DC/DC Converter Control Circuits

General Description

The RT34063A Series is a monolithic control circuit containing the primary functions required for DC/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 specially designed to be incorporated in step-down and step-up and Voltage-inverting applications with a minimum number of external components.

Features

- **Operation from 3.0V to 30V Input**
- **Low Standby Current**
- **Current Limiting**
- **Internal Switch Current to 1.5A**
- **Output Voltage Adjustable**
- **Frequency Operation to 100kHz**
- **Precision 2% Reference**
- **RoHS Compliant and 100% Lead (Pb)-Free**

Applications

- Saver for Cellular Phones
- DC/DC Converter Module

Ordering Information

RT34063A □ □

Package Type
N : DIP-8
S : SOP-8

Operating Temperature Range
P : Pb Free with Commercial Standard
G : Green (Halogen Free with Commercial Standard)

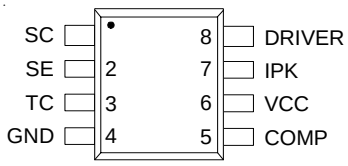
Note :

Richtek Pb-free and Green products are :

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.
- 100%matte tin (Sn) plating.

Pin Configurations

(TOP VIEW)

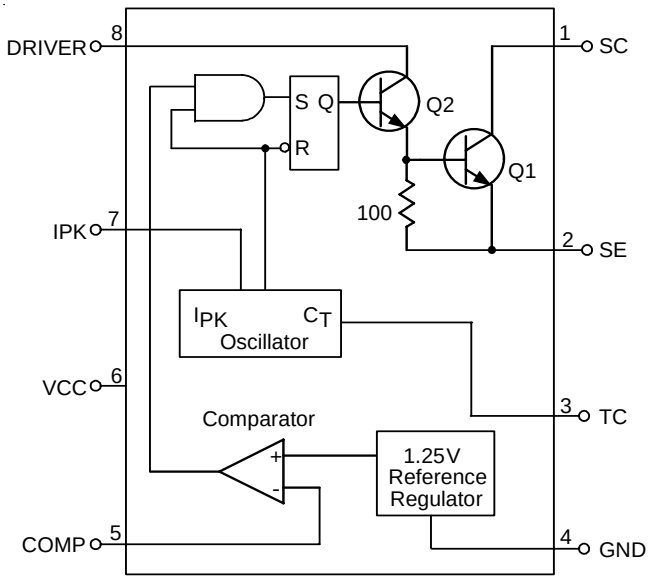


DIP-8 / SOP-8

Functional Pin Description

Pin Name	Pin Function
SC	1.5A Switch Collector.
SE	Darlington Switch Emitter.
TC	Oscillator Timing Capacitor.
GND	Power GND.
COMP	Feedback Comparator Inverting Input.
VCC	Power Supply Input.
IPK	High side Current Sense Input VCC-V_{IPK} = 330mV.
DRIVER	Driver Collector.

