

# R2A20124AFP/R2A20124ASP

REJ03D0928-0200

Rev.2.00

## Synchronous Phase Shift Full-Bridge Control IC Series

Aug 03, 2010

### Description

The R2A20124AFP/R2A20124ASP controls a full-bridge phase shift circuit and secondary synchronous rectification. The R2A20124AFP/R2A20124ASP has adjustable delay time functions which make ZVS of primary side and make loss of body diode of primary switching device minimal.

The R2A20124AFP/R2A20124ASP is based on HA16163/R2A20121. And RAMP slope compensation circuit is built-in as an additional function. Also its output driver circuits are improved to enlarge gate drive output voltage swing from VREF to VCC.

In addition R2A20124AFP has ON/OFF function of synchronous rectification and includes amplifier which detect input current signal.

### Features

- Maximum ratings
  - Supply voltage Vcc: 20 V
  - Operating junction temperature Tj-opr: -40 to +125°C
- Electrical characteristics
  - VFB feedback voltage VFB(-): 1.25 V ± 2.0%
  - UVLO (Under Voltage Lockout) operation start voltage VH: 8.4 V ± 0.7 V
  - UVLO operation shutdown voltage VL: 8.0 V ± 0.6 V
  - UVLO hysteresis voltage dVUVL: 0.4 V ± 0.1 V
  - Output voltage swing of OUT-A, B, C, D, and E for gate drive: GND to VCC
- Functions
  - R2A20124AFP/R2A20124ASP
    - Full-bridge phase-shift switching circuit with adjustable delay times
    - Pulse by pulse current limit
    - Synchronization I/O for the oscillator
    - Ramp sloping adjustor
    - Error amplifier built-in
    - Soft start function
  - R2A20124AFP
    - Synchronous rectification on/off control
    - Remote on/off control
    - Amplified output of current sense input voltage: CS
- Package lineup
  - Pb-free LQFP-40: R2A20124AFP
  - Pb-free SOP-20: R2A20124ASP

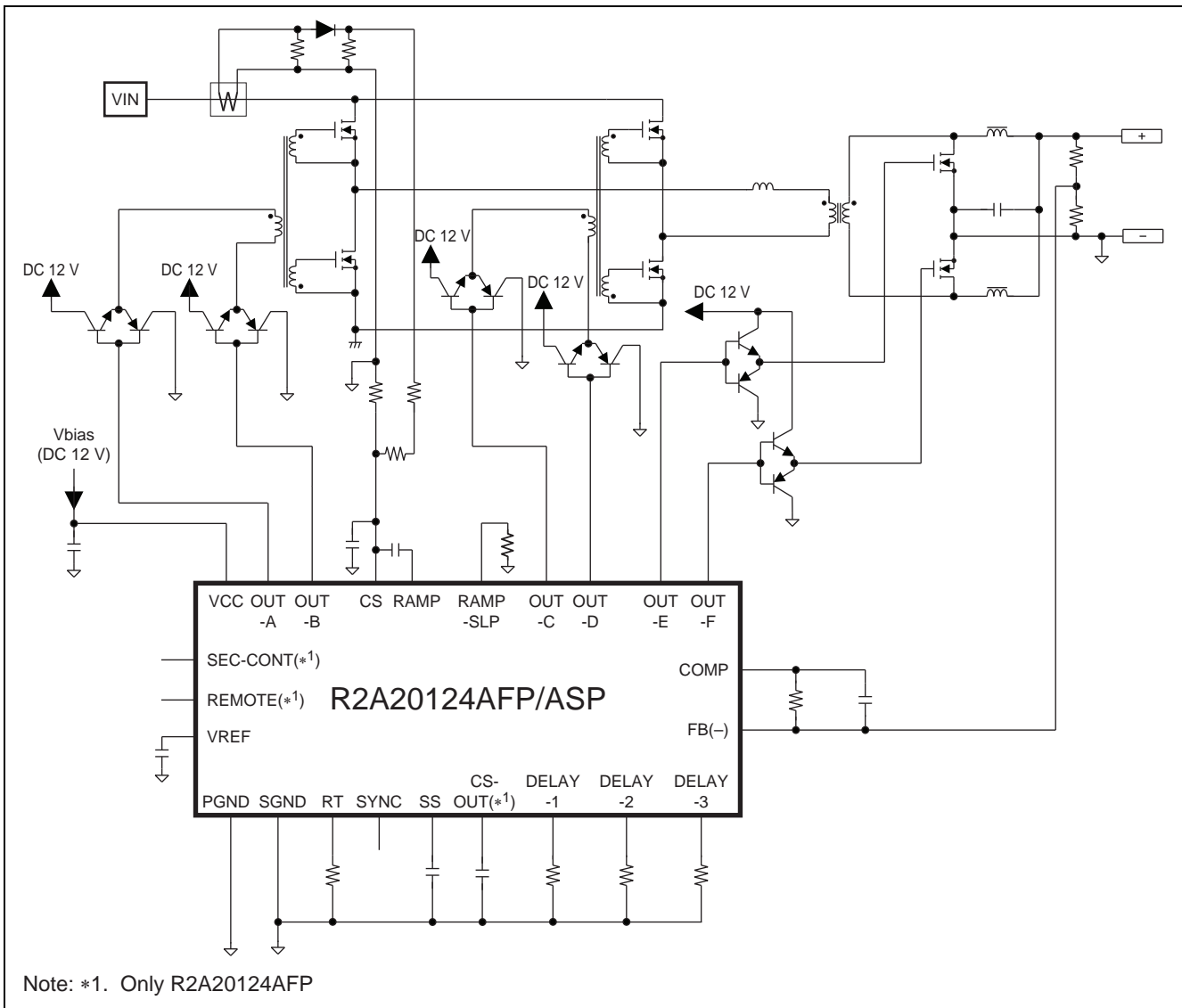
### Ordering Information

Part No.	Package Name	Package Code	Taping Spec.
R2A20124AFP-W0	FP-40EV	PLQP0040JB-C	2000 pcs./one taping product
R2A20124AFP-W5			2000 pcs./one taping product
R2A20124AFP-U0			—
R2A20124AFP-U5			—
R2A20124ASP-W0	FP-20DAV	PRSP0020DD-B	2000 pcs./one taping product
R2A20124ASP-W5			2000 pcs./one taping product
R2A20124ASP-U0			—
R2A20124ASP-U5			—

