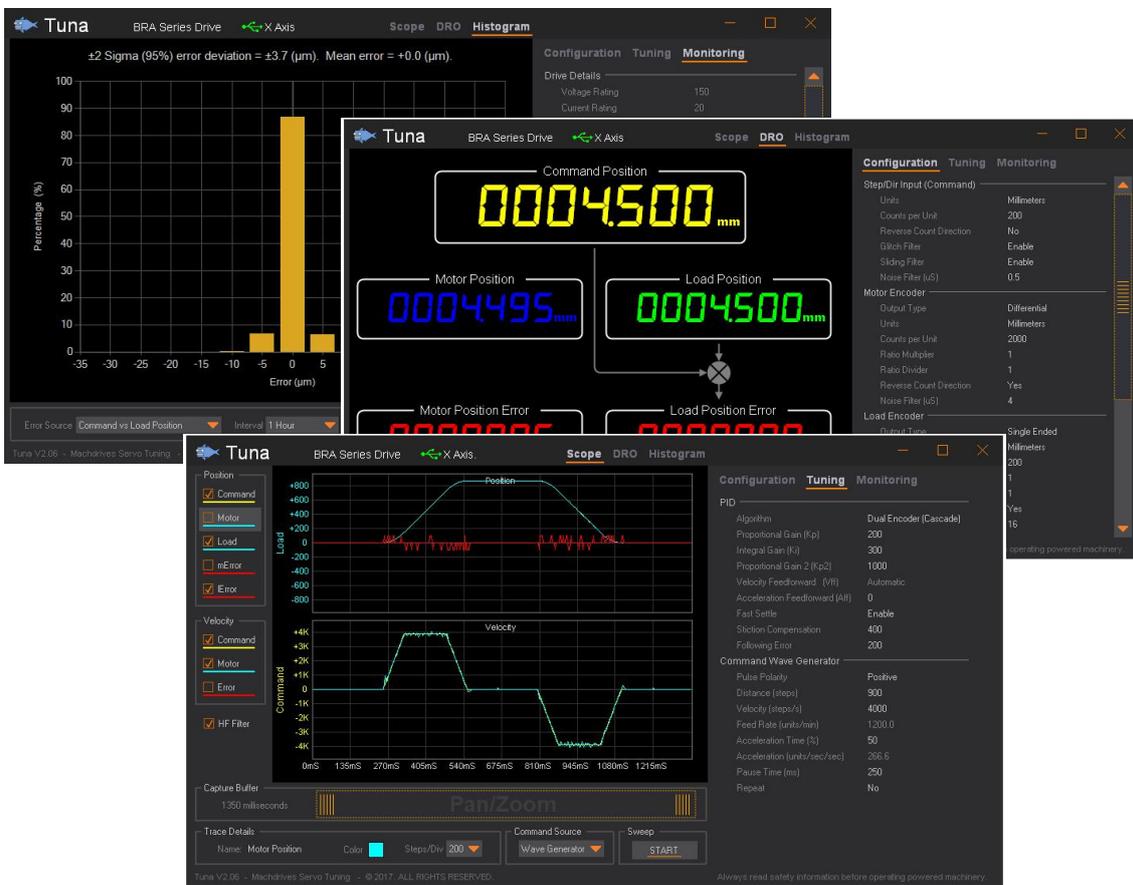# Tuna™

Servo Tuning Software
for Windows®

User Manual

www.machdrives.com

Notice

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Document Revision History

Document Name: TUNAUM

Version	Date	Details
1.0	04-Jan-2017	Initial release
1.1	20-Mar-2017	Updated software revision history.
1.2	23-Jun-2022	Updated software revision history, 1.0 Safety, 2.0 System Requirements, 3.1 Installing the Tuna Software, 3.2 Installing the USB Drivers, 6.0 Activating the Drive.

Software Revision History

Software Name: Tuna™ for Windows®

Version	Date	Details
2.06	14-Jan-2017	Initial Release
2.07	20-Mar-2017	Added support for BRB and BRC series servo drives.
2.08	23-Jun-2022	Added support for BRD, BRE and BRF series servo drives. Added support for non-standard DPI screen resolution. Performance enhancements.

Contact

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1.0 SAFETY

⚠ WARNING

- Using this software with powered machinery involves inherent electrical and mechanical risks. You or any associated third parties shall be suitably qualified or experienced to manage such risks and ensure this software and associated equipment are operated safely and in accordance with your local regulations and industry best practice.

- This software may contain defects that could cause sudden uncontrolled machine motion. You shall never operate the machine in such a way that machine motion may cause property damage, personal injury or death. Keep all body parts well away from the machine while under power.

- You should be prepared to shut down the drive(s) during the tuning process if the system becomes unstable or experiences runaway. You can stop the drive(s) with the $\overline{\text{Enable}}$ or ENA input, but you should not rely solely on electronics and firmware for safety. It is recommended that you also completely remove power to the drive(s) in emergency situations.

- While all efforts has been taken in the preparation of this manual to ensure its accuracy, it still may contain errors or omissions. Where the contents of this manual differ from, or conflict with your local regulations or industry best practice, then your local regulations or industry best practice shall prevail. If an any doubt please contact Machdrives support for clarification before proceeding.

2.0 SYSTEM REQUIREMENTS

- Microsoft Windows XP, Windows 7, Windows 8.x, Windows 10 or Windows 11
- .Net framework 2.0 or higher installed
- Pentium 4 processor or equivalent (minimum)
- 512MB RAM (minimum)
- ST Microelectronics Virtual COM Port driver (for BRA, BRB and BRC drives)
- WCH CH340 USB driver (for BRD, BRE and BRF drives)

3.0 INSTALLATION

3.1 Installing the Tuna Software

The Tuna application for Windows can be downloaded from https://machdrives.com/app/tuna.zip
Extract the executable file from the .zip and follow the prompts to install the software.
You will need to read and accept the EULA before the software can install.

