ON Semiconductor®

An Improved 2-Switch Forward Converter Application

Agenda

1. Generalities on forward converters
2. Core reset: tertiary winding, RCD clamp, 2-switch forward
3. Specs review of the NCP1252’s demo board
4. Power components calculation
5. NCP1252 components calculation
6. Closed-loop feedback: simulations and compensation
7. Demo board schematics & picture.
8. Board performance review
9. Conclusions

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Generalities About the 1-Switch Forward Converter

PROs

- It is a transformer-isolated buck-derived topology
- It requires a single transistor, ground referenced
- Non-pulsating output current reduces rms content in the caps

CONs

- Smaller power capability than a full or half-bridge topology
- Limited in duty-cycle (duty ratio) excursion because of core reset
- The drain voltage swings to twice the input voltage or more

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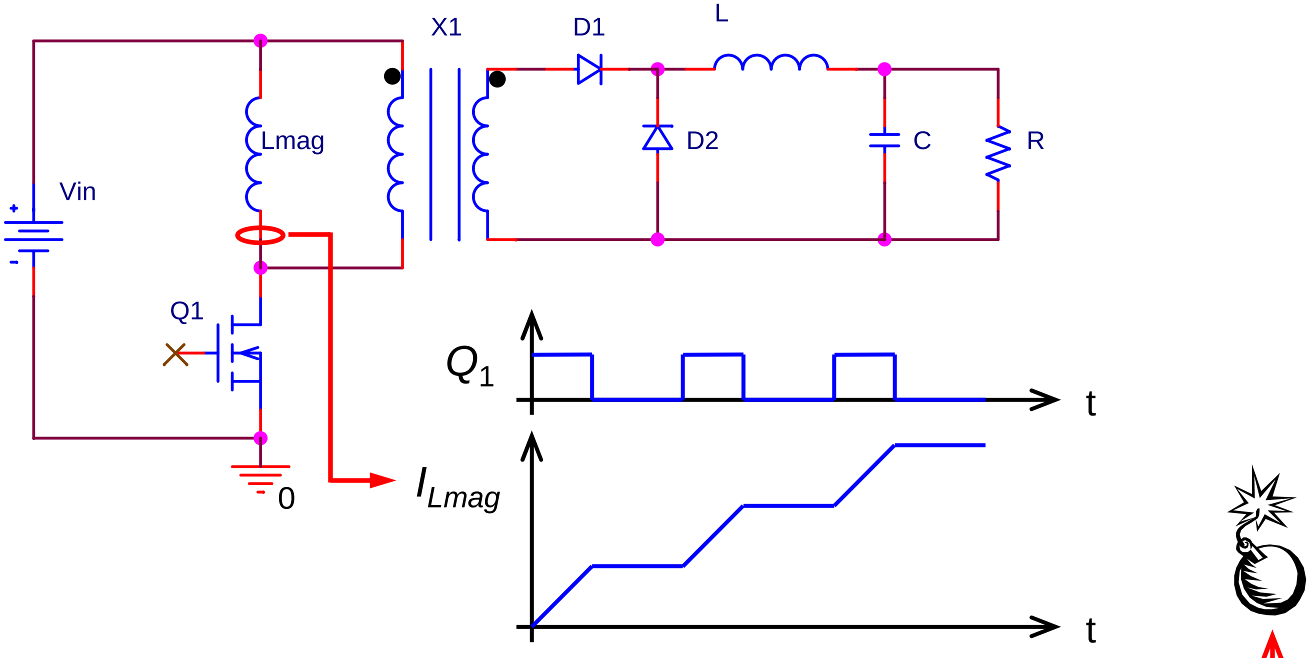
Transformer Core Reset: Why?

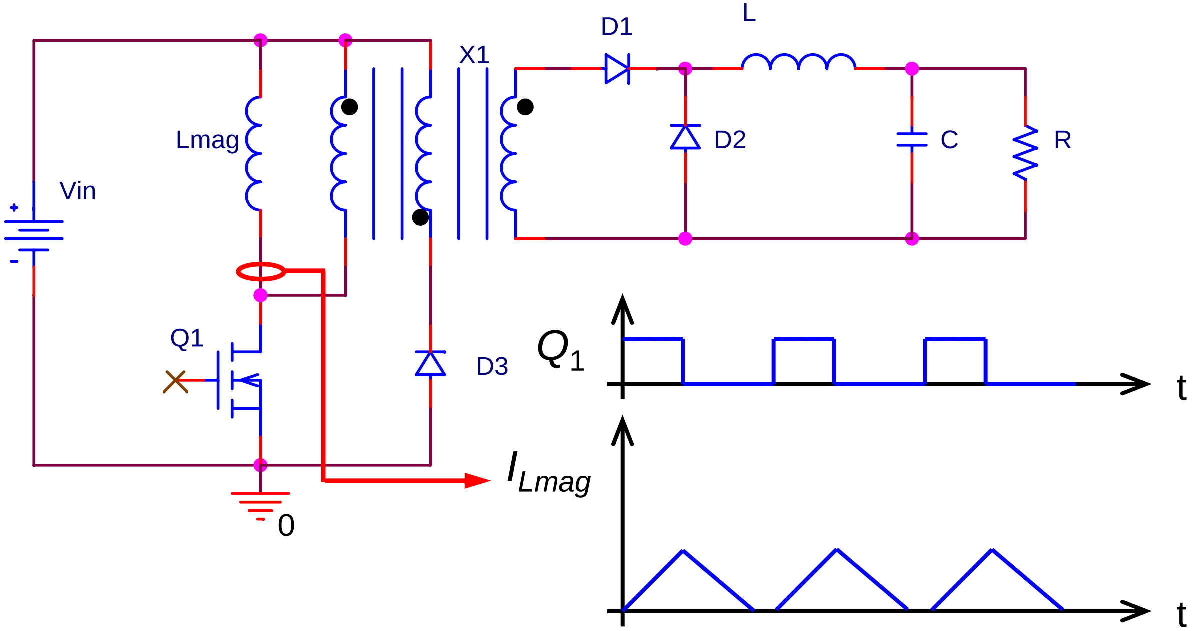
- ❑ Without transformer core reset:

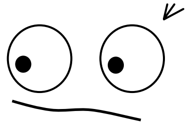


- ➢ The current builds up at each switching cycle
- ➢ It brings the core into saturation

Transformer Core Reset: Why?

❑ With transformer core reset:





- The current does not build up at each switching cycle
  - Volt-seconds average to zero during each cycle
- The voltage reverses over L_{mag} and resets it

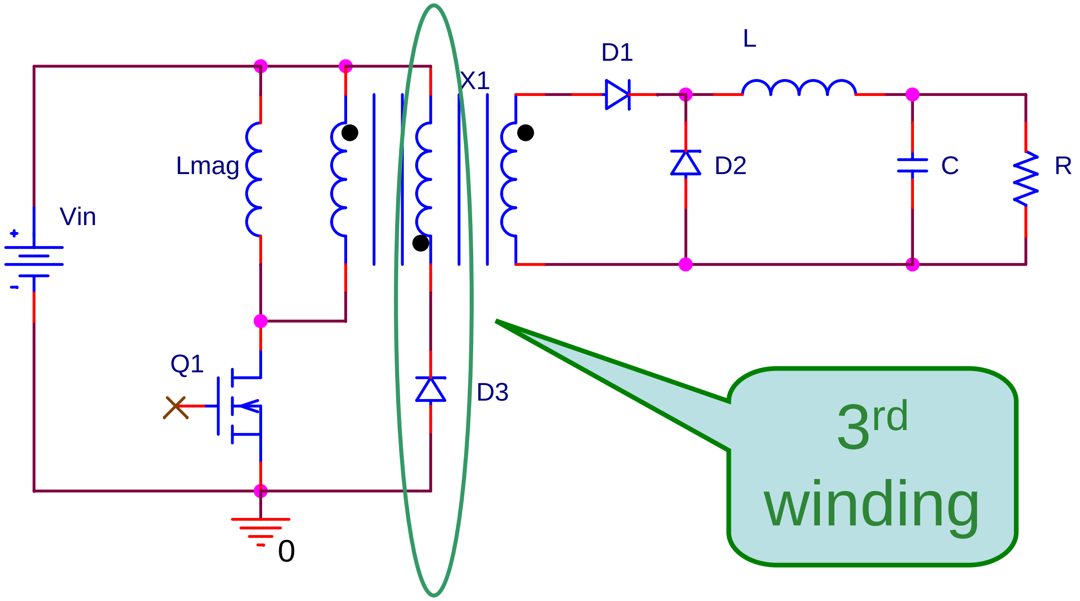
Core Reset Techniques: How ?

- Energy is stored in the magnetizing inductor
- This energy does not participate to the power transfer
    - It needs to be released to avoid flux walk away
- 3 common standard techniques for the core reset:
    - ✓ Tertiary winding
    - ✓ RCD clamp
    - ✓ 2-switch forward

Core Reset Techniques: Tertiary Winding

- Reset with the 3rd winding
  - ☺ Duty ratio can be > 50%

  But
  - ☹ Q_1 peak voltage can be $> 2 \bullet V_{in}$
  - ☹ 3rd winding for the transformer

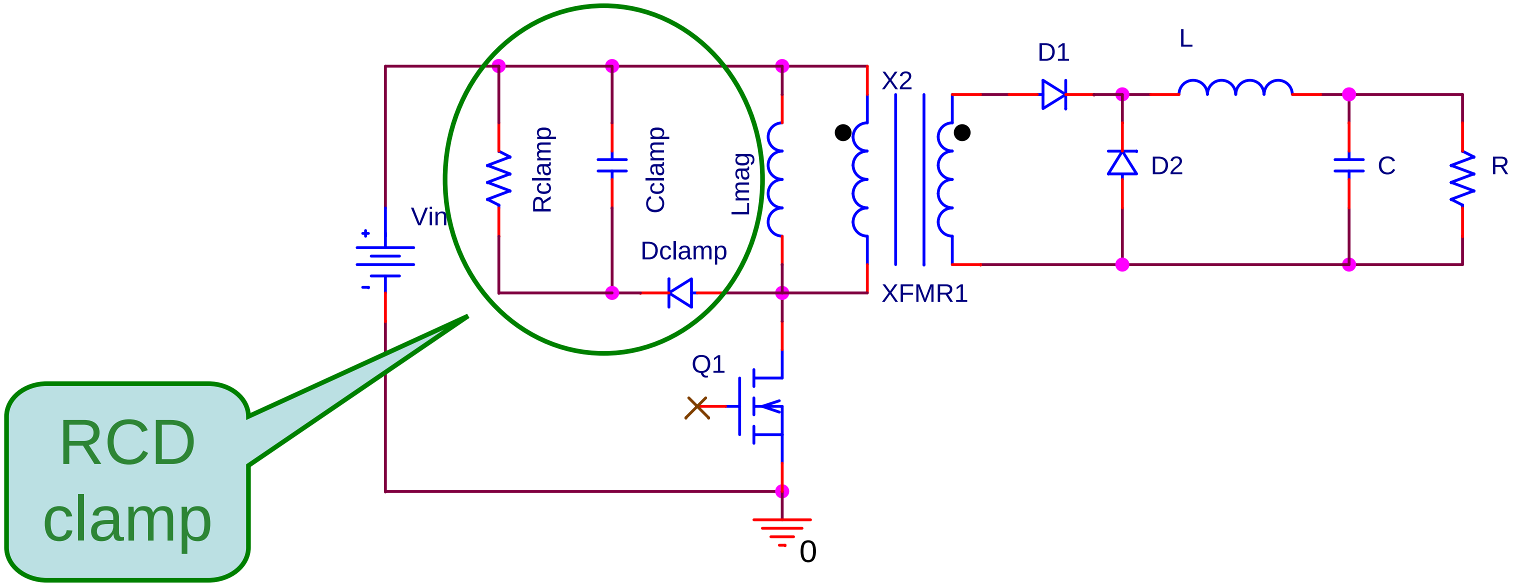


3rd winding

Core Reset Techniques: RCD Clamp

- Reset with RCD clamp
  - ☺ Duty ratio can be > 50%

  But
  - ☹ Writing equation and simulation are required for checking the correct reset
  - ☹ Lower cost than 3rd winding technique

