Datasheet

4.5V to 25V Input, 1ch Synchronous Buck DC/DC Controller

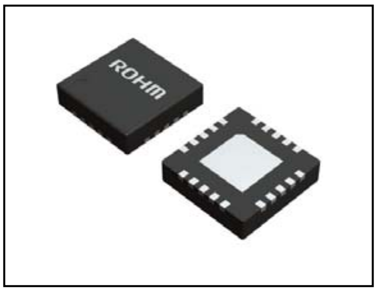
BD95601MUV-LB

●Description
BD95601MUV-LB is a high current buck regulator that produces low output voltage (0.75V to 2.0V) from a wide input voltage range (4.5V to 25V). High efficiency is realized using external N channel MOSFETs. Using H^3Reg^{TM}, Rohm's advanced proprietary control method that uses constant on-time control to provide ultra high transient responses to load changes. SLLM(Simple Light Load Mode) technology is added to improve efficiency with light loads giving high efficiency over a wide load range. Soft start functionality, short circuit protection with timer latch, over current protection and tracking are all included features. This switching regulator was designed for low voltage high current power supplies.

●Features
- Adjustable Light Load and Selectable Continuous Modes
- Multifunctional Protection Circuits
  - -Thermal Shut Down (TSD)
  - -Under Voltage Lock Out (UVLO)
  - -Over Current Protection (OCP)
  - -Over Voltage Protection (OVP)
  - -Short Circuit Protection (SCP)
- Adjustable Soft Start
- Power Good Output
- 200kHz to 500kHz Switching Frequency

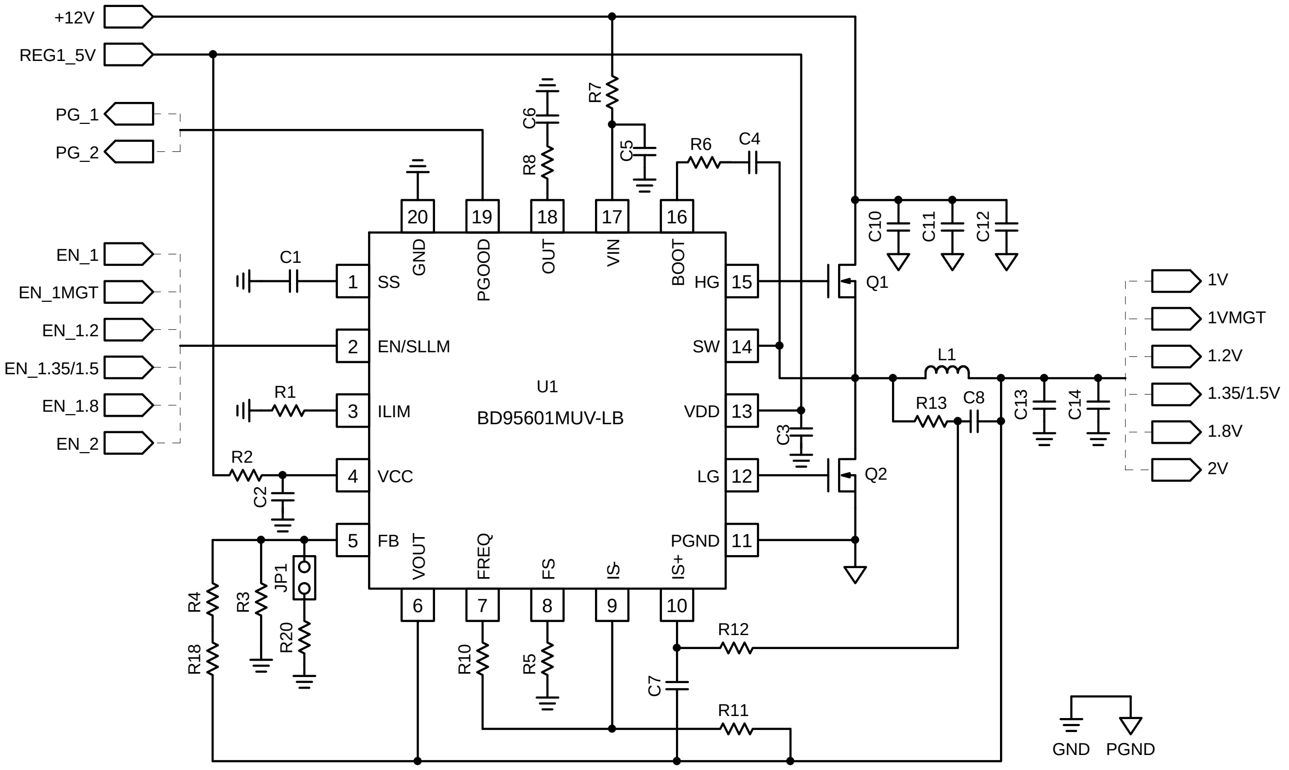
●Important Characteristics
VIN Input Voltage Range:	4.5V to 25V
VCC Input Voltage Range:	4.5V to 5.5V
VDD Input Voltage Range:	4.5V to 5.5V
Output voltage range:	0.75V to 2.0V
Standby Current:	0μA (Typ.)
Operating Temperature Range:	-10℃ to +85℃

●Package
	W(Typ.) x D(Typ.) x H(Max.)
VQFN020V4040	4.00mm x 4.00mm x 1.00mm



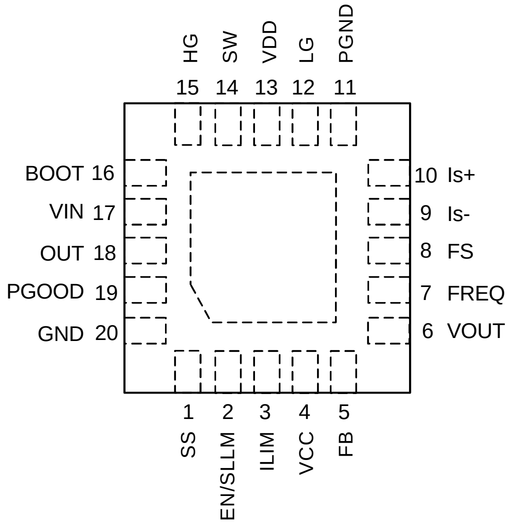
●Applications
- FPGA, POL application
- Mobile PC, Desktop PC, LCD-TV Digital Components etc.
- Industrial Equipment

