Non-isolated Quasi-Resonant Buck LED Power Switch

FEATURES

- Integrated with 500V MOSFET
- Integrated HV VDD Power Supply Circuit
- No VDD Cap Design
- Integrated 600V Current-Supply Diodes Design
- ±5% CC Regulation
- Quasi-Resonant for High Efficiency
- 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)

APPLICATIONS

- High Power LED Lighting

GENERAL DESCRIPTION

DP951XB is a highly integrated power switch with Quasi-Resonant Buck (QR-Buck) constant current (CC) control for LED lighting applications without auxiliary winding.

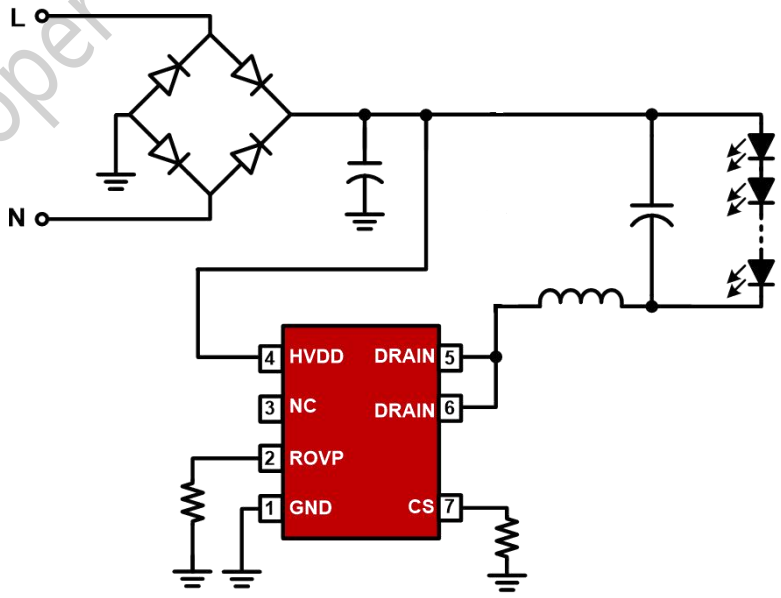
DP951XBcombines a 500V power MOSFET and high voltage startup/IC supply circuit in one chip which reduced system design cost. The IC also adopts high accuracy current sensing control method which maintains accurate output current and good line/load regulation.

DP951XB 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.

ORDERING INFORMATION

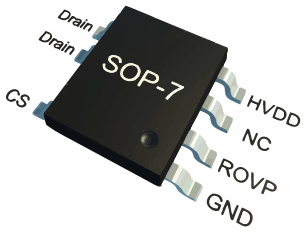
Part Number	Description
DP951XB	SOP-7，ROHS 4000pcs/reel
	DIP-7，ROHS 50 Pcs/Tube

TYPICAL APPLICATION CIRCUIT



PRODUCT DESCRIPTION

➢ Pin Configuration



➢ Pin Description

Pin Number	Pin Name	I/O	Description
1	GND	P	IC Ground
2	ROVP	I	Connect a Resistor to IC Ground for Output OVP Level Setting. Recommended Value of ROVP is greater than 6K. OVP Function is Disabled if ROVP Pin Left Floating. When ROVP is shorted, the system stops switching.
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	I	Internal Power MOSFET Source Terminal and Current Sensing Input Pin

➢ Marking Information

DP951XB for product name:

XXXXXX The first X represents the last year,2014 is 4;The second X represents the month,inA-L 12 letters;The third and fourth X on behalf of the date,01-31said;The last two X represents the wafer batch code

