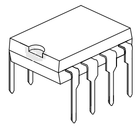
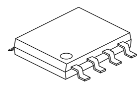
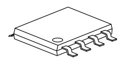
# DC TO DC CONVERTER CONTROLLER



DIP-8



SOP-8



TSSOP-8

## ■ DESCRIPTION

The UTC **MC34063A** is a monolithic regulator subsystem, intended for use as DC to DC converter. This device contains a temperature compensated band gap reference, a duty-cycle control oscillator, driver and high current output switch. It can be used for step down, step-up or inverting switching regulators as well as for series pass regulators.

## ■ FEATURES

* Operation from 3.0V to 40V.
* Short circuit current limiting.
* Low standby current.
* Output switch current of 1.5A without external transistors.
* Frequency of operation from 100Hz to 100kHz.
* Step-up, step-down or inverting switch regulators.

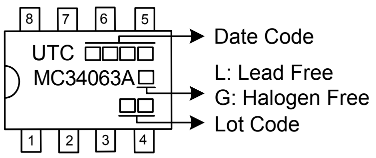
## ■ ORDERING INFORMATION

| Ordering Number | | Package | Packing |
|---|---|---|---|
| Lead Free | Halogen Free | | |
| MC34063AL-D08-T | MC34063AG-D08-T | DIP-8 | Tube |
| MC34063AL-S08-R | MC34063AG-S08-R | SOP-8 | Tape Reel |
| MC34063AL-P08-R | MC34063AG-P08-R | TSSOP-8 | Tape Reel |

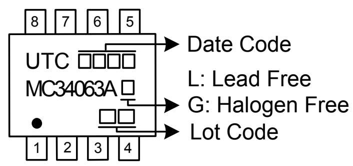
| MC34063AG-D08-T | |
|---|---|
| (1)Packing Type | (1) T: Tube, R: Tape Reel |
| (2)Package Type | (2) D08: DIP-8, S08: SOP-8, P08: TSSOP-8 |
| (3)Green Package | (3) G: Halogen Free and Lead Free, L: Lead Free |

