R2A20112SP/DD

Critical Conduction Mode Interleaved PFC Control IC

REJ03D0904-0200
Preliminary
Rev.2.00
Nov 13, 2007

Description

The R2A20112 controls a boost converter to provide a active power factor correction.

The R2A20112 adopts critical conduction mode for power factor correction and realizes high efficiency and a low switching noise by zero current switching.

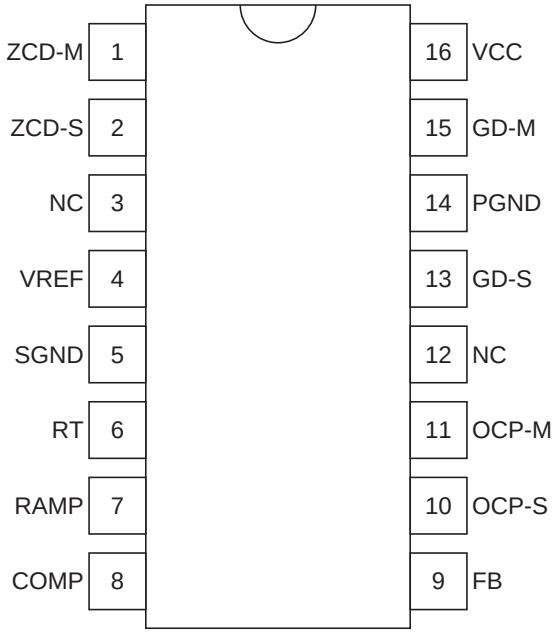
Interleaving function improve ripple current on input or output capacitor by 180 degrees phase shift.

The feedback loop open detection, two mode overvoltage protection, overcurrent protection are built in the R2A20112, and can constitute a power supply system of high reliability with few external parts.

Features

- Maximum Ratings
  - Supply voltage Vcc: 24 V
  - Operating junction temperature Tjopr: –40 to +150°C
- Electrical characteristics
  - VREF output voltage VREF: 5.0 V ± 3%
  - UVLO operation start voltage VH: 10.5 V ± 0.7 V
  - UVLO operation shutdown voltage VL: 9.3 V ± 0.5 V
  - UVLO hysteresis voltage Hysuvl: 1.2 V ± 0.5 V
- Functions
  - Boost converter control with critical conduction mode
  - Interleaving control
  - Two mode overvoltage protection
    Mode1: Dynamic OVP corresponding to a voltage rise by load change
    Mode2: Static OVP corresponding to overvoltage in stable
  - Feedback loop open detection
  - Master and Slave independence overcurrent protection
  - 280 µs restart timer
  - Package lineup: Pb-free SOP-16/DILP-16

