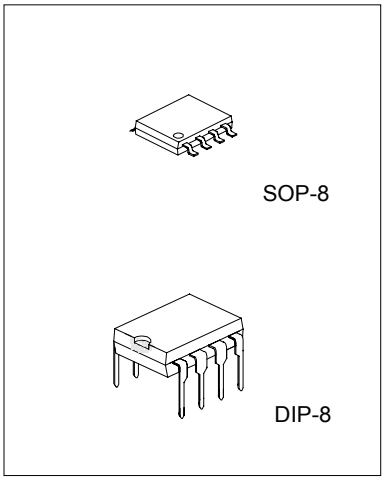
# UTC 3563 LINEAR INTEGRATED CIRCUIT

## HIGH-EFFICIENCY DC/DC CONVERTER




### DESCRIPTION

The UTC 3563 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 UTC 3563 can deliver 1.5A continuous current without requiring a heat sink.

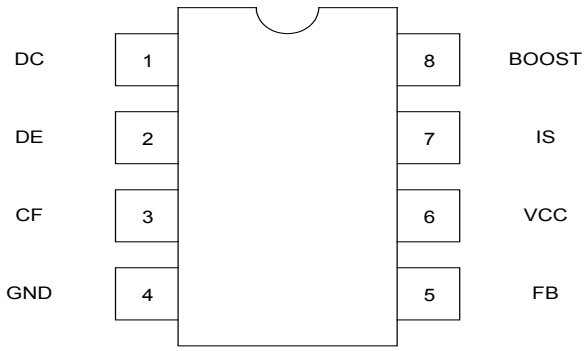
### FEATURES

*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.

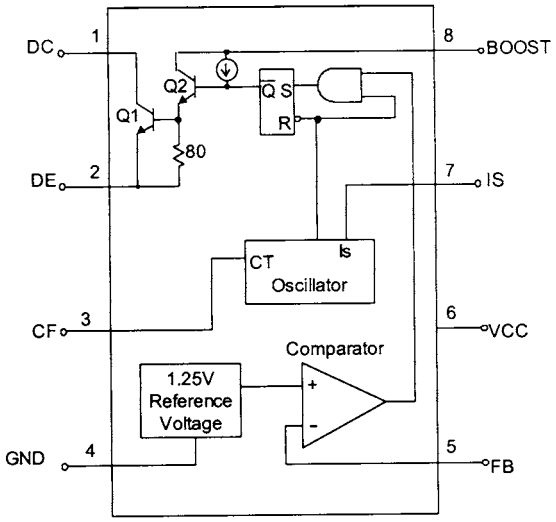
### APPLICATIONS

*Constant current source for battery chargers.
*Saver for cellular phones.
*Step-Down DC-DC converter module.

### PIN CONFIGURATION



BLOCK DIAGRAM




| PIN | SYMBOL | DESCRIPTION | PIN | SYMBOL | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | DC | 2A switch collector | 5 | FB | Feedback comparator inverting input |
| 2 | DE | Darlington switch emitter | 6 | VCC | Power supply input |
| 3 | CF | Oscillator timing capacitor | 7 | IS | Highside current sense input ($V_{CC}$-VIS=300mV) |
| 4 | GND | Power ground | 8 | BOOST | Bootstrapped driver collector |

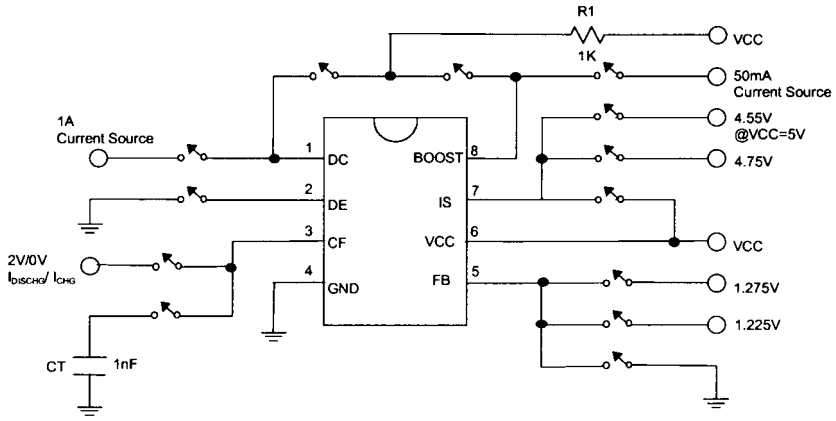
ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