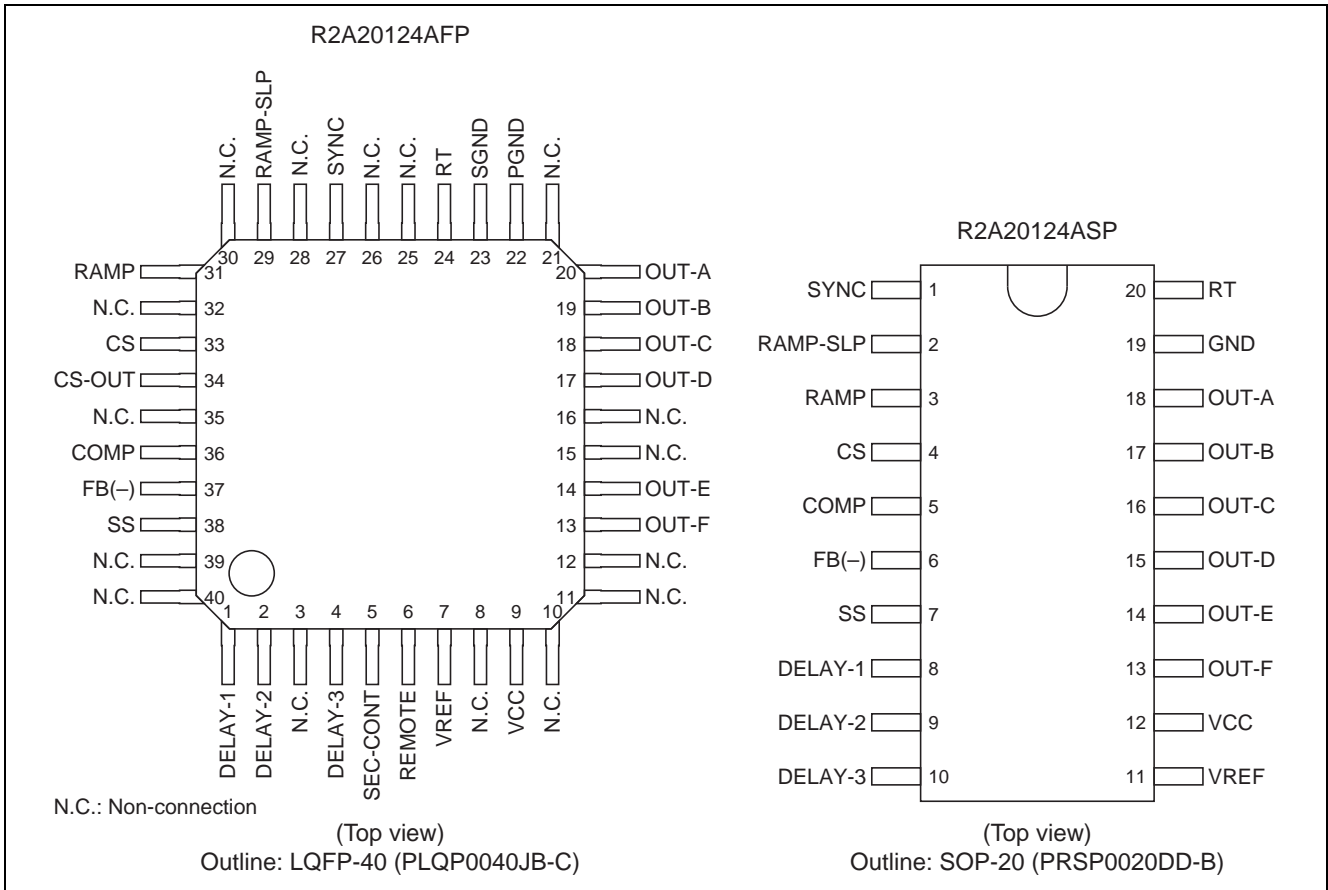
### Modified Points from R2A20121SP

- The swing level of the maximum output voltage is changed from VREF to VCC.
- Ramp sloping compensation circuit is added.
- Synchronous rectification control is possible to turned off at light load. (only R2A20124AFP)
- On/off control terminal for Remote is added. (only R2A20124AFP)

