# Versatile DC/DC Converter

## FEATURES

- 3V to 30V Input Voltage Operation.
- Internal 2A Peak Current Switch.
- 1.5A Continuous Output Current.
- Bootstrapped Driver.
- High Side Current Sense Capability.
- High Efficiency (up to 90%).
- Internal ±2% Reference.
- Low Quiescent Current at 1.6mA.
- Frequency Operation from 100Hz to 100KHz.

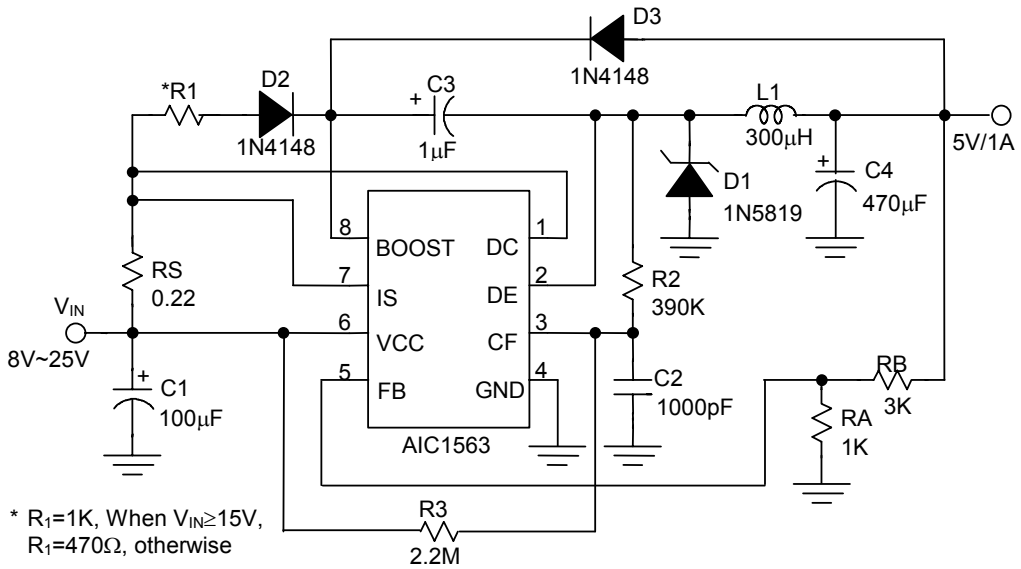
## APPLICATIONS

- Constant Current Source for Battery Chargers.
- Saver for Cellular phones.
- Step-Down DC-DC Converter Module.

## DESCRIPTION

The AIC1563 is a monolithic control circuit containing the primary functions required for DC to DC converters and highside-sensed constant current source. The device consists of an internal temperature compensated reference, comparator, controlled duty cycle oscillator with an active current sense circuit, bootstrapped driver, and high current output switch. This device is specifically designed to construct a constant current source for battery chargers with a minimum number of external components. Bootstrapped driver can drive the NPN output switch to saturation for higher efficiency and less heat dissipation. The AIC1563 can deliver 1.5A continuous current without requiring a heat sink.

## TYPICAL APPLICATION CIRCUIT




| | | |
|---|---|---|
| Line Regulation | $V_{IN}$ = 10V~20V @ $I_O$=1A | 40mV |
| Load Regulation | $V_{IN}$ = 15V, @ $I_O$=100mA~1A | 20mV |
| Short Circuit Current | $V_{IN}$ =15V, @ $R_L$ = 0.1Ω | 1.3A |

**Step-Down Converter**

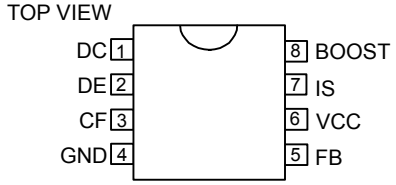
## ■ ORDERING INFORMATION

AIC1563-XXXX

- PACKING TYPE
  TR: TAPE & REEL
  TB: TUBE
- PACKAGING TYPE
  N: DIP-8
  S: SOP-8
- C: COMMERCIAL
  P: LEAD FREE COMMERCIAL

PIN CONFIGURATION

DIP-8
SOP-8
TOP VIEW




Example: AIC1563CSTR
→ in SOP-8 Package & Taping & Reel Packing Type
(CN is not available in TR packing)
AIC1563PSTR
→ in SOP-8 Lead Free Package & Taping & Reel Packing Type

