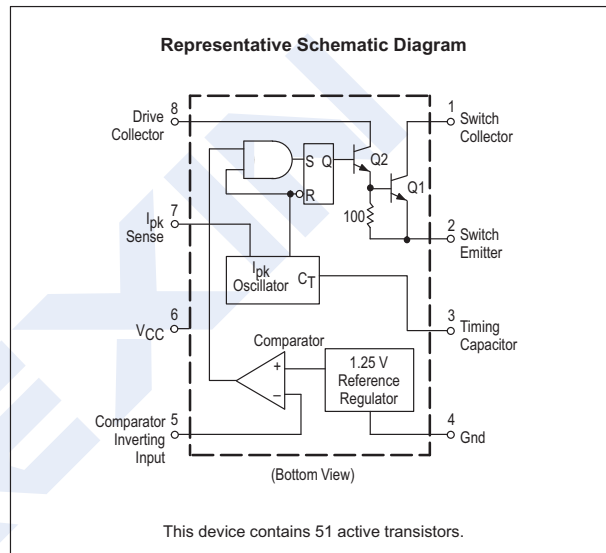
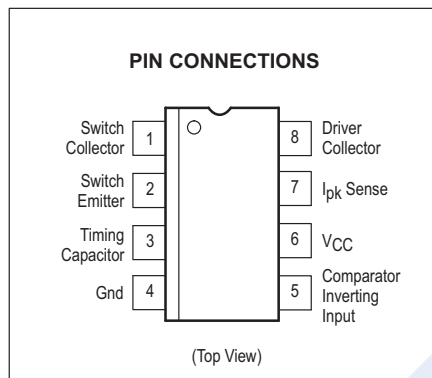
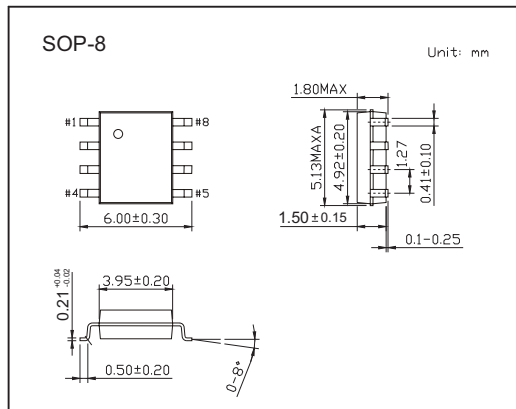


## DC-to-DC Converter Control Circuits

### KM34064

#### ■ Features

- Operation from 3.0 V to 40 V Input
- Low Standby Current
- Current Limiting
- Output Switch Current to 1.2 A
- Output Voltage Adjustable
- Frequency Operation to 100 kHz
- Precision 2% Reference



#### ■ Absolute Maximum Ratings $T_a = 25^\circ\text{C}$

| Parameter                                       | Symbol      | Rating      | Unit                      |
|---|-------------|-------------|---------------------------|
| Power Supply Voltage                            | VCC         | 40          | V                         |
| Comparator Input Voltage Range                  | VIR         | -0.3 to +40 |                           |
| Switch Collector Voltage                        | VC(switch)  | 40          |                           |
| Switch Emitter Voltage (VPin 1 = 40 V)          | VE(switch)  | 40          |                           |
| Switch Collector to Emitter Voltage             | VCE(switch) | 40          |                           |
| Driver Collector Voltage                        | VC(driver)  | 40          |                           |
| Driver Collector Current (Note 1)               | IC(driver)  | 100         | mA                        |
| Switch Current                                  | ISW         | 1.2         | A                         |
| SOP8 Package, D Suffix $T_A = 25^\circ\text{C}$ | PD          | 625         | mW                        |
| Thermal Resistance                              | RθJA        | 160         | $^\circ\text{C}/\text{W}$ |
| Operating Junction Temperature                  | TJ          | +150        | $^\circ\text{C}$          |
| Operating Ambient Temperature Range             | TA          | 0 to +70    | $^\circ\text{C}$          |
| Storage Temperature Range                       | Tstg        | -65 to 150  |                           |

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

2.ESD data available upon request.