### Illustrative Circuit



Pin Arrangement

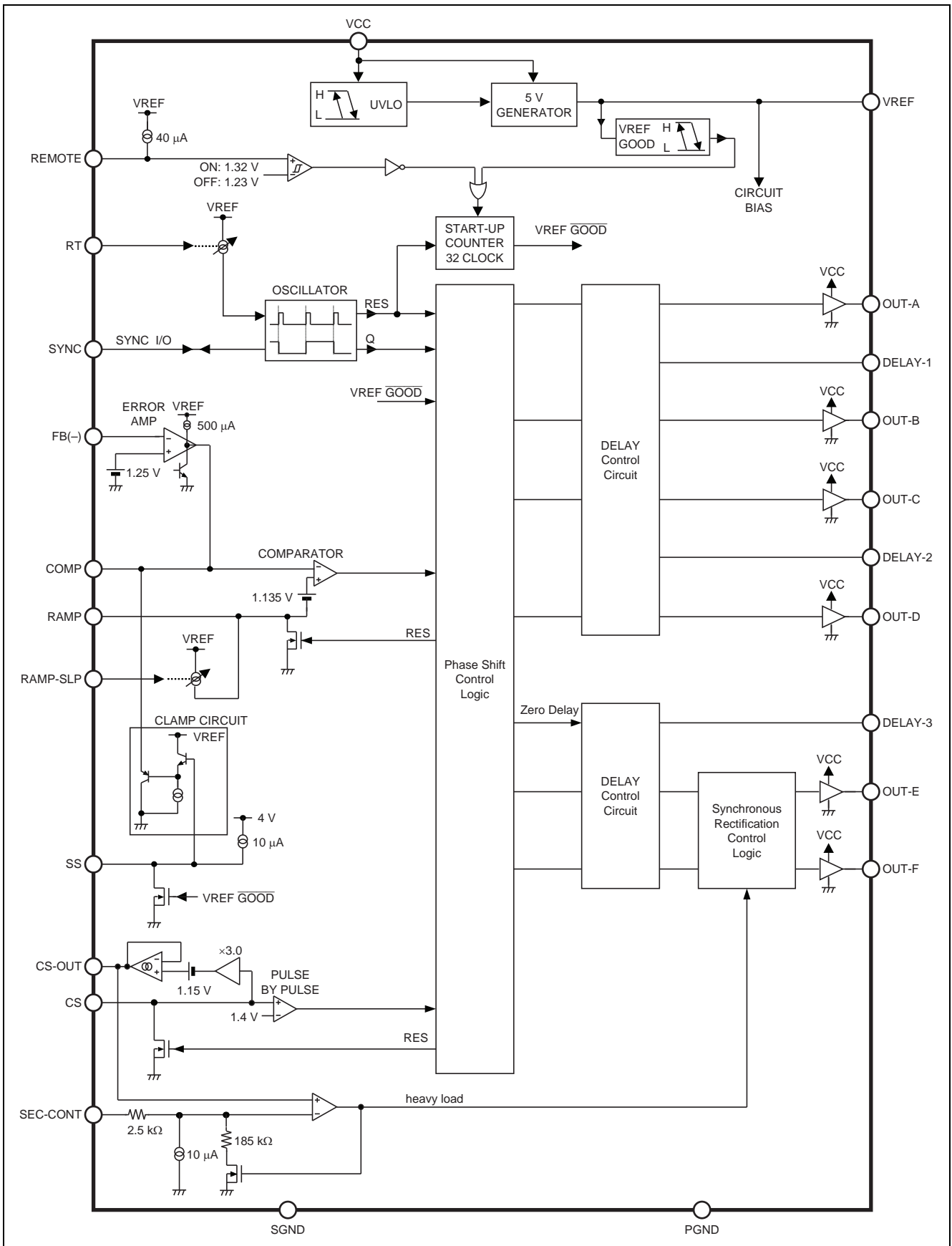


## Pin Functions

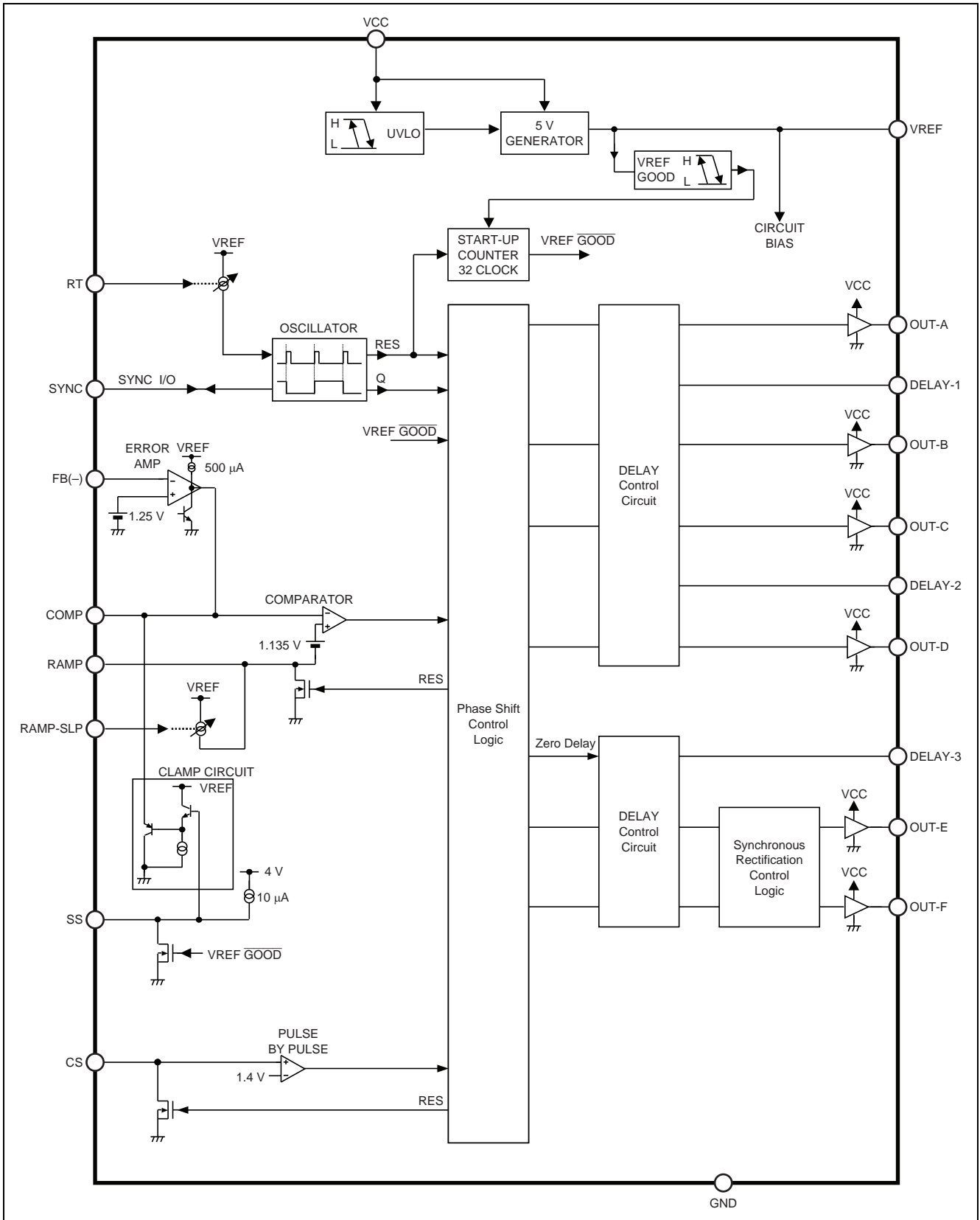
LQFP-40 Pin No.	SOP-20 Pin No.	Pin Name	Input/Output	Pin Function
1	8	DELAY-1	Input/Output	Delay time adjustor for the full-bridge control signal (OUT-A and B)
2	9	DELAY-2	Input/Output	Delay time adjustor for the full-bridge control signal (OUT-C and D)
4	10	DELAY-3	Input/Output	Delay time adjustor for the secondary control signal (OUT-E and F)
5	—	SEC-CONT	Input	Synchronous rectification on/off control
6	—	REMOTE	Input	Remote on/off control
7	11	VREF	Output	5 V/20 mA output
9	12	VCC	Input	IC power supply input
13	13	OUT-F	Output	Secondary control signal
14	14	OUT-E	Output	Secondary control signal
17	15	OUT-D	Output	Full-bridge control signal
18	16	OUT-C	Output	Full-bridge control signal
19	17	OUT-B	Output	Full-bridge control signal
20	18	OUT-A	Output	Full-bridge control signal
22	—	PGND	—	Ground level for the output signal
23	—	SGND	—	Ground level for the small signal
—	19	GND	—	Ground
24	20	RT	Input/Output	Timing resistor for the oscillator
27	1	SYNC	Input/Output	Synchronization I/O for the oscillator
29	2	RAMP-SLP	Input/Output	Ramp sloping adjustor
31	3	RAMP	Input	Ramp waveform set
33	4	CS	Input	Current sense signal input for OCP
34	—	CS-OUT	Output	Current sense information amplifier output
36	5	COMP	Output	Error amplifier output
37	6	FB(-)	Input	Error amplifier negative input
38	7	SS	Output	Timing capacitor for soft start
3, 8, 10 to 12, 15, 16, 21, 25, 26, 28, 30, 32, 35, 39, 40	—	N.C.	—	Open