| PARAMETER | SYMBOL | VALUE | UNIT |
|---|---|---|---|
| Supply Voltage | VCC | 30 | V |
| Comparator input voltage range | Vi | -0.3~+30 | V |
| Switch collector voltage | $V_C$(switch) | 30 | V |
| Switch emitter Voltage | $V_E$(switch) | 30 | V |
| Switch collector to emitter voltage | $V_{CE}$(switch) | 30 | V |
| Driver collector Voltage | $V_C$(driver) | 30 | V |
| Switch current | $I_{SW}$ | 2 | A |
| Power dissipation (Ta=25°C)<br>DIP-8<br>SOP-8 | | <br>1000<br>625 | <br>mW<br>mW |
| Thermal Resistance<br>DIP-8<br>SOP-8 | | <br>100<br>160 | <br>°C/W<br>°C/W |
| Operating junction temperature | Tj | 125 | °C |
| Operating ambient temperature range | Ta | 0~+70 | °C |
| Storage temperature range | Tstg | -65~+150 | °C |

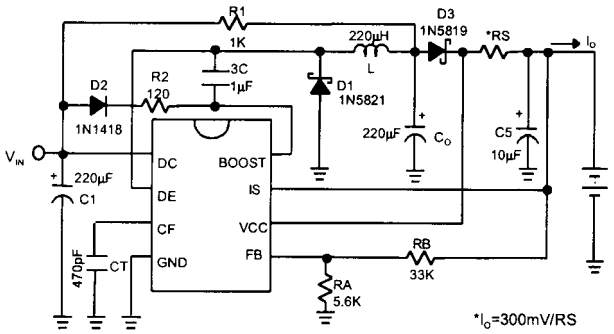
ELECTRICAL CHARACTERISTICS (VCC=5.0V, Ta=25°C, unless otherwise specified)

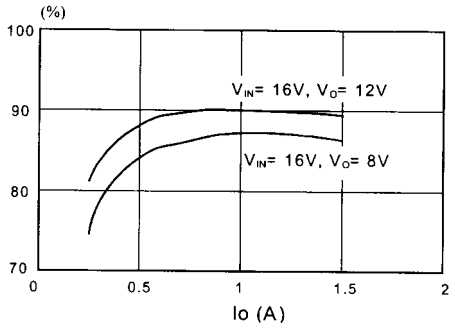
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP. | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Oscillator** | | | | | | |
| Charging Current | $I_{CHG}$ | 5V≤VCC≤30V | 10 | 25 | 40 | μA |
| Discharging Current | $I_{DISCHG}$ | 5V≤VCC≤30V | 100 | 150 | 200 | μA |
| Voltage Swing | Vosc | PIN 3 | | 0.6 | | V |
| Discharge to Charge Current Ratio | $I_{DISCHG}$ / $I_{CHG}$ | $V_{IS}$=VCC | | 6.0 | | |
| Current limit Sense Voltage | VCC -$V_{IS}$ | $I_{CHG}$=$I_{DISCHG}$ | 250 | 300 | 350 | mV |
| **Output Switch** | | | | | | |
| Saturation Voltage, Emitter Follower Connection | $V_{CE(SAT)}$ | $I_{DE}$=1.0A, $V_{BOOST}$=$V_{DC}$=VCC | | 1.5 | 1.8 | V |
| Saturation Voltage | $V_{CE(SAT)}$ | $I_{DC}$=1.0A, $I_{BOOST}$=50mA, (Forced β≈20) | | 0.4 | 0.7 | V |
| DC Current Gain | $h_{FE}$ | $I_{SC}$=1.0A<br>$V_{CE}$=5.0V | 35 | 120 | | |
| Collector Off State Current | $I_{C(OFF)}$ | $V_{CE}$=30V | | 10 | | nA |
| **Comparator** | | | | | | |
| Threshold Voltage | $V_{FB}$ | Ta=25°C<br>0°C≤Ta≤70°C | 1.225<br>1.210 | 1.250 | 1.275<br>1.290 | V<br>V |
| Threshold voltage Line Regulation | $REG_{LINE}$ | 3V≤VCC≤30V | | 0.1 | 0.3 | mV/V |
| Input Bias Current | $I_{IB}$ | $V_{IN}$=0V | | 0.4 | 1.0 | μA |
| Supply Current | ICC | $V_{IS}$=VCC, PIN 5>$V_{FB}$, 5.0V≤VCC≤30V, $C_T$=1nF, PIN 2=GND, Remaining pins open | | 1.6 | 3.0 | mA |

