WS9055X Non-isolated BUCK LED Constant Current controller

FEATURES

- Integrated HV star-up& Vdd power supply
- Quas-resonant BCM opearation
- Patented non-vcc capacitor technology
- High accuracy output current[±5%]
- Reliable LED short & Open protections
- Reliable high temperature fold-back protection

APPLICATIONS

- Universal non-dimmable LED lighting
- Residential and Commercial lighting
- Retrofit A19,GU10,T5/T8 and down lights

DESCRIPTION

The WS9055X is a highly integrated controller, it adopts the non-vcc capacitor technology to dramaticlly enhance the cost-effecitve system BOM.WS9055X builds in the accurate constant current controlling to achieve the good line and output regulation.

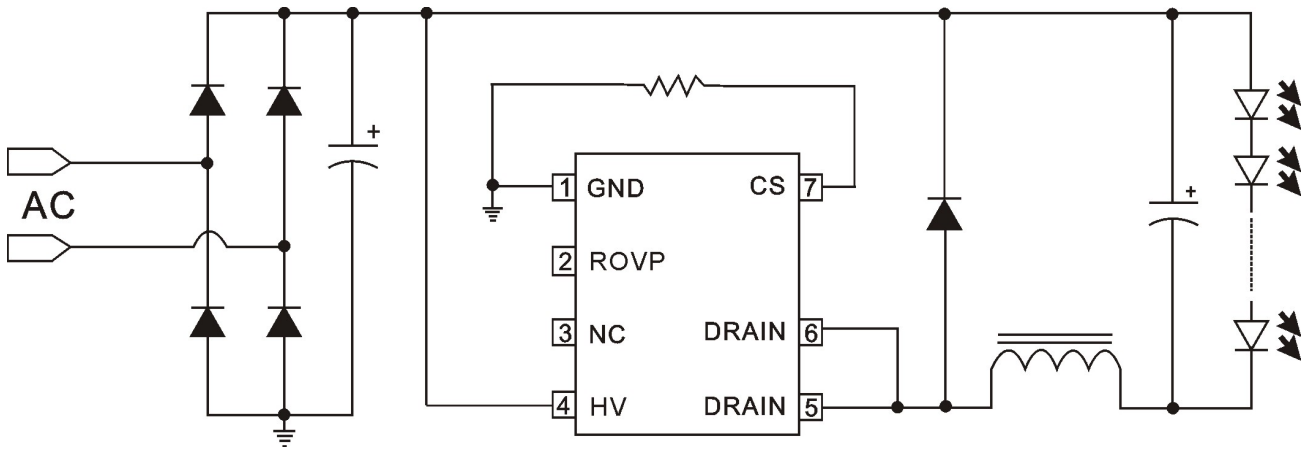
The WS9055X operates in Bondary Conducted Mode(BCM) to get ease EMI designing and high system efficiency.

The WS9055X integrates the high voltage MOSFET and the start-up circuit without the external vcc capacitor,WS9055X is suitable for compact and cost-effective non-dimmable system design.

The WS9055X build-in multiple protections: OCP,UVLO, high temperature foldback, Output Short-circuit Protection and open-circuit protection.

WS9055X is available in SOP-7 and DIP-7 package.

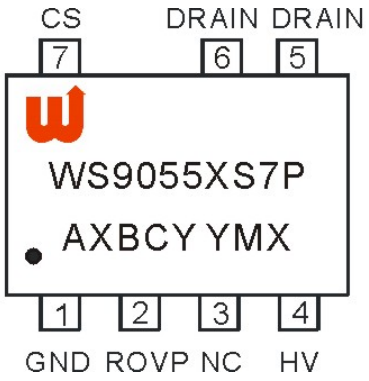
TYPICAL APPLICATION



Note 1. ROVP PIN not connection,Tovp=4.5uS; 2.ROVP PIN connects to GND,OVP be disable.

