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## Description

The AP34063 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 is specifically designed for incorporating in Step-Down and Step-Up and Voltage-Inverting applications with a minimum number of external components.

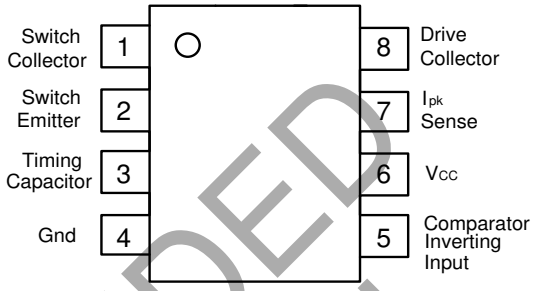
## Features

- Operation from 3.0V to 40V Input
- Low Standby Current
- Current Limiting
- Output Switch Current to 1.6A
- Output Voltage Adjustable
- Frequency Operation to 100kHz
- Precision 2% Reference
- PDIP-8 and SO-8 Packages
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

## Pin Assignments

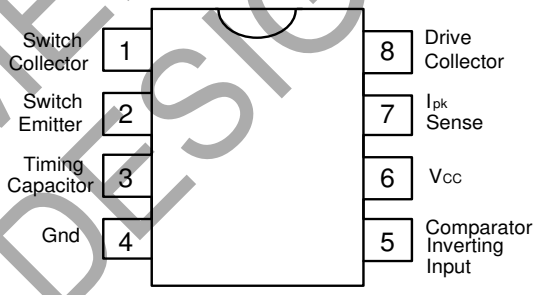
**SO-8**

**( Top View )**




**PDIP-8**

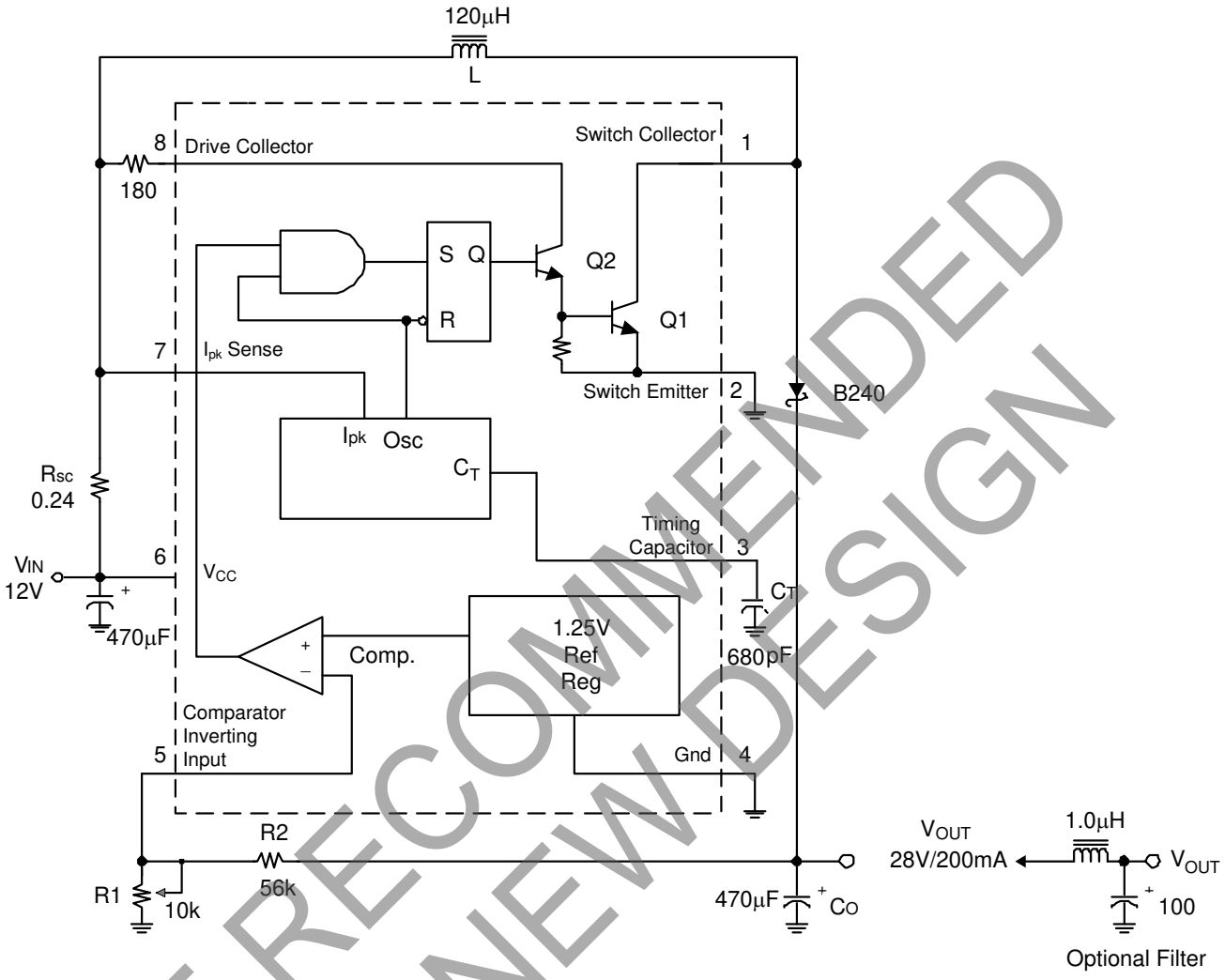
**( Top View )**




Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

## Typical Applications Circuit

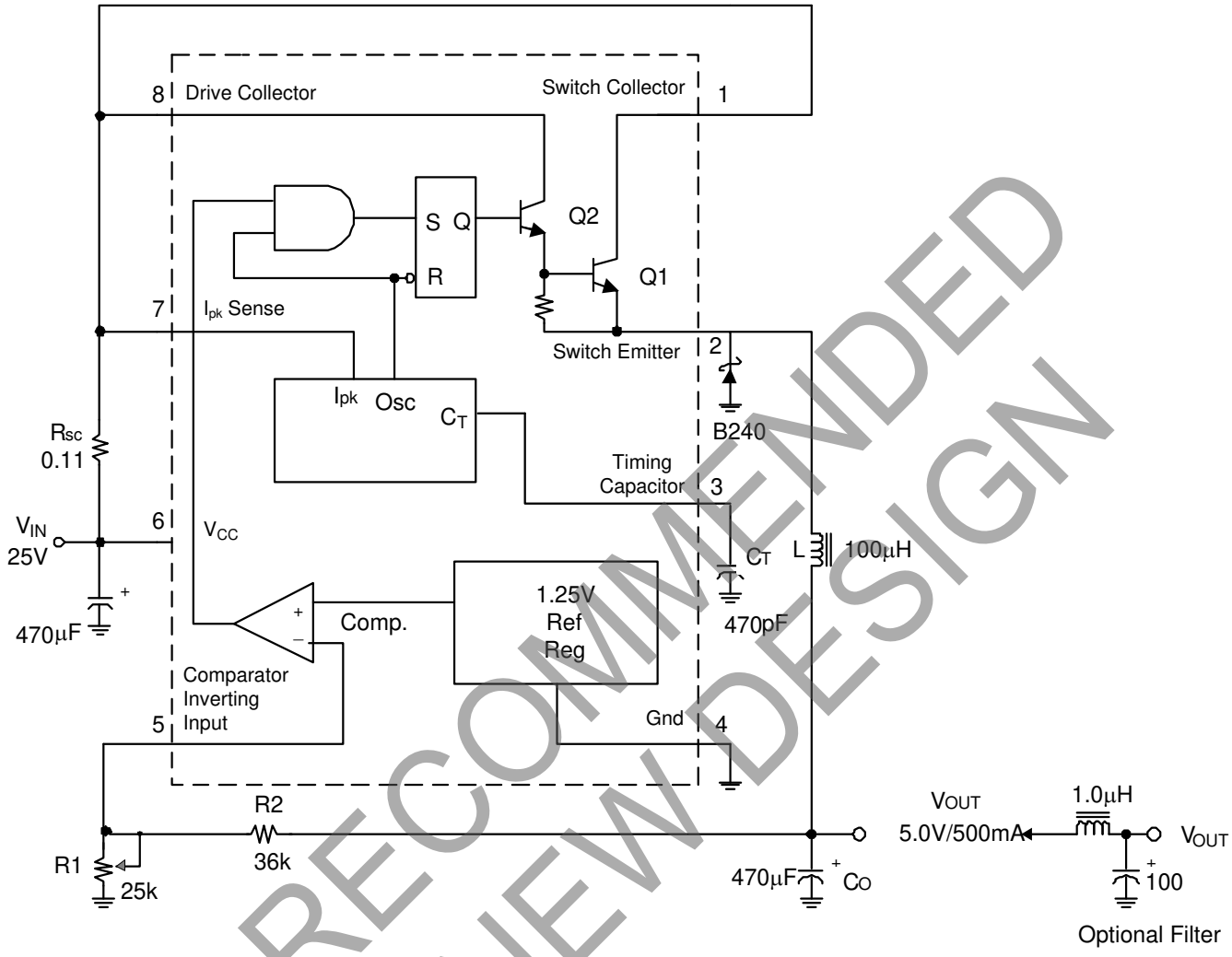
**(1) Step-Up Converter**




| Test | Conditions | Results |
|---|---|---|
| Line Regulation | $V_{IN}$ = 9V to 12V, $I_O$ = 200mA | 20mV = ±0.035% |
| Load Regulation | $V_{IN}$ = 12V, $I_O$ = 50mA to 200mA | 15mV = ±0.035% |
| Output Ripple | $V_{IN}$ = 12V, $I_O$ = 200mA | 500m$V_{PP}$ |
| Efficiency | $V_{IN}$ = 12V, $I_O$ = 200mA | 80% |

