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CR5203

High Precision CC/CV PSR Power Switch with BJT

FEATURES

- Low startup current (about 1μA)
- Low operating current (about 0.4mA)
- Power on Soft Start
- ±5% Constant Voltage Regulation and Constant Current Regulation at Universal AC input
- Primary-side Sensing and Regulation Without TL431 and Opto-coupler
- Programmable CV and CC Regulation
- Built-in Primary winding inductance compensation
- Programmable Cable Drop Compensation
- Built-in Feedback Loop Open Protection
- VDD Over Voltage Protection
- Built-in Short Circuit Protection
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis (UVLO)
- DIP7L(B) green Packaging

APPLICATIONS

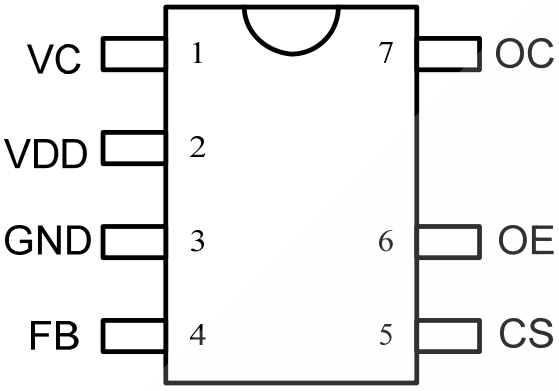
- Switching AC/DC Small Power Adaptor
- Cell Phone or Digital Cameras Charger
- Auxiliary Power for PC, TV etc
- Linear Regulator/RCC Replacement

GENERAL DESCRIPTION

CR5203 is a high performance offline PSR controller for low power AC/DC charger and adapter applications. It operates in primary-side sensing and regulation, So opto-coupler and TL431 could be eliminated. In CC control, the current and output power setting can be adjusted externally by the sense resistor R_S at CS pin. In CV control, PFM operations are utilized to achieve high performance and high efficiency. In addition, good load regulation is achieved by the built-in cable drop compensation.

The chip consumes very low operation current (typical 400μA), it can achieve less than 50mW standby power to meet strict standby power standard. CR5203 offers comprehensive protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD over voltage protection, feedback loop open protection, short circuit protection, built-in leading edge blanking, VDD under voltage lockout (UVLO), etc. CR5203 is offered in DIP7L(B) package.

PIN ASSIGNMENT

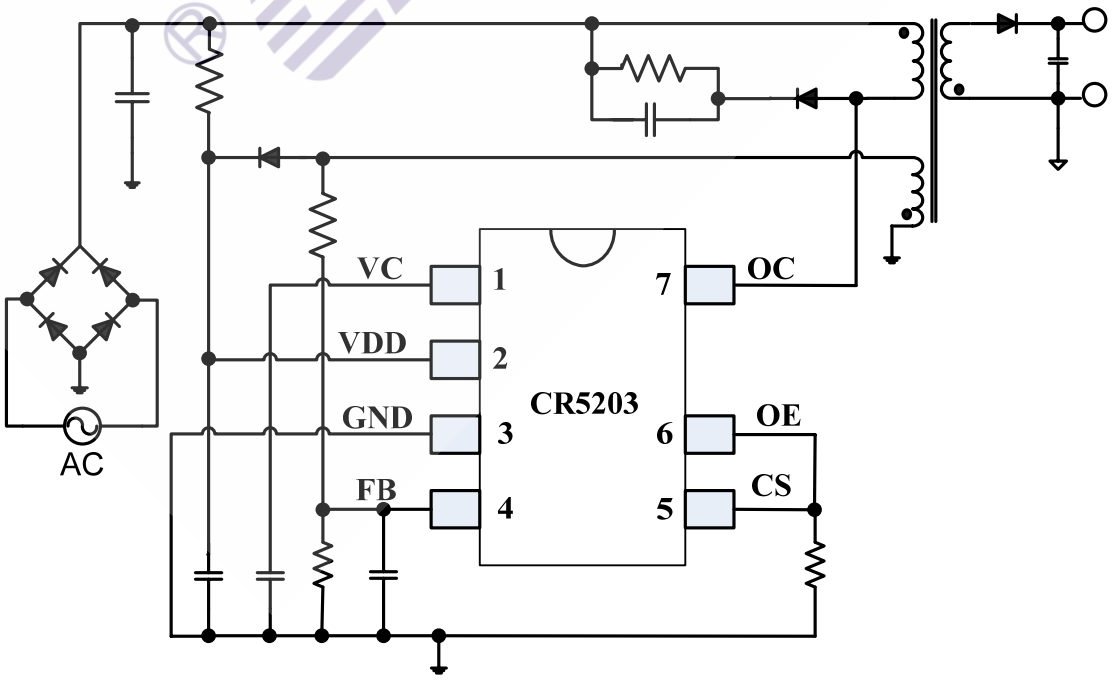


DIP7L(B)

