

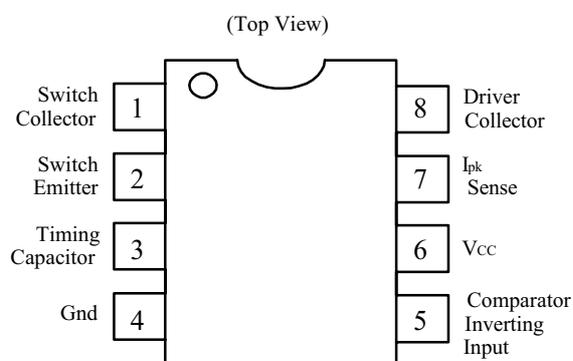
# AP34063

## Universal DC/DC Converter

### ■ 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 100 kHz
- Precision 2% Reference

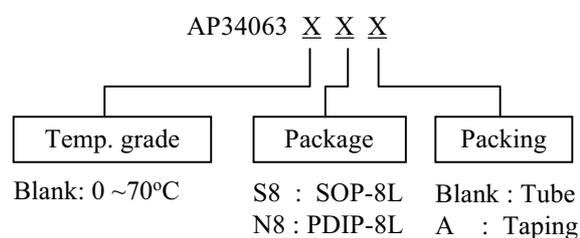
### ■ Pin Connections



### ■ General 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 was specifically designed to be incorporated in Step-Down and Step-Up and Voltage-Inverting applications with a minimum number of external components.

### ■ Ordering Information



### ■ Maximum Ratings

Rating	Symbol	Value	Unit
Power Supply Voltage	V <sub>CC</sub>	40	V
Comparator Input Voltage Range	V <sub>IR</sub>	-0.3 ~ +40	V
Switch Collector Voltage	V <sub>C(switch)</sub>	40	V
Switch Emitter Voltage(V <sub>Pin 1</sub> = 40V)	V <sub>E(switch)</sub>	40	V
Switch Collector to Emitter Voltage	V <sub>CE(switch)</sub>	40	V
Driver Collector Voltage	V <sub>C(driver)</sub>	40	V
Driver Collector Current (Note 1)	I <sub>C(driver)</sub>	100	MA
Switch Current	I <sub>SW</sub>	1.6	A
Power Dissipation and Thermal Characteristics			
PDIP: T <sub>A</sub> = 25°C	P <sub>D</sub>	1.25	W
Thermal Resistance	P <sub>θJA</sub>	100	°C/W
SOP: T <sub>A</sub> = 25°C	P <sub>D</sub>	600	mW
Thermal Resistance	R <sub>θJA</sub>	160	°C/W
Operating Junction Temperature	T <sub>J</sub>	+150	°C
Operating Ambient Temperature Range AP34063	T <sub>A</sub>	0 ~ +70	°C
Storage Temperature Range	T <sub>stg</sub>	-65 ~ +150	°C

- Notes: 1.Maximum package power dissipation limits must be observed.  
2.ESD data available upon request.

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### ■ Electrical Characteristics (V<sub>CC</sub> = 5.0V, unless otherwise specified.)

Characteristics	Symbol	Min	Typ	Max	Unit
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#### OSCILLATOR

Frequency(V <sub>Pin 5</sub> = 0V, C <sub>T</sub> = 1.0nF, T <sub>A</sub> = 25°C)	f <sub>osc</sub>	24	33	42	kHz
Charge Current(V <sub>CC</sub> = 5.0V to 40V, T <sub>A</sub> = 25°C)	I <sub>chg</sub>	24	30	42	μA
Discharge Current(V <sub>CC</sub> = 5.0V to 40V, T <sub>A</sub> = 25°C)	I <sub>dischg</sub>	140	200	260	μA
Discharge to Charge Current Ratio(Pin 7 to V <sub>CC</sub> , T <sub>A</sub> = 25°C)	I <sub>dischg</sub> / I <sub>chg</sub>	5.2	6.5	7.5	-
Current Limit Sense Voltage(I <sub>chg</sub> = I <sub>dischg</sub> , T <sub>A</sub> = 25°C)	V <sub>ipk(sense)</sub>	250	300	350	mV

#### OUTPUT SWITCH (Note 3)

Saturation Voltage, Darlington Connection (I <sub>SW</sub> = 1.0A, Pins 1,8 connected)	V <sub>CE(sat)</sub>	-	1.0	1.3	V
Saturation Voltage, Darlington Connection (I <sub>SW</sub> = 1.0A, I <sub>D</sub> = 50mA, Forced β ≈ 20)	V <sub>CE(sat)</sub>	-	0.45	0.7	V
DC Current Gain(I <sub>SW</sub> = 1.0A, V <sub>CE</sub> = 5.0V, T <sub>A</sub> = 25°C)	h <sub>FE</sub>	50	75	-	-
Collector Off-State Current (V <sub>CE</sub> = 40V)	I <sub>C(off)</sub>	-	0.01	100	μA

#### COMPARATOR

Threshold Voltage T <sub>A</sub> = 25°C T = 0°C ~ 75°C	V <sub>th</sub>	1.225 1.21	1.25 -	1.275 1.29	V
Threshold Voltage Line Regulation(V <sub>CC</sub> = 3.0V to 40V) AP34063	Reg <sub>line</sub>	- -	1.4 1.4	5.0 6.0	mV

#### TOTAL DEVICE

Supply Current(V <sub>CC</sub> = 5.0V to 40V, C <sub>T</sub> = 1.0nF, Pin 7 = V <sub>CC</sub> , V <sub>Pin 5</sub> > V <sub>th</sub> Pin 2 = Gnd, remaining pins open)	I <sub>CC</sub>	-	-	3.5	mA
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Note: 3. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

4. If the output switch is driven into hard saturation (non-Darlington configuration) at low switch currents (≤300mA) and high driver currents (≥30mA), it may take up to 2.0 μs for it to come out of saturation. This condition will shorten the off time at frequencies ≥30kHz, and is magnified at high temperatures. This condition does not occur with a Darlington configuration, since the output switch cannot saturate. If a non-Darlington configuration is used, the following output drive condition is recommended:

$$\text{Forced } \beta \text{ of output switch : } \frac{I_{C \text{ output}}}{I_{C \text{ driver}} - 7.0\text{mA}^*} \geq 10$$

\*The 100Ω resistor in the emitter of the driver device requires about 7.0mA before the output switch conducts.

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## ■ Representative Schematic Diagram

