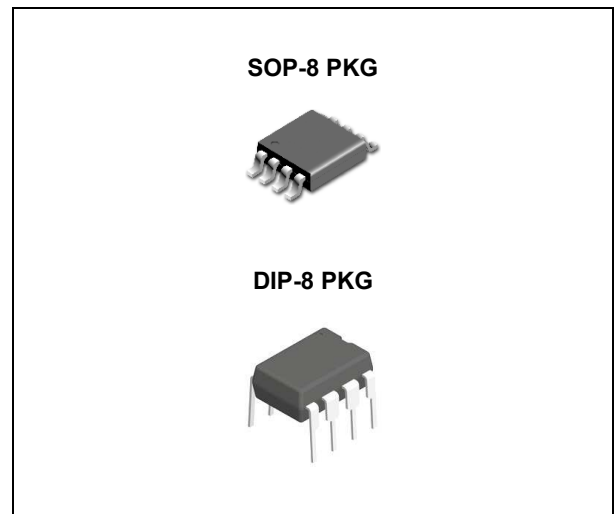# DC-DC Converter Control Circuits      MC34063A/B

## FEATURES

- Output Switch Current In Excess of 1.5A
- 2% Reference Accuracy
- Low Quiescent Current : 2.5mA(Typ.)
- Operating From 3V to 40V
- Frequency Operation to 100KHz
- Active Current Limiting
- Moisture Sensitivity Level 3D
- MC34063AG is Halogen Free Products

## APPLICATION

- Battery Chargers
- NICs / Switches / Hubs
- ADSL Modems
- Negative Voltage Power Supplies

**SOP-8 PKG**

**DIP-8 PKG**

**ORDERING INFORMATION**

| Device | Package |
|---|---|
| MC34063AD | |
| MC34063AGD | SOP-8 |
| MC34063BD | |
| MC34063AN | DIP-8 |

## DESCRIPTION

The MC34063A/B series is a monolithic control circuit delivering the main functions for DC-DC voltage converting. The device contains an internal temperature compensated reference, comparator, duty cycle controlled oscillator with an active current limit circuit driver and high current output switch.

Output voltage is adjustable through two external resistors with a 2% reference accuracy.

Employing a minimum number of external components the MC34063A/B devices series is designed for Step-Down, Step-Up and Voltage-Inverting applications.

## Absolute Maximum Ratings [Note 1]

| CHARACTERISTIC | SYMBOL | MIN. | MAX. | UNIT |
|---|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | - | 50 | V |
| Comparator Input Voltage Range | $V_{IR}$ | -0.3 | 40 | V |
| Switch Collector Voltage | $V_{SWC}$ | | 40 | V |
| Switch Emitter Voltage($V_{SWC}$=40V) | $V_{SWE}$ | | 40 | V |
| Switch Collector to Emitter Voltage | $V_{CE}$ | | 40 | V |
| Driver Collector Voltage | $V_{dc}$ | - | 40 | V |
| Driver Collector Current [Note 2] | $I_{dc}$ | - | 100 | mA |
| Switch Current | $I_{SW}$ | - | 1.5 | A |

## Absolute Maximum Ratings (Continued)

| CHARACTERISTIC | | SYMBOL | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| Power Dissipation (at $T_A$ = 25°C) | SOP-8 | $PD_{MAX\_SOP-8}$ | | 1.250 | W |
| | DIP-8 | $PD_{MAX\_DIP-8}$ | | 0.625 | W |
| Thermal Resistance | SOP-8 | $\theta_{JA-SOP-8}$ | | 100 | °C/W |
| | DIP-8 | $\theta_{JA-DIP-8}$ | | 160 | °C/W |
| Operating Junction Temperature Range | | $T_J$ | -40 | 150 | °C |
| Operating Ambient Temperature Range | MC34063A | $T_{AOPR}$ | 0 | 75 | °C |
| | MC34063B | | -40 | 85 | °C |
| Storage Temperature Range | | $T_{STG}$ | -65 | 150 | °C |

Note 1. Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.
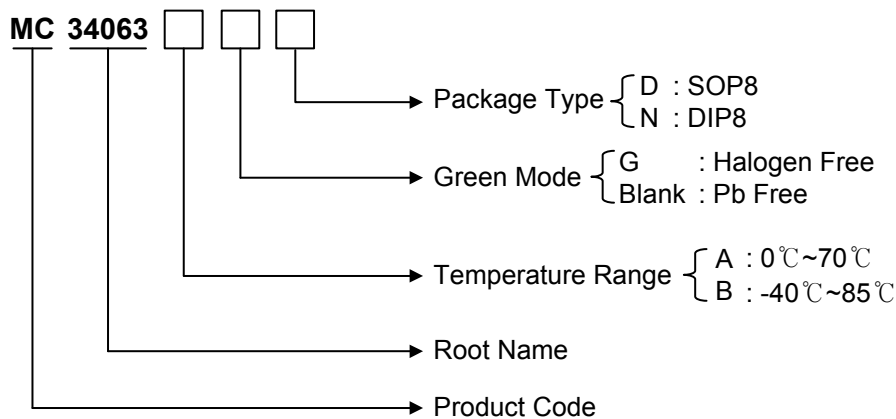
## THERMAL DATA

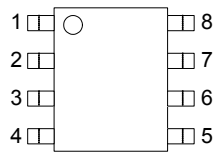| SYMBOL | PARAMETER | | DIP-8 | SOP-8 | UNIT |
|---|---|---|---|---|---|
| $R_{THJ-AMB}$ | Thermal Resistance Junction-Ambient(*) | Max | 100 | 160 | ℃/W |

(*) This value depends from thermal design of PCB on which the device is mounted.
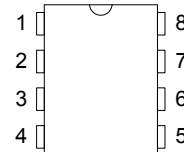
## Ordering Information

| Operating Ambient Temperature($T_{AOPR}$) Range | Package | Order No. | Supplied As | Status |
|---|---|---|---|---|
| 0℃~70℃ | SOP8 | MC34063AD | Reel | Active |
| 0℃~70℃ | | MC34063AGD | Reel | Contact us |
| -40℃~85℃ | | MC34063BD | Reel | Active |
| 0℃~70℃ | DIP8 | MC34063AN | Tube | Active |
| -40℃~85℃ | | MC34063BN | Tube | Active |

