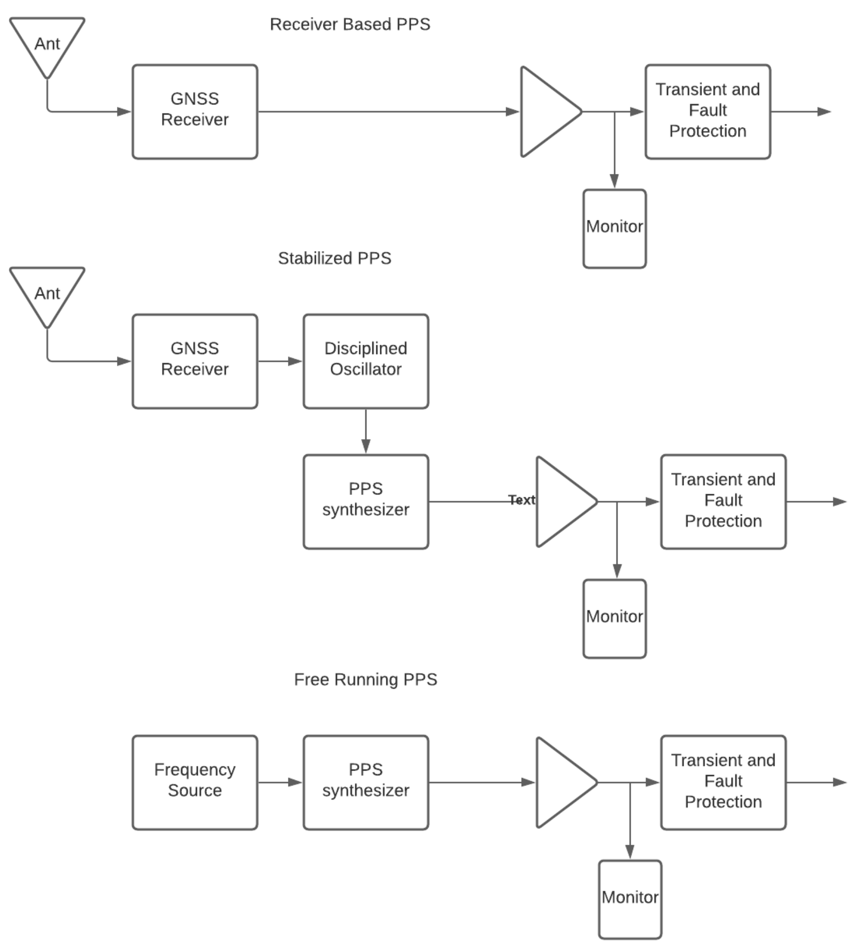
PPS Technical Considerations

There are numerous attributes to the PPS that need to be specified and/or understood for successful system implementation. The PPS is typically an output of the GNSS receiver being used. Depending upon the receiver - accuracy and jitter vary. These attributes also vary with signal strength to the point that the PPS availability can be made a function of estimated accuracy. The PPS rising edge is the start of the second of UTC time.
The PPS can be routed directly from the radio (GNSS-PPS) or be a synthesized PPS (SYTH-PPS). The SYTH-PPS may be locked to the GNSS-PPS or be completely free-running and have no relationship to UTC. The PPS may occur more frequently than once a second. The pulse width may be programmable, and the amplitude may also be specified. 3.3 Volt or 5 Volt CMOS levels are the most common. The SYHTHPPS may be locked to the GNSSPPS and may be the result of significant signal processing to improve accuracy and reduce jitter. Jitter can vary from tens of nsec to tens of psec.

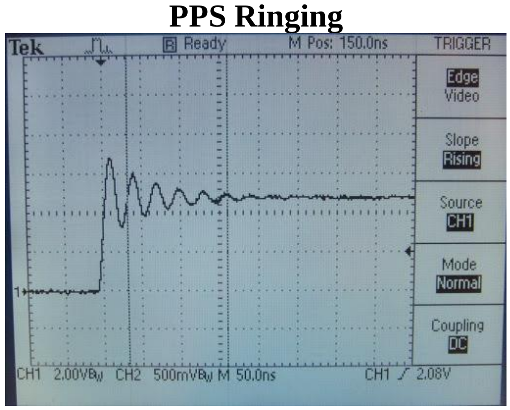


For the GNSS locked reference, the typical GNSS-PPS and SYTH-PPS performance is summarized in the table below:

