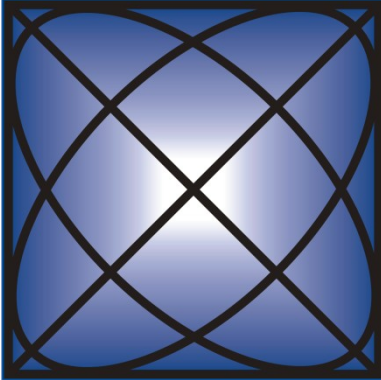


New Ridge



Technologies

NRT-2500 User Manual



Table of Content

Chapter	Page
1. Introduction	3
2. Getting Familiar with the NRT-2500	3
3. Installing the NRT-2500 Software	5
3.1 Automatic Setup	5
3.2 Manual setup	8
4. Connecting to the NRT-2500	9
5. Modes of Operation	11
5.1 Tracker Mode	11
5.1.1 Tracking Error Function (TEF)	12
5.1.2 Editing the TEF	13
5.1.3 Loading a TEF	15
5.1.4 Tracking Optimizer	15
5.2 Scrambler Mode	20
5.3 Spinner Mode	21
5.4 Randomizer Mode	25
5.5 Paddle Mode	27
5.6 Depolarizer Mode	27
6. File Menu.....	28
7. Help Menu	28
7.1 About NRT-2500	29
7.2 Short User Manual	30
8. NRT-2500 Automation	31
8.1 DLL Purpose	31
8.2 Before You Start	31
8.3 Calling the DLL from LabVIEW	32
8.4 List of Commands	34
8.4.1 General commands	34
8.4.2 Tracker Mode Commands	35
8.4.3 Spinner Mode Commands	35
8.4.4 Scrambler Mode Commands	36
8.4.5 Randomizer Mode Commands	36
8.4.6 Paddle Mode Commands	37
8.4.7 Depolarizer Mode Commands	37
8.5 Driver usage	37
9. Updating the NRT-2500 Memory	38
10. Firmware Update	39

1. Introduction

The NRT-2500 Polarization Controller is designed as a flexible platform for laboratory test, measurement and product prototyping. The NRT-2500 currently has five polarization-function capabilities:

1. Tracker
2. Scrambler
3. Spinner
4. Randomizer
5. Manual State of Polarization (SOP) control

The NRT-2500 achieves this diversity due to 5 technologies, integrated for maximum speed and flexibility:

1. An ultra-fast LiNbO_3 polarization control device driven by high slew rate voltage drive amplifiers.
2. DSP to run tracking algorithm and other polarization control processes.
3. FPGA and communications isolated from the DSP.
4. A superior tracking algorithm that controls the polarization depending on the ADC inputs and user-defined feedback error signal and algorithm parameters.
5. ADC to accept external input signals for control and feedback.

New capabilities are constantly being added, predominately from customer requests.

2. Getting Familiar with the NRT-2500

The front of the NRT-2500 has a power switch, power/communication indicator, and optical inputs, as shown in Figure 1.



Figure 1: Front view of the NRT-2500

The rear of the NRT-2500 has:

1. 12 VDC input from a 120-240VAC converter
2. 4 ADC (BNC) inputs
3. Ethernet LAN connection
4. RS-232 serial connection
5. Link I/O (for the master/slave operation of 2 NRT-2500 units or for digital interface)
6. DAC outputs – not shown (optional configuration)

See Figure 2 through Figure 5 for a detailed description of the available connections and their use.



Figure 2: Rear view of the NRT-2500



Figure 3: Analog connections (BNC) to the 4 ADC channels on the NRT-2500



Figure 4: Power and communications ports on the back of the NRT-2500



Figure 5: Rear of NRT-25xx ready for operation with a single analog input in stand-alone mode.

3. Installing the NRT-2500 Software

The user can choose between two options of setting up the NRT-2500:

- Automatic setup that will install all the required 3rd party software (such as LabVIEW Run Time Engine), copy the NRT-2500 software to a designated folder, and create a shortcut in the Start menu.
- Manual install, where the user is required to install all the 3rd party software, create a folder for the NRT-2500 software and copy all the necessary files from the CD to that folder.

The two methods are described in sections 3.1 Automatic Setup and 3.2 Manual setup

3.1 Automatic Setup

In the automatic procedure, 3rd party software will be installed first. Two components will be automatically installed: LabVIEW Run Time Engine, and VISA Run Time Engine. Both components have to be installed, otherwise the NRT-2500 will not operate properly. Follow the procedure shown in Figure 6 through Figure 8.

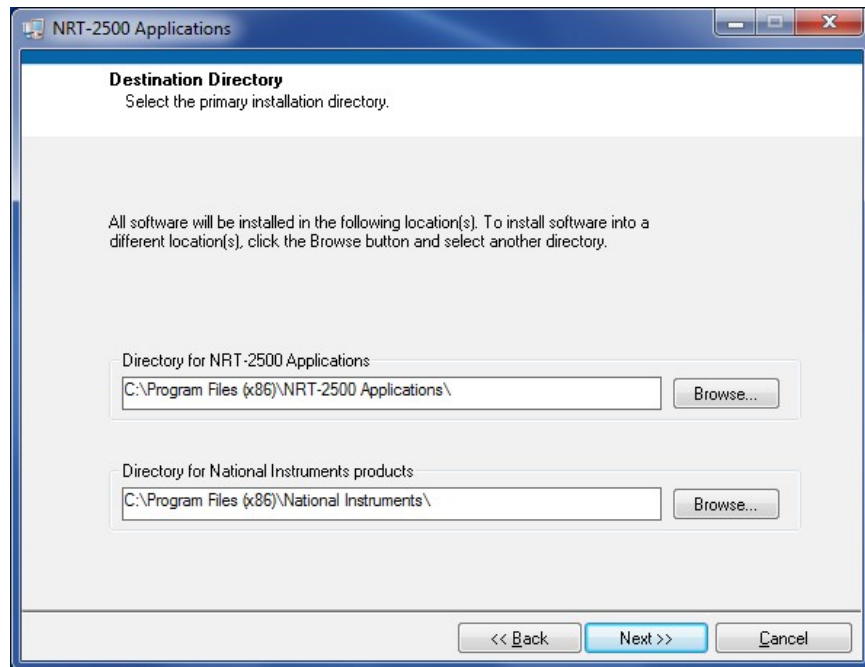


Figure 6: Initial setup screen; Use the default folders or change the folders used for the installation as needed and click NEXT.

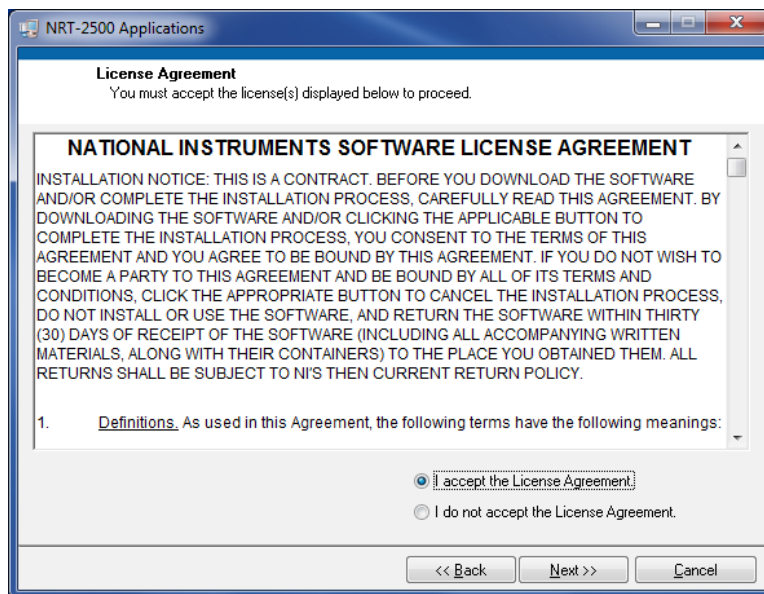


Figure 7: License agreement for National Instruments software. Select “I accept the license agreement” and click on the NEXT button.

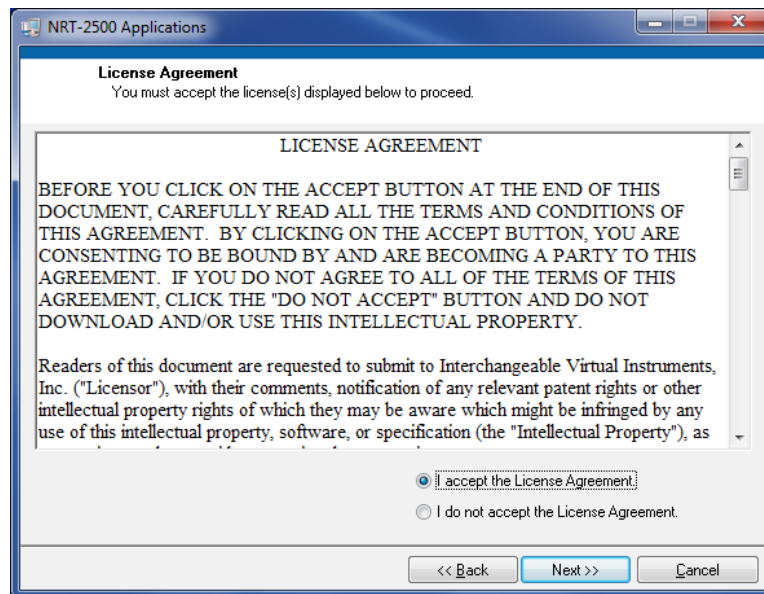


Figure 8: License agreement for the NRT-2500 GUI software. Select “I accept the license agreement” and click on the NEXT button.

Let the installation procedure complete, and follow the instructions on the screen. We recommend to restart your computer before attempting to execute the GUI software. This will ensure that all the software components were properly installed and configured.

3.2 Manual setup

If you choose to install the necessary components yourself, follow the procedure described in Figures 9 through 11.

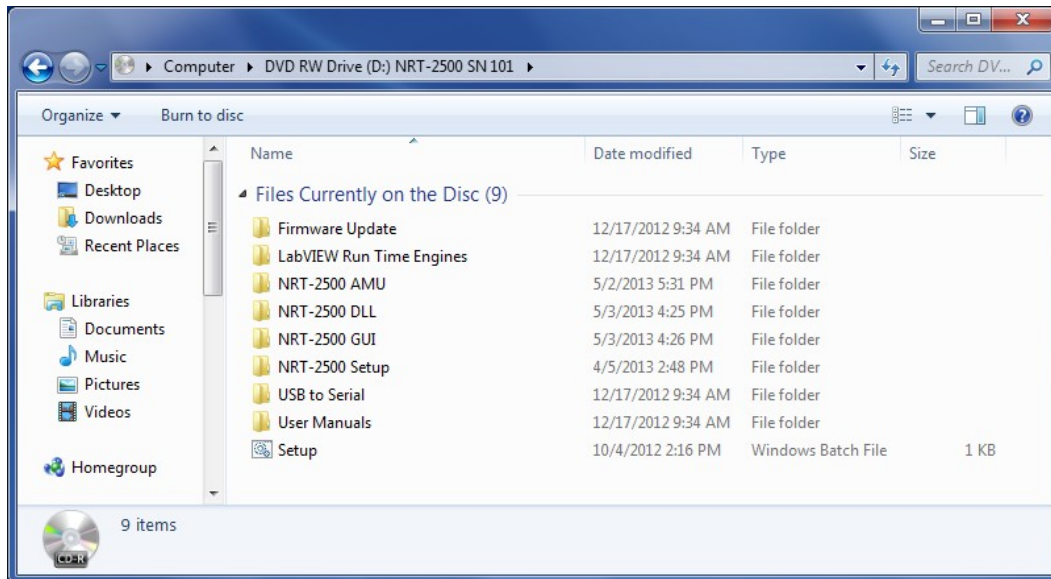


Figure 9: On the NRT-2500 CD you received with the instrument, navigate to the root directory of the CD, and double click on the “LabVIEW Run Time Engines” folder to display its contents.

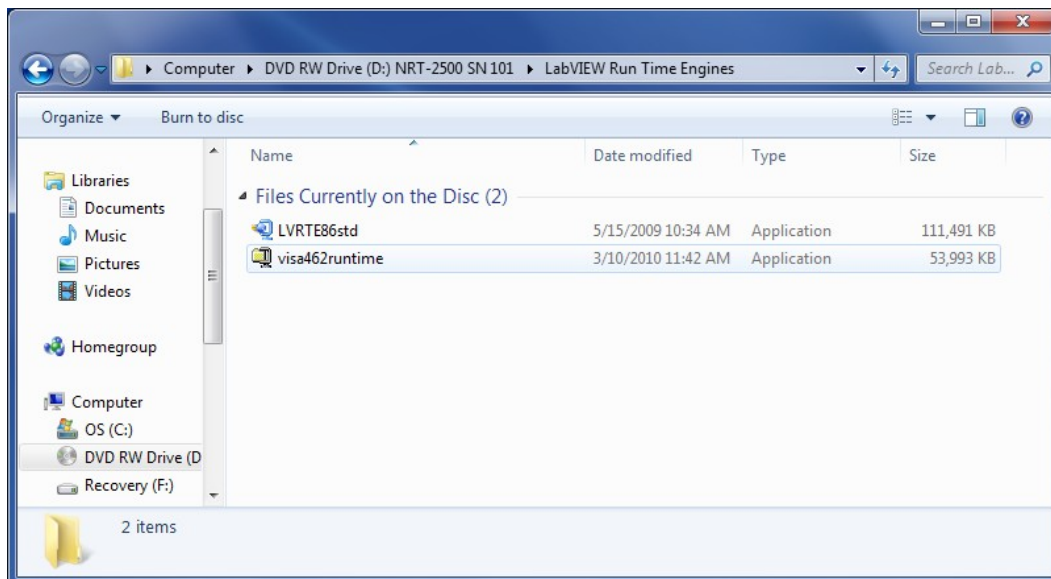


Figure 10: In the “LabVIEW Run Time Engines” Folder, double click on the file LVRTRE86std to install the LabVIEW run Time Engine. Follow the instructions on the screen. When the application is installed, repeat the procedure for the visa462runtime file.

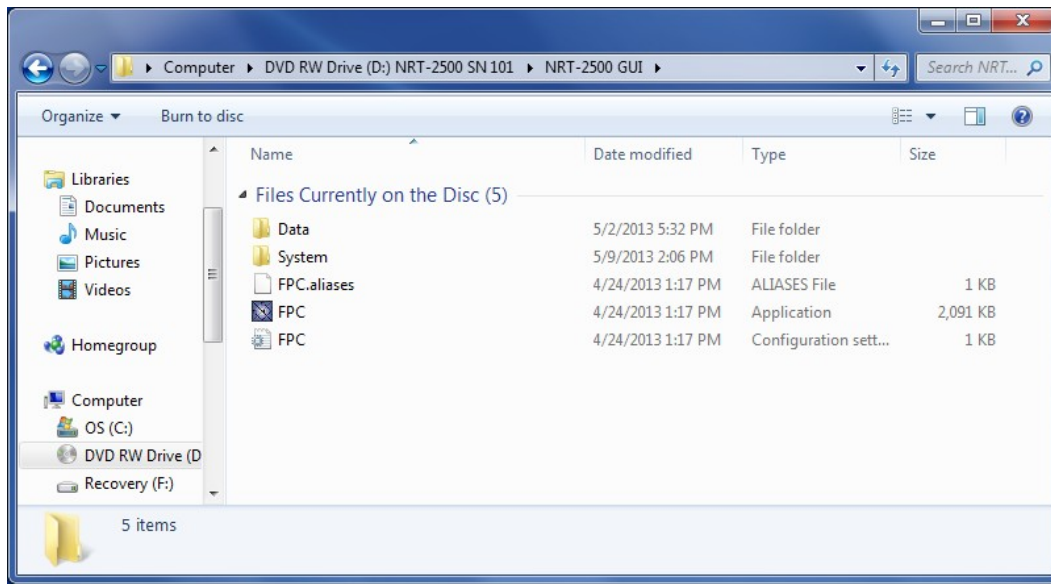


Figure 11: Once both Run Time Engines are installed, navigate to the NRT-2500 GUI folder on the NRT-2500 CD. Copy the entire folder, keeping its exact structure, onto a location on your computer.

