

R2A20114AFP/ASP

Continuous Conduction Mode Interleaving PFC Control IC

R03DS0051EJ0201
Rev.2.01
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Description

R2A20114AFP/ASP 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. 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 reduce ripple currents in input and output current and then this allows use of smaller components such as boost inductors, input filters and output capacitors.

R2A20114AFP/ASP 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
 - Junction temperature Tj: from -40 to +150 degrees centigrade
- Electrical characteristics
 - VFB feedback voltage VREF: 2.5 V $\pm$ 1.5%
 - UVLO (Undervoltage Lockout) operation start voltage VH: 10.4 V $\pm$ 0.7 V
 - UVLO operation shutdown voltage VL: 8.9 V $\pm$ 0.5 V
 - UVLO hysteresis voltage Hysuvtl : 1.5 V $\pm$ 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 (R2A20114AFP)
 - Pb-free SOP-20 (R2A20114ASP)

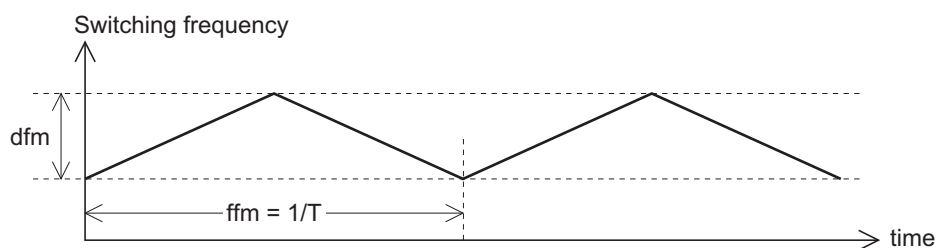
Notes: *1 Supported only by R2A20114AFP

*2 Frequency modulation periods (dfm) of R2A20114ASP are fixed.

The Function List of R2A20114AFP/ASP

Item		R2A20114ASP	R2A20114AFP
PFC control		Continuous conduction mode interleaving	
Current detection method		Shunt resistor	
Package		SOP-20	LQFP-40
Protection circuits	Brownout detection	Supported	Supported
	2nd OVP	Not supported	Supported
	Phase error	Not supported	Supported
Noise reduction	Jitter generation (Frequency modulation)	Supported (But, frequency modulation period (ffm)(^{*1}) is fixed)	Supported
Synchronization with external signal	Input	Supported	Supported
	Output	Not supported	Supported
Efficiency improvement	Phase drop	Not supported	Supported

Note: ^{*1} Refer to the figure depicted below:

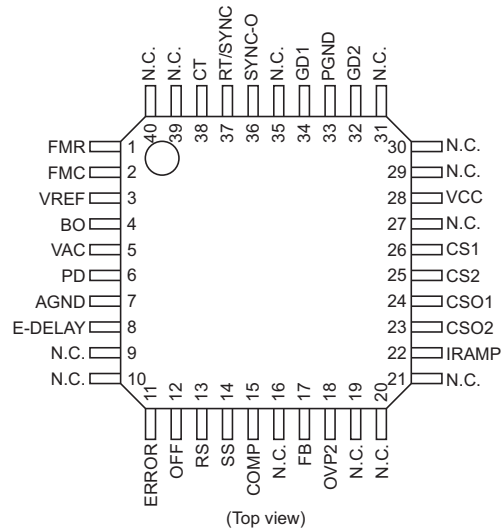


Ordering Information

Part No.	Package Name	Package Code	Package Abbreviation	Taping Abbreviation (Quantity)	Remarks
R2A20114AFPW0	FP-40EV	PLQP0040JB-C	FP	W (2000 pcs/reel)	non-HF
R2A20114AFPW5					HF
R2A20114ASPW0	FP-20DAV	PRSP0020DD-B	SP	W (2000 pcs/reel)	non-HF
R2A20114ASPW5					HF