## ■ ABSOLUTE MAXIMUM RATINGS

Supply Voltage ..... 30V
Comparator Input Voltage Range ..... -0.3V~30V
Switch Collector Voltage ..... 30V
Switch Emitter Voltage ..... 30V
Switch Collector to Emitter Voltage ..... 30V
Driver Collector Voltage ..... 30V
Switch Current ..... 2A
Power Dissipation and Thermal Characteristics

***DIP Package***

$T_A$= 25°C ..... 1.0W
Thermal Resistance ..... 100°C/W

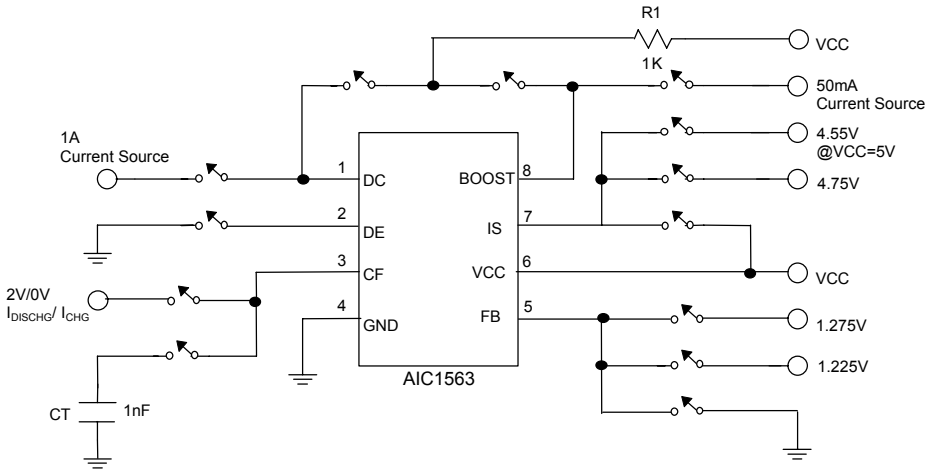
***SOP Package***

$T_A$= 25°C ..... 625mW
Thermal Resistance ..... 160°C/W

Operating Junction Temperature ..... 125°C
Operating Ambient Temperature Range..... -40~85°C
Storage Temperature Range ..... - 65°C ~ 150°C
Lead Temperature (Soldering 10 Sec.) .....260°C

***Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.***

## TEST CIRCUIT




## ELECTRICAL CHARACTERISTICS ($V_{CC}$= 5V, $T_A$=25°C, unless otherwise specified.) (Note1)

| PARAMETER | TEST CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| ***Oscillator*** | | | | | | |
| Charging Current | 5.0V≤VCC≤30V | $I_{CHG}$ | 10 | 25 | 40 | μA |
| Discharge Current | 5.0V≤VCC≤30V | $I_{DISCHG}$ | 100 | 150 | 200 | μA |
| Voltage Swing | PIN 3 | $V_{OSC}$ | | 0.6 | | V |
| Discharge to Charge Current Ratio | $V_{IS}$ =VCC | $I_{DISCHG}$ / $I_{CHG}$ | | 6.0 | | |
| Current Limit Sense Voltage | $I_{CHG}$=$I_{DISCHG}$ | VCC – $V_{IS}$ | 250 | 300 | 350 | mV |
| ***Output Switch*** | | | | | | |
| Saturation Voltage, Emitter Follower Connection | $I_{DE}$=1.0A; $V_{BOOST}$ =$V_{DC}$ = VCC | $V_{CE(SAT)}$ | | 1.5 | 1.8 | V |
| Saturation Voltage | $I_{DC}$=1.0A; $I_{BOOST}$ =50mA, (Forced β≅20) | $V_{CE\ (SAT)}$ | | 0.4 | 0.7 | V |
| DC Current Gain | $I_{SC}$ =1.0A; $V_{CE}$=5.0V | $h_{FE}$ | 35 | 120 | | |
| Collector Off-State Current | $V_{CE}$=30V | $I_{C(OFF)}$ | | 10 | | nA |