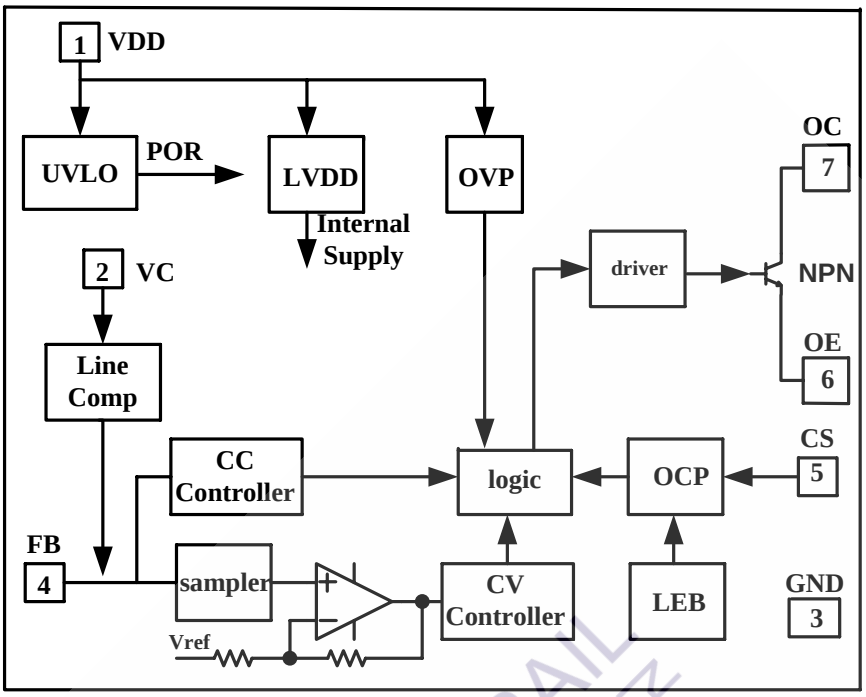
PIN DESCRIPTIONS

Pin No.	Symbol	Description
1	VC	Low pass filter capacitor for cable compensation
2	VDD	Supply voltage pin.
3	GND	GND Pin
4	FB	Voltage feedback pin. Output current of this pin could controls the PWM duty cycle、OLP and SCP.
5	CS	Current sense pin, a resistor connects to sense the NPN current.
6	OE	The emitter of NPN
7	OC	The connector of NPN

TYPICAL APPLICATION



BLOCK DIAGRAM



Simplified Internal Circuit Architecture

ABSOLUTE MAXIMUM PARAMETERS

Symbol	Parameter		Value	Unit
V_{DD}	VDD Supply voltage		-0.3 to 30	V
VC	VC Supply voltage		-0.3 to 7	V
OC	OC Supply voltage		-0.3 to 700	V
OE	OE Supply voltage		-0.3 to 7	V
CS	CS Supply voltage		-0.3 to 7	V
FB	FB Supply voltage		-0.3 to 7	V
V_{CEO}	Connector-Emitter voltage		400	V
V_{CBO}	Connector-Base voltage		700	V
V_{EBO}	Emitter-Base voltage		9	V
I_C	The Current of Connector		1.5	A
ESD	ESD Capability(HBM Model)		3000	V
T_L	Lead Temperature (Soldering)	20s DIP7L(B)	220	℃
T_J	Operating Junction Temperature Range		-40 to + 150	℃
T_{STG}	Storage Temperature Range		-55 to + 150	℃

RECOMMENDED OPERATION CONDITIONS

Symbol	Applications	Min. ~ Max.	Value
P_{O_MAX}	Adapter and Charger at universal voltage	0~11	W
	LED illumination at universal voltage	0~11	W

