FINAL REPORT NUMBER 226EM-MGA-25-09

SAFETY COMPLIANCE TESTING FOR FMVSS 226
Ejection Mitigation

FORD MOTOR CO.
2025 Ford Ranger
NHTSA No. C20250202

MGA RESEARCH CORPORATION
446 Executive Drive
Troy, Michigan 48083

Test Date: June 12, 2025
Report Date: July 18, 2025

FINAL REPORT

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
ENFORCEMENT
OFFICE OF VEHICLE SAFETY COMPLIANCE
1200 New Jersey Avenue, SE
West Building
WASHINGTON, D.C. 20590

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Prepared By: _____
John Gizowski, Project Engineer

_____
Helen A. Kaleto, Project Manager

Approved By: _____

Approval Date: _____

FINAL REPORT ACCEPTANCE BY OVSC:

Accepted By: DANIEL MARLIN LIND Digitally signed by DANIEL MARLIN LIND Date: 2025.07.18 15:32:38 -04'00'

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John Gizowski, Project Engineer</td><td colspan="2">8. Performing Organization Report No.
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A compliance test series was conducted on the subject vehicle 2025 Ford Ranger, NHTSA No.C20250202, 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 June 12, 2025. The test failure identified was as follows:
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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 693JJ923D000050. The purpose of this test was to evaluate ejection mitigation performance in a 2025 Ford Ranger.

Tests were conducted on June 12, 2025, on a 2025 Ford Ranger, manufactured by Ford Motor Co.

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 11/30/2017
MGATP_226_EM_GOV_IMPACT TEST SERIES, dated 04/11/2014

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 2025 Ford Ranger Supercrew 4 x 2 XL was tested on June 12, 2025, by MGA Research Corporation, in Troy, Michigan. The window targets tested as part of the compliance test are as follows:

- 2nd Row Left-Hand (LH) Front Upper Primary, 20 kph / 1.5 sec.
- 2nd Row Right-Hand (RH) Front Upper Primary, 20 kph / 1.5 sec.

Pre-test and post-test photographs of the test vehicle, a 2025 Ford Ranger, 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) high-speed video cameras.

DATA SHEET NO. 1
REPORT OF VEHICLE CONDITION

CONTRACT NO. 693JJ923D000050 Date: April 7, 2025
From: MGA Research Corporation

To: NHTSA, OVSC, NVS-224

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

Model Year/Make/Model/Body Style: 2025 Ford Ranger Supercrew 4 x 2 XL

MANUFACTURE DATE: 02/2025 NHTSA NO.:C20250202
BODY COLOR: Oxford White VIN: 1FTER4BH5SLE03012
GVWR 2744 kg GAWR (Fr) 1329 kg GAWR (Rr) 1619 kg
Odometer Readings: ARRIVAL miles 7.3 DATE June 9, 2025
Completion miles: 7.4_ Date: June 12, 2025
Dealer's name: _Jenkins & Wynne Ford

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: ___N/A

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

Model Year/Make/Model/Body Style: 2025 Ford Ranger

NHTSA No. C20250202

REMARKS: Two FMVSS 226 compliance tests were performed on this vehicle.

Equipment that is no longer on the test vehicle as noted on previous page:
Curtain airbags were taken by Ford personnel after a vehicle inspection performed on June 18, 2025, and the headliner was taken by Ford after a 2nd vehicle inspection was held on July 15, 2025.

Explanation for equipment removal:
Post-test evaluation of curtain airbags by Ford representatives approved by NHTSA.

Test Vehicle Condition:
Pillars not installed back in the vehicle following the final inspection.

RECORDED BY: _____ DATE: July 15, 2025

APPROVED BY: _____

DATA SHEET NO. 2
CERTIFICATION LABEL AND TIRE PLACARD INFORMATION

VEH. MOD YR/MAKE/MODEL/BODY: 2025 Ford Ranger Supercrew 4 x 2 XL

VEH. NHTSA NO.: C20250202 VIN: 1FTER4BH5SLE03012

COLOR: Oxford White VEH. BUILD DATE: 02/2025

TEST DATES: June 12, 2025

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, John Gizowski, Luca Grodsky

CERTIFICATION LABEL
Ford Motor Co.

Date of Manufacture: 02/2025 VIN.: 1FTER4BH5SLE03012

Vehicle certified as: ___Passenger car __ MPV __X__ Truck ____ Bus

GVWR: 2744 kg GAWR FRONT: 1329 kg GAWR REAR: 1619 kg

TIRE PLACARD
Vehicle Capacity Weight (VCW) 810 kg

Designated Seating Capacity: Front 2; Rear 3 TOTAL 5

Recommended Cold Tire Pressure: FRONT: 240 kPa REAR: 240 kPa

Tire Pressure w/Maximum Capacity Vehicle Load:
FRONT: _240_ kPa
REAR: __240__kPa

Recommended Tire Size: 255/70R17 112T; Load Index: 112T
Tire size on Test Vehicle: 255/70R17 112T

REMARKS:

RECORDED BY: Luca Grodsky DATE: June 9, 2025

APPROVED BY: Helen A. Kaleto

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

VEH. MOD YR/MAKE/MODEL/BODY: 2025 Ford Ranger

VEH. NHTSA NO.: C20250202 VIN: 1FTER4BH5SLE03012

COLOR: Oxford White VEH. BUILD DATE: 02/2025

TEST DATES: June 12, 2025

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, John Gizowski, Luca Grodsky

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 – Pass____ 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: Luca Grodsky DATE: June 9, 2025
APPROVED BY: Helen A. Kaleto

DATA SHEET NO. 4
VEHICLE TEST WEIGHT AND ATTITUDE

VEH. MOD YR/MAKE/MODEL/BODY: 2025 Ford Ranger Supercrew 4 x 2 XL

VEH. NHTSA NO.: C20250202 VIN: 1FTER4BH5SLE03012

COLOR: White Fresh Powder VEH. BUILD DATE: 02/2025

TEST DATES: June 12, 2025

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, John Gizowski, Luca Grodsky

LG 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 240; LF 240; RR 240; LR 240

Owner's Manual Pressure (kpa): RF 240; LF 240 ; RR 240 ; LR 240

Actual Inflated Pressure (kpa): RF 240; LF 240; RR 240; LR 240

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

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

Right Front = 531.5 kg Right Rear = 398.5 kg

Left Front = 524.0 kg Left Rear = 453.5 kg

TOTAL FRONT = 1055.5 kg TOTAL REAR = 852.0 kg

% Total Weight = 55.3% % Total Weight = 44.7%

UVW = TOTAL FRONT PLUS TOTAL REAR = 1907.5 kg

LG 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.

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

LG 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.

LG 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.

LG 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 Targeted** Left	**As Targeted** Right	As Tested 06/12/2025	As Tested 06/12/2025
Pitch Angle Nose Down (ND) Nose UP (NU)	Right Door Sill	1.0 ND	1.2 ND	1.0 ND	1.0 ND	1.0 ND
	Left Door Sill	1.1 ND	1.1 ND	1.1 ND	1.1 ND	1.1 ND
Roll Angle Left Up (LU) Right Up (RU)	Front Bumper	0.0	0.0	0.0	0.0	0.0
	Rear Bumper	0.0	0.0	0.0	0.0	0.0

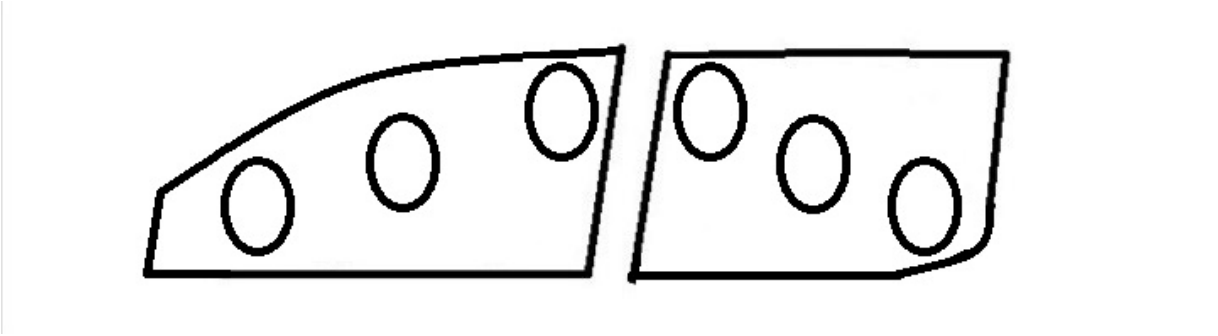
The support for the vehicle must be capable of supporting the vehicle weight, loads applied and preventing movement of the vehicle. In addition, it must safely allow for the locating, testing, and filming of the impacts per the requirements of the standard and this test procedure.

RECORDED BY: Luca Grodsky DATE: June 9, 2025

APPROVED BY: Helen A. Kaleto

TARGET COORDINATES

C20250202 – 2025 Ford Ranger



LH (Driver) Side - MGA			RH (Passenger) Side - MGA		
1st Row	**X (mm)**	**Z (mm)**	**1st Row**	**X (mm)**	**Z (mm)**
Front Lower Primary	2740.04	1570.05	Front Lower Primary	2739.13	1570.05
Bisect	2934.64	1619.66	Bisect	2933.72	1620.51
Rear Upper Primary	3129.24	1669.26	Rear Upper Primary	3128.30	1670.96
2nd Row	**X (mm)**	**Z (mm)**	**2nd Row**	**X (mm)**	**Z (mm)**
Front Upper Primary	3555.78	1682.42	Front Upper Primary	3553.40	1683.02
Bisect	3757.19	1645.47	Bisect	3754.80	1645.51
Rear Lower Primary	3958.60	1608.51	Rear Lower Primary	3956.21	1607.99

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 2468.88 mm, Z 1430.88 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 2901.80 mm Z 1597.58 mm	
Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 2740.04 mm, Z 1570.05 mm	☑ Upper-Rear ☐ Lower-Rear	X 3129.24 mm Z 1669.26 mm
Horizontal Distance Between Primary Targets	389.20 mm	☑ Forward of B-Pillar	☐ Rearward of B-Pillar	
Secondary Target Centers	☑ Upper-Front ☐ Lower-Front	X 2869.77 mm, Z 1624.55 mm	☑ Lower-Rear ☐ Upper-Rear	X 2999.51 mm, Z 1574.18 mm
Target Elimination	Upper Secondary to Lower Secondary	H 129.74 mm, V 50.37 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Remaining Secondary	H 129.73 mm, V 95.08 mm	☑ Eliminate 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 389.20 mm, V 99.21 mm	☐ Eliminate Upper Primary?	
Bisect Target	☑ Only 2 Targets Remaining? ☑ Absolute Distance > 360 mm?	Bisect Target Location:	X 2934.64 mm, Z 1619.66 mm	☑ Less Than 4 Targets?
[R] Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 2670.98 mm, Z 1545.90 mm	☑ Upper-Rear ☐ Lower-Rear	X 3110.15 mm, Z 1691.36 mm
[R] Horizontal Distance Between Primary Targets	439.17 mm	☑ Forward of B-Pillar	☐ Rearward of B-Pillar	
[R] Secondary Target Centers	☑ Upper-Front ☐ Lower-Front	X 2817.37 mm, Z 1619.68 mm	☑ Lower-Rear ☐ Upper-Rear	X 2963.76 mm, Z 1553.01 mm
[R] Target Elimination	Upper Secondary to Lower Secondary	H 146.39 mm, V 66.67 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Remaining Secondary	H 146.39 mm, V 138.35 mm	☐ Eliminate Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H 292.78 mm, V 7.11 mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 439.17 mm, V 145.46 mm	☐ Eliminate Upper Primary?	
[R] Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X N/A mm, Z N/A mm	Do Original Targets ≥ Rotated Targets? ☑ Yes = Use Original Targets ☐ No = Use Rotated Targets
Incremental Rotation	☐ Do no targets fit?	Target Angle N/A	Target Location:	X N/A, Z N/A

RECORDED BY: Luca Grodsky DATE: June 10, 2025

APPROVED BY: Helen A. Kaleto

DATA SHEET NO. 5 (continued)
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 2463.78 mm, Z 1430.47 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 2902.51 mm Z 1599.63 mm	
Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 2739.13 mm, Z 1570.05 mm	☑ Upper-Rear ☐ Lower-Rear	X 3128.30 mm Z 1670.96 mm	
Horizontal Distance Between Primary Targets	389.17 mm	☑ Forward of B-Pillar	☐Rearward of B-Pillar		
Secondary Target Centers	☑ Upper-Front ☐ Lower-Front	X 2868.85 mm, Z 1626.92 mm	☑ Lower-Rear ☐ Upper-Rear	X 2998.98 mm, Z 1575.28 mm	
Target Elimination	Upper Secondary to Lower Secondary	H 129.73 mm, V 51.64 mm	☑ Eliminate Upper Secondary?		
	Upper Primary to Remaining Secondary	H 129.72 mm, V 95.68 mm	☑ Eliminate 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 389.17 mm, V 100.91 mm	☐ Eliminate Upper Primary?		
Bisect Target	☑ Only 2 Targets Remaining? ☑ Absolute Distance > 360 mm?	Bisect Target Location:	X 2933.72 mm, Z 1620.51 mm	☑ Less Than 4 Targets?	
[R] Primary Target Centers	☑ Lower-Front ☐ Upper-Front	X 2668.80 mm, Z 1545.32 mm	☑Upper-Rear ☐ Lower-Rear	X 3110.97 mm, Z 1692.04 mm	
[R] Horizontal Distance Between Primary Targets	442.17 mm	☑ Forward of B-Pillar	☐ Rearward of B-Pillar		
[R] Secondary Target Centers	☑ Upper-Front Lower-Front	X 2816.19 mm, Z 1617.61 mm	☑ Lower-Rear ☐ Upper-Rear	X 2963.58 mm, Z 1551.42 mm	
[R] Target Elimination	Upper Secondary to Lower Secondary	H 147.39 mm, V 66.19 mm	☑ Eliminate Upper Secondary?		
	Upper Primary to Remaining Secondary	H 147.39 mm, V 140.62 mm	☐ Eliminate Upper or Remaining Secondary?		
	Lower Primary to Lower or Remaining Secondary	H 294.78 mm, V 6.10 mm	☐ Eliminate Lower or Remaining Secondary?		
	Upper Primary to Lower Primary	H 442.17 mm, V 146.72 mm	☐ Eliminate Upper Primary?		
[R] Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X N/A mm, Z N/A mm	Do Original Targets ≥ Rotated Targets? ☑ Yes = Use Original Targets ☐ No = Use Rotated Targets	
Incremental Rotation	☐ Do no targets fit?	Target Angle N/A	Target Location:	X N/A, Z N/A	

RECORDED BY: Luca Grodsky DATE: June 12, 2025

APPROVED BY: Helen A. Kaleto

DATA SHEET NO. 5 (continued)
IMPACT TARGET LOCATION DETERMINATION FORM

Window Type	☑ Left Outboard, ☐ Right Outboard		☐1st Row, ☑ 2nd Row, ☐ 3rd Row, ☐ 4th Row	
Measurements taken ☐ Front Lower corner of Daylight Opening, ☑ Vehicle Coordinates, Front Lower Corner = X 3446.07 mm, Z 1452.63 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 3746.52 mm Z 1639.02 mm	
Primary Target Centers	☐ Lower-Front ☑ Upper-Front	X 3555.78 mm, Z 1682.42 mm	☐ Upper-Rear ☑ Lower-Rear	X 3958.60 mm Z 1608.51 mm
Horizontal Distance Between Primary Targets	402.82 mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar	
Secondary Target Centers	☐ Upper-Front ☑ Lower-Front	X 3690.05 mm Z 1587.70 mm	☐ Lower-Rear ☑ Upper-Rear	X 3824.33 mm Z 1675.09 mm
Target Elimination	Upper Secondary to Lower Secondary	H 134.28 mm, V 87.39 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Remaining Secondary	H 134.27 mm, V 74.72 mm	☑ Eliminate 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 402.82 mm, V 73.91 mm	☐ Eliminate Upper Primary?	
Bisect Target	☑ Only 2 Targets Remaining? ☑ Absolute Distance > 360 mm?	Bisect Target Location:	X 3757.19 mm Z 1645.47 mm	☑ Less Than 4 Targets?
[R] Primary Target Centers	☐ Lower-Front ☑ Upper-Front	X 3581.39 mm, Z 1708.14 mm	☐ Upper-Rear ☑ Lower-Rear	X 3934.40 mm, Z 1586.00 mm
[R] Horizontal Distance Between Primary Targets	353.01 mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar	
[R] Secondary Target Centers	☐ Upper-Front ☑ Lower-Front	X 3699.06 mm, Z 1567.54 mm	☐ Lower-Rear ☑ Upper-Rear	X 3816.73 mm, Z 1700.70 mm
[R] Target Elimination	Upper Secondary to Lower Secondary	H 117.67 mm, V 133.16 mm	☑ Eliminate Upper Secondary?	
	Upper Primary to Remaining Secondary	H 117.67 mm, V 140.6 mm	☐ Eliminate Upper or Remaining Secondary?	
	Lower Primary to Lower or Remaining Secondary	H 235.34 mm, V 18.46 mm	☐ Eliminate Lower or Remaining Secondary?	
	Upper Primary to Lower Primary	H 353.01 mm, V 122.14 mm	☐ Eliminate Upper Primary?	
[R] Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X N/A , Z N/A	Do Original Targets ≥ Rotated Targets? ☑ Yes = Use Original Targets ☐ No = Use Rotated Targets
Incremental Rotation	☐ Do no targets fit?	Target Angle N/A	Target Location:	X N/A, Z N/A

