Trimbale Navigation Limited
Trimbale Agriculture
10355 Westmoor Drive
Suite #100
Westminister, CO 80211
USA
trimble_support@trimble.com
www.trimble.com

Legal Notices
Copyright and Trademarks
© 2010, Trimble Navigation Limited. All rights reserved.

Trimble, the Globe & Triangle logo, AgGPS, FmX, GreenSeeker, Nomad, and Recon are trademarks of Trimble Navigation Limited, registered in the United States and/or other countries.

Microsoft, ActiveSync, Windows, Windows Mobile, and Windows Vista are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

All other trademarks are the property of their respective owners.

This product is covered by the following patents: 5,585,626, 5,296,702, and 5,389,781.

Release Notice
This is the April 2010 release (Revision M) of the GreenSeeker RT200 System Installation and Operation Guide, part number 500-1-032. It applies to version 1.00 of the GreenSeeker RT200 software.

LIMITED WARRANTY TERMS AND CONDITIONS
Product Limited Warranty
Subject to the following terms and conditions, Trimble Navigation Limited ("Trimble") warrants that for a period of one (1) year from date of purchase this Trimble product (the "Product") will substantially conform to Trimble's publicly available specifications for the Product and that the hardware and any storage media components of the Product will be substantially free from defects in materials and workmanship.

Software Fixes
During the limited warranty period you will be entitled to receive such Fixes to the Product software that Trimble releases and makes commercially available and for which it does not charge separately, subject to the procedures for delivery to purchasers of Trimble products generally. If you have purchased the Product from an authorized Trimble dealer rather than from Trimble directly, Trimble may, at its option, forward the software Fix to the Trimble dealer for final distribution to you.

For purposes of this warranty the following definitions shall apply: (1) "Fixes" means an error correction or other update created to fix a product limitation, which shall control over the terms and conditions set forth in this limited warranty.

Software Fixe	

LIMITATION OF LIABILITY
TRIMBLE's ENTIRE LIABILITY UNDER ANY PROVISION HEREIN SHALL BE LIMITED TO THE AMOUNT PAID BY YOU FOR THE PRODUCT TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHAL\nTRIMBLE OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHATSOEVER UNDER ANY CIRCUMSTANCE OR LEGAL THEORY RELATING IN ANY WAY TO THE PRODUCTS, SOFTWARE AND ACCOMPANYING DOCUMENTATION AND MATERIALS (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF DATA, OR ANY OTHER PECUNIARY LOSS), REGARDLESS OF WHETHER TRIMBLE HAS BEEN ADVISED OF THE POSSIBILITY OF ANY SUCH LOSSES.

How to Obtain Warranty Service
To obtain warranty service for the Product, please contact your local Trimble authorized dealer. Alternatively, you may contact Trimble to request warranty service at +1-408-481-6940 (24 hours a day) or e-mail your request to trimble_support@trimble.com. Please be prepared to provide:

- your name, address, and telephone numbers
- proof of purchase
- a copy of this Trimble warranty
- a description of the nonconforming Product including the model number
- an explanation of the problem

The customer service representative may need additional information from you depending on the nature of the problem.

Warranty Exclusions and Disclaimer
This Trimble limited warranty shall only apply in the event and to the extent that (a) the Product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with Trimble's applicable operator's manual and specifications; and, (b) the Product is not modified or misused. This Trimble limited warranty shall not apply to, and Trimble shall not be responsible for, defects or performance problems resulting from (i) the combination or utilization of the Product with hardware or software products, information, data, software, interfaces, or devices not made, supplied, or supported by Trimble; (ii) the operation of the Product under any specification other than, or in addition to, Trimble's standard specifications for its products; (iii) the unauthorized installation, modification, or use of the Product; (iv) damage caused by; accident, lightning, or other electrical discharge, fresh or salt water immersion or spray (outside of Product specifications); or exposure to environmental conditions for which the Product is not intended; (v) normal wear and tear on consumable parts (e.g., batteries); or (vi) cosmetic damage. Trimble does not warrant or guarantee the results obtained through the use of the Product, or that software components will operate error free.

NOTICE REGARDING PRODUCTS EQUIPPED WITH TECHNOLOGY CAPABLE OF TRACKING SATELLITE SIGNALS FROM SATELLITE BASED AUGMENTATION SYSTEMS (SBAS) (WAAS/EGNOS, AND MSAS), OMNISTAR, GPS, MODERNIZED GPS OR GLONASS SATELLITES, OR FROM IALA BEACON SOURCES: TRIMBLE IS NOT RESPONSIBLE FOR THE OPERATION OR FAILURE OFOPERATION OF ANY SATELLITE BASED POSITIONING SYSTEM OR THE AVAILABILITY OF ANY SATELLITE BASED POSITIONING SIGNALS.

The foregoing limited warranty terms state Trimble's entire liability, and your exclusive remedies, relating to the Trimble Product. Except as otherwise expressly provided herein, the Product, and accompanying documentation and materials are provided "AS-IS" and WITHOUT EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, TITLE, AND NONINFRINGEMENT. THE STATED EXPRESS WARRANTIES ARE IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF TRIMBLE ARISING OUT OF OR IN CONNECTION WITH, ANY PRODUCT. BECAUSE SOME STATES AND JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES, THE ABOVE LIMITATION MAY NOT APPLY OR FULLY APPLY TO YOU.

Limitation of Liability

The customer service representative may need additional information from you depending on the nature of the problem.

Warranty Exclusions and Disclaimer
This Trimble limited warranty shall only apply in the event and to the extent that (a) the Product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with Trimble's applicable operator's manual and specifications; and, (b) the Product is not modified or misused. This Trimble limited warranty shall not apply to, and Trimble shall not be responsible for, defects or performance problems resulting from (i) the combination or utilization of the Product with hardware or software products, information, data, software, interfaces, or devices not made, supplied, or supported by Trimble; (ii) the operation of the Product under any specification other than, or in addition to, Trimble's standard specifications for its products; (iii) the unauthorized installation, modification, or use of the Product; (iv) damage caused by; accident, lightning, or other electrical discharge, fresh or salt water immersion or spray (outside of Product specifications); or exposure to environmental conditions for which the Product is not intended; (v) normal wear and tear on consumable parts (e.g., batteries); or (vi) cosmetic damage. Trimble does not warrant or guarantee the results obtained through the use of the Product, or that software components will operate error free.

NOTICE REGARDING PRODUCTS EQUIPPED WITH TECHNOLOGY CAPABLE OF TRACKING SATELLITE SIGNALS FROM SATELLITE BASED AUGMENTATION SYSTEMS (SBAS) (WAAS/EGNOS, AND MSAS), OMNISTAR, GPS, MODERNIZED GPS OR GLONASS SATELLITES, OR FROM IALA BEACON SOURCES: TRIMBLE IS NOT RESPONSIBLE FOR THE OPERATION OR FAILURE OFOPERATION OF ANY SATELLITE BASED POSITIONING SYSTEM OR THE AVAILABILITY OF ANY SATELLITE BASED POSITIONING SIGNALS.

The foregoing limited warranty terms state Trimble's entire liability, and your exclusive remedies, relating to the Trimble Product. Except as otherwise expressly provided herein, the Product, and accompanying documentation and materials are provided "AS-IS" and WITHOUT EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, TITLE, AND NONINFRINGEMENT. THE STATED EXPRESS WARRANTIES ARE IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF TRIMBLE ARISING OUT OF OR IN CONNECTION WITH, ANY PRODUCT. BECAUSE SOME STATES AND JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES, THE ABOVE LIMITATION MAY NOT APPLY OR FULLY APPLY TO YOU.

Limitation of Liability

TRIMBLE's ENTIRE LIABILITY UNDER ANY PROVISION HEREIN SHALL BE LIMITED TO THE AMOUNT PAID BY YOU FOR THE PRODUCT TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL TRIMBLE OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGE WHATSOEVER UNDER ANY CIRCUMSTANCE OR LEGAL THEORY RELATING IN ANY WAY TO THE PRODUCTS, SOFTWARE AND ACCOMPANYING DOCUMENTATION AND MATERIALS (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF DATA, OR ANY OTHER PECUNIARY LOSS), REGARDLESS OF WHETHER TRIMBLE HAS BEEN ADVISED OF THE POSSIBILITY OF ANY SUCH LOSSES. REGARDLESS OF WHETHER TRIMBLE HAS BEEN ADVISED OF THE POSSIBILITY OF ANY SUCH LOSS AND REGARDLESS OF THE COURSE OF DEALING WHICH DEVELOPS OR HAS DEVELOPED BETWEEN YOU AND TRIMBLE. BECAUSE SOME STATES AND JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, THE ABOVE LIMITATION MAY NOT APPLY OR FULLY APPLY TO YOU.