TEST CIRCUIT




TYPICAL APPLICATION CIRCUIT

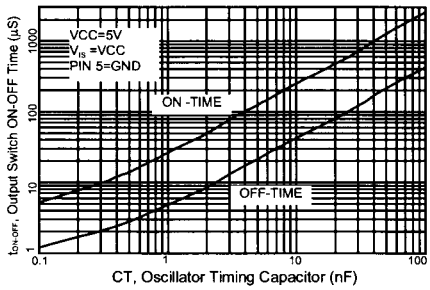


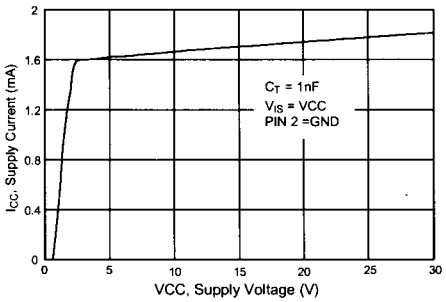

EFFICIENCY vs OUTPUT CURRENT

## TYPICAL PERFORMANCE CHARACTERISTICS

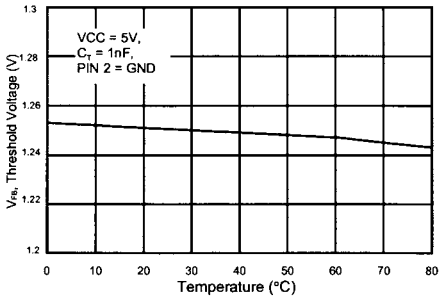
Output Switch ON-OFF Time vs Oscillator Timing Capacitor



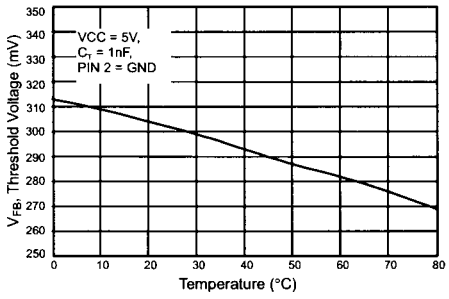

Standby Supply Current vs Supply Voltage



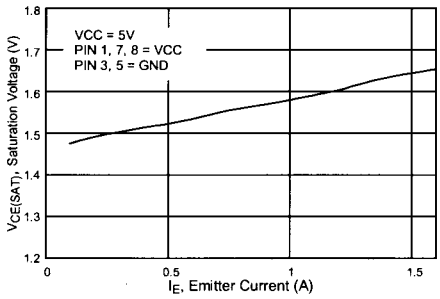

$V_{FB}$, Threshold Voltage vs Temperature



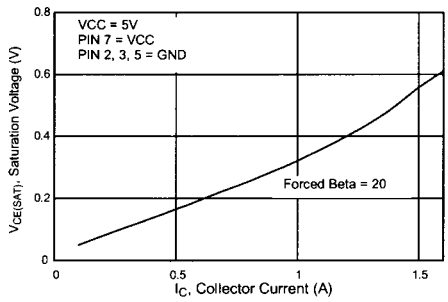

$I_S$ Threshold Voltage vs Temperature




Emmiter Follower Configuration Output Switch Saturation Voltage vs Emmiter Current




