

Pseudolite System

PL-L₁-GPS / PL-915-GPS ; PL-L₁-CLK / PL-915-CLK ; PL-915-GPS (DUAL)

Model # PL-915-GPS-P



Pseudolites (PL) are used in a variety of situations, both to augment the GPS based navigation and also to navigate entirely without GPS. At least four pseudolite transmitters are used to illuminate the region of interest, if navigation without GPS is necessary.

These pseudolites can thus be used to navigate in indoor conditions, urban canyons or in other GPS obscured situations. These can also be used for augmentation of GPS, improving accuracies, such as those required for precision approach and landing, etc.

In order to meet the diverse applications using an unified architecture, CRS developed a software-based pseudolite system that offers unprecedented flexibility and reconfigurability.

CRS offers entirely software-based Pseudolite transmitters and receivers that allow reconfiguration and adaptation under different situations and scenarios. These flexible pseudolites can be positioned in almost any platform (ground based, ship-borne, UAV based, aircraft based or satellite-borne) and can be used for stand alone applications (operation without GPS) or with various levels of GPS availability. The software-based architecture provides the flexibility of using any waveform—offering selective denial capabilities in the region of interest.

SOFTWARE PSEUDOLITES FOR FLEXIBILITY, RECONFIGURATION AND ACCURACY (C/A AND P-CODES)

- *Improved Accuracy with or without GPS*
- *Operation in GPS or 915 MHz band*
- *Pulse Blanking on/off*
- *Versatile siting: Ground Based, Air-Borne, Satellite-Borne*
- *Flexible Waveforms - Selective Denial*

Although the primary use of pseudolites is to aid GPS based navigation, very often a signal can not be transmitted in the GPS band. The pseudolite family provided by CRS can be comprised of:

1. Pseudolites transmitting in the GPS band (L₁)(PL-L₁), and/or
2. Pseudolites transmitting in the 915 MHz ISM band (PL-915)

The 915 MHz ISM band is usable by any user under most situations. Both classes comprise GPS like signal waveforms both C/A code and P-code capabilities.

Typically, a minimum of four pseudolite transmitters with known positions are needed to obtain unambiguous positions and time estimation. It is also necessary to have accurate time synchronization between the pseudolite transmitters.



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The pseudolite positions can be obtained from :

1. External sources (via network or manual entry)
2. Built-in GPS receivers

When the GPS signal is not available to the pseudolite transmitter (inside a building, tunnel, etc.), pre-determined positions (or positions determined by independent means) can be used for fixed siting of PL transmitters. PL transmitters also require very accurate time synchronization. This can be provided by external stable clocks (10 MHz) derived from GPS signal, or made available through various networks. CRS pseudolites (PL-L₁ and PL-915 series) offer operation with GPS (PL-L₁-GPS; PL-915-GPS) or with external clocks (PL-L₁-CLK; PL-915-CLK).

The transmitted waveforms may be selected by the user. These can be any of the pseudolite codes (PRNs 33 to 37), or, alternatively, arbitrary waveforms determined by the user. This allows for additional capabilities, such as navigation using signals of opportunity (TV, radio). The software-based pseudolite architecture allows for extreme flexibility, providing the user with various run-time options, such as selective denial and pulse blanking, as well as integration of various options with the standard units.

PL-L₁-GPS / PL-915-GPS

These PL transmitter units use GPS to determine the PL positions. The PL transmitters must have visibility to the GPS constellation. The transmitted signals are either in the GPS band (L₁) or in the 915 MHz band. The PL-L₁-GPS and PL-915-GPS units are the optimal solution for civil environments where the minimum constellation for navigation may not be available at the receiver location.

The waveforms are identical to C/A and P codes of GPS satellites (PRN 33 to 36). Pulse blanking can be turned on or off by the user. Pulse blanking is used to enable both GPS and PL signals to be tracked on the L₁ channel, avoiding near far problems caused by the PL signals being far more powerful than the received GPS signals.

PL-L₁-CLK / PL-915-CLK

The PL transmitters use external position and timing information. The position information can be provided through manual entry or Ethernet connections. The external clock input of 10 MHz must be synchronized for all the four PL transmitters. This can be accomplished manually by using a single source, or automatically through self-synchronization.

