SINE WAVE GENERATOR

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OUTLINE

1. First Section
   - Circular-CORDIC Algorithm (BASIC)

2. Second Section
   - Implementation in MATLAB
   - Implementation of Circular CORDIC in RTL

MOTIVATION

If a unit vector with co-ordinates $(x_1, y_1) = (1, 0)$ is rotated by an angle θ, its new co-ordinate will be $(x_2, y_2) = (\cos\theta, \sin\theta)$. Thus, by finding the (x_2, y_2), $\cos\theta, \sin\theta$ can easily be computed.

Pseudorotations

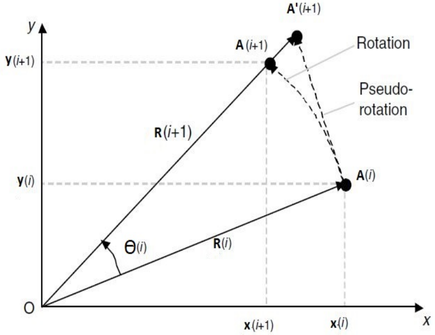

Figure: pseudorotation step in CORDIC

$$R(i+1) = R(i)(1 + \tan^2\theta(i))^{1/2}$$

Domain of Convergence

- In rotation mode, convergence of $\alpha(n)$ to 0 is possible because each CORDIC angle is more than half the previous angle.

$$\tan^{-1}(2^{-(i+1)}) \geq 0.5 * \tan^{-1}(2^{-i})$$

- Thus, domain of convergence is $-99.7^o \leq \alpha \leq 99.7^o$ where $\pm 99.7^o$ is the sum of the CORDIC angle.
- Beyond the above range, we can use Trigonometric identities to convert the problem within the domain of convergence.

Implementation in MATLAB

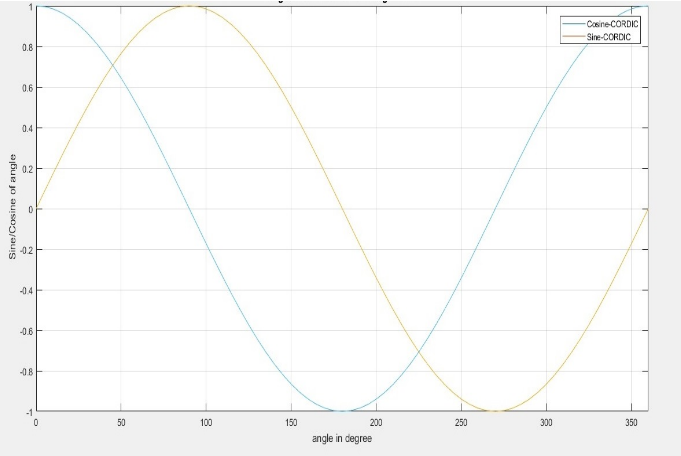

Figure: Trigonometric Functions using CORDIC

Implementation of Circular CORDIC in RTL

- The digital design should be able to compute Sine and Cosine of the input angles $\in [0, 2\pi]$ including the floating point angles like 89.45^o, 29.7^o etc.
- A 32-bit binary scaling system has been used to represent angles. The resolution of the design is $360^o/2^{32} = 8.381903172$ X 10^{-8}.
- To convert the angle from degrees to 32-bit value, multiply the angle^o by 2^{32}, then divide it 360^o. FInally, convert the decimal value to binary.
- The upper two bits represent the quadrant.
  - 2b'00 = represents I quadrant i.e (0 - $\pi/2$) range
  - 2b'01 = represents II quadrant i.e ($\pi/2$ - π) range
  - 2b'10 = represents III quadrant i.e (π - $3\pi/2$) range
  - 2b'11 = represents IV quadrant i.e ($3\pi/2$ - 2π) range

Testbench tested for different values of input angle using Xilinx-ISim software. After 16-clock cycles, Output Data was displayed on the simulator screen. Ouput value is scaled 25000 times (i.e Xout $= 25000 * \cos\alpha$ and Yout $= 25000 * \sin\alpha$).

Figure: $\alpha = 35^o$

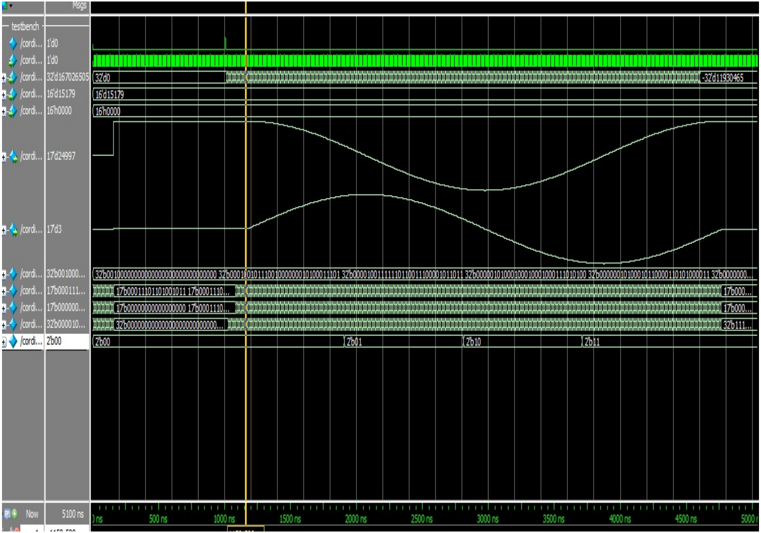

Figure: Sinusoidal wave