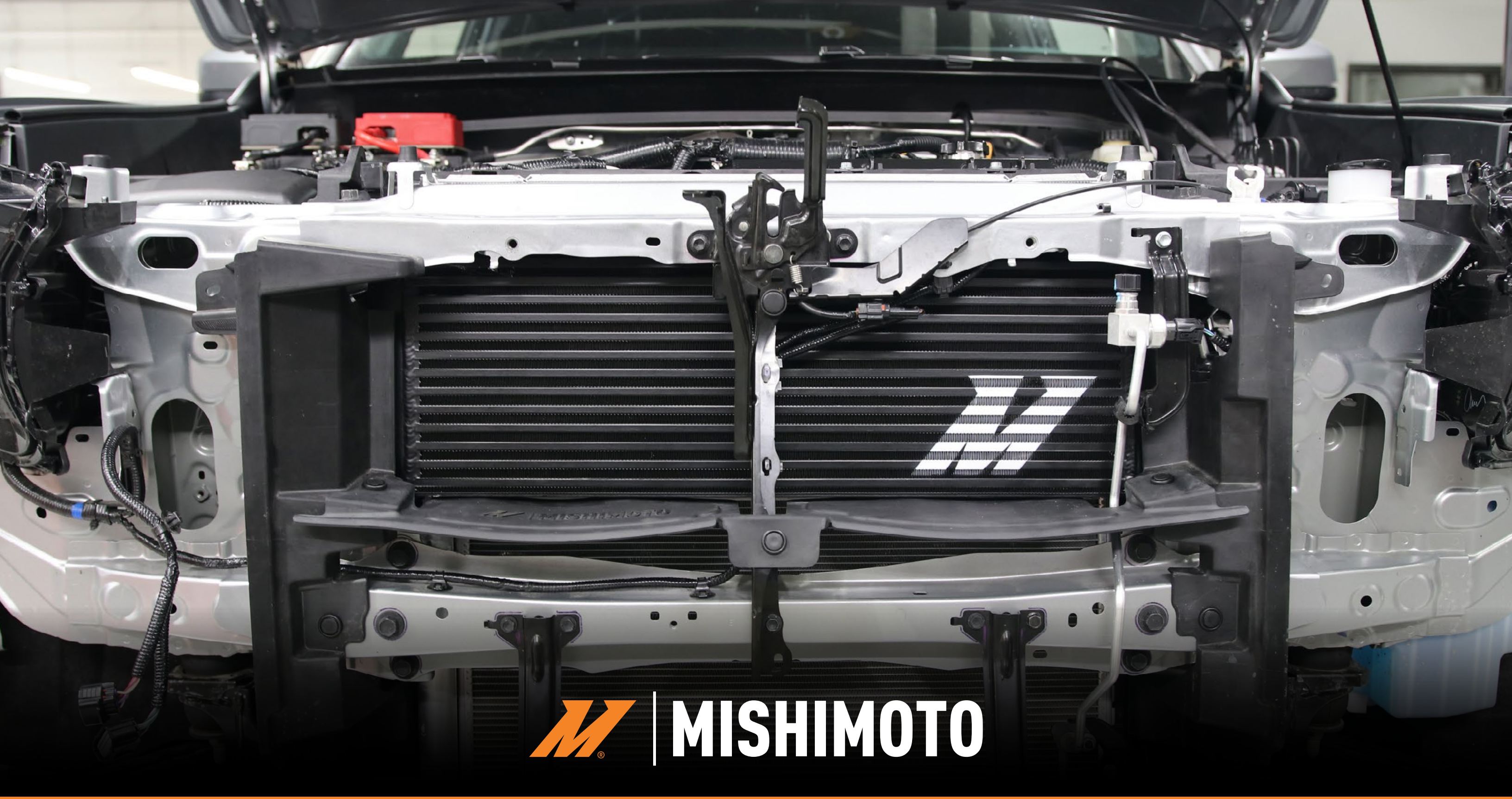


ENGINEERING REPORT

Performance Intercooler for the 2024+ Toyota Tacoma | SKU: MMINT-TAC-24

By: Mishimoto Engineering

REPORT AT A GLANCE

- **Goal:** To create a direct-fit performance intercooler that outperforms the stock intercooler for better flow, charge air temperatures, power and torque.
- **Results:** The Mishimoto performance intercooler dropped peak charge air temperatures by 12°F while decreasing pressure drop through the core while maintaining a peak efficiency of over 97% all the way to redline. Combined with the Mishimoto charge pipes, the intercooler increases the peak horsepower and torque by 2hp and 3ft-lbs respectively while greatly reducing turbo response times due to lower pressure drop.
- **Conclusion:** The Mishimoto direct-fit performance intercooler is a great upgrade for those who want to push the limits of their Toyota Tacoma truck and will perform consistently with whatever you can throw at it.

CONTENTS

DESIGN OBJECTIVES

- Create a direct-fit intercooler for the 2024+ Toyota Tacoma
- The intercooler should be the largest possible size that can fit with all other stock components
- Fits with Stock and Mishimoto intercooler pipes
- Measurable HP gains and/or decrease of air intake temps vs stock

DESIGN AND FITMENT

We begin the R&D process by evaluating the stock intercooler and its surroundings. The factory intercooler is a tube and fin design, measuring 24" long, 8.1" tall, and 2.5" thick. The intercooler is mounted closely to the radiator and sits above the A/C condenser. The stock intercooler connects to the charge pipes via o-ringed quick disconnect connections, and the outlet end tank has a temperature sensor as well as two vacuum ports on the inlet end tank. In addition, the factory intercooler has a lower duct that ensures that air must go through the intercooler instead of underneath it.

Figure 1: 2024 Toyota Tacoma with the front bumper cover removed, showing the factory intercooler and ducting.

The Mishimoto intercooler measures 24.1" long, 8.9" tall and 3.5" thick, for a total core volume increase of 55% and a frontal area increase of 10%. This core volume maximizes the space that the intercooler takes up, to the point that the factory lower duct cuts off the last 2 rows. To maximize airflow through the core, we designed a new lower duct that promoted airflow to as much of the core as possible.