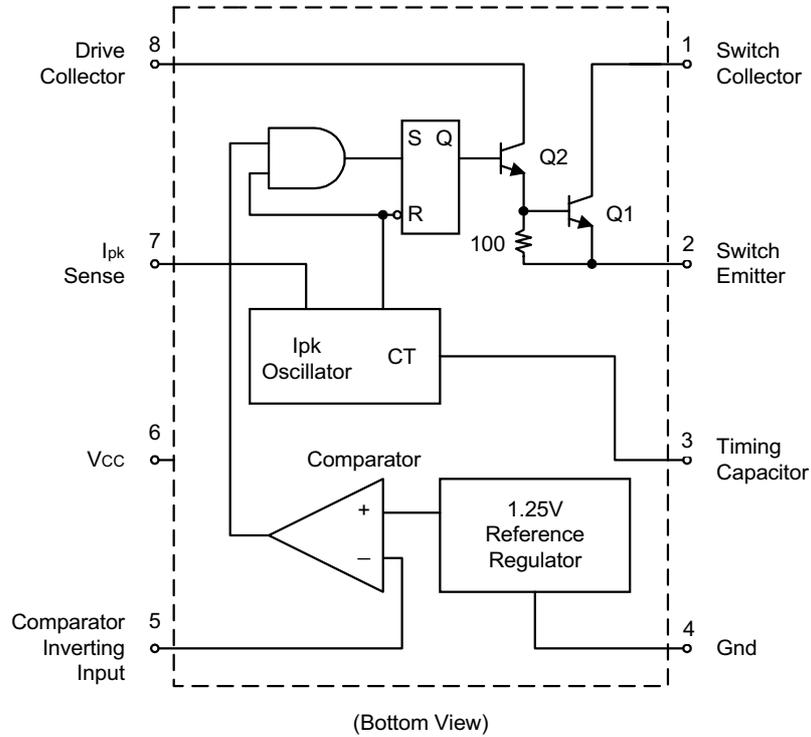


Figure 1. Vce(sat) versus Ie

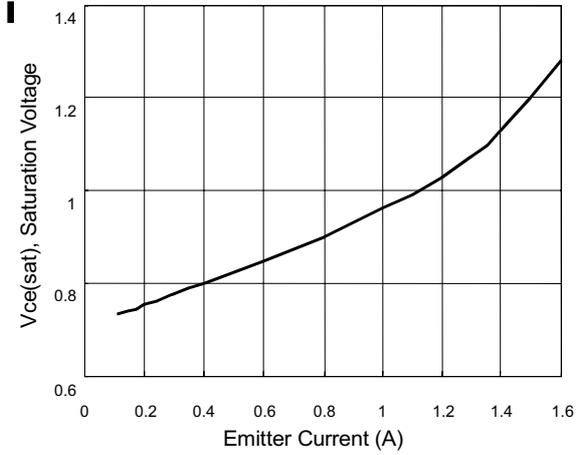


Figure 2. Reference Voltage versus Temp.

