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.

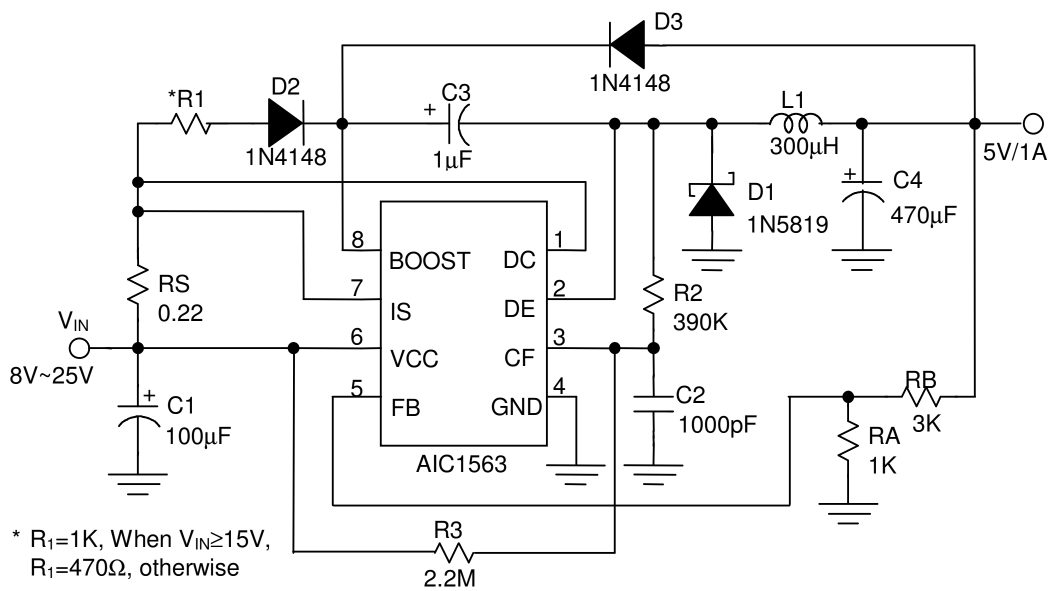
APPLICATIONS

- 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.

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

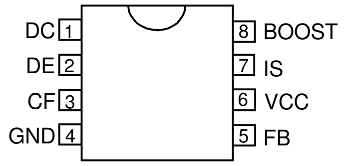
AIC1563-XXX XX

- PACKING TYPE
  TR: TAPE & REEL
  TB: TUBE
  (DIP is not available in TR packing)
- PACKAGING TYPE
  N: DIP-8
  S: SOP-8
  SH: SOP-8 Exposed Pad
- C: COMMERCIAL
  P: LEAD FREE COMMERCIAL
  G: GREEN PACKAGE

Example: AIC1563CSTR
→ in SOP-8 Package & Taping & Reel Packing Type
AIC1563PSTR
→ in SOP-8 Lead Free Package & Taping & Reel Packing Type

PIN CONFIGURATION

DIP-8
SOP-8(Exposed Pad)
TOP VIEW



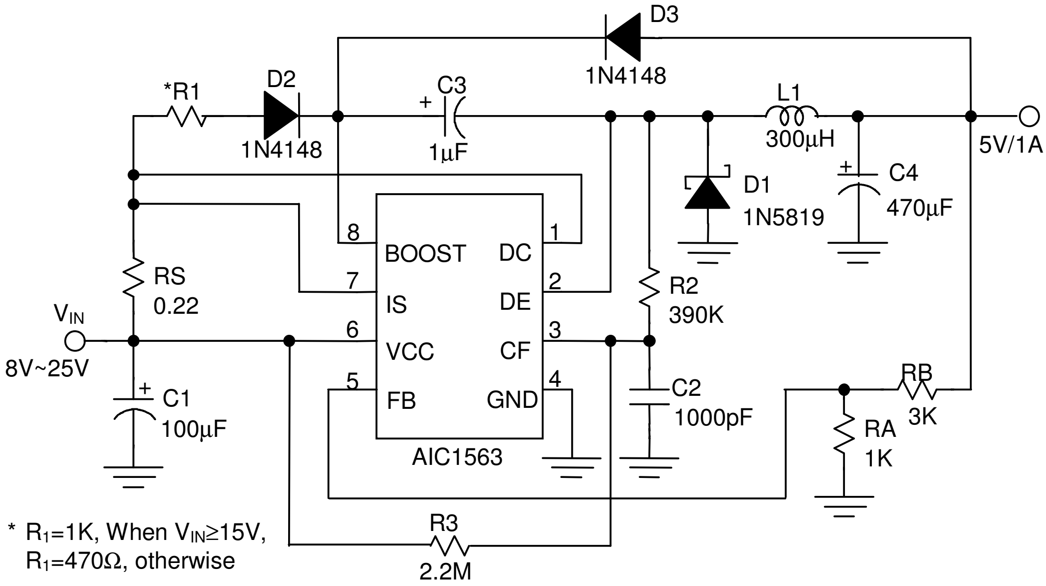
■ ABSOLUTE MAXIMUM RATINGS

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
Thermal Resistance Junction to Case	SOP8	40°C/W
	SOP8 Exposed Pad*	16°C/W
	DIP8	60°C/W
Thermal Resistance Junction to Ambient	SOP8	160°C/W
(Assume no ambient airflow, no heatsink)	SOP8 Exposed Pad*	60°C/W
	DIP8	100°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.

