

# VSN Operation Manual

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# CHAPTER

# 1

# IMPORTANT SAFETY INFORMATION

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## NOTICE

Read this manual and the operation and safety instructions included with your implement and/or controller carefully before installing the VSN™ system.

- Follow all safety information presented within this manual.
- If you require assistance with any portion of the installation or service of your Raven equipment, contact your local Raven dealer for support.
- Follow all safety labels affixed to the system components. Be sure to keep safety labels in good condition and replace any missing or damaged labels. To obtain replacements for missing or damaged safety labels, contact your local Raven dealer.

When operating the machine after installing the system, observe the following safety measures:

- Be alert and aware of surroundings.
- Do not operate the system or any agricultural equipment while under the influence of alcohol or an illegal substance.
- Remain in the operator's position in the machine at all times when the system is engaged.
- Disable the system when exiting the operator's seat and machine.
- Do not drive the machine with the system enabled on any public road.
- Determine and remain a safe working distance from other individuals. The operator is responsible for disabling the system when the safe working distance has diminished.
- Ensure the system is disabled prior to starting any maintenance work on the system or the machine.

## CAUTION

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### ELECTRICAL SAFETY

- Always verify that the power leads are connected to the correct polarity as marked. Reversing the power leads could cause severe damage to the equipment.
- Ensure that the power cable is the last cable to be connected.



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When coupled with a Raven field computer and RS1/SC1, VSN™ is designed to offer hands-free steering of agricultural sprayers.

The chapters in this manual are intended to assist with the proper calibration and operation of the VSN system.

FIGURE 1. VSN Home Screen



## SYSTEM SPECIFICATIONS

TABLE 1. VSN™ Technical Specifications

		U.S.	Metric
<b>Dimensions</b>	Height	7.74 in.	19.66 cm
	Width	9.94 in.	25.25 cm
	Depth	3.36 in.	8.53 cm
	Weight	approx. 8.75 lbs.	approx. 3.9 kg
<b>Power</b>	Operating Voltage	9 to 16 V DC nominal (reverse polarity protected)	
<b>Environmental</b>	Operating Conditions	-40° to 185° F	-40° to 85° C
	Storage Conditions	-40° to 185° F	-40° to 85° C

## INSTALLATION



 **WARNING**

Carefully read and follow all safety requirements and precautions contained in this manual and the machine-specific or implement Installation Manual. Failure to follow safety instructions may lead to equipment damage, personal injury, or death.

## RECOMMENDATIONS

Raven Industries recommends the following best practices when installing or operating the VSN system for the first time, at the start of the season, or when moving the VSN system to another machine:

- Verify that the machine hydraulic system is using fresh oil and that the filters have been recently changed.
- Ensure there are no issues with the machine hydraulic system (e.g., pump issues, faulty hydraulic motors, fine metal deposits in the hydraulic hoses, etc.).

## CARE AND MAINTENANCE

### GLASS CARE AND CLEANING

- Avoid pressure washing the camera lens.
- Use any glass cleaning products with a soft cloth. Avoid any abrasive products that could scratch or damage the glass.

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## UPDATES

Software and manual updates are available on the Raven Applied Technology website.

<https://portal.ravenprecision.com/>

Sign up for email alerts, and you will be automatically notified when updates for your Raven products are available on the website.

At Raven Industries, we strive to make your experience with our products as rewarding as possible. One way to improve this experience is to provide us with feedback on this manual.

Your feedback will help shape the future of our product documentation and the overall service we provide. We appreciate the opportunity to see ourselves as our customers see us and are eager to gather ideas on how we have been helping or how we can do better.

To serve you best, please send an email with the following information to

[techwriting@ravenind.com](mailto:techwriting@ravenind.com)

- VSN Operation Manual
- 016-2020-001 Rev. A
- Any comments or feedback (include chapter or page numbers if applicable).
- Let us know how long have you been using this or other Raven products.

We will not share your email or any information you provide with anyone else. Your feedback is valued and extremely important to us.

Thank you for your time.



## 3

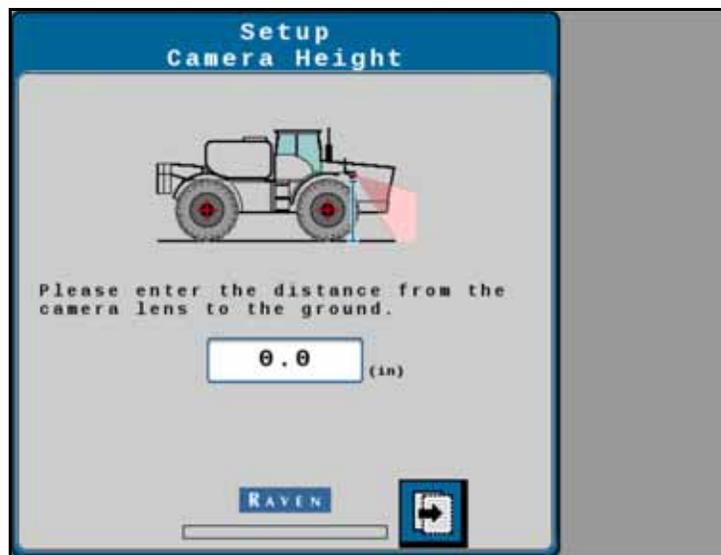
Complete the following steps to configure the VSN system for the mounting position on a specific machine.

**NOTE:** For best results, take all measurements in operating conditions and measure to the nearest 1/4 inch [nearest cm].

To reset or adjust the Machine Calibration, the VSN system must be reset to factory defaults.

1. Measure the height of the camera lens to the bottom of the furrow.
2. Use the on-screen keypad to enter the camera height.

FIGURE 1. VSN Camera Height



3. Select the Next button.
4. Next, measure and enter the distance from the rear axle of the vehicle to the camera lens.

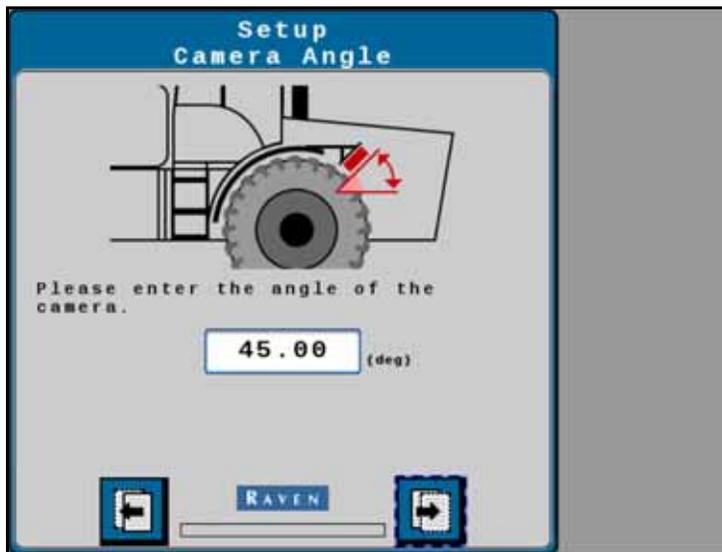
**NOTE:** A positive value means the camera is located in front of the rear axle.