MC 34063 ☐ ☐ ☐

Package Type ⎰ D : SOP8
⎱ N : DIP8

Green Mode ⎰ G : Halogen Free
⎱ Blank : Pb Free

Temperature Range ⎰ A : 0℃~70℃
⎱ B : -40℃~85℃

Root Name

Product Code

## PIN CONFIGURATION



SOP-8                                          DIP-8

## PIN DESCRIPTION

| Pin No. | SOP-8 / DIP-8 PKG | |
| --- | --- | --- |
| | Name | Function |
| 1 | Switch Collector | Internal switch transistor collector |
| 2 | Switch Emitter | Internal switch transistor emitter |
| 3 | Timing Capacitor | Timing Capacitor to control the switching frequency |
| 4 | GND | Ground pin for all internal circuits |
| 5 | Comparator Inverting Input | Inverting input pin for internal comparator |
| 6 | $V_{CC}$ | Voltage supply |
| 7 | $I_{PK}$ Sense | Peak Current Sense Input by monitoring the voltage drop across an external I sense resistor to limit the peak current through the switch |
| 8 | Driver Collector | Voltage driver collector |

## BLOCK DIAGRAM
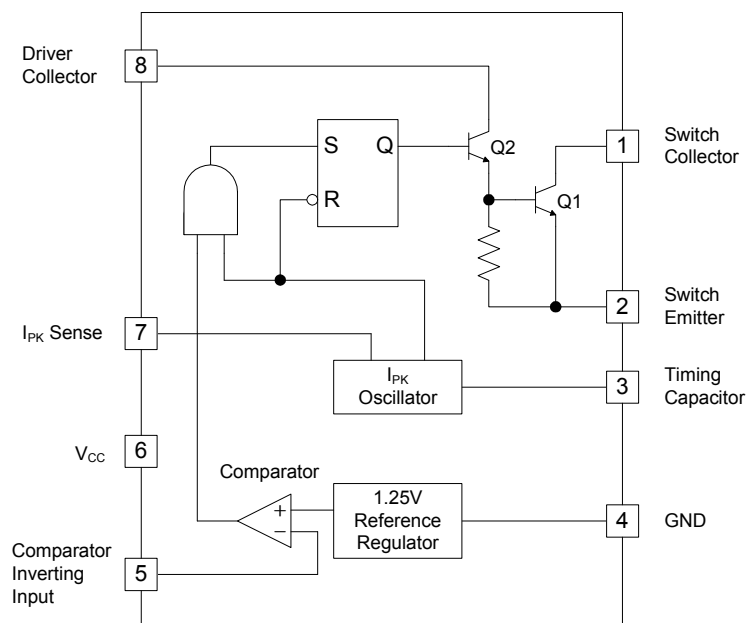
## ELECTRICAL CHARACTERISTICS

(Refer to the test circuits, $V_{CC}$=5V, $T_A$=$T_{LOW}$ to $T_{HIGH}$, unless otherwise specified, see note 2)

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| OSCILLATOR | | | | | | |
| $F_{OSC}$ | Frequency | $V_{PIN5}$=0V, $C_T$=1nF, $T_A$=25℃ | 24 | 33 | 42 | KHz |
| $I_{CHG}$ | Charge Current | $V_{CC}$=5 to 40V, $T_A$=25℃ | 24 | 35 | 42 | $\mu A$ |
| $I_{DISCHG}$ | Discharge Current | $V_{CC}$=5 to 40V, $T_A$=25℃ | 140 | 220 | 260 | $\mu A$ |
| $I_{DISCHG}$/$I_{CHG}$ | Discharge to Charge Current Ratio | Pin 7= $V_{CC}$, $T_A$=25℃ | 5.2 | 6.5 | 7.5 | |
| $V_{IPK(SENSE)}$ | Current Limit Sense Voltage | $I_{CHG}$=$I_{DISCHG}$, $T_A$=25℃ | 250 | 300 | 350 | mV |
| OUTPUT SWITCH | | | | | | |
| $V_{CE(SAT)}$ | Saturation Voltage, Darlington connection | $I_{SW}$=1A, Pins 1,8 connected | | 1.0 | 1.3 | V |
| $V_{CE(SAT)}$ | Saturation Voltage | $I_{SW}$=1A, $R_{PIN8}$=82Ω to $V_{CC}$, Forced β ~ 20 | | 0.45 | 0.7 | V |
| $h_{FE}$ | DC Current Gain | $I_{SW}$=1A, $V_{CE}$=5V, $T_A$=25℃ | 50 | 75 | | |
| $I_{C(OFF)}$ | Collector Off-State Current | $V_{CE}$= 40V | | 0.01 | 100 | $\mu A$ |
| COMPARATOR | | | | | | |
| $V_{TH}$ | Threshold Voltage | $T_A$=25℃ | 1.225 | 1.25 | 1.275 | V |
| | | $T_A$=$T_{LOW}$ to $T_{HIGH}$ | 1.21 | | 1.29 | V |
| $REG_{LINE}$ | Threshold Voltage Line Regulation | $V_{CC}$= 3 to 40V | | 1 | 5 | mV |
| $I_{IB}$ | Input Bias Current | $V_{IN}$= 0V | | -5 | -400 | nA |
| TOTAL DEVICE | | | | | | |
| $I_{CC}$ | Supply Current | $V_{CC}$= 5 to 40V, $C_T$=1nF Pin7= $V_{CC}$, $V_{PIN5}$>$V_{TH}$, Pin2=GND Remaining pins open for MC34063A/B | | 1.4 | 4 | mA |

