Dual Synchronous Buck Converter

Pb Free ROHM Electronic Components
RoHS Directive Compliance

BD93291EFJ

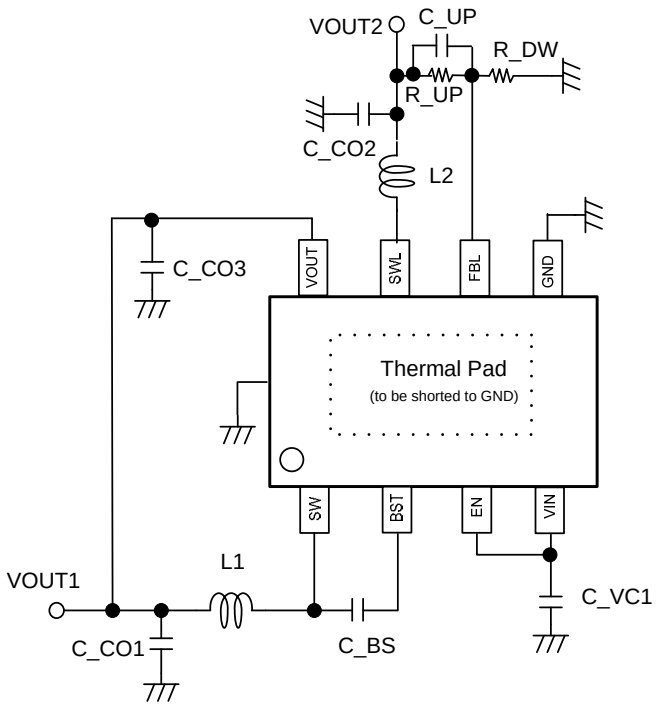
●Description

The BD93291EFJ is a dual synchronous buck converter. It integrates wide input voltage range (8.0V to 26V) synchronous buck converter and low input voltage (Vout1 : 5.0V) synchronous buck converter.
The IC also incorporates a new technology called H^3Reg^{TM}, a Rohm proprietary control method which facilitates ultra-high transient response against changes in load. SLLM (Simple Light Load Mode) technology is also integrated to improve efficiency when powering lighter loads. For protection and ease of use, the IC also incorporates soft start.
Space-saving and high efficient switching regulator can be achieved due to built-in N-MOSFET power transistor in HTSOP-J8 package.

●Applications

・Distributed Power System
・Pre-Regulator for Linear Regulator

●Typical Application Circuit



●Features

・Dual Synchronous Buck Converter in small package.
・standby mode (Istandby = 0uA)
・High Voltage Synchronous Buck Converter(Vout1)
- Wide input range(8.0V to 26V) *absolute voltage 30V
- H^3Reg^{TM} DC/DC Converter Controller included
- Output Current 1.7A *1
- FET on resistance High-side 0.175Ω/Low-side 0.175Ω
- Internal soft-start function
- Switching Frequency 300 to 600kHz (*According to input/output conditions)
- Fixed output voltage (5.0V ± 1.5%; Normal Mode)
・Low Voltage Synchronous Buck Converter(Vout2)
- Input voltage range 5.0V(VOUT1)
- H^3Reg^{TM} DC/DC Converter Controller included
- Output Current 0.5A *1
- FET on resistance High-side 0.25Ω/Low-side 0.25Ω
- Internal soft-start function
- Switching Frequency 1.5M to 2.5MHz (*According to input/output conditions)
- Feedback voltage (0.8V ± 1.5%; Normal Mode)
・Protection Circuits
Under Voltage Lockout Protection
Thermal Shutdown
Over Current Protection
・HTSOP-J8 Package with Exposed thermal PAD.

*1 Vout1 maximum output current capability is 2.5A, and Vout2 maximum output current capability is 1.5A with the optimal PCB power consumption design.

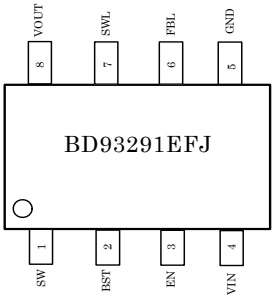
●Structure

・Silicon Monolithic Integrated Circuit

●Package

・HTSOP-J8 6.00mm x 4.90mm x 1.00mm

●PIN Configuration (TOP VIEW)

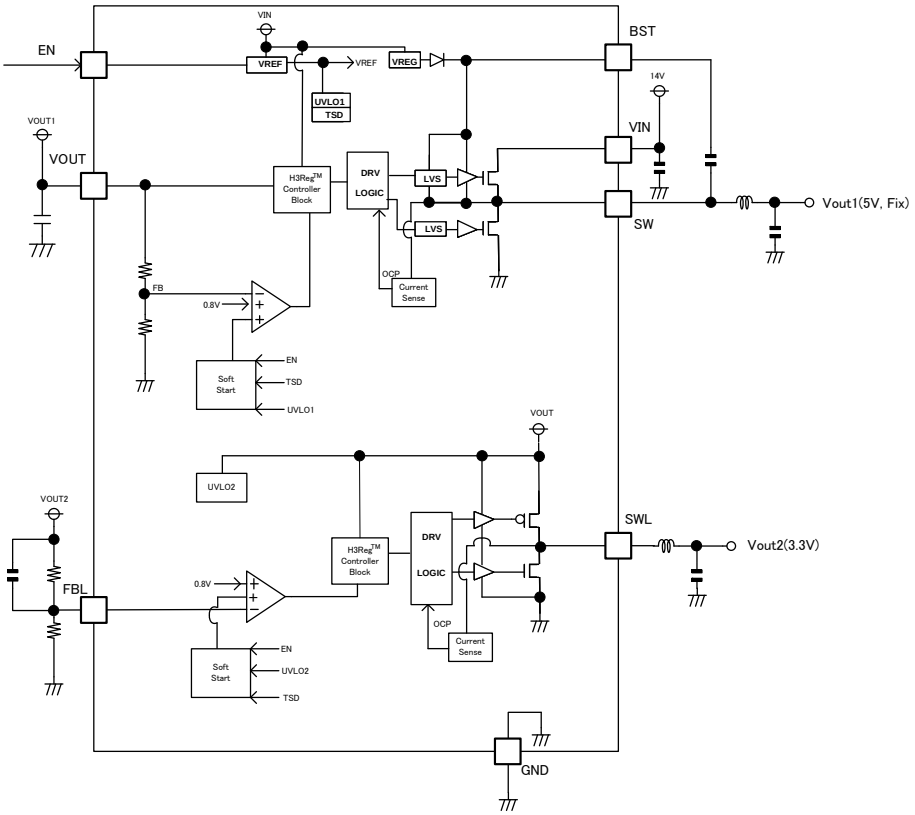


○Product structure : Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

● Block Diagram



●Pin Assignment and Pin Function

No.	Symbol	Description
1	SW	Connect the inductor switching node of high voltage buck converter. This pin is connected to the source node of High side FET and the drain node of Low side FET.
2	BST	Connect 0.1uF Boot Strap capacitor between BST pin and SW pin. This capacitor is for generating the driving voltage of High-side N-channel MOSFET.
3	EN	This is Enable pin of BD93291EFJ. High input (2.3V typ.) is output active. Low input (1.8V typ.) is IC shutdown. The internal impedance of EN pin is high, therefore add capacitor between EN and GND pin to reduce noise influence when this pin is connected to high-impedance node.
4	VIN	Power supply pin of high voltage buck converter. This pin is connected to power FET supply and internal control blocks of high voltage buck converter. Connect to 10uF(recommended value) ceramic capacitor for bias capacitor.
5	GND	This pin is Low-side N-channel MOSFET power ground of high voltage buck converter, Low-side N-channel MOSFET power ground of low voltage buck converter and analog ground of other blocks.
6	FBL	This pin is output voltage feed-back pin of low voltage buck converter. Refer to ---page regarding the setting of output voltage.
7	SWL	Connect the inductor switching node of low voltage buck converter. This pin is connected to the drain node of High side Pch-FET and the drain node of Low side FET.
8	VOUT	This pin is power supply pin of low voltage buck converter and output voltage feed-back pin of high voltage buck converter. This pin is connected to power FET supply and internal control blocks of low voltage buck converter. Connect to 10uF(recommended value) ceramic capacitor for bias capacitor.