Function Block Diagram



Typical Application Circuit

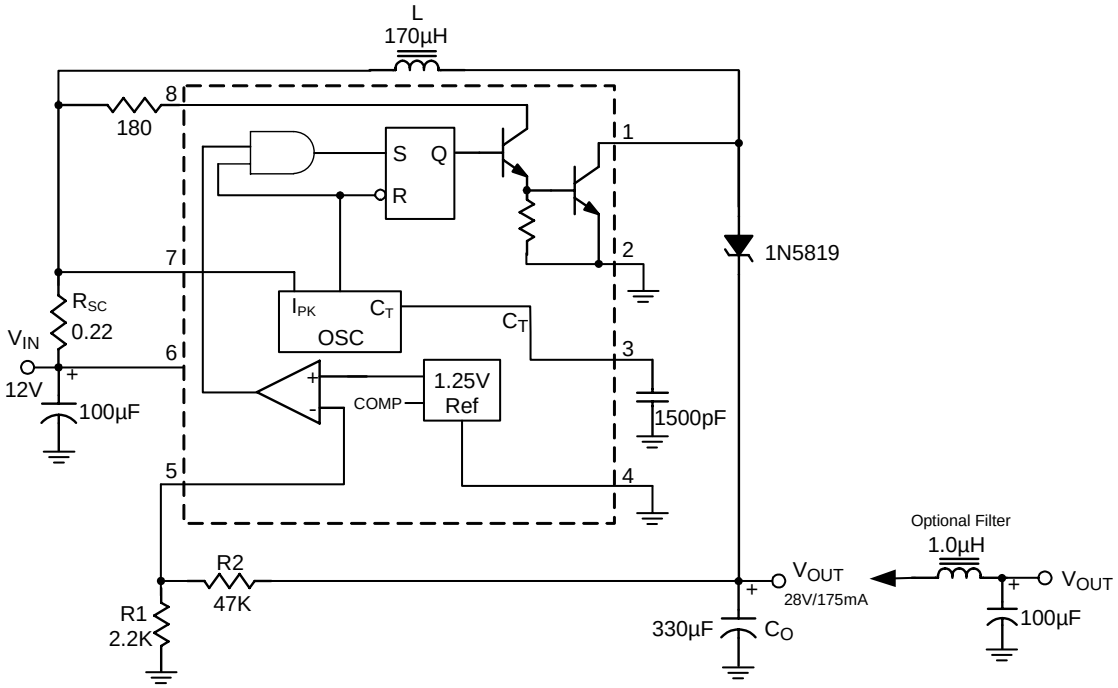
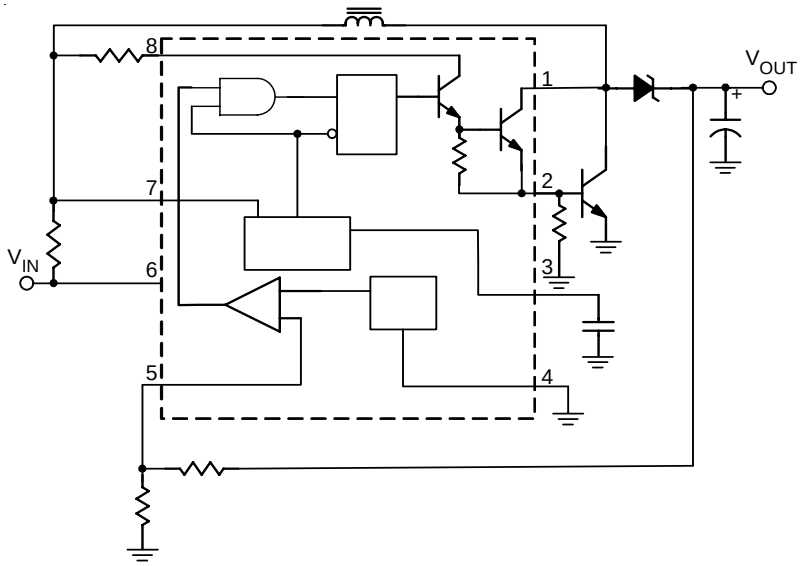
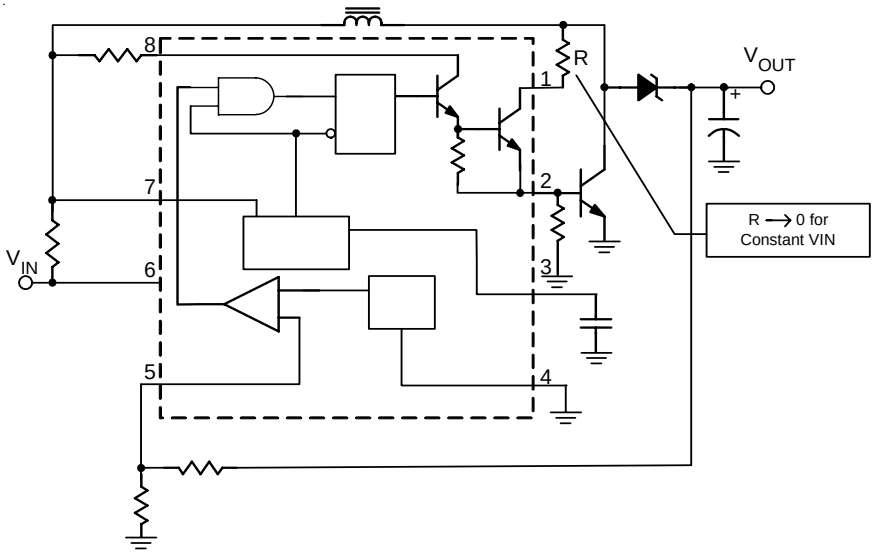


Figure 1. Step-up Converter



(a) External NPN Switch



(b) External NPN Saturated Switch (See Note)

Figure 2. External Current Boost Connections for I_C Peak Greater than 1.5A

Note: If the output switch is driven into hard saturation (non-Darlington 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 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.