# Block Diagram

## R2A20124AFP



R2A20124ASP



## Absolute Maximum Ratings

(Ta = 25°C)

Item	Symbol	Ratings	Unit	Note
Power supply voltage	Vcc	20	V	1
Peak output current	Ipk-out	±200	mA	2, 3
DC output current	I <sub>dc-out</sub>	±50	mA	3, 4
VREF output current	Iref-out	-20	mA	3
COMP sink current	I <sub>sink-comp</sub>	2	mA	3
DELAY set current	I <sub>set-delay</sub>	0.3	mA	3
RT set current	I <sub>set-rt</sub>	0.3	mA	3
RAMP-SLP set current	I <sub>set-ramp-slp</sub>	0.3	mA	3
VREF terminal voltage	V <sub>ter-ref</sub>	-0.3 to +6	V	1, 5
Terminal group 1 voltage	V <sub>ter-1</sub>	-0.3 to (V <sub>ref</sub> + 0.3)	V	1, 6
Operating junction temperature	T <sub>j-opr</sub>	-40 to +125	°C	7
Storage temperature	T <sub>stg</sub>	-55 to +150	°C	

- Notes: 1. Rated voltages are with reference to the GND or SGND pin.  
 2. The Rating shows the transient current when driving a capacitive load.  
 3. For rated currents, inflow to the IC is indicated by (+), and outflow by (-).  
 4. Total current of OUT-A, Out-B, OUT-C, OUT-D, OUT-E, and OUT-F must be not exceed ±90 mA.  
 5. VREF pin voltage must not exceed VCC pin voltage.  
 6. Terminal group 1 is defined the pins;  
 REMOTE, RAMP-SLP, SEC-CONT, CS, RAMP, COMP, CS-OUT, FB(-), SS, RT, SYNC, and DELAY-1 to 3  
 7. Thermal resistance  $\theta_{ja}$   
 R2A20124AFP (40-pin); 85.3°C/W Board condition; Glass epoxy 50 mm × 50 mm × 1.6 mm, 10% wiring density.  
 R2A20124ASP (20-pin); 120°C/W Board condition; Glass epoxy 40 mm × 40 mm × 1.6 mm, 10% wiring density.

## Electrical Characteristics

(Ta = 25°C, Vcc = 12 V, RT = 180 kΩ, Rdelay = 51 kΩ, Rramp-slp = 27 kΩ, unless otherwise specified.)