Note: HF: Halogen-Free

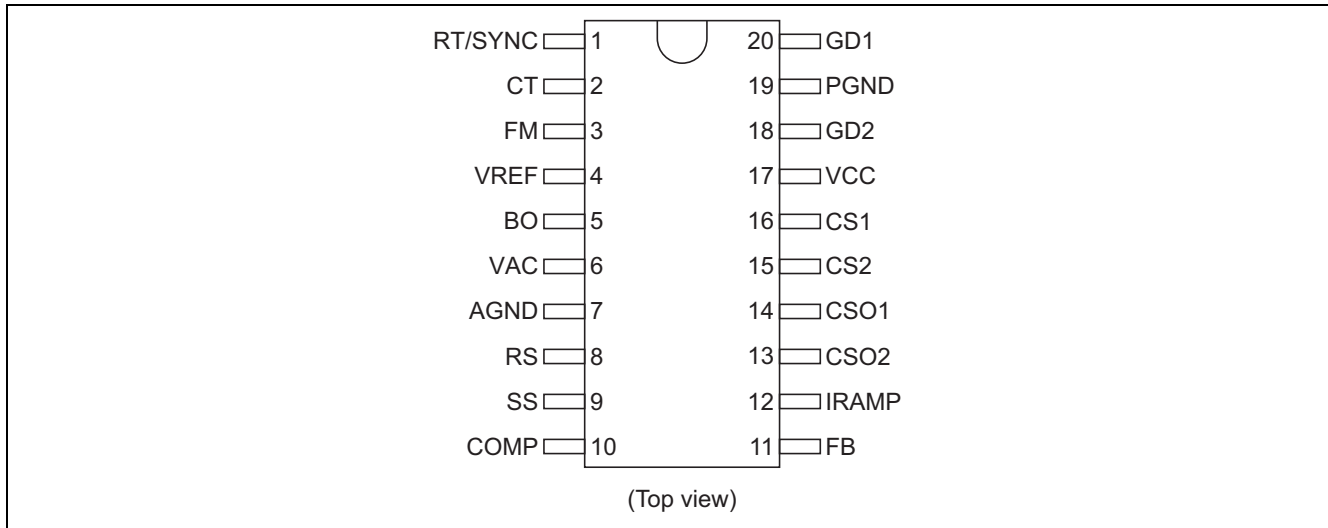
Pin Arrangement of R2A20114AFP



Pin Functions of R2A20114AFP

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

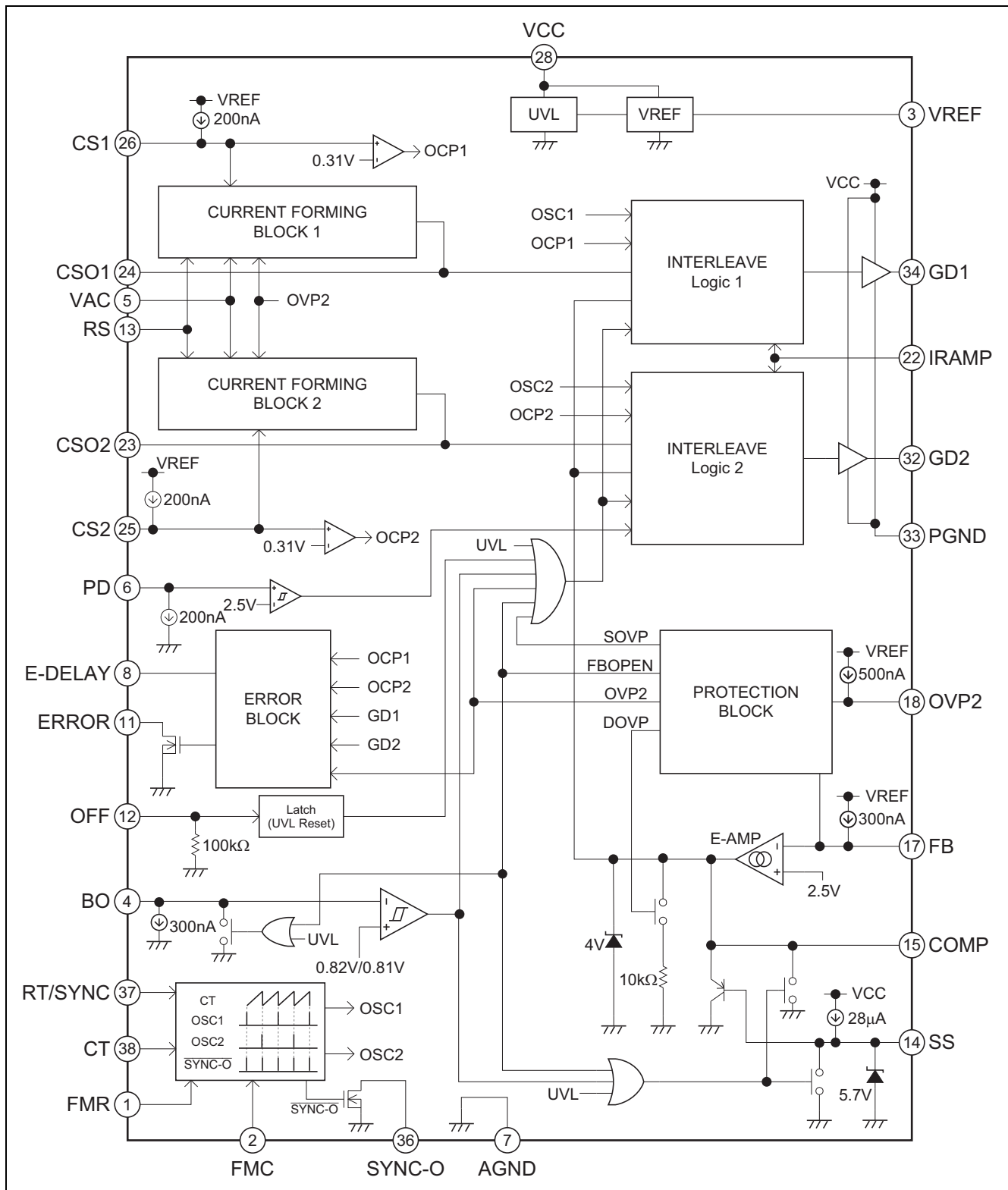
Pin Arrangement of R2A20114ASP



Pin Functions of R2A20114ASP

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

Block Diagram of R2A20114AFP



Absolute Maximum Ratings

Item		Symbol	Value	Unit	Note
Supply voltage		VCC	−0.3 to +24	V	3
GD1 and 2	Peak current	I _{pk-gd1} , I _{pk-gd2}	±1	A	3, 4
	DC current	I _{dc-gd1} , I _{dc-gd2}	±0.1	A	3
Vref terminal current		I _{ref}	−5	mA	3
Terminal current		I _{t-group}	±1	mA	3, 5
RS terminal current		I _{rs}	−500	μA	3
RT terminal current		I _{rt}	−200	μA	3
IRAMP terminal current		I _{ramp}	−200	μA	3
BO clamp current		I _{bo}	300	μA	3
Terminal voltage		V _{t-group}	−0.3 to V _{ref}	V	3, 6
Vref terminal voltage		V _{t-ref}	−0.3 to V _{ref} +0.3	V	3
SS terminal voltage		V _{t-ss}	−0.3 to V _{ref} +1	V	3
Power dissipation		P _t	1	W	3, 7
Operating ambient temperature		T _{a-opr}	−40 to +125	°C	
Junction temperature		T _j	−40 to +150	°C	8
Storage temperature		T _{stg}	−55 to +150	°C	

