CURRENT MODE PWM+PFM CONTROLLER WITH BUILT-IN HIGH VOLTAGE MOSFET

DESCRIPTION

SD6835 is current mode PWM+PFM controller used for SMPS with built-in high-voltage MOSFET and external sense resistor.

It features low standby power and low start current. In standby mode, the circuit enters burst mode to reduce the standby power dissipation.

The switch frequency is 25~67KHz decided by the load with jitter frequency for low EMI.

Built-in peak current compensation circuit makes the limit peak current stable even with different input AC voltage. Built-in limit output power compensation circuit to balance the limit output power under different AC voltage inputs. Built-in slope compensation circuit to adapt to more transformer applications. Maximum peak current compensation during power-on reduces pressure on transformer to avoid saturation, the peak current compensation will decrease for balance after power-on. Limit output current can be adjusted through the resistor connected to CS.

It integrates various protections such as undervoltage lockout, overvoltage protection, overload protection, leading edge blanking and thermal shutdown. The circuit will restart until normal if protection occurs.

DIP-8-300-2.54
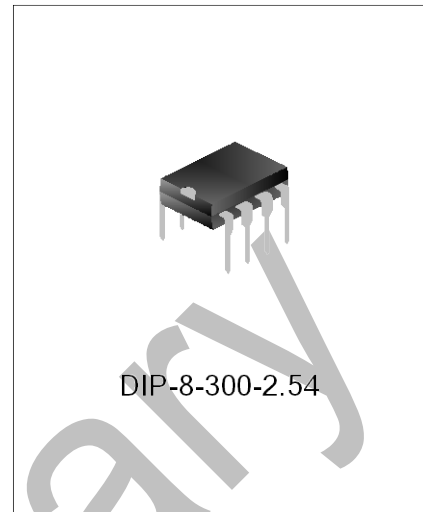
APPLICATIONS

* SMPS

FEATURES

* Energy Star 2.0 standard
* Lower start-up current (4μA)
* Various switching frequency following load for the high efficiency
* EMI Frequency jitter for low EMI
* Overvoltage, overload and over temperature protections
* External peak current sense resistor
* Limit output power compensation
* Slope compensation
* Undervoltage lockout
* Built-in high voltage MOSFET
* Auto restart mode
* Peak current compensation
* Maximum peak current compensation for initialization to realize the soft start function.
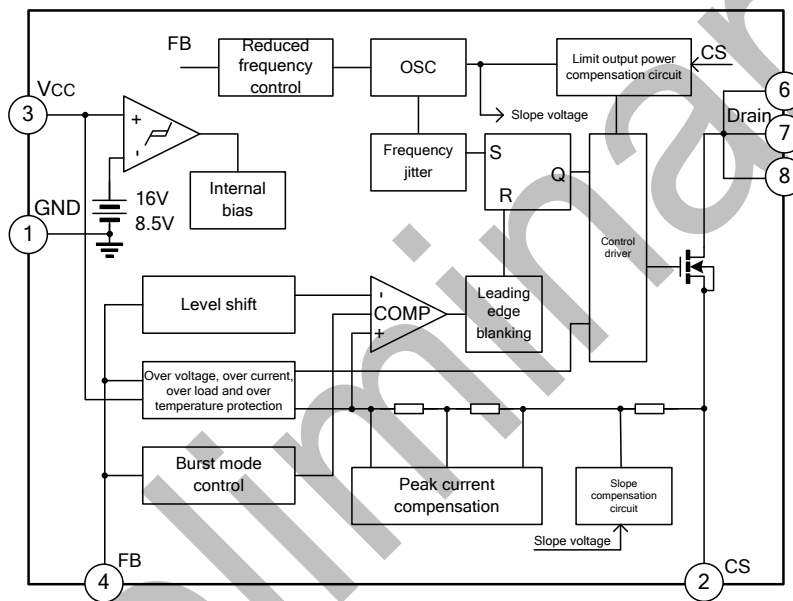* Burst mode
* Cycle by cycle current limit

