WinhiSemi

WA0001

Datasheet

Multi-Mode PWM Controller with Integrated Protections WA0001

Features

- Multi-Mode Operation
  CCM / QR-Like Operation / Green mode / Burst Mode
- Cycle-by-cycle Over Current Protection
- Adjustment OVP on DEM Pin
- Brown Out Protection
- Soft Driver
- 6ms Soft-Start
- OVP(Over Voltage Protection) on VCC Pin
- On Chip OTP Protection
- Built in slope compensation
- Built in peak current compensation

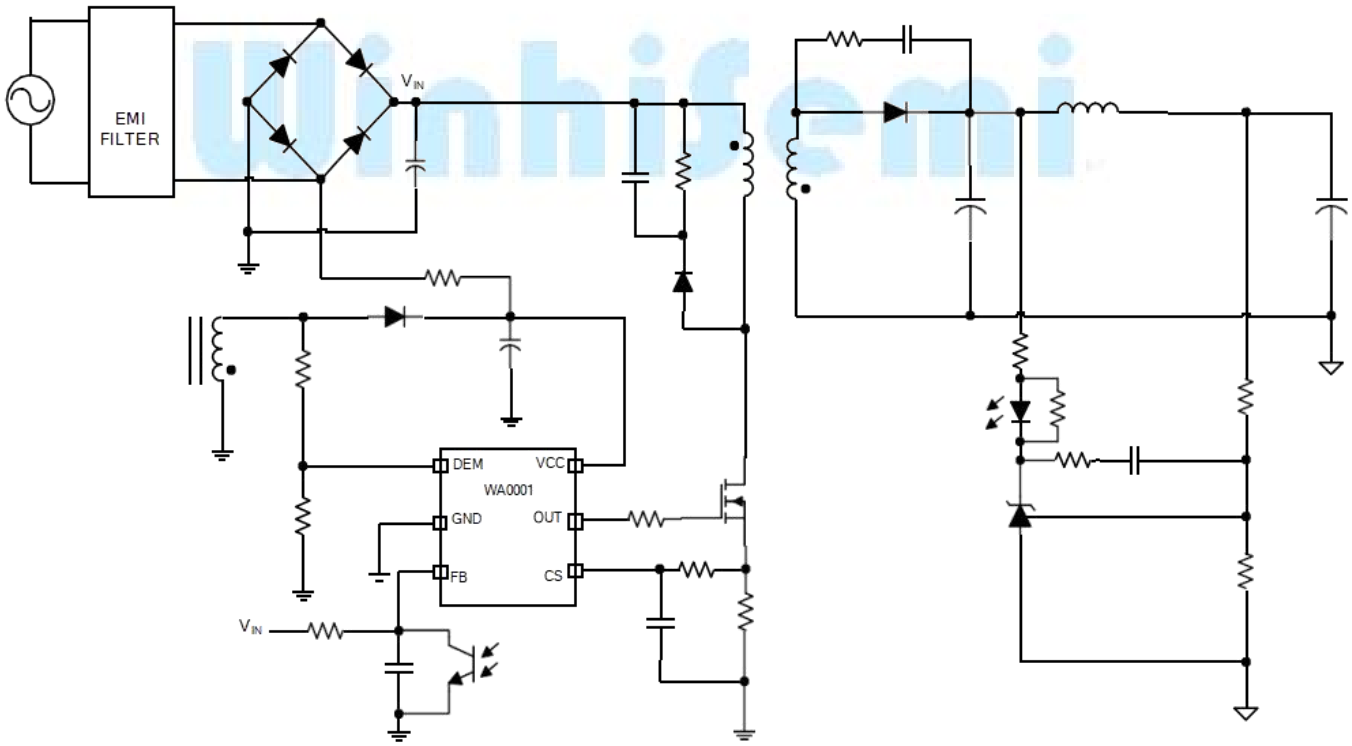
Description

The WA0001 is a high performance multi-mode (QR/CCM) PWM controller for flyback converter. It minimizes the components counts and is available in a tiny SOT23-6 package. Those make it an ideal design for low cost application. It provides functions of low startup current, green- mode power-saving operation, brownout protection and DEM VOP protection, and VCC over-voltage protection.