3.2 Installing the USB Drivers

The following is for BRA, BRB and BRC drives only
Your servo drive appears as a **V**irtual **C**OM **P**ort in Windows and needs a VCP driver to communicate.

Make sure the PC has internet connection before connecting the USB cable for the first time. The drive does not need power or any other cables connected. The PC will automatically download and install the correct driver. This may take a few minutes.

If there is no internet connection available the first time the drive is plugged in, Windows will not install the drivers on subsequent connections. You will then need to open Device Manager/Ports and find the USB Serial Device and uninstall it before trying again. Note: the device will only be listed if the USB cable is connected to the drive. If auto installation fails, or there is no internet connection available, the driver can be downloaded from https://machdrives.com/app/VCP_V1.4.0_Setup.zip

The following is for BRD, BRE and BRF drives only
The WCH CH340 USB driver should automatically install on most systems with internet access. If not, it can be downloaded and installed manually from https://machdrives.com/app/ch341ser.zip
Follow the prompts to install the driver.

For all model drives
Whether the Tuna application is "installed" or "open" has no effect on the driver installation.

When the driver is installed correctly it will show in "Devices and Printers" and will also appear in the "Device Manager" under "Ports (COM & LPT)". Note: The servo drive must be connected with the USB cable before it will appear, but the drive does not need to be powered on.

4.0 CONNECTING THE DRIVE

A mini-B USB cable is required to use the Machdrives Tuna application. Make sure the PC has internet connection before plugging in the drive for the first time. This will enable it to find and install the correct USB driver automatically.

It is important that a good quality shielded USB cable is used with the shield connected to the metal shells at both ends as required by the USB standard. The cable should be as short as practical to reduce susceptibility to radio interference. Do not use USB extension cables. Running Tuna from a notebook often allows a shorter cable to be used if the CNC controller is some distance from the drives.

During testing different low cost "shielded" USB cables were purchased online and most were found to be faulty with the shield not connected. A properly constructed cable should never drop the connection between the drive and the Tuna software.
If in doubt check both end shells for continuity with a meter, then strip the sleeve from a small section in the middle of the cable and check the braided shield to end shell for continuity as well.

4.0 CONNECTING THE DRIVE

5.0 APPLICATION LAYOUT

5.1 Main Form

The Tuna application is laid out with the Parameter List on the right, the Display Screen on the left, the Title Bar on the top and the Status Bar on the bottom. The display tabs can select three different types of display screens.

- **Scope**: This is an oscilloscope style display that shows real-time position and velocity information.
- **DRO**: This is a **D**igital **R**ead **O**ut display that shows real-time motor and load encoder positions.
- **Histogram**: This shows real-time statistical analysis of position error.
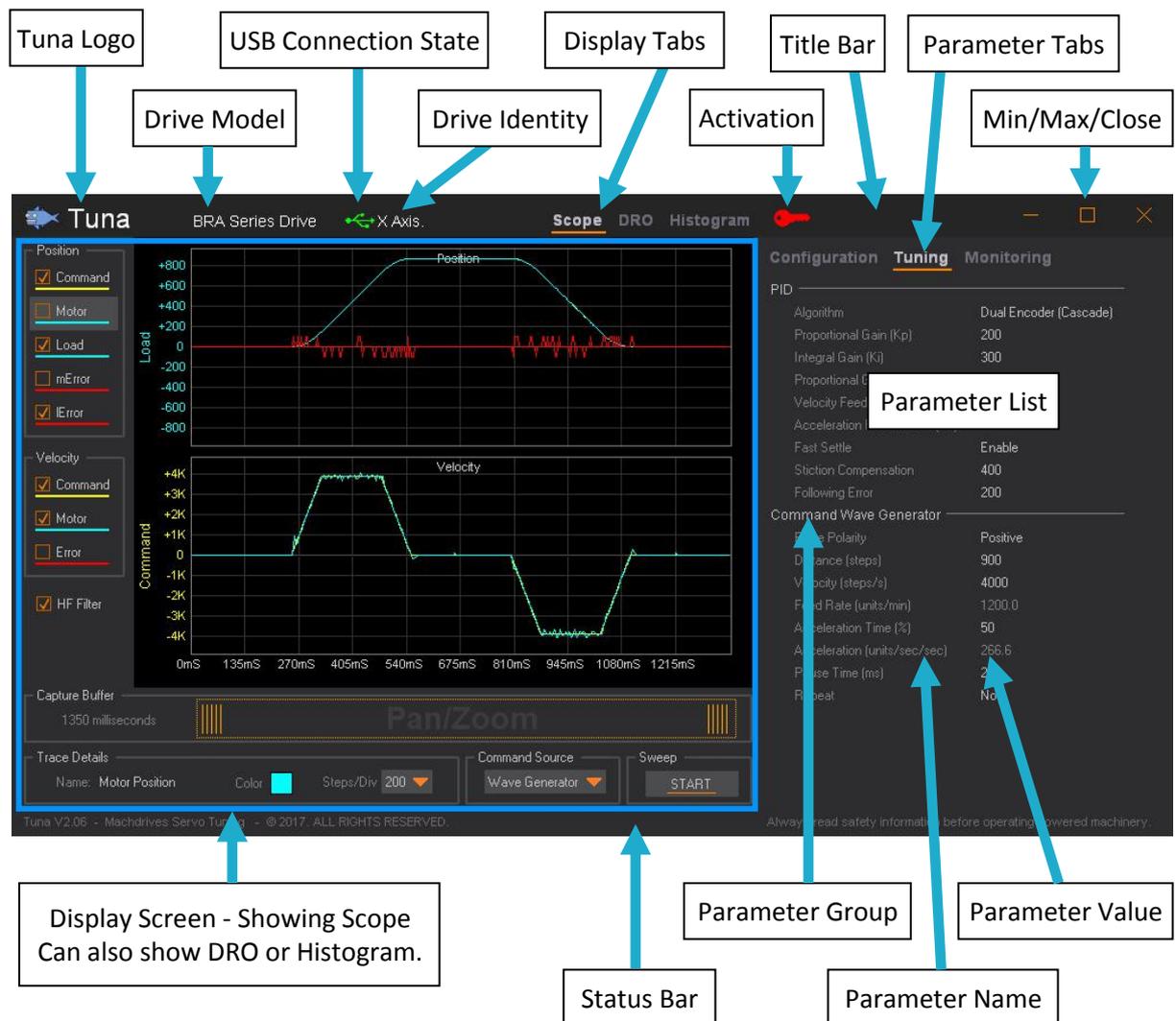
5.2 Scope Display

