R2A20118ASP

Critical Conduction Mode Interleaved PFC Control IC

R03DS0002EJ0100
Rev.1.00
Jul 14, 2010

Description

The R2A20118A controls a boost converter to provide an active power factor correction.

The R2A20118A is based on R2A20117, and additional functions are OVP2 and Brownout.

The R2A20118A adopts critical conduction mode for power factor correction and realizes high efficiency and a low switching noise by zero current switching.

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

The feedback loop short detection, two modes overvoltage protection and OVP2, overcurrent protection, overcurrent timer latch protection, and ZCD open detection are built in the R2A20118A, and can constitute a power supply system of high reliability with few external parts.

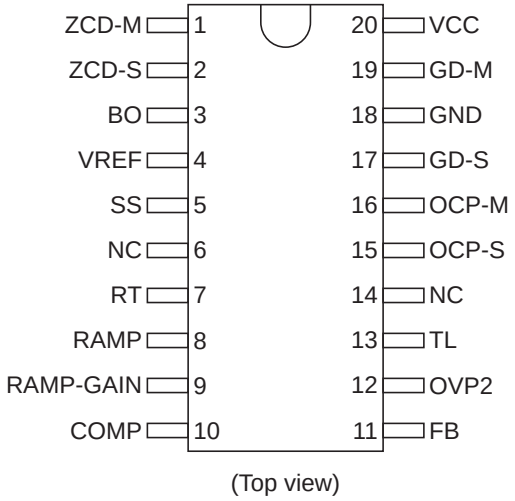
Features

- Absolute Maximum Ratings
  - Supply voltage Vcc: 24 V
  - Operating junction temperature Tjopr: –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
  - Brownout function
  - Two mode overvoltage protection and OVP2
    Mode1: Dynamic OVP corresponding to a voltage rise by dynamic load change
    Mode2: Static OVP corresponding to overvoltage in stable.
    OVP2: OVP2 sense the PFC output voltage by independenced pin.
  - Feedback loop short detection
  - Slave ZCD signal open detection
  - RAMP charge current selectable function
  - Master and Slave independenced overcurrent protection
  - Overcurrent timer latch protection at abnormal operation
  - 280 μs restart timer
  - Soft start function for the reference voltage of Error Amp
  - Package: Pb-free SOP-20

Ordering Information

Part No.	Package Name	Package Code	Package Abbreviation	Taping Abbreviation (Quantity)
R2A20118ASPW0	FP-20DAV	PRSP0020DD-B	SP	W (2,000 pcs/reel)

