The following Mathcad Sheet is based on TI's MathCAD file Rev A, available on the UCC3818 webpage. To reduce confusion, every attempt was made to match the reference designators of the UCC3818 data sheet reference design, but it is still best to correlate with USCi's schematic and board layout.

This sheet is provided to ease the parameter calculations and should be used in parallel with TI's UCC3818 data sheets and Application Notes

General Specifications

$Vinmin := 440\ V$ $Vout := 800\ V$ $\eta 1 := 0.98$ $Vovp := 850 \cdot volt$

$Vinmax := 480\ V$ $Pout := 1650\ W$ $fs := 50 \cdot 10^3 \cdot Hz, \left(100 \cdot 10^3\right) \cdot Hz .. \left(150 \cdot 10^3\right) \cdot Hz$

$Vrmsmin := 3\ V$ $Vrmsmax := 10\ V$ $Vref := 7.5\ V$

$Veamin := 0.5\ V$ $Veamax := 5.5\ V$

$Vp := 4\ V$

Calculate maximum Duty Cycle

$$D := \frac{Vout - \sqrt{2} \cdot Vinmin}{Vout}$$

$D = 0.222$

$$Idc := \frac{Pout}{Vout}$$ PFC DC Output Current

$Idc = 2.063\ A$

$VF := 1.1 \cdot volt$

$Pdiode := VF \cdot Idc$

$Pdiode = 2.269\ W$ PD on Diode

Boost Inductor

$$Ipk := \sqrt{2} \cdot \frac{\frac{Pout}{\eta 1}}{Vinmin}$$

$Ipk = 5.412\ A$

$dI := 0.2 \cdot Ipk$

$dI = 1.082\ A$ ripple current

Calculate Inductance

$$L1(fs) := \frac{Vinmin \cdot \sqrt{2} \cdot D}{dI \cdot fs}$$

$L1(45000 \cdot Hz) = 2.839 \cdot 10^{-3}\ H$ $L1(100000 \cdot Hz) = 1.277 \cdot 10^{-3}\ H$ $L1(125000 \cdot Hz) = 1.022 \cdot 10^{-3}\ H$

R1 and C1 Timing Passives

$C1 := 220 \cdot 10^{-12} \cdot farad$ C1

$$R1(fs) := \frac{0.6}{C1 \cdot fs}$$

$R1(25000 \cdot Hz) = 1.091 \cdot 10^{5}\ \Omega$ $R1(100000 \cdot Hz) = 2.727 \cdot 10^{4}\ \Omega$ $R1(150000 \cdot Hz) = 1.818 \cdot 10^{4}\ \Omega$

$R1 := 27 \cdot 10^{3} \cdot ohm$ R1

Boost Output Capacitor

Select Boost Capacitor

$tholdup := 5 \cdot 10^{-3} \cdot s$

$Vpfc\_Droop := 100 \cdot volt$

Minimum Capacitance Required

$$C12 := \frac{2 \cdot \frac{Pout}{\eta 1} \cdot tholdup}{Vout^{2} - (Vout - Vpfc\_Droop)^{2}}$$

$C12 = 1.122 \cdot 10^{-4}\ F$

$C12 := \left(100 \cdot 10^{-6} \cdot farad\right)$ C12

Setting IAC

$Iacmax := 500 \cdot 10^{-6}\ A$

$$Riacmax := Vinmax \cdot \frac{\sqrt{2}}{Iacmax}$$

$Riacmax = 1.358 \cdot 10^{6}\ \Omega$

$$RIAC\_max\_4 := \frac{Riacmax}{4}$$

$RIAC\_max\_4 = 3.394 \cdot 10^{5}\ \Omega$

$R21A := (634 \cdot 10^{3} \cdot ohm)$

R21

$R21B := (634 \cdot 10^{3} \cdot ohm)$

$R13A := (634 \cdot 10^{3} \cdot ohm)$ R13

$R13B := (634 \cdot 10^{3} \cdot ohm)$

$Riac := R21A + R21B + R13A + R13B$

$Riac = 2.536 \cdot 10^{6}\ \Omega$

$$Iiacmax := \frac{Vinmax \cdot \sqrt{2}}{Riac} \qquad Iac\_min := Vinmin \cdot \frac{\sqrt{2}}{Riac}$$

