RAA23014x RAA23015x

28.0V Input, Step-Down DC/DC Converter + Battery Backup

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Description

The RAA23014x and RAA23015x are 1CH step-down DC/DC converter, 7V to 28V input voltage range. Auto PFM mode makes devices low power operation at light load, so it makes a system lower power.
The RAA23014x is suitable for battery backup system using lithium primary cell with built-in battery backup circuit.

Features

- DC/DC

Synchronous rectification type step-down DC/DC	
Auto PFM mode	
Battery backup circuit (RAA23014x)	
Input voltage range	7V to 28V
Output voltage range	0.8V to 6V
Maximum output current	3A
Shutdown current	1uA (typ.)
Switching frequency	1.1MHz (fixed)
Soft start	2ms (fixed)
Integrated power MOSFETs	
Discharge circuit	
Internal phase compensator	

- Protection circuit

Short circuit protection (latch type)	
Thermal shutdown circuit	165°C (typ.)
Under voltage lockout circuit (recovery type)	

- Package

  16-pin HTSSOP (RAA23014x)
  8-pin HLSOP (RAA23015x)

Application

Communication (Router, Home Gate Way, Radio, etc.)
Industrial (Surveillance camera, Various controller, etc.)
Building (Security device, Emergency device, Various controller, etc.)
OA (Printer, Plane paper copier, etc.)
Smart meter
Smart home appliances
And, usable various application

Note: A quality grade of the devices is “Standard”. Recommended applications are indicated below.
Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment, and industrial robots, etc.

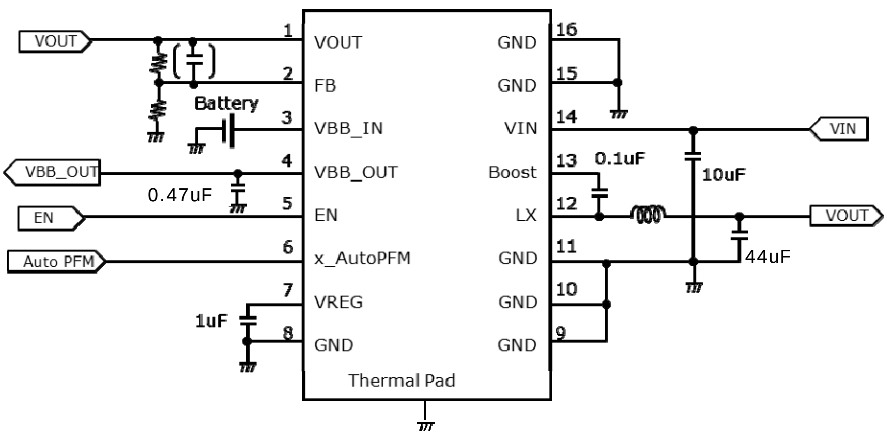
Product Lineup Table

Part number	Output	Type	VIN range	VOUT	IOUT (max.)	Package	SW frequency
RAA230141	1	Step-down + BB	7V to 28V	3.3V(fixed)	3A	16pin HTSSOP	1.1MHz
RAA230142	1	Step-down + BB	7V to 28V	5.0V(fixed)	3A	16pin HTSSOP	1.1MHz
RAA230143	1	Step-down + BB	7V to 28V	0.8V to 6.0V (adjustable by external resistors)	3A	16pin HTSSOP	1.1MHz
RAA230151	1	Step-down	7V to 28V	3.3V(fixed)	3A	8pin HLSOP	1.1MHz
RAA230152	1	Step-down	7V to 28V	5.0V(fixed)	3A	8pin HLSOP	1.1MHz
RAA230153	1	Step-down	7V to 28V	0.8V to 6.0V (adjustable by external resistors)	3A	8pin HLSOP	1.1MHz

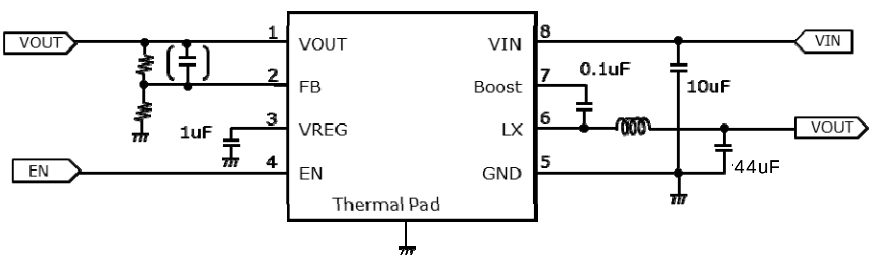
Note BB : Battery Backup

Circuit example

RAA230143 (1CHDCDC + Battery Backup, VOUT set by external resistors)

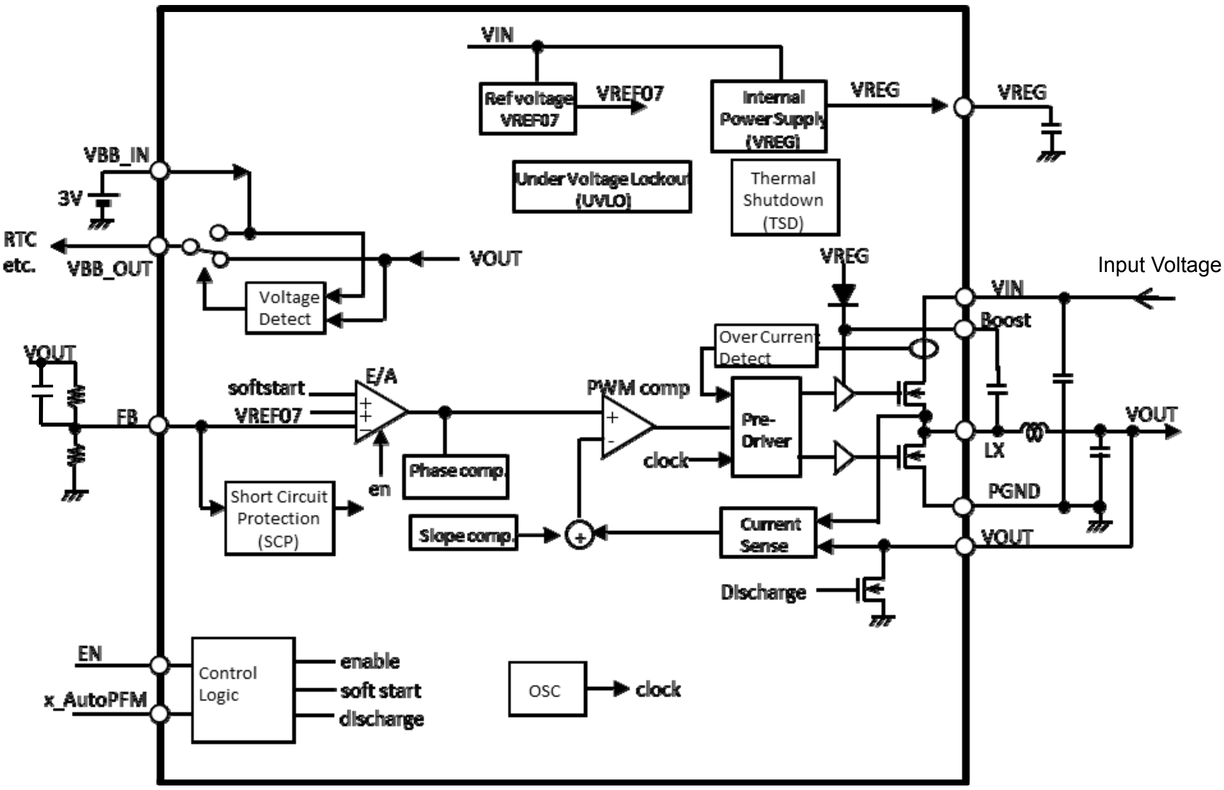


RAA230153 (1CHDCDC, VOUT set by external resistors)

