



GreenSeeker RT100 Data Collection and Mapping Unit Operating Manual



GreenSeeker[®]
Variable Rate Application and Mapping System

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The GreenSeeker RT100 Data Collection and Mapping Unit
Congratulations on your purchase of a GreenSeeker RT100 Data Collection and Mapping unit. This manual provides the description and operation of both the unit and the data capture program.

Introduction

The GreenSeeker RT100 Data Collection and Mapping Unit is a tool for crop research and consulting that provides precision measurement and data logging of the Normalized Difference Vegetative Index (NDVI) and Red to Near Infrared Ratios of plant material. These data points can be used in conjunction with other agronomic references to index basic nutrient response, crop condition, yield potential, stress, pest and disease impact in a quantitative manner. The unit can be used to monitor changing field (plant/crop) conditions during the growing season and the effects of different levels of an input compared to a local standard.

The GreenSeeker Optical Sensor utilizes NTech's second-generation optical sensor technology. The Unit generates light at two specific wavelengths and measures the light reflected off the target (typically plants in soil). The microprocessor within the Sensor analyzes the reflected light and calculates the results. The data from the Sensor is transmitted serially.

The supplied NTech Capture[®] program running on a PDA is used to display the output in real-time and also logs the output data to a file. This data may also be transferred to a desktop computer for analysis. There are additional features available for users using other tools to log data. See *Appendix A: Data Output Options* for more information.

Additional Items Required for Mapping (Geo-Referencing) Data

- Farm Works Farm Site Mate VRA[®] Data logging Pocket PC software or other PDA/Pocket PC software that has a feature to log GreenSeeker data
- GPS Receiver - Can be a WAAS CF Card type receiver or higher resolution receiver. Non-CF card slot receiver requires use of a CF to Serial adapter for connecting to PDA

Included Accessories

- NTech Capture[®] program for Pocket PC[™] 2002/2003 (for Sensor data collection only, does not geo-reference data for creating maps)
- Auto adapter (for Powered Cradle only)

Quick Start for NTech Capture[®]

- Connect serial cable to the connector on the bottom of the PDA or Powered Cradle and the Control Box.
- Turn on the power to the Sensor (switch is located on the Control Box).
- Turn on your PDA and go to the Start menu. Click on Programs then the NTech Capture icon to open the program.
- Select FP_NDVI (Farmer Practice) or RS_NDVI (Nitrogen Rich Strip) by clicking on Activate. Button will change and display Monitoring.
- Select Sensor and Start GreenSeeker.
- Position the Sensor at the beginning of the target region. The Sensor should be roughly parallel to, and 32 to 48 inches above the canopy. Toggle the sample switch ON and traverse the region. At the region boundary, toggle the sample switch OFF.
- When the sample switch is turned OFF, the number displayed in the white box is the average of all readings to that point. Each toggle of the switch logs a new value.
- When you have completed the data collection, go to File and select Save.



Primary Components

Control Box

The control box contains a circuit board to interface the power and switches to the Sensor and external connectors. The 9-pin RS232 connector is for data from the Sensor.

Power Connector

Connects power from the vehicle battery (12VDC in).

Power Switch/Indicator

The switch supplies power to the Sensor and Powered Cradle. The switch will illuminate when power is on.

External Data Port

The serial port allows the collection of data through an RS232 connection using the serial cable provided (Com Port: 38,400 Baud, 8, 1, N, Flow Control: None).

Sensor Port

The Sensor port sends power and commands to the Sensor using the controller cable provided.

Personal Digital Assistant

The Sensor Unit requires a PDA running Pocket PC 2002 or 2003 to display and store the data from the Sensor. Refer to your iPAQ, Recon, or other PDA manual for operating instructions. The NTech Capture[®] program is pre-loaded on the iPAQ and Recon PDA (if included with system).

PDA Cradle

- The Powered Cradle gets its power from the Control Box. It will charge or extend the battery life of the iPAQ if the Power Switch is turned on.
- The Universal Cradle acts only as a mechanical mount for the Recon or other PDA.

