

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

DESCRIPTION

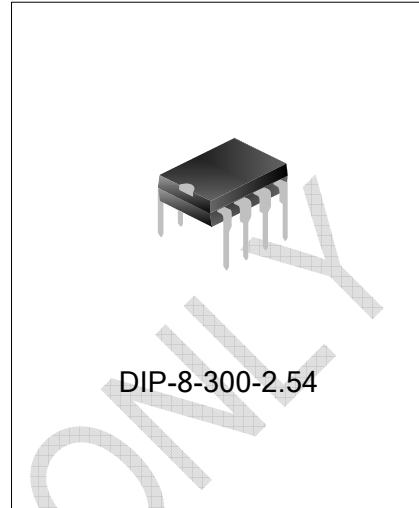
SDH6881/3/4 is current mode PWM+PFM controller with built-in high-voltage start and high-voltage MOSFET used for SMPS.

SDH6881/3/4 has the built-in high-voltage start and the charge current is large. In standby mode, the circuit enters burst mode to reduce the standby power dissipation.

The switch frequency is 25~67KHz with jitter frequency for low EMI.

Built-in peak current compensation circuit makes the limit peak current stable even with different input AC voltage. Limit output power can be adjusted through the resistor. 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.

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



APPLICATIONS

- * SMPS

FEATURES

- * Energy Star 2.0 standard
- * High-voltage start, low stand-by power dissipation(100mW)
- * Various switching frequency following load for the higher efficiency
- * Frequency jitter for low EMI
- * Overvoltage, primary winding overcurrent, overload and over temperature protections
- * Adjustable limit output power
- * Undervoltage lockout
- * Built-in high voltage MOSFET
- * Auto restart mode
- * Peak current compensation
- * Slope compensarion circuit
- * Maximum peak current compensation for initialization
- * Burst mode
- * Cycle-by-cycle current limit

