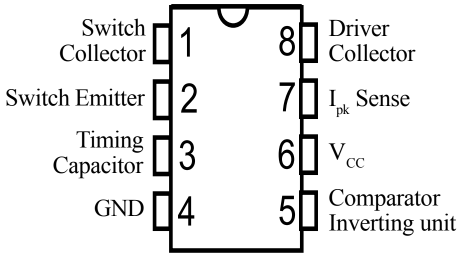
1.5A DC-to-DC CONVERTER CONTROL CIRCUIT

- **3.0V to 40V input**
- **Adjustable Output Voltage**
- **Current Limiting**
- **Output Switch Current to 1.5A**
- **Low Standby Current**
- **Operating Frequency to 100kHz**
- **Precision 2% Reference**

The GM34063 has all the functions required for DC-to-DC converters: an internal temperature-compensated reference, comparator, controlled duty cycle oscillator with an active current limit circuit, driver, and high-current output switch. The 34063 designed for step-down, step-up and voltage-inverting applications using a minimum number of external components.

PIN CONNECTIONS

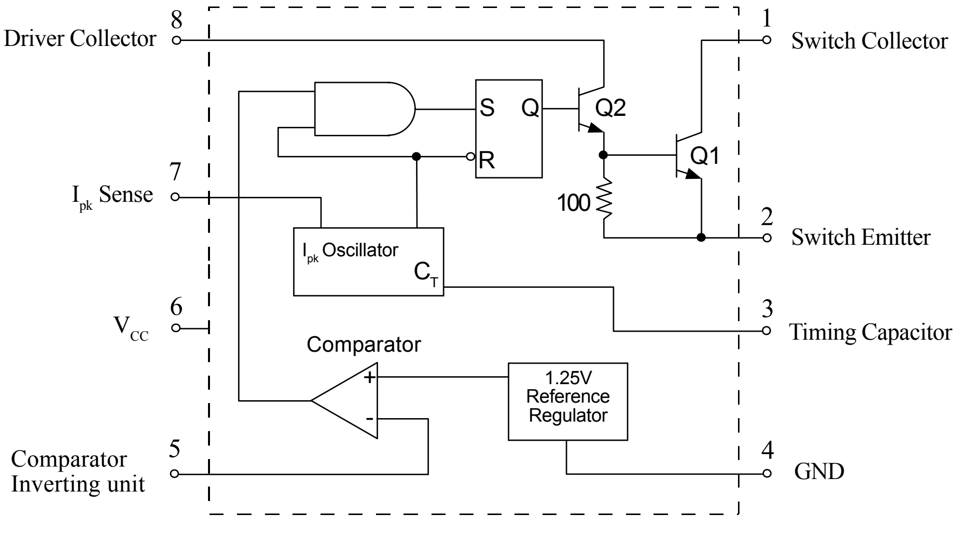


(Top View)

Applications:

- **CD-ROM**
- **Motherboards**
- **SMPS Power Supply**
- **Battery Chargers**

SCHEMATIC DIAGRAM



(Bottom View)

* The GM34063 has 51 active transistors on-chip.

Absolute Maximum Ratings

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	40	Vdc
Comparator Input Voltage Range	V_{IR}	–0.3 to +40	Vdc
Switch Collector Voltage	$VC_{(switch)}$	40	Vdc
Switch Emitter Voltage ($V_{Pin\ 1}$ = 40 V)	$VE_{(switch)}$	40	Vc
Switch Collector to Emitter Voltage	$VCE_{(switch)}$	40	Vdc
Driver Collector Voltage	$VC_{(driver)}$	40	Vdc
Driver Collector Current (Note 1)	$IC_{(driver)}$	100	mA
Switch Current	I_{SW}	1.5	A
Power Dissipation and Thermal Characteristics			
Plastic Package, P, P1 Suffix			
T_A = 25°C	P_D	1.25	W
Thermal Resistance	$R_{\theta JA}$	100	°C/W
SOIC Package, D Suffix			
T_A = 25°C	P_D	625	mW
Thermal Resistance	$R_{\theta JA}$	160	°C/W
Operating Junction Temperature	T_J	+150	°C
Operating Ambient Temperature Range	T_A	0 to +70	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

Note 1. Maximum package power dissipation limits must be observed.

