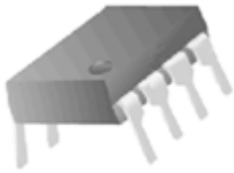
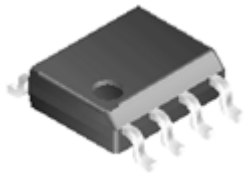
# DC-DC Converter Control Circuits

# LR34063



DIP-8



SOP-8

## DESCRIPTION:

The LR34063 Series is a monolithic control circuit containing the primary functions required for DC-to-DC converters.These devices consist of an internal temperature compensated reference,comparator, controlled duty cycle oscillator with an active current limit circuit, driver and high current output switch.This series was specifically designed to be incorporated in Step-Down and Step-Up and Voltage-Inverting applications with a minimum number of external components.

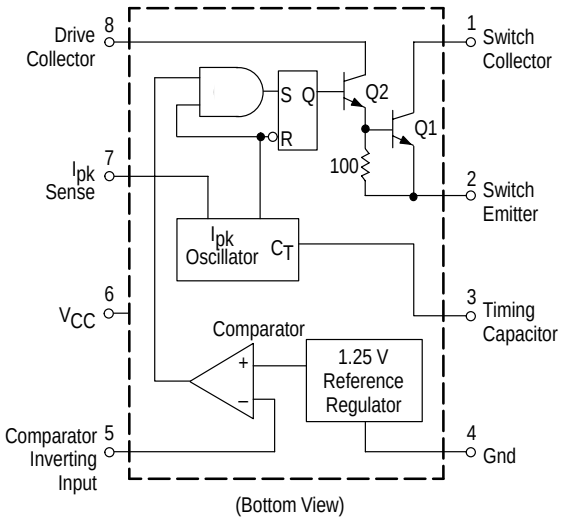
## FEATURE:

- Operation from 3.0 V to 40 V Input
- Low Standby Current
- Current Limiting
- Output Switch Current to 1.5 A
- Output Voltage Adjustable
- Frequency Operation to 100 kHz
- Precision 2% Reference

## ORDERING INFORMATION

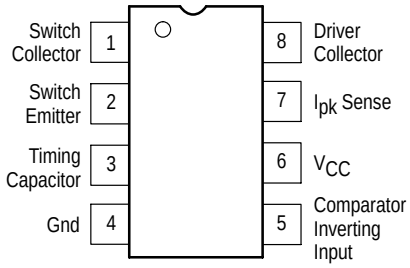
| Device | Package |
|---|---|
| LR34063 | DIP-8 |
| LR34063D | SOP-8 |

## BLOCK DIAGRAM




(Bottom View)

## PIN CONNECTIONS




(Top View)

## LR34063

### 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 | $V_{C(switch)}$ | 40 | Vdc |
| Switch Emitter Voltage ($V_{Pin\ 1}$ = 40 V) | $V_{E(switch)}$ | 40 | Vdc |
| Switch Collector to Emitter Voltage | $V_{CE(switch)}$ | 40 | Vdc |
| Driver Collector Voltage | $V_{C(driver)}$ | 40 | Vdc |
| Driver Collector Current (Note 1) | $I_{C(driver)}$ | 100 | mA |
| Switch Current | $I_{SW}$ | 1.5 | A |
| Power Dissipation and Thermal Characteristics<br>DIP-8 Package,<br>$T_A$ = 25°C<br>Thermal Resistance<br>SOP-8 Package, D Suffix<br>$T_A$ = 25°C<br>Thermal Resistance | <br><br>$P_D$<br>$R_{\theta JA}$<br><br>$P_D$<br>$R_{\theta JA}$ | <br><br>1.25<br>100<br><br>625<br>160 | <br><br>W<br>°C/W<br><br>mW<br>°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 |

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

### ELECTRICAL CHARACTERISTICS ($V_{CC}$ = 5.0 V, $T_A$ = $T_{low}$ to $T_{high}$ [Note 2], 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 3) | | | | | |
| Saturation Voltage, Darlington Connection (Note 4)<br>($I_{SW}$ = 1.0 A, Pins 1, 8 connected) | $V_{CE(sat)}$ | – | 1.0 | 1.3 | V |
| Saturation Voltage, Darlington Connection<br>($I_{SW}$ = 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 |

**NOTES:** 2. $T_{low}$ = 0°C ,$T_{high}$ = +70°C
3. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.
4. 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.

