DC-to-DC Converter Control Circuits

General Description

The RT34063A 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 specially designed to be incorporated in step-down and step-up and Voltage-inverting applications with a minimum number of external components.

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.

Features

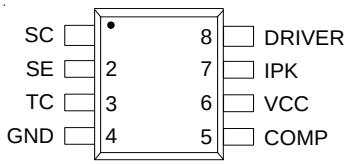
- **Operation from 3.0V to 30V Input**
- **Low Standby Current**
- **Current Limiting**
- **Internal Switch Current to 1.5A**
- **Output Voltage Adjustable**
- **Frequency Operation to 100kHz**
- **Precision 2% Reference**
- **RoHS Compliant and 100% Lead (Pb)-Free**

Applications

- Saver for Cellular Phones
- DC-DC Converter Module

Pin Configurations

(TOP VIEW)

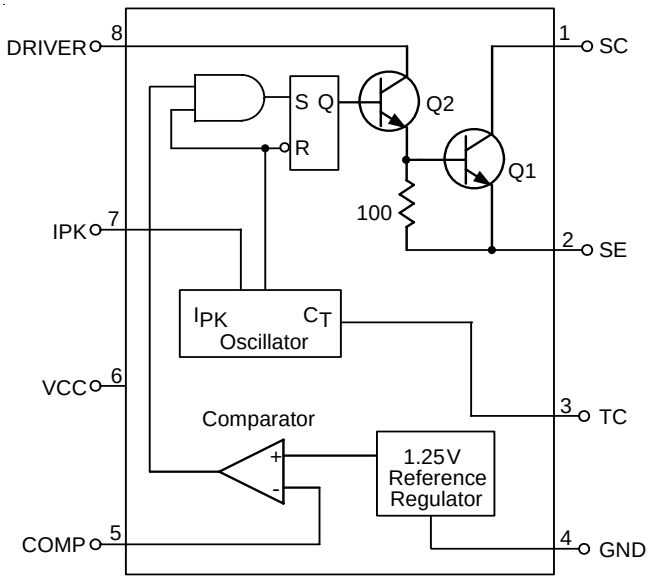


DIP-8 / SOP-8

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	Highside Current Sense Input VCC-V_{IPK} = 330mV
DRIVER	Driver Collector