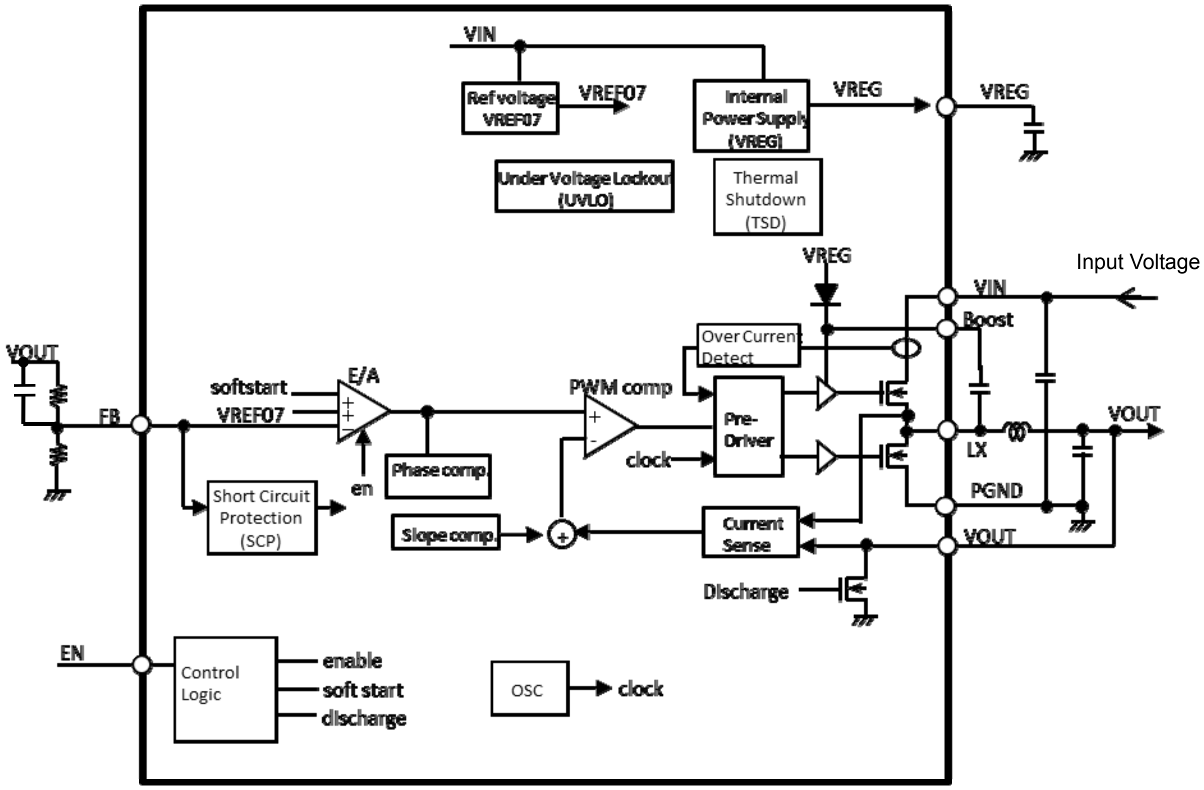


Block Diagram

RAA23014x (1CHDCDC + Battery backup, VOUT set by external resistors)



RAA23015x (1CHDCDC, VOUT set by external resistors)



Pin Function

RAA23014x (1CHDCDC + Battery backup)

Pin No.	Symbol	I/O	Function
1	VOUT	I	VOUT feedback
2	FB	I	Feedback resistor connection
3	VBB_IN	I	Battery connection
4	VBB_OUT	O	Backup voltage output
5	EN	I	Device enable EN="L" : Disable (shutdown) EN="H" : Enable (operation)
6	x_AutoPFM	I	Auto PFM mode ON/OFF x_AutoPFM="L" : Auto PFM mode (change automatically) PFM mode at light load PWM mode at heavy load x_AutoPFM="H" : PWM mode (fixed)
7	VREG	O	Internal power supply output (Connect 1uF capacitor between VREG and GND)
8	GND	I/O	Ground
9	GND	I/O	Ground
10	GND	I/O	Ground
11	GND	I/O	Ground
12	LX	O	Inductor connection
13	Boost	I	Boot strap input (Connect 0.1uF capacitor between LX and Boost)
14	VIN	I	Power supply
15	GND	I/O	Ground
16	GND	I/O	Ground

RAA23015x (1CHDCDC)

Pin No.	Symbol	I/O	Function
1	VOUT	I	VOUT feedback
2	FB	I	Feedback resistor connection
3	VREG	O	Internal power supply output (Connect 1uF capacitor between VREG and GND)
4	EN	I	Device enable EN="L" : Disable (shutdown) EN="H" : Enable (operation)
5	GND	I/O	Ground
6	LX	O	Inductor connection
7	Boost	I	Boot strap input (Connect 0.1uF capacitor between LX and Boost)
8	VIN	I	Power supply

Absolute Maximum Ratings

(Unless otherwise specified, TA = 25°C)

Parameter		Symbol	Ratings	Unit	Condition
VIN applied voltage		VIN	-0.3 to +30.0	V	VIN
EN applied voltage		EN	-0.3 to +30.0	V	EN
x_AutoPFM applied voltage (RAA23014x)		x_AutoPFM	-0.3 to +30.0	V	x_AutoPFM
FB applied voltage		FB	-0.3 to +6.5	V	FB
VOUT applied voltage		VOUT	-0.3 to +6.5	V	VOUT
VBB_IN applied voltage (RAA23014x)		VBB_IN	-0.3 to +6.5	V	VBB_IN
VIN input current(peak)		IVIN(peak)-	4.2	A	VIN
LX output current(peak)		ILX(peak)+	4.2	A	LX
VOUT sink current (DC)		IVOUT(DC)-	100	mA	VOUT When discharge circuit operation
GND voltage		GND	-0.3 to +0.3	V	GND
Total power dissipation	16pin HTSSOP	PT	2900[*1]	mW	TA≦＋25℃
	8pin HLSOP	PT	2600[*2]		
Operating ambient temperature		TA	-40 to +85	°C	
Operating junction temperature		TJ	-40 to +125	°C	
Storage temperature		Tstg	-55 to +150	°C	

Note: *1 This is the value at T_A < +25°C. At T_A > +25°C, the total power dissipation decrease with -29.0 mW/°C.
Board specification : 4-layers glass epoxy board, 76.2mm x 114.3mm x 1.664mm.
Copper coverage area: 50%, 0.070mm thickness (top and bottom layers)
95%, 0.035mm thickness (layers 2 and 3).
Connecting exposed pad

*2 This is the value at T_A < +25°C. At T_A > +25°C, the total power dissipation decrease with -26.0 mW/°C.
Board specification : 4-layers glass epoxy board, 76.2mm x 114.3mm x 1.664mm.
Copper coverage area: 50%, 0.070mm thickness (top and bottom layers)
95%, 0.035mm thickness (layers 2 and 3).
Connecting exposed pad

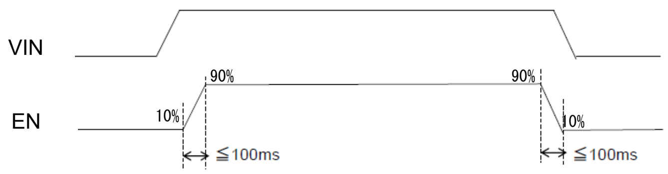
Caution: Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

