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MISHIMOTO ENGINEERING REPORT

Testing Mishimoto CAI for 2013+ Subaru BRZ/Scion FR-S/ Toyota GT86

Figure 1: 2013 Scion FR-S used for R&D and testing

Test Vehicle:

2013 Scion FR-S

Modifications:

None, fully stock.

Objective:

To make a direct-fit cold-air intake that produces more power than the OEM without harming the motor

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Testing conditions:
The ambient temperature on the day of testing was approximately 65°F with 27% humidity.

Testing Equipment:
To test the effects of different intake setups, a DynoJet dynamometer was used to measure the power output.

Goals and Metrics:
Before development began on the BRZ/FRS cold-air intake, goals and metrics were defined for the project. First and foremost, we set out to create an intake that would make more power without potentially harming the motor and without the need for a tune. To accomplish this, air-fuel ratios (AFRs) were closely monitored to ensure that enough fuel was being supplied to the engine. Another goal was to create an intake that was isolated from the radiating heat of the engine bay. Cold air is denser than hot air and therefore creates a larger combustion, so the ideal intake would draw in as much cool air as possible. This can be achieved by placing the intake away from the engine and close to the cool air coming in through the front bumper. The final goal for this intake was to ensure that no permanent modification is necessary when installing it. This means that it should be a direct bolt-in part without any cutting or grinding required.

Research and Developement:
To create an intake that would provide more power than the stock unit, we first set out to reduce all possible restrictions. The filter was placed directly behind the bumper to allow it to draw cool air rushing in from the front bumper, without being too low and potentially drawing in water. Also, placing the filter in this location frees up a good amount of room in the engine bay and gives it a much cleaner look. An air diversion plate was added to ensure that the air was routing not only to the filter but also through the radiator. Once the filter location was chosen, the piping was routed in the least restrictive way, avoiding sharp turns and bends wherever possible. For the final step we needed to choose an appropriate internal diameter for the pipe that has the mass airflow (MAF) sensor mounted to it. We knew from previous intake development that this dimension is crucial and directly affects the AFRs (and subsequently the power output) of the engine.

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Figure 2: Three pipes of different internal diameters were used for this experiment.

Experiment:

For our experiment we chose to test three different-size MAF housing pipes (Figure 2) to determine what kind of effects they would have on overall power output and AFR readings. Throughout this experiment the internal diameter of the MAF pipe was the only variable. The air filter, primary piping, and engine tune all remained constant. The dynamometer chart in Figure 3 shows the acquired results from our testing.

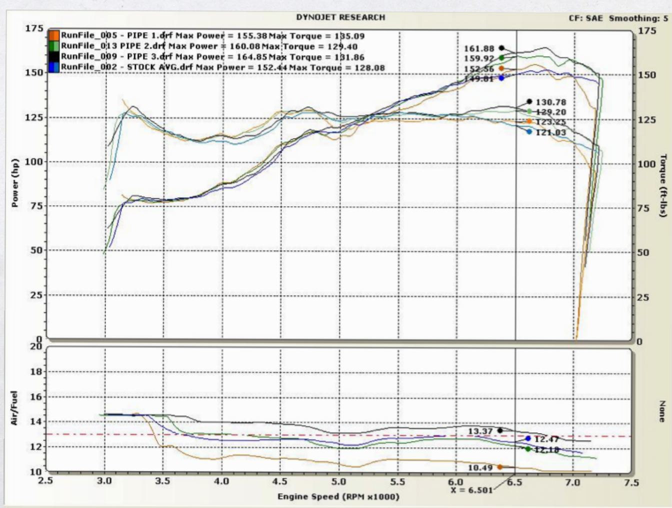

Figure 3: This dyno graph shows how the FRS reacted to the different MAF housing sizes. The diameter chosen has a direct effect on the engine's AFR curve.

