CORDIC

1. Rotation Mode

1.1. Inputs:
- mode (1 bit) $\leftarrow 1$
- start (1 bit) $\leftarrow 1$
- $x_{\text{in}} \leftarrow \times$
- $y_{\text{in}} \leftarrow \times$
- z_{in} (20 bits) $\leftarrow$ angle (Q4.16)

1.2. Set internal values:
- done (1 bit) $\leftarrow 0$
- x_{calc} (21 bits) $\leftarrow 0.6072529351$ (Q5.16)
- y_{calc} (21 bits) $\leftarrow 0$
- z_{calc} (21 bits) $\leftarrow \text{q416\_to\_q516}(z_{\text{in}})$
- i (5 bits) $\leftarrow 0$

1.3. Iteractive process:

while $i \neq 16$:
  if $z_{\text{calc}} \geq 0$:
    $x_{\text{temp}} \leftarrow x_{\text{calc}} - (y_{\text{calc}} \gg i)$
    $y_{\text{temp}} \leftarrow y_{\text{calc}} + (x_{\text{calc}} \gg i)$
    $z_{\text{calc}} \leftarrow z_{\text{calc}} - \text{arctans\_list}(i)$
  else :
    $x_{\text{temp}} \leftarrow x_{\text{calc}} + (y_{\text{calc}} \gg i)$
    $y_{\text{temp}} \leftarrow y_{\text{calc}} - (x_{\text{calc}} \gg i)$
    $z_{\text{calc}} \leftarrow z_{\text{calc}} + \text{arctans\_list}(i)$
  $x_{\text{calc}} \leftarrow x_{\text{temp}}$
  $y_{\text{calc}} \leftarrow y_{\text{temp}}$
  $i \leftarrow i + 1$

1.4. Outputs:
- done (1 bit) $\leftarrow 1$
- x_{out} (21 bits) $\leftarrow x_{\text{calc}}$
- y_{out} (21 bits) $\leftarrow y_{\text{calc}}$
- z_{out} (21 bits) $\leftarrow 0$

1.5. Conclusion:
- $x_{\text{out}} = \cos(z_{\text{in}})$
- $y_{\text{out}} = \sin(z_{\text{in}})$
- $z_{\text{out}} = 0$

2. Vectoring Mode

2.1. Inputs:
- mode (1 bit) $\leftarrow 0$
- start (1 bit) $\leftarrow 1$
- x_{in} (9 bits) $\leftarrow x$ (Q4.5)
- y_{in} (9 bits) $\leftarrow y$ (Q4.5)
- $z_{\text{in}} \leftarrow \times$

2.2. Set internal values:
- done (1 bit) $\leftarrow 0$
- x_{calc} (21 bits) $\leftarrow \text{q45\_to\_q516}(x_{\text{in}})$
- y_{calc} (21 bits) $\leftarrow \text{q45\_to\_q516}(y_{\text{in}})$
- z_{calc} (21 bits) $\leftarrow 0$
- i (5 bits) $\leftarrow 0$

2.3. Iteractive process:

while $i \neq 16$:
  if $y_{\text{calc}} \geq 0$:
    $x_{\text{temp}} \leftarrow x_{\text{calc}} + (y_{\text{calc}} \gg i)$
    $y_{\text{temp}} \leftarrow y_{\text{calc}} - (x_{\text{calc}} \gg i)$
    $z_{\text{calc}} \leftarrow z_{\text{calc}} + \text{arctans\_list}(i)$
  else :
    $x_{\text{temp}} \leftarrow x_{\text{calc}} - (y_{\text{calc}} \gg i)$
    $y_{\text{temp}} \leftarrow y_{\text{calc}} + (x_{\text{calc}} \gg i)$
    $z_{\text{calc}} \leftarrow z_{\text{calc}} - \text{arctans\_list}(i)$
  $x_{\text{calc}} \leftarrow x_{\text{temp}}$
  $y_{\text{calc}} \leftarrow y_{\text{temp}}$
  $i \leftarrow i + 1$

2.4. Adjust x_{calc}:
- $x_{\text{calc}} \leftarrow x_{\text{calc}} \cdot 0.6072529351$

2.5. Outputs:
- done (1 bit) $\leftarrow 1$
- x_{out} (21 bits) $\leftarrow x_{\text{calc}}$
- y_{out} (21 bits) $\leftarrow 0$
- z_{out} (21 bits) $\leftarrow z_{\text{calc}}$

2.6. Conclusion:
- $x_{\text{out}} = \|\vec{v}\| = \sqrt{x_{\text{in}}^2 + y_{\text{in}}^2}$
- $y_{\text{out}} = 0$
- $z_{\text{out}} = \arctan\left(\frac{y_{\text{in}}}{x_{\text{in}}}\right)$

$$x \cdot 0.6072529351 = [(x \gg 1) + (x \gg 3)] - \{[(x \gg 6) + (x \gg 9)] + (x \gg 12)\}$$