Recommended Operating Condition

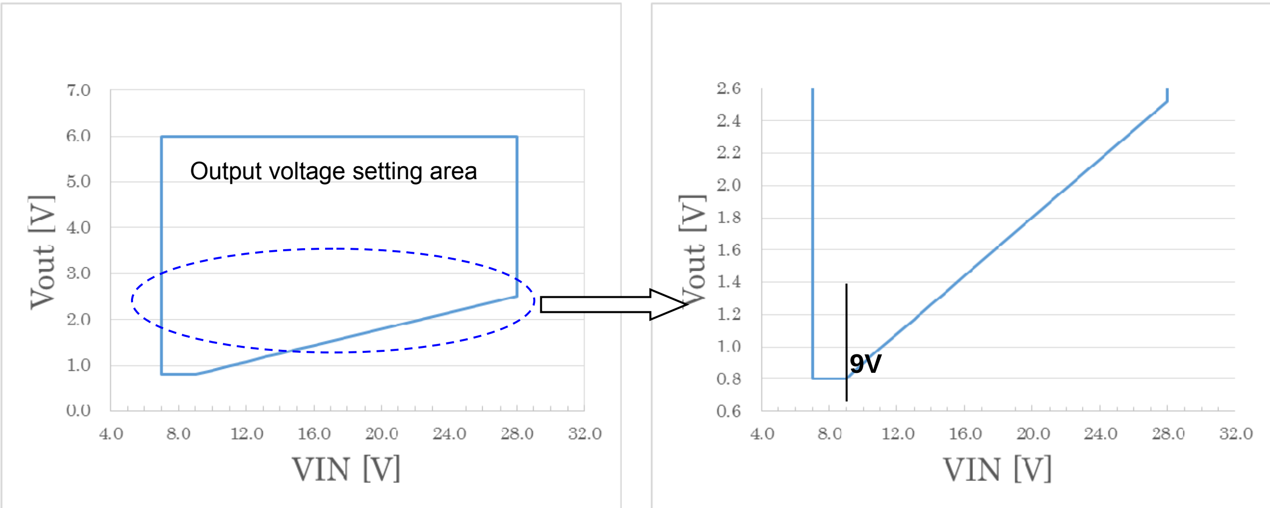
(Unless otherwise specified, TA = 25°C)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Condition
VIN applied voltage	VIN	7		28.0	V	VIN
EN applied voltage	EN	0		28.0	V	EN*1
x_AutoPFM applied voltage	x_AutoPFM	0		28.0	V	x_AutoPFM
FB applied voltage	FB	0		6.0	V	FB
Output voltage set by external resistors	Vdcdc_ext	*2		6.0	V	RAA230143/153

*1 About rising time (tr) and falling time (tf) of input signal to EN1 and EN2 pins, when EN1 and EN2 pins are not connected to power supply pin (VIN), set tr and tf less than 100ms.
When EN1 and EN2 pins are connected to VIN pin, there are no restriction.



*2 RAA230143/153 Output voltage setting area (Expansion of a lower limit)



Electrical Characteristics

(Unless otherwise specified, TA = 25°C, VIN = 24V)

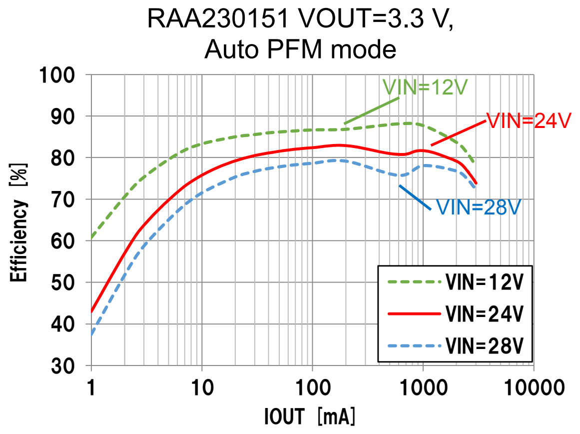
Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Condition
Total	Shutdown current	IDD(SHDN)		1	10	uA	EN=GND
Under voltage lock out circuit (UVLO)	Operating start voltage	Vrls(vin)	3.6	3.9	4.2	V	VIN rising are detected
	Operating stop voltage	Vdet(vin)	3.4	3.7	4.0	V	VIN falling are detected
Internal power supply (VREG)	Internal power supply voltage	VREG	4.7	5.0	5.3	V	Ireg = 0mA, VIN=7V to 28.6V
Output (PWM mode)	E/A feedback voltage	vref07	0.693	0.700	0.707	V	Include input offset RAA230143/153
	E/A feedback voltage + Feedback resistor accuracy	Vacc	-2.5		+2.5	%	RAA230141/142/151/152
	High side FET on-resistance	Ronh		220		mΩ	Iout = 100mA
	Low side FET on-resistance	Ronl		170		mΩ	Iout = 100mA
Discharging Circuit block	On resistance	Rondc		100	200	Ω	Io=15mA
Soft start	Soft start time*1	tss	1.2	2	3.5	ms	
Thermal shutdown circuit	Detect temperature*2			165		°C	
	Hysteresis temperature*2			20		°C	
Logic input	High level threshold voltage	VIH	1.3		VIN+0.3	V	EN, x_AutoPFM
	Low level threshold voltage	VIL	-0.3		0.4	V	EN, x_AutoPFM
	Input current	IEN		1		uA	EN = 3.3V x_AutoPFM = 3.3V
Battery backup (only RAA23014x)	VBB input voltage range	VBB	2.7	3.0	3.7	V	
	On-resistance between VBB_IN and VBB_OUT	Ron_vbat		400		Ω	VBB_OUT = VBB_IN, Io=0.5mA
	On-resistance between VOUT and VBB_OUT	Ron_vout		100		Ω	VBB_OUT = VOUT, Io=0.5mA

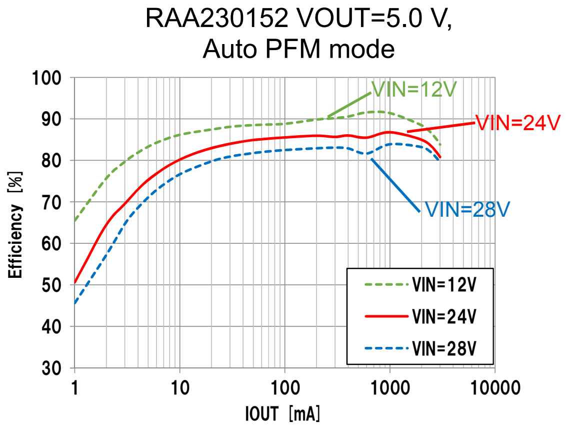
Note: *1 Reference value
*2 Not production tested.

Typical Performance Characteristics

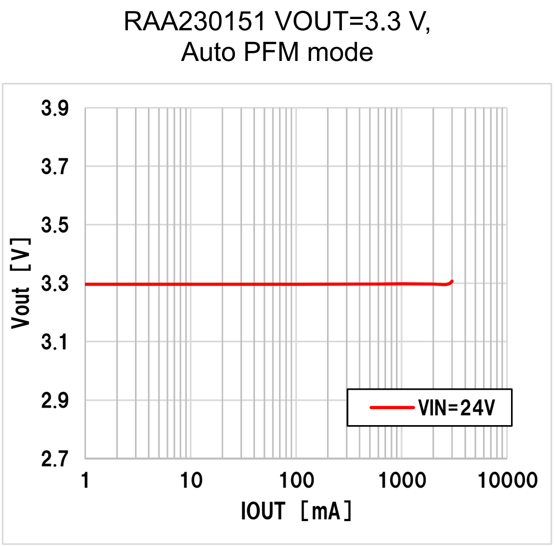
(Unless otherwise specified, T_A = 25°C)

