MC34063 1.5-A Peak Boost/Buck/Inverting Switching Regulators

1. General Description

1.1 Description

The MC34063 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
MC34063	DIP
	SOP

2. Connection Diagrams and Pin Description

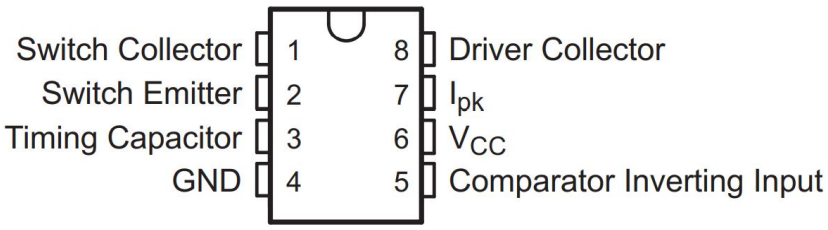


Figure 2.1 Top View

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

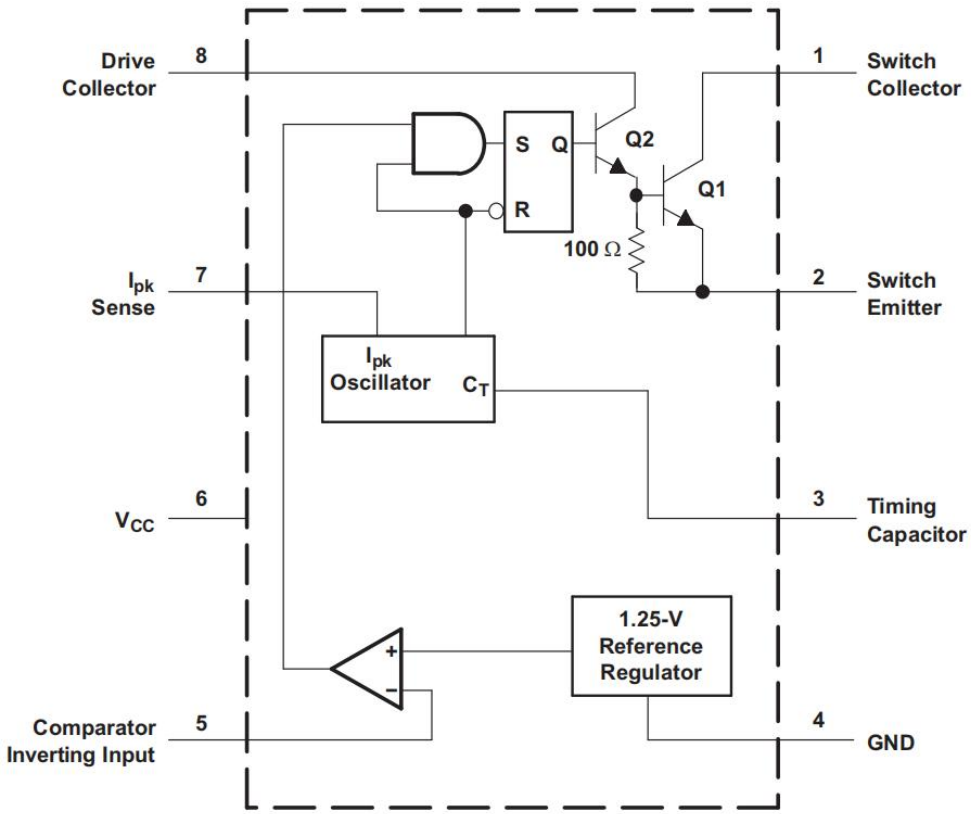


Figure 2.2: MC34063 Functional Block Diagram

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
ΔV_{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

