

# R2A20132SP

R03DS0094EJ0201

Rev.2.01

Jan 08, 2016

## Critical Conduction Mode Interleave PFC Control IC

### Description

The R2A20132SP controls two boost converters to provide a active power factor correction.

The R2A20132SP is based on R2A20112 and additional functions are Slave drop function at light load, Off time control, Brownout, Double OVP, Dynamic under voltage protection, and ZCD signal open detection.

Also the reference voltage tolerance is improved.

The R2A20132SP 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, over current protection are built in the R2A20132SP, and can constitute a power supply system of high reliability with few external parts.

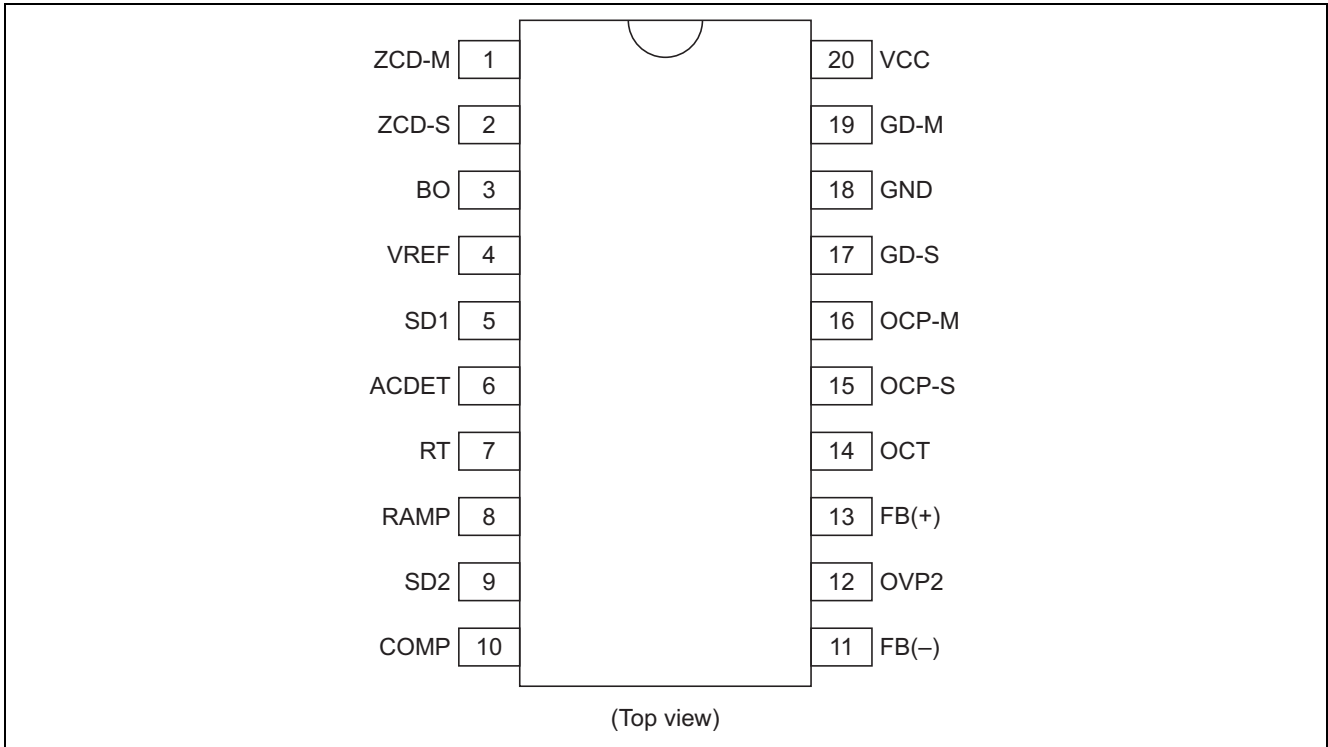
### Features

- Maximum ratings
  - Supply voltage Vcc: 24 V
  - Junction temperature Tj: -40 to +150°C
- Electrical characteristics
  - VREF output voltage VREF: 5.0 V ± 1.5%
  - UVLO operation start voltage Vuvlh: 10.5 V ± 0.7 V
  - UVLO operation shutdown voltage Vuvll: 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 with slave drop (SD) function at light load
  - Off time control (OTC) function: Switching loss is decreased at light load.
  - Brownout function
  - Double OVP: Two line sense for over voltage protection
  - Dynamic under voltage protection (DUVP): Sense for under voltage protection
  - AC Hi voltage detection (ACDET)
  - Feedback loop open detection
  - ZCD signal open detection
  - Master and Slave independenced over current protection
  - 140 μs restart timer
  - Package lineup: Pb-free SOP-20