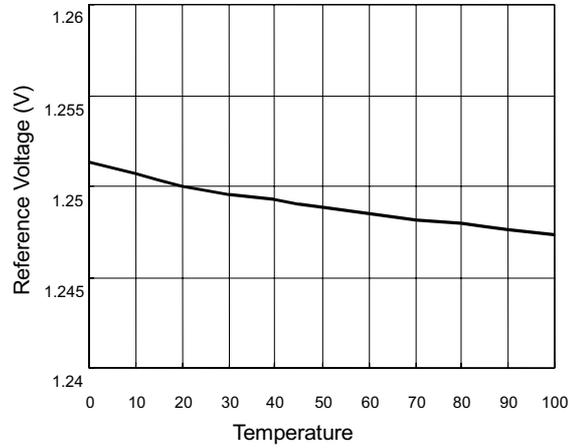


Figure 3. Current Limit Sense Voltage versus Temperature

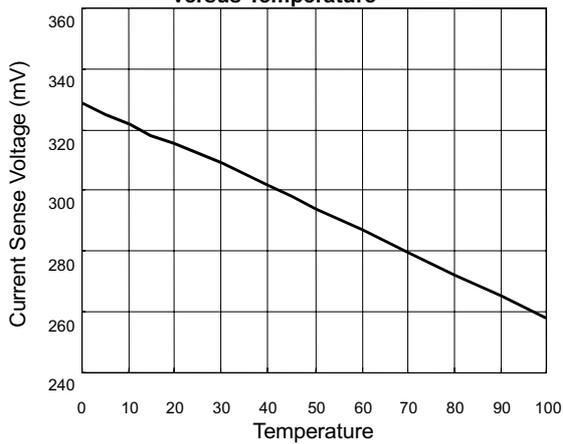


Figure 4. Standby Supply Current versus Supply Voltage

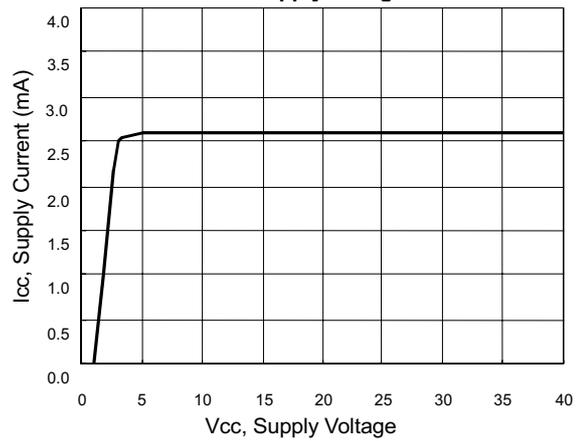


Figure 5. Emitter Follower Configuration Output Saturation Voltage vs. Emitter

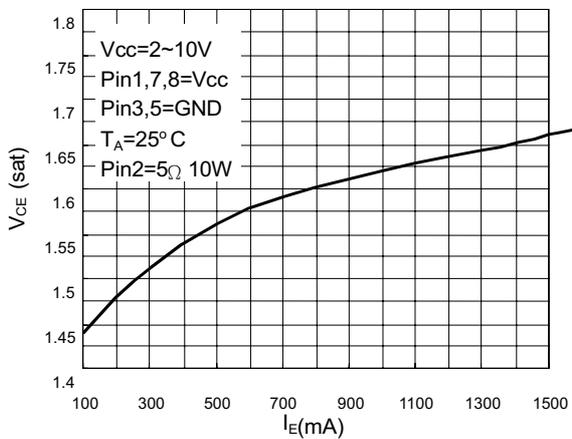
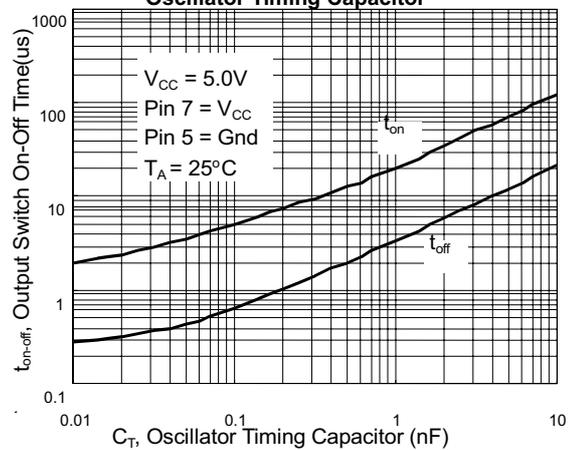
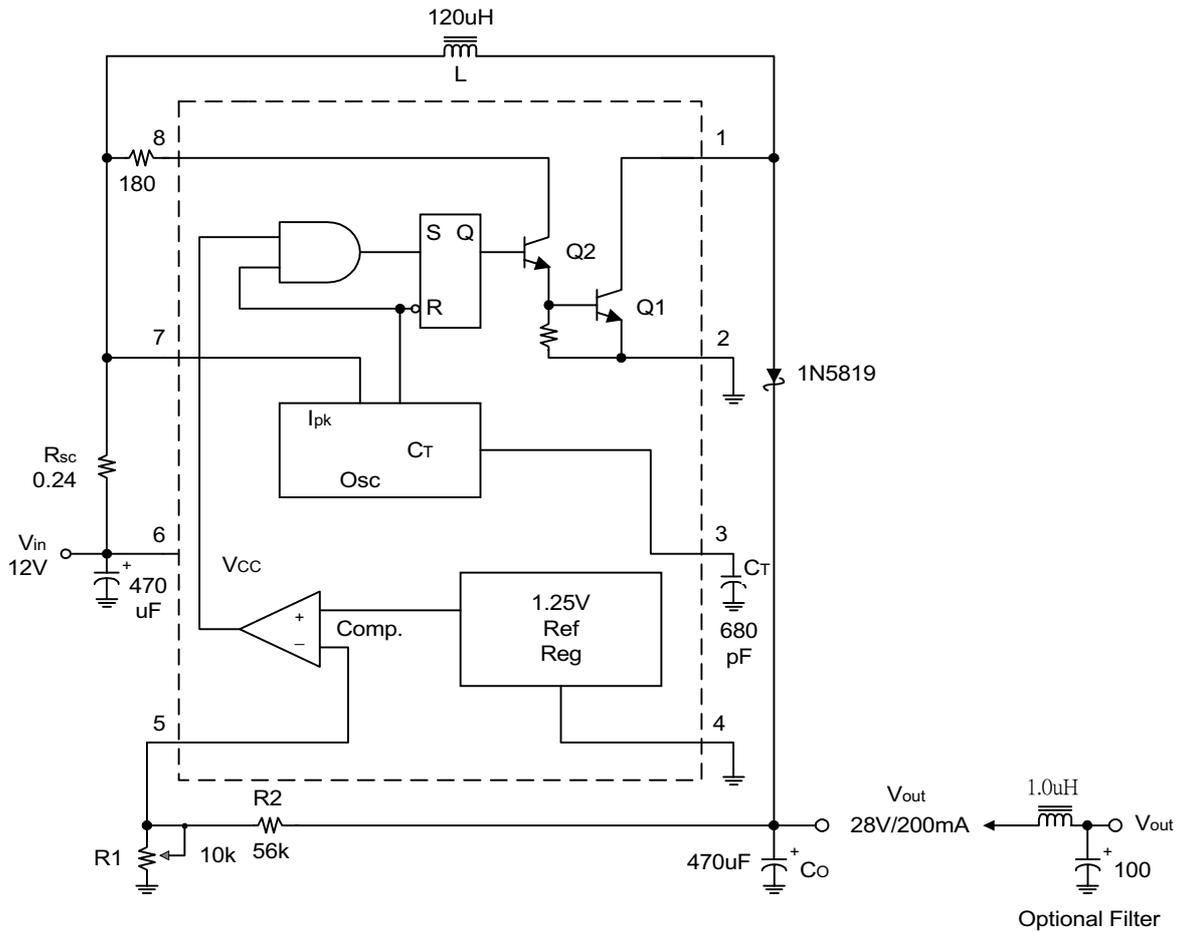


