

**Flyin' Miata**  
*We make Miatas fly!*



## **Flyin' Miata Mark 1 ECU installation and tuning instructions**

**Revision 1.3  
For software revisions 116M0125 and later  
4-20-01**



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## Section 1: Theory of operation

The Flyin' Miata ECU replaces the factory ECU taking full control of the car's engine functions including fuel delivery and ignition timing. The Flyin' Miata ECU uses a manifold absolute pressure (MAP) sensor to measure airflow so the stock airflow meter can be removed eliminating a restriction in the intake tract. The Flyin' Miata ECU uses the signal from the oxygen sensor to calibrate fuel delivery so it can control larger fuel injectors for high performance normally aspirated engines as well as forced induction engines.

The Flyin' Miata ECU is user programmable, so it can be configured for virtually any engine configuration. The programming variables, called zones, operate all aspects of the engine and are viewed and adjusted using a hand held keypad. The zones are utilized as follows. Zones Z0 through Z31 control general operating parameters of the engine. Zones Zf100 through Zf675 are used as a grid of 6 rows and 16 columns to control fuel delivery to the engine. Zones Zi100 through Zi675 use the same grid layout but control ignition timing advance.

Most of the zones from Z0 to Z31 are displayed in the main menu on the keypad with a text description so the user will not have to remember the different zones based on their number (i.e. Z1 being master fuel). A full list of the zones can be found on page 10 and a detailed description of all the zones follows in this section. The words in bold type are what the keypad displays. Zones not listed with text descriptions are noted. The zones are viewed by scrolling through the keypad using the select buttons. When the ECU is powered up the keypad always displays the same zone, "TEST RPM". Use the **select up** button to view the other zones. The last display shows "EDIT Z0". This is the first of the EDIT Z windows. EDIT Z is a submenu where you can make manual adjustments to any zone. The edit buttons are used to scroll through the zones in sequence denoted by their zone number (i.e. Z16). In all windows, the adjust buttons are used to change the value. Note: You can perform a "store" from anywhere in the EDIT Z submenu by holding both "edit" arrows down until you get a full row of asterisks.

The software chip includes 4 different programs of default values for all of the operating zones, two for normally aspirated and two for turbo use. These default values will be very close to the final values required to make the car run at peak efficiency and power. The ECU features a self-learning mode called Lambda, where the ECU uses the air/fuel ratio signal from the O2 sensor to adjust the fuel delivery to the engine.

Below is a detailed list of all the operating parameters of the computer. The text in bold print reflects exactly how it displays on the keypad if that particular zone is listed. Words in **red** are displayed on the key pad. Words in **blue** are not listed and can only be modified in the EDIT Z menu. The number in parentheses is the data location in the EDIT Z menu. **Green** refers to the buttons on the keypad.

**TEST RPM:** Displays the engine RPM. To the right of the RPM readout the ECU displays the fuel correction factor number. Pressing the **adjust up** button displays the data log type and the engine temperature. Pressing the **adjust down** button displays the manifold pressure (MAP) and the air/fuel ratio from the oxygen sensor (O2). Pressing the **edit up** arrow will display the ECU type and the software release code. Pressing the **edit down** button will display the atmospheric pressure and the wastegate duty cycle. Pressing both **adjust** buttons together accesses the security feature. Pressing the **edit up** button (while holding both adjust buttons) turns the security feature on or off. When security is turned on the car will not start when the keypad is disconnected from the ribbon cable.

**STORE:** The ECU works like a PC. Any information changed in the memory while the car operates must be saved before turning the car off. Scroll to the window that says **STORE** and press both **adjust** buttons down together and hold until the screen fills with asterisks. Once the asterisks are gone all new information is saved into permanent memory. The ECU will not **STORE** above idle speed. A **STORE** can also be done anywhere in the EDIT Z menu by holding both **edit** buttons down until a row of asterisks fill the screen. The ECU displays the fine tuning status to the right of the **STORE** window.

**ZONEF:** FUEL ZONES (Zf100 to Zf675) These zones represent a grid, 6 rows by 16 columns, of fuel correction values used to fine tune the operation of the engine. See the grid on page #11. The first digit of the zone number indicates manifold pressure row. The second and third digits indicate RPM column. Example: zf 105 would mean “row 1” (high vacuum), between 500 and 1,000 RPM (05). Rows are divided by manifold pressure as follows:

Row	Pressure for turbo application		Pressure for N/A application	
1	0 to 40kPa	30 to 18 inHg	0 to 33kPa	30 to 19.8inHg
2	41 to 80kPa	17 to 3 inHg	34 to 47kPa	19.5 to 15.7inHg
3	81 to 120kPa	2inHg to 3psi	48 to 60 kPa	15.4 to 11.8inHg
4	121 to 160kPa	4 to 9psi	61 to 73kPa	11.5 to 8.0inHg
5	161 to 200kPa	10 to 15psi	74 to 87kPa	7.7 to 3.8inHg
6	201 to 254kPa	16 to 22psi	88 to 100kPa	3.5 to 0inHg

The columns are divided by engine RPM, 0-8000 in 500RPM steps.

**INJ % OXY:** Instantaneous display of the fuel injector duty cycle and the value from the oxygen sensor. In this screen the MAP type can be changed by pressing both **adjust** buttons together and either the **edit up** or **edit down** button. The default setting is for the Mk1 MAP sensor, which was fitted with all Mk1 ECUs. If the sensor goes bad it can be replaced with the Mk2 sensor and selecting the Mk2 sensor in this screen.

**ZONEIGN:** IGNITION ZONES: (Zi100 to Zi675) The same grid used for fuel values, but for ignition advance values. All values in the ignition zone grid must be added to the static timing set by the cam angle sensor (CAS). The timing readings in the edit z ignition zones will be four times actual values. So a reading of "40" is actually 10 degrees. **All ignition timing values are now set for a CAS setting of 0° BTDC.**

**IDLE % RPM:** (Z8) Two pieces of information are displayed in this window. The right side of the window displays the target idle RPM value. The left side displays the duty cycle of the Idle Air Control (IAC) valve. With the engine fully warm, adjust the bypass screw on the throttle body so that the IAC value is between 30% & 40%, with the ideal reading of 35%. When the throttle is closed an \* will appear to the right of the idle target value. If the \* is not showing when the throttle is closed the car will not idle properly.

**IDLE MAP:** (Z0) Sets the hot idle MAP value in the ECU. With the engine fully warm the idle MAP value should be set to the reading number in parentheses. If the MAP reading varies slightly, set IDLE MAP equal to the lowest number.

**AC IDLE:** (Z20) The amount the IAC valve increases when the air conditioner is turned on. Used to prevent idle droop when the AC compressor turns on.

**COLD:** (Z16) Amount of additional fuel added to the engine during cranking and warm up. This amount of fuel decays to zero as the engine warms to 80°C. The current engine temperature is shown in parentheses.

**CSTART:** This window displays the cold start enrichment, similar to the choke on a carburetor. The choke fuel (Z6) is shown after the "f" and is adjustable using the **adjust** buttons. The choke decay time (Z710) is shown after the "t" and is adjustable by using the **edit** buttons.

