DESCRIPTION

The AP8012 consists of a Pulse Width Modulator (PWM) controller and a power MOSFET, specifically designed for a high performance off-line converter with minimal external components. AP8012 offers complete protection coverage with automatic self-recovery feature including Cycle-by-Cycle current limiting (OCP), over temperature protection (OTP), under-voltage Lockout protection(UVLO) , V_{DD} over-voltage protection(OVP), and soft-start. Burst mode operation and device very low consumption helps to meet the standby energy saving regulations. Excellent EMI performance is achieved with frequency modulation. The device consists of a high voltage start-up circuit in order to reduce the system set-up time. The device provides an advanced platform well suited for low standby-power and cost-effective flyback converters.

The AP8012 is available in DIP8 and SOP8 packages.

ORDERING INFORMATION

Package Type	Part Number	
DIP8 SPQ: 50pcs/Tube	P8	AP8012P8U
		AP8012P8VU
SOP8 SPQ: 4,000pcs/Reel	M8	AP8012M8R
		AP8012M8VR
Note	V: Halogen free Package R: Tape & Reel U: Tube	
AiT provides all RoHS products		

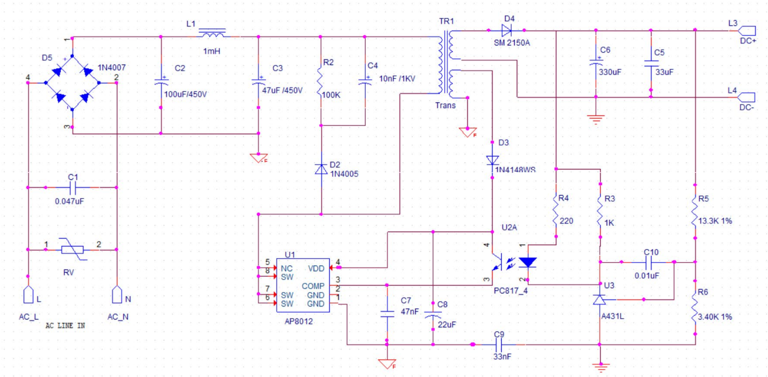
FEATURES

- Integrated 800V avalanche-rugged power MOSFET
- 85V to 265V wide range AC voltage input
- Semi enclosed steady output power 6W(DIP8)@85~265V_{AC}
- Frequency modulation for low EMI
- Burst-mode Operation
- Built-in Soft Start
- Internal HV Start-up Circuit
- Excellent Protection :
  Over Current Protection (OCP)
  Over Temperature Protection (OTP)
  V_{DD} over-voltage protection (OVP)
- Available in DIP8 and SOP8 Packages

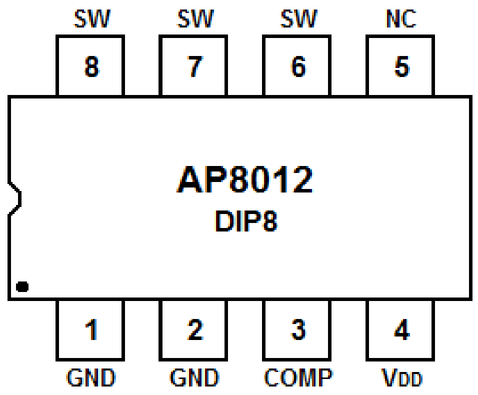
APPLICATION

- Electromagnetic Oven power supplies
- Small household application power supplies (Coffee machine, Electric kettle, etc.)

