PID Screen, Eddy Current, Auto Mode

RPM: The first line is the actual RPM the PID is trying to control. Typically dyno RPM is more stable than Engine RPM, so we suggest controlling dyno RPM.

Mx: If you do an accelerating test, Mx is the RPM where the controller will stop accelerating and return to the starting RPM. If the controller is reading dyno RPM, this will be the dyno RPM, not engine RPM. (Older firmwares do not show this.)

Setpoint:: The second line is the setting the PID is trying to control to. For example, if the RPM reading is 3000 and the Setpoint is 2500, the controller will try to reduce the actual RPM down from the actual 3000 RPM to the desired 2500 RPM. NOTE: In the picture, the RPM is matching the Setpoint, so the Error is very low, DAC out is very low (0.18 volts) and very little power is required from the dyno. The 0.18 volts is likely the "Offset Voltage" that can be set in the DataMite software, and is not 0.00 volts as you might expect.

Error: Is the difference between the Actual reading (first line) and the Setpoint (2nd line).

Kp: Is the proportional setting in the PID equation in the PID controller software. The P effect tries to control based on the current Error. To the right of Kp: is the setting you can control with the DataMite software. To the left is the total effect of this proportional setting.

Ki: Is the integral setting in the PID controller. The I effect tries to control based on past errors, and is typically used for trying to control to a steady Setpoint. For example, if the Actual RPM has been 200 RPM higher than the Setpoint RPM for the last 1-2 seconds, the integral effect adds additional load to get them to match. To the right of Ki: is the setting you can control with the DataMite software. To the left is the total effect of this integral setting.

Kd: Is the derivative setting in the PID controller software. The D effect tries to control based on predicting future errors, and is typically used for trying to control quickly changing systems, like an accelerating test. For example, if the Setpoint is increased and the actual RPM is trying to follow it, the derivative effect will get large quite quickly, but then reduce the effect as it gets close to matching the Setpoint so it does not overshoot the new Setpoint. To the right of Kd: is the setting you can control with the DataMite software. To the left is the total effect of this derivative setting.

PID output: Is the total of the Kp, Ki and Kd outputs (to the left of their labels).

DAC out: Is the conversion of the PID output to actual 12 bit counts, and in parentheses volts which you could CAREFULLY measure with a voltmeter.

Controls:

Turn the Load Control knob to increase or decrease the desired RPM. You will see it adjusting the Setpoint value on the display. Once you start a test by pressing the "Start Test" button, the computer takes over, you should see the Setpoint changing to sweep the dyno through the designed RPM range. If you adjust this knob during the test, control comes back to the knob, which is a good safety to let you over-ride the computer control should something go wrong.

Large red "Start Test" button works just like a hand held recording switch discussed in the Dyno DataMite instructions. You must plug the 4 pin connector into the "Switch" connector on the DataMite III or 4 for this to work properly.

Press the "Back Light" button to turn LCD display backlight On/Off.

PID Screen, Eddy Current, Auto Mode when controlling higher loads

Read the sheet PID Screen, Eddy Current, Auto Mode first to better understand this page.

RPM: The first line is the actual RPM the PID is trying to control, in this case 2112 RPM

Mx: If you do an accelerating test, Mx is the RPM where the controller will stop accelerating and return to the starting RPM. (Older firmwares do not show this.)

Setpoint:: The second line is the setting the PID is trying to control to, in this case 1250 RPM.

Error: Is the difference between the Actual reading (first line) and the Setpoint (2nd line), in this case -864 RPM.

Kp: shows the Proportional part of the error of 346.

Ki: shows the Integral part of the error of 100. The DataMite software has a limit set on the Integral error to not let go above 100.

Kd: shows the Derivative part of the error of 0. This is likely very low because the Error number has not been changing much.

PID output: Is 444 and is the total of the Kp, Ki and Kd outputs (to the left of their labels). These do not add up exactly because each line of the controller screen is updated separately, to give the PID control loop in the firmware lots of time to do its calculations.

DAC out: Is the conversion of the PID output to actual 12 bit counts, and in parentheses volts to the power module. You will see it is relatively high, 1.73 volts because the engine is putting out significant power.

This is the typical situation when doing full power testing. The desired RPM is less than the actual RPM. That is needed to produce enough Error to produce enough PID output to produce enough DAC out to tell the eddy current brake to apply load.

PID Screen, Eddy Current, Manual Mode

Read the sheet PID Screen, Eddy Current, Auto Mode first. Then this special case of Manual Mode will make more sense.

Press the Auto/Manual button to put the controller into "Man" mode. This is indicated by the "Man" label on the right of the 2nd line. In this mode, the knob simply dials in more or less load on the eddy current dyno.

In Manual Mode, most of the readings on this screen have no affect. As you dial the knob up and down, the Setpoint on the 2nd line changes and the DAC out on the bottom line changes. The 2.47 volts shown in the picture is the signal voltage to the controller power module, which applies current to the dyno which applies load. The maximum load will be at about 4.7 volts, so 2.47 should produce over half of the dyno's absorption capability.

Manual Mode is very useful for setting up and troubleshooting your dyno. For example, your first vehicle on your dyno should be lower powered street vehicle, ideally with a manual transmission. Before starting the vehicle, dial the RPM Setpoint in Auto mode down to a low RPM, counterclockwise. Then press the Man button which will apply no load.

Start the vehicle and let it idle or give it a little throttle in a gear with about a 1:1 transmission ratio (typically 4th gear). Bring up the vehicle speed to something slow, like 30-50 MPH.

Dial up the load turning the knob clockwise and you should see load being applied and MPH dropping. Apply more throttle to the vehicle (more engine power) to bring the MPH back up, and then apply more load to the dyno with the knob. Go back and forth and see how much DAC out on the bottom line is needed to hold the vehicle at full power.

If you can not hold this vehicle at full power (wide open throttle), you must determine what the problem is, like you need a 220 VAC power module instead of a 110 VAC, this dyno's coils are wired wrong, this dyno does not have enough power absorption, etc.

IMPORTANT:

It is best to switch between Auto and Man mode with no vehicle on the dyno, or with the rollers stopped. Switching between Auto and Man or back can cause huge surges of power in the eddy current dyno if you are not careful.

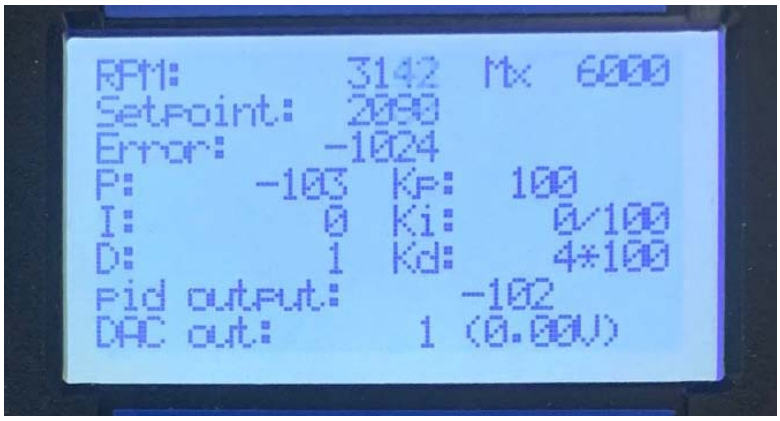
Starting in Firmware 3.12, the controller limits how quickly the control signal can change for Eddy Current dynos. It is controlled in v4.2 B.059 software or later as the Controller advanced Option called "Eddy Current Response (make more gradual)" as described on page 11.

PID Screen, Water Brake, Troubleshooting

In RPM Control mode, the controller is controlling the RPM by adjusting the valve position or opening.

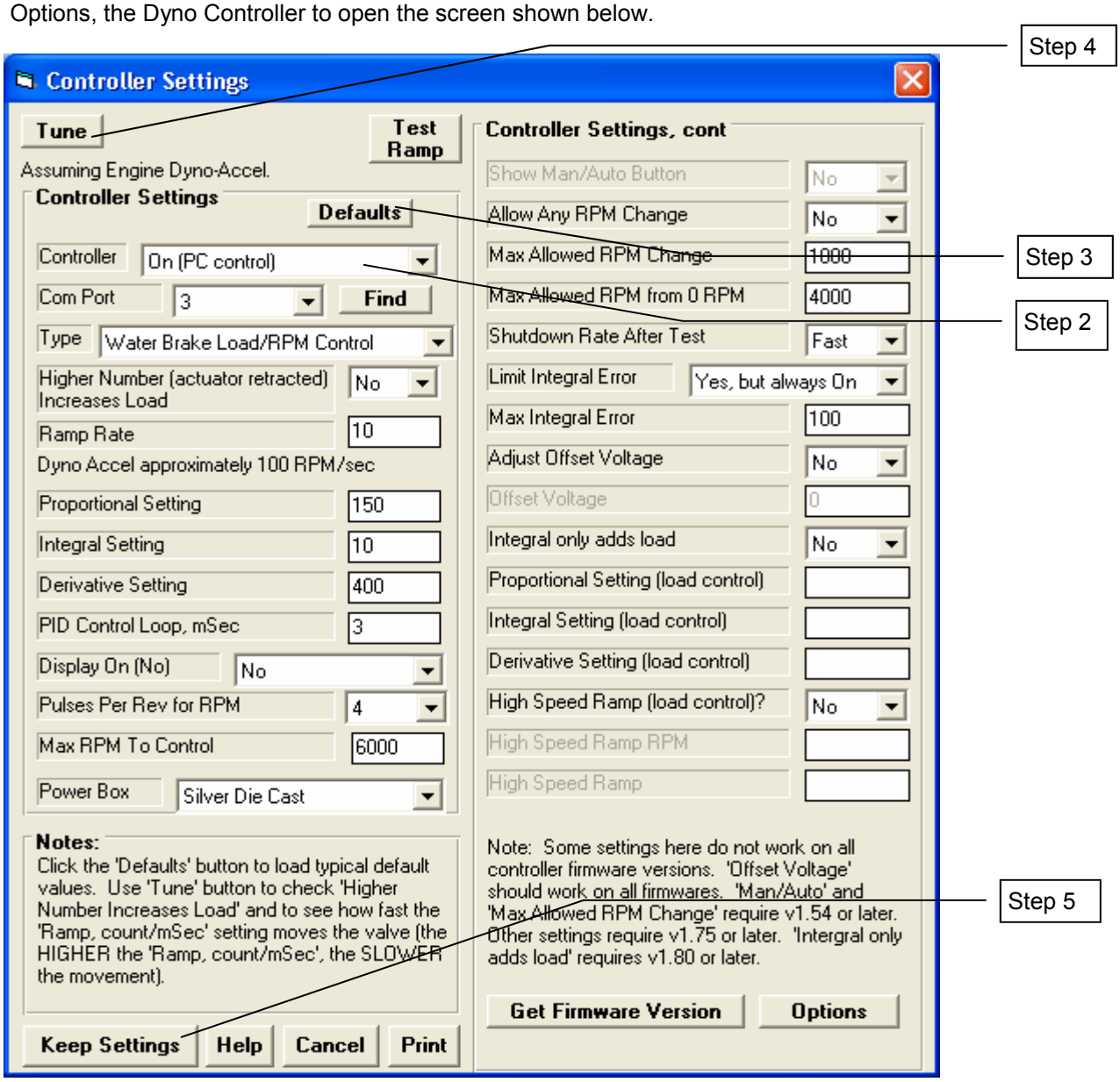
The screen to the right shows the condition where the controller wants the RPM to be 2084 but the actual RPM is only 1136. You will see the DAC out is 4.70 volts, the maximum it will produce. It is telling the valve to shut off water to the dyno (or release water from the dyno in the case of the SuperFlow style system) to remove load. This would be a situation where the engine is producing almost no power, like it is idling. In this situation with the DAC out at 4.70 volts, the controller is not in control.

The screen to the right shows the condition where the controller wants the RPM to be 2090 but the actual RPM is 3142. You will see the DAC out is 0.00 volts. It is telling the valve to add water to the dyno (or hold water in the dyno in the case of the SuperFlow style system) to add load. This would be a situation where the engine is producing more power than the dyno can hold. In this situation with the DAC out at 0.00 volts, the controller is not in control.



Typically the actual RPM will be slightly higher than Setpoint RPM. This allows the controller to put out a DAC out volts telling the water valve to apply more load. Typically this is with a voltage less than 2.35, like the 1.68 volts shown here.

Click on DataMite at the top of the Main Screen to open the DataMite logger settings. Then click on DataMite USB Options, the Dyno Controller to open the screen shown below.



The basic procedure for setting up the controller involves these 5 steps:

1) Outside of this screen, set up the Dyno specs for the type of dyno, DataMite specs for the type of RPM pickup and # magnets, and the Test Conditions screen for the type of runs you will make (accel or decel). You would need to do this even without a controller.

2) In the screen above, set:
- Controller
- Com Port (click the Find button to find a possible com port)
- Type (of control, like Water Brake, Load Control)
- Power Box (lower left to choose type of power box for eddy current or water brake dynos)

3) Click the Defaults button to load in typical settings for these conditions. Note: This also checks that you have communications with the Controller, and the Controller firmware version will be displayed at the upper left.

4) Click the “Tune” button to load these settings into the controller. It may also ask you to answer some questions.

5) Click the Keep Settings to save these settings in the DataMite software.

This will load settings which are a good starting point. Once you start running tests, you will likely want to “tweek” settings like Ramp Rating to do faster or slower accelerations, or the Proportional setting if the controller seems to jumpy or sluggish.

As you close this screen, the program may also suggest settings for the Recording Switch settings which will work best for the type of control you have set up. We suggest you follow these suggestions.

Here’s a description of each item you can tune:

"Controller" has these choices:

- Off
- On (PC control only)
- On (stand alone only)

"On (PC control only)" means the PC does most all the control. It will send commands to the hand held controller to start a test and end a test. In this mode, the controller does NOT need to read the RPM. In this mode you can also change settings from the Current Readings screen. This method is typically suggested for older controller firmware, before version 2.55. It is also recommended when you want to do special tests where you want to hold RPM at different RPM set points, or change other controller settings often.

