

Ultra-Fast Turn-off Synchronous Rectifier Controller

Features

- Operates in a Wide Output Voltage Range Down to Zero Voltage
- Self-supply for Operation with Low Output Voltage and/or High-side Rectification without an Auxiliary Winding
- Gate Drive Clamp Voltage is Up to 9.5V
- 10ns Fast Turn-off and 25ns Turn-on Delay
- Programmable Minimum on time to support wide frequency range
- VD/HVIN Pin Supports Negative Voltage Spikes Down to -3V
- VG Clamping Circuit works well for low Vth Value of MOSFET
- Optimized for up to 1MHz Frequency
- Supports Active Clamp Flyback with GaN FET or Super-junction MOSFET at Primary Side
- Supports DCM, QR and CCM Operations
- Supports both High-side and Low-side Rectification
- Adaptive Gate Drive for Maximum Efficiency
- SOT23-6 Package Available

General Description

The AS2566 is a compact secondary side synchronous rectifier controller and driver for high frequency and high-performance flyback converters. It is compatible with DCM, CCM and QR operations.

The AS2566 generates its own supply while used in high-side rectification, which eliminates the need of external supply generated by auxiliary winding of the transformer.

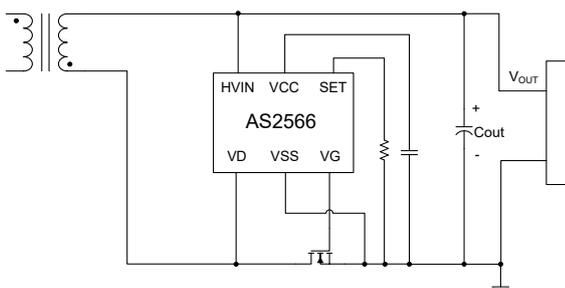
The extremely low 10ns turn-off propagation delay time and high sink current (~4A) capability of the driver improve SR VDS stress at CCM mode.

The unique VG clamping circuit works well to prevent VG from turning on by fast rising at VD pin with no VCC, that avoids the shoot through between primary side and secondary side during system startup even if the SR VCC is still below 2V.

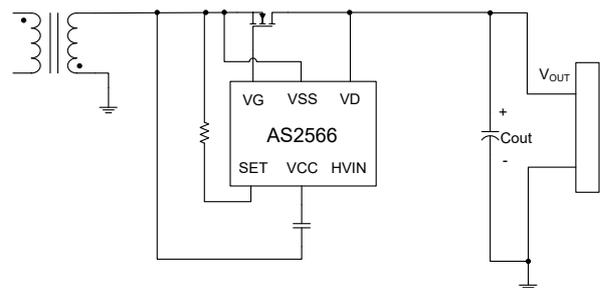
Application

- AC/DC Adapters for Mobile Phone and Notebook
- High Power density AC/DC Power Supply

Simplified Application

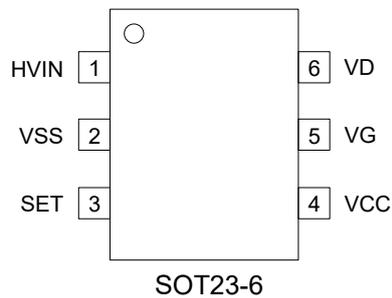


Used in low side rectification



Used in high side rectification

Pin Configuration



Pin Descriptions

PIN	Name	Description
1	HVIN	HV Linear Regulator Input
2	VSS	Ground, also used as FET source sense reference for VD
3	SET	Programming for GATE minimum turn on time
4	VCC	Linear Regulator Output, supply AS2566
5	VG	Gate drive output
6	VD	FET drain voltage sense; HV pulse LDO input

Ordering Information

PART No.	Package	Tape&Reel
AS2566	SOT23-6	3000pcs/reel

Absolute Maximum Ratings ⁽¹⁾

Parameter	Value	Units
VCC, VG, SET to VSS	-0.3 to +20	V
VD to VSS	-1 to +155	V
HVIN to VSS	-1 to +115	V
VD to VSS ⁽²⁾	-3 to +165	V
HVIN to VSS ⁽²⁾	-3 to +120	V
Operating Junction Temperature	-40 to +150	°C
Lead Temperature	+260	°C
Storage Temperature	-65 to +150	°C

(1) Exceeding these ratings may damage the device.