This is an oscilloscope style display that shows real-time position and velocity information. Traces can be turned on and off using the Trace Selector on the left. The "Trace Details" panel allows customization of the selected trace color and scale. The "Pan/Zoom" control allows a close up view of a time slice of the display. The "HF Filter" removes data that is too dense to display for the selected zoom level.

The "Command Source" can be switched between the "Step/Dir Inputs" or the "Wave Generator". The "Capture Buffer" length is set automatically for the Wave Generator and can be manually configured for the "Step/Dir Inputs".

The Wave Generator profiles are configured on the "Tuning" Parameter tab. Note: The Wave Generator sweep can only be started if the drive is enabled.

Load traces are only available on dual encoder servo drives.
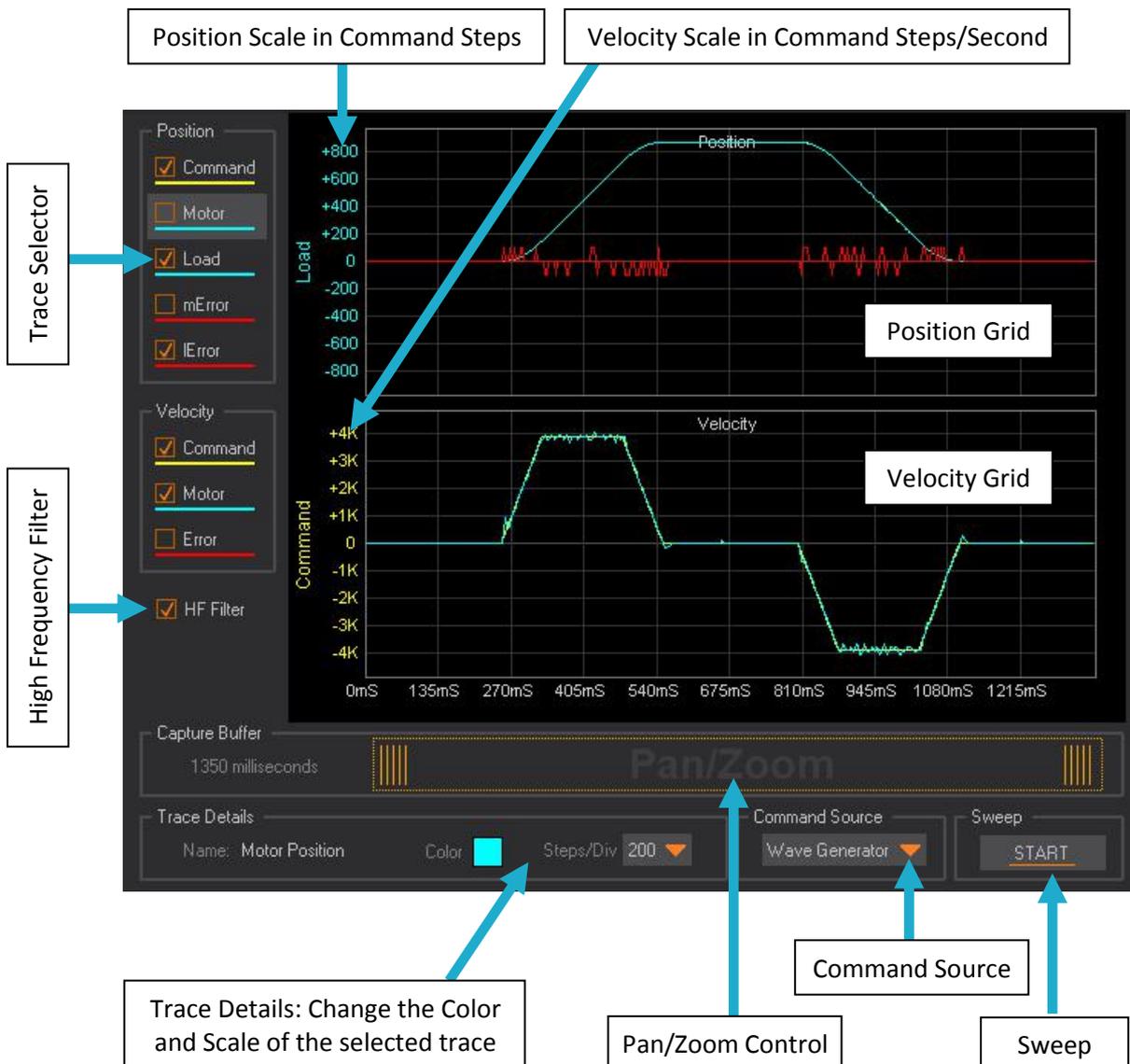
5.3 DRO Display

The **D**igital **R**ead **O**ut (DRO) shows the command position from your CNC software or Waveform Generator, and compares it to the actual motor and load position in real-time. Load position will only function on dual encoder drives.