**ELECTRICAL CHARACTERISTICS (continued)** ($V_{CC}$ = 5.0 V, $T_A$ = $T_{low}$ to $T_{high}$ [Note 2], unless otherwise specified.)

| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **COMPARATOR** | | | | | |
| Threshold Voltage<br>$T_A$ = 25°C<br>$T_A$ = $T_{low}$ to $T_{high}$ | $V_{th}$ | <br>1.23<br>1.21 | <br>1.25<br>– | <br>1.27<br>1.29 | V |
| 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 |

**NOTES:** 2. $T_{low}$ = 0°C , $T_{high}$ = +70°C

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

4. 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.

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

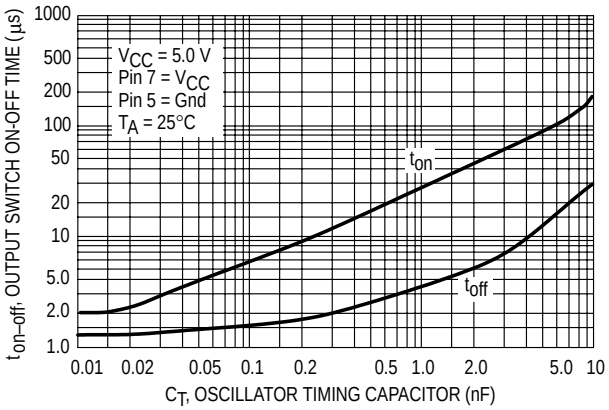



**Figure 2. Timing Capacitor Waveform**

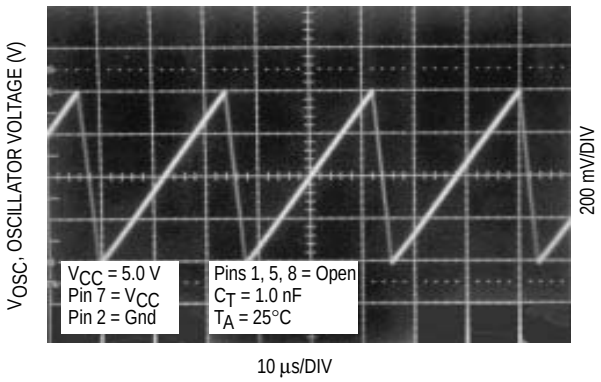



**Figure 3. Emitter Follower Configuration Output Saturation Voltage versus Emitter Current**

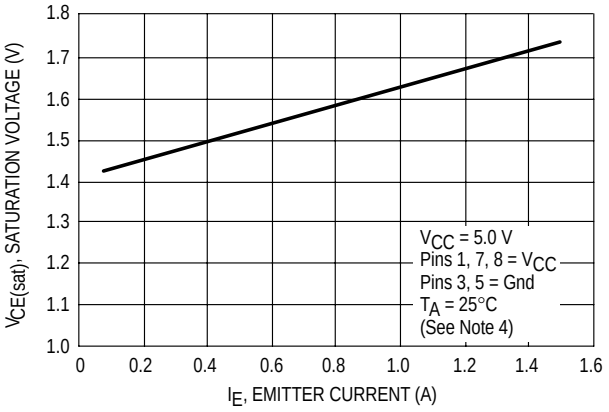



**Figure 4. Common Emitter Configuration Output Switch Saturation Voltage versus Collector Current**

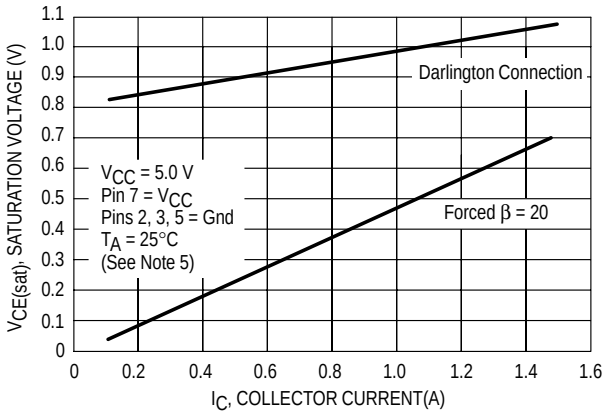



**Figure 5. Current Limit Sense Voltage versus Temperature**

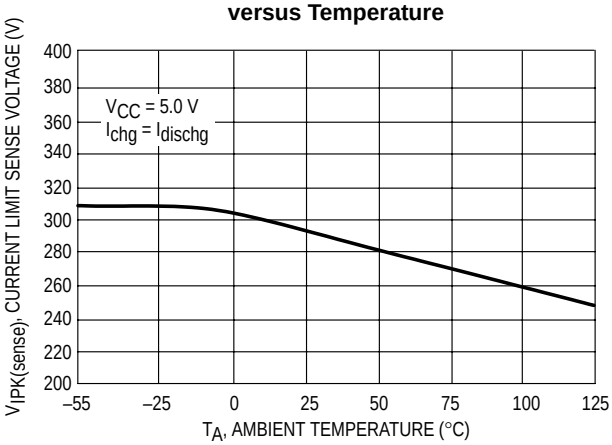
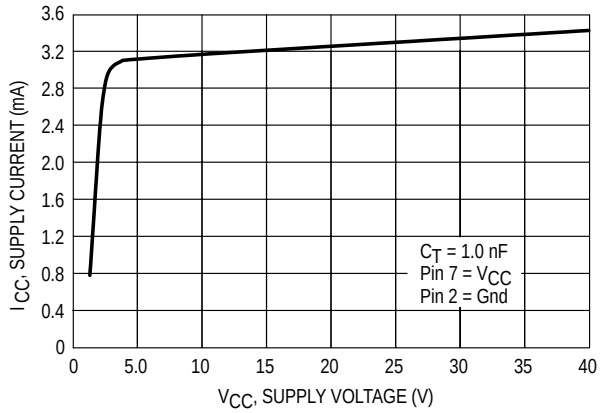
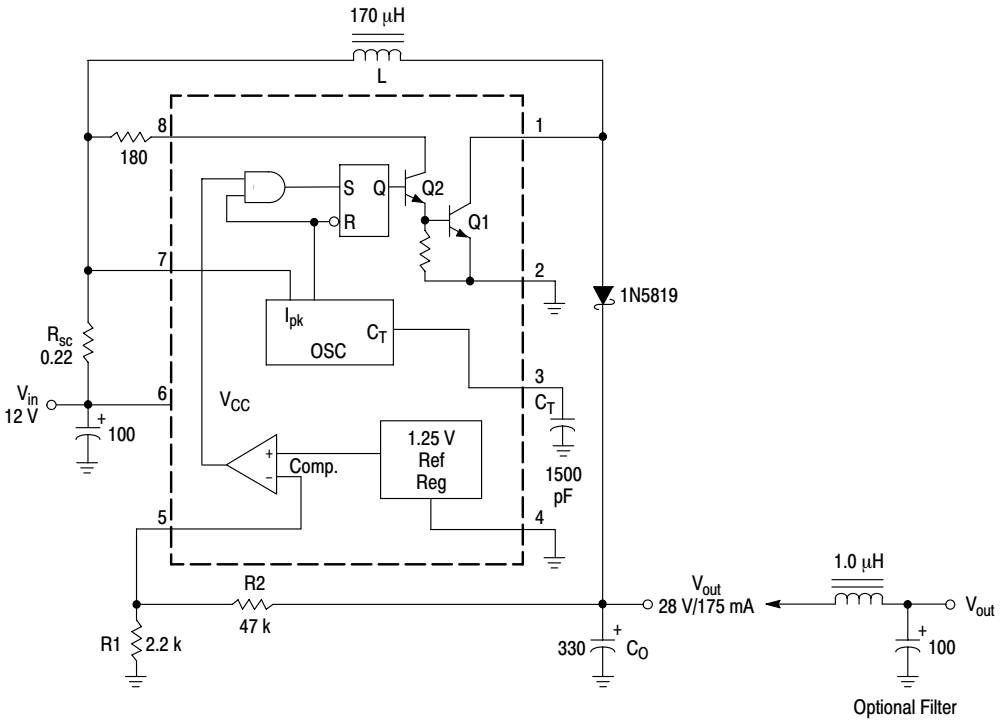