PLEASE NOTE: THE ABOVE TRIMBLE LIMITED WARRANTY PROVISIONS WILL NOT APPLY TO PRODUCTS PURCHASED IN THOSE JURISDICTIONS (E.G., MEMBER STATES OF THE EUROPEAN ECONOMIC AREA) IN WHICH PRODUCT

2 GreenSeeker RT200 System Installation and Operation Guide
on, the user is encouraged to try to correct the interference by one or
reception, which can be determined by turning the equipment off and
this equipment does cause harmful interference to radio or television
harmful interference to radio communication. However, there is no
equipment generates, uses, and can radiate radio frequency energy and,
protection against harmful interference in a residential installation. This
found to comply with the limits for a Class B digital device, pursuant to
Class B Statement - Notice to Users. This equipment has been tested and
covered in the additional documentation are provided below.
Registration
To receive information regarding updates and new products, please
contact your local Trimble authorized dealer or visit the Trimble website
www.trimble.com/register. Upon registration you may select the
newsletter, upgrade or new product information you desire.
EXTENDED LIMITED WARRANTY TERMS AND
This Trimble Navigation Limited Product comes with Trimble's
Extended Limited Warranty coverage for serialized hardware
components for a period of one (1) year commencing on the first
anniversary of date of purchase; and except as otherwise stated herein is
provided under the same terms and conditions as those of the standard
Trimble Limited Warranty Terms and Conditions with which the
Product is sold and distributed.
The Extended Limited Warranty applies to serialized hardware
components (as configured at the time of purchase) of the Product and
includes updates to associated Product firmware2 but does not apply to
consumable parts (such as batteries), application software, or to
detachable components or accessories that are separately warranted
and furnished solely with Trimble's standard one (1) year limited warranty.
Registration
To receive product upgrades included with this Extended Limited
warranty as well as information regarding updates and new products, please
register by visiting the Trimble website at
www.trimble.com/register. Upon registration you may select the
newsletter, upgrade or new product information you desire.
PLEASE NOTE: THE TRIMBLE NAVIGATION LIMITED EXTENDED
LIMITED WARRANTY WILL NOT APPLY TO PRODUCTS
PURCHASED IN THOSE JURISDICTIONS (E.G., MEMBER STATES
OF THE EUROPEAN ECONOMIC AREA) IN WHICH PRODUCT
WARRANTIES ARE THE RESPONSIBILITY OF THE LOCAL DEALER
FROM WHOM THE PRODUCTS ARE ACQUIRED. IN SUCH A CASE,
PLEASE CONTACT YOUR LOCAL TRIMBLE DEALER FOR
APPLICABLE WARRANTY INFORMATION.
Notes
1. A copy of the Trimble Navigation Limited Limited Warranty Terms and Conditions is provided with the distributed Product and is available from your local Trimble authorized dealer and upon request at trimble_support@trimble.com.
2. “Firmware” means software used in the hardware device to enable the
different hardware systems to communicate and function together.
These functions are essential to the performance of the hardware device.
Notices
For a complete list of notices for the GreenSeeker RT200 system, refer to
the documentation for each component of the system. Notices not
covered in the additional documentation are provided below.
Class B Statement - Notice to Users. This equipment has been tested and
found to comply with the limits for a Class B digital device, pursuant to
Part 15 of the FCC rules. These limits are designed to provide reasonable
protection against harmful interference in a residential installation. This
equipment generates, uses, and can radiate radio frequency energy and,
if not installed and used in accordance with the instructions, may cause
harmful interference to radio communication. However, there is no
guarantee that interference will not occur in a particular installation. If
this equipment does cause harmful interference to radio or television
reception, which can be determined by turning the equipment off and on,
the user is encouraged to try to correct the interference by one or
more of the following measures:
– Reorient or relocate the receiving antenna.
– Increase the separation between the equipment and the receiver.
– Connect the equipment into an outlet on a circuit different from that
to which the receiver is connected.
– Consult the dealer or an experienced radio/TV technician for help.
Changes and modifications not expressly approved by the manufacturer
or registrant of this equipment can void your authority to operate this
equipment under Federal Communications Commission rules.
Safety Information

Before you start the installation, you must read and understand the information contained in this section.

Always follow the instructions that accompany a Warning or Caution. The information they provide is intended to minimize the risk of personal injury and/or damage to property. In particular, observe safety instructions that are presented in the following format:

⚠️ **WARNING** – This alert warns of a potential hazard, which, if not avoided, can cause severe injury.

⚠️ **CAUTION** – This alert warns of a hazard or unsafe practice which, if not avoided, can cause injury or damage.

*Note – An absence of specific alerts does not mean that there are no safety risks involved.*

**Warnings**

⚠️ **WARNING** – If someone else attempts to drive the vehicle while you are working on or under it, you can suffer serious or fatal injuries. To avoid this possibility, install a lockout box on the battery terminal to prevent the battery from being reconnected, remove the key from the vehicle’s ignition switch, and attach a “Do not operate” tag in the cab.

⚠️ **WARNING** – Vehicle cabs can be quite high in the air. To avoid potentially serious injury through falling from this height, always use the steps and handrails, and face the vehicle, when you enter or exit it.

⚠️ **WARNING** – Do not remove/cut or bypass the auto adapter end of the power adapter cable for the PDA. Do not connect directly to 12 V DC as this will cause immediate failure of the PDA.

⚠️ **WARNING** – There are no field serviceable components of the electronic system; do not attempt any field repair of a malfunctioning controller or sensors. If you experience operating problems, contact your local dealer or representative or GreenSeeker distributor for assistance.

⚠️ **WARNING** – The system installation may bring you into contact with chemical substances, such as oil, which can cause poisoning. Wash your hands thoroughly after you finish working on the system.
WARNING – Battery posts, terminals, and related accessories contain lead and lead compounds, which can cause serious illness. To avoid ingesting lead, wash your hands thoroughly after touching the battery.

WARNING – Always wear protective equipment appropriate to the job conditions and the nature of the vehicle. This includes wearing protective glasses when you use pressurized air or water, and correct protective welder’s clothing when welding. Avoid wearing loose clothing or jewelry that can catch on machine parts or tools.

WARNING – Parts of the vehicle may be under pressure. To avoid injury from pressurized parts, relieve all pressure in oil, air, and water systems before you disconnect any lines, fittings, or related items. To avoid being sprayed by pressurized liquids, hold a rag over fill caps, breathers, or hose connections when you remove them. Do not use your bare hands to check for hydraulic leaks. Use a board or cardboard instead.

WARNING – Always read chemical manufacturer’s instructions before handling or spraying chemicals.

WARNING – Always install boom stop before working under or around raised spray booms.
Cautions

**CAUTION** – The GreenSeeker RT200 system works with GPS receivers and spray controllers. Be sure to read and understand the other manufacturer’s manuals and equipment before operating the system.