The units (millimeters or inches) for all readouts are controlled by the Command "Units" parameter on the "Configuration" tab. This is the unit you prefer to work in, and is the same as your native units in Mach3. This allows the mixing of hardware and displayed units. For example using low cost metric ballscrews or glass scales, yet displaying in inches. Conversion is performed automatically inside the drive without rounding or any loss of precision.

The position feedback path shows which encoder is being used for position feedback. This reflects the PID "Algorithm" parameter setting on the "Tuning" tab.

Individual readouts can be turned on or off by clicking on them. A display offset can also be entered by double clicking outside the readouts. This allows the synchronization of readout values with your CNC software. Offsets only affect displayed values and do not change drive position or operation in any way. The readout values are zeroed automatically when the drive is enabled.

Double Click for Offset

Feedback Path
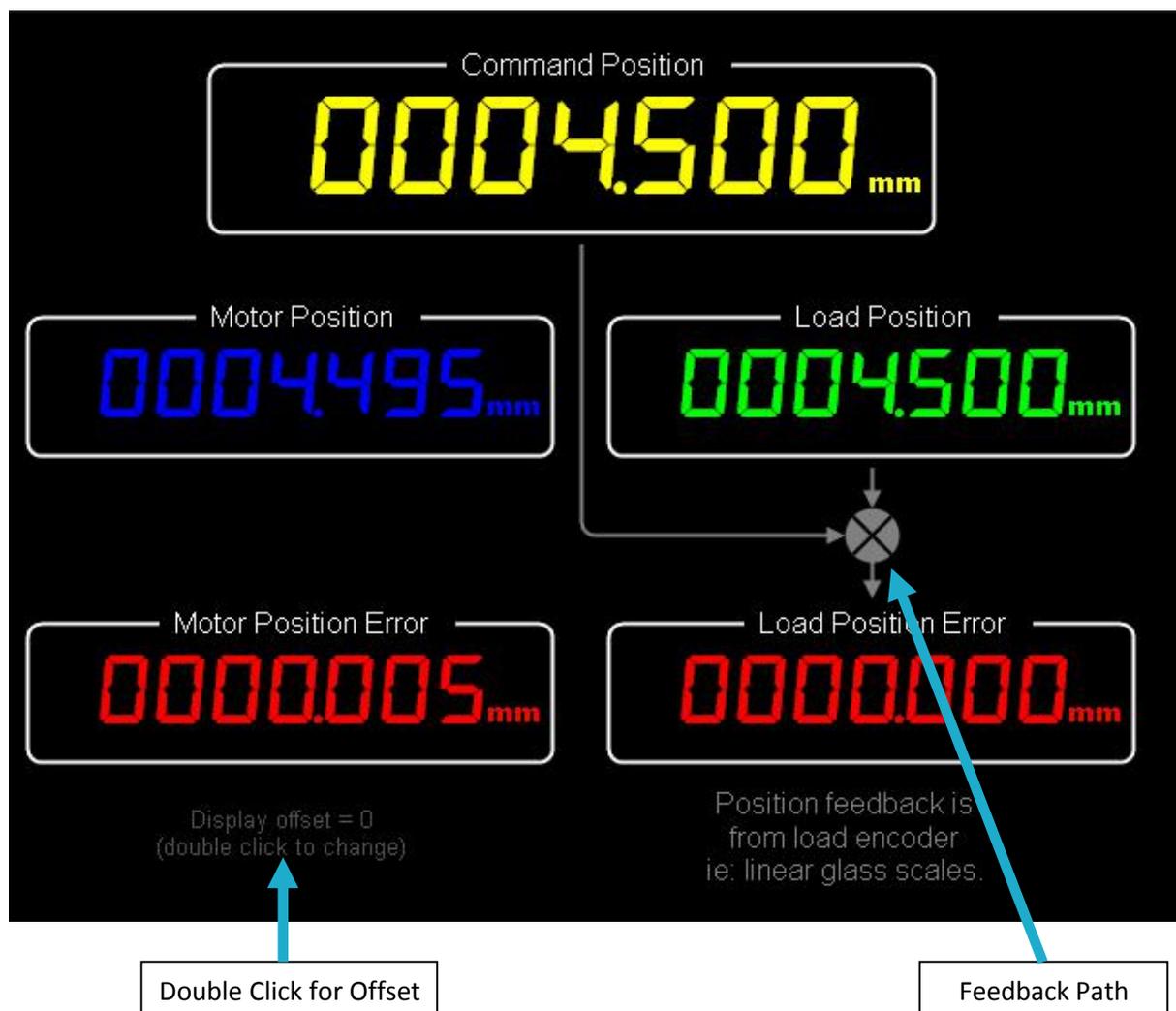
5.4 Histogram Display

The histogram display shows a real-time statistical analysis of position error. Error can be calculated from "Command vs. Motor Position" or "Command vs. Load Position" on dual encoder systems.

Error resolution displayed on the X axis is in Command Steps as configured for the "Step/Dir Input". The example below shows 200 counts/mm, giving a step resolution of 0.005mm or 5um.

Errors are sampled 1000 times a second and grouped by step deviation. The percentage of errors in each group is then displayed as a percentage of the total errors during the collection "Interval". Data for all intervals is collected and calculated continuously while the "Sweep" is running. Changing the "Interval" selection only affects the displayed data and can be changed at any time.

Data collection can be paused using the "PAUSE" / "CONTINUE" button, and data for all intervals can be cleared with the "CLEAR ALL" button.

