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MDSP-7000 Series Dynamometer Controller

Software Manual

MUSTANG DYNAMOMETER


MD
MUSTANG
DYNAMOMETER

MDSP 7000 Series Dynamometer Controller Software Manual

Version 2.49

Safety Information

DYNAMOMETERS ARE DANGEROUS! THE FOLLOWING LIST OF SAFETY PRECAUTIONS IS **NOT** EXHAUSTIVE, BUT REPRESENTS A MINIMUM LEVEL OF SAFETY PRECAUTIONS TO BE USED.

KEEP PEOPLE AWAY FROM THE DYNAMOMETER TESTING AREA WHILE TESTS ARE IN PROGRESS. ONLY THE VEHICLE OPERATOR SHOULD BE IN THE VICINITY OF THE DYNAMOMETER/VEHICLE-UNDER-TEST WHEN A TEST IS BEING PERFORMED.

ALWAYS SECURELY RESTRAIN A VEHICLE BEFORE TESTING ON A DYNAMOMETER. FRONT-DRIVE VEHICLES IN PARTICULAR MUST BE RESTRAINED NOT ONLY AGAINST FORWARDS/BACKWARDS MOVEMENT, BUT ALSO AGAINST SIDE-TO-SIDE MOVEMENT.

DO NOT WEAR LOOSE FITTING CLOTHING AROUND A DYNAMOMETER. TIES, SLEEVES, SCARVES, CHAINS, ETC. CAN BECOME WRAPPED THE ROLLS, SHAFTS, ETC. AND CAUSE SERIOUS OR FATAL INJURIES.

DO NOT LEAVE TOOLS, ROPES, CHAINS, PARTS OR ANY OTHER OBJECTS LOOSE AROUND THE DYNAMOMETER. THESE OBJECTS MAY BE THROWN, CRUSHED, TWISTED, ETC. IF THEY VIBRATE INTO CONTACT WITH THE DYNAMOMETER OR THE VEHICLE UNDER TEST.

DO NOT APPLY SUDDEN THROTTLE OR BRAKE CHANGES WHILE ON THE DYNAMOMETER, AS THIS MAY CAUSE THE VEHICLE UNDER TEST TO SUDDENLY CHANGE POSITION ON THE DYNAMOMETER CAUSING A LOSS OF CONTROL OF THE VEHICLE.

DYNAMOMETERS CONTAIN VERY HEAVY COMPONENTS OPERATING AT HIGH SPEEDS WITH HIGH FORCES. DO NOT TOUCH OR COME INTO CONTACT WITH ANY PART OF THE DYNAMOMETER WHEN IT IS IN OPERATION, PARTICULARLY THE ROLLS, SHAFTS AND BELTS.

DYNAMOMETERS CAN THROW FOREIGN OBJECTS AT VERY HIGH VELOCITY. ALWAYS WEAR APPROVED EYE PROTECTION WHEN WORKING AROUND A DYNAMOMETER.

THE CONTROL BOX CONTAINS DANGEROUS VOLTAGES. ONLY QUALIFIED PERSONELL SHOULD EVER WORK ON A CONTROL BOX, PAU (POWER ABSORBING UNIT), MOTOR, OR ANY OTHER ELECTRICAL COMPONENT OF A DYNAMOMETER. FURTHERMORE, SOME CONTROL BOXES CONTAIN MULTIPLE POWER SOURCES; ANYONE WORKING ON A CONTROL BOX MUST BE CERTAIN THAT ALL POWER SOURCES HAVE BEEN DISCONNECTED PRIOR TO WORKING ON THE EQUIPMENT.

DYNAMOMETERS CONTAIN POWER ABSORBING UNITS (PAU'S OR MOTORS) THAT BECOME VERY HOT. DO NOT TOUCH ANY PART OF A PAU OR MOTOR TO AVOID POTENTIALLY SEVERE BURNS.

HIGH PRESSURE AIR IS USED IN VARIOUS ELEMENTS OF A DYNAMOMETER. OBSERVE ALL PRECAUTIONS REQUIRED FOR SAFELY WORKING AROUND COMPRESSED AIR WHEN WORKING ON A DYNAMOMETER.

THE LIFT/ROLL-LOCK OF A DYNAMOMETER CAN LIFT A CAR! DO NOT ALLOW ANY PART OF YOUR BODY TO FALL INTO THE LIFT/ROLL-LOCK AREA OF THE DYNAMOMETER TO AVOID POTENTIALLY FATAL CRUSHING WOUNDS.

VEHICLE EXHAUST GASSES, AS WELL AS EXHAUST GAS SENSOR CALIBRATION GASSES, ARE POISONOUS AND CAN BE FATAL. MAKE SURE THAT ADEQUATE VENTILATION IS PROVIDED BEFORE OPERATING A VEHICLE OR EXHAUST GAS ANALYZER IN AN ENCLOSED SPACE.

Introduction

This document provides the operating instructions for Mustang Dynamometer's 7000 series of dynamometer control software.

Before operating your dynamometer, please read and understand the following section titled "Safety Information", along with any and all other safety information provided with your dynamometer.

Based on our own experience with various software packages, we recommend that the reader of this manual follow the following procedure for learning about our software:

1) Before trying to operate your dynamometer, you should quickly review this document in its entirety, in order to gain an overall idea of the capabilities of the software.
2) The following sections require that you actually use the software, so you should have this manual handy for reference.
3) Since your system should arrive with the software preinstalled, we suggest that you start working with the software by navigating through the various menus, again to gain an overall impression of how the software works, and how to get to the various functions provided.
4) Next, we suggest that you add your company information, the screen for which can be found under the "Database" menu.
5) Now you can add a customer and vehicle definition, so that you can save the results of any tests that you will run.
6) On the "Calibration" menu, make sure that all the physical parameters (roll diameter, etc) of your dynamometer are set to the correct values, and calibrate the load cell inputs of your system.
7) You are now ready to start performing vehicle tests, which will generate test data that you can use to learn about the various test reports, graphing and data exporting facilities.

Users of this software have frequently reported that the MD-7000 software takes longer to master than some other dynamometer control packages, but that the initial effort yields significant long-term benefits. The better you understand your dynamometer, the better your dynamometer will serve you.

Instructions for all database, calibration and testing routines are provided, along with screen images to help the reader identify the correct screen for performing the described actions.

Unlike some other dynamometer control systems, our 7000 series software has been designed to work with many different types of dynamometers. Thus, there are many, many configurable parameters in the software. For most applications, only a handful of parameters will require changes. However, in some cases other parameters will require changes, and this document does not describe every parameter used in the software. In the event of unusual system requirements, every parameter that the software uses is available in the standard Windows "Ini" file that the application uses for parameter storage. Before attempting any manual modifications to values in the application's "Ini" file, please contact Mustang Dynamometer for technical assistance.

While this document has been carefully written and verified, errors may still exist. In the event that you find any information in this document that appears to be incorrect, please contact Mustang Dynamometer using the contact information provided below:

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2300 Pinnacle Parkway
Twinsburg, Ohio 44087
Phone: 330-963-5400
Fax: 330-425-3310
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E-mail: service@mustangdyne.com

Table of Contents

Dynamometer Concepts

Basic Functions

A chassis dynamometer's basic functions are:

1) To measure the power output of a vehicle; and

2) To apply a specific loading to a vehicle.

Chassis dynamometers are capable of very accurately measuring the speed, torque and power that is delivered to them. With the appropriate hardware and software, they are also capable of applying a well-controlled loading to the vehicle under test. The typical loading modes used with a chassis dynamometer are constant force, constant speed, or a vehicle-simulation value

Values Reported by a Chassis Dynamometer

A chassis dynamometer can directly measure the following values:

1) Roll shaft RPM/speed.

2) Torque/force applied to the dynamometer's roll shaft(s).

All other values are based on these original 2 values. For example, acceleration is computed from 2 successive speed measurements, power is calculated based on the measured speed and torque of the dynamometer's roll shaft(s), etc.

When a chassis dynamometer reports a "torque" value, the value reported is the torque measured on the dynamometer's roll shaft(s), **not** on the vehicle's drive axle or engine crankshaft.

A chassis dynamometer and the vehicle that is being tested on it effectively form a geared power transfer system. While force is obviously not an engine-crankshaft relative term, and power values do not scale (ignoring transmission losses) from shaft to shaft in a geared system, torque values **do** scale from shaft to shaft in a geared system. So, in order for a chassis dynamometer to report engine crankshaft relative torque values, the control software must know:

1) Dynamometer roll shaft torque.

2) Dynamometer roll shaft RPM.

3) Engine crankshaft RPM.

Using these 3 values, the control software can calculate the engine crankshaft torque that the engine must be producing, using the formula below:

EngineTorque = ((DynoShaftTorque * DynoShaftRPM) / EngineRPM)

When engine RPM is not available, there is no way to report an engine crankshaft relative torque value.

In Mustang Dynamometer chassis dynamometer software, when an engine-crankshaft relative torque value is reported, it is simply a calculated value as described above. No "correction" factor has been applied to account for drive-train losses. The overall gearing between the vehicle's engine and the

dynamometer's rolls has been calculated and used to scale the measured torque from a dynamometer roll shaft value to an engine crankshaft value. So, just as power values will be lower on a chassis dynamometer than on a test-stand dynamometer, any reported engine torque values will be similarly lower.

Differences Between Chassis and Test-Stand Dynamometers

It is important to remember that a chassis dynamometer reports the power, force, and speed experienced by the dynamometer's roll shaft(s). A power figure obtained for an engine using a test stand dynamometer will (and should) inevitably be higher than the power figure obtained using a chassis dynamometer, for (among others) the following reasons:

1) On a test stand, there are no torque-converter/clutch, transmission, driveshaft, differential or axle bearing losses.

2) On a test stand, there are no losses between the tires of the vehicle and the rolls of the dynamometer.

3) On a test stand, some or all of the engine accessories may be disconnected.

4) On a test stand, the engine intake air, water and oil supplies may be externally controlled.

5) On a test stand, the exhaust may be different than the exhaust system used on the vehicle.

Differences in Reported Power Between Dynamometers

All of the following factors can influence the power measured by a chassis dynamometer:

1) Tire compound, pressure and temperature.

2) Engine, transmission and differential temperatures.

3) Lubricant types.

4) Method of vehicle restraint (downward pressure will waste power).

5) Type of testing performed: fast decelerating sweeps will generate the highest values, steady state tests will generate intermediate values, and fast accelerating sweeps will generate the lowest values, due to the internal power requirements of the engine and drive-train in the vehicle under test.

6) Atmospheric condition corrections to different "standard" conditions.

7) Operator driving differences (can be very significant!).

8) Data acquisition options, particularly smoothing/averaging and clipping functions.

While all chassis dynamometers should report the same power output for the same vehicle, this is seldom the case. Most commonly, the difference in reported power values for the same vehicle on different dynamometers can be traced to one or more of the factors listed above.

Installation

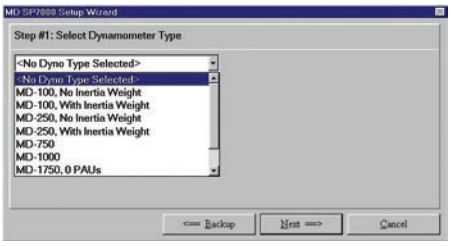
The installation software for Mustang Dynamometer's 7000 series software is provided on CD. This section describes the installation procedure to use with our standard CD distribution.

The Setup Wizard

The first time the software is run on a new installation, the Setup Wizard will execute before the software is run. This wizard is intended to help the user properly configure the software for the particular model of dynamometer that they have.

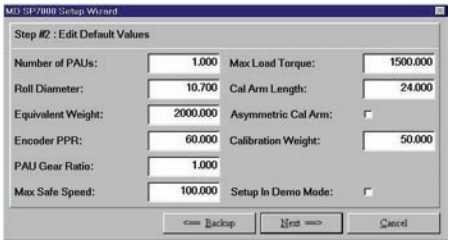
Note that there are numerous systems in the field that have non-standard configurations; the default values provided by this wizard, based on the selected dynamometer type, will not work with every dynamometer. If you are unsure as to the status of your dynamometer (standard or non-standard configuration), try the standard configuration first; if the standard configuration doesn't appear to operate correctly, contact Mustang Dynamometer for further assistance.

Step #1: Select Dynamometer Type



This page allows the operator to select the type of dynamometer that they have. This value is used to set the default values for several operating parameters, and must be set correctly.

Step #2: Edit Default Values



This page allows the operator to review and/or modify several default configuration values.

Number of PAUs: The number of eddy-current Power Absorber Units in the dynamometer.

Roll Diameter: The diameter of the tire rollers, in inches.

Equivalent Weight: The equivalent vehicle weight of the dynamometer, in pounds.

Encoder PPR: The number of pulses generated by the speed encoder per revolution of the tire rollers.

PAU Gear Ratio: The gear ratio between the tire rollers and the PAU(s) of the dynamometer. If the PAU(s) will turn faster than the tire rollers, this number will be greater than 1. If the PAU(s) will turn slower than the tire rollers, this number will be less than 1.

Max Safe Speed : The maximum safe operating speed of the dynamometer, in MPH.

Max Load Torque: The maximum tire roller-shaft torque that the dynamometer's PAU(s) can generate.

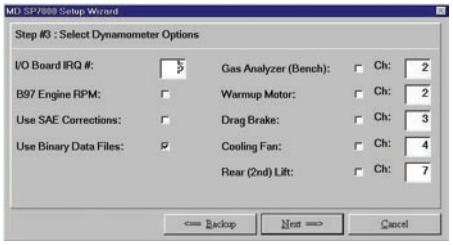
Cal Arm Length: The length of the PAU load cell calibration arm, in inches. More specifically, the distance between the center of the calibration weight and the PAU shaft center when the calibration arm is installed on the PAU.

Asymmetric Cal Arm: This option MUST be left UN-CHECKED if you have a dynamometer with a built-in calibration arm, eg older MD-100's, MD-250's, etc. If you have a separate calibration arm, the setting of this value is determined this way: If the calibration arm for your dynamometer is symmetrical (sticks out the same length on each side of the PAU), leave this option un-checked. If the calibration arm for your dynamometer is asymmetrical (sticks out further on one side of the PAU than on the other side), check this option.

Calibration Weight: The PAU load cell calibration weight, in pounds. This value is stamped into the calibration weight itself.

Setup In Demo Mode: **WARNING**: If this option is selected, no dynamometer control will be possible. This option is provided for users who wish to run the software on PCs that are not connected to a dynamometer. This may be done for evaluation or training purposes. This may also be done by users who wish to view/print test results (generated on the dynamometer control PC) on another PC.

Step #3: Select Dynamometer Options



This page allows the operator to review and/or modify several dynamometer option values.

I/O Board IRQ #: The PC hardware interrupt number in use by the dynamometer controller board in the PC. This number is most commonly 5, but may be 7 (on Compaq PCs) or 2 (on older systems). Note that systems older than 1996 may have the controller board configured to use (2) interrupts; if you have a system of that vintage, you will need to have Mustang Dynamometer modify your controller board for use with this software.

B97 Engine RPM: If you have the B97 engine RPM board installed in your PC, check this option.

Use SAE Corrections: If you wish to have all data corrected per SAE J1349 (Jun90) (or your own custom standards), check this option.

Use Binary Data Files: Checking this (recommended) option causes all trace (strip-chart) data for tests to be stored in binary files, rather than in the system database. Binary file storage is ~1000 times faster than database storage, and minimizes the load on the database facility, leading to a more stable database. If this option is not checked, all test data will be stored in the database (not recommended). If you are updating an existing system, you will probably want to use the "Export To Binary Files" utility located under the "Database" menu.

Gas Analyzer (Bench): If you have an Andros 5-gas bench, check this box, and specify the serial communications port it is connected to.

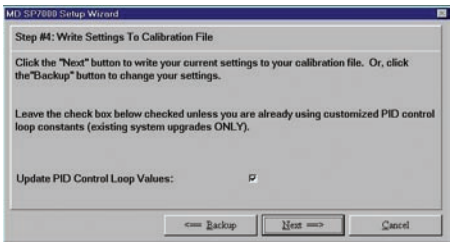
Warmup Motor: If you have a warmup motor on your dynamometer, check this box, and specify the digital output channel it is connected to.

Drag Brake: If you have a drag brake on your dynamometer, check this box, and specify the digital output channel it is connected to.

Cooling Fan: If you have a vehicle cooling fan on your dynamometer, check this box, and specify the digital output channel it is connected to.

Rear (2nd) Lift: If you have a rear (2nd) lift on your dynamometer, check this box, and specify the digital output channel it is connected to.

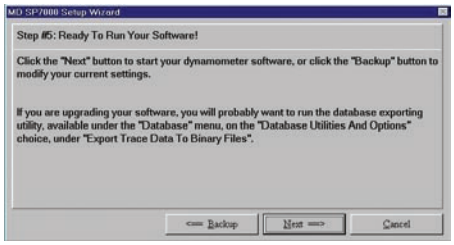
Step #4: Write Settings To Ini FIle



This page allows the operator to specify whether PID control loop values should be updated (normally yes), and writes the new values to the application's Ini file.

Update PID Control Loop Values: If this option is checked (recommended), the PID control loop values will be updated. This option should always be checked, **UNLESS** you have developed a set of custom PID values that you wish to keep.

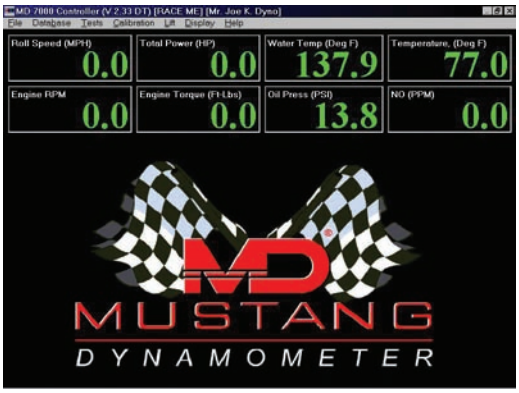
Step #5: Ready To Run Your Software!



This page allows the user to confirm that the current settings are correct, and launch the dynamometer control software.

The Main Screen

This is the main screen of the dynamometer control software. This upper portion of this form is visible in all test routines. The eight (8) value displays may be configured as to value displayed, format used, and safe/warning/danger limit values and colors. There is a horizontal bar-indicator of acceleration (+/- 10 MPH/second) between the upper and lower rows of values.



Specifying A Value For Display

The operator can specify the value displayed in each indicator panel by simply double-clicking on the panel to be modified. Using the left mouse button will bring up a menu of the most common values, while using the right mouse button will bring up a menu of gas analyzer and external data acquisition channels.

Left mouse button menu

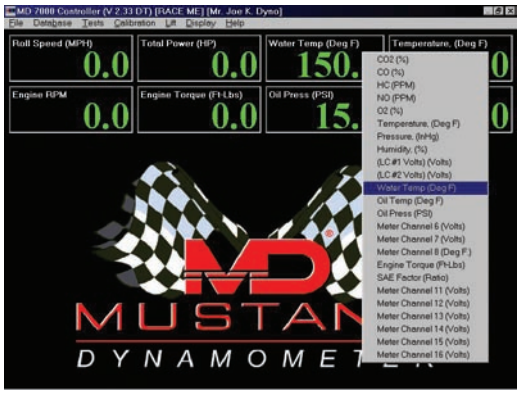
The items in this list are described below. Note that this list represents approximately ½ of the items that can be viewed in the trace-data graph viewer, while the right-mouse-button list represents the remainder of the items that can be viewed.

Roll Speed (MPH) Roll / vehicle speed.

Roll Speed (RPM) Roll speed.

Acceleration (MPH/Sec)	Vehicle acceleration.
Acceleration (Ft/Sec^2)	Vehicle acceleration.
Acceleration (Gs)	Vehicle acceleration. (NOTE: The following "Torque" values are in terms of the dynamometer's roll shaft; these are not scaled back to the engine crankshaft.)
Total Torque (Ft-Lbs)	Total torque measured on the dynamometer's roll shaft.
Static Torque (Ft-Lbs)	Sum of PAU Torque and Parasitics Torque.
PAU Torque (Ft-Lbs)	Torque applied to the dynamometer's roll shaft by the PAU(s).
Parasitics Torque (Ft-Lbs)	Torque applied to the dynamometer's roll shaft by parasitic losses (bearings, belts, windage, etc.)
Accel Torque (Ft-Lbs)	Torque applied to the dynamometer's roll shaft by the acceleration of the dynamometer inertia.
Total Force (Pounds)	Total force measured by the dynamometer at the roll surface.
Static Force (Pounds)	Sum of PAU Force and Parasitics Force.
PAU Force (Pounds)	Force applied to the dynamometer's roll surface by the PAU(s).
Parasitics Force (Pounds)	Force applied to the dynamometer's roll surface by parasitic losses (bearings, belts, windage, etc.)
Accel Force (Pounds)	Force applied to the dynamometer's roll surface by the acceleration of the dynamometer's inertia.
Total Power (HP)	Total power input to the dynamometer.
Static Power (HP)	Sum of PAU Power and Parasitics Power.
PAU Power (HP)	Power absorbed by the dynamometer's PAU(s).
Parasitics Power (HP)	Power absorbed by the dynamometer's parasitic losses (bearings, belts, windage, etc.)
Accel Power (HP)	Power absorbed by the acceleration of the dynamometer's inertia.
Engine RPM	Engine RPM
Opacity (%)	(Diesel) Exhaust opacity.

Right mouse button menu



The items in this list are described below. Note that this list represents approximately ½ of the items that can be viewed in the trace-data graph viewer, while the left-mouse-button list represents the remainder of the items that can be viewed.

CO2 (%) — Exhaust gas CO^2 concentration.

CO (%) — Exhaust gas CO^2 concentration.

HC (PPM) — Exhaust gas (T)HC concentration (PPM Propane).

NO (PPM) — Exhaust gas NOx concentration.

O^2 (%) — Exhaust gas O^2 concentration.

Temperature (Deg F) — Ambient temperature.

Pressure (InHg) — Ambient atmospheric pressure (absolute).

Humidity (%) — Ambient (relative) humidity.

(LC #1 Volts) (Volts) — Auxiliary analog input channel #1 configured to monitor load cell #1.

(LC #2 Volts) (Volts) — Auxiliary analog input channel #2 configured to monitor load cell #2.

Water Temp (Deg F) — Auxiliary analog input channel #3 configured to monitor water temp.

Oil Temp (Deg F) — Auxiliary analog input channel #4 configured to monitor oil temp.