Restart your computer. You are now ready to test your NRT-2500 by double clicking on the FPC icon.

4. Connecting to the NRT-2500

Communication and control of the NRT-2500 is done via RS-232. Double click on the FPC icon to load the NRT-2500 GUI. Two windows will open. The first step is to choose the communication port.

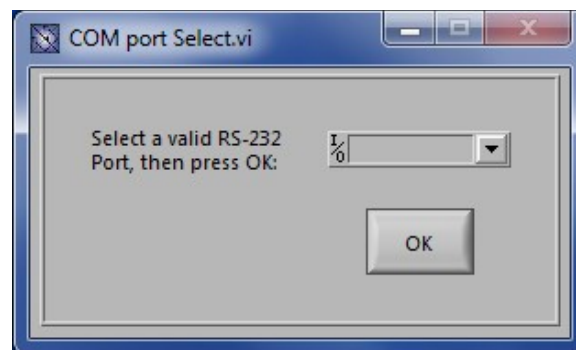


Figure 12: Select COM port - default screen. Press on the arrow to show the available connections (see Figure Figure 13) .

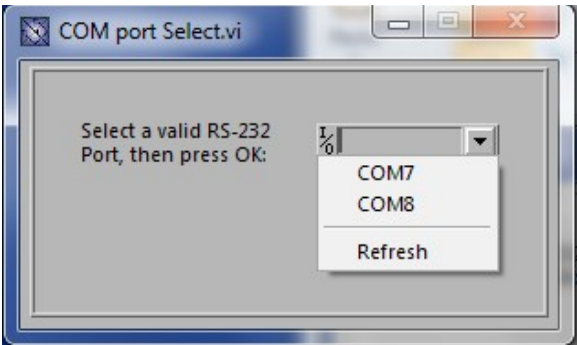


Figure 13: Select the active port from the pull-down menu. If no connections show up, press Refresh to reload the list of available connections. If you still have no available connections, verify that a serial cable is connected between the NRT-2500 and your computer.

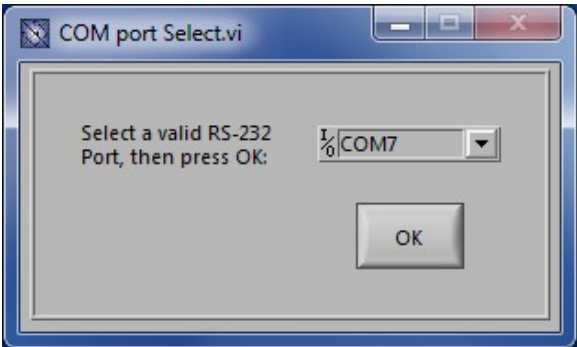


Figure 14: Press OK to select the port and hand-shake with the NRT-2500

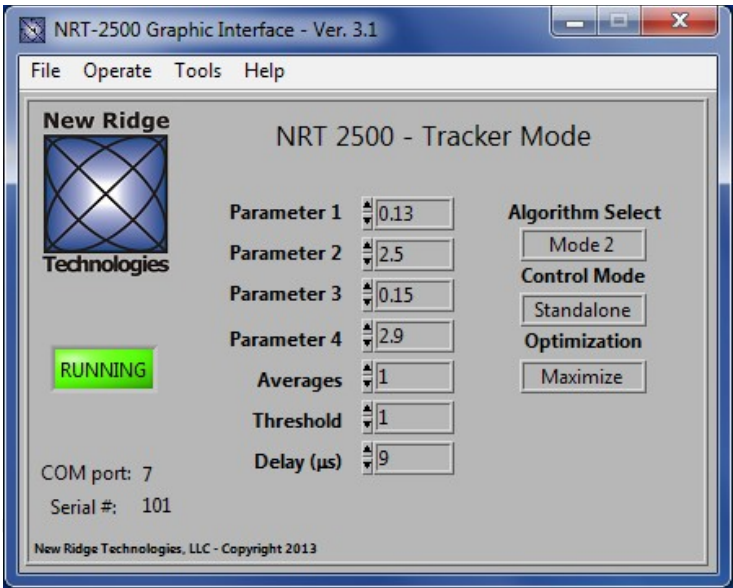


Figure 15: The Default GUI screen – Tracker Mode will show. The NRT-2500 Serial Number and the Com Port in use shown on the left bottom corner will verify serial connection.

5. Modes of Operation

The NRT-2500 has 5 modes of operation. The modes are accessible from the *Operate* menu. The mode of operations are:

- Tracker mode
- Scrambler mode
- Spinner mode
- Randomizer mode
- Paddle mode

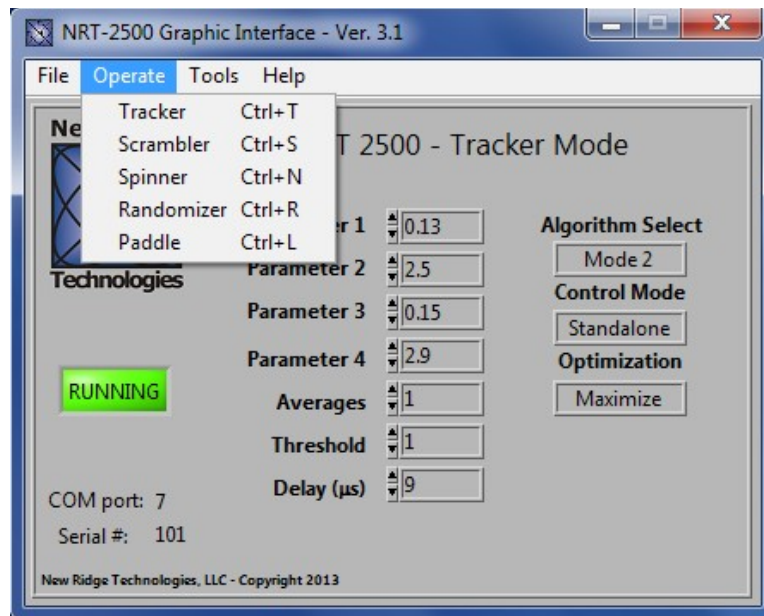


Figure 16: Select the desired mode of operation from the *Operate* pull-down menu.

5.1 Tracker Mode

The default mode upon starting the NRT-2500 is the Tracker Mode (see Figure 15). Tracker Mode has 2 modes of operation; *Mode 1* and *Mode 2*. Toggle between these two modes by clicking on the *Algorithm Select* box. In *Mode 1*, the tracker is using a simple algorithm with only 2 optimization parameters, parameters 1 & 2 (parameters 3 & 4 will be grayed out). In *Mode 2* the tracker is using the NRT proprietary algorithm with all 4 parameters active. Additionally, the user can select **Averages** to set the number of dithers per waveplate update iteration. The **Threshold** is the minimal signal change (in mV) that will result in an update of the control algorithm. And the **Delay** is the time, in μsec , between performing a dither and the measurement of the analog input(s). This parameter depends on the experimental setup, detectors' responses, etc. Under **Optimization**, the user may choose to *Minimize* or *Maximize* the value of the Tracking Error Function (TEF).

Up to two NRT-2500s can be used for tracking. When one NRT-2500 is used, the **Control Mode** should be set to *Standalone*. When two NRT-2500's are used, one should operate as *Master*. The feedback input(s) are connected to the *Master* NRT-2500. The second unit should be set up as the *Slave* in *Control Mode*. A link cable should be connected between the two NRT-2500s (See *Figure 2*).

The operation of the Tracker can be suspended by clicking on the green *Running* indicator. The NRT-2500 will halt execution of the tracking algorithm, and the indicator will turn amber and read *Idle*. Click the amber *IDLE* indicator again to resume the tracking operation. The indicator will return to green and will read *Running*.

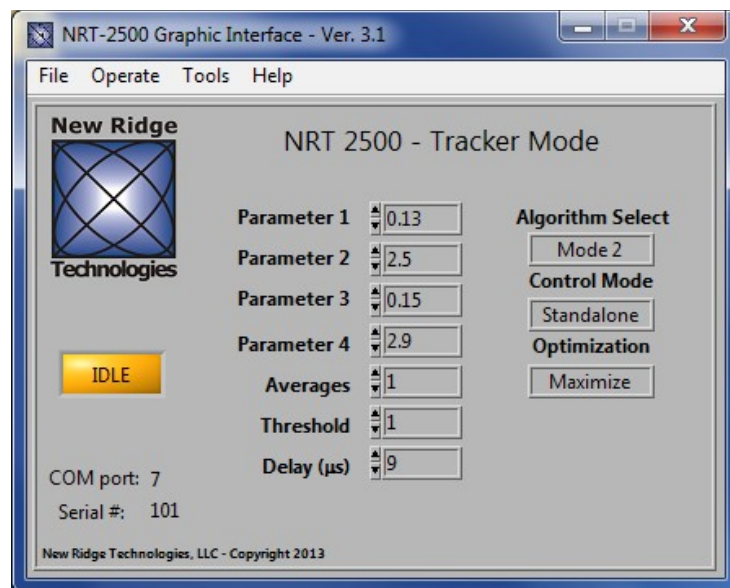


Figure 17: Idle in Tracker mode.

5.1.1 Tracking Error Function (TEF)

The Tracking Error Function converts the analog signals, fed into 1 to 4 BNC inputs on the back of the NRT-2500, into a single feedback signal. The TEF is accessible from the *Tools* menu. The TEF can be edited for different feedback schemes. Different TEF's can be saved and loaded into the NRT-2500 memory. For each feedback scheme, the tracking parameters should be optimized for best operation. The TEF template is very general and flexible allowing the user to realize complicated tracking functions and cover most desired control schemes.

5.1.2 Editing the TEF

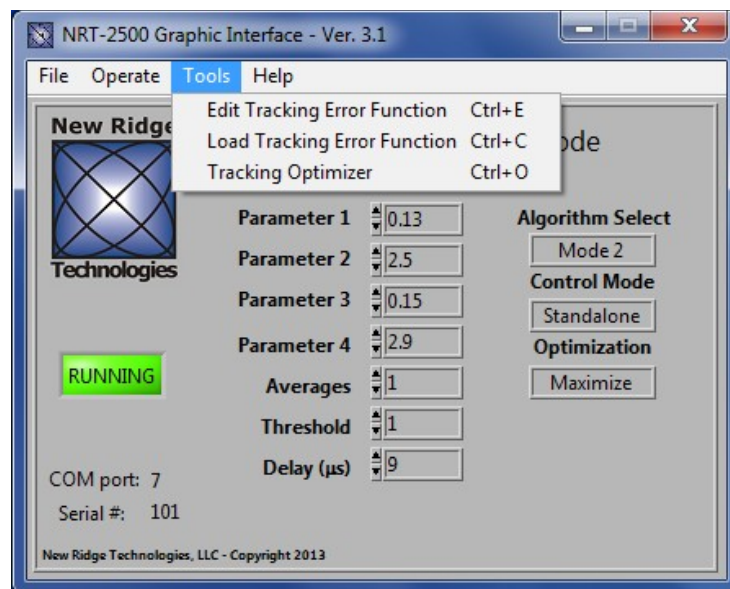


Figure 18: The Tools menu enables editing the Tracking Error Function, loading a Tracking Error Function and executing the automated Tracking Optimizer to find the best 4 tracking parameters.

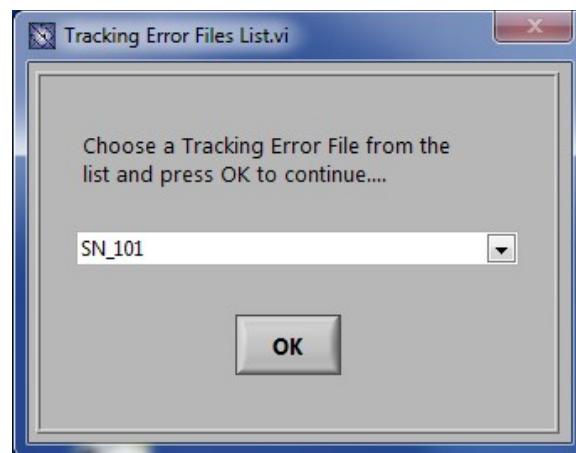


Figure 19: Select the desired TEF file from pull-down list.

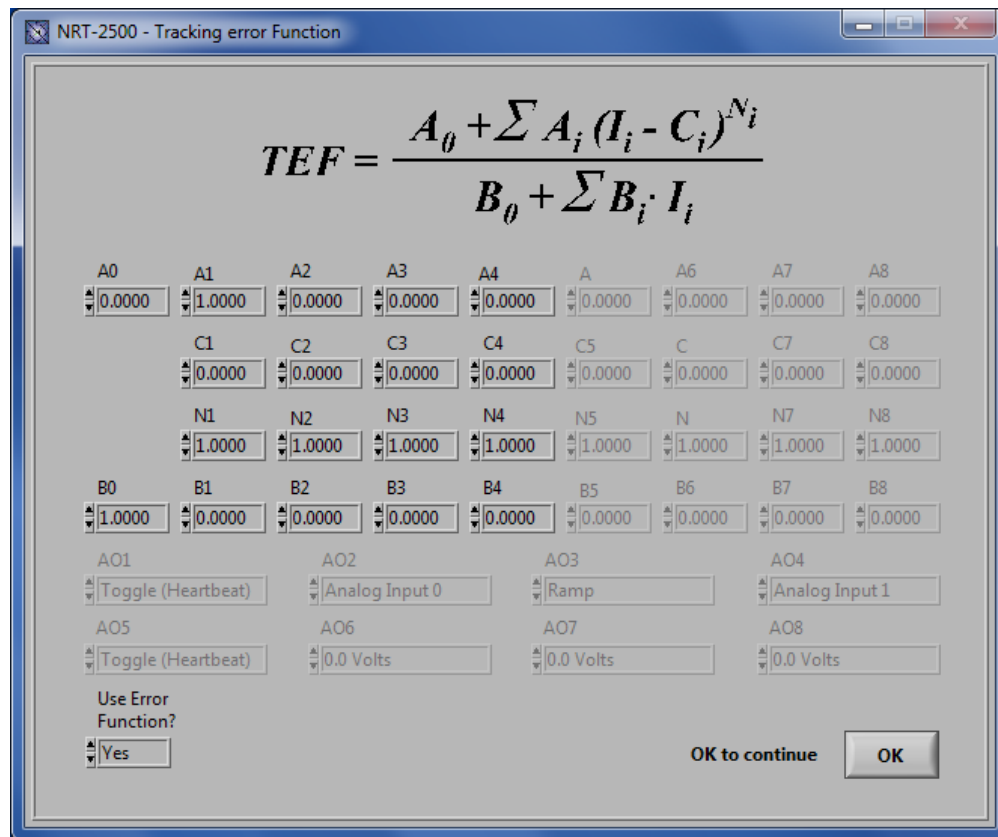


Figure 20: The TEF editor. Change the values of the coefficients A, B, C and N to construct the desired TEF, according to the formula shown at the top of the TEF editor window. Press OK to continue.

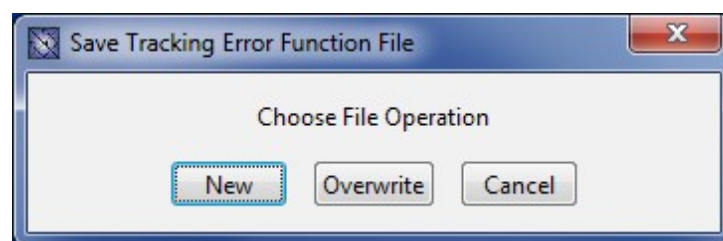


Figure 21: You may now Save the TEF. Save as a NEW TEF, OVERWRITE an existing TEF or choose to CANCEL to return to the main GUI screen.

If you choose to save a NEW TEF file, a new dialog box will show. Type a name for the new TEF file, the file will be automatically saved to the System folder with the .tef extension.

Creating and Saving a TEF does NOT automatically load the TEF into the Tracker's memory. To use the newly created and saved TEF you MUST load the TEF.