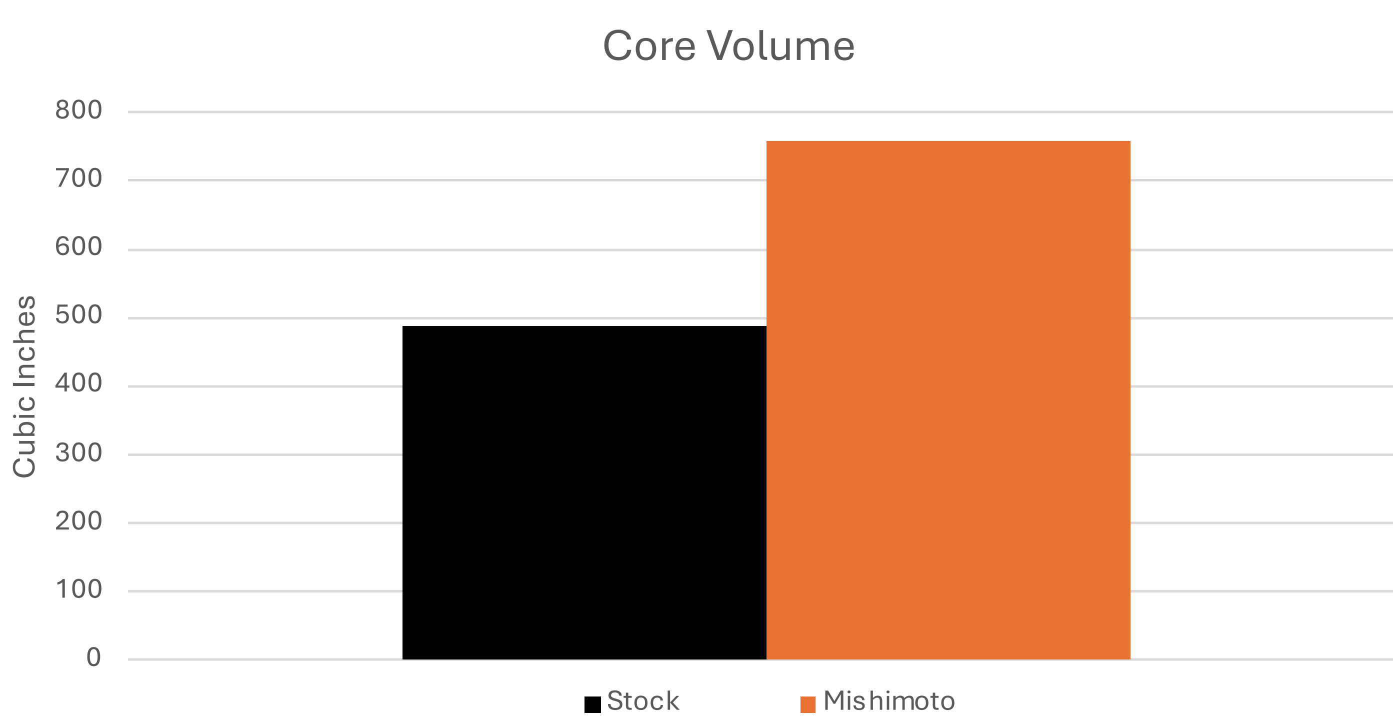


Figure 2: Mishimoto intercooler core volume is 55% larger than stock, with a 10% increase in frontal area.

