# lamaPLC Communication: GPS


The *Global Positioning System* (**GPS**), originally Navstar GPS, is a satellite-based radio navigation system owned by the United States government and operated by the United States Space Force. It is one of the global navigation satellite systems (GNSS) that provide geolocation and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

It does not require the user to transmit any data, and operates independently of any telephone or Internet reception, though these technologies can enhance the usefulness of the GPS positioning information. It provides critical positioning capabilities to military, civil, and commercial users around the world. Although the United States government created, controls and maintains the GPS system, it is freely accessible to anyone with a GPS receiver.

The GPS project was started by the U.S. Department of Defense in 1973. The first prototype spacecraft was launched in 1978 and the full constellation of 24 satellites became operational in 1993. Civilian use by the United States military was limited to an average of 100 meter uncertainty in location by broadcasting Selective Availability (SA).

Although an executive order from President Ronald Reagan after the Korean Air Lines Flight 007 disaster announced civil use would be eventually available without the degradation, it remained until President Clinton announced on May 1, 2000, the removal of SA to provide free civil access to the full GPS accuracy.[6] Advances in technology and new demands on the existing system have now led to efforts to modernize the GPS and implement the next generation of GPS Block IIIA satellites and Next Generation *Operational Control System* (**OCX**) which was authorized by the U.S. Congress in 2000.

# How It Works

The basic GPS service provides users with approximately 7.0 meter accuracy, 95% of the time, anywhere on or near the surface of the earth. To accomplish this, each of the 31 satellites emits signals that enable receivers through a combination of signals from at least four satellites, to determine their location and time. GPS satellites carry atomic clocks that provide extremely accurate time. The time information is placed in the codes broadcast by the satellite so that a receiver can continuously determine the time the signal was broadcast. The signal contains data that a receiver uses to compute the locations of the satellites and to make other adjustments needed for accurate positioning.

The receiver uses the time difference between the time of signal reception and the broadcast time to compute the distance, or range, from the receiver to the satellite. The receiver must account for propagation delays or decreases in the signal's speed caused by the ionosphere and the troposphere. With information about the ranges to three satellites and the location of the satellite when the signal was sent, the receiver can compute its own three-dimensional position. An atomic clock synchronized to GPS is required in order to compute ranges from these three signals. However, by taking a measurement from a fourth satellite, the receiver avoids the need for an atomic clock. Thus, the receiver uses four satellites to compute latitude, longitude, altitude, and time.

## Satellite frequencies

All satellites broadcast at the same two frequencies, 1.57542 GHz (L1 signal) and 1.2276 GHz (L2 signal). The satellite network uses a CDMA spread-spectrum technique: 607 where the low-bitrate message data is encoded with a high-rate pseudo-random (PRN) sequence that is different for each satellite. The receiver must be aware of the PRN codes for each satellite to reconstruct the actual message data. The C/A code, for civilian use, transmits data at 1.023 million chips per second, whereas the P code, for U.S. military use, transmits at 10.23 million chips per second.

| Band | Frequency | Description |
|---|---|---|
| L1 | 1575.42 MHz | Coarse-acquisition (C/A) and encrypted precision (P(Y)) codes, plus the L1 civilian (L1C) and military (M) codes on Block III and newer satellites. |
| L2 | 1227.60 MHz | P(Y) code, plus the L2C and military codes on the Block IIR-M and newer satellites. |
| L3 | 1381.05 MHz | Used for nuclear detonation (NUDET) detection. |
| L4 | 1379.913 MHz | Being studied for additional ionospheric correction. |
| L5 | 1176.45 MHz | Used as a civilian safety-of-life (SoL) signal on Block IIF and newer satellites. |

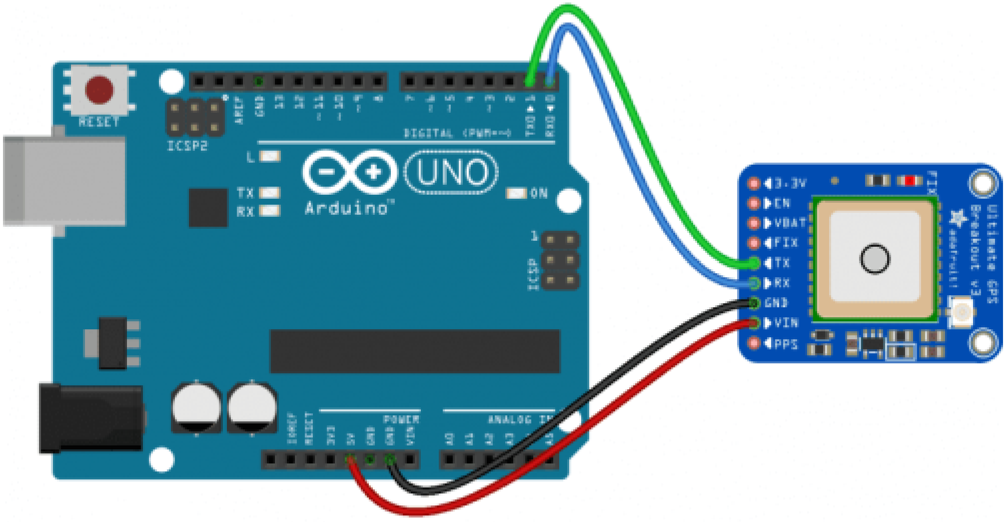
## GPS Similar systems

Following the United States' deployment of GPS, other countries have also developed their own satellite navigation systems. These systems include:

- The Russian *Global Navigation Satellite System* (**GLONASS**) was developed at the same time as GPS, but suffered from incomplete coverage of the globe until the mid-2000s. GLONASS reception in addition to GPS can be combined in a receiver thereby allowing for additional satellites available to enable faster position fixes and improved accuracy, to within two meters (6.6 ft).
- China's **BeiDou** Navigation Satellite System began global services in 2018 and finished its full deployment in 2020.
- The **Galileo** navigation satellite system, a global system being developed by the European Union and other partner countries, began operation in 2016, and is expected to be fully deployed by 2020.
- Japan's *Quasi-Zenith Satellite System* (**QZSS**) is a GPS satellite-based augmentation system to enhance GPS's accuracy in Asia-Oceania, with satellite navigation independent of GPS scheduled for 2023.
- The Indian Regional Navigation Satellite System, deployed by India.

## GPS applications

Today, almost all smart devices contain a GPS signal receiver, so their prices have become quite low. Automation technical solutions obviously require a device that can be used to communicate, so UART applications are most often prioritized in this case. Of course, accuracy is also important, which can be enhanced by the fact that the unit can connect to several systems, so in addition to GPS, Glonass, Beidou and Galileo connections are also useful.




## Sources

Wikipedia (https://en.wikipedia.org/wiki/Global_Positioning_System)

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