# GR34063 1.5-A Peak Boost/Buck/Inverting Switching Regulators

## 1. General Description

### 1.1 Description

The GR34063 device is easy-to-use ICs containing all the primary circuitry needed for building simple DC-DC converters. This device primarily consists of an internal temperature compensated reference, a comparator, an oscillator, a PWM controller with active current limiting, a driver, and a high-current output switch. Thus, the device requires minimal external components to build converters in the boost, buck, and inverting topologies.

### 1.2 Features

- Wide Input Voltage Range: 3 V to 40 V
- High Output Switch Current: Up to 1.5 A
- Adjustable Output Voltage
- Oscillator Frequency Up to 100kHZ
- Precision Internal Reference: 2%
- Short-Circuit Current Limiting
- Low Standby Current

### 1.3 Ordering Information

| PART NUMBER | PACKAGE |
|---|---|
| GR34063 | DIP |
| | SOP |

## 2. Connection Diagrams and Pin Description

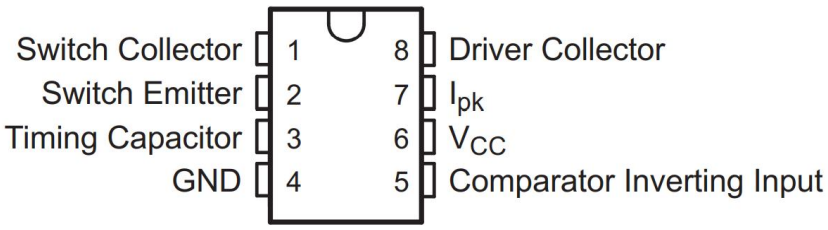



Figure 2.1 Top View

| NAME | PIN | I/O | DESCRIPTION |
|---|---|---|---|
| Switch Collector | 1 | I/0 | High-current internal switch collector input. |
| Switch Emitter | 2 | I/0 | High-current internal switch emitter output. |
| Timing Capacitor | 3 | - | Attach a timing capacitor to change the switching frequency. |
| GND | 4 | - | Ground |
| Comparator Inverting Input | 5 | I | Attach to a resistor divider network to create a feedback loop. |
| VCC | 6 | I | Logic supply voltage. Tie to $V_{IN}$. |
| $I_{PK}$ | 7 | I | Current-limit sense input. |
| Driver Collector | 8 | I/0 | Darlington pair driving transistor collector input. |