Figure 6. Output Switch On-Off Time versus Oscillator Timing Capacitor



### ■ Application Circuit

#### (1) Step-Up Converter



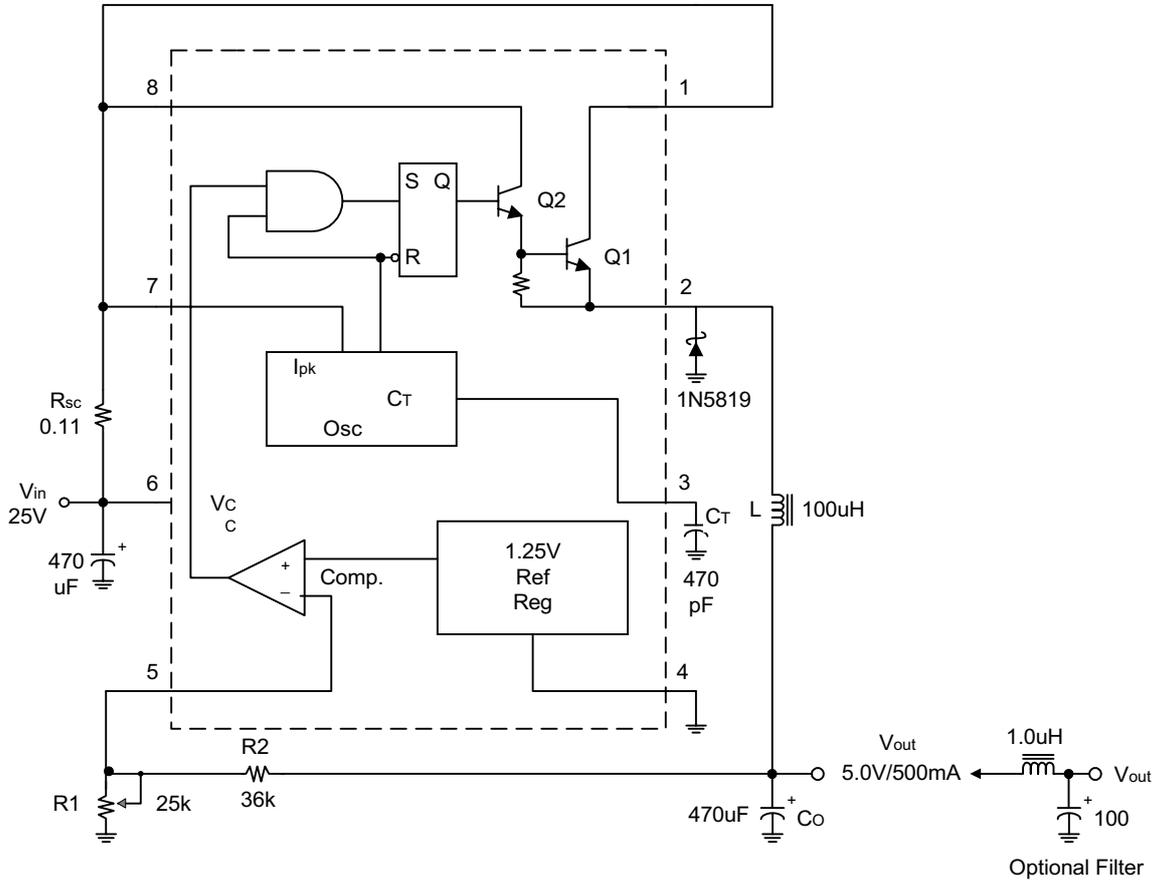
Test	Conditions	Results
Line Regulation	$V_{in} = 9V$ to $12V$ , $I_O = 200mA$	$20mV = \pm 0.035\%$
Load Regulation	$V_{in} = 9V$ , $I_O = 50mA$ to $200mA$	$15mV = \pm 0.035\%$
Output Ripple	$V_{in} = 9V$ , $I_O = 200mA$	$500mV_{PP}$
Efficiency	$V_{in} = 9V$ , $I_O = 200mA$	$80\%$

