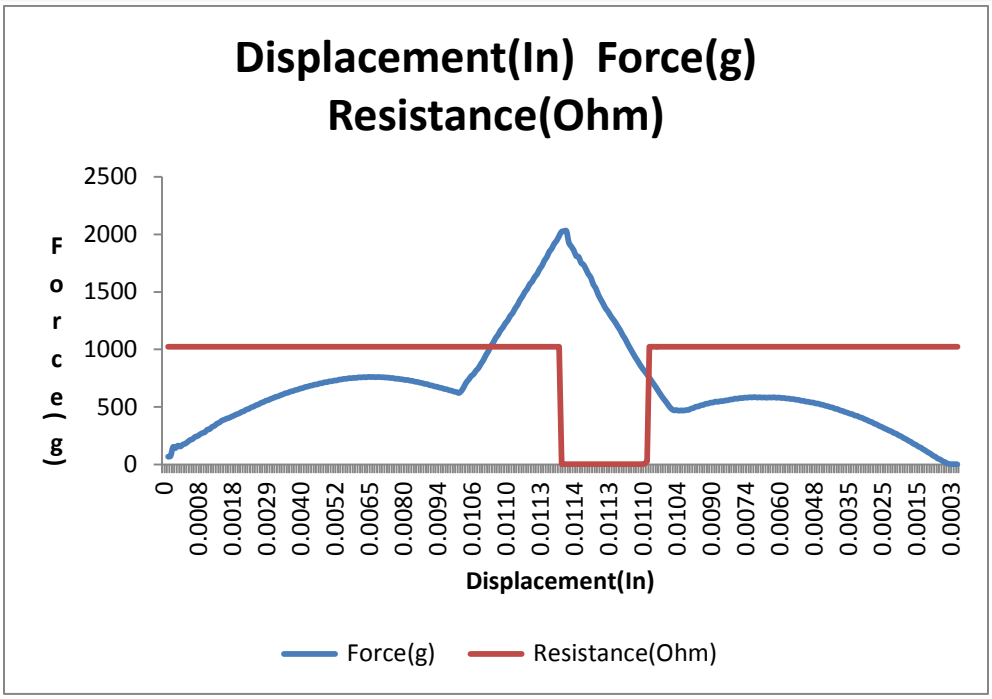


Figure 11 - Push Button Profile

6.4. ACCEPTANCE CRITERIA

The DUT must be functionally tested and operate as intended during and after the test.
DUT must have no damage or disassembled parts.

6.5. TEST RESULTS

All DUT passed the test. No damage or disassembled parts were detected.

Table 2 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
71-75, 81-90	Push Button Life	62 Series Optical Encoders DV Test Plan	PASS	Grayhill Inc.	2/07/2019- 2/18/2019

7.0 ROTATIONAL LIFE TEST (62 SERIES OPTICAL ENCODER PLAN)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Rotational Life Test	62 Series Optical Encoder Plan	621402-3	91-120	Grayhill Inc.	12/04/2018-1/03/2018
				Results:	PASS

7.1. PURPOSE

The purpose for this test is to determine the effects of subjecting the mechanical and electronic components to clockwise and counter clockwise shaft rotation to a number of cycles approximating the specified life of the encoder. Functional test measurements and rotational torque measurements shall be made prior to, during, and after test.

7.2. TEST SETUP DETAILS

1. Visual Inspection of DUT is to be performed before and after testing.
2. Perform the Functional Test.
3. Measure and record initial torque data for DUT. Measure torque in each detent position for both clockwise and counterclockwise rotation. DUT average torque is average of all detent positions.
4. Mount DUT on test fixture.
5. Set and adjust test fixture to Smart Motor Life Tester to assure that it rotated DUT correctly.
6. Set Life Tester to rotate through 100 cycles.
7. Remove DUT from tester and measure DUT torque at 100 cycles.
8. Mount DUT on test fixture.
9. Set Life Tester to rotate through 250,000 cycles.
10. Remove DUT from tester and measure DUT torque at following overall cycle count: 250,000, 500,000, and 750,000 cycles.
11. When DUT reaches 1 million cycles, perform final torque and functional test.