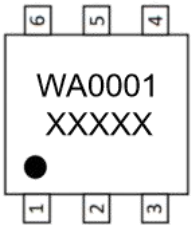
Applications

- Switching AC/DC power adapter
- SMPS Power Supply

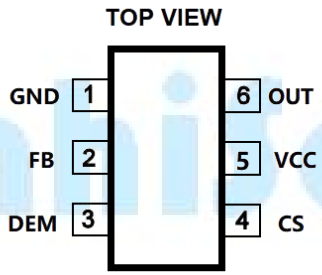
Typical Application Circuit



Ordering and Marking Information

Part Number	Marking Code	Package
WA0001	 WA0001=Device code XXXXX= Data code	**SOT23-6**

Pin Configuration



Pin Description

Pin No.	Name	Pin Function
1	GND	Ground
2	FB	Voltage feedback pin, by connecting a photo-coupler to control the duty cycle. Input Voltage detect pin, by connecting a resistor to control the brown in function.
3	DEM	Demagnetization detection signal. This pin can provide adjustable output voltage OVP and AC brown in/out protection.
4	CS	Current sense pin, connected to sense resistor for sensing the MOSFET current signal.
5	VCC	Power supply pin.
6	OUT	The output driver for driving the external MOSFET.

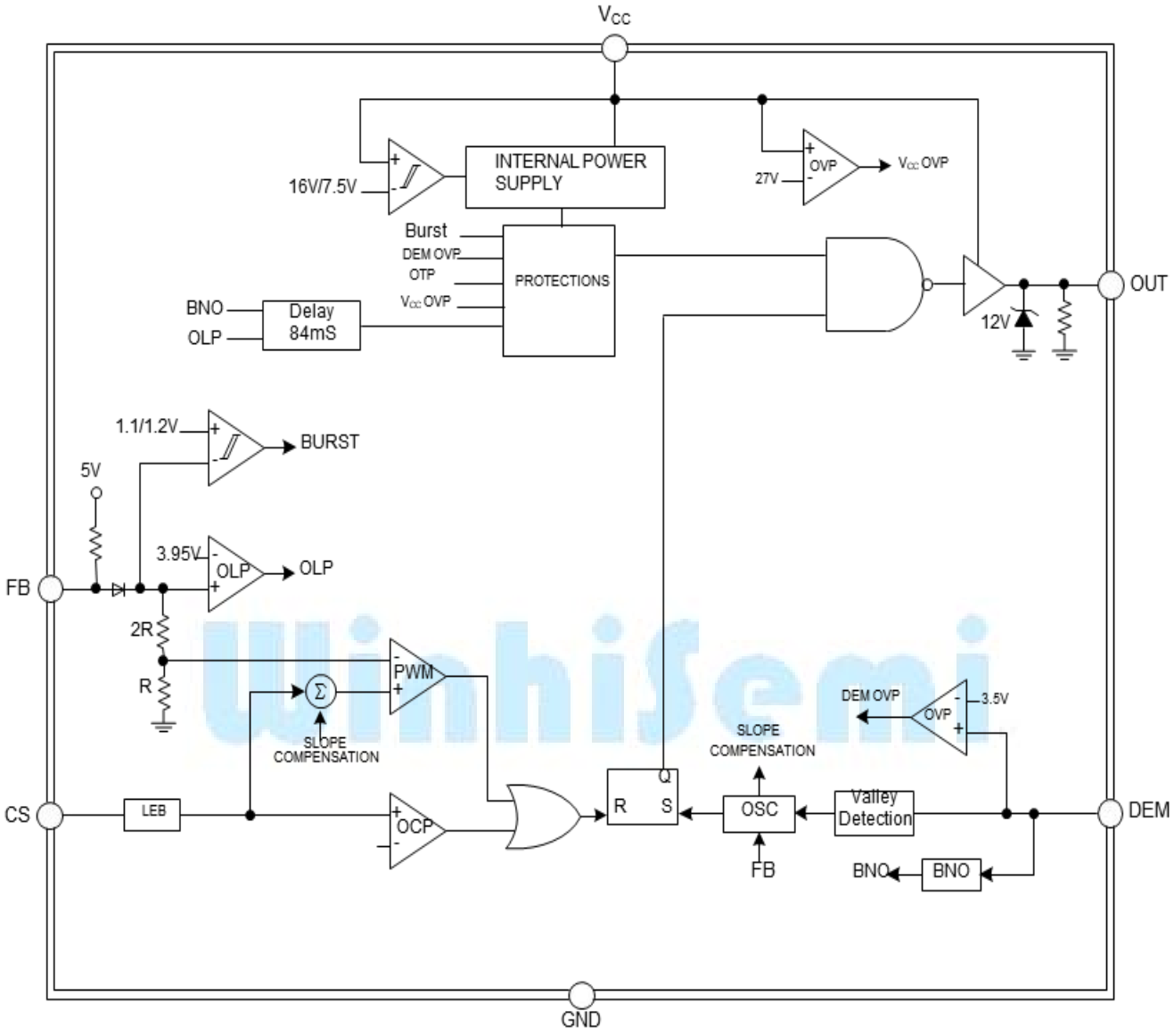
Absolute Maximum Values

Parameter	Symbol	Value	Unit
Supply Voltage(V_{CC})	VCC	0 to 29.0	V
OUT Voltage	OUT	-0.3~12.5	V
FB Voltage	FB	-0.3~5.5	V
CS Voltage	CS	-0.3~5.5	V
DEM Voltage	DEM	-0.3~5.5	V
ESD Human Body Rating		3	KV
ESD, Charged Device Rating		1	KV
Lead Temperature(soldering,10sec)		230	℃
Junction Temperature		150	℃
Storage Temperature		-65 to 150	℃
SOT23-6 Package Thermal Resistance	$R_{\theta JA}$	250	℃/W
SOT23-6 Package Thermal Resistance	$R_{\theta JC}$	115	℃/W
Power Dissipation (SOT23-6, at ambient temperature = 85℃)		250	mW

Protection Mode

CCM Switching Frequency	OLP	VCC OVP	DEM OVP	BNO
65kHz	Auto recovery	Auto recovery	Auto recovery	Auto recovery

Block Diagram



