



USER'S GUIDE
FOR
MAZDA RX-7



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LIMITED WARRANTY

EFI SYSTEMS, INC. warrants this product to be free of defects in parts or workmanship for a period of six (6) months. All warranties will be void if the unit is abused, altered, damaged, improperly installed, or rendered unserviceable due to malfunction of equipment, negligence, or by any other cause within the control of the **BUYER**. **EFI SYSTEMS, INC.** makes no specific claims of substantial engine performance increase. This is a **LIMITED WARRANTY** and is the **ONLY warranty** made by **EFI SYSTEMS, INC.** or agents thereof. The **BUYER** receives no other warranty expressed or implied, and there are expressly excluded all warranties of merchantability and fitness for a particular purpose. **EFI SYSTEMS, INC.** shall have no liability with respect to its obligations under this agreement for consequential, exemplary, incidental damages including, but not limited to, lost profits. **EFI SYSTEMS, INC.'s** liability for any damages to **BUYER** or any other party shall in no event exceed the amount paid by the **BUYER** for the **PRODUCT**, regardless of the form of the claim. Some states do not allow the exclusion or limitations of incidental or consequential damages, so these limitations and exclusions may not apply to you.

WARNING

THIS PRODUCT IS INTENDED FOR **OFF ROAD USE ONLY**. INSTALLATION ON A VEHICLE USED ON PUBLIC ROADS MAY VIOLATE UNITED STATES, CANADIAN, OR STATE LAWS REGARDING POLLUTION CONTROL REQUIREMENTS. CHECK LOCAL LAWS AND REGULATIONS IN YOUR AREA. **IN ADDITION, THE INSTALLATION OF THIS PRODUCT MAY AFFECT OR VOID THE WARRANTY COVERAGE ON YOUR VEHICLE.**

To activate your product warranty, please fill out the information below, with signature, and return this sheet to :

**EFI Systems, Inc.
335 Mayors Drive
Walhalla, SC 29691**

I, _____ have read the above warranty and warnings and acknowledge and agree to the said requirements. I agree to use this product only in an off-road application and accept any and all liability for the use or misuse of this product.

Signature: _____

Date: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Country: _____

Product Purchased: _____

Welcome to the Programmable Management System!

The Programmable Management System (PMS) from EFI Systems is a state-of-the-art engine control computer. The PMS reads the stock fuel injection and spark timing signals from the engine's ECU and changes them by an amount you specify, allowing different fuel and timing adjustments to be made for Idle, Part Throttle, and Wide Open Throttle (WOT) conditions.

In addition, the PMS includes specialized functions for maximizing the performance of turbocharged, supercharged, and nitrous-oxide injected vehicles, including turbo boost control on vehicles equipped for it. It's massive non-volatile storage capacity allows you to save three complete performance programs which can be instantly activated - even while driving!

Two Systems in One

The PMS is really two systems in one - it monitors your stock engine control computer's fuel and timing commands and sensor signals in real time, letting you know exactly what your engine is doing. More importantly, it allows you to reprogram the fuel and timing curves of your engine for maximum performance. Fuel adjustments are made in two percent (2%) steps, and timing adjustments in one degree (1°) increments.



A Complete Tuning System

The PMS makes aftermarket performance “chips” obsolete. All aftermarket chips are a compromise between performance and coverage - the chip maker can't afford to burn a custom program for each vehicle. Even if this were possible, a chip is a static device - it can't react to changing conditions or vehicle modifications. The PMS can! It is a complete tuning system; one that allows you to maximize the performance of your vehicle both now and in the future. And, with the optional InterAQ PC software, you can even capture and log performance data.

Electronic Fuel Injection Basics

In the past performance tuning could be performed with a few hand tools and a basic knowledge of carburetors and mechanical distributors. Those times are gone. With the advent of electronic fuel injection and ignition control, the principles of performance tuning remain the same, but the tools required have changed. The EFI System's Programmable Management System is one of the tools you need. With it and some basic knowledge you can still tune your engine for maximum performance. But before you start, let's take a look at the basics of electronic fuel injection systems. NOTE: The following description is generic; a general overview of how electronic fuel injection works. All items discussed here do not necessarily apply to your specific vehicle.

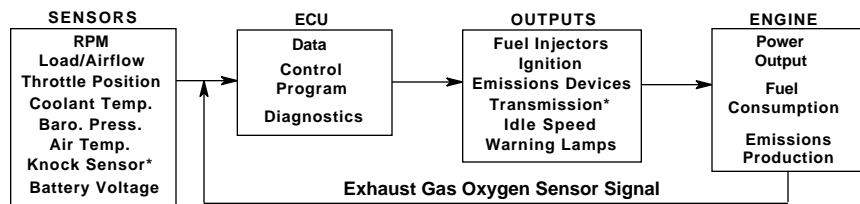
Electronic Control Unit (ECU)



All electronic fuel injection (EFI) systems operate basically the same. Sensors measure engine operating conditions (rpm, load or air flow, throttle position, temperature, and exhaust gas oxygen content) and feed signals to the electronic control unit (ECU). The ECU is factory pre-programmed to analyze these inputs and produce appropriate command signals for the fuel injectors, ignition, idle speed, and emissions controls of your engine.. Thus the ECU determines the engine's power output, fuel consumption, and emissions production.

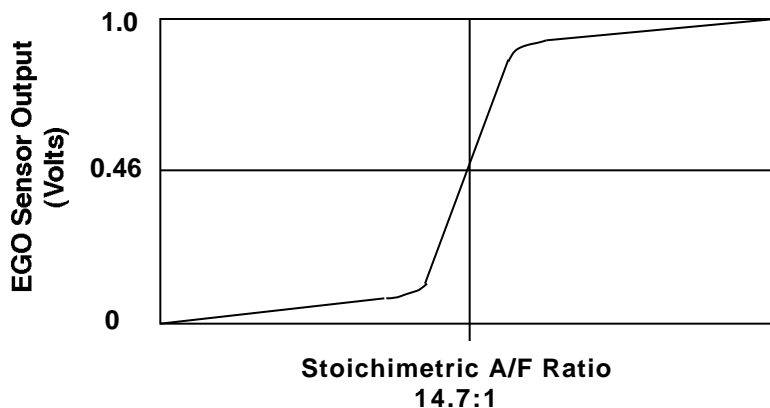
Since production variations cause fuel delivery to vary slightly from engine to engine, and it can change over time as components wear, most ECUs have the ability to learn to compensate. In essence, the

ECU tries to achieve a perfect air/fuel ratio by making the mixture richer or leaner based on the signal from the exhaust gas oxygen (EGO) sensor. Once the chemically correct, or stoichiometric, air/fuel ratio has been achieved the ECU "remembers" how much fuel to add or subtract from the ECU baseline programming to achieve it. This value is used from then on to adjust the stock programming. Learned values are generally erased when the ECU is disconnected from the car's battery for any significant period of time.



Exhaust Gas Oxygen Sensor Signal

To minimize engine emissions a special sensor is used to measure the oxygen content of the exhaust gas; this value is "fed back" to the ECU and under specific conditions is used to produce a desired air/fuel ratio. This is known as closed-loop operation. Since closed-loop operation is important for drivability, fuel economy, and emissions control, the EGO signal is one of the most important signals to watch on the PMS monitor screens.



The typical EGO sensor produces a voltage which changes with air/fuel ratio. The signal is close to 0 volts for very lean mixtures, rises sharply near the "ideal" air/fuel ratio, and continues to rise to almost 1.0 volt for very rich mixtures. The PMS interprets signals from 0-0.46 volts as lean ("L") and signals above 0.46 volts as rich ("R") and displays "L" or "R" on the Main Monitor screen (see page 8). The Air/Fuel Monitor screen adds a two-

digit voltage display to give some indication of how rich or how lean the mixture is. For example "87R" means the EGO sensor is reading 0.87 volts, indicating a rich condition.

The EGO signal is a valuable tool for tuning your engine but it has some important limitations. First, EGO sensors operate correctly **only** when they are hot, about 600°F or above. Thus when an engine is first started the EGO sensor(s) will show lean ("L") until reaching operating temperature. Under most conditions this takes a minute or two; perhaps longer in very cold weather. If for some reason the EGO sensors must be moved to a different (non-stock) position in the exhaust system, keep them as close to the engine as possible. This will help maintain them at operating temperature.

The graph also illustrates another problem with EGO sensors; note that the sensor output is not a straight line. Once the air/fuel ratio gets outside of a narrow band around the stoichiometric, or perfect, value, sensor voltage barely changes at all for very rich or very lean mixtures. This is one reason why the ECU does not try to achieve a single, perfect voltage during closed loop operation. Instead, it varies the fuel commands to switch the EGO voltage back and forth around the desired value.

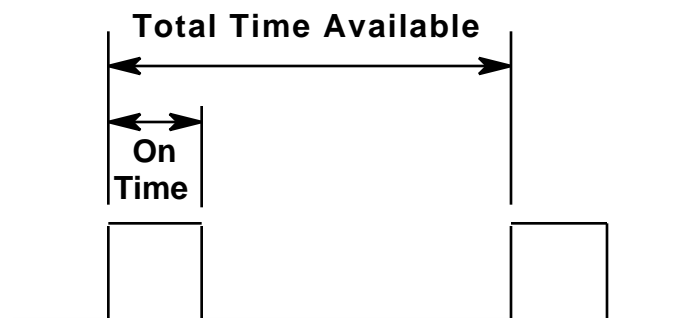
Finally, EGO sensor output must be interpreted in light of sensor quality and service life. Although laboratory-grade sensors can be manufactured and individually calibrated to read out air/fuel ratio directly, the realities of the assembly line and economies of production make them impractical and too expensive (at present) for everyday use. Thus mass-produced EGO sensors **should not be used to assign a precise air/fuel ratio other than that at the switch point (stoichiometric mixture)**. Also, the response of EGO sensors degrades with time and mileage. Sensors often require replacement after 50,000 miles, and shock (impact), overheating, or lead fouling (such as from using racing fuel) may also damage EGO sensors and render them inoperative.

Fuel Injectors

In older vehicles the sensing, control, and fuel metering functions were all performed by the carburetor. In EFI-equipped engines fuel delivery is done with injectors, which are small on/off valves controlled by an electric signal. When voltage is applied, they open and allow fuel to flow from a pressurized source (usually a fuel rail) into the manifold. When the voltage removed, they close, stopping the fuel flow. Since the injector is either fully open ("On") or completely shut ("Off"), changing the rate of fuel flow can only be accomplished by changing the pulse width, or "on-time" of the injector, or by changing the fuel supply pressure.

As the accompanying graph shows, injector pulse width cannot be increased indefinitely. For every rpm there is a fixed maximum time for each injection pulse. Injector "On" time cannot exceed this value or the end of one pulse will overlap the start of the next, at which point the injectors are on all of the time. This condition is known as "static" or "DC." Thus one way to measure the rate of fuel delivery is to measure the pulse width in milliseconds (1 millisecond = 1/1000 sec).

