

My NC2 Full Exhaust & Tuning Experience

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Discussion

All Miata owners, to some degree, have a built-in genome that makes them want to leave things NOT well enough alone. In other words, how many of you have owned a Miata for any significant length of time and kept it bone stock, exactly as it came from the factory? I would venture that, among those who are members of SAMOA and other enthusiast clubs, not too many.

Miataphiles modify their cars for any number of reasons and in various fashions. Some want their car to look a little different, others want theirs to drive differently. Some will add a muffler for a different sound, others just switch to synthetic oil because of the perceived benefit. But each and every one of us bought and drive this car because of a passion for the Miata. I did too.

My goal with my Miata, a 2012 PRHT with a manual transmission, was to make my car look unique and provide me with weekend driving thrills to match my enthusiasm for the car. From the appearance side, many modifications, such as wheels and tires, or lowering, provide a more aggressive look but were primarily made to improve the car's handling.

And conversely, a lot of handling upgrades cannot be seen by the casual observer. Such things as aftermarket sway bars and underbody braces can only be observed by getting on your hands and knees and looking under the car... or driving it.

As pleased as I am with the way my car handles, I next wanted to tackle and improve the power side of the equation. And living in California, adding significant power to anything other than an early nineties NA Miata is difficult, at least legally. Last summer I experimented with the Electric Supercharger (ESC) offered by Vishnu Tuning. It offered a significant horsepower boost, but was difficult to live with in practical terms, as it required the driver to always go to full throttle to activate the compressor. So I sold mine, as have some other early adopters.

Next I **implored** Flyin Miata to obtain CARB approval for their Cosworth-based supercharger system. This kit, which is street legal in most of the universe except California, offers over 200 RWHP (about 235 at the crank vs 167 stock) on an otherwise stock NC. Add full exhaust to open things up and we are talking real power – finally. But alas, that project has been in the works for nearly two years now, with no assurance that it will ever get CARB approval. So short of buying a new Mustang GT what is one to do?



After some research I started looking for other ways to boost horsepower without buying a whole new farm. After researching the Forums, Goodwin Racing and other sites, I decided that a full exhaust and ECU tune was the most reasonable way to go. By full exhaust I mean a header to replace the NC's restrictive exhaust manifold, a midpipe to do the same, and a high flow muffler. Since California cars get no love from the State as far as legal exhaust mods save mufflers, I needed a solution that I could live with, that was still as clean as stock, and could pass a visual inspection when the time comes... all while adding significant increases in horsepower and torque. So

last week I ordered a GWR street header to complement the GWR catted midpipe and RSII muffler that was already on my car. The street header contains an EPA-approved catalytic converter, and both of the stock O2 sensors connect in the stock before/after locations. I also contracted with Dynotronics, a master tuner of all things Miata, to provide a custom EcuTek ECU reflash to help maximize the power and torque gains and improve driveability.



Dyno results on a stock NC2 (2009-2012) Miata show 167 crank HP and about 142 at the rear wheels. That is a driveline loss of about 15%, average for a front engine/rear drive car. Untuned, GWR has achieved nearly 159 RWHP on their 2012 project car with the same header/midpipe/muffler combination, an 11.5% increase. Or, inversely, that's 186 crank horsepower, up 19. With a proper tune and cold air intake (CAI), some have achieved nearly 200 crank horsepower. Many folks say that is what the Miata really needs to make it go the way it can turn. Will I be able to achieve those results? That remains to be seen.

Installation

Once I had my tracking information for the header and knew that it would arrive on Friday (February 27th) I started on Thursday the process of removing the existing hardware. This task has been described lovingly as knuckle-scuffing, and with malice as the worst ****ing job you can undertake below the hood of your Miata. In reality it was somewhere between the two extremes. And in fairness, there are plenty of threads on both the Miata Forum and the Goodwin MazdaTalk Forums with detailed instructions. The overriding instruction is to have plenty of tools, plenty of patience, and to just take your time. Estimates for header virgins (my first time) ranged from 6 hours to 24 hours for the entire process.

I spent about 3.5 hours on Thursday with the removal of the old header. This task on my car included...