Oil Press (PSI) — Auxiliary analog input channel #5 configured to monitor oil pressure.

Meter Channel 6 (Volts) — Auxiliary analog input channel #6, not in use

Meter Channel 7 (Volts) — Auxiliary analog input channel #7, not in use

Meter Channel 8 (Volts) — Auxiliary analog input channel #8, not in use

Engine Torque (Ft-Lbs) Auxiliary analog input channel #9 configured to monitor Engine Torque. No analog input is actually used here; rather, by simply entering the name "Engine Torque", an engine-crankshaft-relative total torque output value can be monitored, displayed, recorded and graphed. This value can only be used when an engine RPM input source is available, since the Engine Torque value is simply the Total Torque value (from the dynamometer's roll shaft) scaled by (Roll Shaft RPM / Engine RPM).

SAE Factor (Ratio) Auxiliary analog input channel #10 configured to monitor SAE Factor. No analog input is actually used here; rather, by simply entering the name "SAE Factor", the current power correction factor can be monitored, displayed, recorded and graphed.

Meter Channel 11 (Volts) Auxiliary analog input channel #11, not in use

Meter Channel 12 (Volts) Auxiliary analog input channel #12, not in use

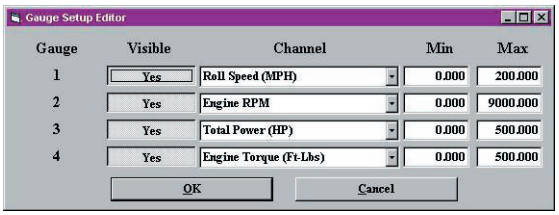
Meter Channel 13 (Volts) Auxiliary analog input channel #13, not in use

Meter Channel 14 (Volts) Auxiliary analog input channel #14, not in use

Meter Channel 15 (Volts) Auxiliary analog input channel #15, not in use

Meter Channel 16 (Volts) Auxiliary analog input channel #16, not in use

Gauge Setup Editor



The main form of the software has 8 numeric displays on it. It can also have a mixture of numeric displays and guage displays. Each gauge takes the place of two (2) numeric displays.

Visible
Tells if the selected gauge should be displayed. Otherwise, the two (2) numeric displays will be visible.

Channel
Tells which system channel should be displayed in the selected gauge.

Min
Tells the minimum value that should be displayed on the gauge.

Max
Tells the maximum value that should be displayed on the gauge.

Note: While the "Min" and "Max" values establish the absolute limits of these gauges, the red/yellow/green/yellow/red ranges are determined by the display limits and colors set in the separate editor used to configure the limits and colors for the numeric displays. Similarly, the numeric format used for the numeric display on the gauges is set by the separate display format editor used for the numeric display panels.

The File Menu

Load Configuration

2WD Mode
4WD Mode
Bike Mode

These menu items let the operator store various dynamometer configurations, for dynamometers that can be configured. The values that are saved/loaded are:

Dynamometer inertia value
Which load cell inputs should be read
Which PAU enables should be driven
Which PAU control signals should be driven
Which parasitic losses file should be loaded
Whether the second speed input should be used to derive an averaged speed

The software must be configured for the desired mechanical configuration, then the settings must be saved. Later, the "Load" commands can be used to quickly restore the software to the saved configurations whenever the mechanical configuration is changed.

Save Configuration

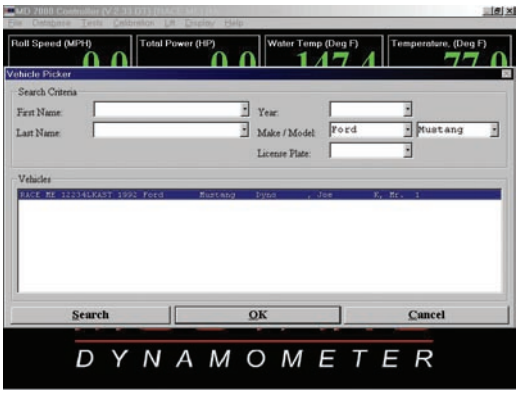
2WD Mode
4WD Mode
Bike Mode
(See comments above)

The Database Menu

All company, customer, vehicle and test data can be accessed via the database menu. The database is a hierarchical relational database, wherein the primary relationships are: customers have vehicles, and vehicles have test results. There are also utilities for backing up, restoring, repairing and exporting values from the database, along with several data entry and viewing screens.

Pick Vehicle For Testing

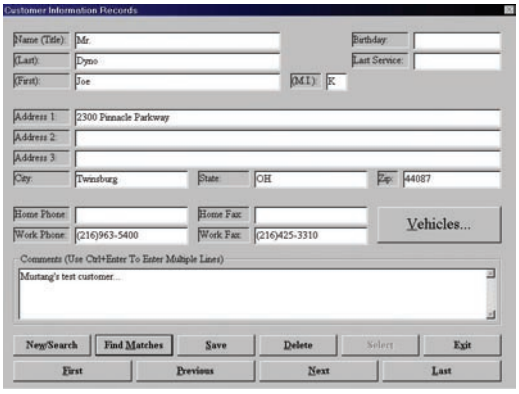
This form allows the operator to select a vehicle that future test results will be saved under (until a new vehicle is selected). Note that no test results can be saved until a vehicle is selected to associate the test results with.



The operator can specify full or partial values for each field, to narrow the search results.

Customers/Vehicles (Customers)

This form allows the operator to enter new customer records, or edit/delete existing customer records.



To add a new customer

1) Click "New/Search".
2) Enter the information for the new customer.
3) Click "Save".
4) The new customer information will be saved.

To find existing customers

1) Click "New/Search".
2) If desired, enter any full or partial field value to reduce the number of records that will be found.
3) Click "Find Matches".
4) The list of all existing customers can now be navigated using the "Next", "Previous", "First" and "Last" buttons.

To edit an existing customer

1) Find the customer using the method given above.
2) Make any desired changes to the current customer information.
3) Click "Save".
4) The new customer information will be saved.

To delete an existing customer

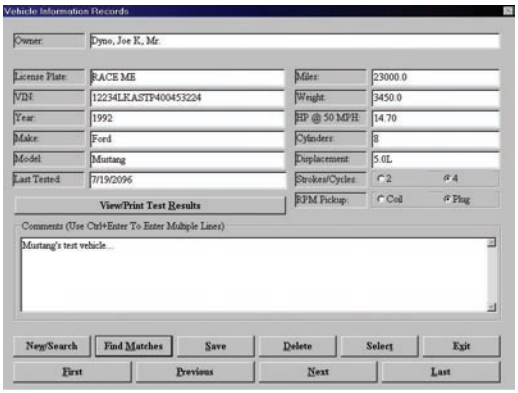
1) Find the customer using the method given above.
2) Click "Delete".
3) The customer, ALONG WITH ALL OF THE CUSTOMER'S VEHICLES, AND THE TEST RESULTS FOR THOSE VEHICLES, WILL BE ERASED.

To add/change/delete/view the current customer's vehicles and their test results

1) Find the customer using the method given above.
2) Click "Vehicles…"
3) You will be taken to a similar data entry screen where the current customer's vehicles, and the vehicle's test results, can be edited and/or viewed.

Customers/Vehicles (Vehicles)

This form allows the operator to enter new vehicle records, or edit/delete existing vehicle records.



To add a new vehicle

1) Click "New/Search".
2) Enter the information for the new vehicle.
3) Click "Save".
4) The new vehicle information will be saved.

To find existing vehicles

1) Click "New/Search".
2) If desired, enter any full or partial field value to reduce the number of records that will be found.
3) Click "Find Matches".
4) The list of all existing vehicles (for the current customer) can now be navigated using the "Next", "Previous", "First" and "Last" buttons.

To edit an existing vehicle

Find the vehicle using the method given above.

2) Make any desired changes to the current vehicle information.
3) Click "Save".
4) The new vehicle information will be saved.

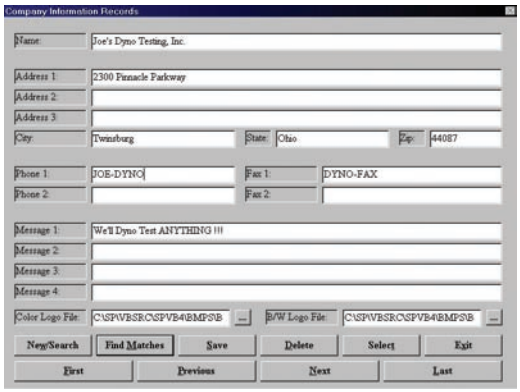
To delete an existing vehicle
1) Find the vehicle using the method given above.
2) Click "Delete".
3) The vehicle, ALONG WITH ALL OF THE TEST RESULTS FOR THE VEHICLE, WILL BE ERASED.

To view/print the current vehicle's test results
1) Find the customer using the method given above.
2) Click "View/Print Test Results"
3) You will be taken to a similar data entry screen where the current vehicle's test results can be viewed and/or printed.

To select the current vehicle (so test results will be saved under this vehicle)
1) Find the customer using the method given above.
2) Click "Select".
3) All future test results will be saved under the current vehicle (until another vehicle is selected).

Companies

This form allows the operator to enter new company records, or edit/delete existing company records.



Company records allow the user to specify their company specific information. This information is used when test results are printed. Multiple company definitions may be entered, to allow for facilities where dynamometer use is shared among multiple companies.

It is important to remember that company information is only used once it has been selected; after you add your company information and save it, make sure to select that company, so that the appropriate company information will be printed on future test report sheets.

To add a new company
1) Click "New/Search".
2) Enter the information for the new company.
3) Click "Save".
The new company information will be saved.

To find existing companies

1) Click "New/Search".
2) If desired, enter any full or partial field value to reduce the number of records that will be found.
3) Click "Find Matches".
4) The list of all existing company can now be navigated using the "Next", "Previous", "First" and "Last" buttons.

To edit an existing company

1) Find the company using the method given above.
2) Make any desired changes to the current company information.
3) Click "Save".
4) The new company information will be saved.

To delete an existing company

1) Find the company using the method given above.
2) Click "Delete".
3) The company information record will be ERASED.

To select the current company (so test reports will print this company's information)

1) Find the company using the method given above.
2) Click "Select".
3) All future test reports will include the current company's information (until another company is selected).

Trace Graph Viewer

This form is significantly different starting with version 2.49 of the software.

Most of the functions available on the graphing screen are available by clicking on a button or menu item, but some functions are not directly visible, and are discussed below.

To open a test run

Double-click on the "Run #1", "Run #2" or "Run #3" buttons, using the left mouse button.

To "hide" or "un-hide" a loaded test run

Double-click on the "Run #1", "Run #2" or "Run #3" buttons, using the right mouse button. Loaded but hidden test runs will have a red background.

To unload a test run

Double-click on the "Run #1", "Run #2" or "Run #3" buttons, using the left mouse button, while holding the "Shift" button down.

To set the color for any test run (when in per-test coloring mode)

Double click on the vehicle description box just to the right of the "Run #1", "Run #2", "Run #3" boxes.

To edit the comments for a test run

Double click on the test comments box for the test run you wish to edit.

To change channels used in the the Y-axis scales, click on the Y-axis scale headers ("Acceleration" and "Acceleration); a menu of channels will be displayed which you can use to select the channels used for each of the two (2) Y-axis scales.

To change the color used to display a channel, click on the channels legend (on the right side of the graphing form), and a color-selecting window will be displayed which you can use to change the color of the channel you clicked on.

To enter specific X- or Y-axis scale limits, click on the minimum or maximum value that you would like to change (Y-axis minimum and maximum values are located on the left side of the screen at the bottom and top of the Y-axis scales, X-axis minimum and maximum values are located at the bottom of the graphing area at the left and right of the Xaxis scale.) A dialog box will pop up, and you can enter the value you would like to use in that dialog box.

To zoom in on the displayed graph area, use your mouse to draw a box around the area you would like to zoom in to; click down with the left mouse button, and hold that button down while dragging the mouse to draw a box. When you let go of the mouse button, the display will zoom in to the area inside the box you have drawn. The box you draw must be at least 20% of the width/height of the graphing area, or nothing will happen. If you draw a very "thin" box (20+% vertically or horizontally, but very small in the other direction), the display will zoom in on the axis that your box is larger in **only**.

To show specific values for each data point in the graph, click down on the graph area using the right-mouse button. What happens next will depend on the setting of "Free-Ranging Cursor" / "Point-Locked Cursor" under the "Options" menu. If "Free-Ranging Cursor" is checked: An X/Y crosshair will be shown on the graphing area, and the corresponding X- and Y-scale values will be displayed in sliding value boxes aligned with the cross-hair lines. If "Point-Locked Cursor" is checked: An X/Y crosshair will be shown on the graphing area, but with two (2) horizontal lines. The vertical line will "snap" to the nearest actual data point, and the horizontal lines will snap to the nearest actual data point for each of the two (2) Y-axis scales. The sliding value boxes will be aligned with the crosshair lines, and will show the actual point values. Additionally, the graph legend on the right side of the graphing area will show the actual point values for all channels.

Smoothing, by setting the smoothing values under the "Options" menu, you can make the displayed values more or less smoothed looking. The "FIR" mode is generally superior to the "IIR" mode. Note that heavy smoothing values (>50 in "FIR" mode, > 90 in "IIR" mode) can hide transient values that may be important indicators of your vehicle's performance.

Min/Max/Avg Values

You can pop up a second window that will show the minimum, maximum and average values for all loaded test runs, for all selected channels, as currently smoothed and displayed.

Per-channel –vs- per-test coloring

You can select either per-channel or per-test coloring of the traces displayed. When examining many channels from a single test run, per-channel coloring will be easier to see. When examining the same channels from several test runs, per-test coloring will be easier to see. When examining multiple channels from multiple test runs, it is easiest to see with per-channel coloring, with patterned lines enabled. The first run lines will be solid, the second run lines will be dashed, the third run lines will be dashed, but more off than on.

Graph by Time / MPH / RPM

You can select any of these three common X-axis channels using the buttons on the form. Note that this form maintains X-axis limit values for all three of these channels. If you need to graph data by some other channel (possibly intake manifold pressure, if you do constant speed/RPM tests while varying boost levels), you can click on the X-axis caption ("Time (Seconds)" above) to pick any channel from a list. Note that X-axis limit values are not stored for other channels.

Saving Default Display Settings

Once you have the channels, colors, X-axis selection, etc configured the way you like them, you can save those settings to disk, so they will be the default values for future sessions.

Saving/Restoring Custom Display Settings

You can also save display settings to any number of files. Once you have a few custom display settings files, you can quickly configure the display to use those values by simply loading the saved custom configuration file. This can save significant time when you find yourself using 2 or more significantly different viewing setups.

Exporting Data

You can export the values currently displayed to a text file or as text to a printer. If you export test data from one specific test, the values exported will be the exact values from the dataset – however many are displayed. If you export test data from all of the loaded tests (which can be just one test if desired), you are prompted to enter the number of X-axis units per data point exported (since you want one value for each test run per line, but the raw test data will not have exact X-axis matches for multiple test runs). For example, if the display is showing 2000 through 7000 RPM, and you specify 100 X-axis units per exported data point, you would get lines in the exported data for 2000, 2100, 2200, … 6900, 7000 RPM. Note that the exported data EXACTLY matches the displayed data, including the current smoothing settings. Only channels that are currently displayed will be exported.

Power Curve Viewer (Single or Comparing)

This form allows the operator to view power curve test results.

Power Curve Viewer (Differences)

This form is used to display the test results from the power curve test. These test results differ from the Trace Graph Viewer data in that a) these test results can only be acquired during the power-curve test (rather than during any test), and b) these test results are averaged into specific MPH/RPM ranges during acquisition (whereas the trace data is acquired strip-chart style, one point at a time).

Power curve test results are always collected twice, once organized by speed, and once organized by RPM. Thus, you can view the results of each power curve two (2) ways: versus speed and versus RPM. The biggest difference between by-MPH and by-RPM data is that by-RPM data will only ever generate one curve, whereas by-MPH data can generate a multiple-peak curve showing power developed in each gear used during testing. Note that by-RPM data is only available if your dynamometer system has an engine RPM input source active.

The most significant item the user of this screen should be aware of is: when viewing data that is by-MPH, the reported torque values are in terms of dynamometer roll-shaft torque, but when viewing data that is by-RPM, the reported torque values are in terms of engine-crankshaft torque. See the section on **Dynamometer Concepts** for more information on this important difference.

Setting the X-axis Scale Limits

The scale limits for the X-axis can be set by entering the desired minimum and maximum X-axis scale values and clicking on the "ReDraw" menu item. Note that the default X-axis scale limits are determined by the current band-sampling parameters, which can be set from the Power Curve test form. If you find yourself using this option too often, you should consider setting the band-sampling parameters to values more appropriate to your testing requirements.

Showing Test Results

To view the results of a test (rather than the difference between 2 tests), click on "Show Test Graph(s)", and click the "ReDraw" menu item.

Showing Test Differences

To view the difference between two (2) sets of test results (rather than the test curves themselves), click on "Show Differences", and click the "ReDraw" menu item.

The File Menu Item

This menu item allows the user to perform various file related functions, as described below.

Test Types to List Allows the user to specify that either only by-MPH, only by-RPM, or by-MPH and by-RPM test results should be listed in the test selection form.

Select Test Allows the user to select the results of a test for display.

Select Baseline Test Allows the user to select the results of a test for baseline comparisons.

Clear Baseline Test Allows the user to clear the baseline test results (test results only).

Print Graph Prints the on-screen graph.

Print Comparison Report Prints a test report comparing the current test and the baseline test.

Print Test – Raw Values Prints a raw-values sheet of the current test results.

Print Test – Report Prints a test report for the current test results.

Export Test To Text File Exports the raw values of the current test to a text file.

Print Test – Raw Values Prints a raw-values sheet of the current baseline test results.

Print Test – Report Prints a test report for the current baseline test results.

Export Test To Text File Exports the raw values of the current baseline test to a text file.

Edit Test Comments This option allows the operator to edit the comments associated with the test results currently being displayed.

Edit Base Test Comments This option allows the operator to edit the comments associated with the baseline test results currently being displayed.

Close This option allows the operator to close the graph viewing utility.

The Options Menu Item

This menu item allows the user to select various display options, as described below.

Show Torque Toggles the display of the torque values on/off.

Show Horsepower Toggles the display of the power values on/off.

Horizontal Grid Toggles the display of the horizontal grid on/off.

Vertical Grid Toggles the display of the vertical grid on/off.

Thick Lines This option toggles the width of the graph lines between a very thin an somewhat thicker line width.

Legend Toggles the display of the legend on/off.

MPH/Line in Text Files Allows the user to specify how many MPH each line in text files should step by.

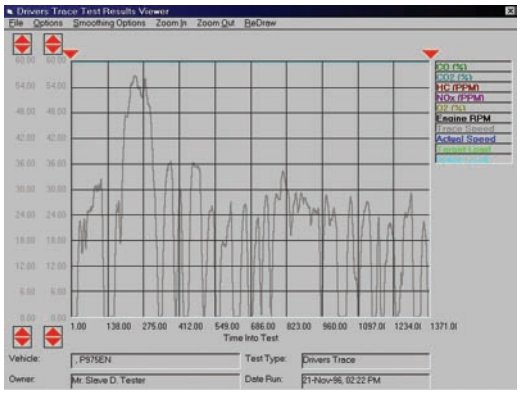
RPM/Line in Text Files Allows the user to specify how many RPM each line in text files should step by.

The ReDraw Menu Item

This menu item causes the graph to be redrawn. This is useful when the display is over-written or for any reason is not reflecting the current display settings.

Drivers Trace Viewer

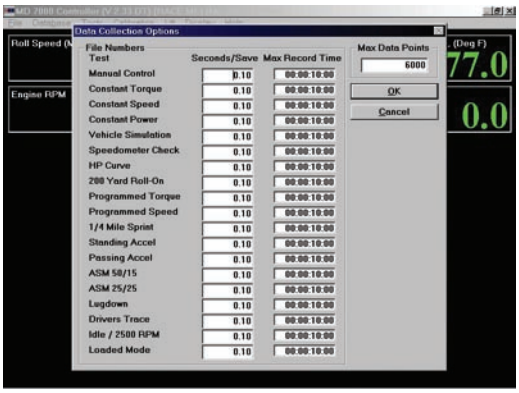
This form allows the operator to view the results of an IM-240 type emissions test.



The functioning of this screen is very similar to the "Trace Graph Viewer" form. Please see that form for documentation on this form.

Trace Data Collection Speed

This form allows the operator to specify how frequently data points will be recorded during testing, if trace data collection is enabled.



For each test routine that the software supports, the operator may specify a recording rate for trace data collection, in terms of seconds per save. Based on the specified recording rate, the maximum trace data recording time is shown just to the right of the recording rate values. The maximum recording time also depends upon the maximum number of data points specified. This allows the operator to collect data at high speed during highly transient testing, while recording at much slower rates in durability type testing.

Seconds/Save — The time between trace data points. This value can range from 0.01 (100 samples/second) up to 3600 (1 sample / hour).

Max Record Time — The maximum trace data recording time available, based on the specified recording rate and the specified maximum number of data points.

Max Data Points — The maximum number of data points that can/will be recorded. This value may be modified by the user, although 6000 data points is normally more than enough. If a value that can not be supported by the available memory (RAM) is entered, an error message will be displayed.

Trace Data Graphing/Printing Options

This form allows the operator to specify which trace data channels will be displayed in the Trace Graph Viewer. (Note that this form is accessible from the trace graph viewer screen; access to this form from the Database menu is incidental and not recommended.)

Notice that the channels displayed on this form represent the left-mouse-button and right-mouse-button menus that can be used to select value for display on the main screen.

Report Page Layout

This form allows the operator to specify certain formatting parameters for printed reports.

Print Quality The user can select from several print quality settings. Higher print quality usually results in slower printing, whereas reduced print quality usually results in faster printing.

Print Margins The Left, Right, Top and Bottom print margins can be set to correctly center printed reports on the paper.

Print Options These options allow the operator to customize the printing of all test reports.

Use Color Printer Features
If enabled, reports will print with various elements in color.

Use Gray-Scale Printer Features

If enabled, reports will print with various elements gray-scaled.

Print Borders On Reports

If enabled, a border box will be printed around all test reports.

Font For Printed Text Files

The user can specify the font used when printing simple text files.

Pick A New Font

The user can use this button to select a font for printing simple text files from the list of fonts available on their computer / printer.

Database Utilities and Options

This form allows the operator access to the various database related utilities and options.