"On (stand alone only)" means the PC does NOT send commands to the controller to start or stop a test. In this mode, the recording switch on the controller will start and stop the test. It is recommended in this mode to turn OFF the ability of F1 and F2 to start and stop recording. This is done by clicking on DataMite USB Options in the DataMite specs screen. Then click on Dyno Recording Switch, then F1/F2 Keys for Recording, then Do Not Allow F1/F2 Keys to Start/ Stop Recording**. In this mode, the controller NEEDS to read the RPM. This is typically done with an RPM T Cable. This mode only works for doing accelerating tests or holding RPM or load constant.** In this mode, it is recommended to have the USB cable plugged in if possible. Then commands from the PC to the controller about changing the Max RPM, or Ramp Rate, etc will take affect.

"Com Port" is the com port for the controller. Click on the Find button to find available com ports. Note that this will NOT be the same com port as the DataMite logger.

Type

- Eddy Current RPM Control
- Water Brake RPM Control
- Water Brake Load Control
- Water Brake RPM/Load Control
- Eddy Current Load Control
- Eddy Current RPM/Load Control

"Eddy Current RPM Control" is for an Eddy Current dyno, typically a chassis dyno. In this mode, the controller will control the dyno RPM and the control knob is used to set the RPM you want to hold constant. If the engine makes more or less power, the dyno will add or remove load to hold the RPM constant. If this is an engine dyno, there is significantly less inertia in the system, and this makes it more difficult to keep RPM steady. When you press the red Record button on the controller, it will either direct the dyno to accelerate or decelerate through the RPM range through the test. The rate it accelerates or decelerates is set by the Ramp Rate set in this screen.

“Water Brake…” options are not used for Eddy Current Dynos.

"Eddy Current Load Control" is for an Eddy Current dyno. In this mode, the controller will control the current fed to the eddy current dyno with the control knob. This current is what puts the load on the dyno. This operation is much like manual dyno control, EXCEPT once you press the red Record button on the controller. Then the controller will either add or remove current and load to the dyno to make the dyno either accelerate or decelerate through the test. The rate it opens or closes is well controlled and set by the Ramp Rate set in this screen.

"Eddy Current RPM/Load Control" is a combination of RPM and Load control. Before you start your test, you can dial in the desired RPM with the control knob. Then you can open the throttle to full power and the controller will hold RPM close to the desired RPM. Then when you press the record button, the control switches to load control and the controller will add or remove load (electrical current) to the dyno to make the dyno either accelerate or decelerate

through the test. The rate it opens or closes is well controlled and set by the Ramp Rate set in this screen. When the test is over, the control reverts back to RPM control to go back to the RPM set at the beginning of the test. This method typically produces more smooth accelerations. See important note on page 23 for RPM/Load control.

"Higher Number Increases Load" is for telling the controller if a higher number on the controller is for more or less load on the dyno. The controller is designed to work best in situations where a higher number does NOT increase load. **This setting is typically 'No'. If you believe this is not the case for your system, contact Performance Trends to check this.**

"Ramp Rate" is how much the RPM or valve position changes per unit of time. When you change this, the label below this updates with an estimate of the RPM/sec for RPM control. **IMPORTANT: The lower this number, the faster the change during the test.**

"Proportional Setting" is the "P" in the PID control loop and is shown on the controller's LCD screen. This setting is the most important for control. If the control seems slow or sluggish to respond, you can try increasing this number. If the control seems unstable with oscillating RPM or actuator position, then try reducing this number. The Proportional Setting set by clicking on the Defaults button is typically a good starting point.

"Integral Setting" is the "I" in the PID control loop and is shown on the controller's LCD screen. This setting is used to fine tune the control so the Setpoint and the Actual reading will match more closely. If the Setpoint and the Actual readings do not match closely, you can try increasing this number. If the control seems unstable with oscillating RPM or actuator position, then try reducing this number. The Integral Setting set by clicking on the Defaults button is typically quite a small number or 0, and is a good starting point.

"Derivative Setting" is the "D" in the PID control loop and is shown on the controller's LCD screen. This setting is used to fine tune the control so the controller can "anticipate" what will happen in the future. Typically this is a small number or 0. If the control seems unstable with oscillating RPM or actuator position, then try reducing this number. The Derivative Setting set by clicking on the Defaults button is typically quite a small number or 0, and is a good starting point.

"PID Control Loop, mSec" is how much time there is between loops in the PID control loop in the controller. Basically, the smaller this time, the faster the control loop works. Three (3) mSec is about as fast as it can run, and is the typical default value. If you go faster than 3, the control may not work because it does not have enough time. There really is no advantage to going slower than about 5. Typically you will just accept the default setting, typically 3.

"Display On (No)" is typically set to Yes. Setting to No will allow the PID control loop to work faster, but we have not seen No to be necessary.

"Pulses Per Rev" for RPM let's the controller calculate RPM correctly. This will typically match the pulse/Rev for the RPM signal in the DataMite specs. You can select 0.5 RPM increments because 4 stroke engines fire every 2nd RPM if you are using an ignition RPM signal. For example, for a 1 cylinder, 4 stroke motor you would choose 0.5 Pulse/Rev.

Note: Most small 4 stroke engines fire every RPM in a process called "wasted spark". So these would actually be a 1 Pulse/Rev.

Dyno RPM is typically a more reliable and stable RPM signal for control than engine RPM from the ignition.

For good control, it is important to have enough targets (typically magnets) on the drum, dyno shaft, etc for fast updates. But you do not want too many, because that can bog down the controller just calculating RPM. *It is also critical the targets are VERY evenly spaced.* Here's the recommended number of targets for various maximum dyno RPMs:

Max RPM	**1500**	**3000**	**6000**	**More than 6000**
Targets	**8**	**4**	**2**	**1**

For chassis dynos, you can calculate the Max RPM for your drum (roller) from this equation:

Max RPM = Max MPH / Roller Diameter in inches x 333

For example, for a 16" roller going up to 140 MPH: 140 / 16 x 333 = 2913 RPM (would require 4 magnets)

"Max RPM To Control" serves 2 purposes:

- It adjusts the RPM span that the control knob will adjust for. For example, if you enter a low RPM like 4000, the knob will go from about 0-4000 RPM.
- It will set the Max RPM for the end of an accelerating test. This number should match the Max RPM set in the Test Conds. screen. The program will warn you if these 2 settings do not match.

NOTE: In PC mode, the PC is expected to catch the max RPM and send a signal to the controller to shut down. However, if the controller has newer software, it will also show a Max RPM about 3.5% higher. This is a safety that if the PC does not catch the Max RPM, the controller will catch it at this higher RPM and shut down the test. In Stand Alone mode, the PC will act as a safety and watch for an RPM about 3.5% greater than the Max RPM. If the Controller does not catch the Max RPM, the PC will send a signal to the controller to shut down the accel.

"Power Box" is the style of box which provides power to the actuator.

- Eddy Current 110 VAC is for Eddy Current Dynos with a 110 VAC power module.
- Eddy Current 220 VAC is for Eddy Current Dynos with a 220 VAC power module.

Be sure to select the correct type, or your control will be sluggish or too jumpy.

"Show Man/Auto Button" is for **Eddy Current dynos only**. If you set this to Yes, the "Auto/Man" button on the hand held controller becomes enabled. In Auto (automatic) mode, the controller tries to hold the RPM you set with the knob. In Man (manual) mode, the knob just tells the controller how much amperage to send to the dyno. This can be handy for troubleshooting, or if you want to bypass the RPM control.

"Allow Any RPM Change" lets you tell the controller if certain RPM changes are assumed to be an error. If you set this to No, then the controller accepts any RPM change as correct, even a noise spike that could jump from, say, 1,200 RPM to 20,000 in .020 seconds, which is not possible. Set this to Yes and the limits below this are enabled so you can set them. NOTE: What you set here is also used in the DataMite software for removing possible bad RPM readings when the Controller mode is “On (PC control only).

"Max Allowed RPM Change" lets you specify the largest RPM to allow as being "real". An RPM change larger than what is specified here will be discarded and ignored. Setting this too low may corrupt the RPM readings as real RPM changes are ignored. Setting this too high may allow noise spikes in and produce very erratic control. For systems with low inertia, this number should be quite high, like a water brake dyno. Chassis dynos with large rollers are high inertia so real RPM changes are slower, and this number can be set lower. Note: In PC Control, the software will also try to set this type of limit to RPM changes. If you do not want this to happen, set "Allow Any RPM Change" to No.

"Max Allowed RPM" from 0 RPM is the max acceptable RPM when the RPM starts at 0. We have made refinements in the controller so this setting is no longer needed. To remove this parameter’s effect, we recommend you set this to a very high RPM, like 16,000 or more.

"Shutdown Rate After Test" tells the software and controller how quickly you want to bring the engine down from the Maximum RPM at the end of the test. For a water brake, engine dyno, it would make sense to choose Fast. For an eddy current, chassis dyno with lots of rotating inertia in the dyno and vehicle, Medium or Gentle may make more sense to be easier on the dyno. NOTE: The Fast rate will return load back to where it started at the beginning of the acceleration. Medium and Gentle will ramp the load back more slowly to possibly putting more load than when the acceleration started. Once the RPM returns back to the original starting RPM, then load well return to the original load at the start of the acceleration.

"Limit Integral Error" tells the controller to now allow the integral error get too large. Integral errors add up the error between the desired setpoint or RPM, and the actual setpoint or RPM. If something happens that the control can not work correctly (the control is asking for, say, 3000 RPM, but the engine is only putting out enough power to run at 2000 RPM because the throttle is not open), the integral error can grow quite quickly. Once the problem is fixed (the throttle is opened), this large integral error can cause problems with the proper control for a while. If you limit the error, these type of problems will be easier to correct for.

NOTES:

- If the RPM to the controller is 0, the integral effect is turned off, because this condition will produce very high integral errors. Once the controller sees RPM, the integral effect is turned on again.
- In PC Control mode, the integral effect is turned off, because constant communicating to the controller from the PC about turning it on or off depending on RPM will slow down data communications to the DataMite.
- In PC Control mode, you CAN turn on the integral effect if you choose the Option of "Hold" to better hold a particular RPM. This is typically used only to hold RPM constant, and not do an accelerating power test. It will also temporarily turn on if you change the "I" setting, but it will NOT turn off in the RPM goes to 0. For this reason, you should be sure to always have the dyno turning to turn this On.

"Max Integral Error" is the limit for how much the Integral error can grow.

"Adjust Offset Voltage" is used for Eddy Current dyno control. There is typically a small amount of control signal voltage which produces no current to the dyno coils and therefore No power absorption. You can typically test this by getting the rollers going, then dial in an RPM which is lower than the actual roller RPM and watching the "DAC out:" voltage on the bottom line of the LCD screen. Keep adjusting the RPM lower and notice when you can start to tell dyno is starting put load on the dyno to reduce the RPM. This voltage is typically n the 0.1 to 0.4 volts range. Set this to Yes if you want to be able to enter a volts for this.

"Offset Voltage" is the voltage offset described above. Sometimes we recommend a particular Offset Voltage for a particular controller we have tested:

Recommended Offset Voltage: _____

"Integral only adds load" is set to Yes if the controller is not adding enough load. This is the situation where the desired RPM is LOWER than the actual RPM, where adding load will produce a better match in the RPMs. When there is the situation where the desired RPM is HIGHER than the actual RPM, the controller can not make the engine RPM increase. Adding load will NOT produce a better match in the RPMs. Therefore for most situations, it is best to set this to Yes.

"Proportional Setting (load control)", "Integral Setting (load control)", "Derivative Setting (load control)", "High Speed Ramp (load control)?", "High Speed Ramp RPM", and "High Speed Ramp" is for Water Brake dynos only.

---------- Buttons ----------

"Tune" button at upper left will send all your settings to the controller. You will notice a message about which tuning step you are on out of how many steps are required after you click this button. You will also see what type of dyno the program is assuming you are tuning to control, like "Assuming Engine Dyno-Accel". If this is not correct, it is because other settings in the program have not been correctly set. You should change them first before doing the Tune, as these settings affect what the "Default" button will load.

"Test Ramp" button will demonstrate the current "Ramp Rate" you have set so you get a feel for how slow or fast the rampe will be by watching the Water Brake actuator motion. It is recommended you don't have the motor running when you do this.

"Defaults" button will load typical settings for the type of control and type of dyno and tests you will be running. After "Defaults" are loaded, you can "tweek" settings for what you have learned work best for your dyno.

"Find" button will search your computer's ports for the available Com Ports, one of which can have the controller.

"Get Firmware" button will get the current Firmware Version of the controller. Depending on the Version of the controller, certain features may or may not be available. NOTE: The "Get Firmware" button is also a quick way to test if you have communications with the controller after you find possible Com Ports with the "Find" button.

"Keep Settings" will save all these settings to the program (not the controller) for use in the future. You need to click the “Tune” button to store these settings in the Controller, or by using the options at the Current Readings screen by clicking on the “Set” button.

"Help" displays this help info.

"Cancel" lets you back out of this screen without saving the changes.

"Print" lets you print this screen.

"Options" button will present some more advanced options that most people will not use. This button has to be turned on in Preferences under the Operation tab. See page 19 for info on some of these options. Here's an outline of the options presented:

- Shape of Controller Output Curve
  - Adjust 'Dead Band'
  - Adjust Slope
  - Adjust 'Jump Start' for Accelerations
- Adjust RPM Readings
  - Average RPM
  - Max Counts for Filtering RPM
  - Use New Method for Limiting RPM Change
- Eddy Current Options
  - Make Eddy Current Control Stronger
  - Eddy Current Response (make more gradual)
- Adjust Controller Limits
  - Adjust Lowest RPM for doing Derivative
  - Adjust Max Derivative Allowed
  - Adjust Maximum Stepper Motor Signal Volts
  - Adjust Max Proportional Allowed
- Adjust Controller Gear Ratio

"Adjust 'Dead Band'" lets you adjust the amount of error between the Desired Condition and the Actual Condition before the controller tries to correct it. Make this too small and the controller will constantly "dither" and the actuator can over heat. Make it too large and the control may be sluggish or oscillate.
"Adjust Slope" lets you adjust how quickly the correction for the error ramps in. Similar to 'Dead Band' if this is too fast, the controller will likely overshoot, oscillate, "dither" and have the actuator can over heat. Make it too slow and the control may be sluggish.
"Adjust 'Jump Start' for Accelerations" has the controller respond more quickly after pressing the Record button for an accelerating test.