- Place the car firmly on jack stands and remove the front wheels.
- Remove the in cabin sound enhancing tubing.
- Remove the aftermarket (or factory) strut brace.
- Unhook and plug a heater coolant line.
- Unbracket and relocate (temporarily) a brake line.
- Remove upper and lower stock heat shields (3 pieces). Access to the fasteners for these was mostly from under the car using long and wobbly socket. One upper shield is reused.
- Remove battery and battery mounting hardware. This provides a lot more access to the factory manifold later on.
- Soak seven (7) stock manifold fasteners in WD40 or PBBlaster for an hour (more on a high mileage car – mine only has 22,000 miles).
- Disconnect the factory clips on the O2 sensors and remove them from the stock manifold. A 22mm special slotted socket is required for removal.
- Unbolt 2 of 3 mounting bolts for the alternator so it can rotate forward about an inch at the top to allow more room.
- Unbolt the 7 header bolts. Some are hard to reach from above and must be loosened from below. A breaker bar is helpful to get some of them started.

- Unbolt the header from the midpipe and save the mounting studs and springs. Gently peel off the factory gasket (looks like a woven metal doughnut) and save it for reuse.
- Remove the header and save the metal gasket as it will be reused. I might add that this is the part of the process that is the biggest knuckle-busting PITA part of the whole job. Just when you think that it can't possibly be removed you wiggle it a bit more...back up and try another angle...move it a bit more and finally...a newborn stock exhaust manifold.

If you are not immediately reinstalling the new header – and who in their right mind would want to do that without first having several martinis or beers – then it is a good idea to cover the exhaust ports with painter's tape to prevent mice, etc from entering your motor overnight.

Keep in mind that nothing in life goes entirely by the book, and my uninstal had some glitches, which I did not count on the clock. I found that I had to make 2 runs to the store. First I realized that I need the 22mm O2 sensor socket, so that required a quick trip to Autozone. Then I found that one of the manifold/midpipe studs just could not be removed from the exhaust manifold (others have reported this issue as well), so I trekked to East Sacramento Hardware for some high grade metric bolts, nuts and washers in the correct size (NOTE: these worked fine on the final install, but for \$10 I ordered a pair of the correct studs from Maita Mazda and may substitute those down the road).

FedEx could not come soon enough on Friday, and with my luck my package would be the last one dropped off at 7:00PM. But no, at around 10:30 Friday morning I heard a familiar truck out in front and sure enough, my header had arrived. As Brian Goodwin remarked to me, the hard part is over and now the fun begins. Oh I wish it were so...

The Goodwin street header is a beautiful piece of craftsmanship. I bought the less expensive stainless version but there is also a pricier ceramic header as well. It is about 5 pounds lighter than the factory contraption, and takes up less space under the hood. And getting it in place was easy. I cleaned the factory metal gasket and all the mounting surfaces, mounted the header and hand tightened the 7 mounting nuts. Here is the first challenge – torquing those 7 nuts to 25 ft/lbs each. I now realized that my large 1/2" drive torque wrench would not fit in the spaces required to torque these nuts, and my neighbor across the street (Craig races in Lemons and owns every tool on the planet) was out of town. Well, I had not been to Harbor Freight in a while, and so I took a break. For \$25 they have a very nice 3/8" drive wrench that would do the trick. I then reinstalled the downstream gasket and connected the bolts/springs assemblies and torqued these to 17 ft/lbs. Once everything was mounted and there were no clearance issues, I torqued everything to these specs. Now to reinstall the O2 sensors and...oops.



Where did that very expensive upstream wide band O2 sensor go to? Hmmm – oh there it is on the floor... GASP with a smashed plug! Seems I accidentally stepped on it earlier and never noticed. Did I say expensive? \$300 from Montgomery Mazda online, \$250 direct from Denso, but all requiring 2 business days. I finally convinced the good folks at Maita Mazda to sell me a replacement for wholesale, but It would not arrive until the following Monday afternoon. The price of power!

Well, the only thing left to do was to complete the process and install the O2 sensor when it arrived. So in went the the rear sensor... in went the 2 bolts from the alternator (a 14mm ratchet turned clockwise on the pulley nut directly below the alternator will relieve tension on the belt to make this easier)... on went the upper heat shield to protect the cooling and brake lines from header heat... on went some

heat resistant covering (purchased in a roll from Autozone) on the side of the alternator facing the first header runner... reinstall coolant hose to the heater... reinstall battery... reinstall strut brace... and reinstall sound enhancing hardware... And now wait patiently for O2 sensor YOU DUMMY...

Impressions

Maita Mazda called me at noon on Monday (at this point I had no finger nails left) and I was back and had the sensor installed by 1:00PM. I really – REALLY – wanted this install to work. And guess what? It did just that.