Electrical Characteristics (T_A= 25 ºC, unless otherwise stated, VCC=15.0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply Voltage (VCC pin)						
Startup Current	I_{CC_START}		2	5.5	μA	UVLO_ON–0.1V
Operating Current	I_{CC_OP}		1.8		mA	V_{FB}=3V, C_{out}=1nF
Operating Current standby	$I_{CC\_STANDBY}$		425		μA	V_{FB}=0V, C_{out}=1nF
UVLO(off)	V_{UVLO_OFF}	6.9	7.5	8.1	V	
UVLO(on)	V_{UVLO_ON}	14.8	16	17.2	V	
VCC OVP level	VCC_{OVP}		27		V	
Voltage Feedback (FB pin)						
Short Circuit Current of FB	I_{ZERO}	70	120	170	μA	V_{FB} =0V
Open Loop Voltage		4.2	4.6	5	V	FB pin open
Burst Mode Entry Voltage	V_{BR_IN}		1.1		V	
Burst Mode Ending Voltage	V_{BR_IN}		1.2		V	
Green Mode Entry Voltage*	*V_{GR_IN}		2.45		V	
Green Mode Ending Voltage*	*V_{GR_IN}		2		V	
OLP Trip level*		3.8	3.95	4.1	V	
Delay Time of FB pin Open Loop Protection			84		ms	
Current Sensing(CS Pin)						
Leading Edge Blanking Time	T_{LEB}	275	350	425	ns	
Current Limiting Threshold Max.*	*V_{CS_MAX}		970		mV	
Current Limiting Threshold Min.*	*V_{CS_MIN}		600		mV	
Delay to output*	*T_{d_OCP}		100	200	ns	
Demagnetization Detection(DEM Pin)						
Output OVP Trigger Point	V_{DEM_OVP}	3.37	3.5	3.63	V	
Threshold Current of Brown_In	I_{BNI}		45		μA	
BNO De-bounce Time	T_{d_BNO}		84		ms	
DEM OVP de-bounce time			8		cycles	
Demagnetization Detection Level			200		mV	
Oscillator for Switching Frequency						
Internal Soft Start Time*	T_{SS}		6		ms	
CCM Frequency	F_{CCM}	60	65	70	kHz	
Frequency Jittering	F_{JITTER}	-6		6	%	
Green Mode Frequency	F_{GREEN}	21	25	29	kHz	
Max Duty Cycle in CCM	D_{MAX}		63		%	
On Chip Thermal Shutdown						
OTP level*			150		℃	