Database Options

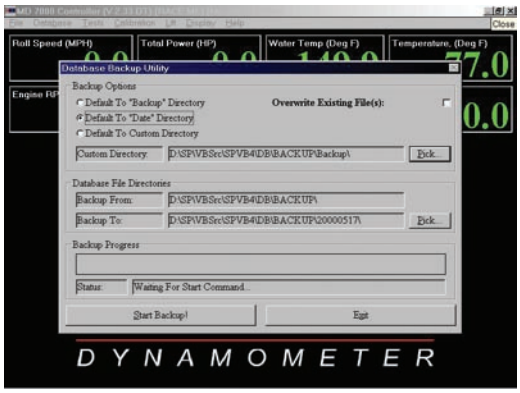
These options affect the operation of the customer/vehicle/test results database.

Store Trace Data In Binary Files — If selected, all trace data will be saved in binary files external to the main database file. This option has several advantages, including much faster (1000x) reading and writing of trace data and a much smaller database file. A smaller database is much less likely to become corrupted than a very large database. Use of this option is definitely recommended.

Auto Check Database At Startup — If selected, the main database file (but not any binary trace data files) will be checked for errors when the dynamometer software is started. This recommended option will attempt to automatically correct any errors found in the database when it is run.

Backup Database

This button allows the user to access the database backup utility. Regular use of this utility will protect your vehicle test data from hardware failure, power outages, virus attacks, etc.



Backup Options

Overwrite Existing Files: If set, any existing files in the backup-to directory will be overwritten with newer versions. If not set, the user will be prompted before any files are overwritten.

Default To "Backup" Directory: Sets the default backup-to directory on this form to the database file directory plus "\Backup", every time this form is loaded. Use this option if you want to always back-up to the same location. This is an acceptable but not optimal solution.

Default To "Date" Directory: Sets the default backup-to directory on this form to the database file directory plus "\<Date>", where <Date> is the current date, every time this form is loaded. Use this option if you want to create a new backup every time you run this backup utility. This is a better solution, because you will have multiple backups, which gives better database protection.

Default To Custom Directory: Sets the default backup-to directory on this form to the user-specified custom directory. This could be set to "Z:\", where your "Z:" drive is a removable media drive, such as a ZIP drive. This is probably the optimal solution, since you can not only have multiple backups, but you can remove the backup media from the PC for safe storage.

Database File Directories

Backup From: The working database directory for your dynamometer software. This will normally be "C:\Mustang\Chassis\SP7000\DB", but advanced users may change this value if required.

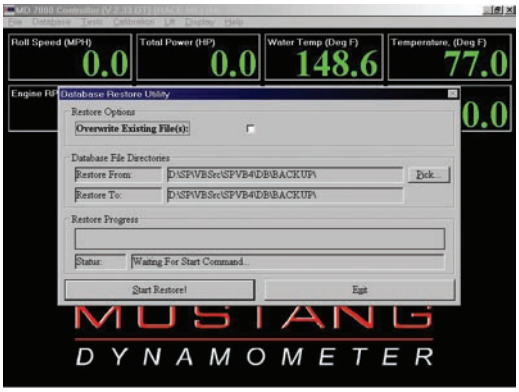
Backup To: The directory to which your database files will be backed-up. The default value for this field can be set using the backup options described above.

Start Backup: Starts the backup process using the current settings.

Exit: Exits the backup utility form.

Restore Database

This button allows the user to access the database restore utility, which can be used to restore lost or corrupted customer/vehicle/test results data from existing backup sources.



Restore Options

Overwrite Existing Files If set, any existing files in the restore-to directory will be overwritten with backup versions. If not set, the user will be prompted before any files are overwritten.

Database File Directories

Restore From: The directory from which your database files will be restored. You can select any existing backup directory to restore from using the "Pick…" button.

Restore To: The working database directory for your dynamometer software. This will normally be "C:\Mustang\Chassis\SP7000\DB", but advanced users may change this value if required.
The directory to which your database files will be backed-up. The default value for this field can be set using the backup options described above.

Start Restore: Starts the restore process using the current settings.

Exit Exits the restore utility form.

Backup Ini File

This button allows the user to access the Ini file backup utility. Regular use of this utility will protect your dynamometer configuration and calibration values from hardware failure, power outages, virus attacks, etc.

To backup the Ini file, the user is provided with a typical Windows file-save dialog box, which can be used to select the location and file name to backup the Ini file to.

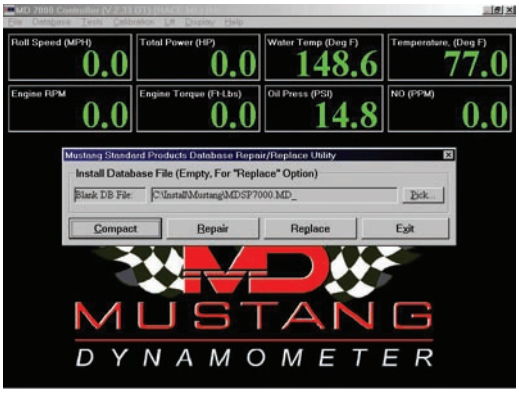
Restore Ini File

This button allows the user to access the Ini file restore utility, which can be used to restore lost or corrupted dynamometer configuration and calibration values from existing backup sources.

To restore the Ini file, the user is provided with a typical Windows file-open dialog box, which can be used to select the backup file to restore from.

Repair/Replace/Compact Database

This button allows the user to access the repair / replace / compact database utilities. These utilities can be used to repair a corrupted database (if possible), install a new, blank database, or compact your database following the deletion of unwanted records. It is important to compact your database following the deletion of any large number of records, since the database does not actually release unused disk space until the compact utility is run.



Blank DB File This field allows the user to specify where the software can find a blank, compressed version of the database files. This may be "C:\Install\Mustang\MDSP7000.MD_", or "D:\MDSP7000.MD_", depending on the exact version of software you are using. If your software was delivered on a CD, you can use the root directory of your CD for this value ("D:\MDSP7000.MD_"(This field is only used in the Replace function.)

Compact — Performs a compacting function on your database. This utility should be run whenever a large number of records have been deleted from your database, to shrink your database file and reclaim unused disk space.

Repair — Performs a repair function on your database. In the event that your database becomes corrupted, this utility may be able to repair your database.

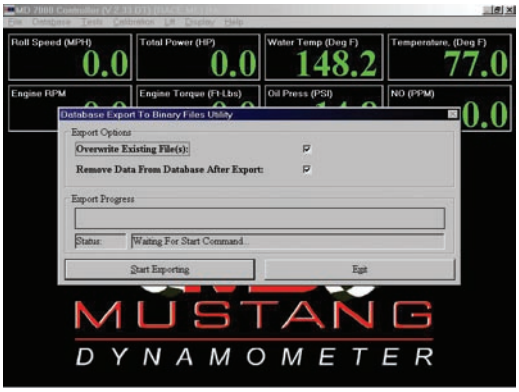
Replace — Replaces your existing database with a new, blank database. THIS WILL PERMANENTLY ERASE ALL EXISTING COMPANY, CUSTOMER, VEHICLE AND TEST RESULTS RECORDS.

Exit — Closes this utility form.

Export Trace Data To Binary Files

This button allows the user to access the trace data exporting utility. For customers with existing databases, which can be very slow to load at system startup, or when saving test results at the end of a test, this utility allows all the trace data in the database to be exported to binary files. This utility only needs to be run one (1) time, assuming that the "Store Trace Data In Binary Files" option is enabled. After running this utility, you should be sure to use the "Compact Database" utility, to shrink your existing database file and reclaim unused disk drive space.

BEFORE USING THIS UTILITY, MAKE SURE YOU CREATE A BACKUP COPY OF YOUR DATABASE, IN CASE ANYTHING GOES WRONG WHILE THE UTILITY IS RUNNING.



Overwrite Existing Files — If selected, any existing binary files will be overwritten with newer versions. If not selected, the operator will be prompted to confirm any file overwrites.

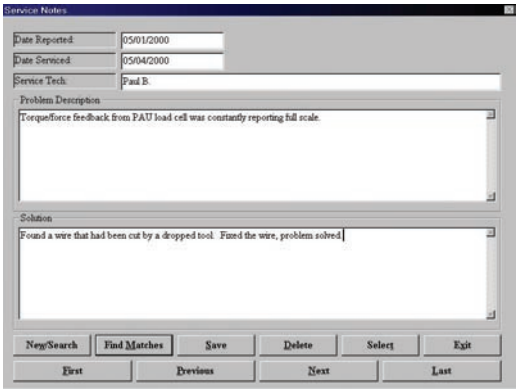
Remove Data From Database After Export — If selected, all trace data successfully exported to binary files will be removed from the database file. This box should normally be left checked; if this box is not checked, you will not receive the full benefits of maintaining your trace data in external binary files.

Start Exporting — Starts the exporting process using the current settings.

Exit — Exits the data exporting utility form.

Service Notes

This form allows Mustang Dynamometer service technicians to keep a history of all service work performed on your dynamometer, for future reference.



Use of this form is normally restricted to Mustang Dynamometer employees; however, if the system owner / operator wishes to use this screen to keep a maintenance history, they may do so. Operation of this form is identical to the "Company Information" and "Customer Information" forms, so please see those sections for additional information on how to use this form.

The Calibration Menu

The Calibration Menu offers access to all of the required calibration functions of the dynamometer. The "Diagnostics" sub-menu is only available when in "Debugging" mode, which can be turned on/off in the "Dyno Parameters" screen.

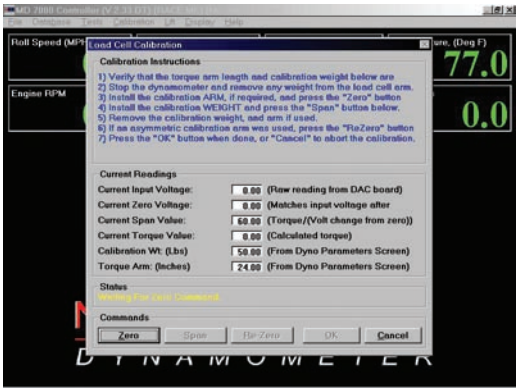
Load cell calibrations are on a sub-menu, with support for up to 4 load cells. Only load cells that are in use (as determined on the "Dyno Parameters" screen) are enabled.

The "Auxiliary I/O" sub-menu allows access to the configuration screens for the analog outputs that are used to drive signals out to external data acquisition systems.

The "Vehicle Controller" menu item allows access to the vehicle (throttle) controller setup screen.

Load Cell #1 Calibration

This form allows the operator to calibrate load cell #1 (torque) input.



Load cell calibration is a very simple two (2) step process required to generate a linear calibration. The steps required to perform a load cell calibration are described below.

1) If you are calibrating a multiple-PAU dynamometer, make sure that you are working on the primary load cell.

2) Verify that the displayed calibration weight and torque arm length values are correct. These values are associated with your dynamometer's physical design, and will not change after initial configuration. You may change these values, if required, using the "Dyno Parameters" form.

3) Remove the PAU cover on your dynamometer to gain access to the load cell area.

4) Since the first point in the calibration is at a zero input condition, make sure that there is no weight on the calibration arm or fixture, that the dynamometer's lift is down, and that no vehicle is on the dynamometer.

5) If you are using a dynamometer with a separate load cell calibration arm, install the calibration arm on the PAU.

6) Visually verify that the current analog input voltage is nearly 0.0 volts (+/- 0.5 volts typical).

7) Click the "Zero" button to set the zero calibration point.

8) Assuming that the zero command worked (otherwise the message box will indicate that the zero calibration failed due to an invalid input voltage), you may proceed with the span point calibration, or simply click the "OK" button (if you only wish to perform a zero point calibration (not recommended)).

9) Install your calibration weight on the calibration arm or fixture. If you are using a built-in calibration arm, make sure that the calibration weight is pushed up against the cross-bar to ensure a correct effective calibration arm length. If you are using a separate calibration arm, the calibration weight should be mounted on a locating pin.

10) Click the "Span" button. If the span calibration is successful, you can click the "OK" button to save the calibration values. If the span calibration is not successful, the message box will indicate that the

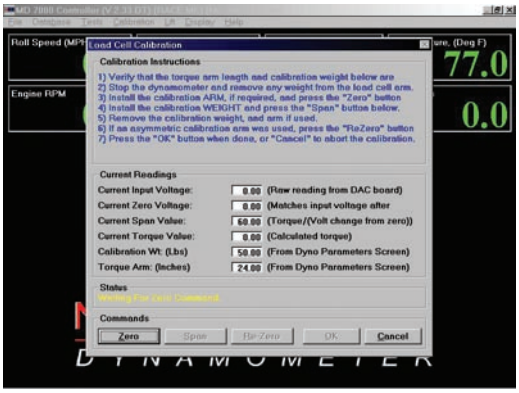
span calibration failed. If the span calibration fails, it is due to too-small voltage change from the zero point calibration. Please note the zero and span point values and contact Mustang Dynamometer for assistance.

11) If you are using an asymmetric separate calibration arm (for example, on an MD-1750 dynamometer), you need to perform an additional zero calibration. (The first zero point calibration was only performed to have a known starting point for the span point calibration.) Simply remove the calibration weight and arm, and click the "Re-Zero" button. Assuming that the re-zero function works correctly (check the message box), you can click the "OK" button to save your new calibration values.

12) MAKE SURE TO REMOVE BOTH THE CALIBRATION WEIGHT AND (IF YOU ARE USING A SEPARATE CALIBRATION ARM) CALIBRATION ARM FROM YOUR DYNAMOMETER WHEN YOU ARE FINISHED WITH THIS CALIBRATION.

Load Cell #2, #3 & #4 Calibration

This form allows the operator to calibrate load cells 2 through 4 (torque) input.



Calibration of these load cells is identical to the Load Cell #1 Calibration procedure described in that section.

Analog RPM Input Calibration

This form allows the operator to calibrate the analog engine RPM input.

The analog engine RPM input calibration is a very simple two (2) step process required to generate a linear calibration. The steps required to this calibration are described below.

Using an Analog Input from a Device with No Output Calibration Capability

1) Make sure that the "Zero Point" "RPM" value is set to 0.

2) Make sure that the "Span Point" "RPM" value is set to an engine RPM value that your calibration vehicle can maintain steadily for several seconds.

3) Attach your engine RPM sensor to your calibration vehicle, and make sure that your engine RPM measurement device can properly measure engine RPM on that vehicle.

4) Turn your calibration vehicle's engine off. Your device should now be generating an analog output that represents 0 RPM.

5) Click the "Zero" button. The "Status" message box will indicate whether the zero point calibration was successful or not.

6) Assuming that the zero point calibration was successful, you can perform the span point calibration.

7) Start your calibration vehicle, and maintain the engine RPM value you entered in the "Span Point" "RPM" value field.

8) Once you have achieved and are steadily maintaining the span point engine RPM value, click the "Span" button. If the span calibration is successful, you can click the "OK" button to save the calibration values. If the span calibration is not successful, the message box will indicate that the span calibration failed. If the span calibration fails, it is due to too-small voltage change from the zero point calibration. Please note the zero and span point values and contact Mustang Dynamometer for assistance.

Using an Analog Input from a Device with Output Calibration Capability

1) Make sure that the "Zero Point" "RPM" value is set to the RPM value that your RPM device drives out on its analog output for a zero point (or low calibration point) calibration. This value is typically 0 RPM.

2) Make sure that the "Span Point" "RPM" value is set to the RPM value that your RPM device drives out on its analog output for a span point (or high calibration point) calibration. This value may range from 1,000 to 20,000 RPM, and may depend on the currently selected analog output RPM range of your device.

3) Configure your RPM device to drive the zero point (or low calibration point) RPM value out on its analog output.

4) Click the "Zero" button. The "Status" message box will indicate whether the zero point calibration was successful or not.

5) Assuming that the zero point calibration was successful, you can perform the span point calibration

6) Configure your RPM device to drive the span point (or high calibration point) RPM value out on its analog output.

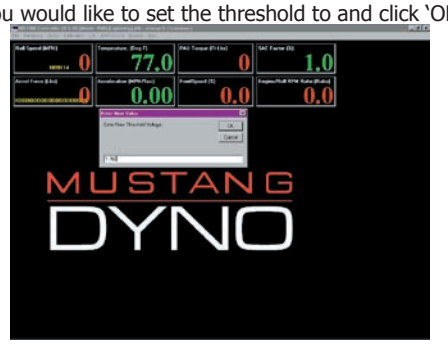
7) Click the "Span" button. If the span calibration is successful, you can click the "OK" button to save the calibration values. If the span calibration is not successful, the message box will indicate that the span calibration failed. If the span calibration fails, it is due to too-small voltage change from the zero point calibration. Please note the zero and span point values and contact Mustang Dynamometer for assistance.

SmartTach Setup

To change the SnartTach RPM system voiltage threshold and pulses per revolution, access the SmartTach Setup Menu as shown below.

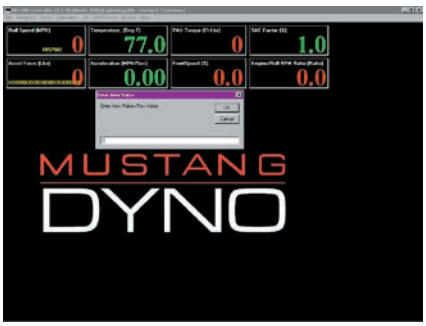
Voltage Threshold

To change the voltage threshold, select 'Set Voltage Threshold' and the text box shown below will appear with the current threshold setting displayed. To change, simply enter the value you would like to set the threshold to and click 'OK'.



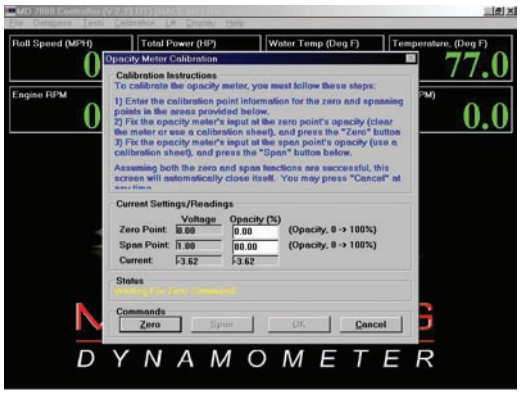
Pulses per Revolution

To change the pulses per revolution, select 'Set Pulses/Rev' and the text box shown below will appear with the current pulses per revolution setting displayed. To change, simply enter the value you would like to set the pulses per revolution to and click 'OK'.



Opacity Meter Calibration

This form allows the operator to calibrate the analog exhaust opacity input.



The analog exhaust opacity input calibration is a very simple two (2) step process required to generate a linear calibration. The steps required to this calibration are described below.

Using an Analog Input from a Device with No Output Calibration Capability

1) Make sure that the "Zero Point" "Opacity %" value is set to 0.

2) Make sure that the "Span Point" "Opacity %" value is set to the value of a calibration filter/plate that you have available for your opacity meter.

3) Remove everything from the measurement path of the opacity meter. Your device should now be generating an analog output that represents 0% opacity.

4) Click the "Zero" button. The "Status" message box will indicate whether the zero point calibration was successful or not

5) Assuming that the zero point calibration was successful, you can perform the span point calibration.

6) Install the calibration filter/plate value you entered in the "Span Point" "Opacity %" value field.

Click the "Span" button. If the span calibration is successful, you can click the "OK" button to save the calibration values. If the span calibration is not successful, the message box will indicate that the span calibration failed. If the span calibration fails, it is due to too-small voltage change from the zero point calibration. Please note the zero and span point values and contact Mustang Dynamometer for assistance.

Using an Analog Input from a Device with Output Calibration Capability

1) Make sure that the "Zero Point" "Opacity %" value is set to the opacity value that your opacity device drives out on its analog output for a zero point (or low calibration point) calibration. This value is typically 0 % opacity.

2) Make sure that the "Span Point" "Opacity %" value is set to the opacity value that your opacity device drives out on its analog output for a span point (or high calibration point) calibration. This value may range from 20 to 100 % opacity.

3) Configure your opacity device to drive the zero point (or low calibration point) opacity value out on its analog output.

4) Click the "Zero" button. The "Status" message box will indicate whether the zero point calibration was successful or not.

5) Assuming that the zero point calibration was successful, you can perform the span point calibration.

6) Configure your opacity device to drive the span point (or high calibration point) opacity value out on its analog output.

7) Click the "Span" button. If the span calibration is successful, you can click the "OK" button to save the calibration values. If the span calibration is not successful, the message box will indicate that the span calibration failed. If the span calibration fails, it is due to too-small voltage change from the zero point calibration. Please note the zero and span point values and contact Mustang Dynamometer for assistance.

Auxillary I/O Setup Menu

The "Auxiliary Analog Input Setup" menu item allows access to the setup screen used to configure the auxiliary analog inputs used for extra data acquisition hardware, e.g. exhaust gas oxygen sensors, pressure sensors, etc.

The "Auxiliary Analog Output Setup" menu item allows access to the setup screen used to configure the speed/RPM and torque/force analog outputs supported by the ADA-1100 I/O boards.

The "External DAC Board Setup" menu item allows access to the setup screen used to configure the analog output boards used to drive system values out to external data acquisition systems.

The "External DAC Channel Setup" menu item allows access to the setup screen used to configure the values sent out via the analog outputs to external data acquisition systems.

Auxiliary Analog Input Setup

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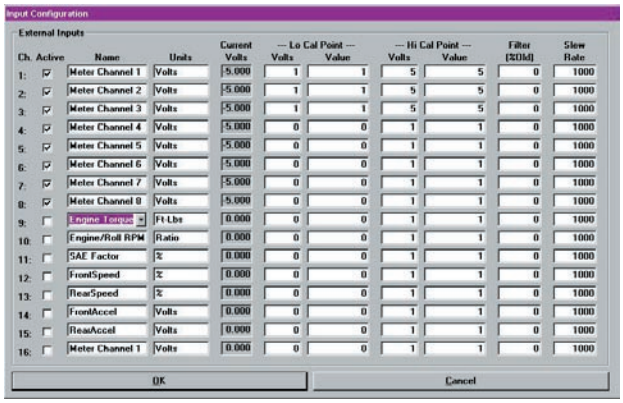


Your electronics system provides for several additional analog inputs that can be connected to additional data acquisition sensors. For example, various pressures and temperatures may be monitored during testing. Most electronics systems sold are capable of handling up to seven (7) auxiliary analog inputs, although options such as a 2nd PAU, analog engine RPM, opacity and/or weather station inputs may reduce the number of available analog inputs. If you purchased a second data acquisition board with your system, you will have an additional eight (8) analog input available for monitoring additional sensors.

