Synchronous Rectification Switcher Supporting CCM

1. Description

The TS16E18H is a compact secondary side synchronous rectification switcher which integrated controller and MOSFET for high performance flyback converters. It is compatible with CCM, DCM and QR operations.

The TS16E18H can generate its own supply voltage while with high-side rectification; this eliminates the need of auxiliary winding of the transformer, which is usually required to produce supply voltage.

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.

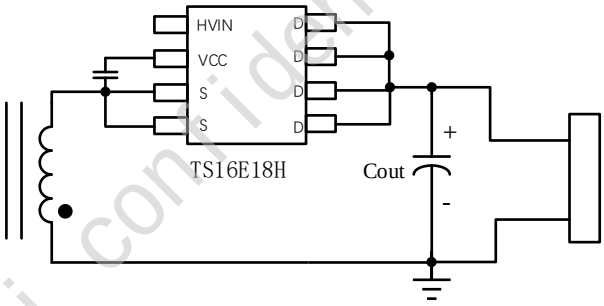
2. Typical Applications

- AC/DC Adapters for Mobile Phone and Notebook
- High Power density AC/DC Power Supplies
- Battery Powered System

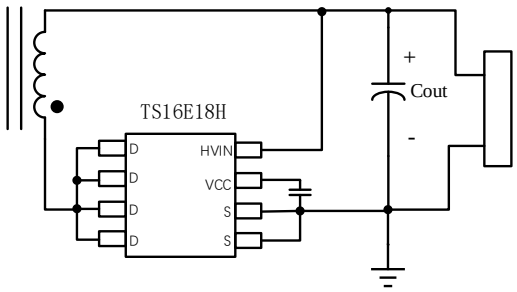
3. Features

- Integrated 8.5mΩ 100V Power MOSFET
- Operates in a wide output voltage range down to 3V voltage (self-supply)
- Self-supply for operations with low-side rectification and high–side rectification without an auxiliary winding
- 10ns Fast Turn-off and 25ns Turn-on Delay
- VG Clamping Circuit Works Well when VCC is Below 2V
- Supports CCM, DCM and QR Operations
- Precise 0V turn off for maximum efficiency
- Designed for <300kHz working frequency
- Minimal peripheral circuit that requires at least one 0.1uF capacitor
- Available in SOP-8 Package

4. Simplified Application



Used in high side rectification

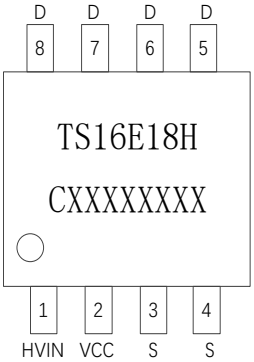


Used in low side rectification
(high frequency recommendation circuit)

5. Ordering Information

Ordering No.	Description
TS16E18HCBR	SOP-8, MSL-3, 4000 PCS/REEL
TS16E18HEAB	SOP-8, MSL-3, 4000 PCS/REEL

6. Package Reference



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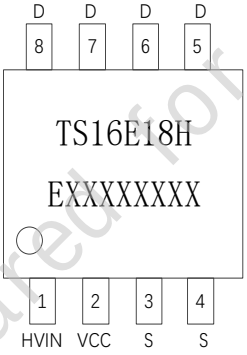
TS16E18HCBR
SOP-8



XXXXXXXX: Lot code
TS16E18HEAB
SOP-8

Absolute Maximum Ratings (1)

VCC to S ..... –0.3V to +20V
D to S ..... –0.7V to 100V
VD to S ..... –1V to 115V
VD to S ..... –3V to 120V (2)
Continuous drain current I_D ..... 9A(3)
Pulsed drain current I_{DM} ..... 40A(4)
Continuous Power Dissipation 2.5W (T_A = +25°C) (5)
Junction Temperature ..... 150°C

Recommended Operation Conditions

VCC to S…. ..... ……. .5V to 9.5V
D to S……..-0.7V to 90V
Maximum Junction Temp. (T_J)..... +125°C

Thermal Resistance (6)

	θ_{JA}	θ_{JC}	
SOP-8	80	35	°C/W

Notes:

(1) Exceeding these ratings may damage the device.