Statistical error calculations displayed at the top of the histogram are calculated for the selected "Interval". The error deviation shows the error spread covering 95% of errors. The mean error shows the bias or average offset of those errors.
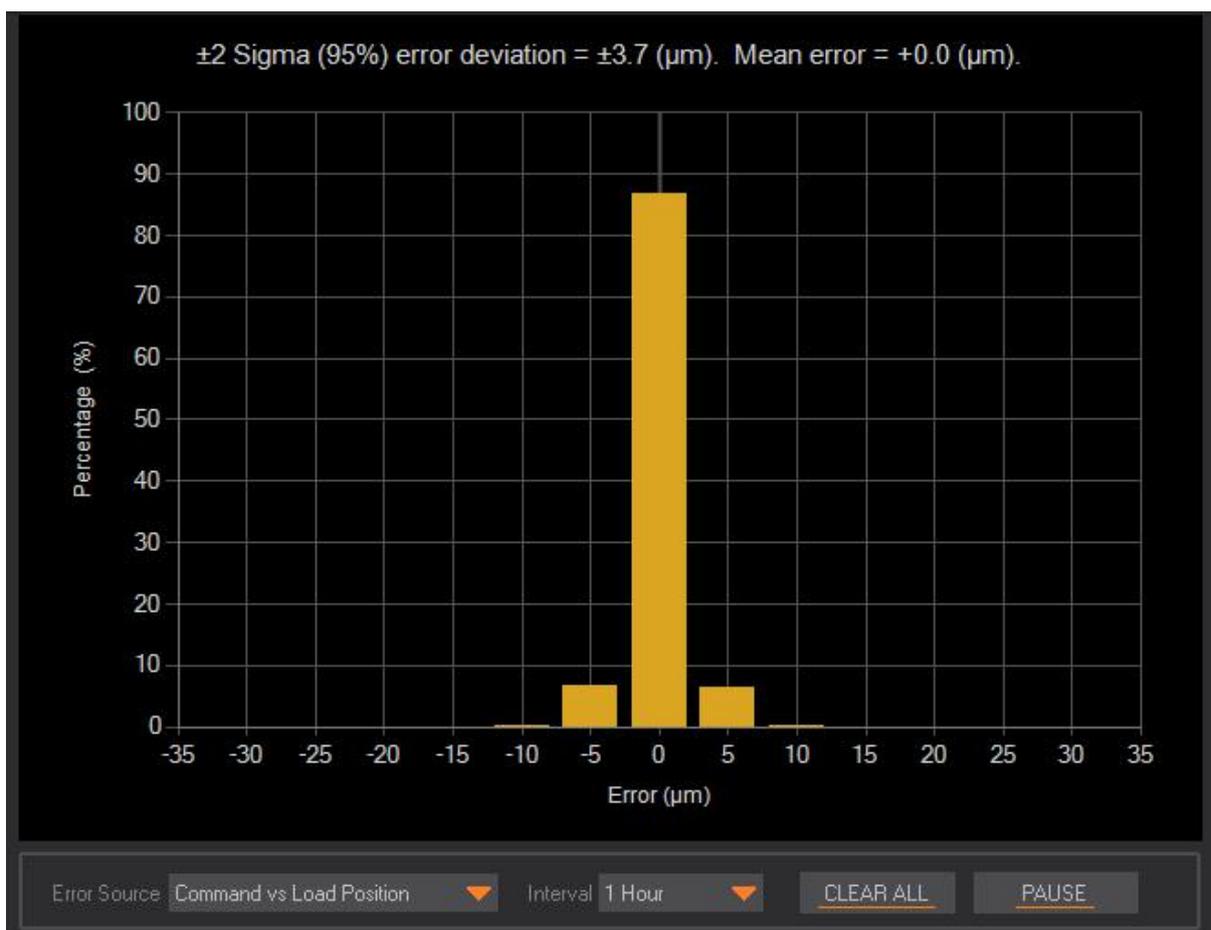
5.5 Parameter List

The parameter list allow a user to view and change the drive's parameter values when connected by USB. When disconnected, the current values will still be displayed, but will become read-only. The Parameters are grouped into three tabs as follows.

- **Configuration**: Used to configure the drive, normally only during installation.
- **Tuning**: Used to tune the servo control loops, normally only during installation.
- **Monitoring**: Used to monitor the drive health, can be done at any time. All parameters on this tab are read-only.

Parameters can be selected by clicking the desired row with the mouse. The selected parameter is highlighted as shown and an orange pointer appears on the right. The selected row can be moved up or down with the arrow keys.
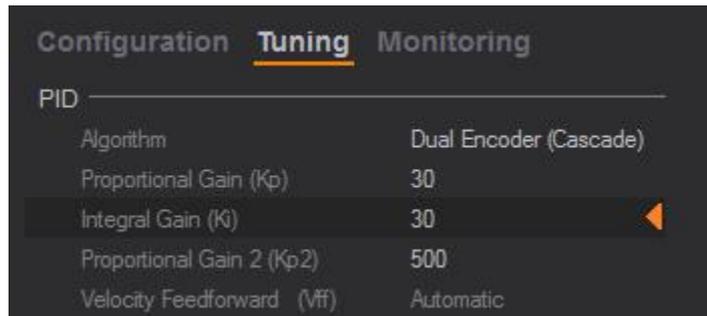
Numeric parameters can be changed by typing the new value directly and then pressing ENTER. Alternatively numbers can be adjusted up and down by the "+" and "-" keys respectively. Editing can also be started by double clicking or pressing ENTER.   All values must be positive integers and are validated for minimum and maximum limits on entry.

Descriptive text parameter values are not typed in, but are selected from a drop-down list. Double clicking or pressing ENTER on the selected row will drop down the selection list. A new value can be selected with the mouse or using the arrow keys and pressing ENTER.

During entry of a parameter, changes can be abandoned by pressing the ESC key. Changes are effective in real-time and are saved automatically.

Scrollbars will appear if the parameter list length exceeds the available space. The list can be scrolled with the mouse or alternatively the mouse scroll wheel can be used. The arrow keys can also be used, and the list will scroll automatically to keep the selected parameter in view.