(2) Repetitive pulse < 200ns

Recommended Operation Conditions

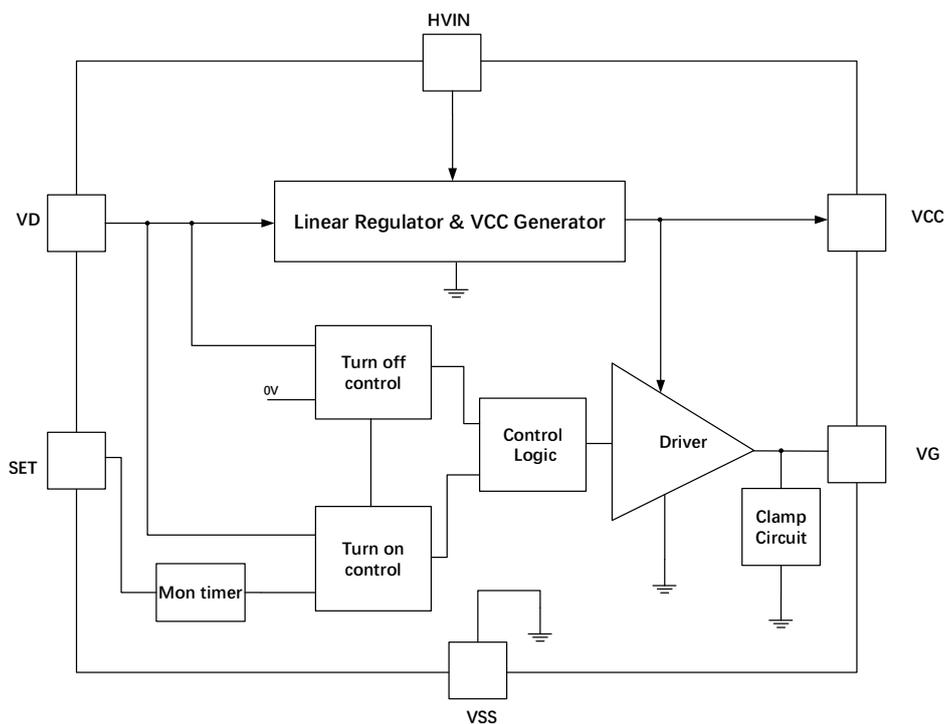
Parameter	Value	Units
VCC to VSS	3.6 to 10	V
VD to VSS	-0.7 to 150	V
HVIN to VSS	-0.7 to 100	V
Maximum Junction Temp. (T_J)	+125	°C

Thermal Resistance (1)

	Θ_{JA}	Θ_{JC}	Units
SOT23-6	100	66	°C/W

(1) Measured on JE5DSD51-7, 4 layers PCB

Block Diagram



Electrical Characteristics

TA = 25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
SUPPLY MANAGEMENT						
VCC UVLO Rising	VCC_ON		4.44	4.7	4.94	V
VCC UVLO Falling	VCC_OFF		3.9	4.1	4.25	V
VCC UVLO Hysteresis	VCC_HYST		0.54	0.6	0.7	V
VCC Maximum Charging Current	I _{VCC}	VCC=8V, VD=0V, HVIN=20V	70			mA
		VCC=5V, HVIN=0V, VD=20V	40			mA
VCC Regulation Voltage	VCC_REG	VD= 0V, HVIN=14V	8.3	9.2	9.9	V
		VD= 10V, HVIN=0V	6	6.4	6.8	
Operating Current	I _{CC}	VCC=9V, C _{LOAD} =2.2nF, F _{SW} =100kHz	2.25	2.4	2.9	mA
		VCC=6.5V, C _{LOAD} =2.2nF, F _{SW} =100kHz	1.65	1.8	2.1	mA
Quiescent Current	I _{q(VCC)}	VCC=6.5V	140	190	230	μA
MOSFET VOLTAGE SENSING						
V _D -V _{SS} Adjusting Voltage	V _{DS_reg}		-55	-40	-16	mV
Turn-On Threshold (V _D -V _{SS})	V _{ON_th}		-300	-250	-200	mV
Turn Off Threshold (V _D -V _{SS})	V _{OFF_th}		-19	0	15	mV
Turn-On Propagation Delay	T _{D_on}	C _{LOAD} = 0nF, VD step down from 3V to -0.5V in 5ns, measure VG rising to 1V	10	25	40	ns
Turn-Off Propagation Delay	T _{D_off}	C _{LOAD} = 0nF, VD step up from -0.5V to 3V in 5ns, measure VG falling to 90% of V _{G-H}	4	10	15	ns
Turn On Blanking Time	T _{B_ON}	R _{SET} =0ohm, C _{LOAD} = 2.2nF	0.35	0.45	0.56	us
	T _{B_ON}	R _{SET} =VCC, C _{LOAD} = 2.2nF	0.9	1.05	1.2	us
Turn Off Blanking V _{DS} Threshold in T _{B_ON} ⁽¹⁾	V _{B_OFF}			2		V
Turn Off Blanking Time	T _{B_OFF}	C _{LOAD} = 2.2nF	250		350	ns

