Single-chip Type with Built-in FET Switching Regulators

Simple Step-down Switching Regulators with Built-in Power MOSFET

BD9G101G

●General Description

The BD9G101G is switching regulator with integrated internal high-side 42V Power MOSFET.
It provides 0.5A DC output with small SOT-23 package.

Operating frequency is fixed 1.5MHz, allowing the use of small inductor and ceramic capacitor.
The components of phase compensation is built in.
The BD9G101G is available in SOT-23-6(SSOP6) package.

●Features

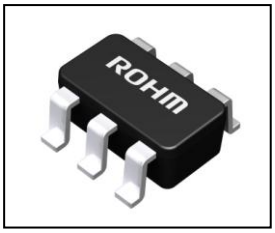
- High and Wide Input Range (VCC=6V~42V)
- 45V/800mΩ Internal Power MOSFET
- 1.5MHz Fixed Operating Frequency
- Feedback Pin Voltage 0.75V±1.5%
- Internal compensated
- Internal Over Current protection, Under Voltage Locked Out, Thermal shutdown
- 0μA Shutdown Supply Current
- 6-Lead SOT-23 package(SSOP6)

●Key Specifications

- Input Voltage 6～42 [V]
- Ref. Precision (Ta=25℃) ±1.5[%]
  (Ta=-25~105℃) ±2.0[%]
- Max Output Current 0.5 [A] (Max.)
- Operating Temperature -40℃~105℃
- Max Junction Temperature 150℃

●Packages

SSOP6 2.90 ㎜×2.80 ㎜×1.25 ㎜



SSOP6

●Applications

- Industrial distributed power applications
- Automotive Applications
- Battery powered equipment
- OA instruments

●Typical Application Circuits

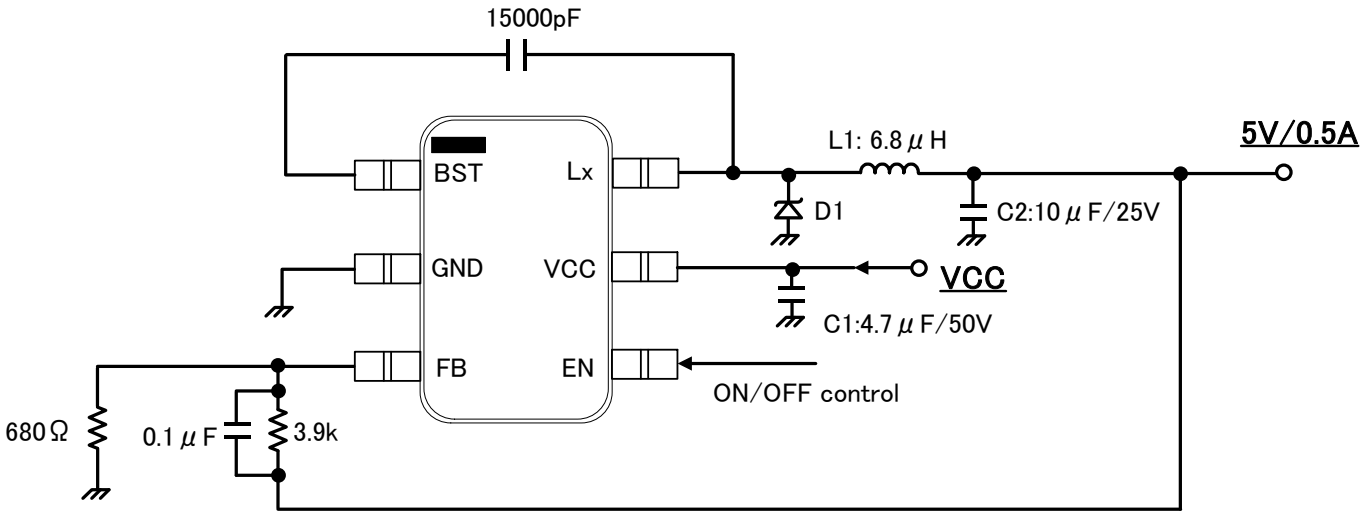


Figure 1. Typical Application Circuit

○Structure：Silicon Monolithic Integrated Circuit ○This product is not designed for normal operation with in a radioactive.

●Pin Configuration

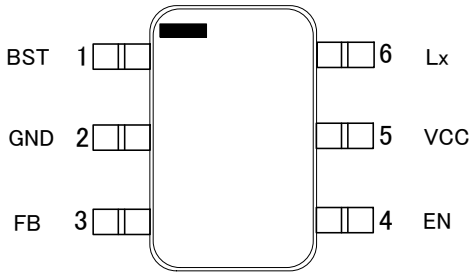


Figure 2. Pin Configuration (TOP VIEW)

●Pin Description

Pin No.	Pin Name	Description
1	BST	The pin is power supply for floating Power NMOS driver. Connected a bypass capacitor between the pin and Lx pin for bootstrap operation.
2	GND	Ground. It should be connected as possible to the output capacitor ground avoiding the high current switch paths.
3	FB	Voltage feedback pin. This pin is error-amp input, the DCDC is set 0.75V at this pin with feed-back operation.
4	EN	Enable input pin. The DCDC is start-up to apply over 2.0V. This pin is pull-down about 550kΩ, the DCDC is shutdown to open or apply under 0.8V.
5	VCC	Input supply. It should be connected as near as possible to the bypass capacitor.
6	Lx	Power FET switch output. It should be connected as near as possible to the schottky barrier diode, and inductor.

●Block Diagram

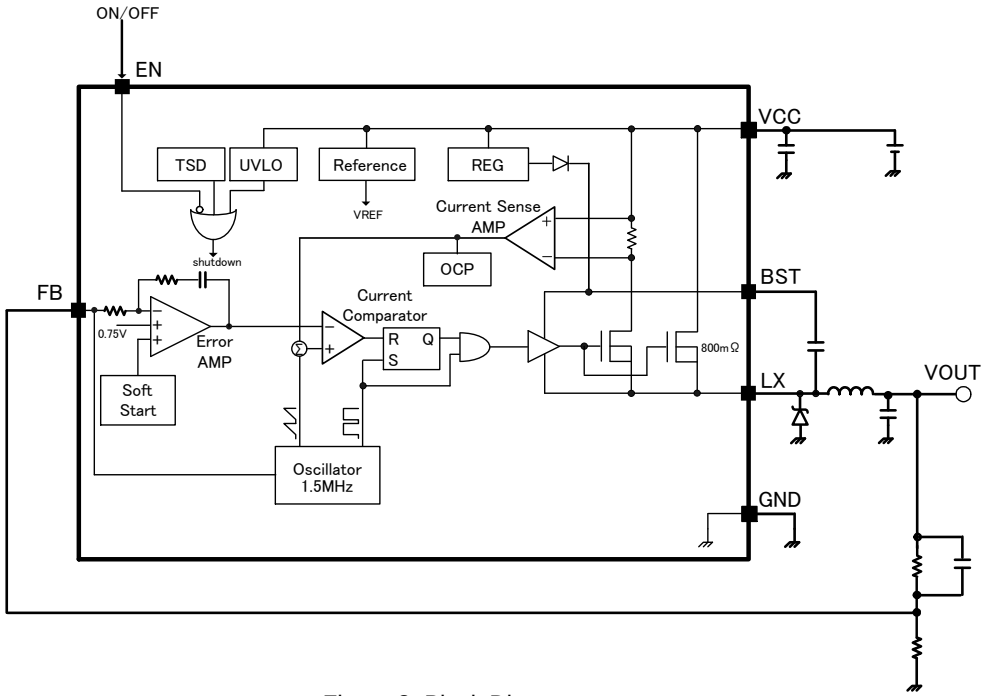


Figure 3. Block Diagram

●Description of Blocks

1. Reference
   This block generates reference voltage and current. It start operation by applying EN more than 2.0V.
   It provides reference voltage and current to error-amp , oscillator ,and etc.

2. REG
   This is a gate drive voltage generator and 4.2V regulator for internal circuit power supply.

3. OSC
   This is a precise wave oscillation circuit with operation frequency fixed to 1.5MHz fixed.
   To protect from output shorted to GND, Frequency fold-back function is built in.

4. Soft Start
   This block does Soft Start to the output voltage of DC/DC comparator, and prevents in-rush current during Start-up.
   Soft Start Time depend on application and start-condition because Frequency fold-back function is built in.

5. ERROR AMP
   This is an error amplifier what detects output signal, and outputs PWM control signal.
   Internal reference voltage is set to 0.75V. Also, the BD9G101G has internal phase compensated element between input and output.

6. Current Comparator
   This is a comparator that outputs PWM signal from current feed-back signal and error-amp output for current-mode.

7. Nch FET SW
   This is an 45V/800mΩ Power Nch MOSFET SW that converts inductor current of DC/DC converter.

8. UVLO
   This is a low voltage error prevention circuit.
   This prevents internal circuit error during increase of power supply voltage and during decline of power supply voltage.
   It monitors VCC pin voltage, And when VCC voltage becomes 5.4V and below, it turns OFF all output FET and turns OFF DC/DC comparator output, and Soft Start circuit resets.
   Now this Threshold has hysteresis of 200mV.

9. EN
   When a Voltage of 2.0V or more is applied, it turns ON, at Open or 0V application, it turns OFF.
   About 550kΩ Pull-down Resistance is contained within the Pin.

10. OCP
    The current of power MOSFET is limited by this function.
    The power MOSFET current is sensed by current sense FET. If the current of power MOSFET is over 1.2A(typ), this function reduce duty by pulse –by- pulse and restrict the and restraint on over current.

11. TSD
    Circuit for preventing malfunction at high Temperature .
    When it detects an abnormal temperature exceeding Tj=175℃, it turns OFF DC/DC Comparator Output. The threshold of TSD has Hysteresis(25℃). If Temperature falls 150℃,the IC automatically returns.