### Ordering Information

Part No.	Package Name	Package Code	Taping Spec.
R2A20132SPW0	FP-20DAV	PRSP0020DD-B	2000 pcs./one taping product

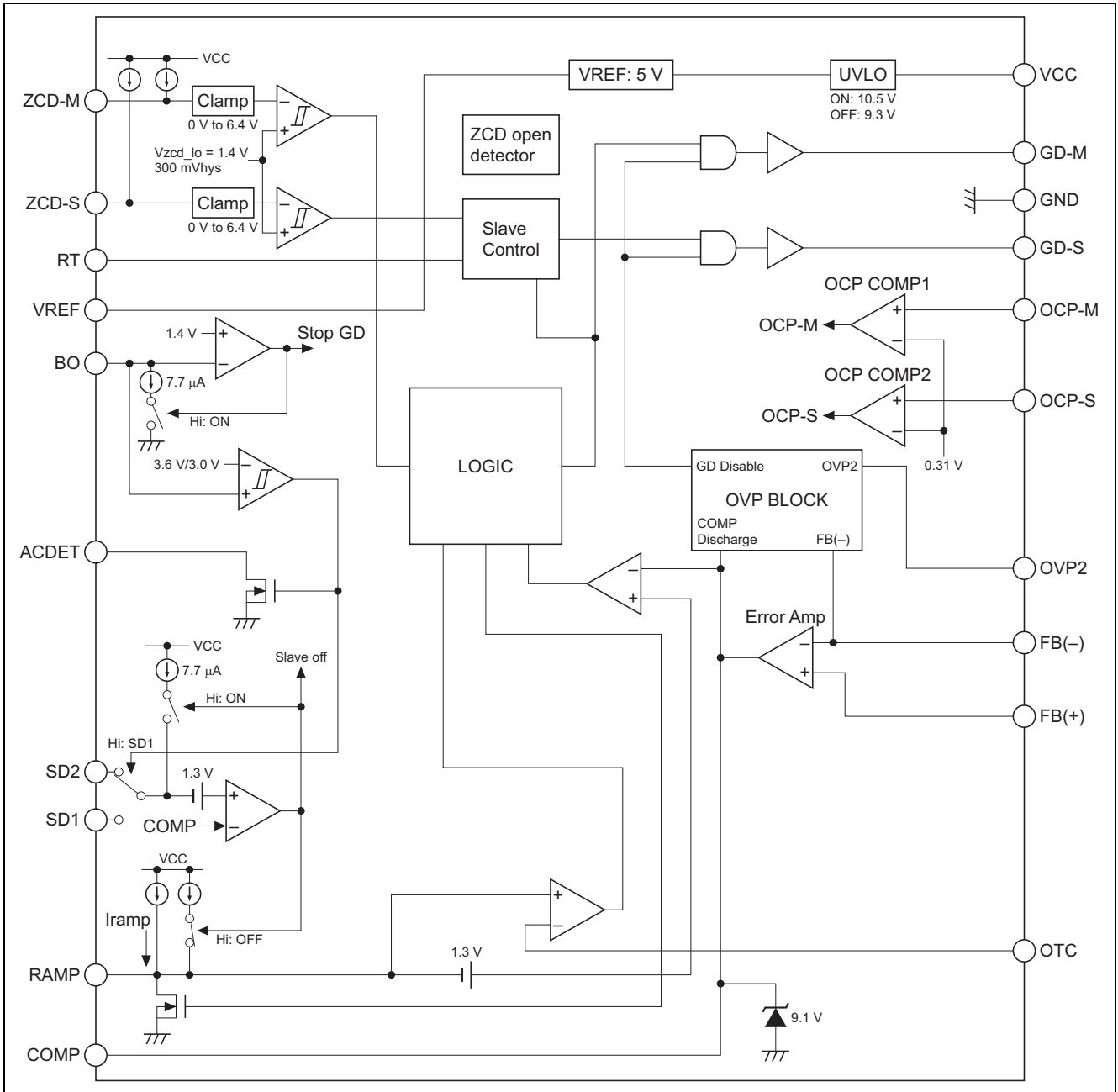
## Pin Arrangement



## 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	BO	Input	Brownout input terminal
4	VREF	Output	Reference voltage output terminal
5	SD1	Input	Slave drop threshold voltage input terminal (for Lo line: 100 V)
6	ACDET	Output	AC hi voltage detection output terminal
7	RT	Input/Output	Oscillator frequency setting terminal
8	RAMP	Input/Output	Ramp waveform setting terminal
9	SD2	Input	Slave drop threshold voltage change terminal (for Hi line: 200 V)
10	COMP	Output	Error amplifier output terminal
11	FB(-)	Input	Error amplifier input (-) terminal
12	OVP2	Input	Over voltage detection terminal
13	FB(+)	Input	Error amplifier input (+) terminal
14	OTC	Input	Off time control input terminal
15	OCP-S	Input	Slave converter over current detection terminal
16	OCP-M	Input	Master converter over current detection terminal
17	GD-S	Output	Slave converter Power MOSFET drive terminal
18	GND	—	Ground
19	GD-M	Output	Master converter Power MOSFET drive terminal
20	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 peak current	Ipk-gd	-300 +1200	mA	3
GD DC current	I <sub>dc-gd</sub>	-15 +60	mA	
ZCD terminal current	I <sub>zcd</sub>	+10 -10	mA	
BO terminal current	I <sub>bom</sub>	300	μA	
RT terminal current	I <sub>rt</sub>	-200	μA	
Vref terminal current	I <sub>ref</sub>	-5	mA	
COMP terminal current	I <sub>comp</sub>	±1	mA	