GATE DRIVER						
V _G (Low)	V _{GL}	I _{LOAD} = 100mA		0.1	0.3	V
V _G (High)	V _{GH}	I _{LOAD} = 100mA	V _{CC} -0.6	V _{CC} -0.3		V
Maximum Source Current ⁽¹⁾	I _{VGH}			1		A
Maximum Sink Current ⁽¹⁾	I _{VGL}			4		A
Pull Down Impedance ⁽¹⁾	R _{SINK}	I _{LOAD} = 100mA		0.53		Ω

(1) Values are verified by characterization on bench, not tested in production

Operation Descriptions

The AS2566 is an advanced secondary side synchronous rectifier controller and driver for high frequency and high performance flyback converters, which supports DCM, CCM and QR operations. The extremely low 10ns turn-off propagation delay time and high sink current (~4A) capability of the driver improve SR V_{DS} stress at CCM mode, particularly at the conditions of startup and V_{OUT} shorting to ground. The unique VG clamping circuit works well to prevent VG from turning on by fast rising at VD pin with no VCC, that avoids the shoot through between primary side and secondary side during system startup.

VCC AND STARTUP

In order to reduce switching and conduction loss with wide range of voltage threshold V_{th} of MOSFETs, AS2566 provides the flexibility of different VG voltage. VCC is regulated at 9.5V which supplies AS2566 including VG when connect HVIN pin to a voltage source higher than 9.8V. Here the source for HVIN pin can be a DC voltage such as V_{OUT} for low side rectification or an AC voltage such as the DRAIN of SR MOSFET. The average maximum charging current is 62mA while VCC is regulated from HVIN voltage source. Be noted the voltage applied to HVIN pin is self-limited with <100mA DC and 1A pulse after exceeding 120V, and VD pin is self-limited with <100mA DC and 1.5A pulse after exceeding 160V. When the voltage on HVIN pin is below 9.5V but above 6.2V, VCC follows HVIN with dropout voltage depending on the load current at VCC, until HVIN drops to around 6.2V. Once HVIN drops around 6.2V, a 45mA current source from VD starts charging up VCC and regulating it at 6.2V.

The typical system implementations with different bias connections are shown below. A 0.1uF to 1uF bypass capacitor is suggested at VCC pin.