**HOT RESTART:** (Z17) Amount of additional fuel added to the engine during hot restart. This additional fuel decays to zero over ninety seconds.

**MASTER FUEL:** (Z1) Sets the overall fuel delivery to the engine. Unless you are using an injector size not supported by our defaults, the default values included with the software should be used. In master fuel the type of number display can be changed. Pressing **edit up** button displays an "a" in this window. This mode allows the ECU to alter master fuel if it finds a majority of the fuel

zones to be too rich or too lean. When the ECU has to change master fuel it undoes all the zone changes and starts tuning again.

**TEMP LIMIT:** (Z705) If your engine exceeds this setting, ECU will drop rev limit to 3,000 RPM, to “suggest” that you might want to take a look at your engine temp gauge. This limit is adjustable (temp, not rpm)

**IGN TRIM:** (Z21) Provides an overall ignition timing adjustment for all the ignition zones. If the car is filled with low octane fuel, ignition timing can be removed using this screen to prevent detonation and having the knock sensor take timing out of the ignition zones. When the fuel is used up, the retard can be removed restoring all the previous zone ignition settings. The value in IGN TRIM will not take any ignition zones below 0. It is also handy for making overall timing changes when dyno-tuning.

Pressing both **edit** buttons together will change the screen to the Cam Angle Sensor (CAS) set up screen. The screen will display **IGN SETUP +10°**. Any time the CAS is set this screen must be used. In this mode the CAS will be set to 10° BTDC because the ECU is adding 10° of timing to stabilize the idle.

**RPM LIMIT:** (Z2) Sets the rev limit for the engine. Hard limit, fuel cut off, occurs at set point.

**MAP LIMIT:** (Z3) Overboost protection. This sets the manifold maximum pressure anywhere from 0 to 254kPa. When the manifold pressure reaches the MAP limit, the ECU shuts off the fuel delivery. Setting MAP limit to 255 eliminates the manifold pressure limit. We do **not** recommend doing this.

**SW RPM:** Illuminates the check engine light as a shift light. The CEL will illuminate at the RPM set on the right.

**LAMBDA:** The ECU uses 3 different kinds of auto-tuning schemes to alter the fuel delivery curve to ensure the car operates at the proper air/fuel ratio at all times.

COARSE TUNING: occurs when the ZONEF window is selected on the keypad. Coarse tuning make changes often and in a wide range of the fuel zone so the values may not be perfect, but close. This is the first step in tuning the ECU

FINE TUNING: occurs in the STORE window. Here the adjustments are small and occur within 100RPM of the center of the fuel and MAP zone. This tuning adjusts the fuel zones as closely as possible to ideal. This is the second step in tuning the ECU. By tuning only the exact zone centers, excellent interpolation is ensured.

The two types of tuning above get performed once after a new chip is installed. These values are saved and then they do not have to be performed again.

**L3 TUNING:** This third type of tuning is used strictly for day-to-day driving. L3 tuning occurs in all windows on the keypad except STORE and ZONEF and alters the MASTER FUEL delivery to the engine to compensate for temperature and/or humidity differences from day-to-day. The function of this feature can be seen in the TESTRPM window. The number to the far right will indicate the compensation. The range goes from 1-9 with 5 being no compensation. Lower numbers indicate less fuel higher numbers indicate more fuel.

Another way to describe the third lambda mode: Once you have done fine and coarse tuning, you have basically set your fueling to mirror the volumetric efficiency requirements of your engine. The shape of this curve will stay pretty constant, so if one of your fuel zones needs more or less fuel under given conditions, then all of your fuel zones would need about the same correction. When in L3, the entire curve will be shifted up or down. This does your daily housekeeping type tuning.

Pressing adjust up turns on the L3 tuning. Pressing adjust down turns off L3 tuning. Pressing edit up turns on the coarse and fine tuning. Pressing edit down turns off the coarse and fine tuning. We recommend leaving all three tuning modes on all the time after finishing the fine tuning process.

**RELOAD:** Used during the initial setup to transfer the default data table in to the ECU's permanent memory. RELOAD fills the ECU memory with the default settings from one of the following tables:

Turbo 1	Turbo defaults
Turbo 2	Turbo defaults, same as Turbo 1
N/A OEM INJ	Defaults for N/A stock injectors
N/A Big INJ	Defaults for N/A 440 or 550 injectors (1.6 or 1.8)

The different defaults can be selected by pressing and holding a combination of the edit buttons that displays the desired title in the window. While holding the edit button(s) down press and hold both adjust buttons until the window fills with asterisks. The new defaults are now loaded in the ECU. Any changes made before the reload will be lost.

**EDIT:** Enables the zone editor function, which allows access to all zones for viewing and editing. The EDIT function may be used at any time, with or without the engine running. Use the edit buttons to select the appropriate zone(s) and the adjust buttons to change the selected zone. The zones are identified by a number, which may be correlated to its function by consulting the zone editor sheet. ZONE FUEL and ZONE IGN are identified by an "f" or "i" respectively to discriminate between fuel and ignition values. Storing of edited values may be

done by pressing both **edit** buttons together until display shows a row of asterisks and then releasing. This method of storing works only when in the Edit menu. Alternatively, **STORE** may be selected and used as normal.

**MODE:** (Z5) This number corresponds to 8 different bit flag settings. They have no user functions. IOW, don't mess with these.

**CHOKE SCALE:** (Z6) Cold start fuel enrichment during starting. A higher number delivers more fuel. This value appears in the CSTART window next to the "f".

**VOLTS:** (Z7) Battery voltage correction factor used to compensate for heavy electrical loads. As the battery voltage drops, injector duty cycle drops, leaning out the mixture. The default value works well. Probably a good zone to stay away from.

**HOT ID:** (Z18) Default duty cycle of the IAC valve when the engine is warm and the engine is under high vacuum.

**COLD ID:** (Z19) Default duty cycle of the IAC valve when the engine is cold and the engine is under high vacuum.

The purpose of Z18 and Z19 is to keep the idle from drooping when coming to a stop. Anytime the "\*" is showing in the idle window, the idle duty cycle will default to Z18 (hot) or Z19 (cold). As you come to a stop, the duty cycle will stay at Z18/19 for a second or two, then go into closed loop idle control. Settings between 38 and 42 provide good prevention of idle droop when coming to a stop. When properly set, the engine will hang at 1300 RPM for a second when coming to a full stop before falling to the idle setpoint. To view Z18 without going into EDIT Z, look in the idle window in the main menu. Any time the \* is not showing (denoting idle switch closed), edit Z18 (or Z19, if engine temp is below 80C) will show.

**ACCEL:** (Z22-Z25) Simulates the accelerator pump on a carburetor by increasing the amount of fuel upon sudden throttle opening. The zones affect the following RPM ranges:

Z22 0 to 2000 RPM  
Z23 2001 to 4000 RPM  
Z24 4001 to 6000 RPM  
Z25 6001 to 8000 RPM

**LAMBDA TARGETS:** (Z26-31) Target O2 sensor output used during closed loop, LAMBDA ON, operation. The ECU adjusts the fuel delivery in each fuel zone to reach these values of O2 sensor richness. We have found on a few cars running 93 or 94 octane that the O2 target for row 5 & 6 to be too high and cause mis-fires. If this happens reduce the O2 target in row 5 & 6 to 89

Z26 row 1&2 idle O2 sensor target = 76

Z27 row 1&2 "cruise" O2 sensor target = 77

Z28 row 3 O2 sensor target = 78

Z29 row 4 O2 sensor target = 87

Z30 row 5 O2 sensor target = 90

Z31 row 6 O2 sensor target = 91

**CHOKE DECAY TIME:** (Z710) The amount of time the additional fuel added in the CSTART window will take to decay to zero.

