

**9 V to 36 Vin dc, Constant Current LED Driver**

ON Semiconductor

Device	Application	Input Voltage	Output Power	Topology	I/O Isolation
NCP3063	DC-DC Constant Current LED Driver	9 Vdc to 36 Vdc	10 W	Non Inverting Buck Boost	None

**Other Specifications**

	Output 1	Output 2	Output 3	Output 4
<b>Output Voltage</b>	12 Vdc	N/A	N/A	N/A
<b>Ripple</b>	200 mV	N/A	N/A	N/A
<b>Max Current</b>	1 A	N/A	N/A	N/A

<b>PFC (Yes/No)</b>	No
<b>Minimum Efficiency</b>	70%
<b>Cooling Method/Supply Orientation</b>	Convection

**Circuit Description**

ON Semiconductor's latest monolithic NCP3063 control circuit and family of e2PowerEdge bipolar transistors are combined to create a non inverting buck boost topology optimized to drive strings of LED's at a constant current.

A high side, low drop, current sensing scheme has been implemented, targeted for automotive and other high efficiency applications.

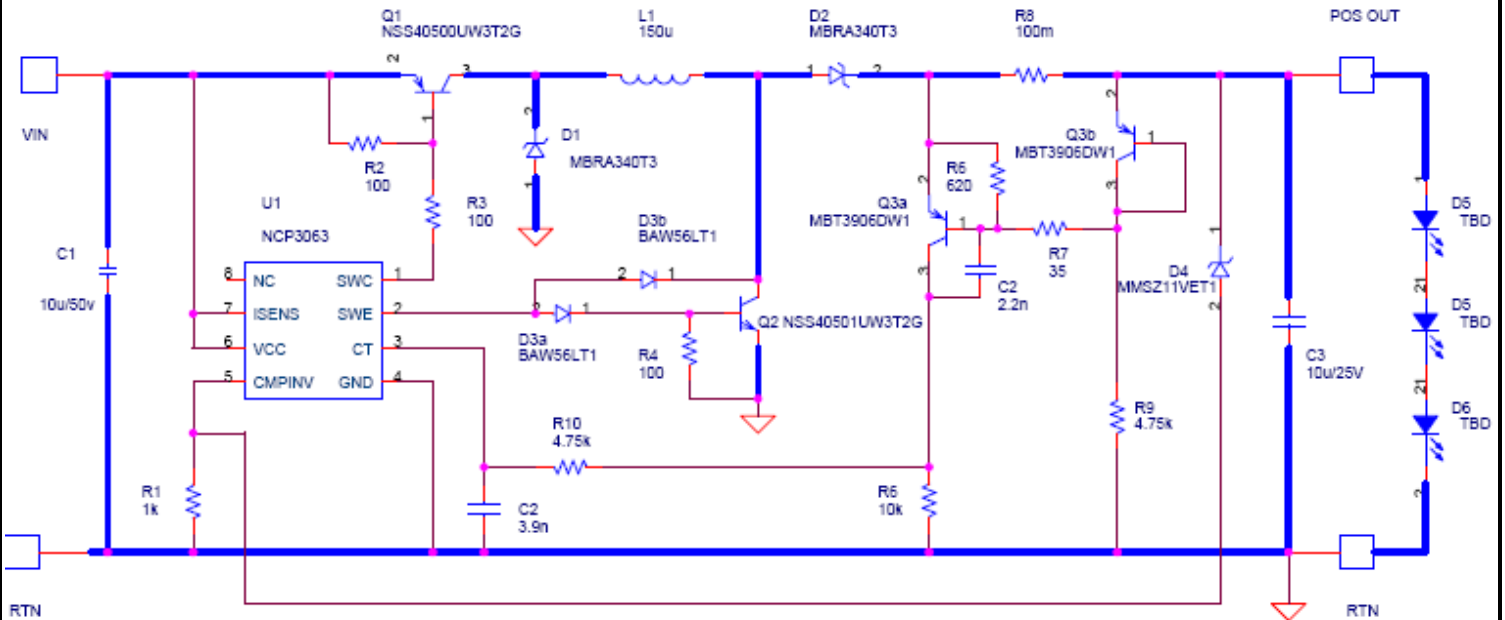
The output from the current sense is used to vary the slope of the oscillator ramp and achieve duty cycle modulation, independent of the gated oscillator function provided on the IC.

**Key Features**

- Seamless buck or boost operation
- Constant current output with voltage clamp
- Low drop high side current sensing
- Baker clamp drive on external transistor for enhanced efficiency
- High frequency operation to enable cost effective magnetic and capacitive (e.g. MLCC) filter components
- Minimal ripple current through LED string

# DN06001/D

## Schematic



### Design Notes

For low ripple current assume CCM operation. Switches Q1 and Q2 turn on for time  $D \cdot T_s$  ( $D$  duty cycle,  $T_s$  switching period) charging inductor  $L1$  from input  $V_{in}$ . When Q1 and Q2 turn off, diodes D1 and D2 deliver inductor energy to output  $V_{out}$ .

