New Ridge Technologies

NRT-2500
User Manual

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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 six polarization-function capabilities:

1. Tracker
2. Scrambler
3. Spinner
4. Randomizer
5. Manual State of Polarization (SOP) control
6. Acquirer (Find Min or Max)

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

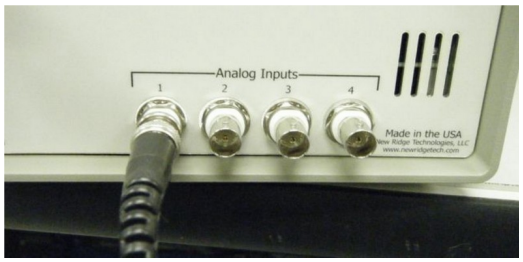

Figure 3: Analog connections (BNC) to the 4 ADC channels on the NRT-2500

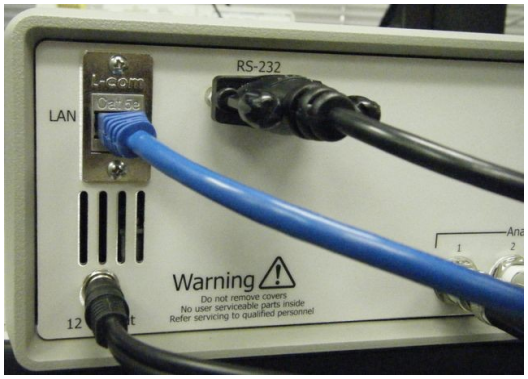

Figure 4: Power and communications ports on the back of the NRT-2500

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

3. Installing the NRT-2500 Software

Insert the disk you received with your NRT-2500 and double click on the ***NRT-2500-2.0.0.6 Setup.exe*** to start the software installation. Follow the procedure shown in Figures 6 through 11.

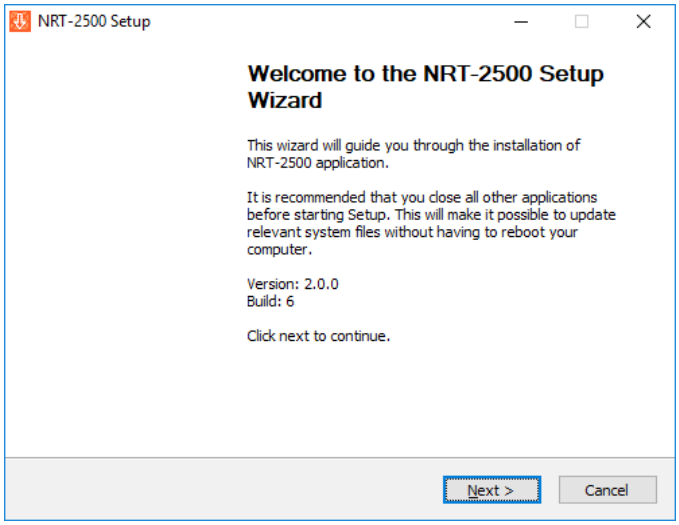

Figure 6: Initial setup screen; Click NEXT to continue.

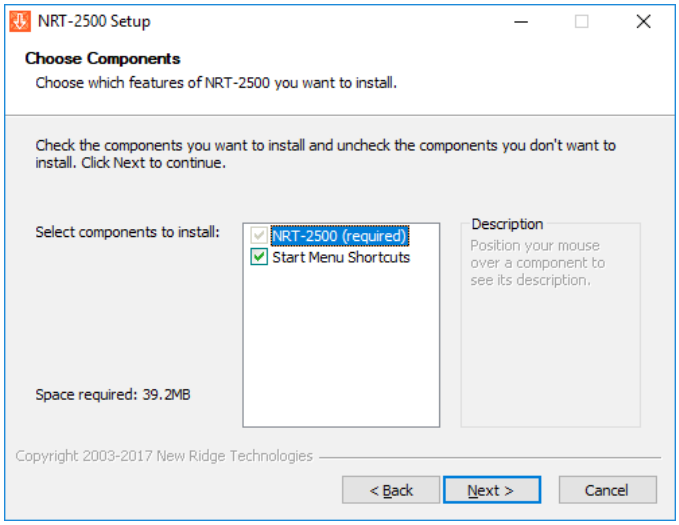

Figure 7: Select the optional components you would like to be installed by checking or unchecking the box next to the optional components list. Click NEXT to continue.

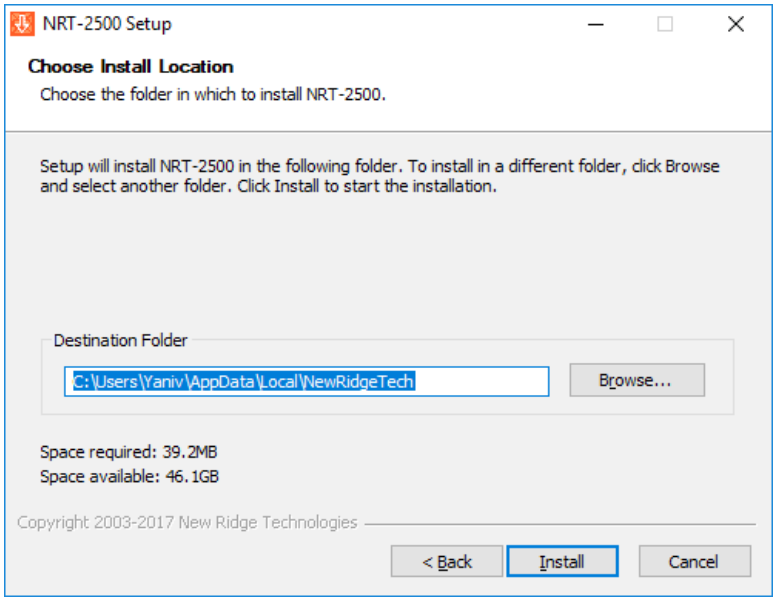

Figure 8: Select the location to which you want the installer to install the NRT-2500 application. Click on BROWSE to navigate and select a folder different from the default folder. Click INSTALL to continue.

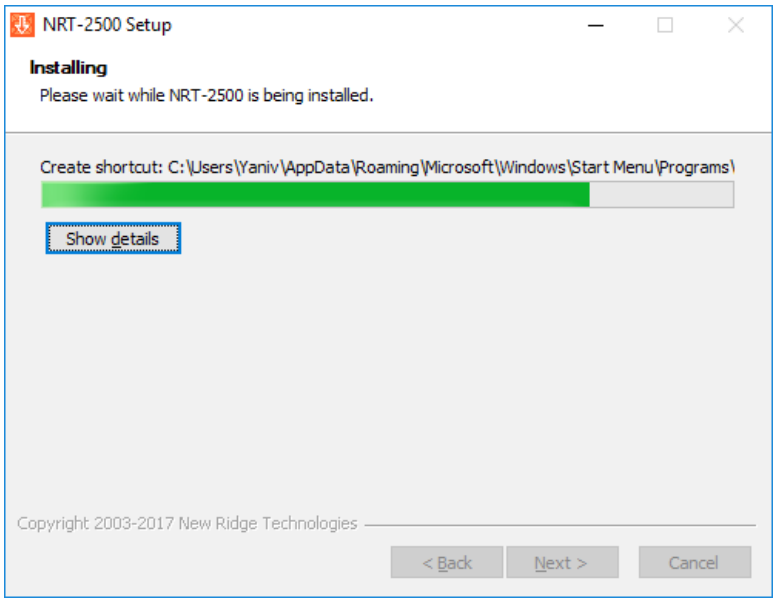

Figure 9: The installer will copy the components required for the NRT-2500 application and will create an entry in the start menu and place a shortcut on the desktop if you have selected to do so.

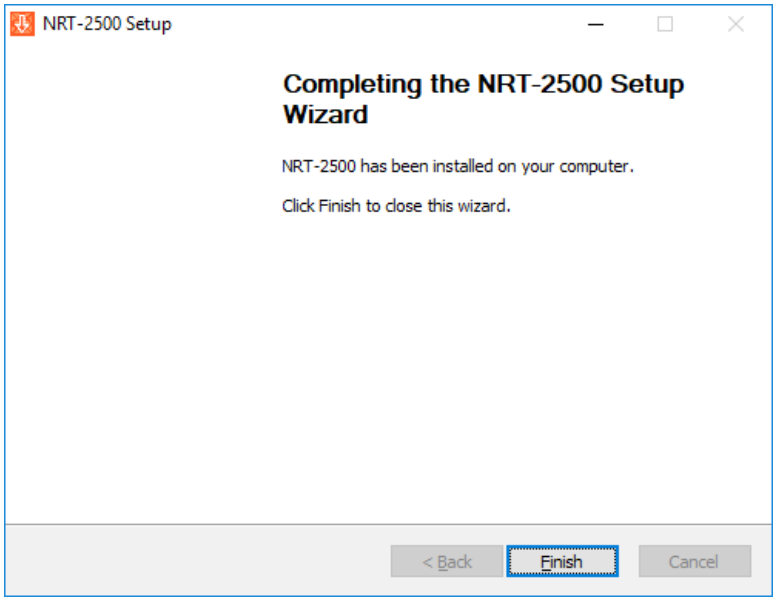

Figure 10: Once the installation is completed, click on the FINISH button to end the installation process.

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.

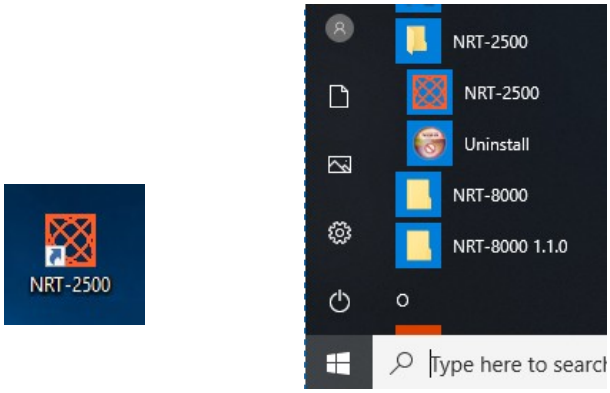

Figure 11: A new entry is now available on the start menu and if selected, as well as a shortcut on the desktop (optional).

4. Connecting to the NRT-2500

Communication and control of the NRT-2500 is done via RS-232 or Ethernet. Double click on the NRT-2500 icon to start the NRT-2500 GUI. Once the windows opens, you will be able to select the communication type and port you would like to use (see Figure 12).

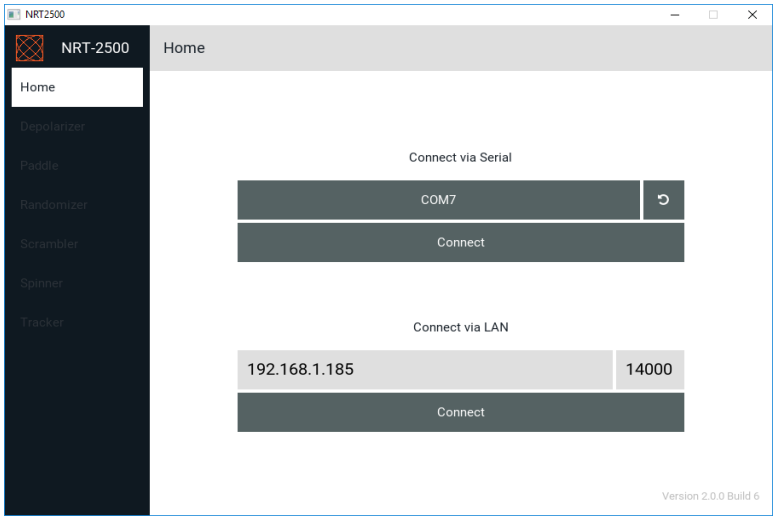

Figure 12: Select the communication type (Serial or LAN) and port. Click on the COM# or the LAN IP to see a list of available connections. Click on the refresh arrow to refresh the list. Click CONNECT to establish communication with the NRT-2500.

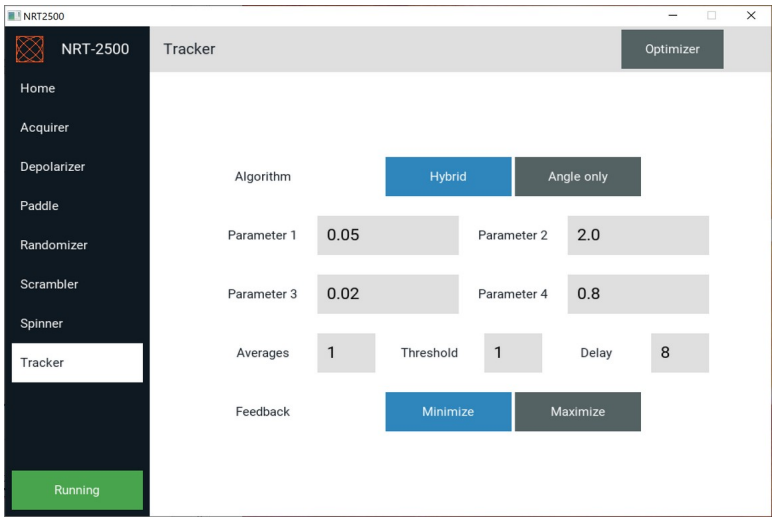

Figure 13: Once the communication between the computer ant the NRT-2500 was established the NRT-2500 will default to Tracker Mode and the tracker screen will show up. The values showed by the GUI are the last values that were used in the GUI.