**PRIME FACTOR:** (Z715) Fuel prime added when the key is turned on.

**MINIMUM ATMOSPHERIC PRESSURE:** (Z720) The ECU uses the current atmospheric pressure to control the wastegate and it measures this value every time the car is started. If the ECU does not get the chance to measure the ambient atmospheric pressure, (the car is started too quickly) the ECU uses the value in Z720.

Below are a few terms used in the set up instructions are defined in detail.

**Store** – the ECU works like a PC. Any information changed in the memory while the car operates must be saved before turning the car off. Scroll to the window that says **STORE** and press both **adjust** buttons down together and hold until the screen fills with asterisks. Once the asterisks are gone all new information is saved into permanent memory. When the ECU is storing information the tach will jump around and the car will misfire. DO NOT store while driving. The best way is to pull over into a parking lot to store. If you stall while storing, allow the store to finish ("STORE" reappears) before turning key off. A "store" can also be done anywhere in the EDIT Z menu by holding both **edit** buttons down until a row of asterisks fill the screen. Remember, if you have had knocks while driving or tuning, the retarded timing will be stored.

**Tuning** – This is the process of allowing the ECU to self-calibrate its fuel correction numbers through feedback from the oxygen (O2) sensor so that the O2, air/fuel ratio (A/F), signal equals targets programmed for each row of manifold pressure. Since the tuning depends on the accuracy of the O2 sensor, we strongly recommend the single wire O2 sensor be replaced with the 4-wire sensor.

As the engine operates throughout its RPM and manifold pressure range, the ECU interpolates from one zone to the next to make the transitions smooth. To make tuning quick and accurate there are two types of tuning, coarse and fine. Coarse tuning occurs only in the ZONEF window. During coarse tuning the ECU samples the O2 sensor voltage very rapidly and adjusts the fuel correction numbers accordingly. The samples are taken anywhere in the operating zone in order to make tuning go quickly at the expense of accuracy. Tuning close to the edge of a zone will affect the adjacent zone. Fine tuning occurs in the STORE window. During fine tuning the ECU samples the O2 sensor less rapidly and averages the readings together giving more accurate values. Also, when in fine tuning, the ECU only tunes in a narrow range at the center of each zone. This provides more accurate values at the expense of being harder to do.

To perform tuning go to the ZONEF window and drive the car. The ECU will do the tuning while you drive. The ZONEF window constantly displays the current fuel zone. Use this to identify the current operating zone. Tuning works best in the upper gears, where you can stay in one zone long enough for it to tune itself.

While tuning is occurring the ECU will show different characters next to the zone display. They are listed below:

A – Acceleration, the car is accelerating and the ECU will not tune.

D – Deceleration, the car is decelerating and the ECU will not tune.

V – High vacuum, the ECU will not tune.

T – Timer, the ECU will not tune for 90 seconds after the car is started.

E – Engine temperature, the ECU will only tune after the engine has warmed to over 80°C. The “E” is displayed until that time. When in L3 mode, autotune will start at 40C.

P – Additional fuel being added during hot restart. Tuning will not occur during this time. This is on 1.8L cars only.

“+” The ECU is adding fuel to the engine.

“-“ The ECU is subtracting fuel from the engine.

“=” The ECU has reached its a/f target for that zone.

“?” The car is not operating in the center of a fuel zone. During coarse tuning the ECU still tunes while “?” shows. During fine tuning the ECU will not tune with “?” showing.

“X” indicates that the fuel has been changed 3%, during fine tuning only, and will not change any more without storing. This feature is to keep the ECU from tuning itself to death in the event that you have a sensor problem, such as a bad O2 sensor.

The ECU can only tune the zone that the car is currently operating in. The 3 digit number in the center of the “ZONEF” window displays the current operating zone. When tuning the car must be driven in different situations to ensure that the engine operates in as many different zones as possible. Start by driving the car around a suburban setting, accelerate slowly and try to stay in the 200 row. Then move to an area where the car can be accelerated somewhat harder,

keeping the car in the 300 row (zero on your boost gauge). Finally, find a road where the car can be accelerated from 1500RPM to redline in 4<sup>th</sup> gear. Do a run with very light throttle to keep the car in the 200 row all the way to redline, trying to stay in each zone long enough to get “=”. Repeat for each row, modulating the throttle to keep the car in the 300 row, then 400, then 500 (and 600, if N/A or turbo running over 15psi).

While the car is driven in these conditions the ECU will display the characters shown above. Have a co-pilot read off the tuning information, specifically when the ECU shows “+” and “-“ signs. These are important because they indicate when the computer is tuning. Try to hold the car in a particular zone until the “+” or “-“ sign turns into an “=” sign. Each zone usually tunes within 2 to 4 seconds. After driving for 15-20 minutes, pull over and store the changes.

Miscellaneous															
IDLE MAP	MAST F	REV LIM	MAP LIM		MODE	CH SCL	VOLTS	IDLE	FAN						
Z0	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9	Z10	Z11	Z12	Z13	Z14	Z15

						Acceleration				Lambda Targets					
COLD	HOT RST	HOT ID	COLD ID	AC IDLE	IG OSET	0-2K	2K-4K	4K-6K	6K-8K	ROW1	ROW2	POW3	ROW4	ROW5	ROW6
Z16	Z17	Z18	Z19	Z20	Z21	Z22	Z23	Z24	Z25	Z26	Z27	Z28	Z29	Z30	Z31

Zone Fuel																
kPa	0		1000		2000		3000		4000		5000		6000		7000	
40	Z100	Z105	Z110	Z115	Z120	Z125	Z130	Z135	Z140	Z145	Z150	Z155	Z160	Z165	Z170	Z175
80	Z200	Z205	Z210	Z215	Z220	Z225	Z230	Z235	Z240	Z245	Z250	Z255	Z260	Z265	Z270	Z275
120	Z300	Z305	Z310	Z315	Z320	Z325	Z330	Z335	Z340	Z345	Z350	Z355	Z360	Z365	Z370	Z375
160	Z400	Z405	Z410	Z415	Z420	Z425	Z430	Z435	Z440	Z445	Z450	Z455	Z460	Z465	Z470	Z475
200	Z500	Z505	Z510	Z515	Z520	Z525	Z530	Z535	Z540	Z545	Z550	Z555	Z560	Z565	Z570	Z575
254	Z600	Z605	Z610	Z615	Z620	Z625	Z630	Z635	Z640	Z645	Z650	Z655	Z660	Z665	Z670	Z675

