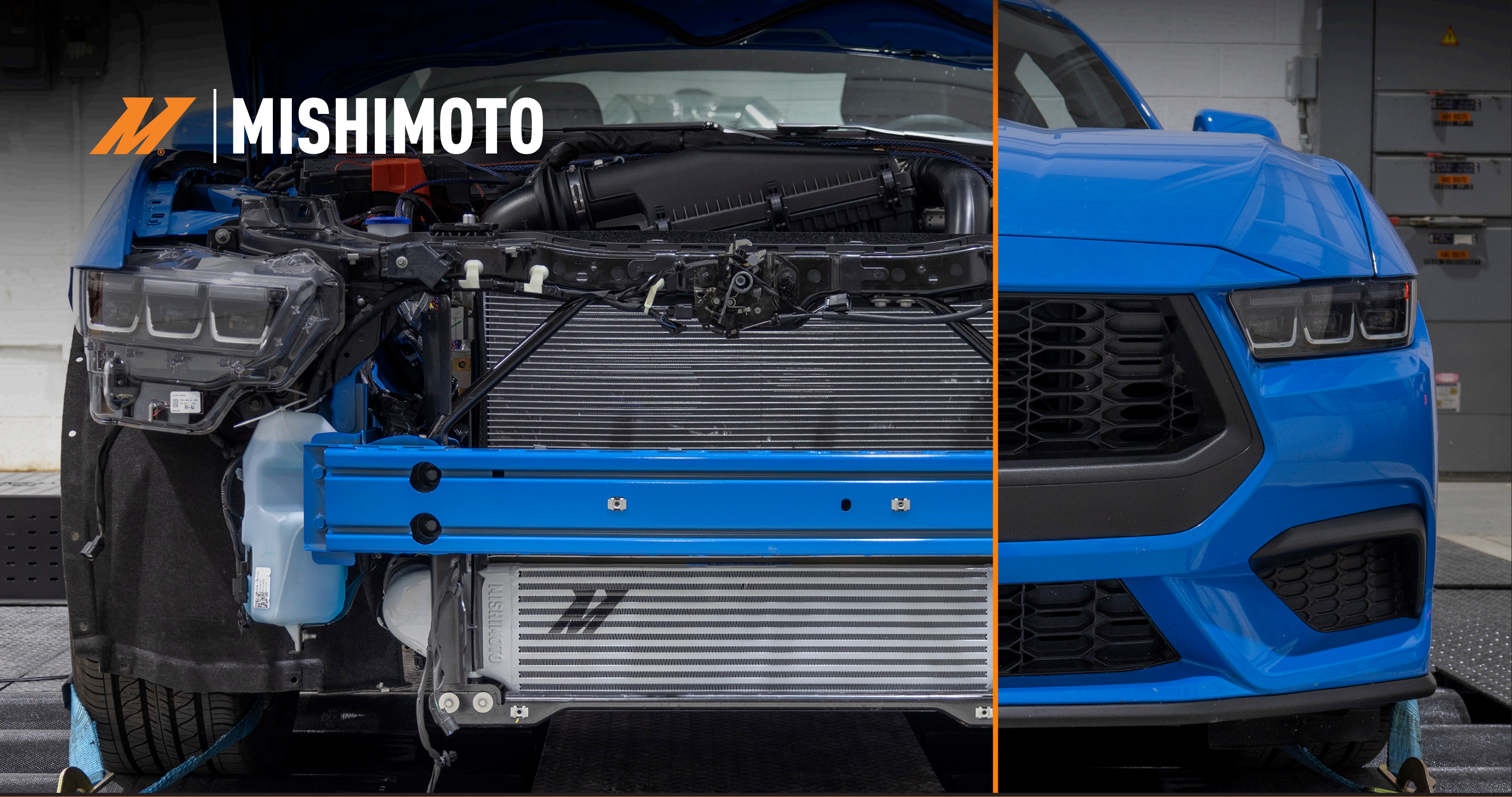

ENGINEERING REPORT

2024+ Ford Mustang 2.3L EcoBoost Performance Intercooler | SKU: MMINT-MUS4-24

By: Ye Liu, *Mishimoto Product Engineer*

REPORT AT A GLANCE

- **Goal:** Create a direct-fit intercooler that outperforms stock intercooler and is compatible with stock and Mishimoto intercooler piping.

