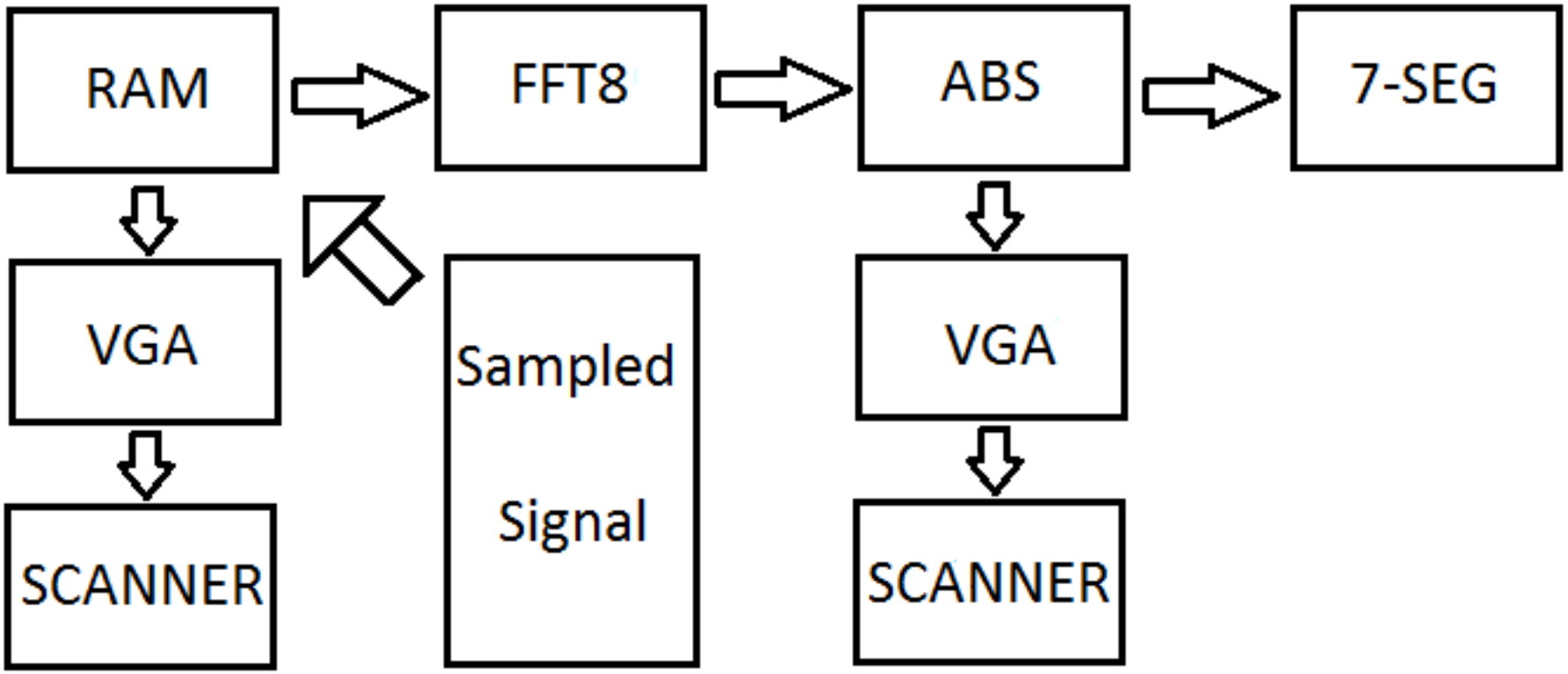
Spectrum Analyzer and Wave Generator

Prepared by Junyi Huang

Objective

- Make a wave generator can generate sin wave, rectangle wave and triangular wave.
- Make the generator display the spectrum of every wave in 7-segment LEDs.

