



Chapter 2: Troubleshooting Precision Agricultural Equipment



Nicholas Uilk (Nicholas.Uilk@sdstate.edu)

Even though modern equipment generally operates trouble free, problems still occur (Fig. 2.1). In some situations, attempting to fix the equipment can void warranties. The following chapter provides basic troubleshooting guides for precision agricultural equipment, and it does not provide techniques to overcome proprietary defenses.

General GPS Guidance Systems

A majority of precision agriculture equipment relies on the Differential Global Positioning System (DGPS) to provide accurate locations during planting, harvesting, and applying precision treatments. DGPS, which is often referred to as GPS, can provide sub-inch accuracy. Unfortunately, when the GPS fails, your farming operation may be at a standstill until repaired. Troubleshooting GPS guidance systems may require contacting the manufacturer's technical support. However, there are some simple steps that you can follow before calling a technician.

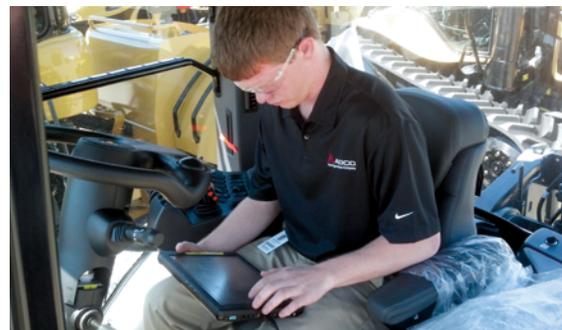


Figure 2.1 A technician calibrates the guidance system on a new tractor. (Courtesy of AGCO)

Problem: Not receiving a GPS signal.

1. Check for software or firmware updates that may be required by the system. Not having the current software updates can lead to communication issues between implements and control modules, causing the equipment to malfunction.
2. Make sure the GPS receiver is not adjacent to buildings, tree lines, or vehicles and that it has a clear view of the sky. Attempt to install and test the guidance system before the equipment is needed. In most situations, guidance systems cannot be tested in the shop because GPS signals are transmitted over relatively weak signals and small obstructions can interfere with the signal.

Problem: The vehicle has a clear view of the sky but still does not have a GPS signal.

1. Check for tight and secure connections, starting at the globe on the roof, to the receiver, to the display cable. Check all connectors to make sure that the pins have not been pushed sideways. Loose connections can cause a loss of or a sporadic signal.

2. Check the indicator lights on the receiver (if equipped). If the cab roof receiver's green light is on, the receiver is receiving a GPS signal. If the receiver has a signal, but the display indicates no connection, there is a problem between the receiver and the display.
3. Check if the correct differential correction is selected. For example, the display may be set to utilize WAAS for differential correction when it needs to be set to OmniSTAR or StarFire.
4. If the GPS light is yellow or blinking (depending on manufacturer), there is an interference with the signal. Trees or buildings that are blocking the signal between the satellite and the receiver can cause interference.
5. A red light or amber blinking light on your GPS indicates no communication between satellites and your receiver as you attempt to restart the system. If the problem persists, contact your local dealer.
6. Check the baud rate, which is the speed at which the system communicates with satellites. Baud rate is the rate at which information is transferred from the receiver to the computer, and if it is not set to the correct setting, the GPS system will not work. Recently purchased systems have baud rates that often are 19,200 or 38,400. Older systems may have baud rates of 4,800 or 9,600. Check your manual for correct baud rate settings.
7. Check the Controller Area Network (CAN) bus systems to make sure that the appropriate baud rates for the receiver, wheel-angle sensors, and steering valve are appropriate (Bartak, 2014).

Problem: The location is not correct.

1. This is a common problem when the GPS system has been off for an extended period of time. When the system is turned on, the software uses old information to calculate its location. As the almanac (which is a list of all the satellites and their location in orbit) is obtained, the locations will become more accurate. Wait until convergence is down to 2"-5" if using a satellite-based correction system (Breuer, 2014).
2. Poor location accuracy can be caused by the satellite arrangement in the sky. The satellites may not be evenly distributed in the sky, or close to the horizon rather than overhead. This can lead to poor Dilution of Precision (DOP) values, which can be found in the display. Typical numbers desired for DOP are: 0-3 good, 3-5 acceptable, and above 5 unusable (Breuer, 2014).
3. 3) Make sure that the receiver is at the highest point on the vehicle. For example, if you added extensions to the combine's grain tank and the receiver is on top of the cab, the extensions may protrude above the receiver, reducing the number of viewed satellites. It also could cause a multipath error. Multipath error occurs when the GPS signal bounces off of an object (in this case the extension) and then is picked up by the receiver (Fig. 2.2). This causes the receiver to receive multiple signals, one directly from the satellite, and one from the signal bouncing off of the bin extension.
4. It is possible that the receiver is communicating with the GPS satellites, but not receiving a correction signal from a WAAS / OmniSTAR / StarFire satellite. When this happens, the GPS correction will not be accurate enough for most purposes. All displays have a screen that indicates the type of GPS correction. It is important that you are receiving Differential GPS (DGPS).
5. An additional frequent problem is the vehicle wandering off course. Two-way radios and citizens band (CB) radios can interfere with GPS signals, causing loss of satellites. If the vehicle is wandering off course, change the frequency of the radios and CBs. Electrical noise from a bad alternator can also cause degradation or loss of GPS signal quality.

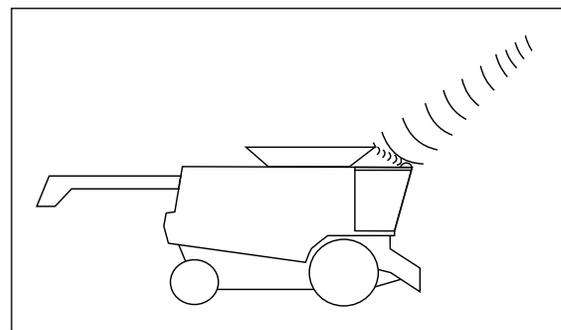


Figure 2.2 Grain extensions can cause multipath error, leading to signal degradation.

Planting and Application Issues

Problem: The planter shutoffs/startups are producing gaps in the field (Fig. 2.3)

1. This can be an issue if the offsets are not correctly entered into the display. The machine needs to know where everything is in respect to the GPS receiver. Many companies offer default settings that auto-populate based on the vehicle model and implement model numbers. These values must be checked.
2. Check whether the tire size has been changed, the GPS receiver has been moved, or the hitch type has been changed.
3. Most systems also have a lead-in or turn-on/turn-off time that can be adjusted. If the product application starts too soon, decrease the turn-on time. If application starts too late, increase turn-on time. If product application stops too soon, decrease turn-off time, and if product application stops too late, increase turn-off time (Popkens, 2014).



Figure 2.3 Offsets entered incorrectly can lead to skips and overlaps on the headlands. (Courtesy of author)

Problem: Row does not shut off when entering a headland.

1. 1) The headland or turnrow is the end of each planted field. These areas are subject to greater compaction than the rest of the field. To avoid double planting, double fertilizing, and double spraying, farmers often turn off the equipment when entering these areas. If the wire controlling the row clutch is broken, the planter will default to plant mode. Check the wiring coming from the individual row clutch and replace if broken.
2. 2) With planters and other application equipment, it is not uncommon to tie one brand of implement to another type of tractor. This can lead to having multiple displays in the tractor cab, utilizing one for guidance lines and the other to run the planter or application equipment.
 - a. Feed GPS from the tractor monitor into the planter monitor for row shutoffs, and variable-rate planting.
 - b. Make sure the proper NMEA sentences are being sent to the planter monitor from the tractor display.
 - i. Typical message strings are the GGA, VTG and ZDA message strings, depending on the piece of equipment.
 - ii. Check with the manufacturer or owner's manual to confirm which NMEA 0183 message strings will be needed for input to the implement prior to planting season.
 - iii. If the message strings are correct, set the communication rate in Hertz. Hertz is the number of times per second the sentence is communicated.
 - iv. A typical setting when communicating with application equipment is 5 Hz – 10 Hz. This means the sentences are sent to the implement 5 times per second (5 Hz), meaning the implement is receiving its location information 5 times per second.
 - v. A setting of 1 Hz would cause a slower reaction time of the planter. As an example, if you are planting at 5 mph, you travel at a rate of 7.33' or 88" per second. The planter would travel 7.33' between rate adjustments (Weaver, 2014).

Harvest Issues

Problem: The yield map does not make sense.

Yield maps are a powerful resource and contain a vast amount of information when made correctly. However, if the yield-monitoring system is not calibrated and set up correctly, the data has little value. To minimize errors, calibrate the system using the prescribed protocols. Grain yield can be calibrated by measuring combine grain harvested compared with a local elevator's estimates.

Problem: Combine is counting bushels but not showing yield.

Every combine with a yield-monitoring system has a header height sensor that tells the system if the

header is down (combine should be recording yield) or up (combine should not be recording yield). If you are harvesting and the monitor is counting the bushels but not showing a yield, the problem might be improper header-height calibration. Check your owner's manual for the correct calibration methods. This is a common problem when switching from soybeans to corn. With soybeans, the head rides on the ground, and when switched to corn, the yield-monitoring system may think the header is up.

Problem: The yield displayed is not correct.

Check each of the sensors used to determine yield. The combine calculates yield using the header width, the combine speed, and measured grain flow. Make sure speed sensors are communicating properly and that the header width is entered correctly. Common problems are that the header width is not correct and the vibration calibration was not conducted. To conduct the vibration calibration, follow the manufacturer's protocols. Additional suggestions are:

1. With an impact sensor yield-monitoring system, harvested grain is deflected by a plate at the top of the clean grain elevator. As the plate flexes, a voltage signal is produced. Vibration makes these estimates unreliable.
2. If the impact plate is dirty or worn, the accuracy of the reported values decreases. Inspect and clean these plates.
3. With an optical yield-monitoring system, check the eyes for dirt/dust debris. Next, check the clearance between the sensor plate and the paddles of the clean grain elevator. In most systems, this should be approximately one-half inch.
4. Clean the clean grain elevator speed sensor. This sensor is used to indicate to the display the speed of the clean grain elevator, which is used to determine the amount of time each paddle is allowed to fill. Typically, this has a minimum and a maximum speed range, commonly 250 – 600 (Bartak, 2014).

Mapping

Problem: Which map is correct?

This problem can be avoided by identifying the fields correctly when harvesting. To minimize errors, identify field names during the winter months and then place a list in each vehicle/machine.

Troubleshooting Electrical Problems

Problem: You have an electrical problem somewhere in the system.

Based on the electrical schematic (back of operator's manual or from the manufacturer), a voltmeter can be used to check voltages at specific pins and continuity of wires. A series of steps are outlined below:

1. For all electrical problems, start the diagnosis by checking all fuses. Check the fuse by touching each end of the leg of the fuse with a lead from the digital multimeter (DMM) while set on the continuity setting. If the DMM beeps, the fuse is good; if the DMM does not react, the fuse is bad. A blown fuse is an indicator that there is short circuit in the electrical system.
2. Check the voltage of the system. Voltage is simply the electrical potential, or electrical pressure. Think of the voltage as being the equivalent of fluid pressure in a hydraulic system. A DMM measures the "pressure" and has nearly infinite resistance, like a hose with such a small diameter, no fluid would be allowed to flow. Volts are comparable to psi, the higher the psi, the more "push" a fluid has. It is the same for volts, higher volts means more "push."
3. Check the battery by setting the DMM to voltage DC in the range that corresponds with the likely voltage of the battery. For a 12-volt battery, set the range to 20 DCV. Put the voltmeter probes on the battery terminals. If the probes are backward, the only consequence is a negative reading.
4. To measure a voltage drop across a piece of the circuit such as a light bulb, connect the digital multimeter in parallel with the light bulb (Fig. 2.4). This analysis is useful because it provides information if the circuit is operating correctly. All sensors typically output a voltage that corresponds to a specific speed, position, and temperature. For example, if your auto-steer system is not steering correctly, you may want to check the wheel-angle sensor to ensure it is functioning properly. To do this, connect one probe to the input wire and the other to the ground wire of the sensor. As you turn the wheels from left to right, you should see the voltage change accordingly (hypothetically -2.5 – +2.5

volts for this example). If the DMM does not return a smooth voltage signal as the wheel is turned, this could indicate a bad wheel-angle sensor. If you can't get to a bare wire with your DMM lead, one trick is to poke a hole through the insulation with a thin sharp needle. When you have completed the assessment, use waterproof silicone to fill the hole.

5. Current is the electrical flow through a circuit and is usually measured in amps or milliamps. To measure the current running through a circuit, break the circuit and reconnect the circuit using the probes. Again, if you hook the probes up backward, you will merely get a negative reading. The DMM acts as though it has no resistance in this setup, so it does not change the circuit but it will measure the electrical flow. Make sure to have the probes plugged into the right ports for current measurement and have the settings at the correct range (Fig. 2.5).
6. The resistance (measured in ohms) is the measurement of resistance to electrical flow. The resistance of a resistor, section of wire, a switch, or anything can be measured. A variable resistor, or potentiometer, is usually a dial or slider that changes resistance as it is adjusted to create larger or smaller voltage drop. Variable resistors are used to set the resistance accordingly. Unlike measuring current and voltage, a circuit must be disconnected from power when measuring resistance. To measure resistance, place a probe on each side of the piece you are trying to measure.
7. Continuity is a test that detects electrical flow through the system. The DMM will signal a 1 and beep when electricity is flowing. This is very useful when checking wires, fuses, connections, and switches. It is also useful in a bundle of wires to match the inputs with the outputs. Short circuits are identified by testing for continuity between components that should not be connected.

