

# R2A20124AFP/R2A20124ASP

R03DS0031EJ0300

Rev.3.00

## Synchronous Phase Shift Full-Bridge Control IC Series

Mar 11, 2011

### 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

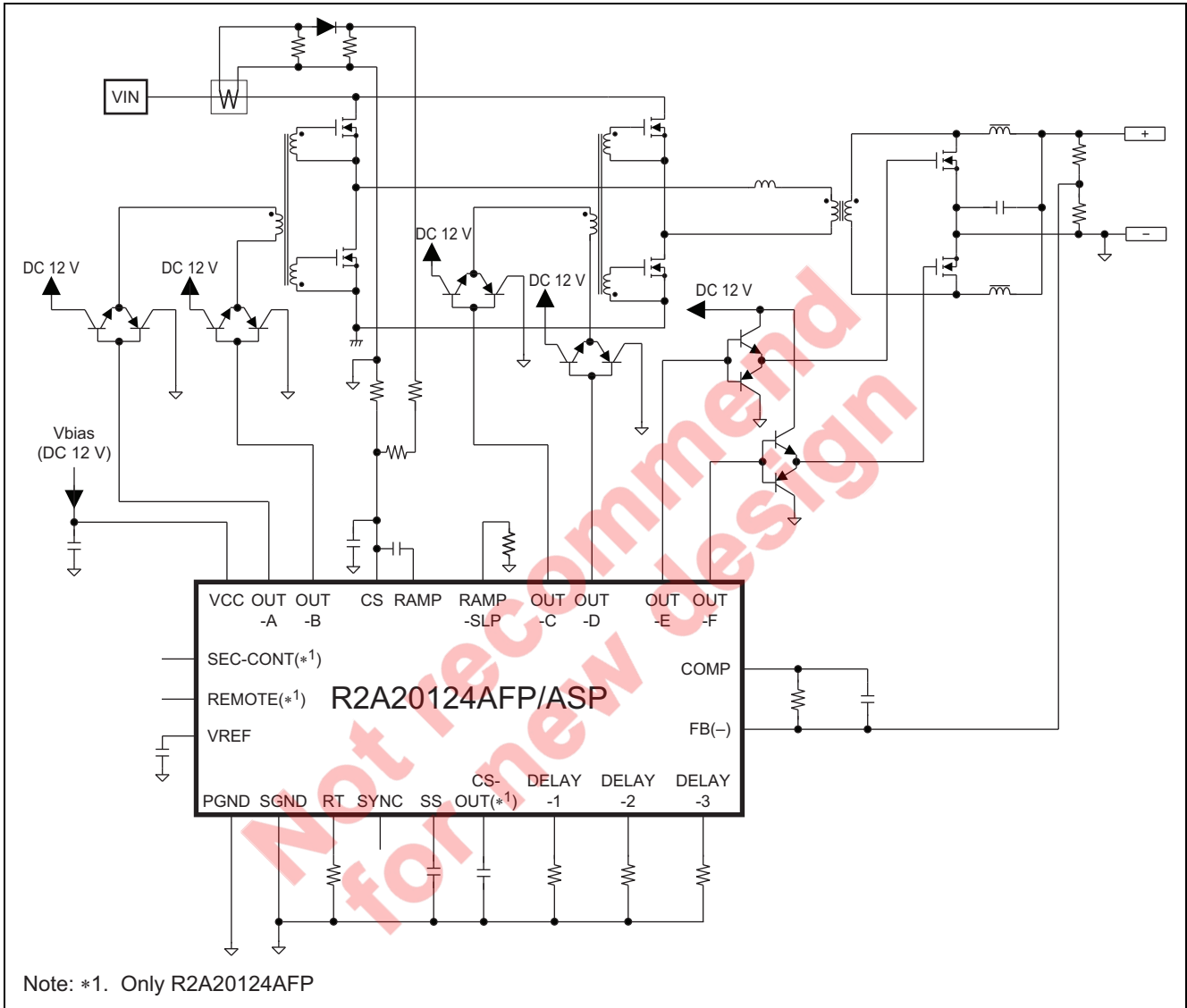