ELECTICAL CHARACTERISTICS

(T_A=25°C unless otherwise noted, VDD = 16V)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Power Voltage (V_{DD} Pin)						
I_{DD_ST}	Startup Current	VDD=11V		1	3	μ A
I_{STATIC}	Operating Current	VDD=15V		400	500	μ A
$UVLO_{\_OFF}$	Turn-on Threshold Voltage		11.5	12.5	13.5	V
$UVLO_{\_ON}$	Turn-off Threshold Voltage		6.0	7	8	V
V_{DD_OVP}	VDD OVP Voltage		25	27	29	V
V_{DD_MAX}	VDD Maximum Supply voltage				25	V
Inductor（CS Pin）						
T_{LEB}	Leading edge blanking time			500		ns
V_{TH_OC}	CS Maximum Voltage Level		390	420	450	mV
T_{D_OC}	Delay to Output			100		ns
FB Input section						
V_{REF_FB}	Reference voltage for feedback		1.98	2	2.02	V
T_{PAUSE_MIN}	Minimum cut off time			2		μs
T_{PAUSE_MAX}	Maximum cut off time			10		ms
I_{COMP_MAX}	Maximum cable compensation current		39	45	48	μA
Drive Output (BASE Pin)						
I_{S_MAX}	Maximum BASE driver current		40	50	65	mA
I_{S_PREOFF}	BASE driver current after pre_off		0.5	1	2.5	mA
R_{DSON_I}				1		ohm

OPERATION DESCRIPTION

Startup and Under Voltage Lockout

Startup current of CR5203 is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

CC/CV Operation

CR5203 is designed to produce good CC/CV control. In charger applications, a discharged battery charging starts in the CC portion of the curve until it is nearly full charged and smoothly switches to operate in CV portion of the curve. The CC portion provides output current limiting. In CV operation, the output voltage is regulated through the primary side control. In CC operation mode, CR5203 will regulate the output current constant regardless of the output voltage drop.

Principle of Operation

To support CR5203 CC/CV control, system needs to be designed in DCM mode for flyback system. In the DCM flyback converter, the output voltage can be sensed via the auxiliary winding. During NPN turn-on time, the load current is supplied from the output filter capacitor. The current in the primary winding ramps up. When NPN turns off, the energy stored in the primary winding is transferred to the secondary side. The current in the secondary winding is

$$I_S = \frac{N_P}{N_S}.I_P \quad (1)$$

The auxiliary voltage reflects the output voltage and it is given by

$$V_{AUX} = \frac{N_{AUX}}{N_S}.(V_O + \Delta V) \quad (2)$$

Where ΔV indicates the drop voltage of the output Diode.

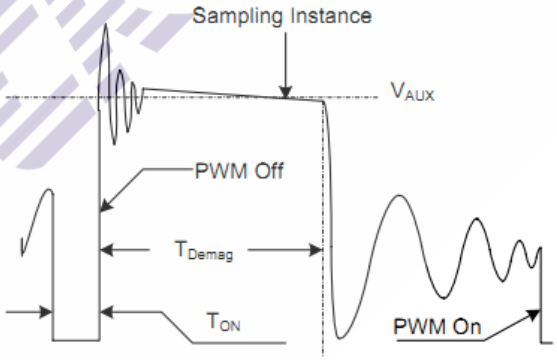


Figure.2. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB (pin 4), the auxiliary voltage is sampled at the middle of the de-magnetization and it is hold until the next sampling. The sampled voltage is compared with V_{REF_FB}(2.0V) and the error is amplified. The error amplifier output reflects the load condition and controls the switching off time to regulate the output voltage, thus constant output voltage can be achieved. When the sampled voltage is below V_{REF_FB} and the error amplifier output reaches its minimum, the switching frequency is controlled by the sampled voltage to regulate the output current, thus the constant output current can be achieved.

Adjustable CC point and Output Power

In CR5203, the CC point and maximum output power can be externally adjusted by external current sense resistor Rs at CS pin as illustrated in typical application diagram. The larger Rs, the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Figure.3.

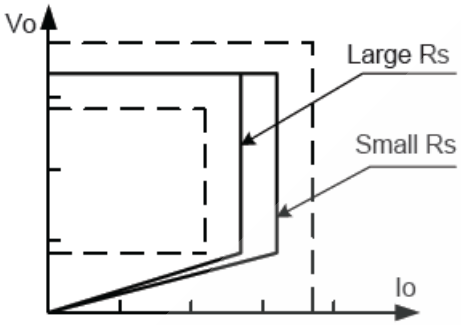


Figure.3. Adjustable output power by changing Rs

Operation switching frequency

The switching frequency of CR5203 is adaptively controlled according to the load conditions and the operation modes. For flyback operating in DCM, The maximum output power is given by