Another method is to divide the pulse width by the total available pulse width. This fraction is known as the duty cycle of the injector and is usually expressed as a percentage. Both of these measurements of injector performance appear on the PMS Air/Fuel Monitor. Generally speaking, injectors operate best



with a duty cycle between 5% and 85%. When injectors are on for very short periods (such as is the case at idle), their fuel delivery can become erratic. The same is true for duty cycles above 85%-90%. Duty cycle values above 90% indicates that larger injectors may be required. One of the most vital uses of the Monitor Modes of the PMS is to confirm that your injectors are operating within their limits.

Note that total fuel delivery depends not only on the injectors, but also on the ability of the fuel pump to provide adequate flow at the desired pressure. The stock pump is sized to deliver the fuel needed to sustain your engine's fuel requirements at it's stock horsepower, with some additional margin. Where the power output has been increased a larger pump may be needed.

The PMS as a Tuning Tool

The PMS allows you to customize your engine's tuning for your vehicle and driving style. You do this by altering the fuel and timing values to improve drivability, throttle response, and wide-open throttle (WOT) power. Here are some tips to help you get the most from your PMS and your vehicle.

Stock Calibration - Safe But Slow

In trying to find the optimum set of adjustments for your vehicle, it is helpful to know the shortcomings of the stock fuel and timing calibration to give you some direction for your initial adjustments. Stock fuel and timing values are generally very conservative (safe). This means fewer warranty claims for the manufacturer but in some cases they limit vehicle performance. Spark advance is almost always less than optimum for several reasons.

First, manufacturers have to allow for a wide range of fuel quality, from high-octane racing gas to the cheapest unleaded regular. Second, not all engines are equipped with a knock sensor(s) to adjust the factory calibration for the effects of engine wear, chamber deposits, and the occasional batch of bad fuel etc.

Every engine has a unique spark advance curve, or "Wmap," which produces peak torque at a given RPM. This is sometimes referred to as Maximum Brake Torque (MBT) timing. MBT spark timing for any given load and RPM generally occurs very near the onset of spark knock or "ping." The problem lies in that this magic point (called incipient knock) begins to change the moment the car leaves the showroom. To begin with the owner can choose from a wide variety of fuels which can dramatically affect the engine's spark knock behavior. Then as the engine accumulates mileage mechanical wear and the formation of deposits can also change the optimum timing curve. Faced with this situation engineers choose a conservative spark advance map.

These same uncertainties also make it impossible for EFI Systems to provide an optimum spark timing map for the PMS. You will need to determine this map yourself. The best method to determine part throttle timing is to work on one Load/RPM point at a time, increasing the timing in 1 or 2 degree steps until knock is detected, then backing off 2 degrees or so. For WOT, be even more careful, increasing the advance in 1 degree steps. The PMS Monitor Mode shows the total spark advance and is an invaluable tool in finding MBT timing.

Fuel Delivery

Many owners of fuel-injected vehicles think the way to increase power is to raise their fuel pressure or install larger injectors. This is misleading since **MORE** fuel is not necessarily the goal - getting the **RIGHT** amount of fuel for the air pumped by the engine is the key. This is why the PMS allows you to both add and subtract fuel.

Fuel mixture control is separated into two modes: closed-loop and open-loop. During closed-loop engine operation (Idle and Low and Medium Load, 2000 RPM and below) the ECU uses the oxygen sensor(s) to trim the fuel/air ratio to the chemically perfect value of 14.7:1 for best emissions performance. Thus, any fuel adjustments you make in these areas should be canceled out by the ECU. For Mass Airflow equipped vehicles, a slight increase in fuel in these areas **may** help throttle response because of the way tip-in enrichment is applied. For Speed Density equipped vehicles the same advice applies for stock engines. For modified Speed Density engines, fuel often needs to be subtracted at these points because of decreased pumping efficiency. For example cams with more duration and overlap than stock sacrifice low-RPM torque for mid and upper RPM power.

Open-loop fuel adjustments are not canceled out by the ECU. Open-loop operation is generally considered to be at Medium and High Load, 4000 RPM and above and of course, wide-open throttle (WOT). Since emissions at these loads and speeds are essentially unregulated, engineers generally choose a very rich fuel curve to protect the engine from knock and thermal stress and to insure that fuel pump and injector wear will not result in dangerously lean conditions over the life of the vehicle. In doing so they compromise peak power and harm fuel efficiency. Stock vehicles generally respond to fuel subtraction in these open-loop areas. For modified engines, the guidelines above apply once again. Mass Airflow vehicles may still respond to fuel subtraction while Speed Density vehicles may need substantial fuel addition if the modifications have increased mid and upper RPM power. The Monitor Mode displays the reading of the oxygen sensor(s), Rich or Lean. Once the engine has reached normal operating temperature this should display "R" during heavy acceleration. If the Fuel Injector Duty Cycle (F.XX% on the Air/Fuel Monitor Mode Screen) exceeds 95% the engine probably needs larger injectors or more fuel pressure.

These guidelines should help you find the right combination of fuel and timing adjustments for your vehicle. We recommend you keep one of the three Data Sets as a pass-through, or stock, program (no adjustments) for comparison's sake. One of the other two Data Sets might be used for a mild performance gain and the third for a no-holds-barred, maximum performance program for use with premium fuel (93+ octane). Make the mild performance (stock) Data Set the default, and switch to the other Data Sets when you need them.

The PMS and your Mazda RX-7

The PMS Control Knob -

The PMS gives you, at the turn of a knob, three separate performance programs. Each position of the PMS control knob takes you to one of three pre-programmed data sets.

- Position 1 selects the stock data set and retains the stock performance of your vehicle.
- Position 2 selects an increased performance data set for higher-performance driving.
- Position 3 selects the maximum performance data set.

But that is only the beginning of the control available with the PMS. As you gain experience with the way your car responds to PMS inputs you can use the PMS Data Terminal to modify any or all of the three data sets to customize your vehicle's performance to your own needs, or make adjustments for additional engine modifications.

Setup

Before beginning to use your PMS, you should set it up for the number of turbochargers in the system. The default setting is the normal turbo mode. See Appendix B, Set-Up, page 35.

IMPORTANT:

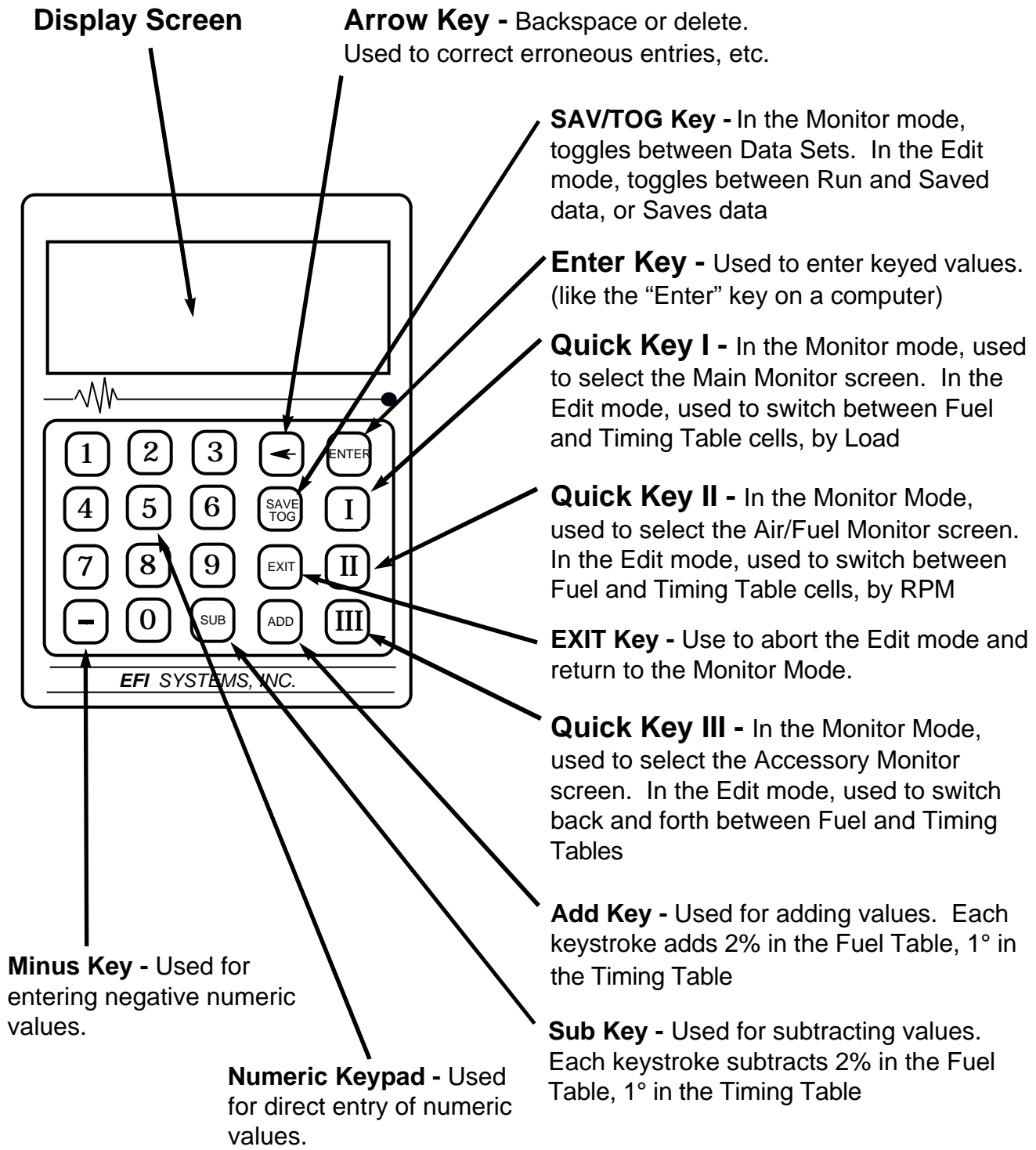
Should spark knock become apparent, timing must be retarded until NO spark knock remains, or serious engine damage may result. Initial timing is mechanically determined by the position of the vehicle's distributor/spark trigger unit relative to the crankshaft; it is not controlled by the engine's ECU or the PMS.

Full instructions for the advanced uses of the PMS are explained in the following pages.

Have fun!

The PMS Data Terminal

Layout and Key Functions



Monitoring Your Engine

One of the most unique features of the PMS is its ability to monitor critical engine control parameters. In the Monitor mode the PMS Data Terminal reports engine data in "real time," like a sophisticated set of electronic gauges, so you know exactly how your engine is operating. You can actually see how performance modifications affect engine operation.

When you start your engine, or just turn the key "On," the PMS automatically enters the Main Monitor Mode. Since the PMS can display so many pieces of data, there are three separate Monitor screens, each displaying a different set of measurements.