## ELECTRICAL CHARACTERISTICS ($V_{CC}$= 5V, $T_A$=25°C, unless otherwise specified.) (Note1)

| PARAMETER | TEST CONDITIONS | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| ***Comparactor*** | | | | | | |
| Threshold Voltage | $T_A$=25°C<br>0°C ≤ $T_A$ ≤ 70°C | $V_{FB}$ | 1.225<br>1.21 | 1.25 | 1.275<br>1.29 | V<br>V |
| Threshold Voltage Line Regulation | 3.0V≤VCC≤30V | $REG_{LINE}$ | | 0.1 | 0.3 | mV/V |
| Input Bias Current | $V_{IN}$=0V | $I_{IB}$ | | 0.4 | 1 | μA |
| Supply Current | $V_{IS}$ =VCC, pin 5>$V_{FB}$<br>5.0V≤ VCC ≤30V<br>$C_T$=1nF<br>PIN 2=GND<br>Remaining pins open | $I_{CC}$ | | 1.6 | 3 | mA |

Note 1: Specifications are production tested at $T_A$=25°C. Specifications over the -40℃ to 85℃ operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

## TYPICAL PERFORMANCE CHARACTERISTICS

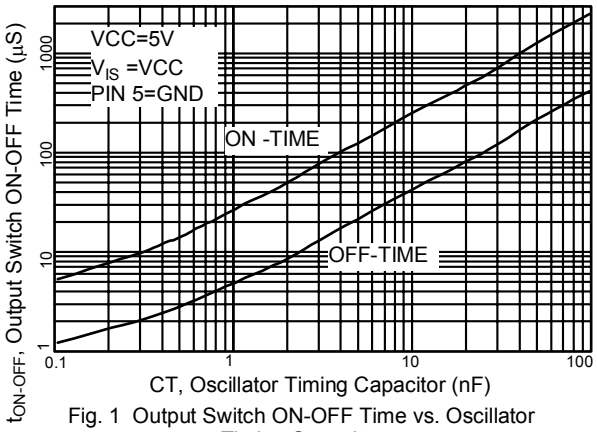



Fig. 1 Output Switch ON-OFF Time vs. Oscillator Timing Capacitor

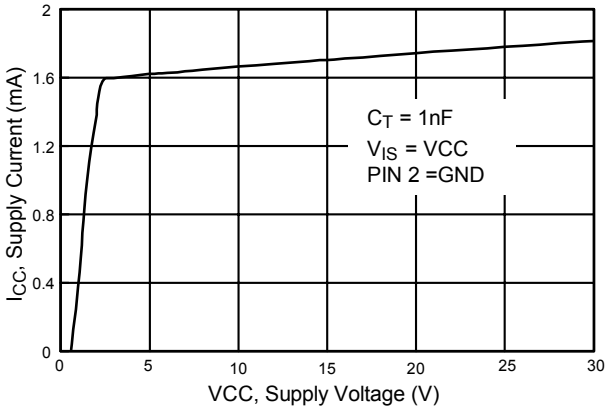