●Absolute Maximum Ratings

Item	Symbol	Ratings	Unit
VCC	VCC	45	V
Maximum input current	Imax	1.0	A
BST to GND	VBST	50	V
BST to LX	⊿VBST	7	V
EN	VEN	45	V
Lx	VLx	45	V
FB	VFB	7	V
Power Dissipation	Pd	0.675(*1)	W
Operating Temperature	Topr	-40～+105(*2)	℃
Storage Temperature	Tstg	-55～+150	℃
Junction Temperature	Tjmax	150	℃

(*1)During mounting of 70×70×1.6t mm 1layer board.Reduce by 5.4mW for every 1℃ increase. (Above 25℃)
(*2)Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage. thermal shutdown engages at Tj=175℃(typ) and disengages at Tj=150℃ (typ)

●Electrical Characteristics (Unless otherwise specified Ta=25℃, VCC=24V, Vo=5V,EN=3V)

Parameter		Symbol	Limit			Unit	Condition
			Min	Typ	Max		
【Circuit Current】							
Stand-by Current		Ist	－	0	5	μA	VEN=0V
Operating Current		Icc	－	0.7	1.2	mA	FB=1.2V
【Under Voltage Lock Out (UVLO)】							
Threshold Voltage		Vuv	5.1	5.4	5.7	V	
Hysteresis width		Vuvhy	－	200	300	mV	
【Oscillator】							
Switching Frequency		fosc	1.3	1.5	1.7	MHz	
Max Duty Cycle		Dmax	85	-	-	%	
【Error AMP】							
FB Pin Reference Voltage		VFBN	0.739	0.750	0.761	V	Ta=25℃
		VFBA	0.735	0.750	0.765	V	Ta=-25~105℃
FB Pin Bias Current		IFB	-100	0	100	nA	VFB=2.0V
Soft-Start Time		Tsoft	1.2	4.0	-	ms	
【Current Comparator】							
Trans-conductance		G_{CS}	-	3	-	A/V	
【Output】							
Nch MOSFET ON Resistance		RonH	－	800	－	mΩ	
Min ON Time		Tmin	－	100	－	nsec	
Switch Current Limit		Iocp	0.85	1.2	－	A	
【CTL】							
EN Thresohold Voltage	ON	VENON	2.0	－	VCC	V	
	OFF	VENOFF	-0.3	－	0.8	V	
EN Input Bias Current		REN	2.7	5.5	11	μA	VEN=3V

◎ Not designed to withstand radiation.

●Operating Ratings

Item	Symbol	Ratings			Unit
		Min	Typ	Max	
Input Voltage	VCC	6	-	42	V
Output Voltage	VOUT	1.0(*2)	-	VCC × 0.7(*3)	V
Output Current	IOUT	-	-	500	mA

(*2)Restricted by minimum on pulse typ. 100nsec
(*3)Restricted by maxduty ,Ron and BST-UVLO.

●input and output voltage restriction

The input voltage range of BD9G101G is limited by Ron, Maxduty(min85%) and preventing malfunction at low voltage between BST and LX(BST-UVLO).

①BST-UVLO

BSTUVLO is the function that prevent the IC from abnormal operation that is caused by shortage of charge of High-SideFET driving. If the voltage between BST and Lx is lower than 1.5V, High-Side FET is turned off and there are new pass to charge voltage VCC to BST. BST voltage is charged by Vcc and goes over BST-UVLO threshold. As a result , BST-UVLO is turned off.

The condition that BST-UVLO is working property is
VCC>>(BST-UVLO threshold + Vf)+ Vout.
Therefore maximum output voltage is lower than Vin -3V.

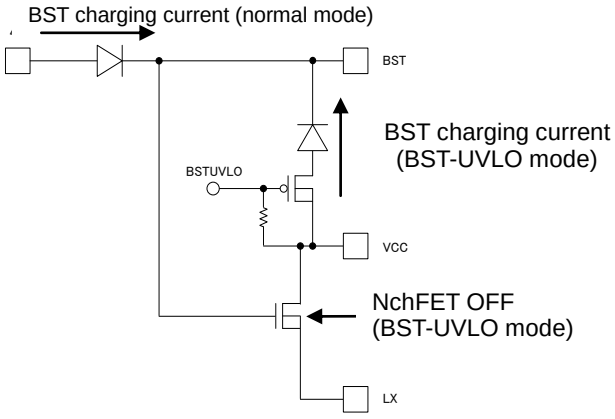


Figure 4. BST-UVLO image

※When operation can be considered by Vin-Vout<3V, output voltage leaps up to near input voltage by BSTUVLO operation at the time of a light load.
The waveform of operation and a mechanism are shown.

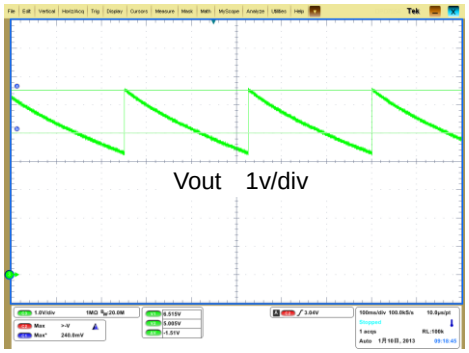


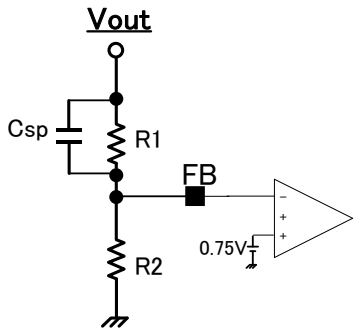
Figure 5. BSTUVLO operation waveform
Vout=5V Vin=7V Iout=0mA

①BSTUVLO detection →Nch MOS FET is turned OFF
↓
②Vout、Lx are discharged
⇒ErrorAMP output is raised
↓
③ The voltage between BST-Lx is secured enough
→BSTUVLO release
↓
④ In order to carry out a start of operation with Max Duty cycle, an output leaps up.
↓
⑤ The voltage between BST-Lx is insufficient.

As a measure, it is necessary to lower the order of division resistance and to put in a feed-forward capacitor between output-FB terminals.
The setting method of the feed-forward capacitor between output division resistance and output-FB terminals is shown in below.

・Output voltage setting

The internal reference voltage of ERROR AMP is 0.75V. Output voltage is determined like (1) types.



$$Vo = \frac{(R1+R2)}{R2} \times 0.75[V] \quad \cdots \quad (1)$$

Figure 6. Output voltage setting

However, in order to avoid the BSTUVLO operation at the time of a reduced power and light load, please set up R1+R2 is satisfied the following formulas.

$$R1 + R2 \leq V_{out} \times 10^3 \quad \cdots (2)$$

The example of output resistances setting : output voltage 5V R1=3.9kΩ R2=0.68kΩ
output voltage 12V R1=7.5kΩ R2=0.51kΩ

・Feed-forward capacitor Csp

Please mount feed-forward capacitor in parallel to output resistance R1.
In order that a feed-forward capacitor may adjust the loop characteristic by adding the pair of a pole and zero to the loop characteristic. A phase margin is improved and transient response speed improves.
The feed-forward capacitor Csp should use the value near the following formulas.

$$Csp = \frac{4.7k}{R1} \times 0.15 \quad [uF] \quad \cdots (3)$$

The example of a Csp setting : output voltage 5V R1=3.9kΩ R2=0.68kΩ Csp = 0.1uF or 0.22uF
output voltage 12V R1=7.5kΩ R2=0.51kΩ Csp = 0.1uF

By above mentioned measure, there is not BSTUVLO operation in litgh load and Vin-Vout<3V.

②Max duty , Ron

Maximum output voltage is limited by maxduty(min85%) and FET Ron.
In the case of Io=500mA, VCC drop down 500mA × 0.8Ω=0.6V besides maxduty.
Vomax = (Vcc-Ron × Iomax) × 0.85 (casually formula)
Considering the negative voltage in the case of pulling diode current,
Formula of maximum output voltage is
Vomax = VCC × 0.7.

③minimum on pulse

Minimum output voltage is limited by minimum on pulse (typ 100nsec).
Output voltage = frequency(typ 1.5MHz) × FET on time × Vin
If output voltage is lower than this formula , Output ripple voltage is boosted by intermittent spring.

●Frequency fold-back function

This IC has the frequency fold-back function to prevent from over current with the circuit output is shorted.
The frequency fold-back has the function that the frequency is changed by FB voltage.
Figure.5 shows FB voltage vs frequency Characteristics.

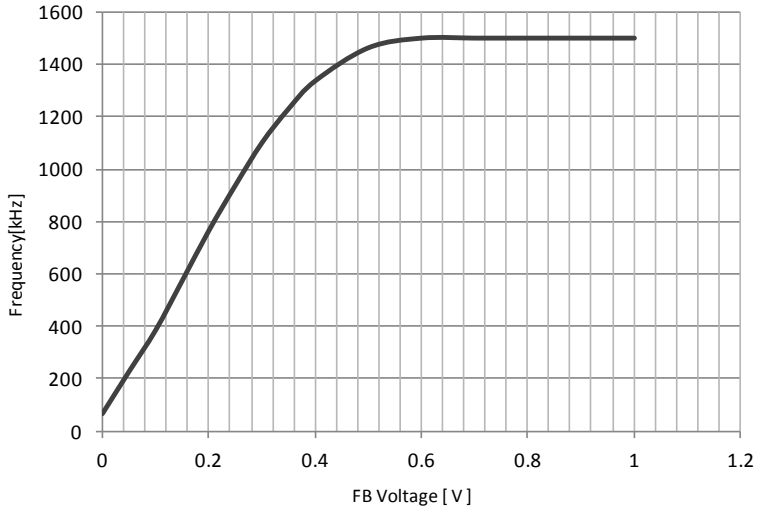


Figure 7. FB voltage -frequency Characteristics

When the output node is shorted, the IC narrows the frequency to 150kHz(typ) so that input current limiting.
This IC operates on1.5MHz in case of normal mode, the voltage of FB is about 0.75V.