### Ordering Information

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			—

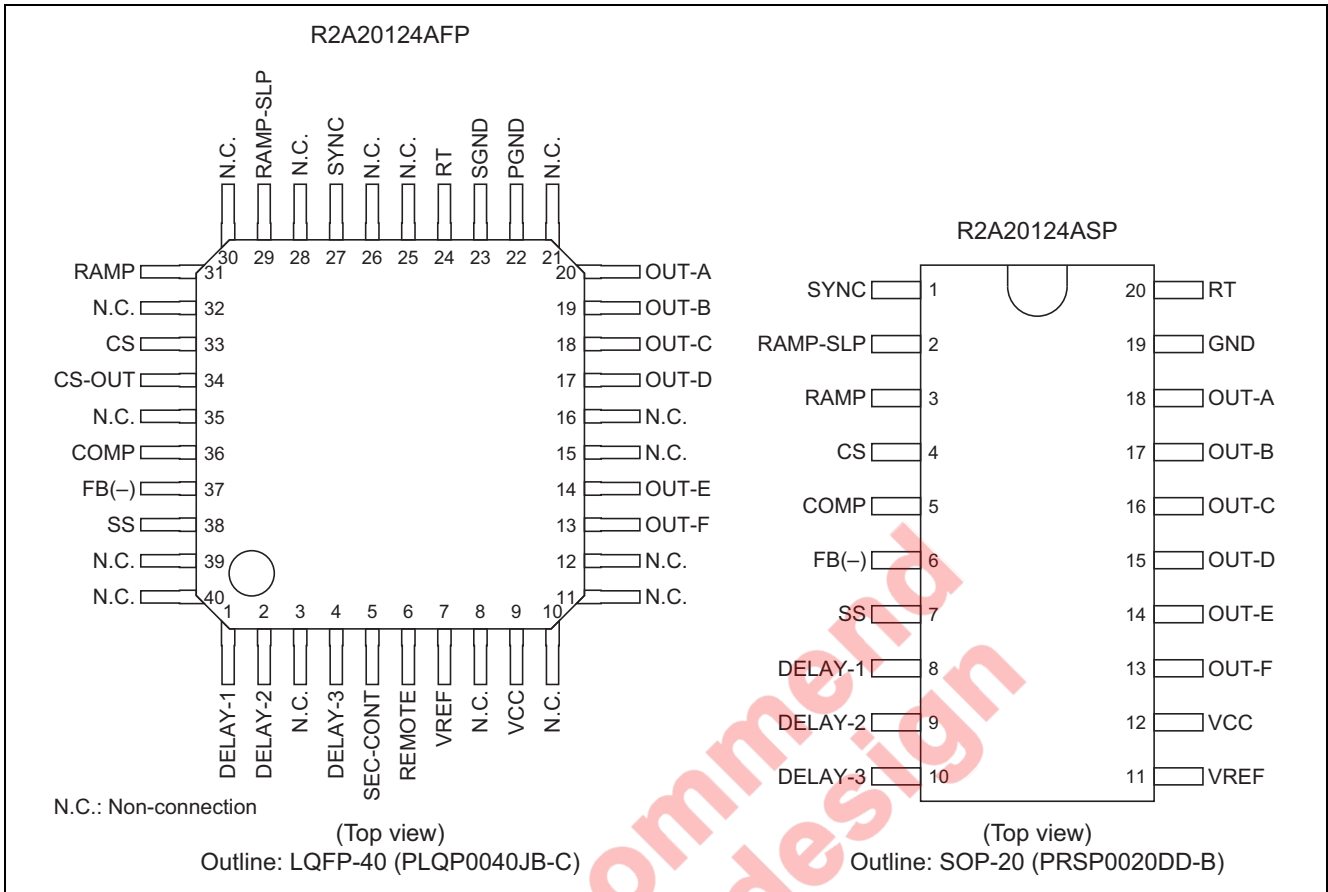
### Modified Points from R2A20121SP

- 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

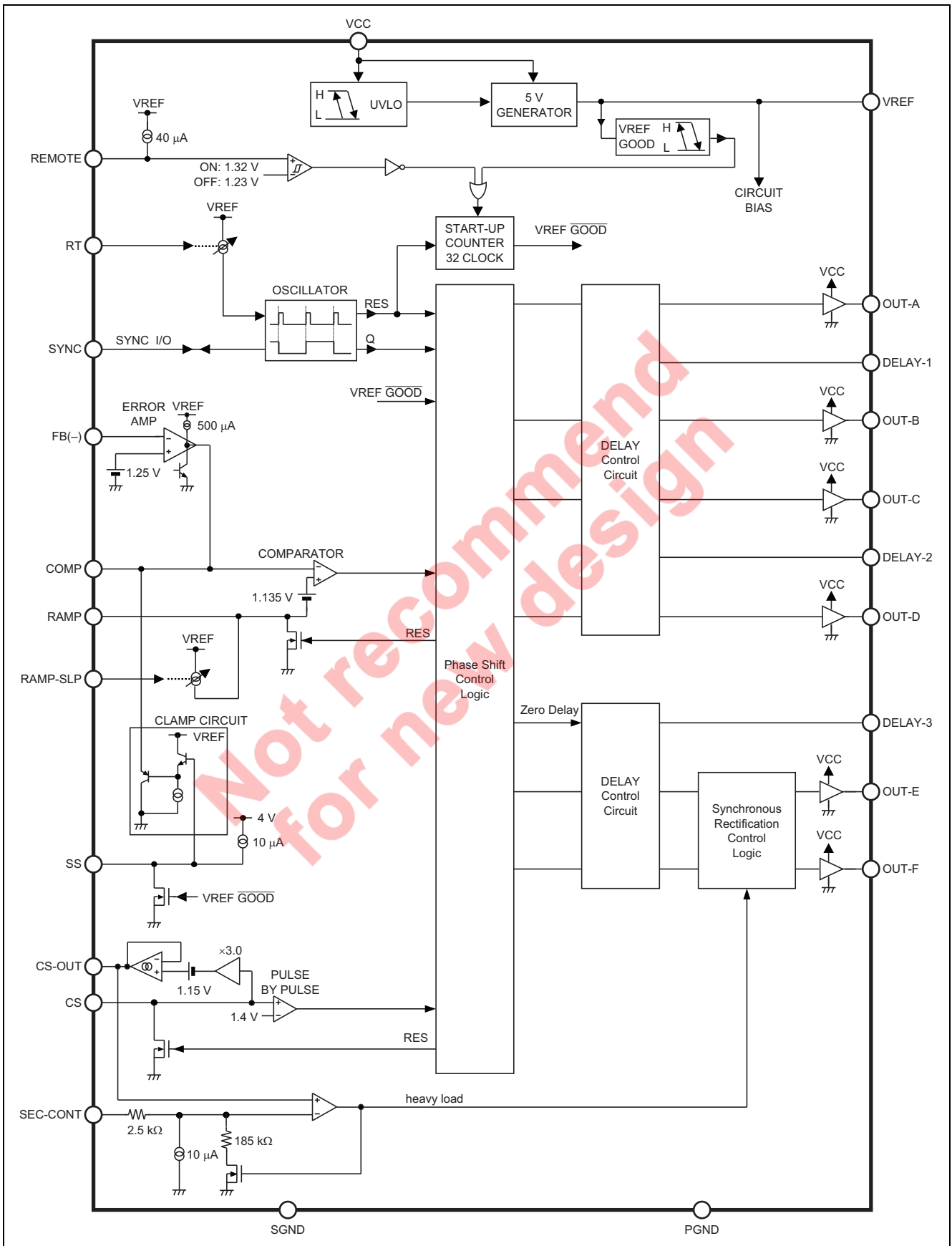


## Pin Functions

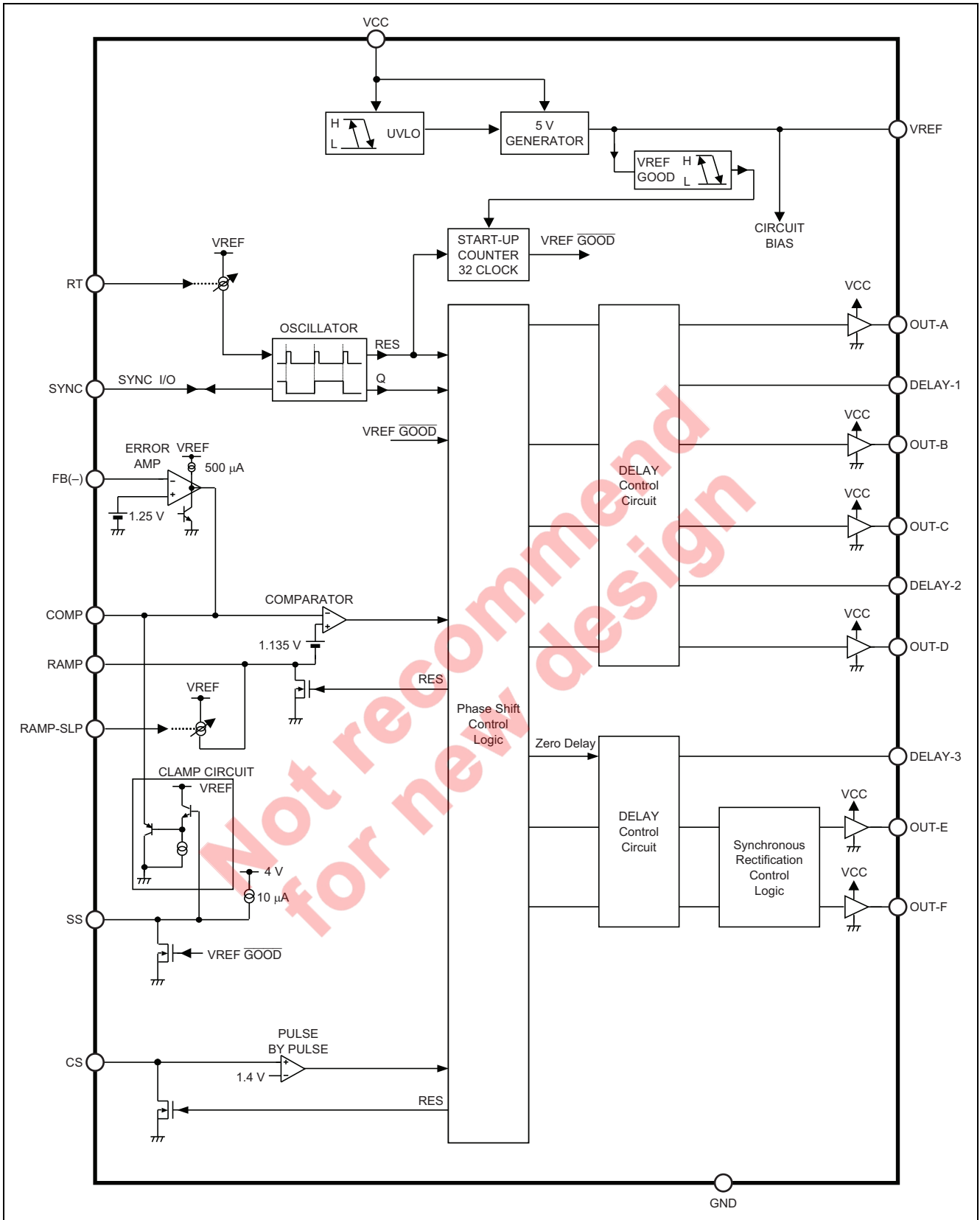
LQFP-40 Pin No.	SOP-20 Pin No.	Pin Name	Input/Output	Pin Function
1	8	DELAY-1	Input/Output	Delay time adjustor for the full-bridge control signal (OUT-A and B)
2	9	DELAY-2	Input/Output	Delay time adjustor for the full-bridge control signal (OUT-C and D)
4	10	DELAY-3	Input/Output	Delay time adjustor for 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	I <sub>ref-out</sub>	-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.