PIN Assignments and Marking Information

WS9055X is avaliable in SOP-7 and DIP-7 Package, The top marking is shown as below:

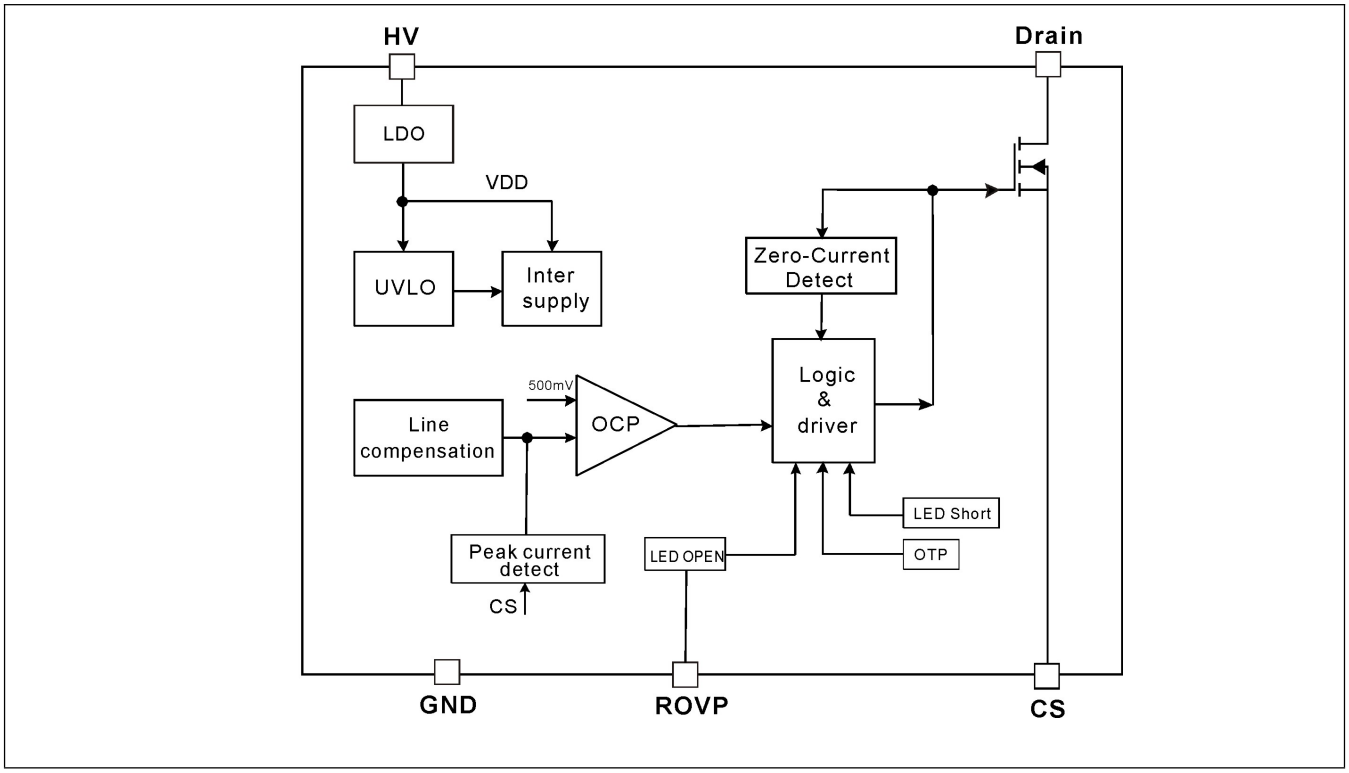


WS9055XS7P：Product Code
A：Product Code
X：Internal Code
BCY：Internal Code For QC
YMX：D/C

Pin Descriptions

Pin Name	Pin Number	Function
GND	1	GND pin
ROVP	2	ROVPpin, Not connect has the OVP function, connects a resistor to GND, the OVP function is disable;
NC	3	Not connect
HV	4	High voltage supply pin
DRAIN	5/6	Drain of the internal power MOSFET
CS	7	Current sense of the internal power MOSFET. Connect a resistor form CS to GND to cycle by cycle sense the current through the inductor.

