DESCRIPTION

The AP8012C 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.

AP8012C offers complete protection coverage with an 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 the device's very low consumption help to meet the standby energy saving regulations. Excellent EMI performance is achieved with frequency modulation. The AP8012C consists of a high-voltage start-up circuit to reduce the system set-up time.

The AP8012C provides an advanced platform well-suited for low-standby-power and cost-effective flyback converters.

The AP8012C is available in DIP8 and SOP8 packages.

ORDERING INFORMATION

Package Type	Part Number	
DIP8 SPQ: 50pcs/Tube	P8	AP8012CP8VU
SOP8 SPQ: 4,000pcs/R	M8	AP8012CM8VR
Note	U: Tube R: Tape & Reel V: Halogen free Package	
AiT provides all RoHS products		

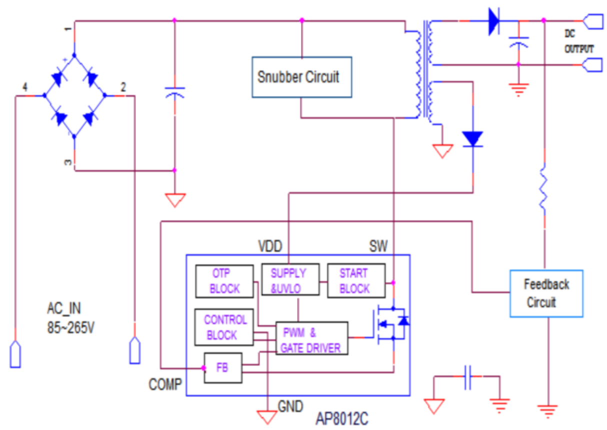
FEATURES

- Integrated 700V avalanche-rugged power MOSFET
- 85V to 265V wide range AC voltage input
- Wide operation voltage from 9V to 39V
- 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)

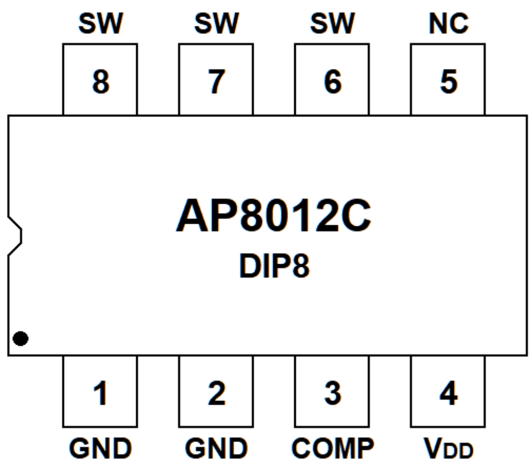
APPLICATION

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

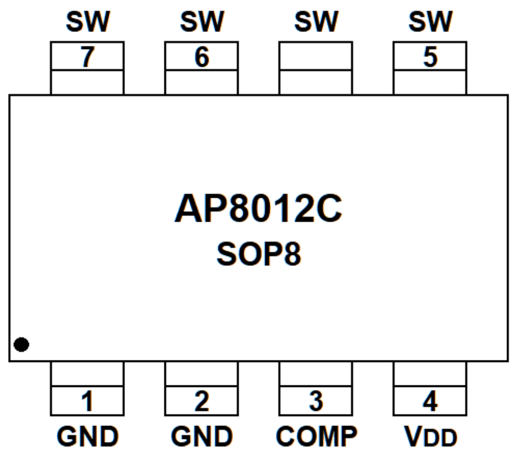
TYPICAL APPLICATION



PIN DESCRIPTION



DIP8, P8
Top View



SOP8, M8
Top View

Pin #		Symbol	Function
DIP8	SOP8		
1, 2	1, 2	GND	Ground
3	3	COMP	Voltage feedback. By connecting an 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]	High power[NOTE2]
DIP8	85-265 V_{AC}	8W	13W
SOP8	85-265 V_{AC}	5W	8W