●Basic Application Circuit



○製品構造：シリコンモノリシック集積回路　○耐放射線設計はしておりません

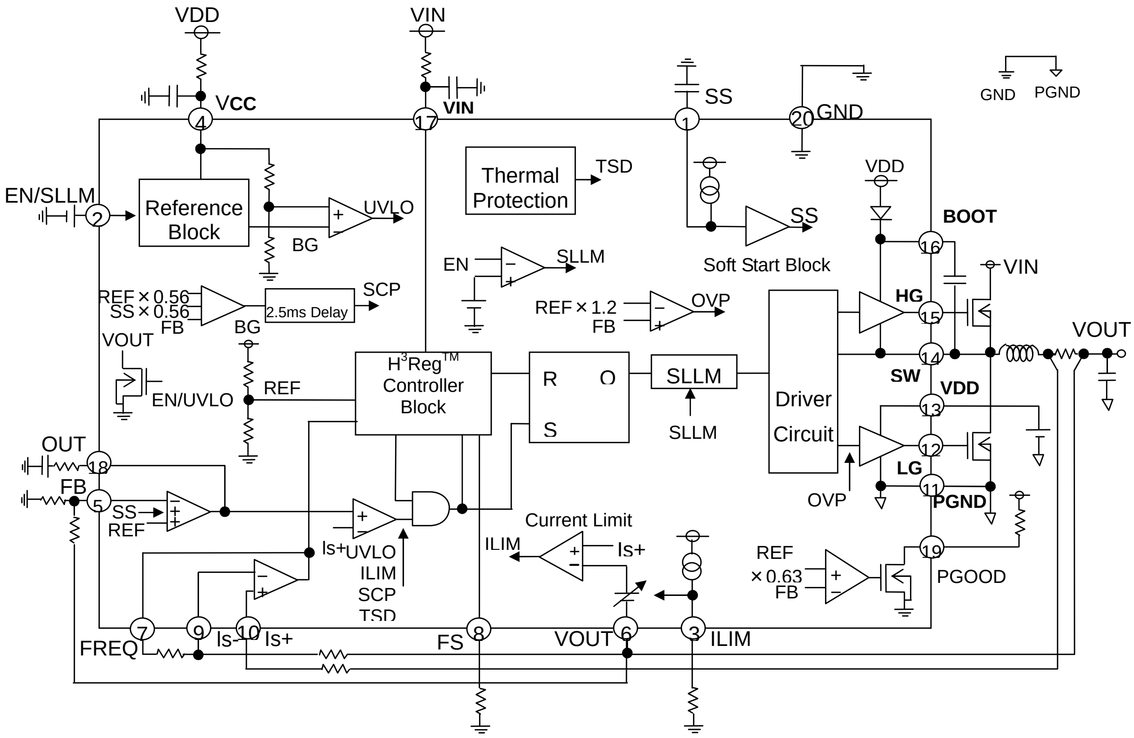
●Pin Configuration



●Pin Function Table

Pin No.	Pin Name	Pin Function
1	SS	Soft Start Time input. The rise time is set by a capacitor connected between SS and ground. At startup, a fixed current flows into the SS capacitor. Output voltage is controlled until the SS input reaches the reference voltage of 0.75V.
2	EN/SLLM	Enable and Mode Selection Input. Voltage on this input selects the operating mode. Standby Mode: < 0.8V Continuous Mode: 2.3V – 3.8V Light Load Mode: 4.2V – 5.5V
3	ILIM	Coil Current Limit input. A 100KΩ resistor should be connected between this input and ground.
4	VCC	IC Internal Circuits Power input.
5	FB	Output Voltage Sense input. A resistor divider to this input sets the output voltage.
6	VOUT	Output Voltage Monitor input.
7	FREQ	Current Sense Amplifier Output.
8	FS	Frequency input. A resistor sets the switching frequency. The frequency can be set from 200kHz to 500kHz.
9	Is-	Input Current Sense Amplifier input. FREQ pin is output.
10	Is+	Output Current Sense Amplifier input. If the voltage between this pin and VOUT pin reaches the specified voltage level (setting at ILIM pin), the switching is turned OFF.
11	PGND	Ground pin for low side FET driver.
12	LG	This is the pin to drive the gate of the low side FET. This voltage swings between VDD and PGND. High-speed gate driving for the low side FET is achieved using an output MOS (3Ω when LG is high, 0.5Ω when LG is low.).
13	VDD	This is the power supply pin to drive the low side FET. It is recommended that 10μF bypass capacitor be used to compensate for peak current during the FET on/off transition.
14	SW	This is the ground pin for high side FET. The maximum absolute rating is 30V from ground.
15	HG	This is the pin to drive the gate of the High side FET. The status of the switching swings between BOOT and SW. High-speed gate driving for high side FET is achieved using an output MOS (3Ω when HG is high, 2Ω when HG is low).
16	BOOT	This is the power supply pin to drive the high side FET. The maximum absolute ratings are 35V from ground and 7V from SW. The switching waveform sweeps from (VIN+VDD) to VDD by BOOT operation.
17	VIN	This is the pin for H^3Reg^{TM} control. It determines necessary on-time by monitoring input voltage. It is recommended to connect 1kΩ / 0.1μF CR filter. .
18	OUT	This is the output pin of output voltage control amp. Please connect a resistor and capacitor to ground in series. It is recommended that a 0.01μF capacitor be established in normal operation.
19	PGOOD	Power Good output. This pin outputs a high-level when the FB pin voltage is above 63% of the reference voltage. This is an open drain pin and therefore requires an external pull-up.
20	GND	Ground pin of control circuit. It is the same as FIN potential.
FIN	FIN	Backside thermal pad. Please connect to the Ground.

●Block Diagram



●Absolute Maximum Ratings(Ta = 25℃)

Parameter	Symbol	Limits	Unit
Input Voltage 1	VCC	7 *1*2	V
Input Voltage 2	VDD	7 *1*2	V
Input Voltage 3	VIN	28 *1*2	V
BOOT Voltage	BOOT	35 *1*2	V
BOOT-SW Voltage	BOOT-SW	7 *1*2	V
HG-SW Voltage	HG-SW	7 *1*2	V
LG Voltage	LG	VDD	V
Output Voltage	VOUT/Is+/Is-	VCC	V
EN Input Voltage	EN	7 *1	V
Power Dissipation 1	Pd1	0.34 *3	W
Power Dissipation 2	Pd2	0.70 *4	W
Power Dissipation 3	Pd3	2.20 *5	W
Power Dissipation 4	Pd4	3.56 *6	W
Operating Temperature Range	Topr	-10~+85	℃
Storage Temperature Range	Tstg	-55~+150	℃
Maximum Junction Temperature	Tjmax	+150	℃

*1 Not to exceed Pd.
*2 Instantaneous surge voltage, back electromotive force and voltage under less than 10% duty cycle.
*3 Reduced by 2.7mW/℃ for each increase in Ta of 1℃ over 25℃ (when don't mounted on a heat radiation board)
*4 Reduced by 5.6mW/℃ for increase in Ta of 1℃ over 25℃. (when mounted on a board 70.0mm×70.0mm×1.6mmt Glass-epoxy PCB.)
*5 Reduced by 17.6mW/℃ for increase in Ta of 1℃ over 25℃. (when mounted on a board 70.0mm×70.0mm×1.6mmt Glass-epoxy PCB.)
*6 Reduced by 28.5mW/℃ for increase in Ta of 1℃ over 25℃. (when mounted on a board 70.0mm×70.0mm×1.6mmt Glass-epoxy PCB.)

●**Recommended Operating conditions (Ta=25℃)**

Parameter	Symbol	Limits		Unit
		MIN.	MAX.	
Input Voltage 1	VCC	4.5	5.5	V
Input Voltage 2	VDD	4.5	5.5	V
Input Voltage 3	VIN	4.5	25	V
BOOT Voltage	BOOT	4.5	30	V
SW Voltage	SW	-0.7	25	V
BOOT-SW Voltage	BOOT-SW	4.5	5.5	V
EN Input Voltage	EN	0	5.5	V
Is Input Voltage	Is+/Is-	0.7	2.7	V
Minimum on-time	Tonmin	-	80	ns

●**ELECTRICAL CHARACTERISTICS**

(Unless otherwise stated, Ta=25℃ VCC=5V,VDD=5V,EN=3V,VIN=12V,VOUT=1.05V,R_{FS}=36kΩ)

Parameter	Symbol	Standard Value			Unit	Conditions
		MIN.	TYP.	MAX.		
[Whole Device]						
VCC bias current	Icc	-	1500	1800	µA	
VCC stand-by current	Iccstb	-	0	10	µA	EN=0V
VIN bias current	Iin	-	30	80	µA	
VIN stand-by current	Iinstb	-	0	10	µA	EN=0V
EN Low voltage	Enlow	GND	-	0.8	V	
EN High voltage (Forced continuous mode)	Enhigh_con	2.3	-	3.8	V	
EN High Voltage (SLLM mode)	Enhigh_sllm	4.5	-	5.5	V	
EN bias current	Ien	-	15	25	µA	EN=3V
[Under Voltage Locked Out]						
VCC threshold voltage	Vcc_UVLO	3.7	4.0	4.3	V	VCC:Sweep up
VCC hysteresis voltage	dVcc_UVLO	100	160	220	mV	VCC:Sweep down
[H^3Reg^{TM} Control]						
ON Time	Ton	194	219	244	ns	
Maximum ON Time	Tonmax	-	3.5	-	µs	
Minimum OFF Time	Toffmin	-	490	700	ns	
[FET Driver]						
HG High side ON resistance	HGhon	-	3.0	6.0	Ω	
HG Low side ON resistance	HGlon	-	2.0	4.0	Ω	
LG High side ON resistance	LGhon	-	3.0	6.0	Ω	
LG Low side ON resistance	LGlon	-	0.5	1.0	Ω	
[SCP]						
SCP start-up voltage	Vscp	0.345	0.420	0.495	V	
SCP delay time	Tscp	-	2.5	-	ms	
[OVP]						
FB threshold voltage	Vovp	0.825	0.900	0.975	V	
[Soft Start]						
Charge current	Iss	1	2	3	µA	
Stand-by voltage	Vss_stb	-	-	50	mV	
[Current Limit]						
Setting current	I_{ilim}	-	10	-	µA	
Current limit threshold voltage	V_{ilim}	75	100	125	mV	R_{ILIM}=100kΩ
[Output Voltage Sense]						
Output Reference voltage 1	REF1	0.743	0.750	0.757	V	
Is+ Input voltage	IIs+	-1	0	1	µA	Is+=1.05V
Is- Input voltage	IIs-	-1	0	1	µA	Is-=1.05V
[POWER GOOD]						
FB Power good voltage	Vpgood	0.38	0.47	0.56	V	
Discharge ON resistance	Ronpgood	-	50	150	Ω	
[Diode for BOOT]						
VF voltage	VF	0.4	0.5	0.6	V	IF=1mA

●**Characteristic data（Reference data）**

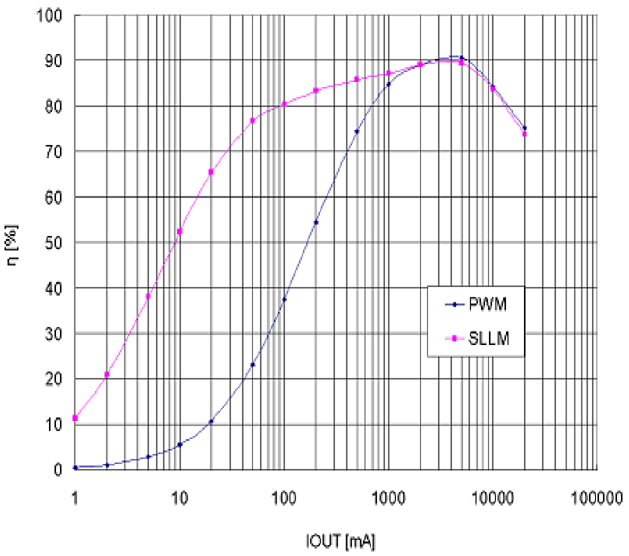


Figure 1. Efficiency (VIN=7.5V)