Click on H*ome* to verify the serial number of the unit connected to the computer, the communication type and firmware version. You can also terminate the connection between the NRT-2500 and the computer by clicking on the Disconnect button (see Figure 14).

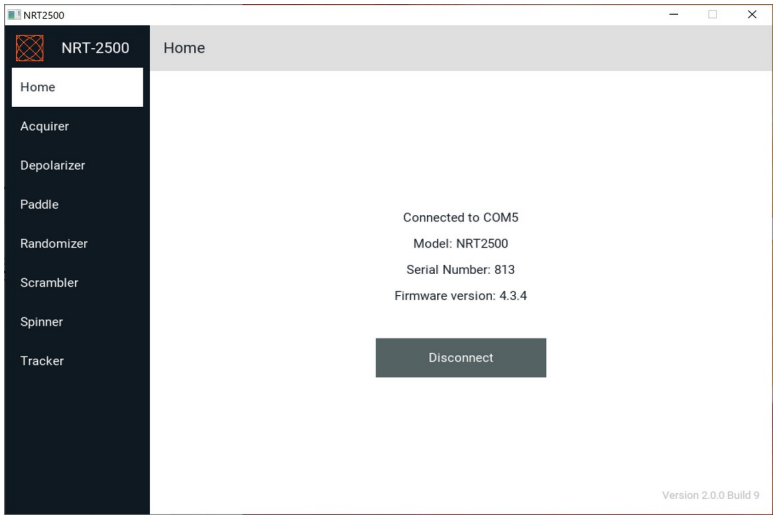

Figure 14: The NRT-2500 GUI Home screen. The screen shows the serial Number of the unit, the firmware version, model of the unit, and the communication type and port in use. Click the Disconnect button to terminate the connection between the computer and the NRT-2500.

5. Modes of Operation

The NRT-2500 has 6 modes of operation. The modes are accessible from the Mode Selector bar, situated on the left side of the GUI (see Figure 15). The 6 modes of operation are:

- Tracker mode
- Scrambler mode
- Spinner mode
- Randomizer mode
- Paddle mode
- Depolarizer mode
- Acquirer mode

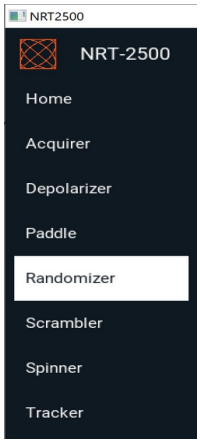

Figure 15: The Mode Selector bar. Click on the mode you would like to select, the GUI screen will adjust to the selected mode.

5.1 Tracker Mode

The default mode upon starting the NRT-2500 is the Tracker Mode (see Figure 16). Tracker Mode has two modes of operation; *Hybrid* and *Angle Only.* Toggle between these two modes by clicking on the desired mode, the background of the selected mode will turn blue. In *Angle Only* mode, the tracker is using a simple algorithm with only two optimization parameters, parameters 1 & 2 (parameters 3 & 4 will be grayed out). In *Hybrid* mode, the tracker is using the NRT proprietary algorithm with all four parameters active. Additionally, the user can select ***Averages*** to set the number of ADC readings that are used per waveplate update iteration. The ***Threshold*** is the minimal signal change (in mV) that will result is an update of the control algorithm. The ***Delay*** is the time, in µsec, between performing a dither and measuring the level of the analog input(s). This parameters depend on the experimental setup, detectors' response time, as well as other system configurations. The user may choose to *Minimize* or *Maximize* the value of the Tracking Error Function (TEF).

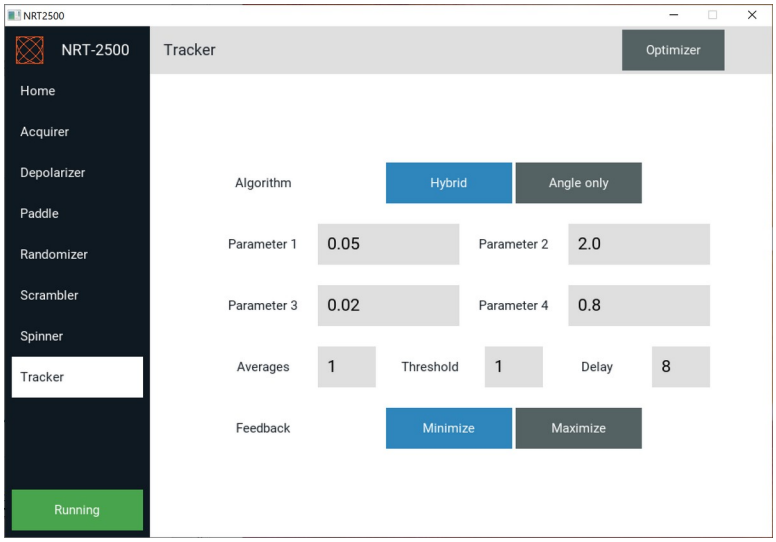

Figure 16: Select the desired mode of operation from the left panel of the GUI.

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* (see Figure 17). Click the amber IDLE indicator again to resume the tracking operation. The indicator will return to green and will read *Running*.

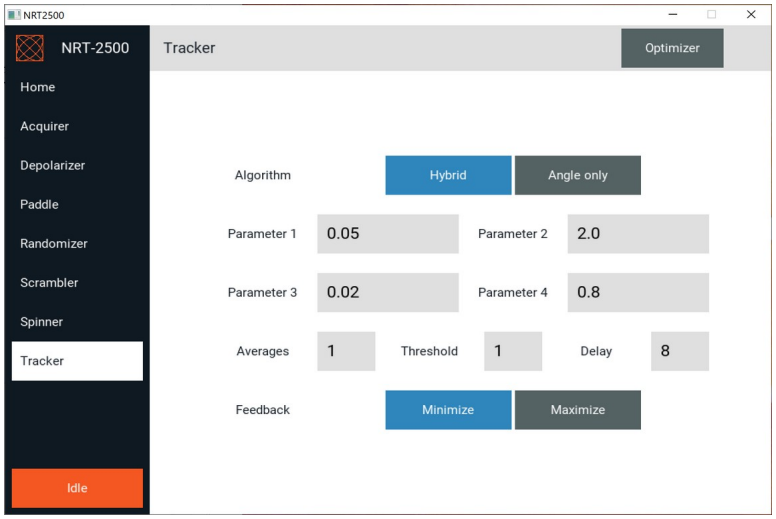

Figure 17: Idle in Tracker mode.

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 can be edited for different feedback schemes. 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

To access the Tracking Error Function click on the *Optimizer* button located on the top right corner of the GUI when *Tracker mode* is selected. The screen shown in Figure 18 will show up on the GUI. The parameters shown on the screen will correspond to the parameters that have been used in the last time the TEF was edited. These parameters are stored in the NRT-2500 internal memory.

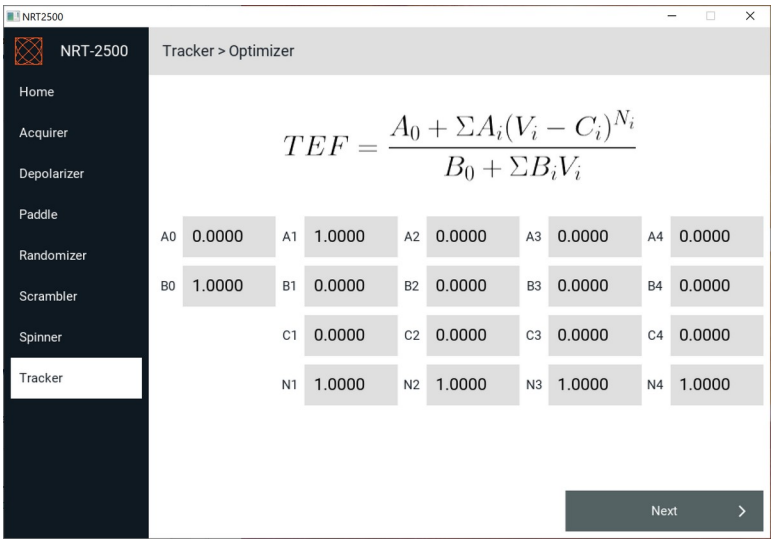

Figure 18: The Tracking Error Function (TEF) screen of the GUI. Use this screen to edit the feedback signal used for the NRT-2500 tracking mode. Change the values of the coefficients A, B, C and N to construct the desired TEF, according to the formula shown at the top of the TEF editor. Click NEXT to run the Optimizer, or choose Tracker from the mode selector bar to go back.

To go back to the previous GUI screen (shown in Figure 17) just click on the Tracker function on the mode selector bar. To run the optimizer click on the *Next* button to initialize the optimizer.

5.1.3 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). 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 20) 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 Figures 19 through 26.

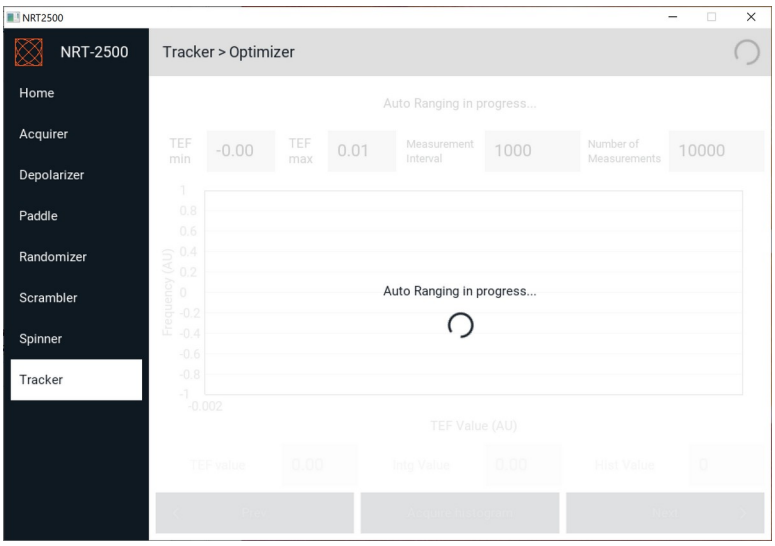

Figure 19: The TEF Optimizer – Step 1, Auto Range: the unit will auto range the input level of the Tracking Error Signal and acquire a histogram of that signal to visualize the system behavior and allow the user to better define the level at which the system would be considered to be below the desired...

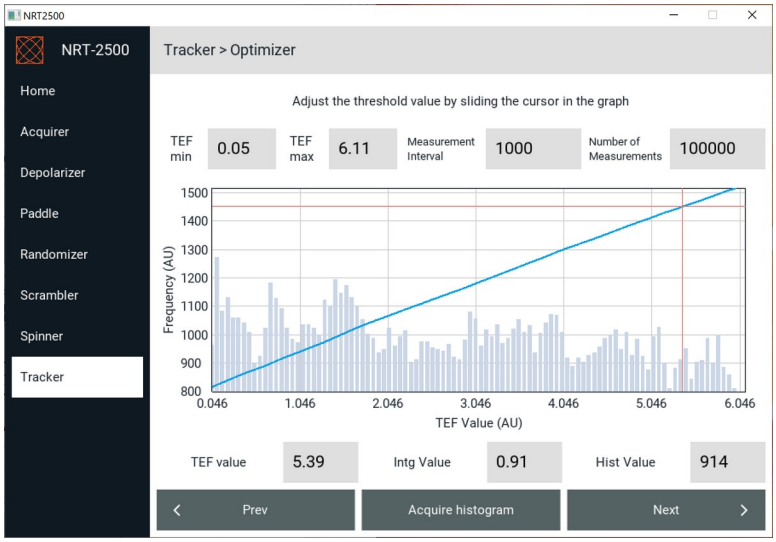

Figure 20: The TEF Optimizer – Step 2, Setting the Error Level Threshold : The graph shows the frequency (number of occurrences) as a function of the TEF value. Slide the cursor to select the TEF error-threshold value. The GUI will show the TEF Value at the cursor location, the Integral Value i.e. the normalized integral value of the TEF and the Histogram Value (frequency) at the cursor location. Press Next to continue using the selected threshold value. Press Acquire Histogram to collect new histogram data or Previous to return to the screen shown in Figure 18 in order to modify the TEF function.