ELECTRICAL CHARACTERISTICS

(V_{CC} = 5.0 V, $T_A = T_{low}$ to T_{high} unless otherwise specified)

Characteristics	Symbol	Min	Typ	Max	Unit
OSCILLATOR					
Frequency ($V_{Pin\,5}$ = 0 V, C_T = 1.0 nF, T_A = 25°C)	f_{osc}	24	33	42	kHz
Charge Current (V_{CC} = 5.0 V to 40 V, T_A = 25°C)	I_{chg}	24	35	42	µA
Discharge Current (V_{CC} = 5.0 V to 40 V, T_A = 25°C)	I_{dischg}	140	220	260	µA
Discharge to Charge Current Ratio (Pin 7 to $V_{CC,}$ T_A = 25°C)	I_{dischg}/I_{chg}	5.2	6.5	7.5	–
Current Limit Sense Voltage ($I_{chg} = I_{dischg}$, T_A = 25°C)	$V_{ipk(sense)}$	250	300	350	mV
OUTPUT SWITCH (Note 2)					
Saturation Voltage, Darlington Connection (I_{SW} = 1.0 A, Pins 1, 8 connected)	$V_{CE(sat)}$	–	1.0	1.3	V
Saturation Voltage (Note 3) (I_{SW} = 1.0 A, $R_{Pin\,8}$ = 82 Ω to V_{CC}, Forced β ≈20)	$V_{CE(sat)}$	–	0.45	0.7	V
DC Current Gain (I_{SW} = 1.0 A, V_{CE} = 5.0 V, T_A = 25°C)	h_{FE}	50	75	–	–
Collector Off–State Current (V_{CE} = 40 V)	$I_{C(off)}$	–	0.01	100	µA
COMPARATOR					
Threshold Voltage	V_{th}				V
T_A = 25°C		1.225	1.25	1.275	
$T_A = T_{low}$ to T_{high}		1.210	-	1.29	
Threshold Voltage Line Regulation (V_{CC} = 3.0 V to 40 V)	Reg_{line}	-	1.4	5.0	mV
Input Bias Current (V_{in} = 0 V)	I_{IB}	-	-20	-400	nA
TOTAL DEVICE					
Supply Current (V_{CC} = 5.0 V to 40 V, C_T = 1.0 nF, Pin 7 = V_{CC}, $V_{Pin\,5} > V_{th}$, Pin 2 = Gnd, remaining pins open)	I_{CC}	-	-	4.0	mA

Note 2. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

Note 3. If the output switch is driven into hard saturation (non–Darlington configuration) at low switch currents (≤300 mA) and high driver currents (≥30 mA), it may take up to 2.0 µs for it to come out of saturation. This condition will shorten the off time at frequencies ≥30 kHz, and is magnified at high temperatures. This condition does not occur with a Darlington configuration, since the output switch cannot saturate. If a non–Darlington configuration is used, the following output drive condition is recommended:

Forced β of output switch :

$$\frac{I_C \text{ output}}{I_C \text{ driver} - 7.0 \text{ mA}^*} \geq 10$$

* The 100 Ω resistor in the emitter of the driver device requires about 7.0 mA before the output switch conducts.

Test	Conditions	Results
Line Regulation	V_{in} = 8.0 V to 16 V, I_O = 175 mA	30 mV = ±0.05%
Load Regulation	V_{in} = 12 V, I_O = 75 mA to 175 mA	10 mV = ±0.017%
Output Ripple	V_{in} = 12 V, I_O = 175 mA	400 mVpp
Efficiency	V_{in} = 12 V, I_O = 175 mA	87.7%
Output Ripple With Optional Filter	V_{in} = 12 V, I_O = 175 mA	40 mVpp