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Rating	Unit
Supply Voltage 1	VIN	30	V
Switch Voltage 1	V_{SW}	30	V
Supply Voltage 2	VOUT	7.0	V
Switch Voltage 2	V_{SWL}	7.0	V
Power Dissipation for HTSOP-J8	Pd	3760 *1	mW
Package thermal resistance θja *2	θja	29.27	℃/W
Package thermal resistance θjc *2	θjc	3.75	℃/W
Operating Temperature Range	Topr	-40 to +85	℃
Storage Temperature Range	Tstg	-55 to +150	℃
Junction Temperature	Tjmax	150	℃
BST Voltage	V_{BST}	V_{SW}+7	V
EN Voltage	V_{EN}	30	V

*1 Derating in done 30.08 mW/℃ for operating above Ta≧25℃(Mount on 4-layer 70.0mm×70.0mm×1.6mm board)
*2 Mount on 4-layer 50mm x 30mm x 1.6mm application board

●Operation Range(Ta= -40 to 85℃)

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage 1	V_{IN}	8.0	14	26	V
Supply Voltage 2	V_{OUT}	-	5.0	-	V
SW Voltage 1	V_{SW}	-0.5	-	26	V
SW Voltage 2	V_{SWL}	-0.5	-	5.5	V
Output voltage range 1 (Fixed)	V_{out1}	-	5.0	-	V
Output voltage range 2	V_{out2}	0.8	3.3	4.0	V

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●**Electrical characteristics (unless otherwise specified VIN=14V, VOUT1=5V, VOUT2=3.3V Ta=25℃)**

Parameter	Symbol	Limits			Unit	Conditions
		Min	Typ	Max		
【High Voltage Synchronous Buck Converter】						
Output Voltage	V_{OUT1}	4.925	5.0	5.075	V	±1.5%,normal mode
Hi-side FET On-resistance	R_{ONH1}	-	0.175	-	Ω	I_{SW}= -0.8A
Lo-side FET On-resistance	R_{ONL1}	-	0.175	-	Ω	I_{SW}= 0.8A
Hi/Lo-side FET Leak current	I_{LEAK1}	-	0	10	μA	V_{IN}= 26V, V_{SW} = 0V / 26V
Switch Current Limit	I_{LIMIT1}	3.0	-	-	A	
Soft-start time	V_{SS1}	2.5	5.0	7.5	ms	
ON Time	T_{ON1}	635	794	953	ns	Fsw1=450kHz(typ) Iout=0.3A
Minimum Off Time	T_{OFF1}	-	200	-	ns	
【Low Voltage Synchronous Buck Converter】						
Feed-back Voltage	V_{FBL}	0.788	0.8	0.812	V	±1.5%,normal mode
FBL input bias current	I_{FBL}	-1.0	0	1.0	μA	
Hi-side FET On-resistance	R_{ONH2}	-	0.25	-	Ω	I_{SWL}= -0.8A
Lo-side FET On-resistance	R_{ONL2}	-	0.25	-	Ω	I_{SWL}= 0.8A
Hi/Lo-side FET Leak current	I_{LEAK2}	-	0	10	μA	V_{OUT1}= 5.5V, V_{SWL} = 0V / 5.5V
Switch Current Limit	I_{LIMIT2}	2.0	-	-	A	
Soft-start time	V_{SS1}	1.25	2.5	3.75	ms	
ON Time	T_{ON2}	264	330	396	ns	Fsw2=2MHz(typ) Iout=0.2A
Minimum Off Time	T_{OFF3}	-	50	-	ns	
【General】						
Enable Sink current	I_{EN}	33	56	73	μA	V_{EN}= 14V
Enable Threshold voltage 1	V_{EN_R}	2.2	2.3	2.4	V	Rising
Enable Threshold voltage 2	V_{EN_F}	1.7	1.8	1.9	V	Falling
VIN Under Voltage Lockout threshold	V_{UVLO1}	7.1	7.5	7.9	V	V_{IN} rising
VIN Under Voltage Lockout Hysteresis	V_{HYS1}	-	1.0	-	V	
VOUT Under Voltage Lockout threshold	V_{UVLO2}	2.3	2.5	2.7	V	V_{OUT} rising
VOUT Under Voltage Lockout Hysteresis	V_{HYS2}	-	0.2	-	V	
Circuit Current VIN	I_{CC_VIN}	-	0.6	1.5	mA	V_{OUT}= 5.5V, V_{EN}= 14V
Circuit Current VOUT	I_{CC_VOUT}	-	0.6	1.5	mA	V_{FBL}= 1.0V, V_{EN}= 14V
Standby Current	I_{QUI}	-	0	5	μA	V_{EN}= 0V

* This product is not designed for protection against radioactive rays

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=14V, VOUT1=5V, VOUT2=3.3V)

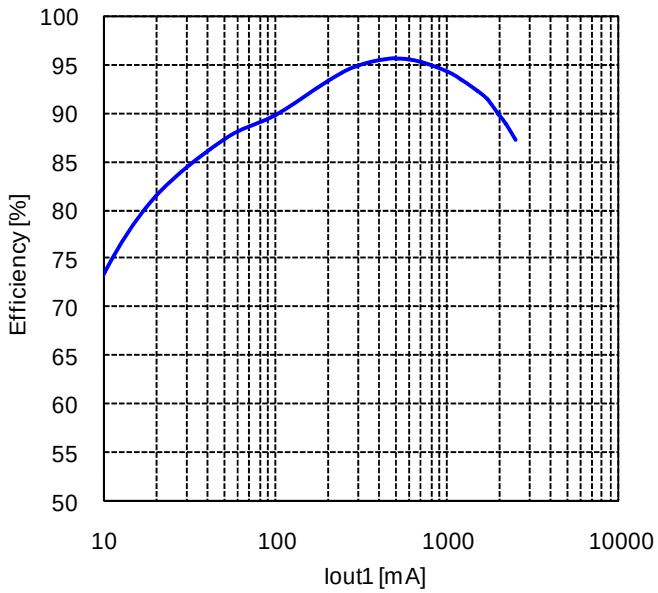


Figure 4. VOUT1 Efficiency
(VIN=14V, L=22μH)

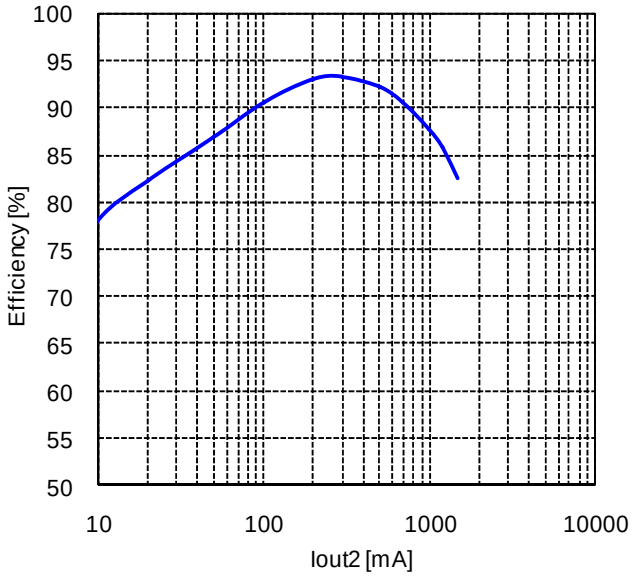


Figure 5. VOUT2 Efficiency
(VOUT1=5V, VOUT2=3.3V, L=2.2μH)

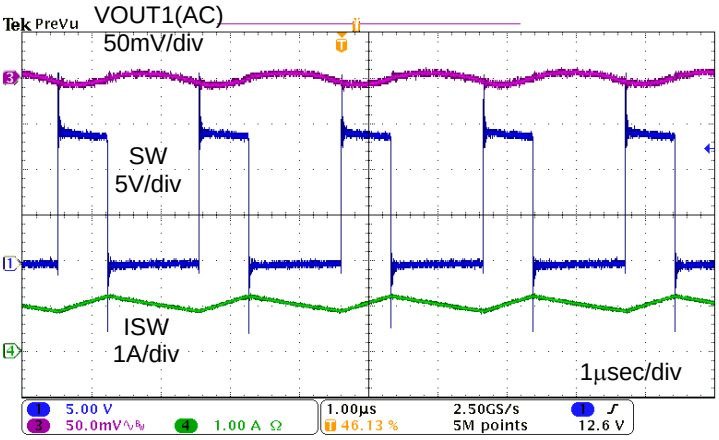


Figure 6. VOUT1 Ripple voltage
(VIN=14V, L1=22μH, COUT1=22μF, Iout=1A)