Zone Ignition																
kPa	0		1000		2000		3000		4000		5000		6000		7000	
40	Z100	Z105	Z110	Z115	Z120	Z125	Z130	Z135	Z140	Z145	Z150	Z155	Z160	Z165	Z170	Z175
80	Z200	Z205	Z210	Z215	Z220	Z225	Z230	Z235	Z240	Z245	Z250	Z255	Z260	Z265	Z270	Z275
120	Z300	Z305	Z310	Z315	Z320	Z325	Z330	Z335	Z340	Z345	Z350	Z355	Z360	Z365	Z370	Z375
160	Z400	Z405	Z410	Z415	Z420	Z425	Z430	Z435	Z440	Z445	Z450	Z455	Z460	Z465	Z470	Z475
200	Z500	Z505	Z510	Z515	Z520	Z525	Z530	Z535	Z540	Z545	Z550	Z555	Z560	Z565	Z570	Z575
254	Z600	Z605	Z610	Z615	Z620	Z625	Z630	Z635	Z640	Z645	Z650	Z655	Z660	Z665	Z670	Z675

SP FAC	TEMP LIM	CH DEC	PRIM FAC	MIN A.P.											
Z700	Z705	Z710	Z715	Z720	Z725	Z730	Z735	Z740	Z745	Z750	Z755	Z760	Z765	Z770	Z775

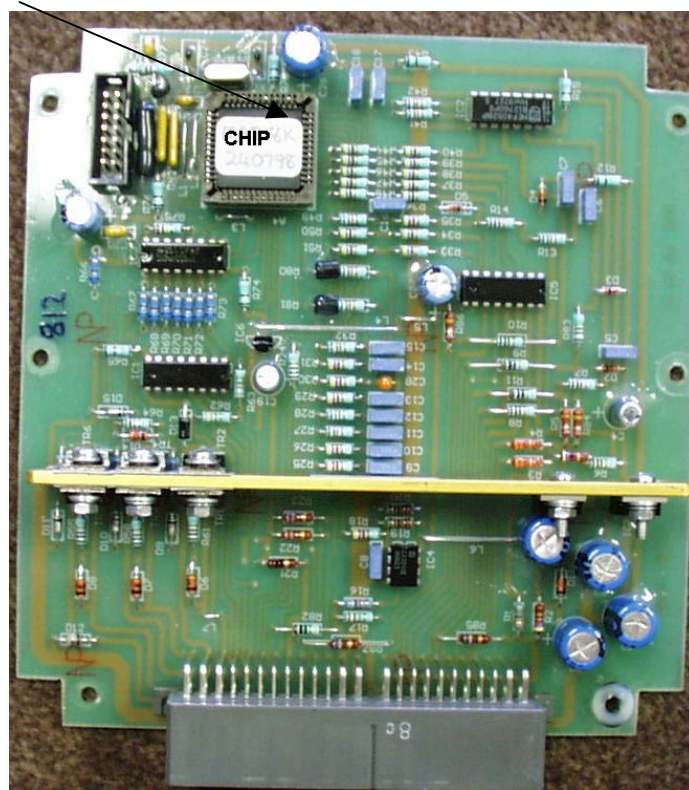
KEYPAD DESCRIPTION	DESCRIPTION	ZONE NUMBER	KEYPAD SEQUENCE
TEST RPM	Current engine RPM		1
STORE	Save any and all changes		2
ZONEF (current zone)	Fuel correction for the current operating zone	ZF100-ZF750	3
INJ= % OXY=(O2 volts)	Injector duty cycle & oxygen sensor voltage		4
ZONEIGN (current zone)	ignition correction for the current operating zone	ZI100-ZI750	5
IDLE % RPM (engine RPM)	Idle control solenoid duty cycle & idle set point	Z8	6
IDLE MAP (MAP)	Hot idle MAP value	Z0	7
A/C IDLE	Idle compensation for A/C	Z20	8
COLD (engine temp)	Cold start enrichment scale factor	Z16	9
CSTART f(Z6) t(Z710)	Cold start choke, f= fuel, t=decay time		10
HOT RESTART	Hot restart enrichment scale factor	Z17	11
MASTER FUEL	Overall fuel delivery	Z1	12
TEMP LIM	Temp at which the ECU limits engine RPM	Z705	13
IGN TRIM	Overall ignition adjustment	Z21	14
RPM LIMIT	Maximum allowed engine RPM	Z2	15
MAP LIMIT	Maximum allowed manifold pressure	Z3	16
LAMBDA	Self learn mode on or off		17
RELOAD	Reload default program and variables		18
EDIT Z	First screen in Edit Z menu		19
	On/off bit flags	Z5	
	Choke fuel enrichment value	Z6	
	Voltage compensation for heavy current draw	Z7	
	Radiator fan energize temperature	Z9	
	Hot default IAC duty cycle	Z18	
	Cold default IAC duty cycle	Z19	
	Acceleration scale factor 0 to 2K RPM	Z22	
	Acceleration scale factor 2K to 4K RPM	Z23	
	Acceleration scale factor 4K to 6K RPM	Z24	
	Acceleration scale factor 6K to 8K RPM	Z25	
	Row 1&2 idle oxygen sensor target	Z26	
	Row 1&2 cruise oxygen sensor target	Z27	
	Row 3 oxygen sensor target	Z28	
	Row 4 oxygen sensor target	Z29	
	Row 5 oxygen sensor target	Z30	
	Row 6 oxygen sensor target	Z31	
	Choke decay time scale factor	Z710	
	Prime factor	Z715	
	Minimum atmospheric pressure	Z720	