Sample Switch

This allows the user to control the data flow and the count of the data collected. A small buzzer located in the control box will sound while the Sample Switch is turned "ON". Position the Sensor over the target before toggling the Sample Switch to avoid erroneous data. (The buzzer can be disabled. See the *Helpful Hints* section for details.)

Sensor

The reflectance readings are taken in this unit. This unit uses internal illumination for use in any lighting condition, day or night. When the unit is on, a red band of light will be observed immediately below the rectangular Sensor window. The Sensor is designed to be 32 to 48 inches over the desired plant/crop canopy to be sensed. The width of the Sensor measurement is a constant 24 inches. The sensing width does not change with height.

Sensor Mount

The Sensor can be mounted to a bracket, tubing or other suitable surface using 5/16" hardware. Mount the Sensor parallel to the target.

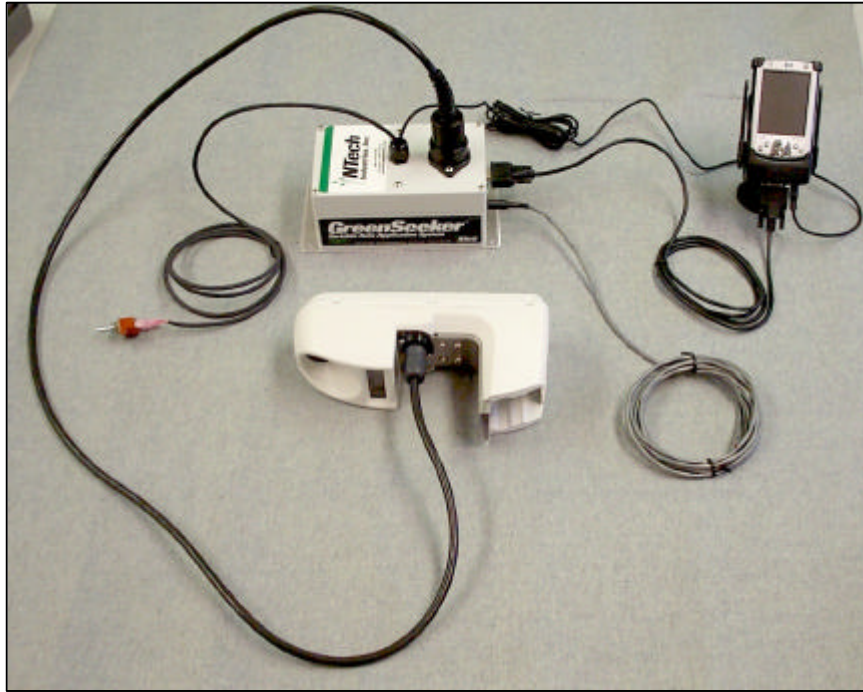


Connections

Verify the connections between the Sensor, the Control Box and the PDA per the figures below.

Cable Connections

The Control Box is connected to the Powered Cradle/iPAQ with a DB9 (RS232) serial cable. The small black power cable must be plugged in for the Powered Cradle to get its power from the Control Box.



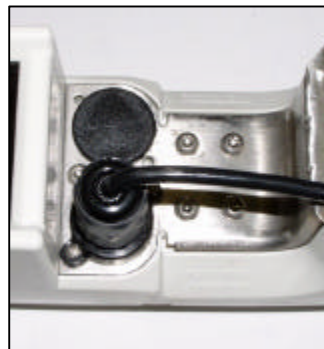
The gray battery cable needs to be cut to an appropriate length and attached to the vehicle battery using the supplied ring terminals.

The sample switch should be mounted within reach of the vehicle driver to start/stop data collection.

Note: The Sensor and Control Cable are weatherproof, but the Control Box, cradle, and cables are intended for mounting in a dry location.

Sensor Connection

A 12-pin connector mates to the Sensor with two captive screws. Be sure it is mounted in the lower port shown below. *Do not connect to the adjacent connector port.*



Software Information

If you are geo-referencing data with Farm Works Farm Site Mate VRA or other PDA software, see specific information provided with that software.

NTech Capture[®] is a software program developed to capture the readings from the GreenSeeker Hand Held Sensor, display the current reading, and store them for later data analysis or to make fertilizer recommendations. Prior to shipment, the software was loaded onto your iPAQ.