Fig. 2 Standby Supply Current vs. Supply Voltage

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

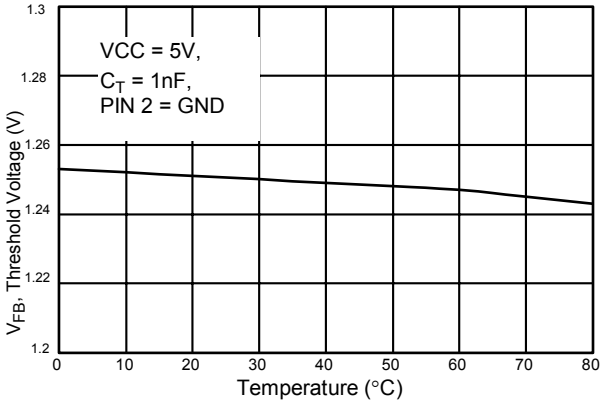



Fig. 3 $V_{FB}$, Threshold Voltage vs. Temperature

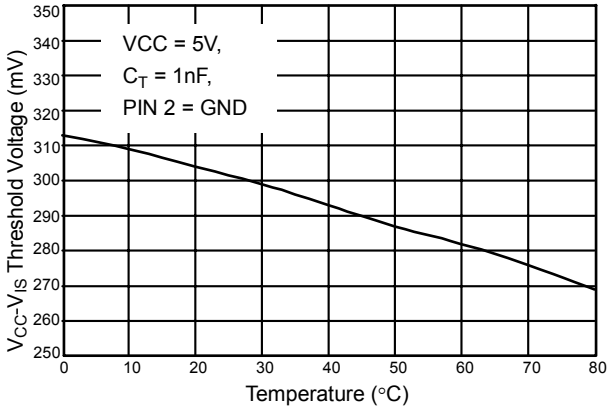



Fig. 4 $I_S$ Threshold Voltage vs. Temperature

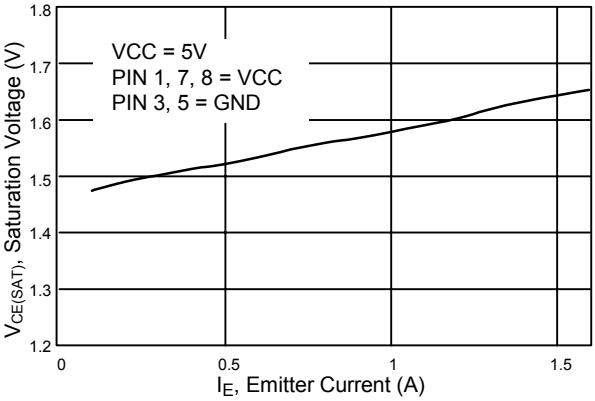



Fig. 5 Emmiter Follower Configuration Output Switch Saturation Voltage vs. Emmiter Current

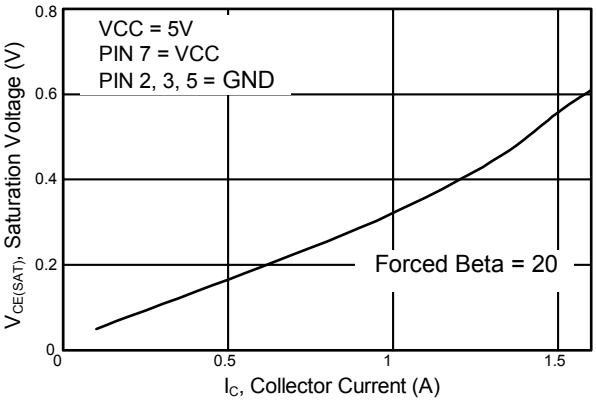
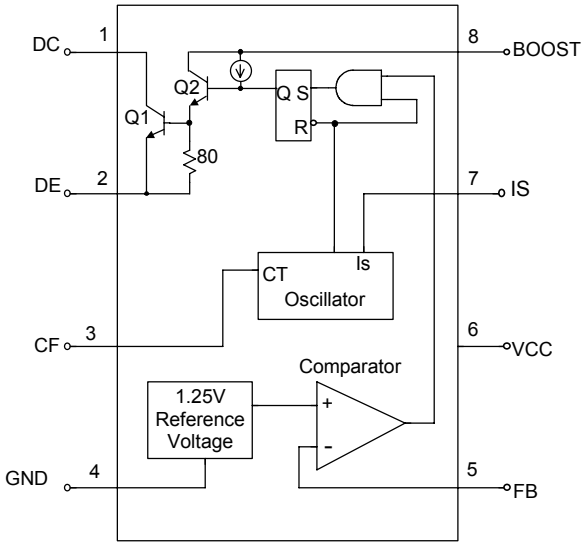



Fig. 6 Common Emitter Configuration Output Switch Saturation Voltage vs. Collector Current

## BLOCK DIAGRAM



## PIN DESCRIPTIONS

PIN 1: DC - The switch collector is 2A.

PIN 2: DE - Darlington switch emitter.

PIN 3: CF - Oscillator timing capacitor.

PIN 4: GND - Power ground.

PIN 5: FB - Feedback comparator inverting input.

PIN 6: VCC - Power supply input.

PIN 7: IS - Highside current sense input. VCC - $V_{IS}$=300mV.

PIN 8: BOOST-Bootstrapped driver collector.

