R2A20132SP

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.
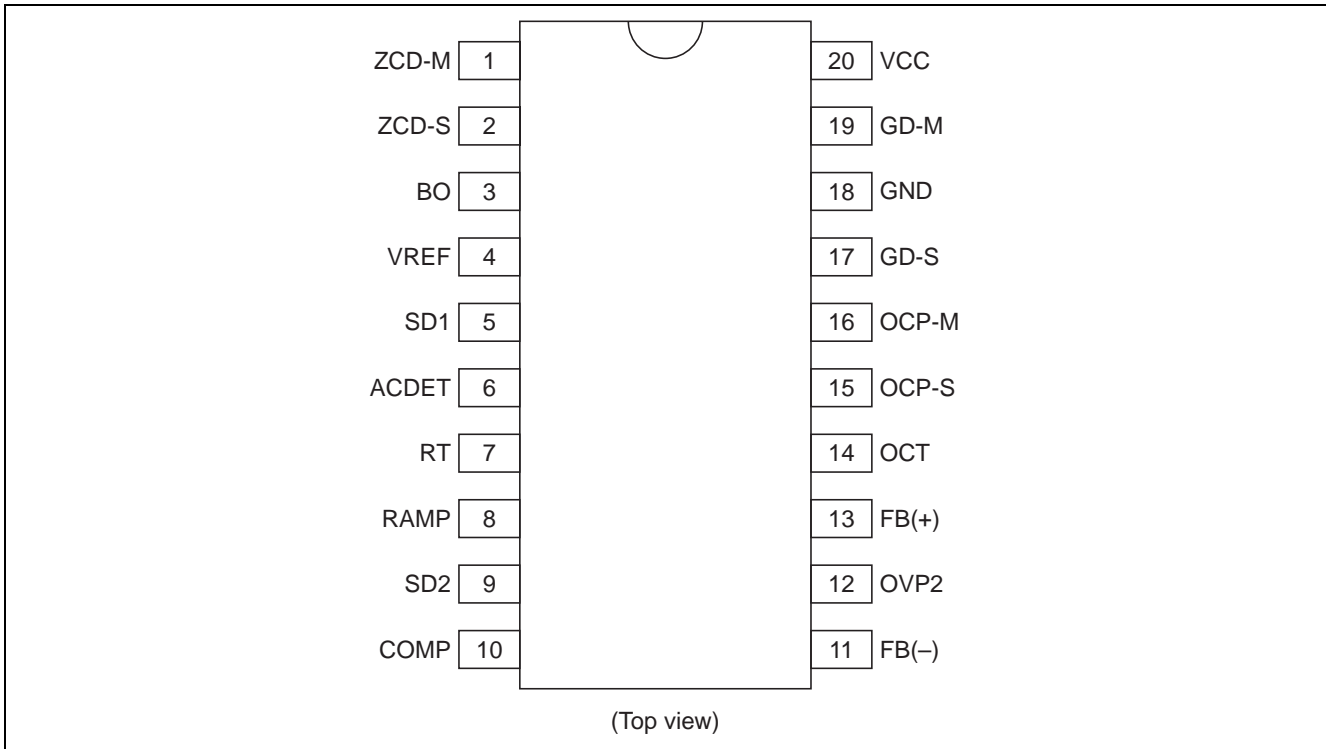
Features

- Maximum ratings
  - Supply voltage Vcc: 24 V
  - Operating junction temperature Tj-opr: –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

```
                    ZCD-M | 1          20 | VCC
                    ZCD-S | 2          19 | GD-M
                       BO | 3          18 | GND
                     VREF | 4          17 | GD-S
                      SD1 | 5          16 | OCP-M
                    ACDET | 6          15 | OCP-S
                       RT | 7          14 | OCT
                     RAMP | 8          13 | FB(+)
                      SD2 | 9          12 | OVP2
                     COMP | 10         11 | FB(−)
```

(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	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

