DataMaster-OBD1 Operating Manual

The Turbo Shop Inc.

Copyright and Disclaimer Notice

The information in this document is subject to change without notice and does not represent a commitment on any part of TTS Inc. While the information contained herein is assumed to be accurate, TTS Inc. assumes no responsibility for any errors or omissions. Use of the MasterTune, DataMaster and VTune software products are at the user's risk.

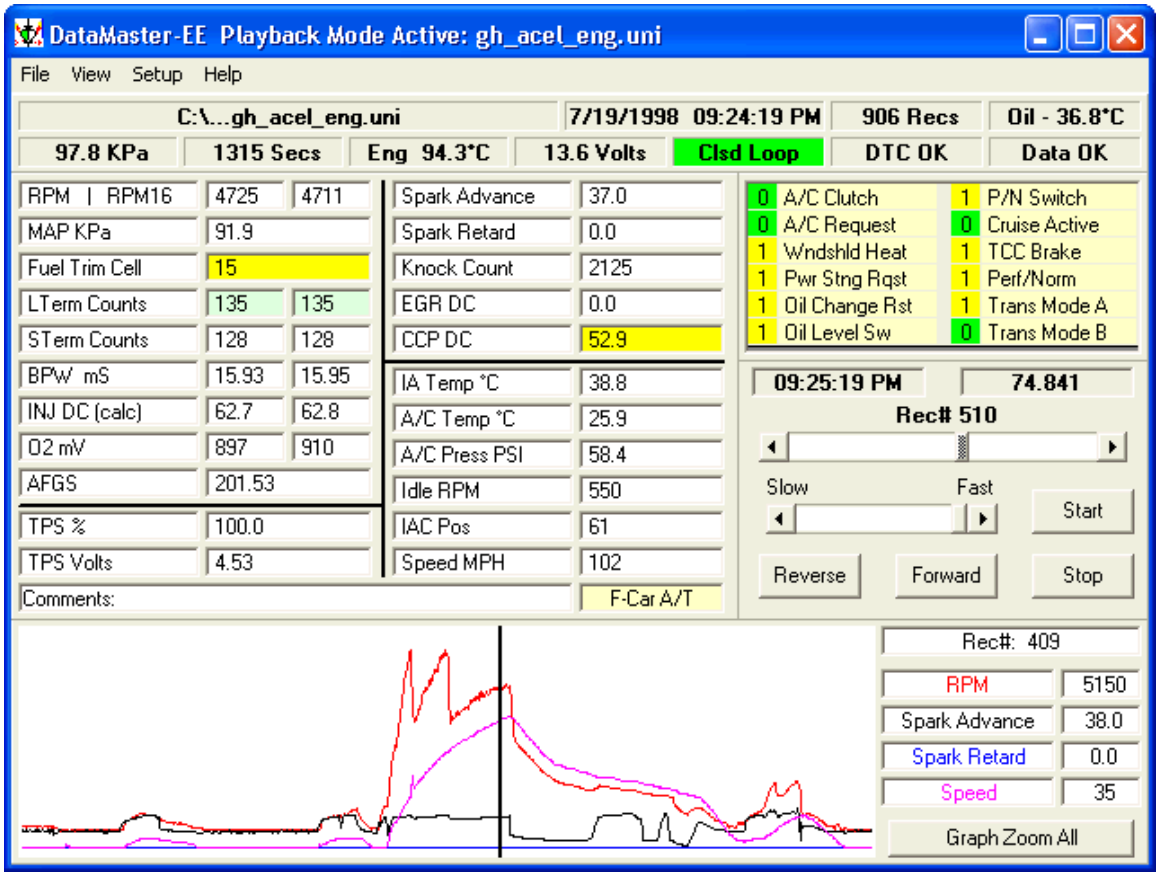
In no event shall TTS Inc, its employees, its contractors, or the authors of this document be liable for special, direct, indirect or consequential damage, losses, costs, charges, claims, demands, claim for lost profits, fees, or expenses of any nature or kind.

Table of Contents

1 Introduction

1.1 General Information

DataMaster is a complete software application used to monitor and record engine and transmission data from 1986 to 1995 F & Y-body cars and 1990 to 1995 General Motors S-,C-,K-series trucks. DataMaster provides a highly graphical display of all engine parameters, and allows the user to quickly identify and zoom in on critical regions of operation. All engine operational parameters are displayed, including Diagnostic Trouble Codes ("**DTC**") and Binary Status Bit data. If supported by the particular vehicle, DataMaster will also record and display the transmission data stream, either separately or interleaved with the engine data to provide a comprehensive method of monitoring powertrain performance.



DataMaster Main Screen

1.2 Data files

DataMaster data is organized as individual records in a file, where each record is a single "snapshot" of information from the Powertrain Control Module (PCM). Up to 32,000 records of data may be recorded per session, allowing almost 60 minutes of continuous recording at the maximum sample rate of 10 per second! TTS supplies the necessary signal adapter interface to connect the PC to the vehicle's PCM through the ALDL port without requiring any external power supply or batteries.

1.3 Playback

After data is captured, it can be played back immediately or transferred to another computer for playback by the DataMaster software. Each PCM has a unique data configuration, thus each version of DataMaster is tailored to a specific car/engine combination, and will not correctly display files collected for a different PCM.

1.4 DataMaster Program Versions

1.4.1 Summary

Version	Vehicles Supported
DM32x0D	94-95 LD Trucks with 4L60E or Manual Trans.
DM32x31	94-95 HD Trucks with 4L80E or Manual Trans.
DM32x32	87-89 F-Car, 87-89 Y-Car
DM32x85	91-93 HD Trucks with 4L80E or Manual Trans.
DM32x8D	90-92 F-Car, 90-91 Y-Car
DM32x8F	89 Turbo Grand Prix
DM32xDA	93 F-Car, 92-93 Y-Car (LT1)
DM32xE6	93 LD Trucks with 4L60E or Manual Trans.
DM32xEE	94-95 F-Car, 94-95 Y-Car, 94-95 B-Car (LT1)
DM32xL1	90-95 Lotus Elan M100
DM32xTT	90-93 Syclone and Typhoon 4.3 Turbo
DM32xZ1	90-92 Y-Car ZR1 (LT5)
DM32xZ2	93-95 Y-Car ZR1 (LT5)

1.4.2 Application Details

1.4.2.1 DM32x0D: 94-95 LD Trucks

Engine	Displ / EFI	Years	Application
L03	5.0L TBI	94-95	VIN = H C,K,G
L05	5.7L TBI	94-95	VIN = K C,K,G
L35	4.3L CPI	94-95	VIN = W S,T,M,L
LB4	4.3L TBI	94-95	VIN = Z G,M,L,S,T,C,K
LB4	4.3L TBI	94	VIN = Z C,K Manual Trans

1.4.2.2 DM32x31: 94-95 HD Trucks

Engine	Displ / EFI	Years	Application
LB4	4.3L TBI HD	94-95	VIN = Z C,K,G,P 4L80E Trans
L05	5.7L TBI HD	94-95	VIN = K C,K,G,P,W-MD 4L80E Trans
L19	7.4L TBI HD	94-95	VIN = N C,K,G,P 4L80E Trans
LB4	4.3L TBI HD	94-95	VIN = Z C,K (HD) Manual Trans
L19	7.4L TBI HD	94-95	VIN = N C,K (HD) Manual Trans

1.4.2.3 DM32x32: 87-89 F-Car, 87-89 Y-Car

Engine	Displ / EFI	Years	Application
LB9	5.0L TBI	86-89	VIN = F Y-CAR, F-CAR
L98	5.7L TBI	86-89	VIN = 8 Y-CAR, F-CAR

1.4.2.4 DM32x85: 91-93 HD Trucks

Engine	Displ / EFI	Years	Application
LB4	4.3L TBI	91-93	VIN = Z C,K,P
L05	5.7L TBI	91-93	VIN = K C,K,G,P
L19	7.4L TBI	91-93	VIN = N C,K,G,P

1.4.2.5 DM32x8D: 90-92 F-Car, 90-91 Y-Car

Engine	Displ / EFI	Years	Application
LB9	5.0L PFI	90-92	VIN = F F-Car
L98	5.7L PFI	90-92	VIN = 8 F-Car
L98	5.7L PFI	90-91	VIN = 8 Y-Car

1.4.2.6 DM32x8F: 89 Turbo Grand Prix

Engine	Displ / EFI	Years	Application
LB9	3.2L Turbo LG5	1989	VIN = V Grand Prix

1.4.2.7 DM32xDA: 93 F-Car, 92-93 Y-Car LT1

Engine	Displ / EFI	Years	Application
LT1	5.7L MFI HO	92	VIN = P Y-CAR
LT1	5.7L MFI HO	98	VIN = P Y-CAR, F-CAR

1.4.2.8 DM32xE6: 93 LD Trucks

Engine	Displ / EFI	Years	Application
L03	5.0L TBI	93	VIN = H C,K,G
L05	5.7L TBI	93	VIN = K C,K,G
L19	4.3L CPI	93	VIN = W S,T,M,L
LB4	4.3L TBI	93	VIN = Z G,M,L,S,T,C,K

1.4.2.9 DM32xEE: 94-95 F, Y, B-Car LT1

Engine	Displ / EFI	Years	Application
L99	4.3L SFI	94-95	VIN = W 1B - CAR
LT1	5.7L SFI	94-95	VIN = P 1,4B, 6D, 1Y, 1F – CARS

1.4.2.10 DM32xL1: 90-95 Lotus Elan M100

Engine	Displ / EFI	Years	Application
Lotus	1.6L Turbo	1989	Euro and US M100 Turbo

1.4.2.11 DM32xTT: 90-93 Syclone and Typhoon

Engine	Displ / EFI	Years	Application
LB4	4.3L PFI	91.5	VIN = Z SYCLONE TURBO
LB4	4.3L PFI	92-93	VIN = Z TYPHOON TURBO

1.4.2.12 DM32xZ1: 90-92 Y-Car ZR1

Engine	Displ / EFI	Years	Application
LT5	5.7L SFI	90-92	VIN = J CPC/Lotus Y-CAR

1.4.2.13 DM32xZ2: 93-95 Y-Car ZR1

Engine	Displ / EFI	Years	Application
LT5	5.7L SFI	93-95	VIN = J CPC/Lotus Y-CAR

1.5 Minimum Computer Requirements

DataMaster requires Windows 2000/XP/Vista/Win7 and will run on 32- or 64-bit versions of these operating systems. It is highly recommended that the operating system have all current Windows updates installed.

Operation on Windows 98 and earlier OS are no longer supported.

- Pentium-class PC at 400 MHz or above
- Display Resolution 800 x 600 or above, 1024 x 768 recommended
- Serial RS-232 Communication port or USB** port depending on which cable was ordered

****NOTE:** TTS has found that most USB adaptors fail to operate correctly when used for OBD1 Data Collection. For this reason, it is recommended that the TTS USB serial port adaptor be used, as this is extensively tested with all Windows versions. Refer to chapter 7 for information on configuring USB serial adapters.

For additional information, refer to Tips for Using USB Serial Port Adapters.

1.6 Contacting The Turbo Shop

Address:	The Turbo Shop Inc. 1280 Kona Drive Compton, CA 90220 USA
Telephone:	1-310-669-8101
FAX:	1-310-669-8130
World Wide Web:	http://www.ttspowersystems.com
Office Hours:	Monday to Friday 9:00 AM to 6:00 PM Pacific Time

2 Getting Started

2.1 Installation of DataMaster Software

DataMaster software is supplied on a CD-ROM disk or may be downloaded from our website. To install the software, use this procedure:

- Insert the CD into the CD-ROM of the computer.
- Within a few seconds, the install screen will appear. Click on the ***Install Products*** button to bring-up the installation options.
- Click on the ***Install Data Mode*** button to begin the installation process.

Follow the on-screen instructions during the install process. It is recommended that you use the default installation settings during installation.

The installation will place a DataMaster icon on your desktop, and add a menu entry under the ***TTS – GM – DataMaster-OBD1*** menu list.

The first time DataMaster is run, it will copy some sample recordings to the users documents folder. These are located in the following location: (where "xx" refers to the DataMaster version you have installed)

My Documents\TTS\GM\DataMaster-OBD1\DX-xx\SampleData

2.1.1 Installation of Multiple Versions of DataMaster Software

There are currently 13 different versions of the DataMaster software available to support various GM vehicles.

All of these versions may be installed on the same PC at one time. Each version will keep track of its individual setup parameters independently of the others. Note that each version must be individually authorized for recording data.

2.2 Removal of DataMaster Software

NOTE: Before removing DataMaster, back-up any recorded Data files you want to save. These files will have a .UNI extension. Older versions of DataMaster stored these in the folder where DataMaster was installed; DataMaster v400 and later stores these in the User's Documents folder and they will not be removed during the uninstall.

DataMaster software is be removed by running the "***Add/Remove Programs***" program (found under ***Start—Settings—Control Panel***).

Scroll down the list and select **TTS DataMaster**. Press the ***Add/Remove…*** button to remove DataMaster. Follow the on-screen prompts to complete the removal process.

CAUTION: *Make sure you select the intended program for removal, there is no undo for this command!*

2.3 Updating DataMaster Software

DataMaster v400 uniquely installs on your PC, and may be co-installed with earlier versions. You may be manually uninstall prior versions if desired following the instructions in “Removal of DataMaster Software”.

Check the TTS website for availability of program updates, http://www.ttspowersystems.com

2.4 Launching DataMaster

DataMaster is invoked from Windows by double clicking on the DataMaster icon on the desktop, or by selection from the ***Start—Programs—TTS—DataMaster-OBD1*** menu. This will bring up the main display.

No user configuration of DataMaster is required for playback of recorded data files. When recording data, it will be necessary to select the serial Com port which is connected to the interface, refer to the Data Recording topic for more information.

The first time DataMaster is run, the position and sizing of the forms are set to their default values and are centered in the display screen. Many forms may be re-sized and moved to the positions that best suit your needs and monitor size. DataMaster will remember the last size and position of these forms and return to them the next time the program is started. To resize the main display screen, refer to Resizing the Screen.

Data Mode keeps track of the path to the files last accessed for recording or playback, and always returns to the last accessed folder. By default, this is the **My Documents\TTS\GM\DataMaster-OBD1\DM_xx\TestData** folder.

2.4.1 Turning ToolTips On/Off

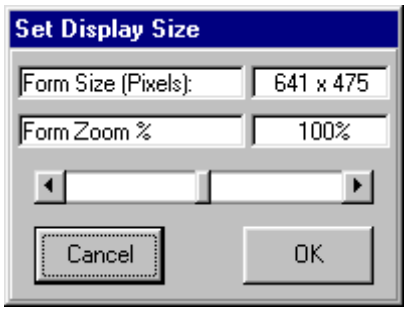
As the mouse cursor is moved over various parts of the screen, a "ToolTip" is generated giving information about the control or label. This feature may be turned on or off via the ***Setup—Preferences—ToolTips*** menu item.

2.4.2 Turning the BEEP On/Off

When a file record has a DTC error, this is signaled immediately by turning the DTC label red and sounding a "Beep" If the DTC is present in all records, this can be very annoying so this feature may be turned off via the ***Setup—Preferences—Beep on DTC*** menu item.

2.5 Resizing the Main Screen

Depending on your monitor and/or screen resolution, you may wish to expand or shrink the size of the main program display. To resize the main form select Setup Screen Size... from the File menu and a dialog box is presented which allows resizing the main form from 50% to 150 % of the nominal 640 x 480 pixel size. The screen may be resized at any time, and the new size will be recalled automatically the next time the program is run.



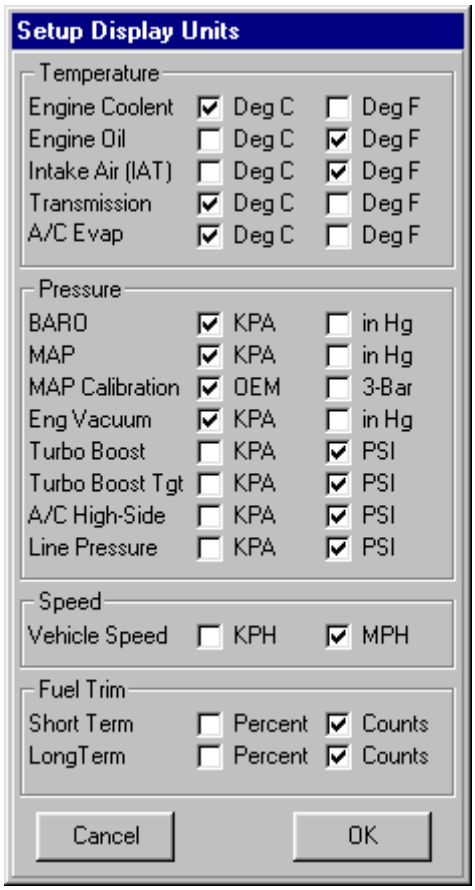
This feature is especially useful when running on small laptop & netbook computers.

2.6 Setting the Measurement Units

DataMaster may be configured to display in any combination of English or Metric units, and is configured by selecting the ***Setup—Display Units*** Menu.

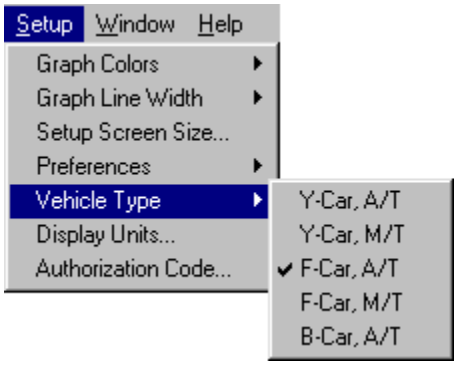
Note that the MAP sensor setting allows selecting either the OEM calibration, or an alternate 3-bar calibration for use with some aftermarket super- or turbocharged applications such as the GMC Syclone or Typhoon.

After making the desired selections, press **OK** to update the display with the new values.
TIP: not all items will be applicable to every ECM type; only the applicable items will be used by DataMaster.



2.7 Selecting the Vehicle Type

Many DataMaster versions support several vehicle types which have small differences in the data collected. The vehicle type selection should always be made prior to recording data, as this selection becomes a permanent part of the data file.



The Vehicle Type selection can be changed when viewing data if the wrong selection was made during recording. However, this information will have to entered each time the recording is played back!

Note that when the Vehicle Type selection is changed, some data items on the display previously selected may not be available for the new vehicle type, and will appear as "N/A".

2.8 Authorizing the DataMaster Program

The DataMaster program as initially installed operates in demonstration mode. Demonstration mode allows the user full capability to playback all data files, but limits the ability to record new data to 20 total uses.

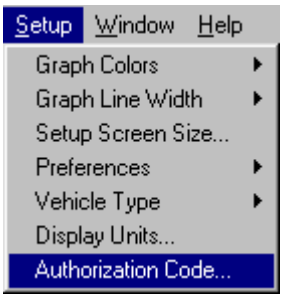
Whenever the ***File—Record ALDL Data*** menu item is selected, the user will be prompted with a reminder of the remaining trial period and a choice is given to return to playback mode or continue and record data.

If the user selects return to playback, no usage is subtracted from the trial period.

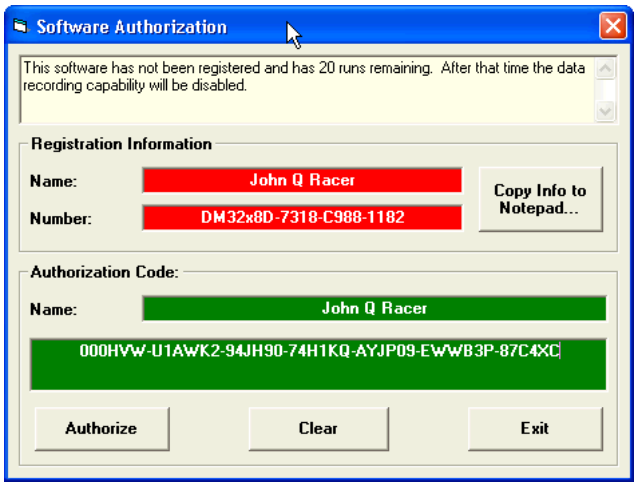
Demo Mode Message Dialog

The registration number and authorization code is **unique** for every installation on every PC, and will not transfer between machines. If you need to transfer the license to a different machine, contact your TTS distributor for further instructions. Note that re-installing the software will not reset an expired trial period!

In order to fully authorize DataMaster, select the ***Setup- Authorization Code*** menu item and a dialog will be presented prompting the user with instructions.



The Auth Code Menu



The Authorization Form

To register the software and obtain your authorization code, contact the TTS distributor you purchased DataMaster from and supply them the following information copied from the **RED** Registration Information boxes:

- The name you are registering to (i.e. John Q Racer)
- The registration number (the unique 22-character sequence)

All the required registration information can be automatically copied to a Notepad text file by pressing the ***Copy Info to Notepad*** button. This can be emailed or faxed to your distributer to generate your authorization code.

When you receive your authorization code, enter it in the **GREEN** registration boxes **EXACTLY** as received including the dashes between the digit groups! Press the ***Register*** button to complete the process.

2.9 Running DataMaster

2.9.1 Loading a File

After invoking DataMaster, a data file must be loaded before any features of the program can be used. From the File menu, select ***Playback DataMaster File...*** and the file dialog box is presented. By default, DataMaster will open to the ***My Documents\TTS\GM\DataMaster-OBD1\DM-xx*** folder In the ***DmSampleData*** folder are several test recordings, each with a **.UNI** file extension. Select any file by double-clicking on the file name or typing the name in the box and selecting ***OK***. This will read the file into DataMaster and display the first record. The last 4 files that have been accessed are remembered by DataMaster and are displayed on the bottom of the File menu. Double-clicking on one of these entries will immediately load that file into DataMaster.

2.9.2 Maximum Recording Time

When data is collected from the PCM, it is stored as a series of records. Each record contains a complete snapshot of exactly what the PCM was doing at that instant in time. Under optimum conditions, up to 10 records per second may be collected by DataMaster; the exact rate depends on the particular PCM and the computer being used to collect the data. DataMaster allows loading a file containing up to 32,767 records of information. If collected at the maximum rate of 10 per second, this is roughly 60 minutes of continuous data!

Note that when a large data file is loaded, it may take significant time to plot the records on the display. This will be dependent on your PC speed, so find what works best for your application.

2.9.3 Playing DIACOM files

Diacom .GDF files can be played back with DataMaster. From the File menu at the top of the PCM Display select ***Playback Diacom File...*** and a File Dialog box will be presented. Note that Diacom files do not utilize any time stamping of the PCM data, so this information is calculated by DataMaster when the file is loaded. For this reason, time related calculations (speed to distance and quarter-mile) will not be as accurate as DataMaster recorded files.

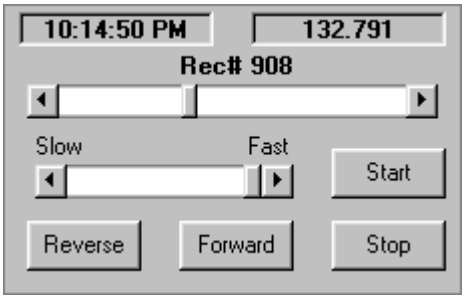
3 Using DataMaster

3.1 Moving Through the Data file

3.1.1 The Playback Control Center

In the right-hand center of the screen there are several controls that allow the user to scroll through the data file. By clicking on the scrollbar, the user can either step through the records 1 at a time (small increment) or 10 at a time (large increment).

You can also drag the scrollbar 'thumb' with the mouse and drop it along its length to move anywhere in the data file. The current record is indicated in the box just above the scrollbar.



The Playback Control Center

The upper left display box shows the time at which this data was recorded (as reported by the PC time clock); the upper right box shows the high resolution time stamp (in seconds and decimals) relative to when the first data was collected for this file.

3.1.2 Autoplayback

Adjacent to the record scrollbar are several buttons that control playback of the file. By utilizing the Forward, Reverse Start and Stop buttons, the user can watch for anomalous conditions as the file is played back. Autoplayback is useful for generating the histogram data for identifying the rich and lean operating regions.

The speed of the Autoplayback is controlled by the ***Slow-Fast*** scrollbar.

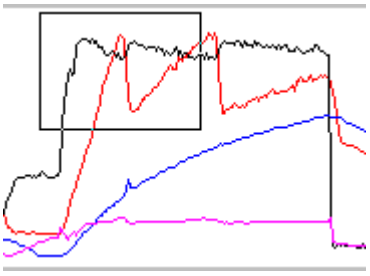
3.1.3 Left-mouse Click on the Graph Display

The user can also move to an area of interest by clicking the left mouse button when the cursor is in the graph display. The current record will move to the location under the cursor. The user can then "zero in" on the area using the playback scrollbar.

3.1.4 Zooming in on an Interesting Area of the Graph

A very powerful tool is the "Zoom Box" which magnifies an area of interest in the graph. This is done by drawing a "Zoom Box" on the graph display while holding down the Right Mouse Button. When the button is released, the display will zoom in to the area you drew.