For the inductor flux (volt microsecond) to remain in equilibrium after each switching cycle,  $V_{in} \cdot D \cdot T_s$  must equal  $V_{out} \cdot (1-D) \cdot T_s$ , neglecting circuit losses. Hence voltage gain of buck boost is given by  $V_{out} = V_{in} \cdot D / (1-D)$ . When  $D=0.5$ ,  $V_{out} = V_{in}$ .

Ripple current in inductor obtained from expression  $\Delta I(L1) = V_{in} \cdot D \cdot T_s / L1$ .

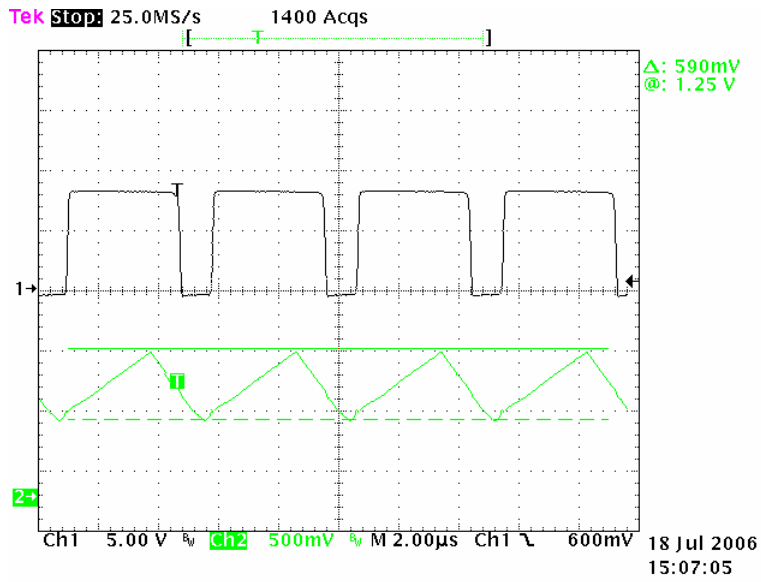
A value for  $L1$  of  $150 \mu\text{H}$  will maintain a  $\pm 15\%$  ripple current in a 700 mA application (3 watt LED's) assuming  $V_{in} = 12 \text{ V}$  and 200 kHz operation ( $D \cdot T_s = 0.5 \cdot 5 \mu\text{s}$ ).

The base current for Q1 and Q2 is determined by  $V_{in}/R3$ . (100:1 base drive good starting point but remember to include  $V_{be}/R2$  contribution). Q1 and Q2 are turned off passively via base resistors R2 and R4. To improve switch off times, switch Q2 may be held out of saturation by the Baker clamp created by diodes D3a and D3b. Several points of efficiency improvement may be achieved using this technique. Low drop current sensing is achieved across current sense resistor R8.

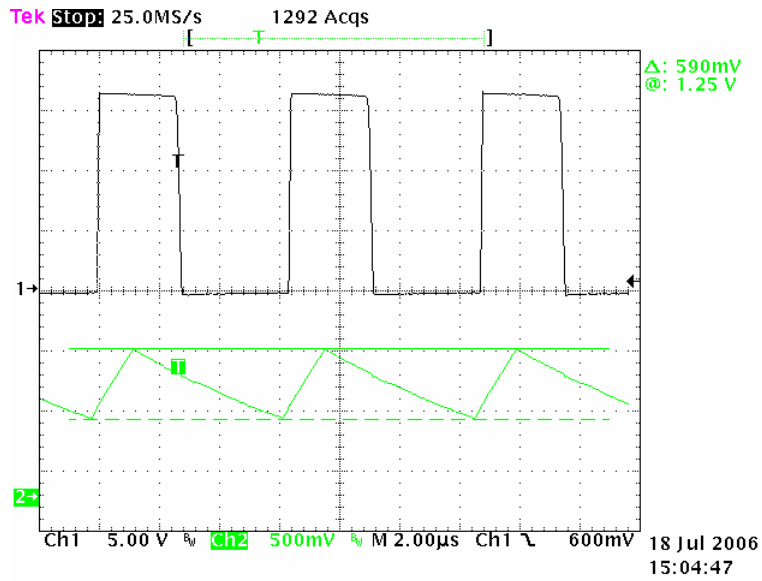
The constant output current is determined from the equation  $I_o \cdot R8 = (V_{be}(Q3a)/R6) \cdot R7$  where  $V_o/R9 = 2 \cdot V_{be}(Q3a)/R6$ .  $V_{clamp}$  equals  $V_z(D4) + 1.25 \text{ V}$ . Alternatively, if D4 is replaced with a resistor R11 then  $V_{clamp} = (1+R11/R1) \cdot 1.25 \text{ volts}$ .