NOTE: If the battery of the iPAQ discharges completely, you will have to reload the software.

The software is designed to operate like most Windows programs. Saving and opening a new file are similar to the operation of a word processing program. Make certain you note where you save the files on the iPAQ.



There are two modes available for logging data

Log Strips or Log Plots

The strip logging mode is for collecting sensor readings from large strips with different fertilizer levels. More specifically, it is for comparing nitrogen rich strips (NRS_NDVI) with lower rate, farmer practice strips (FP_NDVI) to determine recommendations.

The plot logging mode is for collecting readings from multiple “plots” and is better suited to data analysis.

Log Strips Mode

To Log Strips:

- Turn on the power switch located on the Control Box.
- Turn on your iPAQ and go to the Start menu. Click on Programs then the NTech Capture icon to open the program.
- Select Non Ref (Farmer Practice) or Reference (N Rich Strip) by tapping on selection. Button will change and display Monitoring..
- Select Sensor and Start GreenSeeker.
- Position the Sensor at the beginning of the target region. Press the trigger and traverse the region. At the end, release the trigger. Data will be recorded to the file when the trigger is pressed.
- When the trigger is released the number displayed in the white box is the average of all readings to that point.
- When you have completed the data collection, go to File and select Save.



Data: Log Strips Mode

Once saved, you can view the data collected by simply selecting the name of the file in the "Field/File Name:" box.

The *filename.txt* file contains three pieces of information:

Average FP_NDVI value

Average RS_NDVI value

Maximum NDVI from the rich strip (RS).

The data displayed can be used to generate a nitrogen recommendation when used in conjunction with the Oklahoma State University webpage:

<http://www.soiltesting.okstate.edu/SBNRC/SBNRC.php>

If you switch between modes and you have not saved the data file, you will be prompted to save the file.

NOTE: Once you switch modes or close the program you cannot open an existing file and save more measurements to it. After saving a data file, you can create a new file by selecting File and New. This will clear the data cells and allow you to collect readings for a new field.

The following is a sample of the text file for reference:

filename.txt

FP_NDVI :

AVG = 0.67112, STDEV = 0.11562

RS_NDVI :

AVG = 0.77964, STDEV = 0.01023

MAX_NDVI :

Max_NDVI = 0.77740

Log Plots Mode

To Log Plots:

- Turn on the power switch located on the Control Box.
- Turn on your iPAQ and go to the Start menu. Click on Programs then the NTech Capture icon to open the program.
- Select Sensor and Start GreenSeeker.
- Click on the Log Plots tab.
- Position the Sensor at the beginning of the target region. Press the trigger and traverse the region. At the end, release the trigger. Data will be recorded to the file when the trigger is pressed.
- When the trigger is released the software will display:
 - Sample No.
 - NDVI
 - Avg NDVI
- Each time you press the trigger switch the plot increments by one.
- When you have completed the data collection, go to File and select Save.



Data Log Plots Mode

Three files are created when data is saved. Each file is automatically saved to the following folder: My Device\My Documents\NtechCapture.

<i>filename.txt</i>	file contains all of the data collected
<i>filenameAvg.txt</i>	file contains only an average NDVI for each sample (plot)
<i>filenameDiag.txt</i>	contains all the diagnostic information for the sensor (typically empty)

If you switch between modes and you have not saved the data file, you will be prompted to save the file.

NOTE: Once you switch modes or close the software you cannot open a created file and save more measurements to it. After saving a data file, you can create a new file by tapping File and New (similar to Log Strips mode). This will clear the data cells and allow you to collect readings for a new field.

Log Plots Mode Data Management

The data collected with the GreenSeeker Hand Held may be written to the iPAQ's internal memory or a removable SD (Secure Digital) memory card. It can then be exported to your PC by syncing the iPAQ with your computer.

filename.txt and *filenameAvg.txt* are written to a comma-delimited ASCII text file suitable for direct import to Microsoft Excel.

- Download the data file(s) to your computer by syncing the iPAQ with your computer.
- Then launch Excel and select Open from the File menu.
- Change File Types to All Files and select your .txt data file.
- Select Delimited Text, delimited by commas and spaces. This will import data into separate columns in the spreadsheet file.