**CAUTION** – GreenSeeker sensors are designed to operate in harsh environments. The sensor enclosure and connections are environmentally sealed. Although the sensor is sealed, DO NOT wash the sensor directly with a high pressure washer. To clean the sensors, use low pressure and gentle washing procedures.
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Information</td>
<td>5</td>
</tr>
<tr>
<td>Warnings</td>
<td>5</td>
</tr>
<tr>
<td>Cautions</td>
<td>7</td>
</tr>
<tr>
<td>1 Introduction</td>
<td>11</td>
</tr>
<tr>
<td>System overview</td>
<td>12</td>
</tr>
<tr>
<td>Definitions of terms</td>
<td>13</td>
</tr>
<tr>
<td>Care and maintenance</td>
<td>13</td>
</tr>
<tr>
<td>Resources</td>
<td>14</td>
</tr>
<tr>
<td>PDA support: Tripod Data Systems</td>
<td>14</td>
</tr>
<tr>
<td>Other resources</td>
<td>15</td>
</tr>
<tr>
<td>GPS</td>
<td>15</td>
</tr>
<tr>
<td>Technical assistance</td>
<td>15</td>
</tr>
<tr>
<td>Your comments</td>
<td>15</td>
</tr>
<tr>
<td>2 Installation and Setup</td>
<td>17</td>
</tr>
<tr>
<td>System layout with the Trimble Recon handheld</td>
<td>18</td>
</tr>
<tr>
<td>System layout with Trimble Nomad handheld</td>
<td>19</td>
</tr>
<tr>
<td>System layout with Trimble AgGPS FmX display</td>
<td>20</td>
</tr>
<tr>
<td>Cables</td>
<td>21</td>
</tr>
<tr>
<td>RT200 interface module</td>
<td>22</td>
</tr>
<tr>
<td>User interface</td>
<td>23</td>
</tr>
<tr>
<td>Ruggedized PDA</td>
<td>23</td>
</tr>
<tr>
<td>USB to serial box</td>
<td>24</td>
</tr>
<tr>
<td>AgGPS FmX integrated display</td>
<td>25</td>
</tr>
<tr>
<td>GreenSeeker sensors</td>
<td>25</td>
</tr>
<tr>
<td>Product rate controller</td>
<td>27</td>
</tr>
<tr>
<td>GPS receiver</td>
<td>28</td>
</tr>
<tr>
<td>Field preparations for nitrogen application</td>
<td>28</td>
</tr>
<tr>
<td>Field information</td>
<td>28</td>
</tr>
<tr>
<td>Setting up the field</td>
<td>29</td>
</tr>
<tr>
<td>Field preparations for user-defined rates (custom table)</td>
<td>30</td>
</tr>
<tr>
<td>Installing the RT Commander software</td>
<td>32</td>
</tr>
<tr>
<td>3 Configuration and Operation</td>
<td>33</td>
</tr>
<tr>
<td>Starting the RT Commander software</td>
<td>34</td>
</tr>
<tr>
<td>Setup and configuration</td>
<td>35</td>
</tr>
<tr>
<td>Logging options</td>
<td>35</td>
</tr>
<tr>
<td>Communication port assignments</td>
<td>35</td>
</tr>
<tr>
<td>GPS receiver communication setup</td>
<td>35</td>
</tr>
<tr>
<td>Rate controller communication setup</td>
<td>37</td>
</tr>
</tbody>
</table>
Contents

RT200 interface module communication setup ........................................ 38
Variable rate application setup .............................................................. 39
  Collecting Reference Strip data ......................................................... 40
Mapping with the user interface ............................................................. 43
Data output ......................................................................................... 44
Diagnostic tools .................................................................................. 45
  Status tab ....................................................................................... 45
  Errors tab ..................................................................................... 45
  Comm View tab ............................................................................. 46
Data management .................................................................................. 46
Application information ........................................................................ 47
  Delivery system and liquid control ................................................... 47
  Selecting a nozzle ........................................................................... 48
Troubleshooting .................................................................................... 48
A  Cable Diagrams .............................................................................. 51
B  Custom Algorithm .......................................................................... 57
  Custom Formula ............................................................................... 58

GreenSeeker RT200 System Installation and Operation Guide
This manual describes how to install and operate the hardware and software for the Trimble® GreenSeeker® RT200 system.
System overview

The GreenSeeker RT200 variable rate application and mapping system is a tool for variably applying agricultural chemicals based on real-time measurements of the crop. The sensors measure NDVI (Normalized Difference Vegetation Index) of the plants while traversing the field, and the software collects the data that can be used to generate maps of the NDVI and rates (where applicable) for crop analysis and historical data collection. This type of data can be used in conjunction with other agronomic references to index nutrient response, crop condition, yield potential, stress, pest, and disease impact in a quantitative manner. The RT200 system can be used to monitor changing crop conditions during the growing season and the effects of different levels of an input compared to a defined standard.

The applicator allows you to variably apply agricultural chemicals in real time (as the applicator passes over the crop). The NDVI-based variable rate algorithm and parameters may be selected in the field, and all rate changes are then made “on the go,” so there are no lengthy delays between evaluating the crop and application. When applying fertilizer or other material, the NDVI, the target rate on, and the applied rate are mapped simultaneously with the GreenSeeker RT200 system. Some spray controllers do not respond with an As Applied value.

The GreenSeeker optical sensor emits light at two specific wavelengths, and measures the reflected light. The microprocessor in the sensor analyzes the reflected light and calculates the resulting Index value. The data from each sensor is collected by the RT200 interface module, processed and then transmitted to a PDA in the cab running one of the following:

- RT Commander software
- Version 3.0 or later of the AgGPS® FmX® integrated display

The RT Commander software displays the NDVI and location in real-time, logs the output data to a file, and sends the appropriate rates to the applicator's rate controller or FmX integrated display. The logged data is easily transferred to a desktop computer for analysis.

The ruggedized PDA (Personal Digital Assistant) could be a Trimble Recon® or Nomad® handheld computer. In this document, “PDA” refers to both handheld models. If anything refers to only one model, this is clearly indicated.
Definitions of terms

The following terms occur throughout this manual and in the RT Commander software. Becoming familiar with the terms will make using the RT Commander software much easier.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN</td>
<td>Controller Area Network. A high-integrity data communications bus for real-time applications that operates at data rates of up to 1 Megabit per second, and has excellent error detection and confinement capabilities.</td>
</tr>
<tr>
<td>GDD</td>
<td>Growing Degree Days. Some GreenSeeker algorithms use this value as an input to determine expected plant growth stage. For more information, see “Where to Find GDD Information” at <a href="http://www.greenseeker.com/software">http://www.greenseeker.com/software</a>.</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System. A system using satellites, receivers and software to allow users to determine their exact geographic position.</td>
</tr>
<tr>
<td>N</td>
<td>Nitrogen fertilizer</td>
</tr>
<tr>
<td>NDVI</td>
<td>Normalized Difference Vegetation Index. Commonly used to measure plant health and vigor. NDVI = (NIR_reflected - Red_reflected)/(NIR_reflected + Red_reflected).</td>
</tr>
<tr>
<td>NUE</td>
<td>Nitrogen Use Efficiency. A percentage of nitrogen taken up by the plant. For example, an NUE of 60% means that 6 lbs. of nitrogen fertilizer is expected to be used by the plant that year for every 10 lbs. applied. For more information, see <a href="http://www.nue.okstate.edu">www.nue.okstate.edu</a>.</td>
</tr>
<tr>
<td>NRS</td>
<td>Nitrogen Rich Strip. This reference strip/area determines the amount of nitrogen being made available to the plant by the environment (mineralization, and so on), and importantly the present year’s expected maximum yield potential and response to additional nitrogen.</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal Digital Assistant. See User Interface.</td>
</tr>
<tr>
<td>RI</td>
<td>Response Index. Provides an indication of how the crop will respond this season to additional N.</td>
</tr>
<tr>
<td>User Interface</td>
<td>A portable hand held computer. Typically, a ruggedized PDA such as a Trimble Recon or Trimble Nomad handheld computer.</td>
</tr>
<tr>
<td>VI</td>
<td>Vegetation Index. A value that is calculated (or derived) from sets of remotely-sensed data that is used to quantify plant health, stress, and vigor.</td>
</tr>
<tr>
<td>VRA</td>
<td>Variable Rate Application. Based on information supplied to a rate controller, the rate of fertilizer or other chemical applied.</td>
</tr>
</tbody>
</table>

Care and maintenance

**WARNING** – There are no field serviceable components of the electronic system; do not attempt any field repair of a malfunctioning controller or sensors. If you experience operating problems, contact your local reseller, representative, or GreenSeeker distributor for assistance.
You must take good care of your GreenSeeker RT200 variable rate application and mapping system to maintain high performance. At the end of each day of spraying, do the following:

- Check the detector and light source windows for dust and dirt, and wipe clean with a soft rag.

- **Do not** leave the GreenSeeker system outdoors during extreme weather conditions. Wide temperature variations may reduce the operating life of the system.

- **Do not** store a GreenSeeker system with the sensors facing upward. Doing so may allow water to collect around the windows and gaskets, causing seal failures in those areas. Direct sunlight can in some cases also focus enough energy into the sensor to damage the detector.

- When rinsing off the machine, take care not to use high pressure to directly spray the sensors. Even though all connectors and modules are fully sealed, there still exists potential leakage from a pressurized stream.

- Every time the spray tank is filled, take a soft cloth and wipe the lenses of the sensors if needed. Try to check sensors at least once a day during full-time operation.

- Be more aware of cleaning the sensors directly behind the machine.