●Start-up Characteristics

When the IC is starting up, frequency reacts to the voltage of FB on the function of frequency fold back.
For the Softstart is operated by internal frequency clock, according to rising to the output voltage, the Softstart rising speed is more faster. Please check the using condition and the application waveform (P.11,P14) because of the Start-up characteristics changes to the output load and the output capacitor.

●**Typical Performance Characteristics**
(Unless otherwise specified, Ta=25℃, VCC=12V, Vo=5V, EN=3V)

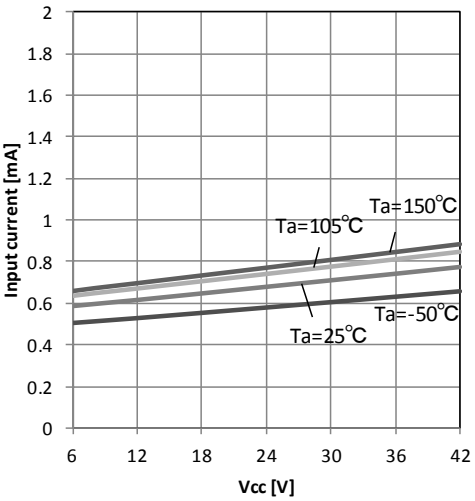


Figure 8. Operating Current - Input Voltage

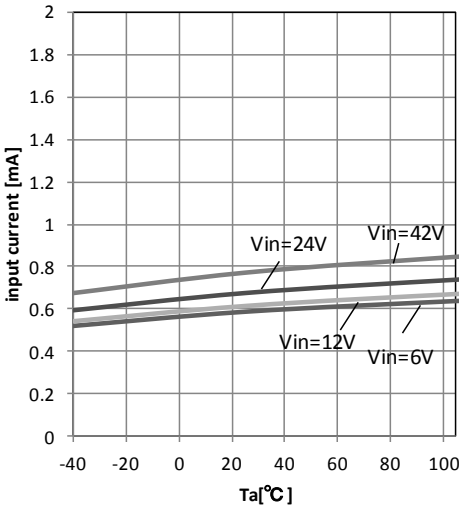


Figure 9. Operating Current - Temperature

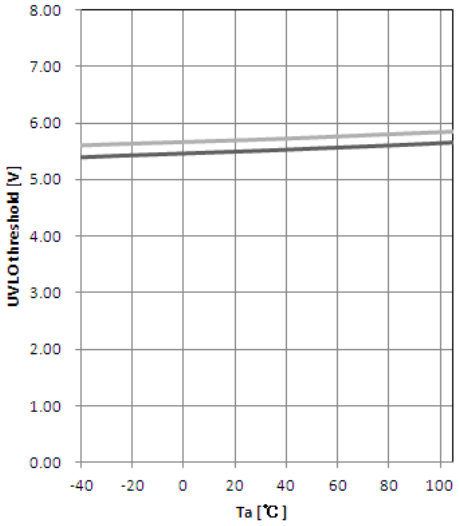


Figure 10. UVLO Threshold - Temperature

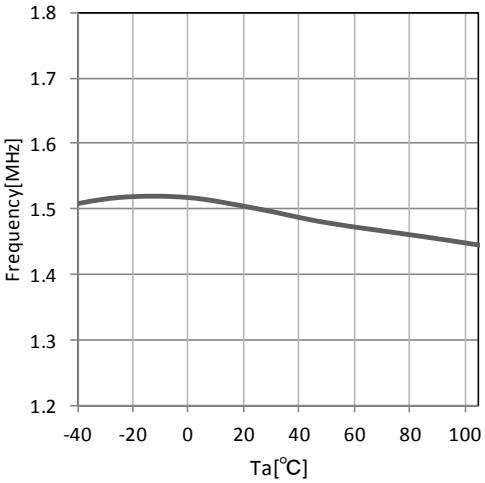


Figure 11. Oscillation frequency - Temperature

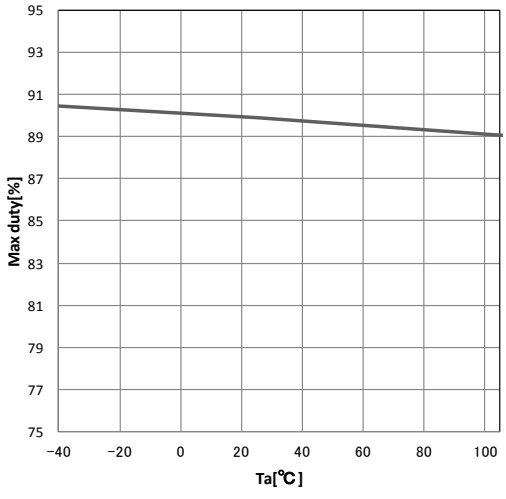


Figure 12. Max Duty - Temperature

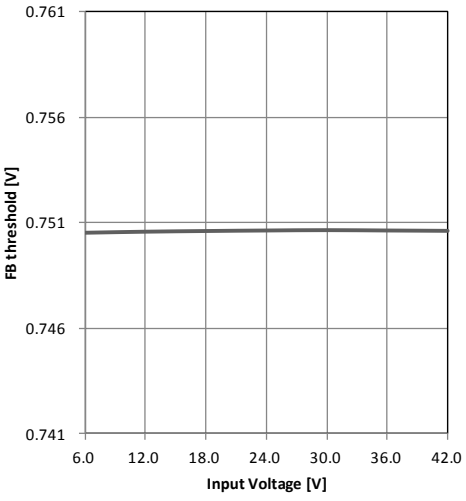


Figure 13. FB Pin Reference Voltage – Input Voltage

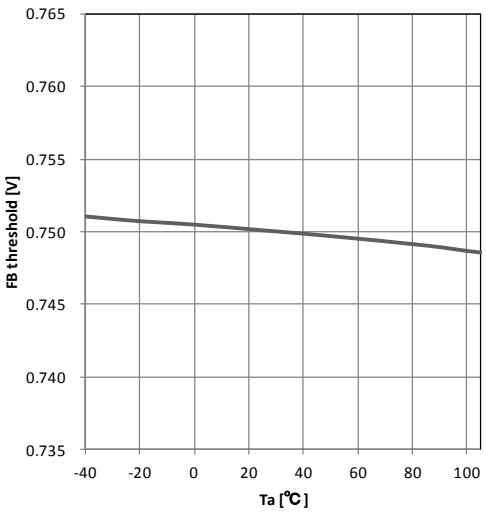


Figure 14. FB Threshold - Temperature

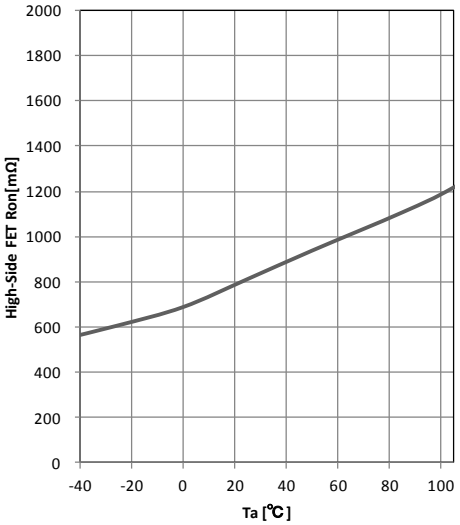


Figure 15. Nch MOSFET ON Resistance - Temperature

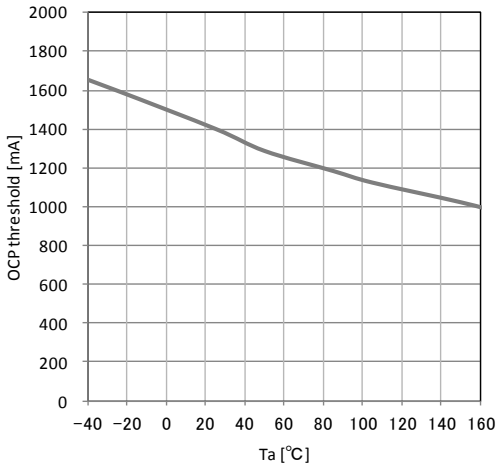


Figure 16. OCP threshold- Temperature

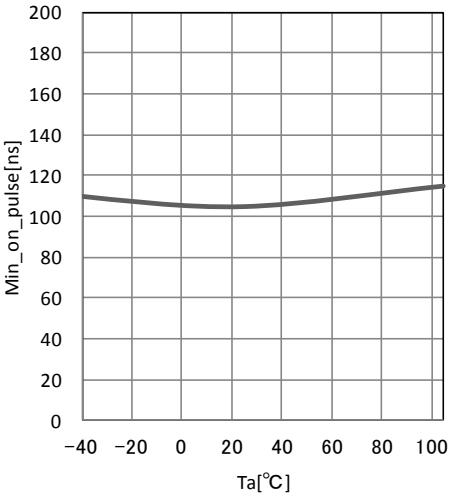


Figure 17. Min ON Time - Temperature

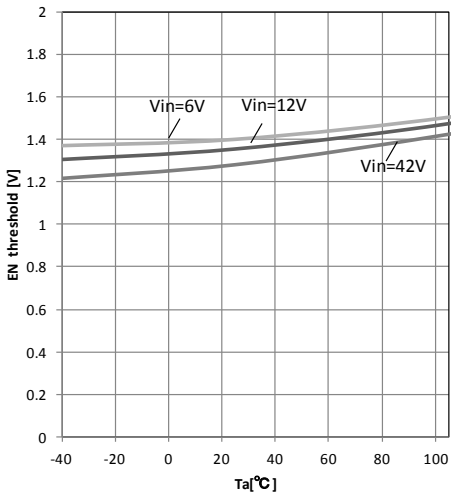


Figure 18. EN Threshold Voltage - Temperature

●**Reference Characteristics of typical Application Circuits**

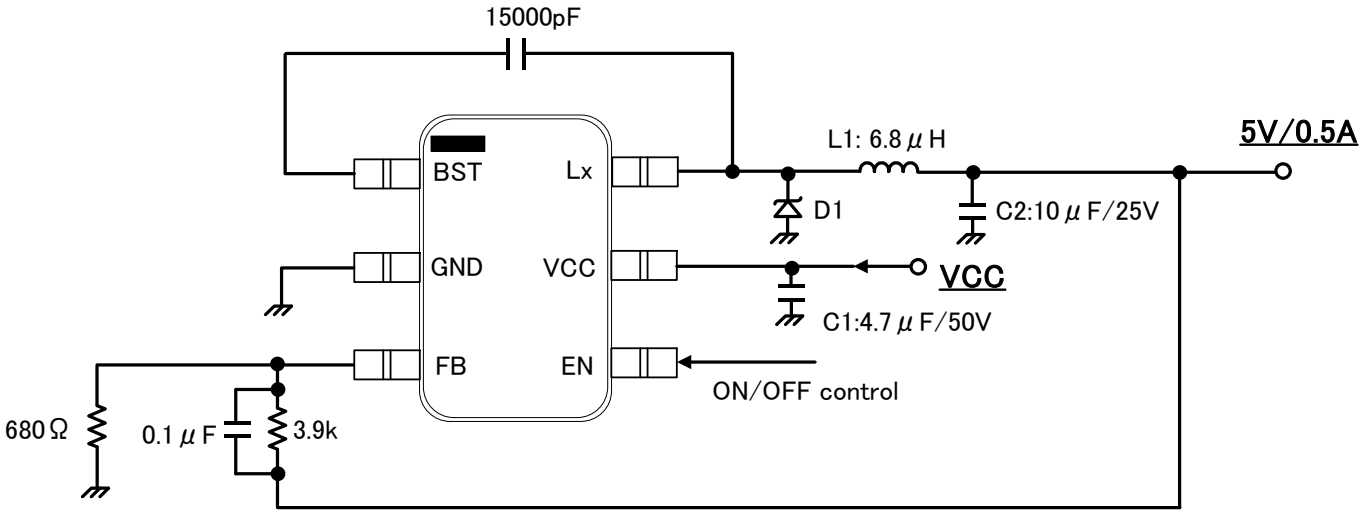


Figure 19. Typical Application Circuit (VOUT=5V)

Parts	L1 :	TOKO	DEM4518C 1235AS-H-6R8M	6.8μH
		TAIYO YUDEN	NR4018	6.8μH
	C1 :	Murata	GRM32EB31H475KA87	4.7μF/50V
	C2 :	Murata	GRM31CB11A106KA01	10μF/10V
	D1 :	Rohm	RB060M-60	