* The package is place on a two layers PCB with 2 ounces copper and 2 square inch, connected by 8 vias.

■ TEST CIRCUIT



* R_1=1K, When $V_{IN}\geq$15V,
R_1=470Ω, otherwise

■ 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
Comparactor						
Threshold Voltage	T_A=25°C 0°C ≤ T_A ≤ 70°C	V_{FB}	1.225 1.21	1.25	1.275 1.29	V 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} 5.0V≤ VCC ≤30V C_T=1nF PIN 2=GND 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

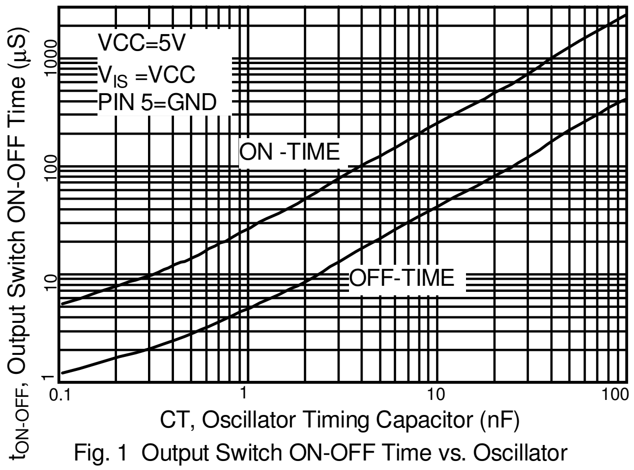


Fig. 1 Output Switch ON-OFF Time vs. Oscillator Timing Capacitor

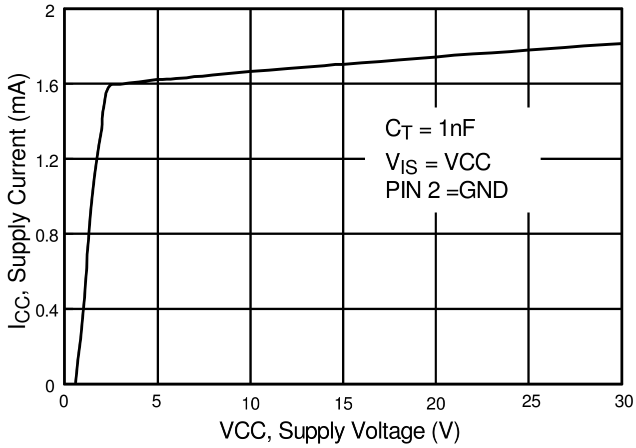


Fig. 2 Standby Supply Current vs. Supply Voltage

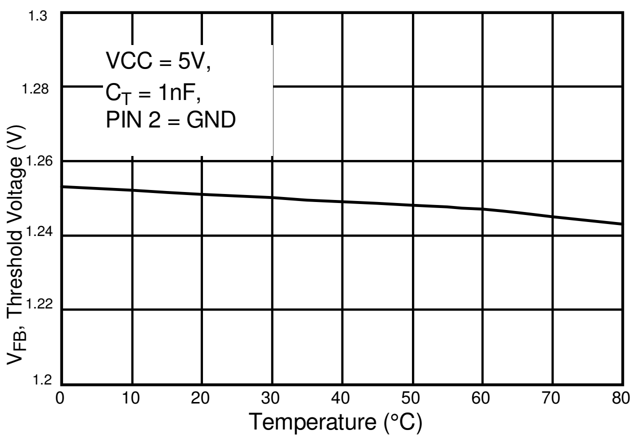