ACDET terminal current	I <sub>acdetm</sub>	500	μA	
Terminal voltage	V <sub>t-group1</sub>	-0.3 to V <sub>cc</sub>	V	4
	V <sub>t-group2</sub>	-0.3 to V <sub>ref</sub>	V	5
Vref terminal voltage	V <sub>t-ref</sub>	-0.3 to V <sub>ref</sub> + 0.3	V	
Power dissipation	P <sub>t</sub>	1	W	6
Operating ambient temperature	T <sub>a-opr</sub>	-40 to +125	°C	
Junction temperature	T <sub>j</sub>	-40 to +150	°C	7
Storage temperature	T <sub>stg</sub>	-55 to +150	°C	

- Notes:
- Rated voltages are with reference to the GND terminal.
  - For rated currents, inflow to the IC is indicated by (+), and outflow by (-).
  - Shows the transient current when driving a capacitive load.
  - This is the rated voltage for the following pins:  
RAMP, ACDET
  - This is the rated voltage for the following pins:  
FB(+), FB(-), OCP-M, OCP-S, OVP2, SD1, SD2, OTC
  - In case of R2A20132SP (SOP):  $\theta_{ja} = 120^{\circ}\text{C/W}$   
This value is a thing mounting on  $40 \times 40 \times 1.6$  [mm], a glass epoxy board of wiring density 10%.
  - Stresses exceeding the absolute maximum ratings may damage the device.  
These are stress ratings only. Functional operation above the recommended operating ambient temperature range is not implied.  
Extended exposure to stresses above the absolute maximum ratings may affect device reliability.

## Electrical Characteristics

(Ta = 25°C, VCC = 12 V, RT = 22 kΩ, OCP = GND, CRAMP = 680 pF, FB(+) = 2.5 V, FB(-) = COMP, BO = 5 V, OVP2 = GND, SD1 = SD2 = GND)

