SAE J2908:
Hybrid System Power Rating

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### SAE J2908 Timing, Milestones

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<th>Task</th>
<th>2014</th>
<th>2015</th>
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<tr>
<td>Recruit committee, define scope</td>
<td>Q1</td>
<td>Q2</td>
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<tr>
<td>Chair Monthly SAE J2908 meeting</td>
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<td>Analyze Existing Data</td>
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<td>Run New Tests on Chassis Dyno</td>
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<td>Receive rented Hub Dyno</td>
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<td>Run Tests for Hub Dyno</td>
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<td>Decide on best practices</td>
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<td>Draft document</td>
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<tr>
<td>Send J2908 to Ballot</td>
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2014 | 2015
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N | D | J | F | M | A | M | J | J | A | S | O
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Q1 | Q2 | Q3 | Q4

*(Now)*
J2908 Must Satisfy a Challenging List of Objectives

1. Describe **Hybrid System Power** in clear, unambiguous terms
2. Avoid **creative interpretation** of procedure → “horsepower wars”
3. If we use **wheel power**, what about current **Engine Flywheel power**?
   - The same “200 HP” car could rate at “162 System HP”
4. Avoid requirement to buy **expensive new dynamometer equipment**
5. Target the needs and perspectives of **both audiences**:
   - Consumers
   - Vehicle Systems Engineers
6. Provide a procedure **robust** enough to succeed in any powertrain configuration
   - Power-split, series, step transmission, belt CVT, mild HEV, full PHEV, (even BEV?)
Two System Power Approaches

A. Nominal System Power Rating
   - Based upon component-level power(s)
   - Similar to current engine power rating, “Catalog Rating”

B. System Power Test
   - Based upon dyno test
   - Verifiable test for engineers to communicate power levels
Additional Hybrid System Metrics in J2908

Ratings Will Provide Common Data Benchmarks

1. Electric Assist
   - How much electric power assist is given during maximum total power?
   - Provides an input needed for **Nominal System Power Rating**

2. Electric-only Drive Power (mostly for PHEVs)
   - Maximum electric traction power assist in “EV Mode”

3. Regen Power
   - Maximum electric power going to battery during braking
A. Nominal System Power Rating

- This approach parallels current engine power ratings
  - Rating look at sum of “upstream” component power
  - Powertrain losses downstream of the engine do not diminish peak power.

- Current OEM catalog ratings use this approach. However:
  - There are no rules or standards in how, or in what condition ratings are given.
  - Added components not consistent: Motor + Engine? Battery + Motor?
  - Claims can not be traced back to standard test for validation

- 2015 Dodge Challenger Hellcat
  Engine: 707 HP

- 2015 Ford Focus
  Engine: 123 HP

- 2010 Toyota Prius
  Engine: 98 HP
  Motor: 80 HP
  Battery: 36 HP
  System Net: 134 HP
  Photo: Argonne
  Specs: “Toyota Prius Product Information”

- 2011 Sonata HEV
  Engine: 166 HP
  Motor: 40 HP
  System Net: 206 HP
  Photo: Argonne

2015 DOE AMR, June 9, 2015
Progress on Defining A. Nominal Rating

Engine Power + Electric Power = Hybrid System Power

Results from B. System Power Test

Peak Engine Power

Peak Electric Power Data

(goal is to agree with JARI/ISO method)
B. System Power Test

- Only valid approach to measure net power is at wheel/hub
  - HEV configurations are too varied
  - Unique system controls regulate component powers for each configuration

- Either Chassis or Hub dyno for test
  - Many labs already own chassis dynamometer
  - **Chassis dynamometer** could limit wheel torque in some tests
  - **Hub dynamometer** allows high torque and less expensive for new installations
System Power Test Hardware

Chassis Dyno
Using axle torque sensors to directly measure powertrain power

Hub Dyno
Using two hub dynos to directly measure powertrain power
*very small losses in wheel bearings*
Several Vehicles in Validation Study at Argonne

- Tested on both Hub and Chassis dynos
- HEVs (power-split, step transmission, mild HEV CVT), Conventional, BEV
- All vehicle have axle torque sensors for chassis dyno testing

Sonata HEV  Prius HEV  Volt PHEV  Accord PHEV

Gen 2 Insight HEV  Fusion Conventional  Focus BEV
Findings Are Ensuring Test Works for All HEV Types

- Peak battery power not always during peak total power
- Fixed speed test fails with step transmissions
- Peak battery power ≠ peak electric assist (lost power in engine spool-up)
- New Terminal Velocity test method invented - very promising

Acceleration test with zero inertia and F0, F1, F2 road load adjusted to match peak power with MPH
Additional Tests for J2908 Accomplishments

Developed test cycle for finding Regen Power

Successful Fixed-Speed EV Drive Power Procedure

Photo: Argonne  Photo: Argonne  Photo: Argonne