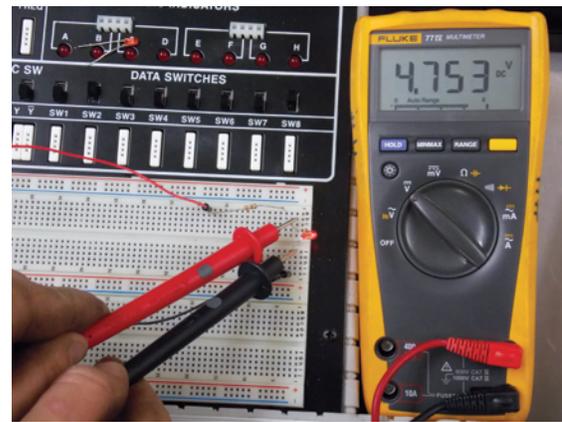


Figure 2.4 Using a voltmeter to test for a voltage drop (courtesy author)

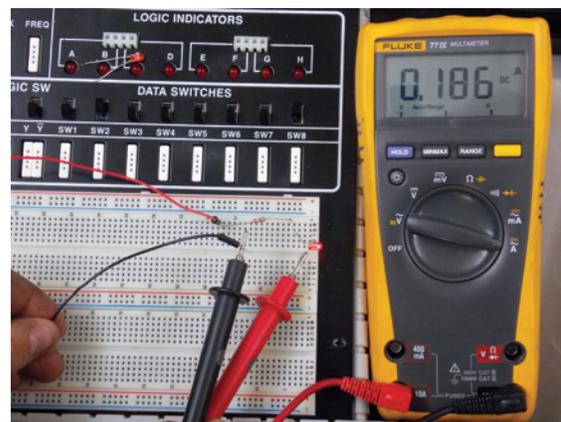


Figure 2.5 Using a volt meter to test current (courtesy author)

References and Additional Information

- Bartak, S. 2014. Personal interview. Ag Partners LLC, Calumet, IA.
- Breuer, J. 2014. Personal Interview. Deere and Company. Des Moines, IA.
- Deere and Company. 2014. Electronic and Electrical Systems. John Deere Publishing. <http://www.johndeere.com/publications>. Moline, IL. (accessed 4 November 2015).
- Deere and Company. 2010. The Precision Farming Guide for Agriculturalists. John Deere Publishing. <http://www.johndeere.com/publications>. Moline, IL (accessed 4 November)
- Mazur, G. 2009. Digital Multimeter Principles. American Technical Publishers. Orland Park, IL.
- Popken, A. 2014. Personal interview. ICON Ag & Turf, Le Mars, IA.
- Weaver, J. 2014. Personal interview. Butler Machinery, Sioux Falls, SD.

Acknowledgements

Support for this document was provided by South Dakota State University, SDSU Extension, and the South Dakota Corn Utilization Council.



A G R O W I N G I N V E S T M E N T

Iilk, N. 2016. Chapter 2: Troubleshooting Precision Agricultural Equipment. In Clay, D.E., C.G. Carlson, S.A. Clay, and E. Byamukama (eds). iGrow Corn: Best Management Practices. South Dakota State University.

The preceding is presented for informational purposes only. SDSU does not endorse the services, methods or products described herein, and makes no representations or warranties of any kind regarding them.

In accordance with Federal civil rights law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, the USDA, its Agencies, offices, and employees, and institutions participating in or administering USDA programs are prohibited from discriminating based on race, color, national origin, religion, sex, gender identity (including gender expression), sexual orientation, disability, age, marital status, family/parental status, income derived from a public assistance program, political beliefs, or reprisal or retaliation for prior civil rights activity, in any program or activity conducted or funded by USDA (not all bases apply to all programs). Remedies and complaint filing deadlines vary by program or incident.

Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotope, American Sign Language, etc.) should contact the responsible Agency or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. Additionally, program information may be made available in languages other than English.

To file a program discrimination complaint, complete the USDA Program Discrimination Complaint Form, AD-3027, found online at http://www.ascr.usda.gov/complaint_filing_cust.html and at any USDA office or write a letter addressed to USDA and provide in the letter all of the information requested in the form. To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by:

*(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;*

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

USDA is an equal opportunity provider, employer, and lender.

SDSU Extension is an equal opportunity provider and employer in accordance with the nondiscrimination policies of South Dakota State University, the South Dakota Board of Regents and the United States Department of Agriculture.