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Project**: Active Filter based on Conservative Power Theory (CPT) wiht digital controller.**

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Parameters Specifications

$V_{s\_ef} := 127$ RMS grid phase-voltage

$f_s := 60$ Grid Frequency

$VDC := 220$ DC link Voltage

$L_f := 4.8 \cdot 10^{-3}$ Active Filter inductor output

$R_f := 0.1$ Active Filter resistance output

$H_i := 0.1$ Current Sensor Gains

$V_t := 1$ Carrier Amplitude

$F_s := 30 \cdot 10^3$ Switching Frequency

$f_c := \frac{F_s}{20} = 1.5 \times 10^3$ Desired cut-off frequency

$MF_d := 55$ Desired Margin Phase

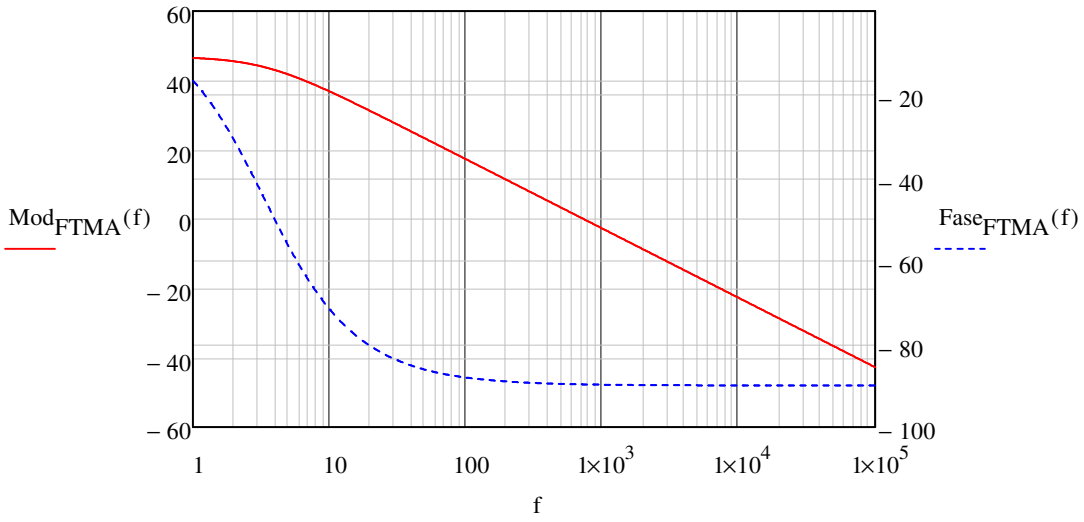
$T_a := \frac{1}{F_s} = 3.333333333333 \times 10^{-5}$ Switching period

$G_i(f) := \frac{VDC}{2 \cdot \pi \cdot f \cdot i \cdot L_f + R_f}$ Current Plant GIs(Z)

$FTMA(f) := H_i \cdot G_i(f)$

$Mod_{FTMA}(f) := 20 \cdot \log(|FTMA(f)|)$

$Fase_{FTMA}(f) := \arg(G_i(f)) \cdot \frac{180}{\pi}$



Controller Desgin

$G_{c\_dB} := Mod_{FTMA}(f_c)$

$G_{c\_dB} = -6.261814899986$ dB gain

$G_c := 10^{\frac{|G_{c\_dB}|}{20}}$ Real gain to be compensated

$G_c = 2.056320215265$

$F_u := Fase_{FTMA}(f_c)$

$F_u = -89.87334872673$

$\alpha_2 := MF_d - F_u - 90$ Required Phase [degree]

$\alpha_2 = 54.87334872673$

$K_2 := \tan\left(\frac{\alpha_2 \cdot \frac{\pi}{180}}{2} + \frac{\pi}{4}\right)$