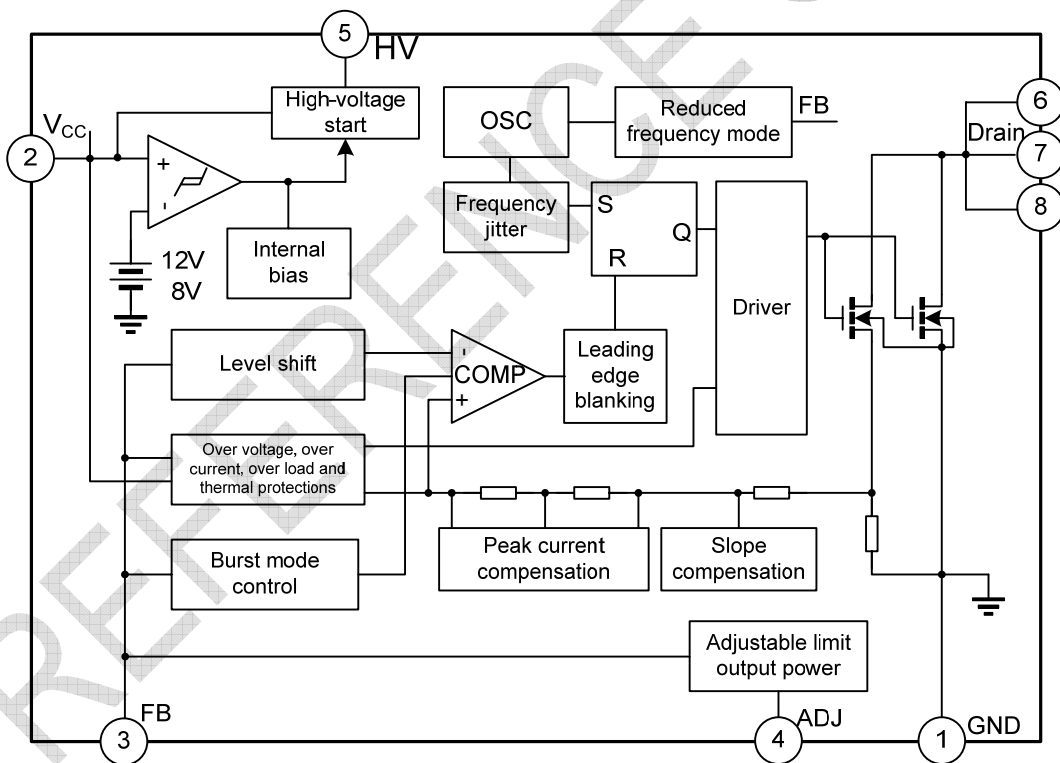
ORDERING INFORMATION

Part No.	Package	Marking	Material	Packing
SDH6881	DIP-8-300-2.54	SDH6881	Pb free	Tube
SDH6883		SDH6883	Pb free	Tube
SDH6884		SDH6884	Pb free	Tube

TYPICAL OUPUT POWER CAPABILITY

Part No.	190~265V		85~265V	
	Adapter	Open	Adapter	Open
SDH6881	10W	14W	8W	12W
SDH6883	14W	19W	12W	15W
SDH6884	16W	21W	14W	18W

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATING

Characteristics	Symbol	Ratings	Unit
Drain-Gate Voltage ($R_{GS}=1M\Omega$)	V_{DGR}	650	V
Gate-Source (GND) Voltage	V_{GS}	± 30	V
Drain Current Pulse ^{note1}	SDH6881	6	A
	SDH6883	11	
	SDH6884	14	
Continuous Drain Current ($T_{amb}=25^{\circ}C$)	SDH6881	1.5	A
	SDH6883	3	
	SDH6884	4	
Signal Pulse Avalanche Energy ^{note2}	SDH6881	30	mJ
	SDH6883	140	
	SDH6884	200	
High voltage input	$V_{HV,MAX}$	650	V
Power Supply Voltage	$V_{CC,MAX}$	28	V
Feedback input voltage	V_{FB}	-0.3~7	V
Limit output power voltage	V_{ADJ}	-0.3~2	V
Total Power Dissipation	P_D	1.5	W
	Darting	0.017	W/°C
Operating Junction Temperature	T_J	+170	°C
Operating Temperature Range	T_{amb}	-25~+85	°C
Storage Temperature Range	T_{STG}	-55~+150	°C

Note: 1. Pulse width is limited by maximum junction temperature;
 2. $L=51mH$, $T_J=25^{\circ}C$ (start).

ELECTRICAL CHARACTERISTICS (for MOSFET, unless otherwise specified, $T_{amb}=25^{\circ}C$)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	BV_{DSS}	$V_{GS}=0V$, $I_D=50\mu A$	650	--	--	V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS}=650V$, $V_{GS}=0V$	--	--	50	μA
		$V_{DS}=480V$, $V_{GS}=0V$, $T_{amb}=125^{\circ}C$	--	--	200	μA
Static Drain-Source On Resistance	$R_{DS(ON)}$	$V_{GS}=10V$, $I_D=0.5A$	SDH6881	8.0	9.6	Ω
			SDH6883	4.0	4.8	
			SDH6884	3.0	3.6	
Input Capacitance	C_{ISS}	$V_{GS}=0V$, $V_{DS}=25V$, $f=1MHz$	SDH6881	250	--	pF
			SDH6883	640	--	
			SDH6884	840	--	
Output Capacitance	C_{OSS}	$V_{GS}=0V$, $V_{DS}=25V$, $f=1MHz$	SDH6881	25	--	pF
			SDH6883	40	--	
			SDH6884	44	--	

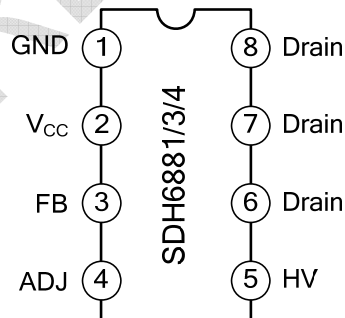
Characteristics		Symbol	Test conditions	Min.	Typ.	Max.	Unit
Reverse Transfer Capacitance	SDH6881	C_{RSS}	$V_{GS}=0V, V_{DS}=25V, f=1MHz$	--	10	--	pF
	SDH6883			--	30	--	
	SDH6884			--	40	--	
Turn On Delay Time	SDH6881	$T_{D(ON)}$	$V_{DD}=0.5BV_{DSS}, I_D=25mA$	--	12	--	ns
	SDH6883			--	33	--	
	SDH6884			--	40	--	
Rise Time	SDH6881	T_R	$V_{DD}=0.5BV_{DSS}, I_D=25mA$	--	4	--	ns
	SDH6883			--	19	--	
	SDH6884			--	25	--	
Turn Off Delay Time	SDH6881	$T_{D(OFF)}$	$V_{DD}=0.5BV_{DSS}, I_D=25mA$	--	30	--	ns
	SDH6883			--	70	--	
	SDH6884			--	90	--	
Fall Time	SDH6881	T_F	$V_{DD}=0.5BV_{DSS}, I_D=25mA$	--	10	--	ns
	SDH6883			--	32	--	
	SDH6884			--	42	--	

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, $V_{CC}=12V, T_{amb}=25^{\circ}C$)

Characteristics		Symbol	Test conditions	Min.	Typ.	Max.	Unit
High-voltage start Section							
Charge current		I_{HVC}	$V_{CC}=10V$	0.3	0.5	0.8	mA
High-voltage shutdown current		I_{HVS}	$V_{CC}=16V$	--	3	20	μA
Undervoltage Section							
Start threshold voltage		V_{START}		11	12	13	V
Stop threshold voltage		V_{STOP}		7	8	9	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	--	± 2.5	± 3.5	KHz
Frequency Change With Temperature		--	$25^{\circ}C \leq T_{amb} \leq +85^{\circ}C$	--	± 5	± 10	%
Maximum Duty cycle		D_{MAX}		72	77	82	%
Feedback Section							
MAX. Feedback Source Current		I_{FBMAX}	$V_{FB}=0V, R_{ADJ}=0$	0.8	0.9	1.0	mA
Shutdown Feedback Voltage (over load protection)		V_{SD}		3.8	4.3	4.8	V
Shutdown Feedback Delay Time		T_{SD}	FB is increased to 5V from 0V instantly	15		40	ms
Shutdown Delay Current		I_{DELAY}	$V_{FB}=5V$	3	5.5	8	μA
Limit Output power							
FB current 1		I_{FB1}	$V_{FB}=0V, R_{ADJ}=200K\Omega$	0.57	0.65	0.73	mA

Characteristics		Symbol	Test conditions	Min.	Typ.	Max.	Unit
Min. Resistor For Limit Output Power Adjust		R_{ADJ}	$V_{FB}=0V$, FB current is decreased	70	90	110	K Ω
Current Limit							
Peak Current Limit	SDH6881	I_{OVER}	Max. inductor current	0.67	0.75	0.83	A
	SDH6883			1.10	1.20	1.30	
	SDH6884			1.35	1.50	1.65	
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	23.5	24.5	26	V
Over temperature protection		T_{OTP}		125	150	--	$^{\circ}C$
Quit over temperature protection		T_{OTU}		80	100	120	$^{\circ}C$
Leading-edge Blanking Time		T_{LEB}		350	500	--	ns
Total Standby Current							
Start Current		I_{START}	V_{CC} increases from 0V to 10V	--	10	200	μA
Quiescent Current		I_{STATIC}	$V_{FB}=0V$	1.0	1.9	3.0	mA
Operating Current	SDH6881	I_{OP}	$V_{FB}=3V$	1.0	2.0	3.0	mA
	SDH6883			1.2	2.2	3.2	
	SDH6884			1.4	2.4	3.4	

PIN CONFIGURATION



PIN DESCRIPTION

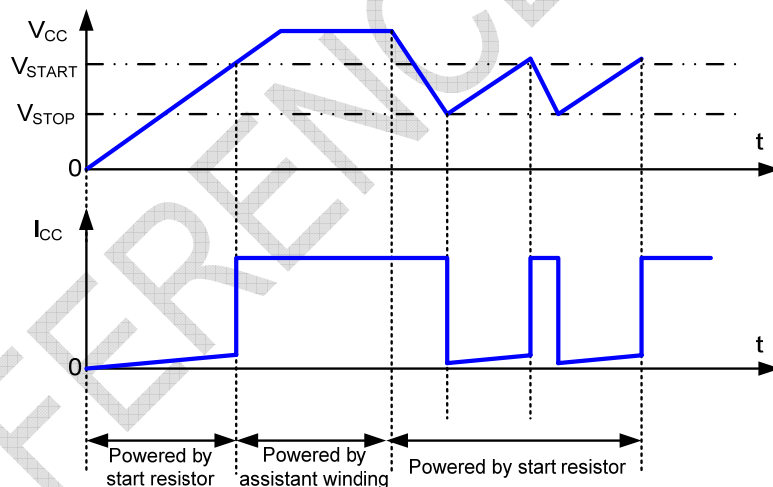
Pin No.	Pin Name	I/O	Function description
1	GND	I	Ground
2	V_{CC}	I	Power supply pin
3	FB	I/O	Feedback input pin
4	ADJ	I	ADJ pin
5	HV	I	High-voltage start pin
6, 7, 8	Drain	O	Drain pins

FUNCTION DESCRIPTION

SDH6881/3/4 is designed for off-line SMPS, consisting of high voltage start, 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 and overload protection. Frequency jitter generated from oscillator is used to lower EMI. 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. Peak current compensation reduces the pressure on transformer during circuit starts, output power limit can be adjusted by resistor through ADJ pin and slope compensation brings more application. Few peripheral components are needed for higher efficiency and higher reliability and it is suitable for flyback converter and forward converter.

1. High-voltage start and under voltage self-start

At the beginning, the capacitor connected to pin V_{CC} is charged via high voltage start circuit by HV pin and the charge current is large. The circuit starts to work if voltage at V_{CC} is 12V and charge current is shutdown. 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 8V below to lower current dissipation and the capacitor is recharged for restarting.

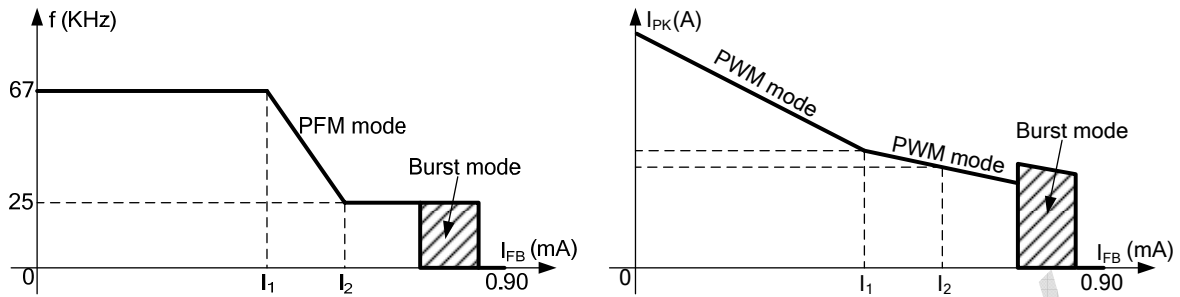


2. Frequency Jitter and reduced frequency mode

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): $\pm 2.5\text{KHz}$ change in 4ms, 63 frequency points in all.

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

1. Frequency is reduced according to current output from FB pin. If output power has not been adjusted, that is $R_{ADJ} \leq 90\text{K}\Omega$, when I_{FB} value raises to typical value I_1 , frequency starts to be reduced from 67KHz and reduced to 25KHz (typ.) when I_{FB} comes to typical value I_2 , the change is shown below.
2. I_{PK} is changed according to I_{FB} , shown below.



3. Peak current compensation and initialization

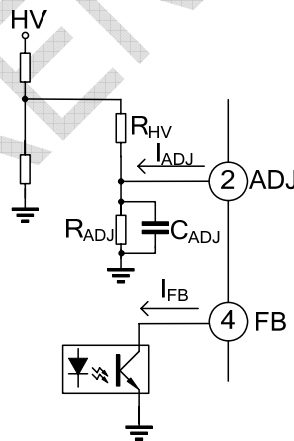
Generally, limit peak current changes with different inputs. Limit peak current is hold in this circuit because of peak current compensation. Larger peak current compensation for higher input AC voltage, it decreases to zero with light load and no peak current compensation in burse mode.

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.

4. Limit output power adjust

Limit output power is adjusted by varying FB current through resistor R_{ADJ} adjust. When $R_{ADJ}=0$, no change in limit output power; when R_{ADJ} exceeds typ. $90K\Omega$, limit output power begins to be reduced.

Moreover, limit output power can be kept stable (under different HV conditions) through pin ADJ, shown below.



5. Slope compensation

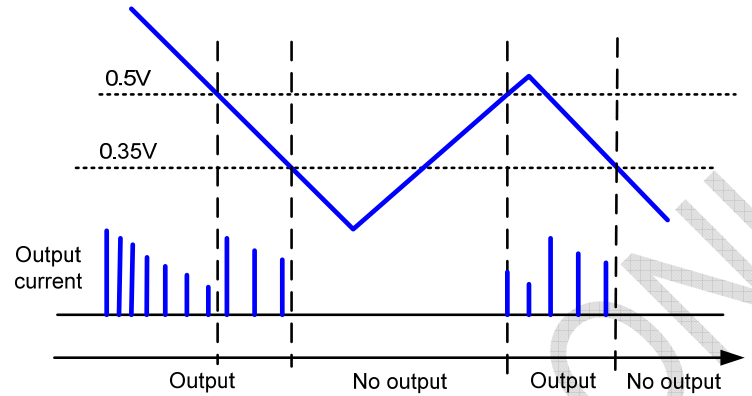
Slope compensation is adopted to avoid subharmonic oscillation which will occur if the switch turning on time exceeds 50% of one period. High compensation value for higher duty factor.

6. Burst mode

Working in this mode id for reducing 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 voltage changes from low to high, there is no action for switch and it is the same with condition of FB voltage lower than 0.35V; the other is that FB voltage changes form high to low, comparison value is increased for increasing turning on time to

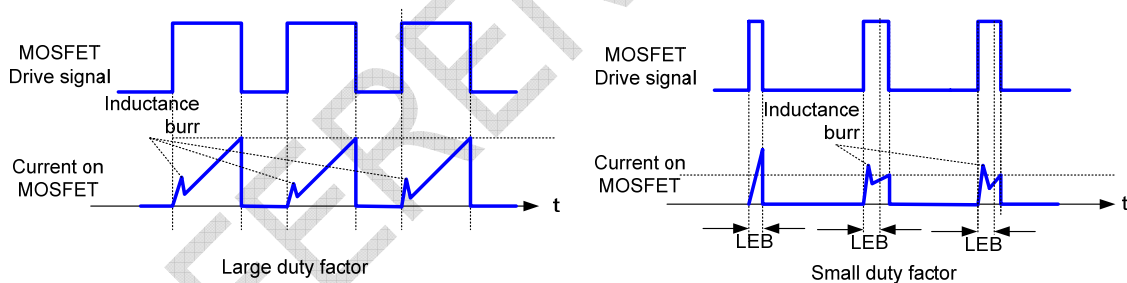
decrease switch loss. In this mode, switching frequency is down to 25KHz.

For this mode, during FB changes form 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 decreases (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.



7. 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.



8. 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.

9. Overload Protection

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

10. 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.

