

2014 Fiat Chrysler HFE 845RE Transmission – NCAT Test Report

**NCAT – National Center for Advanced Technology**

*National Vehicle and Fuel Emissions Laboratory* – *Office of Transportation and Air Quality*

*U.S. Environmental Protection Agency*

**SUGGESTED CITATION:** *2014 FCA HFE 845RE Transmission Mapping – Test Data Package*. Version 2019-04. Ann Arbor, MI: US EPA, National Vehicle and Fuel Emissions Laboratory, National Center for Advanced Technology, 2019.

April 9, 2019

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Version: 04-09-19

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# Purpose of Test

The purpose of this testing is to characterize the performance of a 2014 Fiat Chrysler HFE 845RE transmission and to generate efficiency and spin loss data that may be used in the ALPHA (Advanced Light-Duty Powertrain & Hybrid Analysis) model.

# Test Article

The transmission used in this project was an 845RE RWD 8-speed automatic transmission removed from a 2014 Ram 1500 HFE Regular Cab 4X2, VIN 3C6JR6RG5EG220807.

# Test Methodology

EPA contracted FEV engine technologies under EPA contract EP-C-12-014 to complete benchmarking of the 845RE transmission. The benchmarking activities encompassed the following areas:

* Perform a 4,000 mile vehicle break-in following the manufacturer’s recommendations over a combination of city and highway driving.
* Evaluate transmission control strategy in the vehicle and determine main line pressures for later bench testing.
* Conduct spin loss testing on a transmission test stand.
* Conduct loaded efficiency testing on a transmission test stand.
* Conduct neutral coast down loss testing on a transmission test stand, matching conditions observed in the vehicle.
* Measure transmission inertia on the test stand.
* Measure sensitivity to oil pressure changes.
* Measure transmission oil pump efficiency.
* Measure torque converter efficiency.

In-vehicle testing was performed using the 2014 Ram 1500 HFE Regular Cab 4X2 with the original Transmission Control Module (TCM) as installed from the manufacturer with the production calibration. The shift solenoids were instrumented to collect solenoid actuation logic for each gear and during neutral coast downs. In addition, a pressure transducer was installed in the oil pump outlet; the actual pressures recorded are given in the accompanying file *4b- 2014 FCA HFE 845RE Line Pressure Map (FEV) – Test Data.xlsx*.

The remainder of the testing was performed in a dedicated transmission test stand as shown below in Figure 1. This testing was performed without the TCM to not be limited to hard-coded range of operation. The line pressures recorded during in-vehicle testing were slightly smoothed and extrapolated as needed to produce a final line pressure map, given on page 10 of the accompanying presentation authored by FEV, *3b- 2014 FCA HFE 845RE Final Transmission Benchmark Presentation by FEV.pdf*. Unless otherwise noted, all transmission stand testing was performed using these hydraulic line pressures.

Further information on the test setup and test methodology, as well as summary results for all the testing, are detailed in the presentation authored by FEV, *3b- 2014 FCA HFE 845RE Final Transmission Benchmark Presentation by FEV.pdf*.



**Figure 1: 845RE Mounted in FEV’s Test Stand**

# Data Set

The data obtained by FEV are given in the following data files accompanying this document:

* *4a- 2014 FCA HFE 845RE Input and Output Driven Inertia (FEV) – Test Data.xlsx:* inertia study comparing both input and out driven inertia.
* *4b- 2014 FCA HFE 845RE Line Pressure Map (FEV) – Test Data.xlsx*: transmission hydraulic line pressure in each gear as a function of speed and load. The data were taken with the transmission installed in the Ram 1500 with the production TCM.
* *4c- 2014 FCA HFE 845RE Loaded Efficiency (FEV) – Test Data.xlsx*: transmission efficiency in each gear as a function of input speed and input load. Data are taken at three different temperatures: 35 °C, 60 °C, and 100 °C*.* The hydraulic line pressures applied matched those measured in the vehicle.
* *4d- 2014 FCA HFE 845RE Neutral Coast Down (FEV) – Test Data.xlsx:* torque required to back-drive the transmission with the transmission in neutral, mimicking drag during a coast down.
* *4e- 2014 FCA HFE 845RE Oil Pump Efficiency (FEV) – Test Data.xlsx:* transmission oil pump efficiency and leakage as a function of speed, recorded at three different temperatures (35 °C, 60 °C, and 100 °C) and three different pressures (5.2 bar, 8.0 bar, and 11.5 bar).
* *4f- 2014 FCA HFE 845RE On-Road Coast Downs 50mph (FEV) – Test Data.xlsx:* vehicle speed and shift events recorded during a coast down in the Ram 1500, in both neutral and drive. Data were used to calibrate neutral coast down testing on the test stand.
* *4g- 2014 FCA HFE 845RE Spin-Loss and Inertia (FEV) – Test Data.xlsx:* input torque required to spin the transmission in each gear, as a function of speed, at three different temperatures (35 °C, 60 °C, and 100 °C). Data from two additional tests which rely on the base spin loss data for final calculations are also included: (a) transmission acceleration testing used to calculate transmission inertia in each gear; and (b) testing with different line pressure used to determine the sensitivity of spin losses to changes in line pressure.
* *4h- 2014 FCA HFE 845RE Torque Converter Efficiency (FEV) – Test Data.xlsx:* torque converter torque ratio and K factor as a function of speed ratio for a range of testable conditions. The data were extrapolated to provide calculated values for untestable points (see note on page 88 of the accompanying presentation, *3b- 2014 FCA HFE 845RE Final Transmission Benchmark Presentation by FEV.pdf)*.

# Results

A summary of the results is provided in FEV’s final report, *3b- 2014 FCA HFE 845RE Final Transmission Benchmark Presentation by FEV.pdf*.

# Discussion and Data Usage

In general, the transmission data produced in this testing are robust and can be used for any purpose. The benchmarking results from this testing were provided to the ALPHA model to perform full vehicle simulations over several drive cycles and vehicle road loads. Additional details pertaining to this modeling and the results obtained are described in the attached SAE paper *SAE 2016-01-1142 Investigating the Effect of Advanced Automatic Transmissions.pdf.* [1]

# References

[1] Moskalik, A., Hula, A., Barba, D., and Kargul, J., "Investigating the Effect of Advanced Automatic Transmissions on Fuel Consumption Using Vehicle Testing and Modeling," *SAE Int. J. Engines* 9(3):2016, doi:10.4271/2016-01-1142.