ANTENNA SOLUTIONS FOR POSITIVE TRAIN CONTROL (PTC) SYSTEMS

PCTEL®
Performance Critical

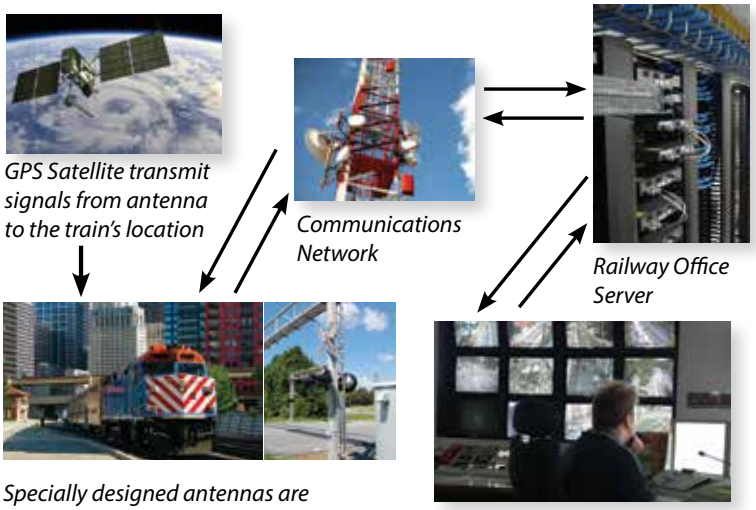
APPLICATION NOTE

The technology exists to design a system that can help prevent accidents by starting to apply a train's brakes should an engineer fail to obey stop signals, or if a train is traveling above speed limits. Positive Train Control (PTC), a command/control/communications system that overlays existing signal systems and monitors railroads through a wireless network, can help prevent train crashes and enhance railroad safety. PTC offers safety improvements at a time when train use and congestion is expected to rise. In addition to helping protect railroad workers and passengers from collisions or derailments, the system is expected to provide more reliable scheduling and increased energy efficiency through maintenance alert features.

The federal Railroad Safety Improvement Act (RSIA) of 2008 directs the Federal Railroad Administration (FRA) to put new safety regulations into effect, including mandated implementation of PTC systems by the biggest (Class I) freight companies, inter-city passenger, and commuter trains across a significant portion of U.S. railways. Antennas will be a critical component to the PTC system. With its extensive design and manufacturing capabilities, PCTEL, Inc. is well-positioned to meet the antenna requirements for this market.

The FRA defines positive train control as communication-based/processor-based train control technology that provides a system capable of reliably and functionally preventing train-to-train collisions, overspeed derailments, incursions into established work zone limits, and the movement of a train through a main line switch in the improper position. Transportation officials look to technology for further gains in railroad safety – as a way to correct human error. The National Transportation Safety Board has had PTC on its "Most Wanted List" since 1990. Some experts say that technology could have played a role in preventing recent crashes and the resulting fatalities. In September 2008, there was a horrific crash in Chatsworth, California. In 2013, a New York City Metro-North commuter train derailed in the Bronx. The train engineer did not slow the train from its 82 mph speed to the maximum of 30 mph as it headed to a curve. For the May 12, 2015 Amtrak crash near Philadelphia, the train's data recorder indicated that the train had been traveling at 106 mph in an 80 mph zone just before it entered a curve with a speed limit of 50 mph.

PTC is a flexible wireless system of monitoring train data such as location, speed, track information, and equipment functioning. This information, often gathered with the help of a Global Positioning System (GPS), is used to warn train operators about safety hazards. If necessary, the PTC system can automatically slow or stop trains. With PTC, information is sent from the train to antennas placed trackside where the data is relayed through another wireless system to the dispatch control center. This sophisticated communication requires highly advanced design and technology components, ranging from the digital data network to GPS systems and antennas, to on-board and dispatch computers and throttle-brake interfaces.



GPS Satellite transmit signals from antenna to the train's location

Communications Network

Railway Office Server

Specially designed antennas are placed on the locomotive and at regular intervals trackside to provide a continuous wireless data link with the control center

Control Room and Dispatching System

Several performance critical wireless communication links are involved in a typical PTC system. A GPS antenna placed on top of the locomotive receives location information and time stamps these messages, which are passed onto the core PTC module. The core PTC module interfaces with the rest of the control systems in the locomotive. It also collects other pieces of information, such as speed, engine performance, and driver awareness, combines it with location information from GPS, and sends it over a wireless communication link through an antenna placed over the roof of the locomotive, to the control center. Specially designed antennas are placed at regular intervals on trackside to provide a continuous wireless data link with the train. Data received by these antennas is then funneled over to the control center, either through a wireline connection or through a point-to-point wireless backhaul link. Data from the control center is sent back to the train via the same route. All of these links require high performance and robust antenna systems to enable accurate and timely transmission of appropriate data.

Rugged low profile mobile GPS antennas are required for locomotive placement to support location tracking

Most of the antenna systems in PTC get deployed in harsh environments, particularly those deployed on locomotives which experience heavy vibration and temperature variations. In addition to mechanical robustness, these antennas need to be designed to optimize coverage and minimize interference. GPS antennas deployed on locomotives face significant Radio Frequency (RF) interference from RF noise generated by the locomotive engines and from other data link antennas, particularly those operating in 212 MHz-222 MHz range dedicated for PTC. For the PTC system to work properly, the GPS antennas will be designed with appropriate filtering, and the trackside antennas will incorporate a pattern designed to provide continuous uninterrupted coverage over the tracks.

The PTC system needs a well-defined group of complimentary sub-systems that includes radios, control devices, interconnects, and antennas. One consideration that is often overlooked is the layout for antenna placement: updated engine communication systems for PTC can require nearly 30 antennas which need to interoperate. The PTC system must contemplate the relative number and placement of these individual ruggedized antennas to minimize interference, maximize throughput, and provide signal redundancy to ensure performance critical reliability. Optimal wireless performance can be accomplished with electromagnetic (EM) modelling for each unique implementation. EM modeling can identify and mitigate problems, weigh performance tradeoffs, mitigate crosstalk problems, and determine where filtering needs to occur. Antenna feed cables must be deliberately routed in the design for reliability and performance, as well as labeled/color coded for ease of installation and maintenance.

Omnidirectional (left) and offset dipoles (right) serve as data receptors for the dispatch control center

PCTEL designs and manufactures a number of antenna products that are required to deploy PTC systems. In particular, PCTEL has a wide selection of wideband and multiband transit and base station antennas that serve the needs of PTC systems. The company has extensive experience in custom design of antenna farms, to optimize the placement and communication efficiency of an array of antennas and associated feed cables. PCTEL has environmental testing capabilities to produce antennas able to withstand extreme weather conditions and high vibration exposure. As railroads work to meet new federal requirements, PCTEL provides antennas, antenna farm design, and other equipment for the potentially life-saving system.

Editorial contributions made by Josh Singer.

CONTACT PCTEL FOR ASSISTANCE WITH RAILROAD ANTENNA SOLUTIONS

PCTEL, Inc. is a customer-focused company dedicating its research and development to create high performance antenna products to meet market needs.

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