- If you do not have ground protection devices on the boom, such as gauge wheels or skids, take extra care to not run the boom into the ground. Also, be aware of sensor vulnerability to stationary structures in the field. Sensors are usually mounted on the front of the boom and do not have rigid protection.

- Rinse the boom after the end of every day. This will keep the system clean and wash any corrosive materials off. This will greatly extend the life of your machine.

- At the beginning of each season, and periodically as required, check the hose clamps, plumbing connections, and other fluid handling system components for tightness and leak free operation.

- Make sure all wiring harness components remain fastened to the boom as to not obstruct the view of the sensors and are free of any pinch points from boom folding and movement.

**Resources**

**PDA support: Tripod Data Systems**

http://www.tdsway.com/support
Tel: 720-587-4700
Other resources

Nitrogen Use Efficiency, www.nue.okstate.edu
Sensor-Based Nitrogen Rate Calculator, www.soiltesting.okstate.edu/SBNRC/SBNRC.php

GPS

Even if you have used other Global Positioning System (GPS) products before, Trimble recommends that you spend some time reading this manual to learn about the special features of this product. If you are not familiar with GPS, visit the Trimble website (www.trimble.com) for an interactive look at Trimble and GPS.

Technical assistance

If you have a problem and cannot find the information you need in the product documentation, contact Trimble technical support:

1. Go to the Trimble website (www.trimble.com).
2. Click the Support & Training link at the top of the screen, select Support and then select Support A–Z list of products.
3. Scroll to the bottom of the list.
4. Click the submit an inquiry link. A form appears.
5. Complete the form and then click Send.

Your comments

Your feedback about the supporting documentation helps us to improve it with each revision. Email your comments to ReaderFeedback@trimble.com.
Installation and Setup

In this chapter:

- System layout with the Trimble Recon handheld
- System layout with Trimble Nomad handheld
- System layout with Trimble AgGPS FmX display
- Cables
- RT200 interface module
- User interface
- GreenSeeker sensors
- Product rate controller
- GPS receiver
- Field preparations for nitrogen application
- Field preparations for user-defined rates (custom table)
- Installing the RT Commander software

This chapter describes the system layout and installation of the GreenSeeker RT200 system components.
System layout with the Trimble Recon handheld
System layout with Trimble Nomad handheld
System layout with Trimble AgGPS FmX display

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Trimble part number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>FmX integrated display</td>
<td>93100-01</td>
</tr>
<tr>
<td>2</td>
<td>FmX power cable</td>
<td>66694</td>
</tr>
<tr>
<td>3</td>
<td>FmX basic power cable</td>
<td>67258</td>
</tr>
<tr>
<td>4</td>
<td>8 m GPS TNC/TNC RT angle cable</td>
<td>50449</td>
</tr>
<tr>
<td>5</td>
<td>Ag25 GNSS antenna</td>
<td>68040-005</td>
</tr>
<tr>
<td>6</td>
<td>FmX / FM-1000 to CAN w/port replicator cable</td>
<td>75407</td>
</tr>
<tr>
<td>7</td>
<td>Cable Assy, GreenSeeker to Display</td>
<td>77704</td>
</tr>
<tr>
<td>8</td>
<td>RT200 interface module</td>
<td>900-1-047</td>
</tr>
<tr>
<td>9</td>
<td>30’ RT200 power cable</td>
<td>400-1-276</td>
</tr>
<tr>
<td>10</td>
<td>20’ RT200 interface module cable</td>
<td>400-1-277</td>
</tr>
<tr>
<td>11</td>
<td>20’ RT200 sensor cable</td>
<td>400-1-265-240</td>
</tr>
</tbody>
</table>
**Cables**

Before mounting sensors, loosely route cables on the machine:

- Route all cables in areas where protection from mechanical movement can be assured.
- Do not kink any of the cables. You must allow at least a 6-inch (15 cm) bend radius in all cables.
- Once cables are routed and all hardware is mounted, final placement of cables can be made.
- Finalize by securing cables with tie wraps, zip ties, and so on as required.

Cable placement is as follows:

<table>
<thead>
<tr>
<th>Cable number</th>
<th>Cable description</th>
<th>Placement</th>
</tr>
</thead>
</table>
| 400-1-278    | RT200 interface module to a Recon handheld             | Connect the Recon handheld and interface module:  
  - Connect the cable end with the DB9 connector to the Y-cable connector marked "Port 1" on the handheld. See the vehicle's manual for cab access holes—most cabs have auxiliary access holes available.  
  - Route the other end of this cable to the RT200 interface module, see page 18. |
| 400-1-265-240| Sensor cables                                          | Place cables between the outer two or three sensors on each side of the boom. These cables connect the sensors in a "sensor chain". For appropriate sensor placement, see GreenSeeker sensors, page 25. |
| 400-1-277    | Sensor to interface module cables                      | Connect the two innermost sensors to the interface module. The sensors "daisy chained" on the left side of the boom must connect to the port labeled Left CAN Bus, and the sensors on the right side must connect to the port labelled Right CAN Bus. For hardware placement, see RT200 interface module, page 22 and GreenSeeker sensors, page 25. |
| 77704        | "T" cable                                              | Connected between one of the 400-1-277 cables and the interface module, the long part of this cable connects to the FmX integrated display on Port A or Port B. |
| 400-1-276    | Power cable                                            | This cable provides 12 VDC power to the system:  
  - Connect one end to the interface module.  
  - Connect the other end to battery power.  
  Do the following to install the inline toggle switch that is provided to control system power:  
  1. Mount the switch in the required location in the cab.  
  2. Splice the toggle switch into the red wire (+12 V) that is included with the cable.  
  **Note** – Some vehicles may provide battery power terminals in the cab. A minimum of 11.4 V is required to operate the system. |
Installation and Setup

For emergency repair and troubleshooting purposes, see Appendix A, Cable Diagrams. These diagrams are provided for use by qualified technicians only.

### RT200 interface module

The RT200 interface module contains circuitry to interface boom-mounted sensors with the user interface. The interface module has serial, CAN, and power connections. It is an environmentally sealed enclosure that can be installed inside or outside the cab.

Mount the module in close proximity to the center of the boom-mounted sensors (check the length of cables 400-1-277 and 400-1-278 for suitable placement).

There are two small indicator lights on the lid.

The interface module has mounting brackets with drilled holes for mounting.

1. Mount the module in a structurally safe location on the machine. Trimble recommends that you mount the module with connectors facing down to avoid water in the connectors. An additional bracket may need to be made.

2. After the enclosure is mounted, connect cable 400-1-276 to the 12 V DC port. You must fully rotate (approx ¼ turn) the gray retaining nut on the connector into the locked position.

3. Connect cable 400-1-277 (this goes to the innermost sensor on the right boom) to the port labeled Right CAN Bus.

4. Connect the second cable 400-1-277 (this goes to the innermost sensor on the left boom) to the port labeled Left CAN Bus.

5. If using a PDA, connect cable 400-1-278 to the connection port labeled Serial Port.

<table>
<thead>
<tr>
<th>Cable number</th>
<th>Cable description</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>400-1-066</td>
<td>Serial cables with standard female DB9 connectors</td>
<td>Connect the PDA to the GPS and rate control modules in the cab. <strong>Note</strong> – Some GPS units and rate control modules may require a null modem or gender change adapter. Refer to the manuals for the GPS and rate controller for proper connections (if either module requires a null modem connection to a desktop computer then it will also require one to be connected to the Recon). Null modem cables and adapters are available from most electronic stores.</td>
</tr>
<tr>
<td></td>
<td>Power adapter cable</td>
<td>Provided with each PDA. It contains a voltage converter/regulator to provide the correct charging voltage. <strong>WARNING</strong> – Do not remove/cut or bypass the auto adapter end of the power adapter cable for the PDA. Do not connect directly to 12 V DC as this will cause immediate failure of the PDA.</td>
</tr>
</tbody>
</table>
**Note** – Be careful not to loosen the black strain relief portion of the connector when connecting or disconnecting.

**Note** – If you are using the FmX display, the serial port is not used. Install the cable port cap to protect this port.

![Image](image.png)

**User interface**

**Ruggedized PDA**

The RT200 system includes a ruggedized PDA that is powered by a Windows Mobile® operating system and that is pre-loaded with the RT Commander software.

- The Recon handheld uses 3 serial ports through a CF-to-2-port serial splitter.
- The Nomad handheld uses a USB-to-4 port serial converter.