FIGURE 2. VSN Camera Fore/Aft Position



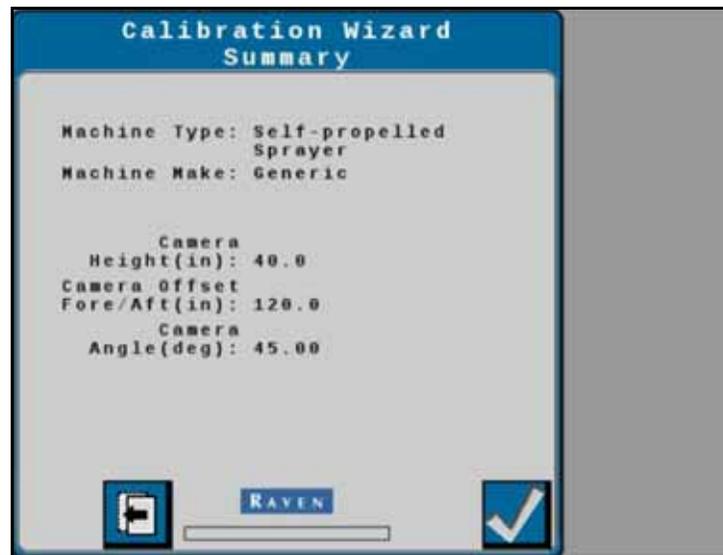
5. Select the Next button.
6. Enter the pitch (tilt) of the camera from horizontal.

FIGURE 3. VSN Camera Tilt



7. Select the Next button.
8. The Calibration Summary page will be displayed.

FIGURE 4. VSN Machine Calibration Summary



- To complete the Machine Calibration and save the displayed settings, select the check mark button.

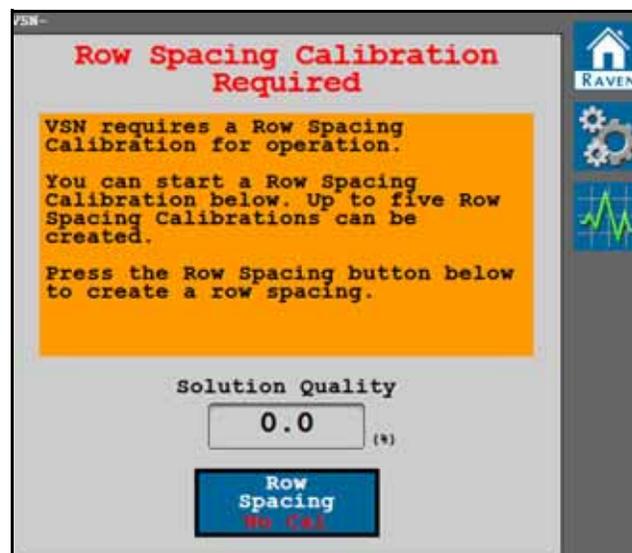
## INITIAL ROW SPACING PRESET CALIBRATION

Complete the following steps to calibrate the VSN system for a crop row spacing preset.

**NOTE:** Up to 5 row spacing presets may be saved with the VSN system.

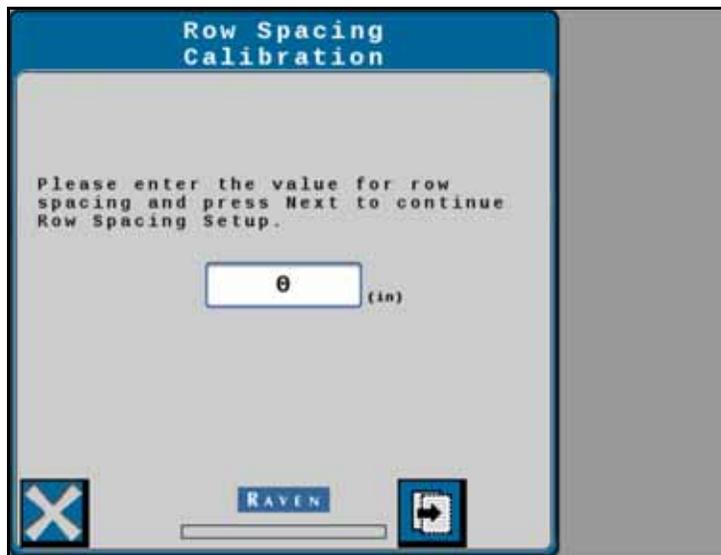
- Select the Row Spacing button near the bottom of the VSN Home screen.

FIGURE 5. VSN Row Spacing Preset Selection



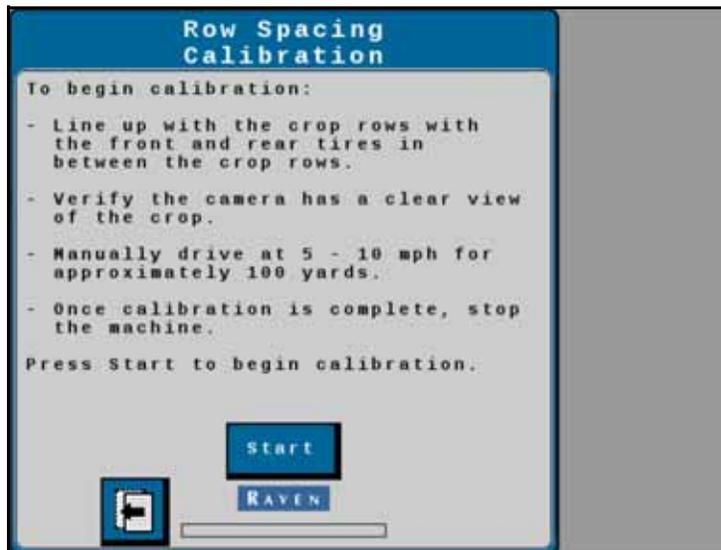
- Select the Next button.
- Enter the row spacing of the crop (in inches [cm]) in which the VSN steering system will be used.