CAUTION: If the iPAQ has not been charged for several days, the captured data on the iPAQ may be lost. *It is critical that you copy the data from the iPAQ and save it to your PC or a Secure Digital card.*

The following is a sample of the text files for reference:

filename.txt

```
Time(ms), Smp1, Cnt, NDVI, selected_VI,  
11000, 0, 17, 0.700, 0.171  
11100, 0, 18, 0.730, 0.156  
11200, 0, 19, 0.720, 0.157  
11300, 0, 20, 0.740, 0.148  
11400, 1, 1, 0.740, 0.149  
11500, 1, 2, 0.730, 0.156  
11600, 1, 3, 0.730, 0.153  
11750, 1, 4, 0.720, 0.156  
11800, 1, 5, 0.720, 0.161
```

filenameAvg.txt

```
GS Time(ms), Sample, Count, NDVI, selected_VI  
18570, 1, 12, 0.78517, 0.78517  
21570, 2, 13, 0.78031, 0.78031  
24570, 3, 9, 0.77944, 0.77944
```

filenameDiag.txt

```
*** Sensor Summary *****  
Model.....: 500/505  
Hardware Rev..: G*-J/B-D J  
Software Ver...: 1.6.6  
Compiled.....: Feb 14 2005  
Serial Num....: J1019  
Module Addr...: [19]  
Sensor Mode...: [HH]
```

Helpful Hints

- **CAUTION:** If the PDA has not been charged for several days, the captured data on the PDA may be lost. It is critical that you pull the data off the PDA and save it to your PC or a removable memory card.
- Charge the PDA's battery completely before going to the field. The HP iPAQ battery is fully charged when the amber LED is on solid.
- Make sure to clear enough memory on your PDA before going to the field.
- Make sure the Sensor is approximately parallel to and 32-48 inches from the area being sensed.
- Before going to the field, test the Sensor using the steps outlined in the Sensor Performance section.
- To disable the buzzer:
 1. Open the Control Box by removing the four screws in the corners with a Phillips head screwdriver.
 2. Carefully separate the two halves of the box making sure the cables remained plugged in.
 3. Remove the black jumper from J5 on the yellow connector PCB (ASSY 400-1-014).
 4. Close the Control Box and reinstall the four screws.
- If you do not have a current version of Microsoft ActiveSync, go to <http://www.microsoft.com/downloads/> and select ActiveSync from the "Product/Technology" pull-down menu. Follow the instructions for downloading and installing the software.

Design Revisions

Continuing a policy of research and development, NTech Industries, Inc. and its subsidiaries reserve the right of price, product or design changes without notice of obligation.

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U.S. Patent No: 5,585,626 5,296,702 5,389,781

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APPENDIX A: Data Output Options

For special applications, the user can change the output of the Sensor. From the Outputs Menu, you can change the speed, format, and type of data. *Some of these options are not compatible in Capture, but are useful for proprietary data logging systems.*

Connect the serial cable to a PC and run HyperTerminal with the following Com settings:
38,400 Baud, Data bits: 8, Parity: None, Stop bits: 1 (38400,8,N,1).
Flow control: None.

Turn on the Sensor and the following header will display:

```
*** Sensor Summary *****
Model.....: 500/505
Hardware Rev.: G*-J/B-D  J
Software Ver..: 1.6.6
Compiled.....: Feb 14 2005
Serial Num....: J
Module Addr...: [01]
Sensor Mode...: [HH]
```

Type “m” to bring up the Main Menu:

```
--- M A I N   M E N U  -----
c. AutoCalibrate
u. Select HH or APP ....: [HH]
s. Set Sensor Address ..: [01]
p. Print Parameter Summary

o. OUTPUTS Menu
e. EXTRAS Menu
d. DIAGNOSTICS Menu
q. Quit
```

Type ‘o’ to select the Outputs Menu.