Not recommended  
for new design

## 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>	—	0.10	0.18	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)

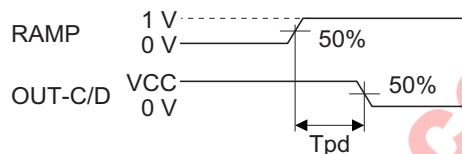
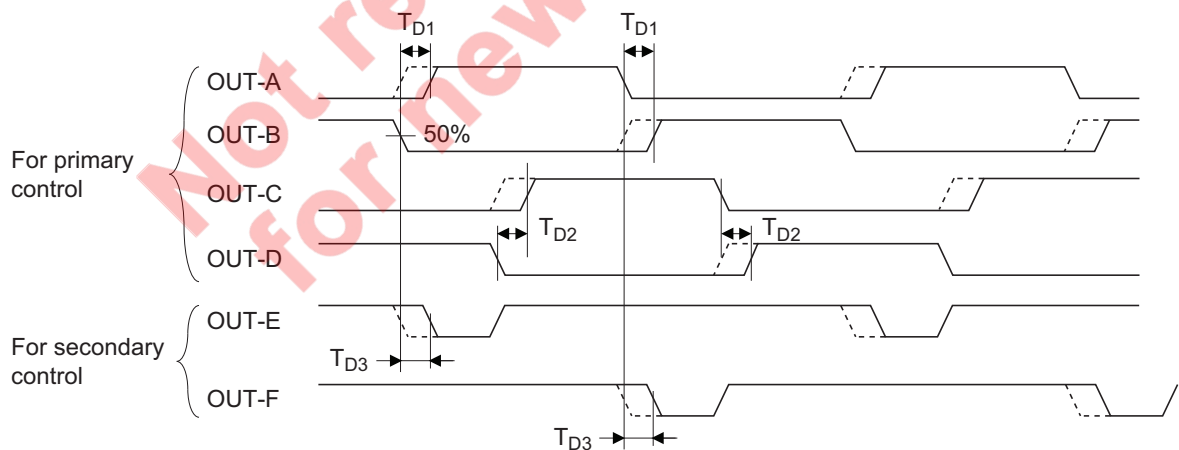


## Electrical Characteristics (cont.)

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

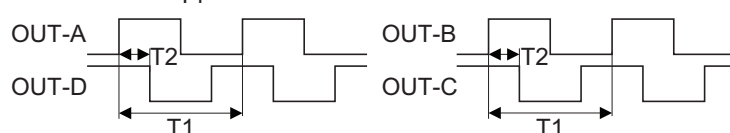
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
PHASE MODULATOR: R2A20124AFP/ASP						
RAMP offset voltage	V <sub>RAMP</sub>	1.035	1.135	1.235	V	
RAMP source current	I <sub>SOURCE-RAMP</sub>	-220	-185	-150	μA	RAMP = 0.15 V, COMP; open
RAMP sink current	I <sub>SINK-RAMP</sub>	3	10	—	mA	RAMP = 0.15 V, COMP = 0 V
Minimum phase shift	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 <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;

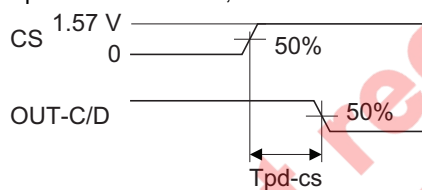
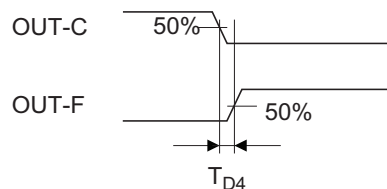
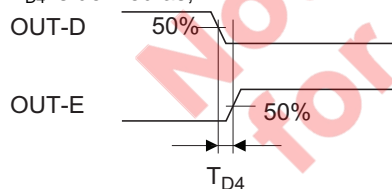
$$D = \frac{T_2}{T_1} \times 2 \times 100 (\%)$$