## 2.1 Simplified Schematic

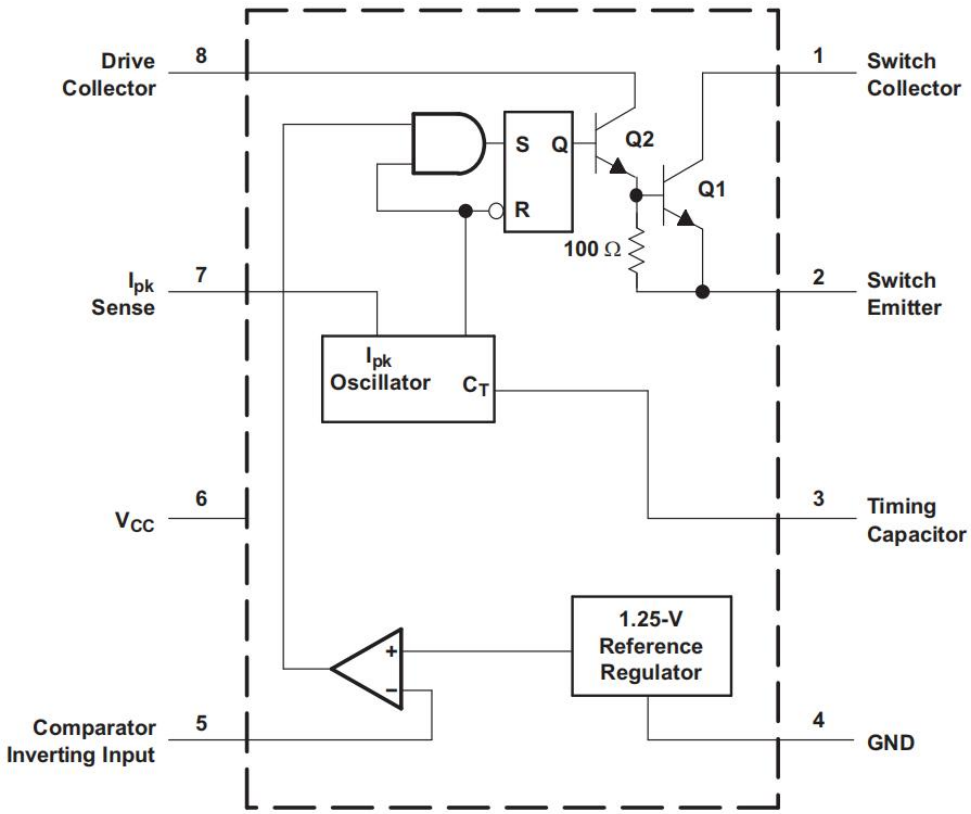



Figure 2.2: GR34063 Functional Block Diagram

# 3. Specifications

## 3.1 Absolute Maximum Ratings

| Symbol | Parameter | | MIN | MAX | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | | - | 40 | V |
| $V_{IR}$ | Comparator inverting input voltage range | | -0.3 | 40 | V |
| $V_{C(switch)}$ | Switch collector voltage | $V_{PIN1}$ = 40 V | - | 40 | V |
| $V_{E(switch)}$ | Switch emitter voltage | | - | 40 | V |
| $V_{CE(switch)}$ | Switch collector to switch emitter voltage | | - | 40 | V |
| $V_{C(driver)}$ | Driver collector voltage | | - | 40 | V |
| $I_{C(driver)}$ | Driver collector current | | - | 100 | mA |
| $I_{SW}$ | Switch current | | - | 1.5 | A |
| $T_J$ | Operating virtual junction temperature | | - | 150 | ℃ |
| $T_{STG}$ | Storage Temperature | | -65 | 150 | ℃ |

Absolute maximum ratings are those values beyond which the device could be permanently damaged,These are stress ratings only,which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions.

## 3.2 Recommended Operating Conditions

| Symbol | Parameter | MIN | MAX | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 3 | 40 | V |
| $T_A$ | Operating Temperature | -40 | 85 | ℃ |

## 3.3 Electrical Characteristics—Oscillator

$V_{CC}$ = 5 V, TA = 25℃ (unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $f_{osc}$ | Oscillator frequency | $V_{PIN5}$ = 0V, $C_T$ = 1nF | 24 | 33 | 42 | kHZ |
| $I_{chg}$ | Charge current | $V_{CC}$ = 5V to 40V | 24 | 35 | 42 | uA |
| $I_{dischg}$ | Discharge current | $V_{CC}$ = 5V to 40V | 140 | 220 | 260 | uA |
| $I_{dischg}/I_{chg}$ | Discharge-to-charge current ratio | $V_{PIN7}$ = $V_{CC}$ | 5.2 | 6.5 | 7.5 | - |
| $V_{Ipk}$ | Current-limit sense voltage | $I_{dischg}$ = $I_{chg}$ | -- | 340 | -- | mV |

## 3.4 Electrical Characteristics—Output Switch

$V_{CC}$ = 5 V, TA = 25℃ (unless otherwise noted) (1)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CE(sat)}$ | Saturation voltage Darlington connection | $I_{SW}$ = 1A, pins 1 and 8 connected | | 1 | 1.3 | V |
| $V_{CE(sat)}$ | Saturation voltage non-Darlington connection(2) | $I_{SW}$ = 1A, $R_{PIN8}$ = 82 Ω to $V_{CC}$, forced β ~ 20 | | 0.5 | 0.7 | V |
| $h_{FE}$ | DC current gain | $I_{SW}$ = 1A, $V_{CE}$ = 5V | 50 | 75 | | - |
| $I_{C(off)}$ | Collector off-state current | $V_{CE}$ = 40V | | 0.01 | 100 | μA |

(1) Low duty-cycle pulse testing is used to maintain junction temperature as close to ambient temperature as possible.

(2) In the non-Darlington configuration, if the output switch is driven into hard saturation at low switch currents (≤300mA) and high driver currents (≥30mA), it may take up to 2us for the switch to come out of saturation. This condition effectively shortens the off time at frequencies ≥30kHz, becoming magnified as temperature increases. The following output drive condition is recommended in the non-Darlington configuration:

Forced β of output switch = $I_{C,SW}$ / ($I_{C,driver}$ – 7mA) ≥ 10, where ~7mA is required by the 100-Ω resistor in the emitter of the driver to forward bias the $V_{be}$ of the switch.

