R2A20114 Series

Continuous Conduction Mode Interleaving PFC Control IC

R03DS0008EJ0100
Rev.1.00
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Description

R2A20114 series is a boost converter control IC with PFC (Power Factor Correction). Employing continuous conduction mode interleaving PFC, it performs higher efficiency and lower switching noise even for high power use. The control of continuous conduction mode is carried out by detecting the current in power MOSFET. The R2A20114 series supports two types of current detection methods; current detection by current transformers (R2A20104SP/FP), and that by shunt resisters (R2A20114SP/FP). So that, it can be applicable for a variety of applications. Interleaving control of the boost converters, namely, producing 180 degrees phase shift between the output signals (GD1,2) driving the boost converters, enables the system to perform high conversion efficiency and low switching noises and, at the same time, to reduces ripple currents in input and output current and then this allows use of smaller components such as boost inductors, input filters and output capacitors. R2A20114 series integrates a various kinds of protection circuits, such as the detection circuit of breaking of wire in feedback loop, two modes of over voltage protection circuits, over current protection circuit and error output circuit (*[1]), which improve the reliability of the power supply system and reduce the number of component parts on the system.

Features

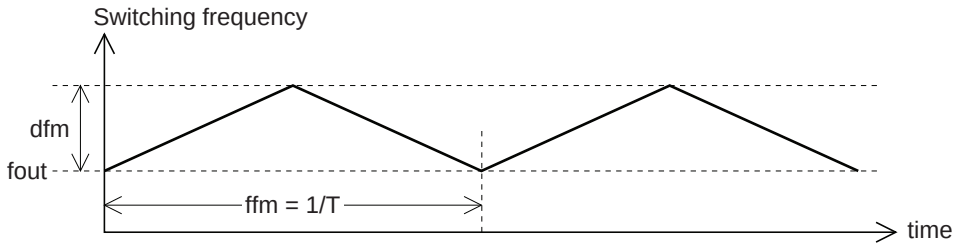
- Maximum Ratings
  - Supply voltage Vcc: 24 V
  - Operating junction temperature Tjopr: from –40 to +150 degrees centigrade
- Electrical characteristics
  - VFB feedback voltage VREF: 2.5 V ± 1.5%
  - UVLO (Undervoltage Lockout) operation start voltage VH: 10.4 V ± 0.7 V
  - UVLO operation shutdown voltage VL: 8.9 V ± 0.5 V
  - UVLO hysteresis voltage Hysuvl : 1.5 V ± 0.5 V
- Functions
  - Boost converter control with continuous conduction mode
  - Interleaving control
  - Frequency modulation (*[2])
  - Brownout
  - Phase drop (*[1])
  - External clock synchronization input
  - External clock synchronization output (*[1])
  - Two modes of over voltage protections
    Mode 1: Dynamic OVP preventing over voltage after sudden variation of load.
    Mode 2: Static OVP preventing over voltage in the period of normal operation.
  - Feedback loop wire breaking/open detector
  - Dual over voltage protection circuits (*[1]): FB and OVP2 terminals
  - Current balance control
  - Phase 1 and Phase 2 independent over current protection
  - Package line-up
    Pb-free LQFP-40 (R2A20104FP, R2A20114FP)
    Pb-free SOP-20 (R2A20104SP, R2A20114SP)

Notes: *1 Supported only by R2A20104FP and R2A20114FP
*2 Frequency modulation periods (dfm) of R2A20104SP and R2A20114SP are fixed.

The Function List of R2A20114 Series

Item		R2A20104SP	R2A20104FP	R2A20114SP	R2A20114FP
PFC control		Continuous conduction mode interleaving			
Current detection method		Current transformer		Shunt resistor	
Package		SOP-20	LQFP-40	SOP-20	LQFP-40
Protection circuits	Brownout detection	Supported	Supported	Supported	Supported
	2nd OVP	Not supported	Supported	Not supported	Supported
	Phase error	Not supported	Supported	Not supported	Supported
Noise reduction	Jitter generation (Frequency modulation)	Supported (But, frequency modulation period (dfm)(*1) is fixed)	Supported	Supported (But, frequency modulation period (dfm)(*1) is fixed)	Supported
Synchronization with external signal	Input	Supported	Supported	Supported	Supported
	Output	Not supported	Supported	Not supported	Supported
Efficiency improvement	Phase drop	Not supported	Supported	Not supported	Supported

Note: *1 Refer to the figure depicted below:

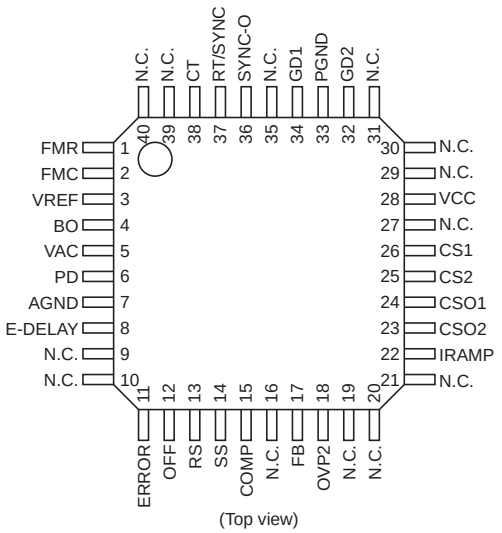


Ordering Information

Part No.	Package Name	Package Code	Package Abbreviation	Taping Abbreviation (Quantity)	Remarks
R2A20104FPW0	FP-40EV	PLQP0040JB-C	FP	W (2000 pcs/reel)	non-HF
R2A20104FPW5					HF
R2A20114FPW0					non-HF
R2A20114FPW5					HF
R2A20104SPW0	FP-20DAV	PRSP0020DD-B	SP	W (2000 pcs/reel)	non-HF
R2A20104SPW5					HF
R2A20114SPW0					non-HF
R2A20114SPW5					HF

Note: HF: Halogen-Free

Pin Arrangement of R2A20104FP and R2A20114FP

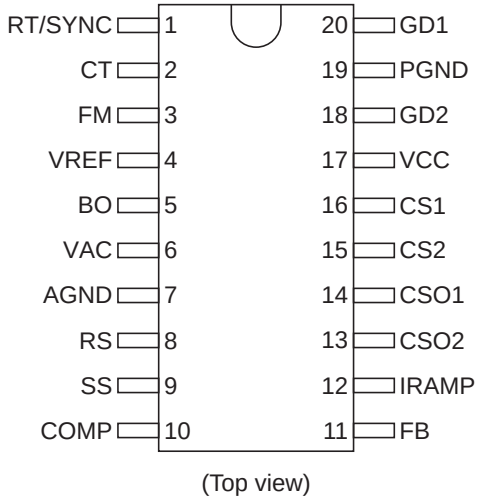


(Top view)

Pin Functions of R2A20104FP and R2A20114FP

Pin No.	Pin Name	Input/Output	Function
1	FMR	Input	Frequency modulation setting resistor connecting terminal
2	FMC	Input	Frequency modulation setting capacitor connecting terminal
3	VREF	Output	Reference voltage output terminal
4	BO	Input	Brownout input terminal
5	VAC	Input	AC voltage input terminal
6	PD	Input	Phase drop input terminal
7	AGND	—	Analog ground
8	E-DELAY	Input	Delay of the Error signal setting terminal
9, 10	N.C.	—	Open
11	ERROR	Output	Error output terminal
12	OFF	Input	Shutdown terminal (VCC Reset)
13	RS	Input	Current correction setting resistor connecting terminal
14	SS	Input	Soft start setting capacitor connecting terminal
15	COMP	Output	Error amplifier output terminal (to be phase-compensated)
16	N.C.	—	Open
17	FB	Input	Error amplifier input terminal (feedback voltage input terminal)
18	QVP2	Input	OVP2 input terminal
19-21	N.C.	—	Open
22	IRAMP	Input	Ramp waveform setting resistor connecting terminal
23	CSO2	Output	Current sense amplifier 2 output terminal (to be phase-compensated)
24	CSO1	Output	Current sense amplifier 1 output terminal (to be phase-compensated)
25	CS2	Input	Current sense 2 input terminal
26	CS1	Input	Current sense 1 input terminal
27	N.C.	—	Open
28	VCC	Input	Supply voltage terminal
29-31	N.C.	—	Open
32	GD2	Output	Converter 2 Power MOSFET drive terminal
33	PGND	—	Power ground
34	GD1	Output	Converter 1 Power MOSFET drive terminal
35	N.C.	—	Open
36	SYNC-O	Output	Synchronization signal output terminal
37	RT/SYNC	Input	Frequency setting resistor connecting terminal / Sync. Signal input terminal
38	CT	Input	Frequency setting capacitor connecting terminal
39, 40	N.C.	—	Open