My car started with a bark just slightly louder than what it was with the stock manifold (but with the GWR midpipe and muffler). Off idle it is definitely louder but not obtrusive. It sounds like a proper sports car.

The modern Miata (as most modern cars) have 2 O2 sensors plumbed into their exhaust. The first (upstream) sensor is a wide band 4-wire sensor that measures, among other things, the air/fuel ratio of the motor. This allows the ECU to constantly monitor this ratio and adjust it as necessary for optimum performance. The second sensor, after the catalytic converter in the header, simply measures the performance of the cat in doing its job. Because the exhaust is now flowing so much better with the new exhaust, the mass airflow sensor (MAF) and the ECU allows more fuel into the motor. The result is more power.

My first drive around town was Tuesday, for about 20 miles. This drive allows the ECU to “relearn” the new hardware configuration and optimize the car’s performance. I definitely felt an increase in SOTP performance – quicker, higher willingness to rev to redline, more torque, and still no engine codes. My second drive was Thursday, taking our traditional route to Napa through Winters and Lake Berryessa. In all about 140 miles door to door. This route, a combination of freeway and spirited two lanes, provided an ideal opportunity to test the increased torque and power, as well as disclose any issues that may have not manifest themselves on the shorter drive. I am happy to say that no issue cropped up, and the overall performance upgrade is obvious. Money and aggravation well spent.

The Next Step

In order to complete the upgrade, I am awaiting receipt of an EcuTek tuning kit from Dynotronics in Texas. Joe represents one of the 3 master EcuTek tuners of Miatas in the US, the other 2 being Tuning Done Right in Florida and Moto-East in Pennsylvania. The process is basically the same for all three. The end user (me), using a laptop, installs and updates the EcuTek tuning software via the internet on the laptop. When that is completed, the laptop is connected to the EcuTek hardware which is in turn connected vius the OBDII port to the car. Once the ignition is turned to the ON position, the software will detect the vehicle. Save the query, which verifies that the car contains a valid stock ECU, and send it to your tuner via email. You will then receive a basic tuning file back from the tuner. This process provides a basic “ball park” tune based upon the equipment you have on your car.

Follow up tunes get more detailed and provide better performance based upon the user recording datalogs of his/her car in actual operation, and sending those files to the tuner. The tuner then reviews those logs and makes iterative changes until both parties are satisfied that the tune has been optimized. Each datalogging session requires first driving the car a minimum of 20 or so miles, then setting the equipment (yes it is still plugged into the OBDII port and in turn into the laptop which you have in the

seat next to you) to LOG TO FILE while you conduct a 5-6 mile driving cycle and at least 2 wide open throttle (WOT) runs in 3rd gear from 1500 – 6000 RPMs (25 – 85 MPH). Best to find a level, deserted section of highway with good sight lines to conduct such a test.

And that is all there is to it. I'll be adding to this blog after I receive my EcuTek gear and conduct at least my first datalogging session and get the results back. Until then stay tuned...

Update 03/11/15

Unfortunately my tuning experience with Dynotronics did not pan out. I won't belabor the issue as my situation may be different than most. But, after telling me twice that the tuning hardware was shipped to me when in fact it wasn't, I cancelled the order with Dynotronics. To his credit Joe issued me a refund right away so as to take the burden off my credit card.

I have since done further research and purchased the hardware, tune license and tune from Mike at Moto-East. The package is enroute and according to the USPS it will arrive tomorrow. This tune also includes the RaceRom features that EcuTek implemented last summer...

Update 03/20/15

After receiving my EcuTek cable and license key, I installed the EcuTek software on my laptop (Windows7) computer. The next step entailed taking the cable, license key (do not lose this) and laptop out to my car to query my ROM file and pair it to the software on the laptop (the EcuTek cable plugs into the OBDII port and into the laptop via USB). This results in no additional licenses available for any other vehicles, although the cable can certainly be used on another car with the purchase of a second license. I then emailed the resultant definition file to Mike at Moto-East so he could create a base custom map (calibration) file for my vehicle and specific equipment. This is commonly referred to as a base tune file.

I received the base tune file the next day via email, and copied it to my laptop. I then programmed my car's ECU with this base calibration, again plugging the EcuTek cable into my car's OBDII port and into my laptop via USB port, and also plugging my license into another USB port. The programming took about 8 minutes. After programming it is suggested that you drive 25-50 miles to allow the ECU to recognize the new parameters (called allowing the trims to settle).