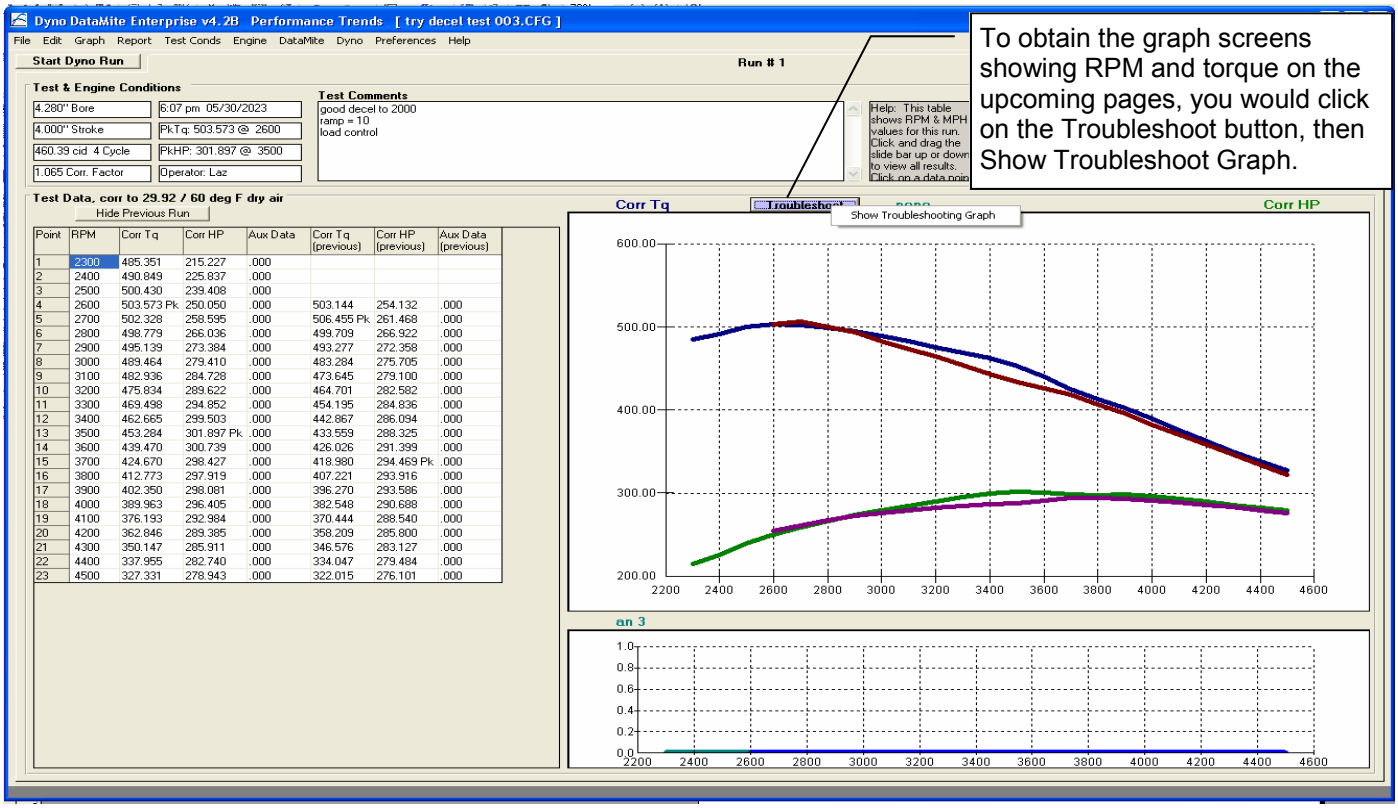
"Average RPM" lets you tell the controller to average 2 RPM readings together and control on this Average RPM. This can improve control if, say, the 2 magnets on the dyno are not evenly spaced, of if you are testing a 1 cylinder, 4 stroke motor which tends to have a fast power rev followed by a slower intake/exhaust rev. Turn this Off and the control will be slightly quicker.
"Max Counts for Filtering RPM" tells the controller how many times to check for a good RPM after finding a bad RPM before it just starts accepting a new RPM as good. The higher this number, the more time the controller could be without a good RPM reading on which to do control. The lower this number, the more likely a bad RPM reading could be assumed to be good. Good RPM readings are critical for doing RPM control and for knowing when a test is over and the RPM should be brought down after an Accel test.
"Use New Method for Limiting RPM Change" tells the controller to use the new method of RPM filtering, which uses "Max Counts for Filtering RPM" . The older method should not be used unless told to do so by Performance Trends because a bad RPM reading could get stuck in the controller, producing many types of control problems.

"Make Eddy Current Control Stronger" tells the controller to produce more load more quickly. Through our experience, we've learned this should be set to something higher than 0. Setting it to 0 will produce the same aggressiveness as previous versions of firmware and software. Setting it to 1 or greater will produce a significantly more aggressive control.
"Eddy Current Response (make more gradual)" tells the controller to not make sudden changes to the control signal to the power module. Sudden changes can produce excessive loads on the power module and the dyno.

"Adjust Max Derivative Error Allowed" tells the controller to limit the derivative part to what you enter here. Very high derivatives can produce surging control.
"Adjust Max Proportional Error Allowed" tells the controller to limit the proportional part to what you enter here. Very high proportionals can produce surging control.
"Adjust Max Proportional Change Allowed" tells the controller to limit how much the proportional part can change

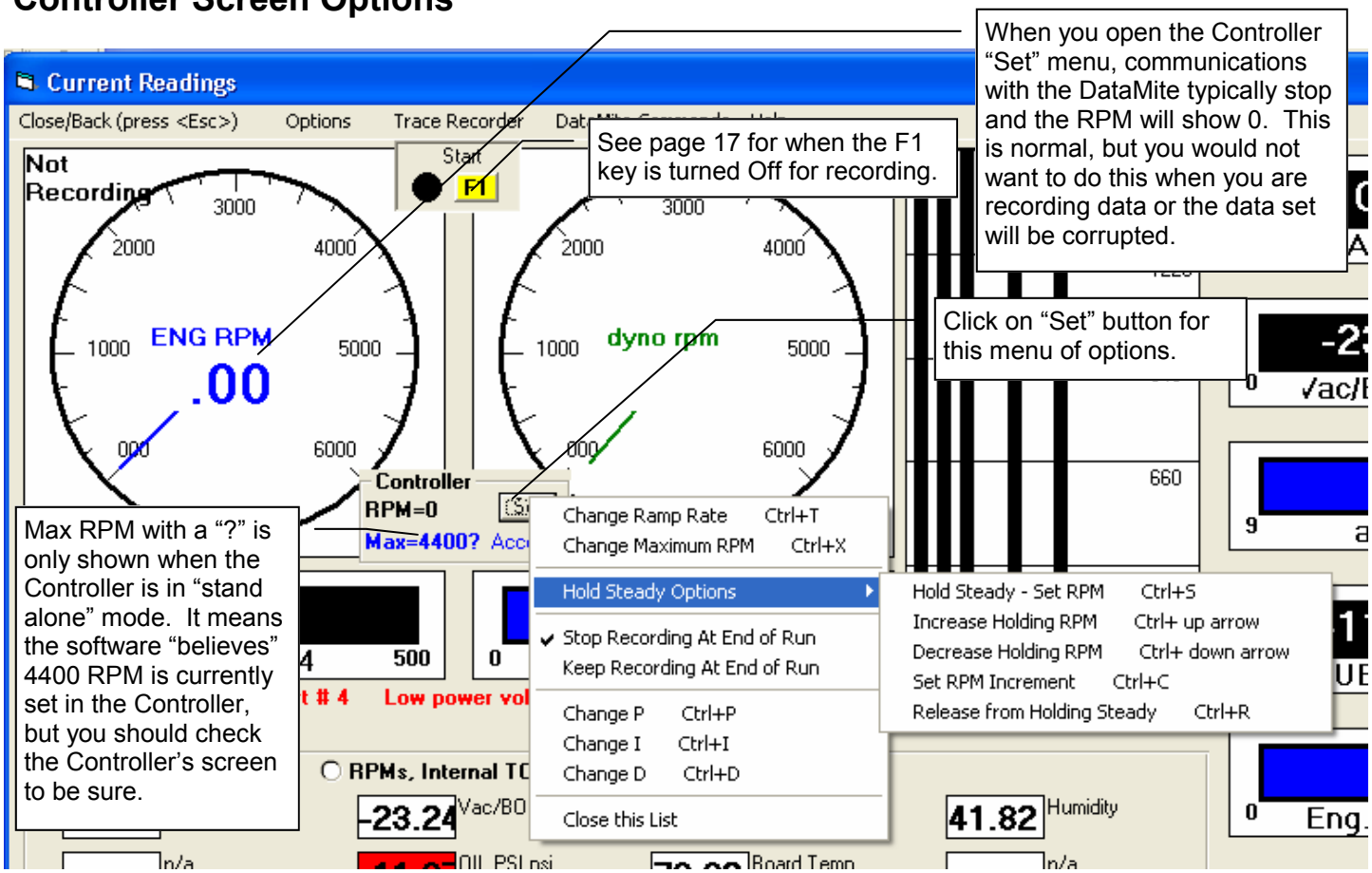
each time through the control loop. Making this number small will reduce the amount of change, and make control more “sluggish”, but which may also limit oscillations. Our experience is reducing this from the default high value of 500 to a quite low number can risk the controller not reducing engine speed quickly at the end of the run.
“Adjust Maximum Stepper Motor Signal Volts” tells the controller to allow more or less volts to the stepper motor for water brake control. Increasing this number over the default risks damaging the stepper motor.

“Adjust Controller Gear Ratio” tells the program the engine is not running at the same RPM as where the RPM sensor is placed. It is rare to use this, so we recommend keeping this set to 1 (1;1 gear ratio).



To obtain the graph screens showing RPM and torque on the upcoming pages, you would click on the Troubleshoot button, then Show Troubleshoot Graph.

Controller Screen Options



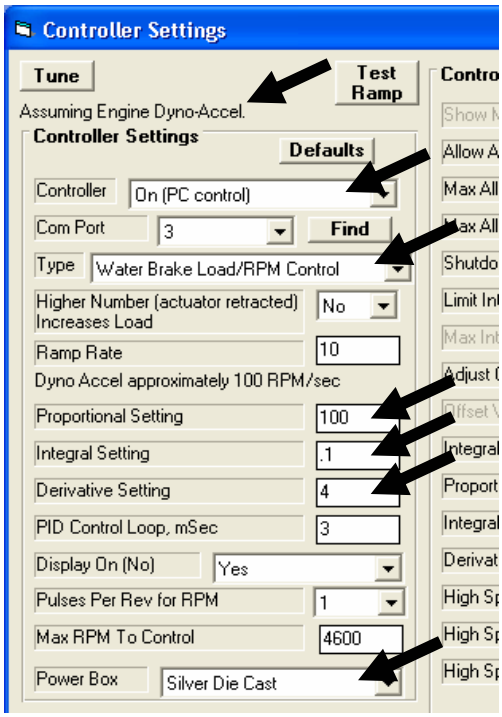
For many options, these are the same as offered in the Controller Setup screen. They just offer a faster, more convenient way of making changes. The "0 Ramp Rate", "Hold" options and "Stop Recording" and "Keep Recording" are new and only available at this screen.

0 Ramp Rate The "Change Ramp Rate" option lets you enter a Ramp Rate of 0. With 0 Ramp Rate the controller will not ramp the motor up or down in RPM when you start recording. This is very handy when you want to record some type of custom test, where you are changing the RPM manually with the knob, or using one of the "Hold" options to hold RPM constant.

Hold Options Choosing one of these options puts the controller into a mode where it will try to hold RPM constant. (Note: The control knob is disabled in this mode.) This is only available if the controller is in one of the RPM Control modes. Typically you will enter this mode with the "Hold Steady - Set RPM Ctrl-S" command where you can enter the RPM you want the controller to Hold. The "Increase" and "Decrease" commands will change the Hold RPM by the amount you have set with the "Set RPM Increment" command. The "Release" command reverts the controller back to normal manual mode where the knob controls the RPM setting.

"Stop Recording..." and "Keep Recording..." options tells the software if you want to keep recording data after an accelerating or decelerating run. The default is to "Stop Recording…". If you select to "Keep Recording…" you have to stop recording by pressing the Record switch button, or clicking on the yellow Stop recording button.

Tuning the Controller



First you must choose the Type of Dyno in Dyno Specs, and the Type of test in Test Conds screens. These choices are shown by the comment under the "Tune" button. Then on the controller screen, pick the type of "Controller" and "Type" of control and "Power Box".