Function Block Diagram



Typical Application Circuit

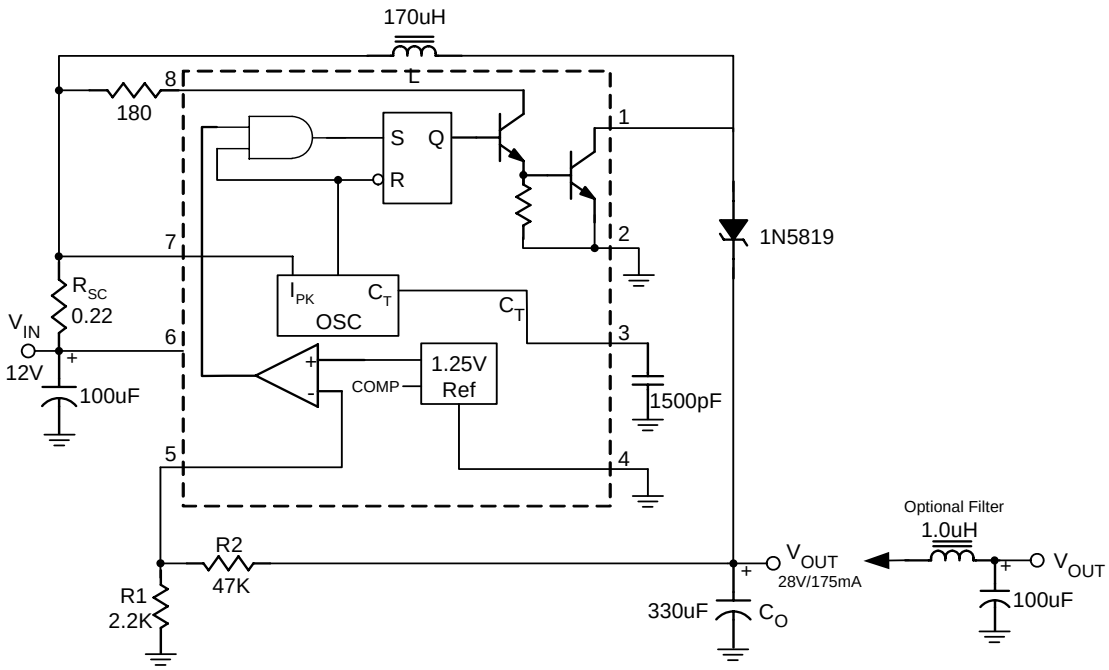
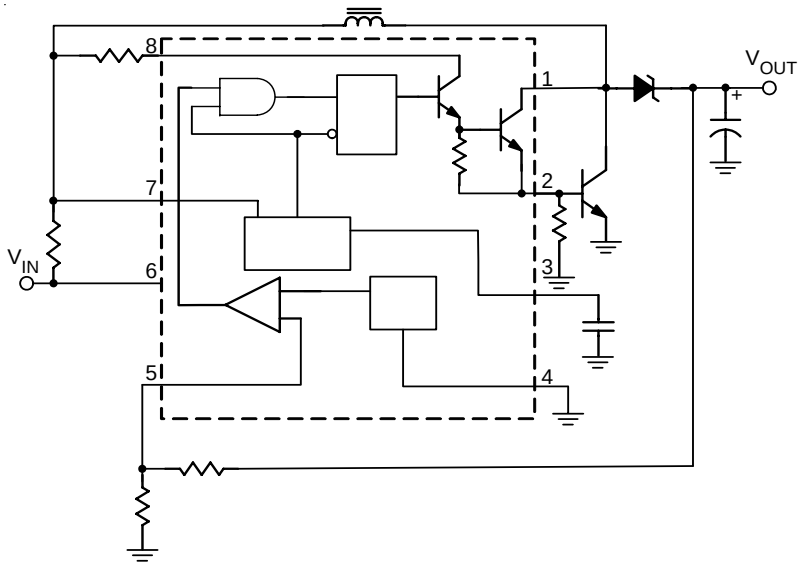
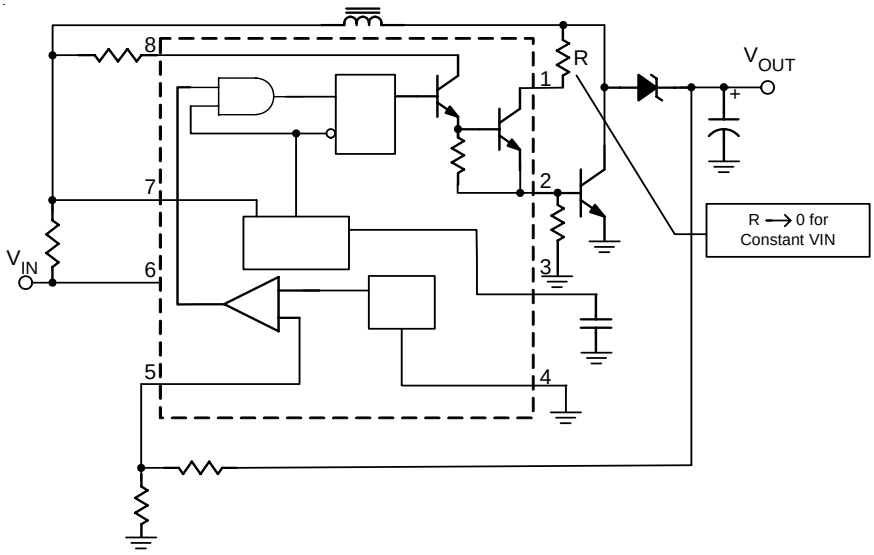


Figure 1. Step-up Converter



(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.

