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 X-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*π*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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