RECORDED BY: Luca Grodsky DATE: June 11, 2025

APPROVED BY: Helen A. Kaleto

DATA SHEET NO. 5 (continued)
IMPACT TARGET LOCATION DETERMINATION FORM

Window Type	☐ Left Outboard, ☑ Right Outboard		☐1st Row, ☑ 2nd Row, ☐ 3rd Row, ☐ 4th Row		
Measurements taken ☐ Front Lower corner of Daylight Opening, ☐ Vehicle Coordinates, Front Lower Corner = X 3444.29 mm, Z 1452.61 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 3748.56 mm Z 1637.98 mm		
Primary Target Centers	☐ Lower-Front ☑Upper-Front	X 3553.40 mm, Z 1683.02 mm	☐ Upper-Rear ☑ Lower-Rear	X 3956.21 mm Z 1607.99 mm	
Horizontal Distance Between Primary Targets	402.81 mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar		
Secondary Target Centers	☐ Upper-Front ☑ Lower-Front	X 3687.67 mm Z 1588.52 mm	☐ Lower-Rear ☑ Upper-Rear	X 3821.94 mm Z 1675.04 mm	
Target Elimination	Upper Secondary to Lower Secondary	H 134.27 mm, V 86.52 mm	☑ Eliminate Upper Secondary?		
	Upper Primary to Remaining Secondary	H 134.27 mm, V 94.50 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 402.81 mm, V 75.03 mm	☐ Eliminate Upper Primary?		
Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X 3754.81 mm Z 1645.55 mm	☑ Less Than 4 Targets?	
[R] Primary Target Centers	☐ Lower-Front ☑ Upper-Front	X 3580.47 mm, Z 1706.64 mm	☐ Upper-Rear ☑ Lower-Rear	X 3933.96 mm, Z 1584.24 mm	
[R] Horizontal Distance Between Primary Targets	353.49 mm	☐ Forward of B-Pillar	☑ Rearward of B-Pillar		
[R] Secondary Target Centers	☐ Upper-Front ☑ Lower-Front	X 3698.30 mm, Z 1566.11 mm	☐ Lower-Rear ☑ Upper-Rear	X 3816.13 mm, Z 1700.61 mm	
[R] Target Elimination	Upper Secondary to Lower Secondary	H 117.83 mm, V 134.5 mm	☑ Eliminate Upper Secondary?		
	Upper Primary to Remaining Secondary	H 117.83 mm, V 140.53 mm	☐ Eliminate Upper or Remaining Secondary?		
	Lower Primary to Lower or Remaining Secondary	H 235.66 mm, V 18.13 mm	☐ Eliminate Lower or Remaining Secondary?		
	Upper Primary to Lower Primary	H 353.49 mm, V 122.40 mm	☐ Eliminate Upper Primary?		
[R] Bisect Target	☐ Only 2 Targets Remaining? ☐ Absolute Distance > 360 mm?	Bisect Target Location:	X N/A mm, Z N/A mm	Do Original Targets ≥ Rotated Targets? ☑ Yes = Use Original Targets ☐ No = Use Rotated Targets	
Incremental Rotation	☐ Do no targets fit?	Target Angle N/A	Target Location:	X N/A, Z N/A	

RECORDED BY: Luca Grodsky DATE: June 11, 2025

APPROVED BY: Helen A. Kaleto

3.0 TEST DATA AND PHOTOGRAPHS

VEH. MOD YR/MAKE/MODEL/BODY: 2025 Ford Ranger Supercrew 4 x 2 XL

VEH. NHTSA NO.: C20250202 VIN: 1FTER4BH5SLE03012

COLOR: Oxford White VEH. BUILD DATE: 02/2025

TEST DATES: June 12, 2025

TEST LABORATORY: MGA Research Corporation

OBSERVERS: Helen Kaleto, John Gizowski, Luca Grodsky

Test No.	Date	Temp / RH	Target & Vehicle Side	Velocity (km/h)	Time to Impact (s)	Excursion (mm) (Reqt ≤100 mm)
EM5035	06/12/2025	24.0° C 41% RH	2nd Row Right-Hand (RH) Front Upper Primary	20.11	1.501	99.3
EM5036	06/12/2025	24.4º C 41% RH	2nd Row Left-Hand (LH) Front Upper Primary	20.17	1.502	64.9

\

RECORDED BY: John Gizowski DATE: June 12, 2025

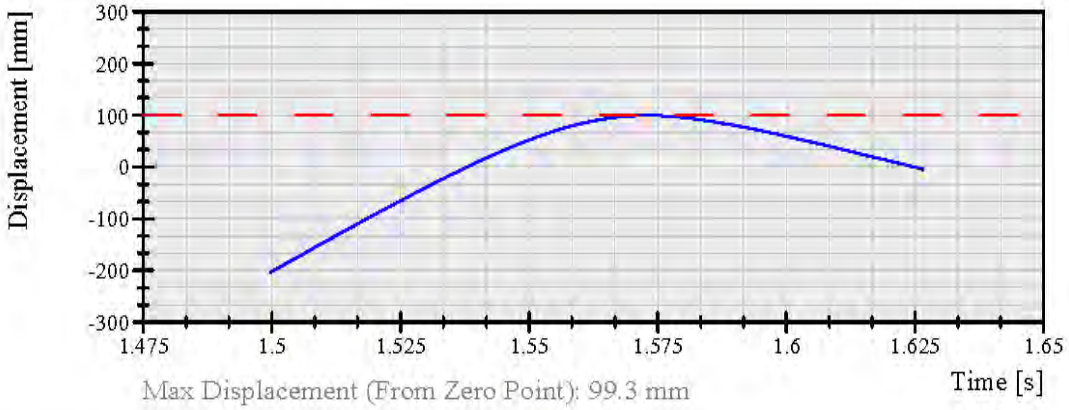
APPROVED BY: Helen A. Kaleto

Test EM5035 Data

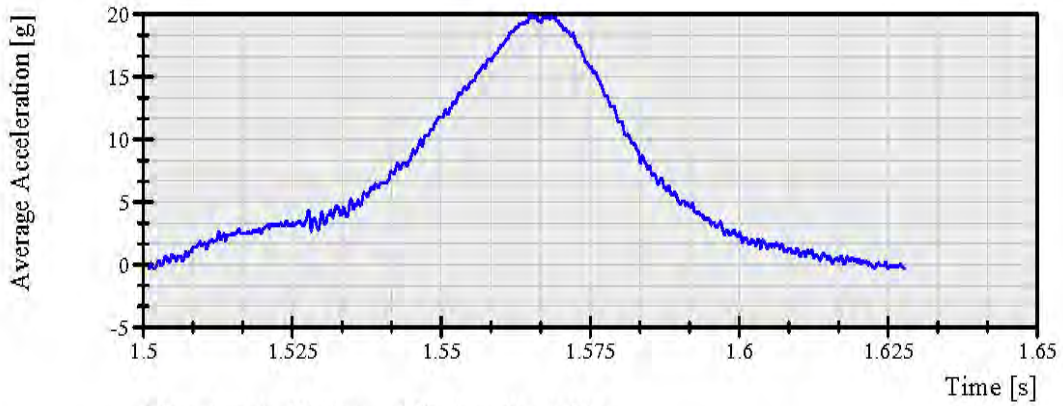
mga research corporation

FMVSS 226 Ejection Mitigation

Test Date: 06/12/2025
Impact Velocity (Speed Trap): 20.105 km/h
Job Number: G25I7-001.8
Test Number: EM5035
Impact Location: 2nd Row Front Upper Primary
Time to First Contact: 1.501 sec
Test Type: 20 km/h with 1.5 second delay
Vehicle/Model: 2025 Ford Ranger
Airbag Description: RH
Comments: Airbag Deployed.



Max Displacement (From Zero Point): 99.3 mm



Max Accel: 20.00 g Min Accel: -0.40 g

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

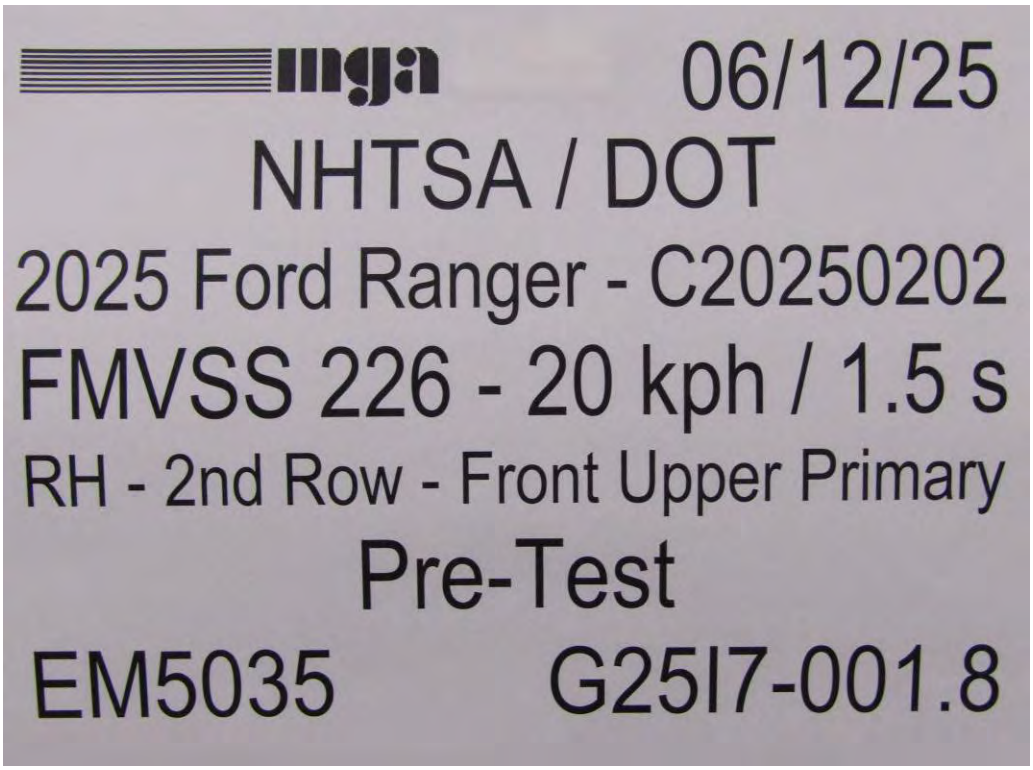
9. Using the data collected from the speed check, find the time value T_1 that corresponds to the LVDT displacement D_1. Subtract T_1 from the test requirement time T_R to find the amount of time to offset firing the impactor, T_{OFF}.

Time Delay calculation:

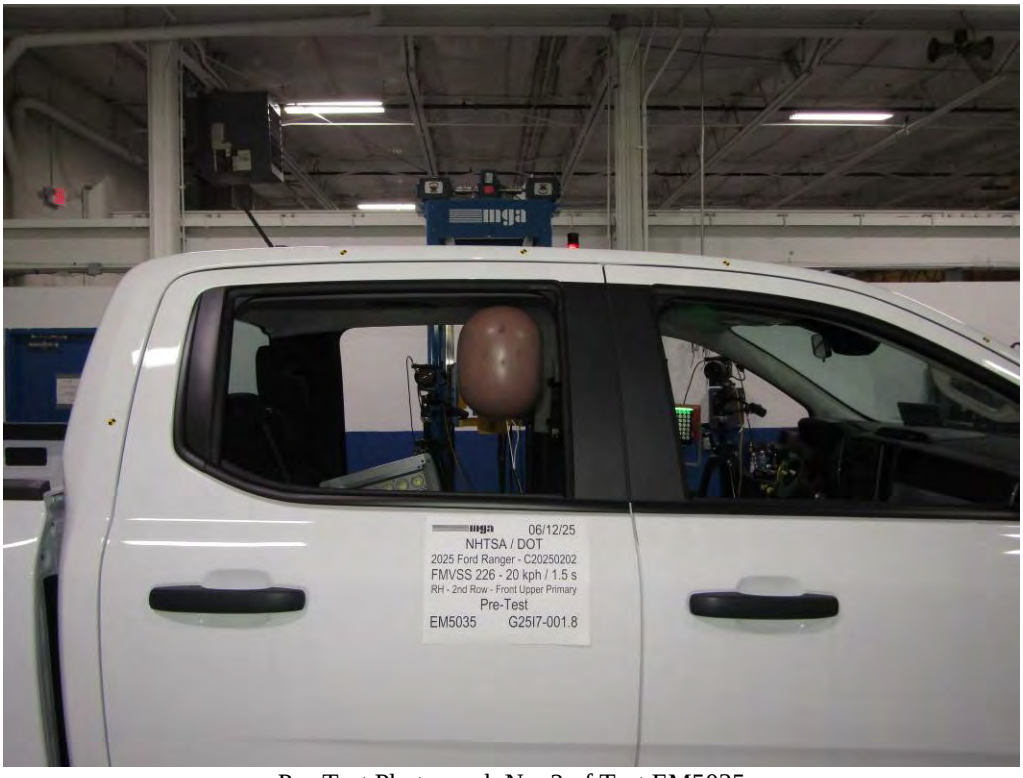
LVDT Value at Window, D_L (mm)		Airbag Maximum Inflation, D_A (mm)		Contact with the Airbag, D_1 (mm)
560	-	200	=	360
Test Requirement Time, T_R (ms)		**T_1, the Time at D_1 (ms)**		**System Offset Time, T_{OFF} (ms)**
1500 or 6000	-	121	=	1379

10. Repeat the speed check process ensuring that both the velocity and time achieved at D_1 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	3553.55	Y	135.18	Z	1684.07
Zero Displacement	X	3553.48	Y	695.71	Z	1683.66
Reference Point	X	3555.31	Y	690.29	Z	1743.28