To zoom back out, the Graph Zoom All button must be pressed.



3.2 The Status Bar Display

The status display at the top of the form shows information about the current file and other slowly changing PCM information. It also shows some key status indicators; Open Loop, DTC Errors, and Data OK. The contents of the status bar will vary based on the vehicle type.

The DataMaster Status Display

3.2.1 Status Display Items

3.2.1.1 File Path

This shows the current file that is loaded into DataMaster. The display is truncated to 40 characters in length, so the complete path may not show in this box. A file path and name combination may be up to 255 characters in length.

3.2.1.2 File Date

This shows the date and time at which the file was first written to disk. Since disk writes only occur every 100 records that are collected, this may indicate a slightly different time that when you first started collecting data.

3.2.1.3 Record Count

The Record Count display shows the total number of records in this particular file. The maximum file size is limited to 32,767 records (approximately 4 Megabyte). If a larger file is loaded, DataMaster will only display the first 32,767 records.

3.2.1.4 Oil Temperature

Only Corvettes (Y-Cars) will display Oil Temperature. If F-Car, B-Car or Truck is selected, the Oil Temperature will read "N/A". An exception to this is the 1994-5 vehicles, which DataMaster has enabled the oil temperature display for all models, as many performance enthusiasts install this sensor. If no sensor is installed, the value will read –34 Degrees C.

3.2.1.5 PCM Type

Some versions of DataMaster allow selecting between several different PCM types. This display shows the currently selected ECU/PCM.

3.2.1.6 PROM ID

This indicates the PCM internal EPROM ID #. This is identifies the exact version of EPROM code that the PCM is using. This is not used by all vehicle types, so this item may not be present in your display.

3.2.1.7 Baro kPa

This indicates the computed atmospheric pressure. Unless you are at high altitudes, this will be close to 100 kPa. A few vehicles do not support BARO readout, in this case the display will read "N/A" or will not appear in the status bar at all.

3.2.1.8 Runtime

This shows the # of seconds elapsed since the engine was last started.

3.2.1.9 Coolant Temp

Shows the current engine Coolant temperature.

3.2.1.10 Ignition Volts

Shows the ignition (battery) voltage. Very informative to watch during engine cranking!

3.2.1.11 Open Loop

This display indicated if the PCM is operating in open loop of closed loop mode. When the PCM is open loop, the display will be Yellow; when in closed loop this display will be Green.

3.2.1.12 DTC Errors

This display shows if there is a Diagnostic Trouble Code set. Will turn red on any record that contains a DTC, instantly flagging a DTC error.

3.2.1.13 Data OK

The Data OK display shows if the data record contains any data errors (checksum error). If this turns red and shows **Data Err**, that particular record is bad and should not be trusted! This can occasionally occur during data collection if there is noise on the ALDL data link, or if a data transmission is interrupted.

NOTE: A common source of **Data Err** is from poorly grounded aftermarket ignition systems. All such devices should be carefully grounded to the chassis using a flat braided-metal ground strap, available from auto parts stores. Also, ignition manufacturers often sell a noise suppressor kit which will help solve this issue.

If a data file from a different PCM type is loaded, this display will immediately show the data mismatch and indicate **Data Err**.

3.3 Understanding the Main Data Display

This section will explain each of the display items in the main display. Note that the main display is divided into several groupings:

- Engine Learning & Operation
- Idle Control
- Fuel Control
- Spark Control
- Miscellaneous

Each version of DataMaster has unique data display requirements, this example shows the type EE display:

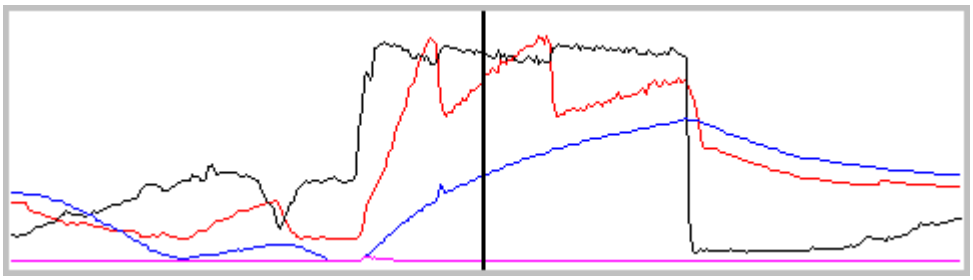
RPM | RPM16	4875	4780	Spark Advance	36.0
MAP KPa	90.4		Spark Retard	0.0
Fuel Trim Cell	15		Knock Count	2125
LTerm Counts	135	135	EGR DC	0.0
STerm Counts	128	128	CCP DC	25.5
BPW mS	15.98	15.92	IA Temp °F	104.5
INJ DC (calc)	64.9	64.7	A/C Temp °C	32.3
O2 mV	928	924	A/C Press PSI	78.5
AFGS	204.53		Idle RPM	550
TPS %	100.0		IAC Pos	60
TPS Volts	4.53		Speed MPH	61
Comments:				F-Car A/T

PCM Type EE Main Display

Note that several labels will change colors under various operating conditions. This is designed to quickly notify the user that something important has changed.

3.4 Using the Graph and Snapshot Display

The graph at the bottom left of the display is a powerful way to quickly zoom into an area of interest in the data file.



The DataMaster Main Graph Display

3.4.1 Vertical Graph Scaling

The items that are plotted are scaled to fit within the fully zoomed-out vertical axis. There are no units or conversion factors that can be easily applied to the plot itself, as there are multiple plots overlaid on the same area. The exact values at any point are shown either by the snapshot display to the right, or the Main display above. What the plot clearly shows is what signals are doing or trending and how they are related, not their absolute value! For accurately scaled presentation plots, the files may be exported to a spreadsheet program (such as Excel) and plotted from there.

3.4.2 Moving to a Specified Record in the Graph

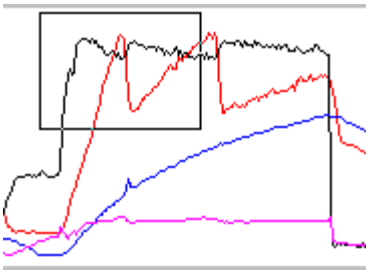
There are two ways to move around the data file using the graph: The Left mouse click in the display area, and by holding the Right mouse button and drawing a Zoom Box around the area of interest.

3.4.3 Left-mouse Click on the Graph Display

The user can move to an area of interest by clicking the left mouse button when the mouse cursor is in the graph display area. The current record will move to the location under the cursor. The user can then hone in on the area using the Record Scrollbar control.

3.4.4 Zooming in on an Interesting Area of the Graph

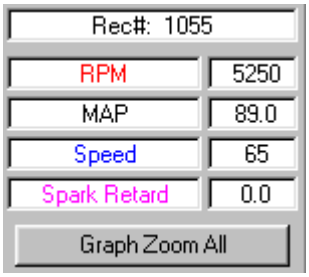
A very powerful tool is the "Zoom Box" which magnifies an area of interest in the graph. This is done by drawing a "Zoom Box" on the graph display while holding down the Right Mouse Button. When the button is released, the display will zoom in to the area you drew. To Zoom back out, the ***Graph Zoom All*** button must be pressed.



The 'Zoom' Box

3.4.5 The Snapshot Display

The Graph snapshot Display is located directly to the right of the graph display, and shows the color code and name of the 4 items selected for graphing. As the cursor is moved through the display, these values rapidly change, indicating the exact value for those items anywhere in the display.

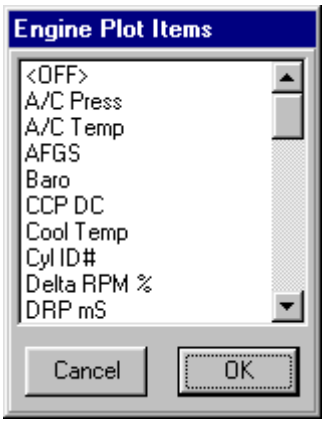


The Snapshot Display

3.4.6 Changing the Graph Assignments

When DataMaster is first installed, a default set of items is loaded into the graph for plotting. These are easily changed by double-clicking on the Item Name in the snapshot display. This will bring up the Engine Plot Items box from which you can select what item you want plotted. If you want nothing plotted, select the <off> selection at the top of the list. Press the "OK or "Cancel" buttons to return to the main program.

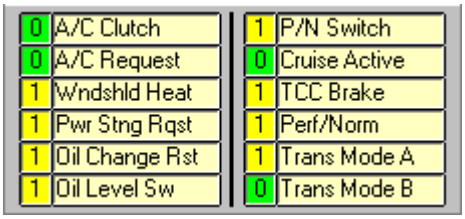
The selections you make will be remembered the next time you invoke DataMaster.



The Engine Plot Items

3.5 Using the Status Bit Display

The status bit display is located on the upper right of the Main display, and shows up to 12 individual status bit values. A small indicator to the left of each bit description shows a Yellow "1" or a Green "0" to indicate its value. In general, values of "1" indicate that a function is activated but this is not always the case.



The Status Bit Display

3.5.1 Obtaining Bit Descriptions

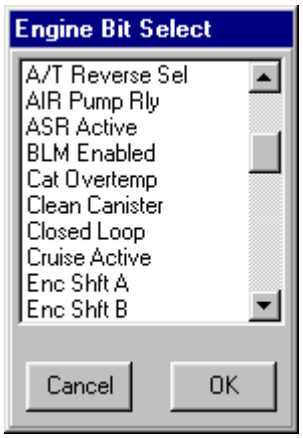
To find out what the function of a bit is, double-click on the 0/1 value indicator.
A dialog box will appear with information pertaining to that bit. You must click on the OK button to continue.

Status Bit Description

3.5.2 Changing Bit Assignments

When DataMaster is first installed, a default set of items is loaded into the Status Bit display. These are easily changed by double-clicking on the yellow Bit Item Name. This will bring up the Engine Bit Select box from which you can select what status bits you want displayed. Press the OK or Cancel buttons to return to the main program.

The selections you make will be remembered the next time you invoke DataMaster.

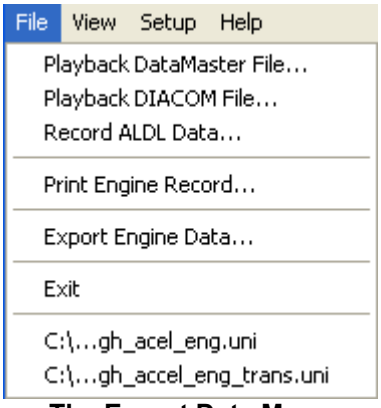


The Engine Bit Select Form

3.6 Exporting Data

After a data file has been loaded, the user can export any range of records to a "Comma Separated Value" (CSV) file. Most popular spreadsheets can directly import a CSV file, where the user can then manipulate the data and calculate and/or plot information of interest.

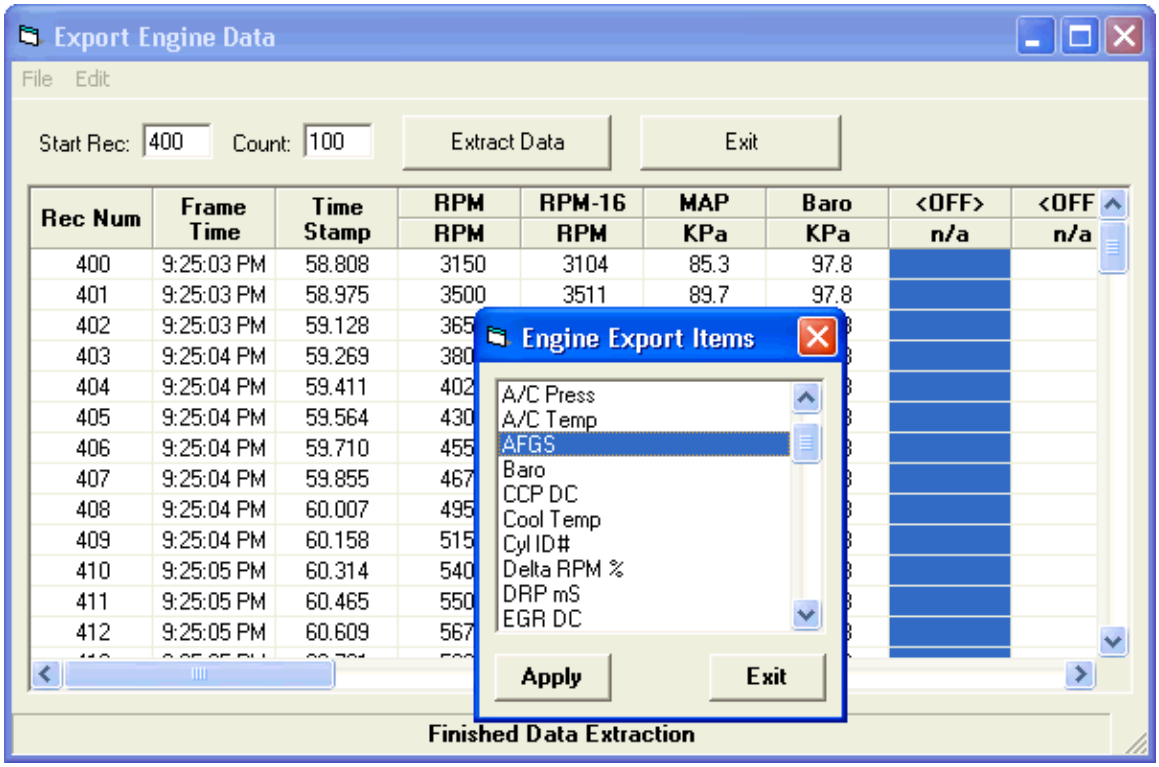
To export data, select the ***File-Export Data*** from either the Main or Transmission data display. A form will be presented which allows the user to select up to 32 data items to export.



The Export Data Menu

3.6.1 Selecting Export Items

Items are selected by clicking on the Column header, which will bring up a item selection box. Scroll to the data item of interest and press "OK" to add this to the export list. Continue through the column assignments until all the items of interest are selected. Any column marked "<OFF>" is ignored and will not be exported.

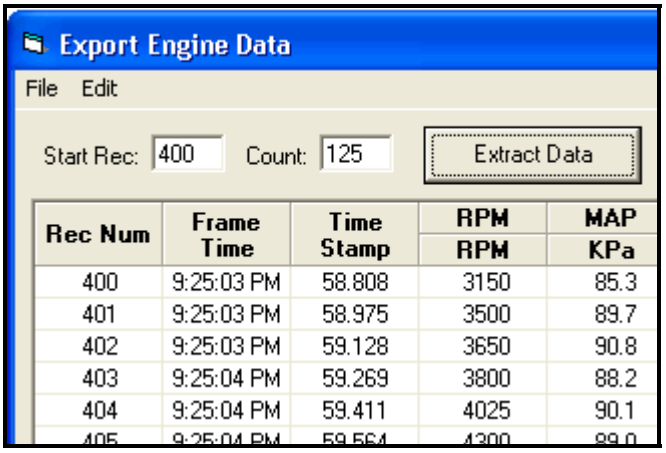


Selecting Items for Export

3.6.2 Setting the Export Record Range

The export data range is set by entering a Starting Record and Count which brackets the area of interest.

In this example, a total of 125 records will be exported starting at record 400; thus all records from 400 to 529 will extracted.

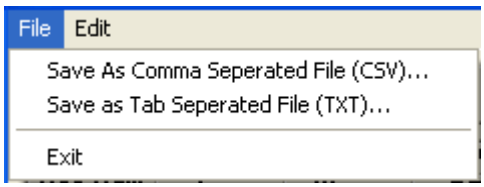


Setting the Data Export Range

3.6.3 Extracting and Saving the Export Data

After export assignments are made, click the Extract Data button. The grid will fill with the extracted data, one row per record.

To save the extracted data, select the File-Save As CSV menu item. A file dialog will be presented prompting you for a file name. Enter a name, press OK, and the data will be written to the file.

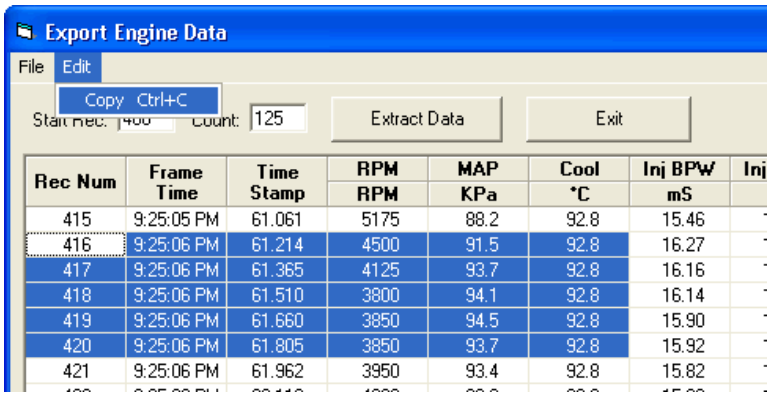


Save Export Data Menu

Alternately, you can copy and paste data using the windows Clipboard. To do this, follow these steps:

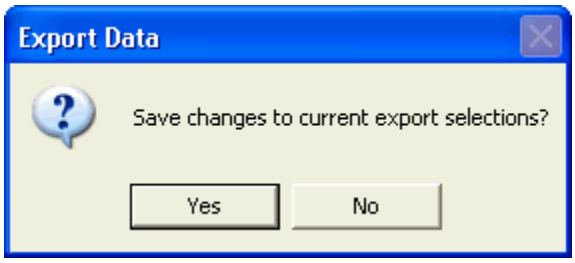
- Use the left mouse button and drag to select an area of the grid
- From the menu, select Edit- Copy or type Control-C from the keyboard

This will copy the selected area to the clipboard and it may be directly paste into other Windows applications such as Excel or Notepad.



3.6.4 Saving Assignment Changes

When you are finished and exit the data export form, you will be prompted to save the item selection changes you made. Select Yes to store the current selection list which will be automatically recalled the next time the Export function is selected.

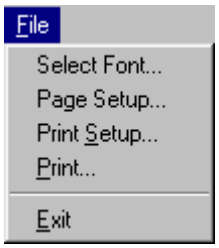


Save Export Selections Dialog

3.7 Printing the Data

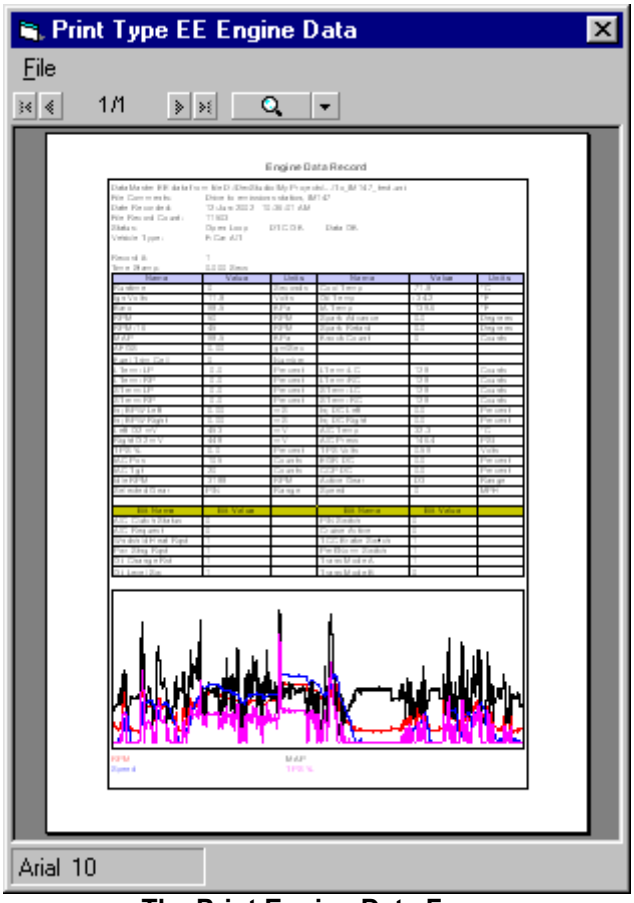
The current record and graph display on the screen is printed by making the ***File- Print Engine Record*** menu selection. This will bring up the print preview form which will show exactly what will be printed.

The printer set-up and fonts are selected from the File menu:



Make the desired selection(s) and use the ***Print*** selection to send the document to the printer.

You can zoom in and out of the document preview by clicking on the magnifying glass icon. Also, the form may be resized to fit the preview by dragging the borders.

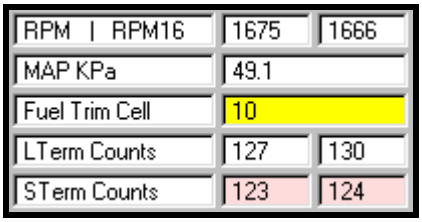


The Print Engine Data Form

3.8 The Engine Data Display Groups

3.8.1 Engine Learning & Operation Group

The illustration to the right shows a typical layout for the engine learning and operation data items. Every PCM is somewhat different and may show different items than this illustration!



Typical Learning Group

For instance, the type TT Syclone / Typhoon vehicles are factory turbo equipped, and include the target boost pressure and only a single side for L/S term counts and BPW.

3.8.1.1 RPM

This displays the current engine RPM. Note that sometimes during initial engine starting this value will be shown as extremely high as the PCM attempts to sync-up with the engine. If the RPM value falls below 500 RPM, the label will turn yellow to indicate a pending stall condition. Note that the GM datastream limits this value to 6375 RPM maximum.

3.8.1.2 RPM16

This displays the current engine RPM as calculated from the Distributor Reference Pulse (DRP) rate. This allows displaying RPM Values well above the usual 8-bit datastream limit of 6375 RPM.
Note that because DRP is measured at a slightly different point in time, and with greater precision than the 'normal' RPM calculation, the value is often 10-15 RPM different than the 'normal' RPM reading. This will be particularly evident during hard acceleration.

3.8.1.3 MAP

Manifold **A**bsolute **P**ressure, measured in kilo-Pascals (kPa) or inches Mercury indicates the pressure measured in the intake manifold.

Note: An absolute pressure of 0 KPA indicates a perfect vacuum, while a reading of 100 KPA is approximately atmospheric pressure. A typical reading for an engine is 35-40 KPA during idle, and 90-100 KPA under full throttle. This assumes no wild cams or boosted applications!

3.8.1.4 Short Term Fuel Trim (STerm)

Formally called the Integrator, this is the short term fuel correction factor that the PCM is using. This is displayed in percent deviation from the nominal value of 128 counts. Negative values indicate that the AFR is rich, and if this exceeds 2% the display will turn red. Conversely, positive values indicate the AFR is lean, and if this exceeds 2% the display will turn green. For SFI systems, this is divided into left and right side values.

3.8.1.5 Long Term Fuel Trim (LTerm)

Formally called the Block Learn Mode (BLM), this is the long term fuel correction factor that the PCM is using. This is displayed in percent deviation from the nominal value of 128 counts. Negative values indicate that the AFR is rich, and if this exceeds 2% the display will turn red. Conversely, positive values indicate the AFR is lean, and if this exceeds 2% the display will turn green. For SFI systems, this is divided into left and right side values.

3.8.1.6 Fuel Trim Cell

This shows the current fuel trim cell that the PCM is operating out of. The PCM typically has 16-20 distinct operating regions that are each assigned a unique cell number. Each of these cells has a stored Long Term fuel trim factor that corrects for each engine's unique operating

conditions. Whenever the cell number changes, the color is momentarily changed to yellow to catch your attention.

3.8.1.7 Mass Air Flow (AFGS)

This shows the current mass airflow the engine is using. Calibration is in grams per second and does not change when English units are selected. This parameter is only used on vehicles that utilize a MAF sensor.

3.8.1.8 TPS%

Shows the percent throttle opening. This is calculated by the PCM and will be a value 0 to 100%.

3.8.2 Idle Control Group

Typical Idle Control Group Items

3.8.2.1 Idle Target (RPM)

This shows the that the PCM is attempting to reach during idle conditions. Not available for all PCM's.

3.8.2.2 IAC Position

This is the actual counts (0 to 255) for the Idle Air Control Valve position. This valve controls the idle speed and air density during throttle overrun conditions.

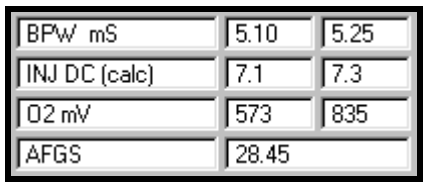
3.8.2.3 TPS Percent

This shows the calculated Load Value the PCM is using at the current instant. Roughly corresponds to the throttle position, but takes into account many other items as well. This value will not necessarily track the TPS volts value

3.8.2.4 TPS Volts

This shows the voltage measured from the Throttle Position Sensor. Will generally range from 0.5 Volts (throttle closed) to 4.5 Volts (throttle fully open).

3.8.3 Fuel Control Group



Typical Fuel Control Group

3.8.3.1 Inj BPW

This is the fuel injector Base Pulse Width measured in Milliseconds. For SFI systems, this is divided into left and right side values. When the injector pulse is less than 1 mS, the color is changed to Yellow.