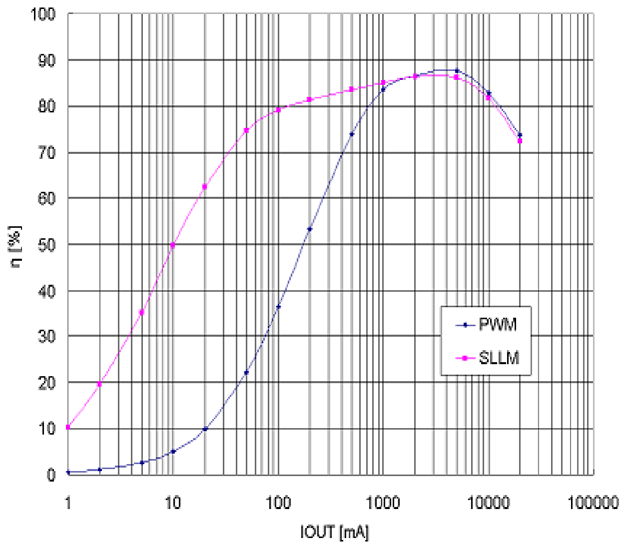


Figure 2. Efficiency (VIN=12V)

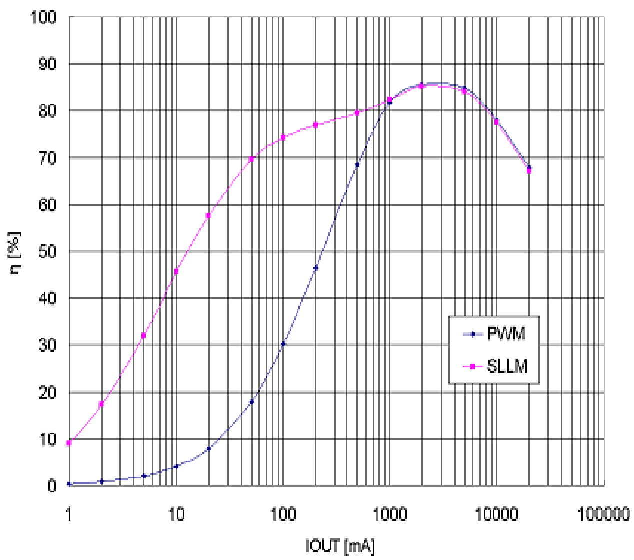


Figure 3. Efficiency (VIN=21V)

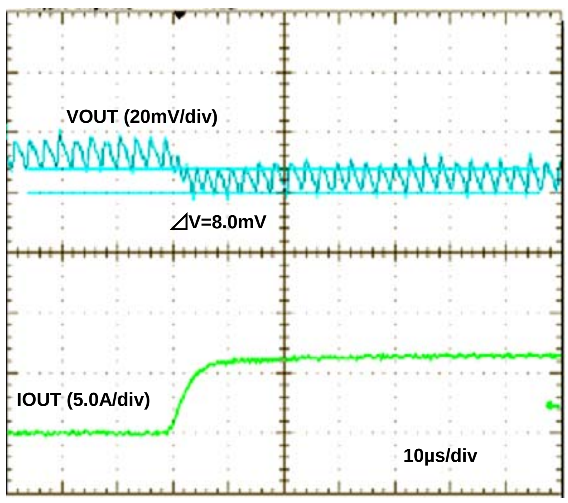


Figure 4. Transient Response Waveform (VIN=5V)

●Characteristic data（Reference data） – continuation

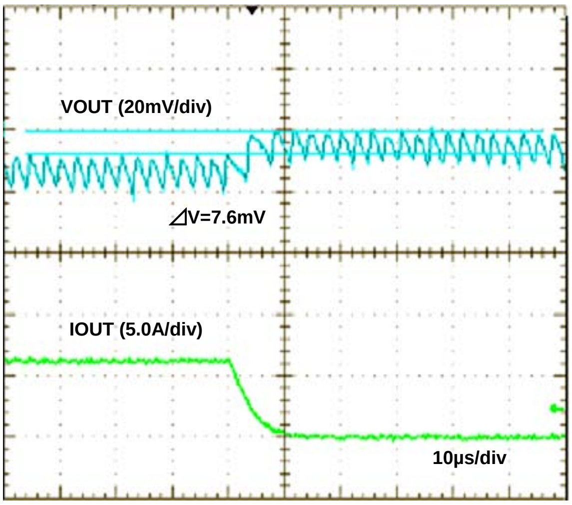


Figure 5. Transient Response Waveform (VIN=5V)