## 3.5 Electrical Characteristics—Comparator

$V_{CC}$ = 5 V, TA = 25℃ (unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{th}$ | Threshold voltage | | 1.225 | 1.25 | 1.275 | V |
| $\Delta V_{th}$ | Threshold-voltage line regulation | $V_{CC}$ = 5V to 40V | | 1.4 | 5 | mV |
| $I_{IB}$ | Input bias current | $V_{IN}$ = 0V | | -0.02 | -1 | uA |

## 3.6 Electrical Characteristics—Total Device

$V_{CC}$ = 5 V, TA = 25℃ (unless otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{CC}$ | Supply current | $V_{CC}$ = 5V to 40V, CT =1nF, $V_{PIN7}$ = $V_{CC}$, $V_{PIN5}$ > Vth, $V_{PIN2}$ = GND, All other pins open | | | 4 | mA |

# 4. Typical Application

## 4.1 Voltage-Inverting Converter Application

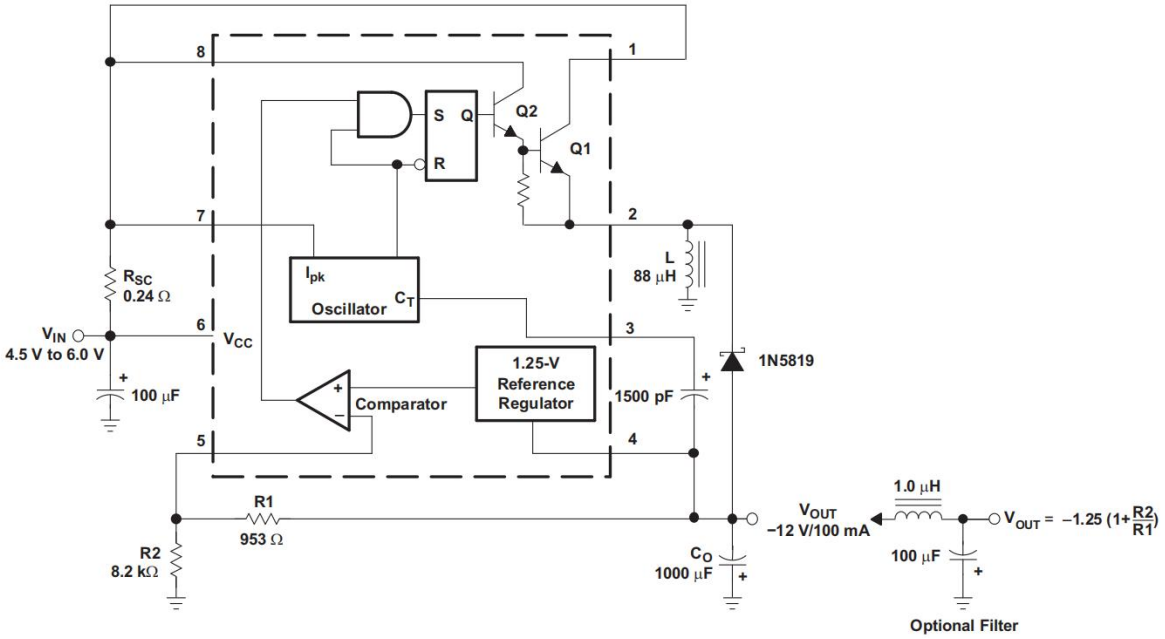



Figure 4.1: Voltage-Inverting converter

### 4.1.1 Design Requirements

The user must determine the following desired parameters:

$V_{sat}$ = Saturation voltage of the output switch

$V_F$ = Forward voltage drop of the chosen output rectifier

The following power-supply parameters are set by the user:

$V_{in}$ = 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 Vin and Iout

$V_{ripple}$ = Desired peak-to-peak output ripple voltage. The ripple voltage directly affects the line and load regulation and, thus, must be considered. In practice, the actual capacitor value should be larger than the calculated value, to account for the capacitor's equivalent series resistance and board layout.

