R2A20112ASP

Critical Conduction Mode Interleaved PFC Control IC

R03DS0047EJ0201
Rev.2.01
Jan 08, 2016

Description

The R2A20112A controls a boost converter to provide an active power factor correction.

The R2A20112A 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.

Soft-star, the feedback loop short detection, two mode over-voltage-protection, over-current-protection, Over current ON/OFF timer protection for boost Diode short and slave ZCD open detection are built in the R2A20112A, and can constitute a power supply system of high reliability with few external parts.

Features

- Absolute 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

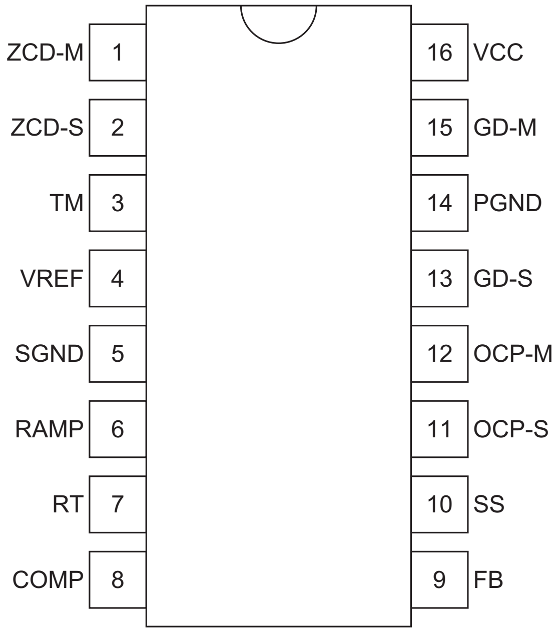
- Functions
  - Boost converter control with critical conduction mode
  - Interleaving control
  - Soft start function for the reference voltage of Error Amp
  - Two mode PFC output Over-voltage-protection
    Mode1: Dynamic OVP corresponding to a voltage rise by dynamic load change.
    Mode2: Static OVP corresponding to over-voltage in stable.
  - PFC output Dynamic-under-voltage-protection (DUVP)
  - Feedback loop open/short detection
  - Master and Slave independence over-current-protection
  - 280 µs restart timer
  - Slave ZCD signal open detection
  - Over current ON/OFF timer protection for boost Diode short

- Package
  - Pb-free SOP-16

Ordering Information

Part No.	Package Name	Package Code	Package Abbreviation	Taping Abbreviation (Quantity)
R2A20112ASPW0	FP-16DAV	PRSP0016DH-B	SP	W (2,000 pcs/reel)