5.1.3 Loading a TEF

To load a saved TEF, choose *Load Tracking Error Function* from the *Tools* menu. A dialog box will open. Use the scroll down list to select the desired TEF and press the *OK* button. Once loaded, this TEF will be used whenever the Tracker is operational (until a new TEF is loaded).

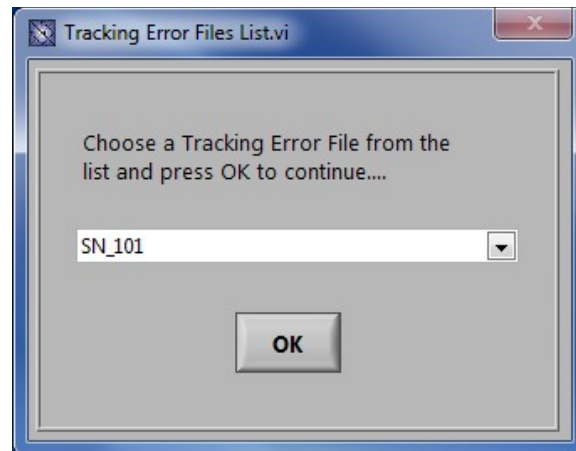


Figure 22: Load the a new TEF from the pull-down list and Press OK.

5.1.4 Tracking Optimizer

The tracking algorithm parameters can be adjusted directly through the GUI. However, adjusting all 4 parameters to optimize the tracking can not be easily achieved. Therefore, the NRT-2500 GUI has a built-in **Tracking Optimizer** that finds the best set of values to use for P1, P2, P3 and P4 using a non-linear search algorithm by minimizing the number of measured tracking errors, as defined by the tracking threshold.

The first step in the optimization procedure is to determine the range of values generated by the TEF with the tracking function disabled for 30 seconds (Auto-Ranging, see Figure 23). After the maximum and minimum values of the TEF are determined, a histogram of the TEF values is calculated and displayed. The histogram window (shown in Figure 26) will be displayed. An accurate measurement of the TEF's histogram is essential for determining the error threshold level. Next the number of samples included in the histogram and the time delay between measurement samples are set. The slower the system changes, the longer the Delay value should be set to ensure all the possible error values are sampled.

The user can also set Lower and Upper limits of the TEF band, TEF min and TEF max respectively. The histogram is always composed of 100 bins. Therefore, when selecting the TEF min and TEF max, the user should select an appropriate band that will not include significant number of bins with frequency of 0. The TEF optimizer procedure is demonstrated, step-by-step, in Figure 23 through Figure 29.

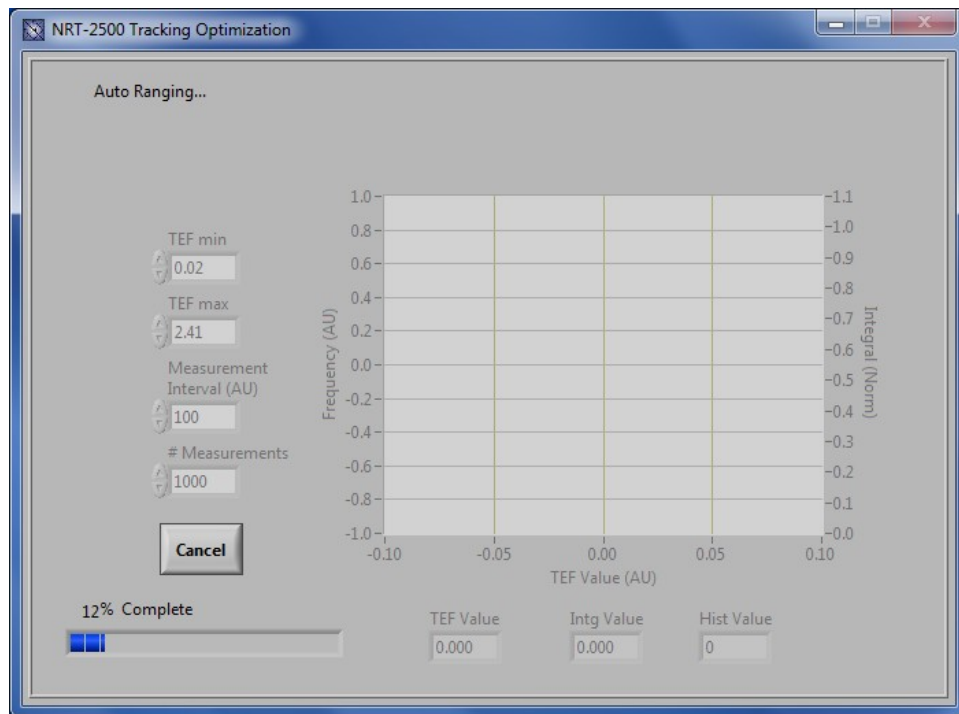


Figure 23: TEF optimizer step 1 – Auto-Ranging.

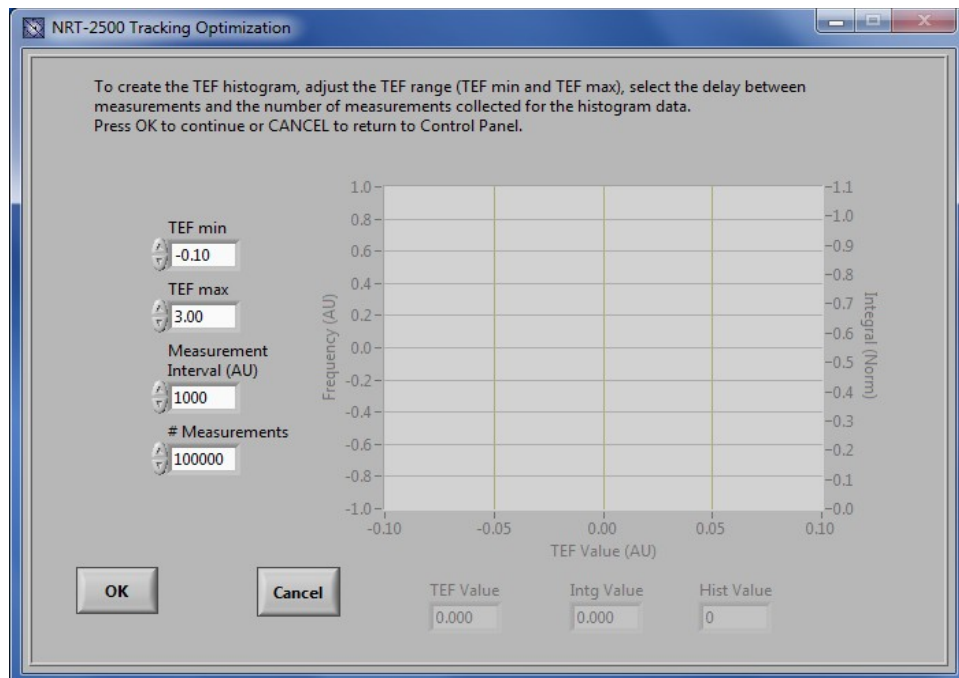


Figure 24: TEF optimizer step 2 – TEF range settings (TEF min & TEF max) and histogram measurement settings (Measurement Interval & number of Measurements).

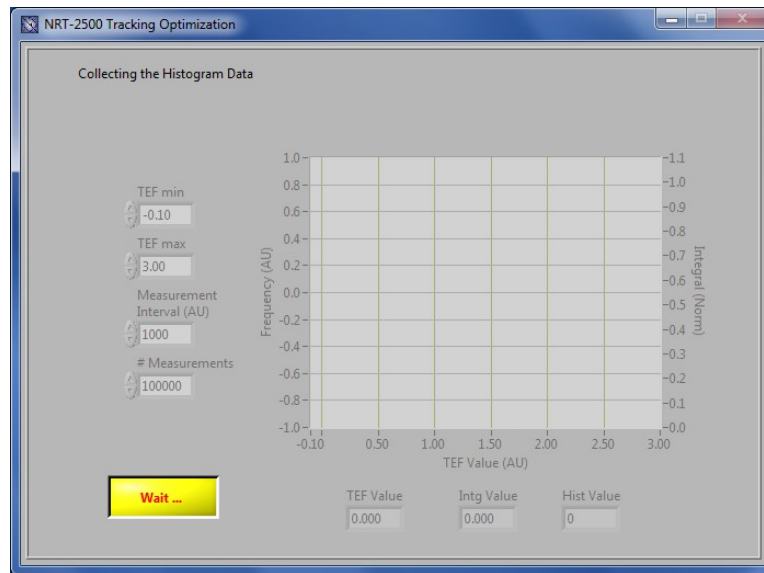


Figure 25: Collecting the histogram data. The Optimizer takes time to complete the measurement. when complete, the histogram will be displayed.

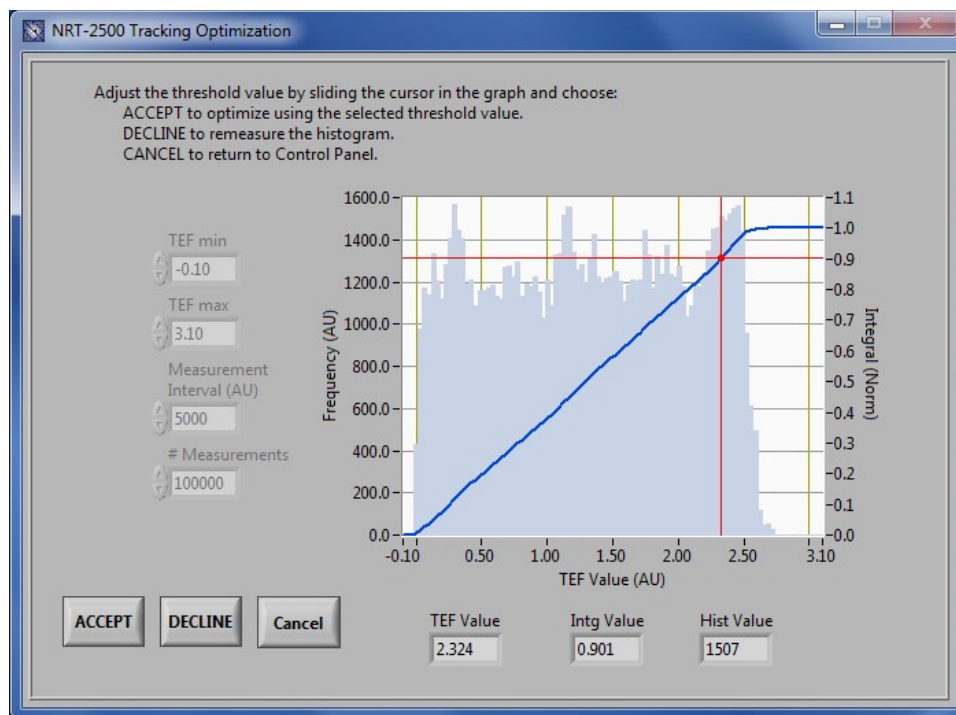


Figure 26: TEF Optimizer step 3 - slide the cursor to select the TEF error-threshold value. The TEF error-threshold value at the cursor location. The Integral Value is the integrated histogram from the minimum TEF to the cursor location, and the Histogram Value is the measured frequency at the cursor location. Press ACCEPT to move on using the selected threshold value.

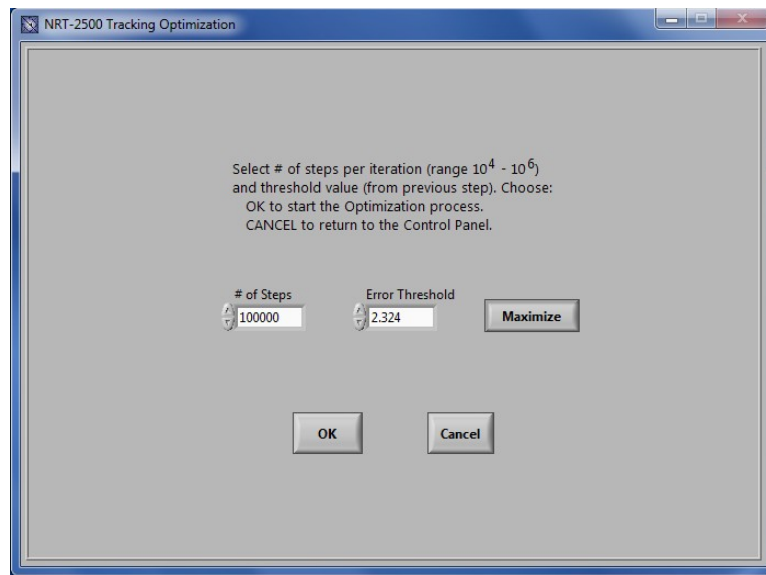


Figure 27: TEF optimizer step 4 - Select the number of steps per optimization trial. Confirm the value of the Error Threshold, select Minimize or Maximize the TEF, and then press OK to start the Optimizer execution.

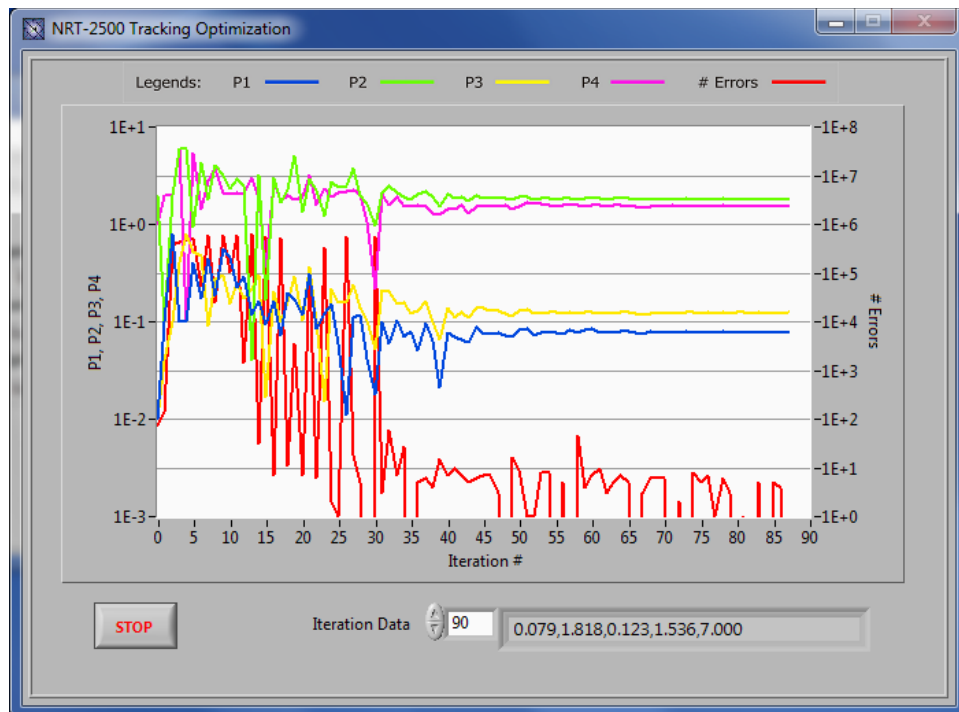


Figure 28: TEF Optimizer step 5 - While the optimizer is running, the set of 4 optimization parameters is displayed together with the number of tracking errors measured. Each iteration value can be viewed in the Iteration Data box. When the values of the 4 parameters reaches the asymptotic value, press STOP to end the Optimizer run.