Item	Symbol	Min	Typ	Max	Unit	Test Conditions
SUPPLY: R2A20124AFP/ASP						
Start threshold	VH	7.7	8.4	9.1	V	
Shutdown threshold	VL	7.4	8.0	8.6	V	
UVLO hysteresis	dVUVL	0.3	0.4	0.5	V	
Start-up current	Is	—	90	150	μA	Vcc = 7.5 V
Operating current	Icc	—	8	11.5	mA	No load on VREF pin
VREF: R2A20124AFP/ASP						
Output voltage	Vref	4.9	5.0	5.1	V	
Line regulation	Vref-line	—	0	10	mV	Vcc = 10 V to 16 V
Load regulation	Vref-load	—	6	20	mV	Iref = -1 mA to -20 mA
Temperature stability	dVref/dTa	—	±80* <sup>1</sup>	—	ppm/°C	Ta = -40°C to 105°C
OSCILLATOR: R2A20124AFP/ASP						
Oscillator frequency	fosc	—	200* <sup>1</sup>	—	kHz	
Switching frequency	fsw	85	100	115	kHz	Measured on OUT-A, -B
Line stability	fsw-line	-1.5	0	1.5	%	Vcc = 10 V to 16 V
Temperature stability	dfsw/dTa	—	±0.1* <sup>1</sup>	—	%/°C	Ta = -40°C to 105°C
RT voltage	V <sub>RT</sub>	2.5	2.7	2.9	V	
SYNC: R2A20124AFP/ASP						
Input threshold	V <sub>TH-SYNC</sub>	2.5	2.85	3.2	V	
Output high	V <sub>OH-SYNC</sub>	3.5	4.0	—	V	RSYNC = 33 kΩ to GND * <sup>2</sup>
Output low	V <sub>OL-SYNC</sub>	—	0.05	0.15	V	RSYNC = 33 kΩ to VREF
Minimum input pulse	T <sub>I-MIN</sub>	50	—	—	ns	
Output pulse width	T <sub>O-SYNC</sub>	—	3.0* <sup>1</sup>	—	μs	
REMOTE: R2A20124AFP						
On threshold voltage	V <sub>ON-REMOTE</sub>	1.12	1.32	1.52	V	
Off threshold voltage	V <sub>OFF-REMOTE</sub>	1.04	1.23	1.42	V	
REMOTE hysteresis	dVREMOTE	60	90	120	mV	
Input bias current	I <sub>REMOTE</sub>	-100	-50	—	μA	REMOTE = 2 V
ERROR AMPLIFIER: R2A20124AFP/ASP						
FB(-) input voltage	V <sub>FB(-)</sub>	1.225	1.250	1.275	V	FB(-) and COMP are shorted
FB(-) input current	I <sub>FB(-)</sub>	-2.0	0	2.0	μA	FB(-) = 1.25 V
Open-loop DC gain	A <sub>v</sub>	—	80* <sup>1</sup>	—	dB	
Unity gain bandwidth	BW	—	2* <sup>1</sup>	—	MHz	
Output source current	I <sub>SOURCE</sub>	-650	-500	-390	μA	FB(-) = 0.75 V, COMP = 2 V
Output sink current	I <sub>SINK</sub>	2.0	6.5	—	mA	FB(-) = 1.75 V, COMP = 2 V
Output high voltage	V <sub>OH-EO</sub>	3.7	3.9	—	V	FB(-) = 0.75 V, COMP; open
Output low voltage	V <sub>OL-EO</sub>	—	0.1	0.4	V	FB(-) = 1.75 V, COMP; open
Output clamp voltage * <sup>3</sup>	V <sub>CLAMP-EO</sub>	-0.16	-0.07	0.0	V	FB(-) = 0.75 V, COMP; open, SS = 1 V

- Notes: 1. Design specification (reference data)  
 2. R2A20124AFP: SGND and PGND  
 3. V<sub>CLAMP-EO</sub> = V<sub>COMP</sub> - SS voltage (1 V)

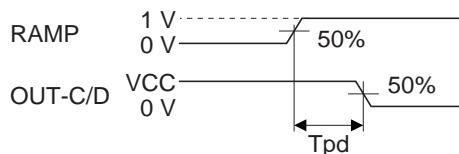
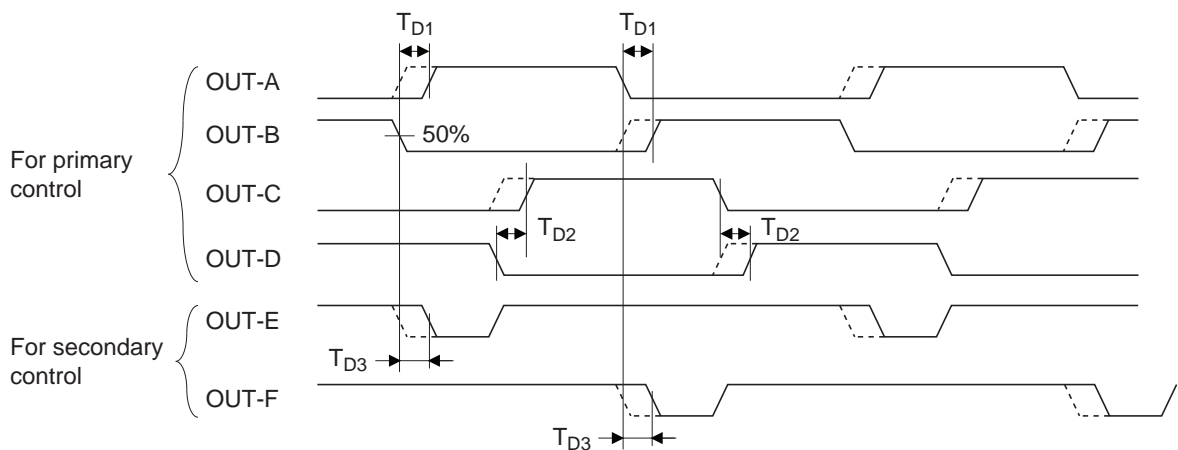


## Electrical Characteristics (cont.)

(Ta = 25°C, Vcc = 12 V, RT = 180 kΩ, Rdelay = 51 kΩ, Rramp-slp = 27 kΩ, unless otherwise specified.)

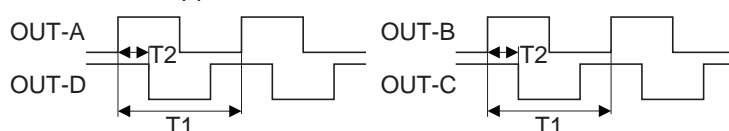
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
PHASE MODULATOR: R2A20124AFP/ASP						
RAMP offset voltage	V <sub>RAMP</sub>	1.035	1.135	1.235	V	
RAMP source current	I <sub>SOURCE-RAMP</sub>	-220	-185	-150	μA	RAMP = 0.15 V, COMP; open
RAMP sink current	I <sub>SINK-RAMP</sub>	3	10	—	mA	RAMP = 0.15 V, COMP = 0 V
Minimum phase shift	D <sub>min</sub>	—	0*1*4	—	%	RAMP = 0 V, COMP = 0 V
Maximum phase shift	D <sub>max</sub>	—	97.0*1*4	—	%	RAMP = 0 V, COMP = 2.1 V
Delay to OUT-C, -D *2	T <sub>pd</sub>	—	100	200	ns	COMP = 1.6 V
RAMP discharge time *1	T <sub>dis</sub>	—	80	120	ns	FB(-) = 0.75 V, COMP; open
RAMP-SLP voltage	V <sub>RAMP-SLP</sub>	2.1	2.3	2.5	V	
DELAY: R2A20124AFP/ASP						
DELAY-1, -2 *3	T <sub>D1,2</sub>	70	100	130	ns	Delay set R = 51 kΩ
DELAY-3 *3	T <sub>D3</sub>	45	65	85	ns	Delay set R = 51 kΩ
DELAY2-1, -2 *1*3	T <sub>D2_1,2</sub>	140	220	300	ns	Delay set R = 180 kΩ
DELAY2-3 *1*3	T <sub>D2_3</sub>	110	170	230	ns	Delay set R = 180 kΩ
Terminal voltage	V <sub>D1,2,3</sub>	1.9	2.0	2.1	V	Delay set R = 51 kΩ
SOFT START: R2A20124AFP/ASP						
Source current	I <sub>SS</sub>	-14	-10	-6	μA	SS = 1 V
SS high voltage	V <sub>OH-SS</sub>	3.9	4.0	4.1	V	