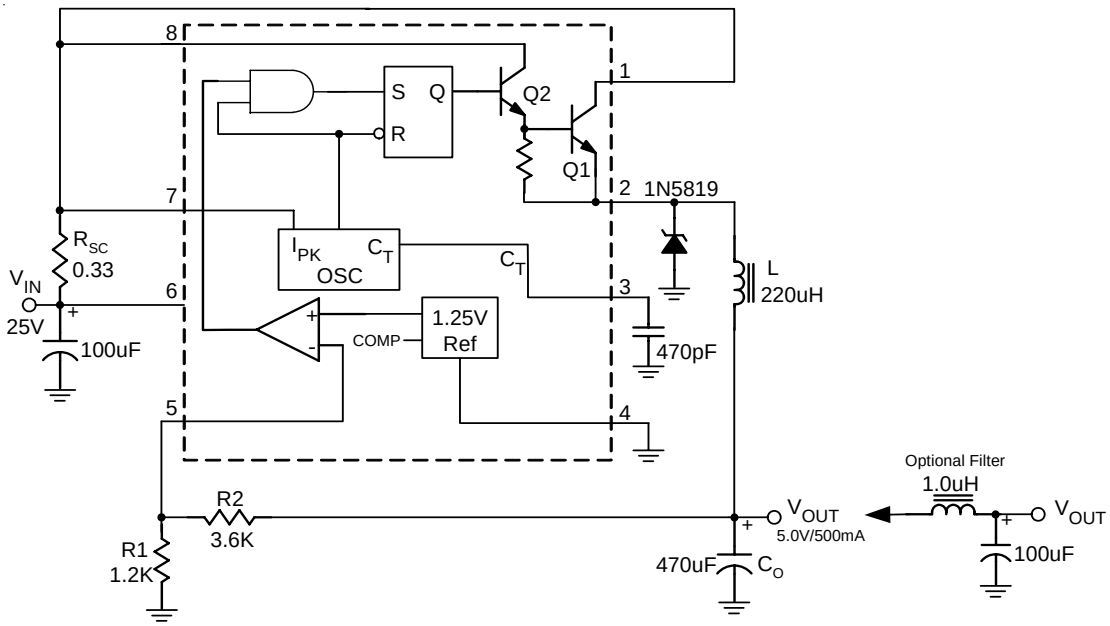
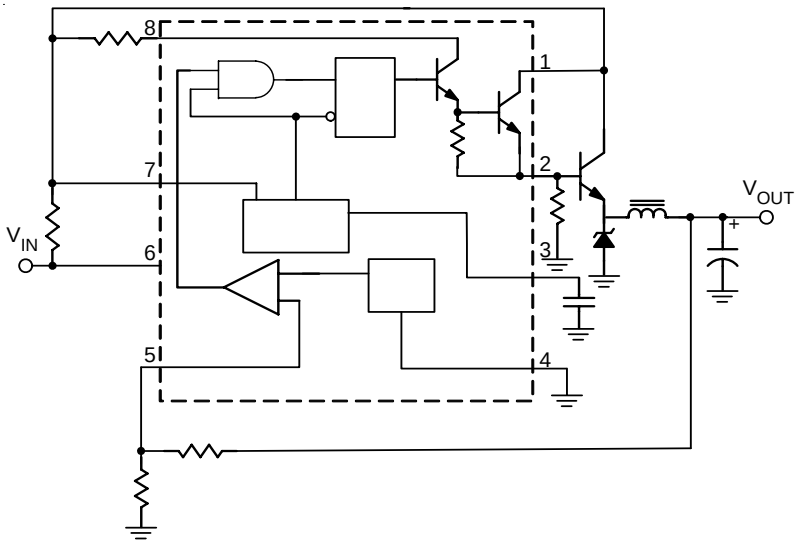
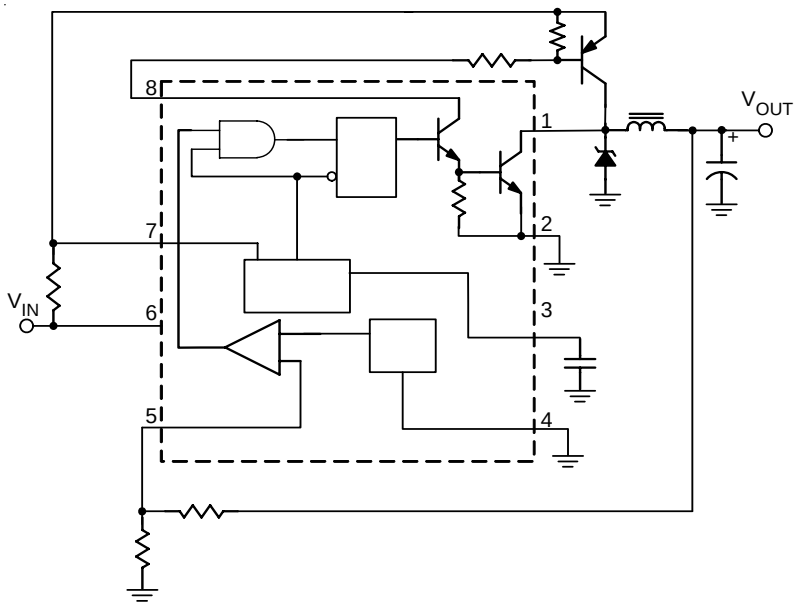