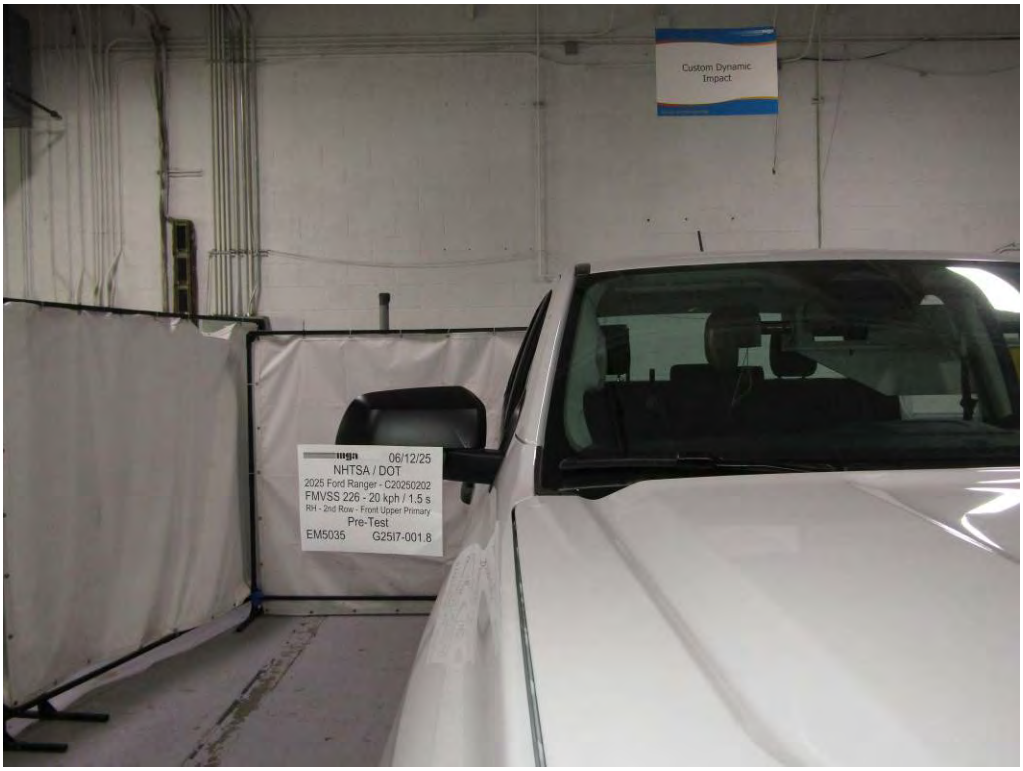


Pre-Test Photograph No. 1 of Test EM5035

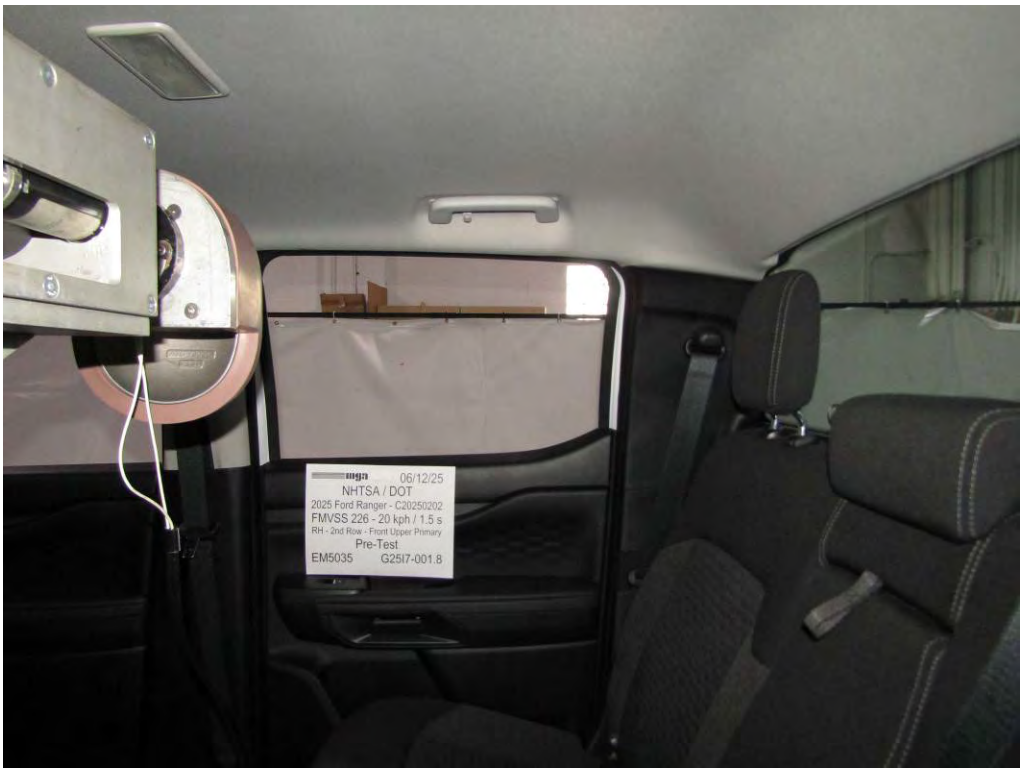


Pre-Test Photograph No. 2 of Test EM5035

Pre-Test Photograph No. 3 of Test EM5035

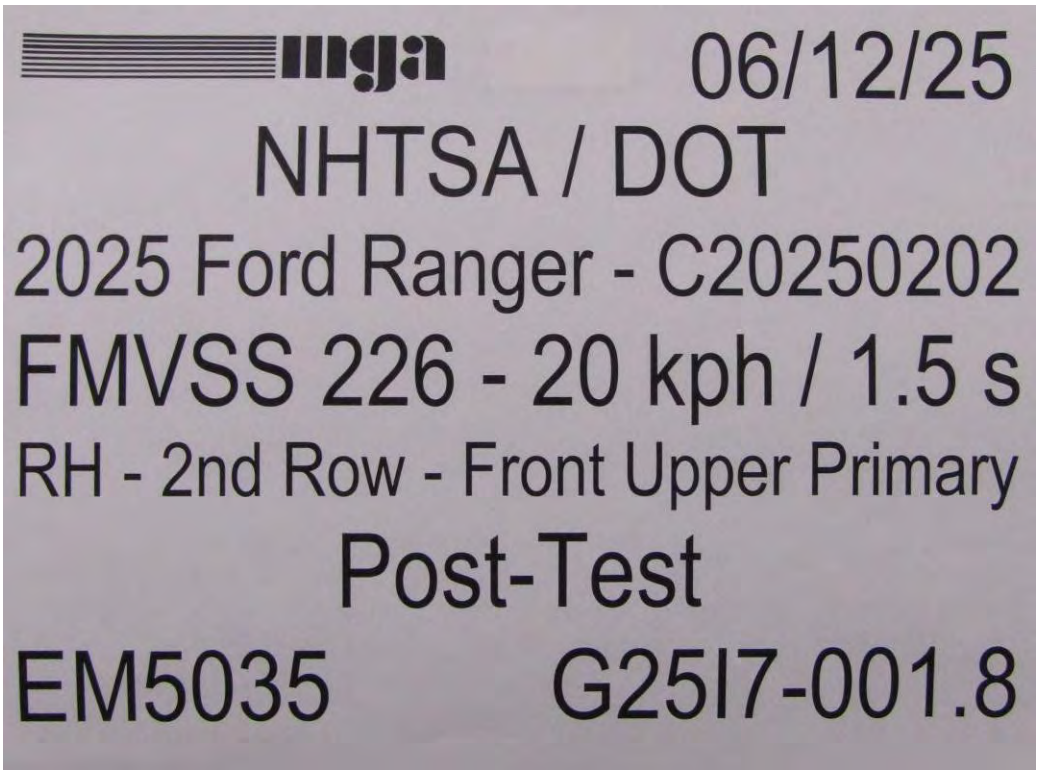


Pre-Test Photograph No. 4 of Test EM5035



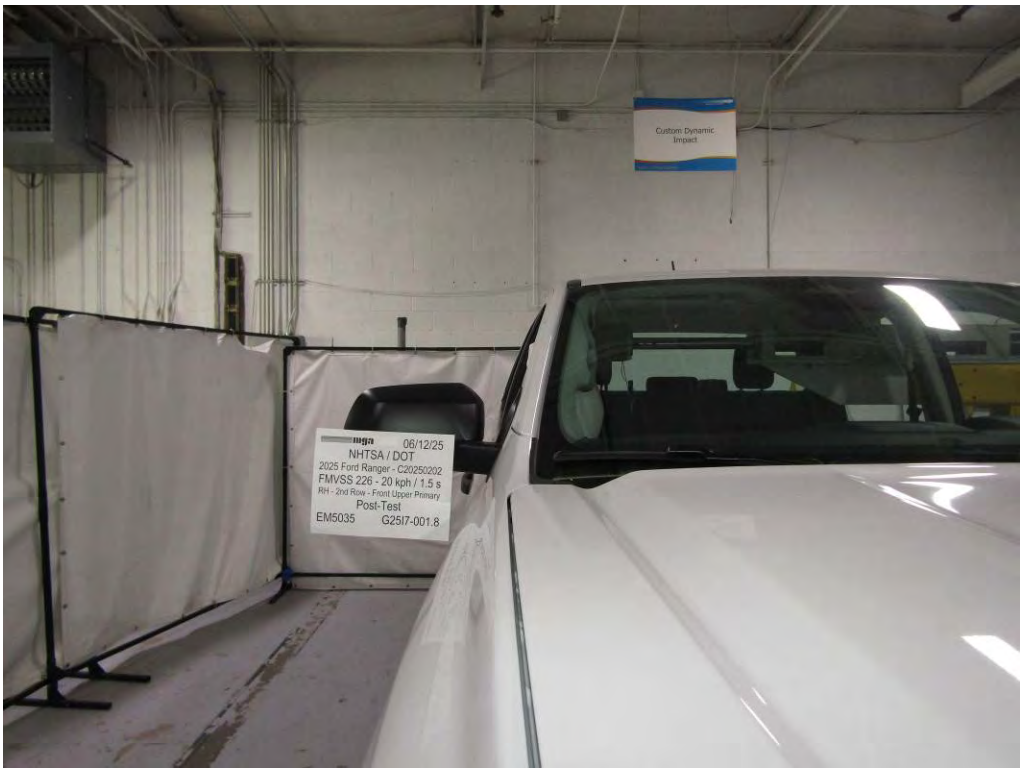
Pre-Test Photograph No. 5 of Test EM5035

Pre-Test Photograph No. 6 of Test EM5035



Post-Test Photograph No. 1 of Test EM5035

Post-Test Photograph No. 2 of Test EM5035



Post-Test Photograph No. 3 of Test EM5035

Post-Test Photograph No. 4 of Test EM5035

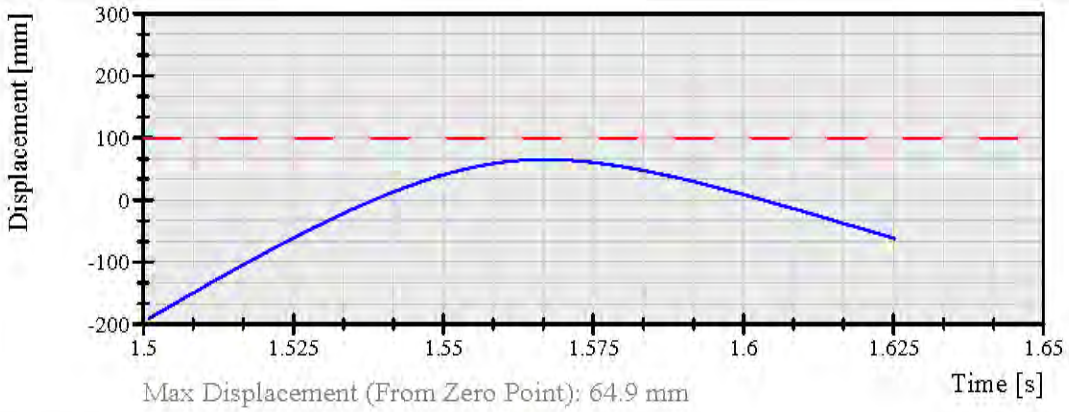
Post-Test Photograph No. 5 of Test EM5035

Test EM5036 Data

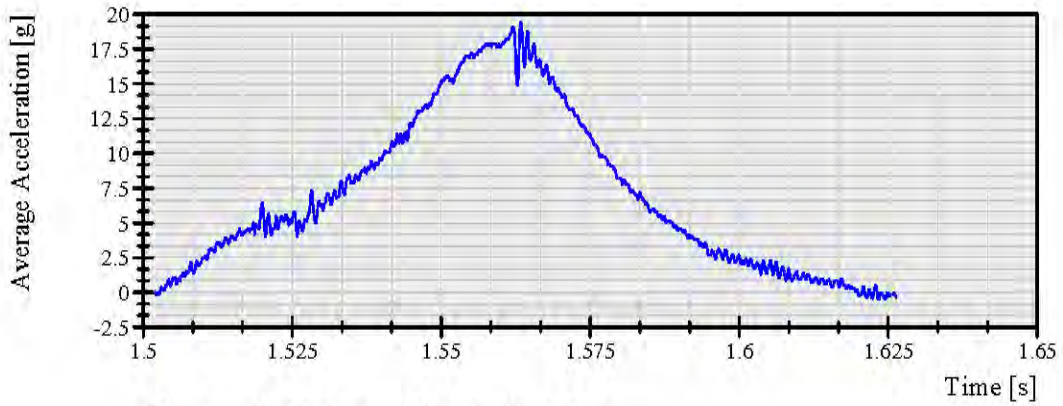
mga research corporation

FMVSS 226 Ejection Mitigation

Test Date: 06/12/2025
Impact Velocity (Speed Trap): 20.173 km/h
Job Number: G25I7-001.8
Test Number: EM5036
Impact Location: 2nd Row Front Upper Primary
Time to First Contact: 1.502 sec
Test Type: 20 km/h with 1.5 second delay
Vehicle/Model: 2025 Ford Ranger
Airbag Description: LH
Comments: Airbag Deployed.



Max Displacement (From Zero Point): 64.9 mm



Max Accel: 19.44 g Min Accel: -0.53 g

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

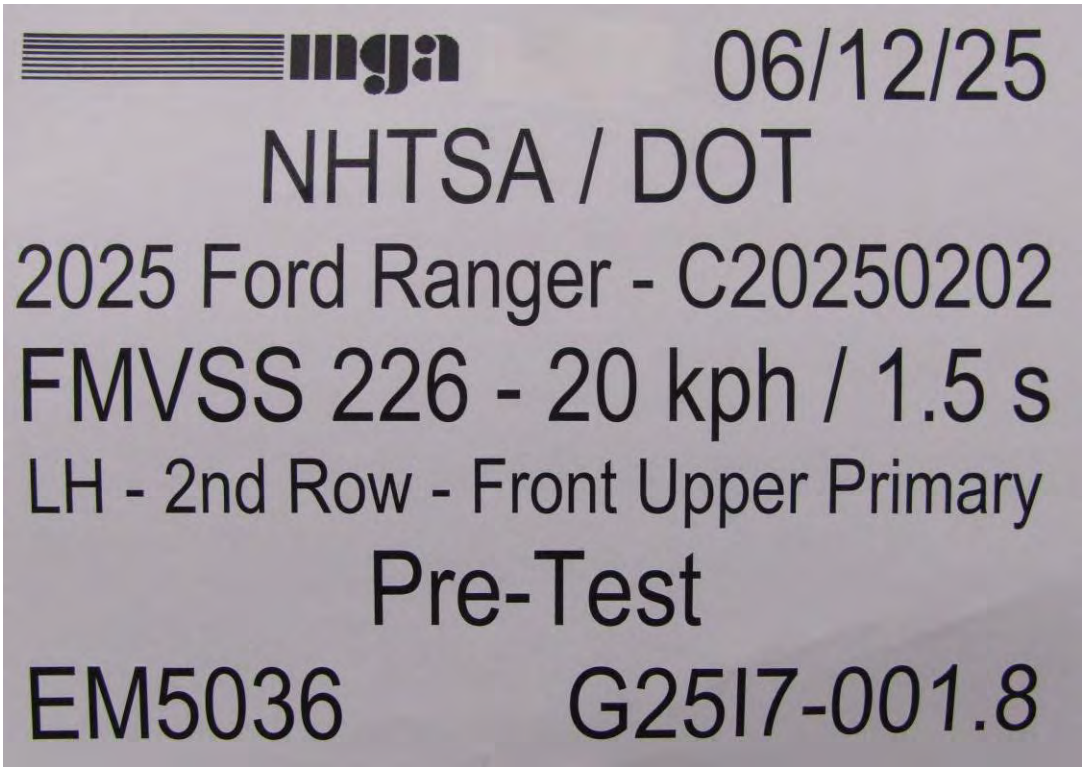
9. Using the data collected from the speed check, find the time value T_I that corresponds to the LVDT displacement D_I. Subtract T_I from the test requirement time T_R to find the amount of time to offset firing the impactor, T_{OFF}.

Time Delay calculation:

LVDT Value at Window, D_L (mm)		Airbag Maximum Inflation, D_A (mm)		Contact with the Airbag, D_I (mm)
360	-	200	=	360
Test Requirement Time, T_R (ms)		**T_I, the Time at D_I (ms)**		**System Offset Time, T_{OFF} (ms)**
500 or 6000	-	121	=	1379

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	3555.00	Y	-139.59	Z	1684.16
Zero Displacement	X	3555.06	Y	-699.10	Z	1682.72
Reference Point	X	3554.49	Y	-693.83	Z	1741.56



Pre-Test Photograph No. 1 of Test EM5036

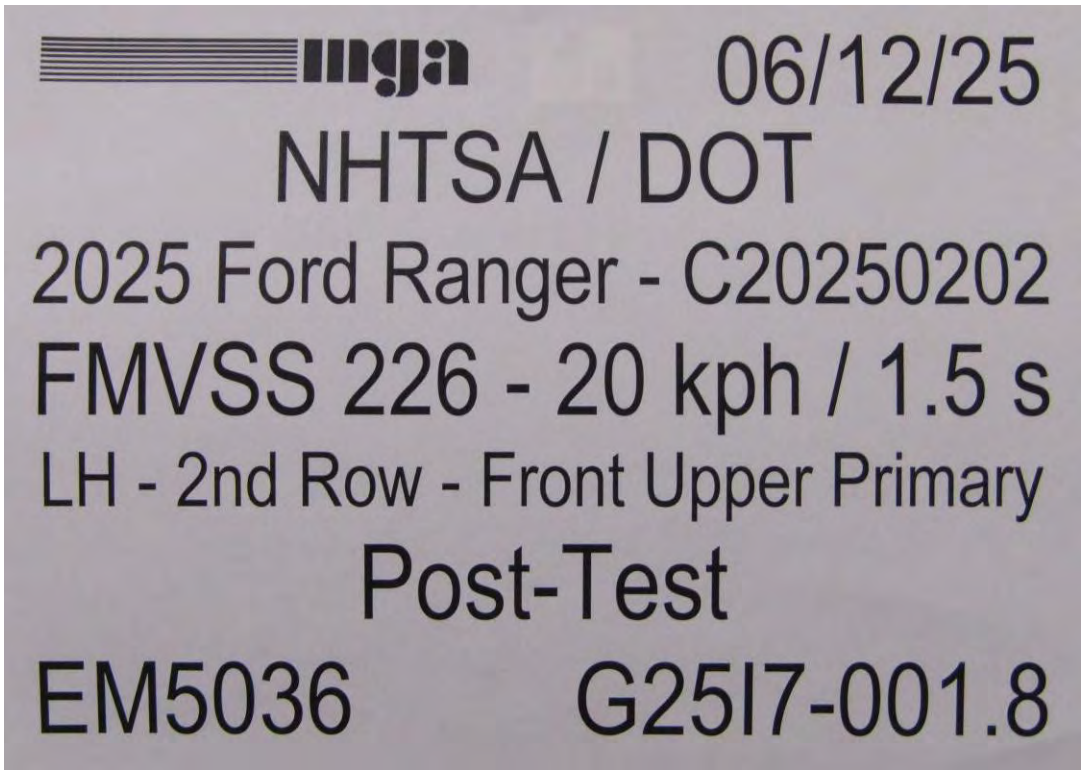
Pre-Test Photograph No. 2 of Test EM5036

Pre-Test Photograph No. 3 of Test EM5036

Pre-Test Photograph No. 4 of Test EM5036

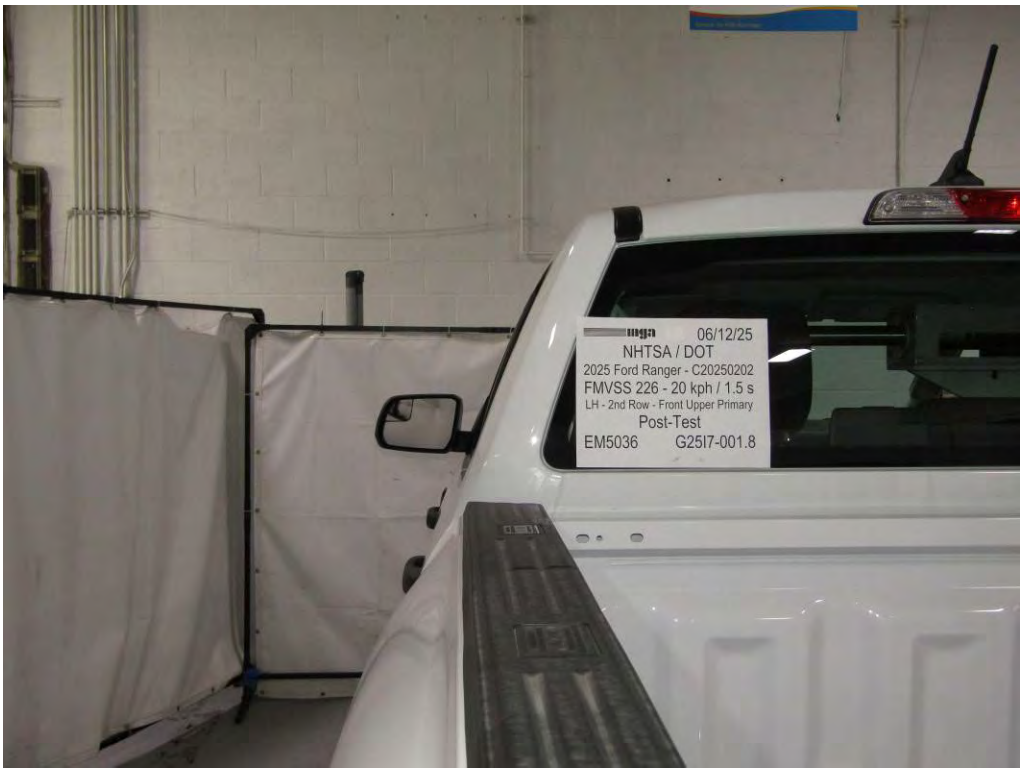
Pre-Test Photograph No. 5 of Test EM5036

Pre-Test Photograph No. 6 of Test EM5036



Post-Test Photograph No. 1 of Test EM5036

Post-Test Photograph No. 2 of Test EM5036



Post-Test Photograph No. 3 of Test EM5036

Post-Test Photograph No. 4 of Test EM5036

Post-Test Photograph No. 5 of Test EM5036

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.