- **Results:** During a speed ramp test from 30 mph to 100 mph, the Mishimoto intercooler delivered an 11 hp and 12 ft-lb increase over the stock intercooler while reducing peak charged-air temperatures at the outlet by 60°F. In heat soak tests, the Mishimoto intercooler maintained 48% efficiency under the highest inlet temperatures, compared to the stock intercooler's 24%. The enhanced cooling capability increased charged-air density by up to 56%.

- **Conclusion:** The Mishimoto intercooler is a well-rounded upgrade for 2.3L EcoBoost Mustang owners seeking improved power and charged air cooling performance.

CONTENTS

DESIGN OBJECTIVES

- Create an intercooler that outperforms the stock in power, torque, and charged-air temperature reduction.
- Ensure direct-fit installation with minimal modifications.
- Utilize a bar-and-plate style core for maximum thermal performance and robustness.
- Compatible with both stock and Mishimoto intercooler piping.
- Integrate air diverter plate inside the end tank for optimum airflow.

DESIGN AND FITMENT

After analyzing available space, we designed a core approximately 23 x 5.8 x 3.5 inches, offering a 60% increase in core volume. This provides substantial cooling improvements without requiring permanent modifications or the removal of stock components.

In contrast to the tube-and-fin style core commonly used on stock intercoolers, the Mishimoto intercooler core uses the bar-and-plate design. With this construction, solid aluminum bars and plates stack together to form the internal and external air passages instead of thin extruded aluminum tubes. Bar-and-plate cores can support much higher boost pressure and are much less susceptible to damage caused by road debris or deterioration from long-term heat cycles. Additionally, this design allows greater flexibility in core dimensions and fin configurations for optimal performance, whereas tube-and-fin core designs are constrained by the limited tube sizes available for manufacturing.

The stock intercooler is mounted to the end tanks of the radiator through 4x plastic clips. With the increased weight of the bar-and-plate core, we decided to completely de-couple the Mishimoto intercooler from the stock radiator for the best mounting rigidity and reliability. The Mishimoto intercooler is independently mounted to the subframe using 4x EPDM rubber sandwich mounts, providing secure attachment and vibration isolation.

The Mishimoto intercooler also incorporated internal air diverter plates inside the hot side end tank. The diverter plate reduces air turbulence, which can lead to pressure loss, and helps to evenly guide charged air across the intercooler core to improve cooling performance.

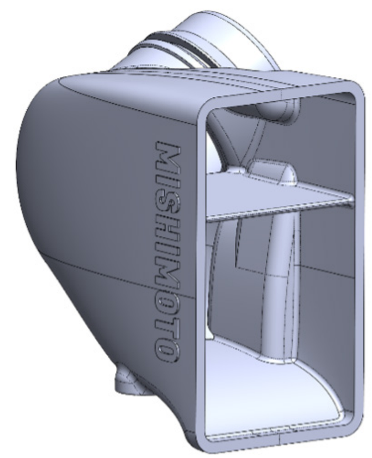

Figure 1: *Mishimoto intercooler hot side endtank internal air diverter*

Figure 2: *Mishimoto intercooler production sample installed*

PERFORMANCE TESTING

Extensive dyno tests are conducted in-house on our Mustang dynamometer. We use the AEM AQ-1 data acquisition system to gather data from two temperature sensors and four pressure sensors installed on the intercooler system. We also monitor all relevant OBD-II channels to ensure reliable and consistent results.

A unique challenge we encountered on the dyno was the transmission. Our R&D vehicle is a non-Performance Package model with a 10-speed automatic transmission. This means that we cannot control the gear selection or prevent downshifting during a pull on a loaded roller dyno. So, instead of a traditional RPM sweep in a set gear, we performed a speed sweep test where the dyno is set to ramp up speed from 30mph to 100mph in a set amount of time. We confirmed that the shift points are consistent through multiple runs by carefully monitoring the engine RPM, wheel speed, and ramp time. This test method allowed us to gather reliable and consistent data without setting the vehicle to a single gear.

Once the vehicle was warmed to operating temperatures, we performed heat soak tests on the stock and Mishimoto intercoolers. An intercooler heat soak test is used to evaluate an intercooler's thermal performance and efficiency under conditions that simulate prolonged exposure to high temperatures. This test is vital for understanding how well an intercooler can dissipate heat and maintain optimal engine performance, especially under continuous heavy load or high ambient temperature conditions.

