SEVEN Solutions
When every nanosecond counts

Integrating High Accuracy Timing IP Core (HATI) on Xilinx FPGAs

HATI IP Core

High Accuracy Timing IP

The HATI (High Accuracy Timing IP) is a FPGA core designed to provide sub-nanosecond synchronization accuracy by using 1 Gbps optical fiber links. The core is based on precise internal clock corrections to achieve sub-nanosecond synchronization accuracy. Its architecture allows to adapt the IP to different platforms. These are some of its major features:

- **Sub-nanosecond time accuracy.**
- **Distance range: over 80 km using fiber without amplifiers and calibration.**
- **Dynamic compensation of asymmetries caused by weather conditions.**
- **Minimal data bandwidth consumption.**
- **Easily integrable.**

The HATI IP Core contains the whole design from the transceiver to an embedded ARM that executes a Linux OS, including the mandatory clocking circuitry to achieve a highly accurate synchronization.

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Specifications / HATI IP Core

Currently, the HATI IP Core is **only available on Xilinx Zynq** programmable SoCs because of its internal vendor dependent architecture. The example design is developed for a Xilinx Virtex-7 FPGA VC709 Connectivity Kit, but it can be adapted to work on different platforms.

Its purpose is to work as a last hop timing connecting to the optical interfaces of a WR Z16 device. The developed technology allows to correct the internal clock offset after receiving periodical data exchanges from the master WR Z16.

This design is a technology demonstrator that shows the capability to **integrate a high accurate timing system on many FPGA** based boards. For this reason, it has a modular architecture that allows the IP to coexist in different scenarios. Future integration projects can be discussed for different platforms, use cases and vendors.

The resource utilization on the Virtex-7 VC709 development kit is shown at **Table 1**.

LUT	5719	433200	1,32
LUTRAM	48	174200	0,03
FF	5948	866400	0,69
BRAM	39,50	1470	2,69
DSP	3	3600	0,08
IO	20	850	2,35
GT	1	36	2,78
BUFG	5	32	15,63

Table 1: HATI utilization on the Virtex-7 VC709 kit.

The accuracy level is measured by comparing the 1PPS (Pulse Per Second) outputs from a master WR Z16 device and a VC709 board that integrates the HATI core configured as a slave. It is a long-term measurement using a short fiber. The obtained peak-to-peak time offset is **lower than 300 picoseconds.**

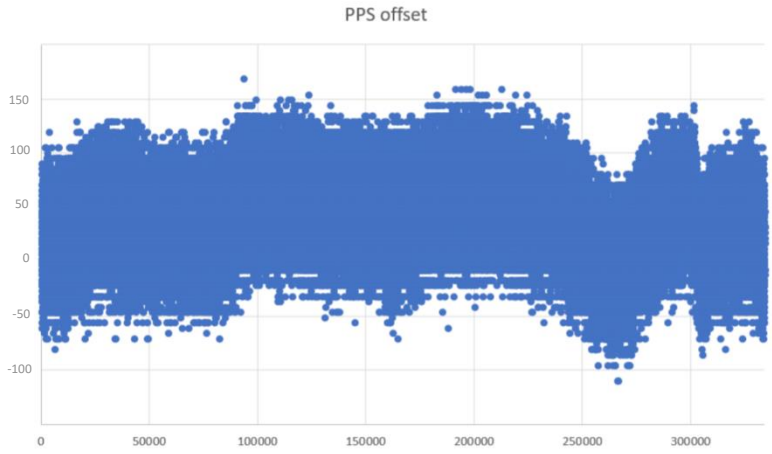

Figure 1: Long-term PPS offset measurement.

Max-Min (ps)	280,66
Mean (ps)	52,54
Dev. Std. (ps)	43,15952618

Table 2: Long-term PPS offset measurement results.

WR Z16

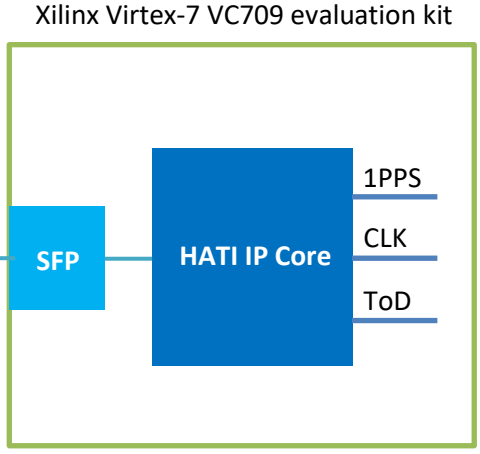

Figure 2: HATI integration demonstrator

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