Hysteresis*			25		℃	
Driver(OUT Pin)						
Output Voltage Low State	V_{OL}			1	V	I_{SOURCE} =20mA
Output Voltage High State	V_{OH}	8			V	I_{SINK} =20mA
Output Voltage Rise Time	T_R		250		ns	C_L=1.0nF, 10% to 90% of V_{out}
Output Voltage Fall Time	T_F		40		ns	C_L=1.0nF, 10% to 90% of V_{out}
Output clamp Voltage	V_{CLAMP}		12		V	

*Guaranteed by Design

Typical Performance Characteristics

Fig.1:I $_{StartUp}$ Current vs Temperature

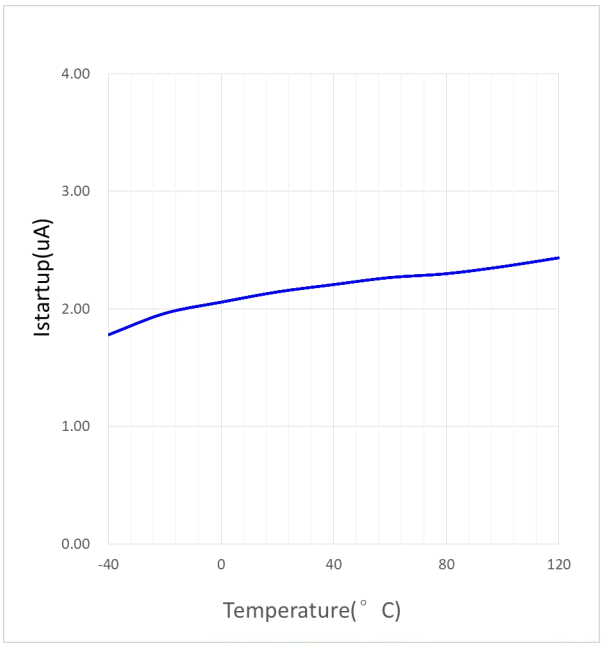


Fig.2 :UVLO$_{(ON)}$ vs Temperature

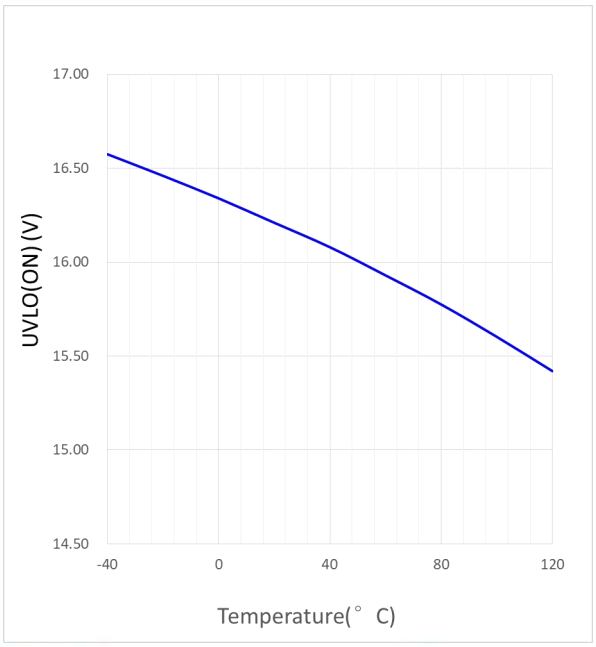


Fig.3 :UVLO$_{(OFF)}$ vs Temperature

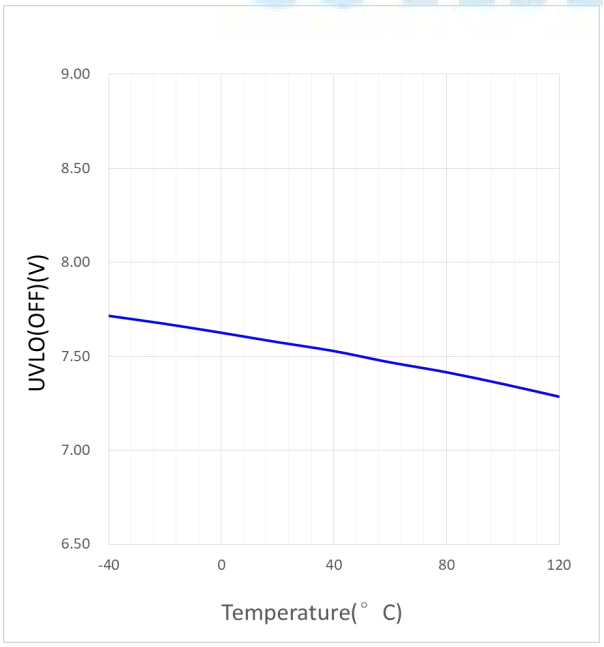


Fig.4 :V$_{COMP}$ Open Loop Voltage vs Temperature

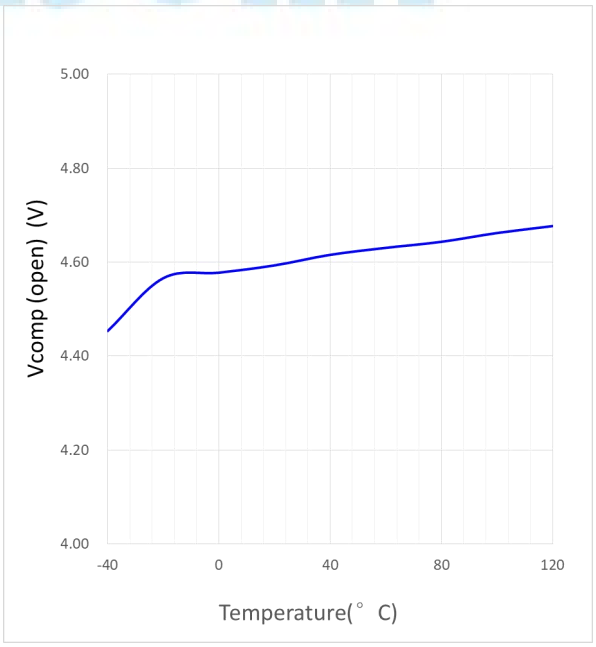


Fig.5 :Vcomp (OLP) vs Temperature

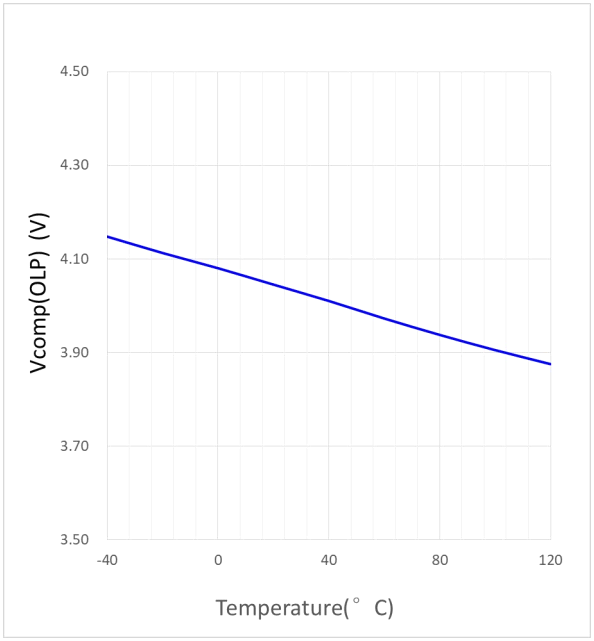
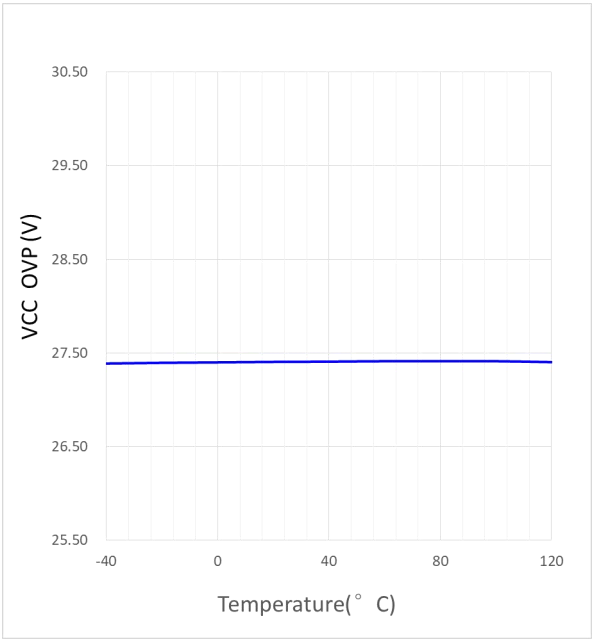


