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CAI for 2008+ Subaru STI

MISHIMOTO ENGINEERING REPORT

Testing Mishimoto CAI for 2008+ Subaru STI

Test Vehicle

2010 Subaru STI

Modifications

Mishimoto radiator, hose kit, and oil filler cap. No engine modifications.

Objective

Design a cold-air intake (CAI) that is a direct fit and can be installed without any external tuning requirement.

Testing conditions

Ambient temperature 84 °F, atmospheric pressure (ATM) 29.53 in Hg, humidity 40%

Apparatus

Dynojet 424X dynamometer with linx, Dynojet wideband air/fuel ratio (AFR) system

Research and Development:

Mishimoto engineers first dissected the stock air intake system, which has a mass airflow (MAF) sensor for incoming air. These measurements are sent to the ECU, which processes the information and then adjusts the fuel and timing to get a predetermined optimal engine output. The MAF sensor is programmed with the cross-sectional area of the stock air intake tube at the point where the sensor is mounted. The Mishimoto engineers then created an intake system that used the same internal cross-sectional area as the stock intake system. Next the car was strapped to the dyno and engineers began to measure horsepower and air/fuel ratios (AFRs). Despite a huge increase in horsepower and torque, the AFR was too lean, measuring from 16:1 to 14:1 under full boost.

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This is not a safe level for running your Subaru. Mishimoto engineers reasoned that, because of the increased airflow the new filter allows into the system, the MAF sensor is not sending the correct amount of fuel to the engine. They then decided to adjust the cross-sectional area and test again. After some adjustments and the addition of an internal air diverter (see Figure 1), the engine achieved high increases in horsepower and torque without sacrificing safe AFR numbers.

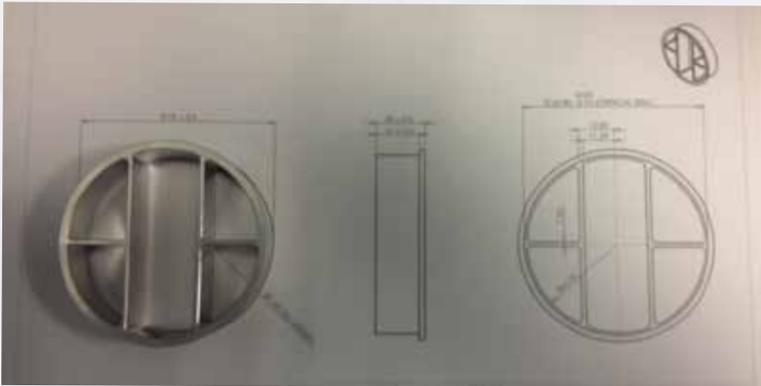


Figure 1: For more precise readings, the air diverter is welded into the Mishimoto CAI to promote laminar airflow just before reaching the MAF sensor.

Dyno Data:

Mishimoto engineers wanted increased power while maintaining a safe AFR and without any ECU modifications. The goal was set to keep the AFR below 12:1 while under full boost. Most tuners will tune forced induction cars ranging from a conservative 11.5:1 to a more aggressive 12.5:1. In general, any AFR greater than 13:1 is considered unsafe and unreliable over time.

Figures 2 and 3 shows how the Mishimoto CAI starts to make power above 4000 rpm and continues to gain power until redline. The maximum gain achieved was about 25 hp and 24 tq at around 5300 rpm, with a peak gain of 12.7 hp and 2 tq. These results are very good for such an easy part to swap out. Increases on average through the power band measured around 20 hp and 18 tq, which would certainly be noticeable to the driver.

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AFR:

In the AFR graph at the bottom of Figure 2, the Mishimoto CAI follows the stock AFR as the car builds its boost. Once the engine reaches 4000 rpm the car is under full boost, as seen when the Mishimoto CAI starts to differ from the stock unit. The maximum AFR reached was about 11.7:1, but on average the Mishimoto CAI runs about 11.3:1 when under full boost. The stock AFR maxed out at about 11:1 and averaged about 10.5:1 when under full boost. These numbers were consistent throughout multiple runs, which assured the engineers that this CAI can be used every day without harming the engine.

