Vehicle Data Display and Logger
Installation and Operation Manual

Rev 1.0 1-2015

Focus Applied Technologies

INTRODUCTION

This Vehicle Data Display and Logger is designed as a robust display and logger for small vehicles. It is preset to operate at 10Hz, automatically recording a new file to the SD memory card every time the unit is powered on. The files are saved as ASCII text files numbered sequentially, with commas separating the individual columns of data for easy importing to Excel or other spreadsheet programs. The data can similarly be analyzed by other programs, or by simply viewing the data in the text file. The Data logger stores ten parameters in the file every 100ms, including the following:

RPM1

This speed channel is setup in the main menu. The Upper and Lower signal triggering thresholds are adjustable, as well as the number of pulses per revolution. Typically this signal will come from an ignition trigger (such as the "pulser" or "trigger" for a CDI unit, or the points signal to an inductive coil).

RPM2

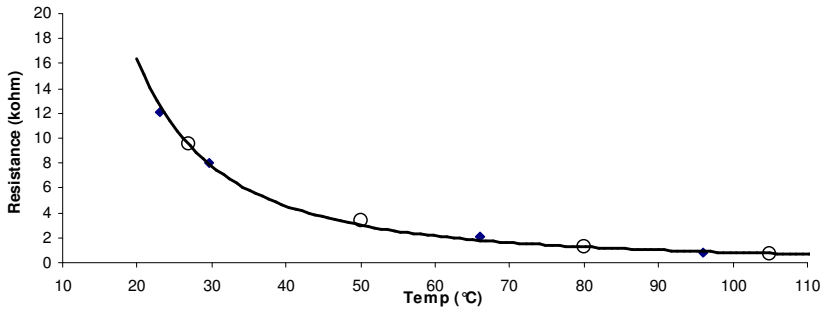
This speed channel is setup in the main menu. The Upper and Lower signal triggering thresholds are adjustable, as well as the number of pulses per revolution. Typically this signal will come a wheel speed pickup.

Throttle Position Signal

The Throttle Position is recorded as a voltage, 0-5V. If the TPS signal is not required, you can treat this as a generic analog input.

Thermistor

This channel is designed to accept a thermistor between this pin and ground. It is internally pulled up to 5V via a 2.5k ohm resistor. Internally the voltage is converted to °C based on the common Synerject Air Cooled Engine Cylinder Head Temperature Sensor characteristics shown to the right.



Thermo Couple

This is designed to accept a K-type thermocouple. The temperature is automatically calculated in °C.