(2) Repetitive pulse< 200ns

(3) Calculated continuous current based on maximum allowable junction temperature

(4) Repetitive rating: pulse width limited by maximum junction temperature

(5) The maximum allowable power dissipation is a function of the maximum junction temperature T_J(MAX), the junction-to-ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P_D(MAX)=(T_J(MAX)-T_A)/θ_{JA}. Exceeding the maximum allowable power dissipation will cause excessive die temperature.

(6) Measured on JESDSD51-7, 4 layers PCB

7. Electrical Characteristics

T_A=25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Internal MOS Section						
Internal MOS Rdson	R_{dson}	VCC=9V, Id=1A		8.5	13.5	mΩ
Drain to Source Breakdown	$V_{DSS(BR)}$	VCC=6.8V，Id=2mA	100			V
Supply Management Section						
VCC UVLO Rising	V_{CC_ON}		4.3	4.6	4.9	V
VCC UVLO Falling	V_{CC_OFF}		3.8	4	4.3	V
VCC UVLO Hysteresis	V_{CC_HYST}		0.25	0.6	0.75	V
VCC Regulation Voltage	V_{CC_REG}	HVIN= 14V	8.2	9.1	10	V
Operating Current	ICC(1)	VCC=6.5V, Fsw=100KHz,	1.5	2.0	2.5	mA
Quiescent Current	$I_{q(VCC)}$	VCC=6V, Fsw=0Hz	100	350	550	μA
Mosfet Voltage Sensing						
V_D–V_{SS} Adjusting Voltage	V_{DS_REG}		-55	-40	-25	mV
Turn-On Threshold (V_D–V_{SS})	V_{ON_th}		-350	-300	-50	mV
Turn Off Threshold (V_D–V_{SS})	V_{OFF_th}			0	10	mV
Turn-On Propagation Delay	T_{D_on}			25	40	ns
Turn-Off Propagation Delay	T_{D_off}			10	15	ns
Turn On Blanking Time	T_{B_ON}	C_{LOAD} = 2.2nF	0.35	0.43	0.5	μs
Turn Off Blanking V_{DS} Threshold in T_{B_ON}	V_{B_OFF}			2		V
Turn Off Blanking Time	T_{OFF}		250	300	350	ns
Gate Driver						
V_G (Low)	V_{G_LOW}	VCC=6.4V, ILOAD=0.1A	0	0.2	0.4	V
V_G (High)	V_{G_HIGH}	VCC=6.4V, ILOAD=0.1A	VCC-0.6	VCC-0.3	VCC	V

Note:

(1) ICC in the table is the current consumed by the internal controller when 2.2nF load capacitance and 100kHz operating frequency.

8. PIN Functions

Pin #	Name	Description
1	HVIN	HV pulse LDO input
2	VCC	Inner Regulator Output, supply TS16E18H
3,4	S	Chip ground, built-in MOSFET source
5,6,7,8	D	MOSFET drain

9. Block Diagram

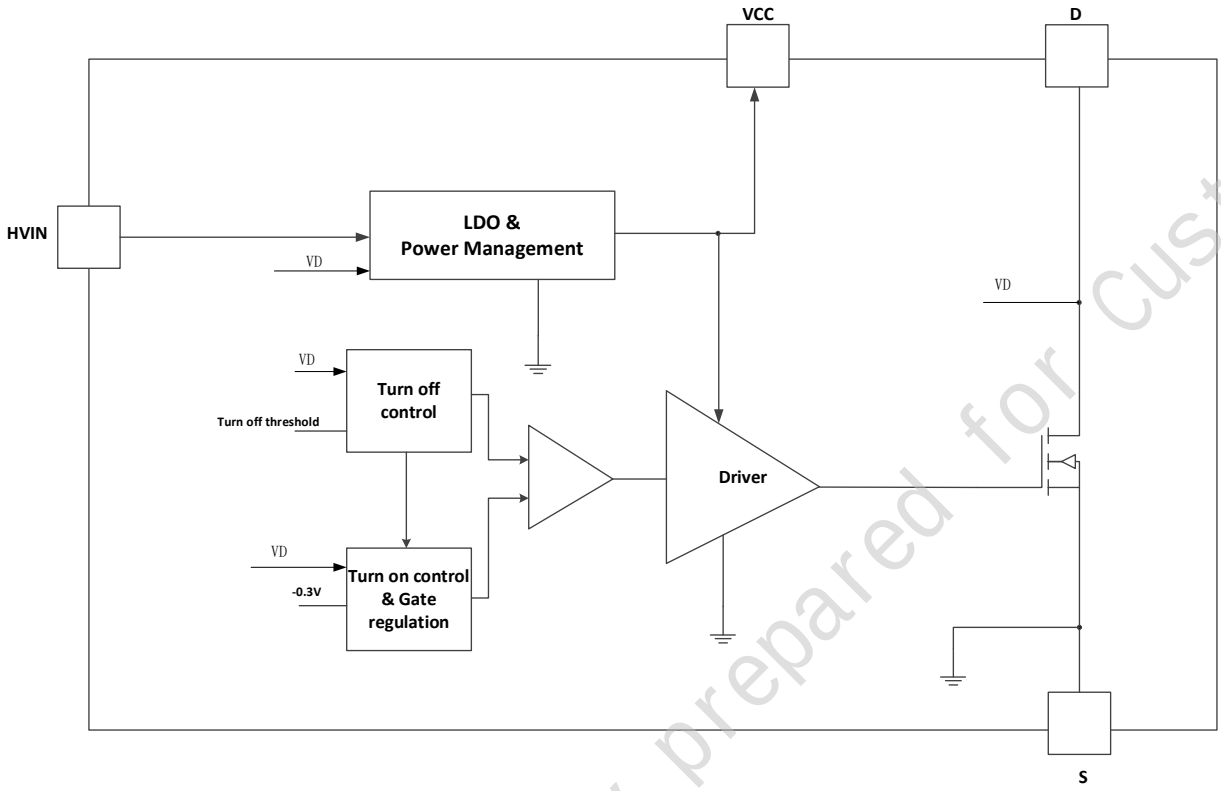


Figure 1. Functional Block Diagram

10. Operation Descriptions

TS16E18H is a high-performance synchronous rectifier which can replace the Schottky diode rectification in the flyback converter to improve efficiency, which supports DCM, CCM and QR operations. A great flexibility for system designing is brought by Self-supply which supports operations with both low-side rectification and high–side rectification without an auxiliary winding.

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 is around 0.43us for TS16E18H, during which the turn off threshold is increased to 2V. Right before T_{B_ON} timer expires, TS16E18H starts monitoring V_{DS} against a -40mV value to determine if internal 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.

Turn off Phase

TS16E18H's turn-off threshold is different at different time. 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 around 0V, 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.

11. Typical Implementations

As shown in Figure 2 to Figure 4, the TS16E18H can be placed at the positive or negative output terminals to replace the Schottky diode, without the need for additional auxiliary winding power supply. In this case, the VCC is supplied by the internal DARIN and regulated at around 6V. In the PPS system, the output voltage Vout will be as low as 3.3V, but the VCC will still be maintained at around 6V.

The HVIN is the LDO power supply pin inside the chip. By supplying power through the HVIN, the VCC voltage will be maintained at around 9V (when the HVIN voltage is higher than 9V). This connection method is shown in Figure 5, but it may cause greater power supply loss in high frequency applications.For high frequency applications, the connection method in Figure 3 or Figure 4 is recommended. A 0.1uF bypass capacitor is suggested to regulate the bias voltage and reduce noise coupling from switching.

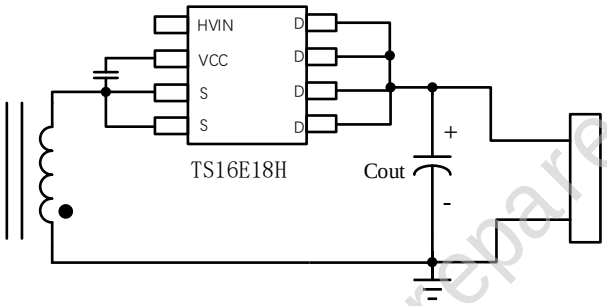


Figure 2. The High side rectification(VCC=6V)