Fig. 3 V_{FB}, Threshold Voltage vs. Temperature

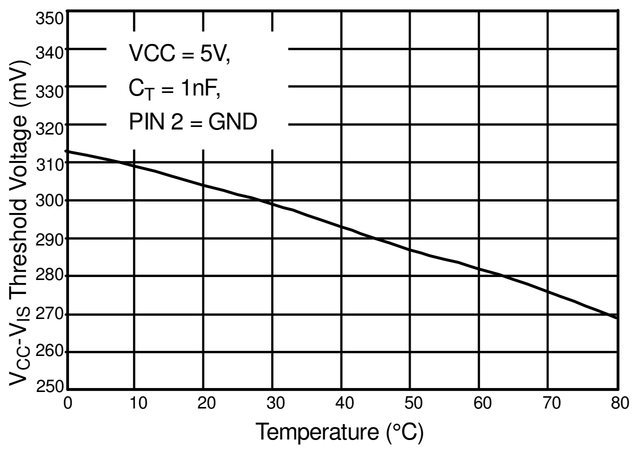


Fig. 4 I_S Threshold Voltage vs. Temperature

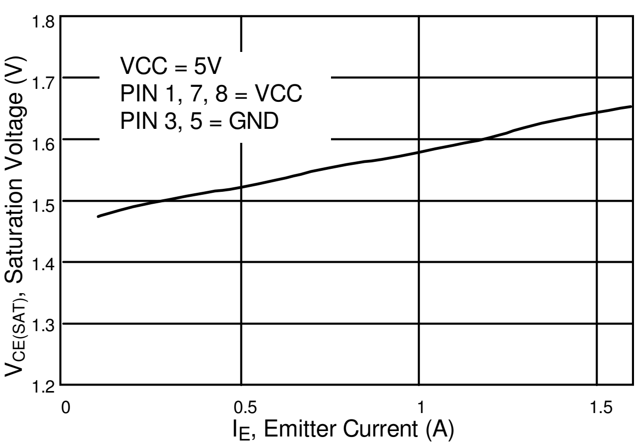


Fig. 5 Emmiter Follower Configuration Output Switch Saturation Voltage vs. Emmiter Current

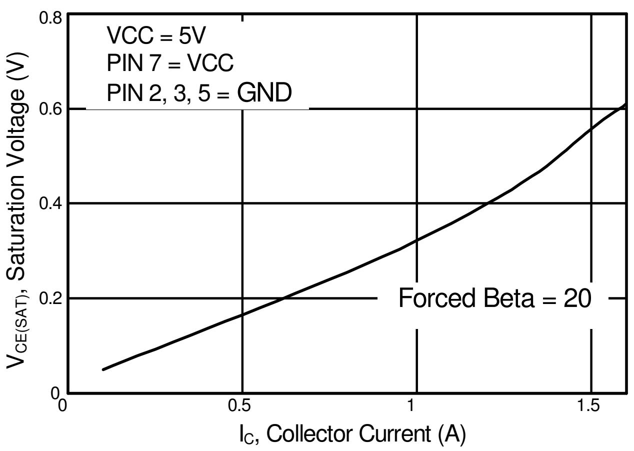
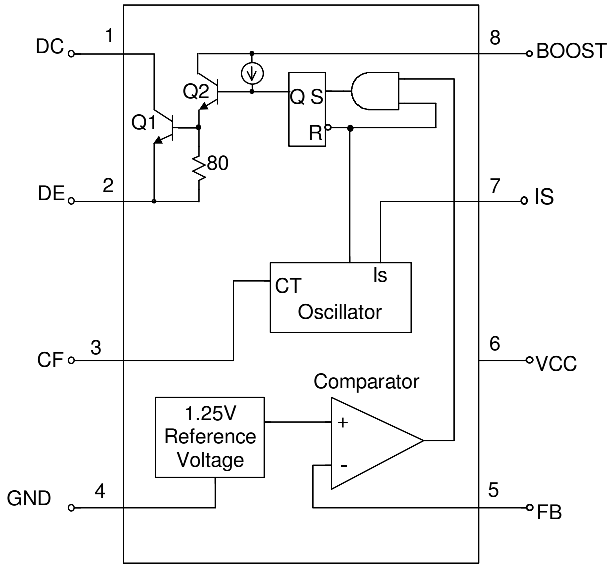


Fig. 6 Common Emitter Configuration Output Switch Saturation Voltage vs. Collector Current

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	$\frac{0.9 \times V_{CURRENT\ SENSE(min.)}}{I_{C(SWITCH)}} = \frac{225mV}{I_{C(SWITCH)}}$	$\frac{0.9 \times V_{CURRENT\ SENSE(min.)}}{I_{C(SWITCH)}} = \frac{225mV}{I_{C(SWITCH)}}$
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.