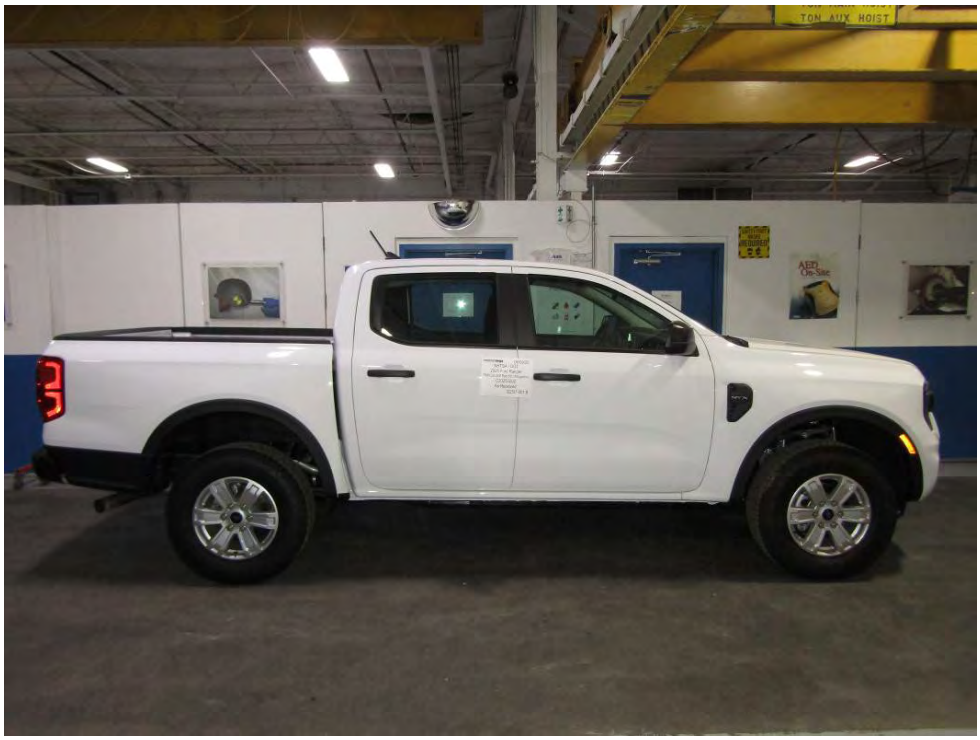
TABLE 4-1 LIST OF ITEMS USED

DEVICE	MANUFACTURER NAME	SERIAL #	FUNCTION OF ITEM	SENSITIVITY	CAL. INTERNAL
Ejection Mitigation Impactor	MGA	EM-04	Testing Impactor	± 0.5kg	6 months
Accelerometer	Endevco	T21382	Acceleration Data	±0.5%	Annual
Accelerometer	Endevco	T21383	Acceleration Data	±0.5%	Annual
LVDT	MTS	90425350	Displacement Data	±0.5%	6 months
DTS Data Rack	DTS	LR0089	Data Collection	--	Annual
DTS Data SIM	DTS	LM0212	Data Collection	--	Annual
DTS Data TOM	DTS	TOML038	Data Collection	--	Annual
MGA Velocity Measurement System	MGA Research Corporation	19.020.01	Measurement	± 0.2σ	Annual
Tape Measure	Stanley	TPM010-08	Measurement	1mm	Annual
*FARO™	Faro Technologies	A35-E5-21-37083	Target/Impact Location	± 0.1%	Annual
Digital Scale	Detecto	MGA00783	Weigh Headform	± 0.01 lb	Annual
Inclinometer	Spi	MI0343	Measurement	± 0.1°	Annual
Vehicle Scale	Intercomp	0128MA14010	Weighing Vehicle	± 0.5 kg	Annual
Temperature Recorder	Omega	MI0340	Measurement	± 0.072	Annual

5.0 OTHER DOCUMENTATION

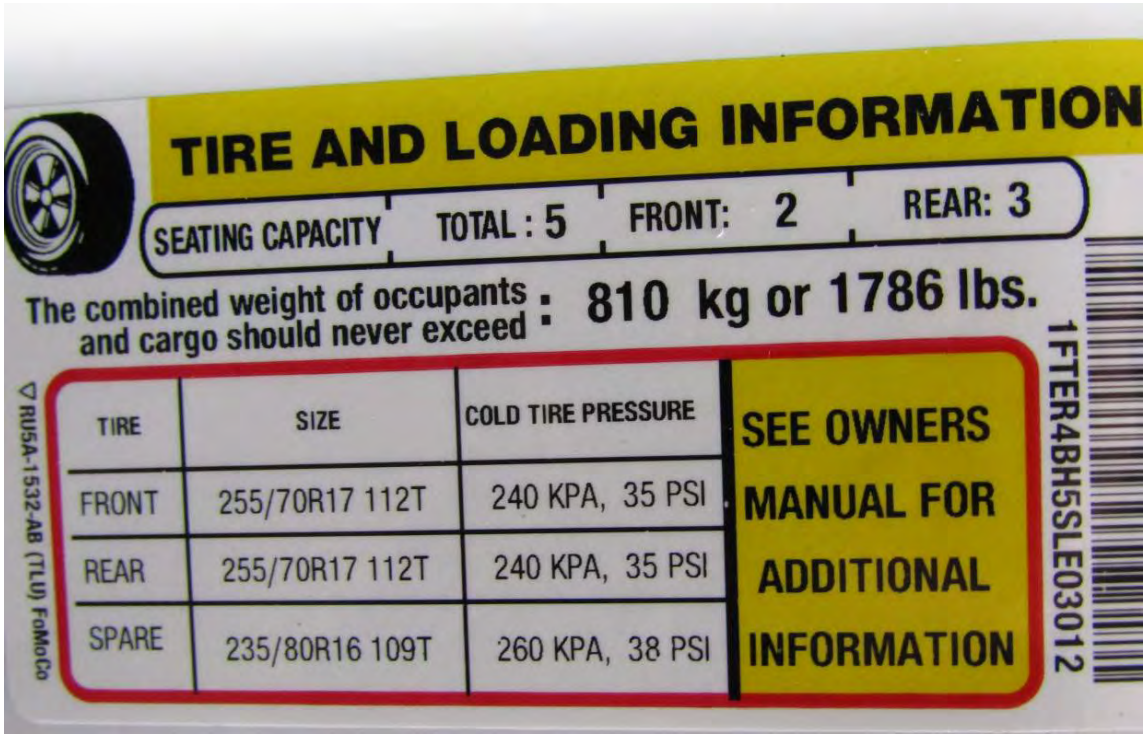
As Received – Left Side View

As Received – ¾ Front View From Left Side

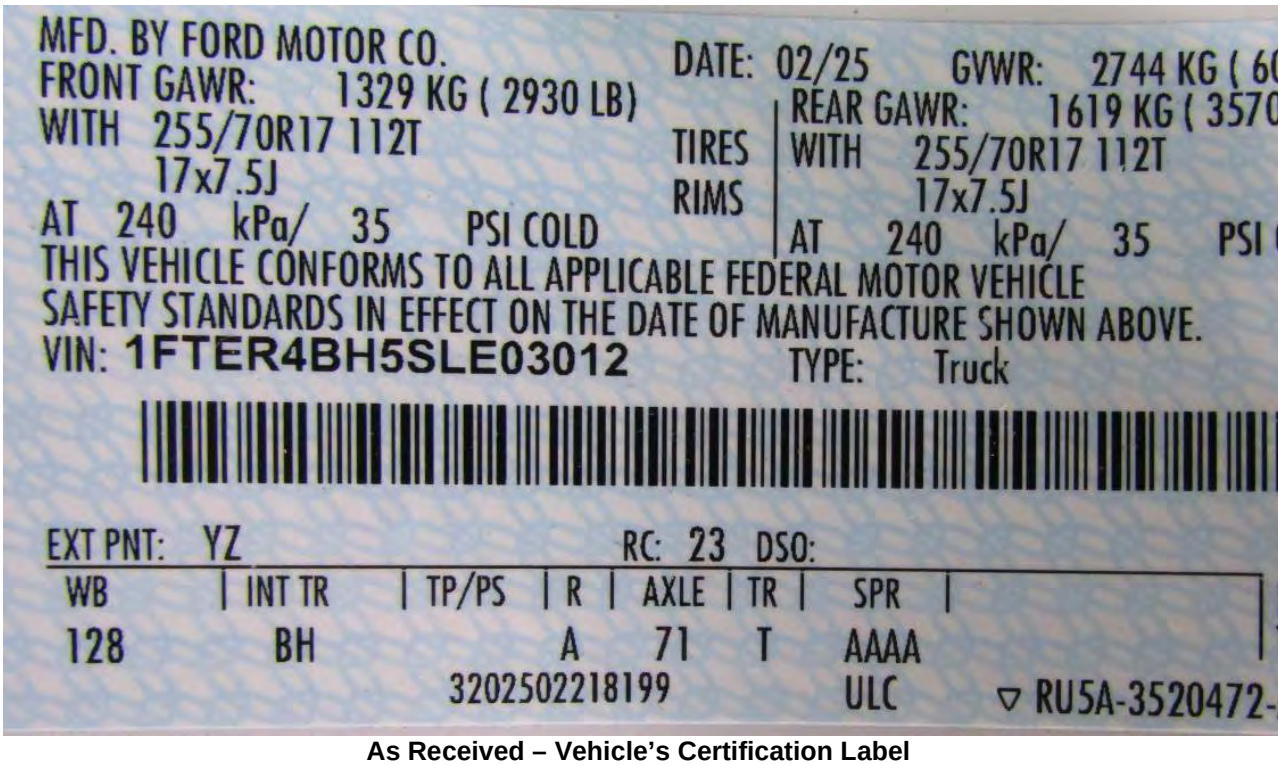


As Received – Right Side View

As Received – ¾ Rear View From Right Side



As Received – Vehicle's Tire Information Label



As Received – Vehicle's Certification 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: 4/22/25
Customer: MGA

MGA Project #: -
Model/Serial #: EM04 impactor
Procedure: Deflection & Friction

Reference Equipment Used

Equipment	Information	Cal Due
SN: 1905415	Calibrated Micrometer	9/12/25
SN: 1558962A	Load Cell	9/18/25
SN: 90425350	LVDT	10/22/25

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		Value	Unit	Pass/Fail
	Upper	Lower			
Radial Deflection	20	N/A	16.08	mm	PASS
Dynamic Coefficient of Friction	0.250	N/A	0.163	--	PASS

Performed by: Luca Grodsky Test Date: 04/22/25

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 #: MGA-EM04	Project #: -	Test Date: 4/22/25

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	[illegible]	[illegible]	[illegible]	[illegible]	16.08
Loaded Dynamic Friction Force (nominal force needed to maintain motion)	F2(d) [N]	1	118.968	153.901	61.239	187.234	190.60
		2	115.827	153.208	63.737	190.598	
		3	113.742	153.453	64.093	187.535	
		4	111.086	151.369	64.980	189.892	
		5	113.689	152.086	62.187	189.680	
		Average	**114.66**	**152.80**	**63.25**	**188.99**	
	F2(dev) [N]	1	31.59	31.72	18.57	30.20	35.34
		2	31.99	32.23	18.05	34.52	
		3	30.91	33.23	18.22	35.34	
		4	28.72	32.75	18.48	34.70	
		5	29.65	33.29	18.54	33.62	
Dynamic Coefficient of Friction	μ_k		[illegible]	[illegible]	[illegible]	[illegible]	0.1633

Stroke (mm): 933.0000

100 Hz

~Calibration Certificate~

ACCREDITED
Cert # 1196.05

Sensor Information

Model Number:	7264CM47-2KTZ-360
Serial Number:	T21382
Manufacturer:	Endevco
Description:	Accelerometer
Location:	MI - General

Calibration Data

Excitation Voltage:	10.0	V
Sensitivity @ 100 Hz:	0.01817	mV/V/g
Test Level:	10.00	g
DLR (100k Shunt)	69.961	g
Bridge Resistance:	509.891	ohms

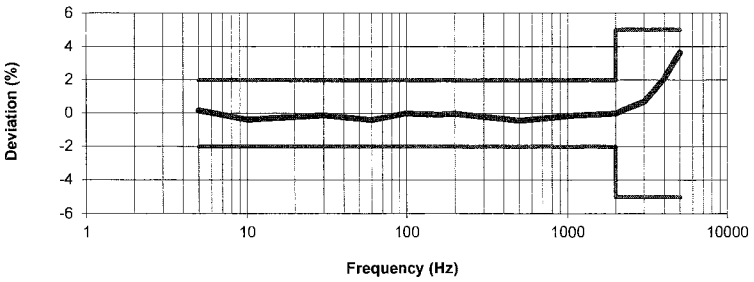
Transducer Specifications

Amp. Range:	± 2000	g
Resonant Freq:	≥ 26000	Hz
Temp. Range:	-18 to 66	°C
	0 to 150	°F

Data Table

Freq. (Hz)	Deviation (%)
5	0.17
10	-0.38
30	-0.12
60	-0.40
100	0.00
160	-0.08
200	-0.02
500	-0.43
750	-0.29
1000	-0.15
2000	0.01
3000	0.72
4000	2.12
5000	3.65

Amplitude Response



Notes

Results relate only to the items calibrated.

This certificate may not be reproduced except in full, without written permission.

Method: Calibration is performed in compliance with ISO 17025.

This calibration was performed with TMS 9155 Calibration Workstation version 5.4.6.

Procedure Used: Accelerometer Frequency Calibration Procedure (Rev. New; 8/20/2024).

Calibrated sensitivity uncertainty no greater than the following at the 95% confidence level using k=2: 5 Hz: 1.0%, >5 - <100 Hz: 0.57%, 100 & 159 Hz: 0.34%, 160 - <1kHz: 0.57%, 1k - <5kHz: 0.75%, 5k - 15k: 1.5%.

This calibration is traceable to SI units through a nationally recognized laboratory (NIST).

Several factors may cause the calibrated unit to drift out of tolerance throughout the calibration interval. Please refer to manufacturer's recommended practices.

Calibration due date is per customer provided calibration interval, if applicable.

The decision rule used is ILAC-G8:2019 Simple Acceptance.

Performed By

MGA Research Corporation
5000 Warren Road
Burlington, WI 53105

User Notes

Unit Condition

As Found: In Tolerance
As Left: In Tolerance

Customer

MGA Research Corporation
446 Executive Drive
Troy, MI 48083

Approval Information

Technician: Peyton Powers
Approval:
Cal Date: 5/29/2025

Lab Conditions

Temperature:	21.5	°C
	70.7	°F
Humidity:	39	%RH

Due Date: 5/29/2026

Equipment Used

Manufacturer	Type	Model	Serial	Cal Date	Cal Due	Cal'd By
PCB	Accelerometer	080A200C	259256	12/18/2024	6/18/2025	The Modal Shop
PCB	Signal Conditioner	482A21	7164	12/18/2024	6/18/2025	The Modal Shop

Cal ID: 33315 6/6/2025

~Calibration Certificate~

ACCREDITED
Cert # 1196.05

Sensor Information

Model Number:	7264CM47-2KTZ-360
Serial Number:	T21383
Manufacturer:	Endevco
Description:	Accelerometer
Location:	MI - General

Calibration Data

Excitation Voltage:	10.0	V
Sensitivity @ 100 Hz:	0.01788	mV/V/g
Test Level:	10.00	g
DLR (100k Shunt)	71.067	g
Bridge Resistance:	509.434	ohms

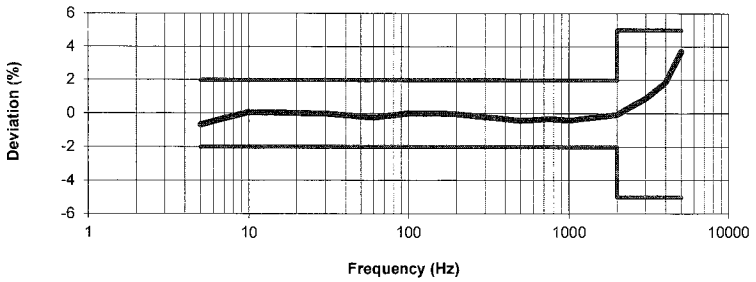
Transducer Specifications

Amp. Range:	± 2000	g
Resonant Freq:	≥ 26000	Hz
Temp. Range:	-18 to 66	°C
	0 to 150	°F

Data Table

Freq. (Hz)	Deviation (%)
5	-0.68
10	0.07
30	-0.02
60	-0.25
100	0.00
160	-0.01
200	-0.04
500	-0.44
750	-0.32
1000	-0.41
2000	-0.07
3000	0.91
4000	1.86
5000	3.73

Amplitude Response



Notes

Results relate only to the items calibrated.
This certificate may not be reproduced except in full, without written permission.
Method: Calibration is performed in compliance with ISO 17025.
This calibration was performed with TMS 9155 Calibration Workstation version 5.4.6.
Procedure Used: Accelerometer Frequency Calibration Procedure (Rev. New; 8/20/2024).
Calibrated sensitivity uncertainty no greater than the following at the 95% confidence level using k=2: 5 Hz: 1.0%, >5 - <100 Hz: 0.57%, 100 & 159 Hz: 0.34%, 160 - <1kHz: 0.57%, 1k - <5kHz: 0.75%, 5k - 15k: 1.5%.
This calibration is traceable to SI units through a nationally recognized laboratory (NIST).
Several factors may cause the calibrated unit to drift out of tolerance throughout the calibration interval. Please refer to manufacturer's recommended practices.
Calibration due date is per customer provided calibration interval, if applicable.
The decision rule used is ILAC-G8:2019 Simple Acceptance.

Performed By
MGA Research Corporation
5000 Warren Road
Burlington, WI 53105

User Notes

Unit Condition
As Found: In Tolerance
As Left: In Tolerance

Customer
MGA Research Corporation
446 Executive Drive
Troy, MI 48083

Approval Information
Technician: Peyton Powers
Approval:
Cal Date: 5/30/2025

Lab Conditions

Temperature:	21.3	°C
	70.3	°F
Humidity:	43	%RH

Due Date: 5/30/2026

Equipment Used

Manufacturer	Type	Model	Serial	Cal Date	Cal Due	Cal'd By
PCB	Accelerometer	080A200C	259256	12/18/2024	6/18/2025	The Modal Shop
PCB	Signal Conditioner	482A21	7164	12/18/2024	6/18/2025	The Modal Shop

Cal ID: 33321 6/6/2025

MGA Research Corporation

CALIBRATION CERTIFICATE

Name: 226 Impactor LVDT S/N: 90425350
Model: RHS0555UD60
S/N: 90425350
Range: 933mm

Calibration Date: 04/22/2025

Scale Factor: 3.5518299 mV/mm

Measured Values		Reproduced from Calculated Slope		
Distance (mm)	Voltage (mV)	Calculated Distance (mm)	% Error *	Scale factor Best Fit Line (dist/mV)
0.00	983.685	-0.026	0.003	0.2815450
100.00	1338.545	99.883	0.013	Intercept
200.00	1693.775	199.896	0.011	-276.9777
300.00	2049.930	300.170	0.018	
400.00	2404.235	399.923	0.008	Scale Factor (mV/mm)
500.00	2760.205	500.144	0.015	3.5518299
600.00	3115.250	600.105	0.011	
700.00	3470.665	700.171	0.018	
800.00	3825.154	799.975	0.003	
900.00	4180.199	899.936	0.007	Maximum Error
933.00	4297.005	932.823	0.019	0.019
: percent Error calculated by 100(Measured - Calculated) / Measured Range				

standards used

MFG	Model Number	Serial Number	Description	Cal Due Date
Stanley	33-215	TPM008-90	Tape Measure	08/12/2025

Performed By:

Approved By:

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.

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Calibration and Test Report

Model # : TDAS PRO LAB Rack System, 6-Module Serial # : LR0089 Firmware: 08C3 Procedure: TDAS PRO Rack Calibration, Rev 7.8 Order: 75286 Customer: MGA Research 2927A Elliott Ave. Troy, MI, USA, 48083	**CERTIFICATE NUMBER:** 20250502LR0089 **First use date:** **Next calibration date:**	Date Received: 1 May 2025 Date Calibrated: 2 May 2025 Item Received: In Tolerance Item Returned: In Tolerance Temperature: 73°F / 22.7°C Humidity: 45 %

This instrument has been processed and calibrated in accordance with the DTS Quality Assurance Manual and ISO/IEC 17025. DTS has been audited by the American Association for Laboratory Accreditation (A2LA) and found in compliance with ISO/IEC 17025. 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. Timing and frequency response meet the requirements of SAE J211 and ISO 6487.

DTS reference standards are tested and calibrated in accordance with the DTS Quality Assurance System, and traceable to a National Metrology Institute (NMI) such as National Institute of Standards and Technology (NIST). Uncertainties have been estimated at an approximately 95 percent confidence level (k=2). Simple acceptance is used as defined in ILAC G8 with a TUR > 4:1 unless otherwise noted.

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 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.

DTS products may be stored for up to 6 months from the calibration date without impact to its specifications. The First Use Date can be set by the integrator or end user when the products placed into service. Next Calibration Date should be one Calibration Period from the First Use Date. The recommended Calibration Period for DTS products is 12 months.

Standards Used

ID #	Manufacturer	Model #	Description	Cal Date	Due Date
MY42006281	Keysight	34420A	Nanovolt/micro-ohm meter, 7.5 digit	9-Oct-2024	9-Oct-2025
CAL208	DTS	CS2.0	Cal Station 2.0	19-Nov-2024	19-Nov-2025

IP Configuration

IP Address: 192.168.1.89 **Netmask:** 255.255.255.0 **MAC:** 00:50:15:00:1A:B6

Results

Test Description	As Received / As Returned
Visual Examination	PASS
Ethernet and Serial Communication	PASS
Control Signal Response	PASS
System Power Output Voltage	PASS
Battery and Charging	PASS

Measurement Data

As Received / As Returned	UUT (V)	U (V)	MIN (V)	MAX (V)	PASS/ FAIL
Bus Power Output	11.8	1.1E-03	11.50	12.00	Pass
Memory Backup Supply	3.3	1.8E-04	3.20	3.40	Pass

Calibration Site:
DTS-MI
25865 Meadowbrook Road
Novi, MI 48375 USA

Calibrated By:
Zach Cholette
Calibration Technician

** End of Report **

Diversified Technical Systems, Inc.
25865 Meadowbrook Road, Novi, MI 48375 USA
Phone: +1 248 513 6050 • Fax: +1 248 513 6051
www.dtsweb.com

Calibration and Test Report

Model # : TDAS PRO LAB SIM Serial # : LM0212 Firmware: 07E4 Procedure: TDAS PRO SIM Calibration, Rev 8.7 Order: 75286 Customer: MGA Research 2927A Elliott Ave. Troy, MI, USA, 48083	**CERTIFICATE NUMBER:** 20250502LM0212 **First use date:** **Next calibration date:**	Date Received: 1 May 2025 Date Calibrated: 2 May 2025 Item Received: In Tolerance Item Returned: In Tolerance Temperature: 71°F / 21.5°C Humidity: 47 %

This instrument has been processed and calibrated in accordance with the DTS Quality Assurance Manual and ISO/IEC 17025. DTS has been audited by the American Association for Laboratory Accreditation (A2LA) and found in compliance with ISO/IEC 17025. 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. Timing and frequency response meet the requirements of SAE J211 and ISO 6487.

DTS reference standards are tested and calibrated in accordance with the DTS Quality Assurance System, and traceable to a National Metrology Institute (NMI) such as National Institute of Standards and Technology (NIST). Uncertainties have been estimated at an approximately 95 percent confidence level (k=2). Simple acceptance is used as defined in ILAC G8 with a TUR > 4:1 unless otherwise noted.

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 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 manufacturers operating instructions.

DTS products may be stored for up to 6 months from the calibration date without impact to its specifications. The First Use Date can be set by the integrator or end user when the product is placed into service. Next Calibration Date should be one Calibration Period from the First Use Date. The recommended Calibration Period for DTS products is 12 months.

Standards Used

ID #	Manufacturer	Model #	Description	Cal Date	Due Date
MY42006281	Keysight	34420A	Nanovolt/micro-ohm meter, 7.5 digit	9-Oct-2024	9-Oct-2025
CAL208	DTS	CS2.0	Cal Station 2.0	19-Nov-2024	19-Nov-2025

Results

Test Description	As Received / As Returned
Visual Examination	PASS
Communication to TDAS Rack Bus	PASS
Timebase Calibration	PASS
Internal Calibration Source Calibration	PASS
Excitation Calibration	PASS
Amplitude/Gain Calibration	PASS
AC Filter Response Calibration	PASS
Diagnostic Shunt Performance Test	PASS
Sensor ID Performance Test	PASS
Internal Self-Checks	PASS

Calibration Site:
DTS-MI
25865 Meadowbrook Road
Novi, MI 48375 USA

Calibrated By:
Zach Cholette
Calibration Technician

DTS

Measurement Data
As Received

Cert #: 20250502LM0212
Serial #: LM0212
Order #: 75286
Date: 2 May 2025

Timebase Calibration

Std (Hz)	UUT (Hz)	Dev (Hz)	Dev (ppm)	U (ppm)	Limits (ppm)	PASS/ FAIL
1000.00	1000.02	0.02238	22.4	2.3E+01	+/-100	Pass

Internal Calibration Source

UUT (mV)	Std (mV)	U (mV)	MIN (mV)	MAX (mV)	PASS/ FAIL
0	-0.0436	4.6E-02	-2.5	2.5	Pass
1200	1199.96	6.2E-02	1197.5	1202.5	Pass
2400	2399.83	9.6E-02	2397.5	2402.5	Pass

Excitation Calibration, 5V

Chan	Std (mV)	UUT (mV)	Dev (mV)	U (mV)	Dev (%)	Limits (%)	PASS/ FAIL
1	4976.8	4977.3	0.56	2.0E-01	0.01	+/-0.5	Pass
2	4974.6	4973.2	-1.32	2.0E-01	-0.03	+/-0.5	Pass
3	4996.5	4997.2	0.73	2.0E-01	0.01	+/-0.5	Pass
4	5005.1	5005.8	0.64	2.0E-01	0.01	+/-0.5	Pass
5	5001.6	5002.4	0.80	2.0E-01	0.02	+/-0.5	Pass
6	4979.1	4980.2	1.10	2.0E-01	0.02	+/-0.5	Pass
7	4989.6	4990.6	0.91	2.0E-01	0.02	+/-0.5	Pass
8	4978.3	4978.9	0.56	2.0E-01	0.01	+/-0.5	Pass

Excitation Calibration, 10V

Chan	Std (mV)	UUT (mV)	Dev (mV)	U (mV)	Dev (%)	Limits (%)	PASS/ FAIL
1	9975.9	9976.4	0.44	4.0E-01	0.00	+/-0.5	Pass
2	9970.5	9968.7	-1.87	4.0E-01	-0.02	+/-0.5	Pass
3	9985.4	9985.3	-0.10	4.0E-01	0.00	+/-0.5	Pass
4	10011.4	10012.0	0.58	4.0E-01	0.01	+/-0.5	Pass
5	10010.3	10011.2	0.93	4.0E-01	0.01	+/-0.5	Pass
6	9975.1	9975.8	0.70	4.0E-01	0.01	+/-0.5	Pass
7	9983.7	9983.9	0.19	4.0E-01	0.00	+/-0.5	Pass
8	9971.0	9970.8	-0.24	4.0E-01	0.00	+/-0.5	Pass

Excitation Diagnostic, 5V

Chan	Std (mV)	UUT (mV)	Dev (mV)	U (mV)	Dev (%)	Limits (%)	PASS/ FAIL
1	4976.8	4966.1	-10.7	4.6E+00	-0.21	+/-1.5	Pass
2	4974.6	4988.5	13.9	4.6E+00	0.28	+/-1.5	Pass
3	4996.5	5010.5	14.0	4.6E+00	0.28	+/-1.5	Pass
4	5005.1	5014.0	8.9	4.6E+00	0.18	+/-1.5	Pass
5	5001.6	5015.4	13.9	4.6E+00	0.28	+/-1.5	Pass
6	4979.1	4989.9	10.8	4.6E+00	0.22	+/-1.5	Pass
7	4989.6	5001.9	12.3	4.6E+00	0.25	+/-1.5	Pass
8	4978.3	4987.6	9.2	4.6E+00	0.19	+/-1.5	Pass

Excitation Diagnostic, 10V

Chan	Std (mV)	UUT (mV)	Dev (mV)	U (mV)	Dev (%)	Limits (%)	PASS/ FAIL
1	9975.9	9944.2	-31.8	5.4E+00	-0.32	+/-1.5	Pass
2	9970.5	9981.0	10.4	5.4E+00	0.10	+/-1.5	Pass
3	9985.4	9992.8	7.3	5.4E+00	0.07	+/-1.5	Pass
4	10011.4	10015.9	4.5	5.4E+00	0.04	+/-1.5	Pass
5	10010.3	10014.7	4.4	5.4E+00	0.04	+/-1.5	Pass
6	9975.1	9979.8	4.7	5.4E+00	0.05	+/-1.5	Pass
7	9983.7	9991.8	8.1	5.4E+00	0.08	+/-1.5	Pass
8	9971.0	9979.1	8.1	5.4E+00	0.08	+/-1.5	Pass

Excitation Source Output, 5V

Parameter	Chan	UUT (mV)	U (mV)	MIN (mV)	MAX (mV)	PASS/ FAIL
350 Ohm Load	**1**	4976.8	2.0E-01	4950	5050	Pass
" "	**2**	4974.6	2.0E-01	4950	5050	Pass
" "	**3**	4996.5	2.0E-01	4950	5050	Pass
" "	**4**	5005.1	2.0E-01	4950	5050	Pass
" "	**5**	5001.6	2.0E-01	4950	5050	Pass
" "	**6**	4979.1	2.0E-01	4950	5050	Pass
" "	**7**	4989.6	2.0E-01	4950	5050	Pass
" "	**8**	4978.3	2.0E-01	4950	5050	Pass
Rated Load	**1**	4974.4	1.9E-01	4900	5100	Pass
" "	**2**	4970.7	1.9E-01	4900	5100	Pass
" "	**3**	4992.7	1.9E-01	4900	5100	Pass
" "	**4**	5003.0	1.9E-01	4900	5100	Pass
" "	**5**	4998.9	1.9E-01	4900	5100	Pass
" "	**6**	4976.8	1.9E-01	4900	5100	Pass
" "	**7**	4986.5	1.9E-01	4900	5100	Pass
" "	**8**	4975.1	1.9E-01	4900	5100	Pass
Short Recovery	**1**	4976.5	1.9E-01	4900	5100	Pass
" "	**2**	4974.5	1.9E-01	4900	5100	Pass
" "	**3**	4995.9	1.9E-01	4900	5100	Pass
" "	**4**	5004.5	1.9E-01	4900	5100	Pass
" "	**5**	5000.8	1.9E-01	4900	5100	Pass
" "	**6**	4978.6	1.9E-01	4900	5100	Pass
" "	**7**	4989.1	1.9E-01	4900	5100	Pass
" "	**8**	4977.5	1.9E-01	4900	5100	Pass

Excitation Source Output, 10V

Parameter	Chan	UUT (mV)	U (mV)	MIN (mV)	MAX (mV)	PASS/ FAIL
350 Ohm Load	**1**	9975.9	4.0E-01	9950	10050	Pass
" "	**2**	9970.5	4.0E-01	9950	10050	Pass
" "	**3**	9985.4	4.0E-01	9950	10050	Pass
" "	**4**	10011.4	4.0E-01	9950	10050	Pass
" "	**5**	10010.3	4.0E-01	9950	10050	Pass
" "	**6**	9975.1	4.0E-01	9950	10050	Pass
" "	**7**	9983.7	4.0E-01	9950	10050	Pass
" "	**8**	9971.0	4.0E-01	9950	10050	Pass
Rated Load	**1**	9976.6	4.0E-01	9900	10100	Pass
" "	**2**	9971.7	4.0E-01	9900	10100	Pass
" "	**3**	9986.8	4.0E-01	9900	10100	Pass
" "	**4**	10012.3	4.0E-01	9900	10100	Pass
" "	**5**	10011.5	4.0E-01	9900	10100	Pass
" "	**6**	9976.0	4.0E-01	9900	10100	Pass
" "	**7**	9984.9	4.0E-01	9900	10100	Pass
" "	**8**	9972.2	4.0E-01	9900	10100	Pass
Overload	**1**	9975.2	4.0E-01	9800	10200	Pass
" "	**2**	9970.3	4.0E-01	9800	10200	Pass
" "	**3**	9984.2	4.0E-01	9800	10200	Pass
" "	**4**	10010.0	4.0E-01	9800	10200	Pass
" "	**5**	10008.3	4.0E-01	9800	10200	Pass
" "	**6**	9974.2	4.0E-01	9800	10200	Pass
" "	**7**	9982.4	4.0E-01	9800	10200	Pass
" "	**8**	9970.1	4.0E-01	9800	10200	Pass
Short Recovery	**1**	9975.4	4.0E-01	9800	10200	Pass
" "	**2**	9969.6	4.0E-01	9800	10200	Pass
" "	**3**	9985.2	4.0E-01	9800	10200	Pass
" "	**4**	10010.3	4.0E-01	9800	10200	Pass
" "	**5**	10009.0	4.0E-01	9800	10200	Pass
" "	**6**	9974.6	4.0E-01	9800	10200	Pass
" "	**7**	9983.0	4.0E-01	9800	10200	Pass
" "	**8**	9970.3	4.0E-01	9800	10200	Pass

Measurement Data
As Received

Cert #: 20250502LM0212
Serial #: LM0212
Order #: 75286
Date: 2 May 2025

DC Amplitude/Gain Accuracy

Gain	Chan	Std (mV)	UUT (mV)	Dev (mV)	U (mV)	Dev (%)	Limits (%)	PASS/ FAIL
5	1	-695.5	-695.9	-0.34	1.0E-01	-0.03	+/-0.5	Pass
"	1	-344.4	-344.6	-0.17	7.8E-02	-0.02	+/-0.5	Pass
"	1	341.9	342.1	0.14	8.3E-02	0.01	+/-0.5	Pass
"	1	687.6	687.8	0.27	9.3E-02	0.03	+/-0.5	Pass
"	2	-695.5	-695.9	-0.42	1.0E-01	-0.04	+/-0.5	Pass
"	2	-344.4	-344.6	-0.18	7.8E-02	-0.02	+/-0.5	Pass
"	2	341.9	342.1	0.18	8.3E-02	0.02	+/-0.5	Pass
"	2	687.6	688.0	0.38	9.3E-02	0.04	+/-0.5	Pass
"	3	-695.5	-695.9	-0.36	1.0E-01	-0.04	+/-0.5	Pass
"	3	-344.4	-344.6	-0.18	7.8E-02	-0.02	+/-0.5	Pass
"	3	341.9	342.1	0.18	8.3E-02	0.02	+/-0.5	Pass
"	3	687.6	688.0	0.39	9.3E-02	0.04	+/-0.5	Pass
"	4	-695.5	-696.0	-0.45	1.0E-01	-0.05	+/-0.5	Pass
"	4	-344.4	-344.6	-0.19	7.8E-02	-0.02	+/-0.5	Pass
"	4	341.9	342.1	0.21	8.3E-02	0.02	+/-0.5	Pass
"	4	687.6	688.1	0.51	9.3E-02	0.05	+/-0.5	Pass
"	5	-695.5	-695.9	-0.38	1.0E-01	-0.04	+/-0.5	Pass
"	5	-344.4	-344.5	-0.14	7.8E-02	-0.01	+/-0.5	Pass
"	5	341.9	342.2	0.24	8.3E-02	0.02	+/-0.5	Pass
"	5	687.6	688.0	0.40	9.3E-02	0.04	+/-0.5	Pass
"	6	-695.5	-695.9	-0.39	1.0E-01	-0.04	+/-0.5	Pass
"	6	-344.4	-344.5	-0.15	7.8E-02	-0.02	+/-0.5	Pass
"	6	341.9	342.1	0.18	8.3E-02	0.02	+/-0.5	Pass
"	6	687.6	687.9	0.36	9.3E-02	0.04	+/-0.5	Pass
"	7	-695.5	-696.0	-0.44	1.0E-01	-0.04	+/-0.5	Pass
"	7	-344.4	-344.5	-0.13	7.8E-02	-0.01	+/-0.5	Pass
"	7	341.9	342.2	0.29	8.3E-02	0.03	+/-0.5	Pass
"	7	687.6	688.0	0.44	9.3E-02	0.04	+/-0.5	Pass
"	8	-695.5	-695.9	-0.40	1.0E-01	-0.04	+/-0.5	Pass
"	8	-344.4	-344.6	-0.19	7.8E-02	-0.02	+/-0.5	Pass
"	8	341.9	342.1	0.22	8.3E-02	0.02	+/-0.5	Pass
"	8	687.6	688.0	0.42	9.3E-02	0.04	+/-0.5	Pass
16	1	-215.79	-215.91	-0.119	6.3E-02	-0.04	+/-0.5	Pass
"	1	-107.40	-107.46	-0.058	4.8E-02	-0.02	+/-0.5	Pass
"	1	106.63	106.67	0.038	5.0E-02	0.01	+/-0.5	Pass
"	1	213.32	213.46	0.140	7.9E-02	0.04	+/-0.5	Pass
"	2	-215.79	-215.89	-0.096	6.3E-02	-0.03	+/-0.5	Pass
"	2	-107.40	-107.45	-0.051	4.8E-02	-0.02	+/-0.5	Pass
"	2	106.63	106.70	0.068	5.0E-02	0.02	+/-0.5	Pass
"	2	213.32	213.44	0.119	7.9E-02	0.04	+/-0.5	Pass
"	3	-215.79	-215.93	-0.135	6.3E-02	-0.04	+/-0.5	Pass
"	3	-107.40	-107.47	-0.077	4.8E-02	-0.02	+/-0.5	Pass
"	3	106.63	106.66	0.029	5.0E-02	0.01	+/-0.5	Pass
"	3	213.32	213.44	0.125	7.9E-02	0.04	+/-0.5	Pass
"	4	-215.79	-215.94	-0.148	6.3E-02	-0.05	+/-0.5	Pass
"	4	-107.40	-107.46	-0.058	4.8E-02	-0.02	+/-0.5	Pass
"	4	106.63	106.70	0.069	5.0E-02	0.02	+/-0.5	Pass
"	4	213.32	213.49	0.173	7.9E-02	0.06	+/-0.5	Pass
"	5	-215.79	-215.90	-0.113	6.3E-02	-0.04	+/-0.5	Pass
"	5	-107.40	-107.44	-0.046	4.8E-02	-0.01	+/-0.5	Pass
"	5	106.63	106.71	0.079	5.0E-02	0.03	+/-0.5	Pass
"	5	213.32	213.46	0.141	7.9E-02	0.05	+/-0.5	Pass
"	6	-215.79	-215.91	-0.117	6.3E-02	-0.04	+/-0.5	Pass
"	6	-107.40	-107.45	-0.048	4.8E-02	-0.02	+/-0.5	Pass
"	6	106.63	106.67	0.042	5.0E-02	0.01	+/-0.5	Pass
"	6	213.32	213.44	0.127	7.9E-02	0.04	+/-0.5	Pass
"	7	-215.79	-215.94	-0.146	6.3E-02	-0.05	+/-0.5	Pass
"	7	-107.40	-107.48	-0.080	4.8E-02	-0.03	+/-0.5	Pass
"	7	106.63	106.69	0.062	5.0E-02	0.02	+/-0.5	Pass
"	7	213.32	213.48	0.163	7.9E-02	0.05	+/-0.5	Pass
"	8	-215.79	-215.93	-0.140	6.3E-02	-0.04	+/-0.5	Pass
"	8	-107.40	-107.47	-0.072	4.8E-02	-0.02	+/-0.5	Pass
"	8	106.63	106.72	0.095	5.0E-02	0.03	+/-0.5	Pass
"	8	213.32	213.50	0.181	7.9E-02	0.06	+/-0.5	Pass

DC Amplitude/Gain Accuracy

Gain	Chan	Std (mV)	UUT (mV)	Dev (mV)	U (mV)	Dev (%)	Limits (%)	PASS/ FAIL
32	1	-107.40	-107.45	-0.050	1.8E-02	-0.03	+/-0.5	Pass
"	1	-53.23	-53.25	-0.015	1.3E-02	-0.01	+/-0.5	Pass
"	1	52.99	53.02	0.031	1.3E-02	0.02	+/-0.5	Pass
"	1	106.62	106.68	0.058	1.6E-02	0.04	+/-0.5	Pass
"	2	-107.40	-107.46	-0.059	1.8E-02	-0.04	+/-0.5	Pass
"	2	-53.23	-53.26	-0.029	1.3E-02	-0.02	+/-0.5	Pass
"	2	52.99	53.04	0.044	1.3E-02	0.03	+/-0.5	Pass
"	2	106.62	106.69	0.062	1.6E-02	0.04	+/-0.5	Pass
"	3	-107.40	-107.49	-0.091	1.8E-02	-0.06	+/-0.5	Pass
"	3	-53.23	-53.26	-0.024	1.3E-02	-0.02	+/-0.5	Pass
"	3	52.99	53.02	0.032	1.3E-02	0.02	+/-0.5	Pass
"	3	106.62	106.69	0.070	1.6E-02	0.05	+/-0.5	Pass
"	4	-107.40	-107.47	-0.071	1.8E-02	-0.05	+/-0.5	Pass
"	4	-53.23	-53.27	-0.039	1.3E-02	-0.03	+/-0.5	Pass
"	4	52.99	53.02	0.029	1.3E-02	0.02	+/-0.5	Pass
"	4	106.62	106.68	0.061	1.6E-02	0.04	+/-0.5	Pass
"	5	-107.40	-107.43	-0.036	1.8E-02	-0.02	+/-0.5	Pass
"	5	-53.23	-53.26	-0.025	1.3E-02	-0.02	+/-0.5	Pass
"	5	52.99	53.03	0.040	1.3E-02	0.03	+/-0.5	Pass
"	5	106.62	106.68	0.052	1.6E-02	0.03	+/-0.5	Pass
"	6	-107.40	-107.46	-0.059	1.8E-02	-0.04	+/-0.5	Pass
"	6	-53.23	-53.26	-0.022	1.3E-02	-0.01	+/-0.5	Pass
"	6	52.99	53.01	0.014	1.3E-02	0.01	+/-0.5	Pass
"	6	106.62	106.70	0.074	1.6E-02	0.05	+/-0.5	Pass
"	7	-107.40	-107.46	-0.064	1.8E-02	-0.04	+/-0.5	Pass
"	7	-53.23	-53.27	-0.038	1.3E-02	-0.02	+/-0.5	Pass
"	7	52.99	53.02	0.033	1.3E-02	0.02	+/-0.5	Pass
"	7	106.62	106.71	0.083	1.6E-02	0.05	+/-0.5	Pass
"	8	-107.40	-107.46	-0.059	1.8E-02	-0.04	+/-0.5	Pass
"	8	-53.23	-53.26	-0.023	1.3E-02	-0.01	+/-0.5	Pass
"	8	52.99	53.03	0.039	1.3E-02	0.03	+/-0.5	Pass
"	8	106.62	106.71	0.087	1.6E-02	0.06	+/-0.5	Pass
128	1	-26.680	-26.741	-0.0610	5.6E-03	-0.16	+/-1.5	Pass
"	1	-13.344	-13.375	-0.0303	4.4E-03	-0.08	+/-1.5	Pass
"	1	13.270	13.300	0.0299	4.3E-03	0.08	+/-1.5	Pass
"	1	26.440	26.501	0.0609	6.8E-03	0.16	+/-1.5	Pass
"	2	-26.680	-26.738	-0.0588	5.6E-03	-0.15	+/-1.5	Pass
"	2	-13.344	-13.373	-0.0287	4.4E-03	-0.07	+/-1.5	Pass
"	2	13.270	13.299	0.0288	4.3E-03	0.07	+/-1.5	Pass
"	2	26.440	26.500	0.0598	6.8E-03	0.15	+/-1.5	Pass
"	3	-26.680	-26.744	-0.0640	5.6E-03	-0.16	+/-1.5	Pass
"	3	-13.344	-13.376	-0.0321	4.4E-03	-0.08	+/-1.5	Pass
"	3	13.270	13.303	0.0329	4.3E-03	0.08	+/-1.5	Pass
"	3	26.440	26.506	0.0664	6.8E-03	0.17	+/-1.5	Pass
"	4	-26.680	-26.744	-0.0645	5.6E-03	-0.17	+/-1.5	Pass
"	4	-13.344	-13.377	-0.0321	4.4E-03	-0.08	+/-1.5	Pass
"	4	13.270	13.300	0.0304	4.3E-03	0.08	+/-1.5	Pass
"	4	26.440	26.506	0.0664	6.8E-03	0.17	+/-1.5	Pass
"	5	-26.680	-26.742	-0.0625	5.6E-03	-0.16	+/-1.5	Pass
"	5	-13.344	-13.374	-0.0292	4.4E-03	-0.07	+/-1.5	Pass
"	5	13.270	13.301	0.0314	4.3E-03	0.08	+/-1.5	Pass
"	5	26.440	26.505	0.0646	6.8E-03	0.17	+/-1.5	Pass
"	6	-26.680	-26.742	-0.0628	5.6E-03	-0.16	+/-1.5	Pass
"	6	-13.344	-13.373	-0.0286	4.4E-03	-0.07	+/-1.5	Pass
"	6	13.270	13.300	0.0306	4.3E-03	0.08	+/-1.5	Pass
"	6	26.440	26.503	0.0633	6.8E-03	0.16	+/-1.5	Pass
"	7	-26.680	-26.745	-0.0653	5.6E-03	-0.17	+/-1.5	Pass
"	7	-13.344	-13.375	-0.0303	4.4E-03	-0.08	+/-1.5	Pass
"	7	13.270	13.301	0.0308	4.3E-03	0.08	+/-1.5	Pass
"	7	26.440	26.507	0.0674	6.8E-03	0.17	+/-1.5	Pass
"	8	-26.680	-26.744	-0.0641	5.6E-03	-0.16	+/-1.5	Pass
"	8	-13.344	-13.375	-0.0309	4.4E-03	-0.08	+/-1.5	Pass
"	8	13.270	13.299	0.0296	4.3E-03	0.08	+/-1.5	Pass
"	8	26.440	26.504	0.0639	6.8E-03	0.16	+/-1.5	Pass

DTS

Measurement Data
As Received

Cert #: 20250502LM0212
Serial #: LM0212
Order #: 75286
Date: 2 May 2025

DC Amplitude/Gain Accuracy

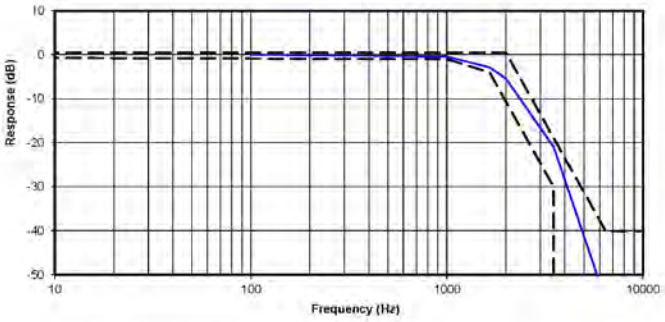
Gain	Chan	Std (mV)	UUT (mV)	Dev (mV)	U (mV)	Dev (%)	Limits (%)	PASS/ FAIL
512	1	-6.691	-6.709	-0.0180	4.4E-03	-0.18	+/-1.5	Pass
"	1	-3.319	-3.327	-0.0085	2.8E-03	-0.09	+/-1.5	Pass
"	1	3.299	3.307	0.0080	2.7E-03	0.08	+/-1.5	Pass
"	1	6.615	6.635	0.0201	4.2E-03	0.21	+/-1.5	Pass
"	2	-6.691	-6.707	-0.0166	4.4E-03	-0.17	+/-1.5	Pass
"	2	-3.319	-3.327	-0.0078	2.8E-03	-0.08	+/-1.5	Pass
"	2	3.299	3.306	0.0075	2.7E-03	0.08	+/-1.5	Pass
"	2	6.615	6.633	0.0180	4.2E-03	0.18	+/-1.5	Pass
"	3	-6.691	-6.707	-0.0159	4.4E-03	-0.16	+/-1.5	Pass
"	3	-3.319	-3.325	-0.0065	2.8E-03	-0.07	+/-1.5	Pass
"	3	3.299	3.305	0.0066	2.7E-03	0.07	+/-1.5	Pass
"	3	6.615	6.632	0.0174	4.2E-03	0.18	+/-1.5	Pass
"	4	-6.691	-6.706	-0.0149	4.4E-03	-0.15	+/-1.5	Pass
"	4	-3.319	-3.327	-0.0083	2.8E-03	-0.09	+/-1.5	Pass
"	4	3.299	3.305	0.0066	2.7E-03	0.07	+/-1.5	Pass
"	4	6.615	6.631	0.0166	4.2E-03	0.17	+/-1.5	Pass
"	5	-6.691	-6.706	-0.0157	4.4E-03	-0.16	+/-1.5	Pass
"	5	-3.319	-3.325	-0.0067	2.8E-03	-0.07	+/-1.5	Pass
"	5	3.299	3.306	0.0068	2.7E-03	0.07	+/-1.5	Pass
"	5	6.615	6.634	0.0188	4.2E-03	0.19	+/-1.5	Pass
"	6	-6.691	-6.708	-0.0172	4.4E-03	-0.18	+/-1.5	Pass
"	6	-3.319	-3.327	-0.0084	2.8E-03	-0.09	+/-1.5	Pass
"	6	3.299	3.307	0.0083	2.7E-03	0.09	+/-1.5	Pass
"	6	6.615	6.634	0.0187	4.2E-03	0.19	+/-1.5	Pass
"	7	-6.691	-6.710	-0.0194	4.4E-03	-0.20	+/-1.5	Pass
"	7	-3.319	-3.329	-0.0105	2.8E-03	-0.11	+/-1.5	Pass
"	7	3.299	3.308	0.0090	2.7E-03	0.09	+/-1.5	Pass
"	7	6.615	6.636	0.0215	4.2E-03	0.22	+/-1.5	Pass
"	8	-6.691	-6.709	-0.0181	4.4E-03	-0.19	+/-1.5	Pass
"	8	-3.319	-3.327	-0.0087	2.8E-03	-0.09	+/-1.5	Pass
"	8	3.299	3.307	0.0079	2.7E-03	0.08	+/-1.5	Pass
"	8	6.615	6.635	0.0203	4.2E-03	0.21	+/-1.5	Pass
2000	1	-1.740	-1.745	-0.0054	4.8E-03	-0.22	+/-1.5	Pass
"	1	-0.875	-0.875	0.0005	3.2E-03	0.02	+/-1.5	Pass
"	1	0.867	0.870	0.0027	2.5E-03	0.11	+/-1.5	Pass
"	1	1.737	1.742	0.0051	5.0E-03	0.20	+/-1.5	Pass
"	2	-1.740	-1.746	-0.0066	4.8E-03	-0.27	+/-1.5	Pass
"	2	-0.875	-0.875	0.0005	3.2E-03	0.02	+/-1.5	Pass
"	2	0.867	0.869	0.0018	2.5E-03	0.07	+/-1.5	Pass
"	2	1.737	1.742	0.0046	5.0E-03	0.19	+/-1.5	Pass
"	3	-1.740	-1.746	-0.0059	4.8E-03	-0.24	+/-1.5	Pass
"	3	-0.875	-0.874	0.0011	3.2E-03	0.04	+/-1.5	Pass
"	3	0.867	0.870	0.0032	2.5E-03	0.13	+/-1.5	Pass
"	3	1.737	1.743	0.0055	5.0E-03	0.22	+/-1.5	Pass
"	4	-1.740	-1.746	-0.0062	4.8E-03	-0.25	+/-1.5	Pass
"	4	-0.875	-0.874	0.0007	3.2E-03	0.03	+/-1.5	Pass
"	4	0.867	0.869	0.0025	2.5E-03	0.10	+/-1.5	Pass
"	4	1.737	1.742	0.0055	5.0E-03	0.22	+/-1.5	Pass
"	5	-1.740	-1.748	-0.0078	4.8E-03	-0.31	+/-1.5	Pass
"	5	-0.875	-0.876	-0.0014	3.2E-03	-0.05	+/-1.5	Pass
"	5	0.867	0.870	0.0036	2.5E-03	0.14	+/-1.5	Pass
"	5	1.737	1.743	0.0062	5.0E-03	0.25	+/-1.5	Pass
"	6	-1.740	-1.748	-0.0080	4.8E-03	-0.32	+/-1.5	Pass
"	6	-0.875	-0.875	0.0003	3.2E-03	0.01	+/-1.5	Pass
"	6	0.867	0.872	0.0053	2.5E-03	0.21	+/-1.5	Pass
"	6	1.737	1.743	0.0056	5.0E-03	0.23	+/-1.5	Pass
"	7	-1.740	-1.746	-0.0061	4.8E-03	-0.25	+/-1.5	Pass
"	7	-0.875	-0.874	0.0009	3.2E-03	0.04	+/-1.5	Pass
"	7	0.867	0.871	0.0041	2.5E-03	0.16	+/-1.5	Pass
"	7	1.737	1.742	0.0052	5.0E-03	0.21	+/-1.5	Pass
"	8	-1.740	-1.745	-0.0054	4.8E-03	-0.22	+/-1.5	Pass
"	8	-0.875	-0.874	0.0008	3.2E-03	0.03	+/-1.5	Pass
"	8	0.867	0.870	0.0030	2.5E-03	0.12	+/-1.5	Pass
"	8	1.737	1.740	0.0031	5.0E-03	0.12	+/-1.5	Pass

DTS

Measurement Data
As Received

Cert #: 20250502LM0212
Serial #: LM0212
Order #: 75286
Date: 2 May 2025

Filter Response vs. SAE J211 Class 1000 Corridor
(All 8 Channels Overlapped)



SAE J211 Class 1000 Filter Response
(2V p-p Sine Input, with Software Filter)

Chan	Input (Hz)	UUT (mV)	U (mV)	UUT (dB)	MIN (dB)	MAX (dB)	PASS/ FAIL
1	100	703.4	8.0E+00	0.00	-0.88	0.50	Pass
1	1000	671.1	8.0E+00	-0.41	-1.00	0.50	Pass
1	1650	507.5	7.5E+00	-2.84	-4.00	0.50	Pass
1	2000	378.7	5.6E+00	-5.38	-10.66	0.50	Pass
1	3496	63.50	4.6E-01	-20.89	-30.00	-18.84	Pass
1	6441	1.163	2.6E-02	-55.63	-inf	-40.00	Pass
2	100	702.8	8.0E+00	0.00	-0.88	0.50	Pass
2	1000	671.1	8.0E+00	-0.40	-1.00	0.50	Pass
2	1650	508.3	7.5E+00	-2.81	-4.00	0.50	Pass
2	2000	379.7	5.6E+00	-5.35	-10.66	0.50	Pass
2	3496	64.04	4.6E-01	-20.81	-30.00	-18.84	Pass
2	6441	1.174	2.6E-02	-55.54	-inf	-40.00	Pass
3	100	703.2	8.0E+00	0.00	-0.88	0.50	Pass
3	1000	671.2	8.0E+00	-0.40	-1.00	0.50	Pass
3	1650	508.0	7.5E+00	-2.82	-4.00	0.50	Pass
3	2000	379.2	5.6E+00	-5.36	-10.66	0.50	Pass
3	3496	63.74	4.6E-01	-20.85	-30.00	-18.84	Pass
3	6441	1.162	2.6E-02	-55.64	-inf	-40.00	Pass
4	100	702.8	8.0E+00	0.00	-0.88	0.50	Pass
4	1000	670.0	8.0E+00	-0.41	-1.00	0.50	Pass
4	1650	506.1	7.5E+00	-2.85	-4.00	0.50	Pass
4	2000	377.3	5.6E+00	-5.40	-10.66	0.50	Pass
4	3496	63.05	4.6E-01	-20.94	-30.00	-18.84	Pass
4	6441	1.160	2.6E-02	-55.64	-inf	-40.00	Pass

SAE J211 Class 1000 Filter Response
(2V p-p Sine Input, with Software Filter)

Chan	Input (Hz)	UUT (mV)	U (mV)	UUT (dB)	MIN (dB)	MAX (dB)	PASS/ FAIL
5	100	703.3	8.0E+00	0.00	-0.88	0.50	Pass
5	1000	671.2	8.0E+00	-0.41	-1.00	0.50	Pass
5	1650	507.8	7.5E+00	-2.83	-4.00	0.50	Pass
5	2000	379.0	5.6E+00	-5.37	-10.66	0.50	Pass
5	3496	63.65	4.6E-01	-20.87	-30.00	-18.84	Pass
5	6441	1.163	2.6E-02	-55.63	-inf	-40.00	Pass
6	100	703.4	8.0E+00	0.00	-0.88	0.50	Pass
6	1000	671.2	8.0E+00	-0.41	-1.00	0.50	Pass
6	1650	507.9	7.5E+00	-2.83	-4.00	0.50	Pass
6	2000	379.1	5.6E+00	-5.37	-10.66	0.50	Pass
6	3496	63.76	4.6E-01	-20.85	-30.00	-18.84	Pass
6	6441	1.174	2.6E-02	-55.55	-inf	-40.00	Pass
7	100	703.6	8.0E+00	0.00	-0.88	0.50	Pass
7	1000	671.3	8.0E+00	-0.41	-1.00	0.50	Pass
7	1650	507.6	7.5E+00	-2.84	-4.00	0.50	Pass
7	2000	378.8	5.6E+00	-5.38	-10.66	0.50	Pass
7	3496	63.54	4.6E-01	-20.89	-30.00	-18.84	Pass
7	6441	1.164	2.6E-02	-55.62	-inf	-40.00	Pass
8	100	703.9	8.0E+00	0.00	-0.88	0.50	Pass
8	1000	670.8	8.0E+00	-0.42	-1.00	0.50	Pass
8	1650	506.3	7.5E+00	-2.86	-4.00	0.50	Pass
8	2000	377.3	5.6E+00	-5.42	-10.66	0.50	Pass
8	3496	62.86	4.6E-01	-20.98	-30.00	-18.84	Pass
8	6441	1.151	2.6E-02	-55.73	-inf	-40.00	Pass

Fixed Filter Response
(2V p-p Sine Input, no Software Filter)

Chan	Input (Hz)	UUT (mV)	U (mV)	UUT (dB)	MIN (dB)	MAX (dB)	PASS/ FAIL
1	4300	495.8	5.7E+00	-3.04	-3.50	-2.50	Pass
2	4300	501.2	5.7E+00	-2.94	-3.50	-2.50	Pass
3	4300	497.8	5.7E+00	-3.00	-3.50	-2.50	Pass
4	4300	492.0	5.7E+00	-3.10	-3.50	-2.50	Pass
5	4300	497.1	5.7E+00	-3.01	-3.50	-2.50	Pass
6	4300	498.7	5.7E+00	-2.99	-3.50	-2.50	Pass
7	4300	496.2	5.7E+00	-3.03	-3.50	-2.50	Pass
8	4300	489.4	5.7E+00	-3.16	-3.50	-2.50	Pass

** End of Report **

Diversified Technical Systems, Inc.
25865 Meadowbrook Road, Novi, MI 48375 USA
Phone: +1 248 513 6050 • Fax: +1 248 513 6051
www.dtsweb.com

Calibration and Test Report

Model # : TDAS PRO LAB TOM	**CERTIFICATE NUMBER:**	Date Received: 1 May 2025
Serial # : TOML038	20250502TOML038	Date Calibrated: 2 May 2025
Firmware: 01C6		
Procedure: TDAS PRO TOM Calibration, Rev 7.5	**First use date:**	Item Received: In Tolerance
Order: 75286		Item Returned: In Tolerance
Customer: MGA Research		
2927A Elliott Ave.	**Next calibration date:**	Temperature: 71°F / 21.5°C
Troy, MI, USA, 48083		Humidity: 47 %

This instrument has been processed and calibrated in accordance with the DTS Quality Assurance Manual and ISO/IEC 17025. DTS has been audited by the American Association for Laboratory Accreditation (A2LA) and found in compliance with ISO/IEC 17025. 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. Timing and frequency response meet the requirements of SAE J211 and ISO 6487.

DTS reference standards are tested and calibrated in accordance with the DTS Quality Assurance System, and traceable to a National Metrology Institute (NMI) such as National Institute of Standards and Technology (NIST). Uncertainties have been estimated at an approximately 95 percent confidence level (k=2). Simple acceptance is used as defined in ILAC G8 with a TUR > 4:1 unless otherwise noted.

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 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.

DTS products may be stored for up to 6 months from the calibration date without impact to its specifications. The First Use Date can be set by the integrator or end user when the product is placed into service. Next Calibration Date should be one Calibration Period from the First Use Date. The recommended Calibration Period for DTS products is 12 months.

Standards Used

ID #	Manufacturer	Model #	Description	Cal Date	Due Date
MY42006281	Keysight	34420A	Nanovolt/micro-ohm meter, 7.5 digit	9-Oct-2024	9-Oct-2025
CAL208	DTS	CS2.0	Cal Station 2.0	19-Nov-2024	19-Nov-2025

Results

Test Description	As Received / As Returned
Visual Examination	PASS
Communication to TDAS Rack Bus	PASS
Timebase Calibration	PASS
Squib Current Calibration	PASS
Voltage and Current Recording Calibration	PASS
Squib Output Performance Tests	PASS
Squib Resistance Performance Test	PASS
Digital Output Performance Test	PASS
Sensor ID Performance Test	PASS
Internal Self Checks	PASS

Calibration Site:
DTS-MI
25865 Meadowbrook Road
Novi, MI 48375 USA

Calibrated By:
Zach Cholette
Calibration Technician

Cert #: 20250502TOML038
Serial #: TOML038
Order #: 75286
Date: 2 May 2025

Measurement Data
As Received

Timebase Calibration, Data Recording

Std (Hz)	UUT (Hz)	Dev (Hz)	Dev (ppm)	U (ppm)	Limits (ppm)	PASS/ FAIL
1000.00	1000.01	0.0100	10.0	2.3E+01	+/-100	Pass

Timebase Calibration, Squib and Digital Output

Set (sec)	UUT (sec)	Dev (sec)	Dev (ppm)	U (ppm)	Limits (ppm)	PASS/ FAIL
26.0000	26.0003	0.00031	12.0	2.3E+01	+/-100	Pass

Squib Current Output Calibration

Chan	Std (amps)	UUT (amps)	Dev (amps)	U (amps)	Dev (%)	Limits (%)	PASS/ FAIL
1	2.00	2.00	-0.002	2.0E-03	-0.09	+/-1	Pass
2	2.00	2.00	-0.001	2.0E-03	-0.05	+/-1	Pass
3	2.00	2.00	0.002	2.0E-03	0.12	+/-1	Pass
4	2.00	2.00	0.003	2.0E-03	0.15	+/-1	Pass

Squib Voltage Recording Calibration

Chan	Std (V)	UUT (V)	Dev (V)	U (V)	Dev (%)	Limits (%)	PASS/ FAIL
1	4.07	4.07	-0.001	7.6E-03	0.03	+/-1	Pass
2	4.06	4.06	-0.005	7.6E-03	0.12	+/-1	Pass
3	4.10	4.10	0.001	7.6E-03	-0.02	+/-1	Pass
4	4.11	4.11	0.000	7.6E-03	0.01	+/-1	Pass

Internal Squib Diagnostic Performance Test

Chan	UUT (amps)	U (amps)	MIN (amps)	MAX (amps)	PASS/ FAIL
1	7.93	7.6E-03	7	9	Pass
2	8.20	7.6E-03	7	9	Pass
3	7.93	7.6E-03	7	9	Pass
4	8.27	7.6E-03	7	9	Pass

Squib Resistance Diagnostic Performance Test

Chan	Std (ohms)	UUT (ohms)	Dev (ohms)	U (ohms)	Limits (ohms)	PASS/ FAIL
1	2.03	2.03	0.00	8.8E-02	+/-0.5	Pass
2	2.03	2.02	-0.01	8.8E-02	+/-0.5	Pass
3	2.05	2.05	0.00	8.8E-02	+/-0.5	Pass
4	2.05	2.05	0.00	8.8E-02	+/-0.5	Pass
1	5.01	4.99	-0.01	5.6E-02	+/-0.5	Pass
2	5.01	4.99	-0.02	5.6E-02	+/-0.5	Pass
3	5.00	5.01	0.01	5.6E-02	+/-0.5	Pass
4	5.01	4.98	-0.03	5.6E-02	+/-0.5	Pass

Squib Current Recording Calibration

Chan	Std (amps)	UUT (amps)	Dev (amps)	U (amps)	Dev (%)	Limits (%)	PASS/ FAIL
1	2.00	2.01	-0.010	3.0E-03	0.52	+/-2	Pass
2	2.00	2.01	-0.016	3.0E-03	0.79	+/-2	Pass
3	2.00	2.01	-0.004	3.0E-03	0.22	+/-2	Pass
4	2.00	1.99	0.017	3.0E-03	-0.84	+/-2	Pass

** End of Report **

mga

CERTIFICATE OF CALIBRATION

CUSTOMER: MGA Inventory

MANUFACTURER: MGA

AS RECEIVED: N/A

MODEL NUMBER: N/A

AS RETURNED: IN TOLERANCE

SERIAL NUMBER: 19.020.01

DESCRIPTION: Mobile Propulsion System VMS

COMMENTS:

1. Calibrated for a 30mm flag distance.
2. 68.2% of values drawn from each standard normal distribution are within one standard deviation of the average value. 95.4% of values are within two standard deviations of the average value. 99.7% of values are within three standard deviations of the average value.

MGA Research maintains reference standards of measurement which are traceable to the National Institute of Standards and Technology or other authorized National Standards. This calibration was conducted utilizing the guidelines of MIL-STD-45662, ANSI/NCSL Z540-1 and ISO/IEC Guide 25 Standards. Results shall not be reproduced except in full without the written approval of MGA Research. The results relate only to the item(s) calibrated.