Table 16 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-400	Torque Wrench	CAL-36/4 Roto Torq	Sturtevant Richmont	4/19
P-988	Torque Sensor	BGI	Mark-10	9/19
RLS-105 w/fix #65	Rotational Life Cycle Assy.	N/A	Grayhill	N/A
RLS-90 w/fix #63	Rotational Life Cycle Assy.	N/A	Grayhill	N/A
RLS-92 w/fix #83	Rotational Life Cycle Assy.	N/A	Grayhill	N/A

Table 17 –Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Cycles	1 Million *
Cycle Rate	RPM	30 *
Operational Mode		Unpowered
Temperature	°C	Ambient
Mating Connector Attached		No

Note: One cycle is a full rotation clockwise and a full return rotation counterclockwise

7.3. TEST SETUP PHOTOS

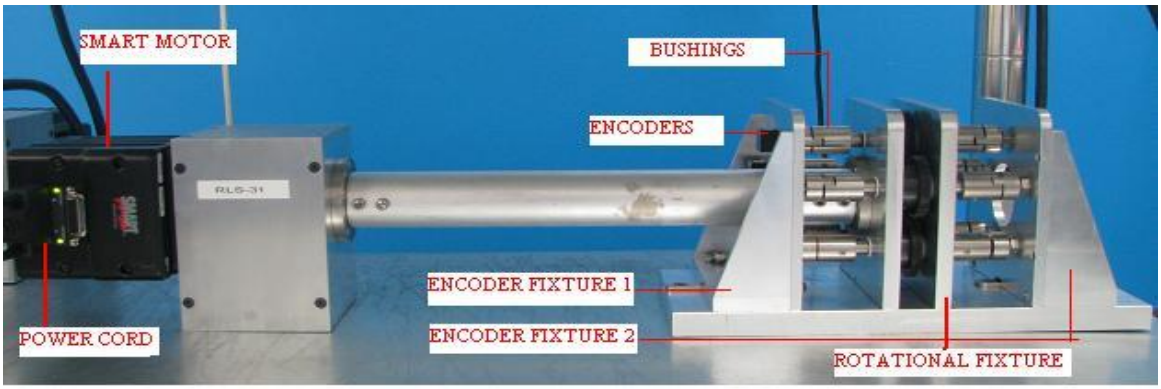


Figure 12 – Rotational Life Test Setup

7.4. ACCEPTANCE CRITERIA

The DUT must be functionally tested and operate as intended after the test.
DUT must have no damage or disassembled parts. Final average torque measurement (after 1 million cycles) for DUT must be no less than 50% of initial torque measurement.

7.5. TEST RESULTS

All DUT had no disassembled parts and operate as intended after Rotational Life. Final torque was within 50% of initial

Table 18 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
621402-3	Rotational Life Test	62 Series Optical Encoder Plan	**PASS**	Grayhill Inc.	12/04/2018-1/03/2018

8.0 PUSH-OUT FORCE (62 Series Optical Encoders DV Test Plan)

	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Push-Out Force	62 Series Optical Encoders DV Test Plan	621402-3	121-148	Grayhill Inc.	12/04/18
				Results:	PASS

8.1. PURPOSE

This test is to determine if the DUT can handle the specified compressive force applied in the direction of the axis of the shaft. The force applied shall be the minimum specified for the switch.

8.2. TEST SETUP DETAILS

1. Mounted DUT in a metal plate using the specified maximum mounting torque.
2. Applied a compressive force in the direction of the axis of the shaft.

Table 19 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-171	Force Gauge	M5-500	MARK-10	2/28/19
GT-172	Force and Travel	ESM 301L	MARK-10	N/A

8.3. TEST SETUP PHOTO

Figure 13 - Pull Out Test Setup

Table 20 - Test Conditions

Test Condition	Units	Parameters
Quantity	DUT	28
Operational Mode		Unpowered
Temperature	°C	Ambient
Compressive Force Limits	Lbs.	45

8.4. ACCEPTANCE CRITERIA

DUT must have no damage or disassembled parts when tested at a Compressive Force limits (45Lbs.). The DUT must be functionally tested and operate as intended after application of 45 Lbs. load.