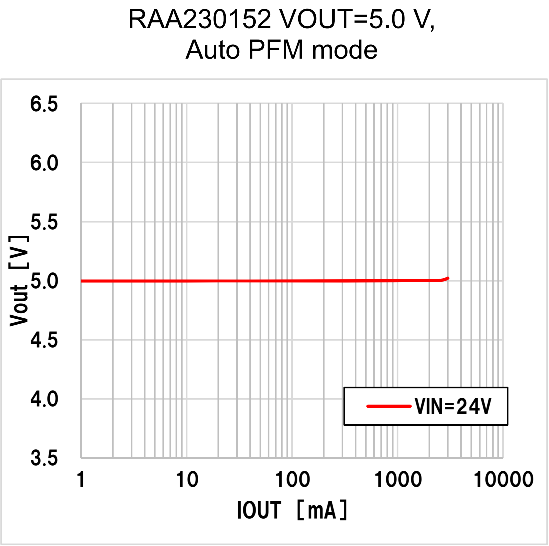
Efficiency vs. Output Current



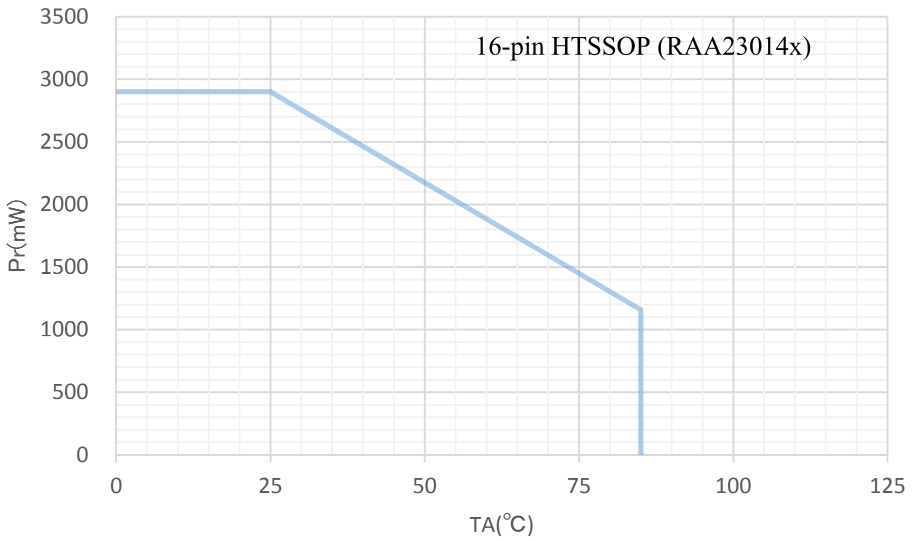


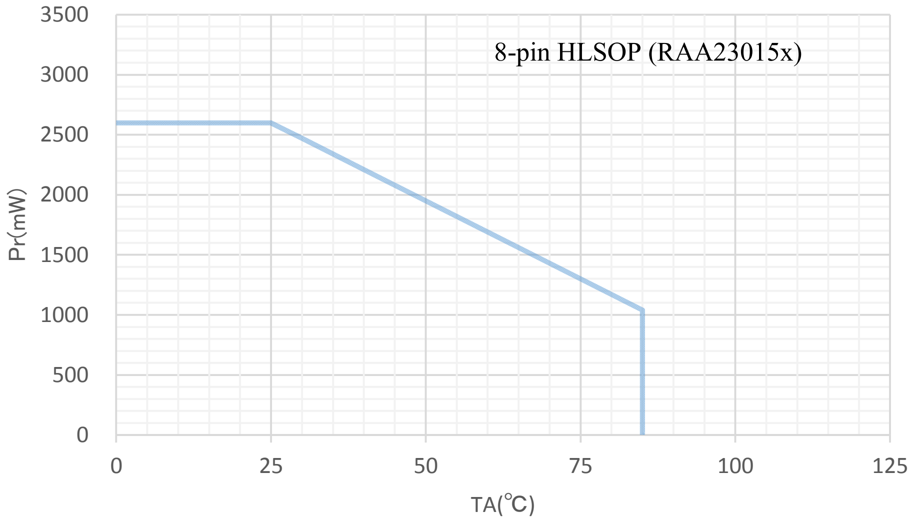
Output Voltage vs. Output Current





Temperature Derating Curve





Detailed Description

Control Block

EN : ON/OFF setting

EN	state	VREG
L	Shutdown	0V
H	Operation	5.0V

Note: L: Low level, H: High level

Note: There is no pull-down resistor within EN pin because of reducing power consumption at light load. Fix EN pin to high level or low.

x_autoPFM : AutoPFM mode/ PWM mode setting (only RAA23014x)

x_autoPFM	Operation
L	Auto PFM mode (change automatically) PFM mode at light load PWM mode at heavy load
H	PWM mode (fixed)

Note: L: Low level, H: High level

Note: There is no pull-down resistor within x_autoPFM pin because of reducing power consumption at light load. Fix x_autoPFM pin to high level or low.

Auto PFM mode

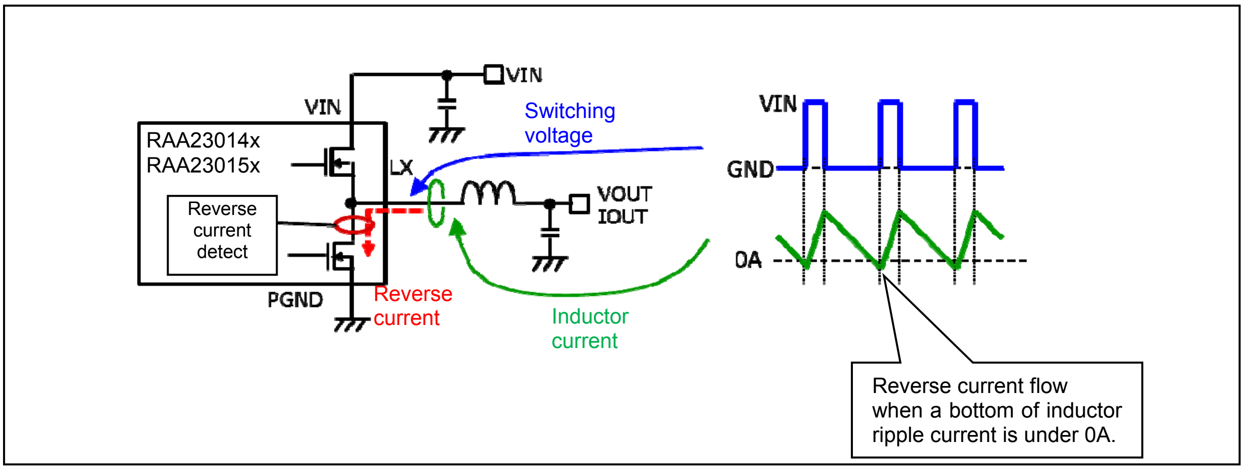
RAA23014x and RAA23015x have Auto PFM mode to achieve high efficiency over a wide load current range. The devices operate with PFM (Pulse Frequency Modulation) mode at light load current, and PWM (Pulse Width Modulation) mode at heavy load current. An operation mode is automatically switched depending on load current.