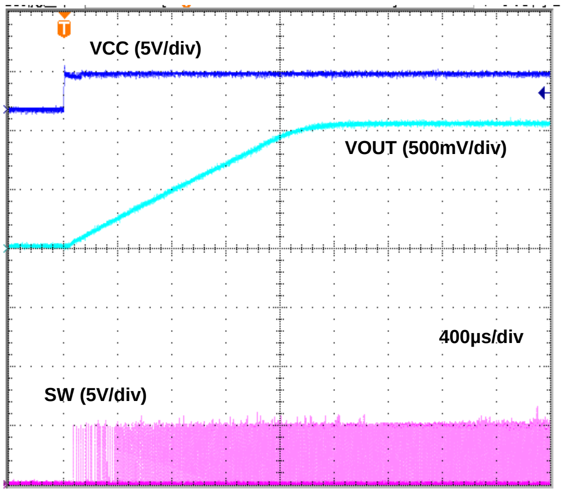


Figure 6. Power-up with VCC

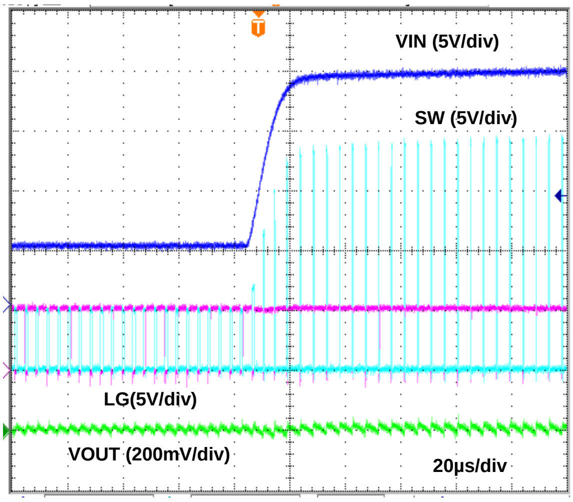


Figure 7. Line regulation

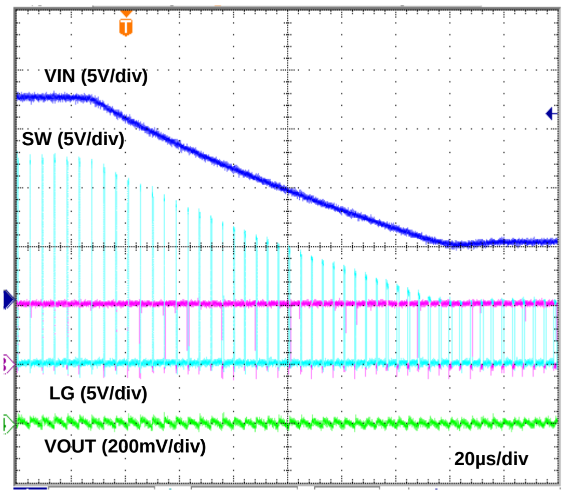


Figure 8. Line regulation

●Characteristic data（Reference data） – continuation

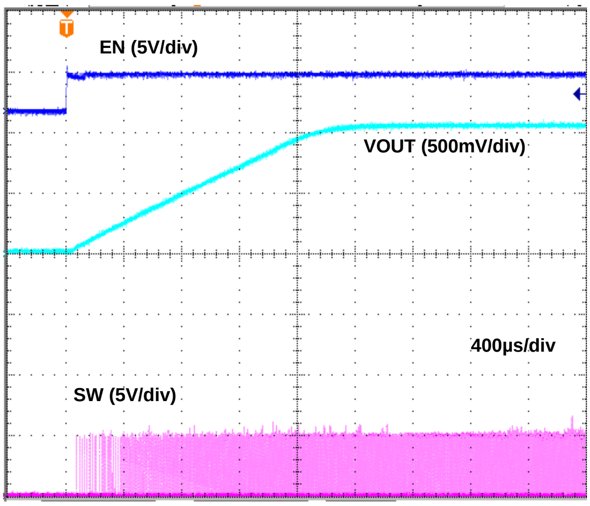


Figure 9. Power-up with EN

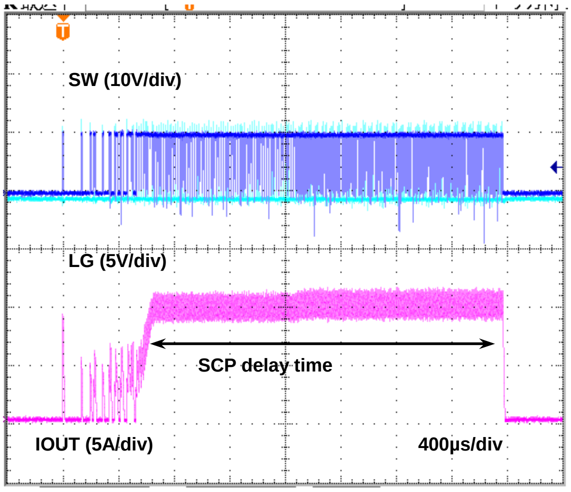


Figure 10. OCP & SCP

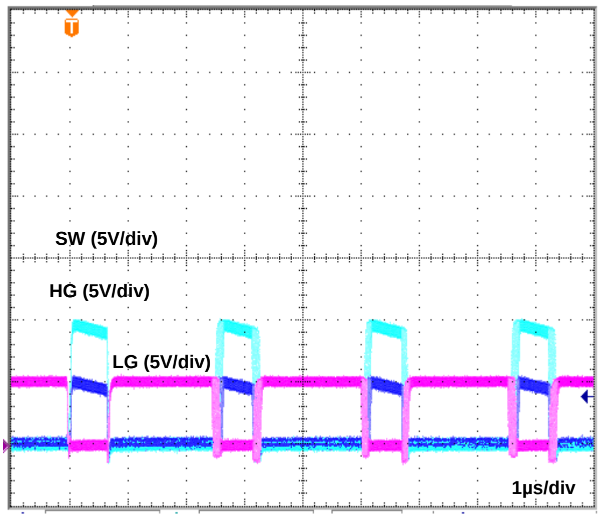


Figure 11. Switching Waveform (Vin=5V,Iout=18A)

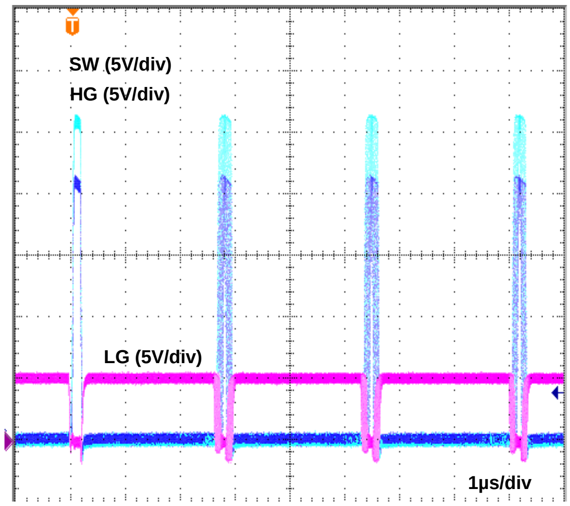
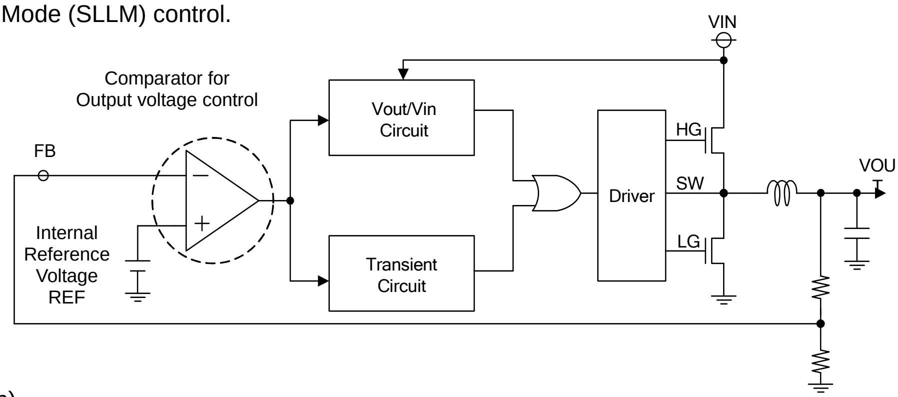


Figure 12. Switching Waveform (Vin=21V,Iout=18A)

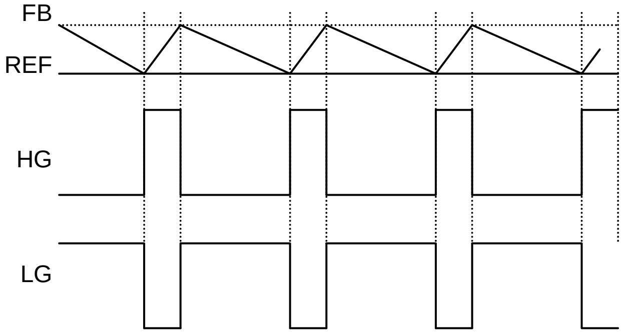
●Description of Operation

BD95601MUV-LB is a single channel synchronous buck regulator using H³Reg™, Rohm's latest constant on-time controller technology. Fast load response is achieved by controlling the output voltage using a comparator without relying on the switching frequency.

When VOUT drops due to a rapid load change, the system quickly restores VOUT by extending the t_{ON} time interval. Thus, it serves to improve the regulator's transient response. Activating the light load mode further increases efficiency by using Simple Light Load Mode (SLLM) control.



H³Reg™ Control
(Normal operation)

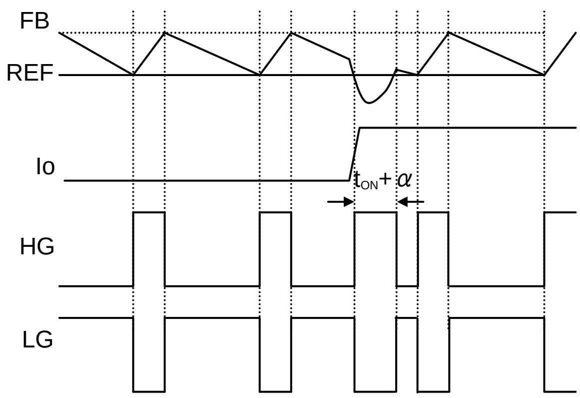


When FB falls to a reference voltage (REF), the drop is detected, activating the H³Reg™ control system

$$t_{ON}= \frac{VOUT}{VIN} \times \frac{1}{f} \ [\mathrm{sec}] \cdots (1)$$

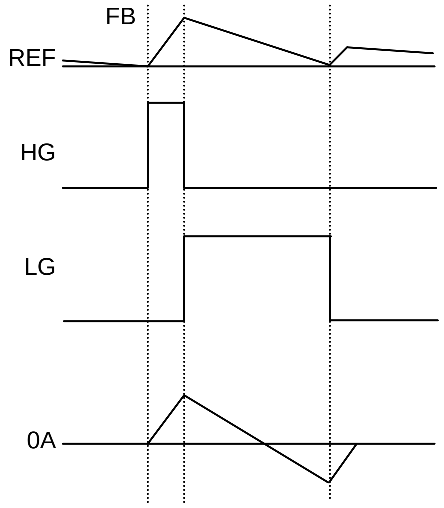
HG output on-time is determined by the formula (1). When HG is off, LG is on until the output voltage becomes FB=REF.

(VOUT drops due to a rapid load change)



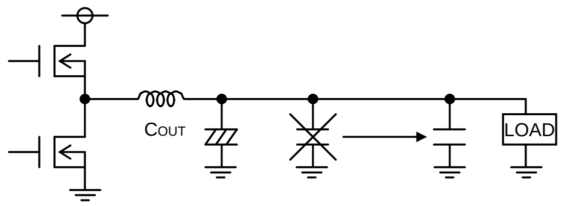
When VOUT drops due to a rapid load change, and the voltage remains below the output setting following the programmed t_{ON} time, the system quickly restores VOUT by extending the t_{ON} time, thus improving the transient response. Once VOUT is restored, the controller continues normal operation.

(Light Load Control)



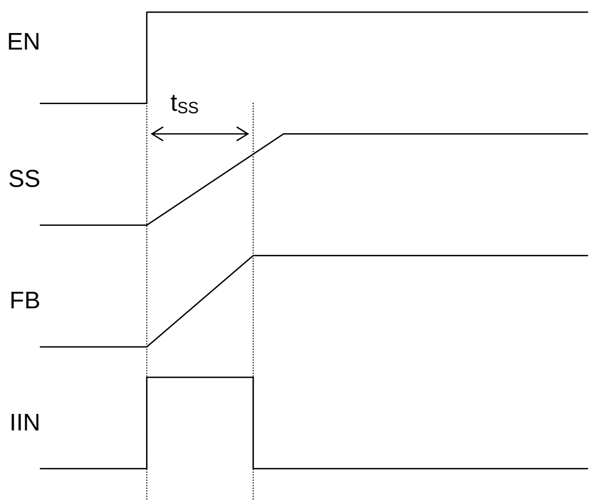
In SLLM (EN/SLLM = 4.5V to 5.5V), SLLM function will operate when the LG pin is off and the coil current is lower than 0A (the current goes from VOUT to SW). When the FB input is lower than REF voltage again, HG will be enabled once again.