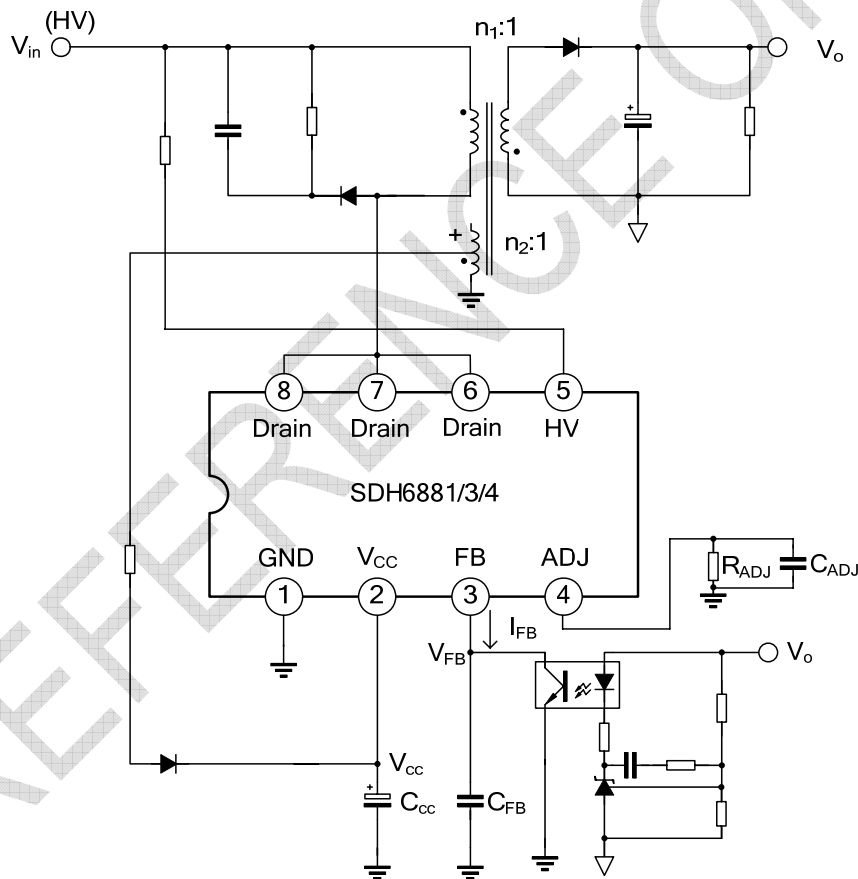
11. Primary winding over current protection

If secondary diode is short, or the transformer is short, this protection will occur. At this time, once it is over current in spite of the leading edge blanking (L.E.B) time, protection will occur after 350ns, and it is active for every cycle. When the voltage on the current sense resistor is 1.5V, this protection will occur and the output is shut down. This state is kept until the under voltage occurs, and the circuit will start.

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 is kept until it quit the temperature protection, and the circuit will start.

TYPICAL APPLICATION CIRCUIT

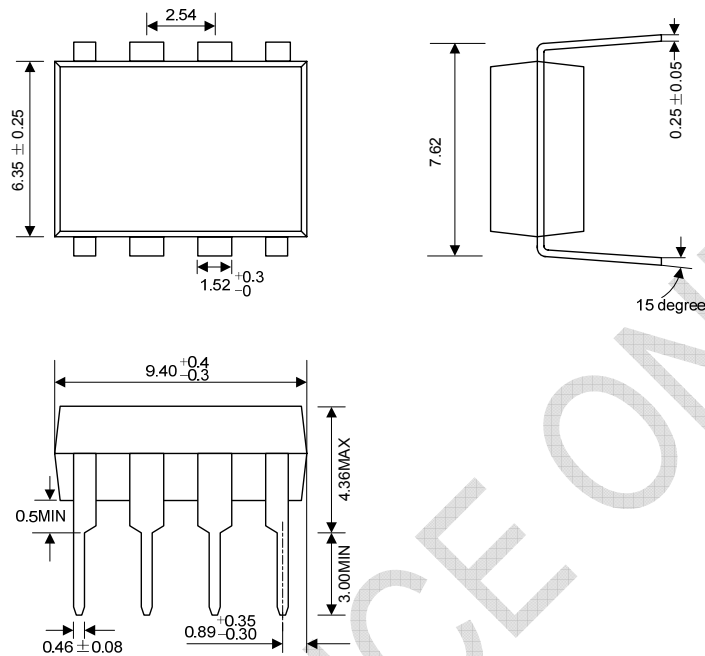


Note: The circuit and parameters are for reference only, please set the parameters of the real application circuit based on the real test.

PACKAGE OUTLINE

DIP-8-300-2.54

UNIT: mm



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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