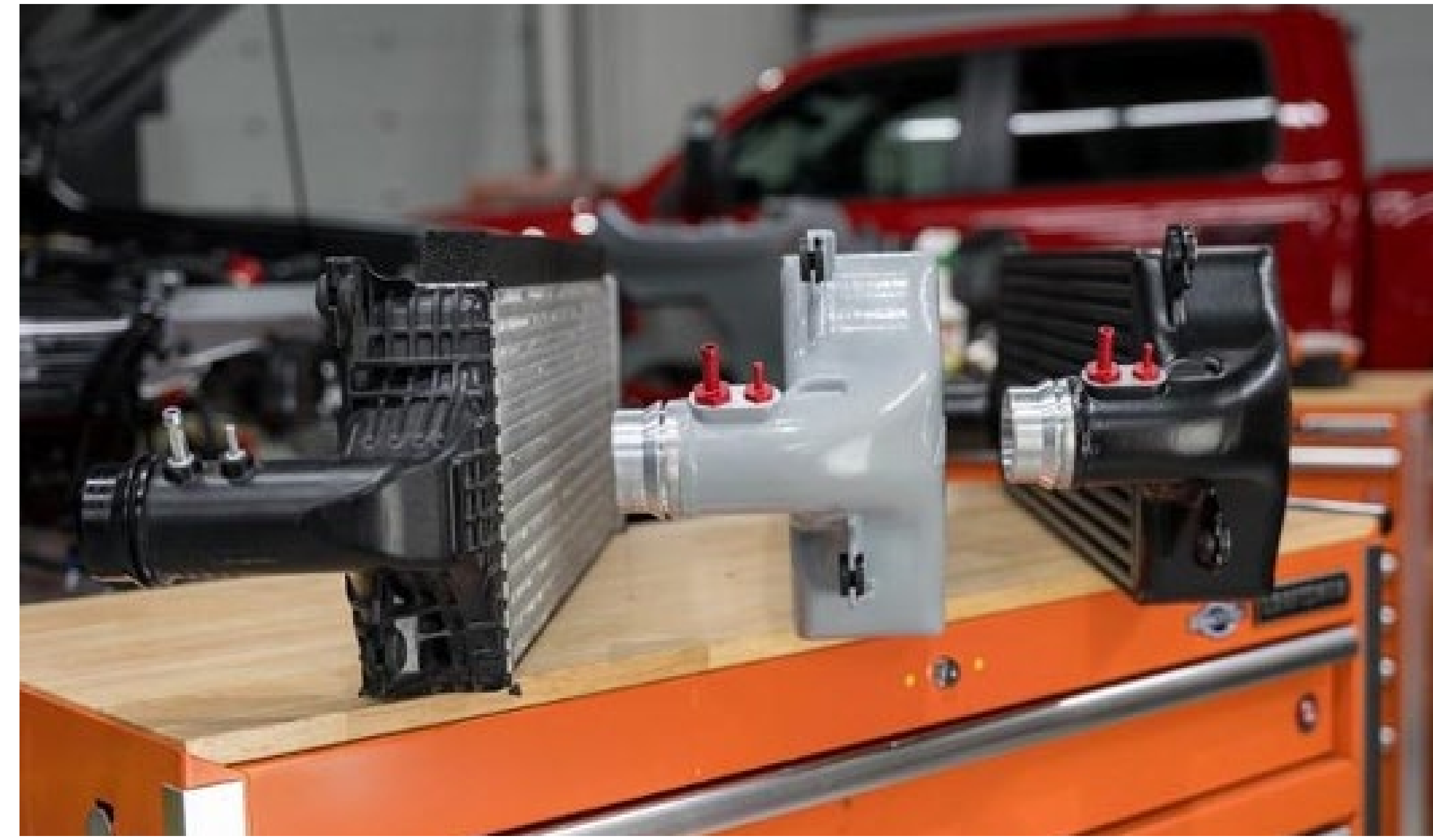


Figure 3: Comparison between the factory intercooler (left) and the Mishimoto Intercoolers.

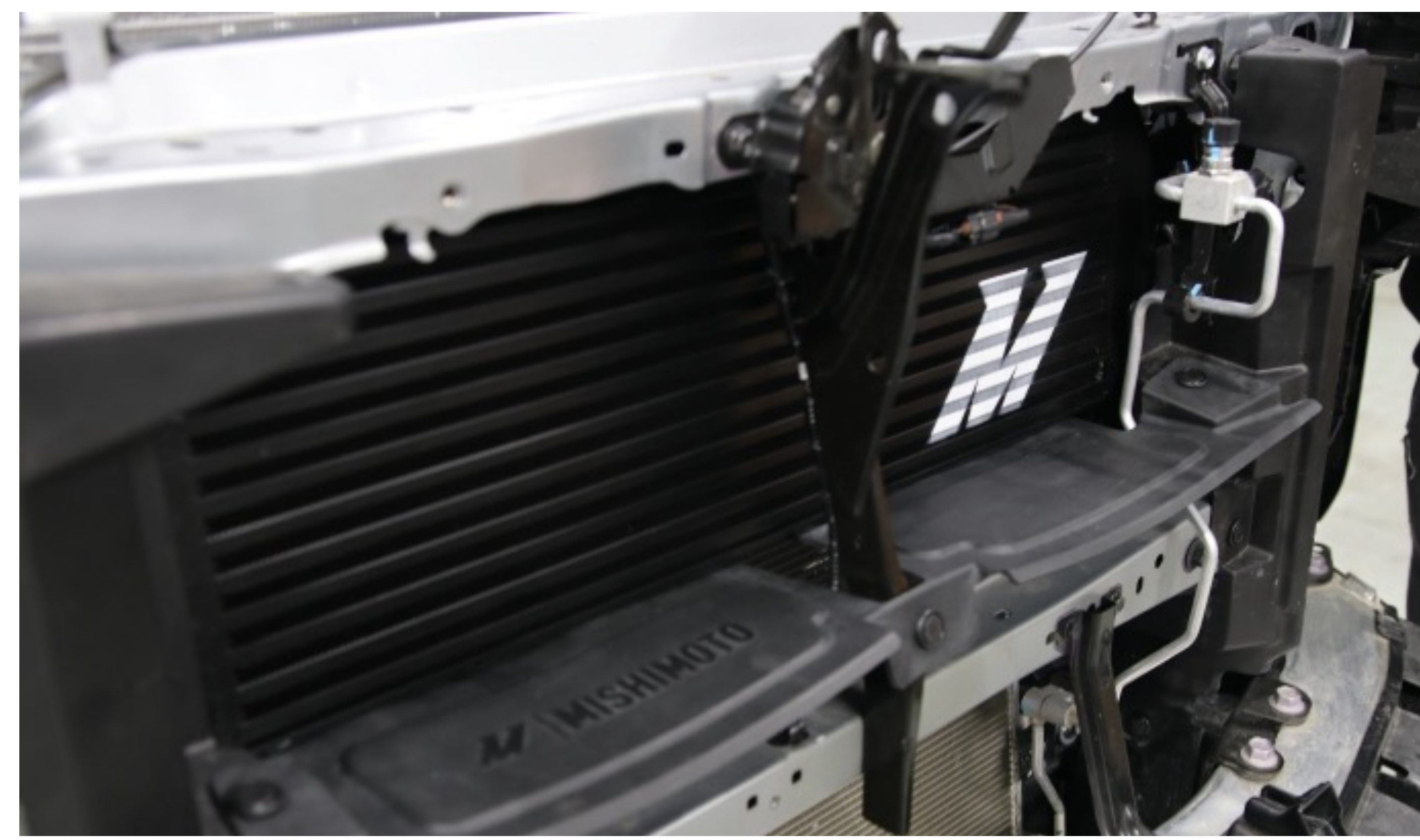


Figure 4: Mishimoto intercooler and ducting installed on the vehicle.

Other features of the core include CNC machined inlets and outlets. This allows a precise O-ring seal with the charge pipes as well as flow matched inlets and outlets to promote smooth flow and minimize pressure drop throughout the system. The intercooler also includes new mounting bushings to make sure that the intercooler is properly mounted regardless of the age and condition of the factory intercooler mounting bushings. We also supply O-ringed fittings for the vacuum ports and a new crush washer to mount the factory temperature sensor to make sure that the sensor has a leak free seal to the intercooler, as crush washers are not recommended for reuse.