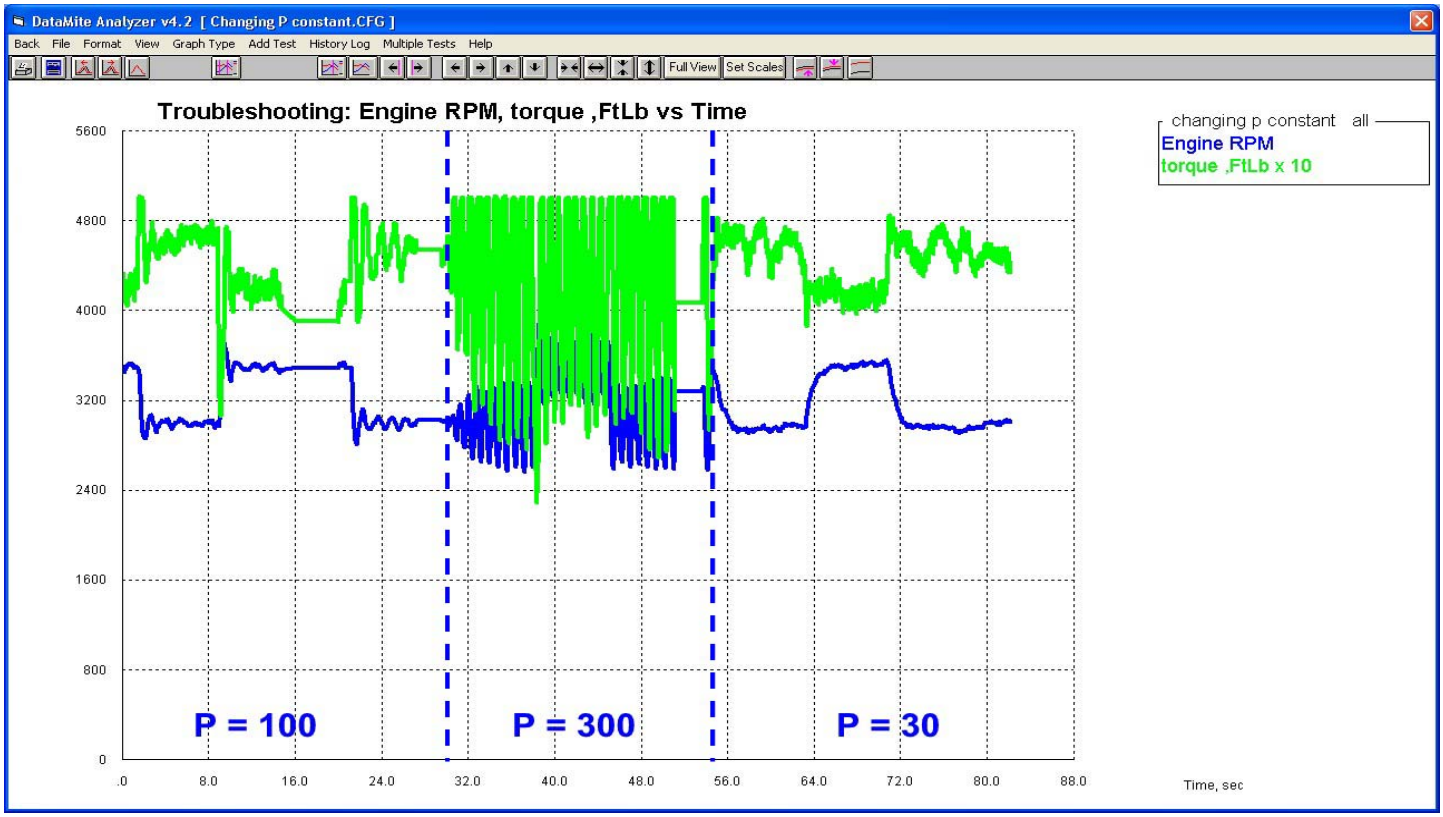
Now you can click the Defaults button and the software will load in good "starting point" settings for doing the type of testing you have chosen. Most users will not make any more changes than that.

However, if you think your controller is too "jumpy" or "sluggish", you can fine tune it by adjusting the Proportional (P), Integral (I), and/or Derivative (D) settings. This can happen depending your exact type of dyno.

The Proportional setting will have the greatest effect, so it is typically what you will adjust. If you adjust P setting, it is also best to adjust the Derivative (D) setting by the same factor. For example, if you double the P in the picture to the right from 100 to 200, double the D factor from 4 to 8.

Integral is typically not that important unless you are trying to hold RPM very constant. Check your LCD screen on your controller to see if I is even being used for your type of control. If it shows 0, the controller has disabled if, like if there is no RPM present.

The Troubleshooting graph below shows what the RPM and Torque signal look like when the P setting is about right. This data was done in RPM Control Mode, in RPM Holding mode doing Ctrl-↑ and Ctrl-↓ commands between holding at 3000 and 3500 RPM. In RPM control mode, a P setting of 100 is a typical Default. You can see in this case the RPM will overshoot the desired RPM some on the changes, but then quickly settles in on the desired RPM. With the P setting of 300 you can see how "jumpy" the controller is.



With a P of 30, you will see the RPM change is somewhat slow. You want the fastest control (highest P setting) which still prevents the control from being "jumpy". When holding RPM constant it may look like P = 30 is good, but it is too slow when doing accelerating or decelerating tests. Then P = 100 with its faster response is much better.

Running Tests in the 3 Different Modes, RPM, Load and RPM/Load Control

These 3 modes have their advantages and disadvantages. The “hybrid” of RPM/Load control seems best for most situations but can only be used for doing accelerating tests in Stand Alone mode (no PC Control).

One big difference between the 3 modes is what happens before doing the actual test. The next 3 graphs will explain the process for each.

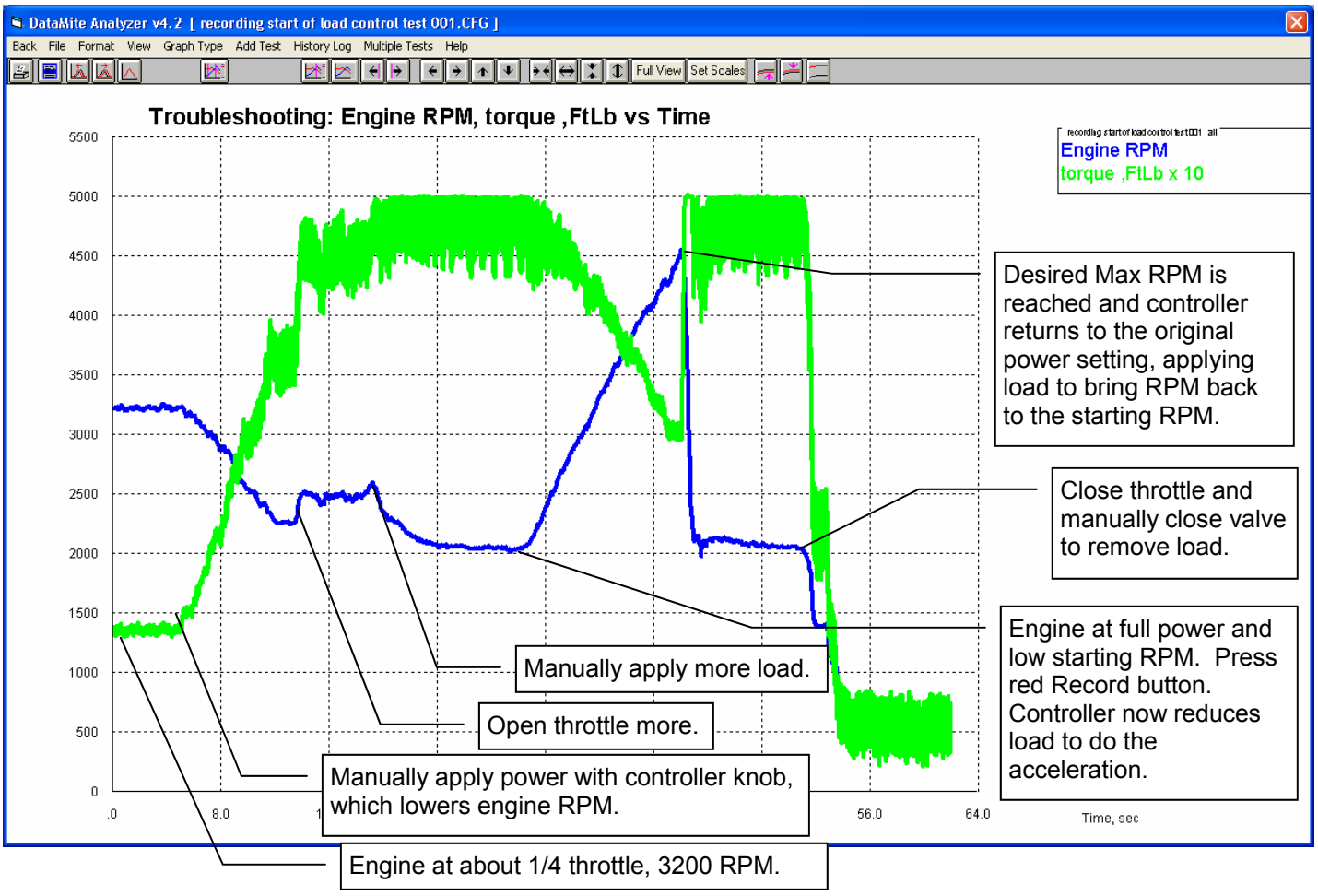
NOTES: These graphs are different than typical Troubleshooting graphs because the controller is in Stand Alone mode, but we have disconnected the Record switch from the DataMite. The Controller will “see” the Record button being pressed (with firmware approximately 2.00 or later) and do the acceleration. We click the Yellow “Record” button on the Current Readings screen to start the PC recording data well before the actual test so we can watch the entire process. We’ve also set the option to “Keep Recording at end of Run” to record what happens after the test.

The torque sensor (green line in the graphs) is too small for this engine’s torque output. That is why you see it max out at 500 ft lbs, producing slightly lower torque numbers than are accurate. But for demonstrating the controller, it is not a problem.

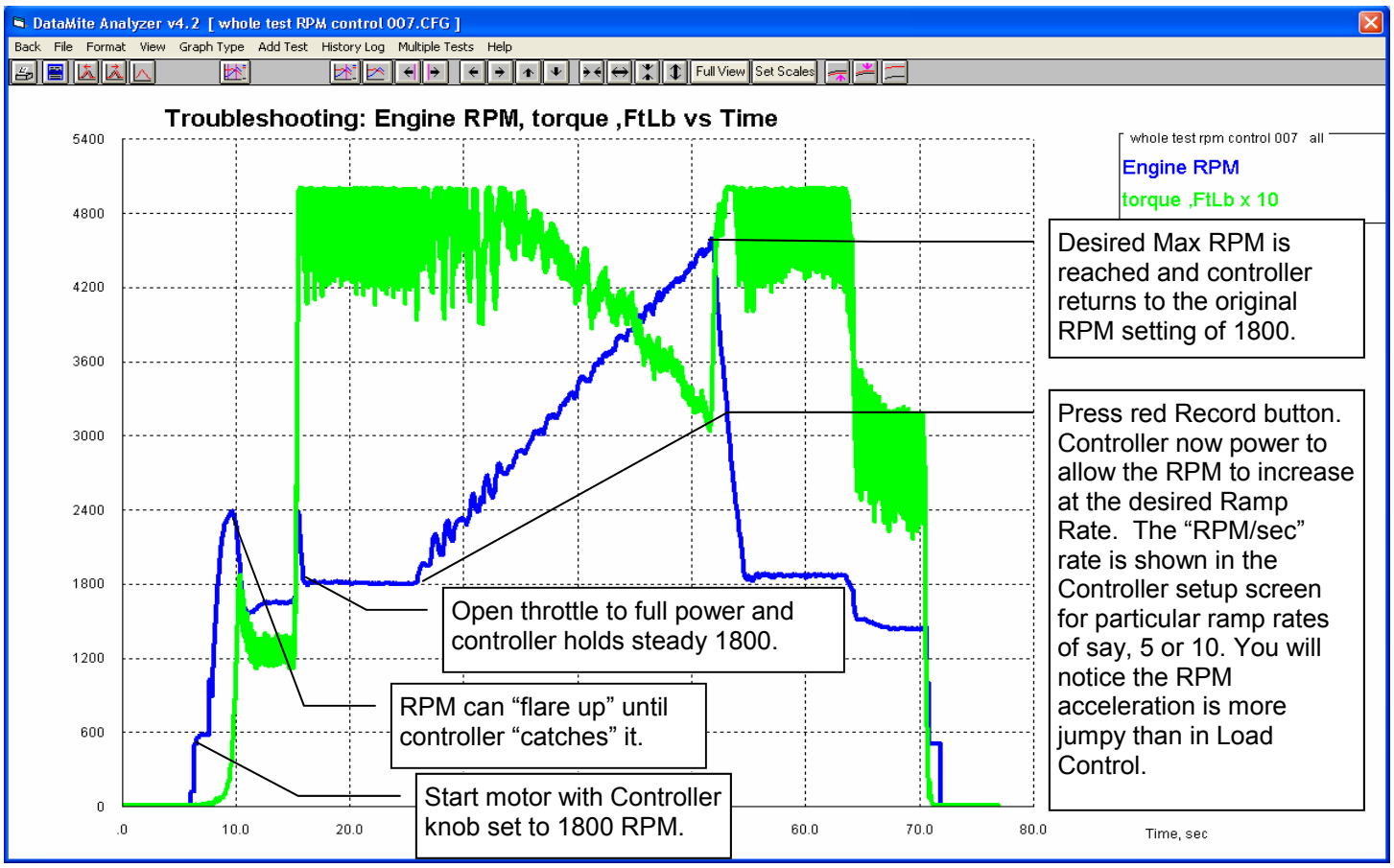
Load Control

Here you have complete manual control of the power to the eddy current dyno. Before running the acceleration, you must get the engine to full power (wide open throttle) with the engine RPM at a relatively low RPM. Once you have this condition, you can press the Red Record button and the controller will close the valve at the Ramp Rate you have set.