Main Monitor Mode

To activate,
press Quick Key



RPM: 850	L: Idle *
02 : R	T:28° 1r

- RPM:** Actual engine speed as measured using the distributor trigger signal. Accurate to +/-10 rpm.
- L:** Load Value - indicates the load (power) level at which the engine is operating and which table is active: Idle, Part Throttle or Wide Open throttle (WOT).
- *** Trouble Indicator - warns that the PMS's internal diagnostics have detected an error. Switch to the Accessory Monitor Mode to view the associated Error Code.
- O₂:** Fuel/Air Mixture as indicated by the Heated Exhaust Gas Oxygen (HEGO) sensor. R=Rich and L= Lean
- T:** Total spark advance in degrees BTDC. This value includes the stock advance plus any programmed adjustment.
- "1"** Active Data Set Number. This number (1, 2, or 3) shows which of the three Data Sets is in use.
- "r"** Edit Mode Indicator. During editing (programming) this value shows whether the Saved ("s") or Run ("r") versions of the Data Set being edited is currently active. When not editing, or running on a saved Data Set, no letter is displayed.

Air/Fuel Monitor Mode

To activate,
press Quick Key



RPM: 25	PW: 12.3
02 : 65	F : 84%

- RPM:** Actual engine speed as measured using the distributor trigger signal. Accurate to +/-10 rpm.
- PW:** Fuel Injector Pulse Width. This is time (in milliseconds) that the injectors are "On" for each pulse of fuel.
- O₂:** Oxygen sensor voltage. These values indicate not only whether the HEGO sensor is reading a rich or lean condition, but also how rich or how lean. Zero (0V) indicates very lean and 99 (1.0V) indicates very rich.
Caution: Stock O₂sensors are not laboratory grade instruments, so a precise fuel/air ratio cannot be derived from this value.
- F:** Fuel Injector Duty Cycle. This value (0-99%, MAX) indicates the total fuel delivery to the engine as a percentage of the maximum fuel the injectors can deliver. Injectors should not be operated above 85 - 90% for extended periods.

Accessory Mode

To activate,
press Quick Key



MP : 10.3	N20 : Off
Acc: - - - -	E : 0000

- MP:** This value indicates manifold pressure. When not under boost it acts as a vacuum gauge (0 - 30 in Hg vac); when under boost it acts as a /Boost gauge (0 - 15 psig boost).
- N₂O:** Nitrous Oxide Input. Indicates the state (ON or OFF) of the optional N₂O input. When N₂O is turned on and +12V is applied to this input, the N₂O Fuel and Timing tables are activated.
- Acc:** This display is not used in the Mazda PMS application.
- E:** Error Code - A4-digit value which indicates an error condition has been detected by the PMS's internal diagnostics. (See Appendix D, Self-Diagnostics, page 37, for possible error codes.)

Using the PMS Data Terminal -

Editing, Switching, and Saving Data Sets - An Overview

The PMS Data Terminal is the tool for accessing the advanced features of the PMS. This section describes the basics of using the Data Terminal, and is followed by a tutorial to give you “hands on” experience with using it.

The PMS allows you to make and save modifications to your car’s fuel and timing tables. These changes may be stored in any of three separate Data Sets. Each Data Set is made up of seven tables, each containing fuel and timing data which can be edited (modified) at will. Different calibrations can be stored in each Data Set, so three complete “Performance Programs” can be on hand at any time. Any Data Set may be reedited, or discarded and replaced, should the modifications not give the desired results.

Switching between Data Sets, to verify the effect of any changes you have made or to tailor your vehicle’s performance to a specific situation, is easy to do. The PMS Data Terminal can “call up” or switch between any of the Data Sets as conditions demand, even while driving. Or, if you want to limit your car’s performance, such as for younger drivers or parking lot attendants, you can program a Data Set for that purpose and leave it “In Control.” A built-in passcode feature ensures that unauthorized persons cannot switch Data Sets or edit your performance tables.

Before starting, a note about the format of the instructions to follow. The text in the center column describes the operation being performed. The PMS display is shown on the left side of the page, with the right are the keystrokes required **to take you to the next screen** shown in the left hand column. By following the key stroke sequence you can practice using your own PMS.

Editing a Data Set -

Start the engine, or just turn the ignition key “On.” The PMS will enter the Main Monitoring mode, with Data Set number 1, the default Data Set , appearing in the lower right corner of the display.

Turn to the next page, and let’s begin.

RPM : 0 L : Idle
02 : R T: 10° 1

Edit Data Set:
(0= Password 1 2 3)

Select from
menu:

Idle Fuel
Sv + 0% Rn + 0%

Idle Fuel
Sv + 0% Rn + 10%

Idle Fuel
Sv + 0% Rn + 10%

(Next screen on following page.)

Editing starts by pressing "ENTER."
This will bring up the screen "Edit Data Set."

Select a Data Set to edit by pressing 1, 2, or 3 followed by "ENTER." The selected Data Set is copied into RAM and becomes active, "Select from menu:" appears, and editing may begin. Select Data Set 1 to edit by pressing "1," followed by "ENTER."

The use of "0 = Password" is covered separately. (See Appendix B, page 31)

To exit the Edit mode and return to the Monitor mode at any time, press "EXIT." (Don't do this as this time.)

After a Data Set is selected, "Select from menu" appears. Each editable item has a 3-digit code. Enter the code number of the menu item you wish to edit, in this case "100 - Idle," by pressing keys "1-0-0", followed by "ENTER." (A list of editable menu items is found on page 10, and also on the back of the data terminal.)

The Idle Fuel screen is now displayed.

Edit the Idle Fuel Table by adding 10%. There are two ways to do this. You can either press the "ADD" key five times (remember, fuel moves in 2% increments) OR you can enter "10," followed by "ENTER." In either case the new data automatically becomes the Run (Rn) setting, indicated by the " " pointing towards "Rn."

If the engine is running you can compare the performance of the edited data set with the original, unedited version by pressing the "SAV/TOG" key. This will switch back to running on the original, or Saved (Sv) version of the Idle Fuel Table, indicated by the " " now pointing to Saved (Sv).

This allows you make back-to-back comparison tests of your changes as you drive, to determine the effectiveness of any changes.

To Exit the Monitor Mode and select a Data Set to Edit, Press:



To select a Data Set to Edit, press:



followed by:

To abort the Edit mode and return to the Monitor mode, press:



To select a Table for editing press:



followed by:

Press five times

OR



To switch between the edited ("Rn") and original ("Sv") tables to compare the results of changes, press:



Idle Sv + 0% Fuel Rn + 10%



Select from menu:



Save Data Set
(0 = abort 1 2 3)

Saving the Changes -

When you are finished editing and are ready to SAVE (or discard) your changes, press "ENTER." This will bring up "Select from menu:"

Pressing "SAV/TOG" will display the screen "Save Data Set:"

At this point the edited data may be saved into any of the three available Data Sets or it may be discarded. To save an edited Data Set, press "1", "2", or "3" as desired, followed by "ENTER." In this example, save to Data Set 2 by pressing "2" followed by "ENTER". To discard any changes and exit the Edit Mode, press "0", followed by "ENTER".

After changes are saved the PMS returns to the Monitor Mode and the Data Set into which you saved your changes becomes active.

To begin Saving your changes, press:



Then press:



followed by:



At this point if you turned the ignition off and the changes would be retained, as they are stored in permanent memory.

Switching to a Different Data Set

When not in the Edit mode, the SAVE/TOG key has a different function; it allows you to change to a new active Data Set. Switching to a new active Data Set can only be done outside of the Edit Mode. You may make this switch with the key on and engine off, or while driving.

NOTE: This does not change the Default Data Set (the one which is active when you first turn your key on); it is always #1.

RPM : 0 L : Idle
02 : R T : 0° 2



(Next screen on following page.)

To change to a new Data Set, press the "SAV/TOG" key. This will bring up the screen "Toggle to Data Set (1 2 3)."

Press:



Toggle to Data Set (1 2 3)



RPM : 0 L : Idle
02 : R T: 0° 1



RPM : 0 L : Idle
02 : R T: 0° 2



RPM : 0 L : Idle
02 : R T: 0° 1


Press the key for the Data Set you wish to switch to (1, 2, or 3), followed by "ENTER."

For this example we switched from Data Set 2 to Data Set 1, which is now active and running the engine. Switching to a new Data Set changes not only all the fuel and spark adjustments, but also any Option selections, such as Boost and Nitrous Oxide. (Discussed beginning on page 19.)

If you wish to make back-to-back comparisons between Data Sets 1 and 2, you can do so by pressing "SAV/TOG."

Pressing it again will take you back to Data Set 1, etc.



followed by: 

Press: 

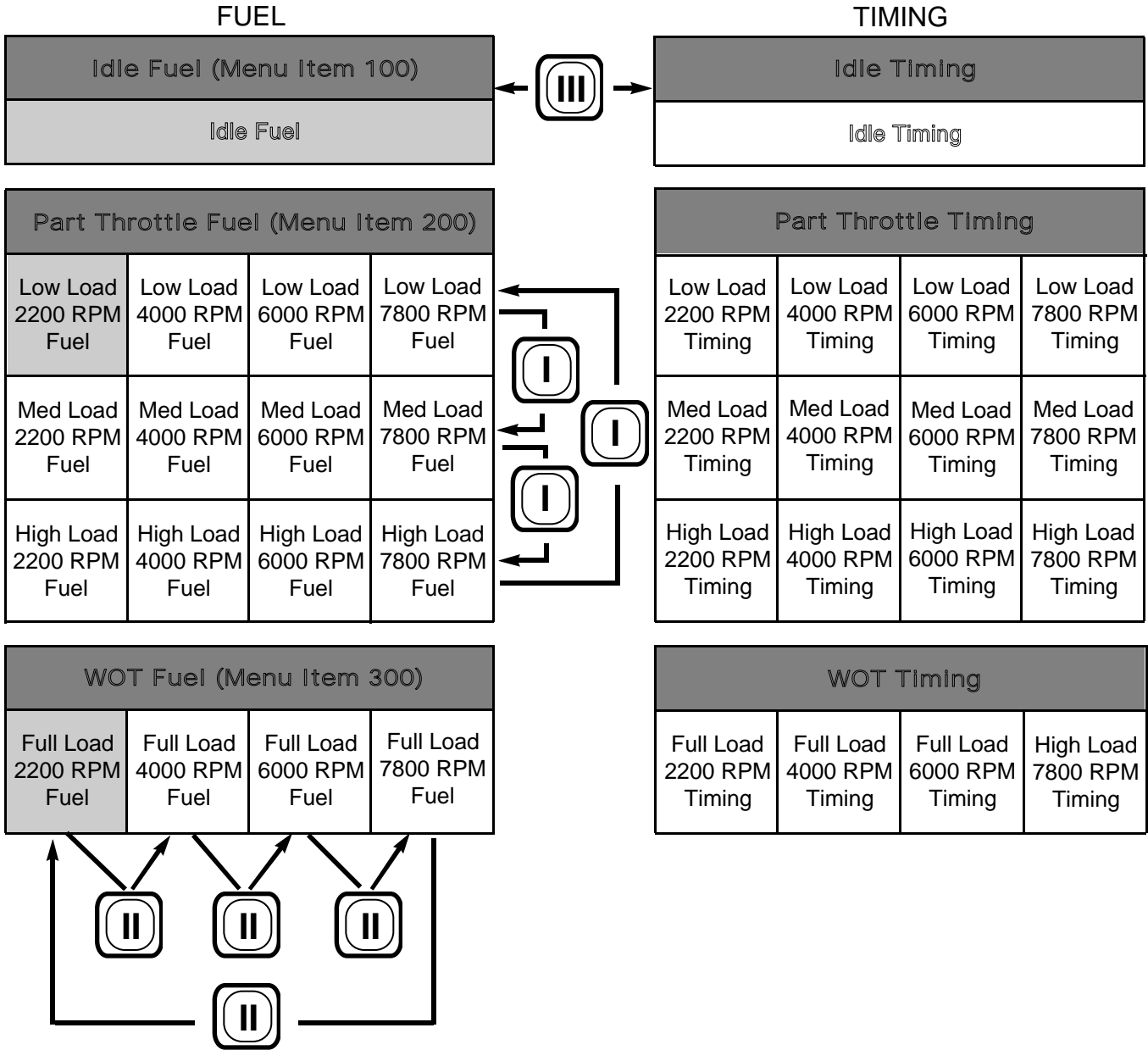
Press: 