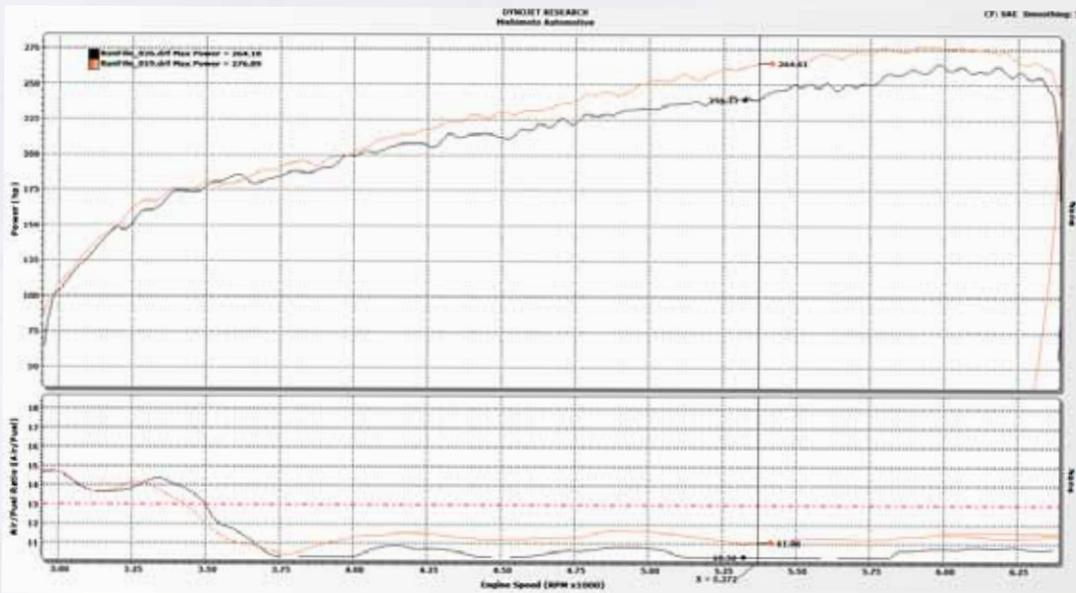


Figure 2: . Mishimoto CAI is shown in orange, and the stock intake is shown in black. The lower graph represents the respective AFRs during each run.

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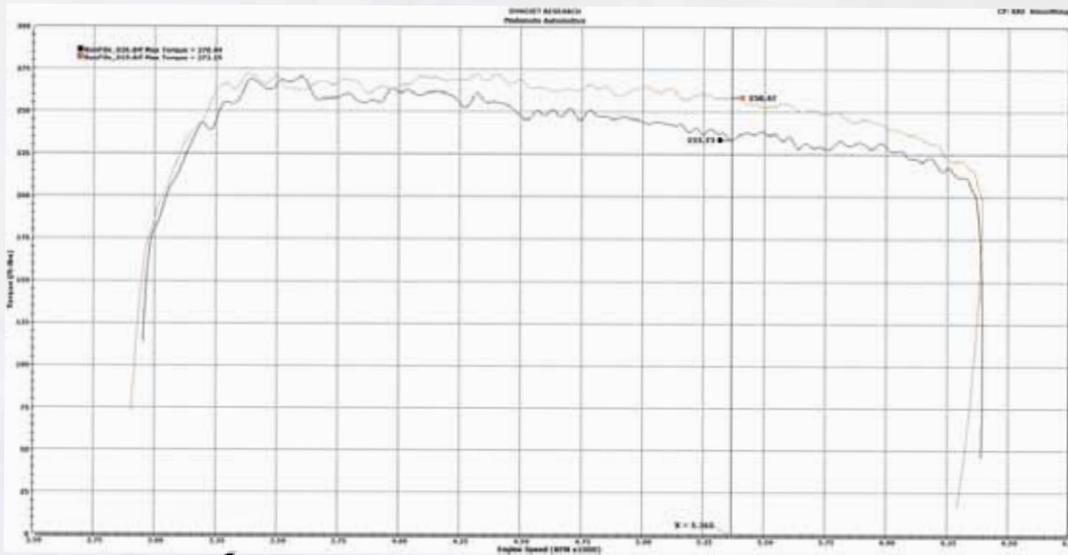


Figure 3: .Mishimoto CAI is shown in orange, and the stock intake is shown in black.