## ■ MARKING

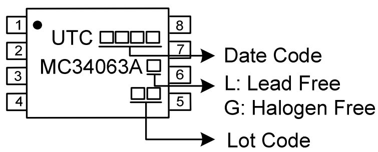
DIP-8



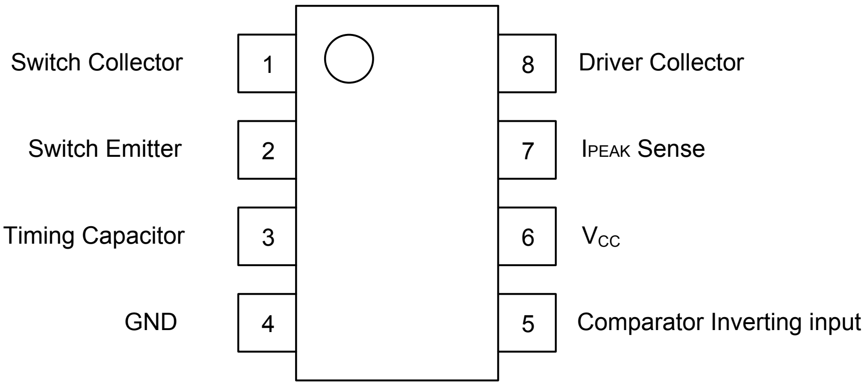

SOP-8




TSSOP-8



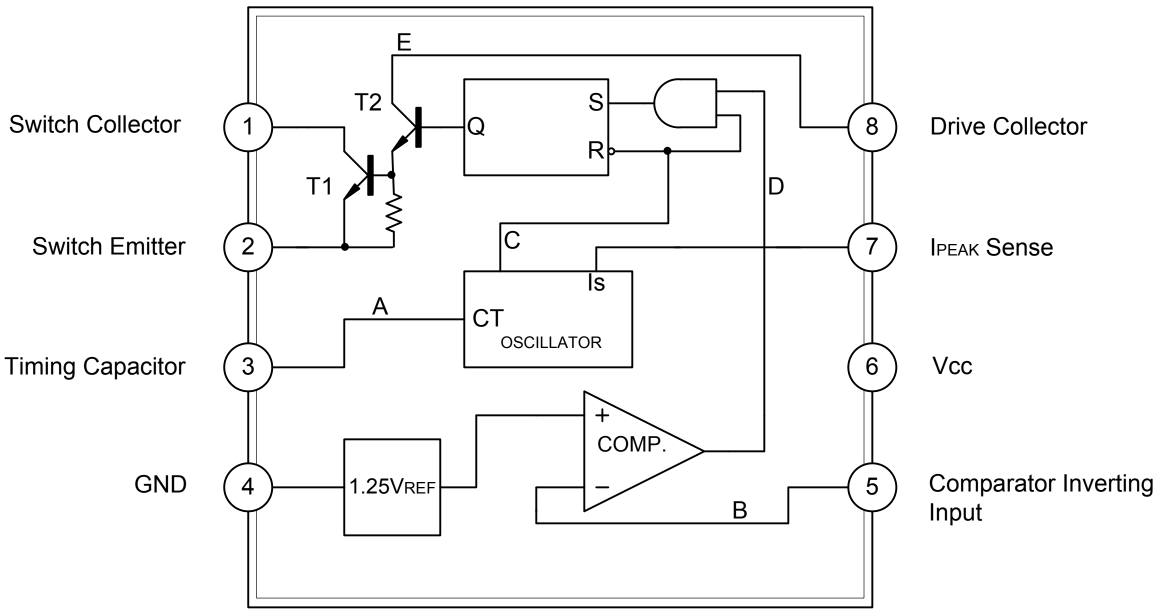
## ■ PIN CONFIGURATION




## ■ PIN DESCRIPTION

| PIN NO | PIN NAME | I/O | DESCRIPTION |
|---|---|---|---|
| 1 | Switch Collector | I | Internal Darlington pairs TI collector |
| 2 | Switch Emitter | O | Internal Darlington pairs TI emitter |
| 3 | Timing Capacitor | | The value of selected capacitor controls the internal oscillator run rate |
| 4 | GND | | |
| 5 | Comparator Inverting Input | I | Inverting input of comparator which can set & initiate the Darlington pairs output switch |
| 6 | $V_{CC}$ | | |
| 7 | $I_{PEAK}$ Sense | I | Current sense input to monitor the voltage drop across an external resistor placed in series with $V_{CC}$ |
| 8 | Driver Collector | I | Internal Darlington pairs TI collector |

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS ($T_A$=25°C, unless otherwise specified. )

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Supply Voltage | | $V_{CC}$ | 40 | V |
| Comparator Input Voltage | | $V_{IN(COMP)}$ | -0.3 ~ +40 | V |
| Switch Collector Voltage | | $V_{C(SW)}$ | 40 | V |
| Switch Emitter Voltage | | $V_{E(SW)}$ | 40 | V |
| Switch Collector to Emitter Voltage | | $V_{CE(SW)}$ | 40 | V |
| Driver Collector Voltage | | $V_{C(DR)}$ | 40 | V |
| Switch Current | | $I_{SW}$ | 1.5 | A |
| Power Dissipation ($T_A$=25°C) | DIP-8 | $P_D$ | 1250 | mW |
| | SOP-8 | | 625 | mW |
| | TSSOP-8 | | 300 | mW |
| Junction Temperature | | $T_J$ | +150 | °C |
| Operating Temperature | | $T_{OPR}$ | 0 ~ +70 | °C |
| Storage Temperature | | $T_{STG}$ | -65 ~ +150 | °C |

Note: Absolute maximum ratings are those values beyond which the device which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