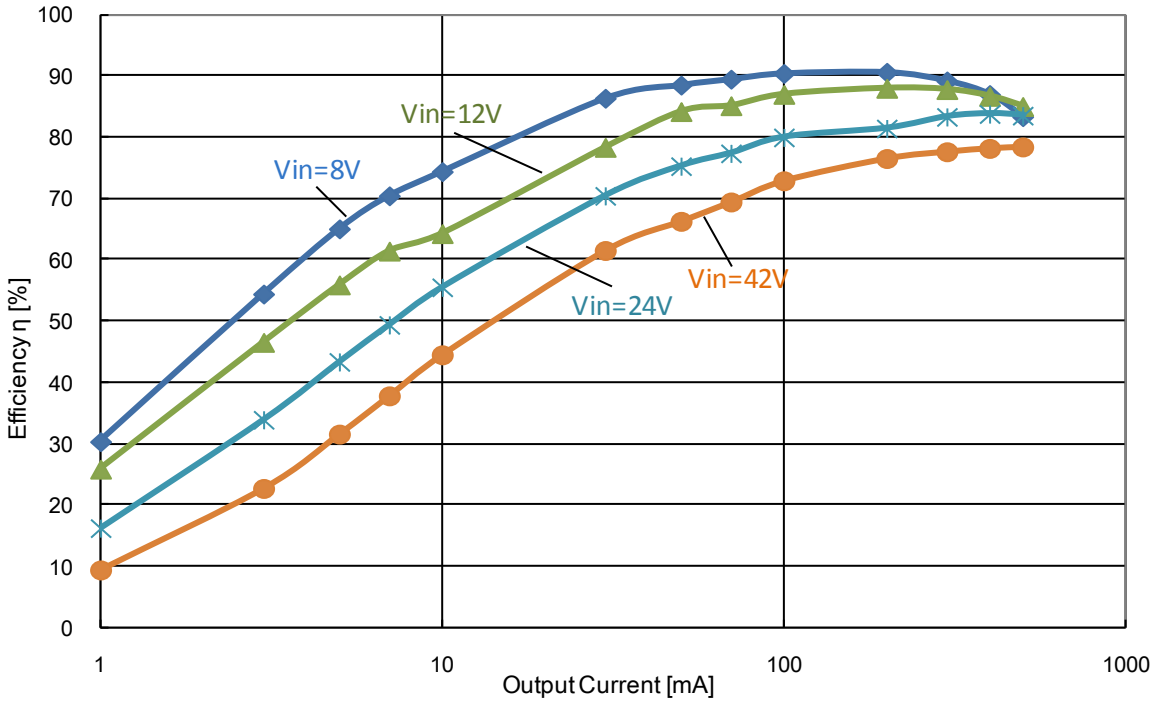


Figure 20. Efficiency - Output Current VOUT=5V

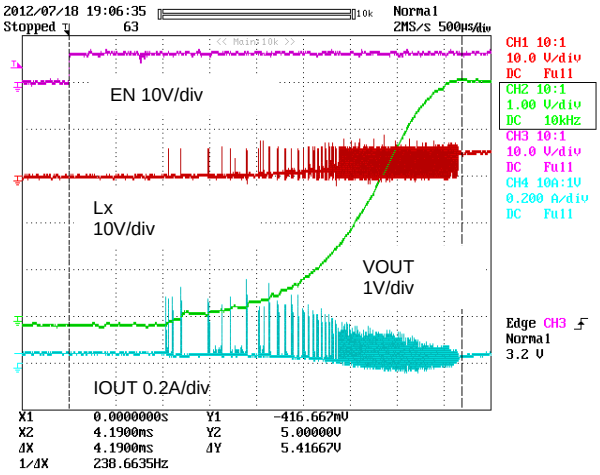


Figure 21. Start-up Characteristics
VIN=8V, IOUT=0mA ,VOUT=5V

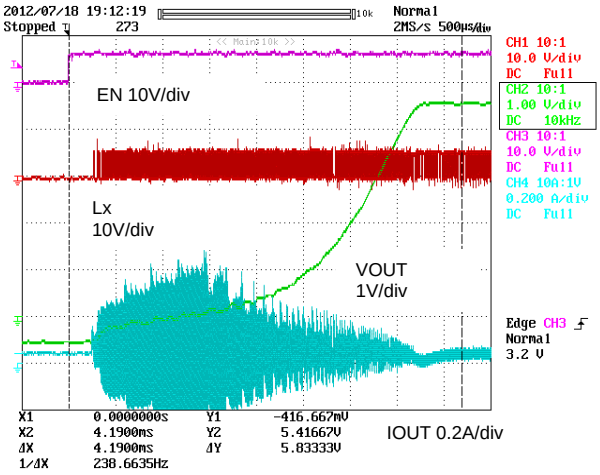


Figure 22. Start-up Characteristics
VIN=8V. IOUT=500mA. VOUT=5V

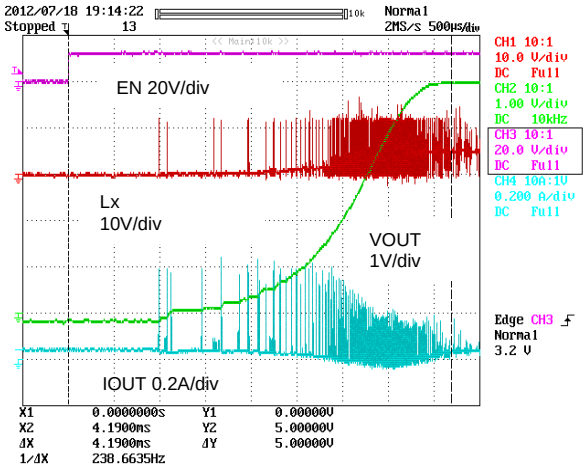


Figure 23. Start-up Characteristics
VIN=12V, IOUT=0mA, VOUT=5V

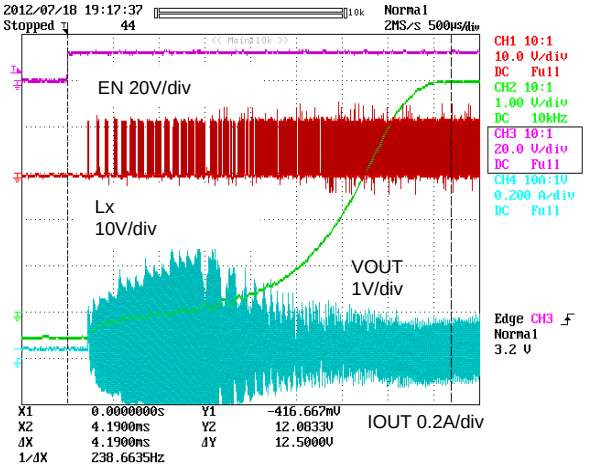


Figure 24. Start-up Characteristics
VIN=12V, IOUT=500mA ,VOUT=5V

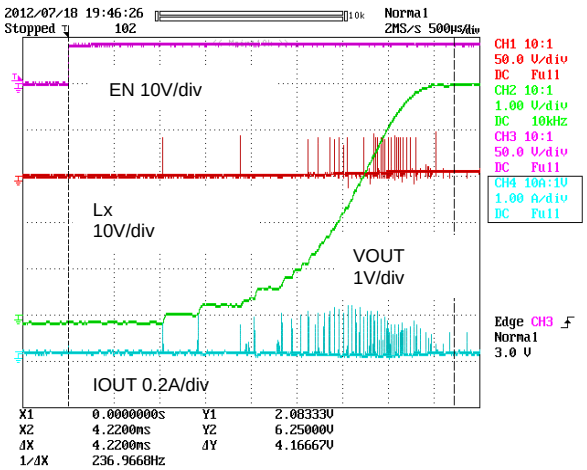


Figure 25. Start-up Characteristics
VIN=42V. IOUT=0mA. VOUT=5V

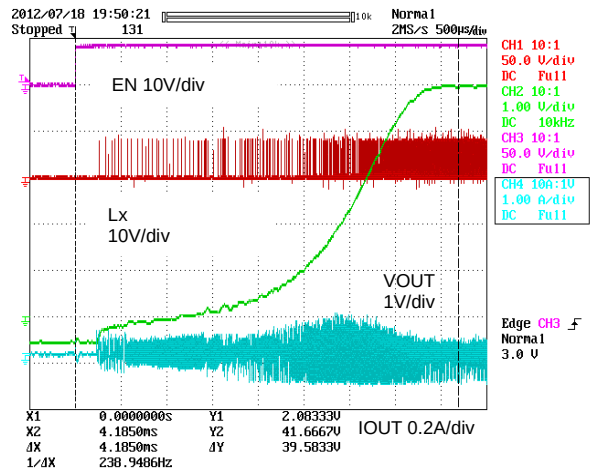