**Note** – In this document, “PDA” refers to both handheld models: If anything refers to only one model, this is clearly indicated.

A removable memory card is supplied and pre-installed in the PDA for easy data transfer; alternatively, connect the PDA to a desktop computer for data transfer.
An adjustable mount is provided that allows you to easily mount and remove the PDA in the cab. Place it where the operator can easily view it and select the buttons:

1. Assemble the entire mounting structure before mounting the base. Verify that the mounting location allows for cable connections to the PDA (the bottom and/or top as required by the specific PDA).

2. Mount the base securely in the cab and then place the PDA in its clip mount. Snap the PDA into place until secure:

![Recon handheld and Nomad handheld](image)

*Note – See also the corresponding System Layout diagrams: System layout with the Trimble Recon handheld, page 18 and System layout with Trimble Nomad handheld, page 19.*

3. To keep the PDA’s battery charged, plug the auto-adapter power cable (included) into an available 12 V DC outlet in the cab.

*WARNING – Do not remove/cut or bypass the auto adapter end of the power adapter cable for the PDA. Do not connect directly to 12 V DC as this will cause immediate failure of the PDA.*

*Note – The auto adapter for the Recon and Nomad handhelds are not interchangeable.*

4. Once all the cables are connected, secure the cables in the cab to avoid damage to the cable.

**USB to serial box**

This box is used for all systems that use the Trimble Nomad handheld. It converts the USB port at the bottom of the handheld into four DB9 serial ports.
**AgGPS FmX integrated display**

Version 3.0 or later of the FmX integrated display has a large color touchscreen and integrated GPS and GLONASS receivers for complete guidance, steering, mapping, and application control.

The GreenSeeker plugin shows and stores the data from the sensors, and communicates with the applicator’s rate controller. The GreenSeeker plugin and VRA unlock code are required to unlock the GreenSeeker function on the display.

The FmX integrated display is not packaged with the GreenSeeker RT200 system. For more information, see the *AgGPS FmX Integrated Display Installation Instructions* and the *AgGPS FmX Integrated Display User Guide*.

**GreenSeeker sensors**

---

**CAUTION** – GreenSeeker sensors are designed to operate in harsh environments. The sensor enclosure and connections are environmentally sealed. Although the sensor is sealed, DO NOT wash the sensor directly with a high pressure washer. To clean the sensors, use low pressure and gentle washing procedures.

The sensor takes reflectance readings. The units generate their own illumination for use in any lighting condition, day or night. When the unit is on, a red band of light shows directly below the rectangular sensor window.

The sensor operates by emitting light from the rectangular window onto a crop’s canopy. Reflected light from the canopy is focused on a detector behind the circular window:

- Both the rectangular and circular windows need to be free of any viewing obstructions when mounted.
- Mount the sensor so that there is at least 12” (0.3 m) in front and 6” (0.15 m) in back of the lenses’ peripheral view.
- Keep at least 12” (0.3 m) for the peripheral side view of the sensor free of objects.

The sensor is designed for an optimal height of 28” to 48” (0.7 m to 1.2 m) from the rectangular LED window to the crop canopy. The extended range (with greater deviation) is 26” to 62” (0.6 m to 1.6 m). The field of view (the width of the sensor measurement) is ~24” (0.6 m) within the sensor’s optimal height range.

Sensor readings are nearly constant with the optimal height range, but will vary somewhat over the extended range. Momentary movement out of the operating height range does not significantly affect performance of the RT200 system, but take care to keep sensors within the recommended height range most of the time.
Mounting the sensors

- Sensors are typically mounted using the standard stainless steel bracket (provided). These brackets are designed to fit most boom structures.

- The two outer sensors will have only one cable connected. The other port in the outer sensors must be electrically terminated using a small plug device called a CAN terminator. (The CAN terminator is usually pre-installed in two sensors.) Mount these sensors in the outside (end) positions.

- The bracket can be secured to most boom structures with standard size U-bolts. One set of U-bolts is included with the system. Some booms may require different U-bolts and/or custom fabricated brackets.

- The sensor is bolted to the bracket with two 5/16" bolts (provided).

- Sensors can be mounted in front of or behind a boom. The "direction" of the sensor is not important, but the rectangular LED window must be parallel to the applicator boom:
• For crops such as wheat and canola, the RT200 system works best when sensors are evenly spaced across the swath of the boom. For example, if a boom is 60 feet wide then the sensors would be spaced approximately 10 feet apart and the outer two sensors would be spaced approximately 5 feet from the tips. Boom folding procedures may prevent even spacing of sensors. This is acceptable as long as the sensors are spread across the boom as evenly as possible. For row crop applications, sensors must be positioned directly over a row. When used in fields with a “guess row” or “wide and narrow row” you may have to mount the sensor within your planter width.

• Once the sensors are mounted, connect the sensor cables (400-1-265-240) as shown in the system layout figure:
  a. These cables have a 12-pin connector on each end. Slide the connector into one of the ports on the sensor with the keyed side towards the front of the sensor.
  b. After firmly seating the connector, use a Phillips screwdriver to secure the connectors retaining ring. It does not matter which port the 400-1-265-240 cables are connected to. The two outer sensors will have only one cable connected. The other port in the outer sensors must be terminated.
  c. Insert the terminator (if not already installed) in the unused port of the outer sensors and then secure the retaining ring.
• As described in previous sections, use the 400-1-277 cables to connect the two inner sensors to the interface module in the same way used for the 400-1-265-240 cables. Once all cables are connected, secure the cables to the boom. Verify that cables will not be damaged by moving parts.

**Product rate controller**

Most applicators come with an installed product rate controller. The RT200 system interfaces with most available controllers. If you have a rate controller that is not currently supported by the RT Commander software, contact Trimble or your dealer to inquire about obtaining support.
GPS receiver

A GPS receiver is necessary for logging geo-referenced data and viewing on-the-go mapping. An applicator may already use a GPS receiver for other operations such as guidance. In many cases it can be shared. The RT200 accepts a serial connection (RS-232) from a GPS receiver to the ruggedized PDA through a serial-to-USB converter.

Field preparations for nitrogen application

Field information

Before the GreenSeeker applicator can be used to apply nitrogen (N) across a field, you must establish a nitrogen rich reference strip (NRS) before or shortly after planting. This reference strip determines the amount of nitrogen being made available to the plant by the environment mineralization and importantly, the present year’s expected maximum yield potential and response to additional nitrogen. The ideal NRS runs the length of the field, but it should at least be 300 feet (91 m) long. Establish the NRS in a representative portion of the field (that is, not in a high or low spot). The rate of N necessary to establish a NRS depends on the crop and region, and should be equivalent to the highest rate necessary to satisfy crop needs throughout the growing season. For example, winter wheat grown in the Southern Great Plains should have a minimum of 100 lbs N/acre applied to establish the NRS. Lower pre-plant N rates should be applied across the rest of the field. Application of 20 to 30 lbs of pre-plant N/acre would be ideal for this situation.

The rest of the field is referred to as the Non-Reference (Non-Ref) portion. It may also be referred to as the N-limited area or farmer practice region.

For best results, use the RT200 interface module to “read” the NRS and apply N at growth stages dependent upon the crop algorithm used. For Trimble-supplied algorithms the following is typically:

- Wheat: Feekes growth stage 4-6
- Corn: V8-V12.

For the sensors to accurately determine NDVI for topdressing (or sidedressing), plant coverage should be at least 50%. The RT200 system with RT Commander can use the sensor mounted booms to read the NRS, or the GreenSeeker handheld sensor can be used to determine field conditions.

To collect sensor readings for the NRS, pass the boom-mounted sensor (or handheld sensor) over the crop at 32” to 48” (81 cm to 122 cm) above the canopy. Sense a large area of the NRS and non-reference portion of the field to accurately determine their respective NDVI values. Once you have measured the NDVI values, enter them into the RT Commander software. You can do this automatically with the boom-mounted sensors, or manually with the GreenSeeker handheld sensor. The RT Commander software and the RT200 system allows for “straddling” the edge of the NRS and using...
either the right side or left side of the boom for reading the respective areas, for example, with three sensors over the NRS and three over the rest of the field. You can also use the complete boom (with all sensors) to “read” NDVI in each area separately.

If response is obviously variable across the field, select an area where the difference between the Reference and the Non-Reference areas are most apparent. This ensures that the algorithm determines a rate that uses the highest yield potential prediction and maximum response to N for that year.