Figure 3. Step-down Converter



(a) External NPN Switch



(b) External PNP Saturated Switch

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

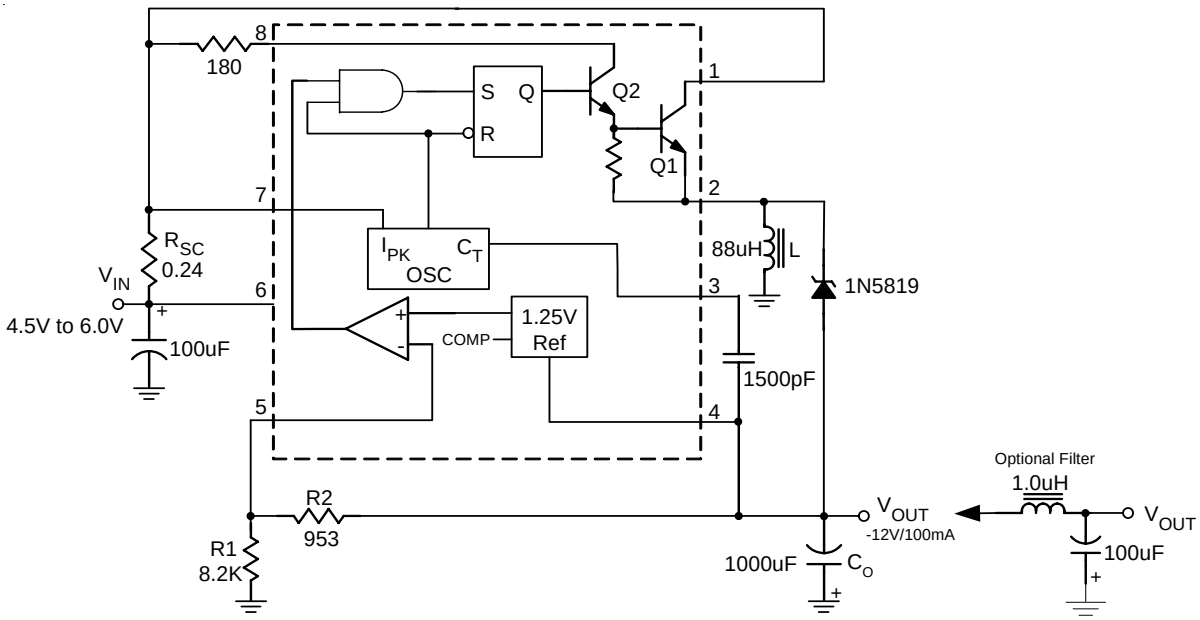
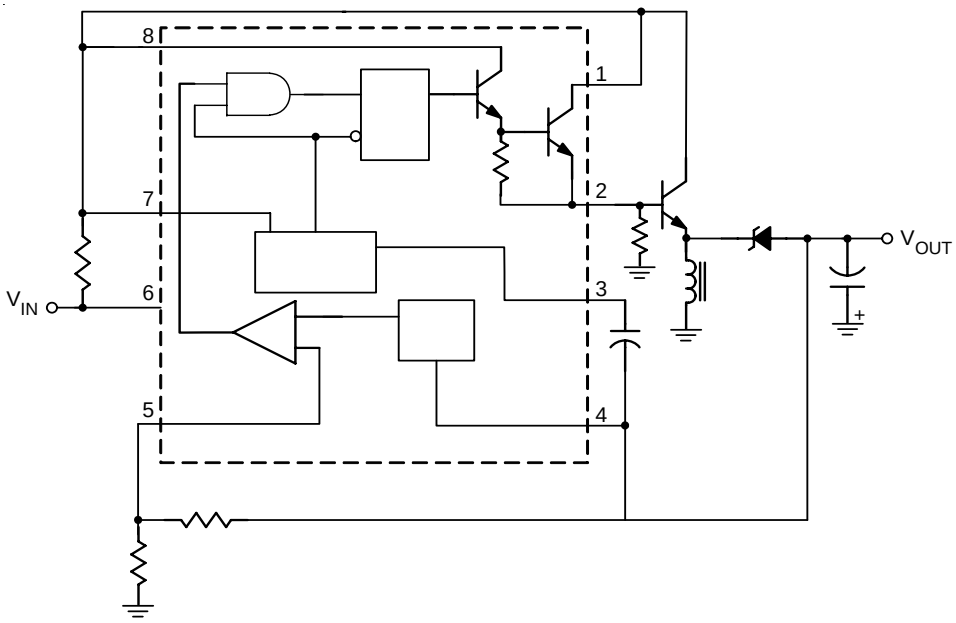
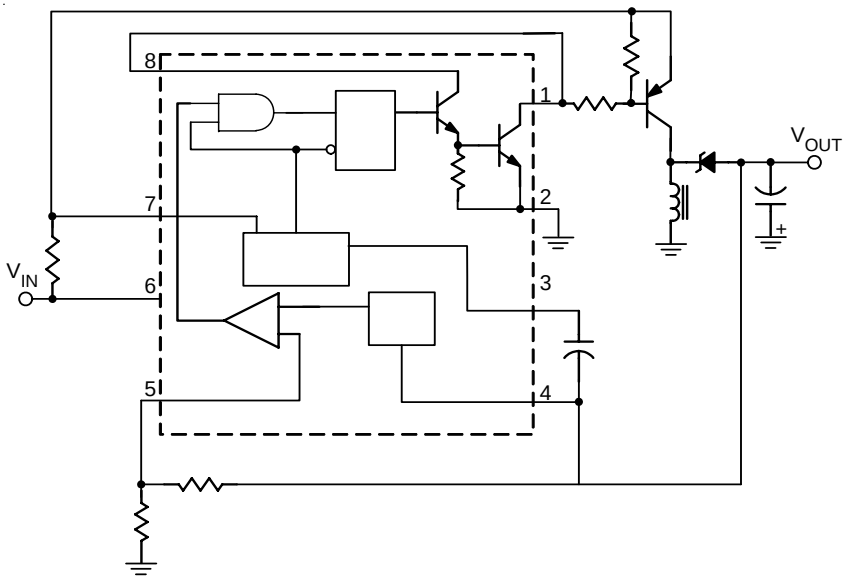