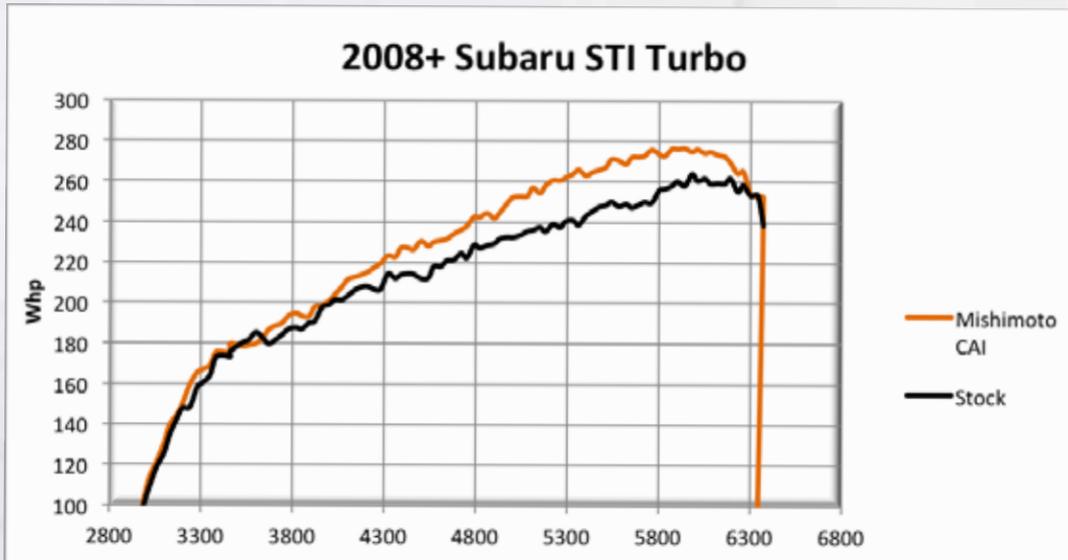


Figure 4: .Graph of the dyno run shows a clearer view of the power gains..

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Results:

Run conditions: 84 °F, ATM 29.53 in Hg, humidity 40%, SAE factor 1.01

Stock peak: 264.18 hp and 270.44 tq

Mishimoto CAI peak: 276.89 hp and 272.19 tq

Max gain: 25.1 hp and 24.7 tq @5370 rpm

Air filter:

Compared with the stock unit, the Mishimoto air filter is more free-flowing and has a 16% increase in surface area. The filter is made from eight-layer cotton with red oil. All filters are testing to ISO 5011 standards.

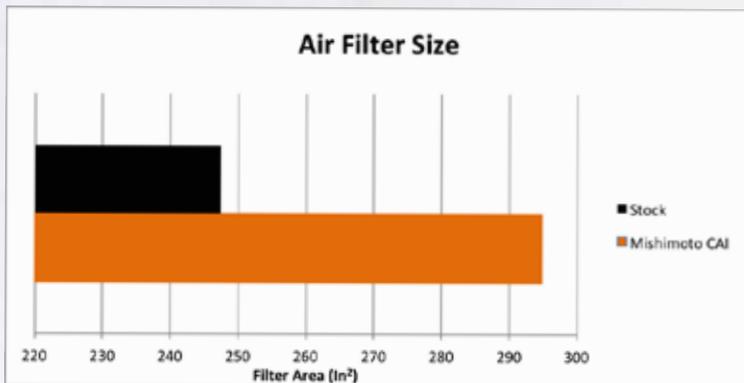


Figure 5: Chart compares the surface area of the stock and Mishimoto air filters.