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As expected, the internal diameter of the MAF housing played a critical role in how the Subaru FA20 engine performed. In the first part of this experiment we acquired a baseline reading from the all-OEM FR-S. Next, sample pipe 1 was tested. From Figure 3 it is clear that this pipe caused the motor to run much richer than stock without providing more power, which would lead to poor mileage, fouled plugs, and potential cylinder wall wash. Sample pipe 2 was tested next. The results from this pipe were certainly desirable as the motor made significantly more power while maintaining close-to-stock AFRs (as seen in the green and blue lines in Figure 3). Finally, we tested sample pipe 3 and found that while this pipe did make slightly more power than in the previous test, AFRs were far too lean for our liking. A motor that consistently runs lean is prone to premature failure due to conditions such as detonation and overheating. The clear choice was then to use pipe number 2.

Figure 4 is a dynamometer plot showing the OEM BRZ/FR-S intake compared to the Mishimoto cold-air intake. The Mishimoto intake added as much as 10 hp and more torque while closely following the factory AFR curve

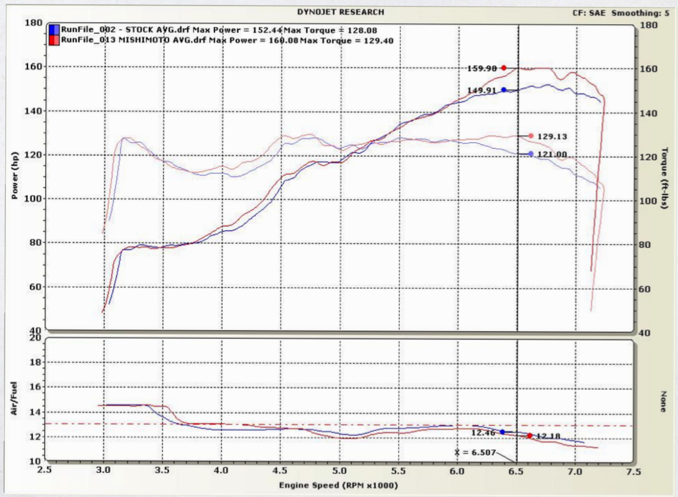

Figure 4: The selected Mishimoto intake provides more horsepower and torque over stock while still closely following the OEM AFR curve.

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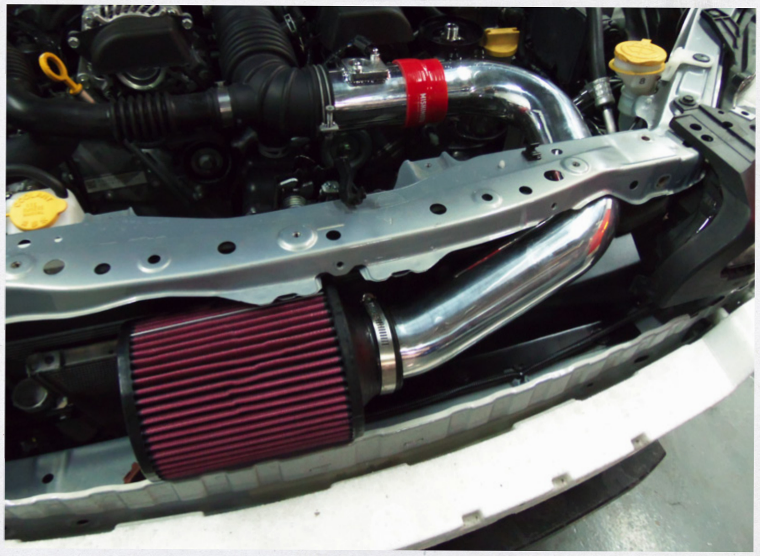

Figure 5: The Mishimoto Cold-Air Intake fully installed on our testing vehicle.

Conclusion:

By running these experiments we were able to conclude that the second pipe sample was the best fit for this intake. This MAF pipe, along with the larger primary pipe and high-flow Mishimoto air filter, provides an ample power increase over the OEM setup while still maintaining safe AFRs. The entire system is a direct bolt-in unit that requires no permanent modification to your BRZ/FR-S. Along with an increase in power, the intake also provides a nice deep, rich intake tone over the stock setup. The Mishimoto FR-S/BRZ Cold-Air Intake is an excellent choice for any BRZ/FR-S owner looking to get a bit more sound and power out of their ride without the need for a tune.

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