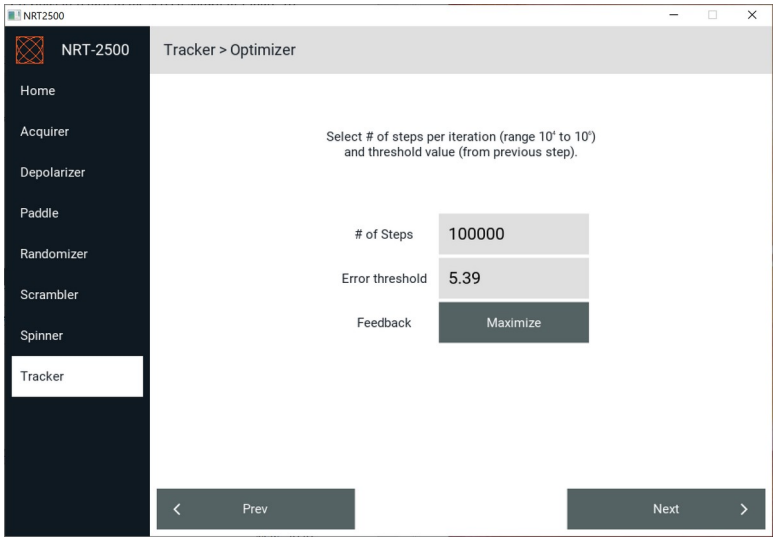

Figure 21: TEF optimizer Step 3, Select the number of steps per optimization iteration. Confirm the value of the Error Threshold, select Minimize or Maximize the TEF. and then press OK to start the Optimizer execution.

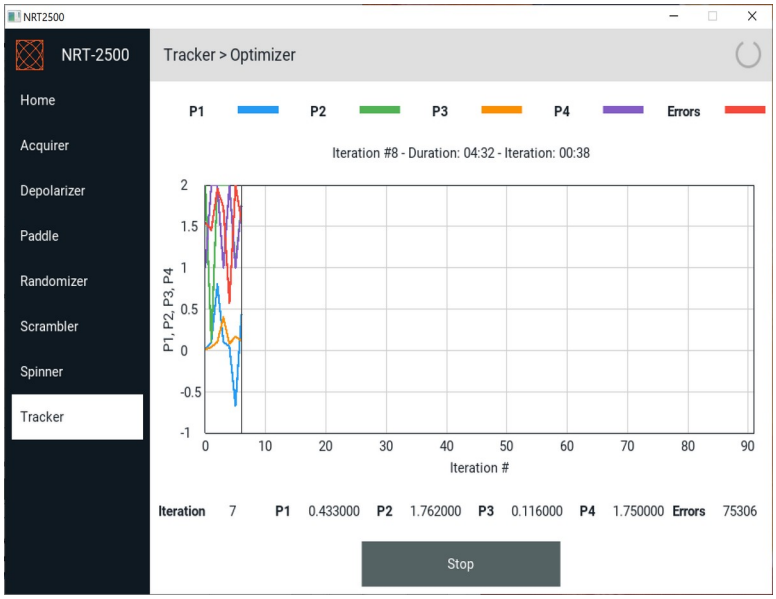

Figure 22: TEF Optimizer step 4 - While the optimizer is running, the set of 4 optimization parameters is displayed together with the number of tracking errors measured. Each iteration value can be viewed in the Iteration Data box. Terminate the execution of the Optimizer program by clicking on any of the 3 buttons below the graphic screen.

Figure 23: TEF Optimizer step 5 – once the Optimizer execution is terminated, the 4 optimized parameters are shown in the lower part of the window. The user may choose between 3 options: 1. Save Parameters to NRT: update the NRT-2500 memory. 2. Export as CSV: save the data to a CSV file, or 3. Previous: ignore the parameters calculated in the optimizer run and go back to set new optimization parameters.

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 x π x R_{mode}.

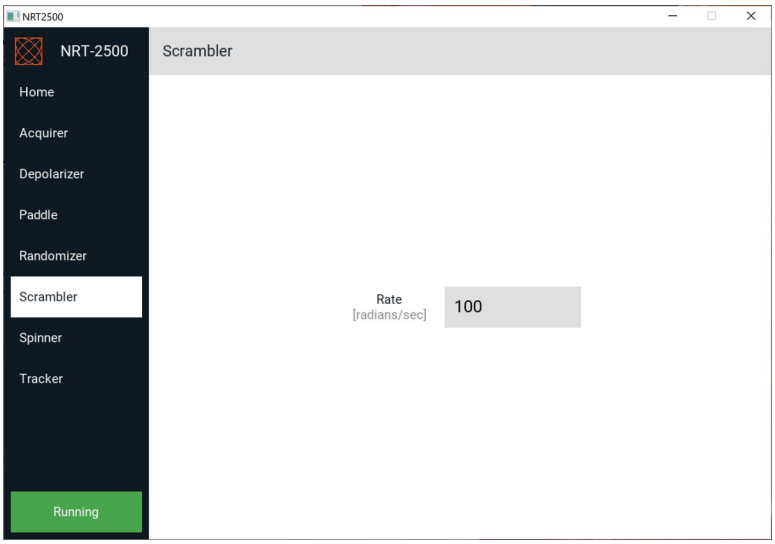

Figure 24: Scrambler mode: Set the scrambling speed by setting the value of R_{mode}. The Rayleigh distribution scales linearly with the value of R_{mode}.

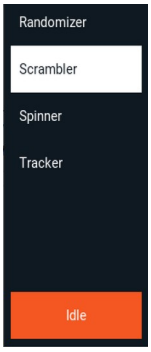

Figure 25: Stop the Scrambler execution by clicking on the RUNNING indicator. The indicator will turn amber and read IDLE. (You may also set the R_{mode} speed to 0 to stop the Scrambler.)

5.3 Spinner Mode

In Spinner mode the NRT-2500 'imitates' the function of a rotating *Half-Wave-Plate* (HWP) inserted between two ¼-½-¼ *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 2πf and the rotation of the power (about the equator of the Poincaré sphere) is 4πf. 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* x 2π**	**= *f* x 4π**
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 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.

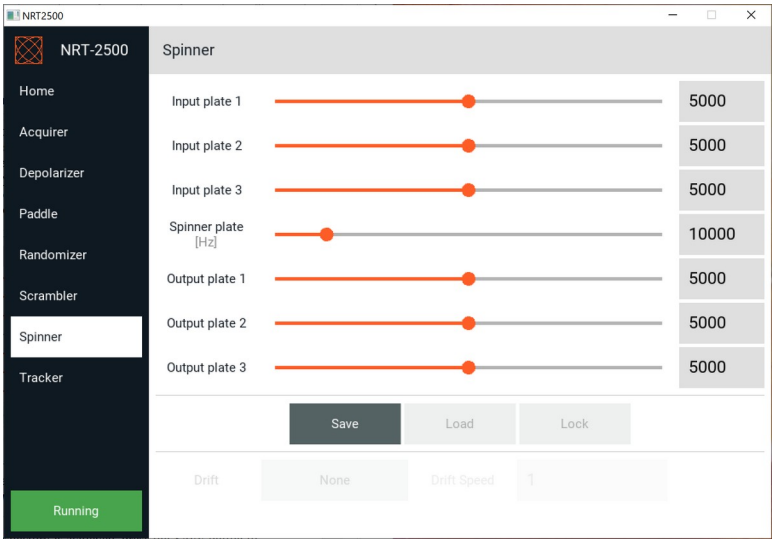

Figure 26: Spinner mode: From the default GUI screen the user can control the spinner speed, the HWP trajectory elevation and orientation, and can set the NRT-2500 to Idle.

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. See Figures 26 through 37 for a more detailed explanation of the Spinner mode and Drift 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.

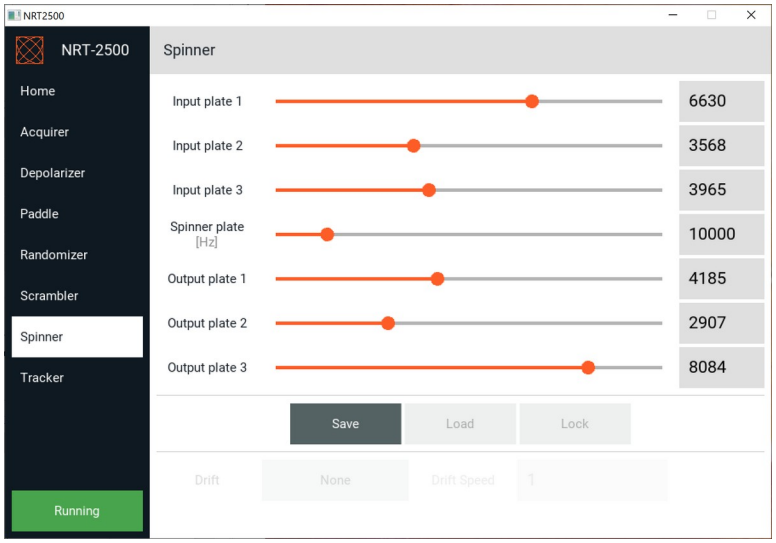

Figure 27: Pressing the SAVE button will store the settings of the input and output polarization controllers. Once you press SAVE, the LOAD and Lock buttons will appear.

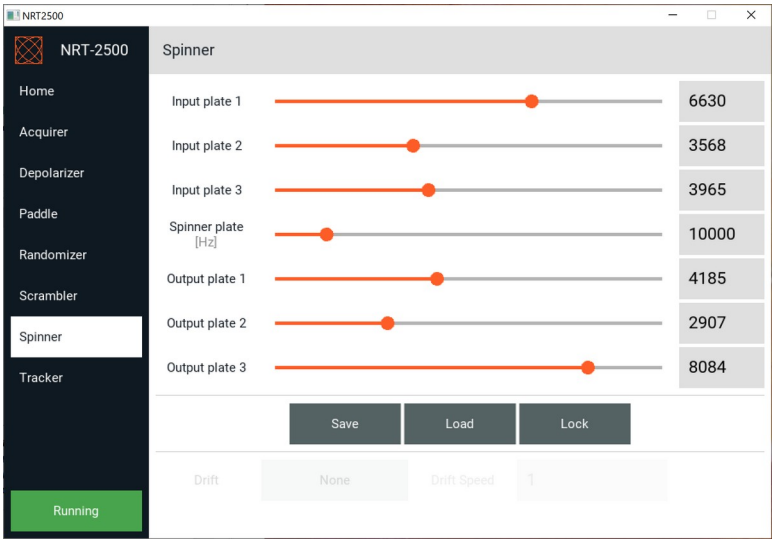

Figure 28: You can now change the sliders positions. Pressing the Load button will restore the values to the values saved before the changes have been made. Pressing the Lock button, the plates sliders and indicators as well as the Save and Load buttons will be grayed out and locked. The Drift mode selector and speed will appear on the bottom of the GUI window (see Figure 29).

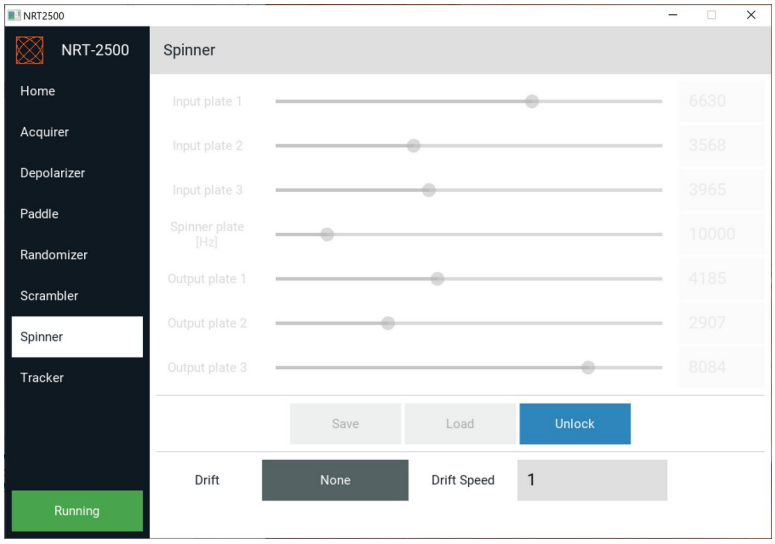

Figure 29: The Drift mode will read None (no drift). Press on the Drift button to select the desired drift mode. Choose between None, Along Spin Axis, Rotate Spin Axis or Both (see Figure 30). You can also change the drift rate between the non calibrated drift rates 1-10.