Pin Arrangement of R2A20104SP and R2A20114SP

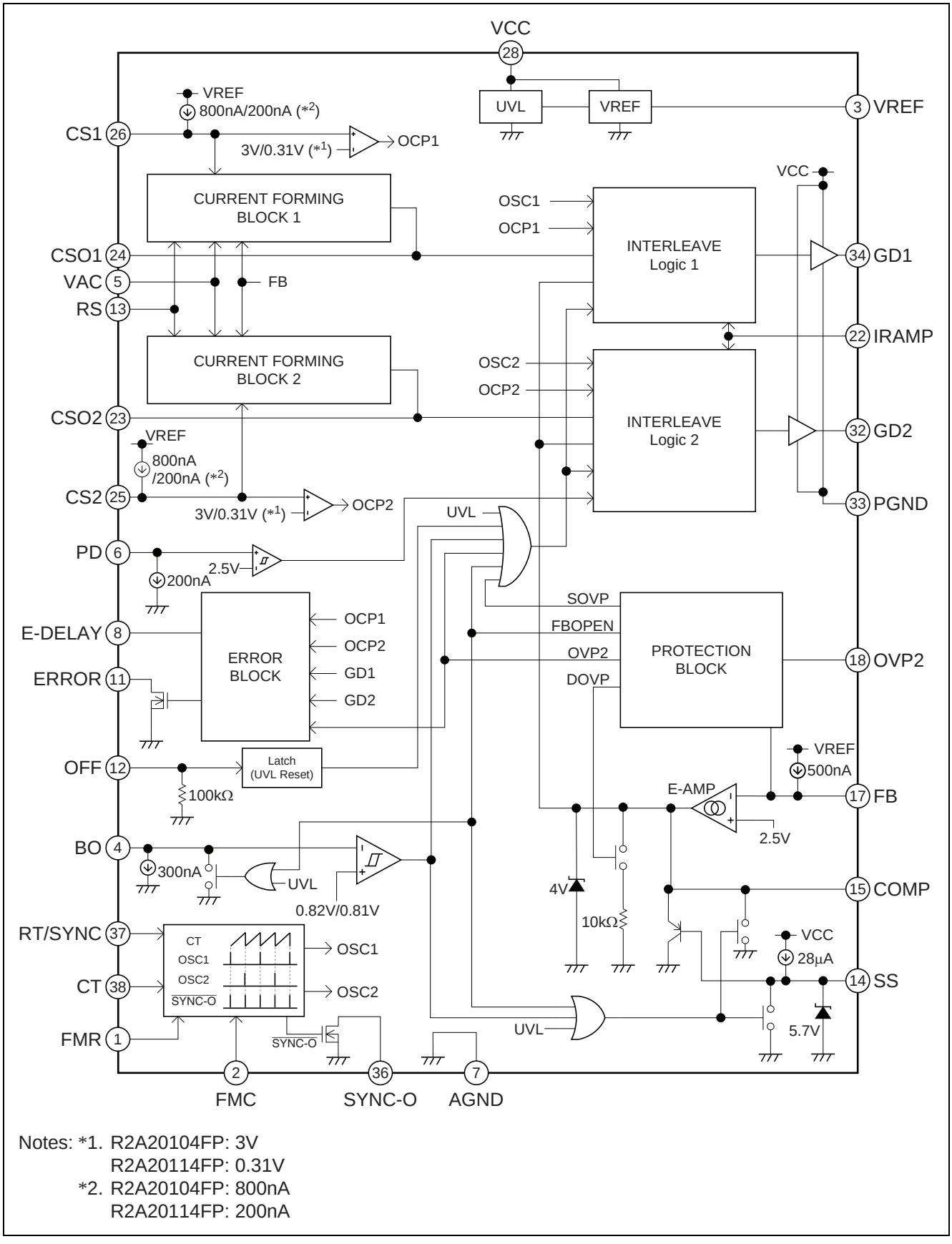


(Top view)