Figure 26. tart-up Characteristics
VIN=42V, IOUT=500mA, VOUT=5V

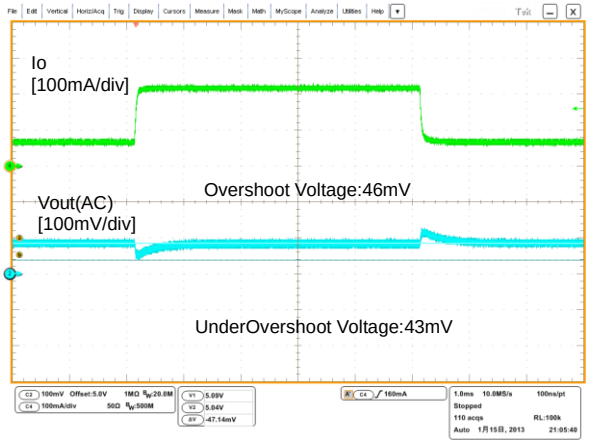


Figure 27. Load Response
Io=50mA⇔200mA

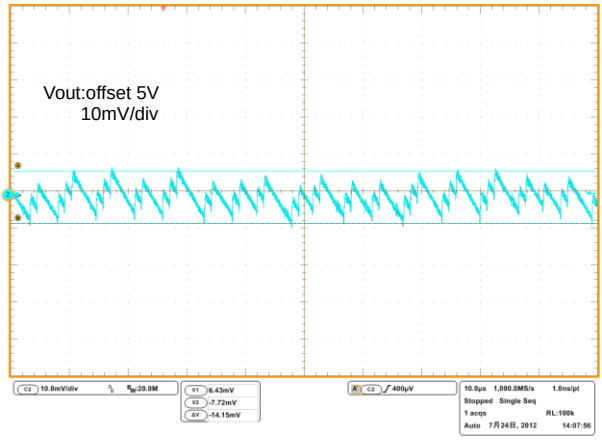


Figure 28. Lx Switching/ Vout Ripple

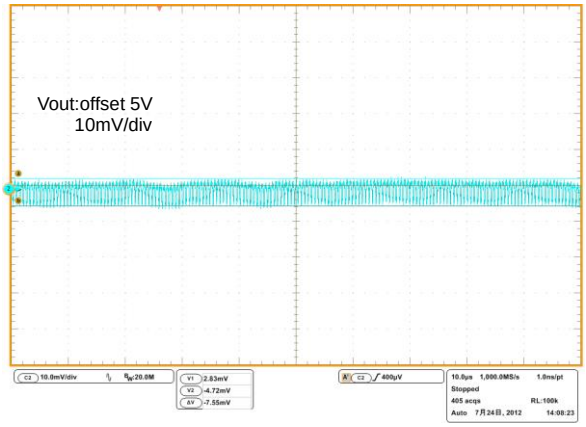


Figure 29. Lx Switching/ Vout Ripple

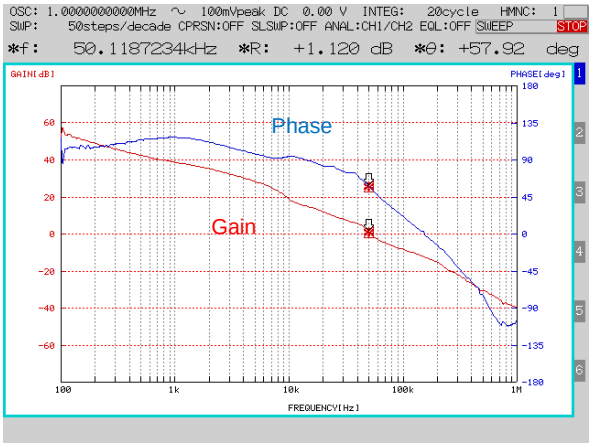


Figure 30. Frequency Response
Io=100mA, VOUT=5V

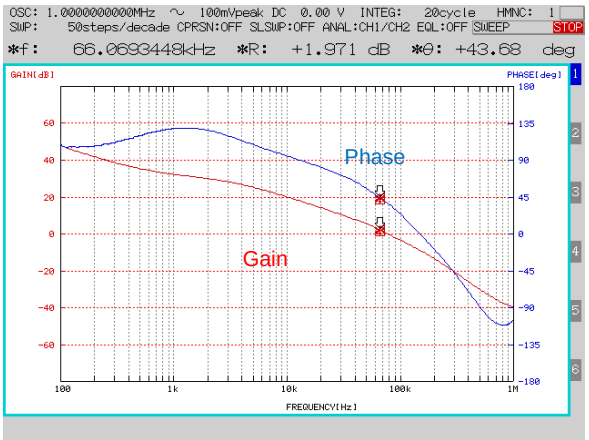


Figure 31. Frequency Response
Io=500mA, VOUT=5V

●**Reference Characteristics of typical Application Circuits**

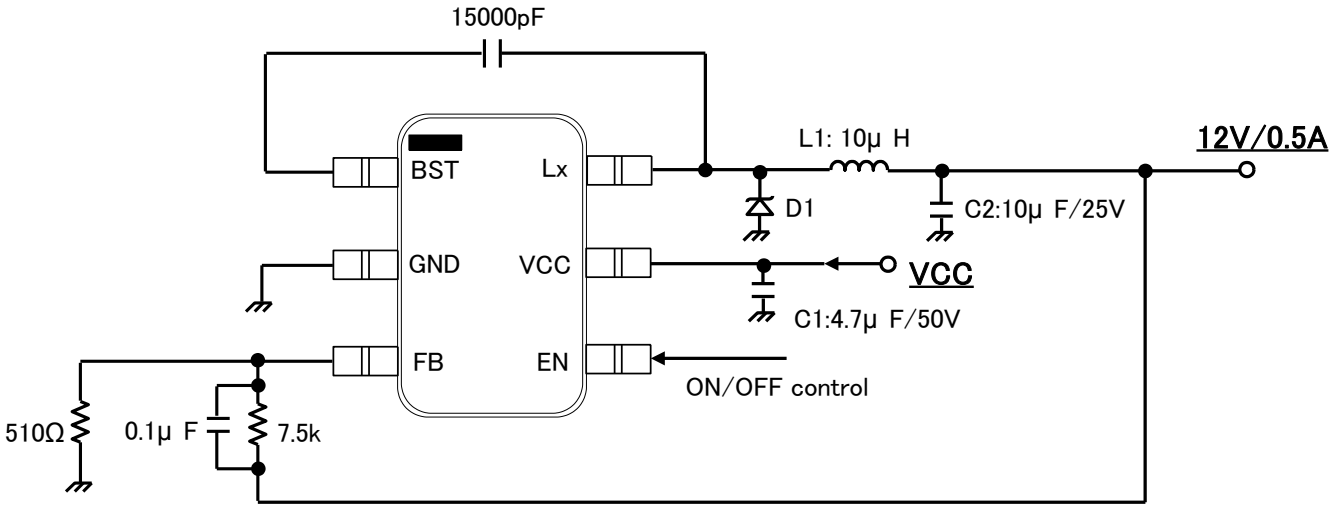
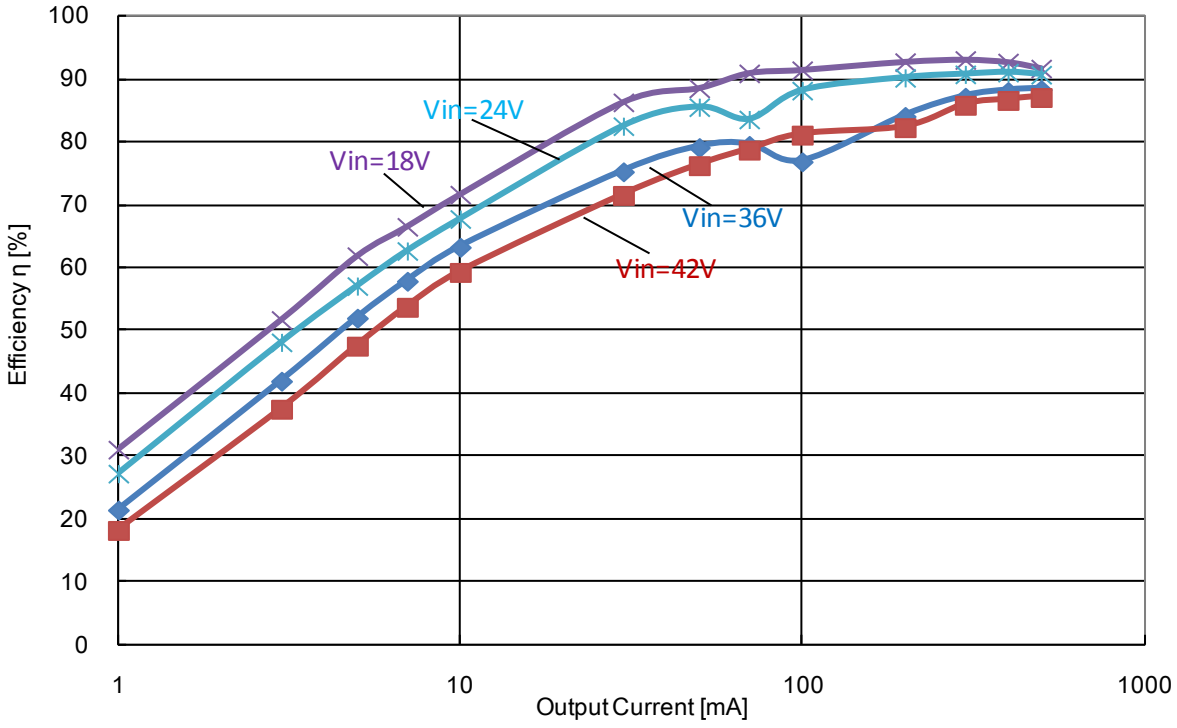


