VIRTUAL EVENT

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Dancing over Digital-Analog Dichotomy

“- Engendering Analog Signals from Digital Channels”

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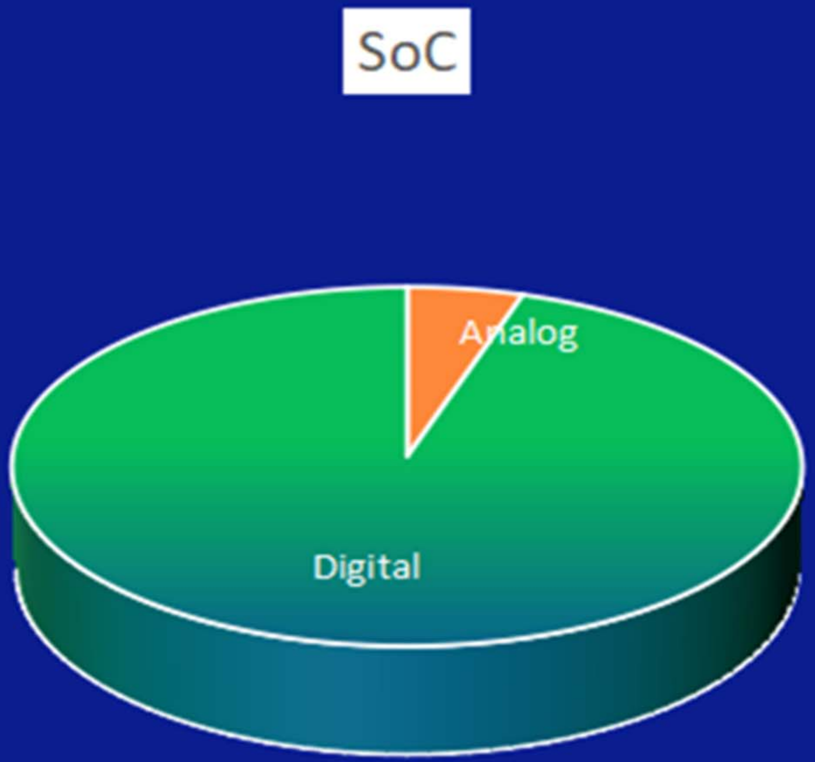
AGENDA

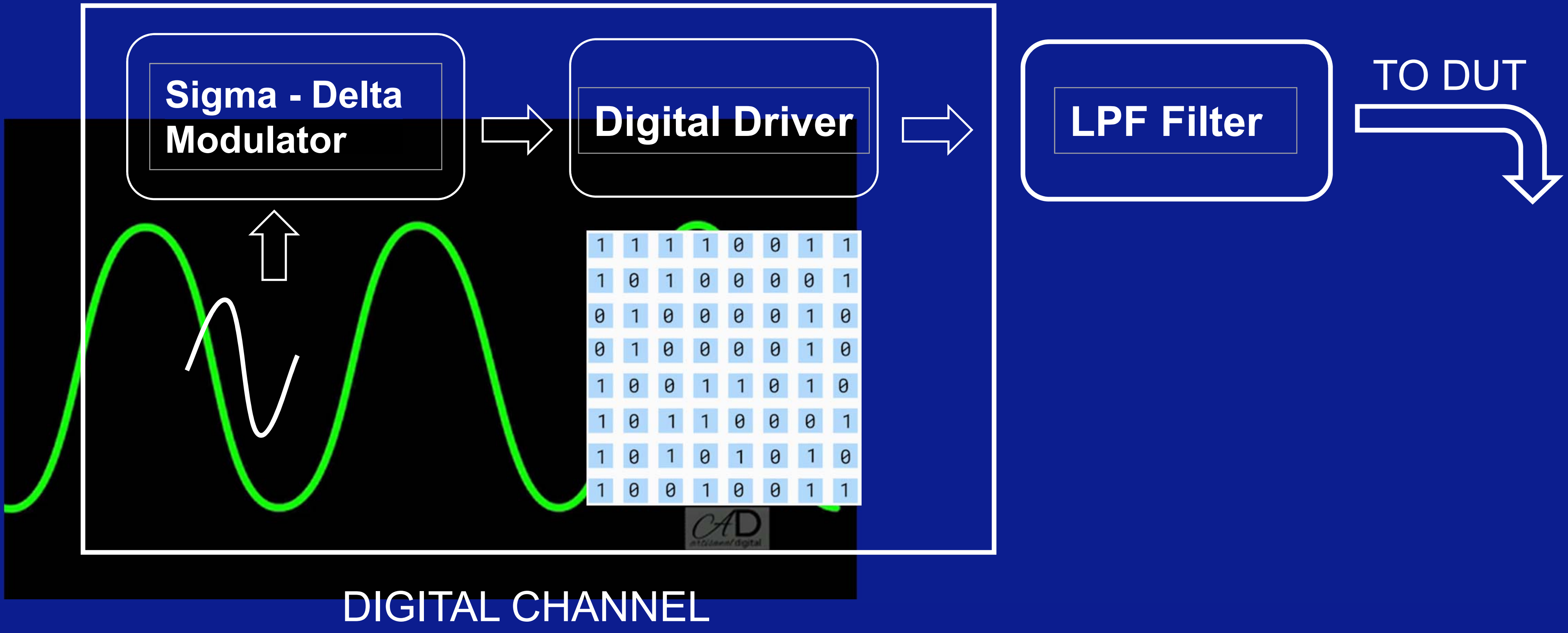
- Introduction
- Methodology
- Implementation and Validation
  - Analog signal generation
  - Digital stream capture
  - Filter circuit implementation
- Case Study
- Conclusion

Why Testing Analog devices using Digital Channel?

- Acquiring analog instrument for minimal scope of analog resources in a SoC results in additional cost.
- Prelude of generation technique using pre-existing digital instrument.
- Pulse Width Modulation Technique is independent of Tester platform; however the case study is implemented on Advantest 93K.