## ■ THERMAL DATA

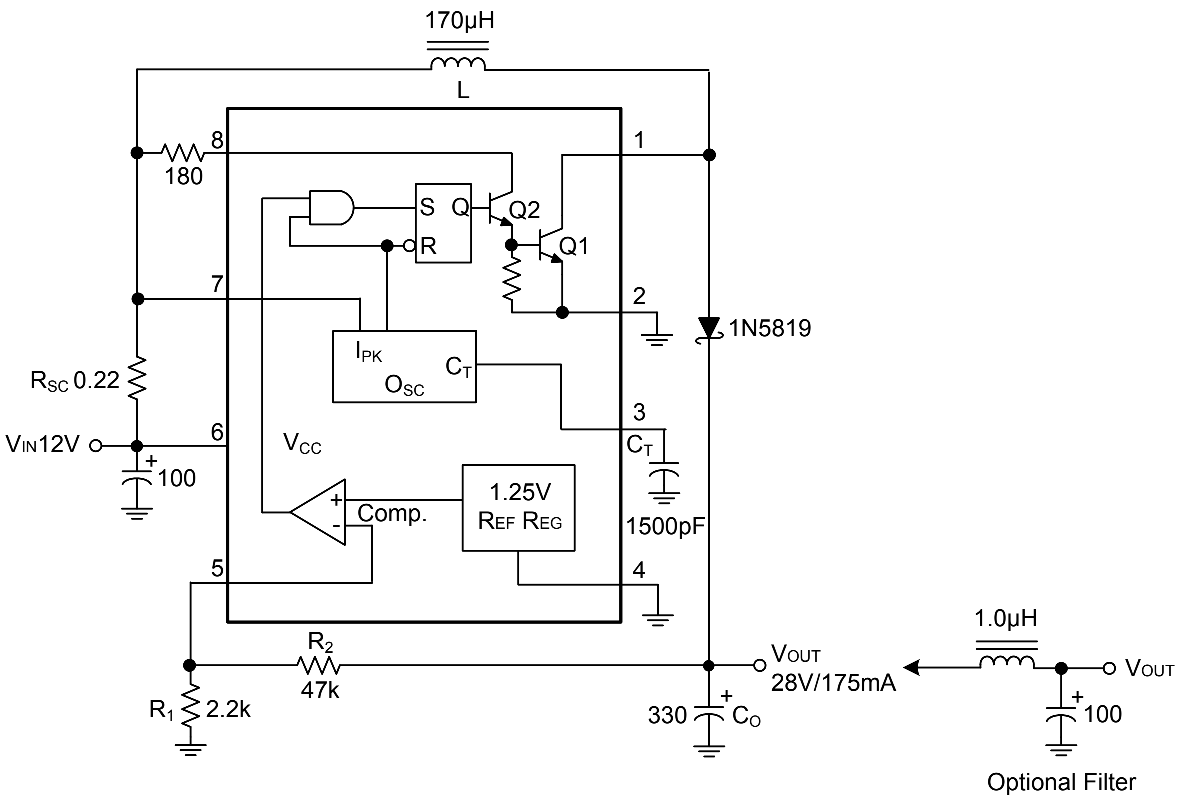
| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| Junction-to-Ambient | DIP-8 | $\theta_{JA}$ | 100 | °C/W |
| | SOP-8 | | 160 | °C/W |
| | TSSOP-8 | | 333 | °C/W |

## ■ ELECTRICAL CHARACTERISTICS ($V_{CC}$=5.0V, $T_A$=0~+70°C, unless otherwise specified.)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **OSCILLATOR** | | | | | | |
| Maximum Oscillator Frequency | $F_{OSC}$ | $V_{PIN}$ 5=0V, CT=1.0nF, $T_A$=25°C | 24 | | 42 | kHz |
| Charging Current | $I_{CHG}$ | $V_{CC}$=5 to 40V, $T_A$=25°C | 22 | 31 | 42 | μA |
| Discharging Current | $I_{DISCHG}$ | $V_{CC}$=5 to 40V, $T_A$=25°C | 140 | 190 | 260 | μA |
| Oscillator Amplitude | $V_{OSC}$ | $T_A$=25°C | | 0.5 | | V |
| Discharge to Charge Current Ratio | K | $V_7$=$V_{CC}$, $T_A$=25°C | 5.2 | 6.1 | 7.5 | |
| Current limit Sense Voltage | $V_{SENSE}$ | $I_{CHG}$=$I_{DISCHG}$, $T_A$=25°C | 250 | 300 | 350 | mV |
| **OUTPUT SWITCH** | | | | | | |
| Saturation Voltage 1 (Note) | $V_{CE(SAT)1}$ | $I_{SW}$=1.0A, $V_{C(DRIVER)}$=$V_{C(SW)}$ | | 0.95 | 1.3 | V |
| Saturation Voltage 2 (Note) | $V_{CE(SAT)2}$ | $I_{SW}$=1.0A, $V_{C(DRIVER)}$=50mA | | 0.45 | 0.7 | V |
| DC Current Gain (Note) | $G_{I\ (DC)}$ | $I_{SW}$=1.0A, $V_{CE}$=5.0V, $T_A$=25°C | 50 | 75 | | |
| Collector Off State Current (Note) | $I_{C(OFF)}$ | $V_{CE}$=40.0V, $T_A$=25°C | | 0.01 | 100 | μA |
| **COMPARATOR** | | | | | | |
| Threshold Voltage | $V_{THD}$ | | 1.21 | 1.25 | 1.29 | V |
| Threshold Voltage Line Regulation | $V_{THD}$ | $V_{CC}$=3 ~ 40V | | 2.0 | 5.0 | mV |
| Input Bias Current | $I_{I(BIAS)}$ | $V_{IN}$=0V | | 50 | 400 | nA |
| **TOTAL DEVICE** | | | | | | |
| Supply Current | $I_{CC}$ | $V_{CC}$=5~40V, $C_T$=0.001<br>$V_7$=$V_{CC}$, $V_C$>$V_{THD}$, Pin2=GND | | 2.7 | 4.0 | mA |

