MISHIMOTO

ENGINEERING REPORT

2012+ BMW M5/M6 Intercooler | SKU: MMINT-F10-12

By: Mitchell Levy, *Mishimoto Product Engineer*

REPORT AT A GLANCE

- **Goal:** Create a set of intercoolers and charge pipes that increase the performance of the vehicle by increasing flow and lowering charge air temperature. Intercoolers and charge pipes should be direct fit without any cutting or vehicle modification required.
- **Results:** The Mishimoto intercooler and charge pipes reduced the peak intercooler outlet temperature by 24°F compared to the stock intercooler and charge pipes on a tuned vehicle. This resulted in a peak power increase of 25 horsepower and 22 pound-feet of torque while maintaining lower pressure drop than the stock system.
- **Conclusion:** The Mishimoto intercooler system is a great upgrade for BMW owners looking to reduce heat soak and increase power with a great fitting intercooler. These intercoolers will help keep charge air temperatures in control for stock, tuned, or vehicles with upgraded turbochargers.

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DESIGN OBJECTIVES

- Create a direct-fit air-to-water intercooler kit that is the largest possible size that can fit with all other factory components
- No cutting or modification necessary
- Fits vehicles with aftermarket air intakes
- Increase power and torque on a tuned vehicle
- Outflow stock intercoolers

DESIGN AND FITMENT

The design process began with evaluating the stock intercoolers as well as the space that the engine bay allowed for the new intercoolers. The factory intercoolers fit quite tightly in the engine bay and interface with several components. The S63 engine is a different animal from what we have worked with before. The S63 is a "hot V," meaning the air flows from the intakes on the outside of the V, to the exhaust and turbochargers in the middle of the V. The intercooler and charge pipes gave a very straight and direct path from the turbochargers to the intake manifolds at the sides of the engine bay. Another unique feature is that the throttle body mounts to the intercooler outlet, instead of on the intake manifold where most vehicles locate the throttle body. This arrangement means that the intercoolers must fit precisely to locate the throttle body in the correct orientation and location.

After analyzing the internal cooling passages, as well as the air pathway and fin specifications, we noted that the factory intercoolers were very similar internally to what we have seen before with the F8X M3/M4. We carefully scanned the engine bay in several different steps to create a layered scan so we could isolate different parts in the engine bay that might interface with, or mount close to, the intercoolers.

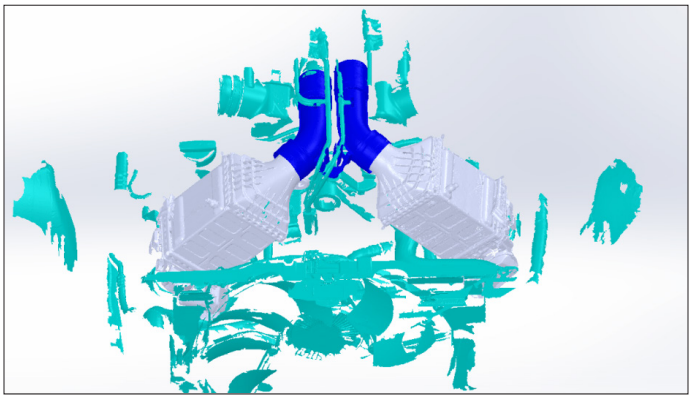

Figure 2: *Engine Bay scan with factory intercoolers in gray, charge pipes in dark blue, and engine bay surroundings in teal.*

With the scan complete, we were able to figure out exactly how large of a core we could fit in the space previously occupied by the factory intercoolers. Each core will be 37% larger than factory, which will