To estimate yield potential, an environmental factor (Growing Degree Days) is used, which takes into account weather and time since planting.

*Note – Different GDD variations are used for different crops. To obtain the GDD value, you need the planting date and sensing date. Regional values for GDD are available on the Internet. For more information, see Where to Find GDD Information at [http://www.greenseeker.com/software/](http://www.greenseeker.com/software/).*

### Setting up the field

1. Decrease the pre-plant Nitrogen (N) application rate of the field to a level at least half of previous total N applied during non-GreenSeeker management practice:
   - For spring or winter wheat, if the application rate has historically been 100 lbs N/acre, decrease the rate to 50 lbs N/acre.
   - For corn, if application rates have historically been 200 lbs N/acre, decrease the rate to 75 to 125 lbs N/acre.

2. Prior to or shortly after planting, establish the NRS (Nitrogen Rich Strip) in a representative portion of the field (that is, not in a historically high or low spot). Apply an applicator’s width swath of N. The rate of N applied should be high enough to satisfy crop N needs in a good year:
   - For spring or winter wheat, the N rate should be at least 100 lbs N/acre.
   - For corn, the N rate should be at least 200 lbs N/acre.

   Use a marker to ensure that you can easily find the NRS later in the season.

   The ideal NRS runs the length of the field, but it should at least be 300 ft (91 m) long.

3. At the appropriate crop growth stage, take readings of the NRS and an adjacent part of the field to be fertilized. For the supplied algorithms the following is typical:
   - Wheat: Feekes growth stage 4-6.
   - Corn: V8-V12.

4. Find the area where the nitrogen rich strip is most apparent in comparison to the rest of the field (this indicates greatest potential for the crop).

5. Take sensor readings with the RT200 system or a handheld sensor to input to the selected crop algorithm.
6. Match nozzles and/or rate control system to maximize response time and performance for each field’s requirements. For more information, see Delivery system and liquid control, page 47. Also refer to the application equipment and rate control systems manuals.

Field preparations for user-defined rates (custom table)

Example: Cotton Defoliant

The RT200 system can be used to apply materials other than Nitrogen. The RT200 software permits a custom algorithm to be entered; this is a table of product values compared to NDVI. A table has 16 points corresponding to an NDVI range of 0.25 - 0.88. These values are entered directly on the RT Commander software screen (select Crop Algorithm / Custom Formula).

Note – In RT Commander software version 1.3.x and later, there is also a high-resolution 100 point table option for NDVI values from 0.00 - 0.99. All points must have a value entered.

Growers or crop consultants have historical crop knowledge that enables them to determine different crop input requirements based upon biomass/size of the crop/plant, for example, the variable rate application of defoliant in cotton. If this is the case, the field is scouted or “field calibrated” to determine areas of the field that require different rates of defoliant. The RT200 system or a GreenSeeker handheld sensor is used to obtain the NDVI values in representative areas of the field. In the following figure, the NDVI of the crop was measured under particular conditions for which the grower knew the approximate required rate, using the GreenSeeker handheld sensor:

A table is then created with NDVI values corresponding to application rates. These values are entered into the Custom Formula application table. See Appendix B, Custom Algorithm.
The following table (and the resultant Calibration Graph) is an example for defoliant variable rate application in cotton:

<table>
<thead>
<tr>
<th>NDVI</th>
<th>Rate</th>
<th>Non-Ref</th>
<th>Ref</th>
<th>Ref-Peak</th>
<th>GDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>10.00</td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>10.00</td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>12.00</td>
<td></td>
</tr>
<tr>
<td>0.35</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>12.00</td>
<td></td>
</tr>
<tr>
<td>0.40</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>12.00</td>
<td></td>
</tr>
<tr>
<td>0.45</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>12.00</td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>12.00</td>
<td></td>
</tr>
<tr>
<td>0.55</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>12.00</td>
<td></td>
</tr>
</tbody>
</table>

These values are only an example; the grower/consultant must develop these rates. Also keep the rate range ability of the specific rate controller and nozzles used to achieve these rates in mind when developing the rates.

To use the Custom Formula feature, you must enter some required values as shown below. The default is zero; enter a value (for example, 1) in the Non-Ref, Ref and Ref-Peak, and the GDD fields and then tap OK:
Installing the RT Commander software

An update procedure is available for installing or updating RT Commander software at http://www.greenseeker.com/lit/gs/RTCommander_Update_Procedure.pdf

Also use these instructions if the PDA has lost its charge, has had to be hard reset, or if you need to install the factory installed software and drivers on a new PDA.

1. Connect the PDA to a computer using Microsoft ActiveSync technology or the Windows Mobile Device Center (if the computer is running the Windows Vista® operating system).

2. Once the ActiveSync technology indicates that the PDA is connected, insert the RT Commander CD into your computer.

3. Click Start | Run. When the Run window appears, enter D:\RT Commander\Install.exe (where D:\ is the CD drive).

4. Follow the on-screen instructions to complete the installation.

5. To soft reset the PDA, hold down the power button for about 8 seconds.

6. If you are prompted to enter a registration number after running the program for the first time, register your software at www.greenseeker.com/register/.
   A registration number will be emailed to you.

If you need additional help, contact your reseller.
Configuration and Operation

In this chapter:

- Starting the RT Commander software
- Setup and configuration
- Variable rate application setup
- Mapping with the user interface
- Data output
- Diagnostic tools
- Data management
- Application information
- Troubleshooting

This chapter describes how to configure and use the system.

The RT200 system can be used with either version 3.0 of the FmX integrated display, or with a PDA. This document describes the system using a PDA; for information on the FmX operation, see the GreenSeeker chapter in the AgGPS FmX Integrated Display User Guide.

The software interface of the RT200 system is the RT Commander software or version 3.0 or later of the FmX integrated display. The RT Commander software was developed for use with a ruggedized PDA powered by a Windows Mobile operating system. Typically, RT200 systems are supplied with a ruggedized PDA.

The software provides an interface where you select setup features and enter operating parameters. It can also display the current system status and data logging capabilities. For more information, familiarize yourself with the PDAs operating instructions.

This manual describes version 1.3.x of the RT Commander software. The operation is the same as for version 1.2. However, additional diagnostics functions and more options for custom algorithms have been added.
Starting the RT Commander software

1. Turn on the RT200 interface module, GPS, and rate controller (if applicable).
   The RT200 green Power LED blinks three times, accompanied by three beeps when it is first turned on. The Status LED will then blink corresponding to each transmission of sensor data over the CAN bus. You will see a brief green flash, followed by a red flash at the I/M message rate (typically at 0.5 sec), indicating data from the Left and Right CAN ports, respectively.

2. Turn on the PDA. When it starts, you may hear two separate "new hardware" chimes:
   - The first chime indicates that the CF-to-Serial device is detected.
   - The second chime marks the initialization of the two additional COM ports.

   If no chimes are heard after the first five seconds, your PDA does not have the chimes feature. If this is the case, wait at least 10 seconds before opening any applications.

   **Do not launch the RT Commander software until you have heard both chimes or until at least 10 seconds have passed.**

3. Select Start / Programs.

4. Tap RT Commander. The RT Commander startup screen appears.
Setup and configuration

The RT Commander software communicates with up to three devices: the GPS receiver, the rate controller, and the RT200 interface module.

You usually need to configure these devices only once as the software retains the settings. You need to update the setup parameters if new equipment is used with the system.

Note – If you plan to only collect GreenSeeker sensor data for mapping, you may skip the Controller section of the setup.

Logging options

The Recording Interval is the rate at which data points are written to the file. It defaults to 1000 ms (1 second) and should always be less than or equal to the GPS rate.

Communication port assignments

<table>
<thead>
<tr>
<th></th>
<th>Nomad handheld</th>
<th>Recon handheld</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT200 data</td>
<td>COM 5</td>
<td>COM 2 (Port 1)</td>
</tr>
<tr>
<td>GPS</td>
<td>COM 6</td>
<td>COM 3 (Port 2)</td>
</tr>
<tr>
<td>Rate controller</td>
<td>COM 7</td>
<td>COM 1 (built in)</td>
</tr>
</tbody>
</table>

GPS receiver communication setup

The RT Commander software is configured to accept GPS data in NMEA 0183 format (industry standard). The minimum NMEA messages necessary to acquire a valid GPS coordinate are GGA and VTG or GGA and RMC.