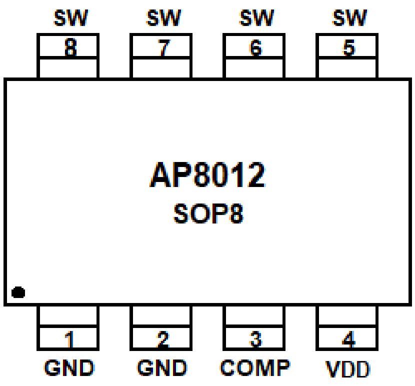
TYPICAL APPLICATION



PIN DESCRIPTION



Top View



Top View

Pin #		Symbol	Function
DIP8	SOP8		
1, 2	1, 2	GND	Ground
3	3	COMP	Voltage feedback. By connecting a opto-coupler to close the control loop and achieve the regulation.
4	4	V_{DD}	Positive Supply voltage Input.
5	-	NC	No connection
6,7,8	5,6,7,8	SW	The SW pin is designed to connect directly to the primary lead of the transformer.

TYPICAL POWER

Package	AC line Voltage	continuous power[NOTE1]	Peak power[NOTE2]
DIP8	85-265 V_{AC}	6W(12V500mA)	8.4W(12V700mA)
SOP8	85-265 V_{AC}	3.6W(12V300mA)	6W(12V500mA)

NOTE1: Maximum output power in a semi enclosed design measured at 75°C ambient temperature, Duration:2 hours

NOTE2: Peak power in a semi enclosed design measured at 75°C ambient temperature, Duration:1 min

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Pin V_{DD}		-0.3V~45V
High-Voltage Pin, SW		-0.3V~750V
COMP		-0.3V~7V
Junction Temperature		-40℃~150℃
Storage Temperature		-55℃~150℃
Lead Temperature (Soldering, 10secs)		260℃
$R_{\theta JC}$, Package Thermal Resistance	SOP8	80℃/W
$R_{\theta JC}$, Package Thermal Resistance	DIP8	40℃/W
Electrostatic Discharge Human Body Mode (HBM, ESDA/JEDEC JDS-001-2014)		±4kV
SD Voltage Protection[NOTE3] (Air discharge to pins of AP8012 with ESD Generator)		8kV
Drain Pulse Current (Tpulse=100us)		2A

Stress beyond above listed "Absolute Maximum Ratings" may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

NOTE3: Enterprise internal standards, for reference only.

ELECTRICAL CHARACTERISTICS

T_J =25°C, V_{DD} = 15 V, unless otherwise specified

Power section

Parameter	Symbol	Conditions	Min.	Typ.	Max	Unit
VDMOS Breakdown Voltage	B_{VDSS}	I_{SW} =250uA	750	820	-	V
Static Drain-Source off Current	I_{OFF}	V_{SW} =550V	-	-	100	μA
Static Drain-Source on Resistance	R_{DSON}	I_{SW} = 400mA, T_J =25°C	-	18	-	Ω

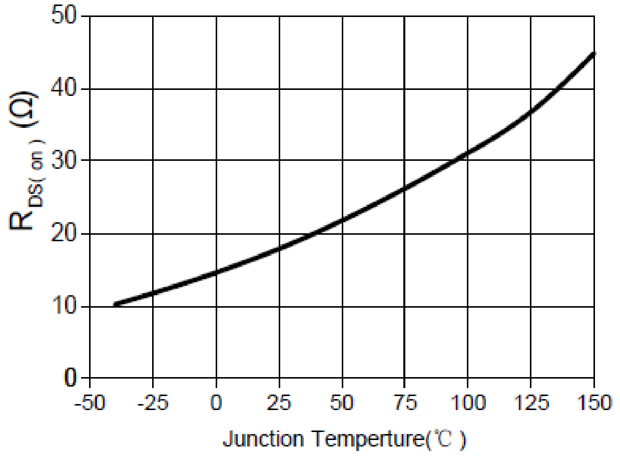
Control section

Parameter	Symbol	Conditions	Min.	Typ.	Max	Unit
UVLO SECTION						
V_{CC} Start Threshold Voltage	V_{START}	V_{COMP}=0V	13	14.5	16	V
V_{CC} Stop Threshold Voltage	V_{STOP}	V_{COMP}=0V	7	8	9	V
V_{CC} Threshold Hysteresis	V_{HYS}		-	6.5	-	V
V_{DD} Reset Voltage	V_{RST}		5.5	6.0	6.5	V