## Section 2: Chip installation instructions

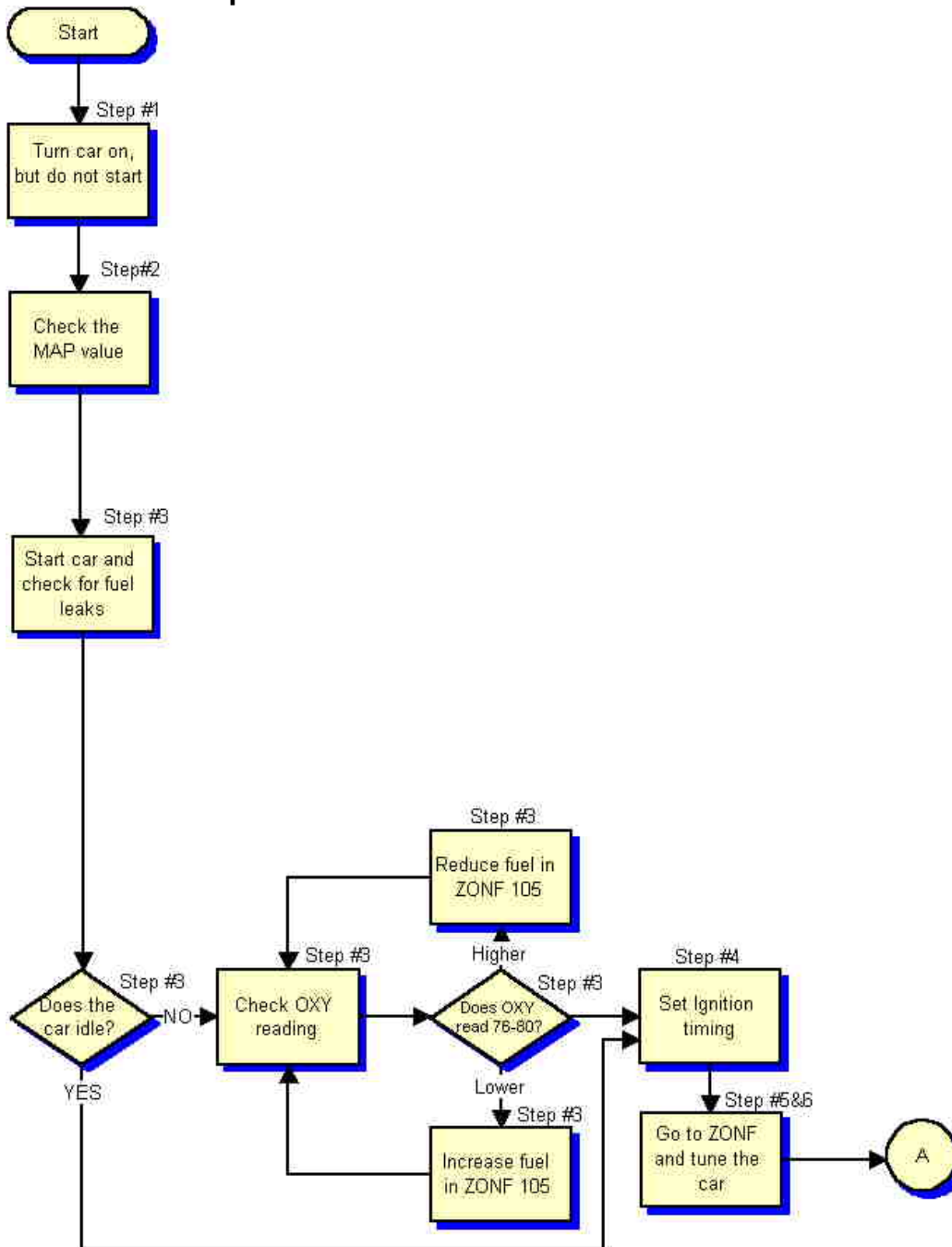
Please stop by your local Radio Shack and invest in a chip puller for a 52 pin processor. Using paperclips, etc to try to remove your chip will probably damage the chip or socket. The chip can be found in the picture of the circuit board below. After removing the old chip with the proper puller, install the new chip by pressing it into place firmly with your thumb. The chip must be properly oriented. If you look very closely at the edges of the chip, you will see that one edge is beveled and has a small dot in the middle of the edge. This is the top of the chip. With the multiplugs on the printed circuit board at the bottom, the top of the chip should face up. You can also go by the printing on the chip, if the printing is right side up, the chip is facing up.

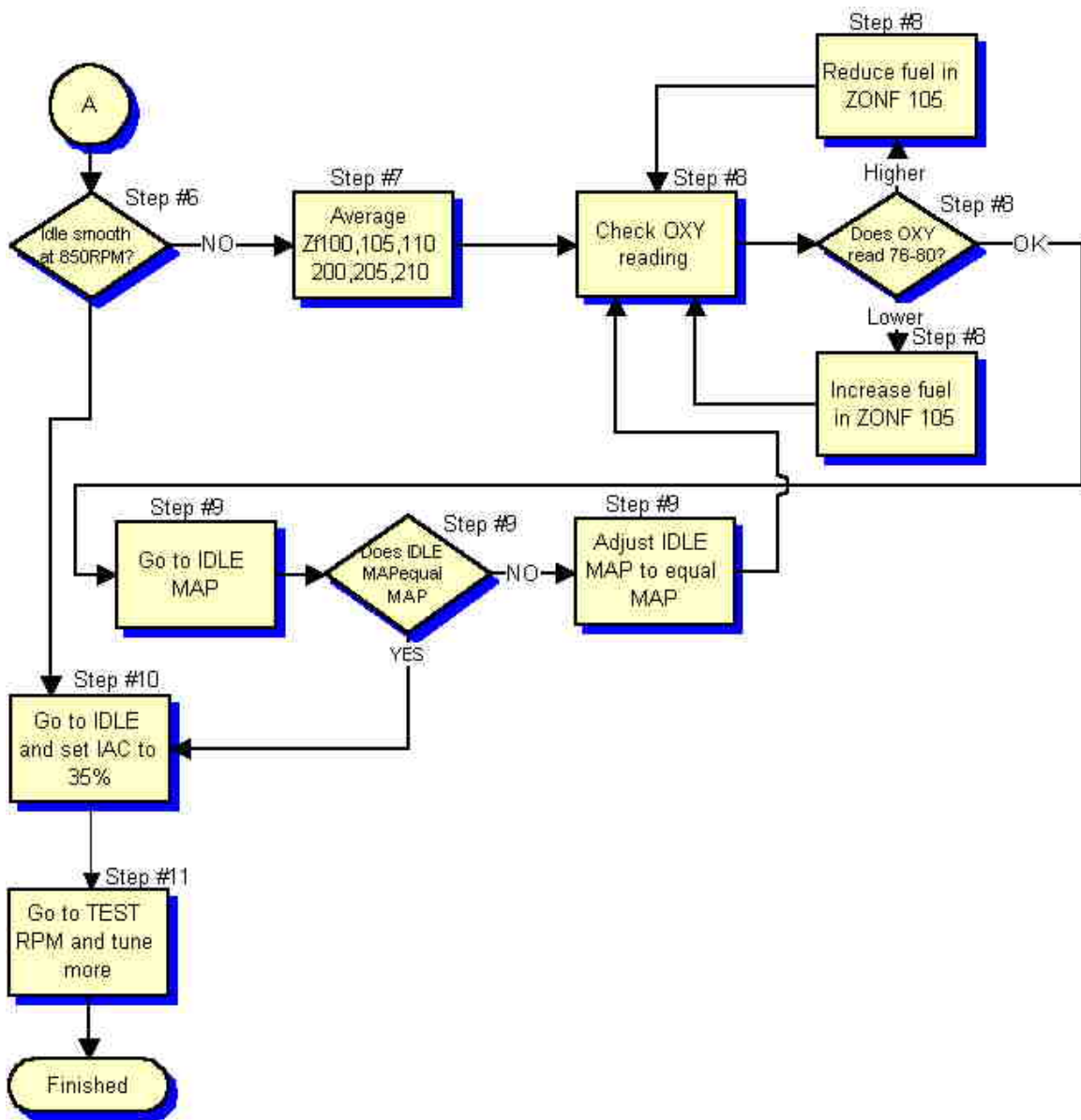
Chip, beveled edge up

Once the chip is in place, you can close up the computer. If you are running 440cc or 550cc injectors on a turbo car, you don't need to reload, just fire it up. If you are running stock injectors on an N/A car, go to reload, push the **edit arrow** to read "n/a stock injectors", then, while holding the **edit arrow**, hold both **adjust arrows** down until you get a row of asterisks across the screen. Release the buttons and wait for the asterisks to clear. If you are running 440s on your n/a car (perhaps while you wait for your aerodyne to return), refer to the section of this document that corresponds to your engine set up for more information on set-up procedures.