NOTE1: Maximum output power in a semi-enclosed design measured at 25°C ambient temperature, Duration 85Vac~265Vac

NOTE2: High power in a semi-enclosed design measured at 25°C ambient temperature, Duration 180Vac~265Vac

NOTE3: For output power above 10W, it is recommended to add heat dissipation measures according to the actual solution:

ABSOLUTE MAXIMUM RATINGS

Supply Voltage Pin V_{DD}		-0.3V~40V
High-Voltage Pin, SW		-0.3V~650V
Maximum feedback current, I_{COMP}		3mA
Junction Temperature		-40℃~150℃
Storage Temperature		-55℃~150℃
Lead Temperature (Soldering, 10secs)		260℃
$R_{θJC}$, Package Thermal Resistance	SOP8	25℃/W
	DIP8	15℃/W
$R_{θJA}$, Package Thermal Resistance	SOP8	55℃/W
	DIP8	45℃/W
Electrostatic Discharge Human Body Mode (HBM, ESDA/JEDEC JDS-001-2014)		±2kV

Stress beyond above above-listed "Absolute Maximum Ratings" may lead to 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.

ELECTRICAL CHARACTERISTICS

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

Power section

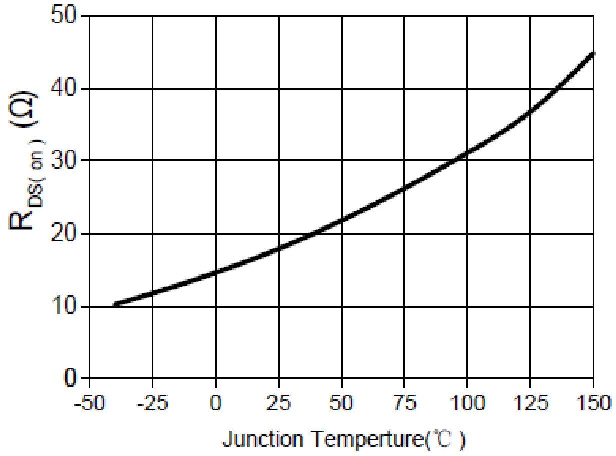
Parameter	Symbol	Conditions	Min.	Typ.	Max	Unit
VDMOS Breakdown Voltage	B_{VDSS}	I_{SW} =250uA	650	-	-	V
Static Drain-Source off Current	I_{OFF}	V_{SW} =550V	-	-	100	μA
Static Drain-Source on Resistance	R_{DSON}	I_{SW} = 400mA, T_J =25°C	5	-	30	Ω

Control section

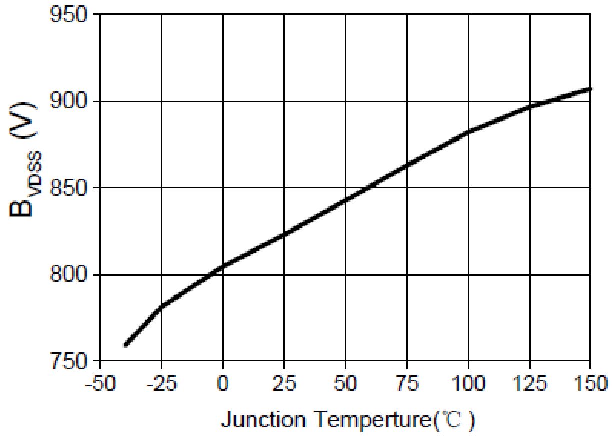
Parameter	Symbol	Conditions	Min.	Typ.	Max	Unit
UVLO SECTION						
V_{CC} Start Threshold Voltage	V_{START}	V_{COMP}=0V	13	14.5	16	V
V_{CC} Stop Threshold Voltage	V_{STOP}	V_{COMP}=0V	7	8	9	V
V_{CC} Threshold Hysteresis	V_{HYS}		-	6.5	-	V
V_{DD} Reset Voltage	V_{RST}		5.5	6.0	6.5	V
OSCILLATOR SECTION						
Initial Accuracy	f_{OSC}	T_A = 25°C	58	60	67	kHz
FEEDBACK SECTION						
Feedback Shutdown Current	I_{COMP}		-	0.9	-	mA
COMP Pin Input Impedance	R_{COMP}		-	1.23	-	kΩ
Current sense delay to turn OFF	t_d	$I_{D=0.2A}$		200		ns
CURRENT LIMIT(SELF-PROTECTION) SECTION						
Peak Current Limit	I_{LIM}	T_A = 25°C	-	0.4	-	A
Leading Edge Blanking	t_{LEB}	LEB time	-	300	-	ns
Soft-start Time	t_{SS}		-	10	-	ms
Minimum On-Time	I_{D_BM}	VDD=18V	-	700	-	ns
PROTECTION SECTION						
Thermal Shutdown Temperature	T_{SD}		145	-	-	℃
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	-	4.5	-	mA
Operating Voltage Range	V_{DD}	After turn-on	10	-	35	V
Minimum standby power	P_{STN}	V_{ac}= 220V/ = 110V	-	120/-	-	mW
V_{DD} Over Voltage	V_{OVP}		37	39	40	V
Operating Supply Current with V_{DD} < V_{STOP}	I_{DD_OFF}	V_{DD} = 6V	100	-	400	μA