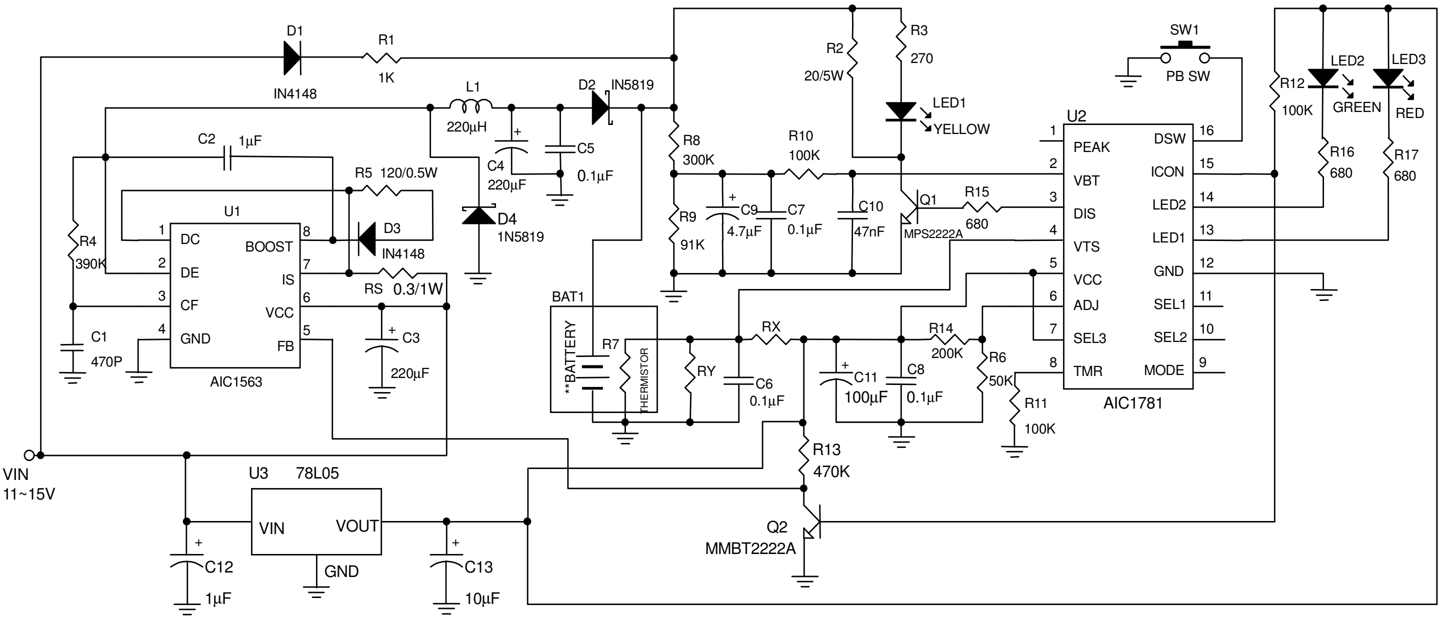
F_{MIN} - Minimum desired switching frequency at selected values for V_{IN} and I_{OUT}.

$V_{RIPPLE\ (P-P)}$ - 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.

LAYOUT GUIDANCE FOR EP THERMAL PATH

The AIC1563 uses a thermally-enhanced SOP8 package that has an exposed thermal pad at the bottom side of the package. The layout should connect as mush as possible to copper on the exposed pad. Typically the component layer is more effective in dissipating heat. The thermal impedance can be further reduced by using other layers of copper connecting to the exposed pad through a thermal via array. Each thermal via is recommended to have 0.3mm diameter and 1mm distance from other thermal vias.

■ APPLICATION EXAMPLES

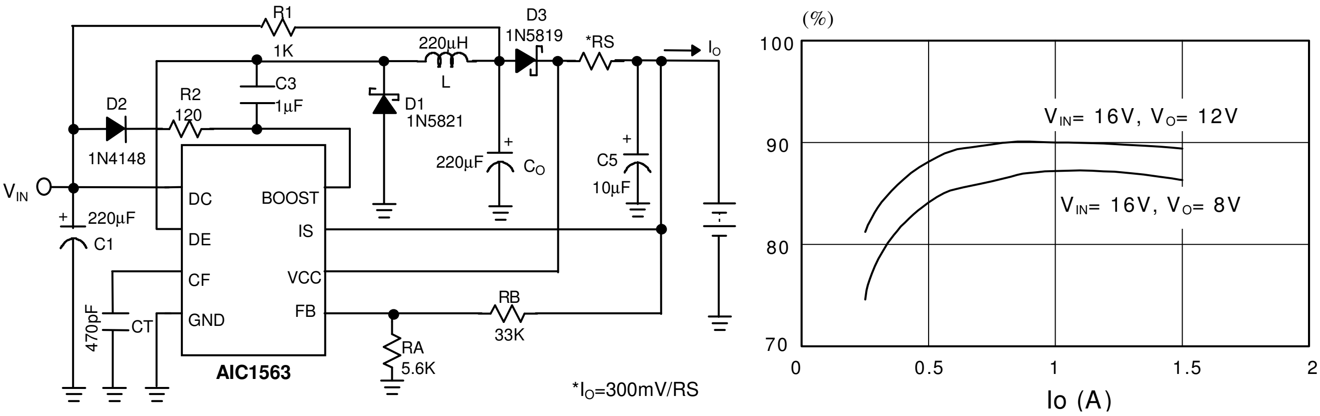


**3~5 NiMH/NiCd cells.

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)