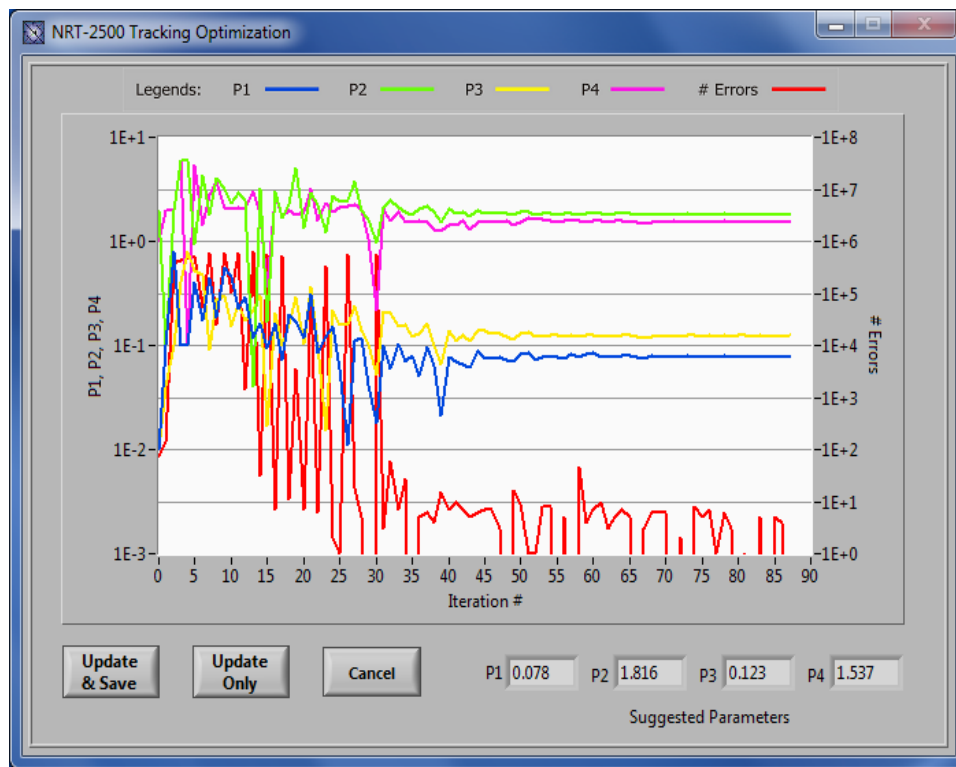


Figure 29: TEF Optimizer step 6 – once the Optimizer execution is terminated, the 4 optimized parameters are shown in the lower right corner of the window. The user may choose between 3 options: 1. Update & Save: update the NRT-2500 memory with the new parameters and save the data to a CSV file, 2. Update Only: update the NRT-2500 memory, or 3. Cancel: ignore the parameters calculated in the optimizer run.

If you choose to save the data file, a dialog window will open. Type a file name and press the OK button. The data will be saved in a comma separated file that can be later opened with Microsoft Excel or similar spreadsheet applications.

5.2 Scrambler Mode

In scrambler mode the NRT-2500 creates SOP changes that follow Rayleigh statistics. The scrambling rate is defined by the rate at the peak of the Rayleigh distribution, R_{mode} . The distribution reaches the asymptotic zero at about $1.2 \times \pi \times R_{mode}$.

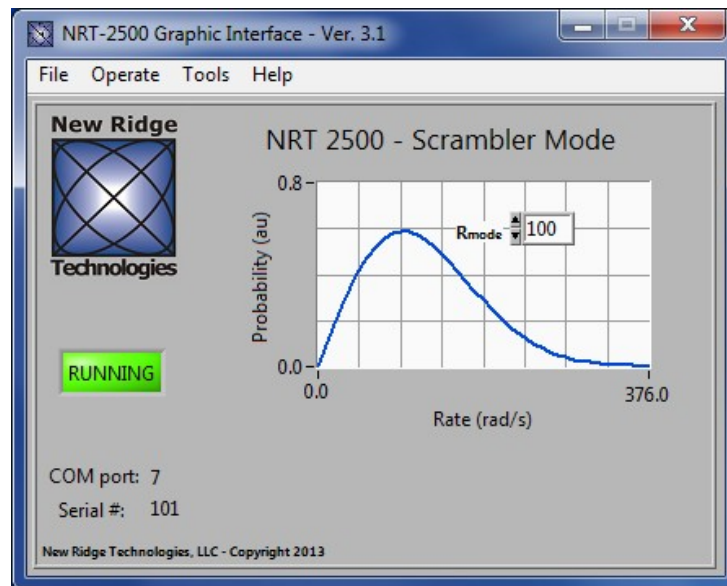


Figure 30: Scrambler mode: Set the scrambling speed by setting the value of R_{mode} . The Rayleigh distribution scales linearly with the value of R_{mode} .

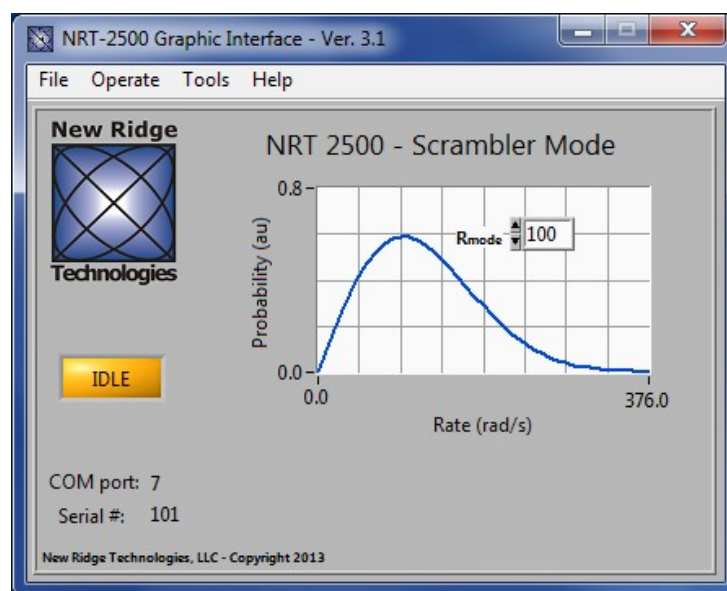


Figure 31: Stop the Scrambler by clicking on the **RUNNING** indicator to **IDLE**. (You may also set the R_{mode} speed to 0 to stop the Scrambler.)

5.3 Spinner Mode

In Spinner mode the NRT-2500 'imitates' the function of a rotating *Half-Wave-Plate* (HWP) inserted between two $\frac{1}{4}$ - $\frac{1}{2}$ - $\frac{1}{4}$ *Polarization-Controllers* (PC's), one at the input of the HWP and one at the output of the HWP. The two PC's are labeled “*Input*” and “*Output*” respectively on the NRT-2500 GUI.

The rotation speed of the SOP (in radians per second) depends on both (1) the rotation rate of the Spinner HWP rotation, and (2) the SOP input to the Spinner's HWP. We define the Spinner's setting by the sinusoidal drive frequency, in Hz. The SOP rotation speed will be maximum for light linearly polarized incident to the driven HWP. (By contrast, if the input to the HWP is circularly polarized, the SOP rotation rate is 0 for any Spinner frequency.) At drive frequency, f [Hz], the maximum angular rotation speed of the electric field is $2\pi f$ and the rotation of the power (about the equator of the Poincaré sphere) is $4\pi f$. The table below has conversions for common (maximum) SOP rotations, rad/sec, and Spinner settings, f .

NRT-2500 Spinner Setting [kHz]	Maximum E-field rotation (in real space) [rad/sec]	Maximum Power Rotation (Equator of Poincaré sphere) [rad/sec]
f	$= f \times 2\pi$	$= f \times 4\pi$
1	6.3	12.6
8	50	100
40	250	500
80	500	1,000
199	1,250	2,500
398	2,500	5,000
796	5,000	10,000
1,989	12,500	25,000
3,979	25,000	50,000
5,968	37,500	75,000
7,958	50,000	100,000
15,915	100,000	200,000
23,873	150,000	300,000
31,831	200,000	400,000
47,746	300,000	600,000
63,662	400,000	800,000
75,000	471,239	942,478

To set the Spinner frequency, change the *Frequency* value within the allowed range of 0 to 75,000 Hz. Next use the *Output* PC to change the orientation of Spinner's rotation trajectory. (Most commonly, the Spinner's rotation trajectory is parallel to the equator of the Poincaré sphere.) Then set the elevation of the Spinner's rotation along the axis of rotation by adjusting the *Input* PC. (Most commonly the The

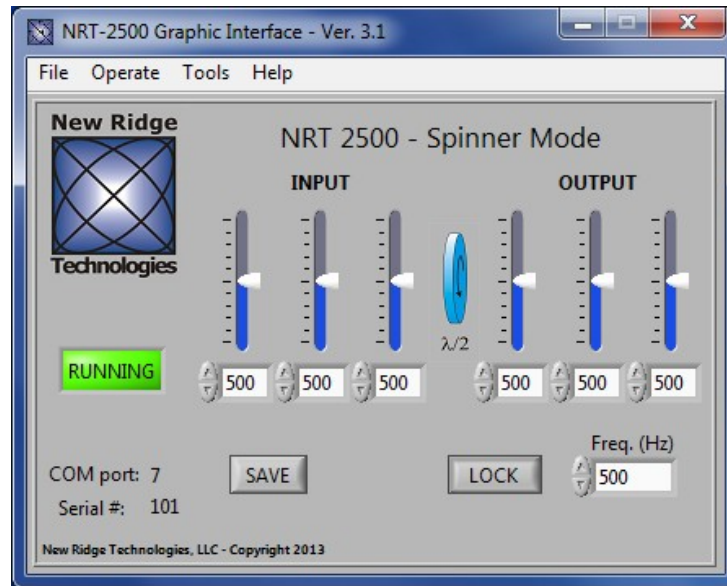


Figure 32: Spinner mode: From the default GUI screen the user can control the spinner speed, the HWP trajectory elevation and orientation, and can set the NRT-2500 to Idle.

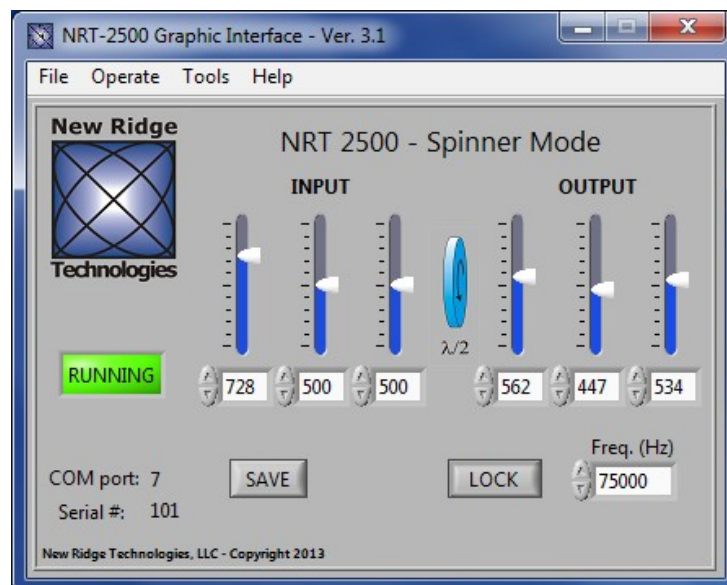


Figure 33: Change the input polarization controller to set the spinner trajectory elevation, and the output polarization controller to set the spinning orientation. Changing the frequency will not affect the above settings

spinner's rotation trajectory is raised or lower to coincide with the equator of the Poincaré sphere. This is the state when the input to the HWP is linear.) You may drag the sliders, click the up/down arrows or type values for each of the wave-plates in the input and output PCs to bring the trajectory to the desired configuration. You may toggle the RUNNING indicator to IDLE to halt the Spinner's rotation.

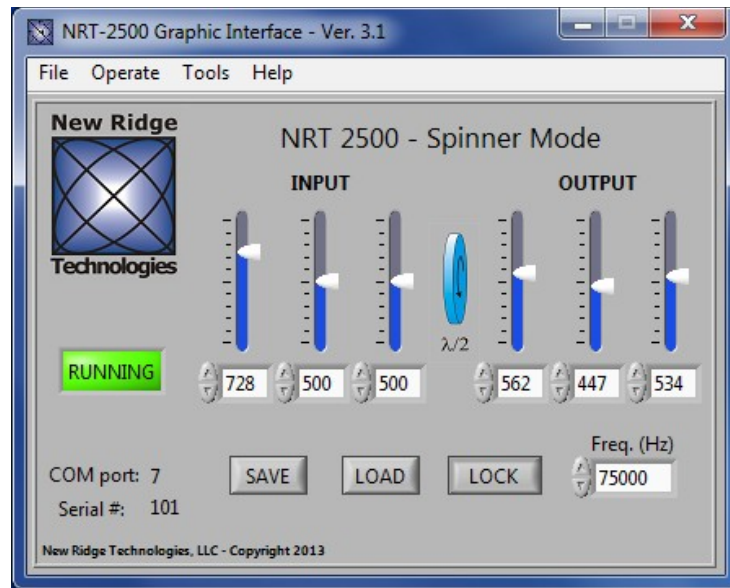


Figure 34: Pressing the SAVE button will store the settings of the input and output polarization controllers. Once you press SAVE, a LOAD button will appear.

When the desired orientation and elevation of the HWP trajectory is achieved, press the *SAVE* button to store the PC's locations in the NRT-2500 memory. A new button will appear: the *LOAD* button. You may now change the PCs to change the HWP trajectory. Pressing the *LOAD* button will load the saved position and reorient the HWP trajectory to the saved settings.

Use the *Lock* button to disable the PC's. The *Save* and *Load* buttons will disappear, the *Lock* button will turn into an *Unlock* button and the *Drift* settings will appear. The drift option will continuously change the HWP trajectory. Click on the drift box to select from 4 drift options:

1. None – No drift.
2. Along SpinAxis – drift the HWP trajectory elevation; the spinning speed varies with the elevation. (Using only the input PC.)
3. Rotate Spin Axis – drift the HWP trajectory orientation; the spinning speed stays constant. (Using only the output PC.)
4. Both – Change both the elevation and orientation of the HWP trajectory.

Press the *Unlock* button to go back to the settings shown in Figure 34.

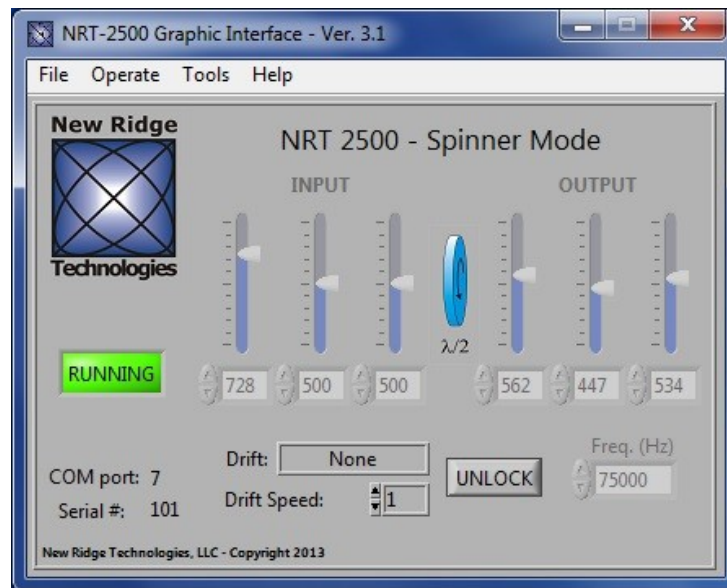


Figure 35: Pressing the LOCK button will disable the polarization controllers settings. The LOCK button will be replaced by the UNLOCK button. The Drift setting will appear where the SAVE and LOAD buttons used to be. The user can select the drift mode and the drift speed (uncalibrated drift speed 1-10, where 1 is the slowest drift and 10 is the fastest drift).

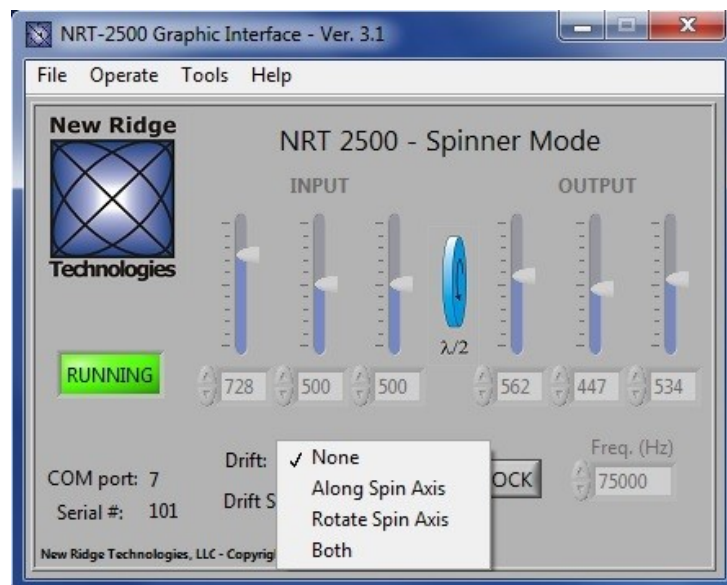


Figure 36: Drift modes: 1. None – no drift, 2. Along spin axis – the trajectory elevation will change, the spinning speed varies with the elevation, 3. Rotate Spin Axis – the trajectory orientation changes while the spinning speed is constant, 4. Both – both the trajectory orientation and elevation will change.

