

# ON Semiconductor

## Is Now

# onsemi™

To learn more about onsemi™, please visit our website at  
[www.onsemi.com](http://www.onsemi.com)

---

**onsemi** and **onsemi** and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi** product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.



# 24 V to 12 V Buck Switching Regulator

ON Semiconductor

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP3063	DC –DC converter	24 V	10 W	Buck	NONE

Other Specifications				
	Output 1	Output 2	Output 3	Output 4
<b>Output Voltage</b>	12 V	N/A	N/A	N/A
<b>Ripple</b>	100mV	N/A	N/A	N/A
<b>Nominal Current</b>	0.7 A	N/A	N/A	N/A
<b>Max Current</b>	N/A	N/A	N/A	N/A
<b>Min Current</b>	N/A	N/A	N/A	N/A

<b>PFC (Yes/No)</b>	NO
<b>Minimum Efficiency</b>	75%

## Circuit Description

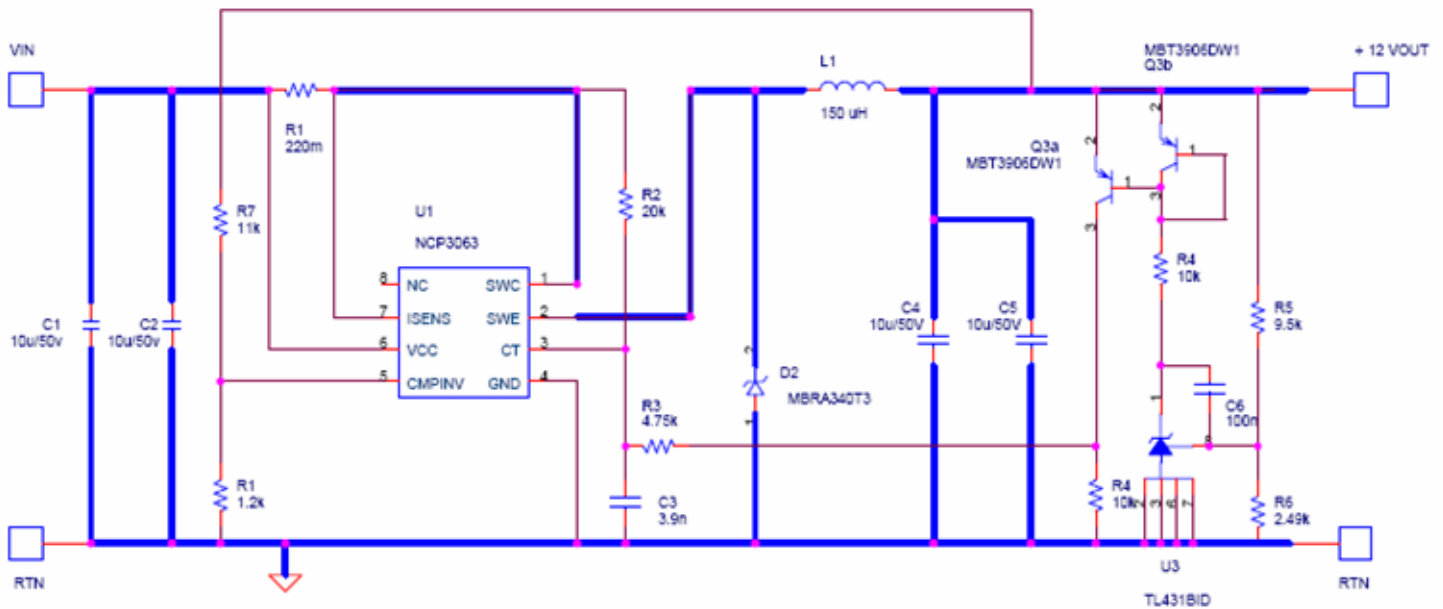
ON Semiconductor's latest monolithic NCP3063 control circuit operating at 150 kHz is combined with MLCC capacitors to create a cost effective buck topology optimized for size and efficiency.

Feed forward and feedback information is used to vary the slope of the oscillator ramp and achieve duty cycle control, independent of the gated oscillator function provided on the IC.

## Key Features

- Buck operation
- Regulated output voltage
- Inhibit Function using gating pin
- High frequency operation to enable cost effective magnetic and capacitive (e.g. MLCC) filter components
- Minimal output ripple

## Schematic



## Design Notes

For low ripple current, assume CCM operation.

Switch Q1 (inside controller) turns on for time  $D \cdot T_s$  ( $D$  duty cycle,  $T_s$  switching period) charging inductor  $L1$  from input  $V_{in}$ . When Q1 turns off, diode  $D2$  delivers inductor energy to output  $V_{out}$ . For the inductor flux (volt microsecond) to remain in equilibrium after each switching cycle,  $(V_{in} - V_{out}) \cdot D \cdot T_s$  must equal  $V_{out} \cdot (1 - D) \cdot T_s$ , neglecting circuit losses. Hence voltage gain of buck converter is given by  $V_{out} = D \cdot V_{in}$ . When  $D = 0.5$ , 24 volts input = 12 volts output.

Ripple current in inductor obtained from expression  $\Delta I(L1) = V_{out} \cdot (1 - D) \cdot T_s / L1$ . A value for  $L1$  of 150  $\mu H$  will maintain a  $\pm 20\%$  ripple current in a 700 mA application, assuming  $V_{in} = 24$  V and 150 kHz operation [ $(1 - D) \cdot T_s = 0.5 \cdot 6.7 \mu s$ ]. A TDK SMD power inductor SLF10145T-151MR65 or equivalent is rated at 150  $\mu H$  and 0.8 A.

Feed forward from  $V_{in}$  is applied to the oscillator CT pin 3 by selecting the value of  $R2$ . The output voltage is sensed at  $U3$ . When  $V_{out}$  equals  $(1 + R5/R6) \cdot 2.5$  V, the TL431 shunt regulator turns on the current mirror formed by  $Q3a$  and  $Q3b$  in the MTB3906 dual, causing additional current to flow into the oscillator pin, thereby reducing the duty cycle  $D$  and regulating the output at its set point. A simple compensation scheme is illustrated with  $C6$  as a feedback element around  $U3$ . Current limit is selected by the equation  $I_{cl} \cdot R1 = V_{sense}$  (nominal value is 200 mV).

The input and output capacitors are low value MLCC SMT capacitors. For example, a 10  $\mu F$  0805 SMT package has sufficiently low ESR and ESL that the switching ripple is determined only by the inductor ripple current flowing into the capacitor value chosen.

Pin 5 of the NCP3063 is available to use as a non-latching inhibit function. If the voltage on pin 5 exceeds 1.25 V, the oscillator is turned off, allowing the output voltage to fall. Hence CMPINV pin may be used in several ways depending on designer preference. Divider  $R1$  and  $R7$  may be set up to regulate the output voltage (with large output ripple variation), as an input or output over voltage detector set at  $(1 + R7/R1) \cdot 1.25$  volts. CMPINV could equally be used as an "enable" function, or thermal shutdown, etc.

© 2006 ON Semiconductor.

**Disclaimer:** ON Semiconductor is providing this design note "AS IS" and does not assume any liability arising from its use; nor does ON Semiconductor convey any license to its or any third party's intellectual property rights. This document is provided only to assist customers in evaluation of the referenced circuit implementation and the recipient assumes all liability and risk associated with its use, including, but not limited to, compliance with all regulatory standards. ON Semiconductor may change any of its products at any time, without notice.

Design note created by Dennis Solley, e-mail: [dennis.solley@onsemi.com](mailto:dennis.solley@onsemi.com)