Pin Arrangement

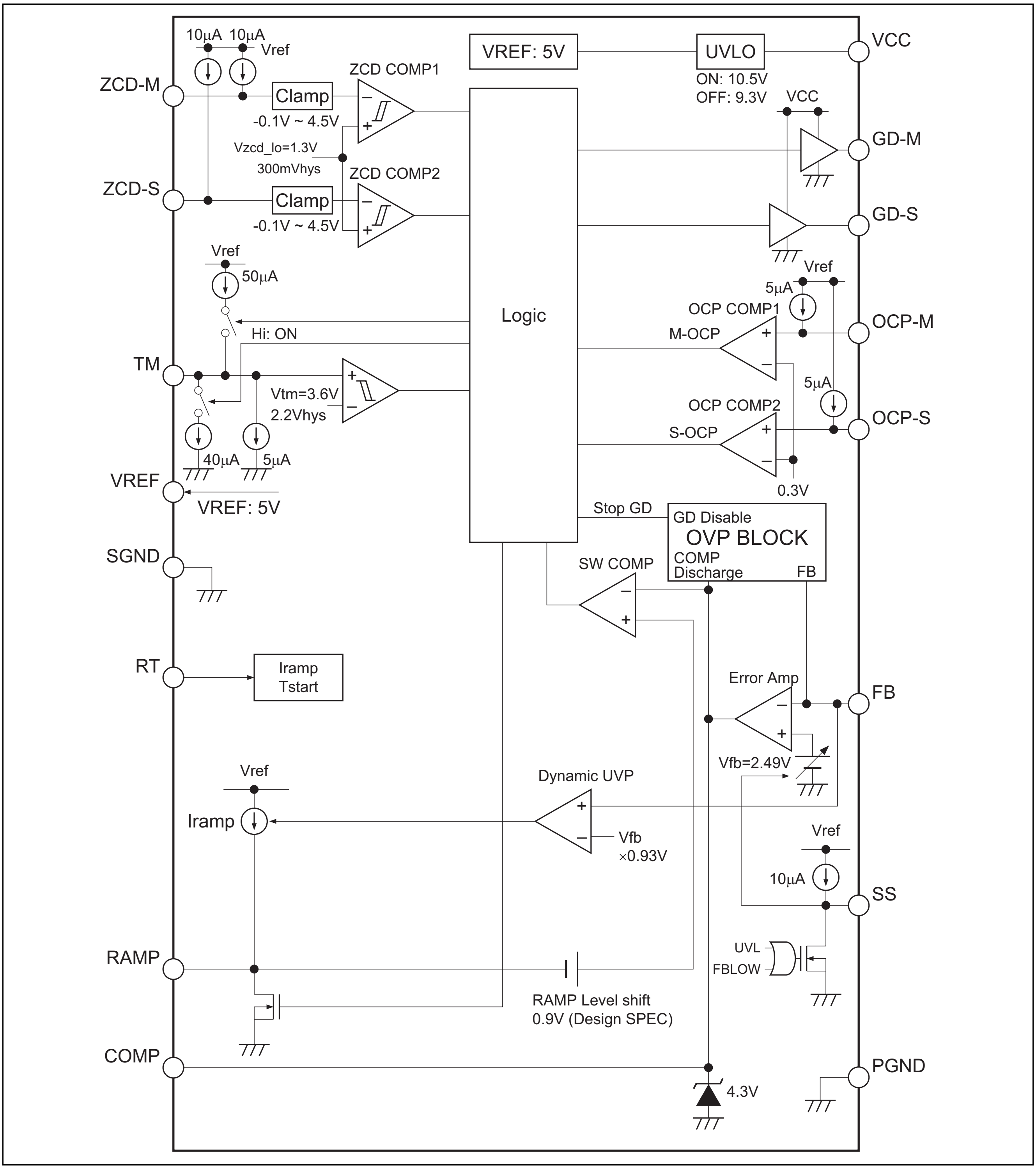


(Top view)

Pin Functions

Pin No.	Pin Name	Function
1	ZCD-M	Master converter zero current detection input terminal
2	ZCD-S	Slave converter zero current detection input terminal
3	TM	Over current ON/OFF timer protection terminal
4	VREF	Reference voltage output terminal
5	SGND	Signal Ground
6	RAMP	Ramp waveform setting terminal
7	RT	Oscillator frequency setting terminal
8	COMP	Error amplifier output terminal
9	FB	Error amplifier input terminal
10	SS	Soft start time setting terminal
11	OCP-S	Slave converter overcurrent detection terminal
12	OCP-M	Master converter overcurrent detection terminal
13	GD-S	Slave converter Power MOSFET drive terminal
14	PGND	Power Ground
15	GD-M	Master converter Power MOSFET drive terminal
16	VCC	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	
RT terminal current	Irt	–200	µA	4
Vref terminal current	Iref	–5	mA	
Vref terminal load capacitor	Cref min	1000	pF	
	Cref max	1	µF	
COMP terminal current	Icomp	±1	mA	
Terminal voltage	Vt-group1	–0.3 to Vcc	V	5
	Vt-group2	–0.3 to Vref	V	6
Vref terminal voltage	Vt-ref	–0.3 to Vref + 0.3	V	
OCP terminal voltage	Vt-ocp	*–1 to Vref	V	7
Power dissipation	Pt	1	W	8
Operating ambient temperature	Ta-opr	–40 to +125	°C	
Junction temperature	Tj	–40 to +150	°C	9
Storage temperature	Tstg	–55 to +150	°C	