Step–Up Converter

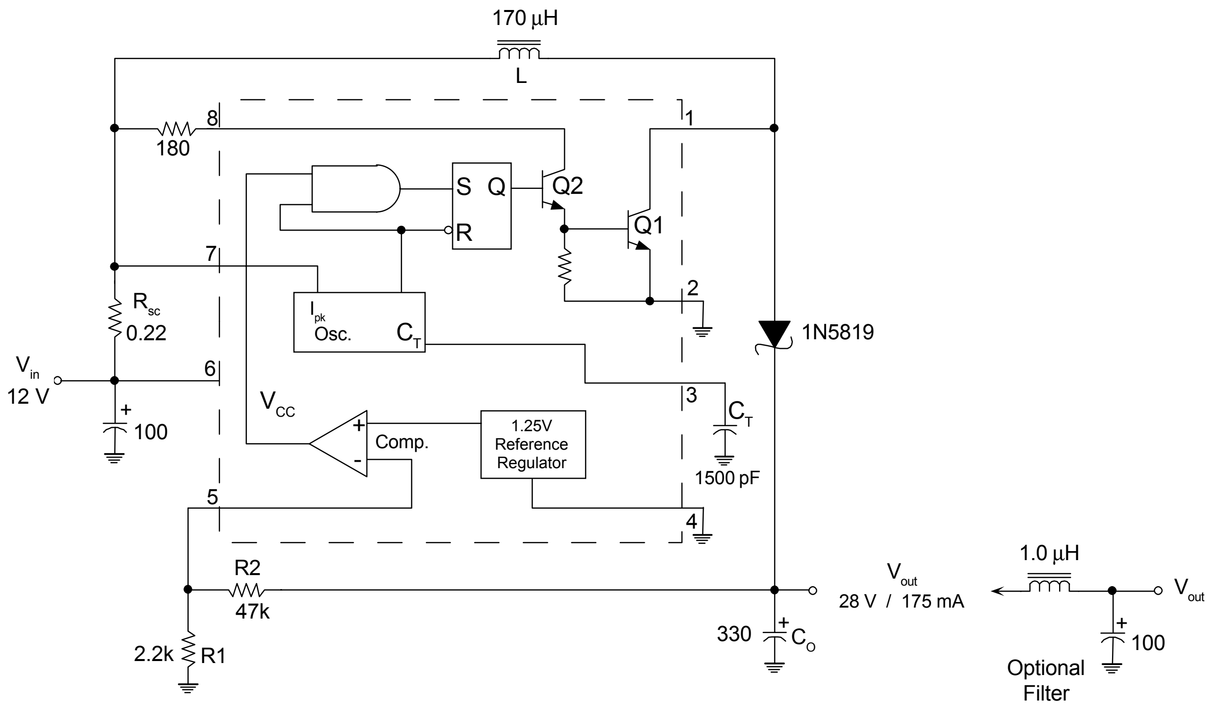
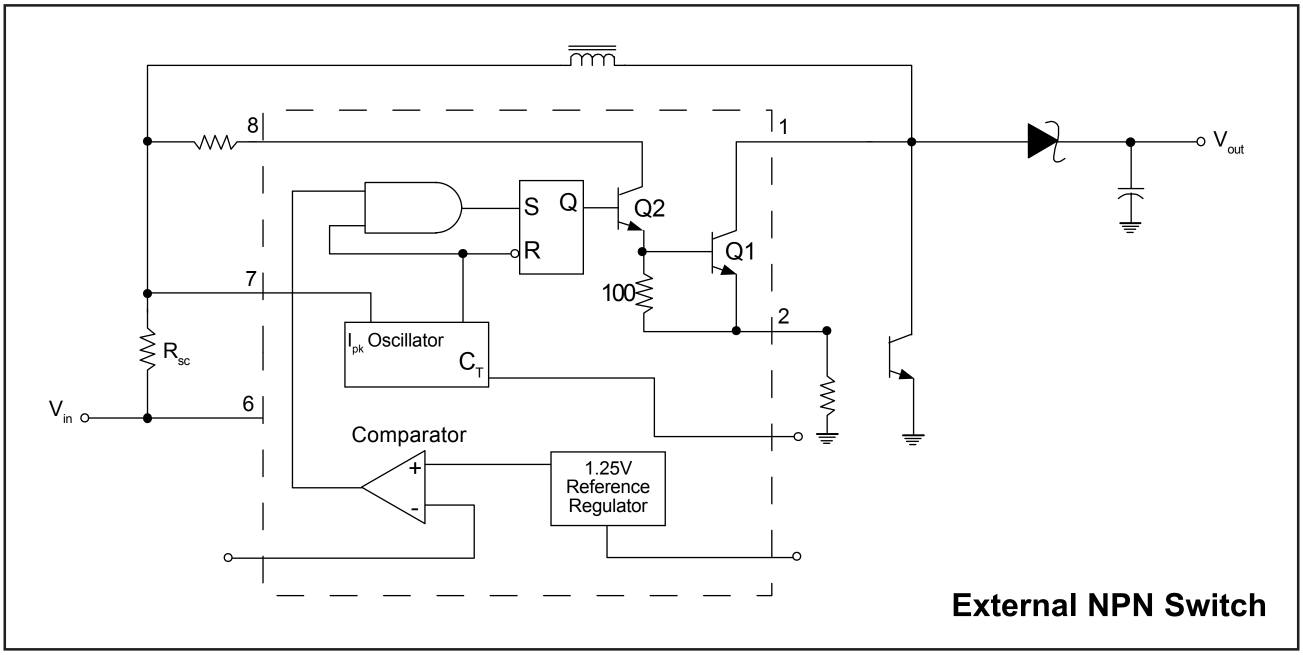
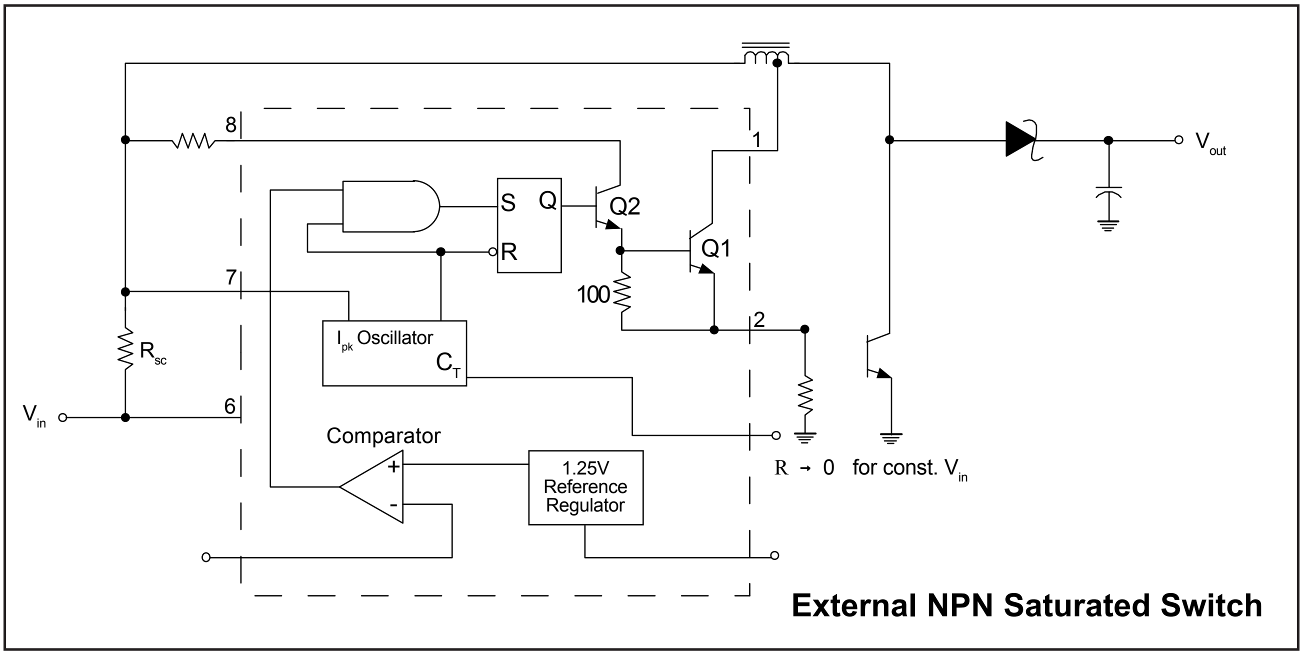