Pin Arrangement

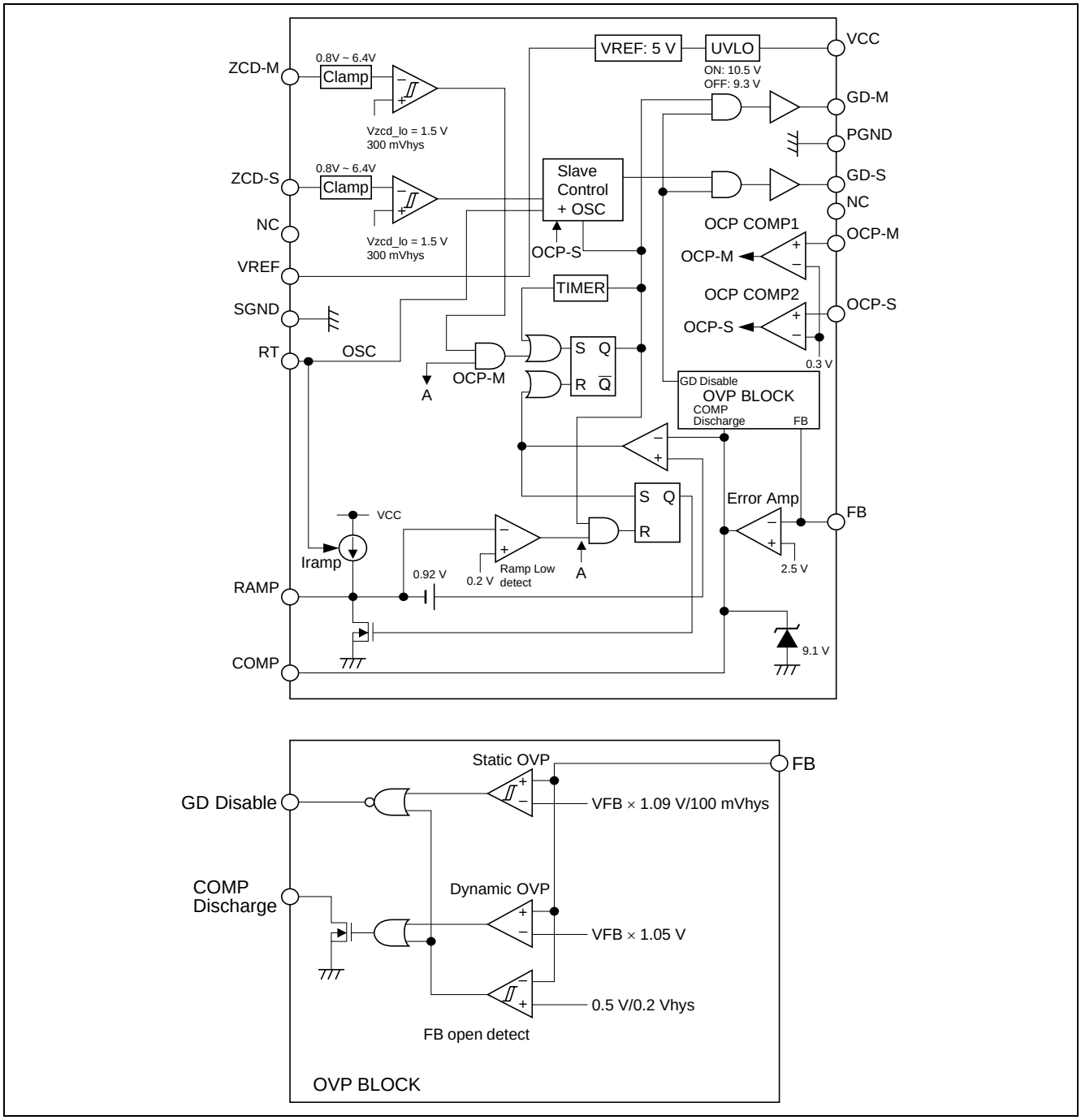


(Top view)

Pin Functions

Pin No.	Pin Name	Input/Output	Function
1	ZCD-M	Input	Master converter zero current detection input terminal
2	ZCD-S	Input	Slave converter zero current detection input terminal
3	N.C.	—	Open
4	VREF	Output	Reference voltage output terminal
5	SGND	—	Ground for small signal circuit
6	RT	Input/Output	Oscillator frequency setting terminal
7	RAMP	Input/Output	Ramp waveform setting terminal
8	COMP	Output	Error amplifier output terminal
9	FB	Input	Error amplifier input terminal
10	OCP-S	Input	Slave converter overcurrent detection terminal
11	OCP-M	Input	Master converter overcurrent detection terminal
12	N.C.	—	Open
13	GD-S	Output	Slave converter Power MOSFET drive terminal
14	PGND	—	Ground for power stage
15	GD-M	Output	Master converter Power MOSFET drive terminal
16	VCC	Input	Supply voltage terminal

Block Diagram



Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Ratings	Unit	Note
Supply voltage	Vcc	–0.3 to 24	V	
GD-M Peak current	Ipk-gdm	±200	mA	3
GD-M DC current	Idc-gdm	±10	mA	
GD-S Peak current	Ipk-gds	±200	mA	3
GD-S DC current	Idc-gds	±10	mA	
ZCD terminal current	Izcd	±10	mA	
RT terminal current	Irt	–200	μA	
Vref terminal current	Iref	–5	mA	
COMP terminal current	Icomp	±1	mA	
Terminal voltage	Vt-group1	–0.3 to Vcc	V	4
	Vt-group2	–0.3 to Vref	V	5
Vref terminal voltage	Vt-ref	–0.3 to Vref+0.3	V	
Power dissipation	Pt	1	W	6
Operating junction temperature	Tj-opr	–40 to +150	°C	
Storage temperature	Tstg	–55 to +150	°C	