Pin Functions of R2A20104SP and R2A20114SP

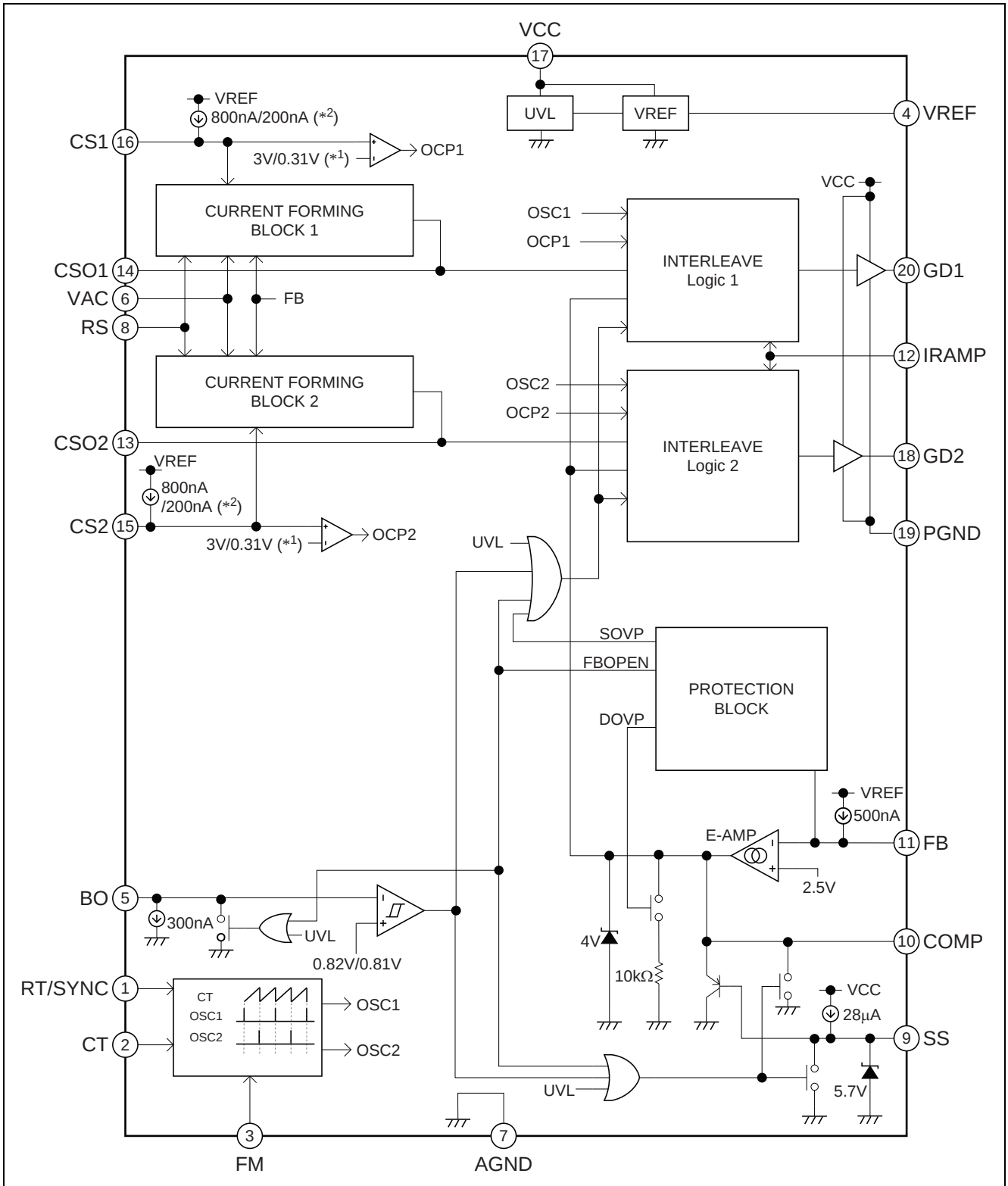
Pin No.	Pin Name	Input/Output	Function
1	RT/SYNC	Input	Frequency setting timing resistor connecting terminal / Sync. signal input terminal
2	CT	Input	Frequency setting timing capacitor connecting terminal
3	FM	Input	Frequency modulation setting timing capacitor connecting terminal
4	VREF	Output	Reference voltage output terminal
5	BO	Input	Brownout input terminal
6	VAC	Input	AC voltage input terminal
7	AGND	—	Analog ground
8	RS	Input	Current correction setting resistor connecting terminal
9	SS	Input	Soft start setting capacitor connecting terminal
10	COMP	Output	Error amplifier output terminal (to be phase-compensated)
11	FB	Input	Error amplifier input terminal (feedback voltage input terminal)
12	IRAMP	Input	Ramp waveform setting resistor connecting terminal
13	CSO2	Output	Current sense amplifier 2 output terminal (to be phase-compensated)
14	CSO1	Output	Current sense amplifier Output 1 output terminal (to be phase-compensated)
15	CS2	Input	Current sense 2 input terminal
16	CS1	Input	Current sense 1 input terminal
17	VCC	Input	Supply voltage terminal
18	GD2	Output	Converter 2 Power MOSFET drive terminal
19	PGND	—	Power ground
20	GD1	Output	Converter 1 Power MOSFET drive terminal