METHODOLOGY



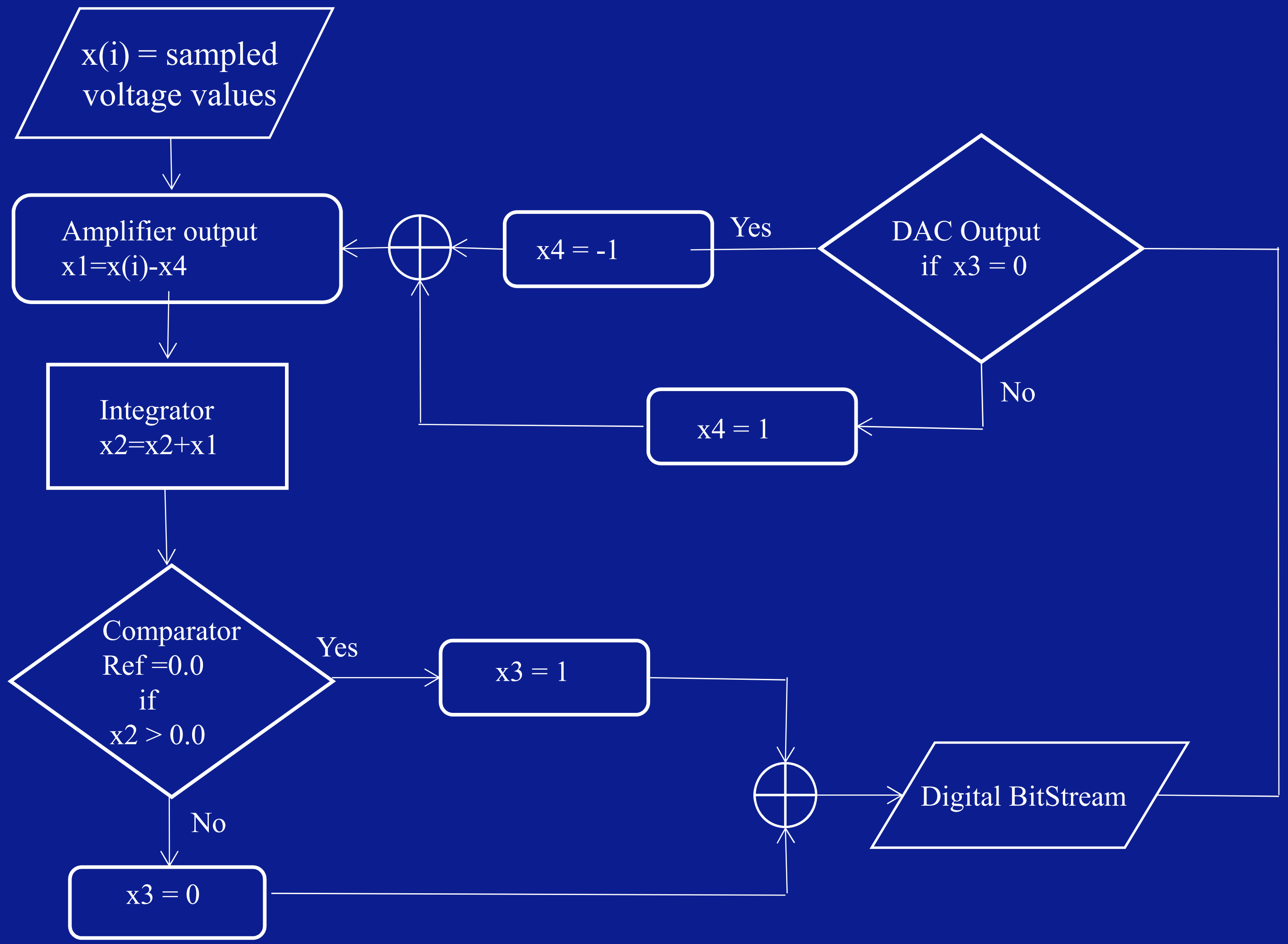
Generation of Digital Pulse Stream

- **Sigma-Delta Modulation** technique used for digital pulse generation.

Why ∑-Δ modulation?

- High transmission efficiency ascertained by capturing the delta between consecutive samples.
- Oversampled input ensures reduction in noise power.
- Implements Noise Shaping function that pushes noise to high frequency.

FLOW CHART - ∑-Δ MODULATOR



Generated Bit Stream

- Sine Wave :
  Fundamental freq (Fm) = 1KHz
  Sampling Freq (Fs) = 10KHz

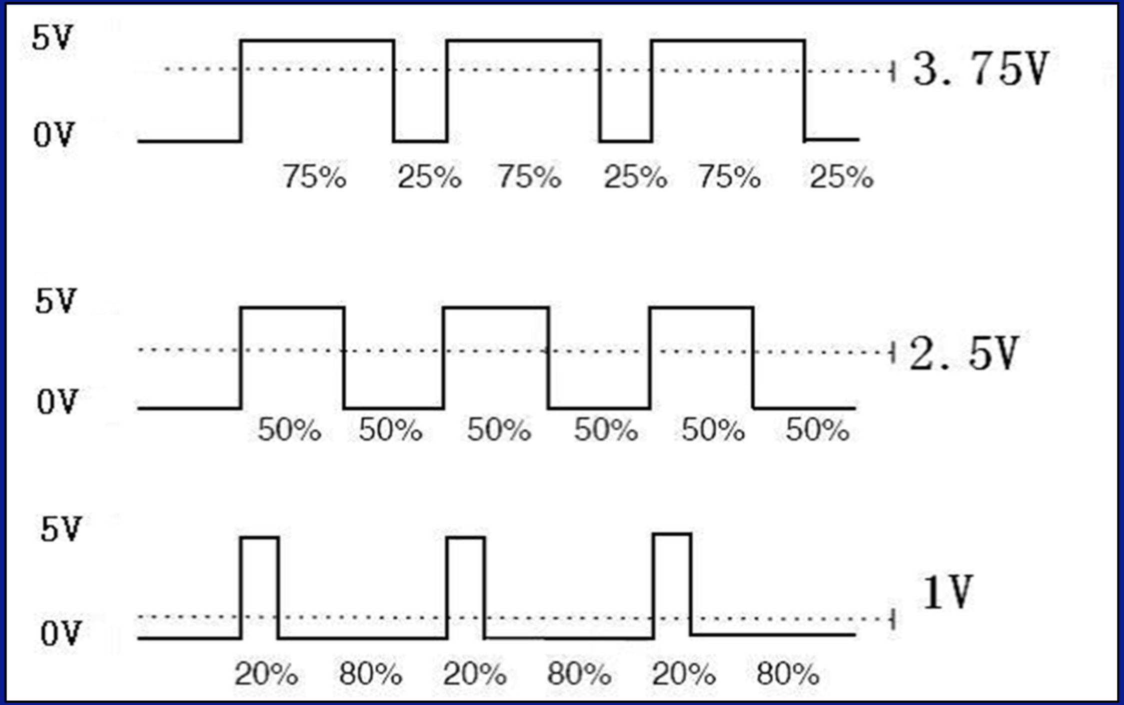
- Intermediate calculation for equivalent bit stream generation.

