

Arctan Function

Introduction

The arctan function is based on the Hammercores by Altera® CORDIC function. It has the ability to accept 4 quadrant input data in cartesian form, and returns a 4 quadrant arctangent.

The macro can operate as a combinatorial (single cycle) function, or a pipelined function. When pipelined, the macro produces a new result every clock cycle.

The arctan function is straightforward to evaluate, and accurate even for relatively low-precision implementations.

Parameters and Ports

Table 1: Parameters

Signal Name	Description
INWIDTH	This is the precision of the input cartesian coordinates (x,y). The valid range is from 6 to 24. The precision of the arctangent bus will be INWIDTH + 3.
PIPELINED	When this parameter is "YES", the macro will be pipelined with a total of (INWIDTH + 3) stages. When it is "NO", the macro will be purely combinatorial.

Table 2: Input Signals

Signal Name	Description
SYSCLK	The SYSCLK input is optional, and is used only if the PIPELINED parameter is "YES". When it is used the result will appear at the output ports (INWIDTH + 3) clock cycles after the input.
XX[inwidth..1]	This input is for the horizontal, or X-axis, input. The input is signed.
YY[inwidth..1]	This input is for the vertical, or Y-axis, input. The input is signed.

Table 3: Output Signals

Signal Name	Description
ARCTAN[(inwidth+3)..1]	This bus contains the angle, in radians, of the vector from the origin to the input point. The value is unsigned, and expressed as a ratio of the maximum number of radians (2π) in a circle. For example, with INWIDTH = 8, 1 radian would be represented by 256, and 2π radians by $2*\pi*256 = 1608$.

Examples

Pipelining has no effect on the size of the arctan macro, only on the throughput. When pipelined, a new result is computed with each clock cycle. The examples in Table 4 were compiled into Altera EPF10K10A-1 devices, with pipelining.

Table 4: Arctan Examples

Precision	Size (LCs)	Performance (MHz)
8	362	74
12	739	69
16	1244	59

All inputs are signed.

Example 1

8 bit inputs, $(x,y) = (200,150)$ – 3rd quadrant.

Expected result: Angle – 242°, or 4.24 rad = 4.24*256 = 1086

Actual result: arctan – 1083

Example 2

8 bit inputs, $(x,y) = (206,100)$ – 2nd quadrant.

Expected result: Angle – 117°, or 2.05 rad = 2.05*256 = 525

Actual result: arctan – 523

Example 3

8 bit inputs, $(x,y) = (120,254)$ – 4th quadrant.

Expected result: Angle – 359°, or 6.27 rad = 6.27*256 = 1604

Actual result: arctan – 1603



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