- Notes:
- Rated voltages are with reference to the AGND and PGND terminal.
 - For the direction of Rated currents, (+) denotes the current flowing into the IC, and (−) denotes the current flowing out of the IC.
 - Ambience temperature, T_a is 25 degrees centigrade.
 - Transient current when driving a capacitive load.
 - Rated currents of the terminals listed below:
COMP, CSO1, CSO2
 - Rated voltages of the terminals listed below:
in the case of R2A20114AFP: 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 R2A20114ASP: CS1, CS2, VAC, RS, FB, BO, IRAMP, FM, RT/SYNC, CT, COMP, CSO1, CSO2
 - Thermal resistor
in the case of R2A20114AFP: θ_{ja} = 85.3 degrees centigrade/W
in the case of R2A20114ASP: θ_{ja} = 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%.
 - 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, 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)

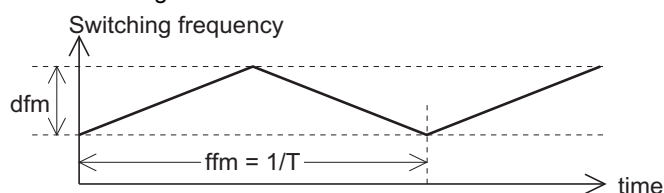
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Supply	UVLO turn-on threshold	Vuvlh	9.7	10.4	11.1	V
	UVLO turn-off threshold	Vuvll	8.4	8.9	9.4	V
	UVLO hysteresis	Hysuvl	1.0	1.5	2.0	V
	Standby current	Istby	—	100	160	μA
	Operating current	Icc	—	5	7.5	mA
VREF	Output voltage	Vref	4.85	5.00	5.15	V
	Line regulation	Vref-line	—	5	20	mV
	Load regulation	Vref-load	—	5	20	mV
	Temperature stability	dVref	—	±80	—	ppm/°C
Error amplifier	Feedback voltage	Vfb	2.462	2.500	2.538	V
	Input bias current (*1)	Ifb	−0.5	−0.3	−0.05	μA
	Input bias current (*2)	Ifb	−1.3	−0.8	−0.25	μA
	Open loop gain	Av	—	40	—	dB
	Upper clamp voltage	Vclamp-comp	3.8	4.0	4.3	V
	Low voltage	VL-comp	0.0	0.1	0.3	V
	Source current	Isrc-comp	−190	−135	−80	μA
	Sink current 1	I _{snk-comp1}	—	120	—	μA
	Sink current 2	I _{snk-comp2}	220	320	420	μA
	Transconductance	gm	120	200	290	μs
Brownout	PFC enable voltage	Von-pfc	0.74	0.82	0.9	V
	PFC disable voltage	Voff-pfc	0.73	0.81	0.89	V
Oscillator	Initial accuracy	fout	70	78	86	kHz
	fout temperature stability	dfout/dTa	—	±0.1	—	%/°C
	fout voltage stability	fout-line	−1.5	0.5	1.5	%
	CT top voltage	Vct-H	—	3.6	4.0	V
	RT voltage	Vrt	1.15	1.25	1.35	V
	FMC sink current (*1)/ FM sink current (*2)	I _{snk-fmc} (*1)/ I _{snk-fm} (*2)	6	11	16	μA
	FMC source current (*1)/ FM source current (*2)	I _{so-fmc} (*1)/ I _{so-fm} (*2)	−16.5	−11.5	−6.5	μA
	FM magnitude change	dfm	19	24	29	kHz
	FM frequency 1 (*1)	ffm1	0.25	0.38	0.5	kHz
	FM frequency 2 (*1)	ffm2	14	25	35	kHz
	FM frequency (*2)	ffm	6	10	14	kHz

Notes: *1 Applied to R2A20114AFP

*2 Applied to R2A20114ASP

*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	0.42	0.51	0.6	V
	RS output voltage 2	Vrs2	−0.1	0	0.1	V
	VAC bias current	Ivac	−0.8	−0.5	−0.2	μA
Soft start	Source current	Iss	−40	−28	−16	μA
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
AMP1, 2	CSO offset voltage1	Voffset	0.68	0.88	1.0	V
	CSO offset voltage2	Vcaoh	2.83	3	3.17	V
	CS Bias current	Ics-r	−0.4	−0.2	−0.05	μA
Gate drive 1, 2	Gate drive rise time	tr-gd	—	30	100	ns
	Gate drive fall time	tf-gd	—	30	100	ns
	Gate drive low voltage	Vol1-gd	—	0.05	0.2	V
		Vol2-gd	—	1	1.25	V
	Gate drive high voltage	Voh-gd	11.5	11.9	—	V
	Minimum duty cycle	Dmin-out	—	—	0	%
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
	Static OVP Hysteresis	Hys-sovp	30	80	130	mV
	OVP2 Threshold voltage (*1)	Vovp2	VFB× 1.065	VFB× 1.080	VFB× 1.095	μA
	OVP2 Hysteresis (*1)	Hys-ovp2	30	80	130	mV
	OVP2 Bias current (*1)	Iovp2	−0.8	−0.5	−0.2	μA
	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 (*1)	VCL	0.28	0.31	0.34	V
	Delay to output	td-CL	—	100	250	ns

Notes: *1 Applied to R2A20114AFP

*2 Applied to R2A20114ASP

Electrical Characteristics (cont.)