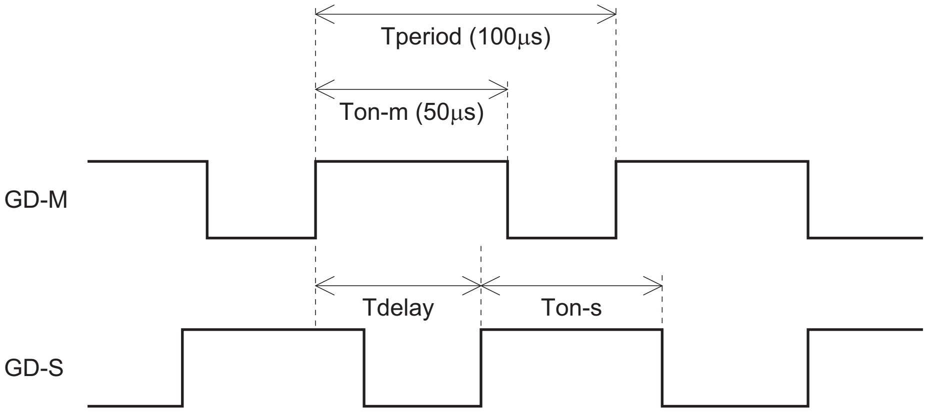
Notes:
1. Rated voltages are with reference to the PGND terminal.
2. For rated currents, inflow to the IC is indicated by (+), and outflow by (–).
3. Shows the transient current when driving a capacitive load.
4. RT terminal's resistor is fixed 33 kΩ to GND.
5. This is the rated voltage for the following pins:
   Nothing
6. This is the rated voltage for the following pins:
   FB, SS, RAMP, TM
7. Minus value is peak voltage. Do not impress the DC voltage of the minus.
8. 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%.
9. 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 = 33 kΩ, RAMP = 820 pF, TM = 2.2 µF, SS = 1.0 µF, OCP = 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	—	85	170	µA	VCC = 8.9 V
	Operating current	Icc	—	4.2	6.3	mA	
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	2.490	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	4.2	4.3	4.4	V	FB = 2.0 V
	Low voltage	Vl-comp	—	0.1	0.3	V	FB = 3.0 V
	Source current	Isrc-comp	—	–120	—	µA	FB = 1.5 V COMP = 2.5 V *1
	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 at DUVP disable condition	Ic-ramp1	–60	–50	–40	µA	FB = 2.4 V
	RAMP charge current at DUVP enable condition	Ic-ramp2	–32	–25	–18	µA	FB = 2 V
	RAMP discharge current	Id-ramp	7	15	29	mA	RAMP = 1 V
	Low voltage	Vl-ramp	—	17	200	mV	Isink = 100 µA
Slave control	Phase delay	Phase	160	180	200	deg	FB = 2.5 V, COMP = 2 V *1, 2
	On time ratio	Ton-ratio	0	—	5	%	

Notes: *1 Design spec
*2

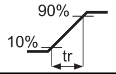
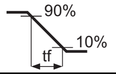


$$\text{Phase} = \frac{\text{Tdelay}}{\text{Tperiod}} \times 360\ [\text{deg}]$$

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

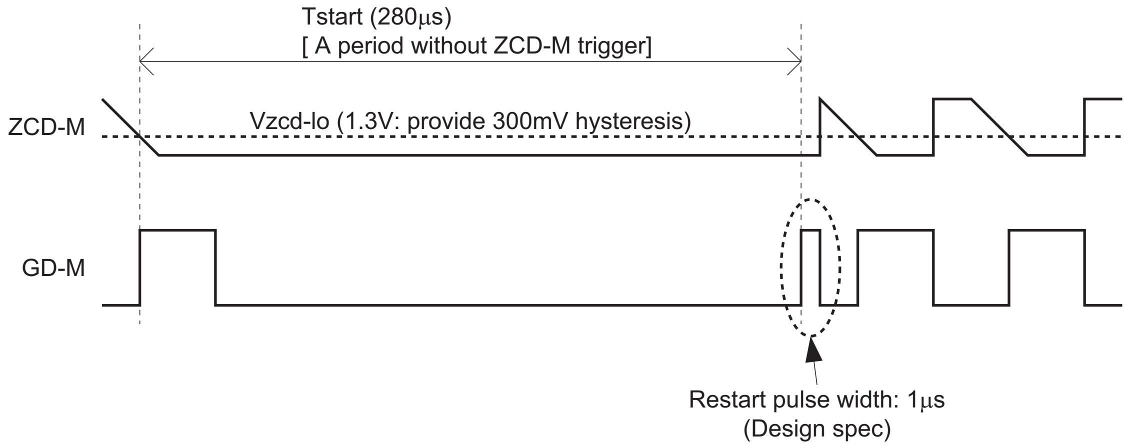
Electrical Characteristics (cont.)

