



Care and Keeping of Pro Formula Mazda  
and  
Introduction to Pro Formula Mazda  
Operating Systems  
23.January.2010





# Pro Formula Mazda Capacities



## Engine Oil

- 8 quarts with new external regulator
- 10-30wt
- Changed every 2 hours of run time
- Should be 6.5 inches from bottom of the tank

## Gearbox Oil

- 3 quarts for street and road courses, add .5 quart for oval races.
- Recommended weight of 75-90wt. Hewland recommends SAE 80 or 90





# Pro Formula Mazda Capacities

## Fuel

- The cell is designed to hold 19 gallons
- BUT remember that the last few gallons will not get picked by the tower
- These cars get on average 5-8 mpg
- If pump gas it to be used it should be 100 octane minimum, VP race brand, plus 2 oz per gallon of oil

## Water

- 2 gallons
- Dual pass and single pass legal
- 20-25 psi cap



# Engine Vitals: Limits and Suggested Warning Light Values



## Oil Temperature:

Operating Range = 190F – 230F

Terminal Temp = 250F

Warning light suggestion = High: 230F, Low: 150F

## Water Temperature:

Operating Range = 180F – 220F

Terminal Temp = 240F

\*Map compensation starts at 212F

Warning light suggestion = High: 220F, Low: 160F

## Battery Voltage:

Operating Range = 13v-14v

ECU will not fire coils at 8v. Plugs need 11.2 to fire.

Warning light suggestion = High: 14.5v, Low: 12.5V



# Engine Vitals: Limits and suggested warning light values



## Oil Pressure:

Operating Range = 100psi – 110 psi at 8600rpm

Terminal Pressure = High: 150psi, Low: 60 psi

Warning light suggestion = High: 140psi, Low: 75 psi

## *Setting Oil Pressure:*

Completely warmed up oil and water

Monitor Oil Pressure in ECU View Live Sensors

Raise Engine RPM to 3000, monitor Oil Pressure increase

Make adjustments to regulator, retest or allow to cool then retest as necessary.

## Fuel Pressure:

Operating Range = 56 +/- 2%

Warning light suggestion = 45 psi



## Engine Vitals: Lambda



Lambda is the measure of the amount of oxygen in the exhaust stream. The value expressed is a percentage of the stoichiometric air/fuel ratio 14.7:1.

Air/fuel ratio can be calculated by multiplying the lambda value monitored by data system by 14.7

(ex: .90 Lambda translates as  $(.9 \times 14.7 = )13.23$  Air/fuel ratio

**Operating Range = .87 - .91, aim for .90**

Overly rich (lower lambda) numbers will reduce economy and power

Overly lean (higher lambda) numbers will elevate temperatures, reduce power and possibly cause detonation

Lambda will read lean after a shift, traction control event, pit lane speed limit and valve immediate opening.



## Engine Vitals: Lambda continued

There are two methods of lambda monitoring: ECU or ADL (the ADL reads approximately .2 higher)

Lambda bung location should be toward rear of pipe, 6" from muffler junction (be sure to accommodate for possible interference with the bellhousing)

The depth of the sensor in the pipe should be so that the tip is flush with the inner wall of the tube.

Lambda sensor precision:

Sensor life

Sensors tend to wear out more quickly when closer to header

Monitor Channel Lambda ZP

monitors the time the heater has been on in basic terms and reflects the temperature of the sensor

Low numbers means too hot, High numbers means too cold – both produce corrupt readings

Calibrating Lambda per memo 23.Jan.2010





# Engine Vitals: Exhaust Gas Temperatures



Exhaust Gas Temperatures (EGTs) are the second most important tuning and troubleshooting channel next to Lambda.

EGTs reflect on the injector balance between the front and rear rotor

Reflects misfires through high readings accompanied by normal lambda

Decline in engine performance can be evidenced by the rate of temperature acceleration between the rotors during a long pull – gapping

Emphasis needs put on the condition of the EGTs – low reading sensors are beginning to fail. In order to have an accurate assessment of the performance, EGT sensors must be replaced often.

Generally, one EGT sensor is used per rotor. One sensor bung should be welded on the each the outer exhaust pipes 3” from the header flange (the center pipe usually does not receive a sensor). The sensor depth should be enough to where the tip of the sensor is in the centerline of the exhaust flow.

**Operational Range: Front Rotor: 1450F – 1600F,  
Rear Rotor: 1400F – 1550F**



## Procedure: Shop Prep



### Gearbox bulletins:

- Drilled Differential holes

- Shift Pawl

- 4 spider update (per update 30.November.2010)

- Get current manual (FTR 23.March.2009)

### Fuel hose routing (per update 18.May.2007)

### Fuel system Maintenance:

- Importance of draining between races

- Replacing stock supply line

- Replacing foam yearly

- Fuel line inspection

- Surge tank door inspection

- Year of cell



## Procedure: Shop Prep continued



New regulator spring (per update 30.November.2009) – switch out regulator diagram

Radiator cap

Upright studs

Toe links

Drive shafts and tripods

Wiring harness history and replacement

*Pre Race Weekend:* Be sure to check the website under the upcoming event to see when our Crew Chief Meeting and Driver's Meetings are and for other important updates!



## Procedure: Start Up



These cars hate the cold!

Always use the jumper battery. The battery will need to be able to start the car twice without the battery to pass the tech inspection

Idle @ 1500 RPM until 120F Water Temperature

Raise RMP slowly, approx to 3000, until 180F Water Temperature.