**Figure 6. Standby Supply Current versus Supply Voltage**




**NOTE:** 5. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.




| 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 |

**Figure 7. Step−Up Converter**

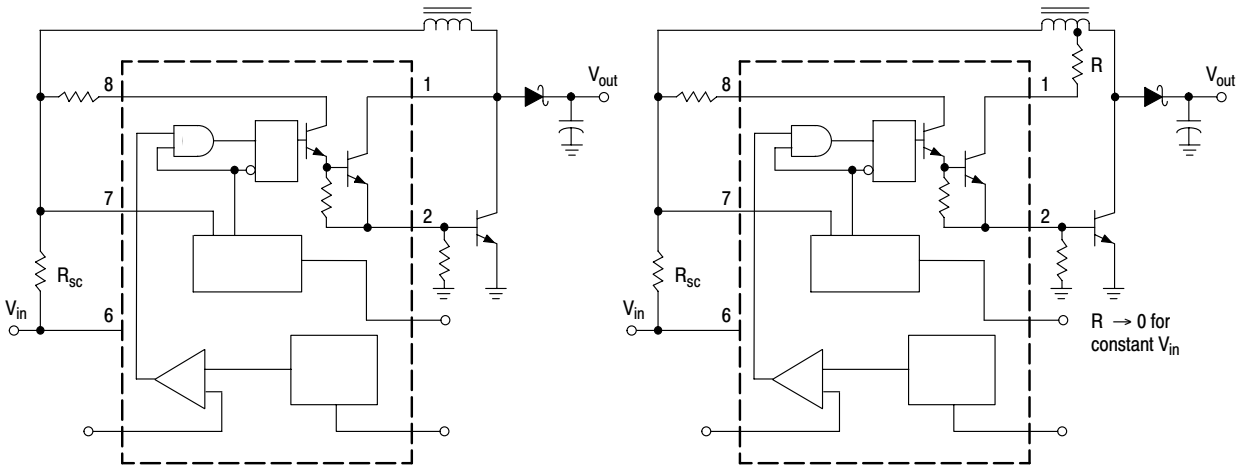
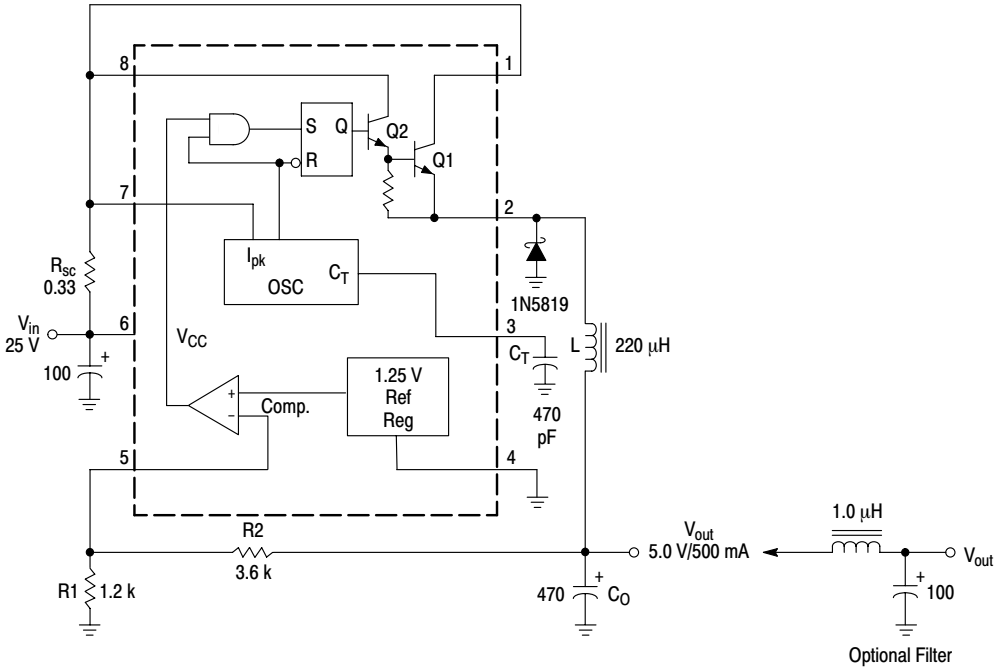