$K_2 = 3.159414619832$

$$Prod_2 := \frac{1}{2\cdot\pi\cdot f_c\cdot G_c\cdot K_2}$$ Prod2=C2*R1

$Prod_2 = 1.633170415287\times 10^{-5}$

$C_2 := 100\cdot 10^{-9}$ Adobted

$$R_1 := \frac{Prod_2}{C_2}$$

$R_1 = 163.317041528734$

$C_1 := C_2\cdot\left(K_2^{\,2} - 1\right)$

$C_1 = 8.981900740005\times 10^{-7}$

$$R_2 := \frac{K_2}{2\cdot\pi\cdot f_c\cdot C_1}$$

$R_2 = 373.222007663598$

Type 2 controller transfer function

$$C_{tipo2}(f) := \frac{1 + 2\pi\cdot f\cdot i\cdot C_1\cdot R_2}{2\cdot\pi\cdot f\cdot i\cdot R_1\cdot\left(C_1 + C_2 + 2\cdot\pi\cdot f\cdot i\cdot R_2\cdot C_1\cdot C_2\right)}$$

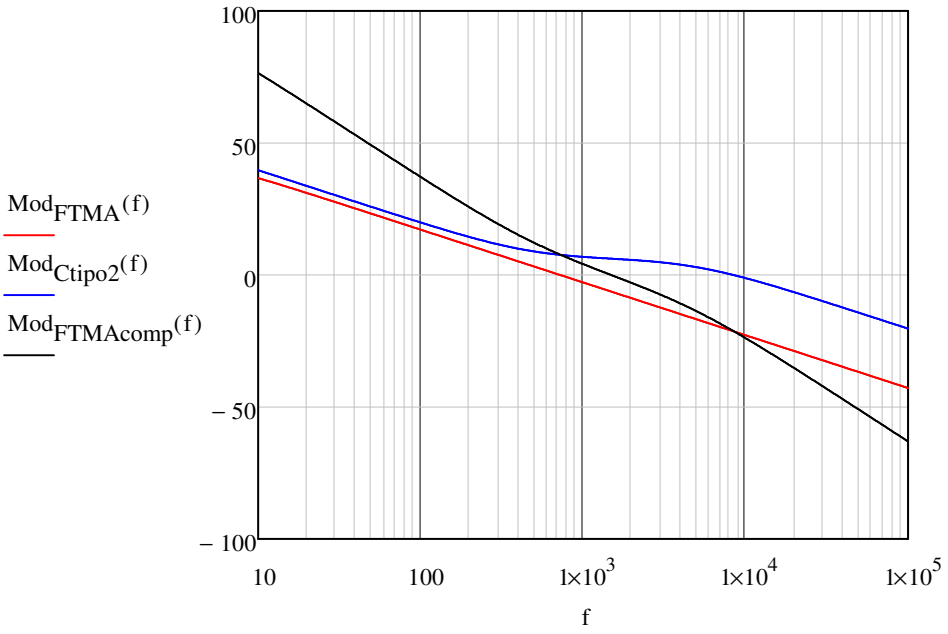
$$Mod_{Ctipo2}(f) := 20\cdot\log\left(\left|C_{tipo2}(f)\right|\right)$$