When a bottom of inductor ripple current is under 0A, reverse current flow at low-side N-channel MOSFET of output block. The devices operate with PFM mode during detecting this current.
A current of switching PFM / PWM mode (I_{change}) is calculated by an equation below.

$$I_{change} = \frac{\Delta IL}{2}$$

$$\Delta IL = \frac{(V_{IN} - V_{OUT})}{L} \times \frac{V_{OUT}}{V_{IN}} \times \frac{1}{f_{SW}}$$

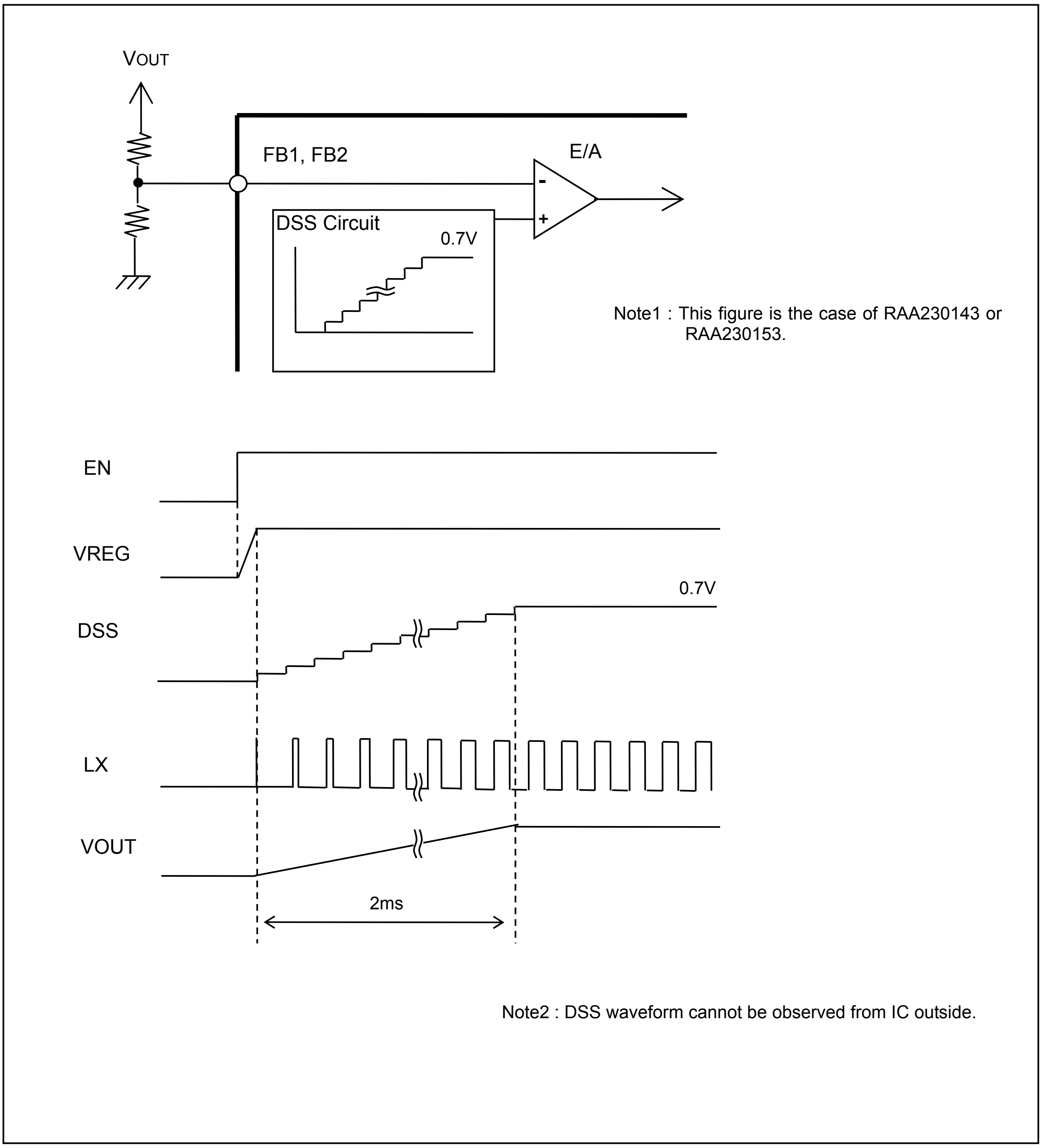
L : inductance, f_{SW} : 1.1MHz



RAA23014x has x_autoPFM pin. When Low level, the devices operate Auto PFM mode (PFM mode / PWM mode changed automatically). When High level, the devices operate PWM mode, then not change into Auto PFM mode.
RAA23015x operates only Auto PFM mode.

Soft Start

To limit the startup inrush current and output voltage overshoot, a soft start circuit is used to ramp up the reference voltage from 0 V to its final value linearly. When EN pin is set from low level to high level, the device starts operation and output voltage rises with soft start. Soft start time are fixed at 2ms(Typ.) and no additional components are needed. Soft start feature gradually increases the error amplifier (E/A) input threshold voltage by using the voltage that is generated by the digital soft start (DSS) circuit.



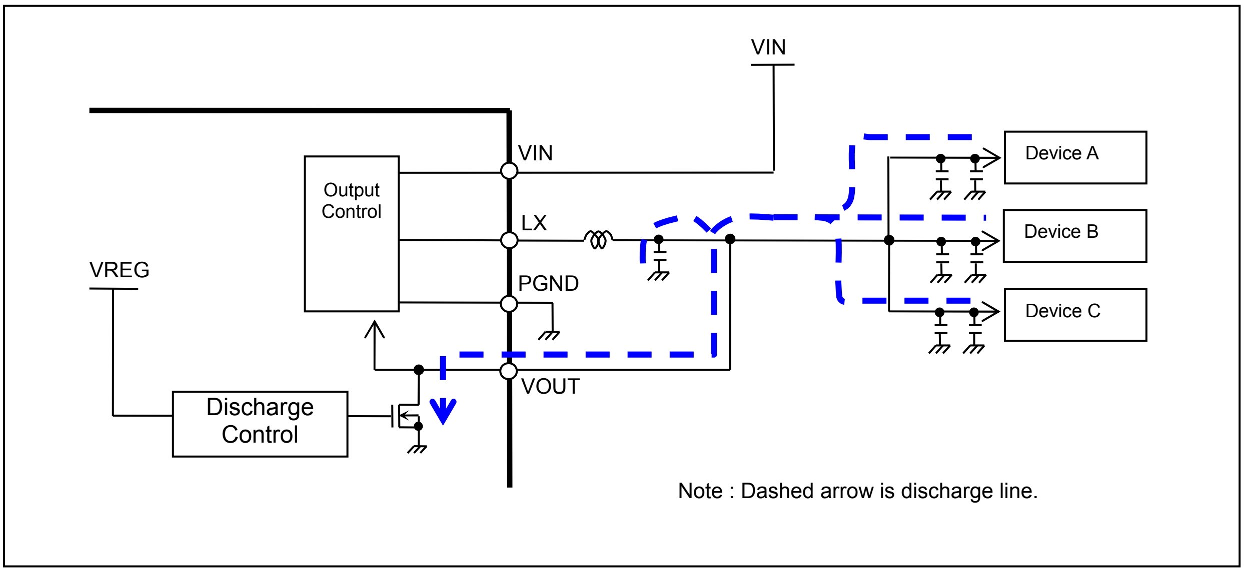
Discharge Circuit

The device has discharge circuit. This enables a rapid discharge without an external MOSFET. When an EN pin is changed from high level to low, discharge switch in VOUT pin is turned on and all capacitors which are connected to DC/DC output are rapidly discharged through VOUT pin. When VIN pin voltage becomes low level, discharge switch become off because there are no voltage to keep them on. The control voltage of discharge switches is VREG, and the discharge time of VREG capacitor is over 100ms when VIN voltage falls down, so even if EN pin is connected to VIN pin, output voltage can be discharged because VREG voltage level can keep the discharge switches on. When VREG voltage falls under 3.7V(typ.), VOUT pin becomes high impedance.

Discharge time can be calculated by an equation below.

$$V_{dc} = V_{OUT} \times e^{-\frac{t_{dc}}{C_{ALL} \times R_{ondc}}}$$

V_{dc} is a voltage after t_{dc}(s).
C_{ALL} is sum of all capacitance which are connected to output (output capacitor, bypass capacitor around MCU, etc.).
R_{ondc} is on resistance of discharge circuit.



