

Flyin' Miata

tech line: 1 970 242 3800



Installation and tuning instructions for the Hydra Nemesis 2.1 & 2.5 ECU

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Glossary

ECU: engine control unit
MAP: manifold absolute pressure
ATS: air temperature sensor
CTS: coolant temperature sensor
BCS: boost control solenoid
EBC: electronic boost control
WBO2: wideband oxygen sensor
NBO2: narrowband oxygen sensor
MSM: Mazdaspeed Miata
FI: forced induction
PID: proportional, integral, derivative
AFR: air fuel ratio
TPS: throttle position sensor
IAC: idle air control
WOT: wide open throttle
RPM: revolutions per minute
STT: short term (fuel) trim
kPa: kilopascals
PSI: pounds (per) square inch
CAS: cam/ crank angle sensor

WARNINGS!

Modifying your vehicle can be very rewarding, and it can also lead to financial and emotional distress. The Hydra ECU is no different. Standalone engine management tuning is serious business! If you are not qualified to tune your vehicle, PLEASE seek out the assistance of a professional. The tech staff at FM will be happy to help as much as we can with installation and tuning via phone and email, but there are still a number of things that have to be done in person by you or a qualified professional. Our base maps are good, but it is impossible to account for every variable there is. With that in mind, neither Flyin' Miata nor Hydra EMS will be held responsible for the results of bad tuning or bad luck on the part of the end user. P.S.- When street tuning, use either a co-pilot or the datalog feature in your laptop. Please do not try to drive and tune at the same time! *Note- the Hydra will not return OBD-II codes and is not CARB legal. Keep that in mind if this is a part of your state's emissions testing procedure.*

Basic Info About the Hydra ECU

Congratulations on your purchase of the Hydra Nemesis ECU! This full standalone engine management system will allow you to tune your Miata to its maximum potential. It incorporates tuning tools that assist in developing the best map for your system, and also includes safety features that protect the engine from certain adverse situations. It will allow you to datalog and store map files using a laptop computer, which can then be emailed to the techs at FM who can assist you in tuning your car remotely. This manual is a Miata specific addendum to the main manual from Hydra that is available at <http://hydraems.com/>. **Please refer to both** for maximum insight on how to operate the system.

Parts List. The Hydra ECU comes with the control box, an adaptor harness to interface the unit with your factory wiring, a serial cable for connecting the Hydra to your laptop computer, a vacuum hose for sourcing the manifold absolute pressure (MAP) signal, a NTK wideband oxygen sensor (WBO2), an air temp sensor (except MSM), a mounting clip for the ECU, and a CD with the program file and instructions. 90-97 cars will also come with a knock sensor (99+ Miatas have one from the factory). Optional items you may have purchased are larger fuel injectors (if you are running more boost than your stock injectors can handle), an electronic boost control solenoid (BCS) if you have a turbocharged car and wish to use electronic boost control (EBC), and the Data Log Lab software for graphing datalogs. *Note- Contact FM for recommendations on spark plug heat range and gap. We recommend Magnecor wires and NGK plugs for all applications.*

Installing the Hydra ECU

Location. Start by locating the stock ECU. On U.S. spec cars it is under the dash by the steering column on 99-05 cars, behind the passenger seat on 94-97 cars, and under the passenger's feet on 90-93 cars. Unplug the factory harness connectors. For 90-97 cars the Hydra will sit in the location that the factory ECU occupied, so you'll need to remove the stock ECU. For 99-05 cars take the adaptor harness and run it behind the dash (above the transmission tunnel) such that the single connector end is on the driver's side and the three connector end is on the passenger's side. Plug the stock harness ends into the adaptor harness plug. Have Band-Aids handy. Next, mount the Hydra behind the glove box with the supplied bracket. To remove the glove box on the 99-05, open it and pull forward on the right side. Once the right side pops out the left side will slide out. Next, attach the serial cable and run it out somewhere where it can be stashed normally and accessed for tuning. Attach the MAP sensor hose to the barb on the Hydra and run it out to an appropriate signal source (vacuum nipple) on the intake manifold plenum. If your car has a different intake manifold setup, the source must be between the throttle body and head when looking at the direction of airflow. This way the Hydra will see both vacuum and boost. This means **no** check valves inline! In fact, we don't recommend sharing this MAP hose with anything other than the boost



gauge. **Note- This is the most important hose on the car!** A failure, a leak, or a pinch here can cause poor running and possibly major engine damage. Please maintain this hose accordingly! Plug the 3 plug side of the adaptor harness into the Hydra. *Note- If you are installing the WBO2, skip ahead to the instructions for plugging the WBO2 wires into the harness plugs on page 7 before attaching the plugs to the Hydra.*

MAF Removal. Because the Hydra uses an internal 3 bar MAP sensor you can eliminate the factory mass air flow sensor on 94-05 cars (MAF) or the air flow meter on 90-93 cars (AFM) which imposes a restriction on your intake system. This sensor is located at the outlet of the factory air cleaner assembly. Remove this sensor if you want to increase the flow potential of your intake. If the removal of this unit creates a void that needs to be filled in your intake system, you will need to fabricate a pipe to take its place. *Our kits all include a stainless steel delete pipe for this.* The section of harness that went to the MAF can be tied back out of the way- it is no longer used. You may want to tape the end up to prevent a short since one wire is 12v.

Link Piggyback. If you are upgrading to the Hydra from a Link piggyback engine management setup or some other brand of fuel and timing management, you will need to remove all of the fuel and timing management associated with that system and return the car in effect to stock. (Except for the secondary injectors themselves from the Link system if you will be using them as staged injectors with the Hydra.) This will make the Hydra installation much more straightforward.

Air Temp Sensor. The supplied GM air temp sensor will need to be mounted and wired in. *(Except for 04-05 MSM cars that are using the factory turbo setup and FM intake- they can reuse the stock sensor. However, the GM sensor is much more responsive than the MSM unit so it may be worth a few more bucks to you if you can fabricate around the fact that they use a different thread pitch. the MSM unit is M10x1.25.)* FM kits include a bung for the sensor; other systems will require you to fabricate a 3/8 NPT bung to mount the GM sensor. With 99-05 cars you could alternatively remove the upper intake manifold and drill / tap the hole in the backside (recommended for water injection setups). The Hydra ATS comes with a length of wire and two pins that must be crimped onto the wires and inserted in the plastic piece to form the connector. These metal pins must be crimped onto a wire and then slid into the plastic connector **from the front side of the connector** with the metal tab facing up. (see photo) Therefore, if you are using the factory wires and want a clean look you will need to slide the plastic connector onto the wires **before** you crimp on the metal pins! For wiring on the 99-05 Miata (except MSM) you will be using the two wires that go to the factory air temp sensor which was mounted in the stock airbox. Remove these wires and splice them into the connector that is provided with the new sensor. *Note- if you may need to revert back to stock in the future, use spade connectors here to make the swap easier. The 99+ cars running on a stock ECU may not charge the battery without the factory ATS connected.* If you have a MSM, the ATS that is mounted in the throttle body inlet pipe is wired through the harness to the Hydra, and the other ATS in the airbox needs to be secured out of the way. 90-97 cars will require one wire from the supplied ATS run to chassis ground and the other (signal) wire to be connected to the power steering pump wire that runs



across the front of the engine- it is blue with a yellow stripe and has a female bullet connector at the end. Remove the wire from the pump and connect it to the ATS lead. If your car does not have this wire, you will need to run a flying lead back to D9 in the Hydra harness (Large blue, bottom row. See pg 7).

Fuel Injectors. The factory fuel injectors will only support up to around 200 rwhp on 99-05 cars and around 170 rwhp on 90-97 cars, give or take based on octane and tuning. *Note- the stock injectors are sufficient for all naturally aspirated builds.* The Hydra can control both high impedance (saturated) and low impedance (peak and hold) injectors with a simple change to the software (Tools -> Load Injector Response). If you have the option, use low impedance units. We supply low impedance 550cc injectors with our standard kits which can fuel up to around 300 rwhp on the stock fuel system. For those who want more power, with our big turbo kit we can supply 750cc units which should get you over 400hp when matched with our complete high flow fuel system. *Note- these boundaries can all be extended with water injection.* To install the injectors on a 99-05 Miata, you will need to remove the upper portion of your intake manifold and your fuel rail. For the 90-97 Miatas, you will just need to remove the fuel rail and the hoses/ solenoids that are in the way. You will then need to splice the supplied pigtails for the injectors into the factory wiring (*the wires are non polarized*), or if you need to be able to put the car back to stock we have plug and play injector harnesses which are far easier. *Note- After installing fuel injectors make sure to check for fuel leaks **immediately** after starting the car for the first time!* Remember to use a light coating of oil on the upper O ring before pushing the injector into the rail to avoid a pinch. Also, cleaning the lower seat area can prevent vacuum leaks on a fresh install. Be careful not to drop FOD in through the holes.