My first drive was eye-opening. The car immediately had more pep, accelerated more smoothly, and I immediately felt more torque and horsepower than with the new exhaust only supported by the stock ROM file. But the process is not yet complete.

The following day (Tuesday 3/17) in honor of St. Patrick's Day I went out into the boonies to do some datalogging. This is a process whereby I record 20-30 minutes worth of real time engine parameters to a log file, which is then sent back to Moto-East for evaluation and further tweaking of my custom map. Mike is able to look at up to 25 different engine parameters (such as A/F ratios, knock retard, speed, etc) actually experienced while I drove. My drive of about 20 minutes also included 4 full throttle acceleration runs in 3rd gear from 2000 to 7300 rpm. When I arrived back home I emailed the file back to Mike. On Thursday (3/19) afternoon I received my revised calibration and programmed it to my car's ECU. Mike's comment was that the base tune was pretty good, but he wanted to make some minor changes to A/F ratios at certain rpm's to eliminate any knock which retards the ignition and reduces power.

This morning I took a pleasure drive to Napa and back on the usual route from Winters (via SR128/121). The car is an absolute blast to drive! It has significantly more power and torque throughout the rev range. Acceleration is smooth, and my redline has been raised to about 7300 rpm, so I have more power up top as well.

The EcuTek license also now includes features collectively named RaceRom, and I have activated all of those features. They primarily include launch control, flat lift shifting, and downshift auto-blip. The first two I have not yet tested, but downshift auto-blip is a neat and useful feature, especially on two lane curvy roads requiring plenty of downshifting into corners. Basically, at speeds generally in excess of 30-35 mph the throttle is automatically blipped (without touching the gas) when the brake pedal is depressed quickly followed by the clutch. It mimics heel and toe shifting for those klutzes like me. Think of the Nissan 370Z 6-speed that has this feature from the factory. I was able to put it to good use on my drive.

Summary & What's Next

So would I do this all again? Yes, without hesitation. I have to admit that spending about \$1,300 for hardware (header - \$600) and software (EcuTek cable, license and tunes for the life of the car as long as I stay normally aspirated - \$700) is nothing to sneeze at, however Brian Goodwin's 2012 Miata with essentially the same exhaust and M-E tune puts out about 163 RWHP, or about 190 crank HP. Compare that to Mazda's rated crank horsepower for the NC of 167. This is the car that Mazda should have made optional all along.

A final piece of equipment is currently on order from Moto-East. That is their M-E cold air intake, which they have dynoed to add 4-5 additional RWHP to the mix. That will arrive next Tuesday or so, and after installation I will do a final datalog session to fine tune my calibration.

Final Update 04/06/15

I installed the ME cold air intake last week. At the same time I also removed the ISE (intake sound enhancer) hardware that sends intake "noise" into the cabin. This was an option that never really appealed to me, and the removal cleans up the underhood area nicely. [NOTE: doing this requires the purchase of a different rubber intake hose from the dealer – about \$50].

After installing the new intake I proceeded to datalog once again. Mike got back to me with a new tune file almost immediately. Yesterday I did a second datalog, and again Mike cleaned things up a little bit (slightly lean at low rpm, a tad rich in the mid, but nothing major. I finally feel that I am at the point with this setup where I have maximized the gains possible, but safely as well. The car runs really strong, and is a real pleasure to take through the gears. And surprisingly, my gas mileage has improved nearly 15% since I started this process.

What are the downsides to all this, besides cost? Well, the header and midpipe is currently not CARB approved in California, so there is a risk that I might have to remove all or part of the equipment and flash back a stock tune come smog test time (3 more years away). However many others with this gear on NC Miatas (I DO have both catalytic converters in the correct locations and have never experienced any trouble codes) have easily passed the sniffer test here in California. And most locations have now converted to the new OBDII testing (no tailpipe test) on cars MY2000 and newer. From a bvisual

perspective, it is almost impossible to tell the difference between the aftermarket and stock header with the upper heat shield in place. Because I am confident that my car with the tune is actually cleaner than stock I feel no guilt whatsoever.

The big dog in the room, however, is still Flyin Miata. They are currently working on securing CARB approval for their FM/Cosworth supercharger kit, and if that becomes reality, I will seriously consider purchasing it.

For those interested, here are some links to the vendors that have supported me in these modifications.

[Goodwin Racing](#)

[Moto-East](#)

[EcuTek Tuning](#)