We conducted three consecutive 30-100 mph speed sweep runs without allowing the system to fully cool down to evaluate thermal performance under sustained high-temperature conditions. During the first run, the Mishimoto intercooler reduced outlet temperatures by 60°F compared to the stock unit, resulting in an immediate 11 hp and 12 ft-lb gain. By the third run, the stock intercooler exhibited significant power loss due to heat soak, while the Mishimoto intercooler maintained superior performance, culminating in a 45 hp and 42 ft-lb advantage. Dyno results are presented in Figures 4 and 5.

Next, with data gathered during heat soak testing, we plotted intercooler efficiency and charged air density chart to understand the intercooler performance better. Intercooler efficiency is a measure of how effectively an intercooler cools the air passing through it. It is defined as the ratio of the actual temperature drop achieved by the intercooler to the maximum possible temperature drop.

$$\varepsilon = \frac{T_{in} - T_{out}}{T_{in} - T_{ambient}}$$

This metric accounts for variations in inlet and ambient temperatures, offering a clear view of cooling performance. Plotting efficiency over time also provides a more intuitive picture of how the cooling performance drops once the heat soak process begins. It can be observed from Figure 6 that the Mishimoto intercooler system demonstrated higher efficiency consistently, never dropped below the starting point, and maintained a 48% efficiency at the highest inlet temperature, where the stock intercooler efficiency dropped to 24% when the thermal load became too great.

Charged air density is another intuitive index to measure the intercooler system's ability to cool charged air, which directly translates to engine performance. Everything else being equal, the denser the air, the more oxygen is delivered to the combustion chamber to burn, which means the engine can produce more power. Charged air density is calculated with existing temperature and pressure data at the turbo outlet and intake elbow, and the percentage change across the intercooler system is plotted in Figure 7. With the inlet air density being the same, the Mishimoto intercooler showed a 56% increase in charged air density.

