
TDR Fuel and Timing Card Programming

TDR Fuel card Capability

The TDR Fuel card is capable of controlling fuel injectors up to about 50% larger than stock. The 90-97 Miata use a return fuel system and limits the fuel to about 43 PSI. The 90-93 Miata with the 1.6 engine come with 190 cc/43 PSI. We use up to 310 cc injectors in this setup. Using the larger injectors will run a little rich at idle due to the Batch Fired Injector setup (fires two injectors at a time) but, will be adequate up to about 11 PSI. This does require our TDR Fuel pump 190 LPH if you are running 8 PSI or higher. For boost levels of around 7 PSI or lower, usually non-intercooled, your stock injectors and stock fuel pump will be adequate.

The 94-97 Miata with the 1.8 engine uses 230 cc/43 PSI. We limit our injector size to 335 cc. The 94-05 Miata injectors are Sequential meaning they fire individually. This improves idle over Batch firing. This will also provide power levels of up to 11 PSI. You do require our TDR Fuel pump 190 LPH if you are running 8 PSI or higher. For boost levels of around 7 PSI or lower, usually non-intercooled, your stock injectors and stock fuel pump will be adequate.

The 99-05 Miata fuel system uses a Non-Return fuel system. This setup uses fuel pressure of around 56 PSI. Injector industry standard rate injectors at 43 PSI. The 99-00 Miata injectors are rated at 230 cc/43 PSI, but at 56 PSI they are around 260 cc. The 01-05 injectors are rated at 260 cc/ 43 PSI, but at 56 PSI they are rated at around 290 cc. The 99-00 we limit injectors to 335 cc where the 01-05 we limit the injectors to 350 cc. This will also provide power levels of up to 11 PSI. You do require our TDR Fuel pump 190 LPH if you are running 8 PSI or higher. For boost levels of around 7 PSI or lower, usually non-intercooled, your stock injectors and stock fuel pump will be adequate.

Measuring Air Fuel Ratio

The TDR Fuel Card comes preprogrammed for boost levels of around 6 PSI. Our TDR Rotrex setup will be preprogrammed for its own application. The 90-05 Miata comes standard with a Narrow Band Oxygen (O2) sensor to control the engines proper air fuel ratio (AFR). This uses a low voltage, 0-1 Volts signal to feedback the engine management (ECU). At idle and cruising the voltage signal is around 0.7 Volts This sensor is mounted into the exhaust and measures the burnt gas ratio to properly control the fuel intake.

Below around 4200 RPM the engine is in Closed Loop meaning it uses the O2 sensor to maintain 14.7 AFR. This is known as Stoic ratio and has been determined to be the best fuel to air ratio that admits the least carbons and produces the best gas mileage. At idle and cruising you will see around 14.0-14.9 AFR ratio.

The narrow band O2 is not accurate enough to use as your AFR, for tuning. Therefore, the Wideband 0-5 Volt offers a more accurate signal. In order to adjust the TDR Fuel Card you need to have a wideband AFR reading. A Dyno usual offers a wideband O2 and can adjust the FC for optimum AFR.

We also sell the Innovate Wideband unit that has a digital display for accurate readings. Having a wideband allows you to tune yourself and to monitor the proper AFR so you are driving safely under boosted conditions. This gauge requires a bung mounted to the exhaust. If you were going to have only one gauge this would be the most important gauge. You can use a single A-pillar mount option to mount the gauge or add two more gauges such as vacuum/boost and water temperature and use our gauge panels mounted above the radio. Contact TDR for more information.

Understanding the TDR Fuel Card

The Fuel Card (FC) has 5 Modes that are adjustable. The adjustment to the injectors only adds fuel in boost, not when in vacuum such as idle or cruising. Fuel is added by manipulating the voltage signal which intern changes the on/off pulse width of the injectors. As the load changes, meaning the boost increases, the FC will increase the fuel requirement.

There are 8 digits on the FC. Each of the five Modes has a different color arrangement using either one light in the first three modes or two lights in the last two modes. If a Mode needs to be Off, we call this Zero. Zero is determined by a Fast Flashing One. After you power the FC, you will need to know the difference between a Zero setting and a One setting. On the One light display, a fast flashing 1 equals Zero. A slow flashing 1 equals One. All lights 2-8 will be a slow flashing light. Two lights lit up such as 4-5 equals 4 ½ as shown in Photo 5.

Each time you press the Mode button, you will go to the next Mode and then rotate back to the start. You have about 2-3 seconds when you enter the Mode to make a change. After the time out, the control returns back to ready state. Make sure you know what adjustment you want to make before you enter the Mode. Sometimes the Mode button can be sensitive and skip the next Mode, if this happens continue pressing the Mode.