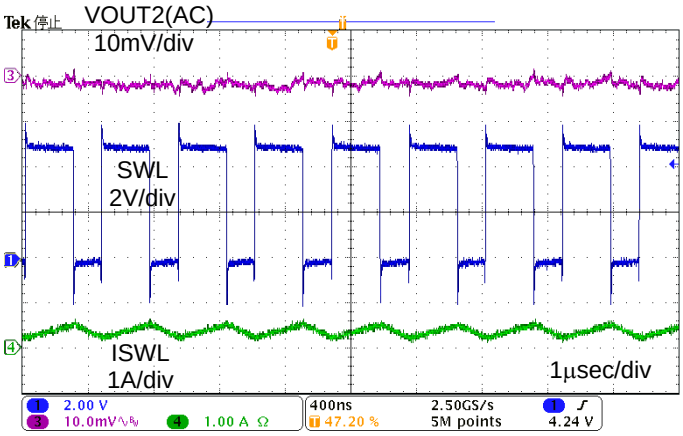


Figure 7. VOUT2 Ripple voltage
(VOUT1=5V, VOUT2=3.3V, L2=2.2μH, COUT2=22μF, Iout=0.3A)

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=14V, VOUT1=5V, VOUT2=3.3V) (Continued)

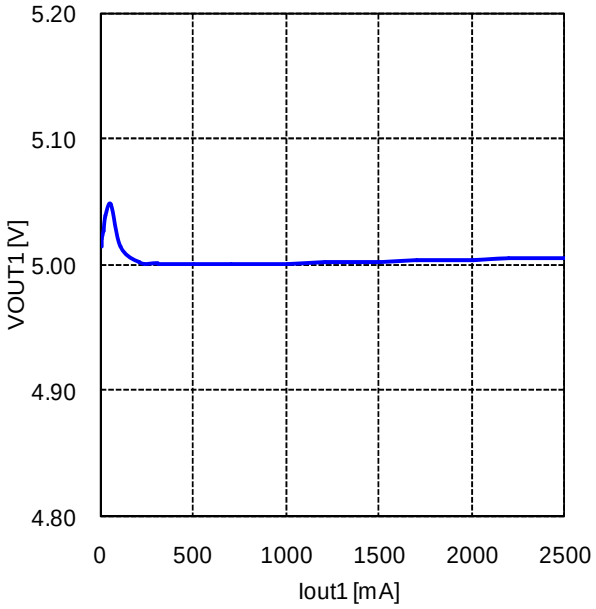


Figure 8. VOUT1 Load Regulation
(VIN=14V, L1=22μH)

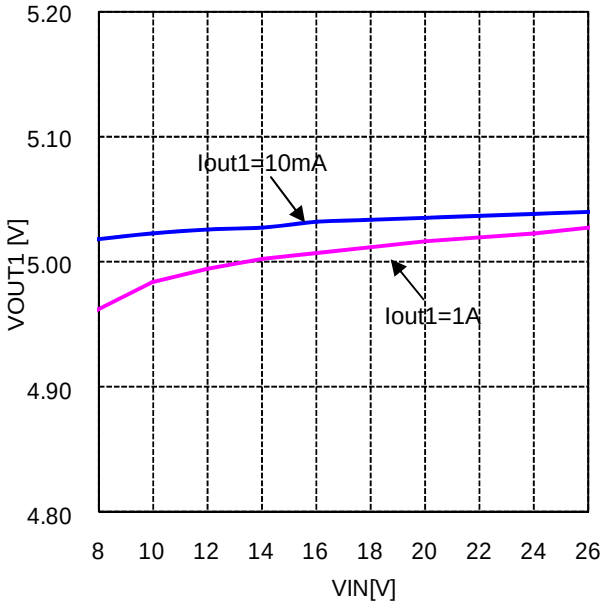


Figure 9. VOUT1 Line Regulation
(VIN=14V, L1=22μH, Iout1=10mA / 1A)

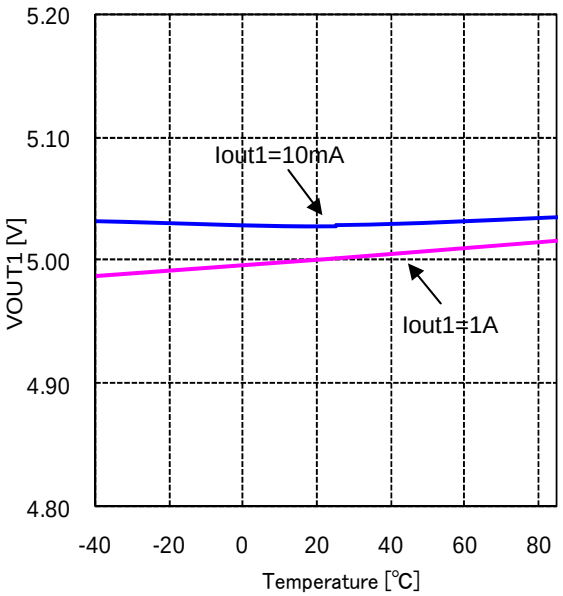


Figure 10. VOUT1 - Temperature
(VIN=14V, L1=22μH, Iout1=10mA/1A)

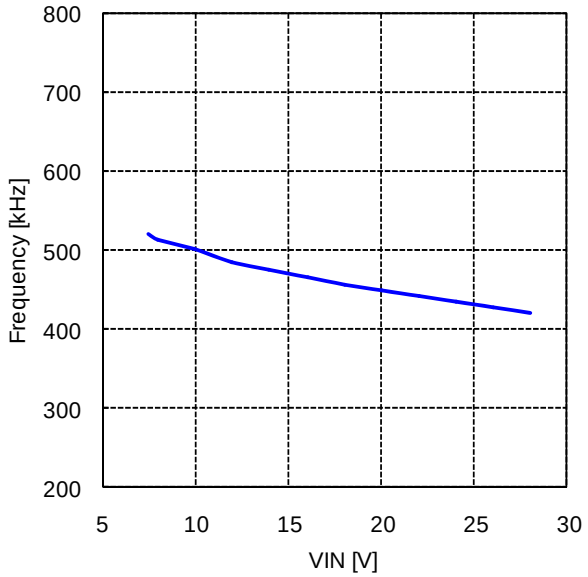


Figure 11. SW_Frequency - VIN
(VIN=14V, L1=22μH, Iout1=1A)

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=14V, VOUT1=5V, VOUT2=3.3V) (Continued)

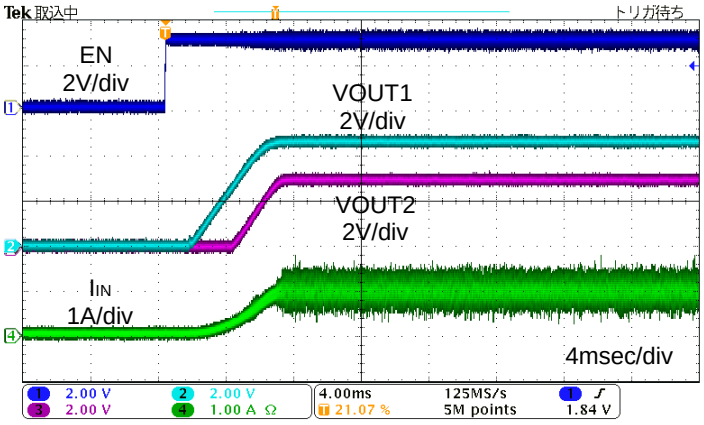


Figure 12. Start up wave form
(VIN=14V, VOUT1=5V, VOUT2=3.3V, L1=22µH, L2=2.2µH, COUT1=22µF, COUT2=2.2µF, Iout1=2A, Iout2=1A)

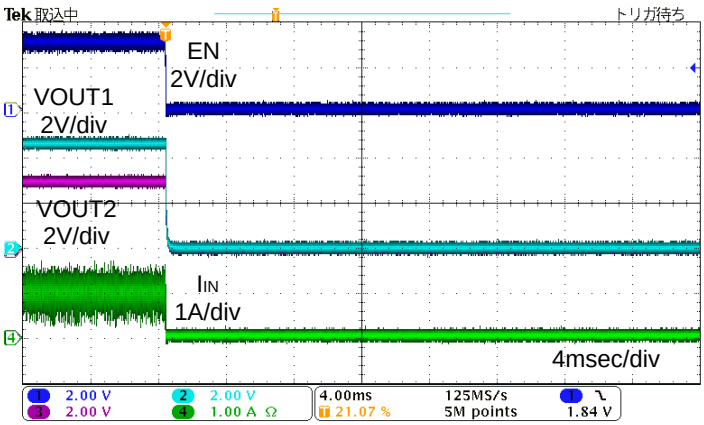


Figure 13. Off wave form
(VIN=14V, VOUT1=5V, VOUT2=3.3V, L1=22µH, L2=2.2µH, COUT1=22µF, COUT2=2.2µF, Iout1=2A, Iout2=1A)

