Allan Phillips Racing, L.L.C.
XTune User's Manual
Version.00
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Table of Contents

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Getting Started

Thank you for choosing APR's X-One product line.

The objective of this document is to detail the functions and operation of the XTune software for calibrating (mapping / tuning) the X-One ECU. Before getting started with the installation, please spend some time reading through this guide. Familiarity with its contents will greatly aid the tuning workflow.

Warning:
Always have 2 people in the vehicle while performing calibration development work; 1 driver and 1 tuner. This allows the tuner to focus on their work while keeping it safe.

1.00 Installing XTune
XTune is delivered as a single Microsoft Install file "XTuneSetup.msi". This setup installs all necessary components including working directories and files on the user's hard drive.

1.01 Prerequisites
XTune is compatible with any x86 based machine with a minimum of 500MB memory, 2GB available disk space and an operating system capable of running Microsoft's .Net Framework 3.5. The setup program will automatically detect and/or install .Net 3.5. XTune is compatible with the following operating systems:

Windows Vista – all versions
Windows Server 2008, 2003
Windows XP
Windows 98

1.02 Running XTuneSetup.msi
XTune is installed by either double clicking on the "XTuneSetup.msi" file or by choosing "Install" from the context menu after right-clicking on the file. Setup will guide you through the installation and will only take a few minutes to complete.

2.00 XTune Files and Directory Structure

XTuneSetup will create the following directories in your "Program Files" folder:
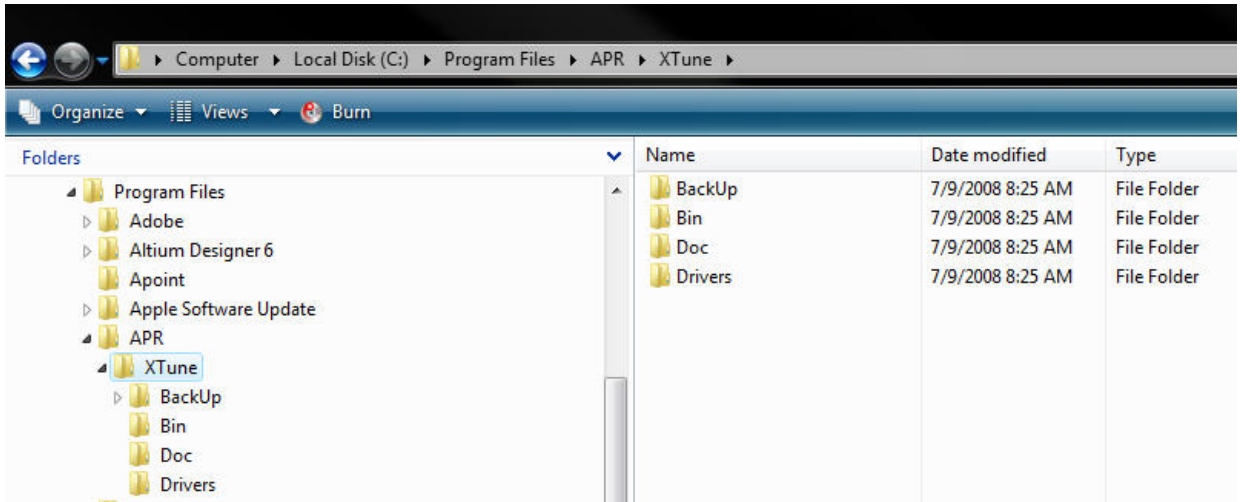
"BackUp"   contains the original calibration and data acquisition files.

"Bin"   contains the XTune executable and necessary assemblies.

"Doc"   contains the user, parameter and calibration guides.

"Driver"   contains XTune's USB driver and utilities.

2.01 XTune Work Directory

A working directory for calibration development and data acquisition is created under the "Documents" folder in the user's desktop:
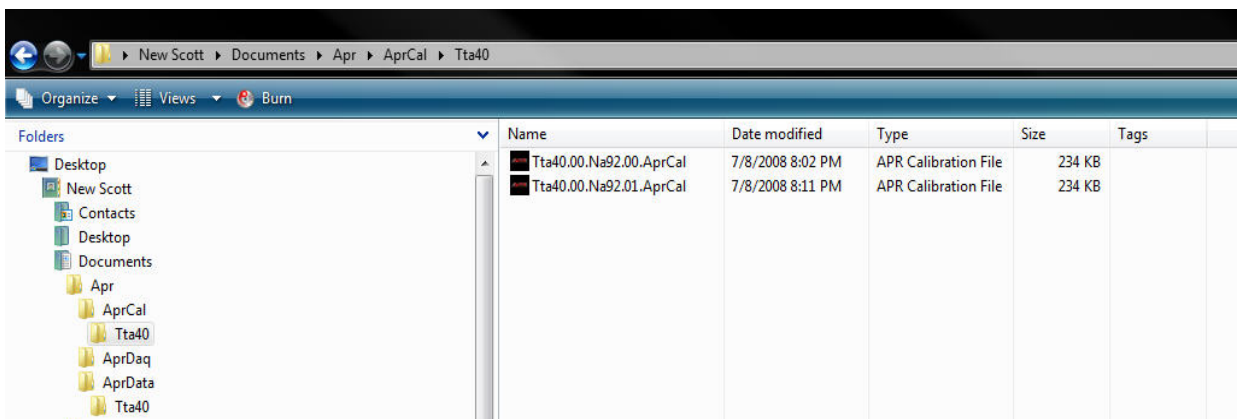
2.02 XTune Work Directory Calibrations

"Apr"   is the top folder.
"Apr\AprCal"   is the parent folder for all calibration models.
"Apr\AprCal\Tta40"   contains all calibration files specific to the vehicle model.

Two calibration files with the ".AprCal" extension are included in this directory:

"Tta40.00.Na92.00.AprCal"
"Tta40.00.Na92.01.AprCal"

The ~.00.AprCal is a read-only base calibration generated by APR's dynamometer and vehicle calibration methodology. This file will be used for comparison with your calibration making it easy to revert back to any part of the original base map. The ~.01.AprCal file is your starting calibration file that is modifiable. All calibration for the Toyota Tacoma 4.0L will be stored in this directory – including revisions. The user may change the "Na92.01" part of the name that identifies their calibration. Here, "Na" stands for naturally aspirated and 92 indicates the octane level. The front part of the name "Tta40.00" indicates the software name /version and is controlled by APR and is not modifiable (XTune will ignore renames to this part).

2.03 XTune Work Directory Data Acquisition (Daq) Configurations
"Apr\AprDaq" contains a single data acquisition list/configuration file with the ".AprDaq" extension:

"Main.AprDaq"

This file stores all data acquisition and instrument configurations maintained by XTune.

2.04 XTune Work Directory Data Store

"Apr\AprData"   is the parent data store directory.
"Apr\AprData\Tta40"   contains all dataset files specific to the vehicle model.

All dataset files with the ".AprData" extension are stored in this directory including an example file:

"Main.Tta40.00.Na92.01.123.AprData."