Some parameters are calculated automatically and are read-only. These are displayed for information only. Parameters that are not applicable are hidden and their values are ignored. For example setting the PID "Algorithm" to "Single Encoder" hides the entire configuration section for the "Load Encoder" parameters.

Parameters are model dependant. Your parameters may be different to the examples shown in this manual.

6.0 ACTIVATING THE DRIVE

BRD, BRE and BRF drives do not require activation, so this section does not apply to them.

BRA, BRB and BRC drives require a one-time activation before they are fully functional. Activation ensures that only the correct person receives and commissions the drive, and that you have received a genuine Machdrives product.

To activate the drive, email the serial number and your order number to support@machdrives.com.

You will receive a 24 character code in the format: DGLH-LXMI-LWXU-MFEI-HIHG-FZXD Every code is unique and will only work in the drive with the supplied serial number.

Open the Tuna application and plug the USB cable into the drive.
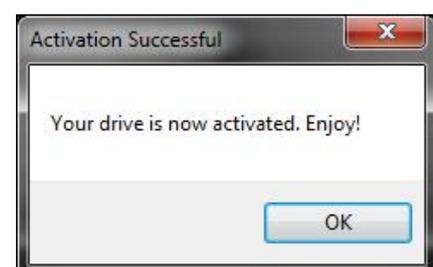
An orange key will appear on the title bar if the drive has not been activated.
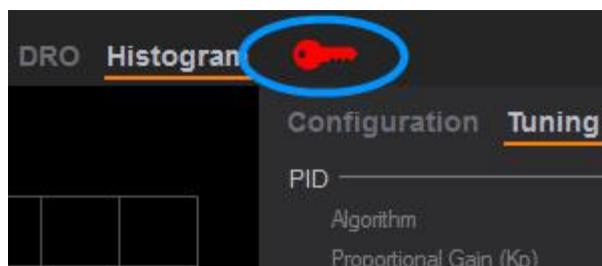
Click the key and paste the code in the dialog box exactly as supplied, then click OK.
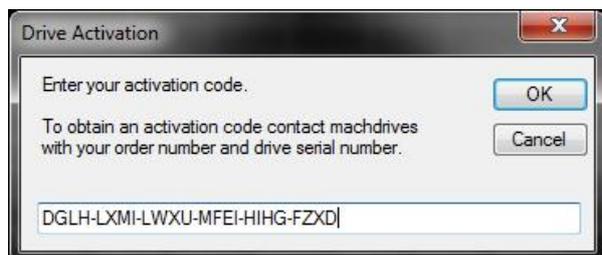
You will receive a confirmation message that the drive has been activated, and the key will disappear from the title bar.

If the code is entered incorrectly three times, the Tuna application will need to be restarted before it can be attempted again.

You should receive the activation code within one business day of requesting it. While you are waiting you can still install and configure the drive. You can also tune it by setting the command source to "Wave Generator". This uses the internal motion profile generator as the command source. The drive cannot however be commanded from the Step/Direction interface until it has been activated.

7.0 SETTING THE DRIVE IDENTITY

7.1 Overview

The drive identity allows the COM port name to be replaced with an axis letter for each drive in your CNC machine. This is useful when configuring or monitoring multiple axes at the same time.

The drive identity is shown in the Tuna title bar next to the USB icon as shown. By default this is set to the COM port name that the drive appears as under Windows. If no drive is currently connected this will show as "Not Connected".
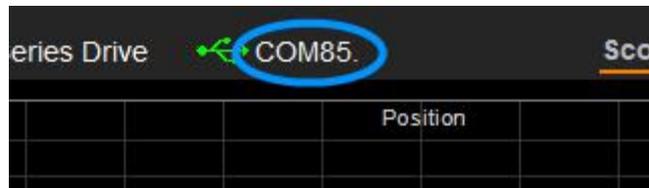
7.2 Setting

To change the identity from the COM port number to the axis letter, connect your drive then choose a "Drive Axis" letter from the "Misc" parameter group on the "Configuration" tab as shown.
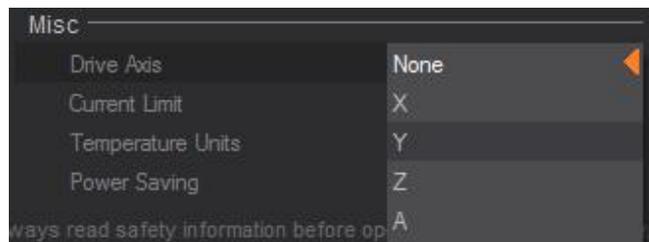
The drive axis letter will now be displayed in the title bar in place of the COM port number. This is saved automatically and will appear in future every time the drive is connected.


Setting the drive identity has no effect on your CNC controller software such as Mach3. It is only used for convenience when connecting to the Tuna application. Normally the drive axis letter would be set to reflect the same axis name as configured in your CNC controller.