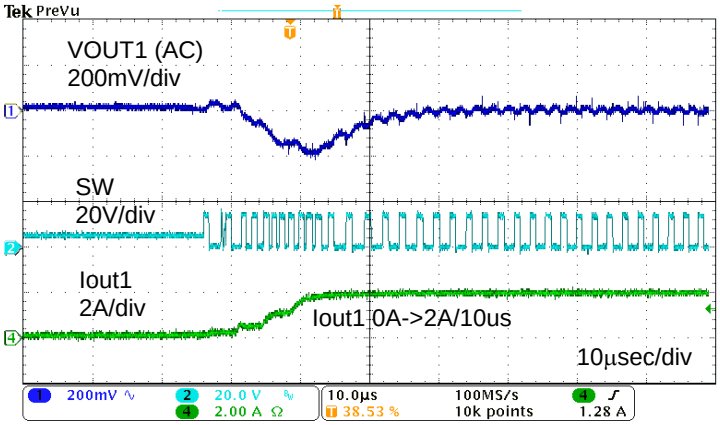


Figure 14. VOUT1 Transient Response
(VIN=14V, VOUT1=5V, L=22µH, COUT=22µF)
Iout=0->2A (SR=0.2A/µsec)

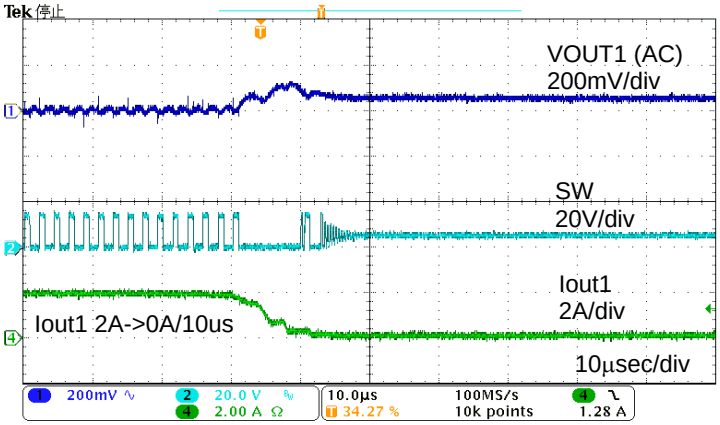


Figure 15. VOUT1 Transient Response
(VIN=14V, VOUT1=5V, L=22µH, COUT=22µF)
Iout=2->0A (SR=0.2A/µsec)

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=14V, VOUT1=5V, VOUT2=3.3V) (Continued)

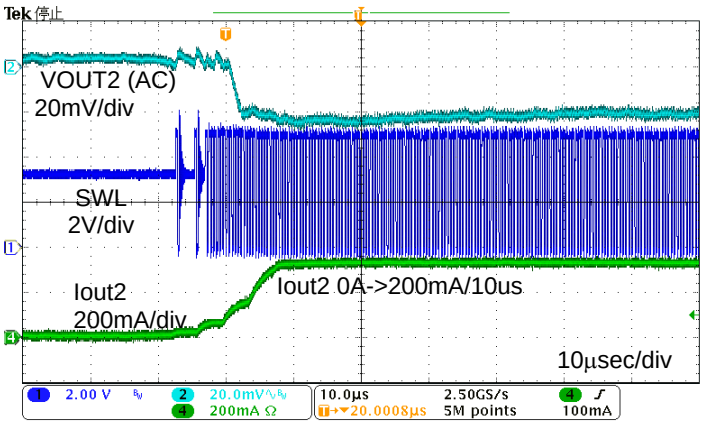


Figure 16. VOUT2 Transient Response
(VOUT1=5V, VOUT2=3.3V, L2=2.2μH,
COUT2=22μF),
Iout2=0->200mA (SR=20mA/μsec)

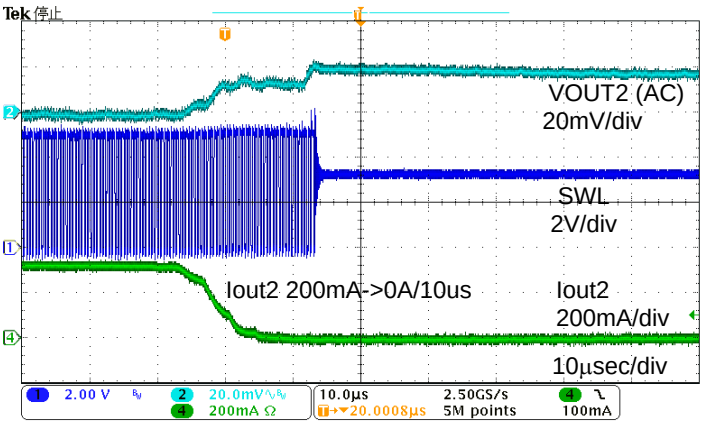


Figure 17. VOUT2 Transient Response
(VOUT1=5V, VOUT2=3.3V, L2=2.2μH,
COUT2=22μF),
Iout2=200mA->0mA (SR=20mA/μsec)

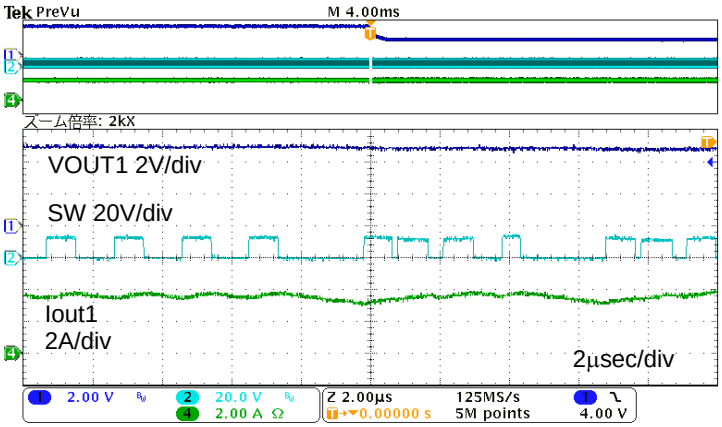


Figure 18. VOUT1 OCP function
(VIN=14V, VOUT1=5V, VOUT2=3.3V, L1=22μH,
COUT1=22μF)
(VOUT1 is shorted to GND)

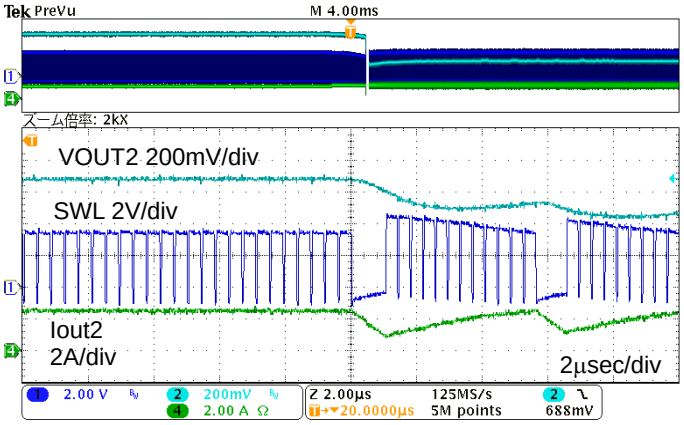


Figure 19. VOUT2 OCP function
(VIN=14V, VOUT1=5V, VOUT2=3.3V, L2=2.2μH,
COUT2=22μF)
(VOUT2 is shorted to GND)

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Typical Performance Curves (Unless otherwise noted Ta=25℃, VIN=14V, VOUT1=5V, VOUT2=3.3V) (Continued)