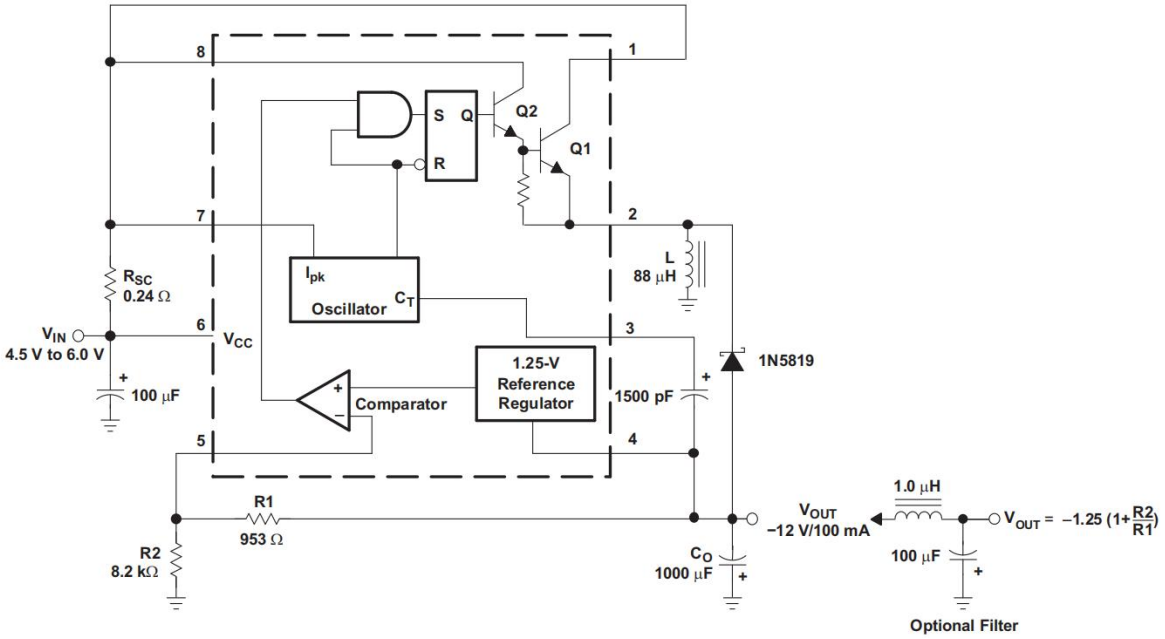


Figure 4.1: Voltage-Inverting converter

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

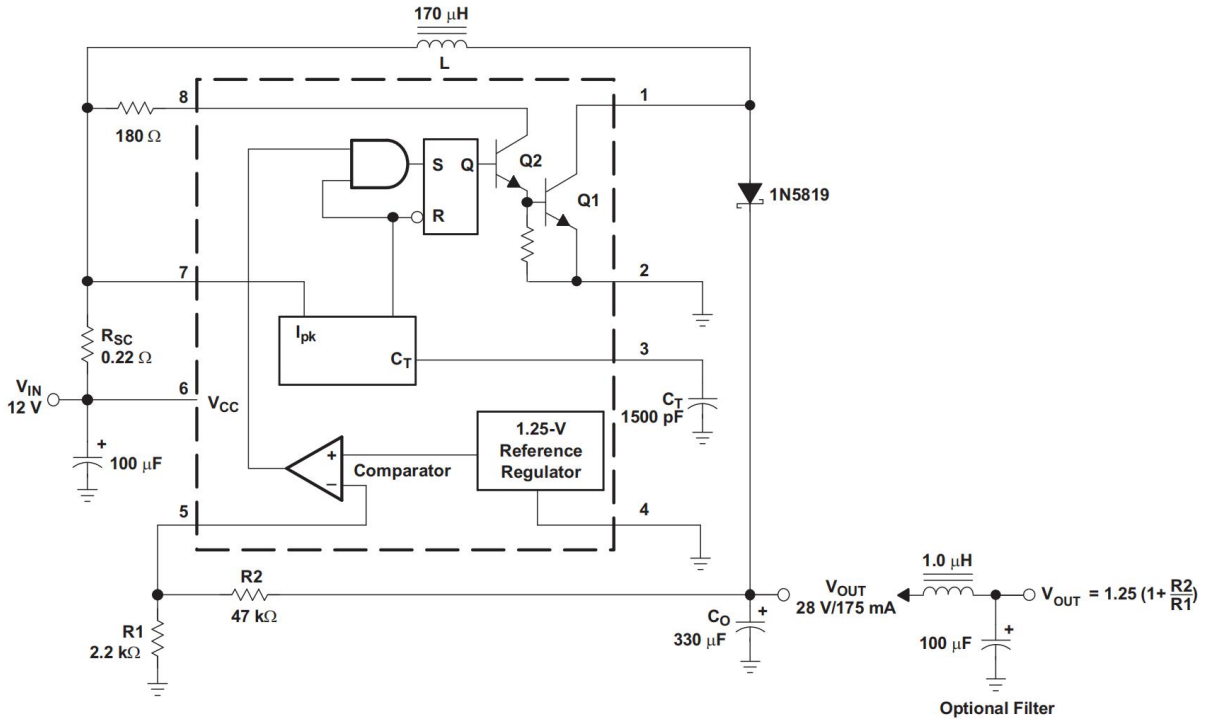


Figure 4.2: Step-Up Converter

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

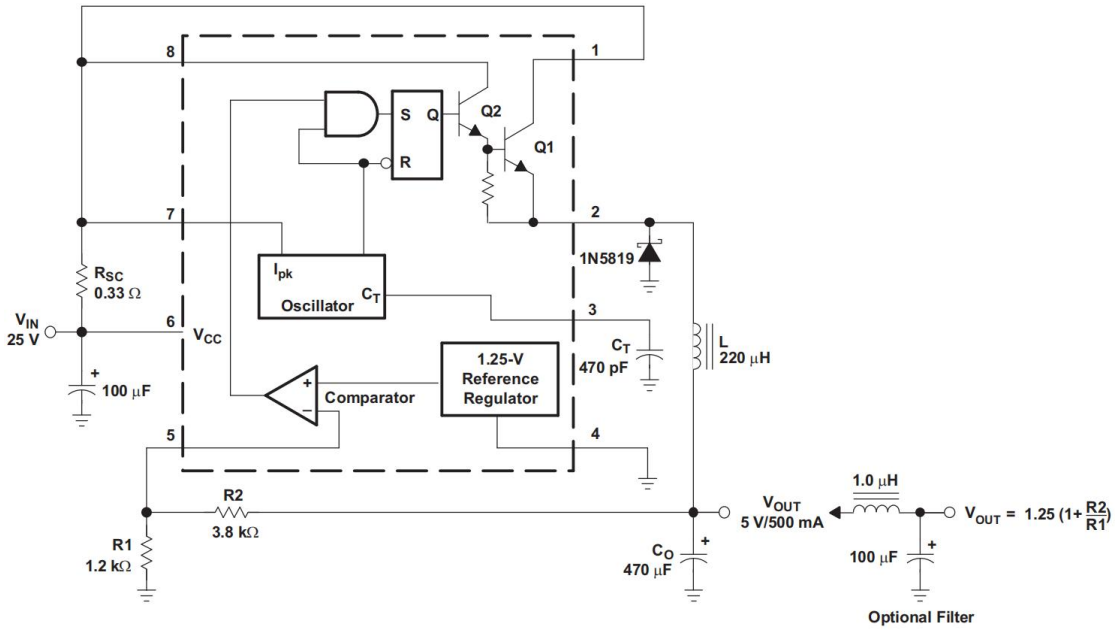


Figure 4.3: Step-Down Converter

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

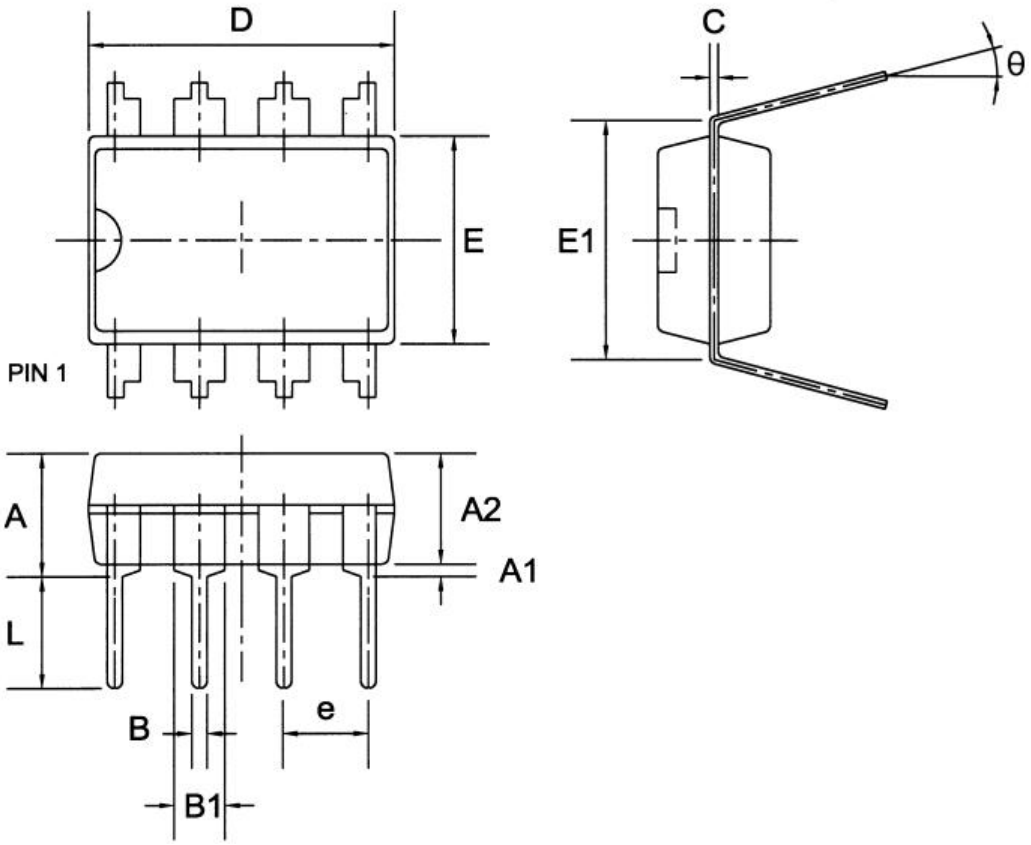
CALCULATION	STEP DOWN
t_{on}/t_{off}	$\frac{V_{out}+V_F}{V_{in(min)}-V_{sat}-V_{out}}$
$(t_{on}+t_{off})$	$\frac{1}{f}$
t_{off}	$\frac{t_{on}+t_{off}}{\frac{t_{on}}{t_{off}}+1}$
t_{on}	$(t_{on}+t_{off})-t_{off}$
C_T	$4\times10^{-5}t_{on}$
$I_{pk(switch)}$	$2I_{out(max)}$
R_{SC}	$\frac{0.3}{I_{pk(switch)}}$
$L_{(min)}$	$\left(\frac{(V_{in(min)}-V_{sat}-V_{out})}{I_{pk(switch)}}\right)t_{on(max)}$
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
MC34063ND08ATEQ	DIP	8	Tube	50
MC34063NS08ARBE	SOP	8	Tape & Reel	2500

