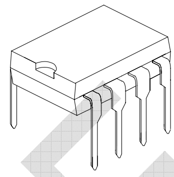
PRIMARY SIDE POWER CONTROLLER WITH BUILT-IN HIGH VOLTAGE MOSFET

DESCRIPTION

SD4851 is primary side power controller with built-in high voltage MOSFET. It senses the output voltage indirectly by using the auxiliary wind of the power transformer. It adopts Pulse Frequency Modulation (PFM) technology for flyback power supply controller.

SD4851 provides accurate constant voltage, constant current (CV/CC) regulation for higher efficiency and higher reliability.

By using SD4851 for flyback power controller, Few peripheral components are needed, the Opto-coupler and secondary control circuitry is not needed and the loop compensation circuitry for maintaining stability is also unnecessary.



DIP-8A-300-2.54

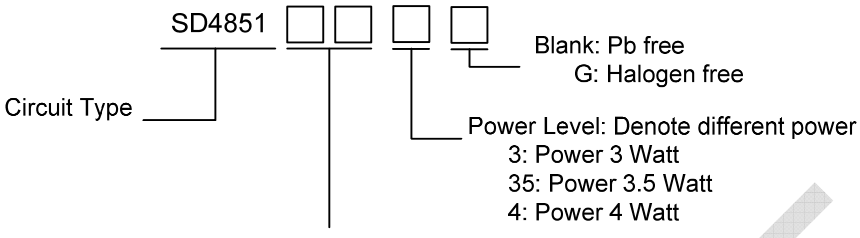
FEATURES

* Lower start-up current
* Primary side control for Constant Voltage (CV) and Constant Current (CC)
* Leading edge blanking
* Pulse-Frequency Modulation
* Overvoltage protection
* Undervoltage lockout
* Over temperature protection
* Built-in high voltage MOSFET
* Cycle by cycle current limiting
* Open Loop Protection
* Cable drop compensation
* Peak current compensation

APPLICATIONS

* Chargers for Cell Phones
* Adapters
* MP3 and Other Portable Apparatus
* Standby Power Supply

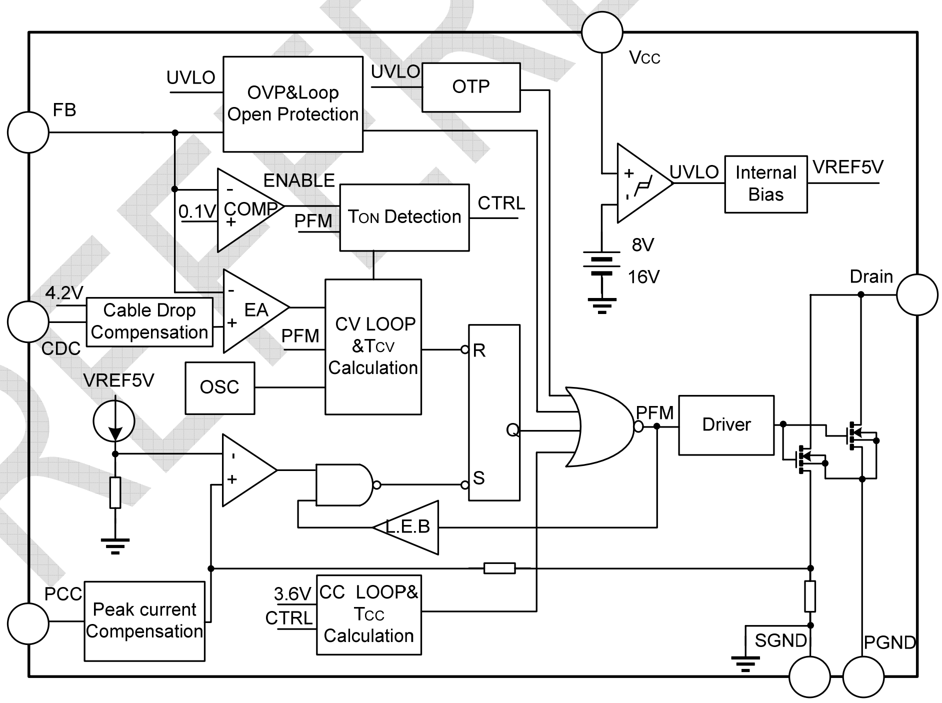
ORDERING INFORMATION



Package: (DD: DIP-8A-300-2.54)