CALIBRATION PERFORMED BY:

CONDUCTED BY: Nolan Nowak

ISSUED DATE: 6/21/2024

CALIBRATION DATE: 6/21/2024

APPROVED BY: Douglas Smith

APPROVED DATE: 6/21/2024

CALIBRATION DUE DATE: 6/21/2025

STANDARDS USED:

MFG	MODEL NUMBER	SERIAL NO.	DESCRIPTION	CAL DUE DATE
BK Precision	4052	388K13116	Function Generator	06/23/24

CERTIFICATE OF CALIBRATION

CALIBRATION INFORMATION:

CALIBRATION VALUE SETUP			
SPEED [kph]	SPEED [m/s]	TIME [ms]*	FREQ [Hz]
5.0	1.389	21.600	46.30
10.0	2.778	10.800	92.59
15.0	4.167	7.200	138.89
20.0	5.556	5.400	185.19
25.0	6.944	4.320	231.48
30.0	8.333	3.600	277.78
50.0	13.889	2.160	462.96
75.0	20.833	1.440	694.44
85.0	23.611	1.271	787.04
99.9	27.750	1.081	925.00

CALIBRATION TEST RESULTS										
	SPEED [kph]									
TEST NO.	5	10	15	20	25	30	35	50	75	99.9
1	5.000	10.001	15.000	20.000	25.008	30.008	50.007	75.016	84.998	99.942
2	5.000	10.001	15.001	20.002	25.006	30.003	50.022	75.016	85.018	99.913
3	5.000	10.001	15.002	20.002	25.004	30.008	50.000	75.033	85.018	99.913
4	5.000	10.001	15.000	20.003	25.003	30.003	50.014	75.016	85.018	99.971
5	5.000	10.001	15.000	20.002	25.004	30.003	50.022	75.016	85.039	99.942
6	5.001	10.000	15.003	20.000	25.003	30.008	50.022	75.016	84.998	99.942
7	5.000	10.000	15.000	20.002	25.003	30.013	50.022	75.033	84.998	99.971
8	5.000	10.001	15.003	20.003	25.001	29.997	50.007	75.033	85.018	99.942
9	5.000	10.001	15.002	20.000	25.003	30.000	50.007	75.033	84.977	99.971
10	5.000	9.999	15.000	20.000	25.003	30.010	50.014	75.033	85.018	99.942
AVG	5.000	10.001	15.001	20.001	25.004	30.005	50.014	75.025	85.010	99.945
STD DEV [+/-1σ]**	0.0003	0.0007	0.0012	0.0012	0.0018	0.0046	0.0077	0.0085	0.0164	0.0203

Time duration calculated using a 30mm flag distance
***68.2% of values drawn from each standard normal distribution above are within one standard deviation of its average value*
95.4% of values drawn from each standard normal distribution are within two standard deviations of its average
99.7% of values drawn from each standard normal distribution are within three standard deviations of its average value

**For information on calibration traceability, contact MGA Technical Support at [illegible]*

MICHIGAN OPERATIONS
DATE: 07/31/2023
SUPERCEDES: MGATPTMC.11

DOC. NO.: MGATP_TMC
REVISION NO.: 12

Tape Measure Calibration Certificate

Reference Steel Rule

Brand: Swanson
S/N: MGA00798
Calibration Date: 04/07/2024

Subject Tape Measure

Brand: Stanley
S/N: TPM010-08
Calibration Date: 8/6/2024

Reference in (mm)	Subject Tape Measure		Difference	
	Pull	Push	Pull	Push
0 (0)	0	0	0	0
4 (100)	100	99	0	-1
8 (200)	200	199	0	-1
12 (300)	300	299	0	-1
16 (400)	400	399	0	-1
20 (500)	500	499	0	-1
24 (600)	600	599	0	-1
28 (700)	700	699	0	-1
32 (800)	800	799	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 X Fail ____ Maximum Difference = 1mm

Date: 8/6/2024 Performed By: S. Arsen

All calibrations are traceable to the National Institute of Standards and Technology. Estimated uncertainty of the measurement is ± 0.164%. 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.

MetroCal inc.

ACCREDITED
CALIBRATION CERT #0513.01

3631 44th Street SE Suite B, Kentwood MI 49512, Telephone: 616-698-3124, Fax: 616-698-2364, www.metrocal.com

Certificate of Calibration

MGA Research
33653 Dequindre
Troy, MI 48083

Order Number: **25271**
Certificate Number: **241029200**
Page: **1 of 3**

Gauge Number: **A35-E5-21-37083**
CMM Type: **Faro Articulating Arm**
CMM Manufacturer: **Faro**
Model Number: **41000**
Probe Type: **6mm Ruby**
Serial Number: **A35-E5-21-37083**

Customer PO: **MI1012**
Last Calibration: **11/21/23**
Calibration Date: **10/29/24**
Next Calibration: **10/29/25**

As Found Condition: **See Results**

As Left Condition: **See Results**

MetroCal, Inc maintains reference standards of measurement which are traceable to the National Institute of Standards and Technology, or other authorized National Standards. Calibration was performed in accordance with relevant sections of the ASME B89.4.1a and MetroCal Procedure CP019. This calibration complies with the ANSI/NCSL Z540-1 and ISO/IEC 17025 Standards. Results shall not be reproduced, except in full, without the written approval of MetroCal, Inc. Calibration was performed at the customers facility. Results relate only to the item(s) calibrated. Any number of factors may cause the calibration item to drift out of calibration before the recommended interval has expired. Statement of conformity follows the simple acceptance rule, or shared risk. This means the acceptance limit is equal to the tolerance limit without considering measurement uncertainty (MU). User can take into account the level of risk for false Pass/Fail or In Tolerance/Out of Tolerance, as a percentage, by using this calculation: (MU ÷ Tolerance)*100.

Standard Used	Cal. Date	Due Date	Traceable No.
8 pc Long Gage Block Set	5/6/24	5/31/25	ID# 30965
Ball Bar	11/28/23	11/30/24	ID# 13723
Calibration Process Uncertainty, Expressed at 95% Confidence and a K factor of 2			
Volumetric = 190 µin , Repeatability = 150 µin , Linearity = (11 + 5.6L) µin + 0.6R; L = Length in inches			

Units: mm

Tolerances: Client's Discretion

Results:

	Linear					
	As Found			As Left		
	Nominal	Actual	Deviation	Nominal	Actual	Deviation
	508.000	507.977	-0.023	508.000	507.977	-0.023
	406.400	406.374	-0.026	406.400	406.374	-0.026
	304.800	304.755	-0.045	304.800	304.755	-0.045
	203.200	203.254	0.054	203.200	203.254	0.054
	System Repeatability					
X	0.0310			0.0310		
Y	0.0350			0.0350		
Z	0.0240			0.0240		
	Volumetrics					
Ball Bar	0.0630			0.0630		

Comments: Environmental conditions during Test: 72 °F, 43% RH.
Machine is repeating well within the manufacturers tolerance.

Issued: 11/7/24

Authorized by: **Andrew Barber**
Calibration Technician

11/7/2024
SA

Form - Faro Arm CMM - Layout

NovaStar SOLUTIONS
Metrology Management Services

Calibration Certificate

ACCREDITED Calibration #1277.01

35200 Plymouth Rd. / Livonia, MI 48150 / 734.453.8003

Certificate # Z54487:663729

AP-20 - DETECTO - SCALE

SERIAL NUMBER:	E10807-0187	WORK ORDER:	663729
ASSET NUMBER:	Z54487	TEST RESULT:	PASS
CUST ASSET NUMBER:	MGA00783	PERFORMED ON:	01/09/25
PROCEDURE NAME:	Scales and Balances - MMC	CAL DUE DATE:	01/09/26
PROCEDURE REV:	1	DATA TYPE:	FOUND-LEFT
CALIBRATED BY:	Cody Brent	TEMPERATURE:	21 °C
CUSTOMER:	MGA RESEARCH - OPERATIONS 2927 ELLIOTT DR TROY, MI 48083	HUMIDITY:	25 %
PRIMARY CONTACT:	Noel Riehl		

This instrument has been processed and calibrated in accordance with the NovaStar Solutions Quality System Manual. All calibrations are traceable to the International System of Units (SI) through a National Metrology Institute (NMI) such as NIST, acceptable intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. The NovaStar Solutions quality system is accredited ISO/IEC 17025 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.

Where statements of compliance are made, the measurement uncertainty is not factored in unless otherwise noted. 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. If applicable, the data for this certificate can be found on the Report of Calibration for this UUT.

AS RECEIVED CONDITION:	In Tolerance	REMARKS:	N/A
AS RETURNED CONDITION:	In Tolerance		
ACTION TAKEN:	FULL CALIBRATION		

Standards Used

Asset #	Cert #	Description	Cal Date	Due Date
1633	1633:661150	CLASS 6 - RICE LAKE - 18 PC. WEIGHT SET	12/17/2024	12/17/2025
1960	1960:643386	CLASS 6 - RICE LAKE - 11 PC. WEIGHT SET	10/01/2024	10/01/2025
4314	4314:583980	42280 - EXTECH - DATA LOGGER	01/24/2024	01/24/2025

QA Signature: Date: 1/10/2025 2:00:17 PM

1/15/2025
SA

NovaStar SOLUTIONS
Metrology Management Services

Calibration Certificate

ACCREDITED Calibration #1277.01

35200 Plymouth Rd. / Livonia, MI 48150 / 734.453.8003

Certificate # Z251859:633102

PRO 360 - SPI-TRONIC - DIGITAL PROTRACTOR

SERIAL NUMBER:	N/A	WORK ORDER:	633102
ASSET NUMBER:	Z251859	TEST RESULT:	PASS
CUST ASSET NUMBER:	MI0343	PERFORMED ON:	08/22/24
PROCEDURE NAME:	MIT - PRO 360 - MMC	CAL DUE DATE:	08/22/25
PROCEDURE REV:	1.2	DATA TYPE:	FOUND-LEFT
CALIBRATED BY:	Nick Bush	TEMPERATURE:	20 °C
CUSTOMER:	MGA RESEARCH - OPERATIONS 2927 ELLIOTT DR TROY, MI 48083	HUMIDITY:	38 %
PRIMARY CONTACT:	Noel Riehl		

This instrument has been processed and calibrated in accordance with the NovaStar Solutions Quality System Manual. All calibrations are traceable to the International System of Units (SI) through a National Metrology Institute (NMI) such as NIST, acceptable intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. The NovaStar Solutions quality system is accredited ISO/IEC 17025 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.

Where statements of compliance are made, the measurement uncertainty is not factored in unless otherwise noted. 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. If applicable, the data for this certificate can be found on the Report of Calibration for this UUT.

AS RECEIVED CONDITION:	In Tolerance	REMARKS:	N/A
AS RETURNED CONDITION:	In Tolerance		
ACTION TAKEN:	FULL CALIBRATION		

Standards Used

Asset #	Cert #	Description	Cal Date	Due Date
2222	2222:467350	550-050 - YUASA - ROTARY TABLE	08/19/2022	08/19/2027
4302	4302:572036	42280 - EXTECH - DATA LOGGER	11/27/2023	11/27/2024
4436	4436:555006	2' X 2' - UNKNOWN - GRADE A SURFACE PLATE	08/24/2023	08/24/2024

QA Signature: Michael Ford Date: 8/23/2024 11:42:01 AM

8/27/2024
SA

Standard Scale & Supply Co.
Serving Industry Since 1946

25421 Glendale Ave.
Redford MI 48239
Ph.: 313-255-6700
Fax: 313-255-6799
www.standardscale.com

Calibration Certificate-Revised 9/26/24

TEST NO: SS-09-24-6541-2 **TEST DATE:** 09-04-2024 **NEXT DUE:** September 2025 **PAGE 1 OF** 1

CALIBRATED FOR:
MGA Research
2839 Elliott Ave.
Troy, MI 48083

CALIBRATED BY:
Company: Standard Scale
Technician: JLB
Vehicle ID: 94

CONTACT: Scott Arsen **PHONE:** 248-577-5001 **FAX:**

ITEMS SERVICED: Intercomp SW500, S/N: 0128MA14010, ID: B, Capacity Per Platform: 700 kg X 0.5 kg, Div: 1400

ENVIRONMENTAL FACTORS : 75.5 F, 45% Humidity

TEST WEIGHT STANDARDS USED: Vehicle 94 test weights on file. Test report copies available upon request.

All calibrations are performed in compliance with the specifications set forth in procedure P-750 "Scale Calibration" using methods set forth therein, and also as recommended by the original equipment manufacturers. Calibration services were performed under a controlled Quality Assurance Program, which complies with ISO/IEC 17025:2017. All test weight standards in use for calibration are traceable through the National Institute of Standards and Technology (N.I.S.T) to the International System of Units (SI). Measurement of uncertainty presented at K=2@95% confidence level. Statement of conformity upon customer request. The results relate only to the items calibrated.

LINEAR CALIBRATION

(to establish proper and correct weighment)

Test Load	Weights Applied	AS FOUND	As Found Error (±)	AS LEFT	As Left Error (±)	HB44 Tolerance (±)	PASS/FAIL	
Zero Balance	0 kg	0.0 kg	0.0 kg	0.0 kg	0.0 kg	0.5 kg	PASS	FAIL
LEFT FRONT	SM #1 + 20 kg	111.0 kg	0.0 kg	111.0 kg	0.0 kg	0.5 kg	PASS	FAIL
Maximum Test Load	SM #2 + 20 kg	247.0 kg	0.0 kg	247.0 kg	0.0 kg	0.5 kg	PASS	FAIL
Test Load	Weights Applied	AS FOUND	As Found Error (±)	AS LEFT	As Left Error (±)	HB44 Tolerance (±)		
Zero Balance	0 kg	0.0 kg	0.0 kg	0.0 kg	0.0 kg	0.5 kg	PASS	FAIL
RIGHT FRONT	SM #1 + 20 kg	111.0 kg	0.0 kg	111.0 kg	0.0 kg	0.5 kg	PASS	FAIL
Maximum Test Load	SM #2 + 20 kg	247.5 kg	+ 0.5 kg	247.5 kg	+ 0.5 kg	0.5 kg	PASS	FAIL
Test Load	Weights Applied	AS FOUND	As Found Error (±)	AS LEFT	As Left Error (±)	HB44 Tolerance (±)		
Zero Balance	0 kg	0.0 kg	0.0 kg	0.0 kg	0.0 kg	0.5 kg	PASS	FAIL
LEFT REAR	SM #1 + 20 kg	111.0 kg	0.0 kg	111.0 kg	0.0 kg	0.5 kg	PASS	FAIL
Maximum Test Load	SM #2 + 20 kg	247.0 kg	0.0 kg	247.0 kg	0.0 kg	0.5 kg	PASS	FAIL
Test Load	Weights Applied	AS FOUND	As Found Error (±)	AS LEFT	As Left Error (±)	HB44 Tolerance (±)		
Zero Balance	0 kg	0.0 kg	0.0 kg	0.0 kg	0.0 kg	0.5 kg	PASS	FAIL
RIGHT REAR	SM #1 + 20 kg	111.0 kg	0.0 kg	111.0 kg	0.0 kg	0.5 kg	PASS	FAIL
Maximum Test Load	SM #2 + 20 kg	248.0 kg	+ 1.0 kg	247.0 kg	0.0 kg	0.5 kg	PASS	FAIL

NOTES: 200 lb in kg = 90.718 lb, Submass #1 / 91.0. 500 lb in kg = 226.796 lb, Submass #2 / 227.0. Highest test loads achieved using substitution test methods per N.I.S.T. Handbook 44 (certified weights combined with known mass)
Revised 9/26/24 to split into two separate certificates per customer request only.

Signed:

JLB
Calibrating Technician

Alexis Molnar-Ortiz
Approved Signatory

CC-006
Rev. Z
4-24-24

An ISO/IEC 17025:2017 Accredited Calibration Laboratory

PJLA Calibration
Accreditation #59180

NovaStar SOLUTIONS
Metrology Management Services

Calibration Certificate

ACCREDITED
Calibration #4277.01

35200 Plymouth Rd. / Livonia, MI 48150 / 734.453.6003

Certificate # Z250320:628966

OM-EL-WIFI-TH - OMEGA - TEMP/RH DATA LOGGER

SERIAL NUMBER:	N/A	WORK ORDER:	628966
ASSET NUMBER:	Z250320	TEST RESULT:	PASS
CUST ASSET NUMBER:	MI0340	PERFORMED ON:	08/05/24
PROCEDURE NAME:	HUMIDITY	CAL DUE DATE:	08/05/25
PROCEDURE REV:	1.0	DATA TYPE:	FOUND-LEFT
CALIBRATED BY:	James Johnson	TEMPERATURE:	23 °C
CUSTOMER:	MGA RESEARCH - OPERATIONS 2927 ELLIOTT DR TROY, MI 48083	HUMIDITY:	35 %
PRIMARY CONTACT:	Noel Riehl		

This instrument has been processed and calibrated in accordance with the NovaStar Solutions Quality System Manual. All calibrations are traceable to the International System of Units (SI) through a National Metrology Institute (NMI) such as NIST, acceptable intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. The NovaStar Solutions quality system is accredited ISO/IEC 17025 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.

Where statements of compliance are made, the measurement uncertainty is not factored in unless otherwise noted. 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).

AS RECEIVED CONDITION:	In Tolerance	REMARKS:	N/A
AS RETURNED CONDITION:	In Tolerance		
ACTION TAKEN:	FULL CALIBRATION		

Standards Used

Asset #	Cert #	Description	Cal Date	Due Date
1504	1504:555218	1502A - HART SCIENTIFIC - THERMOMETER READOUT	09/19/2023	09/19/2024
3038	3038:564124	5628 - FLUKE - PRT	10/16/2023	10/16/2024
4314	4314:583980	42280 - EXTECH - DATA LOGGER	01/24/2024	01/24/2025
4423	4423:598064	2500 - THUNDER SCIENTIFIC CORPORATION - HUMIDITY GENERATOR	03/21/2024	03/21/2025

QA Signature: Michael Jones Date: 8/6/2024 6:25:49 AM

8/9/2024
SA

Appendix B - Temperature Trace