3B-09

Examination of Input Signal to Reduce ADC Histogram Test Time

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Background

Background

Internet of Things (IoT)

Everything is connected to internet.

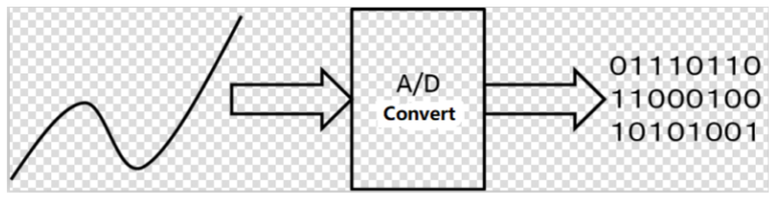
- Exchange information

- Process, analyze data on the server.

Sensor interface ADC is a key.

Research Target

Short time, high quality testing of high resolution, low speed analog-to-digital converter (ADC)

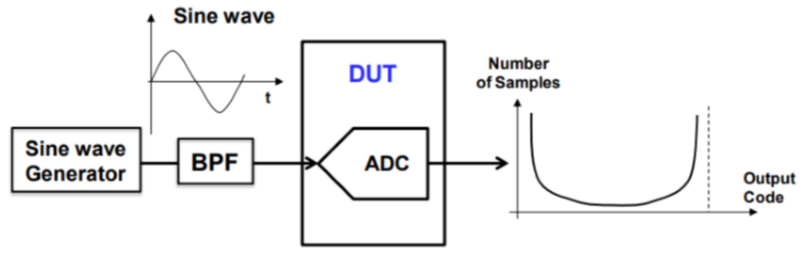


For IoT applications

ADC Histogram Test

ADC test with high precision linearity

But it takes long time

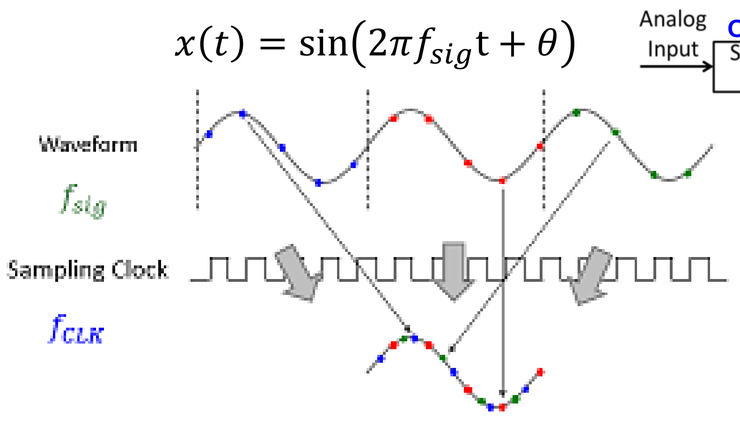


Test cost is proportional to test time.

Overview

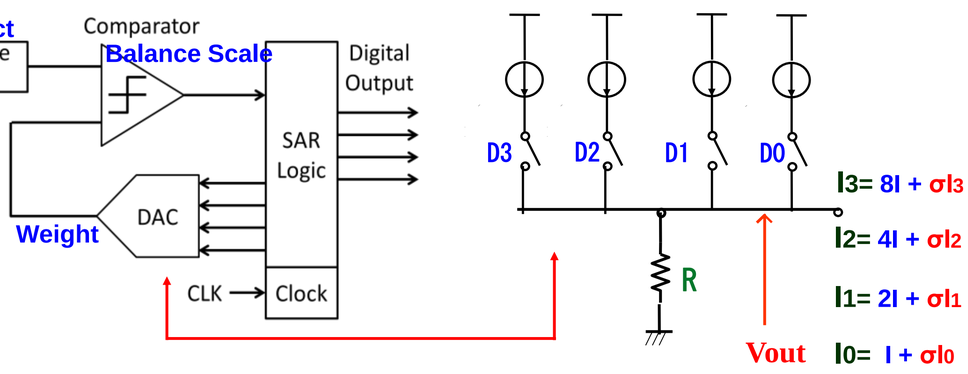
Sinewave Sampling

$$x(t) = \sin(2\pi f_{sig} t + \theta)$$



Construct a single waveform by sampling the repetitive waveform with asynchronous CLK.

Error-prone Code



Taking the DAC in SARADC as an example, when D3 changes, it is the position where the DNL error is most likely to become large.

Our Approach

Shorten ADC test time by sampling only necessary range of codes.

(A)Adjusting the sampling clock frequency and the initial phase of the input .