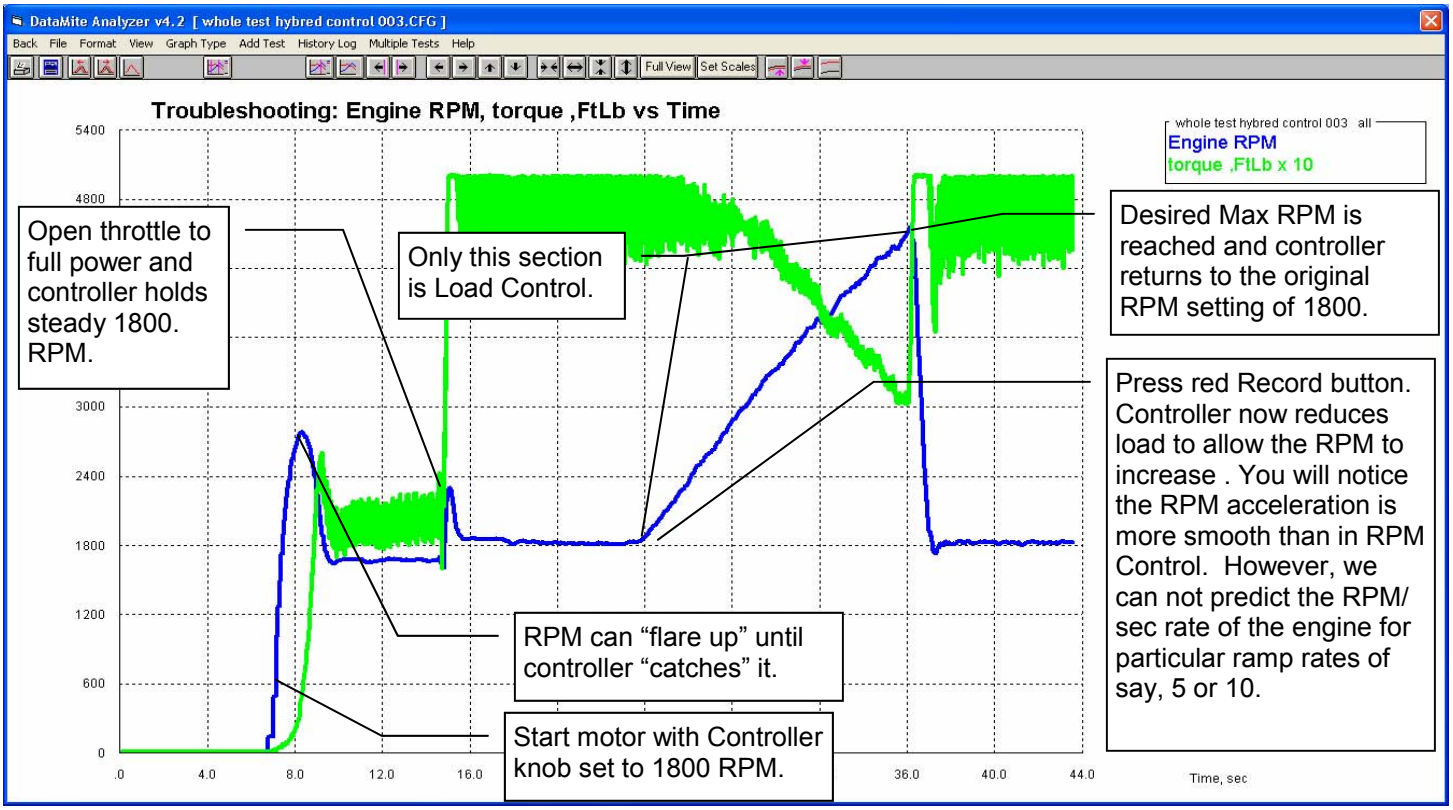
When the maximum RPM is reached, the power quickly returns to the power level you had a the beginning of the acceleration.