TYPICAL PERFORMANCE CHARACTERISTICS

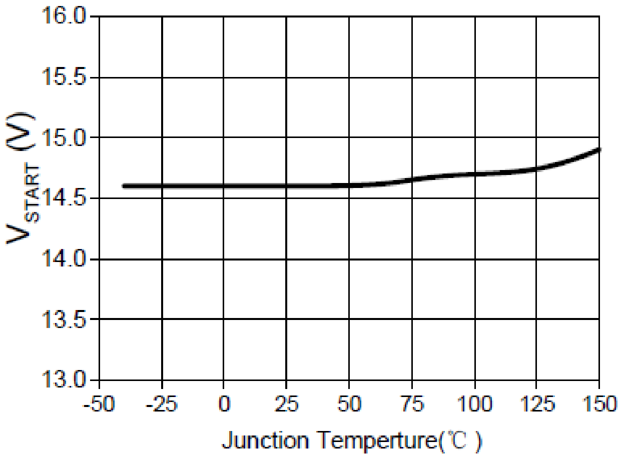
1. $R_{DS(on)}$ vs. T_J



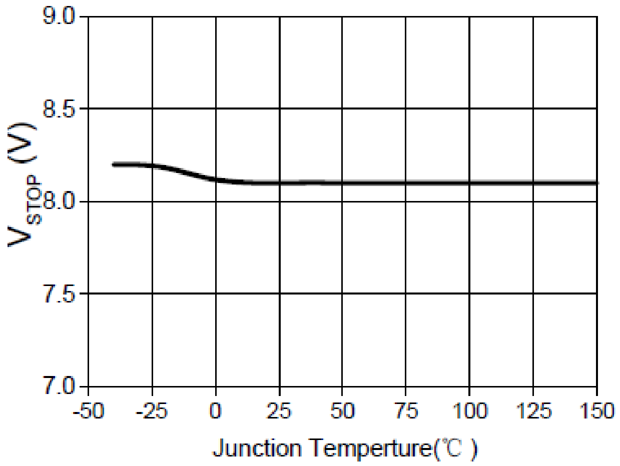
2. B_{VDSS} vs. T_J



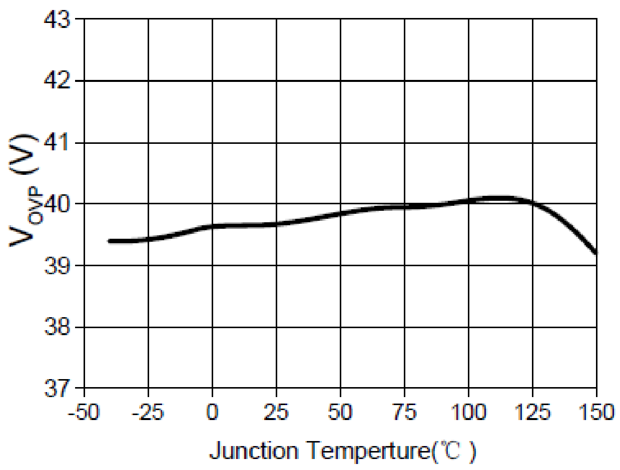
3. V_{START} vs. T_J



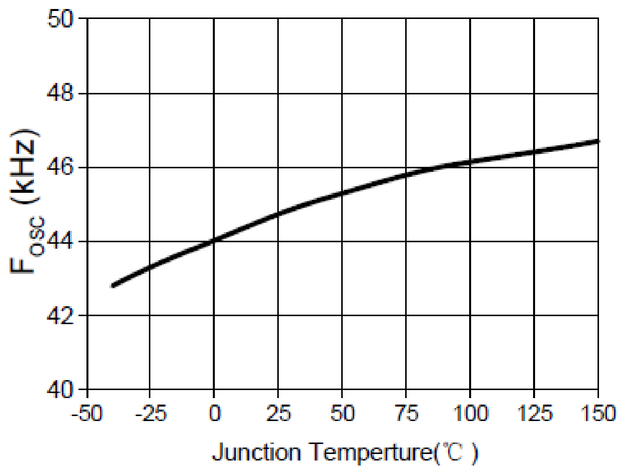