Fig.6: VCC OVP vs Temperature



Application Information

Overview

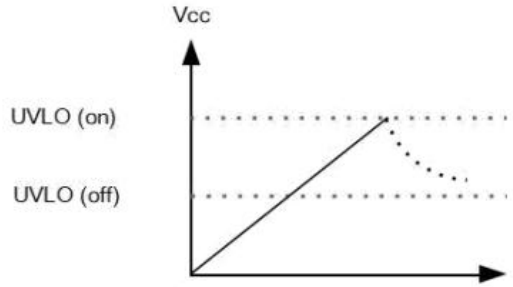
The WA0001 is a high performance multi-mode (QR/CCM) PWM controller for flyback converter. This results in a low-cost solution for low power AC/DC adapters. It integrated more functions to reduce the external components counts and the size. Using Power Forest patented technology, several function are integrated. Its major features are described as below.

Start-up Current

The start-up current is connected to one node of the AC bus. The typical start-up current is 2μA. Low start-up current allows a start-up resistor with a high resistance and a low-wattage to supply the start-up power for the controller.

Under-Voltage Lockout (UVLO)

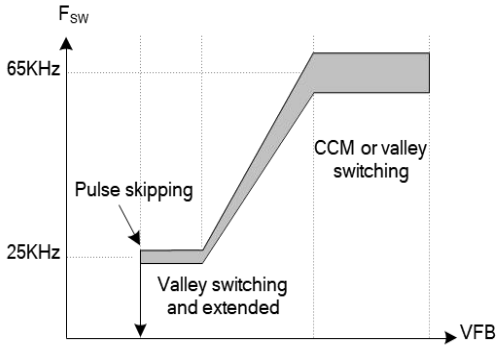
A hysteresis UVLO comparator is implemented in WA0001, then the turn-on and turn-off thresholds level are fixed at 16V and 7.5V respectively. This hysteresis shown in here ensures that the start-up capacitor will be adequate to supply the chip during start-up.



Multi-Mode Operation for High Efficiency

The WA0001 provides a CCM/valley switching mixed mode operation for better efficiency performance. The operation mode stays at CCM at heavy load, once if the converter enters into DCM, the WA0001 automatically finds the local minimum V_{DS} point and switching at this local valley.

Normally, the conduction loss is dominated at heavy load condition, and the switching loss turns to be larger than conduction loss in light load, especially at 1/4 ~ 1/2 of full load. By this kind of mixed mode operation to have CCM in heavy load and valley switching in light load can optimize the overall average efficiency during the entire operation range.



Leading-edge Blanking (LEB)

Each time the power MOSFET is switched on, a turn-on spike will inevitably occur at the sense resistor. To avoid fault trigger, a leading-edge blanking time is built in. During this blanking period, the current-limit comparator is disabled and cannot switch off the gate driver.

Internal Slope Compensation

A built-in slope compensation circuit is constructed in WA0001. When the switch is on, a ramp voltage is added to the sensed voltage across the CS pin, which helps to stabilize the system and prevent sub-harmonic oscillations.

Over-voltage Protection (OVP) on Auto Recovery mode

To prevent power MOSFET from being damaged, the WA0001 is implemented an OVP function on VCC. When the VCC voltage is higher than the OVP threshold voltage, the output gate driver circuit will be shut down to stop the switching of power MOSFET. The VCC OVP function is an auto-recovery type protection. If OVP happens, the pulses will be stopped and recover at the next UVLO on.