Staged Injection. If you are upgrading from a Link Piggyback ECU and are keeping your auxiliary fuel rail and extra injectors, the Hydra harness will include two flying leads for the injector switched grounds. One lead will be labeled injectors 5&8, and will go to one wire each of the injectors on the outside. The other lead will be labeled 6&7, and will go to one wire each of the middle two injectors. The injectors fire in batch; we just run two injectors per wire to reduce the load on the drivers. *Note- staged (secondary) injectors must be high impedance.* At this point all 4 injectors will still have one wire hanging. These 4 wires need to be spliced together and all will go to a switched 12v source. The easiest place to get this voltage from is to tap into the power wire of any of the various 2 wire harnesses going to sensors in that general area. (All of the emissions control sensors are over there.) Where there is a 2 wire harness, one of the wires may be white with a red stripe. This color wire will be switched 12v. Refer to your factory wiring diagram for other options.

Boost Control Solenoid. If you are adding the Boost Control Solenoid it will need to be wired in and mounted. You will want to mount it on the frame of the car by the shock tower so the signal lines to the turbo will be short. On FMII cars, the air baffle is a convenient location and holes are provided. On MSMs, you may want to fabricate a spot on the plastic baffle behind the driver's side headlight that holds a couple relays. The boost control solenoid has two wires which are non-polarized. One wire will go to a 12v source. The best place to get this is to tap into the power wire in the diagnostics box located right in that area. Access the wires as they come out of the bottom of the box. In 90-97 Miatas it is the white wire with the red stripe. In 99-05 Miatas it is the black wire with the white stripe. (Both should be coming from the top right slot if you are looking down at the top of the diagnostics box while standing at the front

of the car.) The other wire from the BCS will go to the Hydra where it will be controlled by a switched ground. The Hydra harness runs this switched ground into the factory harness to make it easier to wire up- it leads into the harness to the wire that goes to the TEN terminal in the diagnostics box (right next to the 12v wire you already tapped into!). T tap the other wire from the BCS to the following wire (labeled TEN) coming out of the diagnostics connector: 90-97 light green with a yellow stripe, 99-05 brown with a yellow stripe. *Notes- if you want to have a switched high and low boost setting, install a toggle switch inline on the signal wire so that you can switch from mechanical base boost to electronically controlled boost. This wire goes to A5 (small blue plug, top row) at the Hydra.* Your mechanical base boost should be at least 6 psi so that there is sufficient tension on the WG door. Your EBC pressure should be no more than around double your mechanical base boost. **The following is the vacuum hose routing to the current FM BCS: attach the post-compressor signal line to the EXH port, the nipple on the wastegate actuator to the OUT port, and vent the IN port to atmosphere (or port it back in between your air filter and compressor inlet). Note- these labels are stamped into the BCS housing.**

Extra Wiring for 90-93 Cars. On 90-93 cars there are extra wires that need to be run. **1)** The wire coming out of F6 (bottom of small grey) needs to be run through the firewall to the single wire coming out of the top of the thermostat housing on the front of the engine- this is to control the main fan. (It is not your water temp sensor- that is on the back of the head.) Cut the wire a couple inches before the plug and crimp the harness side of the wire into the wire going to F6. **2)** We will be running the injectors in sequential since all 90-93 cars except 93 California cars run batch injection. *(For the 93 CA cars you can skip this step and ignore the following fuel injector leads since the sequential wiring is already in place within the harness.)* The flying lead from A7 (top of small blue) will be run through the firewall to injector 3. (Injector 1 is at the front of the engine and 4 is at the firewall.) Find the yellow wire going to injector 3 and cut it (leaving a pigtail in case you ever go back to stock). Connect the injector side of this wire to the flying lead from A7. Next, we will be doing the same thing for injector 4. The flying lead from the Hydra for injector 4 is coming from C16 (top of large blue). Run it out to the yellow wire with a black stripe going to injector 4. Cut the Y/B wire and attach the injector side to the wire going to the Hydra. **3)** In order to remove the AFM from the car you will also need to run a jumper wire from A6 in the Hydra harness (there is a flying lead in A6- use this) across the transmission tunnel to the light green wire in the fuel pump relay plug that is under the dash next to the steering column. You can T tap it in if you'll need to go back to stock, otherwise you can cut the wire and attach the Hydra lead to the side going into the relay. **4)** Your 90-93 car comes with a 1 wire NBO2 that takes forever to warm up and seems to work inconsistently. If you want to install a better NBO2 you can purchase a 4 wire unit- we have them. Take the wire that went to your 1 wire unit, cut it, and splice it to the signal (black) wire on the 4 wire. The grey wire is a signal ground- you will need to run it to F11 (small grey) at the Hydra (see next page). The two white wires are the heater element and polarity doesn't matter. Run one to chassis ground and the other to a switched 12v source. The blue single spade plug behind



the driver's side headlight is an easy spot for switched power. *Note- if you must use the stock 1 wire sensor, in addition to switching to the NBO2 the outputs per the instructions in the "More Info on Maintaining the WBO2" section of this manual, in Select -> Settings -> Setup make sure that Enable O2 Lightup Delay is checked.*

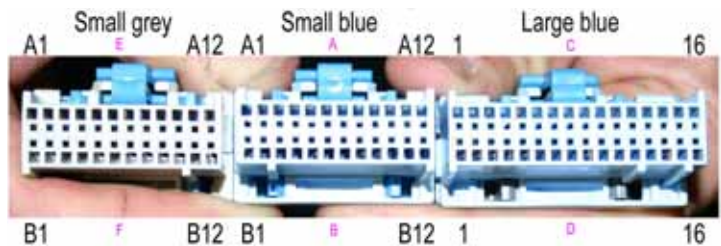
Knock Sensor. On the 90-97 cars you will need to install and wire in a knock sensor. (The 99-05 cars have one from the factory and no additional work is required.) The knock sensor itself replaces the upper front mounting bolt on the passenger side motor mount. Remove the 10mm bolt in the upper forward corner of the motor mount. Replace this bolt with the supplied adapter bolt and tighten to 20 ft/lbs. Fasten the knock sensor to the adapter with the supplied 8mm allen bolt. Tighten this bolt to 12 ft/lbs, using Locktite on the threads. **PLEASE TORQUE CAREFULLY!** Next, there is a long coaxial flying lead that comes out of the Hydra adaptor harness. Run this through the firewall at the main harness port on the passenger side. Once it is through and run down to the knock sensor, attach the 2 wire plug to it- one end goes to the main inner wire of the coaxial lead, and the other attaches to the shielding after you peel back the insulation and twist the shielding into a rope with your fingers. Finally, plug the harness onto the knock sensor- it will snap in. Use zip ties to secure the wiring appropriately.



Wideband Oxygen Sensor. The wires for the Wideband O2 sensor will need to be run and the sensor calibrated. First, plug the 5 wires into the appropriate locations in the Hydra harness. Notice the plastic plug in the WBO2 harness has letters to indicate each wire. You will notice the 3 plugs on the Hydra harness are numbered as well, but may be referred to in one of two ways per the diagram below (A-F in the picture, not stamped on the plugs). Attach the wires in the following locations by removing the retaining clip and sliding the pins into the appropriate hole until they click in:



- WBO2 A -> Small grey F1
- WBO2 B -> Small grey F2
- WBO2 C -> Small grey F9
- WBO2 D -> Small grey E11
- WBO2 E -> Large blue D7



Please double check your work here! Replacement sensors are \$275 and the heater element is delicate! The sensor itself now needs to be calibrated and installed.