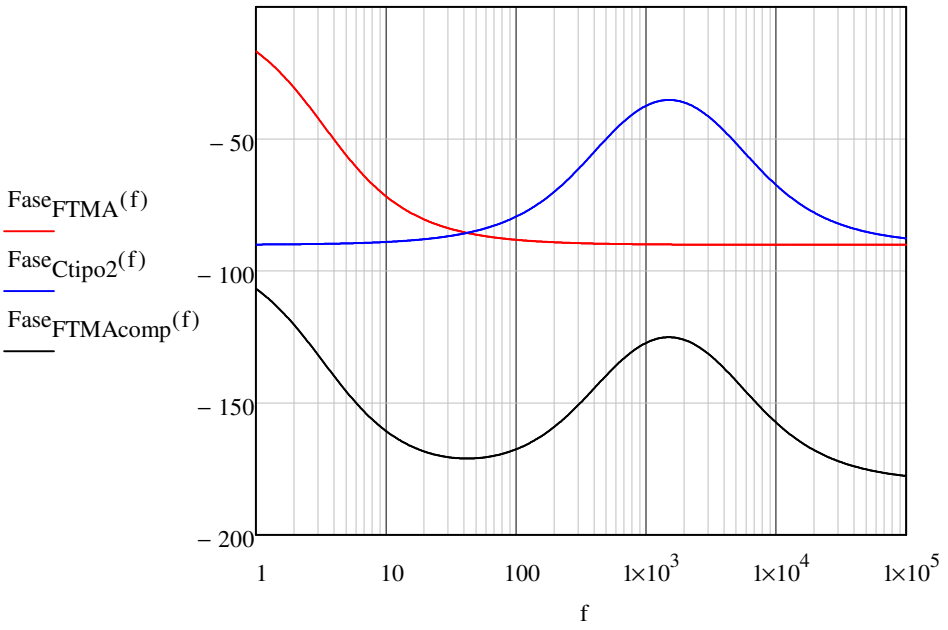
$$Fase_{Ctipo2}(f) := \arg\left(C_{tipo2}(f)\right)\cdot\frac{180}{\pi}$$

$FTMA_{comp}(f) := FTMA(f)\cdot C_{tipo2}(f)$ Open-loop transfer function

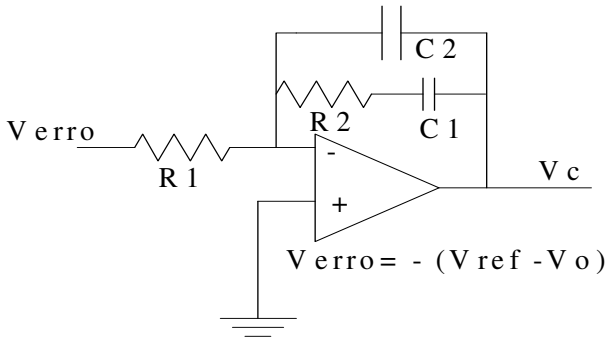
$$Mod_{FTMAcomp}(f) := 20\cdot\log\left(\left|FTMA_{comp}(f)\right|\right)$$

$$Fase_{FTMAcomp}(f) := \arg\left(FTMA_{comp}(f)\right)\cdot\frac{180}{\pi}$$





Implementation



$R_1 = 163.317041528734$ $C_1 = 8.981900740005 \times 10^{-7}$

$R_2 = 373.222007663598$ $C_2 = 1 \times 10^{-7}$

Digital: z transfer function. PSIM implementation CIs(Z)

$\beta := 4 \cdot R_1 \cdot R_2 \cdot C_1 \cdot C_2 + 2 \cdot T_a \cdot R_1 \cdot (C_1 + C_2) = 3.27672331963 \times 10^{-8}$

Numerator coeficients

$$b_0 := \frac{T_a^{\,2} + 2 \cdot T_a \cdot C_1 \cdot R_2}{\beta} = 0.715940763629$$

$$b_1 := \frac{2 \cdot T_a^{\,2}}{\beta} = 0.067818427296$$

$$b_2 := \frac{T_a^{\,2} - 2 \cdot T_a \cdot C_1 \cdot R_2}{\beta} = -0.648122336333$$

Denominator Coeficients

$a_{zero} := 1$

$$a_1 := \frac{-8 \cdot R_1 \cdot R_2 \cdot C_1 \cdot C_2}{\beta} = -1.336648499666$$

$$a_2 := \frac{4 \cdot R_1 \cdot R_2 \cdot C_1 \cdot C_2 - 2 \cdot T_a \cdot R_1 \cdot (C_1 + C_2)}{\beta} = 0.336648499666$$