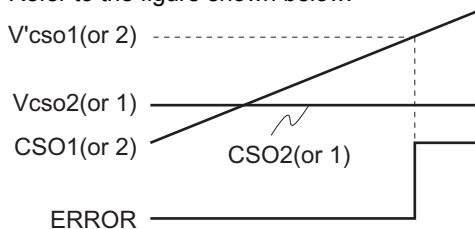
(Ta = 25°C, VCC = 12 V, CT = 1000 pF, RT = 27 kΩ, CS1, CS2 = GND, IRAMP = 10 kΩ, BO = 1 V, VAC = 0 V, RS = 220 kΩ, FMC = GND (*1), FM = GND (*2), FB = COMP)

	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 (*5)
	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 R2A20114AFP

*2 Applied to R2A20114ASP

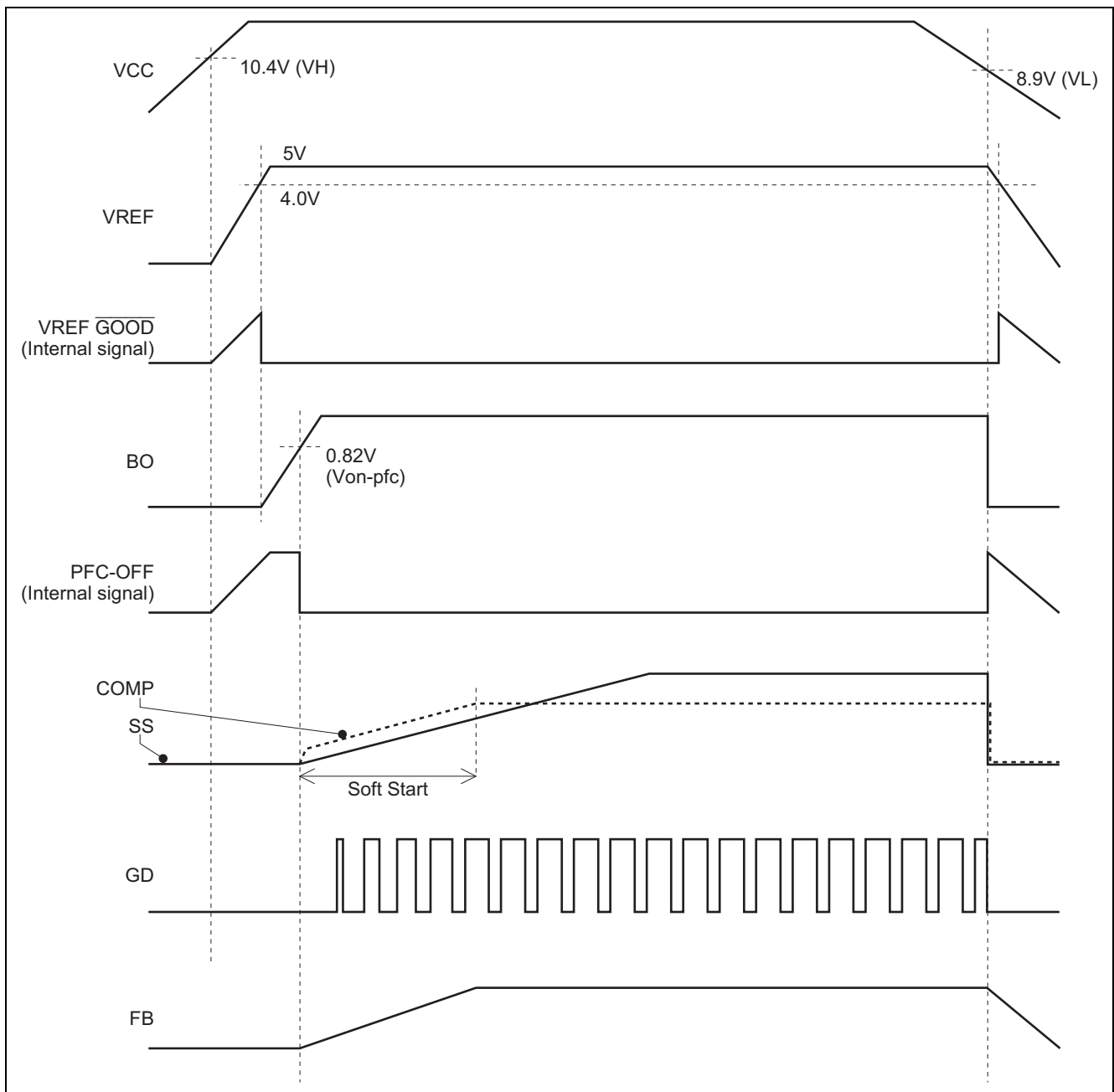
*5 Refer to the figure shown below:



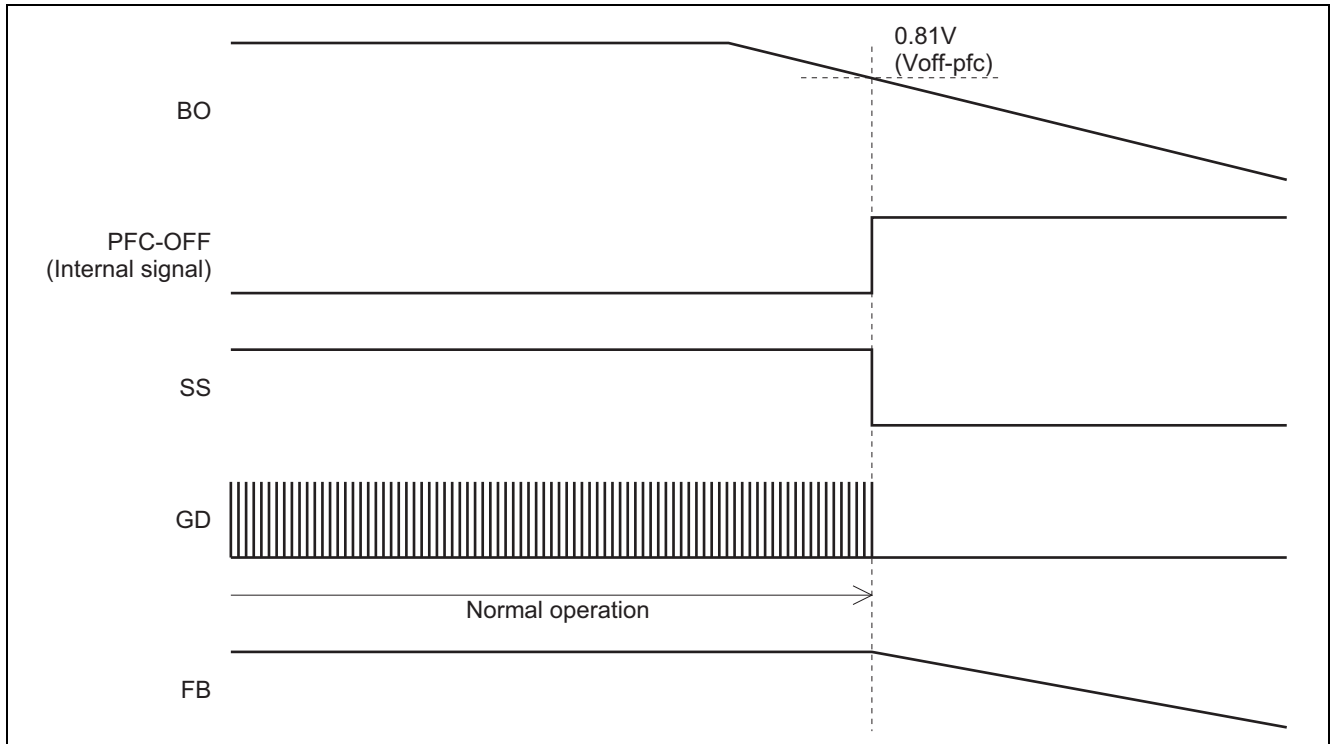
$$P_{\text{error}} = \frac{V'_{\text{cso1(or 2)}}[\text{V}] - 0.55[\text{V}]}{V_{\text{cso2(or 1)}}[\text{V}] - 0.55[\text{V}]}$$