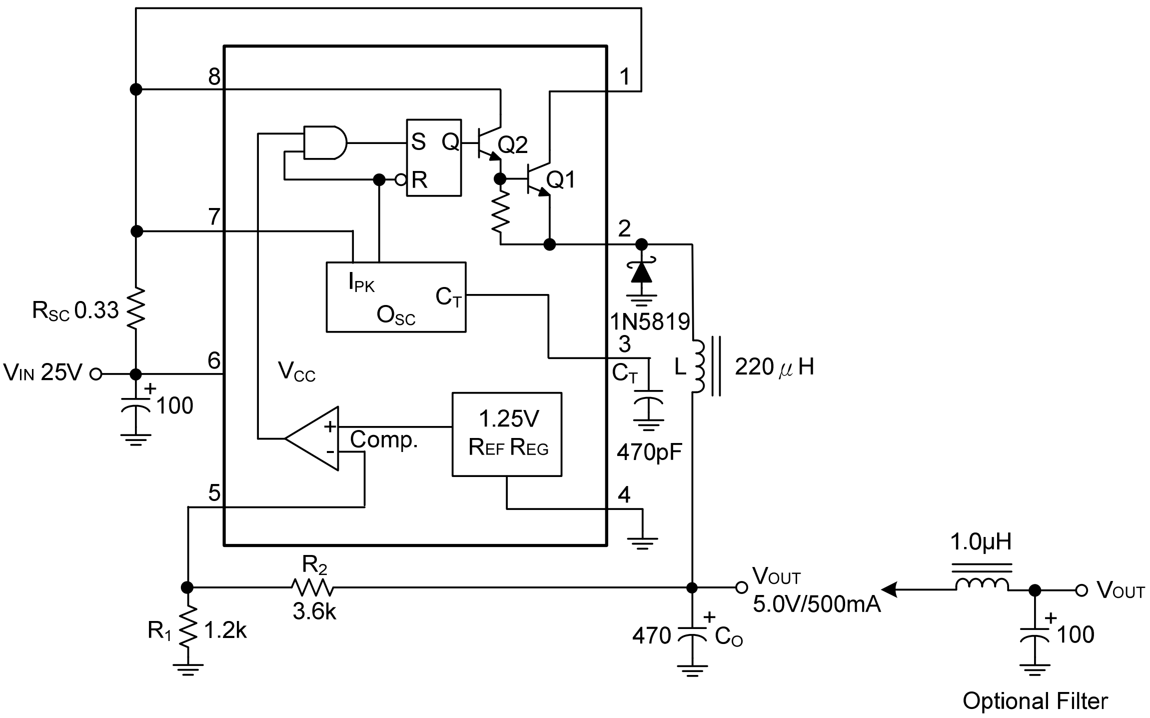
Note: Output switch tests are performed under pulsed conditions to minimize power dissipation.