## APPLICATION INFORMATION

- **DESIGN FORMULA TABLE**

| CALCULATION | STEP-DOWN | STEP-UP |
|---|---|---|
| $\frac{t_{ON}}{t_{OFF}}$ | $\frac{V_{OUT} + V_F}{V_{IN(MIN)} - V_{SAT} - V_{OUT}}$ | $\frac{V_{OUT} + V_F - V_{IN(MIN)}}{V_{IN(MIN)} - V_{SAT}}$ |
| $(t_{ON} + t_{OFF})_{MAX}$ | $\frac{1}{F_{MIN}}$ | $\frac{1}{F_{MIN}}$ |
| $C_T$ | $4x10^{-5}t_{ON}$ | $4 \times 10^{-5}t_{ON}$ |
| $I_{C\ (SWITCH)}$ | $2I_{OUT(MAX)}$ | $2I_{OUT(MAX)}\ (\frac{t_{ON} + t_{OFF}}{t_{OFF}})$ |
| RS | $0.3/I_{C(SWITCH)}$ | $0.3/\ I_{C\ (SWITCH)}$ |
| L(MIN) | $(\frac{V_{IN(MIN)} - V_{SAT} - V_{OUT}}{I_{C(SWITCH)}})t_{ON(MAX)}$ | $(\frac{V_{IN(MIN)} - V_{SAT}}{I_{C(SWITCH)}})t_{ON(MAX)}$ |
| Co | $\frac{I_{C\ (SWITCH)}\ (t_{ON} + t_{OFF})}{8V_{RIPPLE\ (P-P)}}$ | $\frac{I_{OUT}\ t_{ON}}{V_{RIPPLE(P-P)}}$ |

$V_{SAT}$ = Saturation voltage of the output switch.
$V_F$ = Forward voltage of the ringback rectifier

The following power supply characteristics must be chosen:

$V_{IN}$ - Nominal input voltage.

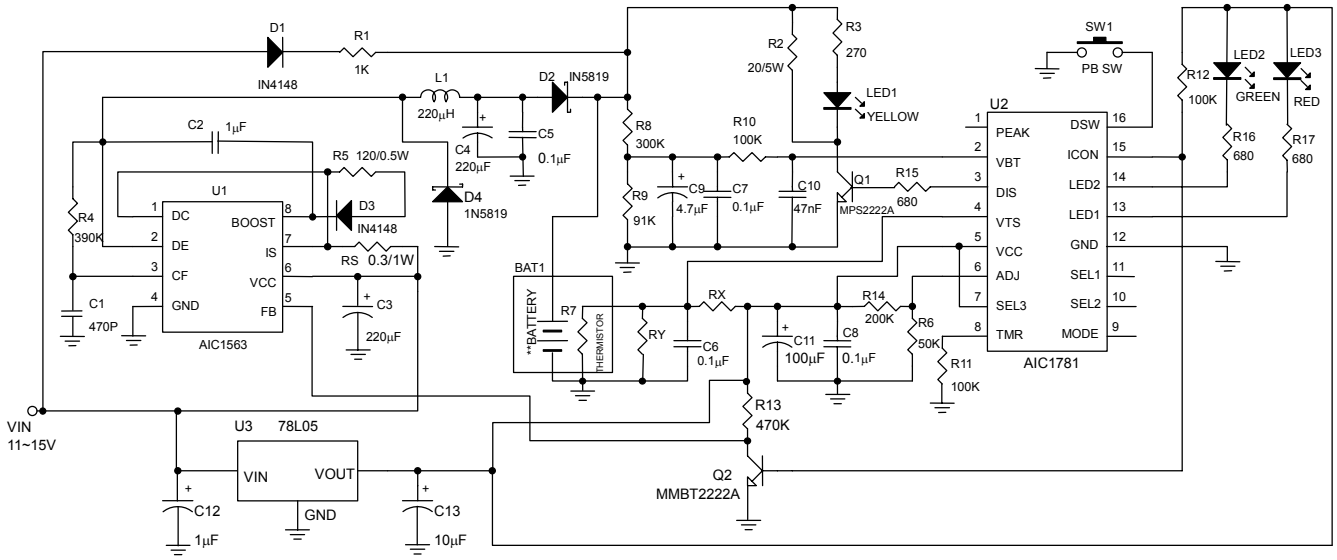
$V_{OUT}$ - Desired output voltage, $V_{OUT}$ = 1.25 (1 + RB/RA)

$I_{OUT}$ - Desired output current.

$F_{MIN}$ - Minimum desired switching frequency at 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 affect the line and load regulation.