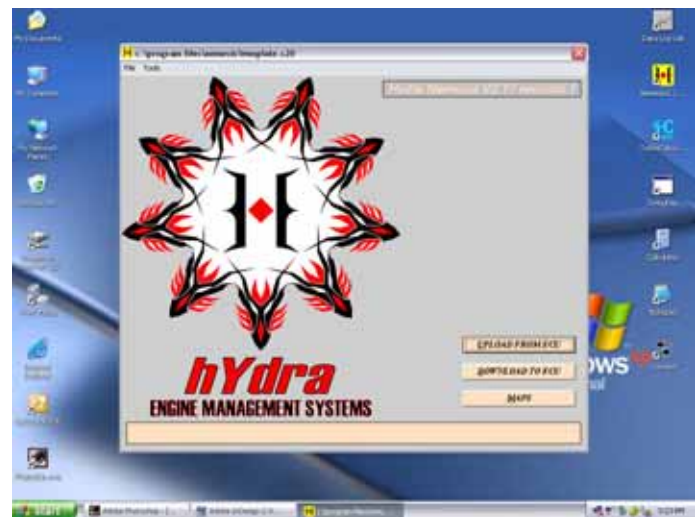
Free air calibration will be covered in the next section. Until that is done, run everything to where it needs to be, but leave the sensor itself *in free air and unplugged* from the harness. For installation, the best way to get the sensor under the car is to run it through the shift boot. If you have a FM turbo kit, there will be an extra bung for the WBO2 already in place in the downpipe just before the catalytic converter. If you have something else, you will need

to weld in a bung. (Make sure the sensor is as perpendicular as possible so that condensation does not pool in the sensor tip.) Alternatively, you can install the sensor in place of the factory narrowband O2 sensor (the one before the cat if you have two) **if it is at least 18"** from the turbine outlet. Keep in mind that with the WBO2 you lose the ability to autotune your idle fuel delivery since it does not react well to low flow rates. (Autotuning idle with the WBO2 typically causes the idle fuel to go lean, which results in idle oscillation.) This means you must manually set your idle fuel. The WBO2 will read the idle fuel mixture just fine, it just cannot autotune it. *Note- in 96-05 OBD-II Miatas, the rear factory O2 sensor (post-cat) is not wired in with the Hydra. Remove it and plug the hole or it will foul and fail.*

99 Engine Swap. If you are using a 99-00 head in a 90-97 chassis you will have to run the wires for VICS. Locating its solenoid, one post will go to 12v and the other needs to go to A11 (small blue) in the Hydra harness. If you have a 94-97 car the PRC wires already go to B+ and A11, however the Hydra can't control PRC (hot restart fuel control solenoid) at this time so just run those two wires to the VICS solenoid and you're done. Finally, while online you'll have to go to Select -> Outputs -> PWM 12 and select User 2, which should be Engine Speed < 5250. The switchover RPM can be optimized on the dyno. (PWM 12 is turned off in the 90-97 base map.)

Setting up the ECU

After you have completed the hardware installation it is time to perform the initial setup procedures in the software. The CD that came with the unit has the Hydra interface software that you need to load onto your laptop computer. Yes, you need a laptop in order to tune this system. Also, make sure that you have the correct software revision for your ECU flash- contact FM if you have any questions. Once you have installed the software, restart your computer and open the Hydra program. You will see a screen appear with the Hydra logo, software revision, the file and tools menus up top, and three buttons in the lower right corner. *Note- the 2.1 screen is in the photo. The 2.5 screen has different graphics but the menus are the same.* From the file menu, you can open and save map files. From the tools menu, you can set your preferences. Here, we recommend setting your axes labels to metric, your panel mode to digital, your auto connect to enable, your logging speed to maximum, and selecting the default COM port that you will be using. The Upload From ECU button takes the current map out of the ECU and puts it into the program for display. The Download To ECU button takes whatever file is open (displayed in the header) and writes it to the ECU, erasing what was in the ECU previously. **Be very careful that you do not press this button unless you mean to!** The "template.s20" file that opens when you open the Hydra program is not a Miata map: if you click "Download to ECU" with this file open you will erase your custom Miata map that was loaded into the box when it left FM and the car will not run! Therefore, we highly recommend taking your tuned map and overwrite it to the template.s20 file (which



tion. **2.1 Boxes-** With your foot off the pedal, see what value is in the TPS feedback. Set the value in Closed Throttle Cal to that value and click enter. Click OK to get back to the real-time screen and check the value for TPS on the left. It will probably read 1 or 2 (not zero). The idea here is to increase the value in the Closed Throttle Cal box one point at a time until you get a value of 0 for the TPS reading in the main window, and then go one more point. The reason for going one more is that the first time you see a 0 it may actually be a decimal (like 0.5) and that will keep you in open loop idle control. Going one point further makes sure it is actually zero, and this is required to go into closed loop idle. *Note- The calibrate closed button next to the TPS feedback window doesn't always get it right- some software revisions work and some don't. This is why you want to do it manually. Another note- If it always says 0 in the real-time screen, just use the Calibrate Closed button. Yet another note- Any time you change a value in a box that has an "enter" button next to it, if you do not click that button the changes will not be saved. No, the Enter button on your keyboard doesn't work for this- use your mouse to click the box.* Next, you will need to move the throttle to wide open with your foot and then click the "calibrate wide open" button. You will see the Wide Open Throttle Cal box set itself. Yes, the WOT calibration button works fine. **2.5 and later boxes-** Just use the Calibrate Closed and Calibrate Open buttons. They work properly. When you are finished, click OK.

WBO2 Calibration. Now you are back in the main real-time screen and we can calibrate the WBO2. Your battery needs to be at least 12v for this to work, and over 13v is better. If it is weak, you will need to start the car to bring the voltage up in order to do the following calibrations. On the left, take note of the value in AFR. We want this value for stoichiometric calibration of the WBO2 to be 14.7. (Remember- the WB is still unplugged at its connector.) If it is not,



go to Select -> Settings -> Sensor, and alter the value in WEGO Zero Cal until you get the 14.7 real-time value in the main screen. (You will have to click "enter", and then "Ok" each time to save the change and go have a look.) The value here should be within 125-130: if it is not contact FM for assistance as the box may need to be sent in for a reflash. (See addendum in next paragraph for more specific setup info.) Now, plug the sensor in and let it hang in free air. Give it a couple minutes to fully heat up- you will see the value in the real-time screen stabilize when it does. It will get very hot so be careful! Next,

you'll to calibrate the sensor to free air. The procedure is the same as above, however in the real-time screen we are looking for a value of 20.7 and the alterations to get there will be made in the WEGO Grad Cal box. *Note- as the sensor ages it is a good idea to repeat the free air calibration procedure. You can easily check to see if it is way off- your AFR (WBO2) should read around 14.7 when your O2 (NBO2) is dithering from 0-1.* When these steps are complete you can close the main window and remove the key from the ignition. Install the WBO2 sensor in the exhaust pipe once it has cooled down. You are now calibrated and ready to begin tuning. *Note- as you make alterations it is a good idea to save the files so you have a running log of changes. Take a look towards the top of the screen and you will see the "Save" button. This way, if errors occur you always have a place to go back to.*

More info on maintaining the WBO2

The system voltage does make a difference when calibrating the WBO2- if it is too low it won't calibrate. Therefore, it will be calibrated to free air most accurately when the car is running and you are at normal system voltage. This means that you will need to plug the sensor hole with a bung plug and do something to keep the exhaust from blowing back around the sensor while the car runs. If you can't start the car, make sure the system voltage is above 12v.

The NTK lab grade WBO2 that the Hydra comes with isn't as robust as the commercial grade Bosch LSU units used in many other aftermarket WBO2 setups. Therefore, you have the option of removing the WBO2 and switching back to the factory NBO2 for daily driving after doing all your fuel tuning and getting your fuel map right where you want it. The NBO2 does have short term (Enable Closed Loop) and long term (Long Term Learning) fuel trims, so as long as your fuel map is internally consistent it will move it around as necessary using these trims as temperatures and pressures change. Your other choice would be to run the WB full time and be OK with maybe having to replace the sensor from time to time at \$275 a pop. We honestly don't know what to expect for a lifespan- it depends on a lot of things. Hydra says they have a lifespan of around 500-800 hours on turbocharged cars. Keep in mind that if it is in and does start to fail, the Hydra doesn't know the difference and will continue to make changes to your fuel trim causing a possible rich or lean everywhere condition. A failing WBO2 sensor will have an output that is not responsive to changes in throttle input, up to the point where it is dead and the output flatlines- you will want to monitor for this. Typically it flatlines at ~14.7 AFR.