Pin Arrangement

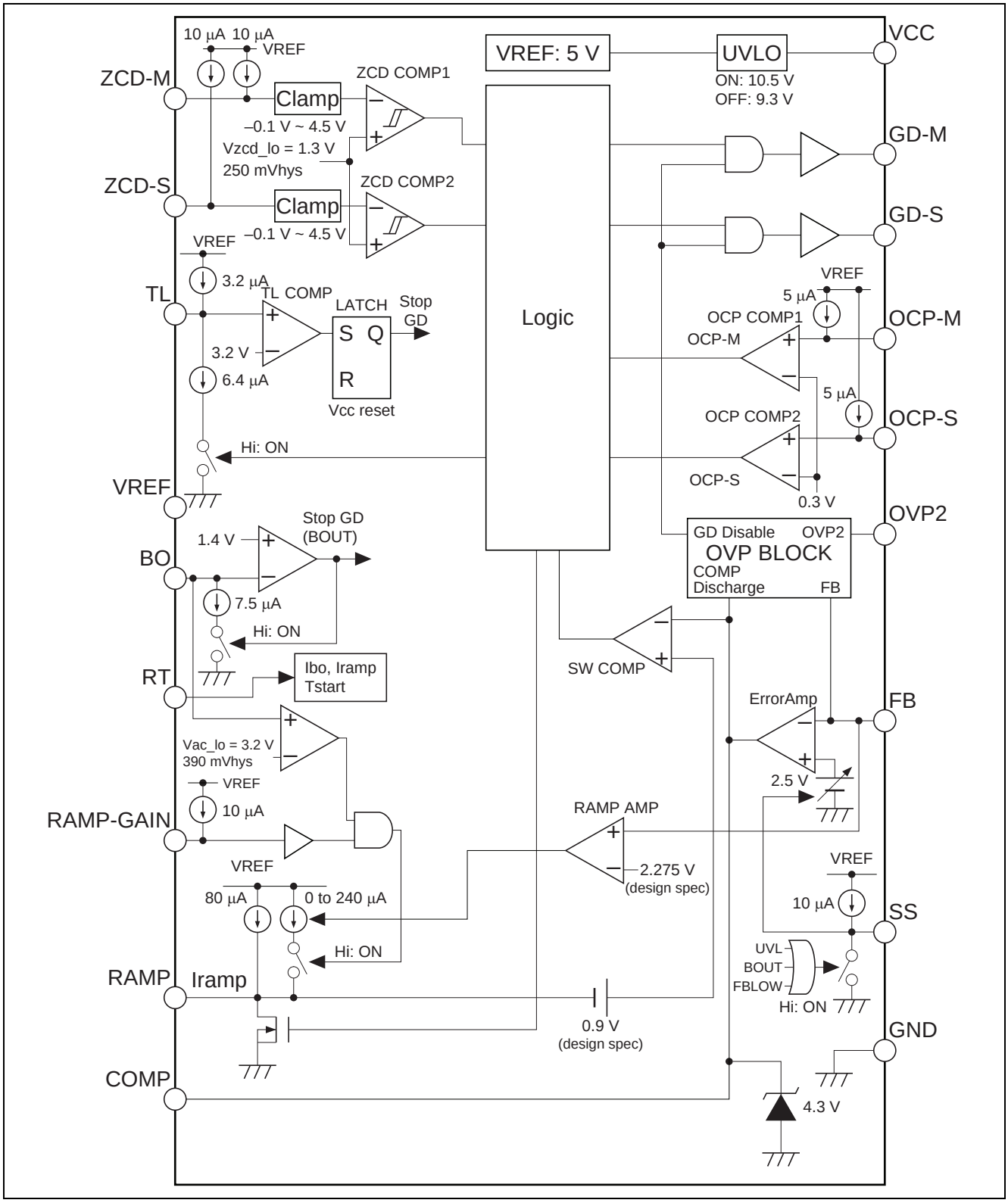


(Top view)

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	BO	Input	Brownout input terminal
4	VREF	Output	Reference voltage output terminal
5	SS	Output	Soft start time setting terminal
6	NC	—	Open terminal
7	RT	Input/Output	Oscillator frequency setting terminal
8	RAMP	Input/Output	Ramp waveform setting terminal
9	RAMP-GAIN	Input	RAMP charge current selection terminal
10	COMP	Output	Error amplifier output terminal
11	FB	Input	Error amplifier input terminal
12	OVP2	Input	Over voltage detection terminal
13	TL	Output	Timer latch time setting terminal
14	NC	—	Open terminal
15	OCP-S	Input	Slave converter overcurrent detection terminal
16	OCP-M	Input	Master converter overcurrent 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	Notes
Supply voltage	VCC	–0.3 to 24	V	
GD terminal peak current	Ipk-gd	–300 +1200	mA	3
GD terminal DC current	Idc-gd	–15 +60	mA	
ZCD terminal current	Izcd	+3 –3	mA	
BO terminal current	Ibom	200	μA	
RT terminal current	Irt	–200	μA	
Vref terminal current	Iref	–5	mA	
Vref terminal capacitor	Cref min	1000	pF	
	Cref max	1	μF	
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	
OCP terminal voltage	Vt-ocp	*–1 to Vref	V	6
Power dissipation	Pt	1	W	7
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:
   NC
5. This is the rated voltage for the following pins:
   FB, OVP2, RT, TL, RAMP-GAIN, SS, RAMP
6. Minus value is peak voltage. Do not impress the DC voltage of the minus.
7. θja = 120°C/W
   This value is a thing mounting on 40 × 40 (thickness: 1.6 mm) [mm^2],
   a glass epoxy board of wiring density 10%.