## Electrical Characteristics (cont.)

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

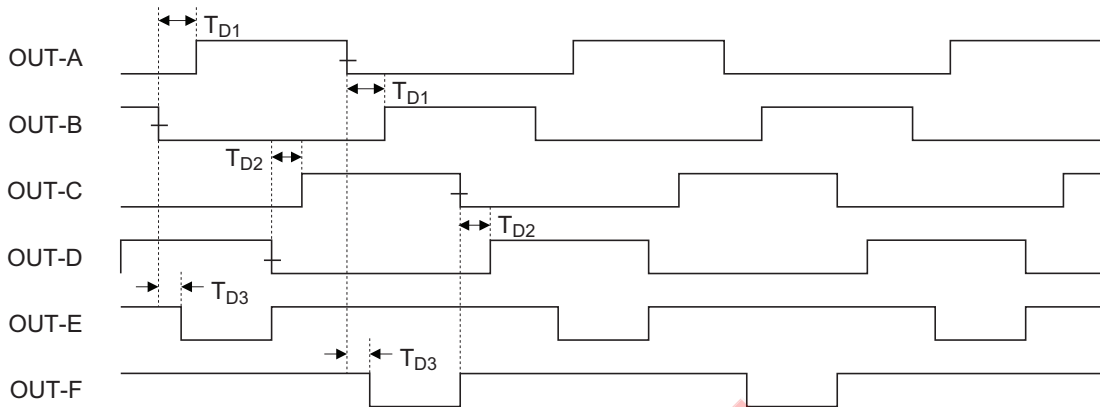
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
OVER CURRENT PROTECTION: R2A20124AFP/ASP						
Pulse-by-pulse current limit threshold	V <sub>CS-PP</sub>	1.26	1.4	1.54	V	SEC-CONT = 0.3 V (AFP)
Delay to OUT pins *1	T <sub>pd-cs</sub>	—	100	200	ns	CS = 0 V to 1.57 V, SEC-CONT = 0.3 V (AFP)
CS sink current	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;

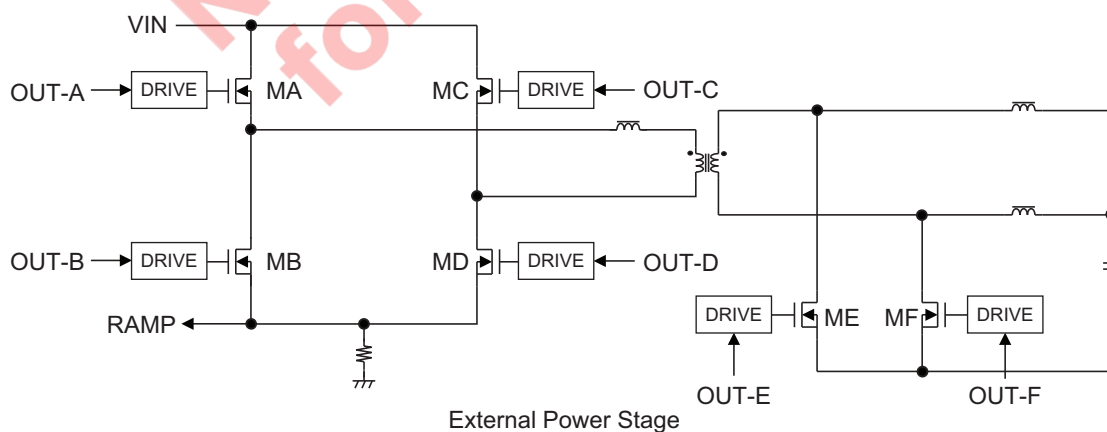
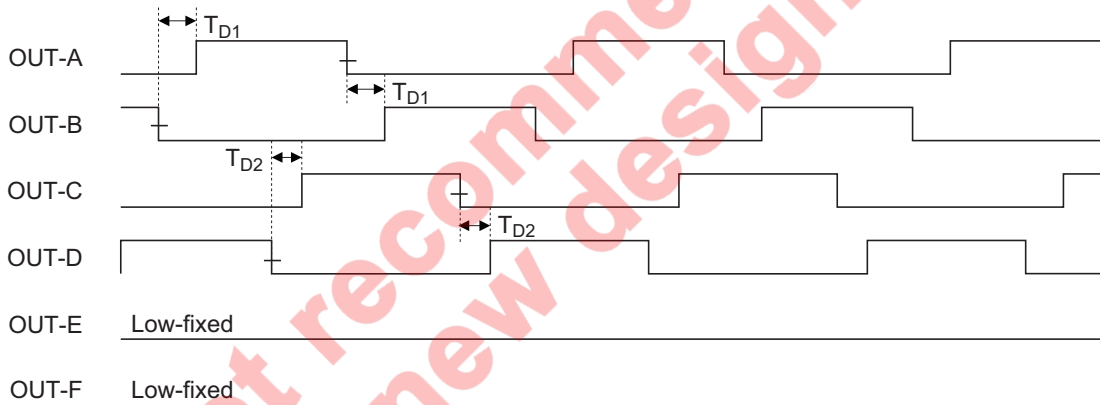
### Timing Diagram