Figure 5. Voltage Inverting Converter



(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

- 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
  DIP-8, θ_{JA} ---------- 100°C/W
  SOP-8, θ_{JA} ---------- 160°C/W
- Operating Junction Temperature ---------- +125°C
- Storage Temperature Range ---------- 65 to +150°C

  Note:Maximum package power dissipation limits must be observed.

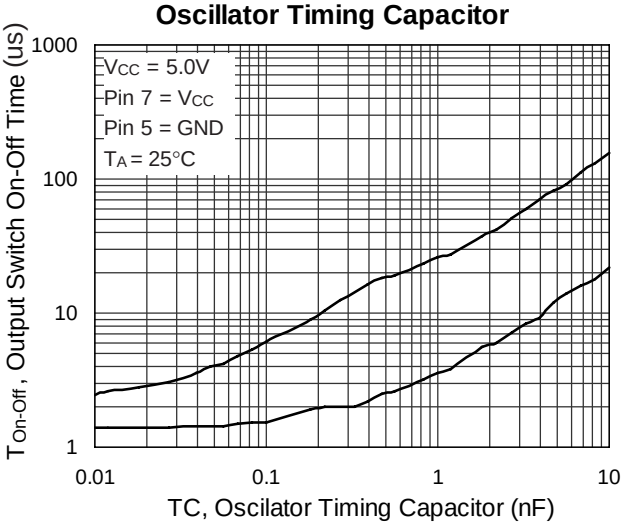
Electrical Characteristics

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

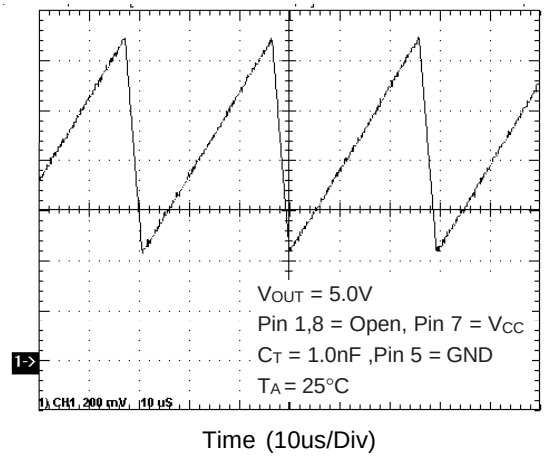
Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Oscillator						
Frequency		V_{PIN5} = 0V, C_T = 1.0nF	26	38	48	kHz
Charge Current	I_{CHG}	5.0V ≤ VCC ≤ 30V	25	36	43	μA
Discharge Current	I_{DISCHG}	5.0V ≤ VCC ≤ 30V	160	250	290	μA
Discharge to Charge Current Ratio		Pin 7 to VCC	5.5	6.9	7.9	--
Current Limit Sense Voltage	V_{LIMIT}	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
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}	V_{IN} = 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