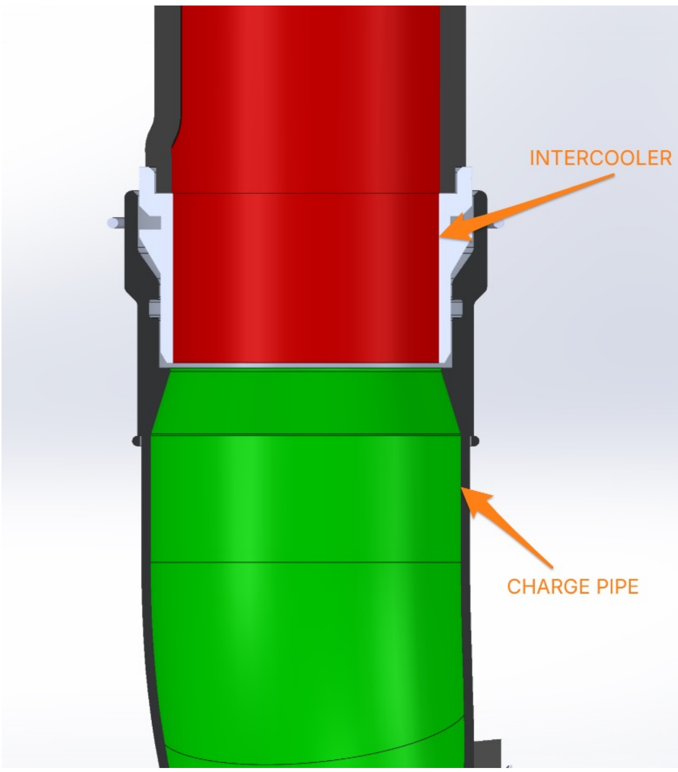


Figure 5: This CAD diagram shows the optimized flow at the junction between the charge pipes and the intercooler to minimize flow restriction going into and out of the intercooler.

TESTING APPARATUS

For testing the intercooler, we installed Rife temperature and pressure sensors in the charge pipes before and after the intercooler. These sensors were monitored and logged via the AEM AQ-1 datalogging system. In addition, OBD-II parameters as well as ambient conditions were logged via the Powerdyne Software on our Mustang Dyno MD-500XL-AWD dyno, utilizing the Mustang Dyno data acquisition system, JBOX.

Figure 6: AEM AQ-1 datalogging unit.

Figure 7: 2024 Toyota Tacoma ready to be tested on the Mustang Dyno MD-500XL-AWD

PERFORMANCE TESTING

A 2024 Toyota Tacoma TRD Sport was used for testing. Three separate tests were performed to properly put the intercooler system through its paces. The intercooler was tested in conjunction with the Mishimoto charge air pipe upgrade. We also note that our testing data also applies to the hybrid drivetrain, as both drivetrains use the same engine, and the electric motor in the hybrid system applies power after the engine, through the transmission.

1. Single power runs – the vehicle was run through the RPM band and the run was recorded by the dyno software. The vehicle is allowed to cool back to a steady state between runs. This was repeated until consistent runs were performed. Only consistent data was used. This test helps to isolate the performance differences of the intercooler.

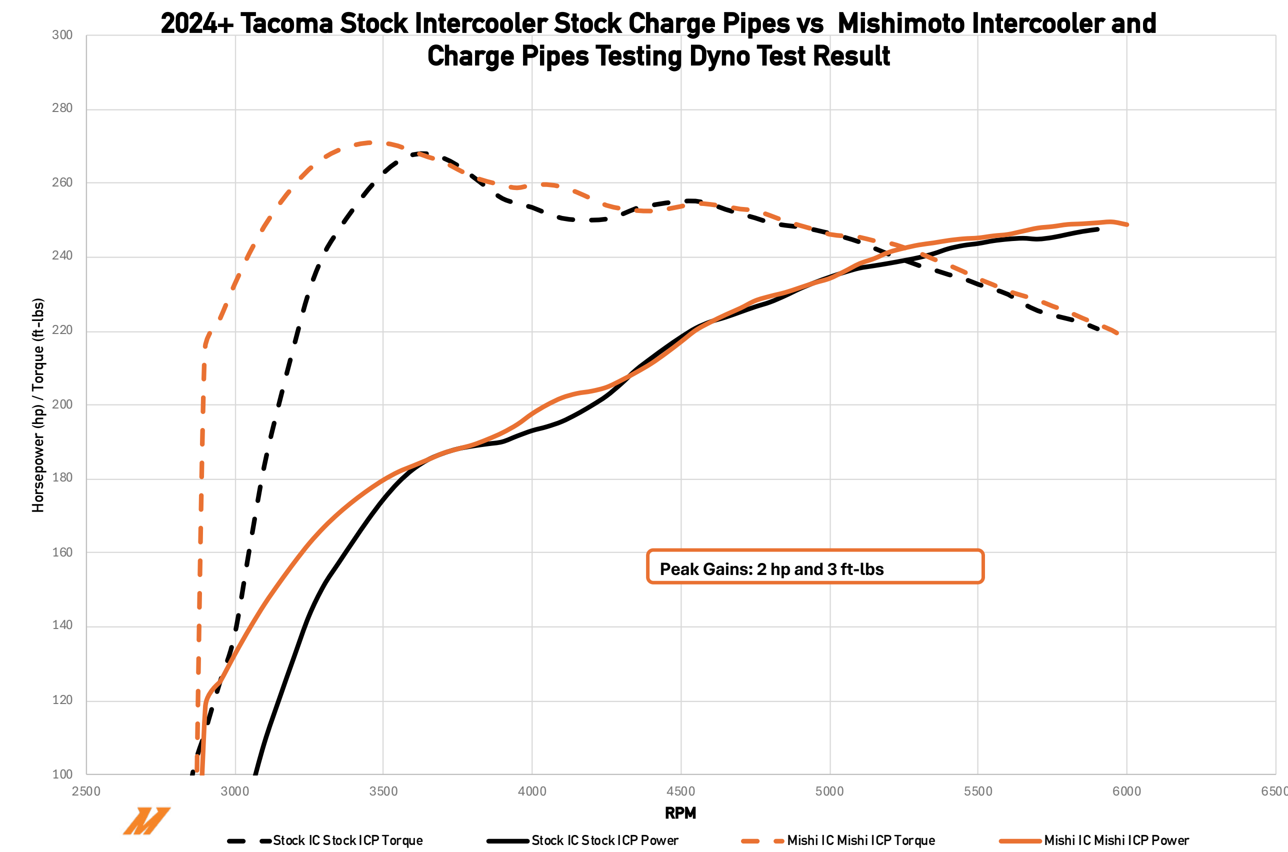


Figure 8 Single Dyno run power results show the Mishimoto parts picked up low end torque due to less restriction and top end power due to better charge air cooling.

