

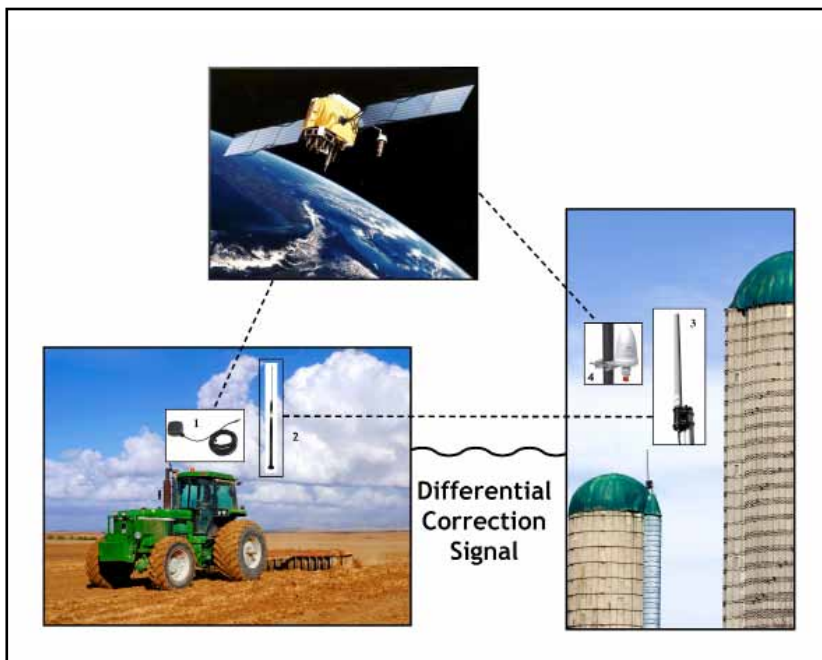


Antennas for Precision Agriculture and Precision Farming

The scope of Precision Agriculture continues to evolve into a more *accurate* industry. Throughout the last few decades, innovators in wireless technology have taken farmers out of a relative stone age with the incorporation of GPS and other wireless communications in order to optimize efficiency and reduce cost in an increasingly competitive market.

Knowing your geographic location and optimizing tractor path in swath-to-swath widths during a harvest is only a fraction of GPS utilization in agriculture applications. While GPS has been used to optimize and even automate Parallel Tracking for tractors, it is equally important for the driver to understand the terrain itself. Field Mapping has saved farmers countless amounts of money in tractor repairs by being able to record and map out the location of rocks, potholes, power lines, broken drain tiles, poorly drained regions and other various obstructions. Using this technology a farmer will also be able to record and understand geographic areas where there are pest infestations or high weeds as well as map soil-sampling locations which allow growers to develop contour maps showing fertility variations throughout the field.

Water usage in agriculture has received a lot of attention in the past few years as states such as California have implemented restraints on the overuse of water in irrigation. According to the U.S. Department of Agriculture, roughly 80% of all water consumed in the United States from agriculture. Field flooding continues to be utilized as a common practice that is not only wasteful but destructive as the overflow can drown crops and have significant pesticide and fertilizer runoff. Continuous innovation in this field over the last three decades has led farmers to deploy sensors to record moisture levels in soil and irrigate appropriately. In recent years, however, wireless technology has taken this efficiency to a new level. A farmer from a remote location can now measure and gauge the soil moisture as often as once a minute and redistribute water as needed without having to manually inspect meters in the field. GPS antennas positioned on center pivot sprinkler systems allow these automated systems to evenly distribute and cover massive crop circles without overwatering.



PCTEL's 3910D(1) gets positioning information from the satellites. PCTEL's elevated feed antenna (2) not only relays the positioning information to the management center but also receives the differential signal from PCTEL base station omnidirectional BOA series antenna (3). This allows the farmer to improve his accuracy to the sub-meter level. PCTEL's GPS-TMG (4) antenna may also be used for redundancy in positioning to mitigate errors caused by multipath and achieve pin-point accuracy.

Knowing your vehicle's position on an interstate highway for personal navigation needs an accuracy of roughly 10 meters. The most efficient agriculture systems need sub-centimeter accuracy in order to work comfortably between subsurface irrigation lines or to plant in narrow strip-till furrows. With the price of crop seeds on the

rise, accurate GPS systems can reduce cost by minimizing double planting and increasing overall crop yield. In order to achieve this level of accuracy, GPS systems must mitigate the slightest errors in GPS location caused by signal delay, multipath, satellite orbit error and timing synchronization discrepancies. This can be accomplished by using various methods of differential correction. One level of differential correction would be to include specific dual band GPS systems that utilize multiple satellite constellations such as GPS L1 along with GPS L2, L5, GLONASS and EGNOS/GALILEO which necessitate multiband GNSS antennas. PCTEL also provides base station GPS reference antennas that can be used in DGPS (Differential Global Positioning Systems). In this environment, each rover would have mobile GPS and either 400MHz or 900MHz mobile antennas that would communicate with a reference base station. This base station, which has to be within 5 miles of the rover for optimized accuracy, also contains a GPS base station reference antenna and an Omni-directional base station antenna that would transmit the differential signal to the rover.



Base station high gain omnidirectional antennas collect data from the rovers and assist in differential correction for precision agriculture.

At any given time, a GPS antenna must pick up the signal of at least three separate satellites in order to triangulate its latitude and longitude position and a fourth satellite to determine elevation. With 24 satellites covering the globe in the GPS L1 frequency band, an antenna should always be able to acquire signal lock on 8-9 satellites. Antennas with high out-of-band rejection such as PCTEL's 3911D-HR minimize harmonic interference caused by adjacent antenna propagation and can keep a greater number of satellites in lock and therefore improve receiver accuracy. PCTEL also offers GPS products with low noise characteristics in the event that the GPS antenna may interfere with other on board system communications.

In addition to unique electrical properties, antennas used on spray systems and rovers must be mechanically engineered to survive exposure to harsh chemicals, diesel fuel, axle grease and petroleum-based products that eat away at rubber compounds. They must also be designed to be robust enough in order to survive the extreme vibration specifications that are induced through navigation in uneven and rocky terrain. All products designed by PCTEL undergo full environmental testing that ensure that the antennas not only perform through vibration and agrochemical exposure but are also immune to water and dust ingress that may cause latent damage to the antenna's electronic components.

Increased pressure is being put on farmers to increase their yield while minimizing cost in an increasingly competitive market. Farmers are finding that current wireless platforms have not only improved yield and efficiency by as much as eight-fold but allow the farmer to automate many of the labor intensive processes they had deployed in the past. Farmers now have the ability to identify pest and disease infestations and track the amount of pesticides that are used, significantly reducing the room for human error. GPS antennas and wireless data transfer are making large farms manageable, more affordable and certainly more accurate.



PCTEL's Medallion antenna covers GPS L1, PCS/Cellular and W-Fi frequencies in a rugged, low profile housing

For more information on PCTEL's antenna product portfolio, visit www.pctel.com.