Battery Backup (RAA23014x)

RAA23014x has a battery backup circuit which is used to operate some devices at system power-off. The circuit can be easily designed by RAA23014x without two diodes.
When DC/DC operates, VBB_OUT = VOUT. When DC/DC stops and VOUT pin voltage is higher than VBB_IN pin, VBB_OUT = VOUT pin. When DC/DC stops and VOUT pin voltage is lower than VBB_IN pin, VBB_OUT = VBB_IN pin.
VBB_OUT voltage value is dependent on on-resistance between VBB_IN and VBB_OUT, On-resistance between VOUT and VBB_OUT and VBB_OUT output current. VBB_OUT can be calculated by equations below.

1. Normal operation mode (VBB_OUT = VOUT)

$$V_{BB\_OUT} = V_{OUT} - I_{BB\_OUT} \times R_{on\_vout}$$

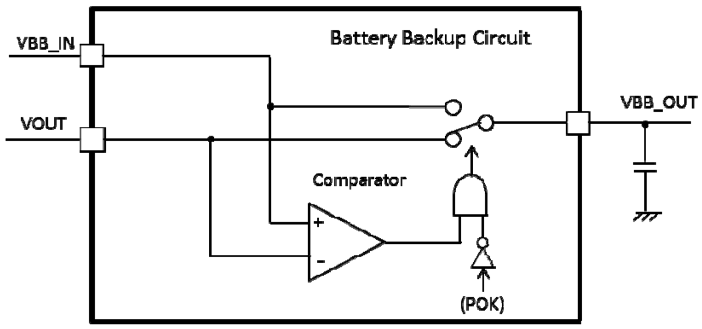
2. Battery backup mode (VBB_OUT = VBB_IN)

$$V_{BB\_OUT} = V_{BB\_IN} - I_{BB\_OUT} \times R_{on\_vbat}$$

V_{BB_OUT} : VBB_OUT voltage (V)
V_{OUT} : VOUT voltage = DC/DC output voltage (V)
V_{BB_IN} : VBB_IN voltage = Battery voltage (V)
I_{BB_OUT} : VBB_OUT output current (A)
R_{on_vout} : On resistance between VOUT and VBB_OUT 100Ω (Typ.)
R_{on_vbat} : On resistance between VBB_IN and VBB_OUT 400Ω (Typ.)

Note : $2.7V \le V_{BB\_OUT} \le 3.7V$

Connect over 0.47nF capacitor to VBB_OUT pin.



Note : POK is an IC internal signal which identifies DC/DC operating status.
It cannot be seen from IC outside.
After DC/DC has started up, there is about 1ms delay time till POK becomes high level.

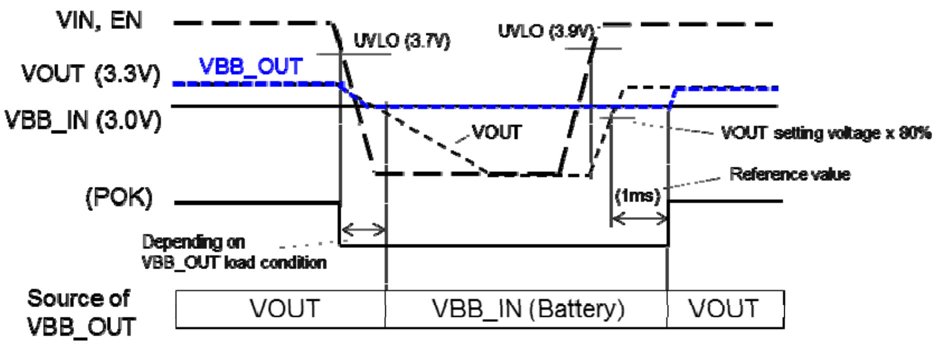
VBB_OUT pin output status

DC/DC	VOUT, VBB_IN	VBB_OUT
Operation (POK = H)	VOUT ≥ VBB_IN or VOUT < VBB_IN	VOUT
Stop (POK = L)	VOUT ≥ VBB_IN	VOUT
	VOUT < VBB_IN	VBB_IN

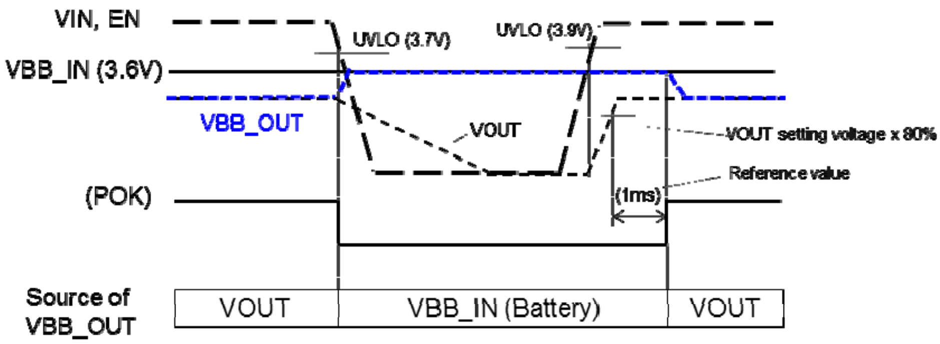
Note : L: Low level, H: High level

Timing chart of battery backup

1. With 3.0V battery



2. With 3.6V battery



Reference

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Condition
VBB leak current	IL_BB		0.5		uA	VBB_OUT = VBB_IN = 3.0V, No load

Protection Circuit View

Protection circuit	Function	Operation status		Reset
		Common circuit (VREG, etc.)	Output	
Short circuit protection (SCP)	Detect output voltage dropping because of short circuit, etc. (Latch type)	Operation	Latched to off	Turn EN pin from high level to low level or Drop VIN pin voltage under operation stop voltage of UVLO
Thermal shutdown circuit (TSD)	Detect rise up of IC internal temperature (Over 165˚C) (Auto recovery type)	Operation	Stop	The temperature falls
Under voltage lockout circuit (UVLO)	Detect dropping of VIN (Auto recovery type)	Operation	Stop	Up VIN over operating start voltage (3.9V)

Note SCP : Short Circuit Protection
TSD : Thermal Shutdown Circuit
UVLO : Under Voltage Lockout Circuit

Short Circuit Protection (Latch type)

When output voltage drops, FB pin input voltage also drops. If this voltage falls below the input detection voltage (0.35V(typ.)) of the short circuit protection, the output are stopped (latched to OFF). At this time, common circuits (such as the internal power supply block, etc.) continue operating.
When the protection is operating, to reset the latch, either turn the EN pin from high to low or drop the VIN pin voltage under operation stop voltage of UVLO.

Thermal Shutdown Circuit (Auto Recovery Type)

When overheating has been detected (detect temperature: 165°C), the output is stopped. Then, power MOSFET of output both high side and low side are turned off. Common circuits (such as the internal power supply block, etc.) continue operating.
If the device temperature falls and becomes under detect temperature, the protection is canceled and output automatically resumes.

Under Voltage Lockout Circuit (Auto Recovery Type)

(1) Under voltage lockout operation
When the power supply voltage (VIN) falls to the operation stop voltage (3.7V(typ.)), output from all channels stops. Common circuits (such as the internal power supply block, etc.) continue operating.
(2) Restoring output
Once VIN is restored to the Operating start voltage (3.9V(typ.)), the under voltage lockout operation is canceled and output automatically resumes. The output voltage cannot be restored while the under voltage lockout circuit is operating, not even by manipulating the EN pin.