2. Heat Soak – 6 single power runs are performed back-to-back. The next run starts as soon as the dyno slows down to a wheel speed which meets the starting engine RPM of the next run. No cooling time is allowed between runs. This better simulates real world conditions and the ability of the intercooler to resist heat soak.

3. Torture test – the vehicle is held at 50mph by the dyno and held at wide open throttle for 20 seconds. Like the heat soak test, this represents a worst-case scenario while finding the limits of what the intercooler.

For the single power runs, each configuration was tested for either 6 or 7 runs. The first run of the series was thrown out and the power charts were compared to make sure a run was picked which represents an average run. This method allows us to remove outlier runs to represent the data accurately.

The vehicle seemed to pick up torque faster than with the factory intercooler. This was likely due to the significantly lower pressure drop through the intercooler. The peak pressure drop with the factory intercooler was 2.9 psi vs 1.9 psi with the Mishimoto intercooler. The larger flow area, CFD designed end tanks, and optimized internal fin specification allowed the air to go through the system faster and reach the engine quicker. As a result, the vehicle will feel significantly more responsive with the Mishimoto intercooler and pipes.

The factory intercooler performed great in terms of its ability to exchange heat efficiently. The peak outlet temperature of the factory intercooler was 95˚F degrees, with a 76˚F ambient temperature. This translated to a peak efficiency of 97%. However, the Mishimoto intercooler was significantly more effective, with a peak outlet temperature of 82˚F, at a slightly higher 77.5˚F ambient and a peak efficiency of 98%, with a peak charge air temperature 12.1˚F lower than the stock part. The peak outlet temperature with the Mishimoto intercooler was only 5.2 degrees above ambient! In addition, the outlet temperature decreased by 1 degree from the start to the end of the run with the Mishimoto intercooler, while it increased by 12˚F with the factory intercooler. It seems that while the factory intercooler was efficient, it starts to lose efficiency at high RPM as the intercooler no longer has the cooling power to effectively cool the increased volume of air. This is demonstrated in the efficiency graphs of the power runs.

At the end of the run, the Mishimoto intercooler was 97%, a 9% increase in efficiency over the factory intercooler. If the customer chooses to increase the power and airflow in their vehicle, this difference will continue to increase as the Mishimoto intercooler is designed to accommodate higher airflow than the factory configuration.

Generally, when testing intercoolers, we will see an increase in power from an intercooler because of a drastic lowering of temperature or a significant decrease in pressure drop between the turbo outlet and the throttle body. In this application, the factory charge air temperatures were not high enough for the Engine Control Unit to start to dial back ignition timing. As a result, even if the Mishimoto intercooler was 100% efficient (and it's very close) the vehicle would likely not pick up significant power over the factory part. Additionally, in the Tacoma, there is an adapter between the cold side charge air pipe and the throttle body. This adapter restricts airflow significantly compared to the charge pipes and intercooler due to its small diameter and sharp bend. When analyzing the data, we saw that there was a peak pressure drop of almost 2psi through just this elbow, compared to 2.9 psi through the factory intercooler. By decreasing the pressure drop through the intercooler by 1psi, it did not create a significant enough effect on the overall system to get more boost pressure and flow into the engine and decrease the pressure ratio at the turbo.

Nonetheless, the intercooler is still a significant improvement in both pressure drop and heat rejection over the factory unit and may work in conjunction with other upgrades in the flow path to increase power.

In our heat soak testing, we saw similar results. The factory intercooler performed quite well and the Mishimoto intercooler performed significantly better. The peak intercooler outlet temps on the factory intercooler were about 114°F compared to 100°F on the Mishimoto intercooler. The Mishimoto intercooler stayed within 24.5°F of ambient after 6 back-to-back dyno runs. This is very impressive as the intercooler inlet temps peaked at 270°F, meaning the intercooler was able to drop the temperature of the charge air by 170°F, even while heat soaked.

The heat soak test can measure the consistency of power when pushing the vehicle hard. The Mishimoto intercooler allows the vehicle to lose the least amount of power when the vehicle is put through a high heat scenario. From the 1st to the 6th run, the Mishimoto intercooler only lost 3.35hp peak whereas the factory intercooler lost 5.58hp between runs. The Mishimoto intercooler will increase the vehicles' ability to consistently perform in harsh situations.