Typical Operating Characteristics

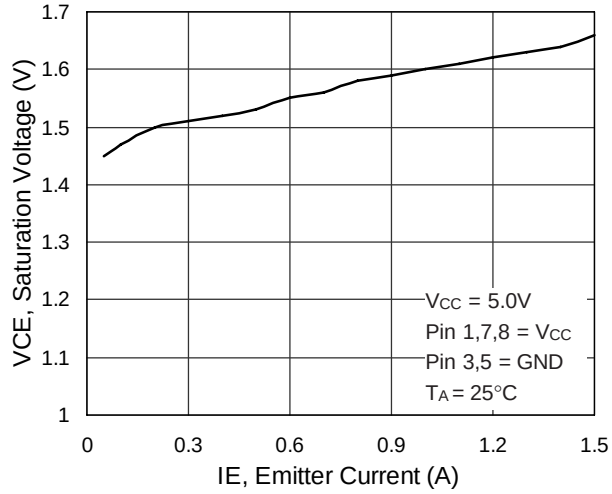
Output Switch On-Off Time vs. Oscillator Timing Capacitor



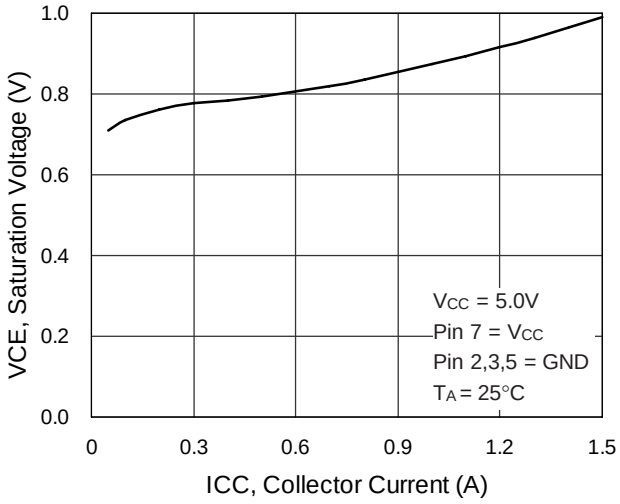
Timing Capacitor Waveform



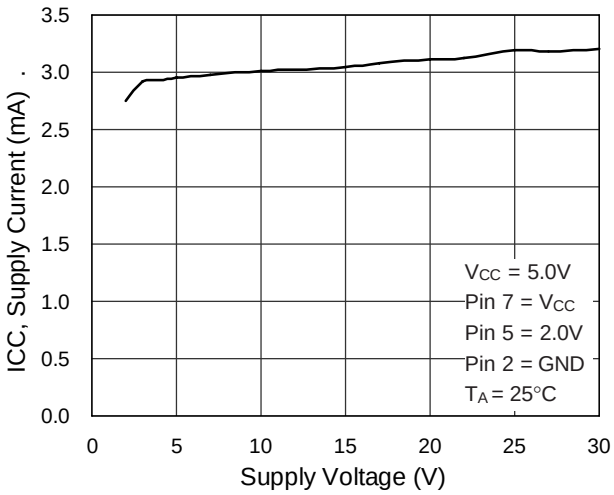
Emitter Follower Configuration Output Saturation Voltage vs. Emiter Current



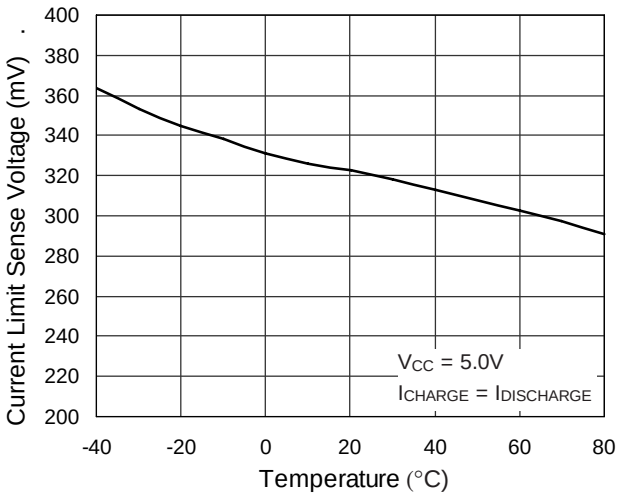
Common Emiter Configuration Output Switch Saturation Voltage vs. Collector Current