Most GPS receivers are configured to output these messages by default and no additional programming or configuration is necessary. For more information, see your GPS receiver manual.

1. Select Setup (at the bottom of the main screen) and then tap GPS Setup.
2. Select GPS on COM Port.
   
   GPS simulation is for troubleshooting only.

3. Tap the Comm tab.

4. Verify that the correct COM Port is selected. For settings, see Communication port assignments, page 35.

5. Configure the COM settings to match the output specifications of your GPS receiver—values shown here are typical.
   
   For exact settings, see the GPS unit’s manufacturer defaults.

6. Tap OK.

7. Check the status bar to confirm that a valid GPS coordinate appears after you enter the settings.

   Note – If you open a job before acquiring a valid GPS location, you may not see data on the mapping screen.
Rate controller communication setup

1. Select Setup (at the bottom of the main screen) and then tap Rate Controller Setup.

2. The RT Commander software can communicate with several brands and models of rate controllers. For more information, refer to the Compatible Rate Controllers list: http://www.greenseeker.com/pdf/Compatible%20Rate%20Controllers.pdf.

   To create a new setup, tap New.

3. In the Setup Description field, enter a description of the equipment and/or controller. For example, rav1 (and may be for a RoGator 854 with Raven 440). You usually need to create this configuration only once, unless you move the RT200 to other equipment.

4. From the Type drop-down field, select the controller brand/type.

5. Verify that the correct COM Port is selected. For options, see Communication port assignments, page 35.

6. Tap the Controller tab and verify that the controller’s specifications match the options shown. These specifications and screen options are different depending on the selected controller brand.

7. Tap OK.
**RT200 interface module communication setup**

1. Select *Setup* (at the bottom of the main screen) and then tap *RT200 Setup*.

2. Verify that the correct COM Port is selected. For options, see Communication port assignments, page 35.

3. From the *Selected V.I.* drop-down list, select the index. The default (and most likely choice) is *NDVI*. When you select an algorithm in the *Measure Parameters* screen, this value changes automatically as appropriate for the algorithm.

   *Note* – *Custom tables will not change the value you select here.*

4. In the *Update* field, enter the frequency at which sensor data is sent to the RT Commander software. The interval should be about half of the GPS update interval at lower rates and equal to the GPS interval at higher rates:
   - 1 Hz update: 495 ms (~2 Hz)
   - 2 Hz update: 245 ms (~4 Hz)
   - 5 Hz update: 200 ms (~5 Hz)

5. In the *Data Format* field, select *RT200*. This must be used to log sensor data and perform variable rate application using sensor readings. The other options are to create simulated data for troubleshooting only.

6. Tap **OK**.
Variable rate application setup

The RT200 system enables you to apply variable amounts of nitrogen in real-time based on the condition of the crop.

1. Tap **New Application Job** or **Open Existing Job**.

2. From the **Field Name** field, select an existing field or select **Add/Edit** fields.

   The **File Name** is created automatically in the format A (application file), current date (dmmmyy), and the field at the end of the file name. Tap the browse icon to change the file location to which the file will be saved. For more information, see **Data management, page 46**.

3. To check the configuration, tap the **Config** button next to the device.

4. In the **Swath Width** field, enter the swath width of the applicator for the mapping screen display.

5. Tap **OK**. The **Select Measurement Method** screen appears.

   You can now collect reference strip data.
Collecting Reference Strip data

1. Do one of the following to collect and/or input the reference strip data:
   
   - Use the **GreenSeeker handheld sensor** before application to read the reference strip:
     
     a. Tap the From GreenSeeker Handheld option.
     
     b. Enter the data that you collected previously. When you tap the required field, a numeric keypad appears.
     
     *Note* – You must enter the Ref-Peak value and this must be equal to or greater than the Ref value.

    - Use the **boom-mounted sensors** on the RT200 system
      
      a. To “read” the reference strip, do one of the following:
      
      - Tap the Simultaneous Ref Strip & Non-Ref Strip option and then “straddle” the edge of the reference strip with the left or right side of the boom over the reference strip. Once over the appropriate area, tap Go to collect data; tap Stop when finished. This populates the required fields in real time
        If required, repeat this procedure to ensure correct readings.

      - Tap the Drive Calibration Reference Strip option to read the reference strip. Tap Go to collect data; tap Stop when finished. This populates the Ref and Ref_max fields.
        Tap the Drive Non Reference Area option to read the reference strip.
        Tap Go to collect data from the non-reference strip (area to apply to); tap Stop when finished. This populates the NonRef-Min and Non-Ref fields.
        If required, repeat this procedure to ensure correct readings.

    2. Tap OK to continue to the next screen.
3. The reference data is transferred to this screen. To change the values if required, tap **Edit**.

4. Select the appropriate crop algorithm or select to create a custom application rate table of your own from the *Crop* drop-down list. To use a custom table as your algorithm, see Appendix B, Custom Algorithm.

5. Most crop algorithms require you to enter a value for GDD (Growing Degree Days). For some crops this will be *Days From Planting*.

6. For fertilizer, select NUE (Nitrogen Use Efficiency). The default depends on the Algorithm selected in Step 4.

7. Select **Liquid** or **Granular**, and enter the %N by weight.

8. Enter *Min* and *Max* settings to limit the rate commands given to the rate controller if required. Use these for nozzle and or application system limitations.

9. If you have a second boom that will be operated at a flat rate (for example, a herbicide injection system that uses UAN for carrier fluid), select the **Dual Booms** check box and then enter a *Fixed* rate value.

10. To display the actual application graph for the specific sensor to rate commands, tap **Show Graph**.

   a. Review the application graph for each field to determine the required nozzle selections and/or application equipment settings.

   Note – If you use the RT200 sensors for variable rate control, you must set up the application equipment and rate controller to match the expected delivery rate commands. For more information, see Application information, page 47.

   b. Select other units as required for the material/delivery system of your sprayer from the *Units* drop-down list.
11. Tap OK. The *Apply to an Area* screen appears. The field name is shown in the upper left corner (in this example, N 40).

12. With your application system and rate controller ready to perform VRA, tap Go and begin applying. Tap Stop when finished.

13. Your progress in the field is shown on the screen, along with sensor values, target application rates, and as applied rates received back from the rate controller.

   GPS is shown in the Status bar—tap this area to open the *Status* screen (see page 45) appears.

   Tap Stop to stop logging and rate commands. Use the existing boom controls to stop application of material.

14. Once you complete the job, do one of the following:
   - To start a new job, tap File and then select Close Job.
   - To exit the program, tap File and then select Exit.
15. Tap Yes to accept the confirmation message. The progress bar shows the progress of creating a shape file to allow mapping of your data. Depending upon how long you worked, this could take several minutes.

*Note* – From version 1.3.6, data is written to the file incrementally, so closing happens within 3 seconds.

### Mapping with the user interface

The RT200 system enables you to map vegetation characteristics for crop analysis and historical data collection.

1. Tap **New Application Job** or **Open Existing Job**.

2. From the *Field Name* field, select an existing field or select *Add/Edit* fields.

   The *File Name* is created automatically in the format M (mapping file), current date (ddmmyy), and the field at the end of the file name. Tap the browse icon to change the file location to which the file will be saved. For more information, see *Data management*, page 46.

3. To check the configuration, tap the **Config** button next to the device.

4. In the *Swath Width* field, enter the swath width of the applicator for the mapping screen display.
5. Tap **OK**. The *Map an Area* screen appears. The field name is shown in the upper left corner (in this example, **N 40**).

6. Your progress in the field is shown on the screen. GPS is shown in the Status bar. Tap this area to open the *Status* screen (see page 45). Tap **Stop** to stop logging.

7. Once you complete the job, do one of the following:
   - To start a new job, tap **File** and then select **Close Job**.
   - To exit the program, tap **File** and then select **Exit**.

8. Tap **Yes** to save application data or tap **No** to resume data collection.

9. The progress bar shows the progress of creating a shape file to allow mapping of your data. Depending upon how long you worked, this could take several minutes.

   **Note** – *From version 1.3.6, data is written to the file incrementally, so closing happens within 3 seconds.*

---

**Data output**

The data from the GreenSeeker sensors is collected by the RT200 interface module over the CAN bus, and then output as ASCII text in RS-232 format (38, 400, 8, N, 1) to the RT Commander software that is running on the PDA.