5.4 Randomizer Mode

In Randomizer mode, a sudden, arbitrary change of the SOP is made. There are two modes of operation:

1. Internal Trigger – An SOP change will occur automatically every N microseconds, where N is the value set by the *Dwell time*. *Dwell time* can receive values between 200 and 32,000,000 microseconds (see Figure 37).
2. External Trigger – An SOP change will occur every time the signal on the analog input, selected in the *Trigger Source*, crosses the *Threshold* value set by the user (see Figure 38).

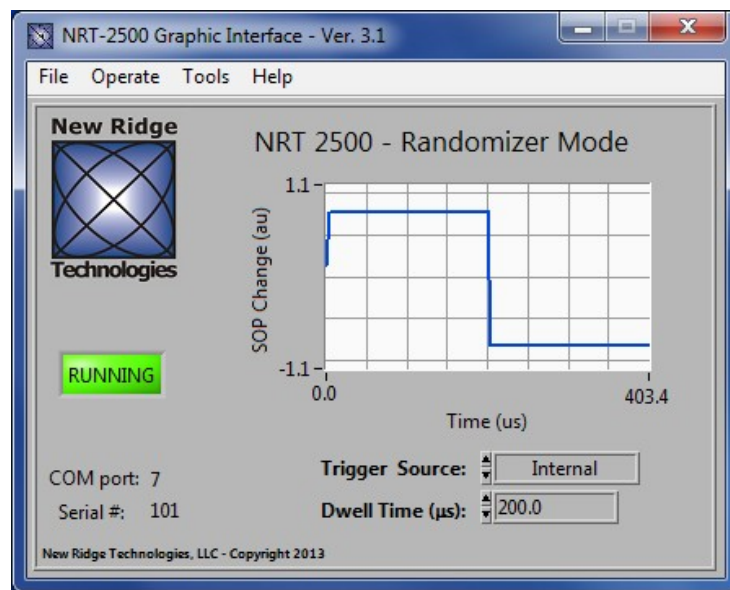


Figure 37: Randomizer - internal trigger mode of operation. The user can change the time between SOP changes (the Dwell time).

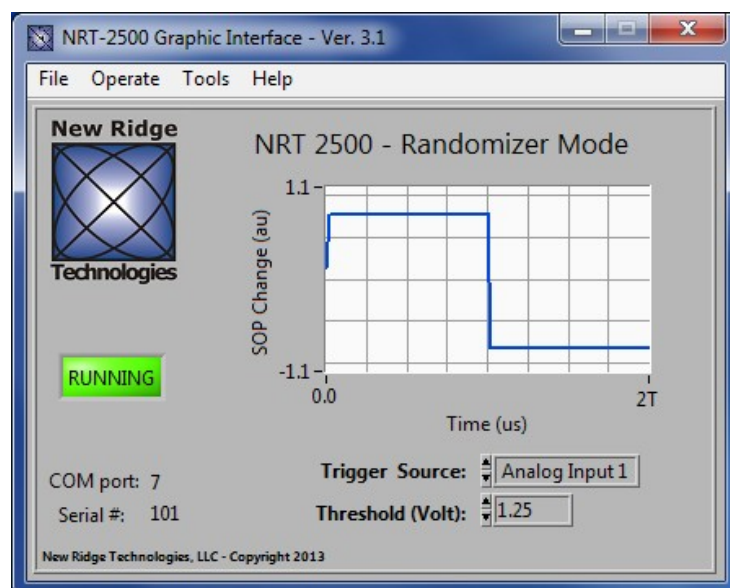


Figure 38: Randomizer - external trigger mode of operation. The user should connect an external trigger source to one of the four analog inputs on the back of the NRT-2500, and set the threshold for SOP trigger.

5.5 Paddle Mode

In Paddle mode the NRT-2500 serves as a manual polarization controller. The SOP change is achieved by changing the 5 available sliders, or changing the value of each slider to a value between 0 and 1000, corresponding to 0 and 2π respectively. The polarization controller is based on a $\frac{1}{4}$ - $\frac{1}{4}$ - $\frac{1}{2}$ - $\frac{1}{4}$ - $\frac{1}{4}$ wave-plate configuration.

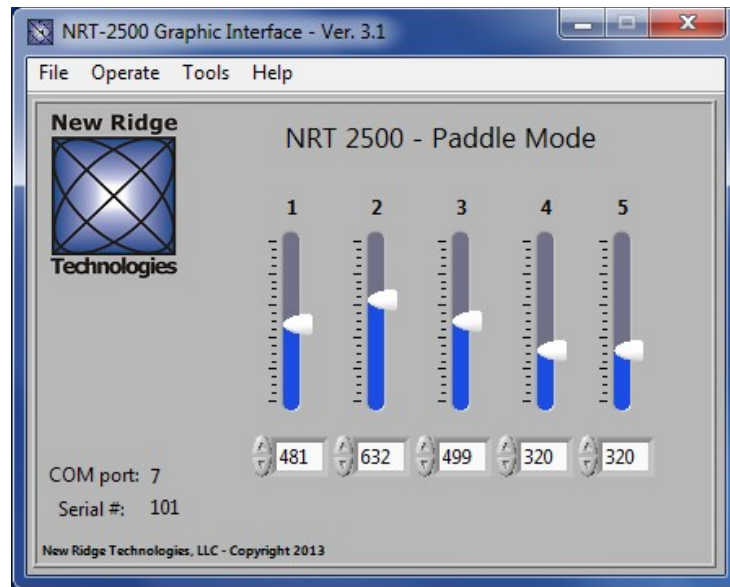


Figure 39: Paddle Mode – Polarization controller in a $\frac{1}{4}$ - $\frac{1}{4}$ - $\frac{1}{2}$ - $\frac{1}{4}$ - $\frac{1}{4}$ wave-plate configuration.

5.6 Depolarizer Mode

In Depolarizer mode the NRT-2500 scrambles the light in a very high speed while uniformly covering the Poincare Sphere. dSOP/dt changes faster than 2,000,000 rad/s can be detected, however, the distribution is not a Rayleigh distribution.

6. File Menu

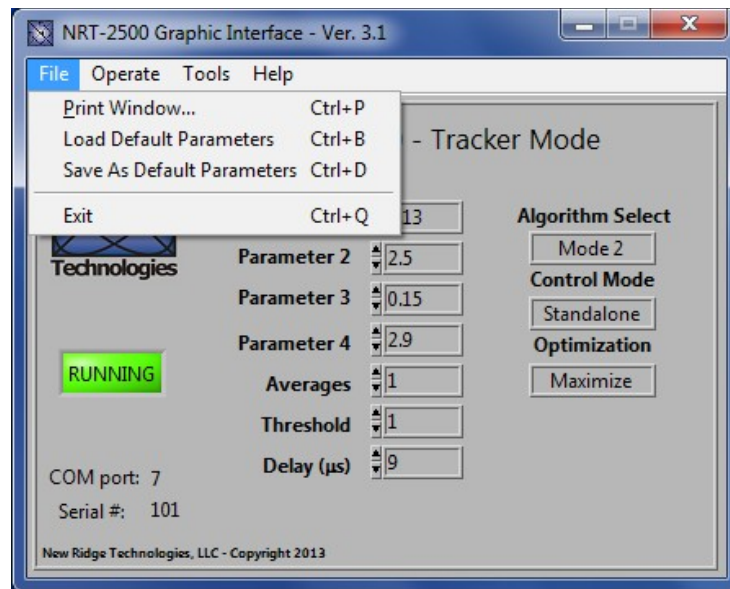


Figure 40: File menu – The user can print the window, Load Default Parameters, Save Default Parameters and Exit the application.

7. Help Menu

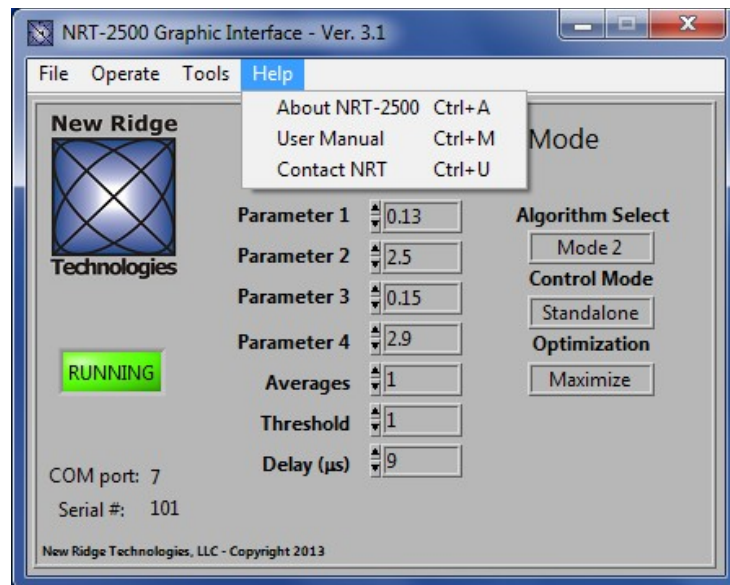


Figure 41: Help menu – contains (1) About NRT-2500, (2) a short reference User manual and (3) an automated e-Mail to New Ridge Technologies for support purposes.

7.1 About NRT-2500

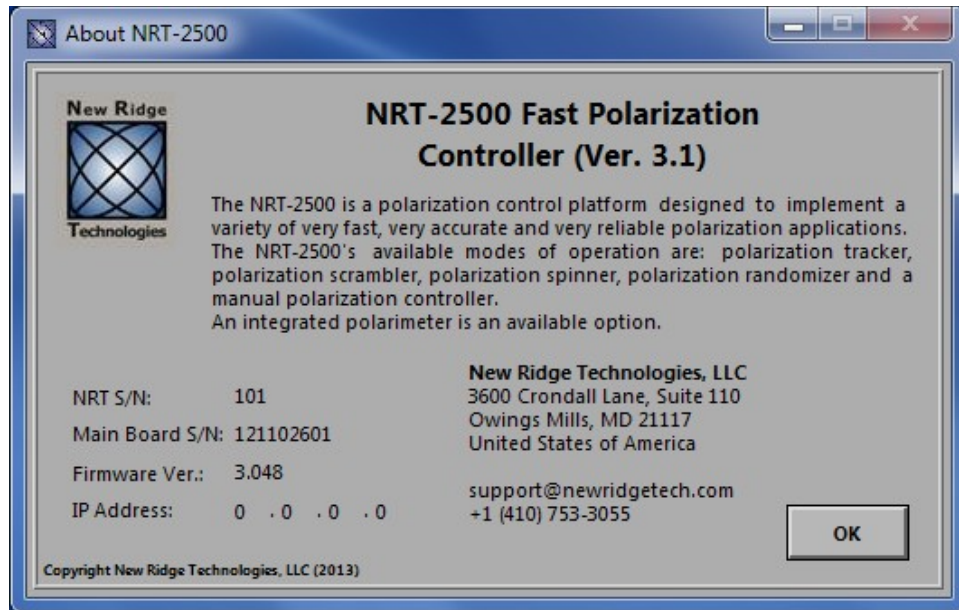


Figure 42: About NRT-2500 – a short description of the NRT-2500 together with information specific to the unit in use: the unit serial number, main board serial number, firmware version, IP address (if the Ethernet cable is connected), and New Ridge Technologies contact information.

7.2 Short User Manual

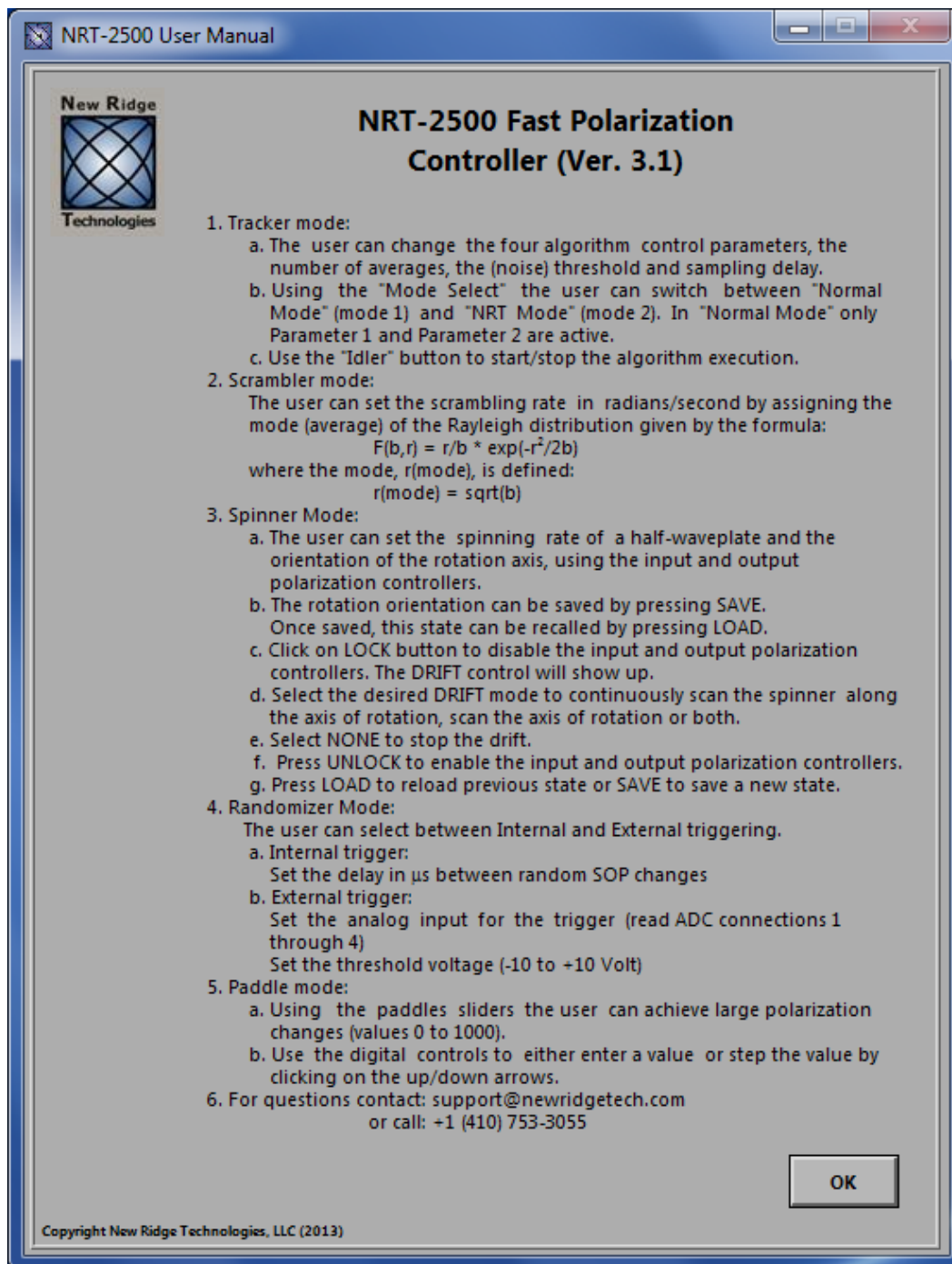


Figure 43: Short reference NRT-2500 User Manual form of the user manual, describing each mode of operation and the options available in each mode.

8. NRT-2500 Automation

This section is for NRT-2500 automation using the optional DLL software commands.