The "Main.Tta40.00" identifies the DaqList, software and version while the "Na92.01.123." part identifies the calibration/version and dataset number. In addition to storing all signals, XTune will store the active calibration that produced the dataset so that there is never any confusion about what calibration produced the dataset.

2.05 XTune USB Flash Disk (UFD)

The X-One ECU comes with a standard UFD for rapid calibration changes with the engine running or not without the need for a PC. Any standard FAT32, FAT16 or FAT12 file systems with the sector size set to 512 bytes and capacities up to 4GB are compatible. Simply store your favorite calibration in the root directory on the supplied APR UFD and rename the file by tagging it with "X1" in the leading characters:

"X1TTa40.00.Na92.01.AprCal"
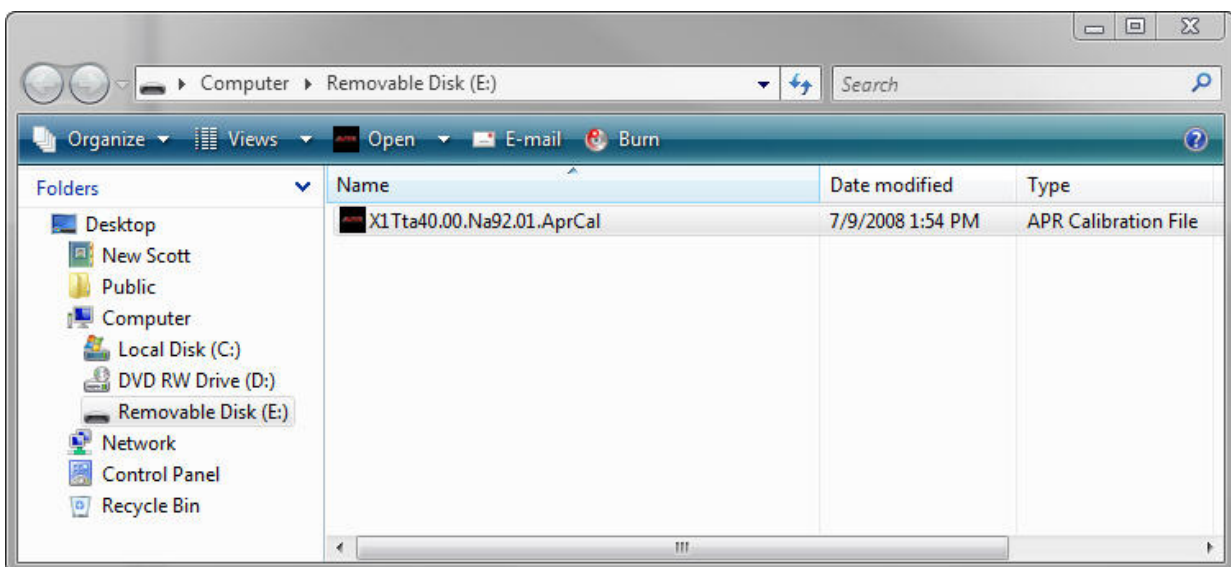
The X-One will detect all UFD assertions/removals, search for any file starting with "X1" and ending with the ".AprCal" extension, read and validate the file, then load it into RAM in less than a second. After successfull loading, the X-One will flash the factory Malfunction Indicator Lamp (MIL) a calibratable number of times based upon the user settable tuning parameter "Config\CalID" in the map.

Any number of files can be loaded on the UFD, however, the X-One will only load the top alpha-numerical file tagged with "X1". This tagging system allows file selection while preserving the calibration identity.

3.00 XTune USB Drivers

After the XTune software is installed, the USB device driver must be installed before connecting to the X-One ECU. XTune's USB device driver is fully Microsoft USB Certified. However, with the surge in popularity of USB devices, it is possible that you may have an older driver installed on your system that will conflict with XTune. Therefore, it is recommended that you run a "Clean" utility first before installing the driver.

3.01 FTClean.exe Utility

The APR XTune Program Folder contains all the drivers and clean utility located in:

"Program Files\Apr\XTune\Drivers"

Locate the utility "FTClean.exe" and double click to launch the program. The user is presented with the following dialogs:
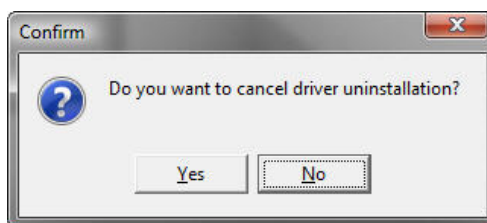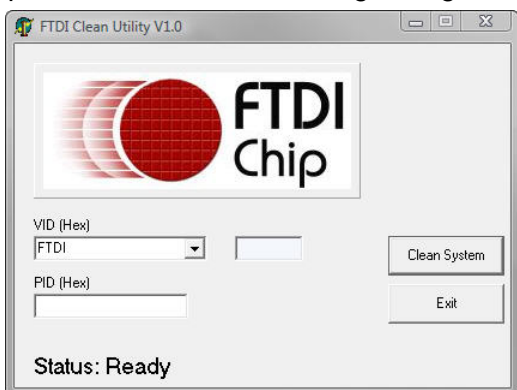
Select the "Clean System" button and follow the instructions – the default FTDI setting is correct. Note, the "Confirm" message box asks to cancel – hit "No" to continue. FTClean will search your system and cleanup all conflicting USB drivers.

3.02 Automatic USB Driver Install

In the same driver folder is the latest USB device driver, double click on the "CDM 2.04.06.exe" program and the drivers will be install automatically.

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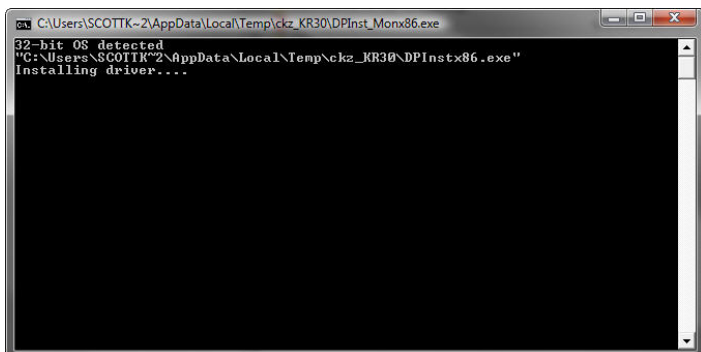
3.03 Manual USB Driver Install

The automatic USB driver installation may not work on some operating systems depending on its configuration. In the case you plug the X-One in for the first time and a Window's dialog ask "How do you want to search for driver software?" Select "Browse my computer for driver software" and then select the following folder under the Apr directory:

"c:\Program Files\Apr\AprDrivers\CDM 2.04.06 WHQL Certified"

And Windows will install the driver properly.