➢ Output Power Table

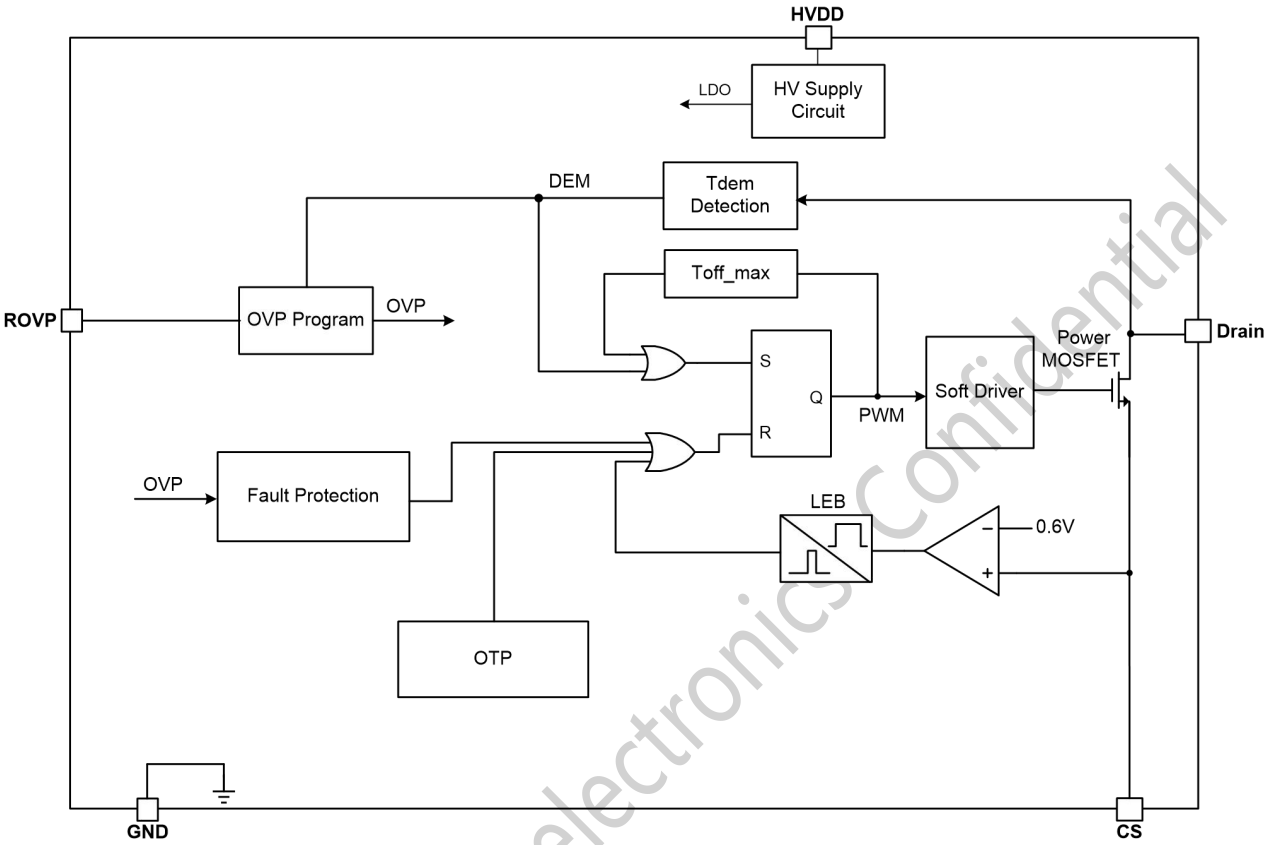
Part Number	Package	Output Current for 176-265Vac		Minimum Output Voltage
		36V output	72V output	
DP9511SB	SOP-7	150 mA	130 mA	30V
DP9511AB	SOP-7	190 mA	160 mA	
DP9511B	SOP-7	260 mA	180 mA	
DP9512AB	SOP-7	280 mA	250 mA	
DP9512B	SOP-7	300 mA	280 mA	

➢ Absolute Maximum Ratings(Note 1)

Parameter	**Value**	**Unit**
Drain Voltage	-0.3 to 500	V
HVDD Voltage	-0.3 to 650	V
CS,ROVP Voltage	-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	℃/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

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.