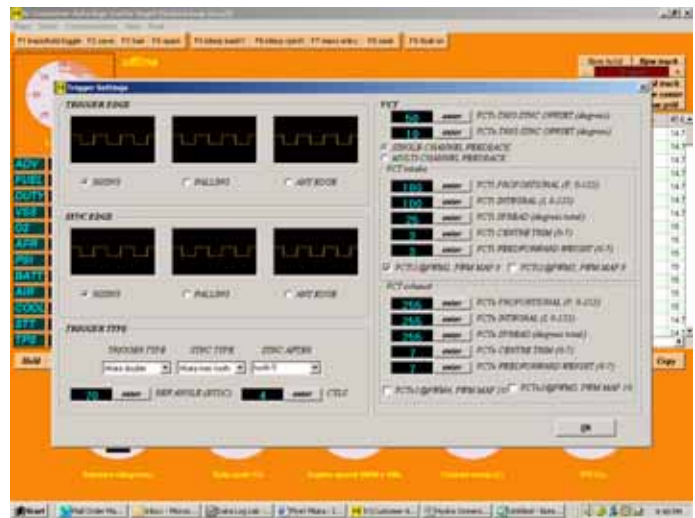
When switching from WBO2 to NBO2, you have to alter some settings in the Hydra to tell it what to pay attention to. In Select -> Settings -> Closed Loop you have the following:

For the WBO2- check Enable Closed Loop, make your lower RPM limit 1500 since the WB can't tune idle and your upper RPM limit the same as where your rev limiter is set. If your car idles above 1500 for some reason (say with AC on), set the minimum to just above your high idle speed. Check Wideband Target Table for the left and right channel. The left channel is what is used in 4 cylinder and straight 6 engines. *Note- both the left and right would be used in a V6 or a V8.* Therefore the right channel is not used in the Miata, but we check it anyway as not to confuse the Hydra. Of course, if you are auto tuning you will also need to check Enable Auto-tune and have the laptop running. (Long Term Learning does not apply to the WBO2.)

For the NBO2- check Enable Closed loop for short term trim and Enable Long Term Learning for long term trim. (Auto-tune does not apply to the NBO2.) Set your lower RPM limit to 750 and your upper RPM limit to say 500-1000rpm above the highest RPM you normally have as a cruising speed on the highway- we usually use 4750 or 5000. *Note- on some cars, especially supercharged ones, the engine just doesn't like to idle at stoich. In these cases, make your lower limit 1500 and manually tune your idle AFR in the 13.5-14 range which should help stabilize the idle. Of course, this won't fly for an idle emissions test..* Set the left sensor source to 14.7 left and the right sensor source to 14.7 right. The last thing to do is to click OK to get out of there and then go to Select -> Control 3 -> Closed Loop Limit. This is the max manifold pressure at any RPM that it will allow NBO2 tuning. Somewhere around 70-75 kPa is a normal cutoff. You can monitor while you are driving where the manifold pressure is (at or below) during cruise or light acceleration, and then at what point it makes the break to "I'm accelerat-

light. With the car running and at a smooth idle, look at the top of the real-time number display on the left of the home screen. The box labeled "ADV" is your actual ignition advance in degrees. This value is determined by taking the value from the ignition map and applying to it any trim as defined in your air and water temperature spark compensation tables. Next, under the hood of the car hook a timing light up to the #1 plug wire and flash the light at the timing marker (around 1-2 o'clock) on the main (crank) pulley. What we want to see is the following: the timing marker on the pulley (the passenger side notch if there are two) lines up with the value on the backing plate that corresponds to the ADV reading, in real-time (online mode). If it does not, you will need to adjust your base timing.

For example- if the value in ADV is 10, it makes the procedure easy. If your main pulley has one timing notch (90-93), we want this notch to line up with the "10" on the backing plate. If your main pulley has two timing notches (94-05), you want the left notch to line up with the "10" and the right notch to line up with the "T" (top dead center, or 0 degrees) on the backing plate (as viewed from the front of the car). If the value in ADV is more or less than 10 you will use the idea behind the procedure in the last sentence, however make sure the backing plate marker value that you line the timing notch up with is the same as the value you see in the ADV screen. *Note- each notch on the backing plate is 2 degrees!* Therefore, if the ADV value says 12, line the timing notch up to the notch on the backing plate one left of the 10 marker. If it says 9, line it up in-between the 10 and the next notch to the right.



Reference Angle. Adjustments to your base timing will be made in the Ref Angle box under Select -> Triggers. The default is 76. You will need to get offline to view this screen, and any changes will have to be Downloaded to ECU to take effect. Lowering this number will advance the base timing and raising the number will retard it. Continue altering the number as necessary while offline, then downloading, then key off/ key on and upload, and then re-checking with the timing light until the ADV value matches the pulley value. Once it matches, the base timing is calibrated. **All years must have the base timing calibrated.**

For 90-97 cars you may run out of adjustment in Ref Angle (There is a floor and a ceiling) and will have to move your Cam Angle Sensor to get it back in range. To do this, loosen the 12mm bolt that locks the cam angle sensor (CAS) in place and rotate the sensor until the timing marker on the pulley lines up with the appropriate marker on the backing plate. Remember to re-tighten when finished. The CAS is at the back of the head: behind the intake cam for 1.6L engines and behind the exhaust cam for 1.8L engines.

Zone Grid Manipulation. In order to manually alter a zone in the Hydra software, first look at the top right of the real-time screen. Click on RPM hold and Load hold. This locks the table from walking around so you can move through it with the arrow keys. Also, below the spread-

sheet there is a light blue box with a value that is your resolution of change. Identify a zone that needs to be altered and move to it using your arrow keys. You will see a blue highlighted box moving with your actions. (The yellow box is where the ECU is in real-time) Once you reach the zone to change, use the Page Up and Page Down buttons to alter that zone in the increments defined in the box at the bottom. If you are online you must hit Enter after the change is made. If you wish to alter a number of zones at the same time in a 3D table, highlight them all by holding the Ctrl key while moving around with the arrow keys. Also, if you need to change a zone or zones all to one value in a 3D table, hit F7 and enter the value (offline mode only). Everything highlighted will change to the value you enter.

Tuning Your Idle Fuel. Because the WBO2 will not read precisely at low flow rates, you need to manually tune your idle fuel. We will assume you are now running and at a point close to correct. To get this dialed in, once you've fully warmed up the engine get online and look at the O2 value on the left side of the real-time screen. (The left of the two numbers in the O2 box.) (Have all accessories off.) This value is the feedback from your stock narrowband O2 (NBO2) sensor. It's actually pretty good for idle and cruise tuning (and that's about it). *Note- while the O2 value in real-time refers to the factory NBO2 sensor, the AFR value below it refers to the WBO2 sensor that came with the Hydra.* If you see a value of 0.0, you are lean. If you see a value of 1.0, you are rich. If it is dithering between 0 and 1 you are at stoichiometric. (This is the air/ fuel ratio at which the most complete combustion occurs. The value with gasoline is roughly 14.7:1.) Remember, a dither around stoich is normal for a NBO2. If your WBO2 is properly calibrated, then when the NBO2 is dithering you should see a value of ~14.7 in the WBO2 output. Alter your real-time fuel zones until you see the value switching from 0 to 1 in the NBO2, or in the mid 14s with the WBO2. Next, you may want to repeat this procedure for the zones that the ECU goes into as you introduce electrical load. Turn on all your accessories and repeat. When you look at the graph or spreadsheet in the real-time screen while you are online you will notice the yellow highlighted box following where you are. As loads are introduced (fan, radio, headlights, AC) it should move towards decreased vacuum (right). If at this point there are issues with idle oscillation, you can try going a little rich of stoich to see if it will stabilize. (Some cars, especially supercharged ones or ones with really big injectors, do not like to idle at stoich. In this case make your idle fuel zones just rich enough to where they idle smooth.) When this is done, manually interpolate the areas in-between and around these zones so that a smooth fuel curve is maintained.