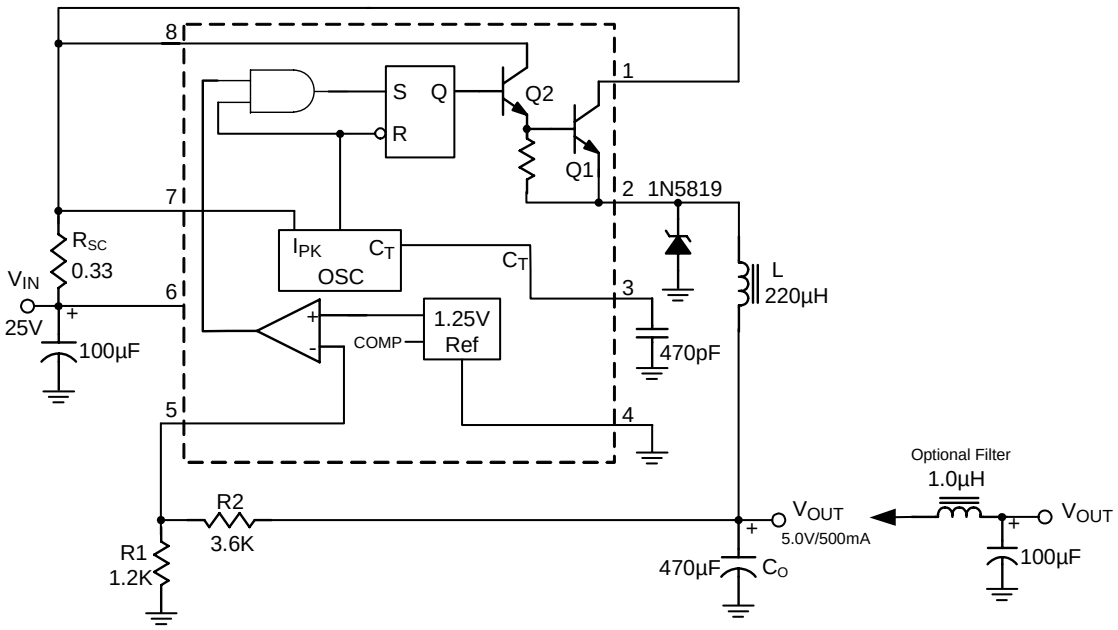
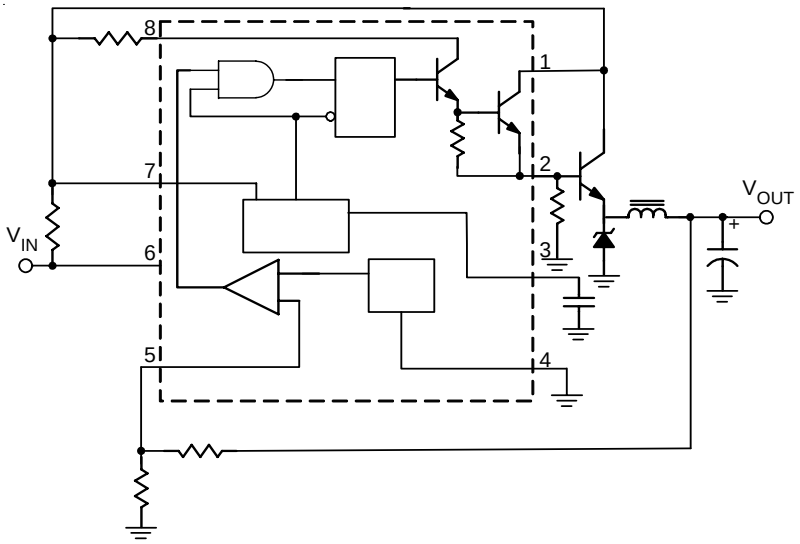
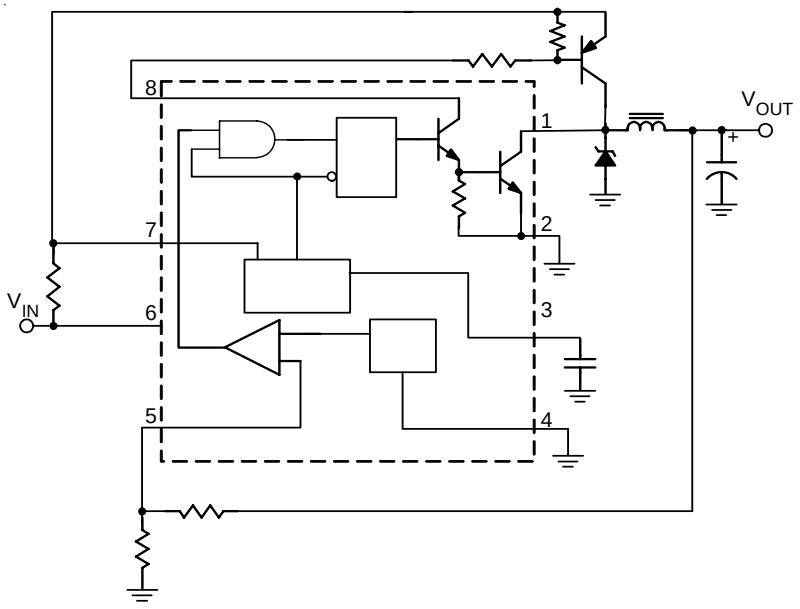


