Electronic Instrumentation
Problem sheet: ADC

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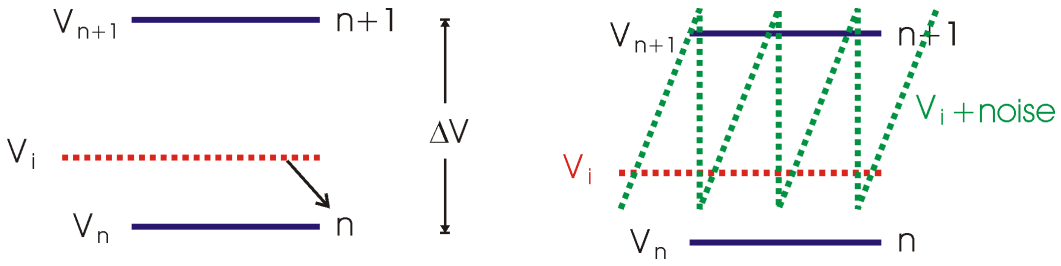
Adding signals such as noise can increase the resolution of an ADC. Without the added signal, the ADC will always result in the same digital value; see for example the situation below (left):



In this example, the constant input voltage V_i will always result in the digital value n and there is thus a constant (systematic) error $\delta V = V_i - V_n$.

- Show that by adding a saw-tooth or triangular signal to V_i (see right figure), in combination with oversampling and averaging, the resolution can be increased.
- What is the needed amplitude and offset of the signal ($\Delta V \equiv V_{n+1}\ V_n$)?

The above example is equivalent to adding noise with a rectangular distribution (probability $P(v)$ to add voltage v is constant in the range defined by the amplitude and offset).

- Can the same result be achieved by adding a sine wave signal or by adding random noise? In case yes: what are the parameters (amplitude and offset)? Note: random ("white") noise has a probability density function

$$P(v) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{v^2}{2\sigma^2}\right]$$

(for Normal Distribution, see Wikipedia: http://en.wikipedia.org/wiki/Normal_distribution)