ORDERING INFORMATION

Part No.	Package	Marking	Material	Packaging
SD6835	DIP-8-300-2.54	SD6835	Pb free	Tube

TYPICAL OUPUT POWER CAPABILITY

Part No.	190~265V		85~265V	
	Adapter	Open	Adapter	Open
SD6835	22W	26W	20W	24W

BLOCK DIAGRAM

ABSOLUTE MAXIMUM RATING

Characteristics	Symbol	Rating	Unit
Drain-Gate Voltage ($R_{GS}=1M\Omega$)	V_{DGR}	650	V
Gate-Source (GND) Voltage	V_{GS}	±30	V
Drain Current Pulse [note1]	I_{DM}	20	A
Continuous Drain Current ($T_{amb}=25°C$)	I_D	7.0	A
Signal Pulse Avalanche Energy[note2]	E_{AS}	350	mJ
Power Supply Voltage	$V_{CC,MAX}$	28	V
Feedback input voltage	V_{FB}	-0.3~7	V
Peak current sense voltage	V_{CS}	-0.3~2	V
Allowable Power Dissipation	P_D	6.3	W
Ambient thermal resistance	θja	77	°C/W
Surface thermal resistance	θjc	20	°C/W
Operating Junction Temperature	T_J	+150	°C
Operating Temperature Range	T_{ORG}	-25~+85	°C

Characteristics	Symbol	Rating	Unit
Storage Temperature Range	T_{STG}	-55~+150	°C

Note: 1. Pulse width is limited by maximum junction temperature;

      2. L=51mH, T_J=25°C(start).

## ELECTRICAL CHARACTERISTICS (for MOSFET, unless otherwise specified, T_{amb}=25°C)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	BV_{DSS}	V_{GS}=0V, I_D=50µA	650	--	--	V
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS}=650V, V_{GS}=0V	--	--	50	µA
		V_{DS}=480V, V_{GS}=0V T_{amb}=125°C	--	--	200	µA
Static Drain-Source On Resistance	$R_{DS(ON)}$	V_{GS}=10V, I_D=3A	1.1	1.6	2.1	Ω
Input Capacitance	C_{ISS}	V_{GS}=0V, V_{DS}=25V, f=1MHz	520	700	950	pF
Output Capacitance	C_{OSS}	V_{GS}=0V, V_{DS}=25V, f=1MHz	50	86	120	pF
Reverse Transfer Capacitance	C_{RSS}	V_{GS}=0V, V_{DS}=25V, f=1MHz	1.8	3.5	6.5	pF
Turn On Delay Time	$T_{D(ON)}$	V_{DD}=0.5BV_{DSS} , I_D=25mA	13	20	26	ns
Rise Time	T_R	V_{DD}=0.5BV_{DSS} , I_D=25mA	37	51	68	ns
Turn Off Delay Time	$T_{D(OFF)}$	V_{DD}=0.5BV_{DSS} , I_D=25mA	26	37	50	ns
Fall Time	T_F	V_{DD}=0.5BV_{DSS} , I_D=25mA	21	32	44	ns

ELECTRICAL CHARACTERISTICS (unless otherwise specified, V_{CC}=12V, T_{amb}=25°C)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Undervoltage Section						
Start Threshold Voltage	V_{START}		14.5	16	17	V
Stop Threshold Voltage	V_{STOP}		7.5	8.5	9.5	V
Oscillator Section						
Max. Oscillate Frequency	f_{OSCMAX}	V_{FB}=3V	61	67	73	KHz
Min. Oscillate Frequency	f_{OSCMIN}	V_{BURL}<V_{FB}<V_{BURH}	20	25	30	KHz
Frequency jitter	f_{MOD}	Oscillate frequency is the maximum	±1.5	±2.5	±3.5	KHz
Frequency Change With Temperature	--	25°C≤T_{amb}≤+85°C	--	±5	±10	%
Maximum Duty cycle	D_{MAX}		72	77	82	%
Feedback Section						
MAX. Feedback Source Current	I_{FBMAX}	V_{FB}=0V	0.25	0.35	0.45	mA
Shutdown Feedback Voltage (over load protection)	V_{SD}		3.8	4.3	4.8	V