Notes: 1. Rated voltages are with reference to the SGND terminal.
2. For rated currents, inflow to the IC is indicated by (+), and outflow by (–).
3. Shows the transient current when driving a capacitive load.
4. This is the rated voltage for the following pins:
RAMP, FB
5. This is the rated voltage for the following pins:
RT, OCP-M , OCP-S
6. In case of R2A20112DD (DILP): θja = 120°C/W
In case of R2A20112SP (SOP): θja = 120°C/W
This value is a thing mounting on 40 × 40 × 1.6 [mm], a glass epoxy board of wiring density 10%.

Electrical Characteristics

(Ta = 25°C, Vcc = 12 V, RT = 22 kΩ, OCP = GND, CRAMP = 680 pF, RZCD-GND = 51 kΩ, FB = COMP)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Supply	UVLO Turn-on threshold	Vuvlh	9.8	10.5	11.2	V	
	UVLO Turn-off threshold	Vuvll	8.8	9.3	9.8	V	
	UVLO hysteresis	Hysuvl	0.7	1.2	1.7	V	
	Standby current	Istby	—	120	200	μA	Vcc = 8.9 V, ZCD = Open
	Operating current	Icc	—	4.9	7.0	mA	
VREF	Output voltage	Vref	4.85	5.00	5.15	V	Isource = –1 mA
	Line regulation	Vref-line	—	5	20	mV	Isource = –1 mA, Vcc = 10 V to 24 V
	Load regulation	Vref-load	—	5	20	mV	Isource = –1 mA to –5 mA
	Temperature stability	dVref	—	±80	—	ppm/°C	Ta = –40 to 125°C *[1]

Note: 1. Design spec.

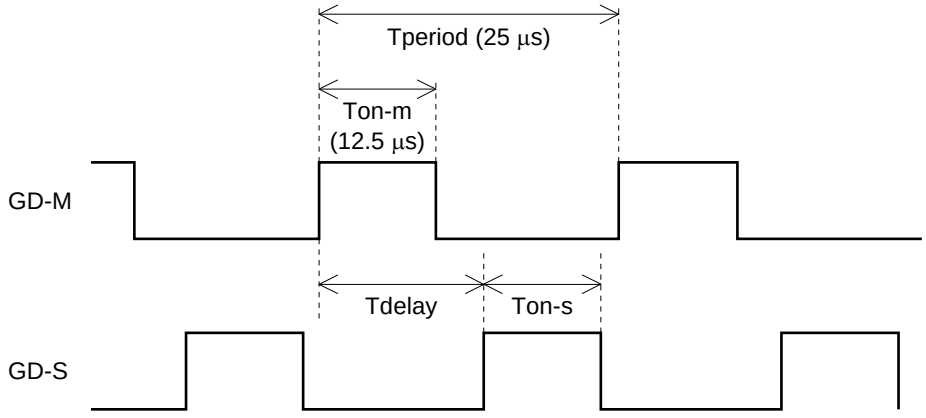
Electrical Characteristics (cont.)