FIGURE 6. VSN Row Spacing



4. Select the Next button.
5. Review the calibration instructions on-screen before selecting the Start button to begin the calibration.

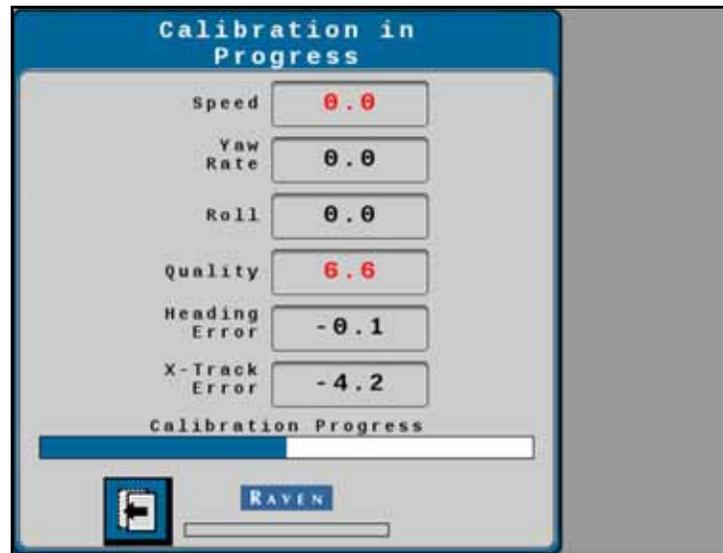
FIGURE 7. Begin VSN Camera Calibration



6. Drive slowly down the row while steering the machine manually. Drive at a speed of 5 to 10 mph [8.5 to 16 km/h]. After approximately 100 yards [91 m], the calibration process will be complete.

**NOTE:** The VSN camera needs to be calibrated in straight rows, in a flat field. A good calibration is extremely important to good steering performance.

FIGURE 8. Calibration In Progress



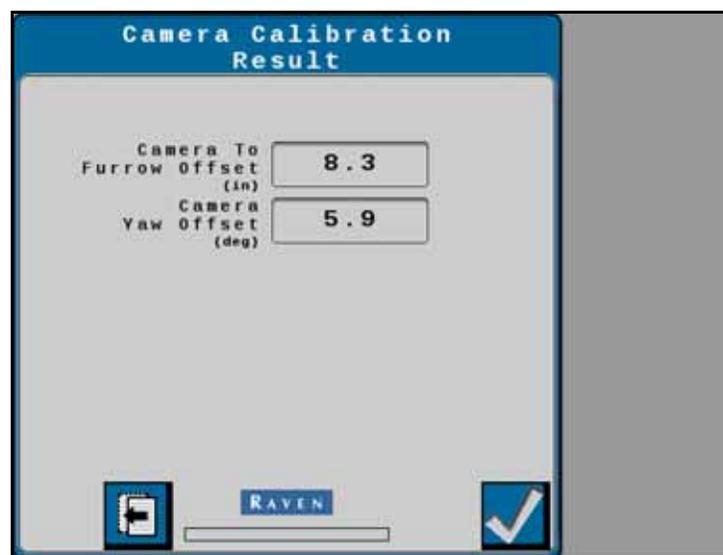
**NOTE:** Values displayed in red during the calibration process indicate an issue with the calibration parameters and may cause the calibration to stop or require the calibration to be restarted.

To successfully complete calibration, the following values will be required:

- Yaw rate must remain below 2.5° per second
- Roll must be less than 2°
- Quality must be above 50

7. Bring the machine to a complete stop.
8. Review the calibration summary page. To complete the calibration and save the displayed values, select the check mark button.

FIGURE 9. VSN Camera Calibration Summary







**NOTICE**

Do not use abrasive cleaning materials or sharp objects on the VSN camera lens. Check the lens periodically during field operations. Wipe lens with a soft cloth using glass cleaner if needed.

Refer to the ROS (Raven Operating System) Basic Operation Manual (P/N 016-0171-539) for instructions on starting a job and setting guidance lines.

### HOME PAGE

The following sections provide information about the system status and settings shown on the VSN System Home page.

FIGURE 1. VSN Camera Calibration Summary



The screenshot shows the VSN System Home page with the following labeled components:

- Quality:** A green box showing a camera view with a 65.2% quality indicator.
- Machine Speed:** A label pointing to the right side of the screen.
- VSN Status:** A label pointing to the top left corner of the screen.
- Machine Roll:** A label pointing to the roll indicator showing -0.6 (deg).
- Camera Furrow Offset:** A label pointing to the offset control showing 8.3.
- Solution Quality:** A label pointing to the solution quality control showing 50 (%).
- Row Spacing:** A label pointing to the row spacing indicator showing 27 (in).

## VSN STATUS ICON

TABLE 1. VSN System Status Icon Displays

Status Icon	Description
Green	System is ready for row steering operation. No active Diagnostic Trouble Codes (DTC).
Yellow	Solution quality is low. No active DTCs. System may be operated with caution.
Red	Active DTCs are preventing the system from operating.

## QUALITY

The percentage displayed indicates the current steering solution quality.

## MACHINE SPEED

Current GPS speed of the machine.

## CAMERA FURROW OFFSET

Distance from the right camera to the center of the nearest furrow bottom.

- A positive value means the camera is to the right of the furrow.
- A negative value means the camera is to the left of the furrow.

The offset value may be edited after the VSN camera has been calibrated to fine tune the tire-to-furrow position and help to center the tire in the furrow. Select the left button to nudge the tire to the left, and the right button to nudge the tire to the right. Using these buttons will nudge the tire in  $\pm 1$  inch increments.

## ROW DETECTION QUALITY

Set the minimum quality value that must be met to engage VSN. This value is the cameras ability to detect the crop rows versus the furrows. This value is editable.

A value of 50% is recommended. In Vision Only mode, VSN will disengage if the solution quality goes below the set percentage. In Vision Plus mode, VSN will revert back to GPS guidance.

## ROW SPACING

Displays the current row spacing entered for the current row spacing preset. Select the button to select a currently calibrated row spacing preset or calibrate a new row spacing preset. Up to 5 row spacing presets may be saved.

## VSN OPERATION WIDGETS

The following widgets are available for use with the VSN system to quickly change modes, monitor system operations, and engage the system from the field computer during field operations.

### OPERATION MODE WIDGETS

The Operation Mode widget must be added to the guidance screen to allow the operator to change modes during a field operation.