## Typical Applications Circuit (Cont.)

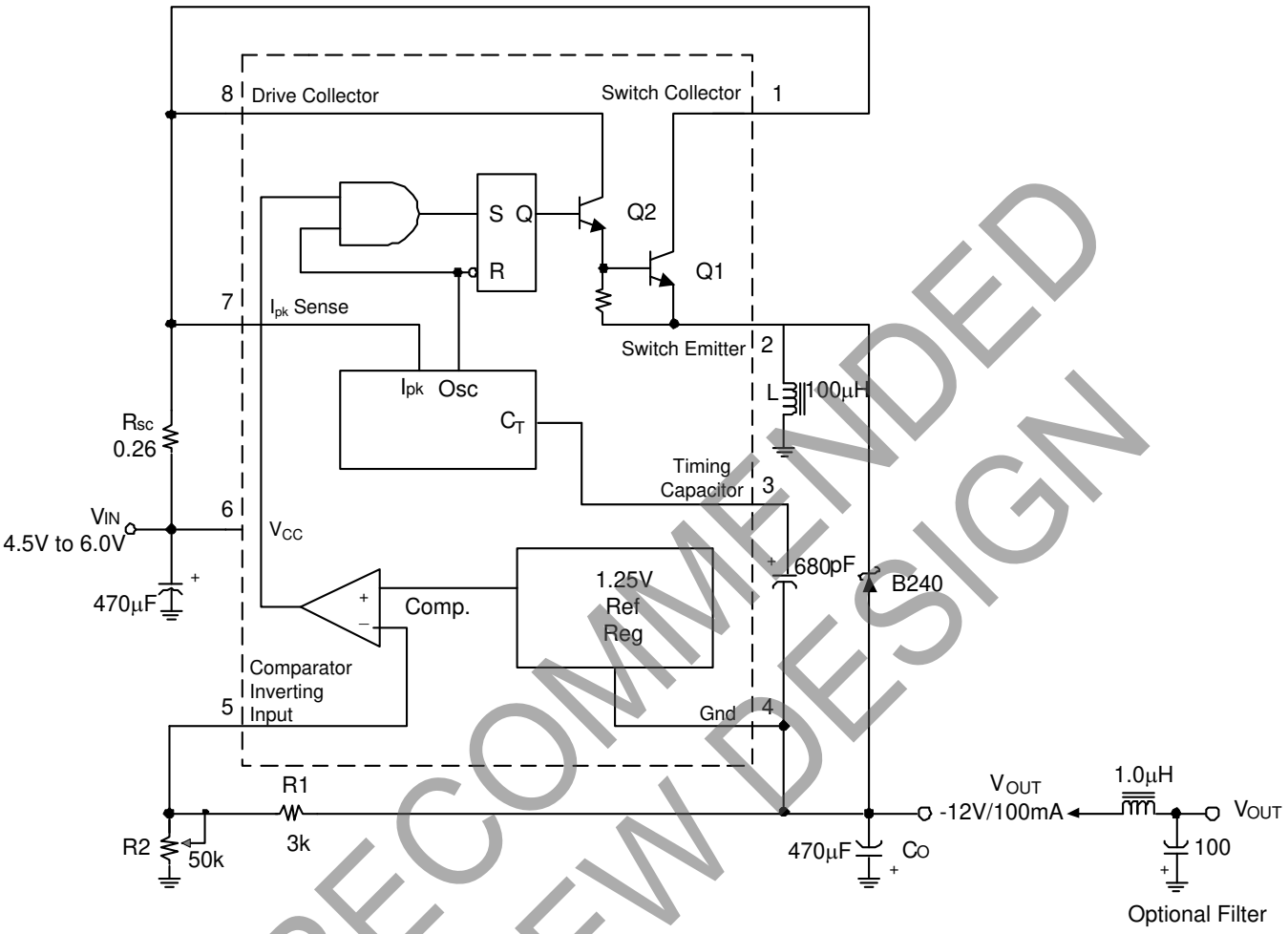
**(2) Step-Down Converter**




| Test | Conditions | Results |
|---|---|---|
| Line Regulation | $V_{IN}$ = 12V to 24V, $I_O$ = 500mA | 20mV = ±0.2% |
| Load Regulation | $V_{IN}$ = 24V, $I_O$ = 50mA to 500mA | 5mV = ±0.05% |
| Output Ripple | $V_{IN}$ = 24V, $I_O$ = 500mA | 160m$V_{PP}$ |
| Efficiency | $V_{IN}$ = 24V, $I_O$ = 500mA | 82% |