Briefly, those are the basic operations used to program the PMS. In the next section "Getting Started," and the tutorial that follow it, we will talk you through the programming operations in greater detail, step-by-step so that you can really get to know the capabilities of the PMS and how to use them.

Getting Started -

To familiarize you with the operating the PMS this manual will take you step-by-step through a practice exercise where you will make a set of basic performance adjustments for Idle and Part Throttle operation, for both Fuel and Ignition timing.

Before starting, take some time to become familiar with the tables and data that you will be working with. (For your information the Wide Open Throttle - WOT - Tables are also shown, even though you won't be editing them in this exercise.)



Note that the Part Throttle and WOT tables are made up of a number of "cells," each cell containing the settings related to a particular condition of engine load and RPM. The Part Throttle Fuel and Timing tables have twelve cells each, and the WOT tables have four. Within each table cell is a value that you can change, or edit, with the PMS.

The shaded boxes in the tables are the starting points for editing each Menu Item. For example, Menu Item 200 (Part Throttle Fuel) modifications begin at the cell for Fuel at Low Load and 2200 RPM. When this cell has been edited, Quick Key I is used to move to the next cell, "Med Load, 2200 RPM," in the Fuel table. Or, if you wish, Quick Key III can be used to move to the "Low Load, 2200 RPM," cell in the Part Throttle Timing tables.

Assume that you have edited the Low Load, 2200 rpm cell of the Fuel table. Pressing Quick Key I moves you to the "Medium Load, 2200 RPM" cell, and pressing it again moves you to the "High Load, 2200 RPM" cell. Pressing it a third time cycles you back to the "Low Load" cell, all at the same RPM. Quick Key II operates similar to Quick Key I, but cycles through the cells according to RPM. Pressing Quick Key III at any time moves you to the corresponding load/RPM cell in the other table, i.e. from Fuel to Timing, or Timing to Fuel.

Programming the PMS - A Tutorial

The Fuel and Timing Table changes you will make in this section are intended only to familiarize you with programming the PMS; they will not benefit your car's performance. When you have finished the tutorial discard the changes; doing that is part of the exercises.

Tuning for optimum performance is engine-specific. Modified engines will require substantially different programming than stock ones, and programming for modified engines will vary widely depending on the type and extent of the modifications. Once you become comfortable with the PMS, you'll be able to make specific adjustments of your own to optimize the performance of your particular vehicle.

As stated earlier it is **very** important to verify that initial ignition timing is set to factory specifications, before changing any stock fuel or timing calibrations. **Should spark knock become apparent, timing must be retarded until NO spark knock remains, or serious engine damage may result.** Initial timing is mechanically determined by the position of the vehicle's distributor/spark trigger relative to the crankshaft; it is not controlled by the engine's ECU or the PMS.

If at any time you wish to abort any editing sequence, or you want to go back and "take it from the top", simply turn the ignition key "Off," wait about 15 seconds, and turn it back on again. At that point you will be back at the beginning of the programming sequence (none of the adjustments you just made will have been saved) so the original calibrations will be unchanged. You can also abort an editing sequence by saving it to Data Set 0.

Editing can be done with the engine running, or with the ignition key "On" and the engine not running. Because the changes you will make in this tutorial are for educational purposes only and not useful for your Mazda, it would be better to perform them with the engine not running.

Making Fuel and Timing Adjustments

The sample Fuel and Timing Tables below show the changes you will make while familiarizing yourself with the PMS. As this is only a tutorial to familiarize you with the PMS, you won't be altering the 6000 and 7800 RPM cells or the WOT Tables; the procedures for switching to and editing them are the same as for the tables and cells you will be practicing.

FUEL

Idle Fuel Adjustments:				
- 4% Fuel				

Part Throttle Fuel Adjustments:				
RPM	2200	4000	6000	7800
Low Load	None	None	None	None
Med Load	-4%	-6%	-8%	None
High Load	-6%	-8%	None	None

WOT Fuel Adjustments:				
RPM	2200 RPM	4000 RPM	6000 RPM	7800 RPM
Full Load	None	None	None	None

TIMING

Idle Timing Adjustments:				
+4° Timing				

Part Throttle Timing Adjustments:				
RPM	2200	4000	6000	7800
Low Load	None	None	None	None
Med Load	+4°	+5°	+6°	None
High Load	+4°	+5°	None	None

WOT Timing Adjustments:				
RPM	2200 RPM	4000 RPM	6000 RPM	7800 RPM
Full Load	None	None	None	None

To access specific menu items in the Edit mode, enter the appropriate 3-digit code for the item you wish to edit from the table below. For quick reference the Menu Item numbers are also on the back of the PMS Data Terminal.

- 100** Idle
- 200** Part Throttle (PT)
- 300** Wide Open Throttle (WOT)
- 400** Primary and Secondary Boost Pressure
- 500** NO2
- 600** Boost
- 700** Not Used
- 800** Temperature compensation
- 900** Performance Options

Idle Table Adjustments

Start by editing Data Set 1 to lean the idle fuel mixture by 4% and increase spark advance by 4 degrees. To do so turn the ignition key "On" and follow the key strokes shown.

Note: In this practice exercise the engine is not running, but in the future you may be using the PMS when it is. **When working with the PMS or doing anything else that requires running the engine, ALWAYS have the vehicle either outdoors or in a well-ventilated area; preferably outdoors. Prolonged breathing of exhaust fumes can result in unconsciousness or death.**

RPM : 0 L : Idle
02 : L T: 0° 1



Edit Data Set:
(0= Password 1 2 3)



Select from
menu:



Idle Fuel
Sv + 0% Rn + 0%



(Go to next page)

The Monitor Mode is automatically selected when the ignition key is switched "ON". Data Set 1, the default data set, is active as indicated by the number 1 at the lower right of the display screen.

Any of the three Data Sets may be selected for editing, but for practice we are going to edit Data Set 1.

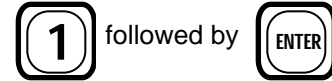
This will bring up "Select from menu:" Enter the appropriate three-digit code for the table to be edited. In this case select the Idle table by entering "100". (Press "1"- "0"- "0" followed by "Enter")

The Idle Fuel screen, the first of the two Idle screens (Idle Fuel and Idle Timing), is now displayed. Because no previous editing has been done, both the Saved (Sv) and Run (Rn) values are zero. Begin the Fuel adjustment by pressing the "SUB" key twice; remember that in the Fuel Tables, a 2% adjustment is made each time the key is pressed. Watch the "Rn" value change as you press the key.

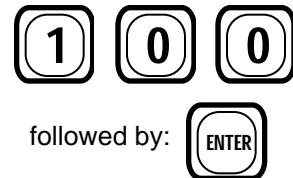
To Exit the Monitor Mode and select a Data Set to Edit, Press:



Select Data Set 1, press



Select the Idle Table for editing by pressing:



Press two times



Idle **Fuel**
Sv + 0% **Rn - 4%**



Idle **Time**
Sv + 0° **Rn + 0°**



Idle **Time**
Sv + 0° **Rn +4°**



Idle **Fuel**
Sv + 0% **Rn - 4%**



Select from menu:

(Go to next section)


Notice that the Run value ("Rn") changes to -4% while the Saved value ("Sv") is unchanged. Note also that the arrow (" ") is pointing towards the run value, indicating that it is the one being used by the engine. Later you will learn to switch or "Toggle" between the Sv and Rn values to instantly compare the effect of the changes. For now, however, use Quick Key III to switch from the Idle Fuel to the Idle Timing Table.

The screen now displays "Idle Timing" and we are ready to change the timing value. Timing changes are made in one degree increments, so press the "ADD" key four times and watch the display change, adding 1° with each keystroke.

After you have made the idle timing changes, press Quick Key III again to move back to the Fuel Table.


Quick Key III switches back and forth between the Fuel and Timing for a particular set of tables (Idle, Part Throttle, WOT, etc.) but does not alter any information in them. When switching tables Quick Key III takes you from the cell you were in to the corresponding cell in the other table. That is, if you are in the Part Throttle, Medium Load, 6000 RPM cell for Fuel, Quick Key III will move you to the Part Throttle, Medium Load, 6000 RPM cell for Timing, and vice-versa.

Press "ENTER" to terminate editing the Idle table and bring up the "Select From Menu:" screen.