Figure 9. **External Current Boost Connections for I_c Peak Greater than 1.5 A**



External NPN Switch

If the output switch is driven into hard saturation (non – Darlington configuration) at low switch currents (≤300 mA) and high driver currents (≥30 mA), it may take up to 2.0 µs to come out of saturation. This condition will shorten the off time at frequencies ≥30 kHz, and is magnified at high temperatures. This condition does not occure with a Darlington configuration, since the output switch cannot saturate. If a non–Darlington configuration is used, the following output drive condition is recommended.



External NPN Saturated Switch

Test	Conditions	Results
Line Regulation	V_{in} = 15 V to 25 V, I_O = 500 mA	12 mV = ±0.12%
Load Regulation	V_{in} = 25 V, I_O = 75 mA to 500 mA	3.0 mV = ±0.03%
Output Ripple	V_{in} = 25 V, I_O = 500 mA	120 mVpp
Short Circuit Current	V_{in} = 25 V, R_L = 0.1 Ω	1.1 A
Efficiency	V_{in} = 25 V, I_O = 500 mA	83.7%
Output Ripple With Optional Filter	V_{in} = 25 V, I_O = 500 mA	40 mVpp

Step – Down Converter

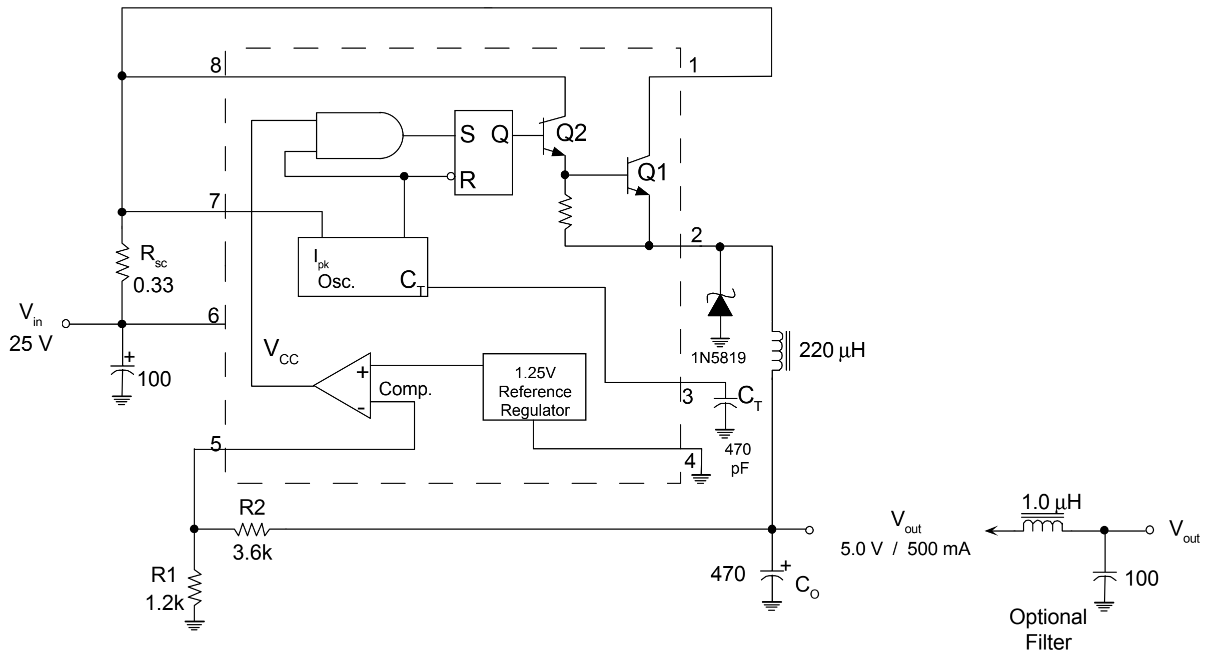
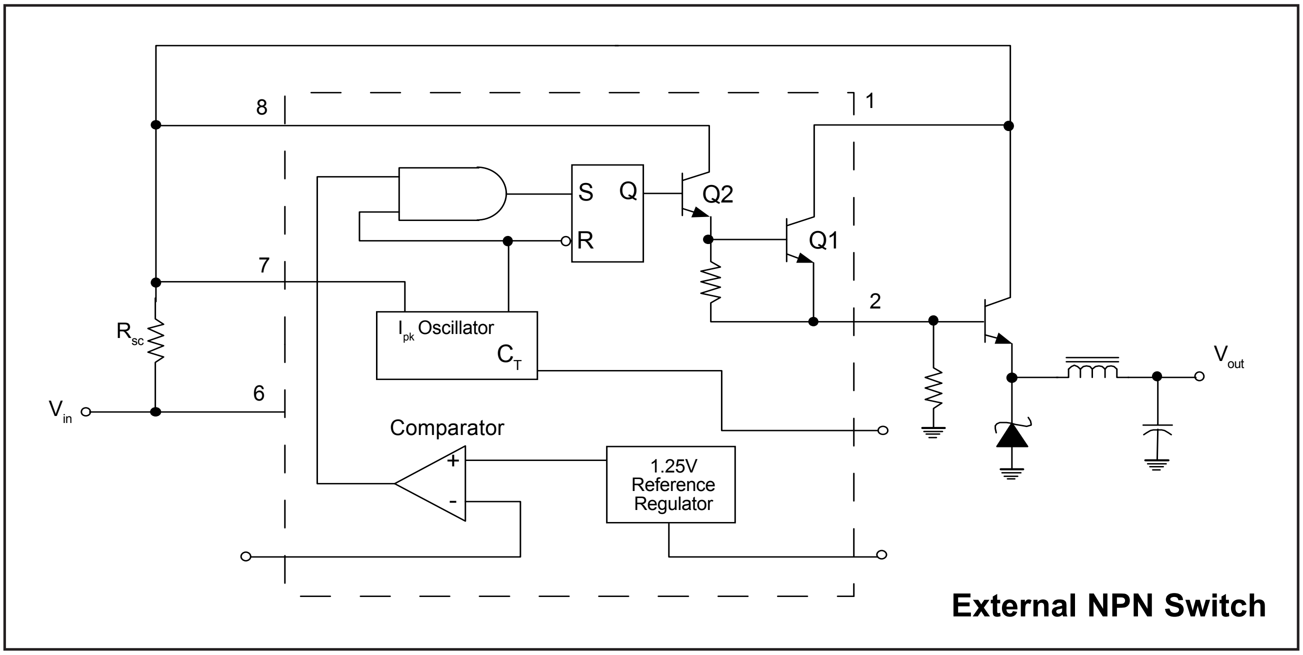
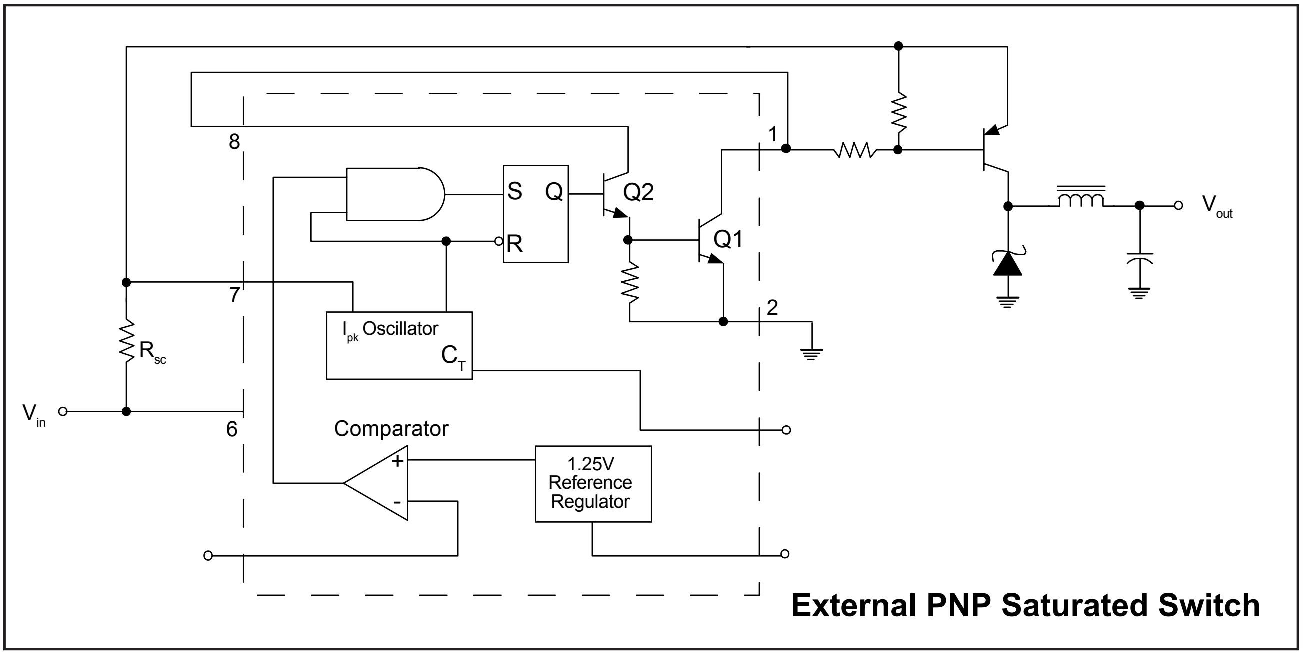