## DC-to-DC Converter Control Circuits

### KM34064

#### ■ ELECTRICAL CHARACTERISTICS ( $V_{CC} = 5.0\text{ V}$ , $T_A = T_{low}$ to $T_{high}$ [Note 3], unless otherwise specified.)

| Characteristics   | Symbol               | Min           | Typ       | Max           | Unit          |
|---|----------------------|---------------|-----------|---------------|---------------|
| <b>OSCILLATOR</b>   |                      |               |           |               |               |
| Frequency ( $V_{Pin 5} = 0\text{ V}$ , $C_T = 1.0\text{ nF}$ , $T_A = 25\text{ }^\circ\text{C}$ )   | $f_{osc}$            | 24            | 33        | 42            | kHz           |
| Charge Current ( $V_{CC} = 5.0\text{ V to } 40\text{ V}$ , $T_A = 25\text{ }^\circ\text{C}$ )   | $I_{chg}$            | 24            | 35        | 42            | $\mu\text{A}$ |
| Discharge Current ( $V_{CC} = 5.0\text{ V to } 40\text{ V}$ , $T_A = 25\text{ }^\circ\text{C}$ )  | $I_{dischg}$         | 140           | 220       | 260           | $\mu\text{A}$ |
| Discharge to Charge Current Ratio (Pin 7 to $V_{CC}$ , $T_A = 25\text{ }^\circ\text{C}$ )   | $I_{dischg}/I_{chg}$ | 5.2           | 6.5       | 7.5           | –             |
| Current Limit Sense Voltage ( $I_{chg} = I_{dischg}$ , $T_A = 25\text{ }^\circ\text{C}$ )   | $V_{ipk(sense)}$     | 250           | 300       | 350           | mV            |
| <b>OUTPUT SWITCH (Note 4)</b>   |                      |               |           |               |               |
| Saturation Voltage, Darlington Connection (Note 5)<br>( $I_{SW} = 1.0\text{ A}$ , Pins 1, 8 connected)  | $V_{CE(sat)}$        | –             | 1.0       | 1.3           | V             |
| Saturation Voltage, Darlington Connection<br>( $I_{SW} = 1.0\text{ A}$ , $R_{pin 8} = 82\ \Omega$ to $V_{CC}$ , Forced $\beta \approx 20$ )                       | $V_{CE(sat)}$        | –             | 0.45      | 0.7           | V             |
| DC Current Gain ( $I_{SW} = 1.0\text{ A}$ , $V_{CE} = 5.0\text{ V}$ , $T_A = 25\text{ }^\circ\text{C}$ )  | $h_{FE}$             | 50            | 75        | –             | –             |
| Collector Off-State Current ( $V_{CE} = 40\text{ V}$ )  | $I_{C(off)}$         | –             | 0.01      | 100           | $\mu\text{A}$ |
| <b>COMPARATOR</b>   |                      |               |           |               |               |
| Threshold Voltage<br>$T_A = 25\text{ }^\circ\text{C}$<br>$T_A = T_{low}$ to $T_{high}$  | $V_{th}$             | 1.225<br>1.21 | 1.25<br>– | 1.275<br>1.29 | V             |
| Threshold Voltage Line Regulation ( $V_{CC} = 3.0\text{ V to } 40\text{ V}$ )   | $Reg_{line}$         | –             | 1.4       | 6.0           | mV            |
| Input Bias Current ( $V_{in} = 0\text{ V}$ )  | $I_{IB}$             | –             | –20       | –400          | nA            |
| <b>TOTAL DEVICE</b>   |                      |               |           |               |               |
| Supply Current ( $V_{CC} = 5.0\text{ V to } 40\text{ V}$ , $C_T = 1.0\text{ nF}$ , Pin 7 = $V_{CC}$ ,<br>$V_{Pin 5} > V_{th}$ , Pin 2 = Gnd, remaining pins open) | $I_{CC}$             | –             | –         | 4.0           | mA            |