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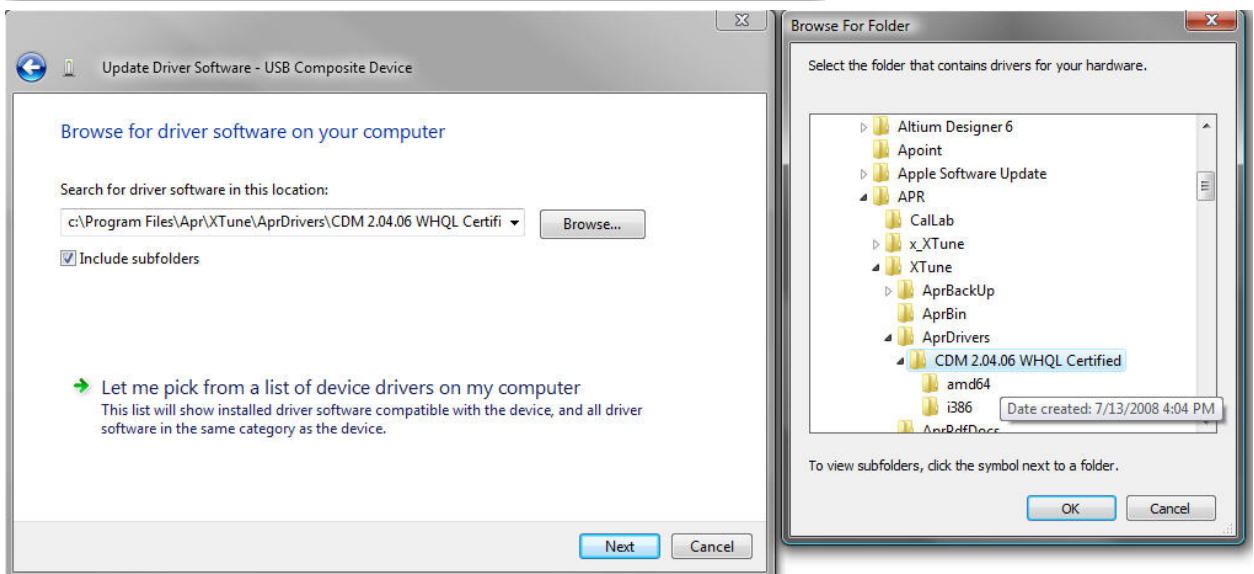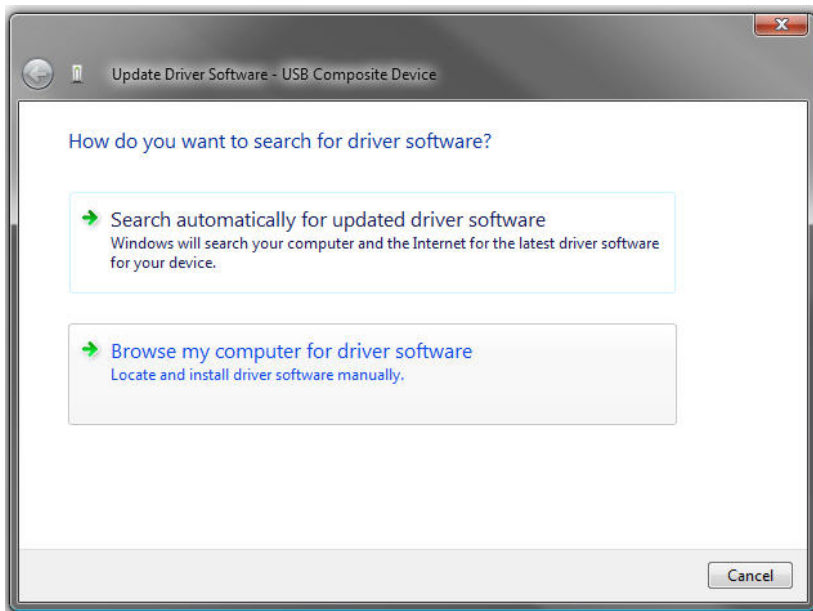
4.00 XTune Overview

After installing the USB drivers, XTune is now ready to run. In the Start Menu, either click on the top XTune shortcut or go to the APR folder and select it there. It is also convenient to keep a shortcut on a Quick Launch bar (as show to the right). Shortcuts to all of XTune's documentation can be located in the APR folder as well. XTune can be started with or without the X-One attached and may be connected/disconnected at any time. In addition, the X-One computer can be powered by the USB port without having to be connected in the vehicle for desktop programming.
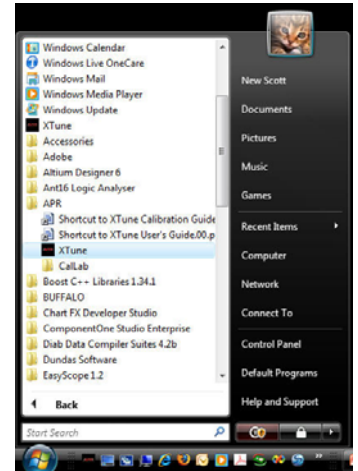
The following diagram identifies the specific panels utilized in XTune:

Explorer Panel   Instrument Tabs   Instrument Panel   Instrument DockTab

Calibration Tabs   Calibration Panel   Chart Tabs   Chart Panel   Calibration DockTab

4.01 XTune Parameter Types

The following table lists all of XTune's parameter types:

Type:	Identifier:	Equations:	Definition:
VS1	V1	V1 = Variable	Basic 1-dimensional variable located in RAM
RS1	R1	R1 = Scalar	Single number loaded from FLASH to RAM
RPs2	R2	R2 = Func(V)	Polynomial sensor class
RLs2	R2	R2 = Func(V)	Linear-interpolated sensor class
RLe2	R2	R2 = Func(X0)	Standard 2-point interpolation function.
RLe3	R3	R3 = Func(X0, X1)	Standard 4-point interpolation table.
.Y	.Y	Structure.Output	Type output value
.X0	.X0	Structure.Input0	Type first ordinate x input
.X1	.X1	Structure.Input1	Type second ordinate x input
.V	.V	Structure.InputVolts	Sensor voltage input ordinate

The number in the type/identifier indicates the parameters dimension (i.e. 1 = a single point on a line, 2 = a line, 3 = a surface). The type identifier is displayed in the Property Grid underneath the Explorer Tree while the simplified identifier (i.e. V1, R1, R2…) is utilized in the tree to indicate dimension. The "VS1" type is a simple variable that represents signals that change during runtime (i.e. RPM). All parameters starting with "R" are calibration types that get loaded into RAM from FLASH during startup and only change if the user changes them in XTune. The "RS1" type is a scalar calibration constant (i.e. a single number such as the CalID – the calibration ID). The "RPs2" type is a polynomial sensor class containing the A2D channel number, filter coefficient and polynomial :

$$Y = a0 + a1*V + a2*V^2 + a3*V^3 + a4*V^4$$

The coefficients for the polynomial must be supplied either by the sensor manufacturer or may be fitted from the data using any math package (such as Matlab or Excel).

The "RLs2" type is a linear-interpolated sensor class containing the A2D channel number, filter coefficient and an array of "Y-Values" that match the sensor's transfer function.

The "RLe2" type is a standard 2-point interpolation:

Y = Function Of (X0)

Where the y-values can be adjusted to fit any single-valued line (one that doesn't have more than one y-point for each x-point) – sometimes referred to as a "fox function" for FofX.

The "RLe3" type is a standard 4-point interpolation:

Y = Function Of(X0,X1)

Where the y-values can be adjusted to fit any surface – sometimes referred to as either a "table" or "map".