**TABLE 2. VSN Operation Modes**

Icon	Description
	<p><b>GPS Mode.</b> Guidance is performed via GPS guidance points only.</p>
	<p><b>Vision.</b> Guidance is performed via the VSN camera only. GPS corrections are neither utilized for guidance nor available as a fall-back solution. Line acquire must be performed manually. When the solution quality falls below the minimum threshold the steering system will disengage.</p>
	<p><b>Vision+.</b> Guidance is performed via a combination of GPS and the VSN camera. This mode can be utilized for line acquire via GPS with the system switching to the VSN camera when the machine is aligned and near the guidance line.</p> <p>This mode will also fall back to GPS guidance if the solution quality falls below the minimum threshold. The system will then return to VSN guidance automatically when the solution quality is above the minimum threshold.</p> <p><b>NOTE:</b> It is recommended to use Last Pass when using Vision+ mode.</p>

STATUS AND ENGAGE WIDGET

The following widget may be used with Raven steering systems to engage steering from the screen and view the current status of the steering system.

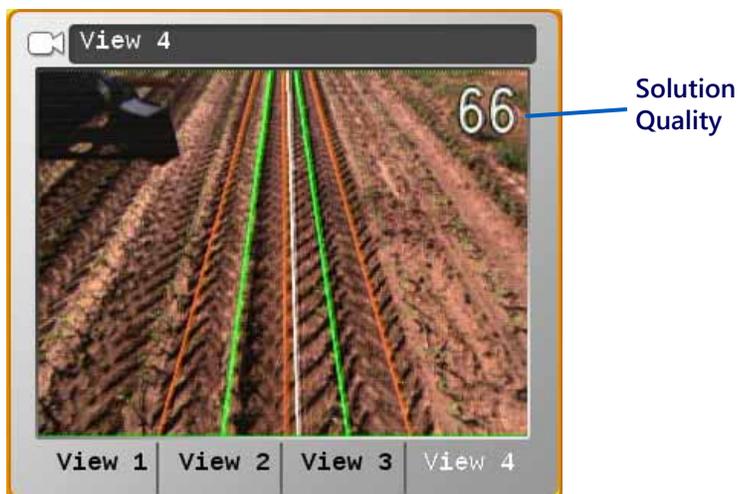
**NOTE:** The VSN steering system may be engaged using the machine engage switch. Refer to the RS1 or SC1/TC1 manual for additional information on using the machine engage switch.

ROS Widget	Description
	<p>System disabled and cannot be engaged. Check for active DTCs and VSN solution quality.</p>
	<p>VSN solution quality is nearing minimum thresholds. System may be engaged, but system performance may be impacted.</p>
	<p>System ready for steering.</p>
	<p>System engaged in GPS mode or using GPS fall back corrections in Vision+ mode.</p>
	<p>System engaged and using Vision for steering solution.</p>

## ANALOG VIDEO DISPLAY WIDGET

The Analog Video Display widget can be helpful when troubleshooting the visual guidance system.

**FIGURE 2. Analog Video Widget**



**NOTE:** Refer to the Viper/Viper 4+ Installation and Operation manual (P/N 016-0171-539) for information on adding widgets.

**Solution Quality Display.** The solution quality is displayed on the analog video display from the VSN camera.

**Vehicle Heading.** The current vehicle heading is displayed on the VSN analog video as a white line.

**Rows.** The green lines shown on the analog video display should correspond with crop rows shown in the video image.

**Furrows.** The brown lines displayed in the analog video should correspond to the furrow bottoms.

VSN STATUS WIDGET

The VSN Status widget allows the operator to quickly check the current status of the VSN system during operation.

ROS Widget	Description
	VSN requires calibration.
	No A-B path or guidance line has been set, solution quality is below minimum threshold, or an active DTC is preventing the VSN system from engaging.
	VSN is detected and ready.
	VSN solution quality is nearing minimums. While in a caution state, the system may be engaged, but system performance may be impacted.

**NOTE:** Machine roll is displayed on the VSN Status widget.

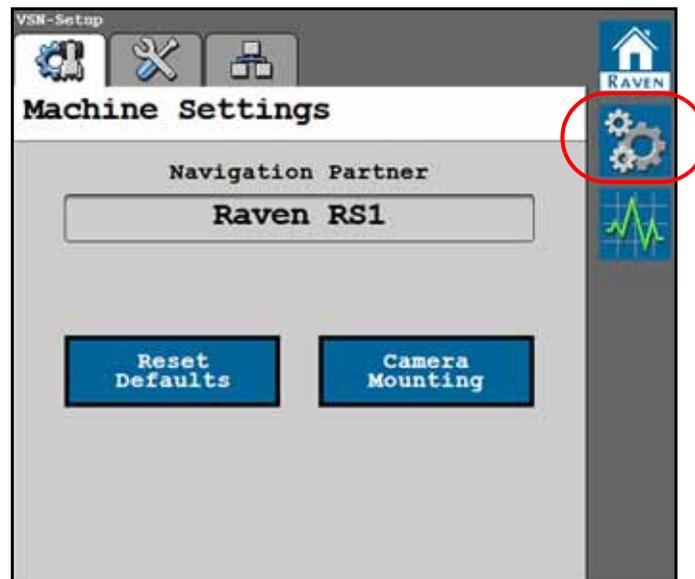
Refer to *Diagnostic Trouble Codes Screen* section on page 30 for additional status conditions which may be displayed in the VSN on-screen widget.

UT NAVIGATION BUTTONS

	<b>Accept</b> - Saves the changes made to the VSN system at the end of the setup process and returns the to the Tools Menu.
	<b>Next</b> - Saves the changes made to the VSN system and proceeds to the next step in the setup process.
	<b>Previous</b> - Returns the UT display to the previous screen in the setup process.

MACHINE SETTINGS

FIGURE 1. Machine Settings Tab



NAVIGATION PARTNER

Displays the Navigation Controller to which the VSN system is communicating.

RESET DEFAULTS

Touch the Reset Defaults button to clear stored row spacing presets and recalibrate the system. Accepting the confirmation will restore the VSN back to factory default settings.