(Ta = 25°C, VCC = 12 V, RT = 33 kΩ, RAMP = 820 pF, TM = 2.2 µF, SS = 1.0 µF, OCP = GND)

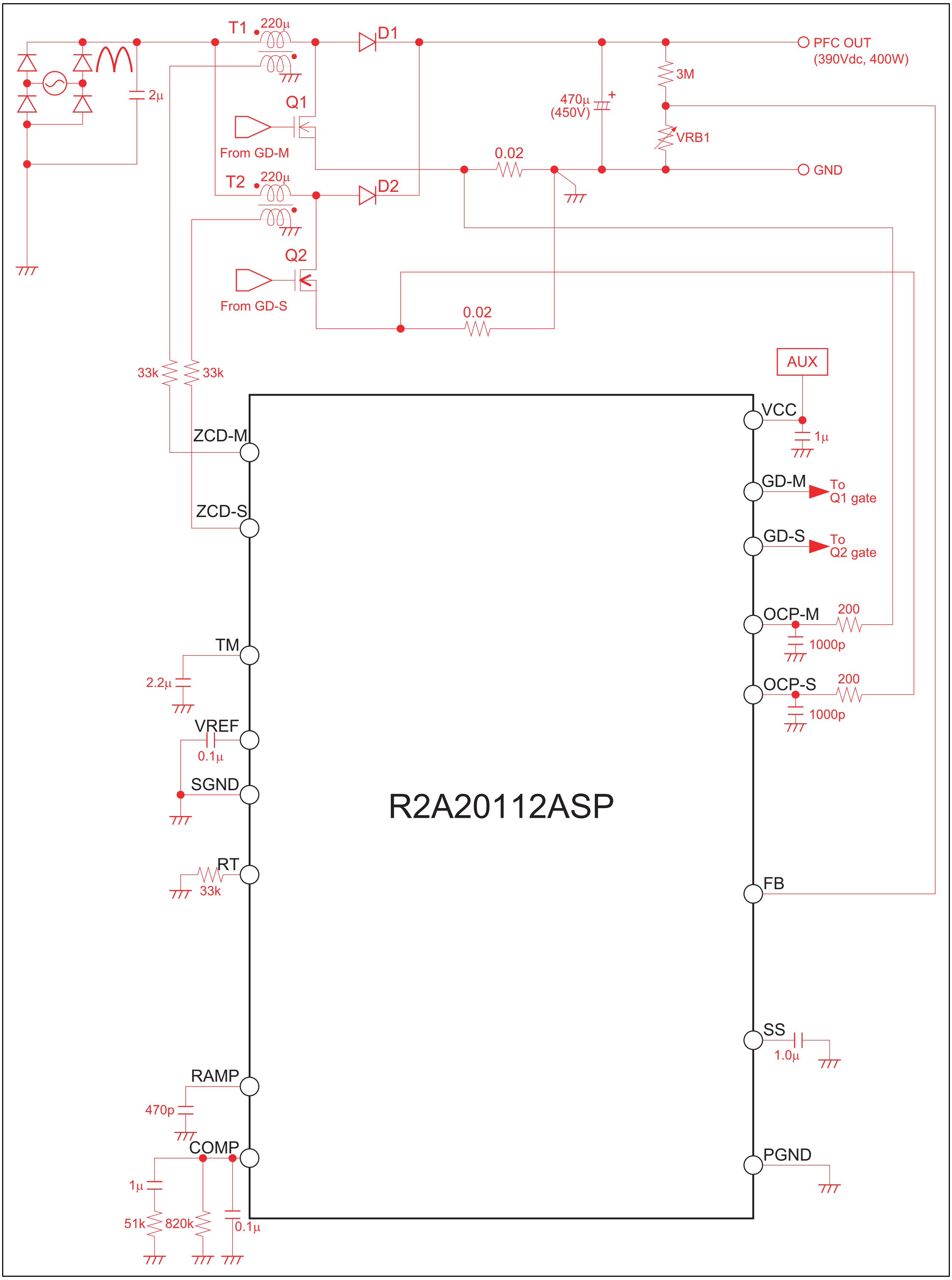
Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Gate drive (GD-M & GD-S)	Gate drive rise time	tr-gd	—	20	100	ns	FB-COMP short CL = 100 pF 
	Gate drive fall time	tf-gd	—	5	30	ns	FB-COMP short CL = 100 pF 
	Gate drive low voltage	Vol1-gd	—	0.02	0.1	V	Isink = 2 mA
		Vol2-gd	—	0.01	0.2	V	Isink = 1 mA, VCC = 5 V
	Gate drive high voltage	Voh-gd	11.5	11.9	—	V	Isource = –2 mA *1
Over current protection (OCP-M & OCP-S	OCP threshold voltage	Vocp	0.27	0.30	0.33	V	
	OCP source current	Iocp	–10	–5	–2.5	µA	OCP = 0 V
ON/OFF timer protection for Boost diode short	ON/OFF timer threshold voltage	Vtm	3.52	3.6	3.68	V	
	ON/OFF timer hysteresis	Hys-tm	2.1	2.2	2.3	V	
	Charge current	Isrc-tm	–54	–45	–36	µA	TM = 2 V, OCP-M = 1 V
	Discharge current at TM disable condition	Isnk-tm1	36	45	54	µA	TM = 2 V
	Discharge current at TM enable condition	Isnk-tm2	4.2	5	5.8	µA	TM = 5 V to 2 V
PFC output abnormality protection	Dynamic OVP threshold voltage	Vdovp	Vfb× 1.035	Vfb× 1.050	Vfb× 1.065	V	COMP = 2.5 V
	Static OVP threshold voltage	Vsovp	Vfb× 1.075	Vfb× 1.090	Vfb× 1.105	V	COMP = 2.5 V
	Static OVP hysteresis	Hys-sovp	50	100	150	mV	COMP = 2.5 V
	Dynamic UVP threshold voltage	Vduvp	—	Vfb× 0.930	Vfb× 0.950	V	COMP = 2.5 V *1
	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
Zero current detector (ZCD-M & ZCD-S)	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	300	410	mV	*1
	Input bias current	Izcd	–14	–10	–6	µA	1.2 V < Vzcd < 2.5 V
ZCD-S 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 = 3 V, FB = 1 V
Restart	Restart time delay	Tstart	210	280	350	µs	ZCD-M = 10 kΩ to GND ZCD-S = 10 kΩ to GND *2