Electrical Characteristics

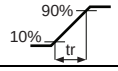
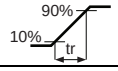
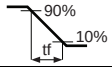
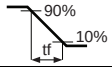
(Ta = 25°C, VCC = 12 V, RT = 33 kΩ, BO = 5 V, OCP = TL = OVP2 = GND, CRAMP = 820 pF, FB = COMP, RAMP-GAIN = OPEN)

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	—	85	170	μA	VCC = 8.9 V
	Operating current	Icc	—	4.2	6.3	mA	FB: Open
Brownout	BO threshold voltage	Vbo	1.33	1.40	1.47	V	
	BO pin hysteresis current	Ibo	6.7	7.5	8.3	μA	BO = 1 V
VREF	Output voltage	Vref	4.925	5.00	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	2.452	2.49	2.528	V	FB-COMP short
	Input bias current	Ifb	–0.5	–0.3	–0.1	μA	Measured pin: FB FB = 3 V *[1]
	Open loop gain	Av	—	60	—	dB	*[1]
	Upper clamp voltage	Vclamp-comp	4.0	4.3	—	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	Isnk-comp	—	330	—	μA	FB = 3.5 V COMP = 2.5 V
	Transconductance	gm	120	200	290	μs	FB = 2.45V ↔ 2.55 V COMP = 2.5 V
RAMP	RAMP charge current 1	Ic-ramp1	72	80	88	μA	RAMP = 0 V to 3 V RAMP-GAIN = GND
	RAMP charge current 2	Ic-ramp2	288	320	352	μA	RAMP = 0 V to 3 V
	RAMP discharge current	Id-ramp	7	15	29	mA	FB = 3 V RAMP = 1 V
	Low voltage	Vl-ramp	—	17	200	mV	FB = 3 V Isink = 100 μA
RAMP gain control	Threshold voltage	Vth-ramp_gain	1.5	2.5	3.5	V	Measured pin RAMP-GAIN
	Input bias current	Iramp_gain	–14	–10	–6	μA	RAMP-GAIN = 3.5 V
	AC detect low threshold voltage	Vac-lo	2.9	3.2	3.5	V	Measured pin BO
	AC detect hysteresis	Hys-ac	350	390	430	mV	Measured pin BO

Note: *1 Design spec.

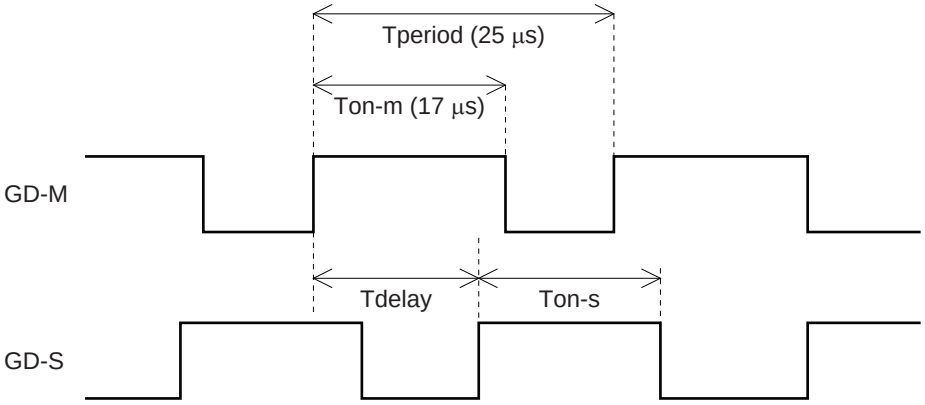
Electrical Characteristics (cont.)

(Ta = 25°C, VCC = 12 V, RT = 33 kΩ, BO = 5 V, OCP = TL = OVP2 = GND, CRAMP = 820 pF, FB = COMP, RAMP-GAIN = OPEN)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Slave control	Phase delay	Phase	160	180	200	deg	*1, *2
	On time ratio	Ton-ratio	0	—	5	%	*1, *2
Gate drive	Master gate drive rise time	tr-gdm	—	20	100	ns	CL = 100 pF 
	Slave gate drive rise time	tr-gds	—	20	100	ns	CL = 100 pF 
	Master gate drive fall time	tf-gdm	—	5	30	ns	CL = 100 pF 
	Slave gate drive fall time	tf-gds	—	5	30	ns	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 *1
	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	0.27	0.30	0.33	V	
Over voltage protection	Dynamic OVP threshold voltage	Vdovp	VFB× 1.035	VFB× 1.050	VFB× 1.065	V	COMP = 2.5 V
	Static OVP threshold voltage	Vsovp1	VFB× 1.075	VFB× 1.090	VFB× 1.105	V	COMP = 2.5 V
	Static OVP hysteresis	Hys-sovp1	50	100	150	mV	COMP = 2.5 V
	FB Low detect threshold voltage	Vfblow	0.45	0.50	0.55	V	COMP = 2.5 V
	FB Low detect hysteresis	Hysfblow	0.16	0.20	0.24	V	COMP = 2.5 V
	OVP2 threshold voltage	Vovp2	2.670	2.725	2.780	V	Measured pin: OVP2
	OVP2 pin input bias current	Iovp2	–0.5	–0.3	–0.1	μA	Measured pin: OVP2 OVP2 = 3 V *1

Notes: *1 Design spec.