**Figure 8. External Current Boost Connections for $I_C$ Peak Greater than 1.5 A**

**8a. External NPN Switch**

**8b. External NPN Saturated Switch**
(See Note 6)

6. 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 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.




| 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, $I_O$ = 50 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 |

**Figure 9. Step−Down Converter**

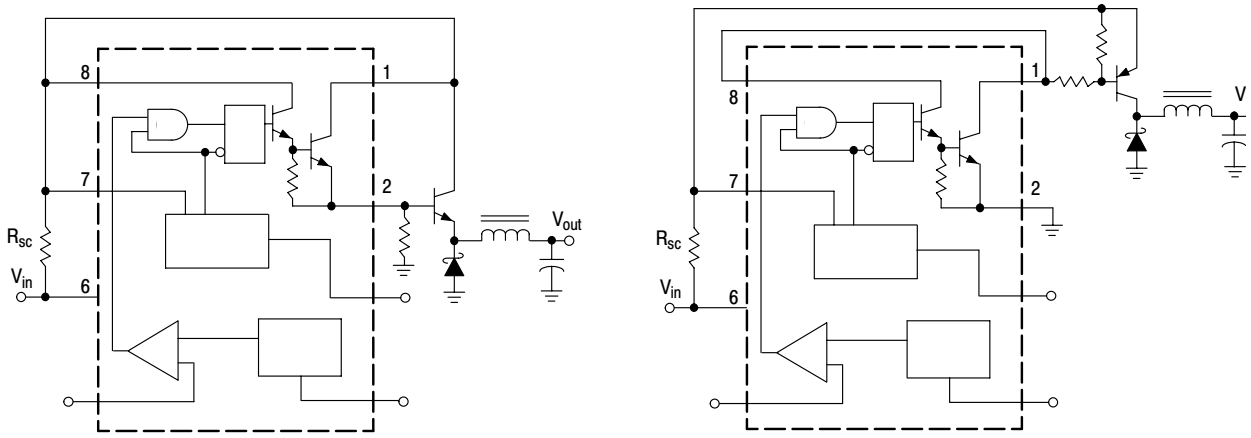
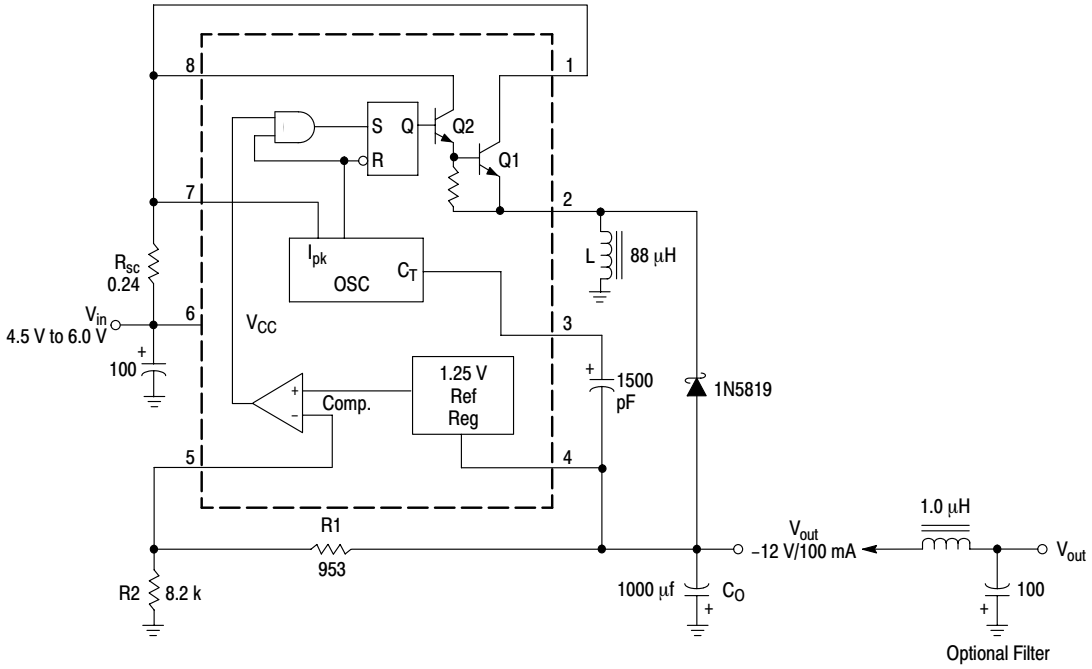



