Phase Controlled Rectifier, Fully Controlled

RMS values

(%i1) Vrms: Vm / sqrt(2);

$$\frac{Vm}{\sqrt{2}} \tag{Vrms}$$

current, 1st harmonic

(%i2) assume(Iout > 0);

$$[Iout>0] \tag{\%o2}$$

(%i3) Irms: Iout;

$$Iout \tag{Irms}$$

(%i4) I1s: 1 / %pi * (integrate(Iout * sin(x), x, alpha, %pi + alpha) + integrate(- Iout * sin(x), x, %pi + alpha, 2 * %pi + alpha));

$$\frac{4\cos\left(\alpha\right) Iout}{\pi} \tag{I1s}$$

(%i5) I1c: 1 / %pi * (integrate(Iout * cos(x), x, alpha, %pi + alpha) + integrate(- Iout * cos(x), x, %pi + alpha, 2 * %pi + alpha));

$$-\frac{4\sin\left(\alpha\right) Iout}{\pi} \tag{I1c}$$

(%i6) I1: sqrt(I1c^2 + I1s^2);

$$\sqrt{\frac{16\sin\left(\alpha\right)^2 Iout^2}{\pi^2}+\frac{16\cos\left(\alpha\right)^2 Iout^2}{\pi^2}} \tag{I1}$$

(%i7) I1: trigsimp(I1);

$$\frac{4Iout}{\pi} \tag{I1}$$

(%i8) I1rms: I1 / sqrt(2);

$$\frac{2^{\frac{3}{2}} Iout}{\pi} \tag{I1rms}$$

DPF

(%i9) DPF: I1s / I1;

$$\cos\left(\alpha\right) \tag{DPF}$$

P

(%i10) P: Vrms * I1rms * DPF;

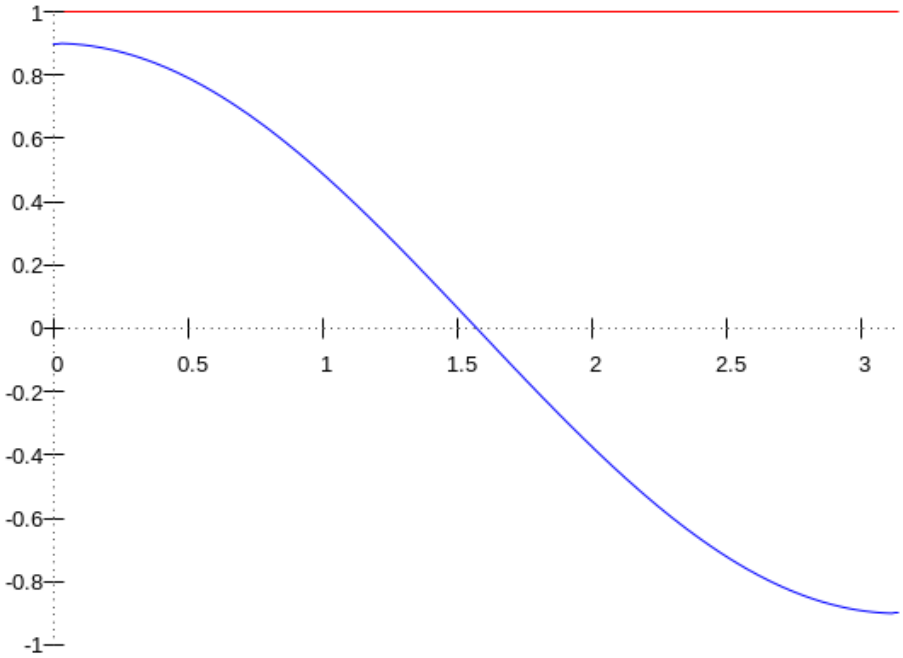
$$\frac{2\cos\left(\alpha\right) Iout\ Vm}{\pi} \tag{P}$$

S

(%i11) S: Vrms * Irms;

$$\frac{Iout\ Vm}{\sqrt{2}} \tag{S}$$

(%i12) wxplot2d([P / S, S / S], [alpha, 0, %pi-1e-3], [box, false], [legend, false]);



(%t12)

(%o12)

PF

(%i13) PF: P / S;

$$\frac{2^{\frac{3}{2}}\ \cos\left(\alpha\right)}{\pi} \tag{PF}$$

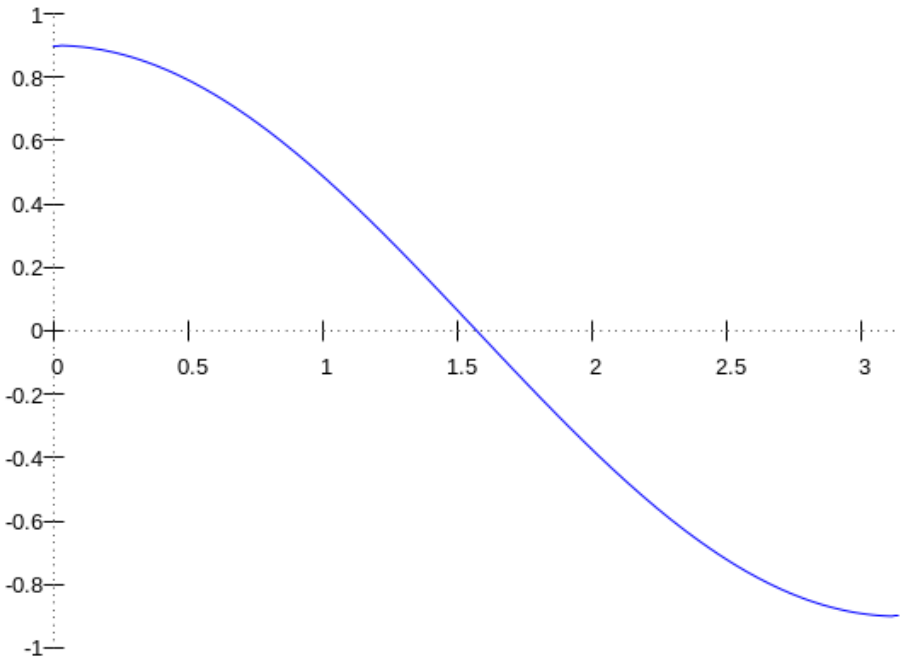
(%i14) ev(PF, alpha = 0);