## Typical Applications Circuit (Cont.)

**(3) Voltage Inverting Converter**




| Test | Conditions | Results |
|---|---|---|
| Line Regulation | $V_{IN}$ = 4.5V to 6.0V, $I_O$ = 100mA | 20mV = ±0.08% |
| Load Regulation | $V_{IN}$ = 5.0V, $I_O$ = 20mA to 100mA | 30mV = ±0.12% |
| Output Ripple | $V_{IN}$ = 5.0V, $I_O$ = 100mA | 500m$V_{PP}$ |
| Efficiency | $V_{IN}$ = 5.0V, $I_O$ = 100mA | 60% |

## Absolute Maximum Ratings (@$T_A$ = +25°C, unless otherwise specified.)

Stresses greater than the 'Absolute Maximum Ratings' specified above, may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

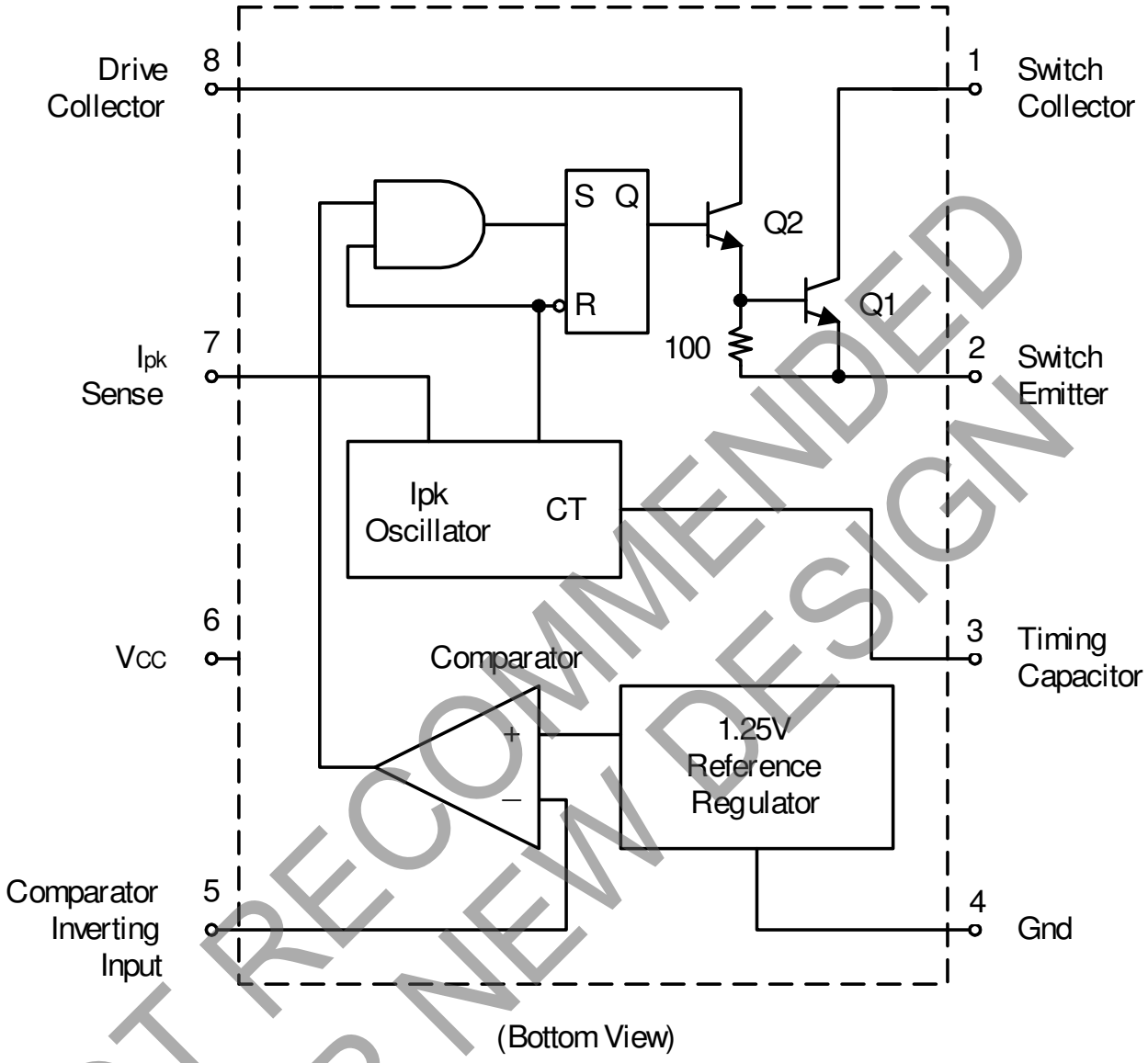
| Symbol | Parameter | | Value | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Power Supply Voltage | | 40 | V |
| $V_{CIIR}$ | Comparator Inverting Input Voltage Range | | -0.3 to +40 | V |
| $V_{C(SWITCH)}$ | Switch Collector Voltage | | 40 | V |
| $V_{E(SWITCH)}$ | Switch Emitter Voltage ($V_{PIN}$ 1 = 40V) | | 40 | V |
| $V_{CE(SWITCH)}$ | Switch Collector to Emitter Voltage | | 40 | V |
| $V_{C(DRIVER)}$ | Driver Collector Voltage | | 40 | V |
| $I_{C(DRIVER)}$ | Driver Collector Current | | 100 | mA |
| $I_{SW}$ | Switch Current | | 1.6 | A |
| $P_D$ | Power Dissipation (Note 4) | SO-8: $T_A$ = +25°C | 600 | mW |
| | | PDIP-8: $T_A$ = +25°C | 1.25 | W |
| $\theta_{JA}$ | Thermal Resistance | SO-8 | 117 | °C/W |
| | | PDIP-8 | 138 | |
| $\theta_{JC}$ | | SO-8 | 19 | |
| | | PDIP-8 | 25 | |
| $T_{MJ}$ | Maximum Junction Temperature (Note 5) | | +150 | °C |
| $T_{OP}$ | Operating Junction Temperature Range | | 0 to +105 | °C |
| $T_{stg}$ | Storage Temperature Range | | -65 to +150 | °C |