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	—	150	230	μA	VCC = 8.9 V, ZCD = OPEN
	Operating current	Icc	—	5.2	7.5	mA	FB(-) = open
Brownout	BO threshold voltage	Vbo	1.33	1.40	1.47	V	
	BO pin hysteresis current	Ibo	6.9	7.7	8.5	μA	BO = 1 V
VREF	Output voltage	Vref	4.925	5.000	5.075	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
Error amplifier	Feedback voltage	Vfb(-)	2.462	2.500	2.538	V	FB(-)-COMP Short, RAMP = 0 V
	Input bias current1	Ifb(-)	-0.5	-0.3	-0.1	μA	Measured pin: FB(-), FB(-) = 3 V
	Input bias current2	Ifb(+)	0.1	0.3	0.5	μA	Measured pin: FB(+), FB(+) = 3 V
	Open loop gain	Av	—	50	—	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 current1	Isrc-comp1	—	-120	—	μA	FB(-) = 0 V to 1.5 V, COMP = 2.5 V
	Source current2	Isrc-comp2	—	-1	—	mA	FB(-) = 3 V to 1.5 V, COMP = 2.5 V
	Sink current	Isnk-comp	—	300	—	μA	FB(-) = 3.5 V, COMP = 2.5 V *1
	Transconductance	gm	100	180	270	μs	FB(-) = 2.45 V ↔ 2.55 V, COMP = 2.5 V
RAMP	RAMP charge current1	Ic-ramp1	72	82	92	μA	RAMP = 0 V to 7 V, FB(-) = 2 V, COMP = 2 V, SD2 = 2.5 V
	RAMP charge current2	Ic-ramp2	150	165	180	μA	RAMP = 0 V to 7 V, FB(-) = 2 V, COMP = 5 V, SD2 = 2.5 V
	RAMP discharge current	Id-ramp	7	15	29	mA	FB(-) = 3 V, COMP = 2 V, RAMP = 1 V
	Low voltage	Vl-ramp	—	17	200	mV	FB(-) = 3 V, COMP = 3 V, Isink = 100 μA
Zero current detector	Upper clamp voltage	Vzcdh	5.8	6.4	7.0	V	Isource = -3 mA
	Lower clamp voltage	Vzcdl	-0.5	0	0.5	V	Isink = 3 mA
	ZCD low threshold voltage	Vzcd-lo	0.95	1.40	1.65	V	*1
	ZCD hysteresis	Hyszcd	180	300	390	mV	*1
	Input bias current	Izcd	-14	-10	-6	μA	1.2 V < Vzcd < 5 V

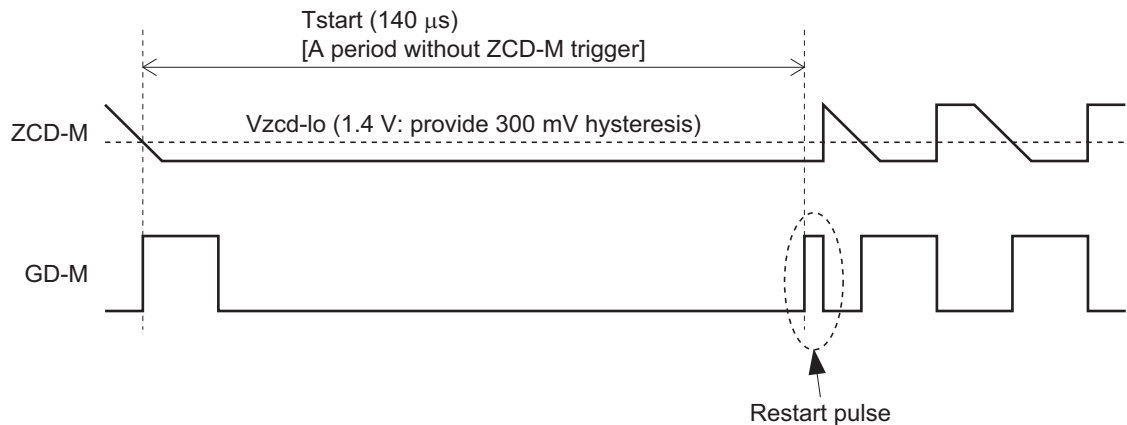
Note: 1. Design spec.

## Electrical Characteristics (cont.)

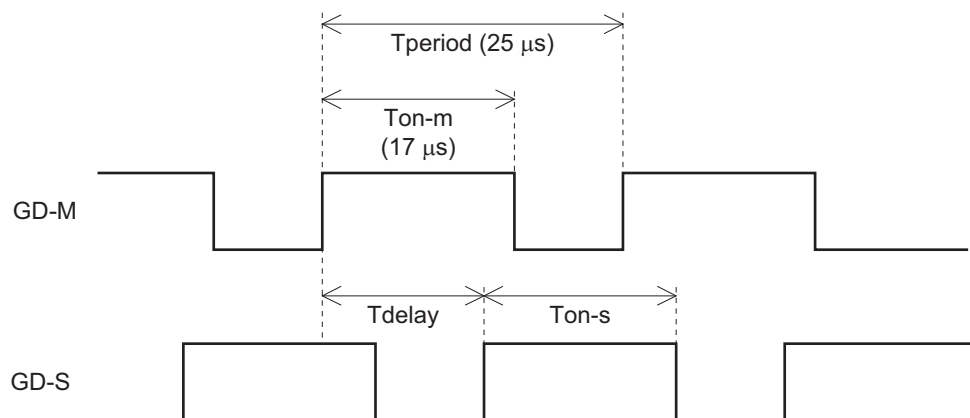
( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{ V}$ ,  $R_T = 22\text{ k}\Omega$ ,  $OCP = \text{GND}$ ,  $\text{CRAMP} = 680\text{ pF}$ ,  $\text{FB}(+) = 2.5\text{ V}$ ,  $\text{FB}(-) = \text{COMP}$ ,  $\text{BO} = 5\text{ V}$ ,  $\text{OVP2} = \text{GND}$ ,  $\text{SD1} = \text{SD2} = \text{GND}$ )