**Figure 10. External Current Boost Connections for $I_C$ Peak Greater than 1.5 A**

**10a. External NPN Switch** **10b. 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 |

**Figure 11. Voltage Inverting Converter**

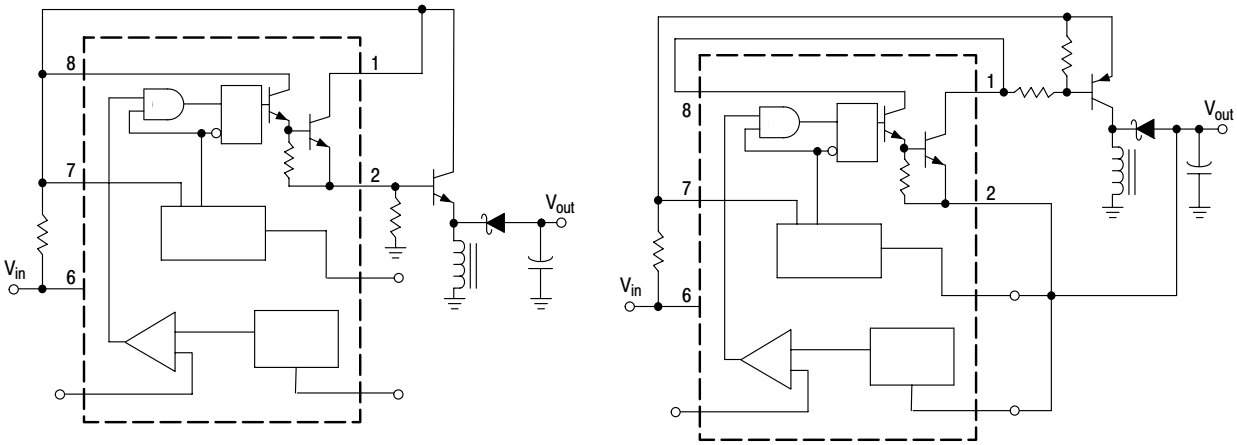
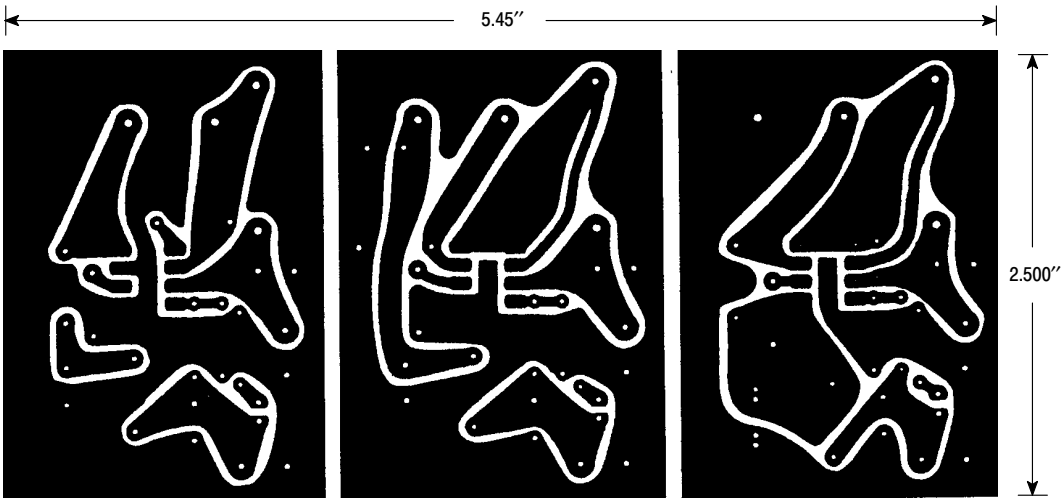
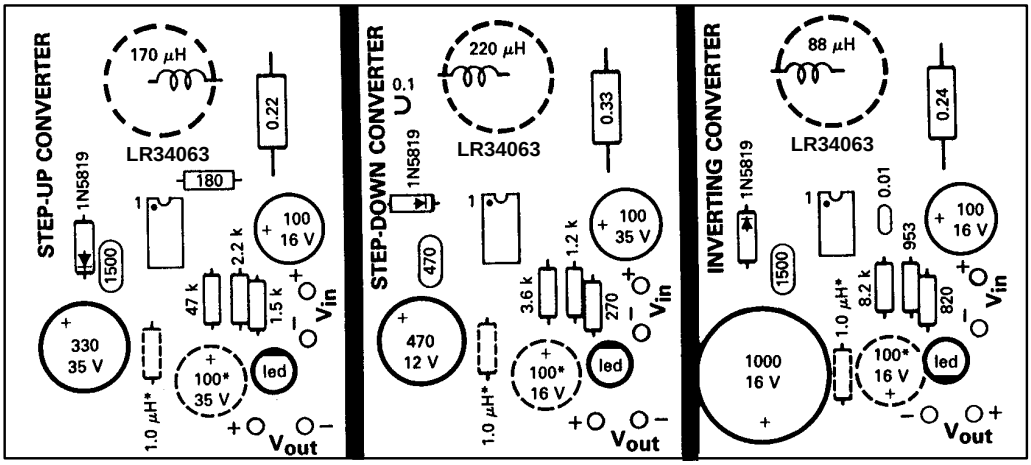



**Figure 12. External Current Boost Connections for $I_C$ Peak Greater than 1.5 A**

**12a. External NPN Switch** **12b. External PNP Saturated Switch**




(Top view, copper foil as seen through the board from the component side)




(Top View, Component Side)

*Optional Filter.

**Figure 13. Printed Circuit Board and Component Layout**
(Circuits of Figures 7, 9, 11)

**INDUCTOR DATA**

| Converter | Inductance (µH) | Turns/Wire |
|---|---|---|
| Step−Up | 170 | 38 Turns of #22 AWG |
| Step−Down | 220 | 48 Turns of #22 AWG |
| Voltage−Inverting | 88 | 28 Turns of #22 AWG |

All inductors are wound on Magnetics Inc. 55117 toroidal core.

| 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.