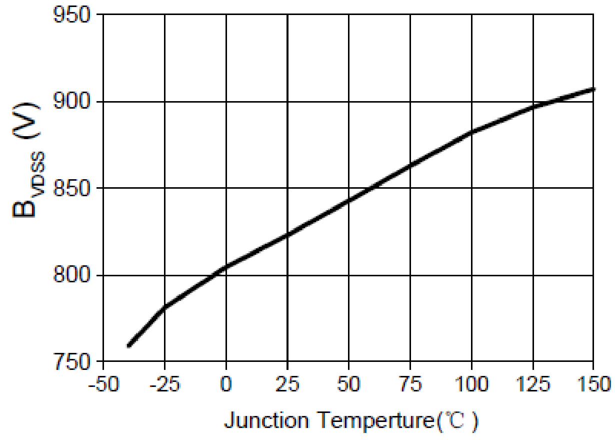
Parameter	Symbol	Conditions	Min.	Typ.	Max	Unit
OSCILLATOR SECTION						
Initial Accuracy	f_{OSC}	T_A = 25°C	40	45	50	kHz
Frequency Variation	f_D		-	±5	-	kHz
Modulation Frequency	f_M		-	167	-	Hz
Maximum Duty Cycle	D_{MAX}		65	80	90	%
FEEDBACK SECTION						
Feedback Shutdown Current	I_{COMP}		-	1.2	-	mA
COMP Pin Input Impedance	R_{COMP}		-	1.15	-	kΩ
CURRENT LIMIT(SELF-PROTECTION) SECTION						
Peak Current Limit	I_{LIM}	T_A = 25°C	0.44	0.55	0.66	A
Minimum Turn On Time	t_{LEB}	LEB time	-	350	-	ns
Soft-start Time	t_{SS}		-	10	-	ms
Peak Drain Current During Burst Mode	I_{D_BM}		-	100	-	mA
PROTECTION SECTION						
Thermal Shutdown Temperature	T_{SD}		140	170	-	℃
Thermal Shutdown Hysteresis	T_{HYST}		-	30	-	℃
SUPPLY CURRENT SECTION						
Startup Charging Current (SW pin)	I_{CH}	V_{DRAIN} = 105V, V_{COMP} = GND, V_{DD} = 12V	-	-1.2	-	mA
Operating Supply Current, Switching	I_{DD}	V_{DD} = 16V, V_{COMP}= 0 V	-	0.6	-	mA
Operating Voltage Range	V_{DD}	After turn-on	10	-	35	V
V_{DD} Over Voltage	V_{OVP}		37	40	43	V
Operating Supply Current with V_{DD} < V_{STOP}	I_{DD_OFF}	V_{DD} = 6V	100	-	400	μA