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Restart	Restart time delay	Tstart	105	140	175	$\mu\text{s}$	$\text{FB}(-) = 2.0\text{ V}$ , $\text{COMP} = 5\text{ V}$ *2
ACDET	ACDET current	Iacdet	0	1	2	$\mu\text{A}$	$V_{\text{acdet}} = 12\text{ V}$ , $V_{\text{bo}} = 3.3\text{ V}$
	ACDET voltage	Vacdet	0.2	0.4	0.6	V	Iacdet = 500 $\mu\text{A}$ , $V_{\text{bo}} = 3.7\text{ V}$
	High threshold voltage	Vacdet-hi	3.2	3.6	4.0	V	Measured Pin: BO
	Low threshold voltage	Vacdet-lo	2.6	3.0	3.4	V	Measured Pin: BO
Slave control	Phase delay	Phase	160	180	200	deg	*1, *3
	On time ratio	Ton-ratio	-5	—	5	%	*1, *3
Slave drop	Input bias current	I <sub>sd1</sub>	-1.0	-0.5	1.0	$\mu\text{A}$	$\text{SD1} = 1\text{ V}$ , $\text{COMP} = 4\text{ V}$ , $\text{FB}(-) = 0\text{ V}$
		I <sub>sd2</sub>	-1.0	-0.5	1.0	$\mu\text{A}$	$\text{SD2} = 1\text{ V}$ , $\text{COMP} = 4\text{ V}$ , $\text{FB}(-) = 0\text{ V}$
	SD pin hysteresis current	I <sub>sd-hys</sub>	-8.5	-7.7	-6.9	$\mu\text{A}$	$\text{SD1} = 2\text{ V}$ , $\text{BO} = 2\text{ V}$ , $\text{COMP} = 2\text{ V}$ , $\text{FB}(-) = 0\text{ V}$
Off time control	Input bias current	I <sub>otc</sub>	-1.0	0	1.0	$\mu\text{A}$	$\text{OTC} = 3\text{ V}$

Note: 1. Design spec.  
2.



3.



$$\text{Phase} = \frac{T_{\text{delay}}}{T_{\text{period}}} \times 360 \text{ [deg]}$$

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

**Electrical Characteristics (cont.)**

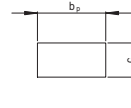
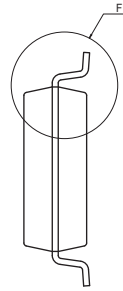
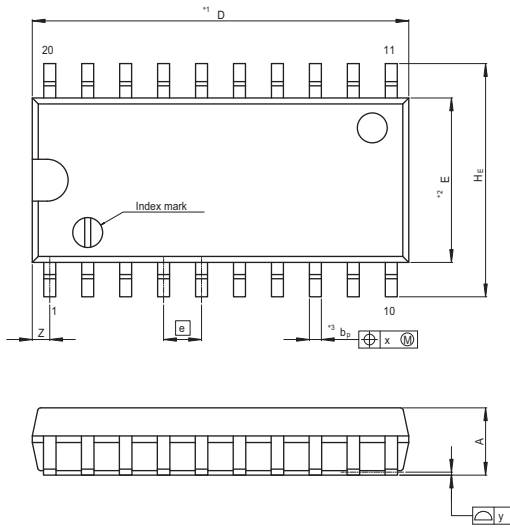
(Ta = 25°C, VCC = 12 V, RT = 22 kΩ, OCP = GND, CRAMP = 680 pF, FB(+) = 2.5 V, FB(−) = COMP, BO = 5 V, OVP2 = GND, SD1 = SD2 = GND)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Gate drive	Master gate drive rise time	tr-gdm	—	30	100	ns	GD-M: 1.2 V to 10.8 V, CL = 100 pF
	Slave gate drive rise time	tr-gds	—	30	100	ns	GD-S: 1.2 V to 10.8 V, CL = 100 pF
	Master gate drive fall time	tf-gdm	—	5	30	ns	GD-M: 10.8 V to 1.2 V, CL = 100 pF
	Slave gate drive fall time	tf-gds	—	5	30	ns	GD-S: 10.8 V to 1.2 V, CL = 100 pF
	Master gate drive low voltage	Vol1-gdm	—	0.02	0.1	V	Isink = 2 mA
		Vol2-gdm	—	0.01	0.2	V	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	—	0.02	0.1	V	Isink = 2 mA
		Vol2-gds	—	0.01	0.2	V	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	0.28	0.31	0.34	V	
Over voltage protection	Dynamic OVP threshold voltage	Vdovp	VFB(+) ×1.035	VFB(+) ×1.050	VFB(+) ×1.065	V	COMP = OPEN
	OVP1 threshold voltage	Vovp1	VFB(+) ×1.075	VFB(+) ×1.090	VFB(+) ×1.105	V	COMP = OPEN
	OVP1 hysteresis	Hys-ovp1	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
	OVP2 threshold voltage	Vovp2	2.635	2.685	2.735	V	COMP = OPEN, VFB(−) = 2.5 V
	OVP2 hysteresis	Hys-ovp2	50	100	150	mV	COMP = OPEN, VFB(−) = 2.5 V
	OVP2 pin input bias current	lovp2	−0.5	0	0.5	μA	Measured pin: OVP2
	Dynamic UVP threshold voltage	Vduvp	VFB(+) ×0.89	VFB(+) ×0.92	VFB(+) ×0.95	V	COMP = OPEN
ZCD open detector	Slave ZCD open minimum detect delay time	tzcds	—	100	—	ms	COMP = 5 V, Gate drive 10 kHz *1

