ITkPix Update

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11/01/22

Motivation

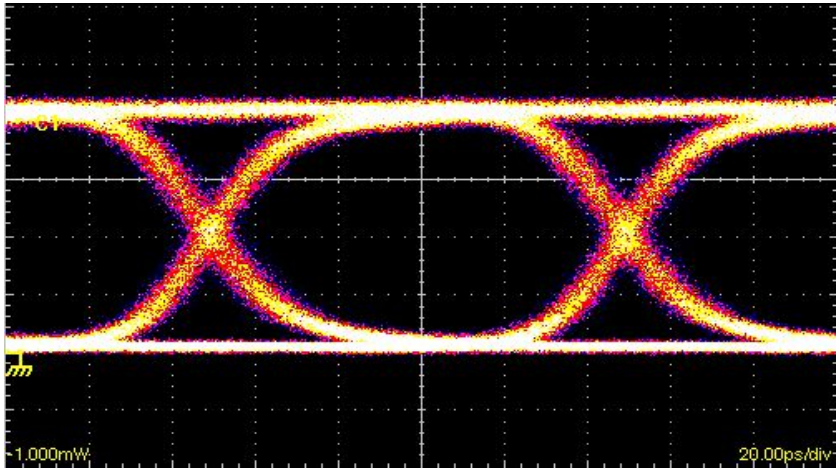
- Detector upgrades → more massive material
- Higher rate of data transmission requires more massive cables
- Can we modify the hardware of the ITkPixV1 to be able to transmit more data through the same cable
- Can we achieve PAM4 using CML bias?

Goal:

- Modify the chip to achieve PAM4 signal transmission as opposed to current NRZ signal transmission

NRZ

NRZ:
Non-Return-to-Zero (NRZ) is a binary code using high/low signal levels to represent 1/0 in digital logic signal. NRZ transmits 1 bit per signal level