Notes: 1. Design specification (reference data)

2. T<sub>pd</sub> is defined as;3. T<sub>D1</sub>, T<sub>D2</sub>, and T<sub>D3</sub> are defined as;

4. Maximum/Minimum phase shift is defined as;

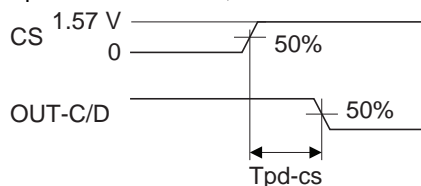
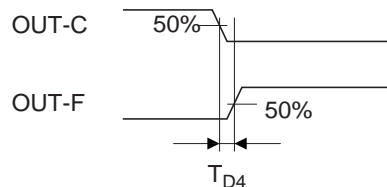
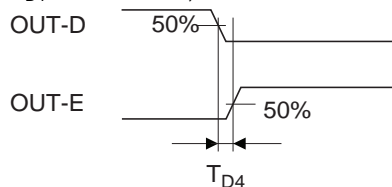
$$D = \frac{T_2}{T_1} \times 2 \times 100 (\%)$$



## Electrical Characteristics (cont.)

(Ta = 25°C, Vcc = 12 V, RT = 180 kΩ, Rdelay = 51 kΩ, Rramp-slp = 27 kΩ, unless otherwise specified.)

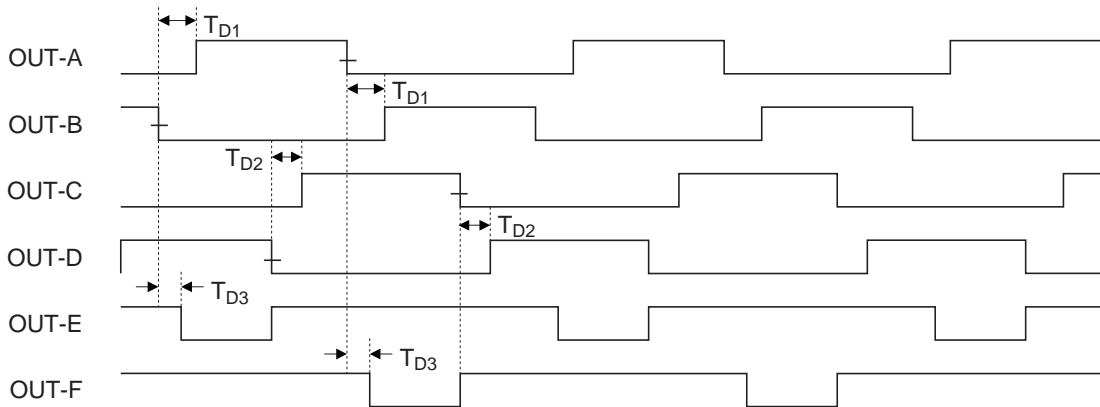
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
OVER CURRENT PROTECTION: R2A20124AFP/ASP						
Pulse-by-pulse current limit threshold	V <sub>CS-PP</sub>	1.26	1.4	1.54	V	SEC-CONT = 0.3 V (AFP)
Delay to OUT pins *1	T <sub>pd-cs</sub>	—	100	200	ns	CS = 0 V to 1.57 V, SEC-CONT = 0.3 V (AFP)
CS sink current	I <sub>SINK-CS</sub>	2	5	—	mA	CS = 0.15 V, COMP = 0 V
OUTPUT: R2A20124AFP/ASP						
High voltage	V <sub>OH-OUT</sub>	11.5	11.9	—	V	IO <sub>UT</sub> = -2 mA
Low voltage	V <sub>OL-OUT</sub>	—	0.05	0.2	V	IO <sub>UT</sub> = 2 mA
Rise time	t <sub>r</sub>	—	30	100	ns	CO <sub>UT</sub> = 100 pF
Fall time	t <sub>f</sub>	—	30	100	ns	CO <sub>UT</sub> = 100 pF
Timing offset *2	T <sub>D4</sub>	—	20	140	ns	
POWER INFORMATION AMPLIFIER: R2A20124AFP						
Transconductance	gm	15	20	25	μs	CS = 0.4 V
SECONDARY CONTROL: R2A20124AFP						
Forced synchronous rectification on voltage	V <sub>on-sec-cont</sub>	4.6	—	—	V	CS = 1 V
Forced synchronous rectification off voltage	V <sub>off-sec-cont</sub>	—	—	0.4	V	CS = 0 V
Input bias current-1	I <sub>SEC-CONT1</sub>	5	10	20	μA	CS = 0 V, SEC-CONT = 2.1 V
Input bias current-2	I <sub>SEC-CONT2</sub>	10	20	40	μA	CS = 1 V, SEC-CONT = 2.1 V
Current hysteresis	dI <sub>SEC-CONT</sub>	5	10	20	μA	

Notes: 1. T<sub>pd-cs</sub> is defined as;2. T<sub>D4</sub> is defined as;