3.8.3.2 INJ DC (Calc)

This is the calculated Injector Duty cycle based on the current BPW and Engine RPM and EFI mode (Batch fire or Sequential). This is useful for determining if the injectors are sized correctly. When the injector duty cycle exceeds 80 percent, the color is changed to Red.

3.8.3.3 O2 Volts

This is the measured voltage (in Millivolts, mV) generated by the O2 (Oxygen) sensor. Will typically range from 100 mV (lean) to 900 mV(rich). For SFI systems, this is divided into left and right side values.

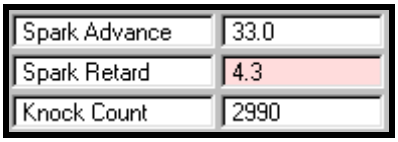
3.8.3.4 O2 Xcounts (Crosscounts)

This is a cumulative count of the number of times the O2 sensor voltage has crossed back and forth from high to low voltage. Will count from 0 to 255, then start over again from 0. Note: When plotted, it is not always apparent the O2 voltage is varying, even though the crosscounts are increasing. This seems to be due to minute variations that may not show on the plot being counted as a crosscount!

3.8.3.5 Target AFR (Air-Fuel Ratio)

Target AFR indicates the Air/Fuel ratio that the PCM is trying to control to. Generally, this is only different from 14.7 during warm-up, full throttle operation, and highway economizer mode. Not available for all PCMs.

3.8.4 Spark Control Group



Typical Spark Control Group

3.8.4.1 Spark Rtd (Spark Retard)

This indicates how many degrees spark retard the PCM has calculated is required. Spark retard is typically caused by the Knock Sensor detecting a knock condition and is generally between 0 and 10 degrees. Note that if any spark retard is present, the label will turn Yellow.

3.8.4.2 Spark Adv (Spark Advance)

This indicates the actual spark advance the PCM is currently using relative to Top Dead Center (TDC). Note that if there is Spark Retard activity, you can observe this value change in real time!

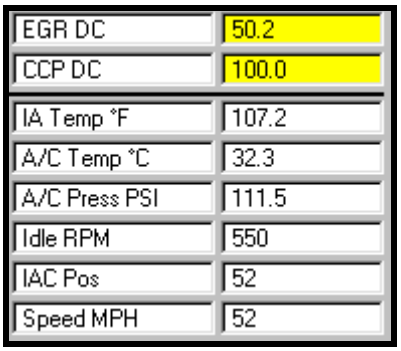
3.8.4.3 Knock Cnt (Knock Count)

This is a cumulative count of the number of knocks that have been detected. Will count from 0 to 65,535 then start over again from 0. Note that it is normal to see the knock count number jump by 100 or more units at a time; and when the vehicle is first started the count may increment several thousand!

Some vehicles have only an 8-bit knock counter, and those will only count from 0 to 255 before resetting to 0.

3.8.5 Miscellaneous Group

The miscellaneous group contains the items that don't fit well into other categories. These include various temperatures, pressures, vehicle speed, auto trans gear selection, and emissions related items.



The Miscellaneous Group

3.8.5.1 EGR DC (Exhaust Gas Recirculation Duty Cycle)

This value reports the percent opening of the EGR valve that the PCM is requesting, and will be a value from 0 to 100%. Whenever there is any EGR activity, the label will turn yellow.

3.8.5.2 CCP DC (Charcoal Canister Purge Duty Cycle)

This value reports the percent opening of the CCP valve that the PCM is requesting, and will be a value from 0 to 100%. Whenever there is any CCP activity, the label will turn yellow.

3.8.5.3 Speed

This is the current speed of the vehicle in Miles Per Hour or Kilometers Per Hour.

3.8.5.4 MAT Temp (Manifold Air Temperature)

This reports the measured temperature of the air within the intake manifold measured in Degrees Celsius or Fahrenheit. Not all vehicles use this sensor, and if not present will indicate a value of -40 degrees.

3.8.5.5 IA Temp (Intake Air Temperature)

This reports the measured temperature of the air prior to entering the intake manifold measured in Degrees Celsius or Fahrenheit. Not all vehicles use this sensor, and if not present will indicate a value of -40 degrees.

3.8.5.6 A/C Temp (Air Conditioner Evaporator Temperature)

This reports the measured temperature of the air conditioning evaporator measured in Degrees Celsius or Fahrenheit. Only used by the LT1 engines

3.8.5.7 A/C Pressure (Air Conditioner high-side pressure)

This reports the high-side pressure of the air conditioning system measured in PSI or kPa. Only used by the LT1 engines

3.8.5.8 Active Gear

This is the current gear that is activated within the automatic transmission. Shows "N/A" for manual transmission applications. Not available for all vehicles.

3.8.5.9 Selected Gear

This is the current automatic transmission gear that is selected by the gear shift lever. Shows "N/A" for manual transmission applications. Not available for all vehicles.

3.9 View Menu Selections

3.9.1 The Histogram Display Form

The Histogram displays tracks the short or long term learning history of the PCM. This can be very useful in determining mixture trends and how the PCM is compensating during a test run. New with DataMaster 3.5, the histogram has added a "Classic" view in addition to the previous "Enhanced" view of the short- and long-term correction data.

The histogram display is activated during file playback by selecting the ***View- Histogram*** menu item from the main display. When the histogram is first activated, the "cells" are all cleared and will be gray, indicating no "hits" have occurred.

By clicking on the main form graph, each data record displayed is evaluated and updated on the histogram. To get a good view of what the PCM is doing over time, select a starting record and click the **Start** button in the playback center. As DataMaster automatically scrolls through the records, each is evaluated and displayed on the Histogram form.

The Histogram can be cleared (reset) at any time by clicking the ***Clear Histogram*** menu item. The cells are color coded for correction range as indicated along the top of the grid, and extends from a value of <117 (dark red), through 128 (white) and on to >139 (bright green). The values lower than 128 indicate that the mixture is rich, and the PCM is compensating by generating a negative correction factor. Conversely, values greater than 128 indicate a lean mixture, and the PCM is generating a positive correction factor. The ideal operation point is between 126 to 129 for part throttle operation.

Note that fuel correction and learning is disabled until the PCM enters closed loop mode. During this time, their values are usually locked down at 128, although there are exceptions to this based on prior learned values. Also, during WOT operation, the correction values are 'locked down' based on prior learned values.

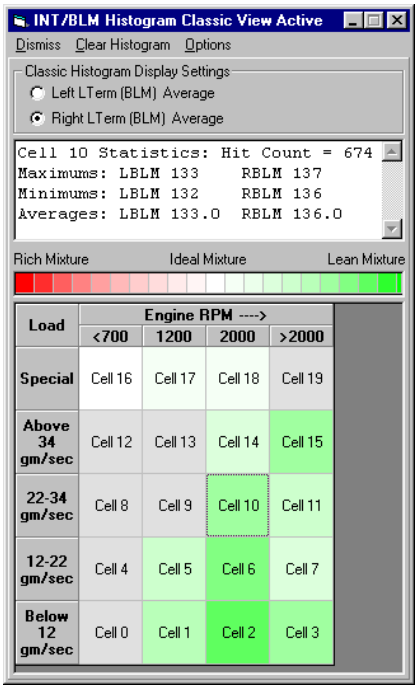
3.9.1.1 The Classic View:

The Classic Histogram view shows the traditional 16 (or 19) "BLM Cells" that the PCM uses to define operating regions that the PCM learns for fuel mixture correction purposes. Each cell is representative of a particular load and RPM range; by observing the long term correction factors (BLM) a Tuner can determine if the mixture is correct for their purposes.

By clicking on a cell (in this case cell 10), the statistics for Minimum, Maximum and Average values are displayed, along with the number of times the cell was used ("Hits").

The colored grid tracks the running average value by color for each cell. The Display Settings controls weather the Left or Right (if available) averages are displayed.

Note that "Special" cells 16 – 19 are only used on a few PCMs, and indicate special modes of operation such as Idle and deceleration.



The Classic Histogram View

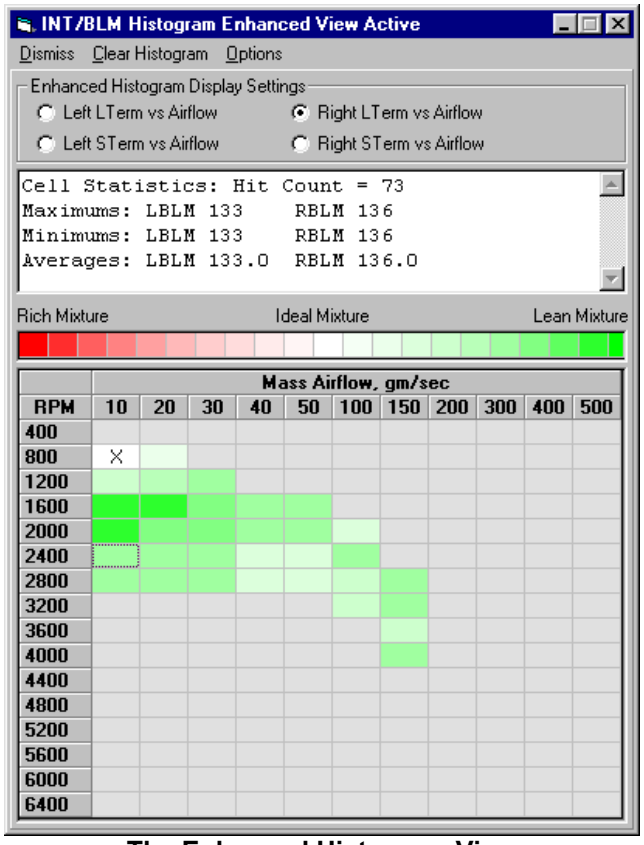
3.9.1.2 The Enhanced View

The Enhanced Histogram display displays a color-coded record of the Short Term or Long Term fuel trim value verses MAP (or Airflow) and RPM as a data file is stepped through. This data is calculated by DataMaster, and allows a finer display of load regions than the Classic histogram does.

There are two basic types of this display depending on the PCM:
Engines that do not use air mass flow meters use MAP (Manifold Absolute Pressure) verses engine RPM to determine the engine load operating point. Engines with air mass flow meters use mass air flow (AFGS, Air Flow Grams/Second) verses engine RPM to determine the engine load operating point.

The highlighted square indicated by the "X" indicates the current operating point, and this will move around as the engine load changes

At any time the user can switch between the Sterm Vs MAP or the Lterm Vs MAP modes and observe the differences.



The Enhanced Histogram View

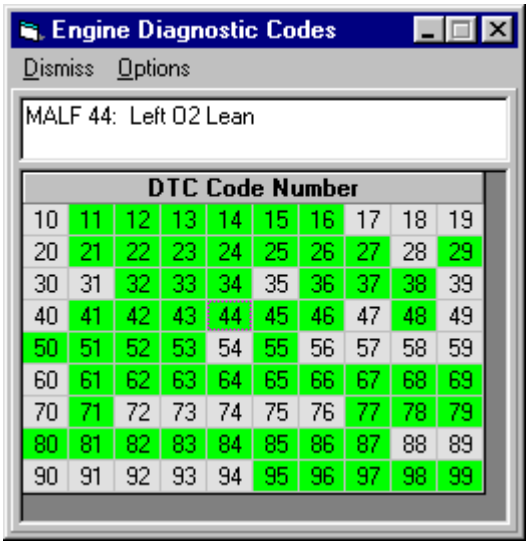
3.9.2 The DTC Code Display Form

Diagnostic Trouble Code (also called DTC or MALF) code display form is invoked form the main form's ***View- DTC Codes*** menu, or by clicking on the DTC panel of the status bar.

The display quickly shows the status of all DTC codes for the current record that is being displayed.

The cells are arranged in a grid, and DTC numbers are printed in each cell. If a code is set, it will be indicated by a RED square, otherwise they will be green (no code set) or gray (unused code).

Clicking on any cell will display the DTC# and a short description of the error. The factory manuals must be consulted for detailed descriptions and troubleshooting for any codes that are set.



The Engine DTC Form

When DTC errors are encountered, the main panel DTC error label turns red and a "Beep" is generated. The Beep can be turned on/off from the ***Setup- Preferences*** menu.

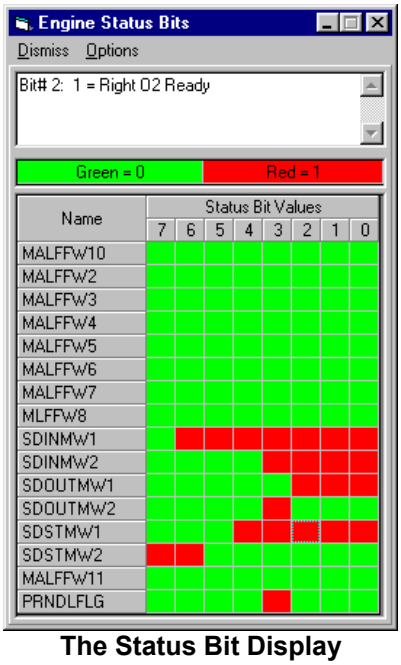
3.9.3 The Status Bit Display Form

The Status Bit display form is invoked form the main form's ***View- Status Bit Data*** menu.

The display shows the value of all control and status bits in the PCM data stream. Many of these bits are proprietary and used by the PCM to indicated different modes of operation and program status; many of them are not publicly documented by the vehicle manufacturer.

A value of "1" is indicated by a red square, and a value of "0" is green. Clicking on a bit square will bring up information on that bit's function (if known). Clicking on the left-hand column **Name** will bring up a description of the data row.

The top columns are numbered from 7 to 0, indicating the bit location on the data byte.
Note Bit 0 = the Least Significant Bit.
Some of the bit descriptions are cryptic, the user is on their own here!



The Status Bit Display

3.9.4 The Transmission Data Display Menu Selection

The transmission data option will be grayed out unless the file contains transmission data records to display. Selecting this option will bring up a form very similar to the main engine display, but with different data items listed. This form is laid out in a similar manner to the main display, however not all the same options are available. The transmission display is documented in the Transmission Display chapter.

3.9.5 The Time to Distance Calculator Form

The Time to Distance calculator estimates the distance traveled between any two points during a data run by integrating the speed and high-resolution time data. Also calculated is the average acceleration and elapsed time for the run.

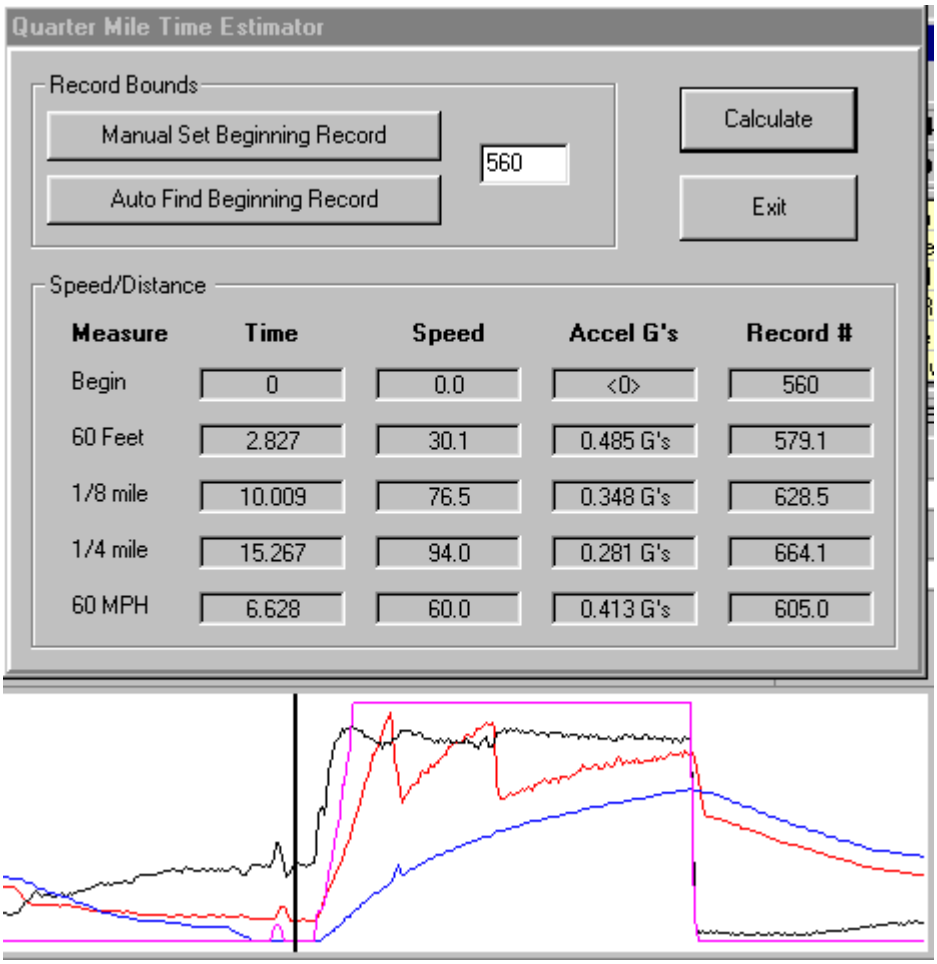
To use the calculator, first set the beginning record by entering the data directly into the text box, or by positioning the red cursor in the graph to the beginning record and pressing the Set Begin Record button. Next, set the ending record following the same process. NOTE: The ending record must always be higher than the beginning record, else the program will automatically switch their order.

To calculate the distance and elapsed time, press the Calculate button. Be aware that excessive tire spin will result in a false speed reading, thus limiting the accuracy of this calculator. However, by carefully selecting your start and end records, a fairly good performance estimate can be made.

The Speed-Distance Calculator

3.9.6 The Quarter Mile Calculator Form

The Quarter-mile time estimator calculates the times to 60 feet, 1/8 and 1/4 mile during an acceleration run, as well as zero-to-60 times. The view below shows the Quarter-mile estimator and the corresponding graph of the data during this run.



The Quarter-Mile Calculator

To use this calculator, set the cursor on the main display to the beginning point that you want to start the measurement from and press the "Manual Set Beginning Record" button. Alternately, if you position the cursor a bit earlier than this and press the "Auto Find Beginning Record" button, the estimator will look for the first non-zero speed and set the beginning record automatically.

To calculate the elapsed times, press the "Calculate" button. Be aware that excessive tire spin will result in a false speed reading, thus limiting the accuracy of this calculator. This calculator uses a linear interpolation of the speed data to give improved accuracy of the time to distance values.

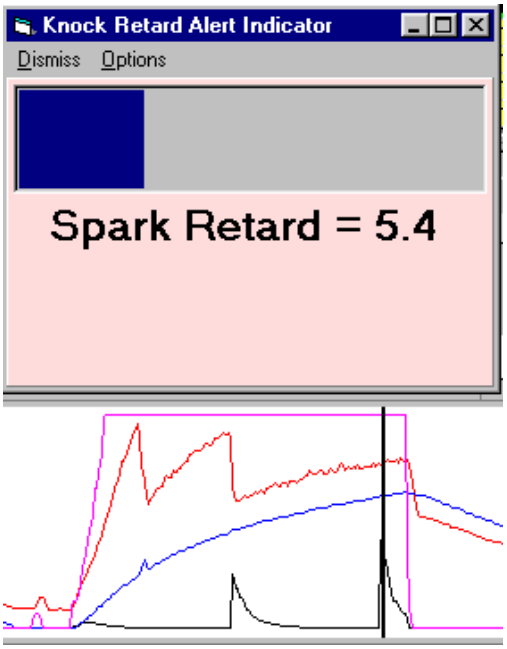
3.9.7 The Knock Retard Alert Indicator Form

The Knock Retard Alert Indicator is selected from the View-Spark Retard Alert menu. This is a resizable form that changes color based on any spark retard that is present.

The form will be gray if no spark retard is present, and turn progressively more red for increasing values. A large progress bar also graphically indicates any spark retard that is present.

This form is designed to get your attention, and can be resized by grabbing any corner and dragging with the mouse.

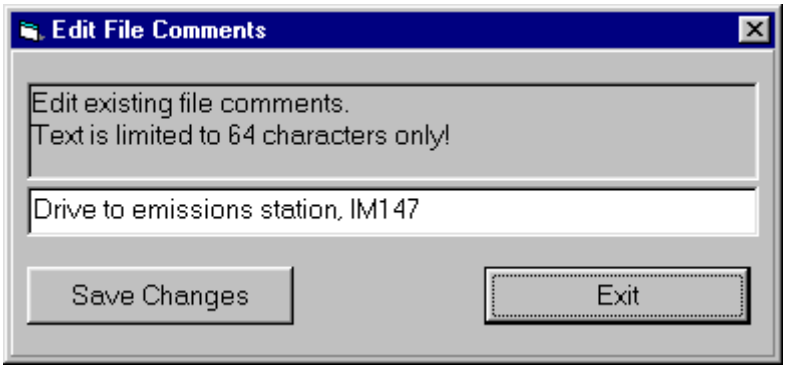
The view shown here shows the knock retard form just above the graph of knock retard (plotted in black) during an acceleration run.



The Knock Retard Alert Form

3.9.8 The Edit Comments Form

The Edit Comments form is selected from the main form ***View- Edit Comments*** menu selection. This form allows the user to view and change the comment text of DataMaster UNI files after they have been recorded. Note that it is not possible to edit comments of Diacom (.GDF) files, as there is no provision in the Diacom file for comment text.



The Edit File Comments form

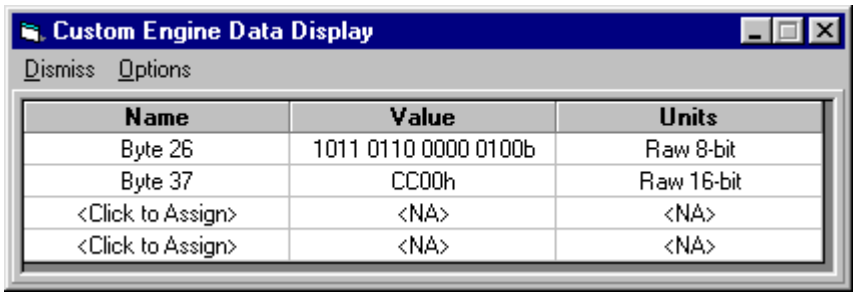
Note that the current version of DataMaster limits comments to 64 characters in length. The comment text box will not allow entering any characters beyond this limit.

After you have made the desired changes, press the **Save Changes** button to update the file and screen. Press Exit to close the form and return to the DataMaster main screen.

3.9.9 The Custom Data Form

The Custom Data form is selected from the main form ***View- Custom Data*** menu selection, and is available for engine data only.

The Custom Data form allows the user to view any four user-defined data items in the recorded data stream. The user must enter a byte position in the datastream to view (1 to 96), along with the data type and any scaling desired. The user is on their own to identify the data of interest; no documentation is supplied identifying the byte positions in the datastream.



The Custom Data Form

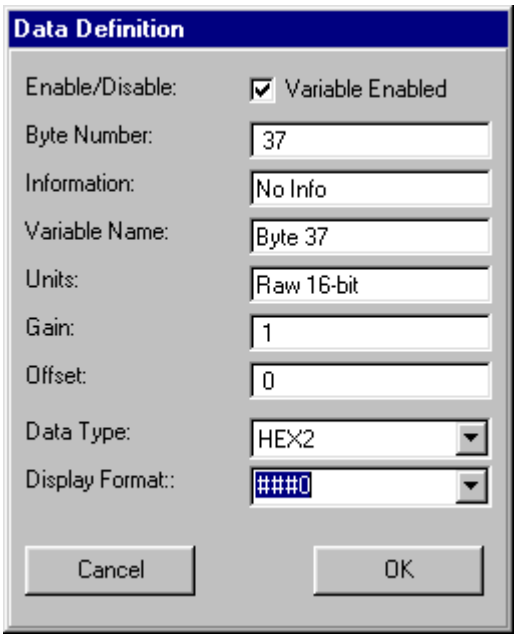
3.9.9.1 Assigning Custom Data Items:

To assign a custom data item, click on the Item Name to bring up the Data Definition form:

Enter the byte number you wish to observe (1 to 96), and fill in the Name, Information, and Units you want displayed. Check the Enable box to allow this variable to be displayed on the Custom data form.

To scale the data, enter Gain and Offset values. Note that scaling factors and display formats are ignored if HEX and BIN data types are selected.

The Data Type drop-down list identifies how to extract the raw data that is stored in the datastream. The following selections are available:



The Custom Data Definition Form

3.9.9.2 Data Conversion Codes:

Data Type	Description
INT	Unsigned 8-bit byte-- Val = (Gain * N) + Offset
INT2	Unsigned 16-bit word-- Val = (Gain * N) + Offset
2INT	Signed 8-bit byte (2's comp data)-- Val = (Gain * N) + Offset
2INT2	Signed 16-bit word (2's comp data)-- Val = (Gain * N) + Offset
IINT	Inverse 8-bit byte: Val = (Gain / N) + Offset (N = 0 forced to 1)
IINT2	Inverse 16-bit Word: Val = (Gain / N) + Offset (N = 0 forced to 1)
HEX	Display as raw HEX 8-bit byte value, gain and offset ignored
HEX2	Display as raw HEX 16-bit word value, gain and offset ignored
BIN	Display as raw binary 8-bit byte value, gain and offset ignored
BIN2	Display as raw binary 16-bit word value, gain and offset ignored

To control how non-BIN and HEX data is formatted (i.e. decimal point location and precision), make a selection from the Display Format drop-down list. The formatting options follow standard Basic-language formatting conventions. The following options are available, but the user can enter their own formatting if desired.