Notes: 4. Maximum package power dissipation limits must be observed.
5. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

## Electrical Characteristics ($V_{CC}$ = 5.0V, unless otherwise specified.)

| Symbol | Parameter | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OSCILLATOR** | | | | | | |
| $f_{OSC}$ | Frequency ($V_{PIN}$ 5 = 0V, $C_T$ = 1.0ηF, $T_A$ = +25°C) | | 24 | 33 | 42 | kHz |
| $I_{CHG}$ | Charge Current ($V_{CC}$ = 5.0V to 40V, $T_A$ = +25°C) | | 24 | 30 | 42 | µA |
| $I_{DISCHG}$ | Discharge Current ($V_{CC}$ = 5.0V to 40V, $T_A$ = +25°C) | | 140 | 200 | 260 | µA |
| $I_{DISCHG}$ / $I_{CHG}$ | Discharge to Charge Current Ratio (Pin 7 to $V_{CC}$, $T_A$ = +25°C) | | 5.2 | 6.5 | 7.5 | — |
| $V_{ipk\ (SENSE)}$ | Current Limit Sense Voltage ($I_{CHG}$ = $I_{DISCHG}$, $T_A$ = +25°C) | | 300 | 400 | 450 | mV |
| **OUTPUT SWITCH** | | | | | | |
| $V_{CE(sat)}$ | Saturation Voltage, Darlington Connection ($I_{SW}$ = 1.0A, Pins 1, 8 connected) | | — | 1.0 | 1.3 | V |
| $V_{CE(sat)}$ | Saturation Voltage, Darlington Connection ($I_{SW}$ = 1.0A, $I_D$ = 50mA, Forced β ≈ 20) | | — | 0.45 | 0.7 | V |
| $h_{FE}$ | DC Current Gain ($I_{SW}$ = 1.0A, $V_{CE}$ = 5.0V, $T_A$ = +25°C) | | 50 | 75 | — | — |
| $I_{C(off)}$ | Collector Off-State Current ($V_{CE}$ = 40V) | | — | 0.01 | 100 | µA |
| **COMPARATOR** | | | | | | |
| $V_{TH}$ | Threshold Voltage | $T_A$ = +25°C | 1.225 | 1.25 | 1.275 | V |
| | | $T_A$ = 0°C to +70°C | 1.21 | — | 1.29 | V |
| $Reg_{LINE}$ | Threshold Voltage Line Regulation ($V_{CC}$ = 3.0V to 40V) | | — | 1.4 | 6.0 | mV |
| **TOTAL DEVICE** | | | | | | |
| $I_{CC}$ | Supply Current ($V_{CC}$ = 5.0V to 40V, $C_T$ =1.0ηF, Pin 7 = $V_{CC}$, $V_{PIN\ 5}$ > $V_{TH}$ Pin 2 = Gnd, remaining pins open) | | — | — | 3.5 | mA |