Press Quick Key III 

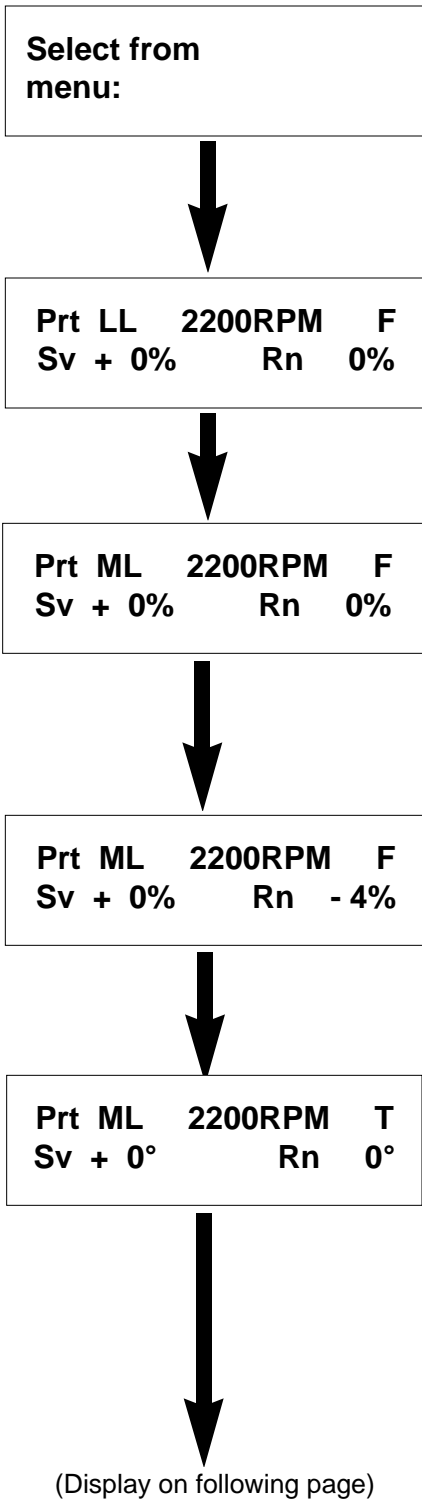
Press  four times

Press Quick Key III 

To return to the Main Edit Menu Screen "Select from Menu:" press: 

Part Throttle Adjustments

Editing the Idle Fuel Table introduced you to the basics of using the PMS; now you are ready to make Part Throttle Fuel and Timing adjustments. There are twelve Load/RPM points in each of the Part Throttle tables, but in this tutorial you will edit only four of them; the Medium Load and High Load cells at 2,000 and 4,000 RPM. Identical procedures are used to edit the 6000 and 7800 RPM cells and the WOT tables.



Begin at the "Select from menu:" screen where you left off under Idle Adjustments. Select the Part Throttle Fuel Table by entering the appropriate three-digit code—in this case 200 ("2"- "0"- "0"), followed by "ENTER."

Part Throttle Fuel Table adjustments begin at the Low Load and 2200 RPM cell. However, you aren't making any adjustments to the Low Load settings, so press Quick Key I to move to the Medium Load, 2200 RPM cell.

Adjust the fuel 4% leaner by pressing the "SUB" key twice, or use the alternate method of pressing "-" and "4", followed by "ENTER". Either method produces the same result.

If the engine is running, the new value is used by it as soon as it is entered. Now move to the corresponding Load/RPM point in the Part Throttle Timing Table by pressing Quick Key III.

With the Timing table displayed, add 4° of timing by pressing the "ADD" button four times or by pressing "4" and "ENTER." Note that since we have already modified the Fuel table the " " already points to the "Rn" value.

Select the Idle Table for editing by pressing:



followed by

Press Quick Key I

Press two times
OR
press:



Press Quick Key III

Press four times
OR
press:



Prt ML 2200RPM T
Sv + 0° Rn + 4°



Prt ML 2200RPM T
Sv + 0° Rn + 4°



Prt ML 2200RPM T
Sv + 0° Rn + 4°



Prt ML 2200RPM F
Sv + 0% Rn - 4%



Prt ML 4000RPM F
Sv + 0% Rn 0%



Prt ML 4000RPM F
Sv + 0% Rn -6%



Prt ML 4000RPM T
Sv + 0° Rn 0°



(Display on following page)

After the Fuel and Timing adjustments are completed, if the engine was running you could compare the results of the edited Data Set ("Rn") to the original Data Set ("Sv") by pressing the "SAVE/ TOG" Key. Note that the " " always points to the active value, i.e. the one the engine is using.

When the arrow (" ") points to the saved value ("Sv"), the PMS is using the original Data Set before any changes. In this case, the saved data is Data Set 1 without the Idle and Part Throttle modifications that you just made. Pressing the "SAVE/TOG" key again switches back to the changed (Rn) data.

The adjustments for Medium Load/ 2200 RPM are now completed, but before moving to the next point, switch back to the Fuel table by pressing Quick Key III again.

Move from Medium Load/2200 RPM to Medium Load/4000 RPM by pressing Quick Key II.

Once there make a fuel adjustment of -6% by pressing the "SUB" key three times (remember, fuel adjustments are in 2% increments).

Press Quick Key III to switch to the Timing Table at this Load/RPM point.

Here we want to add 5° of timing. Do this by either pressing the "ADD" key five times, or by pressing "5" and "ENTER."

Press:

Press:

Press Quick Key III

Press Quick Key II

Press three times

Press Quick Key III

Press five times
OR
press:

+

Prt ML 4000RPM T
Sv + 0° Rn +5°



Prt ML 4000RPM F
Sv + 0% Rn -6%



Prt ML 6000RPM F
Sv + 0% Rn 0%



Prt ML 6000RPM F
Sv + 0% Rn -8%



Prt ML 6000RPM T
Sv + 0° Rn 0°



Prt ML 6000RPM T
Sv + 0° Rn +6°



Prt ML 6000RPM F
Sv + 0% Rn -8%

(Continued on following page)

Press Quick Key III again to switch back to the Part Throttle Fuel Table

Use Quick Key II once to switch to the Medium Load/ 6000 RPM point.

Here we want to make a fuel adjustment of -8%. Press the "SUB" key four times; -8% will be displayed on the screen.

Now press Quick Key III to switch to the 6000 RPM Timing Table.

We want to add 6 degrees (+6°) here, so press press the "ADD" key six times.

Return to the Fuel Table be pressing Quick Key III.

Press Quick Key III




Press Quick Key II



 Press four times

Press Quick Key III



 Press six times

Press Quick Key III



This completes editing the Medium Load points at 2200, 4000, and 6000 RPM, and if we wished we are ready to make adjustments for Part Throttle, High Load, and move on to the Wide Open Throttle (WOT) Tables. However, we won't be doing them at this time.

To access the Part Throttle, High Load Tables, you would press Quick Key I and edit as you did above. When finished with those you would press "ENTER," bringing up the "Select from menu screen:". Then enter menu number 300 for the Wide Open Throttle (WOT) table and proceed from there, moving between the tables and cells exactly as you did with the Idle and Part Throttle Tables.

Before leaving this section, press Quick Key II once to return to Medium Load, 2200 RPM. Then use Quick Key II to cycle through the 4000, 6000, and 7800 RPM points, then back to the 2200 RPM point.

You can see that the Quick Keys I and II move you to the next highest load or RPM point, but if you're already at High Load or 7800 RPM, these keys "wrap around" to the lowest values (Low Load or 2200 RPM).

Please go on to the next page; do not turn off the ignition yet.

Testing and Saving Changes

If you were editing the Fuel and Timing Tables “for real,” you would want to compare the performance difference between the old and new data before saving it, and if the engine was running you could just go for a test drive at this point. However, if you wanted to make the test drive later, you would need to save the changes before you shut the engine off, or they would be lost. If you saved the changes but don’t want them after the test drive, you could still reedit or get rid of them entirely.

To practice saving changes, we will go through the steps for saving your data. **However, we will make the actual save to Data Set 0.** Saving to Data Set 0 always discards any changes and return the data set being edited to it’s unedited state, with no changes to any tables.

This section begins at the screen where you left off in the previous section, in the Fuel Table at the Part Throttle, Medium Load, 6000 RPM cell.

Prt ML 6000RPM F
Sv + 0% Rn -8%



Select from menu:



RPM : 0 L : Idle
02 : L T: 0° 1r



RPM : 0 L : Idle
02 : L T: 0° 1s



(Display on following page)

Pressing “ENTER” after making adjustments to any table, (Idle, PT, WOT, etc.) brings up the 'Select from menu:' screen.



Pressing 'ENTER" again at this point switches you out of the Edit mode and into the Monitor Mode. The Monitor Mode allows you to watch the fuel and timing commands as you drive, making road testing is more meaningful.



Before new data is saved the Monitor screen displays not only the Data Set which is active or being edited (in this case, #1, at the lower right), but also whether the original ("Sv") data or the new ("Rn") data is being used. The edited, or run ("Rn"), data is in use now, so the screen shows "r" next to the Data Set number. To compare the changes with the original Saved ("Sv") data press "SAVE/TOG".



When you do this, the "r" at the lower right changes to "s", indicating the engine is running on the Saved version of Data Set 1. (before changes were made). Pressing 'SAVE/TOG" again switches back to the run ("Rn") data. If the engine were running now, you would feel the change in performance.



RPM : 0 L : Idle
02 : L T: 0° 1r



Select from
menu:



Save data set:
(0 = abort 1 2 3)



RPM : 0 L : Idle
02 : L T: 0° 1

When you pressed 'SAVE/TOG', "r" replaced the 's' at the lower right, indicating the engine is running on the "Run" version of Data Set 1, the data with changes. After you evaluate the performance of the adjusted data, you can make further adjustments, save the new data, or discard the changes. All of these options are accessed from the 'Select from menu:" screen, which can be accessed from any Monitor mode screen. Press "ENTER" to bring up "Select from menu:".

You can save the changes to any Data Set. If this wasn't a strictly practice exercise the most logical place to save the changes you just made would be to save them to Data Set 1. However, since we want to discard the practice data, save the changes to Data Set 0, which always discards any edited data.

Pressing the "Sav/Tog" key while at the "Select from menu:" screen will bring up the prompt "Select data set:"

Since we want to discard the edited data, Press "0," followed by "ENTER." This saves the data to Data Set 0, discarding it.

Had you wanted to save the changes to Data Set 1, 2, or 3 you would have pressed the appropriate number key, followed by "ENTER".

After a Save operation, the PMS enters the Monitor Mode and makes the newly saved Data Set active. If you had saved the changes to Data Set 1, instead of Data Set 0, the PMS would have made data set No. 1 active. Notice that there is no longer any "r" or "s" at the lower right of the screen. This is because the Saved and Run data for Data Set 1 are now the same.

Press: 

Press: 

Press:  + 

When saving data keep in mind that **new data overwrites any existing information in the selected Data Set. Be sure to save any changes to the right one or you may lose data you wanted to keep.**

If the engine is running and you have made no changes to Vent Learn, the adaptive boost feature, you can proceed with a test drive at this point and all changes you did make will be in effect. If you made changes to Vent Learn you must turn the ignition Off, **WAIT 20 SECONDS**, then start your vehicle and make your test drive. The PMS will come up in the Monitor Mode with the Data Set 1, the default Data Set, active. If this is not the Data Set you wish to try out, switch to the desired Data Set as described starting on page 11.

Selecting the Performance Options

The PMS provides a high degree of tuning latitude, allowing the user to "dial in" the fuel calibration and ignition timing of an engine to accommodate a wide range of performance modifications. Keep in mind that calibrations are made in and for EACH Data Set, so you can have different settings for each one. However, this also means that if you want a set of calibrations to be active in more than one Data Set you must enter and save those calibrations separately in each Data Set you want them active in.