Format String	Description
##0	3 leading digits, No DP
###0	4 leading digits, No DP
####0	5 leading digits, No DP
##0.0	3 leading digits, DP, 1 decimal place
##0.00	3 leading digits, DP, 2 decimal place
##0.000	3 leading digits, DP, 3 decimal place
###0.0	4 leading digits, DP, 1 decimal place
###0.00	4 leading digits, DP, 2 decimal place
###0.000	4 leading digits, DP, 3 decimal place

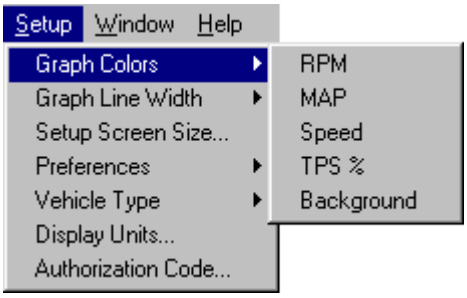
Tip: A pound (#) symbol indicates that a digit will be displayed if not equal to zero. A zero (0) symbol indicates that all digits in this position will be displayed, even if zero.

3.10 Setup Menu Selections

3.10.1 Setup Graph Colors

The color of the plotted graph items is selected form the main form's ***Setup- Graph Colors*** menu. The individual graph items that are currently plotted are labeled in the menu.

When the menu item is selected, a color dialog box is presented allowing the user to choose any desired color for the plot. The color scheme in the Snapshot window will change to match the new assignment.
The background color may also be changed to improve contrast for some color schemes. Normally a white or black background gives the best contrast.



The Graph Color Menu

3.10.2 Setup Preferences

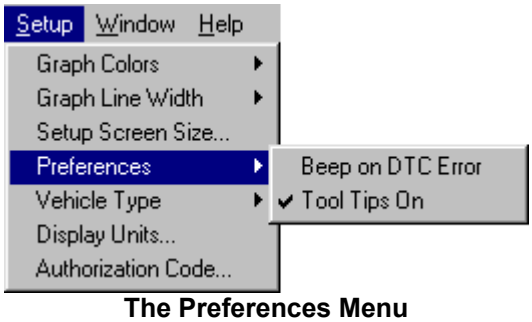
The color of the plotted graph items is selected form the main form's ***Setup- Preferences*** menu.

3.10.2.1 No Beep on DTC

Turns on/off the "beep" when DTC errors occur. Used to reduce annoyance when scrolling through a record that has many DTC errors!

3.10.2.2 Tool Tips On/Off

Turns on/off the tool tips which give information as the mouse cursor is moved across the screen.

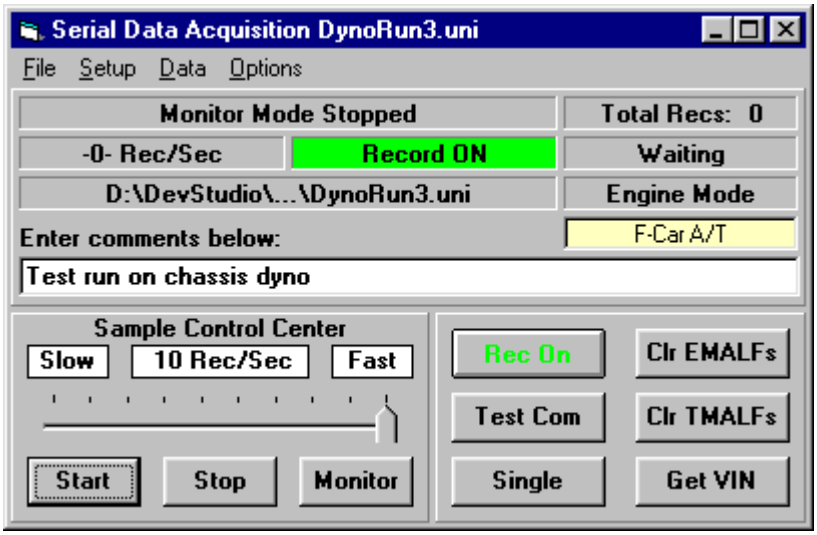


The Preferences Menu

4 Recording ALDL Data

4.1 Introduction

The ALDL data recording function is activated from the main form's ***File- Record ALDL Data*** menu selection. This will dismiss all open forms except the main engine and transmission data displays, and bring up the Serial Data Acquisition form. This form will remain the active form until it is exited. This form may be placed in the background by deselecting the ***Options- Always on Top*** menu item.



The Serial Data Acquisition Form

All aspects of data recording and monitoring are controlled from this form, with the exception of the Vehicle Type selection which must be made from the main Engine Data form. Refer to: Selecting the Vehicle Type.
Functions controlled by this form are listed below and are described in detail in subsequent sections:

- File Name Selection
- Engine and/or Transmission Data
- Com Port Selection
- PCM Com Test
- Clearing DTC codes (Engine and Transmission)
- Retrieving VIN
- Sample Rate 1 – 10 FPS
- File Comments (also can be edited on playback)
- Set-up keyboard control of recording function (Mouseless Operation)
- Ability to pause recording while continuing to view data
- Pre-trigger memory on/off control
- Display Updating All, Some, None to work faster with slower PCs

Note that not all functions are available for all PCMs.

4.1.1.1 NOTICE: DataMaster Program Authorization

The DataMaster program as initially installed operates in demonstration mode. Demonstration mode allows the user full capability to playback all data files, but limits the ability to record new data to 20 total uses. Whenever the ***File Record*** ALDL menu item is selected, the user will be

prompted with a reminder of the remaining trial period and a choice is given to return to playback mode or continue and record data. **If the user selects return to playback, no usage is subtracted from the trial period.**

For information on authorizing DataMaster, refer to Authorizing the DataMaster Program.

4.2 Recording ALDL Data

There are several items that must be set-up before you can record data from the PCM. First, a File Name must be must be selected or entered; Second, the serial Com Port must be selected; Third, the correct Vehicle Type must be selected from the main form menu, and lastly, the Data Mode must be selected.

Beginning with version 3.4.1 and later software, there is an optional monitor only mode which does not require a file name. All data viewed in monitor mode is lost and cannot be recalled!

4.2.1 Selecting the Data File Name

The file name is selected from the File—Open menu item. This will bring up a standard file selection dialog box. Navigate to the directory where you want to store your data file and either select an existing file name or enter a new filename to receive your data. Press the Open button to complete your selection. If the filename you selected already exists, you will be prompted to either overwrite the file, append to the file or cancel the operation.

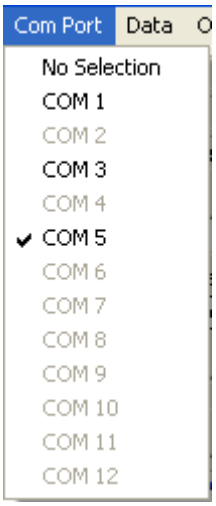
NOTE: If Overwrite is selected, the old file contents will be deleted and cannot be recovered. Append will add the new data to the end of the existing file so no data will be lost.

4.2.2 Selecting the Communications Port

The Communications port must be selected from the Serial Data Acquisition form's ***Setup-Com Port*** menu item. This will bring up a list of the available serial communication ports that the PC currently has available for use. DataMaster allows assigning COM1 through COM12.

A grayed-out selection means that the port is in use by another program, or does not exist on the PC.

Select the COM port that that is connected to the PCM Adapter Cable. DataMaster will remember the selection and automatically return to it the next time it is run.



The Com Port Select Menu

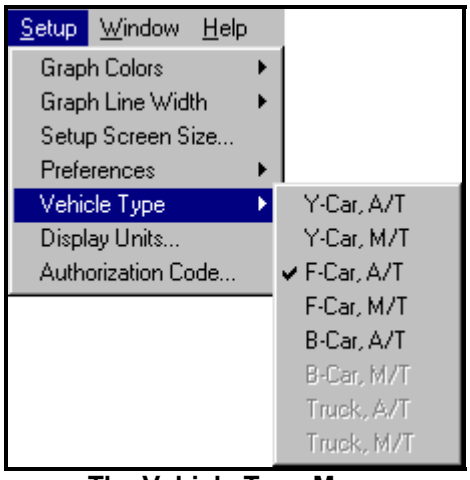
4.2.3 Selecting the Vehicle Type

The Vehicle type is selected from the main engine display form's ***Setup—Vehicle Type*** menu item. A list of supported vehicle types will be presented to choose from.

Make the appropriate selection, and the yellow label near the **Comments** box will indicate what the current selection is.

It is important that this is the same as the vehicle being monitored, as different vehicles often have different calibrations and functions assigned to the data.

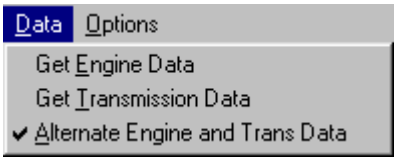
NOTE: For Corvettes, the wrong selection may result in erratic or no communication with the PCM.



The Vehicle Type Menu

4.2.4 Setting the Data Mode

The Data Mode is selected directly from the Data menu item. Depending on the vehicle type, several options may be available for the type of data to be collected.



The Data Menu

All PCM's support Engine data, while others add Transmission data as well. If available, you may select between Engine only, Transmission only, or Alternate Engine and Trans data modes.

The Alternate mode switches automatically between engine and transmission data, such that the data file contains a synchronized record of both! This can be extremely useful when solving an issue that involves an interaction between the engine and transmission.

4.3 ALDL Data Recording Menu Selections

4.3.1 The File Menu Items

4.3.1.1 File- Open
Used to bring up the standard file dialog box to input a file where the test data will be stored.

4.3.1.2 File- Save Now
Saves any data collected since the last file save. Note that data is automatically saved every 100 records that are collected.

4.3.1.3 File- Exit
Exits the data acquisition mode and returns to the playback mode. If there is unsaved data, you will be prompted to save it before exiting.

When playback mode is returned to, the data file that was just collected will be automatically displayed.

4.3.2 The Setup Menu Items

4.3.2.1 Setup- Com Port
Displays a list of available comports for use with DataMaster. This selection may be changed at any time.

4.3.2.2 Setup- Timeouts
Brings up a form that allows changing the default time-outs that DataMaster allows before assuming a communication error. The default settings are 120 for both Receive and Transmit, the units are milliseconds. In some cases (depending on PC hardware and the PCM), it may be necessary to make these values larger if time-out errors occur during data collection.

4.3.3 The Data Menu Items

4.3.3.1 Data- Get Engine Data
Sets the data mode to obtain Engine Data only.

4.3.3.2 Data- Get Transmission Data
Sets the data mode to obtain Transmission Data only. Not available for all PCM's.

4.3.3.3 Data- Alternate Engine and Trans Data
Sets the data mode to alternate between Engine and Transmission Data. Not available for all PCM's.

4.3.3.4 Options- Always on Top
This option "locks" the form on top of all others, or allows it to go into the background. If it disappears from view, it may be recalled from the Windows toolbar or from the main engine display Window—ALDL Data Control Center selection.

4.3.3.5 Options- Record Memory On/Off
This controls operation of the "memory" that runs when record mode is "OFF". If the Record Memory is On, when switching from record "OFF" to record "ON" will cause the last 50 records that were monitored to be recorded to the file. If Record Memory is "OFF", any information collected while record was off is lost. Record memory allows capturing data observed during a monitoring session. If something of interest is seen, press the "Record On" button, and the last 50 records will be saved for later playback.

4.3.4 The Options Menu Items

4.3.4.1 Options- Display…

Allows for 3 different modes of screen update during data acquisition. As each record is received from the PCM, the user may choose how much to display. Note that the mere that is displayed, the slower that data collection will be. For the highest possible sample rate, choose the "Update Off" item.

- Update All. All active displays and graphs are updated.
- Update Partial. Only the status bars are updated for the active displays.
- Update Off. Only the Serial Data Acquisition form is updated.

4.3.4.2 Options- Advanced- Disable ALDL Handshake

This option is provided to "seize" control of the ALDL communications link, bypassing the standard ALDL protocols. On Corvettes, this will result in the dashboard, HVAC and active suspension modules not receiving data updates as expected; thus the ASR light may be activated during data collection. If this occurs, the next vehicle start cycle will clear the ASR light.

4.3.4.3 Options- Advanced--Disable Dashboard Updates

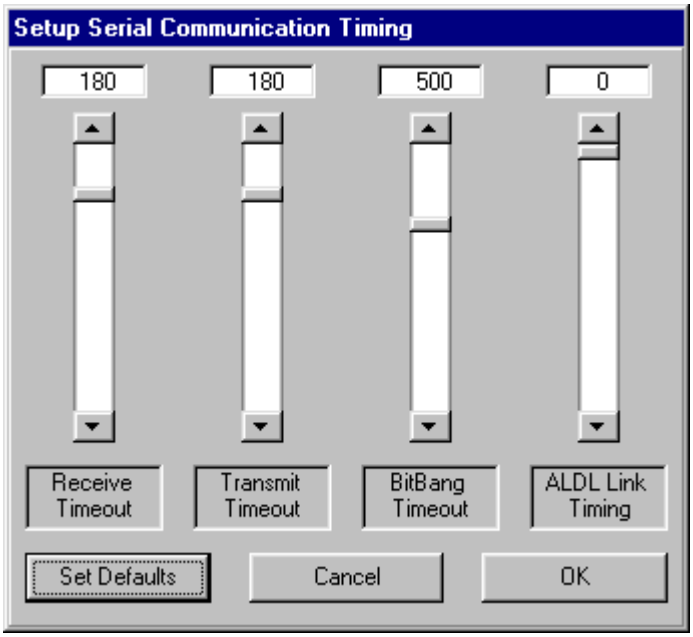
This selection is provided principally for owners of modified Corvettes that have disabled the Central Control Module (CCM) or dashboard for racing purposes. When this selection is activated, no information will be sent to the CCM, Dashboard, HVAC or Active suspension control modules. On non-modified vehicles this will result in the dashboard, HVAC and active suspension modules not receiving data updates as expected; thus the ASR light will be activated during data collection. The next vehicle start cycle will clear the ASR light.

4.3.4.4 Options--Advanced--Timeouts

This selection brings up a form that allows changing the default time-outs that DataMaster allows before assuming a communication error.

The default settings are 180 for both Receive and Transmit, the units are milliseconds. In some cases (depending on PC hardware and the PCM), it may be necessary to make these values larger if time-out errors occur during data collection.

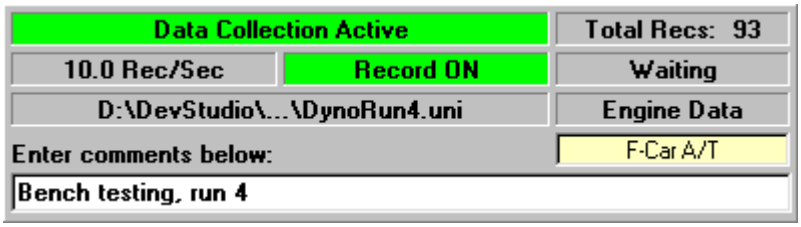
BitBang timeout defaults to 500, and is used when the ALDL handshake is disabled.



Setup Serial Communication Timeouts

4.4 ALDL Data Recording Status Bar

The Data Recording Status Bar provides feedback on the monitoring and recording of data.



The Serial Data Recording Status Bar

4.4.1 The Status Bar Items

4.4.1.1 Com Status – Data Collection active

This reports the status of the latest communications from the PC to the PCM. If any errors occur, it will be reported in this label.

4.4.1.2 Total Record Count

Reports the total number of records that DataMaster has successfully obtained from the PCM, whether recorded of not. Note that if both engine and transmission records are collected, this number will be divided between the engine and transmission display. However, non-recorded data does not update the record count on the Engine and Transmission displays.

4.4.1.3 Records / Second

Shows the actual interrogation rate for the PCM. This can be adjusted using the scrollbar in the record control center. The rate will vary, depending on the display update mode, sample control setting, PCM data type, and the speed of the PC. For full screen update mode at maximum speed, this will typically be in the range of 5-7 records per second. The maximum rate possible is approximately 10 records per second. Faster PCs will give better performance up to a point, but will top out at 10 records per second.

4.4.1.4 Record ON

Indicates whether DataMaster is in Record mode or Monitor mode. Also indicated on the Record On/Off button.

4.4.1.5 Waiting

Shows if DataMaster is waiting to receive data from the PCM. This occurs if the PCM is busy and can't respond to DataMaster. When first connecting to the PCM, it is not uncommon to have several waiting counts while DataMaster and the PCM negotiate for control.

4.4.1.6 File Path

Shows the current file name and path for the current data collection session.

4.4.1.7 Data Mode

Indicates the data type which is being collected. Will read either Engine, Transmission, ALT: Engine or ALT: Trans. The **ALT** indicates that the Alternate mode has been selected, and data collection mode will automatically switch between Engine and Transmission.

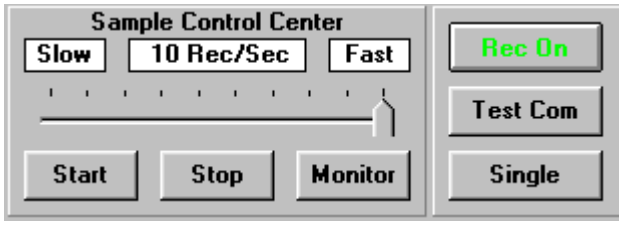
4.4.1.8 Comments

Enter comments you want recorded in the data file PRIOR to beginning data collection. If you are in the file append mode, any changes made to the comments will be lost; the original comments are retained. The current versions of DataMaster limits comments to 64 characters total. Comments are written to disk after the first 100 records have been collected, or if File--Save Now is selected, whichever occurs first.

TIP: Starting with DataMaster version 3.5, comments may be edited during playback. Refer to the ***Edit Comments*** Form.

4.5 The Sample Control Center

The sample control adjusts how fast data is requested, and if data is monitored or actually recorded to disk.



The Sample Control Center

4.5.1 The Sample Control Items

4.5.1.1 Sample Speed

The sample speed is controlled by moving the slider control between slow and fast. The selected sample rate is displayed in the label immediately above the slider control. During data collection, the actual sample rate is displayed in the status bar. Generally, the actual rate will be somewhat lower than the selected rate due to the speed of the PC and other factors. The minimum sample rate is 1 record per second, and the fastest rate is 10 records per second. The default setting is 10.

4.5.1.2 Start (Auto Sample)

The **Start** button starts the auto sample process running. When Sampling is first started, It may take several seconds while DataMaster monitors the bus and negotiates for control. During this time, you will see a message in the status bar indicating what's going on. When sampling begins, several other controls are disabled to prevent unintended program operation. After Auto Sample has started, it may be stopped at any time by pressing the **Stop** button.

4.5.1.3 Single Sample

The **Single** button initiates a single record interrogation of the PCM. The same interrogation process takes place as during Auto Sample mode, except only one sample will be taken.

4.5.1.4 Monitor Only

The **Monitor** button initiates data monitor mode. Data will not be recorded in this mode, but can be viewed real time on all active displays. No file needs to be open when monitoring data.

4.5.1.5 Stop

The **Stop** button is used to end the Auto Sample mode and return to an idle condition.

4.6 The Sample Command Buttons

There are up to 6 command buttons that support various PCM functions.

Only those modes supported by the particular DataMaster version will be visible.

The Sample Command Buttons

4.6.1 The Sample Command Items

4.6.1.1 Record On

This controls whether DataMaster is recording data or just monitoring the PCM. Pressing this button will toggle between these two modes. Note that when switching from record Off to Record On, if Record Memory On is selected (in the Options menu), the last 50 records that were monitored will be saved in the disk file. This allows capturing an event that you just noticed during a long monitoring run.

4.6.1.2 Test Com

This command checks out the connection to the PCM by sending a test command. The results are reported back in a message box as follows:

- **No Errors:** Com Test Successful, Normal operation
- **Error 0:** The COM link is dead. Generally caused if the adapter is not plugged into the computer, the wrong COM port is selected, or the COM port is bad.
- **Error 1:** The COM port is good and can talk to the adapter, but no PCM was detected. Generally caused by a bad connection between the adapter and the DLC, or if the ignition is turned off.
- **Error 2:** An unexpected response was received from the PCM. This can be caused by a noisy connection or if the wrong version of DataMaster is being used for the vehicle being tested
- **Error 3:** An unknown polling message was detected. Generally caused by the wrong version of DataMaster for the application.
- **Error 4:** DataMaster was unable to send a request for control of the ALDL bus.
- **Error 5:** DataMaster Timed out while taking control of the ALDL bus.
- **Error 6:** DataMaster detected the PCM and requested control of the ALDL bus, but did not receive the expected response. This message is generated if there are bus timing problems while connecting (Typically seen when a USB adapter is used). May also occur on Corvettes if there are problems with the CCM computer.

4.6.1.3 Clear Engine MALF's (DTC Errors)

If supported by your PCM, the **Clear EMALF** button will be displayed. When this button is pressed, a command is sent to the PCM to reset any engine related MALF codes that may have been set. Within a few seconds, the command should take effect and the results will be seen on the DTC form if active.

4.6.1.4 Clear Transmission MALF's (DTC Errors)

If supported by your PCM, the **Clear TMALF** button will be displayed. When this button is pressed, a command is sent to the PCM to reset any transmission related MALF codes that may have been set. Within a few seconds, the command should take effect and the results will be seen on the DTC forms.

In many cases, transmission MALF's are displayed on the Engine DTC form. Additional transmission MALFS may be available by viewing the transmission DTC form (accessed from the Transmission Data Display). Which MALF's appear on which forms are very dependent on the particular vehicle being tested.

4.6.1.5 Get VIN

If supported by your PCM, the Get VIN button will be displayed. When this button is pressed, the PCM responds with the 17-digit VIN which has been programmed into the PCM. A message box is presented with the VIN for examination. Press **OK** to close the message box; the VIN will be automatically appended to the comments text box, or press **Cancel** to exit without saving the VIN information.

NOTE: If you want the VIN to become a permanent part of the file record, you must perform this operation prior at the beginning of data collection, as the comment is only written to disk one time after 100 records have been recorded or if the ***File- Save Now*** menu item is selected, whichever comes first!

Get VIN Dialog Box

4.7 Keyboard Control of ALDL Data Acquisition

This feature fully automates the data collection process and eliminates the need to use a mouse when recording data.

When in AutoLog mode, a sequentially numbered file is automatically created and saved in the /AUTOLOG directory. There is no need to type in any file names. Each AutoLog session will create a new file and not overwrite any data until you get to 999 files, at which point is will begin overwriting file 999 each session. At this point, you must either delete the old AutoLog files, or move them to an archive directory so DataMaster has space to start over.

To enable the AutoLog mode, select the ***Options- AutoLogging Activated*** menu item from the Serial Data Acquisition form. Once enabled, pressing the SPACE bar will immediately start datalogging. To stop logging, simply press the ESC key. To turn Recording off, press the "P" (pause) key. When paused, the data display will continue, but data will not be saved. To resume recording, press the SPACE bar again. To exit back to playback, press the "Q" (Quit) key.

