File name: Non-PFC Power: 199W~283W
Purpose: LLC-SRC operation calculation
Date: Nov, 2012

Hold up time calculation:

Nominal AC voltage: $V_{nor\_ac} := 270$ [V]

Nominal bulk voltage: $V_{nor} := V_{nor\_ac} \cdot \sqrt{2}$ [V]

$V_{nor} = 381.838$ [V]

$100 \cdot \sqrt{2} = 141.421$

Cut-off bulk voltage: $V_{cut\_off} := 300$ [Vac]

Cut-off ac voltage: $V_{cut\_off\_ac} := \frac{V_{cut\_off}}{\sqrt{2}}$

$V_{cut\_off\_ac} = 212.132$ [V]

Bulk Cap. capacitance: $C_{bulk} := 560 \cdot u$ [F]

$Thup := 20 \cdot 10^{-3}$

Total output power: $P_o := 300$ [W]

$24 \cdot 12 = 288$

Hold up time: $T_{hold} := \frac{C_{bulk} \cdot \left(V_{nor}^{\ 2} - V_{cut\_off}^{\ 2}\right)}{2 \cdot P_o}$ [W]

$Chup := \frac{Thup \cdot \left(2 \cdot P_o\right)}{V_{nor}^{\ 2} - V_{cut\_off}^{\ 2}}$

$T_{hold} = 52.08 \cdot 10^{-3}$ [S]

$Chup = 215.054 \cdot 10^{-6}$

$B_{plus} := 135 \quad V$

$95 \cdot \sqrt{2} = 134.35$

$R23 := 205 \cdot k$

$R24 := 205 \cdot k$

$R26 := 16.5 \cdot k$

$100 \cdot \sqrt{2} = 141.421$

$V_{minus} := 5.1$

$$V_{plus} := B_{plus} \cdot \frac{R26}{R23 + R24 + R26}$$

$V_{plus} = 5.223$

Customer Specification:

Maximum AC voltage:	$V_{max\_ac} := 288$	[V]
Maximun bulk voltage:	$V_{max\_bulk} := V_{max\_ac} \cdot \sqrt{2}$	[V]
	$V_{max\_bulk} = 407.294$	[V]
Nominal AC voltage:	$V_{nor\_ac} := 270$	[V]
Nominal bulk voltage:	$V_{nor\_bulk} := V_{nor\_ac} \cdot \sqrt{2}$	[V]
	$V_{nor\_bulk} = 381.838$	[V]
Minimun AC voltage:	$V_{min\_ac} := 230$	[V]
Minimun bulk voltage:	$V_{min\_bulk} := V_{min\_ac} \cdot \sqrt{2}$	[V]
	$V_{min\_bulk} = 325.269$	[V]

Cut-off bulk voltage: $V_{cut\_bulk} := 300$ [V]

Cut-off AC voltage: $V_{cut\_ac} := \frac{V_{cut\_bulk}}{\sqrt{2}}$ [V]

$V_{cut\_ac} = 212.132$ [V]

Nominal output voltage: $V_o := 24$ [V]

Total output power: $P_o := 300$ [W]

Maximum output current: $I_o := \frac{P_o}{V_o}$

$I_o = 12.5$ [A]