Figure 3. Step-down Converter



(a) External NPN Switch



(b) External PNP Saturated Switch

Figure 4. External Current Boost Connections for I_C Peak Greater than 1.5A

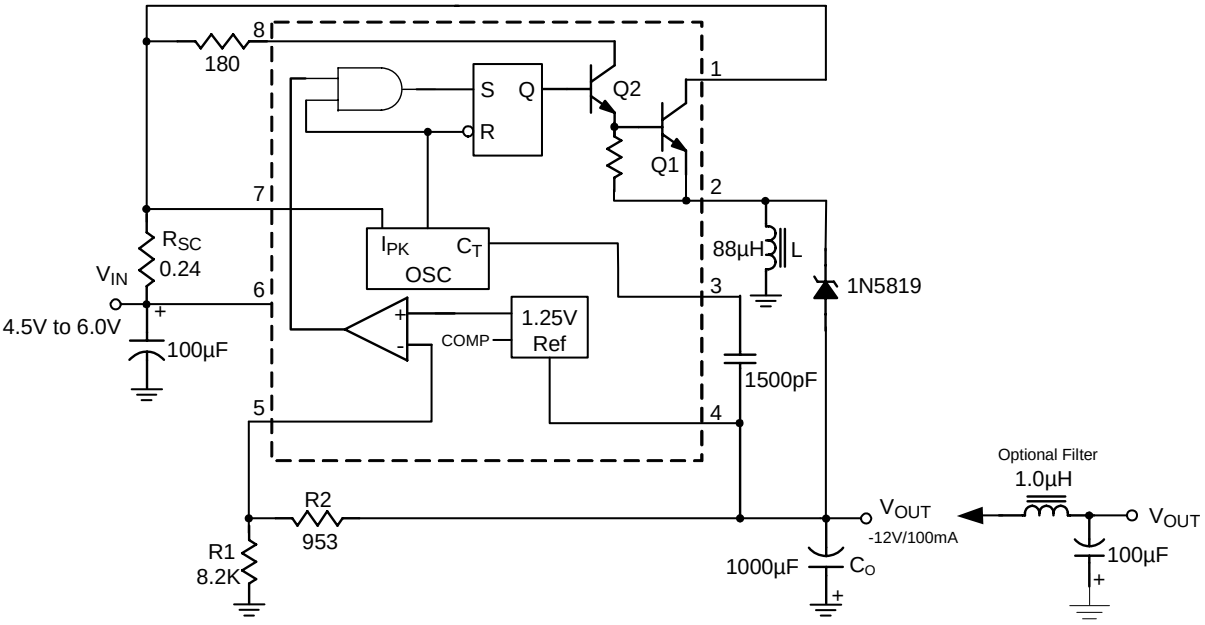
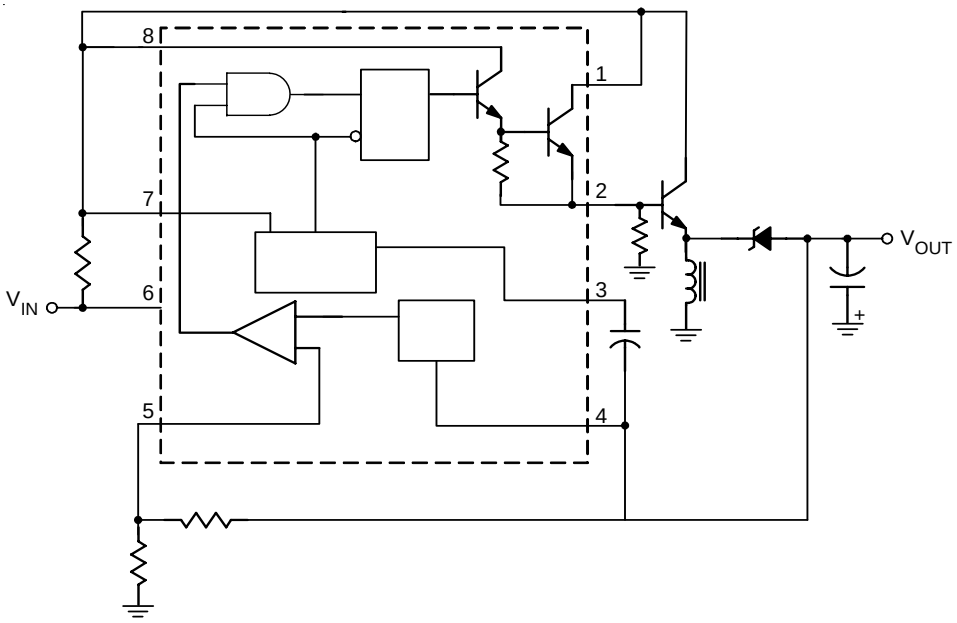
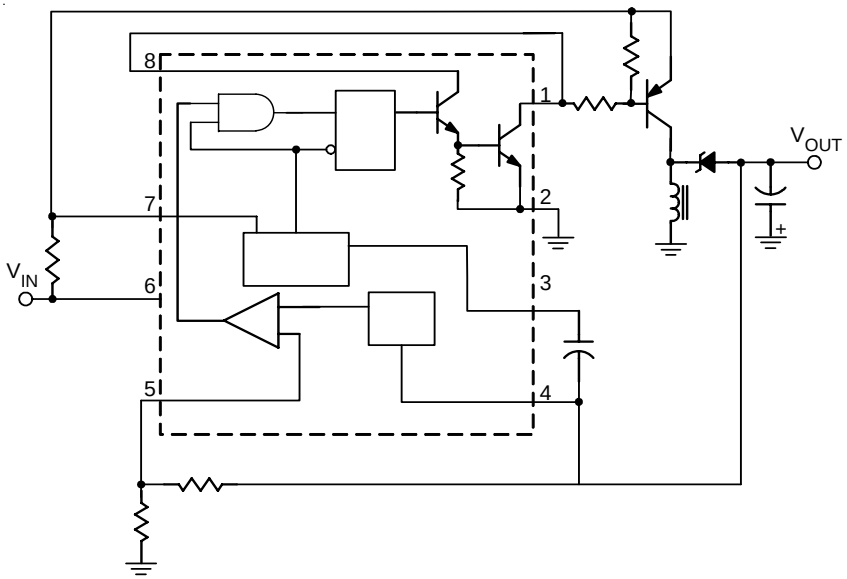