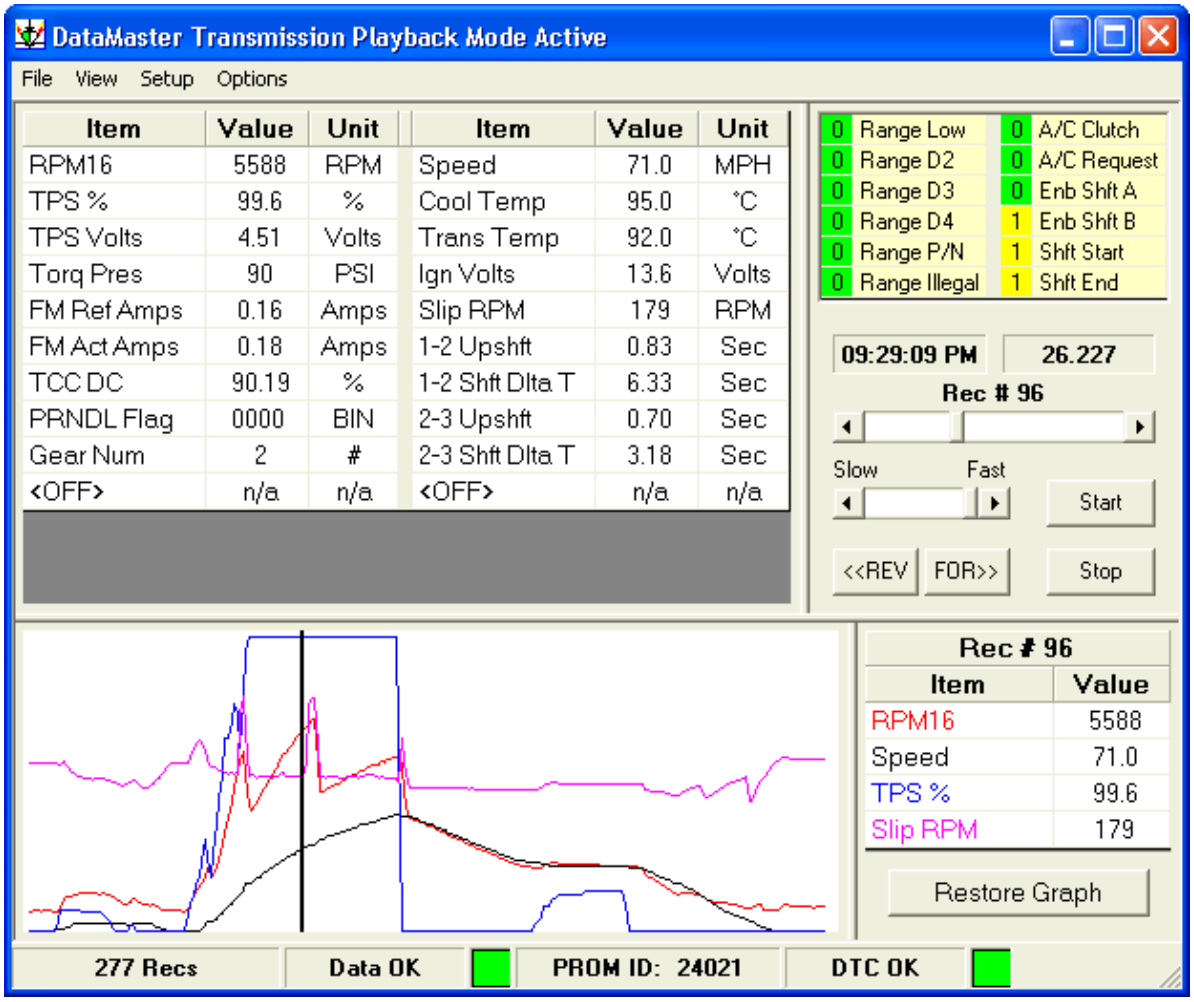
Once enabled, AutoLog mode remains active for all future DataMaster sessions until the user turns it off.

Keystroke	**Function**
Space Bar	Start - Stop Autologging
ESC	Stop Autologging
P	Pause Autologging
Q	Quit Autologging, Saves File

5 The Transmission Data Display

5.1 Introduction

The transmission display is only available for those vehicles which support a transmission data mode, which in general are Trucks and 1994-up F- and Y-Cars. These vehicles are equipped with the 4L60E or 4L80E electronically controlled transmission.



The Transmission Display Form

The transmission display has been revised to allow resizing by pulling on the form's edge. The display is divided into 4 panels which are individually sized by moving the divider bars. All data and bit items can be reassigned to build a display that fits your needs.

5.2 The Transmission Setup Menu Items:

5.2.1 Setting the Transmission Display Units

The display units are selected from the **main** form ***Setup-Display Units*** menu. This affects units used throughout the program.

5.2.2 Setting the Vehicle Type

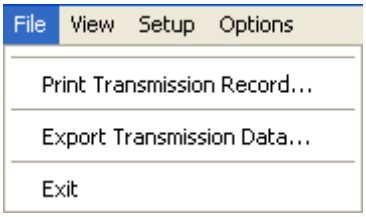
Vehicle type is selected from the **main** form, and must be selected correctly as this may effect some of the data items displayed in the transmission display Use the ***Setup-Vehicle Type*** menu selection to make any changes.

5.3 Differences Between the Engine and Transmission Display

The transmission data is based on a totally separate information stream than the engine data. This data is focused on transmission functionality, and thus most engine information is not available to view on this form. For this reason, the "Alternate Engine and Transmission" data option was built into DataMaster which allows collecting closely interleaved records form both the Engine and transmission. By viewing both sets of data collected at the same time, one can diagnose issues which are due to the interaction between the engine and transmission.

5.3.1 File Menu Differences

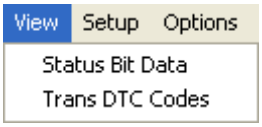
The Transmission ***File*** menu only supports Printing and exporting of data. Files must be opened from the Main Engine display form.



The Transmission File Menu

5.3.2 View Menu Differences

The transmission ***View*** menu only supports DTC codes and Status Bit information forms.



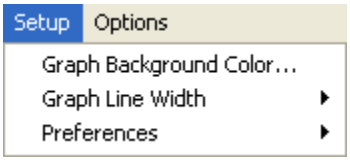
The Transmission View Menu

5.3.3 Setup Menu Differences

The Transmission ***Setup*** menu only supports graph background color and line width, and the Preferences (Beep on DTC, Tool Tips) selections.

The graph plot colors are assigned by clicking on the item in the 'Snapshot' display.

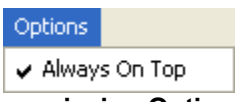
Vehicle Type, Screen Size, and Display Units must be setup from the Main Engine display form.



The Transmission Setup Menu

5.3.4 The Options Menu

The Options menu on the transmission form is used to control the "Always On Top" function of the form.



The Transmission Options Menu

5.4 The Transmission Status Bar Display

The Transmission Status Display is at the bottom of the form, and shows the file record count, the Data OK status, the PROM ID, and the DTC status.

The Transmission Status Bar

5.4.1 Transmission Status Display Items

5.4.1.1 Records

Indicates how many Transmission data records were recorded in this file.

5.4.1.2 Data OK

The Data OK display shows if the transmission data record contains any data errors (checksum error). If this turns red and shows **Data Err**, that particular record is bad and should not be trusted! This can occasionally occur during data collection if there is noise on the ALDL data link, or if a data transmission is interrupted. See also: Errors in Recorded Data

5.4.1.3 PROM ID

This indicates the PCM internal EPROM ID #. This is identifies the exact version of EPROM code that the PCM is using. This is not used by all vehicle types, so this item may not be present in your display.

5.4.1.4 DTC OK

This display shows if there is a transmission Diagnostic Trouble Code set. Will turn red on any record that contains a DTC, instantly flagging a DTC error. Click on the panel to display the DTC information form.

5.5 The Transmission Data Display

The Transmission display now shows data that was previously on the status bar. Note that each of these items may be reassigned by double-clicking on the item to be changed.

Item	Value	Unit	Item	Value	Unit
RPM16	5588	RPM	Speed	71.0	MPH
TPS %	99.6	%	Cool Temp	95.0	°C
TPS Volts	4.51	Volts	Trans Temp	92.0	°C
Torq Pres	90	PSI	Ign Volts	13.6	Volts
FM Ref Amps	0.16	Amps	Slip RPM	179	RPM
FM Act Amps	0.18	Amps	1-2 Upshft	0.83	Sec
TCC DC	90.19	%	1-2 Shft Dlta T	6.33	Sec
PRNDL Flag	0000	BIN	2-3 Upshft	0.70	Sec
Gear Num	2	#	2-3 Shft Dlta T	3.18	Sec
<OFF>	n/a	n/a	<OFF>	n/a	n/a

The Transmission Data Display

5.5.1 The Transmission Data Items

5.5.1.1 RPM16

This is a high-resolution engine RPM value the PCM uses for transmission calculations. The accuracy is to within 1 RPM.

5.5.1.2 TPS %

Shows the percent throttle opening. This is calculated by the PCM and will be a value 0 to 100%. Same as used for the Engine Data Form.

5.5.1.3 TPS Volts

This shows the voltage measured from the Throttle Position Sensor. Will generally range from 0.5 Volts (throttle closed) to 4.5 Volts (throttle fully open). Same as used for the Engine Data Form.

5.5.1.4 Torque Pressure

This value is the current torque signal pressure within the transmission.

5.5.1.5 Force Motor (FM) Reference Amps

This is the commanded current to the Pressure Control Solenoid (PCS) circuit and will have a value between 0 and 1.1 Amps. A value of zero indicates commanded higher line pressure; a value of 1.1 indicates a commanded lower line pressure.

5.5.1.6 Force Motor (FM) Actual Amps

This is the actual current to the Pressure Control Solenoid (PCS) circuit and will have a value between 0 and 1.1 Amps. A value of zero indicates actual higher line pressure; a value of 1.1 indicates a actual lower line pressure.

5.5.1.7 TCC Duty Cycle

This is the duty cycle of the torque converter lock-up solenoid, and typically ranges from 0 to 90%.

5.5.1.8 PRNDL Flag
Indicates the position of the gear select lever.

5.5.1.9 Gear Number
Indicates the current gear the transmission is in.

5.5.1.10 Speed, MPH/KPH
Indicates the current speed of the vehicle.

5.5.1.11 Cool Temp
The engine coolant temperature in °C or °F

5.5.1.12 Trans Temp
The transmission fluid temperature °C or °F

5.5.1.13 Ign Volts
The ignition / battery voltage.

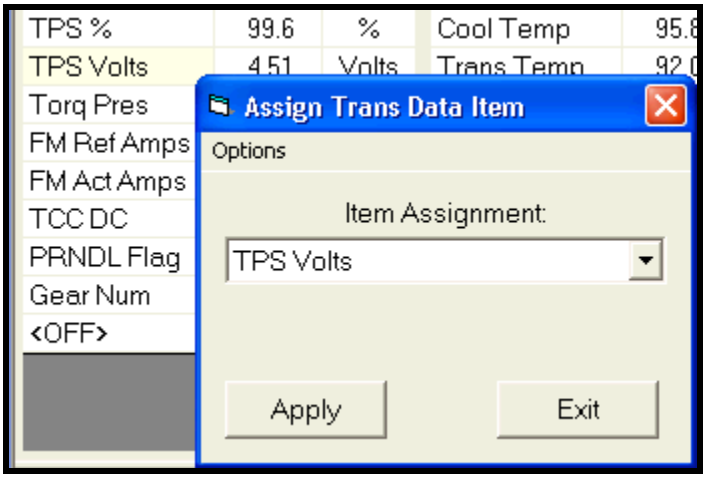
Slip RPM
Indicates the difference between the transmission input speed (at the engine) and the transmission output speed (at the output shaft). A negative value indicates that the input speed is less than the output speed (deceleration); a positive value indicates that the input speed is greater than the output speed (acceleration). A value of zero indicates input speed equals output speed (the torque converter is locked).

5.5.1.14 1-2 Upshift
This is the time duration of the last 1-2 upshift in seconds

5.5.1.15 2-3 Upshift
This is the time duration of the last 2-3 upshift in seconds

5.5.2 Assigning Transmission Data Items
Each data item on the transmission display can be reassigned by double clicking on the item name. This will bring up the Data Item Assignment list. Choose the new item you want to show and click ***Apply*** to make the change.

Once the assignment form is open, you can single click on any other item to change it. Once all items have been assigned, click ***Exit*** to return to playback mode. The assignments you made will be saved when you exit DataMaster.

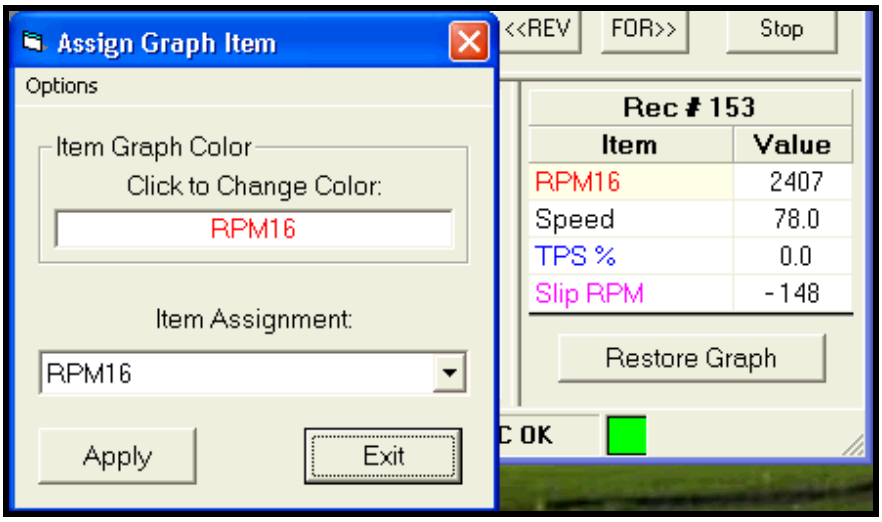


The Transmission Data Item Assignment

5.5.3 Assigning Transmission Graph Items

Each item and color on the transmission graph can be reassigned by double clicking on the item name. This will bring up the Data Item Assignment list. Choose the new item you want to show and click ***Apply*** to make the change.

Once the assignment form is open, you can single click on any other graph item to change it. Once all items have been assigned, click ***Exit*** to return to playback mode. The assignments you made will be saved when you exit DataMaster.

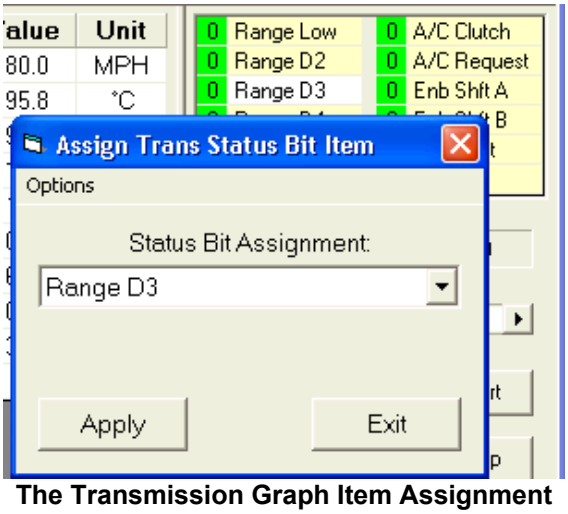


The Transmission Graph Item Assignment

5.5.4 Assigning Transmission Status Bit Items

Each status bit item can be reassigned by double clicking on the item name. This will bring up the Data Item Assignment list. Choose the new item you want to show and click ***Apply*** to make the change.

Once the assignment form is open, you can single click on any other status bit item to change it. Once all items have been assigned, click ***Exit*** to return to playback mode. The assignments you made will be saved when you exit DataMaster.



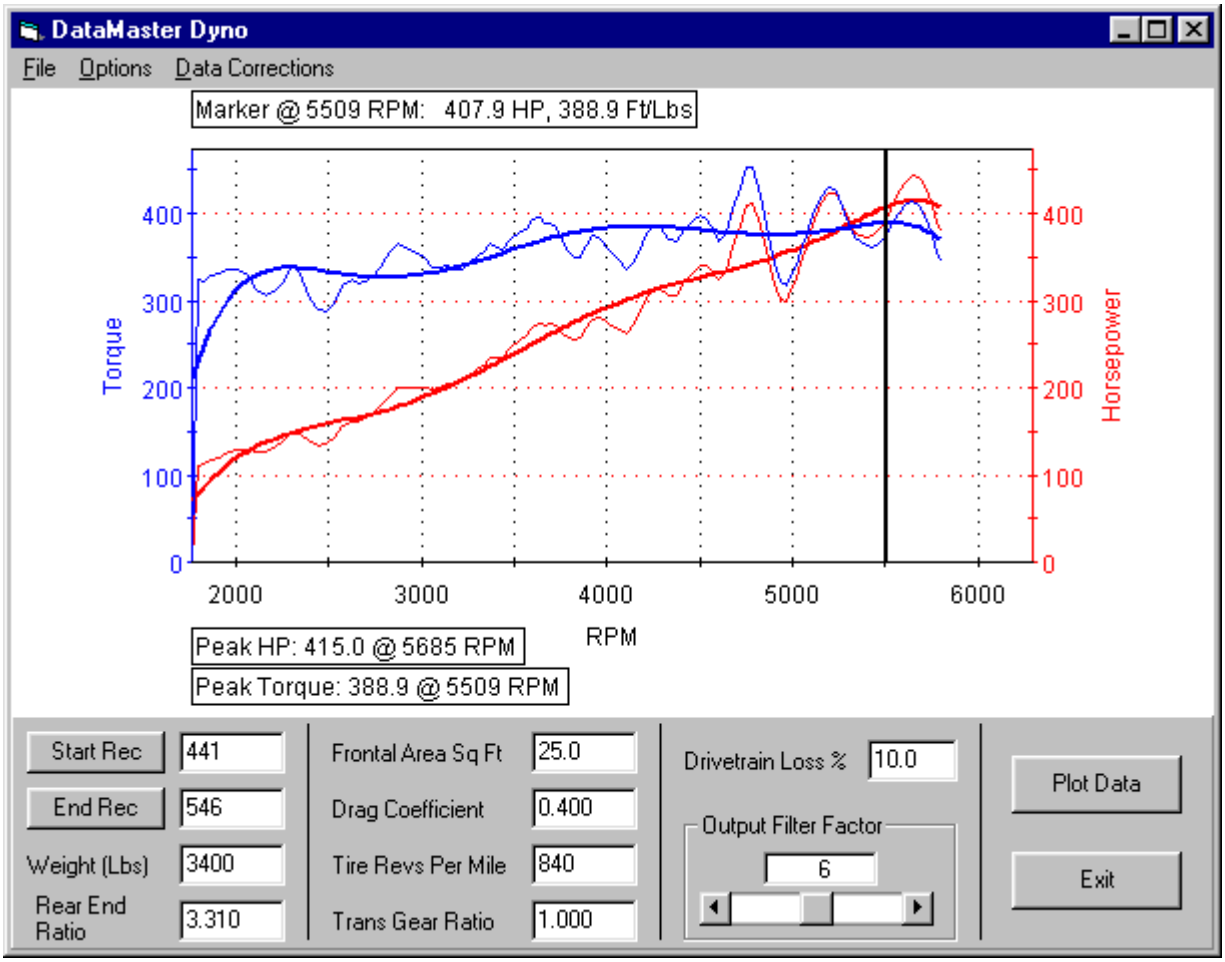
The Transmission Graph Item Assignment

6 The Dynamometer Display

6.1 Introduction

DataMaster Dyno uses PCM data collected during a vehicle test run to calculate horsepower and torque at the engine. It does this by measuring speed, time and engine RPM as the vehicle accelerates. Collecting good data to analyze is the key to getting realistic results. Good driving technique is the **critical** factor. To get best results, the vehicle should be accelerated in a fixed gear at full throttle through the broadest RPM range possible.

6.1.1



The Main Dynamometer Display Form

6.2 Setting up the Dyno

There are several items that must be set up correctly in order to obtain good results form the Dyno calculations. These are:

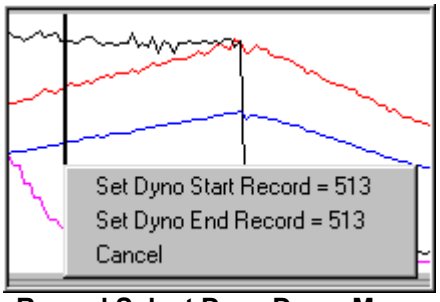
- The Start and End record to use for the calculation
- The Data Correction options
- The Vehicle related test information

6.2.1 Selecting the Start and End record

The start and end record define the range over which the data is evaluated for the Dyno calculations. This range is selected from the main graph by choosing two points which correspond to the beginning and end of a acceleration test run ***in a single gear***. This is best located by zooming into the graph to identify the area of interest, then identify a starting RPM and ending RPM that cover a wide range in a single gear.

By default, when the Dyno form is first opened the beginning and end record will always be set to the current cursor position on the playback form. To change the setting, you may either enter a new value in the box or set the engine display to the desired record and press the ***Start Rec*** button. The end record is set in the same manner using the ***End Rec*** button.

TIP: When the Dyno Form is active, the Start and End records may be directly set from the main form by double-clicking on the desired location in the graph. A 'drop down' menu will appear and allow you to directly apply the current location to the Start or End record.



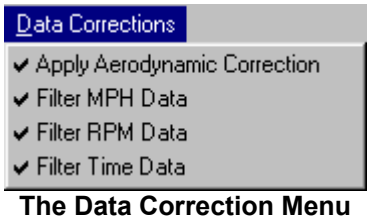
Record Select Drop-Down Menu

Note that the Dyno program end record must always be greater than or equal the begin record. If set to a smaller number the program will automatically change this to equal the starting record.

6.2.2 The Data Correction Items

There are four correction factors that can be applied to the Dyno Data during the calculation:

- Apply Aerodynamic Correction
- Filter MPH Data
- Filter RPM Data
- Filter Time Data



The Data Correction Menu

6.2.2.1 Aerodynamic Correction

The Aerodynamic Correction corrects the calculation for the wind resistance of the vehicle. For motorcycles, is very significant, and should be applied unless the data was collected on a chassis dyno.

6.2.2.2 Filter MPH Data

The Filter MPH Data correction applies weighted average smoothing to the recorded MPH (speed) data and helps make the calculation more consistent. It is recommended to leave this in the default enabled setting

6.2.2.3 Filter RPM Data

The Filter RPM Data correction applies weighted average smoothing to the recorded RPM values and helps make the calculation more consistent. It is recommended to leave this in the default enabled setting

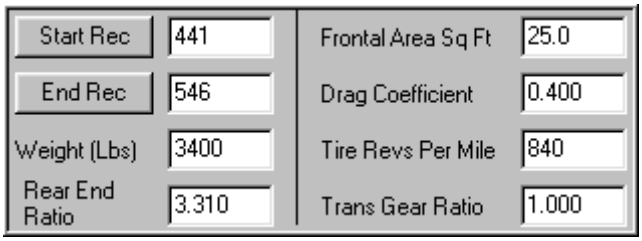
6.2.2.4 Filter Time Data

The Filter Time Data correction applies weighted average smoothing to the recorded data time stamps and helps make the calculation more consistent. It is recommended to leave this in the default enabled setting

6.3 Vehicle Related Test Information

Correct vehicle weight, aerodynamic and gearing information is critical to calculating the engine horsepower and torque. This information is entered on the bottom of the Dyno form and includes:

- Vehicle Test Weight (Pounds)
- Frontal Area
- Drag Coefficient
- Tire revs per mile
- Trans Gear Ratio
- Rear End Ratio
- Drivetrain Loss



Dyno Setup Information

6.3.1 Vehicle Test Weight

Enter the weight of the vehicle as tested in this box. Units are Pounds. The resultant weight is used to calculate the force necessary to accelerate the vehicle. Weight is also used to compensate for the rolling resistance correction.

6.3.2 Frontal Area and Cd

Enter the vehicle frontal area in square feet and the drag coefficient (Cd) in these boxes. For many cars, the frontal area is roughly 25 square feet, and the Cd is in the 0.35 to 0.50 range. Note that a Cd value of zero (0.00) means that the vehicle has no air resistance, while a Cd of 1.00 means the vehicle has the maximum possible air resistance.

Note these values are only applied if the ***Aero Correction*** option is selected from the ***Data Corrections*** drop-down menu.

6.3.3 Gearing

There are several items required to calculate the overall gearing of the vehicle:

- Tire Revs per mile
- Trans Gear Ratio
- Rear End Ratio
- Drivetrain Loss

6.3.3.1 Tire Revs per Mile:

Enter your tire revolutions per mile in this box. Typical values will be in the range of 800 to 1000, but you must consult the tire manufacturer for the exact value. The default setting is 815. Refer to: Typical Tire Revolutions per Mile

6.3.3.2 Trans Gear Ratio:

Enter the transmission gear ratio in effect when for this particular dyno recording. The default stock gear ratio may be set using the gear selection drop-down box. Alternately, you may type the value directly into the box if you are not using stock ratios. See Also: Common Transmission Gear Ratios

6.3.3.3 Rear End Ratio:

Enter the rear end drive ratio for the vehicle. Refer to: Standard GM Axle Gear Ratios

6.3.3.4 Drivetrain Loss:

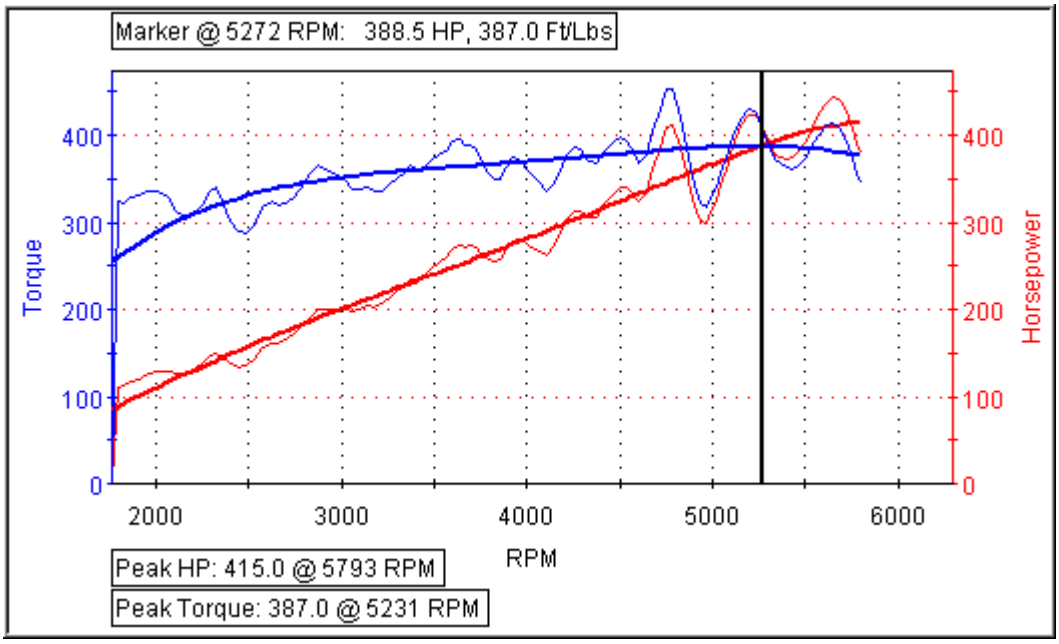
Drivetrain loss represents how much power is lost between the engine and the driven wheel due to friction. 10 percent is a typical value for this and gives good results.