*2



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

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

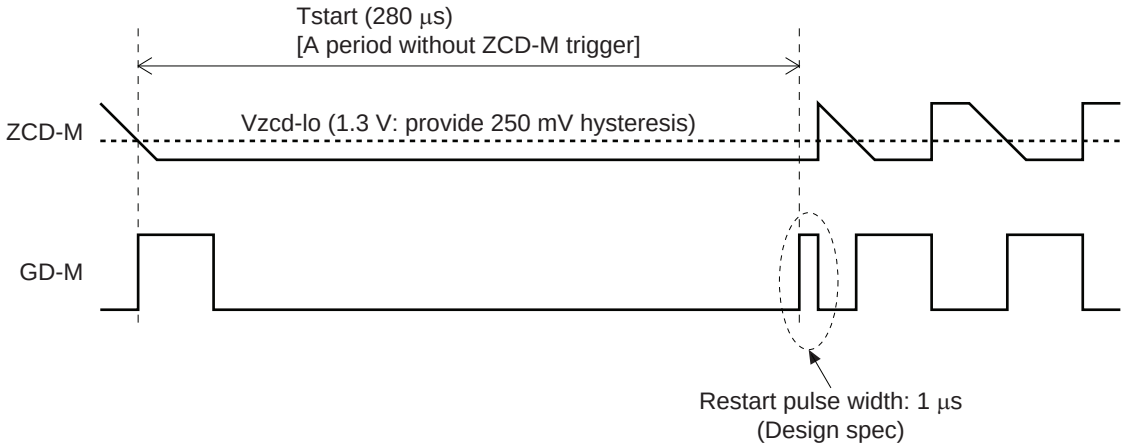
Electrical Characteristics (cont.)

(Ta = 25°C, VCC = 12 V, RT = 33 kΩ, BO = 5 V, OCP = TL = OVP2 = GND, CRAMP = 820 pF, FB = COMP, RAMP-GAIN = OPEN)