4. V_{STOP} vs. T_J



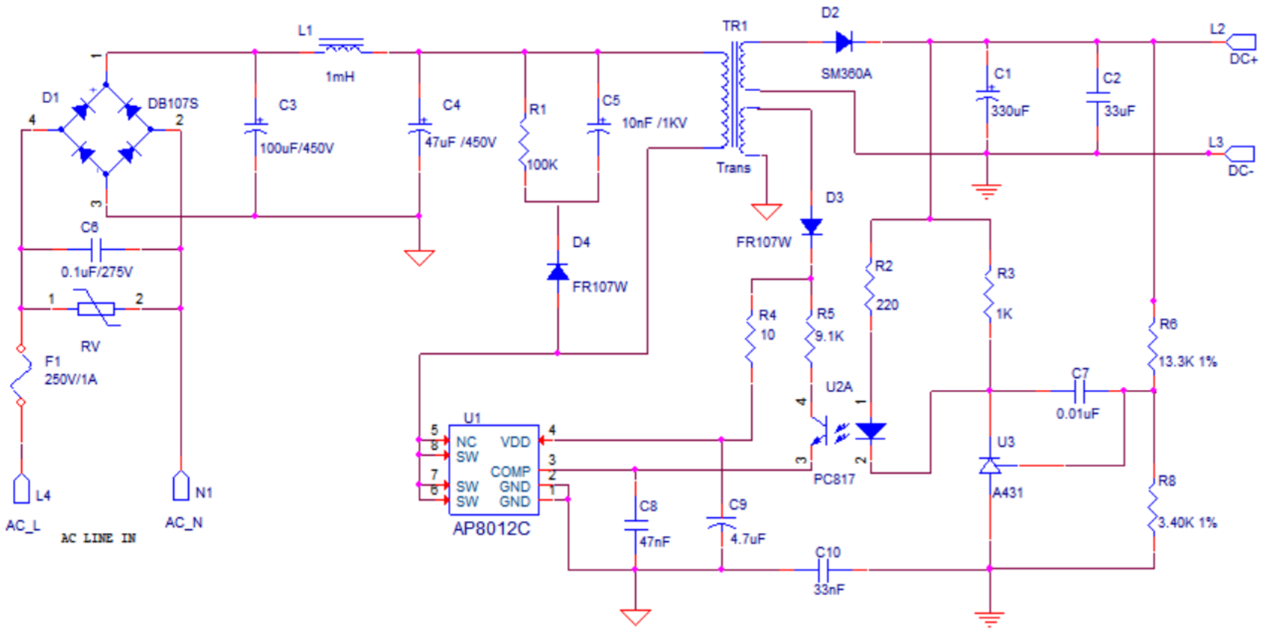
5. V_{OVP} vs. T_J



6. f_{OSC} vs. T_J



TYPICAL CIRCUIT



The output parts U3, U2A, R2, R3, R6, R8, and C7 form a sampling feedback circuit. R6 and R8 determine the output voltage of the system, and the output voltage