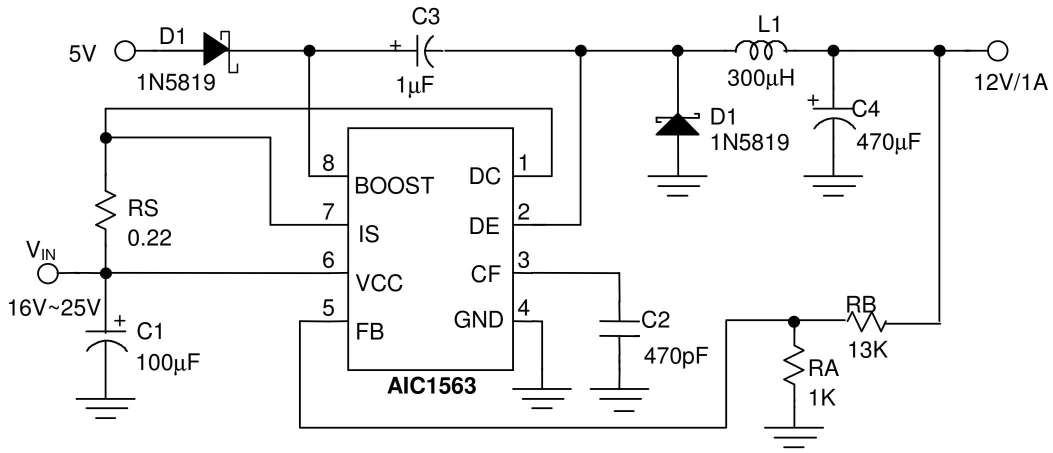
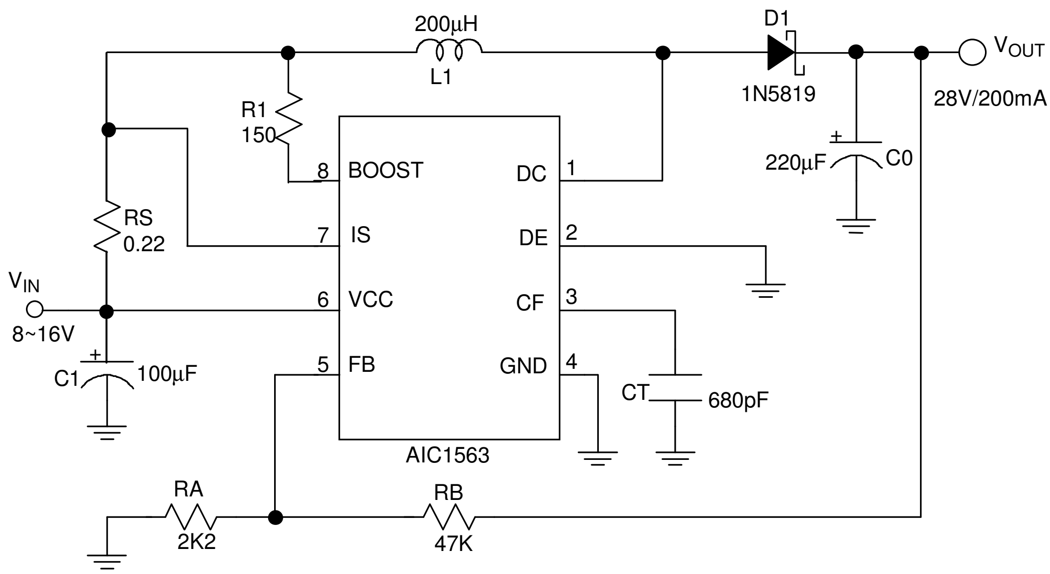


Fig. 9 Step-Down Converter with External 5V Bootstrap



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)

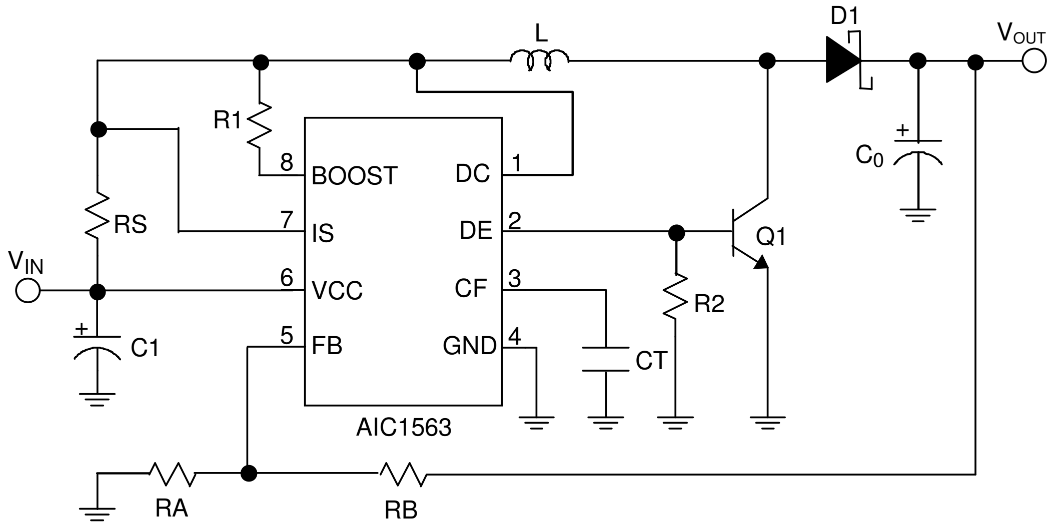
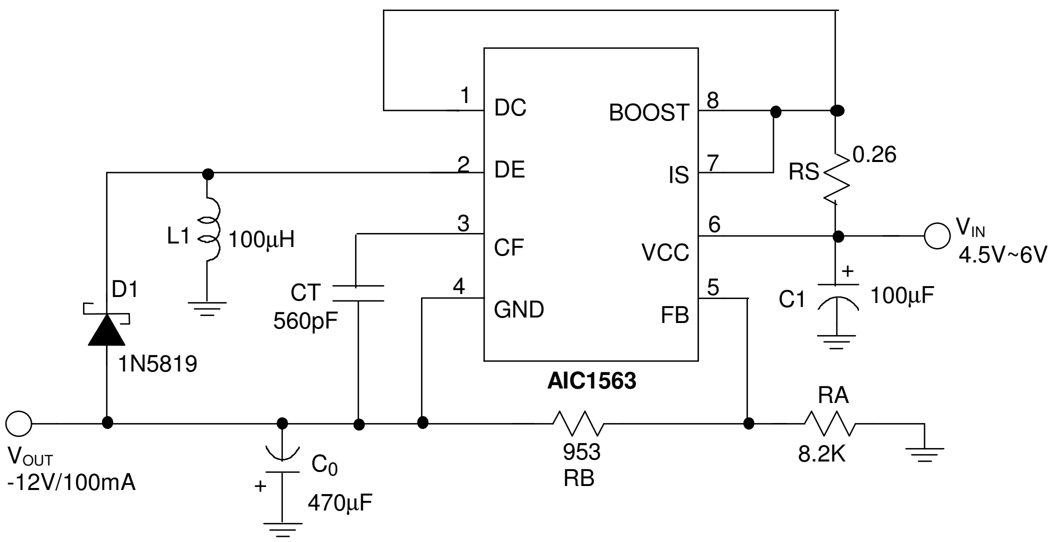