FUNCTION DIAGRAM



Order Information

Package	Pack code	OVP	Part Number
7-Pin SOP-7, Pb-free	WS9055AS7P	Yes	WS9055AS7P
7-Pin SOP-7, Pb-free	WS9055BS7P		WS9055BS7P
7-Pin SOP-7, Pb-free	WS9055CS7P		WS9055CS7P
7-Pin SOP-7, Pb-free	WS9055DS7P		WS9055DS7P
7-Pin SOP-7, Pb-free	WS9055ES7P		WS9055ES7P
7-Pin DIP-7, Pb-free	WS9055ED7P		WS9055ED7P
7-Pin SOP-7, Pb-free	WS9055FS7P		WS9055FS7P
7-Pin DIP-7, Pb-free	WS9055FD7P		WS9055FD7P
7-Pin DIP-7, Pb-free	WS9055GD7P		WS9055GD7P
7-Pin DIP-7, Pb-free	WS9055HD7P		WS9055HD7P

Recommended Operating Condition

Part Number	Package	Input Voltage (VAC)	Output Voltage (V)	Output Current (mA)	Min. Output Voltage (V)
WS9055A	SOP7	175—264	120	≤120	>20
		85—264	72	≤120	
WS9055B		175—264	120	≤130	
		85—264	72	≤130	
WS9055C		175—264	120	≤180	
		85—264	72	≤180	
WS9055D		175—264	120	≤220	
		85—264	72	≤220	
WS9055E		175—264	120	≤240	
		85—264	72	≤240	
WS9055F		175—264	120	≤280	
		85—264	72	≤280	
WS9055E	DIP7	175—264	120	≤280	
		85—264	72	≤280	
WS9055F		175—264	120	≤300	
		85—264	72	≤300	
WS9055G		175—264	120	≤350	
		-	-	-	
WS9055H		175—264	120	≤420	
		-	-	-	

ABSOLUTE MAXIMUM RATINGS(@TA = +25°C, unless otherwise specified.)

Symbol	Parameter	Value								Unit
DRAIN	Input voltage on pin DRAIN	-0.3~500								V
HV	Input voltage on pin HV	-0.3~600								V
CS	Input voltage on pin CS	-0.3~7								V
ROVP	Input voltage on pin ROVP	-0.3~7								V
I_{DMAX}	Max. Current of Drain-Source MOSFET	A	B	C	D	E	F	G	H	mA
		400	500	650	900	1000	1100	1500	1800	
P_{DMAX}	Maximum Power dissipation （Note 2）	SOP7				DIP7				W
		0.45				0.9				
θ_{JA}	Thermal Resistance(Junction to Ambient)	145								℃/W
T_J	Operation Junction Temperature	-40~150								℃
T_{STG}	Storage Temperature	-40~150								℃
ESD	Human Body mode（Note 3）	2000								V
	Machine mode	200								V

Note1:Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability. All voltages unless otherwise stated and measured with respect to GND.

Note 2:Maximum power dissipation value could be decreased as the temperature of the controller rising which it depends on the T_{JMAX}, θ_{JA} and TA, the relevant equation refers to $P_{DMAX}= (TJ_{MAX}-T_A) /\theta_{JA}$..

Note 3:Equivalent to discharging a 100pF capacitor through a 1.5kΩ series resistor.

ELECTRICAL CHARACTERICS

(T_A=25℃ unless otherwise specified.)

