Four Quadrant Inverse Tangent (Low Precision)

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1 Description

This is a low precision and low complexity implementation of the four quadrant inverse tangent (atan2) function. It operates on input complex vectors, $Z = X + jY$, where $X = \{x\}$ and $Y = \{y\}$, and computes the result, $\theta = atan2(\ y,\ x)$, for each point, where $-\pi \le atan2 \le \pi$. The resulting output can be 8 bit (in Q7, [-128 (- pi), 127 (pi)]) or 16 bit (in Q15 format, [-32768 (-pi), 32767 (pi)]) vector. It uses the approximation [1] as given below:

$$r = \frac{x - |y|}{x + |y|}, \qquad \theta = \frac{\pi}{4} - \frac{\pi}{4}r, \qquad (x, y) \in Q1, (x, y) \in Q4$$

$$r = \frac{x + |y|}{|y| - x}, \qquad \theta = \frac{3\pi}{4} - \frac{\pi}{4}r, \qquad (x, y) \in Q2, (x, y) \in Q3$$

$$\theta = -\theta \qquad \qquad (x, y) \in Q4, (x, y) \in Q3$$

(1)

The maximum error using this approximation is expected to be within 0.1 radians of the floating point result.

Project collateral discussed in this document can be downloaded from the following URL:

https://www.ti.com/lit/zip/sprs618 .

2 Kernel Complexity (C64x+™ CPU cycles, based on CPU cycle accurate Simulator)

- With 8-bit outputs, util_atan2_lp_16b_8b: 4.5 L + 53
- With 16-bit outputs, util_atan2_ lp_16b_16b: 4.5 L + 48

where,

L = Length of input/output vector,

3 Cycles on TMS320C6455 EVM

The performance is given for several example cases on the C6455 EVM in cycles. The test bench for math UTIL can be used to find cycles of interest for any other valid configuration.

API	L	Test Case	EVM Cycles
util_atan2_lp_16b_8b	1024	1	4661
util_atan2_lp_16b_8b	512	2	2357
util_atan2_lp_16b_16b	1024	1	4726
util_atan2_lp_16b_16b	512	2	2388

4 Memory

Memory	Size in Bytes
Data	None
Program	~1KB (util_atan2_ lp_16b_8b + util_atan2_ lp_16b_16b)

5 References

- J.M.Shima, *FM Demodulation Using Digital Radio and Digital Signal Processing*, MS Thesis, University of Florida, 1995.

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