The Whole System

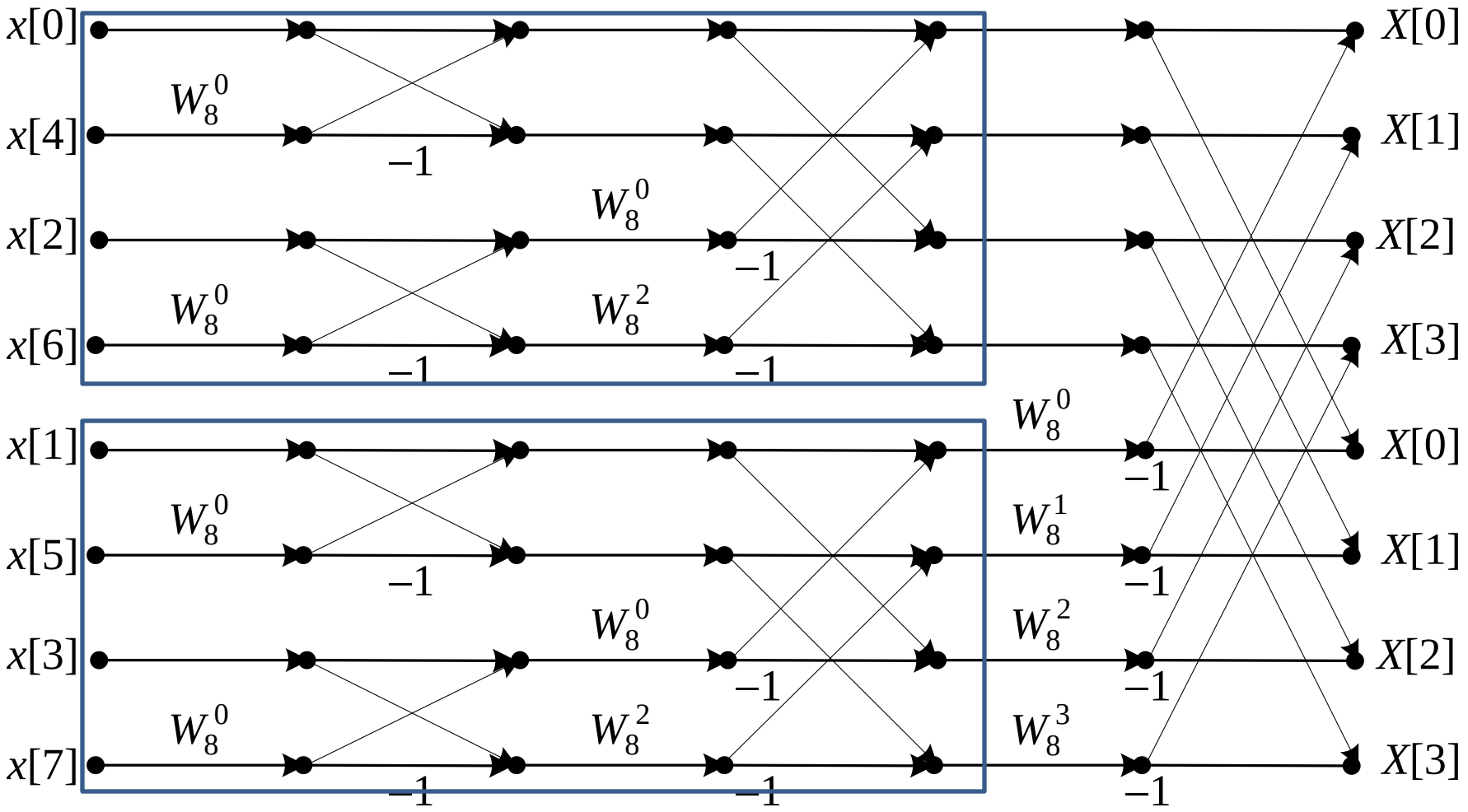


RAM

- Store the sampled signal in the RAM
- VGA get the sampled value from RAM and display it on the scanner.

Fast Fourier Transform

- N = 8



Fast Fourier Transform

x0_im	20
x0_re	20
x1_im	10
x1_re	30
x2_im	20
x2_re	40
x3_im	-50
x3_re	30
x4_im	70
x4_re	60
x5_im	70
x5_re	10
x6_im	-20
x6_re	80
x7_im	-50
x7_re	-70