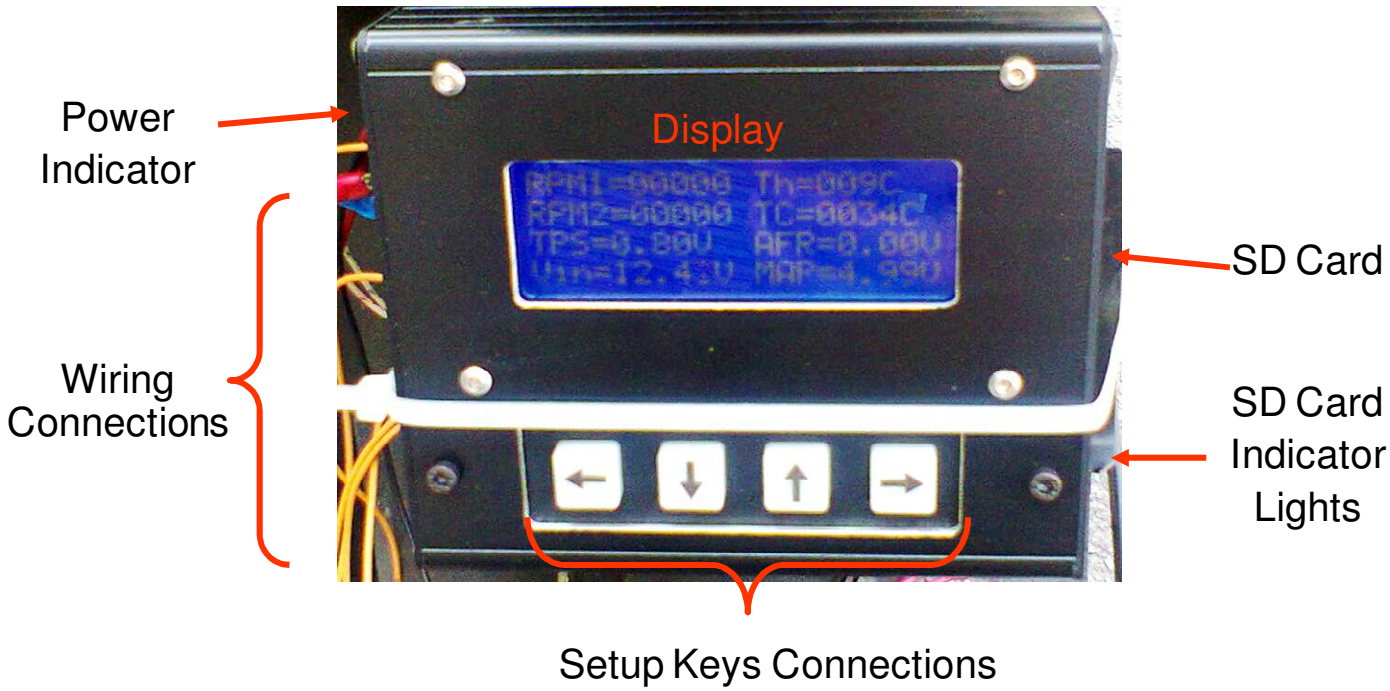
Air Fuel Ratio
This channel is designed to accept the analog 0-5V output of a Wide Band O2 Sensor. It is displayed and stored as the raw voltage. If an AFR meter is not being used, you can treat this as a generic analog input.

O2
This channel is designed to accept the analog output of a standard switching type O2 Sensor. It is displayed and stored as the raw voltage. If an O2 sensor is not being used, you can treat this as a generic analog input.

Manifold Air Pressure
This channel has a "minimum average" circuit. It is designed to store and average the minimum of the MAP signal (which corresponds well to the actual manifold pressure near the end of the intake stroke). The value is stored as the minimum averaged voltage.

12V Line
The power line's voltage is measured and recorded. This can be calibrated via the menu, if a trusted volt meter is connected to the power input.

Extra
This is a generic analog input for any signal in the 0-5V range.



Wiring for power and signals is connected to the right side near the power indication LED, as described below. The SD card is inserted (label UP) on the right hand side as shown below. The SD card should only be inserted, or extracted from the data logger when it is powered OFF. The unit will function normally without the SD card in place, however it will not log any data without the SD card. There are also SD Card Indication LEDs on the right side. If the SD card is not present, the GREEN LED will flicker and stop repeatedly.

SD Card and indicator lights (right Side):

In normal operation several parameters are displayed on the screen with or without the SD card present. These include RPM1 and RPM2, TPS, Vin (ie. the 12V power source), Thermistor temp (Th), Thermocouple temp (TC), AFR and MAP.

Setup Menus

The menus are designed to be self explanatory.
Use the RIGHT/LEFT arrows to move through the various menu options.
When a setting is adjustable, use the UP/DOWN arrows to adjust the parameter.