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Shutdown Feedback Delay Time	T_{SD}	FB is increased to 5V from 0V instantly	30	40	50	ms
Shutdown Delay Current	I_{DELAY}	V_{FB}=5V	3	6	9	μA
CS section						
Max. value of CS	V_{CSMAX}		0.7	0.9	1.1	V
Current Limit Section						
Peak current	I_{OVER}	Maximum inductor current	2.0	2.2	2.4	A
Burst mode						
Burst Mode High Voltage	V_{BURH}	FB voltage	0.40	0.50	0.60	V
Burst Mode Low Voltage	V_{BURL}	FB voltage	0.25	0.35	0.45	V
Protection Section						
Overvoltage Protection	V_{OVP}	V_{CC} voltage	23	24.5	26	V
Over Temperature Protection	T_{OTP}		125	150	175	°C
Leading-edge Blanking Time	T_{LEB}		200	350	500	ns
Total Standby Current						
Start Current	I_{START}	V_{CC} increases from 0V to 12V	--	4	20	μA
Quiescent Current	I_{STATIC}	V_{CC}=12V, V_{FB}=0V	1.0	1.5	2.0	mA
Operating Current	I_{OP}	V_{CC}=12V, V_{FB}=3V	1.2	2.2	3.2	mA

PIN CONFIGURATION
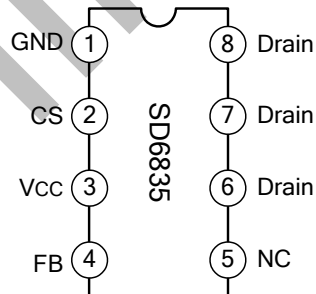
Note: it is recommended to connect pin 5 to pin Drain for better heat dissipation.

PIN DESCRIPTION

Pin No.	Pin Name	I/O	Function description
1	GND	I	Ground
2	CS	I	Peak current sense pin
3	V_{CC}	I	Power supply pin
4	FB	I/O	Feedback input pin
5	NC	--	NC
6, 7, 8	Drain	O	Drain of MOSFET

FUNCTION DESCRIPTION

SD6835 is designed for off-line SMPS, consisting of high voltage MOSFET, optimized gate driver and current mode PWM+PFM controller which includes frequency oscillator and various protections such as undervoltage lockout, overvoltage protection, overload protection, and over temperature protection. Frequency jitter generated from oscillator is used to lower EMI. Peak current compensation reduces the pressure on transformer during circuit starts and peak current limit can be adjusted by resistor through CS pin. Burst mode is adopted during light load to lower standby power dissipation, and function of lead edge blanking eliminates the MOSFET error shutdown caused by interference through minimizing MOSFET turning on time. Few peripheral components are needed for higher efficiency and higher reliability and it is suitable for flyback converter and forward converter.

1. Under Voltage Lockout and Self-Start

At the beginning, the capacitor connected to pin V_{CC} is charged via start resistor by high voltage AC and the circuit starts to work if voltage at V_{CC} is 16V. The output and FB source current are shutdown if there is any protection during normal operation and V_{CC} is decreased because of powering of auxiliary winding. The whole control circuit is shutdown if voltage at V_{CC} is 8.5V below to lower current dissipation and the capacitor is recharged for restarting.
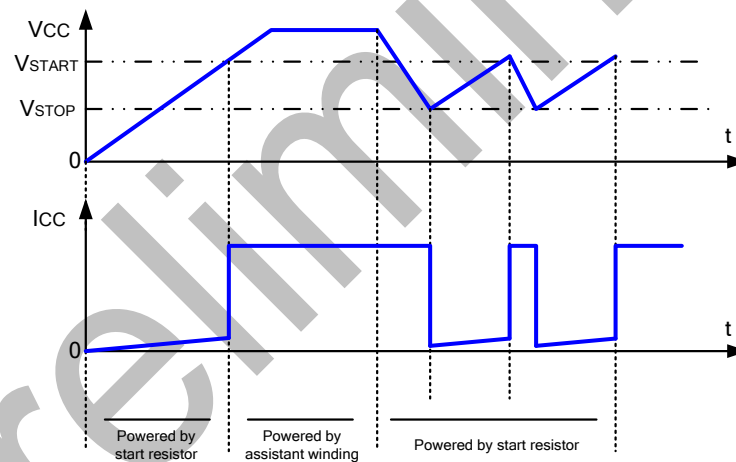

2. Frequency Jitter and reduced frequency mode

The oscillation frequency is kept changed for low EMI and decreasing radiation on one frequency. The oscillation frequency changes within a very small range to simplify EMI design. The rule of frequency changing (frequency center is 67KHz): ±2.5KHz change in 4ms, 63 frequency points in all.

For high efficiency, reduced frequency mode is adopted with two methods:

1. Frequency $f_。$ is reduced according to current output from FB pin. If I_{FB} is higher than I_1, the frequency f decreases from 67KHz and f is 25KHz when the I_{FB} increases to I_2 or higher. This is shown in left diagram below.

2. I_{PK} is changed according to I_{FB}, shown in right diagram below.
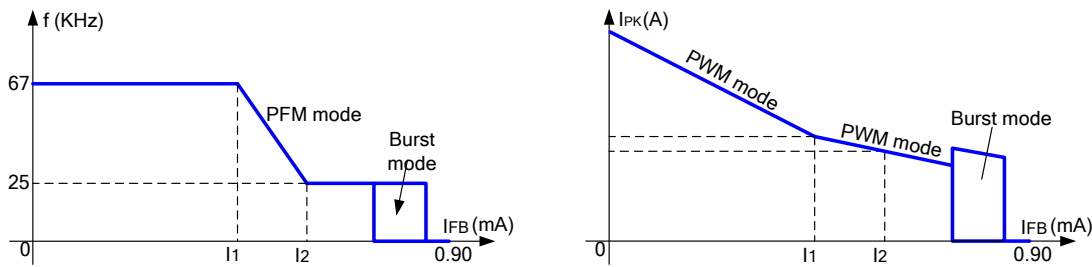
3. Peak current sense resistor

The external resistor (R_{CS}) connected to pin CS is used for peak current limit, the peak current is given by:

$$I_{PKMAX} = V_{CSMAX}/R_{CS}$$

4. Peak current compensation and initialization

Generally, limit peak current changes with different inputs. Limit peak current is hold in this circuit because of peak current compensation. Larger peak current compensation for higher input AC voltage, it decreases to zero with light load and no peak current compensation in burse mode.

Maximum peak current compensation during power-on reduces pressure on transformer to avoid saturation, the peak current compensation will decrease for balance after power-on. The duration is decided by the load.

5. Slope compensation

When the circuit is working with heavy load or even full load, the switch duty cycle increasing over 50% will occur, which leads to system instability due to the sub-harmonic oscillation. In order to eliminate the sub-harmonic oscillation, the slope compensation circuit is used to control the system. The bigger the duty cycle is, the greater the slope compensation is.

6. Limit output power compensation

The limit output power difference under different AC voltage inputs is caused by the continuous mode, the limit output power compensation circuit is used to reduce this difference. The bigger the duty cycle is, the greater the compensation is.

7. Burst mode

Working in this mode can reduce power dissipation. It works normally when FB is 0.5V above, and during 0.35V<FB <0.5V, there are two different conditions: when FB changes from low to high, there is no action for switch and it is the same with condition of FB lower than 0.35V; the other is that FB changes form high to low, comparison value is increased for increasing turning on time to decrease switch loss. In this mode, switching frequency is down to 25KHz.

For this mode, during FB changes from high to low, the output voltage increases (increasing speed is decided by load) because of the high comparison value to decrease FB until it is 0.35V below; when FB <0.35V, there is no action for switch and output voltage decrease (decreasing speed is also decided by load) to increase FB voltage. FB voltage is 0.5V below with light load. This is repeated to decrease action of switch for lower power dissipation.
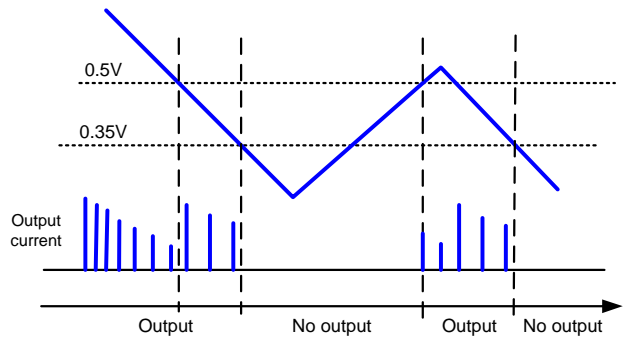
8. Leading Edge Blanking

For this current-controlled circuit, there is pulse peak current during the transient of switch turning on and there is an error operation if the current is sampled during this time. And leading edge blanking is adopted to eliminate this error operation. The output of PWM comparator is used for controlling shutdown after the leading edge blanking if there is any output drive.
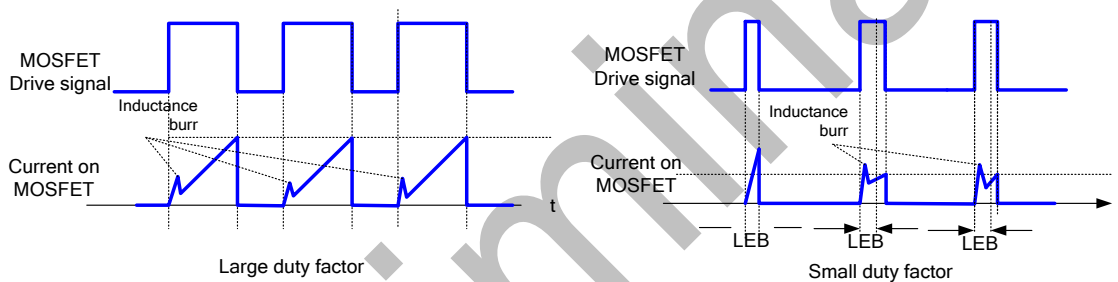
9. Over Voltage Protection

The output is shutdown if voltage at V_{CC} exceeds the threshold value and this state is kept until the circuit is powered on reset.

10. Overload Protection

FB voltage increases if there is overload and the output is shutdown after the shutdown delay time when FB voltage is up to the feedback shutdown voltage. This state is kept until the circuit is powered on reset.

11. Cycle By Cycle Peak Current Limit

During each cycle, the peak current value is decided by the comparison value of the comparator, which will not exceed the peak current limited value to guarantee the current on MOSFET will not be larger than the rating current. The output power will not increase if the current reaches the peak value to limit the max. output power. The output voltage decreases and FB voltage increases if there is overload and corresponding protection occurs.