Note 1. Maximum package power dissipation limit must be observed.
Note 2. $T_{LOW}$= '-30℃, $T_{HIGH}$= '+125℃
Note 3. If Darlington configuration is not used, care must be taken to avoid deep saturation of output switch.
    The resulting switch-off time may be adversely affected.
    In a Darlington configuration the following output driver condition is suggested:
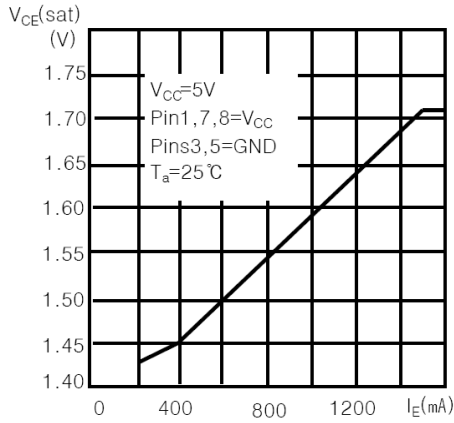
Forced β of output switch : $\dfrac{I_{C(OUTPUT)}}{I_{C(DRIVER)} - 7.0mA *} \geq 10$

\* Currentless due to a built in 1KΩ anti-leakage resistor
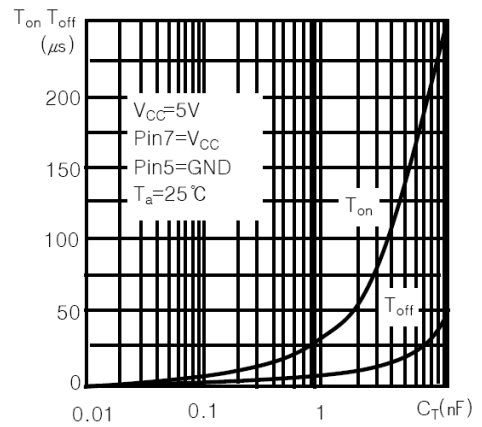
## TYPICAL ELECTRICAL CHARACTERISTICS

Emitter Follower Configuration Output
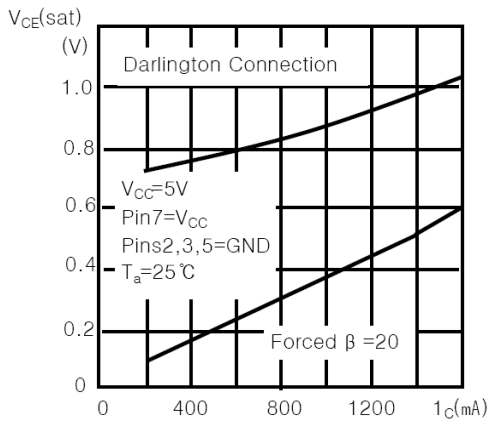
Saturation Voltage vs. Emitter Current



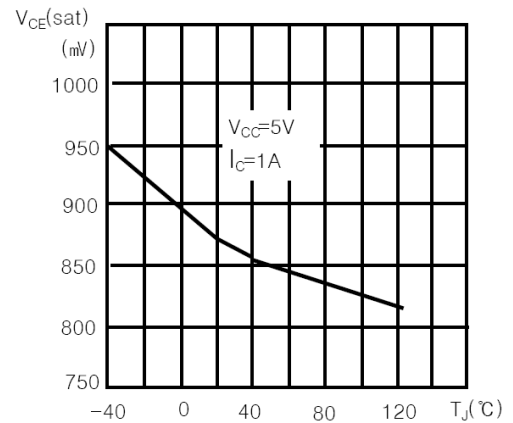Common Emitter Configuration Output Switch

Saturation Voltage vs. Collector Current



Power Collector Emitter Saturation

Voltage ($V_{CE(SAT)}$) vs, Temperature



Output Switch ON-OFF Time
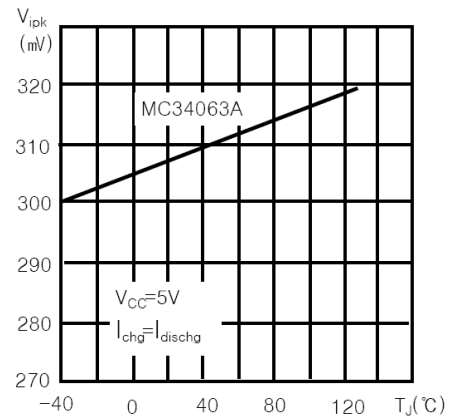
vs. Oscillator Timing Capacitor



Darlington Configuration Collector Emitter

Saturation Voltage ($V_{CE(SAT)}$) vs. Temperature
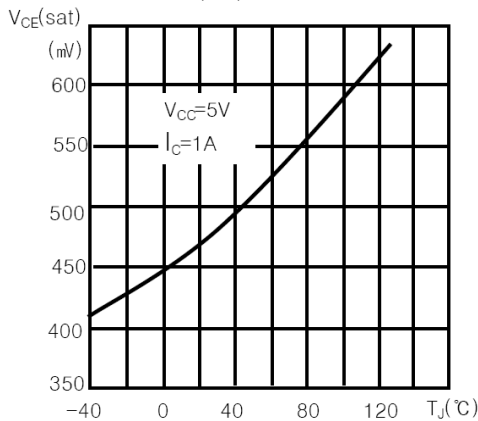


Current Limit Sense Voltage ($V_{IPK}$)

vs. Temperature
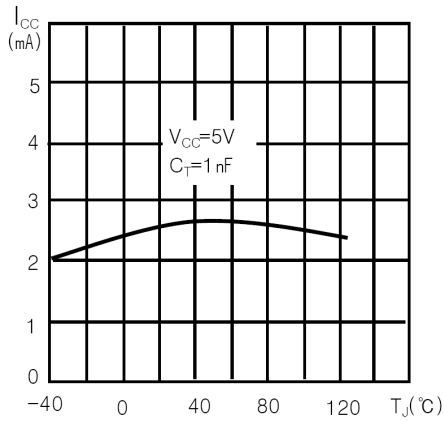
## TYPICAL ELECTRICAL CHARACTERISTICS (Continued)