BLOCK DIAGRAM



RECOMMENDED OPERATION CONDITIONS

Parameter	Value	Unit
Operating Junction Temperature	-40 to 125	℃

ELECTRICAL CHARACTERISTICS

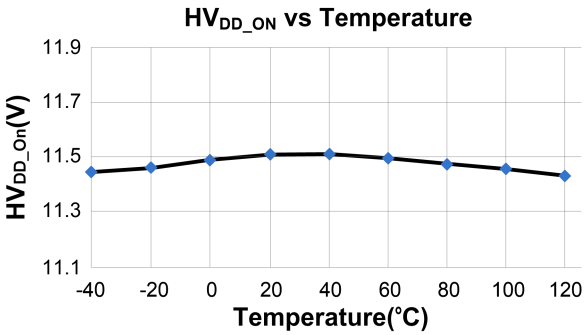
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage Section(HVDD Pin)						
I_{VDD_st}	Startup Current	VDD<V_{DD_Op}		300	700	uA
I_{VDD_Op}	Operation Current	Fsw=7KHz	80	150	300	uA
HV_{DD_ON}	HVDD Pin Startup Voltage		10	11.5	13	V
HV_{DD_OFF}	HVDD Pin Lockout Voltage		5.8	6.6	7.5	V
T_{off_min}	Minimum Off Time	(Note 3)	0.6	1.0	1.4	us
T_{on_max}	Maximum On Time	(Note 3)		50		us
T_{off_max}	Maximum Off Time		195	270	350	us
Current Sense Input Section (CS Pin)						
T_{LEB}	CS Input Leading Edge Blanking Time	(Note 3)	300	500	700	ns
$V_{cs(max)}$	Current limiting threshold		590	600	610	mV
T_{D_OC}	Over Current Detection and Control Delay	(Note 3)		100		ns
Output Over Voltage Protection Section (ROVP Pin)						
I_{ROVP}	ROVP Pin Output Current		49			uA
Enable Function(ROVP Pin)						
V_{ROVP}	ROVP Pin Output Voltage	When V_{ROVP} < 150mV, the system stops working		150		mV
Over Temperature Protection						
T_{SD}	Thermal Shutdown Trigger Point	(Note 3)		145		℃

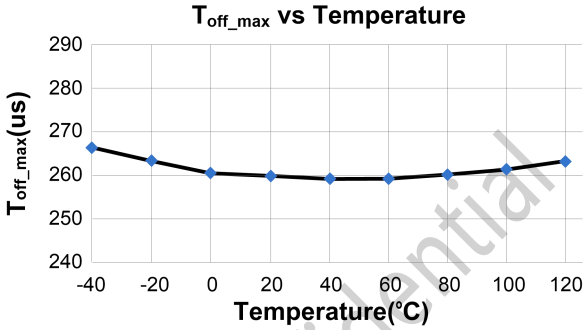
HV Startup and Power Supply Section (Drain Pin)						
I_{HV}	HV Charging Current	Drain =20V		10		mA
I_{HV_leak}	HV Leakage Current		10	40	60	uA
Power MOSFET Section (Drain Pin)						
V_{BR}	Power MOSFET Drain Source Breakdown Voltage		500			V
R_{dson}	Static Drain-Source On Resistance	DP9511SB		16		Ω
		DP9511AB		12		Ω
		DP9511B		8.5		Ω
		DP9512AB		5.8		Ω
		DP9512B		4.8		Ω

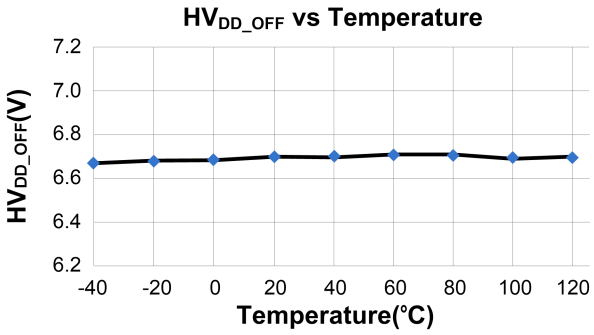
Note2. Maximum Power dissipation $P_{Dmax}= (T_{Jmax}-T_A)/\theta_{JA}$. As ambient temperature rises, P_{Dmax} will decrease.