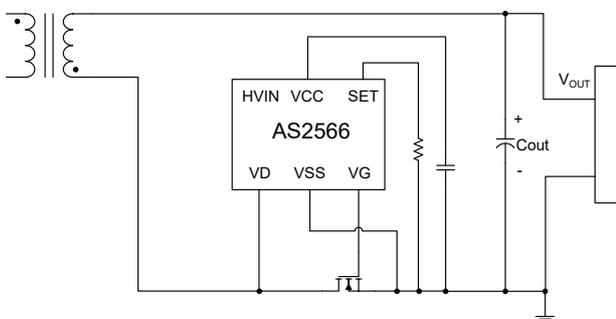


Figure 2. Low-side Rectification 2, $V_{CC_REG}=6.2V$

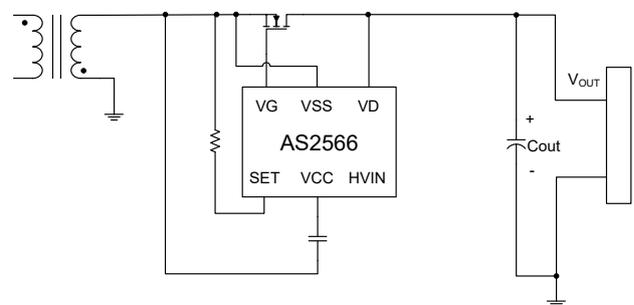


Figure 3. High-side Rectification 2, $V_{CC_REG}=6.2V$

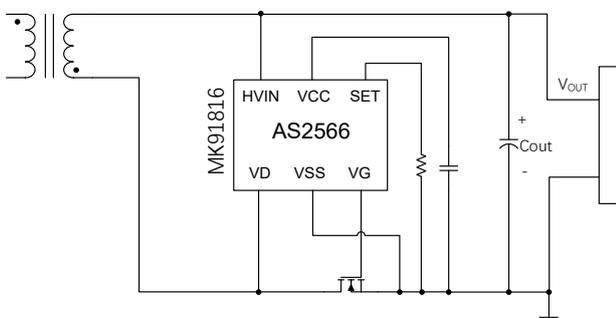


Figure 4. Low-side Rectification 3, $V_{CC_REG}=6.2V$ to 9.5V ⁽¹⁾

(1) In Low-side Rectification 4, VCC is supplied by VD and regulated at 6.2V if V_{OUT} is lower than 6.2V; VCC is regulated at 9.5V through HVIN if V_{OUT} voltage is larger than 9.8V; VCC is close to V_{OUT} while V_{OUT} is between 6.2V and 9.5V, which generated by HVIN path.

Pay attention to the voltage stress when connecting HVIN to Drain of SR MOS, as HVIN pin withstands less voltage rating than VD pin. To achieve 9V VCC, and lower HVIN voltage stress, below connections should be considered.

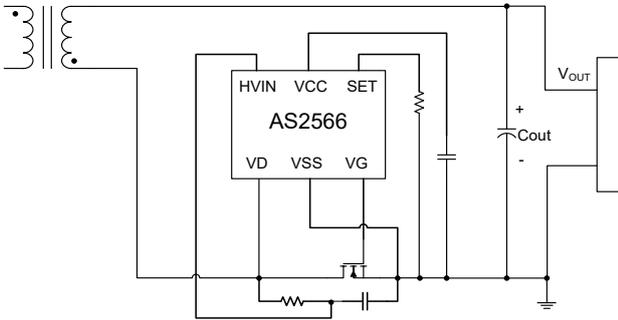


Figure 5. Low-side Rectification, $VCC_{REG}=9V$

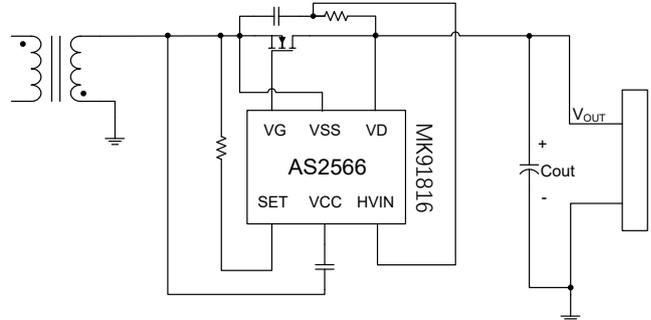


Figure 6. High-side Rectification, $VCC_{REG}=9V$

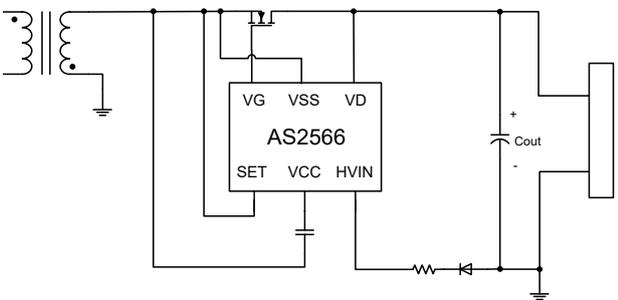


Figure 7. High-side Rectification, $VCC_{REG}=9V$

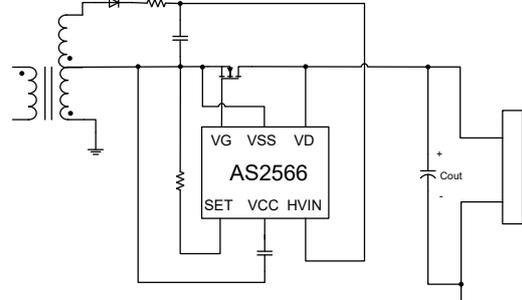


Figure 8. High-side Rectification, $VCC_{REG}=9V$

CONDUCTION PHASE

After SR VG turns on, a minimum blanking time T_{B_ON} is required to prevent the parasitic ringing from falsely turning off SR VG. The minimum turn-on blanking time programmed by Rset for AS2566, during which the turn off threshold is increased to 2V. Right before T_{B_ON} timer expires, AS2566 starts monitoring V_{DS} against a -40mV value to determine if VG needs to be slowly discharged. This operation adjusts V_{DS} of SR MOSFET to be around -40mV until the current through SR MOSFET drops to zero. In CCM mode, VG is prepositioned to be lower than VCC so that VG is turned off even faster; In DCM/QR mode, this V_{DS} adjusting design makes V_{DS} cross 0V exponentially faster, which combines with the 10ns turn-off propagation delay to make turn-off timing more accurately regardless of the accuracy of turn-off threshold.

TURN OFF PHASE

Within the minimum turn-on blanking time T_{B_ON} , V_{DS} turn-off threshold is 2V which is the same as V_{B_OFF} . After the minimum turn-on blanking time T_{B_ON} , the turn-off threshold is decided by T_{B_ON} , that combines with extremely fast 10ns turn-off propagation delay and 4A VG pull-down (sinking) current, synchronous rectifier is able to be turned off not too early which causes more SR FET body diode conduction time and more negative turn-off ringing, or not too late which creates risk of shoot through between primary side and SR side in CCM mode.

MINIMUM ON TIME PROGRAMMING

The turn on blanking time (T_{B_ON}) is programmed by SET pin, $T_{B_ON} = (20/3) * (R_{set}(k) + 60)$ ns, where R_{set} is in the range of 10k to 310k. R_{set} is connected between SET pin and VSS pin. when R_{set} is smaller than 10k, T_{B_ON} is fixed to 400ns. when R_{set} is 310k, T_{B_ON} is ~2.5us. If SET PIN is floating(or $R_{set} \geq 340k$), then T_{B_ON} is around 1us.

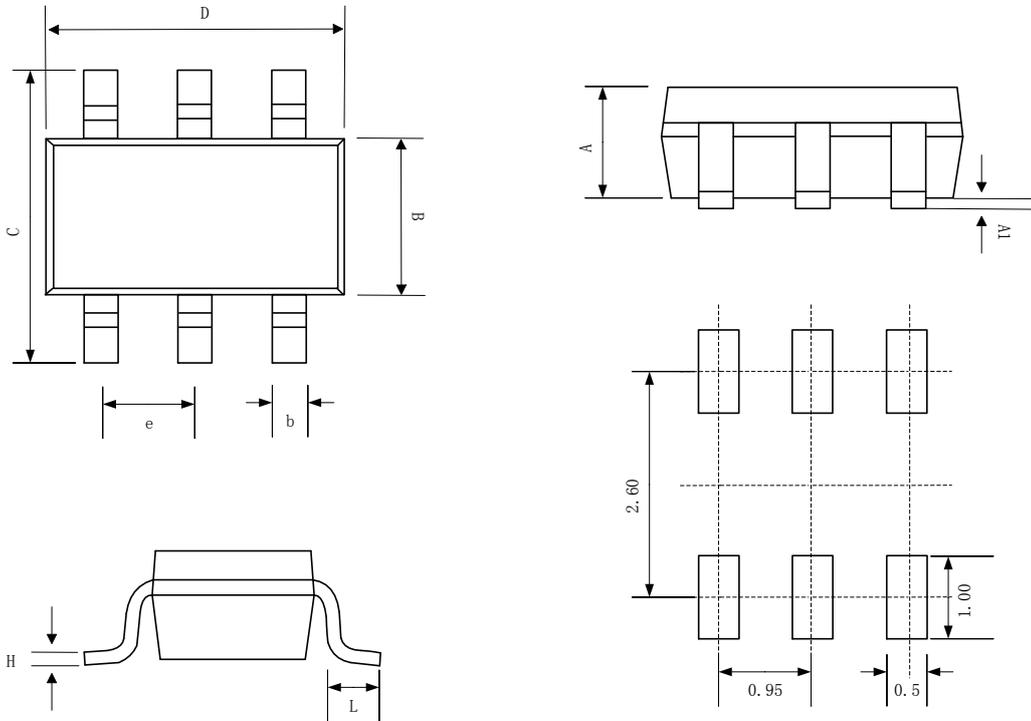
PCB LAYOUT RECOMMENDATIONS

The PCB layout guidance are shown below:

1. The trace from VG pin to the GATE of SR MOSFET needs to be as short as possible. The VSS pin to the SOURCE of SR MOSFET needs to route with short and wide trace
2. The sense loop (VD pin and VSS pin) is as small as possible
3. In two-layer boards, avoid fast dv/dt traces underneath AS2566, such as the DRAIN of SR MOSFET network

Package Information

SOT23-6



Recommended Land Pattern

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.889	1.100	1.295
A1	0.000	0.050	0.152
B	1.397	1.600	1.803
b	0.28	0.35	0.559
C	2.591	2.800	3.000
D	2.692	2.920	3.120
e	0.95BSC		
H	0.080	0.152	0.254
L	0.300	0.450	0.610