Damic Kikckoff meeting 2018
Analog Digital Converter
18 bits, 15 MSPS

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Requirements

• If we want to see energy deposit from $\bar{e}V$ to tens of $K\bar{e}V$ it requires a significant dynamic range (range of CCD = 75 $K\bar{e}$) → we need at least a 17 bits ADC

• Since the dynamic range should be always smaller than total one due to noise so we need at least an 18 bits ADC

• We also need to perform oversampling, for that we should use a fast ADC → 18 bits ADC with 15MSPS

LTC 2387-18
Analog digital conversion
18 bits, 15MSPS

• Features of (LTC 2387-18)
  
  • Bits number = 18 bits
  
  • Serial LVDS Interface
  
  • Input Voltage Range: $\Delta V = 8.192V$ (differential input)
  
  • Quantization step: $\delta V = \frac{\Delta V}{2^{18} - 1} = 31.28\mu V \rightarrow 1 \text{ adu} = 31\mu V$
Quantization Noise

• During the conversion, there is a quantization phase.

• Quantization is the process of converting the sampled continuous valued signals into discrete-valued data.

• Quantizing a sequence of numbers produces a sequence of quantization errors which is sometimes modeled as an additive random signal called quantization noise because of its stochastic behavior.

• Quantization error is white noise & is uncorrelated to the input.
What is OVERSAMPLING?

• Oversampling is the act of sampling the input signal at a frequency much greater than the Nyquist frequency.

• For each additional bit of resolution desired, the signal must be oversampled by a factor of four:
  
  • \( f_C = 4^w \times f_S \) where \( w \) is the number of additional bits desired, \( f_S \) is the original sampling frequency, and \( f_C \) is the oversampling frequency.

  • \( \text{SNR (dB)} = (6.02 \times \text{ENOB}) + 1.76 \)

\[ F_C = \text{MAXIMUM FREQUENCY OF INTEREST} \]
\[ F_S = \text{SAMPLING FREQUENCY} \]
Schemas LTC 2487-18
Noise

- Input is connected to the ADC reference

<table>
<thead>
<tr>
<th>Reading Frequency</th>
<th>Noise (adu)</th>
<th>Nombre of sample (oversampling)</th>
<th>Noise after sampling (adu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mhz</td>
<td>1.42 (44.02 µV)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4 Mhz</td>
<td>1.42 (44.02 µV)</td>
<td>4</td>
<td>0.75 (23.25 µV)</td>
</tr>
<tr>
<td>13 Mhz</td>
<td>1.41 (43.71 µV)</td>
<td>13</td>
<td>0.48 (14.8 µV)</td>
</tr>
</tbody>
</table>

Gaussian distribution

- F = 13 Mhz
Linearity

Input (Ramp):

\[
\begin{align*}
    & f_{\text{trigger}} = 13 \text{ Mhz} \\
    & f_{\text{sin}} = 25 \text{ Khz} \\
    & \text{Amp} = 2V, \text{ offset} = 1V \\
    & \text{number of pixel} = 10240
\end{align*}
\]

This noise is dominated by the generator.
Conclusion & Next Step

• The noise of 18bits ADC with 15 MSPS is equal to 1.42 adu

• Perform finer test on ADC

• Combine the new ADC board with the rest of the test bench (flex,..)

• Design a new board for adc LTC 2487-18 with 4 channels