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

DESCRIPTION

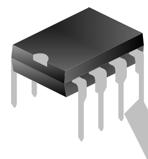
SDH682X is current mode PWM+PFM controller with built-in high-voltage start and high-voltage MOSFET used for SMPS.

SDH682X 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 20~100KHz following the load with jitter frequency for low EMI.

The built-in peak current compensation circuit makes the limit peak current stable even with different input AC voltage. The switch is controlled by line voltage control and when the input AC voltage is too high or too low, the switch is off. At the same time, the maximum peak current can also be compensated by the line voltage control, thus the limit output power can be adjusted. The peak current compensation will decrease for balance after power-on during power-on, which reduces pressure on transformer to avoid saturation. The built-in slope compensation will make the circuit suitable for more transformers.

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



DIP-8-300-2.54

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, overload and over temperature protections
* Line voltage control and compensation
* 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

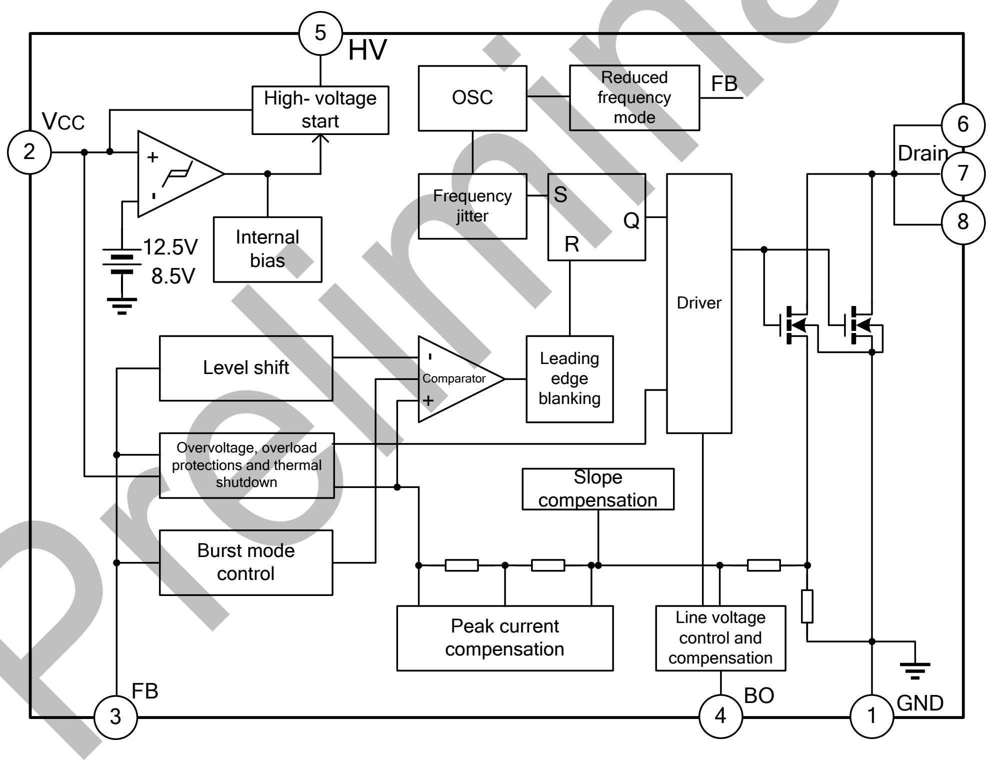
ORDERING INFORMATION

Part No.	Package	Marking	Material	Packing
SDH6821	DIP-8-300-2.54	SDH6821	Pb free	Tube
SDH6823	DIP-8-300-2.54	SDH6823	Pb free	Tube
SDH6824	DIP-8-300-2.54	SDH6824	Pb free	Tube

TYPICAL OUPUT POWER CAPABILITY

Part No.	190~265V		85~265V	
	Adapter	Open	Adapter	Open
SDH6821	10W	14W	8W	12W
SDH6823	14W	19W	12W	15W
SDH6824	16W	21W	14W	18W

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATING

Characteristics		Symbol	Ratings	Unit
Drain-Gate Voltage (R_{GS}=1MΩ)		V_{DGR}	650	V
Gate-Source (GND) Voltage		V_{GS}	±30	V
Drain Current Pulse [note1]	SDH6821	I_{DM}	6	A
	SDH6823		10	
	SDH6824		14	