TYPICAL PERFORMANCE CHARACTERISTICS

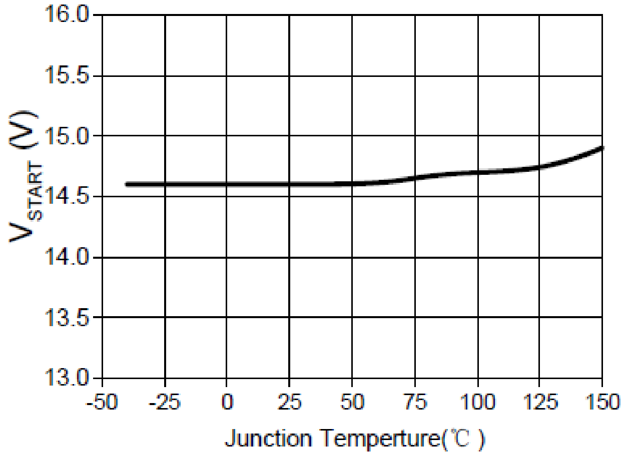
1. $R_{DS(on)}$ vs. T_J



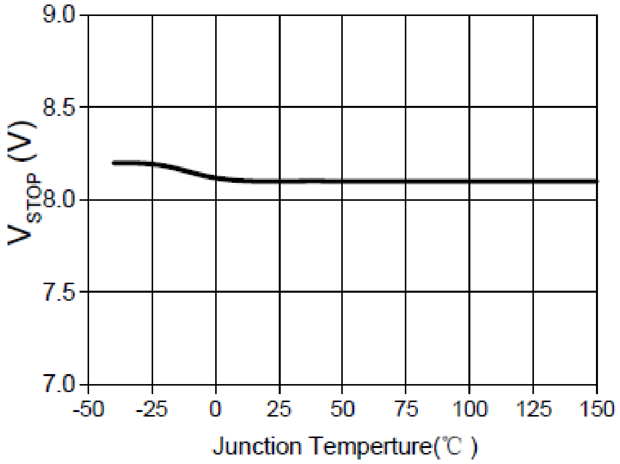
2. B_{VDSS} vs. T_J



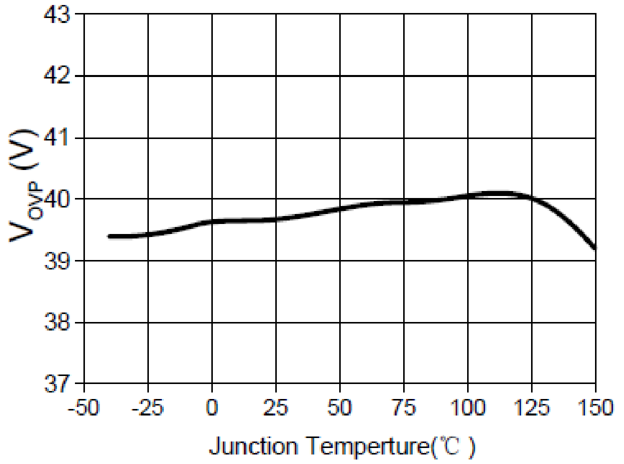
3. V_{START} vs. T_J



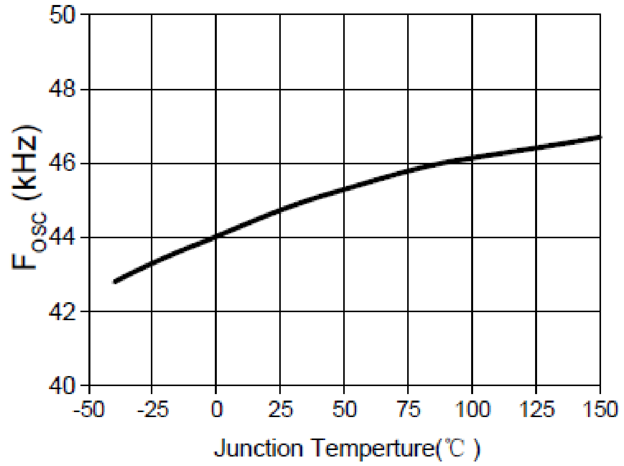
4. V_{STOP} vs. T_J



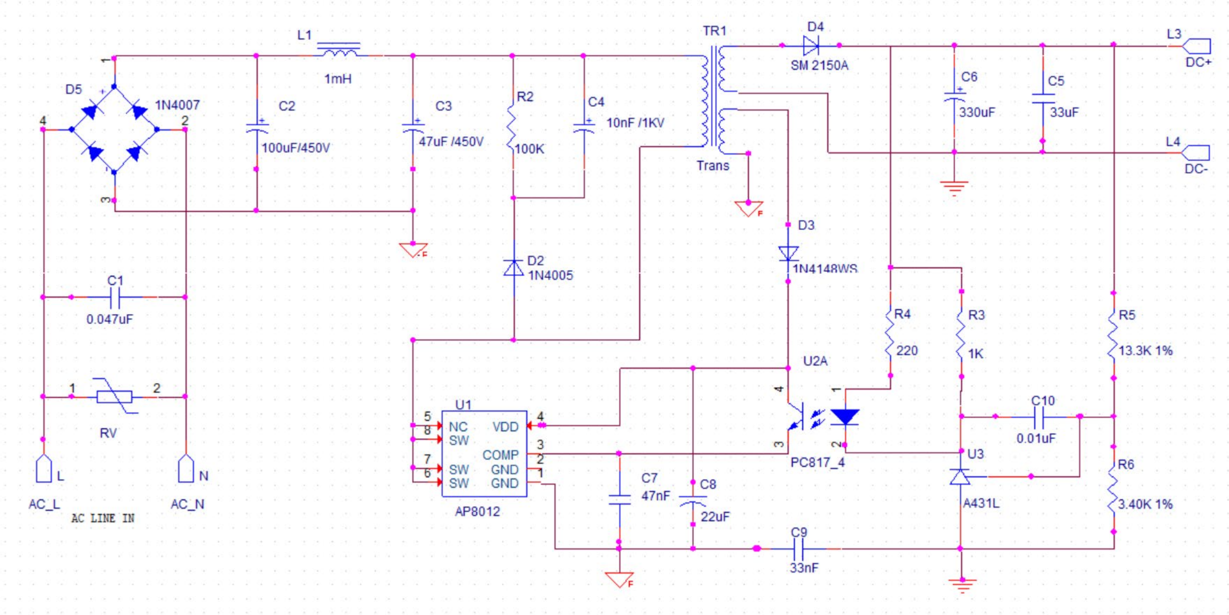
5. V_{OVP} vs. T_J



6. f_{OSC} vs. T_J



TYPICAL CIRCUIT



DETAILED INFORMATION

Functional Description

Startup

This device includes a high voltage start up current source connected on the SW of the device. As soon as a voltage is applied on the input of the converter, this start up current source is activated and to charge the V_{DD} capacitor as long as V_{DD} is lower than V_{START}. When reaching V_{START}, the start up current source is cut off and V_{DD} is sourced by auxiliary side. As V_{DD} falls below V_{STOP}, the HV-Start circuit won't work immediately until V_{DD} is lower than V_{RST}.