Figure 32. Typical Application Circuit (VOUT=12V)

使用部品	: L1 :	TOKO	DEM4518C 1235AS-H-6R8M	10μH
		TAIYO YUDEN	NR4018	10μH
	C1 :	Murata	GRM32EB31H475KA87	4.7μF/50V
	C2 :	Murata	GRM319B31E106KA12	10μF/25V
	D1 :	Rohm	RB060M-60	



*The efficiency is fall when the switching waveform is turning from intermittent mode to continuous mode

Figure 33. Efficiency - Output Current VOUT=12V

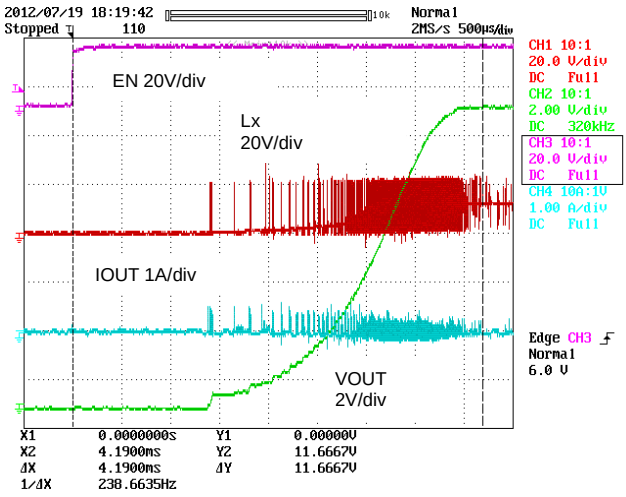


Figure 34. Start-up Characteristics
VIN=18V, IOUT=0mA, VOUT=12V

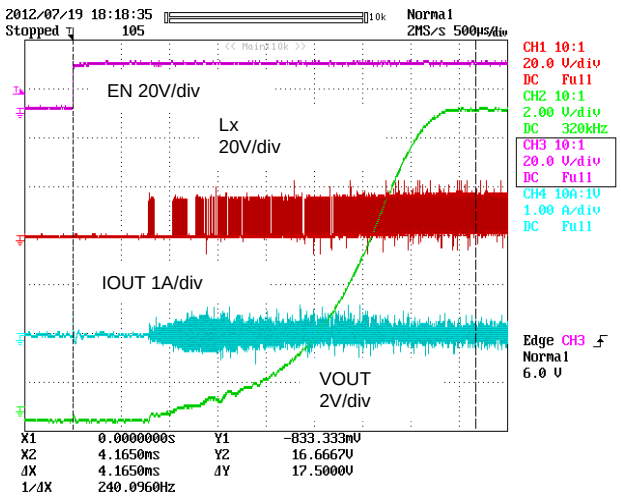


Figure 35. Start-up Characteristics
VIN=18V, IOUT=500mA, VOUT=12V

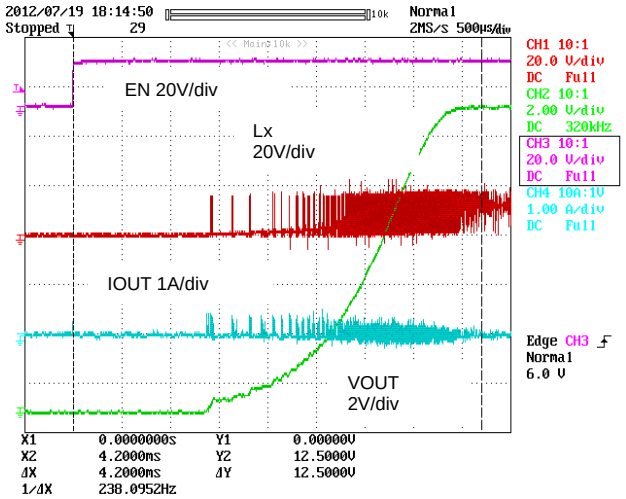


Figure 36. Start-up Characteristics
VIN=24V, IOUT=0mA, VOUT=12V

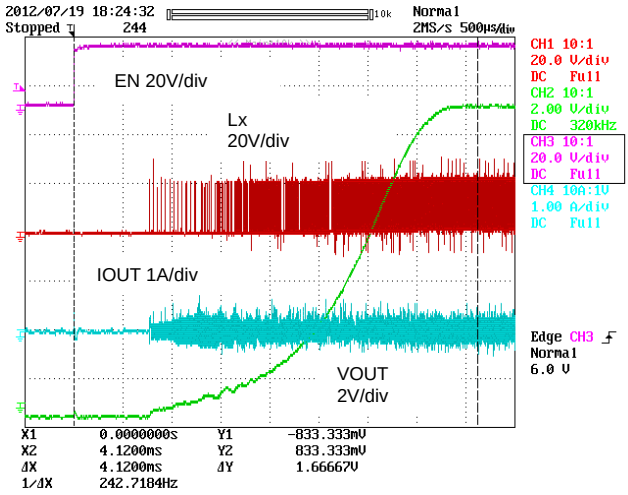


Figure 37. Start-up Characteristics
VIN=24V, IOUT=500mA, VOUT=12V

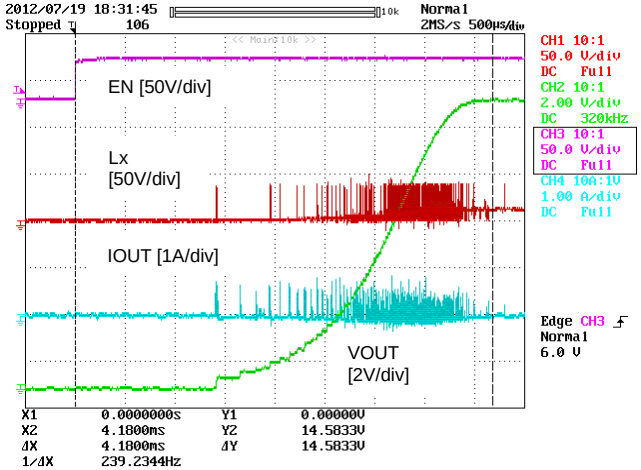


Figure 38. Start-up Characteristics
VIN=42V, IOUT=0mA, VOUT=12V

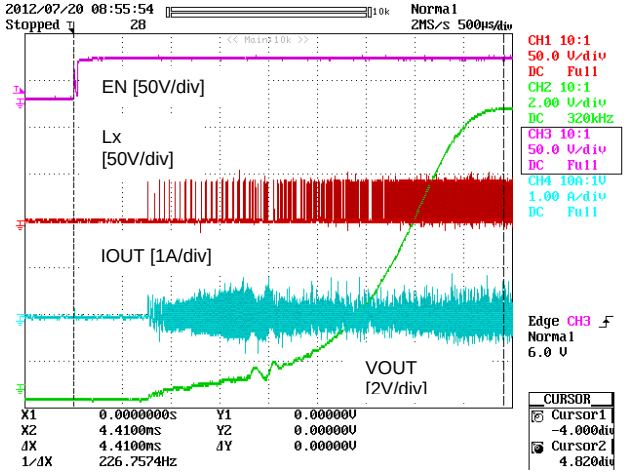


Figure 39. Start-up Characteristics
VIN=42V, IOUT=500mA, VOUT=12V

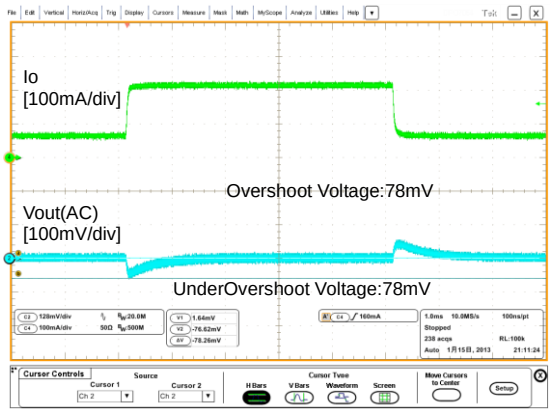


Figure 40. Load Response
Io=50mA⇔200mA, VOUT=12V

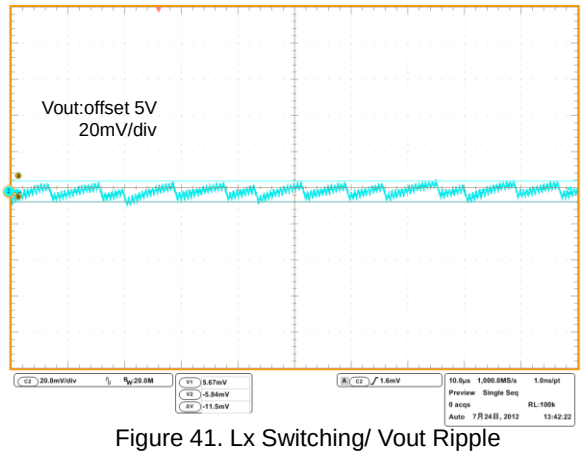


Figure 41. Lx Switching/ Vout Ripple
Io = 50mA, VOUT=12V

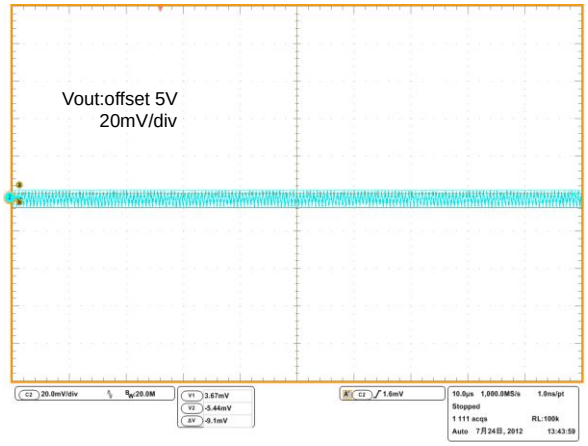


Figure 42. Lx Switching/ Vout Ripple
Io = 200mA, VOUT=12V

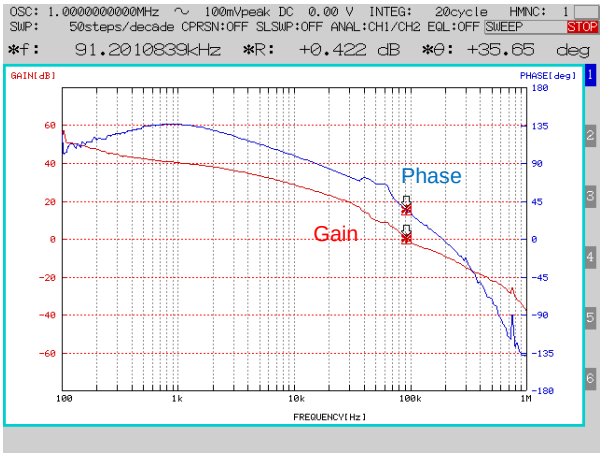


Figure 43. Frequency Response
Io=100mA, VOUT=12V

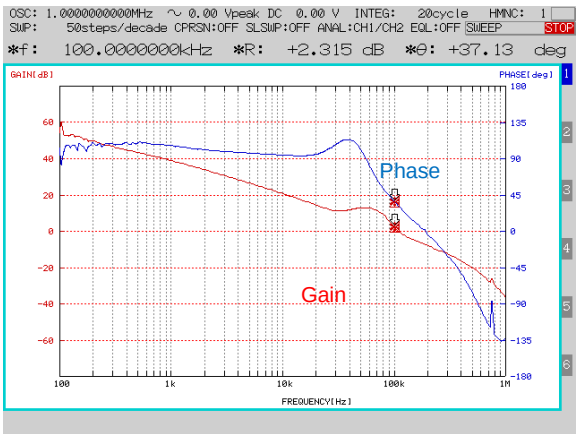


Figure 44. Frequency Response
Io=500mA, VOUT=12V

●Application Components Selection Method

(1) Inductors

Something of the shield type that fulfills the current rating (Current value Ipeak below), with low DCR is recommended.Value of Inductance influences Inductor Ripple Current and becomes the cause of Output Ripple.
In the same way as the formula below, this Ripple Current can be made small for as big as the L value of Coil or as high as the Switching Frequency.

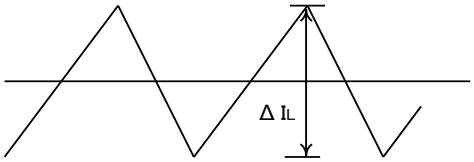


Figure 45. Inductor Current

$$Ipeak = Iout + \Delta IL/2 \ [A] \quad (4)$$

$$\Delta IL = \frac{Vin-Vout}{L} \times \frac{Vout}{Vin} \times \frac{1}{f} \ [A] \quad (5)$$

(⊿IL: Output Ripple Current, f: Switching Frequency)

For design value of Inductor Ripple Current, please carry out design tentatively with about 20%～50% of Maximum Input Current.
In the BD9G101G, it is recommended the below series of 2.2μH～10μH inductance value.

Recommended Inductor **TOKO DE4518C Series**
TAIYO YUDEN NR4018 Series

(2) Input Capacitor

In order for capacitor to be used in input to reduce input ripple, mount low ceramic capacitor of ESR near the Vcc pin.
In the BD9G101G, it is recommended the 4.7uF or more capacitor value. In case of using the electrolytic capacitor, mount 1uF ceramic capacitor in parallel in order to prevent oscillation

(3) Output Capacitor

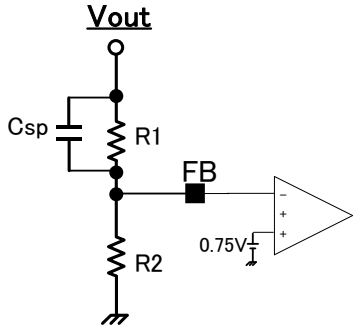
In order for capacitor to be used in output to reduce output ripple, Low ceramic capacitor of ESR is recommended.