By double-clicking on the “Name” column, a drop-down list of predefined channels names can be displayed. These are “magic” names that the system looks for; if any of these names is used for a channel name, then the value of that channel will be over-written with the value described by the “magic” name, even if the channel is active and reading an analog input channel. These named channels are generally used only on analog input channels that are not physically present, ie channels 9-16, which are read from the second I/O board, which is frequently not installed.

It is important to note that any sensor connected to an auxiliary analog input must meet the following conditions:

1) The input voltage must fall in the range –5.0 to +5.0 volts.

2) The input voltage must represent a linear input value (non-linear inputs are not yet supported).

3) Any electrical isolation required to prevent hardware damage is the users responsibility, unless the sensor is provided by Mustang Dynamometer.

Configuring an Auxiliary Analog Input

To configure and/or calibrate an auxiliary analog input, the name of the input channel, the units monitored, and several calibration values must be entered. The process for configuring and calibrating an auxiliary analog input is shown below.

1) Select an input channel. The "Channel" column lists the available analog input channels. If you have only one (1) data acquisition board installed, you only actually have channels 1-8; channels 9-16 require the 2nd data acquisition board be installed.

2) Make sure that the analog input channel is actively being read by checking the "Active" box.

3) Enter the name of the input channel in the "Name" field (for example, "Oil Pressure").

4) Enter the units that the input channel will be measured in in the "Units" field (for example, "PSI").

5) The "Current Volts" field reports the current input voltage for each channel.

6) In the "Lo Cal Point" "Volts" field, enter the input voltage measured at (or known to be present at) the zero/low calibration point value (for example, 0.0 volts).

7) In the "Lo Cal Point" "Values" field, enter the input value for the zero/low calibration point.

8) In the "Hi Cal Point" "Volts" field, enter the input voltage measured at (or known to be present at) the span/high calibration point value (for example, 5.0 volts).

9) In the "Hi Cal Point" "Values" field, enter the input value for the span/high calibration point.

10) To apply a FIR type filter to the input value, you can specify a value between 0 (no filtering) and 100 (solid filter, value will never change) in the "Filter (% Old)" field. Since the analog inputs are normally updated at 100 Hz, a filter value of 90 will result in a 90% response to a step change in 0.2 seconds, while significantly reducing noise. A filter value of 50 will result in a 90% response to a step change in 0.03 seconds, while reducing noise by approximately 50%.

To apply a slew rate (clipping) filter to the input, you can enter a maximum slew rate value in the "Slew Rate" field. These values represent the maximum value by which any two consecutive values may differ; if the difference between two consecutive measurements varies by more than this amount, the reported value is clipped off at the maximum allowed change. These values are between-samples values, so the update rate is important consideration for selecting these values. Since the normal update rate of our systems is 100 Hz, simply take the maximum valid rate of change that you believe your sensor will ever report (in units per second), and divide that value by 100 to determine the value to enter for your "Slew Rate" value. For example, if you believe that a temperature sensor will not change by more than 50 degrees per second, then your "Slew Rate" value would be (50 / 100) = 0.5.

Magic Auxiliary Analog Input Names

There are currently two (2) "magic" auxiliary analog input names, which are used to monitor values that are not otherwise available as input channels. By entering a "magic" name for an auxiliary analog input, the related input channel value can be monitored and recorded as an auxiliary analog input. Since most systems do not have all of the auxiliary analog input channels in use, this does not represent a significant loss of functionality in the auxiliary analog input support.

To use a "magic" input name, you have only to enter the "magic" name; the input channel selected does not even have to be enabled, although the "Units" field should be entered appropriately.

Name	Units	Description
Engine Torque	Ft-Lbs	A calculated engine torque value, in foot-pounds, based on the measured dynamometer roll shaft torque scaled by the ratio of dynamometer roll-shaft RPM divided by engine crankshaft RPM. This value is only available when an engine RPM input source is active.
Name	**Units**	**Description**
SAE Factor	Ratio	The current power correction figure, using logic based on the SAE J-1349 power correction logic. This value may be based on either hardware weather station values or user-entered weather station values, and may indicate a correction ratio based on either the SAE J-1349 JUN90 standard conditions or user-specified standard conditions.

Note that the "Filter (% Old)" and "Slew Rate" fields do not affect values that are reported via "magic" names.

Auxiliary Analog Output Setup

The "Auxiliary Analog Output Setup" menu item allows access to the setup screen used to configure the speed/RPM and torque/force analog outputs supported by the ADA-1100 I/O boards.

Since some dynamometer users use external data acquisition systems, your system can be configured to drive two (2) analog outputs proportional to the speed and torque measured by your dynamometer. These outputs can be fed to the analog inputs of a data acquisition system.

Since the data acquisition boards that we currently use are limited to two (2) analog outputs per board, and our PAU control uses one of them, you must purchase a second data acquisition board if you wish to drive both of these channels simultaneously. Also, if you have a multiple PAU dynamometer, you will need the second data acquisition board to drive either of these channels.

Analog Speed Output

This output is proportional to the dynamometer's roll speed, in either MPH/KPH or RPM. Configuration is as described below.

Enable This Output — This option must be checked for the output to be driven.

Board — The data acquisition board to be used. Normally board #2, although board #1 can be used for single PAU systems where only one auxiliary analog output is required.

Channel — The data acquisition analog output channel to be used. Values for output channels are either 0 or 1. Note that board #1, channel #0 is always reserved for the PAU reference output.

Max Volts — The maximum voltage to be driven out, when the maximum reportable speed is measured. This value must be less than or equal to 5.0 volts.

Min Volts — The minimum voltage to be driven out, when the minimum reportable speed is measured. This value must be greater than or equal to -5.0 volts if the analog output is configured as a bi-polar output, or greater than or equal to 0.0 volts if the analog output is configured as a uni-polar output.

Max Speed — The maximum reportable speed. This value may be in MPH/KPH (depends on "Use Metric Units" setting in "System Parameters") or RPM, depending on the setting of the "Report Roll RPM (Not KPH/MPH)" option.

Report Roll RPM (Not KPH/MPH) — Determines if this output is scaled against dynamometer shaft RPM or MPH/KPH.

Analog Torque Output

This output is proportional to the total torque measured by the dynamometer, in either Ft-Lbs/N-M. Configuration is as described below.

Enable This Output — This option must be checked for the output to be driven.

Board — The data acquisition board to be used. Normally board #2, although board #1 can be used for single PAU systems where only one auxiliary analog output is required.

Channel — The data acquisition analog output channel to be used. Values for output channels are either 0 or 1. Note that board #1, channel #0 is always reserved for the PAU reference output.

Max Volts — The maximum voltage to be driven out, when the maximum reportable torque is measured. This value must be less than or equal to 5.0 volts.

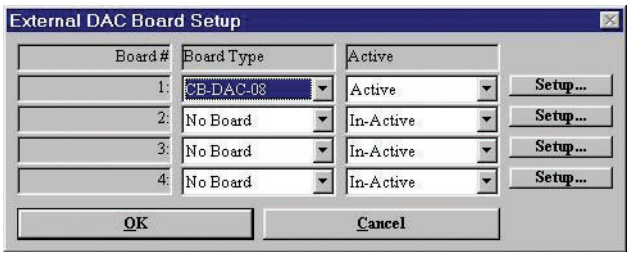
Min Volts — The minimum voltage to be driven out, when the minimum reportable torque is measured. This value must be greater than or equal to -5.0 volts if the analog output is configured as a bi-polar output, or greater than or equal to 0.0 volts if the analog output is configured as a uni-polar output.

Max Torque — The maximum reportable torque. This value may be in Ft-Lbs or N-M (depends on "Use Metric Units" setting in "System Parameters").

Report Crankshaft Values (Not Roll Values) — Determines if this output is scaled against dynamometer shaft torque or engine crankshaft torque. Please see the section on Values Reported by a Chassis Dynamometer for more information on this important difference. The torque values reported include ALL torque measured by the dynamometer, not any single component (such as PAU torque, etc).

External DAC Board Setup

The "External DAC Board Setup" menu item allows access to the setup screen used to configure the analog output boards used to drive system values out to external data acquisition systems.



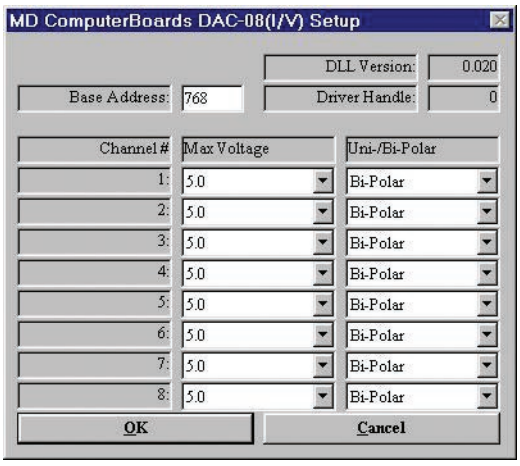
This screen is used to configure any I/O boards that have been installed to drive system values out to external data acquisition systems via analog outputs.

Up to four (4) I/O boards are supported.

Currently, only the ComputerBoards CIO-DAC-08 (ISA) 8 channel, 12-bit analog output I/O board is supported.

Each of the possible four (4) I/O boards can be configured as "No Board" or as a valid board type. Additionally, each I/O board can be enabled ("Active") or disabled ("In-Active").

Once a valid board type (other than "No Board") has been selected, the I/O board can be configured using the "Setup…" button beside the board definition fields.



This screen allows the user to configure a ComputerBoards CIO-DAC-08 (ISA) 8 channel, 12-bit analog output I/O board.

The "DLL Version" and "Driver Handle" displays tell which version of the I/O board interface DLL is in use, and the driver handle that has been allocated for communicating with the board that is currently being configured.

The "Base Address" field displays the base port address of the selected board in decimal notation (768 decimal = 300 hexadecimal). The user may enter base port address values in either decimal (768) or in hexadecimal (in which case the value must be entered as &h300, or &h240, or &hXXX in general). NOTE THAT SETTING THE BASE PORT ADDRESS INCORRECTLY WILL CAUSE THE I/O BOARD TO NOT WORK, AND MAY PREVENT OTHER BOARDS FROM WORKING CORRECTLY.

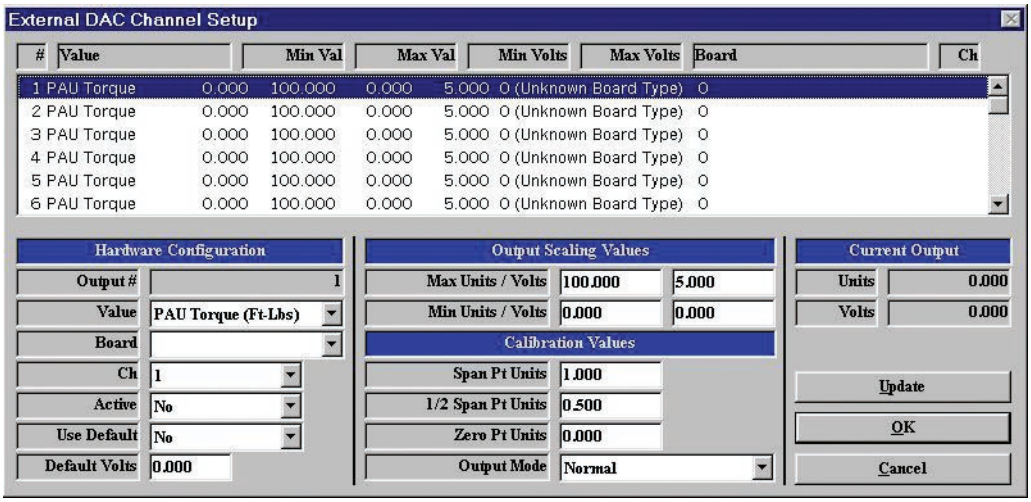
For each output channel the following parameters may be set:

Max Voltage The maximum voltage (magnitude, positive or negative) that the output is configured to drive.

Uni-/Bi-Polar Tells if the output is configured as a uni-polar or bi-polar output.

External DAC Channel Setup

The "External DAC Channel Setup" menu item allows access to the setup screen used to configure the values sent out via the analog outputs to external data acquisition systems.



This screen allows the operator to configure the external DAC channels used to drive system values out to external data acquisition systems via analog outputs.

Up to 32 system values can be driven to external D/A systems (if sufficient I/O boards are installed), and each output can be written to any desired analog output I/O board/channel.

By clicking on an entry in the list box, the complete configuration for the selected system value output can be specified. Clicking on any item in the list box will cause the currently displayed configuration data to be updated.

Hardware Configuration Items

Output # — The number (1 -> 32) of the system output that is being displayed.

Value — The system value that will be driven out, available from a drop-down list.

Board — The analog output I/O board (from the "External DAC Board Setup" screen that the system value will be driven out on.

Ch — The analog output channel on the selected I/O board that the system value will be driven out on. Note that the value displayed in this box will be 1 greater than the value displayed in the list box.

Active — If this value is set to "Yes", the selected system value will be written out on the selected I/O line, otherwise the system value will not be written out.

Use Default — If this value is set to "Yes", the default value (specified in volts, below) will always be written out on the selected output line.

Default Value — The default voltage to write out when the output is not active, if desired. This simply allows the system to drive a constant, specified voltage out to any external D/A system when the operator does not want to drive the selected system value out.

Output Scaling Values

Max Units / Volts

These values establish the maximum voltage (within the analog output's capabilities) which will be driven on the selected analog output line, and the system value that will correspond to that voltage.

Min Units / Volts

These values establish the minimum voltage (within the analog output's capabilities) which will be driven on the selected analog output line, and the system value that will correspond to that voltage.

Calibration Values

Span Pt Units

The system units value (not voltage) that will be driven on the selected analog output line when the selected channel is put into "Span" mode. The voltage that will be driven out will be determined by scaling the specified system value using the min/max voltage/values data pairs entered above.

½ Span Pt Units

The system units value (not voltage) that will be driven on the selected analog output line when the selected channel is put into "Half Span" mode. The voltage that will be driven out will be determined by scaling the specified system value using the min/max voltage/values data pairs entered above.

Zero Pt Units

The system units value (not voltage) that will be driven on the selected analog output line when the selected channel is put into "Zero" mode. The voltage that will be driven out will be determined by scaling the specified system value using the min/max voltage/values data pairs entered above.

Output Mode

The output mode that the channel is to be in. When this field is changed, the output voltage will NOT change until the operator either a) clicks on another entry in the list box, or b) the clicks the "Update" button.

By placing an output channel in "Zero", "Half Span" or "Span" mode, any of three (3) calibration point values can be driven out on the selected analog output line to allow for calibration of any external data acquisition system inputs.

NOTE: All analog output channels will be returned to "Normal" output mode when this screen is exited.

Current Output Values

Units

The current system value that is being driven out on the selected output channel. This value will be one of the following: (Normal mode) The selected system value, (Zero mode) the specified "Zero" point value, (Half Span mode) the specified "Half Span" point value, or (Span mode) the specified "Span" point value.

Volts

The current voltage that is being driven out on the selected output channel. This value will be the scaled value of the displayed "Units" value, using the min/max units/volts data values entered above.

The "Update" button can be used to manually update the selected channel's calibration values. This button will normally be used to update the "Output Mode" value during calibration of external D/A systems, since all fields (including "Output Mode") are updated when the operator clicks on any item in the main list box on this screen (for example, when moving on to configure another channel).

The "OK" button will cause all editing values to be updated and written to the software's calibration ("Ini") file.

The "Cancel" button will cause all calibration values to revert to their pre-editing values.

Bench Calibration

This form allows the operator to calibrate the optional Andros 5-gas analyzer bench.

The optional Andros 5-gas analyzer bench supports 3 fully automated self-calibration routines, using ambient atmospheric air for zeroing and a 4-gas blend in a calibration gas bottle for spanning.

Calibration Status Values

Several check boxes are provided to inform the operator of the need for calibrations, the status of calibrations, and the final results of calibration. These checkboxes are explained below.

Zero Required	Indicates that a zero calibration is required.
Zeroing	Indicates that a zero calibration is in process.
Zero Failed	Indicates that the last zero calibration performed failed.
Span Required	Indicates that a span calibration is required.
Spanning	Indicates that a span calibration is in process.
Span Failed	Indicates that the last span calibration performed failed.
Leak Check Active	Indicates that the leak check test is active.
Leak Check Failed	Indicates that the last leak check test performed failed.

To Perform a Zero Point Calibration

1) Ensure that the sample probe is not anywhere near a vehicle exhaust source or a significant concentration of the gasses of interest, as may be found around a recent gasoline or chemical spill.

2) Click on the "Zero" button. The calibration will be performed automatically. The "Status/Instruction" box will tell you if the calibration succeeds or fails.

To Perform a Zero & Span Calibration

1) Ensure that the calibration gas bottle is connected and turned on, and that the sample probe is not anywhere near a vehicle exhaust source or a significant concentration of the gasses of interest, as may be found around a recent gasoline or chemical spill.

2) Ensure that the calibration gas values (all in parts per million (PPM)) match the values printed on the calibration gas bottle. If the concentration values are printed in percent (%), multiply the percentage values by 10,000 to obtain parts per million (PPM) values before entering the PPM values into the on-screen fields.

3) If the calibration gas bottle only contains some of the calibration gasses, un-check the corresponding "Span xxx" check boxes for any missing gasses.

4) Since most calibration gasses use propane for the HC calibration gas, the "Using Propane For HC (Not Hexane)" check box should normally be left checked.

5) Click on the "Zero & Span" button. The calibration will be performed automatically. The "Status/Instruction" box will tell you if the calibration succeeds or fails.

6) Close the calibration gas bottle valve.

To Perform a Leak Check Test

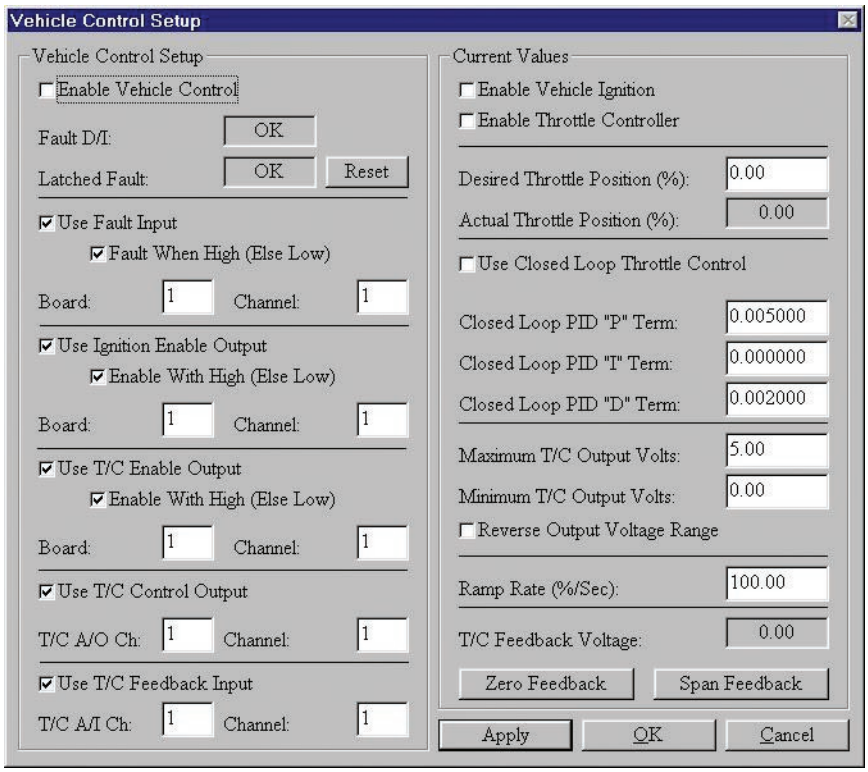
1) Cap the end of the sample probe using the supplied cap.

2) Click on the "Leak Check" button. The leak check test will be performed automatically. The "Status/Instruction" box will tell you if the test succeeds or fails.

3) Remove the sample probe cap and store it.

Vehicle Controller Setup

This screen allows the operator to configure the optional integrated vehicle controller. The vehicle controller is only used in the scripted testing modes of the software (programmed force and programmed speed tests).



Vehicle Control Setup

Enable Vehicle Control — This is an overall enable switch for the vehicle controller. If this switch is off (not checked), then no vehicle controller inputs or outputs will be read or written. This box must be checked if the vehicle controller is to be used.

Fault D/I — This display tells if the vehicle fault digital input is faulted (if the input is enabled).

Latched Fault — This display tells if the vehicle controller has latched a fault condition. Note that a dynamometer E-Stop will cause a latched vehicle controller fault, and that the dynamometer E-Stop condition must be cleared before the vehicle controller latched fault can be cleared.

Reset (Latched Fault) — This button will reset any latched fault of the vehicle controller, providing that the vehicle controller fault digital input is not reporting a fault (or is disabled), and that the dynamometer is not in an E-Stop condition.

Use Fault Input — If checked, the specified digital input line will be checked to see if a vehicle fault has been encountered.

Fault When High (Else Low) — Tells what voltage level (0 (low) or 5 (high)) on the specified input channel indicates a vehicle fault.

Board The I/O board number used to read this input (1 -> 2)

Channel The digital input channel number used to read this input (8 -> 23)

Use Ignition Enable Output If checked, the specified digital output line will be used to drive an enable digital output to the vehicle during testing.

Enable With High (Else Low) Tells what voltage level (0 (low) or 5 (high)) will be driven on the specified output channel to enable the vehicle.

Board The I/O board number used to write this output (1 -> 2)

Channel The digital output channel number used to write this output (0 -> 7).

Use T/C Enable Output If checked, the specified digital output line will be used to drive an enable digital output to the throttle controller during testing.

Enable With High (Else Low) Tells what voltage level (0 (low) or 5 (high)) will be driven on the specified output channel to enable the throttle controller.

Board The I/O board number used to write this output (1 -> 2)

Channel The digital output channel number used to write this output (0 -> 7)

Use T/C Control Output If checked, the specified analog output line will be used to drive a reference output to the throttle controller during testing.

T/C A/O Ch: (Board) The I/O board number used to write this output (1 -> 2)

Channel The analog output channel number used to write this output (0 -> 1).

Use T/C Feedback Input If checked, the specified analog input line will be used to measure the current actual position of the throttle controller during testing.