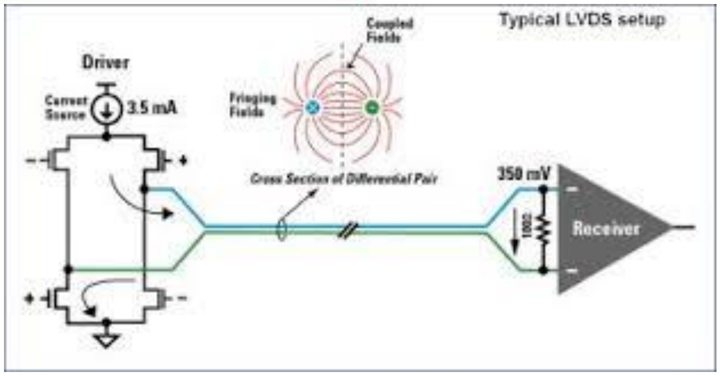
	Accuracy (ns)		Pulse to Pulse Jitter (ns)	
	GNSS-PPS	SYNTH-PPS	GNSS-PPS	SYNTH-PPS
	1 sigma	1 sigma	1 sigma	1 sigma
Analog loop	15	na	10	na
HS1	15	na	15	na
HS2	15	15	10	0.1
HS3	5	3	4	0.1
HS4	5	3	4	0.1

For the free running PPS source the pulse to pulse jitter <100 psec and the accuracy can be correlated to the OCXO, TCXO or Rubidium time base.
Connecting a PPS to a system is a subtle challenge. It is a pulse and as such, connecting a pulse to a distant point is not simple. Firstly, the very name PPS implies that you are dealing with a 1 Hz signal. Nothing could be further from the truth. Most PPS pulse signals have a rise and fall time that is on the order of 5 ns – this is more like a 200MHz signal than a 1 Hz signal. In addition, while many loads look like a CMOS high impedance load, attempts to connect with 50 Ohm cable frequently end up with ringing that may cause an edge to become ill-defined.

PPS Ringing

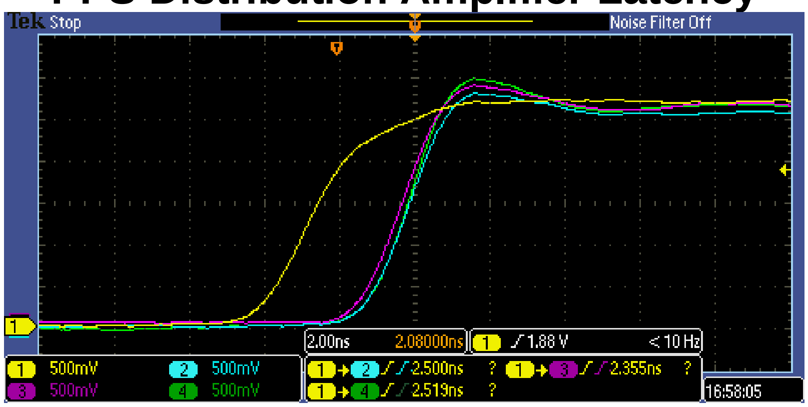


If properly terminated – a 50 Ohm cable can be used, but most CMOS drivers will not drive a 50 Ohm load. If the load is 5 Vdc CMOS at 50 Ohms, then the drive current is approaching 100 mA. This high drive current also compounds the short circuit protection that is essential in any complex system.   Short run, high impedance cabling can work if done so carefully. Other options include LVDS. LVDS works very well < 20 meters and is offered on several references.

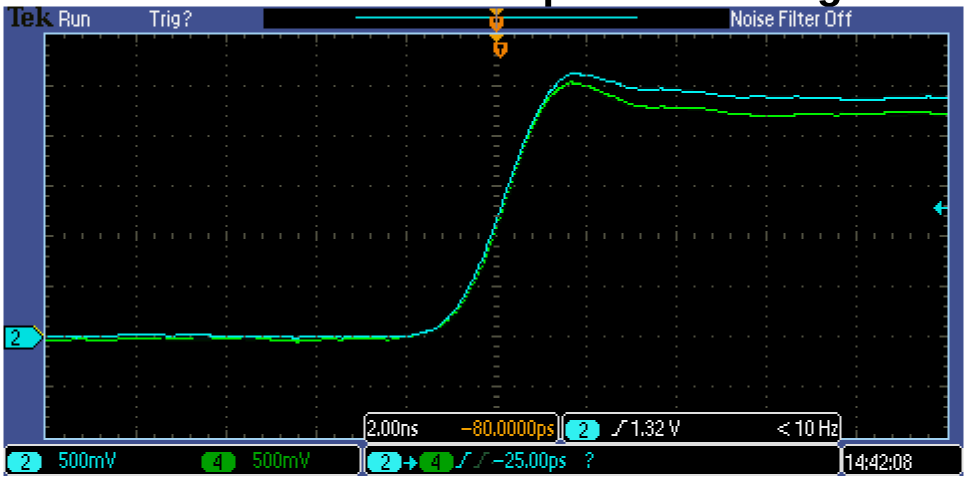


In applications where there is more than one client, a PPS distribution amplifier should be considered. A distribution amplifier will add latency (~25 ns) and skewing. Skewing in the 100 psec range is possible but must be carefully specified.

PPS Distribution Amplifier Latency



PPS Distribution Amplifier Skewing



Fiber optic distribution systems are available for PPS, but edge dispersion can compromise accuracy. Single mode systems must be considered but are more costly.
Depending upon the receiver used, the relationship between the PPS rising edge and the NMEA data varies. The rising edge may be for the NMEA data stream received or for the NMEA data that will be received next.