Also, for capacitor rating, on top of putting into consideration DC Bias characteristics, please use something whose maximum rating has sufficient margin with respect to the Output Voltage.
Output ripple voltage is looked for using the following formula.

$$Vpp = \Delta IL \times \frac{1}{2\pi \times f \times Co} + \Delta IL \times R_{ESR} \ [V] \quad (6)$$

Please design in a way that it is held within Capacity Ripple Voltage.
In the BD9G101G, it is recommended a ceramic capacitor over 10μF.

(4) Output voltage setting

The internal reference voltage of ERROR AMP is 0.75V. Output voltage is determined like (7) types.



$$Vo = \frac{(R1+R2)}{R2} \times 0.75[V] \quad \cdots \ (7)$$

Figure 46. Output voltage setting

However, in order to avoid the BSTUVLO operation at the time of a reduced power and light load, please set up R1+R2 is satisfied the following formulas.

$$R1 + R2 \leq V_{out} \times 10^3 \quad \cdots (8)$$

The example of output resistances setting : output voltage 5V R1=3.9kΩ R2=0.68kΩ
output voltage 12V R1=7.5kΩ R2=0.51kΩ

(5)Feed-forward capacitor Csp

Please mount feed-forward capacitor in parallel to output resistance R1.
In order that a feed-forward capacitor may adjust the loop characteristic by adding the pair of a pole and zero to the loop characteristic. A phase margin is improved and transient response speed improves.
The feed-forward capacitor Csp should use the value near the following formulas.

$$Csp = \frac{4.7k}{R1} \times 0.15 \quad [uF] \quad \cdots (9)$$

The example of a Csp setting : output voltage 5V R1=3.9kΩ R2=0.68kΩ Csp = 0.1uF or 0.22uF
output voltage 12V R1=7.5kΩ R2=0.51kΩ Csp = 0.1uF

By above mentioned measure, there is not BSTUVLO operation in litgh load and Vin-Vout<3V.

(6) Bootstrap Capacitor

Please connect from 15000pF (Laminate Ceramic Capacitor) between BST Pin and Lx Pins.

(7) Diode

Select suitable shottky diode for break down voltage and input current.

●**Cautions on PC Board layout**

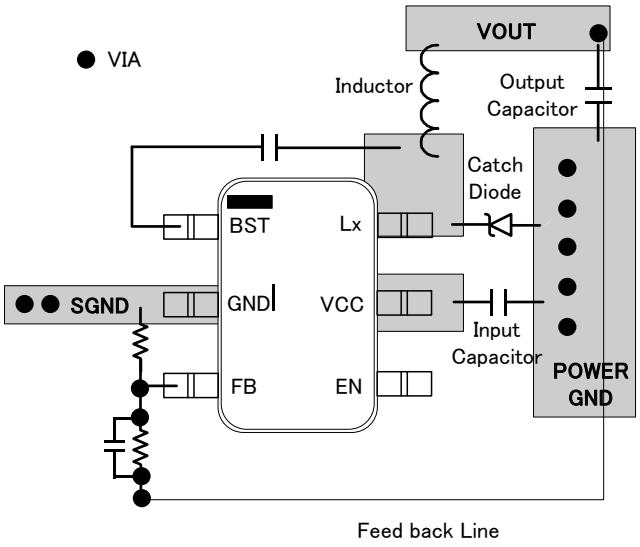


Figure 47. Reference PCB layout

Layout is a critical portion of good power supply design. There are several signals paths that conduct fast changing currents or voltages that can interact with stray inductance or parasitic capacitance to generate noise or degrade the power supplies performance. To help eliminate these problems, the VCC pin should be bypassed to ground with a low ESR ceramic bypass capacitor with B dielectric. Care should be taken to minimize the loop area formed by the bypass capacitor connections, the VCC pin, and the anode of the catch diode. See Figure.45 for a PCB layout example.

In the BD9G101G, since the LX connection is the switching node, the catch diode and output inductor should be located close to the LX pins, and the area of the PCB conductor minimized to prevent excessive capacitive coupling. And GND area should not be connected directly power GND, connected avoiding the high current switch paths. The additional external components can be placed approximately as shown.