∗Attention: To effect the rapid transient response, the H³Reg™ control monitors the current from the output capacitor to the load using the ESR of the output capacitor Do not use ceramic capacitors on C_{OUT} side of power supply. Ceramic bypass capacitors can be used near the individual loads if desired.



●Timing Chart

・Soft-start function



The Soft start function is exercised when the EN/SLLM input is set to high. Current control takes effect at startup enabling a moderate output voltage “ramping.” Soft start timing and incoming current are calculated with the following:

Soft start time

$$t_{SS}=\frac{0.75(\text{typ.})\times Css}{2\mu A(\text{typ.})}\ [\text{sec}]\ \cdots(2)$$

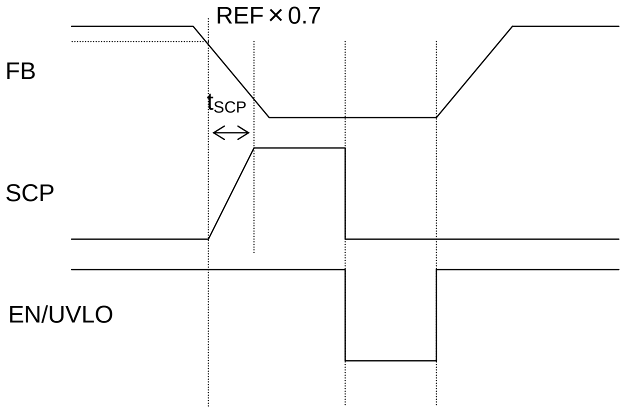
C_{SS}(pF)	Soft start time(ms)
12000	5
27000	10
51000	20

Inrush current

$$I_{in}=\frac{Co\times VOUT}{t_{SS}}\times\frac{VOUT}{VIN}\ [A]\ \cdots(3)$$

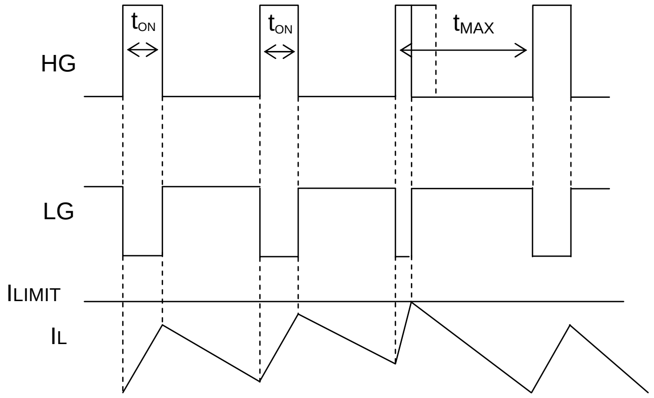
(Css: Soft start capacitor Co: Output capacitor)

・Timer Latch Type Short Circuit Protection



Short circuit protection is enabled when FB falls to or below REF X 0.7. Once the programmed time period has elapsed, the output is latched off to prevent destruction of the circuit. Output voltage can be restored either by cycling the EN pin or disabling UVLO. Short circuit protection time is programmed at 2.5msec (typ.).

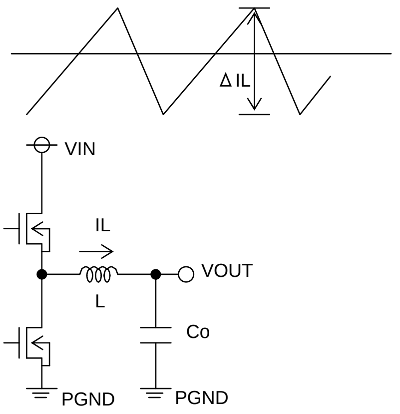
・Over Current Voltage Protection



During normal operation, if FB is less than REF, HG is high during the time t_{ON}, but when the coil current exceeds the I_{LIMIT} threshold, HG is set to off. The next pulse returns to normal operation if the output voltage drops after the maximum on-time or I_L becomes lower than I_{LIMIT}.

●External Component Selection

1. Inductor (L) Selection



Output ripple current

The inductor value is a major influence on the output ripple current.
As formula (4) below indicates, the greater the inductor or the switching frequency, the lower the ripple current.

$$\Delta IL = \frac{(VIN-VOUT)\times VOUT}{L\times VIN\times f}\ [A]\ \cdots (4)$$

Generally, lower inductance values offer faster response times but also result in increased output ripple and lower efficiency.

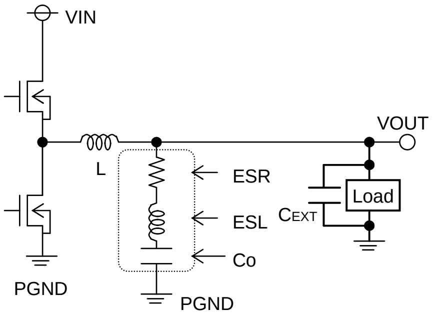
0.47µH to 2.2µH are a recommended range of values.

The peak current rating of the coil is approximated by formula (5).
Please select an inductor equal to or higher than this value.

$$I_{LPEAK} = I_{OUTMAX} + \frac{(V_{IN}-V_{OUT})\times V_{OUT}}{2\times L\times V_{IN}\times f}\ [A]\ \cdots (5)$$

※Passing a current larger than inductor's rated current will cause magnetic saturation in the inductor and decrease system efficiency. When selecting the inductor, be sure to allow enough margin to assure that peak currents do not exceed the inductor rated current value.
※To minimize possible inductor damage and maximize efficiency, choose a inductor with a low (DCR, ACR) resistance.

2. Output Capacitor (Co) Selection



Output capacitor

The output capacitor should be determined by equivalent series resistance and equivalent series inductance so that the output ripple voltage is 30mV or more. The rating of the capacitor is set with sufficient margin given the output voltage.

$$\Delta VOUT = ESR\times \Delta IL + ESL\times \Delta IL / t_{ON}\ \cdots (6)$$

⊿IL: Output ripple current
ESR: Equivalent series resistance,
ESL: Equivalent series inductance

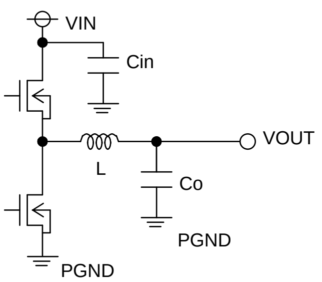
Please give due consideration to the conditions in formula (7) below for the output capacitor, bearing in mind that the output start-up time must be established within the soft start timeframe. Capacitors used as bypass capacitors are connected to the load side affect the overall output capacitance (C_{EXT}, figure above). Please set the soft start time or over-current detection value, regarding these capacities.

$$Co + C_{EXT} \leqq \frac{t_{SS}\times (Limit-IOUT)}{VOUT}\ \cdots (7)$$

t_{SS}: Soft start time
Limit: Over current detection

If an inappropriate capacitor is used, OCP may be detected during activation and may cause startup malfunctions.

3. Input Capacitor (Cin) Selection



Input capacitor

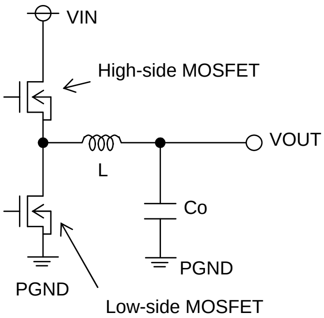
The input capacitor selected must have low enough ESR to fully support high output ripple so as to prevent extreme over current conditions. The formula for ripple current IRMS is given in (8) below.

$$IRMS = I_{OUT}\times \frac{\sqrt{V_{OUT}(V_{IN}-V_{OUT})}}{V_{IN}}\ [A]\ \cdots (8)$$

Where Vin = $2\times V_{OUT}$, IRMS= $\frac{IOUT}{2}$

A ceramic capacitor is recommended to reduce ESR loss and maximize efficiency.

4. MOSFET selection



The High-side and Low-side drivers are designed to activate N channel MOSFETs having low on-resistance.
The chosen MOSFET may result in the loss described below, please select a proper FET for each considering the input-output and load current.