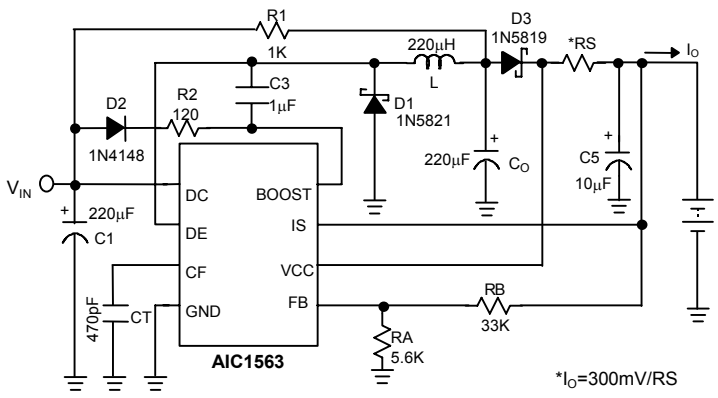
## APPLICATION EXAMPLES

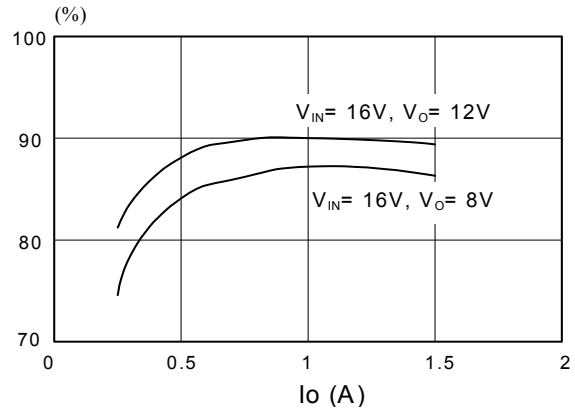



**3~5 NiMH/NiCd cells.

Note: Charge Current=0.3/RS Ampere
Safety Timer: 80min

**Fig. 7 Battery Charge Circuit for Fluctuating Charging Current Applications**




**Efficiency vs Output Current**

**Fig. 8 Battery Charge Circuit**

## APPLICATION EXAMPLES (Continued)

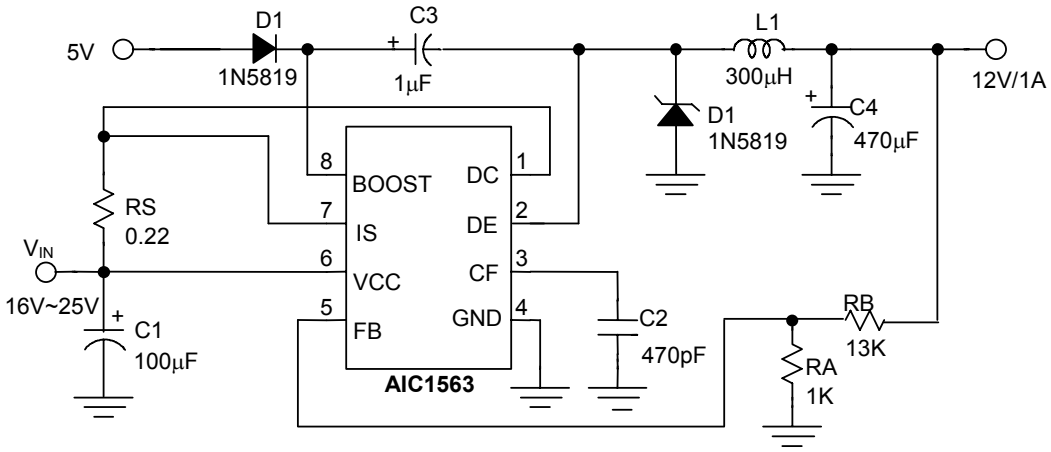
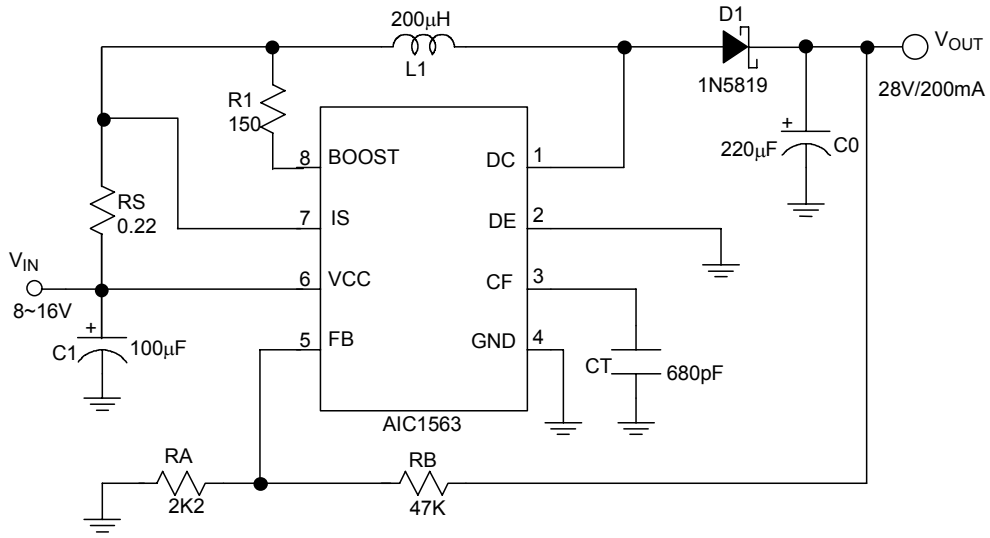



