Single-chip Type with Built-in FET Switching Regulator Series

Step-down Switching regulators with Built-in Power MOSFET

BU9002xNUX Series

●General Description

The BU9002xNUX are a high efficiency 1MHz synchronous step-down switching regulator with low current PFM mode.
It provides up to 1.5A load current and an input voltage range from 4.5V to 5.5V, optimized for various applications with input voltage range up to 5V.
BU9002xNUX has a mode control pin that allows the user to select Forced PWM (Pulse Width Modulation) mode or PFM (Pulse Frequency Modulation) and PWM auto change mode utilized power save operation at light load current.

●Features

- Fast transient response
- Automatic PFM/PWM operation.
- Forced PWM operation
- Internal Soft Start
- Under voltage lockout
- Over current protection
- Thermal shutdown

●Lineup

Part No.	Output voltage
BU90023NUX	1.230V
BU90028NUX	1.175V

●Pin Configuration(s)

(TOP VIEW)

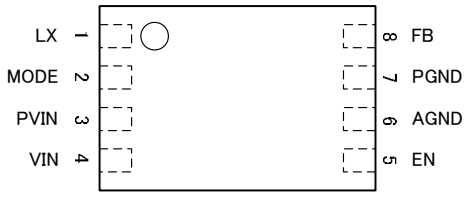


Figure 2. Pin Configuration(s)

●Applications

- POL, 1Cell Li-ion battery for portable applications , USB accessories

●Package(s)

	W(Typ.) x D(Typ.) x H(Max.)
VSON008X2030	2.00mm x 3.00mm x 0.60mm

VSON008X2030

●Typical Application Circuit(s)

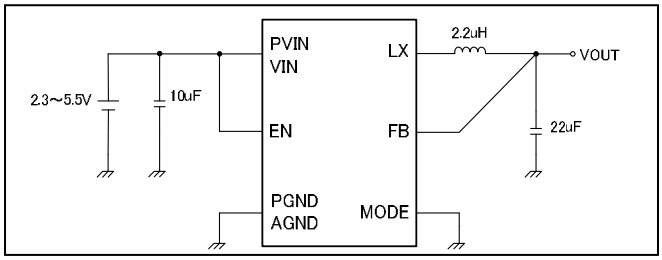


Figure 1. Typical Application Circuit(s)

●Pin Description(s)

Pin No.	Symbol	Function
1	LX	Inductor connection pin
2	MODE	Forced PWM mode pin
3	PVIN	Power supply input pin
4	VIN	Power supply input pin
5	EN	Enable pin
6	AGND	GND pin
7	PGND	GND pin
8	FB	Feedback voltage input pin