The ".Y", ".X0", ".X1", ".V" nomenclature is utilized in the AprDaq and AprData tree locations to indicate the available fields for acquisition. For example, an auxiliary pressure sensor measurement "P1" with the "RPs2" type will have available for measurement:

P1.Y – the sensor output
P1.V – the sensor input voltage

Likewise, a table calibration for the commanded air/fuel trajectory "AfrCmd" will have the following fields available for measurement:

AfrCmd.Y   – the 4-point interpolation output value
AfrCmd.X0 – the first input ordinate (Rpm in this case) utilized in the interpolation
AfrCmd.X1 – the second input ordinate (Load in this case) utilized in the interpolation

4.02 XTune Parameter Type Storage
The XTune parameter types are loaded into RAM from either the internal FLASH or UFD and utilized during runtime allowing real-time tuning (RTT). In order to make calibration changes permanent, the X-One's Flash needs to be programmed (takes about 30 seconds with the key-on and engine-off). Otherwise the next time the ignition power is cycled, the RAM will be loaded again with the internal FLASH parameters. A "Sync" button is provided in XTune's Explorer panel that will refresh the RAM with the active calibration in case the ignition power is ever cycled during a calibration session (engine can be running and only takes a second).

4.03 X-One Power Management

The X-One was designed to be USB or vehicle powered. The USB power feature allows the X-One to be programmed at the desktop if desired (don't have your auxiliary sensor plugged in). In the vehicle, the X-One will either turn on when plugged into the USB port or with the ignition key turned on. However, if the key is off and the USB plugged in, the X-One will cycle to power off every 60 seconds – that will causes the USB port to cycle (as if you removed the device, and then plugged it back in again). This is a reminder for you to always keep the ignition key turned on during development or unplug the USB data cable between development sessions.

4.04 XTune Flash Programming

The X-One was designed to allow the USB data cable to be connected and removed at will. However, there are a few guide lines that will make development easier if followed:

1. Only attempt flash programming after the "Time" parameter on the first "Main" instrument is counting. This affirms that the USB is synchronized with the X-One and ready to go.
2. Leave the X-One plugged in before starting XTune and try not to unplug it while it's operating . Unplugging while operating requires resetting the USB port and takes a few seconds to establish synchronization. Leaving the USB data port plugged in before, during and after assures seamless operation.
3. Never unplug the USB cable while performing a flash programming. This will leave the X-One in an undetermined state. To recover, you will need to:
    1. Shut down XTune with the USB data port unplugged
    2. Turn off the ignition key and wait 2 minutes.
    3. Plug in the USB data port , then re-start XTune.
    4. Wait a minute and then issue a flash command to start a new download (the "Time" parameter will not be counting until programmed successfully).
    5. Don't unplug the USB while programming
4. Turning the power off during programming should be avoided. However, the X-One controls its own power-off so this will not corrupt the programming.

4.05 XTune Parameter Categories

The following table list the available calibration categories:

Category:	Definition:
Config	All configuration parameters such as the calibration ID and fuel type.
Sensors	All OEM sensors
AuxSensors	All auxiliary sensor channels
Fuel	All fuel calibration parameters
Spark	All spark calibration parameters
Injectors	All injector calibration parameters
Actuators	All auxiliary actuator parameters
BoostControl	All auxiliary boost control actuator parameters (dealer only)

In the Explorer panel, the categories are represented with folders. Double-clicking on them will open all parameters for that category in a Calibration panel. There is never any need to hunt for a parameter – just know the category, double-click the folder, and it will be displayed in the calibration panel (more details to follow).
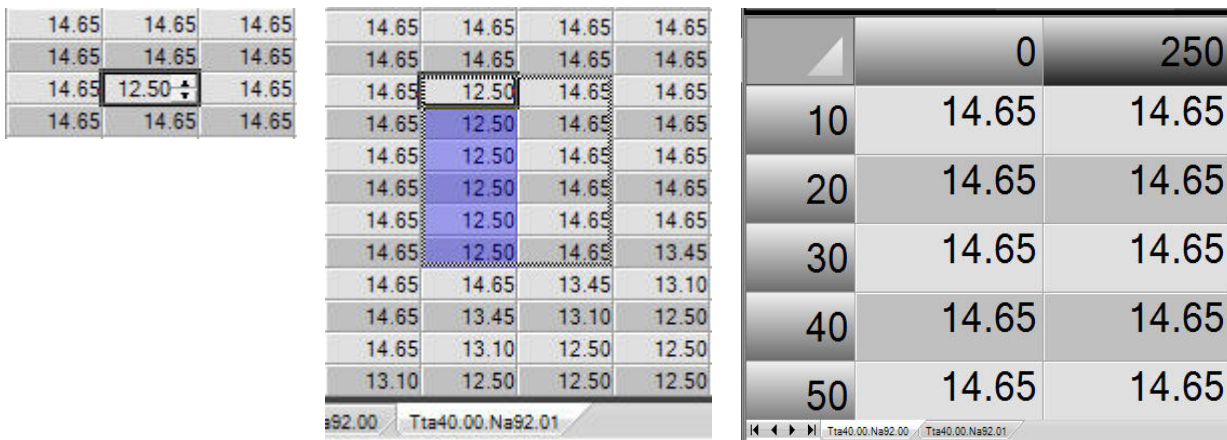
4.06 XTune Spreadsheet Controls

XTune uses an Excel spreadsheet control for all of its data manipulation:

	0	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000	3400	3800	4200	4600	5000	5400	5800	6200	6600	7000	7400
10	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.10
20	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.10	12.70
30	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.10	12.70	12.50
40	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.45	13.10	12.70	12.50	12.20
50	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.10	13.10	12.70	12.50	12.20	11.90
60	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.45	13.10	12.70	12.50	12.20	11.90	11.60
70	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.45	13.45	13.10	12.70	12.50	12.50	12.20	11.90	11.60	11.40
80	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.45	13.45	13.10	12.70	12.70	12.50	12.20	11.90	11.60	11.40	11.20
90	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.10	13.10	13.10	12.50	12.50	12.50	12.20	12.00	12.20	11.90	11.60	11.40	11.20	11.00
100	14.65	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.10	12.50	12.50	12.50	12.50	12.20	12.20	12.00	11.80	11.80	11.60	11.40	11.20	11.00	10.80
110	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	13.10	12.50	12.50	12.50	12.50	12.50	12.20	12.20	11.80	11.50	11.60	11.40	11.20	11.00	10.80	10.50
120	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.10	12.50	12.50	12.50	12.50	12.50	12.50	12.20	12.00	11.50	11.20	11.40	11.20	11.00	10.80	10.50	10.50
130	14.65	14.65	14.65	14.65	14.65	14.65	14.65	13.45	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.20	11.20	11.20	11.00	10.80	10.50	10.50
140	14.65	14.65	14.65	14.65	14.65	14.65	13.45	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.20	11.20	11.00	10.80	10.80	10.50	10.50
150	14.65	14.65	14.65	14.65	14.65	13.10	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.20	11.20	11.00	10.80	10.80	10.50	10.50
160	14.65	14.65	14.65	14.65	14.65	13.45	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.20	11.00	11.00	10.80	10.80	10.50	10.50
170	14.65	14.65	14.65	14.65	13.45	13.10	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.20	11.20	11.00	10.80	10.80	10.50	10.50
180	14.65	14.65	14.65	13.45	13.10	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.20	11.20	11.00	10.80	10.80	10.50	10.50
190	14.65	14.65	14.65	13.10	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.20	11.20	11.00	10.80	10.80	10.50	10.00
200	14.65	14.65	13.10	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.20	11.80	11.50	11.20	11.00	10.80	10.80	10.50	10.00	9.60