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

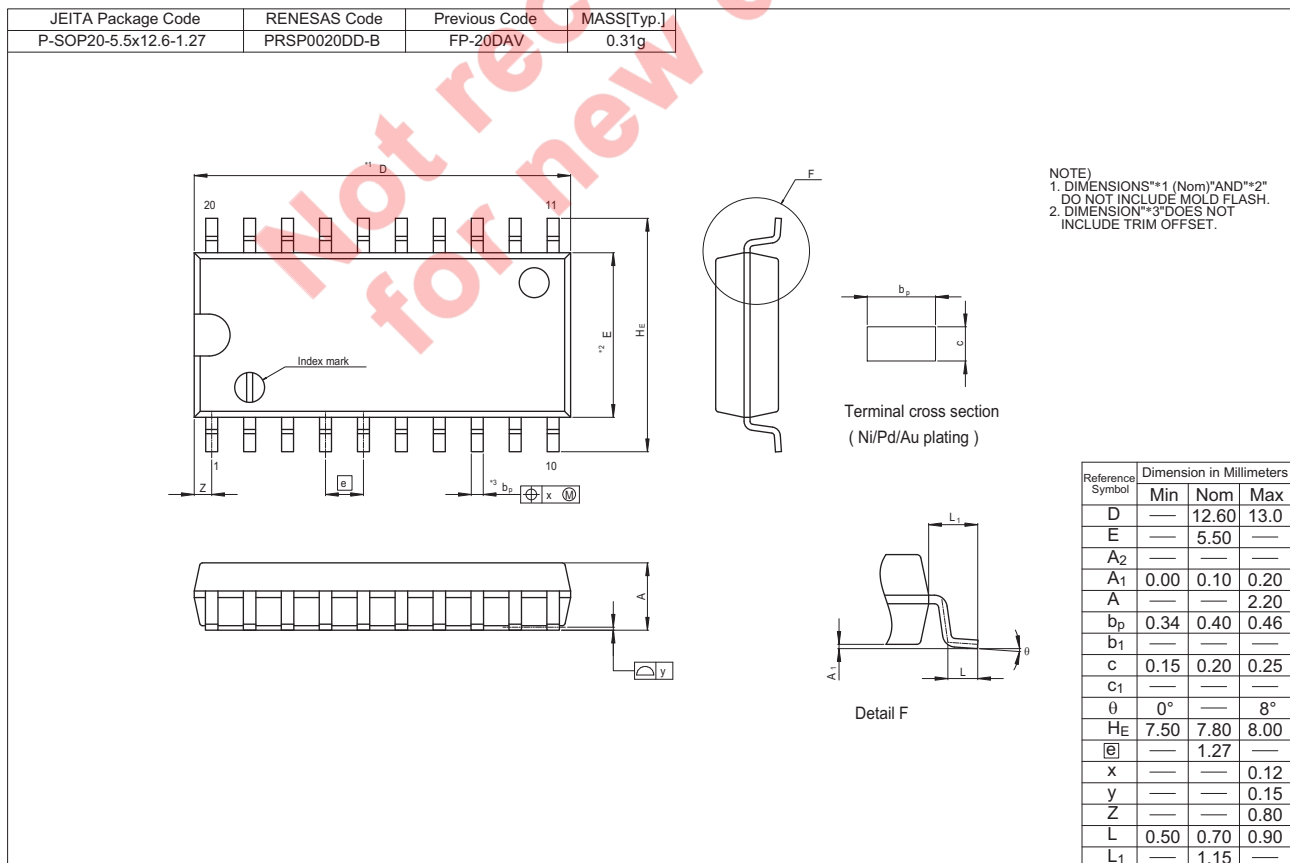
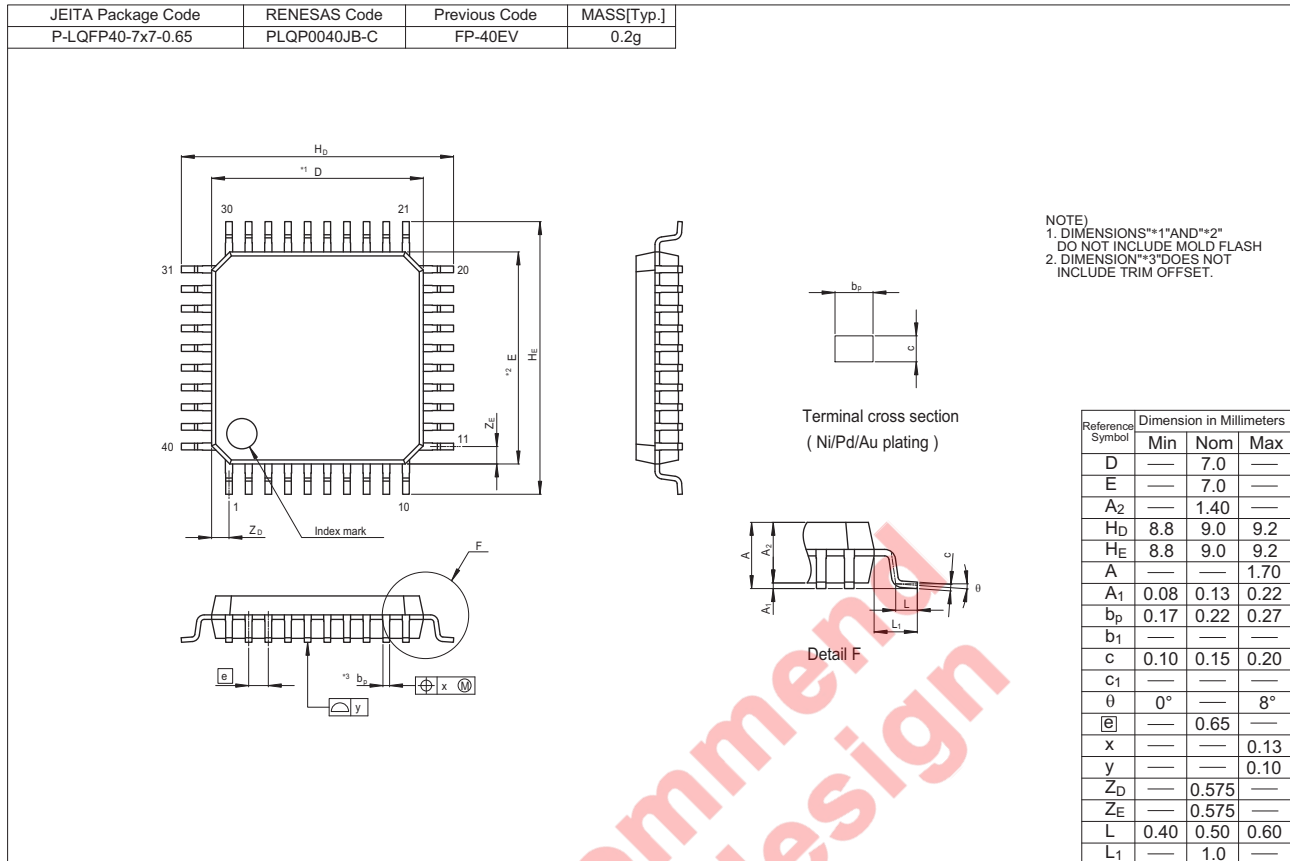
• Full Bridge and Secondary Control: R2A20124AFP/ASP



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



Package Dimensions



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