Shenzhen Tianxinyuan Electronics Co., Ltd.

ATC9501(Document Number:11025)

summary:

This application note describesATC9501The built-in triode primary feedback control chip and its application circuit are described in detail. Its characteristics and working principle are described.

Features:

- Primary side feedback constant voltage (CV)and constant current (CC)control 3%
- Constant pressure accuracy,2%Constant current precision energy saving mode:
- pulse frequency modulation control mode (PFM)
- built-in900VPower switch tube
- Built-in frequency jitter to reduceEMI
- Cycle-by-cycle current limiting
- Built-in soft start
- Low starting current (5uA)
- Feedback overvoltage protection (OVP)
- Undervoltage Lockout (UVLO)
- Over temperature protection (OTP)
- Output short circuit protection
- Feedback loop open circuit protection
- Adjustable output line compensation voltage

Main description:

ATC9501Suitable for constant current and constant voltage with low cost and high precision (CC/CV)Application. Constant current and constant voltage loop does not require optocoupler, TL431and compensation circuits, internally integrated900Vpower tube, reducing system cost. ATC9501Can meet the output voltage±5%The mass production accuracy is very low. The quasi-valley detection can easily meetEPA2.0 The voltage compensation of the output cable can be adjusted according to the customer's

It can be adjusted according to the requirements, which greatly facilitates the customer's system design.

ATC9501It also integrates a variety of protection functions: undervoltage lockout, leading edge blanking, overvoltage protection, overcurrent protection, loop open circuit protection, and output short circuit protection, which greatly increases the stability of the system.

ATC9501 supplySOP-8The package,ATC9501SforSOP-7Encapsulation.

Applications:

- Cell phones, cordless phones,PDA,MP3/MP4, battery chargers for digital cameras and power tools led
- Spotlights, lamp cups and bulbs
- Linear Power Supplies andRCCThe best choice for upgrading switching power supply

�Limit parameters

VCC to GND...-0.3V to + 18V FB to
GND...-0.3V to +8V
CABLE to GND...-0.3V to +8V VC to GND
....-0.3V to +900V CS to GND......
....-0.3V to +8V Operating Temperature
Range...... ....-40℃to +125℃ Junction
Temperature...-40℃to +150℃ Storage
Temperature Range...-60℃to +150℃ ESD Protection
HBM...2000V
MM...500V

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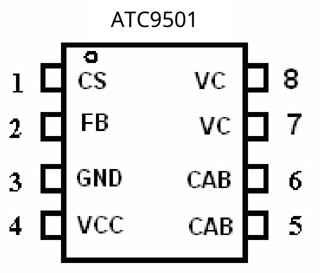
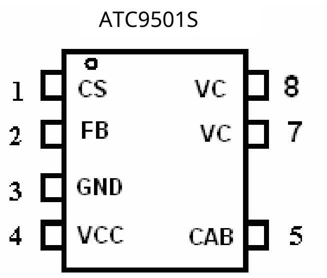
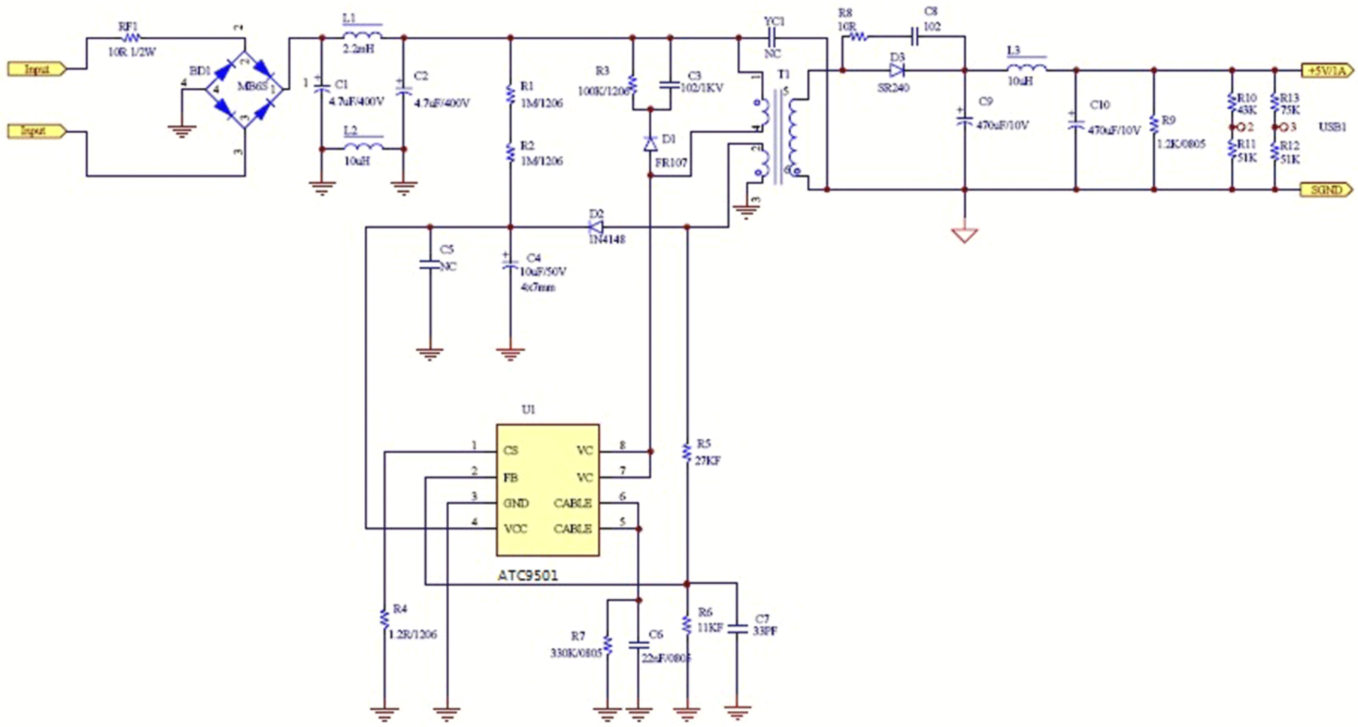
Pin definition:





Pin No.	Pin Name	Description
ATC9501/ATC9501S		
1	CS	Primary current sensing pin
2	FB	Output voltage feedback pin
3	GND	Chip Ground
4	VCC	Chip operating voltage
5,6	CABLE	External capacitor and resistor, output line compensation adjustment
7,8	VC	Connected to the primary high-voltage output terminal of the transformer, can withstand voltage900VVoltage

Typical application circuit diagram:



picture1

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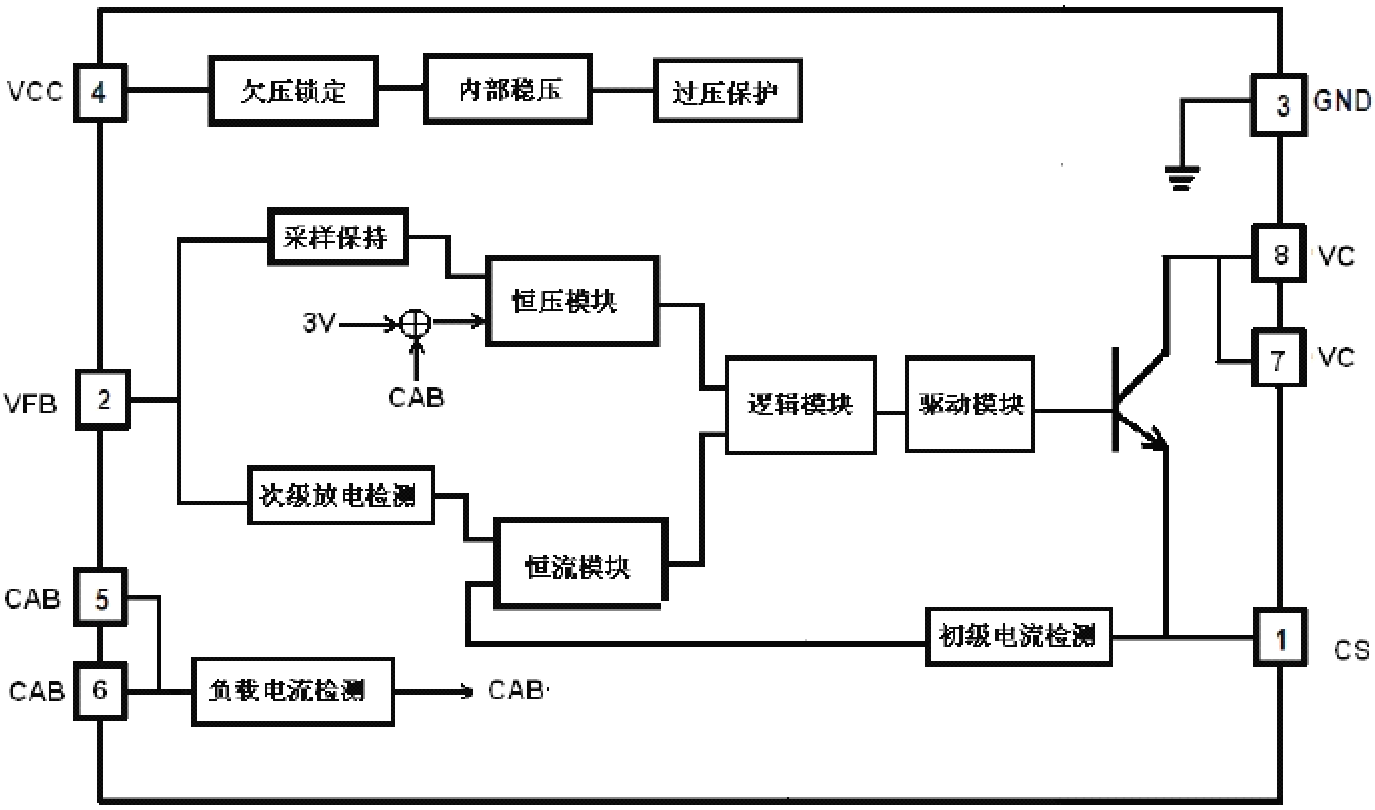
Electrical Characteristics

(TA=25℃,Vcc=10V,unless otherwise noted)

Characteristic	Symbol	Min	Type	Max	Unit
FBPin part					
FBFeedback voltage	VFB	2.98	3.01	3.04	V
FBOvervoltage protection voltage	FB ovp	4.4	4.5	4.6	V
FBMaximum output current	IFB max		5		mA
FBMinimum output current	IFB min		200		uA
CSPin part					
Overcurrent limit voltage	Vcs	0.49	0.50	0.51	V
Leading edge blanking time	LEB		400		ns
VCCPin part					
Starting current	Istart		5	10	uA
VCCStarting voltage	Vcc(on)	13.5	15.2	17	V
VCCShutoff voltage	Vcc(off)	5.5	6.6	7.5	V
VCCStatic operating current	Iq		0.7		mA
VCCOvervoltage protection voltage	Vcc(ovp)	17.5	18.5	19.5	V
CABLEPin part					
The ratio of cable compensation voltage to output voltage (Rbis connected toCABandGNDResistance, unitKohm	Kcab		0.012*Rb		%
Built-in switch tube**NPN**part					
Maximum continuous conduction current	Icc		1.5		A
Collector-base breakdown voltage (Ic=1mA)	BnB	900			V
Collector-emitter breakdown voltage (Ic=10mA)	BV	450			V
Emitter-base breakdown voltage (Ic=1mA)	BV	9			V
Saturation voltage (Ic=200mA,Ib=40mA)	Vcesat1			0.3	V
Saturation voltage (Ic=750mA,Ib=250mA)	Vcesat2			0.5	V

Internal Block Diagram



picture2

introduce

This highly integrated primary feedback control chip includes many functions that effectively improve the performance of low-power flyback converters. The primary feedback topology simplifies the circuit design and can achieve accurate constant voltage and constant current without secondary feedback. Through the frequency jitter technology inside the chip,EMIThis can be solved with the smallest filter possible, so the charger is smaller and lighter than traditional designs and linear transformers.

This primary feedback control chip operates in pulse frequency modulation (PFM) mode, the lighter the load, the smaller the frequency, so the system power consumption is very small when the load is light. The maximum starting current is10uA, so a large starting resistor can be used to improve energy saving.

This primary side control chip also provides a lot of protection functions.FBThe pins are configured with overvoltage protection and input undervoltage lockout. The current limit and constant current control of each cycle ensure overcurrent protection under heavy load. In addition, the overtemperature protection can shut down the control chip and restart when the overtemperature state is released.

By using this primary side feedback chip, the charger can achieve constant voltage and constant current functions with very few peripheral devices and the lowest cost. IC CABLEThe pin is connected to an external resistor-capacitor network to adjust the output line compensation voltage.

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Internal working diagram

Constant pressure control

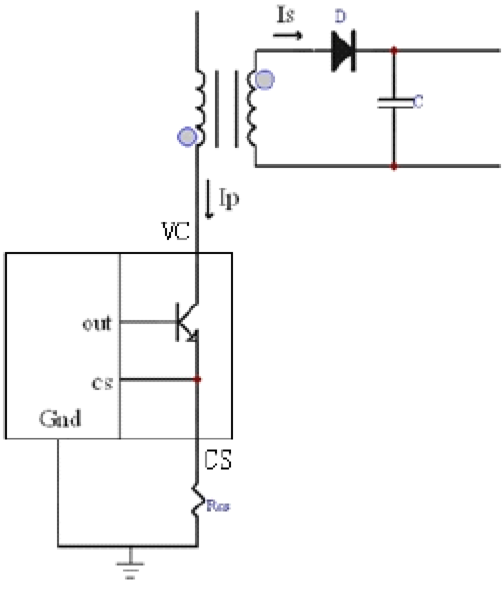
The primary side feedback control method can achieve accurate constant voltage/constant current control without the need for secondary side voltage and current detection.1and3This is a typical application circuit.2This is the internal block diagram of the chip.4These are some of the main waveforms. The secondary output state is obtained from the primary auxiliary winding when the power transistor is turned off. Some unique sampling methods are used to replicate the output winding voltage (Vs)and the discharge time of the secondary diode (Tdis)The sampled voltage is compared with the internal precise reference voltage (V_{FB}) and then modulate the output of the error amplifier to determine the switch off time. This simple method achieves accurate output voltage regulation.

Constant current control

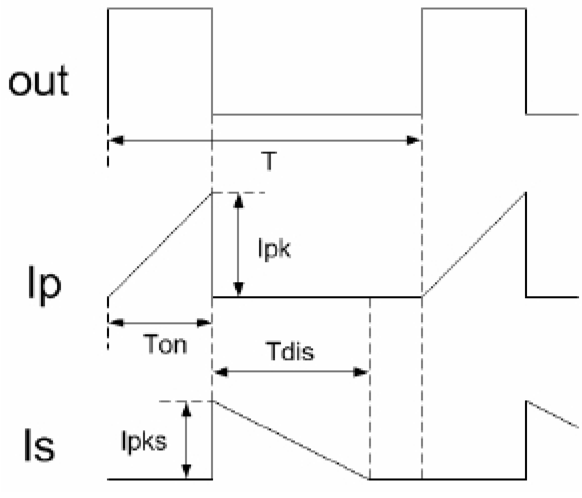
picture4As shown, the output currentIoIn intermittent mode (DCM)In the flyback topology, the equation (1)To express.

$$I_O = \frac{2 \times N_{ps} \times V_{csth}}{7 \times R_{cs}} \qquad (1)$$

in:Npsis the ratio of the number of turns of the primary to the secondary coil.Rcsis the resistance of the current sensing resistor.VxyesRcsThe voltage limit value on the chip is set Vcsth=0.5VTherefore, the output currentIoCan beNpsandRcsLet's calculate and make sureNpsandRcsAfter that, the primary feedback control chip can determine the turn-off time of the power transistor, thereby providing a constant output current.



picture3



picture4

Frequency reduction working mode

When the primary feedback control chip is in constant voltage working mode, the operating frequency decreases as the load current decreases.0With this control mode, the power control chip can easily meet the most stringent power conversion efficiency requirements.

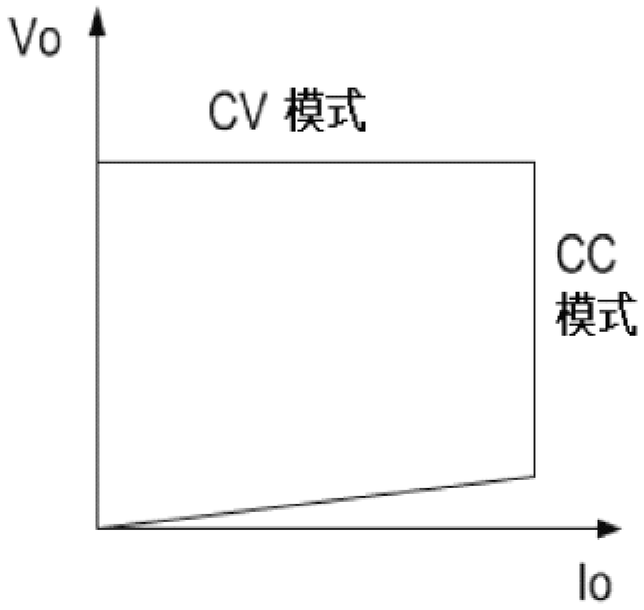
Frequency Jitter

This primary side feedback control chip integrates an internal frequency jitter function to improveEMIperformance.