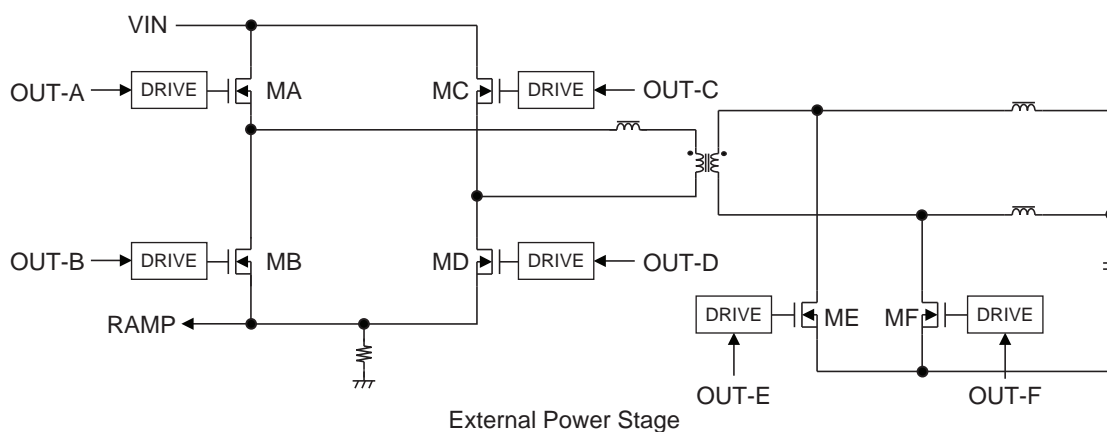
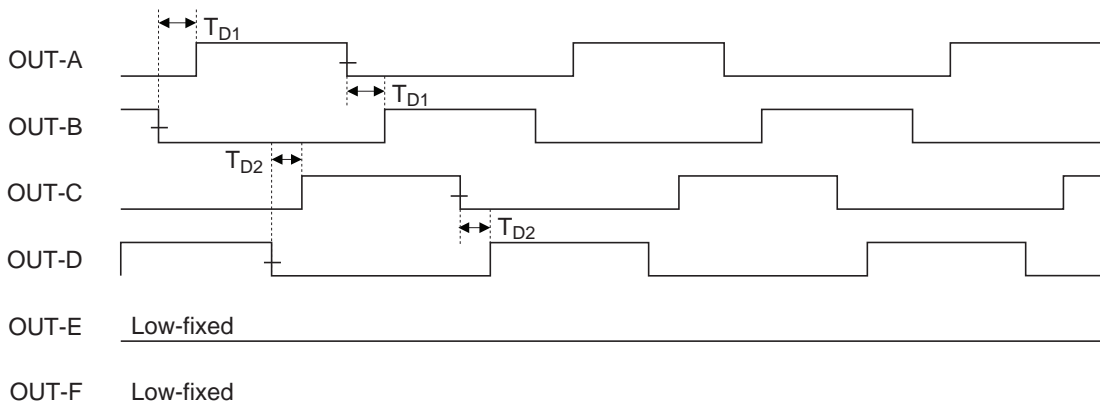
### Timing Diagram

Note: All voltage, current, time shown in the diagram is typical value.

