

Synchronous Rectification Switcher Supporting CCM

1. Description

The MK1716 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 MK1716 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.

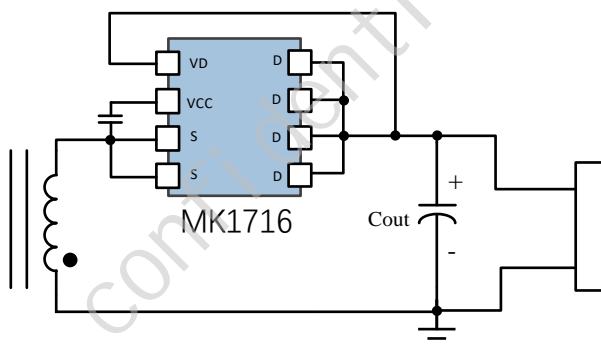
3. Features

- Integrated 16mΩ 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 <200kHz working frequency
- Available in SOP-8 Package

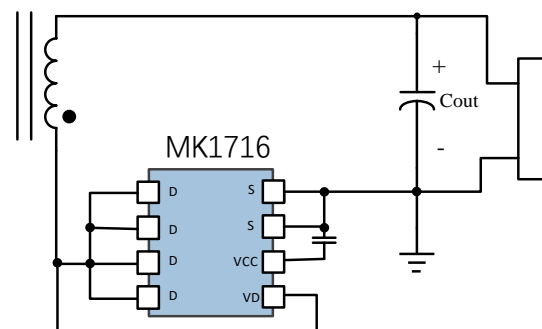
2. Typical Applications

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

4. Simplified Application



Used in high side rectification

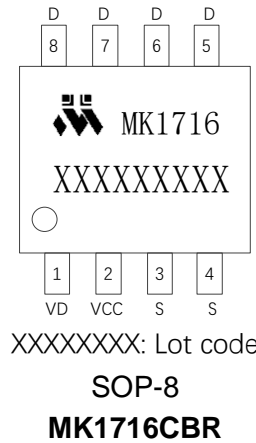


Used in low side rectification

5. Ordering Information

| Ordering No. | Description |
|--------------|-----------------------------|
| MK1716CBR | SOP-8, MSL-3, 4000 pcs/reel |

6. Package Reference



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 | 7A ⁽³⁾ |
| Pulsed drain current I _{DM} | 26A ⁽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) T_A=25°C; 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

$T_A=25^{\circ}\text{C}$, unless otherwise noted.

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|--|----------------------------------|---|--------------------------|--------------------------|-----------------|-------|
| Internal Mos Section | | | | | | |
| Internal MOS R _{dson} | R _{dson} | V _{CC} =9.5V, I _D =1A | | 16 | 25 | mΩ |
| Drain to Source Breakdown | V _{DSS(BR)} | V _{CC} =V _D =0V, I _D =1mA | 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} | V _D = 14V | 8.2 | 9.1 | 10 | V |
| Operating Current | I _{CC} (¹) | V _{CC} =6V, F _{sw} =100kHz, | 1.5 | 2.0 | 2.5 | mA |
| Quiescent Current | I _{q(VCC)} | V _{CC} =6.4V, F _{sw} =0Hz | | 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 | 0.75 | 1.0 | 1.3 | 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} | V _{CC} =6.4V, I _{LOAD} =0.1A | 0 | 0.2 | 0.4 | V |
| V _G (High) | V _{G_HIGH} | V _{CC} =6.4V, I _{LOAD} =0.1A | V _{CC} - 0.6 | V _{CC} - 0.3 | V _{CC} | 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 | VD | FET drain voltage sense; HV pulse LDO input |
| 2 | VCC | Inner Regulator Output, supply MK1716 |
| 3,4 | S | Ground, also used as FET source sense reference for VD |
| 5,6,7,8 | D | FET drain |

9. Block Diagram

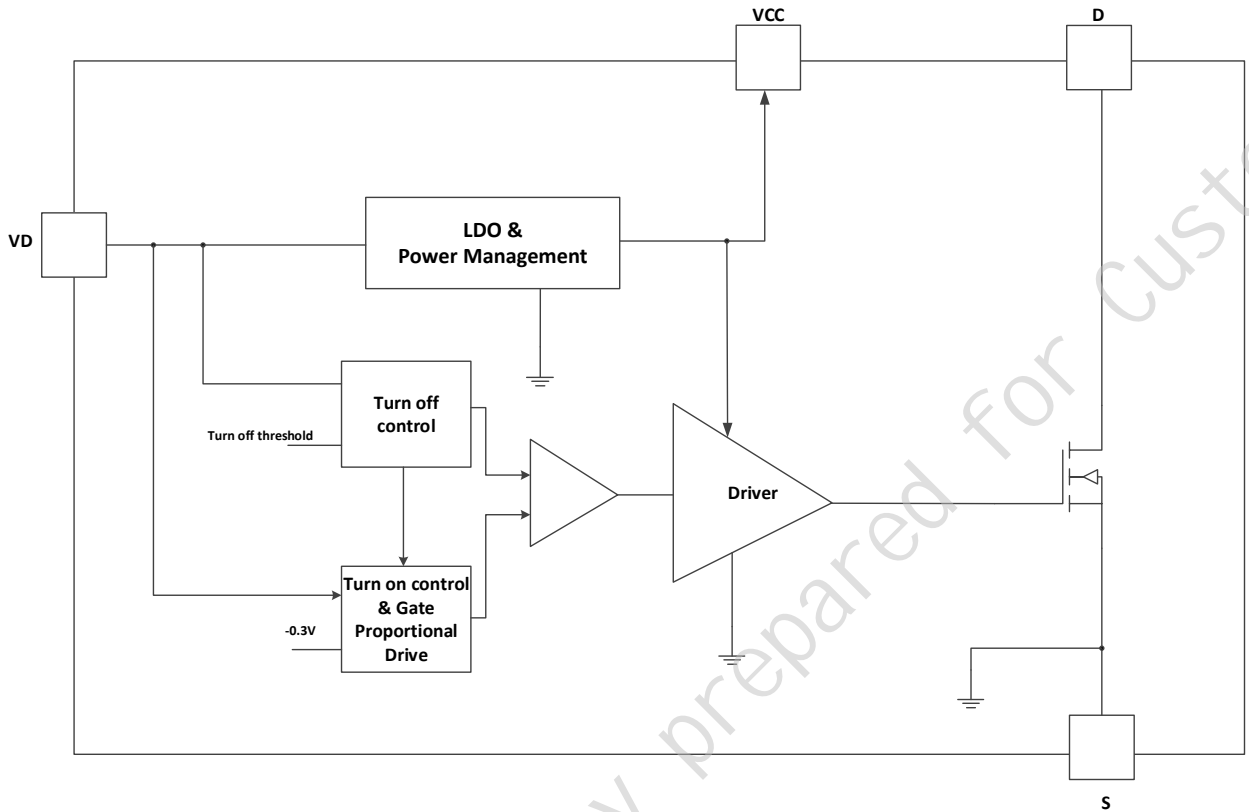


Figure 1. Functional Block Diagram

10. Operation Descriptions

MK1716 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 TB_ON is required to prevent the parasitic ringing from falsely turning off SR VG. The minimum turn-on blanking time is around 1.0us for MK1716, during which the turn off threshold is increased to 2V. Right before TB_ON timer expires, MK1716 starts monitoring VDS against a -40mV value to determine if internal VG needs to be slowly discharged. This operation adjusts VDS of SR MOSFET to be around -40mV until the current through SR MOSFET drops to zero.

Turn Off Phase

MK1716's turn-off threshold is different at different time. Within the minimum turn-on blanking time TB_ON, VDS turn-off threshold is 2V which is the same as VB_OFF. After the minimum turn-on blanking time TB_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

MK1716 supports both high side rectification and low side rectification to replace Schottky diode without the need of auxiliary winding as shown in Figure 2 and Figure 3. VCC is powered from pin D and regulated at ~9V even when Vout is much lower than 5V. A 0.1uF bypass capacitor is suggested to regulate the bias voltage and reduce noise coupling from switching.