T/C A/I Ch: (Board) The I/O board number used to read this input (1 -> 2)

Channel The analog input channel number used to read this input (0 -> 7).

Current Values

Enable Vehicle Ignition Will cause the "Ignition Enable" digital output to be driven to its "True"/"Enabled" value if checked, otherwise the output will be driven to its "False"/"Disabled" value.

Enable Throttle Controller Will cause the "T/C Enable" digital output to be driven to its "True"/"Enabled" value if checked, otherwise the output will be driven to its "False"/"Disabled" value.

Desired Throttle Pos. (%) The operator specified target position for the throttle controller.

Actual Throttle Pos. (%) The actual measured position of the throttle controller.

Use Closed Loop Control

If checked, the dynamometer control software will implement "PID" type closed loop control of the throttle controller; otherwise, the throttle controller will be driven in "open loop" mode, and the throttle controller will be responsible for achieving the specified target throttle position.

NOTE: Enabling this option REQUIRES that the "T/C Feedback" input be enabled, configured and calibrated.

Closed Loop PID "P" Term

A constant used by the dynamometer control software to control the throttle controller when the throttle controller is in closed loop operation.

Closed Loop PID "I" Term

A constant used by the dynamometer control software to control the throttle controller when the throttle controller is in closed loop operation.

NOTE: This term should always be set to "0.0".

Closed Loop PID "D" Term

A constant used by the dynamometer control software to control the throttle controller when the throttle controller is in closed loop operation.

Maximum T/C Output Volts

The maximum output voltage that should ever be written out to the throttle controller (within the capabilities of the analog output channel used). This is useful for limiting the stroke of the throttle controller.

Minimum T/C Output Volts

The minimum output voltage that should ever be written out to the throttle controller (within the capabilities of the analog output channel used). This is useful for limiting the stroke of the throttle controller.

Rev. Output Voltage Range

This box should be checked if the throttle controller in use, as physically connected to the vehicle, achieves the maximum throttle opening with the minimum analog output voltage. If the throttle controller progressively opens the throttle as the analog output voltage is increased, then this box should be left unchecked.

Ramp Rate (% / Sec)

The rate at which the throttle should be adjusted, in % per second.

T/C Feedback Voltage

The voltage measured from the throttle controller's position feedback analog input (if connected and enabled).

Zero Feedback button

Clicking on this button will set the 0% throttle opening calibration point for the throttle controller's feedback analog input. The throttle controller must be set to a commanded 0% setting, and achieve its final position, before this button should be clicked.

Span Feedback button

Clicking on this button will set the 100% throttle opening calibration point for the throttle controller's feedback analog input. The throttle controller must be set to a commanded 100% setting, and achieve its final position, before this button should be clicked.

The "Apply" button will cause all on-screen values to be applied to the controller.

The "OK" button will cause all on-screen values to be applied to the controller and written to the software's configuration ("Ini") file, and the screen will close.

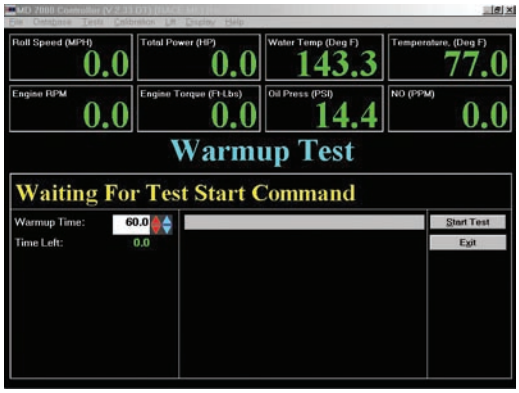
The "Cancel" button will cause all controller parameters to return to their pre-editing values, and the screen will close.

Calibration/Verification Routines

The Calibration / Verification Routines are located on a sub-menu.

Warmup

This form allows the operator to perform an automatic dynamometer warm-up routine.



This test is used to bring the dynamometer' s bearings, belts, etc. up to a warmed up condition.

To perform a warmup test, follow the procedure below.

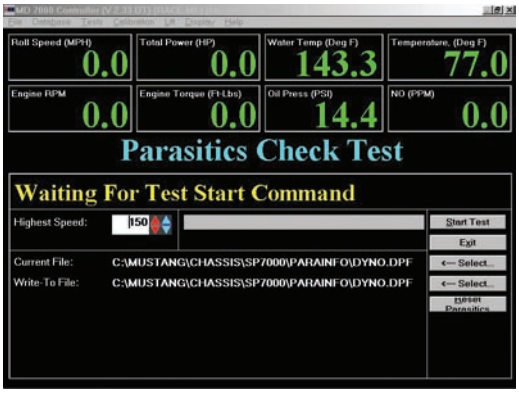
1) Enter the desired warm-up time, in seconds.

2) Click the "Start Test" button.

3) The dynamometer will automatically enable its built-in warm-up motor, and run for the specified time. When the warm-up period is expired, the dynamometer will automatically stop.

Parasitics Measurement

This form allows the operator to perform an automatic dynamometer parasitics measurement routine.



This test is used to measure and record the dynamometer' s parasitic losses due to bearings, belts, etc. The recorded data is reported as "Parasitics Torque", "Parasitics Force", etc., and is a component in the "Static Torque", "Static Force", etc. and "Total Torque", "Total Force", etc. values.

There are two (2) methods for keeping track of parasitic losses of a dynamometer. The traditional and simplest method is to measure the parasitic losses of the dynamometer with no vehicle on the dynamometer. This provides a consistent value that can be used with all vehicles tested. A second method, which accounts for increased dynamometer bearing loadings, tire-to-roll interface losses, etc. is to perform a parasitic losses measurement test with the vehicle to be tested on the dynamometer. This second method is more convenient for those using dynamometers without built-in calibration motors, and leads to greater repeatability and higher reported power values for the vehicles tested.

Since the parasitic losses data measured with a vehicle on a dynamometer is specific to the vehicle that was on the dynamometer when the test was performed, we have provided a method for storing and using as many parasitic losses data sets as required.

To Zero The Parasitic Losses Data

It is occasionally desirable to set the parasitic losses data to all 0 values. This can be accomplished by clicking on the "Reset Parasitics" button. This will create a new parasitic data set that indicates no parasitic losses at any speed, and it will save the all-zero data in a parasitic data set file name "Zero.DPF".

To Select a Parasitic Losses Data Set from the Existing Data Sets

In the event that vehicle-specific parasitic losses data is being used, a method is required to recall the parasitic losses data for a specific vehicle. This form may be used for this purpose, by simply clicking on the "Select..." button next to the "Current File" field, and using the typical Windows file-open dialog box to select the parasitic losses data file to be used. Once a data file has been selected, the dynamometer will report the parasitic losses for that vehicle.

To Perform a Parasitic Losses Measurement Test

Whether dynamometer-only or dynamometer-vehicle parasitic losses data is in use, a parasitic losses measurement test must be performed at some point in order to measure the parasitic losses of the dynamometer or the dynamometer-vehicle system.

To perform a parasitics measurement test, follow the procedure below.

1) Enter the maximum speed for which parasitics data should be measured and recorded.

2) Use the "Select…" button to specify the "Write-To File". You may name your file anything you desire, but you may wish to name a dynamometer-only parasitic losses file "Dyno.DPF", and vehicle-specific parasitic losses data files "<LicensePlate>.DPF", "<CustomerName>.DPF", "<VIN>.DPF", etc., to make finding old data files easier.

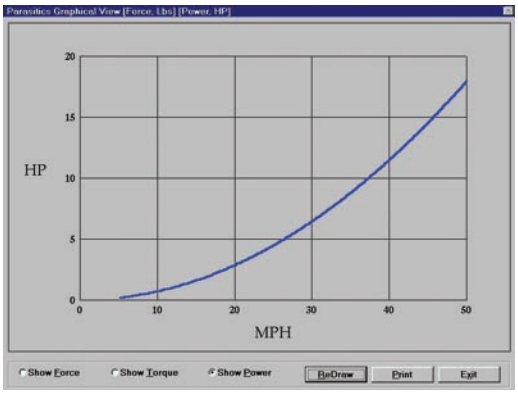
3) Click the "Start Test" button to start the test. The software will wait until the measured speed goes above the maximum testing speed + 5.0 MPH, and then indicate that it has started measuring the parasitic losses of the dynamometer (and vehicle). If the vehicle is left on the dynamometer during testing, the transmission must be placed in neutral, and the brakes must not be touched during the coast-down phase of testing.

4) Once the system's speed decreases to <= 2.5 MPH, the test will automatically complete and save the recorded data to the selected "Write-To" file.

5) If a vehicle is used to spin the dynamometer, and the vehicle is not to be left on the dynamometer during testing, EXTREME CAUTION MUST BE USED. LIFT-OFF TYPE PARASITIC TESTING IS EXTREMELY DANGEROUS AND MAY CAUSE EQUIPMENT DAMAGE, VEHICLE DAMAGE, FACILITY DAMAGE, PERSONAL INJURY AND/OR DEATH. IF YOU CAN NOT ENSURE THE SAFETY OF YOURSELF, THOSE AROUND YOU AND ALL MATERIAL ITEMS WITHIN THE TESTING FACILITY, DO NOT ATTEMPT LIFT-OFF TYPE PARASITIC MEASUREMENTS.

Parasitic Losses Viewer

This form allows the operator to view the current parasitic losses data as a graph.



This form allows the operator to view the current parasitic losses data in a graphical format. The parasitic losses data may be viewed as torque (dynamometer roll shaft torque), power (hp) or force versus system speed.

CoastDown Check

This form allows the operator to perform an automatic dynamometer coast-down test.

This test is used to perform an automatic coast-down verification test. Coast-down tests are used to verify that the dynamometer is properly calibrated by decelerating the dynamometer's inertia using the dynamometer's PAU. The time required to decelerate a known mass by a known amount using a known force can be calculated, and the actual time required is compared against the calculated time.

To Perform a CoastDown Test

1) Select the desired coast-down test type, either RG-240 type or ASM type.

2) Select the desired windows to be run using the "Run xxx Window" check boxes.

3) Click the "Start Test" button.

4) This test requires a built –in warm-up motor. Attempting to perform vehicle-lift-off coast-down tests is EXTREMELY DANGEROUS (SEE THE WARNINGS IN THE PARASITIC MEASUREMENT TEST AND ELSEWHERE IN THIS DOCUMENT), and it is very difficult to achieve repeatable results in that fashion.

5) The dynamometer will automatically engage its built-in warm-up motor, accelerate to the highest required speed, apply the required load, and time the system's deceleration through the selected windows.

6) Once the dynamometer has come to a stop, the test results can be viewed, partially on this screen, and in more detail by viewing the form available via the "View Results" button.

Inertia Check Test

This form allows the operator to perform an automatic dynamometer inertia measurement routine.

This test is used to measure the inertia (actually, vehicle-equivalent weight) or the dynamometer. This test is used in manufacturing and test-out at Mustang Dynamometer, and is not normally used in the field, unless mechanical changes are made to the dynamometer.

This test performs 4 sets of 2 coast-down test pairs, and uses the measured differences in deceleration at various loading forces to determine the inertia of the dynamometer.

To Perform an Inertia Check Test

1) Enter the desired coast-down window top speed, in MPH. (Please use the default value, 30)

2) Enter the desired coast-down window bottom speed, in MPH. (Please use the default value, 15)

3) Enter the desired coast-down window high load value, in HP. (Please use the default value, 24)

4) Enter the desired coast-down window low load value, in HP. (Please use the default value, 12)

5) Enter the desired over-speed value for the coast-down window (Please use the default value, 10)

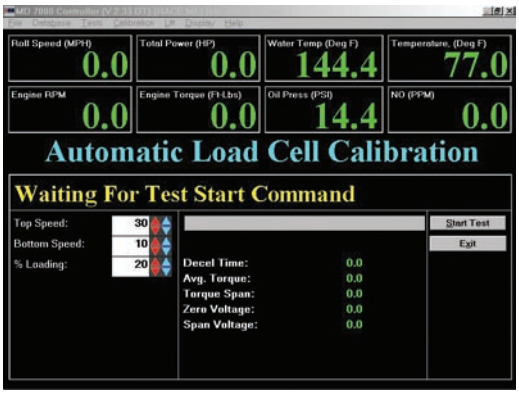
6) Click the "Start Test" button.

7) This test requires the built-in warm-up motor option. DO NOT ATTEMPT TO PERFORM THIS TEST USING VEHICLE-LIFT-OFFS, AS THEY ARE EXTREMELY DANGEROUS.

8) Four (4) sets of two (2) coast-down windows will be performed. When the final coast-down test has been performed, the dynamometer's inertia (vehicle-equivalent-weight) value will be known.

Auto-Calibrate Primary Load Cell

This form allows the operator to perform an automatic load cell calibration routine.



This test is used to calibrate the dynamometer' s PAU load cell using the known inertia of the dynamometer for a calibration weight. This test is not normally used, since a dead-weight calibration is usually quit a bit faster and at least as accurate. A very few customers, all with dynamometer's with built-in warm-up motors, are using the routine to avoid opening the dynamometer covers in high throughput facilities.

To Perform an Automatic Load Cell Calibration Test

1) Enter the desired top speed, in MPH. (Please use the default, 30)

2) Enter the desired bottom speed, in MPH. (Please use the default, 10)

3) Enter the desired % loading value, in percent. (Please use the default, 20)

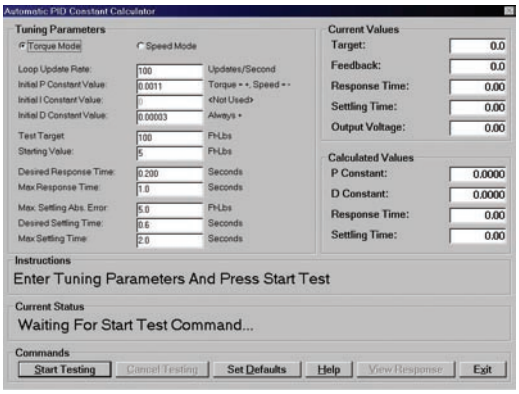
4) Click the "Start Test" button.

5) This test requires the built-in warm-up motor option. DO NOT ATTEMPT TO PERFORM THIS TEST USING VEHICLE-LIFT-OFFS, AS THEY ARE EXTREMELY DANGEROUS.

6) The dynamometer will automatically accelerate to the top speed, apply the specified load, and calculate the load cell calibration values.

Automatic PID Calculator

This form allows the operator to perform an automatic PID tuning routine.



This routine allows a knowledgeable operator to calculate appropriate PID constant values for the dynamometer at hand. This routine is normally only used by Mustang Dynamometer personnel, since considerable knowledge is required to successfully use this routine.

To Perform Automatic PID Tuning

1) Two (2) operators are required to perform this routine.

2) Select either "Torque" or "Speed" mode tuning.

3) Enter the initial values for the PID constants.

4) Enter the testing routine parameters (not described here; if you don't know how to do this, please don't try as you may cause yourself more trouble than benefit).

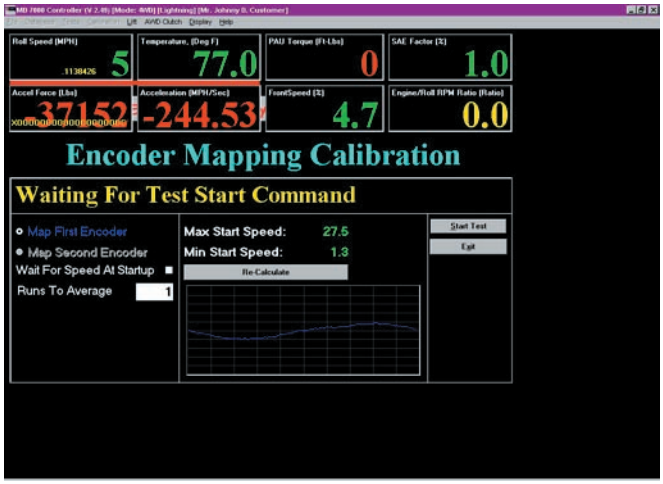
5) Start a SECURELY RESTRAINED vehicle with AN EXPERIENCED DRIVER running on the dynamometer.

6) Click the "Start Testing" button. The software will perform numerous step-response tests to obtain PID values that meet the specified response criteria.

7) The "View Response" button may be used to view a graph of the actual response achieved.

Encoder Noise Mapping Routine

This routine allows the user to create a noise cancelling map of a speed encoder input, which is then used during testing to map the noise generated by the encoder itself out of the speed input. Use of these speed cancelling maps can greatly reduce speed/acceleration/force/torque/power noise during testing, particularly on dynamometers with large diameter rolls.



Map First Encoder
Map Second Encoder
These select which encoder should be mapped during the routine. The first encoder is associated with the primary roll set of the dynamometer (the TWD roll set for configu rable AWD systems).

Wait For Speed At Startup If checked, the test routine will allow several seconds for the operator to acceler ate the system up to an appropriate testing speed. 50 MPH is generally ideal for encoder mapping.

Runs To Average Tells the mapping routine how many data sets to acquire and average into the final noise cancelling map. This value should generally be set to 5.

Min Start Speed
Max Start Speed
These values show the operator the minimum and maximum speeds that can be used during the mapping routine.

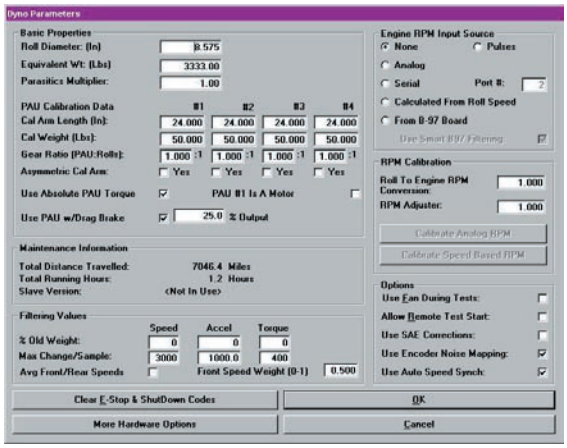
Re-Calculate Tells the software to re-calculate the minimum and maximum start speed values. These values depend on the physical configuration of the dynamometer, as well as on the I/O speed of your computer system.

Running a Mapping Routine

Ideally, noise mapping should be done without a vehicle present on the dynamometer, to avoid measurement errors due to vehicle inputs. However, vehicle-on-dynamometer mapping is possible, and generally works well. The routine is to simply accelerate the system up to approximately 50 MPH, click the "Start Test" button, and place the vehicle in neutral (or hold the clutch firmly to the floor). The test display will prompt the operator during testing, but the only requirement is that the system start at approximately 50 MPH, and that the system be freely coasting during the mapping routine. Once the mapping routine has completed, a graph of the newly acquired noise cancelling map will be displayed, and the new data will be saved to disk.

Dyno Parameters

This form allows the operator to specify dynamometer-specific parameters.



This form is used to enter the dynamometer-specific information for the dynamometer in use. Various physical properties, along with several option values, can be entered on this form.

Roll Diameter The diameter of the dynamometer's rolls, in inches/CM. Normally 8.575, 10.7 or 17.8 inches.

Equivalent Weight The vehicle-equivalent weight of the dynamometer, in pounds/Kg, usually 2000 pounds.

Parasitics Multiplier A multiplier applied to the measured parasitic losses of the dynamometer. This value should be left at 1.0 for all dynamometers except those with very unusual designs (custom units only).

Torque Arm Length The length of the PAU load-cell calibration arm, in inches/CM, usually 12.0, 18.0 or 24.0 inches.

Calibration Weight The calibration weight value, normally stamped into the calibration weight at manufacture time, in pounds/Kg. The nominal value is typically 50.0 pounds.

Gear Ratio The gear ratio between the dynamometer's rolls and the dynamometer's PAU(s). This value is normally 1.0, except on MD-1750 dynamometers, for which the value is 2.769. The value is (PAU-shaft revolutions per roll-shaft revolution).

Asymmetric Cal Arm If an asymmetric external calibration fixture is used for the PAU load-cell calibration, then this box should be checked. This box is normally un-checked, except for MD-1750 dynamometers.

Use Absolute PAU Torque If checked, the torque measured by the PAU load-cells is taken as its absolute value. This box is normally left checked, unless specific customer requirements involve directional torque measurement.

Total Distance The total distance driven on the dynamometer, in miles/KM.

Total Running Hours The total running time on the dynamometer, in hours.

Slave Version In the extremely unlikely event that a serial interface dynamometer controller is in use (rather than the normal PC/IO-Board configuration), the software version executing on the dynamometer controller will be shown.

% Old Weight For the speed/torque/acceleration inputs, an FIR filter constant used to filter the associated input values. This value must be in the range 0 to 99. 0 represent no filtering, while 99 represent a very heavy filter. These values should normally be left at 0, although values up to approximately 90 can be used to smooth measured values.

Max Change / Sample For the speed/torque/acceleration inputs, a clipping value that limits the amount by which the associated input value can change per sample. Since the normal sampling rate is 100 Hz, you can establish these values by taking the maximum expected rate of change for a channel and dividing by 100. These values should normally be left at the default values, which are very large, and therefor do not impose any clipping on the input values.

Avg Front/Rear Speeds If enabled, a second speed input will be used to create a weighted average speed input for the dynamometer. This is generally only used for shaft-coupled AWD dynamometers while in AWD mode to eliminate measurement noise due to driveshaft flex. Note that the second ADA-1100 board must be installed and connected to a second speed encoder for this to be available.

Front Speed Weight This value is used in creating the weighted average speed value discussed above. For a dynamometer with equal inertia values for each axle, this value should be nominally set to 0.500; for systems with different front/rear inertia values, this should be set to the fraction of the total inertia value accounted for by the front axle of the dynamometer. In practice, this value must be set to a slightly different value based upon tire/wheel/drivetrain inertia as applied to the front and rear roll sets. The ideal value for this parameter can be established by monitoring the "Front Accel" and "Rear Accel" 'magic name' values available via the auxiliary analog input channels, along with the "Primary Accel MPH/sec" value. When this value is set correctly, the "Primary Accel MPH/sec" value will track directly between the "Front Accel" and "Rear Accel" values, as can be seen using the Trace Graph Viewer.

Engine RPM Input Source Several input methods are supported for engine RPM measurement.

None No engine RPM source is available.

Pulses An engine RPM pulse train is routed through an on-board pulse train input. This input is not currently supported.

Analog An analog input representing engine RPM is provided from an external RPM measurement device.

Serial A Sheffield Research SmarTach is connected to an RS-232 serial port. This option is now obsolete. If this option is used, the serial port used to interface to the device must be specified.