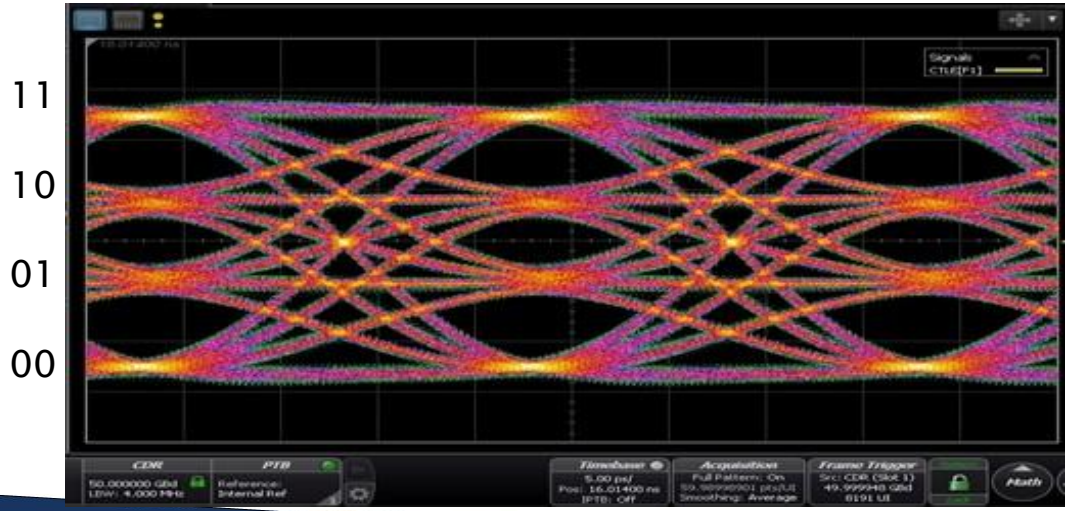


NRZ eye diagram

PAM4

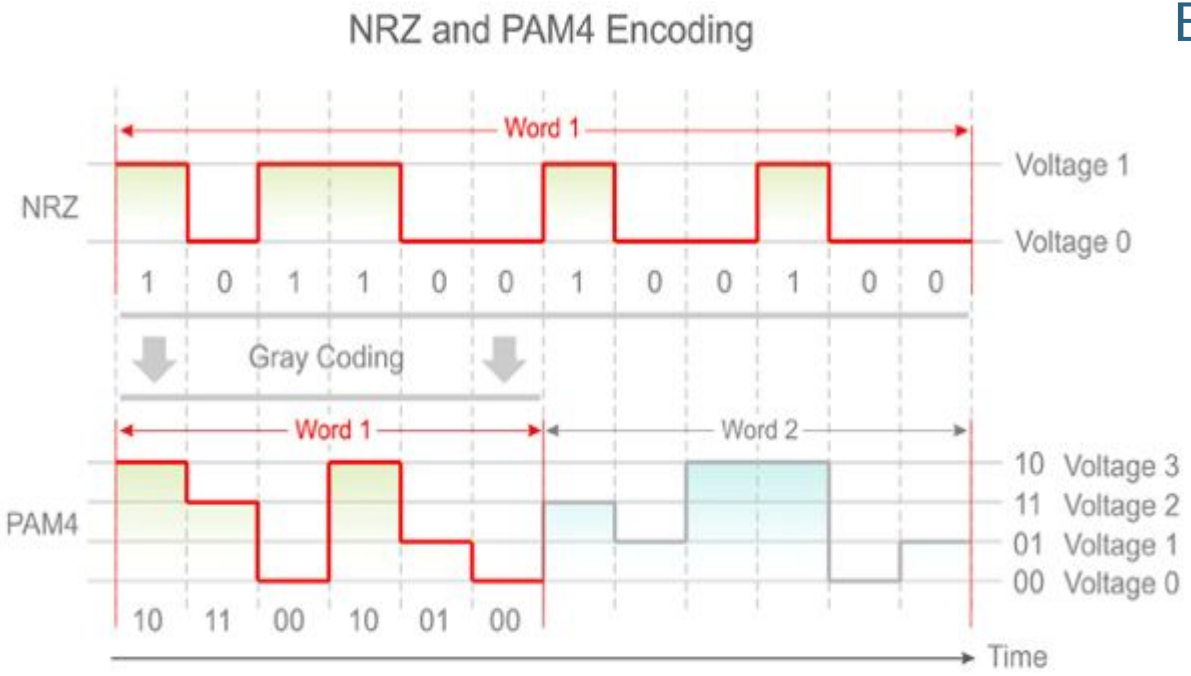
PAM4:

Pulse-Amplitude-Modulation level 4 (PAM4) is a signal transmission format in which each signal level can encode 2 bits of information → 4 distinct levels.



PAM4 eye diagram

NRZ vs PAM4



Example:

- Using PAM4, word 101100100100 was transmitted in half the time compared to NRZ. Higher baud rate

https://blog.samtec.com/post/understanding-nrz-and-pam4-signaling/

NRZ vs PAM4

Drawbacks of PAM4

- PAM4 amplitude is split into 3 eyes A_PAM4 = ⅓ * A_NRZ
- Signal to Noise Ratio loss
  - SNR = 20*log(A)

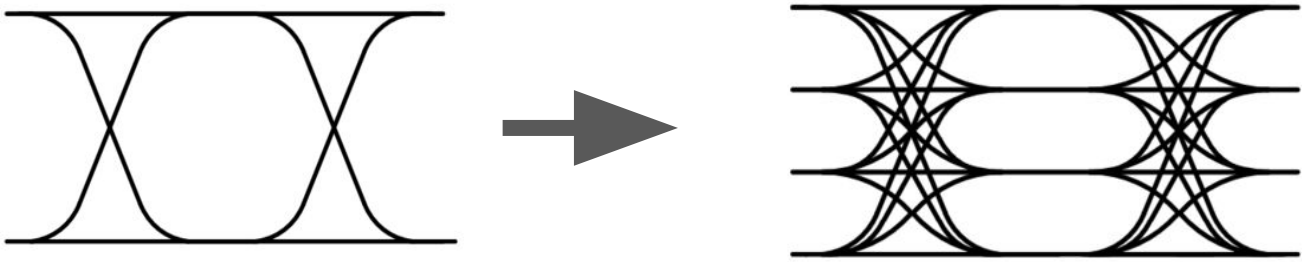
PAM4 has ~9.5dB SNR loss compared to NRZ