●**Block Diagram(s)**

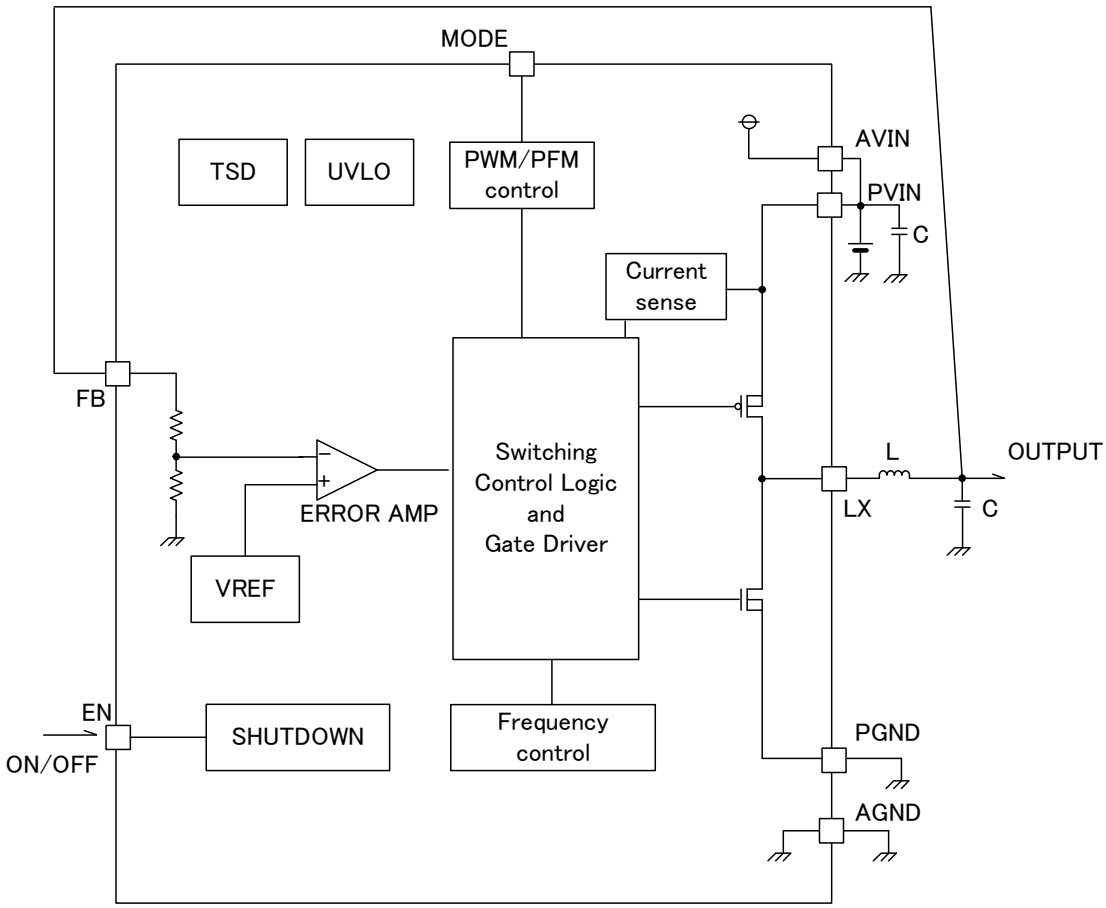


Figure 3. Block Diagram(s)

●**Description of Block(s)**

The BU9002xNUX are a synchronous step-down DC/DC converter that achieves fast transient response from light load to heavy load by hysteretic PWM control system and current constant PFM control system.

○PWM control

BU9002xNUX operates by hysteretic PWM control. This scheme ensures fast switching, high efficiency, and fast transient response.
When the output voltage is below the VREF voltage, the error comparator output is low to high and turning on P-channel MOSFET until above the VREF voltage and minimum on time.

○PFM control

At light load the regulator and MODE=low, the regulator operates with reduced switching frequency and improves the efficiency. During PFM operation, the output voltage slightly higher than typical output voltage.

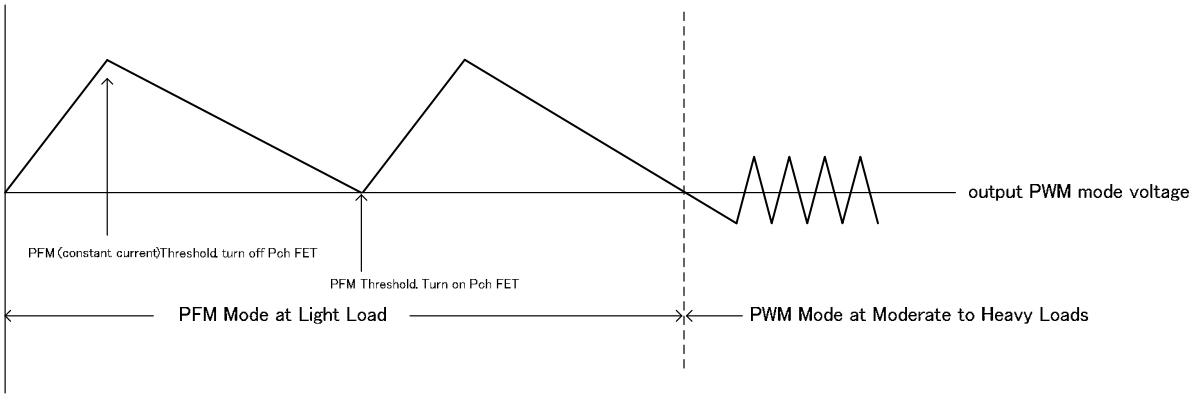


Figure 4. Operation of PFM mode and PWM mode

●Description of operations

1) Shutdown
If the EN input pin set to low (<0.4V), all circuit are shut down and the regulator is standby mode.
Do not leave the EN pin floating.

2) Soft start function
The regulator has a soft start circuit that reduces in-rush current at start-up.
Typical start up times with a 2.2uF output capacitor is 240usec.

3) Current limit
The BU9002xNUX has a current limit circuit that protects itself and external components during overload condition.

4) UVLO
The BU9002xNUX has a Under Voltage Lock Out circuit that turn off device when VIN>2.05V(typ.)

5) FORCED PWM MODE
Setting MODE pin high (>1.4V) places the regulator in forced PWM. This control provides noise reduction and output stability.
Do not leave the MODE pin floating.

6) TSD
The BU9002xNUX has a thermal shutdown feature to protect the device if the junction temperature exceeds 150℃.In thermal shutdown, the DRIVER is disabled.
This circuit is only to cut off the IC from thermal runaway, and has not been design to protect or guarantee the IC. Therefore, the user should not plan to activate this circuit with continued operation in mind.

●Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Rating	Unit
Maximum input power supply voltage	VIN	7	V
Maximum voltage at EN, FB, LX, MODE	VEN, VFB, VLX, VMODE	7	V
Power dissipation	Pd	0.515	W
Operating temperature range	Topr	-40 to +85	℃
Storage temperature range	Tstg	-55 to +125	℃
Junction temperature	Tjmax	+125	℃

(*1) When mounted on the specified PCB (55mm x 63mm), Deducted by 3.9m W/c when used over Ta=25c

●Recommended Operating Rating(s)

Parameter	Symbol	Rating			Unit	Series
		Min.	Typ.	Max.		
Input voltage	VIN	2.3	-	5.5	V	

●**Electrical Characteristic(s)** (unless otherwise specified VIN=5.0V, Ta=25℃)

Item		Symbol	Rating			Unit	Condition
			Min.	Typ.	Max.		
【Switching regulator】							
Output voltage accuracy		VOUTA	1.206	1.230	1.254	V	BU90023NUX MODE:H（PWM）
			1.152	1.175	1.199		BU90028NUX MODE:H（PWM）
【Soft start】							
Soft start time		Tss	120	240	480	usec	
【Frequency control】							
Switching frequency		fosc	0.8	1.0	2.0	MHz	
【Driver】							
PchFET on resistance		RonP	-	250	400	mOhm	VIN=5.0V
NchFET on resistance		RonN	-	220	350	mOhm	VIN=5.0V
【Control】							
EN pin control voltage	Operation	VENH	1.4	-	VIN	V	
	Non Operation	VENL	0	-	0.4	V	
MODE pin control voltage	Operation	VMODEH	1.4	-	VIN	V	Forced PWM
	Non Operation	VMODEL	0	-	0.4	V	Automatic PFM/PWM
【UVLO】							
Protect threshold voltage		Uvth	1.95	2.05	2.15	V	
Hysteresis		Uvhy	50	100	150	mV	
【Current limit】							
Current limit threshold		ILIMIT	2.2	2.5	2.8	A	PMOS current detect, Open loop
【Output discharge】							
Output discharge resistance		DRES	55	110	220	Ohm	EN=0V
【Circuit current】							
Operating quiescent current		IINS		53	75	uA	EN:H, MODE:L, VOUT=3.6V forced Not switching
Shutdown current		SHD	-	0	1	uA	EN=0V

●Electrical characteristic curves (Reference data)

BU90023NUX (1.23V OUTPUT)