12. Thermal Shutdown

If the circuit is over temperature, the over temperature protection will shut down the output to prevent the circuit from damage. This state keeps until the circuit restarts after cooling down.
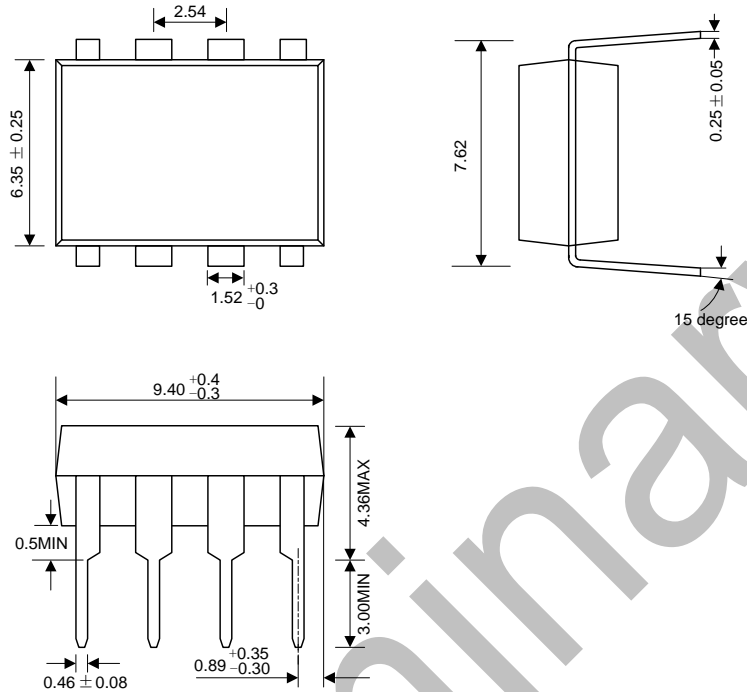
TYPICAL APPLICATION CIRCUIT
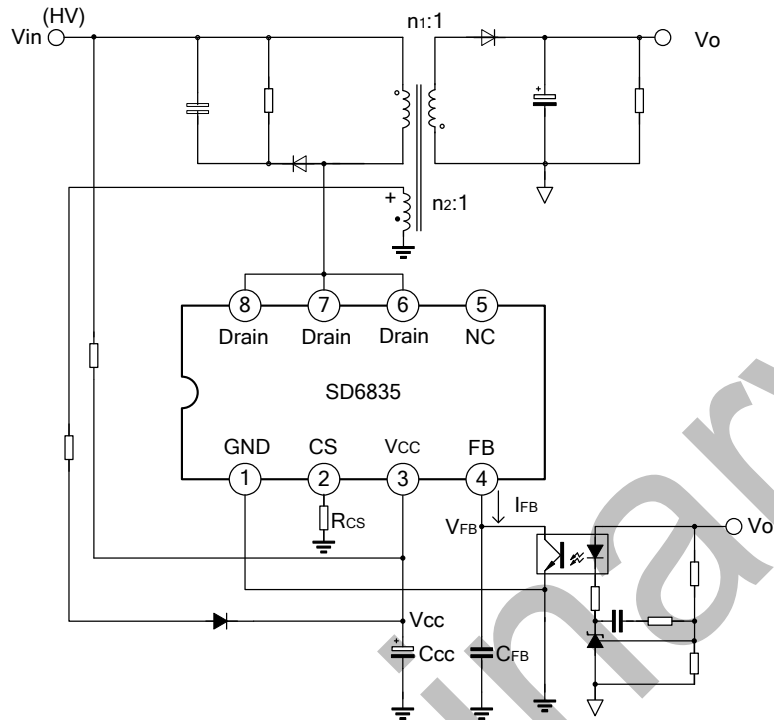
Note:

The circuit and parameters are for reference only, please set the parameters of the real application circuit based on the real test.

PACKAGE OUTLINE

DIP-8-300-2.54   UNIT: mm

2.54

6.35 ± 0.25

1.52 +0.3 -0

7.62

0.25 ± 0.05

15 degree

9.40 +0.4 -0.3

4.36MAX

0.5MIN

3.00MIN

0.46 ± 0.08

0.89 +0.35 -0.30

CAUTION
ELECTROSTATIC
SENSITIVE DEVICE
DO NOT OPEN OR HANDLE
EXPECT AT A STATIC-FREE
WORKSTATION

MOS DEVICES OPERATE NOTES:

Electrostatic charges may exist in many things. Please take following preventive measures to prevent effectively the MOS electric circuit as a result of the damage which is caused by discharge:

● The operator must put on wrist strap which should be earthed to against electrostatic.

● Equipment cases should be earthed.

● All tools used during assembly, including soldering tools and solder baths, must be earthed.

● MOS devices should be packed in antistatic/conductive containers for transportation.

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