Output OVP on DEM - Auto Recovery mode

After startup sequence, the auxiliary winding of transformer will take over the supply voltage of VCC. The auxiliary winding couples with the main transformer in proportional to output voltage. An output overvoltage protection is implemented in the WA0001. It senses the auxiliary voltage via the divided resistors. The overvoltage protection works by sampling the plateau voltage after a delay time. The sampling voltage level is compared with internal threshold voltage.

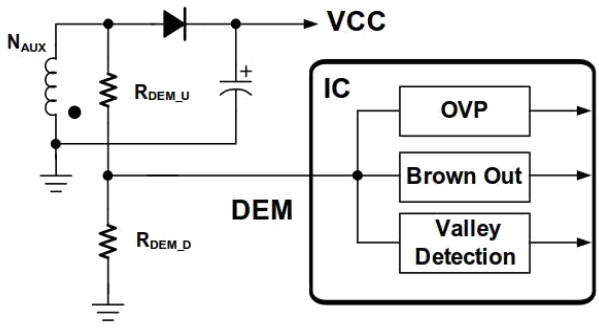
If the sampling voltage exceeds the DEM OVP trip level, the DEM OVP circuit switches the power MOSFET off. The DEM OVP function is an auto-recovery type protection. The de-bounce time of DEM OVP is 8 switching cycles to prevent incorrect OVP detection which might occur during ESD or lightning events.

OLP (Open Loop Protection)--Auto Recovery mode

The purpose of the feedback loop is to maintain a constant output voltage operating from no-load to full load with the full input voltage range. The WA0001 has open loop protection function. An internal circuit detects the V_{FB} level, when the V_{FB} is larger than an OLP threshold level and continues over OLP delay time, the protection will be activated and then turn off the gate output to stop the switching of power circuit. Then VCC decreases below UVLO off level, the controller resets again.

Brown IN & DEM OVP Protection

The DEM pin have two functions, detecting AC voltage and DEM OVP. To prevent high current stress at too low AC voltage condition, the WA0001 implements an AC brown-in protection through the DEM pin. The current sourcing out from the DEM pin monitors the AC input voltage level information when the OUT pin is enabled. Once if the current keeps under the IBNI threshold (45uA, typ.) for more than BNO De-bounce time, the AC brown out condition is issued and the OUT is disabled.



The equation is used to calculate the brown in level:

$$V_{AC\_BNI} = 45\mu \times \frac{R_{DEM\_U}}{\sqrt{2}} \times \frac{N_{PRI}}{N_{AUX}}$$

Through two resistance detection, an over voltage protection for Vout is fulfilled by sampling the voltage on the DEM after OUT turn-off. After OUT turning off a short delay, the sampled voltage is compared to the internal overvoltage reference to determine whether an OVP event has occurred. The internal over voltage reference is biased at 3.5V, users can define the resistor divider ratio by the equation below based on the desired OVP level:

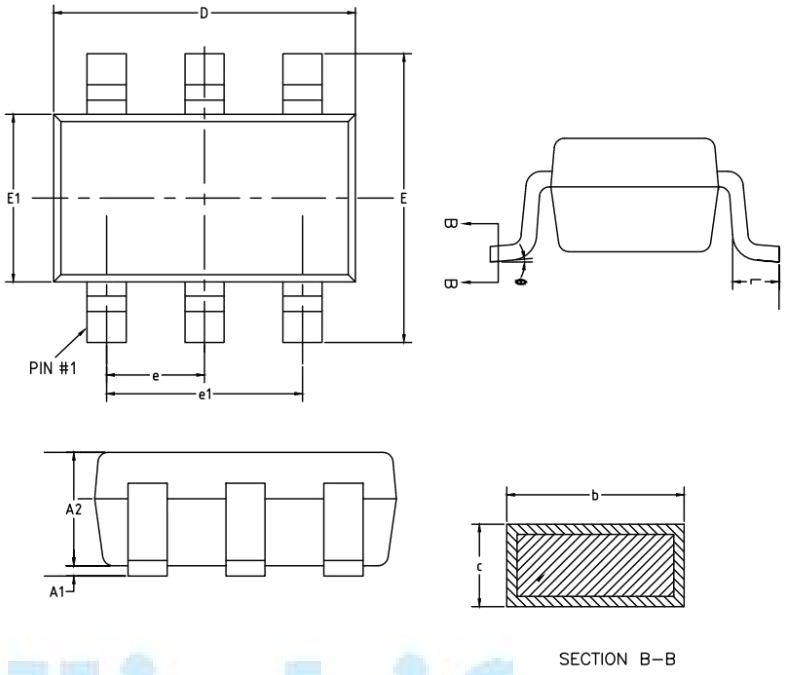
$$V_{OUT\_OVP} = 3.5 \times \frac{R_{DEM\_U} + R_{DEM\_D}}{R_{DEM\_D}} \times \frac{N_{SEC}}{N_{AUX}}$$

Gate Clamp & Soft Driving

Driver output is clamped by an internal 12V clamping circuit to prevent from undesired over-voltage gate signals. The WA0001 also has soft driving function to minimize EMI. The role soft is to achieve the whole startup process without impact and smooth.Effectively improve electromagnetic compatibility. Adopt appropriate industry standards.

Mechanical Dimensions

Package Information for SOT23-6



SYMBOL	SOT23-6			
	MILLIMETERS.		INCHES	
	Min.	Max.	Min.	Max.
A		1.45		0.075
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

Note:

1. Followed from JEDEC MO-178 AB.
2. Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 10mil per si.
3. A is the sum of A1and A2, and the overall height of the product.

NOTICE

Chengdu Winhi Semiconductor Co., Ltd (WH) reserves the right to make changes without notice in order to improve reliability, function or design and to discontinue any product or service without notice. Customers should obtain the latest relevant information before orders and should verify that such information is current and complete. All products are sold subject to WH's terms and conditions supplied at the time of order acknowledgement.

WH, its affiliates, agents, and employees, and all persons acting on its or their behalf, disclaim any and all liability for any errors, inaccuracies or incompleteness contained herein or in any other disclosure relating to any product.

WH disclaims any and all liability arising out of the use or application of any product described herein or of any information provided herein to the maximum extent permitted by law. The product specifications do not expand or otherwise modify WH's terms and conditions of purchase, including but not limited to the warranty expressed therein, which apply to these products.

WH warrants performance of its hardware products to the specifications at the time of sale, testing, reliability and quality control are used to the extent WH deems necessary to support this warrantee. Except where agreed upon by contractual agreement, testing of all parameters of each product is not necessarily performed.

WH does not assume any liability arising from the use of any product or circuit designs described herein. Customers are responsible for their products and applications using WH's components. To minimize risk, customers must provide adequate design and operating safeguards.

WH does not warrant or convey any license to any intellectual property rights either expressed or implied under its patent rights, nor the rights of others. Reproduction of information in WH's data sheets or data books is permissible only if reproduction is without modification or alteration. Reproduction of this information with any alteration is an unfair and deceptive business practice.

WH is not responsible or liable for such altered documentation. Resale of WH's products with statements different from or beyond the parameters stated by WH for that product or service voids all express or implied warrantees for the associated WH product or service and is an unfair and deceptive business practice.

Chengdu Winhi Semiconductor Co., LTD

Main Sites:

- **Headquarters**

Hangzhou Via-Media Semiconductor Co., LTD.
1305-1306, Building 71, No. 90, Wensan Road, Xihu District, Hangzhou, Zhejiang Province, P.R. China
Tel: +86-0571-8515 0563

- **Chengdu Office**

Chengdu Winhi Semiconductor Co., LTD.
Floor 15, Building 5, No. 171, Hele 2nd Street, Chengdu, Sichuan Province, P.R. China
Tel: +86-028-8505 0771

- **Shanghai**

Shanghai R&D Center.
1506~1508, Xinyin Building, 888 Yishan Road, Shanghai, P.R of China
Tel: +86- 021-54201999

- **Shenzhen**

Shenzhen Sales Center.
17B, No.1 Phoenix Building, 2008 Shennan Road, Shenzhen, P.R of China
Tel: +86-0755- 82570682

- **Xi'an**

Xi'an R&D Center
1703B, Building A, Greenland Center, Jinye Road, High-Tech Zone, Xi'an, Shaanxi, P.R of China