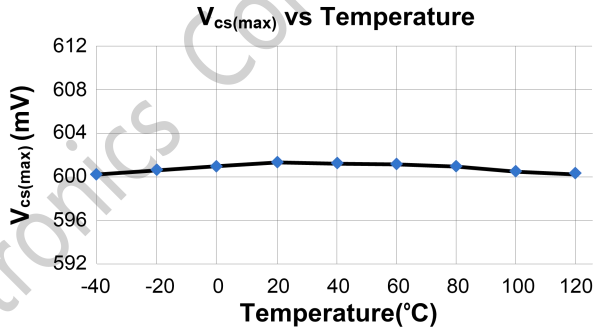
Note 3. Guaranteed by the Design.

CHARACTERIZATION PLOTS









OPERATION DESCRIPTION

DP951XBcombines a high voltage power MOSFET switch with a power controller in one chip. The built-in high precision CC control with high level protection features makes it suitable for LED lighting applications.

- **HVDD Supply**

DP951XB integrates 650V high voltage power supply circuit by which the gate drive of the power MOSFET is directly powered without external VDD capacitor.

- **Constant Current Control**

In QR-Buck mode, the IC keeps CS peak current constant and starts new PWM cycle with valley switching. Therefore, high precision CC and high conversion efficiency can be achieved simultaneously. The average LED regulation output current is given by:

$$I_{CC\_OUT}(mA) = \frac{1}{2} \bullet \frac{V_{cs(max)}}{R_{cs}} = \frac{300mV}{R_{cs}(\Omega)}$$

In the equation above,

Rcs--- the sensing resistor connected between the CS pin to IC GND.

- **Current Limit and Leading Edge Blanking**

The current limit circuit samples the differential voltage between GND and CS Pin. When the. 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 DP951XB, the demagnetization detection circuit is designed internally without auxiliary winding, which reduces system design cost.

- **Minimum and Maximum OFF Time**

In DP951XB, a minimum OFF time (typically 1us) is implemented to suppress ringing when the power MOSFET is off. The maximum OFF time in DP951XB is typically 270us.

- **Output Over Voltage Protection (OVP)**

In DP951XB 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 non-isolated buck converter, following equation can be got when the output over voltage protection is triggered:

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

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}:

$$R_{OVP} \approx 0.08 \bullet \frac{V_{OVP}(V) \bullet R_{CS}(ohm)}{L(mH)} (kohm)$$

- **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 16ms 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)**

DP951XB 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.