- Engendered Bit Stream : 11101000101

X(i)	X1	X2	X3	X4
1.0000	0	1	1	1
0.9046	-0.0954	0.9046	1	1
0.6548	-0.3452	0.5594	1	1
0.3459	-0.6541	-0.0947	0	-1
0.0958	1.0958	0.0011	1	1
0	-1	-0.9989	0	-1
0.09493	1.09493	-0.90397	0	-1
0.34443	1.34443	-0.55954	0	-1
0.65329	1.65329	0.09375	1	1
0.90366	-0.09634	-0.00259	0	-1
0.99999	1.99999	0.9974	1	1

PWM

- Generated bitstream is given as X4 mode pattern to Digital channel.
- Variation in duty cycle of each period controls average output voltage.
- Higher the number of samples, more accurate the analog signal

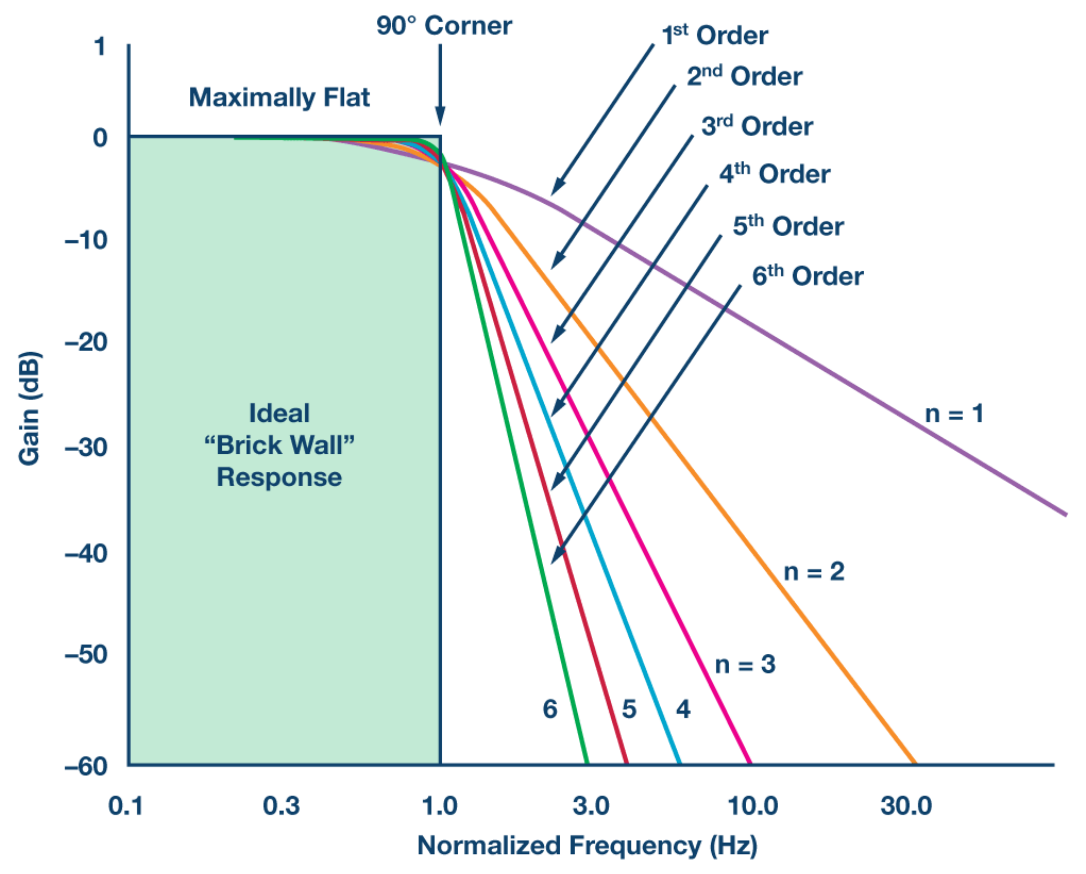


PWM Filter - Objectives

- Eliminates unwanted high-frequency signal components other than DC.
- Achieve the peak desired by the load circuit.
- Eliminate any DC offset.
- Minimize the analog signal ripple.

Filter Circuit Implementation

- Features of properly designed filter :
  - Better level of attenuation and sharpness of cut-off frequency.
  - Higher roll-off rate between Pass Band and Stop Band
  - Assuring the correct quantization-noise attenuation.



Filter Recommendation

- Parameters considered for the filter :
  - Cut-off frequency
  - Order of the filter
  - Series resistance of filter
- Filter designs considerations for selecting cut-off frequency:

Waveform Type	Cut off frequency Selection (fco)	Filter Selection
Sinusoidal	< 1.5 x	Low Pass Filter
Cosine	< 1.5 x	Low Pass Filter
Ramp	Between 10 x and 100 x	Band Pass Filter

Implementation

- Tester Platform - Advantest 93k
- Instrument - PS1600
- Order of modulator - 1
- X-Mode - 4