(Ta = 25°C, Vcc = 12 V, RT = 22 kΩ, OCP = GND, CRAMP = 680 pF, RZCD-GND = 51 kΩ, FB = COMP)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Error amplifier	Feedback voltage	Vfb	2.40	2.50	2.60	V	FB-COMP short, RAMP = 0 V
	Input bias current	Ifb	–0.5	0	0.5	μA	Measured pin: FB
	Open loop gain	Av	—	60	—	dB	*1
	Upper clamp voltage	Vclamp-comp	8.0	9.1	10.6	V	FB = 2.0 V, COMP: Open
	Low voltage	Vl-comp	—	0.1	0.3	V	FB = 3.0 V, COMP: Open
	Source current	Isrc-comp	—	–120	—	μA	FB = 1.5 V, COMP = 2.5 V
	Sink current 1	Isnkcomp1	—	120	—	μA	*1
	Sink current 2	Isnkcomp2	—	300	—	μA	FB = 3.5 V, COMP = 2.5 V
	Transconductance	gm	150	200	290	μs	FB = 2.45 V ↔ 2.55 V, COMP = 2.5 V
RAMP	RAMP charge current	Ic-ramp	130	150	170	μA	RAMP = 0 V to 7 V
	RAMP discharge current	Id-ramp	7	16	29	mA	FB = 1 V, COMP = 2 V, RAMP = 0 V to 1.5 V to 1 V
	Low voltage	Vl-ramp	—	17	200	mV	FB = 1 V, COMP = 3 V, RAMP = 0 V to 2.5 V to open Isink = 100 μA
Zero current detector	Upper clamp voltage	Vzcdh	5.8	6.4	7.0	V	Isource = –3 mA
	Lower clamp voltage	Vzcdl	0.3	0.8	1.3	V	Isink = 3 mA
	ZCD low threshold voltage	Vzcd_lo	1.05	1.50	1.75	V	*1
	ZCD hysteresis	Hyszcd	180	300	390	mV	*1
	Input bias current	Izcd	–1	—	1	μA	1.2 V < Vzcd < 5 V
Slave control	Phase delay	Phase	160	180	200	deg.	*1, *2
	On time ratio	Ton-ratio	–5	—	5	%	*1, *2
Restart	Restart time delay	Tstart	210	280	350	μs	Cramp = 3300 pF FB = 2.0 V, COMP = 5 V

Note: 1. Design spec.

2.



$$\text{Phase} = \frac{\text{Tdelay}}{\text{Tperiod}} \times 360 \text{ [deg.]}$$

$$\text{Ton-ratio} = \left(1 - \frac{\text{Ton-s}}{\text{Ton-m}}\right) \times 100 \text{ [\%]}$$

Electrical Characteristics (cont.)

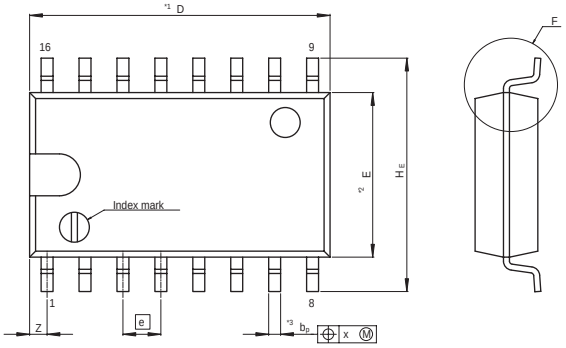
(Ta = 25°C, Vcc = 12 V, RT = 22 kΩ, OCP = GND, CRAMP = 680 pF, RZCD-GND = 51 kΩ, FB = COMP)

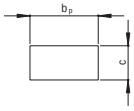
Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Gate drive	Master gate drive rise time	tr-gdm	—	30	100	ns	CL = 100 pF, Cramp = 3300 pF FB = 2.0 V, COMP = 5 V
	Slave gate drive rise time	tr-gds	—	30	100	ns	CL = 100 pF, Cramp = 3300 pF FB = 2.0 V, COMP = 5 V
	Master gate drive fall time	tf-gdm	—	30	100	ns	CL = 100 pF, Cramp = 3300 pF FB = 2.0 V, COMP = 5 V
	Slave gate drive fall time	tf-gds	—	30	100	ns	CL = 100 pF, Cramp = 3300 pF FB = 2.0 V, COMP = 5 V
	Master gate drive low voltage	Vol1-gdm	—	0.05	0.2	V	Isink = 2 mA
		Vol2-gdm	—	0.03	0.7		Isink = 1 mA, VCC = 5 V
	Master gate drive high voltage	Voh-gdm	11.5	11.9	—	V	Isource = –2 mA
	Slave gate drive low voltage	Vol1-gds	—	0.05	0.2	V	Isink = 2 mA
		Vol2-gds	—	0.03	0.7		Isink = 1 mA, VCC = 5 V
	Slave gate drive high voltage	Voh-gds	11.5	11.9	—	V	Isource = –2 mA *[1]
Over current protection	OCP threshold voltage	Vocp	0.27	0.3	0.33	V	
Over voltage protection	Dynamic OVP threshold voltage	Vdovp	VFB× 1.035	VFB× 1.050	VFB× 1.065	V	
	Static OVP threshold voltage	Vsovp	VFB× 1.075	VFB× 1.090	VFB× 1.105	V	COMP = Open
	Static OVP hysteresis	Hys-sovp	50	100	150	mV	COMP = Open
	FB open detect threshold voltage	Vfbopen	0.45	0.50	0.55	V	COMP = Open
	FB open detect hysteresis	Hysfbopen	0.16	0.20	0.24	V	COMP = Open

Note: 1. Design spec.