These systems that rely on an external input to determine the position would be biased to a battle theater where the GPS signal may be intentionally jammed by the enemy. In this situation the PL-L₁-CLK and PL-915-CLK can function as indicated:

- The position fixes just before jamming can be manually entered into the system for a stationary PL
- External navigational and clock signals can be provided at a different frequency from outside the jamming theater. This would ensure that the PL could continue to provide ranging signals and ensure continuous and precise navigation for continuous and precise navigation for the receivers within the jamming theater.

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RECEIVERS (PLRX SERIES)

Several receiver types (software based) are available complementing the various PL systems. These include: PLRX-L₁, PLRX-915, PLRX-L₁/915, PLRX-L₁/L₂, and PL-915-GPS(COMB). All of these receivers are similar except they receive L₁ and 915 MHz together or L₁ and L₂ signals. These receivers can accept the navigation message from the PL (and GPS) signals. All the receivers and transmitters can be used with or without pulse blanking.

For the PL-915-GPS series, the transmitter transmits only 915 MHz signal and the receiver is equipped with 915 MHz antenna and front-end. In one mode, PL-915-GPS(COMB), the receiver is equipped with both 915 MHz and GPS front-ends enabling navigation using both PL and GPS satellite signals.

The receivers are similar in form factor and operation to CRS's advanced dual frequency software receiver ADF-GPS series. They provide standard Rinex outputs and the receiver positions can be displayed in a standard GIS map. The software is bundled with the receiver.

Potential applications include:

- Provide continuous coverage within buildings where the PL transmitters will be able to receive the GPS signal and transmit its own navigational signal in the region where GPS is unavailable. Depending on the capability of the user receiver equipment (URE) the signal would be retransmitted either at 915 MHz or at the L₁ frequency.
- In urban canyons, where a complete GPS constellation may not be available. In this scenario the PL-L₁-GPS would be suitable to serve as an augmentation system to enable a position fix.
- In civil aviation applications for high precision landing (Category II and IV). In this case the PL-915-GPS/PL-L₁-GPS would serve as an additional signal at an offset frequency providing additional ranging signals.

PSEUDOLITE RECEIVER SPECIFICATIONS

- Bandwidth 20 MHz @ 3 dB points
- All satellites in view (12 GPS channels, PRN 1 to 33)
- Five Pseudolite channels (PRN 34 to 37)
- Semi-codeless P-code (or classified Y-code) tracking
- Pseudorange accuracy (variance) of the order of mms
- Independent carrier phase and pseudorange tracking
- Binary and Rinex outputs for logging
- Software for mapping
- Software for post-processing

PL TRANSMITTERS SPECIFICATIONS

- PL-X-GPS:
 - ◊ Software-based Architecture
- PL-X-CLK:
 - ◊ Position and timing from external sources via Ethernet, USB or Keyboard/ext clock
- Both PL-X-GPS & PL-X-CLK:
 - ◊ Built in dual frequency software GPS Receiver for precise positioning and timing
 - ◊ Logging capability via USB
 - ◊ User Input via Ethernet/Keyboard
 - ◊ Remote Control
 - ◊ Output power variable from -130 dBW (10 dB steps, manual; 0.1 dB step via Keyboard)
 - ◊ Waveform selection via Keyboard; remote control
 - ◊ Pulse blanking on/off selection

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PSEUDOLITE FAMILY					
	Tx	WAVEFORM	Tx POSITION	Tx CLK	Rx
PL-L₁-GPS					
C/A	L ₁	C/A	GPS	GPS	L ₁ , C/A
P	L ₁	P, C/A	GPS	GPS	L ₁ , P L ₁ , L ₂ , P
PL-915-GPS					
C/A	915	C/A	GPS	GPS	915, C/A
P	915	P, C/A	GPS	GPS	915, P
PL-915-GPS-COMB					
C/A	915	C/A	GPS	GPS	L ₁ (GPS) & 915 (L ₁ -915)
P	915	P, C/A	GPS	GPS	L ₁ (GPS) & 915 (L ₁ -915); L ₁ , L ₂ (GPS) & 915 (L ₁ ,L ₂ -915)
PL-L₁-CLK					
C/A	L ₁	C/A	Ext	Ext*	L ₁
P	L ₁	P, C/A	Ext	Ext*	L ₁ L ₁ , L ₂
PL-915-CLK					
C/A	915	C/A	Ext	Ext*	915
P	915	P, C/A	Ext	Ext*	915

* GPS derived clock synchronization can be used