**Fig. 9 Step-Down Converter with External 5V Bootstrap**




| | | |
|---|---|---|
| Line Regulation | $V_{IN}$ = 8V~16V @ $I_O$=200mA | 100mV |
| Load Regulation | $V_{IN}$ = 12V, @ $I_O$=80mA~200mA | 40mV |

**Fig. 10 Step-Up Converter**

## APPLICATION EXAMPLES (Continued)

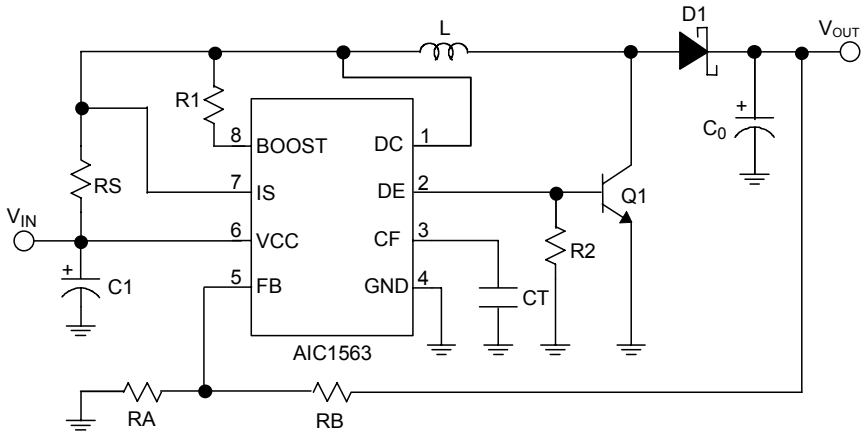
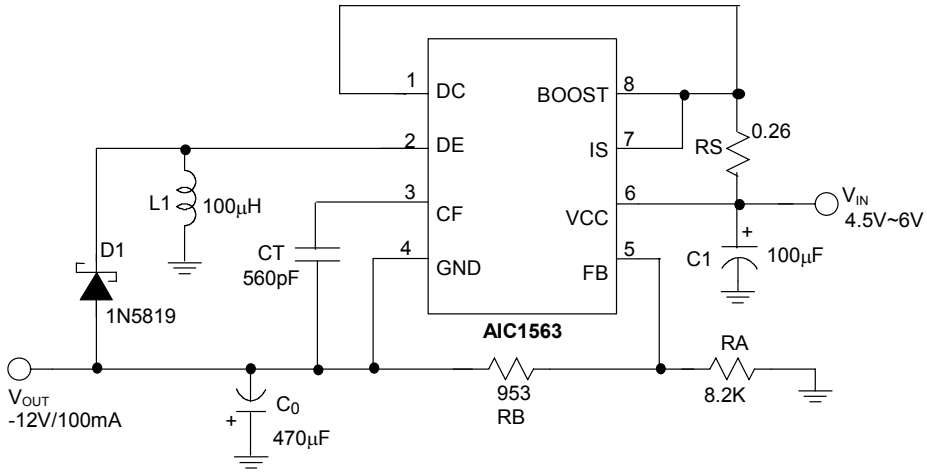