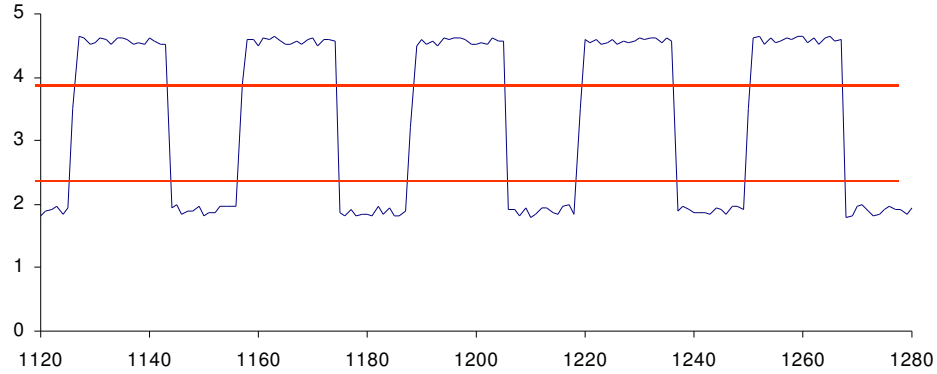
The last menu item (when paging to the right) is "Save Config?" with NO as default.
To change the NO to YES hit the UP arrow. You can change it back to NO by hitting the UP arrow again.
Exit menu with RIGHT arrow. Upon exiting if the "Save Config?" option was set to YES, then the present configuration is burned to memory. If NO was set, then the present configuration is used, but not burned to memory, so the previous settings will be used.

RPM1 and 2 Settings

Pulses Per Revolution: This is simply the number of pulses or transitions you expect to see per revolution of the shaft. On some engines the Crank Position Signal (CPS) will have "24 minus 1" or "12 minus 2" transitions, indicating that the transitions are spaced every 24^{th} or 12^{th} of a revolution respectively. A "24 minus 1" system will actually have 23 pulses per rev, a 12 minus 2 will have 10 pulses per rev.
NOTE: For low-speed signals (such as the drive wheels) it is best to have a higher number of pulses per revolution to increase the resolution of the reading. Generally there should be at least 4 pulses per revolution on wheel speed pickups, while crank shaft speed can be read with a single pulse per revolution, such as the CDI trigger in carbureted vehicles.
Upper Trigger Level: A pulse is defined as the first signal voltage exceeding the Upper Trigger Level. The signal must then drop below the lower trigger level before the next pulse can occur. This "2-Level" qualification of sped pulses helps eliminate noise from interfering with the RPM signals.
Lower Trigger Level: After the signal exceeds the Upper Trigger Level, it must then drop below the Lowe Trigger Level before it can be considered a pulse on the subsequent Upper Trigger Level transgression.

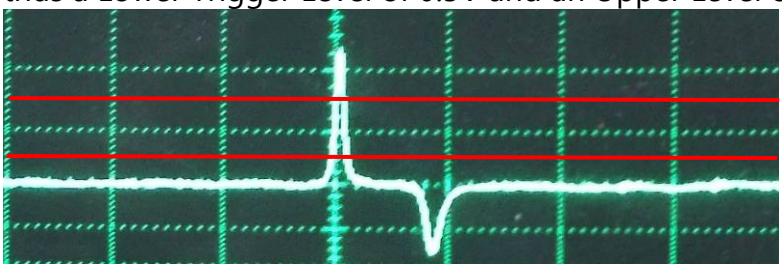
For DC type sensors (Hall Effect, Optical) the output is typically TTL level voltages (ie. nominally 0 to 5V but possibly degrading to 1 to 3.5V). For these type of sensors it is common to use 1V for the Lower Trigger Level, and 3V for the upper Trigger Level.

For the DC signal below we might use a lower threshold of 2.5V and an upper threshold of 4V



For AC type sensors, such as Variable Reluctance (magnetically inductive) sensors, the signal drops below 0V, and may go up to several tens of volts. The triggering circuitry is designed to accept this wide range of signal voltages without harm. For AC sensors it is common to set the Lower Trigger Level at 0.5V, and the upper Trigger Level at 1.0V. It is easy to determine the appropriate voltage levels by viewing the signal on an oscilloscope.

For the CDI trigger signal below (one pulse per revolution) the amplitude is 2V during cranking, thus a Lower Trigger Level of 0.5V and an Upper Level of 1.5V should work well.



