FINAL REPORT NUMBER 226EM-MGA-15-02

SAFETY COMPLIANCE TESTING FOR FMVSS 226
Ejection Mitigation

FCA US LLC
2015 Chrysler 200S
NHTSA No. C20150301

MGA RESEARCH CORPORATION
446 Executive Drive
Troy, Michigan 48083

Test Dates: April 30-May 1, 2015
Report Date: May 6, 2015

FINAL REPORT

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
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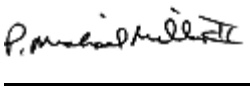
Approved By: 

Approval Date: _____

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Accepted By: _____K. Nuschler_____

Acceptance Date: _____8.31.2015_____

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12. Sponsoring Agency Name and Address U.S. Department Of Transportation National Highway Traffic Safety Administration Enforcement Office of Vehicle Safety Compliance 1200 New Jersey Avenue, SE West Building, 4th Floor Washington, D.C. 20590		13. Type of Report and Period Covered Final Test Report 14. Sponsoring Agency Code NVS-220	
15. Supplementary Notes			
16. Abstract A compliance test series was conducted on the subject 2015 Chrysler 200S, NHTSA No. C20150301, in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-226-00. The testing was conducted at MGA Research Corporation in Troy, Michigan on April 30-May 1, 2015. Test failures identified were as follows: None			
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TABLE OF CONTENTS

1.0 PURPOSE OF COMPLIANCE TEST

The FMVSS 226 Ejection Mitigation compliance test sponsored by the National Highway Traffic Safety Administration (NHTSA) was conducted under Contract DTNH22-11-D-00246. The purpose of this test was to evaluate ejection mitigation performance in a 2015 Chrysler 200S.

Tests were conducted on April 30-May 1, 2015 on a 2015 Chrysler 200S, manufactured by FCA USA LLC.

All tests were conducted in accordance with the U. S. Department of Transportation, National Highway Traffic Safety Administration's Laboratory Test Procedure TP-226-00 dated March 1, 2011 and the corresponding MGA Research Corporation's FMVSS 226 procedure numbers.

MGATP_226_EM_GOV_SETUP/TARGETING, dated 07/05/13
MGATP_226_EM_GOV_IMPACT TEST SERIES, dated 04/11/14

All tests were conducted at MGA Research Corporation in Troy, Michigan and were performed by MGA engineers and technicians. The FMVSS 226 Ejection Mitigation Impactor was used to conduct the testing.

2.0 TEST PROCEDURE AND DISCUSSION OF TEST

A 2015 Chrysler 200S was tested on April 30-May 1, 2015, by MGA Research Corporation, Troy, Michigan. The window targets tested as part of the compliance test are as follows:

- 2nd Row Right-Hand (RH) Front Upper Primary, 20 kph, 1.5 sec.
- 1st Row Left-Hand (LH) Front Lower Primary, 20 kph, 1.5 sec.
- 1st Row Left-Hand (LH) Front Lower Primary, 16 kph, 6.0 sec.
- 2nd Row Right-Hand (RH) Rear Lower Primary, 20 kph, 1.5 sec.

Pre-test and post-test photographs of the test vehicle, a 2015 Chrysler 200S, are included in this report.

An Ejection Mitigation Impactor was placed at each target location according to instructions in the OVSC Ejection Mitigation Laboratory Test procedure dated March 1, 2011. Each event was documented by three (3) cameras.

DATA SHEET NO. 1
REPORT OF VEHICLE CONDITION

CONTRACT NO. DTNH22-11-D-00246 Date: April 29, 2015

From: MGA Research Corporation

To: NHTSA, OVSC, NVS-224

Purpose: □ Initial Receipt □ Received via Transfer ☑ Present Vehicle Condition

Model Year/Make/Model/Body Style: 2015 Chrysler 200S

MANUFACTURE DATE: December, 2014 NHTSA NO.: C20150301
BODY COLOR: Velvet Red Pearlcoat VIN: 1C3CCCBB3FN647237
GVWR 2092.0 kg GAWR (Fr) 1185.0 kg GAWR (Rr) 1185.0 kg
Odometer Readings: ARRIVAL miles 13 DATE February 17, 2015
COMPLETION miles 13 DATE May 1, 2015
Dealer's name: Palmen Motors Inc.

A. All options listed on "window sticker" are present on the test vehicle. ☑Yes __No

B. Tires and wheel rims are new and the same as listed. ☑Yes __No

C. There are no dents or other interior or exterior flaws. ☑Yes __No

D. The vehicle has been properly prepared and is in running condition. ☑Yes __No

E. Keyless remote is available and working. ☑Yes __No __ N/A

F. The glove box contains an owner's manual, warranty document, consumer information, and extra set of keys.☑Yes __No

G. Proper fuel filler cap is supplied on the test vehicle. ☑Yes __No

H. Used permanent marker to identify vehicle with NHTSA number and FMVSS Test type(s) on roof line above driver door. ☑Yes __No

I. Placed vehicle in storage area. ☑Yes __No

J. Inspect the vehicle's interior and exterior, including all windows, seats, doors, etc., to confirm that each system is complete and functional per the manufacturer's specifications. Any damage, misadjustment, or other unusual condition that could influence the test program or test results shall be recorded. Report any abnormal condition to the NHTSA COTR before beginning any test.

☑Vehicle OK ___Conditions reported below in comment section

Identify the letter above to which any of the following comments apply.
Comments: There is a dent along the edge of the drivers side above the B-pillar.

REPORT OF VEHICLE CONDITION AT THE COMPLETION OF TESTING
LIST OF FMVSS TESTS PERFORMED BY THIS LAB:

Model Year/Make/Model/Body Style: 2015 Chrysler 200S

NHTSA No.C20150301

REMARKS: Four FMVSS 226 tests were performed on this vehicle.

Equipment that is no longer on the test vehicle as noted on previous page:
N/A

Explanation for equipment removal:
N/A

Test Vehicle Condition:
The headliner is damaged, both curtain airbags have been deployed, and the pillar trim has been dislodged.

RECORDED BY: _____ DATE: May 1, 2015

APPROVED BY: _____

DATA SHEET NO. 2
CERTIFICATION LABEL AND TIRE PLACARD INFORMATION

VEH. MOD YR/MAKE/MODEL/BODY: 2015 Chrysler 200S

VEH. NHTSA NO.: C20150301 VIN: 1C3CCCBB3FN647237

COLOR: Velvet Red Pearlcoat VEH. BUILD DATE: December, 2014

TEST DATES: April 30-May 1, 2015

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, Ryan Jones, Brian Arsen

CERTIFICATION LABEL
Ford Motor Company

Date of Manufacture December, 2014 VIN 1C3CCCBB3FN647237

Vehicle certified as: X Passenger car ____ MPV ____Truck _____Bus

GVWR: 2092.0 kg; GAWR FRONT: 1185.0 kg GAWR REAR: 1185.0 kg

TIRE PLACARD
Vehicle Capacity Weight (VCW) 408 kg

Designated Seating Capacity: Front 2; Rear 3; TOTAL 5

Recommended Cold Tire Pressure: FRONT: 260 kPa REAR: 260 kPa

Tire Pressure w/Maximum Capacity Vehicle Load:
FRONT: 260 kPa
REAR: 260 kPa

Recommended Tire Size: 235/45R18; Load Range: 94

Tire size on Test Vehicle: 235/45R18

REMARKS:

RECORDED BY: Ryan Jones / Brian Arsen DATE: April 28, 2015

APPROVED BY: Helen A. Kaleto

DATA SHEET NO. 3
READNESS INDICATOR AND OWNER'S MANUAL INFORMATION (S4 2.2, S4 2.3)

VEH. MOD YR/MAKE/MODEL/BODY: 2015 Chrysler 200S

VEH. NHTSA NO.: C20150301 VIN: 1C3CCCBB3FN647237

COLOR: Velvet Red Pearlcoat VEH. BUILD DATE: December, 2014

TEST DATES: April 30-May 1, 2015

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, Ryan Jones, Brian Arsen

1. Does the vehicle have an ejection mitigation countermeasure that deploys in the event of a rollover (Obtain the answer to this question from the COTR)?
☑Yes _____ No – This data sheet is complete

2. Readiness indicator:

2.1. Does the vehicle have a readiness indicator for the ejection mitigation countermeasure (S4.2.2)?
☑Yes – Pass _____ No – FAIL – Go to 3

2.2. Is the readiness indicator clearly visible from the driver's designated seating position (S4.2.2)?
☑Yes – Pass_____ No – FAIL

2.3. Is a list of elements monitored by the indicator included in the vehicle's owner manual or in other written information provided to the consumer (S4.2.2)?
☑Yes – Pass_____ No – FAIL

3. Does the vehicle's owner manual or other written information provided by the manufacturer to the consumer describe the vehicle as having a deployable ejection mitigation countermeasure (S4.2.3(a))?
☑Yes – Pass_____ No – FAIL

4. Does the written information (S4.2.3(b))

4.1. Discuss the readiness indicator and specify a list of elements being monitored by the indicator?
☑ Yes – Pass _____ No – FAIL

4.2. Discuss the purpose and location of the telltale?
☑ Yes – Pass _____ No – FAIL

4.3. Instruct the consumer on what steps to take if the telltale is illuminated?
☑ Yes – Pass _____ No – FAIL

RECORDED BY: Ryan Jones /Brian Arsen DATE: April 28, 2015
APPROVED BY: Helen A. Kaleto

DATA SHEET NO. 4
VEHICLE TEST WEIGHT AND ATTITUDE

VEH. MOD YR/MAKE/MODEL/BODY: 2015 Chrysler 200S

VEH. NHTSA NO.: C20150301 VIN: 1C3CCCBB3FN647237

COLOR: Velvet Red Pearlcoat VEH. BUILD DATE: December, 2014

TEST DATES: April 30-May 1, 2015

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, Ryan Jones, Brian Arsen

BA 1. After the test vehicle is received, add fluids to capacity and inflate tires to the manufacturer's specifications per tire placard. If no tire placard is available, inflate tires to the recommended pressure in the owner's manual.

Tire Placard Pressure (kpa): RF 260 ; LF 260; RR 260; LR 260

Owner's Manual Pressure (kpa): RF 260 ; LF 260; RR 260; LR 260

Actual Inflated Pressure (kpa): RF 260 ; LF 260; RR 260; LR 260

BA 2. Place the vehicle on a flat, horizontal surface.

BA 3. Weigh the vehicle to determine the "Unloaded Vehicle Weight" (UVW).

Right Front = 469.0 kg Right Rear = 314.5 kg

Left Front = 487.5 kg Left Rear = 321.0 kg

TOTAL FRONT = 956.5 kg TOTAL REAR = 635.5 kg

% Total Weight = 60.1% % Total Weight = 39.9%

UVW = TOTAL FRONT PLUS TOTAL REAR = 1592.0 kg

BA 4. Place the vehicle on a flat, horizontal surface. Exercise the suspension, pushing up and down on all four corners of the vehicle at least 5 times in an interval not to exceed 40 seconds.

BA 5. UVW Test Vehicle Attitude (all dimensions in degrees(°)):

BA 5.1. Measure the pitch angle (front-to-rear) relative to a horizontal plane along a fixed reference on the driver's and passenger's door sill. Mark where the angle is measured on the door sill. Record on Table 4.1.

BA 5.2. Measure the roll angle (left-to-right) relative to a horizontal plane along a fixed reference at the vehicle longitudinal centerline on the front and rear of the vehicle (such as the front and rear bumper or instrument panel and rear deck). Mark where each angle is measured. Record on Table 4.1.

BA 6. Support the vehicle off of its suspension, so that it maintains the UVW test attitude angles ±0.5°. Record on Table 4.1. If the vehicle is lowered off of the support fixture to reposition the vehicle during testing, the "as tested" attitude must again be measured and recorded.

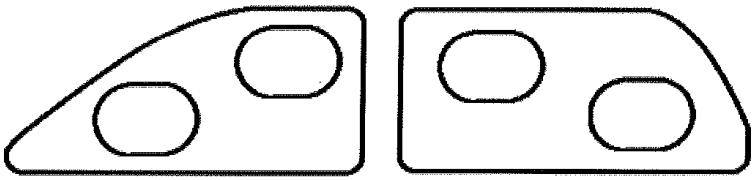
Table 4.1		Vehicle Attitude (deg)			
		UVW	As Tested 04/30/15	As Tested 04/30/15	As Tested 05/01/15
Pitch Angle Nose Down (ND) Nose UP (NU)	Right Door Sill	ND 0.6°	ND 0.7°	ND 0.7°	ND 0.6°
	Left Door Sill	ND 0.6°	ND 0.6°	ND 0.6°	ND 0.6°
Roll Angle Left (L) Right (R)	Front Bumper	RU 0.2°	RU 0.1°	LU 0.2°	RU 0.1°
	Rear Bumper	RU 0.2°	RU 0.1°	LU 0.2°	RU 0.1°

The support for the vehicle must be capable of supporting the vehicle weight, loads applied and preventing movement of the vehicle. In addition, it must safely allow for the locating, testing and filming of the impacts per the requirements of the standard and this test procedure.

RECORDED BY: Ryan Jones / Brian Arsen DATE: April 29, 2015

APPROVED BY: Helen A. Kaleto

C20150301 - 2015 Chrysler 200
Final Target Coordinates



LH (Driver) Side		
1st Row	X (mm)	Z (mm)
Front Lower Primary [R]	1112	822.5
Rear Upper Primary [R]	1404.5	885.2
2nd Row	X (mm)	Z (mm)
Front Upper Primary [R]	1883.7	886.6
Rear Lower Primary [R]	2137.8	852.2

RH (Passenger) Side		
1st Row	X (mm)	Z (mm)
Front Lower Primary [R]	1103.7	822.9
Rear Upper Primary [R]	1394.6	885.2
2nd Row	X (mm)	Z (mm)
Front Upper Primary [R]	1880.3	886.5
Rear Lower Primary [R]	2129.3	852.7

* [R] indicates targets *rotated* to horizontal position

DATA SHEET NO. 5
IMPACT TARGET LOCATION DETERMINATION FORM

Window Type	☑ Left Outboard, ☐ Right Outboard		☑ 1st Row, ☐ 2nd Row, ☐ 3rd Row, ☐ 4th Row	
Measurements taken from ☐ Front Lower corner of Daylight Opening, ☑ Vehicle Coordinates, Front Lower Corner = X 714.7 mm, Z 720.9 mm				
Rearward Edge of Daylight Opening ☑ 1400 mm behind SgRP last row (< 3 rows) ☐ 600 mm behind SgRP 3rd row (≥ 3 rows) ☐ 1400 mm behind non-fixed seat (< 3 rows) ☐ 600 mm behind non-fixed seat (≥ 3 rows) ☐ 25 mm forward partition / bulkhead	Seat Back Design Angle N/A ° Seat Back Test Angle N/A ° Seat Adjustment N/A °		**Opening Geometric Center** X 1179.1 mm Z 856.4 mm	
Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 1306.7 mm, Z 854.4 mm	☑ Upper-Rear ☐ Lower-Rear	X 1417.9 mm Z 866.3 mm
Horizontal Distance Between Primary Targets	111.2 mm	☑ Forward of B-Pillar	☐ Rearward of B-Pillar	
Secondary Target Centers	☑ Upper-Front ☐ Lower-Front	X 1343.8 mm, Z 860.3 mm	☑ Lower-Rear ☐ Upper-Rear	X 1380.9 mm, Z 857.5 mm
Target Elimination	Upper Secondary to Lower Secondary	H 37.1 mm, V 2.8 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H 37.0 mm, V 8.8 mm	☑ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H N/A mm, V N/A mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 111.2 mm, V 11.9 mm	☑ Eliminate Upper Primary?	
Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X _____, Z _____	☑ Less Than 4 Targets?
[R] Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 1112.0 mm, Z 822.5 mm	☑ Upper-Rear ☐ Lower-Rear	X 1404.5, Z 885.2
[R] Horizontal Distance Between Primary Targets	292.5 mm	☑ Forward of B-Pillar	☐ Rearward of B-Pillar	
[R] Secondary Target Centers	☑ Upper-Front ☐ Lower-Front	X 1209.5, Z 852.1	☑ Lower-Rear ☐ Upper-Rear	X 1307.0, Z 827.9
[R] Target Elimination	Upper Secondary to Lower Secondary	H 97.5 mm, V 24.2 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H 97.5 mm, V 57.3 mm	☑ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H N/A mm, V N/A mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 292.5 mm, V 62.7 mm	☐ Eliminate Upper Primary?	
[R] Bisect Target	☑ Only 2 Targets Remaining? ☐Absolute Distance > 360 mm?	Bisect Target Location:	X _____, Z _____	Do Original Targets ≥ Rotated Targets? ☐ Yes = Use Original Targets ☑ No = Use Rotated Targets
Incremental Rotation	☐ Do no targets fit?	Target Angle _____	Target Location:	X _____, Z _____

RECORDED BY: Ryan Jones / Brian Arsen DATE: April 29, 2015
APPROVED BY: Helen A. Kaleto

