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DSP Design

Kdq2

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## Project 2: Dynamic Range Control

### Compressors, Limiters, Expanders and Noise Gates

Calculating the mean-square average can be done by integrating the input function squared over a period. After working through it by hand it does simplify to  $A^2/2$

$$\begin{aligned}\overline{|x(t)|^2} &= \frac{1}{T} \int_0^T A^2 \cos^2(2\pi f t) dt \\ &\downarrow \\ \frac{2A^2}{2\pi f T} \int_0^{T/2} 2\pi f \cos(2\pi f t) dt \\ &\downarrow \\ \frac{2A^2}{2\pi f T} \left[ \sin(2\pi f t) \right]_0^{T/2} \\ &\downarrow \\ \frac{2A^2}{2\pi f T} \left[ \sin\left(\frac{2\pi f T}{2}\right) - \sin(0) \right] \\ &\downarrow \\ \frac{2A^2}{2\pi f T} [1 - 0] \\ &\downarrow \\ \frac{2A^2}{2\pi f T} \cdot \frac{2\pi f T}{2} \\ &\downarrow \\ \frac{A^2}{2}\end{aligned}$$

To find the absolute average I integrated the input function over a quarter period and multiplied by 4.

$$\begin{aligned}\overline{x^2(t)} &= \frac{A^2}{T} \int_0^T \frac{1}{2} dt + \frac{A^2}{2T} \int_0^T \cos(4\pi f t) dt \\ &\downarrow \\ \frac{A^2}{2T} [T - 0] + \frac{A^2}{2 \cdot T \cdot 4\pi f} \int_0^T 4\pi f \cos(4\pi f t) dt \\ &\downarrow \\ \frac{A^2}{2} + \frac{A^2}{8\pi f T} \left[ \sin(4\pi f t) \right]_0^T \\ &\downarrow \\ \frac{A^2}{2} + \frac{A^2}{8\pi f T} [\sin(4\pi f T) - \sin(0)] \\ &\downarrow \\ \frac{A^2}{2} + \frac{A^2}{8\pi f T} [0 - 0] \\ &\downarrow \\ \frac{A^2}{2}\end{aligned}$$