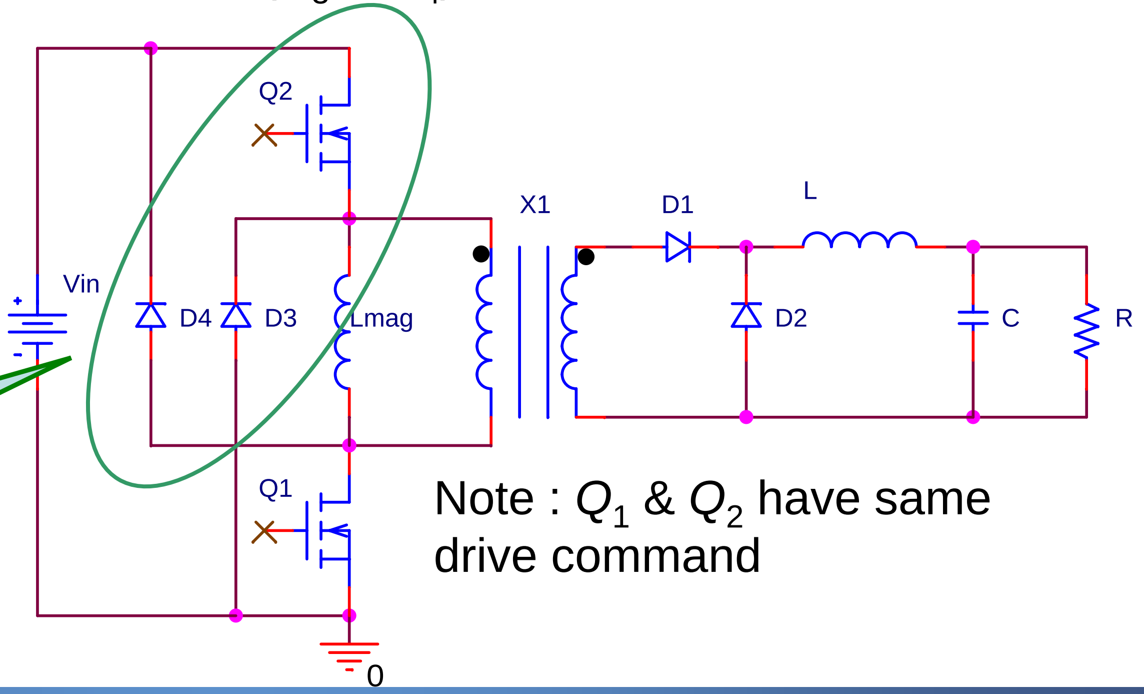


RCD clamp

Core Reset Techniques: 2-switch Forward

- Reset with a 2-switch forward
  - ☺ Easy to implement
  - ☺ Q_1 peak voltage is equal to V_{in}

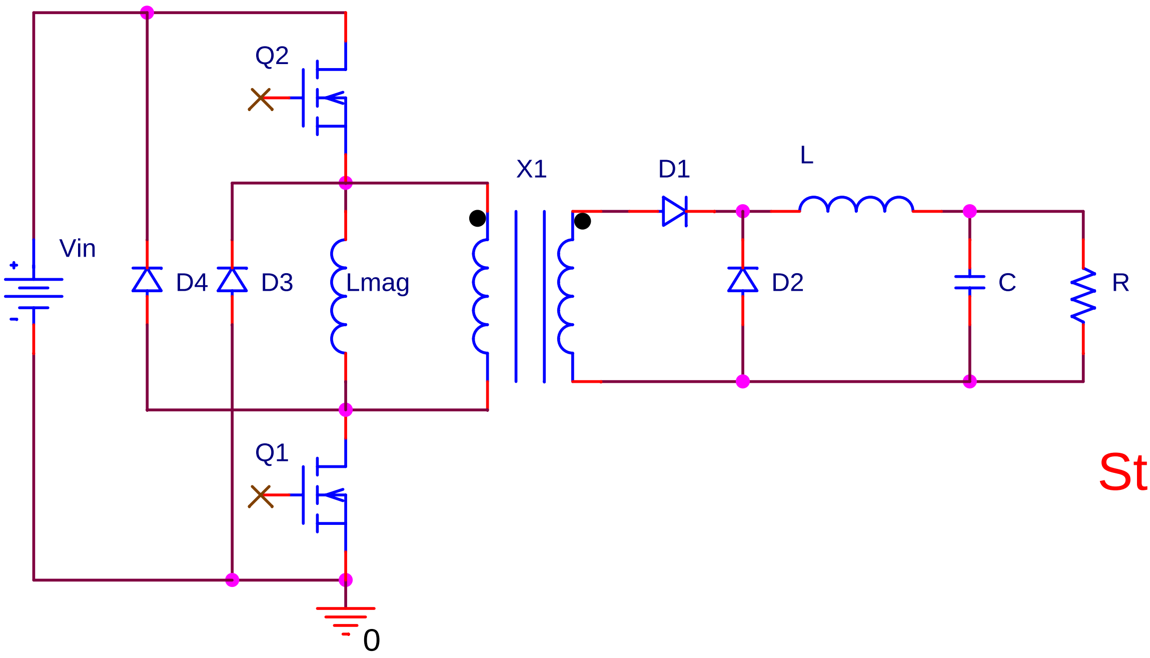
  But
  - ☹ Additional power MOSFET (Q_2) + high side driver
  - ☹ 2 High voltage, low power diodes (D_3 & D_4)

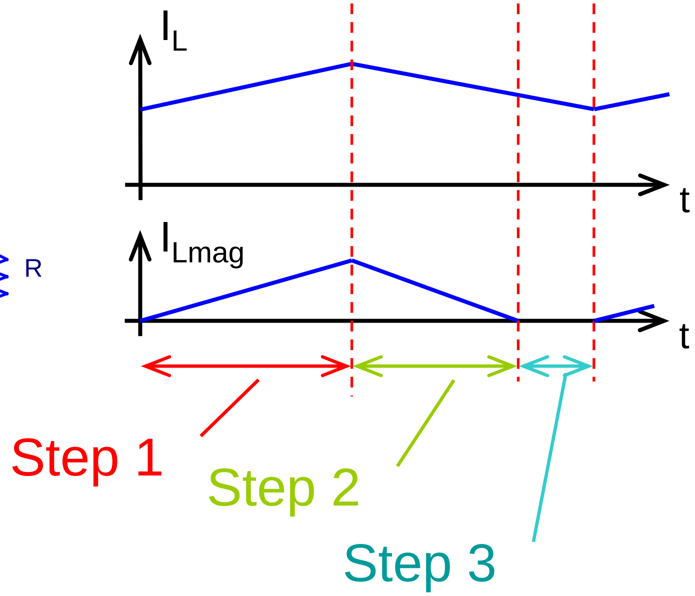


2-switch forward reset

Note : Q_1 & Q_2 have same drive command

2-Switch Forward: How Does It Works?





Note : Primary controller status

- “on time” : Step1
- “off time”: Step 2 + Step 3

	Q_1 & Q_2	D_1	D_2	D_3 & D_4
Step 1	ON	ON	OFF	OFF
Step 2	OFF	OFF	ON	ON
Step 3	OFF	OFF	ON	OFF

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NCP1252 – Fixed Frequency Controller Featuring Skip Cycle and Latch OCP

Value Proposition

The NCP1252 offers everything needed to build a cost-effective and reliable ac-dc switching power supply.

Unique Features

- Adjustable switching freq.
- Delayed operation upon startup
- Latched Short circuit protection timer based.
- skip cycle mode

Benefits

- Design flexibility
- independent of the aux. winding
- Allow temporary over load and latch permanent fault
- Achieve real no load operation

Others Features

- Adjustable soft start duration
- Internal ramp compensation
- Auto-recovery brown-out detection
- Vcc up to 28 V with auto-recovery UVLO
- Frequency jittering ±5% of the switching frequency
- Duty cycle 50% with A Version, 80% with B version

Market & Applications

- ATX Power supply
- AC adapters

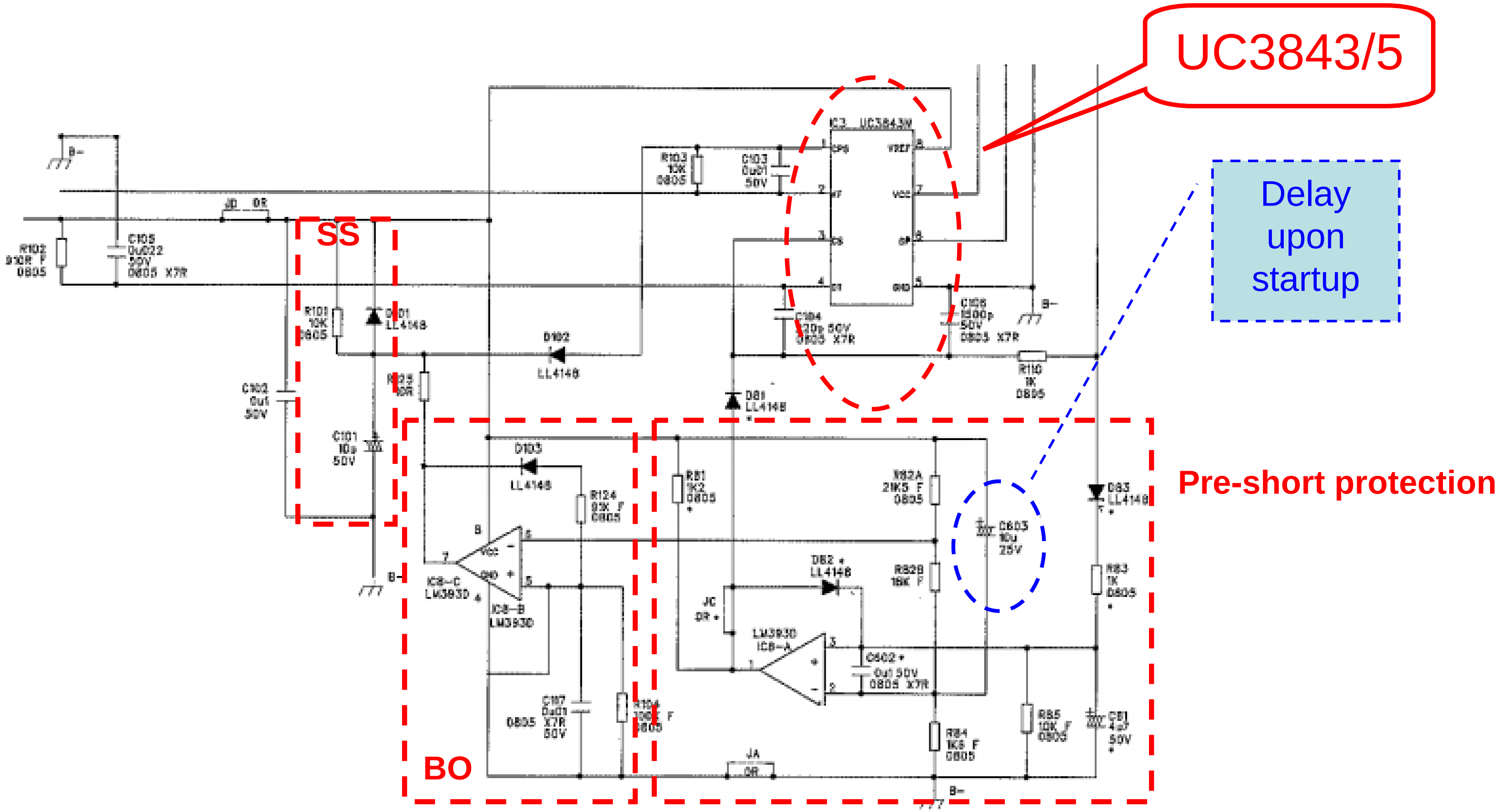
Main differences with the UC384X series

	NCP1252	**UC3843/5**
Startup current	< 100 µA	500 µA
Leading Edge Blanking (LEB)	Yes	No
Internal Ramp Compensation	Adj.	No
Frequency jittering	300 Hz, ±5%	No
Skip Cycle (light load behavior)	Yes	No
Brown-Out with shutdown feature	Yes	No
Pre-short protection	Latch-off, 15 ms delay	No
Delay on startup	120 ms	No
Soft start	Adj.	No
5 V voltage reference	No	Yes

Ordering & Package Information

- NCP1252ADR2G: 50% Duty Cycle SOIC8
- NCP1252BDR2G: 80% Duty Cycle SOIC8

UC3843/5 Application Exemple



UC3843/5

Delay upon startup

Pre-short protection

- ❑ UC384X does not include brown-out, soft-start and overload detection
- ➢ the external implementation cost of these functions is $0.07
- ❖ NCP1252 includes them all, reducing cost and improving reliability

Spec Review: NCP1252's Demo Board

- Input voltage range: 340-410 V dc
- Output voltage: 12 V dc, ± 5%
- Nominal output power: 96 W (8 A)
- Maximal output power: 120 W (5 seconds per minute)
- Minimal output power: real no load (no dummy load!)
- Output ripple : 50 mV peak to peak
- Maximum transient load step: 50% of the max load
- Maximum output drop voltage: 250 mV (from Iout = 50% to Full load (5 A ➔ 10 A) in 5 µs)

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Power Components Calculation: Transformer (1/3)

- Step 1: Turns ratio calculation in CCM:

$$V_{out} = \eta \cdot V_{bulk\,min} \cdot DC_{max} \cdot N$$

$$\Leftrightarrow \quad N = \frac{V_{out}}{\eta \cdot V_{bulk\,min} \cdot DC_{max}}$$

$$N = \frac{12}{0.9 \times 350 \times 0.45}$$

$$\boxed{N = 0.085}$$

Where:

- V_{out} is the output voltage
- η *is* the targeted efficiency
- $V_{bulkmin}$ is the min. input voltage
- DC_{max} is the max duty cycle of the NCP1252
- *N* is the transformer turn ratio

Power Components Calculation: Transformer (2/3)