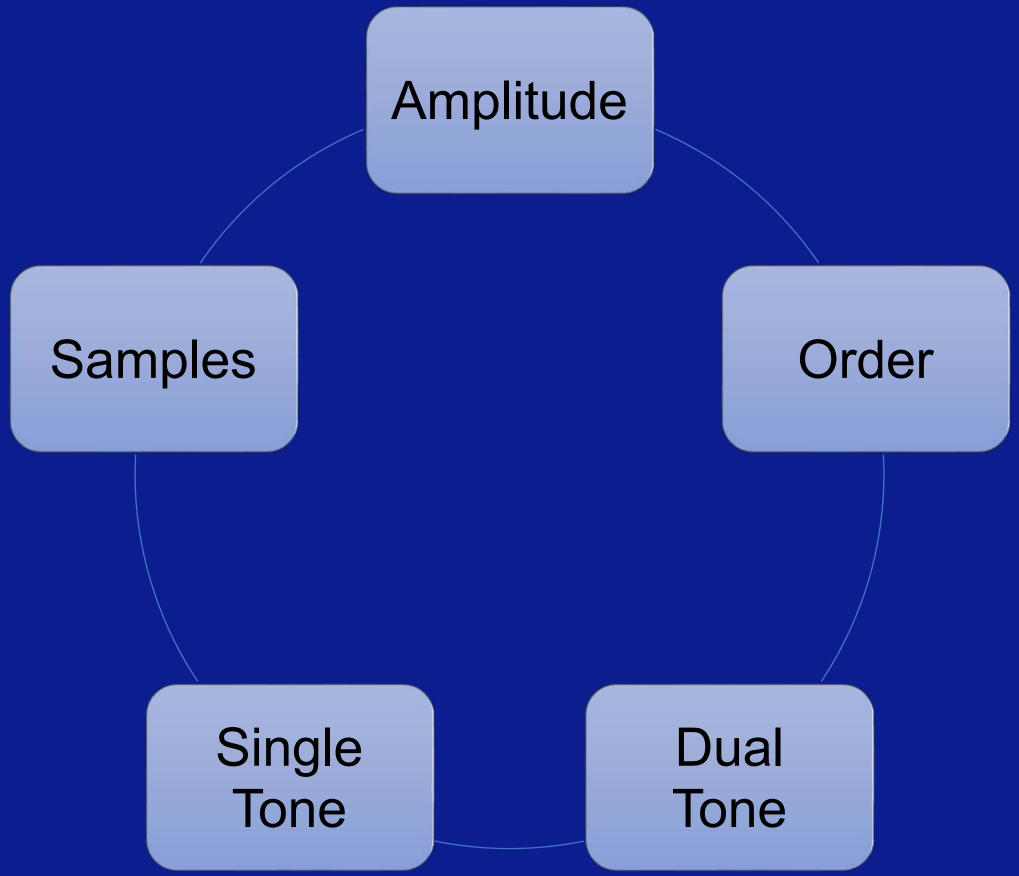
- LPF specs -

  Passive LC &7th order filter, with Fc = 1.3MHz & Zin = 6 ohm

- Output Analog waveform (generated) -

  Amplitude : 5V
  Fm (Fundamental Freq) : 1KHz
  Fs (Sampling Freq) : 5.5 MHz

∑-Δ modulator key in



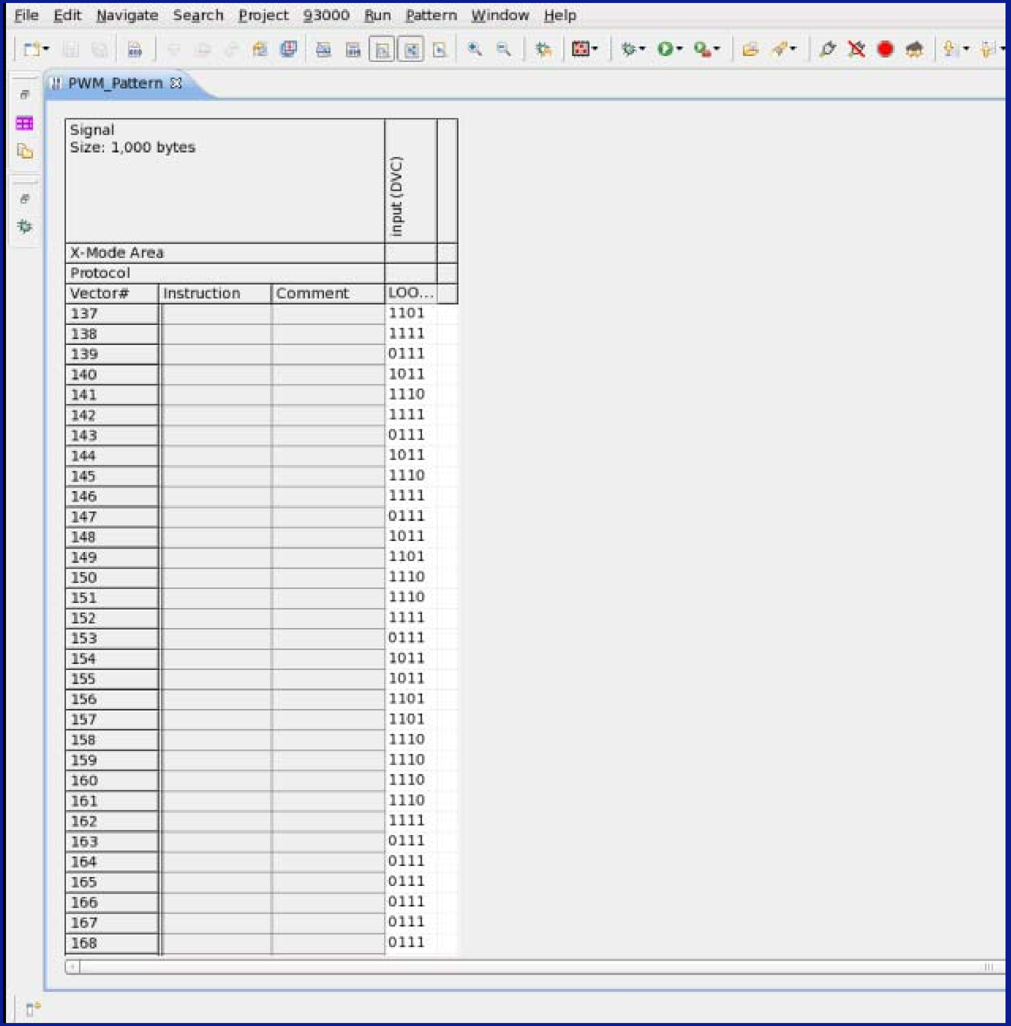
- Formula for input cosine wave generation :

  x[i] = Amplitude *cos (2*pi*cycles/samples*i) +0.5;