Part No.	Package	Marking	Output power	Material
SD4851DD3	DIP-8A-300-2.54	SD4851DD3	3W	Pb free
SD4851DD3G	DIP-8A-300-2.54	SD4851DD3G	3W	Halogen free
SD4851DD35	DIP-8A-300-2.54	SD4851DD35	3.5W	Pb free
SD4851DD35G	DIP-8A-300-2.54	SD4851DD35G	3.5W	Halogen free
SD4851DD4	DIP-8A-300-2.54	SD4851DD4	4W	Pb free
SD4851DD4G	DIP-8A-300-2.54	SD4851DD4G	4W	Halogen free

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATING

Characteristics	Symbol	Rating	Unit
Power Supply Voltage	V_{CC}	-0.3~25	V
Internal Voltage Reference	V_{REF5V}	-0.3~5.5	V
FB Pin Input Voltage	V_{FB}	-20~22	V
Other Pin Input Voltage	V_{IN}	-0.3~ 5.3	V
Input Current	I_{IN}	-10~10	mA
Operating Junction Temperature	T_J	+160	°C
Operating Temperature	T_{amb}	-25~ +85	°C
Storage Temperature	T_{STG}	-55~+150	°C

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

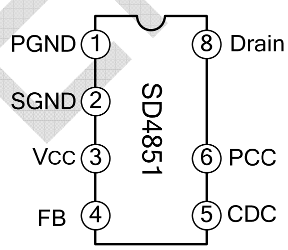
Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	BV_{DSS}	V_{GS}=0V, I_D=50μA	700	--	--	V
Zero VGATE Voltage Drain Current	I_{DSS}	V_{DS}=Max. V_{GS}=0V	--	--	50	μA
		V_{DS}=0.8Max. V_{GS}=0V T_{amb}=125°C	--	--	200	μA
Static Drain-Source On Resistance	$R_{DS(ON)}$	SD4851DD3,SD4851DD4, V_{GS}=10V, I_D=0.5A	--	10	12	Ω
		SD4851DD3, SD4851DD4, V_{GS}=10V, I_D=0.5A	--	8	10	Ω
Forward Trans-Conductance	Gfs	V_{DS}=50V, I_D=0.5A	1.5	--	--	S
Input Capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	--	210	--	pF
Output Capacitance	C_{oss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	--	18	--	pF
Reverse Transfer Capacitance	C_{rss}		--	8	--	pF
Turn On Delay Time	$t_{d(ON)}$	V_{ds}=0.5BV_{DSS}, I_D=25mA	--	10	--	nS
Rise Time	t_r		--	3	--	
Turn Off Delay Time	$t_{d(OFF)}$		--	27	--	
Fall Time	t_f		--	8	--	

ELECTRICAL CHARACTERISTICS (unless otherwise specified, V_{CC}=16V, T_{amb}=25°C)

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Supply Section						
Start-up Current	I_{start}	V_{CC}=14V	--	6	20	μA
Supply Current (Control Part)	I_{op}			400	600	μA
Undervoltage Section						
Start Threshold Voltage	V_{start}		14	16	18	V
Stop Threshold Voltage	V_{stop}		7	8	9	V

Characteristics	Symbol	Test conditions	Min.	Typ.	Max.	Unit
Feedback Section						
Enable Turn on Voltage	V_{FREIG}		50	100	140	mV
Over Voltage Protection	V_{OVP}		7.8	8.8	9.8	V
Loop Open Voltage	V_{AUSB}		-1.2	-1	-0.8	V
S&H Reference	$V_{S\&HREF}$		3.9	4.2	4.6	V
S&H Range	$V_{S\&Hub}$			±0.1		V
Dynamitic parameter						
Leading-edge Blanking Time	T_{LEB}		0.4	0.7	1.1	µs
CV Loop Off-time	T_{CVmin}		1.0		2.8	µs
	T_{CVmax}	FB > $V_{S\&HREF}$+0.2V	3.5	4.2	7.3	ms
Over voltage recover time	T_{OVP}		11	19	30	ms
Current Limit						
Peak Current Limit	I_{SENSE}	I_{PCC}=0	170	185	200	mA
Peak Current Compensation	ΔI_{SENSE}	I_{PCC}=-1uA	1.94	2.16	2.38	mA
Cable Compensation						
Cable Compensation Voltage	V_{CDC}	R_{CDC}=100K,Ds=50%	310	344	378	mV
OTP Section						
Over Temperature Detection	Tsd		125	140	--	°C
Over Temperature Hysteresis	Tsdhys		20	35	50	°C

PIN CONFIGURATION



PIN DESCRIPTION

Pin No.	Pin Name	I/O	Function description
1	PGND	-	Ground for power MOSFET.
2	SGND	-	Ground control part.
3	VCC	-	Power Supply Pin.
4	FB	I	Feedback input pin.
5	CDC	I	Cable drop compensation pin.
6	PCC	I	Input AC line voltage compensation for peak current limiting.
7	--	--	No pin
8	Drain	O	Drain pin.

FUNCTION DESCRIPTION

SD4851 is designed for off-line SMPS, consisting of high voltage MOSFET, cable compensation and peak current compensation without opto-coupler. SD4851 provides constant voltage/constant current (CV/CC) output through primary current and auxiliary voltage. It adopts PFM technology and accurate constant voltage/constant current (CV/CC) control loop for higher stability and efficiency.

A whole work period of SD4851 can be divided into two period sections:

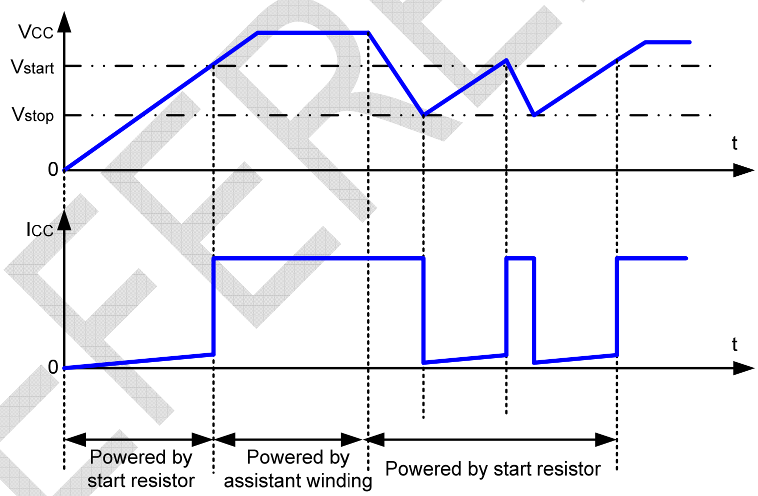
When MOSFET is on, primary current is detected by sample resistor and voltage at pin FB is negative, load is powered by output capacitor and output voltage V_O decreases.

When primary current exceeds the limit, MOSFET is off and voltage at pin FB is detected. Output capacitor is powered by secondary current and V_O increases. MOSFET is on again after stop for T_{CV} and hold for T_{CC}.

And then, it comes to peak current detect again.

1. Under Voltage Lockout and Self-Start

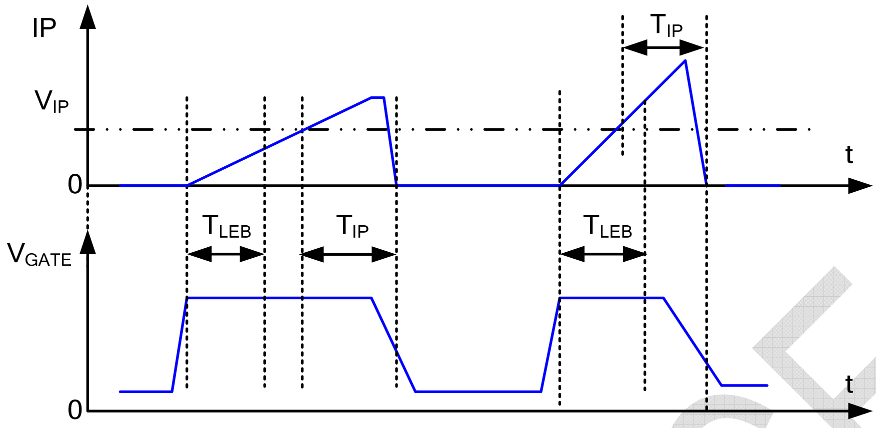
At the beginning, the capacitor connected to pin VCC is charged via start resistor by high voltage DC bus and the circuit start to work if voltage at Vcc is 16V. The output is shutdown if there is any protection during normal operation and Vcc is decreased because of no powering of auxiliary winding. The whole control circuit is shutdown if voltage at Vcc is 8V below to lower current dissipation and the capacitor is recharged for restarting.



2. Driver Circuit

The driver circuit is powered by V_{CC}.

When VGATE＝1, the power MOSFET is on. When VGATE＝0, the power MOSFET is off. It is recommended to set T_{LEB}＝0.7μs to avoid error trigger caused by burr.



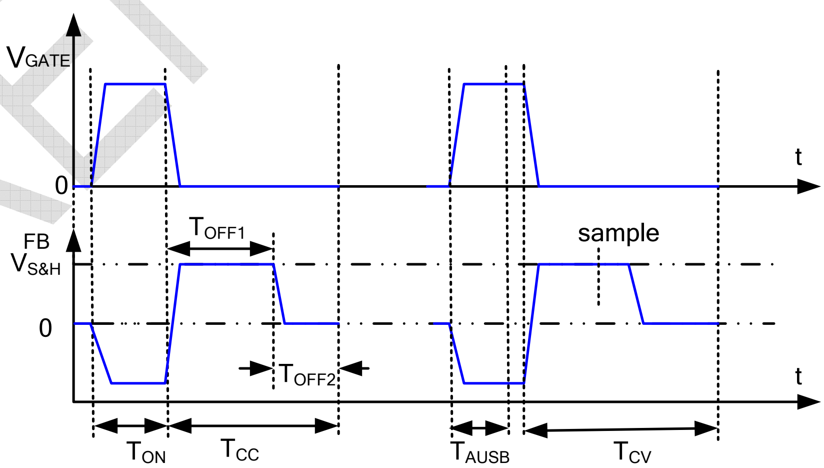
3. Peak Current Detection

The circuit has built-in power MOSFET. The power MOSFET is on, The voltage at pin FB is minus, the input current increases. When the current exceeds the current limit, the VGATE＝0, and the power MOSFET is off.

4. Feedback Voltage Detection

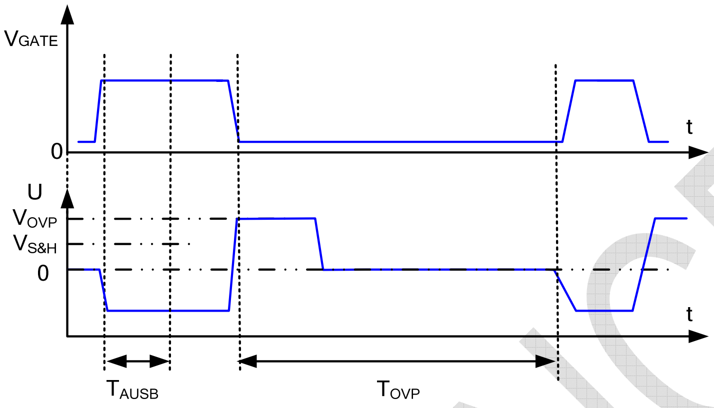
When the power MOSFET is off, the voltage at pin FB is positive and voltage is sampled at 2/3 of this positive voltage to be amplified, held, and compared for stall time T_{CV} control of constant voltage loop.

T_{OFF1}, T_{ON} and T_{OFF2} are counted at the same time which indicates durations of positive FB voltage, FB damping oscillation and FB negative voltage respectively. Positive FB voltage indicates there is current delivered to the secondary side of transformer, while negative and FB damping oscillation indicate there is no current delivered to the secondary side of transformer. Under the condition that the peak current is constant, $T_{OFF1} = T_{OFF2} + T_{ON}$ should be kept for constant current output. Hence, T_{CC} is determined by these three time parameters to guarantee constant current output.



5. Over Voltage Protection

The output is shutdown if voltage at FB exceeds the threshold and this state is kept for 19ms, then the circuit restarts.



6. Over Temperature Protection

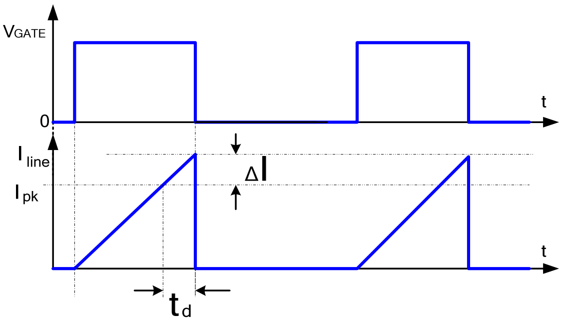
If the circuit is over temperature, the over temperature protection will shut down the output to prevent the circuit from damage. The over temperature protection has hysteresis feature. To recover from the over temperature protection state to normal state, the temperature of the circuit must be lower than the over temperature protection by about 35 °C to aviod that the over temperature protection state and normal state appear alternately with high frequency.

7. Open Loop Protection

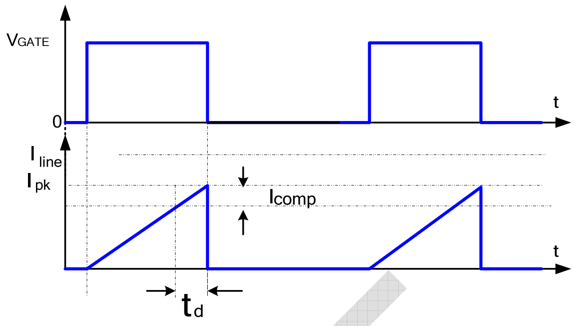
When VGATE＝1, the power MOSFET is on. If the FB voltage is higher than －1V, the loop is open and open loop protection is active to shutdown the output, which keeps for 19ms and then the circuit restarts.

8. AC Input Voltage Compensation for Peak Current

Because of the delay time of switch-off the power MOSFET and different current rising slope for different AC voltage input, the real peak current will vary following input voltage. The higher input voltage is, the bigger current rising slope is and the current overshoot of AC voltage input will be higher. To overcome this shortcoming, SD4851 adopts pin PCC to sense the AC voltage input for peak current compensation.

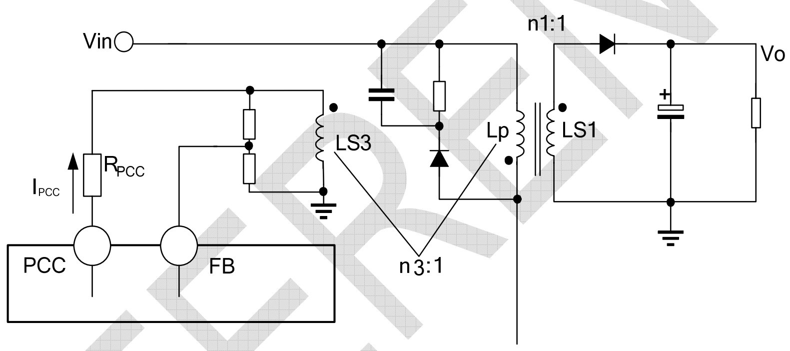


Circuit delay makes the peak current of Input line different



Using compensation for the peak current of Input line

As we know, the minus voltage on transformer's auxiliary wind indicates AC voltage input when the power MOSFET is on. SD4851 uses this voltage to compensate peak current drift caused by AC voltage input. For high AC voltage, the compensation current will be high. By adjusting the resistor R_{PCC}between the pin PCC and the transformer auxiliary wind, the compensation peak current limit can be adjusted. The higher resistor indicates lower compensation.