The image to the right shows an inductive type wheel speed pickup. It is reading the "spokes" of the rear sprocket, thus it generates 4 pulses per revolution.

Battery Voltage Calibration

The battery or system voltage is displayed, and can be adjusted up or down using the appropriate arrow keys to agree with an external reference (ie. voltmeter). Be sure to place the leads of the voltmeter as close as possible to the Datalogger's power terminals to avoid line induced voltage drop.

Logger File Number Reset

The Datalogger saves data in to sequentially numbered files, starting from 1 and counting up. To reset the count back to 1, use the UP arrow to change the "File Number Reset?" from NO to YES.

Wiring and Signal Constraints

All signal and power connections are made via screw terminals on the left side of the unit, as shown below.

NOTE: Unless otherwise specified all inputs should be 0 to 5V only. Exceeding this range may damage the unit!

+ 12V Power In (maximum of 30V)
Power Ground
Throttle Position Signal
Gnd
Thermo Couple +
Thermo Couple –
Gnd
Thermistor (WRT ground)
Air/Fuel Ratio (Wide Band O2)
O2
Gnd
Extra Input (0-5V)
MAP (This channel has a “Minimum Averaging Circuit”)
Rpm1 (Variable Reluctance, Hall Effect type or other)
Gnd
Rpm2 (Variable Reluctance, Hall Effect type or other)
Gnd

Data File and Analysis

Data is saved into a comma separated variables (CSV) text file. This makes it easy to look at the data using any text editor (eg. Notepad), or it can be pulled into Excel or other program for further processing and display. Below is an example of the first few lines of a date file:

FOCUS APPLIED TECHNOLOGIES 2015
DATA LOGGER VER1.0

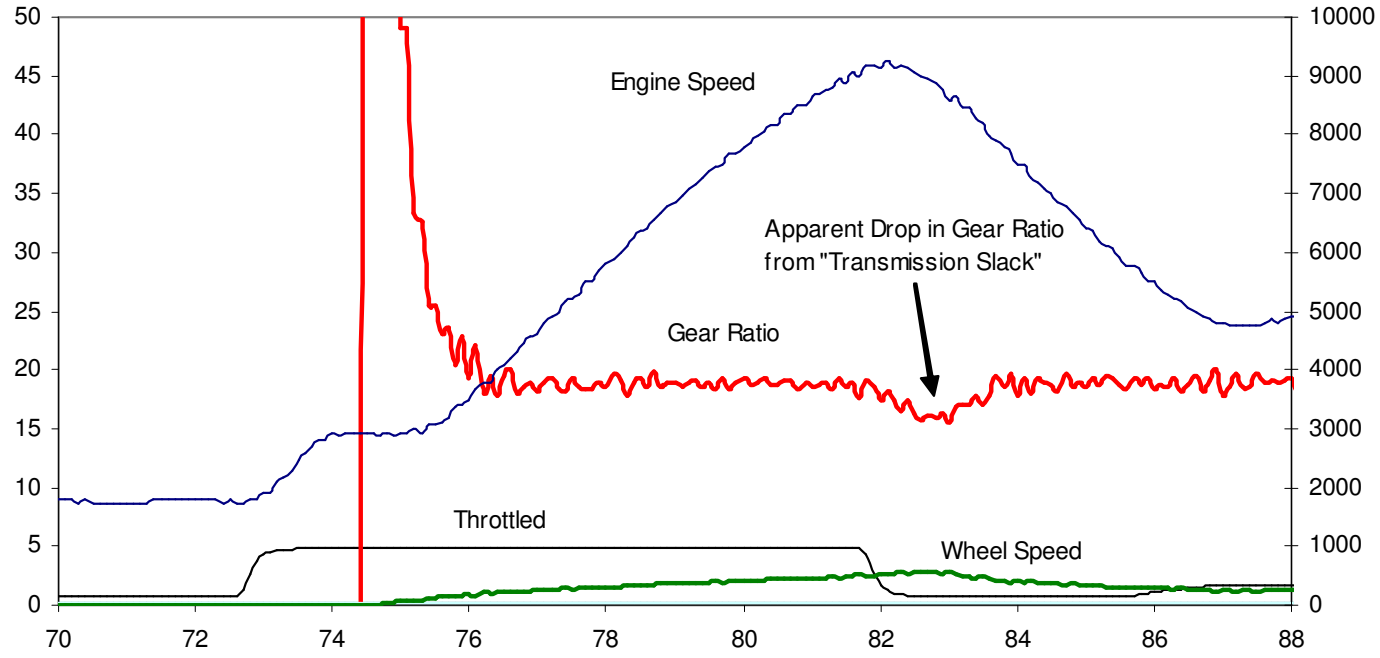
RPM1,RPM2,TPS,Therm,TC,AFR,O2,MAP,Vin,Extra
(rpm),(rpm),(V),(C),(C),(V),(V),(V),(V),(V)
0,0,0.22,9,75,0.15,0.47,4.99,11.21,0.17
28,0,0.23,9,75,0.15,0.51,4.99,10.14,0.20
101,0,0.23,9,75,0.15,0.50,4.99,10.49,0.21
153,0,0.23,9,75,0.15,0.49,4.99,10.89,0.22
273,0,0.33,9,75,0.15,0.49,4.99,11.56,0.22
396,0,0.38,9,75,0.15,0.48,4.99,11.91,0.23
534,0,0.41,9,75,0.15,0.46,4.99,11.95,0.23
673,0,0.42,9,75,0.15,0.46,4.99,11.61,0.24
803,0,0.42,9,75,0.15,0.47,4.99,11.88,0.24
939,0,0.43,9,75,0.15,0.50,4.99,11.40,0.25
1072,0,0.43,9,75,0.15,0.48,4.99,11.74,0.25
1205,0,0.43,9,75,0.15,0.47,4.99,11.63,0.26
1304,0,0.43,9,75,0.15,0.47,4.99,11.56,0.27
1340,0,0.43,9,75,0.15,0.47,4.99,11.44,0.27
1351,0,0.43,9,75,0.15,0.46,4.99,11.51,0.28