< Loss of high-side MOSFET >

$P_{main}=P_{RON}+P_{TRAN}$

$$= \frac{V_{OUT}}{V_{IN}} \times R_{ON} \times I_{OUT}^2 + \frac{(Tr+Tf) \times Vin \times I_{OUT} \times f}{6} \quad \cdot\cdot\cdot (9)$$

(Ron: On-resistance of FET, f: Switching frequency, Tr: Rise time, Tf: Fall time)

< Loss of high-side MOSFET >

$P_{syn}=P_{RON}$

$$= \frac{V_{IN} - V_{OUT}}{V_{IN}} \times R_{ON} \times I_{OUT}^2 \quad \cdot\cdot\cdot (10)$$

The high-side MOSFET generates loss when switching, along with the loss due to on-resistance.
Good efficiency is achieved by selecting a MOSFET with low on-resistance and low Qg (gate total charge amount).
Recommended MOSFETs for various current values are as follows:

Output current	High-side MOSFET	Low-side MOSFET
～5A	RQ3E080GN	RQ3E080GN
5～8A	RQ3E120GN	RQ3E150GN
8～10A	RQ3E150GN	RQ3E180GN

5. Set Point Output Voltage

This IC operates such that output voltage is REF≒FB.

<Output Voltage>

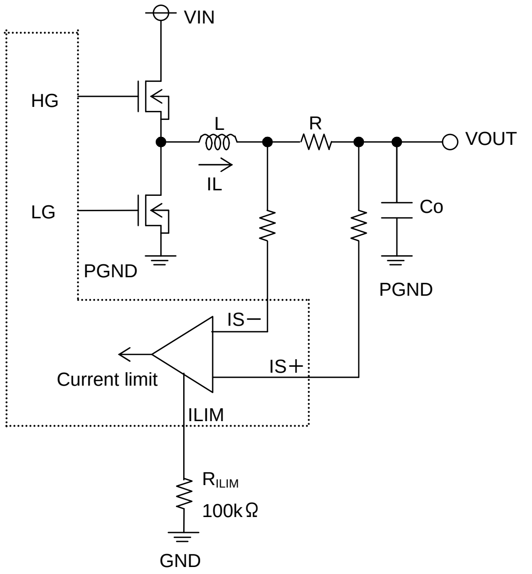
$$V_{OUT} = \frac{(R1+R2)}{R2} \times REF(0.7V)$$

Setting resistance are selected from 10kΩ to 50kΩ, because of external Noise resistant and feedback current.
Please refer to constant the following for typical output voltage.

Output voltage	R1	R2
1.0V	10kΩ	30kΩ
1.2V	18kΩ+1.8kΩ	33kΩ
1.35V	24kΩ	30kΩ
1.5V	24kΩ	12kΩ(30kΩ//20kΩ)
1.8V	39kΩ+3kΩ	30kΩ
2.0V	36kΩ+0.68kΩ	22kΩ

6. Selecting resistance for over current setting

(A) High-precision current detection circuit (use a low value resistor)

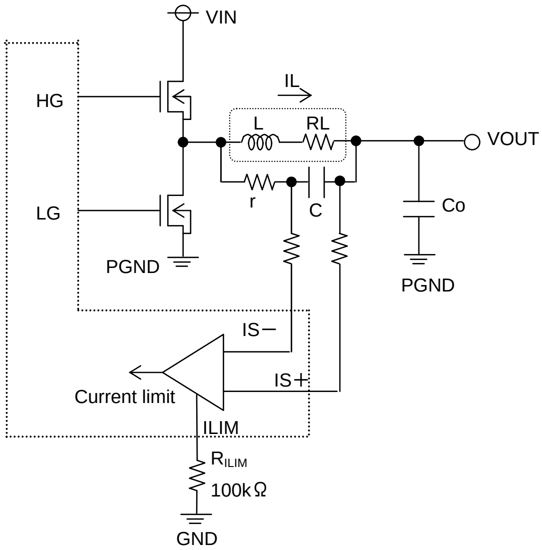


$$I_{LMIT} = \frac{0.1}{R} \quad [A] \cdots (11)$$

(R: Detection resistor)

R_{ILIM} is 100kΩ fixed.

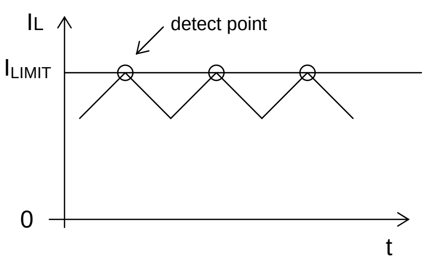
(B) Low loss current detection circuit (Use DCR of L)



$$I_{LMIT} = 0.1 \times \frac{r \times C}{L} \quad [A] \cdots (12)$$

However $\quad RL = \dfrac{L}{r \times C}$

(RL:DCR value of inductor)
Must be adjusted so that the power dissipation into the r.
About 47kΩto 330kΩ.



As shown in the diagram to the left, if the voltage between Is+ and VOUT exceed the I_{LIMIT}, the high-side FET gate is set low.
Because the peak value of inductor current is detected and corresponds to the saturation time of inductor, the reliability of the system is improved.

