

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

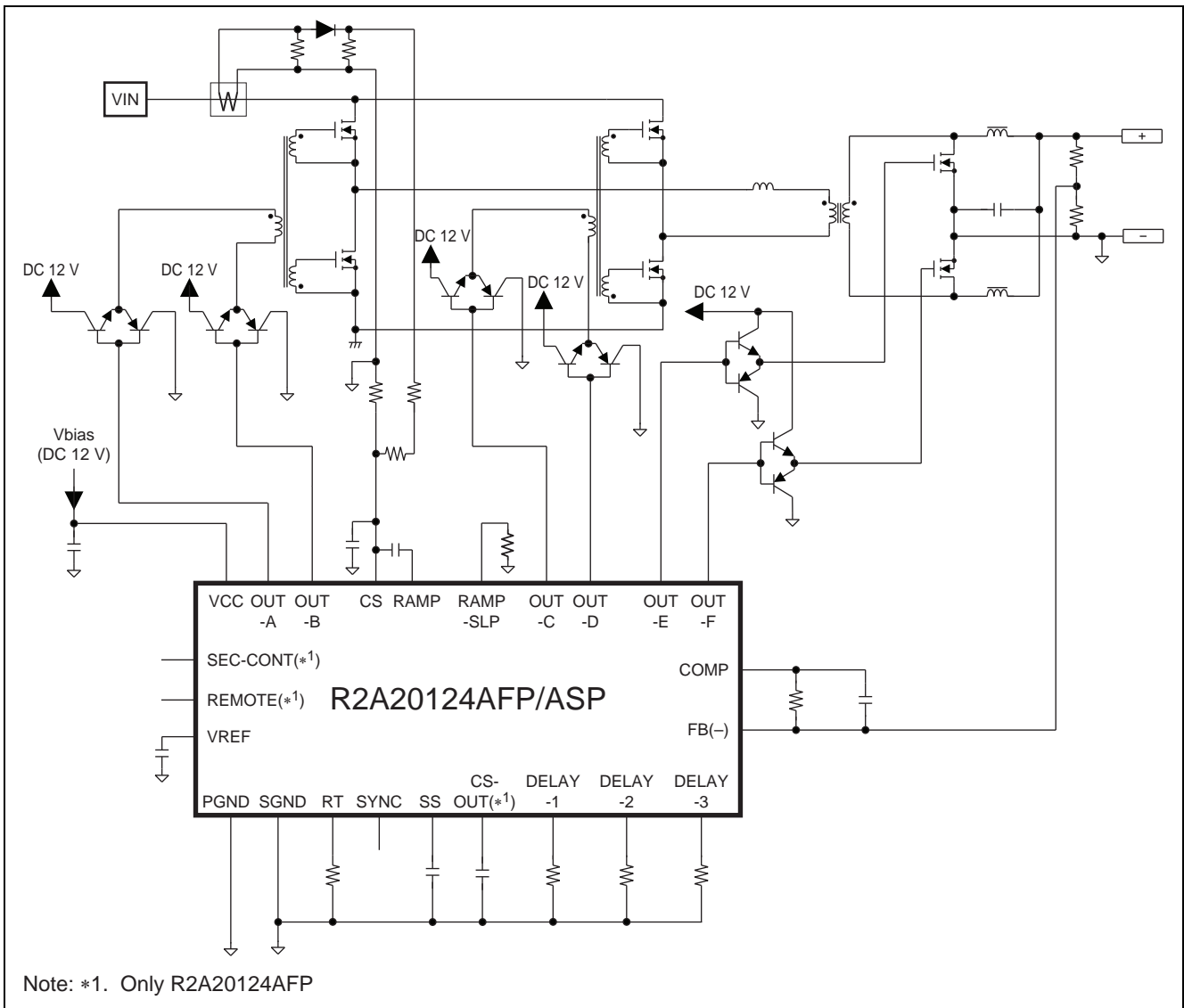
Ordering Information

| 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 | | | — |

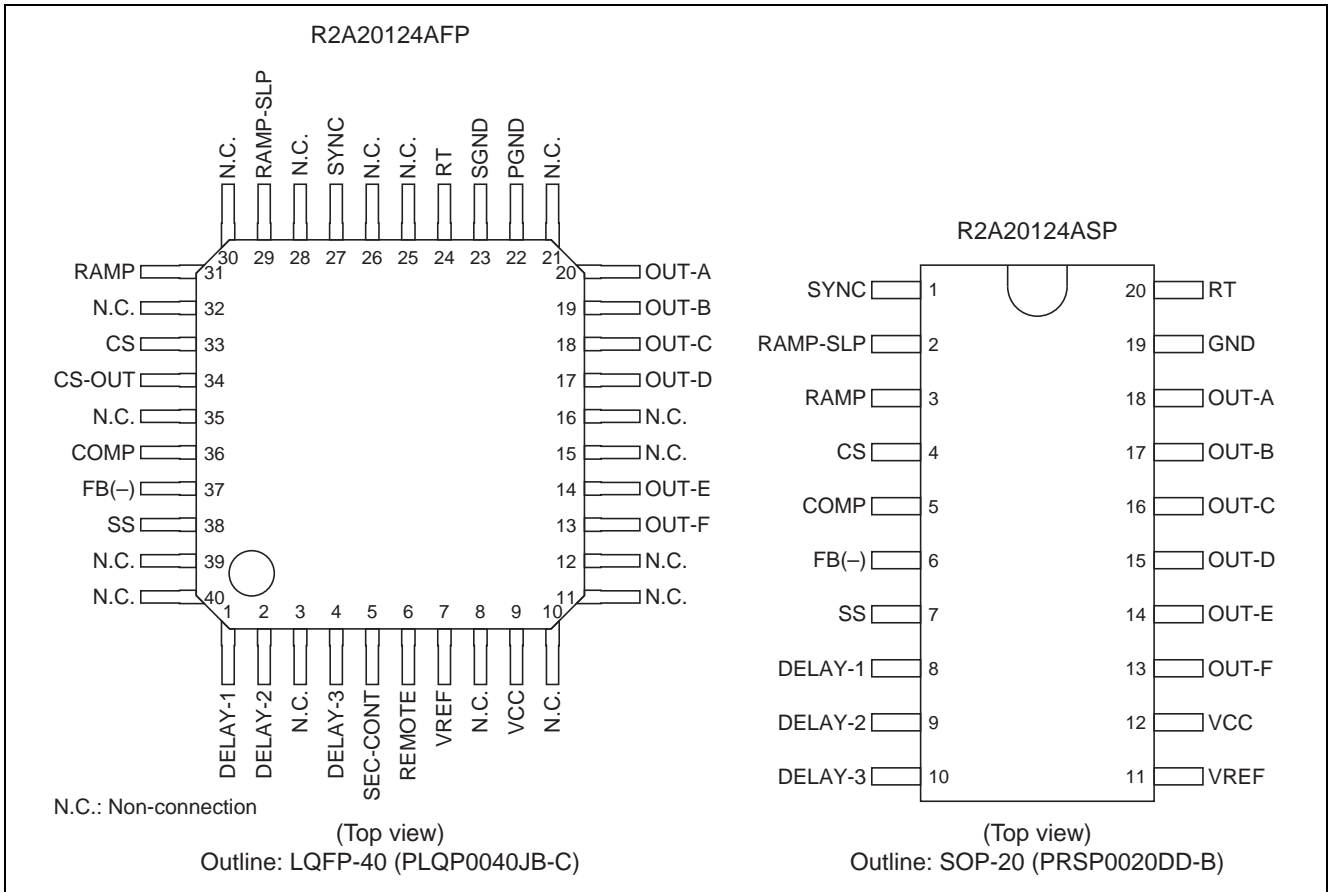
Modified Points from R2A20121SP

- 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

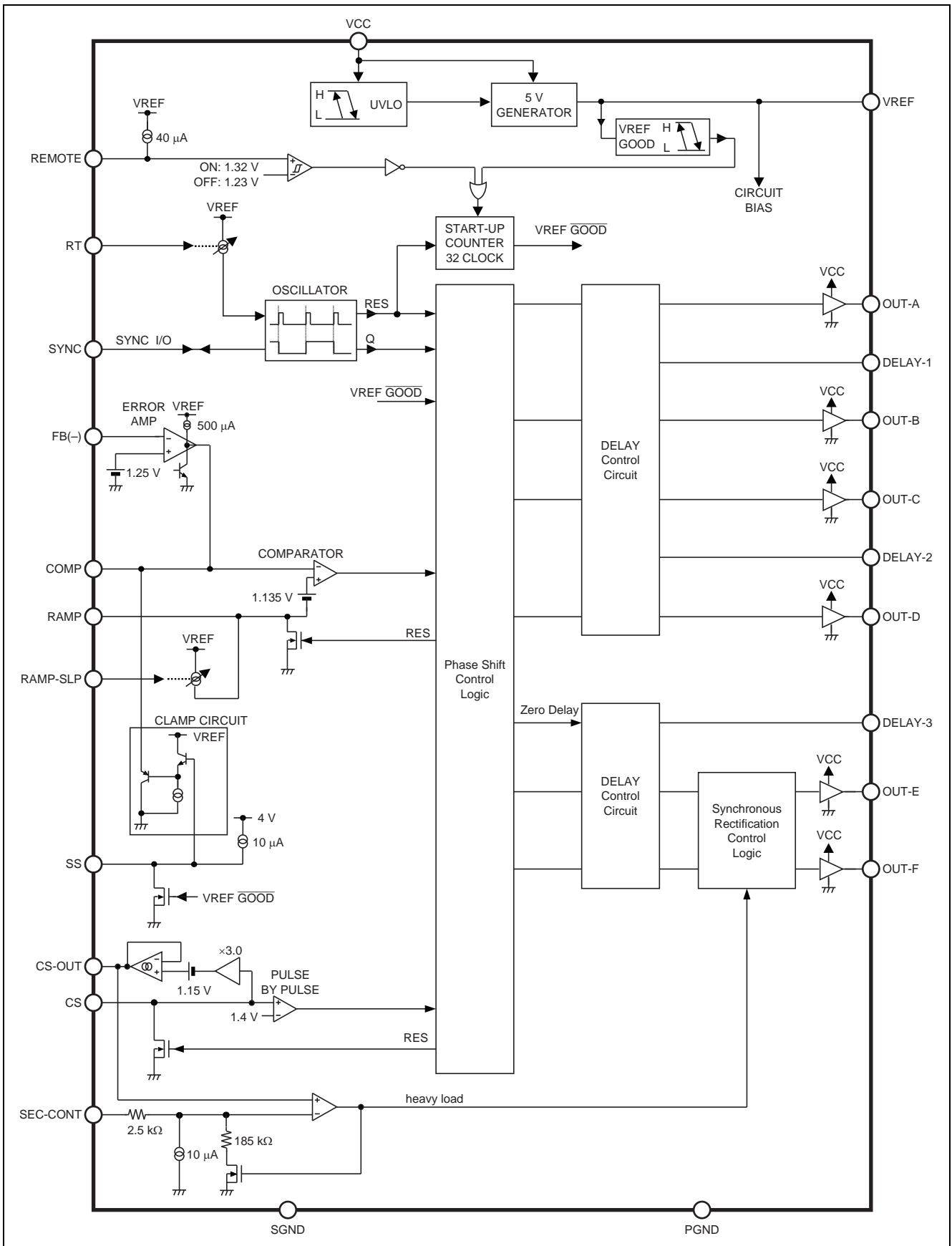


Pin Functions

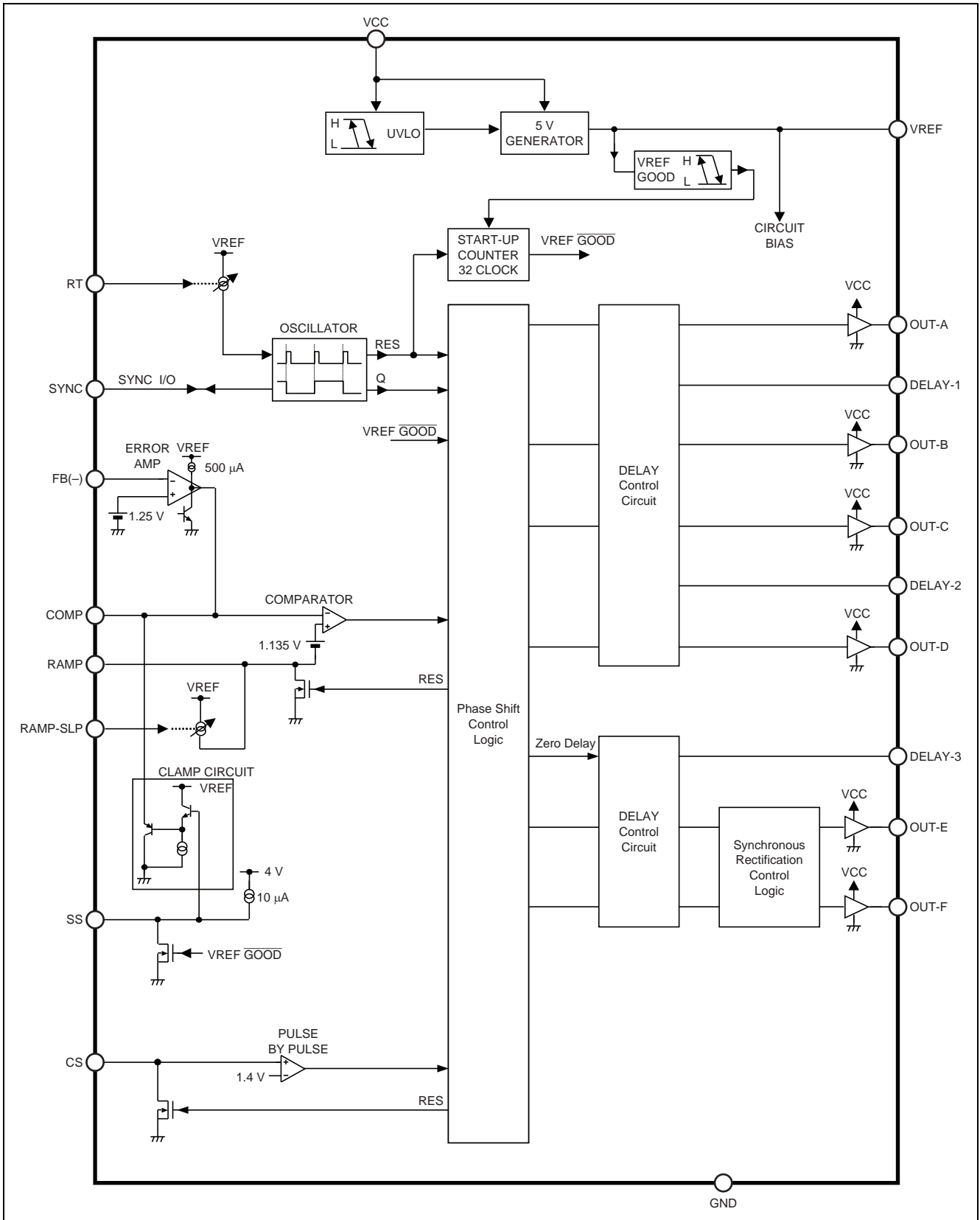
| LQFP-40 Pin No. | SOP-20 Pin No. | Pin Name | Input/Output | Pin Function |
|---|-------------------|----------|--------------|--|
| 1 | 8 | DELAY-1 | Input/Output | Delay time adjustor for the full-bridge control signal (OUT-A and B) |
| 2 | 9 | DELAY-2 | Input/Output | Delay time adjustor for the 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 | Idc-out | ±50 | mA | 3, 4 |
| VREF output current | Iref-out | -20 | mA | 3 |
| COMP sink current | Isink-comp | 2 | mA | 3 |
| DELAY set current | Iset-delay | 0.3 | mA | 3 |
| RT set current | Iset-rt | 0.3 | mA | 3 |
| RAMP-SLP set current | Iset-ramp-slp | 0.3 | mA | 3 |
| VREF terminal voltage | Vter-ref | -0.3 to +6 | V | 1, 5 |
| Terminal group 1 voltage | Vter-1 | -0.3 to (Vref + 0.3) | V | 1, 6 |
| Operating junction temperature | Tj-opr | -40 to +125 | °C | 7 |
| Storage temperature | Tstg | -55 to +150 | °C | |

- Notes:
- Rated voltages are with reference to the GND or SGND pin.
 - The Rating shows the transient current when driving a capacitive load.
 - For rated currents, inflow to the IC is indicated by (+), and outflow by (-).
 - Total current of OUT-A, Out-B, OUT-C, OUT-D, OUT-E, and OUT-F must be not exceed ±90 mA.
 - VREF pin voltage must not exceed VCC pin voltage.
 - 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
 - Thermal resistance θ_{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

($T_a = 25^\circ\text{C}$, $V_{cc} = 12\text{ V}$, $R_T = 180\text{ k}\Omega$, $R_{\text{delay}} = 51\text{ k}\Omega$, $R_{\text{ramp-slp}} = 27\text{ k}\Omega$, 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 | I _s | — | 90 | 150 | μA | $V_{cc} = 7.5\text{ V}$ |
| Operating current | I _{cc} | — | 8 | 11.5 | mA | No load on VREF pin |
| VREF: R2A20124AFP/ASP | | | | | | |
| Output voltage | V _{ref} | 4.9 | 5.0 | 5.1 | V | |
| Line regulation | V _{ref-line} | — | 0 | 10 | mV | $V_{cc} = 10\text{ V to }16\text{ V}$ |
| Load regulation | V _{ref-load} | — | 6 | 20 | mV | I _{ref} = -1 mA to -20 mA |
| Temperature stability | dV _{ref} /dT _a | — | $\pm 80^{*1}$ | — | ppm/ $^\circ\text{C}$ | $T_a = -40^\circ\text{C to }105^\circ\text{C}$ |
| OSCILLATOR: R2A20124AFP/ASP | | | | | | |
| Oscillator frequency | f _{osc} | — | 200 ^{*1} | — | kHz | |
| Switching frequency | f _{sw} | 85 | 100 | 115 | kHz | Measured on OUT-A, -B |
| Line stability | f _{sw-line} | -1.5 | 0 | 1.5 | % | $V_{cc} = 10\text{ V to }16\text{ V}$ |
| Temperature stability | df _{sw} /dT _a | — | $\pm 0.1^{*1}$ | — | %/ $^\circ\text{C}$ | $T_a = -40^\circ\text{C to }105^\circ\text{C}$ |
| RT voltage | V _{RT} | 2.5 | 2.7 | 2.9 | V | |
| SYNC: R2A20124AFP/ASP | | | | | | |
| Input threshold | V _{TH-SYNC} | 2.5 | 2.85 | 3.2 | V | |
| Output high | V _{OH-SYNC} | 3.5 | 4.0 | — | V | R _{SYNC} = 33 k Ω to GND ^{*2} |
| Output low | V _{OL-SYNC} | — | 0.05 | 0.15 | V | R _{SYNC} = 33 k Ω to VREF |
| Minimum input pulse | T _{I-MIN} | 50 | — | — | ns | |
| Output pulse width | T _{O-SYNC} | — | 3.0 ^{*1} | — | μs | |
| REMOTE: R2A20124AFP | | | | | | |
| On threshold voltage | V _{ON-REMOTE} | 1.12 | 1.32 | 1.52 | V | |
| Off threshold voltage | V _{OFF-REMOTE} | 1.04 | 1.23 | 1.42 | V | |
| REMOTE hysteresis | dV _{REMOTE} | 60 | 90 | 120 | mV | |
| Input bias current | I _{REMOTE} | -100 | -50 | — | μA | REMOTE = 2 V |
| ERROR AMPLIFIER: R2A20124AFP/ASP | | | | | | |
| FB(-) input voltage | V _{FB(-)} | 1.225 | 1.250 | 1.275 | V | FB(-) and COMP are shorted |
| FB(-) input current | I _{FB(-)} | -2.0 | 0 | 2.0 | μA | FB(-) = 1.25 V |
| Open-loop DC gain | A _v | — | 80 ^{*1} | — | dB | |
| Unity gain bandwidth | BW | — | 2 ^{*1} | — | MHz | |
| Output source current | I _{SOURCE} | -650 | -500 | -390 | μA | FB(-) = 0.75 V, COMP = 2 V |
| Output sink current | I _{SINK} | 2.0 | 6.5 | — | mA | FB(-) = 1.75 V, COMP = 2 V |
| Output high voltage | V _{OH-EO} | 3.7 | 3.9 | — | V | FB(-) = 0.75 V, COMP; open |
| Output low voltage | V _{OL-EO} | — | 0.1 | 0.4 | V | FB(-) = 1.75 V, COMP; open |
| Output clamp voltage ^{*3} | V _{CLAMP-EO} | -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. $V_{\text{CLAMP-EO}} = V_{\text{COMP}} - \text{SS voltage (1 V)}$

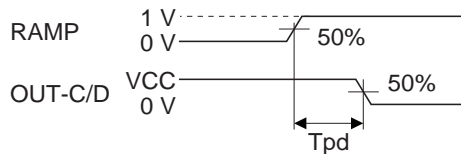
Electrical Characteristics (cont.)

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

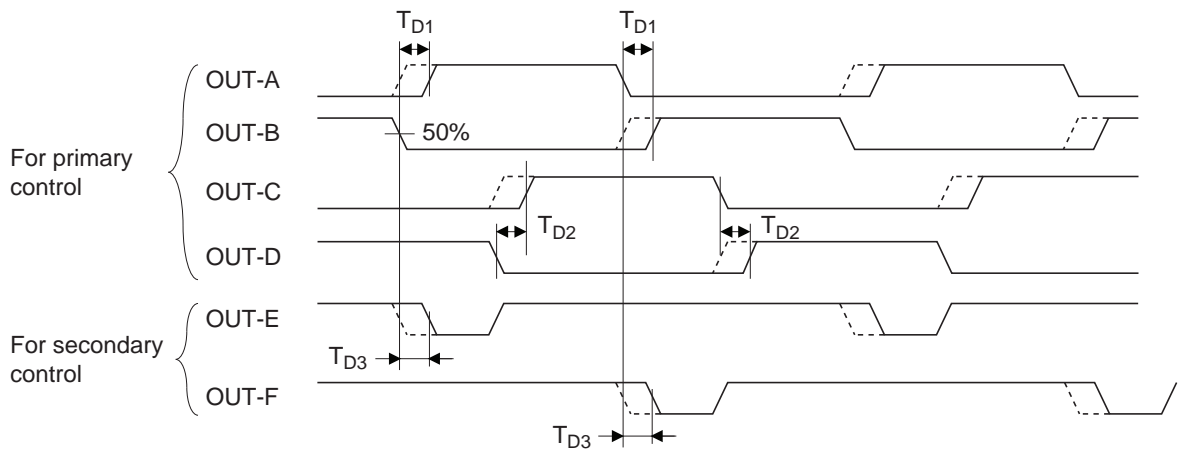
| Item | Symbol | Min | Typ | Max | Unit | Test Conditions |
|----------------------------------|--------------------------|-------|----------|-------|------|----------------------------|
| PHASE MODULATOR: R2A20124AFP/ASP | | | | | | |
| RAMP offset voltage | V _{RAMP} | 1.035 | 1.135 | 1.235 | V |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