8.5. TEST RESULTS

All DUT were able withstand 45 Lbs. of Compressive Force

Table 21 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
621402-3	Push-Out Force	62 Series Optical Encoders DV Test Plan	PASS	Grayhill Inc.	12/04/2018

9.0 PUSH-OUT TO FAILURE TEST (62 Series Optical Encoders DV Test Plan)

	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Push-out to Failure	62 Series Optical Encoders DV Test Plan	621402-3	1-148	Grayhill Inc.	2/18/2019
				Results:	PASS

9.1. PURPOSE

The purpose for this test is to determine the push out force at failure.

9.2. TEST SETUP DETAILS

1. Mounted DUT in a metal plate using the specified maximum mounting torque.
2. Applied a compressive force in the direction of the axis of the shaft.
3. Record actuation force at failure.

Table 22 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-171	Force Gauge	M5-500	MARK-10	2/28/19
GT-172	Force and Travel	ESM 301L	MARK-10	N/A

9.3. TEST SETUP PHOTO

Figure 14 - Push Out Force Test Setup

9.4. TEST RESULTS

Table 23 – Test Results

1. High/Low, Humidity		2.Pushout Force only		3.Thermal Shock, Vibration, Mechanical Shock		4. Rotational Life		5. Push Button Life	
1'-30		121-148		31-60		91-120		61-90	
Serial #	Force (Lbs.)	Serial #	Force (Lbs.)	Serial #	Force (Lbs.)	Serial #	Force (Lbs.)	Serial #	Force (Lbs.)
1	212.9	121	130.9	31	130.9	91	151	61	-
2	148.9	122	171.9	32	171.9	92	140.7	62	-
3	115.4	123	80.5	33	80.5	93	114.8	63	-
4	85.6	124	110.6	34	110.6	94	111.4	64	-
5	124.2	125	108	35	108	95	145.7	65	-
6	173.3	126	160	36	160	96	134	66	-
7	83.8	127	168.2	37	168.2	97	178.1	67	-
8	128.8	128	90.9	38	90.9	98	123	68	-
9	150	129	184.8	39	184.8	99	119	69	-
10	176.5	130	181.5	40	181.5	100	117	70	-
11	121.5	131	138.9	41	138.9	101	118.1	71	99.3
12	169.5	132	151	42	151	102	214	72	165
13	184.7	133	133.4	43	133.4	103	152.2	73	93.1
14	134	134	157	44	157	104	197.3	74	123.1
15	134.7	135	146.9	45	180.6	105	128.9	75	160
16	192.3	136	154.1	46	146.9	106	139.9	76	-
17	84.9	137	95.8	47	154.1	107	136.3	77	-
18	160.5	138	135.8	48	161.3	108	173.7	78	-
19	96.5	139	117.8	49	168.5	109	220.9	79	-
20	163.1	140	161.2	50	175.7	110	86.8	80	-
21	100.6	141	147.3	51	182.9	111	179.6	81	148.7
22	163.5	142	95.8	52	190.1	112	220.4	82	110.5
23	134.9	143	122.7	53	197.3	113	92.9	83	138
24	129	144	199	54	204.5	114	124.1	84	215.2
25	121.3	145	123	55	211.7	115	120	85	167.1
26	96.1	146	87.6	56	218.9	116	139.1	86	200.7
27	117.4	147	153.5	57	226.1	117	131.4	87	111.1
28	110.1	148	143.1	58	233.3	118	80.2	88	135.9
29	95.1			59	240.5	119	148.2	89	141.5
30	178.5			60	247.7	120	137.5	90	150.2

10.0 STORAGE HIGH TEMPERATURE (IEC 68-2-2, METHOD AB)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Storage High Temperature	IEC 68-2-2, Method Ab	621402-3	1-30	Grayhill Inc.	12/13/2018-12/17/2018
				Results:	PASS

10.1. PURPOSE

This test is performed to verify that the DUT can withstand the effects of extreme high temperatures. Typical environmental effects of this test are changes in physical properties and/or dimensions of materials resulting in:

- Binding due to contraction of dissimilar materials
- Permanent setting of resinous materials such as plastics and rubbers
- Cracking or crazing of organic materials

10.2. TEST SETUP DETAILS

1. Visual check.
2. Perform the Functional Test.
3. Power up the chamber and stabilize at the specified temperature in the Test Conditions Table.
4. Expose the DUT for the specified duration in Test Conditions Table.
5. When the test is complete return the DUT to ambient conditions
6. Perform the Visual Check after exposure.
7. Perform the Functional Test after exposure.