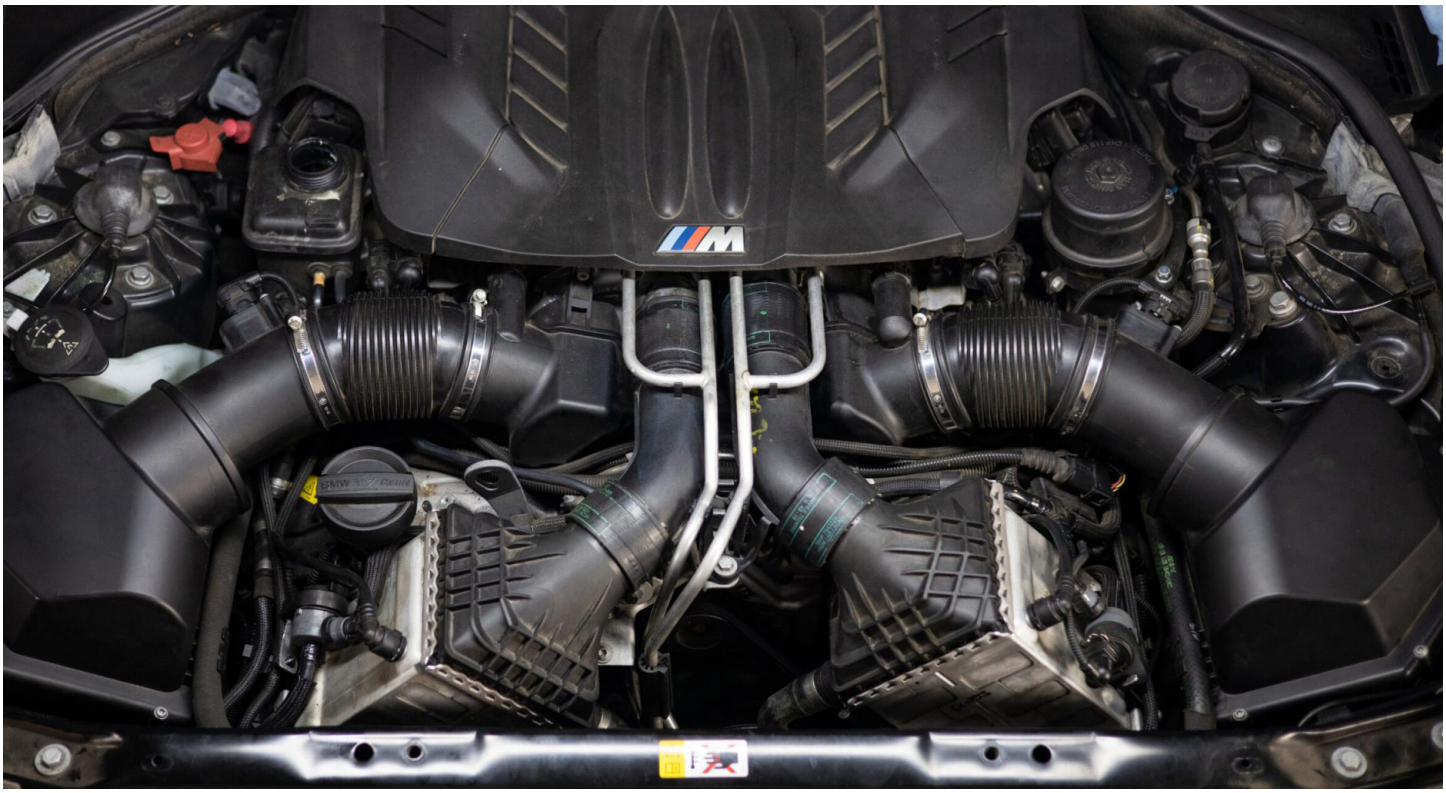

Figure 1: *S63 engine employs dual air-to-water intercoolers that move the charge air from the turbo outlets to the intake manifolds located on the sides of the engine.*

provide a large bump in cooling capacity, even when using the factory heat exchangers.

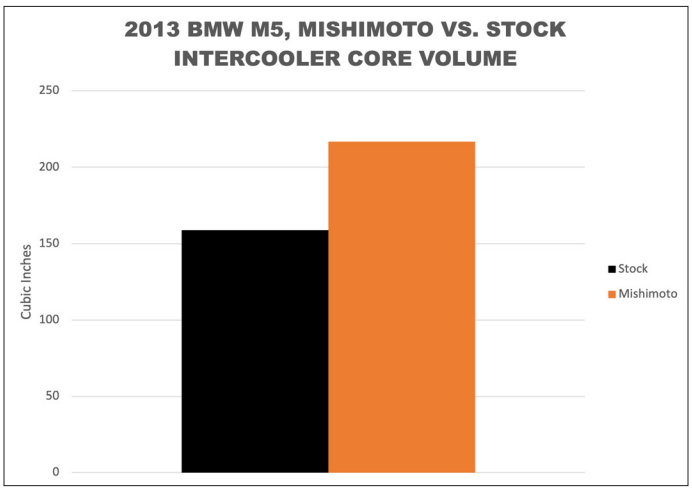

Figure 3: *Graph shows the increase in core volume over the stock units at a 37% increase.*

We set to work creating core and end tank designs that feature all the factory mounting points, MAP sensor ports, throttle body flanges, coolant ports, and brackets that the factory intercoolers incorporated. This is especially challenging as the inlet and outlet of the intercooler had to stay in the same location to fit properly, even though the intercooler core was significantly longer. After the first design iteration was complete, we printed our design to make sure the Mishimoto intercoolers would fit as well in real life as they did in our CAD software.