$$P_{O\_MAX} = \frac{1}{2} L_P F_{SW} I_P^2 \quad (3)$$

Where L_P indicate the inductance of primary winding and I_P is the peak current of primary winding. Refer to the equation 3, the change of the primary winding inductance results in the change of the maximum output power and the constant output current in CC mode. To compensate the change from variations of primary winding inductance, the switching frequency is locked by an internal loop such that the switching frequency is

$$F_{SW} = \frac{1}{2T_{DEMAG}} \quad (4)$$

Since T_{DEMAG} is inversely proportional to the inductance, as a result, the product L_P and F_{SW} is constant, thus the maximum output power and constant current in CC mode will not change as primary winding inductance changes. Up to ±10% variation of the primary winding inductance can be compensated.

Programmable Cable drop Compensation

In CR5203, cable drop compensation is implemented to achieve good load regulation. An offset voltage is generated at FB pin by an internal current flowing into the resister divider. The current is proportional to the switching off time, as a result, it is inversely proportional to the output load current, thus the drop due to the cable loss can be compensated. As the load current decreases from full-load to no-load, the offset voltage at FB will increase. It can also be programmed by adjusting the resistance of the divider to compensate the drop for various cable lines use .The percentage of maximum compensation is

$$\frac{\Delta V}{V_{OUT}} = \frac{I_{COMP\_CABLE} \times (R1 // R2) \times 10^{-6}}{2} \times 100\%$$

Where ΔV is load compensation voltage and V_O is output voltage;

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in CR5203. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial power BJT on state so that the external RC filtering on sense input is no longer needed.

Base Drive

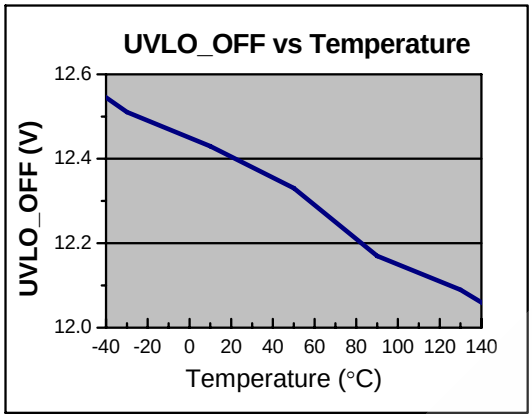
The drive is a push pull stage with supply voltage VDD. It provides the driving current for the external power bipolar transistor. The output signal is current limit to I_{S_MAX} (typical 50mA).

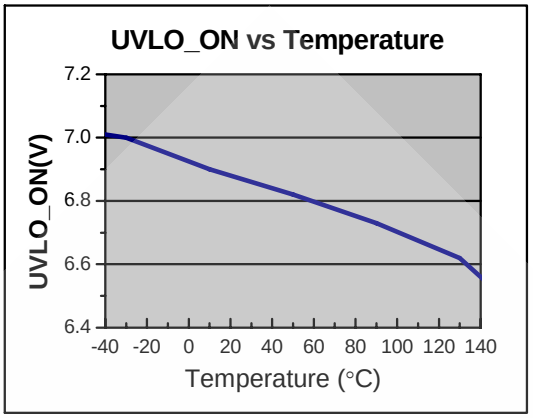
Protection Control

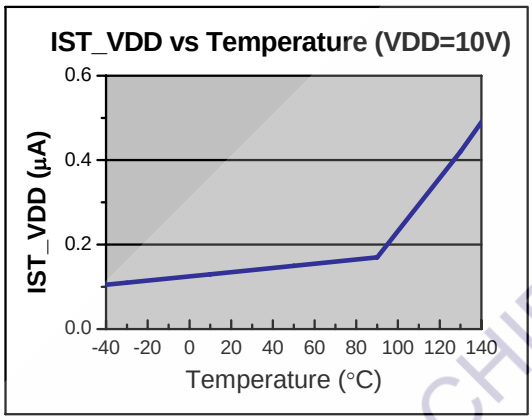
Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD over voltage protection, feedback loop open protection, short circuit protection and Under Voltage Lockout on VDD (UVLO). VDD is supplied by transformer auxiliary winding output. The output of CR5203 is shut down when VDD drops below $UVLO_{\_ON}$ and the power converter enters power on start-up sequence thereafter.