Idle Speed Control. Setting up your idle speed control can be tricky, especially if you are supercharged. Therefore you should not be too concerned if it takes a little while to get it right. The idea is to get a stable idle speed with no significant surging, drooping, or stalling. Your controls for idle speed are at Select -> Settings -> ISC. The Min and Max PWM DUTY parameters control the idle speed. Either can raise and lower it. You'll want to start by setting both of these values to 0, which effectively turns off the ISC motor. Next, you set your base idle speed to 50-100

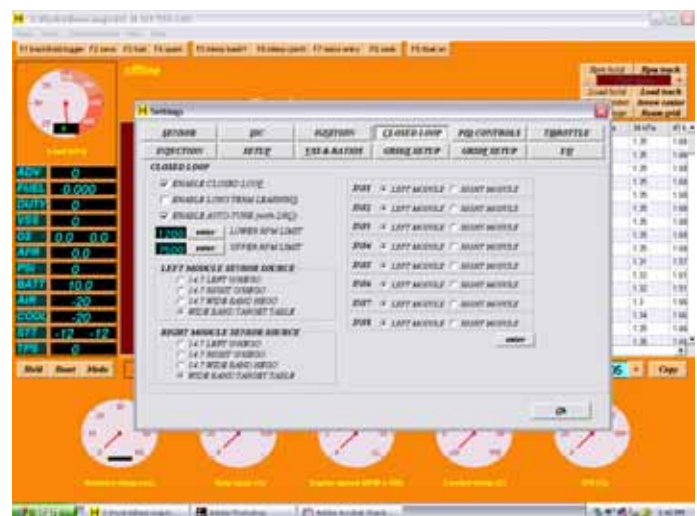
RPM less than your target idle speed by screwing the idle air bypass screw on the side of your throttle body (it is inside a sheath). Tightening will lower idle and loosening will raise your idle. If at this point you have no control over your idle speed with this screw, then you most likely have a vacuum leak that must be fixed before you can move on. After you achieve the desired idle speed, you can set the Min and Max values. Start with 20 and 80, respectively, and then manipulate them from there to hit your target and keep it stable. Once this is done you need to adjust your Max Vacuum. Rev the engine, release the throttle, and see what the RPM does as it drops to idle. If this value is high (more vacuum) it can cause a slight dip in idle (or even a stall) since idle control takes longer to kick in when the revs fall. When the number is too low (less vacuum) the idle will stay high and not come down. What you want is for the RPM to drop to around 1200 RPM, pause as if it were cushioned, then slowly come to your normal stable idle speed. If you alter this in conjunction with the Min and Max you should be able to achieve a solid idle. Next, drive the car. Set your Moving Steps Up as required to keep the idle hanging a little above your idle target if you put it in neutral while the car is moving. Finally, park and turn on your AC. Adjust your AC Steps Up to get an acceptable bump in idle speed when the AC comes on. If it droops or stalls when coming to a stop with the AC on, bump the value up a little more. (Keeping your Min PWM DUTY in the 20-30 range helps this as well.) You may also just need to richen the fuel up to the 13.5-14.0 range with AC on, and/or give your idle timing a couple degrees more advance in the AC idle zones. Increasing the base idle speed with a supercharged car can help as well. *Note- If you want the startup idle flare to last longer, raise the Max ISC Integrator.*



More Information. If you are looking for more general Hydra insight, check out the information on the MR Controls website. Ricky Benitez does Hydras for Toyotas and other cars, and has put a lot of time into a nice writeup that covers ideas that are not car specific. There is a nice tuning primer as well. <http://mrcontrols.com/installs/nemesis/troubleshooting.htm>

Fuel Autotuning

Now you can begin fuel autotuning with the wideband O2 sensor (WBO2). Go to Select -> Settings -> Closed Loop. Enable Closed Loop and Enable Auto-Tune should be checked. Make your Lower RPM Limit 1500 rpm (remember, the WB doesn't tune well at low flow rates such as idle) and the Upper the same as your redline. Now, any time that the laptop is connected and online the Hydra will be autotuning based on closed loop feedback from the WBO2. Its goal is to hit the target for each zone as defined in the Select -> AFR Target



map. On the left in the real-time screen, look at the box labeled STT (short term trim). Any time there are values in there other than 0, autotuning is occurring. *Note- these changes are being stored in the short term memory of the ECU and will not display in the real-time table unless you click the Upload from ECU button again. Also, the fuel table will paint any zones you have been in while you are in the fuel screen- try to tune as many as possible within your operating range.* At this point, just drive the car. When you are done, pull over and leave the car running. Close the real-time screen. Click on Upload from ECU. You have now captured the autotuning changes. Click on Download to ECU- the car will stall. (Yes, this is one of the few times where you will actually mean to press this button!) You have now written the changes to long term memory and they will remain after you turn the car off. (Otherwise, all changes are lost when you turn the car off.) At this point, you should save the file (hit F2) so that you have a running log of all changes. This is useful in case there is a bad upload and you have to go to a previous map to get things going again. *Note- all maps will automatically be saved in C:\Program Files\Wemesis unless you tell it to put them somewhere else.* You can now turn the car off. If you want to keep autotuning, start the car back up, click Upload from ECU to get the current map, and keep going. The more time you spend tuning the fuel, the more smooth and precise things will be. *Note- if you want to reset the real-time traces you can do it in the Tools menu.* Of course, manual smoothing will always help after autotuning. Gentle upward and downward slopes are fine, however you should smooth out the rocks and gopher holes as they are almost certainly not precise. *Note- Keep in mind that the maximum number of milliseconds (which is the measure of value in the Hydra fuel map) that can be injected into the engine at any given engine speed is defined in the equation $[120 / \text{thousand RPM}]$. Therefore, for a 7500 RPM redline the time available is $120 / 7.5$, or 16 milliseconds. If the base fuel plus any added trims exceed this amount at that RPM, the additional fuel will not richen the AFR. Also take note that the Hydra reads a conservative injector duty cycle- 100% in the Hydra is really around 80-85% in actuality. Therefore, you can tune your fuel out to 100% in the Hydra real-time screen and datalogs.*

Going Into Boost

There are a couple of things you will want to do the first time you venture into boost. *Note- We recommend getting the car dialed in on base boost before increasing the boost with electronic boost control. Therefore, until you are ready you'll want to leave Select -> Outputs -> PWM 3 turned off (this is your EBC output).* Activating and tuning EBC will be covered in detail in the Electronic Boost Control section (in a few pages).

Knock Threshold. When you are ready to boost go to Select -> Control 1 -> Knock Threshold. Here you will see a stream of little white "x"s that represent the real-time voltage output from your knock sensor. *Note- the stream has a limit, so when you reach it the oldest "x"s will fall off.* The solid line is defined as the knock threshold. The dotted line is the really big knock threshold. These levels are both user adjustable. The way to set the knock threshold for your car is to monitor



the "x"s while you rev the engine out to redline **while staying in vacuum** (less than 0 on your boost gauge). Without load there won't be knock. Therefore, any "x" activity is engine noise. Set your threshold at around double the height that your engine noise went to during this test. Then, it is reasonable to assume that any "x" outlying from the group while driving under load will be knock. The really big knock threshold line is a buffer voltage that can be set in the Select -> Settings -> Ignition screen.

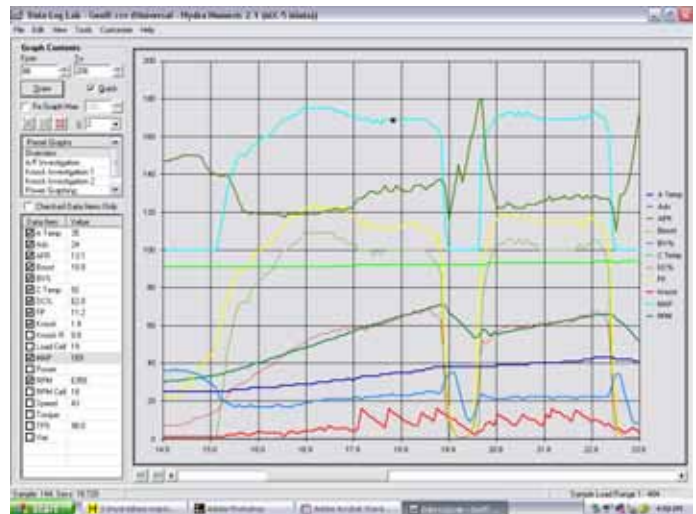
Checking for Knock. As you go into boost for the first time, make sure that you are not getting any knock. If you are, you will want to address your timing and fuelling to get it corrected before spending any time in boost. The other thing that you must verify the first time you go into boost is that in the dial in the top left of the screen you are seeing values above 100. (100 kPa is atmospheric pressure at sea level.) If not, your MAP signal line is not hooked up properly and you will run too little fuel/ too much timing which can cause major engine damage!