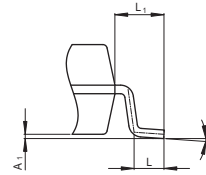
Note: 1. Design spec.

### Package Dimensions

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-SOP20-5.5x12.6-1.27	PRSP0020DD-B	FP-20DAV	0.31g



Terminal cross section  
( Ni/Pd/Au plating )



Detail F

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

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	12.60	13.0
E	—	5.50	—
A <sub>2</sub>	—	—	—
A <sub>1</sub>	0.00	0.10	0.20
A	—	—	2.20
b <sub>p</sub>	0.34	0.40	0.46
b <sub>1</sub>	—	—	—
c	0.15	0.20	0.25
c <sub>1</sub>	—	—	—
θ	0°	—	8°
H <sub>E</sub>	7.50	7.80	8.00
Ⓜ	—	1.27	—
x	—	—	0.12
y	—	—	0.15
Z	—	—	0.80
L	0.50	0.70	0.90
L <sub>1</sub>	—	1.15	—



## Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
3. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.  
"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots etc.  
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; and safety equipment etc.  
Renesas Electronics products are neither intended nor authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems, surgical implantations etc.), or may cause serious property damages (nuclear reactor control systems, military equipment etc.). You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application for which it is not intended. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for which the product is not intended by Renesas Electronics.
6. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You should not use Renesas Electronics products or technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. When exporting the Renesas Electronics products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document, Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.
11. This document may not be reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.



### SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

#### Renesas Electronics America Inc.

2801 Scott Boulevard Santa Clara, CA 95050-2549, U.S.A.  
Tel: +1-408-588-6000, Fax: +1-408-588-6130

#### Renesas Electronics Canada Limited

9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3  
Tel: +1-905-237-2004

#### Renesas Electronics Europe Limited

Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.  
Tel: +44-1628-585-100, Fax: +44-1628-585-900

#### Renesas Electronics Europe GmbH

Arcadiastrasse 10, 40472 Düsseldorf, Germany  
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

#### Renesas Electronics (China) Co., Ltd.

Room 1709, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100191, P.R.China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

#### Renesas Electronics (Shanghai) Co., Ltd.

Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, P. R. China 200333  
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

#### Renesas Electronics Hong Kong Limited

Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
Tel: +852-2265-6688, Fax: +852 2886-9022

#### Renesas Electronics Taiwan Co., Ltd.

13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan  
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

#### Renesas Electronics Singapore Pte. Ltd.

80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949  
Tel: +65-6213-0200, Fax: +65-6213-0300

#### Renesas Electronics Malaysia Sdn.Bhd.

Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

#### Renesas Electronics India Pvt. Ltd.

No.77C, 100 Feet Road, HAL II Stage, Indiranagar, Bangalore, India  
Tel: +91-80-67208700, Fax: +91-80-67208777

#### Renesas Electronics Korea Co., Ltd.

12F., 234 Teheran-ro, Gangnam-Gu, Seoul, 135-080, Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5141