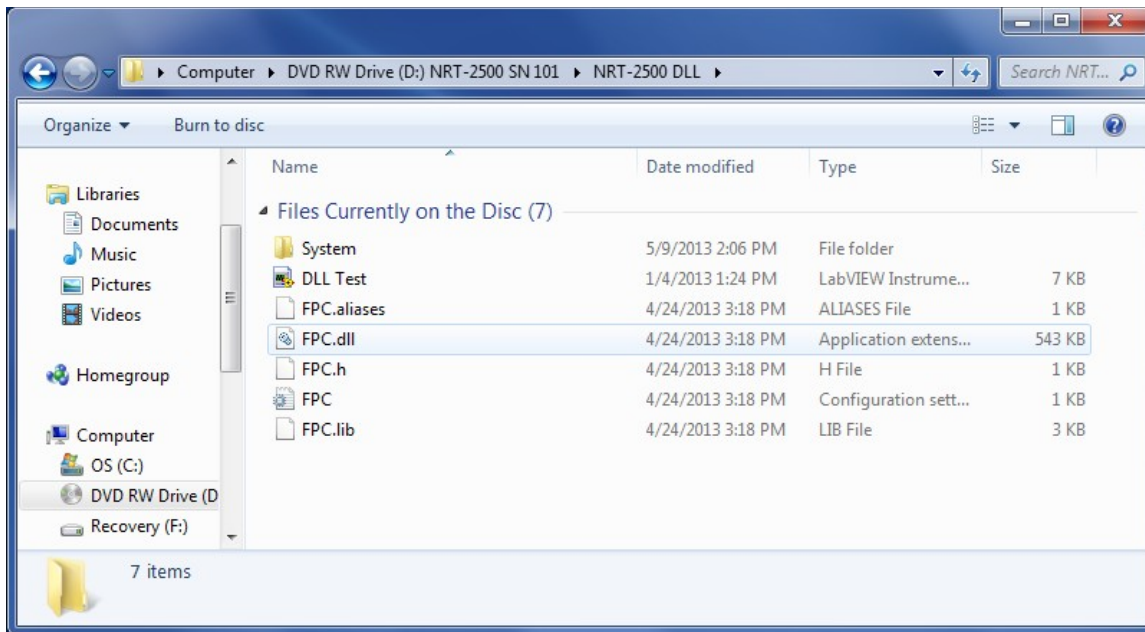


Figure 44: The automation DLL folder

8.1 DLL Purpose

The NRT-2500 driver allows the user to control the Polarization Controller using applications such as C, C++, LabWindows/CVI, Visual C++, Visual Basic etc. The user can access all the modes of operation: Polarization Tracking, Scrambling, Spinner, Randomizer and Paddles. A status command allows the user to read the current mode and control parameters.

8.2 Before You Start

Before attempting to use the driver, copy the content of the *NRT-2500 DLL* folder from the software CD to your computer. Make sure to copy your saved Tracking Error Function (extension .tef) file saved with your GUI System folder to the NRT-2500 DLL *SYSTEM* folder. There may be more than one file with the extension TEF for different tracking configurations, make sure to copy the version you want to use for your application and the unit you are going to use.

8.3 Calling the DLL from LabVIEW

The following paragraph shows the required steps in order to use the DLL in LabVIEW:

1. While editing your LabVIEW application block-diagram, go to the **Functions palette** and select the **Connectivity - Libraries & Executables** tab. Click on the **Call Library Function Node** (see Figure 1a). The library node shown in Figure 45(b) will show up on the Block-Diagram.

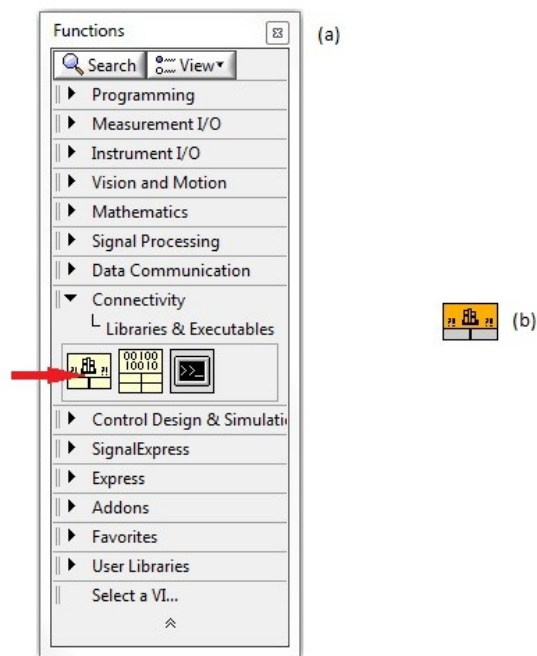


Figure 45: Selecting an external library from the Function palette.

2. Point your cursor on the library node, click on the Right mouse button and select **Configure** (see Figure 46). Enter the Library name or path by browsing to the library folder, and select the Function name from the scroll-down list. Select the thread option; Select **Run in UI** if you call only a single instance of the DLL. If you want to call the DLL more than once simultaneously, select **Run in Any Thread**. Press the **OK** button to continue.

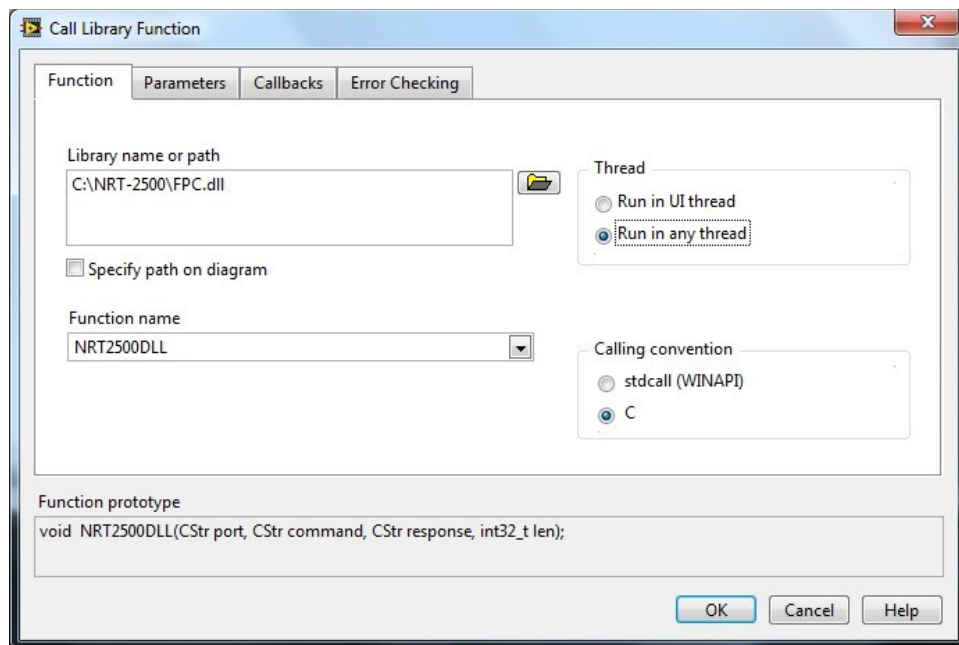


Figure 46: Setting up the parameters for calling the Library Function.

3. The driver is now configured to work in LabVIEW. The icon on the Block-Diagram will change and show all the connectors required for the proper operation of the driver (see Figure 47). The controls and indicators can now be created as shown in Figure 48.



Figure 47: The configured driver icon, showing all the connectors, as seen on the block diagram.

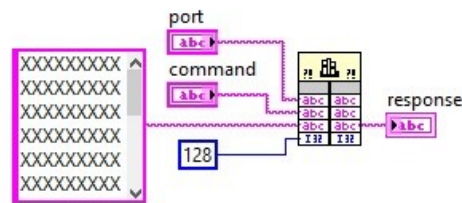


Figure 48: The driver connector diagram as it will show in LabVIEW. The 4 inputs are on the left and the 4 outputs are on the right. The port (top left) is a string (for example COM5). The command input is also a string, The next input is a constant, length of 128 (the X's string constant in this case) and the last input is a 32-bit integer (set to 128 in this example). The only connected output is the response (string). Any response from the device will be directed to this output.

8.4 List of Commands

All the commands are case independent. When a command is followed by an argument, a colon (:) is used as a delimiter. When more than one argument is sent, a comma (,) is used as a delimiter. A command can be entered in full, including all of the associated control parameters, or with only a partial parameters list. When skipping a control parameter, an extra comma has to be used, as shown in the following example:

COMMAND:P1,P2,P3

will set parameters 1 through 3, while:

COMMAND:P1,,P3

will set only parameters 1 and 3, parameter 2 will remain unchanged.

When entering only the **COMMAND**, without any control parameters, the unit will set the new mode of operation restoring the last set of control parameters used. If the mode was not in use before, a default set of parameters will be used. Use the **STATUS** command to read the mode of operation, including all the control parameters.

8.4.1 General commands

INIT Initial hand-shake. The command will initialize the device, set the communication parameters, and execute a command mode to set the device in tracker mode using default parameters.

CLOSE Terminates the communication.

STATUS Returns the unit status, mode and parameters in syntax identical to the command syntax.

IDLE Idle Mode. The unit will stay in stand-by until a new command is initiated. If only the command name is sent, the unit will resume the mode of operation with the last set of parameters used (or the default parameters if the command was not used before). Sending a command including all the parameters for the command will initiate the new mode.

8.4.2 Tracker Mode Commands

TRCKR Tracker Mode syntax:

TRCKR:*Algorithm,P1,P2,P3,P4,Averages,Threshold,Delay*

<i>Algorithm</i>	1 = General tracking using P1 and P2 only. 2 = NRT proprietary algorithm using P1 through P4.
<i>P1-P4</i>	Algorithm parameters values.
<i>Averages</i>	Number of averages per update.
<i>Threshold</i>	Threshold value in mV.
<i>Delay</i>	Time delay in μ s.

LDPAR Load all default parameters from the non-volatile memory.

SAVPAR Save the current parameters as the default parameters in the non-volatile memory.

LDTEF Load a Tracking Error Function file from the **System** folder. A new error function evaluation will start. A new TEF file can be generated only through the Graphic User Interface.

LDTEF:*FileName*

FileName File name only, with no extension.

8.4.3 Spinner Mode Commands

SPINR Spinner Mode syntax:

SPINR:*Speed,P1,P2,P3,P4,P5,P6,DF,DB,DS*

<i>Speed</i>	rotation in kHz, 0.001 to 75 kHz. When setting a speed, the controller will default to the closest value possible.
<i>P1-P3</i>	polarization controller at the spinner input, a set of $\frac{1}{4}$ - $\frac{1}{2}$ - $\frac{1}{4}$ waveplates, value 0-10000
<i>P4-P6</i>	polarization controller after the spinner, a set of $\frac{1}{4}$ - $\frac{1}{2}$ - $\frac{1}{4}$ waveplates, value 0-10000

DF	drift along spin axis, when set to 0 the drift is set to OFF (default), when set to 1 drift is set to ON. The drift setting will take effect only when the speed drift is non zero (see DS parameter).
DB	Rotate the spin axis, when set to 0 the drift is set to OFF (default), when set to 1 drift is set to ON. The drift setting will take effect only when the speed drift is non zero (see DS parameter).
DS	drift speed, the default is 0 (no drift). In order to start a drift set the value of this parameter to a value between 1 and 10, where 1 is slow drift and 10 is fast drift. At least one of the parameters DF and DB has to be non zero for a drift to start.

STPDRFT Stop spinner drift:

The spinner drift will stop, the SOP will continue to spin at the set speed value with the orientation locked to the state the drift was stopped at. Use the STATUS command to read the paddles positions.

8.4.4 Scrambler Mode Commands

SCRMBL Scrambler Mode syntax:

SCRMBL:*Speed*

Speed The scrambler mode follows the Rayleigh distribution. The scrambling speed is defined as the speed at the peak of the Rayleigh distribution, in radians per second (value 1-3400).

8.4.5 Randomizer Mode Commands

RAND Randomizer Mode syntax:

RAND:*Mode,Trigger*

Mode 0 = Internal trigger
1 - 4 = External trigger, trigger source is the analog input corresponding to the number entered as *source*.

Trigger for Internal Trigger, *Trigger* value is the time delay between generated SOP changes. The delay is measured in microseconds, and the range is 200-32000000.
For External Trigger, *Trigger* value is the voltage of the externally applied signal at which a new SOP will be generated.

8.4.6 Paddle Mode Commands

PADLS Paddle Mode syntax:

PADLS:*P1,P2,P3,P4,P5*

P1,P2,P4,P5 $\frac{1}{4}$ wave plate, value 0-10000

P3 $\frac{1}{2}$ wave plate, value 0-10000

8.4.7 Depolarizer Mode Commands

DEPOL Depolarizer mode command

The depolarizer will start operating

8.5 Driver usage

The driver has 4 inputs: port (string), command (string), response (string) and length (int32). In the Input side the response should be set to an empty string, and the length to 50 characters, in order to allow for the whole response string to be read from the driver. See Figure 4 for a graphical illustration.

The driver has 4 outputs corresponding to each one of the 4 inputs. Only the response output is used in the driver output. All communications from the controller to the computer will be received through the response output (see Figure 4).

The calibration files should be placed in a folder named *SYSTEM* at the same location as the driver software. Failing to do so will result in error.

The INIT command should be sent first to initialize the communication with the controller, and set it at the tracking mode with the default parameters.

The CLOSE command closes the communication with the controller and releases the communication port.

The INIT command should be used once at the beginning of the process. The CLOSE command should be used once at the end of the process.

Issue the Mode Command for the mode you would like to set. At the end of the mode command execution the controller will response with a string stating the mode that was executed. Use the STATUS command to check the mode status, including all the mode parameters.

9. Updating the NRT-2500 Memory

The NRT-2500 calibrations are saved in the internal nonvolatile memory of the unit. However, in the rare cases that the internal memory becomes corrupted or erased, the NRT-2500 memory update procedure should be executed, using the Automatic Memory Update (AMU) program found on the NRT-2500 software CD. Navigate to the NRT-2500 AMU folder and execute the FPC-AMU.exe application.

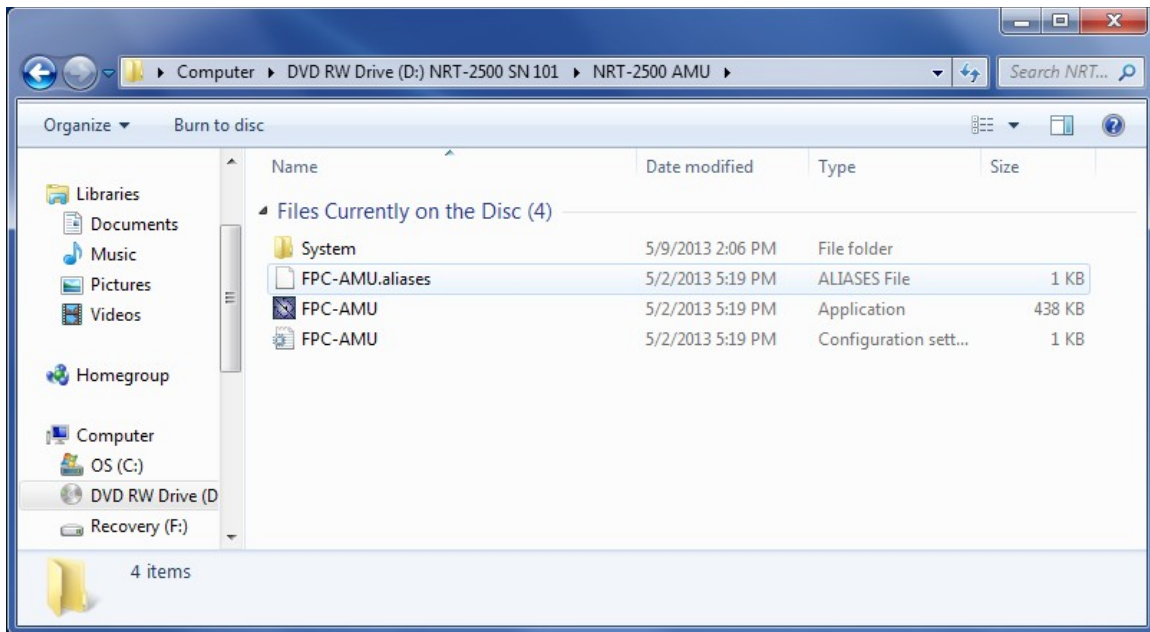


Figure 49: The AMU folder on the NRT-2500 software CD.