●**Power Dissipation**

It is shown below reducing characteristics of power dissipation to mount 70mm × 70mm × 1.6mm^t, 1layer PCB.
Junction temperature must be designed not to exceed 150℃

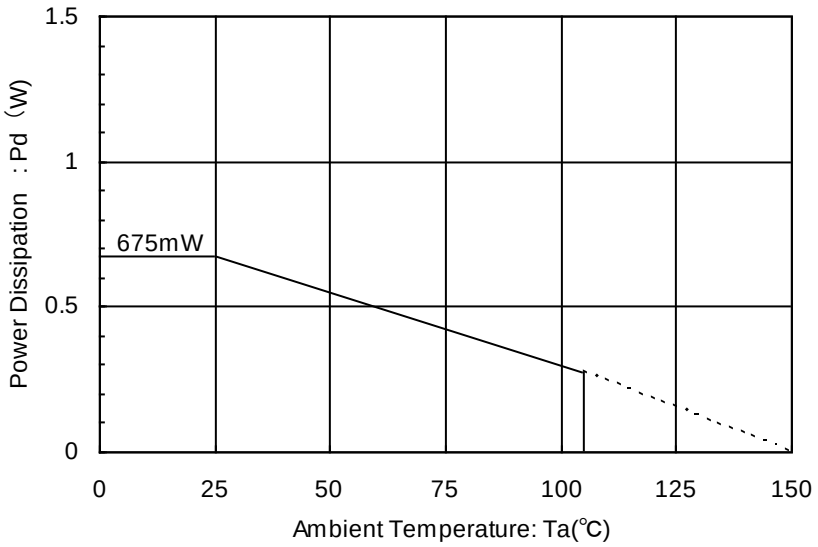
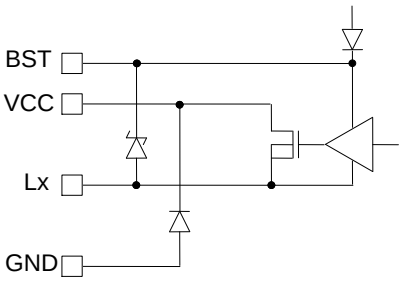
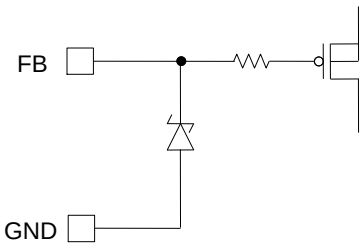


Figure 48. Power Dissipation (70mm × 70mm × 1.6mm^t 1layer PCB)

●Power Dissipation Estimate

The following formulas show how to estimate the device power dissipation under continuous mode operations. They should not be used if the device is working in the discontinuous conduction mode.
The device power dissipation includes:
1) Conduction loss： $Pcon = IOUT^2 \times RonH \times VOUT/VCC$
2) Switching loss: $Psw = 2.5 \times 10^{-9} \times VCC \times IOUT \times fsw$
3) Gate charge loss： $Pgc = 4.88 \times 10^{-9} \times fsw$
4) Quiescent current loss： $Pq = 0.8 \times 10^{-3} \times VCC$
Where:
IOUT is the output current (A）, RonH is the on-resistance of the high-side MOSFET（Ω）, VOUT is the output voltage (V).
VCC is the input voltage (V), fsw is the switching frequency (Hz).
Therefore
Power dissipation of IC is the sum of above dissipation.
$Pd = Pcon + Psw + Pgc + Pq$
For given Tj, $Tj = Ta + \theta ja \times Pd$
Where:
Pd is the total device power dissipation (W), Ta is the ambient temperature (℃)
Tj is the junction temperature (℃), θja is the thermal resistance of the package (℃)

●**I/O equivalent circuit**

Pin. No	Pin Name	Pin Equivalent Circuit
6 2 1 5	Lx GND BST VCC	
3	FB	

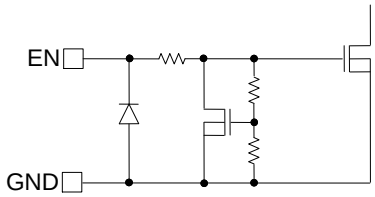
Pin. No	Pin Name	Pin Equivalent Circuit
4	EN	

Figure 49. I/O equivalent circuit

●Operational Notes

1. Reverse Connection of Power Supply
Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2. Power Supply Lines
Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. Ground Voltage
Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. Ground Wiring Pattern
When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. Thermal Consideration
Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6. Recommended Operating Conditions
These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. Inrush Current
When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. Operation Under Strong Electromagnetic Field
Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. Testing on Application Boards
When testing the IC on an application board, connecting a capacitor directly to a low-impedance output 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 the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. Inter-pin Short and Mounting Errors
Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

11. Unused Input Pins
Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

12. Regarding the 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 the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

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 inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, 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.

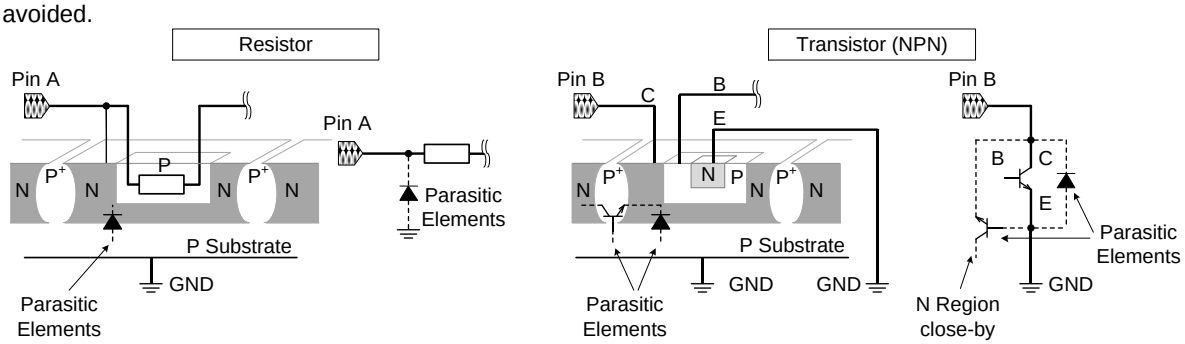


Figure50. Example of monolithic IC structure

13. Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

14. Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

15. Thermal Shutdown Circuit(TSD)

This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's power dissipation rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF all output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.
Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

●Ordering part number

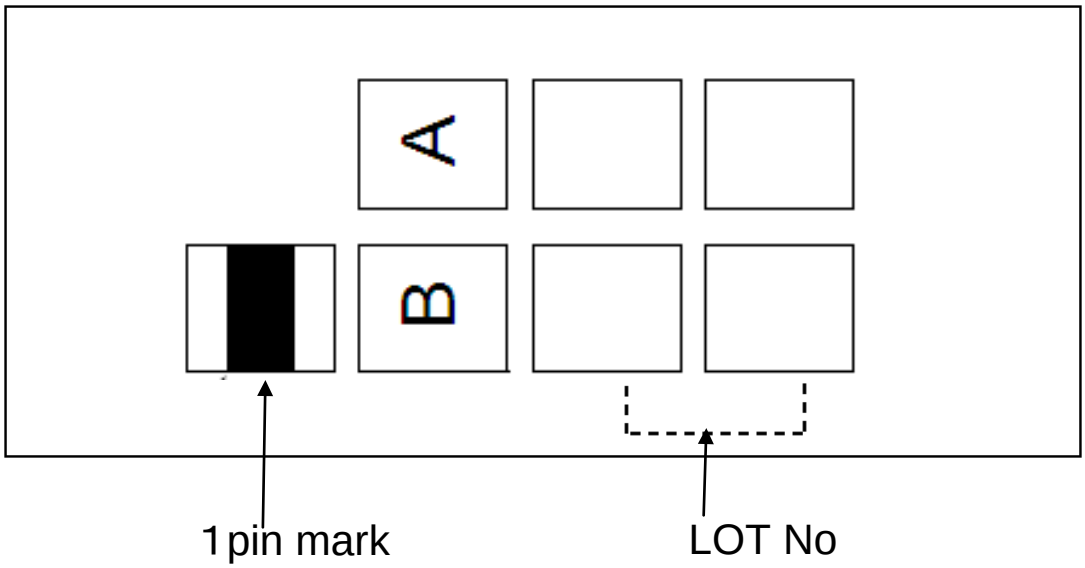
B D 9 G 1 0 1 G	-	TR

Part Number

package
G: SSOP6

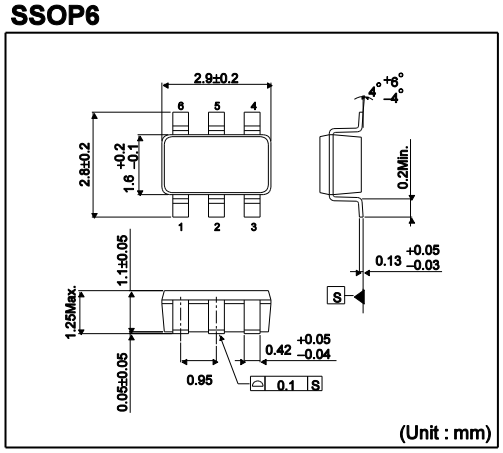
Packaging and forming specification
TR: Embossed tape and reel

●External information



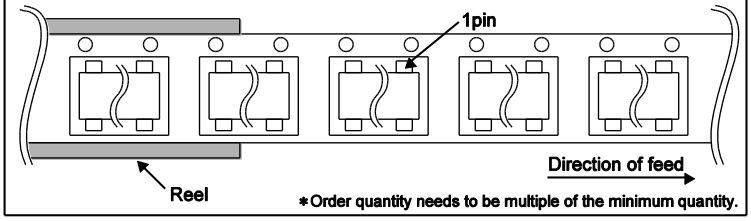
SSOP6

SSOP6



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	3000pcs
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.

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 on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, 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

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.

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.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

ROHM Semiconductor:

BD9G101G-EVK-101 BD9G101G_EVK