### 4.1.2 Detailed Design Procedure

| CALCULATION | VOLTAGE INVERTING |
|---|---|
| $t_{on}/t_{off}$ | $\frac{\lvert V_{out}\rvert + V_F}{V_{in} - V_{sat}}$ |
| $(t_{on} + t_{off})$ | $\frac{1}{f}$ |
| $t_{off}$ | $\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$ |
| $t_{on}$ | $(t_{on} + t_{off}) - t_{off}$ |
| $C_T$ | $4 \times 10^{-5} t_{on}$ |
| $I_{pk(switch)}$ | $2I_{out(max)}\left(\frac{t_{on}}{t_{off}} + 1\right)$ |
| $R_{SC}$ | $\frac{0.3}{I_{pk(switch)}}$ |
| $L_{(min)}$ | $\left(\frac{(V_{in(min)} - V_{sat})}{I_{pk(switch)}}\right) t_{on(max)}$ |
| $C_O$ | $9\frac{I_{out} t_{on}}{V_{ripple(pp)}}$ |
| $V_{out}$ | $-1.25\left(1 + \frac{R2}{R1}\right)$ |

## 4.2 Step-Up Converter Application

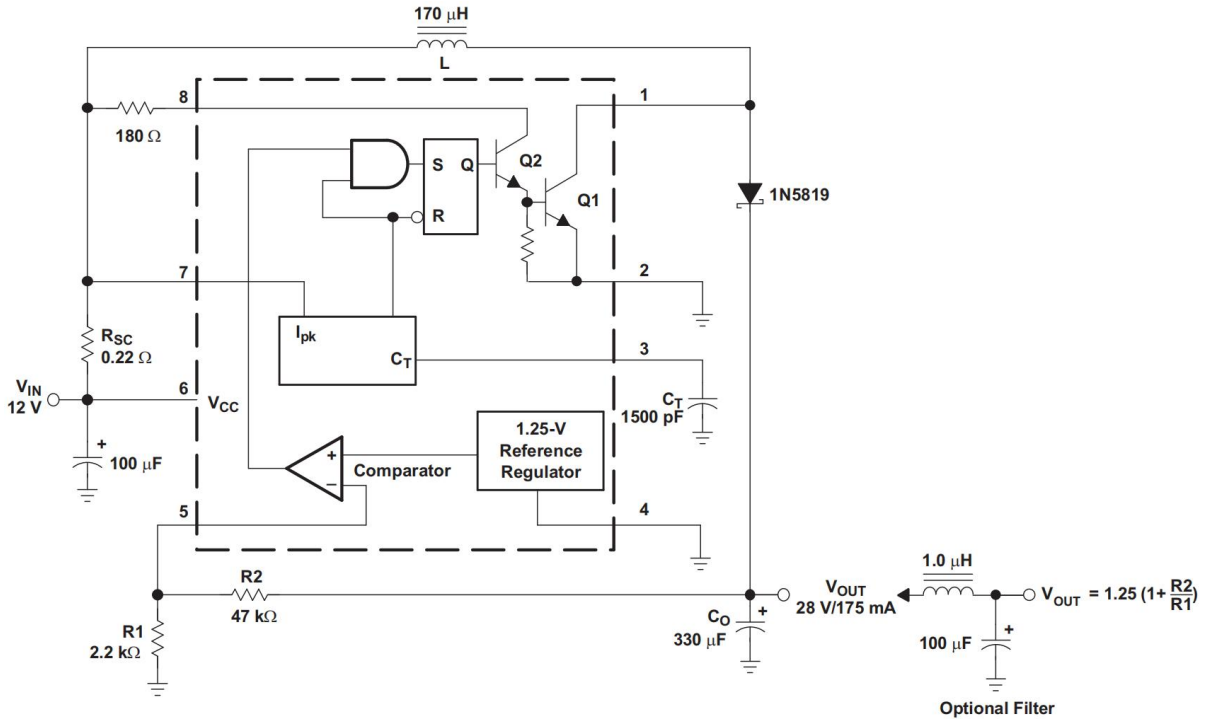



Figure 4.2: Step-Up Converter

### 4.2.1 Design Requirements

The user must determine the following desired parameters:
$V_{sat}$ = Saturation voltage of the output switch
$V_F$ = Forward voltage drop of the chosen output rectifier
The following power-supply parameters are set by the user:
$V_{in}$ = 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 Vin and Iout
$V_{ripple}$ = Desired peak-to-peak output ripple voltage. The ripple voltage directly affects the line and load regulation and, thus, must be considered. In practice, the actual capacitor value should be larger than the calculated value, to account for the capacitor's equivalent series resistance and board layout.