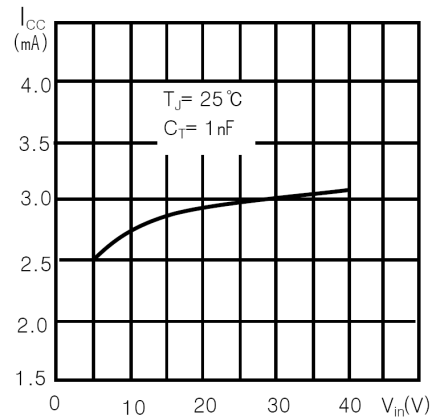Reference Voltage vs. Temperature
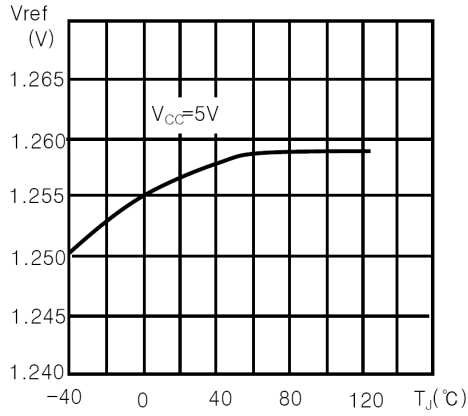
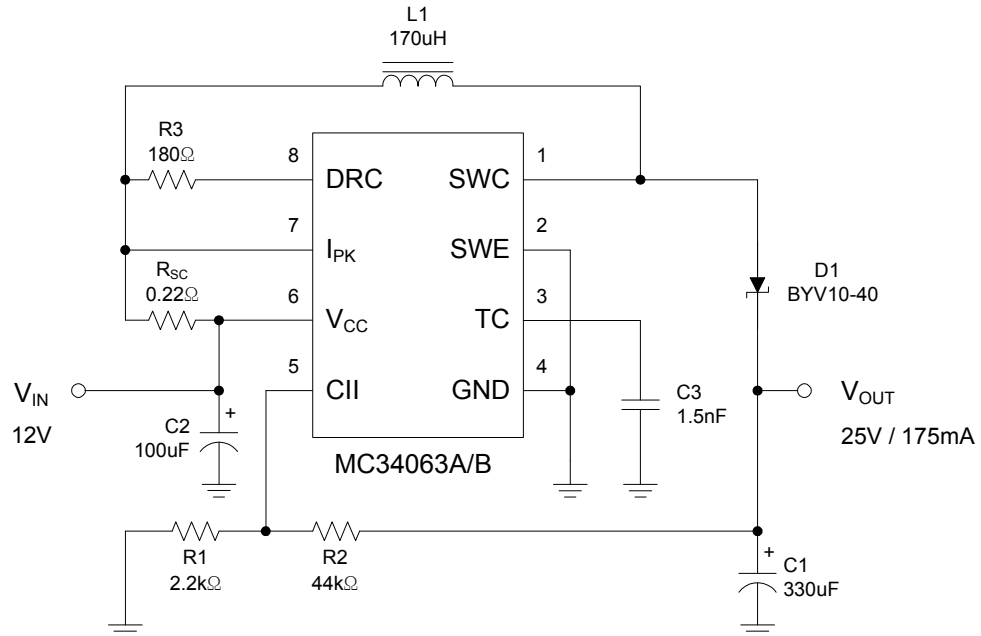Bias Current vs. Temperature
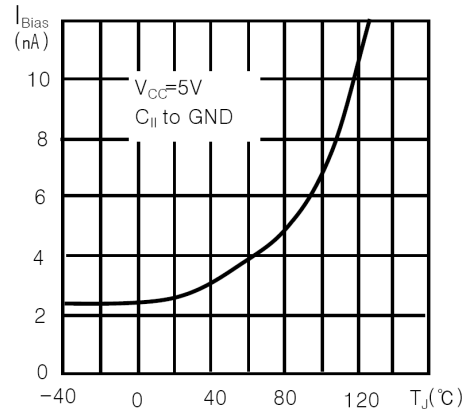
Supply Current vs. Temperature

Supply Current vs. Input Voltage

## TYPICAL APPLICATION CIRCUIT
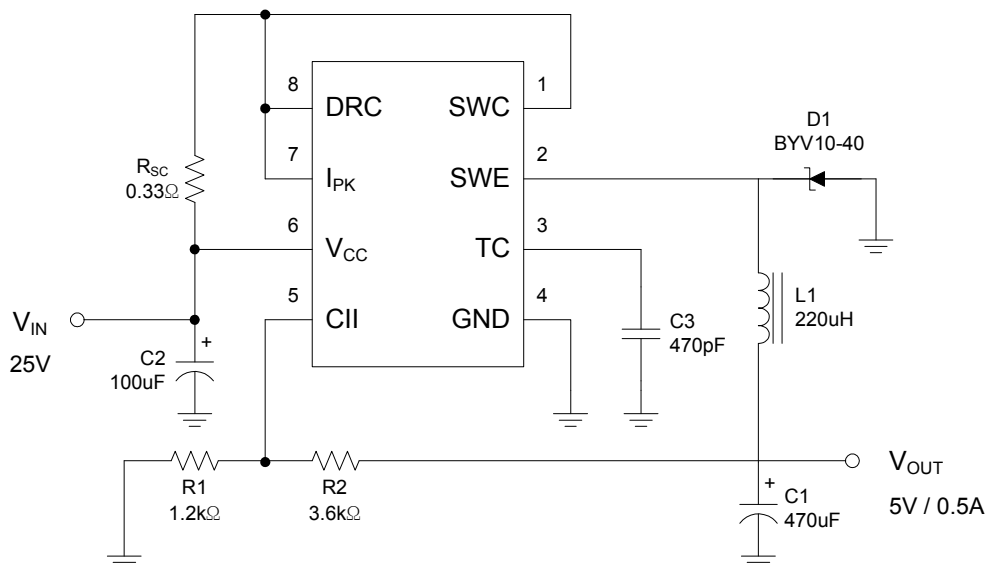
**Step-Up Converter**
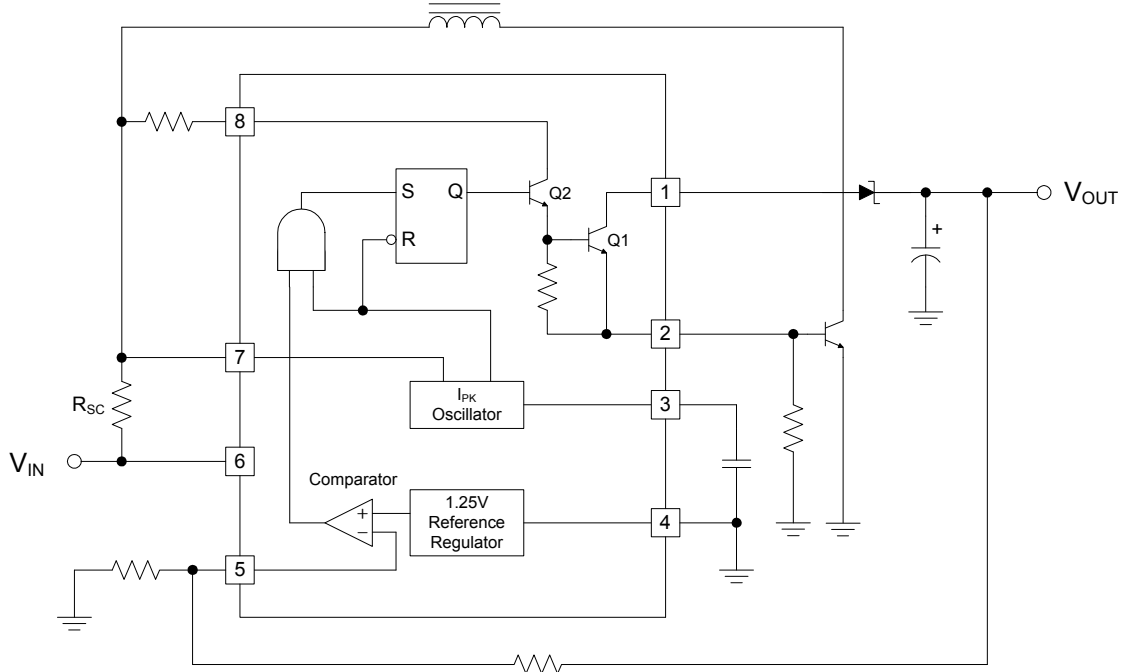
L1
170uH