NOTES: 3.  $T_{low} = 0\text{ }^\circ\text{C}$ ,  $T_{high} = 70\text{ }^\circ\text{C}$

4. Low duty cycle techniques are used during test to maintain junction temperature as close to ambient temperature as possible.
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  $\mu\text{s}$  for it 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 configuration is used, the following output drive condition is recommended:

$$\text{Forced } \beta \text{ of output switch: } \frac{I_{C \text{ output}}}{I_{C \text{ driver}} - 7.0\text{ mA}} \geq 10$$

\*The 100  $\Omega$  resistor in the emitter of the driver requires about 7mA before the output switch conducts.

#### ■ Marking

|         |       |
|---------|-------|
| Marking | 34064 |
|---------|-------|

## DC-to-DC Converter Control Circuits

### KM34064

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

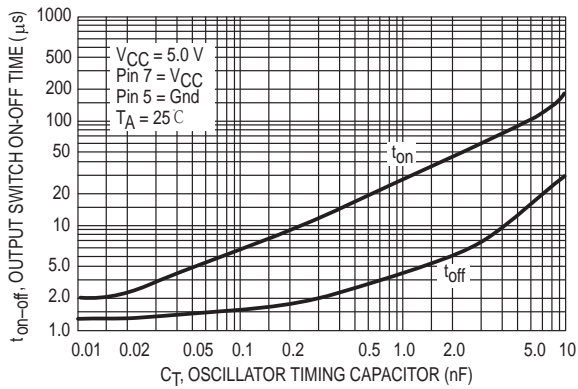


Figure 2. Timing Capacitor Waveform

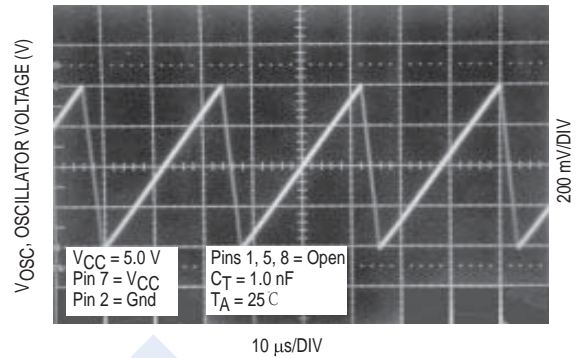


Figure 3. Emitter Follower Configuration Output Saturation Voltage versus Emitter Current

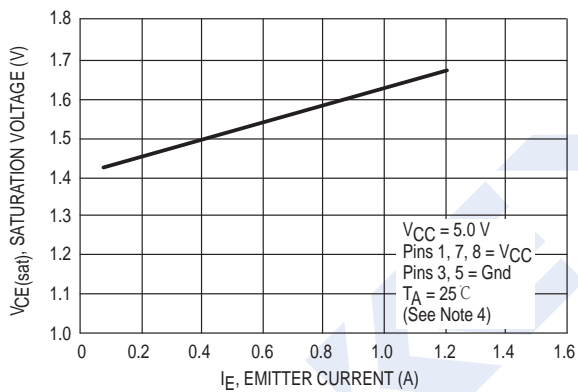


Figure 4. Common Emitter Configuration Output Switch Saturation Voltage versus Collector Current