$Iiacmax = 2.677 \cdot 10^{-4}\ A$ $Iac\_min = 2.454 \cdot 10^{-4}\ A$

Feed Forward

$$Rvff := \frac{1.4\ V}{\frac{Vinmin}{Riac \cdot 2} \cdot 0.9}$$

$Rvff = 1.793 \cdot 10^{4}\ \Omega$

$Rvff := 17.4 \cdot 10^{3} \cdot ohm$

$R6 := Rvff$ R6

$fp := 2.6 \cdot Hz$

$$Cvff := \frac{1}{2 \cdot \pi \cdot Rvff \cdot fp}$$

$Cvff = 3.518 \cdot 10^{-6}\ F$

$Cvff := 3.9 \cdot 10^{-6} \cdot F$

$C6 := Cvff$

$C6 = 3.9 \cdot 10^{-6}\ F$ C6

$fp1 := \frac{1}{2 \cdot 3.14159 \cdot Rvff \cdot Cvff}$

$fp1 = 2.345\ Hz$

Rsense Calculation

$Rsense := \frac{1\ V}{Ipk + 0.5 \cdot dI}$

$Rsense = 0.168\ \Omega$

$Rsense := 0.20 \cdot ohm$

$R14 := Rsense$ R14

Multiplier

$Km := \frac{1}{V}$

$V = 1\ V$

$Imomax := \frac{Iac\_min \cdot (Veamax - 1\ V)}{Km \cdot Vrmsmin^2}$

$Imomax = 1.227 \cdot 10^{-4}\ A$

$Plimit := \frac{Pout \cdot 1.2}{\eta 1}$

$Vrs := \frac{Plimit \cdot \sqrt{2}}{Vinmin} \cdot Rsense$

$Vrs = 1.299\ V$

$Rmout := \frac{Vrs}{Imomax}$

$Rmout = 1.059 \cdot 10^{4}\ \Omega$

$Rmout := 10 \cdot 10^3 \cdot ohm$

R9

$R9 := Rmout$

R10

$R10 := Rmout$

Peak Current Limit

$$Ilimit := \frac{Pout \cdot 1.3 \cdot \sqrt{2}}{\eta 1 \cdot Vinmin} + 0.5 \cdot dI$$

$Ilimit = 7.576\ A$

$Vrs := Ilimit \cdot Rsense$

$Vrs = 1.515\ V$

R11

$R11 := 10 \cdot 10^3 \cdot ohm$

$$R12 := \frac{Vrs \cdot R11}{Vref}$$

$R12 = 2.02 \cdot 10^3 \cdot ohm$

R12

$R12 := 4.22 \cdot 10^3 \cdot ohm$

Current Loop

$fc := 10 \cdot 10^3 \cdot Hz$

$$Gid\_75k := \frac{Vout \cdot Rsense}{2 \cdot \pi \cdot fc \cdot L1(75000 \cdot Hz) \cdot Vp} \quad id\_100k := \frac{Vout \cdot Rsense}{2 \cdot \pi \cdot fc \cdot L1(100000 \cdot Hz) \cdot Vp} \quad Gid\_125k := \frac{Vout \cdot Rsense}{2 \cdot \pi \cdot fc \cdot L1(125000 \cdot Hz) \cdot Vp}$$

$Gid\_75k = 0.374$ $Gid\_100k = 0.498$ $Gid\_125k = 0.623$

$$Gea\_75k := \frac{1}{Gid\_75k} \quad Gea\_100k := \frac{1}{Gid\_100k} \quad Gea\_125k := \frac{1}{Gid\_125k}$$

$Gea\_75k = 2.675$ $Gea\_100k = 2.007$ $Gea\_125k = 1.605$

$Ri := Rmout$

$Rf\_75k := Ri \cdot Gea\_75k$

$Rf\_75k = 2.675 \cdot 10^4\ \Omega$

$R8\_75k := Rf\_75k$

$Rf\_100k := Ri \cdot Gea\_100k$

$Rf\_100k = 2.007 \cdot 10^4\ \Omega$

$R8\_100k := 20.0 \cdot 10^3 \cdot ohm$

R8

$Rf\_125k := Ri \cdot Gea\_125k$

$Rf\_125k = 1.605 \cdot 10^4\ \Omega$

$R8\_125k := Rf\_125k$

$$Cp(fs) := \frac{1}{2 \cdot \pi \cdot R8\_75k \cdot \left(\frac{fs}{2}\right)}$$

$$Cp(fs) := \frac{1}{2 \cdot \pi \cdot R8\_100k \cdot \left(\frac{fs}{2}\right)}$$

$$Cp(fs) := \frac{1}{2 \cdot \pi \cdot R8\_125k \cdot \left(\frac{fs}{2}\right)}$$

