

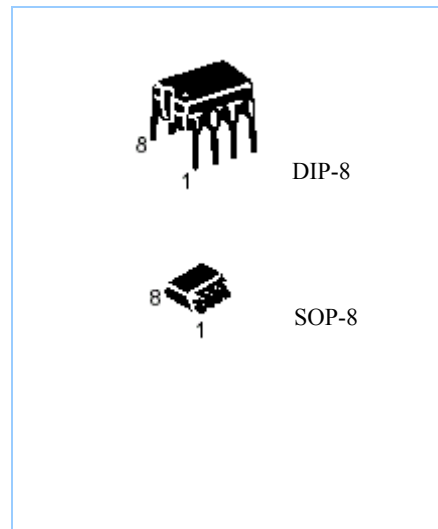
# 1.5A, Step-Up/Down Inverting Switching Regulators

## DESCRIPTION

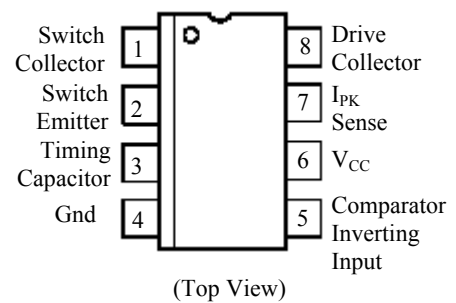
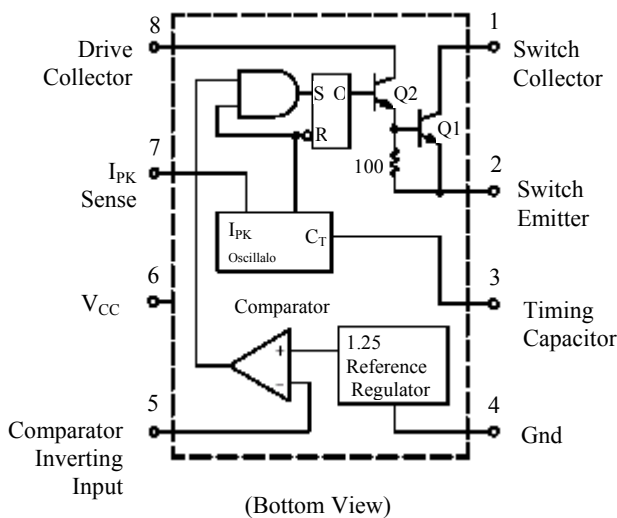
The AV34063 is a monolithic control circuit containing the primary functions required for DC-to-DC converters. This device consists of an internal temperature compensated reference, comparator, controlled duty cycle oscillator with an active current limit circuit, driver and high current output switch. This device was specifically designed to be incorporated in Step-Down and Step-Up and Voltage-inverting applications with a minimum number of external components.

## FEATURES

- Operation from 3.0 to 40V input
- Low standby current
- Current limiting
- Output switch current of 1.5A
- Output voltage adjustable
- Frequency of operation from 100Hz to 100KHz
- Precision 2% reference



## BLOCK DIAGRAM



## ORDERING INFORMATION

Part Number	Operating Temperature Range	Package Type
AV34063	0°C ~+70°C	DIP-8
AV34063S	0°C ~+70°C	SOP-8

**MAXIMUM RATING**

Characteristic	Symbol	Value	Unit
Power Supply Voltage	V <sub>CC</sub>	40	V
Comparator Input Voltage Range	V <sub>IR</sub>	-0.3 to +40	
Switch Collector Voltage	V <sub>C(switch)</sub>	40	
Switch Emitter Voltage (V <sub>PINI</sub> =40V)	V <sub>E(switch)</sub>	40	
Switch Collector to Emitter Voltage	V <sub>CE(switch)</sub>	40	
Driver Collector Voltage	V <sub>C(driver)</sub>	40	
Driver Collector Current (Note1)	I <sub>C(driver)</sub>	100	mA
Switch Current	I <sub>SW</sub>	1.5	A
Power Dissipation and Thermal Characteristics Plastic Package T <sub>A</sub> =25°C	P <sub>D</sub>	1.25	W
Thermal Resistance	R <sub>θJA</sub>	100	°C/ W
SOIC Package T <sub>A</sub> =25°C	P <sub>D</sub>	0.625	W
Thermal Resistance	R <sub>θJA</sub>	100	°C/ W
Operating Junction Temperature	T <sub>J</sub>	+150	°C
Operating Ambient Temperature Range	T <sub>A</sub>	0 to +70	°C
Storage Temperature Range	T <sub>stg</sub>	-60~150	°C

Notes: 1. Maximum package power dissipation limits must be observed.