Figure 5. Voltage Inverting Converter



(a) External NPN Switch



(b) External PNP Saturated Switch

Figure 6. External Current Boost Connections for Peak Greater than 1.5A

Design Formula Table

Calculation	Step-up	Step-down	Voltage-Inverting
t_{on}/t_{off}	$\frac{V_{OUT} + V_F - V_{IN(MIN)}}{V_{IN(MIN)} - V_{SAT}}$	$\frac{V_{OUT} + V_F}{V_{IN(MIN)} - V_{SAT} - V_{OUT}}$	$\frac{\lvert V_{OUT} \rvert + V_F}{V_{IN} - V_{SAT}}$
$(t_{on} + t_{off})$	$\frac{1}{f}$	$\frac{1}{f}$	$\frac{1}{f}$
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	$4.0 \times 10^{-5} t_{on}$	$4.0 \times 10^{-5} t_{on}$	$4.0 \times 10^{-5} t_{on}$
$I_{pk\ (SWITCH)}$	$2\ I_{OUT\ (MAX)} \left(\frac{t_{on}}{t_{off}} + 1 \right)$	$2\ I_{OUT\ (MAX)}$	$2\ I_{OUT(MAX)} \left(\frac{t_{on}}{t_{off}} + 1 \right)$
R_{SC}	$0.3/I_{pk\ (SWITCH)}$	$0.3/I_{pk\ (SWITCH)}$	$0.3/I_{pk\ (SWITCH)}$
L (min)	$\left(\frac{(V_{IN(MIN)} - V_{SAT})}{I_{pk(SWITCH)}} \right) t_{on(MAX)}$	$\left(\frac{(V_{IN(MIN)} - V_{SAT})}{I_{pk(SWITCH)}} \right) t_{on(MAX)}$	$\left(\frac{(V_{IN(MIN)} - V_{SAT})}{I_{pk(SWITCH)}} \right) t_{on(MAX)}$
C_O	$9 \frac{I_{OUT}\ t_{on}}{V_{ripple\ (pp)}}$	$\frac{I_{pk(SWITCH)}(t_{on} + t_{off})}{8 V_{ripple(pp)}}$	$9 \frac{I_{OUT}\ t_{on}}{V_{ripple\ (pp)}}$

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 $\lvert V_{OUT} \rvert = 1.25(1 + \frac{R_2}{R_1})$

I_{OUT} : Desired output current.

f : Minimum desired output switching frequency at the selected values of Vin and I_O.

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

Absolute Maximum Ratings (Note 1)

- Power Supply Voltage ---------- 30V
- Feedback Input Voltage Range ---------- –0.3 to +30V
- Switch Collector Voltage ---------- 30V
- Switch Emitter Voltage ---------- 30V
- Switch Collector to Emitter Voltage ---------- 30V
- Driver Collector Voltage ---------- 30V
- Driver Collector Current (see Note) ---------- 100mA
- Switch Current ---------- 1.5A
- Power Dissipation, P_D @ T_A = 25°C
  - DIP-8 ---------- 1.25W
  - SOP-8 ---------- 0.625W
- Package Thermal Resistance (Note 2)
  - DIP-8, θ_{JA} ---------- 100°C/W
  - SOP-8, θ_{JA} ---------- 160°C/W
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- 65 to +150°C

Note:Maximum package power dissipation limits must be observed.

Recommended Operating Conditions (Note 3)

- Power Supply Input Voltage Range ---------- 3V to 30V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(VCC = 5V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Oscillator						
Frequency		V_{PIN5} = 0V, C_T = 1.0nF	26	38	48	kHz
Charge Current	I_{CHG}	5.0V ≤ VCC ≤ 30V	25	36	43	μA
Discharge Current	I_{DISCHG}	5.0V ≤ VCC ≤ 30V	160	250	290	μA
Discharge to Charge Current Ratio		Pin 7 to VCC	5.5	6.9	7.9	--
Current Limit Sense Voltage	V_{LIM}	I_{CHG} = I_{DISCHG}	280	330	380	mV
Output Switch						
Saturation Voltage, Darlington Connection		I_{SW} = 1.0A, Pins1, 8 connected	--	1.0	1.3	V
Saturation Voltage, Darlington Connection		I_{SW} = 1.0A, R_{PIN8} = 82Ω to VCC, Forced β ≅ 20	--	0.45	0.7	V
DC Current Gain		I_{SW} = 1.0A, V_{CE} = 5.0V	50	75	--	--
Collector Off-state Current		V_{CE} = 30V	--	0.01	100	μA

To be continued

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Comparator						
Threshold Voltage			1.225	1.25	1.275	V
Threshold Voltage Line Regulation		3.0V ≤ VCC ≤ 30V	--	1.4	5.0	mV
Input Bias Current	I_{BIAS}	VIN = 0V	--	−20	−400	nA
Total Device						
Supply Current	I_{CC}	VCC = 5.0V to 30V, C_T = 1.0nF, Pin7 = VCC, $V_{PIN5} > V_{TH}$, Pin2 = GND, Remaining pins open	--	3.0	4.5	mA

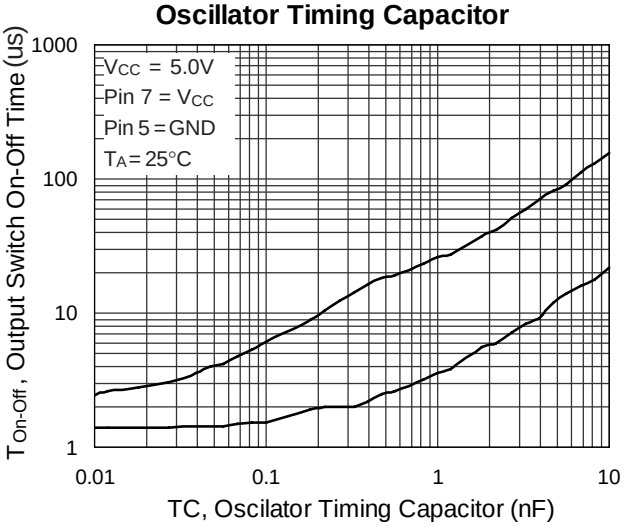
Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