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### (2) Step-Down Converter



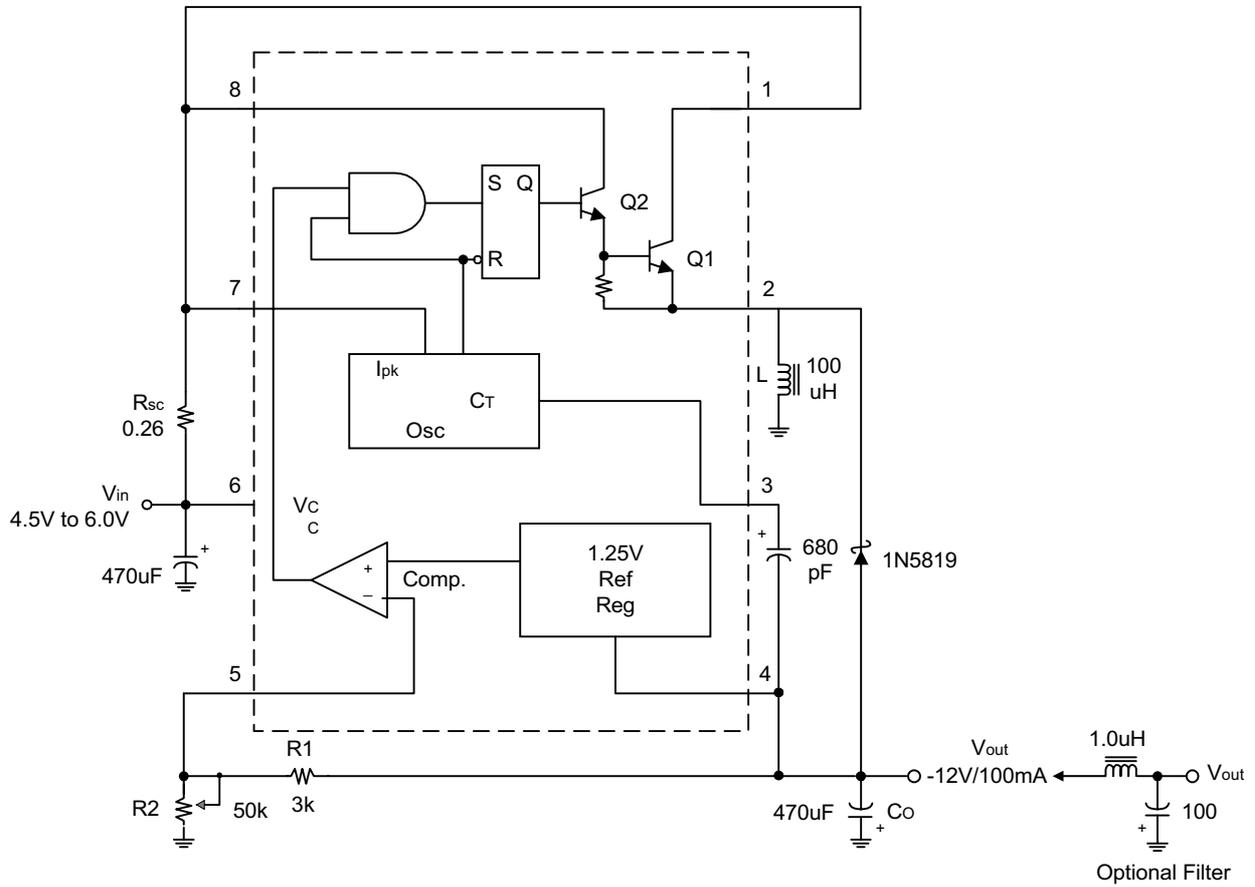
Test	Conditions	Results
Line Regulation	$V_{in} = 12V \text{ to } 24V, I_O = 500mA$	$20mV = \pm 0.2\%$
Load Regulation	$V_{in} = 12V, I_O = 50mA \text{ to } 500mA$	$5mV = \pm 0.05\%$
Output Ripple	$V_{in} = 12V, I_O = 500mA$	$160mV_{pp}$
Efficiency	$V_{in} = 12V, I_O = 500mA$	$82\%$