Timing Chart

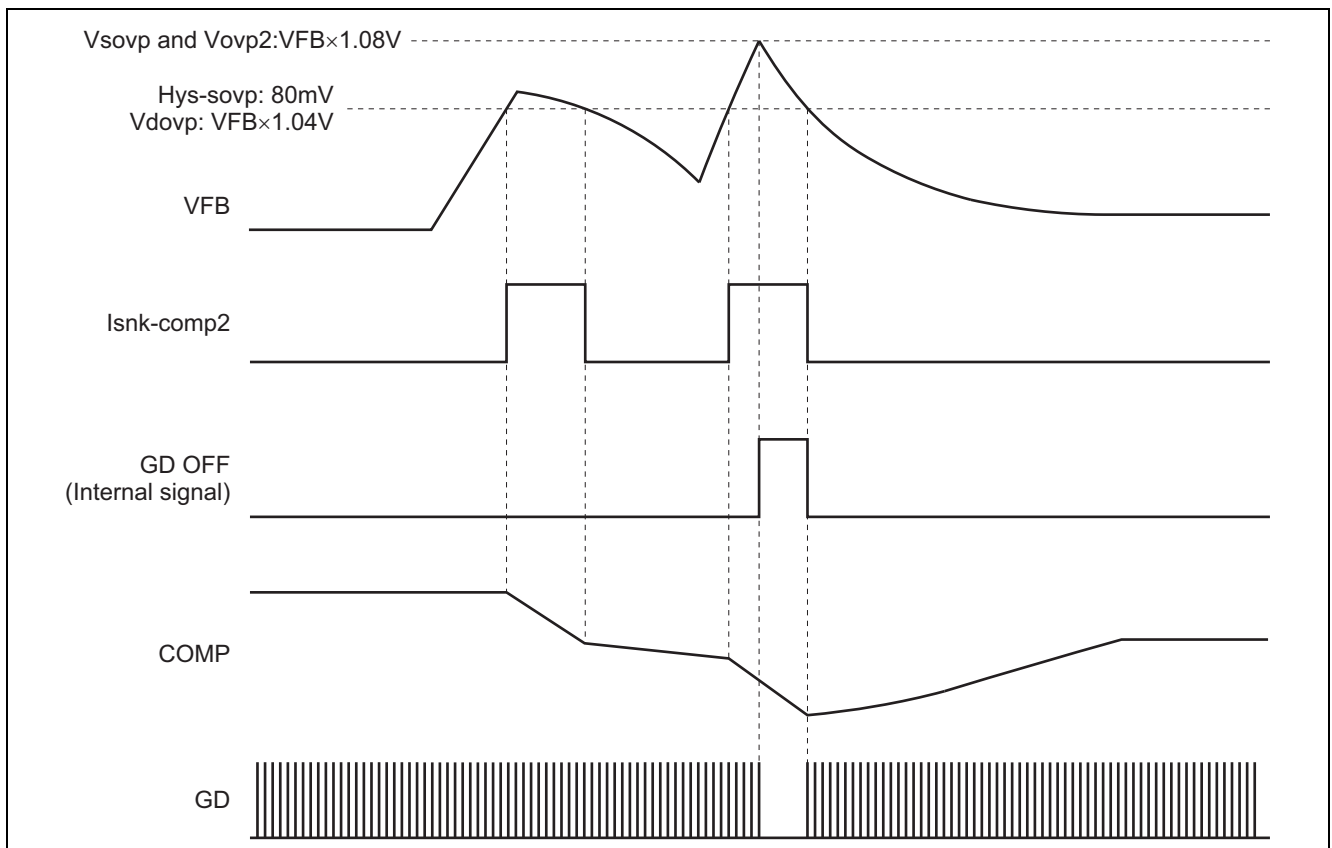
1. Vcc Start-up and Stop Timing



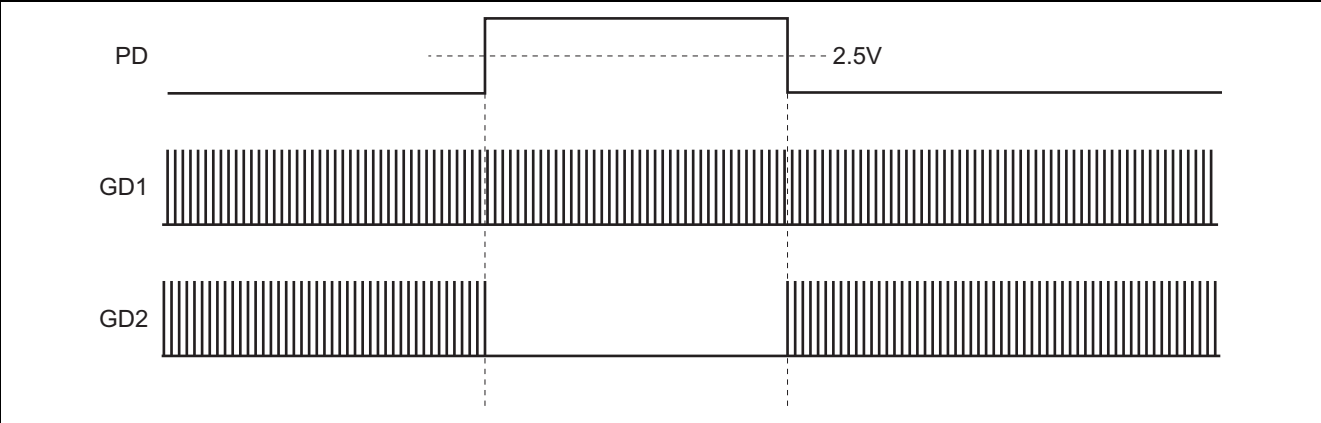
2. Stop Timing



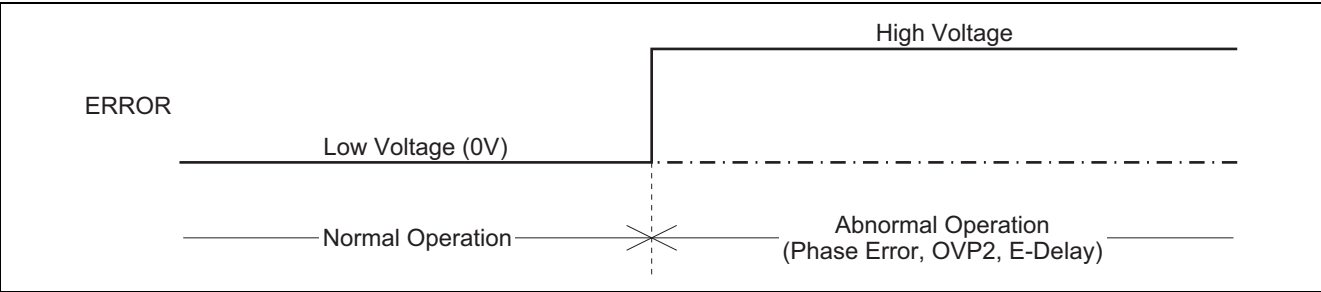
3. Overvoltage Protection (OVP)