Place fan in front of left side pod to reduce Engine Temp. Hold Rpm at 3000 until 180F Oil Temperature is reached.

Check and set the oil pressure per previous slide description



## System: Dampers



2010 Upgrade per Tech Update 18.Jan.2010:

Goal: Based on popular opinion last year, the TTX-36 dampers could use more compression adjustment. The compression adjuster has been changed from a 2-way to a 3-way. The new adjuster increases the low speed compression range and introduces the high speed range.

### Adjustments:

Originally max setting 24-24 compression-rebound.

Now max settings 42-48-24 low speed compression, high speed compression, rebound.

### Damper Maintenance:

Rebuild once/year unless damaged or leaking.

Oil change 1 or twice per year depending on mileage between races.

Damper padding, clocking and pot attachment



## Systems: Intake

### Throttle Body

The throttle body should have .020" gap between the butterfly and the housing.  
The gap translates to 0-3% in the ECU and Dash.

### Valve System

The rotary uses a 6 port intake system (3 ports per rotor)

To maximize efficiency each port is opened via independent valve systems by the M400 based on Engine RPM

The three valves are:

Sequential Shutter Valve (a.k.a. SSV)

Auxiliary Port Valve (a.k.a. APV)

Variable Dynamic Intake Valve (a.k.a. VDI)

Valve opening is most obviously seen in the data through the lambda trace: The lambda will go rich during the valves operation, lean on immediate opening



## Systems: Intake Sequential Shutter Valve (SSV)

Controlled by Aux 3 where open time is described as 100%

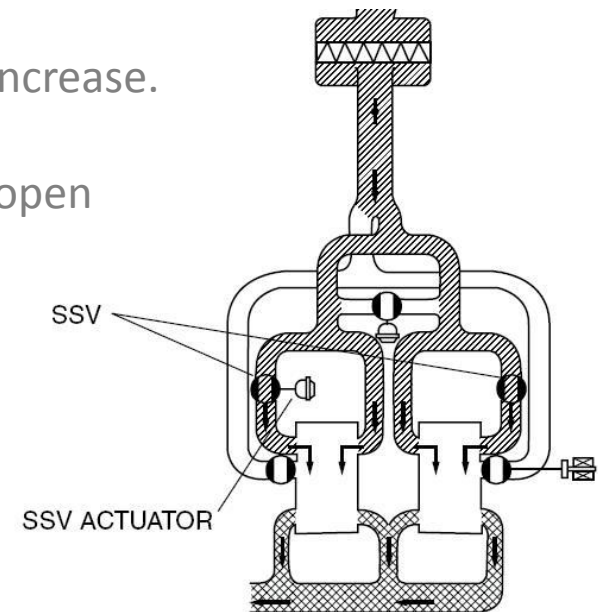
Harness label " Valve B ".



This valve is located in the middle of the engine.

Opens up the secondary (outer) ports at 3500 rpm.

Provides larger airflow path as engine speed and load increase.

Opens based on rpm and throttle position, but always open above 5500 rpm.



 : INTAKE AIR  
 : EXHAUST AIR



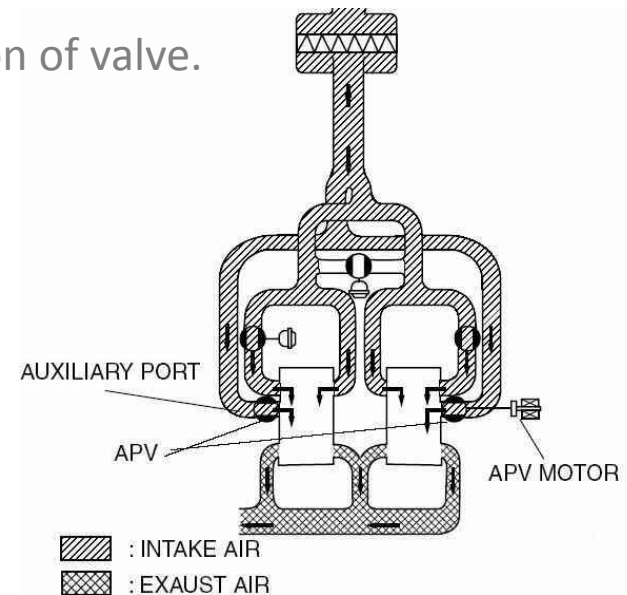
## Systems: Intake Auxiliary Port Valve (APV)

Controlled by Aux 7 and Aux 8 through a motor driven rack and pinion where open time is described as 0% and closed time is described as 100%

Opens the 5th & 6th port at 6300 rpm.  
Closes at 5900 rpm.

Final expansion of intake manifold flow capabilities.

A position switch is incorporated for monitoring action of valve.