●**Recommended Circuit Diagram**

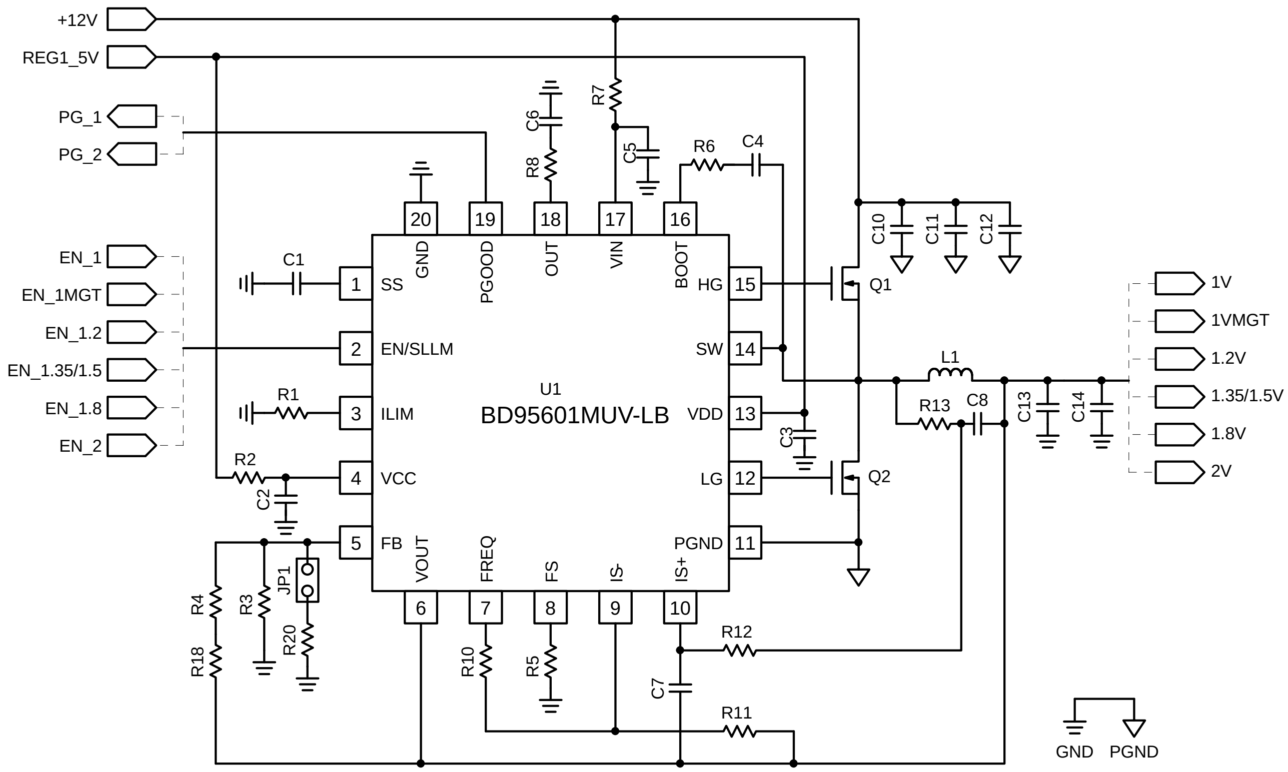


Figure 13. BD95601MUV-LB Basic Application Circuit

Bills of Materials

Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
C1	Ceramic Capacitor	0.022µF	25V, X7R, ±10%	GRM155R71E223KA61	MURATA	1005
C2	Ceramic Capacitor	1µF	10V, X5R, ±10%	GRM188R61A105KA61	MURATA	1608
C3	Ceramic Capacitor	10µF	25V, X5R, ±10%	GRM32DR61E106KA12	MURATA	3225
C4	Ceramic Capacitor	0.47µF	10V, X5R, ±10%	GRM188R61A474KA61	MURATA	1608
C5, C6	Ceramic Capacitor	0.01µF	25V, X7R, ±10%	GRM155R71E103KA01	MURATA	1005
C7	Ceramic Capacitor	10pF	50V, CH, ±5%	GRM1552C1H100JA01	MURATA	1005
C8	Ceramic Capacitor	1000pF	50V, X5R, ±10%	GRM155R61H102KA01	MURATA	1005
C10	Ceramic Capacitor	0.1µF	50V, X5R, ±10%	GRM155R61E104KA87	MURATA	1005
C11, C12	Ceramic Capacitor	10µF	35V, X5R, ±10%	GRM32ER6YA106KA12	MURATA	3225
L1	Inductor	0.56µH	±20%, 14.2A(L=-20%), DCR=3.2mΩmax	FDU0650-H-R56M	TOKO	7667
Q1	MOSFET	-	N-ch, Vdss 30V, Id 15A, Ron 4.7mΩ	RQ3E150GN	ROHM	3333
Q2	MOSFET	-	N-ch, Vdss 30V, Id 18A, Ron 3.3mΩ	RQ3E180GN	ROHM	3333
R1	Resistor	100kΩ	1/16W, 50V, 5%	MCR01MZPJ104	ROHM	1005
R2	Resistor	10Ω	1/16W, 50V, 5%	MCR01MZPJ100	ROHM	1005
R5	Resistor	36kΩ	1/16W, 50V, 5%	MCR01MZPJ363	ROHM	1005
R6	Resistor	3.3Ω	1/16W, 50V, 5%	MCR01MZPJ3R3	ROHM	1005
R7	Resistor	1kΩ	1/16W, 50V, 5%	MCR01MZPJ102	ROHM	1005
R8	Resistor	2.7kΩ	1/16W, 50V, 5%	MCR01MZPJ272	ROHM	1005
R10	Resistor	510Ω	1/16W, 50V, 5%	MCR01MZPJ511	ROHM	1005
R11, R12	Resistor	100Ω	1/16W, 50V, 5%	MCR01MZPJ101	ROHM	1005
R13	Resistor	100kΩ	1/16W, 50V, 5%	MCR01MZPJ104	ROHM	1005
U1	IC	-	Buck DC/DC Controller	BD95601MUV-LB	ROHM	VQFN020V4040

VOUT=1.0V, IOUT=6A

Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
C13, C14	POSCAP	470µF	2.5V, ±20%, ESR 6mΩmax	2R5TPF470M6L	SANYO	7343
JP1	Jumper	n/a	Not applicable	-	-	-
R3	Resistor	30kΩ	1/16W, 50V, 0.5%	MCR01MZPD3002	ROHM	1005
R4	Resistor	10kΩ	1/16W, 50V, 0.5%	MCR01MZPD1002	ROHM	1005
R18	Resistor	0Ω	Jumper, 1A, 50mΩmax	MCR01MZPJ000	ROHM	1005
R20	Resistor	n/a	Not applicable	-	-	-

VOUT=1.2V, IOUT=4A

Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
C13, C14	POSCAP	470µF	2.5V, ±20%, ESR 6mΩmax	2R5TPF470M6L	SANYO	7343
JP1	Jumper	n/a	Not applicable	-	-	-
R3	Resistor	30kΩ	1/16W, 50V, 0.5%	MCR01MZPD3002	ROHM	1005
R4	Resistor	18kΩ	1/16W, 50V, 0.5%	MCR01MZPD1802	ROHM	1005
R18	Resistor	0Ω	Jumper, 1A, 50mΩmax	MCR01MZPJ000	ROHM	1005
R20	Resistor	n/a	Not applicable	-	-	-

VOUT=1.8V, IOUT=6A

Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
C13, C14	POSCAP	470µF	2.5V, ±20%, ESR 6mΩmax	2R5TPF470M6L	SANYO	7343
JP1	Jumper	n/a	Not applicable	-	-	-
R3	Resistor	30kΩ	1/16W, 50V, 0.5%	MCR01MZPD3002	ROHM	1005
R4	Resistor	39kΩ	1/16W, 50V, 0.5%	MCR01MZPD3902	ROHM	1005
R18	Resistor	3kΩ	1/16W, 50V, 5%	MCR01MZPJ302	ROHM	1005
R20	Resistor	n/a	Not applicable	-	-	-

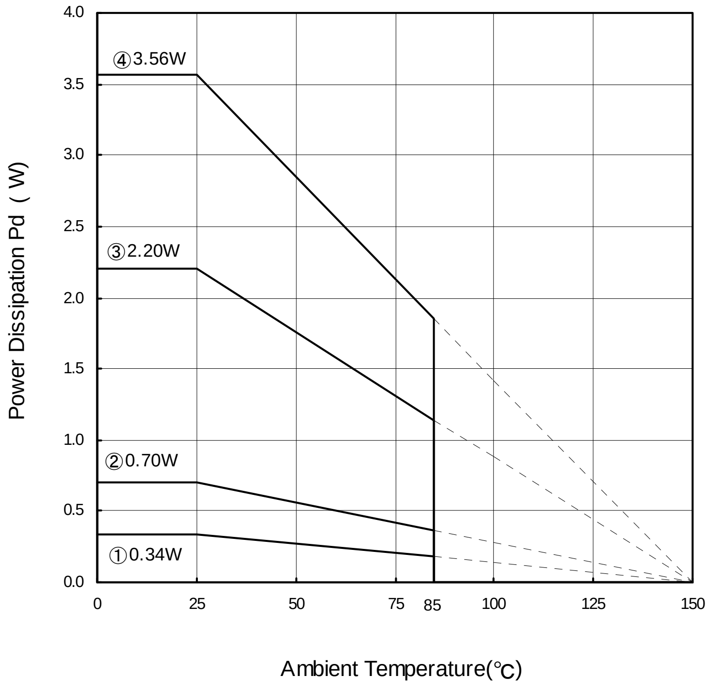
VOUT=1.35V, IOUT=4A

Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
C13, C14	POSCAP	470µF	2.5V, ±20%, ESR 6mΩmax	2R5TPF470M6L	SANYO	7343
JP1	Jumper	-	0: 1.35V, 1: 1.5V	-	-	-
R3	Resistor	30kΩ	1/16W, 50V, 0.5%	MCR01MZPD3002	ROHM	1005
R4	Resistor	24kΩ	1/16W, 50V, 0.5%	MCR01MZPD2402	ROHM	1005
R18	Resistor	0Ω	Jumper, 1A, 50mΩmax	MCR01MZPJ000	ROHM	1005
R20	Resistor	120kΩ	1/16W, 50V, 0.5%	MCR01MZPD1203	ROHM	1005

VOUT=2.0V, IOUT=2A

Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
C13, C14	POSCAP	330µF	6.3V, ±20%, ESR 18mΩmax	6TPE330MIL	SANYO	7343
JP1	Jumper	n/a	Not applicable	-	-	-
R3	Resistor	18kΩ	1/16W, 50V, 0.5%	MCR01MZPD1802	ROHM	1005
R4	Resistor	30kΩ	1/16W, 50V, 0.5%	MCR01MZPD3002	ROHM	1005
R18	Resistor	0Ω	Jumper, 1A, 50mΩmax	MCR01MZPJ000	ROHM	1005
R20	Resistor	n/a	Not applicable	-	-	-

●Heat Dissipation Characteristics



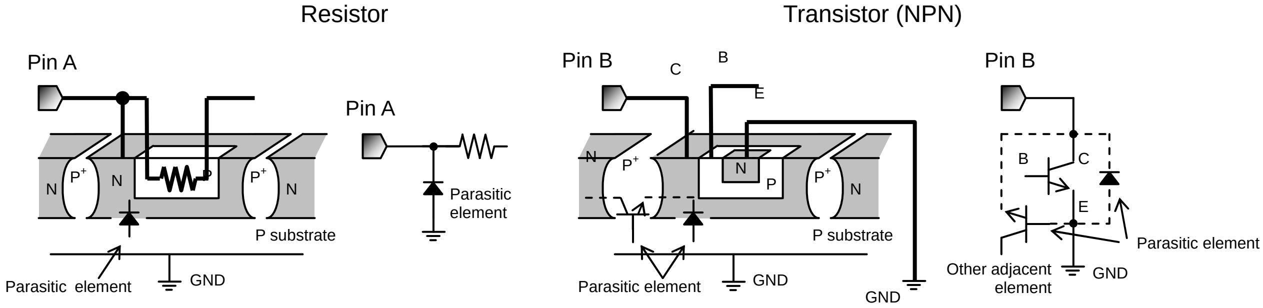
PCB size: 74.2mm×74.2mm×1.6mmt
Substrate①: IC only
Substrate②: 1-layer (copper foil density 0mm^2)
Substrate③: 4-layer (copper foil density 10.29 mm^2)
2,3-layer (copper foil de density 5505mm^2)
Substrate④: 4-layer (copper foil density 5505 mm^2)

Substrate① : θ ja=367.6℃/W
Substrate② : θ ja=178.6℃/W
Substrate③ : θ ja=56.6℃/W
Substrate④ : θ ja=35.1℃/W

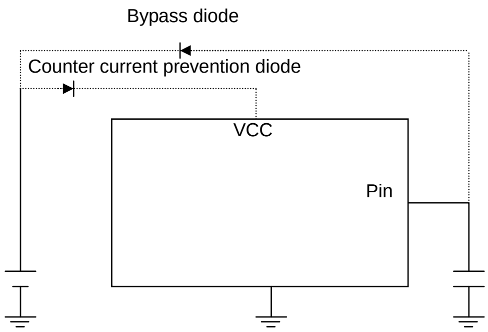
●**Operation Notes and Precautions**

1. This integrated circuit is a monolithic IC, which (as shown in the figure below), has P^+ isolation in the P substrate and between the various pins. A P-N junction is formed from this P layer and N layer of each pin, with the type of junction depending on the relation between each potential, as follows:
   - When GND＞ element A＞ element B, the P-N junction is a diode.
   - When element B＞GND element A, 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, as well as operating malfunctions and physical damage. Therefore, be careful to avoid methods by which parasitic diodes operate, such as applying a voltage lower than the GND (P substrate) voltage to an input pin.