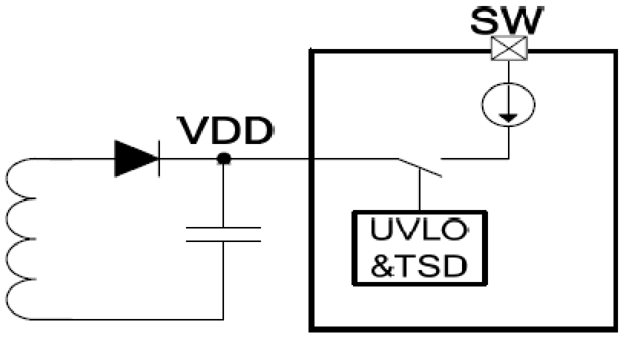


Fig 1. Startup circuit

Soft-start up

In the process of start up, the current of drain increases to maximum limitation step by step. As a result, it can reduce the stress of secondary diode greatly and help to prevent the transformer turning into the saturation states. Typically, the duration of soft-start is 10ms.

Gate driver

The internal power MOSFET in AP8012 is driven by a dedicated gate driver for power switch control. Too weak the gate driver strength results in higher conduction and switch loss of MOSFET while too strong gate drive results in worse EMI.

A good tradeoff is achieved through the built-in totem pole gate design with proper output strength and dead time. The good EMI system design and low idle loss is easier to achieve with this dedicated control scheme.

Oscillator

The switching frequency of AP8012 is internally fixed at 45 kHz. No external frequency setting components are required for PCB design.