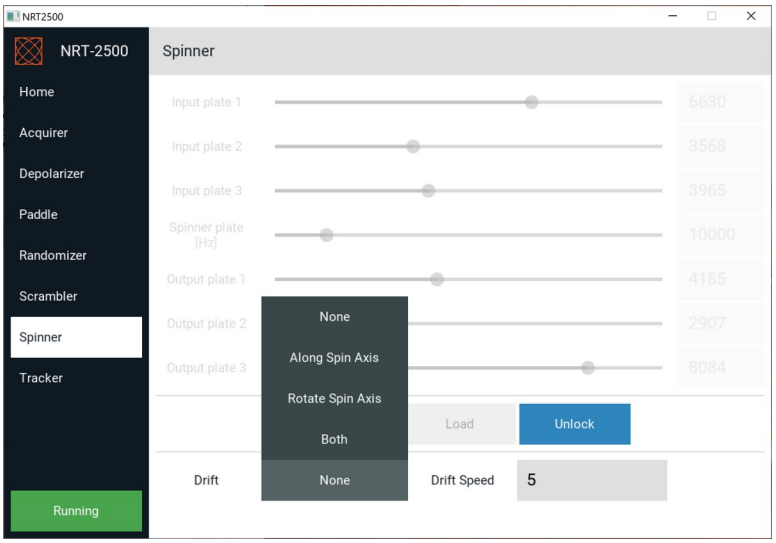

Figure 30: The drift modes and drift speed.

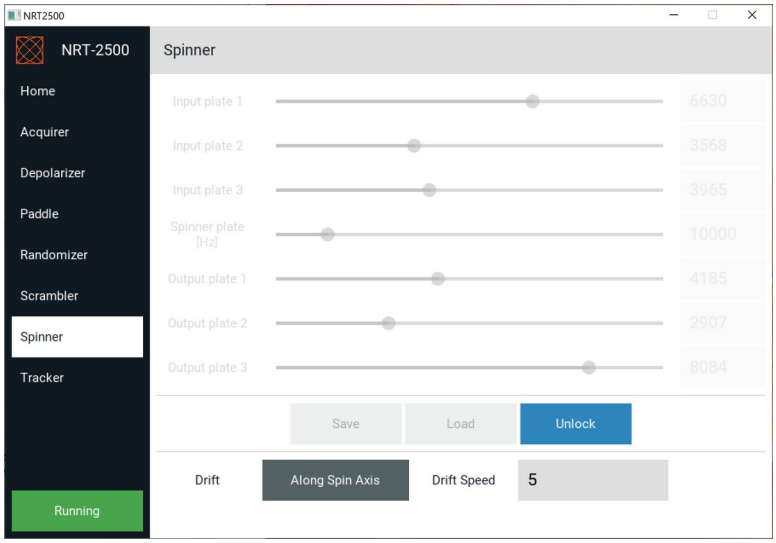

Figure 31: When setting the Drift mode to Along Spin Axis, the input polarization control plates will start changing their values. The spinner will start traveling along the axis of rotation, changing the speed of rotation as it does so.

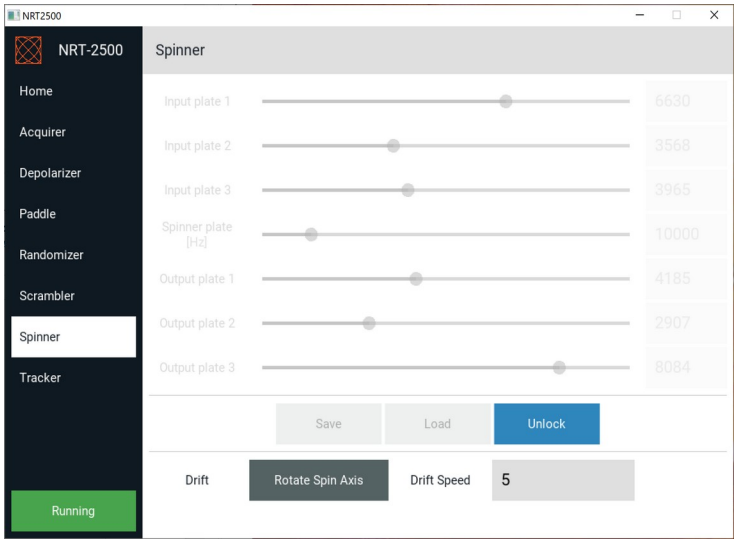

Figure 32: When setting the Drift mode to Rotating Spin Axis, the output polarization control plates will start changing their values. The spinner will start changing its orientation keeping the speed of rotation constant as it does so.

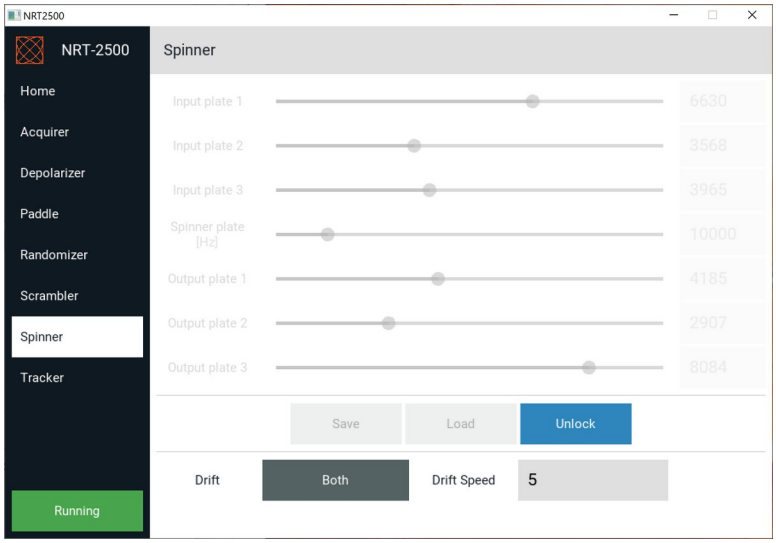

Figure 33: When setting the Drift mode to Both, both the input and output polarization control plates will start changing their values. The spinner will start traveling along the axis of rotation, as well as changing its orientation. The Spinner speed will start changing as it does so.

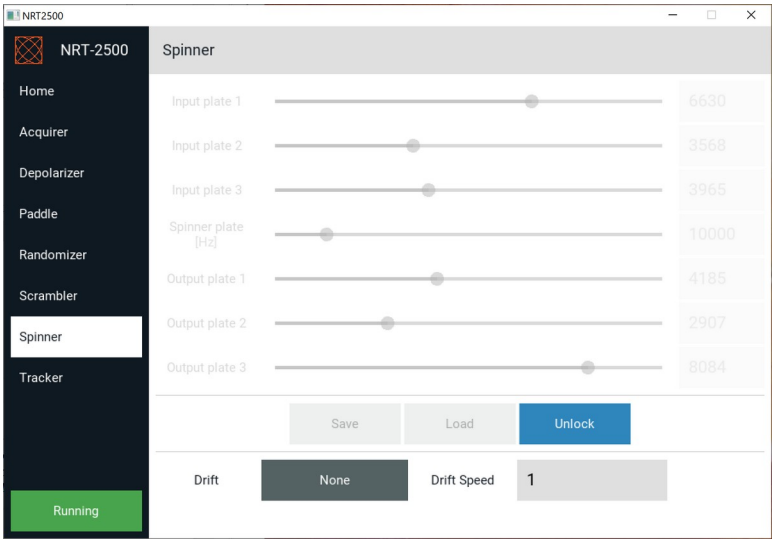

Figure 34: To stop the Drift and go back to the spinner settings (Figure 28) set the Drift mode to None, then press Unlock.

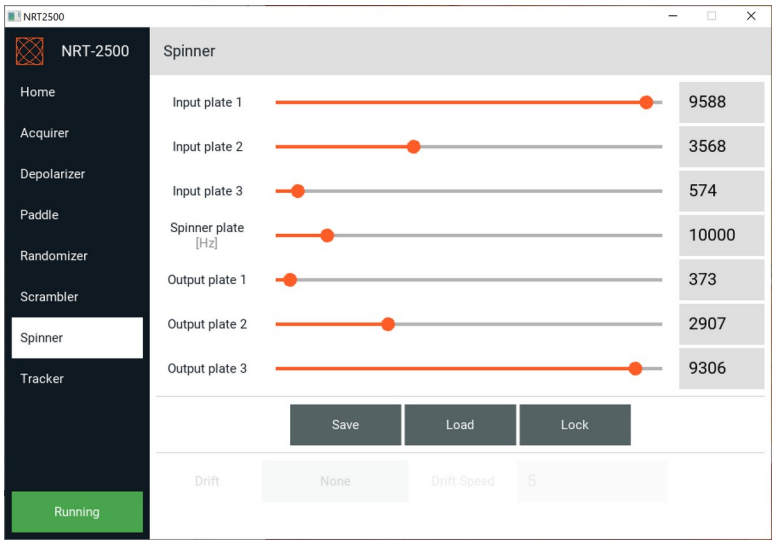

Figure 35: The GUI will update the input and output polarization controllers values to the values at which the drift was stopped. The user can now Save these value, Load back the last set of saved values or Lock again and run a new Drift.

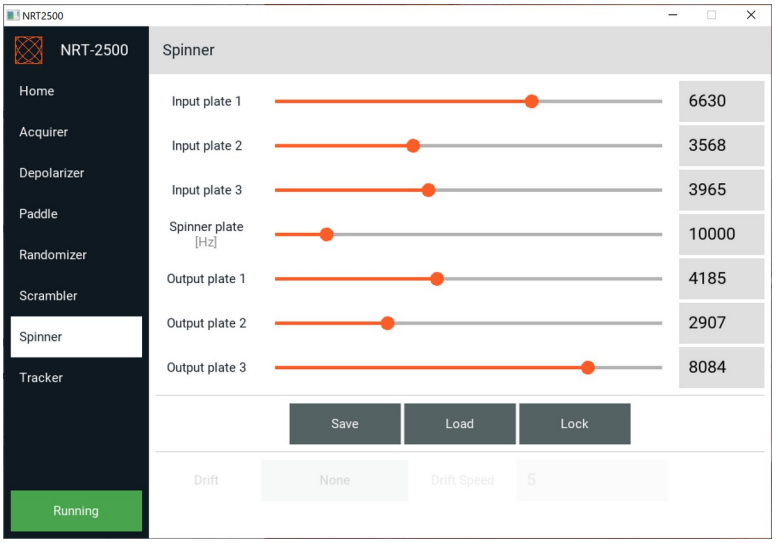

Figure 36: Pressing the Load button will restore the settings last saved (see Figure 28).

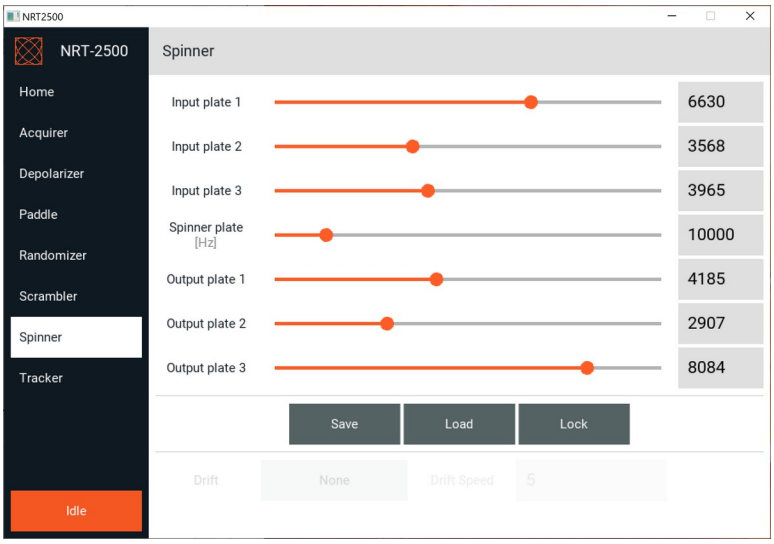

Figure 37: Press on the Running button to stop the spinner. The button will turn amber and read Idle. Press it again to re-initiate the spinner.

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 38).
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 Figures 39 - 40).