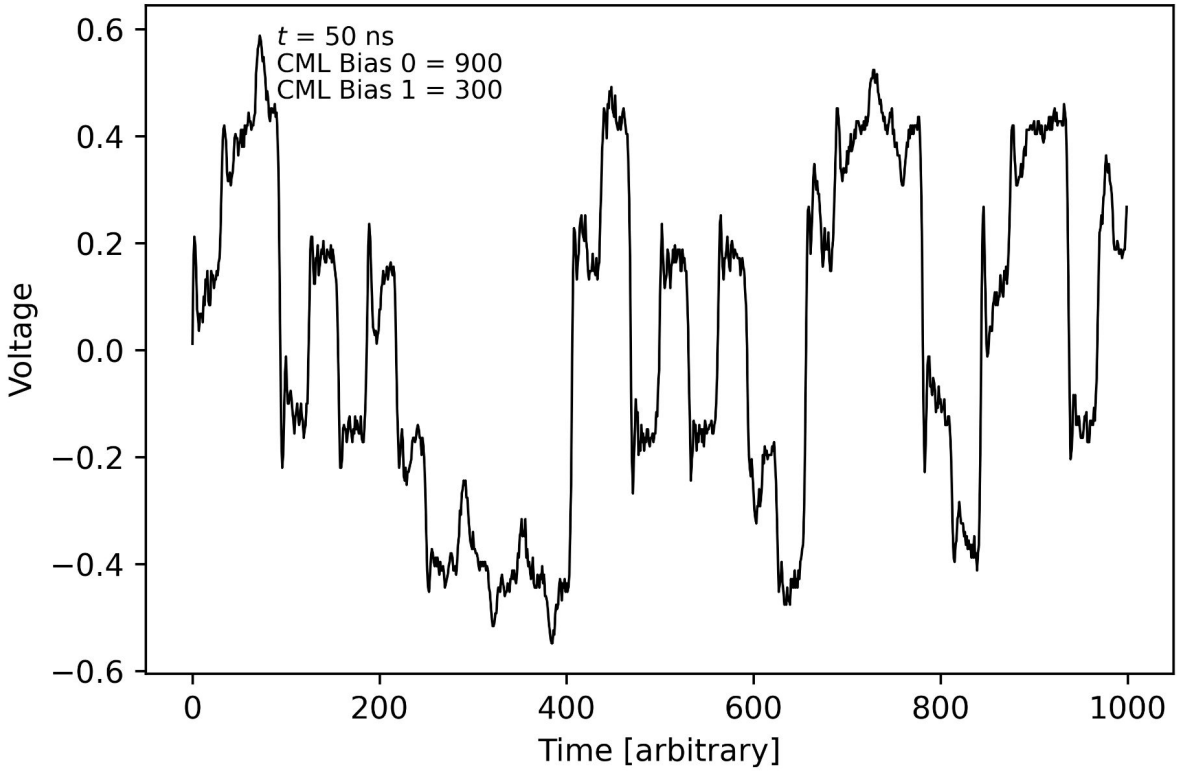
Next steps

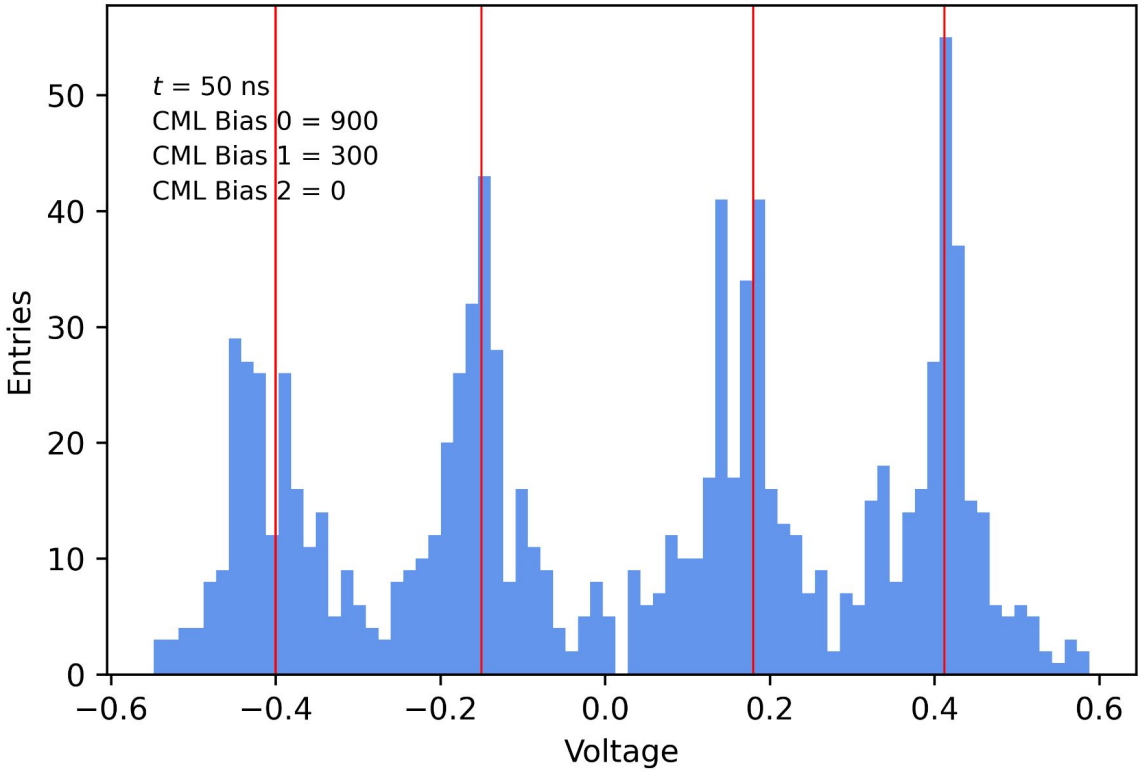
- Design circuit that will merge channels from Cml output and achieve a PAM4 signal output
- Consider achieving PAM4 with the CML bias

Method

- Attach resistive dividers to channel outputs to modify the amplitude of the output to get PAM4 signal




t = 50 ns
CML Bias 0 = 900
CML Bias 1 = 300
Voltage
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
0
200
400
600
800
1000
Time [arbitrary]


t = 50 ns
CML Bias 0 = 900
CML Bias 1 = 300
CML Bias 2 = 0
Entries
0
10
20
30
40
50
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
Voltage