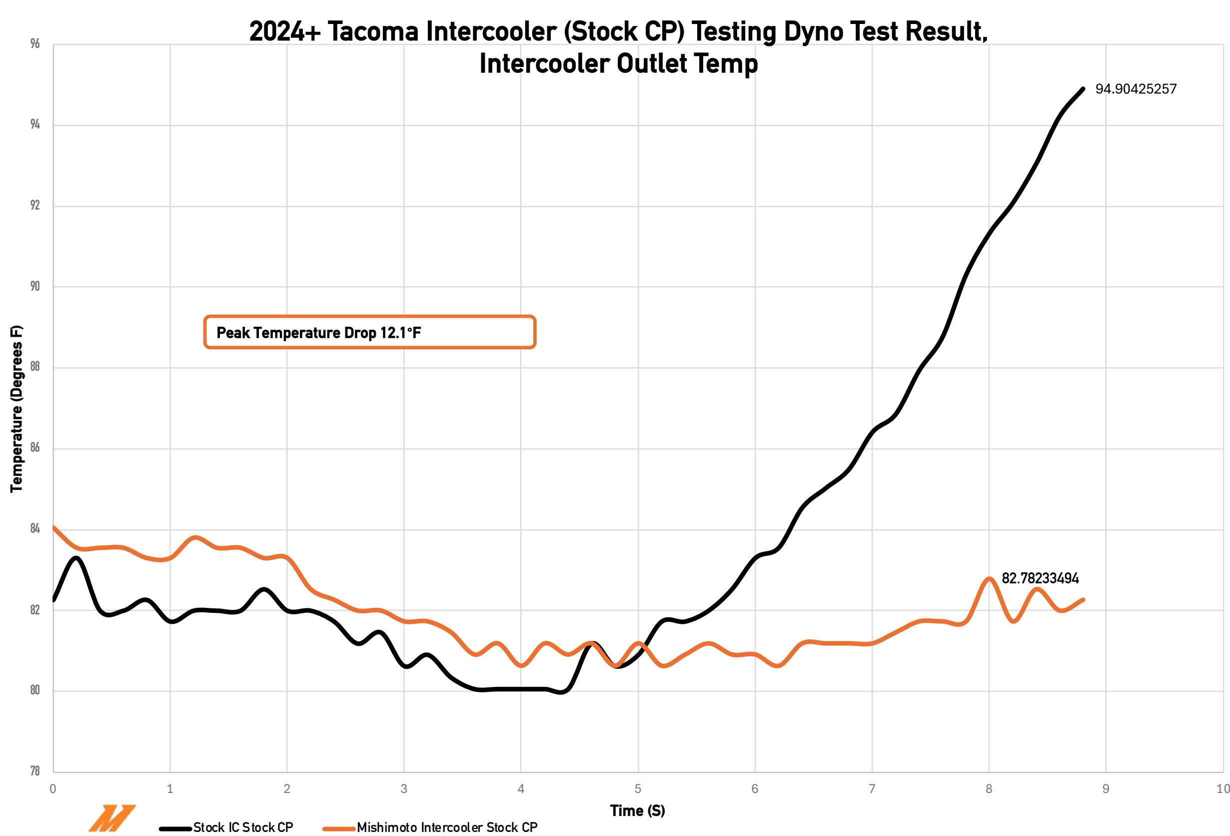


Figure 9: Data from the single dyno runs showed the Mishimoto intercooler lowering peak charge air temps by a little over 12°.

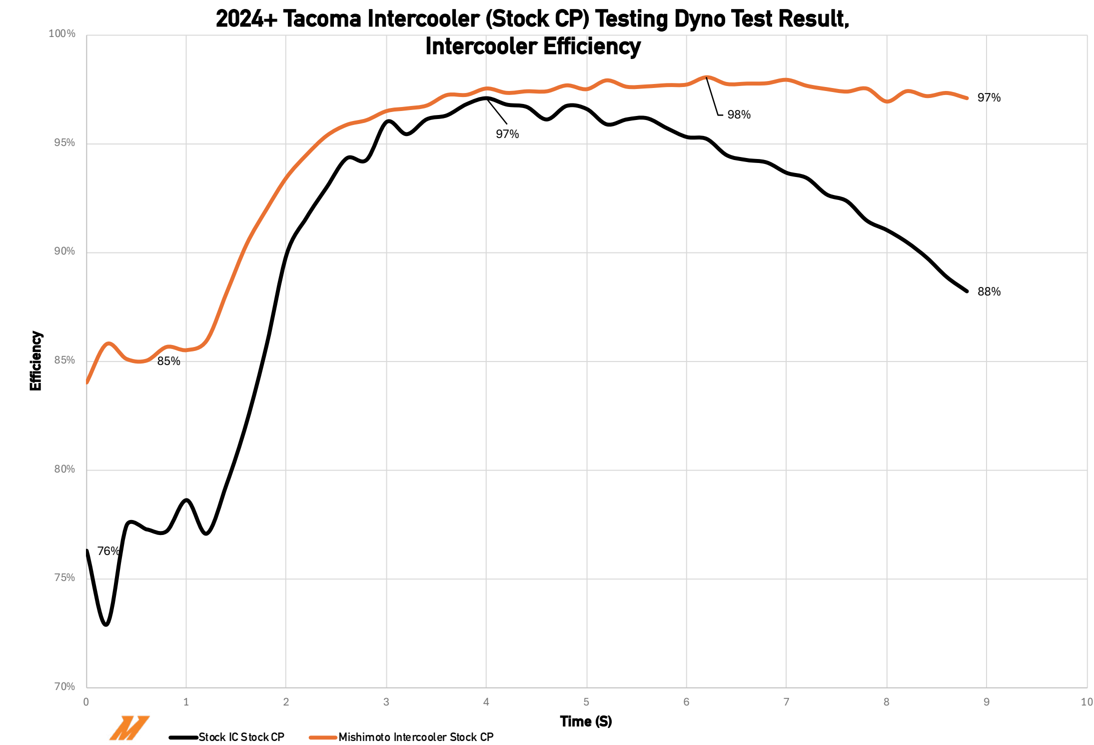


Figure 10: The intercooler efficiency chart shows that while both intercoolers had great peak efficiency, the factory intercooler drops off in the higher RPM's while the Mishimoto intercooler stays efficient.

