Author:
Engineering Support
The Connor-Winfield Corporation

How We Use Our NPLLs to Support Time Synchronization —

A NPLL (Numerical Phase-Locked Loop) is a numerical/ digital implementation of the traditional phase-locked loop, which is a feedback control system that aims to synchronize the phase of an oscillator with the phase of a reference signal. In the context of time synchronization, NPLLs can be used in various ways to ensure that the local oscillator remains synchronized with a reference time source. Here's how NPLLs support time synchronization:

1. Frequency and Phase Alignment:

The primary role of the NPLL is to maintain frequency and phase alignment between the local oscillator and the reference signal. In doing so, it corrects for any drift in the local oscillator.

2. Jitter and Wander Reduction:

Digital systems, especially those transmitting data over networks, can introduce timing jitter (short-term phase variations) and wander (long-term phase variations). A NPLL can act as a filter, reducing these effects and ensuring a more stable output frequency and phase.

3. Clock Recovery in Digital Communications:

One classic application of NPLLs is in clock recovery for digital communication systems. When digital data is received, the original clock used for transmission isn't directly available, but it's embedded in the data itself. A NPLL can "lock" onto this embedded clock information, effectively recovering the original clock, which is then used for data interpretation and further processing.

4. Time Synchronization in Networks:

In networked systems, ensuring that all nodes operate on a synchronized timeline is crucial. Protocols like NTP (Network Time Protocol) or PTP (Precision Time Protocol) transmit time-stamped messages. A NPLL at the receiving end can use these time-stamped messages as reference signals to adjust and synchronize its local clock.

5. Support for Holdover Mode:

In situations where the reference signal becomes unavailable (e.g., a GPS signal loss), a NPLL can switch to a "holdover" mode. In this mode, the NPLL relies on its last known phase and frequency error measurements to maintain the local oscillator's output. While not as accurate as when locked to a reference, it ensures continuity of operations.

6. Interpolation and Time-stamping:

In some advanced time synchronization applications, NPLLs are used alongside digital logic to interpolate between received time reference signals, providing higher resolution time-stamping or alignment capabilities.

7. Frequency Synthesis:

NPLLs, especially when combined with dividers or multipliers, can generate frequencies that are harmonically related to the reference. This is useful in applications that require synchronized clocks at different frequencies.

8. Distributed Systems and Grids:

In complex systems like power grids or distributed computing setups, multiple NPLLs in different locations can synchronize with a common reference, ensuring that all subsystems work in harmony.

By maintaining phase and frequency alignment with a reference signal, NPLLs provide a crucial tool in ensuring accurate time synchronization across diverse applications. As digital systems continue to grow in complexity and the need for precise time synchronization increases, the role of NPLLs and their advanced variants will remain pivotal.