2012 Mitsubishi i-MiEV

Advanced Vehicle Testing – Baseline Testing Results

VEHICLE SPECIFICATIONS[1]

Vehicle Features
VIN: JA3215H11CU033178
Trim Level: SE
Class: Subcompact Car
Seatbelt Positions: 4
Type: BEV
CARB[2]: Type I.5 ZEV
EPA Fuel Economy: 270 Wh/mi, 126 MPGe/340 Wh/mi, 99 MPGe/300 Wh/mi, 112 MPGe (City/Highway/Combined)
EPA Range: 62 miles

Motor
Model: Y51 Electric Motor
Type: Permanent Magnet AC Synchronous
Maximum Power: 49 kW
Maximum Torque: 196 Nm
Cooling: Active – Liquid Cooling

Transmission
Type: Automatic Fixed Gear
Final Drive Ratio: 7.065

Battery
Manufacturer: Lithium Energy Japan
Type: Lithium-Ion (LMO)
Cathode /Anode Material: Lithium-Manganese Dioxide / Carbon
Number of Cells: 88
Cell Config.: Series
Nominal Cell Voltage: 3.7 V
Nominal System Voltage: 330 V
Rated Pack Capacity: 50 Ah
Rated Pack Energy: 16 kWh
Weight of Pack: 500 lb
Pack Location: Underneath Passenger Floor Pan
Cooling: Active – Liquid Cooling

Weights
Design Curb Weight: 2,579 lb
Delivered Curb Weight: 2,574 lb
Distribution F/R (%): 45/55
GVWR: 3,329 lb
GAWR F/R: 1,488/1,962 lb
Maximum Payload: 750 lb

Dimensions
Wheelbase: 100.39 in
Track F/R: 51.57 / 50.00 in
Length/Width: 136.81 / 58.07 in
Height: 63.38 in
Ground Clearance: 5.5 in

Tires
Manufacturer: Dunlop
Model: EnSave 01 A/S
Size: Front: 145/65 R15
Rear: 175/60 R15
Pressure F/R: 36/36 psi
Spare Installed: Sealant and Inflator

PERFORMANCE STATISTICS[3]

TRACK TESTING[4]

Acceleration 0-60 mph[5]

Measured Time: 14.9 s

Performance Goal: ≤13.5 s

Peak Power from Battery: 53.4 kW

Maximum Speed

At ¼ Mile: 69.0 mph

At 1 Mile[6]: 83.3 mph

Performance Goal: ≥90 mph at 1-mile mark

Braking at 50% SOC from 60-0 mph[7]

Measured Time: 3.1s

Distance: 120.5 ft

Peak Power into Battery: 44.3 kW

Braking at 100% SOC from 60-0 mph[7]

Measured Time: 3.2 s

Distance: 124.8 ft

Peak Power into Battery: 43.5 kW

Deceleration 60-10 mph[8]

Measured Time: 42.1 s

Distance: 1896.4 ft

Peak Power into Battery: 15.6 kW

Total Energy into Battery: 78.0 Wh

DYNAMOMETER TESTING[9]

Cycle Results[10]

	72 °F	20 °F	95 °F + 850 W/m^2
UDDS (Cold Start)	212.3 Wh/mi	489.1 Wh/mi	260.9 Wh/mi
UDDS	205.0 Wh/mi	460.3 Wh/mi	230.2 Wh/mi
HWFET	243.0 Wh/mi	379.9 Wh/mi	251.4 Wh/mi
US06	341.2 Wh/mi	485.8 Wh/mi	346.3 Wh/mi
SC03	N/A	N/A	253.9 Wh/mi

City Range	83.8 miles	US06 Range	43.5 miles
Highway Range	61.3 miles		

Energy Consumption at Steady-State Speed, 0% Grade

10 mph	109.0 Wh/mi	50 mph	238.9 Wh/mi
20 mph	124.0 Wh/mi	60 mph	296.2 Wh/mi
30 mph	156.8 Wh/mi	70 mph	348.8 Wh/mi
40 mph	191.7 Wh/mi	80 mph	415.4 Wh/mi

Duration of Passing Maneuver at Grade[11]

	0% Grade	6% Grade
35-55 mph	6.7 s	11.5 s
55-65 mph	5.1 s	14.2 s
35-70 mph	14.8 s	43.1 s
55-80 mph	17.8 s	N/A

Maximum Speed at 25% Grade from Stop: 29.2 mph

NOTES (also from previous page):