$Cp(75000 \cdot Hz) = 2.644 \cdot 10^{-10}\ F$

$C8\_75k := Cp(75000 \cdot Hz)$

$C8\_75k = 2.644 \cdot 10^{-10}\ F$

$Cp(100000 \cdot Hz) = 1.983 \cdot 10^{-10}\ F$

$C8\_100k := Cp(100000 \cdot Hz)$

$C8\_100k = 1.983 \cdot 10^{-10}\ F$

$Cp(125000 \cdot Hz) = 1.586 \cdot 10^{-10}\ F$

$C8\_125k := Cp(125000 \cdot Hz)$

$C8\_125k = 1.586 \cdot 10^{-10}\ F$

$C8\_100k := 220 \cdot 10^{-12} \cdot F$ C8

$$Cz\_75k := \frac{1}{2 \cdot \pi \cdot fc \cdot R8\_75k}$$

$Cz\_75k = 5.949 \cdot 10^{-10}\ F$

$C9\_75k := Cz\_75k$

$$Cz\_100k := \frac{1}{2 \cdot \pi \cdot fc \cdot R8\_100k}$$

$Cz\_100k = 7.958 \cdot 10^{-10}\ F$

$$Cz\_125k := \frac{1}{2 \cdot \pi \cdot fc \cdot R8\_125k}$$

$Cz\_125k = 9.915 \cdot 10^{-10}\ F$

$C9\_125k := Cz\_125k$

$C9\_100k := 820 \cdot 10^{-12} \cdot F$ C9

Voltage Amplifier Loop

$$vopk := \frac{Pout \cdot \frac{1}{\eta 1}}{2 \cdot \pi \cdot 120 \cdot Hz \cdot C12 \cdot Vout}$$

$vopk = 27.913\ V$

$vopp := vopk \cdot 2$

$veapk := 0.015 \cdot (Veamax - Veamin)$

$veapk = 0.075\ V$

$Gvea := \frac{veapk}{vopp}$

$Gvea = 1.343 \cdot 10^{-3}$

$Rin := 4 \cdot 249 \cdot 10^{3} \cdot ohm$ Input resistance to be 1.0MEG

Set Output Voltage

$R2A := 249 \cdot 10^{3} \cdot ohm$ $R2B := 249 \cdot 10^{3} \cdot ohm$ R2

$R19A := R2A$ $R19B := R2B$

$Rin := 2 \cdot R2A + 2 \cdot R19A$ R19

$Rin = 9.96 \cdot 10^{5}\ \Omega$

$Rd := \frac{Vref \cdot Rin}{Vout - Vref}$

$Rd = 9.426 \cdot 10^{3}\ \Omega$

$Rd := 9.31 \cdot 10^{3} \cdot ohm$ R3 Actual resistor R3

$R3 := Rd$

$Cf := \frac{1}{2 \cdot \pi \cdot 120 \cdot Hz \cdot Gvea \cdot Rin}$

$Cf = 9.912 \cdot 10^{-7}\ F$

$C7 := 1 \cdot 10^{-6} \cdot F$ C7

$$Gps\_fc := \frac{Pout}{(Veamax - Veamin) \cdot Vout \cdot 2 \cdot \pi \cdot C12}$$

$Gps\_fc = 656.514\ Hz$

$$Gvea1\_75k := \frac{1}{2\cdot\pi\cdot Rin\cdot Cp(75000\cdot Hz)} \qquad Gvea1\_100k := \frac{1}{2\cdot\pi\cdot Rin\cdot C8\_100k} \qquad Gvea1\_125k := \frac{1}{2\cdot\pi\cdot Rin\cdot Cp(125000\cdot Hz)}$$

$Gvea1\_75k = 604.379\ Hz$ $Gvea1\_100k = 726.337\ Hz$ $Gvea1\_125k = 1.007\cdot 10^{3}\ Hz$

$Tv\_75k := Gps\_fc\cdot Gvea1\_75k$ $Tv\_100k := Gps\_fc\cdot Gvea1\_100k$ $Tv\_125k := Gps\_fc\cdot Gvea1\_125k$

$Tv\_75k = 3.968\cdot 10^{5}\circ Hz^{2}$ $Tv\_100k = 4.769\cdot 10^{5}\circ Hz^{2}$ $Tv\_125k = 6.613\cdot 10^{5}\circ Hz^{2}$

$fc\_75k := \sqrt{Tv\_75k}$ $fc\_100k := \sqrt{Tv\_100k}$ $fc\_125k := \sqrt{Tv\_125k}$

$fc\_75k = 629.907\ Hz$ $fc\_100k = 690.544\ Hz$ $fc\_125k = 813.207\ Hz$

$$Rf\_75k := \frac{1}{2\cdot\pi\cdot fc\_75k\cdot Cp(75000\cdot Hz)} \qquad Rf\_100k := \frac{1}{2\cdot\pi\cdot fc\_100k\cdot Cp(100000\cdot Hz)} \qquad Rf\_125k := \frac{1}{2\cdot\pi\cdot fc\_100k\cdot Cp(125000\cdot Hz)}$$

$Rf\_75k = 9.556\cdot 10^{5}\ \Omega$ $Rf\_100k = 1.162\cdot 10^{6}\ \Omega$ $Rf\_125k = 1.453\cdot 10^{6}\ \Omega$

$R7\_75k := Rf\_75k$ $R7\_100k := 0.909\cdot 10^{6}\cdot ohm$ $R7\_125k := Rf\_125k$

$R7\_75k = 9.556\cdot 10^{5}\ \Omega$ $R7\_100k = 9.09\cdot 10^{5}\ \Omega$ $R7\_125k = 1.453\cdot 10^{6}\ \Omega$

R7

$$Cz\_75k := \frac{1}{2\cdot\pi\cdot\frac{fc\_75k}{10}\cdot Rf\_75k} \qquad Cz\_100k := \frac{1}{2\cdot\pi\cdot\frac{fc\_100k}{10}\cdot Rf\_100k} \qquad Cz\_125k := \frac{1}{2\cdot\pi\cdot\frac{fc\_125k}{10}\cdot Rf\_125k}$$

$Cz\_75k = 2.644\cdot 10^{-9}\ F$ $Cz\_100k = 1.983\cdot 10^{-9}\ F$ $Cz\_125k = 1.347\cdot 10^{-9}\ F$

$C15\_75k := Cz\_75k$ $Cz\_100k = 1.983\cdot 10^{-9}\ F$ $C15\_125k := Cz\_125k$

$C15\_75k = 2.644\cdot 10^{-9}\ F$ $C15\_100k := 2.0\cdot 10^{-9}\ F$ $C15\_125k = 1.347\cdot 10^{-9}\ F$

C15

Set up UnderVoltage Lockout Divider

$V\_UVLO := 1.9 \cdot volt$

$Vo\_set := 500 \cdot volt$

$R5 := 4.12 \cdot 10^3 \cdot ohm$ R5

$Rtop := \frac{R5 \cdot (Vo\_set - V\_UVLO)}{V\_UVLO}$ Under Voltage R5.... R4/R20

$Rtop = 1.08 \cdot 10^6\ \Omega$

$Rtop\_4 := \frac{Rtop}{4}$

$Rtop\_4 = 2.7 \cdot 10^5\ \Omega$

$R4A := 267 \cdot 10^3 \cdot ohm$

$R4B := R4A$

$R20A := R4A$

$R20B := R4A$

$R4B = 2.67 \cdot 10^5\ \Omega$

$R20A = 2.67 \cdot 10^5\ \Omega$

$R20B = 2.67 \cdot 10^5\ \Omega$

R4AB and R20AB

Set up Over Voltage Divider

$V\_UVLO := 2.7 \cdot volt$

$Vo\_set := 900 \cdot volt$

$R51 := 7.87 \cdot 10^3 \cdot ohm$ R51

$Rtop := \frac{R51 \cdot (Vo\_set - V\_UVLO)}{V\_UVLO}$ Under Voltage R5.... R4/R20