When importing into Excel, you should import the file as a “Comma Delimited” file. Once you have analyzed of graphed the data be sure to save it as a standard “.XLS” file. Also it is common practice to insert a new first column labeling it a “Time” with the units of (sec), and then assign the first row 0, and increment each subsequent row by 0.1. This will result in the following data in the spreadsheet:

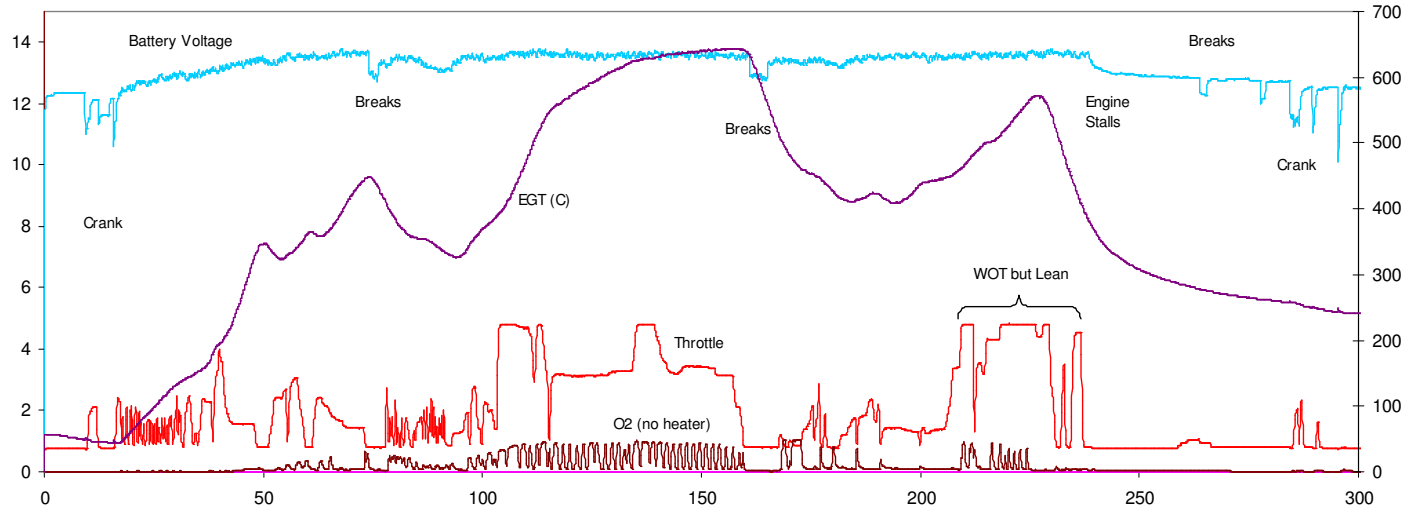
FOCUS APPLIED TECHNOLOGIES 2015
DATA LOGGER VER1.0

Time (sec)	RPM1 (rpm)	RPM2 (rpm)	TPS (V)	Therm (C)	TC (C)	AFR (V)	O2 (V)	MAP (V)	Vin (V)	Extra (V)
0	0	0	0.22	9	75	0.15	0.47	4.99	11.21	0.17
0.1	28	0	0.23	9	75	0.15	0.51	4.99	10.14	0.2
0.2	101	0	0.23	9	75	0.15	0.5	4.99	10.49	0.21
0.3	153	0	0.23	9	75	0.15	0.49	4.99	10.89	0.22
0.4	273	0	0.33	9	75	0.15	0.49	4.99	11.56	0.22
0.5	396	0	0.38	9	75	0.15	0.48	4.99	11.91	0.23
0.6	534	0	0.41	9	75	0.15	0.46	4.99	11.95	0.23
0.7	673	0	0.42	9	75	0.15	0.46	4.99	11.61	0.24
0.8	803	0	0.42	9	75	0.15	0.47	4.99	11.88	0.24
0.9	939	0	0.43	9	75	0.15	0.5	4.99	11.4	0.25
1	1072	0	0.43	9	75	0.15	0.48	4.99	11.74	0.25
1.1	1205	0	0.43	9	75	0.15	0.47	4.99	11.63	0.26
1.2	1304	0	0.43	9	75	0.15	0.47	4.99	11.56	0.27
1.3	1340	0	0.43	9	75	0.15	0.47	4.99	11.44	0.27
1.4	1351	0	0.43	9	75	0.15	0.46	4.99	11.51	0.28

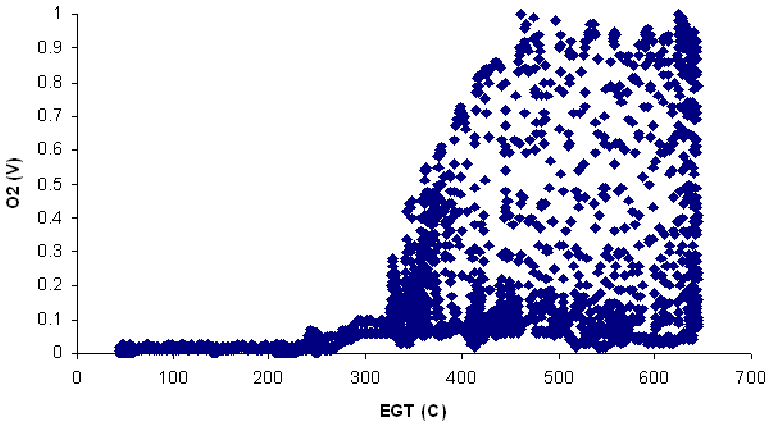
Data is often graphed versus time, looking for correlations between the various parameters as shown below. This data was taken during a Wide Open Throttle acceleration in 4th gear. The vehicle has a centrifugal clutch, which slips (from 73 sec to about 75.5 sec). Engine and Wheel Speed are plotted on the right scale, while TPS voltage and "Gear Ratio" (calculated from Engine Speed divided by Wheel Speed) are plotted on the left scale.