Table 24 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-1012	Temperature and Humidity Chamber	SM-16-3200	Thermotron	8/2019

Table 25 –Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Hours	96
Operational Mode		Powered
Functional Check Frequency	Daily	Minimum Once
Maximum Temperature	°C	100
Mating Connector Attached		Yes

10.3.TEST SETUP PHOTOS

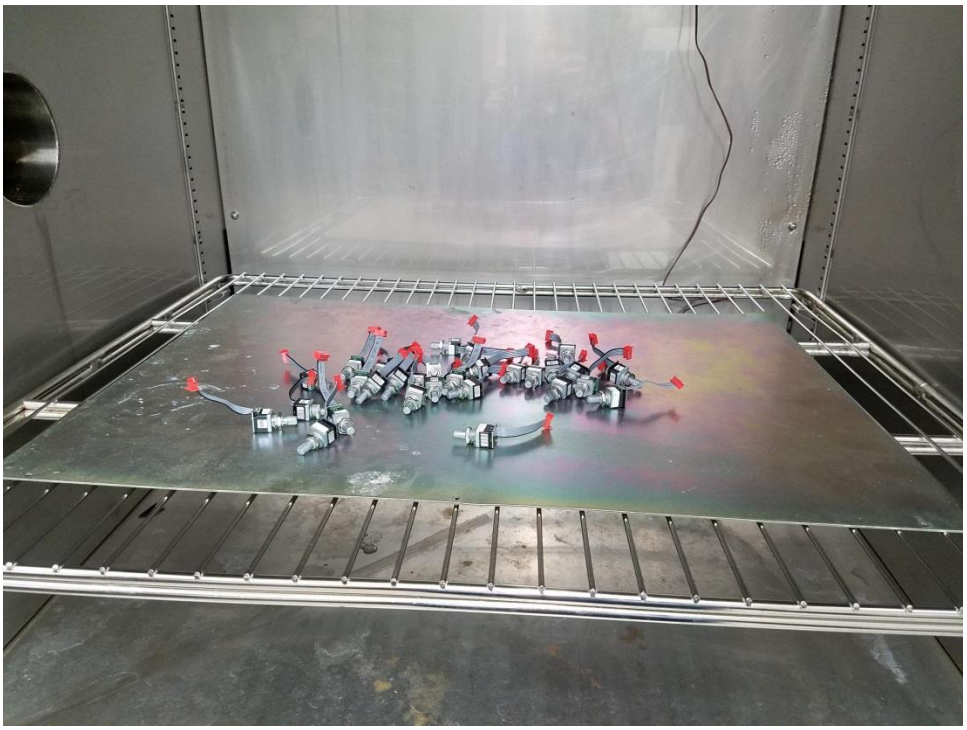


Figure 15 – Storage High Setup

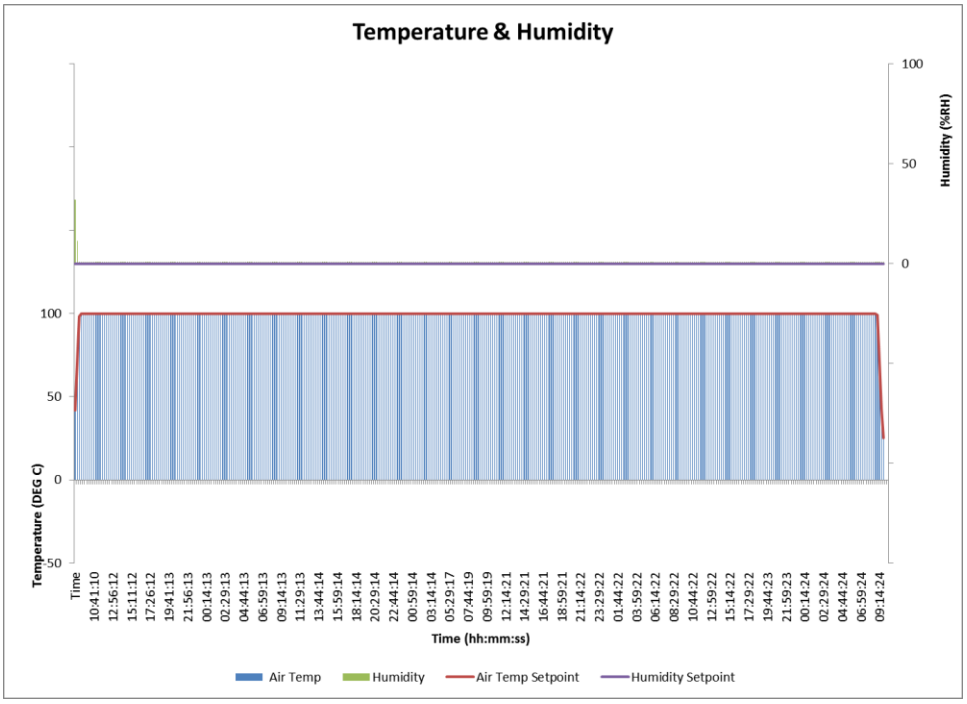


Figure 16 – Storage High Profile

10.4. ACCEPTANCE CRITERIA

The DUT must be functionally tested and operate as intended after test.

10.5. TEST RESULTS

All DUT were fully functional after Storage High.

Table 26 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
1-30	Storage High Temperature	IEC 68-2-2, Method Ab	PASS	Grayhill Inc.	12/13/2018- 12/17/2018

11.0 STORAGE LOW TEMPERATURE (IEC 68-2-2, METHOD AB)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Storage Low Temperature	IEC 68-2-2, Method Ab	621402-3	1-30	Grayhill Inc.	12/18/2018-12/22/2018
				Results:	PASS

11.1. PURPOSE

This test is performed to verify that the DUT can withstand the effects of extreme high temperatures. Typical environmental effects of this test are changes in physical properties and/or dimensions of materials resulting in:

- Binding due to contraction of dissimilar materials
- Permanent setting of resinous materials such as plastics and rubbers
- Cracking or crazing of organic materials

11.2. TEST SETUP DETAILS

1. Perform the Functional Test.
2. Power up the chamber and stabilize at the specified temperature in the Test Conditions Table.
3. Expose the DUT for the specified duration in Test Conditions Table.
4. When the test is complete return the DUT to ambient conditions
5. Perform the Visual Check after exposure.
6. Perform the Functional Test after exposure.

Table 27 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-1012	Temperature and Humidity Chamber	SM-16-3200	Thermotron	8/2019

Table 28 –Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Hours	96
Operational Mode		Unpowered
Functional Check Frequency	Daily	Minimum Once
Maximum Temperature	°C	-55
Mating Connector Attached		Yes