### 4.2.2 Detailed Design Procedure

| CALCULATION | STEP UP |
|---|---|
| $t_{on}/t_{off}$ | $\frac{V_{out} + V_{F-Vin(min)}}{V_{in(min)} - V_{sat}}$ |
| $(t_{on} + t_{off})$ | $\frac{1}{f}$ |
| $t_{off}$ | $\frac{t_{on} + t_{off}}{\frac{t_{on}}{t_{off}} + 1}$ |
| $t_{on}$ | $(t_{on} + t_{off}) - t_{off}$ |
| $C_T$ | $4 \times 10^{-5} t_{on}$ |
| $I_{pk(switch)}$ | $2I_{out(max)}\left(\frac{t_{on}}{t_{off}} + 1\right)$ |
| $R_{SC}$ | $\frac{0.3}{I_{pk(switch)}}$ |
| $L_{(min)}$ | $\left(\frac{(V_{in(min)} - V_{sat})}{I_{pk(switch)}}\right) t_{on(max)}$ |
| $C_O$ | $9\frac{I_{out} t_{on}}{V_{ripple(pp)}}$ |
| $V_{out}$ | $1.25\left(1 + \frac{R2}{R1}\right)$ |

## 4.3 Step-Down Converter Application

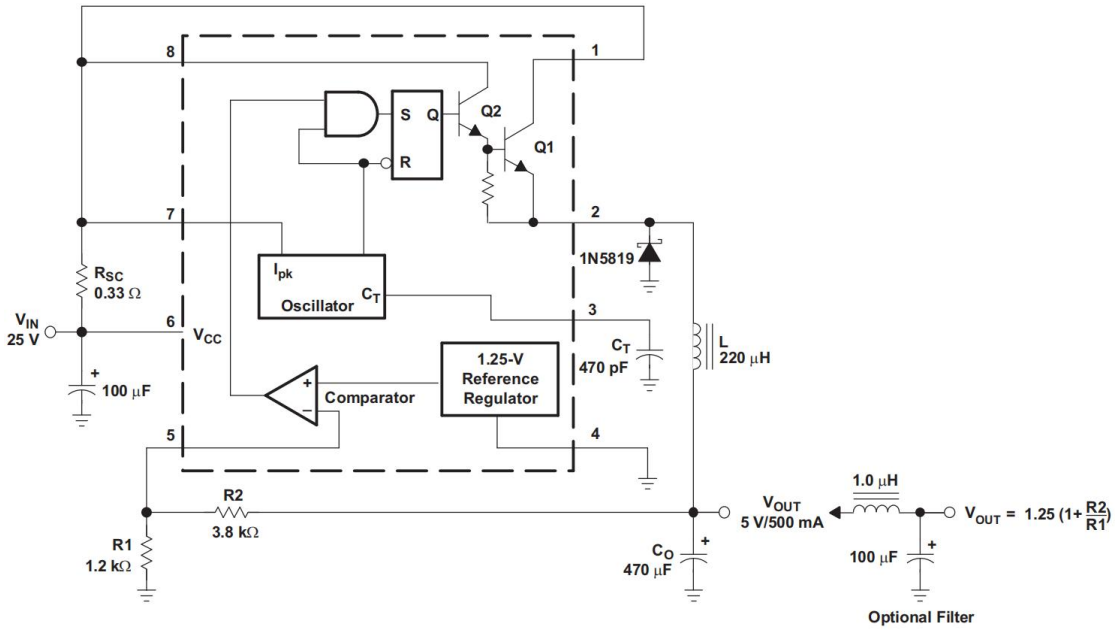



Figure 4.3: Step-Down Converter

### 4.3.1 Design Requirements

The user must determine the following desired parameters:

$V_{sat}$ = Saturation voltage of the output switch

$V_F$ = Forward voltage drop of the chosen output rectifier

The following power-supply parameters are set by the user:

$V_{in}$ = 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 Vin and Iout

$V_{ripple}$ = Desired peak-to-peak output ripple voltage. The ripple voltage directly affects the line and load regulation and, thus, must be considered. In practice, the actual capacitor value should be larger than the calculated value, to account for the capacitor's equivalent series resistance and board layout.