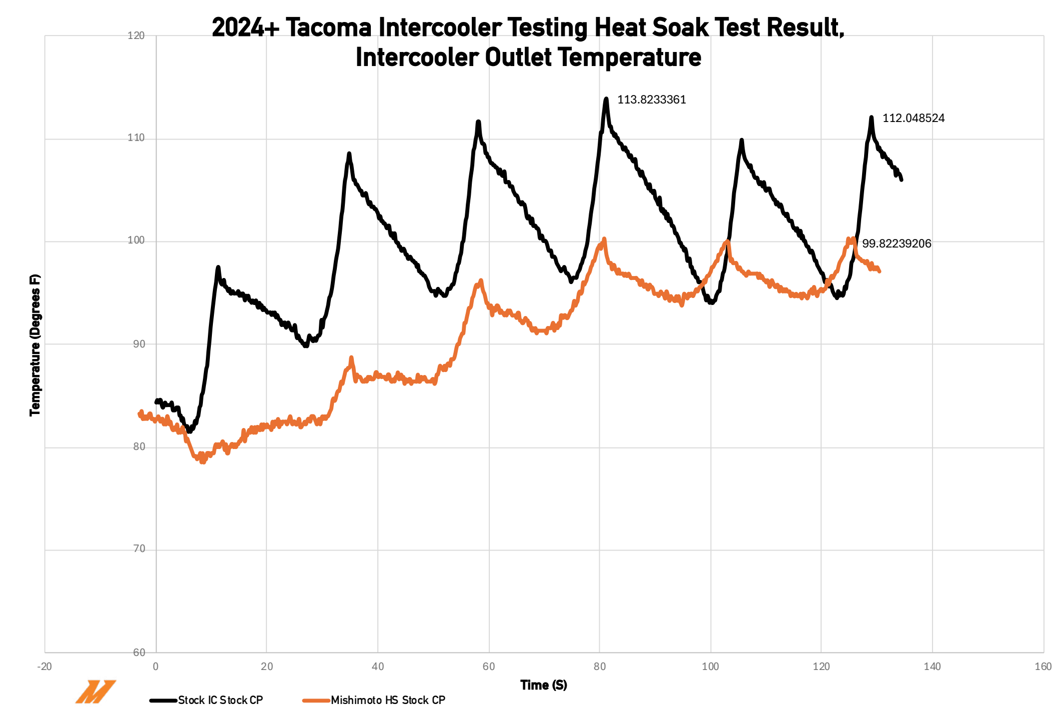


Figure 11: Heat soak test results show a consistently lower intercooler outlet temperature with the Mishimoto intercooler. Both intercoolers seemed to peak after 3 runs.

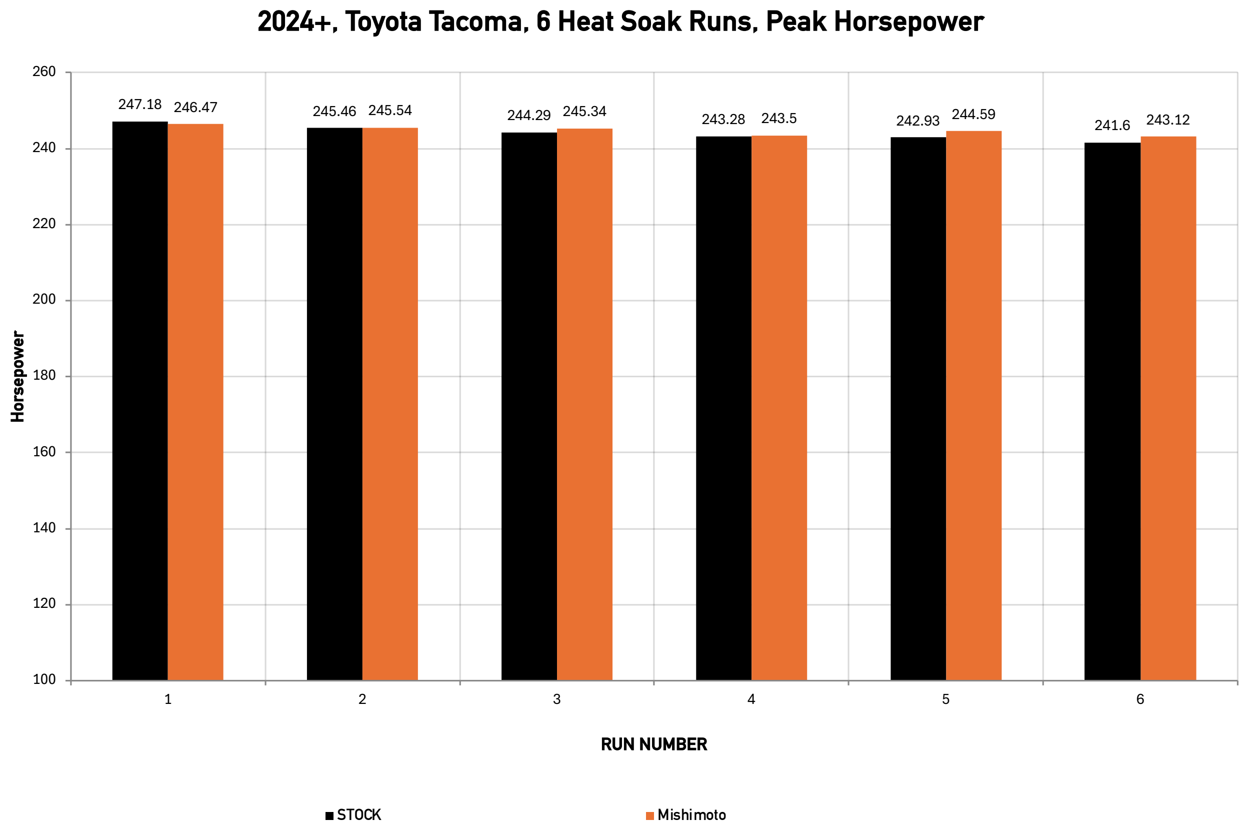


Figure 12: Peak power figures from the heat soak testing showed the Mishimoto intercooler lost less power over the course of the testing and had a higher average peak power.