Executing the AMU software will require connecting the computer to the NRT-2500. Select the COM port in use and press OK.

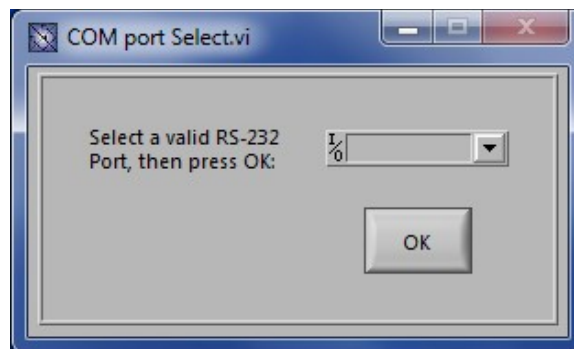


Figure 50: Select COM port.

The AMU program will load the calibration to the NRT-2500; a progress bar will indicate the execution progress. When the update has been completed, the program will automatically close.

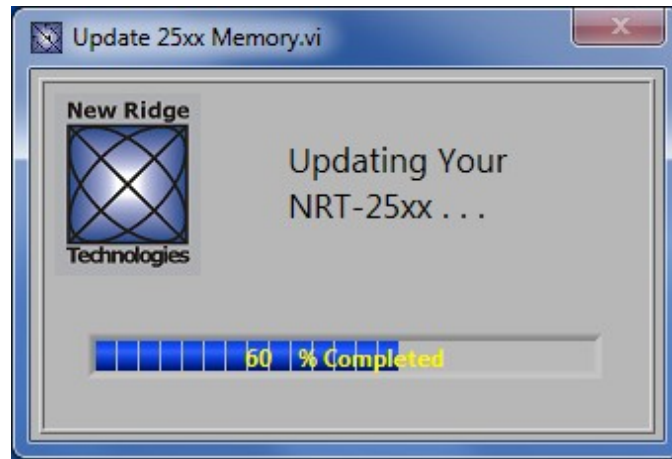


Figure 51: The AMU interface, the progress bar indicates the execution progress.

10. Firmware Update

Follow the steps below when a new firmware version is available from New Ridge Technologies or to recover from a failure.

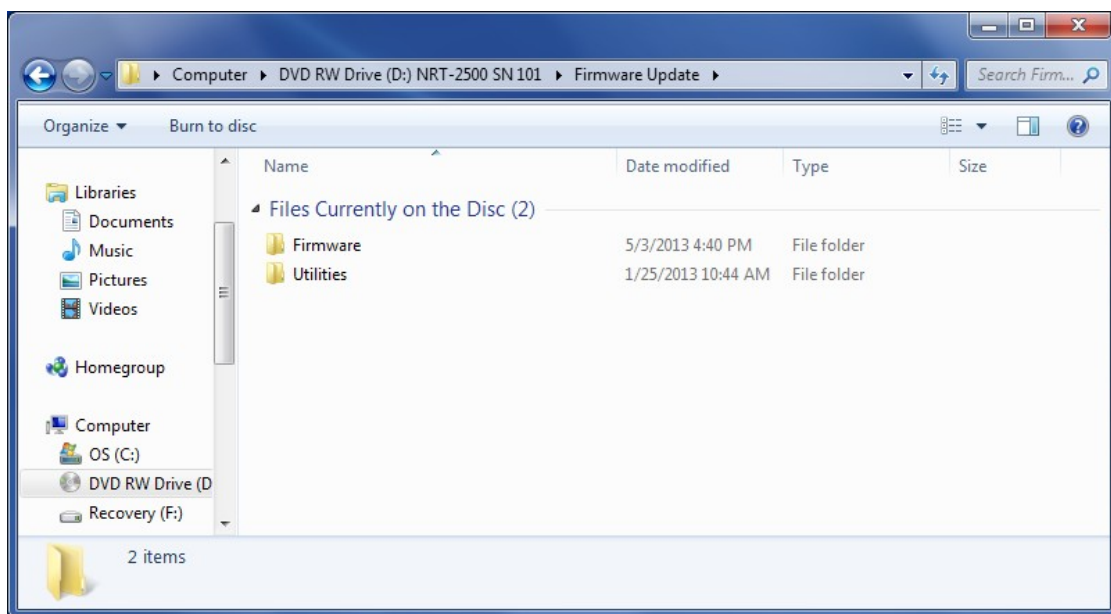


Figure 52: The Firmware folder on the NRT-2500 software CD.

Connect the NRT-2500 to the computer using both a Serial Communication cable and an Ethernet cable. From the *Utilities* folder execute the terminal application *MtTTY*. Connect the terminal to the NRT-2500 and set a convenient font and font size.

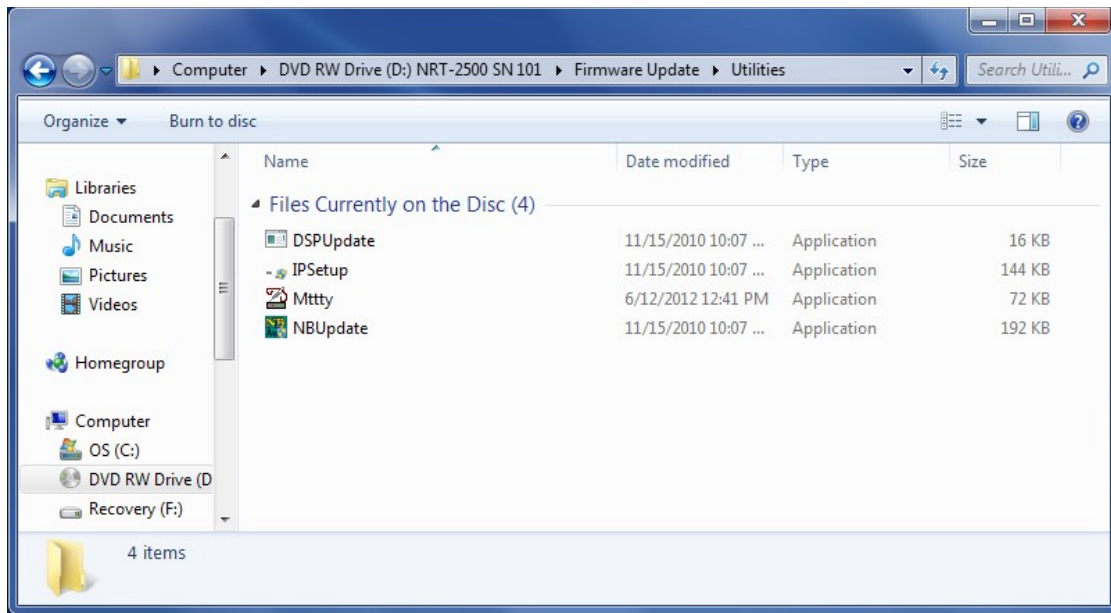


Figure 53: The Utilities folder in the Firmware Update folder.

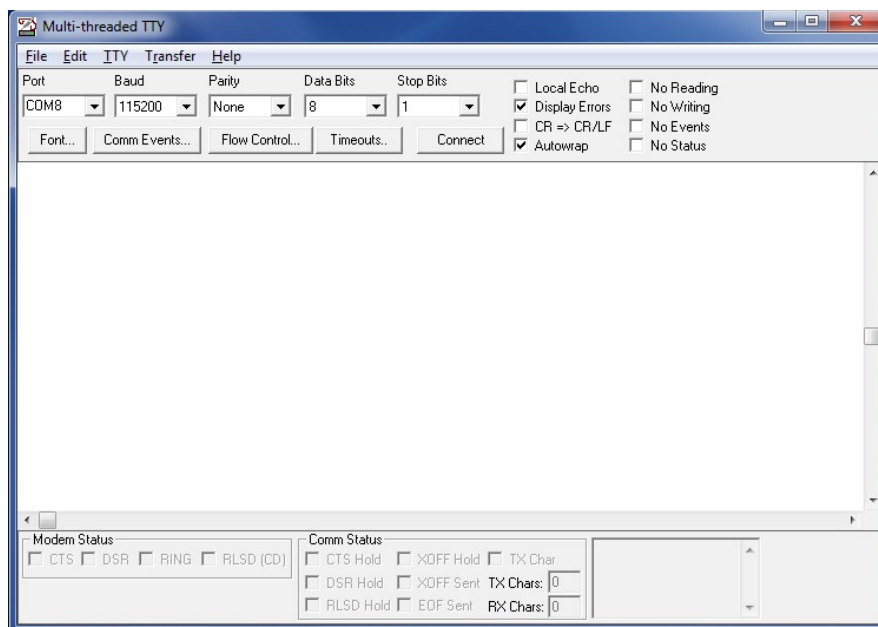


Figure 54: The terminal application. Select the COM port and set the font settings.

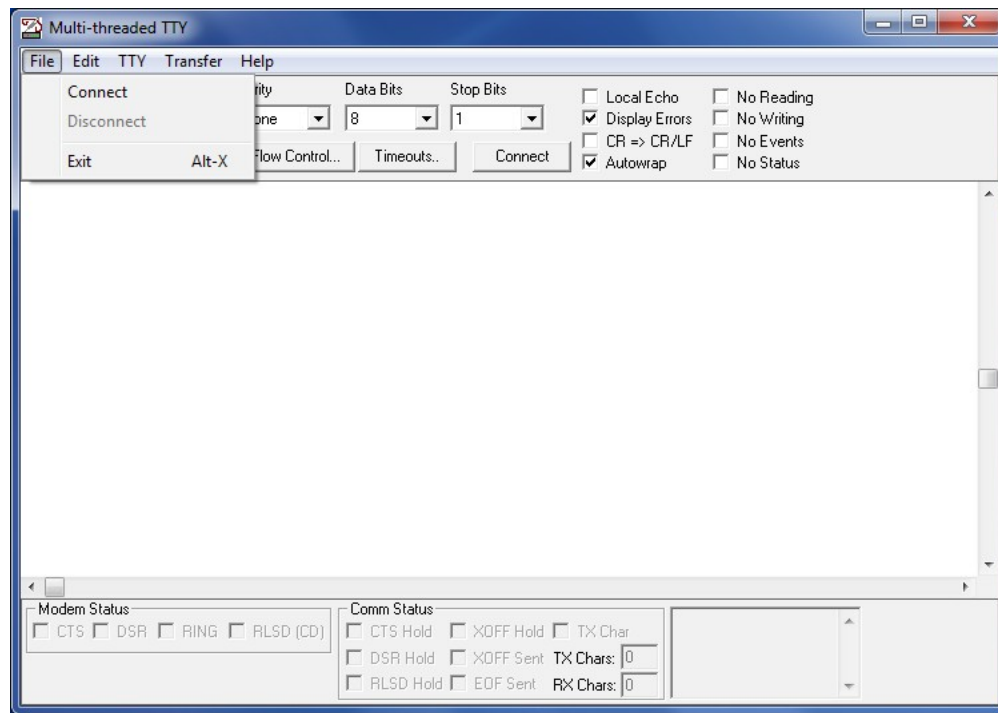


Figure 55: From the File menu select Connect to establish the connection to the selected COM port.

Turn on the NRT-2500 and follow the start up procedure on the terminal screen. Execute the ABOUT command to get the IP address of the NRT-2500. The IP address is needed for the first part of the update process.

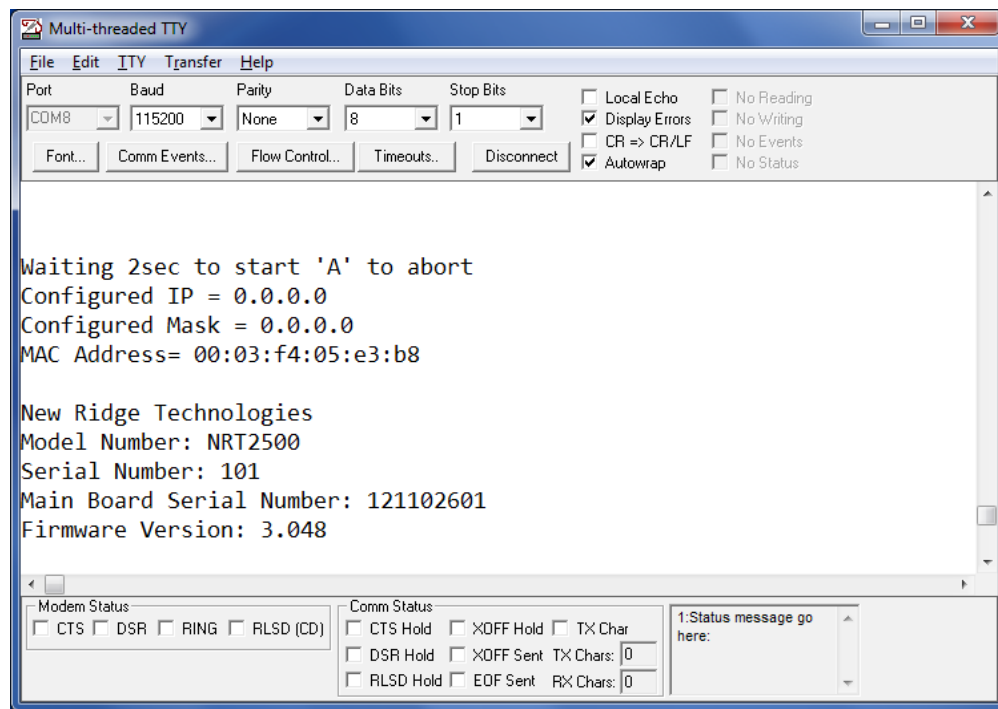


Figure 56: The start-up procedure of the NRT-2500.

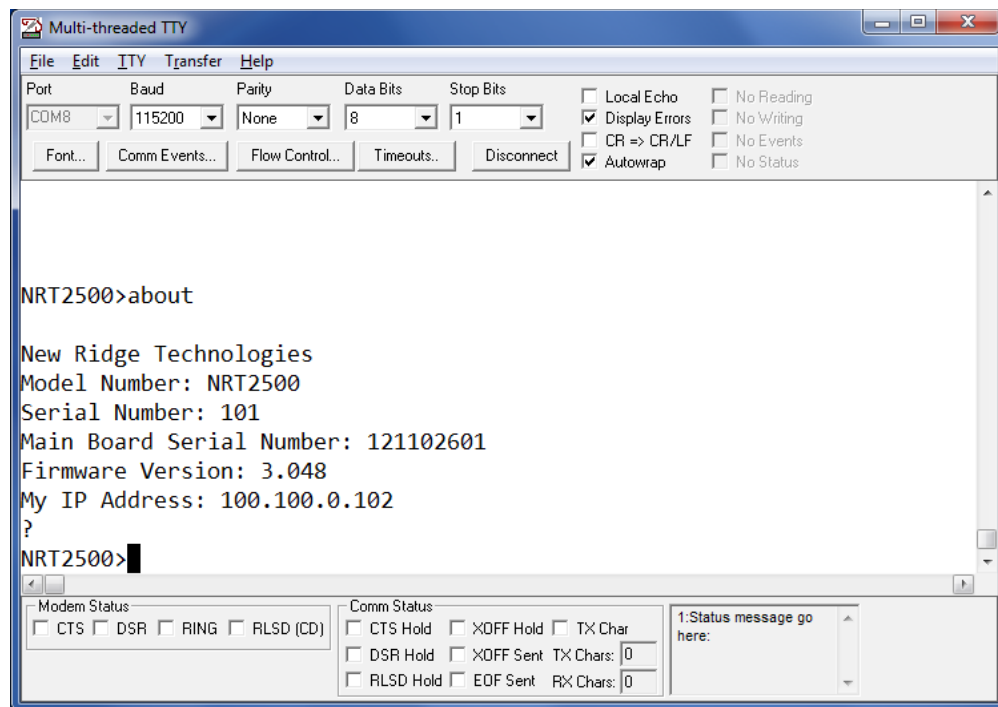


Figure 57: Execute the ABOUT command. The response includes the serial number, the firmware version and the IP address.