### Section 3: Set-up Flow Chart





## Section 4 : Turbo setup

If you have not already done so, please read the Theory of Operation Section before attempting to use the ECU. You will have a difficult time trying to use the ECU if you do not know how the variables effect the car's operation. Initial tuning of the Flyin' Miata ECU is not difficult but having someone in the passenger seat to take some readings while the driver drives the car is a very good idea. If you are running 370cc/min fuel injectors change master fuel to 85.

1. Turn the car "on" but do not start it.
2. Press the **adjust down** button on the keypad. The MAP reading should be atmospheric pressure. Sea level equals approximately 100kPa. Higher elevations will read lower. Refer to the table below for the atmospheric pressure at your elevation.

Elevation	Pressure	Elevation	Pressure
Sea level	100kPa	4920ft	84kPa
820ft	98kPa	5742ft	82kPa
1640ft	95kPa	6562ft	79kPa
2461ft	93kPa	8202ft	75kPa
3281ft	90kPa	9843ft	70kPa
4101ft	87kPa	11483ft	66kPa

3. Start the car. At this point the car should idle, maybe not smoothly, but it should run. If the car idles poorly, scroll up to the **OXY** window and see what the O2 sensor is reading. If it is below 76-80, go to **ZONEF** and increase the number using the **adjust** buttons until you get a reasonable idle. Don't spend a lot of time on idle at this point, the car needs to be driven to operating temp before proper idle adjustment is possible. Sitting and heat soaking for twenty minutes will not yield good idle settings.
4. All of the ignition timing values in the ECU are set based on a Cam Angle Sensor (CAS) setting of 0° BTDC. However, setting the CAS for 0° BTDC can be difficult because the idle will be erratic and the timing mark will appear to jump around. The software has a special mode to make setting the timing easier. Go to the **IGN TRIM** window and press both **edit** buttons. A new screen will appear that reads **IGN SETUP +10°**. With this mode selected, now set the CAS to 10° BTDC. **DO NOT** use the jumper between terminals TEN and GND in the diagnostics connector. When finished press either of the edit buttons to return to the **IGN TRIM** screen.
5. At this point the car is ready to drive to do some auto tuning. Drive with the keypad set to the **ZONEF** window. The ECU can only tune the zone that the car is currently operating in. The 3 digit number in the center of the **ZONEF** window displays the current operating zone. When tuning, the car must be

driven in different situations to ensure the engine operates in as many different zones as possible. Start by driving the car around a suburban setting, accelerate slowly and try to stay in the 200 row. Then move to an area where the car can be accelerated somewhat harder, keeping the car in the 300 row (zero on your boost gauge). Finally, find a road where the car can be accelerated from 1500RPM to redline in 4<sup>th</sup> gear. Do a run with very light throttle to keep the car in the 200 row all the way to redline, trying to stay in each zone long enough to get “=”. Repeat for each row, modulating the throttle to keep the car in the 300 row, then 400, then 500 (and 600, if N/A or turbo running over 15psi). While the car is driven in these conditions the ECU will display the characters shown above. Have a co-pilot read off the tuning information, specifically when the ECU shows “+” and “-“ signs. These are important because they indicate when the computer is tuning. Try to hold the car in a particular zone until the “+” or “-“ sign turns into an “=” sign. ). Each zone usually tunes within 2 to 4 seconds. After driving for 15-20 minutes pull over and store the changes. **Do not forget to store before you shut off the car**

6. After about 20-30 minutes of driving the car should be tuned pretty well. Pull off the road to a place where the car can sit for a few minutes. Does the car idle smoothly at 850RPM? If so skip to step #9
7. Many times after tuning the car will pulsate at idle. This can be solved with the following steps. Scroll up to the **EDIT** window and go to Zf100. Read the values in Zf100, 105, 110, 200, 205, and 210. Average these together and enter that number into all 6 zones. The idle should be much more steady.
8. Scroll down to the **OXY** window and read the O2 sensor voltage. The reading will jump around a bit, estimate the average value. If it is below 76-80, go to the **ZONEF** window and add fuel in the zf105 idle zone by increasing the fuel correction number. If the O2 sensor reads higher than 76-80, decrease the fuel correction number in **ZONEF**.
9. Scroll down to **IDLE MAP**. The number on the far right is the **IDLE MAP** setting. The number in parentheses is the current MAP value. These two numbers must equal each other. If not, adjust the **IDLE MAP** setting and go back and repeat step #9.
10. Go to the **IDLE** window. The car will idle best when the IAC valve operates at 35% duty cycle. Adjust the idle bypass screw on the throttle body until the IAC is 35%.
11. The tuning that the ECU performs in **ZONEF** is coarse, IOW, the ECU will tune anywhere in the zone. To get even more accurate numbers, after getting “=” everywhere in **ZONEF**, set the keypad in either **TESTRPM** or **STORE**. In these two windows the ECU tunes to a much finer degree, by

only tuning in the zone centers, leading to better interpolation. Drive in one of these two windows for a few miles until “=” are common and save these fuel values. The RPM center of the zones is at the 250 RPM point, IOW, 2250, 2750 and so on. Remember that you need to be in the center of the zone both MAP and RPM wise.

12. At this point the ECU is tuned. Drive the car with Lambda “on” all the time. The ECU will boot up in the TEST RPM screen and perform L3 tuning all the time. These values are not to be saved. L3 tuning will make changes daily in reaction to atmospheric conditions. The keypad can be stored in the glove compartment. Be very careful with the keypad, the cases will melt in high temps. Do not leave in the sun.

## Section 5: Supercharger setup

If you have not already done so, please read the Theory of Operation Section before attempting to use the ECU. You will have a difficult time trying to use the ECU if you do not know how the variables effect the car's operation. Initial tuning of the Flyin' Miata ECU is not difficult but having someone in the passenger seat to take some readings while the driver drives the car is a very good idea. The TURBO1 default program can be used as a starting point but the fuel values will have to be increased due to the parasitic nature of the super charger. Auto tuning will take care of this. Additional timing may need to be pulled out between 1500-2500 rpm where the supercharger will make more boost than the typical turbo. This will be accomplished with the knock sensor if fitted, otherwise zones Zi315, 320, &325 need to be adjusted manually. If you are running 370cc/min fuel injectors, change master fuel to 85.

1. Turn the car "on" but do not start it.
2. Press the **adjust down** button on the keypad. The MAP reading should be atmospheric pressure. Sea level equals 100kPa. Higher elevations will read lower. Refer to the table below for the atmospheric pressure at your elevation. If this reading looks good, go to line #5.

Elevation	Pressure	Elevation	Pressure
Sea level	100kPa	4920ft	84kPa
820ft	98kPa	5742ft	82kPa
1640ft	95kPa	6562ft	79kPa
2461ft	93kPa	8202ft	75kPa
3281ft	90kPa	9843ft	70kPa
4101ft	87kPa	11483ft	66kPa

3. Start the car. At this point the car should idle, maybe not smoothly, but it should run. If the car idles poorly, scroll up to the **OXY** window and see what the O2 sensor is reading. If it is below 76-80, go to **ZONEF** and increase the number using the **adjust** buttons until you get a reasonable idle. Don't spend a lot of time on idle at this point, the car needs to be driven to operating temp before proper idle adjustment is possible. Sitting and heat soaking for twenty minutes will not yield good idle settings.
4. **All of the ignition timing values in the ECU are set based on a Cam Angle Sensor (CAS) setting of 0° BTDC.** However, setting the CAS for 0° BTDC can be difficult because the idle will be erratic and the timing mark will appear to jump around. The software has a special mode to make setting the timing easier. Go to the **IGN TRIM** window and press both **edit** buttons. A new screen will appear that reads **IGN SETUP +10°**. With this mode selected, now set the CAS to 10° BTDC. **DO NOT** use the jumper between terminals

TEN and GND in the diagnostics connector. When finished press either of the edit buttons to return to the **IGN TRIM** screen.