Current Limiting

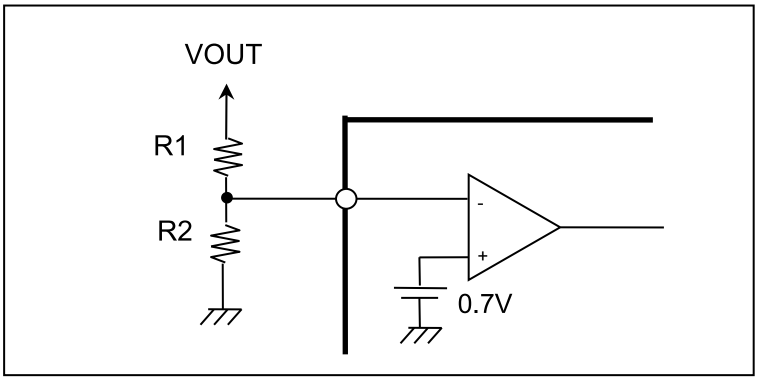
If an overcurrent occurs, an output current is limited on a pulse-by-pulse basis. If the current sensor detects an overcurrent, the current is limited and the switching operation of the Power MOSFET in the output stage stops until the next cycle.
When an output current is limited, the output voltage drops. If a FB pin voltage falls below the input detection voltage, the short-circuit protection circuit starts operating.

Guide for Circuit Design

Setting Output Voltage (When the output voltage is set by external resistor)

The output voltage can be calculated by an equation below.

VOUT = 0.7 x (1 + R1 / R2)



Examples of R1 and R2 selection

Vout	0.9V	1.0V	1.05V	1.1V	1.18V	1.2V	1.5V	1.8V	2.5V	3.3V	5.0V
R1	180k	220k	180k	270k	270k	130k	150k	470k	620k	820k	680k
R2	620k	510k	360k	470k	390k	180k	130k	300k	240k	220k	110k

Output voltage accuracy (When the output voltage is set by external resistor)

Output voltage accuracy can be calculated by an equation below.

$$V_{OUTACC} = V_{ITHACC} + \frac{(Vout - V_{ITH})}{Vout} \times 2 \times R_{ACC}$$

V_{OUTACC} is the output voltage accuracy (%).
V_{ITHACC} is the E/A input threshold voltage accuracy (%).
V_{OUT} is the output voltage (V).
R_{ACC} is the external resistor accuracy (%).

So, an output voltage accuracy of the device is below.

$$V_{OUTACC} = 1 + \frac{(Vout - 0.7)}{Vout} \times 2 \times R_{ACC}$$

Note : These equation don't include Vout fluctuation by load step transient.

Inductor selection

An inductor target is that ripple current (ΔIL) of inductor becomes 10 to 40 % of Iout(max).

When ΔIL increases, inductor current peak raises, so ripple of Vout gets larger and power loss increases. But, large size inductor is required to lower ΔIL.

ΔIL can be calculated by an equation below.

$$\Delta \mathrm{IL} = \frac{(Vin - Vout)}{L} \times \frac{Vout}{Vin} \times \frac{1}{f_{SW}}$$

fsw is 1.1MHz.

Peak current of inductor (ILpeak) can be calculated by an equation below.

$$IL_{Peak} = I_{OUT}(MAX) + \frac{\Delta IL}{2}$$

Choose a inductor which saturation current is higher than ILpeak .

Inductor Example

Inductance (uH)	Inductor	Manufacturer	I_{TEMP} (A)	I_{SAT} (A)	Size (LxWxT, mm)
3.3	NRS5030T3R3MMGJ	TAIYO YUDEN	3.0	3.6	4.9x4.9x3.1
3.3	7447789003	WURTH	3.4	4.2	7.3x7.3x3.2
4.7	NRS5040T4R7NMGK	TAIYO YUDEN	3.1	3.3	4.9x4.9x4.1
4.7	744777004	WURTH	4.0	4.0	7.3x7.3x4.3
6.8	NRS8030T6R8MJGJV	TAIYO YUDEN	3.4	3.0	8.0x8.0x3.0
6.8	7447779006	WURTH	2.9	3.3	7.3x7.3x4.2
10	NRS8040T100MJGJV	TAIYO YUDEN	3.1	3.8	8.0x8.0x4.0
10	744066100	WURTH	3.6	4.0	10.0x10.0x3.8

Note I_{TEMP} : Rated current by temperature rising
I_{SAT} : Rated current by inductance loss
These inductors are examples. About inductor detail, contact each manufacturer

Output capacitor selection

RAA23014x and RAA23015x have a phase compensation circuit which is optimized to DC/DC operation. In order to operate stably with the phase compensation, connect the output capacitor which is over 44 uF. Ceramic capacitor can be used for output capacitor. It has low ESR, so VOUT ripple is decreased.

VOUT ripple (ΔVrpl) can be calculated by an equation below.

$$\Delta V_{rpl} = \Delta IL \times \left(ESR + \frac{1}{(8 \times C_{OUT} \times f_{SW})} \right)$$

ESR : Equivalent Series Resistance

Input capacitor selection

Connect an input capacitor which is over 10 uF between each VIN pin and power ground. It should be placed close to the device as possible.

VREG capacitor

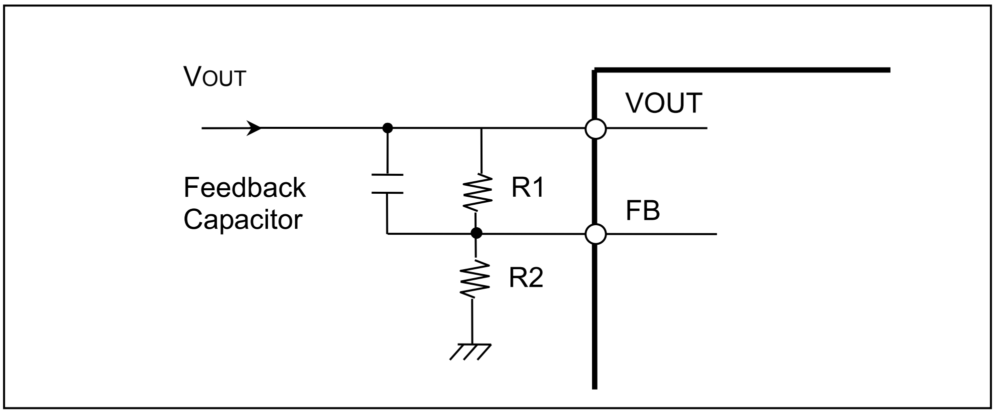
Connect 1uF ceramic capacitor to VREG pin.

Bootstrap capacitor

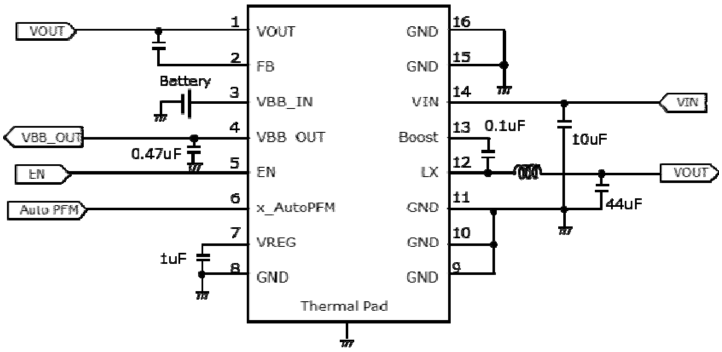
Connect 0.1uF ceramic capacitor between LX pin and Boost pin.

Feedback capacitor

When PFM operation at Auto PFM mode, feedback capacitor can be connected in parallel to high side output voltage setting resistor to adjust phase characteristic. If connected, there are possibility that operation in large current (at PWM operation) is not stable. Confirm the operation with system status.

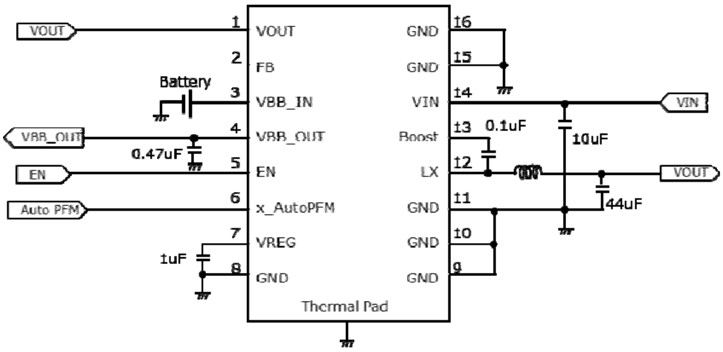


When using feedback capacitor with an output voltage fixed product, connect feedback capacitor between VOUT pin and FB pin.



Example of RAA230141, RAA230142

When not using feedback capacitor with an output voltage fixed product, keep FB pin open.



Example of RAA230141, RAA230142

Components example

VIN (V)	VOUT (V)	L (uH)	Cout (uF)	C_{FB} (pF)	
				Auto PFM mode	PWM mode
24	5V	4.7	44	0 to 100	No need
	3.3V	4.7	44	0 to 100	No need

Notes on Use

Pattern Wiring

To actually perform pattern wiring, separate a ground of control signal from a ground of a power line, so that these grounds do not have a common impedance as much as possible.

Connection of Exposed PAD

HTSSOP and HLSOP packages have an Exposed PAD on the bottom to improve radiation performance. On the mounting board, connect this Exposed PAD to GND.

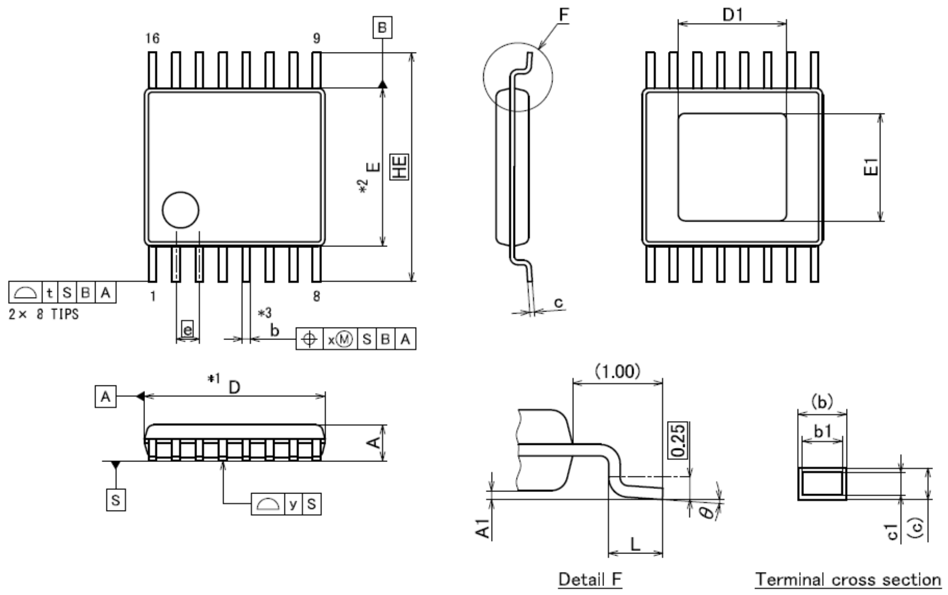
Fixed Usage of Control Input Pin

When EN pin and x_AutoPFM pin are fixed, connect to a pin listed below.

Input Pin	Connect Pin	
	Fixed to Low Level	Fixed to High Level
EN	GND	VIN
x_AutoPFM	GND	VIN

Package Dimensions

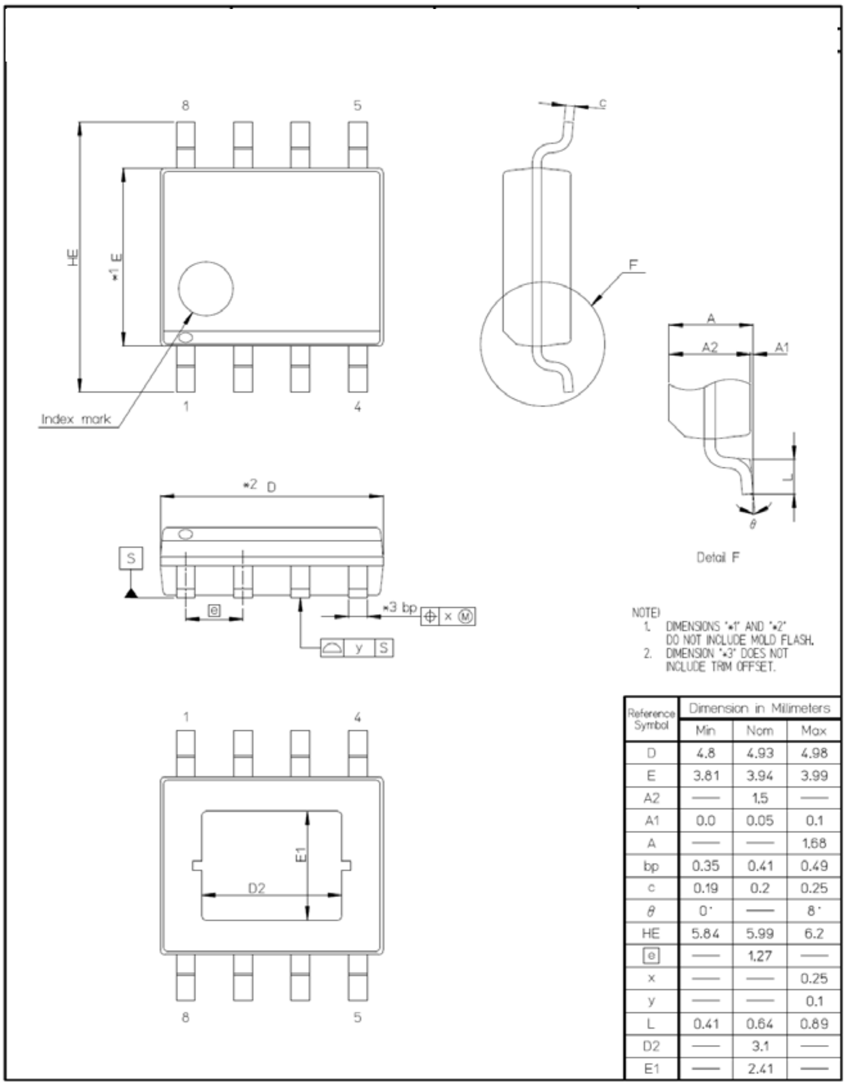
16pin TSSOP (RAA23014x)



NOTE)
1.DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2.DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.

Referrence Symbol	Dimension in Milimeters		
	Min	Nom	Max
D	—	5.00	5.10
E	—	4.40	—
A1	0.05	—	0.15
A	—	—	1.10
b	0.19	—	0.30
b1	0.19	0.22	0.25
c	0.09	—	0.20
c1	0.09	0.127	0.16
θ	0°	—	8°
HE	—	6.40	—
e	—	0.65	—
t	—	—	0.20
x	—	—	0.10
y	—	—	0.076
L	0.50	0.60	0.70
D1	—	3.00	—
E1	—	3.00	—

8pin HLSOP (RAA23015x)



Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	4.8	4.93	4.98
E	3.81	3.94	3.99
A2	——	1.5	——
A1	0.0	0.05	0.1
A	——	——	1.68
bp	0.35	0.41	0.49
c	0.19	0.2	0.25
θ	0°	——	8°
HE	5.84	5.99	6.2
e	——	1.27	——
x	——	——	0.25
y	——	——	0.1
L	0.41	0.64	0.89
D2	——	3.1	——
E1	——	2.41	——

Revision History	RAA23014x, RAA23015x Data Sheet

Rev.	Date	Description	
		Page	Summary
1.00	Sep.09.2015	-	First Edition issued.

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