At each sample interval, the data is transmitted based on the selected options for the RT200 system. In particular, each line of data includes the value of NDVI and the value for a second VI chosen by the user.
Diagnostic tools

To view the Status screen, tap Task and then tap Show Status. The screen has three tabs.

Status tab

This shows the following details. Data here indicates positive communication to these devices.

- GPS detail status.
- RT200 Sensor status. This includes the number of sensors detected on system and error reporting. The RT200 system monitors the sensors for correct operation, and if a sensor reports erroneous data, the data is not included in the rate control calculation. Incorrect data can come from mud on the sensor lenses, sensors viewing concrete, snow, wet asphalt, or other non-soil or plant surfaces. The Sensor Errors field reports the number of sensors reporting NDVI out of expected values. For more information, see Data output, page 44.
- The RT200 interface module hardware and software version report. This also confirms that the interface module and user interface are communicating. The NDVI shown is the combined real-time value from all sensors on the left and right booms respectively.

Note – The Version 1.2 Status screen does not show the NDVI table.

Errors tab

To make setup and troubleshooting easier, this tab shows the ID and error codes from each sensor (version 1.3x of the RT Commander software and later). Error codes are short messages to help diagnose any problems related to a sensor. The ID is the last two characters of the serial number of the sensor.

NDVI values for crop analysis should range from 0.000 to 0.999. Therefore, the RT200 system uses negative NDVI numbers to communicate error conditions to the RT Commander software.
While the system does not enforce this, it is convenient to mount the sensors in numerical order (by convention, with the lowest on the driver’s left side) to aid in diagnosis, or if doing high-resolution mapping with the RT220 system. If there is a problem with a sensor or a connection, use this screen to isolate the location.

**Error conditions**

Error conditions include sensors disconnected from the CAN bus, or a sensor transmitting invalid data. Invalid data could occur if the sensor malfunctions, or more commonly, if it is seeing a target other than plants and soil. For example, when setting up, the sensors may be pointed in the air, or against wet asphalt; either of these will likely generate an error code from a sensor. The following errors are identified:

<table>
<thead>
<tr>
<th>Error</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>RED &gt; NIR</td>
<td>Red reflectance higher than NIR</td>
</tr>
<tr>
<td>-2</td>
<td>BOTH &lt; .01</td>
<td>Both reflectances below 0.01</td>
</tr>
<tr>
<td>-3</td>
<td>RED &lt; .01</td>
<td>Red reflectance below 0.01</td>
</tr>
<tr>
<td>-4</td>
<td>NIR &lt; .01</td>
<td>NIR reflectance below 0.01</td>
</tr>
<tr>
<td>-5</td>
<td>BOTH &gt; .98</td>
<td>Either reflectance above 0.98</td>
</tr>
<tr>
<td>-9</td>
<td>NIR &lt; .015</td>
<td>NIR net reflectance below .015</td>
</tr>
<tr>
<td>-9.x</td>
<td>-9.x</td>
<td>All sensors responded with invalid data</td>
</tr>
<tr>
<td>-10.x</td>
<td>-10.x</td>
<td>No sensors responded at all</td>
</tr>
</tbody>
</table>

**Comm View tab**

Especially during setup, it is helpful to view this tab to confirm if data is streaming to or from various sources, which enables the operator to confirm cabling and serial port settings. Do one of the following:

- To see data from the RT200 system, select the RT200 option.
- To see GPS data, select the GPS option.

**Data management**

The default location for RT Commander files is My Documents. To save these files to another location on the PDA, select a different location when setting up a new job. The new location must be below My Documents.

The RT Commander software creates the following files that are typically used for creating maps of the data using a shape file format:

- `[A/M][date][filename].dbf`
- `[A/M][date][filename].fgp`
An example of an application job file is A20050120_North40.rtj

CAUTION – If the PDA has not been charged for several days, data will be lost. To avoid this, do one of the following:
- Run the Backup Now utility installed on the PDA. This built-in backup is now done at the factory to preserve the software installation. For information on using the backup utility, see the Trimble Recon Getting Started Guide.
- Transfer the data from the PDA and save it to your computer.
- Copy the files to the CompactFlash card.

Application information

Delivery system and liquid control

As with any variable rate system, the minimum and maximum rates obtainable depend on the delivery system. The RT200 system can request any rate, but the actual rates delivered depend on the rate controller and its components. Most liquid rate control systems control (“throttle”) the pressure of the system to affect flow and application rate. There are also more advanced delivery systems that use two booms, multiple nozzles, or special pulsing solenoids on each nozzle, to obtain larger rate changes.

When using the RT200 system with a typical liquid delivery system, you must match nozzle sizes to expected delivery rates. After the appropriate reference strip readings, GDD, and selection of crop type are input into RT Commander software, the application graph can be accessed to show the prescription rates at various sensor NDVI readings. Review the Crop and Measurement screen features of the RT Commander software to determine the expected delivery ranges in each specific field. To do this, tap Show Table. Depending on the delivery system that is is used, there will be actual minimum and maximum rates obtainable. These depend on components such as the pump, control valve, nozzles, and boom plumbing sizes.

The RT Commander software has a feature that allows minimum and maximum rates to be set, regardless of the crop algorithm prescription. Once you choose a nozzle set, set the minimum at the lowest rate at which the nozzles will still give adequate pattern/performance. Maximum rates may be limited by rates that lessen atomization or drift.
Selecting a nozzle

It is usually best to match nozzles to the lower midrange of the typical rates shown on the application graph. It is ultimately up to the grower or crop consultant to determine the min/max rates and nozzles that are most appropriate.

Example

If most of your NDVI readings (in the area of the field not in the NRS) are around 0.53, and the application graph shows at 0.53 NDVI you should apply 15 GPA, select a nozzle that can change rates above and below this NDVI reading. You could select a nozzle that puts out 12.5 GPA at its lowest pressure (for example, 20 psi) and 21 GPA at its highest pressure (for example, 60 psi). Since the penalty to under-fertilize (harm yield) is usually greater than to over-fertilize (waste fertilizer), it may be best to choose a strategy similar to the one shown here. Modify the settings to fit your circumstances and to meet local field and delivery system conditions.

Troubleshooting

- If you do not hear the chimes after turning on the PDA (see Setup and configuration, page 35) or do not get serial communication to GPS and/or the RT200 system, perform a soft reset by holding the Power button down for approximately eight seconds. Then turn off and turn on the PDA. If you still do not hear the chimes, the PDA does not have a chimes feature—wait at least 10 seconds before opening any applications. Do not launch the RT Commander software until you hear both chimes or until at least 10 seconds have passed.

- Trimble recommends that you run a backup often to ensure you never lose any data due to an unforeseen hard reset. For more information, refer to the Trimble Recon Handheld Getting Started Guide.

- If you do not see a black path being drawn on the map screen, verify that the signal quality of GPS is set no higher than 1. Go to GPS Setup and then select the Quality tab.

Note – Rate commands are not sent unless a valid GPS signal is received. If there is not an adequate GPS signal, switch to GPS Setup / Simulation to set up the rate controller.

For more information, refer to the online troubleshooting document. Go to www.greenseeker.com and then select Support / Technical Notes /RT200 Troubleshooting Tree.
Cable Diagrams

This appendix includes the relevant cable assembly diagrams.
Figure A.1  RT200 serial cable assembly
Figure A.2  GreenSeeker RT200 interface module power cable
Figure A.3  GreenSeeker interface module to sensor CAN bus cable
Figure A.4  GreenSeeker interface module to PDA cable
Figure A.5  Cable assembly, GreenSeeker to display
In this appendix:

- Custom Formula

The Custom Formula feature enables you to select the application rates that will be applied at different sensor readings. In version 1.3.x of the RT Commander, software, you can add interpolation to the 16 point table. A 100 point table has also been added.

All positions in the 100 point table must have a valid rate entered.
Custom Formula

1. Select New Custom Formula from the drop-down list.

2. You must name the formula—enter a name in the Custom Formula field.

3. Select the rate at which the RT200 system will send the applicator's rate controller as sensor values change. The standard table is 16 rates, spanning NDVIs of 0.20 - 0.95, with an interpolation option. A high-resolution choice has been added with 100 points for NDVIs of 0.00 to 0.99.

*Note* – The horizontal scroll bar at the bottom of the gray area allows you to access additional fields. You must enter a value in each rate box.

4. When finished, tap OK to return to the Crop & Measurement Parameter screen.