Test Conversion Details - vectors

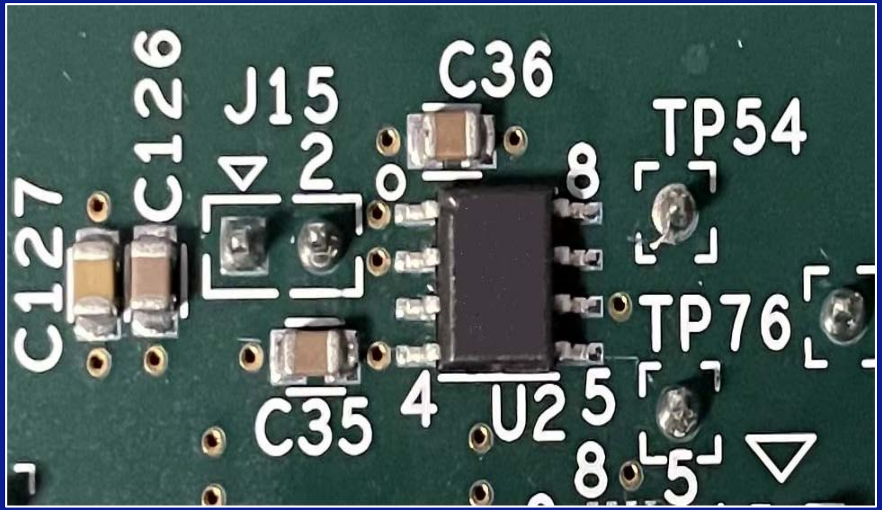
- Generated Bit Stream saved in the mentioned location.
- User needs to copy to pattern file.
- Reference signal:

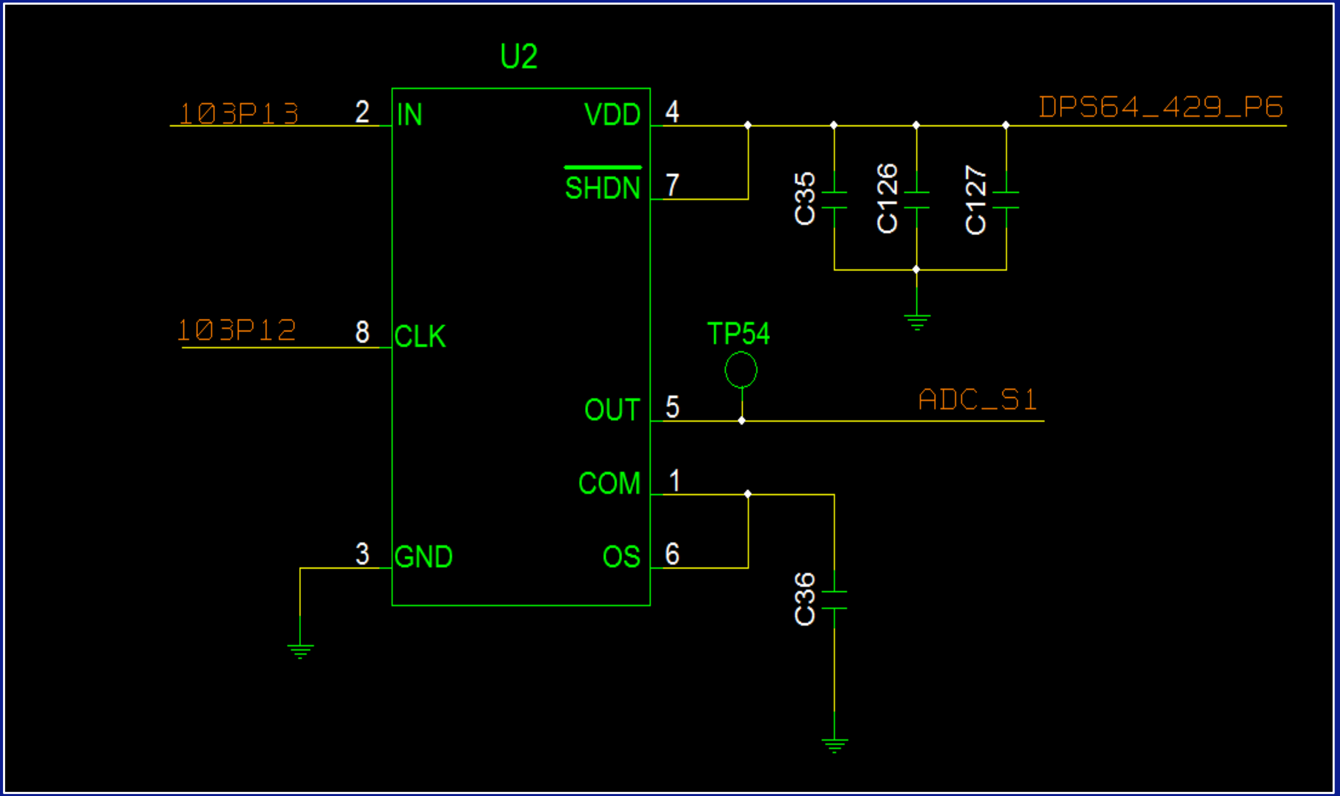
  cycles = 3; samples = 65536
- Executed at frequency = 5.5MHz in X4 mode to obtain variation in duty cycle.



Circuit Implementation On - Board

- Board designed such that both the direct analog source and PWM converted analog source fed to input of ADC.





CASE STUDY

- A sampled study of two scenarios and corresponding comparison of signal parameters i.e., SNR and THD

   i. Direct analog source input to the ADC device

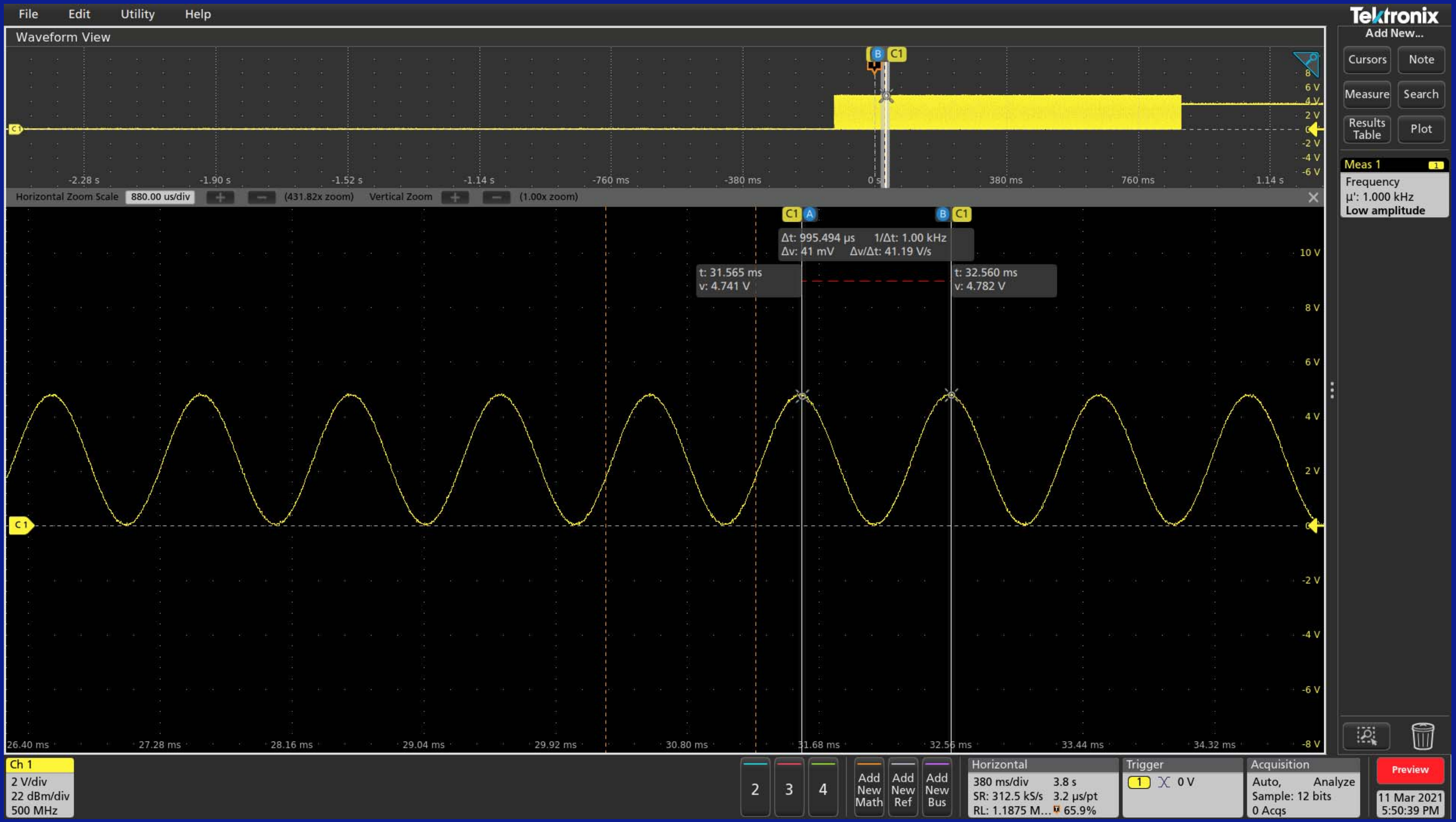
   ii. PWM converted analog source input to the same device

- Larger the SNR (Signal to Noise Ratio) specification, Better an instrument differentiates signal from the noise in measurements.

- THD (Total Harmonic Distortion) expresses the effect of high amplitude frequency components of a given signal frequency on the instrument.

CASE STUDY 1
Direct analog source input from analog instrument

- Freq = 1KHz
- Amplitude = 5V
- Samples = 65536

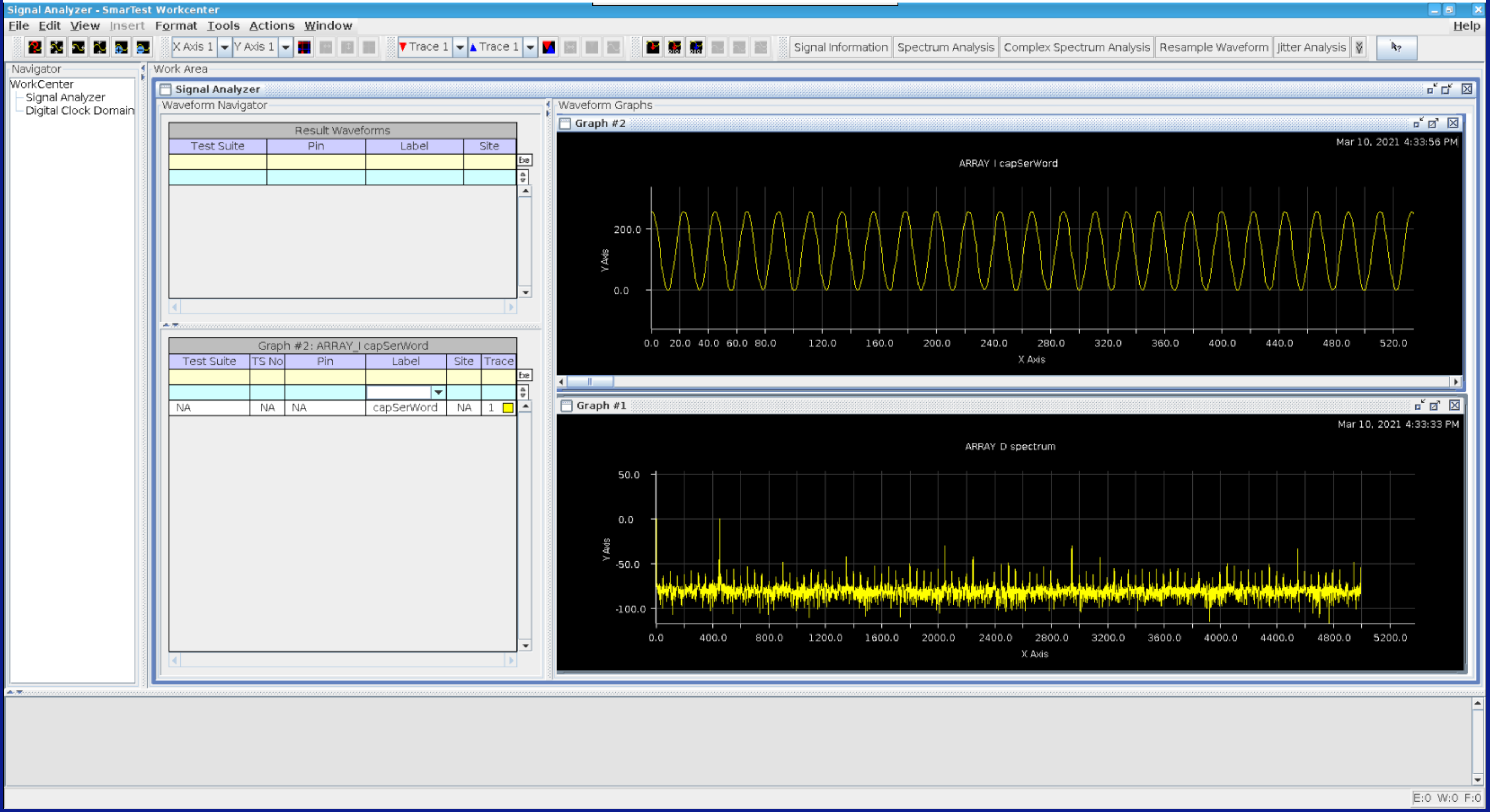


Output of ADC Device from Direct Analog Source

CASE STUDY 2
Analog wave generated using PWM input

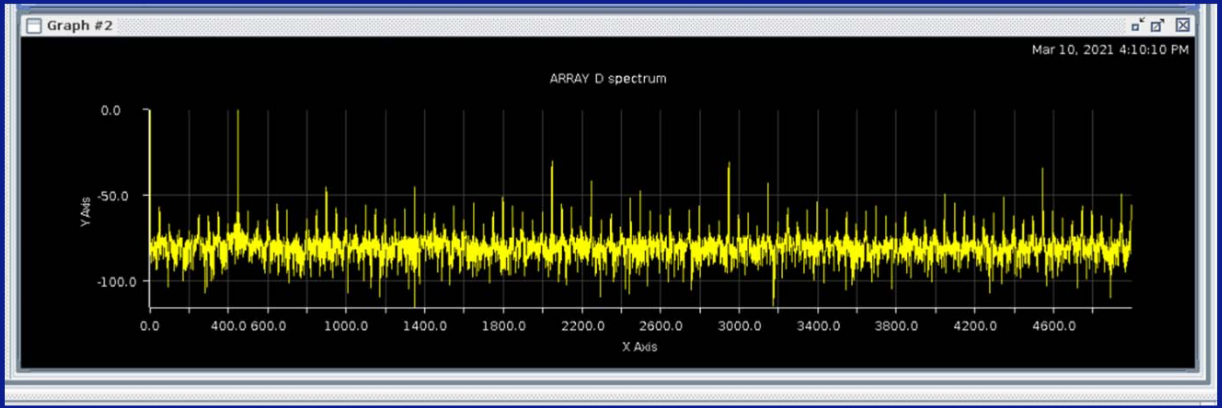
- Freq = 1KHz
- Amplitude = 5V
- Samples = 65536

Output of ADC Device from PWM input



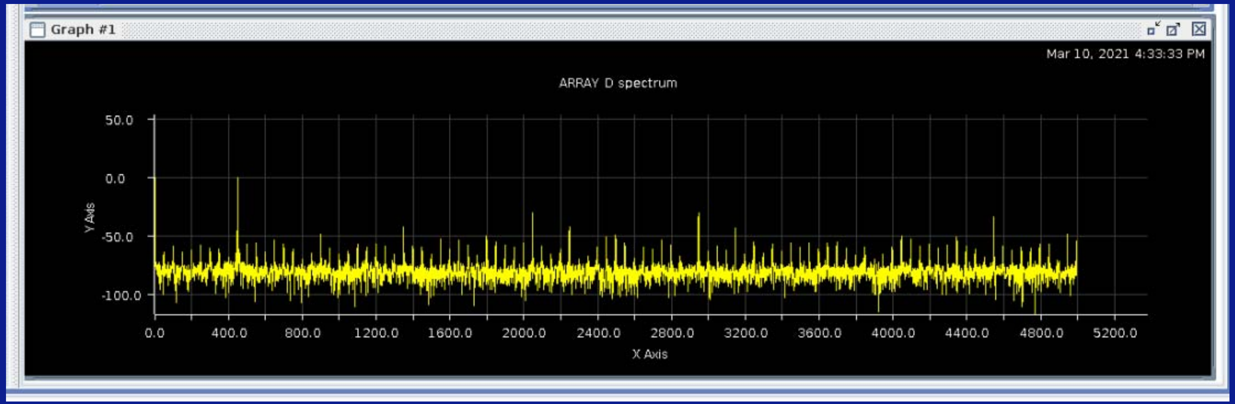
Spectrum Comparison

Spectrum of Analog Instrument



SNR = 65 dB
THD = -60 dB

Spectrum of PWM output



SNR = 63 dB
THD = -58 dB

CONCLUSION

- Implementation of this technique on tester platforms other than Advantest 93k and correlation of the results.

- Further scope for technique is to use on-board PLL after digital driver pin to exceed the limitation.