Block Diagram of R2A20104FP and R2A20114FP



Notes: *1. R2A20104FP: 3V
R2A20114FP: 0.31V
*2. R2A20104FP: 800nA
R2A20114FP: 200nA

Block Diagram of R2A20104SP and R2A20114SP



Notes: *1. R2A20104SP: 3V
R2A20114SP: 0.31V
*2. R2A20104SP: 800nA
R2A20114SP: 200nA

Absolute Maximum Ratings

Item		Symbol	Value	Unit	Note
Supply voltage		VCC	–0.3 to +24	V	3
GD1 and 2	Peak current	Ipk-gd1, Ipk-gd2	±1	A	3, 4
	DC current	Idc-gd1, Idc-gd2	±0.1	A	3
Vref terminal current		Iref	–5	mA	3
Terminal current		It-group	±1	mA	3, 5
RS terminal current		Irs	–500	μA	3
RT terminal current		Irt	–200	μA	3
RAMP terminal current		Iramp	–200	μA	3
BO clamp current		Ibo	300	μA	3
Terminal voltage		Vt-group	–0.3 to Vref	V	3, 6
Vref terminal voltage		Vt-ref	–0.3 to Vref+0.3	V	3
SS terminal voltage		Vt-ss	–0.3 to Vref+1	V	3
Power dissipation		Pt	1	W	3, 7
Operating junction temperature		Tj-opr	–40 to +150	°C	
Storage temperature		Tstg	–55 to +150	°C	

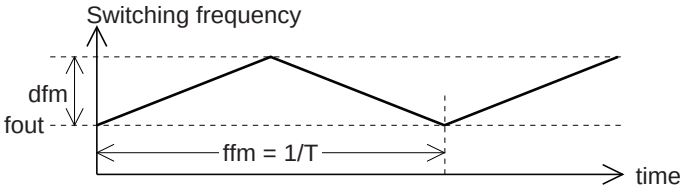
Notes:
1. Rated voltages are with reference to the AGND and PGND terminal.
2. For the direction of Rated currents, (+) denotes the current flowing into the IC, and (–) denotes the current flowing out of the IC.
3. Ambience temperature, Ta is 25 degrees centigrade.
4. Transient current when driving a capacitive load.
5. Rated currents of the terminals listed below:
   COMP, CSO1, CSO2
6. Rated voltages of the terminals listed below:
   in the case of R2A20104FP/R2A20114FP: CS1, CS2, VAC, RS, FB, PD, BO, ERROR, E-DLAY, OFF, OVP2, FMC, FMR, RT/SYNC, IRAMP, SYNC-O, CT, COMP, CSO1, CSO2
   in the case of R2A20104SP/R2A20114SP: CS1, CS2, VAC, RS, FB, BO, IRAMP, FM, RT/SYNC, CT, COMP, CSO1, CSO2
7. Thermal resistor
   in the case of R2A20104FP/R2A20114FP: θja = 85.3 degrees centigrade/W
   in the case of R2A20104SP/R2A20114SP: θja = 120 degrees centigrade/W
   These values are obtained under the condition that the IC is mounted on the glass epoxy board, of which size is 50 × 50 × 1.6 [mm] and wiring density is 10%.