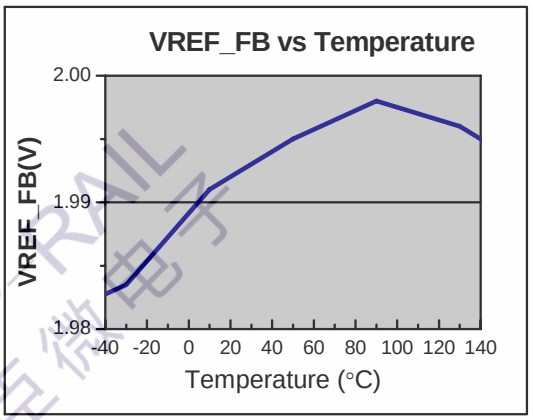
CHARACTERIZATION PLOTS

(VDD=16V, T_A=25℃)

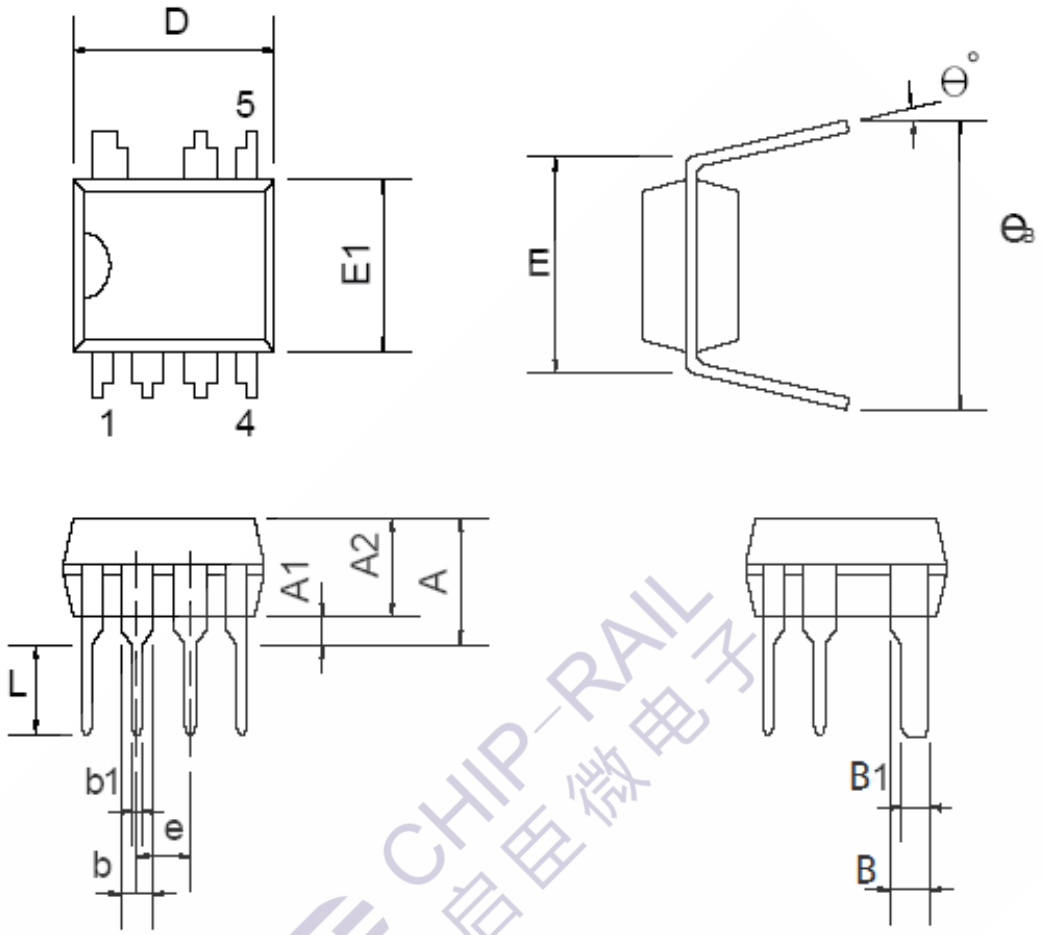








Package Outline Dimensions DIP7L(B)



Symbol	Millimeter			Inch		
	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	1.470	1.524	1.570	0.058	0.060	0.062
b1	0.380	0.460	0.510	0.015	0.018	0.021
D	9.017	9.271	10.160	0.355	0.365	0.400
E	7.620	7.870	8.25	0.300	0.310	0.325
E1	6.223	6.350	6.477	0.245	0.250	0.255
e	2.500	2.540	2.580	0.098	0.100	0.102
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
B	1.97	2.02	2.07	0.078	0.080	0.081
B1	0.95	1	1.05	0.037	0.039	0.041