

### CosCore Facts

- **Design File Formats:** VHDL
  - **Verification:** Test Bench
  - **Instantiation Templates:** VHDL
  - **Simulation Tool Used:** Vivado Simulator (XSIM)
  - **Support Provided by:** Barzak
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### Features

- Available under terms of the Barzak IP License
  - 16-bit unsigned input and output function
  - Function  $y = \cos(\pi/2 \cdot x)$
  - Input range:  $0 < x < 1$ , Output range:  $0 < y < 1$
  - 4-stage pipelined architecture
  - Accuracy of 1 LSB error, 0.00001525878
  - Results available every clock cycle after four cycles
  - Fully configurable and synthesizable
  - Implemented using Harmonized Parabolic Synthesis for optimal accuracy
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### Example Implementation Statistics for Xilinx FPGA

Family	Example device	Fmax(Mhz)	LUT	FF	DSP	BRAM
Zynq Ultrascale	XCZU7EV-3	280.82	73	57	8	1

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## Architecture Overview

- **4 stage pipeline unit:** The computational unit is divided into four stages. Each stage is set by the divided computational formula of Harmonized Parabolic Synthesis.

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## Core I/O Signals

Signal	Direction	Description
clk	Input	Global system clock
datai[31:0]	Input	32-bit input data bus
datao[31:0]	Output	32-bit output data bus

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## Applications

- Embedded arithmetic processing
- Real-time signal processing(Fourier Transform & Filters)
- Computer graphics
- Financial Modeling
- Telecommunications

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## Verification Methods

The Barzak Cos core has been verified in simulation using fully automated testbenches. The cos result is evaluated for  $2^{16}$ (65536) inputs (every conceivable mantissa value).

Additionally, verification was performed using an FPGA testing board, comparing computed cos results with a PC-based 16-bit unsigned fixed-point processor.

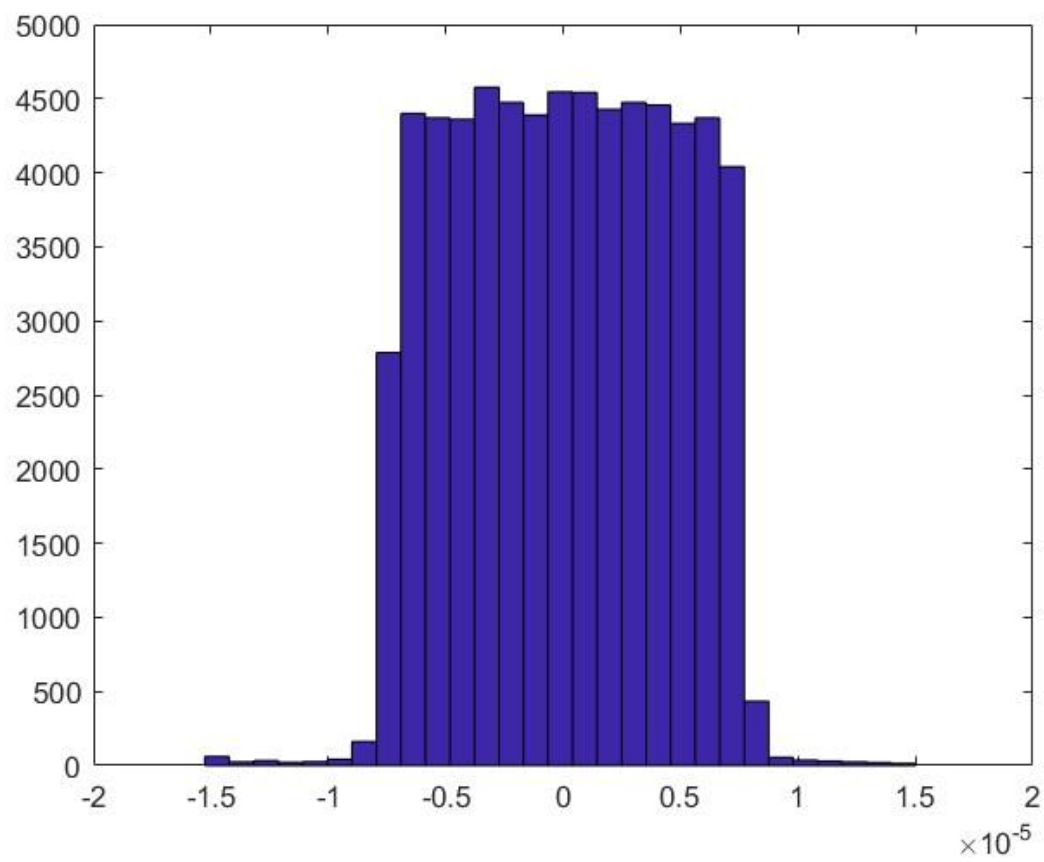
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## Performance

The 16-bit Cos function core achieves an accuracy of  $\pm 1$  Least Significant Bit (LSB), corresponding to a maximum error of approximately 0.00001525878.

The figure below presents the distribution of computation errors evaluated over all 65,536 possible input values. The error distribution is centered around zero and

closely follows a normal distribution pattern, indicating that errors are symmetrically spread and predominantly small across the full input range.



## Related Information

For more information on Barzak products and services, contact:

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