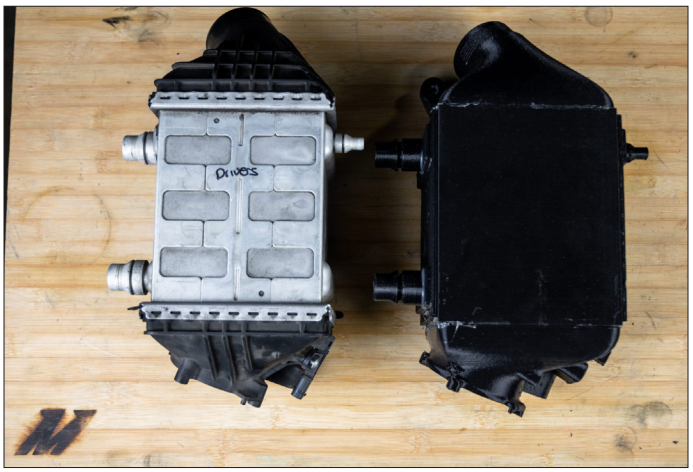

Figure 4: *Stock Drivers side intercooler next to Mishimoto 3D printed prototype.*

With the design complete and the first set of intercoolers and charge pipes manufactured, we performed flow testing on our Superflow flow bench. We tested both the intercoolers by themselves as well as

Figure 5: *Mishimoto 3D Printed prototype installed.*

with the charge pipes attached, which is a more realistic test as this is how they would be installed in the vehicle. The system showed a 10% improvement in flow which is very promising, considering the lack of design freedom and constraints of this intercooler. The M5 uses mass air flow sensors (MAF), which can necessitate recalibration when making large changes to the air path. However, recalibration was not necessary with this intercooler upgrade.

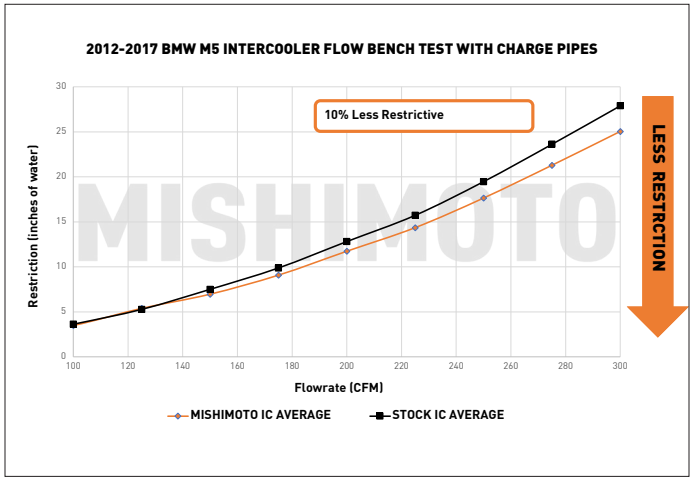

Figure 6: *Flow bench results showing a ~10% decrease in restriction vs the stock intercooler. Both intercoolers showed similar results.*

PERFORMANCE TESTING

Our testing vehicle was a 2013 BMW M5 with a 6-speed manual transmission and a stage-1 ECU flash. Our vehicle was tested using our DynaPack™ chassis dynamometer. Data was collected with an AEM AQ-1 data acquisition system, with intercooler-specific sensors collecting both temperature and pressure data before and after the intercooler core. In addition, the AQ-1 collected OBD-II data from the vehicle for data such as RPM, boost pressure, ignition timing, and coolant temperature. Two specific tests were performed: individual power runs and back-to-back heat soak runs.

During a single power run, the intercooler outlet temperature decreased by 24°F compared to the stock intercooler; from 116°F stock to 92°F with Mishimoto intercoolers. The lower charge air temperature allowed a denser air charge into the engine and decreased the amount of knock activity, allowing the ECU to maintain more ignition timing with the same boost pressure. That resulted in more torque and power across the powerband.

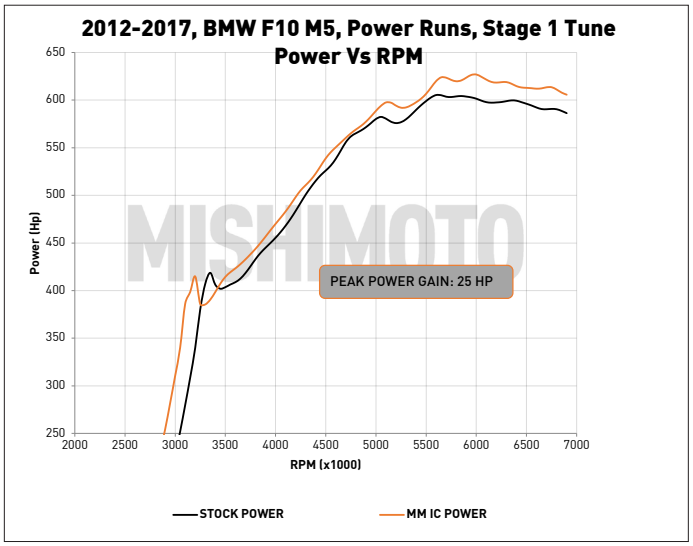

Figure 7: *Power graph shows horsepower gains in the low RPM's and high gains in the high RPM's as the heat builds up from the turbos compressing more and more air.*