2.ESD data available upon request.

**ELECTRICAL CHARACTERISTICS**(V<sub>CC</sub>=5.0V, T<sub>A</sub>=T<sub>low</sub> to T<sub>high</sub> [Note1], unless otherwise specified.)

Characteristics	Symbol	Min	Typ	Max	Unit
<b>OSCILLATOR</b>					
Frequency (V <sub>pin5</sub> =0V, C <sub>T</sub> =1.0nF, T <sub>A</sub> =25°C)	F <sub>OSC</sub>	24	33	42	KHz
Charge Current (V <sub>CC</sub> =5.0V to 40V, T <sub>A</sub> =25°C)	I <sub>chg</sub>	24	35	42	μA
Discharge Current (V <sub>CC</sub> =5.0V to 40V, T <sub>A</sub> =25°C)	I <sub>dischg</sub>	140	220	260	μA
Discharge to Charge Current Ratio (Pin 7 to V <sub>CC</sub> , T <sub>A</sub> =25°C)	I <sub>dischg</sub> / I <sub>chg</sub>	5.2	6.5	7.5	-
Current Limit Sense Voltage (I <sub>chg</sub> = I <sub>dischg</sub> , T <sub>A</sub> =25°C)	V <sub>ipk(sence)</sub>	250	300	350	mV
<b>OUTPUT SWITCH (NOTE 2)</b>					
Saturation Voltage, Darlington Connection (Note 3) (I <sub>SW</sub> =1.0A, Pins 1,8 connected)	V <sub>CE(sat)</sub>	-	1.0	1.3	V
Saturation Voltage, Darlington Connection (I <sub>SW</sub> =1.0A, R <sub>pin8</sub> =82Ω to V <sub>CC</sub> , Forced β≈20)	V <sub>CE(sat)</sub>	-	0.45	0.7	V
DC Current Gain (I <sub>SW</sub> =1.0A, V <sub>CE</sub> =5.0V, T <sub>A</sub> =25°C)	H <sub>EF</sub>	50	75	-	-
Collector Off-State Current (V <sub>CE</sub> =40V)	I <sub>C(off)</sub>	-	0.01	100	μA
<b>COMPARATOR</b>					
Threshold Voltage (T <sub>A</sub> =25°C) (T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> )	V <sub>th</sub>	1.238 1.225	1.25 -	1.262 1.275	V
Threshold Voltage Line Regulation (V <sub>CC</sub> =3.0V to 40V)	Reg <sub>line</sub>	-	1.4	5.0	mV
Input Bias Current (V <sub>in</sub> =0V)	I <sub>IB</sub>	-	-20	-400	nA
<b>TOTAL DEVICE</b>					
Supply Current ((V <sub>CC</sub> =5.0V to 40V, C <sub>T</sub> =1.0nF, (Pin 7 to V <sub>CC</sub> , (Pin 5> V <sub>th</sub> (Pin 2=Gnd, remaining pins open)	I <sub>CC</sub>	-	-	4.0	mA

**Notes:** 1. T<sub>low</sub>=0°C      T<sub>high</sub>=+70°C

- Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.
- If the output switch is driven into hard saturation (non-Darlington) at low switch current (≤300mA) and high driver currents (≥30mA), it may take up to 2.0 μs for it to come out of saturation. This condition will shorten the off time at frequencies ≥30KHz, and is magnified at high temperature. 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 : ( I<sub>C</sub> output/ ( I<sub>C</sub> driver - 7.0mA) ≥10 )