Parameter	Symbol	Conditon	Min.	Typ.	Max.	Unit
Power supply voltage						
Start up voltage	V_{HV}		-	30	-	V
Operation current	I_Q	F=2.5KHZ	-	150	-	uA
Current dectection						
Peak current limit	V_{TH_OC}		388	400	412	mV
Leading-Edge Blanking Time	T_{LEB}		-	350	-	nS
Gate driver delay time	T_{DELAY}		-	100	-	nS
Controlling time						
Max. Turn off time	T_{OFF_MAX}		-	400	-	uS
Max. Turn on time	T_{ON_MAX}		-	50	-	uS
Min. Turn off time	T_{OFF_MIN}		-	3	-	uS
OVP detected turn off time	T_{OVP}	ROVP PIN not connect	-	4.5	-	uS
Power MOSFET						
Drain-Source On-State Resistance	WS9055A R_{DS_ON}	V_{GS}=10V/I_{DS}=0.4A	-	15	-	Ω
	WS9055B R_{DS_ON}	V_{GS}=10V/I_{DS}=0.4A	-	12	-	
	WS9055C R_{DS_ON}	V_{GS}=10V/I_{DS}=0.5A	-	8	-	
	WS9055D R_{DS_ON}	V_{GS}=10V/I_{DS}=1.0A	-	6.2	-	
	WS9055E R_{DS_ON}	V_{GS}=10V/I_{DS}=1.0A		4.9		
	WS9055F R_{DS_ON}	V_{GS}=10V/I_{DS}=1.5A		3		
	WS9055G R_{DS_ON}	V_{GS}=10V/I_{DS}=2A		2.2		
	WS9055H R_{DS_ON}	V_{GS}=10V/I_{DS}=2.5A		1.5		
Drain-Source Breakdown Voltage	BV_{DSS}	V_{GS}=0V/I_{DS}=250uA	500	-	-	V
Drain-Source Leakage Current	I_{DSS}		-	-	10	uA
Thermal foldback						
Threshold Temperature Feedback	T_{REG}		-	140	-	℃

FUNCTION DESCRIPTION

The WS9055X is a highly integrated controller, it integrates the HV JEFET and MOSFET , meanwhile it adopts the non-vcc capacitor technology to minimize the external components,dramaticlly enhance the cost-effecitve system BOM.

WS9055X built-in the accurate constant current controlling to achieve the good line and output regulation performance.

Start-up and Power Supply

The WS9055X HV pin directly connects to the rectified mains voltage and provides the desired start-up voltage(V_{HV_ON}),then the WS9055X starts switching. During normal operation, the rectified voltage provides the sufficient V_{DD} supply by the intenal HV JEFET.

Peak Current Regulator

The WS9055X contains a highly accurate peak current detector. It triggers when the voltage on the CS pin reaches the limit level V_{CS_LIMIT}(400mV),then turns off the integrated MOSFET and turns on is determined by the demagnetization status on the drain voltage of the internal MOSFET, when the lowest voltage is detected,the internal low side switch is switched on. Thus the output current can be regulated and the inductor peak current is determined by the following equations:

$$I_{PK} = \frac{400}{R_{CS}}(mA)$$

RCS is the current sensing resistor.
LED output current caculation：

$$I_{LED} = \frac{I_{PK}}{2}$$

Inductor Consideration

WS9055X builts-in the minimum t_{off} switching time for over voltage protection,when senses the t_{off} time decreasing to the 4.5us several cycle time,the OVP fuction be trigged,WS9055X's fixed OVP time feature to prevent IC be mistriggering from unkonw operated condition(for instance: be mistriggered by the leakage current or humid circumstance). WS9055X's OVP function can be selectable or disabe by connect a resistor to GND.

It is recommeded the LED output open protection voltage is set to 1.3-1.5 times higher than the normal working volgtage,the output OVP voltage can be fine-tuned by the appropriate inductance,usually the normal operated T_{off} time be set to 6.75us with full output load condition,also the OVP voltage is proportionate to the inductance.

The relevant calculation is shown in below:

$$T_{OVP} = \frac{L \times I_{PK}}{V_{OVP}}$$

$$V_{OVP} = 1.5 \times V_{LED_MAX}$$

L: the inductance of the inductor;I_{pk}:the peak current of inductor; V_{LED_MAX}: maximum output LED voltage.