6.4 Plotting and Printing the Dyno Data

After the dyno has been set-up and the vehicle information entered, press the ***Plot Data*** button to calculate and plot the horsepower and torque. Note that the data must be replotted after any setup changes are made.

6.4.1 Finding the horsepower and torque at a given point

By clicking in the plot area, a marker line will be drawn at the closest datapoint to the mouse. The horsepower and torque at the point will be displayed in the label just above the graph.

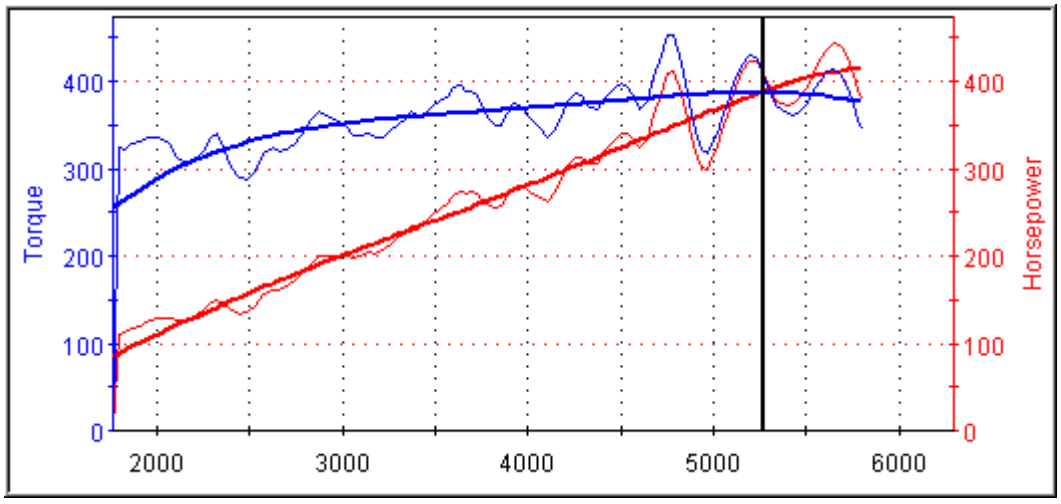


The Dyno Data Marker

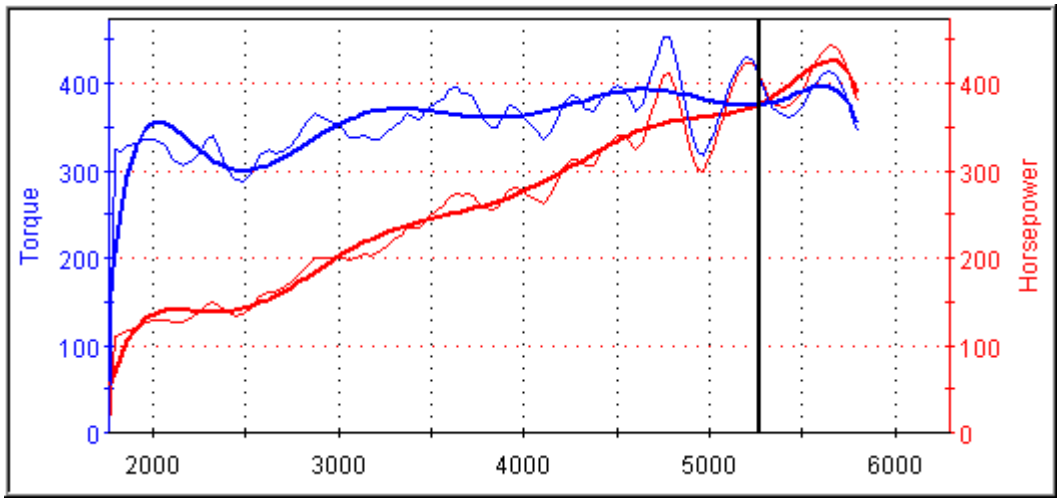
6.4.2 Adjusting the data fit and smoothing

Adjust the output "trendline" fit by setting the ***Graph Smoothing*** to a value from 2 to 10. This is used to compute a polynomial fit of the "raw" Horsepower and Torque data. Note that the higher the graph smoothing number, the closer the plot matches the 'raw' data and the more shape the curve will have. The default setting of 4 gives a good overall match of most data.

Example: Here is a dataset plotted with a smoothing factor set at 4:



And here is the identical data plotted with the smoothing factor set at 6. Note additional shape to the curve as the curve fitting routine fits the plot more closely to the actual data:

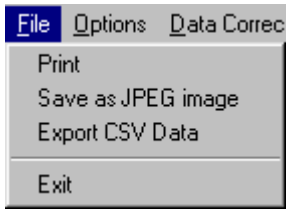


TIP: Some input data will cause problems with the trendline calculation; for difficult cases, try experimenting with the starting and ending record positions, this can make the fit much better.

6.4.3 Printing the Dyno Data

There are several options for printing and saving the Dyno Data:

- Print the graph to a printer
- Save the plot as a JPEG image
- Export the calculation data



6.4.3.1 Print the graph to a printer

Select the Print option to bring up the standard Data Mode print preview form; you may make changes to the printer set-up from here. Note that the Dyno set-up information is included with the printout.

6.4.3.2 Save the plot as a JPEG image

This will save a JPEG formatted image of just the Dyno plot to a file. No setup information is included with the image.

6.4.3.3 Export the calculation data

This exports all the raw, calculated, and filtered data to a Comma Separated Value (CSV) File. All setup data is included. This allows the user to perform their own analysis of the data.

6.5 Dyno Calculation Method

6.5.1 Theory

Engine horsepower and torque are calculated by measuring the vehicle acceleration. By knowing the vehicle weight, the force to cause this acceleration can be calculated. Correction is made for aerodynamic and rolling resistance. Vehicle gearing (which includes transmission, rear end and tire diameter) are then used to convert force at the vehicle to the torque at the engine. Finally, drivetrain loss is applied to give the actual torque supplied by the engine. Horsepower can then be calculated based on the engine RPM and torque.

6.5.1.1 Force to Accelerate Vehicle

Accel = vehicle acceleration in feet per sec^2
W = Vehicle weight in pounds
Rmi = tire revs per mile
gear = overall gearing
TQmult = 840.33 / (gear * Rmi) Torque multiplier via gear and tire diameter
Tscale = TQmult * (W / 32.1741) Overall Torque Scale factor, weight to mass (Slugs)
Engine Torque = Accel * Tscale

6.5.1.2 Aerodynamic and Rolling Resistance Correction

(Only applied if option box checked)
Fa (drag force in pounds force) = q * A * Cd
q (dynamic pressure Lb/Ft^2) = .00256 * V^2 at STP
V = velocity in MPH
Fr = (rolling resistance in pounds force) = (W * Cf) + (W * Cv * V)
Cf = 0.015
Cv = .0001
Aero Corrected Engine Torque = Engine Torque + (Fa + Fr) * TQmult

6.5.1.3 Drivetrain Loss Correction

Loss = percentage drivetrain loss
Drivetrain Corrected Engine torque = Engine Torque / (1 - (0.01 * Loss))

6.5.1.4 Horsepower Calculation

HP = (Torque * RPM) / 5252

6.6 Common Transmission Gear Ratios

6.6.1 4L60E, 700R4

Gear Select	Ratio
1	3.06
2	1.63
3	1.00
4 (OD)	0.70

6.6.2 Borg-Warner T-5 (F-Body V-8)

Gear Select	Ratio
1	2.95
2	1.94
3	1.34
4	1.00
5 (OD)	0.74
5 (OD)	(0.63 some)

6.6.3 ZF 6-Speed (Corvette)

Gear Select	Ratio
1	2.68
2	1.80
3	1.31
4	1.00
5 (OD)	0.75
6 (OD)	0.50

6.6.4 Borg-Warner 6-Speed (1993 F-Body standard)

Gear Select	Ratio
1	3.36
2	2.07
3	1.35
4	1.00
5 (OD)	0.80
6 (OD)	0.62

6.6.5

6.6.6 Borg-Warner 6-Speed (1993 F-Body Close Ratio G92)

Gear Select	Ratio
1	2.97
2	2.07
3	1.43
4	1.00
5 (OD)	0.80
6 (OD)	0.62

6.7 Standard GM Axle Gear Ratios

GM RPO numbers

Z28/Formula/TA	Corvette	Impala, Caprice
2.73 -GU2	2.59 -GM1	2.56 - GM8
3.08 -GU4	3.07 -G44	2.93 -GW9
3.23 -GU5	3.45 -GM3	3.08 -GU4
3.42 -GU6		3.23 -GU5

6.8 Typical Tire Revs per Mile

Several common performance tire sizes are listed here to provide approximate tire revolutions per mile values for the DataMaster Dyno tool. Refer to http://www.nittotire.com/ for the latest information.

- 60 Series Profile NT460
- 35 - 55 Series Profile NT450
- 35 - 45 Series Profile NT555
- Drag Radial NT555R

6.8.1.1 NITTO NT460

Tire Size	Revs/ Mile	Static Radius	Static Width	Dynamic Radius
P185/60R13	956	9.92	7.91	10.55
P185/60R14	912	10.43	7.91	11.06
P195/60R14	896	10.59	8.43	11.26
P205/60R14	877	10.79	8.66	11.50
P195/60R15	857	11.10	8.43	11.77
P205/60R15	843	11.26	8.66	11.97
P215/60R15	824	11.50	9.17	12.24
P225/60R15	808	11.65	9.61	12.48
P215/60R16	793	11.97	9.17	12.72
P225/60R16	779	12.17	9.61	12.95

6.8.1.2 NITTO NT450

Tire Size	Revs/ Mile	Static Radius	Static Width	Dynamic Radius
P205/55R15	871	10.94	8.98	11.57
P195/50R15	912	10.51	8.19	11.06
P205/50R15	902	10.63	8.90	11.18
P225/50R15	871	10.94	9.45	11.57
P205/55R16	834	11.46	8.98	12.09
P215/55R16	821	11.61	9.29	12.28
P225/55R16	811	11.77	9.65	12.44
P235/55R16	795	11.97	10.20	12.68
205/50R16	865	11.14	8.90	11.65
P225/50R16	837	11.46	9.57	12.05
P245/50R16	811	11.73	10.20	12.44
205/45R16	896	10.79	8.78	11.26
205/40R16	925	10.51	8.82	10.91
215/40R16	912	10.63	9.13	11.06
225/50R17	800	12.01	9.53	12.60
255/50R17	767	12.44	10.75	13.15
275/50R17	745	12.76	11.81	13.54
215/45ZR17	845	11.46	8.98	11.93
225/45ZR17	834	11.57	9.49	12.09
205/40ZR17	886	11.02	8.90	11.38
215/40ZR17	874	11.14	9.13	11.54
235/40ZR17	851	11.38	10.35	11.85
215/35ZR18	868	11.30	8.94	11.61

6.8.1.3 NITTO NT555

Tire Size	Revs/ Mile	Static Radius	Static Width	Dynamic Radius
205/45ZR16	899	10.79	8.82	11.22
235/45ZR17	821	11.73	9.88	12.28
P245/45ZR17	811	11.89	10.20	12.44
P255/45ZR17	800	12.01	10.67	12.60
205/40ZR17	884	11.06	9.10	11.41
225/40ZR17	862	11.26	9.57	11.69
255/40ZR17	829	11.65	10.75	12.17
P285/40ZR17	800	12.01	12.05	12.60
225/40ZR18	829	11.73	9.57	12.17
235/40ZR18	821	11.85	10.00	12.28
245/40ZR18	811	12.01	10.31	12.44
P275/40ZR18	781	12.36	11.57	12.91
255/35ZR18	829	11.77	10.67	12.17
265/35ZR18	821	11.85	11.10	12.28
275/35ZR18	812	11.98	11.56	12.42
285/35ZR18	800	12.09	11.97	12.60

6.8.1.4 NITTO NT555R Extreme Drag

Tire Size	Revs/ Mile	Static Radius	Static Width	Dynamic Radius
205/55R14	908	10.43	8.90	11.10
275/50R15	808	11.68	11.77	12.48
205/45R15	938	10.28	8.66	10.75
225/50R16	834	11.46	9.57	12.09
245/50R16	811	11.77	10.39	12.44
205/45R16	899	10.79	8.66	11.22
275/40ZR17	811	11.85	11.57	12.44

7 When Things Go Wrong

This section addresses some of the most common problems that occur when using DataMaster.

7.1 Communication Problems

Here are a few tips of what to look for if DataMaster is having difficulty communicating with your vehicle.

7.1.1 Problems Linking to the Vehicle

When DataMaster has problems establishing the connection to the vehicle, if a USB-based interface is being used, first make sure the following two items are set correctly:

1. The ***Options-Advanced-USB Interface in Use*** option must be selected on the Serial Data Acquisition form.
2. The USB driver "latency" setting **MUST** be set to 1 mS (see the following section on USB COM port configuration)

Some vehicle models have critical timing requirements for linking up and have difficulty establishing their initial connection. This includes the following vehicles:

- Corvettes, 1990 through 1995 (L98, LT1, ZR1)
- F-body and B-body cars, 1994 – 1995 (LT1)
- Syclone / Typhoon trucks, 1991-1993 (Turbo)

The symptom of this problem is that when connecting to the vehicle, pressing the "Test Com" button gives the response that "Test Com Passed, PCM Detected". However, when "Start" or "Single" is pressed, an error occurs indicating "No PCM Sync, Recycling"… or "Unable to connect to PCM".

To solve this problem, the ALDL Link Timing must be adjusted using the following procedure:

Bring up the Serial Data Acquisition form and from the menu select the Options-Advanced-Serial Communication Timing… item. This will bring up the Setup Serial Communication Timing form, and allow you to make adjustments to the ALDL Link Timing, the right-most slider control.

By default, the ALDL Link Timing value is set to "0". This specifies the delay in mS from when the PCM ALDL Polling message is detected to when the computer responds with the link-up command. When the default value of "0" does not work, we need to increase the value to move to the link command timing up to the next poll message. The value required will be slightly different for different PC's, but we have found the optimum range is usually between 190 and 205.

To establish the optimum setting, it is necessary to find both the lowest and highest values that work, and set the control to half-way between. TTS suggests starting at 195 and working up or down from this value to find these limits. Each time a change is made, press the OK button (which saves the change) and retry the connection by pressing the "Start" or "Single" button. Repeat the process until the upper and lower limits are found (generally a very narrow range of only 4 to 5), and set to the middle value. Note this can take 10-20 iterations to find the optimum setting!

7.1.2 Corvettes

Corvettes require a special data protocol when connecting with DataMaster due to the Central Control Module (CCM), which updates the dashboard and Heating/Ventilation (HVAC) systems.

If the CCM is not working correctly, or the vehicle has been modified to remove these components, it may be necessary to select the Options-Advanced-Disable ALDL Handshake and/or the Options-Advanced-Disable Dash Refresh in order to communicate and receive data. When first connecting using this method, it will not be uncommon to receive multiple DataMaster "Data Err" errors until a clear communication path has been established.

If the Dash Refresh is disabled, the dashboard will be frozen until data collection is stopped. This will result in the Service ASR light turning on until the vehicle ignition is cycled "OFF".

Also, during extended data collection periods, it is possible that the Service ASR light may be set. The light will be reset after cycling the vehicle ignition "OFF".

7.1.3 Early Corvettes (1989 and earlier)

Early Corvettes use different wiring of the ALDL connector that5 later GM vehicles, and require that **pins E and M** be connected together in order to communicate with DataMaster. Additionally, a 10K-ohm resistor **must** be connected ***between pins A and B.*** Refer to ALDL Connector Identification for help in locating these pins.

7.1.4 Manual Transmission Vehicles

Manual transmission vehicles do not support transmission data. Make sure that when recording data from manual transmission vehicles that the Data Mode menu is set to "Engine". Failure to do this may result in missed records, or DataMaster may report "Waiting" and never collect any data.

7.1.5 Errors in Recorded Data

Sometimes while recording ALDL data, "erratic" readings are noted on the display. If the "Data OK" indicator in the status bar turns RED and displays "**Data Err**" there is a checksum error in the data received from the PCM, generally due to electrical noise or a bad connection. If the indicator says "Data OK" then the information displayed is exactly what the PCM sent.

NOTE: A common source of **Data Err** is from poorly grounded after market ignition systems. All such devices should be carefully grounded to the chassis using a flat braided-metal ground strap, available from auto parts stores. Also, ignition manufacturers often sell a noise suppressor kit which will help solve this issue.

"Data OK" erratic readings can result from a bad or intermittent sensor; however there is another possibility that has been seen on the older design PCM's: When the PCM is busy running the engine, sometimes there is not enough CPU time left to correctly process the requests for ALDL data. In this case, the ALDL data is incompletely updated (it's not as important as running the motor), and can be a mix of old and new values, and in some cases this results in bogus readings that are way out of normal range! When this occurs it is quickly evident on the data graph, showing up as a "spike" in the data.

7.2 COM Port Selection

DataMaster communicate to the vehicle interface using the PCs serial COM port. These are called COM1, COM2 .... on up to COM255. DataMaster requires that the COM port number be assigned between COM1 and COM12.

7.2.1 Selecting Physical COM ports

Older laptops usually have one "physical" serial COM port (a 9-pin connector) on the back of the laptop. This is assigned to either COM1 or COM2 in the system BIOS setup. Consult the PC manufacturer for details on configuring the COM ports in the BIOS.

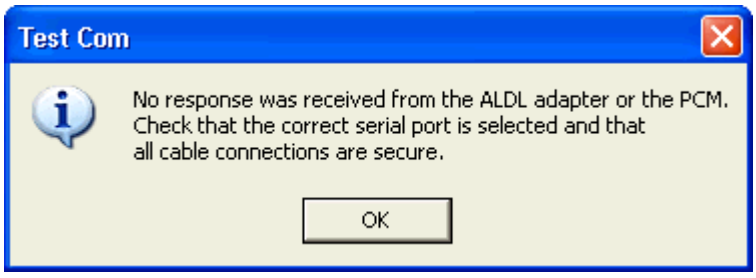
The COM port is selected from the DataMaster ***Serial Data Acquisition*** form.

Note that COM ports are also used by Bluetooth adaptors, infrared (IR) ports and occasionally graphics cards. For this reason, many available COM port selections may be shown in the drop-down menu.

In this example, the PC has 3 COM ports available: COM1, COM8, and COM11. COM1 (the physical COM port) is selected as shown by the check mark. If a COM port is not available on the PC, it will be grayed-out in the menu.

COM Port Assignment

If the wrong COM port is selected, DataMaster will be unable to communicate with the vehicle. This is checked by clicking the ***Test Com*** button. If the correct COM port is selected and the vehicle's ignition is on, information from the ECM will be displayed. If there is a problem, the following error message is shown:



No ECM Communication

If you get this message, the first thing to try is selecting the other COM port numbers and repeating the test. If none of them respond, and you are **not** using a USB serial adaptor then there is probably a problem with the cables or the COM port is not enabled in the BIOS. Configuring the COM port in the BIOS is beyond the scope of this section and the user should contact the PCs manufacturer or a computer repair shop for instructions on how to do this.

7.3 USB COM Port Configuration

Newer laptops have eliminated the physical COM port. For these systems, a USB to serial adaptor must be used. These adaptors come with their own drivers that must be installed on the system prior to use.

NOTICE:
TTS has found that most USB adaptors fail to operate correctly for recording ALDL data . For this reason, it is recommended that the TTS USB serial port adaptor be used, as this is extensively tested with all Windows versions.

NOTICE:
Always install the USB drivers prior to connecting the USB adaptor to the PC for this first time. This way, when the interface is first connected it will automatically be detected and will not prompt you for a driver installation disk.

The USB drivers for the TTS interface are included on the distribution CD, and are installed by selecting the Prerequisites and Drivers button. These can also be downloaded from the FTDI website at http://www.ftdichip.com/FTDrivers.htm. When downloading, select the VCP (Virtual Com Port) driver type.

7.3.1 Installing the TTS USB Driver:

There are two different sets of drivers supplied for the TTS interface depending on your OS. Windows 98 and ME use an older driver technology, and require a manual installation of the driver. Windows 2000, XP, Vista, and Win7 all use newer driver technology, and they are installed directly by pressing the USB Driver 2K / XP / Vista button.

Windows Driver Install

7.3.1.1 Windows 98 / ME Install:

The Windows 98 driver install process is described in a PDF document which is viewed by pressing the USB Driver Win 98 / ME button. Follow the instructions in section 2.2 for the FT245BM VCP device. This will require that you connect the USB interface to the computer and when prompted by the Add New Hardware wizard, browse to the TTS installation CD directory "D:\USB_Drivers\Windows_98SE_ME" and enter OK.

7.3.1.2 Windows 2000 / XP / Vista and Win7 Install:

To install the drivers for the later OS, insert the TTS installation CD and browse to the Prerequisites and Drivers page. Then, press the USB Driver 2K / XP / Vista button to invoke the install process. This will automatically install the drivers for all versions of these OS. Installation may take a minute or two to complete.

7.3.1.3 Windows 2000 / XP / Vista and Win7 Install Failure:

If the automatic driver installation fails for any reason, the drivers can be installed using the manual process similar to windows 98. In this case, connect the interface to the PC, and when prompted by the Add New Hardware wizard, browse to the TTS installation CD directory "D:\USB_Drivers\Windows_2000_XP_Vista\Unpacked-2.04.06" and enter OK. Follow the wizard prompts to complete the installation process. Note the version number may be newer than this example depending on when you received your CD!

7.3.1.4 Configuring the USB Driver:

DataMaster require the COM port be between COM1 and COM12. In some cases, it is necessary to reassign the COM port that the USB driver automatically selects. The following sections show how to do this using Device Manager.

7.3.2 Windows 2000 / XP Com Port Reassignment:

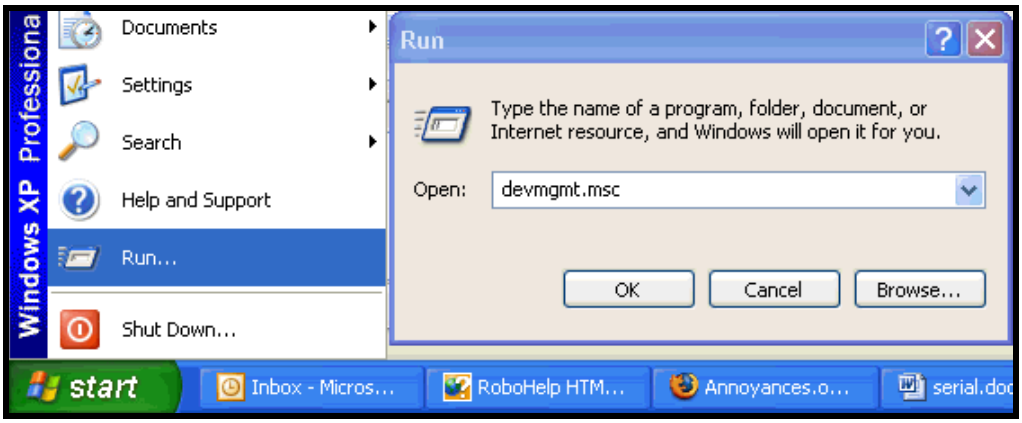
Notes:

- You must be logged in as an administrator to make changes with Device manager!
- The USB interface must be connected to the PC in order to perform the following configuration.

7.3.2.1 Invoking Device Manager:

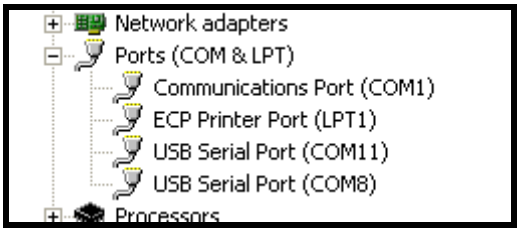
To launch device manager in Windows 2000 or XP, go to ***Start - Settings – Control Panel*** and click on the ***System*** icon. This will open the Systems Properties dialog. Select the "***Hardware***" tab and then press the "***Device Manager***" button.