## Systems: Intake Variable Dynamic Intake Valve (VDI)

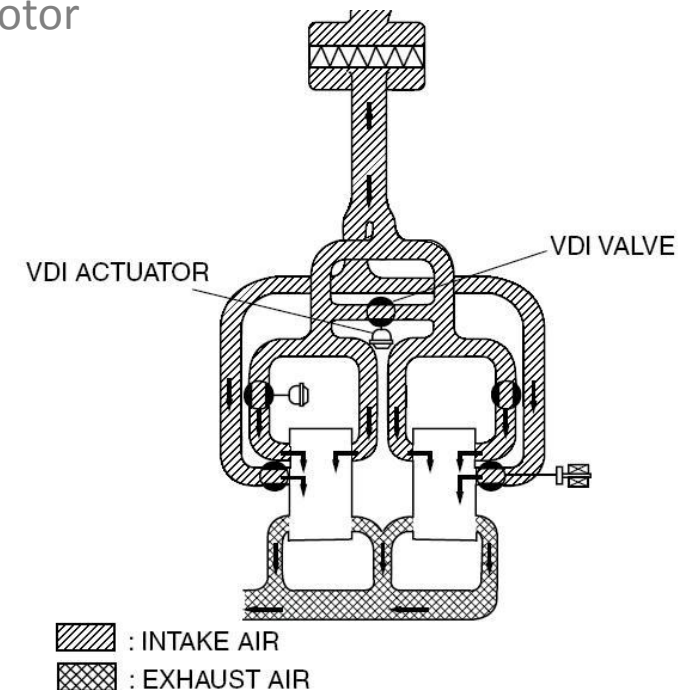
Controlled by Aux 2 where open time is defined at 100%

Harness label "Valve A".

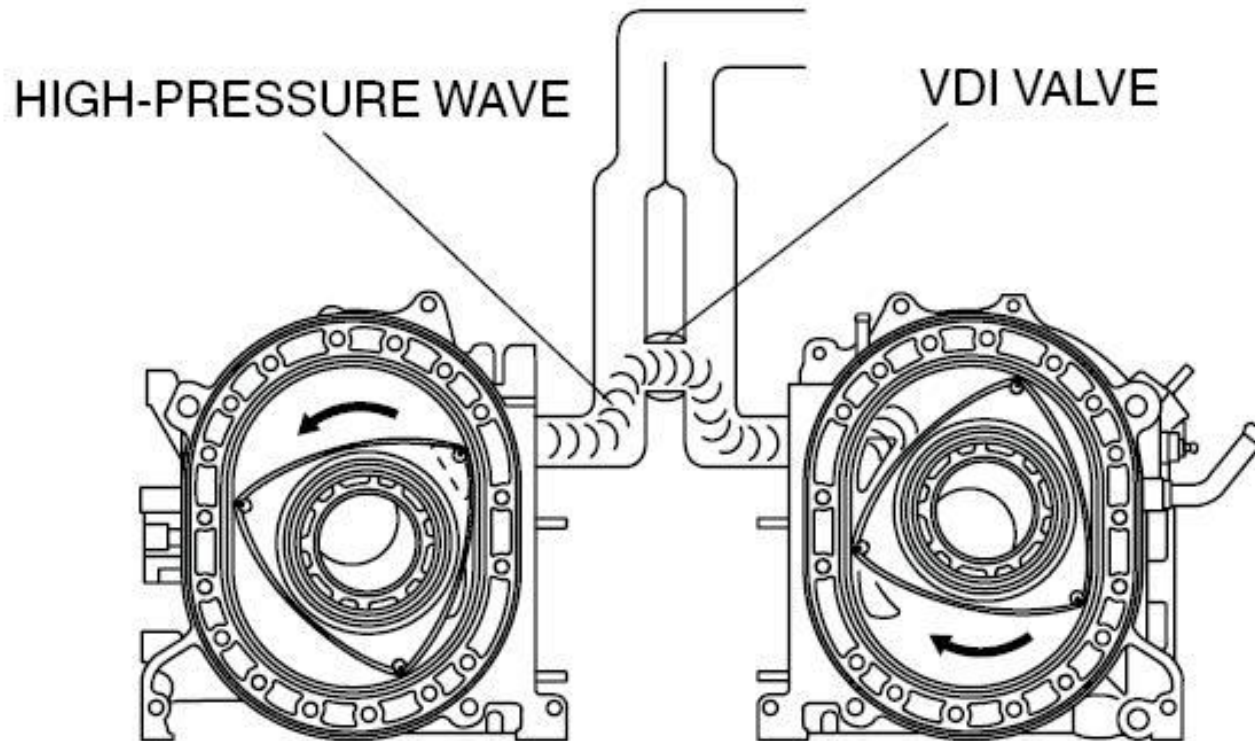
Opens the top intake valve at 7600 rpm.

This valve connects the two intake tracts between both rotors.

When one rotor is closed, it pushes air into the other rotor providing intake supercharging at high engine rpm.



# Systems: Intake Variable Dynamic Intake Valve Diagram



## Systems: Vacuum



The VDI and SSV valves are vacuum actuated via an electric solenoid and therefore requires both an electric and pneumatic signal to operate.

A black vacuum box is connected to the Upper Intake Manifold and pulls vacuum through the green and white check valve

The vacuum solenoid rack is run off the vacuum accumulated in the box

The solenoids then connect the vacuum to the diaphragms in the VDI and SSV actuators.

The actuators then turn the valves when the solenoids are electrically activated.



## Systems: Vacuum

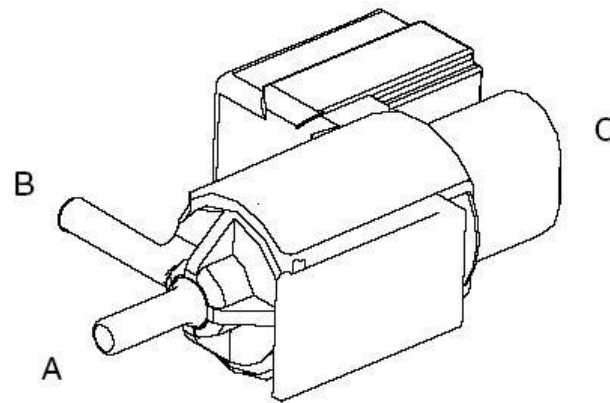


The solenoids that activate the valves have three ports:

A is connected to the vacuum box

B is connected to the actuator

C is vented to atmosphere



When the valve is OFF, A is closed off the actuator B is vented to atmosphere C

When the valve is ON, the solenoid connects the actuator B to the vacuum box A



## System: Ignition



The ignition system is composed of four individually controlled and internally transistorized coil packs.