Turn ration: $n := \frac{V_{nor\_bulk}}{2 \cdot (V_o + 0.5)}$

$n = 7.793$

$$\frac{32}{4} = 8$$

Final parameters

$np := 32$ $L_m := 160 \cdot u$ $C_s := 0.022 \cdot u$ $C_s = 22 \cdot 10^{-9}$

$Rmin := 67.8 \cdot k$ $Cf := 330 \cdot 10^{-12}$

$Fmin := \frac{1.4}{Rmin \cdot Cf}$ $Fmin = 62.573 \cdot 10^{3}$

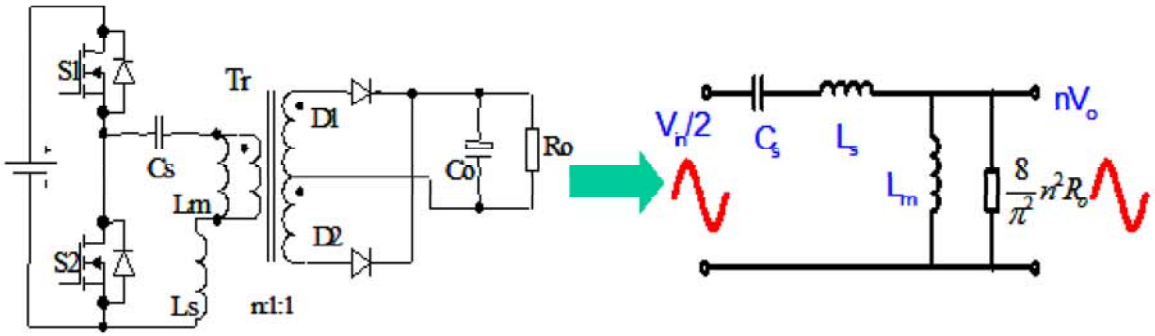
$ns := 4$ $L_s := 30 \cdot u$ $L_m = 160 \cdot 10^{-6}$ $n := \frac{np}{ns}$ $n = 8$

$Fstart := Fmin + \frac{1.4}{Rstart \cdot Cf}$

Magnetizing current :

$f_s := \frac{1}{2 \cdot \pi \cdot \sqrt{L_s \cdot C_s}}$ $f_s = 195.906 \cdot 10^3$ $\omega_s := 2 \cdot \pi \cdot f_s$ $T_s := \frac{1}{f_s}$ $I_m := \frac{n \cdot V_o}{4 \cdot f_s \cdot L_m}$ $I_m = 1.531$

$f_m := \frac{1}{2 \cdot \pi \cdot \sqrt{(L_m + L_s) \cdot C_s}}$ $f_m = 77.845 \cdot 10^3$ $\frac{L_m}{L_s} = 5.333$ $Ae := 149 \cdot 10^{-6}$ EER39L



Max RMS current of the primary switches

$I_{Prms} := \frac{\sqrt{2}}{4} \cdot \sqrt{\left(\frac{\pi \cdot I_o \cdot f_s}{n \cdot f_m}\right)^2 + \left(\frac{n \cdot V_o}{2 \cdot I_m \cdot f_s}\right)^2}$

$I_{Prms} = 4.5$

$Q := \frac{\sqrt{L_s}}{\frac{8}{\pi^2} \cdot n^2 \cdot \sqrt{C_s} \cdot \frac{V_o}{I_o}}$ $Q = 370.747 \cdot 10^{-3}$

$h := \frac{L_m}{L_s}$ $h = 5.333$

DC gain based on frequency domain

$$M(h,Q,\Omega) := \frac{1}{\sqrt{\left(1+\frac{1}{h}-\frac{1}{\Omega^2 \cdot h}\right)^2 + Q^2 \cdot \left(\frac{1}{\Omega}-\Omega\right)^2}}$$

$$V_{out}(h,Q,\Omega,V_{in}) := \frac{V_{in}}{2 \cdot n} \cdot M(h,Q,\Omega) \qquad n = 8$$

$$h := \frac{L_m}{L_s} \qquad h = 5.333$$

$$V_{out\_min}(\omega) := 24 \cdot V \qquad V_{out\_max}(\omega) := 24 \cdot V \qquad V_{out\_nor}(\omega) := 24 \cdot V$$