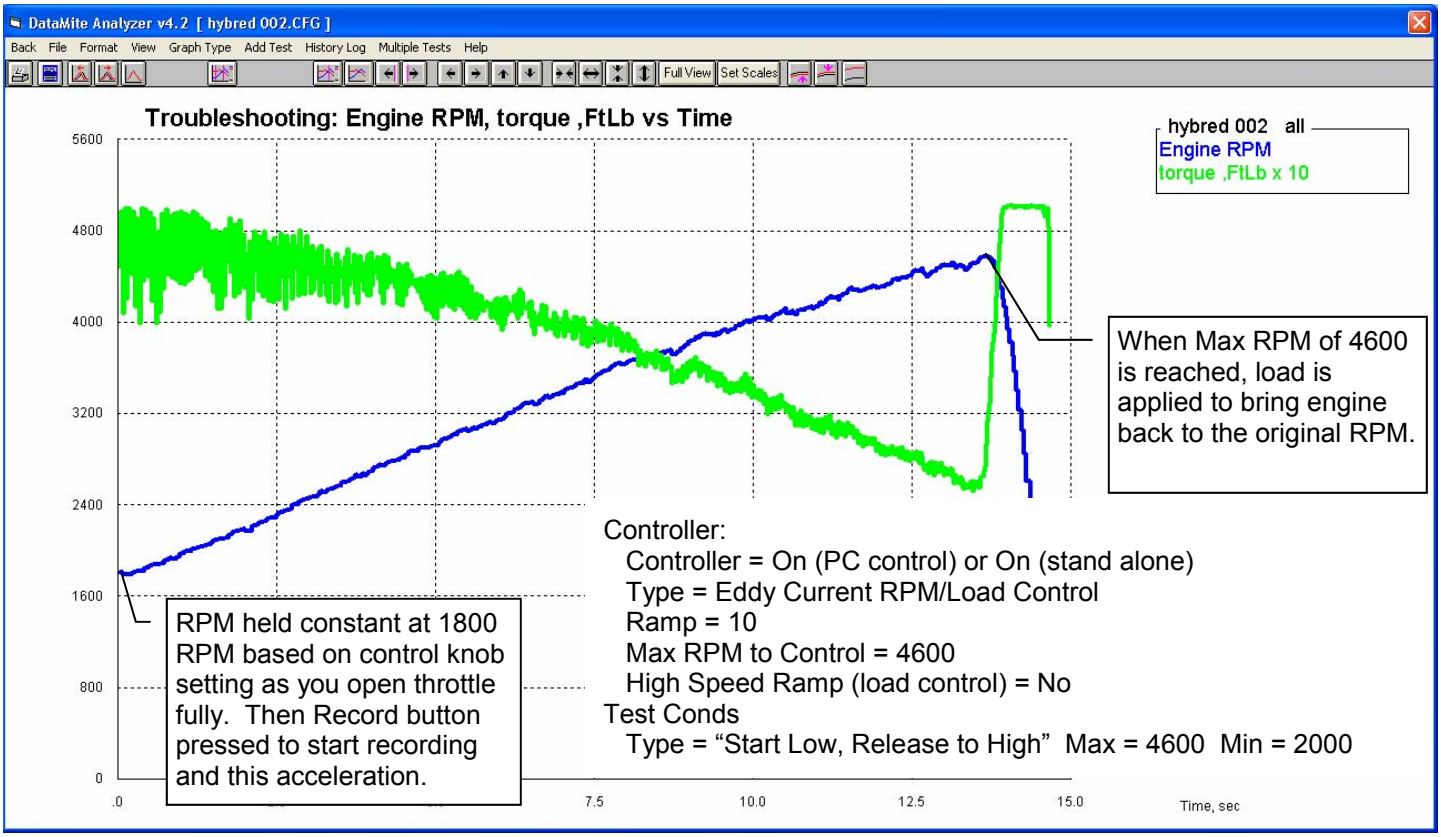
RPM Control



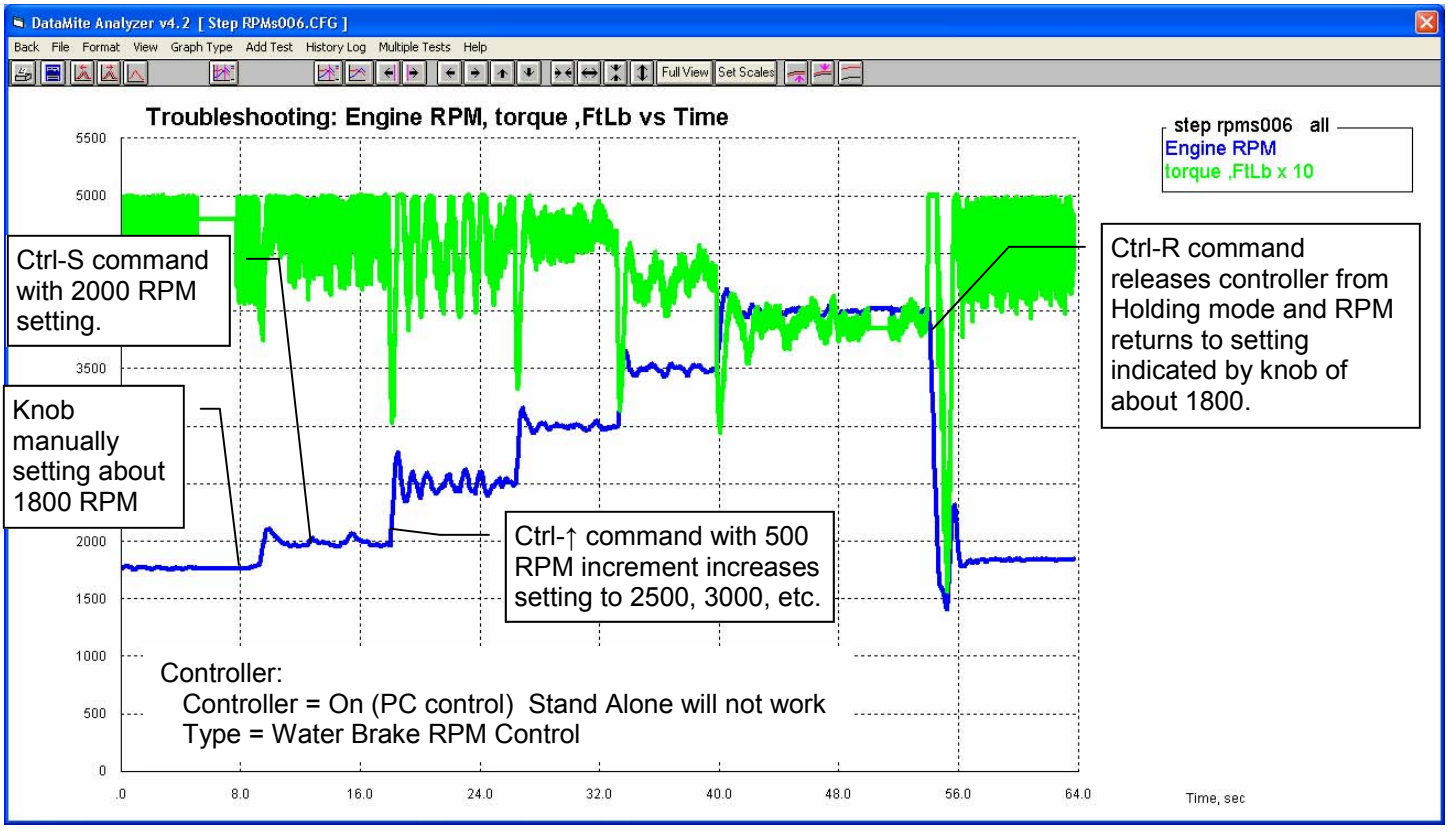
RPM/Load Control



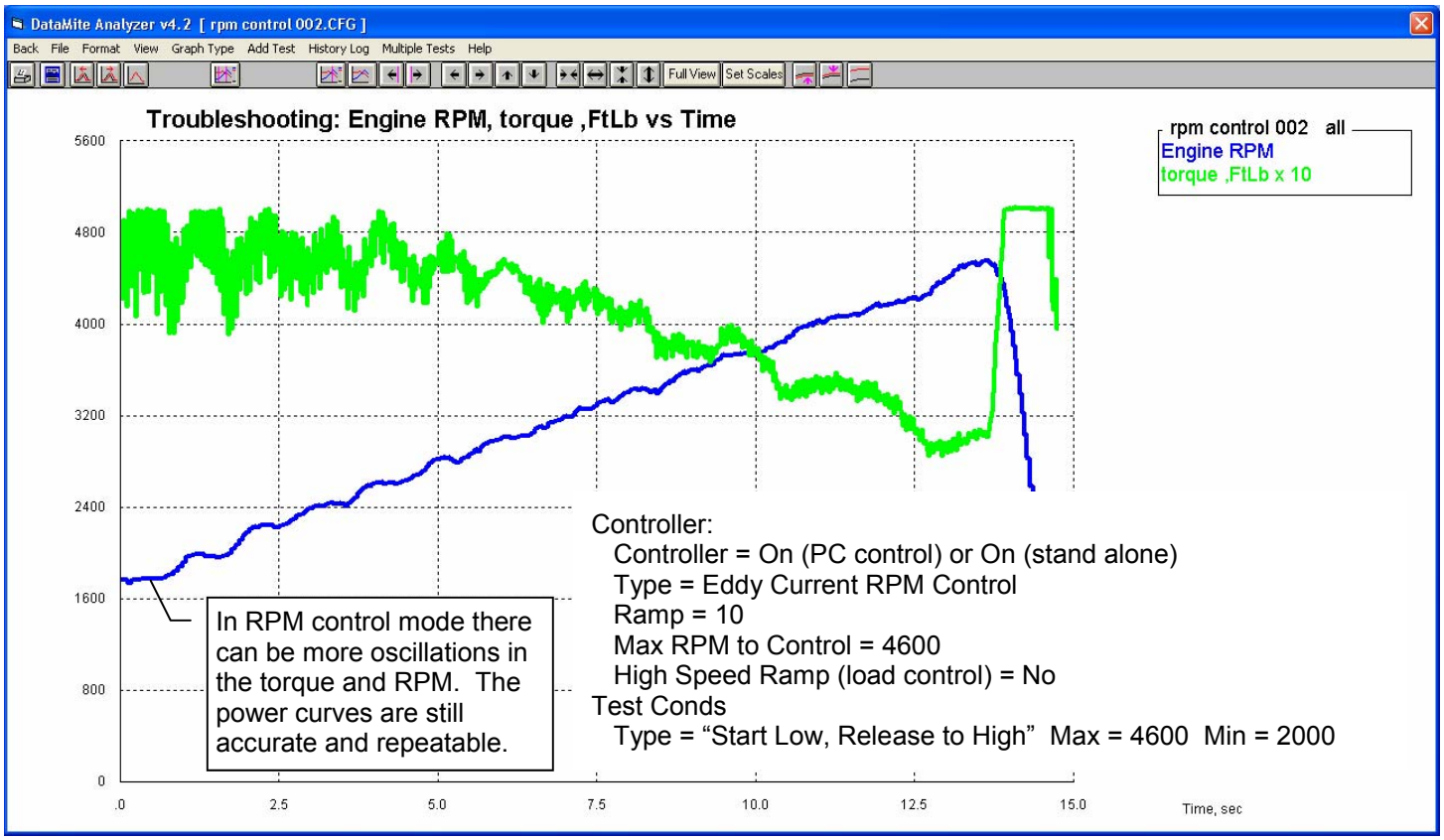
Eddy Current RPM/Load Control



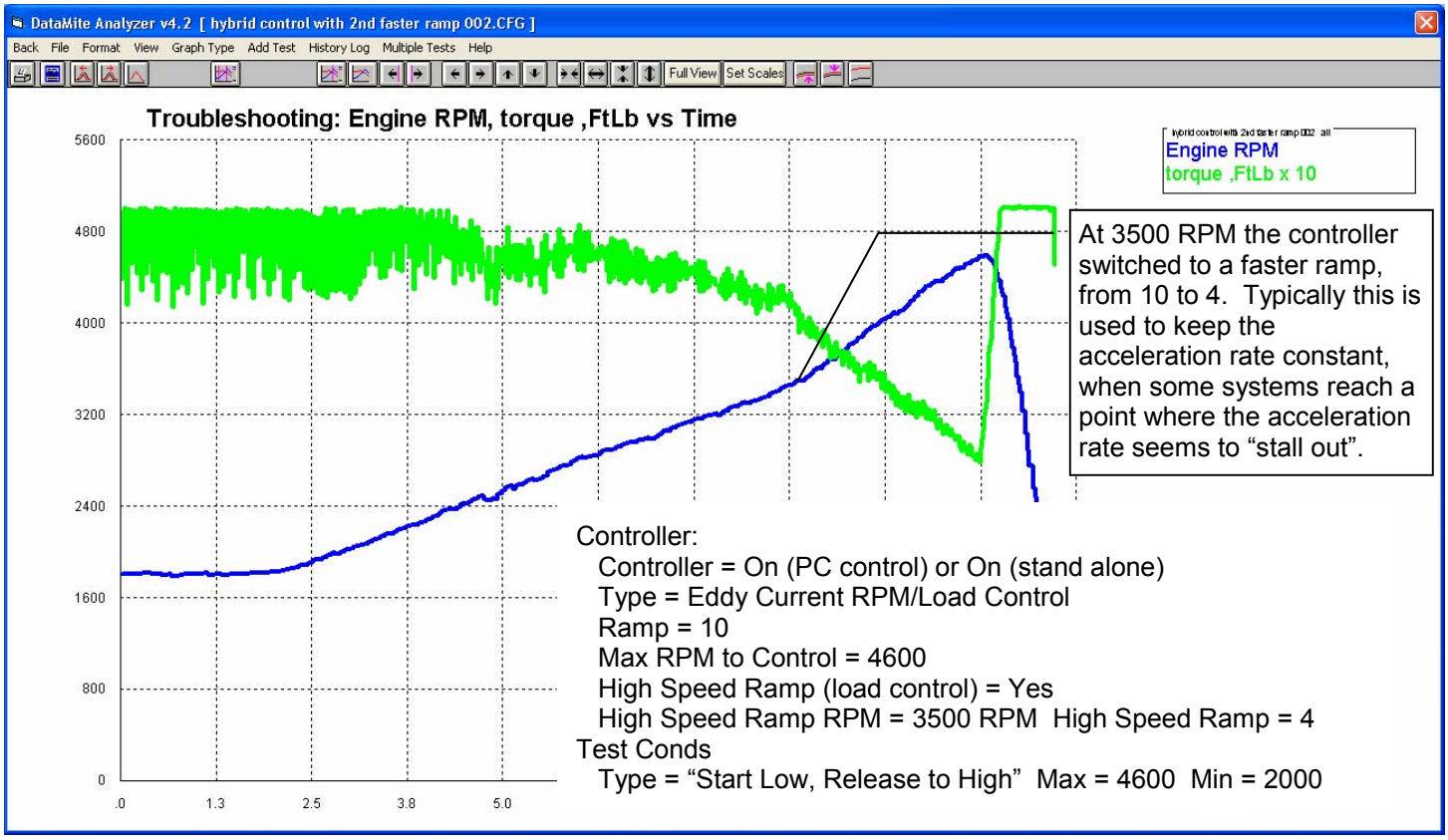
Water Brake RPM Control in Hold Mode



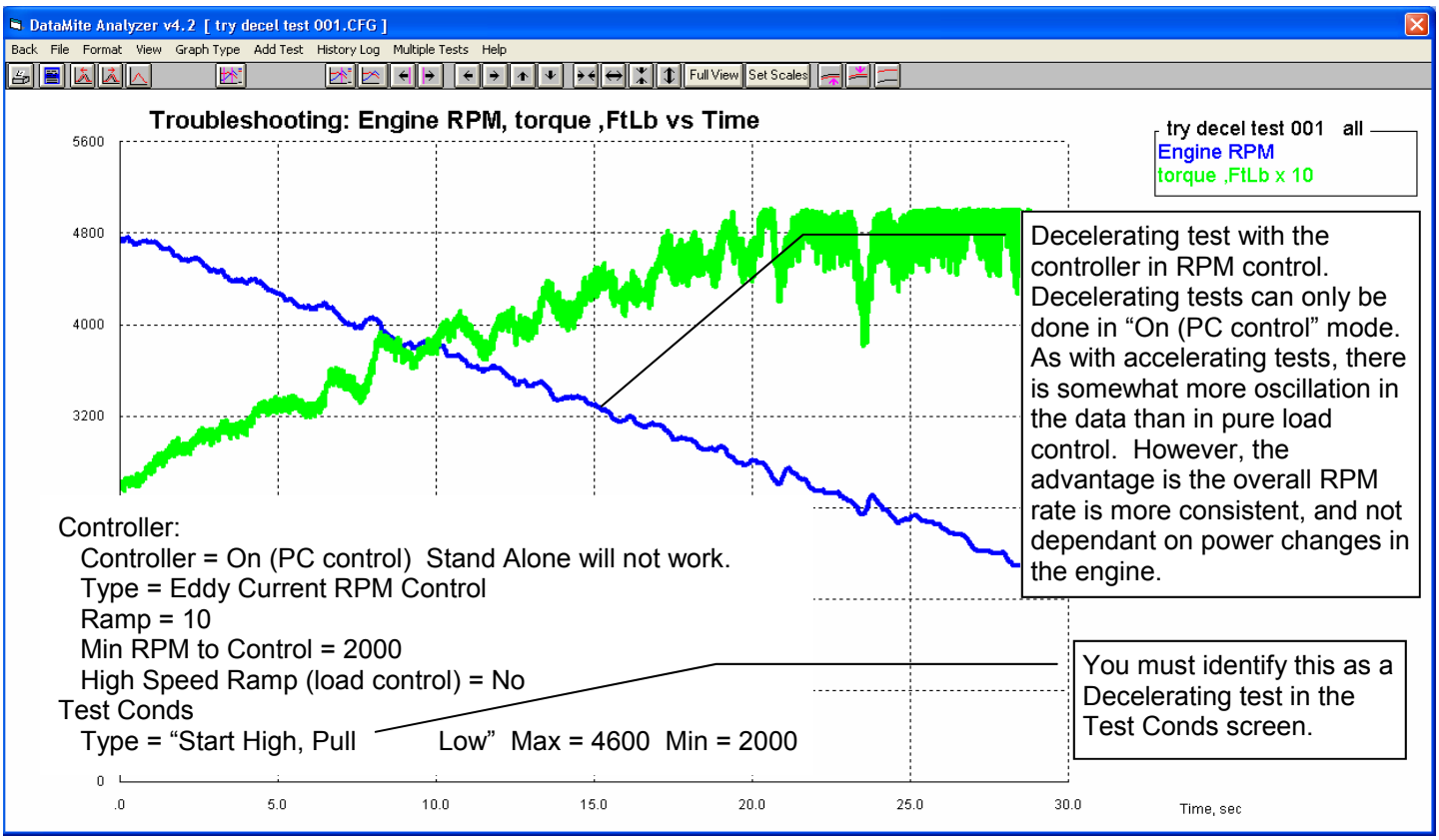
Eddy Current RPM Control



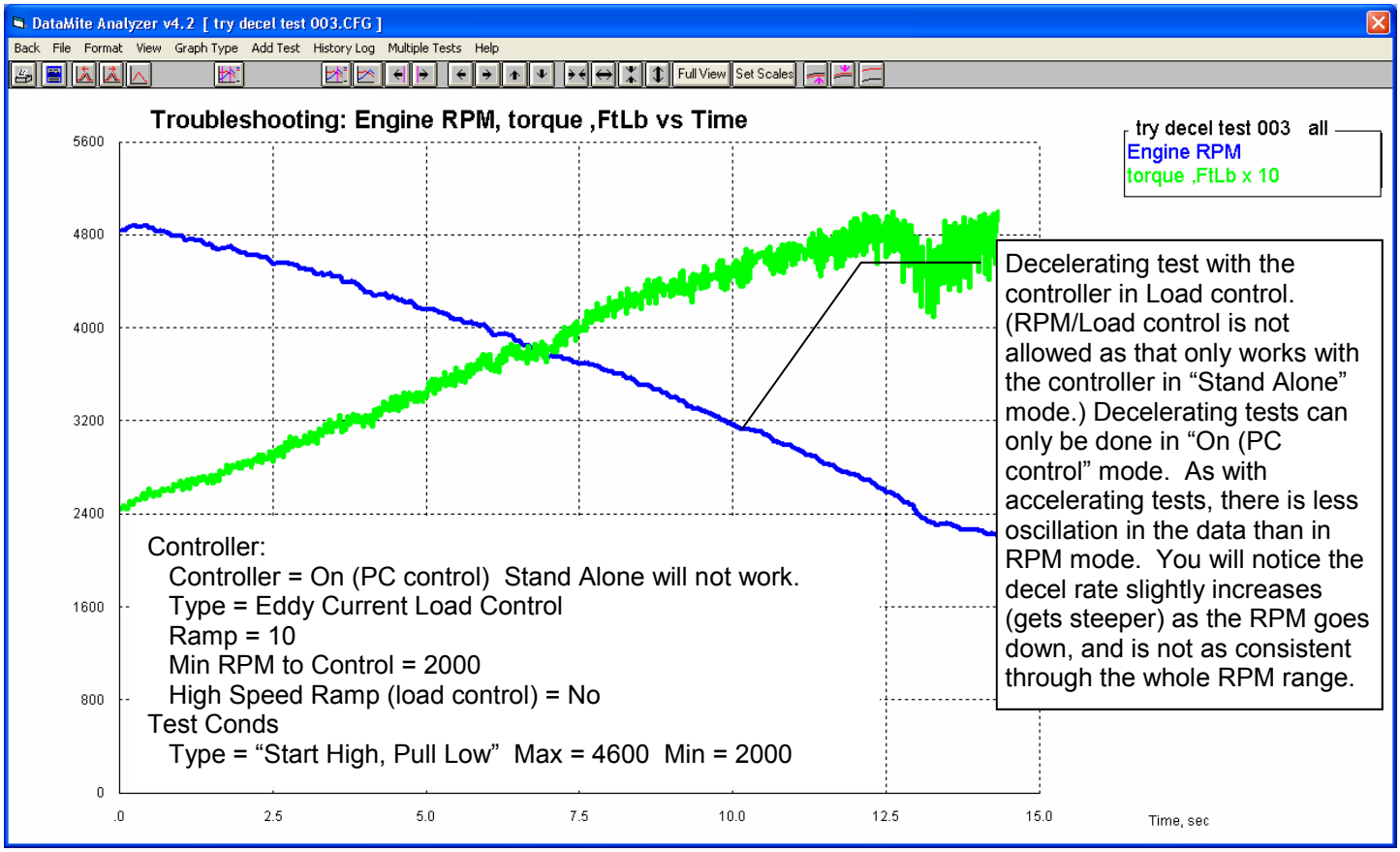
Water Brake RPM/Load Control with High Speed Ramp