Fig. 11 Step-Up Converter with External NPN Switch



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

APPLICATION EXAMPLES (Continued)

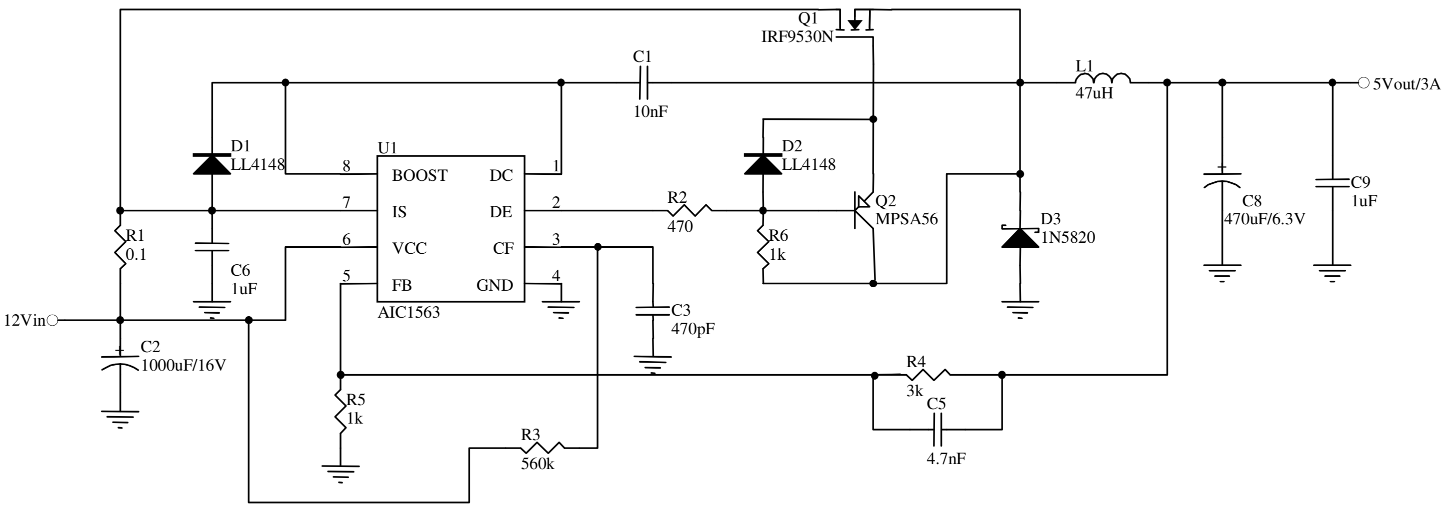