Notes: 1. Design specification (reference data)

2. T_{pd} is defined as;

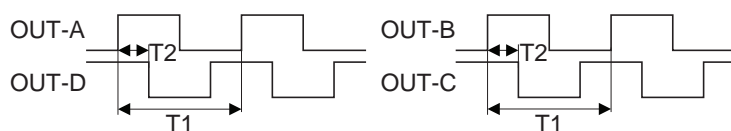


3. T_{D1}, T_{D2}, and T_{D3} are defined as;



4. Maximum/Minimum phase shift is defined as;

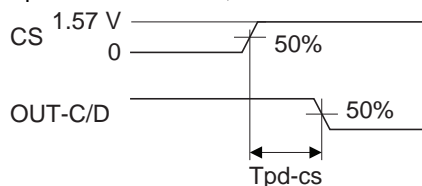
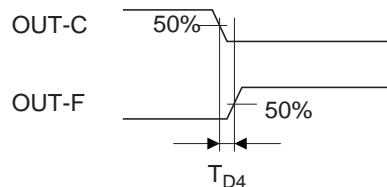
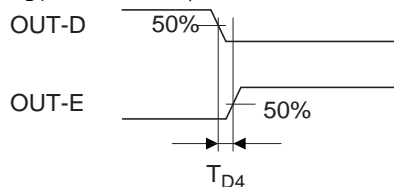
$$D = \frac{T_2}{T_1} \times 2 \times 100 (\%)$$



Electrical Characteristics (cont.)

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

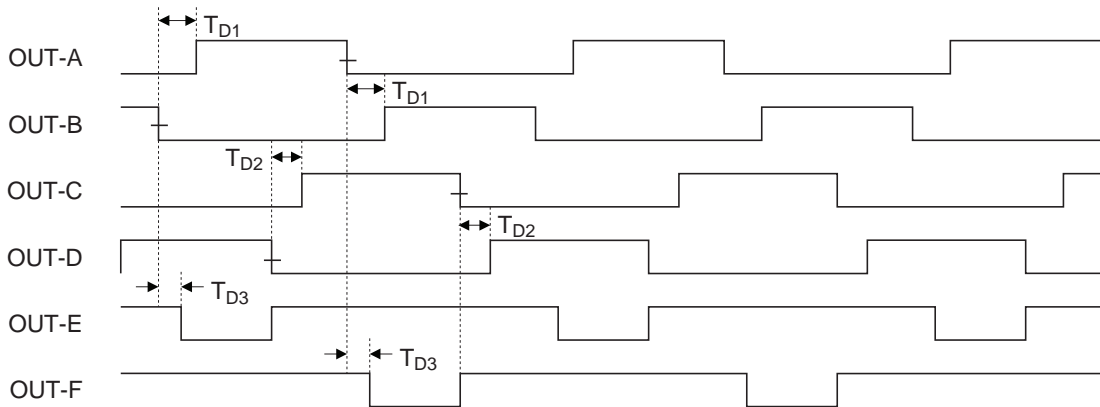
| Item | Symbol | Min | Typ | Max | Unit | Test Conditions |
|--|---------------------------|------|------|------|------|---|
| OVER CURRENT PROTECTION: R2A20124AFP/ASP | | | | | | |
| Pulse-by-pulse current limit threshold | V _{CS-PP} | 1.26 | 1.4 | 1.54 | V | SEC-CONT = 0.3 V (AFP) |
| Delay to OUT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

Notes: 1. T_{pd-cs} is defined as;2. T_{D4} is defined as;