Tuning Your Timing

The timing table that came with your base map was developed using cars tuned at FM on Colorado 91 octane gas, which is about the same as 92 in the midwest. The 93 octane gas in the East will allow for a little more timing and fuelling in boost, and 93 in the South can get you even more. California, Arizona, and Nevada 91 octane fuel may require you to be a little more conservative with your boosted timing than in our base maps. If you hit F4 or go to Select -> Spark, you will see the spark map. The off-boost spark timing is pretty good. There is no real reason to change it unless you have an exhaust gas analyzer and wish to dial it in for emissions. *Note- if you are in the Spark screen and a zone turns red, you have exceeded your knock threshold in that zone!*



Datalogging. The best way to tune your timing is by running a datalog of the car being driven and then analyze the data after the fact. While it is best to do this on a dyno, it is possible to do datalog based tuning on the street if it can be done in a safe, legal manner with a passenger running the laptop. While driving and online, go to Tools -> Log Data. Drag the slider bar in the top right all the way to the right to increase the sampling rate (in Hz) to maximum. The two useful pulls to do for analyzing your full throttle timing and fuelling are a 1-2-3 hard pull as if you



were drag racing, and also a long pull from low RPM to redline in a higher gear. When you are finished, click on the Stop button. Next, at the top of the window export the log to a .csv (comma separated values) file. FM techs need this file for tuning along with a current map (.s20) file. This .csv file can be viewed in Excel as a number chart, and also you can view it graphically in Data Log Lab; a software program that can be purchased through FM. It is highly recommended for its tuning potential and ease of use.

Note- when opening up a .s20 Hydra map file, do not do it by double clicking the file in Windows. Always do it through the Hydra program by going to File -> Open.

We recommend that if you are not experienced with tuning standalone ECUs that you have a qualified professional to do it for you. Optimization in many aspects is key to a good experience and a reliable car. The tech department at FM can assist you- feel free to call us if you have any questions.

Electronic Boost Control

The Hydra can manage electronic boost control on turbocharged cars when all of the associated parameters are tuned properly. This takes some work initially, but when finished it will result in stable boost control and a faster ramp up than with mechanical control. It is of course easier to set up if your mechanical base boost is smooth and stable. If it is not, then electronic boost control (EBC) will be more difficult to optimize. The map that was provided with your Hydra for electronic boost control is one that was successfully set up here at FM. Yours will most likely be at least a little different (typically all higher or all lower), but this gives you an idea about what kind of shape you are looking for. To be on the safe side, once again, do not just go floor it the first time you get the BCS installed with the Hydra. The possibility of overboost dictates that certain tuning steps should first be observed. In actuality, we recommend that you set up and tune the car only using mechanical base boost, and then once the car is running well you can address raising the boost with EBC and tuning those areas of the map.

Step 1. The idea with electronic boost control is that the boost control solenoid bypasses air going to the wastegate actuator in order to raise the boost level above the amount controlled mechanically by the actuator alone, realistically up to about double the pressure controlled by the mechanical gate. (EBC cannot lower boost.) You'll need to dial in a number of parameters to get this closed loop control smooth and precise. The first thing you want to do is to decide on the amount of boost you want to run and enter it in the Boost Target map. (Select -> Control 2 -> Boost Target) Enter it from 0 RPM all the way to your redline RPM (roughly). This way, boost will fall off if you over-rev. *Note- we found once that setting the 0 RPM target to 0 caused a car not to start. This is why we enter the target value even in the lower zones where there will be*



no boost. Keep in mind also that there is a boost limit hard coded into the Hydra of 3 psi over whatever boost level is defined here. This means that if you over-boost, the Hydra will momentarily shut off fuel to prevent damage to the engine. If this happens, you will know it.

Step 2. The next step is to go to Select -> Setting -> PID Controls. The value that you want to enter in Boost Control Start RPM is whatever RPM you first make positive pressure in a high gear. To determine this, you will need to drive on the highway while online and in the real-time screen of your laptop. It is better if there is no traffic. (Remember, data-log or co-pilot!) Slow down to around 2000 RPM while in top gear and then floor it. Monitor the PSI value on the left of the screen. Determine at what RPM you see a 1 in that box, indicating you have gone into boost and are now making 1 psi. This is the RPM you want to enter in the Boost Control Start RPM box. If logistically you just can't do this then use 2400- it works well on all cars at FM. Also in that screen are the Boost Control PID settings. The values we have set up in there (60, 60, 40) are working well for the BCS we sell. If after the next step you have boost oscillations (after you reach boost threshold and are proceeding towards redline) you may need to alter these numbers. In a nutshell, Proportional will indicate how strongly the solenoid will act when the actual boost is not at the target boost. Too small a value will make the action go slowly towards target while too large a value will make it move too quickly and overshoot. Integral will determine how much overshoot is allowed so that you can get to the target quickly. A low value causes a slow convergence and a high value speeds it up, which can also cause overshoot. Derivative acts as a damper. Too small a value will do little to dampen hunting around the target while too large a value will slow down the rate that the system moves towards the target.



Step 3a. Now you will need to activate your EBC (it is turned off in the base map) and test and tune the gain map for the solenoid. Go to Select -> Outputs -> PWM 3. On the left, click the radio button for PWM Map 2. This will bring up a link to Input X = WG PID (%) on the right. Click OK, and your BCS is activated.

Step 3b. Now to actually set your boost level. It is at Select -> 2D pwm -> PWM MAP 2. In here you will see a curve. **This is where the boost level will actually be determined.** Once everything else with the car is safely tuned and you are ready to work on EBC, go for a drive somewhere appropriate and safe with a friend. One of you will drive and the other will work the laptop. Go into full throttle boost. Have the tuner monitor the boost level. Take note of what zone the yellow highlighted



part of the bar was in while you were in boost. (The yellow real-time section will be all the way to the left when you are not in boost.) If you exceed your boost target, immediately lift to prevent overboost. If not, just stop accelerating when appropriate. Next, go into Select -> Control 1 -> Knock Threshold and make sure there are no "x"s above the line. If there are, you will want to reduce timing in the offending zones (the red marked zones in the Spark screen) before working on setting up the boost there. Remember, keep your timing curve smooth!

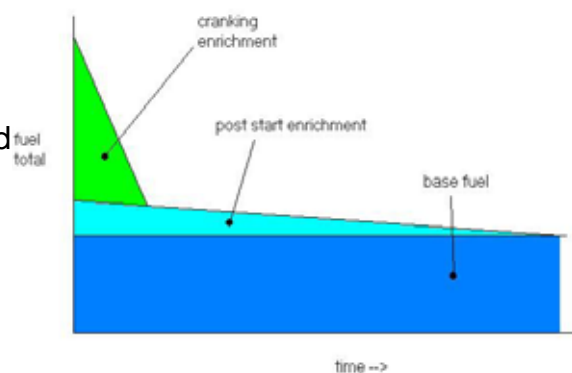
Step 3c. Once the lack of knock is confirmed, go back to PWM Map 2. The yellow section of the graph that was active while you were in boost is what you need to alter if you were not on target. If your boost was below target, increase the value in that section. If you went over target, lower the value. *Note- as you alter the necessary points on the curve, you should make changes to maintain a smooth arc in the points around there that you did not alter.* Repeat this procedure until you come up to boost target in a smooth and stable fashion. The idea here is that this gain amount is the first response of the EBC when you go above your Boost Control Start RPM at full throttle.

Step 3d. Once you have it set up where it will hit target smoothly from below your boost threshold, you can then look at how it behaves at higher RPM levels. If you get boost creep or droop while moving through the RPM range at full throttle, you want to look to see if the yellow real-time portion of the curve moves to an adjacent zone. If this occurs, you will need to set up the adjacent zone the same way as you did the primary zone. If you still get boost oscillations while at full throttle after reaching your boost target, then you may need to alter your settings in the Select -> Settings -> PID Controls menu. *Note- if your atmospheric conditions change significantly and you then experience lower or higher boost levels, you may need to go re-tune your PWM Map 2 for the current conditions.*

Start Settings

There are a number of parameters that will allow you to optimize the starting and warm up behavior of your car. These items stack on top of each other, so the best way to set them up will be from the inside out. (Remember, the link to the MR Controls website has lots of good information on cold start as well.) The first thing you need to do is get the car fully warmed up and tune the idle fuel areas. Without this step the start parameters will not have the correct base to build from. *Note- these parameters are defined as % enrichment per temperature. This means that you will need to set the map up as the seasons change since different times of year will have different ambient temps when you go to start the car cold. The colder it gets, the more fuel you will need to add to get it going.* Once you have gone through a year of seasons while setting this up you should not need to alter it annually. One other thing to consider in addition to the starting parameters below is that Coolant Temp Trim (of fuel, under Select -> Control 1) will be integrated into the base fuel calculations, even during starting.