Fig. 13 Step-down Converter with External N-MOS Switch

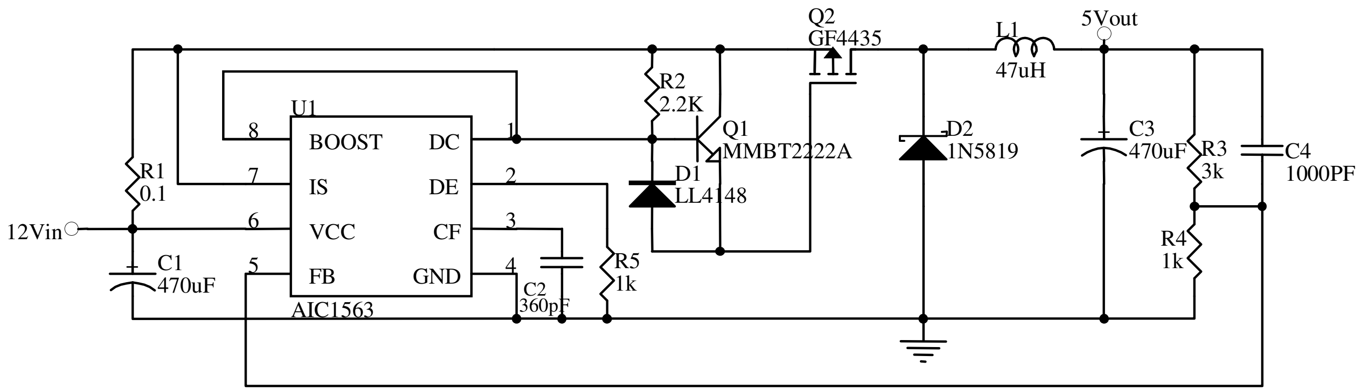
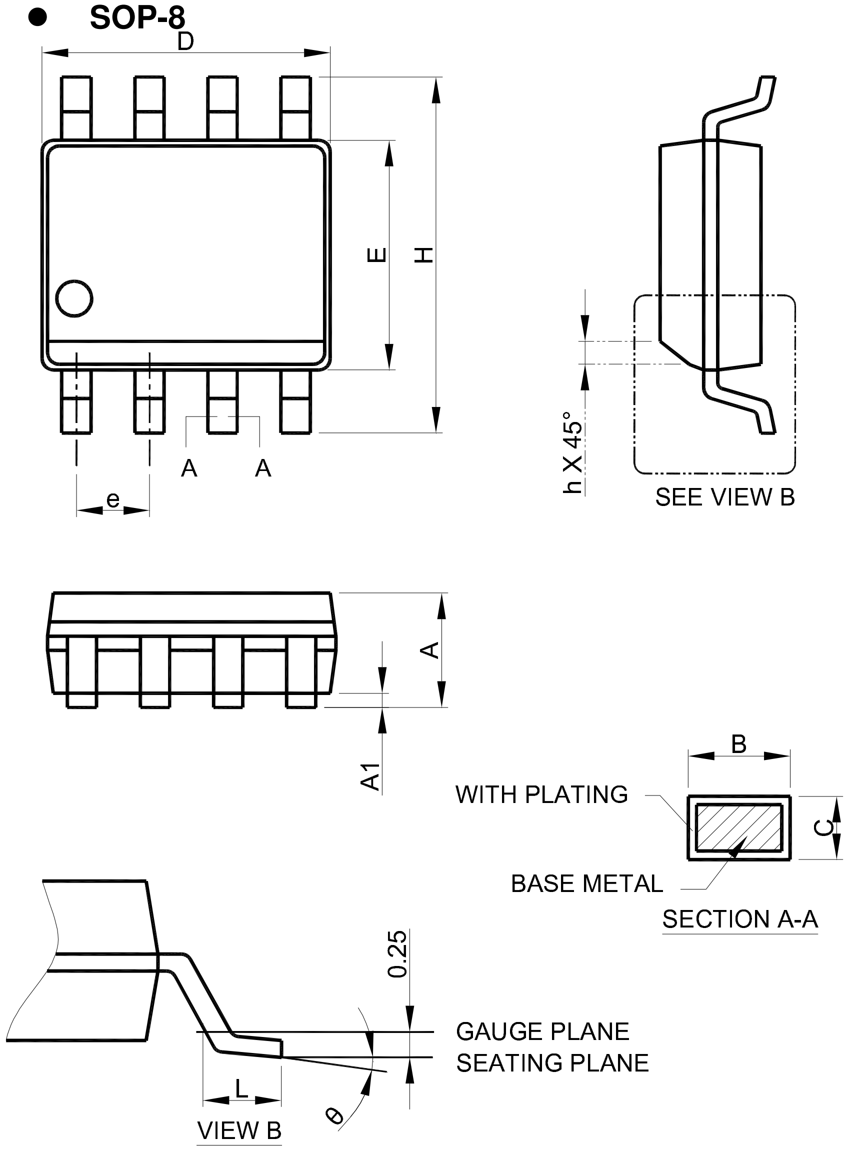


Fig. 14 Step-down Converter with External P-MOS Switch

■ PHYSICAL DIMENSIONS (unit: mm)

