TANH FUNCTION SINE SHAPER--SEAT OF THE PANTS VERSION

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The strategy here is to generate a tri wave, then bung it into a BJT diff pair to curve over a bit, and subtract a bit of the original tri wave to get rid of the cusps. To really optimize this you want to compute the THD as a function of the amplitude going into the tanh shaper and the amount of tri wave subtracted, but that's too much like wor for a sci.electronics.design post!

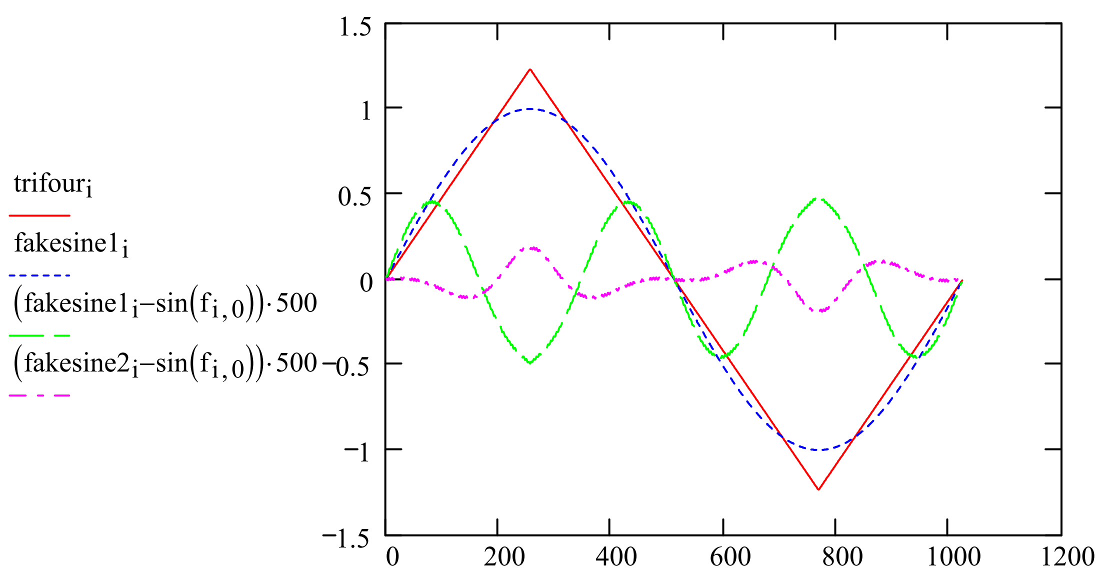
$imax := 1023 \qquad i := 0 .. imax$

$nmax := 100 \qquad n := 0 .. nmax \qquad f_{i,n} := 2 \cdot \pi \cdot \frac{i}{imax + 1} \cdot (2 \cdot n + 1)$

$$trifour_i := \sum_n \frac{(-1)^n \cdot \sin(f_{i,n})}{(2 \cdot n + 1)^2}$$

$fakesine1_i := (\tanh(0.5 \cdot trifour_i) - 0.3495 \cdot trifour_i) \cdot 8.484$ eyeball version

$fakesine2_i := (\tanh(a0 \cdot trifour_i) - a1 \cdot trifour_i) \cdot a2$ optimized version



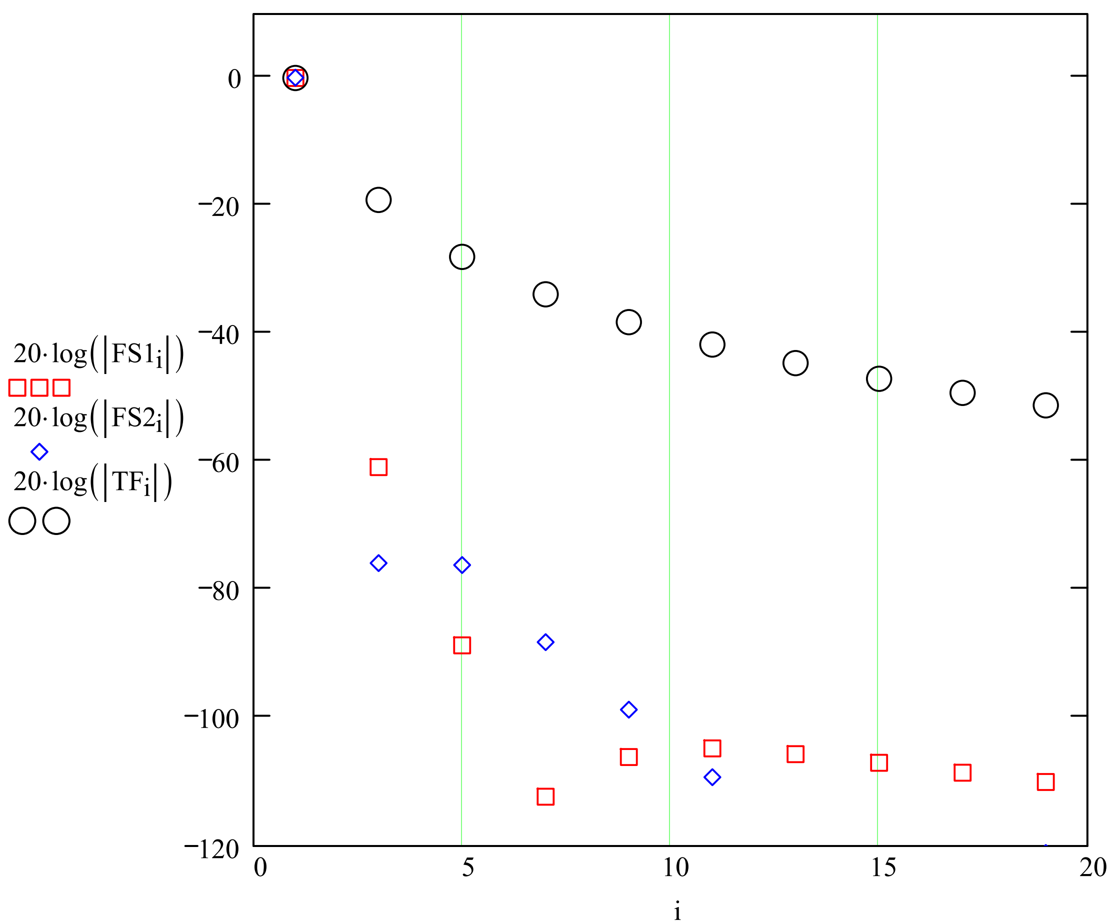
THD 73 dB down

$$\sqrt{\frac{\sum_i \left(\text{fakesine2}_i - \sin\left(f_{i,0}\right)\right)^2}{\sum_i \sin\left(f_{i,0}\right)^2}} = 2.2903673 \times 10^{-4} \qquad \text{norm} := \sqrt{\frac{4}{1024}}$$

$$\text{FS1} := \text{cfft}(\text{fakesine1})\cdot\text{norm} \qquad \text{FS2} := \text{cfft}(\text{fakesine2})\cdot\text{norm}$$

$$\text{TF} := \text{cfft}(\text{trifour})\cdot\text{norm}$$

$$a0 \equiv 0.48 \quad a1 \equiv 0.3445 \quad a2 \equiv 9.3975 \qquad \max(\text{FS1}) = i$$



The tanh shaper (even in this poorly optimized version) gives about 0.1% THD, predominantly third harmonic. Higher harmonics go away nearly completely due to cancelling the cusp. A bit more work gets us to 0.03% THD, just by optimizing the amplitude of the wave going into the tanh shaper.

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