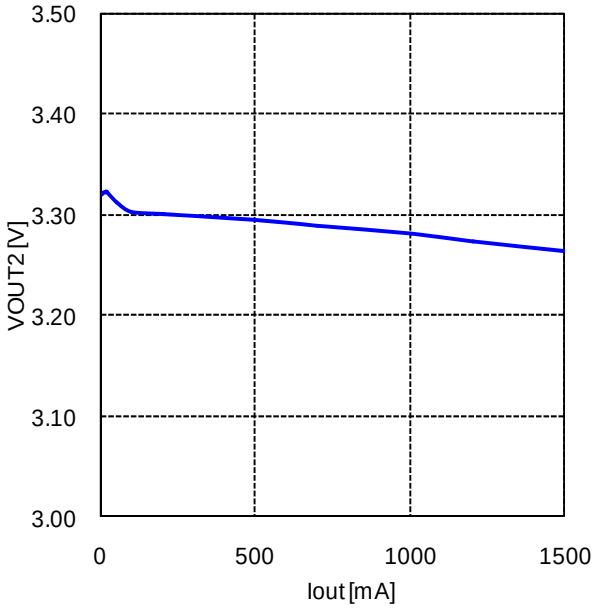


Figure 20. VOUT2 Load Regulation
(VOUT1=5V, L=2.2μH)

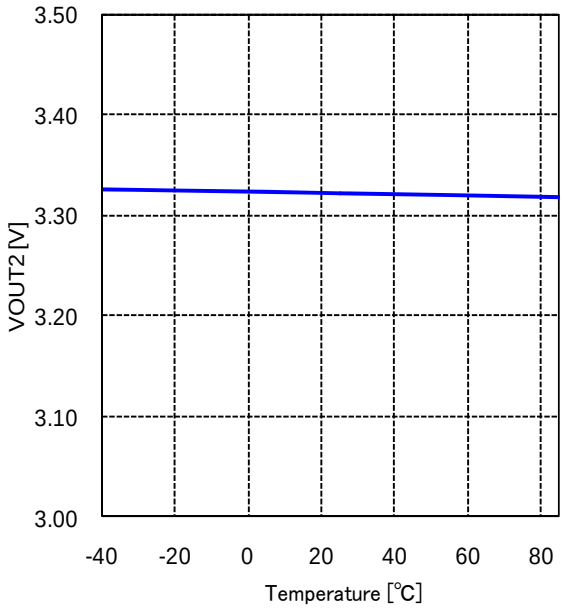


Figure 21. VOUT2 - Temperature
(VOUT1=5V, L=2.2μH, Iout=1.5A)

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Explanation of Operation

The BD93291EFJ is a dual synchronous buck converter incorporating ROHM's proprietary H^3Reg^{TM} CONTROLLA system. When VOUT1 and VOUT2 drop due to a rapid load change, the system quickly restores VOUT1 and VOUT2 by increasing the frequency.

1. H^3Reg^{TM} System

1-1. Normal Operation

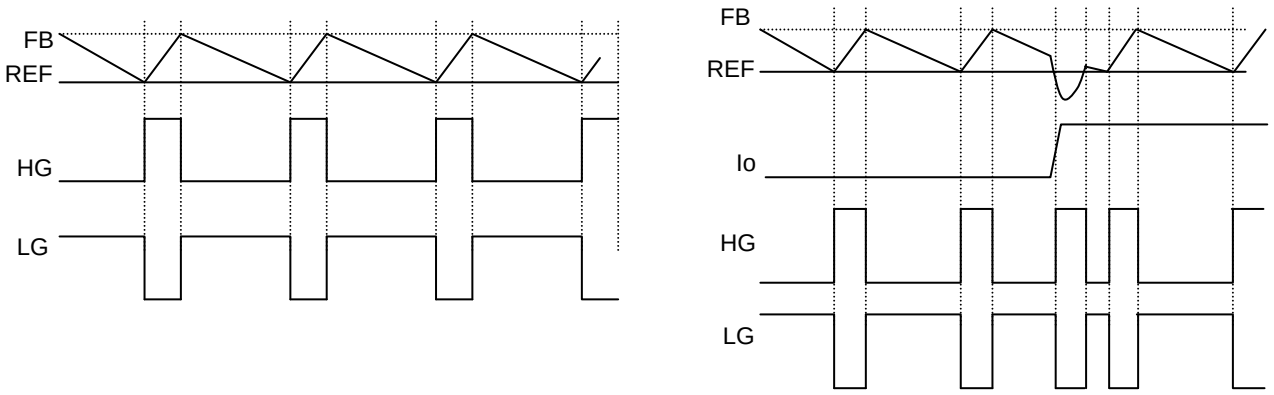
When FB falls below the threshold voltage (REF), a drop is detected, activating the H^3Reg^{TM} CONTROLLA system.

$$Ton = \frac{V_{OUT}}{V_{IN}} \times \frac{1}{f} \quad [sec] \qquad (1)$$

HG (Gate of High side MOSFET) output is determined by the formula (1). LG (Gate of Low side MOSFET) output operates until FB voltage falls below REF voltage after HG becomes OFF. OFF time is restricted by MIN OFF Time (VOUT1 : 200nsec (typ.), VOUT2 : 50nsec (typ.)).
Hence, BD93291EFJ runs with a constant on-time by using the input and output voltage to set the internal on-time timer.

1-2. VOUT drops due to a rapid load change

When FB (VOUT) drops due to a rapid load change and the voltage remains below REF, the system quickly restores VOUT by shortening OFF time of HG (increasing the frequency), improving transient response as shown Figure 22 (b).



(a) Normal operation (b) Rapid load change

Figure 22. H^3REG System

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Timing Chart

1. Soft Start Function

Soft start is utilized when the EN pin is set high. Current control takes effect at startup, enabling a moderate “ramping start” on the output voltage. Soft start time of VOUT1 is 5.0msec (typ) and VOUT2 is 2.5ms (typ).

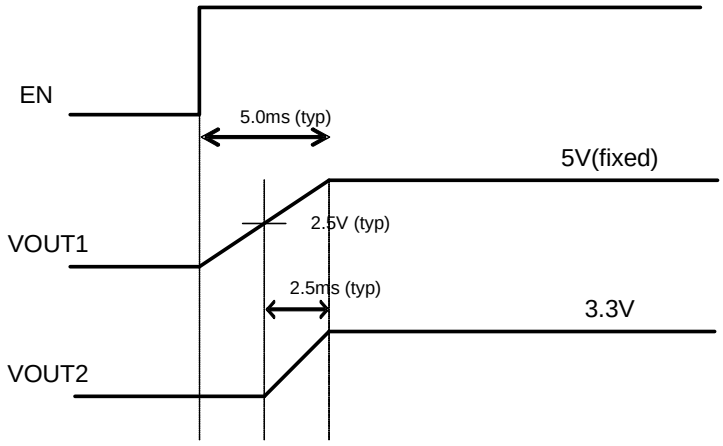


Figure 23. Soft Start Timing Chart

●Protection Operation

1. OCP Operation

Normally, when FB voltage falls below REF voltage, HG becomes high. However, if the peak current through the inductor (I_L) exceeds OCP current value (I_{OCP}) during HG=ON, HG become OFF immediately and I_L is restricted by I_{OCP}. As the result, the output voltage can decrease as the frequency and duty are changed.

When OCP is released in the state that the output has decreased by OCP operation, the output voltage might rise up due to high-speed load response.

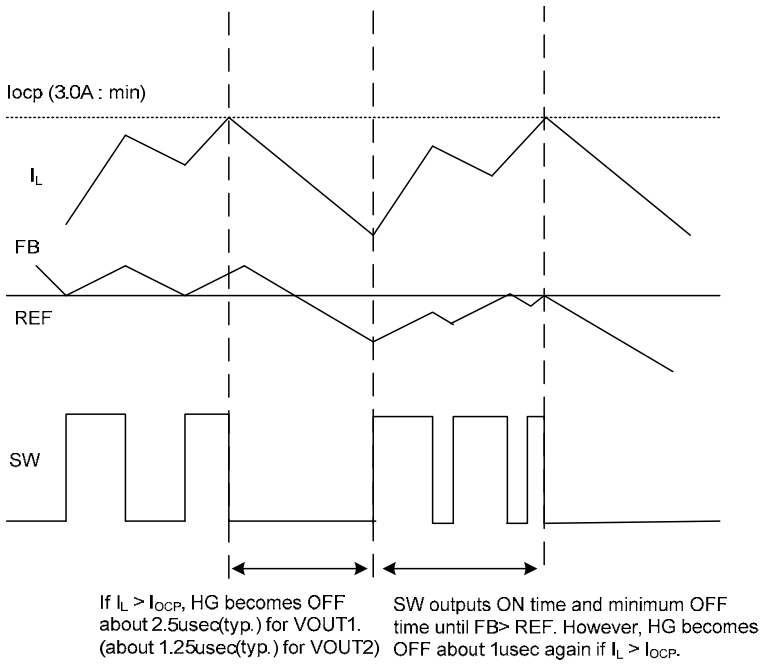


Figure 24. OCP Timing Chart

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

2. TSD Operation (Self Recovery)

TSD is self-activating. If the junction temperature exceeds Tj = 175℃, and HG, LG, and SS become Low.
The IC becomes standby when TSD operating.
When Tj falls below 150℃, it returns to standard operation.