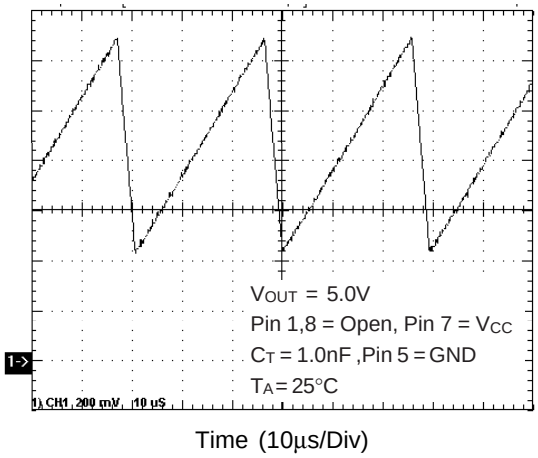
Note 3. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

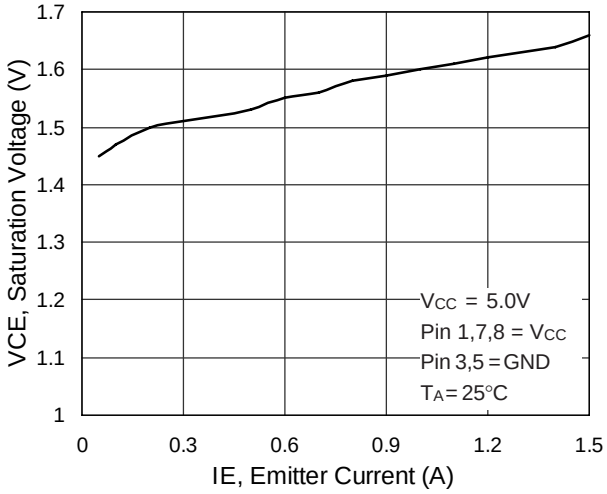
Output Switch On-Off Time vs. Oscillator Timing Capacitor



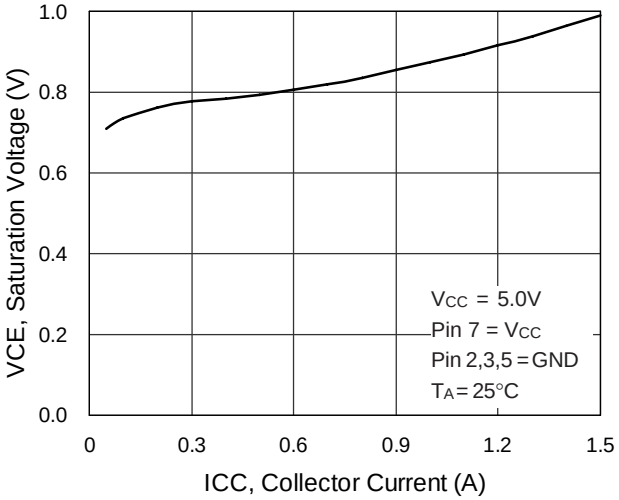
Timing Capacitor Waveform



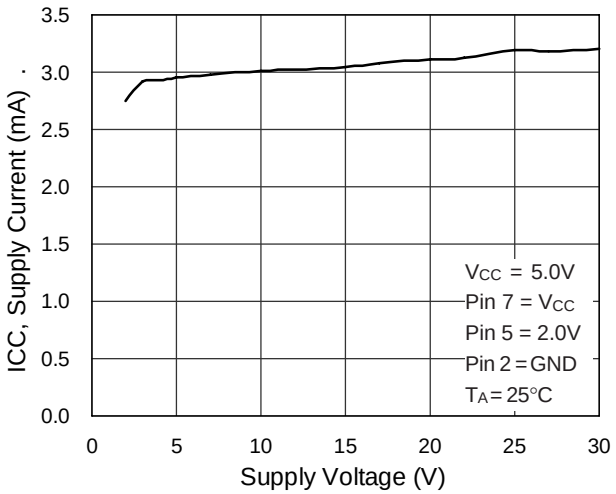
Emitter Follower Configuration Output Saturation Voltage vs. Emiter Current



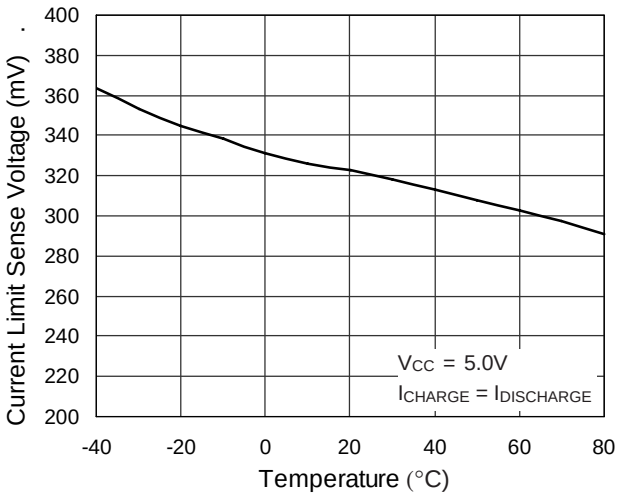
Common Emiter Configuration Output Switch Saturation Voltage vs. Collector Current