Cranking enrichment sets below 300 rpm and rapidly decays after start. Post start enrichment sets at key on and slowly decays over seconds or minutes, depending on engine speed.



Select -> Control 2 -> Start Primer: This is a small amount of fuel squirted into the manifold at key on in really cold temperatures when fuel doesn't like to evaporate as fast. This factor should not be needed for normal temperatures. Start adding some in here below freezing.

Select -> Control 2 -> Cranking Enrichment: This is fuel added during cranking. If the engine cranks for an excessive amount of time without starting (more than ~4 seconds), this value may be too low (or way too rich if you notice fouled plugs).

Select -> Control 1 -> Post Start Enrichment: This is fuel that assists in the warm up of the car after starting. *Note- This decays over the course of a couple minutes, and once it is gone the total fuel output is simply your fuel map with the trims from the air temp and coolant temp trim maps applied.* If the car starts (cranking enrichment) and then stalls soon after (or just runs lean while cold) your post start enrichment may be too low. If it pukes fuel, it may be too high. You want to shoot for a cold idle AFR of around 13.5:1-14:1 and then have it lean down to stoich (14.7:1) as soon as it is happy doing so as the car warms up (assuming you have a car that will idle at stoich).

Closed Loop Alternator Control

While the 90-97 cars have voltage control built into the alternator, the 99-05 cars have ECU regulated voltage control. This means that the Hydra is responsible for maintaining a set voltage range within the system. If in your 99-05 car your system exceeds 15v, your Brake & ABS lights on the dash will come on and the radio will cut out. *Note- the Hydra software will not read over 15v! This means that your system voltage could be dangerously more!* If this occurs, go

to Select -> 2D PWM -> PWM map 1. This is your closed loop alternator control gain map. Observe what zone the real-time yellow bar is in when the over voltage occurs. Lower that section of the map until the voltage stabilizes between 13.5-14.5v when in that zone. Remember, a smooth map is always better so you may consider smoothing the adjacent zones. *Note- if you ever notice your system voltage dropping below 13v, go through the same procedure except raise the correlating zone until your voltage stabilizes between 13.5-14.5v. However, if the voltage goes low when you introduce electrical load and at the same time the yellow bar goes most or all the*



way to the right of the curve, it is a good indication that your alternator is giving up the ghost. If you have system voltage oscillations that need to be stabilized and are not caused by the ya-yas from a lean idle condition, you can try to stabilize them by altering the proportional and integral terms for the closed loop alternator control. You will see them in Select -> Settings -> PID Controls. The normal range for Input Follower Proportional is 200-225 and Input Follower Integral is 100-150.

Variable Cam Timing

On 2001-2005 Miatas (except Mazdaspeeds) there is a hydraulic assembly on the intake cam that allows for infinitely adjustable cam timing between two end points based on a 3D map. Previously there has been no good aftermarket way to take control of this system; now you can. Having control of your valve overlap is an excellent tool- it allows for the user to realize optimal flow rates for both cruise and full throttle. Without this there is always some compromise involved in cam timing. *Warning- improper cam timing can cause increased EGTs, detonation, and also bent valves in interference engines. This variable is not for the amateur tuner.* While normally aspirated and supercharged cars can benefit some from tuning your adjustable cam, turbocharged cars can benefit even more. It will allow you keep enough overlap to assist in spooling the turbo and then back off to a minimal overlap when you are in boost. *Note- The 3D maps and the Triggers must be unlocked together for the 3D spreads to be correct.*

To access the cam map, go to Select -> 3D PWM -> PWM MAP 9. In the spreadsheet you will see %X on the vertical axis and %Y on the horizontal axis. These relate to 0-100% of whatever your spread is as defined in Select -> Settings -> GridX Setup/ GridY Setup. An easier way to see the maximum of your spread is just to go to your fuel or timing map and scroll all the way to the last zone right/ down. *Note- stock Miata engines are non-interference. If you have a head shave, aftermarket pistons, high lift cams, or oversized valves you need to determine if your engine has become an interference one. If so, incorrect tuning of this map could put a piston into a valve!*



X will be your RPM spread, Y will be your load spread. A value of 0 is considered the same as if the gear were a fixed pre-01 unit. Negative numbers are retarded from that position (less overlap, counter clockwise) and positive numbers are advanced from it (more overlap, clockwise). There are 12.5 degrees of total cam movement in the gear. The numbers in the grid however are expressed in crank degrees- which are double the cam degrees. This means that while the numbers in the chart will allow for -12.5 to +12.5, what you are really seeing at the cam is -6.25 to +6.25 degrees. *Note- when the system is not receiving oil pressure to advance the cam, such as if it is unplugged, the cam locks at full retard.*

For idle and low RPM, there is not enough oil pressure in the system and therefore you should leave the value in the chart at full retard (-12.5) so that it does not even try to advance the cam. Not doing so can result in a bad idle. For cruising, we recommend starting with a little cam advance (a positive number). *Note- this is a good place to fine tune on a dyno with an exhaust gas analyzer if you have access to one.* For boost, the most power should be made with some degree of retard in a turbocharged car. Keep in mind that too much retard can cause elevated

EGTs if you are on 91 octane because there is not enough resistance to burn to allow you to increase your ignition advance and bring the EGTs back down. Therefore you should monitor and tune with all relevant sensors. For NA and supercharged cars, best power at WOT may be with the cam advanced in the same general area as you are using at cruise, or it may be with some retard. This is something that really needs to be set up on a dyno for best results. For the areas between cruise and WOT the curve should be shaped to be smooth and effective.

Triggers

Your ignition triggers are loaded into the Hydra along with the base map. 90-97 triggers are different than 99-05. While we used to lock certain things out (such as the triggers) prior to shipping, now that we require the base timing to be set by the end user as defined earlier we are shipping the box to you fully unlocked. Other than the base timing procedure, the items in the Triggers page **are not to be altered**. *Note- if your triggers get locked and then unlocked, you may lose them causing the car not to start. You will need to call FM to get them re-entered.*

Passwords

The Hydra comes with the ability to lock or unlock various sections of the map. This is useful for items that you know you will not need/ want to alter, or if you have tuned the car and want to keep other users from messing things up. If you are a professional tuner, you can also use this feature to protect your intellectual property. You will find the password in Select -> Settings -> Setup. When you are online, the Enter button will enter the password in the box into the Hydra and the Check Status button will tell you what is locked and what is not. A big reason for locking things out is that if maps were ever to be shared, there are many things about the map that are not transferable from car to car- therefore the locking out is to protect you from doing something that will cause the car to not run. *Note- once all initial tuning is done, for your protection please contact FM to walk you through locking out the items that will no longer need to be altered.*

The password is a string of characters, however it is broken up into 3 digit segments. Altering any one digit of a 3 digit segment will lock that variable out. For example, given the complete password below if one wanted to lock out the Triggers they would change the 45m to say 45n (or whatever) when they enter the string of characters. *Note- certain items will not be displayed correctly in the map if they are locked out.* (The password below is just a sample.)

Settings	3D Maps	Autotune	Fuel	Timing	Triggers	3D Axis	Outputs
ABc	123	deF	GHI	JKL	45m	678	9NO

Launch Control

The Hydra can do launch control and flat shift. If you want to use the feature remember the following- If it is a N/A or supercharged car you should use similiar amount of fuel and ignition cut cycles so as not to load the motor up with fuel. For example: Fuel cut cycles: 60, Spark cut

cycles: 60. If however you are using this control in a turbo car you should use relatively less fuel cut cycles in order to build heat. This will help to build boost during the launch process. *Note- if launch control is weird or is hanging up your acceleration on a hard launch, make sure your VSS (vehicle speed sensor) is reading correctly and properly calibrated.*

Shift Light. If you want to hook up a shift light you can run 12v to one side of the light and run a switched ground from the other side to the Hydra, attaching it at D8 (Large blue, bottom row). Then, in Select -> Outputs -> Inj7 you'll select User 3. In the drop down box select Engine Speed (RPM) >. Set the RPM you want and you're done.