Characteristics		Symbol	Ratings	Unit
Continuous Drain Current (T_{amb}=25°C)	SDH6821	I_D	1	A
	SDH6823		2.5	
	SDH6824		3.5	
Signal Pulse Avalanche Energy[note2]	SDH6821	E_{AS}	30	mJ
	SDH6823		140	
	SDH6824		200	
High Voltage Input		$V_{HV,MAX}$	650	V
Power Supply Voltage		$V_{CC,MAX}$	30	V
Feedback Input Voltage		V_{FB}	-0.3~7	V
Line Voltage Control Voltage		V_{BO}	-0.3~7	V
Total Power Dissipation		P_D	1.5	W
		Darting	0.017	W/°C
Operating Junction Temperature		T_J	+150	°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°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		B_{VDSS}	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	SDH6821	$R_{DS(ON)}$	V_{GS}=10V, I_D=0.5A	--	8.4	--	Ω
	SDH6823			--	3.4	--	
	SDH6824			--	2.5	--	
Input Capacitance	SDH6821	C_{ISS}	V_{GS}=0V, V_{DS}=25V, f=1MHz	--	155	--	pF
	SDH6823			--	320	--	
	SDH6824			--	435	--	
Output Capacitance	SDH6821	C_{OSS}	V_{GS}=0V, V_{DS}=25V, f=1MHz	--	23	--	pF
	SDH6823			--	41	--	
	SDH6824			--	53	--	
Reverse Transfer Capacitance	SDH6821	C_{RSS}	V_{GS}=0V, V_{DS}=25V, f=1MHz	--	0.6	--	pF
	SDH6823			--	1.3	--	
	SDH6824			--	1.4	--	
Turn On Delay Time	SDH6821	$T_{D(ON)}$	V_{DD}=0.5BV_{DSS}, I_D=25mA	--	6	--	ns
	SDH6823			--	13	--	
	SDH6824			--	16	--	
Rise Time	SDH6821	T_R	V_{DD}=0.5BV_{DSS}, I_D=25mA	--	13	--	ns
	SDH6823			--	31	--	
	SDH6824			--	36	--	

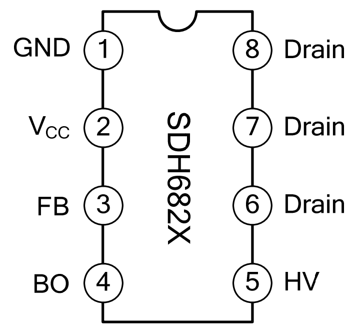
Characteristics		Symbol	Test conditions	Min.	Typ.	Max.	Unit
Turn Off Delay Time	SDH6821	$T_{D(OFF)}$	V_{DD}=0.5BV$_{DSS}$, I_D=25mA	--	9	--	ns
	SDH6823			--	18	--	
	SDH6824			--	17	--	
Fall Time	SDH6821	T_F	V_{DD}=0.5BV$_{DSS}$, I_D=25mA	--	17	--	• ns
	SDH6823			--	20	--	
	SDH6824			--	18	--	

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

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
High-voltage start Section						
Charge current	I_{HVC}	V_{CC}=0V, V_{HV}=60V	0.3	0.6	0.9	mA
High-voltage shutdown current	I_{HVS}	V_{CC}=14V	--	3	20	μA
Undervoltage Section						
Start threshold voltage	V_{START}		11.5	12.5	13.5	V
Stop threshold voltage	V_{STOP}		7.5	8.5	9.5	V
Oscillator Section						
Max. oscillator frequency	f_{OSCMAX}	V_{FB}=3.5V	91	100	109	KHz
Min. oscillator frequency	f_{OSCMIN}	V_{BURL}<V_{FB}<V_{BURH}	16	20	25	KHz
Max. frequency jitter	f_{MOD}	V_{FB}=3.5V	±3.5	±5	±6.5	KHz
Frequency change with temperature	--	25°C≤T_{amb}≤+85°C	--	±5	±10	%
Max. Duty cycle	D_{MAX}		78	83	88	%
Feedback Section						
Feedback source current	I_{FB}	V_{FB}=0V	0.8	1.0	1.2	mA
Feedback shutdown voltage(Overload protection)	V_{SD}		3.6	4.2	4.8	V
Feedback shutdown delay time	T_{SD}	FB is increased to 5V from 0V instantly	52	60	70	ms
Line voltage control and compensation						
Switch off lower threshold voltage	V_{BOD}		0.2	0.3	0.4	V
Lower threshold voltage off delay	T_{BOD}		80	100	120	μs
Switch off upper threshold voltage	V_{BOU}		4.4	4.7	5.0	V
Upper threshold voltage off delay	T_{BOU}		80	100	120	μs
Switch start voltage	V_{BOSTA}		1.0	1.1	1.2	V
Switch stop voltage	V_{BOSTO}		0.5	0.6	0.7	V

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Switch stop delay	T_{BOSTO}		0.4	0.5	0.6	s
Current Limit						
Peak Current Limit – SDH6821	I_{OVER}	Max. inductor current	0.67	0.75	0.83	A
Peak Current Limit – SDH6823	I_{OVER}	Max. inductor current	1.10	1.20	1.30	A
Peak Current Limit – SDH6824	I_{OVER}	Max. inductor current	1.35	1.50	1.65	A
Frequency reducing control						
Voltage of starting point for frequency reducing	V_{FBT}	FB voltage, the frequency begins to drop from the max. value.	2.4	2.8	3.2	V
Voltage of ending point for frequency reducing	V_{FBB}	FB voltage, the frequency drops to the min. value	1.9	2.3	2.7	V
Burst mode						
Burst Mode High Voltage	V_{BURH}	FB voltage	1.5	1.8	2.1	V
Burst Mode Low Voltage	V_{BURL}	FB voltage	1.4	1.7	2.0	V
Protection Section						
Overvoltage Protection	V_{OVP}	V_{CC} voltage	23	24.5	26	V
Over temperature protection	T_{OTP}		125	145	--	°C
Quit over temperature protection	T_{OTU}		90	105	120	°C
Leading-edge Blanking Time	T_{LEB}		200	300	--	ns
Total Standby Current						
Start Current	I_{START}	V_{CC} increases from 0V to 11V	--	30	100	μA
Quiescent Current	I_{STATIC}	V_{FB}=0V	1.5	2.2	3.5	mA
Operating Current – SDH6821	I_{OP}	V_{FB}=3.5V	1.5	2.0	3.5	mA
Operating Current – SDH6823	I_{OP}	V_{FB}=3.5V	1.5	2.2	3.5	mA
Operating Current – SDH6824	I_{OP}	V_{FB}=3.5V	1.5	2.4	3.7	mA

PIN CONFIGURATION



PIN DESCRIPTION

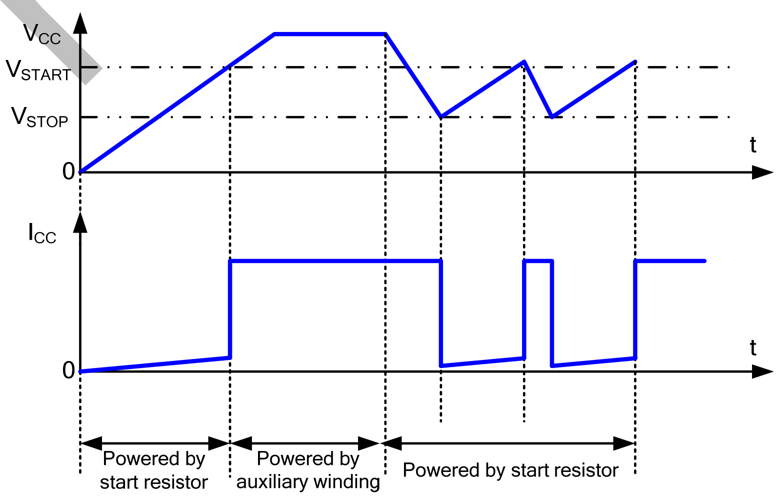
Pin No.	Pin Name	I/O	Function description
1	GND	I	Ground
2	V_{CC}	I	Power supply pin
3	FB	I/O	Feedback input pin
4	BO	I	Line voltage control pin
5	HV	I	High-voltage start pin
6、7、8	Drain	O	Drain pins of power MOSFET

FUNCTION DESCRIPTION

SDH682X 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, overload, primary side overcurrent, and over temperature protections. Frequency jitter generated from oscillator is used to lower EMI. The maximum peak current compensation reduces the pressure on transformer and the built-in slope compensation will make the circuit suitable for more appliances. The line voltage control can control the switch and adjust the limit output power. 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. 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 12.5V and charge current is shutdown. The output and FB source current are shutdown caused by any protection or BO control pin 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.

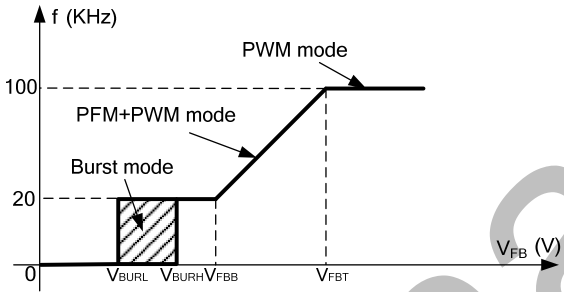


2. Frequency Jitter and reduced frequency mode

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 100 KHz): ±5KHz change in 2.7ms, 63 frequency points in all.

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

To improve the efficiency, the circuit uses reduced frequency mode. The frequency f is reduced by detecting the voltage on pin FB. If the FB voltage is lower thanV_{FBT}, the frequency f decreased from the typical 100KHz, until the voltage reached to V_{FBB}, and f reached to the typical 20KHz. The relation between f and FB voltage is as follows:



3. Peak current compensation and initialization

In general, limit peak current changes with different inputs. Limit peak current is hold in this circuit because of peak current compensation. The higher the input AC voltage is, the larger the peak current compensation is, and the peak current compensation 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. Line voltage control and compensation

The circuit can control the switch by line voltage control pin (pin BO). When the voltage on pin BO is detected lower than 1.1V or higher than 4.7V during power-on, the switch keeps off-state and V_{CC} fluctuates between start voltage and stop voltage; when the voltage detected is between 1.1V and 4.7V, the switch is turned on without protection after V_{CC} starts. If the circuit is normal working, and the switch is turned on normally, when the voltage on pin BO is detected lower than 0.6V and lasts for 0.5s, the switch is turned off; even if the voltage is detected lower than 0.3V for 100μs, the switch is turned off. This state keeps until the under voltage restart occurs. When the voltage on pin BO is detected higher than 4.7V and lasts for 100μs, the switch is turned off; this state keeps until the V_{CC} is lower than 3.5V, while under voltage restart is disabled at this time.

The line voltage detection can also realize the peak current compensation limit. When the voltage on pin BO is detected between 0.9V and 4.2V, the peak current compensation limit decreases following the BO voltage rising. Proper setting the resistance between pin BO to the ground will make the output power limit consistent.。

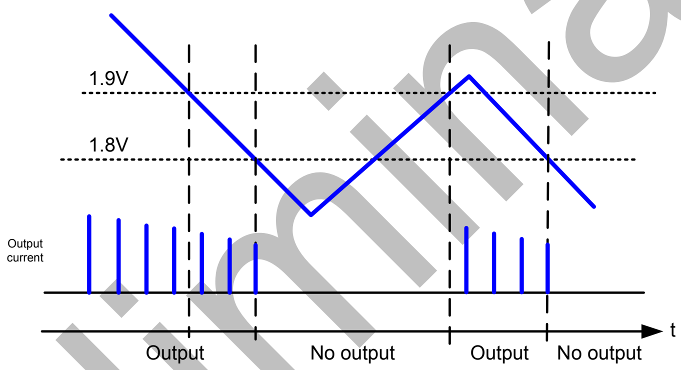
5. Slope compensation

Slope compensation is adopted to avoid subharmonic oscillation which will occur if the switch turning on time exceeds 50% of one period. Higher compensation current is got due to the higher duty factor.

6. Burst mode

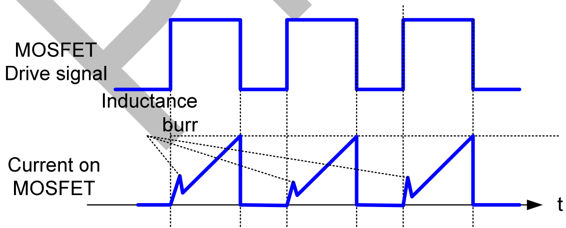
Working in this mode is for reducing power dissipation. When the FB voltage changes from high to low, the switch has no output until FB voltage lower than 1.7V; while the FB voltage changes from low to high, only if the FB voltage is higher than 1.8V, the switch is normal working.

For this mode, the switch adjustment is as follows: FB voltage is about 1.7V below during light load. When the FB voltage changes from high to low, due to the higher comparison value of the current comparator, the output power is higher and the output voltage rises (the rising speed is decided by the load), which makes the FB voltage decrease till to lower than 1.7V; when FB<1.7V, the switch has no action and the output voltage decreases (the decreasing speed is decided by the load), which makes the FB voltage rises till to FB>1.8V, the switch is on again. The above actions are repeated during light load to output discontinuous pulses which reduced the actions of the switch for lower power dissipation.

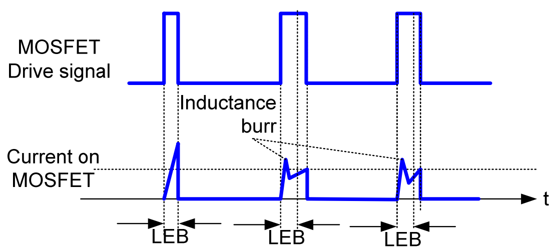


7. Leading Edge Blanking

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.



