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Implementing
PRECISION AGRICULTURE

Connecting a GPS to Other Devices

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Many GPS receivers can be connected to other devices to provide positioning information. For example, GPS receivers are often connected to a yield monitor or variable rate application controller to create a map of yield or a map of how to variably apply agricultural inputs.

GPS receivers can also be connected to a handheld computer (also called a *PDA,* short for "personal digital assistant") or a personal computer. This fact sheet will explain how to connect GPS receivers to other devices using a serial port.

Many different communication protocols (formats for transmitting the data) are used to link GPS receivers with other devices. Some examples of newer protocols include USB, Bluetooth, and CAN (Controller Area Network, which is common on new agricultural machinery).

The most common interface used in agriculture is the RS-232 protocol, which is the same protocol that is used on the serial (com) ports on computers, printers, and PDAs. The National Marine Electronics Association (NMEA) has developed a standard for RS-232 GPS communication that makes it possible to easily connect almost any GPS receiver with NMEA output to any device that is configured to accept the NMEA communication. The user only needs to make sure that:

(1) Hardware is correct (wires and physical connection).
(2) A few simple software configurations are set up properly—both devices need to speak the same digital language.

Hardware

The most common connection used for GPS RS-232 communication is a nine-pin DB9 connector (Figure 1). This is the same connector that is used on the serial port of a PC. With the exception of newer laptop computers, almost all computers will have an RS-232 serial port. Although this connector has nine pins, or wires, only three of the wires are actually needed to transfer data in most GPS communications. One wire transfers data from one device to the other, a second wire transfers data in the opposite direction, and a third wire is used as a ground, or reference (Figure 2).

The most common problem encountered when connecting RS-232 devices is making sure that the two communication wires are connected correctly. Knowing how to connect these wires between devices can be a little tricky. Some RS-232 devices,

**Figure 1.** Male (left) and female (right) nine-pin DB9 serial connectors.

including many GPS receivers and PDAs, are configured to send data out on pin 2 and receive data in on pin 3. These devices often (but not always) use *female* DB9 connectors (Figure 1).

Other devices, such as computers, are configured to send data on pin 3 and receive data on pin 2. These devices often (but not always) use *male* DB9 connectors (Figure 1). To make a computer talk to a GPS receiver, you need to connect them with a cable that has a straight-through configuration, as shown in Figure 2a.

Since a PDA is configured just like a GPS receiver, PDAs cannot talk using a straight-through cable (Figure 2b). Pins 2 and 3 need to be reversed somewhere in the connection so that the devices can communicate. The "twisting" connection is called a *null modem* (Figure 2c).

Manufacturers often offer specialized cables that will take care of the wiring issue for you. In some unique applications, users may have to resolve this hardware issue themselves. Most electronics stores will supply null modem adapters or serial cables configured as null modems. They also are very easy to make from commercially available connectors and wires.

Some manufacturers will take liberties with the connections in a serial cable. One example commonly encountered in precision agriculture is found in the Ag Leader yield monitor. Ag Leader yield monitors have a DB9 connector that is intended to receive GPS data from any receiver; however, this connection is unique in that its pin 1 will have 12-volt power coming out of the yield monitor. The company uses this pin to power its own GPS receivers so that a separate power cable to the receivers is unnecessary.
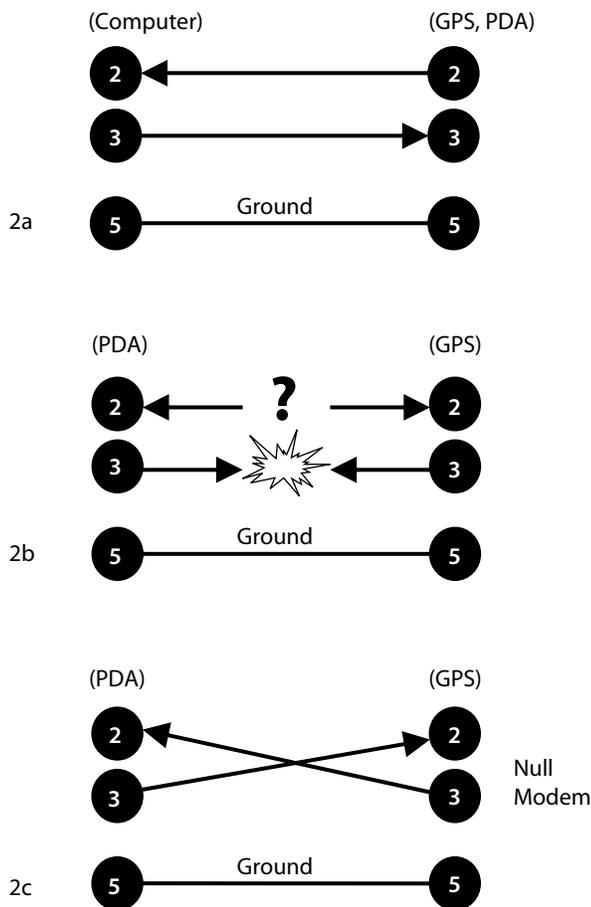
Figure 2. Wiring diagrams for RS-232 cable connections.

Most third-party GPS receivers must be connected to the Ag Leader yield monitor with a null modem cable or adapter. Although most of them do not have any connection to pin 1 in their connector, some do, and they could be damaged from the 12-volt power on that pin.

Many commercial null modem adapters connect pin 1 straight through the cable, so it is a good idea to remove pin 1 from one of the cable connectors using a small pair of cutters or pliers so the GPS equipment will not be damaged. If a null modem adapter is manufactured using the connections in Figure 2, there will not be a problem with pin 1 since it is not connected to the GPS.

Software

Once the hardware is connected properly, both devices must be configured to "speak" the same electronic language. On many GPS receivers and GPS receiving devices, there are several settings that the user can change. These include the baud rate and the number of data, parity, and stop bits. Fortunately, the only thing that the user needs to adjust in most communication scenarios is the baud rate, which can be thought of as a synchronizing speed between the two devices. Typical values for baud rate in GPS receivers are 4,800 and 9,600. In some higher speed applications such as lightbars and autosteer systems, baud rates may be increased to 19,200 or 38,400.

Baud rate should not be confused with the data update rate. Most GPS receivers used in yield monitor or scouting operations will send out a new position or a new data point every second or every two seconds; higher speed operations such as lightbars will use 10 or more data points per second. The number of data points per second is the data update rate. Each of those data points is coded into a series of computerized ones and zeros, which are called *bits*. One data point will have several hundred bits of information in it. The baud rate (the speed with which these digital bits are sent from one device to another) is a setting that can usually be changed under GPS configuration menus on yield monitors, other receiving devices, and on a setup menu in the GPS receiver itself. The important point here is that both devices must be set to the same value.

The other user-configurable RS-232 settings (data bits, parity bits, and stop bits) provide some control on the error checking in the serial communication. They can take on the following values, with the most common value for each of these parameters underlined:

Type of Bit	Most Common Values
Data	7 or 8
Parity	Odd, Even, or None
Stop	1 or 2

Many port setting routines will use a configuration indicator that may look like "*4800-8-n-1,*" which stands for 4,800 baud rate, 8 data bits, no parity, 1 stop bit. Again, the important thing is that both devices are set to the same values.

If the hardware and software settings are correct, GPS data communication should flow reliably because of the NMEA standardization.