Vout =(R6+R8)/R8 x 2.5V

R2 and R3 limit the current of the U2A optocoupler PC817. The addition of C7 makes the system feedback more stable and avoids oscillation.

VDD voltage

The AP8012C chip has a wide operating voltage range of 9V-39V. This feature can be easily applied in some special fields, such as battery chargers.

When the switching power supply is started, the voltage on the capacitor C4 will charge the chip VDD capacitor C9 through the primary coil of TR1 and the high-voltage startup MOSFET inside the chip. electricity. When the voltage of capacitor C9 reaches 14.5V, the internal high-voltage start-up MOSFET is turned off, and PWM is turned on at the same time, and the system starts working.

When the capacitor voltage of C9 drops below 8V, the PWM signal is turned off, and the chip generates a reset signal to restart the system, which is undervoltage protection.

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}.

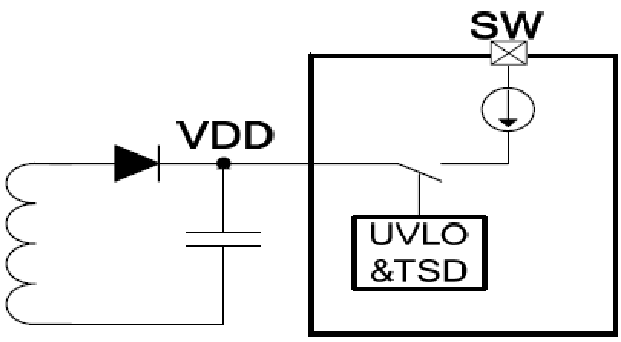


Fig 1. Startup circuit

Soft-start up

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

Gate driver

The internal power MOSFET in AP8012C 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 AP8012C is internally fixed at 60 kHz. No external frequency setting components are required for PCB design.

The frequency modulation is implemented in AP8012C. 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 comes 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.

