60V/12mΩ, HF Synchronous Rectification Switcher

1 Description

The MK17381 is a compact secondary side synchronous rectification switcher which integrated controller and MOSFET for high performance flyback converters in DCM and QR operations only.

The MK17381 generates its own supply voltage while with high-side rectification, which eliminates the need of auxiliary winding of the transformer for providing supply voltage.

The MK17381 offers the proprietary circuit to avoid potential false turn-on during DCM and QR operations. This feature eliminates the need of minimum off time and makes system more reliable.

The precise zero voltage turn off allows the maximum synchronous rectification of MOSFET conduction time for the high efficiency design.

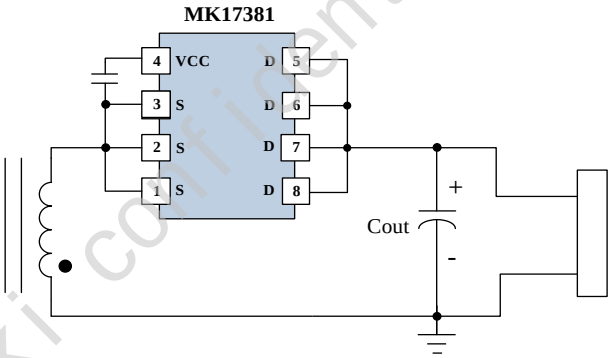
2 Typical Applications

- 9V/12V Output AC/DC Adapters
- USB-PD Chargers

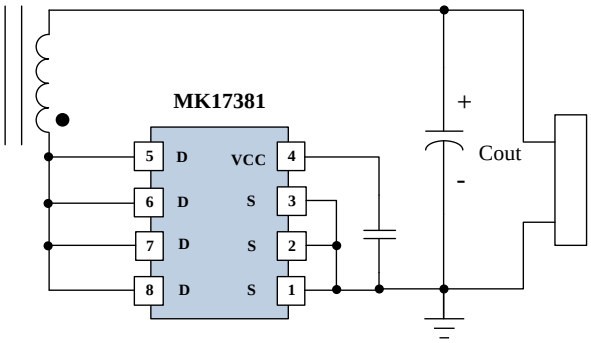
3 Features

- Integrated 12mΩ 60V 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
- No need of external capacitor in low side with Vout bias configuration (Vout<6V)
- Supports DCM and QR Operations
- Precise 0V turn off for maximum efficiency
- Designed for <300kHz working frequency
- <1mW power dissipation in standby
- Available in SOP-8 Package

4 Simplified Application



Used in high side rectification

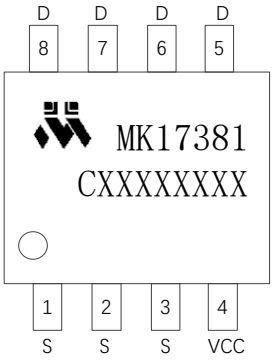


Used in low side rectification

5 Ordering Information

Order No.	Description	Material
MK17381CAB	SOP-8, 4000 pcs/reel	Halogen free

6 Package Reference



XXXXXXXX：Lot Code

SOP-8 Top View

6.1 Absolute Maximum Ratings (1)

VCC to S .....-0.3V to +7V (T_J = +25°C)

D to S ..... –1V to +60V

Continuous drain current I_D.....9A(2)

Pulsed drain current I_{DM} .....40A(3

Continuous Power Dissipation.2.5W (Ta = +25°C)(4)

Junction Temperature ..... 150°C

6.2 Recommended Operation Conditions

VCC to S…. ..... ……. .0V to 6V

D to S……..-0.7V to 55V

Maximum Junction Temp. (T_J)..... +125°C(3)

6.3 Thermal Resistance (5)

	θ_{JA}	θ_{JC}	
SOP-8	80	35	°C/W

Notes:

(1) Exceeding these ratings may damage the device.

(2) Ta=25℃; Calculated continuous current based on maximum allowable junction temperature.

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

(4) 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 $P_D(MAX)=(T_J(MAX)-T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation will cause excessive die temperature.

(5) 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}	V_{CC}=5.9V, Id=0.5A		12		mΩ
Drain to Source Breakdown	$V_{DSS(BR)}$	V_{CC}=5V, Id=2mA	60			V
Supply Management Section						
VCC UVLO Rising	V_{CC_ON}		2.6	3	3.3	V
VCC UVLO Falling	V_{CC_OFF}		2.15	2.25	2.35	V
VCC UVLO Hysteresis	V_{CC_HYST}			0.75		V
VCC Regulation Voltage	V_{CC_REG}	V_D= 7.5V	4.3	5	5.5	V
Operating Current	I_{CC}	V_{CC}=5V, Fsw=100KHz,			2.4	mA
		V_{CC}=5V, Fsw=1KHz			0.18	mA
Quiescent Current	$I_{q(VCC)}$	V_{CC}=5V, Fsw=0Hz	80	130	160	μA
VCC Discharging voltage (OVP)	V_{CC_dis}			6.3		V
VCC Discharging current (OVP)	I_{VCC_dis}			3		mA
Control Circuitry Section						
Turn-On Threshold (V_D–V_{SS})	V_{ON_th}		-300	-200		mV
Turn Off Threshold (V_D–V_{SS})	V_{OFF_th}			0		mV
Turn-On Propagation Delay	T_{D_on}			30		ns
Turn-Off Propagation Delay	T_{D_off}			25	30	ns
Turn On Blanking Time	T_{B_ON}	C_{LOAD} = 2.2nF	0.4	0.5	0.6	μs
Gate Driver Section						
Gate driver output low voltage	V_{G_LOW}		0		0.2	V
Gate driver output high voltage	V_{G_HIGH}				5.4	V

8 PIN FUNCTIONS

Pin #	Name	Description
1,2,3	S	Ground, also used as FET source sense reference for VD
4	VCC	Inner Regulator Output, supply MK17381
5,6,7,8	D	FET drain voltage sense; Internal LDO input

9 Block Diagram

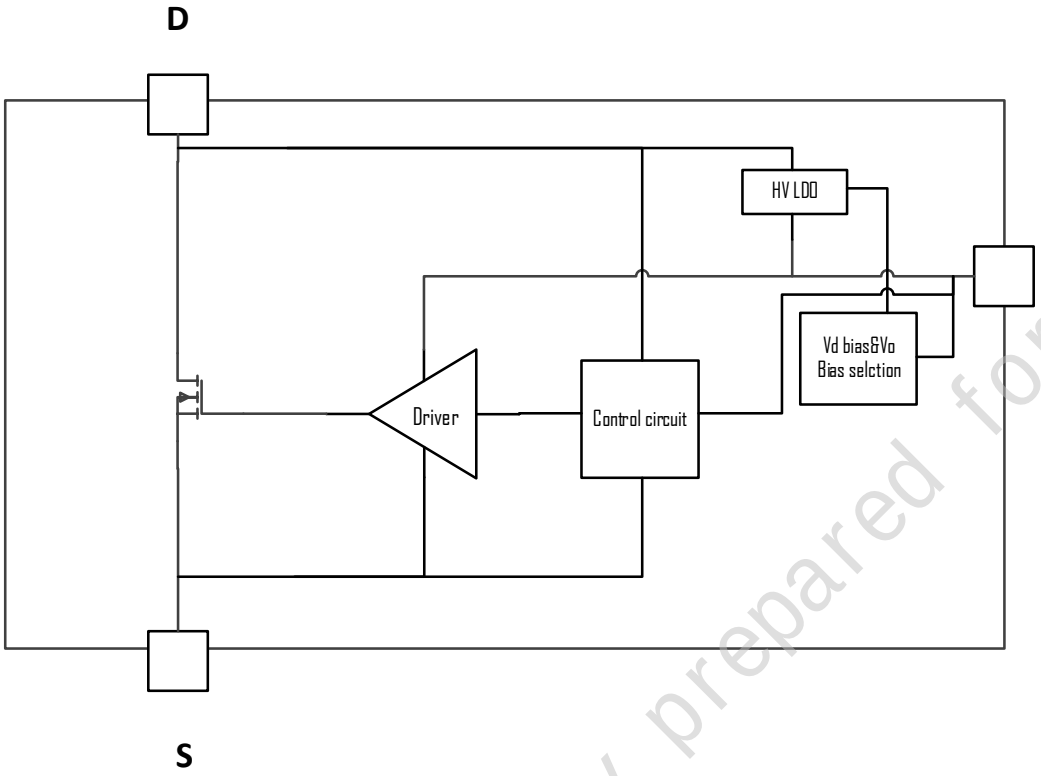


Figure 1. Functional Block Diagram

9.1 Feature Description

MK17381 is a high-performance synchronous rectifier switch used to replace flyback secondary Schottky rectifiers. It supports high-frequency QR operation mode and DCM mode, and is integrated with a 16mΩ low impedance power MOSFET to improve system efficiency. By adopting patented technology, MK17381 supports three typical power supply applications, which is flexibly and adaptively placed at the positive or negative output terminal, or powered by the output terminal (Vout<6V). When MK17381 is placed at the positive end of the output, there is no need for additional auxiliary windings.

9.2 Vcc Power Supply

MK17381's VCC power supply is generated in two ways. One way is to use internal LDO which is supplied from the D pin, and the other way is to directly powered from the Vout when placed on the output negative terminal. When MK17381 is placed on the negative terminal and powered by Vout, the Vout must to be no more than 6V. MK17381 is able to automatically determine whether to use internal LDO to power the chip or not. When the VCC voltage is greater than the VCC overvoltage protection threshold V_{CC_dis} (typical value is 6.3V), an I_{VCC_dis} (typical value is 3mA) current will discharge the VCC. When VCC is powered by Vout, this current provides instantaneous system OVP and protects the downstream ICs.

9.3 Turn on

MK17381 adopts patented technology to determine whether to turn on internal SR MOSFETs correctly. It detects Vds crossing the turn on threshold whether is caused by demagnetization or DCM ringing, to avoid false turn-on of SR MOSFETs. The 30ns turn on delay and -200mV turn on threshold reduce the body diode conduction time of SR MOSFETs and improve efficiency.

9.4 Blanking Time

Once the synchronous rectifier is turned on, MK17381 provides an internal blanking time of about 0.5us (also called minimum on time) to avoid false shutdown caused by the turn-on ringing of the Vds.

9.5 Turn off

Once the SR MOSFET is turned on, the Vds voltage is below 0V and equal to Isd times on-resistance of the SR MOSFET. With the gradual decreases of the secondary current Isd, Vds gradually increases to approach to 0V. When the Vds voltage reaches turn-off threshold V_{OFF_th}, the MK17381 turns off the SR MOSFET quickly and accurately.

9.6 Typical Applications

As shown in Figure 2, MK17381 is placed at the output positive end to replace Schottky diode with no need of auxiliary winding as power supply. In this case, the VCC is powered by the D pin and regulated to around 5V by internal LDO. Even if the system operates in constant current mode, and the output voltage Vout is below 5V, the VCC still regulates to around 5V.

MK17381 supports two other applications when it is placed on the output negative terminal. One application is shown in Figure 3, which is powered by the D pin, and the VCC is regulated to around 5V with an external capacitor ranging from 0.1uF to 1uF connected. As shown in Figure 4, the other application is powered by the system output, where the VCC is directly connected to the Vout. This connection method is only suitable for applications with an output voltage less than 6V. When the PCB layout is good and the VCC routing is short, this connection method does not require external VCC decoupling capacitor. Since VCC is equal to Vout, MK17381 will enter an undervoltage protection state when Vout drops below Vcc_off , and the rectification current will conduct through the body diode of the SR MOSFET. MK17381 uses 2.3V as Vcc_off in order not to enter undervoltage protection state easily to reduce output ripple caused by non-synchronous rectification by body diode. When VCC is powered directly by the system output Vout, the steady-state output voltage of the system should not exceed V_{CC_dis} (typical value is 6.3V). Because the internal circuit of VCC will sink about 3mA current when the VCC voltage exceeds V_{CC_dis}, which causes very low efficiency and chip overheating when the VCC voltage exceeds V_{CC_dis} for a long time.

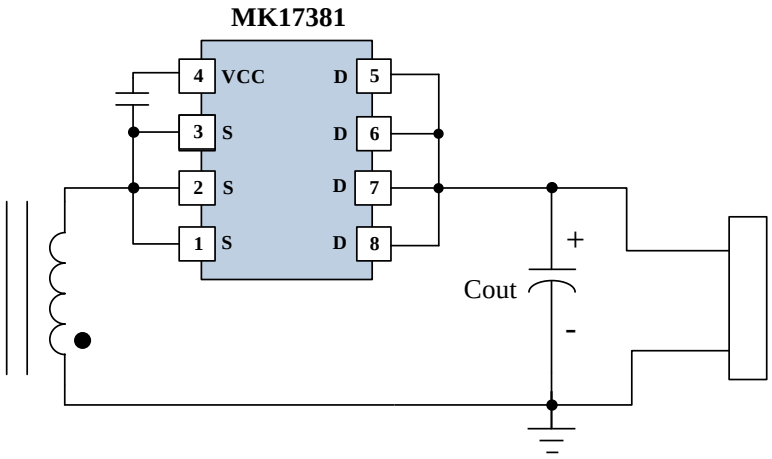


Figure 2. Typical application circuit with SR placed on the positive terminal

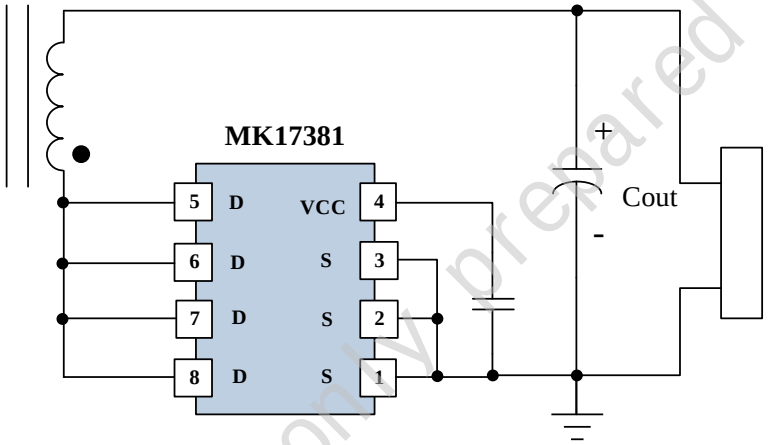


Figure 3. Typical application circuit (1) with SR placed on negative terminal

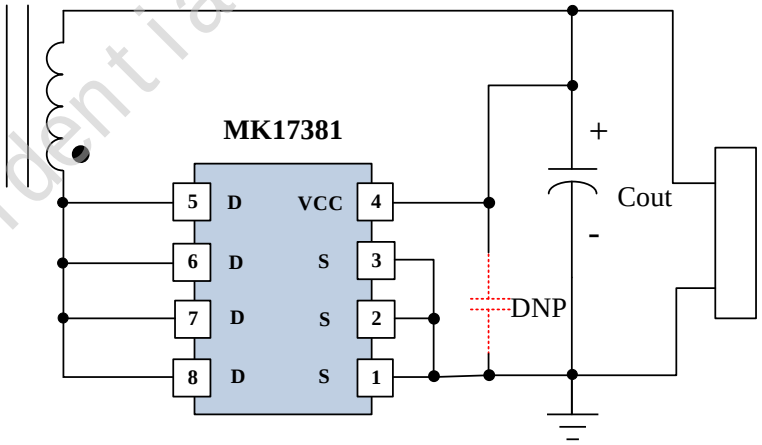
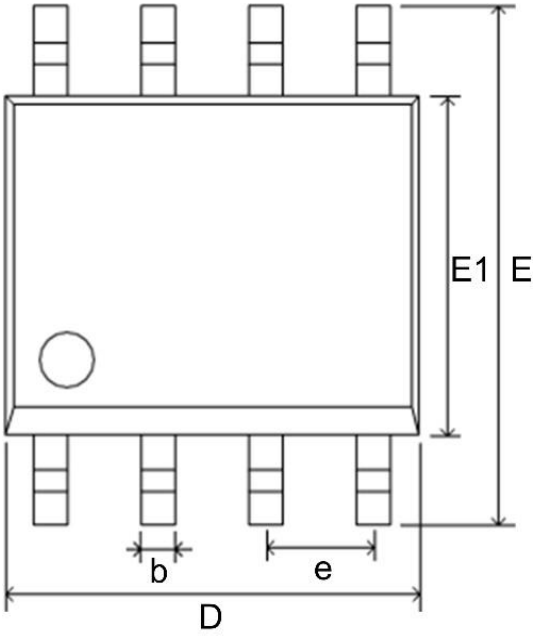
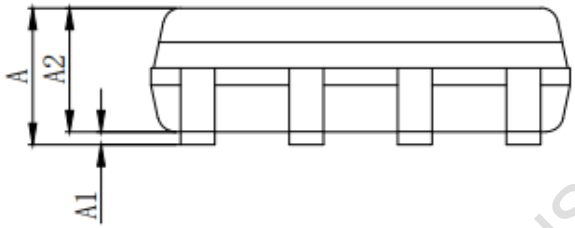


Figure 4. Typical application circuit (2) (only supports Vout<6V) with SR placed in negative terminal and powered by Vout directly

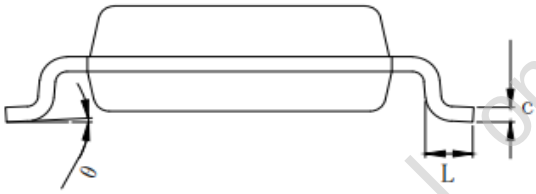
10 Package Information (SOP-8)



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°