The ECU uses three-dimensional dwell and advance point maps to control each coil.

The coil is a stock RX-8 street legal part and the life of the coils has been significantly improved with the additions of new maps over the years.

Coils can be tested using a KV tester but the user should make a point to note the battery voltage and ambient temperature when testing – will not generate precise output measurement but will create an accurate reference.

Coil failure is usually attributed to the switching transistor and is evidenced by a blister above the primary wire connector



## System: Fuel Injectors



**4 injector engine** uses 2 brown primary injectors and 2 green secondary injectors

**6 injector engine** uses 2 red primary injectors and 4 yellow secondary injectors

Both types of engines are allowed however the original 6 will eventually be phased out.

When injectors fail the part will usually either leak externally (easily evidenced) or internally.

Internal leaking will be evidenced in a misfire at low RPM, low lambda numbers, low EGT numbers at idle.

Injector cleaning and flowing is recommended so jets can be more evenly matched to produce the most efficient Lambda values.

When EGTs vary more than 50 F (20C), inspect injectors and match



# Systems: Engine Control Unit



## ECU Characteristics:

M400 Motec ECU Maps are 'locked' to ensure equal programming by an encryption know only by Star Race Cars.

Program updates are delivered from Star Race Cars as encrypted files and can be uploaded by either Star Race Cars or the end user.

The M400 control all aspects of the engine through multi-dimensional maps and detailed programming that has been optimized through out the years.

Communication is delivered from the ECU via CAN (Controller Area Network) to the user's PC or ADL Motec System Dash

## ECU Includes the following features:

- Environmental Adaptation
- Fuel Trim
- Traction Control
- Pit Lane Speed Limiting
- Shift without Lift



# Systems: Engine Control Unit

## Engine Synchronization:

M400 requires a precise understanding of the engine's rotational position at all time

The position is monitored through the **REFerence** sensor which is mounted on the front of the engine and picks up engine speed and cycle **SYCNhronization** from a 36 toothed wheel

The REF and SYNC are signals that can be seen in the Motec i2 analysis and are commonly used to diagnose engine problems.

## Environmental Adaptation:

The M400 is able to make 'on-the-fly' fuel mixture changes based on the environment

The ECU will richen the mixture when the water temperature is cold to help with cold start

The ECU will adjust for air density using the air temperature sensor as a reference

Air density compensation is finalized by the barometric pressure sensor





# Systems: Engine Control Unit

## Fuel Trim:



Fuel pressure and fuel supply are critical to maintaining the proper air/fuel mixtures. Our map corrects for variations in fuel pressure seen through the FP sensor and the driver can make adjustments through the Trim switch

The M400 map allows the driver to make real time adjustments to add fuel to the engine through a Fuel Trim Knob.

The 2010 map controls Fuel Trim through an optional 11-position knob that increases the adjustment range from:

-2 to +8 in 1% increments

The older 4-position switch can still be used with the 2010 map but will be limited in range:

P1 = 0%, P2 = +2%, P3 = +4%, P4 = +6%



# Systems: Engine Control Unit



## Engine Speed Limiting:

The M400 will limit the RPM under the following conditions:

Over Rev, Traction Control, Gear Change, Pit Lane Speed Limit, Cold Start Map

The M400 simultaneously halts fuel and ignition events on a randomly selected rotor face to accomplish the power reduction.

Over Rev: 8600 RPM and above

Driver Controlled Traction Control:

Measures difference between fastest rolling wheel and slowest driven wheel to determine the current slip amount.

Power is limited by a table based on throttle position and other factors. Traction control is controlled using an 11-position switch in the cockpit

All four wheel speed sensors are directed to the ECU for traction control



# Systems: Engine Control Unit



## Engine speed limiting continued:

### Pit lane speed limit:

Activated through a button on the Steering Wheel

The ECU cuts the ignition to slow the engine down (slowing the chassis down is up to the driver!) regardless of gear or throttle position

The maximum speed the ECU will permit the vehicle to travel in with the switch activated is 36 mph (58kph)

Smooth and accurate control of the pit lane speed limit is achieved by the driver using 50% throttle.



# Systems: Engine Control Unit



## Engine Speed Limiting continued:

### Gear Change Ignition Cut:

‘Shift without lift’ allows for drivers to upshift without the clutch or the need to back off the throttle

Down-shifting is not controlled using the ECU but by the driver through throttle blipping

The ignition cut is activated through a switch located near the shift cable mount in the cockpit.

The ECU uses gear position and engine speed to determine the length of the cut. No cut is permitted below 3000 RPM

Drivers have been know to falsely trigger ignition cuts by keeping their hand on the lever too long or by bumping into the lever. Star Race Cars supplies a housing for the switch that mounts directly onto the shift lever.





