Forward Converter Operated in CCM

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1) Input data

$L_{mag} := 2\ mH$ $V_{inFWD} := 100\ V$ $L_{out} := 100\ \mu H$ $P_{out} := 200\ W$

$N_{FWD} := 0.12$ $V_{outFWD} := 5\ V$ $F_{sw} := 100\ kHz$ $N_{demag} := 1$

2) Calculations

Load resistance: $R_{loadFWD} := \frac{V_{outFWD}^2}{P_{out}} = 0.125\ \Omega$

Beyond this load value, the converter operates in DCM: $R_{crit} := 2 \cdot L_{out} \cdot F_{sw} \cdot \left(\frac{N_{FWD} \cdot V_{inFWD}}{N_{FWD} \cdot V_{inFWD} - V_{outFWD}} \right) = 34.286\ \Omega$

Output current: $I_{outFWD} := \frac{V_{outFWD}}{R_{loadFWD}} = 40\ A$

Switching period: $T_{sw} := \frac{1}{F_{sw}} = 10\ \mu s$

Duty ratio: $D_{FWD} := \frac{V_{outFWD}}{N_{FWD} \cdot V_{inFWD}} = 0.417$

Primary ripple current: $\Delta I_{LFWD} := D_{FWD} \cdot T_{sw} \cdot \left(\frac{N_{FWD} \cdot \left(N_{FWD} \cdot V_{inFWD} - V_{outFWD} \right)}{L_{out}} + \frac{V_{inFWD}}{L_{mag}} \right) = 0.243\ A$

2.1) Primary side

Primary peak current: $I_{pFWD} := N_{FWD} \cdot I_{outFWD} + 0.5 \cdot \frac{V_{inFWD}}{L_{mag}} \cdot D_{FWD} \cdot T_{sw} + \frac{\Delta I_{LFWD}}{2} = 5.026\ A$

Primary valley current: $I_{vFWD} := N_{FWD} \cdot I_{outFWD} + 0.5 \cdot \frac{V_{inFWD}}{L_{mag}} \cdot D_{FWD} \cdot T_{sw} - \frac{\Delta I_{LFWD}}{2} = 4.783\ A$

Primary side switch rms current: $I_{SWFWD} := \sqrt{D_{FWD} \cdot \left(\frac{I_{vFWD}^2 + I_{vFWD} \cdot I_{pFWD} + I_{pFWD}^2}{3} \right)} = 3.166\ A$

Demag diode peak current: $I_{pdemagFWD} := \frac{V_{inFWD}}{L_{mag}} \cdot D_{FWD} \cdot T_{sw} = 0.208\ A$

Demag time: $t_{dem} := \frac{L_{mag} \cdot I_{pdemagFWD}}{N_{demag} \cdot V_{inFWD}} = 4.167\ \mu s$

Demag diode rms current: $I_{demagRMS} := I_{pdemagFWD} \cdot \sqrt{\frac{t_{dem}}{3 \cdot T_{sw}}} = 77.641\ mA$

VDS voltage excursion: $V_{DSoff} := V_{inFWD} + N_{demag} \cdot V_{inFWD} = 200\ V$

2.2) Secondary side

output inductor ripple: $\Delta I_{LoutFWD} := \frac{N_{FWD} \cdot V_{inFWD} - V_{outFWD}}{L_{out}} \cdot D_{FWD} \cdot T_{sw} = 0.292\ A$

secondary side peak current: $I_{pout} := I_{outFWD} + \frac{\Delta I_{LoutFWD}}{2} = 40.146\ A$

secondary side valley current: $I_{vout} := I_{outFWD} - \frac{\Delta I_{LoutFWD}}{2} = 39.854\ A$

output inductor rms current: $I_{Loutrms} := \sqrt{\left(\frac{I_{vout}^{\ 2} + I_{vout} \cdot I_{pout} + I_{pout}^{\ 2}}{3}\right)} = 40\ A$

series diode rms current: $I_{D1FWD} := \sqrt{D_{FWD} \cdot \left(\frac{I_{vout}^{\ 2} + I_{vout} \cdot I_{pout} + I_{pout}^{\ 2}}{3}\right)} = 25.82\ A$

series diode average current: $I_{D1FWDavg} := I_{outFWD} \cdot D_{FWD} = 16.667\ A$

freewheel diode rms current: $I_{D2FWD} := \sqrt{\left(\left(1 - D_{FWD}\right) \cdot \left(\frac{I_{vout}^{\ 2} + I_{vout} \cdot I_{pout} + I_{pout}^{\ 2}}{3}\right)\right)} = 30.551\ A$

freewheel diode average current: $I_{D2FWDavg} := I_{outFWD} \cdot \left(1 - D_{FWD}\right) = 23.333\ A$

output capacitor rms current: $I_{CoutRMS} := \sqrt{\frac{I_{vout}^{\ 2} + I_{vout} \cdot I_{pout} + I_{pout}^{\ 2}}{3} - I_{outFWD}^{\ 2}} = 84.197\ mA$