Photo 1: Mode 1 Green 0-1850 RPM setting



Photo 2: Mode 2 Amber 1850-5500 RPM setting



Photo 3: Mode 3 Red 5500-7000 RPM setting

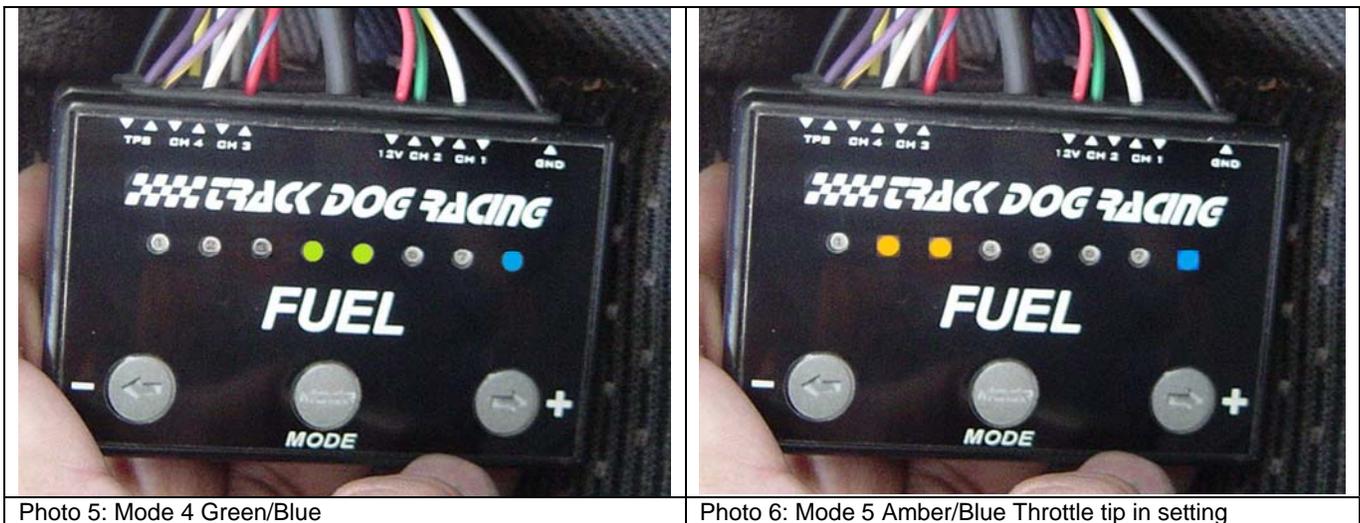


Photo 4: Mode 4 Green/Blue Load setting

Tuning the TDR Fuel Card

The first 3 modes are for fine tuning. The Mode 1 Green, we do NOT use and should be set on Zero, a fast flashing one. Photo 1 shows the Mode 1 Green on number 1. Below is a quick reference of each Mode.

- Mode 1 Green: 0-1850 RPM. This should be on Zero as you will not use this mode.
- Mode 2 Amber: 1850-5500 RPM. This is the mid range and sometimes we will add 1 or 2.
- Mode 3 Red: 5500-7000 RPM. This is for fine tuning the top end but not used often.
- Mode 4 Green/Blue: This is your main Load setting and should used first to determine your fuel requirement.
- Mode 5 Amber/Blue: This is the throttle tip in setting and adjusted after you have the AFR set up.



To start, make sure Mode 1 through 5 are on Zero. Put the Mode 4 at 6 and do a run watching your AFR. Ideally we want to see around 11.2 to 12 AFR. The higher the AFR the leaner. If you see leaner than 12.2 on acceleration stop at that RPM and add more fuel in Mode 4. Retest again evaluating the AFR. When you add or remove fuel this is across the full RPM range. Here are two common examples.

Example 1:

The AFR reading is around 12.5 below 5500 RPM, but good 11.2-12.0 AFR from 5500 RPM to red line. You can add say 1 ½ to the Mode 2 amber range which is the mid RPM range and retest.

Example 2:

The AFR reading is around 11.5 until we reach around 6500 RPM and then it gets leaner, say 12.5 AFR. Try increasing the Mode 3 Red say 1 which is a slow flashing One and test again. This will add fuel from 5500 to 7000 RPM range.

Usually you can get close by adjust the Mode 4 Only and by all mean try this first. You don't need a perfect flat fuel curve, just stay between 11.0 and 12.0 AFR. Sometimes fine tuning the RPM Modes will help.

Once you are good with the AFR we can adjust the 5th mode which is for acceleration. Drive in second gear and at about 2500 RPM floor it. If you feel a delay then adding more fuel will help. Start with maybe a 2 setting. If you add too much fuel it will be sluggish when you floor it. Usually around 1 ½ to 3 is ideal.

TDR Fuel Card Default Settings

The TDR Fuel Card comes preset for boost levels of around 5-6 PSI. As stated above you should consider fine tuning for your application. Below is the preset FC settings based on stock injectors.