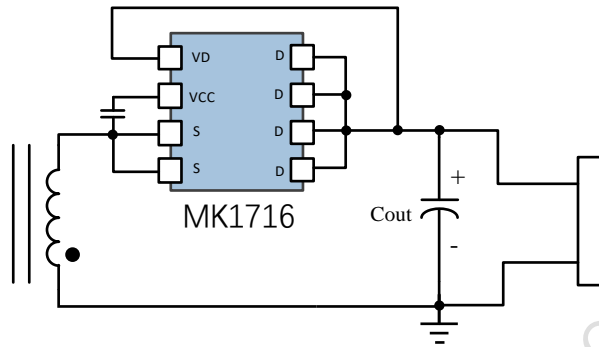


Figure 2. The High side rectification

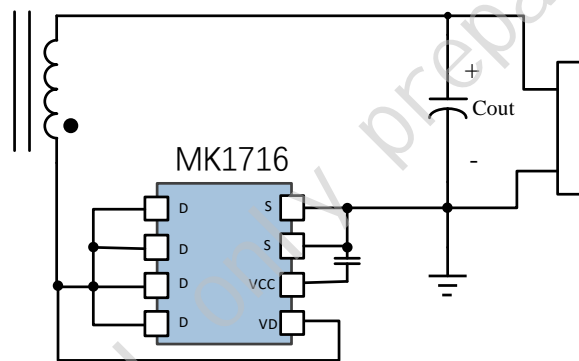


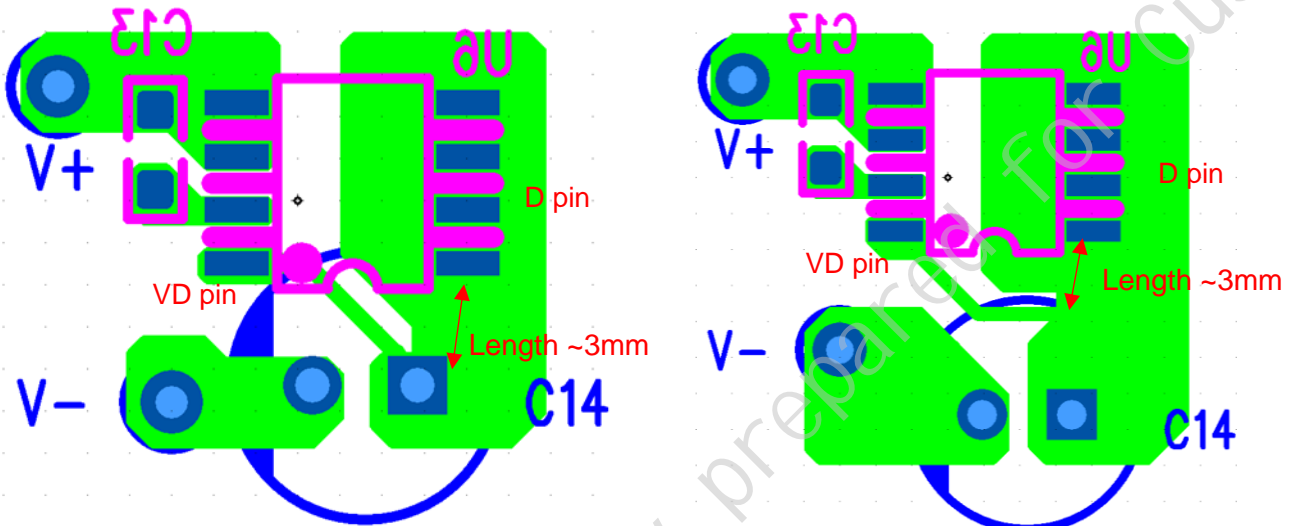
Figure 3. The low side rectification

12. Layout Guidelines

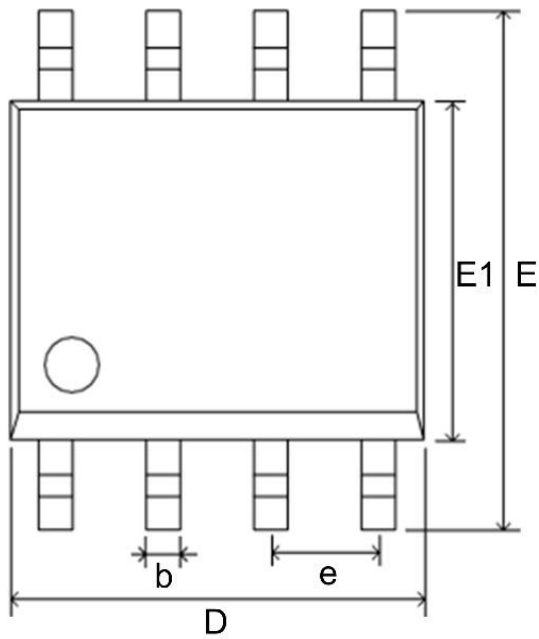
To improve the switching characteristics and the SR vds stress, The following layout rules are suggested to follow.

Locate the VCC bypass capacitor close to MK1716.

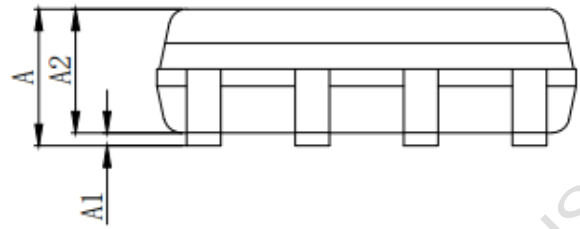
Instead of connecting VD pin to D pin directly, the connection point is suggested to be placed on the power trace to utilize the trace inductance to improve the SR Vds stress in CCM operation. Example layouts are shown as below.



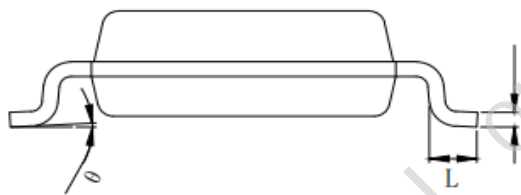
13. Package Information (SOP-8)



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° |