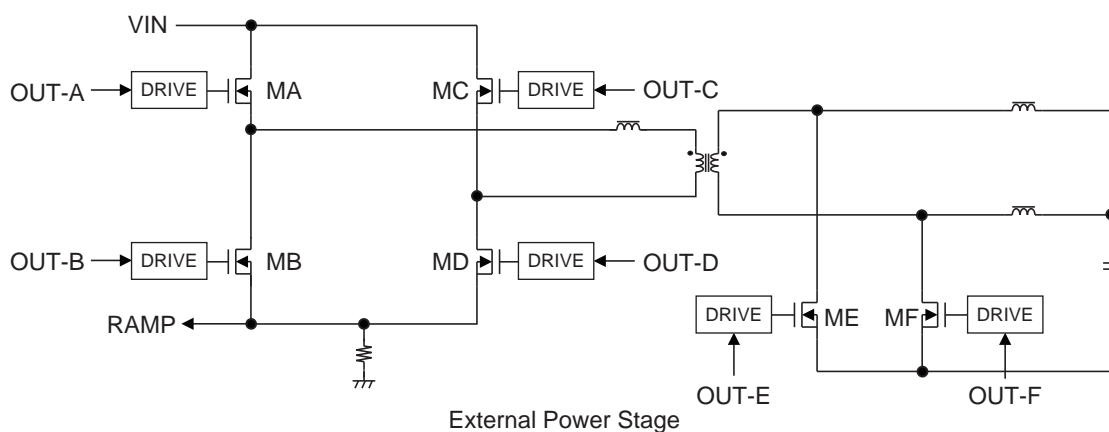
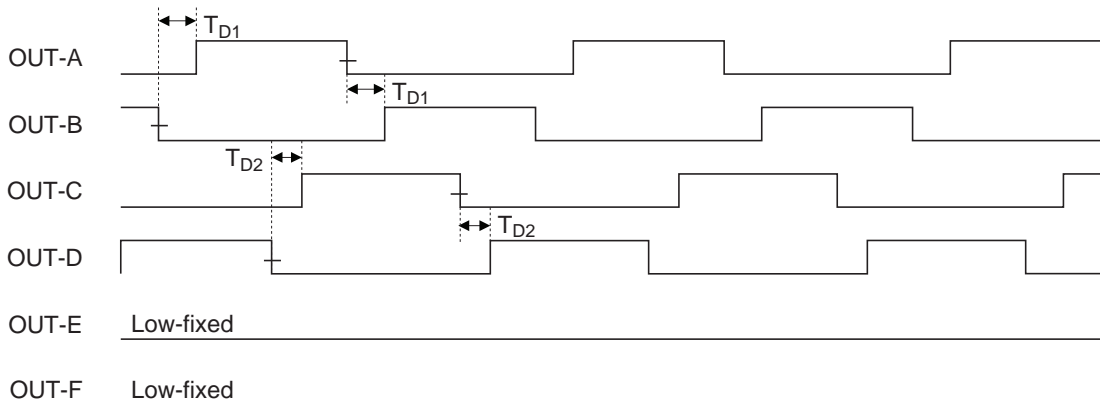
Timing Diagram