## Systems: ECU New Map

Goal: Increase engine life through engine control and record keeping

Cost: Free to all competitors registered in the Series

### Changes:

Cold Start Map: If Oil Temperature is less than 150F AND REF signal has been active for less than 300 seconds, the engine will limit the RPM to 5000

Fuel Trim Range: Originally -2% to +2% in 2% increments, now -2% to +8% in 1% increment, new optional switch is available

Auto Fan Parameters: Turn on when Water Temperature is greater than 190F AND ground speed is less than 18 mph, turn off when Water Temperature is 180F

Memory Upgrade: 512Kb to 1Mb

**\*\*Remember to re-calibrate Lambda and Tire Values in ECU Manager!\*\***



# ECU Trouble Shooting



Importance of ECU Data: Everything that is recorded in the ECU data is not always recorded in the dash regardless if you are running a Motec Dash. Many of the indicators and signals for error and engine performance are recorded in the ECU data. ECU data is where to go first for trouble shooting problems. Be sure to download your ECU data after every session!

## Common Problems:

Communication analysis between ECU and PC

Active System Tests through the ECU

Diagnostic Flags and Warning

Mechanical Tests





## ECU Trouble Shooting: Communication

The ECU connects to the computer through the CAN port located on the roll hoop.

The Motec ADL Dash connects through the same port, however, because the CAN port can only communicate to one system at a time, the ECU communication will always preside over the dash communication.

The status of the CAN connection is reported in the left lower corner of the screen.



-“CAN interface cable has no power”

*-Translation:* 0-8volts not present at download connector

-“Excessive number of CAN bus errors”

*-Translation:* CAN HI and LO wires are reversed or shorted in the harness

-“Communication Timeout: Device not connected”

*-Translation:* CAN Power cannot find ECU, usually occurs with the wrong edition of software

# ECU Trouble Shooting: Active Systems ECU Test



The ECU can test the following sub systems:

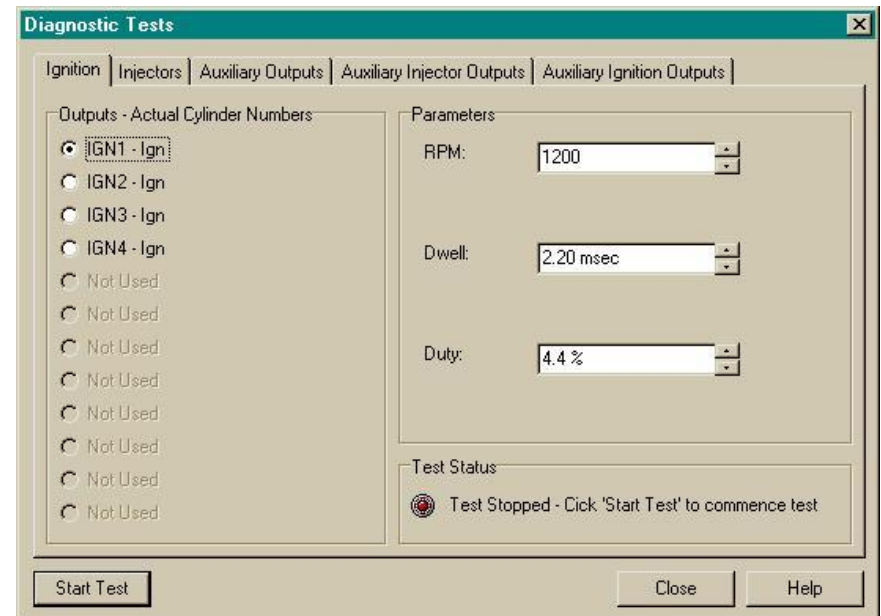
Ignition coils

Fuel injector

Intake Valves

In order to perform the tests, the engine must be off and your laptop must be connected.

Begin the test by selecting ‘Utilities – Test Outputs’ in ECU Manager





## ECU Trouble Shooting: Active Systems ECU Test - Coils



After you select 'Utilities – Test Outputs' select the Ignition page from the Diagnostic Test window

Either a KV tester can be used (or a device of similar nature) or the spark plug can be removed from the engine, remain connected to the coil and must be grounded to the engine block

Ignition must be ON for this test

On the Ignition page, select the output and hit start.

IGN1 = Front Rotor Leading

IGN2 = Rear Rotor Leading

IGN3 = Front Rotor Trailing

IGN4 = Rear Rotor Trailing

You will be looking for spark to start with then compare the intensity across the coils.

Remember accuracy vs. precision!



## ECU Trouble Shooting: Active Systems ECU Test - Injectors



After you select 'Utilities – Test Outputs' select the Injectors page from the Diagnostic Test window

It is advised to have the spark plugs out for this test and to turn the engine over a few time to relieve any injected fuel from the test

The injectors could also be removed from their mounting places and tested, but be prepared for a mess!

The fuel pump must remain OFF for this test – Since the ECU supplies power, unplug the pump

On the Injector page, select the output and hit start.

INJ1 = Front Rotor Primary (Red on 6 injector engine, brown on 4 injector engine)

INJ2 = Rear Rotor Primary

INJ3 = Front Rotor Secondary (Yellow on 6 Injector engine, green on 4 injector)

INJ4 = Rear Rotor Secondary



## ECU Trouble Shooting: Active Systems ECU Test – SSV and VDI



After you select 'Utilities – Test Outputs' select the Auxiliary Outputs page from the Diagnostic Test window

This window will be used to test the SSV (AUX 3) and the VDI valves (AUX 2)

Before beginning the test, increase the Duty Cycle to 100%

Click on the Duty Cycle box and hit Control + the Up arrow key. This will rapidly advance the number

Duty Cycle defaults to original setting after you have closed the test window – no need to reset

Select AUX 2 to test the VDI valve and hit start. (remember to hit STOP)

Select AUX 3 to test the SSV valve and hit start. (remember to hit STOP)

You will hear the valve 'clunk' open but it is also advised to watch it move as well so you can tell if anything is in its way!

