ON Semiconductor

Design Note – DN06016/D

24 V to 12 V Buck Switching Regulator

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**
Output Voltage	12 V	N/A	N/A	N/A
Ripple	100mV	N/A	N/A	N/A
Nominal Current	0.7 A	N/A	N/A	N/A
Max Current	N/A	N/A	N/A	N/A
Min Current	N/A	N/A	N/A	N/A

PFC (Yes/No)	NO
Minimum Efficiency	75%

Circuit Description

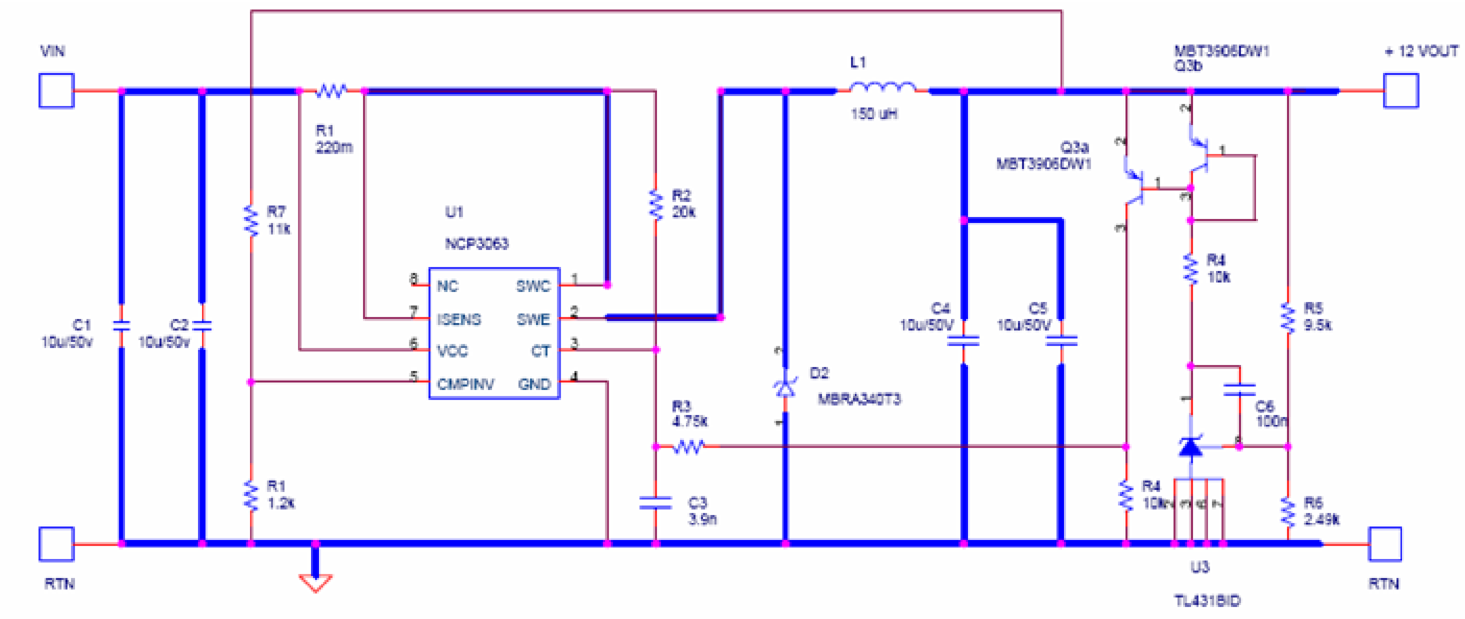
ON Semiconductor’s latest monolithic NCP3063 control circuit operating at 150 kHz is combined with MLCC capacitors to create a cost effective buck topology optimized for size and efficiency.

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*Ts (D duty cycle, Ts switching period) charging inductor L1 from input Vin. When Q1 turns off, diode D2 delivers inductor energy to output Vout. For the inductor flux (volt microsecond) to remain in equilibrium after each switching cycle, (Vin-Vout)*D*Ts must equal Vout*(1-D)*Ts, neglecting circuit losses.
Hence voltage gain of buck converter is given by Vout = D*Vin. When D=0.5, 24 volts input = 12 volts output.

Ripple current in inductor obtained from expression ΔI(L1) = Vout*(1-D)*Ts/L1. A value for L1 of 150 µH will maintain a +/-20% ripple current in a 700 mA application, assuming Vin =24 V and 150 kHz operation [(1-D)*Ts = 0.5*6.7 µs].
A TDK SMD power inductor SLF10145T-151MR65 or equivalent is rated at 150 µH and 0.8 A.

Feed forward from Vin is applied to the oscillator CT pin 3 by selecting the value of R2. The output voltage is sensed at U3. When Vout equals (1+R5/R6)*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 Icl* R1 = Vsense (nominal value is 200 mV).

The input and output capacitors are low value MLCC SMT capacitors. For example, a 10 µF 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)*1.25 volts. CMPINV could equally be used as an “enable” function, or thermal shutdown, etc.

Design note created by Dennis Solley, e-mail: dennis.solley@onsemi.com