Electrical Characteristics

(Ta = 25°C, VCC = 12 V, CT = 1000 pF, RT = 27 kΩ, CS1, CS2 = GND, IRAMP = 10 kΩ, BO = 1 V, VAC = 0 V, RS = 220 kΩ, FMC = GND (*1), FM = GND (*2), FB = COMP)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Supply	UVLO turn-on threshold	Vuvlh	9.7	10.4	11.1	V	
	UVLO turn-off threshold	Vuvll	8.4	8.9	9.4	V	
	UVLO hysteresis	Hysuvl	1.0	1.5	2.0	V	
	Standby current	Istby	—	100	160	μA	VCC = 8.9 V
	Operating current	Icc	—	5	7.5	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 (*3)
Error amplifier	Feedback voltage	Vfb	2.462	2.500	2.538	V	FB-COMP Short
	Input bias current	Ifb	–0.8	–0.5	–0.2	μA	Measured pin: FB
	Open loop gain	Av	—	40	—	dB	(*3)
	Upper clamp voltage	Vclamp-comp	3.8	4.0	4.3	V	FB = 2.0 V, COMP: Open
	Low voltage	Vl-comp	0.0	0.1	0.3	V	FB = 3.0 V, COMP: Open
	Source current	Isrc-comp	–190	–135	–80	μA	FB = 1.5 V, COMP = 2.5 V
	Sink current 1	Isnk-comp1	—	120	—	μA	(*3)
	Sink current 2	Isnk-comp2	220	320	420	μA	FB =3.5 V, COMP = 2.5 V
	Transconductance	gm	120	200	290	μs	FB = 2.45 V ↔ 2.55 V, COMP = 2.5 V
Brownout	PFC enable voltage	Von-pfc	0.74	0.82	0.9	V	Input pin: BO
	PFC disable voltage	Voff-pfc	0.73	0.81	0.89	V	Input pin: BO
Oscillator	Initial accuracy	fout	70	78	86	kHz	Measured pin: OUT, FMC = 0 V
	fout temperature stability	dfout/dTa	—	±0.1	—	%/°C	Ta = –40 to 125°C (*3)
	fout voltage stability	fout-line	–1.5	0.5	1.5	%	VCC = 12 V to 18 V
	CT top voltage	Vct-H	—	3.6	4.0	V	(*3)
	RT voltage	Vrt	1.15	1.25	1.35	V	
	FMC sink current (*1)/ FM sink current (*2)	Isnk-fmc (*1)/ Isnk-fm (*2)	6	11	16	μA	FMC = 1 V (*1)/ FM = 1 V (*2)
	FMC source current (*1)/ FM source current (*2)	Iso-fmc (*1)/ Iso-fm (*2)	–16.5	–11.5	–6.5	μA	FMC = 1 V (*1)/ FM = 1 V (*2)
	FM magnitude change	dfm	19	24	29	kHz	FMC = 5 V (*1)/FM = 5 V (*2) (*3, *4)
	FM frequency 1 (*1)	ffm1	0.25	0.38	0.5	kHz	FMC = 6.8 nF, FMR = 4 V (*4)
	FM frequency 2 (*1)	ffm2	14	25	35	kHz	FM = 220 pF, FMR = 1.2 V (*4)
	FM frequency (*2)	ffm	6	10	14	kHz	FMC = 220 pF (*4)

Notes: *1 Applied to R2A20104FP, R2A20114FP
*2 Applied to R2A20104SP, R2A20114SP
*3 Design Specification (Reference data)
*4 Refer to the figure shown below:



Electrical Characteristics (cont.)