Tip: A shortcut to access Device Manager is to open **devmgmt.msc** from the ***Start -Run dialog***:



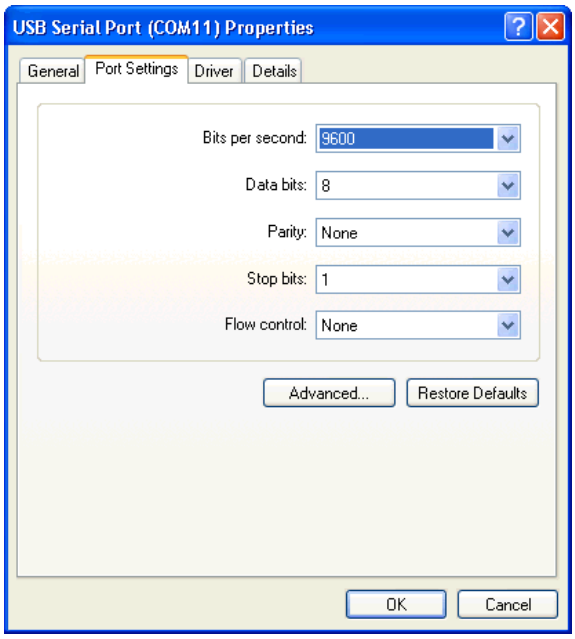
Invoking Device Manager

This will bring up the device manager dialog. Go to the section labeled "***Ports (COM & LPT)***" and press on the "+" symbol to view the port assignments:



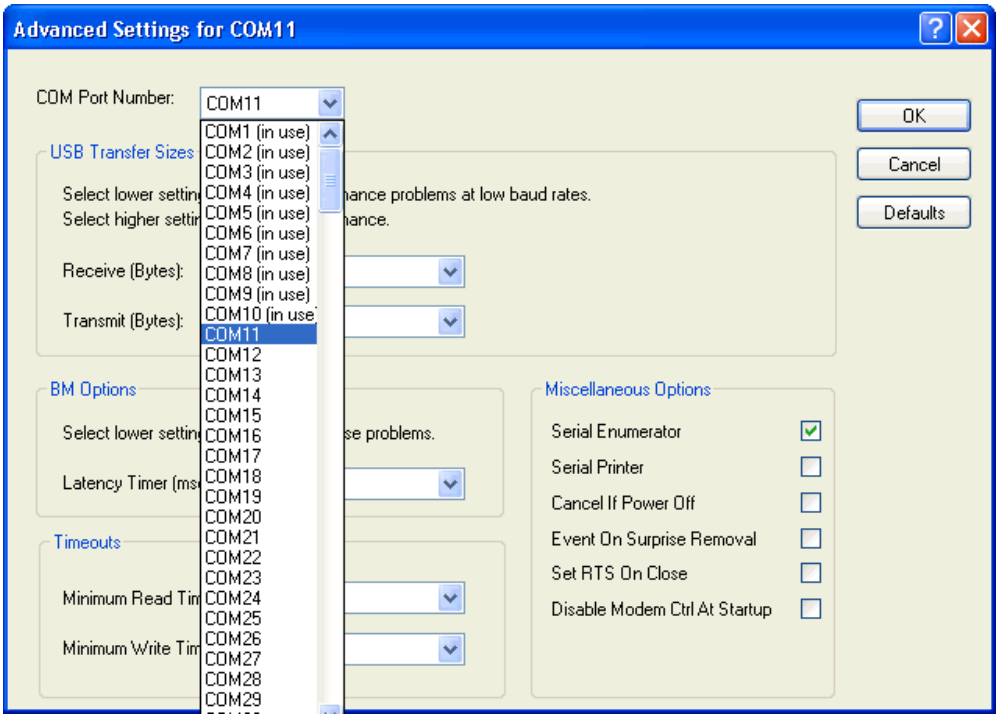
Windows XP Ports Display

To reassign the COM port number, double click on the USB Serial Port selection to be changed. This will bring up the driver configuration dialog:



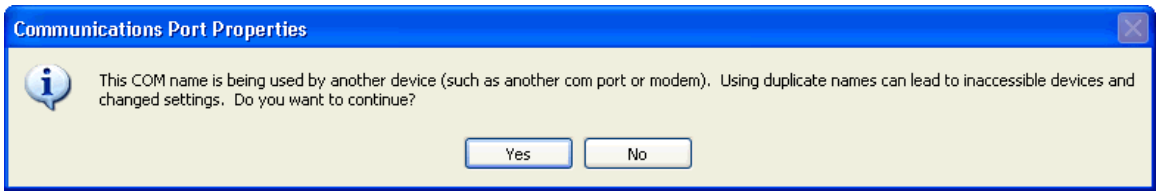
USB Driver Configuration Dialog

Select the Port Settings tab, then press the "Advanced" button: This will bring up the Advanced Port Settings dialog. In this example, note COM1 through COM10 are already "In Use" by other devices.



Advanced COM Settings

The TTS USB port must be assigned between **COM1** and **COM12**. If all these port assignments are already in use, (which often happens with wireless laptops), make a new selection between **COM5 and COM12** (COM1 - 4 are usually the Laptop hardware such as IR or Modem connections) - You will receive the following warning:



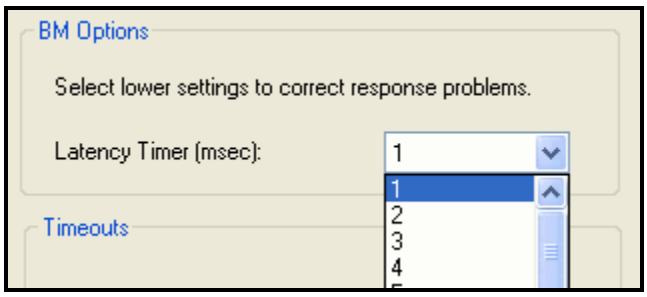
COM Name In Use Warning Dialog

Click "Yes" to accept the new assignment. This will generally not cause any problem - however the selection can be easily changed at a later time if necessary.

Make a note of the port number you selected, and select OK to apply the changes. When you open MasterTune or DataMaster and select the serial Com port, use this port number.

Note: Occasionally you will need to restart the PC in order for the COM port reassignment to become effective.

It is also necessary to set the “Latency Timeout” to 1 msec in the “BM Options” panel on the advanced setting form. This allows the interface to link-up much more consistently with the vehicle.



USB Latency Setting

7.3.3 Windows Vista / Win7 Com Port Reassignment:

Notes:

- You must be logged in as an administrator to make changes with Device manager!
- The USB interface must be connected to the PC in order to perform the following configuration.

7.3.3.1 Invoking Vista Device Manager:

The Windows Device Manager application must be used to configure the USB serial port connection. There are two ways to invoke device manager:

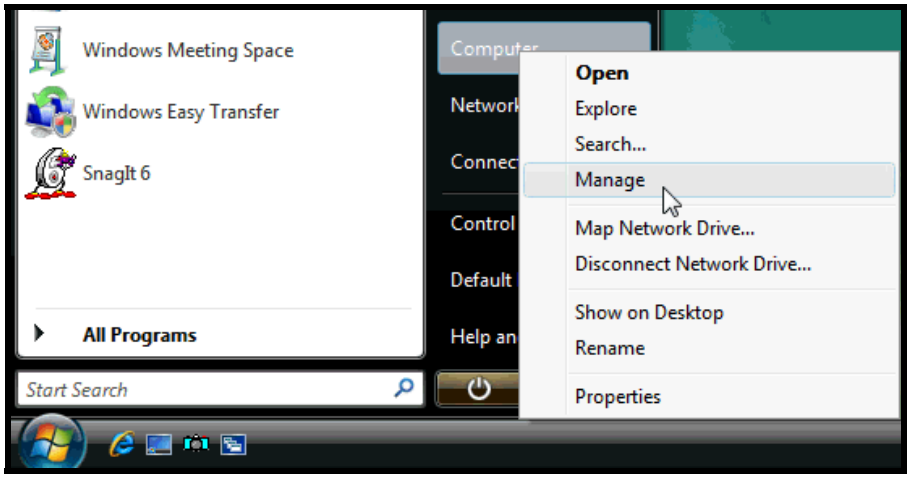
The Windows Device Manager application must be used to configure the USB serial port connection. There are two ways to invoke device manager:

Type **devmgmt.msc** into the windows Search box:

Invoking Vista Device Manager using Run

-OR-

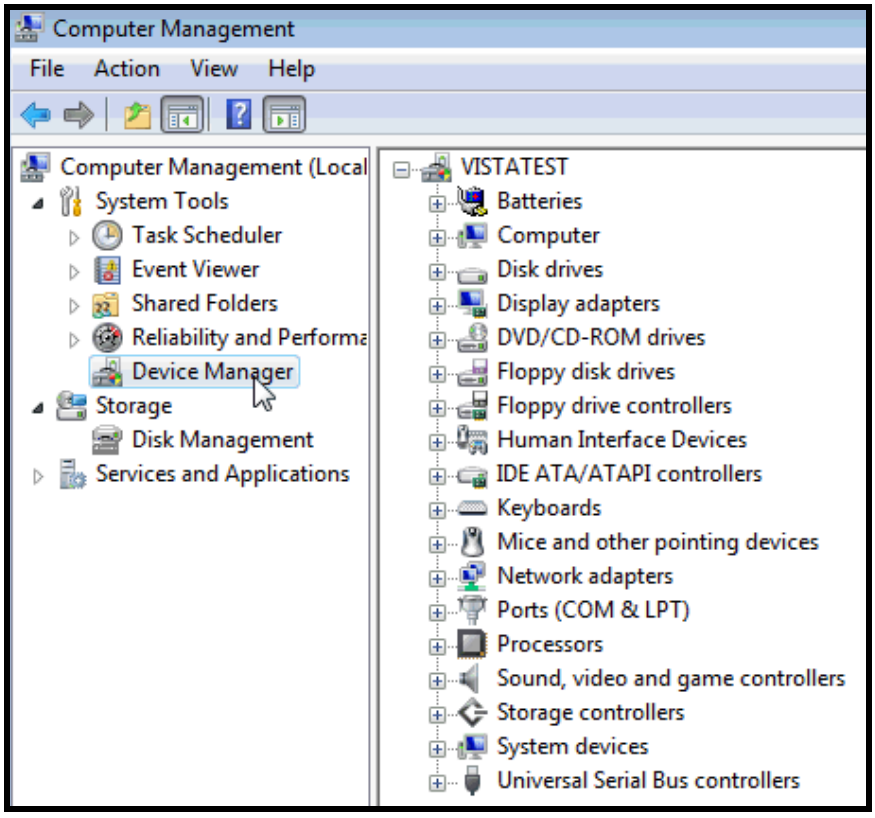
From the start menu, right-clicking on Computer and selecting Manage:



Running Vista Computer Manager

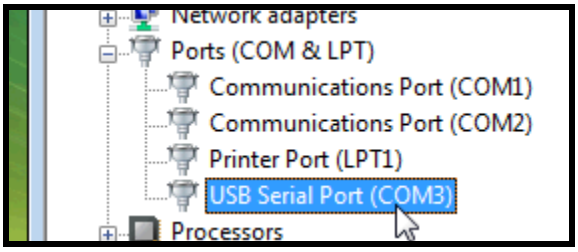
You will receive the message "Windows needs your permission to continue". Press the Continue button.

Click on "Device Manager" in the left-hand tree:



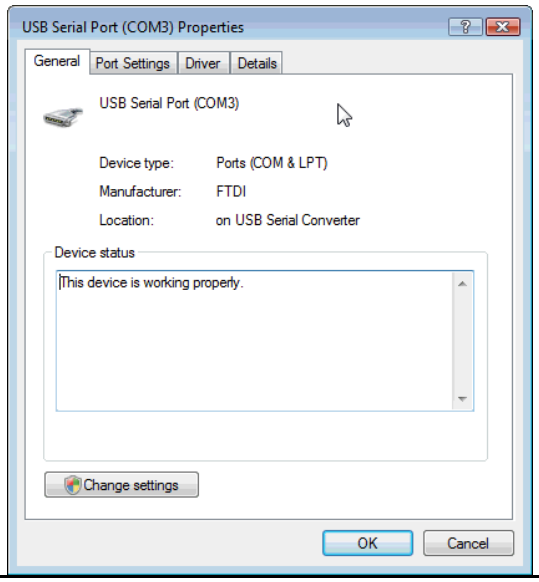
Vista Computer Management

The right hand pane will show a list of all devices. Click on the "Ports (COM & LPT)" in the right hand pane. This will show a list of all the available COM ports:

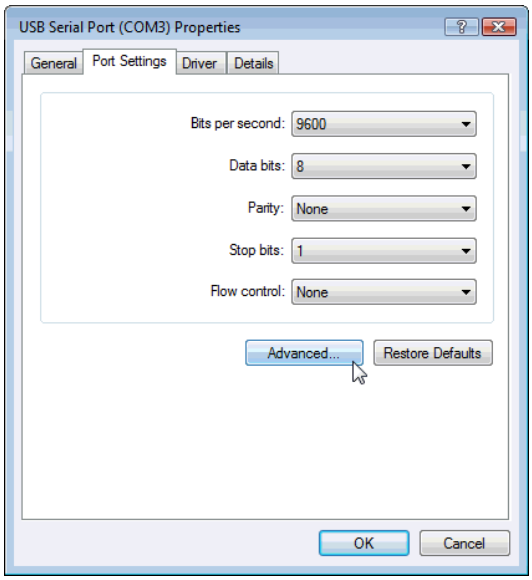


Vista Ports Selection

Double click on the USB Serial Port open the driver properties dialog:

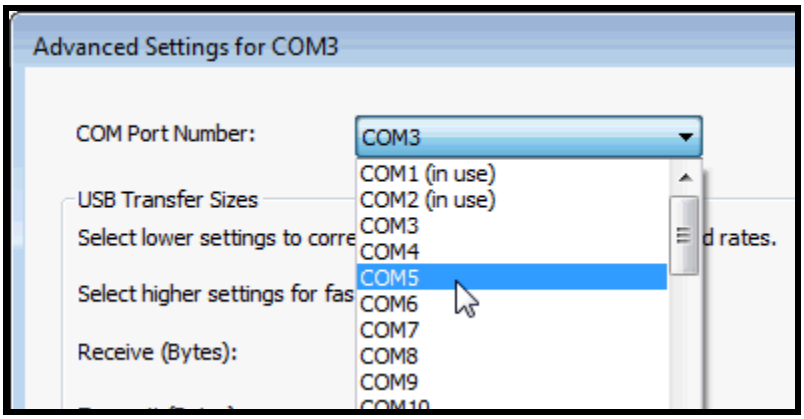


Next, click on the "Port Settings" tab:



Vista USB Serial Port Properties

Press the "Advanced" button to access the advanced port settings dialog. From this dialog, select the new COM port number:

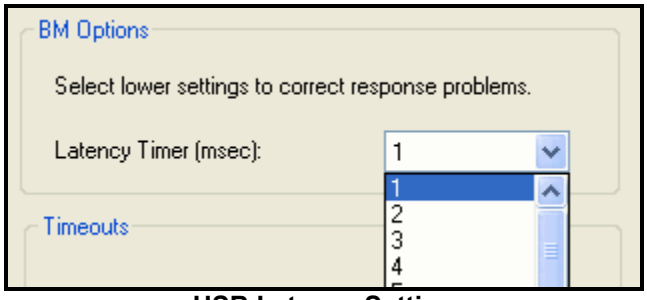


Vista Advanced COM Port Settings

The TTS USB port must be assigned between **COM1** and **COM12**. If all these port assignments are already in use, (which often happens with wireless laptops), make a new selection between **COM5 and COM12** (COM1 - 4 are usually the Laptop hardware such as IR or Modem connections) - You will receive a "***Port Name In Use***" warning.

Click "Yes" to accept the new assignment. This will generally not cause any problem - however the selection can be easily changed at a later time if necessary.

It is also necessary to set the “Latency Timeout” to 1 msec in the “BM Options” panel on the advanced setting form. This allows the interface to link-up much more consistently with the vehicle.



USB Latency Setting

Make a note of the port number you selected, and select OK to apply the changes. When you open DataMaster and select the serial Com port, use this port number.

8 DataMaster FAQs

8.1 Computer, Communication, USB Questions

Q: Is the DataMaster software Vista or Win 7 compatible?
A: Yes, the software will work with all versions of Vista and Win 7 including 64-bit versions.

Q: Will my "brand X" USB serial adapter work with DataMaster?
A: Most do not. We recommend that you use the TTS supplied USB adapter which is fully tested and works with all windows versions from 98 through Win7 64-bit.

Q: DataMaster Test Com reports an unknown ECM. What is the problem?
A: The most common cause of this is an incompatible USB serial adaptor. Try a different adaptor, or use the one that TTS supplies.

Alternately, the wrong COM port may be selected. For USB adapters, use Device Manager to determine which COM port your interface is connected to.

Q: I get an Access Violation when starting DataMaster under Vista, or the program will not launch under Windows XP. What is the problem?
A: This is commonly due to the "Data Execution Protection" (DEP) function in the operating system. DEP must be set to allow DataMaster to run as an exception. Use the following procedure to fix this issue:

1. Log into the Administrator account.
2. From the ***Start*** menu, right click on ***Computer*** and choose ***Properties***
3. Select the ***Advanced System Settings*** task in the left pane
4. Select the ***Advanced*** tab, then click the ***Settings*** button in the performance section
5. Select the ***Data Execution Prevention*** tab
6. Add the DataMaster exe program to the exception list. This is done by browsing to C:\Program Files\TTS\GM\DataMaster-OBD1\DM-xx\DM-xx.exe and selecting the DM-xx file (where xx is the specific version of DataMaster)
7. Click ***Apply*** to save the changes
8. Click OK on the forms to exit
9. The computer may have to be restarted to complete the process.

Q: DataMaster is very slow starting up, and may show high CPU usage during this time.
A: This is commonly due to the Windows Defender program monitoring these programs as they start up. The solution is to place these two programs on the Windows defender exception list as follows:

1. Log into the Administrator account.
2. Select ***Start – Programs – Windows Defender***
3. Select ***Tools*** and then ***Options***
4. Scroll to the bottom of the page to ***Advanced Options***
5. In the "***Do Not Scan these files or Locations"*** box add the following entries:
    a. C:\ Program Files\TTS\GM\DataMaster-OBD1\DM-xx\DM-xx.exe
6. Click ***Save*** to save the changes. Select OK if prompted to OK the changes
7. Close the Windows Defender application.

Note this problem may occur with other third-party anti-spyware programs. Follow the manufacturers instructions for adding DataMaster to their exception list.

9 Miscellaneous Topics

9.1 Unit Conversion Table

To Convert From	To	Multiply By
Feet	Centimeters	30.48
Inch	Centimeters	2.54
Miles	Kilometers	1.609
Square Inches	Square Cm	6.4516
Cubic Inches	Cubic Cm	16.3871
PSI	Kilo Pascals (kPa)	6.8948
PSI	Inches Mercury	2.0360
KPa	Inches Mercury	0.2953
Atmospheres	Kilo Pascals (kPa)	101.325
Degrees C	Degrees F	(1.8 x °C) + 32
Degrees F	Degrees C	(°F - 32) x 0.5556
Horsepower	Watts	746.0
1 "G" accel	Meters/Sec2	9.80665
1 "G" accel	Ft/Sec2	32.1741
Pounds	Kilograms	0.4536
Foot-Pounds	Newton-Meters	1.3558

9.2 Altitude Barometric Pressure Chart

Altitude (F)	kPa	Inches Hg
0	101.321	29.920
1000	97.732	28.860
2000	94.210	27.820
3000	90.789	26.810
4000	87.505	25.840
5000	84.321	24.900
6000	81.206	23.980
7000	78.192	23.090
8000	75.280	22.230
9000	72.435	21.390
10000	69.692	20.580
11000	67.051	19.800
12000	64.443	19.030
13000	61.971	18.300
14000	59.533	17.580
15000	57.196	16.890

9.3 ALDL Connector Identification

There are two basic styles of the GM ALDL connector used with DataMaster: The early (1994 and earlier) OBD1 style with 12 pins and the later (1995 and up) OBD2 style that uses 16 pins.

9.3.1 Early OBD1 style Connector and Pinouts

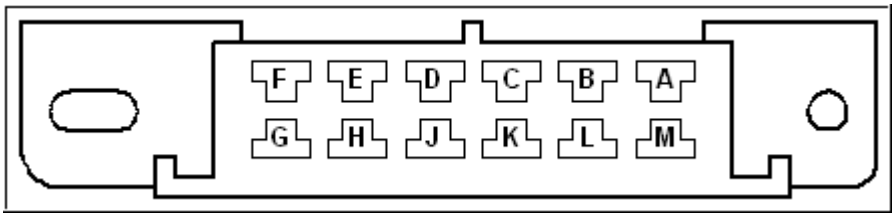


Table 1: 1994 and earlier GM OBD1 ALDL Connector			
Pin	**Function**	**Pin**	**Function**
A	Ground	M	8192-Baud Serial Data
B	Diagnostic Mode	L	N/A
C	AIR (if used)	K	N/A
D	SES Lamp (if used)	J	N/A
E	160-Baud Serial Data	H	N/A
F	TCC (if used)	G	Fuel Pump (if used)

NOTE: In order to communicate with 1989 and earlier Corvettes, ***pins E and M MUST be tied together***. This is typically done in the adaptor cable or in the PC interface pod. If DataMaster is unable to communicate with these early Corvettes, use an ohmmeter to verify the adapter has connected pins E and M.

Additionally, a 10K-ohm resistor must be connected ***between pins A and B.*** This is ONLY required for the early (pre-1989) vehicles using DataMatster-32.

These modifications can be used on all later vehicles without problems, but are **required** for pre-1989.

9.3.2 Late OBD2 style Connector and Pinouts

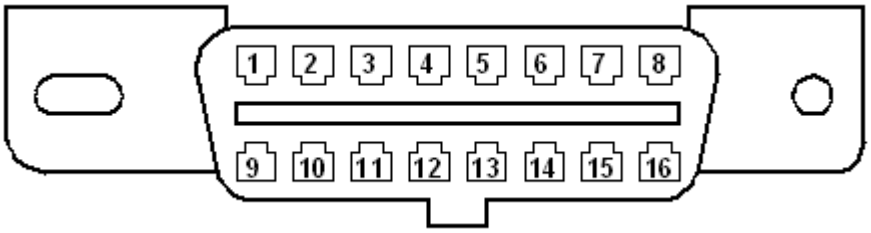


Table 2: 1995 GM OBD1 ALDL Connector (Uses OBD2 Shell)			
Pin	**Function**	**Pin**	**Function**
1	Discretionary	9	Discretionary - GM ALDL 8192
2	J1850 Bus + Data	10	J1850 Bus - Data
3	Discretionary	11	Discretionary
4	Chassis Ground	12	Discretionary
5	Signal Ground	13	Discretionary
6	J2284 CAN High	14	J2284 CAN Low
7	ISO K-line	15	ISO L-line
8	Discretionary	16	Unswitched Battery Voltage

Note that for 1995 GM OBD1 applications using the OBD2 connector, the ALDL data is output on pin 9 (Manufacturer Discretionary pin)

9.4 Common Acronym Glossary

A/T -- Automatic Transmission or Transaxle

A/C -- Air Conditioner

ACL -- Air Cleaner

AAT -- Ambient Air Temperature

AFGS -- Air Flow Grams per Second. The mass air flow reading., used on engines that have mass flow meters.

AFR -- Air Fuel Ratio

ALDL -- Assembly Line Diagnostic Link. The serial data link from the PCM to the monitoring computer. Also referred to as ALCL.

AP -- Accelerator Pedal

APP -- Accelerator Pedal Position

B+ -- Battery Positive Voltage

BARO -- Barometric Pressure. A measure of the atmospheric pressure

BLM -- Block Learn Multiplier. Now called Long Term Fuel Trim. The Long Term fuel correction factor that the PCM is using.

BLM Cell -- Now called Fuel Trim Cell. The Fuel Trim cells store Long Term correction factors that correct for each engine's unique operating conditions. A cell is active within a particular operating region as determined by engine RPM and load. Most PCM's use 16 to 20 cells.

BPW -- Base Pulse Width. The length of time of the injector pulse, usually measured in Milliseconds (1/1000 second).

BPP -- Brake Pedal Position

CAT -- Catalytic Converter

CCM -- Central Control Module. Used in Corvettes to communicate between the various on-board computers. Also called body computer.

CCS -- Coast Clutch Solenoid

CCP -- Charcoal Canister Purge. Typically, there is a solenoid that controls when purge is active. Used to control evaporative emissions.

CFI -- Continuous Fuel Injection. A fuel injection system whereby the injector flow is controlled by the fuel pressure.

CL -- Closed Loop. An operating mode which allows modification engine control parameters based on a feedback system.

CMP -- Camshaft Position

CTOX -- A system for lowering Diesel engine particulate emissions by collecting particulate and continuously burning them through oxidation.

CKP -- Crankshaft Position

CPP -- Clutch Pedal Position

DC -- Duty Cycle. A value from 0 to 100%. The ratio of ON to OFF of a controlled device. A value of 0 means the device is OFF, a value of 25% means the device is 1/4 of full on.