The frequency modulation is implemented in AP8012. So that, it minimizes the conduction band EMI and therefore eases the system design because the tone energy could be spread out.

Feed-back

A feedback pin controls the operation of the device. Unlike conventional PWM control circuits which use a voltage input, the COMP pin is sensitive to current. Fig. 2 presents the internal current mode structure. The Power MOSFET delivers a sense current which is proportional to the main current. R2 receives this current and the current coming from the COMP pin. The voltage across R2 (V_{R2}) is then compared to a fixed reference voltage. The MOSFET is switched off when V_{R2} equals the reference voltage.

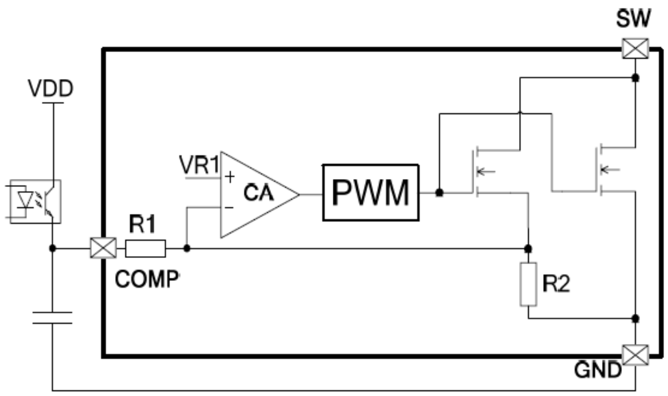


Fig 2. Feedback circuit

Leading Edge Blanking (LEB)

At the instant the internal Sense FET is turned on, there usually exists a high current spike through the Sense FET, caused by the primary side capacitance and secondary side rectifier diode reverse recovery. Excessive voltage across the sense resistor would lead to false feedback operation in the current mode PWM control. To counter this effect, the device employs a leading edge blanking (LEB) circuit. This circuit inhibits the PWM comparator for a short time (typically 350ns) after the Sense FET is turned on.

Under Voltage Lock Out

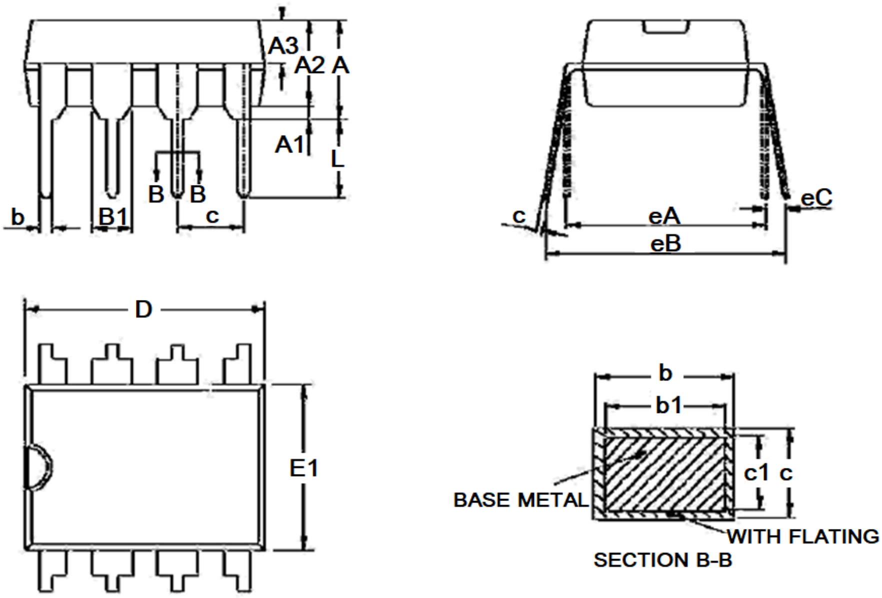
Once fault condition occurs, switching is terminated and the Sense FET remains off. This causes V_{DD} to fall. When V_{DD} reaches the V_{DD} reset voltage, 6V, the protection is reset and the internal high voltage current source charges the V_{DD} capacitor. When V_{DD} reaches the UVLO start voltage, 14.5V, the device resumes its normal operation. In this manner, the auto-restart can alternately enable and disable the switching of the power Sense FET until the fault condition is eliminated.