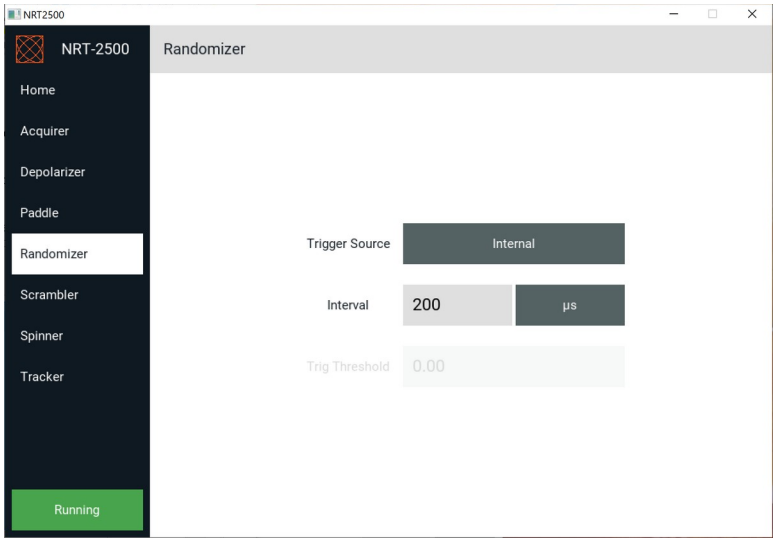

Figure 38: Randomizer Mode - internal trigger mode of operation. The user can change the time between SOP changes (the Dwell time).

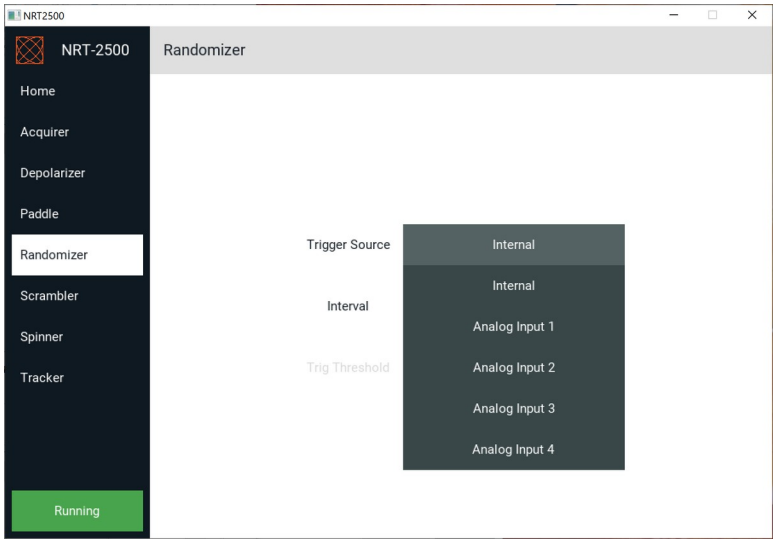

Figure 39: Randomizer Mode - Press on the Trigger Source button to select the internal/external trigger source from the scroll down list.

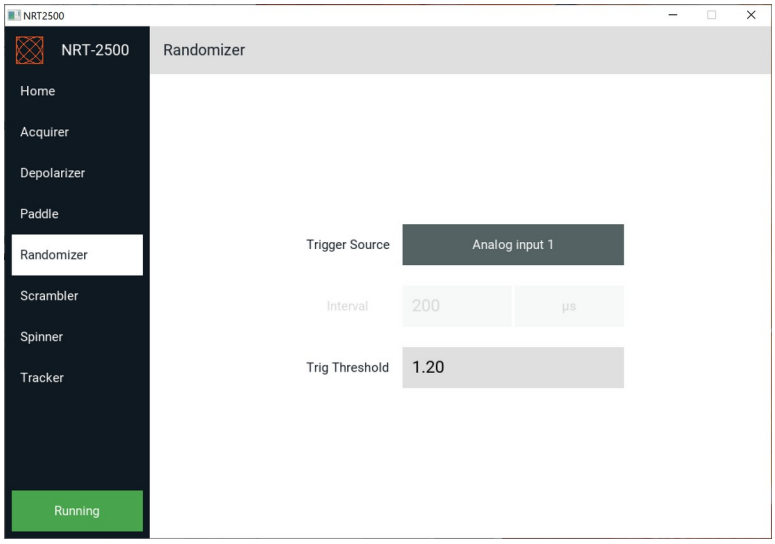

Figure 40: Randomizer Mode - external trigger mode of operation. The user should connect an external trigger source to one of the four analog inputs on the back of the NRT-2500, and set the Voltage threshold for SOP trigger.

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 ¼-¼-½-¼-¼ wave-plate configuration.

Figure 41: Paddle Mode – Polarization controller in a ¼-¼-½-¼-¼ 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.

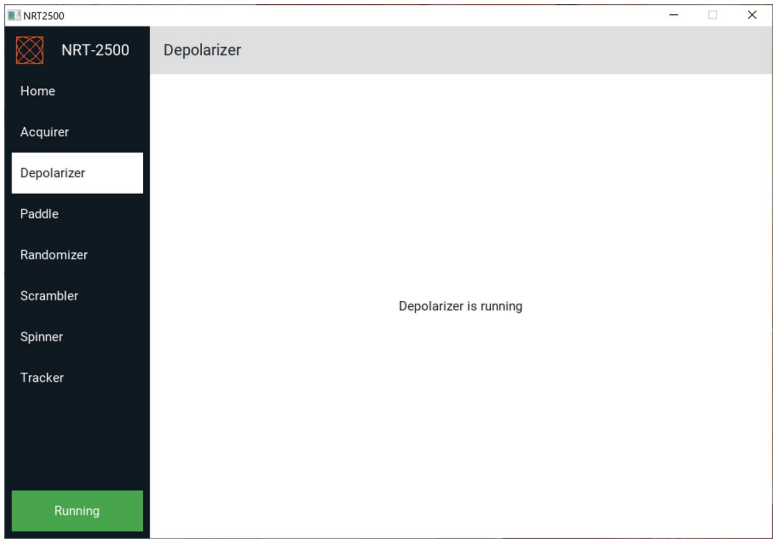

Figure 42: Depolarizer Mode – there are no user settable parameters.

5.7 Acquirer Mode

The function of the Acquirer mode is in-between the Tracker and Paddle modes. The Acquirer adjusts the SOP of the NRT-2500 to find the minimum or maximum value of the TEF from external feedback. Much like a user would manually do with Paddles and visual feedback.
Like the Tracker, the user configures the operation of the Acquirer from the GUI (Figure 43). First, the TEF feedback must be programmed as a function of the 4 analog BNC inputs on the rear of the NRT-2500 (Figure 44). The MODE of the Acquirer is set to either Minimum or Maximum of the TEF. Then AVERAGES is the number of feedback samples averaged before calculating the TEF. It can be adjusted to improve signal-to-noise. Next, the DELAY should be set to the time, in microseconds, between modifying the SOP and measuring the resultant change in the feedback value (TEF). DELAY should be 7 µs or great and long enough to accommodate the response time of the detector, power meter, etc. providing the feedback signal(s). Finally, the Acquirer operation is initiated by pressing the AQUIRE button. Once the minimum or maximum SOP is ‘acquired’, the TEF value (e.g. photodiode voltage) is reported.

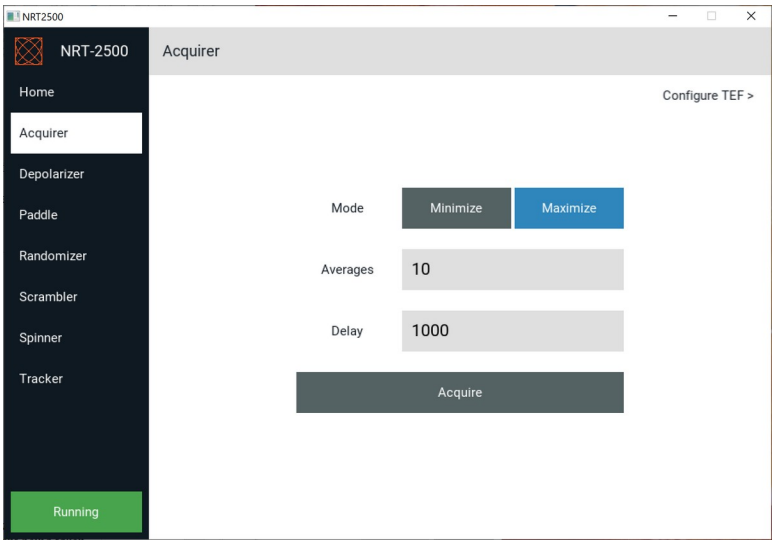

Figure 43: Acquirer Mode: Once the Acquire button is pressed, the unit will adjust the SOP to acquire the minimum or maximum value of the TEF. The number of Averages, and Delay time between the SOP update and a measurement of the feedback are set by the user.

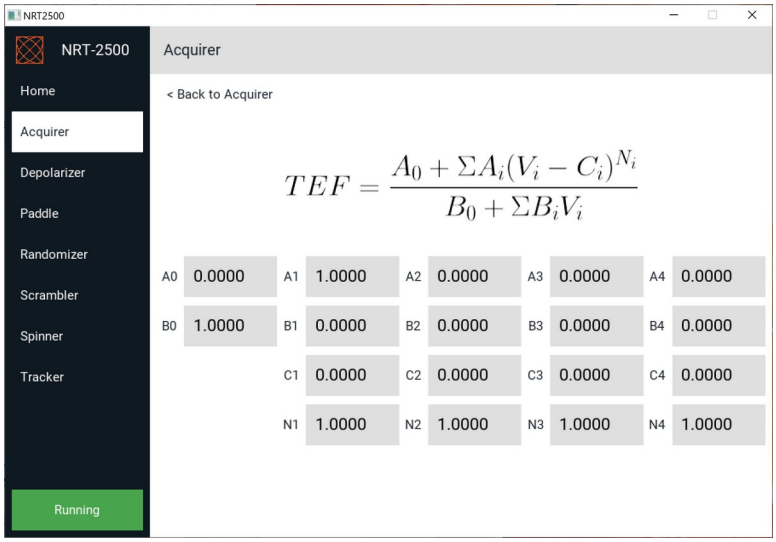

Figure 44: Acquirer Mode TEF: The TEF for the Acquirer mode is the same TEF used in the Tracking mode. Above is the most common TEF measuring the voltage (usually from a photodiode), measured at BNC 1 on the rear of the NRT-2500.

6. NRT-2500 Automation

This section will introduce the SCPI commands used to control the NRT-2500 and will explain how to use those commands for test and measurement automation.

Serial Setup:
Baud Rate: 115200
Parity: None
Data Bit: 8
Stop Bit: 1

6.1 SCPI Protocol

The NRT-2500 can be automated using SCPI commands via RS-232 or Ethernet. The use of SCPI commands is the most generic way of communication which diminish the need of a DLL driver, and allows the user to control the Polarization Controller using a wide variety of applications such as C, C++, LabVIEW, LabWindows/CVI, Visual C++, Visual Basic etc. without difficulties. The user can access all the modes of operation: Polarization Tracking, Scrambling, Spinner, Randomizer, Depolarizer and Paddles. A status command allows the user to read the current mode and control parameters.

6.2 Before You Start

Unless specified, all the **SET** commands have an associated **GET** command, that returns the value previously set by the **SET** command, with the same format. For example:

:TRACKER:TEF:A 0,1,0,1,0

the command:

:TRACKER:TEF:A?

will return:

0,1,0,1,0

6.3 IEEE Mandated Commands

The NRT-2500 has only a partial set of SCPI commands, and it is always working in sequential mode.

6.3.1 Queries

- *IDN?: Identification Query, Returns 4 fields:

    1. Manufacturer Field (NewRidgeTech)
    2. Model Field, should not contain the word “MODEL” (NRT-2500)
    3. Serial Number (S/N 100)
    4. Firmware level field (FW Version: 4.0.1)

- *CLS: Clear all the previous errors

6.3.2 System Commands

Error are stored in a queue. When reading an error, the first error in the queue will be displayed, not the latest one. Thus, in order to get the last error, one must read all the errors in order to clear the queue before sending a new command and attempting to read the current error. There are two ways to read the errors, POP and PEEK. Using Pop, the error will be removed from the queue and sent to the user. Using Peek, The error is read from the queue and sent to the user, however it stays in the queue.

- :SYSTem:ERRor?: Pop error from the queue, and returns it with CODE,"MESSAGE”
- :SYSTem:ERRor:NEXT?: Peek error from the queue, and returns it with CODE,"MESSAGE"
- :SYSTem:ERRor:ALL?: Pop all errors from the queue, and display many CODE,"MESSAGE",CODE,"MESSAGE",...
- :SYSTem:ERRor:COUNT?: Return the number of errors in the queue
- :SYSTem:ERRor:CODE?`: Pop error from the queue and returns the CODE
- :SYSTem:ERRor:CODE:NEXT?: Peek error from the queue and returns the CODE
- :SYSTem:ERRor:CODE:ALL?: Pop all errors from the queue and returns CODEs separated with comma
- :SYSTem:ERRor:CODE:COUNT?: Returns the number of errors.
- :SYSTem:CMD:COUNT?: Returns the number of executed commands. Used by the GUI to keep track of the commands sent and ensure that there is to command lost while communicating.