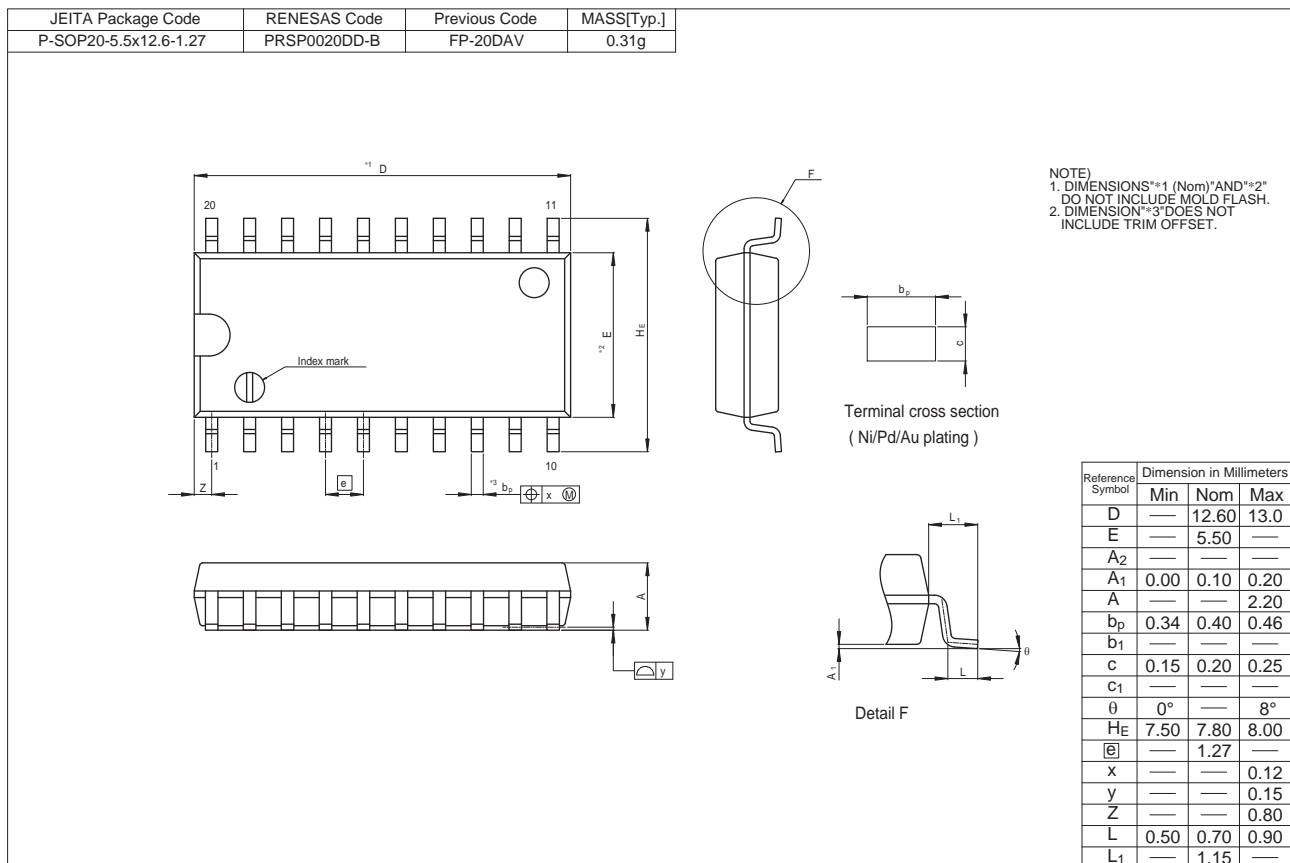
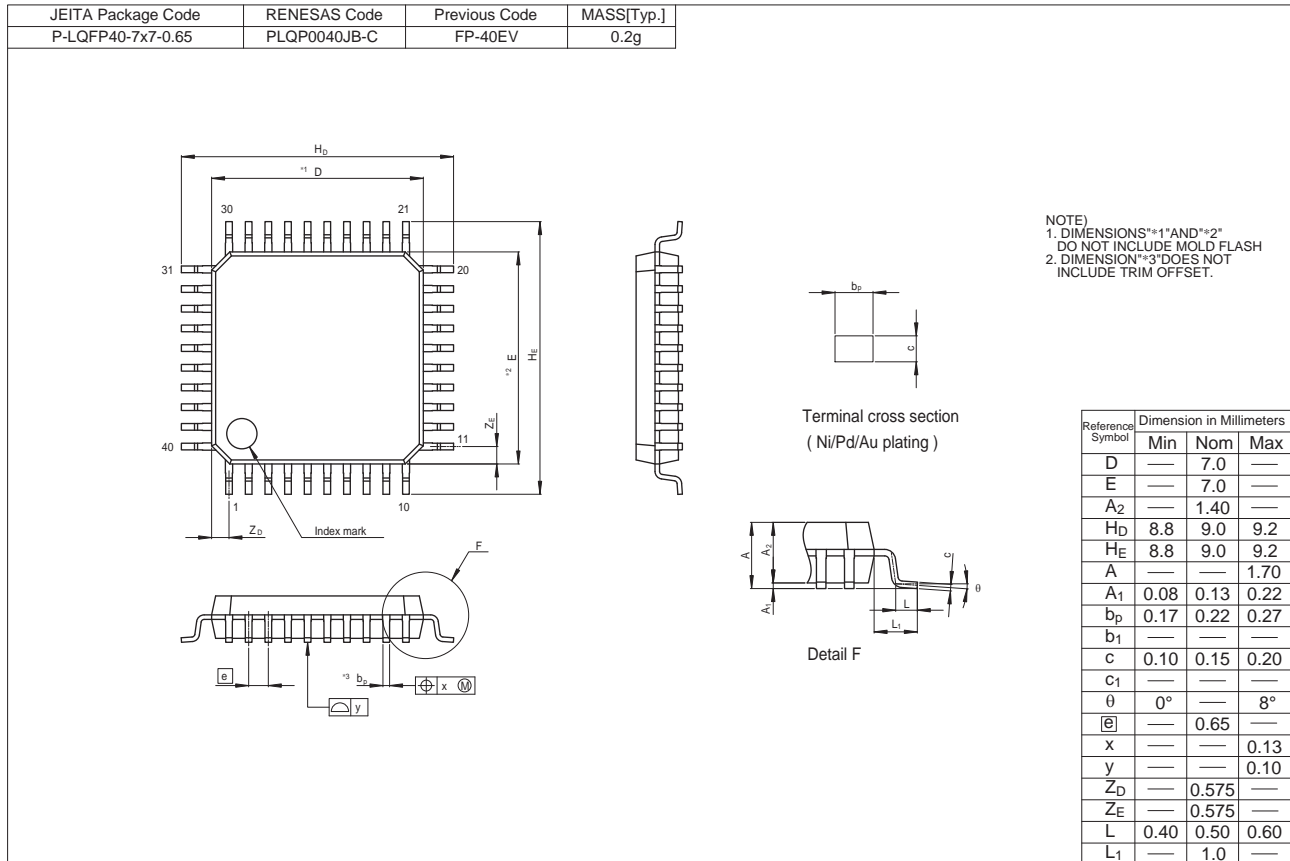
• Full Bridge and Secondary Control: R2A20124AFP/ASP



• Full Bridge and Secondary Control: R2A20124AFP (SEC-CONT > 4.6 V)



Package Dimensions



## Notice

- All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.
- Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
- You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.
- Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
- When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
- Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
- Renesas Electronics products are classified according to the following three quality grades: "Standard", "High Quality", and "Specific". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as "Specific" without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as "Specific" or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is "Standard" unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.  
"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.  
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.  
"Specific": Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.
- You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
- Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.
- Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
- This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.
- Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.  
(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.  
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.



### SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

**Renesas Electronics America Inc.**  
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.  
Tel: +1-408-588-6000, Fax: +1-408-588-6130

**Renesas Electronics Canada Limited**  
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada  
Tel: +1-905-898-5441, Fax: +1-905-898-3220

**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: +49-211-65030, Fax: +49-211-6503-1327

**Renesas Electronics (China) Co., Ltd.**  
7th Floor, Quantum Plaza, No.27 Zhichunlu Haidian District, Beijing 100083, P.R.China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

**Renesas Electronics (Shanghai) Co., Ltd.**  
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China  
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

**Renesas Electronics Hong Kong Limited**  
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
Tel: +852-2886-9318, Fax: +852-2886-9022/9044

**Renesas Electronics Taiwan Co., Ltd.**  
7F, No. 363 Fu Shing North Road Taipei, Taiwan  
Tel: +886-2-8175-9600, Fax: +886-2-8175-9670

**Renesas Electronics Singapore Pte. Ltd.**  
1 HarbourFront Avenue, #06-10, Keppel Bay Tower, Singapore 098632  
Tel: +65-6213-0200, Fax: +65-6278-8001

**Renesas Electronics Malaysia Sdn.Bhd.**  
Unit 906, 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 Korea Co., Ltd.**  
11F., Samik Laviel'or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5141