R3
180Ω

8 DRC    SWC 1

7 I$_{PK}$    SWE 2

R$_{SC}$
0.22Ω

6 V$_{CC}$    TC 3

5 CII    GND 4

MC34063A/B

V$_{IN}$
12V

C2
100uF

D1
BYV10-40

C3
1.5nF

V$_{OUT}$
25V / 175mA

R1
2.2kΩ

R2
44kΩ

C1
330uF

**Step-Down Converter**

8 DRC    SWC 1

7 I$_{PK}$    SWE 2

R$_{SC}$
0.33Ω

6 V$_{CC}$    TC 3

5 CII    GND 4

D1
BYV10-40

L1
220uH

C3
470pF

V$_{IN}$
25V

C2
100uF

R1
1.2kΩ

R2
3.6kΩ

V$_{OUT}$
5V / 0.5A

C1
470uF

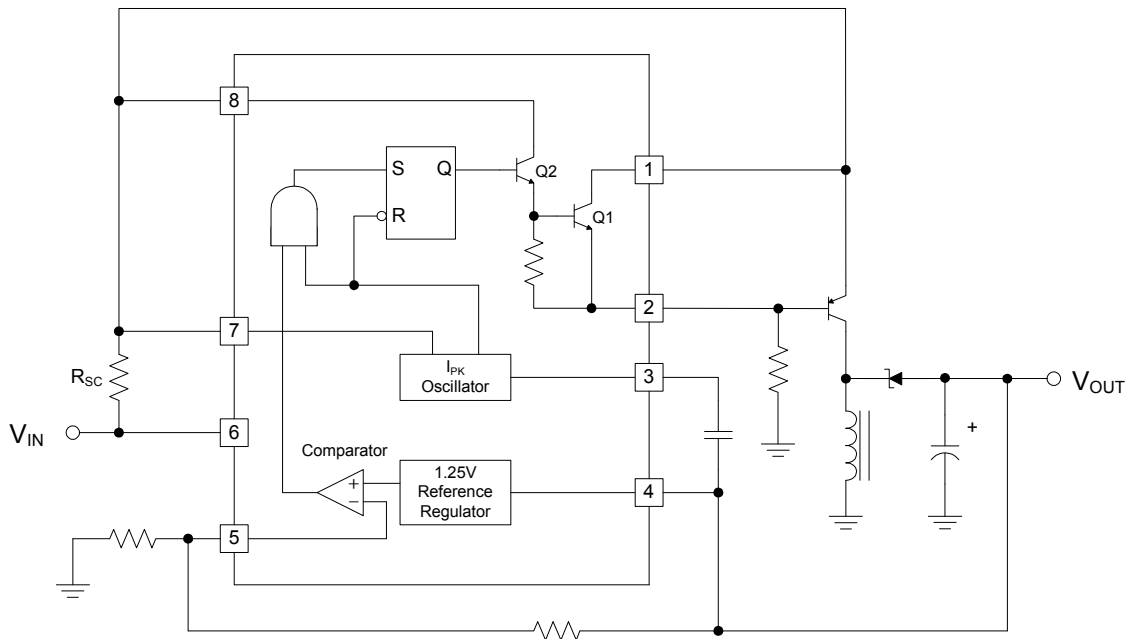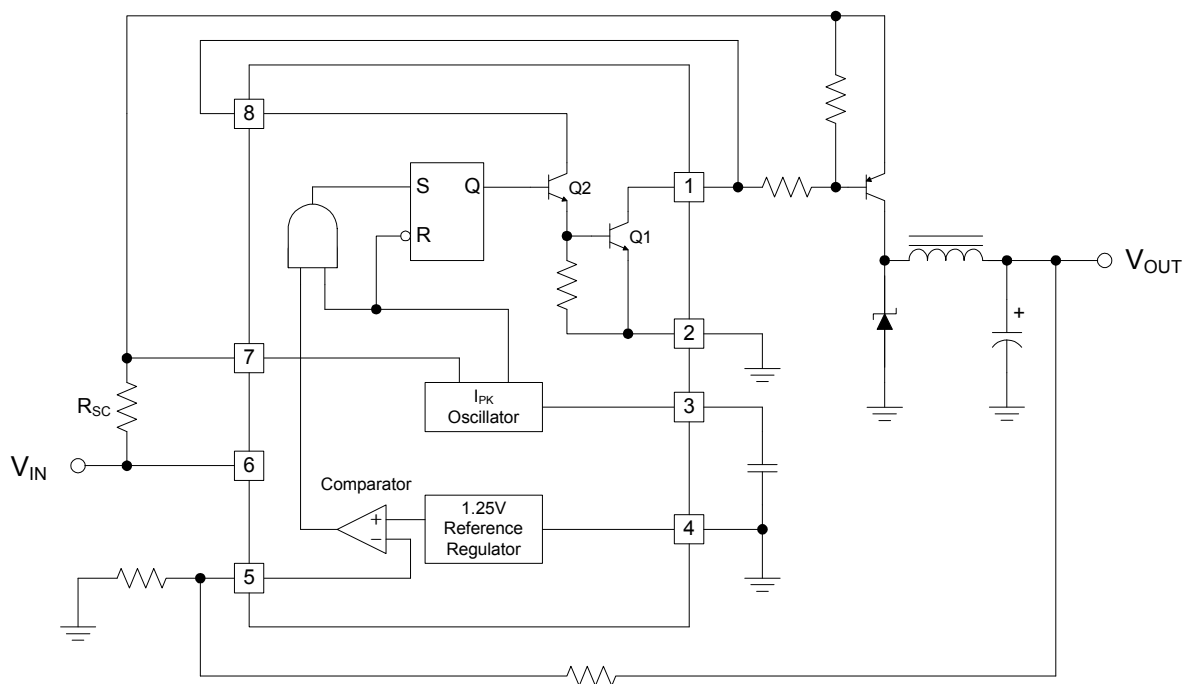**Step-Up with External NPN Switch**
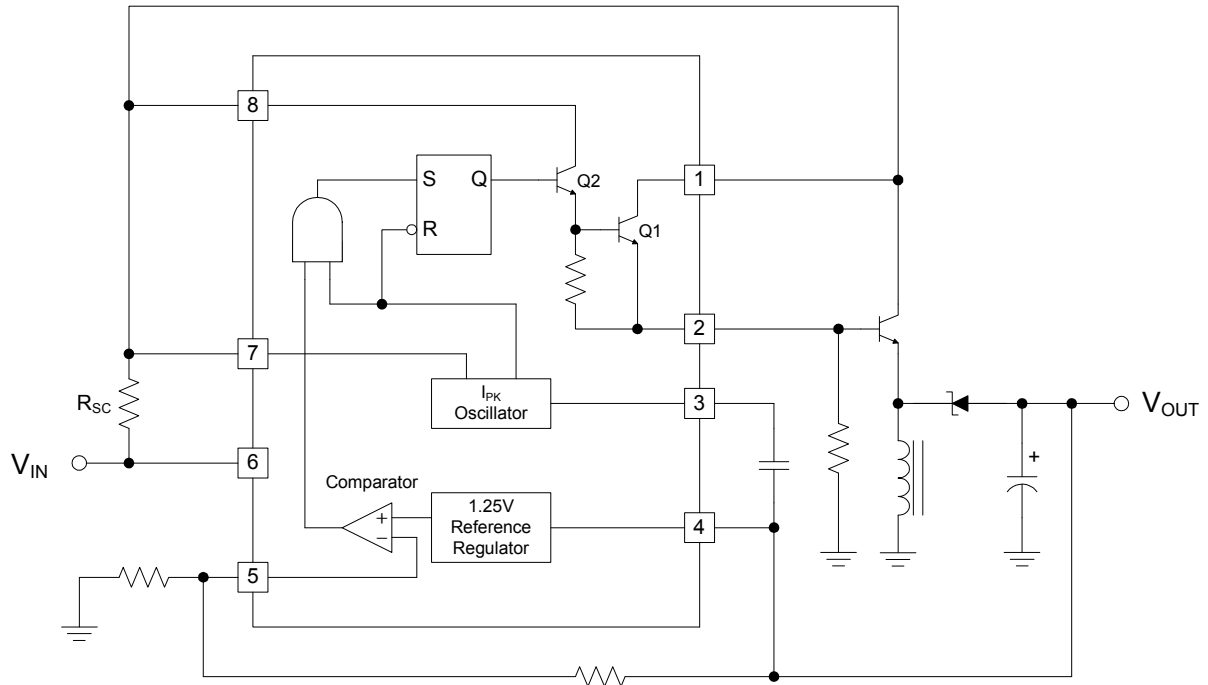