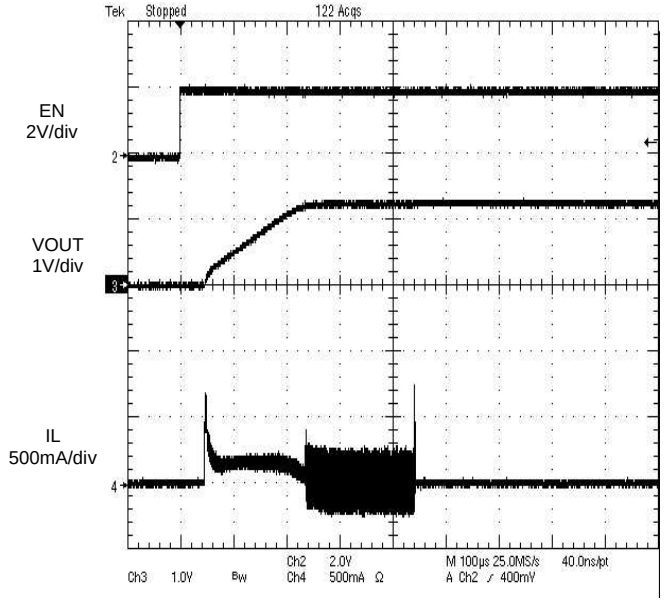


Figure 5. Start up

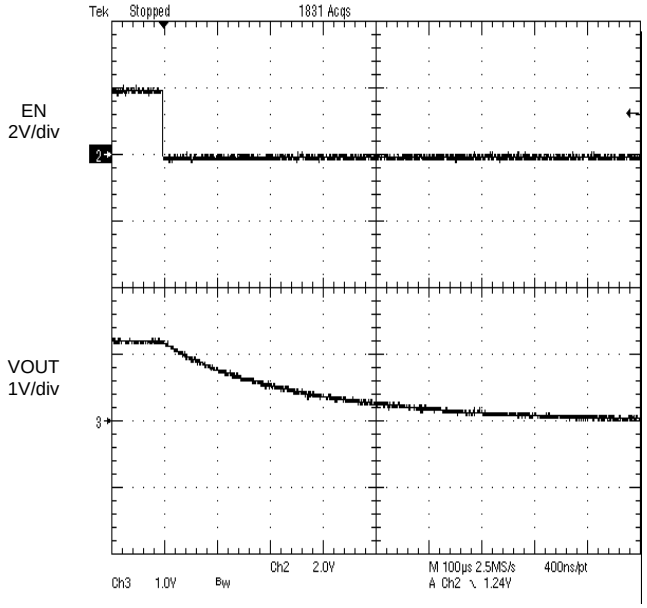


Figure 6. Shut down

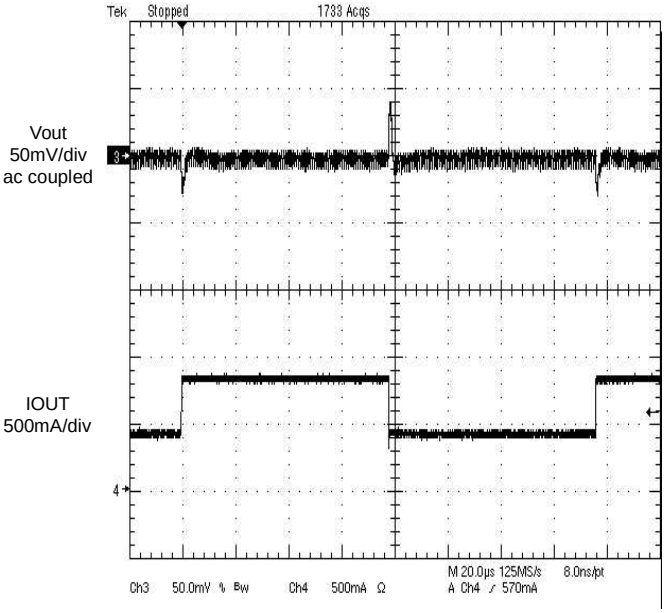


Figure 7. Load transient response 400mA to 800mA
tr=tf=100ns, MODE : Low

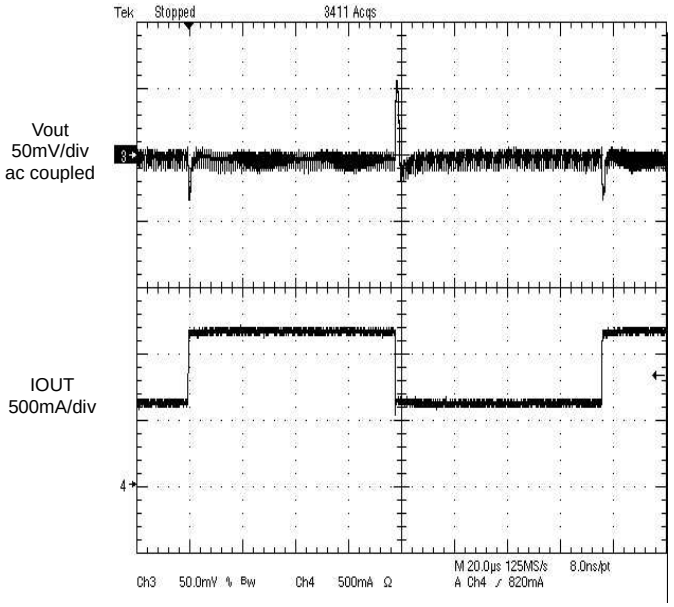


Figure 8. Load transient response 600mA to 1200mA
tr=tf=100ns, MODE : Low

●**Electrical characteristic curves (Reference data)**
BU90023NUX (1.23V OUTPUT) continued