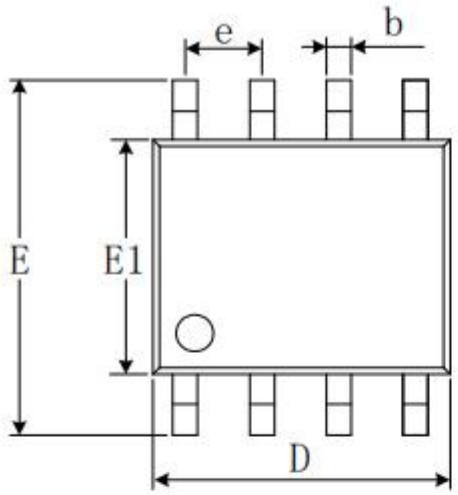
6. Package Information

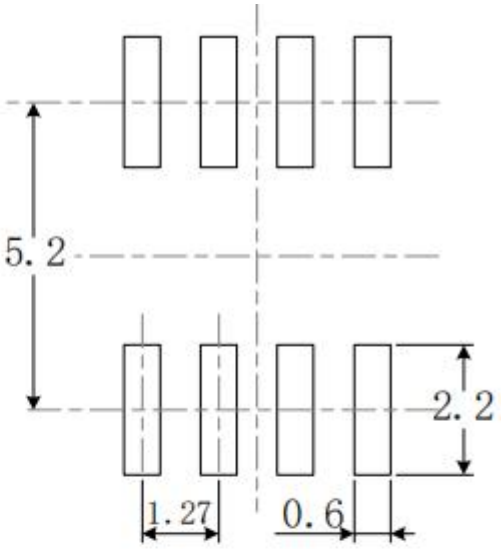
6.1 DIP8



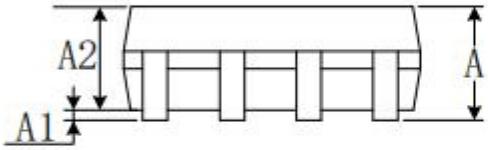
Symbol	Dimensions In Millmeters			Dimensions In Inches		
	Min	Nom	Max	Min	Nom	Max
A	—	—	4.31	—	—	0.170
A1	0.38	—	—	0.015	—	—
A2	3.15	3.40	3.65	0.124	0.134	0.144
B	0.38	0.46	0.51	0.015	0.018	0.020
B1	1.27	1.52	1.77	0.050	0.060	0.070
C	0.20	0.25	0.30	0.008	0.010	0.012
D	8.95	9.20	9.45	0.352	0.362	0.372
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°

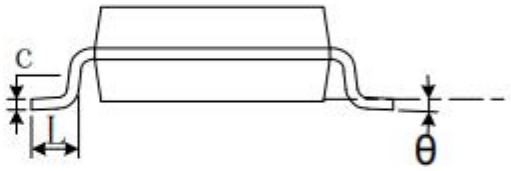
6.2 SOP8





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°