Four Quadrant Inverse Tangent (Low Precision)

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, \( \theta = \text{atan2}(y, x) \), for each point, where \(-\pi \leq \text{atan2} \leq \pi\). 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:

\[
\begin{align*}
\theta &= \frac{\pi}{4} r, \quad (x, y) \in Q1, (x, y) \in Q4 \\
\theta &= \frac{3\pi}{4} r, \quad (x, y) \in Q2, (x, y) \in Q3 \\
\theta &= -\theta, \quad (x, y) \in Q4, (x, y) \in Q3
\end{align*}
\]

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,
\( L = \text{Length of input/output vector} \)

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.

<table>
<thead>
<tr>
<th>API</th>
<th>L</th>
<th>Test Case</th>
<th>EVM Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>util_atan2_lp_16b_8b</td>
<td>1024</td>
<td>1</td>
<td>4661</td>
</tr>
<tr>
<td>util_atan2_lp_16b_8b</td>
<td>512</td>
<td>2</td>
<td>2357</td>
</tr>
<tr>
<td>util_atan2_lp_16b_16b</td>
<td>1024</td>
<td>1</td>
<td>4726</td>
</tr>
<tr>
<td>util_atan2_lp_16b_16b</td>
<td>512</td>
<td>2</td>
<td>2388</td>
</tr>
</tbody>
</table>
4 Memory

<table>
<thead>
<tr>
<th>Memory</th>
<th>Size in Bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>None</td>
</tr>
<tr>
<td>Program</td>
<td>~1KB (util_atan2_.lp_16b_8b + util_atan2_.lp_16b_16b)</td>
</tr>
</tbody>
</table>

5 References

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