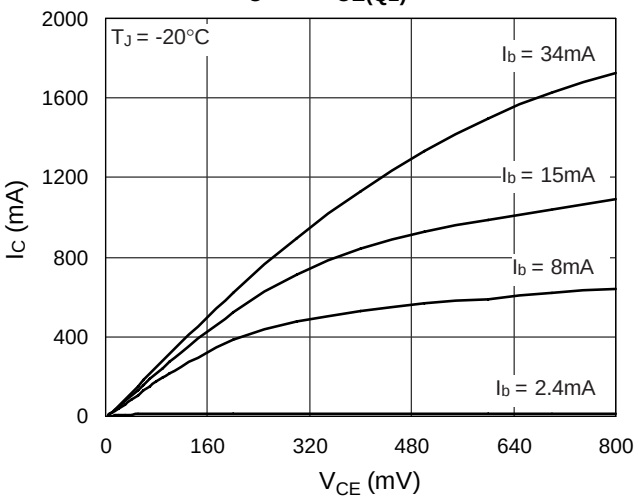
Standyby Supply Current vs. Supply Voltage



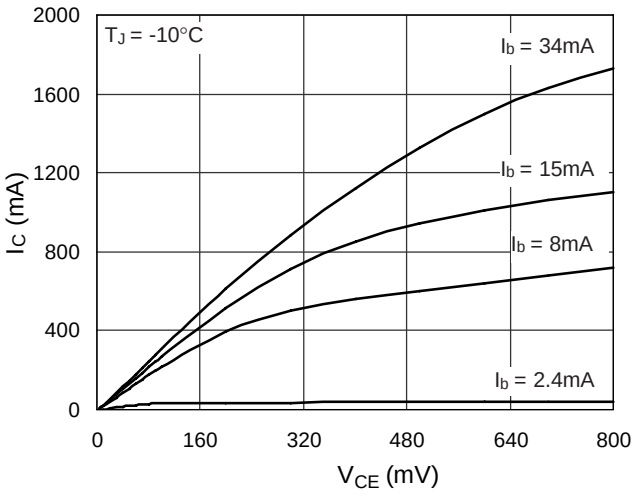
Current Limit Sense Voltage vs. Temperature