z0_im	70
z0_re	200
z1_im	-136
z1_re	-98
z2_im	10
z2_re	140
z3_im	-132
z3_re	-66
z4_im	110
z4_re	200
z5_im	116
z5_re	98
z6_im	170
z6_re	-220
z7_im	-48
z7_re	-94

```
1.0e+002 *

Columns 1 through 5

 2.0000 + 0.7000i  -0.9899 - 1.3728i   1.4000 + 0.1000i  -0.6586 - 1.3243i   2.0000 + 1.1000i

Columns 6 through 8

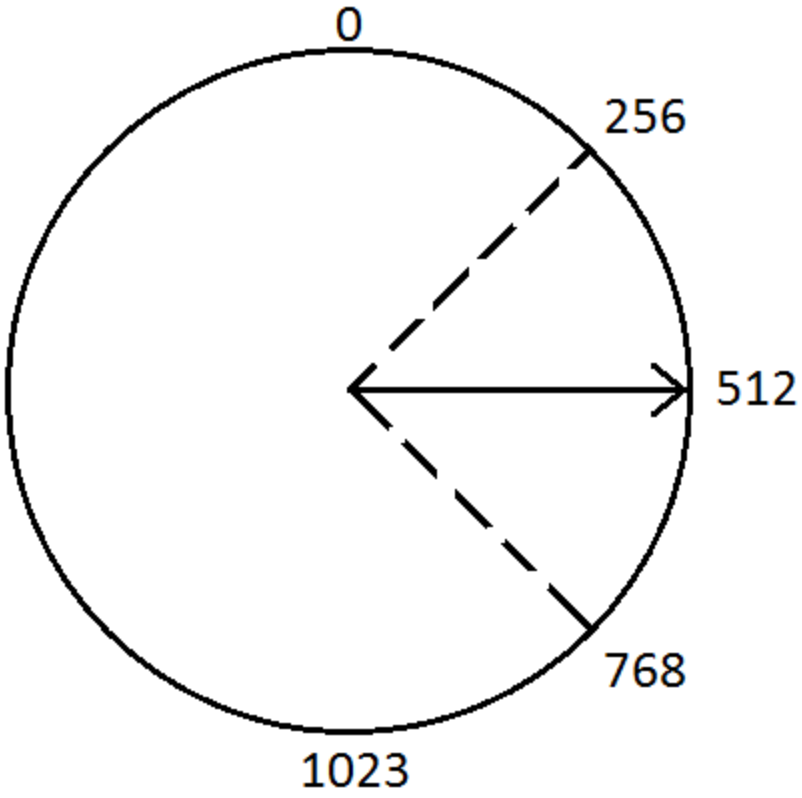
 0.9899 + 1.1728i  -2.2000 + 1.7000i  -0.9414 - 0.4757i
```

Absolute Value

- After the FFT8 calculation, we can get 8 complex number.
- We need its absolute value to display the spectrum
- Equation: $\sqrt{\mathrm{re}^2 + \mathrm{im}^2}$
- Use CORDIC algorithm to realize square root.

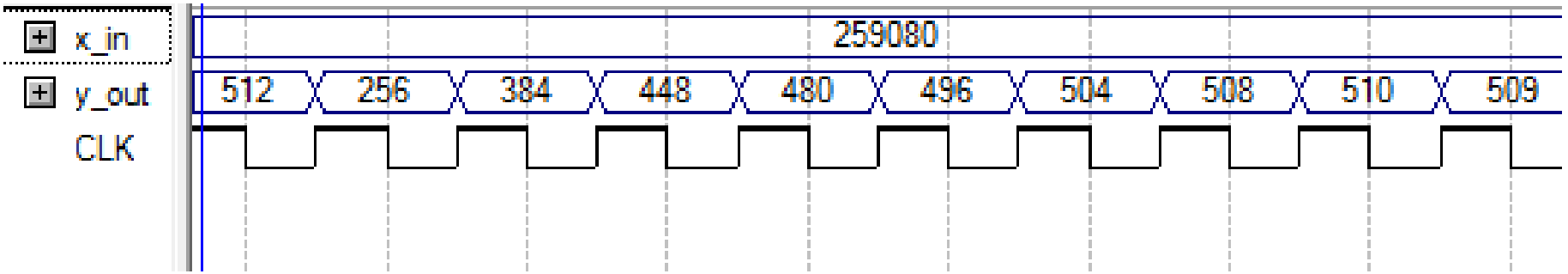
Absolute Value

- CORDIC(Coordinate Rotation Digital Computer)



Absolute Value

- $259080 = 508.999^2$



7-Segment LED

- After the absolute value of FFT8 is calculated.
- Display them with 7-segment LEDs.
- 9 => Abs >450 ; 8 => 400 < Abs < 451 ;
- 7 => 350 < Abs < 401; 6 => 300 < Abs < 351 ;
- 5 => 250 < Abs < 301 ;4 => 200 < Abs < 251 ;
- 3 => 150 < Abs < 201 ;2 => 100 < Abs < 151 ;
- 1 => 50 < Abs < 101 ; 6 => 0 < Abs < 51 ;