## Representative Schematic Diagram



## Typical Performance Characteristics

**Figure 1. $V_{CE(sat)}$ versus $I_E$**

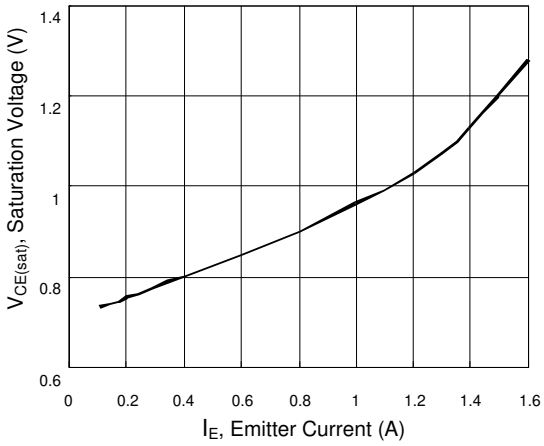



**Figure 2. Reference Voltage versus Temp.**

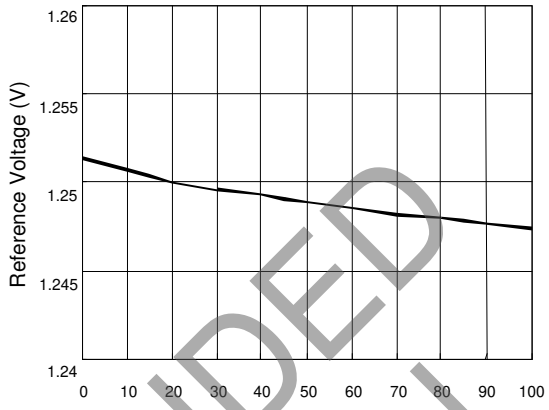



**Figure 3. Current Limit Sense Voltage versus Temperature**

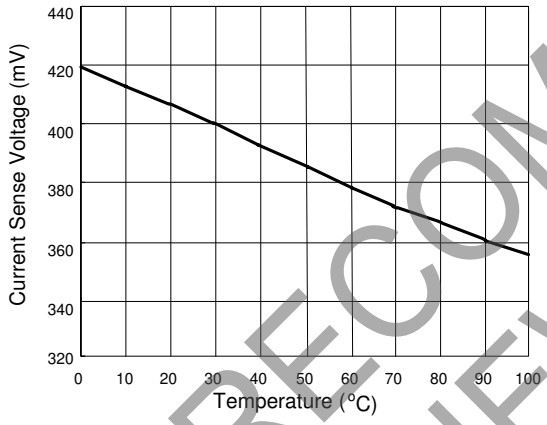



**Figure 4. Standby Supply Current versus Supply Voltage**

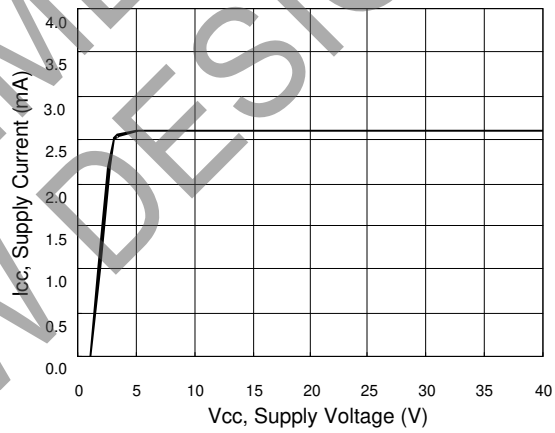



**Figure 5. Emitter Follower Configuration Output Saturation Voltage vs. Emitter Current**

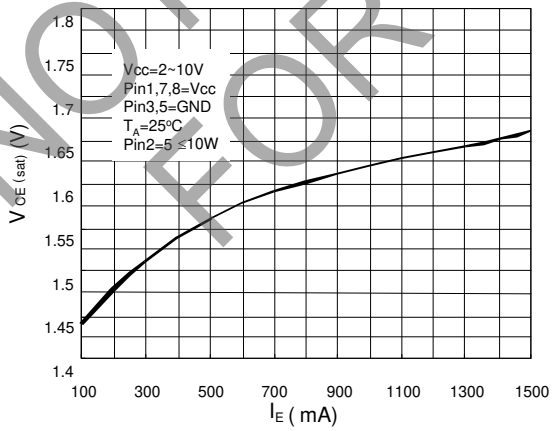
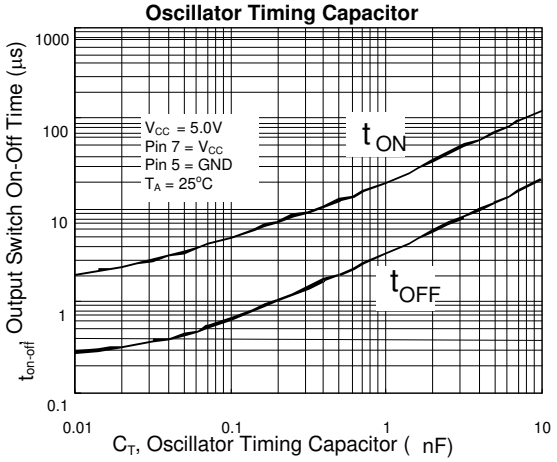