Remember the valves are run on vacuum, intensity depends on the vacuum built up.

Running the valves is a good method to check for vacuum leaks as well



## ECU Trouble Shooting: Active Systems ECU Test – APV



(The APV Test is not controlled by the ECU)

To test the APV Valve, with the Master Switch on open the throttle to 100%.

The motor controlling the rack and pinion will open the valve when the throttle gets to 90% and close the valve below 90%

You will be able to hear the motor turning

It is helpful to place your hand on the motor as well

The intensity of the motor sound helps determine the motor condition

This test is disabled when the engine is running.





# ECU Trouble Shooting: ECU Manager Diagnostic Page

Diagnostic errors, raw voltage and sensors can be monitored using the ECU manager 'View – View Sensors or View Diagnostics'

The ECU must be connected to your laptop in order to view this screen.

Diagnostic Errors are presented in RED text

The Reset Errors button will clear the errors unless there is a problem. If the error does not clear, further investigation is required EXCEPT for:

SYNC status will always be  
NotSYNCED with the engine is off

APV will always be ERROR and  
should be ignored



ViewScreen																	
Sensors		Diagnostic Errors		Fuel		Ignition		Boost		Calculated		Status		Outputs		Internal	
TP	OK	EGT 1	OK	Bat V	OK	REF Err	OK										
TP2	OK	EGT 2	OK	Lo Bat	OK	No REF	OK										
TPD	OK	EGT 3	OK	DeltBat	OK	RefNA	OK										
TPD2	OK	EGT 4	OK	DBW FB	OK	RefNT	OK										
MAP	OK	EGT 5	OK	DBW Aim	OK	RefRnt	OK										
AT	OK	EGT 6	OK	DBW Con	OK	RefLo	OK										
ET	OK	EGT 7	OK	DBWTPx	OK	SYNCErr	OK										
La1	OK	EGT 8	OK	DBWTPDx	OK	No SYNC	OK										
La2	OK	User 1	ERROR	DBW Err	OK	SyncNA	OK										
EMAP	OK	User 2	OK	DBWSUP	OK	SyncNT	OK										
MAF	OK	User 3	OK	DCSvoP	OK	SyncRnt	OK										
BAP	OK	User 4	OK	DCSvoCo	OK	SyncLo	OK										
FT	OK	User 5	OK	StSvoP	OK	Synced	NotSYNCED										
FP	OK	User 6	OK	StSvoCo	OK	InjDuty	OK										
OT	ERROR	User 7	OK	OvBoost	OK	Inj 1 p	OK										
OP	OK	User 8	OK	OverRPM	OK	Inj 2 p	OK										
G Lat	OK	La1 Tmp	OK	Reset	OK	Inj 1 s	OK										
G Long	OK	La2 Tmp	OK	Memory	OK	Inj 2 s	OK										
G Vert	OK	La1 SCL	OK	StOMPCo	OK	Inj	OK										
GSF	OK	La2 SCL	OK	APV	ERROR	Inj	OK										
Slip V	OK	NoL1Htr	OK			Inj	OK										
Gear V	OK	NoL2Htr	OK			Inj	OK										
Knock V	OK	ECU T	OK				OK										

Reset Errors    Reset Fuel Used    Reset Max RPM    Close    Help

## ECU Trouble Shooting: REF and SYNC



When the engine is running properly, the REF and SYNC errors can be cleared after cranking

When the engine is not running properly the REF and SYNC will not be cleared

If there are problems cranking the REF sensor needs to be inspected!

Recall that the REF or Crank Sensor surface is sensitive to the gap between the sensor and the toothed wheel

The gap should be between .030" and .050"

A common problem with the REF sensor is the two wires connected to the plug tend to break at the pin due to vibration – be sure to check when problems arise



## Sensor Trouble Shooting: Diagnostic Error

The 'View Diagnostic' page uses the following abbreviations when problems arise:

TP = Throttle Position Sensor

AT = Air Temperature Sensor

ET = Engine Temperature Sensor

EMAP = Barometric Pressure

FP = Fuel Pressure Sensor

OT = Oil Temperature Sensor

OP = Oil Pressure Sensor

GSF = Gear Shift Sensor

Gear V = Gear Position Sensor

USER 1 = Fuel Trim Knob

DeltBat = Rapid Power Loss

BAT Lo = Battery Voltage Too Low



# Sensor Trouble Shooting: Sensor Error



Sensors that will report error on the View Sensors page are:

Wheel Speeds

Gear Position

Actual Gear Volts

Sensor Supplies

ViewScreen
✕

Sensors
Diagnostic Errors
Fuel
Ignition
Boost
Calculated
Status
Outputs
Internal

Trigger Sensors	Main Sensors	Gear Sensors															
RPM	0	G Sft F (N)	92.0														
Max RPM (rpm)	10158	Gear V (V)	1.10														
SyncPos (%)	50.0	Gear	0														
Ref V (V)	-5.61	<div style="border: 1px solid gray; padding: 5px; margin-top: 5px;"> <b>Speed Sensors</b> <table border="1" style="width: 100%; border-collapse: collapse; font-family: monospace; font-size: 10px;"> <tr><td>Gnd Spd</td><td>20.8</td></tr> <tr><td>Drv Spd</td><td>0.0</td></tr> <tr><td>Speed 1</td><td>20.0</td></tr> <tr><td>Speed 2</td><td>20.8</td></tr> <tr><td>Speed 3</td><td>0.0</td></tr> <tr><td>Speed 4</td><td>0.0</td></tr> <tr><td>Slip</td><td>0.0</td></tr> </table> </div>		Gnd Spd	20.8	Drv Spd	0.0	Speed 1	20.0	Speed 2	20.8	Speed 3	0.0	Speed 4	0.0	Slip	0.0
Gnd Spd	20.8																
Drv Spd	0.0																
Speed 1	20.0																
Speed 2	20.8																
Speed 3	0.0																
Speed 4	0.0																
Slip	0.0																
Sync V (V)	-5.07																
Ref Max (V)	-5.60																
Ref Min (V)	-5.63																
SyncMax (V)	-5.06																
SyncMin (V)	-5.09																
<b>Sensor Supplies</b> <table border="1" style="width: 100%; border-collapse: collapse; font-family: monospace; font-size: 10px;"> <tr><td>5V Aux (V)</td><td>5.00</td></tr> <tr><td>5V Eng (V)</td><td>5.00</td></tr> <tr><td>8V Aux (V)</td><td>7.98</td></tr> <tr><td>8V Eng (V)</td><td>7.96</td></tr> </table>		5V Aux (V)	5.00	5V Eng (V)	5.00	8V Aux (V)	7.98	8V Eng (V)	7.96								
5V Aux (V)	5.00																
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8V Aux (V)	7.98																
8V Eng (V)	7.96																
Bat V (V)	15.0	<div style="border: 1px solid gray; padding: 5px; margin-top: 5px;"> <b>Input Positions</b> <table border="1" style="width: 100%; border-collapse: collapse; font-family: monospace; font-size: 10px;"> <tr><td>SySnPos (deg)</td><td>0.0</td></tr> <tr><td>Din1Pos (deg)</td><td>0.0</td></tr> <tr><td>Din2Pos (deg)</td><td>0.0</td></tr> <tr><td>Din3Pos (deg)</td><td>0.0</td></tr> <tr><td>Din4Pos (deg)</td><td>0.0</td></tr> </table> </div>		SySnPos (deg)	0.0	Din1Pos (deg)	0.0	Din2Pos (deg)	0.0	Din3Pos (deg)	0.0	Din4Pos (deg)	0.0				
SySnPos (deg)	0.0																
Din1Pos (deg)	0.0																
Din2Pos (deg)	0.0																
Din3Pos (deg)	0.0																
Din4Pos (deg)	0.0																
La1	C-6																
La2																	
TP (%)	65.0																
MAP																	
EMAP (kPa)	60.0																
ET (C)	38.0																
AT (C)	2.2																
ECU T (C)	38.9																
MAF		User 1 (V)	0.00														
BAP		User 2															
FT		User 3															
FP (kPa)	-102.0	User 4															
OT (C)	0.0	User 5															
OP (kPa)	-102.0	User 6															
Knock V		User 7															
TP2		User 8															
TPD		G Lat															
TPD2		G Long															
DCSvoP		G Vert															

Reset Errors
Reset Fuel Used
Reset Max RPM

Close
Help





# Sensor Trouble Shooting: Wheel Speed Testing



Wheel Speeds, expressed in KMH, can be viewed on the right hand side of the 'View Sensors' page

Roll the wheels in question and monitor that area:

Speed 1 = Front Left (rolling)

Speed 2 = Front Right (rolling)

Speed 3 = Rear Left (driven)

Speed 4 = Rear Right (driven)

Speed Sensors	
Gnd Spd	0.0
Drv Spd	0.0
Speed 1	0.0
Speed 2	0.0
Speed 3	0.0
Speed 4	0.0
Slip	0.0

The Wheel Speeds are powered by the 8V Aux Supply which can be monitored on the left hand side of 'View Sensors'. The supply needs to be at or around 8 volts to power the sensors.



# Sensor Trouble Shooting: ECU Sensor Supply



There are four regulated voltage supplies in the M400 which power communications and certain sensors. The voltages can be viewed in ECU Manager under the 'View Sensors' tab.

5V Eng supplies Throttle Position, Baro Pressure (EMAP), Fuel Pressure, Oil Pressure, Gear and Ignition Cut and APV

5v Aux supplies GPS and Fuel Trim Knob

8v Eng supplies power to the CAN cable

8V Aux supplies wheel speed sensors

5V Aux (V)	5.00
5V Eng (V)	5.00
8V Aux (V)	7.98
8V Eng (V)	7.96



## Sensor Trouble Shooting: Gear Position and Force Sensor Test

The ECU identifies the gear number based on a signal seen from the micro-switch and voltage from the gear position sensor.

These signals can be view under 'View – View Sensors'.

Gear Position is a rotary potentiometer located on the back of the gearbox and voltage should read around the following values:

Neutral = .85 v	4th = 3.38 v
1 <sup>st</sup> = 1.47 v	5th = 4.05 v
2 <sup>nd</sup> = 2.08 v	6th = 4.71 v
3 <sup>rd</sup> = 2.75 v	

Gear Sensors	
G Sft F (N)	92.0
Gear V (V)	1.11
Gear	0

The Gear Position Sensor can be re-locked to fix discrepancies

Gear Shift Force Sensor is the micro-switch mounted on the gear change cable used to indicate ignition cuts and should move approximately between 10 and 90 while up shifting when viewing the sensor.