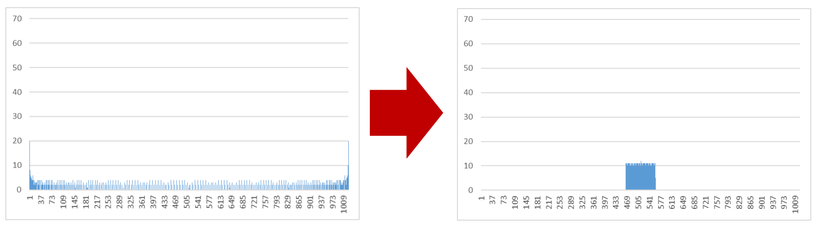
(B) Combining multiple sine waves .

Result

Concentration in Specific Codes

$$f_{\mathrm{CLK}} = f_{sig} \times \frac{x+1}{x}$$

Relationship between f_{CLK} and f_{sig} changes scope of bin.
θ changes position of bin.



It is difficult to control the initial phase freely.

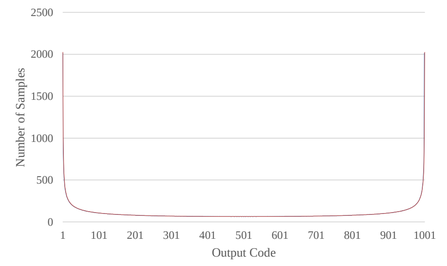
Formulation

Get f (t) to create an arbitrary histogram

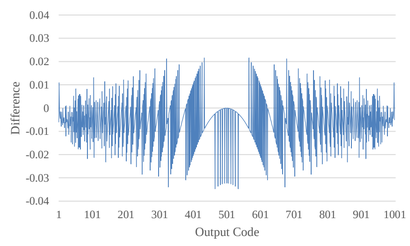
The first step
Find the shape of the histogram mathematically from the input function

Algorithm
1.Using the inverse function $f^{-1}(x)$
2.Using the inverse of the slope of the input function $f(t)$ as the slope of the inverse function $f^{-1}(x)$

Simulation Result



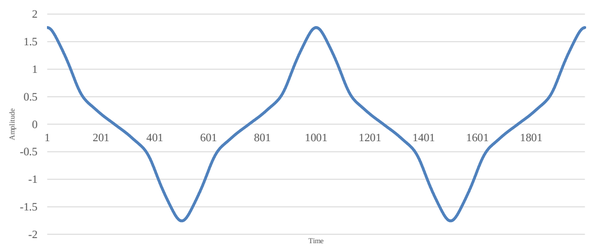
Comparison of algorithm 2 and sampling



Example of $f(t) = \sin \omega t$

Verification was performed on a single sine wave, and good results were obtained to show the validity of the algorithm.

Multiple Sine Waves

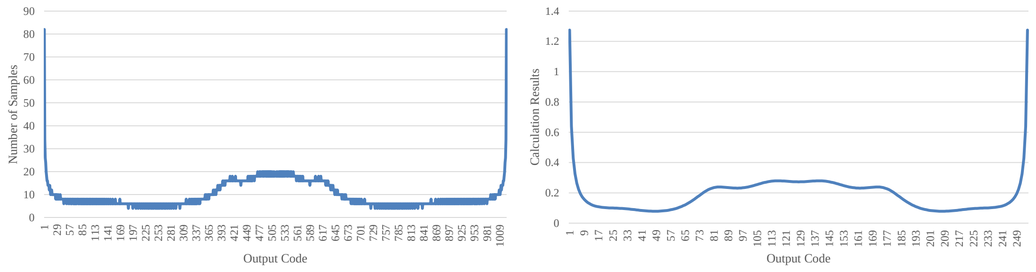


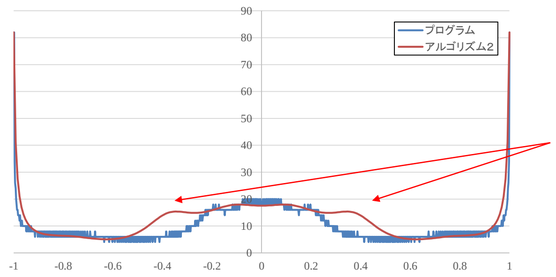
$$f(t) = A(W_1 + 2.6 \cdot W_2 + 1.8 \cdot W_3 + 1.4 \cdot W_6 + 1.2 \cdot W_7) + V_{OS}$$

$$W_m = \frac{\cos((2m-1)\omega t)}{(2m-1)^2} \qquad A = 2.90[V] \qquad V_{OS} = 4.0[V]$$

Algorithm 1 can not be used because the inverse function of f (t) can not be obtained.

Simulation Setting





Deviation is large. The cause is under verification

Normalized between -1 and 1.

Summary

Two algorithms have been devised to calculate the shape of the histogram from the input function.
Verification was performed on a single sine wave, and good results were obtained.
Verification was performed on the multiple sine waves, and Algorithm 2 has some errors compared to sampling.
The next study will improve the algorithm. Reduce deviations for multiple sine waves.