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

Typical Characteristics

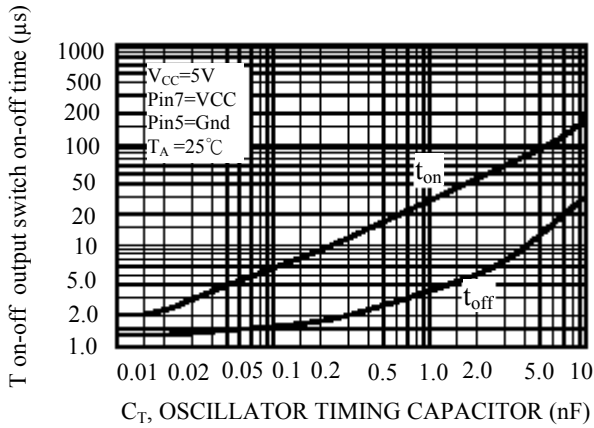


Figure 1. Output Switch On-Off Time versus Oscillator Timing Capacitor

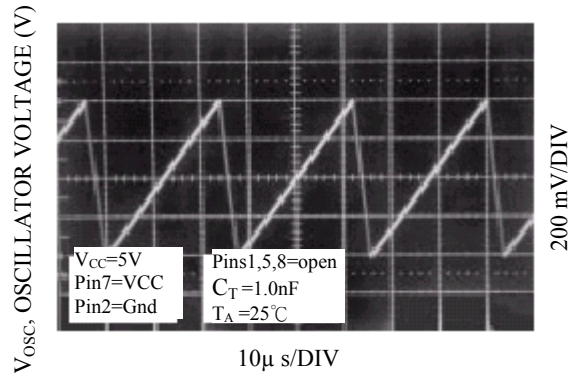


Figure2. Timing Capacitor Waveform

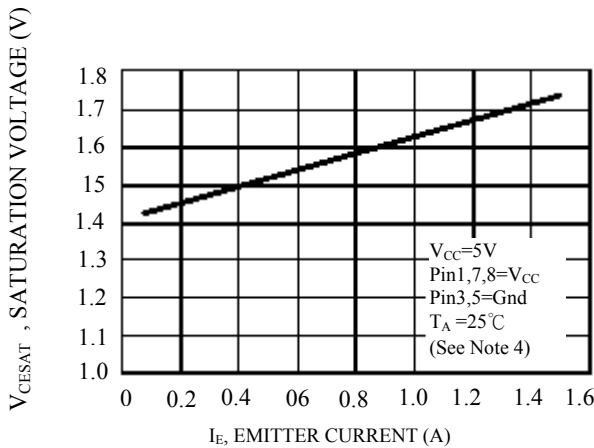


Figure 3. Emitter Follower Configuration Output Saturation Voltage versus Emitter

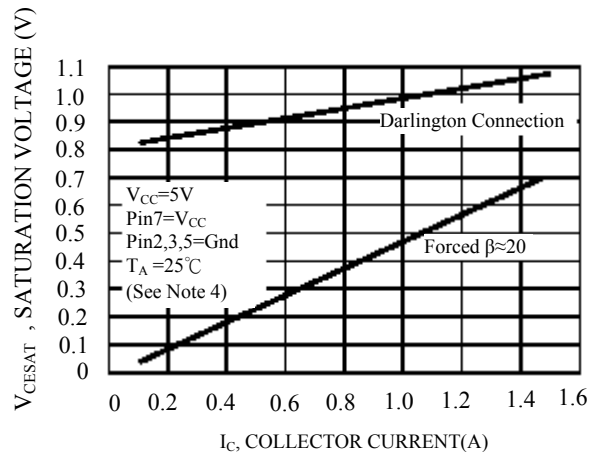


Figure 4. Common Emitter Configuration Output Switch Saturation Voltage versus Collector Current