(Ta = 25°C, VCC = 12 V, CT = 1000 pF, RT = 27 kΩ, CS1, CS2 = GND, IRAMP = 10 kΩ, BO = 1 V, VAC = 0 V, RS = 220 kΩ, FMC = GND (*1), FM = GND (*2), FB = COMP)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Synchroni-zation	SYNC threshold voltage (rising)	Vsync	2.0	2.5	3.0	V	
	SYNC Min. pulse	Psync	2	—	—	µs	
	SYNC-OUT shunt current (*1)	Isync-s	5.0	—	—	mA	
	SYNC-OUT leakage current (*1)	Isync-l	—	—	1.0	µA	
Current slope	RS output voltage 1	Vrs1	0.56	0.65	0.74	V	VAC = 0 V, VFB = 2.5 V
	RS output voltage 2	Vrs2	0.04	0.14	0.26	V	VAC = 2.5 V, VFB = 0 V
	VAC bias current	Ivac	–0.4	–0.2	–0.05	µA	Measured pin: VAC
Soft start	Source current	Iss	–40	–28	–16	µA	SS = 2 V
Phase drop	Phase drop threshold voltage (*1)	Vpd	2.4	2.5	2.6	V	
	Phase drop hysteresis (*1)	Hya-pd	150	200	250	mV	
	PD bias current (*1)	Ipd	0.05	0.2	0.5	µA	Measured pin: PD
AMP1, 2	CSO offset voltage1 (*5)	Voffset	0.68	0.88	1.0	V	Vcs = 0 V
	CSO offset voltage1 (*6)	Voffset	0.54	0.74	0.86	V	Vcs = 0 V
	CSO offset voltage2	Vcaoh	2.83	3	3.17	V	Vcs = 0.24 V (*5), Vcs = 2.3 V (*6)
	CS Bias current (*5)	Ics-r	–0.4	–0.2	–0.05	µA	Measured pin: CS1, 2
	CS Bias current (*6)	Ics-ct	–1.1	–0.8	–0.5	µA	Measured pin: CS1, 2
Gate drive 1, 2	Gate drive rise time	tr-gd	—	30	100	ns	CL = 500 pF
	Gate drive fall time	tf-gd	—	30	100	ns	CL = 500 pF
	Gate drive low voltage	Vol1-gd	—	0.05	0.2	V	Isink = 10 mA
		Vol2-gd	—	1	1.25	V	Isink = 0.25 mA, VCC = 5 V
	Gate drive high voltage	Voh-gd	11.5	11.9	—	V	Isource = –10 mA
	Minimum duty cycle	Dmin-out	—	—	0	%	
	Maximum duty cycle	Dmax-out	90	95	98	%	
Over voltage protection	Dynamic OVP Threshold voltage	Vdovp	VFB× 1.025	VFB× 1.040	VFB× 1.055	V	
	Static OVP Threshold voltage	Vsovp	VFB× 1.065	VFB× 1.080	VFB× 1.095	V	COMP = OPEN
	Static OVP Hysteresis	Hys-sovp	30	80	130	mV	COMP = OPEN
	OVP2 Threshold voltage (*1)	Vovp2	VFB× 1.065	VFB× 1.080	VFB× 1.095	µA	
	OVP2 Hysteresis (*1)	Hys-ovp2	30	80	130	mV	COMP = OPEN
	OVP2 Bias current (*1)	Iovp2	–0.5	–0.3	–0.05	µA	Measured pin: OVP2
	FB Open Detect Threshold voltage	Vfbopen	0.45	0.5	0.55	V	
	FB Open Detect hysteresis	Vfbopen	0.16	0.2	0.24	V	
Over current protection	OCP Threshold voltage (*5)	VCL	0.28	0.31	0.34	V	
	OCP Threshold voltage (*6)	VCL	2.9	3	3.1	V	
	Delay to output	td-CL	—	100	250	ns	

Notes: *1 Applied to R2A20104FP, R2A20114FP
*2 Applied to R2A20104SP, R2A20114SP
*5 Applied to R2A20114FP, R2A20114SP
*6 Applied to R2A20104FP, R2A20104SP

Electrical Characteristics (cont.)

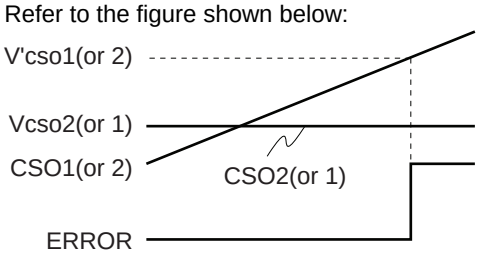
(Ta = 25°C, VCC = 12 V, CT = 1000 pF, RT = 27 kΩ, CS1, CS2 = GND, IRAMP = 10 kΩ, BO = 1 V, VAC = 0 V, RS = 220 kΩ, FMC = GND (*1), FM = GND (*2), FB = COMP)

Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Error signal	ERROR shunt current (*1)	Ierror-s	5.0	—	—	mA	
	ERROR leakage current (*1)	Ierror-l	—	—	1.0	μA	
	Phase error detect point	Perror	1.1	1.35	1.6	—	Vcso1 or 2 = 2.5 V, Vcso2 or 1: sweep (*7)
	OFF threshold voltage (*1)	Voff	3.3	4.0	4.7	V	
	E-DELAY charge current (*1)	Ied-c	–55	–36	–20	μA	
	E-DELAY discharge current (*1)	Ied-d	20	36	55	μA	
	E-DELAY threshold voltage (*1)	Vdelay	2.35	2.45	2.55	V	

Notes: *1 Applied to R2A20104FP, R2A20114FP

*2 Applied to R2A20104SP, R2A20114SP

*7 Refer to the figure shown below:

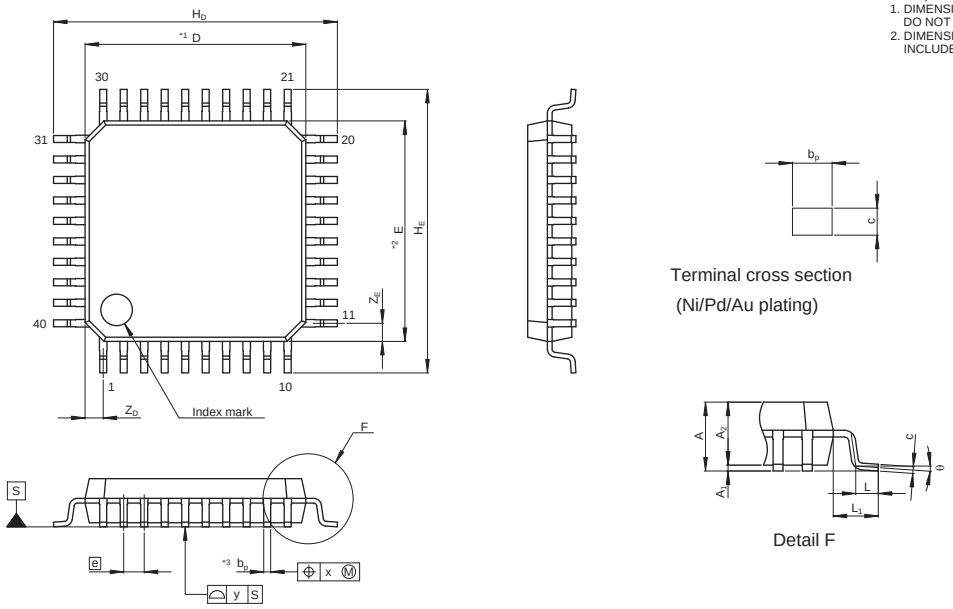


$$Perror = \frac{V'cso1(or\ 2)[V] - 0.55[V]}{Vcso2(or\ 1)[V] - 0.55[V]}$$

Package Dimensions

- R2A20104FP and R2A20114FP

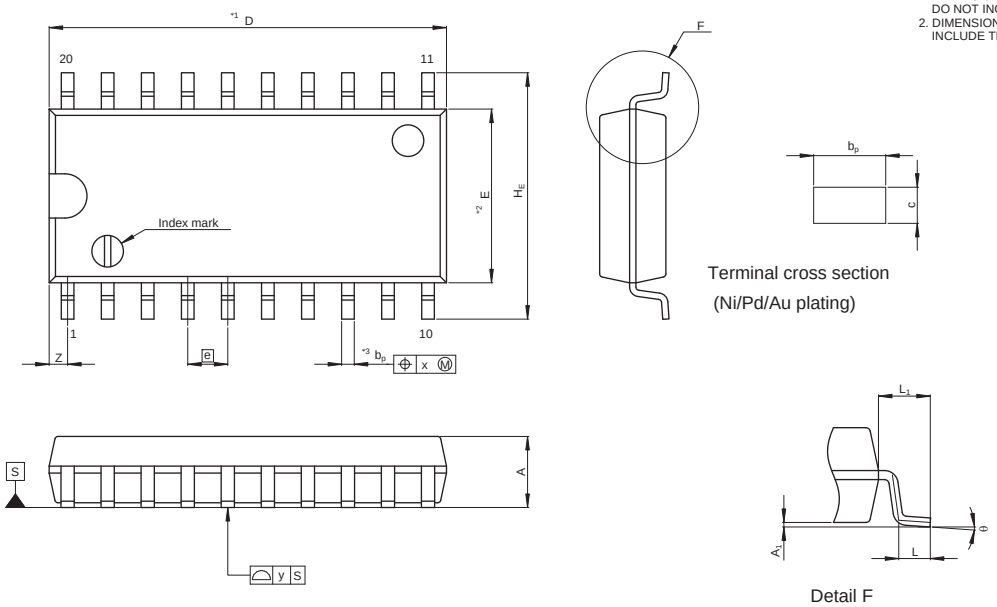
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LQFP40-7x7-0.65	PLQP0040JB-C	FP-40EV	0.2g



Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	—	7.0	—
E	—	7.0	—
A_2	—	1.40	—
H_D	8.8	9.0	9.2
H_E	8.8	9.0	9.2
A	—	—	1.70
A_1	0.08	0.13	0.22
b_p	0.17	0.22	0.27
b_1	—	—	—
c	0.10	0.15	0.20
c_1	—	—	—
θ	0°	—	8°
e	—	0.65	—
x	—	—	0.13
y	—	—	0.10
Z_D	—	0.575	—
Z_E	—	0.575	—
L	0.40	0.50	0.60
L_1	—	1.0	—

- R2A20104FP and R2A20114FP

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



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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