When a Performance Option screen is displayed the current value for each selection appears in the upper right corner. If that setting is not to be changed, press "ENTER" to cycle to the next available display.

To begin editing the Performance Options, enter its 3-digit code when "Select from menu:" is displayed. In this case you want Menu Item 900, "Performance Options."

Select from menu:



Boost: 1
(0 = no 1 = yes)



B Table Lmt: 15
(1 - 15 psi)



(Display on following page)

Starting at the "Select from menu:" screen, press "900" (Performance Options), followed by "ENTER".

Press: **9 0 0**

Followed by: **ENTER**

The "Boost" screen allows you to turn Boost on or off. In the Mazda application it should always be on. If it is not, turn it on by pressing "1" and "ENTER." When Boost is ON the PMS to select and use the Boost Fuel and Timing tables any time the boost exceeds 1 psi. (Boost Fuel and Timing Tables are Menu Item 600; they are not active unless Boost is turned on.)

Press: **1** or: **0**

Followed by: **ENTER**

The following screens below assume that Boost is "On," as it should be for the turbocharged RX-7. If you select "Off" for Boost Control, the next two screens shown, "Max. Boost:" and "Vent Learn," will not appear.

If you selected "Yes" (1) for the Boost Control option the Boost Table Limit screen will appear next. Enter the maximum boost pressure, from 1 to 15 psi, that will be produced. This sets the upper limits of the Boost Fuel and Timing tables. Pressing "Enter" brings up the "Boost Fuel Cut" screen.

Enter the maximum boost pressure, 1 - 15:

1 - 1 5

Followed by: **ENTER**

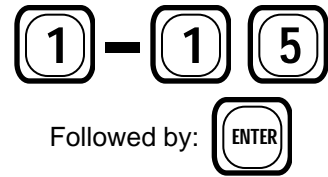
Vent Learn is for turbocharger wastegate control. Activating it enables the PMS to adaptively learn boost pressure control so that the maximum pressure set under Menu Item 400 is actually achieved.

B Fuel Cut @ **15**
(1 - 17 psi)



The next screen displayed is "Boost Fuel Cut." The value set here is used as a hard fuel cut; if the programmed boost pressure is exceeded for more than three seconds the fuel will be turned off until the boost pressure drops below this level. When the desired pressure has been set, press "ENTER."

Enter the boost fuel cut pressure, 1 - 15:



Note 1: If you are editing Data Set 3 (the one most commonly used for the highest performance applications, i.e. the highest fuel and/or boost) the following screens will appear. If you are editing Data Sets 1 or 2, the program will skip "Do Manual Vent," "Select turbo," and the boost screens and the next screen to appear will be "Vent Learn."

Note 2: There are also some differences in the way the PMS presents screens and options depending on the number of turbochargers installed on the vehicle. For that reason it is very important that the PMS be set up for the number of turbochargers installed prior to use. **The PMS comes preset (defaulted) for a twin-turbocharger installation.**

The following sequence of screens assumes the twin-turbocharger, installation.

Do Manual Vent Adj? (1 = Yes)



Select turbo
1 = Pri 2 = Sec



Enter Boost **XX**
(8 - 17 psi)

1=Lower 2=Raise
15 PSI 65

Enter Boost **XX**
(8 - 17 psi)



Select turbo
1 = Pri 2 = Sec

(Go to next page)

"Do Manual Vent" allows you to manually enter the wastegate base number for each boost pressure. The procedure is as follows:

This screens allows you to set the manual venting for either the primary or secondary turbo. In this case, press "1" for the Primary turbo, then "Enter." **This screen will not appear if the PMS is setup for single-turbo use.**

Determine if your boost pressure is reading less or more than the value you have set in the Table 4 menu for PSI@XRPM. If your boost is too high and the system will not adapt go to the "Do Manual Vent" menu and press "1," then "ENTER." Enter the boost value from Menu Item 4 (PSI@RPM), XX (ENTER). Press 2 to increase boost pressure or 1 to lower it. If your boost curve is inverted (too much boost at low RPM, too little boost at high RPM you may need to turn Vent Learn" off.

Repeat the steps above for additional pressures, or press "ENTER" to exit. This will bring up the screen, "Select Turbo" again.

If you are satisfied with the boost pressures you are achieving press "Enter" without making a change (i.e. press no numbers) to continue editing the Performance Options. **This screen will not appear if the PMS is setup for single-turbo use.**

Press:

Followed by:

Press: or

Followed by:

Press:

Press:

Vent Learn **1**
(0 = no 1 = yes)



N₂O **0**
(0 = no 1 = yes)



Stand Alone: **N**
(0 = no 1 = yes)



Max RPM: **8000**
(3000 - 9200)

To activate Vent Learn press "1" and "ENTER". To deactivate it enter "0" only. (For additional information see Appendix E, "Frequently Asked Questions," page 38)




The next screen is the "N₂O" (Nitrous Oxide) screen. If the engine is equipped with nitrous oxide injection this option should be "ON" so that fuel and timing adjustments incorporated in the N₂O tables will be activated when the nitrous system is activated and 12 volts are applied to the N₂O connector on the PMS harness. (For further information on N₂O see page 30)




NOTE: Even though "N₂O" is turned on, nothing will happen unless the Nitrous Oxide Fuel and Timing Tables, Menu Item 500, are edited.




The next screen, "Stand Alone," is a feature for bypassing the factory rev limiter and is for use with the Windows version of InterAQ. Leave it "Off" if not using this program.


The final screen under Performance Options is the Max RPM screen. To set a new maximum RPM limit enter the desired RPM, between 3000 and 9200, and press "ENTER".

NOTE: This value cannot be in excess of the ECU's RPM limit as that limit will occur first.

Press:  or: 
Followed by: 

Press:  or: 
Followed by: 

Press:  or: 
Followed by: 

Enter maximum RPM desired
Followed by: 

Note About The Rev Limiter Option:

The PMS Rev Limiter works by cutting off the pulses to the fuel injectors at a specified RPM. The Rev Limiter may be set as low as 4000 RPM and as high as 9200 RPM. However, there is no point in setting it higher than the factory RPM limit, as that will occur first. The primary reason for using the Rev Limiter feature is to lower the RPM limit, as you might want to do to decrease the performance available to inexperienced drivers or to keep unsupervised drivers such as parking lot attendants from having too much fun.

The fuel cut-off type rev limiting used by the PMS is preferable to spark-only rev limiters for general street use. Spark-only limiters allow unburned fuel to wash the oil film from the cylinder walls. Over time this can spell trouble for a street-driven vehicle.

The fuel cut-off type rev limiter does have some limitations. It is ineffective on vehicles equipped with an additional, independent fuel source such as a nitrous fogger nozzle or auxiliary injectors. Rev limiting will not be effective where additional fuel sources are present.

Save Your Changes

Be sure to save your changes when you have completed setting up the Performance Options items; the procedure is the same as for saving any Data Set. And don't forget to edit any related Fuel and Timing tables, such as the Boost (Menu Item 600) and Nitrous Oxide (Menu Item 500) tables. These tables are covered on pages 28 and 29)

NOTE: Selections made in Data Set 3 "Performance Options" menu that relate to Boost **apply globally, not just to the Data Set 3**. Performance option settings **not related** to boost **do not** across the board. If you want them in one or both of the other Data Sets, they must be entered in those Data Sets separately.

The Boost Option - Menu Item 600

When you selected the Boost feature in "Performance Options" you were asked to enter a boost table limit in psi. This customized the PMS Boost tables below to your specific application. The Boost Fuel and Timing tables allow you to specify fuel and timing adjustments at 1 psi boost and at maximum boost for each RPM range.

Boost Fuel Adjustments (± 2% Steps)				
RPM	2200	4000	6000	7800
1 psi	-50% to + 50%	-50% to + 50%	-50% to + 50%	-50% to + 50%
Boost Table Limit	-50% to + 50%	-50% to + 50%	-50% to + 50%	-50% to + 50%

Boost Timing Adjustments (± 1° Steps)				
RPM	2200	4000	6000	7800
1 psi	-20° to +20°	-20° to +20°	-20° to +20°	-20° to +20°
Boost Table Limit	-20° to +20°	-20° to +20°	-20° to +20°	-20° to +20°

Boost Pressure (psi)				
RPM	2200	4000	6000	7800
Pressure psi	0 - 30	0 - 30	0 - 30	0 - 30

When Menu Item 600 is selected the Boost Fuel, 2200 RPM screen will appear. Edit it as in any other table, then move through the other RPM ranges and the Timing and Fuel tables by using Quick Key II (RPM) and Quick Key III (Table) as appropriate.

For boost levels between 1 psi and the maximum the PMS "interpolates", or splits the difference between the adjustments. For example, if maximum boost is 9 psi and you entered +10% fuel at 1 psi and +30% at maximum boost, then at 5 psi (halfway between 1 psi and maximum) the fuel adjustment would be +20%. If the boost goes beyond the max value you set, the PMS will continue to use the fuel and timing adjustments in the Boost Table Limit row of the tables. (Note: Boost pressures above 20 psi may permanently damage the boost sensor.)

Typical practice in boosted applications is to richen the fuel mixture and reduce the total spark advance to guard against detonation; you will need to experiment to find the proper balance of boost pressure, fuel, and timing to maximize performance without damaging your engine.

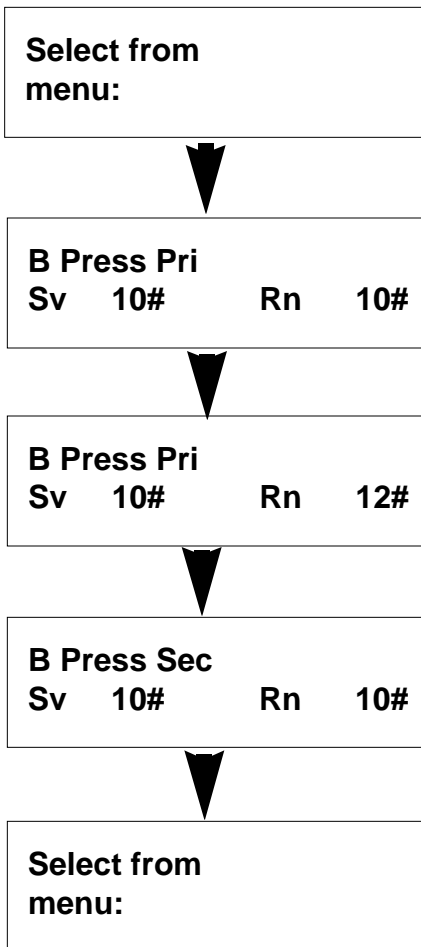
Important points to remember are:

- ✓ The Boost Fuel and Timing tables are only activated when:
 - The Boost feature is selected (turned ON) in the active Data Set,
AND
 - The boost pressure in the manifold exceeds 1 psi
- ✓ The Boost fuel and timing adjustments are added to any Part Throttle, WOT, and N₂O adjustments which may apply
- ✓ Fuel adjustment beyond the capability of your injectors {F: MAX on the Air/Fuel Monitor Mode) will have no effect.