$$0.01 \cdot 3^2 = 90 \cdot 10^{-3}$$

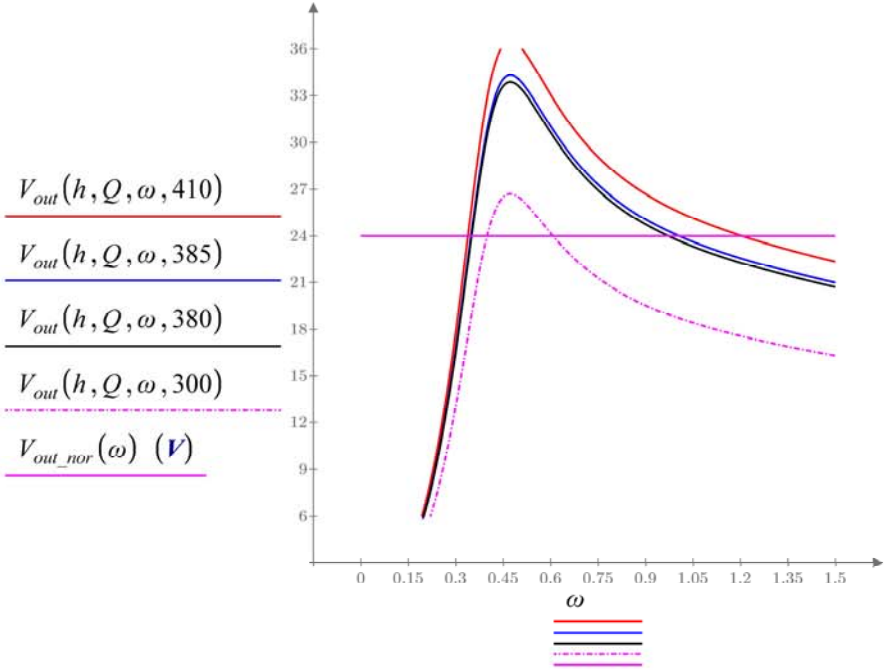
No load frequency range: $f_{max} = 238.189 \cdot 10^3$ $f_{max\_regu} = 326.964 \cdot 10^3$ $f_{nor} = 183.623 \cdot 10^3$ $f_{min\_regu} = 141.474 \cdot 10^3$ $f_{min} = 141.831 \cdot 10^3$

Resonant capacitor voltage:

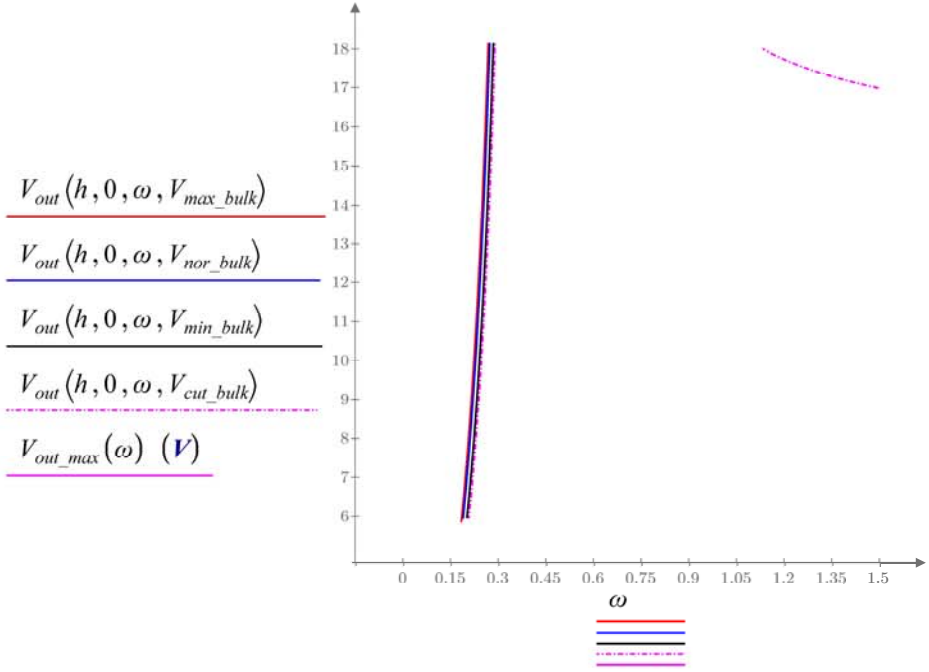
$$Vc := n \cdot V_o + \frac{I_o}{4 \cdot n \cdot f_{min} \cdot C_s} \qquad Vc = 317.189$$