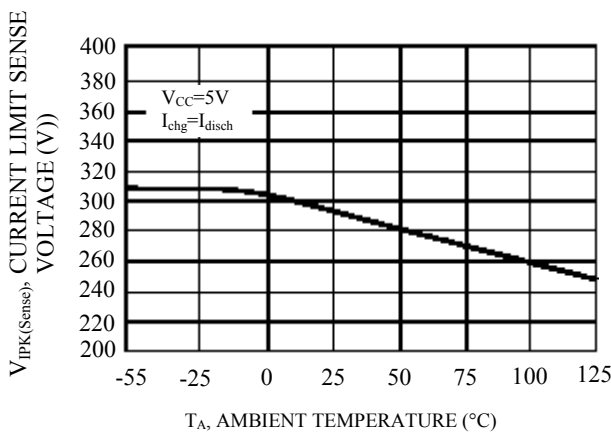


Figure 5. Current Limit Sense Voltage versus Temperature

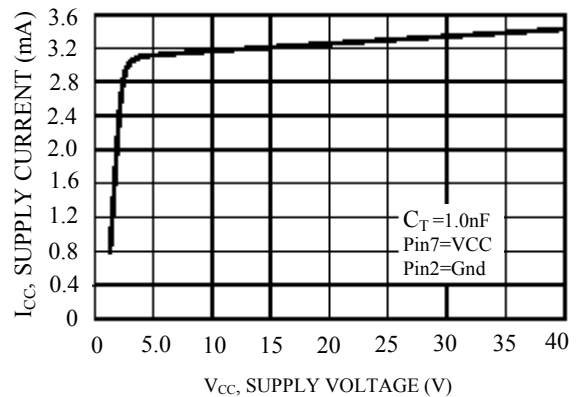
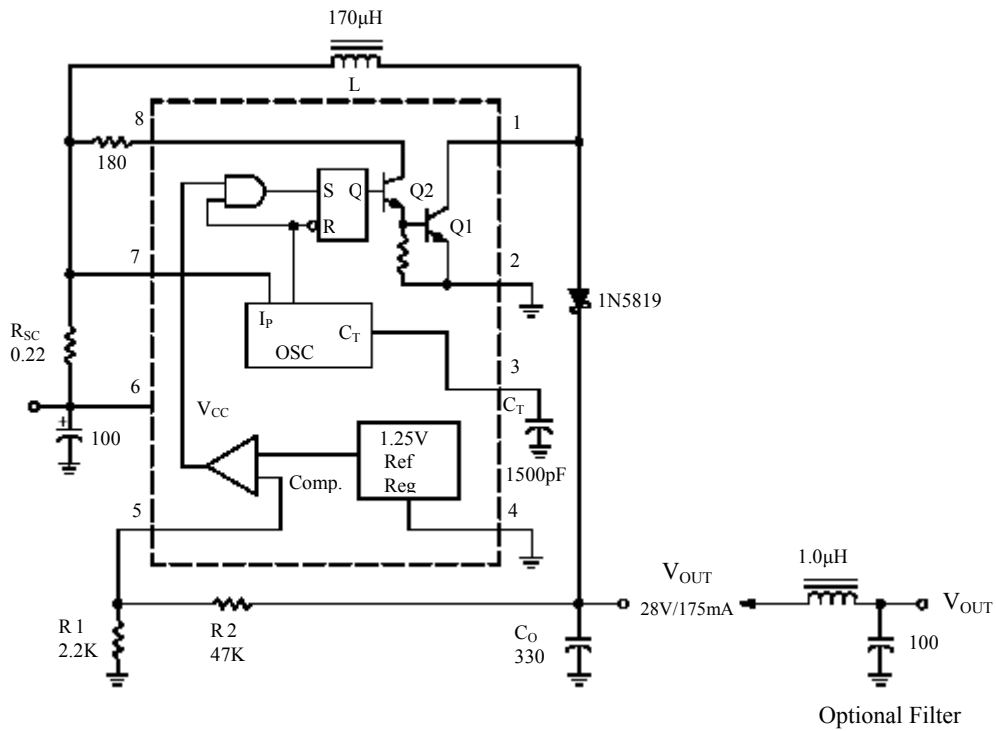