11.3.TEST SETUP PHOTOS

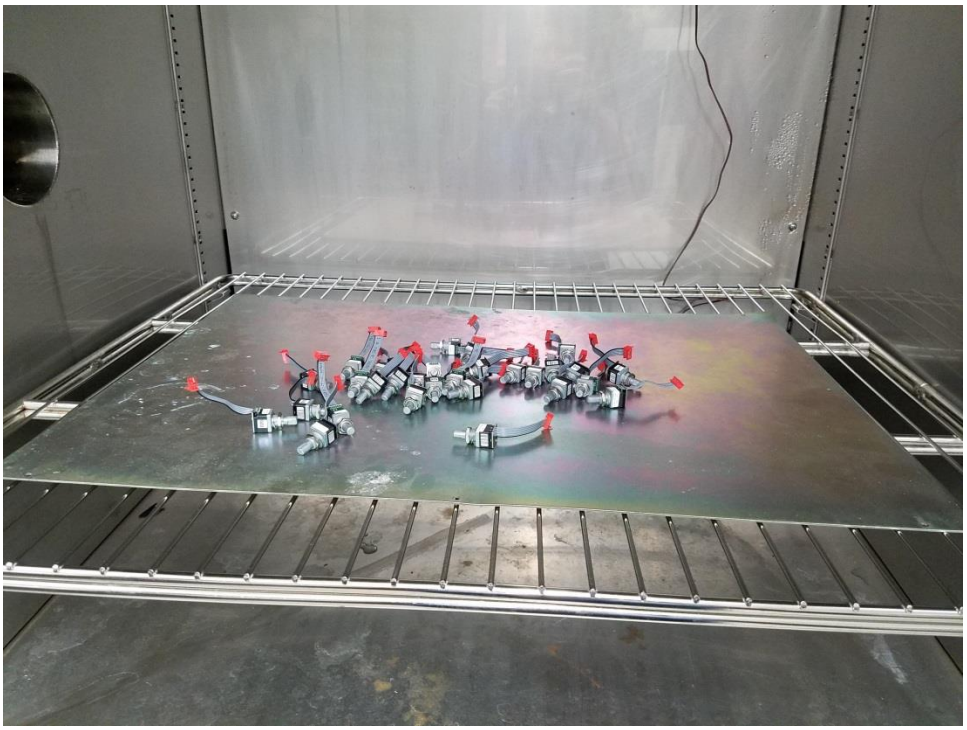


Figure 17 – Storage Low Setup

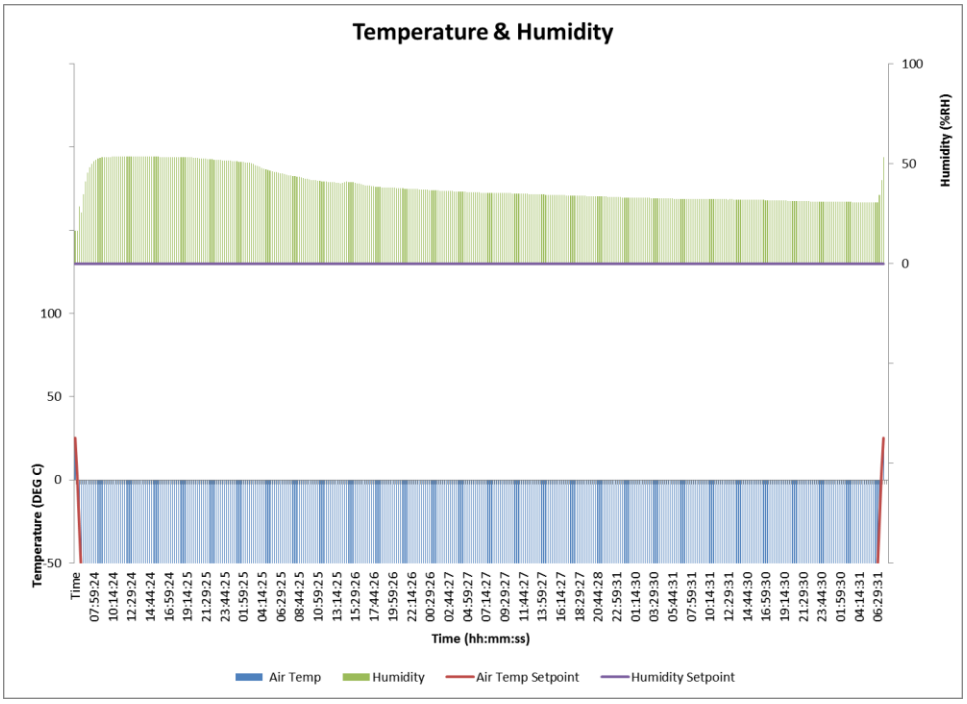


Figure 18 – Storage Low Profile

11.4. ACCEPTANCE CRITERIA

The DUT must be functionally tested and operate as intended after test.

11.5. TEST RESULTS

All DUT were fully functional after Storage Low.