2. In some modes of operation, power supply voltage and pin voltage are reversed, giving rise to possible internal circuit damage. For example, when the external capacitor is charged, the electric charge can cause a VCC short circuit to the GND. In order to avoid these problems, inserting a VCC series countercurrent prevention diode or bypass diode between the various pins and the VCC is recommended.



3. Absolute maximum rating
   Although the quality of this IC is rigorously controlled, the IC may be destroyed when applied voltage or operating temperature exceeds its absolute maximum rating. Because short mode or open mode cannot be specified when the IC is destroyed, it is important to take physical safety measures such as fusing if a special mode in excess of absolute rating limits is to be implemented.

4. GND potential
   Make sure the potential for the GND pin is always kept lower than the potentials of all other pins, regardless of the operating mode.

5. Thermal design
   In order to build sufficient margin into the thermal design, give proper consideration to the allowable loss (Power Dissipation) in actual operation.

6. Short-circuits between pins and incorrect mounting position
   When mounting the IC onto the circuit board, be extremely careful about the orientation and position of the IC. The IC may be destroyed if it is incorrectly positioned for mounting. Do not short-circuit between any output pin and supply pin or ground, or between the output pins themselves. Accidental attachment of small objects on these pins will cause shorts and may damage the IC.

7. Operation in strong electromagnetic fields
   Use in strong electromagnetic fields may cause malfunctions. Use extreme caution with electromagnetic fields.

8. Thermal shutdown circuit
   This IC is provided with a built-in thermal shutdown (TSD) circuit, which is activated when the operating temperature reaches 175℃ (standard value), and has a hysteresis range of -15℃ (standard value). When the IC chip temperature rises to the threshold, all the inputs automatically turn OFF. Note that the TSD circuit is provided for the exclusive purpose shutting down the IC in the presence of extreme heat, and is not designed to protect the IC per se or guarantee performance when or after extreme heat conditions occur. Therefore, do not operate the IC with the expectation of continued use or subsequent operation once the TSD is activated.

9. Precautions for board inspection
   Connecting low-impedance capacitors to run inspections with the board may produce stress on the IC. Therefore, be certain to use proper discharge procedure before each process of the operation. To prevent electrostatic accumulation and discharge in the assembly process, thoroughly ground yourself and any equipment that could sustain ESD damage, and continue observing ESD-prevention procedures in all handling, transfer and storage operations. Before attempting to connect components to the test setup, make certain that the power supply is OFF. Likewise, be sure the power supply is OFF before removing any component connected to the test setup.

10. GND wiring pattern
    When both a small-signal GND and high current GND are present, single-point grounding (at the set standard point) is recommended, in order to separate the small-signal and high current patterns, and to be sure the voltage change stemming from the wiring resistance and high current does not cause any voltage change in the small-signal GND. In the same way, care must be taken to avoid wiring pattern fluctuations in any connected external component GND.

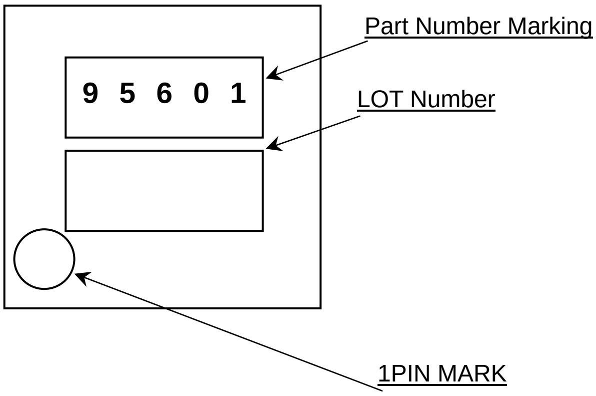
●Ordering Part Number

B	D	9	5	6	0	1	M	U	V	–	L	B	E	2

- Name of product
- Package
  MUV: VQFN
- Product Grade
  LB: Industry use
- Package and forming specification
  E2: Embossed tape and reel

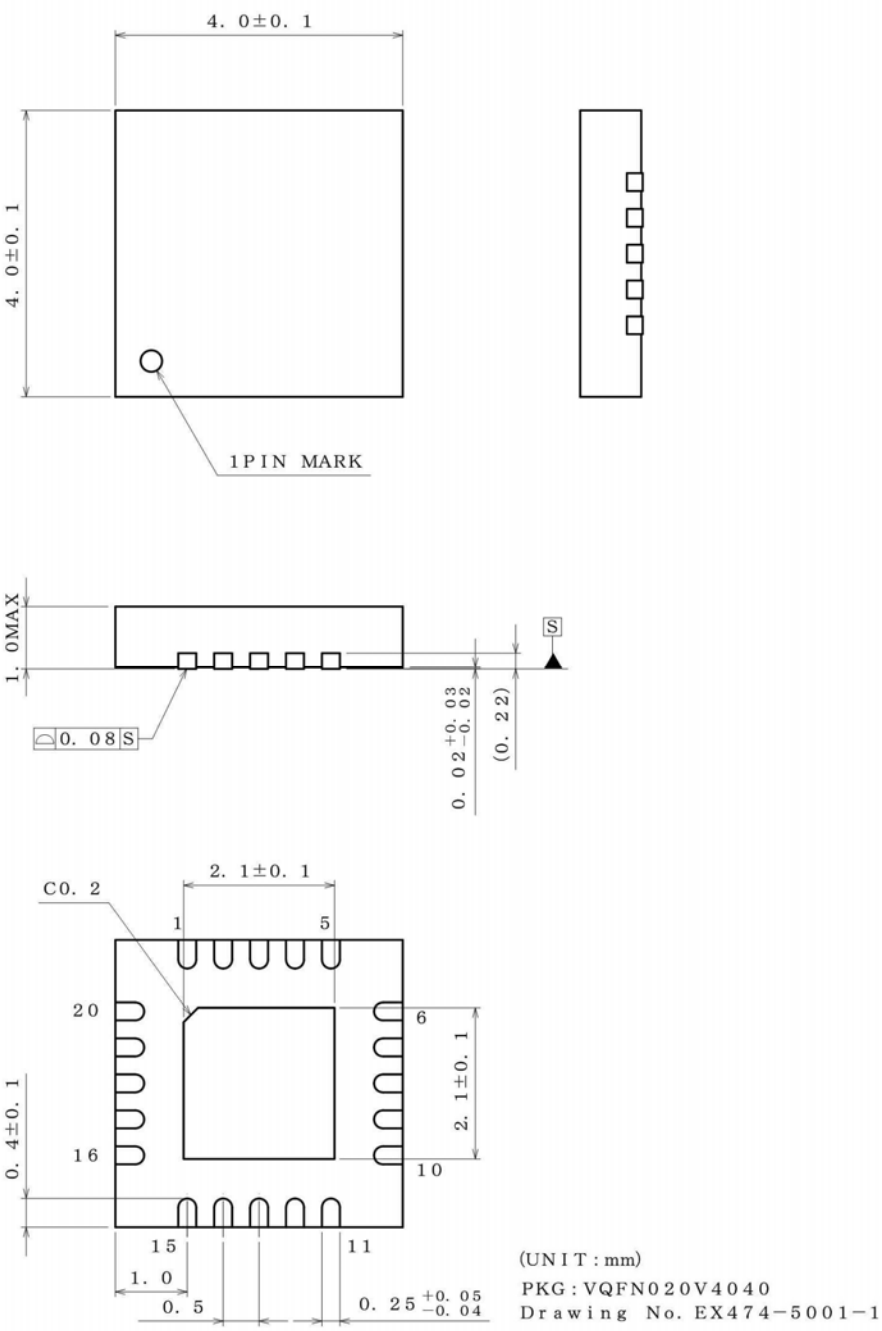
●Marking Diagram

VQFN020V4040 (TOP VIEW)



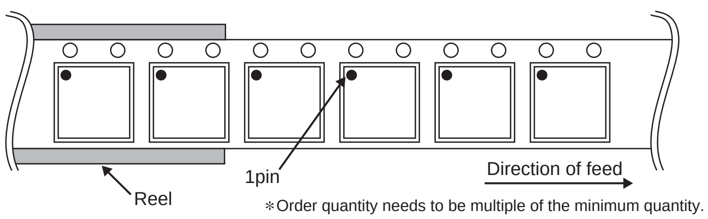
●**Dimensional outline drawing, Package and Forming specification**

Package Name	VQFN020V4040



<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.

●Revision history

Date	Revision	Changed contents
3.Jun.2013	001	New Release

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   [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
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   [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.

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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

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   [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.

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●Precaution for Disposition

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