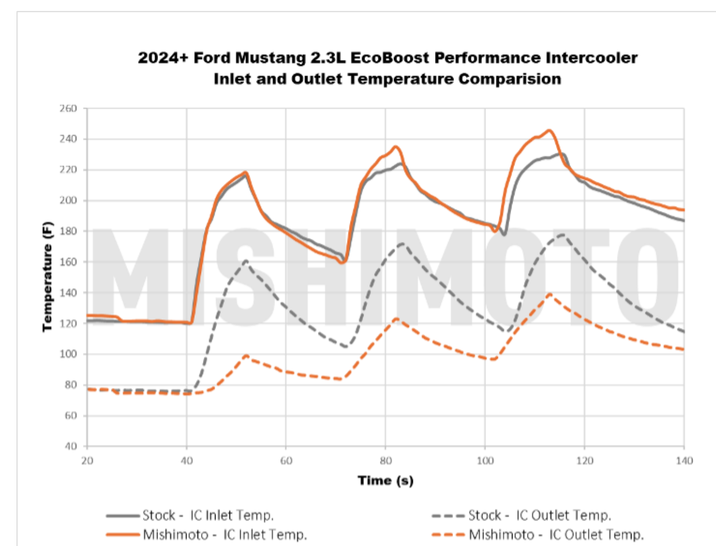

Figure 3: *Heat soak test inlet and outlet temperature comparison*

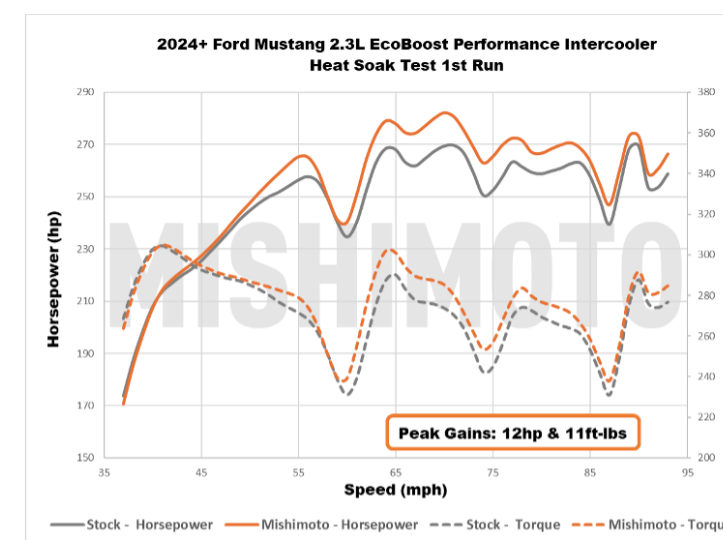

Figure 4: *Heat soak test 1st run*

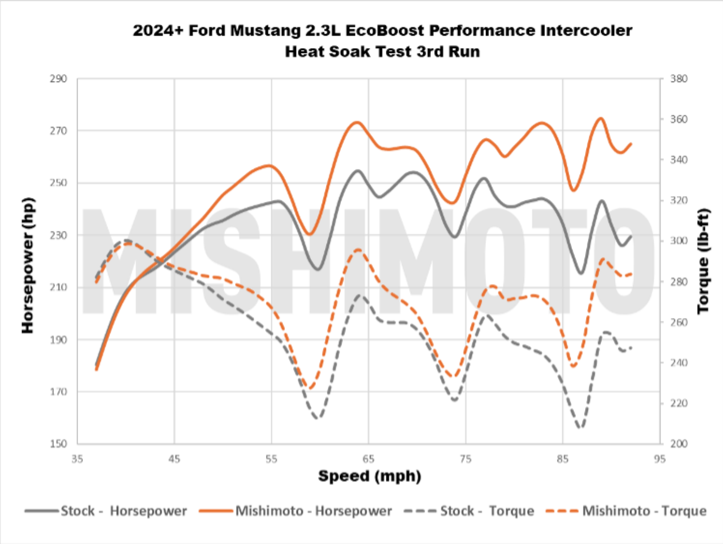

Figure 5: *Heat soak test 3rd run*

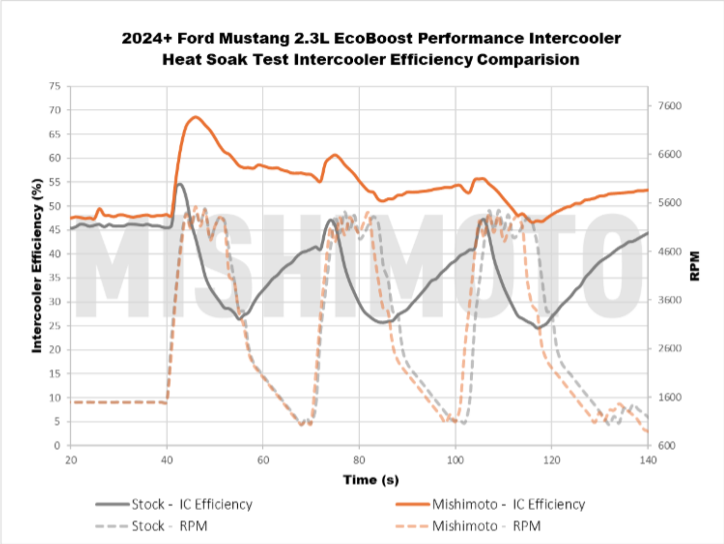

Figure 6: *Heat soak test intercooler efficiency comparison*

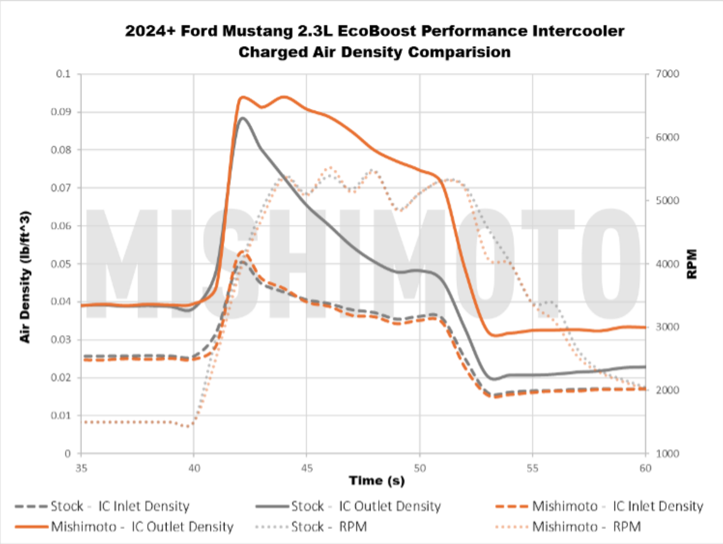

Figure 7: *Charged air density comparison (heat soak test 1st run)*

INSTALLATION NOTES

This intercooler can be installed on the 2024+ Ford Mustang 2.3L EcoBoost without any permanent modification.

TESTING DONE BY:

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Mishimoto is very active on social media so we can be in constant contact with our customers. Our Social Media Team is available via Facebook, Instagram, Youtube, our Engineering Blog, and forums. We sponsor contests and promotional events, so be sure to follow us.

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