■ STEP-UP CONVERTER



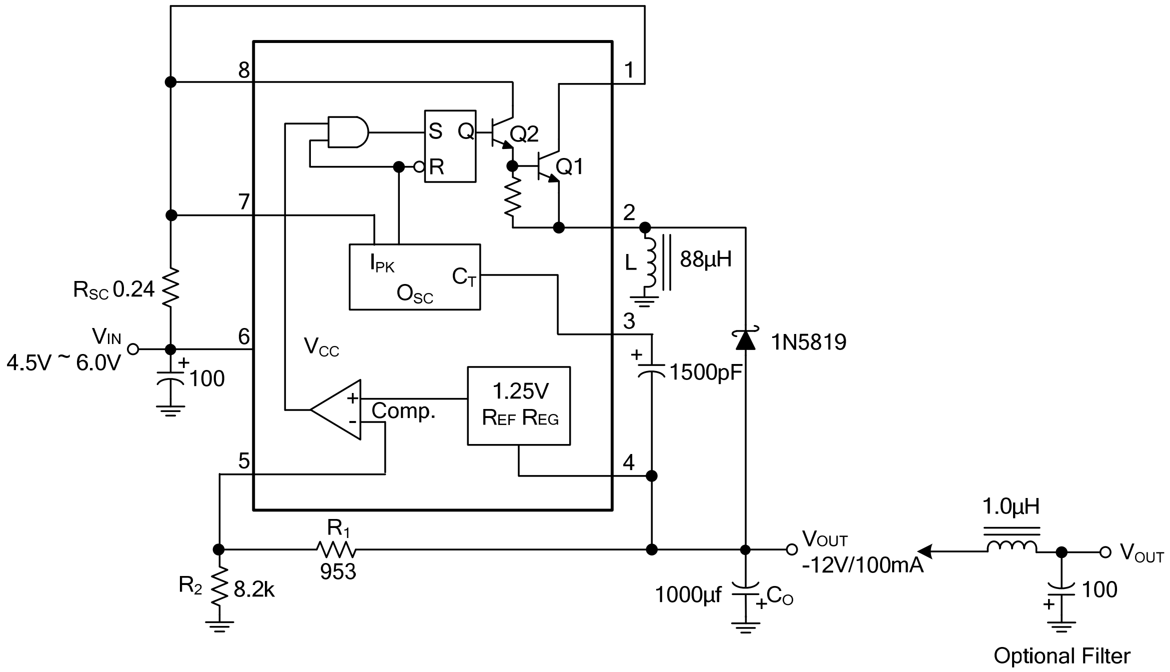

| TEST | CONDITIONS | RESULTS |
|---|---|---|
| Line Regulation | $V_{IN}$ = 8.0V ~ 16V, $I_{OUT}$ = 175mA | 30mV = ±0.05% |
| Load Regulation | $V_{IN}$ = 12V, $I_{OUT}$ = 75mA ~ 175mA | 10mV = ±0.017% |
| Output Ripple | $V_{IN}$ = 12V, $I_{OUT}$ = 175mA | 400mV$_{P-P}$ |
| Efficiency | $V_{IN}$ = 12V, $I_{OUT}$ = 175mA | 87.7% |
| Output Ripple With Optional Filter | $V_{IN}$ = 12V, $I_{OUT}$ = 175mA | 40mV$_{P-P}$ |

■ STEP-DOWN CONVERTER(Cont.)




| TEST | CONDITIONS | RESULTS |
|---|---|---|
| Line Regulation | $V_{IN}$ = 15V ~ 25V, $I_{OUT}$ = 500mA | 12mV = ±0.12% |
| Load Regulation | $V_{IN}$ = 25V, $I_{OUT}$ = 50mA ~ 500mA | 3.0mV = ±0.03% |
| Output Ripple | $V_{IN}$ = 25V, $I_{OUT}$ = 500mA | 120mV$_{P-P}$ |
| Short Circuit Current | $V_{IN}$ = 25V, $R_L$ = 0.1Ω | 1.1A |
| Efficiency | $V_{IN}$ = 25V, $I_{OUT}$ = 500mA | 83.7% |
| Output Ripple With Optional Filter | $V_{IN}$ = 25V, $I_{OUT}$ = 500mA | 40mV$_{P-P}$ |