FIGURE 2. Reset Configuration Prompt



CAMERA MOUNTING

FIGURE 3. Camera Mounting Settings Page



**NOTE:** A factory reset will be required to change or adjust the Camera Mounting Settings.

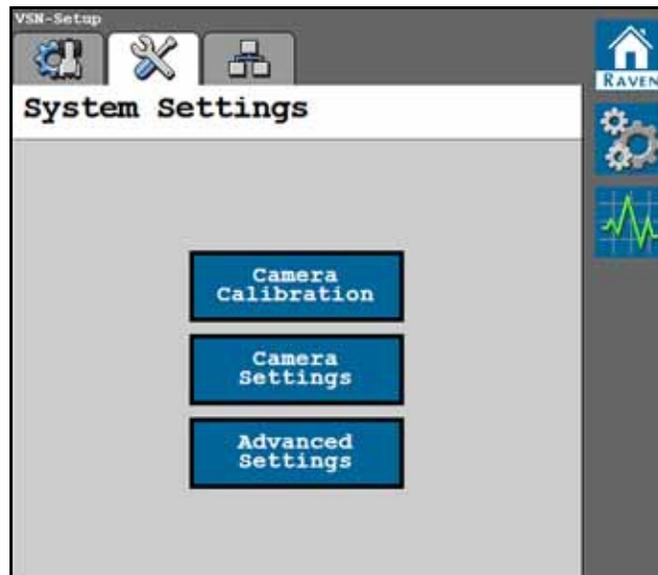
**Camera Fore/Aft.** Distance from the VSN camera lens to the rear axle. A positive value indicates the camera is positioned in front of the rear axle.

**Camera Height.** Distance from the VSN camera lens to the bottom of the furrow.

**Camera Pitch.** Pitch of the camera from horizontal.

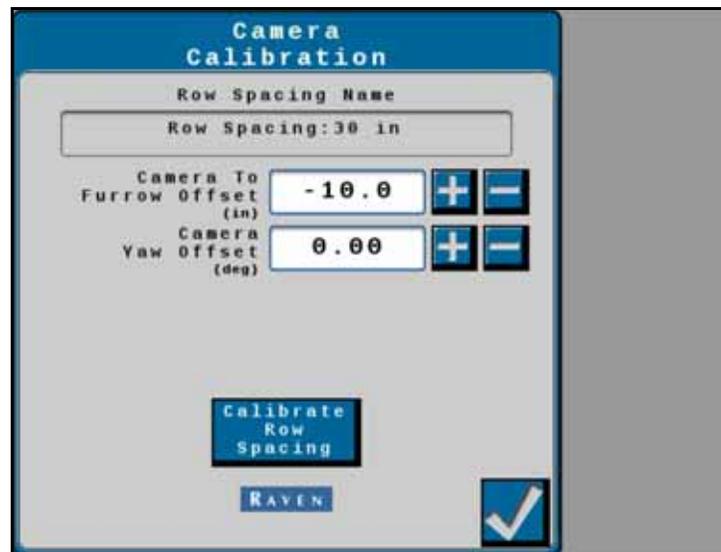
## SYSTEM SETTINGS

FIGURE 4. System Settings Tab



## CAMERA CALIBRATION

FIGURE 5. Camera Calibration Page



**Row Spacing Name.** Displays the currently selected Row Spacing Preset.

**Camera to Furrow Offset.** Displays the distance from the right camera lens to the center of the nearest furrow bottom. This distance value is calculated during the row spacing preset calibration procedure. Use the + and - buttons to fine tune the tire-to-furrow position to center the tire in the furrow.

**Camera Yaw Offset.** Displays the calibrated camera Yaw offset value. This value can be tuned to help account for any camera left or right heading alignment errors. Refer to *Camera Yaw Offset Tuning* section on page 26 for assistance with tuning the Camera Yaw Offset value.

**Row Spacing Calibration.** Touch the Calibrate Row Spacing button to recalibrate the row spacing preset outside of the preset calibration wizard.

CAMERA SETTINGS

FIGURE 6. Camera Settings Page

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**Enable Auto Exposure.** Automatically determines the correct exposure for video without any user input. Disable this option to manually adjust camera exposure.

**NOTE:** Auto Exposure is enabled by default and it is recommended to allow the VSN system to automatically adjust exposure during operation.

**Exposure Control.** Determines how much light is allowed to reach the VSN sensor and adjusts how light or dark the image appears. The correct exposure allows optimal contrast for system performance.

**NOTE:** It is not recommended to manually adjust the Exposure Control value.

**Capture Image.** Touch the Capture Image button to save a still image of the current VSN camera view. The image will be saved on the VSN system and may be used by the Raven Service Team to help troubleshoot potential field issues.

## ADVANCED SETTINGS

FIGURE 7. Advanced Settings Page



**Filter Level.** This setting controls the noise level in the guidance errors sent onto the CANbus from VSN. A lower setting has less filtering and lower latency. A higher setting has more filtering and more latency.

**NOTE:** The default value for the Filter Level is 2. It is only recommended to adjust this setting with the support of a technician.

**Quality Warning Offset.** The threshold above the Row Detection Quality (shown on Home screen) at which the operator will be notified that the solution quality from the VSN system has dropped to into a caution state. This value is editable.

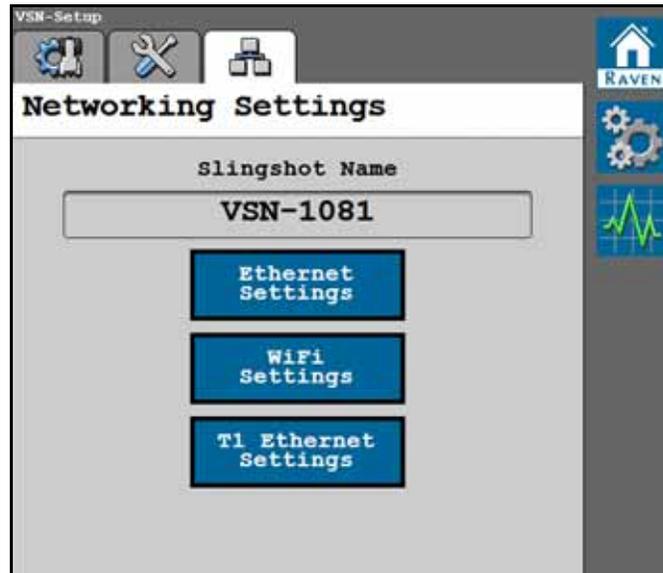
For example, if the Row Detection Quality is set to 50 and the Quality Warning Offset is set to 10, the VSN icon will be in a caution (yellow) state when the Row Detection Quality is between 50 and 60.