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### (3) Voltage Inverting Converter



Test	Conditions	Results
Line Regulation	$V_{in}=4.5V$ to $6.0V$ , $I_O=100mA$	$20mV = \pm 0.08\%$
Load Regulation	$V_{in}=5.0V$ , $I_O=20mA$ to $100mA$	$30mV = \pm 0.12\%$
Output Ripple	$V_{in}=4.5V$ , $I_O=100mA$	$500mV_{PP}$
Efficiency	$V_{in}=4.5V$ , $I_O=100mA$	$60\%$

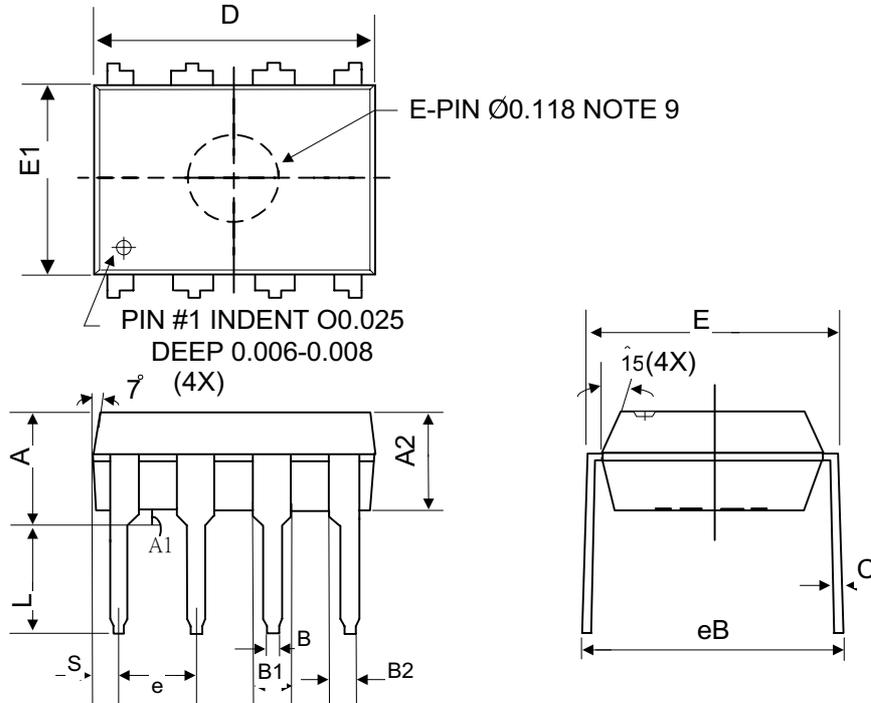
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## ■ Package Dimension

### (1) PDIP-8L



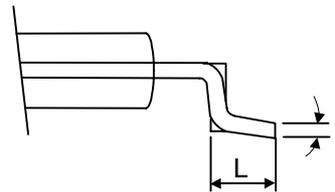
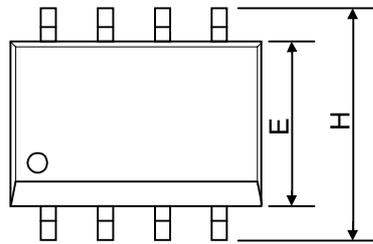
SYMBOL	DIMENSION IN MILLIMETER(mm)			DIMENSION IN INCH(inch)		
	Min	Nom	Max	MIN	NOM	MAX
A	*	*	5.33	-	-	0.210
A1	0.38	*	*	0.015	-	-
A2	3.1	3.3	3.5	0.122	0.130	0.138
B	0.36	0.46	0.56	0.014	0.018	0.022
B1	1.4	1.52	1.65	0.055	0.060	0.065
B2	0.81	0.99	1.14	0.032	0.039	0.045
C	0.2	0.25	0.36	0.008	0.010	0.014
D	9.02	9.35	9.75	0.355/0.364	0.365/0.374	0.375/0.384
E	7.62	7.94	8.26	0.300	0.313	0.325
E1	6.15	6.35	6.55	0.242	0.250	0.258
e	*	2.54	*	-	0.100	-
L	2.92	3.3	3.81	0.115	0.130	0.150
eB	8.38	8.89	9.4	0.330	0.350	0.370
S	0.71	0.84	0.97	0.028	0.033	0.038