Known error codes:

- 101: Invalid character
- 102: Syntax error
- 109: Missing parameter
- 113: Undefined header
- 121: Invalid character in number
- 130: Suffix error
- 150: String data error
- 220: Parameter error (most of the time, the actual error message contain which parameter)
- 900: Application error (also the error can be more explicit)

- 901: Authentication required

6.4 NRT-2500 Specific Commands

The following commands can be used to control the NRT-2500, and access all of its modes of operation via a terminal or an external program to automate the operation of the NRT-2500.

6.4.1 General commands

Idle

- :POLCONtroller:STOP: Idle

Current mode

- :POLCONtroller:MODE?: Return the current mode of the unit, can be one of IDLE, TRACKER, DEPOLARIZER, RANDOMIZER, PADDLE, SPINNER

Set and Read Polcon Voltages

- :POLCONtroller:VOLTAGEs [Array length 14, comma separated] values -50 to +50
- :POLCONtroller:VOLTAGEs? Returns the polcon voltages (Array length 14, comma separated)

6.4.2 Tracker Mode Commands

Tracker Commands

- :TRACKer:PAR1 [VALUE]: Set P1/Angle Step. Value between 0-6.28
- :TRACKer:PAR2 [VALUE]: Set P2/Angle Gain. Value between 0-20
- :TRACKer:PAR3 [VALUE]: Set P3/Retardance Step. Value between 0-6.28
- :TRACKer:PAR4 [VALUE]: Set P4/Retardance Gain. Value between 0-20
- :TRACKer:PAR5 [VALUE]: Set P5/Retardence Restraint Force. Value between 0-1
- :TRACKer:PAR6 [VALUE]: Set P6/Retardance Nominal Value. Value between 0-1
- :TRACKer:AVERages [VALUE]: Set Number of Averages. Value between 1-16
- :TRACKer:DELAy [VALUE]: Set Delay. Value between 5-500000
- :TRACKer:THREshold [VALUE]: Set Threshold. Value between 1-100
- :TRACKer:ALGOrithm [0|1]: Set Algorithm select.
- :TRACKer:MODE [MIN|MAX]: Set Minimize or Maximize
- :TRACKer:INITiate: Run the tracker

Optimizer Commands

- :TRACKer:OPTImizer:THREshold [VALUE]: Set OPT TEF threshold
- :TRACKer:OPTImizer:ITERations [VALUE]: Set OPT Number of iterations per step. VALUE between 1-1000000
- :TRACKer:OPTImizer:INITiate: Start the optimization process
- :TRACKer:OPTImizer:STOP: Stop the optimizer
- :TRACKer:OPTImizer:ITERATE?: Get one iteration of the optimization process. It will return a line with p1,p2,p3,p4,errors. If errors is -2, the optimizer is still working, so wait a little and try again. If errors is -1, you read all the optimizer output, there is nothing left to read.

Analog Input Commands

- :TRACKer:ANalog:AVERAGEs [VALUE]: Set the number of averages. VALUE between 1-20000
- :TRACKer:ANalog:INITiate: Initiate a read
- :TRACKer:ANalog?: Get the 4 values read (or averaged) separated with comma

Histogram Commands

- :TRACKer:ANalog:HISTogram:TEF:MIN [VALUE]: Set the minimum for TEF
- :TRACKer:ANalog:HISTogram:TEF:MAX [VALUE]: Set the maximum for TEF
- :TRACKer:ANalog:HISTogram:MEASurement:INTERval [VALUE]: Set the measurement interval. VALUE between 100-10000
- :TRACKer:ANalog:HISTogram:MEASurement:ITERations [VALUE]: Set the measurement iterations. VALUE between 1000-1000000
- :TRACKer:ANalog:HISTogram:INITiate?: Start the histogram and return a line with 100 values.

TEF Commands

- :TRACKer:TEF:A [A0],[A1],[A2],[A3],[A4]: Set A for TEF.
- :TRACKer:TEF:C [C1],[C2],[C3],[C4]: Set C for TEF.
- :TRACKer:TEF:B [B0],[B1],[B2],[B3],[B4]: Set B for TEF.
- :TRACKer:TEF:N [N1],[N2],[N3],[N4]: Set N for TEF.
- :TRACKer:TEF:ANalog:INITiate: Start the analog reading for TEF
- :TRACKer:TEF:ANalog?: Get the value of the reading, 5 values separated by a comma
- :TRACKer:TEF:RANGE:INITiate: Start the auto ranging for TEF
- :TRACKer:TEF:RANGE?: Returns the detected TEF min and max, separated by a comma

6.4.3 Spinner Mode Commands

- :POLCONtroller:SPINner:PADDle [N,POSITION]: N between 1-6, POSITION is between 0-10000
- :POLCONtroller:SPINner:RATE [RATE]: Set spinner rate. RATE between 1-75000
- :POLCONtroller:SPINner:INITiate: Run spinner rate
- :POLCONtroller:SPINner:INDRift [ON|OFF]: Set input drift on/off
- :POLCONtroller:SPINner:OUDRift [ON|OFF]: Set output drift on/off
- :POLCONtroller:SPINner:DRIFt:RATE [RATE]: Set drift rate (1-10)
- :POLCONtroller:SPINner:DRIFt:STOP: Stop drift
- :POLCONtroller:SPINner:DRIFt:STOP?: Read the value of the STOP initiated previously, returns 4 values (drift 1, 2, 5, 6)

6.4.4 Scrambler & Depolarizer Mode Commands

- :POLCONtroller:SCRAMbler:DEPOLarizer:INITiate: Run scrambler in depolarizer
- :POLCONtroller:SCRAMbler:RATE [RATE]: Set scrambler rate. RATE is between 0-3400
- :POLCONtroller:SCRAMbler:INITiate: Run scrambler

6.4.5 Randomizer Mode Commands

- :POLCONtroller:RANDomizer:DWELL [VALUE]: Set dwell time. No range, must be a double.
- :POLCONtroller:RANDomizer:SOURce [INT|CH1|CH2|CH3|CH4]: Set int or ext. trigger source
- :POLCONtroller:RANDomizer:THREshold [LEVEL]: Set ext. trigger level. No range, must be a double.
- :POLCONtroller:RANDomizer:INITiate: Run randomizer

6.4.6 Paddle Mode Commands

- :POLCONtroller:PADDle [N,POSITION]: Set stage and position. N is between 1-5, POSITION between 0-10000
- :POLCONtroller:PADDle:INITiate: Start paddle mode

6.4.7 Acquirer Mode Commands

- :TRACKer:ACQUirer:MODE [MIN|MAX]: Set the Acquirer mode to minimize or maximize the TEF
- :TRACKer:ACQuirer:DELAY [VALUE]: Set the Acquirer Delay, Value 5-500,000
- :TRACKer:ACQuirer:AVERAGEs [VALUE]: Set the Acquirer Averages, Value 0-16
- :TRACKer:ACQuirer:INITiate: Run the Acquirer

- :TRACKer:ACQuirer:RESult:TEF?: Get the value of the TEF at the end of the Acquirer run
- :TRACKer:ACQuirer:RESult:VOLTages?: Get the value of the NRT-2500 voltages at the end of the Acquirer run (array length 14)

6.5 SCPI Code Sample

```
*IDN?
NewRidgeTech,NRT2500,813,4.3.4
:TRACKER:ACQUIRER:AVERAGES 10
:TRACKER:ACQUIRER:AVERAGES?
10
:TRACKER:ACQUIRER:DELAY 1000
:TRACKER:ACQUIRER:DELAY?
1000
:TRACKER:ACQUIRER:MODE MIN
:TRACKER:ACQUIRER:MODE?
MIN
:TRACKER:ACQUIRER:INITIATE
:TRACKer:ACQuirer:RESult:TEF?
0.004000
:TRACKer:ACQuirer:RESult:VOLTages?
2.866000,23.004000,-21.106000,1.437000,-0.257000,21.914000,9.209000,9.624000,13.272000,-
30.751000,2.002000,-36.137000,-14.724000,11.260000
:POLCONtroller:VOLTages 1,2,3,4,5,6,7,8,9,10,11,12,13,14
:POLCONtroller:VOLTages?
1.000000,2.000000,3.000000,4.000000,5.000000,6.000000,7.000000,8.000000,9.000000,10.000000,11.000000
,12.000000,13.000000,14.000000
:TRACKER:ACQUIRER:MODE MAX
:TRACKER:ACQUIRER:MODE?
MAX
:TRACKER:ACQUIRER:INITIATE
:TRACKer:ACQuirer:RESult:TEF?
6.102000
:TRACKer:ACQuirer:RESult:VOLTages?
26.421000,19.248000,-
11.777000,14.847000,32.149000,12.876000,6.228000,9.526000,20.128000,22.659000,30.125000,14.724000,-
13.687000,12.416000
```

7. Firmware Update

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

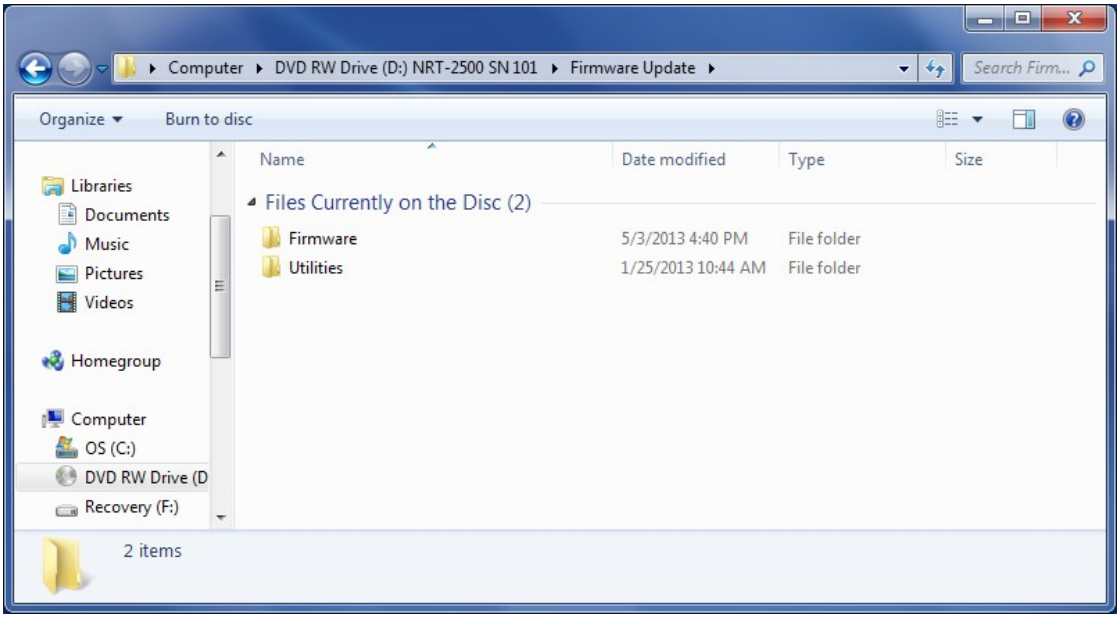

Figure 45: The Firmware folder on the NRT-2500 software CD.

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.

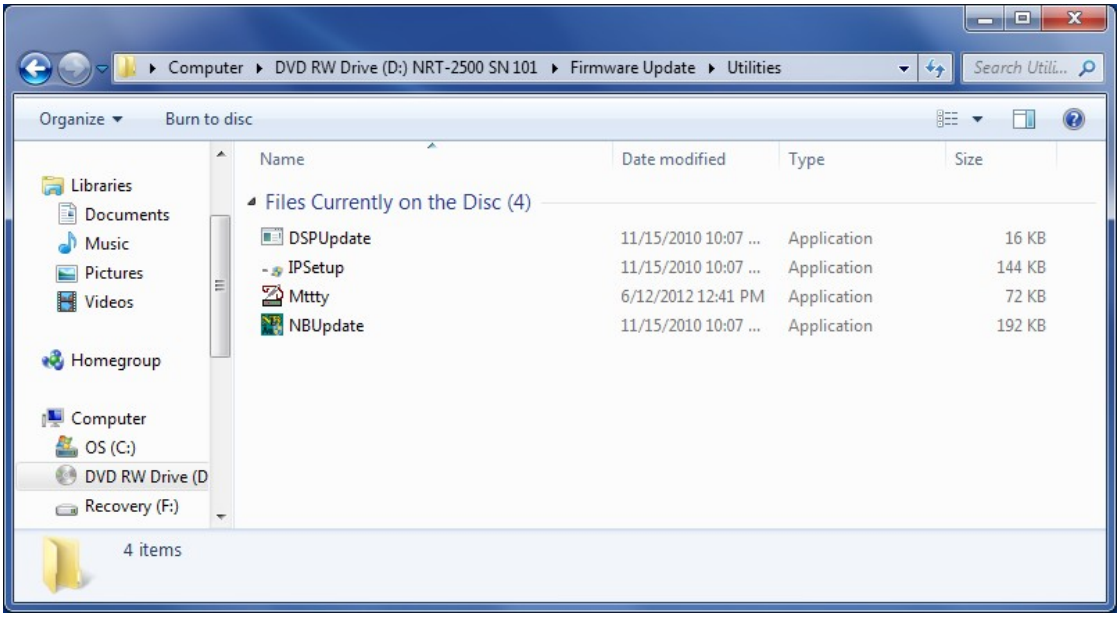

Figure 46: The Utilities folder in the Firmware Update folder.

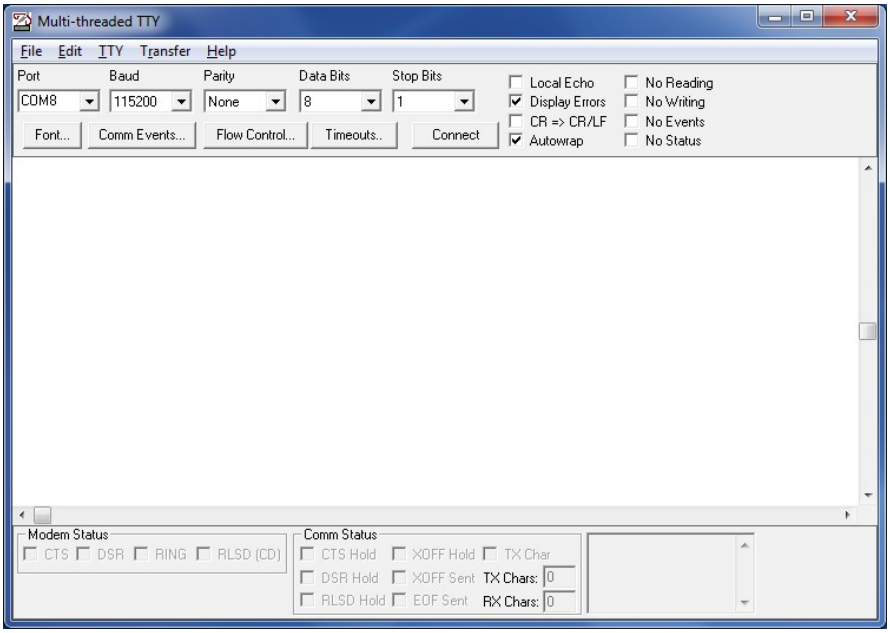

Figure 47: The terminal application. Select the COM port and set the font settings.

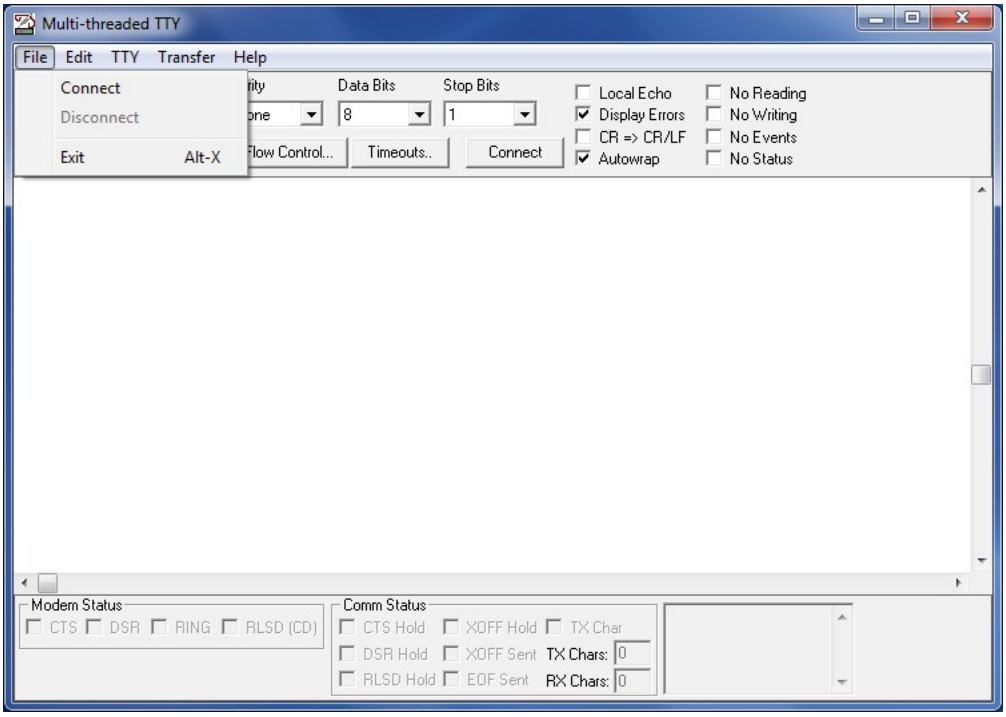

Figure 48: From the File menu select Connect to establish the connection to the selected COM port.

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.

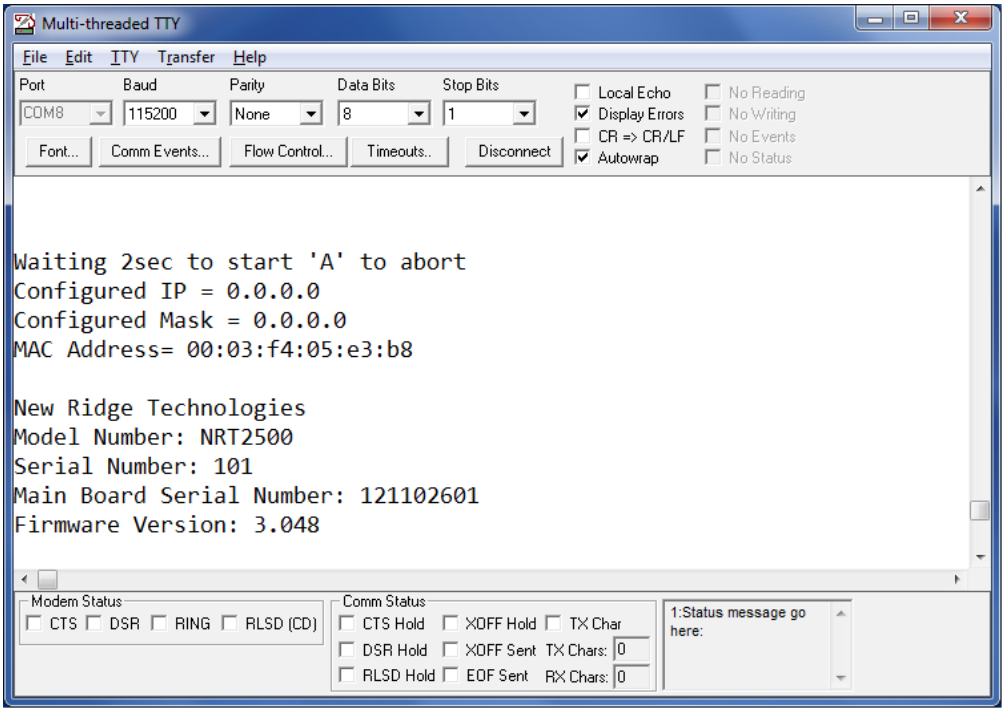

Figure 49: The start-up procedure of the NRT-2500.

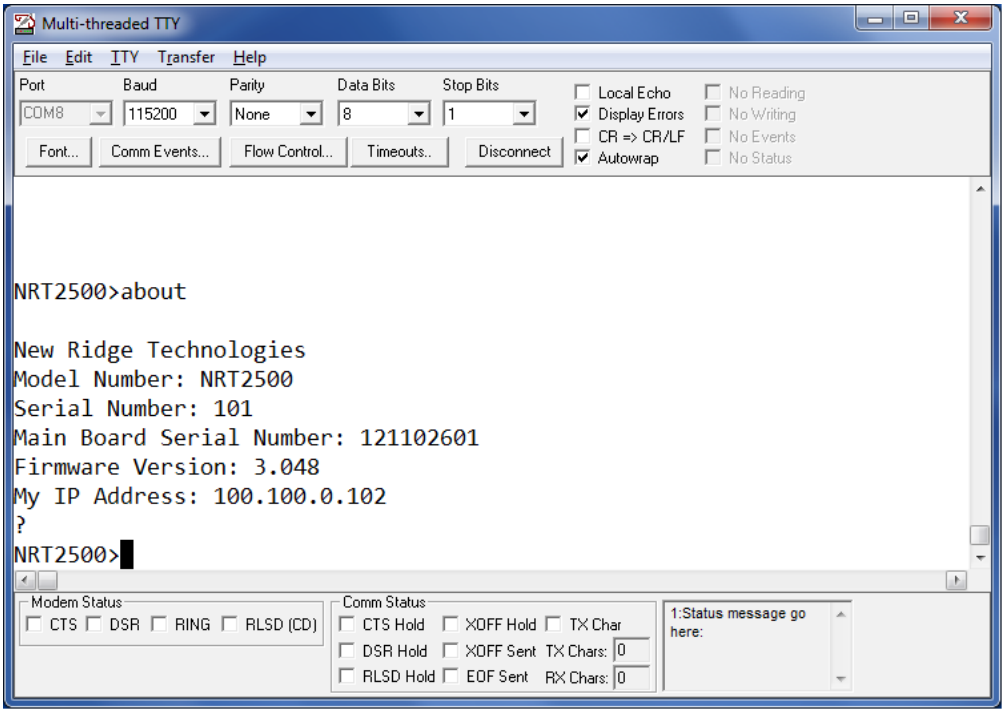

Figure 50: Execute the ABOUT command. The response includes the serial number, the firmware version and the IP address.

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.

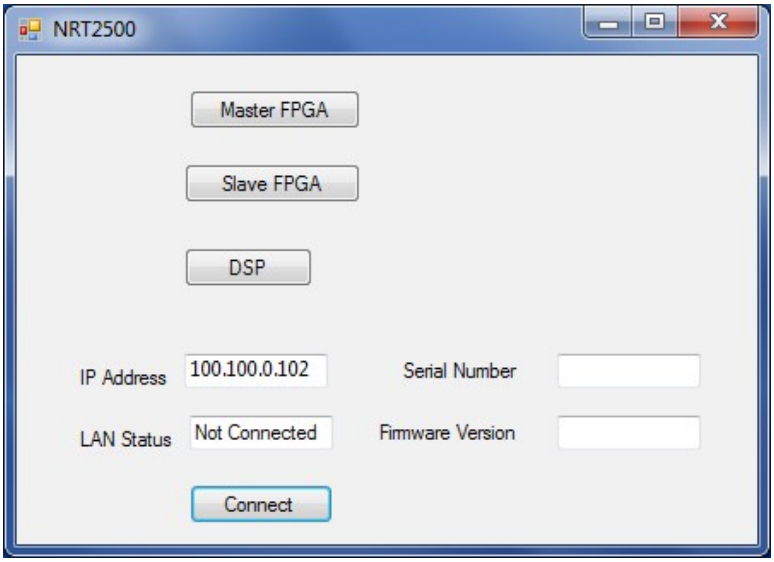

Figure 51: the DSPUpdate interface, enter the IP address and press the CONNECT button to continue.

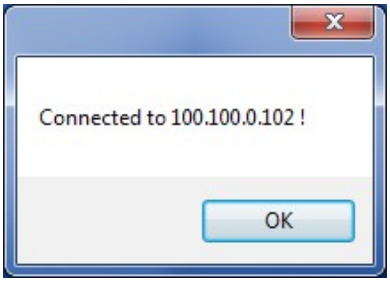

Figure 52: The DSPUpdate dialog box – confirm that the NRT-2500 is connected and press OK.

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.

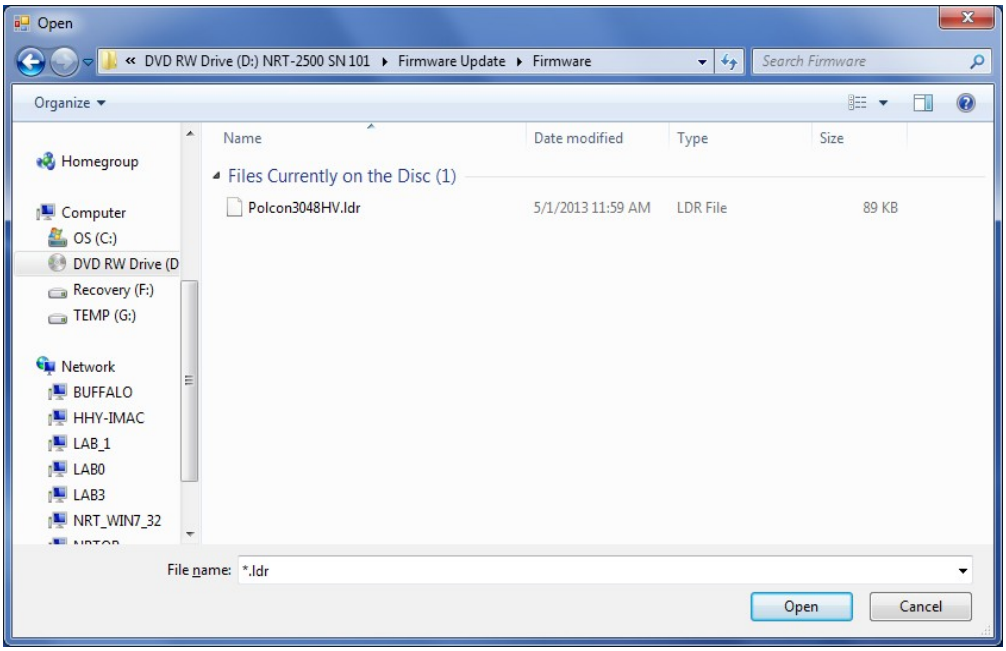

Figure 53: Select the firmware file from the firmware folder on the software CD.

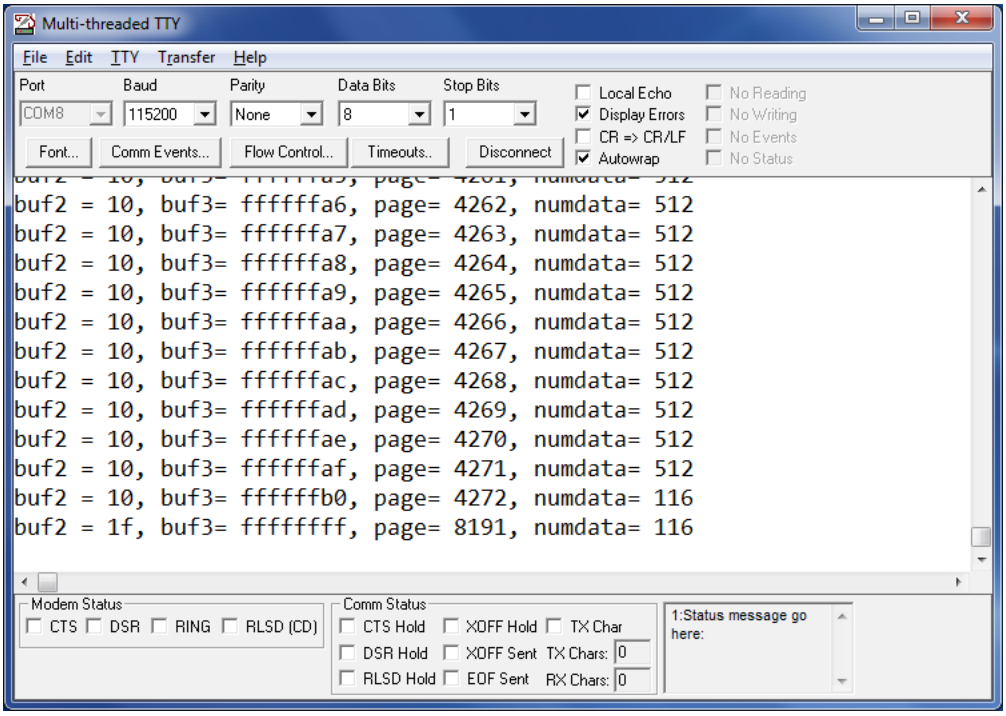

Figure 54: Follow the firmware update execution on the terminal screen. When the update has been completed a dialog window will open.

Figure 55: When the update has been completed a dialog window will open, stating the page count. Press the OK button to proceed.

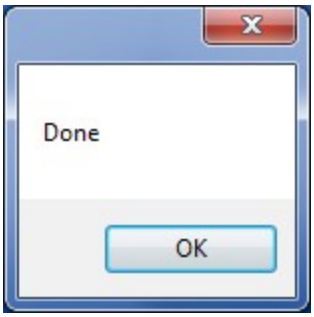

Figure 56: Another dialog window will now open, stating the update procedure is done. Press the OK button.

Repeat the procedure shown in Figure 53 through Figure 56 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 46). A dialog window will appear requesting the IP address for the NRT-2500:

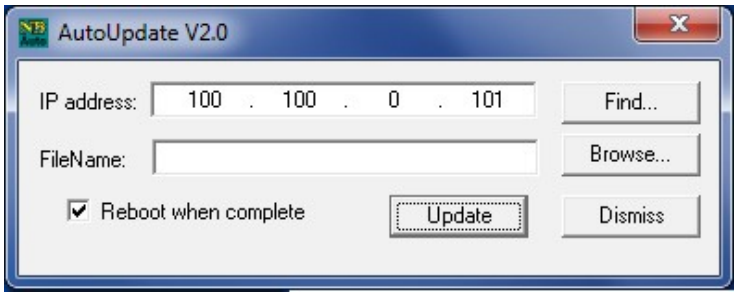

Figure 57: The NBUpdate utility dialog window. The IP address might not be the correct one. Press the Browse window to search the available IP addresses.

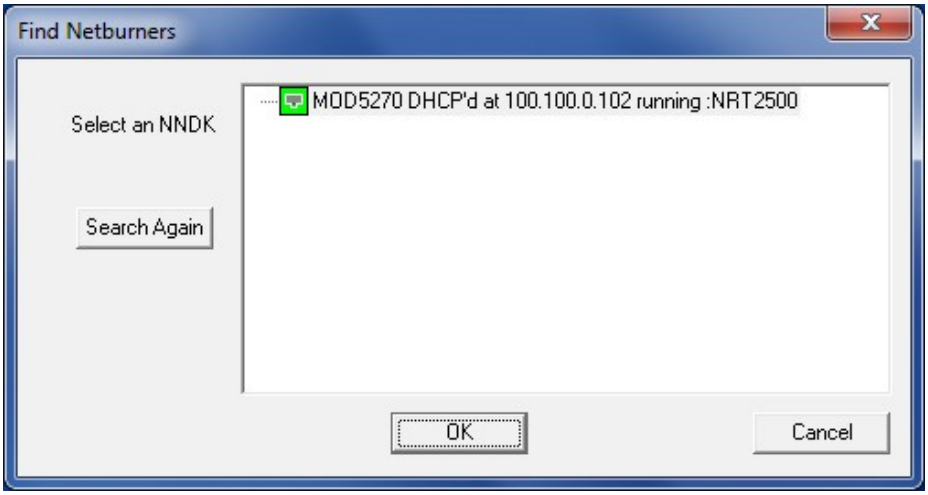

Figure 58: The search results will include a list of connected devices. Choose the device in use and click OK.

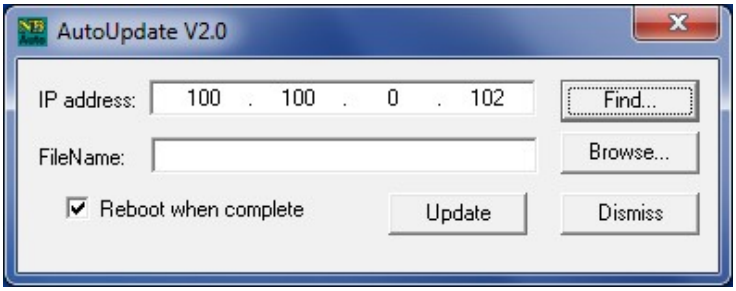

Figure 59: The selected device IP address will now show on the top line of the screen shown here. Click on Browse to select the .s19 extension file required for updating the NRT-2500.

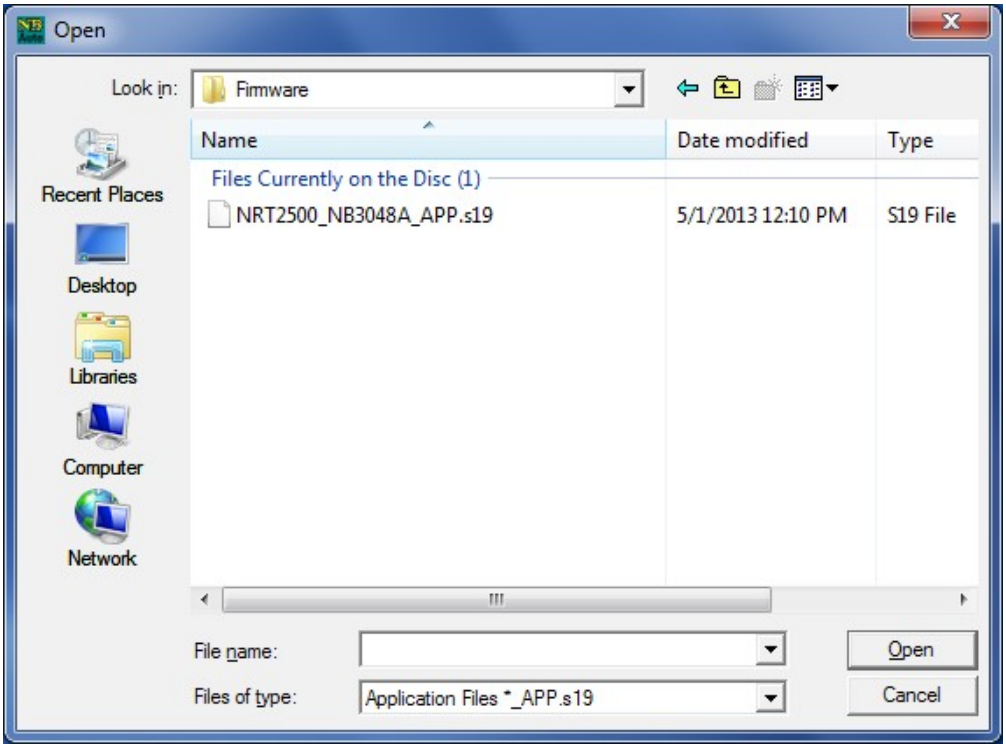

Figure 60: Select the .s19 extension file from the list and click Open. The file name in the previous figure will be updated.

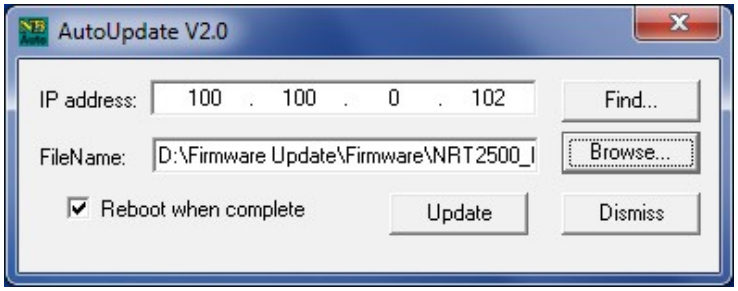

Figure 61: Click the Update button. The update process will start, you can monitor the update progress on the progress bar as well as on the terminal screen.

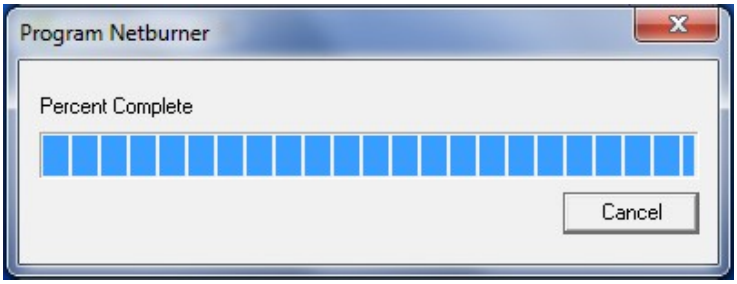

Figure 62: The progress bar will show up, to monitor the progress of the update process

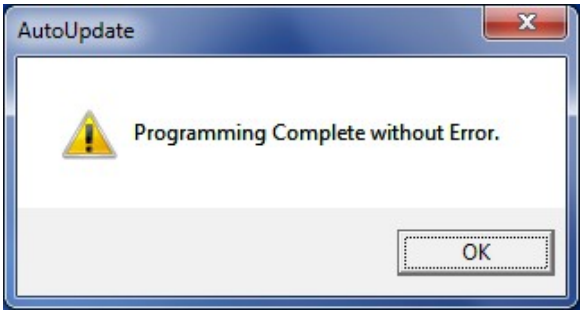

Figure 63: When the update process has been completed, the progress bar window will be replaced by the window shown here.

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