Tta40.00.Na92.00 / Tta40.00.Na92.01

The controls are similar to Microsoft Office allowing cell editing, drag-fill operations and cut-past operations:

14.65	14.65	14.65	
14.65	14.65	14.65	
14.65	12.50 ÷	14.65	
14.65	14.65	14.65	

14.65	14.65	14.65	14.65
14.65	14.65	14.65	14.65
14.65	12.50	14.65	14.65
14.65	12.50	14.65	14.65
14.65	12.50	14.65	14.65
14.65	12.50	14.65	14.65
14.65	12.50	14.65	14.65
14.65	12.50	14.65	13.45
14.65	14.65	13.45	13.10
14.65	13.45	13.10	12.50
14.65	13.10	12.50	12.50
13.10	12.50	12.50	12.50

a92.00 Tta40.00.Na92.01

	0	250
10	14.65	14.65
20	14.65	14.65
30	14.65	14.65
40	14.65	14.65
50	14.65	14.65

Tta40.00.Na92.00 Tta40.00.Na92.01

Located in the lower left-hand corner are the sheet tabs that list the calibration files located in the AprCal directory and are used for navigating between calibrations.   Selections are made either by dragging the mouse with the left mouse button held down or holding the "SHIFT-KEY" and manipulating the arrow keys. Hit the "F5" key to exit edit mode and enable real-time table tracking (RTT) or hit the "ESC-KEY" to exit edit mode without enabling RTT. Every spreadsheet can be zoomed in or out by holding the "CTR-KEY" and scrolling the mouse wheel.

4.07 XTune Chart Controls
XTune uses the same chart control for data displays:

Chart Controls:

Zoom In: hold the "ALT-Key", drag the mouse with the left button held down to get a close-up of an area of interest.

Zoom In/Out: hold the "CTRL-KEY", drag the mouse with the left button held down either up/down or right/left.

Pan: hold the "SHIFT-KEY", drag the mouse with the left button held down in the desired direction.
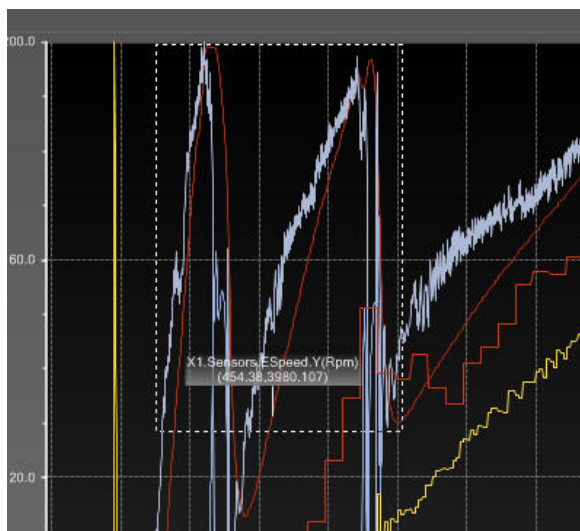
5.00 Explorer Panel Overview
XTune's Explorer panel contains all controls for accessing and viewing the data.

5.01 Explorer Panel Controls
The "Live" combo-box selects the data stream either from the live X-One USB connection or a special Demo mode may be selected for generating data as a learning aid.

The "MSync MSave" combo-box is fixed indicating that the user must manually save their calibration and hit the "Sync" buttons if power is ever cycled during calibration work.

The "Sample" button triggers a data acquisition.

The "Sync" button downloads the active calibration into RAM and may be hit at any time.

The "Progress" bar indicates acquisition, flash programming and sync operation progress.

5.02 Explorer Panel Tree Control
The "XPort" node represents USB connectivity and will load/unload the X-One whenever it is attached or removed.

The "ActiveCal" node indicates what calibration is currently flashed into the X-One. To change calibrations, simply drag the desired calibration from the AprCal node onto the active-cal node for programming. A message-box will be displayed indicating that the engine must be off and the ignition key on for programming.

14
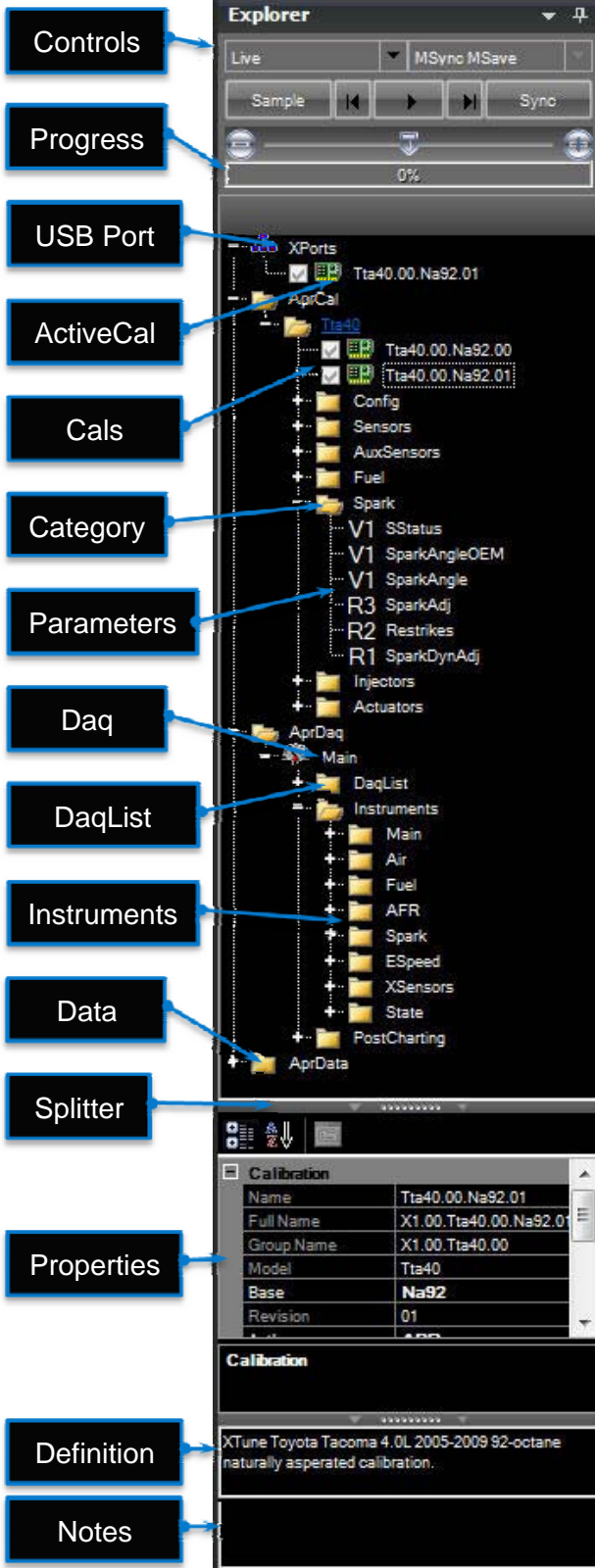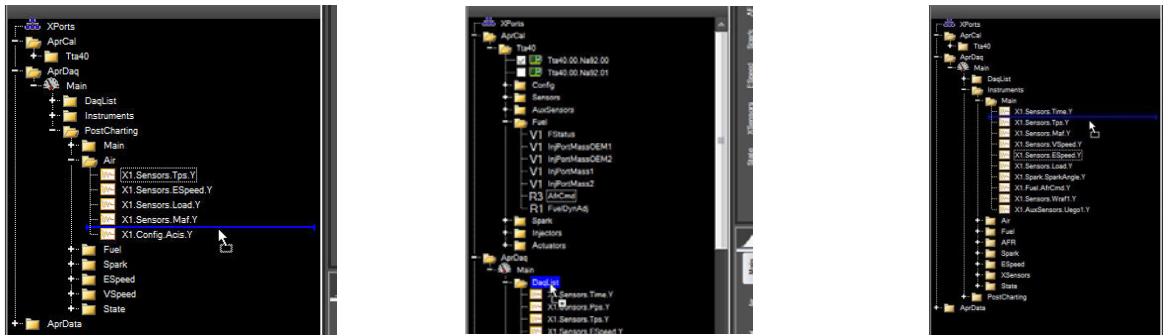
The "Check Boxes" indicate if a calibration needs to be saved after an edit has been performed. A check means that it is saved, unchecked means it needs to be saved. This also applies to the active-cal check-box, a check means that the active-cal is synchronized with the calibration file located in the AprCal directory, uncheck indicates that a flash operation needs to be performed. Simply click an unchecked box to save a calibration or flash the X-One.