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

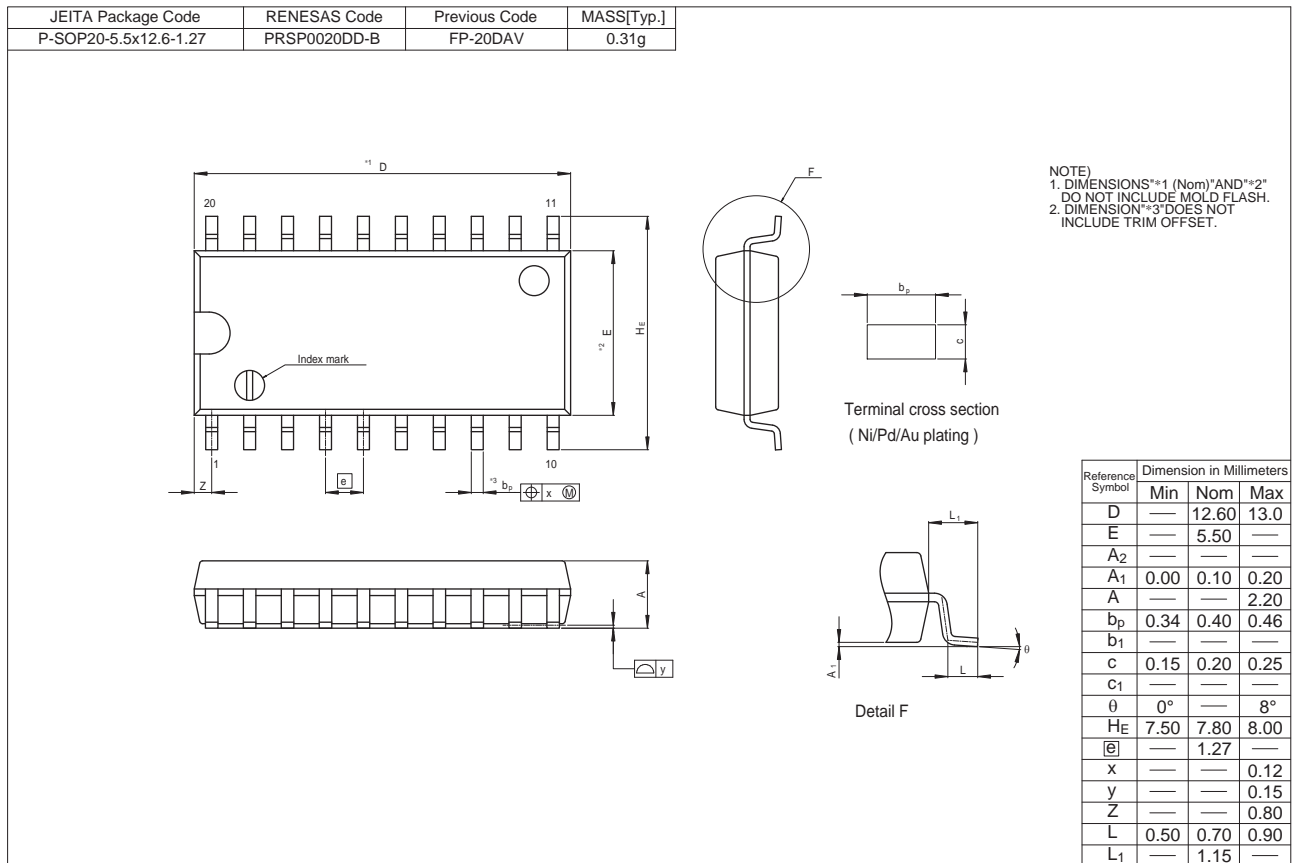
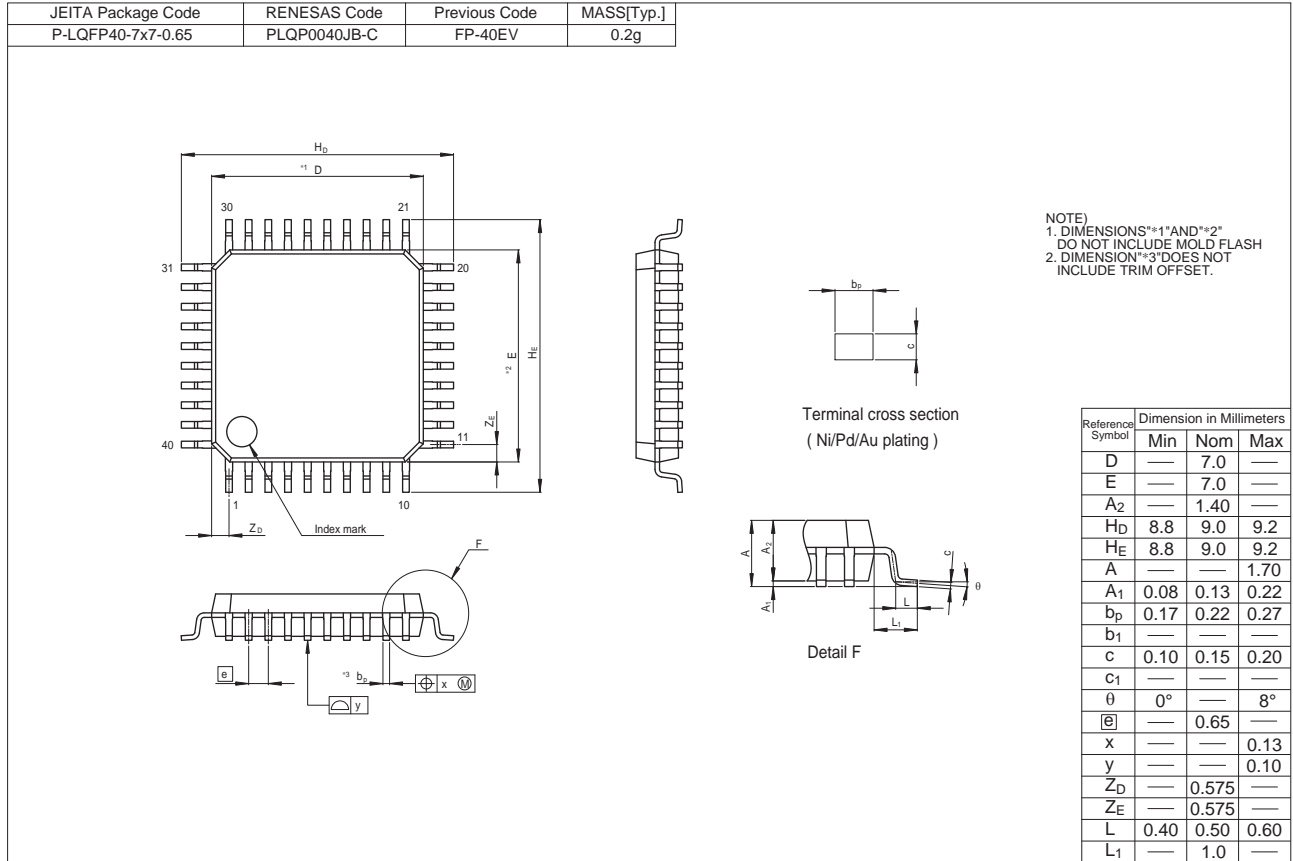
• Full Bridge and Secondary Control: R2A20124AFP/ASP



• 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