**Figure 6.Output Switch On-Off Time versus Oscillator Timing Capacitor**



## Design Formula Table

| Calculation | Step-Up | Step-Down | Voltage-Inverting |
|---|---|---|---|
| $t_{ON} / t_{OFF}$ | $\frac{V_{OUT} + V_F - V_{IN(MIN)}}{V_{IN(MIN)} - V_{SAT}}$ | $\frac{V_{OUT} + V_F}{V_{IN(MIN)} - V_{SAT} - V_{OUT}}$ | $\frac{\lvert V_{OUT} \rvert + V_F}{V_{IN(MIN)} - V_{SAT}}$ |
| $( t_{ON} + t_{OFF} )$ | $1/f$ | $1/f$ | $1/f$ |
| $t_{OFF}$ | $(t_{ON} + t_{OFF}) \left( \frac{t_{ON}}{t_{OFF}} + 1 \right)$ | $(t_{ON} + t_{OFF}) \left( \frac{t_{ON}}{t_{OFF}} + 1 \right)$ | $(t_{ON} + t_{OFF}) \left( \frac{t_{ON}}{t_{OFF}} + 1 \right)$ |
| $t_{ON}$ | $( t_{ON} + t_{OFF} ) - t_{OFF}$ | $( t_{ON} + t_{OFF} ) - t_{OFF}$ | $( t_{ON} + t_{OFF} ) - t_{OFF}$ |
| $C_T$ | $4.0 \times 10^{-5} t_{ON}$ | $4.0 \times 10^{-5} t_{ON}$ | $4.0 \times 10^{-5} t_{ON}$ |
| $I_{PK}$ (Switch) | $2I_{OUT(MAX)} (t_{ON} / t_{OFF} + 1)$ | $2I_{OUT(MAX)}$ | $2I_{OUT(MAX)} (t_{ON} / t_{OFF} + 1)$ |
| $R_{SC}$ | $0.3 / I_{PK (SWITCH)}$ | $0.3 / I_{PK (SWITCH)}$ | $0.3 / I_{PK (SWITCH)}$ |
| $L_{(MIN)}$ | $\frac{( V_{IN(MIN)} - V_{SAT} )}{I_{PK (SWITCH)}} t_{ON(MAX)}$ | $\frac{(V_{IN(MIN)} - V_{SAT} - V_{OUT})}{I_{PK (SWITCH)}} t_{ON(MAX)}$ | $\frac{( V_{IN(MIN)} - V_{SAT} )}{I_{PK (SWITCH)}} t_{ON(MAX)}$ |
| $C_O$ | $9 \frac{I_{OUT} t_{ON}}{V_{RIPPLE (pp)}}$ | $\frac{I_{PK (SWITCH)} (t_{ON} + t_{OFF})}{8 V_{RIPPLE (pp)}}$ | $9 \frac{I_{OUT} t_{ON}}{V_{RIPPLE (pp)}}$ |

$V_{SAT}$ = 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, $|V_{OUT}| = 1.25 (1+R2/R1)$
$I_{OUT}$ - 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.

## Ordering Information

**AP34063 XX X - X**

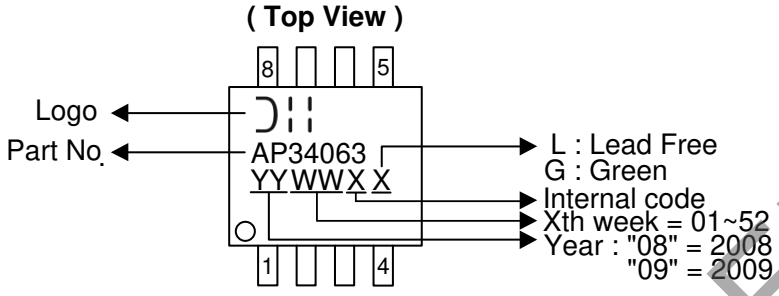
| Package | Green | Packing |
|---|---|---|
| S8 : SO-8 | G : Green | 13 : Tape & Reel |

| Device | Package Code | Package (Note 7) | Green | Quantity | Part Number Suffix | | Status (Note 6) |
|---|---|---|---|---|---|---|---|
| | | | | | Tube | 13" Tape and Reel | |
| AP34063S8G-13 | S8 | SO-8 | Green | 2500 | NA | -13 | In production |

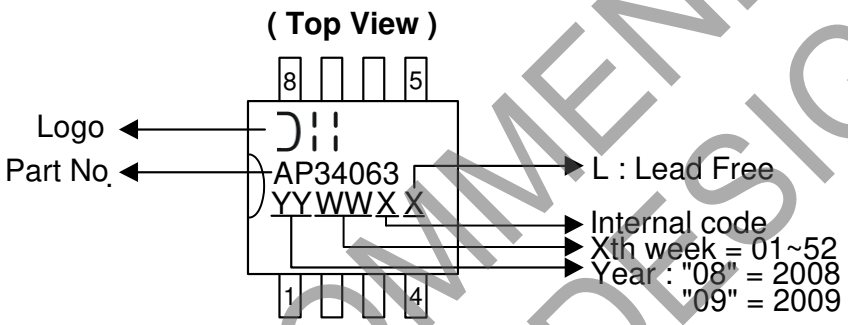
Notes:
6. All Lead-free versions in SO-8 and PDIP-8 are End of Life (EOL) with no replacement.
7. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