$Rtop = 2.615 \cdot 10^6\ \Omega$

$Rtop\_4 := \frac{Rtop}{4}$

$Rtop\_4 = 6.539 \cdot 10^5\ \Omega$

$R50A := 267 \cdot 10^3 \cdot ohm$

$R50B := R50A$

$R50C := R50A$

$R50D := R50A$

R50A,B,C,C

$R50B = 2.67 \cdot 10^5\ \Omega$

$R50C = 2.67 \cdot 10^5\ \Omega$

$R50D = 2.67 \cdot 10^5\ \Omega$

MMSZ5223B – 7 – F

$VDD := 14 \cdot volt$

$Vz := 2.7 \cdot volt$

$Iz := 0.007 \cdot amp$

$$Rz := \frac{(VDD - Vz)}{Iz}$$

$Rz = 1.614 \cdot 10^3\ \Omega$

$$Pd := \frac{(VDD - Vz)^2}{Rz}$$

$Pd = 0.079\ W$

Device Summary

$R11 = 1 \cdot 10^{4}\ \Omega$ peak current limit

$R12 = 4.22 \cdot 10^{3}\ \Omega$ peak current limit

$C1 = 2.2 \cdot 10^{-10}\ F$ timing capacitor

$R1 = 2.7 \cdot 10^{4}\ \Omega$ timing resistor

$C4 := 0.01 \cdot 10^{-6} \cdot F$ soft start capacitor

$R5 = 4.12 \cdot 10^{3}\ \Omega$

$R4A = 2.67 \cdot 10^{5}\ \Omega$

$R4B = 2.67 \cdot 10^{5}\ \Omega$

$R20A = 2.67 \cdot 10^{5}\ \Omega$

$R20B = 2.67 \cdot 10^{5}\ \Omega$

UVL - Enable Divider

$R2A = 2.49 \cdot 10^{5}\ \Omega$

$R2B = 2.49 \cdot 10^{5}\ \Omega$

$R19A = 2.49 \cdot 10^{5}\ \Omega$

$R19B = 2.49 \cdot 10^{5}\ \Omega$

$R3 = 9.31 \cdot 10^{3}\ \Omega$

Voltage Set Divider

$R21A = 6.34 \cdot 10^{5}\ \Omega$

$R21B = 6.34 \cdot 10^{5}\ \Omega$

$R13A = 6.34 \cdot 10^{5}\ \Omega$

$R13B = 6.34 \cdot 10^{5}\ \Omega$

Setting IAC

$C6 = 3.9 \cdot 10^{-6}\ F$ Feed Forward