Eddy Current RPM Control for Decel Testing

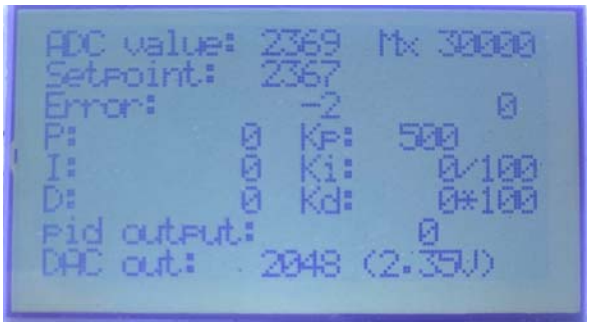


Eddy Current Load Control for Decel Testing



Eddy Current Control for Decel Testing, Notes

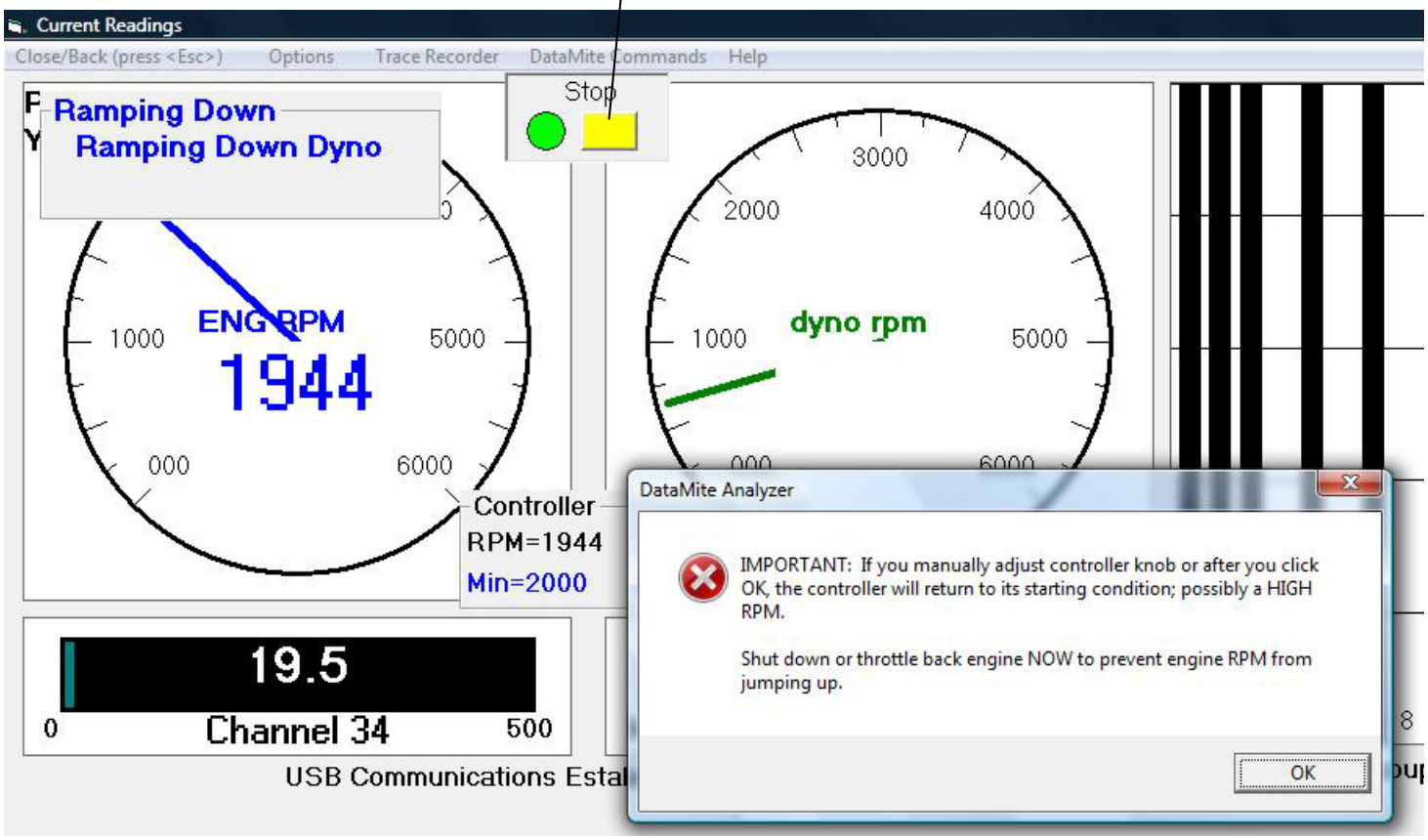
In Decel mode, the software will set the Maximum “Mx” RPM to 30,000 RPM, something much higher than will be encountered during normal testing. See picture to the right. This way “Mx” RPM is never encountered to stop the test.



At the end of the decel test, when the RPM has gone below the Minimum RPM, you will get a message box for you to click. It is best for you throttle back or shut down the engine at this point. If you don’t, the controller will revert back to the condition at the start of the test, typically a high RPM condition. See picture below.

This is what the button looks like when F1 and F2 are turned Off for starting and stopping recording. This is to better ensure your press the red Record button on the Controller for starting recording. Then at the end of the test, you let the program or controller stop recording because the finishing RPM has been reached, as shown here where the RPM has gone below 2000 “Min” RPM. You can also click this yellow button with the mouse to stop recording.

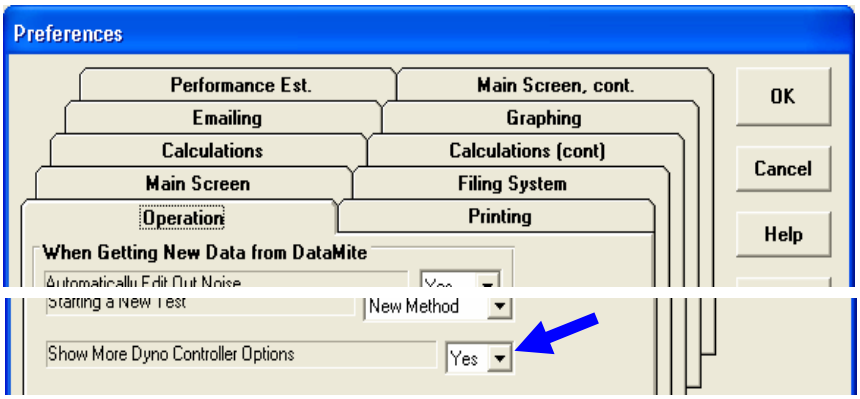
Problems can occur when you start recording with the red record button, but then stop it or restart it with the F1 or F2 button. Things can get “out of sync”. Things work best when you start recording with the red button, and then let the program or controller stop recording because the finishing RPM has been reached.



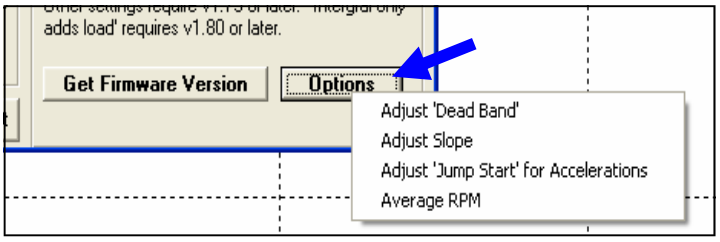
Options Button

You can access more Controller options by turning them on in Preferences under the Operation tab. The reason you must turn this on in Preferences is because most operators will not need to use these Options.

Now you will see the “Options” button at the lower right of the Controller screen.

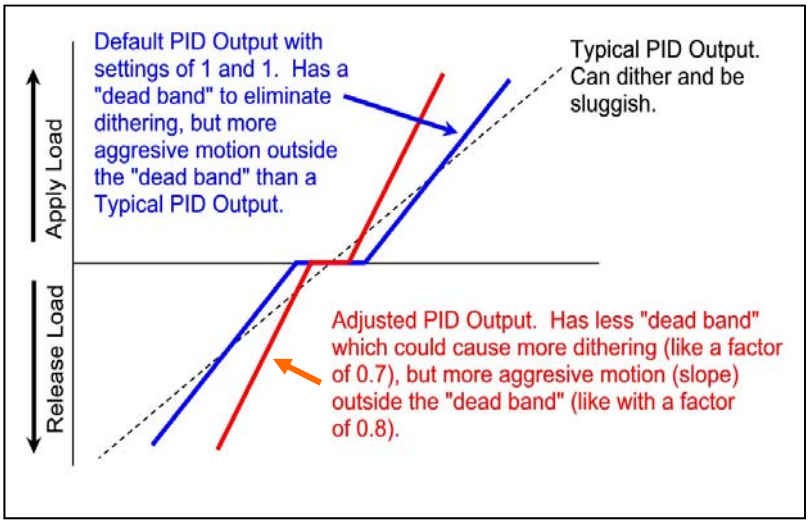


The Adjust ‘Dead Band’ and Adjust Slope are explained in the picture to the right. Without a “dead band”, the controller actuator would be constantly adjusting itself, or dithering. This can cause the actuator motor to overheat and damage itself. Without an adjusted slope, the actuator can act sluggish and not respond quickly to changing RPM or load on the engine.

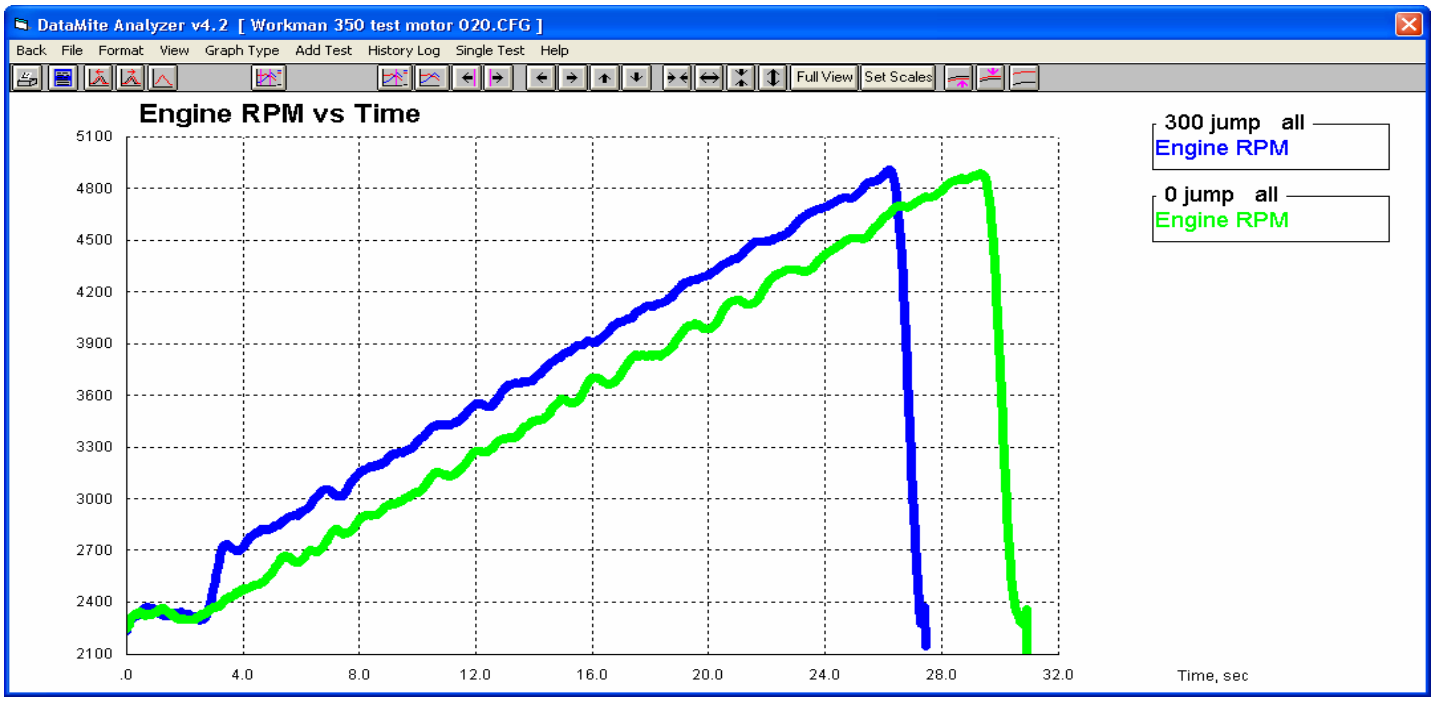


Obviously if you go too far either way with these adjustments you will get dithering, or sluggish response, or overly sensitive response.

The blue graph at the bottom shows what Adjust ‘Jump Start’ for Accelerations will do. If you think the controller does not start the accelerating ramp quick enough after pressing the Record button, you can add this ‘Jump Start’. Proceed slowly with this setting, say in steps of 100 and try it with each change.



Turning on the Average RPM option is typically used only when controlling 1 cylinder, 4 stroke motors. That’s because the power revolution can be much faster than the overlap revolution.



Running a Test Schedule, Enterprise Edition Only

You can now program in a controller schedule for doing testing. The schedule lets you program various times to be at certain RPMs and throttle openings if you have the Auxiliary throttle control. You can select to have this schedule repeat a certain amount of times, should you want to run a particular schedule, like for a break in. Enterprise Edition only. (Figs 10.06, 10.07)

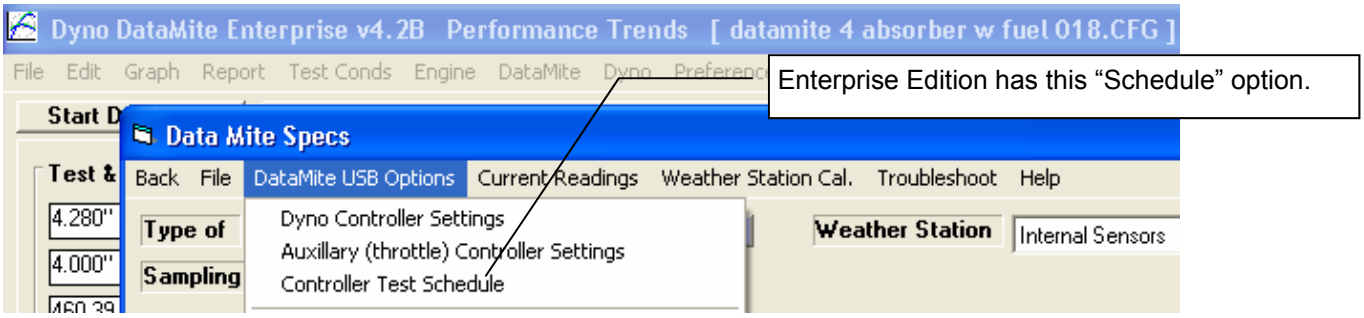
When running a Controller Schedule, here are suggestions for it to work well:

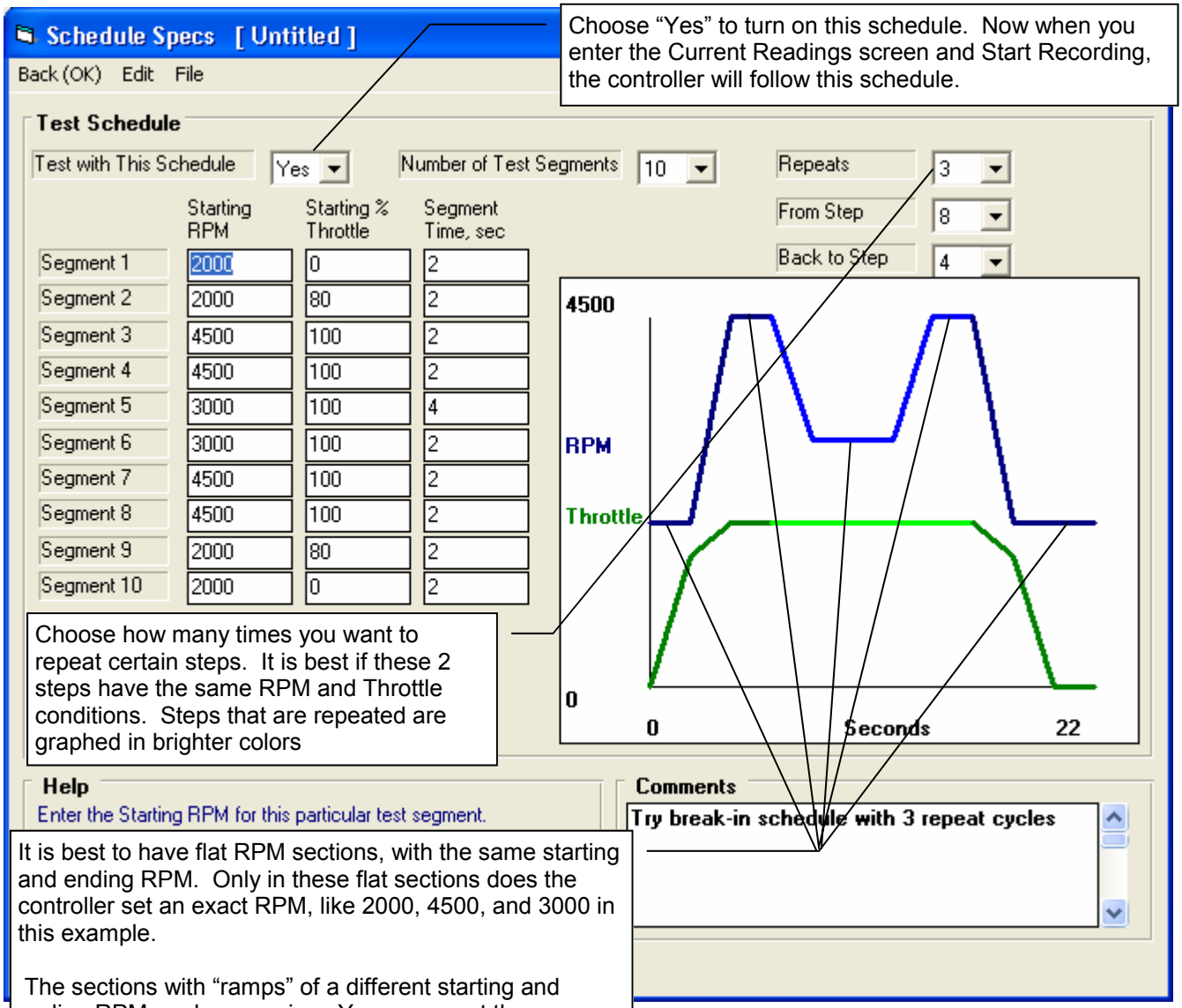
- The controller must be set to PC Control and “Water Brake w RPM Control”.
- The Schedule should have some Segments where the start RPM and ending RPM are the same. This is where the controller is not ramping the RPM (which is less precise), but is commanding an exact RPM which is precise.
- Segments should be about 2 seconds or longer. Ramping segments are more accurate if they are longer than 2 seconds.
- Segments 1 and 2 should have the same RPM and the last 2 segments should have the same RPM. This ensures a stable, exact RPM at the start and end of the test.
- The Schedule is controlled by the PC so the USB communications to the controller must be very reliable. Suggestions to ensure good communications include:
    - Slow down the recording rate in the DataMite specs screen, down from say 50 samples/second to 10 samples/second.
    - Slow down the update rate of the Current Readings screen, down from say 10 updates/second to 5 or less. This is done under Options at the top of the Current Readings screen.
    - Do not maximize the Current Readings screen, but leave it at it’s default (smaller) size. The bigger the gauges, the more computer time it takes to update them and the less time for USB communications to the controller.

Check out the figures on the next 2 pages.

Test Schedule, Enterprise Edition Only

The Enterprise Edition of the software lets you program a test schedule. This is typically used for doing break-ins.





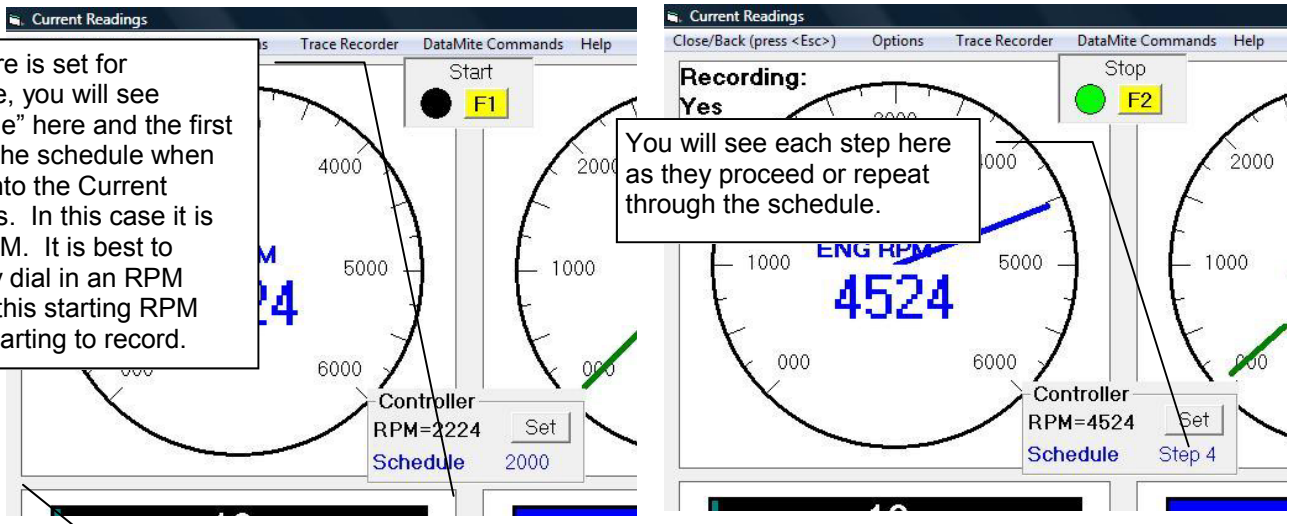
It is best to have flat RPM sections, with the same starting and ending RPM. Only in these flat sections does the controller set an exact RPM, like 2000, 4500, and 3000 in this example.

The sections with “ramps” of a different starting and ending RPM are less precise. You may want the ramp from 2000 to 4500 to end at 4500, but it could be different. Only when you specify the starting and ending RPM the same are you somewhat sure of the RPM that will be set.

Also, it is best if the first 2 segments and last 2 segments also have the same RPM, for predictable results.

Test Schedule, Enterprise Edition Only, cont.

Here are Schedule features on the Current Readings screen.

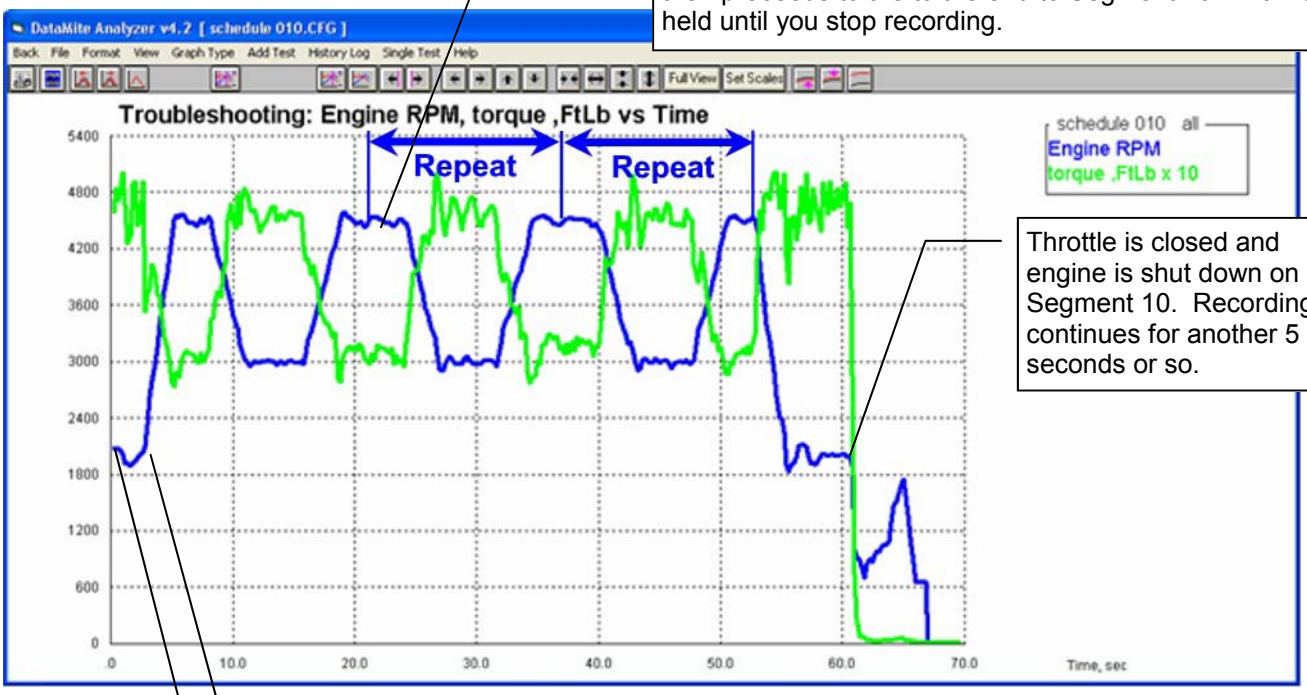


If software is set for Schedule, you will see "Schedule" here and the first RPM of the schedule when you go into the Current Readings. In this case it is 2000 RPM. It is best to manually dial in an RPM close to this starting RPM before starting to record.

You will see each step here as they proceed or repeat through the schedule.

It is critical to have good USB communications to run a Schedule. Read the suggestions on page 19.

After 2 seconds at 4500 with Segment 8, the schedule goes back to Segment 4 and holds 2 additional seconds at 4500. It repeats Segments 4 though 8 two times, then proceeds to the to the end to Segment 10 which is held until you stop recording.



Throttle is closed and engine is shut down on Segment 10. Recording continues for another 5 seconds or so.

Schedule holds 2000 for 2 seconds, then starts ramping up to 4500.

When recording starts (Record button press, F1 key, etc) the schedule starts, controller commands first RPM, 2000 RPM in this case. It is best to manually set an RPM close to this starting RPM with the controller knob before starting to record.

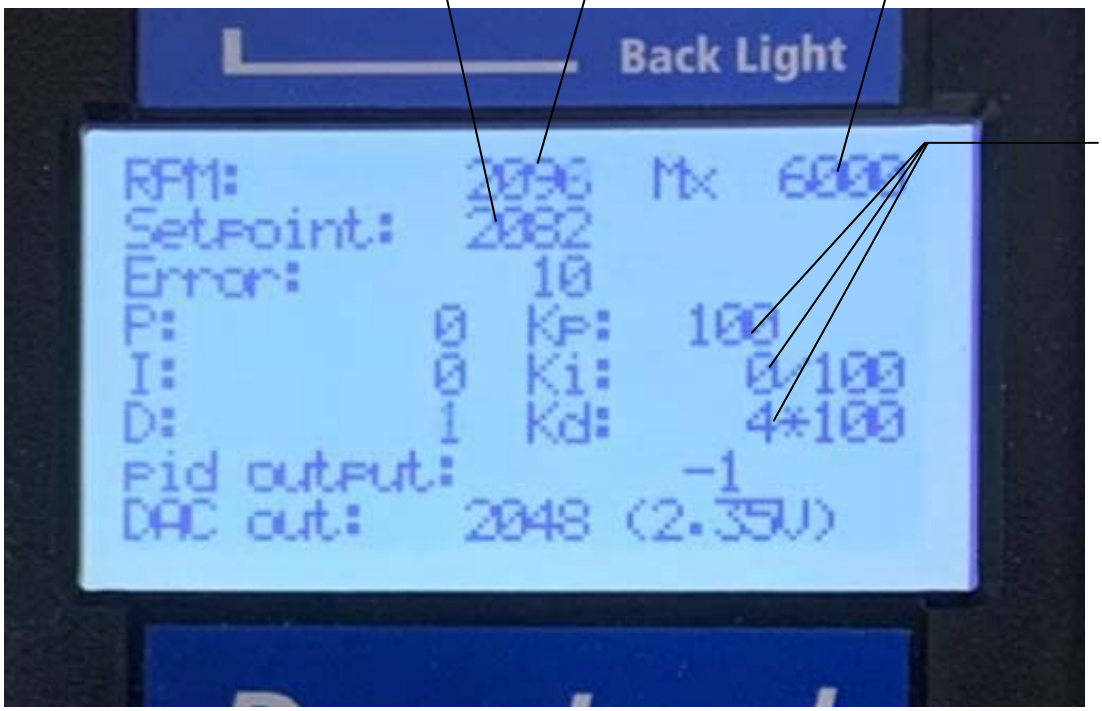
General Tips for Controlling

Here's a handy Overview of important points to watch for at the start of a test.

You will typically start a test by manually dialing the knob to produce the starting condition. This will be adjusting the Setpoint. The RPM or Load value above the Setpoint should be matching somewhat closely. This will indicate things are in control.

In RPM or RPM/Load mode, make sure the RPM reading looks correct**. See important note below about RPM/Load mode.**

Make sure the Mx RPM is correct for the engine you are testing.



When you are more familiar with your controller you will recognize if the P, I and D settings are what you expect. NOTE: In RPM/ Load control mode, these settings will change depending on which control is active.

IMPORTANT: If you are in RPM/Load control mode, the controller will switch back and forth between showing RPM (RPM control) in the upper left corner to Load (ADC in older firmwares). At the start of a test you should be in RPM mode and show RPM in the upper left corner. However, it is possible for the controller to get out of sync, and show Load in the upper left at the start of a test. In that case, simply move the control knob some and then back and the controller should go back to RPM mode. Now it is set correctly for doing an RPM/Load control test.