The inductance range is defined by peak current of inductor and minimum frequency. The minimum switching frequency should be considered with EMI results and inductor dimension, below equation shows the BUCK inductance calculation:

$$L = \frac{1.5 \times T_{OVP} \times V_{LED_MAX}}{I_{PK}}$$

When finish the inductance calculation, the minimum number of winding can be obtained by below equation:

$$N_{\min} = \frac{L \cdot I_{PK}}{A_e \cdot B_m}$$

Short Circuit Protection(SCP)

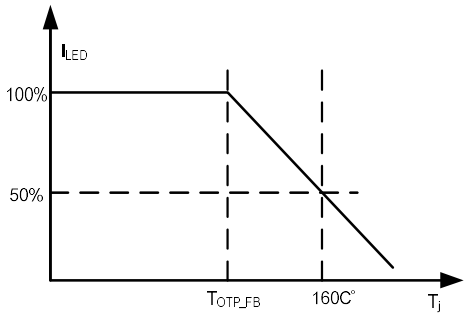
When the LED short circuit occurs,the switching off time extends to an uncertainly time.(minimum frequency is 2.5KHz),Then the output power at this condition is limited below to a safe range. The WS9055X resumes work to normal operation once the short circuit releases.

Line Voltage Compensation

WS9055X builts-in the line voltage compensation feature to get the good LED output current regulation with the full mains input voltage range.

Thermal Foldback

The WS9055X integrates high temperature foldback function to limit the power dissipation while an abnormal condition occurring. When IC junction temperature exceeds T_{REG} ,the LED output current decreases linearly with the preset curve internally, thus the total power dissipation in the application reduces and the further temperature increasing is slowed down.below figure shows the thermal foldback curve.



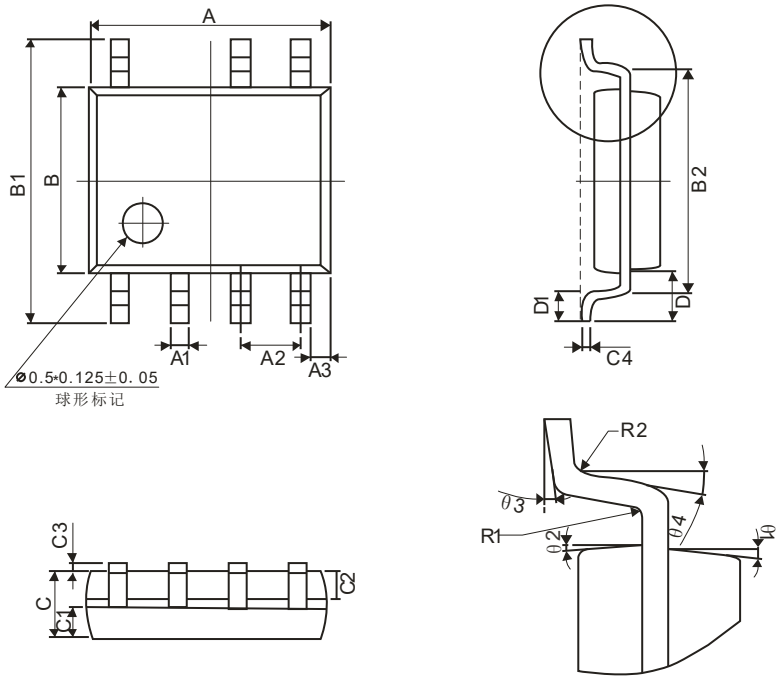
Thermal Foldback Curve

PCB Layout Guidelines

For best performance of the WS9055X, like as the good EMI and good thermal performance in compact size LED application,the following layout guidelines should be strictly followed.