Sound testing:

The Mishimoto CAI makes great power, but it also creates excellent engine tones that will make enthusiasts very happy. To test this, Mishimoto engineers placed AKG Acoustics' studio-quality cardioid condenser microphones around the Subaru with and without the CAI installed. Recordings were made taking special care to keep the input gain levels, microphone placement, and all other recording conditions identical from one run to the next. The recorded sounds were analyzed to compare the relative decibel strengths across the entire bandwidth of frequencies. The red lines in the graphs below represent the maximum volume achieved for each frequency band during the entire dyno pull.

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A note about frequencies: The range of human hearing is typically about 20 Hz to 20 kHz. The majority of the fundamental frequencies fall between 20 Hz and 5 kHz. As a point of reference, some common sounds and their approximate frequency ranges are listed below.

Thunder: 0 Hz to 200 Hz

Female singer: 300 Hz to 1 kHz

Lowest note of a bass guitar: 100 Hz

Jingling keys: 1 kHz to 5 kHz

Male singer: 100 Hz to 500 Hz

The Mishimoto CAI had the most notable volume gain, in the 40 to 160 Hz range, which provided the intake with the additional 'growl' that was missing from the stock intake. Substantial volume increases also occurred at 125 Hz and 250 Hz, providing the intake with some additional low-end resonant tones and contributing to the 'throaty' quality of the sound.

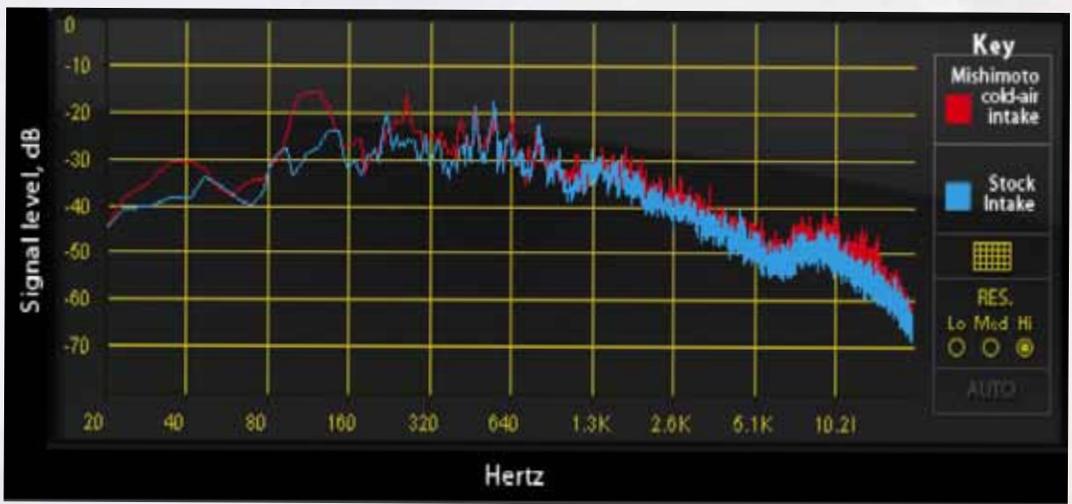


Figure 6: Stock intake and Mishimoto CAI sound comparison.

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Figure 7: External microphones placed around the engine to analyze change in engine tone

Conclusion:

The Mishimoto CAI offers great power and sound while keeping the system as a true direct-fit bolt-on intake. The increase of airflow that this intake allows into the engine can achieve even greater power gains if the customer chooses to reflash the ECU or have a local tuner custom tune the car. This intake upgrade should be at the top of every WRX and STI owner's modification list.

Warning: As with most CAIs, customers should avoid heavy throttle while driving through large puddles, because the risk of pulling in excess water into the engine can potentially result in engine failure.