8.0 USING THE WAVE GENERATOR

8.1 Waveform Components

The Wave Generator functionality is located inside each drive. It can generate precise motion profiles to control the drive during tuning. Waveforms contain position, velocity and acceleration components as illustrated below.
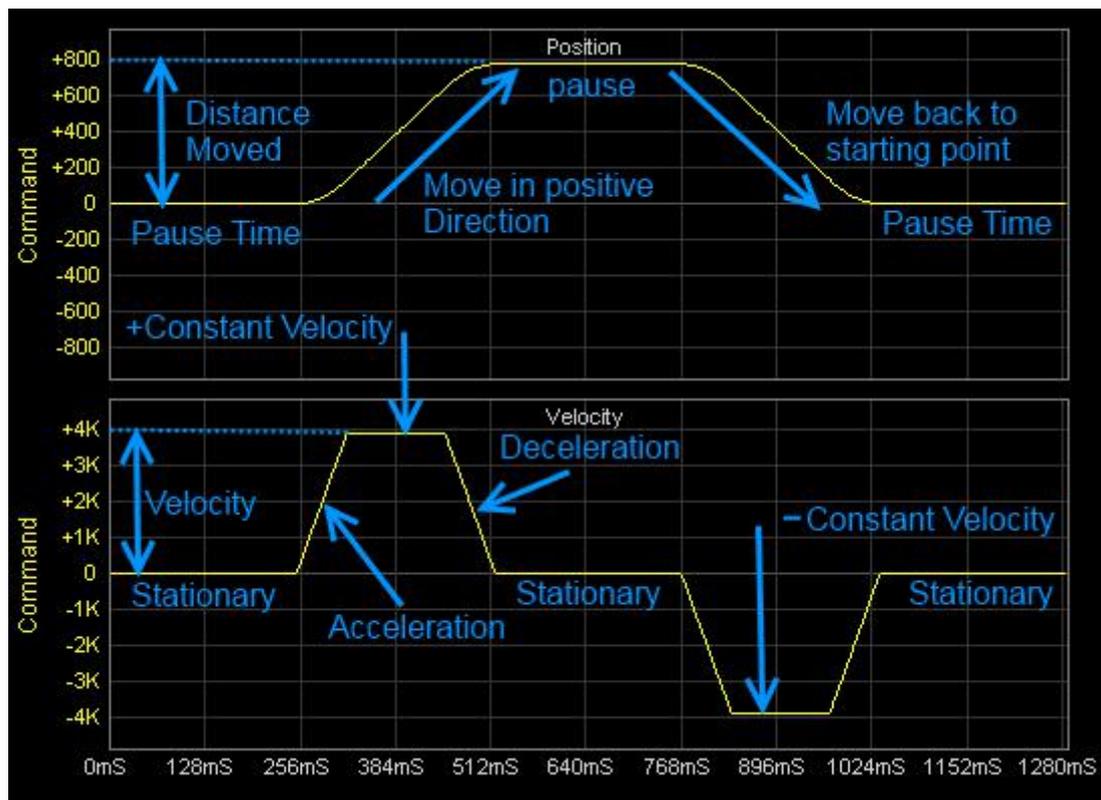
The parameters used to generate the above waveforms are shown here. Note the "Distance" moved of 800 steps, the "Velocity" of 4000 steps/sec and the "Pause Time" of 250ms.

The Wave Generator parameters are located on the "Tuning" tab.

Parameter values shown in gray are read-only and are calculated from other parameter values.

8.2 Waveform Parameters

The following parameters are used to generate waveforms.

Parameter	Description
Pulse Polarity:	
Positive	The axis moves in the positive direction then back to the starting point.
Negative	The axis moves in the negative direction then back to the starting point.
Distance	The distance to move in command steps.
Velocity	The move velocity in command steps/sec.
Feed Rate	This is a calculated value controlled by the Velocity parameter above.
Acceleration Time %	This is the percentage of the move that is spent in both acceleration and deceleration. This controls the shape of the velocity waveform as follows. • 0% - Square waveform. • 100% - Triangular waveform. • 50% - Trapezoid waveform.
Acceleration	This is a calculated value controlled by the Acceleration Time % above.
Pause Time	This is the time the axis pauses between moves in milliseconds.
Repeat:	
No	A single waveform is generated.
Yes	The waveform repeats continuously.

8.3 Creating a Square Velocity Waveform

Square velocity waveforms are useful for tuning velocity loops. The fast rising and falling edges expose any instabilities, making tuning simpler and more accurate. To generate a square profile simply set the "Acceleration Time %" parameter to zero. The other parameters can be adjusted as appropriate. See your drive user manual for specific details on tuning the velocity loop.

8.4 Creating an S-Profile Position Waveform

S-profile position waveforms are useful for tuning position loops. The waveform should match the output from your CNC controller, such as Mach3, as closely as possible. To generate an S-profile use the following steps.

1. Adjust the "Velocity" parameter so the "Feed Rate" matches the feed you most commonly use during machining.
2. Adjust the "Acceleration Time %" parameter so the "Acceleration" parameter is similar to the motor acceleration setting in your CNC controller, such as Mach3.
3. Adjust the other parameters as required to give a suitable waveform.

See your drive user manual for specific details on tuning the position loop.

9.0 USING THE SCOPE

9.1 Overview

The scope display provides up to eight channels of position and velocity information. Load data is only available on models running dual encoder mode.

9.2 Selecting Traces

Up to five position traces and three velocity traces can be displayed at the same time. Traces can be displayed or hidden by ticking the checkbox next to the trace name on the trace selector panel.

Position and velocity traces are displayed on their respective grids. Grids with no traces visible are hidden, and any remaining grid expands to use the available display space.

Trace color and scale can be changed by clicking on the trace name in the "Trace Selector" panel next to the checkbox. The current settings are displayed in the "Trace Details" section under the grids. Clicking on the color square allows selecting a new color. The trace scale in command steps can be selected from the "Steps/Div" drop-down list.

9.3 Pan/Zoom Control

The Pan/Zoom control allows display of a selected time slice of the scope waveform. By default the control displays the entire capture buffer. Dragging either handle inwards, zooms into a smaller time window. Dragging the center of the control left or right pans the window along the time line. Double clicking the control expands it back to its default state. Stopping the sweep before zooming and panning is recommended.

9.4 Command Source Selection

The command information that your servo drive follows normally comes from the Step/Dir outputs of your CNC controller such as Mach3. During tuning the "Command Source" can be switched to come from the internal Waveform Generator instead. This allows precise control of the waveforms without an external CNC controller.
The "Command Source" is automatically set to "Step/Dir Inputs" every time the drive is powered on, and can only be changed when a sweep is not running.