Common Emitter Configuration Output Switch Saturation Voltage vs Collector Current



## APPLICATION INFORMATION

### DESIGN FORMULA TABLE

| CALCULATION | STEP-DOWN | STEP-UP |
|---|---|---|
| $t_{ON}/t_{OFF}$ | $\frac{V_{OUT}+V_F}{V_{IN(MIN)}-V_{SAT}-V_{OUT}}$ | $\frac{V_{OUT}+V_F-V_{IN(MIN)}}{V_{IN(MIN)}-V_{SAT}}$ |
| $(t_{ON}+t_{OFF})_{MAX}$ | $1/F_{MIN}$ | $1/F_{MIN}$ |
| $C_T$ | $4x10^{-5}t_{ON}$ | $4x10^{-5}t_{ON}$ |
| $I_{C(SWITCH)}$ | $2I_{OUT(MAX)}$ | $2I_{OUT(MAX)}(\frac{t_{ON}+t_{OFF}}{t_{OFF}})$ |
| 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:
$V_{IN}$ : Norminal 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

Fig. 1 Simplified Battery Charge Circuit for Ni-Cd/Ni-MH Battery

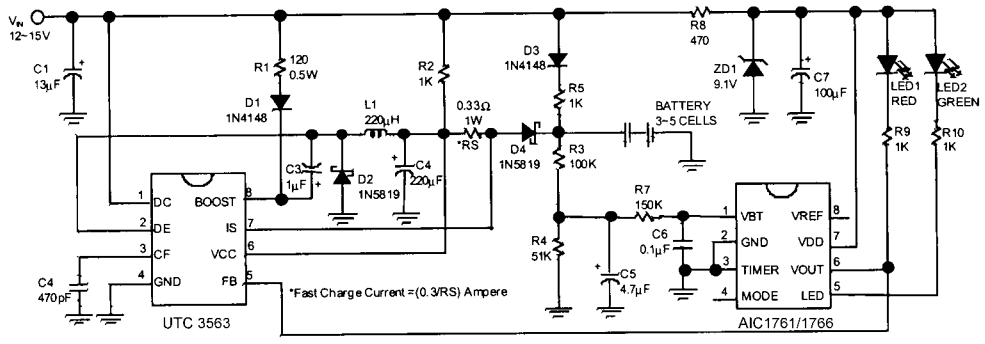


Fig.2 Battery Charge Circuit for Fluctuating Charging Current Applications

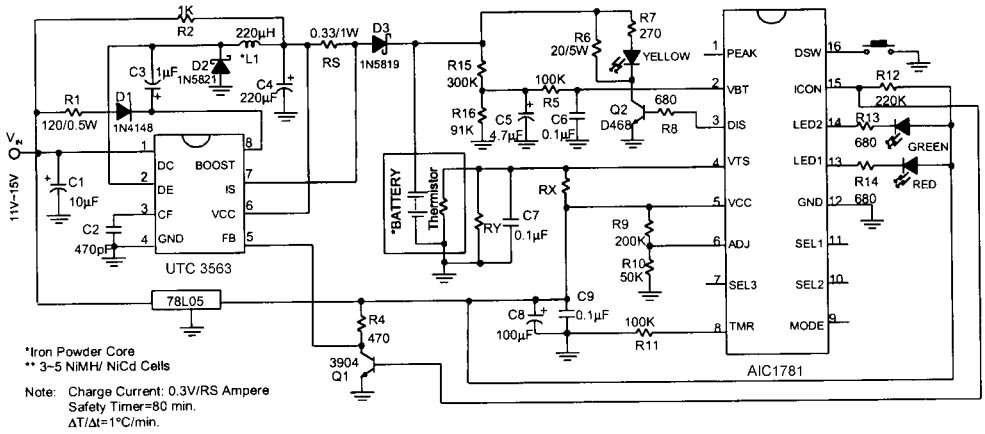
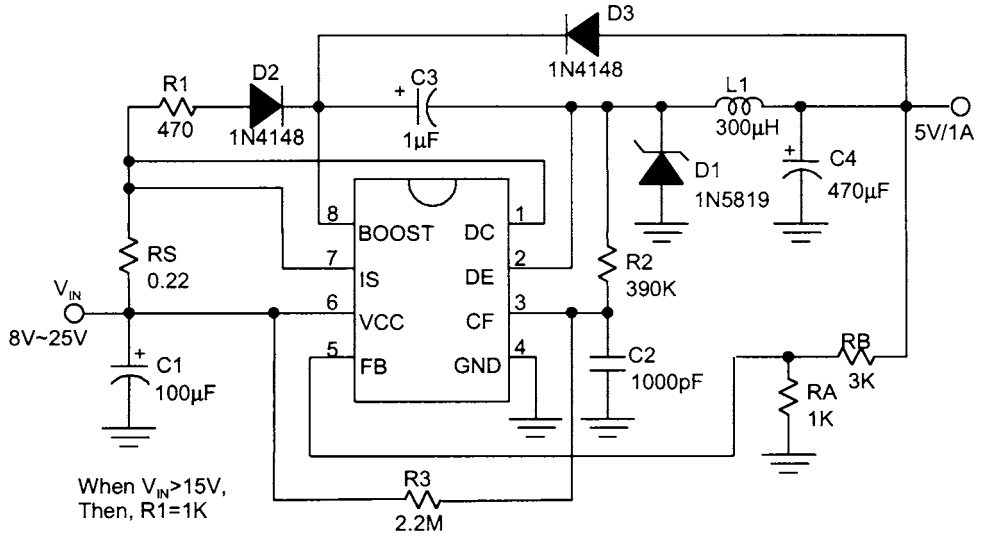



Fig. 3 Step-Down Converter




Line regulation: 40mV ($V_{IN}$=10V~20V, @$I_O$=1A)
Load regulation: 20mV ($V_{IN}$=15V, @$I_O$=100mA~1A)
Short circuit current: 1.3A ($V_{IN}$=15V, @$R_L$=0.1Ω)

Fig. 4 Step-Down Converter with External 5V Bootstrap

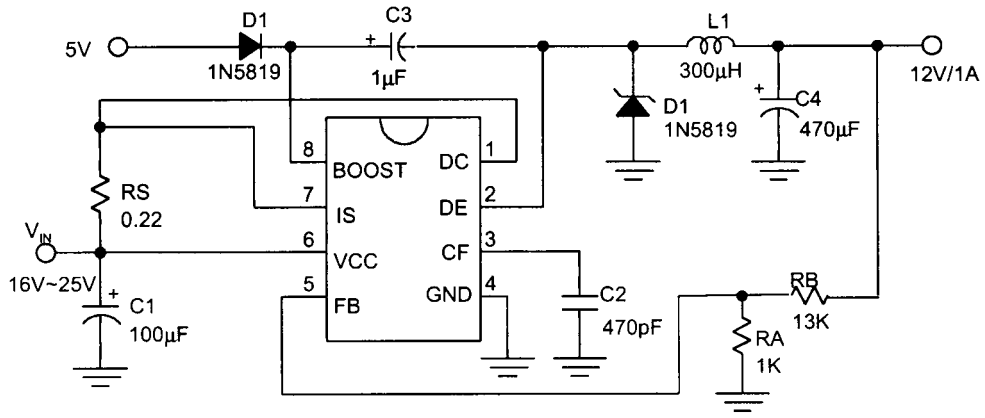
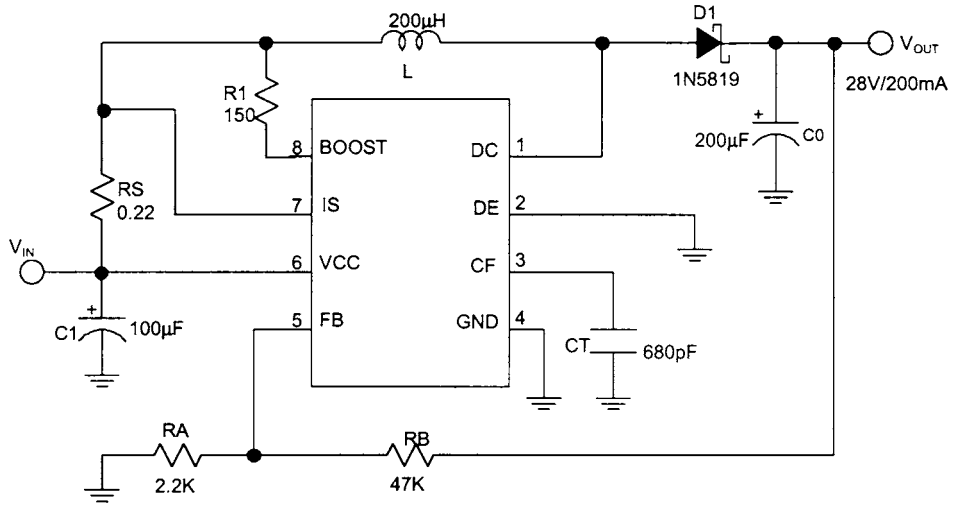