DATA SHEET NO. 5
IMPACT TARGET LOCATION DETERMINATION FORM

Window Type	☑ Left Outboard, ☐ Right Outboard		☐1st Row, ☑ 2nd Row, ☐ 3rd Row, ☐ 4th Row	
Measurements taken from ☐ Front Lower corner of Daylight Opening, ☑ Vehicle Coordinates, Front Lower Corner = X 1725.6 mm, Z 722.5 mm				
Rearward Edge of Daylight Opening ☑ 1400 mm behind SgRP last row (< 3 rows) ☐ 600 mm behind SgRP 3rd row (≥ 3 rows) ☐ 1400 mm behind non-fixed seat (< 3 rows) ☐ 600 mm behind non-fixed seat (≥ 3 rows) ☐ 25 mm forward partition / bulkhead		Seat Back Design Angle N/A ° Seat Back Test Angle N/A ° Seat Adjustment N/A °		**Opening Geometric Center** X 2020.5 mm Z 853.5 mm
Primary Target Centers	☐ Lower-Front ☑ Upper-Front	X N/A, Z N/A No vertical targets fit opening	☐ Upper-Rear ☑ Lower-Rear	X N/A, Z N/A No vertical targets fit opening
Horizontal Distance Between Primary Targets	_____ mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar	
Secondary Target Centers	☐ Upper-Front ☐ Lower-Front	X N/A, Z N/A No vertical targets fit opening	☐ Lower-Rear ☐ Upper-Rear	X N/A, Z N/A No vertical targets fit opening
Target Elimination	Upper Secondary to Lower Secondary	H ____ mm, V ____ mm	☐ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H ____ mm, V ____ mm	☐ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H ____ mm, V ____ mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H ____ mm, V ____ mm	☐ Eliminate Upper Primary?	
Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X _____mm, Z _____mm	☑ Less Than 4 Targets?
[R] Primary Target Centers	☐ Lower-Front ☑ Upper-Front	X 1883.7 mm, Z 886.6 mm	☐ Upper-Rear ☑ Lower-Rear	X 2137.8 mm, Z 852.2 mm
[R] Horizontal Distance Between Primary Targets	254.1 mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar	
[R] Secondary Target Centers	☐ Upper-Front ☑ Lower-Front	X 1968.4 mm, Z 846.8 mm	☐ Lower-Rear ☑ Upper-Rear	X 2053.1 mm, Z 867.6 mm
[R] Target Elimination	Upper Secondary to Lower Secondary	H 84.7 mm, V 20.8 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H 84.7 mm, V 39.8 mm	☑ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H N/A mm, V N/A mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 254.1 mm, V 34.4 mm	☐ Eliminate Upper Primary?	
[R] Bisect Target	☑ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X _____mm, Z _____mm	Do Original Targets ≥ Rotated Targets? ☐ Yes = Use Original Targets ☑ No = Use Rotated Targets
Incremental Rotation	☐ Do no targets fit?	Target Angle _____	Target Location:	X _____, Z _____

RECORDED BY: Ryan Jones / Brian Arsen DATE: April 29, 2015
APPROVED BY: Helen A. Kaleto

IMPACT TARGET LOCATION DETERMINATION FORM

Window Type	☐ Left Outboard, ☑ Right Outboard		☑ 1st Row, ☐ 2nd Row, ☐ 3rd Row, ☐ 4th Row	
Measurements taken from ☐ Front Lower corner of Daylight Opening, ☑ Vehicle Coordinates, Front Lower Corner = X 710.2 mm, Z 721.2 mm				
Rearward Edge of Daylight Opening ☑ 1400 mm behind SgRP last row (< 3 rows) ☐ 600 mm behind SgRP 3rd row (≥ 3 rows) ☐ 1400 mm behind non-fixed seat (< 3 rows) ☐ 600 mm behind non-fixed seat (≥ 3 rows) ☐ 25 mm forward partition / bulkhead	Seat Back Design Angle N/A ° Seat Back Test Angle N/A ° Seat Adjustment N/A °		**Opening Geometric Center** X 1174.6 mm Z 856.2 mm	
Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 1310.2 mm, Z 855.0 mm	☑ Upper-Rear ☐ Lower-Rear	X 1407.0 mm Z 867.3 mm
Horizontal Distance Between Primary Targets	96.8 mm	☑ Forward of B-Pillar	☐ Rearward of B-Pillar	
Secondary Target Centers	☑ Upper-Front ☐ Lower-Front	X 1342.5 mm, Z 860.2 mm	☑ Lower-Rear ☐ Upper-Rear	X 1374.8 mm, Z 857.9 mm
Target Elimination	Upper Secondary to Lower Secondary	H 32.3 mm, V 2.3 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H 32.2 mm, V 9.4 mm	☑ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H N/A mm, V N/A mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 96.8 mm, V 12.3 mm	☑ Eliminate Upper Primary?	
Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X _____, Z _____	☑ Less Than 4 Targets?
[R] Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 1103.7 mm, Z 822.9 mm	☑ Upper-Rear ☐ Lower-Rear	X 1394.6 mm, Z 885.2 mm
[R] Horizontal Distance Between Primary Targets	290.9 mm	☑ Forward of B-Pillar	☐ Rearward of B-Pillar	
[R] Secondary Target Centers	☑ Upper-Front ☐ Lower-Front	X 1200.7 mm, Z 852.6 mm	☑ Lower-Rear ☐ Upper-Rear	X 1297.7 mm, Z 828.8 mm
[R] Target Elimination	Upper Secondary to Lower Secondary	H 97.0 mm, V 23.8 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H 96.9 mm, V 56.4 mm	☑ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H N/A mm, V N/A mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 290.9 mm, V 62.3 mm	☐ Eliminate Upper Primary?	
[R] Bisect Target	☑ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X _____, Z _____	Do Original Targets ≥ Rotated Targets? ☐ Yes = Use Original Targets ☑ No = Use Rotated Targets
Incremental Rotation	☐ Do no targets fit?	Target Angle _____	Target Location:	X _____, Z _____

RECORDED BY: Ryan Jones / Brian Arsen DATE: April 29, 2015
APPROVED BY: Helen A. Kaleto

IMPACT TARGET LOCATION DETERMINATION FORM

Window Type	☐ Left Outboard, ☑ Right Outboard		☐ 1st Row, ☑ 2nd Row, ☐ 3rd Row, ☐ 4th Row	
Measurements taken from ☐ Front Lower corner of Daylight Opening, ☑ Vehicle Coordinates, Front Lower Corner = X 1723.0 mm, Z 725.7 mm				
Rearward Edge of Daylight Opening ☑ 1400 mm behind SgRP last row (< 3 rows) ☐ 600 mm behind SgRP 3rd row (≥ 3 rows) ☐ 1400 mm behind non-fixed seat (< 3 rows) ☐ 600 mm behind non-fixed seat (≥ 3 rows) ☐ 25 mm forward partition / bulkhead		Seat Back Design Angle N/A ° Seat Back Test Angle N/A ° Seat Adjustment N/A °		**Opening Geometric Center** X 2017.9 mm Z 856.7 mm
Primary Target Centers	☐ Lower-Front ☑ Upper-Front	X N/A, Z N/A No vertical targets fit opening	☐ Upper-Rear ☑ Lower-Rear	X N/A, Z N/A No vertical targets fit opening
Horizontal Distance Between Primary Targets	00.0 mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar	
Secondary Target Centers	☐ Upper-Front ☐ Lower-Front	X N/A, Z N/A No vertical targets fit opening	☐ Lower-Rear ☐ Upper-Rear	X N/A, Z N/A No vertical targets fit opening
Target Elimination	Upper Secondary to Lower Secondary	H ___ mm, V ___ mm	☐ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H ___ mm, V ___ mm	☐ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H ___ mm, V ___ mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H ___ mm, V ___ mm	☐ Eliminate Upper Primary?	
Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X _____, Z _____	☑ Less Than 4 Targets?
[R] Primary Target Centers	☐ Lower-Front ☑ Upper-Front	X 1880.3 mm, Z 886.5 mm	☐ Upper-Rear ☑ Lower-Rear	X 2129.3 mm, Z 852.7 mm
[R] Horizontal Distance Between Primary Targets	249.0 mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar	
[R] Secondary Target Centers	☐ Upper-Front ☑ Lower-Front	X 1963.3 mm, Z 847.6 mm	☐ Lower-Rear ☑ Upper-Rear	X 2046.3 mm, Z 867.8 mm
[R] Target Elimination	Upper Secondary to Lower Secondary	H 83.0 mm, V 20.2 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Upper or Remaining Secondary	H 83.0 mm, V 38.9 mm	☑ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H N/A mm, V N/A mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 249.0 mm, V 33.8 mm	☐ Eliminate Upper Primary?	
[R] Bisect Target	☑ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X _____, Z _____	Do Original Targets ≥ Rotated Targets? ☐Yes = Use Original Targets ☑ No = Use Rotated Targets
Incremental Rotation	☐ Do no targets fit?	Target Angle _____	Target Location:	X _____, Z _____

RECORDED BY: Ryan Jones / Brian Arsen DATE: April 29, 2015
APPROVED BY: Helen A. Kaleto

TEST SUMMARY SHEET

VEH. MOD YR/MAKE/MODEL/BODY: 2015 Chrysler 200S

VEH. NHTSA NO.: C20150301 VIN: 1C3CCCBB3FN647237

COLOR: Velvet Red Pearlcoat VEH. BUILD DATE: December, 2014

TEST DATES: April 30-May 1, 2015

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, Ryan Jones, Brian Arsen

Test No.	Date	Temp / RH	Target & Vehicle Side	Velocity (Speed Trap) (km/h)	Time to Impact (s)	Excursion (mm) (Reqt ≤100 mm)
EM5116	04/30/15	21.8ºC 37.0% RH	2nd Row Right-Hand (RH) Front Upper Primary [R]	20.01	1.503	-5.5
EM5117	04/30/15	21.9ºC 37.0% RH	1st Row Left-Hand (LH) Front Lower Primary [R]	20.08	1.500	35.4
EM5118	05/01/15	21.8ºC 35.0% RH	1st Row Left-Hand (LH) Front Lower Primary [R]	16.05	6.008	32.2
EM5119	05/01/15	22.7ºC 32.0% RH	2nd Row Right-Hand (RH) Rear Lower Primary [R]	20.13	1.502	-12.5

RECORDED BY: Ryan Jones / Brian Arsen DATE: May 1, 2015

APPROVED BY: Helen A. Kaleto

3.0 TEST DATA AND PHOTOGRAPHS

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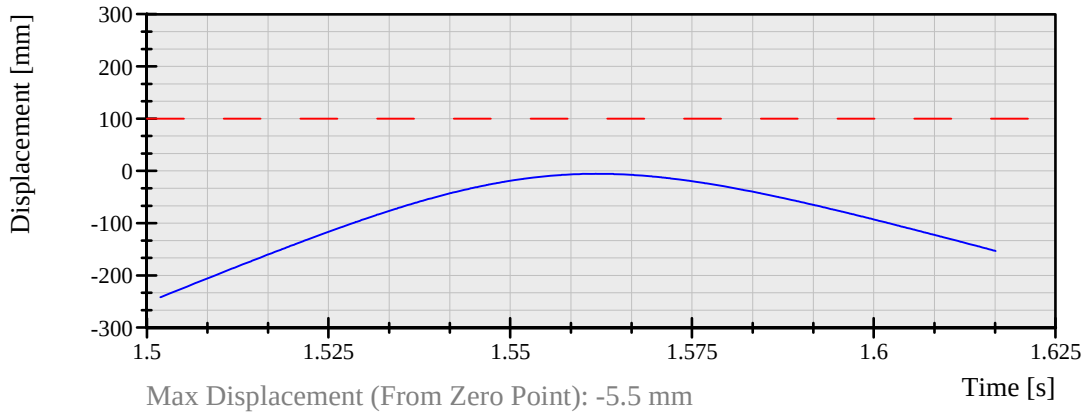
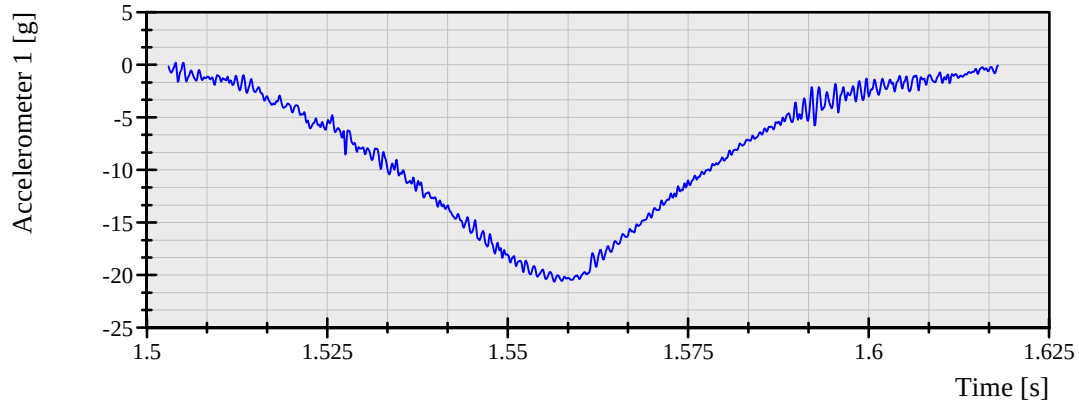
FMVSS 226 Ejection Mitigation

Test Date: 04/30/2015
Impact Velocity (Speed Trap): 20.01 km/h
Job Number: G15I7-002.2
Test Number: EM5116
Impact Location: 2nd Row - Upper Front Primary (R)
Time to First Contact: 1.503 sec
Test Type: 20 km/h with 1.5 second delay
Vehicle/Model: 2015 Chrysler 200
Airbag Description: RH
Comments:



Max Displacement (From Zero Point): -5.5 mm



Max Accel: 0.22 g Min Accel: -20.63 g

6. BJ Remove the window or place it in the fully retracted position. Remove any other obstructions in the path of the head form travel.

   Window Removed: X Window Fully Retracted: ____

   Manufacturer's Selected Option: ____

7. BJ Per the vehicle or airbag manufacturer, record the offset distance that the airbag will reach at maximum inflation, D_A. Calculate the distance the impactor will travel from fully retracted to initial contact with the airbag, D_I. If no information is provided, assume 200 mm.

8. BJ Using a pre-established pressure, perform a speed check by firing the impactor into its own end stops at the desired impact velocity with zero time delay. Ensure all test personnel are at a safe distance away from the test setup prior to firing the impactor! Record the data using the DTS, and process the data using the DIAdem script "Ejection Mitigation". View the following channel.

   - LVDT Displacement

9. BJ Using the data collected from the speed check, find the time value T_I that corresponds to the LVDT displacement D_I. Subtract T_I from the test requirement time T_R to find the amount of time to offset firing the impactor, T_{OFF}.

Time Delay calculation:

LVDT Value at Window, D_L (mm)		Airbag Maximum Inflation, D_A (mm)		Contact with the Airbag, D_I (mm)
582	-	280	=	302
Test Requirement Time, T_R (ms)		**T_I, the Time at D_I (ms)**		**System Offset Time, T_{OFF} (ms)**
(1500) or 6000	-	120	=	1380

10. BJ Repeat the speed check process ensuring that both the velocity and time achieved at D_I is within the desired parameters. Repeat as necessary. For each test, note both the LVDT Value at Window, D_L, and Time Delay, T_{off}, in the summary table.

Initial Position	X	1884.4	Y	145.5	Z	988.2
Zero Displacement	X	1880.8	Y	727.8	Z	895.6
Reference Point	X	1896.9	Y	725.6	Z	930.0

Pre-Test Photograph No. 1 of Test EM5116

Pre-Test Photograph No. 2 of Test EM5116

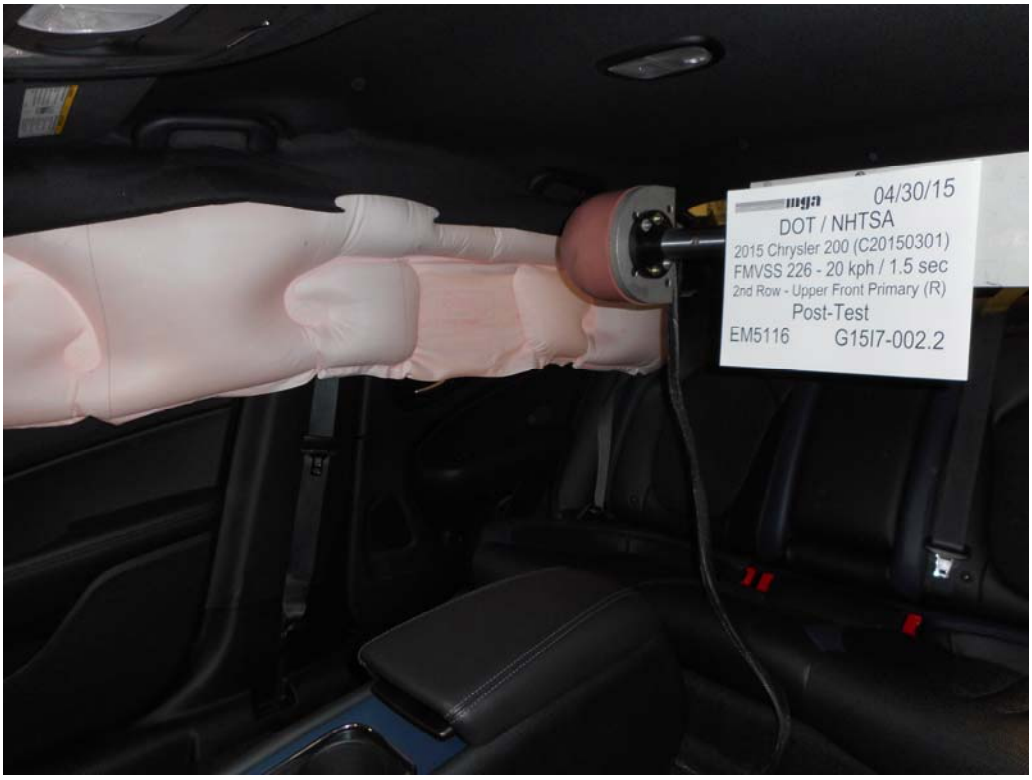
Pre-Test Photograph No. 3 of Test EM5116