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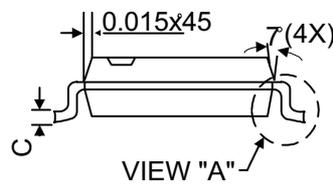
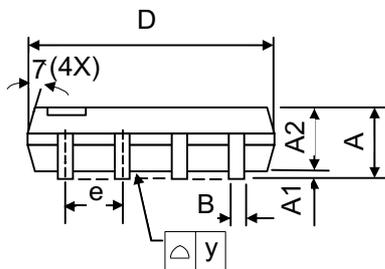
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## (2) SOP-8L



VIEW "A"



SYMBOLS	DIMENSION IN MILLIMETER (mm)			DIMENSION IN INCH (inch)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.40	1.60	1.75	0.055	0.063	0.069
A1	0.10	-	0.25	0.040	-	0.100
A2	1.30	1.45	1.50	0.051	0.057	0.059
B	0.33	0.41	0.51	0.013	0.016	0.020
C	0.19	0.20	0.25	0.0075	0.008	0.010
D	4.80	4.85	5.05	0.189	0.191	0.199
E	3.80	3.91	4.00	0.150	0.154	0.157
e	-	1.27	-	-	0.050	-
H	5.79	5.99	6.20	0.228	0.236	0.244
L	0.38	0.71	1.27	0.015	0.028	0.050
θ	0	-	8	0	-	8

### ■ Design Formula Table

Calculation	Step-Up	Step-Down	Voltage-Inverting
$t_{on}/t_{off}$	$\frac{V_{out} + V_F - V_{in(min)}}{V_{in(min)} - V_{sat}}$	$\frac{V_{out} + V_F}{V_{in(min)} - V_{sat} - V_{out}}$	$\frac{I_{V_{out}} + V_F}{V_{in} - V_{sat}}$
$(t_{on}/t_{off})$	$1/f$	$1/f$	$1/f$
$t_{off}$	$\frac{t_{on} + t_{off}}{\frac{t_{off}}{t_{on}} + 1}$	$\frac{t_{on} + t_{off}}{\frac{t_{off}}{t_{on}} + 1}$	$\frac{t_{on} + t_{off}}{\frac{t_{off}}{t_{on}} + 1}$
$t_{on}$	$(t_{on} + t_{off}) - t_{off}$	$(t_{on} + t_{off}) - t_{off}$	$(t_{on} + t_{off}) - t_{off}$
$C_T$	$4.0 \times 10^{-5} t_{on}$	$4.0 \times 10^{-5} t_{on}$	$4.0 \times 10^{-5} t_{on}$
$I_{pk( switch )}$	$2I_{out(max)} (t_{on}/t_{off} + 1)$	$2I_{out(max)}$	$2I_{out(max)} (t_{on}/t_{off} + 1)$
$R_{sc}$	$0.3/I_{pk( switch )}$	$0.3/I_{pk( switch )}$	$0.3/I_{pk( switch )}$
$L_{(min)}$	$\frac{(V_{in(min)} - V_{sat})}{I_{pk( switch )}} t_{on(max)}$	$\frac{(V_{in(min)} - V_{sat} - V_{out})}{I_{pk( switch )}} t_{on(max)}$	$\frac{(V_{in(min)} - V_{sat})}{I_{pk( switch )}} t_{on(max)}$
$C_O$	$9 \frac{I_{out} t_{on}}{V_{ripple(pp)}}$	$\frac{I_{pk( switch )} (I_{out} + t_{on})}{8V_{ripple(pp)}}$	$9 \frac{I_{out} t_{on}}{V_{ripple(pp)}}$

$V_{sat}$  = 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,  $I_{V_{out}} = 1.25(1 + R2/R1)$

$V_{out}$  -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.