9. Cable Drop Compensation

In this design, the sampled voltage is not the output voltage, but the voltage of the auxiliary wind of the transformer. The difference between these two caused by the induction leakage and the voltage dropout of cable line or diode.

If the voltage dropout of diode is Vd, the voltage dropout of cable line is Vcab, the output voltage is Vo, the ratio of wind circles between auxiliary side for sampling the voltage and secondary side for output the voltage of transformer is Nf. The sampled voltage Vs is as below:

$$V_S = N_f (V_o + V_d + V_{cab})$$

For the peak current control mode, the auxiliary current (if there is) changes with same rate when peak current and output voltage change litter, hence sample voltage difference caused by diode can be ignored with same sampling intervals.

So, only voltage difference caused by CABLE is taken into consideration.

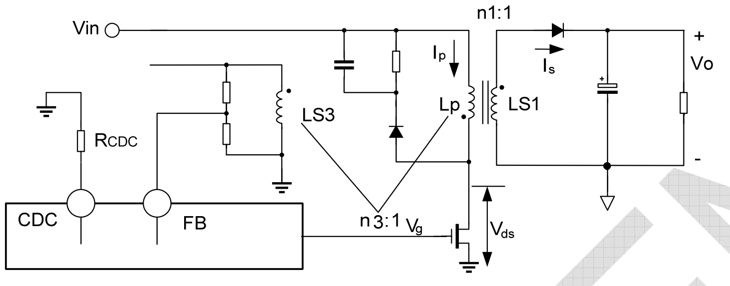
$$V_{cab} = I_{out} R_{cab} = \frac{I_{SP}}{2} D_S R_{cab} = \frac{I_P}{2 \cdot n} D_S R_{cab}$$

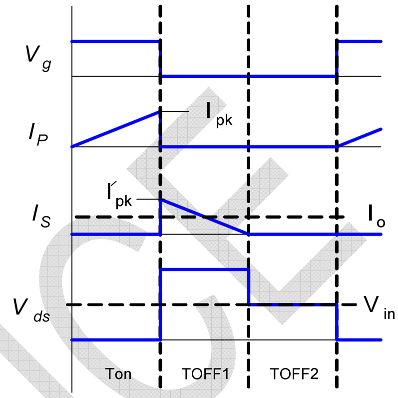
Where, I_{SP}—secondary side peak current, I_P --primary side peak current., D_S--duty cycle of the transformer secondary side current, n--ratio of wind circles between primary side and secondary side of transformer.

Cable voltage drop is proportional to output current and cable resistance.

Cable voltage drop is different with different output currents.

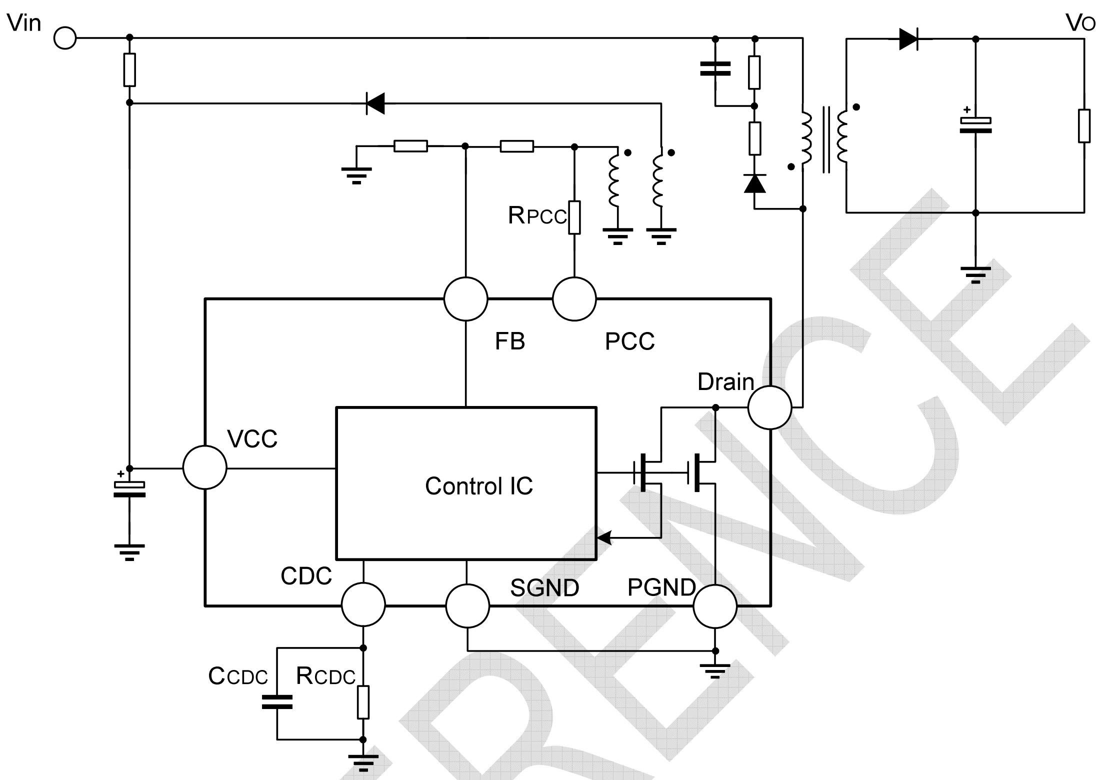
Compensation circuit is needed for voltage compensation and should be adjustable following cable length. One pin (CDC) is used for connecting resistor (R_{CDC}) to simulate cable resistance. The compensation is least when pin CDC is grounded and it is adjusted by external resistor.





$$Ds = \frac{TOFF1}{Ton + TOFF1 + TOFF2}$$

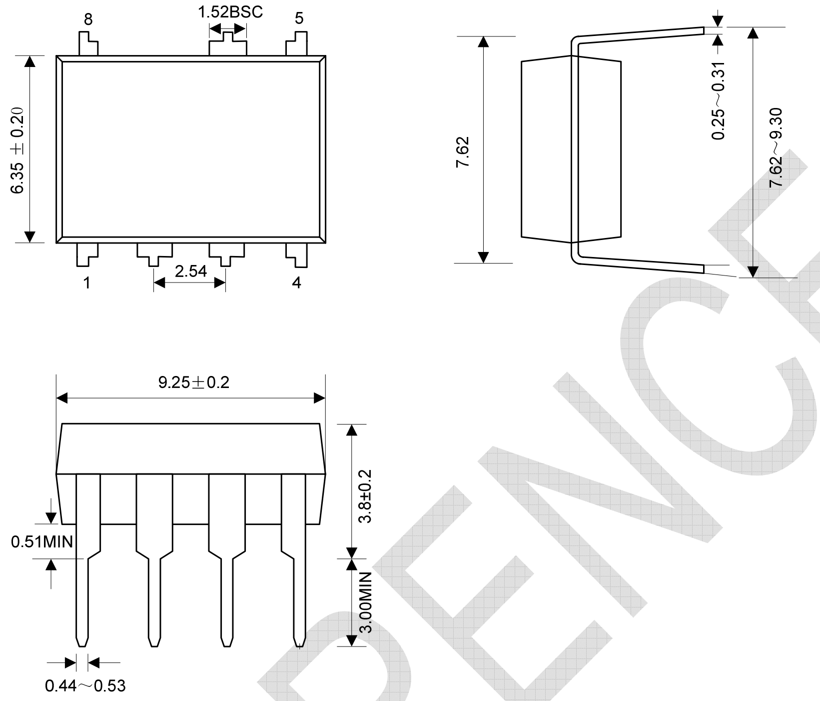
TYPICAL APPLICATION CIRCUIT



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-8A-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.