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Block Diagram

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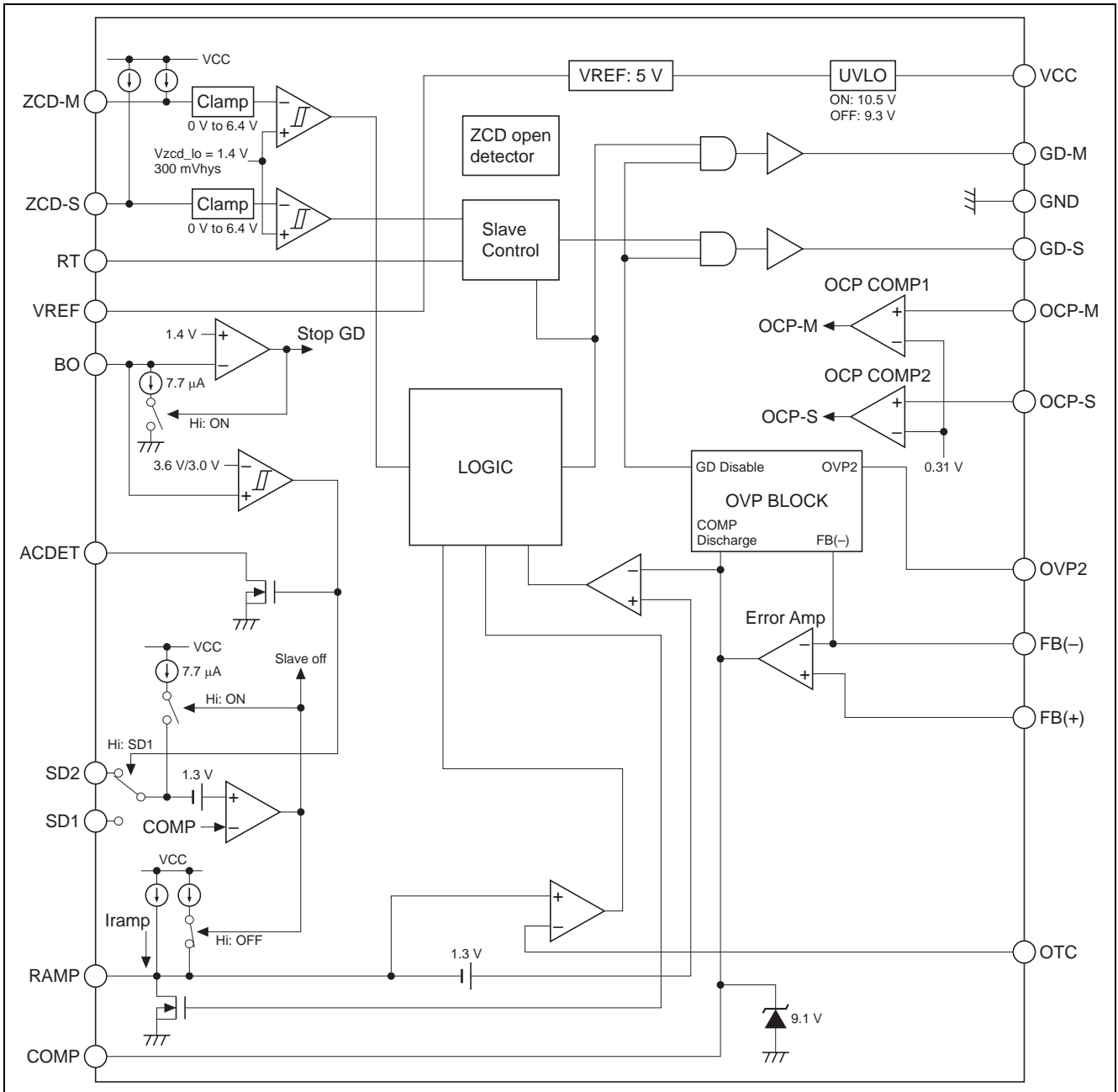
Absolute Maximum Ratings

(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	Idc-gd	−15 +60	mA	
ZCD terminal current	Izcd	+10 −10	mA	
BO terminal current	Ibom	300	μA	
RT terminal current	Irt	−200	μA	
Vref terminal current	Iref	−5	mA	
COMP terminal current	Icomp	±1	mA	
ACDET terminal current	Iacdetm	500	μA	
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 GND 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, ACDET
5. This is the rated voltage for the following pins:
   FB(+), FB(−), OCP-M, OCP-S, OVP2, SD1, SD2, OTC
6. In case of R2A20132SP (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 = 25C, 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.)

(Ta = 25C, 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
Restart	Restart time delay	Tstart	105	140	175	μs	FB(−) = 2.0 V, COMP = 5 V *2
ACDET	ACDET current	Iacdet	0	1	2	μA	Vacdet = 12 V, Vbo = 3.3 V
	ACDET voltage	Vacdet	0.2	0.4	0.6	V	Iacdet = 500 μA, Vbo = 3.7 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	Isd1	−1.0	−0.5	1.0	μA	SD1 = 1 V, COMP = 4 V, FB(−) = 0 V
		Isd2	−1.0	−0.5	1.0	μA	SD2 = 1 V, COMP = 4 V, FB(−) = 0 V
	SD pin hysteresis current	Isd-hys	−8.5	−7.7	−6.9	μA	SD1 = 2 V, BO = 2 V, COMP = 2 V, FB(−) = 0 V
Off time control	Input bias current	Iotc	−1.0	0	1.0	μA	OTC = 3 V

Note: 1. Design spec.