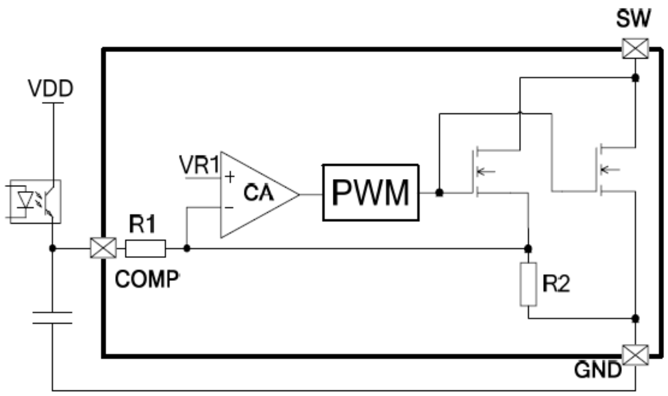


Fig 2. Feedback circuit

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

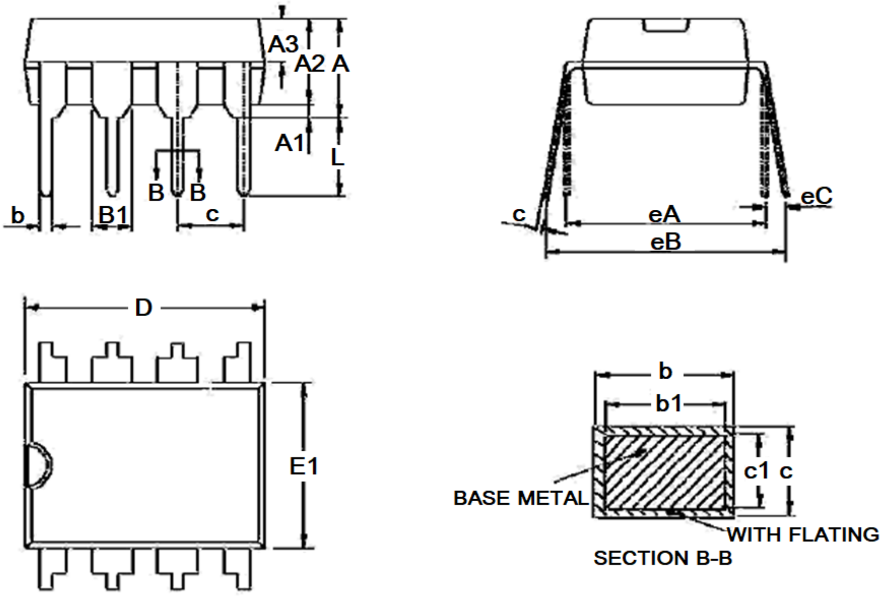
Once the fault condition occurs, switching is terminated, and the Sense FET remains off. This causes V_{DD} to fall. When V_{DD} reaches the V_{DD} reset voltage, 6V, the protection is reset, and the internal high voltage current source charges the V_{DD} capacitor. When V_{DD} reaches the UVLO start 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 150°C, thermal shutdown is activated, the device turns off the Sense FET. The device will go back to work when the lower threshold temperature of about 145°C is reached.

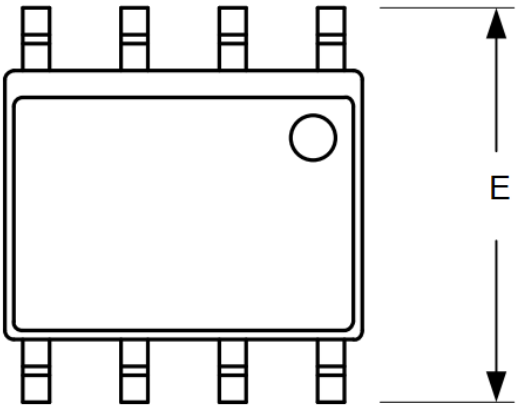
PACKAGE INFORMATION

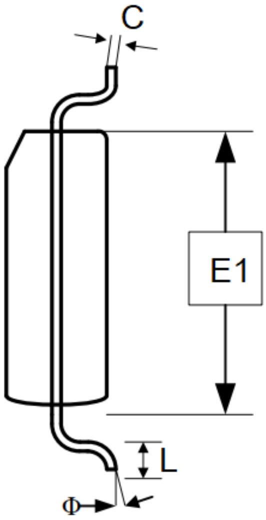
Dimension in DIP8 (Unit: mm)

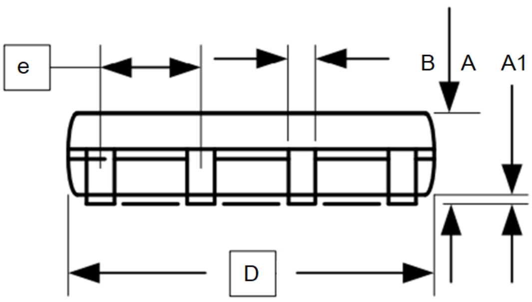


Symbol	Min	Max
A	3.600	4.000
A1	0.510	-
A2	3.000	3.400
A3	1.550	1.650
b	0.440	0.530
b1	0.430	0.480
B1	1.520BSC	
c	0.240	0.320
c1	0.230	0.270
D	9.050	9.450
E1	6.150	6.550
e	2.540BSC	
eA	7.620BSC	
eB	7.620	9.300
eC	0.000	0.840
L	3.000	-

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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