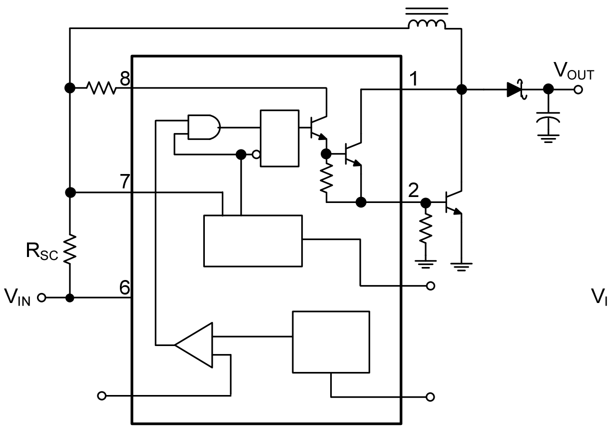
■ VOLTAGE INVERTING CONVERTER



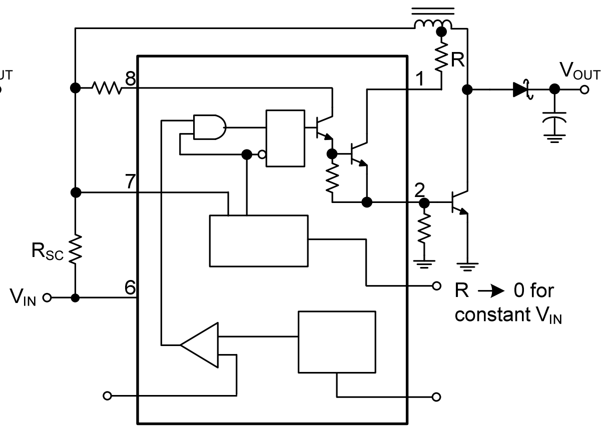

| TEST | CONDITIONS | RESULTS |
|---|---|---|
| Line Regulation | $V_{IN}$ = 4.5V ~ 6.0V, $I_{OUT}$ = 100mA | 3.0mV = ±0.012% |
| Load Regulation | $V_{IN}$ = 5.0V, $I_{OUT}$ = 10mA ~ 100mA | 0.022V = ±0.09% |
| Output Ripple | $V_{IN}$ = 5.0V, $I_{OUT}$ = 100mA | 500m$V_{P-P}$ |
| Short Circuit Current | $V_{IN}$ = 5.0V, $R_L$ = 0.1Ω | 910mA |
| Efficiency | $V_{IN}$ = 5.0V, $I_{OUT}$ = 100mA | 62.2% |
| Output Ripple With Optional Filter | $V_{IN}$ = 5.0V, $I_{OUT}$ = 100mA | 70m$V_{P-P}$ |

## ■ EXTERNAL CURRENT BOOST CONNECTIONS FOR IC PEAK GREATER THAN 1.5A

1a. External NPN Switch

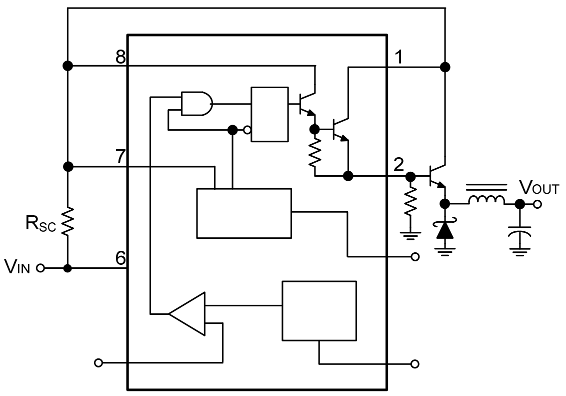



1b. External NPN Saturated Switch
(See Note 4)

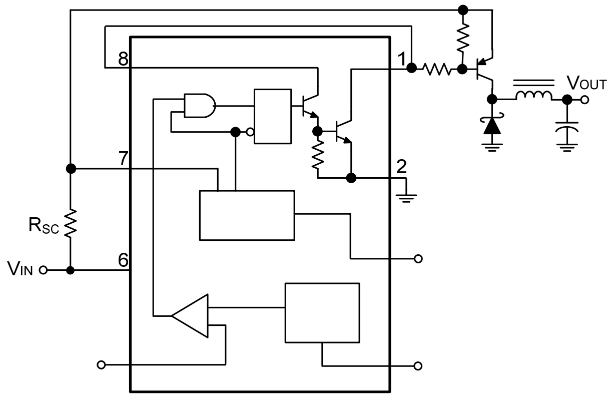



Note: 4. If the output switch is driven into hard saturation (non-Dartington configuration) at low switch currents (≤300mA) and high driver currents (≤30mA), it may take up to 2.0μs to come out of saturation. This condition will shorten the off time at frequencies ≥ 30kHz, and is magnified at high temperatures. 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.