Thermal Shutdown (TSD)

The Sense FET and the control IC are integrated in the same chip, making it easier for the control IC to detect the temperature of the Sense FET. When the temperature exceeds approximately 170°C, thermal shutdown is activated, the device turn off the Sense FET. The device will go back to work when the lower threshold temperature about 140°C is reached.

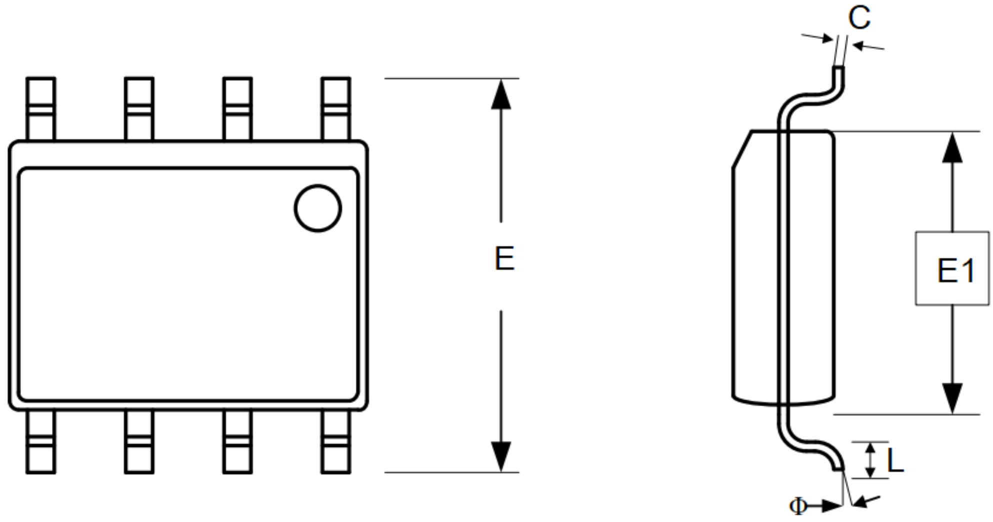
PACKAGE INFORMATION

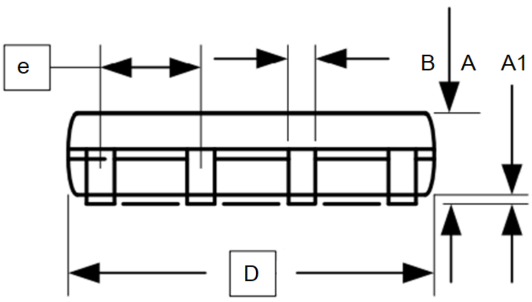
Dimension in DIP8 (Unit: mm)



Symbol	Min	Max
A	3.600	4.000
A1	0.510	-
A2	3.000	3.400
A3	1.550	1.650
b	0.440	0.530
b1	0.430	0.480
B1	1.520BSC	
c	0.240	0.320
c1	0.230	0.270
D	9.050	9.450
E1	6.150	6.550
e	2.540BSC	
eA	7.620BSC	
eB	7.620	9.300
eC	0.000	0.840
L	3.000	-

Dimension in SOP8 (Unit: mm)





Symbol	Min.	Max.
A	1.350	1.750
A1	0.100	0.230
B	0.390	0.480
C	0.210	0.260
D	4.700	5.100
E1	3.700	4.100
E	5.800	6.200
e	1.270 BSC	
L	0.500	0.800
Φ	0°	8°

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