Figure 11. **External Current Boost Connections for I_C Peak Greater than 1.5 A**



External NPN Switch



External PNP Saturated Switch

Test	Conditions	Results
Line Regulation	V_{in} = 4.5 V to 6.0 V, I_O = 100 mA	3.0 mV = ±0.012%
Load Regulation	V_{in} = 5.0 V, I_O = 10 mA to 100 mA	0.022 V = ±0.09%
Output Ripple	V_{in} = 5.0 V, I_O = 100 mA	500 mVpp
Short Circuit Current	V_{in} = 5.0 V, R_L = 0.1 Ω	910 mA
Efficiency	V_{in} = 5.0 V, I_O = 100 mA	62.2%
Output Ripple With Optional Filter	V_{in} = 5.0 V, I_O = 100 mA	70 mVpp

Voltage Inverting Converter

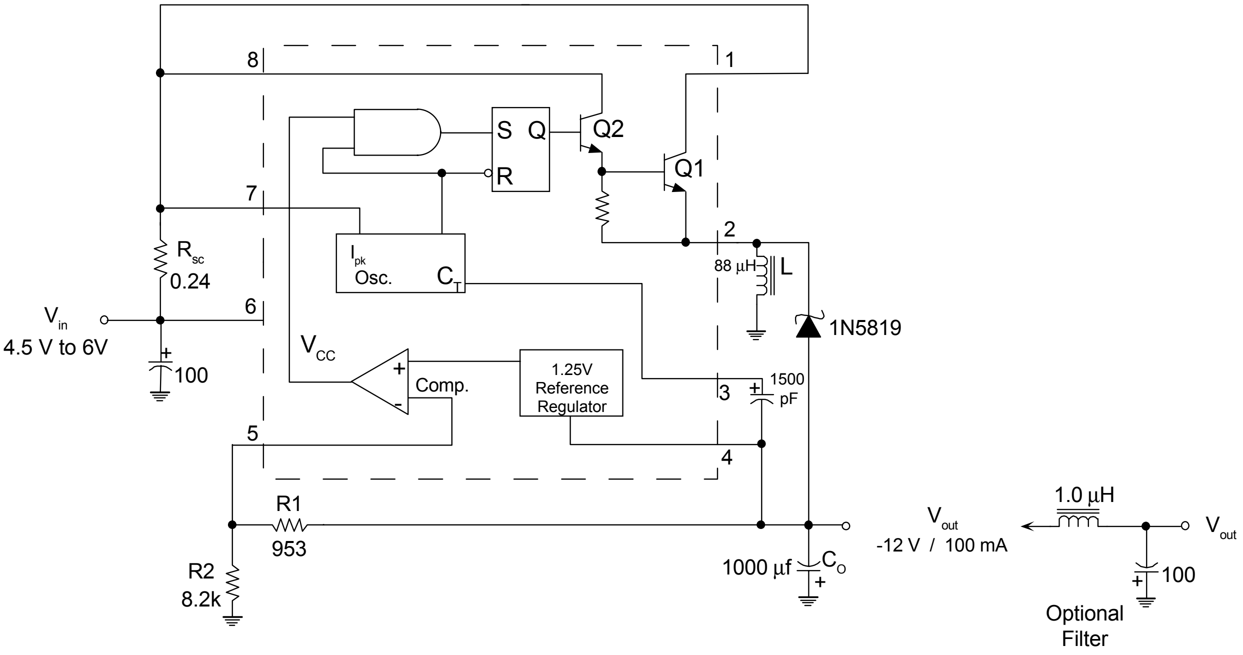
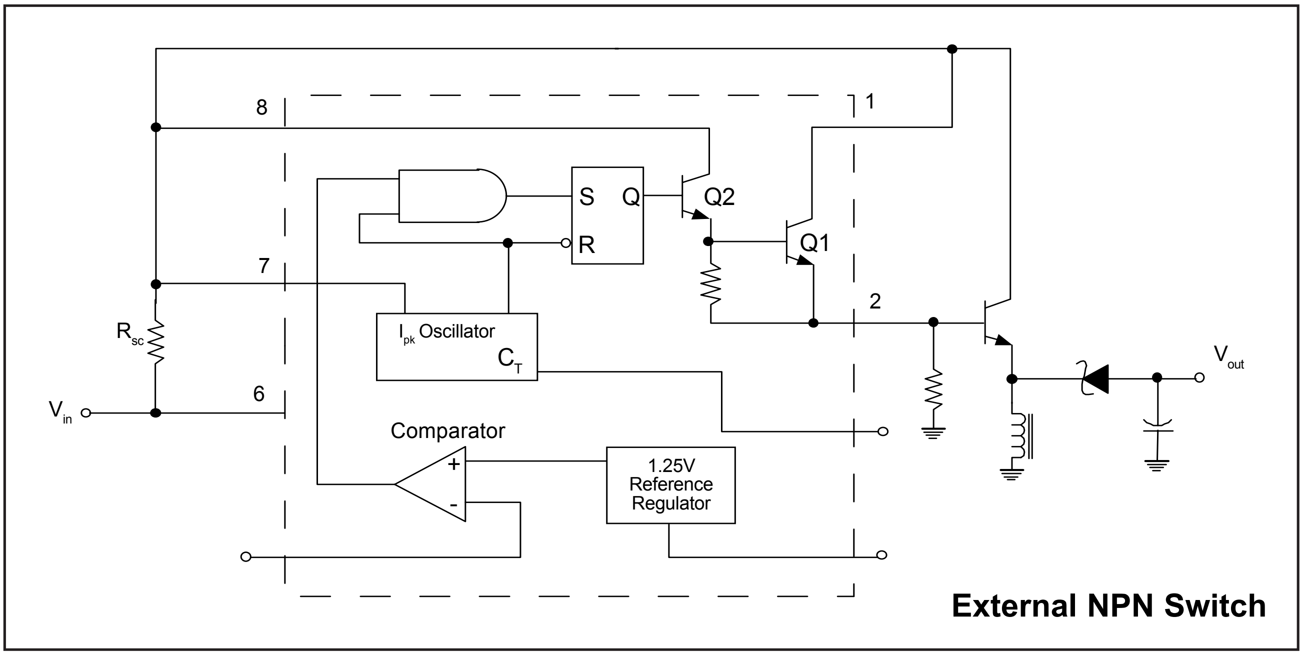
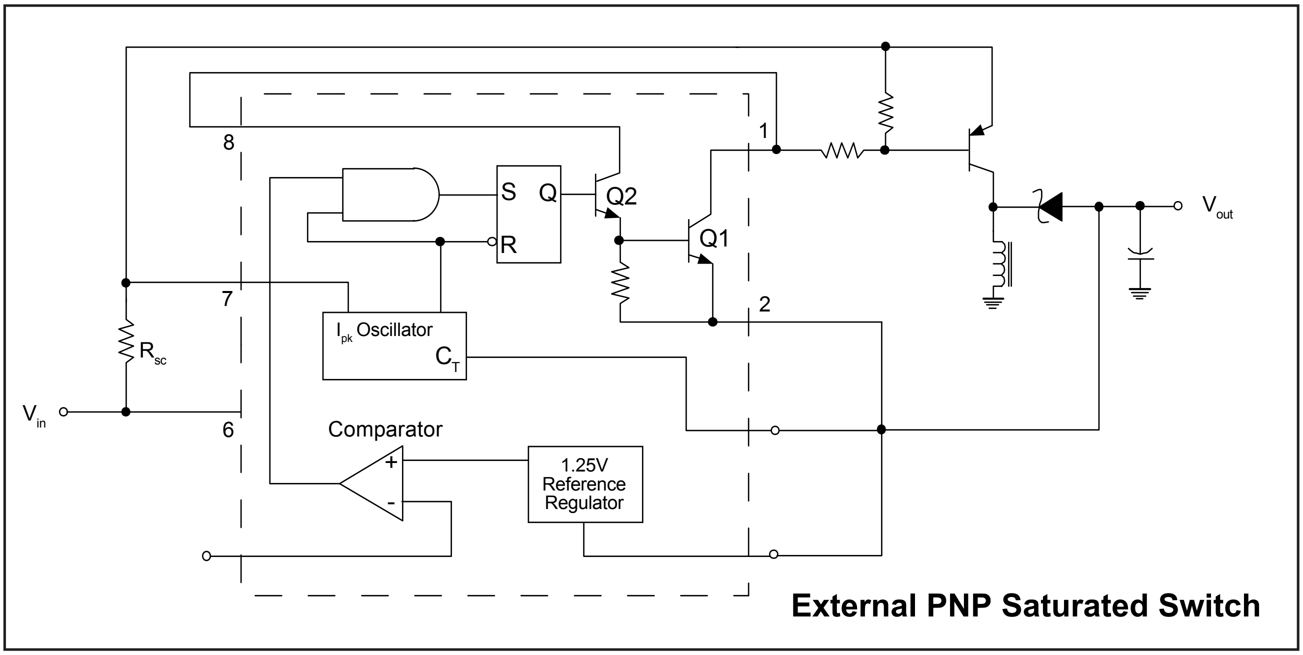