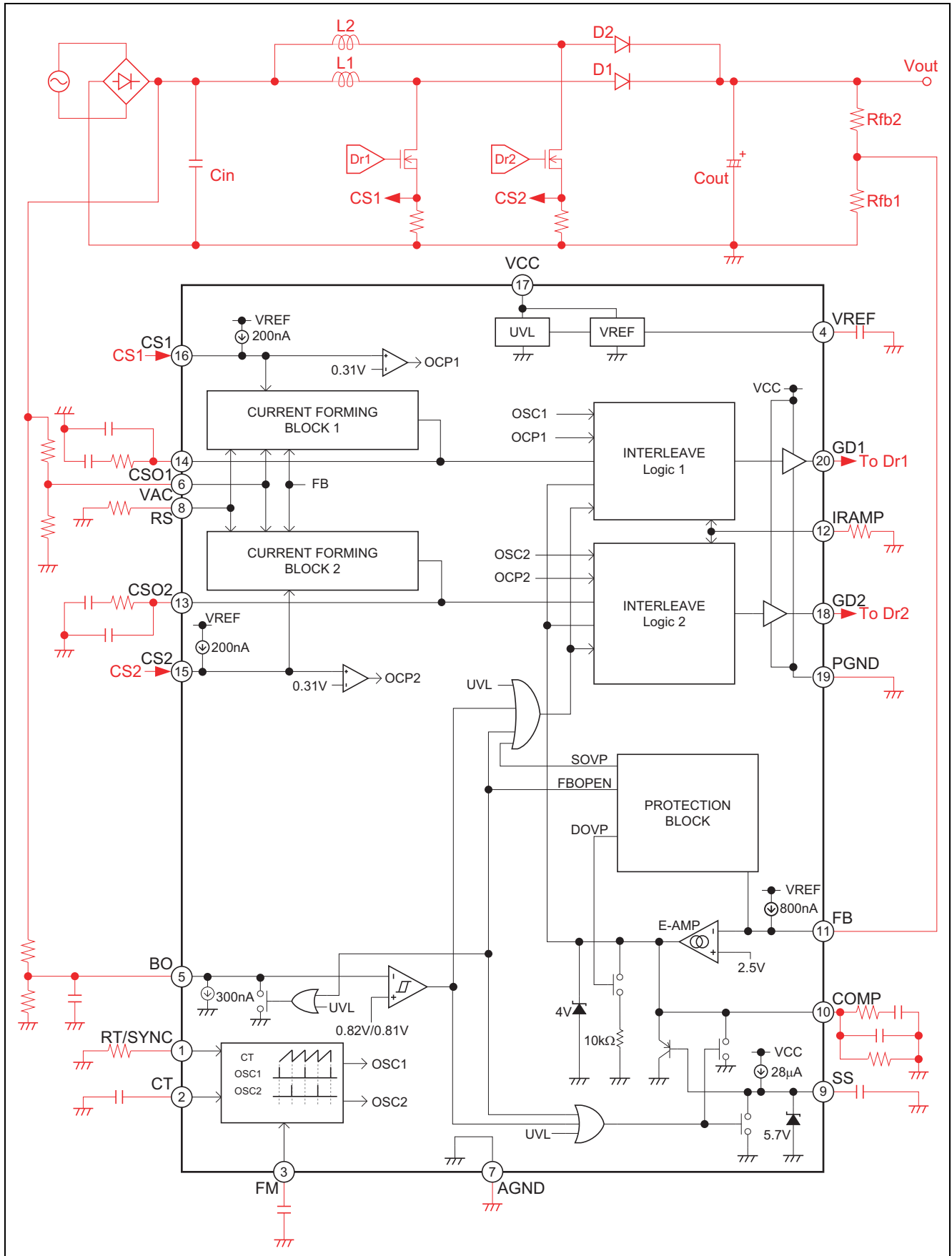
4. Phase Drop (Applied to R2A20114AFP)