**Voltage Inverting Converter**
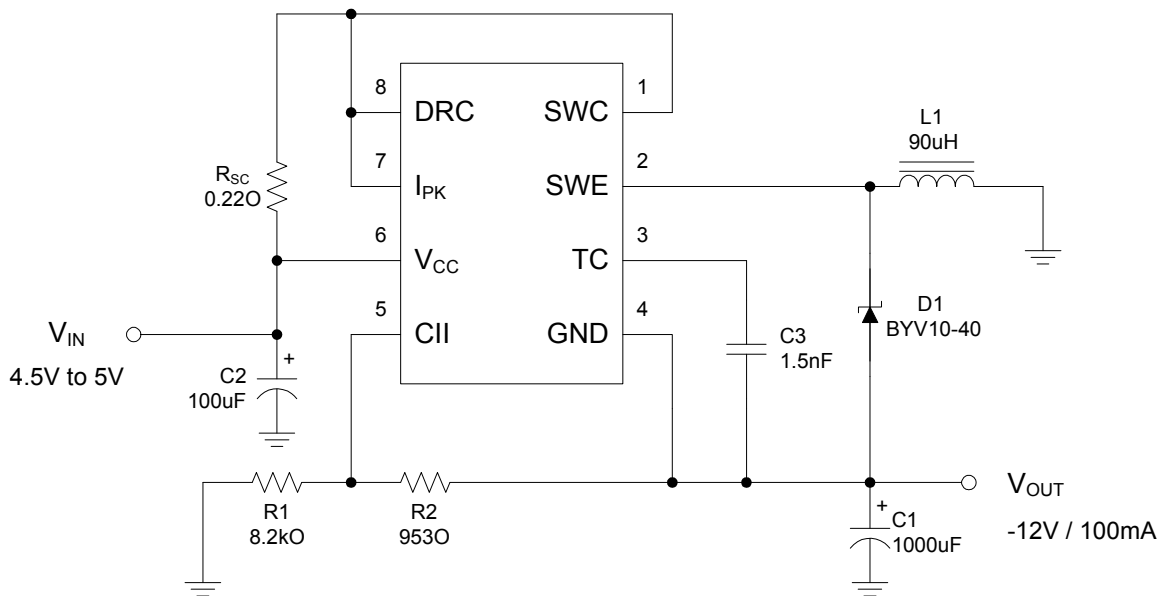
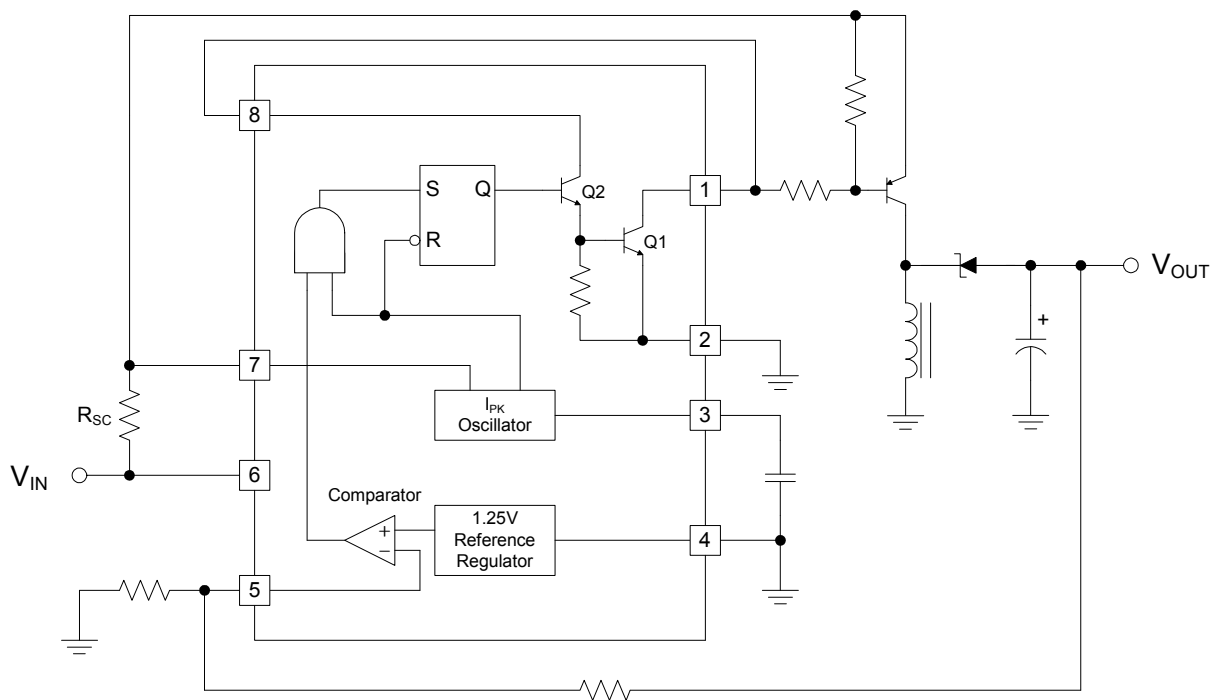**Step-Down with External NPN Switch**