Primary and Secondary Boost Pressure - Menu Item 400

Menu Item 400 allows you to individually set the boost pressure for the primary and secondary turbochargers. The primary turbocharger setting is for 1500 - 4500 rpm; the secondary turbocharger setting is for 4500 rpm and up.

To enter Menu Item 400 and adjust the primary and secondary boost pressures, enter the three-digit code at the "Select from Menu" screen.




Starting at the "Select from menu:" screen, press "400" (Ext), followed by "ENTER".

Press:   

Followed by: 

The next screen displayed will be "B Press Pri" for setting the Primary Boost Pressure. Enter the boost pressure desired (maximum 17 psi). For this example we will enter "12."

Press:  


Followed by: 

The Run boost pressure changes to 12psi. Press any Quick Key and the screen changes to "B Press Sec."

Press any Quick Key

The next screen up is "B Press Sec" for setting the secondary boost pressure. Enter the boost pressure desired (maximum 17 psi). For this example we will enter "12."

Press:  

Followed by: 

Pressing "Enter" returns you to the "Select from Menu" screen.

Note: The Primary and Secondary Boost Pressure screens will appear **only if two turbochargers** are selected in Setup (see page 35). If the PMS is setup for only one turbocharger only the Primary Boost Pressure will be displayed.

The Nitrous Oxide Option - Menu Item 500

Terminal number B3 in the plug connecting the PMS wiring harness to the PMS CPU (see drawing of plug, following page) is used to activate the N₂O Fuel and Timing tables. The N₂O tables become active when 12 volts is applied to this terminal and the N₂O feature is selected in the active Data Set.

To use this feature wire the +12V side of the nitrous oxide solenoid to the PMS accessory plug. That way, every time you "hit the bottle" the N₂O adjustments are applied.

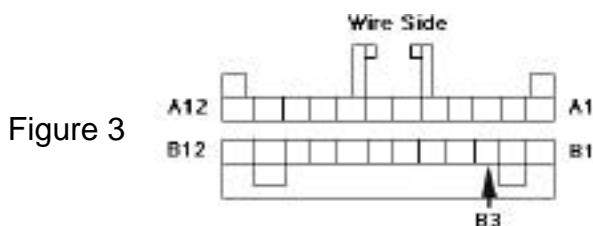
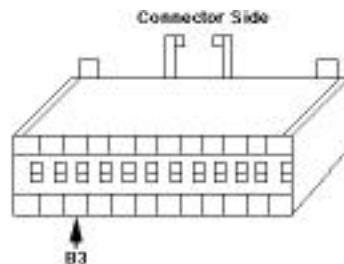
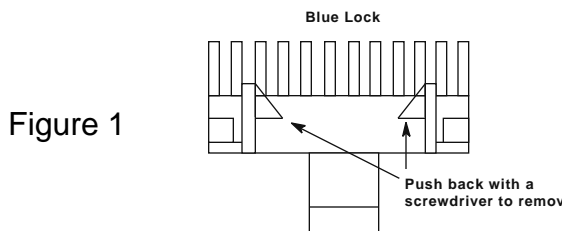
Nitrous Oxide Fuel Adjustments (± 2% Steps)				
RPM	2200	4000	6000	7800
N ₂ O On	-50% to +50%	-50% to +50%	-50% to +50%	-50% to +50%

Nitrous Oxide Timing Adjustments (± 1° Steps)				
RPM	2200	4000	6000	7800
N ₂ O On	-20° to +20°	-20° to +20°	-20° to +20°	-20° to +20°

When Menu Item 500 is selected the Nitrous Oxide Fuel, 2000 RPM screen will appear. Edit it as in any other table, then move through the other RPM ranges and the Timing table by using Quick Key II (RPM) and Quick Key III (Table) as appropriate.

Like the Boost Fuel and Timing Tables, the values in the cells above indicate the range of adjustment available. And also like the Boost Fuel and Timing tables, **N₂O adjustments are made on top of any other adjustments which might be active** (such as WOT). For instance, if you had programmed a WOT, 4000 RPM timing adjustment of +6° and a N₂O, 4000 RPM timing adjustment of -8°, activating the nitrous system at wide-open throttle and 4000 RPM will result in a net timing adjustment of -2°. (+6° -8° = -2°.)

The N₂O connector can be used for things other than nitrous oxide. Any event requiring a change in fuel and timing can be accommodated by applying 12V to this connector. For example, in turbocharged applications an over-boost switch could be used to add fuel and reduce spark advance at a specified manifold pressure.



Notes:

1. The terminal for this connector is NAPA P/N 725159.
2. Terminal B3 is for using the N₂O option; the +12V wire from the N₂O solenoid is connected to the PMS through terminal B3.

Temperature Compensation - Menu Item 800

Temperature compensation allows you to make an adjustment in fuel mixture for increased driveability while the engine is warming up. It allows you to enter a percentage of fuel, plus or minus, for when the engine is “cold”, and a second percentage for when the engine is “warm.” “Cold” is defined as less than 30°F, and “Warm” is approximately 130°F.

When fuel compensation is activated by entering values in the tables, and the engine temperature is under 30°F., the fuel tables will be modified by the Temperature Compensation value. The PMS interpolates between the cold compensation and warm compensation values until the warm value is reached. Warm compensation tapers off after 130°F. until none remains after approximately 180°F.

To use Temperature Compensation enter “800” at the “Select from Menu:” screen.

Select from menu:



Fuel Comp. Cold
Sv + 0% Rn 0%



Fuel Comp. Cold
Sv + 0% Rn 20%



Fuel Comp. Warm
Sv + 0% Rn 0%



Fuel Comp. Warm
Sv + 0% Rn 10%

At the “Select from Menu:” screen press “8-0-0,” followed by “Enter.”

Press: **8** **0** **0**
Followed by: **ENTER**

The first screen to be displayed will be the “Fuel Comp. Cold” screen. Enter the percentage change you desire, as in editing any Fuel Table. For example, in this case lets add 20% fuel. Press “2-0,” followed by Enter.

Press: **2** **0**
Followed by: **ENTER**

To change to the “Fuel Comp. Warm” screen press Quick Key I

Press Quick Key I **I**

Enter the value for warm compensation; for example enter 10%

Press: **1** **0**
Followed by: **ENTER**

When you have finished, save your changes and exit the Edit mode as in editing operation. And, as with the other tables, these changes are specific to a given Data Set. They must be made and saved in each Data Set you want them active in.

Appendix A - Data Table Worksheets

These worksheets are for your convenience in modifying the PMS data tables and keeping a record of what you have done.

Data Set No. 1 -

Idle Fuel Adjustment ($\pm 2\%$ Steps)				

Idle Timing Adjustment ($\pm 1^\circ$ Steps)				

Part Throttle Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
Light Load				
Med. Load				
High Load				

Part Throttle Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
Light Load				
Med. Load				
High Load				

Wide-Open Throttle (WOT) Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
High Load				

Wide-Open Throttle (WOT) Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
High Load				

Boost Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
1 psi Boost				
Maximum Boost				

Boost Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
1 psi Boost				
Maximum Boost				

Nitrous Oxide Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
N ₂ O On				

Nitrous Oxide Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
N ₂ O On				

Boost Feature	
ON <input type="checkbox"/>	Maximum Boost
OFF <input type="checkbox"/>	psig

Rev Limiter Feature	
ON <input type="checkbox"/>	Maximum RPM
OFF <input type="checkbox"/>	rpm

N ₂ O Feature	
ON <input type="checkbox"/>	Maximum Boost
OFF <input type="checkbox"/>	psig

Acc.Switches No. 1 No. 2	
ON <input type="checkbox"/>	ON <input type="checkbox"/>
OFF <input type="checkbox"/>	OFF <input type="checkbox"/>

Appendix A - Data Table Worksheets

Data Set No. 2 -

Idle Fuel Adjustment ($\pm 2\%$ Steps)				

Idle Timing Adjustment ($\pm 1^\circ$ Steps)				

Part Throttle Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
Light Load				
Med. Load				
High Load				

Part Throttle Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
Light Load				
Med. Load				
High Load				

Wide-Open Throttle (WOT) Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
High Load				

Wide-Open Throttle (WOT) Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
High Load				

Boost Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
1 psi Boost				
Maximum Boost				

Boost Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
1 psi Boost				
Maximum Boost				

Nitrous Oxide Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
N ₂ O On				

Nitrous Oxide Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
N ₂ O On				

Boost Feature	
ON <input type="checkbox"/>	Maximum Boost
OFF <input type="checkbox"/>	psig

Rev Limiter Feature	
ON <input type="checkbox"/>	Maximum RPM
OFF <input type="checkbox"/>	rpm

N ₂ O Feature	
ON <input type="checkbox"/>	Maximum Boost
OFF <input type="checkbox"/>	psig

Acc. Switches No. 1 No. 2	
ON <input type="checkbox"/>	ON <input type="checkbox"/>
OFF <input type="checkbox"/>	OFF <input type="checkbox"/>

Appendix A - Data Table Worksheets

Data Set No. 3 -

Idle Fuel Adjustment ($\pm 2\%$ Steps)				

Idle Timing Adjustment ($\pm 1^\circ$ Steps)				

Part Throttle Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
Light Load				
Med. Load				
High Load				

Part Throttle Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
Light Load				
Med. Load				
High Load				

Wide-Open Throttle (WOT) Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
High Load				

Wide-Open Throttle (WOT) Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
High Load				

Boost Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
1 psi Boost				
Maximum Boost				

Boost Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
1 psi Boost				
Maximum Boost				

Nitrous Oxide Fuel Adjustment ($\pm 2\%$ Steps)				
RPM	2200	4000	6000	7800
N ₂ O On				

Nitrous Oxide Timing Adjustment ($\pm 1^\circ$ Steps)				
RPM	2200	4000	6000	7800
N ₂ O On				

Boost Feature	
ON <input type="checkbox"/>	Maximum Boost
OFF <input type="checkbox"/>	psig

Rev Limiter Feature	
ON <input type="checkbox"/>	Maximum RPM
OFF <input type="checkbox"/>	rpm

N ₂ O Feature	
ON <input type="checkbox"/>	Maximum Boost
OFF <input type="checkbox"/>	psig

Acc.Switches No. 1 No. 2	
ON <input type="checkbox"/>	ON <input type="checkbox"/>
OFF <input type="checkbox"/>	OFF <input type="checkbox"/>

Appendix B - Set-Up

The PMS Set-Up menu allows you to tell the PMS whether your Mazda is a single or twin turbo system, and it also permits you to engage a Passcode feature.

The PMS should be set-up regarding the number of turbochargers installed prior to using it for the first time as this changes the internal programming and affects what screens appear when you are setting up the programming and editing data sets.