A "Context Menu" is available by right-clicking a node with available options dependent upon the node selected. Operations available for the active-cal node are "Flash" and "Sync". For a calibration node in the AprCal directory, "New Revision" is available for creating a new copy of the calibration with an incremented calibration revision number. For "Post Charting" under the Daq-node, an option to create a new post chart (charts created automatically for acquisition datasets). The same option is available for creating new charts in a collected dataset.

After the listed calibration are the available categories. Double-click on any category to view the calibration panel that displays all of its parameters. Under a category will be listed the parameters that may be drag/dropped onto the "DaqList" to add to the acquisition. The parameters listed under the DaqList may be drag/dropped onto a gauge listed under the "Instruments" node to change the display. Select any parameter or chart and hit the "DELETE-KEY" to remove. The AprDaq file is automatically saved after every edit.

The last node is the AprData that organizes the collected datasets. Double-click and .AprData node to display the data for analysis and view the dataset. New charts are created with the context menu and drag/dropping parameters onto the new chart node.

5.03 Explorer Panel Property Grid
The property grid displays all parameter information for the selected node. Some properties are read-only but others allow editing like the number of samples to collect on a "Instrument" node.
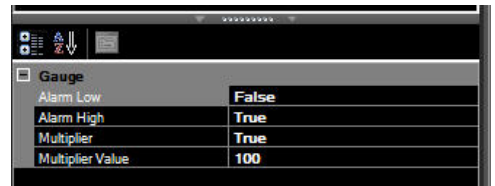
5.04 Explorer Panel Definition and Notes
Below the property grid are the "Definition" and "Notes" windows that display the parameter definition and notes for the selected node. Notes may be added to every parameter, calibration or node to aid in the tuning work.

6.00 Instrument Panel Overview

The "Instrument" panel displays the selected parameter's real-time value. The displayed parameter may be changed by drag/dropping from the "DaqList" node onto the desired gauge. The vertical "Instrument Tab" on the far left allows selection of different instruments.

The parameters "Alarm Low", "Alarm High", "Multiplier", and "Multiplier Value" may be changed in the property grid of the selected gauge.
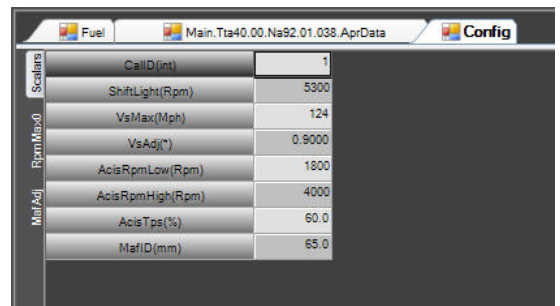

7.00 Calibration Panel Overview

Double-clicking a category will display its calibration panel listing all of its parameters. The vertical calibration tab on the far-left selects between scalar (1D) parameters listed in a spread sheet and has a separate tab for 2D and 3D parameters individually. Click on the desired tab to see its parameter panel.

The horizontal tab allows navigation between all opened panels.


7.01 Calibration Panel Scalar Editing

The "Config" category scalars are displayed to the right listing its parameters that may be edited. The top parameter shown is "CalID" that identifies the loaded calibration by flashing the MIL. At the bottom of this panel are the sheet tabs for different calibrations listed in the "AprCal" directory.

### 7.02 Calibration Panel 2D Polynomial Sensor Editing
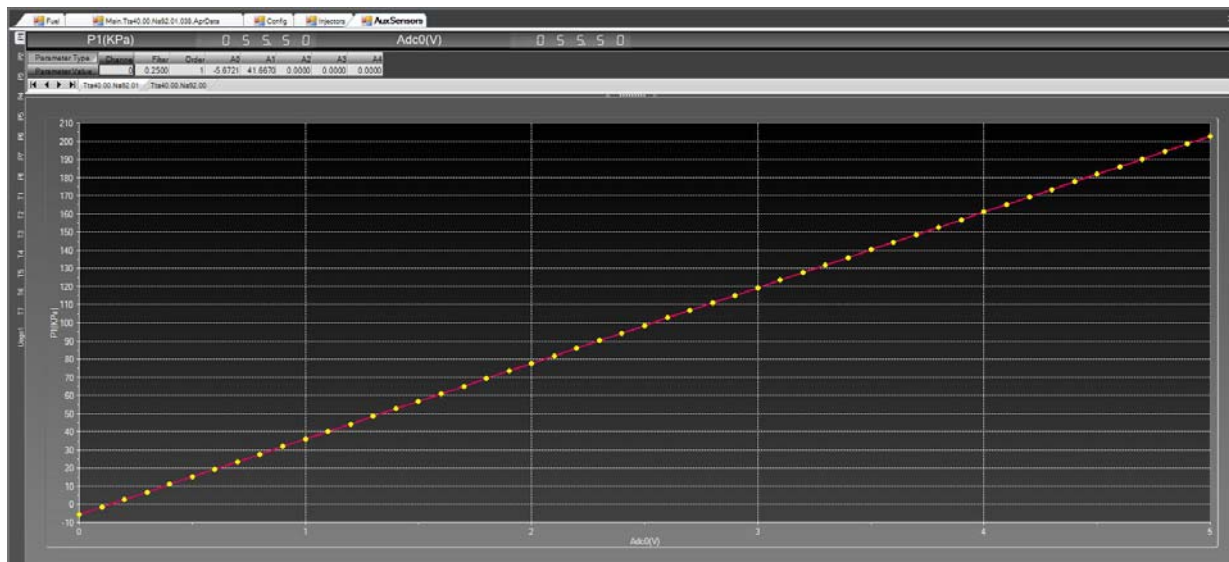
The 2D polynomial sensor panel lists the real-time numeric values for the output and analog-to-digital converter (ADC) voltage. Next is the spreadsheet control for selecting the channel, filter and polynomial coefficients. Values for the filter coeficient are from 0 to 1, the lower the value more filtering is applied (standard low-pass/rolling average filter). A value of 1 results in no filter at all. Below the spreadsheet is a chart displaying the equation x vs. y.