Hydramist Water Injection

Phil Grabow of Element Tuning has designed a water injection setup that is fully integrated into the Hydra Nemesis system. While their directions (http://elementtuning.com/Hydramist/element_hydramist.htm) give you the big picture on the installation and some general instructions, and the kit comes with a detailed wiring diagram for the control unit, the following will tell you additional information on how to hook this up for your Miata Hydra system. Needless to say, this is different than how they do it on their Subaru. *Note- this setup comes with basically everything you need, except for the water tank itself.* For more general information on WI theory, Google it.

Wiring. Complete the installation and wiring per their diagram for the DDS3 Junction Box with the following addendums. The green wire that goes to the Hydra for controlling the high speed valve PWM Map will go to F5 in the small grey plug. The black wire that goes to the Hydra to trigger the Auxilliary fuel and timing maps will go to D13 in the large blue plug. The loose red switched 12v wire will go to an ignition switched battery source. *You have a factory wiring diagram for your car, right?* The loose black ground wire will go to a good chassis ground. *Note- do not share ground points.* The loose green wire that goes to the location labeled Dimming will connect to a wire that gets power when the headlights are turned on. The loose brown wire labeled -SW BCV will not be used. You will not be using any supplied resistor or diode. You will not use the bottom wire ports on either side of the board closest to the dashpots. Make sure that the dashpot on the right is turned fully counter-clockwise. The dimming dashpot on the left you can set as desired.

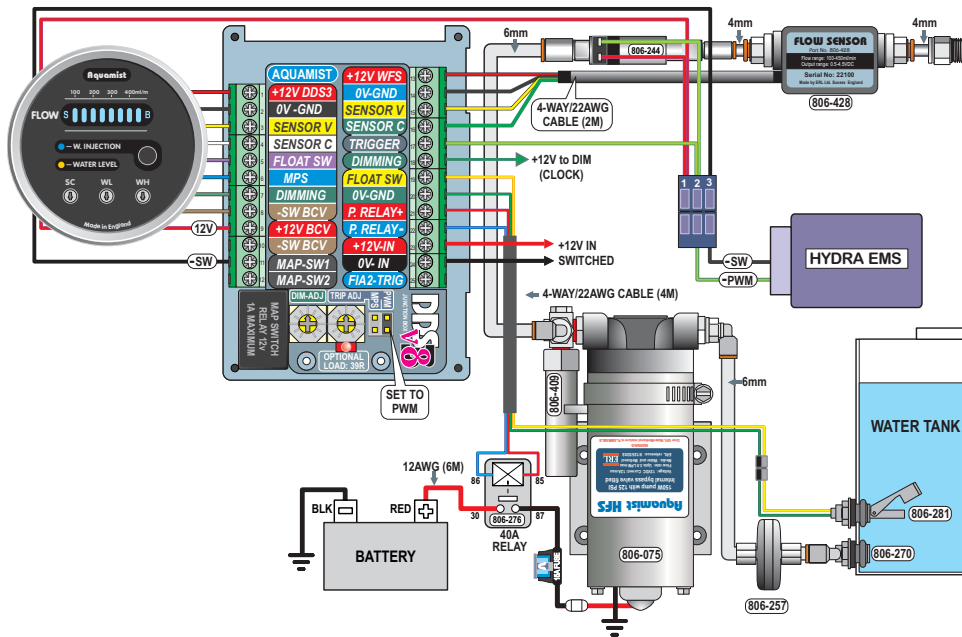
Nozzles. The kit comes with three water nozzles. For GT2560R and smaller turbos, and all superchargers, use one .8 and one .9 nozzle. For the GT3071R and equivalent turbos use the .9 and the 1.0 nozzle. For applications over 450rwhp you may need something bigger- we do have other nozzles in stock. For intercooled applications the nozzles should go after the intercooler and before the throttle body. For non-intercooled applications they should go after the blower / compressor and before the throttle body. If they are placed before your air temp sensor then your air temp trim maps will be much more effective, although we don't know how it will affect sensor longevity.

Software. In the laptop you will need to make changes to the Hydra map file. Upload your map and bring it up online. Go into Select -> Settings -> I/O. For AUX5 Input select Auxilliary Map High Request. Next, put a check in the PWM14 Low Frequency Request box. Click the Enter button next to it, then the OK button. Now you will go to Select -> Outputs -> PWM 14.

Click on the radio button for PWM MAP 11. For Input X choose RPM Spread %, and for Input Y choose Load Spread %. Click OK and you're done with the setup.

HYDRAMIST- v8 SYSTEM WIRING DIAGRAM FOR SUBARU 2007

TRIGGER MODE: PWM :: FAILSAFE: MAP SWITCHING



Panel. When you are finished with the installation you can verify your wiring interface. When you key on the Hydramist display will illuminate. In your laptop (while online with the Hydra) go to View -> Panel. There is an on/off button on your display gauge. When it is on, in Panel you will see the light come on for the auxilliary map request. When you push the button to switch the Hydramist off the light will go out. *Note- you can monitor many other outputs and requests here as well.*

Tuning water injection is complicated, and it is best done by a professional tuner on a dyno. When the system is off (or if your flow sensor detects low flow, or the water in the tank runs low) you will run on your base fuel and timing maps. When the system is on and water flow is sufficient your base fuel and timing maps will have the Auxilliary Fuel and Auxilliary Timing maps applied to them. Take note of the fact that these are **trim** maps, and **not separate** maps. The third piece of the mapping is your Select -> 3D pwm -> PWM Map 11. This is the 3D control map for the High Speed Valve. Its X/Y axis control works in much the same way as the PWM Map 9 does for 01-05 cars with VVT, which is described in detail in the Variable Cam Timing chapter. Your Map 11, Aux Fuel, and Aux Timing maps must all be tuned together in order to deliver the correct outputs for the proper functioning of the water injection system! *Note- Wideband autotuning will always trim your main fuel map. It will not trim your Aux fuel map, even if it is active.*

Mixture. Some people run only distilled water in their WI systems, and some run a mix with distilled water and methanol. While a 50/50 mix is ideal for HP it is not as easy to supply. Distilled water is available at any grocery store and will give you most of the benefit for far less cost. Most all windshield washer fluids (available in 1 gallon bottles anywhere you get gas) are

a mix of water and methanol, but it is less than 50/50. A potential issue here is that they contain detergents, which contain phosphates, which can get things gummy with extended use. If you don't want to buy big drums of methanol and store it but still want 50/50, "HEET" in the yellow bottle is mostly Methanol and is available at most gas stations- mix it 50/50 with distilled water.

WARNING- If you have a turbo setup with a vent-to-atmosphere BOV and you are using a water / methanol mix, be forewarned that methanol **IS FLAMMABLE, and alcohol burns with a clear flame**. Yes, 50/50 does burn! If vapors exit your BOV when you shift they could potentially catch on fire. Please do not allow this to happen. FM will in no way be held responsible if this were to occur.

Mapping. FM can supply base maps for Hydramist users. When tuned optimally (IOW not your base map) you may see in the area of 4-8 more degrees of timing, 12:1 AFR at any boost, and lots more boost (assuming your system can support it- be aware of your limiting factors!) when the injection system is active. This translates to a lot more HP, so please consider the ramifications of this on the other parts of your vehicle. It's in essence like you're running race gas with a much cooler intake charge temperature.

Turbo Boost Level. If you run more boost with WI active then you can on pump gas alone, you'll need to be careful of staying in high boost mode when the WI system turns off. It would be wise to install that switch on your EBC wire so you can drop to base boost as necessary.

Supercharged cars can usually run 12:1 without water injection to begin with. For these cars, the WI will be simply mapped to cool the intake charge in boost and allow for more aggressive timing curves. You may be able to run 12.5:1 with WI and remain conservative, but it is probable that the increase in power will be negligible.

...And Your Elevation Is

An equation that does a pretty good job approximating the altitude vs. pressure is: $P_{(kPa)} = 101.304 \times e^{-Z/26216}$. $P_{(kPa)}$ is the pressure in kilo Pascals, Z is the altitude in feet. Using a little algebra we can re-arrange the equation so that it returns altitude based upon pressure: $Z = -26216 \times \ln(P_{(kPa)} / 101.304)$. This second equation comes in handy when you are trying to determine altitude based upon pressure- something fun to do while travelling. (You can check kPa in the real-time screen with the key on but the engine not running.) Remember, this is just a good approximation.

Hydra Software and Instructions. Remember- if you don't have it, the latest software and factory manual for your Hydra can be found at <http://hydraems.com/>. Make sure to select the correct software revision! Call us if you don't know which you have.