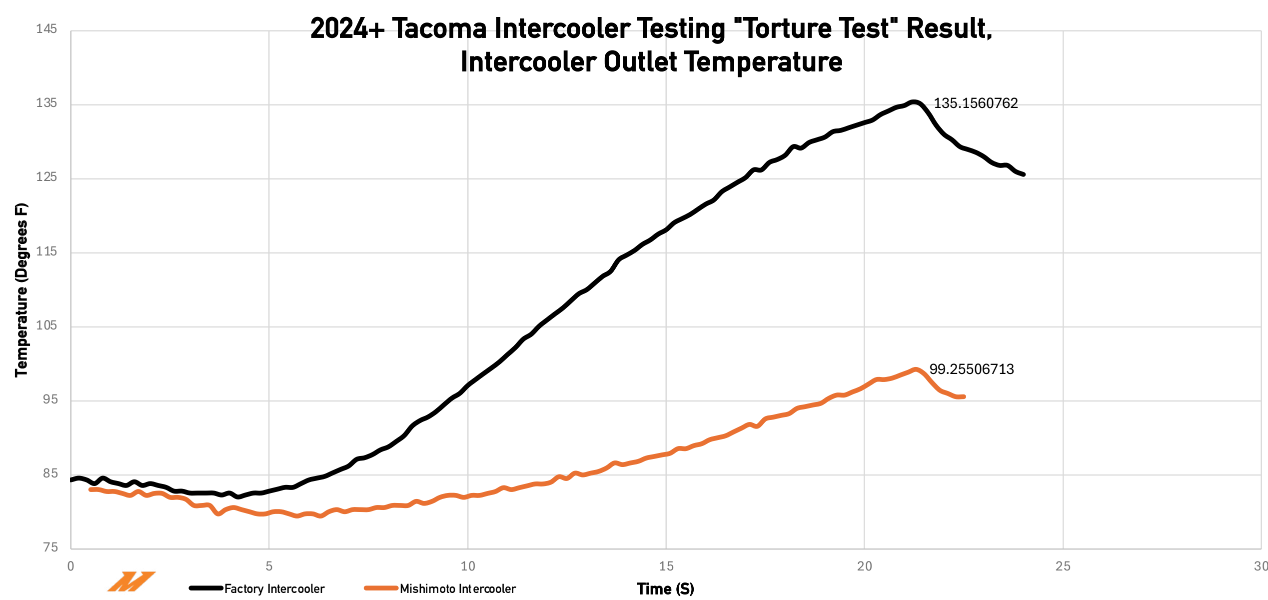
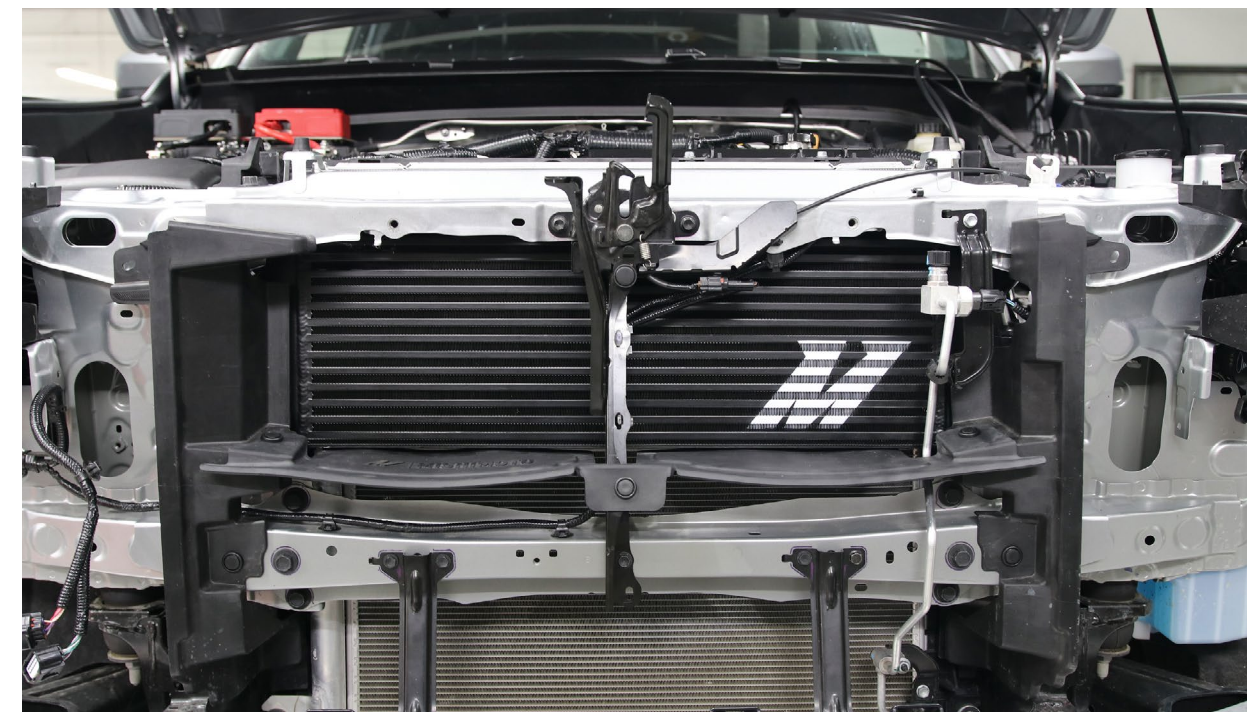


Figure 13: Torture test data shows the Mishimoto intercooler was better able to keep charge air temperatures in check with the vehicle being held at wide open throttle for 20 seconds

The Tacoma is a multi-use vehicle that may be used for street use, towing, off-roading as well as regular commuting duty. It is our goal to design an intercooler that will hold up to the harshest conditions. The torture test simulated a vehicle towing a trailer up-hill, which is more realistic than doing 6 full RPM sweeps in a row. In addition, the RPM and boost were kept constant, so the turbo was operating within its efficiency range, whereas, in the heat soak test, the turbo was outputting very hot air at peak RPM. The peak intercooler outlet temperature was 99.2°F with the Mishimoto intercooler vs 135.2°F with the factory intercooler. The 36°F difference showed a significant improvement in charge air temperature with the Mishimoto intercooler in a real-world scenario.

CONCLUSION

An intercooler's primary job is to lower the temperature of the charge air as close to ambient temperature as possible, while creating the least amount of restriction while doing so. The Mishimoto intercooler shows significant improvement in heat rejection, intercooler efficiency and flow over the factory intercooler. The Mishimoto intercooler stays efficient through the RPM range and through harsh high heat conditions. The Mishimoto intercooler is a great way to get the most out of the 2.4 turbo Toyota Tacoma for the best reliability, consistency and performance.



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CONTACT US

Email
For sales and technical
questions please contact
support@mishimoto.com

By Phone
USA: 877.466.4744
International:
+1.302.762.4501
Fax: 302.762.4503

Mail
Mishimoto
1515 Garnet Mine road,
Garnet Valley, PA 19060

Visit
Mishimoto.com
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