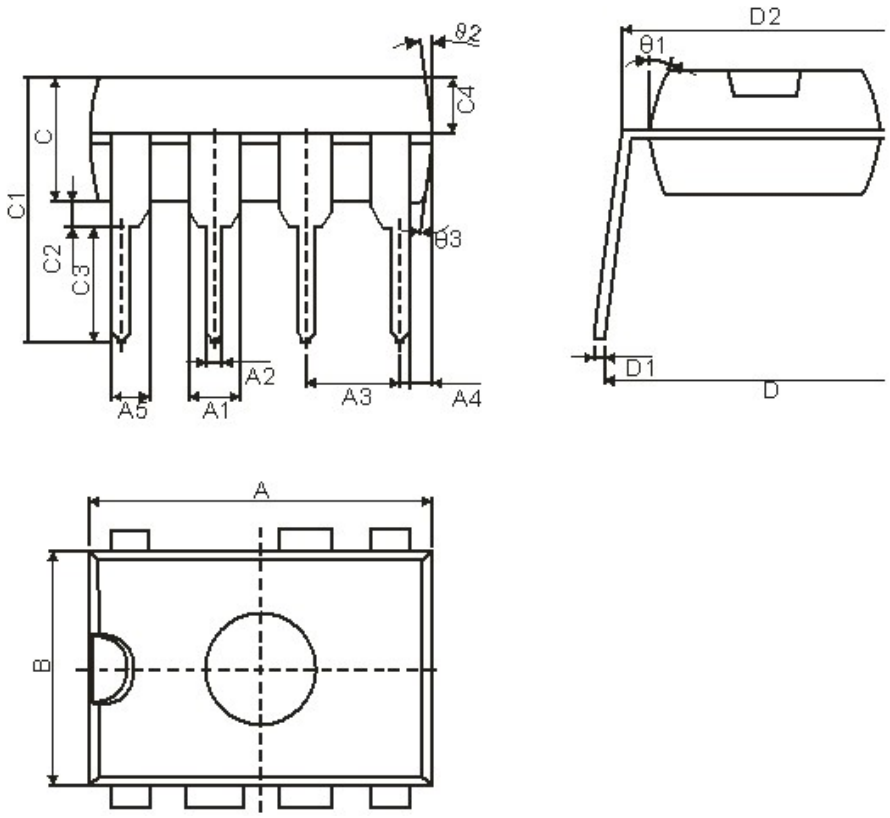
- The IC DRAIN and CS pin are high frequency switching nodes. The whole power current traces must be as wide and short as possible.
- DRAIN pin: approproately increase the cooper trace can helps the IC thermal performance;
- HV pin: Keep the HV pin cooper layout be a safty clearance from other low voltage pin;
- GND: CS pin to ground layout be as short as possible and connect with IC GND pin to the ground point of the Bulk elecitronic capacitor.

SOP-7 Package Information



Symbol	Winsemi			
	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	4.70	5.10	0.185	0.201
B	3.70	4.10	0.146	0.161
C	1.25	1.65	0.049	0.065
A1	0.35	0.48	0.014	0.019
A2	1.27TYP		0.05TYP	
A3	0.345TYP		0.014TYP	
B1	5.80	6.30	0.228	0.248
B2	5.00TYP		0.197TYP	
C1	0.55	0.70	0.022	0.028
C2	0.55	0.70	0.022	0.028
C3	0.05	0.225	0.002	0.009
C4	0.203TYP		0.008TYP	
D	1.05TYP		0.041TYP	
D1	0.40	0.80	0.016	0.031

DIP-7 Package Information



Winsemi				
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	9.00	9.50	0.354	0.374
B	6.10	6.60	0.240	0.260
C	3.0	3.4	0.118	0.134
A1	1.474	1.574	0.058	0.062
A2	0.41	0.53	0.016	0.021
A3	2.44	2.64	0.096	0.104
A4	0.51TYP		0.02TYP	
A5	0.99TYP		0.04TYP	
C1	6.6	7.30	0.260	0.287
C2	0.50TYP		0.02TYP	
C3	3.00	3.40	0.118	0.134
C4	1.47	1.65	0.058	0.065
D	7.62	9.3	0.300	0.366
D1	0.24	0.32	0.009	0.013
D2	7.62TYP		0.3TYP	

DISCLAIMER

WINSEMI products are sold by description only.WINSEMI reserves the right to change the circuitry and specification without notice at any time. Customers should obtain the latest relevant information and data sheets before placing orders and should verify that such information is current and complete.
WINSEMI cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a WINSEMI product. Information furnished by WINSEMI is believed to be accurate and reliable. However, no responsibility is assumed by WINSEMI or its subsidiaries for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of WINSEMI or its subsidiaries.

Contacting DX Semiconductor:

Winsemi Microelectronics Co., Ltd.
Address: Room 1002, East, Phase 2, High Tech Plaza,Tian-An Cyber Park,Chegongmiao, Futian, Shenzhen, P.R. China

Postcode： 518040
Phone number：+86-755-8250 6288
Fax number：+86-755-8250 6299
Web：www.winsemi.com