CAUTION: You should not need any of the other menu functions. ***Especially, do not select AutoCalibrate, as the sensor would lose the calibration, and no longer function correctly; it would then need to be returned to the factory.***

For special applications, the user can change the output of the Sensor. Type “o” to bring up the Outputs Menu:

```
--- O U T P U T S   M E N U  -----
1. Set Data output interval ..: 100ms
2. Set Data Smoothing Value ..: 1
3. Select Output Variables ...: [Standard]
4. Select Data Delimiter .....: [comma]
5. Select Vegetation Index ...: [NDVI]
6. Enable Graphing Mode .....: [OFF]
9. Reset all modes to default

m. MAIN menu
q. Quit
```

1. **Data Output Interval** ranges from 20ms to 1500ms (50Hz - 0.33Hz). This output interval might be decreased to gather data faster, which is useful if moving at higher speeds. It may be increased to match other data logging equipment or to limit the amount of data gathered.
2. **Data Smoothing** may occasionally be useful to smooth (filter) the data in a highly variable environment. A setting of 1 is normal output; higher values average the data over longer intervals.
3. **Output Variables.** For higher throughput on the port, the output stream may be reduced to simply NDVI only as a 3-digit integer instead of the five data fields normally output.
4. The **Data Delimiter** option can change the data output text file to either comma or tab delimited. Tab delimited is much easier to import into Microsoft Excel.
5. **Vegetation Index.** Two values are generally supplied by the Sensor. The first output is always NDVI. The second output may be selected: NDVI, SA-NDVI, WDR-NDVI, RVI, IRVI. See Appendix for an explanation of the various VIs.
6. **Graphing Mode.** Useful primarily for testing, but allows a graph and min-max ranges to be seen on screen, and makes trends in the data more obvious.
7. **Reset to Defaults.** Changes all of the modes back to a standard condition, compatible with the PDA Capture program.

Press “m” to return to the Main Menu or press “q” to quit, putting the Sensor back in the mode to output data.

APPENDIX B: How To Re-install or Update NTech Capture[®]

First, you will need to determine what version of Windows Mobile[™] for Pocket PC Operating System you are running. Currently there are three different versions: Pocket PC 2002 (WinCE 3.x), Pocket PC 2003 (WinCE 4.x, also known as Windows Mobile 3.0), and Windows Mobile 5.0. To determine which Pocket PC version is installed on your iPAQ:

- Find the small decal attached to the back of the iPAQ with the Operating System version and a serial number written on it, OR
- Turn on the iPAQ:
Click: Start -> Settings -> System -> About
The About screen displays:
"Microsoft Pocket PC Version x.x.x..." , or "Microsoft Windows Mobile Version x,x"

Pocket PC 2002 is indicated by Version 3.x.x

Pocket PC 2003 is indicated by Version 4.x.x

Windows Mobile is indicated by Version 5.0

Note: All CD Packets or Downloadable installation files contain "ReadMe" files for additional help if necessary.

For Pocket PC 2002:

- Connect your iPAQ PDA to your computer using Microsoft ActiveSync[™].
- Once Microsoft ActiveSync[™] indicates that the iPAQ is connected, insert the NTech Capture[®] CD into your computer or download the version you would like to install from the NTech Industries website. **Note: V2.1.0 is the last compatible NTech Capture version available for systems running Pocket PC 2002.**
 - If using CD, from the Windows Taskbar, select Start | Run. Once the Run window opens, type:
D:\Ntech Capture\2002\Install.exe (where D: is the CD drive)
 - If installing from the web, double click on the downloaded files and follow the on-screen instructions.
- If prompted to overwrite a file on the iPAQ, select <Yes To All>.
- Press the soft-reset button on the iPAQ (located on the bottom or rear of the iPAQ).

For Pocket PC 2003:

- Connect your iPAQ PDA to your computer using Microsoft ActiveSync[™].
- Once Microsoft ActiveSync[™] indicates that the iPAQ is connected, insert the NTech Capture[®] CD into your computer or download the version you would like to install from the NTech Industries website.
 - If using CD, from the Windows Taskbar, select Start | Run. Once the Run window opens, type:
D:\Ntech Capture\2003\Install1.exe (where D: is the CD drive)
 - If installing from the web, double click on the downloaded files and follow the on-screen instructions.