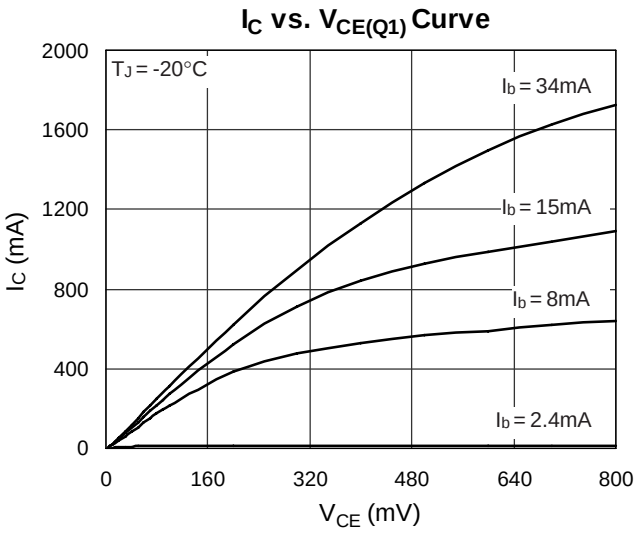


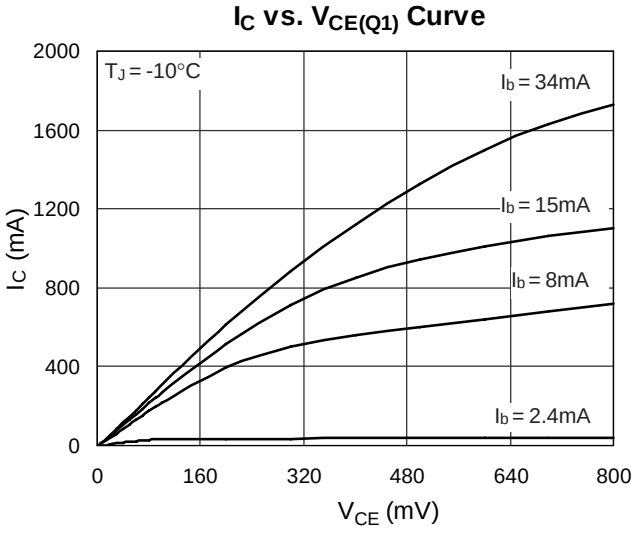
Standyby Supply Current vs. Supply Voltage

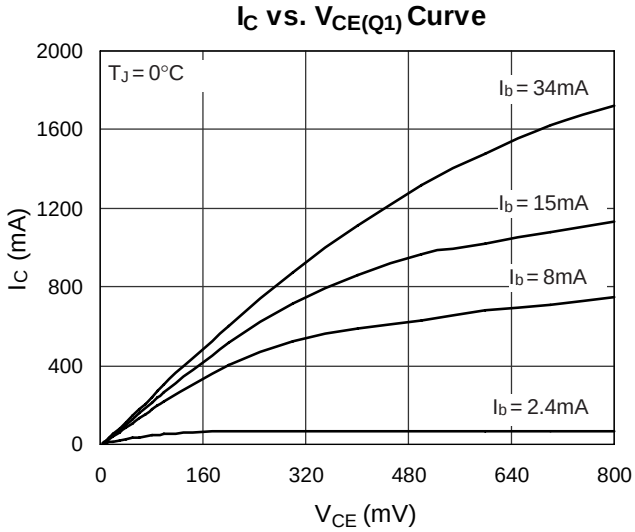


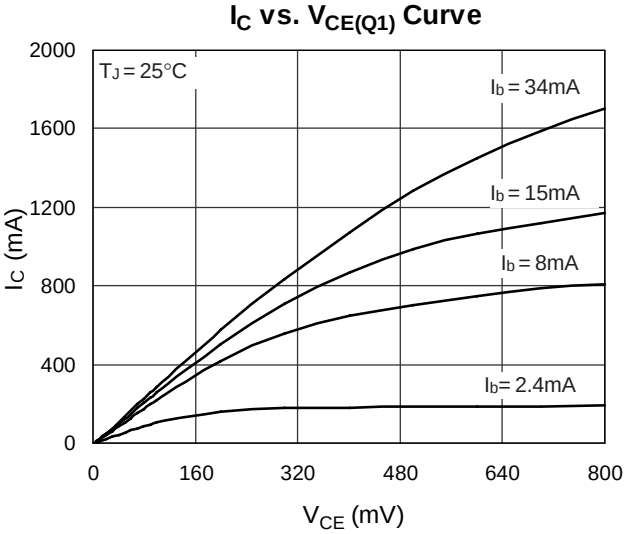
Current Limit Sense Voltage vs. Temperature