Calculated From Roll Speed The engine RPM value is computed based on the dynamometer's measured speed. This input yields a very high quality engine RPM value, but may not be accurate if wheel slip is encountered, and can only be used in a single gear, and only with manual transmissions.

From B-97 Board – Use Smart B97 Filtering An optical or inductive input is fed through an on-board B97 I/O board. If this option is used, it is highly recommended that the "Use Smart B97 Filtering" option be engaged.

RPM Calibration

Roll To Engine RPM Conversion If engine RPM is being calculated from the dynamometer's speed input, then this value represent the multiplier used to go from dynamometer roll-shaft RPM to engine crankshaft RPM. This value is the calibration value resulting from the calibration routine discussed below.

RPM Adjuster This value is a "fix-all" multiplier applied to the raw engine RPM value, to accound for various problems encountered in engine RPM measurement.

Calibrate Analog RPM This button will display a calibration screen used to calibrate the analog engine RPM input. Please see the section titled "Analog RPM Input Calibration" for information on this calibration screen.

Calibrate Speed Based RPM This button will display a calibration screen used to calibrate the dynamometer's roll shaft speed to the engine's RPM. The user has only to specify the engine RPM value to calibrate to, drive the vehicle in the gear that will be used for testing at the specified RPM, and click the "OK" button.

Options

Use Fan During Tests — If checked, the optional vehicle cooling fan will be automatically turned on/off at the beginning/end of tests.

Allow Remote Test Start — If checked, a digital input may be configured to automatically start the current test remotely. This option is used in synchronizing multiple dynamometers, etc.

Use SAE Corrections — If checked, all displayed and recorded data will be corrected using the SAE J-1349 specification's logic, or user-specified standard conditions.

Use Encoder Noise Mapping — Noise on speed/accel/torque/power/force values can be greatly reduced (particularly on dynamometers with large diameter rolls) by using noise cancelling maps for the encoders. If you enable this feature, you must create maps of the various speed encoders, using the mapping routine in this software. Also, at the start of any test routine, you will have to sychronize the encoder with the speed maps, either manually (by aligning the rolls with a mark on the dynamometer's frame) or automatically (by using the auto-synch feature described below).

Use Auto Speed Synch — Enables automatic synch detection for the encoder noise cancelling logic, using a second one (1) pulse per revolution speed input associated with each (1 or 2) normal speed input. This will cause the auto-synch to pop up a small form whenever a test routine is started anytime the dynamometer's speed has fallen below 2 mph.

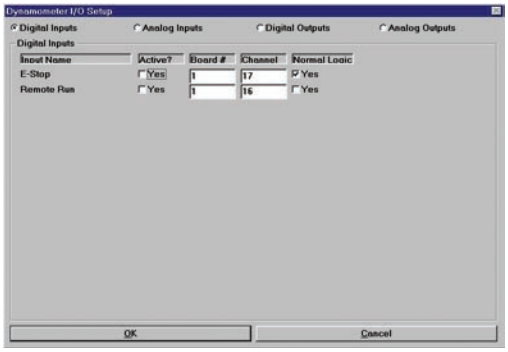
Clear E-Stop & Shut-Down Codes

This button will attempt to clear any E-Stop or shut-down codes.

More Hardware Options

Clicking on this button allows access to the hardware I/O channel assignments for the digital inputs and outputs used by the dynamometer control system.

Digital Input Setup



This view of this screen allows the operator to specify the I/O channels used by the dynamometer control system for digital inputs.

Name The logical name for the signal

Active? If checked, then the output will be read, otherwise the default value specified in the software's configuration ("Ini") file will be used.

Board The I/O board used to read the input (1 -> 2)

Channel The I/O channel used to read the input (8 -> 23)

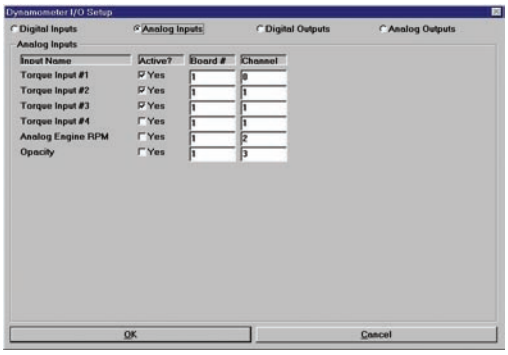
Normal Logic If this box is checked, the input will be taken to be active when the input voltage level is high, and inactive when the input level is low; otherwise, these levels will be reversed.

Digital Input Channels

Estop This input tells the control software that an E-Stop condition has occurred, which will put the dynamometer into an unloaded coast-stop, disable and set to 0% reference the throttle controller (if connected), and prevent further testing until the E-Stop condition is resolved.

Remote Run This input can be used to trigger the start of a test via an external signal. For this functionality to work, the test to be started must be active in the software (i.e. the test screen must be showing), and all required parameters must be set to acceptable values. When this input is triggered, the test will begin, and will run until this input returns to a "false" condition.

Analog Input Setup



This view of this screen allows the operator to specify the I/O channels used by the dynamometer control system for analog inputs.

Name The logical name for the signal

Active? If checked, then the output will be read, otherwise the default value specified in the software's configuration ("Ini") file will be used.

Board The I/O board used to read the input (1 -> 2)

Channel The I/O channel used to read the input (0 -> 7)

Analog Input Channels

Torque #1 This input is used to measure the torque applied to the dynamometer's roll shaft by the loading brake (PAU).

Torque #2 Similar to "Torque Input #1", but for an additional PAU.

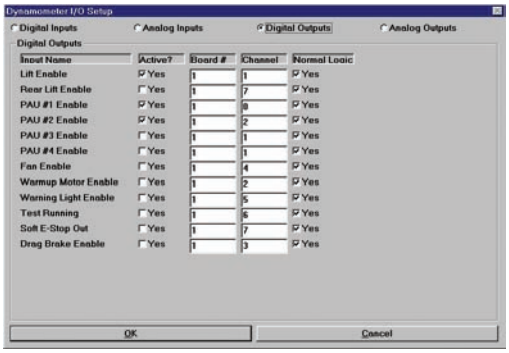
Torque #3 Similar to "Torque Input #1", but for an additional PAU.

Torque #4 Similar to "Torque Input #1", but for an additional PAU.

Analog Engine RPM This input is used to read engine RPM from an external engine RPM measurement system, such as MD's own MD-RPM-2000 system.

Opacity This input is used to measure diesel exhaust opacity using an external opacity measuring device.

Digital Output Setup



This view of this screen allows the operator to specify the I/O channels used by the dynamometer control system for digital outputs.

Name The logical name for the signal

Active? If checked, then the output will be read, otherwise the default value specified in the software's configuration ("Ini") file will be used.

Board The I/O board used to read the output (1 -> 2)

Channel The I/O channel used to read the output (0 -> 7)

Normal Logic If this box is checked, the output will be driven high when the signal value is true, and low when the signal value is false; otherwise, these levels will be reversed.

Digital Output Channels

Lift Enable This output drives the dynamometer's lift up and down.

Rear Lift Enable This output will drive the rear lift of a 4WD dynamometer up and down. If this output is active, the "Rear Lift" control sub-menu will appear on the main menu bar of the software.

PAU #1 Enable This output turns the loading PAU of the dynamometer on/off.

PAU #2 Enable Similar to "PAU #1 Enable", but for an additional PAU.

PAU #3 Enable Similar to "PAU #1 Enable", but for an additional PAU.

PAU #4 Enable Similar to "PAU #1 Enable", but for an additional PAU.

Fan Enable This output will drive a vehicle cooling fan. If this output is active, the "Fan" sub-menu will appear on the main menu bar of the software.

Warmup Motor Enable This output will drive a dynamometer warm-up motor during the warm-up, parasitic and coast-down tests, if the dynamometer is so equipped.

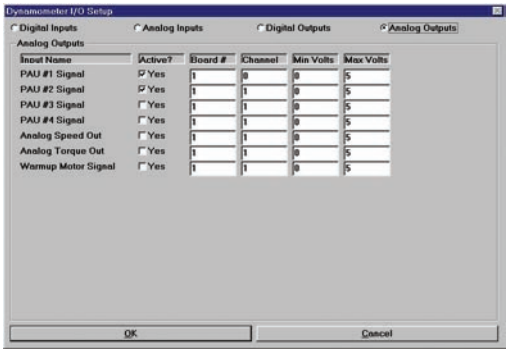
Warning Light Enable This output will drive a warning light any time the dynamometer is actively running a test or the system's speed is above 0.1 MPH.

Test Running This output will be driven high any time the dynamometer is actively running a test. This can be used to trigger external data acquisition software.

Soft E-Stop Out This output will send an E-Stop signal to external systems to indicate that the dynamometer is in an E-Stop condition.

Drag Brake Enable This output will drive the drag brake used on our MD-1750 model dynamometer, which is used to apply a light load to the dynamometer's rolls using the roll-

Analog Output Setup



This view of this screen allows the operator to specify the I/O channels used by the dynamometer control system for analog outputs.

Name The logical name for the signal

Active? If checked, then the current output will be written, otherwise the default value specified in the software's configuration ("Ini") file will be used.

Board The I/O board used to write the output (1 -> 2)

Channel The I/O channel used to write the output (0 -> 1)

Min Volts The minimum voltage that will ever be written to the output channel. Useful for limiting the range of voltages that will be presented to the connected actuator.

Max Volts The maximum voltage that will ever be written to the output channel. Useful for limiting the range of voltages that will be presented to the connected actuator.

Analog Output Channels

PAU #1 Signal This output drives the amplifier that is used to drive the loading brake (PAU) of the dynamometer.

PAU #2 Signal Similar to "PAU #1 Signal", but used to drive an additional loading brake (PAU).

PAU #3 Signal Similar to "PAU #1 Signal", but used to drive an additional loading brake (PAU).

PAU #4 Signal Similar to "PAU #1 Signal", but used to drive an additional loading brake (PAU).

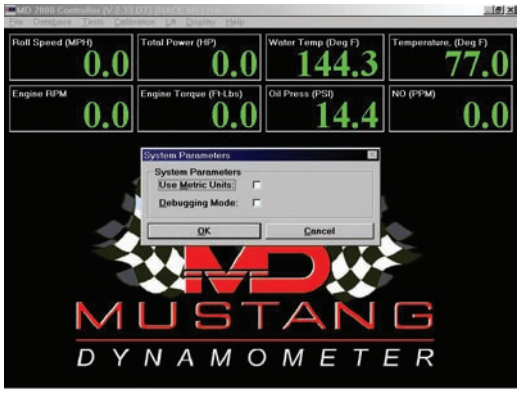
Analog Speed Out This output can be used to drive the system's measured speed (or RPM) value out to external data acquisition systems.

Analog Torque Out This output can be used to drive the system's measured torque (or force) value out to external data acquisition systems.

Warm-up Motor Signal This output is used to provide an output level reference for the warm-up motor, if the dynamometer is so equipped.

System Parameters

This form allows the operator to specify system-level parameters.



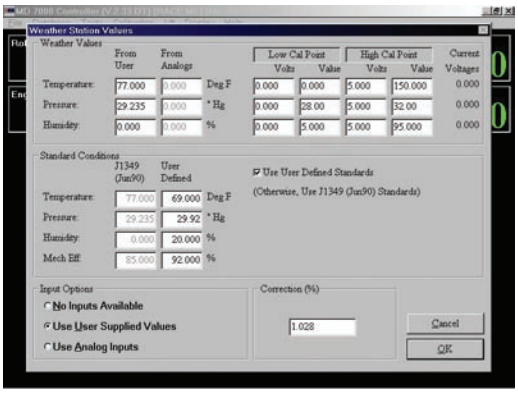
This form is used to view and/or set the system-level parameters.

Use Metric Units If selected, all displayed and printed values will be in metric units; otherwise, English units will be used.

Debugging Mode If selected, numerous debugging/diagnostic display values will be enabled, along with access to several normally disabled diagnostic forms.

Weather Station Parameters

This form allows the operator to configure and/or calibrate the weather station facility.



In order to perform SAE J-1349 atmospheric corrections for torque/power values, the ambient atmospheric conditions must be known. This form allows the operator to configure and/or calibrate the weather station facility of this software.

To Specify a Weather Station Input Type

Select on of the available options:

No Inputs Available	No weather station values are available, no corrections can be performed.
Use User Supplied Values	The user will manually enter the ambient atmospheric values.
Use Analog Inputs	An analog interface to weather station sensors is connected.

To Specify User-Supplied Weather Station Values

If no weather station hardware is connected, the operator may manually enter the ambient atmospheric condition values, in the "From User" column in the "Weather Values" group.

To Specify User-Defined Standard Conditions

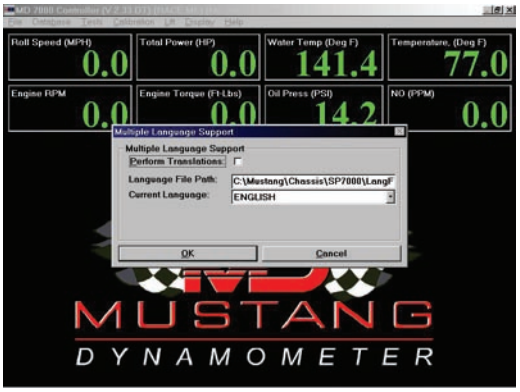
If you do not wish to use the SAE J-1349 JUN90 standard conditions, you may specify alternate standard condition values, in the "User Defined" column in the "Standard Conditions" group. If the "Use User Defined Standards" check box is checked, the user defined values will be taken as the standard conditions values, otherwise the SAE J-1349 JUN90 values will be used.

To Calibrate a Hardware Weather Station

If a hardware weather station is connected to the analog input interface, the user must supply calibration values for each of the inputs. The appropriate calibration values are supplied with the sensors, and must be entered in the "Weather Values" group, under the "Low Cal Point" and "High Cal Point" headers. The "Low Cal Point" voltages are normally 0.0 volts, and the "High Cal Point" voltages are normally 5.0 volts. The low and high calibration point values for each sensor are sensor dependant.

Languages

This form allows the operator to select the current language for display and printing.



This software supports several languages in addition to English. This form allows the operator to select a language for the user interface.

Perform Translations If selected, language translations will be performed to the selected language.

Language File Path Specifies the directory path to the foreign language files used for non-English translations.

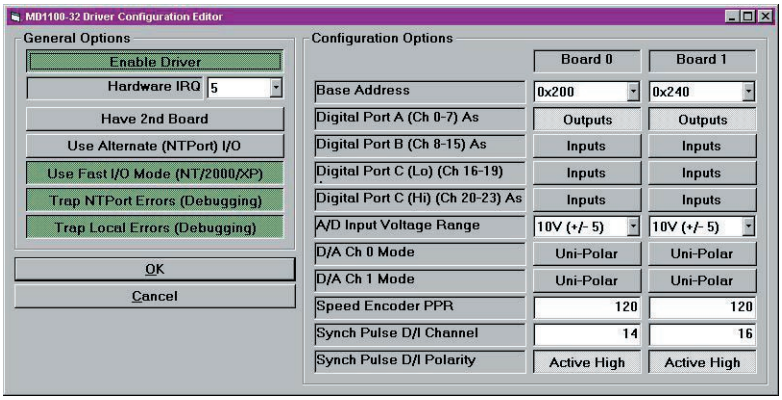
Current Language Indicates the language currently selected for the user interface.

Diagnostics Menu

ADA-1100 I/O Board Driver Configuration Editor

This is the configuration screen for the driver for the ADA-1100 I/O board used to control the dynamometer. This form is generally only used once, to configure the driver for your particular hardware.

NOTE: Use of this screen should be restricted to users with the knowledge required to correctly configure this driver. Invalid settings may render your equipment inoperative, and may require a service call or reinstallation of your software to correct the problem.



Enable Driver Should be enabled; the sole exception is when the software is configured in "Demo" mode. If not enabled, the I/O driver will not work at all.

Hardware IRQ Must be set to match the physical IRQ jumper setting on the ADA-1100 I/O board. Note that for systems with two (2) I/O boards, only the first board will have an IRQ jumper installed; the second board must NOT have the jumper installed. Note that the selected IRQ must not be in use by any other I/O boards (sound board, parallel port, etc), and must not be reserved by the operating system for PCI boards (if your BIOS supports this, it should be reserved for ISA boards).

Have 2nd Board Must be enabled if and only if you have two (2) ADA-1100 I/O boards installed, typically to gain an additional 8 analog inputs, or for a second speed channel on AWD dynamometers.

Use Alternate (NTPort) I/O Configures the driver to use an alternative method of accessing the I/O board. The alternative method is faster on Windows 98 systems, and may or may not be faster on NT/2000/XP systems.

Use Fast I/O Mode (NT/2000/XP) If the alternate (NTPort) I/O configuration is used, this option will increase I/O speed on NT/2000/XP systems.

Trap NTPort Errors (Debugging) Enables message boxes for any errors encountered when using the alternate (NTPort) I/O routines.

Trap Local Errors (Debugging) Enables message boxes for internal driver errors.

OK Button Saves the current configuration values and closes this form.

Cancel Button Closes this form without saving any changes.

Base Address Sets the base port address for the I/O board(s). MUST be set correctly, ie this value must match the physical jumper setting on the I/O board(s).

Digital Port A (Ch 0-7) As Configures this group of digital I/O lines as inputs or outputs.

Digital Port B (Ch 8-15) As Configures this group of digital I/O lines as inputs or outputs.

Digital Port C (Lo) (Ch 16-19) As Configures this group of digital I/O lines as inputs or outputs.

Digital Port C (Hi) (Ch 20-23) As Configures this group of digital I/O lines as inputs or outputs.

A/D Input Voltage Range Sets the analog input voltage range. MUST match the physical jumper setting on the I/O board(s).

D/A Ch 0 Mode Sets the analog output mode for this channel. MUST match the physical configuration of the I/O board(s).

D/A Ch 1 Mode Sets the analog output mode for this channel. MUST match the physical configuration of the I/O board(s).

Speed Encoder PPR Sets the number of pulses per revolution for the speed input encoder connected to the I/O board(s).

Synch Pulse D/I Channel Sets the digital input channel used for a one (1) pulse per revolution speed input used to synchronize encoder noise mapping values to the current encoder position. Only used when the one (1) pulse per revolution input is installed for auto-synch use.

Synch Pulse D/I Polarity Sets the polarity of the digital input channel used for a one (1) pulse per revolution speed input used to synchronize encoder noise mapping values to the current encoder position. Only used when the one (1) pulse per revolution input is installed for auto-synch use.

The Test Menu

The Test menu allows access to the various vehicle testing routines.

The vehicle testing routines are broken down into four (4) main groups. Each group of test types is available from the associated sub-menu.

Diagnostic Test Routines

This menu allows access to the diagnostic vehicle testing routines.

Manual Loading Test

This test allows the user to apply a manually controlled load to the vehicle.

Purpose

The Manual Control Test allows the user to apply a manually controlled load to the vehicle under test. This routine is useful for very simple testing, and as a diagnostic tool for verifying correct functioning of the dynamometer control system.

Intended Test Procedure

This test has no fixed ending time or structure. The vehicle is simply driven under the desired loading. The general testing procedure is outlined below.

1) The "% Output" field should be set to a relatively low value to avoid suddenly applying a jarring load to the vehicle when the test is started.

2) The "Save Results" and "Save Trace" check boxes should be set appropriately.

3) The "Start Test" button is clicked.

4) The vehicle is driven under load.

5) The "Stop Test" button is clicked, and the test terminates.

6) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) (None)

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

You should make sure that the output setting is not too high when starting a test, as the vehicle under test may be violently loaded or bogged down.

Constant Force Test

This test allows the user to apply a controlled constant force loading to the vehicle.

Purpose

The Constant Force Test allows the user to drive the vehicle under a constant, calibrated force. This routine is useful for very simple testing, and for PID loop tuning.

Intended Test Procedure

This test has no fixed ending time or structure. The vehicle is simply driven under the desired loading. The general testing procedure is outlined below.

1) The "Target Force" field should be set to a relatively low value to avoid suddenly applying a jarring load to the vehicle when the test is started.

2) The "Save Results" and "Save Trace" check boxes should be set appropriately.

3) The "Start Test" button is clicked.

4) The vehicle is driven under load.

5) The "Stop Test" button is clicked, and the test terminates.

6) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) (None)

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

The "Target Force" value should not be too high when the test is started, to avoid suddenly applying a jarring load to the vehicle when the test is started.

Constant Speed Test

This test allows the user to hold the vehicle's speed at a constant value.

Purpose

The Constant Speed Test allows the user to hold the vehicle at a specific speed. This test is useful for full-throttle tuning at specific speeds, durability testing, and PID loop tuning.

Intended Test Procedure

This test has no fixed ending time or structure. The vehicle is simply driven at the specified speed, regardless of throttle position. The general testing procedure is outlined below.

1) The "Target Speed" field should be set to a value **higher** speed than the vehicle is operating at to avoid suddenly applying a jarring load to the vehicle when the test is started.

2) The "Save Results" and "Save Trace" check boxes should be set appropriately.

3) The "Start Test" button is clicked.

4) The vehicle is driven under load.

5) The "Stop Test" button is clicked, and the test terminates.

6) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) (None)

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

You should not start this test with a "Target Speed" value that is less than the current speed of the vehicle to avoid sudden jarring loading of the vehicle when the test is started.

Constant Horsepower Test

This test allows the user to apply a constant power loading to the vehicle.

Purpose

The Constant Power Test allows the user to test the vehicle with a constant power loading applied. This test has limited usefulness for most customers, but may be of use to some very specialized tuners.

Intended Test Procedure

This test has no fixed ending time or structure. The vehicle is simply driven under the desired loading. The general testing procedure is outlined below.

1) The "Target Power" field should be set to a relatively low value to avoid suddenly applying a jarring load to the vehicle when the test is started.

2) The "Save Results" and "Save Trace" check boxes should be set appropriately.

3) The "Start Test" button is clicked.

4) The vehicle is driven under load.

5) The "Stop Test" button is clicked, and the test terminates.

6) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) (None)

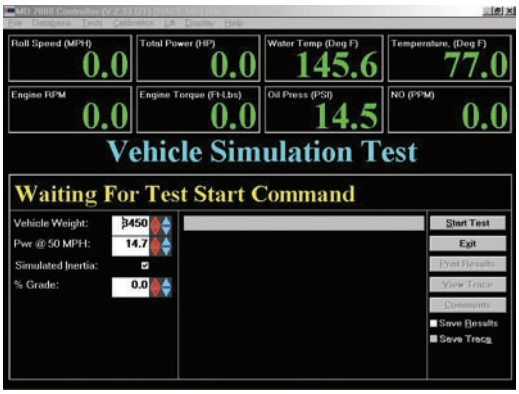
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

The "Target Power" field should not be set to too high a value when the test is started to avoid applying a sudden jarring load to the vehicle when the test is started.

Vehicle Simulation Test

This test allows the user to apply a vehicle simulation loading to the vehicle.



Purpose

The Vehicle Simulation Test allows the user to drive the vehicle on the dynamometer with the same loading that the vehicle would experience on the road. This test is useful for performing road tests on the dynamometer and for diagnosing cruise-speed problems.

Intended Test Procedure

This test has no fixed ending time or structure. The vehicle is simply driven under the desired loading. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Pwr @ 50 MPH" field will default to the value entered for the vehicle currently selected for testing. The user may change this value if desired.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The "% Grade" field will default to the most recently used value. The user may adjust this value while the test is running to simulate different road grade values.

5) The "Save Results" and "Save Trace" check boxes should be set appropriately.

6) The "Start Test" button is clicked.

7) The vehicle is driven under load.

8) The "Stop Test" button is clicked, and the test terminates.

9) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) (None)

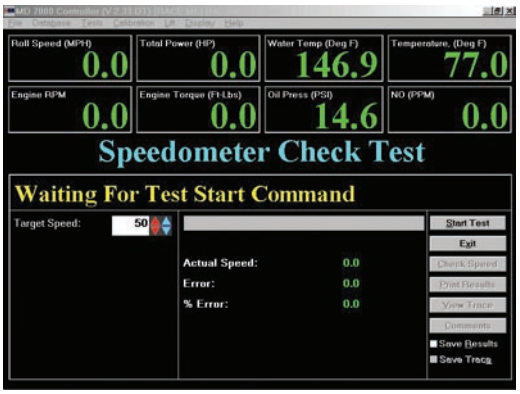
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

The test should not be started with high "% Grade" values, or at very high speeds, in order to avoid applying sudden jarring loads to the vehicle when the test is started.

Speedometer Check Test

This test allows the user to check the accuracy of the vehicle's speedometer.



Purpose

The Speedometer Check Test allows the user to check the accuracy of the vehicle's speedometer. No load is applied to the vehicle during this test.

Intended Test Procedure

This test has no specific ending point, as the speedometer may be checked several times before ending the test. The general testing procedure is outlined below.

1) The "Target Speed" field should be set to the speed at which the speedometer is to be checked.

2) The "Save Results" and "Save Trace" check boxes should be set appropriately.

3) The "Start Test" button is clicked.

4) The vehicle is driven, with no load. When the driver sees the speedometer indicating the target speed, the "Check Speed" button should be clicked. At this point, the actual speed (according to the dynamometer's very accurate digital speed input) is displayed, along with the absolute error of the vehicle's speedometer at the testing speed, and the percentage error that the absolute error represents.

5) The "Stop Test" button is clicked, and the test terminates.

6) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Target Speed
2) Actual (Dynamometer) Speed
3) Speedometer Error, MPH/KPH
4) Speedometer Error, %

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

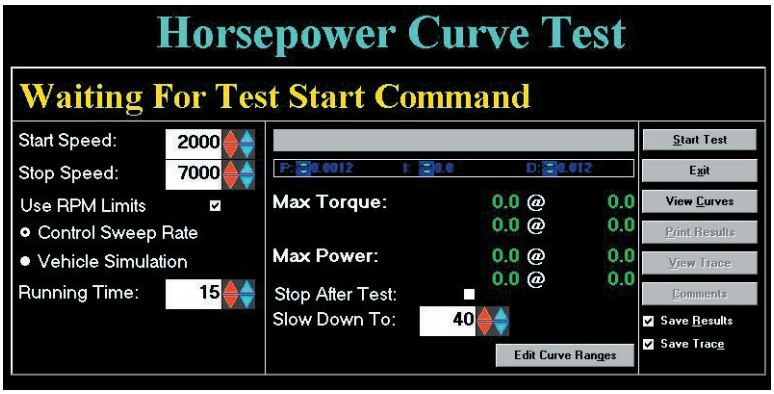
None.

Performance Test Routines

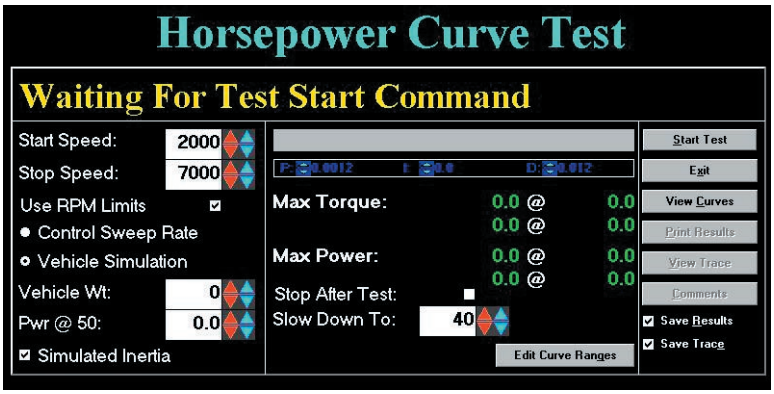
This menu allows access to the performance vehicle testing routines.

Power Curve (Controlled Sweep Rate)

This test allows the user to perform a controlled sweep rate type power curve test on the vehicle.



Power Curve (Vehicle Simulation Mode)



Purpose

The Horsepower Curve Test allows the operator to perform a sweep-type power measurement test on the vehicle. This test routine supports both a fixed-sweep-time mode and a vehicle-simulation-loading mode. The vehicle-simulation-loading mode will most accurately reflect the actual power that the vehicle will deliver in use, while a fixed-sweep-time mode test can be used for comparing against test-stand dynamometer values.

Intended Test Procedure

This test has a specific ending point, which is reached when the vehicle's speed increases past the value entered in the "Stop Speed" field. The general testing procedure is outlined below.

1) Before testing is started, the power and torque averaging ranges and the absolute range for data collection during testing should be set using the data entry forms available via the "Edit Curve Ranges" button. Mustang Dynamometer recommends that the by-MPH values be left at 1.0 MPH ranges with 0.5 tolerances, and the by-RPM values be left at 250 RPM ranges with 125 RPM tolerances, although 100 RPM ranges with 50 RPM tolerances will work very well on systems with high quality engine RPM sensors. The lowest and highest band center values should be set to the minimum and maximum MPH/KPH and RPM values you expect to encounter during testing. These values will remain as you set them until you modify them again.

2) The "Start Speed" field should be set to the lowest speed at which the vehicle is to be tested. This should be the lowest speed at which the vehicle will run cleanly in the gear selected for testing if single-gear testing is to be performed.

3) The "Stop Speed" field should be set to the highest speed at which the vehicle is to be tested. This should be the highest speed at which the vehicle can be operated in the highest gear that will be used during testing.
4) The "Stop After Test" check box should be set appropriately. If this check box is checked, the dynamometer's PAU will be used to stop the dynamometer after the power sweep is complete, to save wear on the vehicle's brakes.

5) You must select either the "Control Sweep Rate" or the "Vehicle Simulation" mode of testing. The "Vehicle Simulation" mode is preferred, since it will most accurately measure the power that the vehicle will deliver during actual driving, while the controlled sweep rate mode may be more useful for comparing to test-stand dynamometers.

6) If "Control Sweep Rate" mode is selected, you must specify a value (in seconds) for the sweep "Running Time". Mustang Dynamometer recommends that you use the longest running time that the vehicle can comfortably tolerate, to enable additional data collection during the sweep.

7) If "Vehicle Simulation" mode is selected, the "Vehicle Wt", "Pwr @ 50" and "Simulated Inertia" fields must be set appropriately. The numeric values will default to the values entered for the vehicle currently selected for testing, and Mustang Dynamometer recommends that the "Simulated Inertia" option always be left on.

8) The "Save Results" and "Save Trace" check boxes should be set appropriately.

9) The "Start Test" button is clicked.

10) The vehicle is driven at just below the specified starting speed, and then accelerated at full power until the specified stopping speed is matched or exceeded. The screen will indicate to the driver when the test is complete.

11) The "Stop Test" button does not need to be clicked, as the test automatically terminates once the dynamometer is stopped. The "Stop Test" button may be used to cancel a test which you do not wish to complete.

12) Any saved test results may be viewed and/or a test report printed.

Use RPM Limits If selected, the "Start Speed" and "Stop Speed" values will be interpreted as engine RPM values rather than vehicle MPH values. NOTE: If you are testing in "Controlled Sweep" mode, the software requires that your vehicle be in the gear you will test in, and at speed, when you click "Start Test". This is required because the system performs speed (MPH) control, and uses the measured RPM/MPH relationship to calculate the MPH/second ramp rate required to achieve the specified RPM/second ramp rate.

Slow Down To If "Stop After Test" is not enabled, then the system will be slowed to this speed at the end of a test, once the measured speed has fallen to the highest speed encountered during actual testing minus 5 MPH. This value might be set to the start speed minus 5 MPH for users performing back-to-back sets of 3 runs.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Maximum torque and power values, and the speed (MPH/KPH) at which they were measured.
2) Maximum torque and power values, and the engine speed (RPM) at which they were measured.
3) A series of data points representing the torque and power measured during testing, ordered by ground speed (MPH/KPH).
4) A series of data points representing the torque and power measured during testing, ordered by engine speed (RPM).

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

1) Torque values recorded as a function of vehicle speed (MPH/KPH) are in terms of dynamometer roll shaft torque, not engine crankshaft torque.

2) Torque values recorded as a function of engine speed (RPM) are in terms of engine crankshaft torque.

3) Since the measured power and torque values are averaged into MPH/KPH and RPM ranges, and the size of the averaging ranges for MPH/KPH and RPM may be significantly different (depending on the current user specified settings), the by-speed and by-RPM values may not exactly agree.

4) Since the measured power and torque values are averaged into MPH/KPH and RPM ranges, the power curve test specific curves may not show torque and power crossing at exactly 5252 RPM.

5) A longer sweep time should generate higher power and torque readings, since a lower acceleration rate

means that less power is absorbed by the vehicle's drive-train.

6) If you experience "drop-outs" in the power curve viewer or printed reports, try using a slower sweep rate. You may also wish to expand the size of the averaging bands using the "Edit Curve Ranges" button on this form.

7) If you experience wavy torque or power curves, you should try to isolate the cause of the waves. You should use the Trace Graph Viewer to isolate torque waves to either "PAU Torque" or "Accel Torque", and you may wish to filter the wavy input, which can be done in the "Dyno Parameters" form. An unstable engine RPM input can also cause distorted torque and power curves.

Programmed Force

This test allows the user to apply a time-based force loading profile to the vehicle.

Purpose

The Programmed Force Test can be used for durability or performance testing, or to simulate real-world loading profiles.

Intended Test Procedure

This test has a fixed termination time, when the last data point has been processed for the last loop through the selected test profile. The general testing procedure is outlined below.

1) Select a test profile using the "Select Test Profile" directory- and file-picking boxes.

2) Enter the number of loops through the selected profile that you wish to execute.

3) The "Save Results" and "Save Trace" check boxes should be set appropriately.

4) A driver should start driving the vehicle at the desired testing speed.

5) The "Start Test" button is clicked.

6) The vehicle is driven until the test completes, while the load on the vehicle is controlled by the selected test profile.

7) When the last data point has been processed for the last time through the selected profile, the test terminates.

8) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database. For this test type, the following additional information is saved as part of the final test results record:

1) (None)

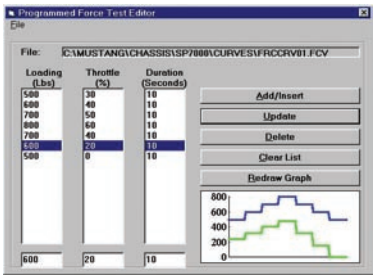
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

None.

Programmed Force Editor

This form allows the user to edit/create time-based force loading profiles.



This form allows the user to edit/create time-based force loading profiles. Each point in these profiles specifies a target loading value, and the number of seconds for which the specified loading should be maintained. Files may be read, written and imported using the related "File" menu items. Creating a new file or editing an existing file is a simple process outlined below. The "Throttle (%)" column has been added to support scripted loading scenarios using the integrated throttle controller. When any existing script file is loaded, the "Throttle (%)" values will show up as "0", and will not affect the functioning of the script. If a value is entered, and the optional throttle controller is connected, the vehicle's throttle will be controlled to the specified position (in %).)

To Create A New Profile

1) Select "New" from the "File" menu.
2) Click in the box under the "Loading (Lbs)" column, and enter the loading force you wish to apply.
3) Click in the box under the "Duration (Seconds)" column, and enter the number of seconds for which you wish the load to be applied.
4) Click the "Add/Insert" button.
5) Repeat as necessary.

To Edit An Existing Profile

1) Select "Load" from the "File" menu, and select a file to load.
2) Edit the existing profile data as described above.

Programmed Speed

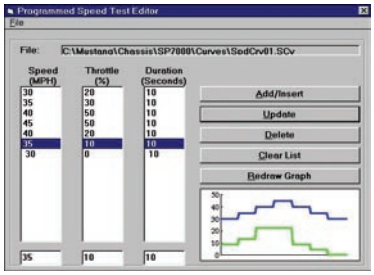
This test allows the user to apply a time-based speed control to the vehicle.

This test is very similar to the "Programmed Force Test", except that the systems speed is controlled, rather than the applied loading force.

Please see the section on the "Programmed Force Test" for additional information.

Programmed Speed Editor

This form allows the user to edit/create time-based speed control profiles.



This form is very similar to the "Programmed Force Test Editor", except that the systems speed is controlled, rather than the applied loading force. Please see the section on the "Programmed Force Test Editor" for additional information. The "Throttle (%)" column has recently been added to support scripted loading scenarios using the integrated throttle controller. When any existing script file is loaded, the "Throttle (%)" values will show up as "0", and will not affect the functioning of the script. If a value is entered, and the optional throttle controller is connected, the vehicle's throttle will be controlled to the specified position (in %).)

Timing Test Routines

This menu allows access to the timing-type vehicle testing routines.

Quarter Mile Sprint

This test allows the user to simulate a ¼ mile sprint race with the vehicle.

Purpose

The Timed Quarter Mile Sprint test allows the user to simulate a ¼ mile sprint race on the dynamometer. The results of these tests are generally within 0.1 to 0.2 seconds of the actual times recorded by a vehicle at a drag strip (if accurate vehicle loading parameters are used).

Intended Test Procedure

This test has a fixed termination time, when the vehicle has traveled ¼ mile. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Pwr @ 50 MPH" field will default to the value entered for the vehicle currently selected for testing. The user may change this value if desired.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The "Save Results" and "Save Trace" check boxes should be set appropriately.

5) The "Start Test" button is clicked.

6) The vehicle is accelerated as quickly as possible through a distance of ¼ mile. Test timing begins as soon as the vehicle's speed exceeds 0.1 MPH.

7) The test terminates when the vehicle has traveled ¼ mile. The "Stop Test" button may be used to terminate a test you do not wish to finish.

8) Once the test is complete, the dynamometer's PAU is used to stop the system, to avoid wear to the vehicle's brakes.

9) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Time to ¼ mile, 60 feet, 100, 200, 300 and 400 yards.
2) Speed at ¼ mile, 60 feet, 100, 200, 300 and 400 yards.

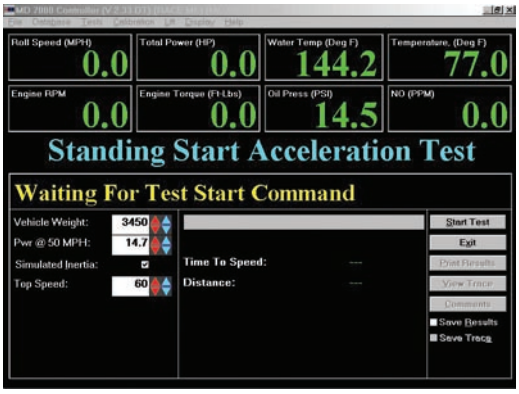
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

1) Do not let the vehicle roll until you are read to start the test.
2) As soon as the vehicle starts rolling, the test will start timing.
3) Drive like you are at the drag strip (including being very careful!

Standing Start Acceleration

This test allows the user to simulate a 0-60 type standing start acceleration run with the vehicle.



Purpose

This test allows the user to simulate a 0-60 type standing start acceleration run with the vehicle.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has reached the specified top speed. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Pwr @ 50 MPH" field will default to the value entered for the vehicle currently selected for testing. The user may change this value if desired.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The "Top Speed" value should be entered, typically 50, 60 or 100 MPH.

5) The "Save Results" and "Save Trace" check boxes should be set appropriately.

6) The "Start Test" button is clicked.

7) The vehicle is accelerated as quickly as possible to the specified top speed. Test timing begins as soon as the vehicle's speed exceeds 0.1 MPH.

8) The test terminates when the vehicle reaches the specified top speed. The "Stop Test" button may be used to terminate a test you do not wish to finish.

9) Once the test is complete, the dynamometer's PAU is used to stop the system, to avoid wear to the vehicle's brakes.

10) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Top speed accelerated to.
2) Time required to reach specified top speed.

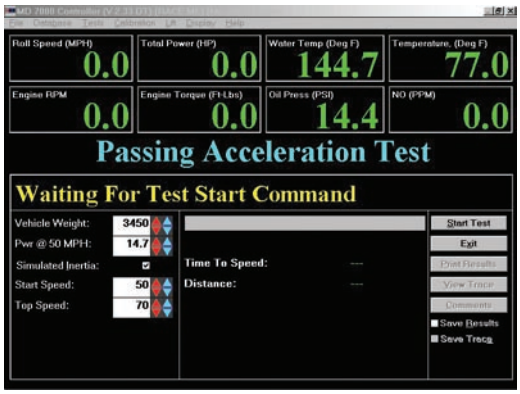
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

1) Do not let the vehicle roll until you are read to start the test.
2) As soon as the vehicle starts rolling, the test will start timing.
3) Drive like you are at the drag strip (including being very careful!

Passing Acceleration

This test allows the user to simulate a 50-70 type passing acceleration run with the vehicle.



Purpose

This test allows the user to simulate a 50-70 type passing acceleration run with the vehicle.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has reached the specified top speed. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Pwr @ 50 MPH" field will default to the value entered for the vehicle currently selected for testing. The user may change this value if desired.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The "Start Speed" value should be entered, typically 30 or 50 MPH.

5) The "Top Speed" value should be entered, typically 50 or 70 MPH.

6) The "Save Results" and "Save Trace" check boxes should be set appropriately.

7) The "Start Test" button is clicked.

8) The vehicle is driven just below the starting speed, then accelerated as quickly as possible to the specified top speed. Test timing begins as soon as the vehicle's speed exceeds the specified starting speed.

9) The test terminates when the vehicle reaches the specified top speed. The "Stop Test" button may be used to terminate a test you do not wish to finish.

10) Once the test is complete, the dynamometer's PAU is used to stop the system, to avoid wear to the vehicle's brakes.

11) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Starting speed.
2) Top speed.
3) Time required to accelerate from the specified starting speed to the specified top speed.

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

1) Do not let the vehicle roll until you are read to start the test.
2) As soon as the vehicle exceeds the specified starting speed, the test will start timing.
3) Drive like you are at the drag strip (including being very careful!

200 Yard Roll-On

This test allows the user to simulate a 200-yard roll-on acceleration run with the vehicle.

Purpose

This test allows the user to simulate a 200-yard roll-on acceleration run with the vehicle. (This test is more popular with motorcycle testers than with automotive testers.)

Intended Test Procedure

This test has a fixed termination time, when the vehicle has traveled 200 yards after reaching the specified starting speed. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Pwr @ 50 MPH" field will default to the value entered for the vehicle currently selected for testing. The user may change this value if desired.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The "Start Speed" value should be entered, typically 50 or 60 MPH.

5) The "Save Results" and "Save Trace" check boxes should be set appropriately.

6) The "Start Test" button is clicked.

7) The vehicle is driven just below the starting speed, then accelerated as quickly as possible to cover 200 yards. Test timing begins as soon as the vehicle's speed exceeds the specified starting speed.

8) The test terminates when the vehicle travels 200 yards after reaching the specified starting speed. The "Stop Test" button may be used to terminate a test you do not wish to finish.

9) Once the test is complete, the dynamometer's PAU is used to stop the system, to avoid wear to the vehicle's brakes.

10) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Starting speed.
2) Time required to cover 200 yards.
3) Speed at 200 yards after starting speed is reached.

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

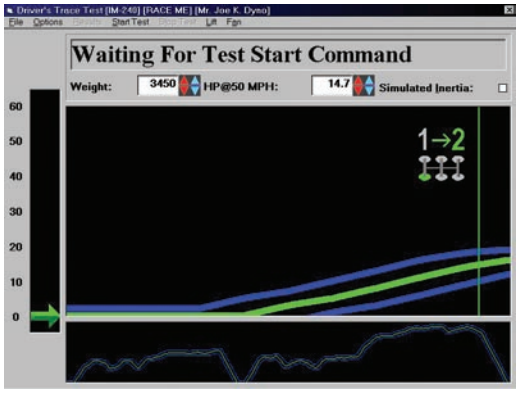
1) Do not let the vehicle roll until you are read to start the test.
2) As soon as the vehicle exceeds the specified starting speed, the test will start timing.
3) Drive like you are at the drag strip (including being very careful!

Emissions Test Routines

This menu allows access to the emissions vehicle testing routines.

Drivers Trace (IM240/FTP/etc)

This test allows the user to perform a (non-certified) IM-240/FTP/etc. type transient emissions test.



Purpose

This test allows the user to perform a (non-certified) IM-240/FTP/etc. type transient emissions test.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has completed the emissions testing profile. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Pwr @ 50 MPH" field will default to the value entered for the vehicle currently selected for testing. The user may change this value if desired.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The desired emissions driving profile should be selected using the "Load Trace" option on the "File" menu.

5) The desired display options should be selected using the entries on the "Options" menu.

6) The "Save Results" and "Save Trace" check boxes should be set appropriately.

7) The "Start Test" button is clicked.

8) The vehicle is driven so that the speed indicating arrow stays between the two (2) blue lines, or very near the green line if the blue lines are not displayed. This test displays a speed profile that the driver is required to follow to perform the emissions test. The driver will find that driving to the displayed trace grows easier with practice.