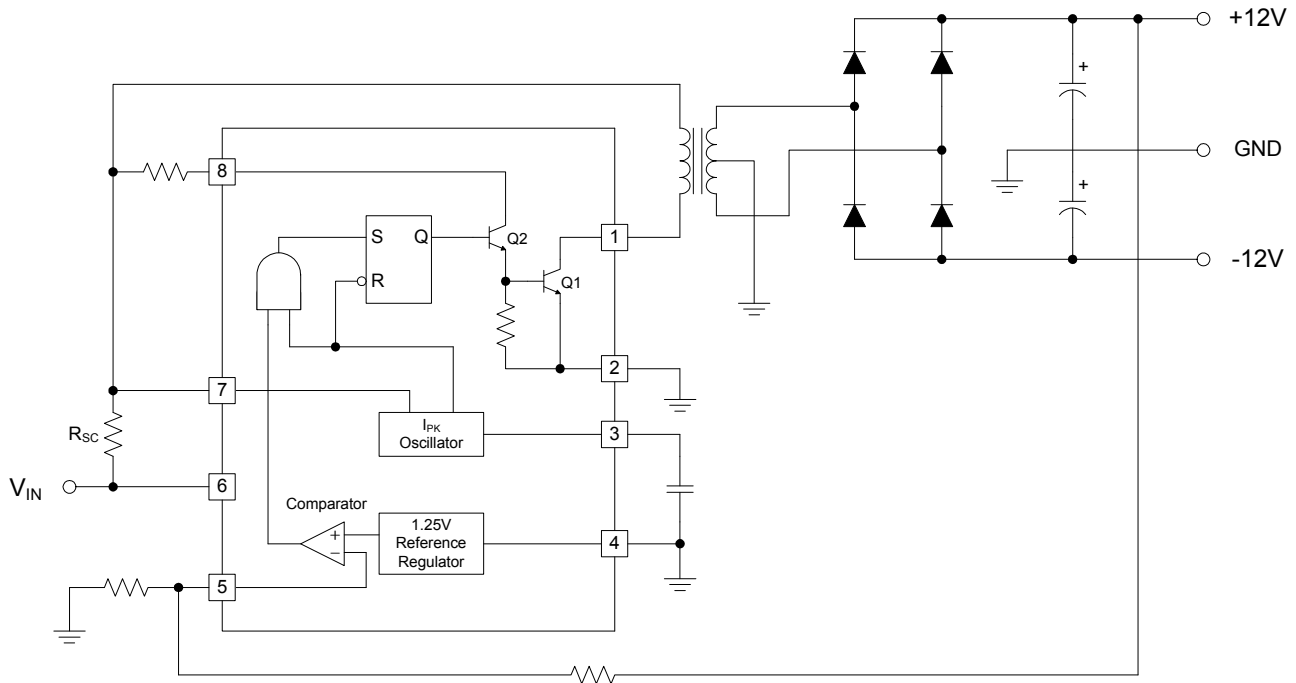**Step-Down with External PNP Switch**

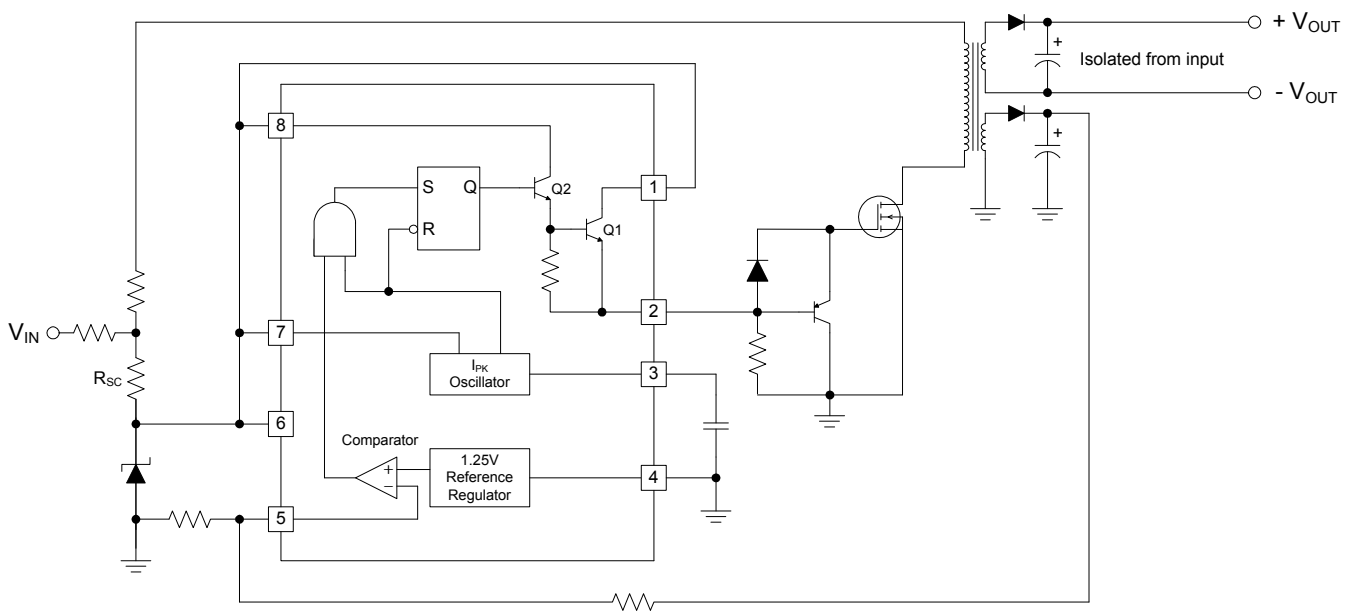**Voltage Inverting with External NPN Switch**



**Voltage Inverting with External PNP Saturated Switch**

**Dual Output Voltage**

**Higher Output Power, Higher Input Voltage**

## Design Formula Table

| Calculation | Step-UP | Step-Down | Voltage Inverting |
|---|---|---|---|
| $t_{on}/t_{off}$ | $\dfrac{V_{OUT} + V_F - V_{IN(MIN)}}{V_{IN(MIN)} - V_{SAT}}$ | $\dfrac{V_{OUT} + V_F}{V_{IN(MIN)} - V_{SAT}}$ | $\dfrac{\left|V_{OUT}\right| + V_F}{V_{IN} - V_{SAT}}$ |
| $(t_{on}/t_{off})$max | $\dfrac{1}{f_{MIN}}$ | $\dfrac{1}{f_{MIN}}$ | $\dfrac{1}{f_{MIN}}$ |
| $C_T$ | $4.0 \times 10^{-5} t_{on}$ | $4.0 \times 10^{-5} t_{on}$ | $4.0 \times 10^{-5} t_{on}$ |
| $I_{PK(SWITCH)}$ | $2 I_{OUT(MAX)} \left(\dfrac{t_{off}}{t_{on}} + 1\right)$ | $2 I_{OUT(MAX)}$ | $2 I_{OUT(MAX)} \left(\dfrac{t_{off}}{t_{on}} + 1\right)$ |
| $R_{SC}$ | $0.3 / I_{PK(SWITCH)}$ | $0.3 / I_{PK(SWITCH)}$ | $0.3 / I_{PK(SWITCH)}$ |
| $L_{(MIN)}$ | $\left(\dfrac{V_{IN(MIN)} - V_{SAT}}{I_{PK(SWITCH)}}\right) \times t_{on(max)}$ | $\left(\dfrac{V_{IN(MIN)} - V_{SAT} - V_{OUT}}{I_{PK(SWITCH)}}\right) \times t_{on(max)}$ | $\left(\dfrac{V_{IN(MIN)} - V_{SAT}}{I_{PK(SWITCH)}}\right) \times t_{on(max)}$ |
| $C_O$ | $9 \dfrac{I_{OUT} t_{on}}{V_{RIPPLE(PP)}}$ | $\dfrac{I_{PK(SWITCH)} (t_{on} + t_{off})}{8 V_{RIPPLE(PP)}}$ | $9 \dfrac{I_{OUT} t_{on}}{V_{RIPPLE(PP)}}$ |

### TERMS AND DEFINITIONS

$V_{SAT}$ - Saturation voltage of the output switch.

VF - 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.

$I_{OUT}$ - Desired output current.

$f_{MIN}$- Minimum desired output switching frequency at the selected values 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.