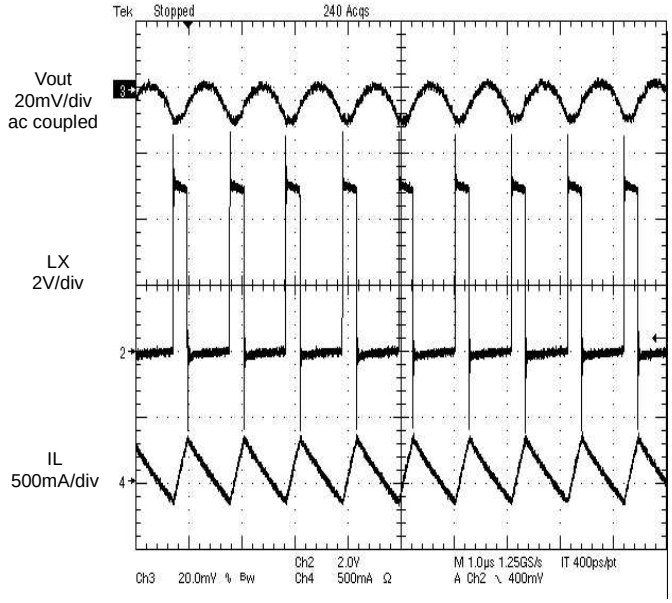


Figure 9. PWM mode
Operation Iout=50mA

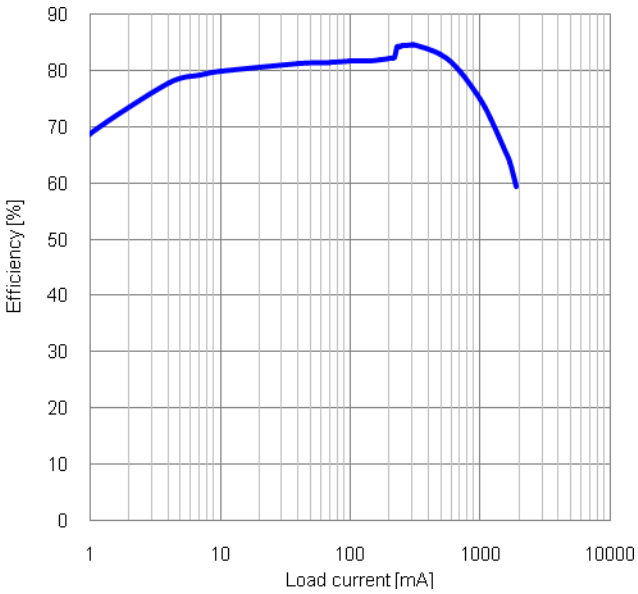


Figure 10. Efficiency vs Load current
VIN=5V PWM/PFM Auto mode

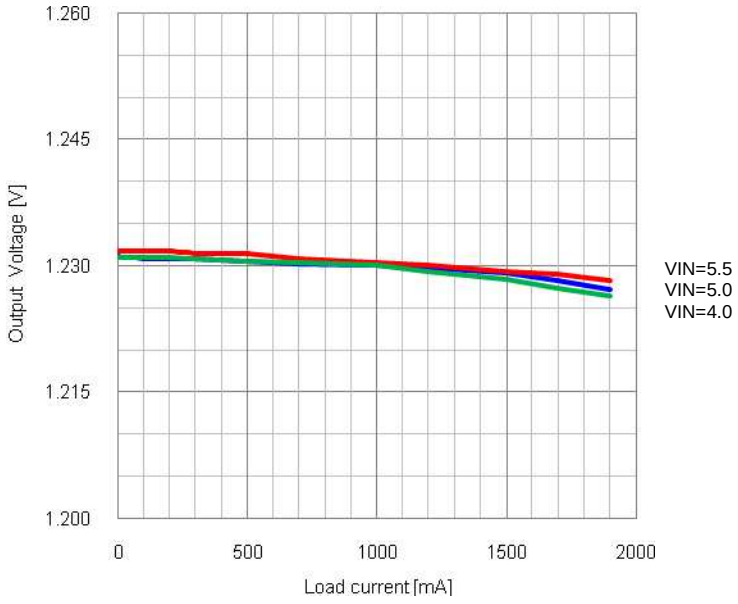


Figure 11. Load regulation
PWM mode

●**Electrical characteristic curves (Reference data)**
BU90028NUX (1.175V OUTPUT)