### 4.3.2 Detailed Design Procedure

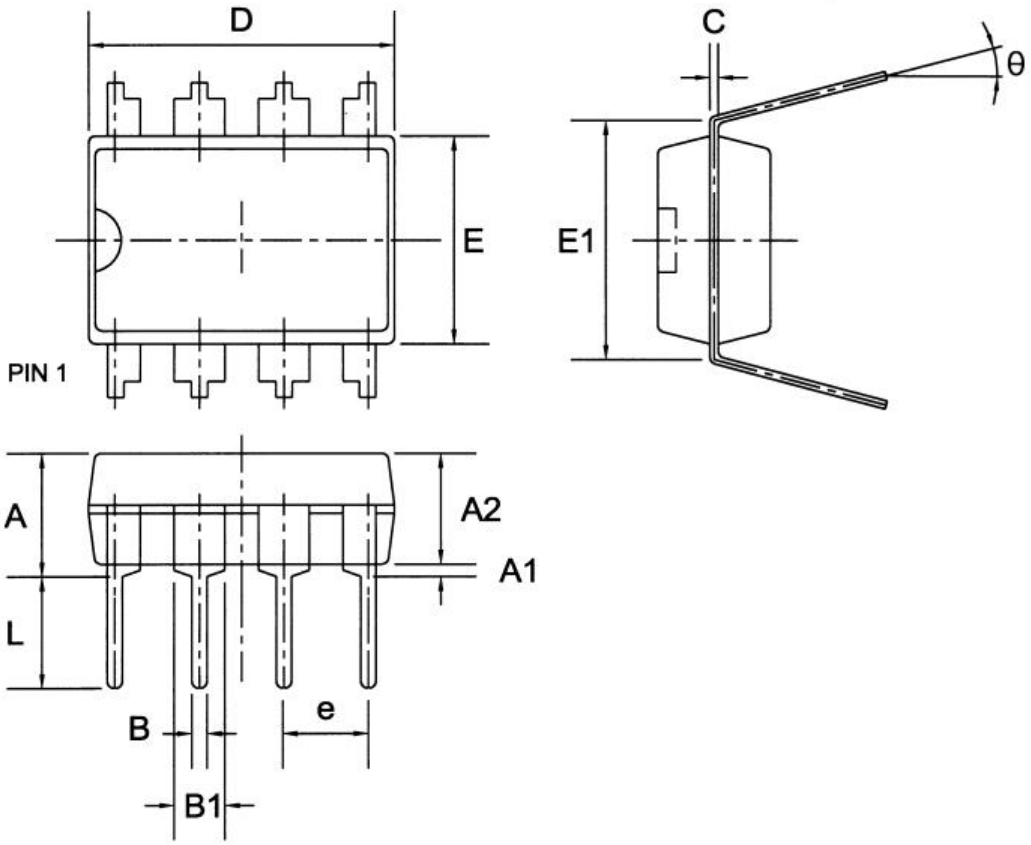
| CALCULATION | STEP DOWN |
|---|---|
| $t_{on}/t_{off}$ | $\frac{V_{out}+V_F}{V_{in(min)}-V_{sat}-V_{out}}$ |
| $(t_{on}+t_{off})$ | $\frac{1}{f}$ |
| $t_{off}$ | $\frac{t_{on}+t_{off}}{\frac{t_{on}}{t_{off}}+1}$ |
| $t_{on}$ | $(t_{on}+t_{off})-t_{off}$ |
| $C_T$ | $4\times10^{-5}t_{on}$ |
| $I_{pk(switch)}$ | $2I_{out(max)}$ |
| $R_{SC}$ | $\frac{0.3}{I_{pk(switch)}}$ |
| $L_{(min)}$ | $\left(\frac{(V_{in(min)}-V_{sat}-V_{out})}{I_{pk(switch)}}\right)t_{on(max)}$ |
| $C_O$ | $\frac{I_{pk(switch)}(t_{on}+t_{off})}{8V_{ripple(pp)}}$ |
| $V_{out}$ | $1.25\left(1+\frac{R2}{R1}\right)$ |