- Step 2: Verification: Maximum duty cycle at high input line DC_{min} (Based on the previous equation)

$$V_{out} = \eta \cdot V_{bulk\,max} \cdot DC_{min} \cdot N$$

$$\Leftrightarrow \quad DC_{min} = \frac{V_{out}}{\eta \cdot V_{bulk\,max} \cdot N}$$

$$DC_{min} = \frac{12}{0.9 \times 410 \times 0.085}$$

$$\boxed{DC_{min} = 38.2\%}$$

Where:

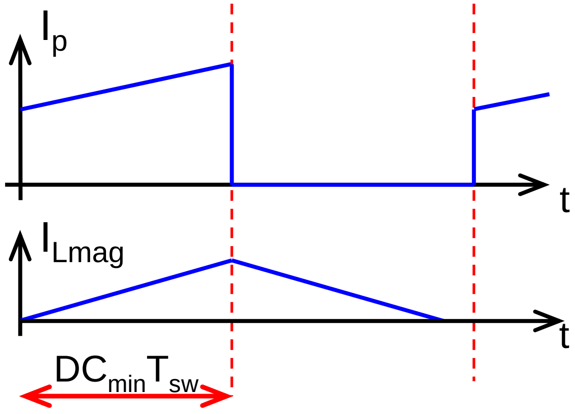
- V_{out} is the output voltage
- η is the targeted efficiency
- $V_{bulkmax}$ is the max. input voltage
- N is the transformer turn ratio

Power Components Calculation: Transformer (3/3)

- Step 3: Magnetizing inductor value.
  - For resetting properly the core, a minimal magnetizing current is needed to reverse the voltage across the winding.
    - (Enough energy must be stored so to charge the capacitance)
  - Rule of thumb: Magnetizing current = 10% primary peak current

    (➔ $I_{Lmag\_pk} = 10\%\ I_{p\_pk}$)

$$L_{mag} = \frac{V_{bulk\_min}}{\dfrac{10\% I_{p\_pk}}{T_{ON}}} = \frac{350}{\dfrac{0.1 \times 0.94}{\dfrac{0.45}{125k}}} = \boxed{13.4\ \text{mH}}$$



Power Components Calculation: LC Output Filter (1/4)

- Step 1: Crossover frequency (f_c) selection
  - arbitrarily selected to 10 kHz.
  - $f_c > 10$ kHz requires noiseless layout due to switching noise (difficult). Crossover at higher frequency is not recommended
- Step 2: C_{out} & R_{ESR} estimation
  - If we consider a $\Delta V_{out} = 250$ mV dictated by f_c, C_{out} & ΔI_{out}, we can write the following equation:

$$\begin{array}{l} C_{out} \ge \dfrac{\Delta I_{out}}{2\pi f_c \Delta V_{out}} \ge \dfrac{5}{2\pi \times 10\text{k} \times 0.25} \Rightarrow \\[2ex] \mathrm{R}_{\mathrm{ESR}} \le \dfrac{1}{2\pi f_c C_{out}} \le \dfrac{1}{2\pi \times 10\text{k} \times 318\mu} \Rightarrow \end{array} \boxed{\begin{array}{l} C_{out} \ge 318\,\mu\text{F} \\[2ex] R_{ESR} \le 50\, m\Omega \end{array}}$$

Where:

- f_c crossover frequency
- ΔI_{out} is the max. step load current
- ΔV_{out} is the max. drop voltage @ ΔI_{out}

Power Components Calculation: LC Output Filter (2/4)

- Step 3: Capacitor selection dictated by ESR rather than capacitor value:
  - Selection of 2x1000 µF, FM capacitor type @ 16 V from Panasonic.
  - Extracted from the capacitor spec:
    - $I_{c,rms}$ = 5.36 A (2*2.38 A) @ T_A = +105 °C
    - $R_{ESR,low}$ = 8.5 mΩ (19 mΩ/2) @ T_A = +20 °C
    - $R_{ESR,high}$ = 28.5 mΩ (57 mΩ/2) @ T_A = -10 °C
  - ΔV_{out} calculation @ ΔI_{out} = 5 A
    - $\Delta V_{out} = \Delta I_{out} R_{ESR,max} = 5 \times 28.5m = \boxed{142 \text{ mV}}$

Is acceptable given a specification at 250 mV

Tips: Rule of thumb: $R_{ESR,high} \square \dfrac{ESR(step\ 2)}{2}$

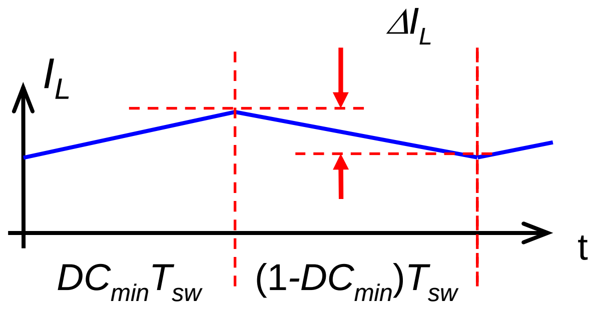
Power Components Calculation: LC Output Filter (3/4)

- Step 4: Maximum peak to peak output current

$$\Delta I_L \le \frac{V_{ripple}}{R_{ESR,max}} \le \frac{50m}{22m} \boxed{\le 2.27\ \mathrm{A}}$$

$R_{ESR,max}$ = 22 mΩ @ 0 ° C

- Step 5: Inductor value calculation



$$\Delta I_L \ge \frac{V_{out}}{L}\left(1 - DC_{min}\right)T_{sw}$$

$$\Leftrightarrow \quad L \ge \frac{V_{out}}{\Delta I_L}\left(1 - DC_{min}\right)T_{sw} = \frac{12}{2.27}\left(1 - 0.38\right)\frac{1}{125k}$$

$$\boxed{L \ge 26\ \mu\mathrm{H}}$$

  - Let select a standardized value of 27 µH

Power Components Calculation: LC Output Filter (4/4)

- Step 6: rms current in the output capacitor

$$I_{C_{out},rms} = I_{out}\frac{1-DC_{min}}{\sqrt{12\tau_L}} = 10\times\frac{1-0.38}{\sqrt{12\times 2.813}}\boxed{= 1.06\text{ A}}$$

$$\text{where}\quad \tau_{\text{L}} = \frac{L_{out}}{\dfrac{V_{out}}{I_{out}}\,\dfrac{1}{F_{sw}}} = \frac{27\mu}{\dfrac{12}{10}\,\dfrac{1}{125k}} = 2.813$$

Note: τ_{L} is the normalized inductor time constant

$\boxed{I_{Cout,rms}\ (1.06\text{ A}) < I_{C,rms}\ (5.36\text{ A})}$ ➔ No need to adjust or change the output capacitors

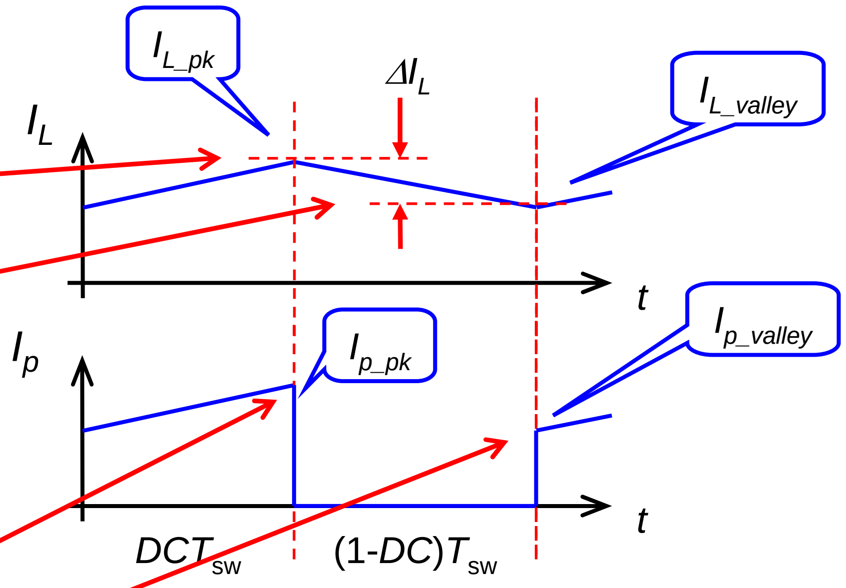
Power Components Calculation: Transformer Current

- RMS current on primary and secondary side
  - secondary currents:

$$I_{L\_pk} = I_{out} + \frac{\Delta I_L}{2} = 10 + \frac{2.27}{2} = \boxed{11.13\ \text{A}}$$

$$I_{L\_valley} = I_{L\_pk} - \Delta I_L = 11.13 - 2.27 = \boxed{8.86\ \text{A}}$$

  - Primary current can calculated by multiplying the secondary current with the turns ratio:



$$I_{p\_pk} = I_{L\_pk} N = 11.13 \times 0.085 \boxed{= 0.95\ \text{A}}$$

$$I_{p\_valley} = I_{L\_valley} N = 8.86 \times 0.085 \boxed{= 0.75\ \text{A}}$$

$$\Rightarrow I_{p,rms} = \sqrt{DC_{max}\left(\left(I_{p\_pk} + 10\%\right)^2 - \left(I_{p\_pk} + 10\%\right)\Delta I_L N + \frac{\left(\Delta I_L N\right)^2}{3} \right)} \boxed{= 0.63\ \text{A}}$$

Note: $I_{p,rms}$ has been calculated by taking into account the magnetizing current (10% of I_{p_pk}).

Power Components Calculation: MOSFET (1/3)

- With a 2-switch forward converter ➔ max voltage on power MOSFET is limited to the input voltage
- Usually a derating factor is applied on drain to source breakdown voltage (BV_{DSS}) equal to 15%.
- If we select a 500-V power MOSFET type, the derated max voltage should be 425 V (500 V x 0.85).
- FDP16N50 has been selected:
  - Package TO220
  - $BV_{DSS} = 500$ V
  - $R_{DS(on)} = 0.434\ \Omega$ @ $T_j = 110$ °C
  - Total Gate charge: $Q_G = 45$ nC
  - Gate drain charge: $Q_{GD} = 14$ nC

Power Components Calculation: MOSFET (2/3)

- Losses calculation:
  - Conduction losses:

$$P_{cond} = I_{p,rms,10\%}{}^{2} R_{DS(on)} @ T_j = 110°C = 0.632^2 \times 0.434 = \boxed{173\text{ mW}}$$

  - Switch ON losses:

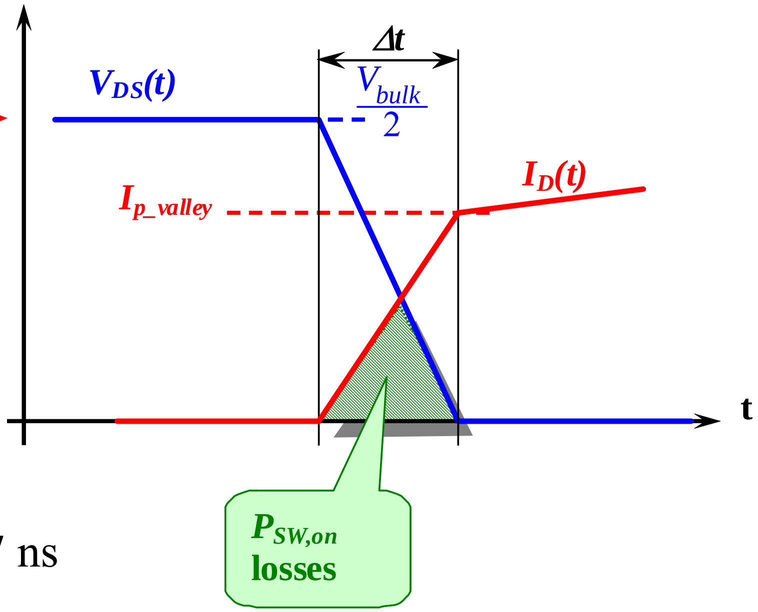
$$P_{SW,on} = F_{sw}\int_0^{\Delta t} I_D(t)V_{DS}(t)\,dt$$

$$= \frac{I_{p\_valley}\frac{V_{bulk}}{2}\Delta t}{6}F_{sw} = \frac{I_{p\_valley}V_{bulk}\Delta t}{12}F_{sw}$$

$$P_{SW,on} = \frac{0.75\times 410\times 46.7n}{12}\times 125k = \boxed{149\text{ mW}}$$

Overlap (Δ_t) is extracted from

$$\Delta_t = \frac{Q_{GD}}{I_{DRV\_pk}} = \frac{14n}{0.3} = 46.7\text{ ns}$$



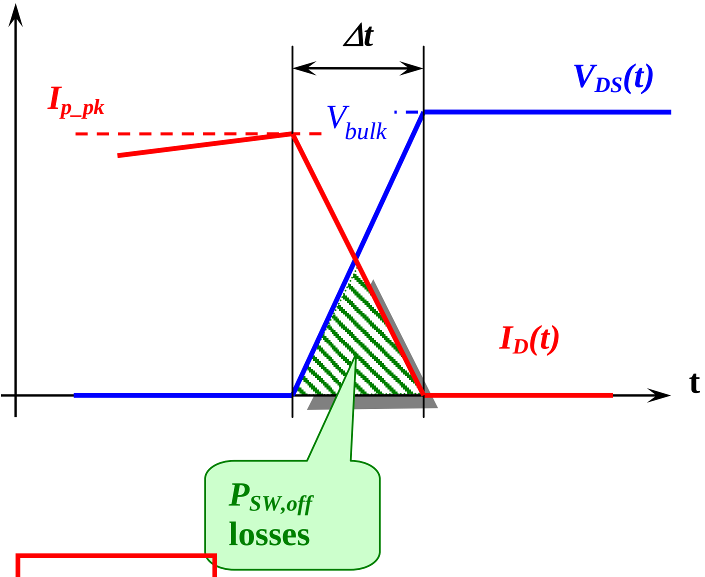
Power Components Calculation: MOSFET (3/3)

- Switch OFF losses: based on the same equation of switch ON

$$P_{SW,off} = \frac{I_{p\_valley} V_{bulk,\max} \Delta t}{6} F_{sw} = \frac{1.04 \times 410 \times 40n}{6} \times 125k = \boxed{355\ mW}$$

Overlap (Δ_t) is extracted from

$$\Delta_t = \frac{Q_{GD}}{I_{DRV\_pk}} = \frac{14n}{0.35} = 40\ \text{ns}$$



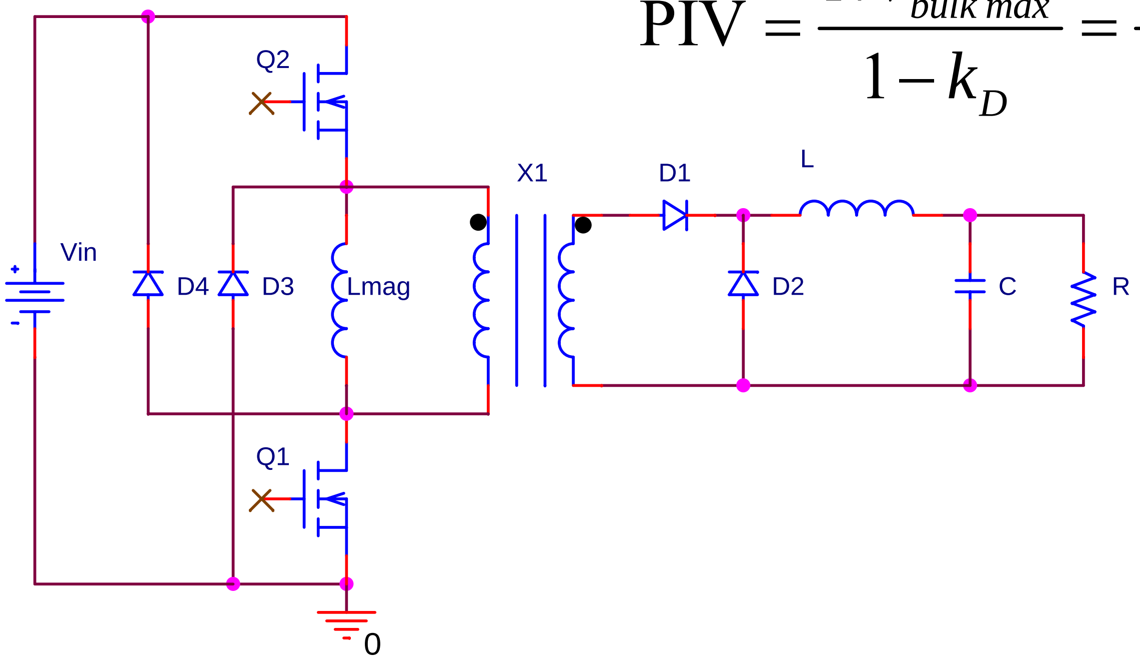
- Total losses:

$$P_{losses} = P_{cond} + P_{SW,on} + P_{SW,off} = 173 + 149 + 355 = \boxed{677\ \text{mW}}$$

Power Components Calculation: Diode (1/2)

- Secondary diodes: D_1 and D_2 sustain same Peak Inverse Voltage (PIV):
  - Where k_D is derating factor of the diodes (40%)

$$\mathrm{PIV} = \frac{NV_{bulk\,max}}{1-k_D} = \frac{0.085\times 410}{0.6} = \boxed{58\ \mathrm{V}}$$



PIV < 100 V ➔ Schottky diode can be selected: MBRB30H60CT (30 A, 60 V in TO-220)

Power Components Calculation: Diode (2/2)

- Diode selection: MBRB30H60CT (30 A, 60 V in TO-220)
- Losses calculation:
  - During ON time : Worst case @ low line (DC_{max})

$$P_{cond,forward} = I_{out} V_f DC_{max}$$
$$= 10 \times 0.5 \times 0.45$$
$$= \boxed{2.25\ \mathrm{W}}$$

  - During OFF time : Worst case @ High line (DC_{min})

$$P_{cond,freewheel} = I_{out} V_f \left(1 - DC_{min}\right)$$
$$= 10 \times 0.5 \times \left(1 - 0.39\right)$$
$$= \boxed{3.05\ \mathrm{W}}$$

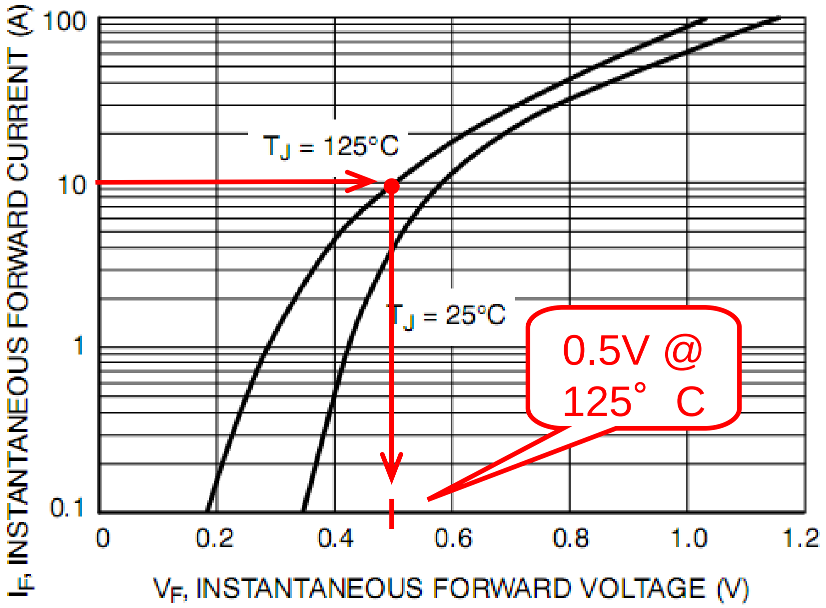


Figure 2. Maximum Forward Voltage

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NCP1252 Components Calculation: R_t

- Switching frequency selection: a simple resistor allows to select the switching frequency from 50 to 500 kHz:

$$R_t = \frac{1.95 \times 10^9 V_{R_t}}{F_{sw}}$$

If we assume F_{sw} = 125 kHz

$$R_t = \frac{1.95 \times 10^9 \times 2.2}{125k} = \boxed{34.3\ k\Omega}$$

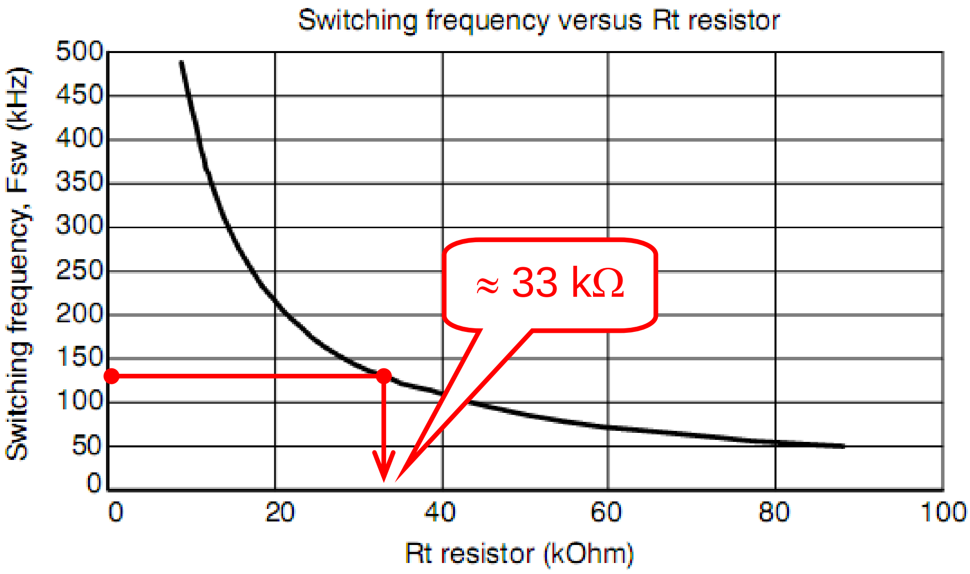


Figure 10. Switching Frequency Selection

Where:

- V_{Rt} is the internal voltage reference (2.2 V) present on R_t pin

NCP1252 Components Calculation: Sense Resistor

- NCP1252 features a max peak current sensing voltage to 1 V.
- The sense resistor is computed with 20% margin of the primary peak current ($I_{p,rms,20\%}$): 10% for the magnetizing current + 10% for overall tolerances.

$$R_{sense} = \frac{F_{CS}}{I_{p\_pk} + 20\%} = \frac{1}{0.946 \times 1.2} = 884\ \text{m}\Omega$$

$$P_{R_{sense}} = R_{sense} I_{p,rms+20\%}{}^{2} = 0.884 \times 0.695^{2} = 427\ \text{mW}$$

If we select 1206 SMD type of resistor, we need to place 2 resistors in parallel to sustain the power: 2 x 1.5 Ω.

Where:

- I_{p_pk} is the primary peak current
- $I_{p,rms,20\%}$ is the primary rms current with a 20% margin on the peak current

NCP1252 Components Calculation: Ramp Compensation (1/5)

- Ramp compensation prevents sub-harmonic oscillation at half of the switching frequency, when the converter works in CCM and duty ratio close or above 50%.
- With a forward it is important to take into account the natural compensation due to magnetizing inductor.
- Based on the requested ramp compensation (usually 50% to 100%), only the difference between the ramp compensation and the natural ramp could be added externally
  - Otherwise the system will be over compensated and the current mode of operation can be lost, the converter will work more like a voltage mode than current mode of operation.

NCP1252 Components Calculation: Ramp Compensation (2/5)

- How to build it?

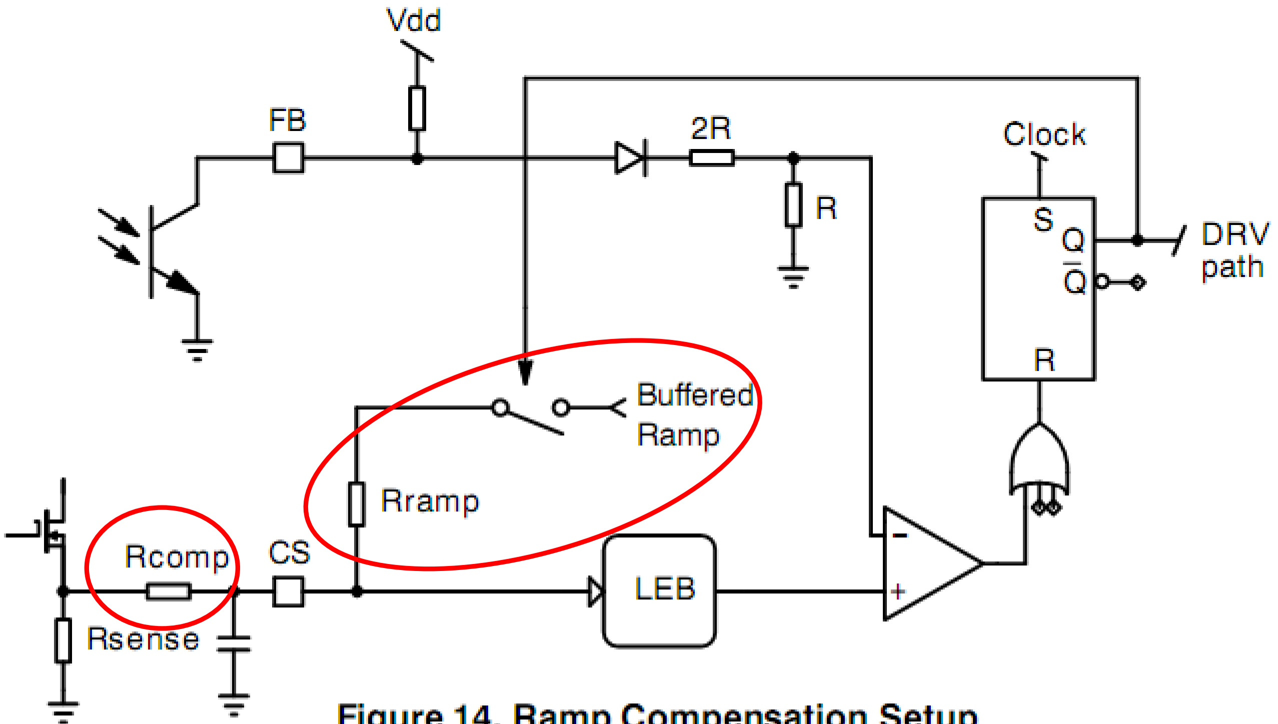


Figure 14. Ramp Compensation Setup

Where:

- V_{ramp} = 3.5 V, Internal ramp level.
- R_{ramp} = 26.5 kΩ, Internal pull-up resistance

NCP1252 Components Calculation: Ramp Compensation (3/5)

- Calculation: Targeted ramp compensation level: 100%
  - Internal Ramp:

$$S_{\text{int}} = \frac{V_{ramp}}{DC_{\max}} F_{sw} = \frac{3.5}{0.50} 125k = \boxed{875\ \text{mV}/\mu\text{s}}$$

  - Natural primary ramp

$$S_{natural} = \frac{V_{bulk}}{L_{mag}} R_{sense} = \frac{350}{13 \cdot 10^{-3}} 0.75 = \boxed{20.19\ \text{mV}/\mu\text{s}}$$

  - Secondary down slope

$$S_{sense} = \frac{(V_{out} + V_f)}{L_{out}} \frac{N_s}{N_p} R_{sense} = \frac{(12 + 0.5)}{27 \cdot 10^{-6}} 0.087 \times 0.75 = \boxed{30.21\ \text{mV}/\mu\text{s}}$$

  - Natural ramp compensation

$$\delta_{natural\_comp} = \frac{S_{natural}}{S_{sense}} = \frac{20.19}{30.21} = \boxed{66.8\%}$$

Where:

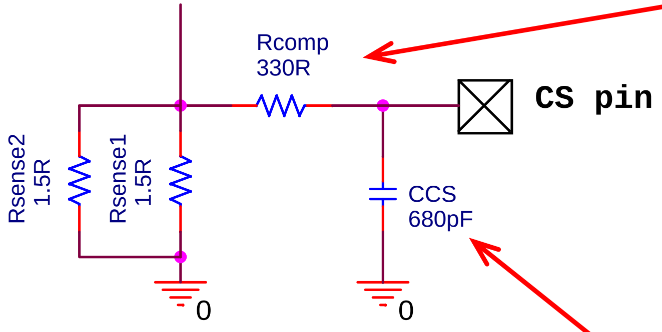
- V_{out} = 12 V
- L_{out} = 27 µH
- V_f = 0.5 V (Diode drop)
- R_{sense} : 0.75 Ω
- F_{sw} : 125 kHz
- $V_{bulk,min}$ = 350 V
- DC_{max} = 50%
- L_{mag} = 13 mH
- N = 0.087

NCP1252 Components Calculation: Ramp Compensation (4/5)

- As the natural ramp comp. (67%) is lower than the targeted 100% ramp compensation, we need to calculate a compensation of 33% (100-67).

$$Ratio = \frac{S_{sense}\left(\delta_{comp} - \delta_{natural\_comp}\right)}{S_{\text{int}}} = \frac{30.21(1.00-0.67)}{875} = \boxed{0.0114}$$

$$R_{comp} = R_{ramp}\frac{Ratio}{1-Ratio} = 26.5\cdot 10^{3}\,\frac{0.0114}{1-0.0114} = \boxed{305\ \Omega}$$



- $R_{comp}C_{CS}$ network filtering need time constant around 220 ns:

$$C_{CS} = \frac{\tau_{RC}}{R_{Comp}} = \frac{220n}{330} = \boxed{666\ pF}$$

NCP1252 Components Calculation: Ramp Compensation (5/5)

- Illustration of correct filtering on CS pin

✓ switching noise is filtered

✓ CS pin current information is not distorted

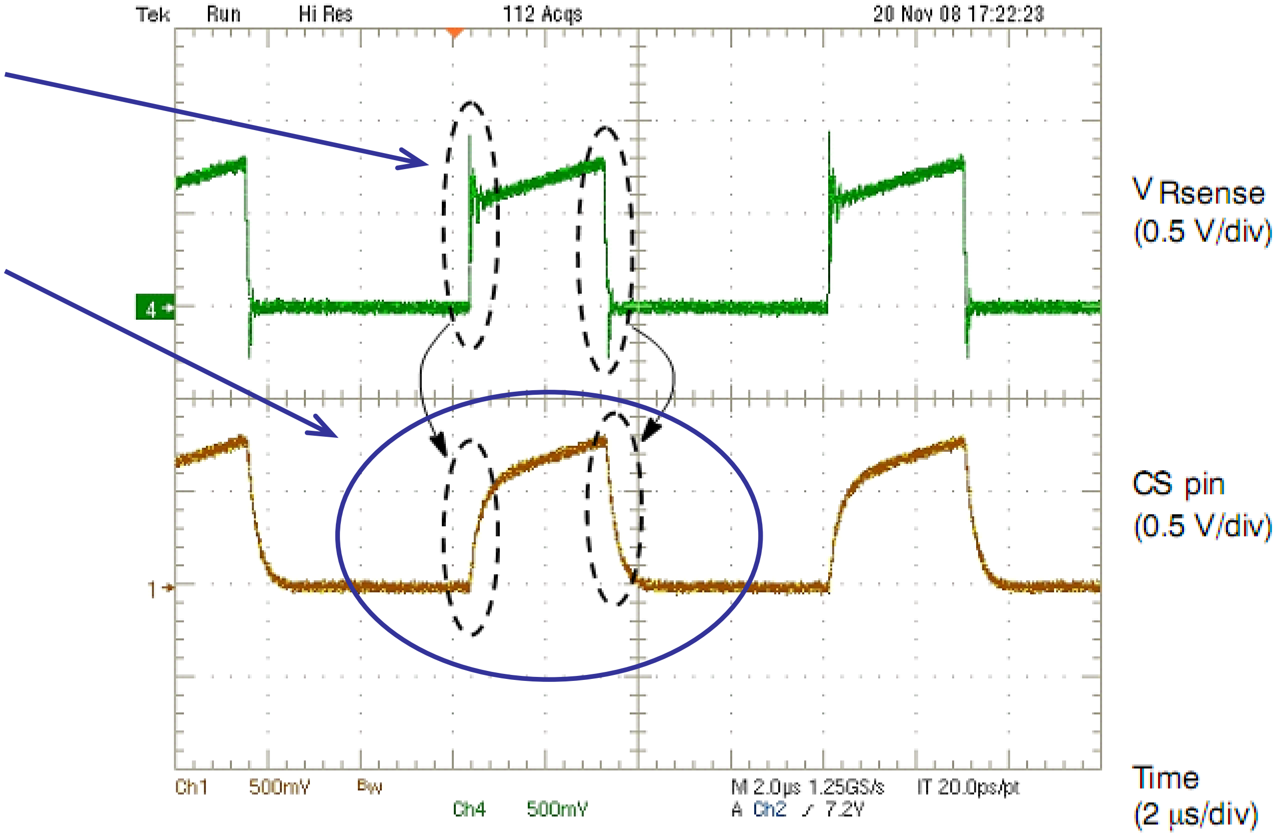


Figure 15. Comparison of the Voltage on the Current Sense Resistor and After the RC Filter

NCP1252 Components Calculation: Brown-Out

- Dedicated pin for monitoring the bulk voltage to protects the converter against low input voltage.

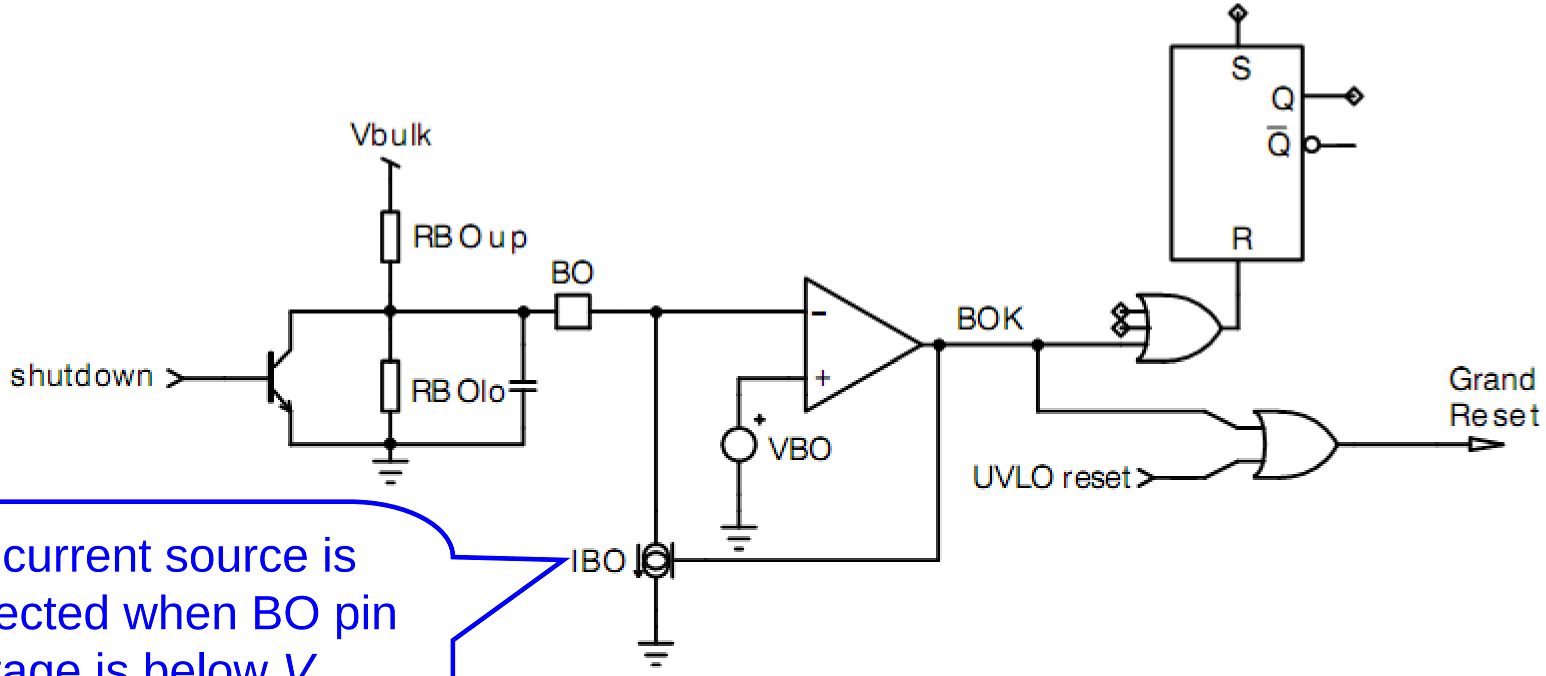


Figure 11. BO Pin Setup

I_{BO} current source is connected when BO pin voltage is below V_{BO} reference: ***its creates the BO hysteresis***

NCP1252 Components Calculation: Brown-Out

- From the previous schematic, we can extract the brown-out resistors

$$R_{BOlo} = \frac{V_{BO}}{I_{BO}}\left(\frac{V_{bulkon}-V_{BO}}{V_{bulkoff}-V_{BO}}-1\right) = \frac{1}{10\mu}\left(\frac{370-1}{350-1}-1\right) = 5731\,\Omega$$

$$\boxed{R_{BOlo} = 5.1\,\mathrm{k}\Omega + 680\,\Omega}$$

$$R_{BOup} = \frac{V_{bulkon}-V_{bulkoff}}{I_{BO}} = \frac{370-350}{10\mu} = 2.0\,\mathrm{M}\Omega$$

$$\boxed{R_{BOup} = 2\times 1\,\mathrm{M}\Omega}$$

Where :

- V_{bulkon} = 370 V, starting point level
- $V_{bulkoff}$ = 350 V, stopping point level
- V_{BO} = 1 V (fixed internal voltage reference)
- I_{BO} = 10 µA (fixed internal current source)

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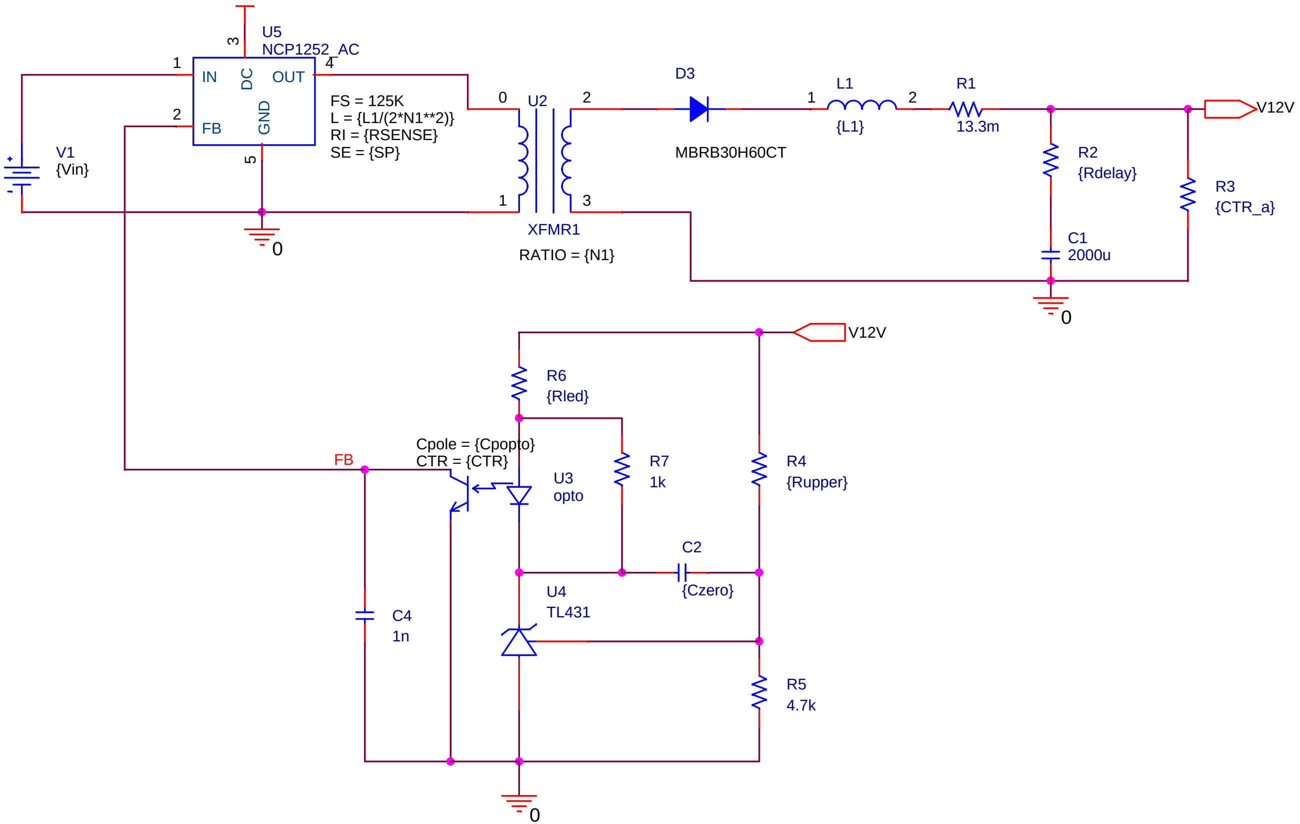
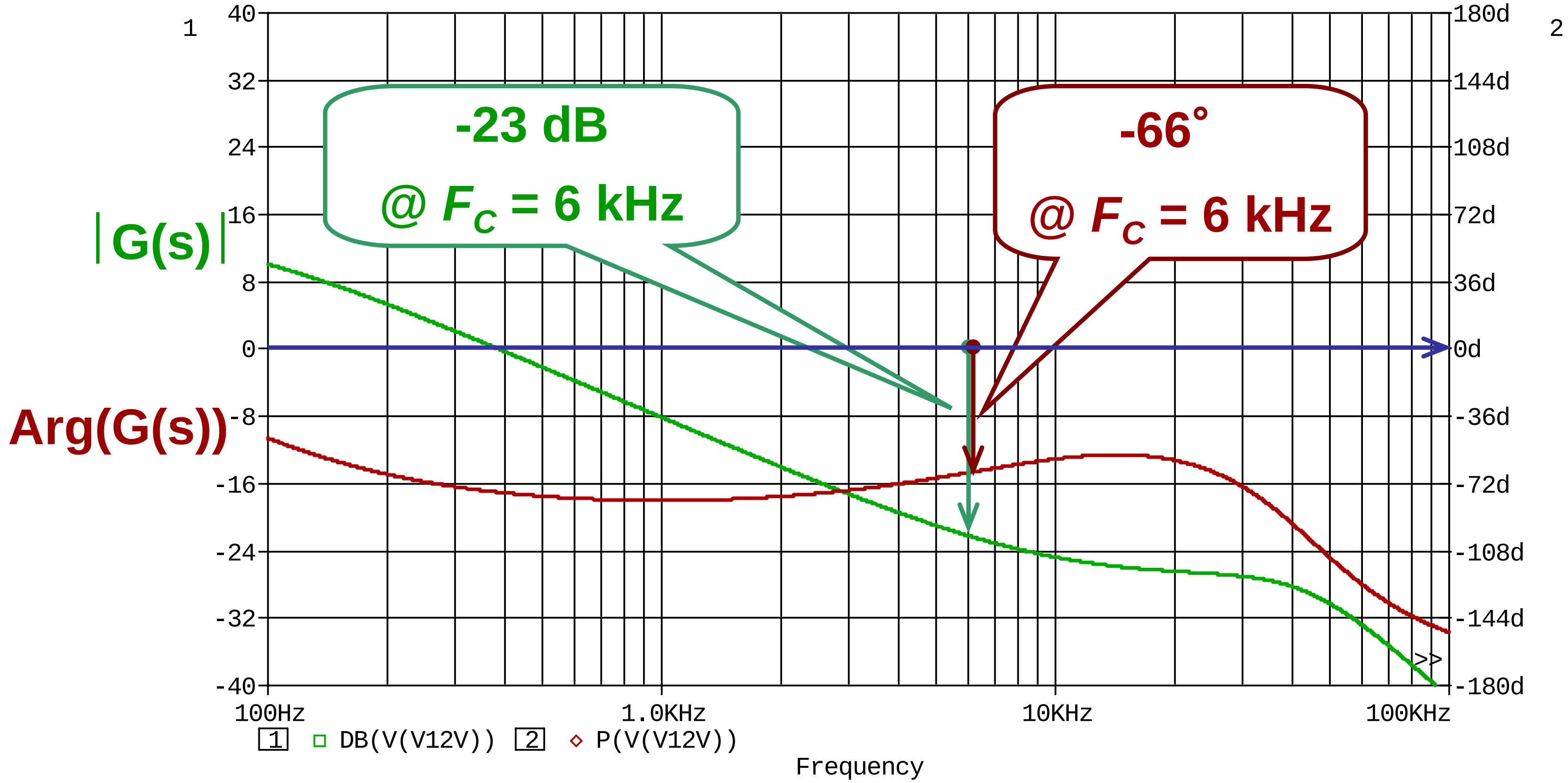
Small Signal Analysis: Model

- NCP1252’s small signal model is available for running and validating the closed loop regulation, as well as the step load response of the power supply with very fast simulation time.



Example of schematic for studying closed loop regulation

Small Signal Analysis: Power Stage



-23 dB

@ F_C = 6 kHz

-66°

@ F_C = 6 kHz

If we want a crossover @ F_c = 6 kHz, we need to measure:

➔ **|G(6 kHz)| = -23 dB**

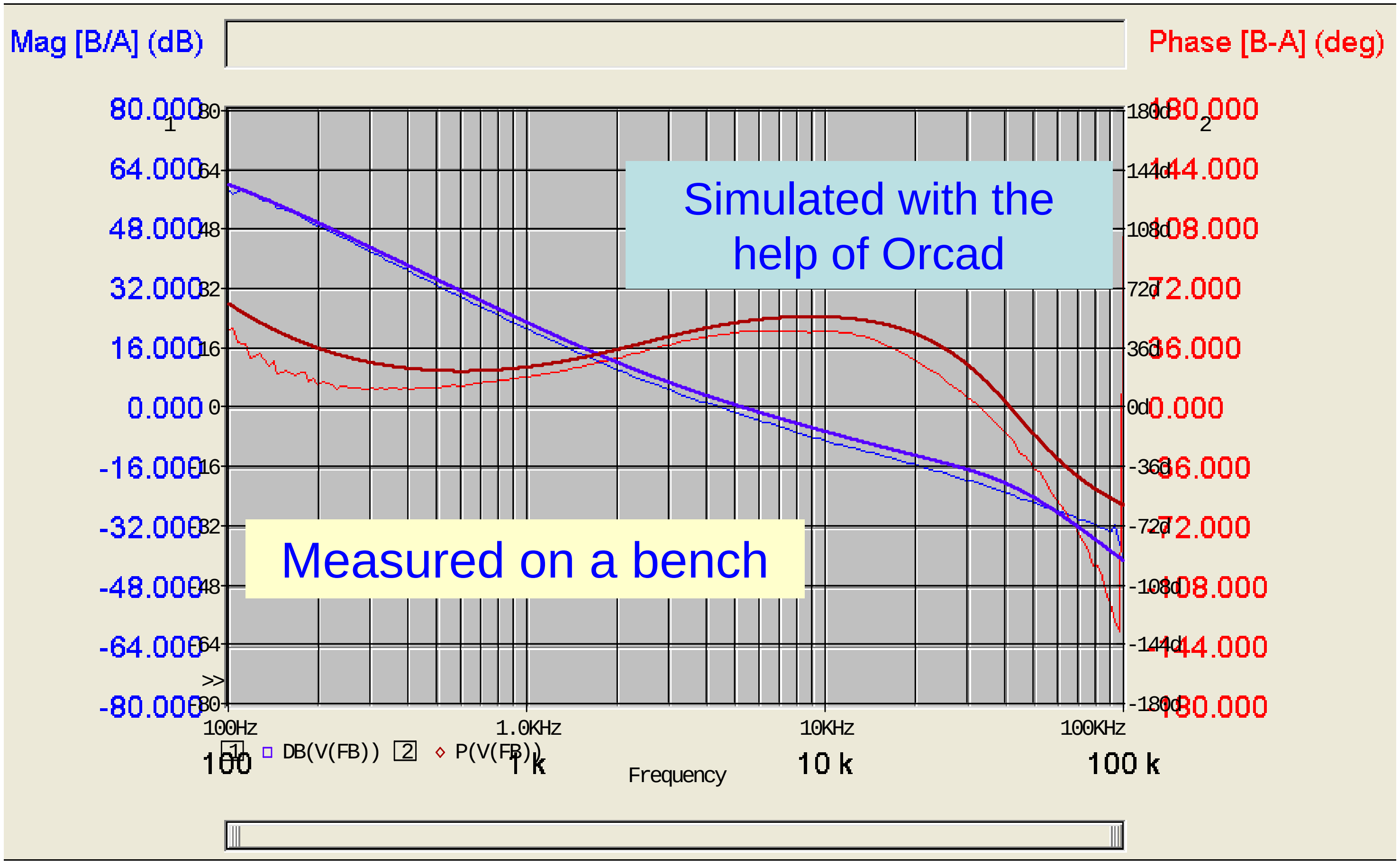
➔ **Arg(G(6 kHz)) = -66°**

Small Signal Analysis: Open Loop

After applying the K factor method @ F_c = 6 kHz and phase margin = 70° , with the help of an automated Orcad simulation, we obtain:

PARAMETERS:
Vout = 12V
L1 = 27u
L2 = {L1*(N2/N1)**2}
N1 = 0.0870
N2 = 0.0498
Rsense = 0.75
Rupper = {(Vout-2.5)/532u}
Fc = 6k
PM = 70
GFc = -25
PFc = -66
G = {10**(-GFc/20)}
boost = {PM-PFc-90}

K = {tan((boost/2+45)*pi/180)}
C2 = {1/(2*pi*Fc*G*K*Rupper)}
C1 = {C2*(PWR(K,2)-1)}
R2 = {K/(2*pi*Fc*C1)}
Fzero = {Fc/K}
Fpole = {K*Fc}
Rpullup = 4k
RLED = {CTR*Rpullup/G}
Czero = {1/(2*pi*Fzero*Rupper)}
Cpole = {1/(2*pi*Fpole*Rpullup)}
CTR = 0.7
Lmag = 12.3mH
Sp = {(Vin/Lmag)*Rsense}
Vin = 390V
Cfb = {Cpole-Cpopto}
Cpopto = 3nF

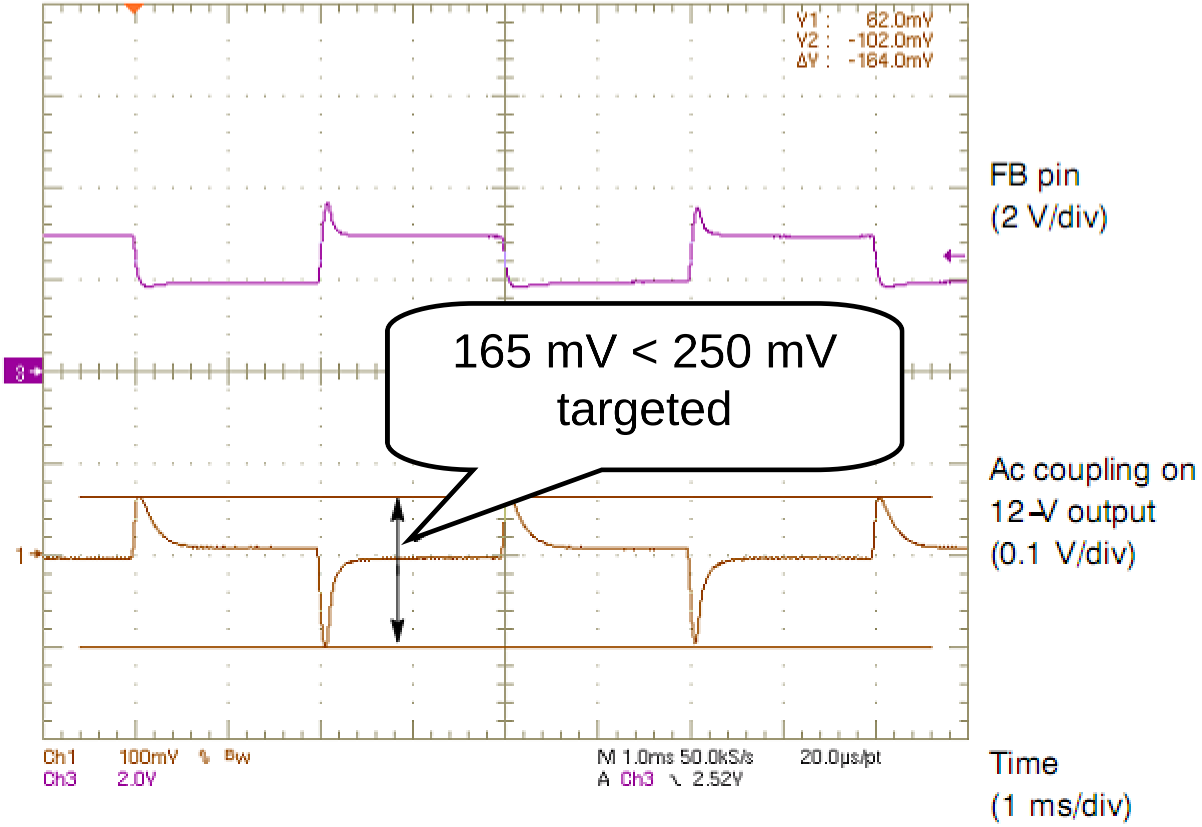


Simulated with the help of Orcad

Measured on a bench

Step Load Stability

Validation of the closed loop stability with a step load test



165 mV < 250 mV targeted

Figure 26. Step Load Response from 5 A to 10 A

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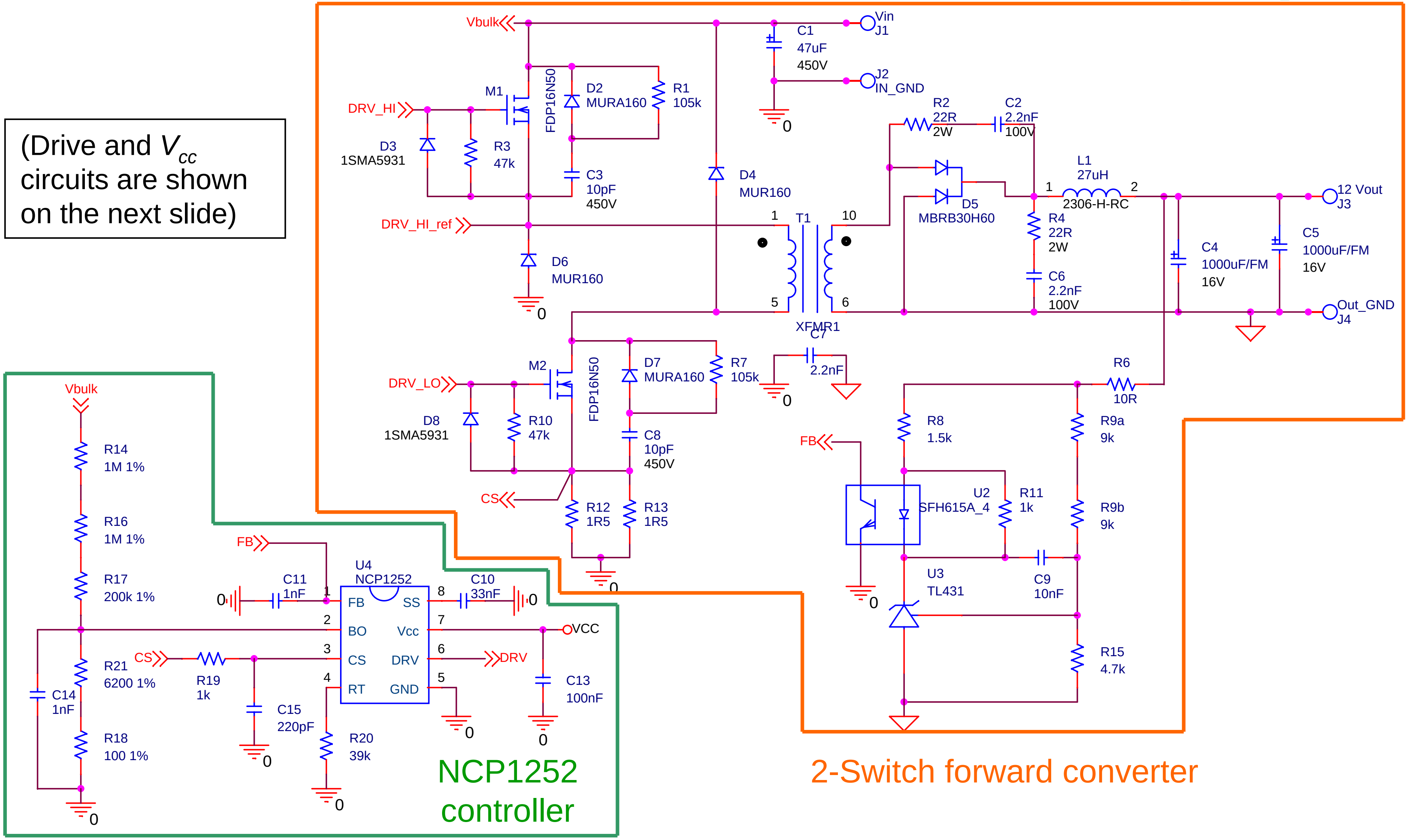
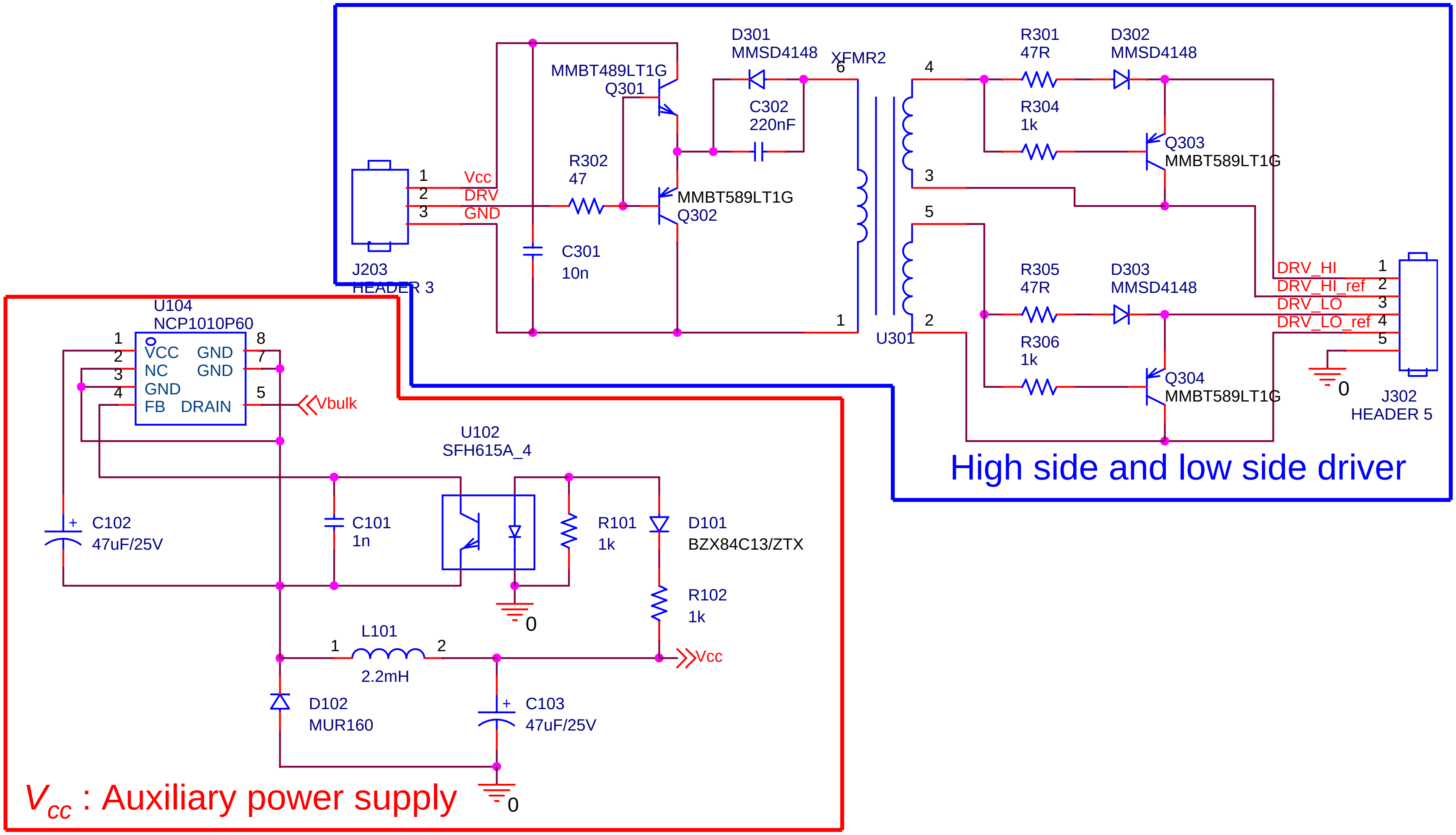
NCP1252 Demo Board Schematic (1/2)

(Drive and V_{cc} circuits are shown on the next slide)



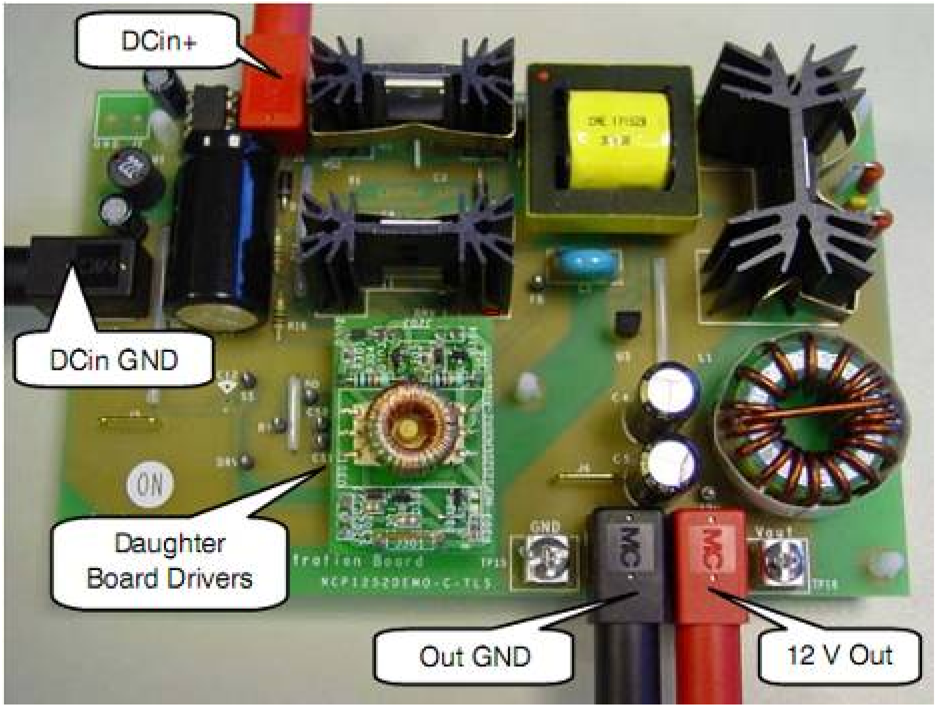
NCP1252 Demo Board Schematic (2/2)



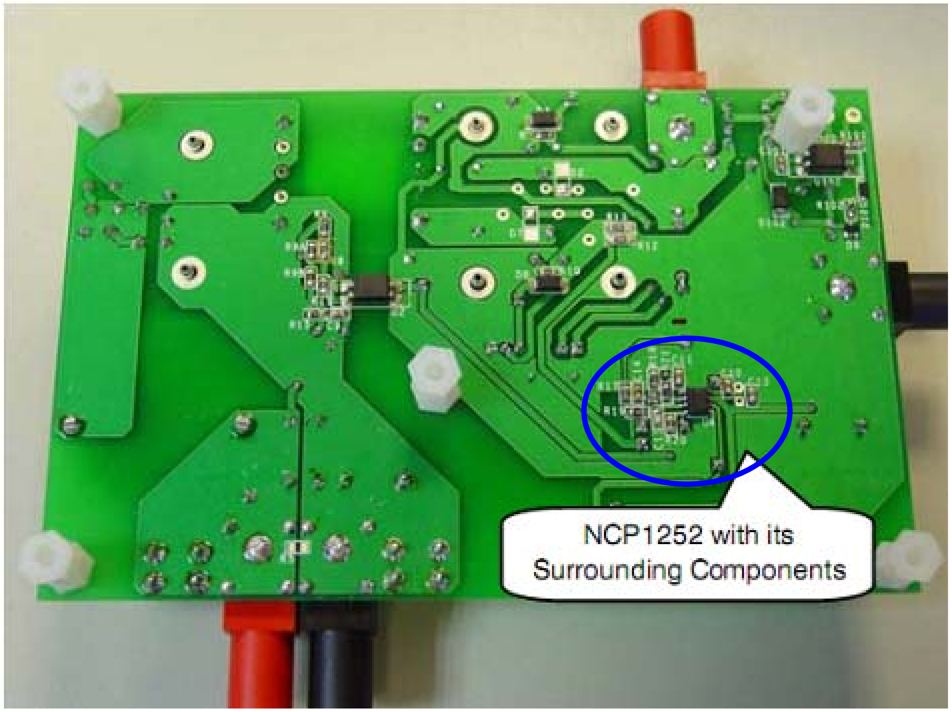
High side and low side driver

V_{cc} : Auxiliary power supply

NCP1252 Demo Board: Pictures



Top view



Bottom view

Link to demoboard web page:
http://www.onsemi.com/PowerSolutions/evalBoard.do?id=NCP1252TSFWDGEVB

Or from the page of the NCP1252:

http://www.onsemi.com/PowerSolutions/product.do?id=NCP1252

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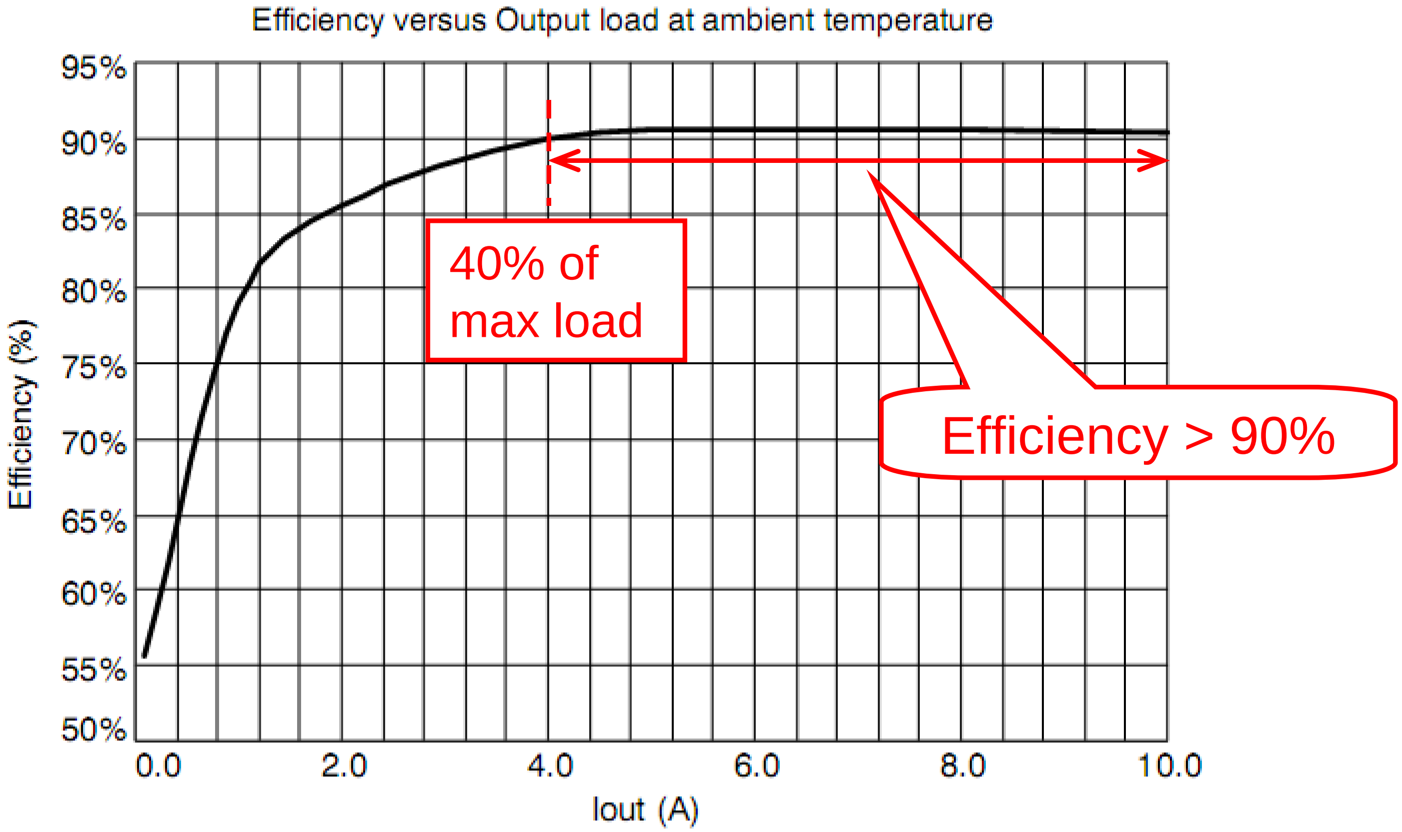
NCP1252 Demo Board: Efficiency

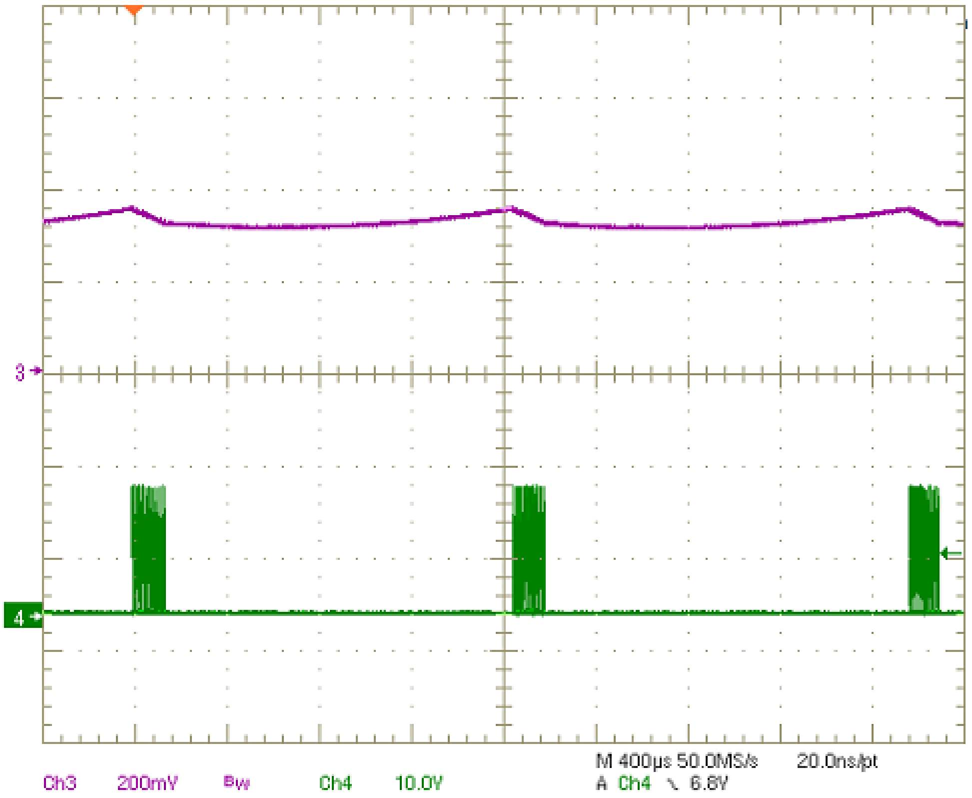


40% of max load

Efficiency > 90%

Figure 28. Efficiency Measurement at Room Temperature and Nominal Input Voltage (390 V dc) versus Output Load Variation

NCP1252
Demo Board: No Load Operation



FB pin
(200 mV/div)

DRV pin
(10 V/div)

Time

(400 µs/div)

Figure 25. No Load Regulation (Real No Load to the Output) Vout = 12.096 V

- Thanks to the skip cycle feature implemented on the NCP1252, it is possible to achieve a real no load regulation without triggering any overvoltage protection. The demonstration board does not have any dummy load and ensure a correct no load regulation. This regulation is achieved by skipping some driving cycles and by forcing the NCP1252 in burst mode of operation.

NCP1252 Demo Board: Soft Start

One dedicated pin allows to adjust the soft start duration and control the peak current during the startup

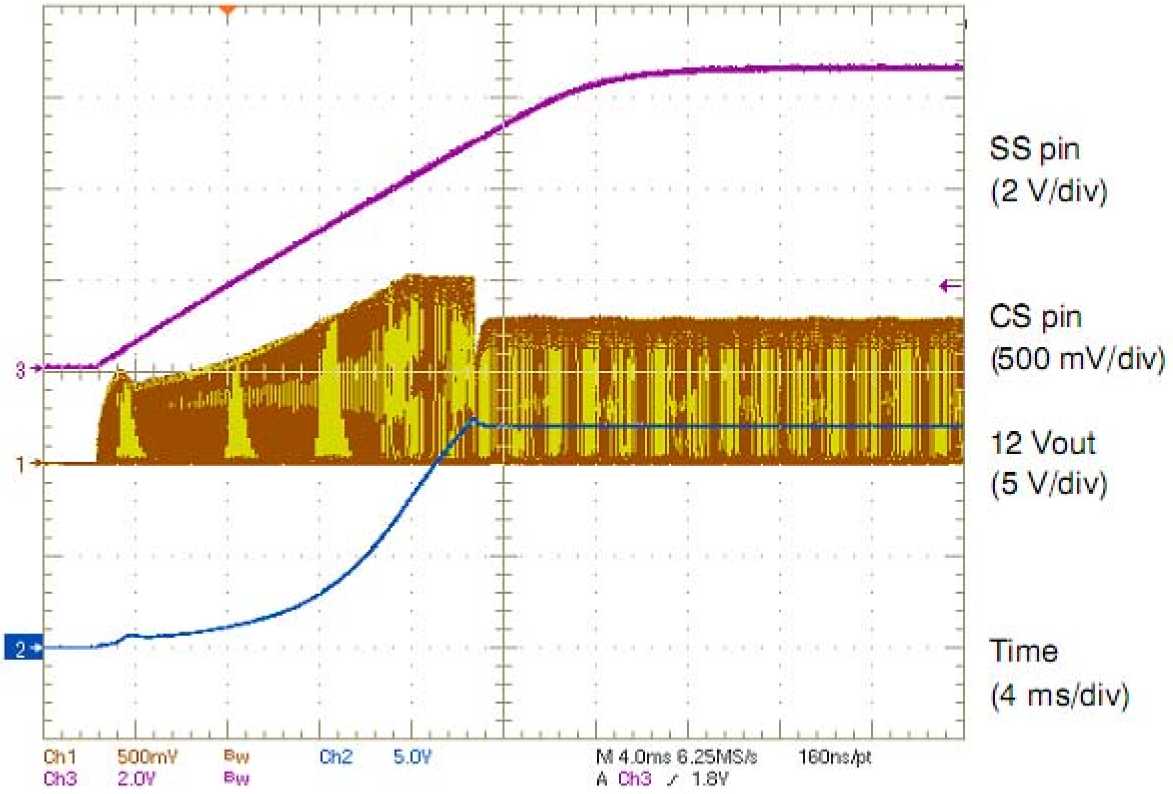


Figure 23. Soft Start at Full Load (10 A)

NCP1252 Demo Board: Performance Improvements

- Synchronous rectification on the secondary side of the converter ➔ will save few percent of the efficiency from middle to high load.
- Stand-by power: The NCP1252 can be shut down by grounding the BO pin ➔ less than 100 µA is sunk on V_{cc} rail when NCP1252 is shutdown.

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Conclusion

- NCP1252 features high-end characteristics in a small 8-pin package
- Added or improved functions make it powerful & easy to use
- Low part-count
- Ideal candidate for forward applications, particularly adapters, ATX power supplies and any others applications where a low standby power is requested.

References

- Datasheet: NCP1252/D ***"Current Mode PWM Controller for Forward and Flyback Applications"***
- Application note: AND8373/D ***"2 Switch-Forward Current Mode Converter"*** Detailed all the calculations presented in this document.
- C. Basso, Director application engineer at ON Semiconductor. ***"Switch Mode Power Supplies: SPICE Simulations and Practical Designs"***, McGraw-Hill, 2008.

- Note : Datasheet and application note are available on www.onsemi.com.

For More Information

- View the extensive portfolio of power management products from ON Semiconductor at www.onsemi.com
- View reference designs, design notes, and other material supporting the design of highly efficient power supplies at www.onsemi.com/powersupplies