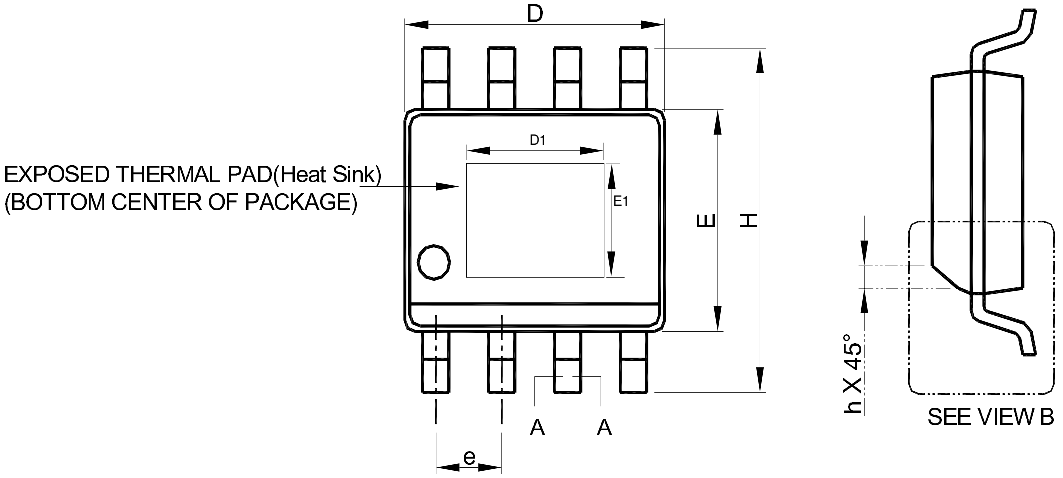
- **SOP-8**

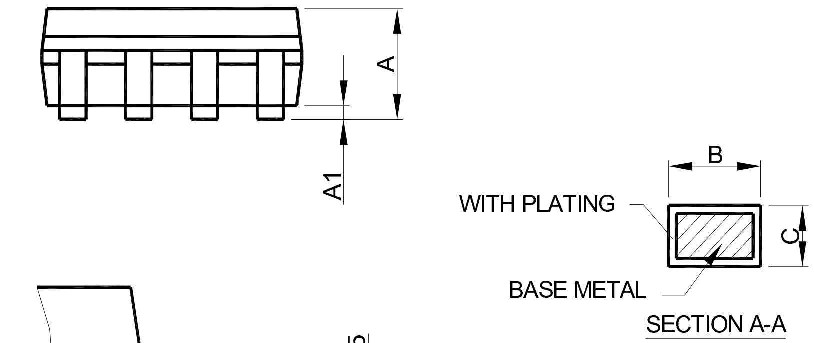


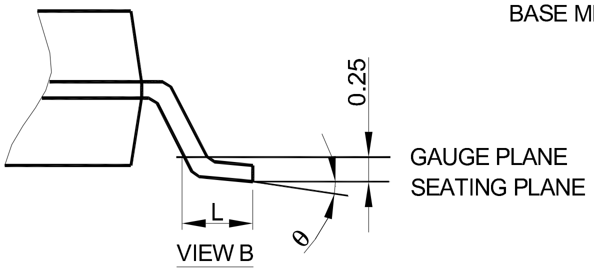
Note: 1. Refer to JEDEC MS-012AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .
3. Dimension "E" does not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

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°

- **SOP-8 (Exposed Pad)**



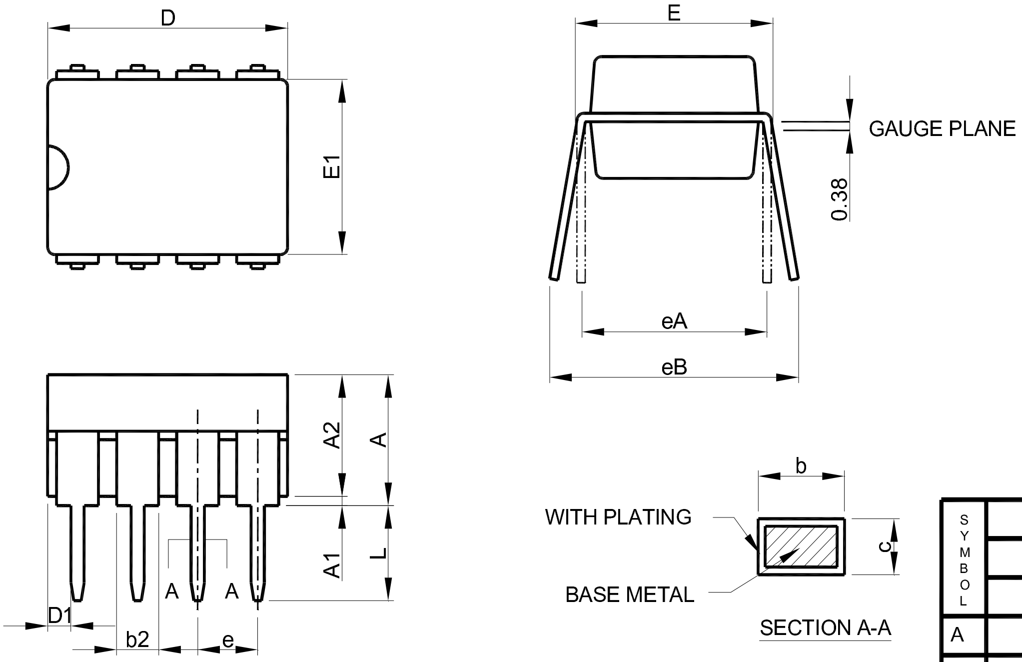




Note : 1. Refer to JEDEC MS-012E.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side .
3. Dimension "E" does not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

SYMBOL	SOP-8 Exposed Pad(Heat Sink)	
	MILLIMETERS	
	MIN.	MAX.
A	1.35	1.75
A1	0.00	0.15
B	0.31	0.51
C	0.17	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
q	0°	8°
D1	1.5	3.5
E1	1.0	2.55

- **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: 1. Refer to JEDEC MS-001BA
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side .
3. Dimension "D1"and "E1" do not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.

Note: