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CR6203

Switching Power Supply Controller ICs

Features

- Set-in high-voltage power switch transistor of 700V and few peripheral components
- With the modulation of lock pulse width, the testing is according to the pulse limit current.
- With the function of output frequency reduction, the non-output power consumption can be less than 0.3W.
- Inner-built ramp and anti-feedback compensation function
- The independent upper-limit current testing controller deals with over-current and over-load of the controller real-timely.
- The period emission pole is turned off and it outputs by deflected voltage, and the pressure resistance of the power transistor is improved.
- Set-in current limit resistance with temperature compensation, which makes the current limit precise
- Set-in heat protection circuit
- Startup is accomplished with the magnification function of the switch power transistor, and the power consumption of startup resistance is reduced more than 10 times.
- Few peripheral components
- Low startup and operating current
- VCC over-voltage automatic limit
- Continuous Wide-voltage output power up to 5W, and the narrow-voltage output power up to 8W.
- Pb-Free DIP-8L Package

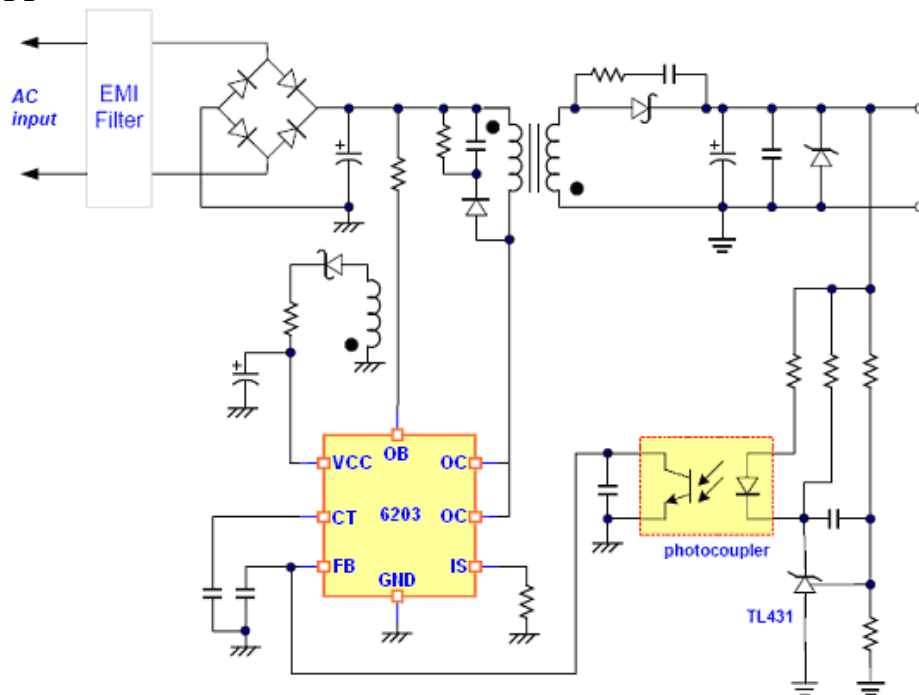
General Description

PWM controller of high-performance current mode is specially designed for AC/DC transformer with high performance and price ratio, which supplies continuous output power of 12W within the range of wide-voltage between 85V and 265V, the output power of peak value can be up to 18W. The combination of optimized reasonable circuit design and bipolar facture technology with high performance and price ratio economizes the whole cost ultimately. The power controller can be applied to the typical flyback circuit topology so as to form a simple AC/DC transformer. The startup circuit inside IC is designed as a particular current inhalation way, so it can start up with the magnification function of the power switch transistor itself, which lessens the power consumption for starting the resistance remarkably; when the output power is lower, IC will reduce the working frequency automatically, therefore, the standby power consumption becomes extremely low. When the power transistor is closed, the interior circuit will bias it reversely, utilize the

characteristic of high pressure resistance CB of bipolar transistor directly, and improve its pressure resistance capacity to the high voltage of 700V, which ensures the security of the power transistor.

Meanwhile, the perfect function of overload and saturation prevention is provided inside of IC, which can keep away some abnormal status, such as overload, saturation of transformer, and output short circuit, so as to improve the reliability of the power supply. The current limit and clock frequency can be set up by exterior components. Now the standard encapsulation and the environmental protection leadless encapsulation that meets European standard of DIP8 are supplied.

Typical Application Circuit

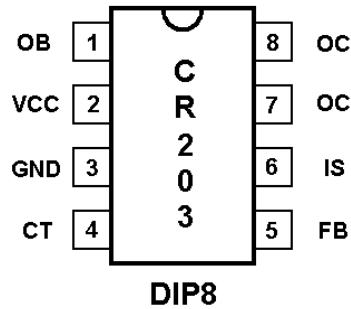


Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{CC}	Power Supply voltage	16	V
V_{ST}	Startup input voltage	16	V
V_{PIN}	Pins input voltage	$V_{CC}+0.3V$	V
V_{OC_Max}	Endurance voltage of OC collector	-0.3 to 700V	V
I_{SW_Max}	Switching current of peak value	800	mA
P_D	Total dissipation power	1000	mW
	ESD Capability, HBM Model	3000	V
T_L	Lead Temperature (Soldering) @DIP-8 (10S)	260	°C
T_{OP}	Operating temperature range	0 to +125	°C
T_{STG}	Storage Temperature Range	-55 to +150	°C

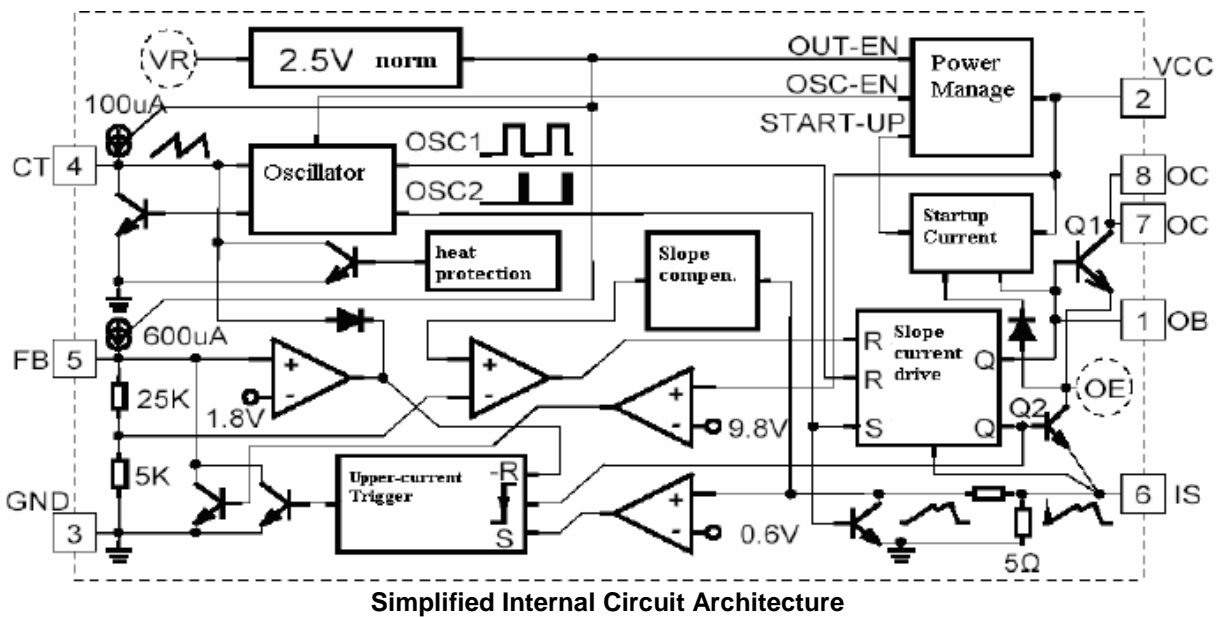
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Pin Assignment & Description



Name	Description
CT	By connecting a cap to ground to set the switching frequency
FB	Feedback pin
GND	GND
IS	Current sense.
OC	Power Transistor Collector drive output and start-up current input.
OB	Power Transistor Base drive output and start-up current control.
VCC	Power Supply.

Block Diagram



CR6203**RECOMMENDED OPERATION CONDITION**

Item	Min.	Typ.	Max.	Unit
Power supply voltage, V_{CC}	4.8	5.5	9.0	V
Pins input voltage	-0.3	-	V_{CC}	V
Reverse voltage of peak value	-	-	520	V
Switching current of peak value	-	-	600	mA
Timing capacitance	650	680	920	pF
Oscillating frequency	50	66	70	kHz
Operating temperature	0		70	°C

Electrical Characteristics ($T_a=25^\circ\text{C}$, $V_{CC}=5.5\text{-}7.5\text{V}$, $C_t=330\text{PF}$)**Output**

Item	Testing condition	Min.	Typ.	Max.	Unit
Maximum pressure resistance of switching transistor	$I_{OC}=10\text{mA}$	700	-	-	V
on-saturation pressure drop	$I_{OC}=250\text{mA}$	-	-	1	V
Output rise-time	$C_L=1\text{nF}$	-	-	75	ns
Output fall-time	$C_L=1\text{nF}$	-	-	75	ns
Output limit current	$T_j=0\text{-}100^\circ\text{C}$	540	580	620	mA
OE clamp voltage	$OE=0.001\text{-}0.29\text{A}$	-	1.5	-	V

Reference

Item	Testing condition	Min.	Typ.	Max.	Unit
Reference output voltage	$I_o=1.0\text{mA}$	2.4	2.5	2.6	V
Power Regulation	$V_{CC}=5.5\text{-}9\text{V}$	-	2	20	mV
Load Regulation	$I_o=0.1\text{-}1.2\text{mA}$	-	-	3	%
Temperature stability		-	0.2	-	mV/°C
Output noise voltage	$F=10\text{Hz}\text{-}10\text{KHz}$	-	-	50	μV
Long-term stability	1000h @ $T=85^\circ\text{C}$	-	5	-	mV

Oscillator

Item	Testing condition	Min.	Typ.	Max.	Unit
Oscillating frequency	$C_t=680\text{PF}$	50	66	75	KHz
Frequency change ratio with voltage	$V_{CC}=5.5\text{-}9\text{V}$	-	-	1	%
Frequency change ratio with	$T_a=0\text{-}85^\circ\text{C}$	-	-	1	%

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temperature					
Vibration amplitude of oscillator (Vp-p)		-	2.4	-	V
Drop edge of oscillator	Ct=680PF	-	900	-	ns

Feedback

Item	Testing condition	Min.	Typ.	Max.	Unit
Pull-up current	Ct=680PF	-	0.50	0.60	mA
pull-down resistance	Vcc=5.5-9V	-	30	-	KΩ
Power supply rejection ratio	Vcc=5.5-9V	-	60	70	dB

Current sampling

Item	Testing condition	Min.	Typ.	Max.	Unit
Current sampling limit		0.54	0.58	0.63	V
upper limit current prevention		0.54	0.58	0.63	A
Power supply rejection ratio		-	60	70	dB
transmission delay		-	150	250	ns

Pulse Width Modulation

Item	Testing condition	Min.	Typ.	Max.	Unit
Maximum duty cycle		55	60	75	%
Minimum duty cycle		-	-	3.5	%

Power Supply current

Item	Testing condition	Min.	Typ.	Max.	Unit
Startup acceptance current		1.6	2.0	2.4	mA
Startup static current		-	50	80	μA
Static current	Vcc=8V	-	3.0	-	mA
Startup voltage		8.5	9.0	9.8	V
Close voltage of oscillator		4.2	4.4	4.6	V
Restart voltage		-	3.6	-	V
Over-voltage limit margin		10.0	10.5	12.0	V

Operation description

- During start-up phase, VR is closed when electrified; FB pull-up power source is closed, the start-up current is input from power transistor to VCC through OE; OB controls the base current of power transistor and limits the current of power transistor collector (namely, CR6203 starts the acceptance current), accordingly, the security of the power transistor is ensured; when VCC voltage goes up to 8.8V, the start-up phase is ended, and it comes into the normal phase.
- During normal phase, VCC voltage shall keep at 4.8~9.0V, VR outputs 2.5V benchmark; FB pull-up

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current source starts up; the oscillator output OSC1 decides the maximum duty cycle, output OSC2 tries to touch off the power supply to enter open cycle to enter the open cycle, and shield flashing peak current of the power transistor ; if FB is less than 1.8V (about between 1.2-1.8V), the cycle of the oscillator will increase with it, the less FB is, the wider the cycle of the oscillator is, until the oscillation stops (This characteristic reduces the standby power consumption of the switching power.) ; if the peripheral feedback tries to make VCC more than 9.6V, the in-circuit is fed back to FB and makes VCC stabilize the voltage at 9.6V (According to this characteristic, we can may not adopt peripheral feedback circuit, and stabilize the output voltage by in-circuit, but the precision of stabilizing voltage is low); During the open cycle, OB supplies base current for the power transistor, OE pulls down the emitter of the power transistor to IS, and OB adopts the driving parameter of ramp current (it refers to that OB on-current is the parameter of IS, when IS is 0V, OB on-current is about 40mA, then OB on-current increases linearly with IS, when IS increases to 0.6V, OB on-current is about 120mA, this characteristic makes effective use of the output current of OB, decreases the power consumption of CR6203), if IS detects that the specified current FB, it will come into the close cycle; during the close cycle, OB pulls down, the power transistor will not shut off immediately, but OE clamps 1.5V (after the power transistor is shut off, the base will be biased reversely, which improves the voltage endurance); during open or close cycle, if the power transistor is detected beyond the upper limit current, the trigger of the upper limit current will be placed preferentially and forces FB to drop, the duty cycle will become less so as to protect the power transistor and transformer; at the beginning of next close cycle or when FB is less than 1.8V, the trigger of the upper limit current will reset. In addition, CR6203 is installed over heat protection internally, when the internal temperature is higher than 140°C, it will broaden the cycle of the oscillator and makes the temperature of CR6203 less than 150°C; The ramp compensation is also placed internally, when CR6203 is in a big duty cycle or in the mode of constant current, it can stabilize the open/close cycle.

- If VCC declines to 4.3V or so, the oscillator will shut off, OSC1 and OSC2 are in the low level, and the power supply keeps at close cycle; when VCC goes on declining to 3.7V or so, CR6203 will come into the start-up phase once again.

Definition of Electric Parameter

- Start-up acceptance current: the current on OC when OB inputs 0.5mA during the start-up phase
- Start-up Quiescent Current: the current of minimum current source that can make VCC oscillate (namely finish the start-up of CR6203) when VCC meets filter capacitance and adjustable current source, CT meets 680PF, and other pins hang in the air.
- Start-up Voltage: Maximum VCC value of above VCC oscillation.
- Re-start Voltage: Minimum VCC value of above VCC oscillation.
- Close Voltage of Oscillator: VCC value that makes RC oscillator stop oscillating when the above VCC oscillates the falling edge.
- Quiescent Current: VCC power current when FB is grounded with 1.0K of resistance at normal phase.

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- Pull-up/pull-down Current of the Oscillator: at normal phase, FB is 2.5V, CT is 1.25V, and CT is in pull-up/pull-down current.
- FB Pull-up Current: Pull-up current on FB at normal phase when FB is 2.5V, IS is 0V.
- FB Upper Limit Current Prevention: The pull-down current on FB at normal phase when FB is 6V, IS is 0.3V.
- Internal Feedback Power Voltage: VCC value of CR6203 power supply of the circuit without peripheral standby at normal phase
- OC Upper Limit Voltage: the minimum OC current of pull-down current on FB when FB is 6V
- Ramp current drive: it refers to the power transistor base drive OB on-current is the function of IS, when IS is 0V, on-current OB is about 40mA, then on-current OB will increase linearly with IS, when IS is increased to 0.6V, on-current OE is about 120mA.

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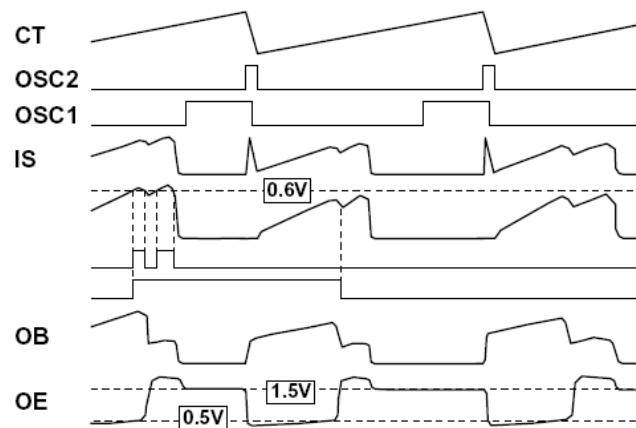


Fig.1 OPEN/CLOSED CYCLE WAVES IN NORMAL OPERATION

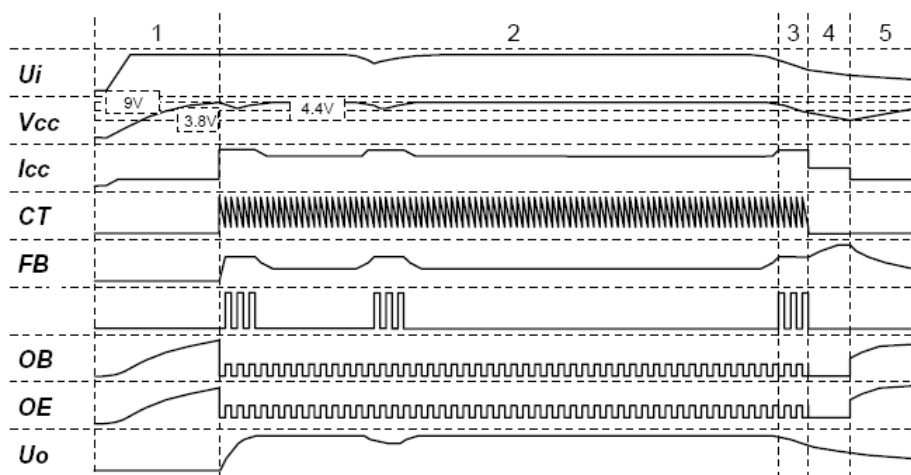


Fig.2 OVERALL SIGNAL WAVEFORMS OF CR6203

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Application Information

1. Relationship between CT timing capacitance and switching frequency

CT capacitance is charged by 100uA constant current through internal current source to for the rise-up edge, when the voltage is charged to 2.5V, the internal circuit will discharge CT with 1.9mA of pull-down current to form the fall-down edge of the clock, and accomplish a clock cycle, which is about:

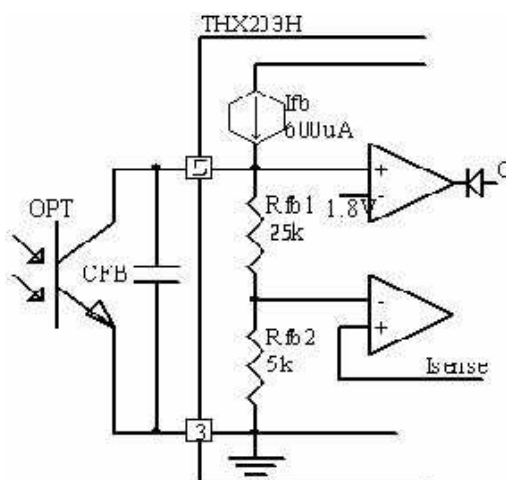
$$T=CT*24000 (S)$$

$$Fs=1/T (Hz)$$

Although the bipolar circuit can work under higher frequency, but for the switch of bipolar power, the influence caused by switch loss for the storage time is still be considered. Generally, the appropriate switching frequency is about below 70KHz. Under common application situation, CT capacitance of THX203H can be configured by 680PF, when the relevant working frequency is around 61KHz.

2. FB feedback and control

In normal working state, the voltage of FB will decide the value of the maximum switching current, the higher the voltage is, the bigger the switching current is (it is only limited at the peak value). FB pins pull up 600uA power source internally, the pull-down resistance is about 33K Ω (it approximates the equivalent value). In addition, when FB voltage is less than 1.8V, the oscillating cycle will be enlarged, the switching frequency will declined, the more it is less than 1.8V, the lower the switching frequency is. The external FB capacitance will influence the feedback bandwidth, so some external parameters will be affected, such as transient-state characteristic.



As for the value of CFB capacitance, the typical application can be selected according to the frequency character of feedback circuit between 10nF and 100nF.

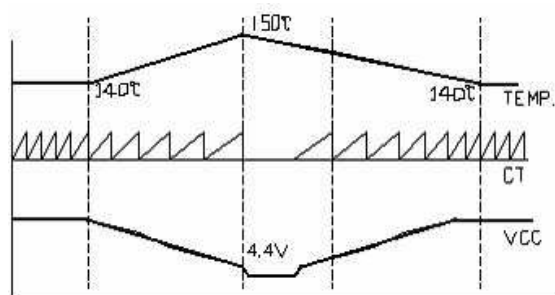
3. Over temperature protection

The interior of IC integrates the function of over temperature protection. When the internal temperature of the chip reaches 140°C, the over-heat protection circuit will work, it will pull down the clock signal, the

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switching frequency will fall until the oscillator is turned off.

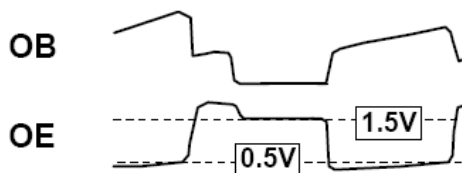
As shown in the following figure,



4. Driving characteristic and high voltage endurance bias technology of power transistor

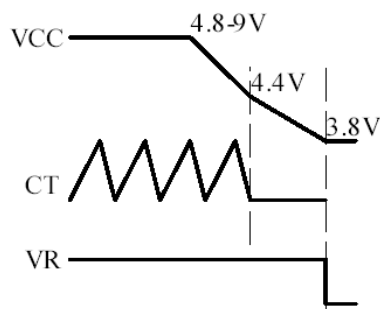
The power transistor adopts the ramp current drive, the driving current will increase with the output power, when FB is 0, the current of OB is about 40mA, when FB is 6V, the current of OB is about 120 mA, and the driving power consumption will decrease remarkably when the output is low.

The interior of IC integrates the particular bias technology, when the power transistor is shut, the output of OB will be pulled down to the ground, meanwhile, it will bias the output of OE to 1.5V or so, bias the emitter junction, accelerate the decreasing speed of Ic current, expand the effective safe working area, the switching transistor affords the reverse voltage CB, therefore, the endurance characteristic of the switching transistor can be up to 700V. For more detail information for the voltage endurance characteristic of the switching transistor, please refer to the relevant technical data. The bias waveform is shown as follows:



5. Over-voltage and under-voltage protection

IC has the function of slow-moving under-voltage protection, when the voltage of VCC reaches 8.8V, IC will set out to start, the initial start-up voltage is provided by the driving resistance, the high voltage of input will be injected into the base of the switching transistor through Ic current, consequently, the driving voltage is formed. When IC works normally, the voltage of VCC should be keep between 4.8V and 9V (including the situation of full load output), if the voltage of VCC falls to 4.4V, the oscillator will enter the state of shutoff, when it decreases to 3.8V further, IC will begin to reset. As shown in the following figure:



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VCC in side IC is provided with a comparator controller of the upper limit voltage, if VCC tries to be more than 9.6V, the comparator will work, FB will be pulled down, and it will lock VCC to 9.6V, and reach the limit function of over voltage, by which the voltage feedback function of the front terminal can be accomplished conveniently, the rising phenomenon of the output voltage in large extent can be avoided when the open-loop is output, so as to guarantee the security of the load. Because of the existence of this characteristic, the design of VCC shall be kept at the proper range, so as to avoid VCC rising excessively high when the output is high, and make the output voltage escape from decreasing when IC over-voltage limit works.

6. Maximum switching current limit

IC has the function of current limit cycle by cycle. It will test every switching current in every switching cycle, if the current fixed by FB or upper limit current prevention is reached, it will come into the close cycle, and the detection of the current has the function of real-time foreland hide, it can shield the switching peak, and avoid the wrong detection of the switching current. Then the reasonable temperature compensation eliminates the influence of temperature, comparing with normal MOSFET (the alteration of R_{on} will be large when the temperature changes) switching chip, the switching current can always be very accurate in a larger range, thus not too much allowance is needed to match a larger working temperature range for the designer when he designs the scenario, and the security of the circuit for use can be improved.

The maximum limit value of switching current for THX203H is 0.80A. When designing a flyback power with 80V of emitter voltage and 0.65A of switching current, it can accomplish the output power of more than 12W easily, and meet the broad temperature range.

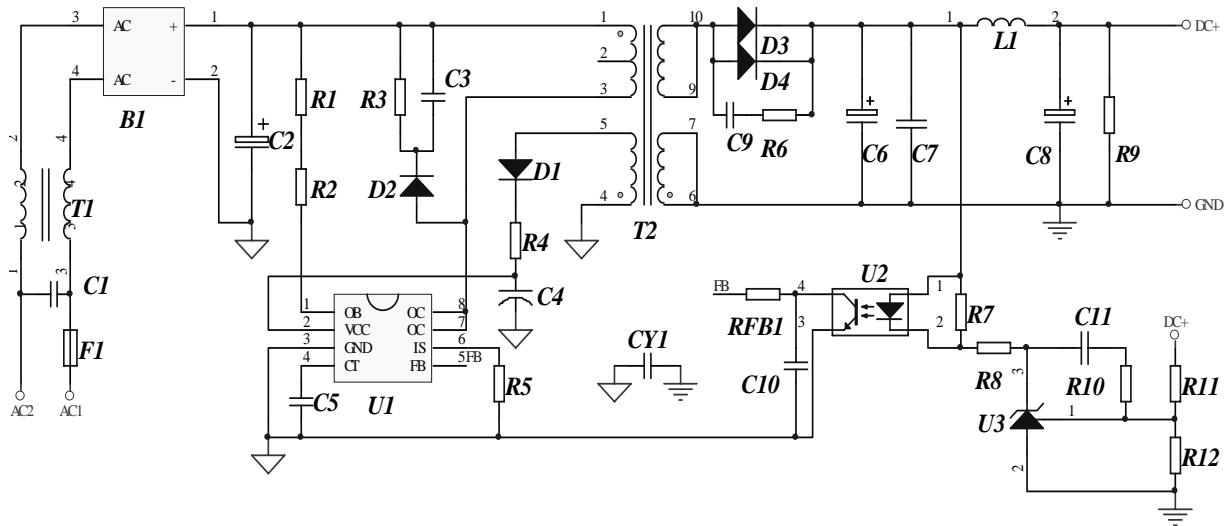
7. Requirement of heat elimination

As for a typical power switch, it must have necessary heat elimination measures, so as to avoid that the excessive heat leads to heat protection. The primary heat inside IC is produced by the on-off wasting of the switching transistor, so appropriate heat elimination position is Pin7-8 pin of IC, one wieldy way is to pave PCB copper foil of a certain area on Pin7-8 pin, what's more, plating tin on the copper foil will improve the heat elimination ability greatly. For an input of 85-265V, the typical application of 12W output and 200mm² copper foil are necessary.

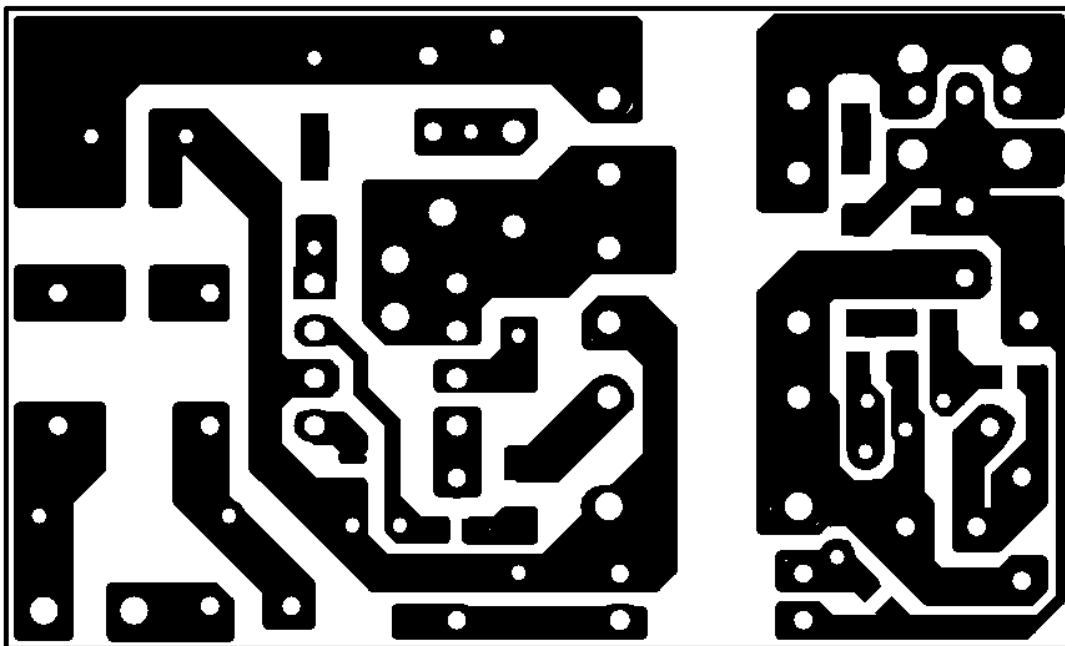
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CR6203_12V1A FLYBACK POWER

SCHEMATIC

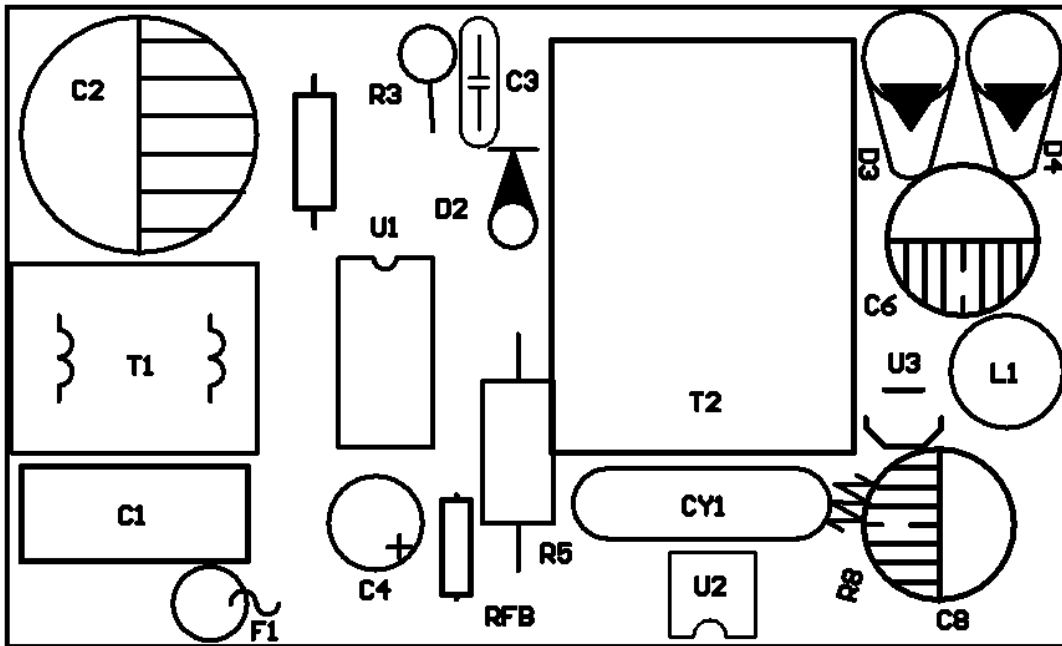


PCB Layout:

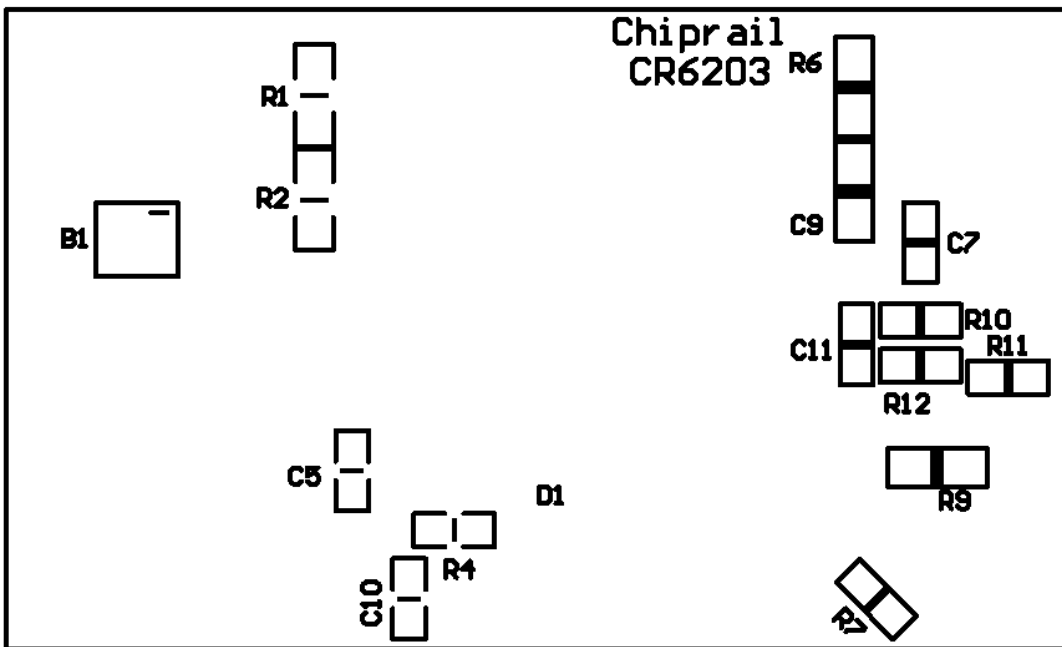


PCB Layout

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PCB Top Overlay



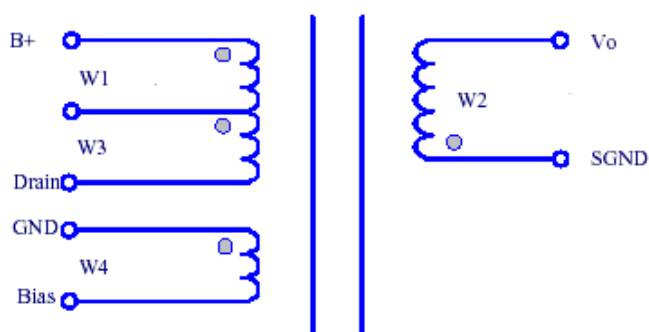
PCB Bottom Overlay

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BOM List:

DESIGNATOR	DESCRIPTION	NOTE	DESIGNATOR	DESCRIPTION	NOTE
B1	1A600V	BRIGE	T1	20mH /1A	16*11*16 (L*W*H)
C1	0.1u/~275V	C/X1; +/-20%;275V;PINTCH=400MIL;	T2	EI22	EI22
C2	22uF/400V	C/C;DIP; +/-10%;PINTCH=200MIL	R1	1M	RES;SMD;1206; +/-5%
C3	103/1KV	C/C;DIP; +/-10%;PINTCH=200MIL	R2	1M	RES;SMD;1206; +/-5%
C4	47uF/25V	Φ 5*12	R3	100K	RES;MOF; +/-3%;1W
C5	680PF/50V	RES;SMD;0805; +/-5%	R4	4.7 Ω	RES;SMD;0805; +/-5%
C6	470u/16V	Φ 8*13	R5	1 Ω	RES;MOF; +/-3%;1W
C7	104/25V	RES;SMD;0805; +/-5%	R6	20 Ω	RES;SMD;1206; +/-5%
C8	470u/16V	Φ 8*13	R7	2.2K	RES;SMD;0805; +/-5%
C9	102/100V	RES;SMD;1206; +/-5%	R8	1K	RES;MOF; +/-3%;1W
C10	103/25V	RES;SMD;0805; +/-5%	R9	3.3K	RES;SMD;1206; +/-5%
C11	104/25V	RES;SMD;0805; +/-5%	R10	10K	RES;SMD;0805; +/-5%
CY1	222/400V	C/Y1; +/-20%;PINTCH=400MIL;	R11	39K	RES;SMD; 0805; +/-5%
D1	1N4148	RES;SMD;1206	R12	10K	RES;SMD; 0805; +/-5%
D2	FR103	DIODE	RFB1	JB	JB
D3	SR3100	DIODE	U1	CR6203	DIP8
D4	SR3100	DIODE	U2	PC817B	DIP4
F1	1A/250V	FUSE	U3	TL431	T092
L1	10uH	Φ 7*12/2A			

变压器示意图及参数配置:



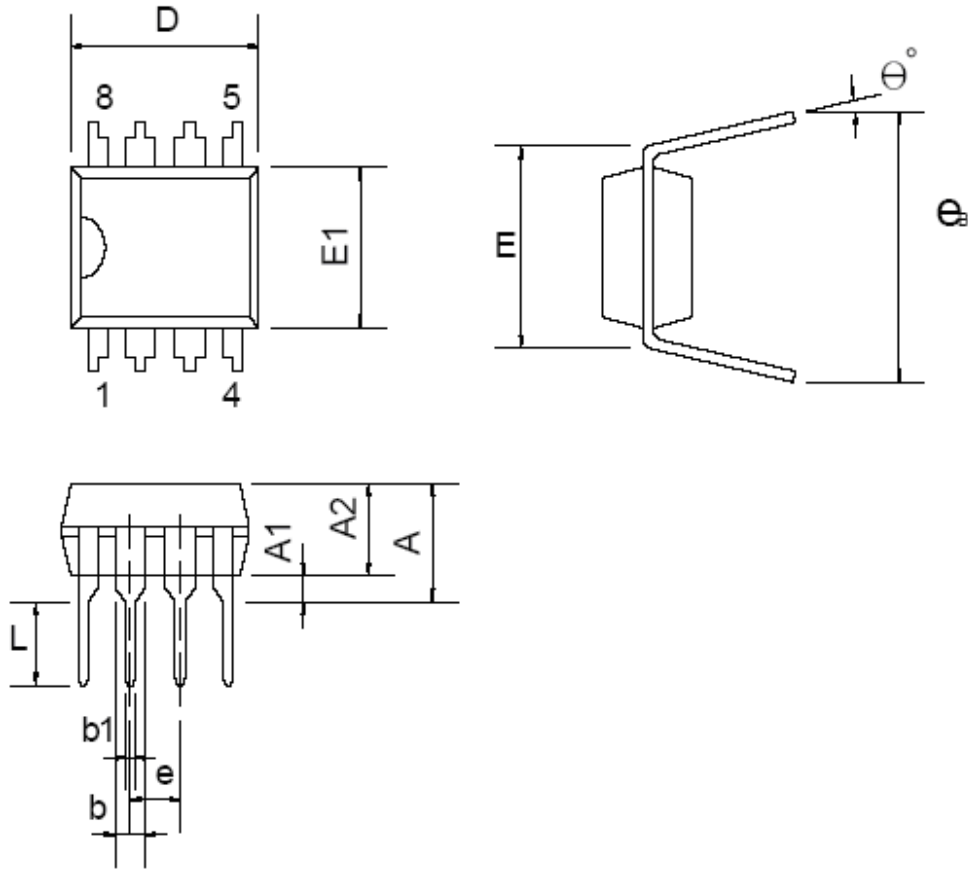
Core & Bobbin	WINDING	WIRE GAUGE(MM)	TURNS
EI22	W1	0.27*1	46
	W2	0.45*2	15
	W3	0.27*1	46
	W4	0.18*1	9

NOTE: $N_1(W_1+W_3)$ INDUCTANCE=1.2MH

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PACKAGE INFORMATION

DIP-8



Dimensions

Symbol	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.334			0.210
A1	0.381			0.015		
A2	3.175	3.302	3.429	0.125	0.130	0.135
b		1.524			0.060	
b1		0.457			0.018	
D	9.017	9.271	10.160	0.355	0.365	0.400
E		7.620			0.300	
E1	6.223	6.350	6.477	0.245	0.250	0.255
e		2.540			0.100	
L	2.921	3.302	3.810	0.115	0.130	0.150
eB	8.509	9.017	9.525	0.335	0.355	0.375
θ°	0°	7°	15°	0°	7°	15°