16-bit Arctan function

February 2025 Product Specification

ArctanCore Facts

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

Features

- Available under terms of the Barzak IP License
- 16-bit unsigned input and output function
- Function y = arctan(x)
- Input range: 0 < x < 1, Output range: 0 < y < π/4
- 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	261.506	228	114	5	0

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.

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

Applications

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

Verification Methods

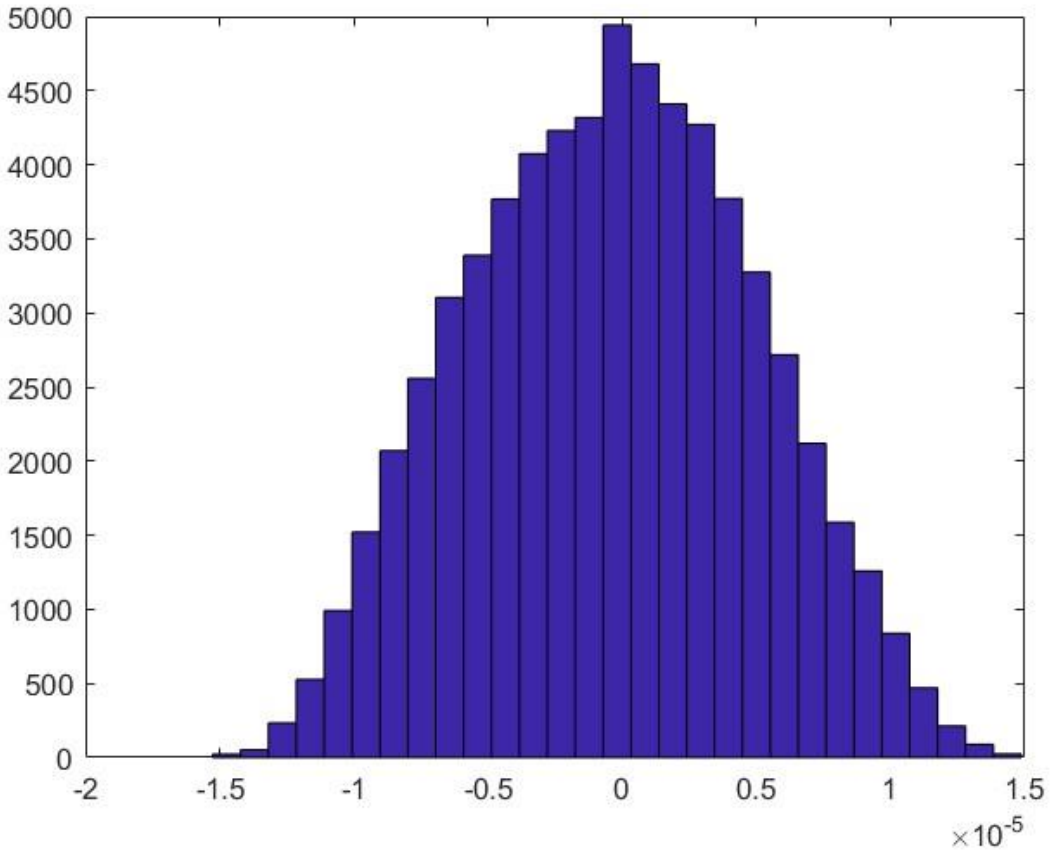
The Barzak Arctan core has been verified in simulation using fully automated testbenches. The arctan result is evaluated for 2^{16}(65536) inputs (every conceivable mantissa value).

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

Performance

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

The figure below presents the distribution of computation errors over all 65,536 evaluated input values. The error distribution is centered around zero and closely follows a normal (Gaussian) distribution, indicating that most errors are small and symmetrically distributed across the entire input range.



Related Information

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