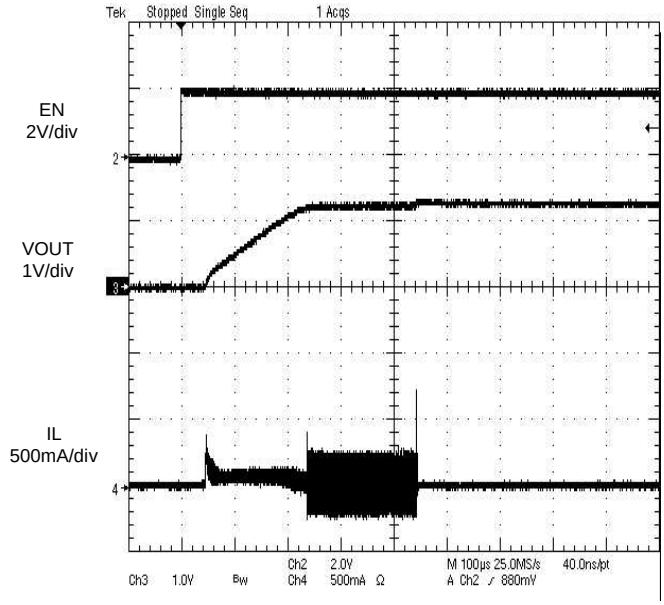


Figure 12. Start up

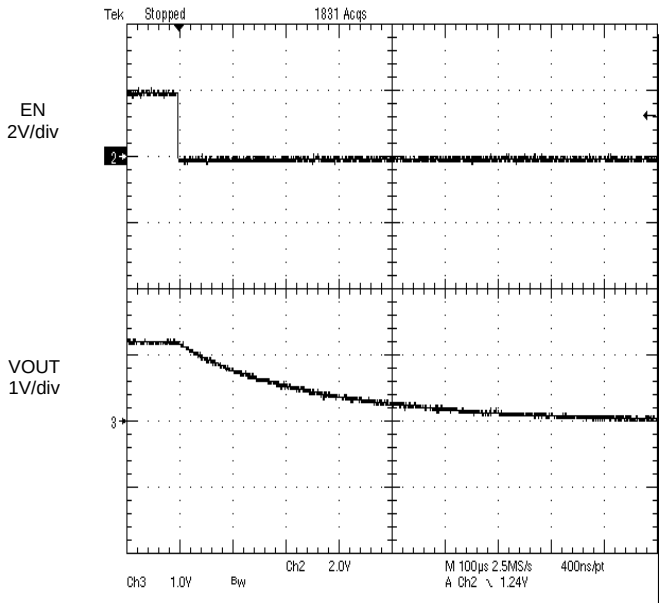


Figure 13. Shut down

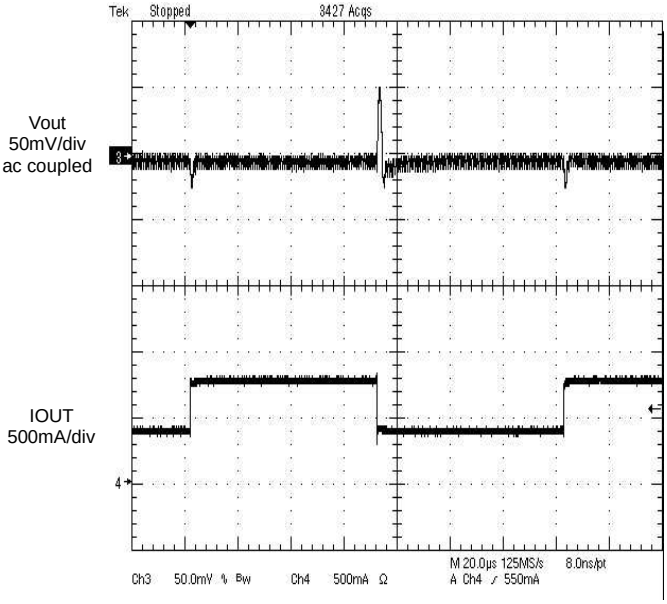


Figure 14. Load transient response 400mA to 800mA
tr=tf=100ns, MODE : Low

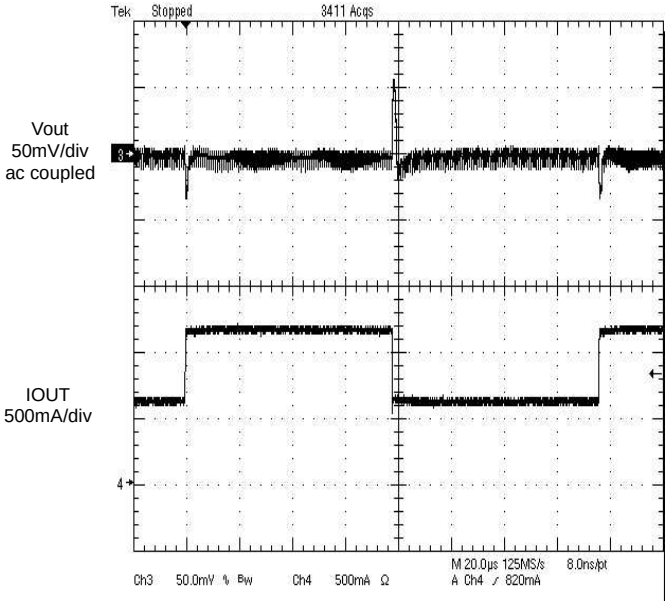


Figure 15. Load transient response 600mA to 1200mA
tr=tf=100ns, MODE : Low

●特性データ(参考データ)
BU90028NUX（1.175V 出力）continued

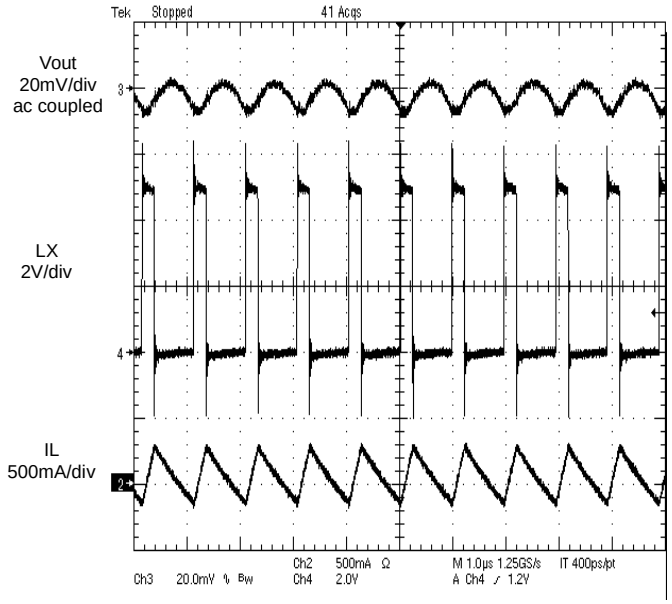


Figure 16. PWM mode
Operation Iout=50mA

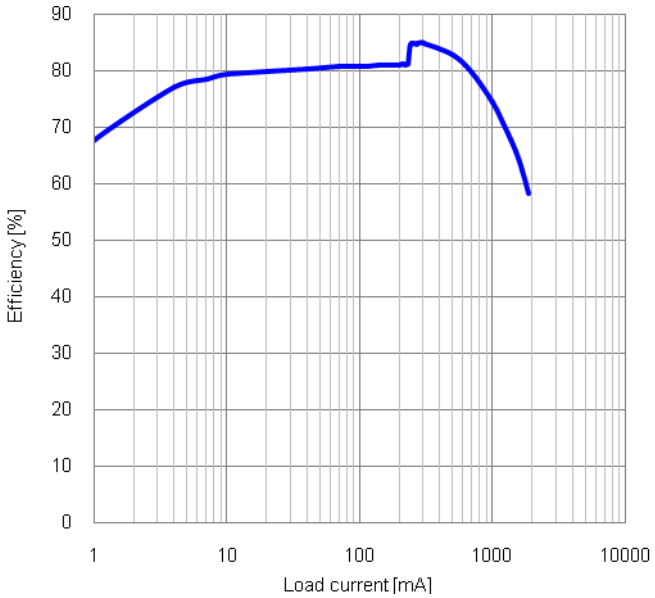


Figure 17. Efficiency vs Load current
VIN=5V PWM/PFM Auto mode

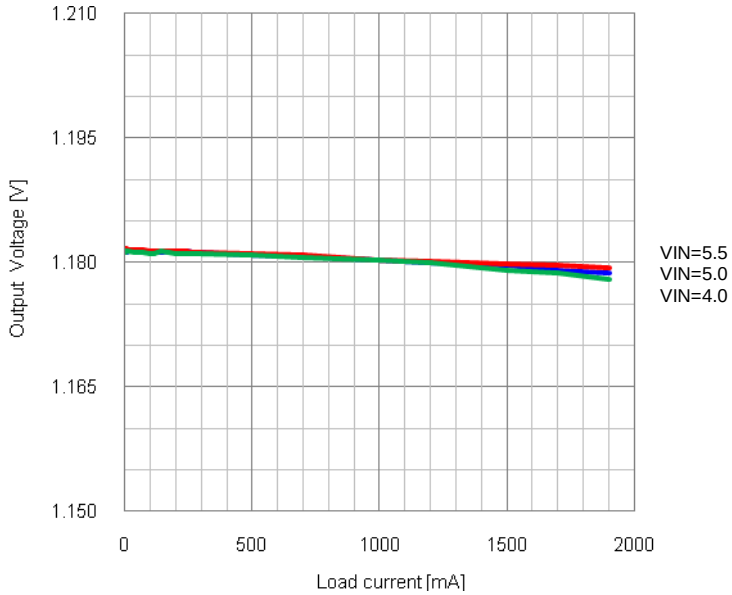


Figure 18. Load regulation
PWM mode

●PC Board layout