DTC -- Diagnostic Trouble Code

DFI -- Direct Fuel Injection. A fuel injection system that supplies fuel directly into the combustion chamber.

DI -- Distributor Ignition. A system in which the ignition coil secondary circuit is sequentially switched by a distributor to the spark plugs

DLC -- Data Link Connector

DLI -- Distributor less Ignition, also called Electronic Ignition (EI). A system in which the ignition coil secondary circuit is dedicated to specific spark plugs without the use of a distributor.

DRIVER -- An electronic switching device used to control an output state.

DTM -- Diagnostic Test Mode. Any of various PCM Test modes that allow the observation and control of PCM signals.

DTC -- Diagnostic Trouble Code

EATX -- Electronic Automatic Transmission/Transaxle.

ECM -- Engine Control Module

ECL -- Engine Coolant Level

ECT -- Engine Coolant Temperature

ECT -- Engine Coolant Temperature.

EDF -- Electro Drive Fan Control

EECS -- Evaporative Emission Control System

EFI -- Electronic Fuel Injection

EGO, EGOS -- Exhaust Gas Oxygen Sensor (O2S)

EGR -- Exhaust Gas Recirculation. Reduces NoX emissions by adding exhaust gas to the incoming air/fuel mixture.

EGRT -- EGR Temperature

EGRV -- EGR Vacuum Regulator Valve

EOP -- Engine Oil Pressure

EOT -- Engine Oil Temperature

EP -- Exhaust Pressure

EPROM -- An electronic memory device which is erasable by UV light and re-programmable using the appropriate equipment.

EI -- Electronic Ignition. A distributorless ignition system in which the ignition coil secondary circuit is dedicated to specific spark plugs without the use of a distributor.

EVAP -- A system used to prevent fuel vapor from escaping into the atmosphere. Typically includes a charcoal canister to store fuel vapors.

EVP -- EGR Valve Position

F4WD -- Full-time Four Wheel Drive

FBC -- Feed Back Control or Feed Back Carburetor

FC -- Fan Control

FI -- Fuel Injection

FLASH – A type of memory that is electrically erasable and re-programmable in-circuit.

FREEZE FRAME -- A block of data containing vehicle operating conditions for a specific instance.

FP -- Fuel Pump

FT -- Fuel Trim. A fuel correction term.

FWD -- Front Wheel Drive

GEN – Generator

GCM -- Governor Control Module

GPM -- Grams Per Mile

GND -- Ground. An electrical conductor used as a common return for an electrical circuit.

HEI -- High Energy Ignition

HO2S -- Heated Oxygen Sensor

IA -- Intake Air

IAC -- Idle Air Control

IACV -- Idle Air Control Valve

IAT -- Intake Air Temperature

IC -- Ignition Control

ICM -- Ignition Control Module

ICP -- Injection Control Pressure

IFS -- Inertia Fuel Shut-off

ISC -- Idle Speed Control

ISS -- Input Shaft Speed

IMRC -- Intake Manifold Runner Control

INT -- Integrator. Now called Short Term Fuel Trim. The Short Term fuel correction factor that the PCM is using.

KS -- Knock Sensor

LONG TERM, LTerm -- Long Term Fuel Trim (previously called Block Learn)

MAF -- Mass Air Flow

MAP -- Manifold Absolute Pressure

MAT -- Manifold Temperature

MFI -- Multipoint Fuel Injection. A fuel injection system in which each cylinder is individually fueled.

MDP -- Manifold Differential Pressure

MIL -- Malfunction Indicator Lamp

MST -- Manifold Surface Temperature

NVRAM -- Non-Volatile RAM. Memory which retains information typically via an internal battery.

O2S -- Oxygen Sensor

OBD -- On Board Diagnostic. A system that monitors some or all computer input and control signals. Signal(s) outside a predetermined range imply a fault in the system or a related system.

OC -- Oxidation Catalytic Converter. A catalytic converter system that reduces HC and CO.

OL -- Open Loop. An operating mode based on programmed values and not modified by a feedback system.

OSS -- Output Shaft Speed

PCM -- Powertrain Control Module

PCV -- Positive Crankcase Ventilation

PNP -- Park Neutral Position

PRNDL -- Automatic transmission gear selection lever. **P**ark, **R**everse, **N**eutral, **D**rive, **L**ow

PROM -- Programmable Read Only Memory. A memory chip which can be programmed only one time.

PSP -- Power Steering Pressure

PSPS -- Power Steering Pressure Switch

PTOX -- A system for lowering Diesel engine particulate emissions by collecting particulates and periodically burning them through oxidation.

PWM -- Pulse Width Modulation. A method of proportionally controlling an actuator by varying the on/off time of a rectangular waveform.

QDM -- Quad Driver Module. An electronic component that contains four output driver circuits.

RAM -- Random Access Memory. A memory which does not maintain its content when power is removed.

RM -- Relay Module

ROM -- Read Only Memory. Memory which is programmed by the device manufacturer and whose contents cannot be altered.

RPM -- Revolutions Per Minute

RWD -- Rear Wheel Drive

SHORT TERM, STerm -- Short Term Fuel Trim. The Short Term fuel correction factor that the PCM is using.

SA -- Spark Advance. The crankshaft angle relative to TDC (generally) at which a spark event is initiated.

SC – Supercharger

SCB -- Supercharger Bypass

SRT -- System Readiness Test (applicable to OBD2 scan tool communications)

SFI -- Sequential Fuel Injection. A multiport fuel injection system in which each injector is individually energized and timed relative to its cylinder intake event.

SR -- Spark Retard. The degrees of spark retard which have been subtracted form the nominal spark advance value. Is generally caused by an engine knock condition.

SRI -- Service Reminder Indicator

SS -- Shift Solenoid

SIR -- Supplemental Inflatable Restraint (air bag)

TAC -- Throttle Actuator Control

TBI -- Throttle Body Injection. An electronically controlled fuel injection system in which one or more fuel injectors are located in a throttle body.

TC – Turbocharger

TCC -- Torque Converter Clutch

TCCP -- Torque Converter Clutch Pressure

TCM -- Transmission Control Module

TDC -- Top Dead Center. The position of the crankshaft when the piston of interest is at the topmost point of travel.

TFP -- Transmission Fluid Pressure

TFT -- Transmission Fluid Temperature

TR -- Transmission Range

TSS -- Turbine Shaft Speed

TRLHP -- Track Road Load Horsepower. The power required to maintain a vehicle at a constant speed, taking into account power losses due to wind resistance, tire losses, bearing friction, etc.

TP -- Throttle Position

TPS -- Throttle Position Sensor

TFP -- Transmission Fluid Pressure

TVV -- Thermal Vacuum Valve. A valve that controls vacuum levels or routing based on temperature.

TWC -- Three Way Catalyst. A Catalytic converter system that reduces HC, NO and NoX.

VAF -- Volume Air Flow. A system that provides information on the volume flow rate of the intake air to the engine.

VCM -- Vehicle Control Module

VCRM -- Variable Control Relay Module

VIN -- Vehicle Identification Number. A 17-character ID number.

WOT -- Wide Open Throttle. A mode of PCM operation that is dependent on the throttle being open beyond a programmed percentage.

WU -- Warm Up

3GR -- Third Gear

2GR -- Second Gear

3-2TS -- 3-2 Timing Solenoid. A device that controls the "third to second" timing valve in an automatic transmission.

4WD -- Four Wheel Drive

4GR -- Fourth Gear

10 MAP Sensor Calibration Information

10.1 GM MAP Sensor Calibrations

10.1.1 Abstract

To resolve 2- and 3-bar MAP sensor calibration issues reported from field use of the Syclone and Typhoon DataMaster scan tool software, a accurate calibration of these sensors was performed. Additionally, detailed examination of the factory ECM code was made to determine the correct calibration equations for these sensors. The equation data was compared to measurements made on the actual sensors. The results are presented in this paper.

10.1.2 Test Setup

A test setup was constructed to accurately produce and measure absolute pressure in the range of ~10 kPa to 350 kPa (Figure 1).

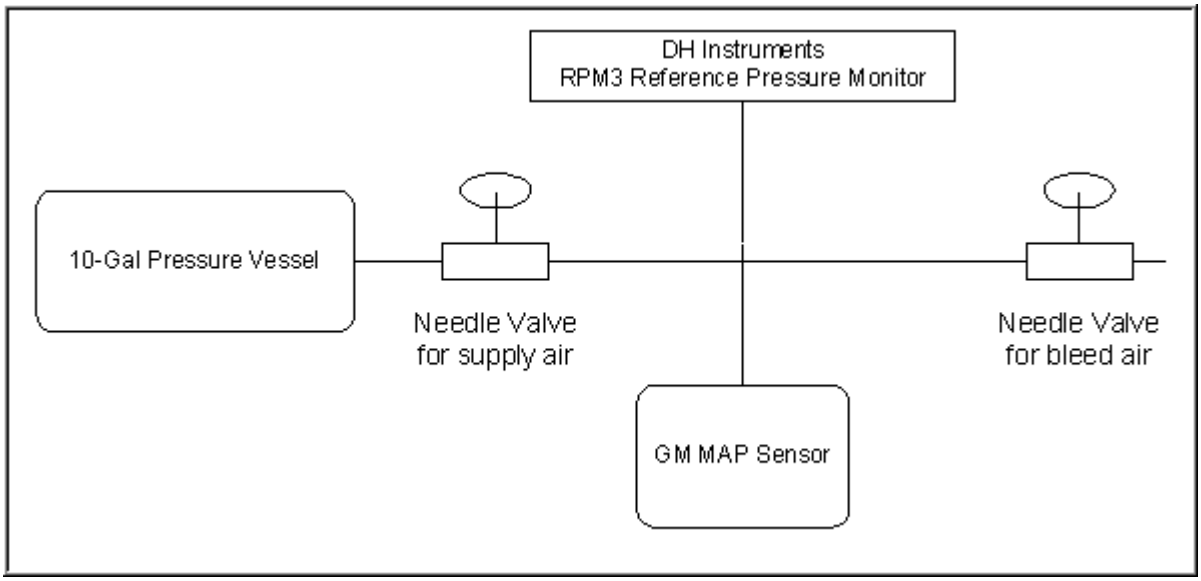


Figure 1: Calibration Setup

A pre-charged 10-gallon pressure vessel supplied a constant pressure (or vacuum) while measurements were made. Two needle valves allowed fine adjustment of the pressure at the MAP sensor. A DH Instruments (http://www.dhinstruments.com/) RPM3 Reference Pressure Monitor system was used to make the absolute pressure measurements. The RPM3 was configured to read from 0 kPa to 400 kPa with an accuracy of roughly 0.015%, well beyond the resolution and repeatability of the MAP sensor under test.

Sensor readings were corrected to an equivalent 5.000 Volt power voltage at the MAP sensor. Equivalent A/D readings were obtained using the 51 bits per Volt PCM calibration constant.

10.1.3 1-bar Sensor Calibration Results

A transfer equation was derived from GM documentation and from the tested calibration data. (See Table 1: One-Bar MAP Sensor Calibration Data)

For this GM sensor, the documented calibration equation is kPa = (0.369 * N) + 10.354.

The best fit data to this particular sensor gives an equation of kPa = (0.371 * N) + 10.354, which is in good agreement. As this is very close, the GM documented calibration values are used for this sensor.

10.1.4 2-bar Sensor Calibration Results

A transfer equation was derived from a disassembly of the PCM code and determined to be kPa = (0.781 * N) + 8. The data fit to the equation and error are tabulated in Figure 1; worst case error at room temperature is +1.27 kPa. Refer to Table Two: Two-Bar MAP Sensor Calibration Data.

A better fit can be obtained for this particular data set using the transfer equation kPa = (0.781 * N) + 9; however, as this data is for a single device at room temperature it was thought best to use the values extracted from the PCM code.

Based on these results, DataMaster versions 3.4.1 and later have been updated to use the kPa = (0.781 * N) + 8 equation for displaying 2-bar MAP pressures. This has a significant impact on the idle kPa readings, dropping them 10-15 kPa down into the expected 35 to 40 kPa region.

10.1.5 3-bar Calibration results

Many enthusiasts are using the GM 3-bar sensor PN 16040749 for high-performance applications on the Syclone / Typhoon engines. For this reason, this sensor's transfer function was measured and the results applied to the DataMaster 'optional' 3-bar sensor readout. Refer to Table 3: Three-Bar MAP Sensor Calibration Data.

Table 2 illustrates the calibration data for the 3-Bar sensor. The best fit transfer function was found to be kPa = (1.23 * N) + 2.2, which gives a maximum error of -0.85 kPa for this particular sensor

10.1.6 Conclusions

The documented 2-bar and 3-bar MAP sensor transfer functions were found to be in considerable error when compared with both the PCM code disassembly and the actual sensors. New transfer functions were developed and applied to the latest release of the DataMaster software.

This information is not in any way a comprehensive characterization of these MAP sensors; this would require thermal chambers, aging, power supply variation and devices from many production lots and it well beyond the scope of this paper. What we show here gives us a first-pass snapshot at what the actual transfer equations and should be suitable for normal engine diagnoses.

10.2 One-Bar MAP Sensor Calibration Data

10.2.1 Table 1: GM 16137039 1-Bar MAP Sensor Calibration Values

RPM3 Reading	Corr MAP	Calc A/D	kPa = (0.369 * N) + 10.354		kPa = (0.371 * N) + 10.354	
kPa	Vout	Value	kPa	Error	kPa	Error
104.20	4.965	253.23	103.80	0.41	104.30	-0.10
103.78	4.945	252.21	103.42	0.36	103.92	-0.14
102.81	4.895	249.66	102.48	0.33	102.98	-0.17
101.84	4.845	247.11	101.54	0.30	102.03	-0.19
100.91	4.795	244.57	100.60	0.31	101.09	-0.18
99.94	4.745	242.02	99.66	0.28	100.14	-0.20
98.98	4.695	239.47	98.72	0.26	99.20	-0.22
98.03	4.646	236.92	97.78	0.25	98.25	-0.22
97.08	4.596	234.38	96.84	0.24	97.31	-0.23
96.13	4.546	231.83	95.90	0.23	96.36	-0.23
95.18	4.496	229.28	94.96	0.22	95.42	-0.24
94.25	4.446	226.73	94.02	0.23	94.47	-0.22
93.30	4.396	224.19	93.08	0.22	93.53	-0.23
91.41	4.296	219.09	91.20	0.21	91.64	-0.23
89.50	4.196	214.00	89.32	0.18	89.75	-0.25
87.63	4.096	208.90	87.44	0.19	87.86	-0.23
85.74	3.996	203.80	85.56	0.18	85.97	-0.23
83.84	3.896	198.71	83.68	0.16	84.08	-0.24
81.94	3.796	193.61	81.80	0.14	82.19	-0.25
80.07	3.696	188.52	79.92	0.15	80.30	-0.23
78.17	3.597	183.42	78.04	0.13	78.40	-0.23
76.29	3.497	178.33	76.16	0.13	76.51	-0.22
74.40	3.397	173.23	74.28	0.12	74.62	-0.22
72.51	3.297	168.14	72.40	0.11	72.73	-0.22
70.61	3.197	163.04	70.52	0.09	70.84	-0.23
68.74	3.097	157.95	68.64	0.10	68.95	-0.21
66.85	2.997	152.85	66.76	0.09	67.06	-0.21
64.95	2.897	147.76	64.88	0.07	65.17	-0.22
63.09	2.797	142.66	63.00	0.09	63.28	-0.19
61.19	2.697	137.57	61.12	0.07	61.39	-0.20
59.32	2.598	132.47	59.24	0.08	59.50	-0.18
57.53	2.498	127.38	57.36	0.17	57.61	-0.08
55.55	2.398	122.28	55.48	0.07	55.72	-0.17
53.66	2.298	117.19	53.60	0.06	53.83	-0.17
51.79	2.198	112.09	51.72	0.07	51.94	-0.15
49.91	2.098	107.00	49.84	0.07	50.05	-0.14

48.01	1.998	101.90	47.96	0.05	48.16	-0.15
46.16	1.898	96.81	46.08	0.08	46.27	-0.11
44.30	1.798	91.71	44.20	0.10	44.38	-0.08
42.40	1.698	86.62	42.32	0.08	42.49	-0.09
40.54	1.598	81.52	40.44	0.10	40.60	-0.06
38.65	1.499	76.43	38.56	0.09	38.71	-0.06
36.76	1.399	71.33	36.68	0.08	36.82	-0.06
34.93	1.299	66.24	34.80	0.14	34.93	0.00
33.07	1.199	61.14	32.92	0.16	33.04	0.03
31.18	1.099	56.05	31.04	0.15	31.15	0.03
29.31	0.999	50.95	29.16	0.16	29.26	0.05
27.45	0.899	45.86	27.28	0.18	27.37	0.08
25.56	0.799	40.76	25.40	0.17	25.48	0.08
23.68	0.699	35.67	23.52	0.17	23.59	0.09
21.80	0.599	30.57	21.64	0.17	21.70	0.10
19.94	0.500	25.48	19.76	0.19	19.81	0.13
18.05	0.400	20.38	17.87	0.18	17.92	0.14
16.17	0.300	15.29	15.99	0.18	16.03	0.15
14.28	0.200	10.19	14.11	0.17	14.13	0.15
12.39	0.100	5.10	12.23	0.16	12.24	0.15

10.3 Two-Bar MAP Sensor Calibration Data

10.3.1 Table 2: GM 16254539 2-Bar MAP Sensor Calibration Values

RPM3 reading	Corr MAP	Calc A/D	kPa = (0.781 * N) + 8		kPa = (0.781 * N) + 9	
kPa	Vout	Value	kPa	Error	kPa	Error
207.04	4.965	253.23	205.77	1.27	206.77	0.27
203.92	4.895	249.66	202.98	0.94	203.98	-0.06
199.91	4.795	244.57	199.01	0.91	200.01	-0.10
195.90	4.695	239.47	195.03	0.87	196.03	-0.13
191.91	4.596	234.38	191.05	0.86	192.05	-0.14
187.89	4.496	229.28	187.07	0.82	188.07	-0.18
183.90	4.396	224.19	183.09	0.81	184.09	-0.19
179.91	4.296	219.09	179.11	0.80	180.11	-0.20
175.96	4.196	214.00	175.13	0.83	176.13	-0.17
171.94	4.096	208.90	171.15	0.79	172.15	-0.21
167.95	3.996	203.80	167.17	0.78	168.17	-0.22
163.97	3.896	198.71	163.19	0.78	164.19	-0.22
159.98	3.796	193.61	159.21	0.77	160.21	-0.23
156.00	3.696	188.52	155.23	0.77	156.23	-0.23
152.00	3.597	183.42	151.25	0.75	152.25	-0.25
148.01	3.497	178.33	147.28	0.74	148.28	-0.27
144.04	3.397	173.23	143.30	0.74	144.30	-0.26
140.06	3.297	168.14	139.32	0.74	140.32	-0.26
136.08	3.197	163.04	135.34	0.74	136.34	-0.26
132.10	3.097	157.95	131.36	0.74	132.36	-0.26
128.14	2.997	152.85	127.38	0.76	128.38	-0.24
124.17	2.897	147.76	123.40	0.77	124.40	-0.23
120.19	2.797	142.66	119.42	0.77	120.42	-0.23
116.22	2.697	137.57	115.44	0.78	116.44	-0.22
112.24	2.598	132.47	111.46	0.78	112.46	-0.22
108.27	2.498	127.38	107.48	0.79	108.48	-0.21
104.30	2.398	122.28	103.50	0.80	104.50	-0.20
100.34	2.298	117.19	99.52	0.82	100.52	-0.18
96.39	2.198	112.09	95.54	0.85	96.54	-0.15
92.42	2.098	107.00	91.57	0.86	92.57	-0.15
88.46	1.998	101.90	87.59	0.88	88.59	-0.13
84.51	1.898	96.81	83.61	0.90	84.61	-0.10
80.51	1.798	91.71	79.63	0.88	80.63	-0.12
76.56	1.698	86.62	75.65	0.91	76.65	-0.09
72.59	1.598	81.52	71.67	0.92	72.67	-0.08
68.63	1.499	76.43	67.69	0.94	68.69	-0.06
64.63	1.399	71.33	63.71	0.92	64.71	-0.08

60.63	1.299	66.24	59.73	0.90	60.73	-0.10
56.68	1.199	61.14	55.75	0.93	56.75	-0.07
52.74	1.099	56.05	51.77	0.97	52.77	-0.03
48.78	0.999	50.95	47.79	0.99	48.79	-0.01
44.82	0.899	45.86	43.81	1.01	44.81	0.01
40.85	0.799	40.76	39.83	1.02	40.83	0.02
36.91	0.699	35.67	35.86	1.06	36.86	0.06
32.94	0.599	30.57	31.88	1.06	32.88	0.06
28.98	0.500	25.48	27.90	1.08	28.90	0.08
25.02	0.400	20.38	23.92	1.10	24.92	0.10
21.06	0.300	15.29	19.94	1.12	20.94	0.12
17.07	0.200	10.19	15.96	1.11	16.96	0.11
13.08	0.100	5.10	11.98	1.10	12.98	0.10

10.4 Three-Bar MAP Sensor Calibration Data

10.4.1 Table 3: GM 16040749 3-Bar MAP Sensor Calibration Values

RPM3 reading	Corr MAP	Calc A/D	kPa= (1.22 * N) + 2.2		kPa = (1.23 * N) + 2.2	
kPa	Vout	Value	kPa	Error	kPa	Error
313.66	4.965	253.23	311.14	2.52	313.67	-0.01
309.02	4.895	249.66	306.79	2.24	309.28	-0.26
302.67	4.795	244.57	300.57	2.10	303.02	-0.35
296.40	4.695	239.47	294.35	2.05	296.75	-0.35
290.04	4.596	234.38	288.14	1.90	290.48	-0.44
283.69	4.496	229.28	281.92	1.77	284.21	-0.52
277.41	4.396	224.19	275.71	1.70	277.95	-0.54
271.05	4.296	219.09	269.49	1.56	271.68	-0.63
264.79	4.196	214.00	263.27	1.52	265.41	-0.62
258.47	4.096	208.90	257.06	1.41	259.15	-0.68
252.17	3.996	203.80	250.84	1.33	252.88	-0.71
245.80	3.896	198.71	244.63	1.18	246.61	-0.81
239.55	3.796	193.61	238.41	1.14	240.35	-0.80
233.24	3.696	188.52	232.19	1.05	234.08	-0.84
226.98	3.597	183.42	225.98	1.00	227.81	-0.83
220.70	3.497	178.33	219.76	0.94	221.55	-0.85
214.44	3.397	173.23	213.55	0.90	215.28	-0.84
208.19	3.297	168.14	207.33	0.86	209.01	-0.82
201.94	3.197	163.04	201.11	0.83	202.74	-0.80
195.66	3.097	157.95	194.90	0.76	196.48	-0.82
189.39	2.997	152.85	188.68	0.71	190.21	-0.82
183.14	2.897	147.76	182.47	0.68	183.94	-0.80
176.87	2.797	142.66	176.25	0.62	177.68	-0.81
170.62	2.697	137.57	170.03	0.59	171.41	-0.79
164.37	2.598	132.47	163.82	0.55	165.14	-0.77
158.15	2.498	127.38	157.60	0.55	158.88	-0.73
151.90	2.398	122.28	151.39	0.52	152.61	-0.71
145.66	2.298	117.19	145.17	0.49	146.34	-0.68
139.44	2.198	112.09	138.95	0.49	140.07	-0.63
133.23	2.098	107.00	132.74	0.49	133.81	-0.58
127.00	1.998	101.90	126.52	0.48	127.54	-0.54
120.78	1.898	96.81	120.31	0.48	121.27	-0.49
114.56	1.798	91.71	114.09	0.47	115.01	-0.45
108.34	1.698	86.62	107.87	0.47	108.74	-0.40
102.13	1.598	81.52	101.66	0.47	102.47	-0.34
96.02	1.499	76.43	95.44	0.58	96.21	-0.19
89.82	1.399	71.33	89.23	0.60	89.94	-0.12

83.61	1.299	66.24	83.01	0.60	83.67	-0.06
77.40	1.199	61.14	76.79	0.61	77.40	0.00
71.20	1.099	56.05	70.58	0.62	71.14	0.06
64.97	0.999	50.95	64.36	0.61	64.87	0.10
58.79	0.899	45.86	58.14	0.65	58.60	0.19
52.60	0.799	40.76	51.93	0.67	52.34	0.26
46.40	0.699	35.67	45.71	0.69	46.07	0.33
40.22	0.599	30.57	39.50	0.72	39.80	0.42
34.04	0.500	25.48	33.28	0.76	33.54	0.51
27.85	0.400	20.38	27.06	0.79	27.27	0.58
21.66	0.300	15.29	20.85	0.81	21.00	0.66
15.47	0.200	10.19	14.63	0.84	14.73	0.74
9.22	0.100	5.10	8.42	0.80	8.47	0.75