9) The test terminates when the vehicle completes the selected driving trace. The "Stop Test" button may be used to terminate a test you do not wish to finish.

10) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Emissions test specific data is recorded, including strip-chart data for each exhaust gas component, vehicle speed, and profile specified speed.

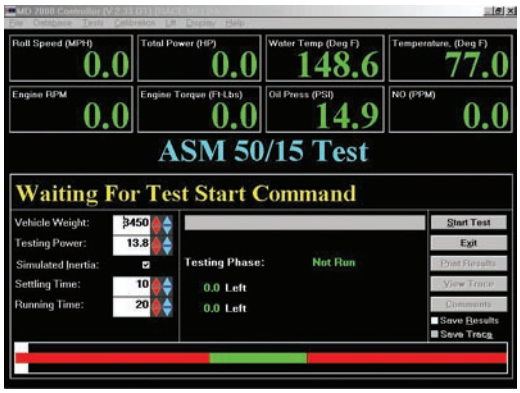
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

1) A non-integrated emissions analyzer may be used as an alternative to the optional integrated Andros 5-gas bench.

ASM 50/15

This test allows the user to perform a (non-certified) ASM 50/15 type emissions test.



Purpose

This test allows the user to perform a (non-certified) ASM 50/15 type emissions test. This test requires the optional Andros 5-gas analyzer bench to be meaningful.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has completed the specified emissions sampling times. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Testing Power" field's value will automatically be set to the "Vehicle Weight" field divided by 250, or the user can manually over-ride this default value.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The desired emissions "Settling Time" and "Running Time" values should be entered.

5) The "Save Results" and "Save Trace" check boxes should be set appropriately.

6) The "Start Test" button is clicked.

7) The vehicle is driven so that the speed-indicating bar stays within the green section of the speed indicator. If the vehicle's speed falls outside of the green range, testing is re-started.

8) The test terminates when the vehicle completes the emissions test. The "Stop Test" button may be used to terminate a test you do not wish to finish.

9) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Average exhaust gas concentrations of each of the gasses of interest.

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

None.

ASM 25/25

This test allows the user to perform a (non-certified) ASM 25/25 type emissions test.

Purpose

This test allows the user to perform a (non-certified) ASM 25/25 type emissions test. This test requires the optional Andros 5-gas analyzer bench to be meaningful.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has completed the specified emissions sampling times. The general testing procedure is outlined below.

1) The "Vehicle Weight" field will default to the weight entered for the vehicle currently selected for testing. The user may change this weight if desired.

2) The "Testing Power" field's value will automatically be set to the "Vehicle Weight" field divided by 300, or the user can manually over-ride this default value.

3) The "Simulated Inertia" check box determines whether inertia simulation will be used or not. Mustang Dynamometer recommends that this option always be used.

4) The desired emissions "Settling Time" and "Running Time" values should be entered.

5) The "Save Results" and "Save Trace" check boxes should be set appropriately.

6) The "Start Test" button is clicked.

7) The vehicle is driven so that the speed-indicating bar stays within the green section of the speed indicator. If the vehicle's speed falls outside of the green range, testing is re-started.

8) The test terminates when the vehicle completes the emissions test. The "Stop Test" button may be used to terminate a test you do not wish to finish.

9) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Average exhaust gas concentrations of each of the gasses of interest.

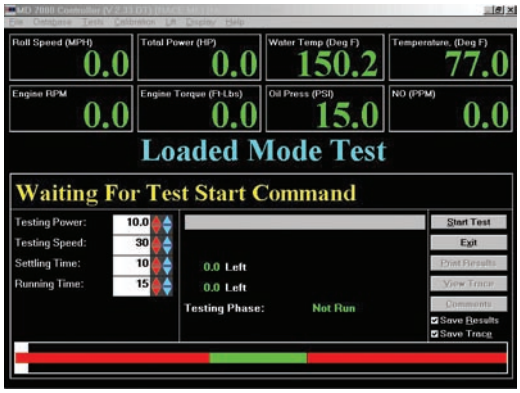
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

None.

Loaded Mode

This test allows the user to perform a (non-certified) loaded mode type emissions test.



Purpose

This test allows the user to perform a (non-certified) loaded mode emissions test. This test requires the optional Andros 5-gas analyzer bench to be meaningful.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has completed the specified emissions sampling times. The general testing procedure is outlined below.

1) The "Testing Power" should be set to the desired power loading.

2) The "Testing Speed" should be set to the desired testing speed.

3) The desired emissions "Settling Time" and "Running Time" values should be entered.

4) The "Save Results" and "Save Trace" check boxes should be set appropriately.

5) The "Start Test" button is clicked.

6) The vehicle is driven so that the speed-indicating bar stays within the green section of the speed indicator. If the vehicle's speed falls outside of the green range, testing is re-started.

7) The test terminates when the vehicle completes the emissions test. The "Stop Test" button may be used to terminate a test you do not wish to finish.

8) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Average exhaust gas concentrations of each of the gasses of interest.

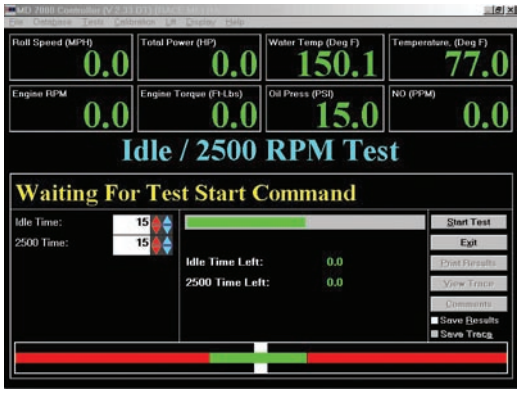
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

None.

Idle / 2500 RPM

This test allows the user to perform a (non-certified) idle/2500 RPM type emissions test.



Purpose

This test allows the user to perform a (non-certified) idle/2500 RPM type emissions test. This test requires the optional Andros 5-gas analyzer bench to be meaningful.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has completed the specified emissions sampling times. The general testing procedure is outlined below.

1) The desired idle and 2500 RPM emissions testing time values should be entered.

2) The "Save Results" and "Save Trace" check boxes should be set appropriately.

3) The "Start Test" button is clicked.

4) The vehicle is driven so that the RPM-indicating bar stays within the green section of the speed indicator. If the vehicle's speed falls outside of the green range, testing is re-started.

5) The test terminates when the vehicle completes the emissions test. The "Stop Test" button may be used to terminate a test you do not wish to finish.

6) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) Average exhaust gas concentrations of each of the gasses of interest, for the idle speed testing.
2) Average exhaust gas concentrations of each of the gasses of interest, for the 2500 RPM testing.

If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

None.

Lugdown

This test allows the user to perform a (non-certified) diesel lug-down exhaust opacity test.

Purpose

This test allows the user to perform a (non-certified) diesel lug-down exhaust opacity test. An opacity meter is generally required to make use of this test routine.

Intended Test Procedure

This test has a fixed termination time, when the vehicle has completed the specified emissions sampling times. The general testing procedure is outlined below.

1) % of maximum speed that should be maintained at each testing step in use should be entered, along with the number of seconds that each point is to be held for.

2) The radio button in the "Last?" column next to the lowest-speed point to be used should be selected.

3) The "Tolerance" field should be set to the maximum number of MPH/KPH by which the system speed can vary from the specified lug-down point speed without triggering a re-start of testing at the point.

4) The "Save Results" and "Save Trace" check boxes should be set appropriately.

5) The "Start Test" button is clicked.

6) The vehicle is driven at its top speed in the gear selected for testing, and the "Mark Top Speed" button is pressed. At this point, the lug-down sequence begins, during which the vehicle's speed will be maintained at each of the in-use testing points for the specified times. (Note that this test logic assumes that the vehicles tested will be equipped with engine RPM governors.)

7) The test terminates when the vehicle completes the lowest-speed testing piont. The "Stop Test" button may be used to terminate a test you do not wish to finish.

8) Any saved test results may be viewed and/or a test report printed.

Results Obtained

If the "Save Results" check box is checked, a record that this type of test was performed on the currently selected vehicle, along with the date and time the test was performed and any comments about the test session, is saved to the application's database.

For this test type, the following additional information is saved as part of the final test results record:

1) (None)

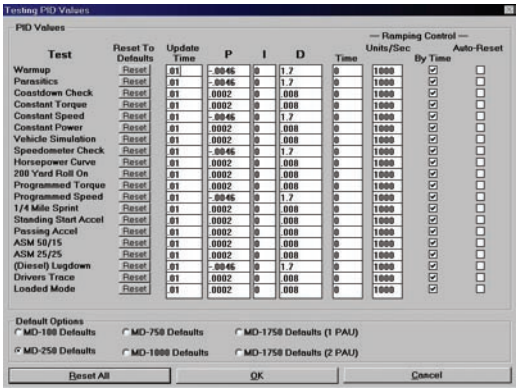
If the "Save Trace" check box is checked, this test generates strip-chart style trace data for all input channels, at the sampling speed specified in the "Trace Data Collection Speed" form found under the database menu. Note that trace data cannot be saved unless the "Save Results" check box is checked along with the "Save Trace" check box.

Special Considerations for This Test

1) You should not attempt to lug an engine down below its lowest acceptable operating speed. Engines operating at full throttle at very low RPM speeds tend to vibrate heavily, in part due to the reduced effectiveness of the crankshaft's harmonic balancer at very low speeds.

PID Values

This form allows the user to specify custom PID values and/or restore the default PID values.



Dynamometer's that incorporate a loading device, such as a PAU, motor or water brake, generally employ some type of closed-loop control to achieve and maintain the desired loading and/or speed values. Inertia-only dynamometers obviously have no need for any closed-loop control, since no loading device is present. All Mustang Dynamometer control systems employee the PID form of closed-loop control.

PID Closed-Loop Control Basics

PID closed-loop control constantly compares the desired loading or speed value to the actual measured loading or speed value, and makes fine adjustments to the PAU control signal to make the measured loading or speed match the desired loading or speed. The letters "PID" stand for "Proportional", "Integral" and "Derivative", which represent the different ways by which the output signal is modified based on the desired values and measured values. For each element in the PID control loop, a constant is used to adjust the magnitude of adjustment the

PAU control signal will experience due to various types of errors between the measured and desired values.

The "Proportional" term constant is used to scale the system's response to a simple error between the desired and measured loading values. Thus, the "Proportional" term is never 0 unless the measured value exactly matches the desired value. Additionally, The "Proportional" term is used to provide over-all scaling of all three terms of the PID control loop. The "Proportional" term handles low to medium frequency response requirements.

The "Integral" term constant is used to scale the system's response to a following error between the desired and measured loading values. The "Integral" term is used to handle situations where the measured values continuously lag behind the desired values, **in the same direction of error**. In almost all dynamometer loading schemes, the desired value changes rapidly, and the measured value chases the desired value both upwards and downwards. Thus, the "Integral" term is very seldom required, and its use is not recommended in our control systems. The "Integral" term handles relatively low frequency response requirements.

The "Derivative" term constant is used to scale the system's response to the rate of change of error between the desired and measured loading values. The "Derivative" term responds to sudden changes in both or either of the desired loading or measured loading values, and to the rate of change of the error between them. The "Derivative" term is never 0 unless the rate of change of error is 0. The "Derivative" term handles medium to high frequency response requirements.

The basic logic for our implementation of the PID closed-loop control logic is given below. The "Desired" and "Measured" values may be torques, forces, speeds, etc. The logic given below happens 100 times per second (by default).

```
Error = (Desired – Measured)
ProportionalTerm = (PConstant * Error)
IntegralTerm = IntegralTerm + (PConstant * ICconstant * Error)
DerivativeTerm = (PConstant * DConstant * ((Error – LastError) / UpdateTime))
PAUVoltage = ProportionalTerm + IntegralTerm + DerivativeTerm
OldError = Error
```

Since the mathematics above remain constant regardless of the value being controlled (e.g. torque or speed), the sign of the "P" constant is critical. This can be observed by considering the "ProportionalTerm" above; if the measured torque is less than the desired torque, the PAU signal must be increased, whereas if the measures speed is less than the desired speed, the PAU signal must be decreased. A sign-error on the "P" constant will result in a loop that works backwards, in effect saying to itself, "The actual load is too low, I must decrease it!".

"Tuning" a PID-type control loop refers to the process of determining the P, I, and D constants required to achieve the desired control characteristics. Generally, the time required to achieve a 90% response to a step change in the desired loading value and the long-term stability of the control loop are the primary considerations in tuning a PID loop.

People new to the concept of closed-loop control frequently ask if there is a method of directly calculating the optimal P, I, and D constant values. Control theory tells use that, in theory, this is possible. In reality, tuning a PID loop requires that some initial PID constant values be selected, and iterative tuning be performed. The initial PID constants selected must be of the correct sign, and must be relatively small. By appropriately selecting the initial PID constants, a very slow, but probably stable, control loop may be achieved. Iterative tuning, wherein the PID constants are gradually varied and the control loop's response evaluated, is then used to increase the PID constants until the desired control loop response characteristics are achieved. For the truly motivated reader, the PID control loop math outlined above can be used to select initial PID constants, knowing that the PID loop's output value is fed to the PAU controller, and has a range of 0.0 volts to 5.0 volts, and that the control loop is

updated (by default) at 100 times per second.

Mustang Dynamometer strongly recommends that the default PID values for your dynamometer type be used.

Users familiar with PID closed-loop control may wonder why there are individual PID constant sets for each test routine, since a dynamometer can generally only control the torque on or the speed of its rolls. The reason that individual PID constant sets are supported for each test routine is to allow the user to configure tests that use the same type of control (torque or speed) to have different response characteristics.

Default PID Values

Mustang Dynamometer engineers have spent many long hours performing the iterative PID loop tuning described above. The results of their testing sessions are the default PID constants available to users of this form by clicking on the individual "Reset" or the global "Reset All" buttons. Mustang Dynamometer recommends that these default PID constant values be used. Note that the ramp rate settings do not require any tuning, and may be varied as desired.

Before clicking on any of the individual "Reset" buttons, or the global "Reset All" button, you must make sure that the correct dynamometer model is selected in the "Default Options" group.

Using Set-Point Ramping

Since a PID closed-loop controller is generally tuned to achieve the fastest response possible with the maximum tolerable long-term instability, the closed-loop control will move from a previously desired value to a newly specified desired value as quickly as possible. In cases where the fastest possible response to a change in the desired loading value is not desired, a ramping function may be used.

Ramping refers to the process of gradually varying the control loop's set-point value from the previously specified value to any newly specified value. For example, the control loop's set-point value will not change from 100 pounds of force to 200 pounds of force instantaneously; rather, the set-point value will be gradually "ramped" from 100 to 200 pounds using the ramping values currently in effect.

This software implements set-point ramping in two (2) different ways.

Ramping with the "By Time" Check Box Checked

If the "By Time" check box for a given test is selected, then the control loop set-point will be ramped from the previous set-point value to the new set-point value in the number of seconds specified in the "Time" field, **regardless of the size of the change**. For example, if the "Time" field value is set to 5.0, then a step from 10 to 20 MPH will take 5.0 seconds, yielding a ramp rate of (20-10)/5 = 2.0 MPH per second. If the step were from 10 to 12 MPH, the ramp will still take 5.0 seconds, yielding a ramp rate of (12-10)/5 = 0.4 MPH per second. This type of ramping control applies particularly well to the "Programmed Force" and "Programmed Speed" test routines, since if the force or speed profile used specifies the same loading duration for each point

in the profile, a ramp "Time" field value of the same value will result in a linear loading change between points in the profile.

Ramping with the "By Time" Check Box Un-Checked

If the "By Time" check box for a given test is not selected, then the control loop set-point will be ramped from the previous set-point value to the new set-point value by the number of units specified in the "Units/Sec" field. For example, if the "Units/Sec" field value is set to 10.0, then a step from 10 to 20 MPH will take (20-10)/10 = 2.0 seconds. If the step were from 10 to 12 MPH, the ramp rate will still be 10.0 MPH/Sec, and the ramp will take (12-10)/10 = 0.2 seconds. This type of ramping is best suited to smoothing transitions between set-points to avoid harsh loading changes during testing.

Description of Values on this Form

The following section describes each of the values on this form.

Field Name	Meaning / Use
Test	The name of the test routine related to the row of values.
Reset To Defaults Button	This button will reset all of the PID control constants for the associated test to the factory default values; the values used depend on the dynamometer type selected in the "Default Options" group.
Update Time	The number of seconds between PID loop updates. The default value of 0.01 means the PID control loops will be updated 100 times per second. This value also sets the maximum trace data sampling speed.
P	PID closed-loop control P constant.
I	PID closed-loop control I constant.
D	PID closed-loop control D constant.
Time	If the "By Time" check box is checked, then the set-point value for the associated test will be varied from its previous value to any new value in the number of seconds entered in this field. (Values are in seconds.)
Units/Sec	If the "By Time" check box is not checked, then the set-point value for the associated test will be varied from its previous value to any new value by the number of units per second entered in this field. (Values are in pounds/second, MPH/second, etc.)
By Time	This check box selects between fixed-time ramping control and fixed-rate ramping control as described above.
Auto-Reset	If this check box is checked, the PID control loop logic "Derivative" term will ignore the sudden transition from any current set-point value to a new value. This may be used to smooth responses to sudden set-point value changes. (Use of this option is not recommended.)
Default Options Group	Before using the "Reset" or "Reset All" buttons, you must make sure that you have selected the correct dynamometer type for your dynamometer in this group.
Reset All Button	This button will reset all of the PID control loops for all tests to the factory default values; the values used depend on the dynamometer type selected in the "Default Options" group.

The Display Menu

The Display menu allows access to various main-display related items.

Default

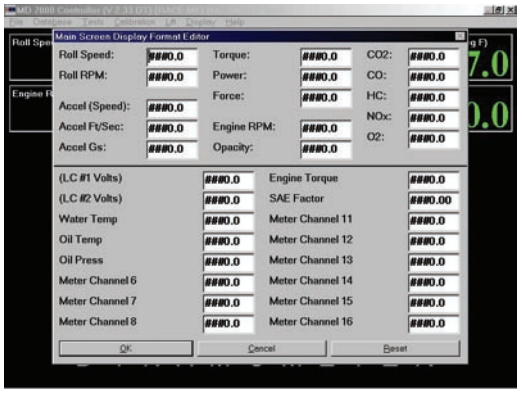
By selecting this option, the main display is configured to display a default set of values. When this option is selected, the main display indicators can not be modified by clicking on them. This option is mainly provided to allow for a known set of display values when technical support is required.

Custom

By selecting this option, the main display is configured to display a custom set of values. When this option is selected, the main display indicators can be modified by clicking on them. This setting is the normal mode of operation.

Setup Display Formats

This option allows the operator to specify the display formats to be used in the main display indicators.

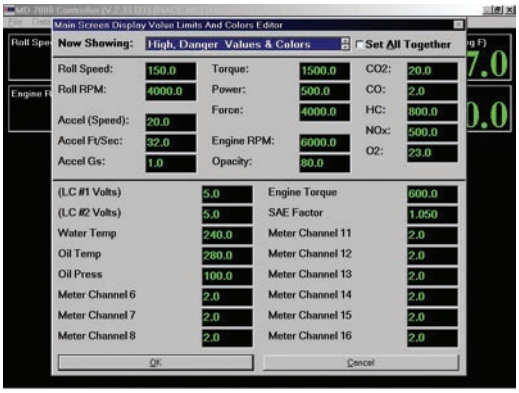


By specifying the correct formatting string, the displayed values will indicate the desired precision for each input channel.

The general format would be "#0.000", where each "0" to the right of the decimal place will add 1 digit of display precision to the related input channel. The leading "#0" means "display a leading 0 for values less than 1.0".

Setup Limits & Colors

This option allows the operator to specify the display colors to be used in the main display indicators.



Each input channel can be configured to display any in any of five (5) different colors for each channel. These five (5) colors are associated with OK, somewhat low, very low, somewhat high, and very high values for the related channel. By default, all colors are set to green, so the display will never vary its displayed colors.

Now Showing

The "Now Showing" field determines which set of values are displayed for editing. NOTE: THE VALUE IN THE "Now Showing" FIELD MUST BE HIGHLIGHTED (IN BLUE) BEFORE THE CAPTION IN THE BOX IS VALID. IF YOU ARE SEEING TEXT THAT IS NOT HIGHLIGHTED, YOU ARE SEEING AND EDITING A DIFFERENT SET OF VALUES THAN THE ONE INDICATED.

This field has the following possible values:

Low, Danger Values & Colors
The displayed colors will be used when the input channel values are below the displayed limit values.

Low, Warning Values & Colors
The displayed colors will be used when the input channel values are below the displayed limit values, but above the "Low, Danger" values.

OK Colors The displayed colors will be used when the input channel values are between the "Low, Warning" and "High Warning" limit values. Notice that there are no limit values for the "OK" range, and "Mustang" is displayed in each box.

High, Warning Values & Colors The displayed colors will be used when the input channel values are above the displayed limit values, but below the "High, Danger" limit values.

High, Danger Values & Colors The displayed colors will be used when the input channel values are above the displayed limit values.

Set All Together

If this box is checked, then the display colors for all input channels, rather than only the input channel that has been double-clicked, will be affected by the color picking function.

Setting a Limit Value and Color

To set a limit value and color, follow the steps below:

1) Select the value range you are interested in using the "Now Showing" list, for example "High, Warning Values & Colors". Make sure that the text in the "Now Showing" box is highlighted.

2) If you wish to set the display colors for this range for all input channels, rather than just one input channel, make sure the "Set All Together" box is checked.

3) Enter the limit value for the selected range (in our example, "High, Warning Values & Colors"). This may be something like "210" for an engine coolant input channel.

4) Double-click on the limit value box for the input channel you are modifying, and use the color-picker dialog box to select the desired display color for the range you are modifying.

You may wish to set the display range colors for all channels at once using the "Set All Together" option. Once you set the various range colors to anything other than the "OK" range color(s), you will need to enter valid range limit values to avoid having your display change colors (apparently) at random.

Other Menu Items

Various other main menu items may be visible depending on the exact configuration of your system. These optional main menu items are discussed below.

Rear Lift This optional menu item allows control of a 2nd dynamometer lift for dynamometers that are so equipped.

Fan This optional menu item allows control of a vehicle cooling fan for dynamometers that are so equipped.

Drag Brake This optional menu item allows control of drag brake for dynamometers that are so equipped.

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