



## DESCRIPTION

The AP8024 consists of an integrated Pulse Frequency Modulator (PFM) controller and power MOSFET, specifically designed for small power non-isolated switching power supply. AP8024 has internal high voltage start-up circuit and complete intelligent protections including adjustable Over Current Protection (OCP), Under Voltage Lockout (UVLO) and Over Temperature Protection (OTP). Excellent EMI performance could be achieved with Pulse Frequency Modulation.

AP8024 is available in a DIP7 package.

## ORDERING INFORMATION

Package Type	Part Number	
DIP7 SPQ: 50pcs/Tube	P7	AP8024P7U
		AP8024P7VU
Note	V: Halogen free Package U: Tube	
AiT provides all RoHS products		

## FEATURES

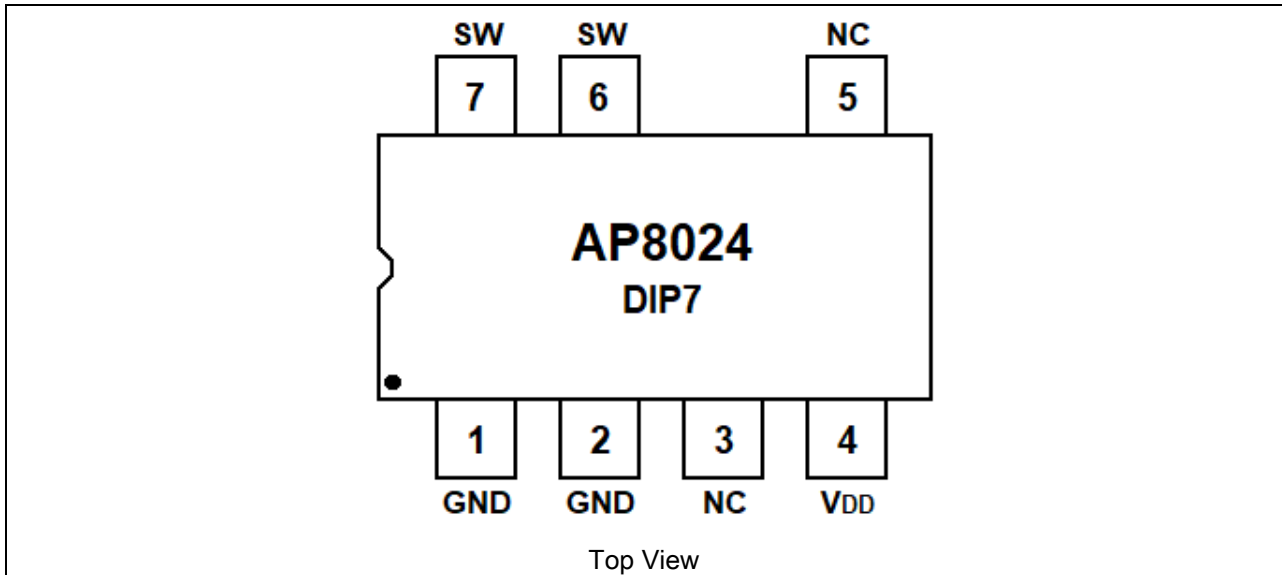
- Internal 650V avalanche-rugged smart power VDMOSFET
- Internal HV Start-up Circuit
- Be optimized with 12V output non-isolated application
- Semi enclosed steady output power 3.6W @230VAC, DIP7
- Frequency modulation for low EMI
- Excellent constant voltage regulation and High efficiency
- Excellent Protection Coverage:  
Adjustable Over Current Protection ( OCP )  
Over Temperature Protection ( OTP )  
Under Voltage Lockout ( UVLO )
- Available in a DIP7 package.

## APPLICATION

- non-isolated assistant power supply



## PIN DESCRIPTION



Pin #	Symbol	Function
1, 2	GND	Ground
3	NC	No connection
4	V <sub>DD</sub>	Positive Supply voltage Input.
5	NC	No connection
6, 7	SW	HV MOSFET Drain pin.

## TYPICAL POWER

Part Number	Input Voltage	Steady output power <sup>NOTE1</sup>	Peak Power <sup>NOTE2</sup>
AP8024 DIP7	150-265 V <sub>AC</sub>	3.6W(12V300mA)	4.8W(12V400mA)
	85-265 V <sub>AC</sub>	3.0W(12V250mA)	4.2W(12V350mA)

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

T<sub>A</sub> = 25°C, unless otherwise noted

V <sub>DD</sub> , Supply Voltage Pin	-0.3V~40V
SW, High-Voltage Pin	-0.3V~650V
Junction Operating Temperature	-40°C~150°C
Storage Temperature Range	-55°C~150°C
Lead Temperature (Soldering, 10secs)	260°C
Package Thermal Resistance (DIP7)	40°C/W
ESD Voltage Protection (HBM, ESDA/JEDEC JDS-001-2014)	±4kV
ESD Voltage Protection <sup>NOTE1</sup> (Air discharge to pins of AP8024 with ESD Generator)	8kV
The Biggest Drain Pulse Current (T <sub>pulse</sub> =100us)	3A

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.

NOTE1: Enterprise internal standards, for reference only.



## ELECTRICAL CHARACTERISTICS

### Power Supply Section

T<sub>A</sub> = 25°C, V<sub>DD</sub> = 11V, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ.	Max	Units
Drain Break-Down Voltage	BV <sub>DSS</sub>	I <sub>SW</sub> = 250uA	650	690	-	V
Off-State Drain Current	I <sub>OFF</sub>	V <sub>SW</sub> = 500V	-	-	100	μA
VDMOS on State Resistance	R <sub>DS(ON)</sub>	I <sub>SW</sub> = 400mA, T <sub>J</sub> = 25°C	-	13.5	-	Ω
Start up Threshold	V <sub>SW_START</sub>	V <sub>DD</sub> = V <sub>DDon</sub> - 1V	-	30	-	V

### Supply Section

Parameter	Symbol	Conditions	Min	Typ.	Max	Units
<b>V<sub>DD</sub> Voltage Parameter</b>						
Operating Voltage Range	V <sub>DD</sub>	After turn-on	10	-	20	V
V <sub>DD</sub> Start Up Threshold	V <sub>DDon</sub>		10.5	11.5	12.5	V
V <sub>DD</sub> Under Voltage Shutdown Threshold	V <sub>DDoff</sub>		8	9	10	V
V <sub>DD</sub> Voltage Hysteresis	V <sub>DDhys</sub>		-	2.5	-	V
V <sub>DD</sub> Clamp Voltage	V <sub>DDclamp</sub>		18	20	22	V
V <sub>DD</sub> Feedback Reference	V <sub>DD-REF</sub>		-	12.3	-	V
<b>V<sub>DD</sub> Current Parameter</b>						
V <sub>DD</sub> Charge Current	I <sub>DDch</sub>	V <sub>DD</sub> = 5V	-	-3	-	mA
Off-State Current	I <sub>DDoff</sub>	V <sub>DD</sub> = 6V	0.3	0.6	0.9	mA
Operating Supply Current	I <sub>DD1</sub>	V <sub>DD</sub> = 13V	-	1.2	-	mA
Operating Supply Current, With Protection Tripping	I <sub>DD_FAULT</sub>	V <sub>DD</sub> = 11V	-	1	-	mA

### Control Section

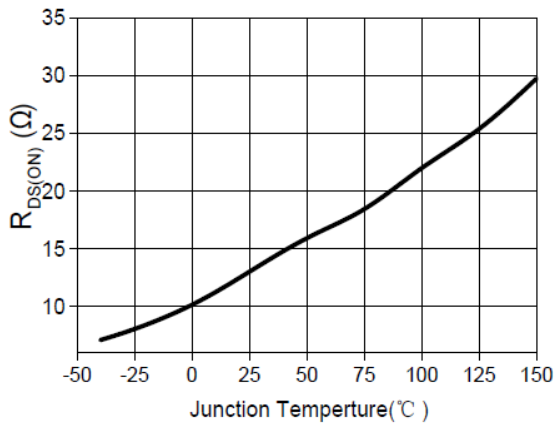
Parameter	Symbol	Conditions	Min	Typ.	Max	Units
<b>Current Sense Parameter</b>						
Drain Current Limit	I <sub>limit</sub>		490	580	670	mA
Leading Edge Blanking Time	t <sub>LEB</sub>		-	300	-	ns
<b>Feedback Input</b>						
Minimum Turn OFF Time	t <sub>offmin</sub>		15	18	21	us
Maximum Turn ON Time	t <sub>onmax</sub>		-	13	-	us
<b>Thermal Shutdown</b>						
OTP Threshold	T <sub>SD</sub>		135	150	-	°C
OTP Protect Hysteresis	T <sub>HYST</sub>		-	30	-	°C
<b>Restart Protection</b>						
Restart Time	t <sub>RESTART</sub>	C <sub>VDD</sub> = 4.7μF	-	3	-	s



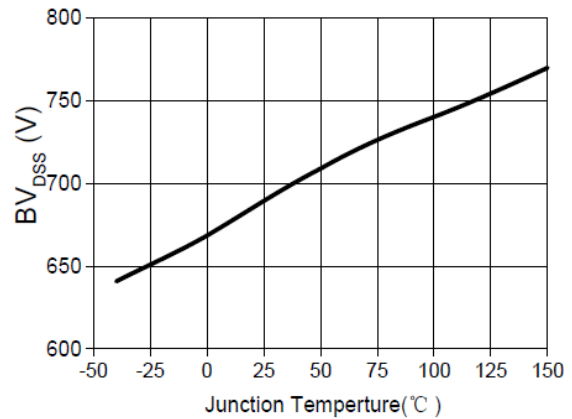
## TYPICAL ELECTRICAL CHARACTERISTICS

25°C, Unless Note

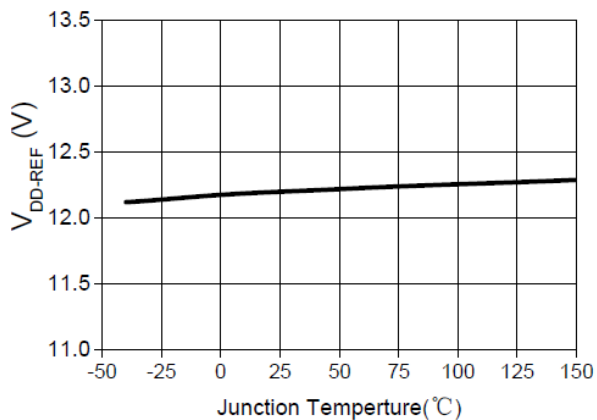
1.  $R_{DS(on)}$  vs.  $T_J$



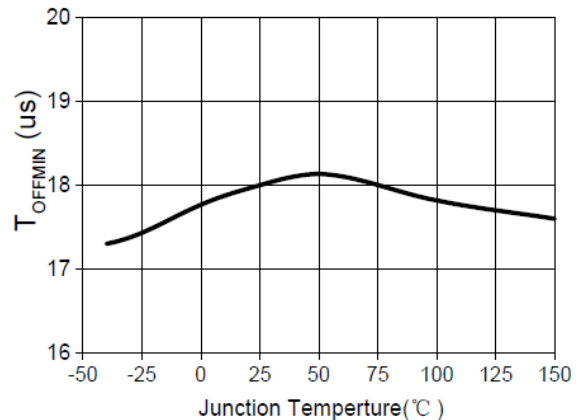
2.  $BV_{DSS}$  vs.  $T_J$



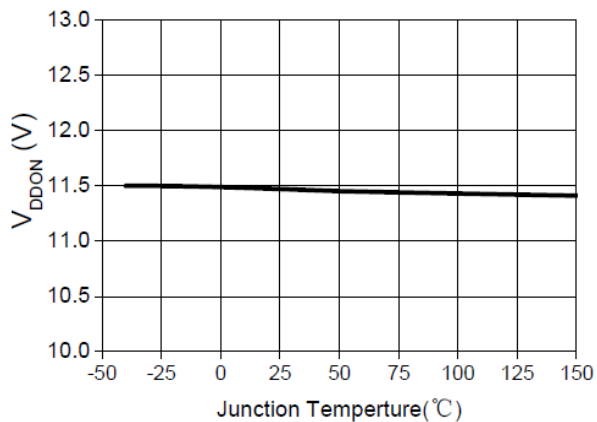
3.  $V_{REF}$  vs.  $T_J$



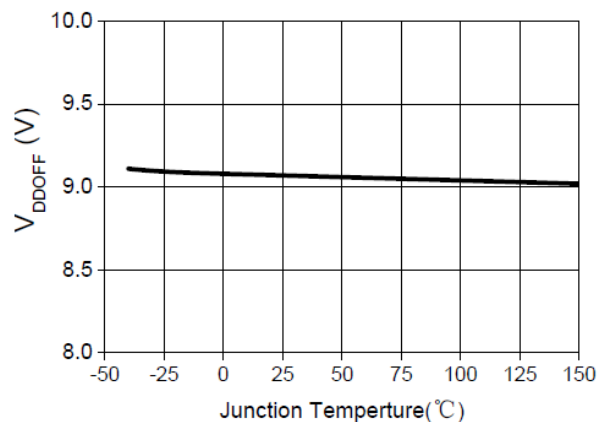
4.  $T_{offmin}$  vs.  $T_J$



5.  $V_{DDon}$  vs.  $T_J$

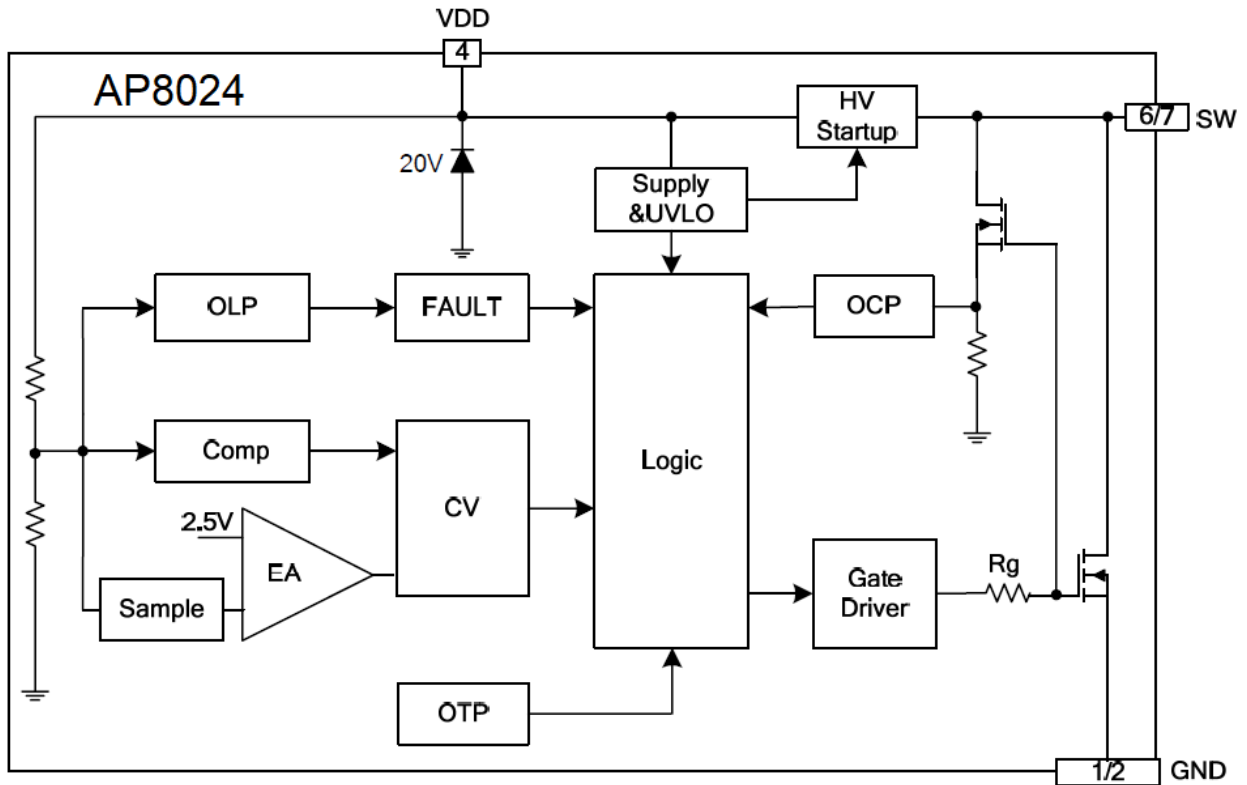


6.  $V_{DDoff}$  vs.  $T_J$





**BLOCK DIAGRAM**





## DETAILED INFORMATION

The AP8024 consists of an integrated Pulse Frequency Modulator (PFM) controller and power MOSFET, specifically designed for small power non-isolated switching power supply. AP8024 has internal high voltage start-up circuit and complete intelligent protections including adjustable Over Current Protection (OCP), Under Voltage Lockout (UVLO) and Over Temperature Protection (OTP). Excellent EMI performance could be achieved with Pulse Frequency Modulation.

### Start up

At start up, the internal high-voltage current source supplies 2.5mA current to charges the external  $V_{DD}$  capacitor. When  $V_{DD}$  rises to  $V_{DDon}$ , AP8024 starts switching and the internal high-voltage current source stops charging the capacitor. After start up, the  $V_{DD}$  voltage is supplied from output.

### CV Operation Mode

In CV operation, AP8024 samples the feedback signal through  $V_{DD}$  pin. While the feedback voltage remains below  $V_{REF}$ , the IC turns on the integrated MOSFET. When the current of the inductor reaches the peak current limit ( $I_{peak}$ ), the integrated MOSFET is turned off. Figure 1 and Figure 2 shows the operating waveform of key nodes in continuous conduction mode (CCM) and discontinuous conduction mode (DCM). Meanwhile, the IC integrates load compensation function to improve load regulation and CV accuracy.

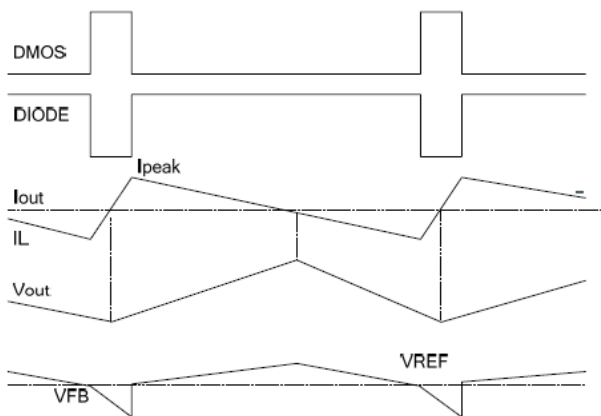


Figure 1 Waveform if CCM mode

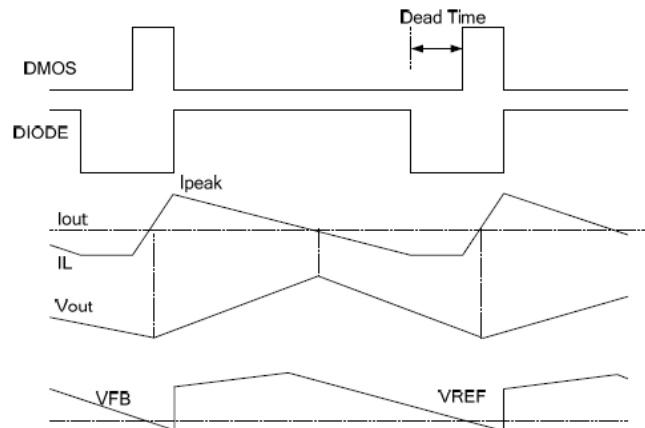


Figure 2 Waveform of DCM mode

In actual applications,  $V_{DD}$  sampling voltage is affected by the forward drop of D2 in addition

### PFM modulation

The IC operates in PFM mode, and  $I_{peak}$  is set to decrease with the decrease of the IC operating frequency ( $f_{sw}$ ). when the IC switching cycle increase 1us,  $I_{peak}$  will decrease 13.3mA. As a result of the internal



current sampling and the maximum current limit ( $I_{limit}$ ), inductance is the only parameter of the frequency modulation when output voltage and output current are fixed.

### **Soft-Start up**

In order to regulate peak current in deep CCM mode, AP8024 build in soft-start function, at the first 10ms of start up, the switching frequency decrease to 25% of the maximum frequency, while 10ms to 15ms of start up, the switching frequency decrease to 50% of the maximum frequency. Meanwhile, the leading edge blanking (LEB) is 300ns (Typ.), in order to regulate peak current.

### **Smart Protection Control**

AP8024 has several smart self-protection functions, such as Over Temperature Protection(OTP),  $V_{DD}$  Under-Voltage Lockout(UVLO).And all these protections have self-recovery mode.

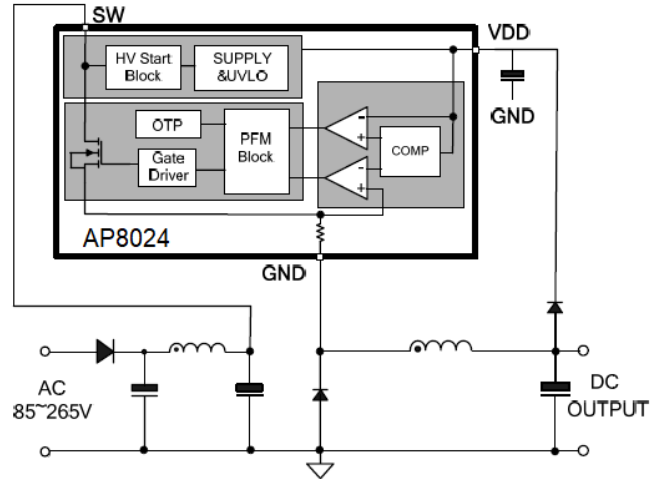
OTP----If the inner junction temperature exceeds 150°C,the IC will shut down switching, until the junction temperature falls to 120°C.

UVLO----If  $V_{DD}$  pin Voltage drops below  $V_{DDoff}$ , the IC will restart. Otherwise, self-restart time can be changed by  $V_{DD}$  capacitor. The larger the capacitor, the longer the self-restart time is.

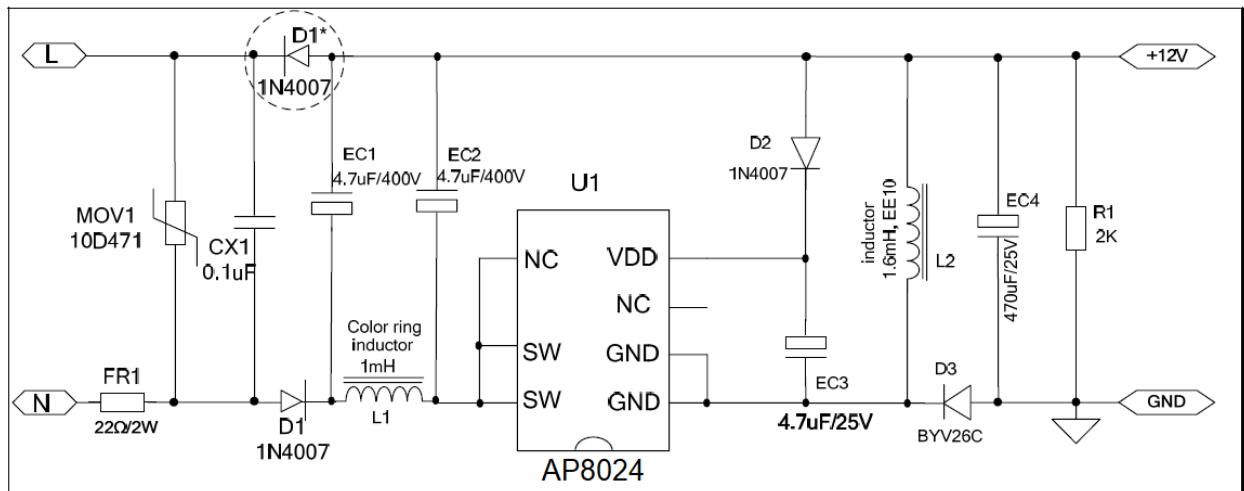




### TYPICAL CIRCUIT



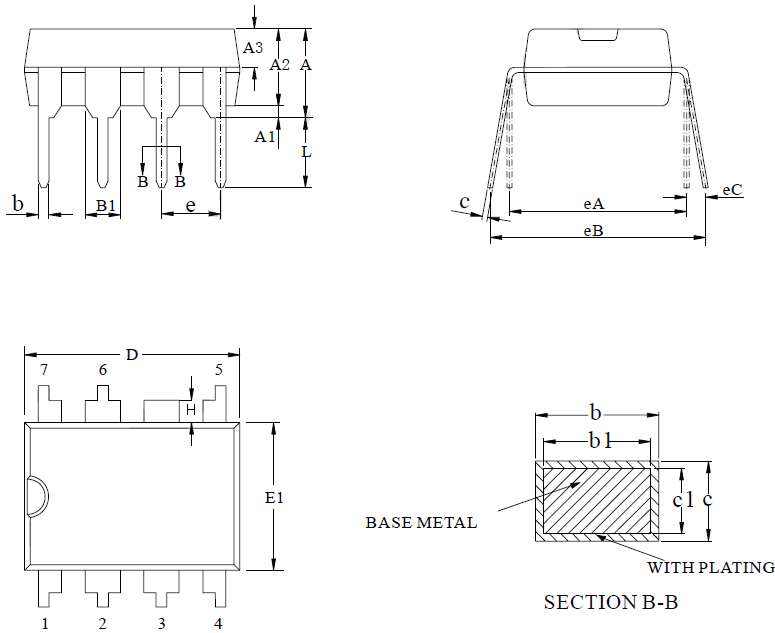
### TYPICAL APPLICATION





**PACKAGE INFORMATION**

Dimension in DIP7 (Unit: mm)



Symbol	Min	Max
A	3.60	4.00
A1	0.51	-
A2	3.00	3.40
A3	1.55	1.65
b	0.44	0.53
b1	0.43	0.48
B1	1.52(BSC)	
c	0.25	0.31
c1	0.24	0.26
D	9.05	9.45
E1	6.15	6.55
e	2.54(BSC)	
eA	7.62(BSC)	
eB	7.62	9.30
eC	0.00	0.84
L	3.00	-



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