3. UVLO Operation

UVLO operates when VIN voltage falls below 6.5V, and HG and LG become Low.
The IC becomes standby when UVLO operating.
UVLO is released when VIN goes up to 7.5V, and starts standard operation

●Selection of Components Externally Connected

1. Output LC Filter Selection (Buck Converter)

1-1. Inductor (L) Selection

The Output LC filter is required to supply constant current to the output load. A larger value inductance at this filter results in less inductor ripple current (ΔI_L) and less output ripple voltage. However, the larger value inductors tend to have less fast load transient-response, a larger physical size, a lower saturation current and higher series resistance. A smaller value inductance has almost opposite characteristics above.
The value of ΔI_L is shown as formula (2). The larger value of the inductance or the faster switching frequency make the lower ripple voltage.

$$\Delta I_L = \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{L \times f \times V_{IN}} \quad [A] \qquad (2)$$

The proper output ripple current setting is about 30% of maximum output current.

$$\Delta I_L = 0.3 \times I_{OUTMAX} \quad [A] \qquad (3)$$

$$L = \frac{(V_{IN} - V_{OUT}) \times V_{OUT}}{\Delta I_L \times f \times V_{IN}} \quad [H] \qquad (4)$$

(ΔI_L : output ripple current、f : switching frequency)

※A larger current than the inductor's rated current will cause magnetic saturation in the inductor, and decrease efficiency. When selecting an inductor, be sure to allow enough margins to assure that peak current does not exceed the inductor's rated current value.

※To minimize loss of inductor and improve efficiency, choose a inductor with a low resistance (DCR, ACR).

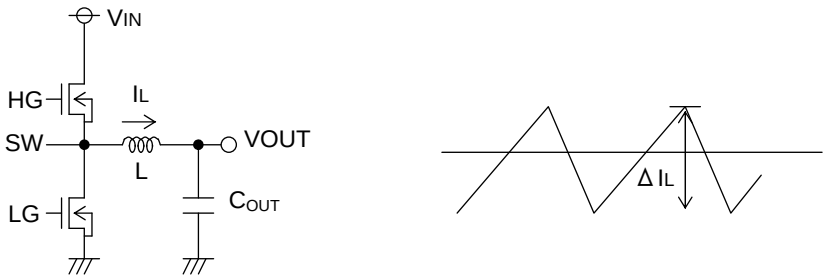


Figure 25. Inductor Ripple Current

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

1-2. Output Capacitor (C_{OUT}) Selection

Output Capacitor (C_{OUT}) has a considerable influence on output voltage regulation due to a rapid load change and smoothing output ripple voltage. Determine the capacitor by considering the value of capacity, the equivalent series resistance, and equivalent series inductance. Also, make sure the capacitor's voltage rating is high enough for the set output voltage (including ripple).

Output ripple voltage is determined as in formula (5) below.

$$\Delta VOUT = \Delta I_L/(8 \times C_{OUT} \times f) + ESR \times \Delta I_L + ESL \times \Delta I_L / Ton \quad [V] \qquad (5)$$

(ΔI_L Output ripple current、ESR: Equivalent series resistance、ESL: Equivalent series inductance)

Also, give consideration to the conditions in formula (6) below for output capacitance, bearing in mind that output rise time must be established within the fixed soft start time. As output capacitance, bypass capacitor will be also connected to output load side (C_{EXT}, Figure 26). Please set the over current detection value with regards to these capacitance.

$$C_{OUT} \leq \frac{SS \times (I_{OCP} - I_{OUT})}{V_{OUT}} \quad [F] \qquad (6)$$

(SS : Soft Start time, I_{OCP} : OCP Current Limit, I_{OUT} : Output Current)

Note: an improper output capacitor may cause startup malfunctions.

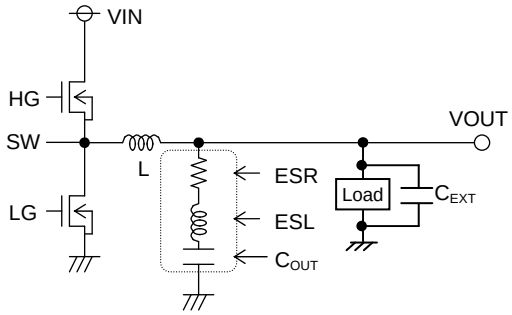


Figure 26. Output Capacitor

2. Input Capacitor (CIN) Selection

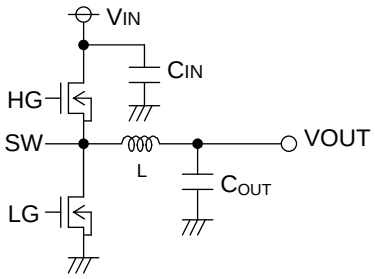


Figure 27. Input Capacitor

In order to prevent transient spikes in voltage, the input capacitor should have a low enough ESR resistance to fully support a large ripple current. The formula for ripple current I_{RMS} is given in equation (7) as below.

$$I_{RMS} = I_{OUT} \times \frac{\sqrt{V_{OUT} \times (V_{IN} - V_{OUT})}}{V_{IN}} \quad [A] \qquad (7)$$

Where $V_{IN} = 2 \times VOUT$, $I_{RMS} = \frac{I_{OUT}}{2}$

A low ESR capacitor is recommended to reduce ESR loss and improve efficiency.

Capacitor Cout between VOUT and GND must be placed near the VOUT pin.

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

3. VOUT2 Output Voltage Setting

The IC controls output voltage as REF≒V_{FBL}.
However, the actual output voltage will also reflect the average ripple voltage value.
The VOUT2 output voltage is set with a resistor divider from the output node to the FBL pin. The formula for output voltage is given in (8) below:

$$VOUT2 = \frac{R_UP+RD_W}{R_DW} \times REF + \Delta VOUT \quad [V] \quad (8)$$

$$REF = V_{FBL}(TYP\ 0.8V) + 0.02 - (ON\ DUTY \times 0.05) \quad [V] \quad (9)$$

$$ON\ DUTY = \frac{VOUT2}{VOUT1} \quad (10)$$

C_UP is needed to feedback output voltage ripple to FBL pin, the value is calculated to

$$C_UP = \frac{11e\text{-}6\ (+/-30\%)}{R_UP} \quad [F] \quad (11)$$

Please refer to eq. (5) regarding ΔVOUT.

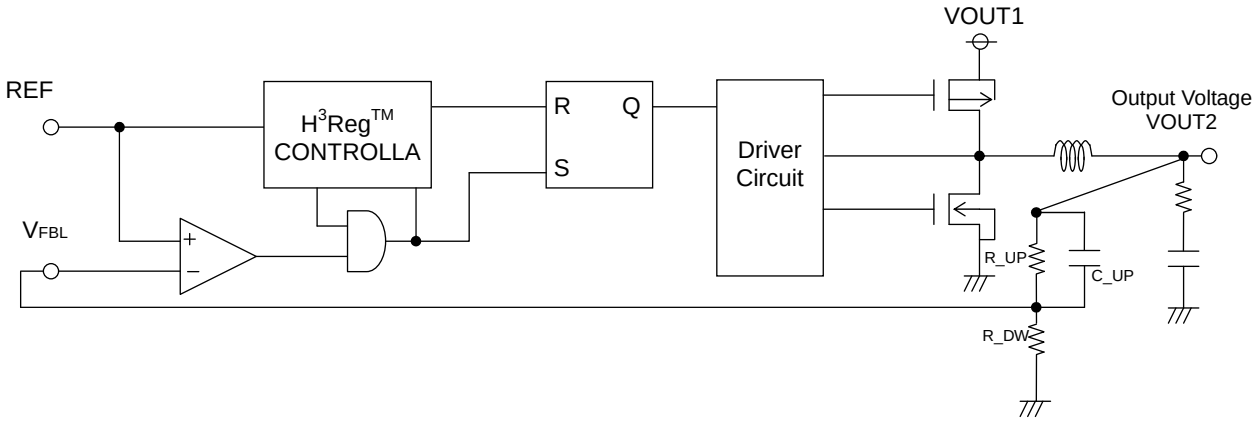


Figure 28. Output Voltage VOUT2 Setting

4. Relationship between Output Voltage and ONTIME

BD93291EFJ is a dual synchronous buck converter controlling constant ONTIME. The ONTIME (Ton) depends on the output voltage settings, as described by the formula (12).

$$Ton \fallingdotseq \frac{V_{OUT}}{V_{IN}} \times \frac{1}{Frequency} \quad [sec] \quad (12)$$

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●PCB Layout Guide

Two high pulsing current flowing loops exist in the buck regulator system.
The first loop, when FET is ON, starts from the input capacitors, to the VIN terminal, to the SW terminal, to the inductor, to the output capacitors, and then returns to the input capacitor through GND.
The second loop, when FET is OFF, starts from the low FET, to the inductor, to the output capacitor, and then returns to the low FET through GND.
To reduce the noise and improve the efficiency, please minimize these two loop area.
Especially input capacitor and output capacitor should be connected to GND plain.
PCB Layout may affect the thermal performance, noise and efficiency greatly. So please take extra care when designing PCB Layout patterns.

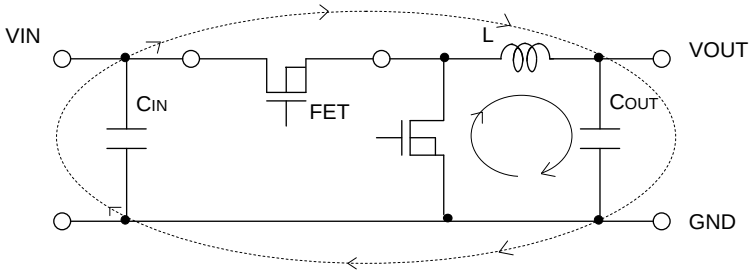


Figure 29. Current loop Buck regulator system

- The thermal pad on the back side of IC has the great thermal conduction to the chip. So using the GND plain as broad and wide as possible can help thermal dissipation. And a lot of thermal via for helping the spread of heat to the different layer is also effective.
- The input capacitors (C_VC1 and C_CO3) should be connected as close as possible to the VIN or VOUT terminal. Especially, C_CO3 between VOUT and GND must be placed near the VOUT pin, and keep the distance "b" less than 2mm.
- When there is unused area on PCB, please arrange the copper foil plain of DC nodes, such as GND, VIN and VOUT for helping heat dissipation of IC or circumference parts.
- To avoid the noise influence from AC combination with the other line, keep the switching line such as SW and SWL not extend as much as possible, and trace shortly and thickly to coil L1 and L2.
- Keep sensitive signal traces such as trace connected FBL away from SW and SWL pins.
- The inductors and the output capacitors should be placed close to SW or SWL pins as much as possible.
- Keep VOUT pattern width "a" more than 3mm to stable the 5V output.

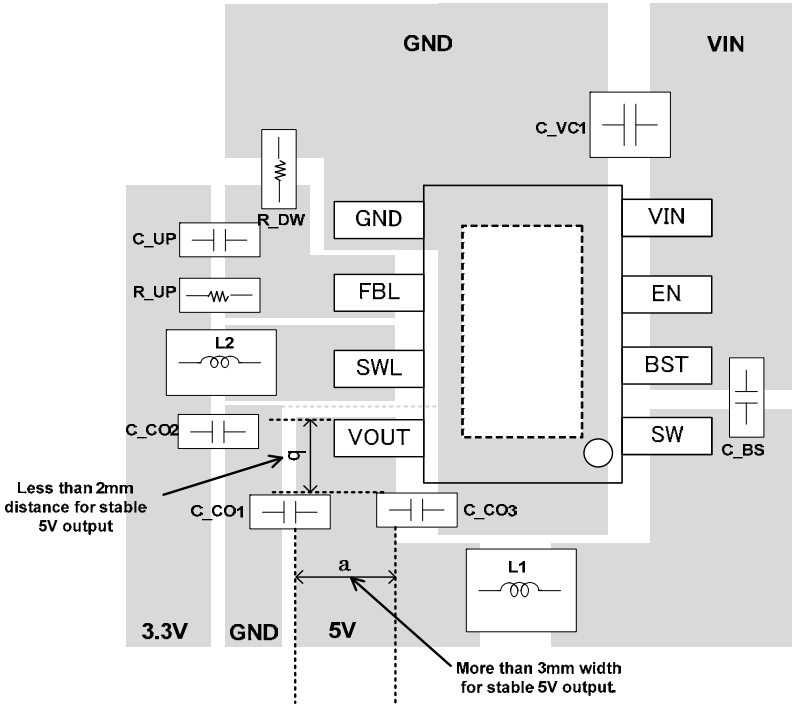


Figure 30. Example of PCB layout pattern

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●List of Evaluation Board Components

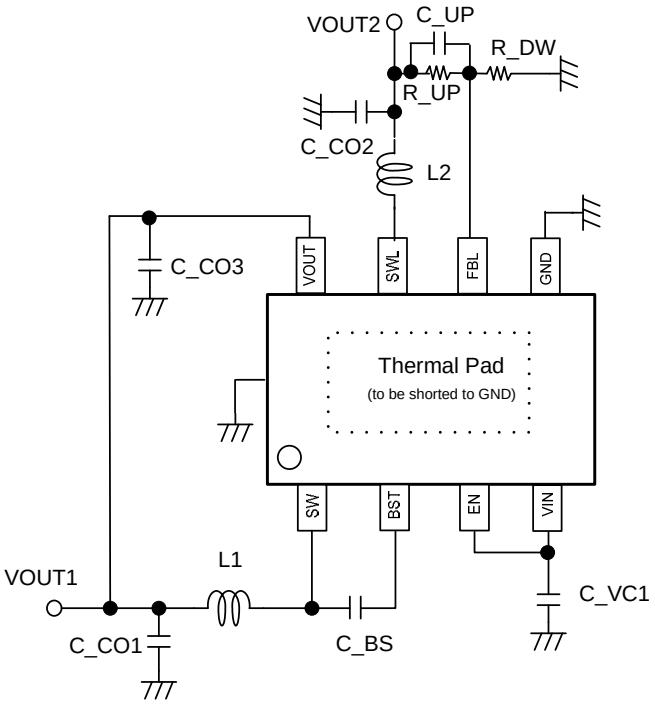


Figure 31. Typical Application Circuit

・Recommended Components List (VIN=14V, VOUT1=5V, VOUT2=3.3V)

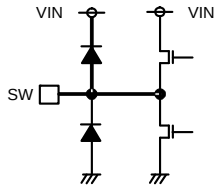
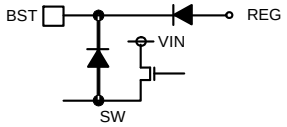
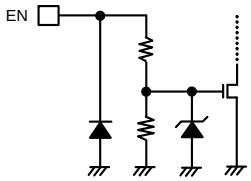
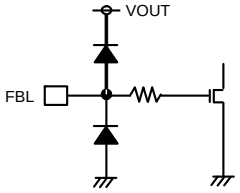
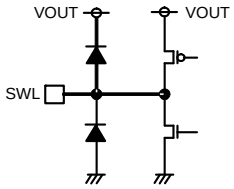
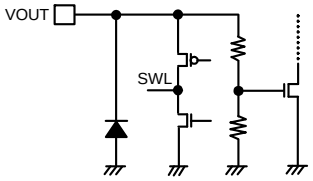
Symbol	Part	Value	Manufacture	Series
C_VC1	Ceramic Capacitor	10uF	murata	GRM32DF51H106ZA01L
C_BST	Ceramic Capacitor	0.1uF	murata	GRM188F11H104ZA01
L1	Coil	22uH	TDK	SLF10165 220M 2R4
L2	Coil	2.2uH	TDK	VLF 4012S 2R2M 1R3
C_CO1	Ceramic Capacitor	22uF	murata	GRM21BB31A226ME51L
C_CO2	Ceramic Capacitor	22uF	murata	GRM21BB31A226ME51L
C_CO3	Ceramic Capacitor	10uF	murata	GRM21BB31A106ME18
C_UP	Ceramic Capacitor	680pF	murata	GRM1882C1H681JA01
R_UP	Resistance	16kΩ	ROHM	MCR03 1608size Tolerance F
R_DW	Resistance	5.1kΩ	ROHM	MCR03 1608size Tolerance F

※The above components list is an example. Please check actual circuit characteristics on the application carefully before use.

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●I/O Equivalence circuit

SW 	BST 	EN 
FBL 	SWL 	VOUT 

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Operational Notes

(1) Absolute Maximum Ratings
Use of the IC in excess of absolute maximum ratings may result in damage to the IC. Assumptions should not be made regarding the state of the IC (e.g., short mode or open mode) when such damage is suffered. If operational values are expected to exceed the maximum ratings for the device, consider adding protective circuitry (such as fuses) to eliminate the risk of damaging the IC.

(2) GND voltage
The potential of the GND pin must be the minimum potential in the system in all operating conditions.

(3) Thermal design
Use a thermal design that allows for a sufficient margin for power dissipation (Pd) under actual operating conditions

(4) Inter-pin Shorts and Mounting Errors
Use caution when orienting and positioning the IC for mounting on printed circuit boards. Improper mounting may result in damage to the IC. Shorts between output pins or between output pins and the power supply and GND pins caused by poor soldering or foreign objects may result in damage to the IC.

(5) Operation in Strong Electromagnetic Fields
Using this product in strong electromagnetic fields may cause IC malfunction. Caution should be exercised in applications where strong electromagnetic fields may be present.

(6) ASO (Area of Safe Operation)
When using the IC, ensure that operating conditions do not exceed absolute maximum ratings or ASO of the output transistors.

(7) Testing on application boards
When testing the IC on an application board, connecting a capacitor directly to a low-impedance pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from a jig or fixture during the evaluation process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

(8) Electrical Characteristics
The electrical characteristics indicated in this datasheet may change upon the conditions of temperature, supply voltage, and external components. Please validate/verify your design at the worst case conditions.

(9) Not of a radiation-resistant design.

(10) Back Electromotive Force
If a large inductive load is connected at the output pin that might cause introducing back electromotive force at the start up and at the output disable, please insert protection diodes.

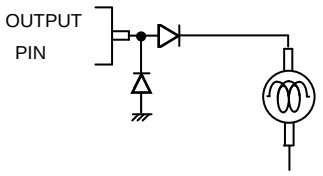


Figure 32. Back Electromotive Force

(11) Regarding input pins of the IC
This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. PN junctions are formed at the intersection of these P layers with the N layers of other elements, creating parasitic diodes and/or transistors. For example (refer to the figure below):、

•When GND > Pin A and GND > Pin B, the PN junction operates as a parasitic diode
•When GND > Pin B, the PN junction operates as a parasitic transistor

Parasitic diodes occur inevitably in the structure of the IC, and the operation of these parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

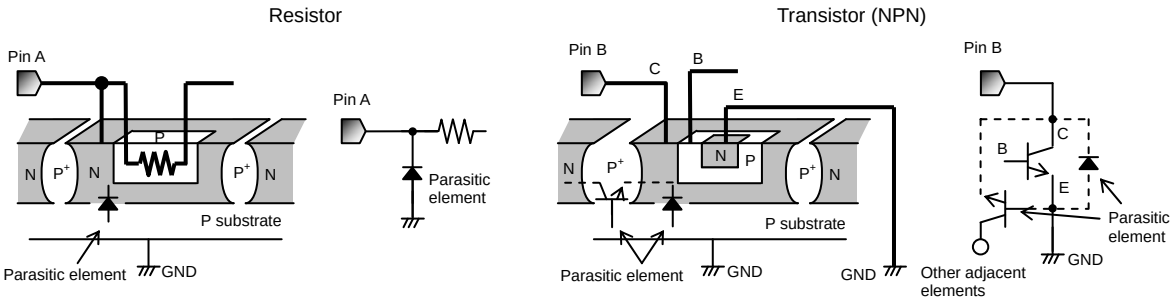


Figure 33. Example of IC structure

(12) Ground Wiring Pattern

When using both small-signal and large-current GND traces, the two ground traces should be routed separately but connected to a single ground potential within the application in order to avoid variations in the small-signal ground caused by large currents. Also ensure that the GND traces of external components do not cause variations on GND voltage.

(13) Operating Condition

The electrical characteristics indicated in this datasheet are not guaranteed for the whole operational and temperature ranges, however these characteristics do not significantly fluctuate within the operational and temperature ranges.

(14) Thermal shutdown (TSD) circuit

The IC incorporates a built-in thermal shutdown circuit, which is designed to turn the IC off completely in the event of thermal overload. It is not designed to protect the IC from damage or guarantee its operation. ICs should not be used after this function has activated, or in applications where the operation of this circuit is assumed. If the thermal shutdown is activated while the load current exists, the output may possibly be latched off at the release of the thermal shutdown.

TSD ON Temp.[℃] (typ.)	Hysteresis Temp[℃] (typ.)
175	25

(15) Heat Sink (FIN)

The heat sink (FIN) is connected to the substrate. Please connect it to GND.

Status of this document

The English version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.

If there are any differences in translation version of this document formal version takes priority

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●Thermal Derating Curves

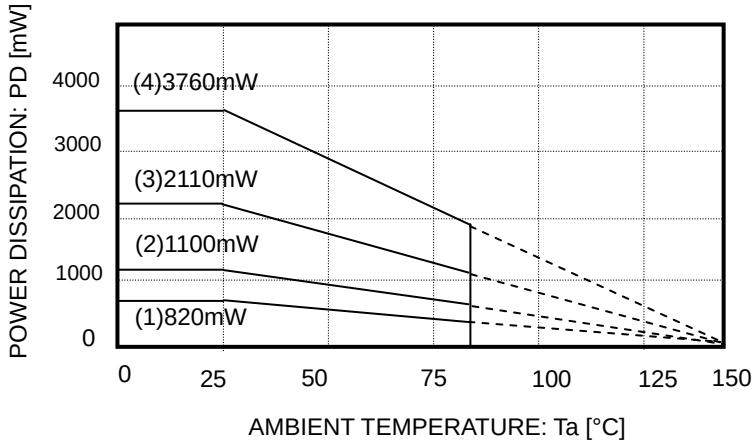


Figure 34. Thermal derating curve (HTSOP-J8)

HTSOP-J8 Package
On 70 × 70 × 1.6 mm glass epoxy PCB
(1) 1-layer board (Backside copper foil area 0 mm× 0 mm)
(2) 2-layer board (Backside copper foil area 15 mm × 15 mm)
(3) 2-layer board (Backside copper foil area 70 mm × 70 mm)
(4) 4-layer board (Backside copper foil area 70 mm × 70 mm)

●Ordering Information

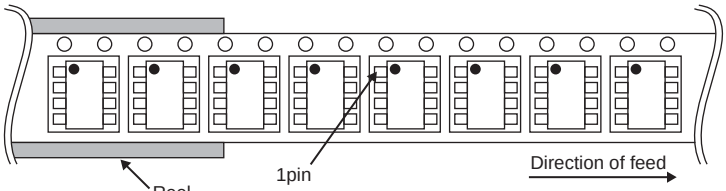
B D 9 3 2 9 1 E F J - E 2

- Part Number
- Package
  EFJ: HTSOP-J8
- Packaging and forming specification
  E2: Embossed tape and reel

●Physical Dimension Tape and Reel Information

<Tape and Reel information>

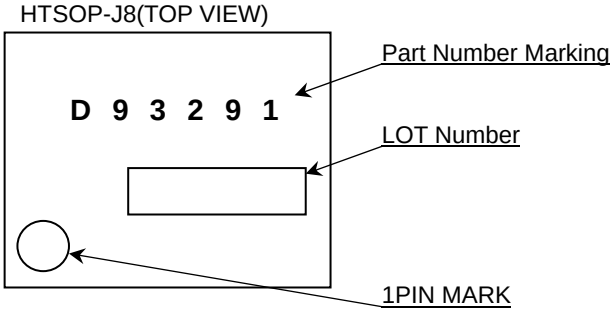
Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



∗Order quantity needs to be multiple of the minimum quantity.

●Marking Diagram

HTSOP-J8(TOP VIEW)



© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

●**Revision History**

Date	Revision	Changes
12.Nov.2012	001	New Release

© 2012 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

© 2014 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data. ROHM shall not be in any way responsible or liable for infringement of any intellectual property rights or other damages arising from use of such information or data.:

2. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the information contained in this document.

Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

© 2014 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

General Precaution

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.

© 2014 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.