Table 29 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
1-30	Storage Low Temperature	IEC 68-2-2, Method Ab	PASS	Grayhill Inc.	12/18/2018- 12/22/2018

12.0 THERMAL SHOCK (MIL-STD-810F, METHOD 503.4, PROCEDURE I)

Test	Specification	DUT Part Number	DUT Serial Number	Test Location	Test Date
Thermal Shock	MIL-STD-810F, Method 503.4, Procedure I	621402-3	31-60	Grayhill Inc.	12/08/2018
				Results:	PASS

12.1. PURPOSE

This test is performed to verify that the DUT is free from manufacturing defects caused by thermally induced stresses, which could occur during intended useful life. This test is intended specifically for assessing thermal coefficient mismatch issues, particularly solder fatigue cracking. Typical environmental effects of this test are fatiguing of materials due to stress created by contraction and expansion of materials. Fatigue issues can occur in:

- solder
- solder connections
- PCB traces

12.2. TEST SETUP DETAILS

1. Visual Inspection of the DUT is to be performed before and after testing.
2. Perform the Functional Test.
3. Place the DUT in the chamber.
4. Power up the chamber and let it stabilize at the specified temperatures.
5. Continue to cycle the DUT according to the test condition table.
6. When the total number of cycles are complete, return the DUT to ambient conditions.
7. Perform the Functional Test.

Table 30 – Equipment List

Equipment ID	Equipment Type	Model Number	Manufacturer	Calibration Due Date
GT-1008	Thermal Shock Chamber	VTS-3-6-6-SC/WC	Cincinnati Sub	10/2019

Table 31 –Test Conditions

Test Condition	Units	Parameters
Quantity		30
Duration	Cycles	25
Operational Mode		Unpowered
Minimum Temperature	°C	-55
Maximum Temperature	°C	100
Dwell Time	Hour	1
Mating Connector Attached		No

12.3.TEST SETUP PHOTOS

Figure 19 – Thermal Shock Setup

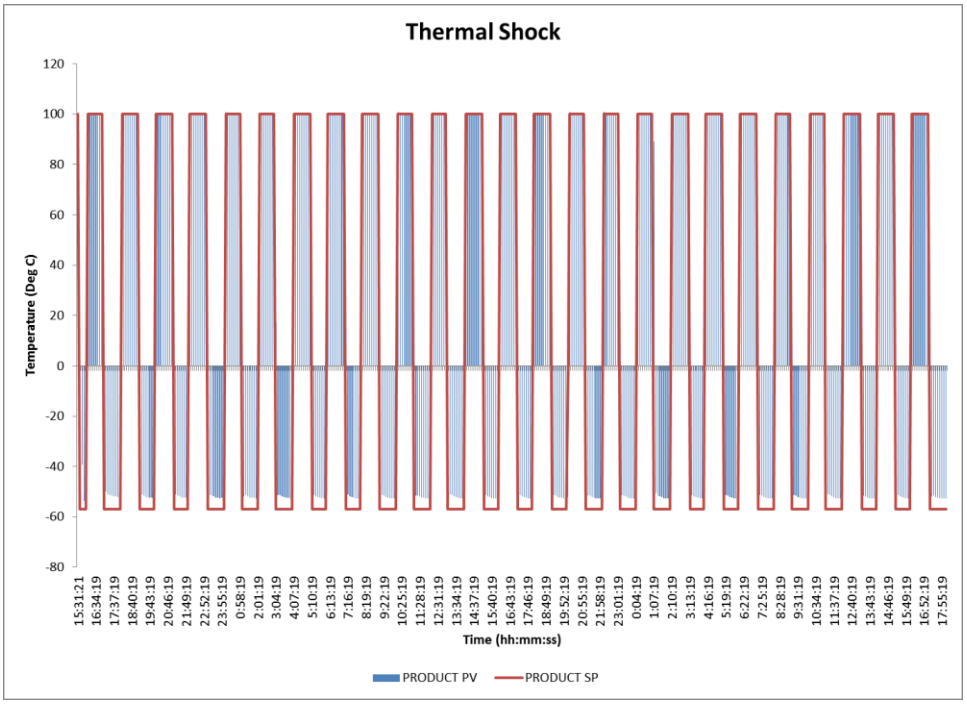


Figure 20 – Thermal Shock Profile

12.4. ACCEPTANCE CRITERIA

The DUT must have no part breakage and no disassembly of parts. The DUT must be functionally tested and operate as intended after test.

12.5. TEST RESULTS

All DUT had no breakage or disassembly of parts and were functional after Thermal Shock

Table 32 – Test Results

DUT	Test	Specification	Pass	Test Location	Test Date
31-60	Thermal Shock	MIL-STD-810F, Method 503.4, Procedure I	PASS	Grayhill Inc.	12/08/2018