# Sensor Trouble Shooting: Status Page

ECU engine management software provides a status table where ON/OFF types of inputs can be monitored and tested

Select 'View – View Diagnostics', then tab over to Status

RED text means that the entry is ACTIVE while the BLACK text indicates the function is not requested or OFF

## Popular inputs to view:

TC Dis = Traction Control disabled (switch closed)

GCutReq = Gear Change Ignition Cut REQUEST active (switch closed)

Spd Lim = Pit Lane Speed Limiting Active (switch closed)

GCutAct = Ignition Cut for Next Gear Active

APV SW = APV is OPEN when red



ViewScreen										
Sensors		Diagnostic Errors		Fuel	Ignition	Boost	Calculated	Status	Outputs	Internal
Digital Input 1	ON	Ign Sw	OFF	RPM Lim	OFF			Synced	NotSYNCD	
Digital Input 2	ON	Nitrous	OFF	Launch	OFF			GCutAct	OFF	
Digital Input 3	ON	Air Con	OFF	GCutReq	ON			ORB Sw	OFF	
Digital Input 4	ON	DualRPM	OFF	TC Dis	OFF			ORB En	OFF	
Switch Input 1	OFF	TC Dis	OFF	Log En	OFF			ORB Act	OFF	
Switch Input 2	OFF	Clutch	OFF	Beacon	OFF			ORB T2	OFF	
Switch Input 3	OFF	Log En	OFF	GCutReq	ON			LaCtrl1	OFF	
Switch Input 4	OFF	Beacon	OFF	Brake	OFF			LaCtrl2	OFF	
Switch Input 5	OFF	GCutReq	ON	Pwr Str	OFF			SBReq	OFF	
Switch Input 6	OFF	Brake	OFF	Spd Lim	OFF			OMP Sw	OFF	
Lambda 1 Cold	ON	Pwr Str	OFF	DifCut	OFF			APV Sw	OFF	
Lambda 2 Cold	ON	Spd Lim	OFF	AirCut	OFF			SttDnRq	OFF	
		AirCut	OFF	TelCtrl	OFF			SttUpRq	OFF	

# Sensor Trouble Shooting: Temperature Sensor



Air Temp Sensor: at 68F (20C) the sensor should read about 3300 Ohm when measuring resistance across the two terminal. This number will fall as the temperature rises

Engine Temp and Oil Temp Sensor: at 68F (20C) the sensor will read about 3000 Ohm when measuring resistance across the two terminals. This number will fall as the temperature rises.



# Star Race Cars Services and Procedures:

## Crash Structures



Crash structures on this car are: Tub, Nose Cone, Tail Cone, Roll Hoop

Crash structures that are damaged beyond the cosmetic repair limit must be sent to a Star Mazda Series approved facility for inspection, quote and repair.

The only approved facility at this time is Crawford Composites in North Carolina

A Cosmetic repair is restricted to any damage that can fit in a 2" diameter circle and has not pierced the outer skin. A Star Race Cars official must be informed of any cosmetic or structural repair

Nose Cones and Tail Cones that have repair documentation from a facility outside of the Star Race Cars approved facility will be allowed to compete until May 1<sup>st</sup> at the discretion of the Competition Director upon being presented with the documentation

Tubs that have been repaired by a facility outside of the Star Race Cars approved facility must have proper documentation presented to Star Race Cars. Those tubs will be allowed to compete for the 2010 season at the discretion of the Competition Director





## Star Race Cars Services and Procedures:

### Series Controlled Parts

Series Controlled parts are defined as sealed items by the Star Mazda Championship

#### Dampers:

Star Race Cars is to oversee and perform all repairs and rebuilds on dampers unless otherwise noted by the Competition Director.

#### ECUs:

Any competitor needing ECU repair must communicate the repair to Star Race Cars. Motec Systems is responsible for the repair of ECUs. It is the discretion of Motec Systems if the ECU needs to be sent to Australia for further repair.

#### Engines:

Star Race Cars is to oversee and perform all repairs and rebuilds of engines.



# Star Race Cars Services and Procedures – Repair Process



Star Race Cars implements a specific repair process for the Series Controlled parts and Crash Structures used on the car.

## Series Repair Process:

Team informs Star Race Cars that a Series Controlled part or Crash Structure has been damaged and will be shipped from the team to the approved repair facility (which may be Star Race Cars)

The approved facility sends Star Race Cars a quote to repair the damage

Star Race Cars send the quote to the owner (individual or team) for approval

Star Race Cars sends a Purchase Order based on the approved quote to the facility

The approved facility completes repair and sends an invoice to Star Race Cars

Star Race Cars invoices the owner and the owner pays Star Race Cars

Star Race Cars pays the facility and the facility ships the structure back to the owner.





# Star Race Cars Services and Procedures:

## Services

### Fuel Injector Service:

Star Race Cars has the ability to flow and match injector sets

### Damper Service:

Rebuild and dyno service available for dampers

### Firebottle Certification Service:

Star Race Cars is a Lifeline dealer and certified refill station.



# Star Race Cars Services and Procedures:

## Suggestions



Our rule book states that anything that is not called out specifically in the rule book should be considered illegal unless it is approved by the Series Competition Director

By presenting your ideas and problems to the Series Officials you can help to improve the Series.

Please present ideas, opinions and problems to:

Kate Gundlach

OR Keith Mellick

Engineer

Competition Director





# Questions?