9.5 Sweeping

Trace sweeping can be controlled by the Sweep "START" / "STOP" button under the grids. If the "Command Source" is set to "Wave Generator" then starting the sweep will also start generating the configured waveform. The drive must be enabled to start the sweep in "Wave Generator" mode. When the "Command Source" is set to "Step/Dir Inputs" the sweep can run even if the drive is disabled or motor power is removed. This is useful for manually checking encoder response during setup.
Note: Until a drive has been activated, sweeps can only be run in "Wave Generator" mode.

10.0 TUNING THE DRIVE

> The PID tuning process is specific to your drive model and the selected PID algorithm.
> See the tuning section of your drive user manual for details.

10.1 Checklist

Before starting the tuning process it is important that the drive is configured correctly. Check the following before proceeding.

- The command parameters are set correctly on the "Configuration" tab.
- The encoder parameters are set correctly on the "Configuration" tab.
- The encoder functionality is checked by manually moving the axis and checking that the DRO value moves by the correct amount, and in the correct direction.
- The "Power Saving" parameter is set to "Disabled" on the "Configuration" tab.
- The Machine axis is positioned in the center of travel.
- The "Following Error" on the "Tuning" tab is set to a number approximately twice the expected move distance output from the Waveform Generator.
- The PID "Algorithm" on the "Tuning" tab is set correctly if multiple algorithms are available.

10.2 Tuning the Velocity Loop

The velocity loop must be tuned first. The objective is to get the motor velocity to follow the command velocity as closely as possible with good stability. This loop is tuned with a square velocity waveform to expose any instabilities and improve tuning. See section 8.3 for details on configuring the Wave Generator to output a square wave.

Follow the procedure detailed in your drive user manual for tuning the velocity loop.

10.3 Tuning the Position Loop

The position loop should be tuned with a waveform as close to your typical machining waveform as possible. Match the "Feed Rate" and "Acceleration" parameters to the output of your CNC controller. This step must follow after tuning the velocity loop.

The Wave Generator should be configured to generate an S-profile position waveform. See section 8.4 for details.

Follow the procedure detailed in your drive user manual for tuning the position loop.

11.0 CONNECTING MULTIPLE DRIVES

As most CNC systems have more than one axis, it is sometimes useful to have Tuna connected to multiple drives at the same time. Connecting multiple drives requires running multiple instances of the Tuna application and a separate USB cable to each drive.
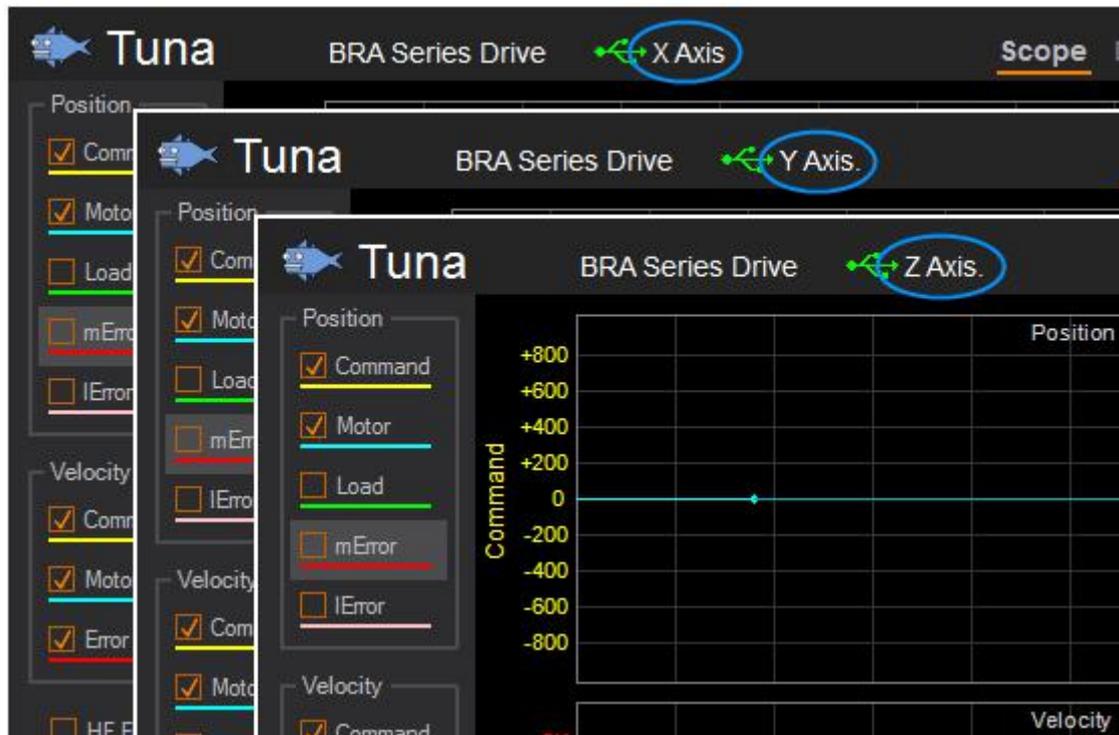
Each instance of Tuna will only connect to one drive at a time. When a drive is connected it is not available for other instances to connect to. Connection is handled automatically when a free Tuna instance and drive are available.

It is recommended to set the drive identities as illustrated when connecting multiple drives. This helps avoid confusion in remembering which axis is assigned to each COM port. See chapter 7 for details on setting the drive identity.

Running multiple Tuna instance requires that your PC has sufficient resources in the form of RAM and CPU capacity. The Tuna application has been designed to place low demands on PC hardware so older PCs with parallel ports can run it successfully. If using a low powered PC it may not be possible to run Tuna and Mach3 successfully at the same time. In such instances it is recommended to run Tuna from a separate PC or notebook.