5. ERROR (Applied to R2A20114AFP)

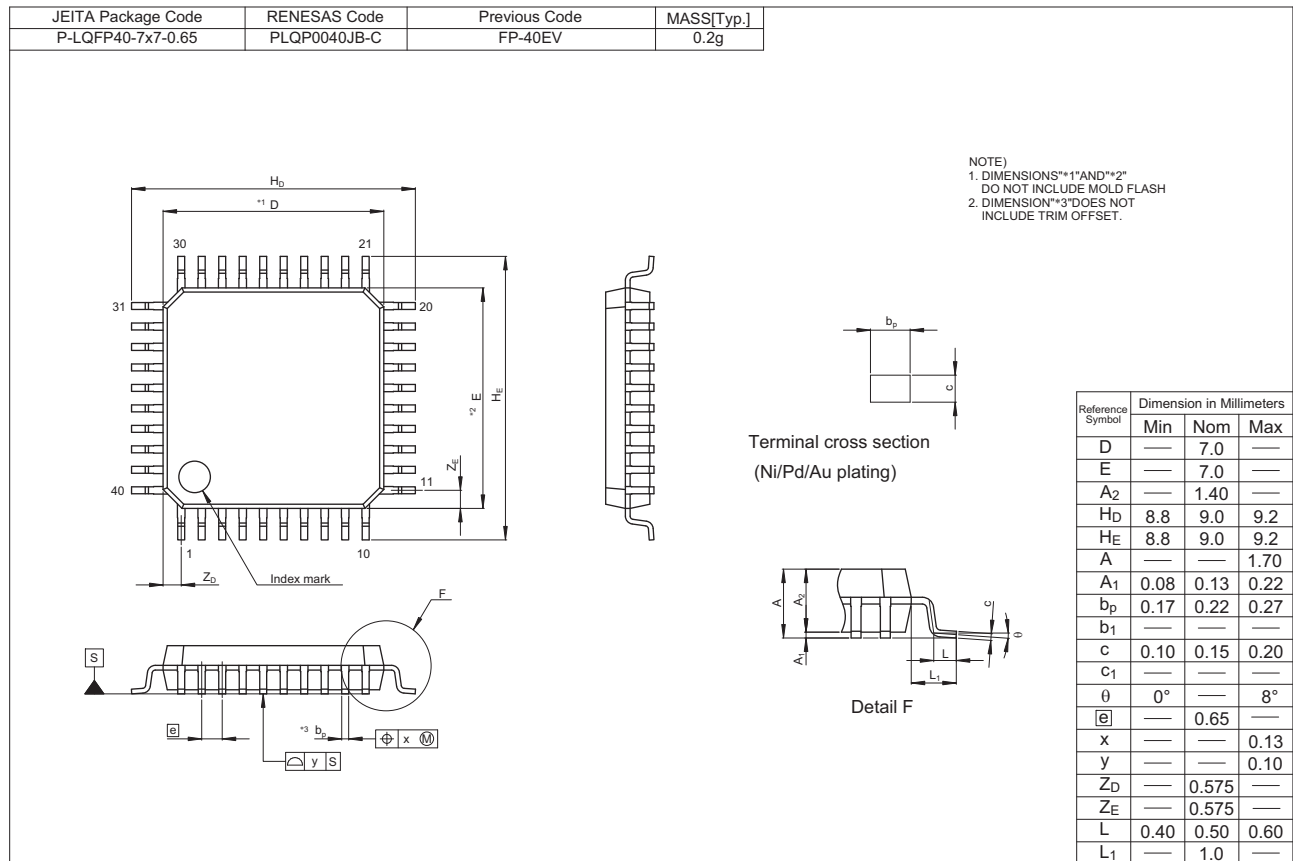


System Diagram (Applied to R2A20114ASP)

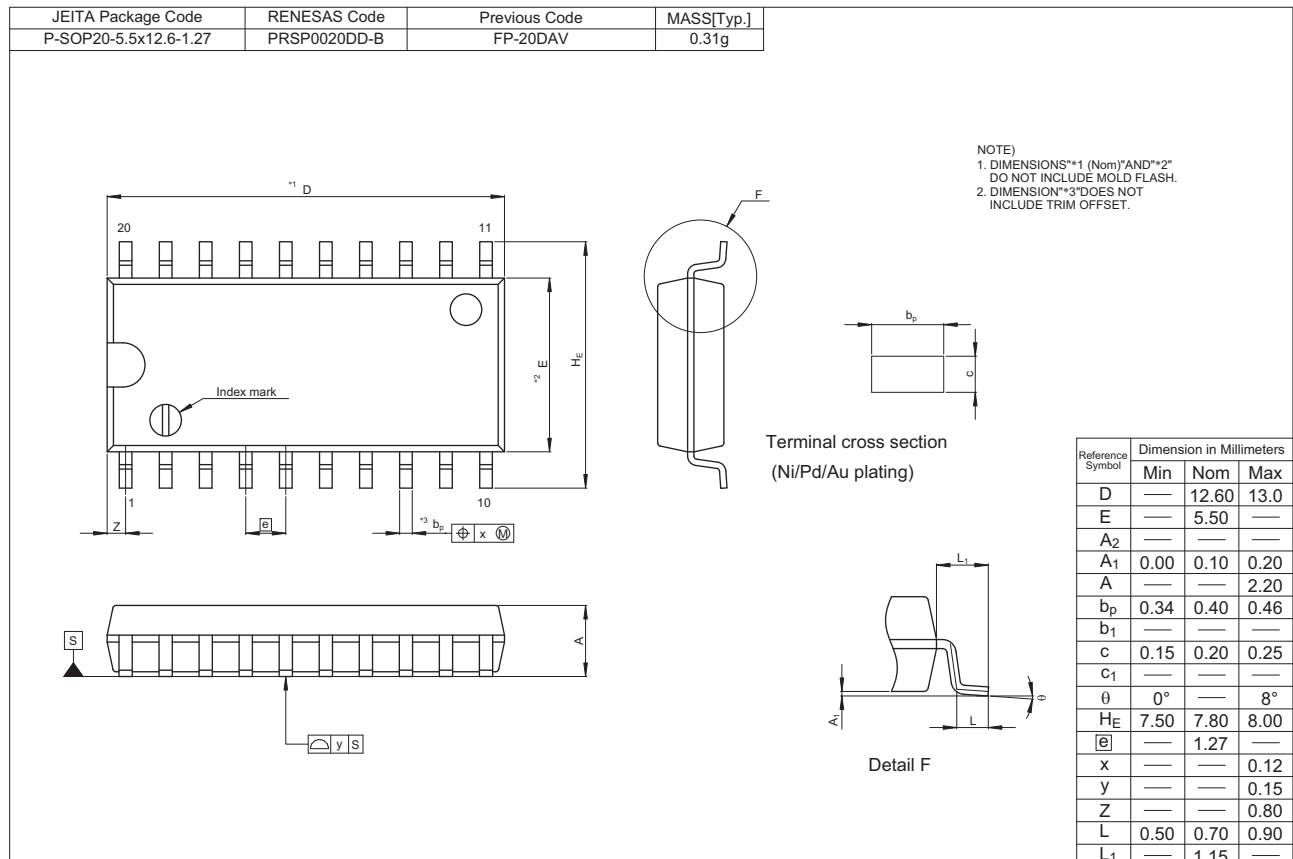


Package Dimensions

• R2A20114AFP



• R2A20114ASP



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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.777C, 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