Package Dimensions

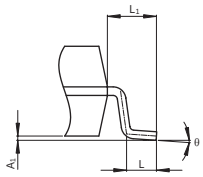
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP16-5.5x10.06-1.27	PRSP0016DH-B	FP-16DAV	0.24g





Terminal cross section
(Ni/Pd/Au plating)

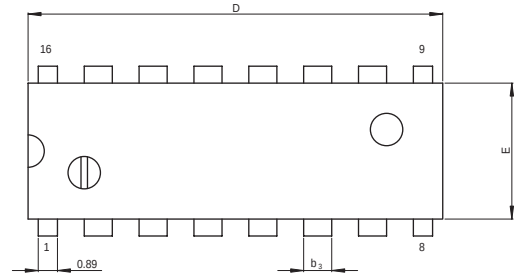
NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

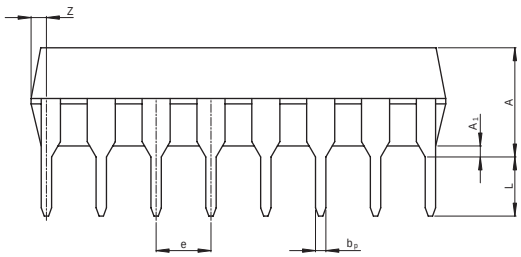


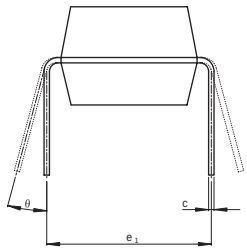
Detail F

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	10.06	10.5
E	—	5.50	—
A_2	—	—	—
A_1	0.00	0.10	0.20
A	—	—	2.20
b_p	0.34	0.40	0.46
b_1	—	—	—
c	0.15	0.20	0.25
c_1	—	—	—
θ	0°	—	8°
H_E	7.50	7.80	8.00
e	—	1.27	—
x	—	—	0.12
y	—	—	0.15
Z	—	—	0.80
L	0.50	0.70	0.90
L_1	—	1.15	—

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-DIP16-6.3x19.2-2.54	PRDP0016AE-B	DP-16FV	1.05g







(Ni/Pd/Au plating)

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
e_1	—	7.62	—
D	—	19.2	20.32
E	—	6.3	7.4
A	—	—	5.06
A_1	0.51	—	—
b_p	0.40	0.48	0.56
b_3	—	1.30	—
c	0.19	0.25	0.31
θ	0°	—	15°
e	2.29	2.54	2.79
Z	—	—	1.12
L	2.54	—	—

Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan

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Renesas Technology America, Inc.
450 Holger Way, San Jose, CA 95134-1368, U.S.A
Tel: <1> (408) 382-7500, Fax: <1> (408) 382-7501

Renesas Technology Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.
Tel: <44> (1628) 585-100, Fax: <44> (1628) 585-900

Renesas Technology (Shanghai) Co., Ltd.
Unit 204, 205, AZIACenter, No.1233 Lujiazui Ring Rd, Pudong District, Shanghai, China 200120
Tel: <86> (21) 5877-1818, Fax: <86> (21) 6887-7898

Renesas Technology Hong Kong Ltd.
7th Floor, North Tower, World Finance Centre, Harbour City, 1 Canton Road, Tsimshatsui, Kowloon, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2730-6071

Renesas Technology Taiwan Co., Ltd.
10th Floor, No.99, Fushing North Road, Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

Renesas Technology Singapore Pte. Ltd.
1 Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001

Renesas Technology Korea Co., Ltd.
Kukje Center Bldg. 18th Fl., 191, 2-ka, Hangang-ro, Yongsan-ku, Seoul 140-702, Korea
Tel: <82> (2) 796-3115, Fax: <82> (2) 796-2145

Renesas Technology Malaysia Sdn. Bhd
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No.18, Jalan Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: <603> 7955-9390, Fax: <603> 7955-9510

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