## Marking Information (Note 6)

**(1) SO-8**



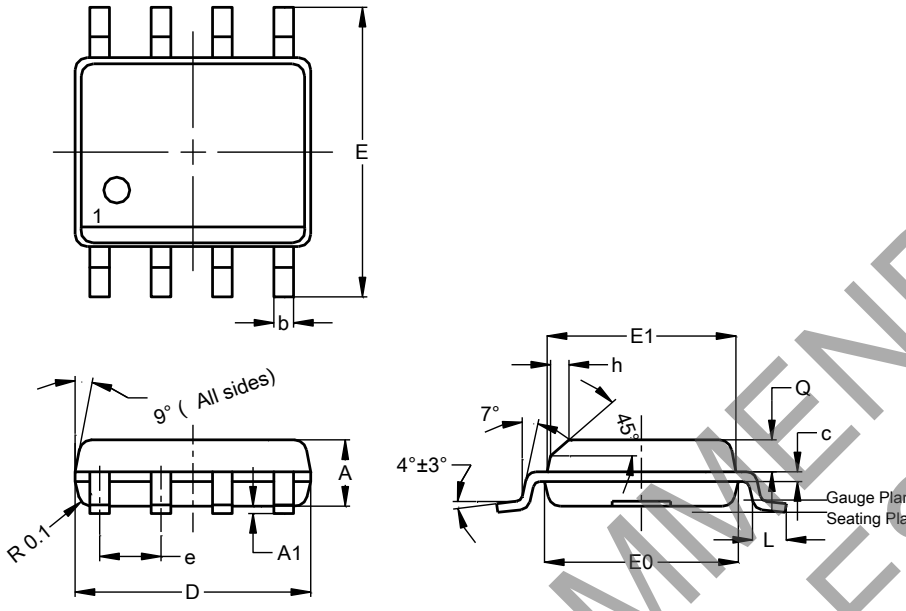

**(2) PDIP-8**



## Package Outline Dimensions (All dimensions in mm.)

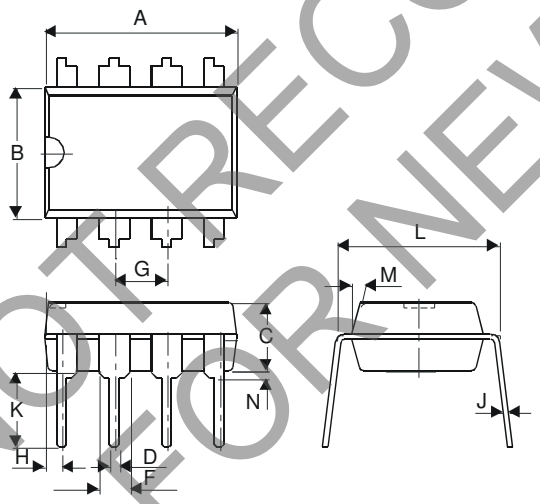
Please see http://www.diodes.com/package-outlines.html for the latest version.

**(1) SO-8**




| SO-8 | | | |
|---|---|---|---|
| Dim | Min | Max | Typ |
| A | 1.40 | 1.50 | 1. 5 |
| A | 0.10 | 0.20 | 0.15 |
| b | 0.30 | 0.50 | 0.40 |
| c | 0.15 | 0.25 | 0.20 |
| D | .85 | 4.95 | 4.90 |
| E | 5.90 | 6.10 | 6.00 |
| E1 | 3.80 | 3.90 | 3.85 |
| E0 | 3.85 | 3.95 | 3.90 |
| e | -- | -- | 1.27 |
| h | - | -- | 0.35 |
| L | 0.62 | 0.82 | 0.72 |
| Q | 0.60 | 0.70 | 0.65 |
| All Dimensions in mm | | | |

**(2) PDIP-8**

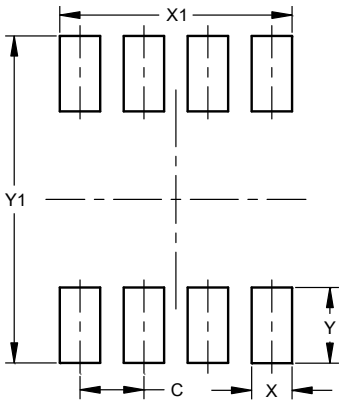



| PDIP-8 | | |
|---|---|---|
| Dim | Min | Max |
| A | 9.02 | 9.53 |
| B | 6.15 | 6.35 |
| C | 3.10 | 3.50 |
| D | 0.36 | 0.56 |
| F | 1.40 | 1.65 |
| G | 2.54 typ. | |
| H | 0.71 | 0.97 |
| J | 0.20 | 0.36 |
| K | 2.92 | 3.81 |
| L | 7.62 | 8.26 |
| M | — | 15° |
| N | 0.38 (min) | |
| All Dimensions in mm | | |

## Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

**(1) SO-8**




| Dimensions | Value (in mm) |
|---|---|
| C | 1.27 |
| X | 0.802 |
| X1 | 4.612 |
| Y | 1.505 |
| Y1 | 6.50 |



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2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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