Turbochargers

To set up the number of turbochargers do the following, with or without the engine running:

RPM : 0 L : Idle
02 : R T: 10° 1

Edit data set:
(0= setup 1 2 3)

Passcode = (7) or
System (9) :

Def. data set: 1
(1 2 3)

of Turbos:
(1 2)

Go to next page

Editing starts by pressing "ENTER."
This will bring up the screen "Edit Data Set."

Since we want to set a password, press "0", followed by "ENTER."

This will bring up the screen "Passcode = 7, System 9." Press "9", followed by "ENTER."

This will bring up the "Def. data set:" screen. Select Data Set 1 by pressing "1," followed by "Enter."

NOTE: Setting number of turbochargers in any data set sets up the PMS for that number in all data sets. It is not necessary to setup in more than one data set.

The next screen is the "# of Turbos" screen. Select the number of turbos installed on your car, followed by "Enter."

Note: In the single turbo mode a special wastegate control solenoid is required.


Exit the Monitor Mode and select a Data Set to Edit, Press:



Select the setup feature by entering:



Press:  or: 

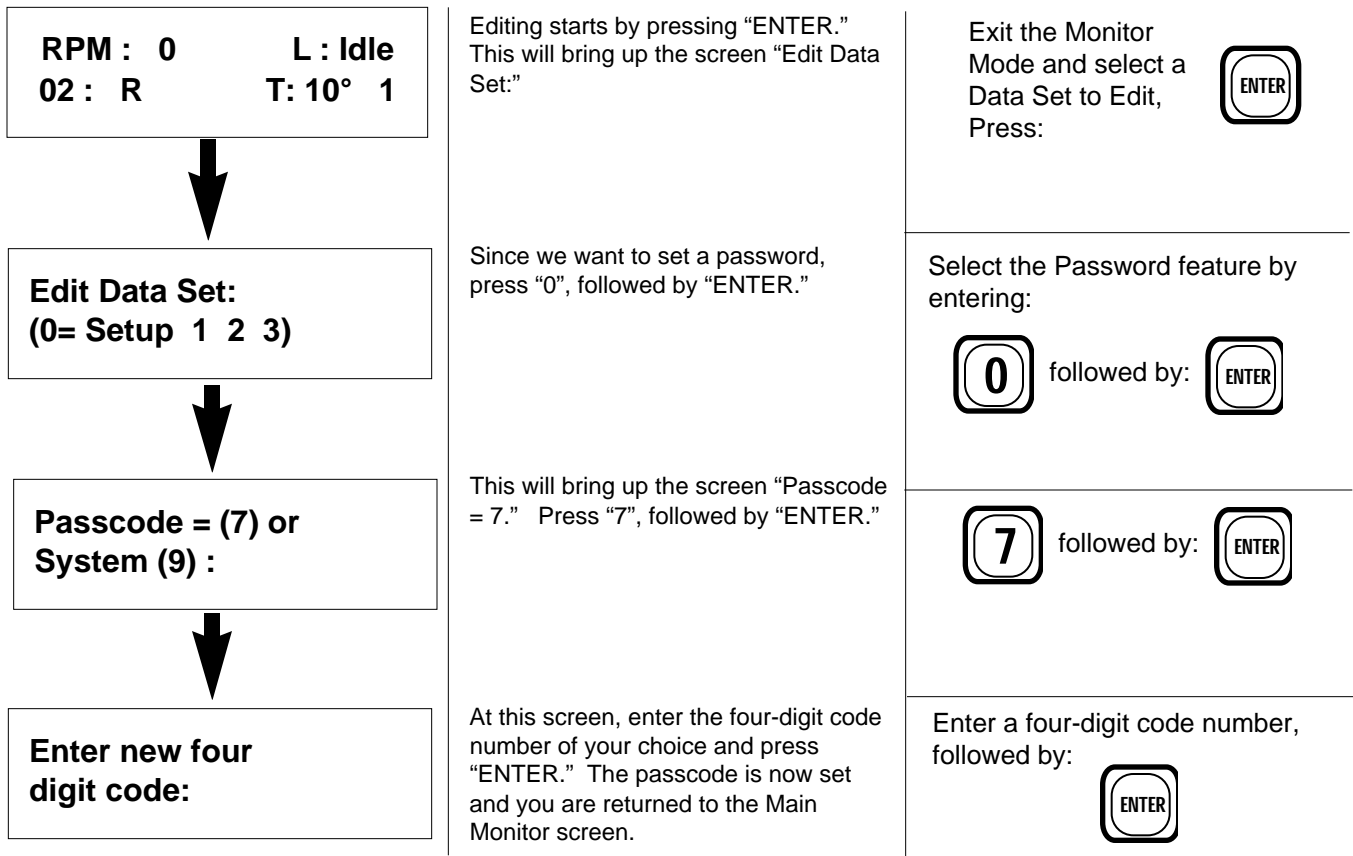
followed by: 

Appendix C - Using the Passcode Feature

The PMS incorporates a Passcode feature, for those who wish to use it, so that the data sets cannot be edited until after a four-digit Passcode, of your choosing, is entered.

An example of why you might want to use this feature would be where you are in a competition situation where some of the other competitors are also familiar with the PMS. Without passcode protection they could use your data terminal (or theirs!) to alter your Fuel and Timing tables to make you less competitive, or even damage your engine.

To activate and use the Passcode feature, start the engine and begin like you are going to edit a data set. **The engine must be running to activate or modify the passcode.** When the engine is started the PMS automatically enters the Main Monitoring mode. Then:



With the passcode set, whenever anyone tries to select from the "Edit Data Set" or "Toggle to Data Set:" menus, a screen will appear asking them to enter the four-digit passcode. If the correct passcode is entered, the PMS will allow the selected operation. But if the correct passcode is not entered, the PMS returns to the "Edit Data Set" or "Toggle to Data Set" screen and will not allow editing.


To cancel a previously-set password and disable the feature, enter passcode "0000."

Appendix D - Self Diagnostics

The PMS includes onboard diagnostics, not only for itself but for many of your vehicle's most important sensors and outputs. When the PMS detects a problem, it generates a Trouble Code which can be displayed on the terminal screen. Trouble Codes are accessed through the Accessory Monitor screen. Note: Trouble Codes are not stored, so they are erased when the ignition key is turned "OFF".


RPM : 0	L : Idle*
02 : L	T: 0° 1

An asterisk (*) in the upper right corner of the Main Monitor screen indicates a Trouble Code is present. To view the code, press Quick Key III to bring up the Accessory Monitor Mode screen.

Press Quick Key III: 

MP : -21.3	N₂O: Off
ACC: 00	E: XXXX

The Trouble Code value, denoted here by "XXXX" will appear in the lower right of this screen. Write the code down, since it will be erased when the key is turned OFF. The Trouble Code may also be viewed on the "Select from menu" screen during editing.

Press Quick Key I: 

To return to the Main Monitor Mode

Each of the four Trouble Code digits covers four possible problems, or faults, for a total of 16. However, each of the four problems for a given digit may or may not be present, or occur in any combination. Thus, each of the digits in the Trouble Code must allow for the 16 ways that the four faults may occur.

For Each Digit:	First Digit Problems:	Second Digit Problems:
1 = Problem #1 2 = Problem #2 3 = Problems #1 & #2 4 = Problem #3 5 = Problems #1 & #3 6 = Problem #2 & #3 7 = Problems #1,#2, 8 = Problem #4 9 = Problems #1 & #4 A = Problems #2 & #4 B = Problems #1, #2, & #4 C = Problems #3 & #4 D = Problems #1, #3, & #4 E = Problems #2, #3, & #4 F = Problems #1, #2, #3, & #4	#1 = Missing MAP Signal #2 = Missing Mass Air Signal #3 = Missing Water Temp Signal #4 = Missing TPS Signal	#1 = Spark input fault #2 = Spark output fault #3 = Fuel injector input fault #4 = Fuel injector output fault
	Third Digit Problems:	Fourth Digit Problems:
	#1 = False interrupt #2 = False reset (or low voltage) #3 = High speed input problem #4 = High speed output problem	#1 = Stack overflow #2 = Invalid EPROM checksum #3 = Invalid EEPROM checksum #4 = RAM (memory) problem

For example, consider Trouble Code "0300". Since the first, third and fourth digits are zero, none of the problems associated with those digits is present (see table). Looking at the table, a "3" in the second position means that Problems # 1 and # 2 are present.

These problems are spark input fault and spark output fault. The most likely cause of this combination of faults is a loose or disconnected distributor harness connector. Remember, Trouble Codes are erased when the key is turned to "OFF".

Appendix E - Questions & Answers About the PMS

- Q.** How do I check the air/fuel ratio to see if it is rich or lean?
- A.** The O₂ voltage displayed on Monitor Screen 2 is a good general indication of mixture. A value between .62 and .82 at WOT is about right. However, if the engine has a misfire the O₂ numbers will not be accurate because of the unburned fuel.
- Q.** At idle or part throttle the O₂ voltage varies; why is this happening?
- A.** This is a result of the system operating in the closed loop mode. The ECU is trying to maintain a 14.7:1 air/fuel ratio. It adjusts the mixture 30 times a second, and what you are seeing is the result of this mixture change as reflected in the O₂ voltage readings.
- Q.** If I add fuel during idle or part throttle it just seems to relearn it; why?
- A.** This again is closed loop in operation. The stock computer has a window of about ±20% fuel that it can adjust in. Any adjustment you make that falls within this window will be changed by the stock computer in an effort to maintain the 14.7:1 ratio. Adjustments made here should be in an attempt to cause the computer to go closed loop for optimum fuel mileage and emissions.
- Q.** Will it relearn at WOT too?
- A.** No. Any adjustments made at high load or WOT will be added to the total. This is what's known as open loop. You will notice the O₂ voltage fluctuates more slowly under these conditions.
- Q.** Will the settings be lost if I disconnect the battery?
- A.** No, the PMS stores your program in a special chip that doesn't lose its memory when the power is removed.
- Q.** I moved the battery from its original location. Now I get error code 0020 at startup.
- A.** When you moved your battery you changed the power and ground paths; sometimes this causes a voltage drop. That's what the 0020 code is indicating. You can help this by adding a 12# wire from the positive battery terminal to the ECU relay's 12V source. This code doesn't cause any problems except during starting.
- Q.** Sometimes I get 0200 code but my car runs fine. What should I do?
- A.** In an effort to check all systems the PMS ECU counts incoming sparks versus outgoing sparks and sometimes, either because of multi - spark ignition or leaky plug wires, it counts an extra spark. This usually doesn't cause a problem.
- Q.** The PMS permits adjustments at 2200, 4000, 6000, and 7800 rpm. What happens in between these points?
- A.** The PMS software averages the difference between adjacent set points. Example: 2000 rpm = 10%, 4000 rpm = 20%. At 3000 rpm it would be half way between 2000 and 4000, so the adjustment would be 15%. The same averaging is used between LLoad, MLoad, HLoad.