7.03 Calibration Panel 2D Interpolated Sensor Editing
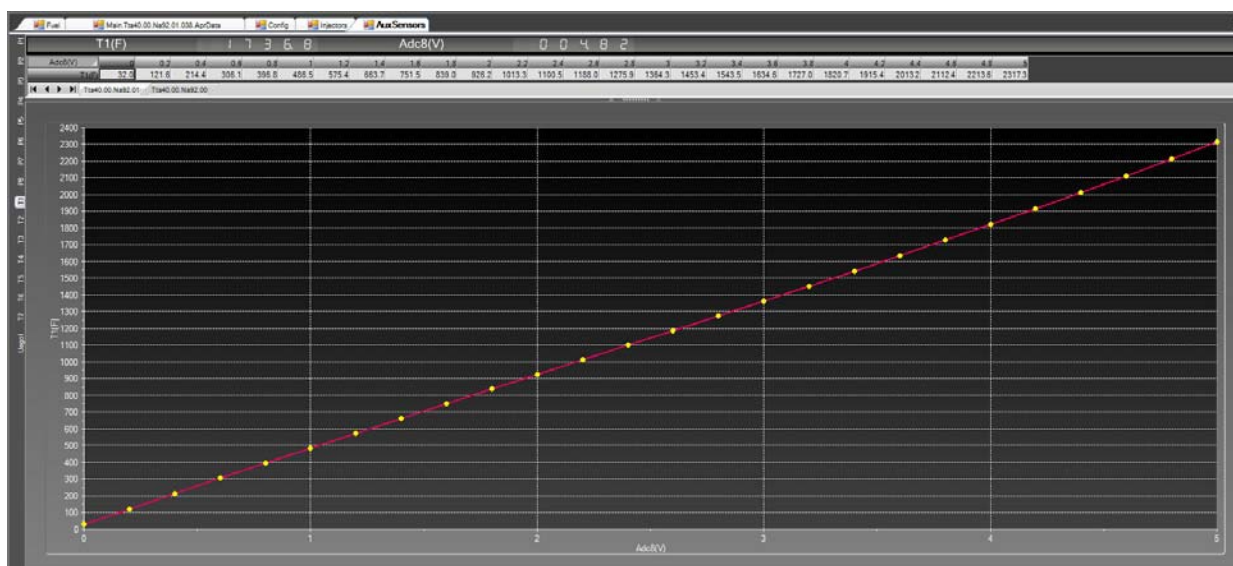

Similar to the polynomial sensor is the linear-interpolated sensor. Here the y-values are set directly with the desired transfer function. The 2D linear-interpolation is identical.

7.04 Calibration Panel 3D Interpolation Editing
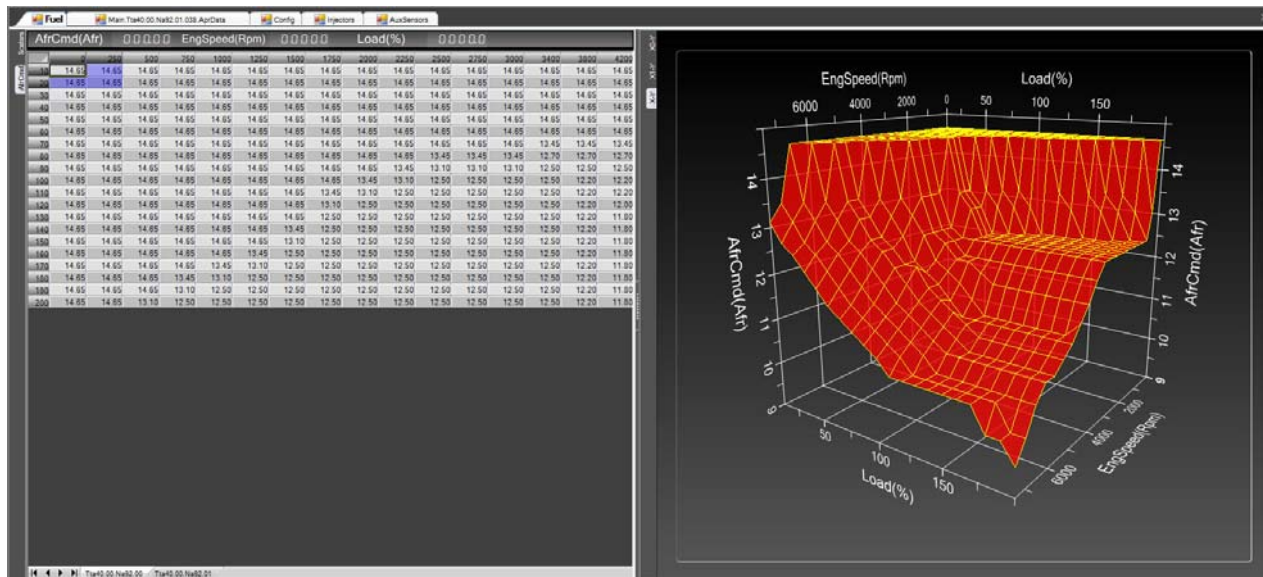
The 4-point interpolation panel also displays the real-time output, and input ordinates. The chart panel allows selecting between 3D and series viewing. The splitter can be collapsed allowing full spreadsheet view or right-clicked to cycle between vertical and horizontal splitting. Use the "CTRL-KEY" and mouse wheel to size the spreadsheet to the desired size.