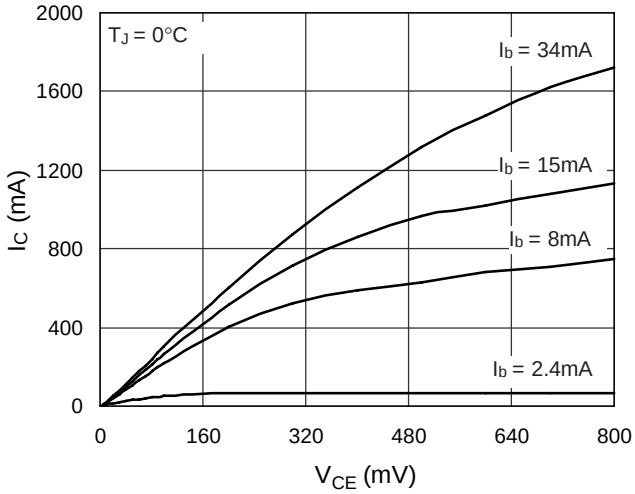
I_C vs. $V_{CE(Q1)}$ Curve



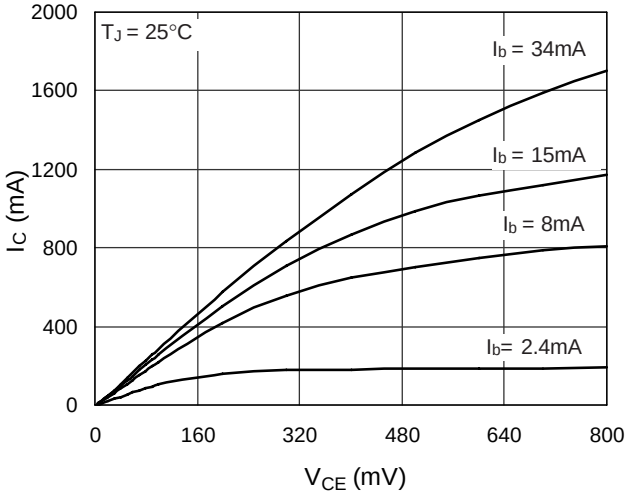
I_C vs. $V_{CE(Q1)}$ Curve



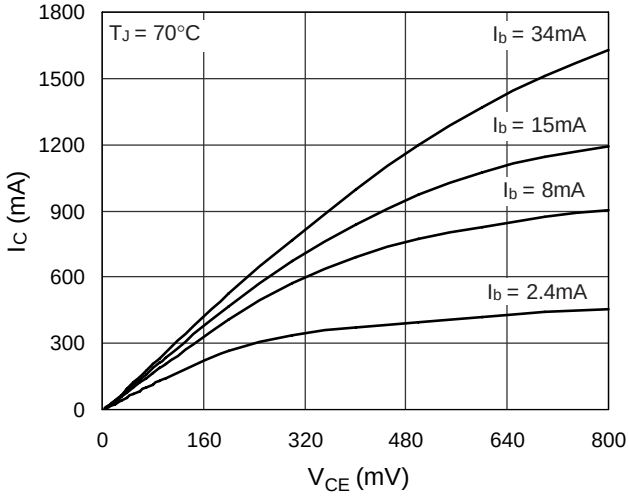
I_C vs. $V_{CE(Q1)}$ Curve



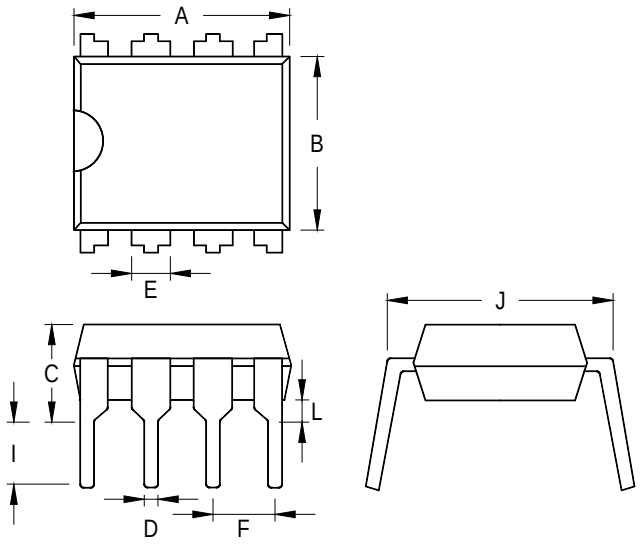
I_C vs. $V_{CE(Q1)}$ Curve



I_C vs. $V_{CE(Q1)}$ Curve

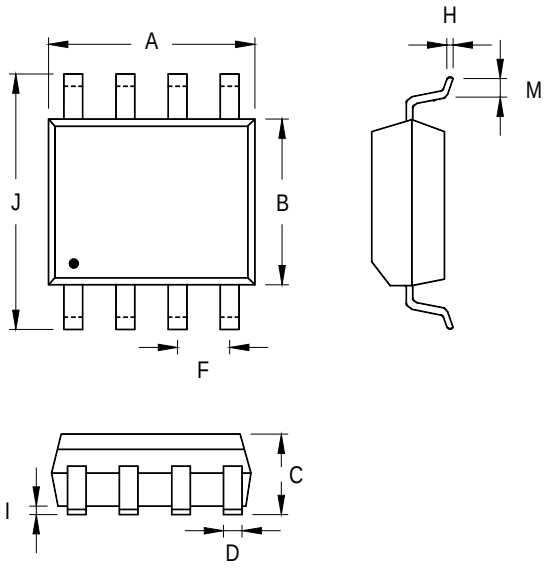


Outline Dimension



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

Richtek Technology Corporation
Headquarter
5F, No. 20, Taiyuen Street, Chupei City
Hsinchu, Taiwan, R.O.C.
Tel: (8863)5526789 Fax: (8863)5526611

Richtek Technology Corporation
Taipei Office (Marketing)
8F, No. 137, Lane 235, Paochiao Road, Hsintien City
Taipei County, Taiwan, R.O.C.
Tel: (8862)89191466 Fax: (8862)89191465
Email: marketing@richtek.com