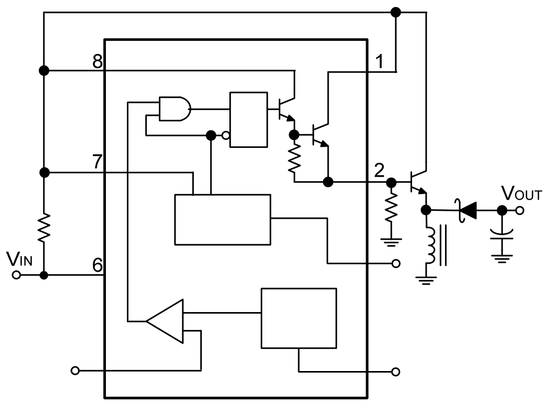
2a. External NPN Switch



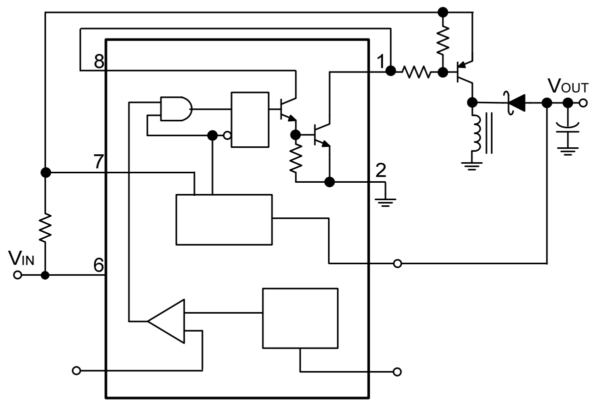

2b. External PNP Saturated Switch




3a. External NPN Switch

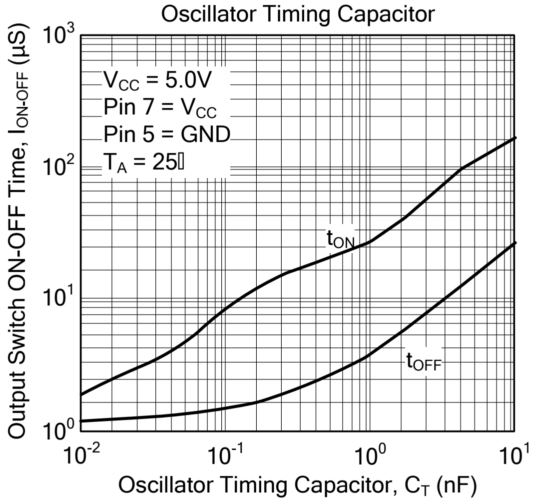



3b. External PNP Saturated Switch

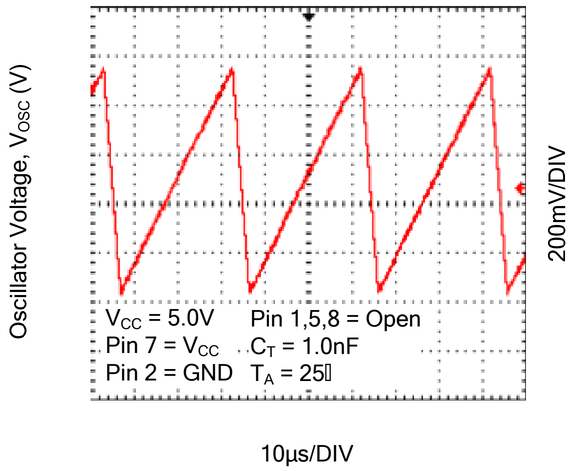


## ■ TYPICAL CHARACTERISTICS

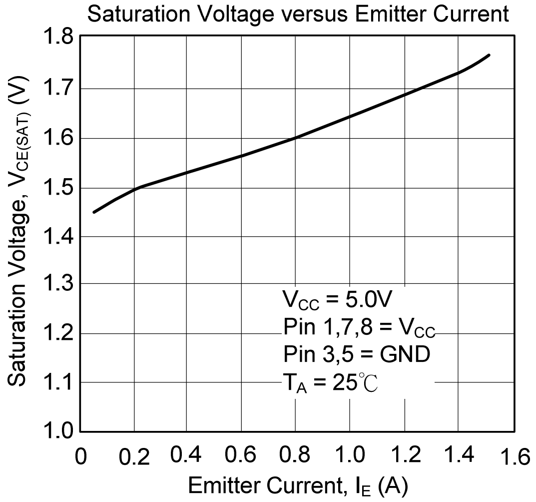
Output Switch ON-OFF Time versus Oscillator Timing Capacitor