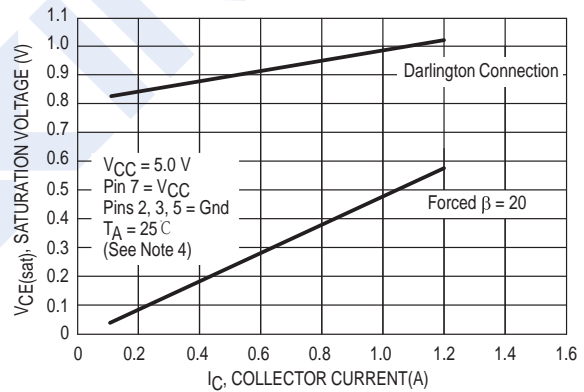


Figure 5. Current Limit Sense Voltage versus Temperature

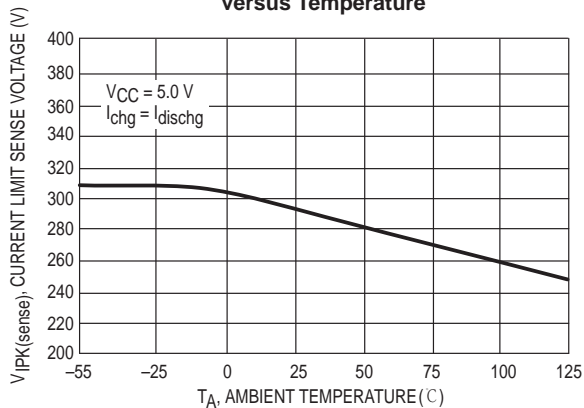
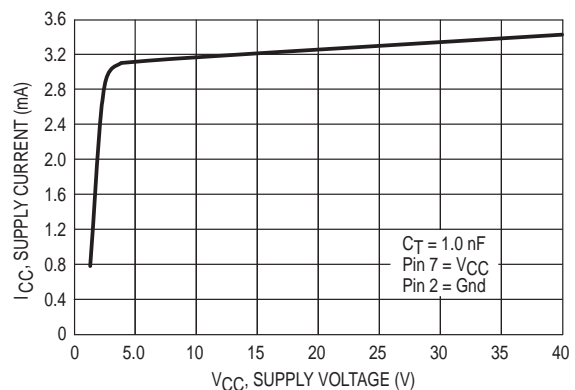


Figure 6. Standby Supply Current versus Supply Voltage

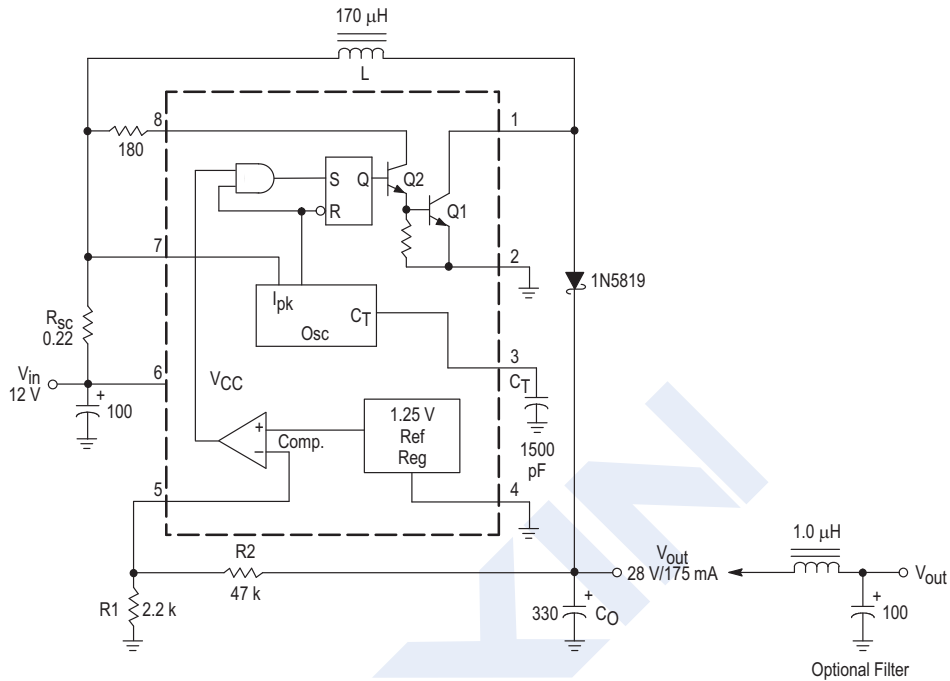


NOTE: 4. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

# DC-to-DC Converter Control Circuits

## KM34064

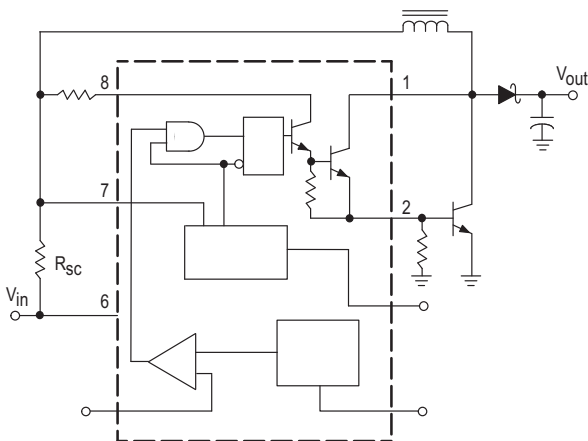
Figure 7. Step-Up Converter



| 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 | $V_{in} = 12\text{ V}, I_O = 175\text{ mA}$                 | $40\text{ mVpp}$           |

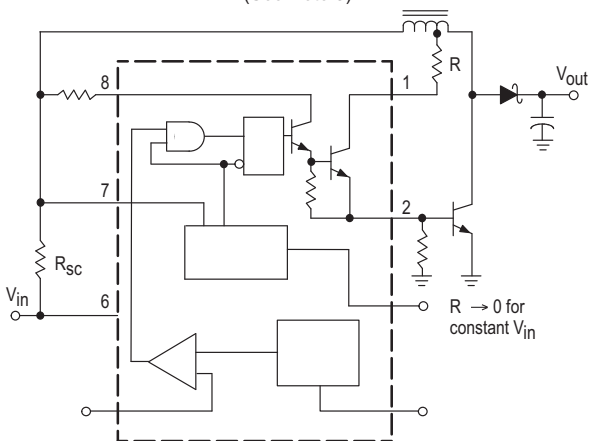
Figure 8. External Current Boost Connections for  $I_C$  Peak Greater than 1.2 A

8a. External NPN Switch



8b. External NPN Saturated Switch

(See Note 5)

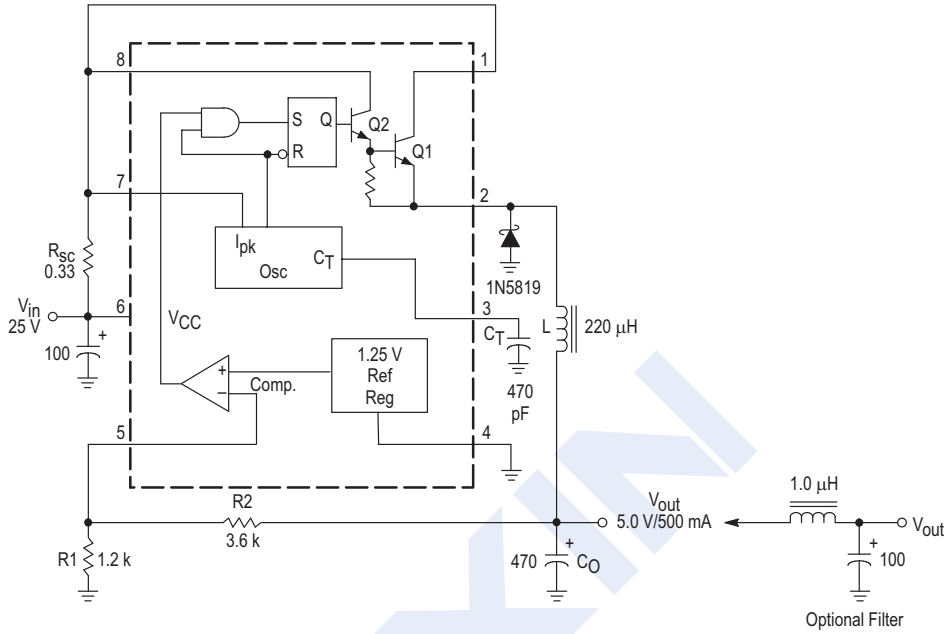


**NOTE:** 5. If the output switch is driven into hard saturation (non-Darlington configuration) at low switch currents ( $\leq 300\text{ mA}$ ) and high driver currents ( $\geq 30\text{ mA}$ ), it may take up to  $2.0\text{ }\mu\text{s}$  to come out of saturation. This condition will shorten the off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

## DC-to-DC Converter Control Circuits

### KM34064

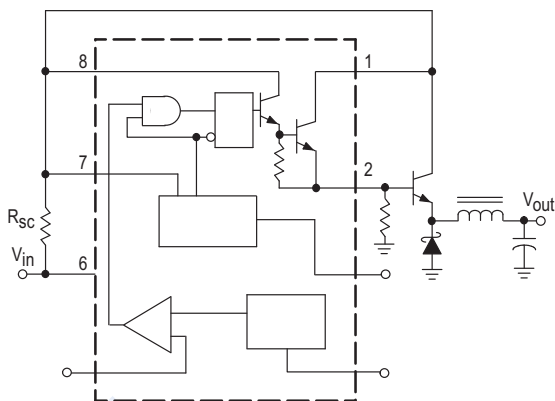
Figure 9. Step-Down Converter



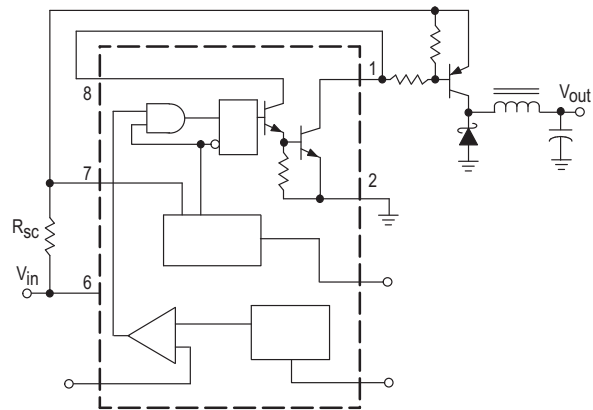
| Test                               | Conditions   | Results                    |
|------------------------------------|--|----------------------------|
| Line Regulation                    | $V_{in} = 15\text{ V to } 25\text{ V}, I_O = 500\text{ mA}$  | $12\text{ mV} \pm 0.12\%$  |
| Load Regulation                    | $V_{in} = 25\text{ V}, I_O = 50\text{ mA to } 500\text{ mA}$ | $3.0\text{ mV} \pm 0.03\%$ |
| Output Ripple                      | $V_{in} = 25\text{ V}, I_O = 500\text{ mA}$                  | $120\text{ mVpp}$          |
| 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 | $V_{in} = 25\text{ V}, I_O = 500\text{ mA}$                  | $40\text{ mVpp}$           |

Figure 10. External Current Boost Connections for  $I_C$  Peak Greater than 1.2 A