Base Fuel Settings

- 90-93 Model 1.6 liter engine
Mode 1: Zero, fast flashing one
Mode 2: Zero, fast flashing one
Mode 3: Zero: fast flashing one
Mode 4: 6
Mode 5: 4-5
- 94-97 Model 1.8 liter engine
Mode 1: Zero, fast flashing one
Mode 2: Zero, fast flashing one
Mode 3: Zero: fast flashing one
Mode 4: 6
Mode 5: Zero, fast flashing one
- 99-05 Model 1.8 liter engine
Mode 1: Zero, fast flashing one
Mode 2: Zero, fast flashing one
Mode 3: Zero: fast flashing one
Mode 4: 6
Mode 5: Zero, fast flashing one

The TDR Rotrex setup uses TDR custom injectors sized from 290 cc for the 90-93 to 335 cc for the 94-05 model. This setup runs around 11 PSI and uses our larger 190 LPH fuel pump.

- 90-93 Model 1.6 liter engine
Mode 1: Zero, fast flashing one
Mode 2: Zero, fast flashing one
Mode 3: Zero: fast flashing one
Mode 4: 3
Mode 5: 3
- 94-97 Model 1.8 liter engine
Mode 1: Zero, fast flashing one
Mode 2: Zero, fast flashing one
Mode 3: Zero: fast flashing one
Mode 4:
Mode 5:
- 99-05 Model 1.8 liter engine
Mode 1: Zero, fast flashing one
Mode 2: Zero, fast flashing one
Mode 3: Zero: fast flashing one
Mode 4:
Mode 5:

Tuning the TDR Timing Card

Octane can make a difference in your timing retard settings. The higher the octane number, example 93 verse 89 the colder the fuel. Higher octane fuels burn slower and intern cooler which help lower the combustion temperature. It also takes more energy to burn a higher octane fuel. A stock horsepower Miata has low compression and a lower octane fuel is more efficient at burning. As the compression ratio is increased the combustion temperatures increase. This is why Mazda recommends using 91-93 octane in the 01-05 models. Forced induction also increase combustion temperature and is why we only use 91-93 octane fuel.

Race gas commonly is around 100 octane. Some race engines are subject to higher combustion temperatures either from high compression or high boost levels. If your combustion temperatures go up then your engine temperatures go up and cooling becomes critical. In this case the higher octane is beneficial.

There is a balancing act between octane and timing advance. You don't want to use full race gas in a 15 PSI or lower setup, it is not necessary. Unless you tune specifically for the race octane, you will not see gains in performance. However, for track use we will sometimes add 2 gallons of race gas to our 91-93 octane for a little assurance.



Photo 7: Mode 1 Green 0-1850 RPM setting



Photo 8: Mode 2 Amber 1850-5500 RPM setting



Photo 8: Mode 3 Red 5500-7000 RPM setting



Photo 4: Mode 4 Green/Blue not used.

Timing Retard Suggestions

The TDR Timing Card (TC) is for 94-05 models only. The TC works identical to the fuel card in programming. There are 4 settings, but we only use the second Mode Amber and third Mode Red to adjust retard. There are 8 lights. Each light retards timing 2 degrees. So example, if we set Mode 2 to 2 you are retarding 4 degrees. If you set the Mode 2 to lights 2 and 3 that equals 2 ½ or times 2 for 5 degrees retard.

In a Non-Intercooled setup, with a maximum of 7 PSI you should use higher settings around 2-3 lights (5 degrees) in Mode 2 Amber and 2 lights (4 degrees) in Mode 3 Red. With our TDR intercooler we often setup boost around 10-11 PSI. With this boost level you don't need as much timing retard due to the cooler air intake from the intercooler. I would suggest settings of 1-2 (3 degrees) in Mode 2 Amber and 1 (2 degrees) in Mode 3 Red. This is based on your timing set at a base of 10 degrees at 850 RPM.

Always listen for detonation. Miatas will knock pretty loud when detonation starts. Detonation sounds like marbles in a can and generally starts around 4000 RPM. Detonation will continue up the RPM range and will burn a piston in short order. If you hear detonation at low RPM, say 2000 RPM at partial throttle then this would be bad gas. If you run lower octane like regular at 87 you will hear detonation. If you have a tank full, drive in low boost until about a 1/3 of a tank and then add higher 91-93 octane. Again don't drive too hard until the gas has run through.

Don't retard anymore timing than necessary so if you here knock, take out 1 degree. Sometimes as little as 1 degree is all you need to stop detonation. Remember we are not using Mode 1 Green and Mode 4 Green/Blue. If you ever suspect detonation, pull your spark plugs to evaluate. Detonation will burn the top of the piston near the ring land. Particles of aluminum will attach to the white porcelain and will look like shinny specs. Anything worst then this, you may be looking for a rebuild. Be careful and tune properly.

Please understand, when it comes to tuning a forced induction car, it is extremely important you are confident in your tuning. If in doubt, stop and contact us or find a local speed shop to help you out. Track Dog Racing cannot be held liable for a poor tune. If you have any questions please don't hesitate to contact us.

Thanks again,

Gary Shuhart