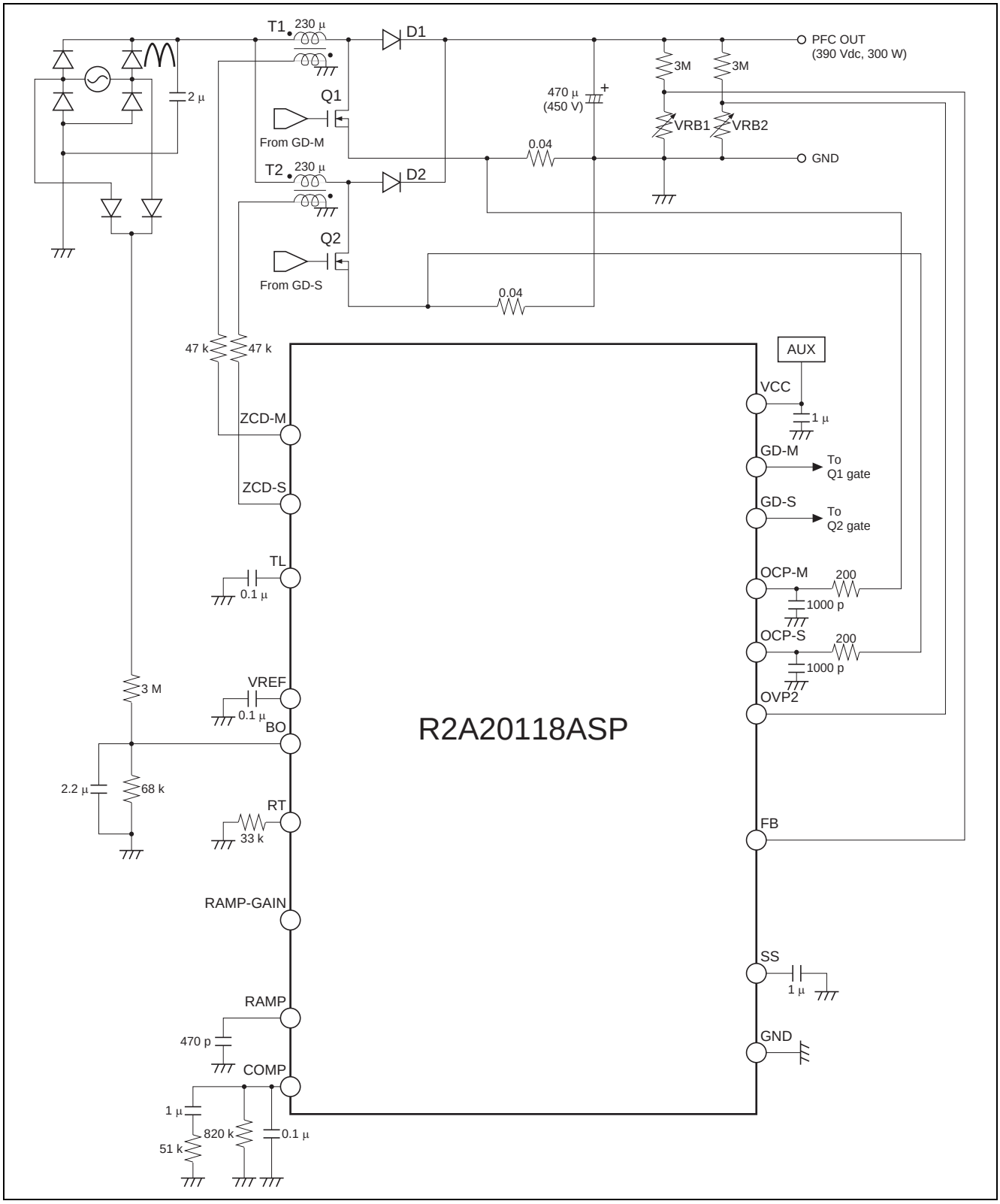
Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Zero current detector	Upper clamp voltage	Vzcdh	4.0	4.5	5.0	V	Isource = –3 mA
	Lower clamp voltage	Vzcdl	–0.5	–0.1	0.4	V	Isink = 3 mA
	ZCD low threshold voltage	Vzcd-lo	0.9	1.3	1.6	V	*1
	ZCD hysteresis	Hyszcd	130	250	360	mV	*1
	Input bias current	Izcd	–14	–10	–6	μA	1.2 V < Vzcd < 2.5 V
ZCD open detector	Slave ZCD open detect delay time	tzcds	—	100	—	ms	ZCD-S: Open Gate drive 10 kHz *1
Soft start	Charge current	Ic-ss	–14	–10	–6	μA	SS = 2 V
Timer latch for overcurrent	Charge current	Ic-tl	–4.8	–3.2	–1.2	μA	TL = 2 V OCP-M = 0.5 V
	Discharge current	Id-tl	1.2	3.2	4.8	μA	TL = 2 V
	Threshold voltage	Vtl	2.88	3.2	3.52	V	
Restart	Restart time delay	Tstart	210	280	350	μs	ZCD-M = 10 kΩ ZCD-S = 10 kΩ *2

Notes: *1 Design spec.

*2

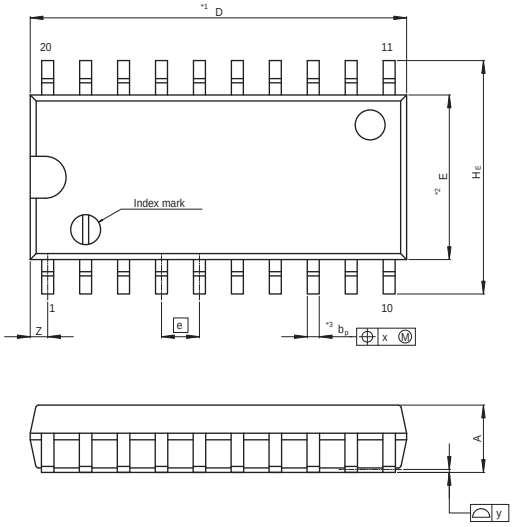


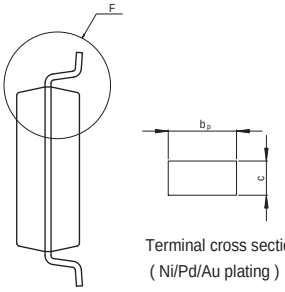
System Diagram



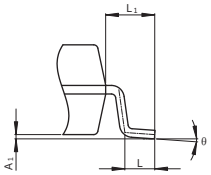
Package Dimensions

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_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	—

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