References

- Advantest Technical Document Center - Topic No. 138518 “Enhancing Analog Signal Generation by Digital Channel Using Pulse Width Modulation”.
- https://www.electronicdesign.com/technologies/analog/article/21798185/understanding-deltasigma-modulators

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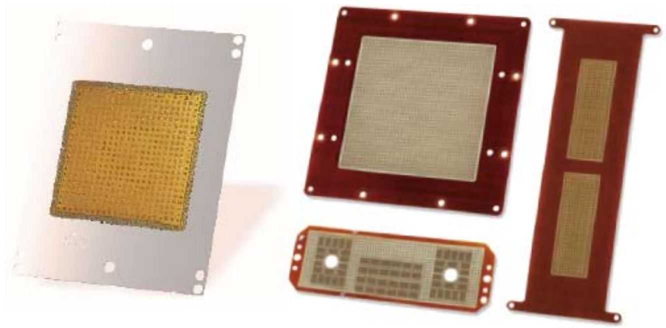
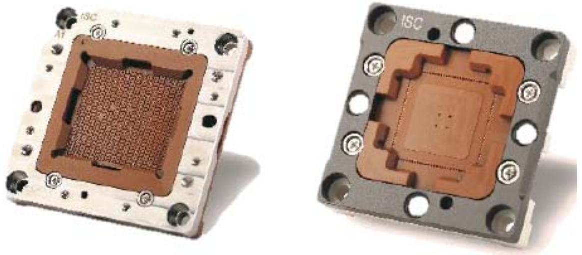


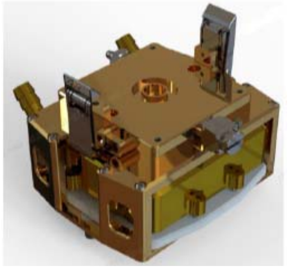
POGO SOCKET SOLUTIONS

- Excellent gap control & long lifespan
- High bandwidth & low contact resistance



THERMAL CONTROL UNIT

- Extreme active temperature control
- Safety auto shut-down temperature monitoring of the device & thermal control unit
- Full FEA analysis & Price competitiveness



BURN-IN SOLUTIONS

- Direct inserting on the board without soldering
- Higher performance BIB solution

CONTACT
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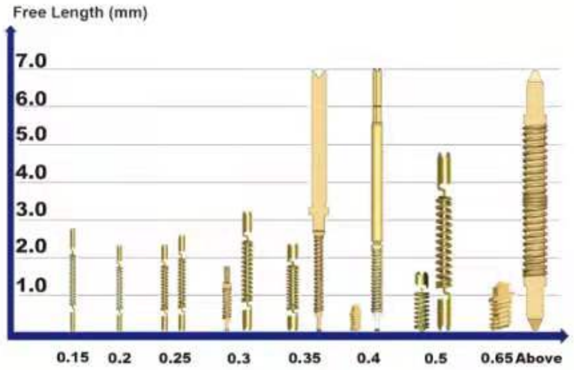
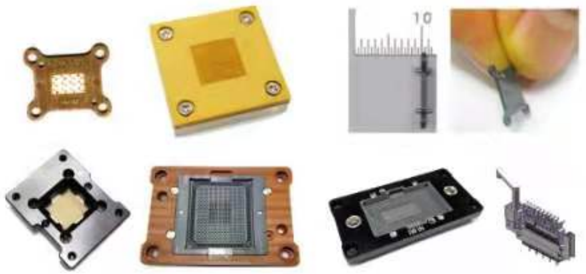
IWIN Co., Ltd. The test probe for high signal integrity at extremely high speed test

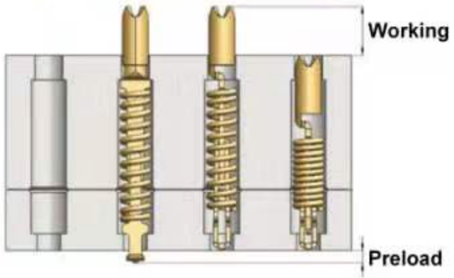
Spring probe by stamping



250 kinds of spring probe pin
300 kinds of test socket (44,000 Pin count socket possible)
One piece spring probe
Three piece spring probe
High speed product → 0.63mm free length spring probe pin available
Finest Pitch → 0.15mm Pitch



Spring probe by stamping

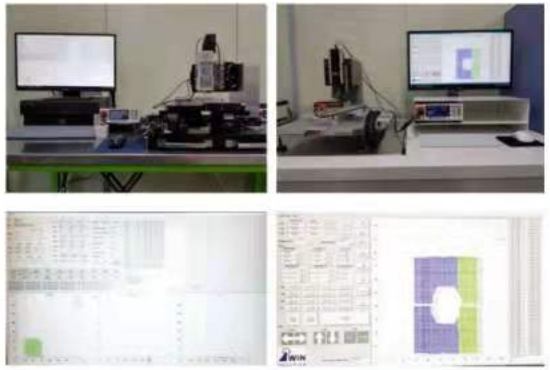


Patented

Pitch(mm)	Free Length(mm)	Current Carrying(Amps)
0.15/0.2/0.25	2.17~	0.5~
0.3	1.5~	1.5~
0.35	2.08~	1.8~
0.4	0.8~	2.5~
0.5	1.5~	3.0~
0.65	1.13~	9.0~
0.8	3.14~	3.0~

Automation

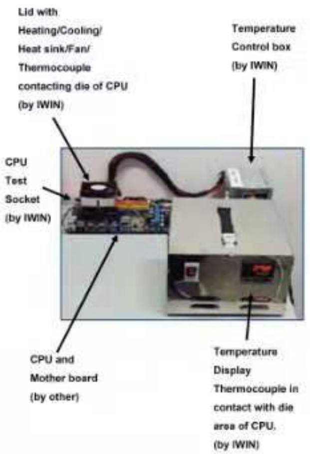
Pin assembly and Quality control



Top Figure: Socket CRES, Force, Stroke test
Bottom Figure: Data displayed

Top Figure: Socket CRES test
Bottom Figure: Data display 5,903 pins socket

Socket and Lid



Pin assembly

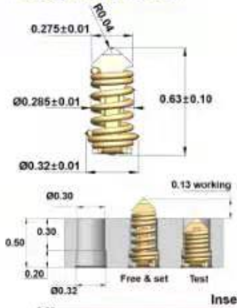
(Fully automated machines)

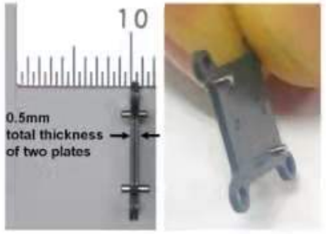
- Stamped piece parts attached to a reel fed into the assembly machine
- Assembled pins can be attached to a reel, or, supply in separate for socket assembly.

Spring probe pins for High speed

Extremely short spring probes by stamping

Design approach





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