Figure 13. **External Current Boost Connections for I_C Peak Greater than 1.5 A**





■ DESIGN FORMULAS

Calculation	Step-Up	Step-Down	Voltage-Inverting
t_{on}/t_{off}	$\frac{V_{out} + V_F - V_{in(min)}}{V_{in(min)} - V_{sat}}$	$\frac{V_{out} + V_F}{V_{in(min)} - V_{sat} - V_{out}}$	$\frac{\lvert V_{out}\rvert + V_F}{V_{in} - V_{sat}}$
$(t_{on} + t_{off})$	$\frac{1}{f}$	$\frac{1}{f}$	$\frac{1}{f}$
t_{off}	$\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$	$\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$	$\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$
t_{on}	$(t_{on} + t_{off}) - t_{off}$	$(t_{on} + t_{off}) - t_{off}$	$(t_{on} + t_{off}) - t_{off}$
C_T	$4.0 \times 10^{-5}\ t_{on}$	$4.0 \times 10^{-5}\ t_{on}$	$4.0 \times 10^{-5}\ t_{on}$
$I_{pk(switch)}$	$2I_{out(max)}\left(\frac{t_{on}}{t_{off}} + 1\right)$	$2I_{out(max)}$	$2I_{out(max)}\left(\frac{t_{on}}{t_{off}} + 1\right)$
R_{sc}	$0.3/I_{pk(switch)}$	$0.3/I_{pk(switch)}$	$0.3/I_{pk(switch)}$
$L_{(min)}$	$\left(\frac{V_{in(min)} - V_{sat}}{I_{pk(switch)}}\right) t_{on(max)}$	$\left(\frac{V_{in(min)} - V_{sat} - V_{out}}{I_{pk(switch)}}\right) t_{on(max)}$	$\left(\frac{V_{in(min)} - V_{sat}}{I_{pk(switch)}}\right) t_{on(max)}$
C_O	$9\ \frac{I_{out} t_{on}}{V_{ripple(pp)}}$	$\frac{I_{pk(switch)}(t_{on} + t_{off})}{8V_{ripple(pp)}}$	$9\ \frac{I_{out} t_{on}}{V_{ripple(pp)}}$

V_{sat} = Saturation voltage of the output switch.
V_F = Forward voltage drop of the output rectifier.
V_{in} – Nominal input voltage.
V_{out} – Desired output voltage,
I_{out} – Desired output current.
f_{min} – Minimum desired output switching frequency at the selected values of V_{in} and I_O.
$V_{ripple(pp)}$ – Desired peak–to–peak output ripple voltage. In practice, the calculated capacitor value will need to be increased due to its equivalent series resistance and board layout. The ripple voltage should be kept to a low value since it will directly affect the line and load regulation.

■ ORDERING INFORMATION

	PACKAGE	PART No.
GM34063	SOP-8	GM34063S8
	DIP-8	GM34063D8