Run the DSPUpdate utility. Enter the IP address obtained from the “*about*” command and press the *CONNECT* button. A dialog window will open indicating that the IP address you selected is connected. Press the *OK* button.

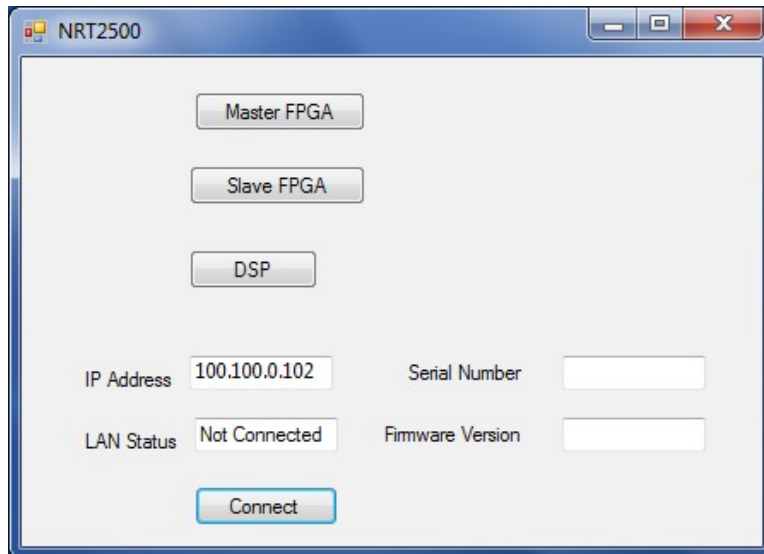


Figure 58: the DSPUpdate interface, enter the IP address and press the *CONNECT* button to continue.

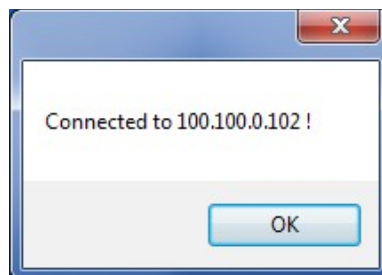


Figure 59: The DSPUpdate dialog box – confirm that the NRT-2500 is connected and press *OK*.

The DSPUpdate utility is used for updating the FPGA firmware and the DSP firmware. Click on the *DSP* button. Navigate to the *Firmware* folder and select the .ldr file of the updated firmware version. Press the *Open* button.

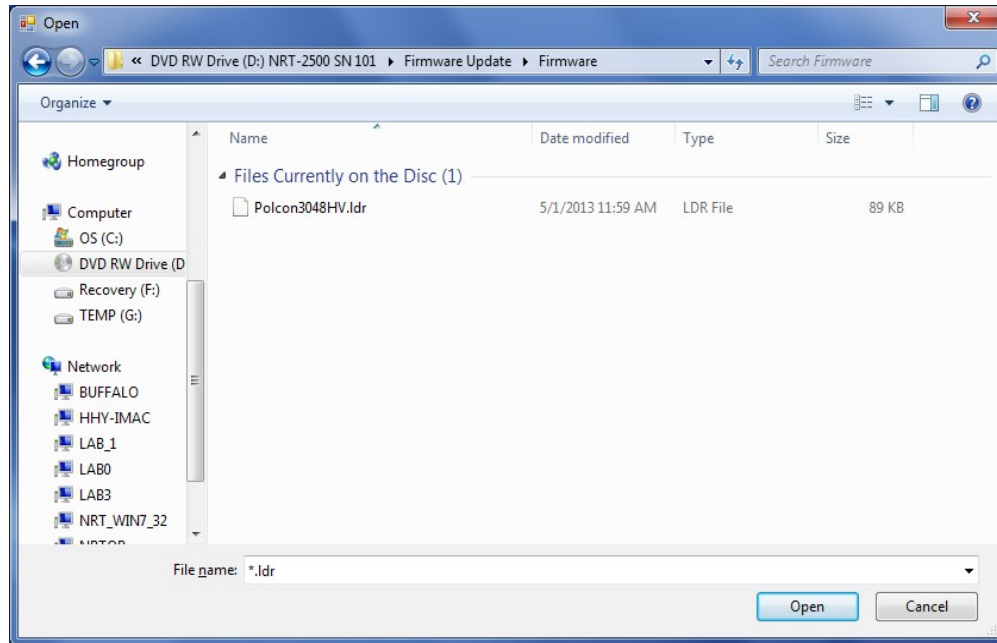


Figure 60: Select the firmware file from the firmware folder on the software CD.

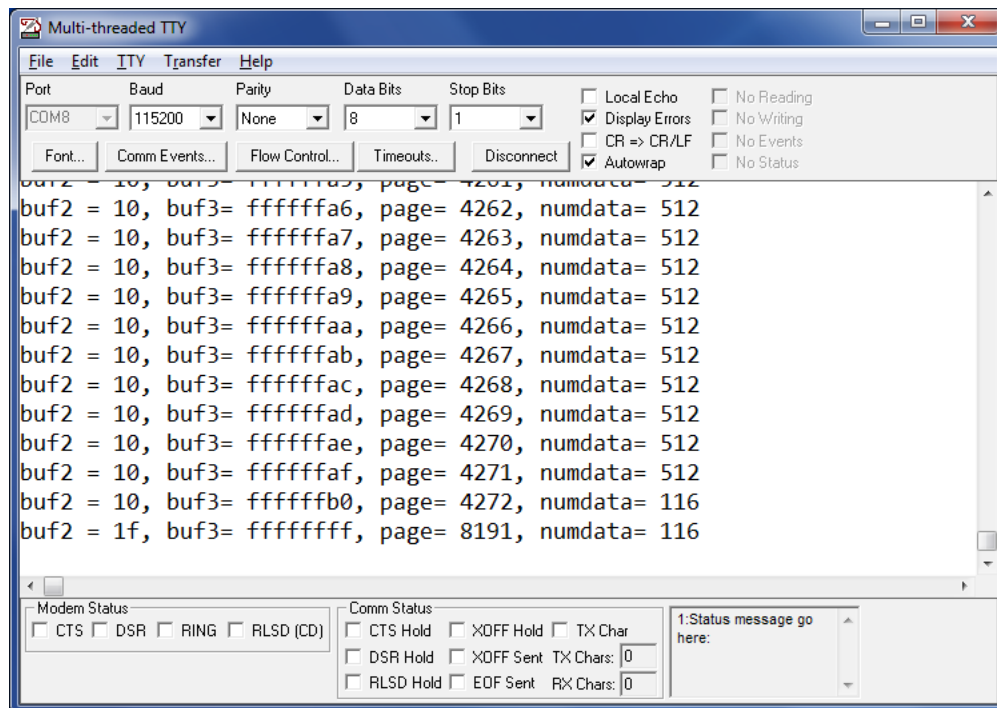


Figure 61: Follow the firmware update execution on the terminal screen. When the update has been completed a dialog window will open.

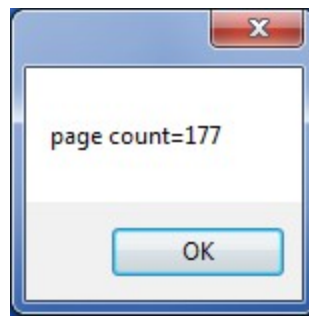


Figure 62: When the update has been completed a dialog window will open, stating the page count. Press the OK button to proceed.

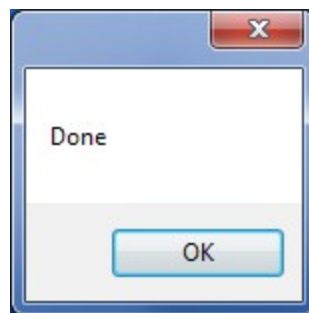


Figure 63: Another dialog window will now open, stating the update procedure is done. Press the OK button.

Repeat the procedure shown in Figure 60 through Figure 63 to update the FPGA Master or FPGA slave selecting the appropriate .xsvf file. Close the DSPUpdate utility.

The next step is to run the NetBurner update. Execute the NBUpdate utility (see Figure 53). A dialog window will appear requesting the IP address for the NRT-2500:

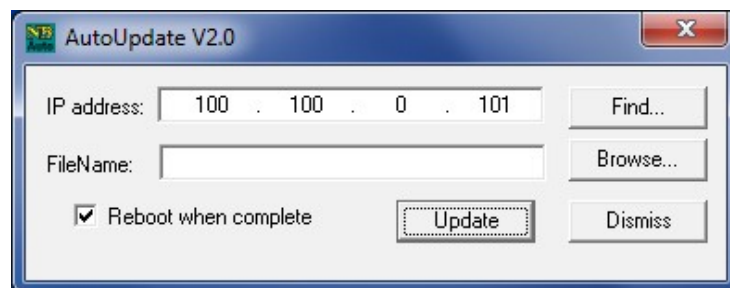


Figure 64: The NBUpdate utility dialog window. The IP address might not be the correct one. Press the Browse window to search the available IP addresses.

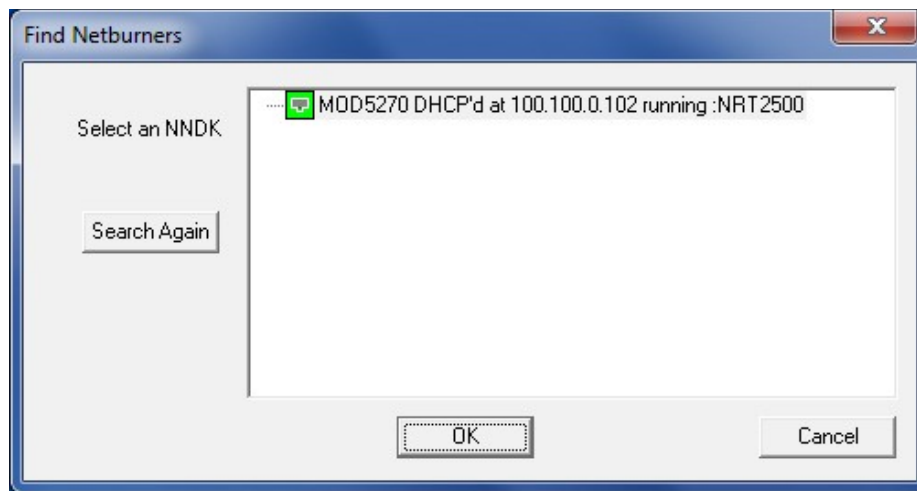


Figure 65: The search results will include a list of connected devices. Choose the device in use and click OK.

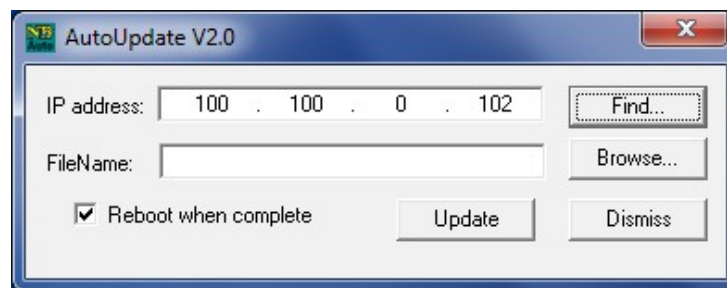


Figure 66: The selected device IP address will now show on the top line of the screen shown here. Click on Browse to select the .s19 extension file required for updating the NRT-2500.

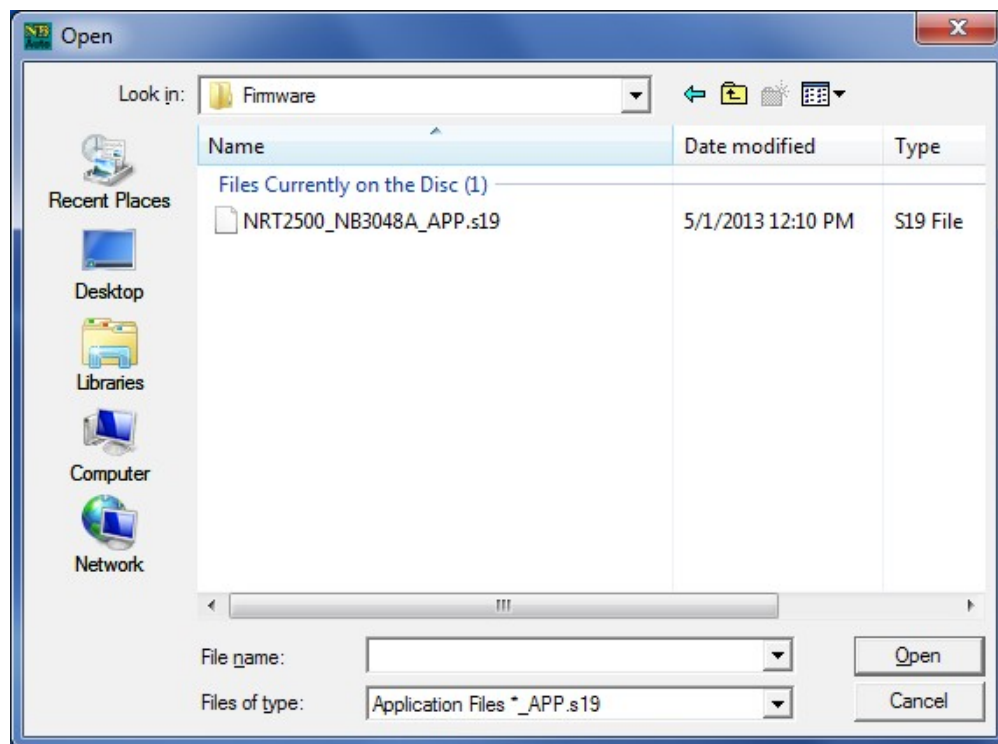


Figure 67: Select the .s19 extension file from the list and click Open. The file name in the previous figure will be updated.

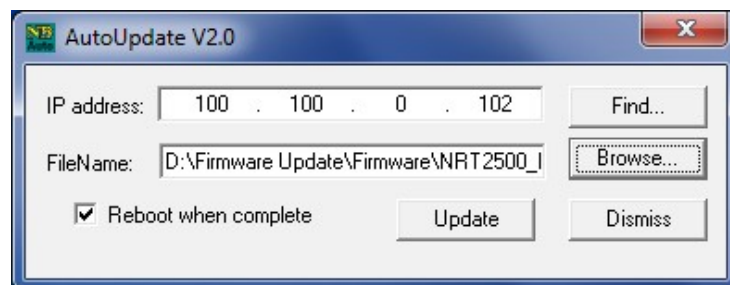


Figure 68: Click the Update button. The update process will start, you can monitor the update progress on the progress bar as well as on the terminal screen.

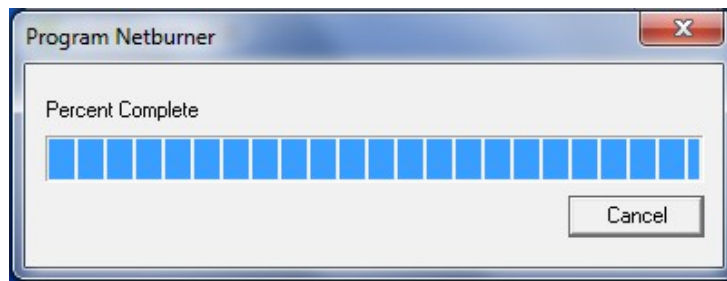


Figure 69: The progress bar will show up, to monitor the progress of the update process

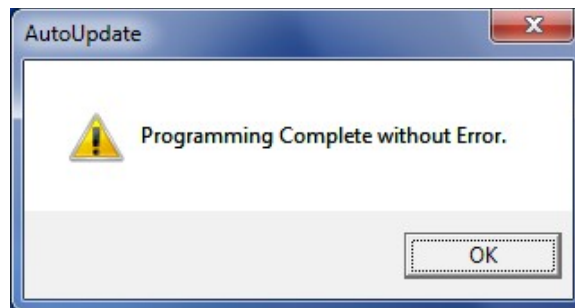


Figure 70: When the update process has been completed, the progress bar window will be replaced by the window shown here.

In case of an error during the update process, please contact New Ridge Technologies for further assistance.

Technical Support:

For technical assistance please contact us at support@newridgetech.com or call us at +1 (410) 753-3055