10a. External NPN Switch

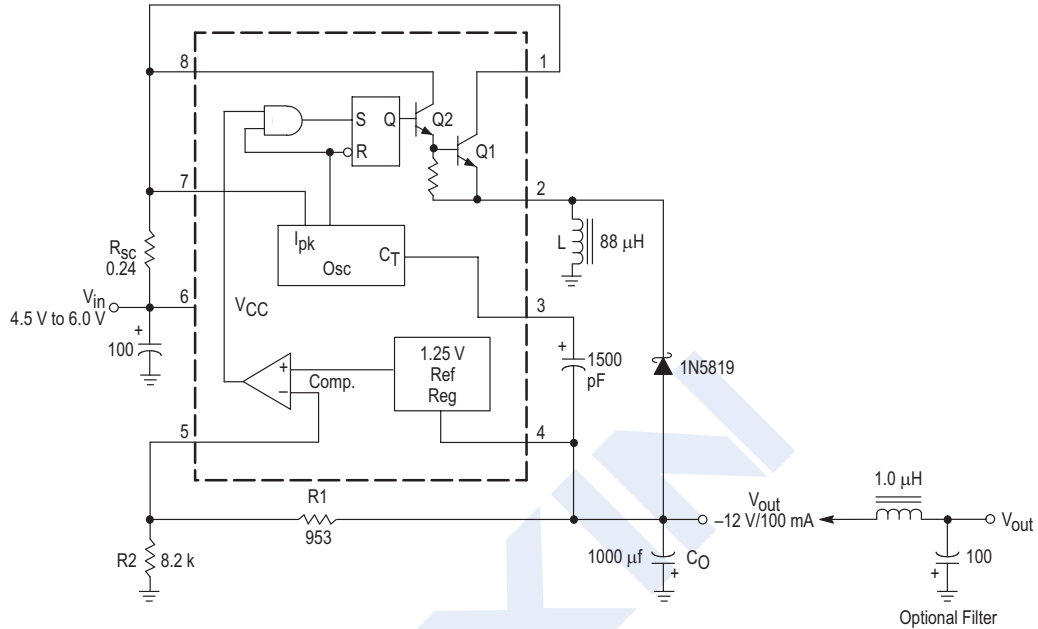


10b. External PNP Saturated Switch



## DC-to-DC Converter Control Circuits KM34064

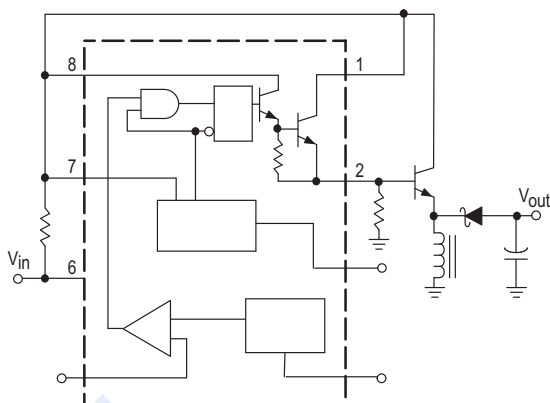
Figure 11. Voltage Inverting Converter



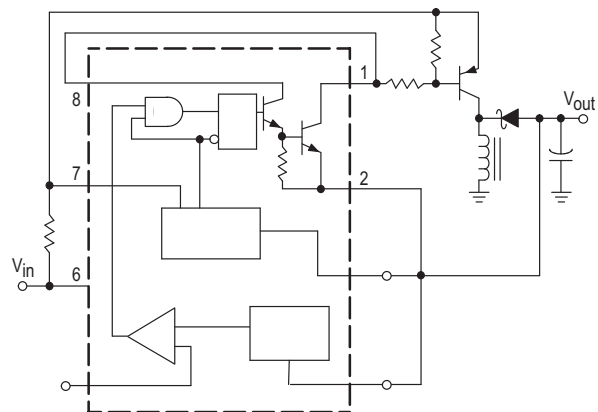
| Test                               | Conditions   | Results                              |
|------------------------------------|--|--------------------------------------|
| Line Regulation                    | $V_{in} = 4.5 \text{ V to } 6.0 \text{ V}, I_O = 100 \text{ mA}$ | $3.0 \text{ mV} \approx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

Figure 12. External Current Boost Connections for  $I_C$  Peak Greater than 1.2 A

12a. External NPN Switch



12b. External PNP Saturated Switch



## DC-to-DC Converter Control Circuits

### KM34064

Figure 13. Design Formula Table

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

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

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

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

$V_{in}$  - Nominal input voltage.

$V_{out}$  - Desired output voltage,  $|V_{out}| = 1.25 \left( 1 + \frac{R_2}{R_1} \right)$

$I_{out}$  - 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.