# Converter Waveforms

## Boost Mode from 8 Vin to 16 Vout



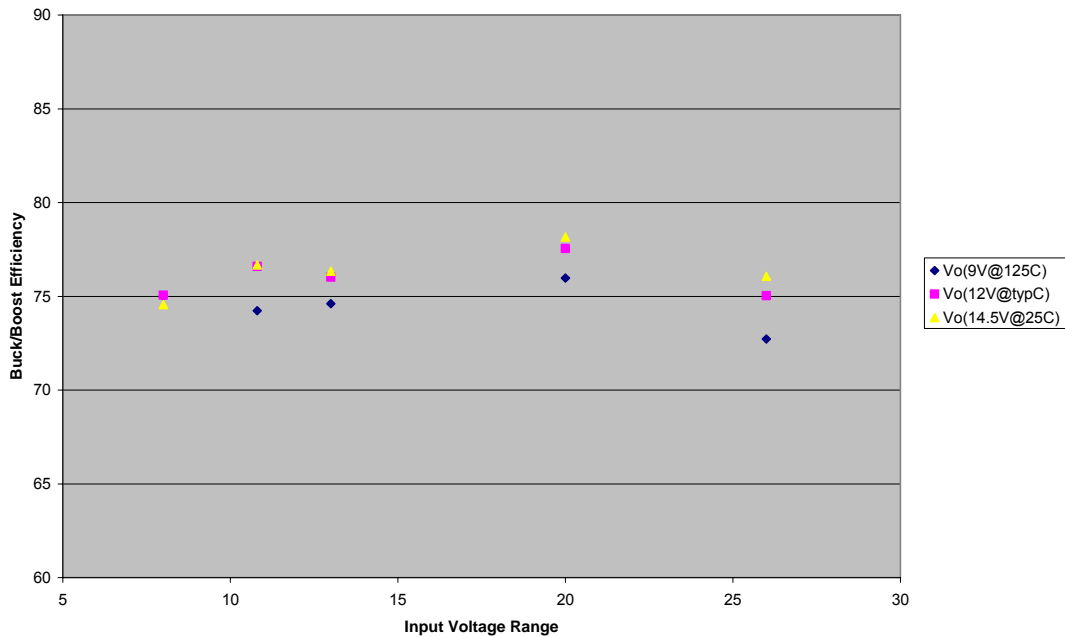
## Buck Mode from 16 Vin to 8 Vout



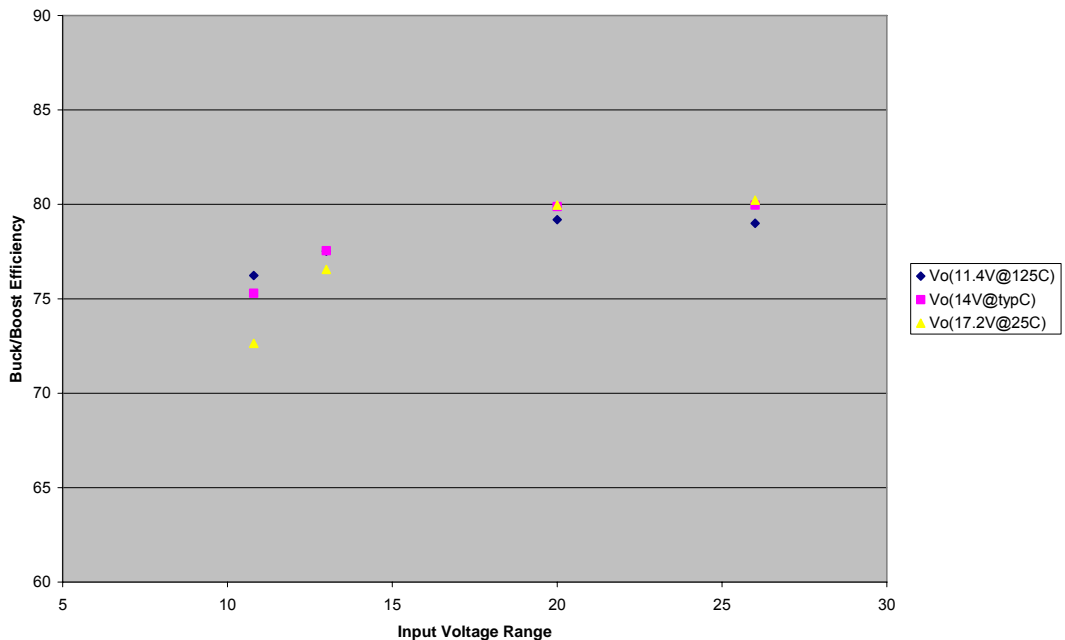
## DN06001/D

# Efficiency data of Buck-Boost converter between 8 Vin dc and 26 Vin dc driving LED strings at 350 mA and 700 mA

OSTAR4 driven at 350mA



OSTAR4 driven at 700mA



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