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

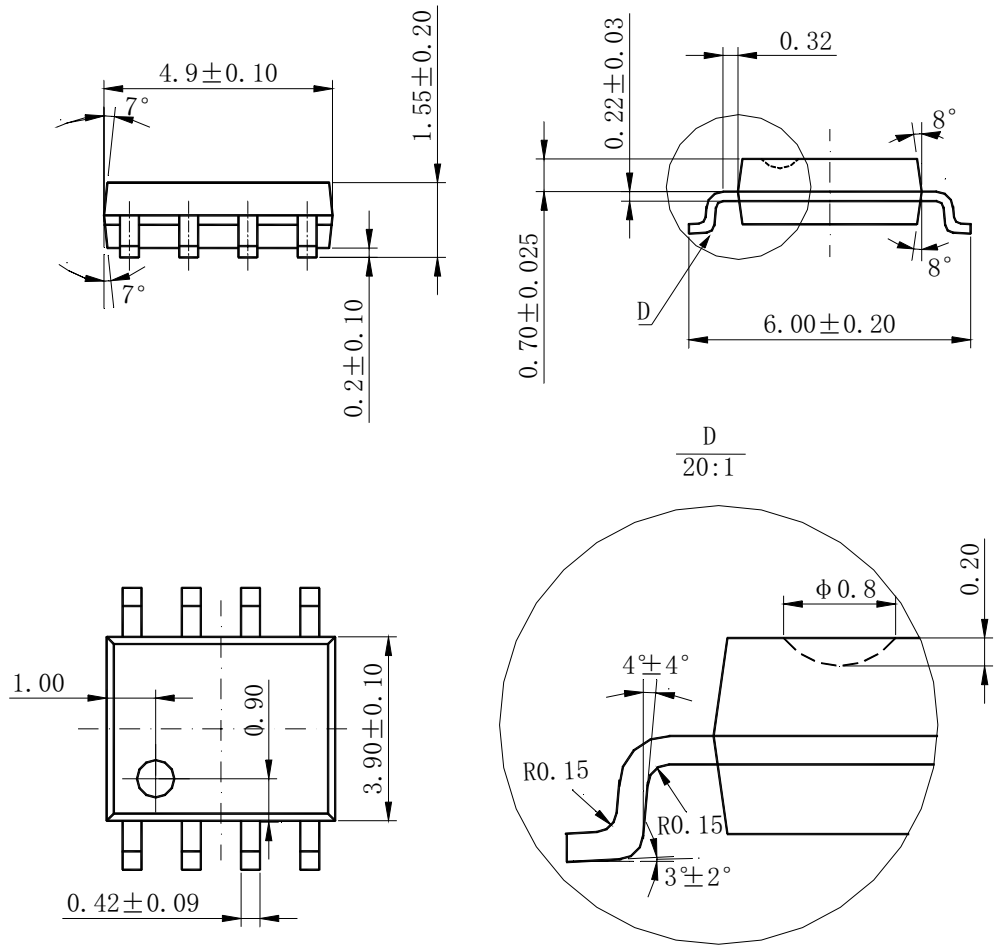
$V_{in}$ − Nominal input voltage.
$V_{out}$ − Desired output voltage, $\lvert V_{out}\rvert = 1.25\left(1 + \frac{R2}{R1}\right)$
$I_{out}$ − Desired output current.
$f_{min}$ − Minimum desired output switching frequency at the selected values of $V_{in}$ and $I_O$.
$V_{ripple(pp)}$ − Desired peak−to−peak 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.

**Figure 14. Design Formula Table**

**LR34063**

## Mechanical Dimensions

**SOP-8** **Unit: mm**



**LR34063**

## Mechanical Dimensions (Continued)

**DIP-8** **Unit: mm**