**Side Hill Compensation.** Provides additional compensation to adjust for guidance errors due to machine roll.

**NOTE:** Side Hill Compensation is enabled by default and it is recommended to leave this option selected.

NETWORK SETTINGS

FIGURE 8. Network Settings Page



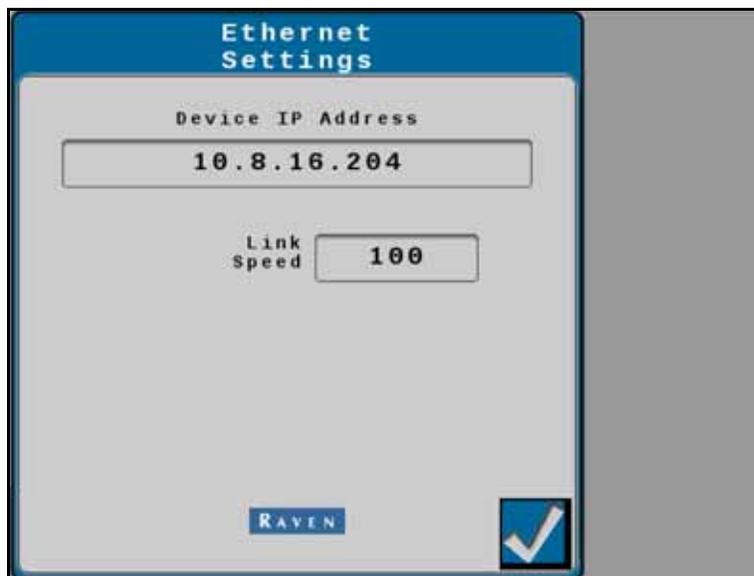
SLINGSHOT NAME

Displays the registered name of the VSN on the Raven Slingshot Portal.

ETHERNET SETTINGS

Touch the Ethernet Settings button to review the IP address assigned to the VSN system and the current link speed.

FIGURE 9. Ethernet Settings Page



WiFi SETTINGS

Touch the WiFi Settings button to review all WiFi Networks available to the VSN system. The network to which VSN is currently connected will be displayed with a green check mark next to the name.

Use the Mode drop down list to select Raven Auto to allow VSN to automatically connect with a compatible Raven device.

FIGURE 10. Raven Auto Mode



If a compatible Raven device is not available, use the drop down list to display a list of available WiFi networks. The network to which VSN is currently connected will be displayed with a green check mark next to the name.

FIGURE 11. Manual Mode



## TUNING

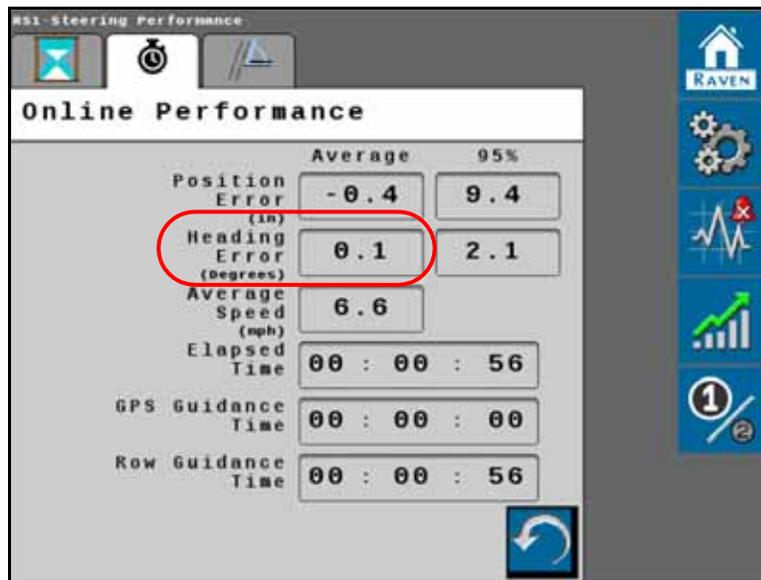
## CAMERA YAW OFFSET TUNING

This value can be modified.

In order to modify this value,

1. Clear the Online Performance Stats in the RS1 working set.

FIGURE 12. RS1 Online Performance Stats Page and Clear Option



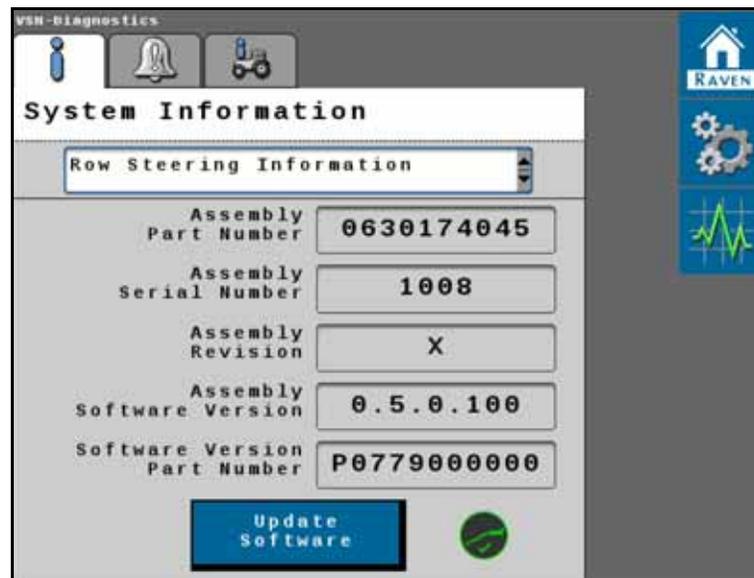
**NOTE:** Refer to the RS1 Calibration and Operation Manual (P/N 016-0171-001) for assistance with navigating and using the RS1 working set.

2. Drive a minimum of 150 meters down and back on the same path with VSN engaged. This should be done on flat ground.
3. Return to the RS1 Online Performance Stats page.
4. If the average heading error in the RS1 object pool is greater than 0.4 degrees, add or subtract the average heading error value from the Camera Yaw Offset.
  - If the average heading error is positive, subtract it from the Camera Yaw Offset.
  - If the average heading error is negative, add it to the Camera Yaw Offset.

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## SYSTEM INFORMATION

FIGURE 1. System Information Tab



The System Information tab displays the following information associated with the VSN system:

- Hardware Version
- Software Version
- Inertial Data
- System Hours
- System Voltages

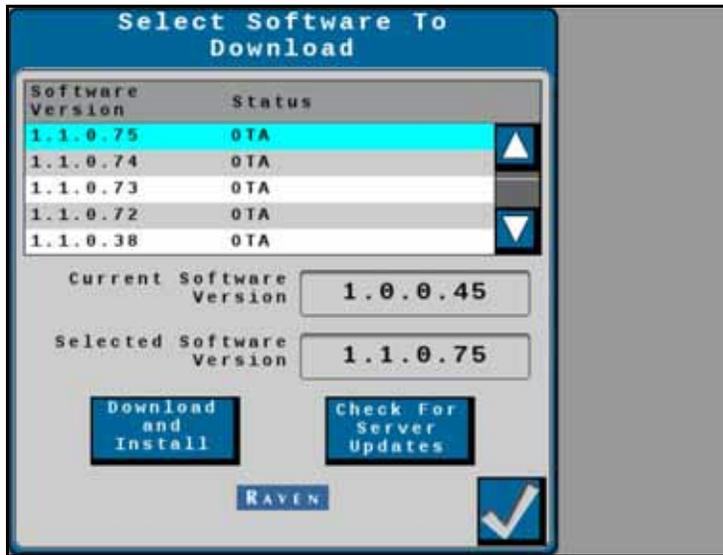
### SLINGSHOT STATUS ICON

- Green - Denotes a VSN connection to Slingshot.
- Red - Denotes that the VSN is NOT connected to Slingshot.