Pre-Test Photograph No. 4 of Test EM5116

Pre-Test Photograph No. 5 of Test EM5116

Post-Test Photograph No. 1 of Test EM5116

Post-Test Photograph No. 2 of Test EM5116



Post-Test Photograph No. 3 of Test EM5116

Post-Test Photograph No. 4 of Test EM5116

Post-Test Photograph No. 5 of Test EM5116

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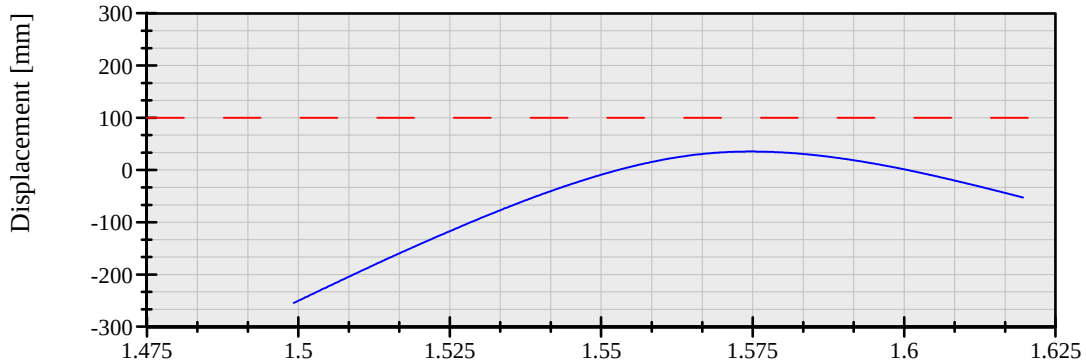
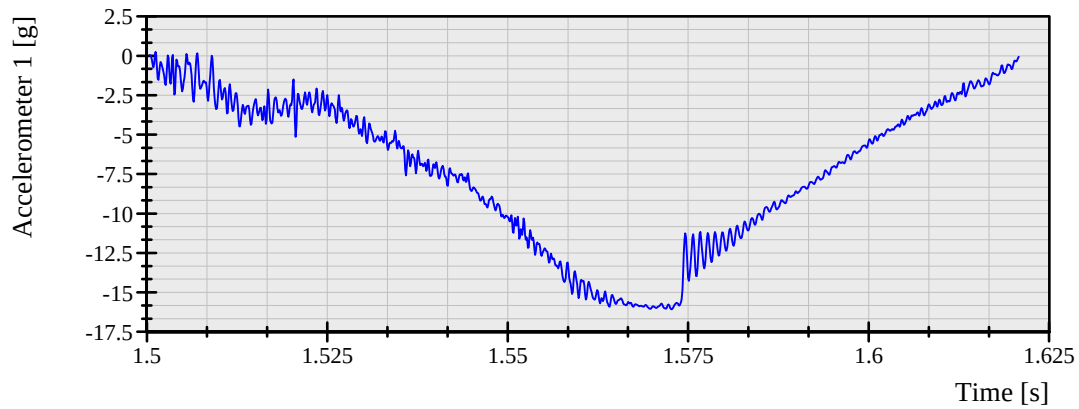
FMVSS 226 Ejection Mitigation

Test Date: 04/30/2015
Impact Velocity (Speed Trap): 20.08 km/h
Job Number: G15I7-002.2
Test Number: EM5117
Impact Location: 1st Row - Lower Front Primary (R)
Time to First Contact: 1.5 sec
Test Type: 20 km/h with 1.5 second delay
Vehicle/Model: 2015 Chrysler 200
Airbag Description: LH
Comments:



Max Displacement (From Zero Point): 35.4 mm



Max Accel: 0.26 g Min Accel: -16.08 g

6. BJ Remove the window or place it in the fully retracted position. Remove any other obstructions in the path of the head form travel.

   Window Removed: ____ Window Fully Retracted: X

   Manufacturer's Selected Option: ____

7. BJ Per the vehicle or airbag manufacturer, record the offset distance that the airbag will reach at maximum inflation, D_A. Calculate the distance the impactor will travel from fully retracted to initial contact with the airbag, D_I. If no information is provided, assume 200 mm.

8. BJ Using a pre-established pressure, perform a speed check by firing the impactor into its own end stops at the desired impact velocity with zero time delay. Ensure all test personnel are at a safe distance away from the test setup prior to firing the impactor! Record the data using the DTS, and process the data using the DIAdem script "Ejection Mitigation". View the following channel.

   - LVDT Displacement

9. BJ Using the data collected from the speed check, find the time value T_1 that corresponds to the LVDT displacement D_I. Subtract T_1 from the test requirement time T_R to find the amount of time to offset firing the impactor, T_{OFF}.

Time Delay calculation:

LVDT Value at Window, D_L (mm)		Airbag Maximum Inflation, D_A (mm)		Contact with the Airbag, D_I (mm)
580	-	280	=	300
Test Requirement Time, T_R (ms)		**T_1, the Time at D_I (ms)**		**System Offset Time, T_{OFF} (ms)**
(1500) or 6000	-	120	=	1380

10. BJ Repeat the speed check process ensuring that both the velocity and time achieved at D_I is within the desired parameters. Repeat as necessary. For each test, note both the LVDT Value at Window, D_L, and Time Delay, T_{off}, in the summary table.

Initial Position	X	1111.9	Y	-170.8	Z	826.9
Zero Displacement	X	1112.2	Y	-751.0	Z	823.9
Reference Point	X	1091.2	Y	-748.9	Z	864.8

Pre-Test Photograph No. 1 of Test EM5117

Pre-Test Photograph No. 2 of Test EM5117

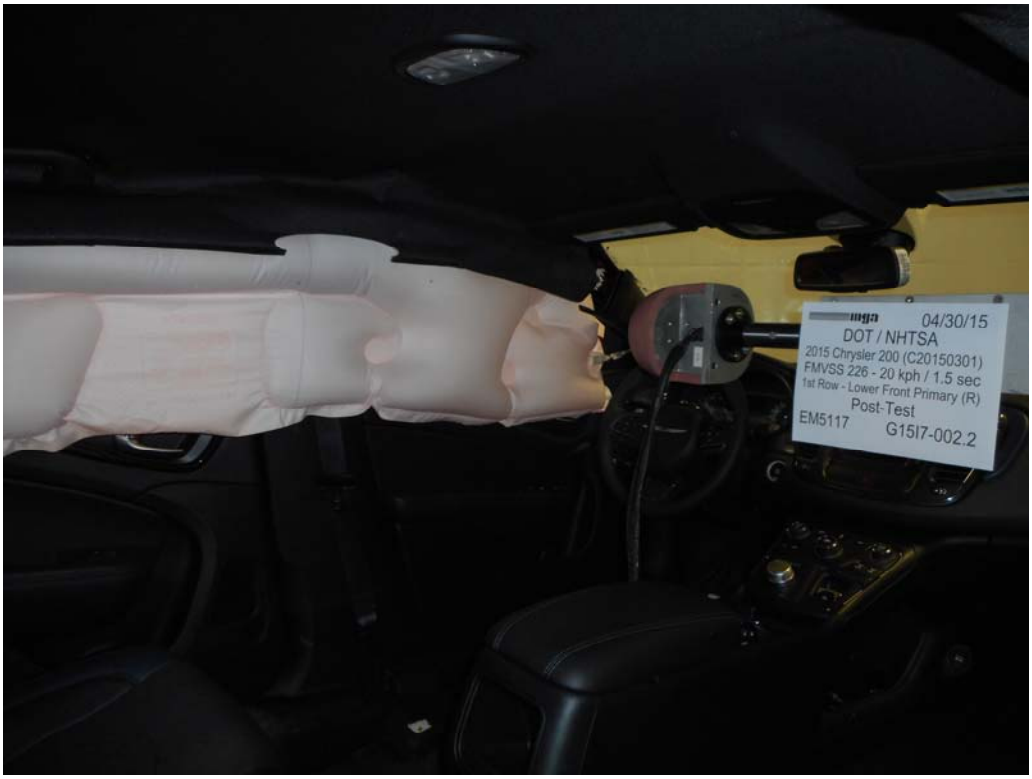
Pre-Test Photograph No. 3 of Test EM5117

Pre-Test Photograph No. 4 of Test EM5117

Pre-Test Photograph No. 5 of Test EM5117

Post-Test Photograph No. 1 of Test EM5117

Pre-Test Photograph No. 2 of Test EM5117



Pre-Test Photograph No. 3 of Test EM5117

Pre-Test Photograph No. 4 of Test EM5117

Pre-Test Photograph No. 5 of Test EM5117

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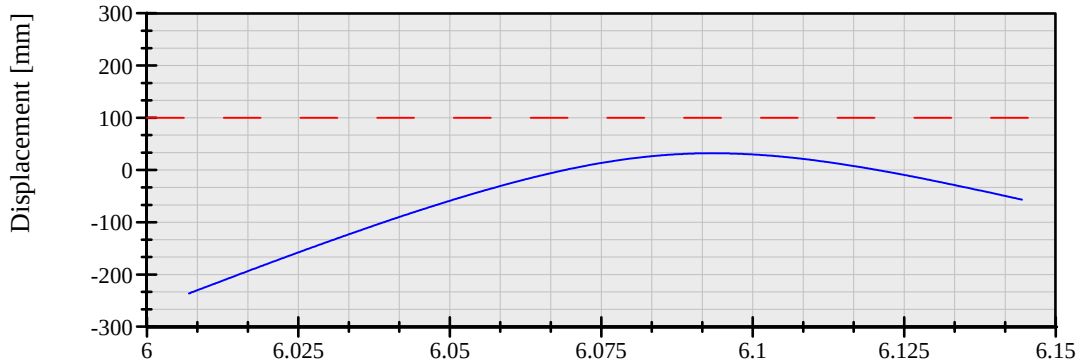
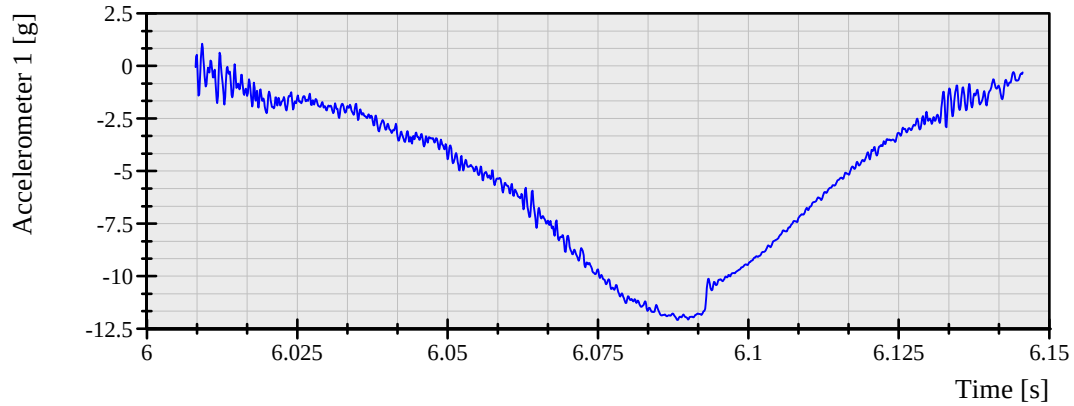
FMVSS 226 Ejection Mitigation

Test Date: 05/01/2015
Impact Velocity (Speed Trap): 16.05 km/h
Job Number: G15I7-002.2
Test Number: EM5118
Impact Location: 1st Row - Lower Front Primary (R)
Time to First Contact: 6.008 sec
Test Type: 16 km/h with 6.0 second delay
Vehicle/Model: 2015 Chrysler 200
Airbag Description: LH
Comments:



Max Displacement (From Zero Point): 32.2 mm



Max Accel: 1.06 g Min Accel: -12.09 g

6. BY Remove the window or place it in the fully retracted position. Remove any other obstructions in the path of the head form travel.

   Window Removed: _____ Window Fully Retracted: X

   Manufacturer's Selected Option: _____

7. BY Per the vehicle or airbag manufacturer, record the offset distance that the airbag will reach at maximum inflation, D_A. Calculate the distance the impactor will travel from fully retracted to initial contact with the airbag, D_I. If no information is provided, assume 200 mm.

8. BY Using a pre-established pressure, perform a speed check by firing the impactor into its own end stops at the desired impact velocity with zero time delay. Ensure all test personnel are at a safe distance away from the test setup prior to firing the impactor! Record the data using the DTS, and process the data using the DIAdem script "Ejection Mitigation". View the following channel.

   - LVDT Displacement

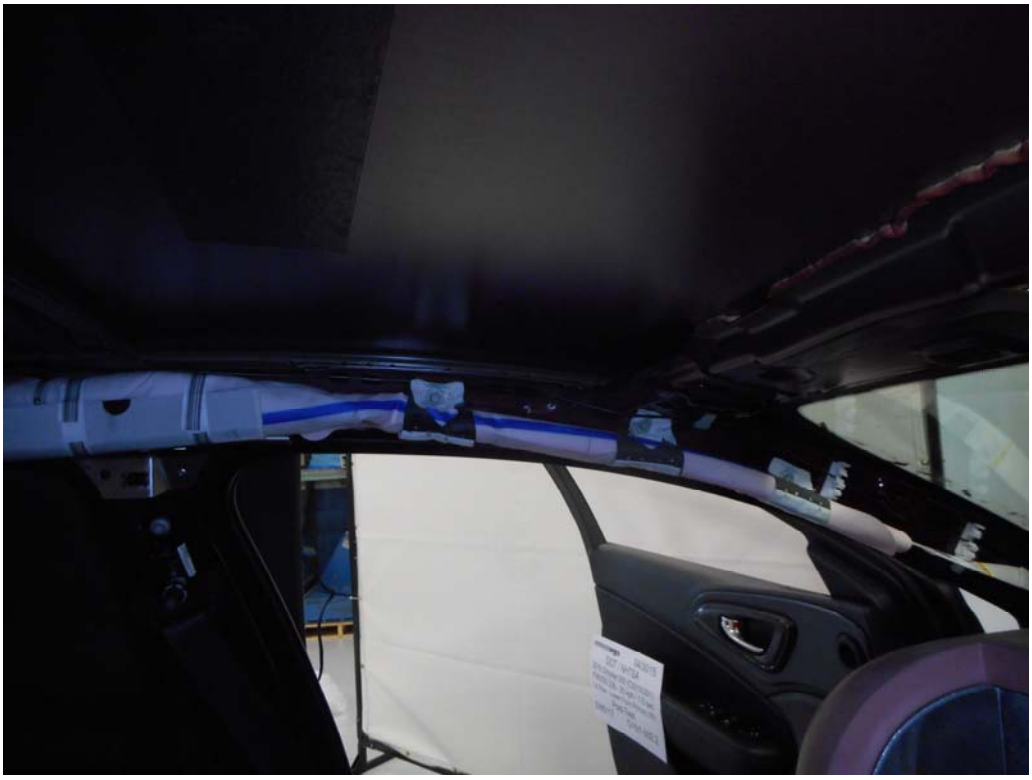
9. BY Using the data collected from the speed check, find the time value T_I that corresponds to the LVDT displacement D_I. Subtract T_I from the test requirement time T_R to find the amount of time to offset firing the impactor, T_{OFF}.

Time Delay calculation:

LVDT Value at Window, D_L (mm)		Airbag Maximum Inflation, D_A (mm)		Contact with the Airbag, D_I (mm)
580	-	280	=	300
Test Requirement Time, T_R (ms)		**T_I, the Time at D_I (ms)**		**System Offset Time, T_{OFF} (ms)**
1500 ~~or 6000~~	-	136	=	5864

10. BY Repeat the speed check process ensuring that both the velocity and time achieved at D_I is within the desired parameters. Repeat as necessary. For each test, note both the LVDT Value at Window, D_L, and Time Delay, T_{off}, in the summary table.

Initial Position	X	1111.9	Y	-170.8	Z	826.9
Zero Displacement	X	1112.2	Y	-751.0	Z	823.9
Reference Point	X	1091.2	Y	-748.9	Z	864.8



Pre-Test Photograph No. 1 of Test EM5118

Pre-Test Photograph No. 2 of Test EM5118

Pre-Test Photograph No. 3 of Test EM5118

Pre-Test Photograph No. 4 of Test EM5118

Pre-Test Photograph No. 5 of Test EM5118

Pre-Test Photograph No. 6 of Test EM5118

Pre-Test Photograph No. 7 of Test EM5118

Post-Test Photograph No. 1 of Test EM5118

Pre-Test Photograph No. 2 of Test EM5118

Pre-Test Photograph No. 3 of Test EM5118

Pre-Test Photograph No. 4 of Test EM5118

Pre-Test Photograph No. 5 of Test EM5118

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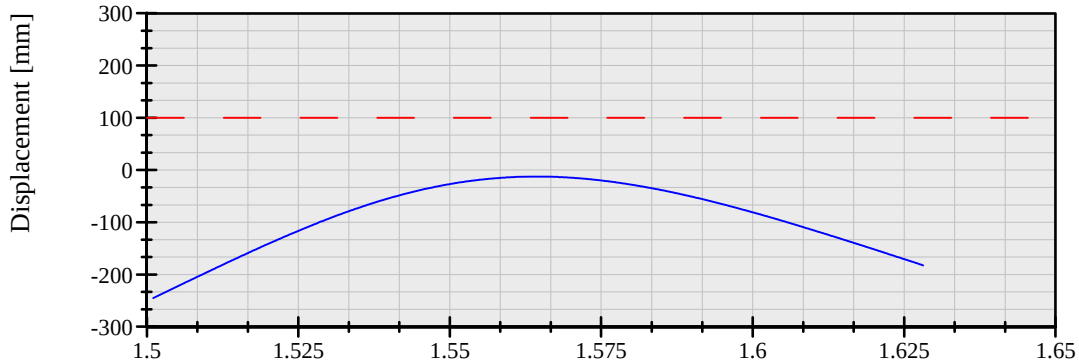
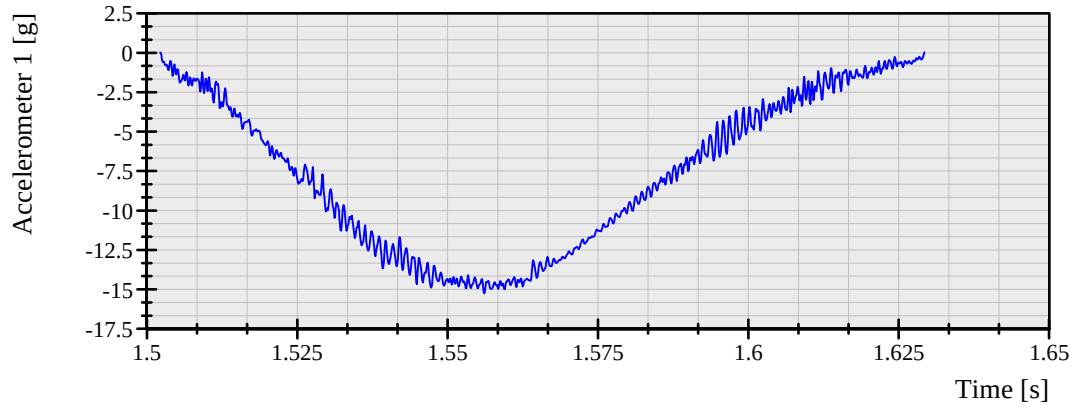
FMVSS 226 Ejection Mitigation

Test Date: 05/01/2015
Impact Velocity (Speed Trap): 20.13 km/h
Job Number: G15I7-002.2
Test Number: EM5119
Impact Location: 2nd Row - Lower Rear Primary (R)
Time to First Contact: 1.502 sec
Test Type: 20 km/h with 1.5 second delay
Vehicle/Model: 2015 Chrysler 200
Airbag Description: RH
Comments:



Max Displacement (From Zero Point): -12.5 mm



Max Accel: 0.04 g Min Accel: -15.25 g

6. Remove the window or place it in the fully retracted position. Remove any other obstructions in the path of the head form travel.

   Window Removed: O Window Fully Retracted: ____

   Manufacturer's Selected Option: ____

7. Per the vehicle or airbag manufacturer, record the offset distance that the airbag will reach at maximum inflation, D_A. Calculate the distance the impactor will travel from fully retracted to initial contact with the airbag, D_I. If no information is provided, assume 200 mm.

8. Using a pre-established pressure, perform a speed check by firing the impactor into its own end stops at the desired impact velocity with zero time delay. Ensure all test personnel are at a safe distance away from the test setup prior to firing the impactor! Record the data using the DTS, and process the data using the DIAdem script "Ejection Mitigation". View the following channel.

   - LVDT Displacement

9. Using the data collected from the speed check, find the time value T_I that corresponds to the LVDT displacement D_I. Subtract T_I from the test requirement time T_R to find the amount of time to offset firing the impactor, T_{OFF}.

Time Delay calculation:

LVDT Value at Window, D_L (mm)		Airbag Maximum Inflation, D_A (mm)		Contact with the Airbag, D_I (mm)
581	-	280	=	301
Test Requirement Time, T_R (ms)		**T_I, the Time at D_I (ms)**		**System Offset Time, T_{OFF} (ms)**
1500 or 6000	-	120	=	1380

10. Repeat the speed check process ensuring that both the velocity and time achieved at D_I is within the desired parameters. Repeat as necessary. For each test, note both the LVDT Value at Window, D_L, and Time Delay, T_{off}, in the summary table.

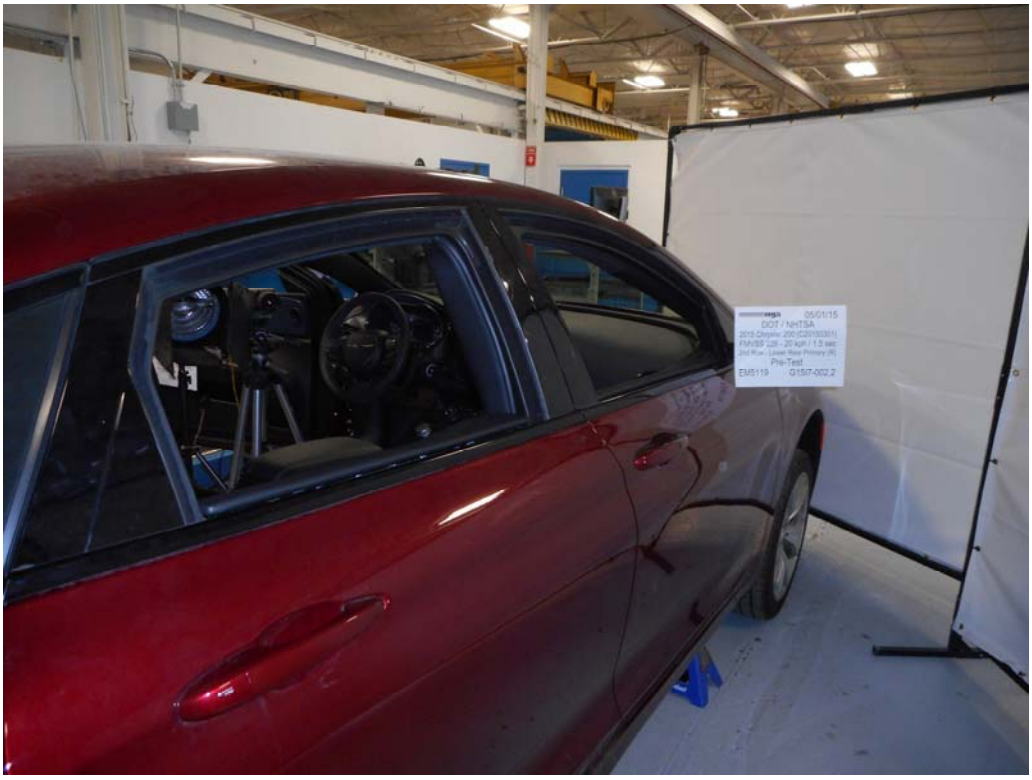
Initial Position	X	2131.8	Y	154.4	Z	853.2
Zero Displacement	X	2128.7	Y	735.4	Z	852.7
Reference Point	X	2153.9	Y	732.1	Z	894.4

Pre-Test Photograph No. 1 of Test EM5119

Pre-Test Photograph No. 2 of Test EM5119

Pre-Test Photograph No. 3 of Test EM5119

Pre-Test Photograph No. 4 of Test EM5119



Pre-Test Photograph No. 5 of Test EM5119

Pre-Test Photograph No. 6 of Test EM5119

Pre-Test Photograph No. 7 of Test EM5119

Post-Test Photograph No. 1 of Test EM5119

Post-Test Photograph No. 2 of Test EM5119

Post-Test Photograph No. 3 of Test EM5119

Post-Test Photograph No. 4 of Test EM5119

Post-Test Photograph No. 5 of Test EM5119

4.0 TEST EQUIPMENT LIST AND CALIBRATION INFORMATION

The following section lists the test equipment for the compliance test series. Items marked with an asterisk are calibrated by an external lab. The temperature trace to confirm testing was conducted between 65ºF and 84ºF (18ºC – 29ºC). Calibration certificates can be found in Appendix A.

TABLE 4-1 LIST OF ITEMS USED

DEVICE	MANUFACTURER NAME	SERIAL #	FUNCTION OF ITEM	SENSITIVITY	CAL. INTERNAL
Ejection Mitigation Impactor	MGA	EM-02	Testing Impactor	±0.05kg	6 months
Accelerometer	Endevco	P71518	Acceleration Data	±0.5%	6 months
Accelerometer	Endevco	P59218	Acceleration Data	±0.5%	6 months
LVDT	MTS	90425350	Displacement Data	±0.5%	6 months
DTS Data System	DTS	LM0212	Data Collection	--	Annual
Digital Protractor	Mitutoyo	MGA00712	Setup/ Horizontal Measurement	0.1°	Annual
Digital Scale	Detecto	MGA00783	Weigh FMH Headform	± 0.01 lb	Annual
Tape Measure	Stanley	TPM001-71	Measurement	1mm	Annual
*FARO™	Faro Technologies	C12-d2-05-03364	Target/Impact Location	±0.1%	Annual
MGA Velocity Measurement System	MGA Research Corporation	VMS MPS1	Measurement	±0.2%	Annual
Timed Output Module	DTS	TOM-041	Airbag Timing Trigger	--	Annual
Vehicle Scale	Intercomp	26032389	Weighing Vehicle	± .5 kg	Annual

5.0 OTHER DOCUMENTATION

As Delivered – Left Side View

As Delivered – Right Side View

As Delivered – ¾ Front View From Right Side

As Delivered – ¾ Rear View From Left Side

As Delivered – Vehicle's Certification Label

As Delivered – Vehicle's Tire Information Label

Appendix A – Calibration Certificates

mga Equipment - MI
446 Executive Dr.
Troy, MI 48083
248-577-5001

mga Equipment - NY
13311 Main Rd.
Akron, NY 14001
716-542-5672

PRODUCT VALIDATION REPORT

Date: 4/10/15
Customer: MGA
MGA Project #:
Model/Serial #: EM-02 Impactor
Procedure: Deflection & Friction

Reference Equipment Used

Equipment	Information	Cal Due
SN: MGA00840	Calibrated Micrometer	4/22/15
SN: 409414	Load Cell	5/11/15
SN: 90425350	LVDT	4/9/16

Comments: 226 impactor certified while mounted to MGA's 3-axis Dyamic Impact Test Frame

RADIAL DEFLECTION & FRICTION MEASUREMENTS

Test Requirements

- 100kg mass to be used, 100Hz minimum sampling rate
- Deflection and frictional characteristics are to be measured in all 4 rotational axes (in 90 degree increments)
- Radial deflection < 20mm
- Dynamic coefficient of friction < 0.25

Test Results

Test Description	Limits				
	Upper	Lower	Value	Unit	Pass/Fail
Radial Deflection	20	N/A	17.63	mm	**PASS**
Dyanmic Coefficient of Friction	0.250	N/A	0.187	--	**PASS**

Performed by: Brian Arsen **Test Date:** 04/10/15

This report applies only to the item(s) listed within this document. These item(s) are validated using approved equipment and within their intended performance tolerances. Performance outside set tolerances cannot be guaranteed. This report shall not be reproduced except in full, without the written approval of MGA.

TITLE

TEST DATA

Model/Serial #: EM-02 Impactor	Project #: 0	Test Date: 4/10/15

Loading Mass (kg): 100
Impactor Moving Mass (kg): 18

Action		Run	+Z (0 degrees)	+X (90 degrees)	-Z (180 degrees)	-X (270 degrees)	Maximum
Radial Deflection	D [mm]	N/A	12.5	17.63	15.44	17.17	17.63
Loaded Dynamic Friction Force (nominal force needed to maintain motion)	F2(d) [N]	1	190.83	173.09	168.98	182.44	243.15
		2	218.24	170.12	178.22	169.12	
		3	210.79	177.38	178.32	186.69	
		4	221.99	174.43	179.86	183.37	
		5	243.15	175.66	186.26	184.66	
		Average	**217.00**	**174.13**	**178.33**	**181.25**	
	F2(dev) [N]	1	35.36	28.67	23.70	33.30	39.13
		2	30.11	39.13	14.98	24.22	
		3	35.11	22.12	26.08	31.10	
		4	35.62	24.99	27.53	34.13	
		5	38.90	24.64	16.86	33.77	
Dynamic Coefficient of Friction	μ_k		0.1875	0.1504	0.1541	0.1566	0.1875

Stroke (mm): 947.0000
250 Hz

mga research corporation

Certificate of Calibration

Test Accelerometer:

Serial No.: P71518
Model No.: Endevco 7264C-2000
Capacity (G's): 2,000
Calibration Date: 11/21/2014
Calibrated By: Scott Arsen
Calibration Time: 16:19:02

Reference Accelerometer:

Serial No.: 95980
Model No.: PCB 352C03
Capacity (G's): 250
Calibration Date: 8/18/2014
Calibrated By: Novastar

Certificate No.: P71518_2014-11-21

		New vs Old
Sensitivity :	0.0224 mV/V/g	0.42 %
DLR (100K Shunt):	56.61 g	-0.22 %

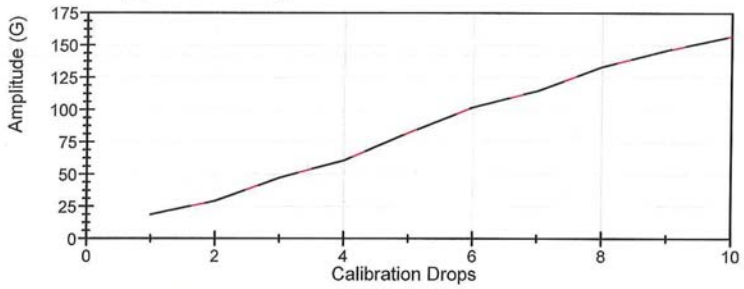
Excitation Voltage: 10 V
Error: 0.1033 %
Linearity (R-Squared): 1.0000

Temperature: 21.4 °C
Relative Humidity: 20.0 %RH
Software Version: CalDLR.vbs v2014.03.05

Approved By: Helen Kaleto

Helen Kaleto

Reference (g) vs Predicted (g)



All calibrations are traceable to the National Institute of Standards and Technology.
Estimated uncertainty of the measurement is ±3.476%. All certification data and equipment are on file for inspection at your request.
Best uncertainties represent expanded uncertainties expressed at
approximately the 95% confidence level using a coverage factor k=2.

www.mgaresearch.com 446 Executive Drive, Troy, MI 48083 Phone: (248) 577-5001, Fax: (248) 577-5025

mga research corporation

Certificate of Calibration

Test Accelerometer:

Serial No.: P59218
Model No.: Endevco 7264C-2000
Capacity (G's): 2,000
Calibration Date: 11/4/2014
Calibrated By: Scott Arsen
Calibration Time: 16:36:43

Reference Accelerometer:

Serial No.: 95980
Model No.: PCB 352C03
Capacity (G's): 250
Calibration Date: 8/18/2014
Calibrated By: Novastar

Certificate No.: P59218_2014-11-04

		New vs Old
Sensitivity :	0.0229 mV/V/g	0.52 %
DLR (100K Shunt):	55.20 g	-0.89 %

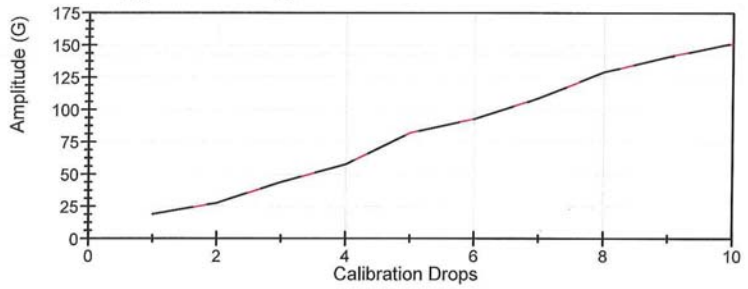
Excitation Voltage: 10 V
Error: 0.3151 %
Linearity (R-Squared): 1.0000

Temperature: 22.4 °C
Relative Humidity: 54.0 %RH
Software Version: CalDLR.vbs v2014.03.05

Approved By: Helen Kaleto

Helen Kaleto

Reference (g) vs Predicted (g)



All calibrations are traceable to the National Institute of Standards and Technology.
Estimated uncertainty of the measurement is ±3.476%. All certification data and equipment are on file for inspection at your request.
Best uncertainties represent expanded uncertainties expressed at
approximately the 95% confidence level using a coverage factor k=2.

www.mgaresearch.com 446 Executive Drive, Troy, MI 48083 Phone: (248) 577-5001, Fax: (248) 577-5025

NovaStar SOLUTIONS
Metrology Management Services

Calibration Certificate

ACCREDITED Calibration #1277.01

35200 Plymouth Rd. / Livonia, MI 48150

Certificate # Z54778:103835

PCB 352C03 ACCELEROMETER

SERIAL NUMBER:	95980	WORK ORDER:	TC081814009
ASSET NUMBER:	Z54778	TEST RESULT:	PASS
CUST ASSET NUMBER:	N/A	PERFORMED ON:	08/18/14
PROCEDURE NAME:	MOD 9150	CAL DUE DATE:	08/18/15
PROCEDURE REV:	D	DATA TYPE:	FOUND-LEFT
CALIBRATED BY:	Thomas Cairns	TEMPERATURE:	23.00 °C
CUSTOMER:	MGA RESEARCH 446 EXECUTIVE DRIVE TROY, MI 48083	HUMIDITY:	47 %
PRIMARY CONTACT:	SCOTT ARSEN		

This instrument has been processed and calibrated in accordance with the NovaStar Solutions Quality System Manual and is traceable to the National Institute of Standards and Technology (NIST) or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. The NovaStar Solutions quality system is accredited ISO/IEC 17025:2005 and ANSI/NCSL Z540-1-1994.

The results reported herein apply only to the calibration of the item described above. No sampling plan was used for this calibration.

The ratio of the tolerance of the instrument or parameter being calibrated to the expanded uncertainty of the standard (TUR) is greater than 4:1 unless otherwise specified. Expanded uncertainties are expressed at the approximate 95% level of confidence using a K=2. Due to any number of factors, the recommended due date on the item does not imply continuing conformance to specifications during the recommended interval. Unless otherwise stated the unit under test meets or exceeds manufacturer specifications.

For range and best measurement capability specifications for the standards used to perform this calibration, see the most recent calibration report maintained by this calibration laboratory (available upon request).

This report may not be reproduced, except in full, without written approval from NovaStar Solutions.