Figure 6. Standby Supply Current versus Supply Voltage



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

Figure 7. Step-Up Converter

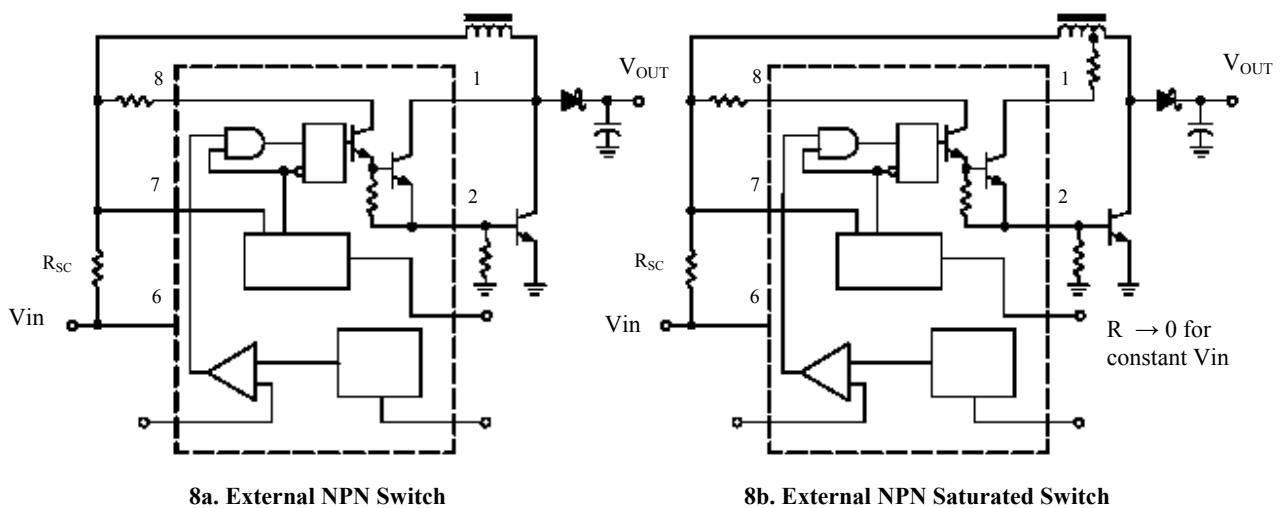
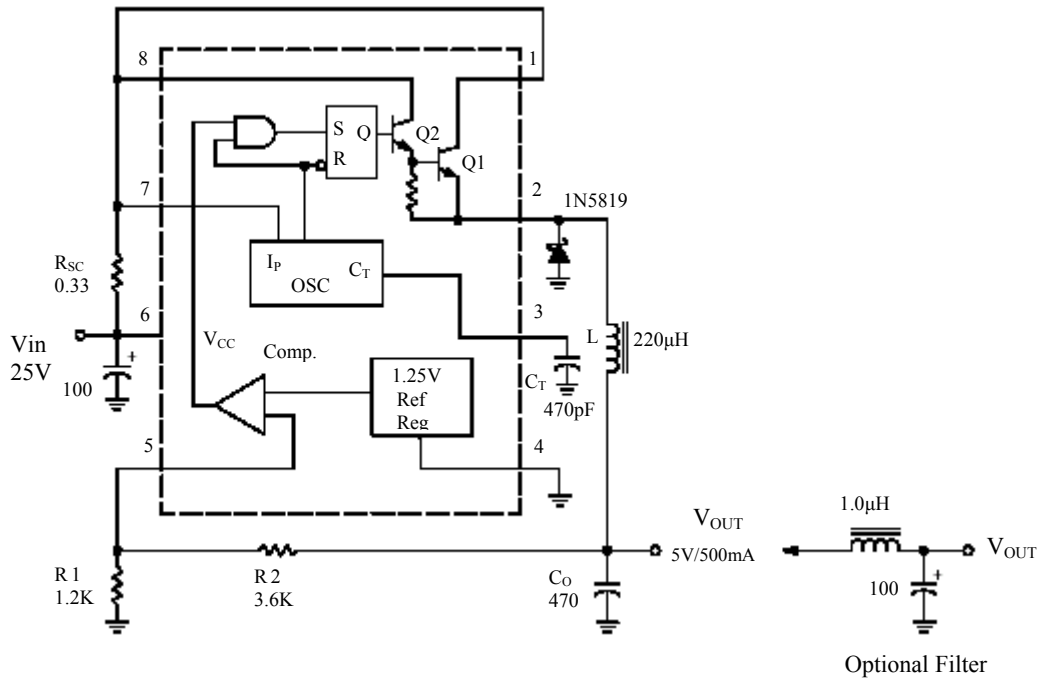
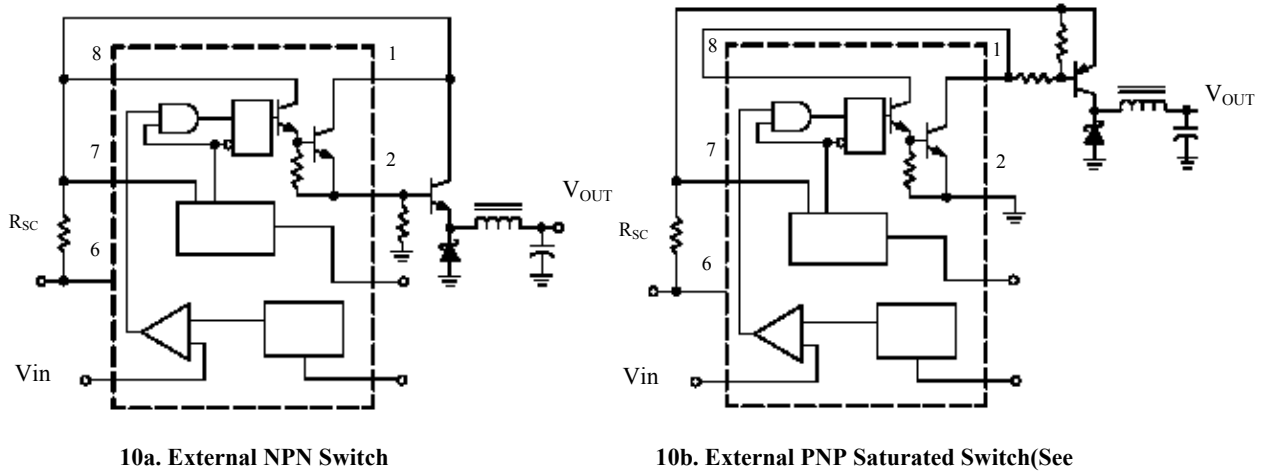


Figure 8. External Current Boost Connections for  $I_C$  Peak Greater than 1.5 A



Test	Conditions	Results
Line Regulation	$V_{in} = 15\text{ V to } 25\text{ V}, I_O = 500\text{ mA}$	$12\text{ mV} = \pm 0.12\%$
Load Regulation	$V_{in} = 25\text{ V}, I_O = 50\text{ mA to } 500\text{ mA}$	$3.0\text{ mV} = \pm 0.03\%$
Output Ripple	$V_{in} = 25\text{ V}, I_O = 500\text{ mA}$	$120\text{ mV}_{pp}$
Short Circuit Current	$V_{in} = 25\text{ V}, R_L = 0.1\Omega$	$1.1\text{ A}$
Efficiency	$V_{in} = 25\text{ V}, I_O = 500\text{ mA}$	$83.7\%$
Output Ripple With Optional Filter	$V_{in} = 25\text{ V}, I_O = 500\text{ mA}$	$40\text{ mV}_{pp}$

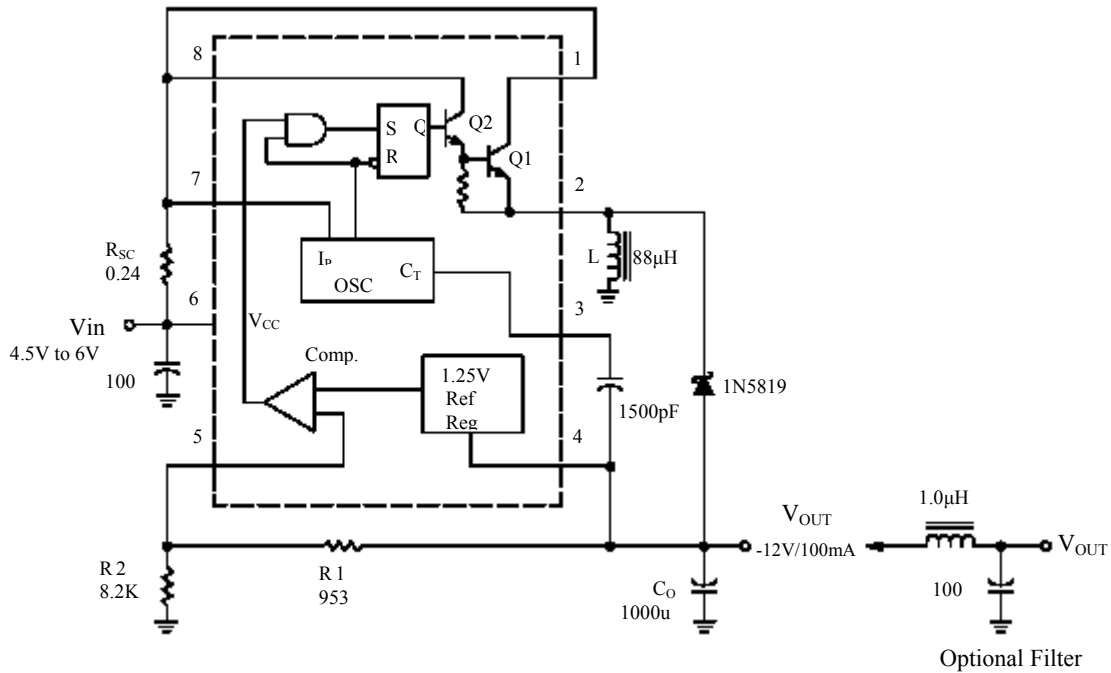
Figure9. Step-Down Converter



10a. External NPN Switch

10b. External PNP Saturated Switch(See

Figure10. External Current Boost Connections for  $I_C$  Peak Greater than 1.5 A



Test	Conditions	Results
Line Regulation	Vin = 4.5 V to 6 V, IO = 100 mA	3.0 mV = ±0.012%
Load Regulation	Vin = 5.0 V, IO = 10 mA to 100 mA	0.022 mV = ±0.09%
Output Ripple	Vin = 5.0 V, IO = 100 mA	500 mVpp
Short Circuit Current	V in = 5.0 V, RL = 0.1Ω	910mA
Efficiency	Vin = 5.0 V, IO = 100 mA	62.6%
Output Ripple With Optional Filter	Vin = 5.0 V, IO = 100 mA	70 mVpp

Figure11. Step-Down Converter

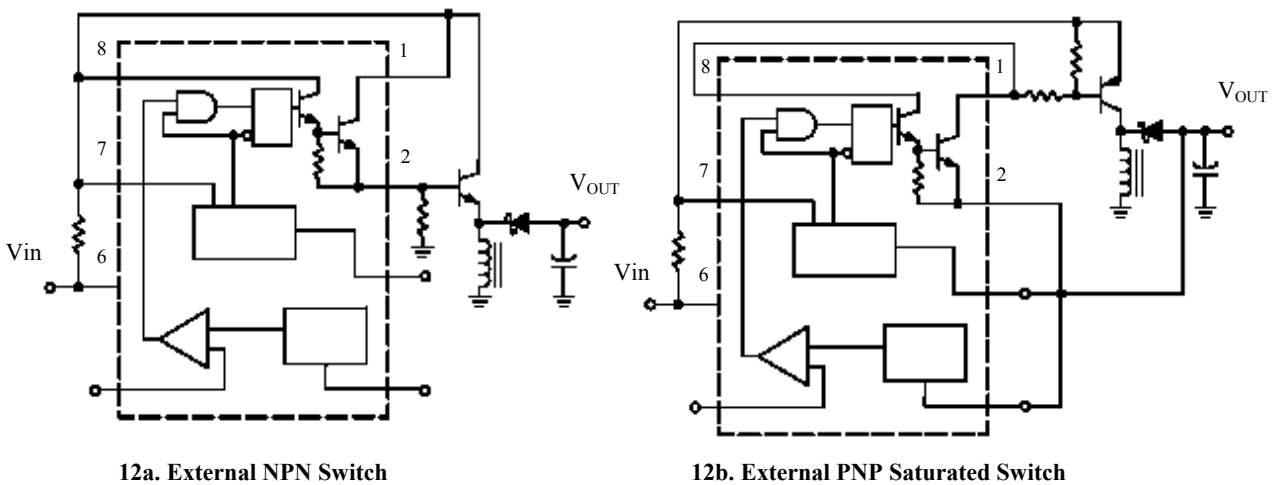


Figure12. External Current Boost Connections for IC Peak Greater than 1.5 A

**Note 5 :** If the output switch is driven into hard saturation (non-Darlington configuration) at low switch currents ( $\leq 300\text{mA}$ ) and high driver currents ( $\geq 30\text{mA}$ ), it may take up to  $2.0\mu\text{s}$  to come out of saturation. This condition will shorten the off time at frequencies  $\geq 30\text{KHz}$ , 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 is used, the following output drive condition is recommended.

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

Figure13. Design Formula Table

$V_{sat}$ =Saturation voltage of the output switch.

$V_F$  =Forward voltage drop of the output rectifier.

**The following power supply characteristics must be chosen:**

$V_{in}$  -Nominal input voltage.

$V_{out}$  -Desired output voltage,  $V_{out} = 1.25(1+R2/R1)$ .

$I_{out}$  - Desired output current.

$F_{min}$  -Minimum desired output switching frequency at the selected value of  $V_{in}$  and  $I_o$ .

$V_{ripple(p-p)}$  - 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.