### SOFTWARE UPDATE

Select the Update Software button at the bottom of the page to update the software version on the VSN system.

FIGURE 2. Software Download Page



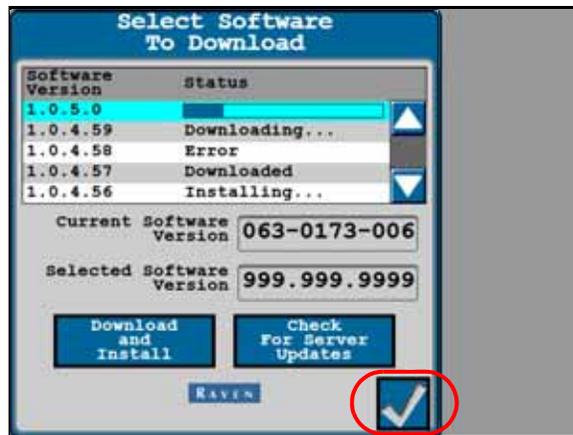
The current software version installed on the VSN system is displayed along with any available OTA (Over the Air) updates.

**NOTE:** VSN may be updated with a USB drive via the Viper 4. An OTA update may be completed with an Internet connection either via WiFi or Ethernet.

Refer to the CAN Node Update process in the field computer manual and ensure WiFi is enabled on the field computer.

TO UPDATE SOFTWARE

FIGURE 3. Software Download Screen



1. Select the **Check for Server Updates** button to search for available updates.
2. Select the desired software update from the list.
3. Select the **Accept** button.

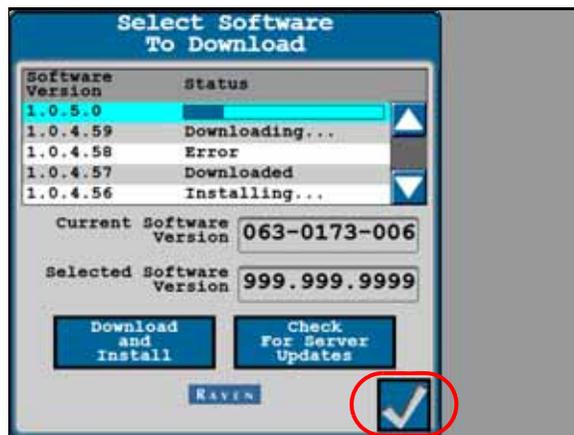
**NOTE:** The software will download, but will not be installed until later in the procedure. Before proceeding, accept the Data Usage Warning to allow the system to use cellular data to download the updates.

FIGURE 4. Data Usage Warning Screen



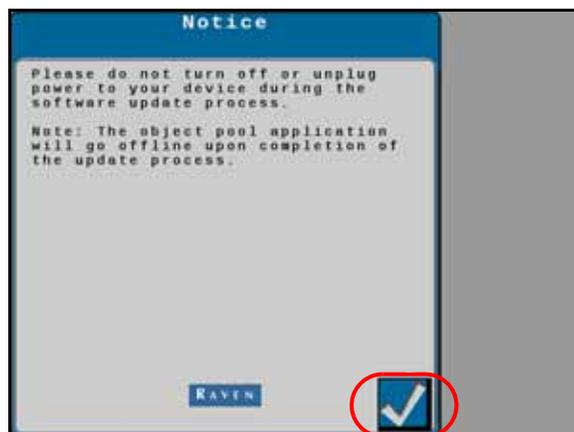
**NOTE:** Select Cancel to exit without downloading the software update.

FIGURE 5. Software Download Screen



4. Select **Accept** to begin the software download.
5. Wait for the software download to be completed.

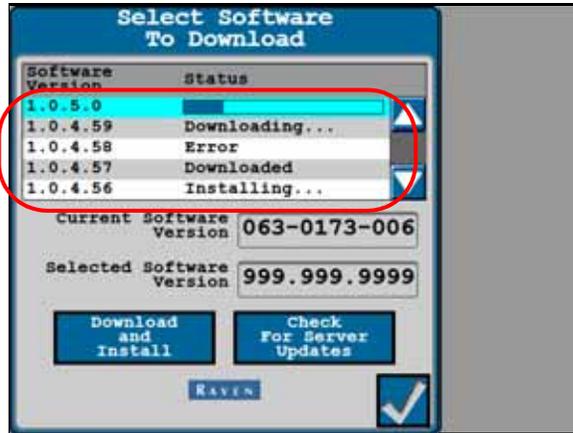
FIGURE 6. Software Update Notice



6. Select **Accept** to install the software.

**NOTE:** Do not shutdown the system or field computer during the software update.

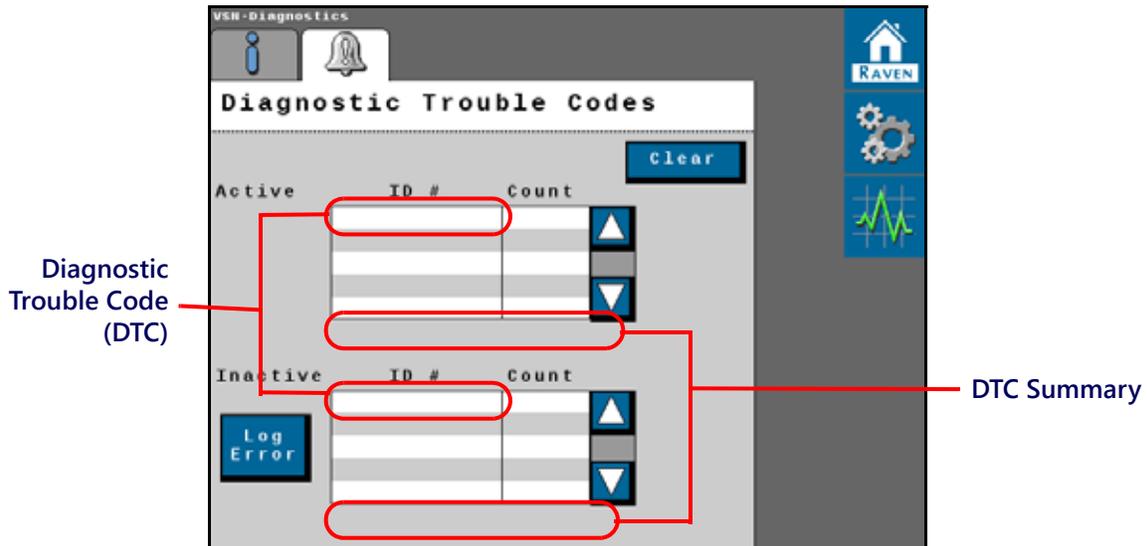
FIGURE 7. Software Installation in Progress