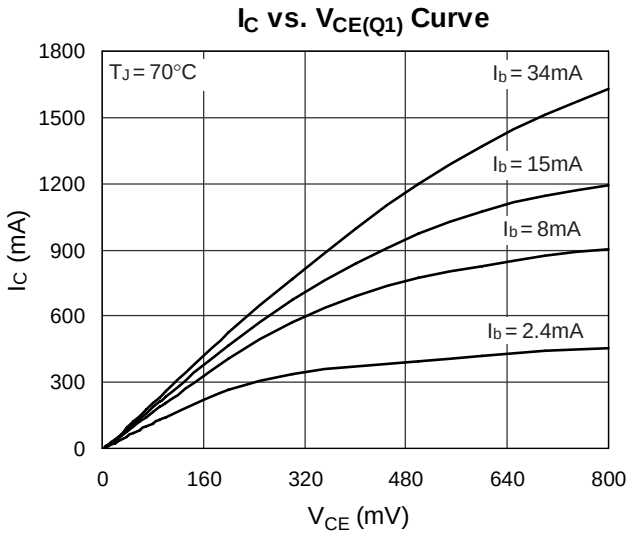



I_C vs. $V_{CE(Q1)}$ Curve
T_J = -20°C
I_b = 34mA
I_b = 15mA
I_b = 8mA
I_b = 2.4mA
I_C (mA)
V_{CE} (mV)
2000
1600
1200
800
400
0
0
160
320
480
640
800

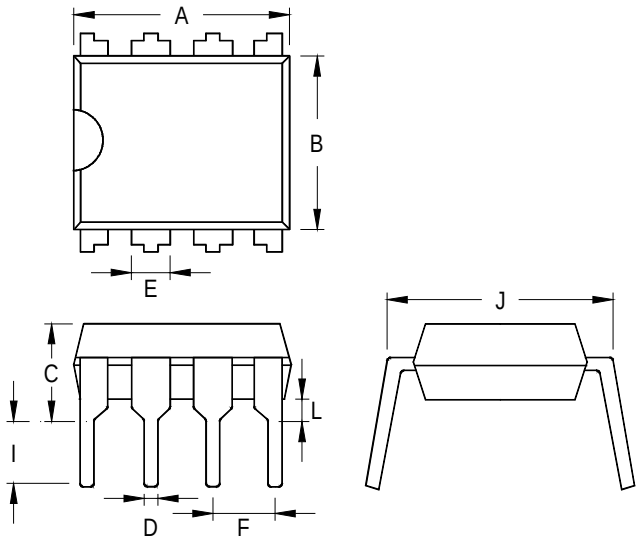

I_C vs. $V_{CE(Q1)}$ Curve
T_J = -10°C
I_b = 34mA
I_b = 15mA
I_b = 8mA
I_b = 2.4mA
I_C (mA)
V_{CE} (mV)
2000
1600
1200
800
400
0
0
160
320
480
640
800


I_C vs. $V_{CE(Q1)}$ Curve
T_J = 0°C
I_b = 34mA
I_b = 15mA
I_b = 8mA
I_b = 2.4mA
I_C (mA)
V_{CE} (mV)
2000
1600
1200
800
400
0
0
160
320
480
640
800


I_C vs. $V_{CE(Q1)}$ Curve
T_J = 25°C
I_b = 34mA
I_b = 15mA
I_b = 8mA
I_b= 2.4mA
I_C (mA)
V_{CE} (mV)
2000
1600
1200
800
400
0
0
160
320
480
640
800

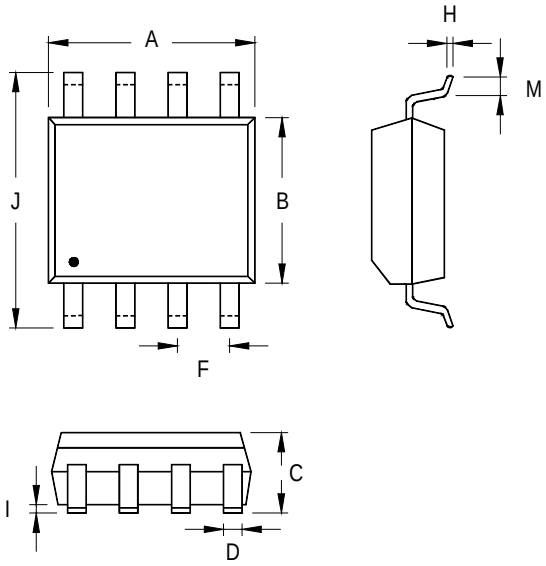

I_C vs. $V_{CE(Q1)}$ Curve
T_J = 70°C
I_b = 34mA
I_b = 15mA
I_b = 8mA
I_b = 2.4mA
I_C (mA)
V_{CE} (mV)
1800
1500
1200
900
600
300
0
0
160
320
480
640
800

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	9.068	9.627	0.357	0.379
B	6.198	6.604	0.244	0.260
C	3.556	4.318	0.140	0.170
D	0.356	0.559	0.014	0.022
E	1.397	1.651	0.055	0.065
F	2.337	2.743	0.092	0.108
I	3.048	3.556	0.120	0.140
J	7.366	8.255	0.290	0.325
L	0.381		0.015	

8-Lead DIP Plastic Package



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	4.801	5.004	0.189	0.197
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.170	0.254	0.007	0.010
I	0.050	0.254	0.002	0.010
J	5.791	6.200	0.228	0.244
M	0.400	1.270	0.016	0.050

8-Lead SOP Plastic Package

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