2.
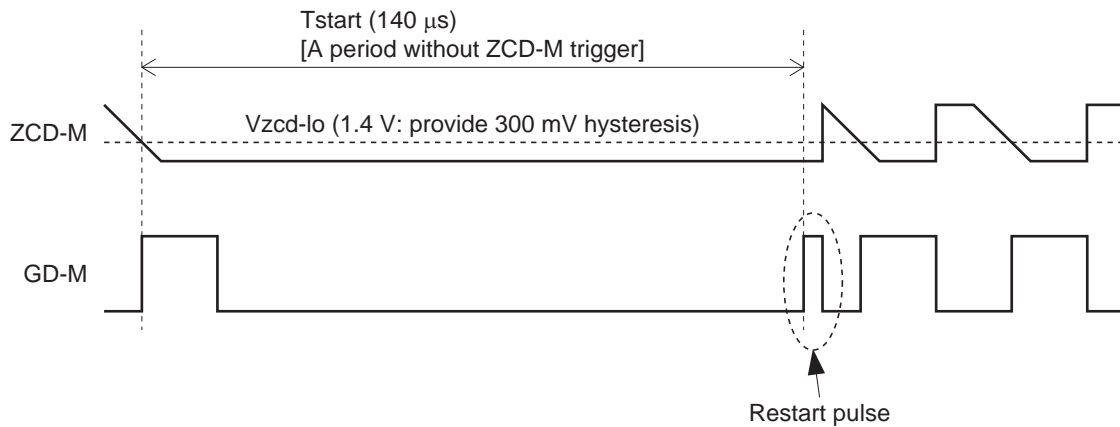
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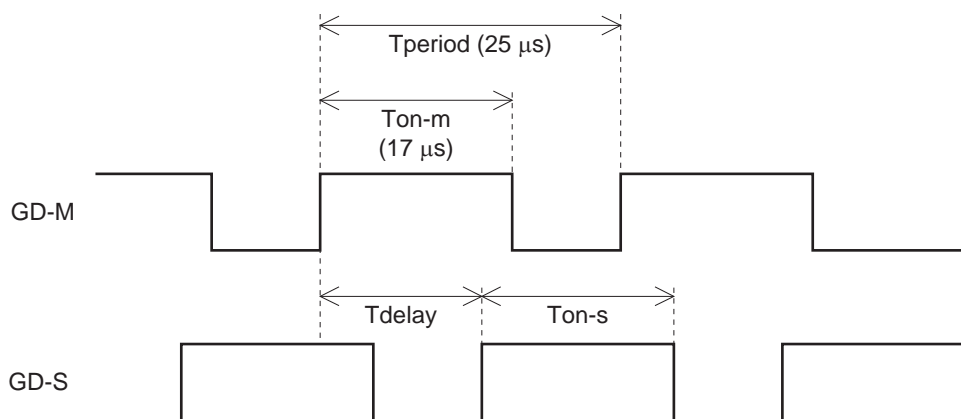
$$Phase = \frac{Tdelay}{Tperiod} \times 360 \text{ [deg]}$$

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

Electrical Characteristics (cont.)

(Ta = 25C, 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	Iovp2	−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
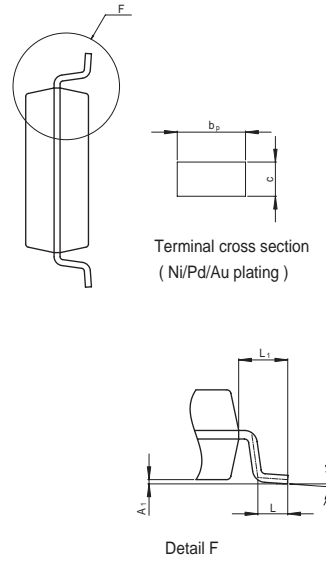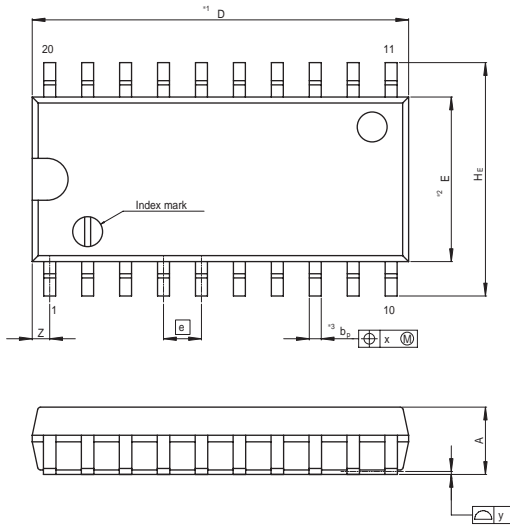
NOTE)
1. DIMENSIONS"*1 (Nom)"AND"*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION"*3"DOES NOT INCLUDE TRIM OFFSET.

Index mark

F

bp

c

Terminal cross section
(Ni/Pd/Au plating)

Detail F

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	——	12.60	13.0
E	——	5.50	——
A₂	——	——	——
A₁	0.00	0.10	0.20
A	——	——	2.20
b_p	0.34	0.40	0.46
b₁	——	——	——
c	0.15	0.20	0.25
c₁	——	——	——
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
L₁	——	1.15	——

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