The suggested PCB layout for the BU9002xNUX are shown in Figure. The following guidelines should be used to ensure a proper layout.

1) The input capacitor CIN should be connect as closely possible to VIN pin and GND pin.

2) From the output voltage to the FB pin line should be as separate as possible.

3) COUT and L should be connected as closely as possible. The connection of L to the LX pin should be as short as possible.

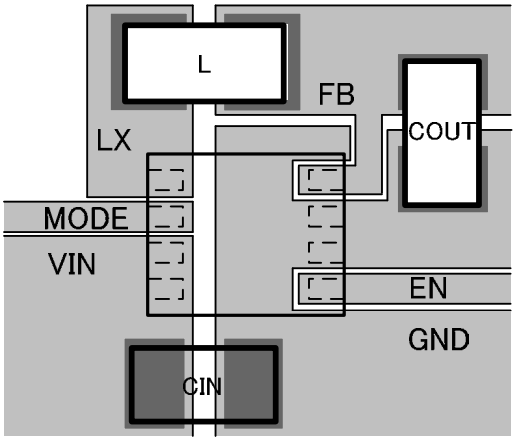


Figure 19. PCB layout

●External parts selection

Inductor selection
The inductance significantly depends on output ripple current. As shown by following equation, the ripple current decreases as the inductor and/or switching frequency increase.