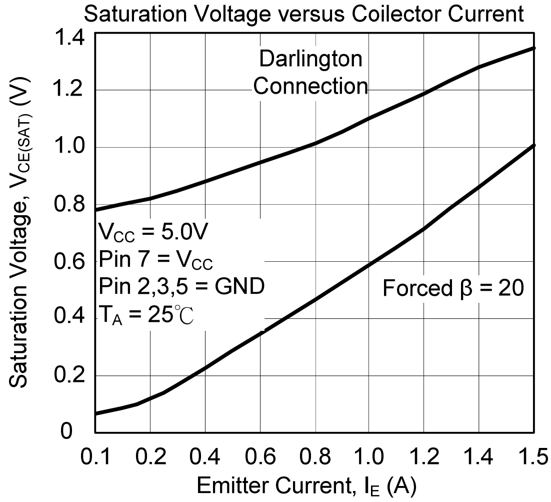

Timing Capacitor Waveform



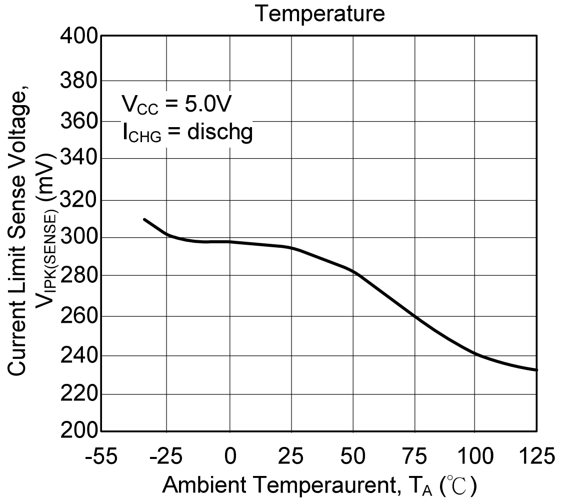

Emitter Follower Configuration Output Saturation Voltage versus Emitter Current



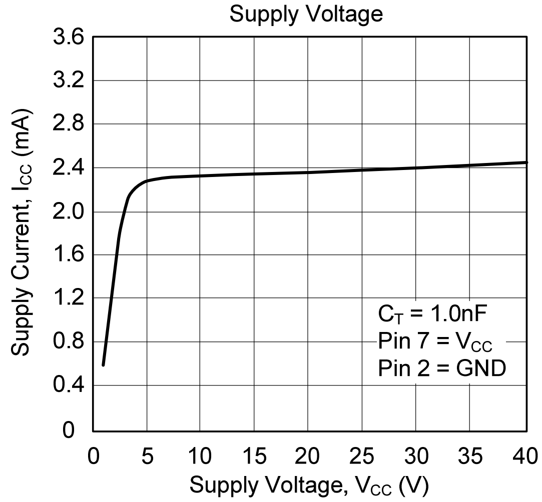

Common Emitter Configuration Output Switch Saturation Voltage versus Coilector Current




Current Limit Sense Voltage versus Temperature




Standby Supply Current versus Supply Voltage



## DESIGN FORMULA TABLE

| CALCULATION | STEP-DOWN | STEP-UP | VOLTAGE-INVERTING |
|---|---|---|---|
| $\frac{t_{ON}}{t_{OFF}}$ | $\frac{V_{OUT}+V_F}{V_{IN(MIN)}-V_{CE(SAT)}-V_{OUT}}$ | $\frac{V_{OUT}+V_F-V_{IN(MIN)}}{V_{IN(MIN)}-V_{CE(SAT)}}$ | $\frac{\lvert V_{OUT}\rvert+V_F}{V_{IN}-V_{CE(SAT)}}$ |
| $(t_{ON}+t_{OFF})_{MAX}$ | $\frac{1}{F_{MIN}}$ | $\frac{1}{F_{MIN}}$ | $\frac{1}{F_{MIN}}$ |
| $C_T$ | $4\times10^{-5}\,t_{ON}$ | $4\times10^{-5}\,t_{ON}$ | $4\times10^{-5}\,t_{ON}$ |
| $I_{SW}$ | $2I_{OUT(MAX)}$ | $2I_{OUT(MAX)}\frac{t_{ON}+t_{OFF}}{t_{OFF}}$ | $2I_{OUT(MAX)}\frac{t_{ON}+t_{OFF}}{t_{OFF}}$ |
| $R_S$ | $0.3/I_{SW}$ | $0.3/I_{SW}$ | $0.3/I_{SW}$ |
| $L_{(MIN)}$ | $\left(\frac{V_{IN(MIN)}-V_{CE(SAT)}-V_{OUT}}{I_{SW}}\right)t_{ON(MAX)}$ | $\left(\frac{V_{IN(MIN)}-V_{CE(SAT)}}{I_{SW}}\right)t_{ON(MAX)}$ | $\left(\frac{V_{IN(MIN)}-V_{CE(SAT)}}{I_{SW}}\right)t_{ON(MAX)}$ |
| $C_O$ | $\frac{I_{SW}(t_{ON}+t_{OFF})}{8V_{RIPPLE(P-P)}}$ | $9\frac{I_{OUT}\,t_{ON}}{V_{RIPPLE(P-P)}}$ | $9\frac{I_{OUT}\,t_{ON}}{V_{RIPPLE(P-P)}}$ |

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

$V_F$ - Forward voltage drop of the ringback rectifier.

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

$V_{IN}$ - Nominal input voltage.

$V_{OUT}$ - Desired output voltage, $\lvert V_{OUT}\rvert=1.25(1+R_2/R_1)$

$I_{OUT}$ - Desired output current.

$F_{MIN}$ - Minimum desired output switching frequency at the selected values for $V_{IN}$ and $I_{OUT}$.

$V_{RIPPLE(P-P)}$ - Desired peak-to-peak output ripple voltage. In practice, the calculated value will need to be increased due to the capacitor equivalent series resistance and board layout. The ripple voltage should be kept to a low value since it will directly effect the line and load regulation.