## DIAGNOSTIC TROUBLE CODES (DTCs)

The Diagnostic Trouble Code tab displays lists of both active and previous (inactive) diagnostic trouble codes (DTCs) that occur during VSN system operation. Active DTCs must be fixed before the VSN system can be enabled for guidance and steering operation. Once a DTC has been corrected, the code moves to the inactive DTC code list. Refer to Figure 8 on page 30 for an example of DTCs and DTC summaries.

FIGURE 8. Diagnostic Trouble Codes Screen



Selecting Clear deletes the inactive DTCs from the Inactive DTC error log. For a complete list of VSN DTCs, please visit:

[http://ravenprecision.force.com/knowledgebase/articles/Tech\\_Tip/RS1-Lights-and-Diagnostic-Codes/](http://ravenprecision.force.com/knowledgebase/articles/Tech_Tip/RS1-Lights-and-Diagnostic-Codes/)

Select the Log Error button to record diagnostic CAN data.

VSN DIAGNOSTIC LED STATES

TABLE 1. VSN Diagnostic LED Displays

<b>Status</b>	<b>Description</b>
Green	• Flashing (1 hz) - VSN system is calibrated and detecting rows.
Yellow	• Flashing (10 hz) - No CAN communication. • Flashing (1 hz) - CAN Communication Present.
Red	• Flashing - VSN has power and is starting up.



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# LIMITED WARRANTY

## WHAT DOES THIS WARRANTY COVER?

This warranty covers all defects in workmanship or materials in your Raven Applied Technology Division product under normal use, maintenance, and service when used for intended purpose.

## HOW LONG IS THE COVERAGE PERIOD?

Raven Applied Technology products are covered by this warranty for 12 months from the date of retail sale. In no case will the Limited Warranty period exceed 24 months from the date the product was issued by Raven Industries Applied Technology Division. This warranty coverage applies only to the original owner and is non-transferable.

## HOW CAN I GET SERVICE?

Bring the defective part and proof of purchase to your Raven dealer. If the dealer approves the warranty claim, the dealer will process the claim and send it to Raven Industries for final approval. The freight cost to Raven Industries will be the customer's responsibility. The Return Materials Authorization (RMA) number must appear on the box and all documentation (including proof of purchase) must be included inside the box to be sent to Raven Industries.

## WHAT WILL RAVEN INDUSTRIES DO?

Upon confirmation of the warranty claim, Raven Industries will (at our discretion) repair or replace the defective product and pay for the standard return freight, regardless of the inbound shipping method. Expedited freight is available at the customer's expense.

## WHAT IS NOT COVERED BY THIS WARRANTY?

Raven Industries will not assume any expense or liability for repairs made outside our facilities without written consent. Raven Industries is not responsible for damage to any associated equipment or products and will not be liable for loss of profit, labor, or other damages. The obligation of this warranty is in lieu of all other warranties, expressed or implied, and no person or organization is authorized to assume any liability for Raven Industries.

**Damages caused by normal wear and tear, misuse, abuse, neglect, accident, or improper installation and maintenance are not covered by this warranty.**

# EXTENDED WARRANTY

## WHAT DOES THIS WARRANTY COVER?

This warranty covers all defects in workmanship or materials in your Raven Applied Technology Division product under normal use, maintenance, and service when used for intended purpose.

## DO I NEED TO REGISTER MY PRODUCT TO QUALIFY FOR THE EXTENDED WARRANTY?

Yes. Products/systems must be registered within 30 days of retail sale to receive coverage under the Extended Warranty. If the component does not have a serial tag, the kit it came in must be registered instead.

## WHERE CAN I REGISTER MY PRODUCT FOR THE EXTENDED WARRANTY?

To register, go online to [www.ravenhelp.com](http://www.ravenhelp.com) and select Product Registration.

## HOW LONG IS THE EXTENDED WARRANTY COVERAGE PERIOD?

Raven Applied Technology products that have been registered online are covered for an additional 12 months beyond the Limited Warranty for a total coverage period of 24 months from the date of retail sale. In no case will the Extended Warranty period exceed 36 months from the date the product was issued by Raven Industries Applied Technology division. This Extended Warranty coverage applies only to the original owner and is non-transferable.

## HOW CAN I GET SERVICE?

Bring the defective part and proof of purchase to your Raven dealer. If the dealer approves the warranty claim, the dealer will process the claim and send it to Raven Industries for final approval. The freight cost to Raven Industries will be the customer's responsibility. The Return Materials Authorization (RMA) number must appear on the box and all documentation (including proof of purchase) must be included inside the box to be sent to Raven Industries. In addition, the words "Extended Warranty" must appear on the box and all documentation if the failure is between 12 and 24 months from the retail sale.

## WHAT WILL RAVEN INDUSTRIES DO?

Upon confirmation of the product's registration for the Extended Warranty and the claim itself, Raven Industries will (at our discretion) repair or replace the defective product and pay for the standard return freight, regardless of the inbound shipping method. Expedited freight is available at the customer's expense.

## WHAT IS NOT COVERED BY THE EXTENDED WARRANTY?

Raven Industries will not assume any expense or liability for repairs made outside our facilities without written consent. Raven Industries is not responsible for damage to any associated equipment or products and will not be liable for loss of profit, labor, or other damages. Cables, hoses, software enhancements, and remanufactured items are not covered by this Extended Warranty. The obligation of this warranty is in lieu of all other warranties, expressed or implied, and no person or organization is authorized to assume any liability for Raven Industries.

**Damages caused by normal wear and tear, misuse, abuse, neglect, accident, or improper installation and maintenance are not covered by this warranty.**