Output voltage and current characteristics

Battery chargers are generally designed with two operating modes: constant voltage charging and constant current charging.5The following figure shows the basic charging characteristics. When the battery voltage is very low, the charger works in a constant current charging state. This is the main mode of current charging. When the battery voltage reaches its final voltage, the current gradually stops.

The device enters constant voltage charging mode. Eventually, the charging current gradually decreases to zero.



picture5

Startup Circuit

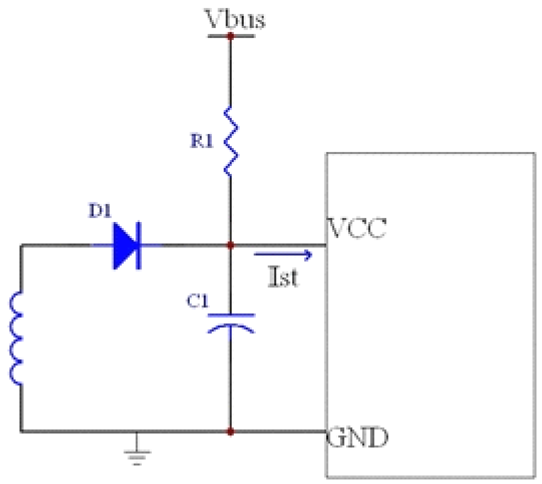
When the power is turned on, as shown in the figure6As shown, the input voltageVbusThrough the start resistorR1CapacitanceC1When the capacitor voltage (VCC) Reaching the chip startup voltage (V_{CC-ON}), the primary feedback control chip starts to start.

Power supply start-up delayTsIt can be calculated by the following formula:

$$T_{st} = -R1 \times C1 \times \ln\left(1 - \frac{V_{CC-ON}}{\sqrt{2} \times V_{ac} - I_{st} \times R1}\right) \qquad (2)$$

in:$V_{CC-ON}$is the chip startup voltage;Istis the chip startup current.

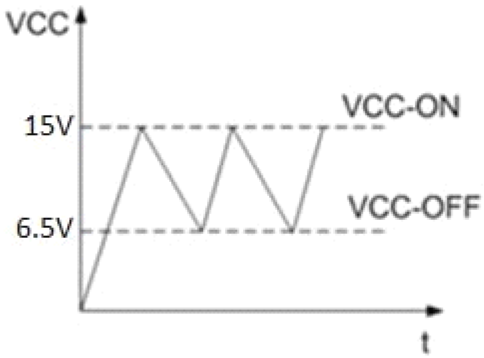
Because of the small starting current,R1The value of can be very large, such as 1.2MΩ.ifVCCThe capacitance is4.7uF, the startup delay is90VAC input can be done1Within seconds.



picture6

VCCUndervoltage Lockout

picture7As shown, the start and shut-down thresholds of this primary feedback control chip are fixed at15Vand6.5VAt startup,VCCThe capacitor must be connected across the start-up resistorR1Charge to15VThereby starting the control chip. When energy cannot be obtained from the auxiliary winding,VCCThe capacitor will continue to supply power to the control chip until the auxiliary winding starts toVCCSupply greater than6.5VIfVCCVoltage below6.5V, the chip will enterVCCUndervoltage lockout state, shut down some circuits inside the chip.VbuspassR1To capacitorC1Charge untilVCCVoltage reaches15V, the chip starts up again and turns on all internal circuits. This undervoltage lockout hysteresis loop will ensure thatVCCThe capacitor is sufficient to power the control chip.

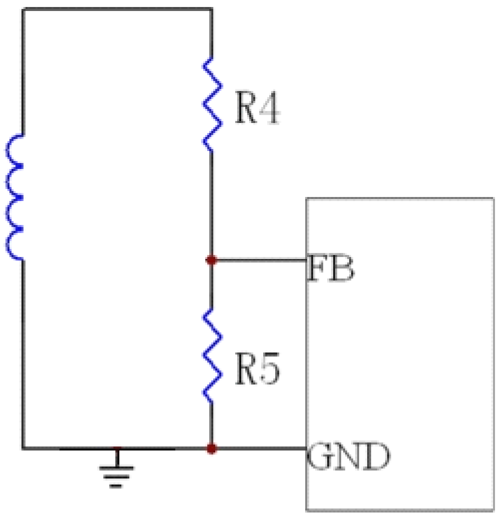


picture7

Output overvoltage and open loop protection

picture8As shown, in normal operation, the output voltage feedback is the voltage of the auxiliary winding, and the auxiliary winding isR4andR5The voltage divider is fed back to the chipFB The chip adjusts the off time to makeFBThe pin voltage remains stable at3VWhen the output voltage suddenly increases, the voltage of the auxiliary winding also increases, resulting inFBThe detected voltage rises whenFBVoltage reaches4.5Vand maintain6usWhen the chip turns off the chipoutThe output of the pin remains on until the chip is started next time.

If the resistorR4Short circuit orR5open circuit,FBThe voltage will quickly rise to4.5V, the chip will restart continuously and work in hiccup mode all the time; if the resistorR4Open circuit orR5 Short circuit or open circuit of auxiliary winding, no signal is input to the chipFBThe chip will start working for one cycle and then shut down.outThe output of the pin remains on until the chip is started next time.



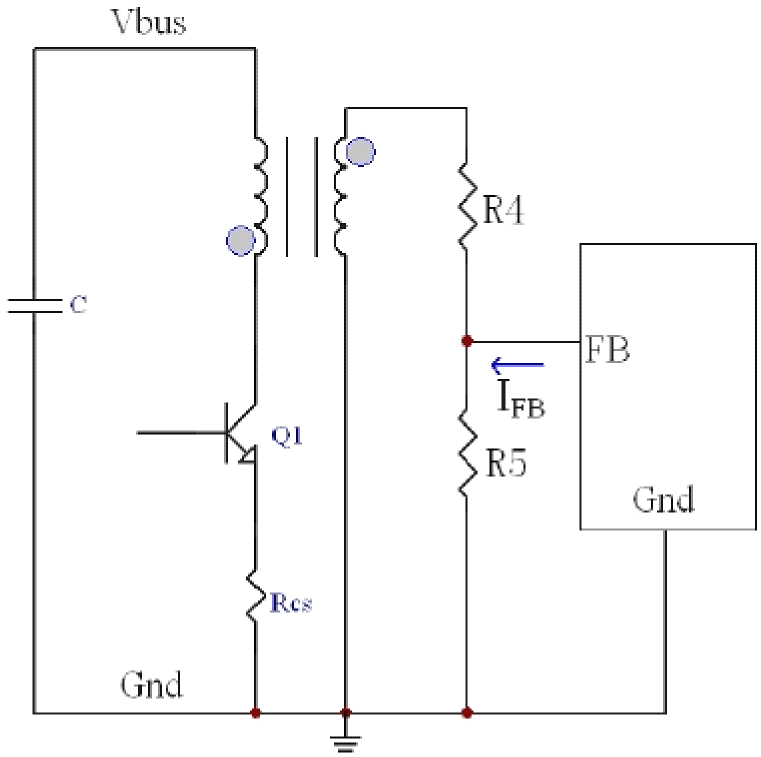
picture8

Input undervoltage protection

This primary feedback control chip has a built-in input undervoltage protection function.9As shown, when the power transistorQ1When conducting,

$$I_{FB} = \frac{V_{bus} \times N_{aux}}{N_P \times R_4} \quad (3)$$

When the input voltageVbusWhen the chipFBCurrent flowing out of the footI_{FB}will also decrease whenVbusDown to a certain extent,I_{FB}Lower than the chip setting value 200uAWhen the chipoutThe output of the pin will be turned off immediately.VCCThe voltage gradually decreases to the undervoltage lockout voltage and then entersVCCRestart process.



picture9

LEBtime

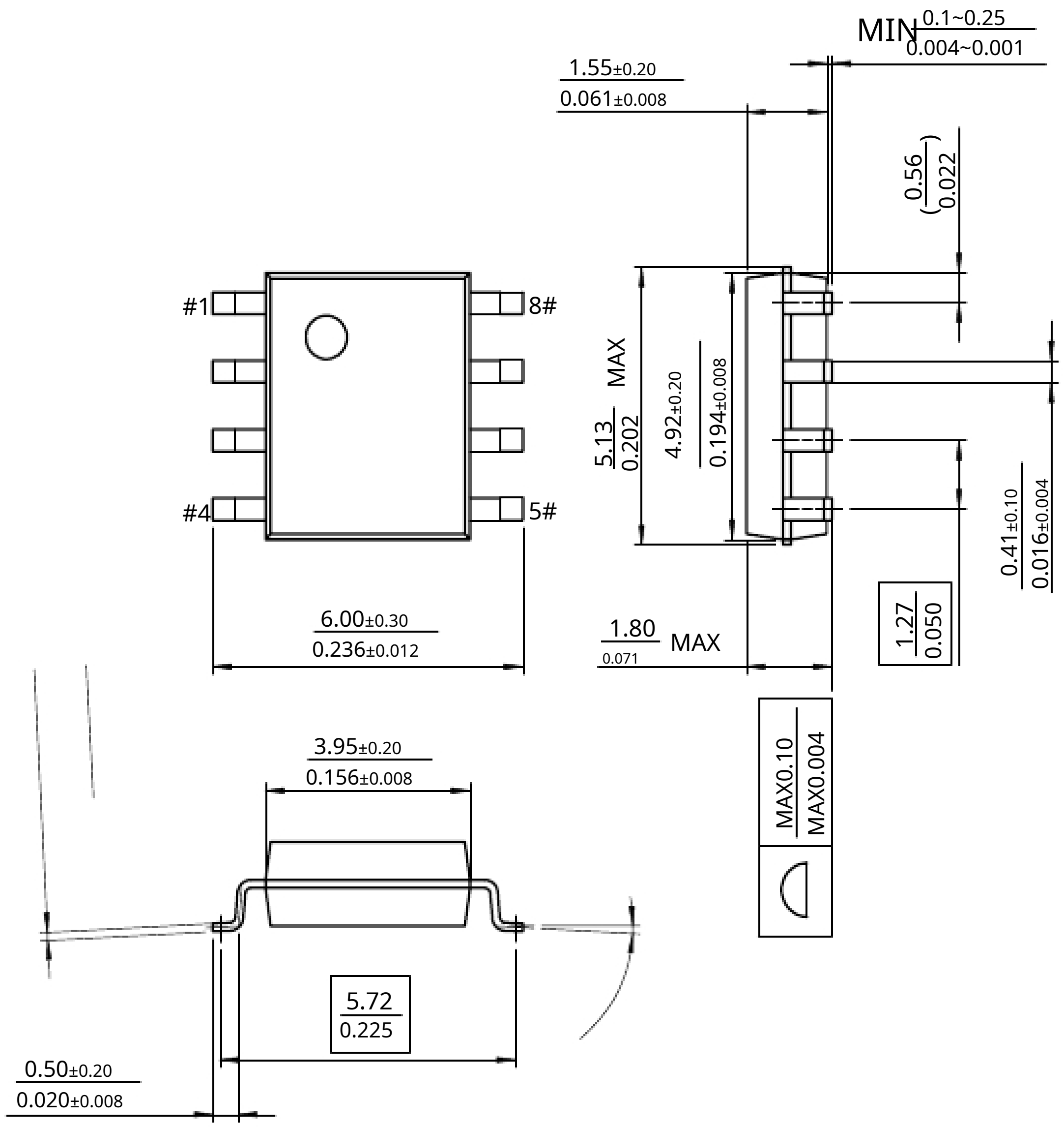
Each power transistorQ1When turned on, the absorption diodeD5Reverse recovery and power transistorsQ1The spikes generated by the parasitic capacitance will reflect existCSIn order to prevent the power transistorQ1To prevent malfunction, the detection of this primary feedback control chip will be blank for a period of time on the rising edge. During this blank time, the current limiting comparator is not enabled and the base drive current cannot be driven.

Over temperature protection

When the temperature exceeds145℃, this primary feedback control chip has a built-in over-temperature detection circuit to shut down the chipoutThe output of the pin.outAfter the output of the pin is turned off,VCCThe voltage will gradually decrease to the undervoltage lockout voltage6.5VSome internal circuits will shut down, causingVCCThe voltage rises again.VCCachieve15VAll internal circuits, including the over-temperature detection circuit, will start up normally again.145℃, chipoutThe output of the pin will be turned off immediately. This state will continue until the over temperature state is released.

SOP8 Packaging information

Dimensions in millimeters



SOP7 Packaging information

Dimensions in millimeters