5. At this point the car is ready to drive to do some auto tuning. Drive with the keypad set to the **ZONEF** window. The ECU can only tune the zone that the car is currently operating in. The 3 digit number in the center of the **ZONEF** window displays the current operating zone. When tuning, the car must be driven in different situations to ensure the engine operates in as many different zones as possible. Start by driving the car around a suburban setting, accelerate slowly and try to stay in the 200 row. Then move to an area where the car can be accelerated somewhat harder, keeping the car in the 300 row (zero on your boost gauge). Finally, find a road where the car can be accelerated from 1500RPM to redline in 4<sup>th</sup> gear. Do a run with very light throttle to keep the car in the 200 row all the way to redline, trying to stay in each zone long enough to get “=”. Repeat for each row, modulating the throttle to keep the car in the 300 row, then 400, then 500 (and 600, if N/A or turbo running over 15psi). While the car is driven in these conditions the ECU will display the characters shown above. Have a co-pilot read off the tuning information, specifically when the ECU shows “+” and “-“ signs. These are important because they indicate when the computer is tuning. Try to hold the car in a particular zone until the “+” or “-“ sign turns into an “=” sign. ). Each zone usually tunes within 2 to 4 seconds. After driving for 15-20 minutes pull over and store the changes. **Do not forget to store before you shut off the car**
4. After about 20-30 minutes of driving the car should be tuned pretty well. Pull off the road to a place where the car can sit for a few minutes. Does the car idle smoothly at 850RPM? If it does skip to step #15.
5. Many times after tuning the car will pulsate at idle. This can be solved with the following steps. Scroll up to the **EDIT** window and go to Zf100. Read the values in Zf100, 105, 110, 200, 205, and 210. Average these together and enter that number into all 6 zones. The idle should be much more steady.
6. Scroll down to the **OXY** window and read the O2 sensor voltage. The reading will jump around a bit, estimate the average value. If it is below 76-80, go to the **ZONEF** window and add fuel by increasing the fuel correction number. If the O2 sensor reads higher than 76-80, decrease the fuel correction number in **ZONEF**.
7. Scroll down to **IDLE MAP**. The number on the far right is the **IDLE MAP** setting. The number in parentheses is the current MAP value. These two numbers must equal each other. If not, adjust the **IDLE MAP** setting and go back and repeat step #9.

8. Go to the **IDLE** window. The car will idle best when the IAC valve operates at 35% duty cycle. Adjust the idle bypass screw on the throttle body until the IAC is 35%.
9. The tuning that the ECU performs in **ZONEF** is coarse. To get even more accurate fuel numbers, set the keypad in either **TESTRPM** or **STORE**. In these two windows the ECU tunes to a much finer degree. Drive in one of these two windows for a few miles until “=” are common and save these fuel values.
10. At this point the ECU is tuned. Drive the car with Lambda “on” all the time. The ECU will boot up in the TEST RPM screen and perform L3 tuning all the time. These values are not to be saved. L3 tuning will make changes daily in reaction to atmospheric conditions. The keypad can be stored in the glove compartment. Be very careful with the keypad, the cases will melt in high temps. Do not leave in the sun.

## Section 6: Normally aspirated setup

If you have not already done so, please read the Theory of Operation Section before attempting to use the ECU. You will have a difficult time trying to use the ECU if you do not know how the variables effect the car's operation. Initial tuning of the Flyin' Miata ECU is not difficult but having someone in the passenger seat to take some readings while the driver drives the car is a very good idea. If you are running 370cc/min fuel injectors change master fuel to 85.

1. Turn the car "on" but do not start it.
2. Use the select up button to get to **RELOAD**. There are 4 programs stored in the chip. The default is "**TURBO 1**". If you are using the ECU with stock injectors press the **edit up** or **edit down** or both **edit** buttons simultaneously until the screen reads "N/A oem inj". The buttons must be held down for the screen to change. While holding down the combination of **edit** buttons to select the correct program, press and hold both **adjust** buttons. The screen will fill with asterisks. When they clear use the **select** up button to get back to TEST RPM. If you are using 440 or 550 injectors, use the combination of edit buttons so that the screen reads "N/A BIG inj.
3. Press the **adjust down** button on the keypad. The MAP reading should be atmospheric pressure. Sea level equals 100kPa. Higher elevations will read lower. Refer to the table below for the atmospheric pressure at your elevation. If this reading looks good go to line #5.

Elevation	Pressure	Elevation	Pressure
Sea level	100kPa	4920ft	84kPa
820ft	98kPa	5742ft	82kPa
1640ft	95kPa	6562ft	79kPa
2461ft	93kPa	8202ft	75kPa
3281ft	90kPa	9843ft	70kPa
4101ft	87kPa	11483ft	66kPa

3. Start the car. At this point the car should idle, maybe not smoothly, but it should run. If the car idles poorly, scroll up to the **OXY** window and see what the O2 sensor is reading. If it is below 76-80, go to **ZONEF** and increase the number using the **adjust** buttons until you get a reasonable idle. Don't spend a lot of time on idle at this point, the car needs to be driven to operating temp before proper idle adjustment is possible. Sitting and heat soaking for twenty minutes will not yield good idle settings.
4. **All of the ignition timing values in the ECU are set based on a Cam Angle Sensor (CAS) setting of 0° BTDC.** However, setting the CAS for 0° BTDC can be difficult because the idle will be erratic and the timing mark will appear

to jump around. The software has a special mode to make setting the timing easier. Go to the **IGN TRIM** window and press both **edit** buttons. A new screen will appear that reads **IGN SETUP +10°**. With this mode selected, now set the CAS to 10° BTDC. **DO NOT** use the jumper between terminals TEN and GND in the diagnostics connector. When finished press either of the edit buttons to return to the **IGN TRIM** screen.