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8.00 Data Panel Overview
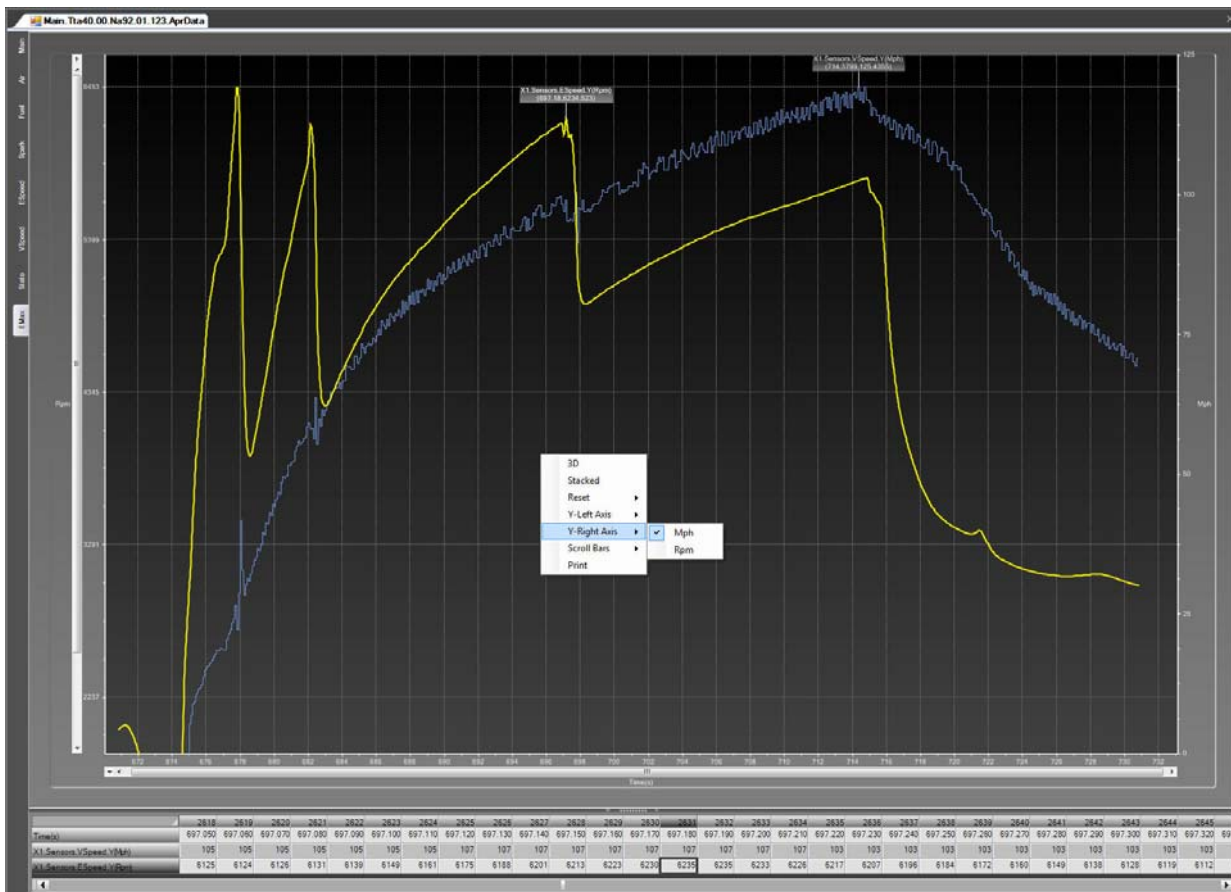
Double-click on any file located under the "AprData" node to open the dataset for charting. On the far left is the vertical "Chart Tab" for selecting the desired view. As stated earlier parameters may be added/deleted from a chart using the tree control as well as creating new charts using the context menu. Click on any signal to highlight (shown in thick yellow) a signal and display a value-label. Double-click any point to pin the value-label at any location.

Below the chart is the dataset that will track to the selected time point chosen. The context menu allows 3D ribbon views, signal stacking, resetting the chart or value-labels, left and right y-axis units selection, x and y scrollbars for navigating while zoomed in and printing.
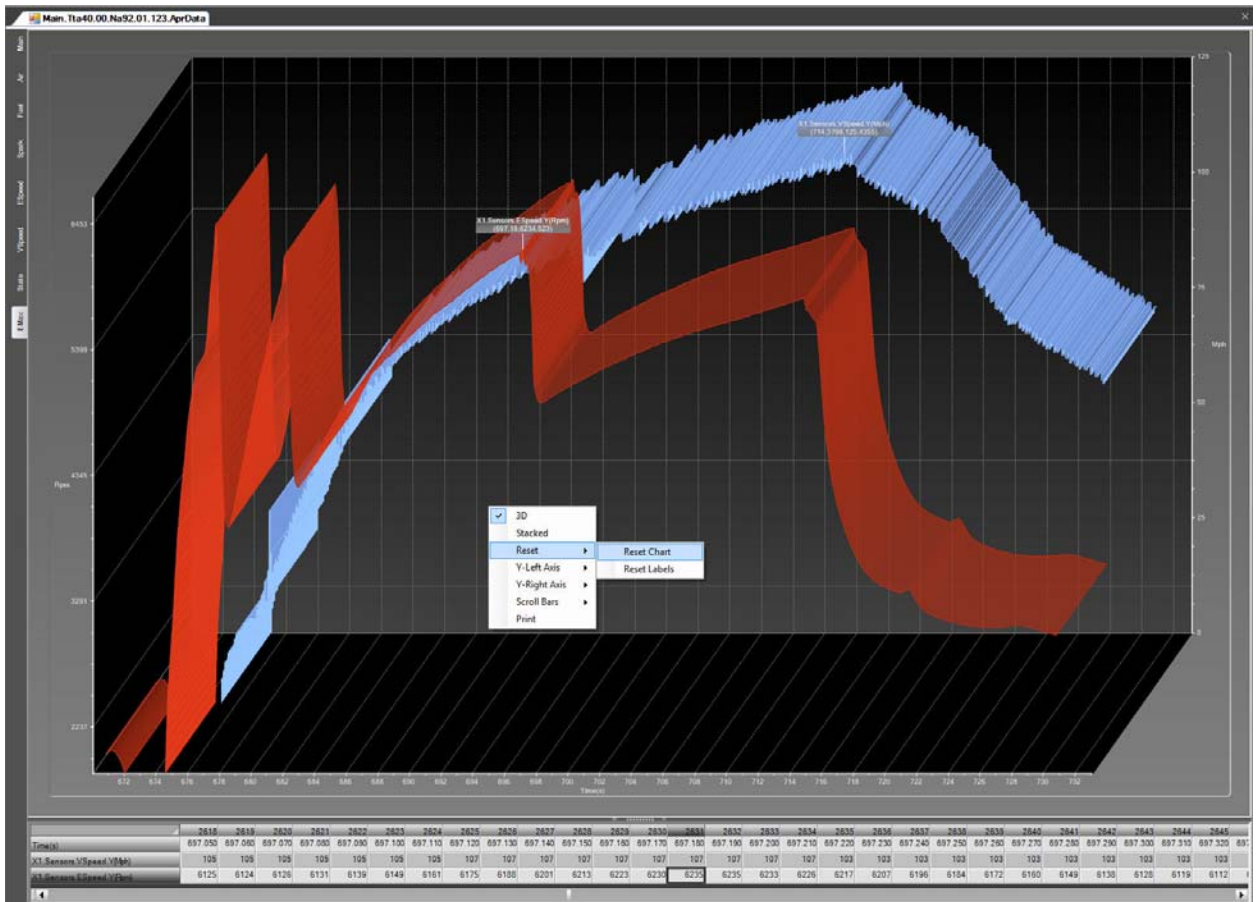
8.01 Data Panel Spreadsheet Features

Data from the spreadsheet can be cut-and-pasted into any Excel compatible spreadsheet for further analysis.