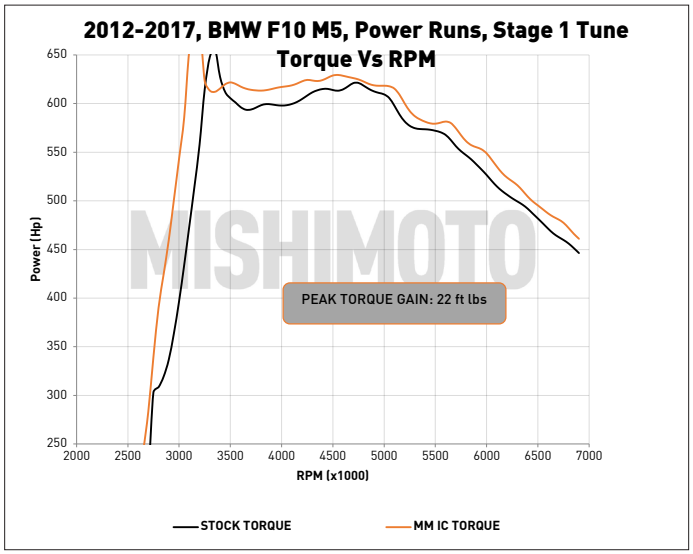

Figure 8: *Torque figures from the power runs show gains throughout the RPM curve. A 22 pound-feet increase in peak torque is a significant improvement.*

The heat soak test was designed to simulate aggressive driving that causes heat soak, such as what is done on a track with back-to-back high-throttle runs. In our testing, we performed 5 back-to-back power

runs. The Mishimoto intercooler limited the climb in intercooler outlet temperature associated with heat soak significantly better than the stock intercooler. The factory intercoolers saw a peak outlet temperature of 151˚F compared to 124˚F seen with the Mishimoto intercoolers, a 27˚F difference in temperature. Like the power runs, the significantly lower temperature allowed the engine control system to run 3 degrees of timing on the last pull of the Mishimoto intercooler heat soak runs, resulting in an approximately 18-horsepower difference between the final runs of the heat soak tests. The Mishimoto intercoolers significantly reduced the intercooler outlet temperature, resulting in greater power, torque, and overall improved performance.

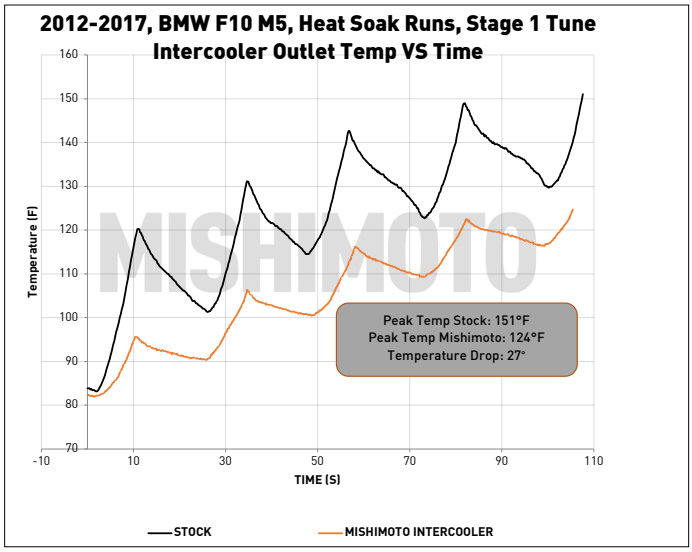

Figure 9: *Heat soak test results show decreased temperature throughout the test with a peak temperature drop of 27 degrees.*

CONCLUSION

The Mishimoto intercoolers and charge pipes for the F10 M5 increase the performance of an already great performance vehicle. For those drivers who are chasing more consistent power from their vehicle or are looking to compliment other performance modifications, the great flow and lower charge air temperatures provided by these parts are a great upgrade. The Mishimoto intercoolers are efficient, great looking and help significantly increase power and torque output.

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