1. Vehicle specifications were supplied by the manufacturer, measured, or derived from a literature review.
2. The vehicle was classified as a Type I.5 ZEV by the California Air Resources Board (CARB) because its range on the UDDS is less than 100 miles (but greater than 75).
3. Performance numbers based on "Normal" vehicle mode. Performance numbers are averages from multiple tests.
4. Vehicle track testing occurs when the vehicle has achieved its "break-in mileage" of between 4,000 to 6,000 miles, and at the delivered curb weight plus 332 ± 10 lb (including driver and test equipment), distributed in a manner similar to the original curb loading of the vehicle. Track testing took place between August 27 and August 30, 2013 with a beginning vehicle odometer reading of 4,080 miles; the constant-speed range test (results on next page) took place between January 24 and January 28, 2014 with a beginning vehicle odometer reading of 4,414 miles. The ambient temperatures ranged from 80 °F to 93 °F for the August tests. No accessories were used except for headlights as required by track regulation.
5. The acceleration is measured from the point at which the vehicle begins to move. The acceleration and maximum speed results were averaged from 12 runs. The peak power value was taken from a single run.
6. The maximum speed was reached before the one-mile mark.
7. Controlled braking on dry surface. Brake testing was performed when the battery was at 50% state of charge (SOC) and also at 100% SOC. The peak power into the battery value was taken from a single run.
8. Coasting in drive on dry surface. Test run data were cut off when the vehicle reached 10 mph, as vehicle creep speeds are typically below this threshold. The peak power into the battery value and total energy into the battery value were both taken from a single (but different) run.
9. Dynamometer testing occurs after the track testing is complete. Dynamometer testing began on February 14, 2014, with the vehicle odometer reading 5,486 miles. A comprehensive explanation of the dynamometer facility and methodology can be found at http://www.transportation.anl.gov/D3/, titled "Chassis Dynamometer Testing Reference Document". The ABC coefficients derived from track coastdown testing and matched on the dynamometer were A: 21.2964 lb, B: 0.5960 lb/mph, and C: 0.0129 lb/mph^2. All electrical consumption values are given in AC Wh/mi.
10. The Cycle Results table presents the fuel economy achieved by the vehicle on five EPA drive cycles at three different ambient temperatures: (1) 72 °F with vehicle climate-control off, (2) 20 °F with vehicle climate-control set to 72°F Auto, and (3) 95 °F with vehicle climate-control set to 72°F Auto. The vehicle is also subjected to 850 W/m^2 of solar load at 95 °F to simulate direct sunlight. The drive cycles include a hot start unless otherwise indicated. The ranges are calculated using SAE J1634.
11. The passing maneuver value indicates the amount of time required for the vehicle to transition from the first to the second speed, at the specified grade.

Values in red indicate that the EV America Performance Goal was not met.

CONSTANT-SPEED RANGE AND CHARGE TESTING[1]

	45 mph Test[2]	60 mph Test[3]	70 mph Test[4]
Average DC power out of battery at set speed (kW):	8.7	15.8	25.3
(A) DC energy out of battery at set speed (kWh)[5,7,9]:	13.3	13.2	12.8
(A+) Total DC energy out of battery (kWh)[5,7,9]:	13.5	13.5	13.3
Battery capacity discharge at set speed (Ah):	39.7	39.9	39.4
(B) Range at set speed (mi)[6,8,10]:	69.7	50.6	35.6
(C) Post-test charge AC energy from EVSE @ 240 V to onboard charger (kWh):	17.1	17.0	16.9
(D) Post-test charge DC energy into battery from onboard charger (kWh):	15.0	14.9	14.9
Post-test charge duration (HH:MM):	06:21	06:30	06:28
AC electricity consumption rate (Wh/mi)[11]:	242	330	456
DC electricity consumption rate (Wh/mi)[12]:	191	261	360
(A+/D) Battery Roundtrip Efficiency[13]:	90%	91%	89%
(D/C) On-Board Charger Efficiency[14]:	88%	88%	88%
(A+/C) Overall Trip Efficiency[15]:	79%	79%	79%

NOTES:

1. See Note 3 and Note 4 on page 2. The vehicle is accelerated to the desired speed and then cruise control is used to maintain the speed. Range is considered reached when the vehicle is no longer capable of maintaining a speed that is 2 mph lower than the set speed.
2. During the 45 mph range test, the maximum battery temperature was 23 °C and the average ambient temperature was 10 °C. During the post-test charge, the maximum battery temperature was 23 °C, and the average ambient temperature was 20 °C.
3. During the 60 mph range test, the maximum battery temperature was 24 °C and the average ambient temperature was 21 °C. During the post-test charge, the maximum battery temperature was 29 °C, and the average ambient temperature was 22 °C.
4. During the 70 mph range test, the maximum battery temperature was 24 °C and the average ambient temperature was 12 °C. During the post-test charge, the maximum battery temperature was 29 °C, and the average ambient temperature was 18 °C.
5. In addition to the energy discharged from the battery during the 45 mph test, energy was discharged during the drive from test prep area to point at which vehicle test speed is achieved and maintained. After the range at 45 mph was completed, there is still ESS energy throughput during the drive to return the vehicle to the test prep area and the EVSE unit for the post-test charge. The pre-test drive required 0.21 kWh while the post-test drive required no net energy throughput, and these energy inputs can be added to the energy consumed during the range test **(A)** to obtain the total output from the battery (13.5 kWh, denoted as **(A+)**) that is used in the calculations discussed in Notes 13-15.
6. In addition to the range measured for the 45 mph test, the pre-test drive required 0.77 miles from test prep area to point at which vehicle test speed is achieved and maintained. After the range at 45 mph was completed, the post-test drive required an additional drive of 0.11 miles to return to the test prep area and the EVSE unit for the post-test charge. These distances can be added to the distance traveled during the range test **(B)** to obtain the total distance traveled (70.6 miles). However, the energy consumption values consider only the distance traveled during the test itself, or value **(B)**.
7. In addition to the energy discharged from the battery during the 60 mph test, energy was discharged during the drive from test prep area to point at which vehicle test speed is achieved and maintained. After the range at 45 mph was completed, the vehicle is in CS mode, but there is still ESS energy throughput during the drive to return the vehicle to the test prep area and the EVSE unit for the post-test charge. The pre-test drive required 0.30 kWh while the post-test drive required 0.02 kWh, and these energy inputs can be added to the energy consumed during the range test **(A)** to obtain the total output from the battery (7 kWh, denoted as **(A+)**) that is used in the calculations discussed in Notes 13-15.
8. In addition to the range measured for the 60 mph test, the pre-test drive required 0.98 miles from test prep area to point at which vehicle test speed is achieved and maintained. After the range at 60 mph was completed, the post-test drive required an additional drive of 0.31 miles to return to the test prep area and the EVSE unit for the post-test charge. These distances can be added to the distance traveled during the range test **(B)** to obtain the total distance traveled (51.9 miles). However, the energy consumption values consider only the distance traveled during the test itself, or value **(B)**.
9. In addition to the energy discharged from the battery during the 70 mph test, energy was discharged during the drive from test prep area to point at which vehicle test speed is achieved and maintained. After the range at 70 mph was completed, there is still ESS energy throughput during the drive to return the vehicle to the test prep area and the EVSE unit for the post-test charge. The pre-test drive required 0.43 kWh while the post-test drive required 0.03 kWh, and these energy inputs can be added to the energy consumed during the range test **(A)** to obtain the total output from the battery (13.3 kWh, denoted as **(A+)**) that is used in the calculations discussed in Notes 13-15.
10. In addition to the range measured for the 70 mph test, the pre-test drive required 1.1 miles from test prep area to point at which vehicle test speed is achieved and maintained. After the range at 70 mph was completed, the post-test drive required an additional drive of 1.1 miles to return to the test prep area and the EVSE unit for the post-test charge. These distances can be added to the distance traveled during the range test **(B)** to obtain the total distance traveled (37.8 miles). However, the energy consumption values consider only the distance traveled during the test itself, or value **(B)**.
11. The AC electricity consumption rate is calculated by dividing the DC electricity consumption rate (in Wh/mi) by the Overall Trip Efficiency for that particular set speed.
12. The DC electricity consumption rate is calculated by dividing the DC energy from the battery at set speed **(A)** by the range at set speed **(B)**.
13. Battery Roundtrip Efficiency is calculated by dividing the DC energy out of the battery **(A+)** by the DC energy from the on-board charger into the battery **(D).**
14. On-Board Charger Efficiency is calculated by dividing the DC energy from the on-board charger into the battery **(D)** by the AC energy from the EVSE **(C).**
15. Overall Vehicle Efficiency is calculated by dividing the DC energy out of the battery **(A+)** by the AC energy from the EVSE **(C)**.

As a production vehicle, this vehicle is assumed to meet all Federal Motor Vehicle Safety Standards (FMVSS) for Battery Electric Vehicles.

This information was prepared with the support of the U.S. Department of Energy (DOE) under Award No. DE-EE0005501. However, any opinions, findings, conclusions or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the DOE.