$$\Delta I_L = \frac{(VIN\text{-}VOUT) \times VOUT}{L \times VIN \times f}$$

f: switching frequency L: inductance ΔI_L: inductor current ripple

As a minimum requirement, the DC current rating of the inductor should be equal to the maximum load current plus half of the inductor current ripple as shown by the following equation.

$$I_{LPEAK} = I_{OUTMAX} + \frac{\Delta I_L}{2}$$

1) Recommended inductor selection
・Iout≦1.5A
DFE252012C Type 2.2uH (TOKO)
NR4018T2R2M (TAIYO YUDEN)
・Iout≦0.6A
NR3010T2R2M (TAIYO YUDEN)

2) Recommended input capacitor(CIN) selection
C1608 Type 22uF (X5R 6.3V TDK)

3)Recommended output capacitor(COUT) selection
C1608 Type 22uF (X5R 6.3V TDK)

●Caution of use

1) Absolute maximum ratings

An excess in the absolute maximum rating, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.

2) GND voltage

The potential of GND pin must be minimum potential in all condition. As an exception, the circuit design allows voltages up to -0.3 V to be applied to the IC pin.

3) Thermal design

Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

4) Inter-pin shorts and mounting errors

Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.

5) Actions in strong electromagnetic field

Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.

6) Mutual impedance

Power supply and ground wiring should reflect consideration of the need to lower mutual impedance and minimize ripple as much as possible (by making wiring as short and thick as possible or rejecting ripple by incorporating inductance and capacitance).

7) Thermal shutdown Circuit (TSD Circuit)

This model IC has a built-in TSD circuit. This circuit is only to cut off the IC from thermal runaway, and has not been design to protect or guarantee the IC. Therefore, the user should not plan to activate this circuit with continued operation in mind.

8) Regarding input pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated.

P-N junctions are formed at the intersection of these P layers with the N layers of other elements, creating a parasitic diode or transistor. For example, as shown in the figures below, the relation between each potential is as follows:

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.

When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes can occur inevitable in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND (P substrate) voltage to an input pin, should not be used.

Status of this document

The Japanese 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

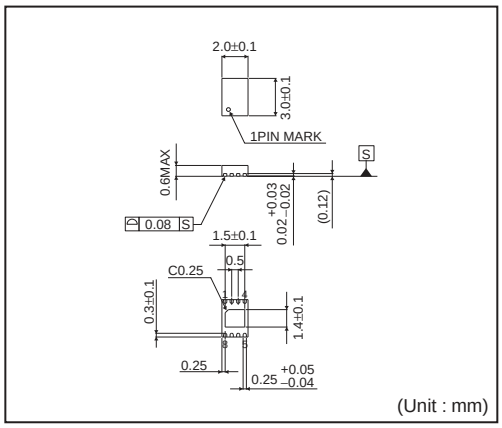
●Ordering Information

B U 9 0 0 2 x N U X	TR

- Part Number
- Package
  NUX: VSON008X2030
- Packaging and forming specification
  TR: Embossed tape and reel
  (VSON008X2030)

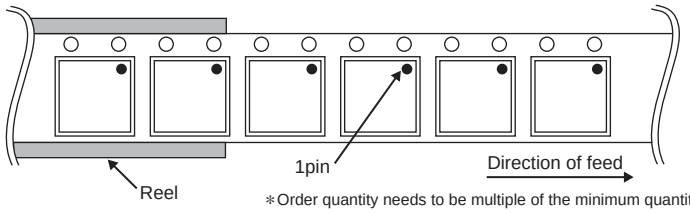
●Physical Dimension Tape and Reel Information

VSON008X2030



<Tape and Reel information>

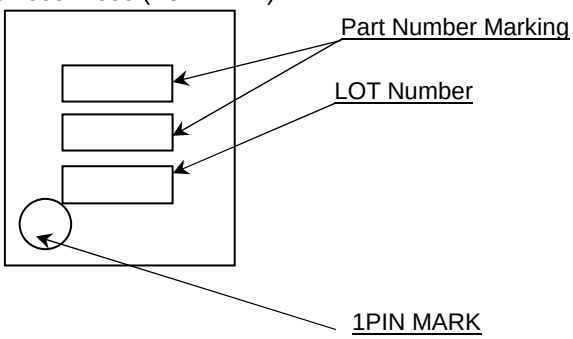
Tape	Embossed carrier tape
Quantity	4000pcs
Direction of feed	TR (The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the tape on the right hand)



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

●Marking Diagram(s)(TOP VIEW)

VSON008X2030 (TOP VIEW)



Part No.	Part Number Marking
BU90023NUX	U90
	023
BU90028NUX	U90
	028

Notice

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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	

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   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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   [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

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

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