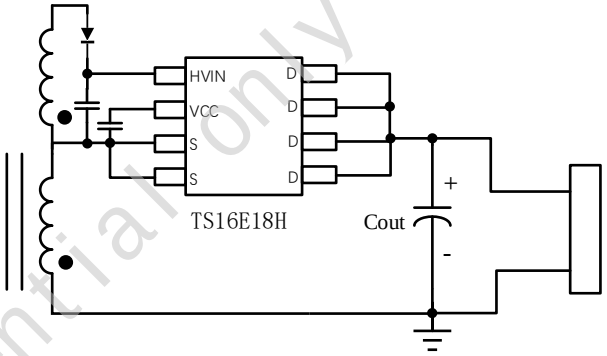


Figure 3. The High side rectification(recommended high-frequency applications)

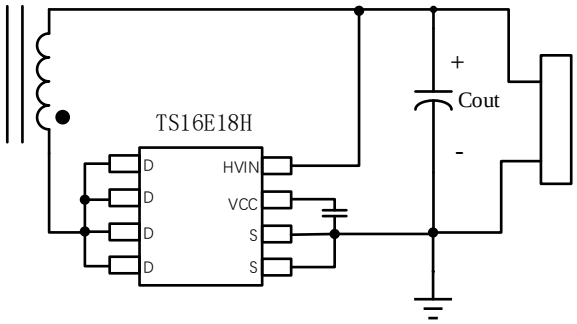


Figure 4. The High side rectification(recommended low or high-frequency applications)

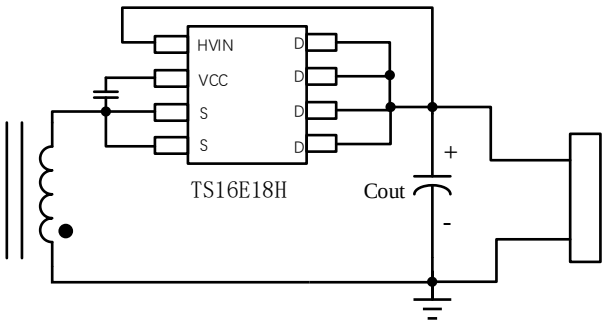
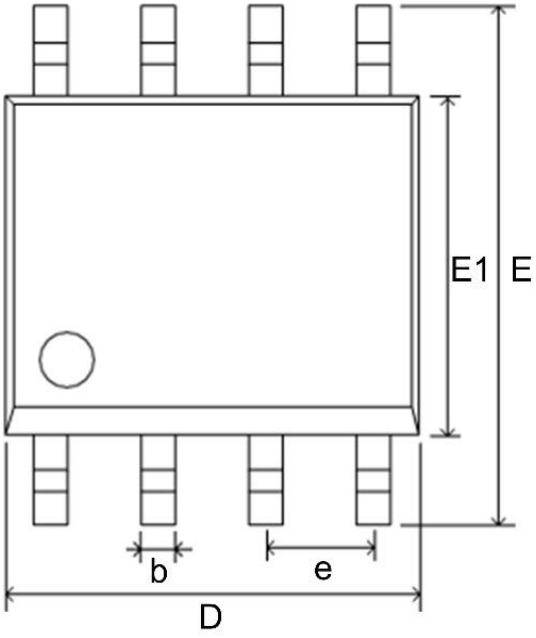
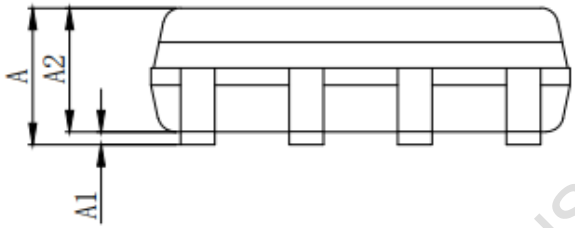


Figure 5. The High side rectification(VCC=9V)

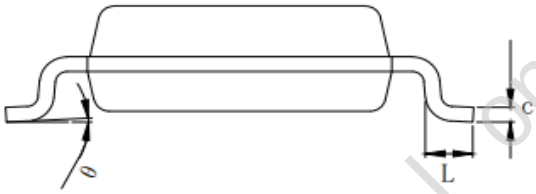
12. Package Information (SOP-8)



TOP VIEW



FRONT VIEW



SIDE VIEW

Symbol	Dimensions In Millimeters	
	MIN	MAX
A	1.3	1.75
A1	0.05	0.25
A2	1.25	1.65
b	0.33	0.51
c	0.2	0.25
D	4.7	5.1
E	5.8	6.2
E1	3.8	4.0
e	1.270(BSC)	
L	0.4	1.27
θ	0°	8°