$$\frac{1}{17} = 58.824 \cdot 10^{-3}$$

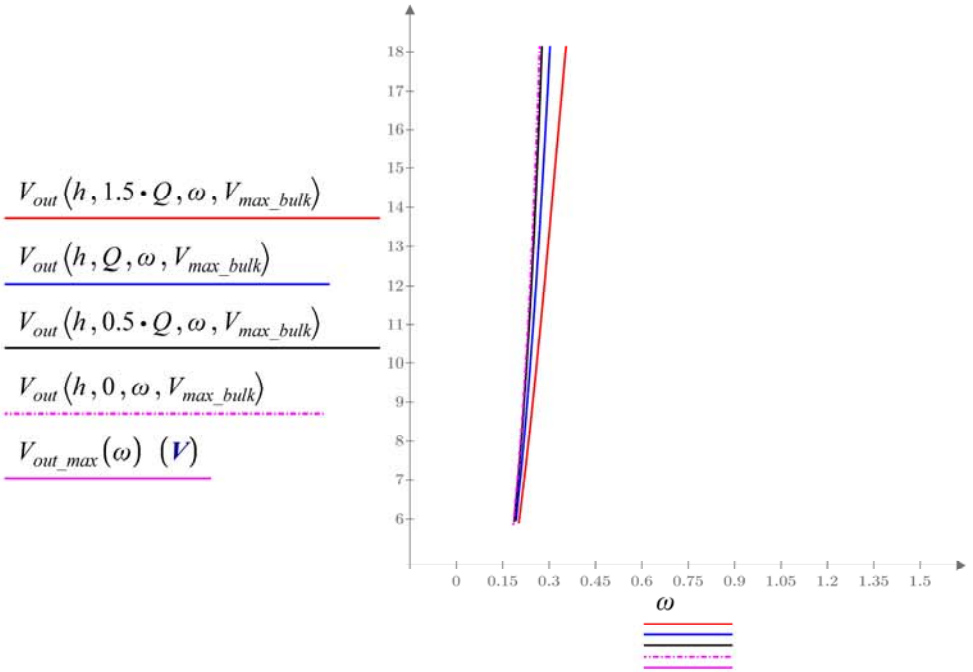
1. AC line in change: Full load



2. AC line in change: No load

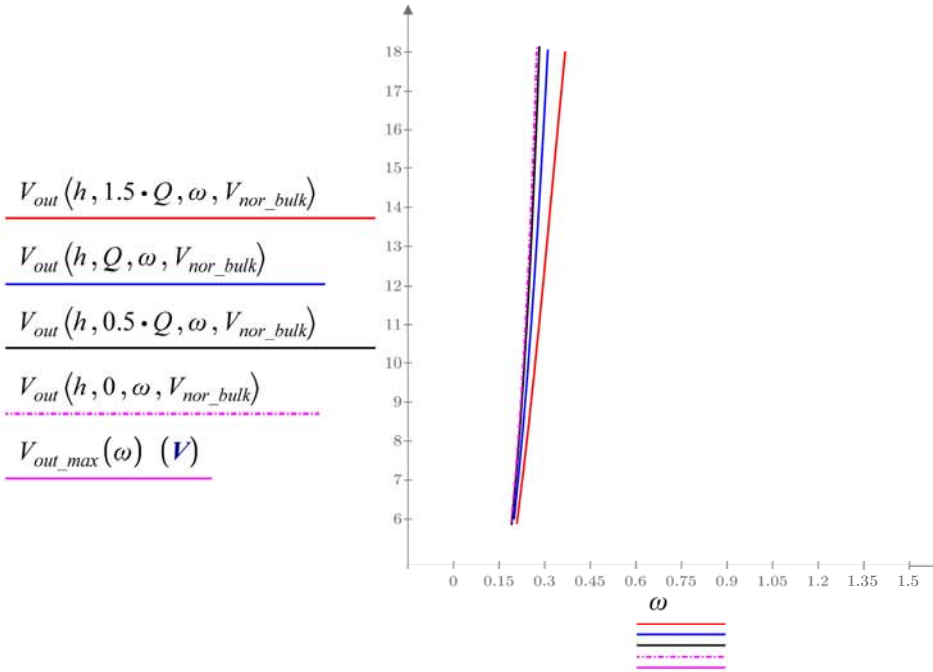


3. Load change @ Maximum AC line

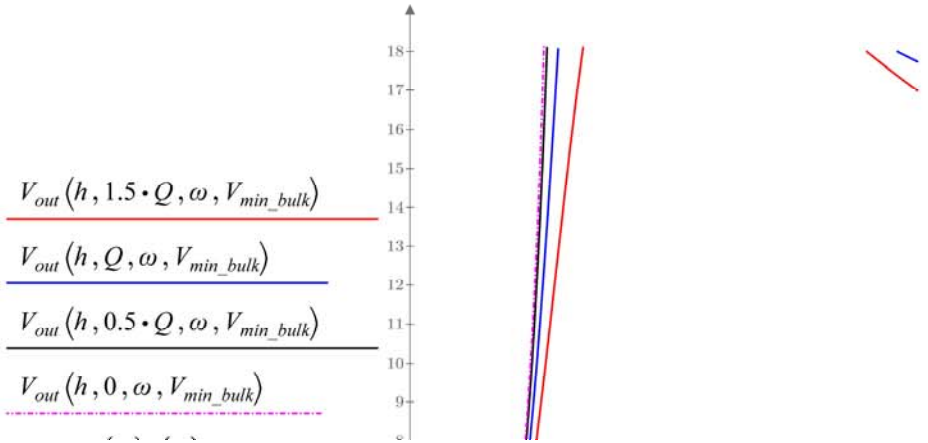


4. Load change @ Nominal AC line

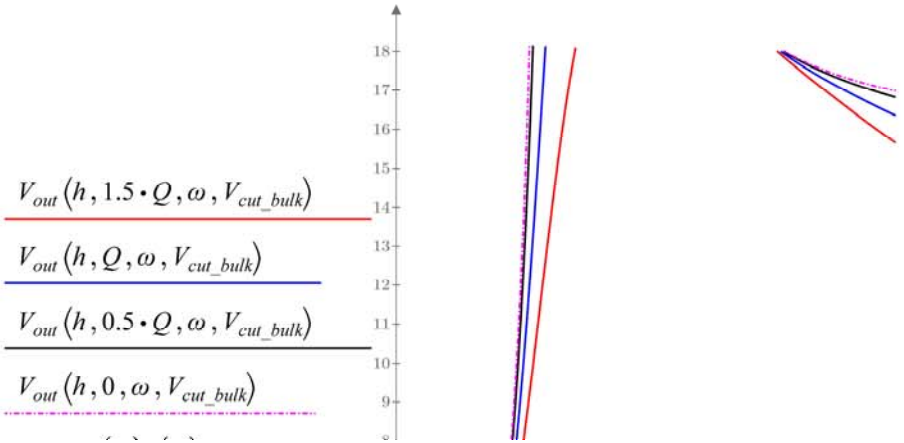
$$\frac{160}{30} = 5.333$$



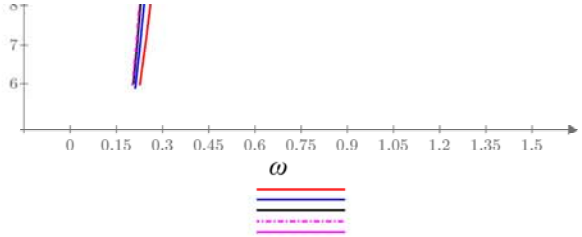
3. Load change @ Minimum AC line



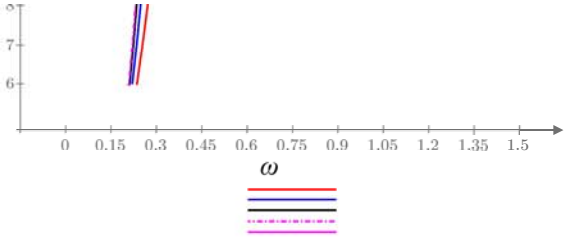
4. Load change @ Cut-off AC line



$V_{out\_max}(\omega)$ (V)



$V_{out\_max}(\omega)$ (V)



$R1 := 511$ $n := 10^{-9}$

$R2 := 3.31 \cdot k$

$$fmin := \frac{1}{2 \cdot \left(150 \cdot n + \frac{R2 \cdot 6 \cdot n}{2.5}\right)}$$ $fmin = 61.774\ k$

$$fmax := \frac{1}{2 \cdot \left(150 \cdot n + \frac{6 \cdot n}{2.5 \cdot \left(\frac{1}{R1} + \frac{1}{R2}\right)}\right)}$$ $fmax = 412.409\ k$