$R6 = 1.74 \cdot 10^{4}\ \Omega$ Feed Forward

$C8\_100k = 2.2 \cdot 10^{-10}\ F$ current amp pole

$C9\_100k = 8.2 \cdot 10^{-10}\ F$ current amp zero

$R8\_100k = 2 \cdot 10^{4}\ \Omega$ current amp zero

$C7 = 1 \cdot 10^{-6}\ F$ voltage amp pole

$C15\_100k = 2 \cdot 10^{-9}\ F$ voltage amp zero

$R7\_100k = 9.09 \cdot 10^{5}\ \Omega$ voltage zero

$R14 = 0.2\ \Omega$ current sense resistor

$R9 = 1 \cdot 10^{4}\ \Omega$ current sense feed

$R10 = 1 \cdot 10^{4}\ \Omega$ current sense feed

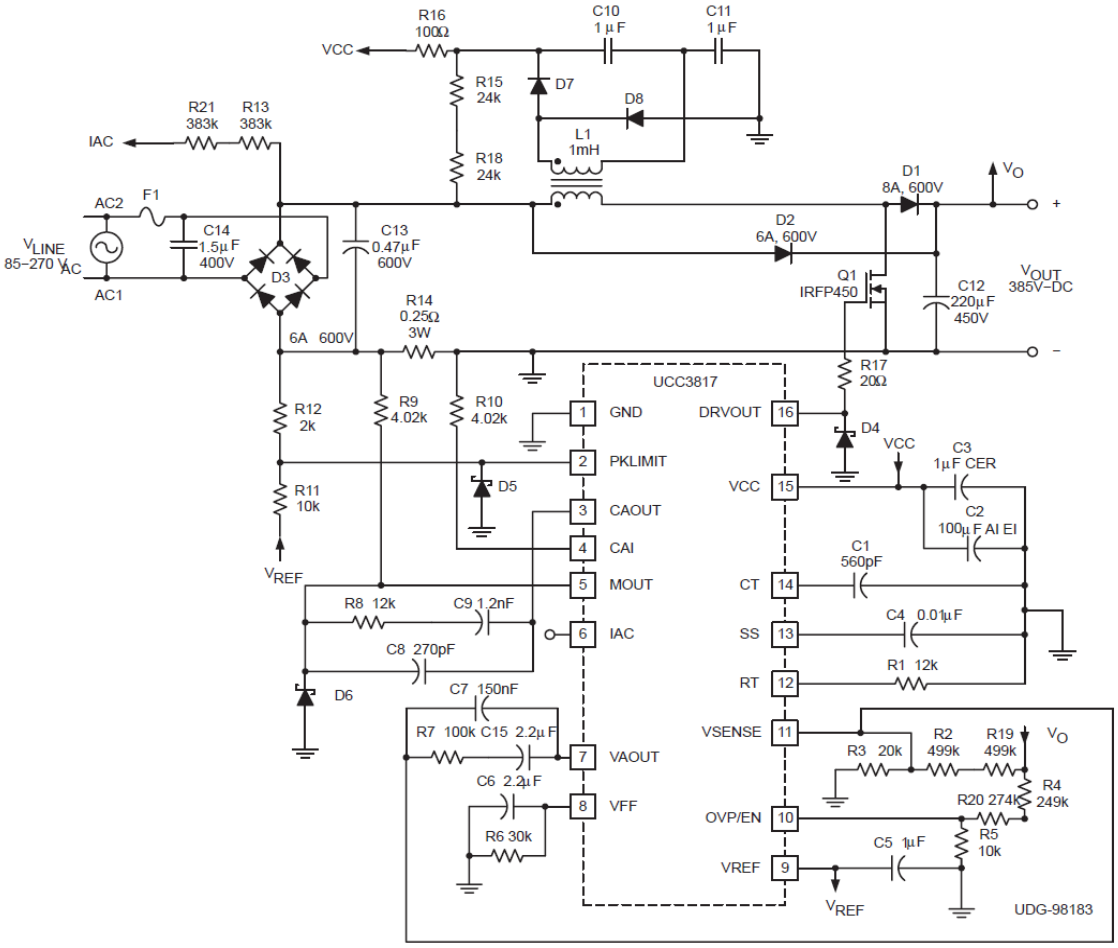
$R51 = 7.87 \cdot 10^{3}\ \Omega$

$R50A = 2.67 \cdot 10^{5}\ \Omega$

$R50B = 2.67 \cdot 10^{5}\ \Omega$ OVP Divider

$R50C = 2.67 \cdot 10^{5}\ \Omega$

$R50D = 2.67 \cdot 10^{5}\ \Omega$


R16
100Ω
C10
1 µF
C11
1 µF
VCC
R15
24k
D7
D8
L1
1mH
R18
24k
R21
383k
R13
383k
IAC
AC2
F1
VLINE
85–270 VAC
AC1
C14
1.5µF
400V
D3
C13
0.47µF
600V
D1
8A, 600V
VO
+
D2
6A, 600V
Q1
IRFP450
C12
220µF
450V
VOUT
385V–DC
–
R14
0.25Ω
3W
6A 600V
R17
20Ω
UCC3817
R12
2k
R9
4.02k
R10
4.02k
1 GND
DRVOUT 16
D4
2 PKLIMIT
VCC 15
VCC
C3
1µF CER
D5
C2
100µF AI EI
R11
10k
3 CAOUT
4 CAI
C1
560pF
VREF
5 MOUT
CT 14
R8 12k
C9 1.2nF
C4 0.01µF
6 IAC
SS 13
C8 270pF
R1 12k
RT 12
D6
C7 150nF
VSENSE 11
R3 20k
R2
499k
R19
499k
VO
R7 100k
C15 2.2µF
7 VAOUT
R4
249k
C6 2.2µF
8 VFF
R20 274k
OVP/EN 10
R6 30k
R5
10k
C5 1µF
VREF 9
VREF
UDG-98183