# 5. Ordering Information

| Orderable Device | Package Type | Pins | Packing | Package Qty |
|---|---|---|---|---|
| GR34063ND08ATEQ | DIP | 8 | Tube | 50 |
| GR34063NS08ARDQ | SOP | 8 | Tape & Reel | 4000 |

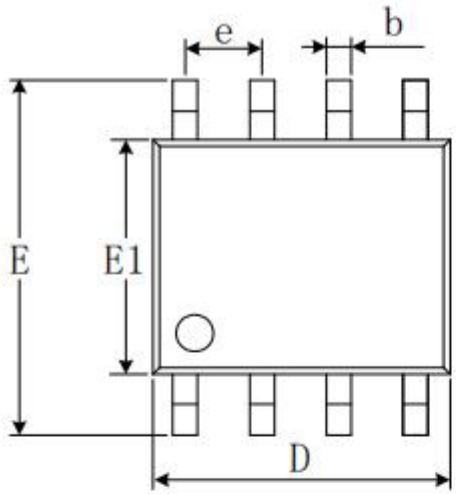
# 6. Package Information

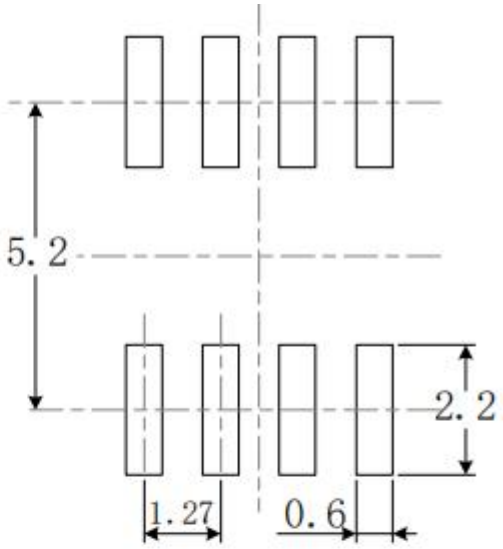
## 6.1 DIP8



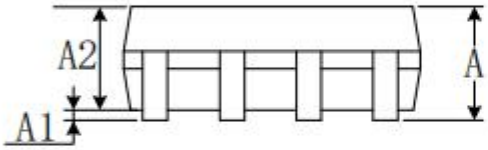

| Symbol | Dimensions In Millmeters | | | Dimensions In Inches | | |
|---|---|---|---|---|---|---|
| | Min | Nom | Max | Min | Nom | Max |
| A | — | — | 4.31 | — | — | 0.170 |
| A1 | 0.38 | — | — | 0.015 | — | — |
| A2 | 3.15 | 3.40 | 3.65 | 0.124 | 0.134 | 0.144 |
| B | 0.38 | 0.46 | 0.51 | 0.015 | 0.018 | 0.020 |
| B1 | 1.27 | 1.52 | 1.77 | 0.050 | 0.060 | 0.070 |
| C | 0.20 | 0.25 | 0.30 | 0.008 | 0.010 | 0.012 |
| D | 8.95 | 9.20 | 9.45 | 0.352 | 0.362 | 0.372 |
| E | 6.15 | 6.40 | 6.65 | 0.242 | 0.252 | 0.262 |
| E1 | — | 7.62 | — | — | 0.300 | — |
| e | — | 2.54 | — | — | 0.100 | — |
| L | 3.00 | 3.30 | 3.60 | 0.118 | 0.130 | 0.142 |
| θ | 0° | — | 15° | 0° | — | 15° |

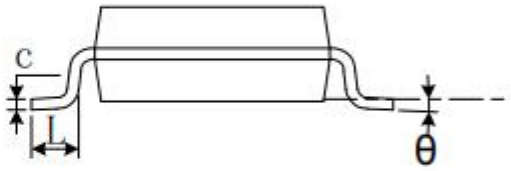
## 6.2 SOP8




RECOMMENDED LAND PATTERN (Unit: mm)




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.007 | 0.010 |
| D | 4.800 | 5.000 | 0.189 | 0.197 |
| e | 1.270(BSC) | | 0.050(BSC) | |
| E | 5.800 | 6.200 | 0.228 | 0.244 |
| E1 | 3.800 | 4.000 | 0.150 | 0.157 |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |