Isolated PSR Constant Current LED Power Switch

FEATURES

- **Integrated with 650V MOSFET**
- **Integrated HV Startup and VDD Power Supply Circuit**
- **PSR CC Control**
- **±5% CC Regulation**
- **Very Low VDD Operation Current**
- **Built-in AC Line CC Compensation**
- **Build in Protections:**
  - **Output Over Voltage Protection (OVP)**
  - **Cycle-by-Cycle Current Limiting**
  - **Leading Edge Blanking (LEB)**
  - **LED Short/Open Protection**
  - **On-Chip Thermal Fold-back (OTP)**
- **Available with SOP-7 and DIP-7 Package**

APPLICATIONS

- **Down Light, Ceiling Light, Panel Light**
- **Other High Power LED Lighting**

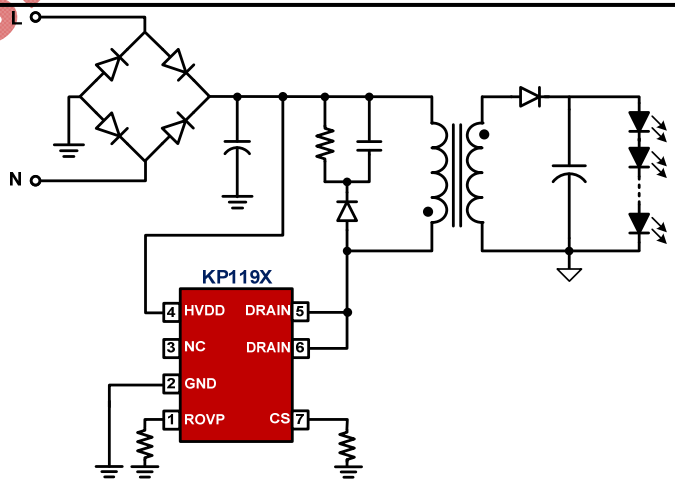
GENERAL DESCRIPTION

KP119X is a family of highly integrated power switch with DCM (Discontinuous Conduction Mode) Primary Side Regulation (PSR) constant current (CC) control for high power isolated LED lighting applications.

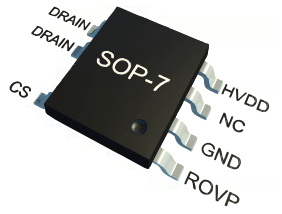
KP119X integrates a 650V power MOSFET and integrates high voltage startup/IC supply circuit and a novel transformer demagnetization circuit, which eliminates transformer auxiliary winding and reduces system design cost. The IC also adopts high accuracy current sensing control method which maintains accurate output current and good line/load regulation.

KP119X integrates functions and protections of Current Limit and Leading Edge Blanking, Under Voltage Lockout (UVLO), Cycle-by-cycle Current Limiting (OCP), Thermal Foldback (OTP), Output Over Voltage Protection (OVP), LED Open/Short Protection, etc.

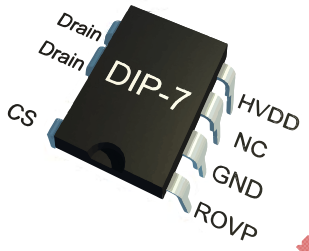
TYPICAL APPLICATION CIRCUIT



Pin Configuration

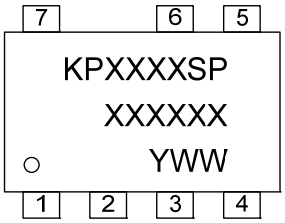


SOP-7



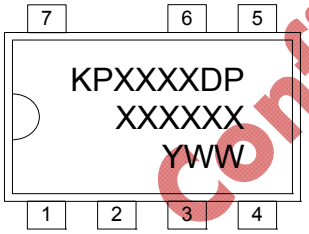
DIP-7

Marking Information



XXXX: Part Number for KP1191 or KP1192
XXXXXX: Wafer Lot Code
Y: Year, H for 2018
WW: Working Week, 01-52

SOP-7



XXXX: Part Number for KP1192、KP1193、KP1194
XXXXXX: Wafer Lot Code
Y: Year, H for 2018
WW: Working Week, 01-52

DIP-7

Output Power Table

Part Number	Package	Maximum Output Power		Minimum Nps*Vo
		85-265V Input	175-265V Input	
KP1191SPA	SOP-7	7W	12W	30V
KP1192SPA	SOP-7	12W	16W	
KP1192DP	DIP-7	16W	20W	
KP1193DP	DIP-7	20W	24W	
KP1194DP	DIP-7	24W	30W	

Note: Maximum output power is constrained by IC maximum Junction Temperature and determined by ambient temperature and PCB. The system actual maximum output power is determined by the test.

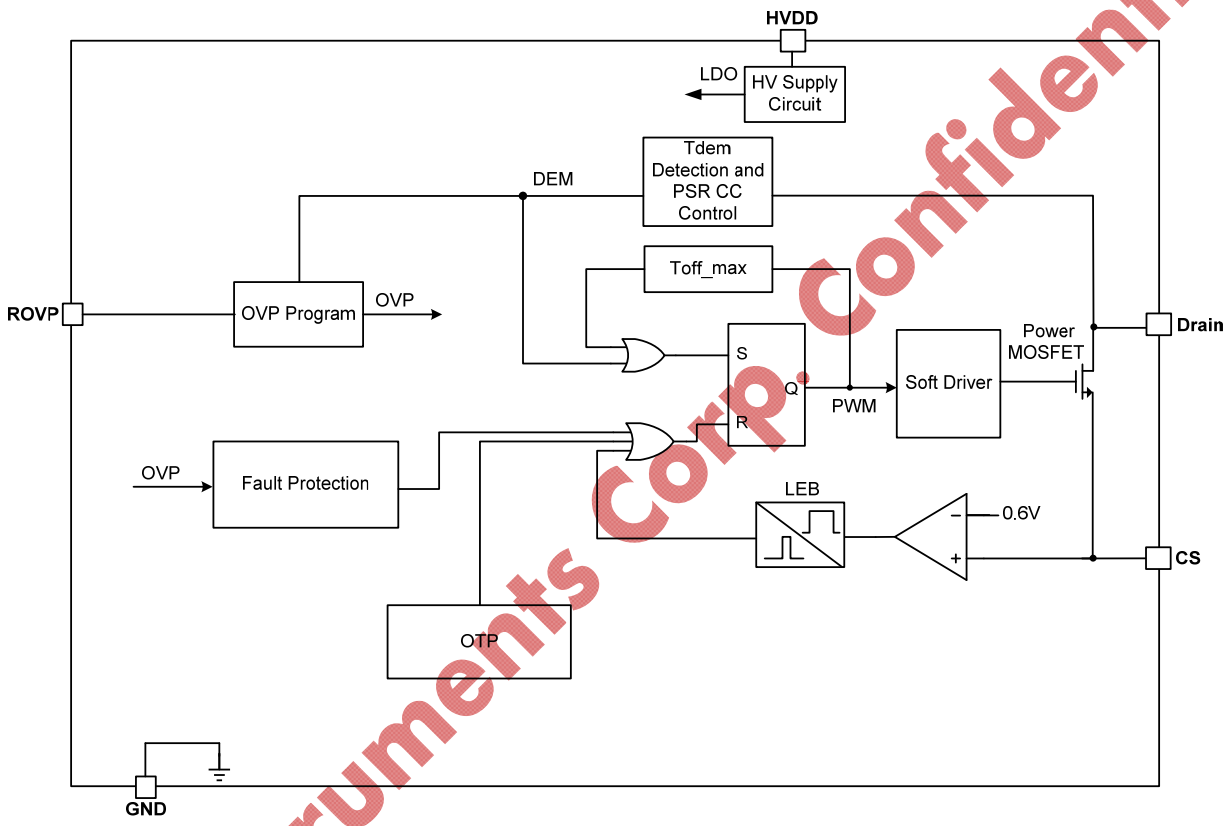
Pin Description

Pin Number	Pin Name	I/O	Description
1	ROVP	I	Connect a Resistor to IC Ground for Output OVP Level Setting. Recommended Value of ROVP is 5K~14K. When ROVP is shorted, the system stops switching.
2	GND	P	IC Ground
3	NC	---	No Function Pin and Left Floating in Application
4	HVDD	P	IC HV Supply PIN
5,6	Drain	P	Internal Power MOSFET Drain Terminal
7	CS	O	Internal Power MOSFET Source Terminal and Current Sensing Input Pin

Ordering Information

Part Number	Description
KP1191SPA / KP1192SPA	SOP-7, Pb free in T&R, 4000Pcs/Reel
KP1192DP / KP1193DP / KP1194DP	DIP-7, Pb free, 50Pcs/Tube

Block Diagram



Absolute Maximum Ratings (Note 1)

Parameter	Value	Unit
Drain, HVDD Voltage	-0.3 to 650	V
CS, ROVP Pin Voltage Range	-0.3 to 7	V
P_{Dmax}, Power dissipation @T_A=50°C (SOP-7) (Note 2)	0.6	W
θ_{JA}, Thermal Resistance---Junction to Ambient (SOP-7)	165	°C/W
P_{Dmax}, Power dissipation @T_A=50°C (DIP-7) (Note 2)	0.9	W
θ_{JA}, Thermal Resistance---Junction to Ambient (DIP-7)	105	°C/W
IC Junction Temperature	150	°C
Storage Temperature Range	-65 to 150	°C
Lead Temperature (Soldering, 10sec.)	260	°C
ESD Capability, HBM (Human Body Model)	3	kV

Recommended Operation Conditions

Parameter	Value	Unit
Operating Junction Temperature	-40 to 125	℃

Electrical Characteristics (Ta = 25℃, If Not Otherwise Noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage Section(VDD Pin)						
I_{VDD_st}	Startup Cutrrent	VDD<V_{DD_Op}		5400		uA
I_{VDD_Op}	Operation Current	Fsw=7KHz	80	150	300	uA
HV_{DD_ON}	HVDD Pin Startup Voltage			15.5		V
HV_{DD_OFF}	HVDD Pin Lockout Voltage		5.8	6.6	7.5	V
T_{off_min}	Minimum Off Time	(Note 3)		3		us
T_{on_max}	Maximum On Time	(Note 3)		35		us
T_{off_max}	Maximum Off Time		195	270	350	us
F_{max}	Maximum Switching Frequency		100	125	150	KHz
Current Sense Input Section (CS Pin)						
T_{LEB}	CS Input Leading Edge Blanking Time		300	500	700	ns

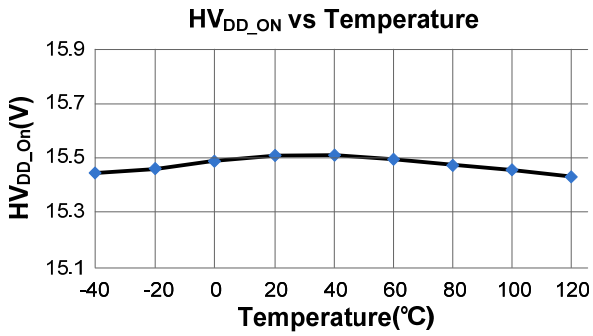
$V_{cs(max)}$	Current limiting threshold		590	600	610	mV
T_{D_OC}	Over Current Detection and Control Delay			100		ns
Output Over Voltage Protection Section (ROVP Pin)						
I_{ROVP}	ROVP Pin Output Current		36	40	44	uA
Enable Function (ROVP Pin)						
V_{ROVP}	ROVP Pin Voltage	When V_{ROVP} ＜ 50mV,the system stop working		50		mV
Over Temperature Protection						
T_{SD}	Thermal Shutdown Trigger Point	(Note 3)		145		°C
HV Startup and Power Supply Section (Drain Pin)						
I_{HV}	HV Charging Current	Drain =20V		10		mA
I_{HV_leak}	HV Leakage Current		10	40	60	uA
Power MOSFET Section (Drain Pin)						
V_{BR}	Power MOSFET Drain Source Breakdown Voltage		650			V
R_{dson}	Static Drain-Source On Resistance	KP1191SP		9.0		Ω
		KP1192SP		4.5		Ω
		KP1192DP		4.5		Ω
		KP1193DP		2.5		Ω
		KP1194DP		2.0		Ω

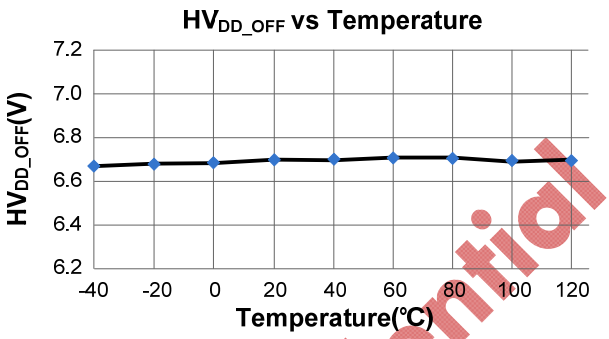
Note1. Stresses listed as the above “Maximum Ratings” may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to maximum rating conditions for extended periods may remain possibility to affect device reliability.

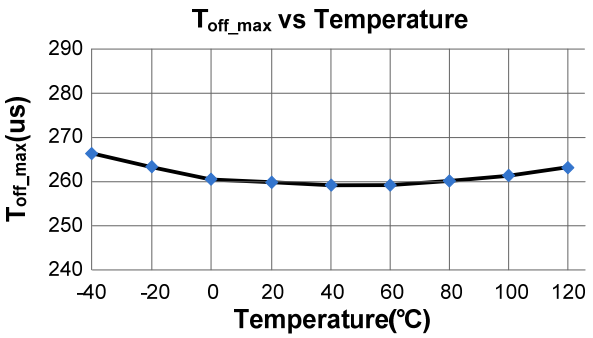
Note 2. Maximum Power dissipation $P_{Dmax}= (T_{Jmax}-T_A) / \theta_{JA}$. As ambient temperature rises, P_{Dmax} will decrease.

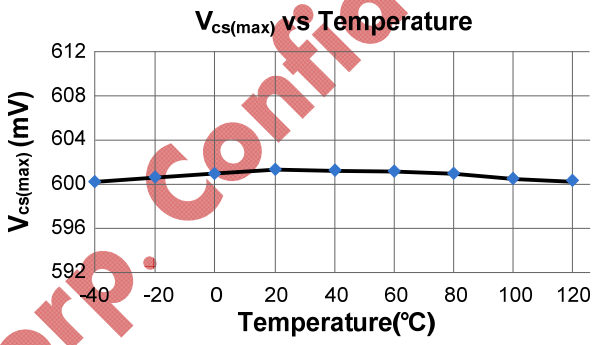
Note 3. Guaranteed by the Design.

Characterization Plots









Operation Description

KP119X is a family of highly integrated DCM PSR Constant Current LED power switch which is integrated with 650V power MOSFET, high voltage startup/IC supply circuit and a novel transformer demagnetization circuit, which reduces system design cost and result in precision CC output.

• HVDD Supply

KP119X integrates 650V high voltage power supply circuit by which the gate drive of the power MOSFET is directly powered without external VDD capacitor.

• PSR Constant Current Control

KP119X operates in DCM PSR constant current mode. Timing information of transformer demagnetization and current information at the CS pin allow accurate regulation of the secondary average current. In KP119X, the ratio between transformer demagnetization time Tdem and switching period Tsw in CC mode is set to 1/2. The average output current can be expressed as:

$$I_{CC\_OUT}(mA) = \frac{1}{4} \bullet \frac{V_{cs(max)}}{R_{cs}} \bullet N_{ps} = \frac{150mV}{R_{cs}(\Omega)} \bullet N_{ps}$$

where:

R_{cs}--- the sensing resistor connected between the CS pin to IC GND.

N_{ps}----The turn ratio between primary winding over secondary winding.

• Current Limit and Leading Edge Blanking

The current limit circuit samples the differential voltage between GND and CS Pin. When the sampled differential voltage exceeds the internal threshold (600mV), the power MOSFET is turned off. An internal leading edge blanking circuit is built in. During this blanking period (500ns, typical), the cycle-by-cycle current limiting comparator is disabled and cannot switch off the GATE driver.

• Demagnetization Detection

In KP119X, the demagnetization detection circuit is designed internally without auxiliary winding, which reduces system design cost.

• Minimum and Maximum OFF Time

In KP119X, a minimum OFF time (typically 3us) is implemented to suppress ringing when the power MOSFET is off. The maximum OFF time in KP119X is typically 270us.

• Output Over Voltage Protection (OVP)

In KP119X the resistor connected to the ROVP Pin is used to set the output over voltage protection level and a high accuracy current sourcing out from the ROVP Pin to generate a voltage reference as $V_{ROVP} = I_{ROVP} \bullet R_{OVP}$ which combines with CS Pin peak voltage to set a over voltage protection threshold T_{ovp}. When the LED is open and output voltage becomes high, the practical demagnetization time T_{dem} starts to be decreased. The switch is to be stopped immediately when the T_{dem} is smaller than T_{ovp} which is followed by the system auto recovery mode until fault disappeared.

In the event of shutdown or low input, the maximum turn on time can be triggered, and the over voltage threshold Tovp is to be proportionally reduced regarding to the peak inductor current to avoid over voltage protection falsely triggered. For

the isolated flyback converter, following equation can be got when the output over voltage protection is triggered:

$$T_{dem} = T_{ovp} = \frac{L_p \bullet V_{CS\_PK}}{N_{ps} \bullet V_{OVP} \bullet R_{cs}}$$

Where:

V_{CS_PK}---the peak cs voltage, for normal operation the value is typically 600mV.

V_{OVP}---the over voltage protection level

When $T_{dem}<T_{ovp}$， the over voltage protection is triggered and the protection level can be set by the resistor of R_{OVP}：

$$R_{OVP} \approx 0.07 \bullet \frac{N_{ps} \bullet V_{OVP}(V) \bullet R_{cs}(ohm)}{L_p(mH)}(kohm)$$

Where:

L_p---Inductance of transformer primary winding.

- **Auto-Restart Protection**

In the event of LED open output OVP protection, the IC enters into auto-restart, wherein the power MOSFET is disabled with a digital counter begins counting. When 67ms had been counted, the IC will reset and start up the system again. However, if the fault still exists, the system will experience the above process. If the fault has gone, the system will resume normal operation.

- **On Chip Thermal Fold-back (OTP)**

KP119X integrates thermal fold-back function. When the IC temperature is over 145℃, the system output regulation current is gradually reduced, as shown in Fig.1. Thus, the output power and thermal dissipation are also reduced. In this way, the system temperature is limited and system reliability is also improved.

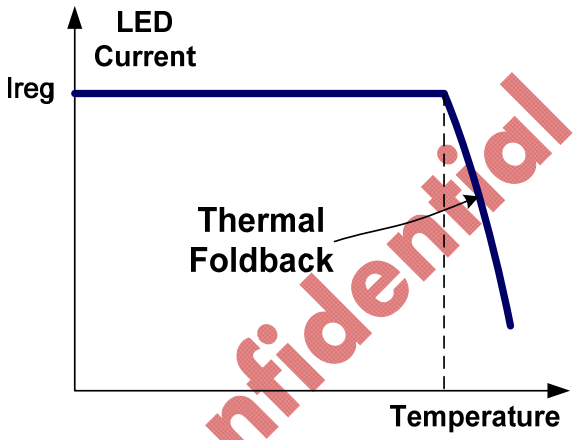


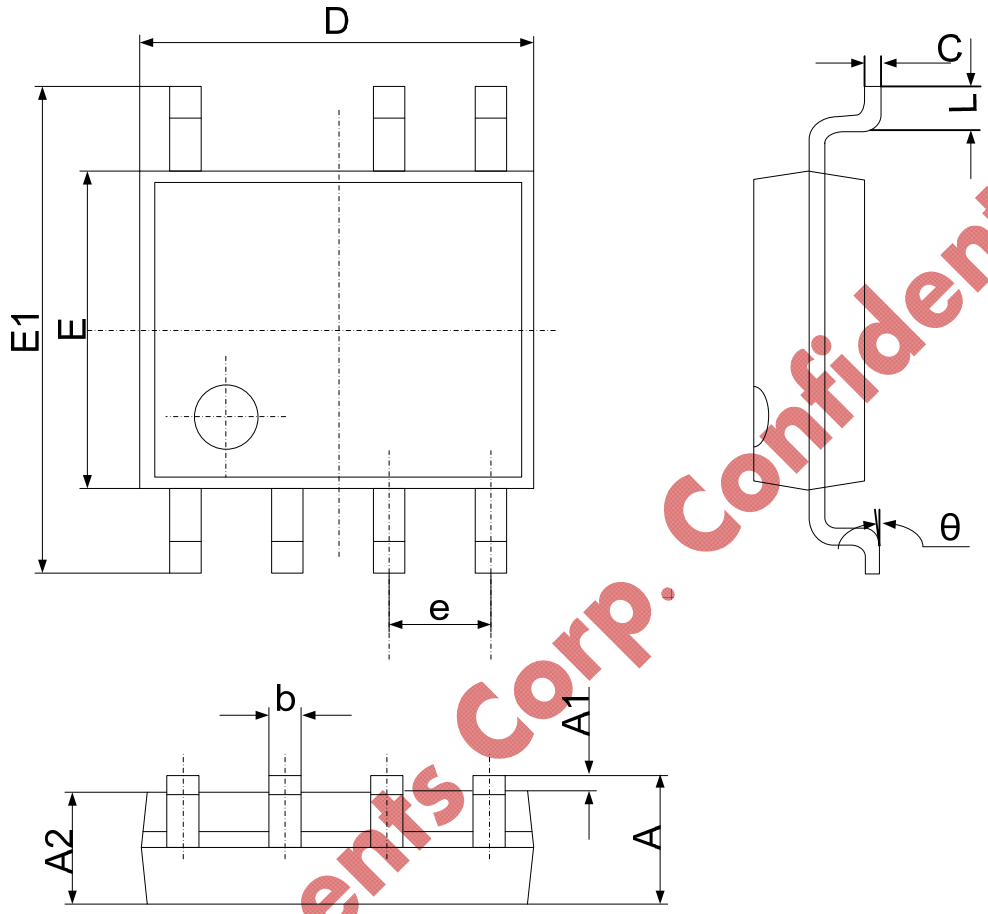
Fig.1

- **Soft Totem-Pole Gate Driver**

KP119X has a soft totem-pole gate driver with optimized EMI performance.

Package Dimension

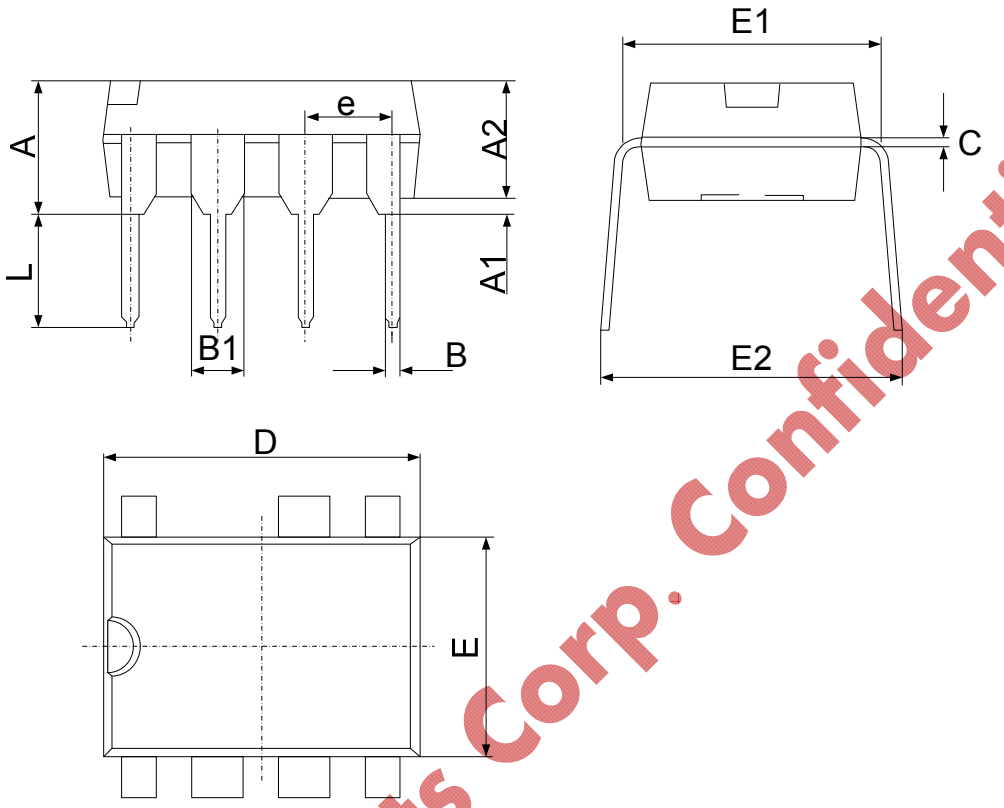
SOP-7



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	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package Dimension (Continued)

DIP-7



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524(BSC)		0.060(BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540(BSC)		0.100(BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

Revision History

DATE	REV.	DESCRIPTION
2017/11/16	1.0	First Release
2018/02/02	1.01	Update Recommended Operation Conditions
2018/05/14	1.1	Update Pin Configuration, Add ROVP open protection and Enable function, Adjust I_{VDD_st} and Note 2
2018/08/27	1.2	Update I_{VDD_st}, HV_{DD_ON},Enable function and OVP recovery time.
2018/11/22	1.3	Add KP1194DP, Update Output Power Table.

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