Notes: *1 Design spec

*2



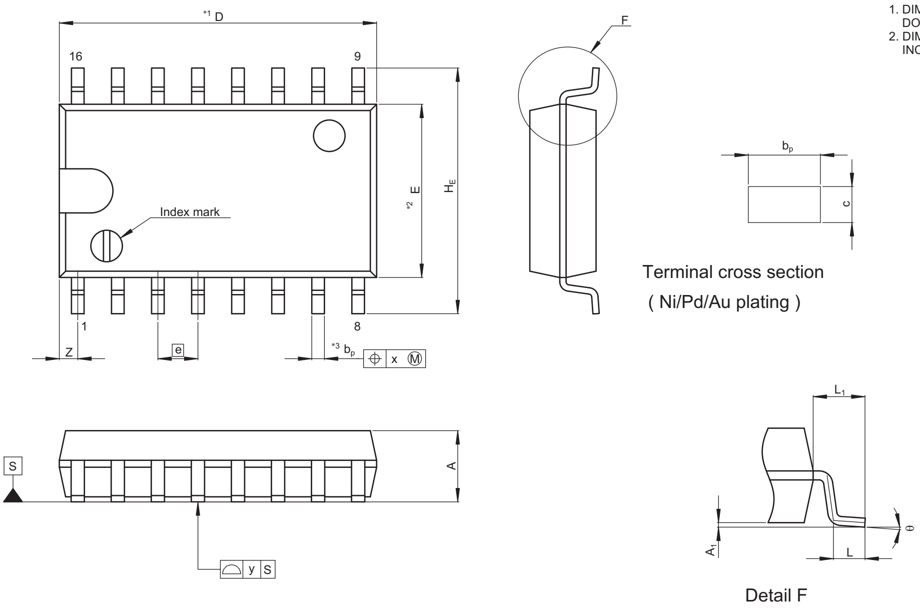
System Diagram



Package Dimensions

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

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	—	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	—

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