5. At this point the car is ready to drive to do some auto tuning. Drive with the keypad set to the **ZONEF** window. The ECU can only tune the zone that the car is currently operating in. The 3 digit number in the center of the **ZONEF** window displays the current operating zone. When tuning, the car must be driven in different situations to ensure the engine operates in as many different zones as possible. Start by driving the car around a suburban setting, accelerate slowly and try to stay in the 200 & 300 rows. Then move to an area where the car can be accelerated somewhat harder, keeping the car in the 300 & 400 rows. Finally, find a road where the car can be accelerated from 1500RPM to redline in 4<sup>th</sup> gear. Do a run with very light throttle to keep the car in the 200 row all the way to redline, trying to stay in each zone long enough to get “=”. Repeat for each row, modulating the throttle to keep the car in the 300 row, then 400, then 500 and 600. While the car is driven in these conditions the ECU will display the characters shown above. Have a co-pilot read off the tuning information, specifically when the ECU shows “+” and “-“ signs. These are important because they indicate when the computer is tuning. Try to hold the car in a particular zone until the “+” or “-“ sign turns into an “=” sign. ). Each zone usually tunes within 2 to 4 seconds. After driving for 15-20 minutes pull over and store the changes. **Do not forget to store before you shut off the car**
6. After about 20-30 minutes of driving the car should be tuned pretty well. Pull off the road to a place where the car can sit for a few minutes. Does the car idle smoothly at 850RPM? If it does skip to step #15.
7. Many times after tuning the car will pulsate at idle. This can be solved with the following steps. Scroll up to the **EDIT** window and go to Zf100. Read the values in Zf100, 105, 110, 200, 205, and 210. Average these together and enter that number into all 6 zones. The idle should be much more steady.
8. Scroll down to the **OXY** window and read the O2 sensor voltage. The reading will jump around a bit, estimate the average value. If it is below 76-80, go to the **ZONEF** window and add fuel by increasing the fuel correction number. If the O2 sensor reads higher than 76-80, decrease the fuel correction number in **ZONEF**.
9. Scroll down to **IDLE MAP**. The number on the far right is the **IDLE MAP** setting. The number in parentheses is the current MAP value. These two

numbers must equal each other. If not, adjust the **IDLE MAP** setting and go back and repeat step #9.

10. Now with the car idling smoothly and the O2 sensor reading between 76-80, go back to the **EDIT** window and set the 6 idle zones with the same number you have in Zf105. Except when setting Zf205 and 210, add about 5 to the number in Zf105 (i.e. if Zf105=120 make Zf205 and Zf210=125).
11. Go to the **IDLE** window. The car will idle best when the IAC valve operates at 35% duty cycle. Adjust the idle bypass screw on the throttle body until the IAC is 35%.
12. The tuning that the ECU performs in **ZONEF** is coarse. To get even more accurate fuel numbers, set the keypad in either **TESTRPM** or **STORE**. In these two windows the ECU tunes to a much finer degree. Drive in one of these two windows for a few miles until "=" are common and save these fuel values.
13. At this point the ECU is tuned. Drive the car with Lambda "on" all the time. The ECU will boot up in the TEST RPM screen and perform L3 tuning all the time. These values are not to be saved. L3 tuning will make changes daily in reaction to atmospheric conditions. The keypad can be stored in the glove compartment. Be very careful with the keypad, the cases will melt in high temps. Do not leave in the sun.

## Section 7: Datalogging

Your Flyin' Miata ecu is capable of datalogging many parameters to a laptop computer, using the Serial Link interface. The Serial Link plugs into the ribbon cable in place of the keypad, then connects to the serial port of your laptop. Do not use the Telix software provided with the Serial Link, it will not work with our current software. Go to the FM Owners page of our website and download the "binary logging software". Save it to your C root directory and it will create a couple of new icons on your desktop. To datalog, click on the "Record" icon on your desktop, wait for it to say "ready", then start the car. You can pause recording at any time by hitting "P" on your keyboard. You may resume by hitting any key. When you are done with your recording, hit "Q".

To view your datalog, go to "Miatalog.bin" icon on your desktop and drag it up to the "MS DOS CONVERT" icon. This will open up Wordpad and pop up your datalog. You must save your datalog from Wordpad, otherwise it will be replaced by the next one you do.

The columns in the datalog are:

**Sample** (this is the line number)

**e** Shows any cam angle sensor errors

**RPM**

**MAP** (manifold pressure)

**L C** shows that lambda control is on (Lambda, tells tuning status, ie: + - =, V, E, etc)

**02**

**W/E** (Wastegate duty cycle) (on 1.8 only, shows EGR position when no boost)

**INJW** (injector pulse width)

**INJ%** (injector duty cycle)

\* (shows \* if idle switch is closed)

**I/T** (idle duty cycle) (1.8 only, shows TPS position when \* not showing)

**S** shows neutral switch position (MKII ecus only)

**KNK** (raw knock sensor loudness signal)

**IADV** (ignition advance, must be added to base timing.)

Periodically, another line will show up, giving voltage, engine temp, speed (1.8 only), CF (1.8 only, shows condensor fan on), EF (1.8 only, shows main engine fan on), PR (1.8 only, shows PRC solenoid activated, giving extra hot start enrichment), CP (charcoal canister purge) and knock count (number of times knock level has exceeded z13 knock threshold).

At the end of the datalog, your starting maps will be printed, followed by two maps filled mainly with asterisks. Any changes made by lambda tuning or the knock sensor will show up in these maps. This can be a wonderful tuning aid, especially on the dyno.

There are 12.2 lines of info printed per second, so you can use the time frame for 0-60mph, etc. There is a slight lag in the speedo cable, so these numbers won't be 100% accurate, they will actually read slightly slower times than reality.

## **Section 8: Frequently Asked Questions**

### **When coming to a stop the idle droops and sometimes the car stalls. Why?**

The ECU has two zones to control the IAC valve when the car is under high vacuum with the throttle closed, Z18 when the car is hot and Z19 when the car is cold. Increase the value in each of these zones to stop the idle drooping. They should typically be set in the low 40's, if you have your idle duty cycle (set with the idle air bypass screw) set in the 30-35% range.

### **When I increase **IDLE MAP**, my idle smoothes out. Why can't I just do that to get a great idle?**

Increasing idle MAP richens up the idle zones, which will almost always give you a good idle. Unfortunately, it will be way too rich an idle. Once you set idle MAP properly a few points below strong idle MAP, leave it alone, make your idle adjustments in the idle fuel zones.

### **All my zones are hitting "=", I have no pinging, but the engine is breaking up under full boost. Why?**

This is most commonly caused by ignition system problems. Try the following items in this order. Re-gap spark plugs to .030", Replace spark plugs with NGK ZFR6F-11s gapped to .030". Replace the spark plug wires with Magnecor 8.5mm wires. And lastly, replace one or both of the coil packs.

### **At 12psi and above my engine misses and stumbles. Why?**

At 10psi and above the spark plug gap needs to be reduced from the factory setting of .043" to .028" to .030". At these boost pressures the incoming air and fuel literally blows out the spark on the plug at the stock gap. Another possible cause of this problem would be O2 target variation caused by different fuel octane ratings. We find that those of you lucky enough to get 93-94 octane fuel may want to reduce z29-30-31 down to 89.

## Section 9: Operation warnings

Fitting the Flyin' Miata ECU to your car will increase performance. In the case of a turbo charged installation, the power output from the motor is more than doubled. An increase like this requires the driver to use good judgment when tuning and operating the car.

1. Always use the highest octane fuel available.
2. If you hear knock from the motor, lift off the throttle immediately. The forces from knock are the most damaging to an engine.
3. On turbo charged cars keep an eye on the boost gauge. If you see the boost pressure exceeding your target boost level lift off the accelerator pedal. Miatas can incur serious engine damage when exposed to boost pressures over 15psi.
4. Be kind to your transmission and differential. The stock transmission and differential have proven reliable in turbo charged cars provided "mechanical empathy" is exercised. This means no smoky burnouts from a standing stop and no "speed shifting".