Fig. 5 Step-Up Converter




Line regulation: 100mV ($V_{IN}$=8V~16V, @Io=200mA)
Load regulation: 40mV ($V_{IN}$=12V, @$I_O$=80mA~200mA)

Fig. 6 Step-Up Converter with External NPN Switch

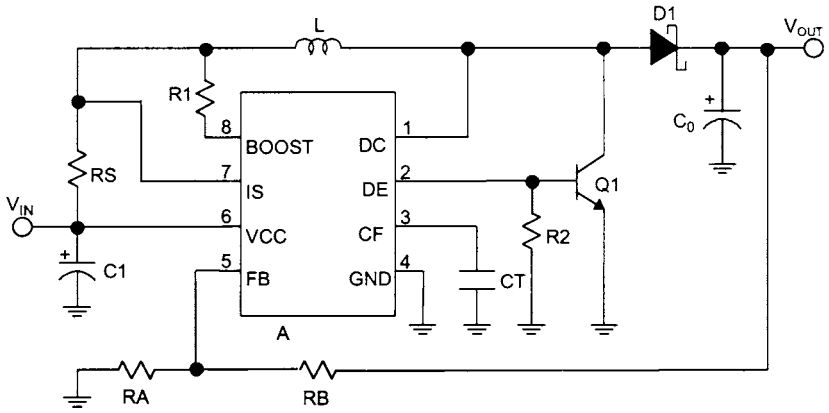
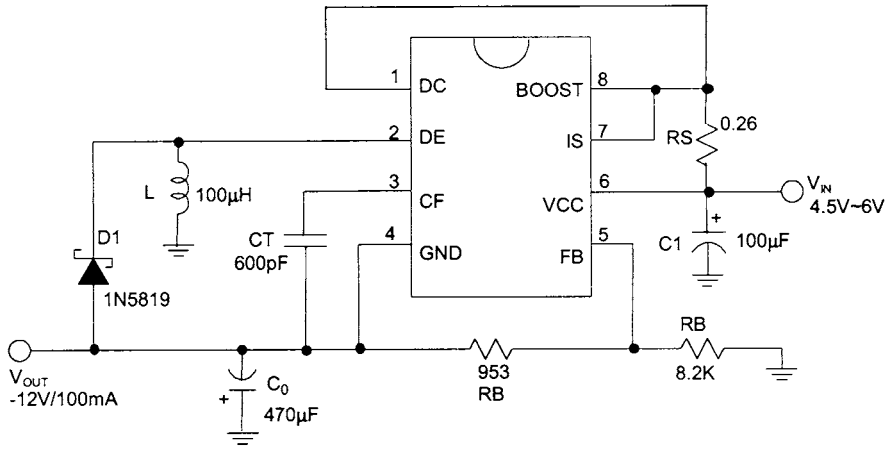



Fig. 7 Inverting Converter




Line regulation: 20mV ($V_{IN}$=4.5V~6V, @$I_O$=100mA)
Load regulation: 100mV ($V_{IN}$=5V, @$I_O$=10mA~100mA)