AS RECEIVED CONDITION:	IN TOLERANCE	REMARKS:
AS RETURNED CONDITION:	IN TOLERANCE	
ACTION TAKEN:	FULL CALIBRATION	

Standards Used

Asset #	Cert #	Description	Cal Date	Due Date
002664	002664:1091515041	VERITEQ 5000A-RH/T RH/TEMPERATURE DATA LOGGER	03/18/2014	03/18/2015
1727	1727:1193650836	MODAL SHOP 9150C ACCELEROMETER CAL SYSTEM	10/29/2013	10/29/2014

QA Signature: Date: 8/20/2014

8/22/2014

- Calibration Certificate -

ID Number	TC081814009
Manufacturer	PCB
Model No.	352C03
Serial No.	95980

Uncertainty @95%K=2; 2.1% @ 5-2000Hz, 2.7 @ 2-10kHz

Key Specifications:

Range	500	+/- g
Resolution	.00005	g
Temperature Range	-65/+250	°F

Calibration Data:

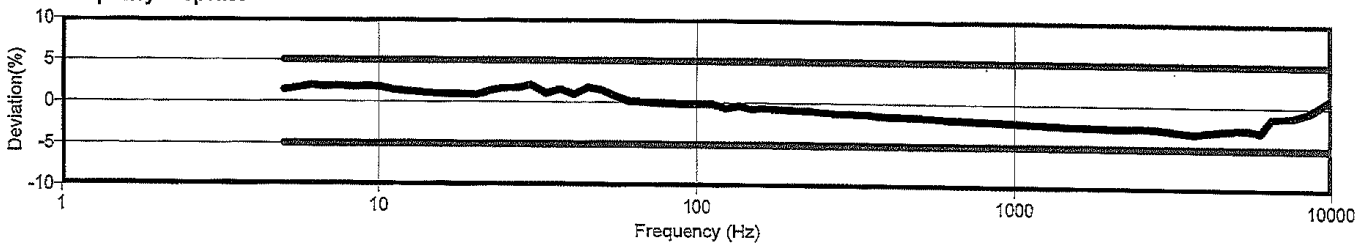
Voltage Sensitivity	9.950	mV/g
Test Accel. Level	1	g

Notes:

Deviation Table

	Frequency(Hz)	Deviation(%)
	5	1.370
	10	1.770
	15	0.968
	30	2.048
	50	1.448
Ref Freq.	100	0.000
	300	-1.191
	500	-1.644
	1000	-2.174
	3000	-2.780
	5000	-2.676
	7000	0.000
	10000	1.121

Frequency Response



NovaStar Solutions
Metrology Management Services

Calibration Date: 08/18/2014
Due Date:
Calibrated by: Tom Cairns

mga research corporation

CALIBRATION CERTIFICATE

Name: 226 Impactor LVDT
Model: RHS0555UD60
S/N: 90425350
Range: 1000mm

Calibration Date: 4/9/2015

Scale Factor: 3.5622481 mV/mm

Measured Values		Reproduced from Calculated Slope		
Distance (mm)	Voltage (mV)	Calculated Distance (mm)	% Error *	Scale factor Best Fit Line (mm/mV)
0.00	985.037	-1.288	0.136	0.2807216
100.00	1343.038	99.211	0.083	Intercept
200.00	1702.106	200.009	0.001	-277.8090
300.00	2062.192	301.093	0.115	
400.00	2421.003	401.819	0.192	Scale Factor (mV/mm)
500.00	2779.321	499.880	0.013	3.5622481
600.00	3129.084	600.592	0.063	
700.00	3484.449	700.351	0.037	
800.00	3839.118	799.914	0.009	
900.00	4192.788	899.197	0.085	Maximum Error
947.00	4360.304	946.223	0.082	0.192

: percent Error calculated by 100(Measured - Calculated) / Measured Range

standards used

MFG	Model Number	Serial Number	Description	Cal Due Date
Celesco	SE1-50	4910	String Encoder	4/07/2016

Performed By:

Approved By: Helen A. Kaleto

All calibrations are traceable to the National Institute of Standards and Technology. Estimated uncertainty of the measurement is ±1.0%. All certification data and equipment are on file for inspection at your request. Best uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor k=2.

446 executive drive • troy, mi 48083
248 / 577-5001 • fax 248 / 577-5025
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DTS
41204 Bridge Street, Novi, MI 48375-1301 USA
Phone: +1 248 427 0045 • Fax: +1 248 427 0630
www.dtsweb.com

ilac-MRA A2LA ACCREDITED
Calibration CERT# 3007.01

Certificate of Calibration

Model #:	Sensor Input Module	Certificate #:	2015217LM0212
Serial #:	LM0212	Date Received:	11 February 2015
Firmware:	07E4	Date Calibrated:	17 February 2015
Procedure Name:	SIM Calibration Revision: 2.2	Next Calibration:	17 February 2016
Order Number:	RA26649	Item Received:	In Tolerance
Customer:	MGA	Item Returned:	In Tolerance
	2807 Elliott Drive	Temperature:	77°F/25.0°C
	Troy, MI 48083	Humidity:	24 %

DTS has been audited by the American Association for Laboratory Accreditation (A2LA) and found in compliance with ISO/IEC 17025:2005. Accredited calibrations performed within the DTS Scope of Accreditation are indicated by the presence of the A2LA Logo and Certificate Number on this Certificate of Calibration.
DTS reference standards are processed and calibrated in accordance with the DTS Quality Assurance System, and traceable to the National Institute of Standards and Technology (NIST).
All calibrations have been performed using processes having a test uncertainty ratio of four or more times greater than the unit calibrated, unless otherwise noted on the report. Uncertainties have been estimated at a 95 percent confidence level (k=2). Calibration at a 4:1 TUR provides reasonable confidence that the instrument is within the manufacturer's published specifications.
The reported data is the raw recorded data and is not corrected for uncertainty or environmental effects. Any number of factors can cause a unit to drift out of tolerance at any time following its calibration.
This report only applies only to the item(s) identified above, and shall not be reproduced except in full, without the written approval of DTS.
Limitations on the uses of this instrument are detailed in the manufacturer's operating instructions.

Remarks:

Standards Used

Serial #	Manufacturer	Model #	Description	Cal Date	Due Date
MY42006281	Agilent	34420A	Nano Volt, Micro-Ohm Meter, 7.5 Digit	1-Nov-2014	1-Nov-2015
MY44062354	Agilent	33220A	Function/Arbitrary Waveform Generator, 20 MHz	28-Oct-2014	28-Oct-2015
CAL012	DTS	CALSTAT	TDAS Calibration Station	15-Nov-2014	15-Nov-2015

Results

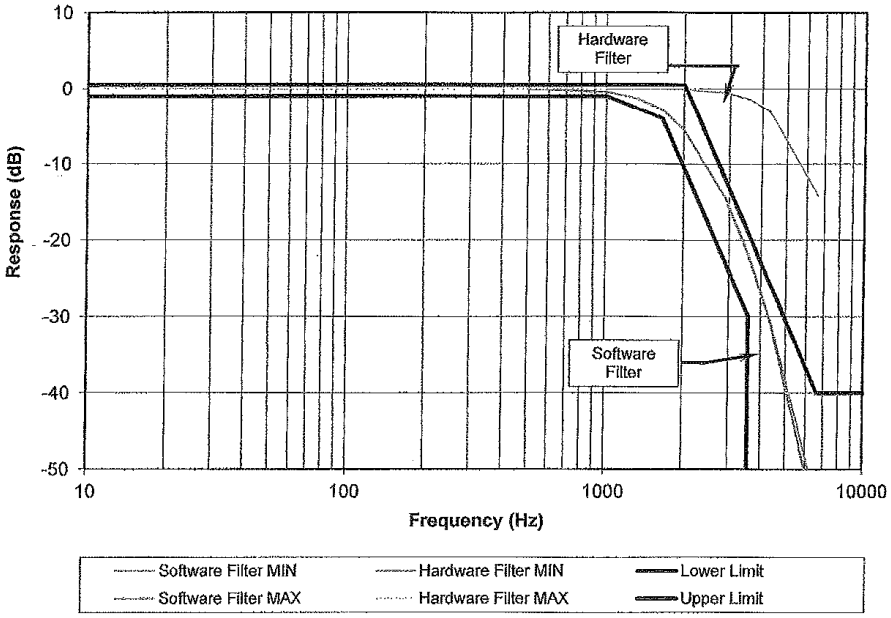
Test Description	Test Result	
	As Received	As Returned
Battery Changed	N/A	N/A
Visual Inspection	Pass	Pass
Basic Channel Functions	Pass	Pass
Calibration DAC Accuracy	Pass	Pass
Shunt Resistor Accuracy	Pass	Pass
Excitation Sources	Pass	Pass
Gain Accuracy	Pass	Pass
Frequency Response	Pass	Pass
Timebase Accuracy	Pass	Pass
T=0 Trigger Function	Pass	Pass
Time Skew	Pass	Pass
Noise Level	Pass	Pass

Calibrated By: Bob Colenso
Bob Colenso
Technical Support Engineer
2/24/15

Calibration Site: 41204 Bridge St
Novi, MI 48375

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Class 1000 System Response vs. SAE J211 (March 2014)
All 8 channels typically overlap due to very tight control of component tolerances.
Only the minimum and maximum response of the 8 channels are shown for clarity.



Test Description

Filter Response-Software

	Limit		As Received/Returned Std	db	Uncertainty (mV)	Pass/ Fail
Channel 1						
10Hz	0.5db	-0.75db	1.414 mV	0.000	2.1E-04	Pass
500Hz	0.5db	-0.96db	1.414 mV	-0.001	1.2E-03	Pass
1000Hz	0.5db	-1db	1.346 mV	-0.429	2.3E-03	Pass
1325Hz	0.5db	-2.69db	1.217 mV	-1.302	3.8E-03	Pass
1650Hz	0.5db	-4db	1.014 mV	-2.890	2.7E-03	Pass
2000Hz	0.5db	-10.66db	0.751 mV	-5.490	2.4E-03	Pass
2900Hz	-12.37db	-23.53db	0.264 mV	-14.560	1.8E-03	Pass
3575Hz	-19.61db	-999db	0.112 mV	-21.998	1.0E-03	Pass
4300Hz	-26db	-999db	0.044 mV	-30.122	5.2E-04	Pass
6600Hz	-40db	-999db	0.003 mV	-53.725	5.5E-04	Pass

DTS

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

Filter Response-Software

	Limit		As Received/Returned Std	db	Uncertainty (mV)	Pass/ Fail
Channel 2						
10Hz	0.5db	-0.75db	1.414 mV	0.000	2.0E-04	Pass
500Hz	0.5db	-0.96db	1.414 mV	0.001	1.3E-03	Pass
1000Hz	0.5db	-1db	1.347 mV	0.001	2.2E-03	Pass
1325Hz	0.5db	-2.69db	1.219 mV	-1.286	4.0E-03	Pass
1650Hz	0.5db	-4db	1.016 mV	-2.868	2.7E-03	Pass
2000Hz	0.5db	-10.66db	0.754 mV	-5.460	2.6E-03	Pass
2900Hz	-12.37db	-23.53db	0.266 mV	-14.499	2.0E-03	Pass
3575Hz	-19.61db	-999db	0.113 mV	-21.915	1.1E-03	Pass
4300Hz	-26db	-999db	0.045 mV	-30.012	6.3E-04	Pass
6600Hz	-40db	-999db	0.003 mV	-53.944	5.1E-04	Pass
Channel 3						
10Hz	0.5db	-0.75db	1.414 mV	0.000	2.1E-04	Pass
500Hz	0.5db	-0.96db	1.414 mV	0.000	1.3E-03	Pass
1000Hz	0.5db	-1db	1.346 mV	0.000	2.1E-03	Pass
1325Hz	0.5db	-2.69db	1.218 mV	-1.291	3.0E-03	Pass
1650Hz	0.5db	-4db	1.015 mV	-2.879	2.6E-03	Pass
2000Hz	0.5db	-10.66db	0.753 mV	-5.477	8.7E-04	Pass
2900Hz	-12.37db	-23.53db	0.265 mV	-14.532	1.6E-03	Pass
3575Hz	-19.61db	-999db	0.113 mV	-21.963	8.7E-04	Pass
4300Hz	-26db	-999db	0.044 mV	-30.067	5.8E-04	Pass
6600Hz	-40db	-999db	0.003 mV	-54.920	4.5E-04	Pass
Channel 4						
10Hz	0.5db	-0.75db	1.414 mV	0.000	1.9E-04	Pass
500Hz	0.5db	-0.96db	1.413 mV	-0.003	1.3E-03	Pass
1000Hz	0.5db	-1db	1.344 mV	-0.003	2.1E-03	Pass
1325Hz	0.5db	-2.69db	1.216 mV	-1.308	3.7E-03	Pass
1650Hz	0.5db	-4db	1.012 mV	-2.907	2.4E-03	Pass
2000Hz	0.5db	-10.66db	0.749 mV	-5.518	2.0E-03	Pass
2900Hz	-12.37db	-23.53db	0.263 mV	-14.606	1.7E-03	Pass
3575Hz	-19.61db	-999db	0.112 mV	-22.056	9.9E-04	Pass
4300Hz	-26db	-999db	0.044 mV	-30.157	5.4E-04	Pass
6600Hz	-40db	-999db	0.002 mV	-55.443	4.6E-04	Pass
Channel 5						
10Hz	0.5db	-0.75db	1.414 mV	0.000	2.3E-04	Pass
500Hz	0.5db	-0.96db	1.414 mV	0.000	1.3E-03	Pass
1000Hz	0.5db	-1db	1.346 mV	0.000	2.4E-03	Pass
1325Hz	0.5db	-2.69db	1.218 mV	-1.291	3.8E-03	Pass
1650Hz	0.5db	-4db	1.014 mV	-2.884	2.7E-03	Pass
2000Hz	0.5db	-10.66db	0.752 mV	-5.486	2.4E-03	Pass
2900Hz	-12.37db	-23.53db	0.265 mV	-14.546	1.8E-03	Pass
3575Hz	-19.61db	-999db	0.113 mV	-21.981	1.1E-03	Pass
4300Hz	-26db	-999db	0.044 mV	-30.064	5.9E-04	Pass
6600Hz	-40db	-999db	0.002 mV	-55.892	3.7E-04	Pass

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

Filter Response-Software

	Limit		As Received/Returned Std	db	Uncertainty (mV)	Pass/ Fail
Channel 6						
10Hz	0.5db	-0.75db	1.414 mV	0.000	2.4E-04	Pass
500Hz	0.5db	-0.96db	1.414 mV	0.000	1.4E-03	Pass
1000Hz	0.5db	-1db	1.345 mV	0.000	2.0E-03	Pass
1325Hz	0.5db	-2.69db	1.219 mV	-1.289	3.8E-03	Pass
1650Hz	0.5db	-4db	1.014 mV	-2.884	2.5E-03	Pass
2000Hz	0.5db	-10.66db	0.752 mV	-5.486	2.3E-03	Pass
2900Hz	-12.37db	-23.53db	0.265 mV	-14.540	1.9E-03	Pass
3575Hz	-19.61db	-999db	0.113 mV	-21.969	1.2E-03	Pass
4300Hz	-26db	-999db	0.045 mV	-30.029	6.6E-04	Pass
6600Hz	-40db	-999db	0.002 mV	-56.077	4.0E-04	Pass
Channel 7						
10Hz	0.5db	-0.75db	1.414 mV	0.000	1.9E-04	Pass
500Hz	0.5db	-0.96db	1.413 mV	-0.001	1.2E-03	Pass
1000Hz	0.5db	-1db	1.345 mV	-0.001	2.3E-03	Pass
1325Hz	0.5db	-2.69db	1.218 mV	-1.292	3.6E-03	Pass
1650Hz	0.5db	-4db	1.013 mV	-2.892	2.7E-03	Pass
2000Hz	0.5db	-10.66db	0.751 mV	-5.498	2.4E-03	Pass
2900Hz	-12.37db	-23.53db	0.264 mV	-14.564	1.7E-03	Pass
3575Hz	-19.61db	-999db	0.112 mV	-22.005	1.0E-03	Pass
4300Hz	-26db	-999db	0.044 mV	-30.071	6.1E-04	Pass
6600Hz	-40db	-999db	0.002 mV	-56.226	4.9E-04	Pass
Channel 8						
10Hz	0.5db	-0.75db	1.414 mV	0.000	2.2E-04	Pass
500Hz	0.5db	-0.96db	1.413 mV	-0.004	1.3E-03	Pass
1000Hz	0.5db	-1db	1.343 mV	-0.004	2.3E-03	Pass
1325Hz	0.5db	-2.69db	1.216 mV	-1.308	3.9E-03	Pass
1650Hz	0.5db	-4db	1.010 mV	-2.919	2.5E-03	Pass
2000Hz	0.5db	-10.66db	0.747 mV	-5.537	2.7E-03	Pass
2900Hz	-12.37db	-23.53db	0.262 mV	-14.638	2.0E-03	Pass
3575Hz	-19.61db	-999db	0.111 mV	-22.108	1.2E-03	Pass
4300Hz	-26db	-999db	0.044 mV	-30.187	7.5E-04	Pass
6600Hz	-40db	-999db	0.002 mV	-56.002	5.5E-04	Pass

Cal DAC	Lower Limit	Upper Limit	As Received/Returned UUT	Uncertainty (Vdc)	Pass/ Fail
0 Vdc	-0.0005 Vdc	0.0005 Vdc	0.0000 Vdc	6.2E-05	Pass
1.2 Vdc	1.1975 Vdc	1.2025 Vdc	1.2002 Vdc	9.4E-05	Pass
2.4 Vdc	2.3975 Vdc	2.4025 Vdc	2.4003 Vdc	1.2E-04	Pass
10V Excitation Short Circuit Recovery					
Channel 1	9.8 Vdc	N/A	9.981 Vdc	1.3E-02	Pass
Channel 2	9.8 Vdc	N/A	9.974 Vdc	1.0E-02	Pass
Channel 3	9.8 Vdc	N/A	9.987 Vdc	1.1E-02	Pass
Channel 4	9.8 Vdc	N/A	10.013 Vdc	1.2E-02	Pass
Channel 5	9.8 Vdc	N/A	10.009 Vdc	1.2E-02	Pass
Channel 6	9.8 Vdc	N/A	9.976 Vdc	1.3E-02	Pass
Channel 7	9.8 Vdc	N/A	9.986 Vdc	1.0E-02	Pass
Channel 8	9.8 Vdc	N/A	9.973 Vdc	9.3E-03	Pass

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

			As Received/Returned		
	Lower Limit	Upper Limit	UUT	Uncertainty (Vdc)	Pass/ Fail
10V Excitation 154 Ohm Startup Load					
Channel 1	9.8 Vdc	N/A	9.981 Vdc	1.3E-02	Pass
Channel 2	9.8 Vdc	N/A	9.974 Vdc	9.9E-03	Pass
Channel 3	9.8 Vdc	N/A	9.987 Vdc	1.1E-02	Pass
Channel 4	9.8 Vdc	N/A	10.013 Vdc	1.1E-02	Pass
Channel 5	9.8 Vdc	N/A	10.009 Vdc	1.2E-02	Pass
Channel 6	9.8 Vdc	N/A	9.976 Vdc	1.4E-02	Pass
Channel 7	9.8 Vdc	N/A	9.986 Vdc	1.1E-02	Pass
Channel 8	9.8 Vdc	N/A	9.973 Vdc	9.7E-03	Pass
10V Excitation 350 Ohm Load Test					
Channel 1	9.95 Vdc	10.05 Vdc	9.982 Vdc	1.3E-02	Pass
Channel 2	9.95 Vdc	10.05 Vdc	9.976 Vdc	1.0E-02	Pass
Channel 3	9.95 Vdc	10.05 Vdc	9.987 Vdc	1.1E-02	Pass
Channel 4	9.95 Vdc	10.05 Vdc	10.013 Vdc	1.2E-02	Pass
Channel 5	9.95 Vdc	10.05 Vdc	10.010 Vdc	1.2E-02	Pass
Channel 6	9.95 Vdc	10.05 Vdc	9.977 Vdc	1.4E-02	Pass
Channel 7	9.95 Vdc	10.05 Vdc	9.986 Vdc	1.0E-02	Pass
Channel 8	9.95 Vdc	10.05 Vdc	9.974 Vdc	9.2E-03	Pass
10V Excitation 200 Ohm Load Test					
Channel 1	9.9 Vdc	10.1 Vdc	9.978 Vdc	1.3E-02	Pass
Channel 2	9.9 Vdc	10.1 Vdc	9.969 Vdc	1.0E-02	Pass
Channel 3	9.9 Vdc	10.1 Vdc	9.980 Vdc	1.1E-02	Pass
Channel 4	9.9 Vdc	10.1 Vdc	10.010 Vdc	1.2E-02	Pass
Channel 5	9.9 Vdc	10.1 Vdc	10.004 Vdc	1.2E-02	Pass
Channel 6	9.9 Vdc	10.1 Vdc	9.972 Vdc	1.4E-02	Pass
Channel 7	9.9 Vdc	10.1 Vdc	9.980 Vdc	1.0E-02	Pass
Channel 8	9.9 Vdc	10.1 Vdc	9.967 Vdc	9.5E-03	Pass
5V Excitation Short Circuit Recovery					
Channel 1	4.9 Vdc	N/A	4.981 Vdc	1.2E-02	Pass
Channel 2	4.9 Vdc	N/A	4.979 Vdc	1.0E-02	Pass
Channel 3	4.9 Vdc	N/A	4.997 Vdc	1.0E-02	Pass
Channel 4	4.9 Vdc	N/A	5.007 Vdc	9.0E-03	Pass
Channel 5	4.9 Vdc	N/A	5.003 Vdc	1.0E-02	Pass
Channel 6	4.9 Vdc	N/A	4.978 Vdc	1.2E-02	Pass
Channel 7	4.9 Vdc	N/A	4.992 Vdc	1.0E-02	Pass
Channel 8	4.9 Vdc	N/A	4.977 Vdc	7.7E-03	Pass
5V Excitation 100 Ohm Load					
Channel 1	4.9 Vdc	5.1 Vdc	4.966 Vdc	1.3E-02	Pass
Channel 2	4.9 Vdc	5.1 Vdc	4.955 Vdc	1.2E-02	Pass
Channel 3	4.9 Vdc	5.1 Vdc	4.977 Vdc	1.1E-02	Pass
Channel 4	4.9 Vdc	5.1 Vdc	4.993 Vdc	9.0E-03	Pass
Channel 5	4.9 Vdc	5.1 Vdc	4.987 Vdc	1.2E-02	Pass
Channel 6	4.9 Vdc	5.1 Vdc	4.963 Vdc	1.3E-02	Pass
Channel 7	4.9 Vdc	5.1 Vdc	4.973 Vdc	1.0E-02	Pass
Channel 8	4.9 Vdc	5.1 Vdc	4.957 Vdc	9.1E-03	Pass

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

	Lower Limit	Upper Limit	As Received/Returned UUT	Uncertainty (Vdc)	Pass/ Fail
5V Excitation 350 Ohm Load Test					
Channel 1	4.95 Vdc	5.05 Vdc	4.981 Vdc	1.2E-02	Pass
Channel 2	4.95 Vdc	5.05 Vdc	4.979 Vdc	1.0E-02	Pass
Channel 3	4.95 Vdc	5.05 Vdc	4.997 Vdc	1.0E-02	Pass
Channel 4	4.95 Vdc	5.05 Vdc	5.007 Vdc	9.0E-03	Pass
Channel 5	4.95 Vdc	5.05 Vdc	5.003 Vdc	1.0E-02	Pass
Channel 6	4.95 Vdc	5.05 Vdc	4.978 Vdc	1.2E-02	Pass
Channel 7	4.95 Vdc	5.05 Vdc	4.992 Vdc	1.0E-02	Pass
Channel 8	4.95 Vdc	5.05 Vdc	4.977 Vdc	7.8E-03	Pass

Gain Response

Gain of 5: 1000mV			As Received/Returned			
	Limit	Std	UUT	Deviation	Uncertainty	Pass/
Channel 1		(mV)	(mV)	(%)	(mV)	Fail
-70%	+/-0.5%	-700.05	-700.11	-0.006	2.6E-01	Pass
-35%	+/-0.5%	-350.02	-350.06	-0.004	1.9E-01	Pass
35%	+/-0.5%	349.87	349.93	0.006	1.9E-01	Pass
70%	+/-0.5%	699.91	699.87	-0.004	1.7E-01	Pass
Channel 2						
-70%	+/-0.5%	-700.05	-700.11	-0.006	2.1E-01	Pass
-35%	+/-0.5%	-350.02	-350.01	0.001	1.7E-01	Pass
35%	+/-0.5%	349.87	349.89	0.002	1.8E-01	Pass
70%	+/-0.5%	699.91	699.90	-0.001	1.6E-01	Pass
Channel 3						
-70%	+/-0.5%	-700.05	-700.18	-0.013	2.5E-01	Pass
-35%	+/-0.5%	-350.02	-350.01	0.000	1.9E-01	Pass
35%	+/-0.5%	349.87	349.92	0.005	1.7E-01	Pass
70%	+/-0.5%	699.91	699.82	-0.009	2.1E-01	Pass
Channel 4						
-70%	+/-0.5%	-700.05	-700.19	-0.014	2.1E-01	Pass
-35%	+/-0.5%	-350.02	-350.05	-0.003	1.9E-01	Pass
35%	+/-0.5%	349.87	349.93	0.005	1.8E-01	Pass
70%	+/-0.5%	699.91	699.79	-0.012	2.5E-01	Pass
Channel 5						
-70%	+/-0.5%	-700.05	-700.19	-0.014	2.7E-01	Pass
-35%	+/-0.5%	-350.02	-350.02	0.000	2.1E-01	Pass
35%	+/-0.5%	349.87	349.96	0.008	1.8E-01	Pass
70%	+/-0.5%	699.91	699.88	-0.003	2.2E-01	Pass
Channel 6						
-70%	+/-0.5%	-700.05	-700.16	-0.011	2.2E-01	Pass
-35%	+/-0.5%	-350.02	-350.03	-0.002	1.3E-01	Pass
35%	+/-0.5%	349.87	349.91	0.004	2.0E-01	Pass
70%	+/-0.5%	699.91	699.83	-0.009	2.4E-01	Pass
Channel 7						
-70%	+/-0.5%	-700.05	-700.22	-0.017	2.0E-01	Pass
-35%	+/-0.5%	-350.02	-350.10	-0.008	1.6E-01	Pass
35%	+/-0.5%	349.87	350.00	0.013	1.3E-01	Pass
70%	+/-0.5%	699.91	699.83	-0.008	2.3E-01	Pass

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

Gain Response

Gain of 5: 1000mV — As Received/Returned

Channel 8	Limit	Std (mV)	UUT (mV)	Deviation (%)	Uncertainty (mV)	Pass/ Fail
-70%	+/-0.5%	-700.05	-700.22	-0.017	2.0E-01	Pass
-35%	+/-0.5%	-350.02	-350.08	-0.006	1.7E-01	Pass
35%	+/-0.5%	349.87	349.90	0.002	2.0E-01	Pass
70%	+/-0.5%	699.91	699.80	-0.012	1.7E-01	Pass

Gain Response

Gain of 16: 312.5mV

Channel 1						
-70%	+/-0.5%	-218.85	-218.85	0.001	1.1E-01	Pass
-35%	+/-0.5%	-109.52	-109.51	0.005	8.3E-02	Pass
35%	+/-0.5%	109.34	109.34	0.000	7.4E-02	Pass
70%	+/-0.5%	218.71	218.68	-0.011	9.3E-02	Pass
Channel 2						
-70%	+/-0.5%	-218.85	-218.84	0.005	8.4E-02	Pass
-35%	+/-0.5%	-109.52	-109.51	0.003	8.7E-02	Pass
35%	+/-0.5%	109.34	109.35	0.002	9.2E-02	Pass
70%	+/-0.5%	218.71	218.69	-0.009	8.7E-02	Pass
Channel 3						
-70%	+/-0.5%	-218.85	-218.88	-0.008	7.5E-02	Pass
-35%	+/-0.5%	-109.52	-109.52	0.000	1.0E-01	Pass
35%	+/-0.5%	109.34	109.35	0.002	8.1E-02	Pass
70%	+/-0.5%	218.71	218.67	-0.015	1.0E-01	Pass
Channel 4						
-70%	+/-0.5%	-218.85	-218.89	-0.011	1.3E-01	Pass
-35%	+/-0.5%	-109.52	-109.52	-0.002	1.1E-01	Pass
35%	+/-0.5%	109.34	109.37	0.009	1.0E-01	Pass
70%	+/-0.5%	218.71	218.71	-0.002	1.3E-01	Pass
Channel 5						
-70%	+/-0.5%	-218.85	-218.87	-0.005	1.0E-01	Pass
-35%	+/-0.5%	-109.52	-109.51	0.005	1.1E-01	Pass
35%	+/-0.5%	109.34	109.36	0.006	8.3E-02	Pass
70%	+/-0.5%	218.71	218.68	-0.011	9.6E-02	Pass
Channel 6						
-70%	+/-0.5%	-218.85	-218.83	0.008	1.1E-01	Pass
-35%	+/-0.5%	-109.52	-109.51	0.003	9.0E-02	Pass
35%	+/-0.5%	109.34	109.36	0.005	6.8E-02	Pass
70%	+/-0.5%	218.71	218.67	-0.015	8.0E-02	Pass
Channel 7						
-70%	+/-0.5%	-218.85	-218.90	-0.014	9.8E-02	Pass
-35%	+/-0.5%	-109.52	-109.52	0.002	9.0E-02	Pass
35%	+/-0.5%	109.34	109.35	0.003	9.5E-02	Pass
70%	+/-0.5%	218.71	218.67	-0.015	8.9E-02	Pass
Channel 8						
-70%	+/-0.5%	-218.85	-218.89	-0.011	9.6E-02	Pass
-35%	+/-0.5%	-109.52	-109.53	-0.003	1.0E-01	Pass
35%	+/-0.5%	109.34	109.38	0.011	9.6E-02	Pass
70%	+/-0.5%	218.71	218.69	-0.008	8.5E-02	Pass

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

Gain Response

Gain of 32: 156.25mV

		As Received/Returned				
	Limit	Std	UUT	Deviation	Uncertainty	Pass/
Channel 1		(mV)	(mV)	(%)	(mV)	Fail
-70%	+/-0.5%	-109.52	-109.54	-0.008	4.6E-02	Pass
-35%	+/-0.5%	-54.73	-54.74	-0.007	2.1E-02	Pass
35%	+/-0.5%	54.60	54.61	0.005	3.5E-02	Pass
70%	+/-0.5%	109.35	109.34	-0.007	3.7E-02	Pass
Channel 2						
-70%	+/-0.5%	-109.52	-109.53	-0.006	3.2E-02	Pass
-35%	+/-0.5%	-54.73	-54.74	-0.011	1.7E-02	Pass
35%	+/-0.5%	54.60	54.61	0.005	3.3E-02	Pass
70%	+/-0.5%	109.35	109.34	-0.006	3.6E-02	Pass
Channel 3						
-70%	+/-0.5%	-109.52	-109.54	-0.009	3.8E-02	Pass
-35%	+/-0.5%	-54.73	-54.74	-0.008	2.0E-02	Pass
35%	+/-0.5%	54.60	54.61	0.009	3.0E-02	Pass
70%	+/-0.5%	109.35	109.34	-0.003	3.2E-02	Pass
Channel 4						
-70%	+/-0.5%	-109.52	-109.55	-0.018	4.4E-02	Pass
-35%	+/-0.5%	-54.73	-54.74	-0.010	2.4E-02	Pass
35%	+/-0.5%	54.60	54.61	0.005	3.6E-02	Pass
70%	+/-0.5%	109.35	109.35	-0.001	3.3E-02	Pass
Channel 5						
-70%	+/-0.5%	-109.52	-109.53	-0.003	4.3E-02	Pass
-35%	+/-0.5%	-54.73	-54.73	0.000	2.2E-02	Pass
35%	+/-0.5%	54.60	54.61	0.004	4.1E-02	Pass
70%	+/-0.5%	109.35	109.34	-0.004	3.9E-02	Pass
Channel 6						
-70%	+/-0.5%	-109.52	-109.53	-0.002	4.3E-02	Pass
-35%	+/-0.5%	-54.73	-54.73	-0.001	2.0E-02	Pass
35%	+/-0.5%	54.60	54.60	-0.001	3.8E-02	Pass
70%	+/-0.5%	109.35	109.34	-0.008	3.5E-02	Pass
Channel 7						
-70%	+/-0.5%	-109.52	-109.55	-0.016	4.7E-02	Pass
-35%	+/-0.5%	-54.73	-54.73	-0.005	1.9E-02	Pass
35%	+/-0.5%	54.60	54.61	0.009	3.3E-02	Pass
70%	+/-0.5%	109.35	109.34	-0.005	3.2E-02	Pass
Channel 8						
-70%	+/-0.5%	-109.52	-109.54	-0.013	4.9E-02	Pass
-35%	+/-0.5%	-54.73	-54.74	-0.008	2.1E-02	Pass
35%	+/-0.5%	54.60	54.62	0.009	3.2E-02	Pass
70%	+/-0.5%	109.35	109.35	0.001	2.9E-02	Pass

Gain Response

Gain of 128: 39.0625mV

Channel 1						
-70%	+/-0.5%	-27.358	-27.411	-0.135	2.8E-02	Pass
-35%	+/-0.5%	-13.861	-13.874	-0.032	4.8E-02	Pass
35%	+/-0.5%	13.695	13.719	0.061	1.5E-02	Pass
70%	+/-0.5%	27.192	27.230	0.097	4.1E-02	Pass

DTS

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

Gain Response — As Received/Returned

Gain of 128: 39.0625mV		Std	UUT	Deviation	Uncertainty	Pass/
Channel 2	Limit	(mV)	(mV)	(%)	(mV)	Fail
-70%	+/-0.5%	-27.358	-27.406	-0.123	2.7E-02	Pass
-35%	+/-0.5%	-13.861	-13.875	-0.035	5.2E-02	Pass
35%	+/-0.5%	13.695	13.719	0.061	1.6E-02	Pass
70%	+/-0.5%	27.192	27.227	0.091	4.4E-02	Pass
Channel 3						
-70%	+/-0.5%	-27.358	-27.408	-0.129	2.6E-02	Pass
-35%	+/-0.5%	-13.861	-13.874	-0.032	4.6E-02	Pass
35%	+/-0.5%	13.695	13.719	0.061	1.6E-02	Pass
70%	+/-0.5%	27.192	27.229	0.094	4.5E-02	Pass
Channel 4						
-70%	+/-0.5%	-27.358	-27.412	-0.138	2.8E-02	Pass
-35%	+/-0.5%	-13.861	-13.878	-0.043	5.1E-02	Pass
35%	+/-0.5%	13.695	13.721	0.066	1.7E-02	Pass
70%	+/-0.5%	27.192	27.229	0.095	4.1E-02	Pass
Channel 5						
-70%	+/-0.5%	-27.358	-27.410	-0.132	2.5E-02	Pass
-35%	+/-0.5%	-13.861	-13.874	-0.032	4.6E-02	Pass
35%	+/-0.5%	13.695	13.719	0.061	1.5E-02	Pass
70%	+/-0.5%	27.192	27.229	0.095	4.1E-02	Pass
Channel 6						
-70%	+/-0.5%	-27.358	-27.409	-0.130	2.5E-02	Pass
-35%	+/-0.5%	-13.861	-13.875	-0.034	4.9E-02	Pass
35%	+/-0.5%	13.695	13.719	0.060	1.6E-02	Pass
70%	+/-0.5%	27.192	27.228	0.092	4.2E-02	Pass
Channel 7						
-70%	+/-0.5%	-27.358	-27.413	-0.142	2.6E-02	Pass
-35%	+/-0.5%	-13.861	-13.876	-0.038	5.0E-02	Pass
35%	+/-0.5%	13.695	13.721	0.066	1.5E-02	Pass
70%	+/-0.5%	27.192	27.229	0.096	4.2E-02	Pass
Channel 8						
-70%	+/-0.5%	-27.358	-27.412	-0.137	2.4E-02	Pass
-35%	+/-0.5%	-13.861	-13.878	-0.043	5.3E-02	Pass
35%	+/-0.5%	13.695	13.722	0.068	1.6E-02	Pass
70%	+/-0.5%	27.192	27.228	0.093	4.7E-02	Pass

Gain Response

Gain of 512: 9.765625mV						
Channel 1						
-70%	+/-1.5%	-6.849	-6.864	-0.158	1.5E-02	Pass
-35%	+/-1.5%	-3.509	-3.513	-0.041	2.6E-02	Pass
35%	+/-1.5%	3.336	3.338	0.023	1.7E-02	Pass
70%	+/-1.5%	6.702	6.708	0.062	2.9E-02	Pass
Channel 2						
-70%	+/-1.5%	-6.849	-6.864	-0.161	1.4E-02	Pass
-35%	+/-1.5%	-3.509	-3.514	-0.048	3.0E-02	Pass
35%	+/-1.5%	3.336	3.337	0.015	1.7E-02	Pass
70%	+/-1.5%	6.702	6.709	0.072	3.0E-02	Pass

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

Gain Response — **As Received/Returned**

Gain of 512: 9.765625mV		Std	UUT	Deviation	Uncertainty	Pass/
Channel 3	Limit	(mV)	(mV)	(%)	(mV)	Fail
-70%	+/-1.5%	-6.849	-6.865	-0.164	1.2E-02	Pass
-35%	+/-1.5%	-3.509	-3.514	-0.053	3.0E-02	Pass
35%	+/-1.5%	3.336	3.338	0.023	1.8E-02	Pass
70%	+/-1.5%	6.702	6.709	0.069	3.0E-02	Pass
Channel 4						
-70%	+/-1.5%	-6.849	-6.865	-0.170	1.4E-02	Pass
-35%	+/-1.5%	-3.509	-3.514	-0.045	2.6E-02	Pass
35%	+/-1.5%	3.336	3.339	0.030	1.8E-02	Pass
70%	+/-1.5%	6.702	6.708	0.065	3.2E-02	Pass
Channel 5						
-70%	+/-1.5%	-6.849	-6.864	-0.159	1.4E-02	Pass
-35%	+/-1.5%	-3.509	-3.514	-0.052	2.7E-02	Pass
35%	+/-1.5%	3.336	3.338	0.022	1.5E-02	Pass
70%	+/-1.5%	6.702	6.709	0.070	3.0E-02	Pass
Channel 6						
-70%	+/-1.5%	-6.849	-6.864	-0.161	1.3E-02	Pass
-35%	+/-1.5%	-3.509	-3.514	-0.050	2.9E-02	Pass
35%	+/-1.5%	3.336	3.338	0.025	1.7E-02	Pass
70%	+/-1.5%	6.702	6.710	0.083	2.8E-02	Pass
Channel 7						
-70%	+/-1.5%	-6.849	-6.865	-0.162	1.2E-02	Pass
-35%	+/-1.5%	-3.509	-3.514	-0.046	2.4E-02	Pass
35%	+/-1.5%	3.336	3.338	0.022	1.7E-02	Pass
70%	+/-1.5%	6.702	6.710	0.079	3.4E-02	Pass
Channel 8						
-70%	+/-1.5%	-6.849	-6.864	-0.155	1.3E-02	Pass
-35%	+/-1.5%	-3.509	-3.514	-0.046	2.6E-02	Pass
35%	+/-1.5%	3.336	3.337	0.018	2.1E-02	Pass
70%	+/-1.5%	6.702	6.709	0.070	3.2E-02	Pass

Gain Response

Gain of 2000: 2.5mV						
Channel 1						
-70%	+/-1.5%	-1.930	-1.932	-0.081	5.0E-02	Pass
-35%	+/-1.5%	-1.052	-1.054	-0.085	4.9E-02	Pass
35%	+/-1.5%	0.879	0.878	-0.030	8.1E-03	Pass
70%	+/-1.5%	1.769	1.773	0.132	1.1E-02	Pass
Channel 2						
-70%	+/-1.5%	-1.930	-1.929	0.048	5.2E-02	Pass
-35%	+/-1.5%	-1.052	-1.052	0.003	4.1E-02	Pass
35%	+/-1.5%	0.879	0.876	-0.110	4.2E-03	Pass
70%	+/-1.5%	1.769	1.770	0.012	1.0E-02	Pass
Channel 3						
-70%	+/-1.5%	-1.930	-1.931	-0.057	6.8E-02	Pass
-35%	+/-1.5%	-1.052	-1.053	-0.054	4.7E-02	Pass
35%	+/-1.5%	0.879	0.877	-0.071	6.3E-03	Pass
70%	+/-1.5%	1.769	1.772	0.104	1.3E-02	Pass

Serial #: LM0212
Order #: RA26649
Date: 17 February 2015

Test Description

Gain Response — As Received/Returned

Gain of 2000: 2.5mV		Std	UUT	Deviation	Uncertainty	Pass/
Channel 4	Limit	(mV)	(mV)	(%)	(mV)	Fail
-70%	+/-1.5%	-1.930	-1.930	-0.004	5.1E-02	Pass
-35%	+/-1.5%	-1.052	-1.052	-0.027	4.4E-02	Pass
35%	+/-1.5%	0.879	0.877	-0.060	7.3E-03	Pass
70%	+/-1.5%	1.769	1.770	0.027	7.9E-03	Pass
Channel 5						
-70%	+/-1.5%	-1.930	-1.930	0.001	4.6E-02	Pass
-35%	+/-1.5%	-1.052	-1.053	-0.040	4.5E-02	Pass
35%	+/-1.5%	0.879	0.876	-0.109	5.6E-03	Pass
70%	+/-1.5%	1.769	1.771	0.045	1.6E-02	Pass
Channel 6						
-70%	+/-1.5%	-1.930	-1.933	-0.105	5.1E-02	Pass
-35%	+/-1.5%	-1.052	-1.054	-0.108	5.0E-02	Pass
35%	+/-1.5%	0.879	0.877	-0.056	9.3E-03	Pass
70%	+/-1.5%	1.769	1.772	0.085	8.0E-03	Pass
Channel 7						
-70%	+/-1.5%	-1.930	-1.932	-0.066	5.0E-02	Pass
-35%	+/-1.5%	-1.052	-1.053	-0.052	4.3E-02	Pass
35%	+/-1.5%	0.879	0.878	-0.054	4.1E-03	Pass
70%	+/-1.5%	1.769	1.771	0.054	9.9E-03	Pass
Channel 8						
-70%	+/-1.5%	-1.930	-1.934	-0.177	5.3E-02	Pass
-35%	+/-1.5%	-1.052	-1.054	-0.103	4.7E-02	Pass
35%	+/-1.5%	0.879	0.879	-0.004	1.0E-02	Pass
70%	+/-1.5%	1.769	1.775	0.220	1.2E-02	Pass

End of Report

NovaStar SOLUTIONS
Metrology Management Services

Calibration Certificate

ACCREDITED Calibration #1277.01

35200 Plymouth Rd. / Livonia, MI 48150

Certificate # Z54482:107387

MITUTOYO PRO 360 DIGITAL PROTRACTOR

SERIAL NUMBER:	06091641
ASSET NUMBER:	Z54482
CUST ASSET NUMBER:	MGA00712
PROCEDURE NAME:	MIT - PRO 360 - MMC
PROCEDURE REV:	1.0
CALIBRATED BY:	Joseph Giordano
CUSTOMER:	MGA RESEARCH 446 EXECUTIVE DRIVE TROY, MI 48083
PRIMARY CONTACT:	SCOTT ARSEN

WORK ORDER:	107387
TEST RESULT:	PASS
PERFORMED ON:	10/27/14
CAL DUE DATE:	10/27/15
DATA TYPE:	FOUND-LEFT
TEMPERATURE:	23.97 °C
HUMIDITY:	36 %

This instrument has been processed and calibrated in accordance with the NovaStar Solutions Quality System Manual and is traceable to the National Institute of Standards and Technology (NIST) or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. The NovaStar Solutions quality system is accredited ISO/IEC 17025:2005 and ANSI/NCSL Z540-1-1994.

The results reported herein apply only to the calibration of the item described above. No sampling plan was used for this calibration.

The ratio of the tolerance of the instrument or parameter being calibrated to the expanded uncertainty of the standard (TUR) is greater than 4:1 unless otherwise specified. Expanded uncertainties are expressed at the approximate 95% level of confidence using a K=2. Due to any number of factors, the recommended due date on the item does not imply continuing conformance to specifications during the recommended interval. Unless otherwise stated the unit under test meets or exceeds manufacturer specifications.

For range and best measurement capability specifications for the standards used to perform this calibration, see the most recent calibration report maintained by this calibration laboratory (available upon request).

This report may not be reproduced, except in full, without written approval from NovaStar Solutions.

AS RECEIVED CONDITION:	IN TOLERANCE
AS RETURNED CONDITION:	IN TOLERANCE
ACTION TAKEN:	FULL CALIBRATION

REMARKS:

Standards Used

Asset #	Cert #	Description	Cal Date	Due Date
1437	1437:1193650835	PHASE 2 220-006 ROTARY TABLE	02/13/2013	02/13/2017
1577	1577:1193650836	RAHN SUPER 100 SURFACE PLATE	02/10/2014	02/10/2015

QA Signature: Duke Rayne Date: 10/29/2014

10/31/2014

Test Results for Calibration with Certificate# : Z54482:107387

Test Procedure Results

Test Description	Nominal	Test Result	Lower Limit	Upper Limit	Units	Exp Uncert	Pass/Fail
60°	60.0	60.0	59.8	60.2	°	0.02° + .6R	Pass
30°	30.0	30.0	29.8	30.2	°	0.02° + .6R	Pass
5°	5.0	5.0	4.9	5.1	°	0.02° + .6R	Pass
0°	0.0	0.0	-0.1	0.1	°		Pass
5°	5.0	5.0	4.9	5.1	°	0.02° + .6R	Pass
30°	30.0	30.0	29.8	30.2	°	0.02° + .6R	Pass
60°	60.0	60.0	59.8	60.2	°	0.02° + .6R	Pass
90°	90.0	90.0	89.9	90.1	°	0.02° + .6R	Pass
60°	60.0	60.0	59.8	60.2	°	0.02° + .6R	Pass
30°	30.0	30.0	29.8	30.2	°	0.02° + .6R	Pass
5°	5.0	5.0	4.9	5.1	°	0.02° + .6R	Pass
0°	0.0	0.0	-0.1	0.1	°		Pass
ABSOLUTE ZERO ANGLE	0.0	0.0	-0.1	0.1	°		Pass

***** End of Report *****

NovaStar SOLUTIONS
Metrology Management Services

Calibration Certificate

ACCREDITED Calibration #1277.01

35200 Plymouth Rd. / Livonia, MI 48150

Certificate # Z54487:107382

DETECTO AP-20 SCALE

SERIAL NUMBER:	E10807-0187	WORK ORDER:	107382
ASSET NUMBER:	Z54487	TEST RESULT:	PASS
CUST ASSET NUMBER:	MGA00783	PERFORMED ON:	10/27/14
PROCEDURE NAME:	122-040	CAL DUE DATE:	10/27/15
PROCEDURE REV:	B	DATA TYPE:	FOUND-LEFT
CALIBRATED BY:	Joseph Giordano	TEMPERATURE:	23.00 °C
CUSTOMER:	MGA RESEARCH 446 EXECUTIVE DRIVE TROY, MI 48083	HUMIDITY:	40 %
PRIMARY CONTACT:	SCOTT ARSEN		

This instrument has been processed and calibrated in accordance with the NovaStar Solutions Quality System Manual and is traceable to the National Institute of Standards and Technology (NIST) or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. The NovaStar Solutions quality system is accredited ISO/IEC 17025:2005 and ANSI/NCSL Z540-1-1994.

The results reported herein apply only to the calibration of the item described above. No sampling plan was used for this calibration.

The ratio of the tolerance of the instrument or parameter being calibrated to the expanded uncertainty of the standard (TUR) is greater than 4:1 unless otherwise specified. Expanded uncertainties are expressed at the approximate 95% level of confidence using a K=2. Due to any number of factors, the recommended due date on the item does not imply continuing conformance to specifications during the recommended interval. Unless otherwise stated the unit under test meets or exceeds manufacturer specifications.

For range and best measurement capability specifications for the standards used to perform this calibration, see the most recent calibration report maintained by this calibration laboratory (available upon request).

This report may not be reproduced, except in full, without written approval from NovaStar Solutions.

AS RECEIVED CONDITION:	IN TOLERANCE	REMARKS:
AS RETURNED CONDITION:	IN TOLERANCE	
ACTION TAKEN:	FULL CALIBRATION	

Standards Used

Asset #	Cert #	Description	Cal Date	Due Date
1081	1081:1193650835	RICE LAKE CLASS 6 18 PC WEIGHT SET	03/18/2013	03/18/2015
1633	1633:1193663229	RICE LAKE CLASS 6 17 PC WEIGHT SET	06/04/2013	12/04/2014

QA Signature: Duke Payne Date: 10/29/2014

10/31/2014
$A

NovaStar SOLUTIONS
Metrology Managment Services

Calibration Data Sheet

36200 Plymouth Rd.
Livonia, MI 48150
734-453-8003

Inst. Type	Scale	**Mfr.**	Detecto	**W.O.**	107382
Last Cal Date	10/21/2013	**Mod.**	AP-20	**Date**	10/27/2014
Form Number	26146 Rev A	**S/N**	E10807-0187	**Test Eng'r**	JG

Note Measurement Uncertainty = 0.008 lbs

Function	Calibration Point	Unit		As Found	Note	As Left	Low Limit	Hi Limit	Unit
Linearity	1.00 lb			1.00		1.00	0.95	1.05	lb
	5.00 lbs			5.00		5.00	4.95	5.05	lbs
	10.00 lbs			10.01		10.01	9.95	10.05	lbs
	15.00 lbs			15.01		15.01	14.95	15.05	lbs
	20.00 lbs			20.02		20.02	19.95	20.05	lbs
Shift Test	Center			10.01		10.01	10.01	10.03	lbs
@ 10lbs	Front			10.02		10.02	10.01	10.03	lbs
	Back			10.00		10.00	10.01	10.03	lbs
	Left			10.01		10.01	10.01	10.03	lbs
	Right			10.01		10.01	10.01	10.03	lbs

107382

MICHIGAN OPERATIONS
DATE: 4/4/2013
SUPERCEDES: MGATPTMC.6

DOC. NO.: MGATP_TMC
REVISION NO.: 7
PAGE 3 OF 3

Tape Measure Calibration Certificate

Reference Steel Rule
Brand: Swanson
S/N: MBA000799
Calibration Date: 5/21/2014

Subject Tape Measure
Brand: Stanley
S/N: TP7001-71
Calibration Date: 1/27/2015

Reference in (mm)	Subject Tape Measure		Difference		Reference in (mm)	Subject Tape Measure		Difference	
	Pull	Push	Pull	Push		Pull	Push	Pull	Push
0 (0)	0	0	0	0	18 (450)	450	449	0	-1
1 (25)	25	24	0	-1	19 (475)	475	474	0	-1
2 (50)	50	49	0	-1	20 (500)	500	499	0	-1
3 (75)	75	74	0	-1	21 (525)	525	524	0	-1
4 (100)	100	99	0	-1	22 (550)	550	549	0	-1
5 (125)	125	124	0	-1	23 (575)	575	574	0	-1
6 (150)	150	149	0	-1	24 (600)	600	599	0	-1
7 (175)	175	174	0	-1	25 (625)	625	624	0	-1
8 (200)	200	199	0	-1	26 (650)	650	649	0	-1
9 (225)	225	224	0	-1	27 (675)	675	674	0	-1
10 (250)	250	249	0	-1	28 (700)	700	699	0	-1
11 (275)	275	274	0	-1	29 (725)	725	724	0	-1
12 (300)	300	299	0	-1	30 (750)	750	749	0	-1
13 (325)	325	324	0	-1	31 (775)	775	774	0	-1
14 (350)	350	349	0	-1	32 (800)	800	799	0	-1
15 (375)	375	374	0	-1	33 (825)	825	824	0	-1
16 (400)	400	399	0	-1	34 (850)	850	849	0	-1
17 (425)	425	424	0	-1	35 (875)	875	874	0	-1

If all differences are ± 1/32 of an inch (1 mm), then the tape measure is acceptable.
Pass ✓ Fail ____ Maximum Difference = -1

Date: 1/27/2015 Performed By: [signature]

All calibrations are traceable to the National Institute of Standards and Technology. Estimated uncertainty of the measurement is ± 0.2%. All certification data and equipment are on file for inspection at your request. Best uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor k=2.

Calibration Certificate

Part Description: Digital Template
Certification Date: 2015-03-31 (YYYY-MM-DD)
Serial#: C12-D2-05-03364
Single Point - (Max-Min)/2 Specification: C12-D2 0.244mm (0.0096")
Certificate#: C12D20503364-3312015-845A
Volumetric (Max Deviation) Specification: C12-D2 +/-0.345mm (+/-0.0136")
Temperature: See attached data

Measurement Standards Traceability

Kinematic Scale Bar - Short	Asset Number: TQ1361	Calibration Due: 5/26/2015	*SI Traceability: 735d3097-fb10-4a0b-bd6f-a038fb5e8830
Kinematic Scale Bar - Long	Asset Number: TQ1381	Calibration Due: 5/26/2015	*SI Traceability: d49451ab-bb6e-47ba-a8f4-867ea23f9a0f
Thermometer	Asset Number: TQ1220	Calibration Due: 5/28/2015	*SI Traceability: KELC-262780
Calibration Probe	Asset Number: 3524	Calibration Due: 9/5/2016	*SI Traceability: 14-331-03026
Reference Sphere	Asset Number: TQ533	Calibration Due: 1/23/2016	*SI Traceability: 13-259-00851

The artifacts above have been calibrated with a device traceable to the International System of Units (SI) through a National Metrological Institute (NMI) or through an ISO17025 Accredited Laboratory.
Calibration was performed following procedure listed on E7MAN015. This procedure was developed in accordance with ASME B89.4.22-2004.
See attached data for measurement results

Calibration Results*

3 Single Point Articulation Tests at <=20%, 20%-80% and >=80% range.	PASSED
1 Effective diameter sphere test.	PASSED
20 Volumetric ball bar tests in 4 quadrants and 2 orientations.	PASSED

Instrument condition as received: Inoperative

Instrument condition outgoing: Within specifications

This certificate invalidates all other certificates generated before: 3/31/2015 8:45:50 AM
This certificate shall not be reproduced, except in full, without permission of FARO Technologies, Inc.
The results of this certificate relate only to the items calibrated or tested.

Approved By: Jundee Apaisom — Cal Cert Technician — Date: 2015-03-31

FARO Technologies, Inc.
PH1:1-800-736-2771
PH2:407-333-9911
FAX:407-333-8056

125 Technology Park
Lake Mary, FL 32746
USA

LABORATORY ACCREDITATION BUREAU ACCREDITED
Cert # L-1147-1 Calibration

4/14/2015

Revised: November 21, 2013
©2013 FARO

Page 1 of 6

f:\control\records\05manufa\partspec\XH08-0495.eps Rev4 RevDate: 04/02/13

Outgoing Certification

FARO

Serial Number: C12-D2-05-03364 Date: 2015-03-31

Effective Diameter Performance Test Results

Test	Quadrant	Calibrated Diameter (Dcal)	Reference Temperature (Tref)	CTE (PPM)	Measured Temperature (Tmea)	Adjusted Diameter (Dadj)*	Measured Diameter (Dm)	Diameter Deviation (Dm-Dadj)	Test Results
1	3/4	25.4011	20.1	10.2	21.6	25.4015	25.3840	-0.0174	Passed
2	3/4	25.4011	20.1	10.2	21.6	25.4015	25.3904	-0.0110	Passed
3	3/4	25.4011	20.1	10.2	21.6	25.4015	25.4130	0.0116	Passed
							Maximum Deviation	0.0174	Passed
							Effective Diameter Specification	0.1220	

* Dadj = Dcal x (1 + ((CTE/1,000,000) x (Tmea - Tref)))

Measurement Uncertainty is 1 micrometer

Single Point Articulation Performance Test Results

Region	Quadrant	(Max-Min)/2	Test Results
< 20%	1/2	0.0597	Passed
20-80%	3/4	0.0398	Passed
>80%	2/3	0.0538	Passed
	Maximum	0.0597	Passed
	Single Point Specification	0.2440	

Measurement Uncertainty is 0.41 micrometer

Volumetric Performance Test Results

Quadrant	Position	Calibrated Length (Lcal)	Reference Temperature (Tref)	CTE (PPM)	Measured Temperature (Tmea)	Adjusted Length (Ladj)**	Measured Length (Lm)	Length Deviation (Lm-Ladj)	Test Results
1	Flat	2199.9734	19.8	0.1	21.5	2199.9739	2199.9795	0.0056	Passed
1	Flat	1149.8541	19.8	0.1	21.5	1149.8544	1149.8378	-0.0166	Passed
2	Flat	2199.9734	19.8	0.1	21.5	2199.9739	2199.9631	-0.0107	Passed
2	Flat	1149.8541	19.8	0.1	21.5	1149.8544	1149.8466	-0.0078	Passed
3	Flat	2199.9734	19.8	0.1	21.5	2199.9739	2199.9500	-0.0239	Passed
3	Flat	1149.8541	19.8	0.1	21.5	1149.8544	1149.8444	-0.0100	Passed
4	Flat	2199.9734	19.8	0.1	21.5	2199.9739	2199.9663	-0.0076	Passed
4	Flat	1149.8541	19.8	0.1	21.5	1149.8544	1149.8506	-0.0038	Passed
1	45°	2199.9734	19.8	0.1	21.5	2199.9739	2200.0320	0.0581	Passed
1	45°	1149.8541	19.8	0.1	21.5	1149.8544	1149.9037	0.0493	Passed
2	45°	2199.9734	19.8	0.1	21.5	2199.9739	2200.0098	0.0359	Passed
2	45°	1149.8541	19.8	0.1	21.5	1149.8544	1149.8997	0.0453	Passed
3	45°	2199.9734	19.8	0.1	21.5	2199.9739	2200.0320	0.0581	Passed
3	45°	1149.8541	19.8	0.1	21.5	1149.8544	1149.9058	0.0514	Passed
4	45°	2199.9734	19.8	0.1	21.5	2199.9739	2200.0027	0.0288	Passed
4	45°	1149.8541	19.8	0.1	21.5	1149.8544	1149.8853	0.0309	Passed
1	Vertical	950.0541	19.8	0.1	21.5	950.0543	950.0449	-0.0095	Passed
2	Vertical	950.0541	19.8	0.1	21.5	950.0543	950.0831	0.0288	Passed
3	Vertical	950.0541	19.8	0.1	21.5	950.0543	950.0388	-0.0156	Passed
4	Vertical	950.0541	19.8	0.1	21.5	950.0543	950.0831	0.0288	Passed
							Maximum Deviation	0.0581	Passed
							Volumetric Specification	0.3450	

** Ladj = Lcal x (1 + ((CTE/1,000,000) x (Tmea - Tref)))

Measurement Uncertainty is 3.6 micrometer*

Uncertainty is expressed at approximately a 95% Level of Confidence using k=2.00.

RJ 4/14/2015

Summary

FARO

Condition As Received: **Inoperative**

Outgoing - Single Point Articulation Test Quadrant 3-4, <20%

FARO

FaroArm Serial Number:	C12-D2-05-03364		
Firmware Version:	312		
FaroArm Temperature:	23.52		
Probe: Ball Probe	X: 26.162	Y: 1.239	Z: 159.152
Probe 2*Sigma:	0.054766506		
Date of Test:	3/31/2015		
Number of Points Taken:	10		
Maximum X:	-302.1419983		
Minimum X:	-302.237915		
(Max-Min)/2:	0.047958374		
Maximum Y:	53.63430786		
Minimum Y:	53.55072021		
(Max-Min)/2:	0.041793823		
Maximum Z:	956.2320557		
Minimum Z:	956.1126709		
(Max-Min)/2:	0.059692383		

Index	X (mm)	Y (mm)	Z (mm)
1	-302.1419983	53.63430786	956.1610107
2	-302.1598816	53.59180832	956.1827393
3	-302.1870422	53.58802414	956.1679077
4	-302.2028503	53.56264496	956.1470337
5	-302.2011719	53.55584335	956.1126709
6	-302.1979675	53.56870651	956.2247314
7	-302.1771851	53.55690384	956.1625366
8	-302.1749268	53.55072021	956.1508179
9	-302.2268066	53.59379196	956.1957397
10	-302.237915	53.59745789	956.2320557

Outgoing - Single Point Articulation Test Quadrant 3-4, 40%

FARO

FaroArm Serial Number:	C12-D2-05-03364		
Firmware Version:	312		
FaroArm Temperature:	23.57		
Probe: Ball Probe	X: 26.162	Y: 1.239	Z: 159.152
Probe 2*Sigma:	0.054786506		
Date of Test:	3/31/2015		
Number of Points Taken:	10		
Maximum X:	341.4140625		
Minimum X:	341.3433533		
(Max-Min)/2:	0.035354614		
Maximum Y:	-86.62831116		
Minimum Y:	-86.66944885		
(Max-Min)/2:	0.020568848		
Maximum Z:	-65.18264008		
Minimum Z:	-65.26217651		
(Max-Min)/2:	0.039768219		

Index	X (mm)	Y (mm)	Z (mm)
1	341.3993225	-86.62831116	-65.26217651
2	341.3791199	-86.64588165	-65.22431946
3	341.4140625	-86.66944885	-65.221138
4	341.4000854	-86.66416931	-65.24797058
5	341.3612366	-86.65323639	-65.19924164
6	341.3968506	-86.66278076	-65.18402863
7	341.3433533	-86.62930298	-65.18264008
8	341.3875427	-86.66137695	-65.2046051
9	341.3831787	-86.66345978	-65.19826508
10	341.3764343	-86.65211487	-65.19019318

Outgoing - Single Point Articulation Test Quadrant 3-4, >80%

FARO

FaroArm Serial Number:	C12-D2-05-03364		
Firmware Version:	312		
FaroArm Temperature:	23.59		
Probe: Ball Probe	X: 26.162	Y: 1.239	Z: 159.152
Probe 2*Sigma:	0.054766506		
Date of Test:	3/31/2015		
Number of Points Taken:	10		
Maximum X:	-213.7299347		
Minimum X:	-213.8376312		
(Max-Min)/2:	0.053848267		
Maximum Y:	35.10113144		
Minimum Y:	35.01716995		
(Max-Min)/2:	0.041980743		
Maximum Z:	-1418.967529		
Minimum Z:	-1419.067017		
(Max-Min)/2:	0.049743652		

Index	X (mm)	Y (mm)	Z (mm)
1	-213.7299347	35.03325272	-1419.015747
2	-213.7741089	35.06063843	-1419.03064
3	-213.8027039	35.03982162	-1418.967529
4	-213.7838745	35.07539368	-1418.999878
5	-213.765976	35.07759094	-1419.041382
6	-213.8026276	35.08253098	-1419.030151
7	-213.8376312	35.02813339	-1418.97876
8	-213.7653503	35.01716995	-1418.992554
9	-213.7877808	35.10113144	-1419.067017
10	-213.7380829	35.0691185	-1419.032593

mga research corporation

CALIBRATION CERTIFICATE

Name: MGA Velocity Measurement System
Model: MGA VMS
S/N: VMS MPS1
Temperature: 21.6°c
Humidity: 35%

Calibration Date: 2/23/2015

Sensor Distance: 29.96mm (Tolerance 30 +/- 0.2mm)

Hz	46.3	92.6	138.9	185.2	231.5	277.8	463	694.4	925.9
Km/h	5	10	15	20	25	30	50	75	100
1	5.000	10.001	15.002	20.001	25.003	30.001	50.001	75.003	100.030
2	5.000	10.001	15.001	20.003	25.003	30.003	50.016	75.003	100.030
3	5.000	10.001	15.002	20.002	25.003	30.003	50.001	75.020	100.000
4	5.000	10.001	15.002	20.002	25.007	30.006	50.016	75.020	100.000
5	5.000	10.001	15.001	20.000	24.997	30.003	49.996	75.003	100.030
6	5.000	10.001	15.002	20.003	25.005	29.998	50.001	75.020	100.030
7	5.000	10.001	15.003	20.002	25.001	30.003	50.001	75.003	100.000
8	5.000	10.001	15.002	20.002	25.003	30.001	50.001	75.020	100.060
9	5.000	10.001	15.002	20.001	25.005	30.001	50.016	75.020	100.030
10	5.000	10.001	15.002	20.002	25.005	30.001	50.001	75.003	99.977
ave	5.000	10.001	15.002	20.002	25.003	30.002	50.005	75.012	100.019
std dev	0.000	0.000	0.001	0.001	0.003	0.002	0.008	0.009	0.024

standards used

MFG	Model Number	Serial Number	Description	Cal Due Date
Agilent	8904A	56.28-01	Function Generator	2/13/2016
Fowler	IP54	131182141	Calipers	9/17/2015

Performed By:

Approved By: Helen A. Kaleto

446 executive drive • troy, mi 48083
248 / 577-5001 • fax 248 / 577-5025
www.mgaresearch.com

DTS
41204 Bridge Street, Novi, MI 48375-1301 USA
Phone: +1 248 427 0045 • Fax: +1 248 427 0630
www.dtsweb.com

Certificate of Calibration

Model #:	Timed Output Module	Certificate #:	2015319TOML041
Serial #:	TOML041	Date Received:	13 March 2015
Procedure Name:	TOM Calibration Revision: 2.0	Date Calibrated:	19 March 2015
Project Number:	RA27091	Next Calibration:	19 March 2016
Customer:	MGA	Test Result:	In Tolerance
	446 Executive Drive	Temperature:	75°F / 24.0°C
	Troy, MI 48083	Humidity:	29 %

This Instrument has been processed and calibrated in accordance with the DTS Quality Assurance Manual, and traceable to National Institute of Standards and Technology (NIST). This report may not be reproduced except in full, without the written approval of DTS unless stated otherwise. The expanded measurement uncertainty of the measurement process does not exceed 95% (2 sigma) confidence limits, no sampling plan or other process was used for the calibration. The results reported herein apply to the calibration of the item described above, and no limitation of use apply to the calibrated unit. This test data is the raw recorded data that is not corrected for uncertainty or corrected for environmental effects.

Remarks:

Standards Used

Serial #	Manufacturer	Model #	Description	Cal Date	Due Date
MY47007610	Agilent	34401A	Digital Multimeter, 6.5 Digit	9-Apr-2014	9-Apr-2015

Results

Test Description	Test Result	Pass/Fail
Visual Inspection		Pass
Squib Output Functions		Pass
Digital Output Functions		Pass
Squib Resistance Monitoring		Pass
Squib Voltage Recording		Pass
Squib Current Recording		Pass
Timebase Accuracy		Pass
T=0 Trigger Function		Pass
Sensor ID Function		Pass
Connector Shield Grounding		Pass
Input Current		Pass

TOM Chassis to Squib Resistance	Lower Limit	Upper Limit	UUT Results	Units	
Channel 1	0 Ohms	0.5 Ohms	0.17280	Ohms	Pass
Channel 2	0 Ohms	0.5 Ohms	0.17020	Ohms	Pass
Channel 3	0 Ohms	0.5 Ohms	0.16880	Ohms	Pass
Channel 4	0 Ohms	0.5 Ohms	0.16890	Ohms	Pass
Squib DC Current					
Channel 1	0.95 mA	1.05 mA	0.99812	mA	Pass
Channel 2	0.95 mA	1.05 mA	0.99687	mA	Pass
Channel 3	0.95 mA	1.05 mA	1.00339	mA	Pass
Channel 4	0.95 mA	1.05 mA	0.99772	mA	Pass

Calibrated by: Craig Myers
Craig Myers
Technical Support Engineer

Calibration Site: 41204 Bridge Street
Novi, MI 48375

End of Certificate

DB 3/24/15

Sterling Scale Co., Inc.
20950 Boening St.
Southfield, MI 48075

Test report for commercial device

F410/12-4
Rev. Date 7/28/08

accredited for calibration 1448.01

Customer: MGA Research ***Cert#*** 14-2713 ***Temp/Humidity:*** Ok
Location of Calibration: 2839 Elliot Ave. Troy, Mi. 48083
Calibration Date: 8/15/2014 ***Cal Due:*** Aug-15 ***Condition of Item:*** good
Equipment Make: Intercomp ***Model:*** SW Deluxe ***Serial:*** 26032389 ***Capacity:*** 8800lb x 1lb
NTEP: ***Class:*** ***COC #:*** section- 2200lb x 1lb

Applied Test Wt	*Before Adustment*	*Tolerance*	*In-Tolerance Y/N*	*After Adjustment*	*In-Tolerance Y/N*	*Unc*	
100lb	100lb	1lb	y	100lb	y	.11lb	LF
1000lb	1000lb	2lb	y	1000lb	y	.5lb	
100lb	100lb	1lb	y	100lb	y	.11lb	RF
1000lb	1000lb	2lb	y	1000lb	y	.5lb	
100lb	100lb	1lb	y	100lb	y	.11lb	LR
1000lb	1000lb	2lb	y	1000lb	y	.5lb	
100lb	100lb	1lb	y	100lb	y	.11lb	RR
1000lb	1000lb	2lb	y	1000lb	y	.5lb	

shift test
N/A
Wheel Weigh

	Platform #1	*Platform #2*	*Platform #3*
	☐ Pass	☐ Pass	☐ Pass
	☐ Fail	☐ Fail	☐ Fail

Tests performed: ☑ Repeatability ☑ Linearity ☐ Sensitivity ☑ Discrimination

Technician comments: Scale passed all tests performed

Traceable certificate for weights used: 50lb wts.- 1163,1168 1k wt.- 10002

☑ Scale Certified ☐ Scale Rejected

Sterling Scale Service Rep: Dan W

1 of 1

The above item has been calibrated using the relevant EPO or OEM procedures utilizing test weights Traceable to International Systems of Units (SI), through the Michigan Department of Agriculture.
Expanded uncertainty(k=2) confidence level of 95% as reported.
Results relate only to items listed.
The reported uncertainty is valid only for the environment in which it is determined.
Any number of factors may cause the item to drift out of calibration before recommended interval has expired for this reason Sterling Scale does not warranty calibration.
This report shall not be reproduced, except in full without approval of the laboratory
Tolerances followed are maintenance/acceptance per HB 44 or customer specific.

Paul Bunt 8/15/14

Appendix B - Temperature Trace

C20150301
2015 Chrysler 200S
FMVSS 226