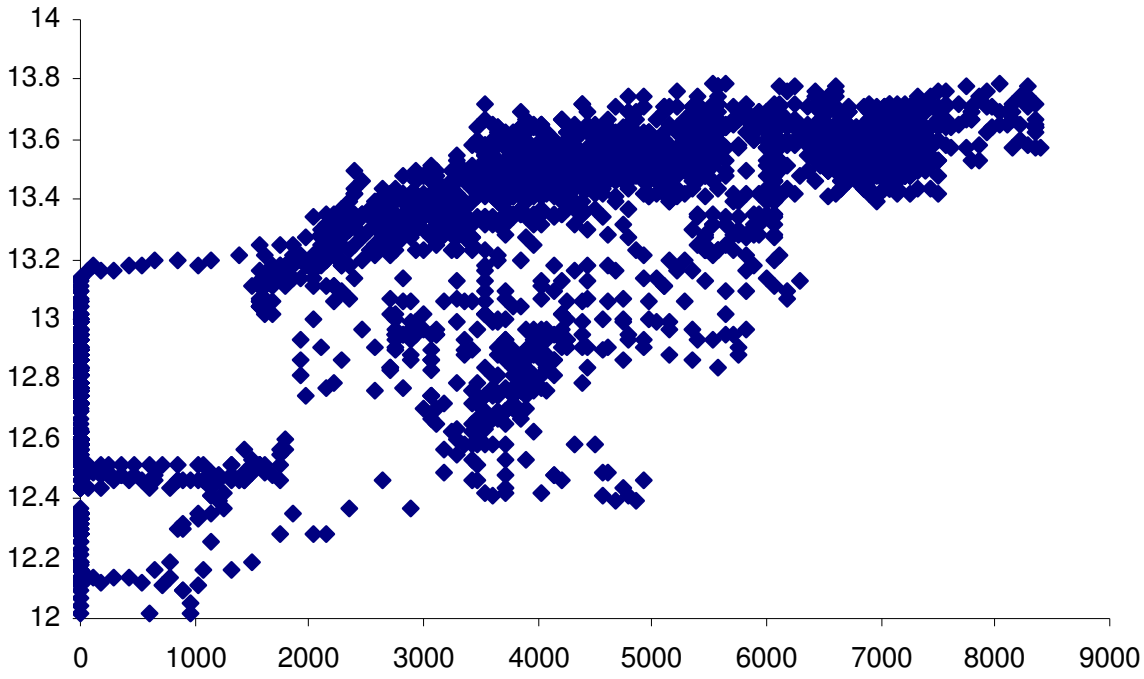
In the following set of data Battery Voltage, Exhaust Gas Temperature (EGT), Throttle Voltage (TPS) and exhaust gas O2 Voltage are shown. It can be noticed that below an EGT of 350C the O2 sensor gives no signal.



Another way of looking at data is to plot one parameter versus another, such as the O2 sensor voltage versus EGT, as shown to the right. From this it is obvious that the O2 sensor (in this case an unheated sensor) gives no signal below about 320C, and only reaches the full signal range of 0 to 1V above 400C.



Similarly the Battery Voltage data of the last page can be replotted against Engine Speed, resulting in the graph below. From this it can be seen that as the engine speed increases the battery voltage also increases, but maxes out at around 13.8V, as it is held in check by a voltage regulator. Occasional low voltages (12.6-13V) can be noticed at intermediate speeds as a result of break lights dropping the system voltage. This is also observed in the previous time based graph during breaking events, which generally precedes a drop in EGT, as engine power is decreased.



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