- The Microsoft VB Runtimes Installer window will open. Click on the Next button and follow the on-screen instructions.
- The NTech Capture Installer window will open. Click on the Next button and follow the on-screen instructions.
- If prompted to overwrite a file on the iPAQ, select <Yes To All>.
- Press the soft-reset button on the iPAQ (located on the bottom or rear of the iPAQ).

For Windows Mobile 5.0:

- Connect your iPAQ PDA to your computer using Microsoft ActiveSync™.
- Once Microsoft ActiveSync™ indicates that the iPAQ is connected, insert the NTech Capture® CD into your computer or download the version you would like to install from the NTech Industries website.
 - From the Windows Taskbar, select Start | Run. Once the Run window opens, type:
D:\NTech Capture\2003\Install1.exe (where D: is the CD drive)
 - If installing from the web, double click on the downloaded files and follow the on-screen instructions.
- The Microsoft VB Runtimes Installer window will open. Click on the Next button and follow the on-screen instructions.
- From the Windows Taskbar, select Start | Run. Once the Run window appears, type:
D:\NTech Capture\2003\Install2.exe (where D: is the CD drive)
- The NTech Capture Installer window will open. Click on the Next button and follow the on-screen instructions.
- If prompted to overwrite a file on the iPAQ, select <Yes To All>.

Press the soft-reset button on the iPAQ (located on the bottom or rear of the iPAQ).

APPENDIX C: Vegetation Indices Available in the GreenSeeker® Sensor

There are several vegetation indices defined, evolving from more than thirty years of research in remote sensing and aerial imaging. In precision agriculture applications, two of the most commonly used indices are the Ratio and the Normalized Difference (NDVI), each comparing the relative reflectance of plant

material and soils at two wavelengths. Additional modifications of the indices have been developed to compensate for various conditions of the plant canopy and background soil.

Several indices are available from the NTech GreenSeeker® Sensors. The sensor always outputs NDVI, plus an additional index (default is IRVI), which makes it possible to *compare indices on the same data at the same time*. This can be changed by connecting the sensor directly to a computer. Once selected, the output options are stored in the sensor, and remain in effect until explicitly changed.

NDVI	Normalized Difference Vegetation Index
SA-NDVI	Soil Adjusted
WDR-NDVI	Wide Dynamic Range
RVI	Ratio
IRVI	Inverse Ratio

Index Equations

The wavelength bands are in the visible (red, 660nm) and infra-red (NIR, 770nm) regions of the spectrum. Half-power bandwidths are approximately 25nm.

$ndvi = \frac{r_{NIR} - r_{VIS}}{r_{NIR} + r_{VIS}}$	$rvi = \frac{r_{NIR}}{r_{VIS}}$
$sandvi = \left(\frac{r_{NIR} - r_{VIS}}{r_{NIR} + r_{VIS} + L} \right) (1 + L)$	$irvi = \frac{r_{VIS}}{r_{NIR}}$
$wdrndvi = \frac{ar_{NIR} - r_{VIS}}{ar_{NIR} + r_{VIS}}$	

The 'a' and 'L' values for the SA and WDR indices, respectively, are entered and stored in the Sensor. SA-NDVI reverts to NDVI if L = 0, and WDR-NDVI reverts to NDVI if a = 1. A typical value for a is 0.1; a typical value for L is 0.5.

References

University of Sheffield Remote Sensing: GEO6370 Vegetation Indices
<http://www.shef.ac.uk/~bryant/6370/veg/vegsoil.htm>

U.S. Water Conservation Laboratory: How a Vegetation Index Works
<http://www.uswcl.ars.ag.gov/epd/remsen/Vi/Vlworks.htm>

Mark Servilla: The First Steps to Understanding Agriculture Remote Sensing
<http://www.eonline.com/modernagsite/archives/Servilla.html>

USGS: Wide Dynamic Range VI application
<http://www.gap.uidaho.edu/Bulletins/12/The Wide Dynamic Range Vegetation Index.htm>

BGR: A Comparison of Slope-Based Vegetation Indices for Agricultural Applications
<http://www.biogeorecon.com/vegindcs.htm>

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