Large duty factor



Small duty factor

8. Over Voltage Protection

The output is shutdown if voltage at V_{CC} exceeds the threshold value, which means overvoltage on the load 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 and keeps for the delay time. This state is kept until the circuit is powered on reset when the V_{CC} is 5.2V below.

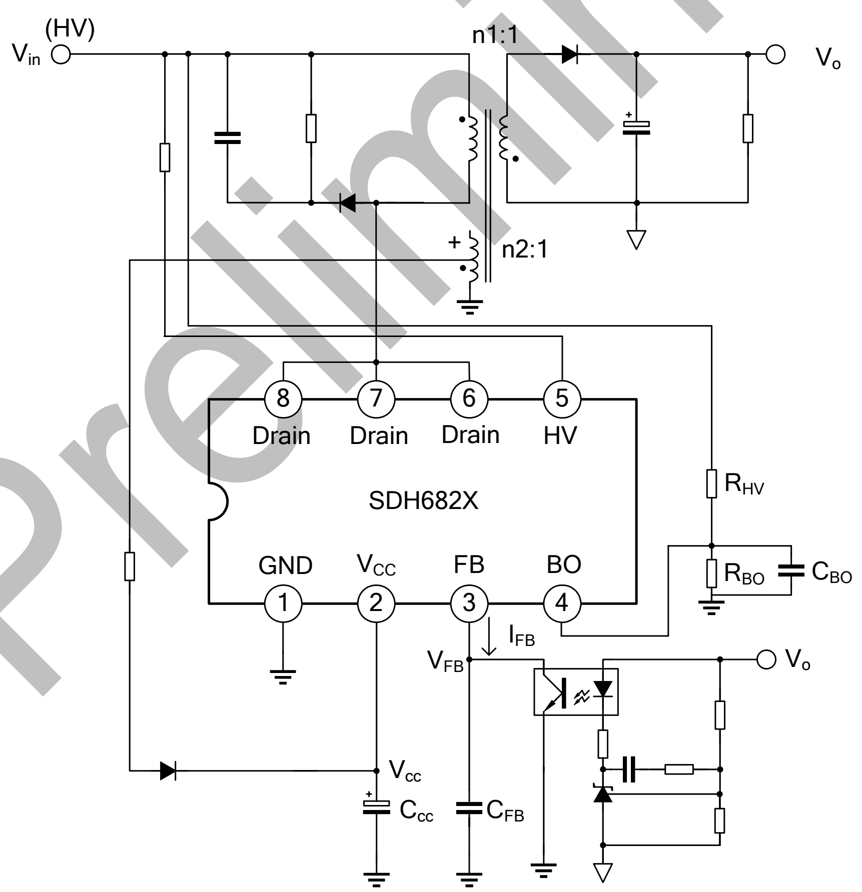
10. Cycle-By-Cycle Peak Current Limit

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. Over temperature protection

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

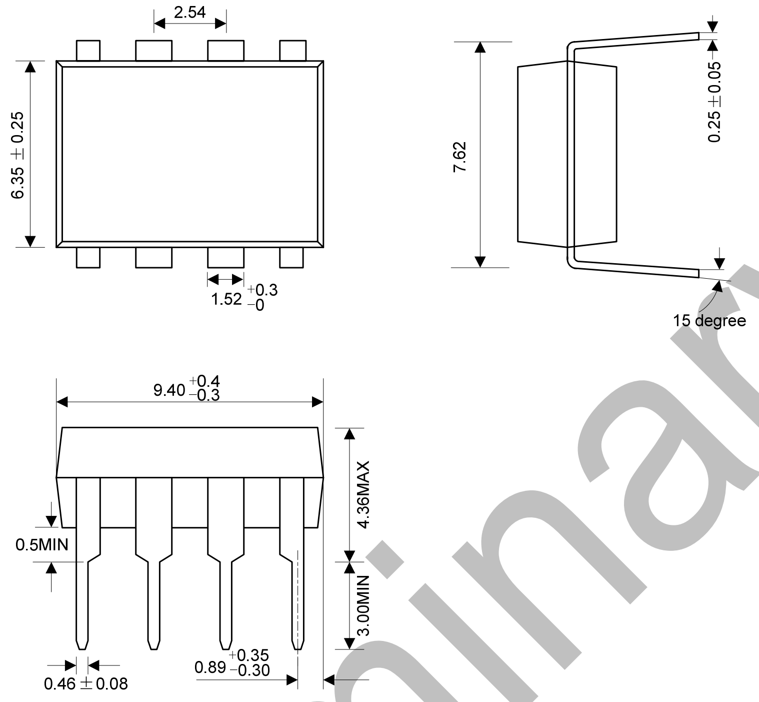


Note:

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.