$$\frac{2^{\frac{3}{2}}}{\pi} \tag{\%o14}$$

(%i15) ev(PF, alpha = 0, numer);

$$0.9003163161571063 \tag{\%o15}$$

(%i16) wxplot2d(PF, [alpha, 0, %pi-1e-3], [box, false], [legend, false]);

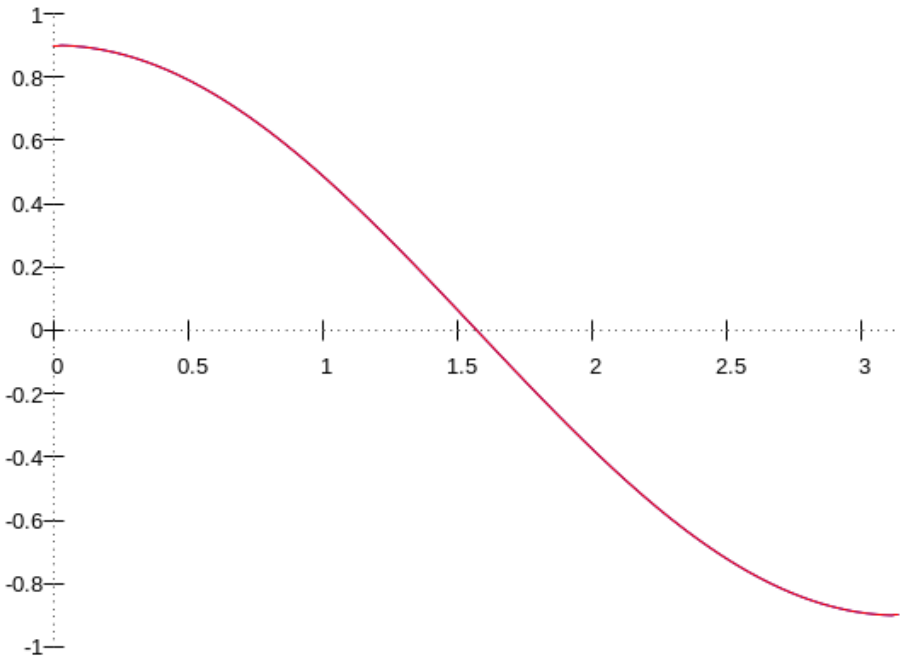


(%t16)

(%o16)

verify PF-DPF relation

(%i17) wxplot2d([PF, I1rms / Irms * DPF], [alpha, 0, %pi-1e-3], [box, false], [legend, false]);



(%t17)

(%o17)

THD

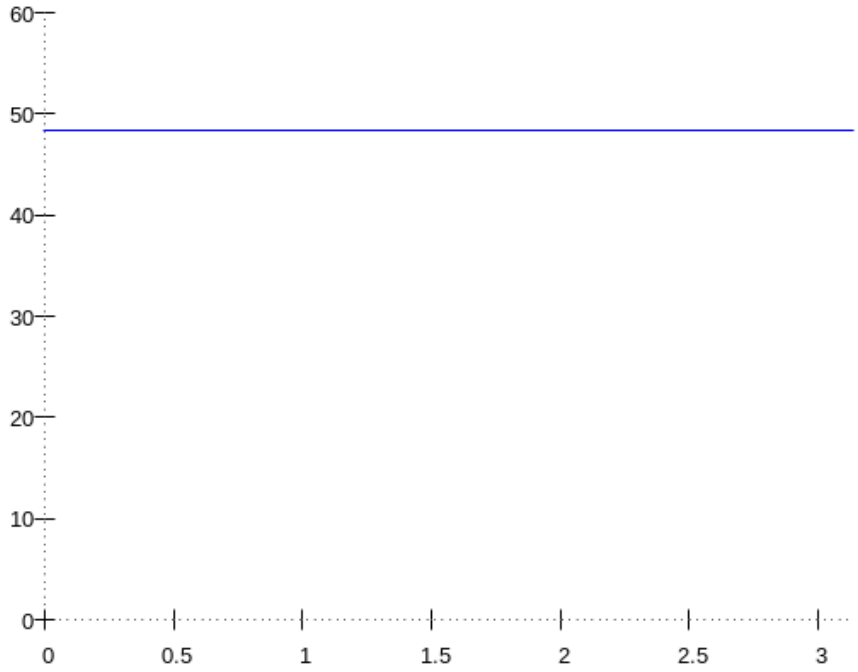
(%i18) THD: sqrt((Irms / I1rms)^2 - 1) * 100;

$$100\sqrt{\frac{\pi^2}{8}-1} \qquad \text{(THD)}$$

(%i19) ev(THD, numer);

48.3425847608679 (%o19)

(%i20) wxplot2d(THD, [alpha, 0, %pi-1e-3], [y, 0, 60], [box, false], [legend, false]);



(%t20)

(%o20)