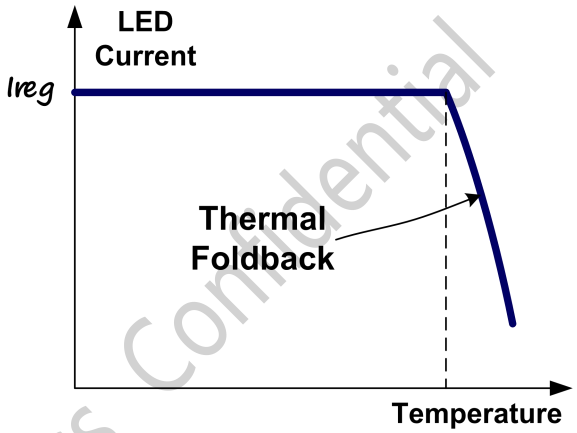


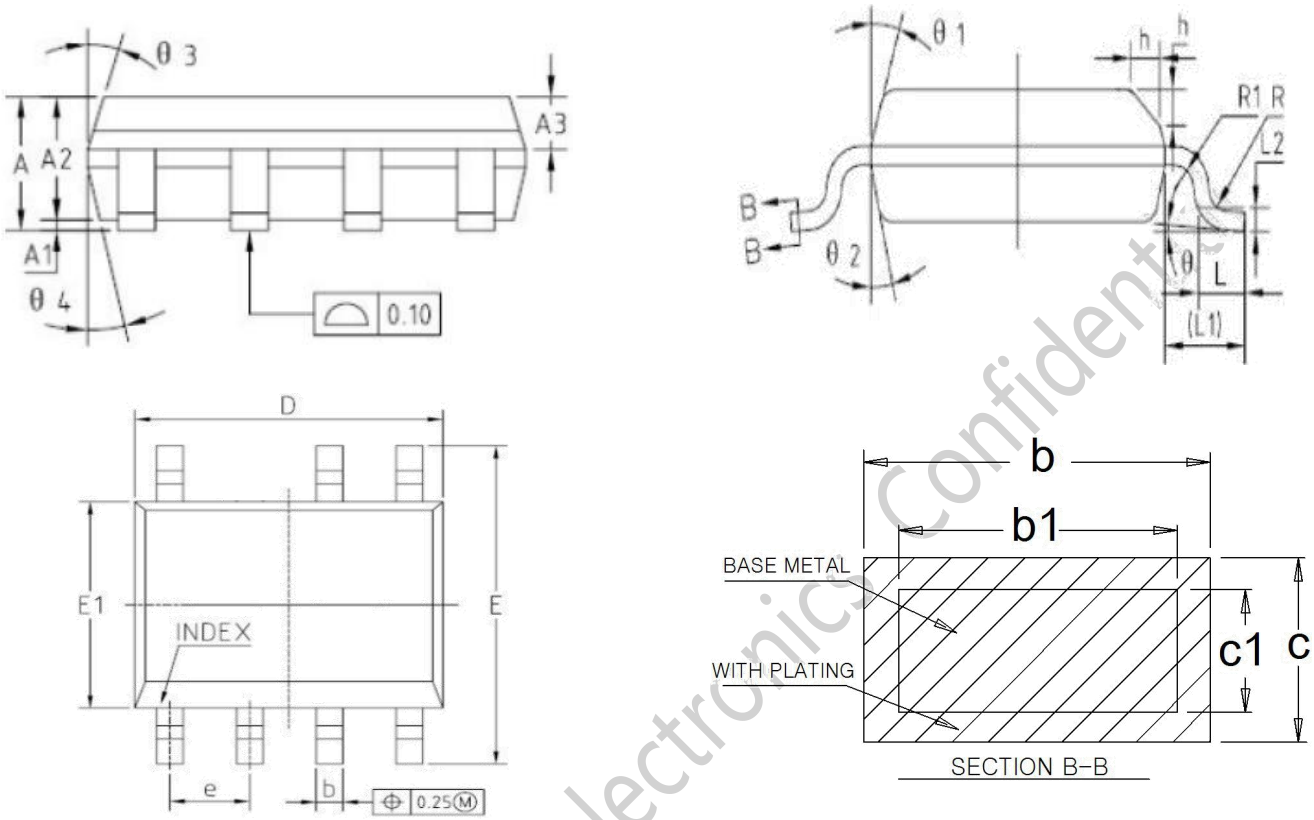
Fig.1

- **Soft Totem-Pole Gate Driver**

DP951XB has a soft totem-pole gate driver with optimized EMI performance.

PACKAGE DIMENSION

SOP-7



Symbol	Dimensions in Millimeters		
	Min	Nom	Max
A	1.45	1.55	1.65
A1	0.10	0.15	0.20
A2	1.353	1.40	1.453
A3	0.55	0.60	0.65
b	0.38	-	0.51
b1	0.37	0.42	0.47
c	0.17	-	0.25
c1	0.17	0.20	0.23
D	4.85	4.90	4.95
E	5.85	6.00	6.15
E1	3.85	3.90	3.95
e	1.245	1.27	1.295
L	0.45	0.60	0.75
L1	-	1.050REF	-
L2	-	0.250BSC	-
Θ1-Θ4	12° REF		
h	0.40REF		
R	0.15° REF		
R1	0.15° REF		

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