**Fig. 11 Step-Up Converter with External NPN Switch**

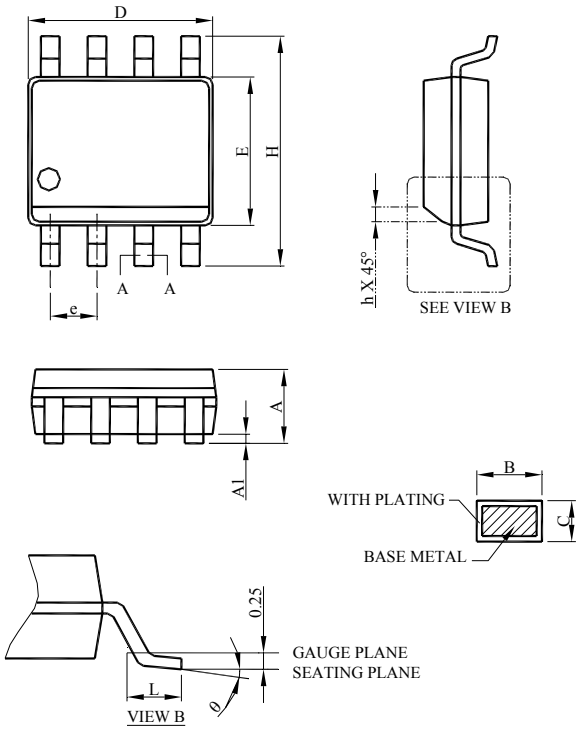



| | | |
|---|---|---|
| Line Regulation | $V_{IN}$ = 4.5V~6V @ $I_O$=100mA | 20mV |
| Load Regulation | $V_{IN}$ = 5V, @ $I_O$=10mA~100mA | 100mV |

**Fig. 12 Inverting Converter**

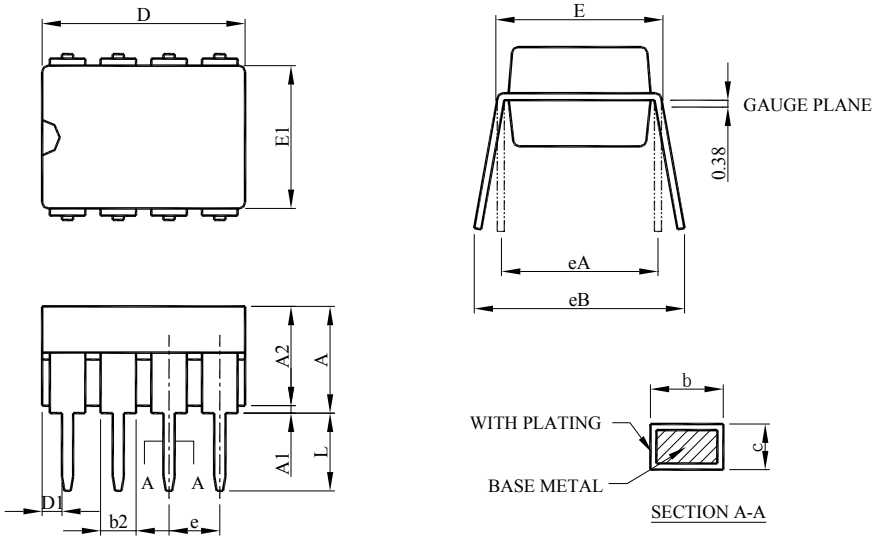
## PHYSICAL DIMENSIONS (unit: mm)

- **SOP-8**




| SYMBOL | SOP-8 | |
|---|---|---|
| | MILLIMETERS | |
| | MIN. | MAX. |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| B | 0.33 | 0.51 |
| C | 0.19 | 0.25 |
| D | 4.80 | 5.00 |
| E | 3.80 | 4.00 |
| e | 1.27 BSC | |
| H | 5.80 | 6.20 |
| h | 0.25 | 0.50 |
| L | 0.40 | 1.27 |
| θ | 0° | 8° |

- **DIP-8**




| SYMBOL | DIP-8 | |
|---|---|---|
| | MILLIMETERS | |
| | MIN. | MAX. |
| A | | 5.33 |
| A1 | 0.38 | |
| A2 | 2.92 | 4.95 |
| b | 0.36 | 0.56 |
| b2 | 1.14 | 1.78 |
| c | 0.20 | 0.35 |
| D | 9.01 | 10.16 |
| D1 | 0.13 | |
| E | 7.62 | 8.26 |
| E1 | 6.10 | 7.11 |
| e | 2.54 BSC | |
| eA | 7.62 BSC | |
| eB | | 10.92 |
| L | 2.92 | 3.81 |

**Note:**

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